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Optoelectronics Data Book 1995 • 1996

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Intelligent Display Devices, Slimline Intelligent Display Devices, Programmable Display Devices, Small Alphanumeric Displays, Intelligent Display Assemblies, Numeric Displays, T1 3/4 LED Lamps, Miniature LED Lamps, GaAlAs T1 LED Lamps, SMT-TOP-LED Surface Mount LED Lamps, Cylindrical LED Lamps, SIDE-LED Lamps, Two-color ARGUS LED Lamps, Phototransistor Optocouplers: Single and Multi-channel, Photodarlington Optocouplers: Single and Multi-channel, Bidirectional Input Optocouplers, Small Outline Surface Mount Optocouplers, Hermetic Phototransistor Optocouplers, High Voltage Solid State Relay Optocouplers, Triac Driver Optocouplers, Components for Plastic Optical Fiber Applications, Components for Glass Optical Fiber Applications, High Powered Laser Diodes, GaAs Infrared Emitters, GaAlAs Infrared Emitters, GaAs SMT-TOP-LED Infrared Emitters, GaAlAs SMT-TOP-LED Infrared Emitters, Silicon PIN Photodiodes, Silicon PIN Photodiodes with Daylight Filter, Silicon Photodiodes, Silicon Differential Photodiodes, Silicon Planar Photodiodes, Photodiode Arrays, Germanium PIN Photodiodes, Silicon NPN Phototransistors, SMT-TOP-LED Silicon NPN Phototransistors, Silicon Photovoltaic Cells, Custom Optoelectronic Products.

Optoeletronics Data Book 1995 · 1996

Siemens
Innovative Optoelectronic Products and Systems

Company Overview

Siemens Components is a major producer in the semiconductor industry, with facilities virtually worldwide. The U.S. Optoelectronics Division, headquartered in Cupertino, California—the heart of Silicon Valley, teamed with the Opto-Semiconductor Group in Munich and Regensburg, Germany, are world leaders in light emitting diode (LED) technology, sophisticated CMOS IC design, optics, fiber optics, and packaging.

Our combined product line is one of the most complete in the world:

- Small Alphanumeric Displays
- Programmable Display™ Devices
- Intelligent Display™ Devices
- Hi Rel/Industrial Displays
- Application-Specific Intelligent Displays
- Numeric Displays
- LED Lamps
- Optocouplers
- Infrared Emitting Diodes & Photodetectors
- Components for Plastic and Glass Fiber Applications & High Power Laser Diodes
- Interrupters
- Custom Optoelectronic Products

Our materials technology includes visible and IR LEDs (GaAsP, GaP or combinations of these; GaAlAs; and Silicon Carbide) and photodetectors. Our Malaysia plant, where final product assembly is done, is a showcase of automation and efficiency, featuring the latest automated assembly and test equipment—resulting in high yields and high quality products.

Siemens USA and Worldwide

Siemens Optoelectronics is a division of Siemens Components, Inc., which is part of Siemens USA, with sales of $7.3 billion and more than 46,000 employees. Siemens USA includes Siemens Corporation and operating companies, Siemens affiliates, and joint ventures. Among the operating companies are Siemens Automotive, Siemens Components, Siemens Energy and Automation, Siemens Industrial Automation, Siemens Medical Systems, Siemens Power Corporation, Siemens Stromberg-Carlson, Siemens Transportation Systems, OSRAM SYLVANIA, Potter & Brumfield, and Siemens Rolm Communications.

Siemens USA is part of Siemens' worldwide organization, with sales of $51.6 billion, 382,000 employees, and operations in 150 countries.

Conclusion

Siemens is strategically positioned to concentrate efforts on innovative products and systems, offering value-added, cost-effective features to our customers. All our resources and capabilities in producing LED materials (visible and infrared), R&D engineering, IC design, optics/packaging, automated assembly, and a strong focus on reliability keep Siemens at the leading edge of opto technology.

TABLE OF CONTENTS

ALPHANUMERIC INDEX (use ordering code numbers only when ordering in Europe)

ALPHANUMERIC INDEX (use ordering code numbers only when ordering in Europe)

ALPHANUMERIC INDEX (use ordering code numbers only when ordering in Europe)

ALPHANUMERIC INDEX (use ordering code numbers only when ordering in Europe)

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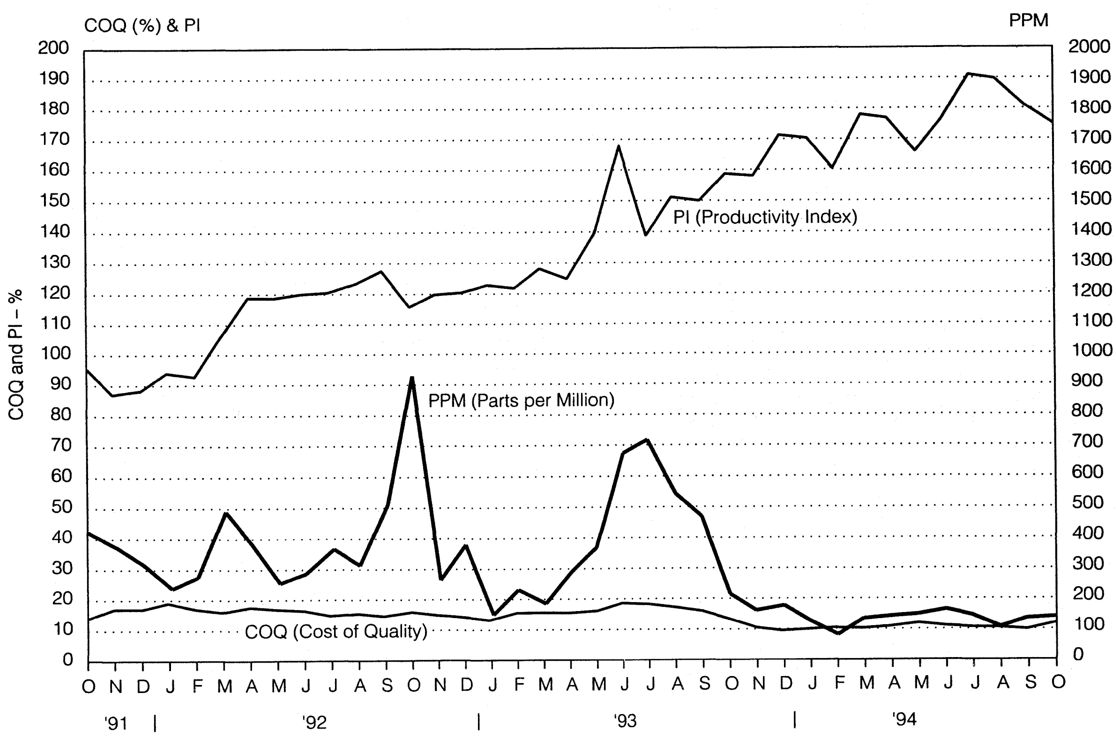
SIEMENS

Quality at Siemens Optoelectronics

At Siemens Optoelectronics, quality means more than today's satisfied customer. It means measuring up to our customer's plans for tomorrow.

It means a sophisticated process: Quality manufacturing and assurance programs, ongoing training and statistical quality control. It means continuously using customer feedback to build in improvements, ensuring just-in time delivery. And it means measurable results. During the past decade, we've continually reduced the cost of quality while increasing our productivity and reducing ppm.

In short, quality has become our way of life, permeating everything we do. It's become the art and science of exceeding our customer's expectations.



Quality Means Measurable Results at Siemens Optoelectronics

SIEMENS

Optoelectronics
Quality and Reliability

Introduction

In the technological community as a whole, the terms "quality" and "reliability" are frequently reduced to little more than advertising platitudes—heavily promised, but seldom delivered in the form of highly reliable, precision-made products. At Siemens Optoelectronics Division, however, we strive for continually increasing product excellence through increased quality and reliability reflecting a company-wide commitment of the highest priority.

Our ability to produce quality optoelectronic products offering long term reliability is directly related to intensive research and development, advanced manufacturing, a quality-oriented work force, and a company-wide philosophy attuned to the changing needs of a technologically sophisticated customer base.

Another important facet of our total commitment to manufacturing excellence is a program of quality control and reliability testing, under the Reliability and Quality Assurance (R&QA) Department. R&QA's responsibility is to interface directly with the customers, not only to determine their present satisfaction level, but to assess their future needs as well. In this way, R&QA makes certain that we will successfully meet all current and future quality/reliability requirements of our customers.

Similarly, it is also R&QA's responsibility to maintain open communication with customers, keeping them informed of our latest capabilities and achievements in the areas of product quality and reliability through detailed reports.

Although the concepts of quality and reliability are closely related, they are somewhat divergent, specialized activities. Simply put, **Quality Assurance** makes certain that products are "made right," ranging from rigid inspection and monitoring of all materials used in production processes, to monitoring the actual production processes themselves. **Reliability**, on the other hand, ensures that products "work right" after assembly. At Siemens, component reliability results from an extensive program of routine monitoring and special testing activites which will be detailed later.

Parts Per Million (PPM) Program

The intensive, quality-oriented efforts of every group have enabled us to achieve one of the lowest defect percentages in the industry. Our Parts Per Million (PPM) program meets all industry expectations and is at a level sufficient to supply high-caliber OEM customers including IBM, DEC, AT&T, ITT, and Ford.

The annual improvement of the PPM level is vital to our ability to remain a cost-effective, on-time supplier of high quality components to the industry. Our PPM program is at the heart of the quality/reliability "revolution" that has occurred in the semiconductor industry during the last few years.

Designed to control and monitor every step of the manufacturing process, as well as assist in predictability studies, our PPM program represents the key to our long-term success in a highly competitive industry. To this end, we are heavily committed to:

- Maximum automation of processes to obtain consistent, reproducible results.
- A system of stringent process controls to ensure the achievement of expected results.
- Effective quality systems to continuously audit the PPM level actually being achieved.

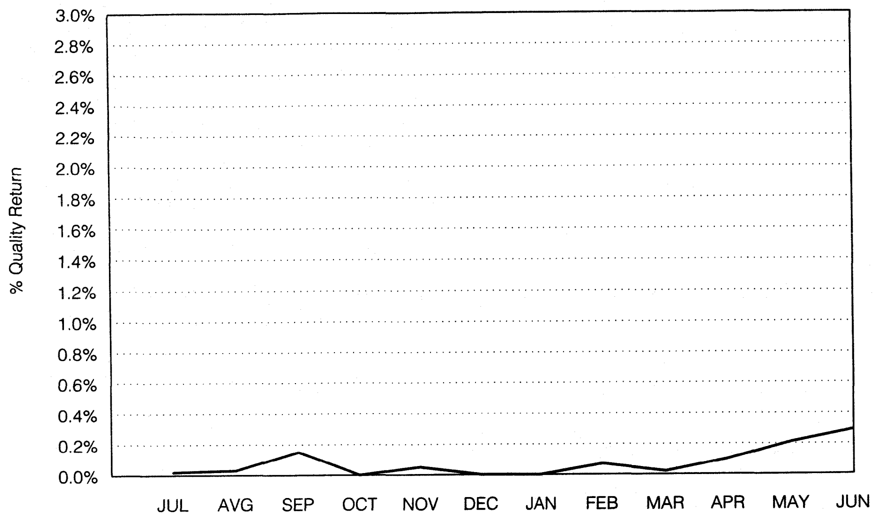
Customer benefits of the PPM system are numerous:

- A low PPM defect rate enabling you to eliminate incoming QA testing.
- Dependable on-time delivery for a "just-in-time" inventory system, significantly reducing inventory costs.
- Efficient, highly automated manufacturing to keep long-term price increases as low as possible.
- Fewer production line failures; lower assembly costs; increased profit margin.
- Fewer field failures on end products; lower warranty and service costs.

The 1991/92 PPM goal for Siemens Optoelectronics is 10 PPM for critical defects.

Customer Quality Return Performance

Fiscal Year 1993-1994 YTD



Customer Quality Return—Average 0.03%

Statistical Quality Control (SQC)

To achieve our PPM goals efficiently, we have implemented a sophisticated program of Statistical Quality Control (SQC). In effect, SQC ensures highly-reproducible, controlled manufacturing processes and "just-in-time" delivery. It enables us to meet our PPM goals without resorting to a "brute force" approach. SQC is consistent with William E. Deming's principal theory that productivity improves as a product's variability rate decreases.

We recognize the necessity of meeting our customers' ever-increasing quality requirements through a carefully developed, well-implemented program of Statistical Quality Control. After considerable research and careful planning, our SQC program was developed using the following six-point plan for Statistical Process Control:

- Establishment of goals and objectives for company-wide implementation of Quality program
- Assessment of SQC technical capability and quantification of training aids
- Provision for training managers, engineers, supervisors, and analysts in methods and practices of SQC, as needed
- Managerial involvement in gaining statistical evidence pertaining to specific processes
- Identification of examples of successful SQC implementation to be used as models for emulation
- Monitoring progress toward established goals through a program of periodic self-audits

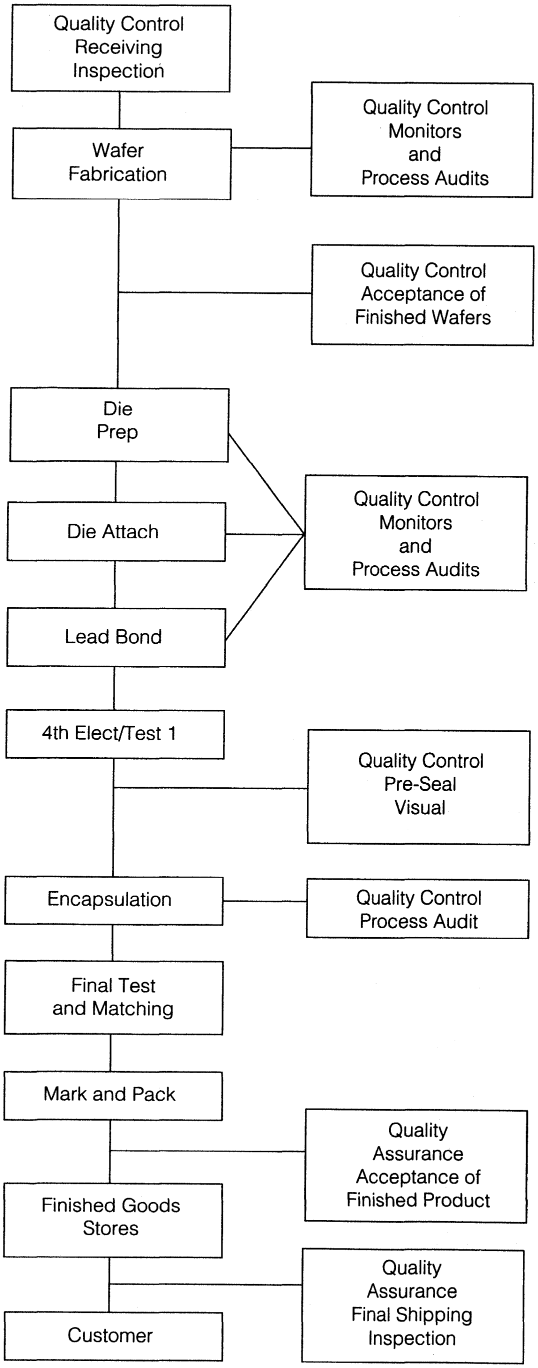
Quality Assurance

At Siemens the Quality Assurance Group serves the vital function of maintaining constant product quality standards. Quality Assurance activities begin with the careful assessment of raw materials, continues through in-process monitoring, and concludes with outgoing audits as outlined below:

- Raw Material
  - Vendor surveys
  - Vendor qualifications
  - Incoming inspections
  - Vendor rating systems
- In-process Monitors
  - Die attach monitors
  - Lead bond monitors
  - Encapsulation monitors
  - Finishing operations monitors
- Outgoing Audits
  - Outgoing audits (all lots)
  - Finished goods monitor (random)

The flowchart on the opposite page shows the basic quality control procedures employed by Siemens Opto in the production of LEDs.

LED Quality Assurance Flowchart



Reliability

The fundamental objective of our reliability program is to ensure that all our products meet or exceed, quantitatively and qualitatively, the performance requirements of our customers and our Engineering Group. To achieve this goal, the Reliability Group constantly monitors products by generic groups. This monitoring provides continuous updated measurement of product reliability in specific operating environments.

The following are typical Reliability Tests performed forthe monitoring program:

- Temperature Cycle: 100 Cycles from -40°C to 100°C*
- Thermal Shock: 30 Cycles from 0°C to 100°C*
- Ambient Life Test: Max rated power for 1000 hours
- Elevated Life Test: Max rated power at 70°C for 1000 hours
- High Temperature Storage: Max storage temperature, 1000 hours
- Low Temperature Storage: Minimum storage temperature, 1000 hours
- Temperature Humidity: 85°C - 85% RH, 500 hours
- Solder Heat Test: 260°C, 5 seconds

*Typical temp cycle and thermal shock condition. Exact condition

Reliability Test Data (1984 – 1994 Monitoring Data)

Type of Test Displays	Lamps	Standard Displays	Intelligent Display Devices	Optocouplers
Temperature Cycle (1000 CY)				
Sample Size	10.024	6421	7473	18.981
Total Cycles	1002K	652K	747%	1898K
Total Reject	0	0	2	0
Percent Reject	0.0%	0.0%	0.03%	0.01%
Thermal Shock (30 CY)				
Sample Size	8.475	4490	4629	13.269
Total Cycles	254K	134K	138K	398K
Total Reject	2	1	0	2
Percent Reject	0.02%	0.02%	0.0%	0.02%
Room Temperature Burn-In (1000 Hrs)				
Sample Size	3652	1372	3422	4620
Total Hours	3652K	1372K	1088K	4619K
Total Reject	0	0	0	0
FR* (%)	0.0%	0.0%	0.0%	0.0%
Solder Heat Test (260°C, 5 sec.)				
Sample Size	2730	2244	2203	10.023
Total Reject	2	0	0	3
Percent Reject	0.0%	0.0%	0.0%	0.0%

*FR = Failure Rate, % per 1000 hours

Type of Test	Military Standard	Pre Test Readings	Test	Post Test Readings
Temp Cycle (T/C)	MIL STD 883B, Method 1010.2	GO/NO GO	10 cycles per sub group, 15 min. swell, 5 sec. transfer time, max. storage temp. ranges vary by product	GO/NO GO
Thermal Shock (T/S)	MIL STD 883B, Method 1011.1	GO/NO GO	30 cycles: boiling water; then ice water with 5 min. dwell time	GO/NO GO
Life Test (L/T)	MIL STD 883B, Method 1005.2	Read/Record	Room temperature burn-in at max. rated conditions, 1000 hours duration	Read/Record at 168,500 and 1000 hours
High Temp Burn in (HI BI)	MIL STD 883B, MIL STD 883B,	Read/Record Read/Record	Maximum rated operating temp. determined from product spec. and derated current as compensation for thermal disipation, 1000 hours duration	Read/Record at 168,500 and 1000 hours
Solder Heat Test	———	GO/NO GO	Temp = 260°C, dwell time = 5 seconds	GO/NO GO

Reliability test equipment ranges from multiple burn-in racks and table testers to a scanning electron-beam microscope. We've even designed and produced our own automatic microprocessor-based read/record tester.

Special testing covers a broad spectrum of environmental and life-stress tests. How well a sample performs under these highly accelerated conditions indicates its reliability potential under service-life conditions.

Special testing affords us vital information in many important areas:

- New product performance
- New processes
- New manufacturing techniques
- New material quality
- Special customer specifications
- Long-term reliability prediction

Reliability is also concerned with failure analysis. To determine the cause of failures, we selectively test and section products to localize and identify their failure mechanism. Selective isolation enables us to gauge the precise effects of stresses induced during reliability testing.

Continuous Improvement Program

In order to assure continuous improvement of our process and products, we are continuously evaluating and adopting new approaches and new procedures. Some of the new procedures and techniques adopted in the past ten years are:

- Tasuchi Method
- Six Sigma
- TQC/TQM
- Total Productive Maintenance
- Process Capability Studies, Cp Cpk

The latest approaches we are now evaluating are ISO9000 and Kaizen.

Conclusion

Siemens is firmly committed to the design, development, and production of innovative optoelectronic components and assemblies of the highest quality and reliability. Working to achieve this goal, every group within the Division— Management, Engineering, Reliability and Quality Assurance, Manufacturing, and Marketing—provides a vital service, enabling us to achieve and maintain the consistent product quality and the high levels of reliability required by our customers in the electronics industry.

Due in large part to the efforts of the Reliability and Quality Assurance Department and to our successful PPM and SQC efforts, we will continue to maintain our leadership position in a highly competitive future-oriented industry.

SIEMENS

High Reliability and Military Optoelectronic Devices

Capabillties

High reliability products must function under severe environmental, mechanical, and electrical stress. To meet this challenge Siemens Optoelectronics has established closely monitored product designs and process control techniques, insuring long product life.

Testing

We maintain a well equipped high reliability lab for electrical, mechanical, and environmental tests. All testing for JAN and Hi-rel products is done in Penang, Malaysia.

Calibration and Quality Control Systems

For calibration systems Siemens complies with the requirements of MIL-S-45662, and for quality control systems, MIL-Q-9858.

We also comply to and are certified to ISO9002 requirements. Siemens supplies qualified MIL-D-87157/3 devices in accordance with the requirements of MIL-S-19500G.

Electrical, environmental, and mechanical testing is done per MIL-STD-750 and MIL-STD-883 test methods and procedures. Our military lines are staffed by highly trained and experienced people who are certified on a periodic basis.

High Reliability Custom Optoelectronic Products

In addition to our standard displays, Siemens has the capability to design, manufacture and test custom optoelectronic devices—ranging from components to assemblies.

High Reliability Displays

Our Hi-rel, Intelligent Display devices are qualified to quality level A of MIL-D-87157 test levels.

Military Specifications

Siemens Hi-rel and military optoelectronic devices conform to the following Military Specifications:

Military Specifications

MIL-D-87157	General specification for display, light emitting diode, and solid state devices
MIL-S-19500	General specification for semiconductor devices
MIL-Q-9858	Quality program requirements
MIL-STD-105	Standard for sampling procedures and tables for tables for inspection by attributes
MIL-STD-202	Standard for test methods for electronics and electrical components
MIL-STD-750	Standard for test methods for semiconductor devices
MIL-STD-883	Standard for test methods and procedures for microelectronics
MIL-STD-45662	Standard for calibration system requirements
DOD-STD-1686	Electrostatic discharge control program
MIL-HDBK-52A	Evaluation of contractor calibration system handbook
DOD-HDBK-263	Electrostatic discharge control handbook

SIEMENS

Optocoupler Manufacturing and Reliability

Single, Dual, and Quad Channel Optocouplers

The Concern for Optocoupler Reliability

Because of the widespread use of optocouplers as an interface device, optocoupler reliability has been a major concern to circuit designers and components engineers. Published studies of comparative tests have indicated a lack of manufacturing consistency with individual manufacturers as well as from manufacturer to manufacturer. This has resulted in user uncertainty about designing in optocouplers despite that these devices often offer the better solution in the circuit.

This report is intended to demonstrate Siemens' concern, efforts, and results in addressing these manufacturing issues to assure users of the quality (out-going) and reliability (long term) of our opto-isolated products. First, aspects of optocoupler characteristics are discussed along with the measures Siemens has taken to assure their quality and reliability. Second, the reliability tests used to approximate worst case conditions and the latest results of these tests are described.

Optocoupler Output

There are a variety of outputs available in optocouplers. A standard bipolar phototransistor is the most common. They are available with different ratings to fit most applications, including versions without access to the base of the transistor to reduce noise transmission. Darlington transistor outputs offer high gain with reduced input current require-ments, but typically trade off speed. Logic optocouplers provide speed but trade off working voltage range. Logic couplers are normally only used in data transmission applications. Silicon Controlled Rectifier (SCR) devices allow control of much higher voltages and typically are applied to control AC loads. They are also offered in inverse-parallel (anti-parallel) SCR (triac) configurations that both cycles of an AC sinusoid can be switched. In Siemens manufacturing flow, all these devices are 100% monitored at a high temperature hot rail (see Figure 4) to eliminate potential failures due to marginal die attaches and lead bends, resulting in a more reliable product. Siemens offers all the above types of products.

In optocouplers, especially the transistor, the slow change over several days in the electrical parameters when voltage is applied, is termed the field effect. This process is extreme particularly at high temperatures (100°C) and with a high DC voltage (1 kV). Changes in the electrical parameters of the silicon phototransistor can occur due to the release of charge carriers. In this way, a similar effect as takes place in a MOS transistor (inversion at the surface) is caused by the strong electrical field. This may result in changes in the gain, the reverse current, and the reverse voltage. In this case, the direction of the electrical field is a decisive factor.

In Siemens' optocouplers, the pn junctions of the silicon phototransistor are protected by a TRIOS (transparent ion screen) from influences of the electrical field. In this way, changes of electrical parameters by the electrical field are limited to an extremely low value or do not occur at all.

Optocoupler Input

The area of greatest concern in optocoupler reliability has been the IR LED. The decrease in LED light output power over current flow time has been the object of considerable attention in order to reduce its effects. (Circuit designs which have not included allowances for parametric changes with temperature, input current, phototransistor bias, etc. have been attributed to LED degradation. To insure reliable system operation over time, the variation of circuit from data sheet conditions must be considered.)

Siemens has focused on the infrared LED to improve CTR degradation and consequently achieved a significant improvement in coupler reliability. The improvements have included die geometry to improve coupling efficiency metalization techniques to increase die shear strength and to increase yields while reducing user cost, and junction coating techniques to protect against mechanical stresses, thus stabilizing long term output.

Current Transfer Ratio

The Current Transfer Ratio (CRT) is the amount of output current derived from the amount of input current. CTR is normally expressed as a percent. For example, if 10 mA of input current is applied to the input (LED) and 10 mA of collector current is obtained, then the CTR is 100 or 100%. CTR is affected by a variety of influences: LED output power, Hfe of the transistor, temperature, diode current, and device geometry. If all these factors remain constant, the principle cause of CTR degradation is the degradation of the input LED.

As mentioned earlier, Siemens has made tremendous progress in manufacturing techniques to reduce CTR degradation. Figure 1 graphs the CTR degradation of Siemens' optocouplers. The data is presented under two conditions. Both conditions apply a constant stress over the 4000-hour period. This is unlikely to occur in actual application, and therefore can be considered as a worst case condition. The first condition (I_F=10 mA) is a typical operating point for actual application. The second condition (I_F=60 mA) stresses the LED at an extremely high, forward current to demonstrate worst case conditions and magnifies CTR degradation. Siemens' manufacturing techniques maximize coupling efficiency which realize high transfer ratios and low input current requirements. Additionally this allows a large variety of standard CTR values, and the capability of special selection in production volumes.

Isolation Breakdown Voltage

Isolation voltage is the maximum voltage which may be applied across the input and output of the device without breaking down. This breakdown will not normally occur inside the package between the LED and the transistor, but rather on the boundardy suraces across which partial discharges can occur. Siemens uses a double mold manufacturing technique where the LED and transistor are encapsulated in an infrared transparent inner mold. The next step in the process is an epoxy over mold. The double mold technique lengthens the leakage path for high voltages discharges appreciably, allowing the device lo achieve very high isolation voltages. All of Siemens oplocouplers are built using U.L. approved process. A standard line of V.D.E. approved optocouplers is also available.

Collector to Emitter Breakdown Voltage

Collector to emitter breakdown voltage (BV_{CEO}) can be thought of as a transistor's working vollage. When considering the application, the selection should be made to include a safety margin to insure the device is of when it is supposed to be off. Siemens transistor technology in wafer processing offers a variety of BV_{CEO} devices. Each is pararmetrically tested to insure proper operation (see Figure 4).

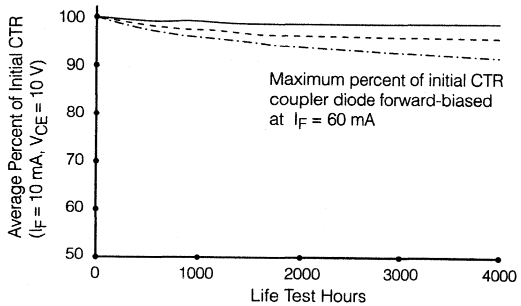
Blocking Voltage

Blocking voltage (V_{DRM}, expressed in peak value) is used when describing the working voltage for SCR or triac type devices. Siemens oflers products through 600 volts of blocking capability.

DV/DT Rating

DV/DT, an important safety specification, describes a triac type device's capability to withstand a rapidly rising voltage without turning on or false firing. Siemens triac type devices have the highest available DV/DT rabng offered on the market. Siemens manufacturing process yields a 10,000 V/µs DV/DT rating. This rating eliminates the need for snubber (RC) networks which negatively affect loads sensitive to leakage currents, while reducing component count for circuit implementation and cost. An example of such a load would be neon indicator lamps. Siemens' triac type devices also carry a load current rating three times the industry standard. This 300 mA current capability allows the device to drive most AC loads without the need for a follow-on triac or interposing an electromechanical relay. Siemens manufactures this device with or without zero crossing detector logic.

Figure 1. CTR Degradation vs. Time



Relative degradation in current transfer ratio (CTR) over a period of time with the coupler diode forward biased.

Life Test Condition: Coupler diode forward-biased at I_F=10 mA, T_{amb}=25°C

LifeTest Condition: Coupler diode forward-biased at I_F=60 mA, T_{amb}=25°C

Figure 2. Reliability Requirements for Optocouplers Mechanical/Environmental Tests

Test	MIL-STD-883 Reference	Test Condition
Temperature Cycle	1010	–55°C to +150°C, 100 Cycles
Thermal Shock	1011	0°C to +100°C, 50 Cycles
Solder Heat		260°C, 10 Seconds
Solderability	2003	260°C, 5 Seconds
Pressure Pot	–	15 PSIG ±1, 121°C, Steam 96 Hours
Solvent Resistance	2015	–
Moisture Resistance*	1004	10 Days, 90-98% RH, –10°C to +65°C, Non-Operating
Shock*	2002 Condition B	5 Blows each X_1,Y_1,Z_1, Axis 1500G, 0.5 ms
Vibration Fatigue*	2005 Condition A	32± 8 Hrs., each X_1,Y_1,Z_1, 96 Hours, 60 Hz, 20G
Constant Acceleration*	2001 Condition A	1 Min. each Axis X,Y,Z, 5KG
Terminal Strength*	2004	1 lb. for 30 Seconds, then 8 oz., 3 Bends 15°

* Monitored periodically.

Life Tests

Tests	Test Conditions			
	Temp (°C)	RH (%)	Bias	Hours
Ambient Life Test	25	≤60%	Max Rating	1000
Elevated Life Test	70	≤60%	Derated Max Rating	1000
High Temp Life Test	150	≤60%	0	1000
Low Temp Life Test	–55	≤60%	0	1000
Temp/Humidity Life	85	85%	0	1000
Intermittent Operating Life	25	≤60%	Max Rating	1000
High Temperature Reverse Bias	125	≤60%	80% of Max Voltage Rating	1000

Quality and Reliability Tests

The tests in Figure 2 were performed on Siemens optocouplers. The tests allow early detection of weak points and provide information regarding the reliability characteristics of the component.

From the Life Test information assumptions of useful life expectancy can be obtained. All quality and reliability tests

Figure 3: Environmental and Life Test Results
Single Channel Optocouplers

ENVIRONMENTAL TEST					
Test	**Test Condition**	**Sample Size**	**Good**	**Reject**	**%Reject**
Temperature Cycle	–55°C to +150°C, 100 Cycles	6056	6056	0	0.00%
Thermal Shock	0°C to +100°C, 30 Cycles	4596	4595	1	0.02%
Solder Heat Test	260°C, 10 Seconds	3392	3392	0	0.00%
High Temp Storage	150°C, 1000 Hours	1442	1441	1	0.07%
Low Temp Storage	–55°C, 1000 Hours	1442	1442	0	0.00%
Temp Humidity	+85°C/85% RH, 1000 Hours	454	454	0	0.00%

LIFE TESTS						
Test	**Test Condition**	**Sample Size**	**Unit Hours (k)**	**Good**	**Reject**	**MTBF* (Unit Hours)**
Ambient Life Test	60 mA, 25°C, P_D = 255 mW Max.	1442	1442	1442	0	2,030,000
Elevated Life Test	40 mA, 70°C, P_D = 104 mW	1442	1442	1442	0	2,030,000
Intermittent Op Test	On = 3 Minutes, Off = 2 Minutes 60 mA, 25°C, P_D = 235 mW Max.	1442	1442	1442	0	2,030,000
	Total	4326	4326	4326	0	6,200,000

*Based on the life test results presented, an overall MTBF of 6,200,000 unit hours can be demonstrated on a "Best Estimate" basis.

Dual Channel Optocouplers

ENVIRONMENTAL TESTS					
Test	**Test Condition**	**Sample Size**	**Good**	**Reject**	**%Reject**
Temperature Cycle	–55°C to +150°C, 100 Cycles	6160	6159	1	0.02%
Thermal Shock	0°C to +100°C, 30 Cycles	3969	3968	1	0.03%
Solder Heat Test	260°C, 5 Seconds	2840	2838	2	0.07%
High Temp Storage	150°C, 1000 Hours	1442	1442	0	0.00%
Low Temp Storage	–55°C, 1000 Hours	1442	1442	0	0.00%
Temp Humidity	+85°C/85% RH, 1000 Hours	402	402	0	0.00%

LIFE TESTS						
Test	**Test Condition**	**Sample Size**	**Unit Hours (k)**	**Good**	**Reject**	**MTBF* (Unit Hours)**
Ambient Life Test	37.5 mA/Channel, P_D = 388 mW Max., 25°C	1442	1442	1442	0	2,030,000
Elevated Life Test	19.6 mA/Channel, P_D = 138 mW Max., 70°C	1442	1442	1442	0	2,030,000
Intermittent Op Life	On = 3 Minutes, Off = 2 Minutes 37.5 mA/Channel, P_D = 388 mW Max., 25°C	1338	1338	1338	0	1,940,000
	Total	4222	4222	4222	0	6,000,000

*Based on the life test results presented, an overall MTBF of 6,000,000 unit hours can be demonstrated on a "Best Estimate" basis.

Quad Channel Optocouplers

ENVIRONMENTAL TESTS					
Test	**Test Condition**	**Sample Size**	**Good**	**Reject**	**%Reject**
Temperature Cycle	–55°C to +150°C, 100 Cycles	6056	6055	1	0.02%
Thermal Shock	0°C to +100°C, 30 Cycles	4296	4296	0	0.00%
Solder Heat Test	260°C, 10 Seconds	3406	3405	1	0.03%
High Temp Storage	150°C, 1000 Hours	1442	1442	0	0.00%
Low Temp Storage	–55°C, 1000 Hours	1442	1442	0	0.00%
Temp Humidity	+85°C/85% RH, 1000 Hours	402	402	0	0.00%

LIFE TESTS						
Test	**Test Condition**	**Sample Size**	**Unit Hours (k)**	**Good**	**Reject**	**MTBF* (Unit Hours)**
Ambient Life Test	37.5 mA/Channel, P_D = 388 mW Max., 25°C	1442	1442	1442	0	2,030,000
Elevated Life Test	19.6 mA/Channel, P_D = 138 mW Max., 70°C	1442	1441	1440	2	530,000
Intermittent Life Test	On = 3 Minutes, Off = 2 Minutes 37.5 mA/Channel, P_D = 138 mW Max., 25°C	1442	1442	1442	0	2,030,000
	Total	4326	4325	4324	2	1,600,000

*Based on the life test results presented (at maximum rated conditions), an overall MTBF of 1,600,000 unit hours can be demonstrated on a "Best Estimate" basis.

are performed in conditions that either exceed or are equivalent to the limits defined in our data sheets. International standards are also considered. Assuming that no new additional failure mechanisms are crealed by the stress conditions, the results of the stress test will correlate to conditions in the field and can be used to estimate useful lifetime. The environmental stress tests ensure Siemens manufacturing capabilities will provide package integrity in the most rigorous conditions The Life Test results highlight our ability in packaging and electrical performance to achieve MTBF hours which meet and exceed the highest expectations for the semiconductor industry.

Package Integrity

Altough packaged in standard IC configurations, optocouplers have some unique package considerations. The use of two chip and internal light transfer medium require careful selection of materials to insure compatibility under a variety of operating conditions. In addition to the high isolation voltages achieved by Siemens optocouplers, our devices are tested to assure high levels of mechanical integrity and moisture resistance. For example, a ninety-six hour pressure pot test has been recently implemented to rnore stringently verify moisture resistance As meaningful test results are accumulated, they will be included in future reports.

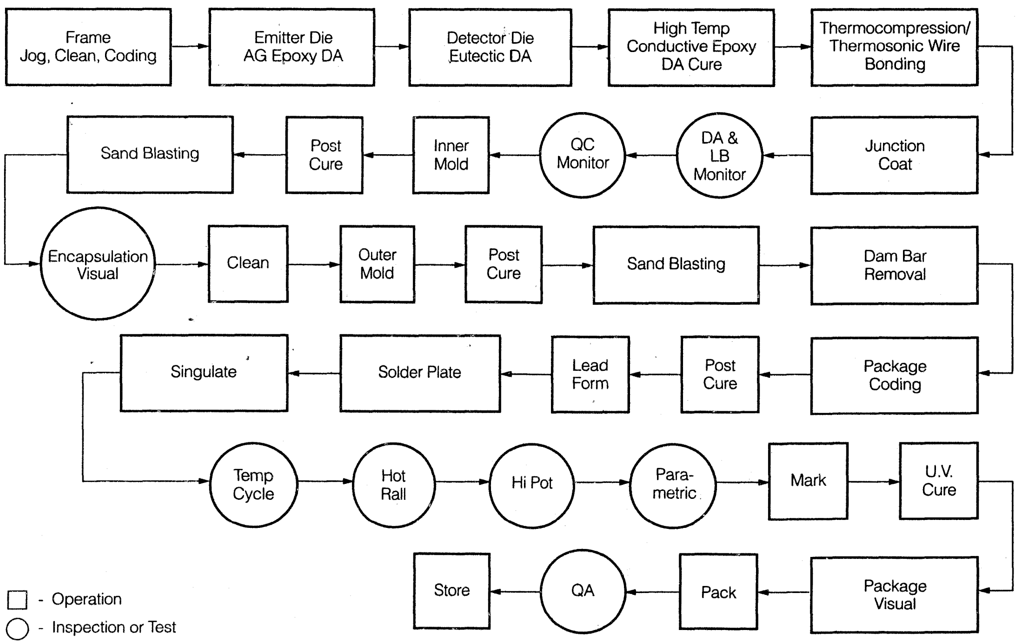
Package Density

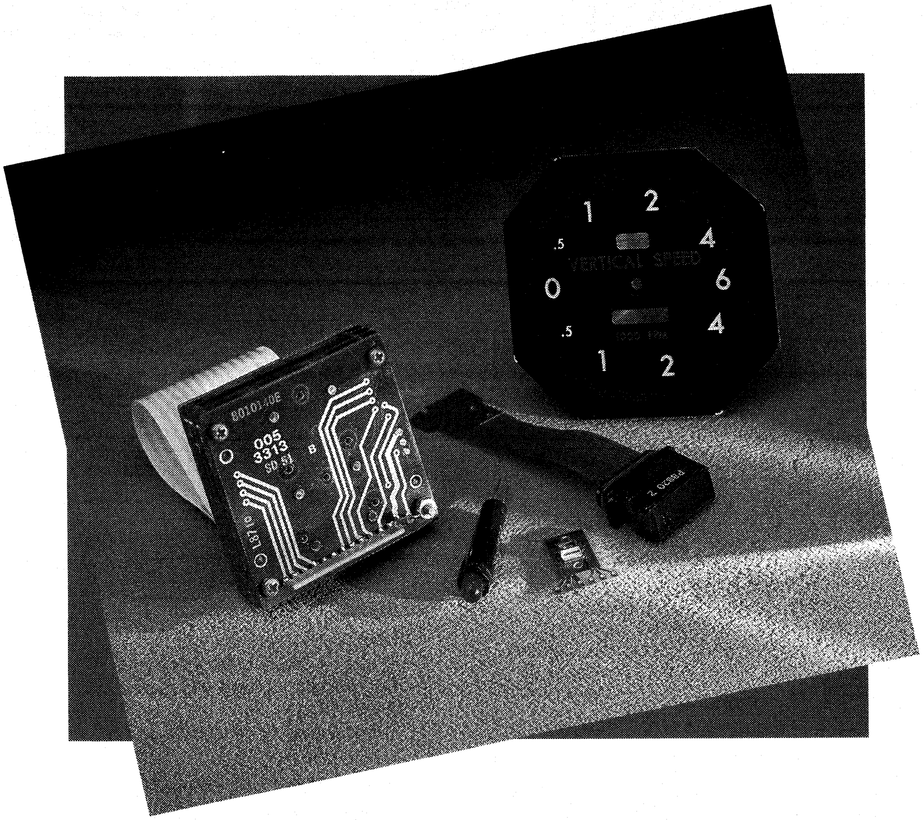
Board space has become increasingly more important in the electronic industry. Siemens uses a plate molding technique to achieve reduction in cost, allowing us to offer a wide selection of packages. These consist of single channel optocouplers in 4, 6, 8, and 16 pin DIP packages, dual channel devices in 8 pin DIP packages, and quad channel devices in 16 pin DIP packages. All of the above devices are available in three surface mount lead configurations, as well as the standard through-the-hole lead. Siemens has also introduced a standard single channel optocoupler in a SOIC-8 footprint package. All of these packages have been designed and tested to meet the highest quality and reliability expectations of the semiconductor industry.

Assembly QA Inspections

1. Die Attach and Lead Bond Inspection — Random sampling of die bonding integrity by a shear strength test and wire attach integrity by a wire pull test.
2. Visual QC Monilor — Microscopic inspection of die placement, die and wire bonds, wire loops, damaged die and wire and emitter junction coat coverage.
3. Encapsulation Inspection — Sample lot inspection for molding defects.
4. Temperature Cycle Test — Sample lot temperature cycling from –55°C to +150°C tor 10 cycles subjecting the parts to thermal stresses in order to eliminate marginal die attach, wire bonds and misalignments.
5. Hot Rail Test —100% electrical continuity testing at 100°C to insure removal of thermal interminent parts.
6. HiPot Test — 100% testing of isolation voltage parameter per UL/VDE requirements.
7. Parametric Tests —100% electrical tests to data book or customer-selection paramelers.
8. QA Final Tests — Lot audits to assure conformance to all product requirements.

Figure 4. Coupler Process Flow and Inspections

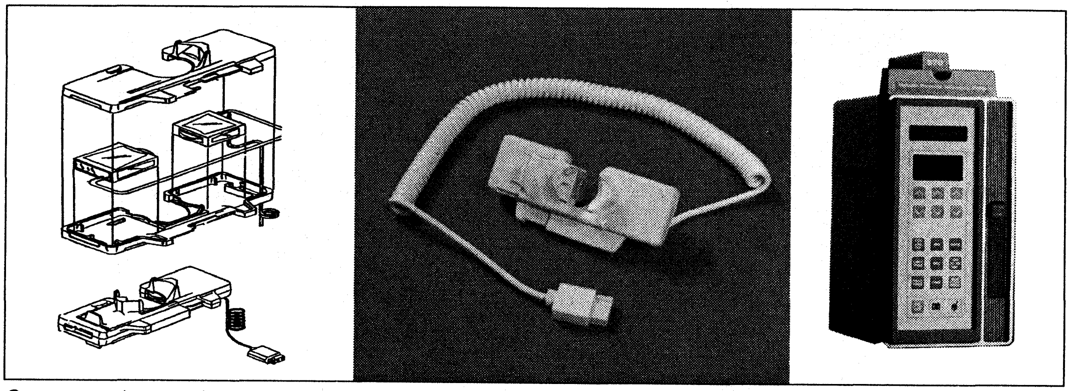




Custom Optoeletronic Products
Materials and Die

SIEMENS

CUSTOM OPTOELECTRONIC PRODUCTS



Custom product services bring your project from design to finished component for use in your application.

Introduction

Siemens Custom Optoelectronic Products are designed typically for unique applications or specific performance requirements using optical devices. Because of our over 20 years experience as an optoelectronics supplier, you benefit from this long time experience and tested performance. Our custom engineering resources include an engineering expertise in solid state optical devices and plastic optics, full custom packaging capability, complex hybrid system capability, IC design, and an optical design and measurements lab. Our custom product approach gives you reduced system cost, improved performance, design ownership, improved reliability, high product quality, and many more benefits and features.

Our Capabilities

- **Optical Design Expertise**
  - **— Solid State Optical Device Solutions**
  - **— Plastic Lens Capabilities**
  - **— Multi-Element Lens Capability**
  - **— Multi-Channel Fiber Optic Design Techniques**
- **Full Range of Custom Packaging Options**
  - **— Modular Assemblies Designed and Built Using:**
    - **- Custom Leadframes**
    - **- Molded Plastic Optics**
    - **- Hybrid Chip-on-Substrate Assemblies**
    - **- Transfer Molded Packages**
    - **- Hermetic Packages**
- **Specialize in Hybrid Functional Modules**
  - **— Extensive Chip-On-Board Experience**
  - **— Precise Die Positioning in Single Units or Arrays**
  - **— Board Component Design**
  - **— Surface Mount Technology**
- **Optical Measurements Facility**
  - **— Absolute Characterization of Optical Performance**
  - **— Fast and Accurate Responses to Customer Requirements**
  - **— Measurements Traceable to National Bureau of Standards**
- **Computer Aided Design Facility**
- **In-House IC Design Capability**
  - **— High Speed Silicon Gate CMOS and Bipolar Technology**
  - **— Complete IC Test, Process and Product Engineering**
- **Quality and Reliability Control**
  - **— Established QC System**
  - **— Average Quality Level, under 50 PPM**
  - **— Extensive Product Characterization**
- **State-of-the-Art Materials**
  - **— Full Spectrum of Visible LEDs, Infrared Emitters, and Detectors**
- **Wafer Fabrication Facility**
  - **— Complete Control of Device Fabrication**
  - **— State-of-the-Art Process and Materials**
  - **— Custom Die Designs**
- **Model, Offshore Assembly Facility**
  - **— Latest Automated Assembly Equipment**
  - **— Test and Burn-in Capability**
  - **— "Just-in-Time" Philosophy**
  - **— Over 20 Years Experience in Optical Hybrid**

- **Customer Benefits**
  - **— Reduced System and Program Costs**
  - **— Higher Level of Integration**
  - **— Reduction in Components Required**
- **Optimum Product Performance**
  - **— Use of Latest Technology**
  - **— Improved Optical Design Techniques**
- **Uniquely Competitive Designs**
  - **— Special Functions and Features**
  - **— Proprietary Customer Design**
- **Reduced Product Development Time**
  - **— Allows Quicker Entry to Market**
- **Improved Reliability and Quality**

Custom Engineering Resources

Siemens is an expert in evaluating customer requirements and proposing systems solutions. For example, our engineers are specialists at integrating LED displays with microprocessors to form display subsystems.

Also, our expertise in optical engineering allows us to optimize emitter/detector system designs. This includes: unique plastic lens design, multi-element lens designs, multichannel fiber optics design techniques as well as the use of other optical elements such as apertures, reflectors, mirrors, etc.

Custom Packaging and Hybrid Capabilities

Custom packaging is another option available to you offering a significant size reduction and resulting cost savings over most existing designs. Our modular assemblies are designed and built using custom leadframes, custom molded plastic lenses, hybrid chip-on-substrate assemblies. We have extensive chip-on-board experience for airgap, concoat, and epoxy encapsulated modules. We support air gap assemblies with metal or plastic housings. We also have the technology to transfer mold epoxy packages. For harsh environmental conditions we offer hermetic processing using glass, ceramic or metal assemblies.

Another area of expertise is in precise die positioning in single units or arrays. Our technology supports both ceramic and PCB substrates. Our component design capability includes visible LEDs, IR LEDs, Op Amps, Photodiodes, Phototransistors, LSI CMOS Chips, Bipolar ICs, Optocouplers, and Discretes. In summary, we are the optoelectronic specialists in the design of hybrid modules.

Optical Design and Measurements Laboratory

The Siemens Optics Lab, a versatile and precise optical measurement facility, provides fast and accurate absolute characterization of optical radiation performance. This insures fast and accurate responses to customer requirements and on-site field support available on complex issues. The lab is coordinated with standards organizations worldwide insuring the latest conventions for optical measurement procedures. All measurements are traceable to the National Bureau of Standards.

Listed below are a few of our optical laboratory's capabilities:

- **LED spectral irradiance from 280 to 1070 nm**
- **LED spectral luminosity from 380 to 780 nm**
- **Radiometric and photometric intensity**
- **Detector response versus wavelength from 280 to 1070 nm**
- **Precise computer based measurement system**
- **Other optical capabilities available to support customer needs**

Wafer Fabrication Facilities

For your custom requirements, Siemens wafer fabrication facilities use state-of-the-art materials such as Gallium Arsenide (GaAs), Gallium Aluminum Arsenide (GaAlAs), Gallium Phosphide (GaP), and Gallium Arsenide Phosphide (GaAsP). We can control wavelength in a range from 560 nm to 840 nm. Our quality material gives you higher reliability and more brightness with lower power. We also provide a material foundry service for your custom die requirements.

CAD/CAM: Design and Assembly

We design custom assemblies and subassemblies by computer and assemble by computer-controlled automated assembly equipment. This vastly improves the reliability and quality control while offering more features at the lowest possible cost.

Automated Offshore Assembly Facility

The Siemens assembly plant, in Penang, Malaysia, uses the latest in automated assembly and test equipment allowing effective and flexible approaches to varying technologies and products yielding competitive costs and prices. Our automated computer tracking system supports a "just-in-time" delivery philosophy. A total quality concept includes a statistical process control program, a continuous calibration program, a preventive maintenance program, and an employee job awareness enhancement program is an ongoing commitment. A complete test and burn-in facility is supported by a failure analysis group and reliability monitors. Production lot traceability can be specified to meet your requirements. A dedicated product development group supports a variety of customer needs. We have accumulated a total of over 20 years experience in the assembly and test of high density optoelectronic hybrid assemblies.

Customer Benefits

Your program benefits in many ways, through a combination of the engineering resources and available technology. We can reduce your system and overall program costs through higher levels of integration, reduced component inventory/ lower component costs, elimination of in-house assembly labor costs, lower inventory costs, reduction of warranty expenses, and lower administrative costs. We can offer optimum product performance with improved optical design techniques using leading edge technology. Our state-of-the-art packaging techniques offer significant size reductions as well as improved operating conditions. All this leads to improved product quality and reliability characteristics since the final product is 100% tested and guaranteed operational.

Your design will be uniquely competitive since it will use features and technologies not available to your competitors. The design will be your proprietary product. Our ability to dedicate engineering resources to your custom project frees up your resources for other programs enabling your products quicker introduction to the market. You receive only fully tested and quality assured product (100% yield) for improved reliability and quality.

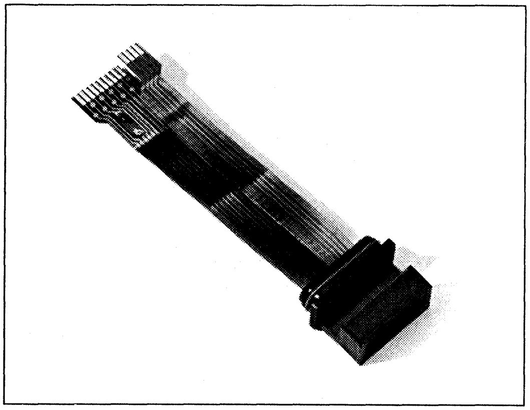
Custom Applications and Markets Served

Siemens Custom Products have applications in virtually every OEM market. We currently serve the industrial, automotive, medical, EDP and computer peripherals, telecommunications, office equipment, and consumer markets. Some high volume applications now in production include: medical fluid flow sensor, medical oximetry probes, glucometry module, electronic coin sensing, industrial controller displays, intelligent indicator (LAN environment), instrument panel cluster and pointer, air-in-line detector, and custom lamps and interrupters.

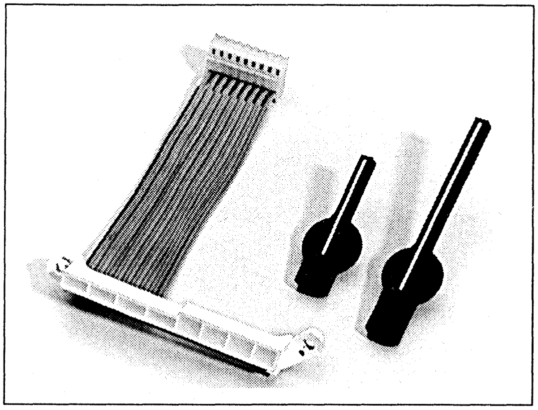
Inquiries

Your inquiries should include mechanical, electrical, and environmental requirements. Also include anticipated product volumes, price objectives and lead times since these considerations affect the design and tooling approach.

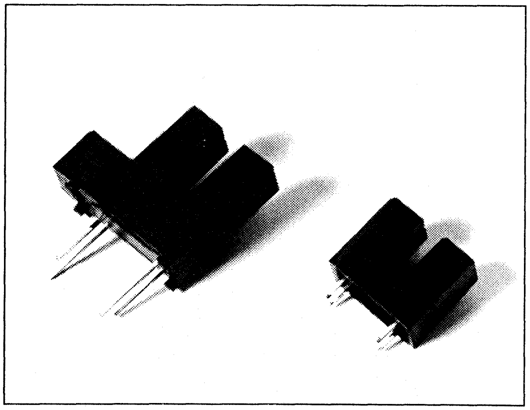
Examples of Products in Production:



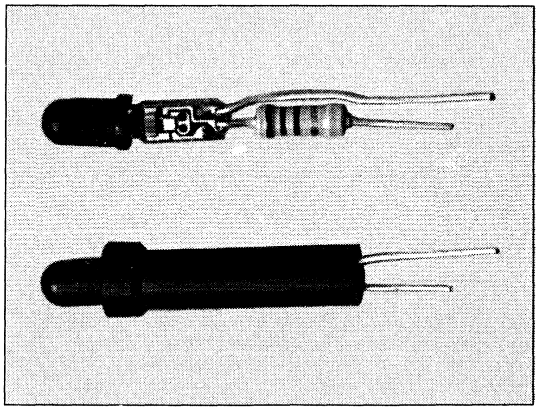
Air-in-line detector



Instrument Panel Pointer & Cluster



Interrupters

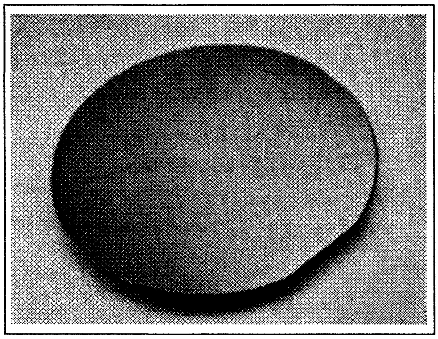


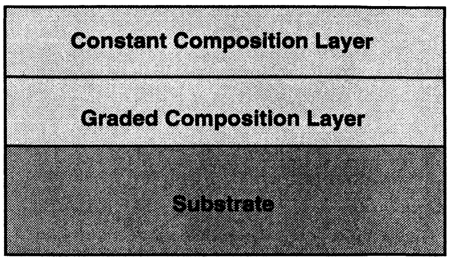
Telephone Switch Indicator Lamp

SIEMENS

655 nm 3" GaAsP/GaAs EPITAXIAL WAFER

PART NO. 2600-7056





DESCRIPTION

Siemens epitaxial layers are grown by Hydride Vapor-Phase Epitaxy (HVPE). High quantum efficiencies and uniformity make these wafers ideal for visible displays and solid-state, near-monochromatic light sources.

EPITAXIAL LAYER

Material:	$GaAs_{1-X}P_X$:Te
Conductivity:	n-type
Carrier Concentration:	0.5–5.0 x $10^{17}cm^{-3}$
Peak PL Wavelength:(1)	655 ±5 nm
Brightness:	0.8 mCd min. at 15 A/cm^2
Graded Layer Thickness:	15 µm min.
Constant Layer Thickness:	15 µm min.

Substrate

Material:	GaAs
Growth Type:	Czochralski or Boat-Grown
Conductivity:	n-type
Orientation:(2)	(100), off 2 ±0.5° toward the (110)

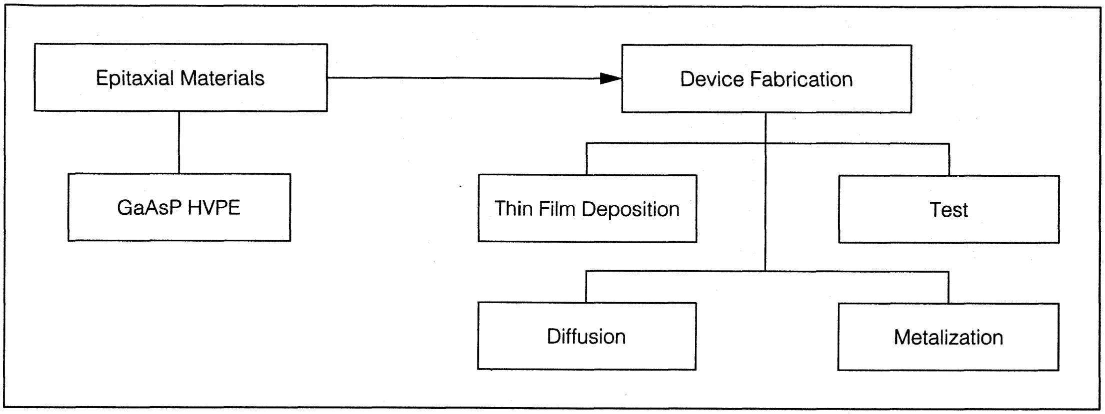
PHYSICAL PROPERTIES

Size:	Grown on 3" diameter SEMI spec substrate
Thickness:	500 ±50 µm
Bow:	–50 ±100 µm
Pits:(3)	15 per square inch maximum
Voids:(3)	3 per wafer maximum; none larger than 1 mm diameter
Projections:(3)	3 per square inch maximum; none higher than 10 µm
Scratches:(3)	3 per wafer maximum; none longer than 10 mm
Chips:	None penetrating further than 2 mm
Cracks:	None
Polycrystal:(3)	None
Broken Lattice:(3)	None
Twin Lines:(3)	None

Notes:
1. Other custom wavelengths from 560 nm to 880 nm also available.
2. Other orientations also available.
3. Excludes outer 2 mm perimeter of wafer.

SIEMENS

Custom Optoelectronic Materials and Die



Introduction

- **Custom Materials Growth**
  - State-of-the-Art Proprietary Reactor Designs
  - GaAsP on GaAs or GaP Growth Capability
  - Complete Materials Analysis Facility
  - Systems Handle Prototype & Production Volumes
  - 3" Diameter Wafers and Custom Shapes
- **Custom Device Fabrication**
  - Thermal & Plasma Thin Film Deposition
  - Optimized Diffusions for Each Composition
  - Customized N- and P-Type Metallizations
- **In-House Computer-Aided Device Design**
  - Custom Electro-Optical Devices
  - Library of Point-Source, Multi-Segment, LED array and Fiber Optic Designs Available
- **Optical Measurements Facility**
  - Absolute Characterization of Optical Performance
  - Fast, Accurate Response to Customer Requests
  - All Measurements are NIST-Traceable
  - 100% Analytical Test Capability
- **Modern Testing and Assembly Facility**
  - Manufacturing Facility in Penang, Malaysia
  - Latest Automated Assembly Equipment
  - 100% Test and Burn-in Capability
  - "Just-in-Time" Philosophy
  - Over 15 Years Experience in Optical Hybrid Assemblies
- **Additional Product Design Expertise**
  - Multi-Element Lens Capability
  - Multi-Channel Fiber Optic Design Techniques
  - Hermetic Packages
  - Board Component Design
  - Surface Mount Technology

Epitaxial Materials Growth Facility

For your custom materials requirements, Siemens' epitaxial growth facility offers optoelectronic products in several compound semiconductor systems. We have over 15 years of experience in the growth of GaAsP materials. Siemens is recognized worldwide for the superior quality and uniformity of our 655 nm "Standard Red" materials, but we also produce and have characterized compositions ranging from 560 nm pure green through 880 nm infrared.

An important consideration for our customers is the shape and size of the wafers we produce. To that end, Siemens offers a selection of 3"-diameter wafers sized to SEMI specifications or wafers shaped to match your specific needs.

Device Fabrication Facility

Siemens has a fully equipped fabrication facility for processing epitaxial wafers into finished devices. The processes available include thin-film deposition, photolithography, diffusion, metallization, lapping, and parametric testing and analysis. We employ statistical quality control (SQC) to ensure consistency of the most critical processes. In-house control of the fabrication process enables us to select a customized combination of technologies that best match your product needs.

Each application has its own pattern requirements dictated by available drive power, optical output power, human recognition, reliability, etc. Siemens helps you choose from a wide selection of device designs. We maintain a library of extensively characterized standard designs for point-source, multisegment, and fiber optic emitters, or you can pick your own proprietary configuration. You can apply our design rules to produce your own masks, or give us your mechanical drawing and let us turn it into a working device. We are experienced in the design of large area, high density devices with as many as 600 uniform emitting areas on a single chip!

If you prefer, Siemens can also produce the fully assembled product by computer design of custom assemblies and subassemblies and use of automated manufacturing equipment. This vertical integration vastly improves reliability and quality control while offering more features at the lowest possible cost.

Optical Design and Measurements Lab

The Siemens Optics Lab, a versatile and precise optical measurement facility, provides fast and accurate characterization of optical radiation performance. This insures prompt and reliable responses to customer requirements. The lab is coordinated with standards organizations worldwide and employs the latest conventions for optical measurement procedures. All measurements are traceable to the National Bureau of Standards.

Automated Offshore Assembly Facility

The Siemens assembly facility in Penang, Malaysia, uses automated test, dicing, and assembly equipment providing both flexibility in device characterization and highest quality/lowest cost for finished products. The test and burn-in operations are supported by a failure analysis group and reliability monitors. The product is fully traceable back to the raw materials, guaranteeing predictability of quality and yield.

Worldwide Technical Commitment

One of our chief strengths lies in Siemens' commitment to establishing leading-edge semiconductor technologies. Divisions throughout the world are involved in the manufacture of optical components for signal processing, ultrahigh-speed communication, and long-haul data transmission. Supporting the efforts are the Corporate Research and Technology Laboratories. They are responsible for research in evolving sciences and supporting the manufacturing divisions with technical advice, coordinated literature access, the latest process technology, and in-depth material and device analysis.

A Typical Cycle from Plan to Product

Your program begins with the "request for quotation (RFQ)" which outlines your product requirements, anticipated delivery and volume, and target price. After review by our technical and manufacturing staffs, we will contact you with any additional questions. If we feel that Siemens can adequately service your needs we will submit a program plan, schedule, and quotation. This cycle is typically completed within five working days of receiving the RFQ.

Upon receipt of your order, we will jointly establish milestones and review dates for tracking the progress of your program. This will include a detailed listing of all key deliverables and evaluations, as well as points where reviews and decisions are required. At the end of the development phase of the program a final summary report will be submitted to complete your records and ensure a smooth transition into manufacturing.

How Do Siemens' Customers Benefit?

Successful development and production of optoelectronic devices requires many qualities. Your supplier must deliver:

A Firm Theoretical Foundation — to guarantee that the latest technology and best equipment put you on the shortest path to the solution,

Stable Processes — to ensure that every step of the product evolution is reliable and reproducible,

Flexibility — to provide the materials, processing, and degree of integration that are most performance- and cost-effective,

Information — to understand how the device will perform in your application,

Consistency — to expeditiously and reliably meet your product needs.

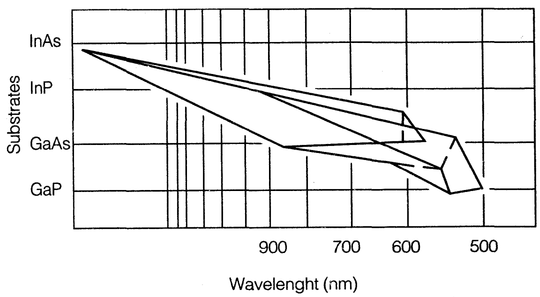
Siemens has been demonstrating these qualities for over 15 years. Whether it is an interactive development of a new product or volume production of an established part, we are the best supplier to service your optoelectronic needs!

Inquiries

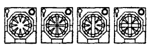
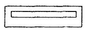
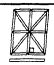
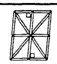
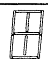
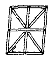
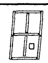
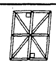
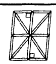
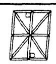
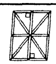
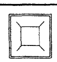
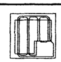
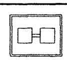
Address all correspondence and telephone calls to the Custom Materials and Devices organization at:

Siemens Components, Inc.
Optoelectronics Division
19000 Homestead Road
Cupertino, CA 95014 USA
TEL (408) 725-3558
FAX (408) 725-3420

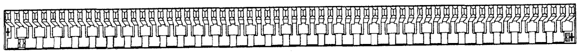
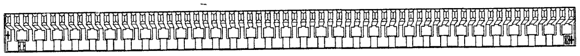
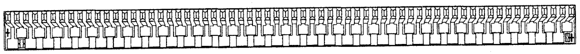
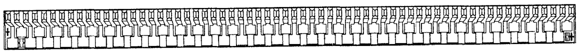
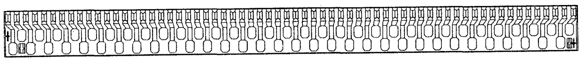
Materials Selection Guide

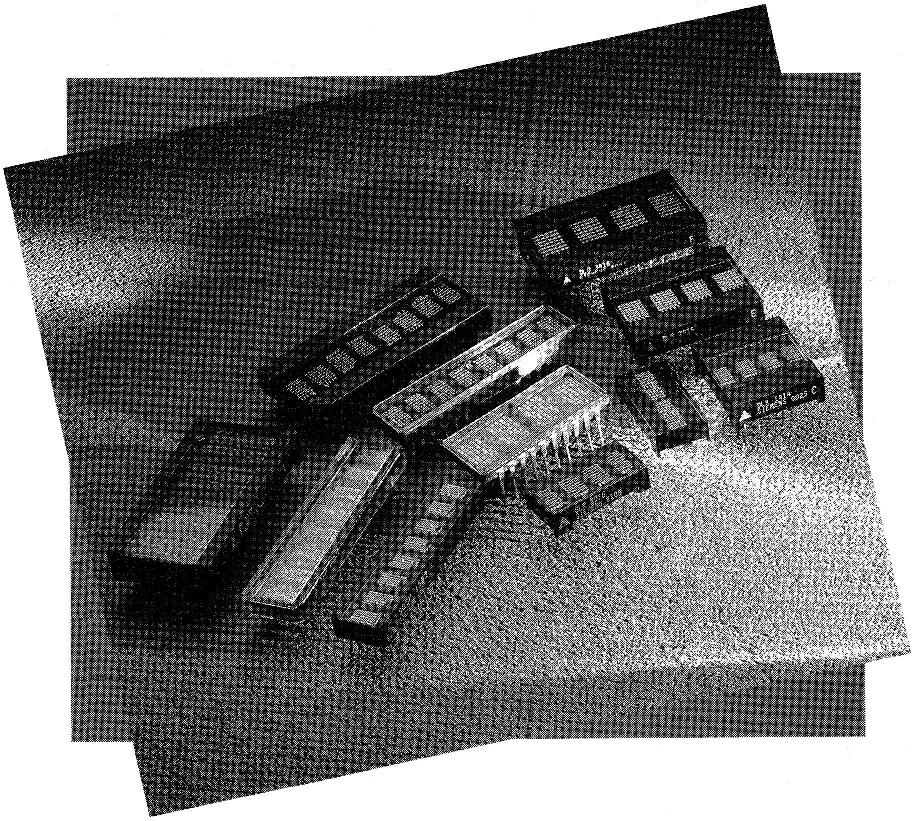


Custom LED Materials

Chip	Diagram	Material	Size(mn)	Cathode	Anode	Vf	Vr	λ (nm)	LI (μCd)	RI (μW/str)
IP-251B		GaAsP/GaAs	0.4 x 0.4	Au-Ge-Ni	Al	1.50	–10.0	705		50
RB-42B		GaAsP/GaAs	1.7 x 0.5	Au-Ge-Ni	Al	1.59	–25.0	655	500	
RM-14A		GaAsP/GaAs	2.7 x 3.7	Au-Ge-Ni	Al	1.57	–23.0	655	240	
RM-15B		GaAsP/GaAs	3.4 x 4.0	Au-Ge-Ni	Al	1.56	–23.0	655	350	
RM-62A		GaAsP/GaAs	2.0 x 2.7	Au-Ge-Ni	Al	1.60	–23.0	655	440	
RM-64A		GaAsP/GaAs	2.4 x 2.7	Au-Ge-Ni	Al	1.60	–24.0	655	350	
RM-73A		GaAsP/GaAs	1.5 x 2.0	Au-Ge-Ni	Al	1.60	–23.0	655	400	
RM-81A		GaAsP/GaAs	2.8 x 3.4	Au-Ge-Ni	Al	1.57	–23.0	655	220	
RM-85D		GaAsP/GaAs	1.9 x 2.2	Au-Ge-Ni	Al	1.59	–23.0	655	320	
RM-86A		GaAsP/GaAs	1.8 x 2.3	Au-Ge-Ni	Al	1.60	–23.0	655	280	
RM-95A		GaAsP/GaAs	1.9 x 2.2	Au-Ge-Ni	Al	1.59	–23.0	655	320	
RP-12C		GaAsP/GaAs	0.3 x 0.3	Au-Ge-Ni	Al	1.64	–25.0	655	500	
RP-13B		GaAsP/GaAs	0.4 x 0.4	Au-Ge-Ni	Al	1.59	–25.0	655	450	
RP-212A		GaAsP/GaAs	0.3 x 0.3	Au-Ge-Ni	Al	1.80	–25.0	655	300	

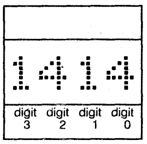
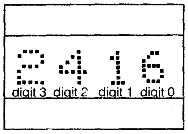
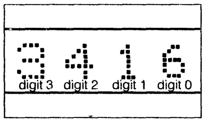
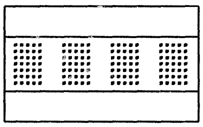
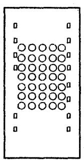
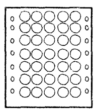
Custom LED Materials

Chip	Diagram	DPI	Material	Size (mm)	Cathode	Anode	Typical		
							Vf	λ (nm)	RI (μW/str)
LA-200A		200	GaAsP/ GaAs	8.0 x 0.4	Au-Ge-Ni	Al	1.90	740	6.27
LA-300A		300	GaAsP/ GaAs	5.4 x 0.4	Au-Ge-Ni	Al	1.90	740	6.27
LA-300B		300	GaAsP/ GaAs	5.4 x 0.4	Au-Ge-Ni	Al	1.90	710	6.27
LA-300C		300	GaAsP/ GaAs	5.4 x 0.4	Au-Ge-Ni	Al	1.90	720	6.27
LA-300D		300	GaAsP/ GaAs	5.4 x 0.4	Au-Ge-Ni	Al	1.90	685	6.27
LA-301A		300	GaAsP/ GaAs	5.4 x 0.4	Au-Ge-Ni	Al	1.90	740	6.27

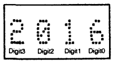
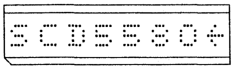
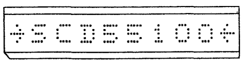
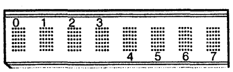


Intelligent Display® Devices
Slimline Intelligent Display® Devices
Programmable Display™ Devices
High Reliability/Industrial Displays
Small Alphanumeric Displays

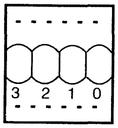
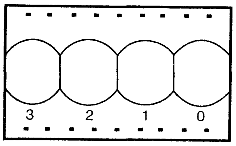
Intelligent Display® Devices–Dot Matrix

Package Outline	Part No./ Color	No. of Characters / Character Height	Viewing Angle	Description	Page
	DLR1414 Red DLO1414 HER DLG1414 Green	4 0.145"	X Axis ±50° Y Axis ±75°	Dot matrix drop-in replacement for DL1414T. Four 5x7 dot matrix characters. 128 ASCII characters (English plus 5 other languages). Access time: 110 ns. For portable applications, telecommunications equipment.	2–18
	DLR2416 Red DLO2416 HER DLG2416 Green	4 0.200"	X Axis ±50° Y Axis ±75°	Dot matrix drop-in replacement for DL2416T. Four 5x7 dot matrix characters. 128 ASCII characters (English plus 5 other languages). Access time: 110 ns. For bench equipment, instrumentation.	2–23
	DLR3416 Red DLO3416 HER DLG3416 Green	4 0.270"	X Axis ±50° Y Axis ±75°	Dot matrix drop-in replacement for DL3416T. Four 5x7 dot matrix characters. 128 ASCII characters (English plus 5 other languages). Access time: 110 ns. For bench equipment, instrumentation.	2–29
	SCF5740 Red SCF5742 HER SCF5744 HEG	4 0.270"	X Axis ±55° Y Axis ±55°	Four 5x7 dot matrix characters. Serial input dot addressable Intelligent Display.Built-in decoders, multiplexers, and LED drivers. Attributes: 140 bit RAM for user defined characters, eight dimming levels, power down mode, hardware/software clear functions, internal or external clock.	2–200
	DLO4135 HER DLG4137 Green	1 0.43"	±75°	Single 5x7 dot matrix character. Readable to 20 feet plus, wide viewing angle; lamp test, brightness control. One chip-enable for easy system expansion. 128 ASCII character format. Access time: 150 ns Telecommunications equipment, table top equipment, instrumentation.	2–14
	DLO7135 HER DLG7137 Green	1 0.68"	±75°	Single 5x7 dot matrix character. Readable to 30 feet plus, wide viewing angle; lamp test, brightness control. One chip-enable for easy system expansion. 96 ASCII character format. Access time: 150 ns Ideal for scales, POS terminals, instrumentation, mainframe peripherals.	

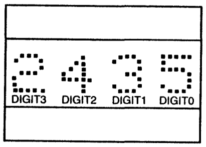
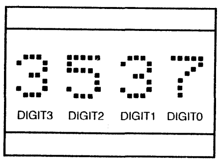
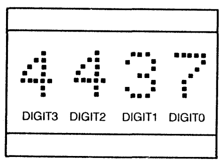
Slimline Intelligent Display® Devices–Dot Matrix

Package Outline	Part No./ Color	No. of Characters / Character Height	Viewing Angle	Description	Page
	SLR2016 Red SLO2016 HER SLG2016 Green SLY2016 Yellow	4 0.180"	X Axis ±50° Y Axis ±75°	Slimline package. Four 5x7 dot matrix characters. Very close multi-line spacing, 0.4" centers. 128 ASCII characters (English plus 5 other languages). Operating temperature: -40°C to +85°C.	2–212
	SCD5580 Red SCD5581 Yellow SCD5582 HER SCD5583 Green SCD5584 HEG	8 0.145"	X Axis ±55° Y Axis ±65°	Slimline package. Eight 5x5 dot matrix characters. Serial input dot addressable display. 200 bit RAM for user defined characters. Low power: 30% less power than 5x7 format. Operating temperature: -40°C to +85°C.	2–143
	SCD55100 Red SCD55101 Yellow SCD55102 HER SCD55103 Green SCD55104 HEG	10 0.145"	X Axis ±55° Y Axis ±65°	Slimline package. Ten 5x5 dot matrix characters. Serial input dot addressable display. 200 bit RAM for user defined characters. Low power: 30% less power than 5x7 format. Operating temperature: -40°C to +85°C.	2–158
	SCE5780 Red SCE5781 Yellow SCE5782 HER SCE5783 Green SCE5784 HEG SCE5785 Soft Orange	8 0.180"	X Axis ±55° Y Axis ±65°	Eight 5x7 dot matrix characters. Serial input dot addressable display. Built-in decoders, multiplexers, and LED drivers. Programmable features: clear function, eight dimming levels, peak current select, prescaler function, internal or external clock.	2–187

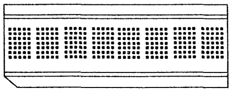
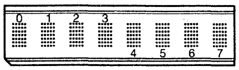
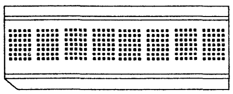
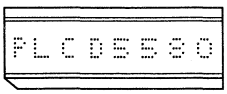
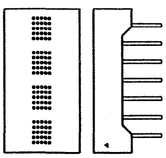
Intelligent Display® Devices–Segmented

Package Outline	Part No./ Color	No. of Characters / Character Height	Viewing Angle	Description	Page
	DL1414T Red	4 0.112"	X Axis ±40° Y Axis ±55°	17 segment, 4 character display with built-in CMOS ASCII decoder, multiplexer, memory and driver. Access time: 110 ns. Low power consumption. For portable applications, telecommunications equipment.	2–4
	DL2416T Red	4 0.160"	X Axis ±45° Y Axis ±55°	17 segment, 4 character display with built-in CMOS ASCII decoder, multiplexer, memory and driver. Access time: 110 ns. Characters readable up to 8 feet, memory clear function, independent cursor function. Two chip enables for easy system expansion. For medical equipment, instrumentation, table top equipment.	2–8

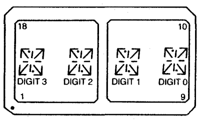
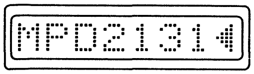
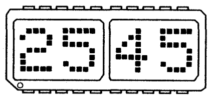
Programmable Display™ Devices–Dot Matrix

Package Outline	Part No./ Color	No. of Characters / Character Height	Viewing Angle	Description	Page
	PD2435 HER PD2436 Red PD2437 Green	4 0.200"	X Axis ±55° Y Axis ±65°	Four dot matrix characters. Built-in CMOS ASCII decoder, multiplexers memory and driver. Software driven, true microprocessor peripherals. Additional features of Programmable Display devices include: control and display memory read/write, dimming (3 levels) and blanking, blinking cursor/character and lamp test. 128 ASCII character format. Extended operating temperature range: –40°C to +85°C.	2–96
	PD3535 HER PD3536 Red PD3537 Green	4 0.270"			
	PD4435 HER PD4436 Red PD4437 Green	4 0.45"			

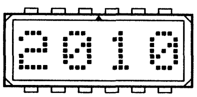
Programmable Display™ Devices–Dot Matrix

Package Outline	Part No./ Color	No. of Characters Character Height	Viewing Angle	Description	Page
	HDSP2110S Red HDSP2111S Yellow HDSP2112S HER HDSP2113S Green HDSP2114S HEG HDSP2115S Soft Orange	8 0.200"	X Axis ±55° Y Axis ±65°	Eight dot matrix characters. Built-in CMOS ASCII decoder, multiplexers memory and driver. Software driven-true microprocessor peripherals. Additional features of Programmable Display devices include: control and display memory read/write, dimming (3 levels) and blanking, blinking cursor/character and lamp test. 128 ASCII characters format. 16 user definable characters. Access time: 110 ns. Extended operating temperature range: –40°C to +85°C.	2–44
	PDSP1880 Red PDSP1881 Yellow PDSP1882 HER PDSP1883 Green PDSP1884 HEG	8 0.180"	X Axis ±55° Y Axis ±65°	Eight dot matrix characters. Built-in CMOS ASCII decoder, multiplexers memory and driver. Software driven-true microprocessor peripherals. Additional features of Programmable Display devices include: control and display memory read/write, dimming (3 levels) and blanking, blinking cursor/character and lamp test. 128 ASCII characters format. 16 user definable characters. Access time: 110 ns. Extended operating temperature range: –40°C to +85°C.	2–107
	PDSP2110 Red PDSP2111 Yellow PDSP2112 HER PDSP2111 Green PDSP2112 HEG	8 0.200"	X Axis ±55° Y Axis ±65°	Eight dot matrix characters. Built-in CMOS ASCII decoder, multiplexers memory and driver. Software driven, true microprocessor peripherals. Additional features of Programmable Display devices include: control and display memory read/write, dimming (3 levels) and blanking, blinking cursor/character and lamp test. 256 ASCII characters format. Access time: 110 ns. Extended operating temperature range: –40°C to +85°C.	2–120
	PLCD5580 Red PLCD5581 Yellow PLCD5582 HER PLCD5583 Green PLCD5584 HEG	8 0.145"	X Axis ±50° Y Axis ±65°	Eight 5x5 dot matrix characters. Built-in 2 page 256 character ROM. Built-in decoders, multiplexers, and drivers. Programmable features: individual flashing character, full display blinking, multi-level dimming and blanking, clear function, lamp test. Low power.	2–131
	SCDV5540 Red SCDV5541 Yellow SCDV5542 HER SCDV5543 Green SCDV5544 HEG	4 0.123"	X Axis ±55° Y Axis ±55°	Vertical format, four 5x5 dat matrix characters. ROMless serial input, dot addressable Intelligent Display. Built-in decoders, multiplexers, and LED drivers.	2–173

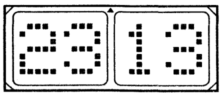
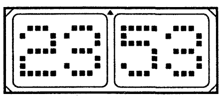
High Reliability/Industrial Alphanumeric Displays

Package Outline	Part No./Color	No. of Characters / Character Height	Operating Temperature Range	Description	Page
	MDL2416C Red MDL2416TXVB Red	4 0.15"	–55°C to +100°C	**Intelligent Display Device** Four 17 segment characters. Built-in CMOS circuitry–TTL and microprocessor compatible. Rugged ceramic package, hermetically sealed flat glass lens. Low profile package. Conforms to Quality Level A.	2–58
	MPD2131TXVB IPD2131 Yellow MPD2132TXVB IPD2132 HER MPD2133TXVB IPD2133 High Eff. Grn.	8 0.200"	–55°C to +100°C	**Programmable Display Device** Eight 5x7 dot matrix characters. Built-in CMOS ASCII decoder, multiplexer, memory, and driver. 128 character ASCII character set. Rugged ceramic package, hermetically sealed flat glass lens. Conforms to Quality Level A.	2–63
	MPD2545ATXVB IPD2545A HER MPD2547ATXVB IPD2547A Green MPD2548ATXVB IPD2548A Yellow	4 0.15"	–55°C to +100°C	**Programmable Display Device** Four 5x7 dot matrix characters. Built-in CMOS ASCII decoder, multiplexer, memory, and driver. 128 character ASCII character set. Rugged ceramic package, hermetically sealed flat glass lens. Conforms to Quality Level A.	2–77

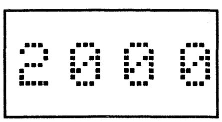
High Reliability/Industrial Small Alphanumeric Displays

Package Outline	Part No./Color	No. of Characters / Character Height	Operating Temperature Range	Description	Page
	MSD2010TXVB ISD2010 Red MSD2011TXVB ISD2011 Yellow MSD2012TXVB ISD2012 HER MSD2013TXVB ISD2013 High Eff. Green	4 0.150"	–55°C to +100°C	MSD versions only–Military alphanumeric displays, conforms to Quality Level A. ISD versions–Industrial alphanumeric displays. Four 5x7 dot matrix characters. Rugged ceramic package, hermetically sealed flat glass lens. Serial input/parallel output. Easily cascaded for multiple displays. Low power, on-board CMOS shift register and constant current LED row drivers. External column strobing allows use of full ASCII and customized fonts.	2–86

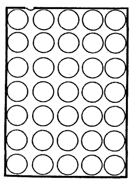
High Reliability/Industrial Small Alphanumeric Displays

Package Outline	Part No./Color	No. of Characters / Character Height	Operating Temperature Range	Description	Page
	MSD2310TXVB ISD2310 Red MSD2311TXVB ISD2311 Yellow MSD2312TXVB ISD2312 HER MSD2313TXVB ISD2313 High Eff. Green	4 0.150"	–55°C to +100°C	MSD versions only–Military alphanumeric displays, conforms to Quality Level A. ISD versions–Industrial alphanumeric displays. Four 5x7 dot matrix characters. Rugged ceramic package, hermetically sealed flat glass lens. Serial input/parallel output. Easily cascaded for multiple displays. Low power on-board CMOS shift register and constant current LED row drivers. External column strobing allows use of full ASCII and customized fonts.	2–86
	MSD2351TXVB ISD2351 Yellow MSD2352TXVB ISD2352 HER MSD2353TXVB ISD2353 High Eff. Green	4 0.200"	–55°C to +100°C	Sunlight viewable. MSD versions only–Military alphanumeric displays, conforms to Quality Level A. ISD versions–Industrial alphanumeric displays. Four 5x7 dot matrix characters. Rugged ceramic package, hermetically sealed flat glass lens. Serial input/parallel output. Easily cascaded for multiple displays. Low power on-board CMOS shift register and constant current LED row drivers. External column strobing allows use of full ASCII and customized fonts.	

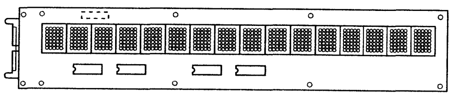
Commercial Small Alphanumeric Displays

Package Outline	Part No./Color	No. of Characters / Character Height	Operating Temperature Range	Description	Page
	HDSP2000LP Red HDSP2001LP Yellow HDSP2002LP HER HDSP2003LP Green	4 0.150"	–40°C to +85°C	Commercial Displays Four 5x7 dot matrix characters. Plastic package. Serial input/parallel output. Easily cascaded for multiple displays. Low power on-board CMOS shift register and constant current LED row drivers. External column strobing allows use of full ASCII and customized fonts.	2–37

Alphanumeric Display

Package Outline	Part No./Color	No. of Characters	Polarity	Luminous Intensity per Segment		Description	Page
		Character Height		Typ. (μcd)	mA		
	DLR5735 Red DLG5735 Green	1 0.69"	Common Cathode Row	200	20	Single 5x7 dot matrix character. No built-in CMOS drive circuitry.	2–35
	DLR5736 Red DLG5736 Green	1 0.69"	Common Anode Row	650	10		

Intelligent Display Assemblies

Package Outline	Part No.	Description
	IDA7135-16 Example assembly—sixteen DLO7135 Intelligent Displays mounted on a PC board.	An Intelligent Display assembly can be made from any of our Intelligent Display devices configured to customer specifications. Contact Product Marketing.

HIGH RELIABILITY TEST TABLES

Two high reliability testing programs are available. The normal test program conforms with MIL-D-87157 Test Table I, Quality Level A and Group A, Table II.

The TXVB program conforms to MIL-D-87157 Level A Test Tables I, II, IIIa and IVa(3).

Table I. Quality Level A of MIL-D-87157

Test Screen	Method	Conditions
1. Precap Visual	2072, MIL-STD-750	
2. High Temperature Storage	1032, MIL-STD-750	T_A =125°C, Time=24 hours
3. Temperature Cycling	1051, MIL-STD-750	Condition B, 10 Cycles, 15 min. dwell T_A =–65°C to +125°C
4. Constant Acceleration	2006, MIL-STD-750	See individual product specs for conditions.
5. Fine Leak	1071, MIL-STD-750	Condition H, Leak Rate ≤5 x 10^{-7} cc/s
6. Gross Leak	1071, MIL-STD-750	Condition C
7. Interim Electrical/Optical Tests(2)		See individual product specs for conditions
8. Burn-in (1)	1015, MIL-STD-883	See individual product specs for conditions
9. Final Electrical Test(2)		Same as Step 7
10. Delta Determinants		See individual product specs for conditions
11. External Visual	2009, MIL-STD-883	

Table II. Group A Electrical Tests–MIL-D-87157

Subgroup/Test	Parameters	LTPD
Subgroup 1 DC Electrical Test at 25°C	See individual product specs for conditions	5
Subgroup 2 Selected DC Electrical Test at High Temperatures(2)	Same as Subgroup 1, except delete I_V and Visual Function, T_A=100°C	7
Subgroup 3 Selected DC Electrical Tests at Low Temperatures(2)	Same as Subgroup 1, except delete I_V and Visual Function, T_A=–55°C	7
Subgroup 4, 5 and 6 Not Applicable		
Subgroup 7 Optical and Functional Tests at 25°C	Satisfied by Subgroup 1	5
Subgroup 8 External Visual	MIL-STD-883, Method 2009	7

Notes:
1. MIL-STD-883 test method applies.
2. Limits and conditions are per the Electrical/Optical Characteristics. The I_{OH} and I_{OL} tests are the inverse of V_{OH} and V_{OL} specified in the Electrical Characteristics.
3. Frequency: Group A every lot, Group B semi-annually, Group C annually.

Table IIIa. Group B, Classes A and B of MIL-STD-87157

Subgroup/Test	MIL-STD-750 Method	Conditions	Sample Size
Subgroup 1			
Resistance to Solvents	1022		4 Devices/0 Failures
Internal Visual and Mechanical	2075	Inspection may be performed through glass cover, includes front and back cavities	1 Device/0 Failures
Subgroup 2[1,2]			
Solderability	2026	TA=245°C for 5 seconds	LTPD=15
Subgroup 3			
Thermal Shock (Temp Cycle)	1051	Condition B, 15 min. dwell	LTPD=15
Moisture Resistance[3]	1021	Within 24 hours after completion of moisture resistance test	
Visual Inspection Endpoints			
Hermetic Seal	1071		
Fine Leak	1071	Condition G or H	
Gross Leak	1071	Condition C	
Electrical/Optical Endpoints[4]		See individual product specs	
Subgroup 4			LTPD=10
Operating Life Test (340 hours)	1027	See individual product specs for conditions.	
Electrical/Optical Endpoints[4]		Same as Subgroup 3	
Subgroup 5			LTPD=10
Non-Operating (Storage) Life Test (340 hours)	1032	TA=+125°C	
Electrical/Optical Endpoints[4]		Same as Subgroup 3	

Notes:
1. Whenever electrical/optical tests are not required as end-points, electrical rejects may be used.
2. The LTPD applies to the number of leads inspected. Always use three or more displays to provide the number of leads required.
3. Initial conditioning shall be a 15 degree inward bend and back to original position, one cycle.
4. Limits and conditions are per the Electrical/Optical Characteristics. The I_{OH} and I_{OL} tests are the inverse of V_{OH} and V_{OL} specified in the Electrical Characteristics.

Table IVa. Group C, Classes A and B of MIL-STD-87157

Subgroup/Test	MIL-STD-750 Method	Conditions	Sample Size
Subgroup 1 Physical Dimensions	 2066		2 Devices/0 Failures
Subgroup 2[1,2] Lead Integrity Hermetic Seal Fine Leak Gross Leak	 2004 1071 1071 1071	Condition B2 Condition G or H Condition C	LTPD=15
Subgroup3 Shock Vibration, Variable Frequency Constant Acceleration External Visual[3] Electrica/Optical Endpoints	 2016 2056 2006 2009	 1500 Gs, Time=0.5 ms, 5 blows in each orientation X1, Y1, Z1 See individual product specs for conditions.	 LTPD=15
Subgroup 4[5,6] Salt Atmosphere External Visual(3)	 1041 2009		LTPD=15
Subgroup 5 Bond Strength[7]	 2037	 Condition A	 LTPD=20 (C=0)
Subgroup 6 Operating Life Test[8] Electrical/Optical Endpoints[4]	 1026	 See individual product specs for conditions. Same as Subgroup 3	 λ=10

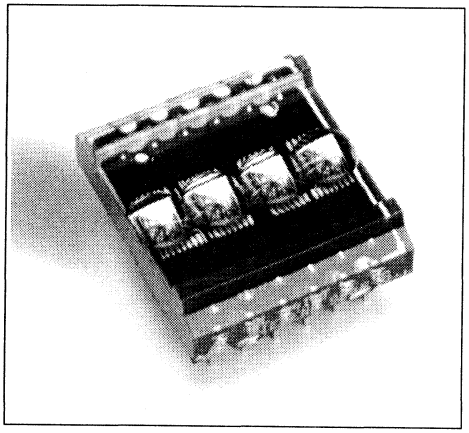
Notes:

1. The LTPD applies to the number of leads inspected. Always use three or more displays to provide the number of leads required.
2. MIL-STD-883 test method applies.
3. Visual requirements shall be as specified in MIL-STD-883, Methods 2009.
4. Limits and conditions are per the electrical/optical characteristics.
5. Whenever electrical/optical tests are not required as endpoints, electrical rejects may be used.
6. Solderability samples shall not be used.
7. Displays may be selected prior to seal.
8. If any given inspection lot undergoing Group B inspection has been selected to satisfy Group C inspection requirements, the 340-hour life tests may be continued on test to 1000 hours to satisfy the Group C Test requirements. In such cases, either the 340-hour endpoint measurement shall be made a basis for Group B lot acceptance or the 1000-hour endpoint measurement shall be used as the basis for both Group B and Group C acceptance.

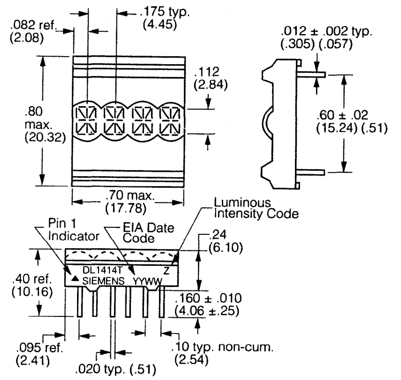
SIEMENS

DL1414T

.112" Red, 4-Character 16 Segment Plus Decimal Alphanumeric Intelligent Display® With Memory/Decoder/Driver



Package Dimensions in Inches (mm)



Tolerance:
.XX ±.01 (2.54)
.XXX ±.005 (.127)

FEATURES

- **0.112" High, Magnified Monolithic Character**
- **Wide Viewing Angle, X Axis ±40°, Y Axis ±55°**
- **Close Vertical Row Spacing, .800" Centers**
- **Rugged Solid Plastic Encapsulated Package**
- **Fast Access Time, 110 ns at 25° C**
- **Compact Size for Hand Held Equipment**
- **Built- in Memory**
- **Built- in Character Generator**
- **Built- in Multiplex and LED Drive Circuitry**
- **Direct Access to Each Digit Independently and Asynchronously**
- **TTL Compatible, 5 Volt Power**
- **17th Segment for Improved Punctuation Marks**
- **Low Power Consumption, Typically 10 mA per Character**
- **Intensity Coded for Display Uniformity**
- **Extended Operating Temperature Range: –40°C to +85•C**
- **End Stackable, 4 Character Package**
- **100% Burned in and Tested**
- **Superior ESD Immunity**

DESCRIPTION

The DL1414T is a four digit display module with16 bar segments plus a decimal and a built-in CMOS integrated circuit.

The integrated circuit contains memory, ASCII character generator, LED multiplexing and drive circuitry. Inputs are TTL compatible. A single 5-volt power supply is required. Data entry is asynchronous and random access. A display system can be built using any number of DL1414s since each digit in any DL1414T can be addressed independently and will continue to display the character last stored until replaced by another.

Loading data into the DL1414T is straightforward. The desired data code (D0-D6 and digit address (A0, A1) is presented in parallel and held stable during a write cycle. Data entry may be asynchronous and in random order. (Digit 0 is defined as right hand digit with A1 = A0 = 0 = low).

System interconnection is very straightforward. The least significant two address bits (A0 A1) are normally connected to the like named inputs of all DL1414Ts in the system. Data lines are connected to all DL1414Ts directly and in parallel. Multiple DL1414T systems usually use an external one-of-N decoder chip. The "write" pulse is connected to the CE of the decoder. A 3-to-8 line decoder multiplexer (74138) or a 4-to-16 line decoder/multiplexer (74154) are possible choices. All higher-order address bits (above A1) become inputs to the decoder.

All product are 100% burned-in and tested, then subjected to out-going AQL's of 0.25% for brightness matching, visual alignment and dimensions, 0.065% for electrical and functional.

Important: Refer to Appnote 18, "Using and Handling Intelligent Displays." Since this is a CMOS device, normal precautions should be taken to avoid static damage.

See Appnote 15 for applications information.

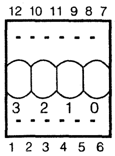
Maximum Ratings

Supply Voltage, V_{CC} .... –0.5 to +7.0 Vdc
Voltage, Any Pin Respect
to GND .... –0.5 to (V_{CC} +0.5) Vdc
Operating Temperature .... –40°C to +85°C
Storage Temperature .... –40°C to +100°C
Maximum Solder Temperature, .063" (1.59mm)
below Seating Plane, t<5 sec. .... 260°C
Relative Humiidity (non condensing) at 85°C 85%

Optical Characteristics at 25°C

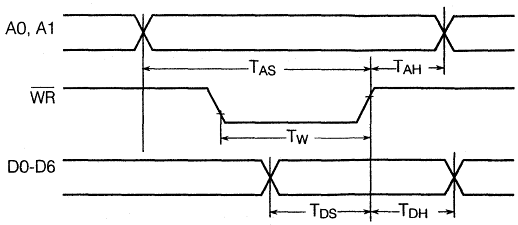
Spectral Peak Wavelength .... 660 nm typ.
Viewing Angle (off normal axis)
Horizontal .... ±40°
Vertical .... ±55°
Magnified Digit Size .... 0.112" X 0.085"
Time Averaged Luminous Intensity
(100% brightness, ... 0.40 mcd/digit min.
8 Segments/Digit, V_{CC} = 5 V .... 0.75 mcd/digit typ.
LED to LED Intensity Matching .... 1.8:1.0 max.
Device to Device Intensity Matching
(one bin) .... 1.5:1.0 max.
Bin to Bin Intensity Matching .... 1.9:1.0 max.

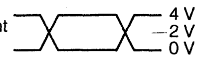
Top View



Pin	Function
1	D5 Data Input
2	D4 Data Input
3	WR Write
4	A1 Digit Select
5	A0 Digit Select
6	V_{CC}
7	GND
8	D0 Data Input (LSB)
9	D1 Data Input
10	D2 Data Input
11	D3 Data Input
12	D6 Data Input (MSB)

Timing Characteristics — Write Cycle Waveforms





DC Characteristics

Parameter	–40°C			+25°C			+85°C			Units	Conditions
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max		
I_{CC} 4 Digitis on 10 segments/digit		60	75		50	65		40	55	mA	V_{CC} = 5 V
I_{CC} Blank		1.5	3.5		1.0	2.7		0.5	2.0	mA	V_{CC} = $\overline{WR}$ = 5 V V_{IN} = 0 V
I_{IL} (all inputs)		60	120		55	100		30	70	µA	V_{IN} = 0.8 V V_{CC}= 5 V
V_{IH}	2.0			2.0			2.0			V	V_{CC} = 5 V±0.5 V
V_{IL}			0.8			0.8			0.8	V	V_{CC} = 5 V±0.5 V

AC Characteristics Guaranteed Minimum Timing Parameters at 4.5 V ≤V_{CC} ≤5.5 V

Parameter	Symbol	–40°C	+25°C (ns)	+85°C (ns)
Address Set Up Time	T_{AS}	10	10	10
Address Hold Time	T_{AH}	20	30	40
Write Time	T_W	60	70	90
Data Set Up Time	T_{DS}	20	30	50
Data Hold Time	T_{DH}	20	30	40
Access Time(2)	T_{ACC}	90	110	140

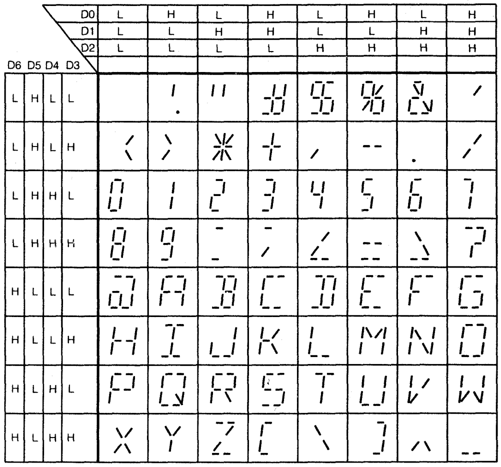
Notes: 1. Access time T_{ACC}=T_{AS}+T_W+T_{DH}
2. Digit multiplex frequency may vary from 200 Hz to 800 KHz.

Loading Data State Table

WR	A1	A0	D6	D5	D4	D3	D2	D1	D0	Digit 3	2	1	0
H	previously loaded display									G	R	E	Y
L	L	L	H	L	L	L	H	L	H	G	R	E	E
L	L	H	H	L	H	L	H	L	H	G	R	U	E
L	H	L	H	L	L	H	H	L	L	G	L	U	E
L	H	H	H	L	L	L	L	H	L	B	L	U	E
L	L	H	H	L	L	L	H	L	H	B	L	E	E
L	L	L	H	L	H	L	H	H	H	B	L	E	W
L	X	X	see character code							see character set			

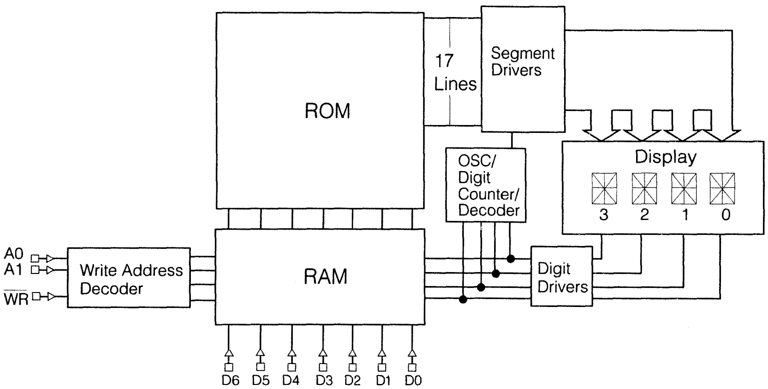
X = don't care

Character Set

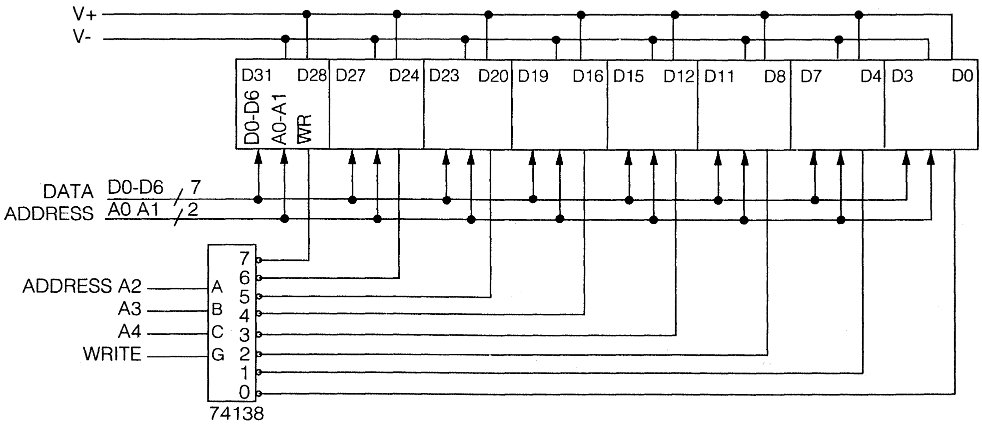


All other input codes display "blank"

Block Diagram



Typical Interconnection for 32 Digits



Design Considerations

For details on design and applications of the DL1414T using standard bus configurations in multiple display systems, or parallel I/O devices, such as the 8255 with an 8080 or memory mapped addressing on processors such as the 8080, Z80, 6502, 8748, or 6800, refer to Appnote 15 in the current Siemens Optoelectronic Data Book.

ELECTRICAL AND MECHANICAL CONSIDERATIONS

Voltage Transient Suppression

We strongly recommend that the same power supply be used for the display and the components that interface with the display to avoid logic inputs higher than V_{CC}. Additionally, the LEDs may cause transients in the power supply line while they change display states. The common practice is to place .01 µF capacitors close to the displays across V_{CC} and GND, one for each display, and one 10 µF capacitor for every second display.

ESD Protection

The metal gate CMOS IC of the DL1414T is extremely immune to ESD damage. However, users of these devices are encouraged to take all the standard precautions, normal for CMOS components. These include properly grounding personnel, tools, tables, and transport carriers that come in contact with unshielded parts. Where these conditions are not, or cannot be met, keep the leads of the device shorted together or the parts in anti-static packaging.

Soldering Considerations

THE DL1414T can be hand soldered with SN63 solder using a grounded iron set to 260°C.

Wave soldering is also possible following these conditions: Preheat that does not exceed 93°C on the solder side of the PC board or a package surface temperature of 85°C. Water soluble organic acid flux (except carboxylic acid) or resin-based RMA flux without alcohol can be used.

Wave temperature of 245°C ±5°C with a dwell between 1.5 sec. to 3.0 sec. Exposure to the wave should not exceed temperatures above 260°C for five seconds at 0.063" below the seating plane. The packages should not be immersed in the wave.

Post Solder Cleaning Procedures

The least offensive cleaning solution is hot D.I. water (60°C) for less than 15 minutes. Addition of mild saponifiers is acceptable. Do not use commercial dishwasher detergents.

For faster cleaning, solvents may be used. Exercise care in choosing solvents as some may chemically attack the nylon package. Maximum exposure should not exceed two minutes at elevated temperatures. Acceptable solvents are TF (trichorotrifluorethane), TA, 111 Trichloroethane, and unheated acetone.

Note: Acceptable commercial solvents are: Basic TF, Arklone P, Genesolve D, Blaco-tron TF, Freon TA, Genesolve DA, and Blaco-tron TA.

Unacceptable solvents contain alcohol, methanol, methylene chloride, ethanol, TP35, TCM, TMC, TMS+, TE, or TES. Since many commercial mixtures exist, contact a solvent vendor for chemical composition information. Some major solvent manufacturers are: Allied Chemical Corporation, Specialty Chemical Division, Morristown, NJ; Baron-Blakeslee, Chicago, IL; Dow Chemical, Midland, MI; E.I. DuPont de Nemours & Co., Wilmington, DE.

For further information refer to Appnotes 18 and 19 in the current Siemens Optoelectronic Data Book.

An alternative to soldering and cleaning the display modules is to use sockets. Eighteen pin DIP sockets .600" wide with .100" centers work well for single displays. Multiple display assemblies are best handled by longer SIP sockets or DIP sockets when available for uniform package alignment. Socket manufacturers are Aries Electronics, Inc., Frenchtown, NJ; Garry Manufacturing, New Brunswick, NJ; Robinson-Nugent, New Albany, IN; and Samtec Electronic Hardware, New Albany, IN.

For further information refer to Appnote 22 in the current Siemens Optoelectronic Data Book.

Optical Considerations

The .112" high characters of the DL1414T gives readability up to eight feet. The user can build a display that enhances readability over this distance by proper filter selection .

Using filters emphasizes the contrast ratio between a lit LED and the character background. This will increase the discrimination of different characters. The only limitation is cost. Remember to take into consideration the ambient lighting environment for the best cost/benefit ratio for filters.

Incandescent (with almost no green) or fluorescent (with almost no red) lights do not have the flat spectral response of sunlight. Plastic band-pass filters are an inexpensive and effective way to strengthen contrast ratios. The DL1414T is a standard red display and should be matched with long wavelength pass filter in the 600 nm to 620 nm range. For displays of multiple colors, neutral density grey filters offer the best compromise.

Additional contrast enhancement can be gained by shading the displays. Plastic band-pass filters with built-in louvers offer the next step up in contrast improvement. Plastic filters can be improved further with anti-reflective coatings to reduce glare. The trade-off is fuzzy characters. Mounting the filters close to the display reduces this effect. Take care not to overheat the plastic filter by allowing for proper air flow.

Optimal filter enhancements are gained by using circular polarized, anti-reflective, band-pass filters. The circular polarizing further enhances contrast by reducing the light that travels through the filter and reflects back off the display to less than 1%.

Several filter manufacturers supply quality filter materials. Some of them are: Panelgraphic Corporation, W. Caldwell, NJ; SGL Homalite, Wilmington, DE; 3M Company, Visual Products Division, St. Paul, MN; Polaroid Corporation, Polarizer Division, Cambridge, MA; Marks Polarized Corporation, Deer Park, NY, Hoya Optics, Inc., Fremont, CA.

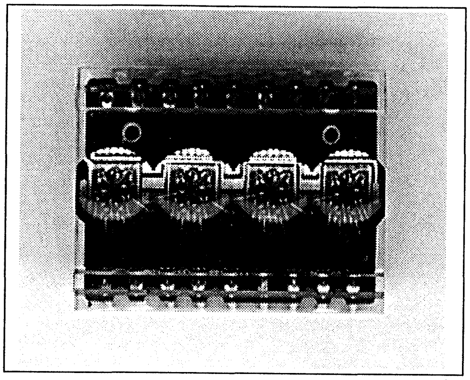
One last note on mounting filters: recessing displays and bezel assemblies is an inexpensive way to provide a shading effect in overhead lighting situations. Several bezel manufacturers are: R.M.F. Products, Batavia, IL; Nobex Components, Griffith Plastic Corp., Burlingame, CA; Photo Chemical Products of California, Santa Monica, CA; I.E.E.-Atlas, Van Nuys, CA.

Refer to Siemens Appnote 23 for further information.

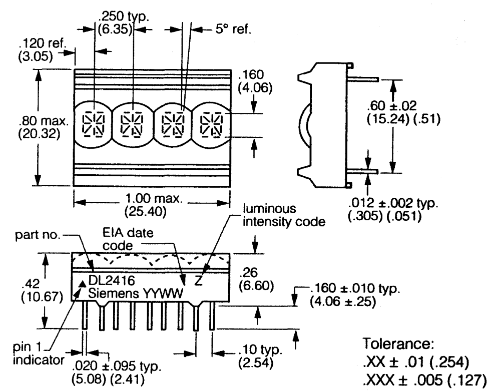
SIEMENS

DL2416T

.160" Red, 4-Character 16 Segment Plus Decimal Alphanumeric Intelligent Display® With Memory/Decoder/Driver



Package Dimensions in Inches (mm)



FEATURES

- 0.16" x 0.125 Magnified Character
- Wide Viewing Angle, X Axis ±45°, Y Axis ±55°
- Close Multi-line Spacing, 0.8" Centers
- Rugged Solid Plastic Encapsulated Package
- Fast Access Time, 110 ns at 25°C
- Full Size for Stationery Equipment
- Built- in Memory
- Built- in Character Generator
- Built- in Multiplex and LED Drive Circuitry
- Direct Access to Each Digit Independently and Asynchronously
- Independent Cursor Function
- 17th Segment for Improved Punctuation Marks
- Memory Clear Function that Clears Character and Cursor Memory Simultaneously
- True Blanking for Intensity Dimming Applications
- Brightness Control for 100%, 85%, 70%, and 57% Brightness Levels
- End Stackable, 4 Character Package
- Intensity Coded for Display Uniformity
- Extended Operating Temperature Range: –40°C to +85°C
- Superior ESD Immunity
- 100% Burned in and Tested
- Wave Solderable
- TTL Compatible over Operating Temperature Range

DESCRIPTION

The DL2416T is a four digit display module with 16 bar segments plus a decimal and a built-in CMOS integrated circuit.

The integrated circuit contains memory, ASCII character generator, multiplexing circuitry and drivers. Data entry is asynchronous and can be random. A display system can be built using any number of DL2416s since each digit in any DL2416T can be addressed independently and will continue to display the character last stored until replaced by another.

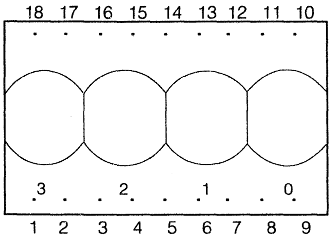
System interconnection is also straightforward. The least significant two address bits (A0, A1) are normally connected to the like named inputs of all DL2416Ts in the system. With two chip enables ($\overline{CE1}$ and $\overline{CE2}$), four DL2416Ts (16 characters) can easily be interconnected without a decoder.

Data lines are connected to all DL2416Ts directly and in parallel, as is the write line ($\overline{WR}$). The display will then behave as a write-only memory.

The DL2416T has several features superior to competitive devices. 100% pre-burned in processing assures users that the device will function in more stressful assembly and use environments. The full width character "J" gives better readability under adverse conditions, and the "true blanking" allows the designer to dim the display for more flexibility of display presentation. The $\overline{CLR}$ clear function will clear the cursor RAM and the ASCII character RAM, simultaneously. Finally, a new brightness control feature allows programming the displays at 100%, 85%, 70%, and 57% brightness levels.

All products are 100% burned in and tested, then subjected to outgoing AQL's of 0.25% for brightness matching, visual alignment, and dimensions, 0.065% for electrical and functional.

Top View



Pin	Function	Pin	Function
1	$\overline{CE1}$ Chip Enable	**10**	GND
2	$\overline{CE2}$ Chip Enable	**11**	D0 Data Input
3	$\overline{CLR}$ Clear	**12**	D1 Data Input
4	CUE Cursor Enable	**13**	D2 Data Input
5	$\overline{CU}$ Cursor Select	**14**	D3 Data Input
6	$\overline{WR}$ Write	**15**	D6 Data Input
7	A1 Digit Select	**16**	D5 Data Input
8	A0 Digit Select	**17**	D4 Data Input
9	V_{CC}	**18**	$\overline{BL}$ Display Blank

Maximum Ratings

Supply Voltage, V_{CC} .... –0.5 to +6.0 Vdc
Voltage, Any Pin Respect to GND .... –0.5 to (V_{CC} +0.5) Vdc
Operating Temperature .... –40°C to +85°C
Storage Temperature .... –40°C to +100°C
Relative Humidity (non condensing) at 85°C 85%
Maximum Solder Temperature, .063" (1.59mm)
below Seating Plane, t<5 sec. .... 260°C

Optical Characteristics

Spectral Peak Wavelength .... 660 nm typ.
Magnified Digit Size .... 0.160" X 0.125"
Time Averaged Luminous Intensity
(100% brightness, ... 0.5 mcd/digit min.
8 Segments/Digit, V_{CC} = 5V .... 1.0 mcd/digit typ.
LED to LED Intensity Matching .... 1.8:1.0 max.
Device to Device Intensity Matching (one bin) ...... 1.5:1.0 max.
Bin to Bin Intensity Matching .... 1.9:1.0 max.
Viewing Angle (off normal axis)
Horizontal .... ±45°
Vertical .... ±55°

DC Characteristics

Parameter	–40°C			+25°C			+85°C			Units	Conditions
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max		
I_{CC}(1) 4 Digitis on 10 segments/digit		100	130		85	115		70	100	mA	V_{CC} = 5 V
I_{CC} Cursor (1,2)		140	185		120	165		100	145	mA	V_{CC} = 5 V
I_{CC} Blank(1)		2.0	5.0		1.5	4.0		1.0	2.7	mA	V_{CC} = 5 V, $\overline{BL}$= 0.8 V
I_{IL} (all inputs)		80	180		60	160		45	90	µA	V_{IN}= 0.8 V, V_{CC} = 5 V
V_{IH}	2.0			2.0			2.0			V	V_{CC} = 5 V±0.5 V
V_{IL}			0.8			0.8			0.8	V	V_{CC} = 5 V±0.5 V

Notes: 1. Measured at 5 sec.
2. 60 sec. maximum duration.

AC Characteristics Guaranteed Minimum Timing Parameters at V_{CC} = 4.5 V ≤ V_{CC} ≤ 5.5 V

Parameter	Symbol	–40°C (ns)	+25°C (ns)	+85°C (ns)	Units
Address Set Up Time	T_{AS}	10	10	10	ns
Cursor Set Up Time	T_{CUS}	10	10	10	ns
Chip Enable Set Up Time	T_{CES}	0	0	0	ns
Clear Disable	T_{CLRD}	1	1	1	µs
Write Time	T_W	60	70	90	ns
Data Set Up Time	T_{DS}	20	30	50	ns
Chip Enable Hold Time	T_{CEH}	0	0	0	ns
Cursor Hold Time	T_{CUH}	20	30	40	ns
Address Hold Time	T_{AH}	20	30	40	ns
Data Hold Time	T_{DH}	20	30	40	ns
Clear Time	T_{CLR}	1	1	1	µs
Total Access Time(1)	T_{ACC}	90	110	140	ns

Notes: 1. Access time $T_{ACC}=T_{AS} + T_W + T_{DH}$.
2. Digit multiplex frequency may vary from 200 Hz to 800 Hz.
3. T_{CLR} = Time to clear character RAM, cursor RAM, counter chain, and the display.
4. T_{CLRD} = Must be inactive before next write cycle.

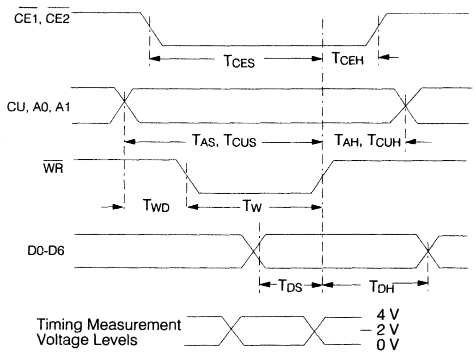
Loading Data

Setting the chip enable (CE1, CE2) to their true state will enable data loading. The desired data code (D0-D6) and digit address (A0, A1) must be held stable during the write cycle for storing new data.

Data entry may be asynchronous and random. (Digit 0 is defined as right hand digit with A1=A2=0.)

Clearing the entire internal four-digit memory can be accomplished by holding the clear (CLR) low for one µS minimum. The clear function will clear both the ASCII RAM and the cursor RAM. Loading an illegal data code will display a blank.

Timing Characteristics—Write Cycle Waveforms



Typical Loading Data State Table

Control							Address		Data							Display Digit			
BL	CE1	CE2	CUE	CU	WR	CLR	A1	A0	D6	D5	D4	D3	D2	D1	D0	3	2	1	0
H	X	X	L	X	H	H			previously loaded display							G	R	E	Y
H	H	X	L	X	X	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	X	H	L	X	X	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	L	L	L	H	L	H	L	L	H	L	L	L	H	L	H	G	R	E	E
H	L	L	L	H	L	H	L	H	H	L	H	L	H	L	H	G	R	U	E
H	L	L	L	H	L	H	H	L	H	L	L	H	H	L	L	G	L	U	E
H	L	L	L	H	L	H	H	H	H	L	L	L	L	H	L	B	L	U	E
L	X	X	X	X	H	H	X	X	blank display										
H	L	L	L	H	L	H	H	H	H	L	L	L	H	H	H	G	L	U	E
H	X	X	L	X	H	L	X	X	clears character displays							see character set			
H	L	L	L	H	L	H	X	X	see character code										

X = don't care

Loading Cursor

Setting the chip enables ($\overline{CE1}$, $\overline{CE2}$) and cursor select ($\overline{CU}$) to their true state will enable cursor loading. A write ($\overline{WR}$) pulse will now store or remove a cursor into the digit location addressed by A0, A1, as defined in data entry. A cursor will be stored if D0=1; and will be removed if D0=0. The cursor ($\overline{CU}$) pulse width should not be less than the write ($\overline{WR}$) pulse or erroneous data may appear in the display.

If the cursor isn't required, the cursor enable signal (CUE) may be tied low to disable the display of the cursor function. For a flashing cursor, simply pulse CUE. If the cursor has been loaded to any or all positions in the display, then CUE will control whether the cursor(s) or the characters appear. CUE does not affect the contents of cursor memory.

Display Blanking

To blank the display, load a blank or space into each digit of the display or use the ($\overline{BL}$) display blank input.

Setting the ($\overline{BL}$) input low does not affect the contents of either data or cursor memory. A flashing display will result by pulsing ($\overline{BL}$).

A flashing circuit can be easily constructed using a 555 astable multivibrator. Figure 1 illustrates a circuit in which varying R1 (100K~10K) will have a flash rate of 1Hz~10Hz.

The display can be dimmed by pulse width modulating the ($\overline{BL}$) at a frequency sufficiently fast not to interfere with the internal clock. This clock frequency may vary from 200 Hz to 1.3KHz. The dimming signal frequency should be 2.5KHz or higher. Dimming the display also reduces power consumption.

See Figure 2 for an example of a simple dimming circuit using a 556. Adjusting potentiometer R2 will dim the display through frequency modulation (2.5 KHz to 4.4 KHz). Adjusting potentiometer R3 will dim the display by increasing the negative pulse width (10% to 50%).

Figure 1. Flashing Circuit for DL2416T Using A 555

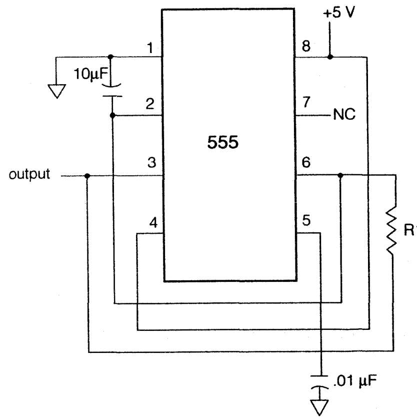
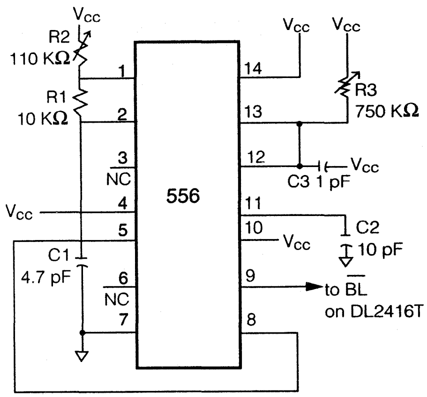


Figure 2. Dimming Circuit for DL2416T Using A 556



Loading Cursor State Table

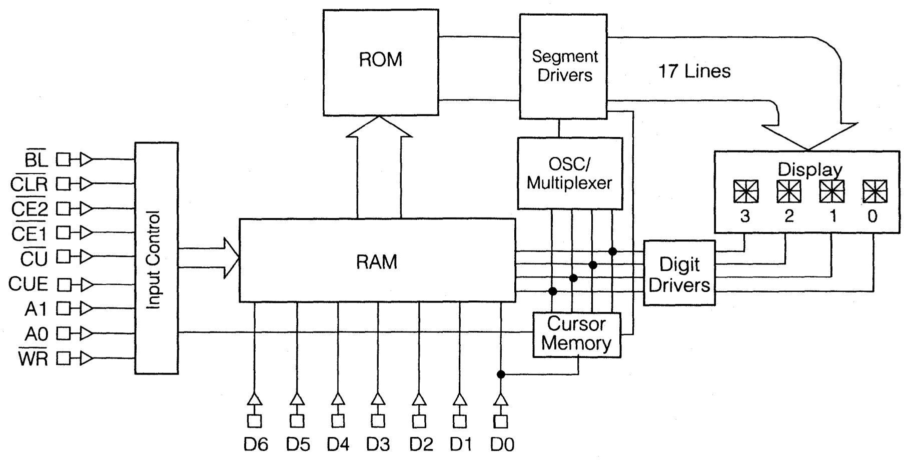
$\overline{BL}$	$\overline{CE1}$	$\overline{CE2}$	CUE	$\overline{CU}$	$\overline{WR}$	$\overline{CLR}$	A1	A0	D6	D5	D4	D3	D2	D1	D0	3	2	1	0
H	X	X	L	X	H	H			previously loaded display							B	E	A	R
H	X	X	H	X	H	H			display previously stored cursors							B	E	A	R
H	L	L	H	L	L	H	L	L	X	X	X	X	X	X	H	B	E	A	
H	L	L	H	L	L	H	L	H	X	X	X	X	X	X	H	B	E		
H	L	L	H	L	L	H	H	L	X	X	X	X	X	X	H	B			
H	L	L	H	L	L	H	H	H	X	X	X	X	X	X	H				
H	L	L	H	L	L	H	H	L	X	X	X	X	X	X	L		E		
H	X	X	L	X	H	H			disable cursor display							B	E	A	R
H	L	L	L	L	L	H	H	H	X	X	X	X	X	X	L	B	E	A	R
H	X	X	H	X	H	H			display stored cursors							B	E		

(Column groups: Control = $\overline{BL}$ to $\overline{CLR}$; Address = A1, A0; Data = D6–D0; Display Digit = 3, 2, 1, 0)

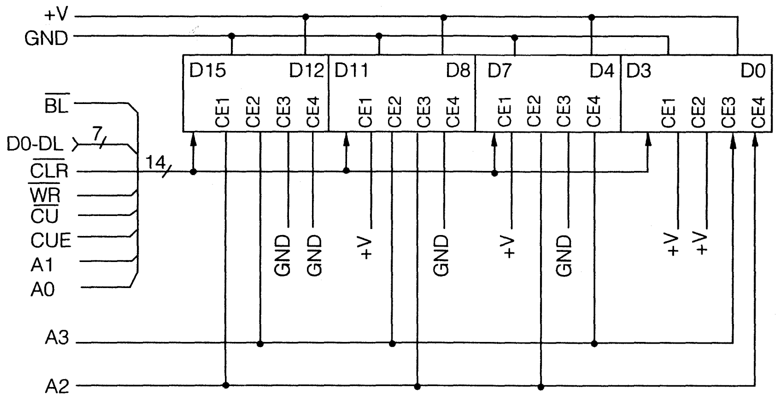
X = don't care

= ⊠

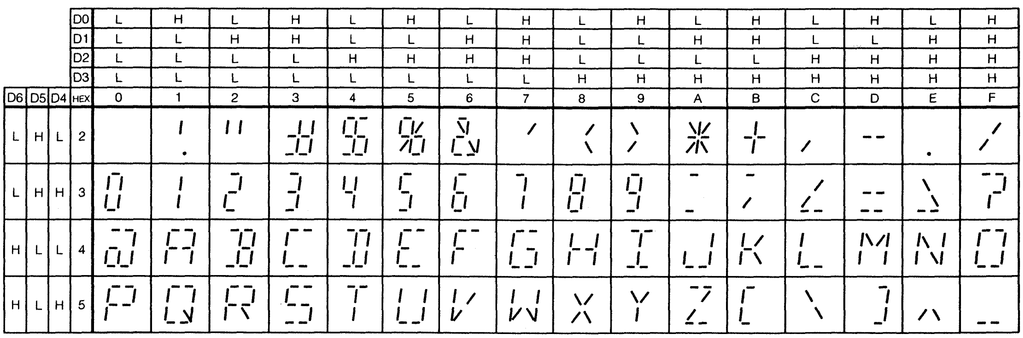
Internal Block Diagram



Typical Schematic for 16 Digit System



Character Set



All other input codes display “blank”

Design Considerations

For details on design and applications of the DL2416T using standard bus configurations in multiple display systems, or parallel I/O devices, such as the 8255 with an 8080 or memory mapped addressing on processors such as the 8080, Z80, 6502, 8748, or 6800, refer to Appnote 14 and 20 in the current Siemens Optoelectronic Data Book.

ELECTRICAL AND MECHANICAL CONSIDERATIONS

Voltage Transient Suppression

We strongly recommend that the same power supply be used for the display and the components that interface with the display to avoid logic inputs higher than V_{CC}. Additionally, the LEDs may cause transients in the power supply line while they change display states. The common practice is to place .01 µF capacitors close to the displays across V_{CC} and GND, one for each display, and one 10 µF capacitor for every second display.

ESD Protection

The metal gate CMOS IC of the DL2416T is extremely immune to ESD damage. However, users of these devices are encouraged to take all the standard precautions, normal for CMOS components. These include properly grounding personnel, tools, tables, and transport carriers that come in contact with unshielded parts. Where these conditions are not, or cannot be met, keep the leads of the device shorted together or the parts in anti-static packaging.

Soldering Considerations

THE DL2416T can be hand soldered with SN63 solder using a grounded iron set to 260°C.

Wave soldering is also possible following these conditions: Preheat that does not exceed 93°C on the solder side of the PC board or a package surface temperature of 85°C. Water soluble organic acid flux (except carboxylic acid) or resin-based RMA flux without alcohol can be used.

Wave temperature of 245°C ±5°C with a dwell between 1.5 sec. to 3.0 sec. Exposure to the wave should not exceed temperatures above 260°C for five seconds at 0.063" below the seating plane. The packages should not be immersed in the wave.

Post Solder Cleaning Procedures

The least offensive cleaning solution is hot D.I. water (60°C) for less than 15 minutes. Addition of mild saponifiers is acceptable. Do not use commercial dishwasher detergents.

For faster cleaning, solvents may be used. Exercise care in choosing solvents as some may chemically attack the nylon package. Maximum exposure should not exceed two minutes at elevated temperatures. Acceptable solvents are TF (trichorotrifluorethane), TA, 111 Trichloroethane, and unheated acetone.

Note: Acceptable commercial solvents are: Basic TF, Arklone P, Genesolve D, Blaco-tron TF, Freon TA, Genesolve DA, and Blaco-tron TA.

Unacceptable solvents contain alcohol, methanol, methylene chloride, ethanol, TP35, TCM, TMC, TMS+, TE, or TES. Since many commercial mixtures exist, contact a solvent vendor for chemical composition information. Some major solvent manufacturers are: Allied Chemical Corporation, Specialty Chemical Division, Morristown, NJ; Baron-Blakeslee, Chicago, IL; Dow Chemical, Midland, MI; E.I. DuPont de Nemours & Co., Wilmington, DE.

For further information refer to Appnotes 18 and 19 in the current Siemens Optoelectronic Data Book.

An alternative to soldering and cleaning the display modules is to use sockets. Eighteen pin DIP sockets .600" wide with .100" centers work well for single displays. Multiple display assemblies are best handled by longer SIP sockets or DIP sockets when available for uniform package alignment. Socket manufacturers are Aries Electronics, Inc., Frenchtown, NJ; Garry Manufacturing, New Brunswick, NJ; Robinson-Nugent, New Albany, IN; and Samtec Electronic Hardware, New Albany, IN.

For further information refer to Appnote 22 in the current Siemens Optoelectronic Data Book.

Optical Considerations

The .160" high characters of the DL2416T gives readability up to eight feet. The user can build a display that enhances readability over this distance by proper filter selection .

Using filters emphasizes the contrast ratio between a lit LED and the character background. This will increase the discrimination of different characters. The only limitation is cost. Remember to take into consideration the ambient lighting environment for the best cost/benefit ratio for filters.

Incandescent (with almost no green) or fluorescent (with almost no red) lights do not have the flat spectral response of sunlight. Plastic band-pass filters are an inexpensive and effective way to strengthen contrast ratios. The DL2416T is a standard red display and should be matched with long wavelength pass filter in the 600 nm to 620 nm range. For displays of multiple colors, neutral density grey filters offer the best compromise.

Additional contrast enhancement can be gained by shading the displays. Plastic band-pass filters with built-in louvers offer the next step up in contrast improvement. Plastic filters can be improved further with anti-reflective coatings to reduce glare. The trade-off is fuzzy characters. Mounting the filters close to the display reduces this effect. Take care not to overheat the plastic filter by allowing for proper air flow.

Optimal filter enhancements are gained by using circular polarized, anti-reflective, band-pass filters. The circular polarizing further enhances contrast by reducing the light that travels through the filter and reflects back off the display to less than 1%.

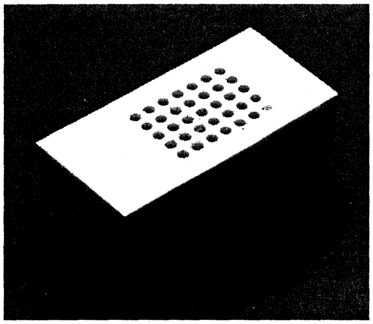
Several filter manufacturers supply quality filter materials. Some of them are: Panelgraphic Corporation, W. Caldwell, NJ; SGL Homalite, Wilmington, DE; 3M Company, Visual Products Division, St. Paul, MN; Polaroid Corporation, Polarizer Division, Cambridge, MA; Marks Polarized Corporation, Deer Park, NY, Hoya Optics, Inc., Fremont, CA.

One last note on mounting filters: recessing displays and bezel assemblies is an inexpensive way to provide a shading effect in overhead lighting situations. Several bezel manufacturers are: R.M.F. Products, Batavia, IL; Nobex Components, Griffith Plastic Corp., Burlingame, CA; Photo Chemical Products of California, Santa Monica, CA; I.E.E.-Atlas, Van Nuys, CA.

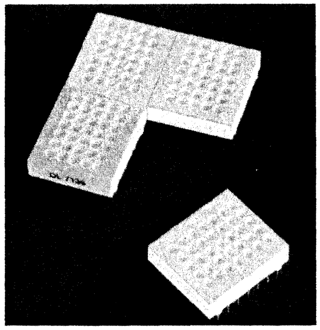
Refer to Siemens Appnote 23 for further information.

SIEMENS

HIGH EFFICIENCY RED DLO4135/7135
GREEN DLG4137/7137
.43" Single Character DLO4135/7
.68" Single Character DLO7135/7
5x7 Dot Matrix Intelligent Display®
with Memory/Decoder/Driver

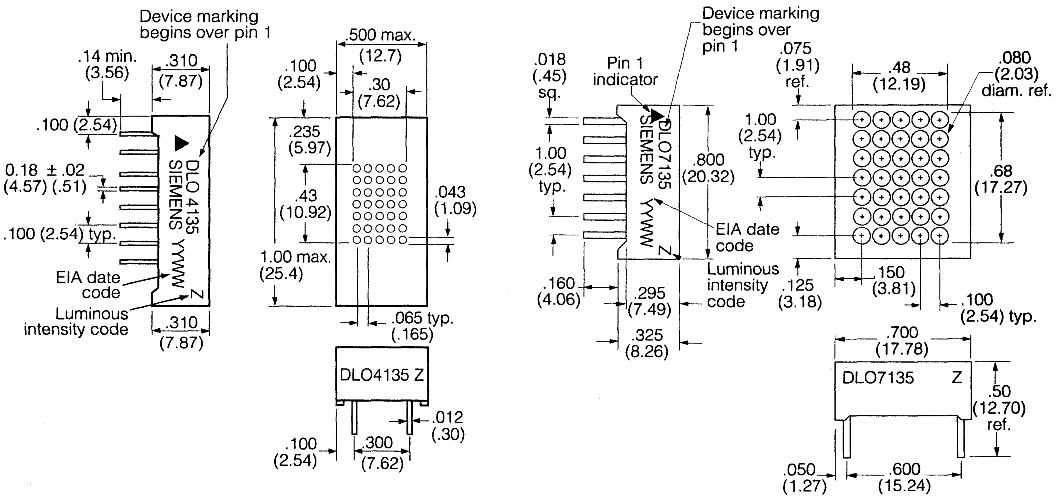


DLO4135/4137



DLO7135/7137

Package Dimensions in Inches (mm)



FEATURES

- 5x7 Dot Matrix Characters
  DLO4135/DLG4137: .43" High
  DLO7135/DLG7137: .68" High
- Wide Viewing Angle ±75°
- 96 Character ASCII Set
  Upper Case and Lower Case Characters
- Fully Encapsulated, Rugged Solid Plastic Package
- Built-in Memory
- Built-in Character Generator
- Built-in Multiplex and LED Drive Circuitry
- Built-in Lamp Test
- Intensity Control (4 levels)
- Microprocessor Bus Compatible
- Intensity Coded for Display Uniformity
- Single 5-Volt Power Supply
- X/Y Stackable
- Available in High Efficiency Red and Green

DESCRIPTION

The DLX413X/DLX713X are single digit 5x7 dot matrix Intelligent Display devices. The DLX413X character is 0.43" high. The DLX713X character is 0.68" high. The built-in CMOS integrated circuit contains memory, ASCII character generator, LED multiplexing and drive circuitry; thereby eliminating the need for additional circuitry. They will display the 96 ASCII characters.

These devices are TTL and microprocessor compatible and offer the possibility of cascading the displays, allowing for multi-character messages. These displays were designed for viewing distances of up to 20 feet(DLX413X) or 30 feet (DLX713X). They require a single 5-volt power supply and parallel ASCII input.

All products are 100% tested, then subjected to out-going AQLs of .25% for brightness matching, visual alignment and dimensions, .065% for electrical and functional.

Important: Refer to Appnote 18, "Using and Handling Intelligent Displays." Since this is a CMOS device, normal precautions should be taken to avoid static damage.

Timing Parameters at 25°C, V_{CC}=5.0 V ±0.5 V

Symbol	Parameter	Units (ns)
T_{CES}	Chip Enable Set-Up	10
T_{DS}	Data Set Up	100
T_W	Write Pulse	120
T_{DH}	Data Hold	20
T_{CEH}	Chip Enable Hold	20
T_{ACC}	Access Time	150

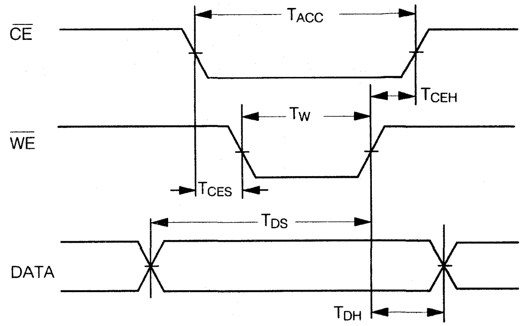
Maximum Ratings

V_{CC} Range (max.) . . . . –0.5 to +7.0 Vdc
Voltage, Any Pin, Respect to GND . . . . . . –0.5 to V_{CC} +0.5 Vdc
Operating Temperature . . . . –40°C to +85°C
Storage Temperature . . . . –40°C to +100°C
Maximum Solder Temperature, .063"
below Seating Plane, t<5 sec. . . . . 260°C
Relative Humidity at 85°C (non condensing) 85%

Optical Characteristics (Typical) at 25°C

Time Averaged Luminous Intensity/Dot at 5 V . . 1500 mcd typ.
Character Size
DLO4135/DLG4137 . . . . 0.43"
DLO7135/DLG7137 . . . . 0.68"
Viewing Angle (Note 1). . . . . ±75°
Spectral Peak Wavelength
DLO4135/7135 (High Efficiency Red) . . . . .635 nm typ.
DLG4137/7137 (Green) .565 nm typ.
Dot to Dot Intensity Ratio . . . . 1.8:1.0 max.

Timing Characteristics — Write Cycle Waveforms

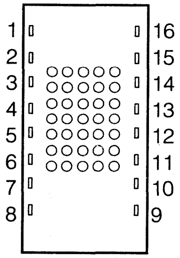


DC Characteristics

Parameter	–40°C			+25°C			+85°C			Units	Conditions
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.		
I_{CC} (20 dots on)		135	180		100	140		85	115	mA	V_{CC}=5 V, $\overline{BL0}$=$\overline{BL1}$=5 V
I_{CC} Blank		2.0	5.5		1.5	4.0		0.8	3.5	mA	V_{CC}=WR=5.0 V, $\overline{BL0}$=$\overline{BL1}$=0 V
I_{IL} (all inputs)				25	50	100				μA	V_{IN}=0.8 V, V_{CC}=5 V ±0.5 V
V_{IH}	2.0			2.0			2.0			V	V_{CC}=5 V ±0.5 V
V_{IL}			0.8			0.8			0.8	V	V_{CC}=5 V ±0.5 V
V_{CC}	4.5	5.0	5.5	4.5	5.0	5.5	4.5	5.0	5.5	V	

Notes
1. "Off Axis Viewing Angle" definition: The minimum angle in any direction from the normal to the display surface at which any part of any dot in the display is not visible.
2. **This display contains a CMOS integrated circuit. Normal CMOS handling precautions should be taken to avoid damage due to high static voltages or electric fields. See Appnote 18.**
3. Unused inputs must be tied to an appropriate logic voltage level (either V + or GND).
4. V_{CC}=5.0 VDC ±10%.
5. Clean only in water, isopropyl alcohol, freon TF, TE (or equivalent).

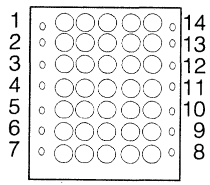
Top View — DLO4135/DLG4137



Pin Functions — DLO4135/DLG4137

Pin	Function	Pin	Function
1	$\overline{LT}$ Lamp	9	D0 Data LSB
2	$\overline{WR}$ Write	10	D1 Data
3	$\overline{BL1}$ Brightness	11	D2 Data
4	$\overline{BL0}$ Brightness	12	D3 Data
5	No Pin	13	D4 Data
6	No Pin	14	D5 Data
7	$\overline{CE}$ Chip Enable	15	D6 Data MSB
8	GND	16	$+V_{CC}$

Top View — DLO7135/DLG7137



Pin Functions — DLO7135/DLG7137

Pin	Function	Pin	Function
1	V_{CC}	8	D0 Data Input LSB
2	$\overline{LT}$ Lamp Test	9	D1 Data
3	$\overline{CE}$ Chip Enable	10	D2 Data
4	$\overline{WR}$ Write	11	D3 Data
5	$\overline{BL1}$ Brightness	12	D4 Data
6	$\overline{BL0}$ Brightness	13	D5 Data
7	GND	14	D6 Data Input MSB

Lamp Test

When the lamp test ($\overline{LT}$) is activated, all dots on the display are illuminated at 1/7 brightness. The lamp test function is independent of write ($\overline{WR}$) and the settings of the blanking inputs ($\overline{BL0}$, $\overline{BL1}$).

This convenient test gives a visual indication that all dots are functioning properly. Lamp test also may be used as a cursor function or pointer which does not destroy previously displayed characters.

Dimming and Blanking the Display

Brightness Level	$\overline{BL1}$	$\overline{BL0}$
Blank	0	0
1/7 Brightness	0	1
1/2 Brightness	1	0
Full Brightness	1	1

Loading Data

Loading data into the display is straightforward. Chip enable ($\overline{CE}$) should be present and stable during a write pulse ($\overline{WR}$). Parallel data information should be stable for the minimum time (T_W) and held for TDH after write has gone high. No synchronization is necessary and each character will continue to be displayed until it is replaced with another. Multiple displays may be stacked together with only an additional decoder IC for chip enable decoding.

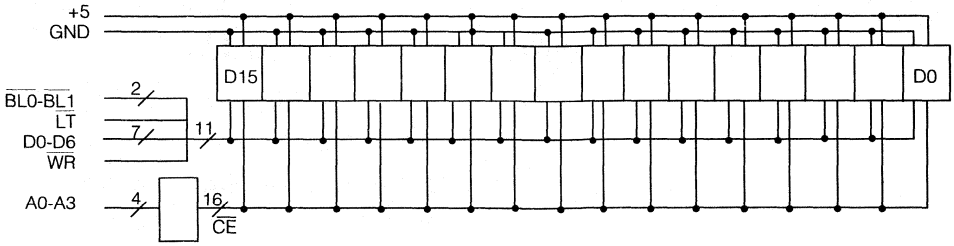
Note : Either $\overline{BL0}$ or $\overline{BL1}$ should be held high for display to light up.

Data Loading Example

$\overline{CE}$	$\overline{WR}$	$\overline{BL0}$	$\overline{BL1}$	$\overline{LT}$	Data Input							
					D6	D5	D4	D3	D2	D1	D0	
H	X	H	X	H	X	X	X	X	X	X	X	NC
X	X	L	L	H	X	X	X	X	X	X	X	Blank
X	X	X	X	L	X	X	X	X	X	X	X	Lamp Test
L	L	H	H	H	H	L	L	L	L	L	H	A
L	L	H	H	H	H	H	H	L	L	H	L	r
L	L	H	H	H	L	H	H	L	L	H	H	3
L	L	H	H	H	L	H	L	H	L	H	H	+

X=don't care, NC=no change

16 Digits Interconnection



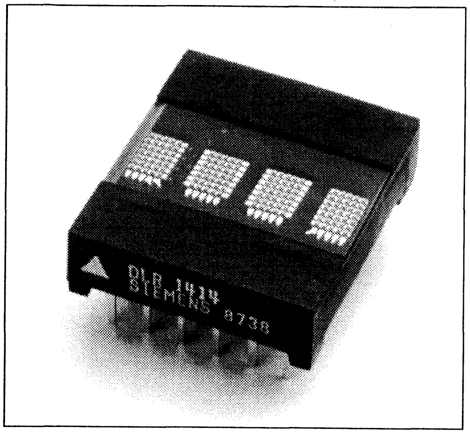
Character Set

ASCII CODE			D0	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
			D1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
			D2	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
			D3	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
D6	D5	D4	HEX	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	0	0	0	THESE CODES DISPLAY BLANK															
0	0	1	1																
0	1	0	2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
0	1	1	3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
1	0	0	4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	0	1	5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
1	1	0	6	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
1	1	1	7	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	▒

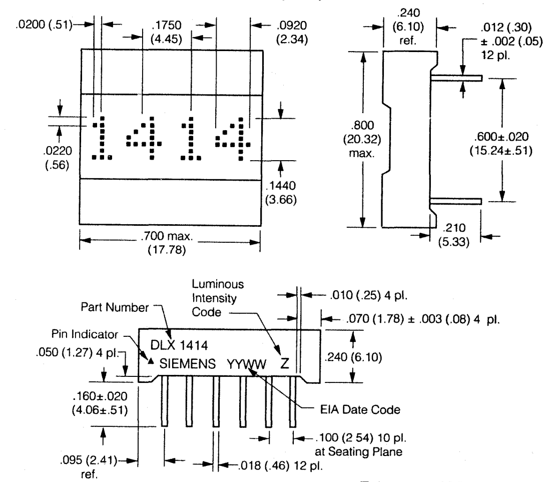
Notes: 1. High = 1 level.
2. Low = 0 level.
3. Upon power up, the device will initialize in a random state.

SIEMENS

RED DLR1414
HIGH EFFICIENCY RED DLO1414
GREEN DLG1414
.145" 4-Character, Dot Matrix Alphanumeric Intelligent Display" With Memory/Decoder/Driver



Package Dimensions in Inches (mm)



Tolerance: .XXX ±.01 (.254)

FEATURES

- **Dot Matrix Replacement for DL1414T**
- **0.145" High, Dot Matrix Character**
- **128 Special ASCII Characters for English, German, Italian, Swedish, Danish, and Norwegian Languages**
- **Wide Viewing Angle: X Axis ±50°, Y Axis ±75°**
- **Close Vertical Row Spacing, 0.800" Centers**
- **Fast Access Time, 110 ns at 25° C**
- **Compact Size for Hand Held Equipment**
- **Built- in Memory**
- **Built-in Character Generator**
- **Built-in Multiplex and LED Drive Circuitry**
- **Direct Access to Each Digit Independently and Asynchronously**
- **TTL Compatible, 5 Volt Power**
- **Low Power Consumption, 20 mA per Character Typical**
- **Intensity Coded for Display Uniformity**
- **Extended Operating Temperature Range: –40°C to +85°C**
- **End Stackable, 4 Character Package**

DESCRIPTION

The DLR/DLO/DLG1414 is a four digit 5x7 dot matrix display module with a built-in CMOS integrated circuit. This display is a drop-in dot matrix replacement for the DL1414T with segmented characters.

The integrated circuit contains memory, ASCII ROM decoder, multiplex circuitry and drivers. Data entry is asynchronous and random. A display system can be built using any number of DLX1414s since each character in any DLX1414 can be addressed independently and will continue to display the character last stored until replaced by another.

System interconnection is very straightforward. The least significant two address bits (A0, A1) are normally connected to the like named inputs of all displays in the system. Data lines are connected to all DLX1414s directly and in parallel as is the write line ($\overline{WR}$). The display then will behave as a write only memory.

The DLX1414 has several features superior to competitive devices. The character set consists of 128 special ASCII characters for English, German, Italian, Swedish, Danish, and Norwegian.

See Appnotes 18, 19, 22, and 23 for additional information.

Maximum Ratings

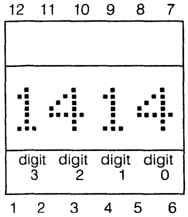
DC Supply Voltage .... –0.5 to +7.0 Vdc
Input Voltage Levels Relative
to GND (all inputs)............... –0.5 to V_{CC} +0.5 Vdc
Operating Temperature ....–40°C to +85°C
Storage Temperature ....–40°C to +100°C
Maximum Solder Temperature, .063" (1.59 mm)
below Seating Plane, t<5 sec. .... 260°C
Relative Humiidity at 85°C 85%

Optical Characteristics

Spectral Peak Wavelength
Red .... 660 nm typ.
High Efficiency Red (HER) .... 630 nm typ.
Green .... 565 nm typ.
Viewing Angle (off normal axis)
Horizontal .... ±50°
Vertical .... ±75°
Character Height... 0.145"
Time Averaged Luminous Intensity[1]
(100% brightness, V_{CC} = 5 V)
Red .... 50 µcd/LED typ.
HER .... 60 µcd/LED typ.
Green .... 70 µcd/LED typ.
LED to LED Intensity Matching .... 1.8:1.0 max.
LED to LED Hue Matching at V_{CC}=5 V
(Green only) .... ±2 nm max.

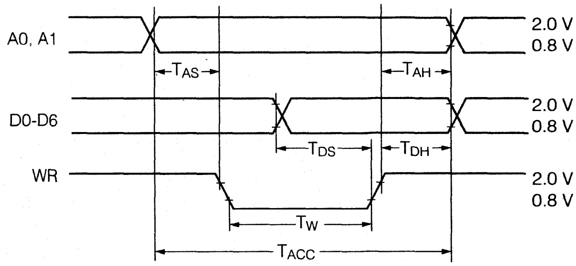
Note:
1. Peak luminous intensity values can be calculated by multiplying these values by 7.

Top View



Pin	Function
1	D5 Data Input
2	D4 Data Input
3	$\overline{WR}$ Write
4	A1 Digit Select
5	A0 Digit Select
6	V_{CC}
7	GND
8	D0 Data Input (LSB)
9	D1 Data Input
10	D2 Data Input
11	D3 Data Input
12	D6 Data Input (MSB)

TIMING CHARACTERISTICS (V_{CC}=4.5 v)



Note: These waveforms are not edge triggered.

DC Characteristics

Parameter	–40°C Min.	–40°C Typ.	–40°C Max.	+25°C Min.	+25°C Typ.	+25°C Max.	+85°C Min.	+85°C Typ.	+85°C Max	Units	Conditions
I_{CC} 4 Digitis on 20 dots/digit		90	120		80	105		70	95	mA	V_{CC}=5 V
I_{CC} Blank		2.8	4.0		2.3	3.0		2.0	2.5	mA	V_{CC}=$\overline{WR}$=5 V V_{IN}=0 V
I_{IL} (all inputs)	30	60	120	25	50	100	20	40	80	mA	V_{IN}=0.8 V V_{CC}= 5 V
V_{IH}	2.0			2.0			2.0			V	V_{CC}=5 V±0.5 V
V_{IL}			0.8			0.8			0.8	V	V_{CC}=5 V±0.5 V
V_{CC}	4.5	5.0	5.5	4.5	5.0	5.5	4.5	5.0	5.5	V	

AC Characteristics Guaranteed Minimum Timing Parameters at V_{CC} =5.0 V ±0.5 V

Parameter	Symbol	–40°C (ns)	+25°C (ns)	+85°C (ns)
Address Set Up Time	T_{AS}	10	10	10
Address Hold Time	T_{AH}	20	30	40
Write Time	T_W	60	70	90
Data Set Up Time	T_{DS}	20	30	50
Data Hold Time	T_{DH}	20	30	40
Access Time(1)	T_{ACC}	90	110	140

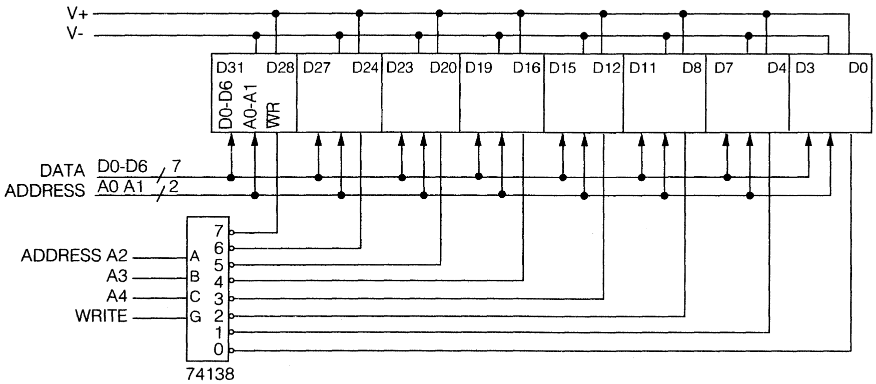
Note: 1. T_{ACC}=Set Up Time + Write Time + Hold Time.

Loading Data State Table

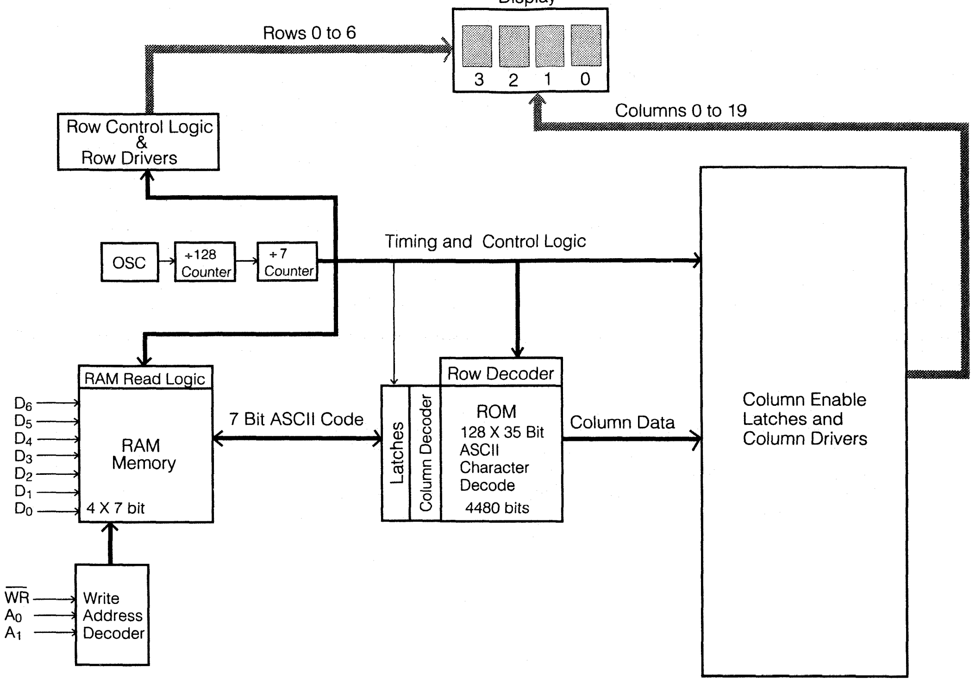
WR	A1	A0	D6	D5	D4	D3	D2	D1	D0	Digit 3	2	1	0
H		previously loaded display								G	R	E	Y
L	L	L	H	L	L	L	H	L	H	G	R	E	E
L	L	H	H	L	H	L	H	L	H	G	R	U	E
L	H	L	H	L	L	H	H	L	L	G	L	U	E
L	H	H	H	L	L	L	L	H	L	B	L	U	E
L	L	H	H	L	L	L	H	L	H	B	L	E	E
L	L	L	H	L	H	L	H	H	H	B	L	E	W
L	X	X	see character code							see character set			

X = don't care

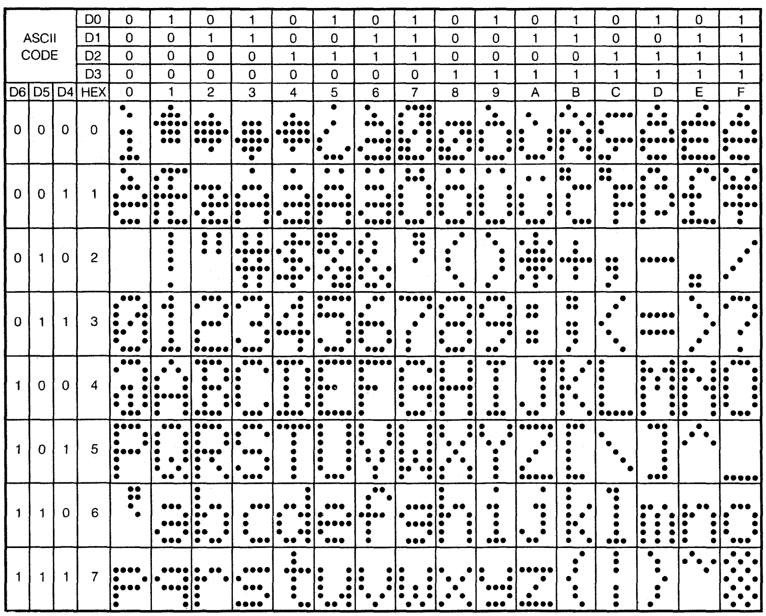
Typical Interconnection for 32 Characters



Block Diagram



Character Set



1. High=1 level. 2. Low=0 level. 3. Upon power up, device will initialize in a random state.

Design Considerations

For details on design and applications of the DLX1414 using standard bus configurations in multiple display systems, or parallel I/O devices, such as the 8255 with an 8080 or memory mapped addressing on processors such as the 8080, Z80, 6502, 8748, or 6800, refer to Appnote 15 in the current Siemens Optoelectronic Data Book.

Electrical & Mechanical Considerations

Voltage Transient Suppression

We strongly recommend that the same power supply be used for the display and the components that interface with the display to avoid logic inputs higher than V_{CC}. Additionally, the LEDs may cause transients in the power supply line while they change display states. The common practice is to place .01 mF capacitors close to the displays across V_{CC} and GND, one for each display, and one 10 mF capacitor for every second display.

ESD Protection

The metal gate CMOS IC of the DLX1414 is extremely immune to ESD damage. However, users of these devices are encouraged to take all the standard precautions, normal for CMOS components. These include properly grounding personnel, tools, tables, and transport carriers that come in contact with unshielded parts. Where these conditions are not, or cannot be met, keep the leads of the device shorted together or the parts in anti-static packaging.

Soldering Considerations

The DLX1414 can be hand soldered with SN63 solder using a grounded iron set to 260°C.

Wave soldering is also possible following these conditions: Preheat that does not exceed 93°C on the solder side of the PC board or a package surface temperature of 85°C. Water soluble organic acid flux (except carboxylic acid) or resin-based RMA flux without alcohol can be used.

Wave temperature of 245°C ±5°C with a dwell between 1.5 sec. to 3.0 sec. Exposure to the wave should not exceed temperatures above 260°C for five seconds at 0.063" below the seating plane. The packages should not be immersed in the wave.

Post Solder Cleaning Procedures

The least offensive cleaning solution is hot D.I. water (60°C) for less than 15 minutes. Addition of mild saponifiers is acceptable. Do not use commercial dishwasher detergents.

For faster cleaning, solvents may be used. Carefully select solvents as some may chemically attack the nylon package. Maximum exposure should not exceed two minutes at elevated temperatures. Acceptable solvents are TF (trichorotrifluorethane), TA, 111 Trichloroethane, and unheated acetone.

Note: Acceptable commercial solvents are: Basic TF, Arklone P, Genesolve D, Blaco-tron TF, Freon TA, Genesolve DA, and Blaco-tron TA.

Unacceptable solvents contain alcohol, methanol, methylene chloride, ethanol, TP35, TCM, TMC, TMS+, TE, or TES. Since many commercial mixtures exist, contact a solvent vendor for chemical composition information. Some major solvent manufacturers are: Allied Chemical Corporation, Specialty Chemical Division, Morristown, NJ; Baron-Blakeslee, Chicago, IL; Dow Chemical, Midland, MI; E.I. DuPont de Nemours & Co., Wilmington, DE.

For further information refer to Appnotes 18 and 19 in the current Siemens Optoelectronic Data Book.

An alternative to soldering and cleaning the display modules is to use sockets. Eighteen pin DIP sockets .600" wide with .100" centers work well for single displays. Multiple display assemblies are best handled by longer SIP sockets or DIP sockets when available for uniform package alignment. Socket manufacturers are Aries Electronics, Inc., Frenchtown, NJ; Garry Manufacturing, New Brunswick, NJ; Robinson-Nugent, New Albany, IN; and Samtec Electronic Hardware, New Albany, IN.

For further information refer to Appnote 22 in the current Siemens Optoelectronic Data Book.

Optical Considerations

The .145" high characters of the DLX1414 gives readability up to eight feet. The user can build a display that enhances readability over this distance by proper filter selection .

Using filters emphasizes the contrast ratio between a lit LED and the character background. This will increase the discrimination of different characters. The only limitation is cost. Remember to take into consideration the ambient lighting environment for the best cost/benefit ratio for filters.

Incandescent (with almost no green) or fluorescent (with almost no red) lights do not have the flat spectral response of sunlight. Plastic band-pass filters are an inexpensive and effective way to strengthen contrast ratios. The DLR1414 is a standard red display and should be matched with long wavelength pass filter in the 600 nm to 620 nm range. For displays of multiple colors, neutral density grey filters offer the best compromise.

The DLO1414 is a high efficiency red display and should be matched with a long wavelength pass filter in the 570 nm to 590 range. The DLG1414 should be matched with a yellow-green band-pass filter that peaks at 565 nm. For displays of multiple colors, neutral density gray filters offer the best compromise.

Additional contrast enhancement can be gained by shading the displays. Plastic band-pass filters with built-in louvers offer the next step up in contrast improvement. Plastic filters can be improved further with anti-reflective coatings to reduce glare. The trade-off is fuzzy characters. Mounting the filters close to the display reduces this effect. Take care not to overheat the plastic filter by allowing for proper air flow.

Optimal filter enhancements are gained by using circular polarized, anti-reflective, band-pass filters. The circular polarizing further enhances contrast by reducing the light that travels through the filter and reflects back off the display to less than 1%.

Several filter manufacturers supply quality filter materials. Some of them are: Panelgraphic Corporation, W. Caldwell, NJ; SGL Homalite, Wilmington, DE; 3M Company, Visual Products Division, St. Paul, MN; Polaroid Corporation, Polarizer Division, Cambridge, MA; Marks Polarized Corporation, Deer Park, NY, Hoya Optics, Inc., Fremont, CA.

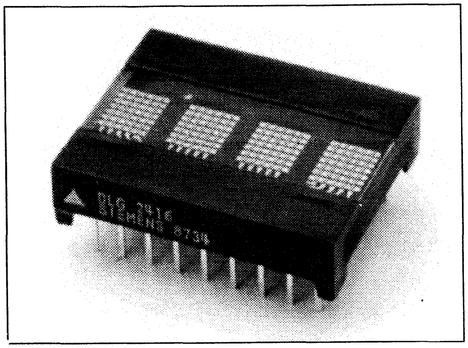
One last note on mounting filters: recessing displays and bezel assemblies is an inexpensive way to provide a shading effect in overhead lighting situations. Several bezel manufacturers are: R.M.F. Products, Batavia, IL; Nobex Components, Griffith Plastic Corp., Burlingame, CA; Photo Chemical Products of California, Santa Monica, CA; I.E.E.-Atlas, Van Nuys, CA.

Refer to Siemens Appnote 23 for further information.

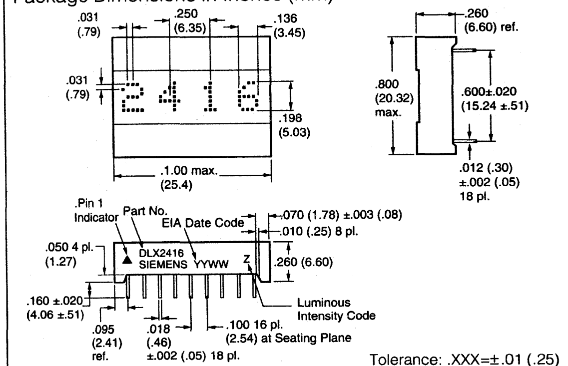
SIEMENS

RED DLR2416
HIGH EFFICIENCY RED DLO2416
GREEN DLG2416

.200" 4-Character 5 x 7 Dot Matrix Alphanumeric Intelligent Display with Memory/Decoder/Driver



Package Dimensions in Inches (mm)



FEATURES

- Dot Matrix Replacement for DL2416T
- 0.200" 5 x 7 Dot Matrix Characters
- 128 Special ASCII Characters for English, German, Italian, Swedish, Danish, and Norwegian Languages
- Wide Viewing Angle: X Axis 50° Maximum, Y Axis ±75° Maximum
- Close Multi-line Spacing, 0.8" Centers
- Fast Access Time, 110 ns at 25°C
- Full Size Display for Stationary Equipment
- Built-in Memory
- Built-in Character Generator
- Built-in Multiplex and LED Drive Circuitry
- Direct Access to Each Digit Independently and Asynchronously
- Independent Cursor Function
- Memory Function: Clears Character and Cursor Memory Simultaneously
- True Blanking for Intensity Dimming Applications
- End-Stackable, 4-Character Package
- Intensity Coded for Display Uniformity
- Extended Operating Temperature Range: -40°C to +85°C
- Superior ESD Immunity
- Wave Solderable
- TTL Compatible over Operating Temperature Range
- Interdigit Blanking

See Appnotes 18, 19, 22, and 23 for additional information.

DESCRIPTION

The DLR/DLO/DLG2416 is a four digit 5x7 dot matrix display module with a built-in CMOS integrated circuit. This display is X/Y stackable.

The integrated circuit contains memory, ASCII ROM decoder, multiplexing circuitry and drivers. Data entry is asynchronous and can be random. A display system can be built using any number of DLX2416s since each digit can be addressed independently and will continue to display the character last stored until replaced by another.

System interconnection is very straightforward. The least significant two address bits (A0, A1) are normally connected to the like-named inputs of all displays in the system. With two chip enables ($\overline{CE1}$ and $\overline{CE2}$) four displays (16 characters) can easily be interconnected without a decoder.

Data lines are connected to all DLX2416s directly and in parallel, as is the write line ($\overline{WR}$). The display will then behave as a write-only memory.

The cursor function causes all dots of a digit position to illuminate at half brightness. The cursor is *not* a character, and when removed the previously displayed character will reappear.

The DLX2416 has several features superior to competitive devices. True "blanking" allows the designer to dim the display for more flexibility of display presentation. Finally the $\overline{CLR}$ clear function will clear the cursor RAM and the ASCII character RAM simultaneously.

The character set consists of 128 special ASCII characters for English, German, Italian, Swedish, Danish, and Norwegian.

All products are subjected to out-going AQL's of 0.25% for brightness matching, visual alignment and dimensions, 0.065% for electrical and functional .

Maximum Ratings

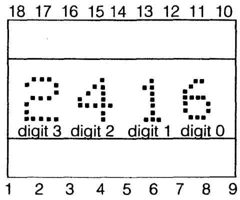
DC Supply Voltage .... –0.5 V to +7.0 Vdc
Input Voltage, Respect to GND
(all inputs) .... –0.5 V to V_{CC} +0.5 Vdc
Operating Temperature .... –40°C to +85°C
Storage Temperature .... –40°C to +100°C
Relative Humidity at 85°C 85%
Maximum Solder Temperature, 0.063" (1.59 mm)
below Seating Plane, t<5 sec .... 260 °C

Optical Characteristics

Spectral Peak Wavelength
Red .... 660 nm typ.
HER .... 630 nm typ.
Green .... 565 nm typ.
Character Height .... 0.200" (5.08 mm)
Time Averaged Luminous Intensity[1]
at V_{CC}=5 V
Red .... 60 µcd/LED typ.
HER .... 100 µcd/LED typ.
Green .... 120 µcd/LED typ.
LED to LED Intensity Matching
at V_{CC}=5 V .... 1.8:1.0 max.
LED to LED Hue Matching (Green only)
at V_{CC}=5 V .... ±2 nm max.
Viewing Angle (off normal axis)
Horizontal .... ±50° max.
Vertical .... ±75° max.

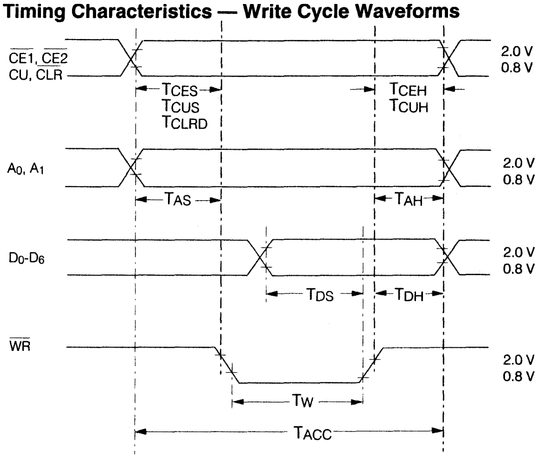
Note 1: Peak luminous intensity values can be calculated by multiplying these values by 7.

Top View



Pin	Function	Pin	Function
1	$\overline{CE1}$ Chip Enable	10	GND
2	CE2 Chip Enable	11	D0 Data Input
3	$\overline{CLR}$ Clear	12	D1 Data Input
4	CUE Cursor Enable	13	D2 Data Input
5	$\overline{CU}$ Cursor Select	14	D3 Data Input
6	$\overline{WR}$ Write	15	D6 Data Input
7	A1 Digit Select	16	D5 Data Input
8	A0 Digit Select	17	D4 Data Input
9	V_{CC}	18	$\overline{BL}$ Display Blank

Timing Characteristics — Write Cycle Waveforms



Note: These waveforms are not edge triggered.

DC Characteristics

Parameter	–40°C			+25°C			+85°C			Units	Conditions
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max		
I_{CC} 80 dots on		135	160		110	130		95	115	mA	V_{CC} = 5 V
I_{CC} Cursor all dots @ 50%			135			100			100	mA	V_{CC} = 5 V
I_{CC} Blank		2.8	4.0		2.3	3.0		2.0	2.5	mA	V_{CC} = 5 V, $\overline{BL}$ = 0.8 V
I_{IL} (all inputs)	30	60	120	25	50	100	20	40	80	µA	V_{IN}=0.8 V, V_{CC} = 5 V
V_{IH} (all inputs)	2.0			2.0			2.0			V	V_{CC} = 5 V ±0.5 V
V_{IL} (all inputs)			0.8			0.8			0.8	V	V_{CC} = 5V ±0.5 V
V_{CC}	4.5	5.0	5.5	4.5	5.0	5.5	4.5	5.0	5.5	V	

AC Characteristics Guaranteed Minimum Timing Parameters at V_{CC}=5.0 V ±0.5 V

Parameter	Symbol	–40°C	+25°C	+85°C	Units
Chip Enable Set Up Time	T_{CES}	0	0	0	ns
Address Set Up Time	T_{AS}	10	10	10	ns
Cursor Set Up Time	T_{CUS}	10	10	10	ns
Chip Enable Hold Time	T_{CEH}	0	0	0	ns
Address Hold Time	T_{AH}	20	30	40	ns
Cursor Hold Time	T_{CUH}	20	30	40	ns
Clear Disable Time	T_{CLRD}	1	1	1	µs
Write Time	T_W	60	70	90	ns
Data Set Up Time	T_{DS}	20	30	50	ns
Data Hold Time	T_{DH}	20	30	40	ns
Clear Time	T_{CLR}	1	1	1	µs
Access Time	T_{ACC}	90	110	140	ns

Note: 1. T_{ACC}=Set Up Time + Write Time + Hold Time.

Loading Data

Setting the chip enable ($\overline{CE1}$, $\overline{CE2}$) to their true state will enable data loading. The desired data code (D0-D6) and digit address (A0, A1) must be held stable during the write cycle for storing new data.

Data entry may be asynchronous and random. Digit 0 is defined as right hand digit with A1=A2=0.`

To clear the entire internal four-digit memory hold the clear ($\overline{CLR}$) low for 1 µs. All illuminated dots will be turned off within one complete display multiplex cycle, 1 msec minimum. The clear function will clear both the ASCII RAM and the cursor RAM.

Loading Cursor

Setting the chip enables ($\overline{CE1}$, $\overline{CE2}$) and cursor select ($\overline{CU}$) to their true state will enable cursor loading. A write ($\overline{WR}$) pulse will now store or remove a cursor into the digit location addressed by A0, A1, as defined in data entry. A cursor will be stored if D0=1 and will removed if D0=0. The cursor ($\overline{CU}$) pulse width should not be less than the write ($\overline{WR}$) pulse or erroneous data may appear in the display.

If the cursor is not required, the cursor enable signal (CUE) may be tied low to disable the cursor function. For a flashing cursor, simply pulse CUE. If the cursor has been loaded to any or all positions in the display, then CUE will control whether the cursor(s) or the characters will appear. CUE does not affect the contents of cursor memory.

Control							Address		Data							Display Digit			
$\overline{BL}$	$\overline{CE1}$	$\overline{CE2}$	CUE	$\overline{CU}$	$\overline{WR}$	$\overline{CLR}$	A1	A0	D6	D5	D4	D3	D2	D1	D0	3	2	1	0
H	X	X	L	X	H	H	previously loaded display									G	R	E	Y
H	H	X	L	X	X	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	X	H	L	X	X	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	L	L	L	H	L	H	L	L	H	L	L	L	H	L	H	G	R	E	E
H	L	L	L	H	L	H	L	H	H	L	H	L	H	L	H	G	R	U	E
H	L	L	L	H	L	H	H	L	H	L	L	H	H	L	L	G	L	U	E
H	L	L	L	H	L	H	H	H	H	L	L	L	L	H	L	B	L	U	E
L	X	X	X	X	H	H	X	X	blank display										
H	L	L	L	H	L	H	H	H	H	L	L	L	H	H	H	G	L	U	E
H	X	X	L	X	H	L	X	X	clears character displays										
H	L	L	L	H	L	H	X	X	see character code							see character set			

X = don't care

Loading Cursor State Table

																	Digit			
$\overline{BL}$	CE1	CE2	$\overline{CE3}$	$\overline{CE4}$	CUE	$\overline{CU}$	$\overline{WR}$	$\overline{CLR}$	A1	A0	D6	D5	D4	D3	D2	D1	D0	3	2	1	0
H	X	X	X	X	L	X	H	H	previously loaded display									B	E	A	R
H	X	X	X	X	H	X	H	H	display previously stored cursors									B	E	A	R
H	H	H	L	L	H	L	L	H	L	L	X	X	X	X	X	X	H	B	E	A	■
H	H	H	L	L	H	L	L	H	L	H	X	X	X	X	X	X	H	B	E	■	■
H	H	H	L	L	H	L	L	H	H	L	X	X	X	X	X	X	H	B	■	■	■
H	H	H	L	L	H	L	L	H	H	H	X	X	X	X	X	X	H	■	■	■	■
H	H	H	L	L	H	L	L	H	H	L	X	X	X	X	X	X	L	■	E	■	■
H	X	X	X	X	L	X	H	H	disable cursor display									B	E	A	R
H	H	H	L	L	L	L	L	H	H	H	X	X	X	X	X	X	L	B	E	A	R
H	X	X	X	X	H	H	X	H	display stored cursors									B	E	■	■

X = don't care ■ = all dots on

Display Blanking

Blanking the display may be accomplished by loading a blank or space into each digit of the display or by using the (BL) display blank input.

Setting the (BL) input low does not affect the contents of either data or cursor memory.

A flashing circuit can easily be constructed using a 555 astable multivibrator. Figure 1 illustrates a circuit in which varying R2 (100K~10K) will have a flash rate of 1 Hz~10 Hz.

The display can be dimmed by pulse width modulating the (BL) at a frequency sufficiently fast to not interfere with the internal clock. The dimming signal frequency should be 2.5 KHz or higher. Dimming the display also reduces power consumption.

An example of a simple dimming circuit using a 556 is illustrated in Figure 2. Adjusting potentiometer R3 will dim the display by changing the blanking pulse duty cycle.

Figure 1. Flashing Circuit DLX2416 Using a 555

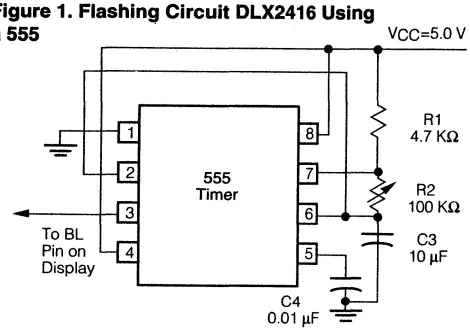


Figure 1a. Flashing (Blanking) Timing

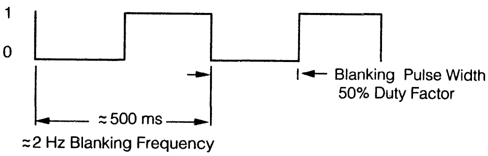


Figure 2. Dimming Circuit for DLX2416 Using a 556

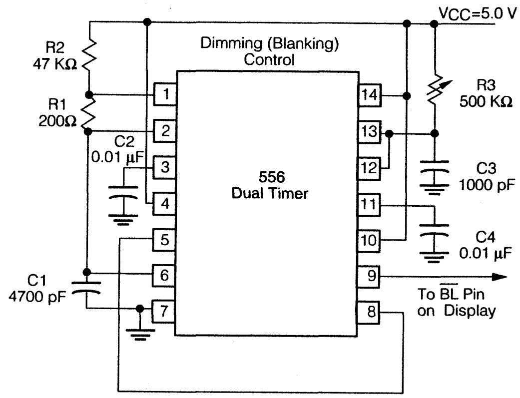
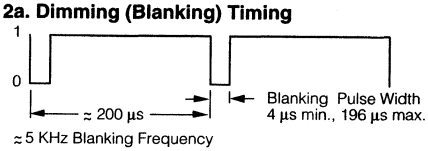
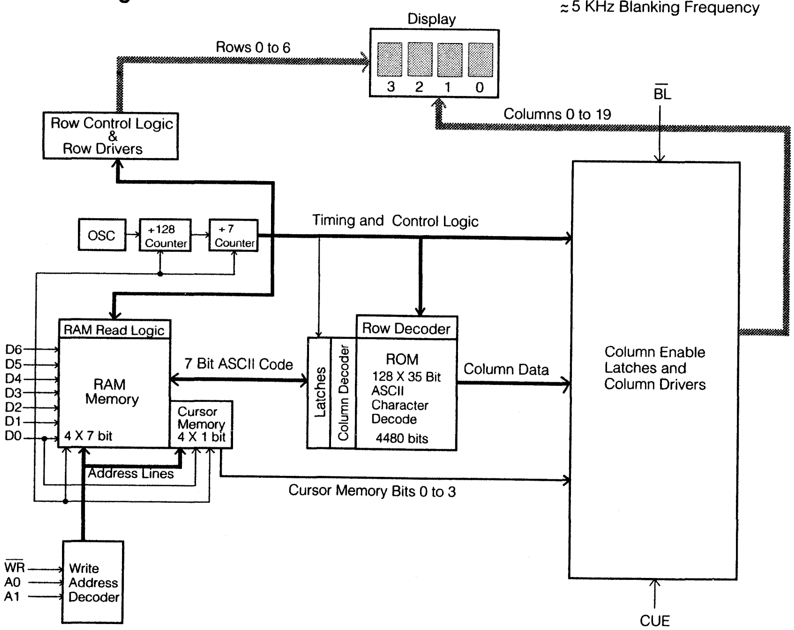


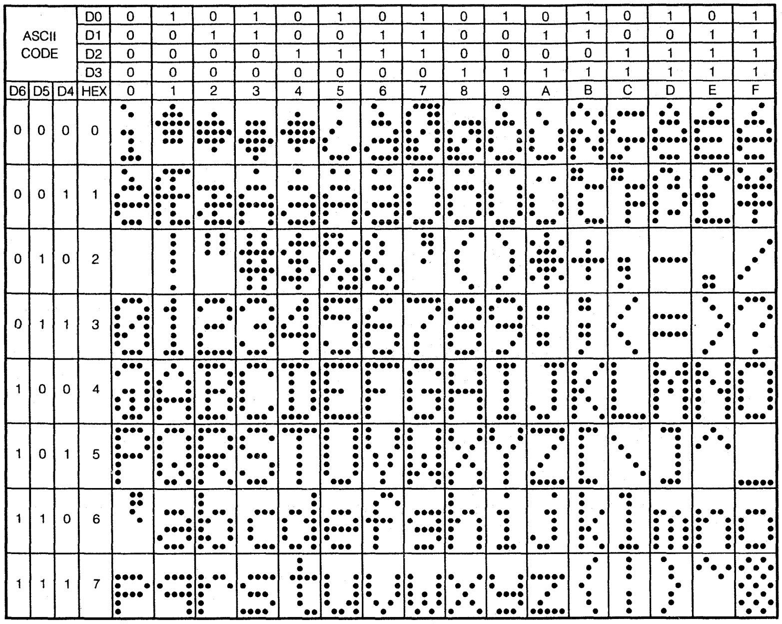
Figure 2a. Dimming (Blanking) Timing



Internal Block Diagram

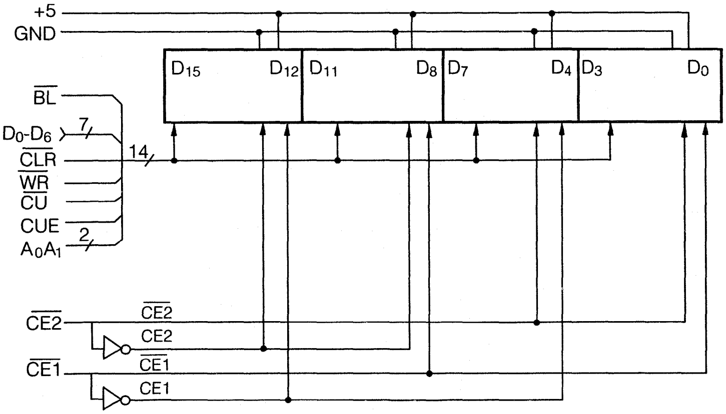


Character Set



1. High=1 level. 2. Low=0 level. 3. Upon power up, device will initialize in a random state.

Typical Schematic – 16 Character System



Design Considerations
For details on design and applications of the DLX2416 using standard bus configurations in multiple display systems, or parallel I/O devices, such as the 8255 with an 8080 or memory mapped addressing on processors such as the 8080, Z80, 6502, or 6800, refer to Appnote 15 in the current Siemens Optoelectronics Data Book.

Electrical and Mechanical Considerations

Voltage Transient Suppression
We recommend that the same power supply be used for the display and the components that interface with the display to avoid logic inputs higher than V_{CC}. Additionally, the LEDs may cause transients in the power supply line while they change display states. The common practice is to place .01 mF capacitors close to the displays across V_{CC} and GND, one for each display, and one 10 mF capacitor for every second display.

ESD Protection
The silicon gate CMOS IC of the DLX2416 is quite resistant to ESD damage and capable of withstanding discharges greater than 2 KV. However, take all the standard precautions, normal for CMOS components. These include properly grounding personnel, tools, tables, and transport carriers that come in contact with unshielded parts. If these conditions are not, or cannot be met, keep the leads of the device shorted together or the parts in anti-static packaging.

Soldering Considerations
The DLX2416 can be hand soldered with SN63 solder using a grounded iron set to 260°C.

Wave soldering is also possible following these conditions: Preheat that does not exceed 93°C on the solder side of the PC board or a package surface temperature of 85°C. Water soluble organic acid flux (except carboxylic acid) or resin-based RMA flux without alcohol can be used.

Wave temperature of 245°C ±5°C with a dwell between 1.5 sec. to 3.0 sec. Exposure to the wave should not exceed temperatures above 260°C for five seconds at 0.063" below the seating plane. The packages should not be immersed in the wave.

Post Solder Cleaning Procedures
The least offensive cleaning solution is hot D.I. water (60°C) for less than 15 minutes. Addition of mild saponifiers is acceptable. Do not use commercial dishwasher detergents.

For faster cleaning, solvents may be used. Carefully select any solvent as some may chemically attack the nylon package. Maximum exposure should not exceed two minutes at elevated temperatures. Acceptable solvents are TF (trichorotribluorethane), TA, 111 Trichloroethane, and unheated acetone.

Note: Acceptable commercial solvents are: Basic TF, Arklone, P. Genesolv, D. Genesolv DA, Blaco-Tron TF, Blaco-Tron TA, and Freon TA.

Unacceptable solvents contain alcohol, methanol, methylene chloride, ethanol, TP35, TCM, TMC, TMS+, TE, or TES. Since many commercial mixtures exist, contact a solvent vendor for chemical composition information. Some major solvent manufacturers are: Allied Chemical Corportation, Specialty Chemical Division, Morristown, NJ; Baron-Blakeslee, Chicago, IL; Dow Chemical, Midland, MI; E.I. DuPont de Nemours & Co., Wilmington, DE.

For further information refer to Siemens Appnotes 18 and 19.

An alternative to soldering and cleaning the display modules is to use sockets. Standard pin DIP sockets .600" wide with 0.100" centers work well for single displays. Multiple display assemblies are best handled by longer SIP sockets or DIP sockets when available for uniform package alignment. Socket manufacturers are Aries Electronics, Inc., Frenchtown, NJ; Garry Manufacturing, New Brunswich, NJ; Robinson-Nugent, New Albany, IN; and Samtec Electronic Hardware, New Albany, IN.

For further information refer to Siemens Appnote 22.

Optical Considerations
The 0.200" high characters of the DLX2416 gives readability up to eight feet. Proper filter selection enhances readability over this distance.

Filters enhance the contrast ratio between a lit LED and the character background intensifying the discrimination of different characters. The only limitation is cost. Take into consideration the ambient lighting environment for the best cost/benefit ratio for filters.

Incandescent (with almost no green) or fluorescent (with almost no red) lights do not have the flat spectral response of sunlight. Plastic band-pass filters are an inexpensive and effective way to strengthen contrast ratios.

The DLR2416 is a standard red display and should be matched with long wavelength pass filter in the 600 nm to 620 nm range. The DLO2416 is a high efficiency red display and should be matched with a long wavelength pass filter in the 470 nm to 590 range. The DLG2416 should be matched with a yellow-green band-pass filter that peaks at 565 nm. For displays of multiple colors, neutral density gray filters offer the best compromise.

Additional contrast enhancement is gained by shading the displays. Plastic band-pass filters with built-in louvers offer the next step up in contrast improvement. Plastic filters can be improved further with anti-reflective coatings to reduce glare. The trade-off is fuzzy characters. Mounting the filters close to the display reduces this effect. Take care not to overheat the plastic filter by allowing for proper air flow.

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than 1%.

Several filter manufacturers supply quality filter materials. Some of them are: Panelgraphic Corporation, W. Caldwell, NJ; SGL Homalite, Wilmington, DE; 3M Company, Visual Products Division, St. Paul, MN; Polaroid Corporation, Polarizer Division, Cambridge, MA; Marks Polarized Corporation, Deer Park, NY, Hoya Optics, Inc., Fremont, CA.

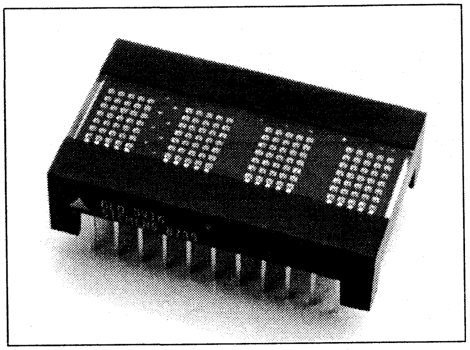
One last note on mounting filters: recessing displays and bezel assemblies is an inexpensive way to provide a shading effect in overhead lighting situations. Several Bezel manufacturers are: R.M.F. Products, Batavia, IL; Nobex Components, Griffith Plastic Corp., Burlingame, CA; Photo Chemical Products of California, Santa Monica, CA; .E.E.-Atlas, Van Nuys, CA.

Refer to Siemens Appnote 23 for further information.

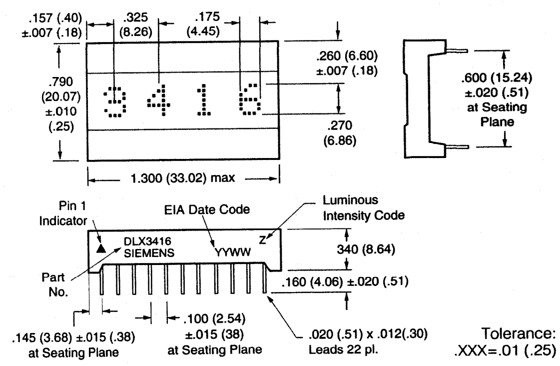
SIEMENS

RED DLR3416
HIGH EFFICIENCY RED DLO3416
GREEN DLG3416

.270" 4-Character 5 x 7 Dot Matrix Alphanumeric Intelligent Display with Memory/Decoder/Driver



Package Dimensions in Inches (mm)



FEATURES

- **Dot Matrix Replacement for DL3416**
- **0.270" 5x7 Dot Matrix Characters**
- **128 Special ASCII Characters for English, German, Italian, Swedish, Danish, and Norwegian Languages**
- **Wide Viewing Angle: X Axis 50° Maximum, Y Axis ±75° Maximum**
- **Close Vertical Row Spacing, 0.800" Centers**
- **Fast Access Time, 110 ns at 25°C**
- **Full Size Display for Stationary Equipment**
- **Built-in Memory**
- **Built-in Character Generator**
- **Built-in Multiplex and LED Drive Circuitry**
- **Each Character Independently Accessed**
- **TTL Compatible, 5 Volt Power, V_{IH}=2.0 V, V_{IL}=0.8 V**
- **Independent Cursor Function**
- **Memory Clear Function**
- **Display Blank Function for Blinking and Dimming**
- **End-Stackable, 4-Character Package**
- **Intensity Coded for Display Uniformity**
- **Extended Operating Temperature Range: –40°C to +85°C**
- **Wave Solderable**

See Appnotes 18, 19, 22, and 23 for additional information.

DESCRIPTION

The DLR/DLO/DLG3416 is a four character 5x7 dot matrix display module with a built-in CMOS integrated circuit. This display is a "drop-in" replacement for the DL3416.

The integrated circuit contains memory, ASCII ROM decoder, multiplexing circuitry and drivers. Data entry is asynchronous and can be random. A display system can be built using any number of DLX3416s since each character can be addressed independently and will continue to display the character last stored until replaced by another.

System interconnection is very straightforward. The least significant two address bits (A0, A1) are normally connected to the like-named inputs of all displays in the system. With four chip enables, four displays (16 characters) can easily be interconnected without a decoder.

Data lines are connected to all DLX3416s directly and in parallel, as is the write line (WR). The display will then behave as a write-only memory.

The cursor function causes all dots of a character position to illuminate at half brightness. The cursor is *not* a character, and when removed the previously displayed character will reappear.

The DLX3416 has several features superior to competitive devices. True "blanking" allows the designer to dim the display for more flexibility of display presentation. Finally the CLR clear function will clear the cursor RAM and the ASCII character RAM simultaneously.

The character set consists of 128 special ASCII characters for English, German, Italian, Swedish, Danish, and Norwegian.

All products are subjected to out-going AQL's of 0.25% for brightness matching, visual alignment and dimensions, 0.065% for electrical and functional.

Maximum Ratings

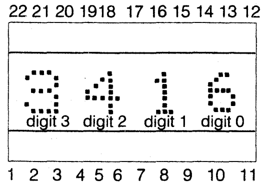
DC Supply Voltage .... –0.5 V to +7.0 Vdc
Input Voltage, Respect to GND
(all inputs) .... –0.5 V to V_{CC} +0.5 Vdc
Operating Temperature .... -40°C to +85°C
Storage Temperature .... -40°C to +100°C
Relative Humidity at 85°C
(non-condensing) 85%
Maximum Solder Temperature, 0.063" (1.59 mm)
below Seating Plane, t<5 sec .... 260 °C

Optical Characteristics

Spectral Peak Wavelength
Red .... 660 nm typ.
HER .... 630 nm typ.
Green .... 565 nm typ.
Character Height .... 0.270" (6.86 mm)
Time Averaged Luminous Intensity (1)
at V_{CC}=5 V
Red .... 60 µcd/LED typ.
HER .... 120 µcd/LED typ.
Green .... 140 µcd/LED typ.
Dot to Dot Intensity Matching
at V_{CC}=5 V .... 1.8:1.0 max.
LED to LED Hue Matching (Green only)
at V_{CC}=5 V .... ±2 nm max.
Viewing Angle (off normal axis)
Horizontal .... ±50° max.
Vertical .... ±75° max.

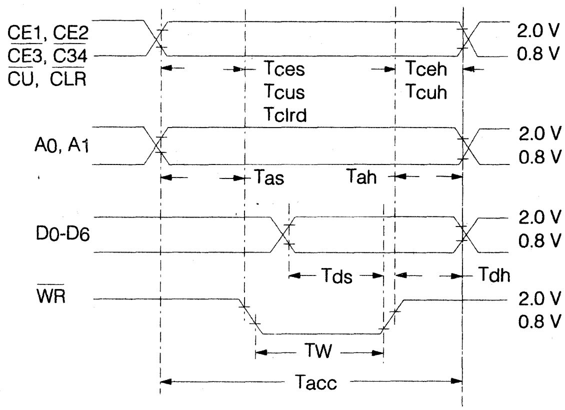
Note 1: Peak luminous intensity values can be calculated by multiplying these values by 7.

Top View



Pin	Function	Pin	Function
1	CE1 Chip Enable	12	GND
2	CE2 Chip Enable	13	NC
3	$\overline{CE3}$ Chip Enable	14	$\overline{BL}$ Blanking
4	$\overline{CE4}$ Chip Enable	15	NC
5	$\overline{CLR}$ Clear	16	D0 Data Input
6	V_{CC}	17	D1 Data Input
7	A0 Digit Select	18	D2 Data Input
8	A1 Digit Select	19	D3 Data Input
9	$\overline{WR}$ Write	20	D4 Data Input
10	CU Cursor Select	21	D5 Data Input
11	CUE Cursor Enable	22	D6 Data Input

Timing Characteristics Write Cycle Waveforms



Note: These waveforms are not edge triggered.

DC Characteristics

Parameter	–40°C Min.	–40°C Typ.	–40°C Max.	+25°C Min.	+25°C Typ.	+25°C Max.	+85°C Min.	+85°C Typ.	+85°C Max	Units	Conditions
I_{CC} 80 dots on		150	190		135	165		115	150	mA	V_{CC}=5 V
I_{CC} Cursor all dots at 50%			170			140			125	mA	V_{CC}=5 V
I_{CC} Blank		2.8	4.0		2.3	3.0		2.0	2.5	mA	V_{CC}=5 V, $\overline{BL}$=0.8 V
I_{IL} (all inputs)	30	60	120	25	50	100	20	40	80	µA	V_{IN}=0.8 V, V_{CC}=5 V
V_{IH} (all inputs)	2.0			2.0			2.0			V	V_{CC}=5 V ±0.5 V
V_{IL} (all inputs)			0.8			0.8			0.8	V	V_{CC}=5 V ±0.5 V
V_{CC}	4.5	5.0	5.5	4.5	5.0	5.5	4.5	5.0	5.5	V	

AC Characteristics Guaranteed Minimum Timing Parameters at V_{CC}=5.0 V ±0.5 V

Parameter	Symbol	– 40°C	+25°C	+85°C	Units
Chip Enable Set Up Time	T_{CES}	0	0	0	ns
Address Set Up Time	T_{AS}	10	10	10	ns
Cursor Set Up Time	T_{CUS}	10	10	10	ns
Chip Enable Hold Time	T_{CEH}	0	0	0	ns
Address Hold Time	T_{AH}	20	30	40	ns
Cursor Hold Time	T_{CUH}	20	30	40	ns
Clear Disable Time	T_{CLRD}	1	1	1	µs
Write Time	T_W	60	70	90	ns
Data Set Up Time	T_{DS}	20	30	50	ns
Data Hold Time	T_{DH}	20	30	40	ns
Clear Time	T_{CLR}	1	1	1	µs
Access Time	T_{ACC}	90	110	140	ns

Note: 1. T_{ACC}=Set Up Time + Write Time + Hold Time.

Loading Data

Setting the chip enable (CE1, CE2, $\overline{CE3}$, $\overline{CE4}$) to their true state will enable loading. The desired data code (D0-D6) and digit address (A0, A1) must be held stable during the write cycle for storing new data.

Data entry may be asynchronous and random. Digit 0 is defined as right hand digit with A1=A2=0.

To clear the entire internal four-digit memory hold the clear ($\overline{CLR}$) low for 1 µs. All illuminated dots will be turned off within one complete display multiplex cycle, 1 msec minimum. The clear function will clear both the ASCII RAM and the cursor RAM.

Loading Cursor

Setting the chip enables (CE1, CE2, $\overline{CE3}$, $\overline{CE4}$) and cursor select ($\overline{CU}$) to their true state will enable cursor loading. A write ($\overline{WR}$) pulse will now store or remove a cursor into the digit location addressed by A0, A1, as defined in data entry. A cursor will be stored if D0=1 and will removed if D0=0. The cursor ($\overline{CU}$) pulse width should not be less than the write ($\overline{WR}$) pulse or erroneous data may appear in the display.

If the cursor is not required, the cursor enable signal (CUE) may be tied low to disable the cursor function. For a flashing cursor, simply pulse CUE. If the cursor has been loaded to any or all positions in the display, then CUE will control whether the cursor(s) or the characters will appear. CUE does not affect the contents of cursor memory.

Typical Loading Data State Table

BL	CE1	CE2	$\overline{CU3}$	$\overline{CE4}$	CUE	$\overline{CU}$	$\overline{WR}$	$\overline{CLR}$	A1	A0	D6	D5	D4	D3	D2	D1	D0	Digit 3	2	1	0
H	X	X	X	X	L	X	H	H	PREVIOUSLY LOADED DISPLAY									G	R	E	Y
H	L	X	X	X	L	X	X	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	X	L	X	X	L	X	X	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	X	X	H	X	L	X	X	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	X	X	X	H	L	X	X	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	X	X	X	X	L	X	H	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	H	H	L	L	L	H	L	H	L	L	H	L	L	L	H	L	H	G	R	E	E
H	H	H	L	L	L	H	L	H	L	H	H	L	H	L	H	L	H	G	R	U	E
H	H	H	L	L	L	H	L	H	H	L	H	L	L	H	H	L	L	G	L	U	E
H	H	H	L	L	L	H	L	H	H	H	H	L	L	L	L	H	L	B	L	U	E
L	X	X	X	X	X	X	H	H	X	X	BLANK DISPLAY										
H	H	H	L	L	L	H	L	H	H	H	H	L	L	L	H	H	H	G	L	U	E
H	X	X	X	X	L	X	X	L	CLEARS CHARACTER DISPLAY												
H	H	H	L	L	L	H	L	H	X	X	SEE CHARACTER CODE							SEE CHARACTER SET			

X = don't care

Loading Cursor State Table

$\overline{BL}$	CE1	CE2	$\overline{CE3}$	$\overline{CE4}$	CUE	$\overline{CU}$	$\overline{WR}$	$\overline{CLR}$	A1	A0	D6	D5	D4	D3	D2	D1	D0	Digit 3	2	1	0
H	X	X	X	X	L	X	H	H	PREVIOUSLY LOADED DISPLAY									B	E	A	R
H	X	X	X	X	H	X	H	H	DISPLAY PREVIOUSLY STORED CURSORS									B	E	A	R
H	H	H	L	L	H	L	L	H	L	L	X	X	X	X	X	X	H	B	E	A	■
H	H	H	L	L	H	L	L	H	L	H	X	X	X	X	X	X	H	B	E	■	■
H	H	H	L	L	H	L	L	H	H	L	X	X	X	X	X	X	H	B	■	■	■
H	H	H	L	L	H	L	L	H	H	H	X	X	X	X	X	X	H	■	■	■	■
H	H	H	L	L	H	L	L	H	H	L	X	X	X	X	X	X	L	■	E	■	■
H	X	X	X	X	L	X	H	H	DISABLE CURSOR DISPLAY									B	E	A	R
H	H	H	L	L	L	L	L	H	H	H	X	X	X	X	X	X	L	B	E	A	R
H	X	X	X	X	H	X	H	H	DISPLAY STORED CURSORS									B	E	■	■

X = don't care ■ = all dots on

Intelligent Display Devices 2

Display Blanking

Blank the display by loading a blank or space into each digit of the display or by using the ($\overline{BL}$) display blank input.

Setting the ($\overline{BL}$) input low does not affect the contents of either data or cursor memory. A flashing display can be achieved by pulsing ($\overline{BL}$). A flashing circuit can be constructed using a 555 a stable multivibrator. Figure 1 illustrates a circuit in which varying R2 (100K~10K) will have a flash rate of 1 Hz~10 Hz.

The display can be dimmed by pulsing ($\overline{BL}$) line at a frequency sufficiently fast to not interfere with the internal clock. The dimming signal frequency should be 2.5 KHz or higher. Dimming the display also reduces power consumption.

An example of a simple dimming circuit using a 556 is illustrated in Figure 2. Adjusting potentiometer R3 will dim the display by changing the blanking pulse duty cycle.

Figure 1. Flashing Circuit Using a 555

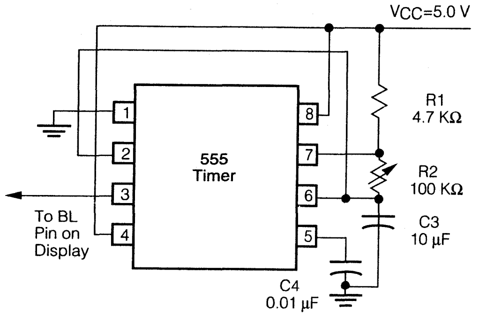


Figure 1a. Flashing (Blanking) Timing

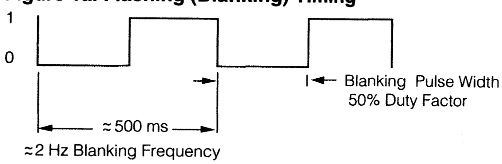


Figure 2. Dimming Circuit Using a 556

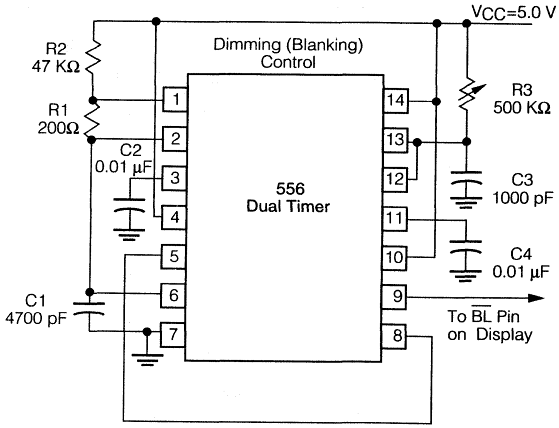
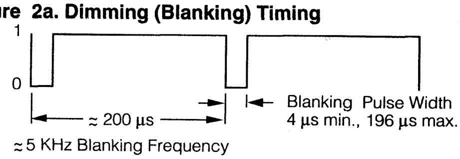
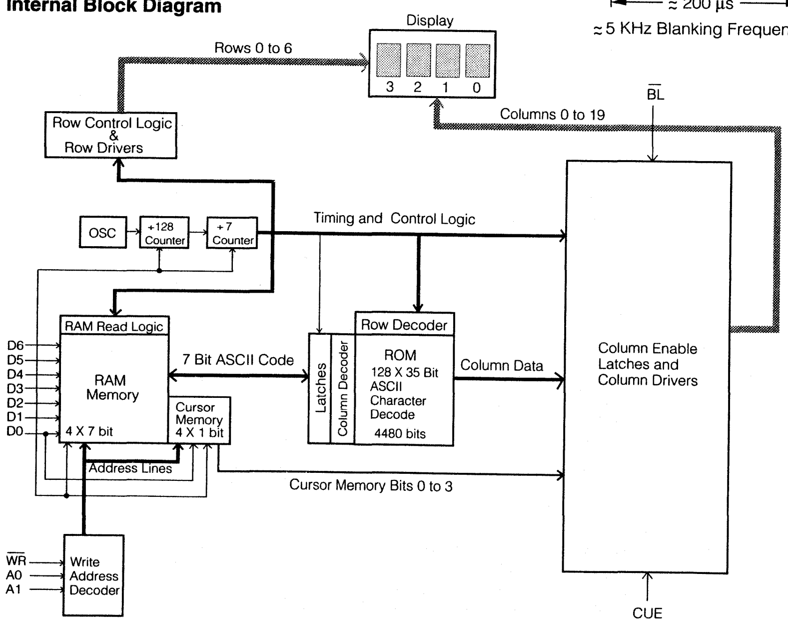


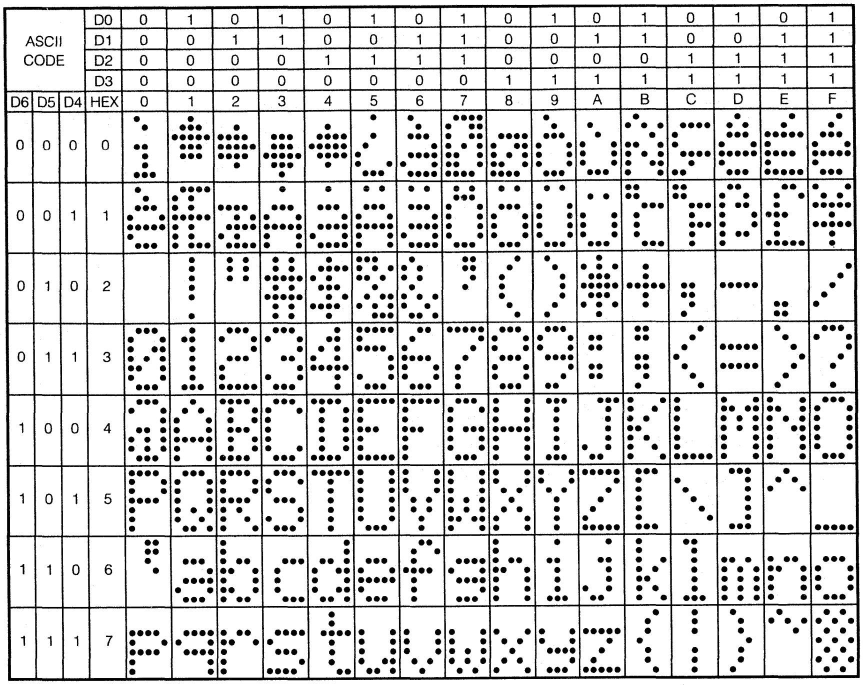
Figure 2a. Dimming (Blanking) Timing



Internal Block Diagram

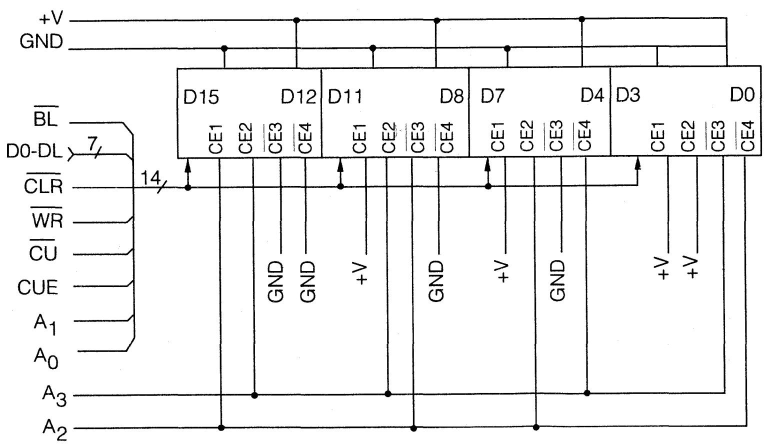


Character Set



1. High=1 level. 2. Low=0 level. 3. Upon power up, device will initialize in a random state.

Typical Schematic – 16 Character System



Design Considerations
For details on design and applications of the DLX3416 using standard bus configurations in multiple display systems, or parallel I/O devices, such as the 8255 with an 8080 or memory mapped addressing on processors such as the 8080, Z80, 6502, or 6800, refer to Appnote 15 in the current Siemens Optoelectronics Data Book.

Electrical and Mechanical Considerations

Voltage Transient Suppression
We recommend that the same power supply be used for the display and the components that interface with the display to avoid logic inputs higher than V_{CC}. Additionally, the LEDs may cause transients in the power supply line while they change display states. The common practice is to place .01 mF capacitors close to the displays across V_{CC} and GND, one for each display, and one 10 mF capacitor for every second display.

ESD Protection
The silicon gate CMOS IC of the DLX3416 is quite resistant to ESD damage and capable of withstanding discharges greater than 2 KV. However, take all the standard precautions, normal for CMOS components. These include properly grounding personnel, tools, tables, and transport carriers that come in contact with unshielded parts. If these conditions are not, or cannot be met, keep the leads of the device shorted together or the parts in anti-static packaging.

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Wave soldering is also possible following these conditions: Preheat that does not exceed 93°C on the solder side of the PC board or a package surface temperature of 85°C. Water soluble organic acid flux (except carboxylic acid) or resin-based RMA flux without alcohol can be used.

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For further information refer to Siemens Appnote 22.

Optical Considerations
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Filters enhance the contrast ratio between a lit LED and the character background intensifying the discrimination of different characters. The only limitation is cost. Take into consideration the ambient lighting environment for the best cost/benefit ratio for filters.

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Additional contrast enhancement is gained by shading the displays. Plastic band-pass filters with built-in louvers offer the next step up in contrast improvement. Plastic filters can be improved further with anti-reflective coatings to reduce glare. The trade-off is fuzzy characters. Mounting the filters close to the display reduces this effect. Take care not to overheat the plastic filter by allowing for proper air flow.

Optimal filter enhancements are gained by using circular polarized, anti-reflective, band-pass filters. Circular polarizing further enhances contrast by reducing the light that travels through the filter and relfects back off the display to less than 1%.

Several filter manufacturers supply quality filter materials. Some of them are: Panelgraphic Corporation, W. Caldwell, NJ; SGL Homalite, Wilmington, DE; 3M Company, Visual Products Division, St. Paul, MN; Polaroid Corporation, Polarizer Division, Cambridge, MA; Marks Polarized Corporation, Deer Park, NY, Hoya Optics, Inc., Fremont, CA.

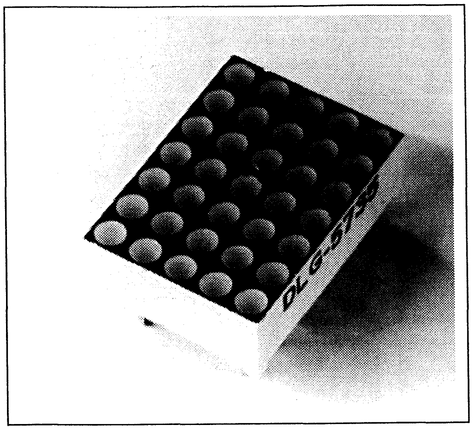
One last note on mounting filters: recessing displays and bezel assemblies is an inexpensive way to provide a shading effect in overhead lighting situations. Several Bezel manufacturers are: R.M.F. Products, Batavia, IL; Nobex Components, Griffith Plastic Corp., Burlingame, CA; Photo Chemical Products of California, Santa Monica, CA; .E.E.-Atlas, Van Nuys, CA.

Refer to Siemens Appnote 23 for further information.

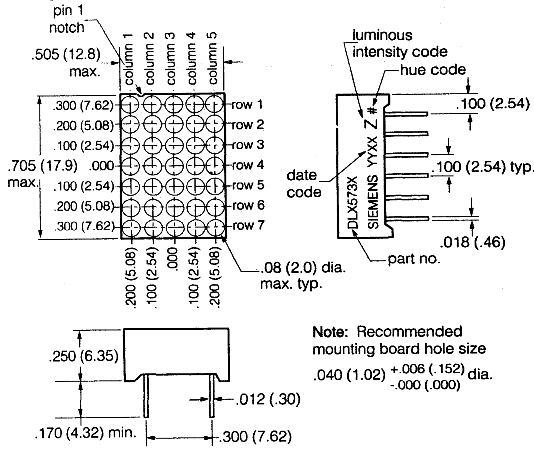
SIEMENS

RED DLR5735
RED DLR5736
GREEN DLG5735
GREEN DLG5736

.69" (17.5 mm) Single Character 5x7 Dot Matrix Alphanumeric Display (No Built-In CMOS Drive Circuitry)



Package Dimensions in Inches (mm)



FEATURES

- **DLR/DLG 5735 Common Row Cathode**
- **DLR/DLG 5736 Common Row Anode**
- **5 x 7 Matrix Array with Row-Column Select**
- **End & Side Stackable**
- **Rugged Encapsulation (Filled Reflector Construction)**
- **Compatible with ASCII and EBCDIC Format**
- **Standard 12 pin, 0.3" Pin Spacing, Dual-Inline Package**
- **Good "OFF" Segment Contrast Grey Face with Clear Segments**

DESCRIPTION

The DLR 5735/5736 Series (gallium arsenide phosphide) and the DLG 5735/5736 Series (gallium phosphide) are 5 x 7 dot matrix light emitting diode alphanumeric displays.

Compatible with ASCII and EBCDIC formats, these displays are well suited for use in keyboard verfiers, computer peripheral equipment, and other applications requiring an alphanumeric display They are stackable both horizontally and vertically to generate large alphanumeric or even graphic displays.

Maximum Ratings

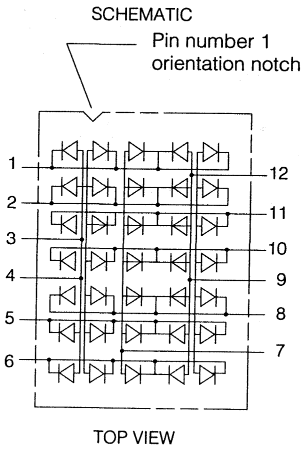
Power Dissipation (Package) .... 750 mW
Derate Linearly from 25°C .... 11.5 mW/°C
Storage /Operating Temperature .... -20°C to + 70°C
Continuous Forward Current Per Segment .... 20 mA
Pulse Peak Current/Segment, 20% DutyCycle 100mA
Reverse Voltage
DLR 5735, 5736 .... 3 V
DLG 5735, 5736 .... 5 V
Solder Temperature, 1/16" below seating plane, 5 sec. .... 260°C

Electrical/Optical Characteristics (T_A=25°C)

Parameter	Min.	Typ.	Max.	Unit	Condition
Luminous Intensity					
Digit Average (Per Dot)					
DLR 5735/5736	100	200		µcd	I_F = 20 mA
DLG 573515736	320	650		µcd	I_F = 10 mA
Forward Voltage					
DLR 5735/5736		1.7	2.0	V	I_F = 20 mA
DLG 5735/5736		2.3	3.0	V	I_F = 20 mA
Reverse Current					
DLR 5735/5736			100	µA	V_R = 3 V
DLG5735/5736			100	µA	V_R =5 V
Peak Emission Wavelength					
DLR 5735/5736		650		nm	
DLG 5735/5736		565		nm	
Spectral Line Half-Width					
DLR 5735/5736		40		nm	
DLG 5735/5736		30		nm	

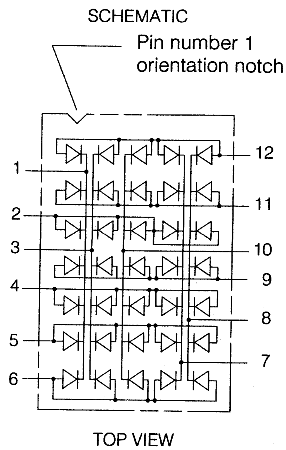
Pin Configurations

DLR5735
DLG5735



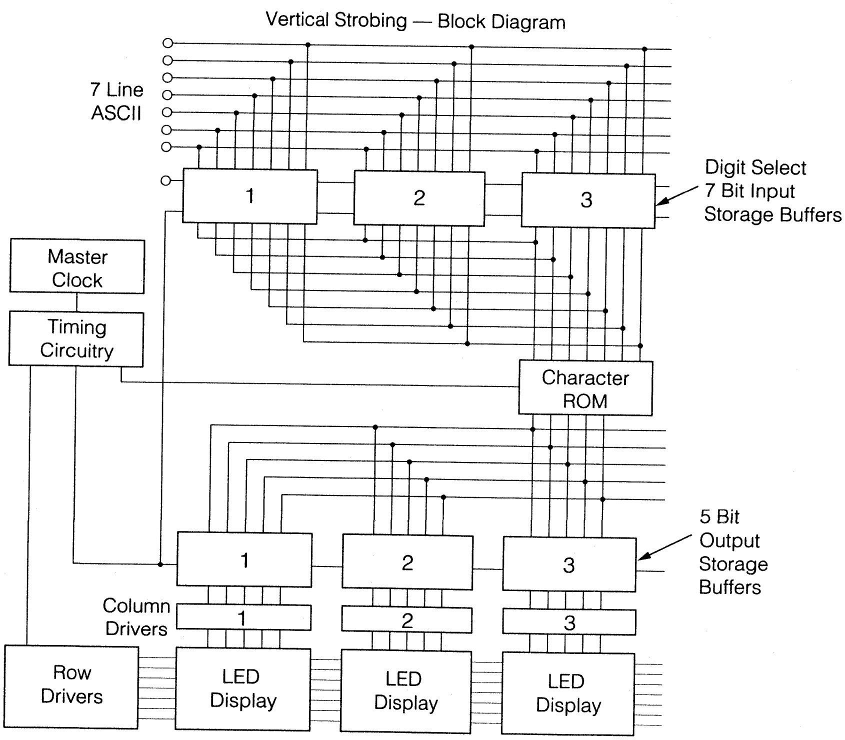
Pin	Function
1	Row 1 Cathode
2	Row 2 Cathode
3	Column 2 Anode
4	Column 1 Anode
5	Row 6 Cathode
6	Row 7 Cathode
7	Column 3 Anode
8	Row 5 Cathode
9	Column 4 Anode
10	Row 4 Cathode
11	Row 3 Cathode
12	Column 5 Anode

DLR5736
DLG5736



Pin	Function
1	Column 1 Cathode
2	Row 3 Anode
3	Column 2 Cathode
4	Row 5 Anode
5	Row 6 Anode
6	Row 7 Anode
7	Column 4 Cathode
8	Column 5 Cathode
9	Row 4 Anode
10	Column 3 Cathode
11	Row 2 Anode
12	Row 1 Anode

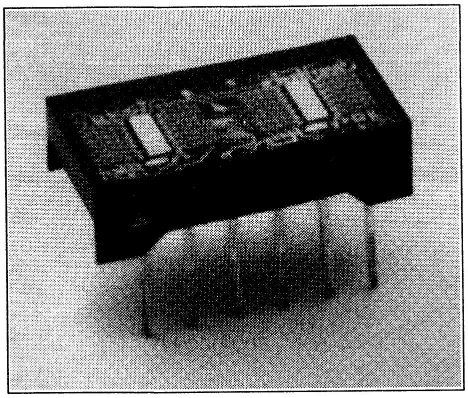
Block Diagram



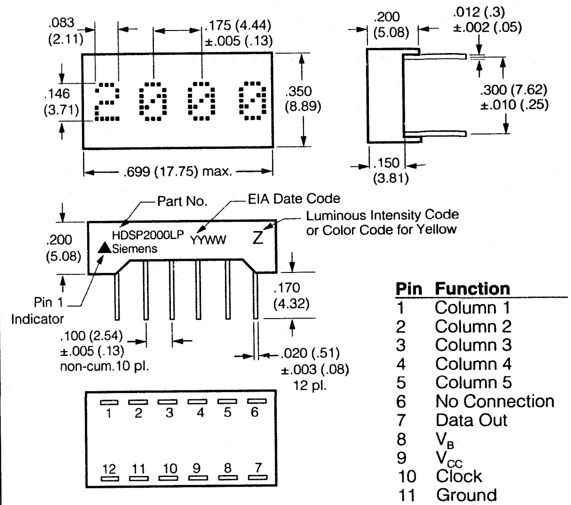
SIEMENS

RED HDSP2000LP
YELLOW HDSP2001LP
HIGH EFFICIENCY RED HDSP2002LP
GREEN HDSP2003LP

.150" 4-Character 5x7 Dot Matrix Serial Input Alphanumeric Display



Package Dimensions in Inches (mm)



Pin	Function
1	Column 1
2	Column 2
3	Column 3
4	Column 4
5	Column 5
6	No Connection
7	Data Out
8	V_B
9	V_{CC}
10	Clock
11	Ground
12	Data In

TOLERANCE: ± .015 (.38)

FEATURES

- **Four 0.150" Dot Matrix Characters**
- **Four Colors: Red, Yellow, High Efficiency Red, Green**
- **Wide Viewing Angle: X Axis +50° Y Axis +75°**
- **Built-in CMOS Shift Registers with Constant Current LED Row Drivers**
- **Shift Registers Allow Custom Fonts**
- **Easily Cascaded for Multiple Displays**
- **TTL Compatible**
- **End Stackable**
- **Extended Operating Temperature Range: –40°C to + 85°C**
- **Categorized for Luminous Intensity**
- **All Displays Color Matched**
- **Compact Plastic Package**
- **100% Burned In and Tested**

DESCRIPTION

The HDSP200XLP are four digit 5x7 dot matrix serial input alphanumeric displays. The displays are available in red, yellow, high efficiency red, or bright green. The package is a standard twelve-pin DIP with a flat plastic lens. The display can be stacked horizontally or vertically to form messages of any length.

The HDSP200XLP has two fourteen-bit CMOS shift registers with built-in row drivers. These shift registers drive twenty-eight rows and enable the design of customized fonts. Cascading multiple displays is possible because of the Data In and Data Out pins. Data In and Out are easily input with the clock signal and displayed in parallel on the row drivers. Data Out represents the output of the 7th bit of digit number four shift register The shift register is level triggered. The like columns of each character in a display cluster are tied to a single pin (see Block Diagram). High true data in the shift register enables the output current mirror driver stage associated with each row of LEDs in the 5x7 diode array.

The TTL compatible V_B input may either be tied to V_{CC} for maximum display intensity or pulse width modulated to achieve intensity control and reduce power consumption.

—Continued

See Appnote 44 for application information.

DESCRIPTION (Continued)

In the normal mode of operation, input data for digit four, column one is loaded into the seven on-board shift register locations one through seven. Column one data for digits 3, 2, and 1 is shifted into the display shift register locations. Then column one input is enabled for an appropriate period of time, T. A similar process is repeated for columns 2, 3, 4, and 5. If the decode time and load data time into the shift register is t, then with five columns, each column of the display is operating at a duty factor of:

$$DF = \frac{T}{5(T+t)}$$

T+t, allotted to each display column, is generally chosen to provide the maximum duty factor consistent with the minimum refresh rate necessary to achieve a flicker free display. For most strobed display systems, each column of the display should be refreshed (turned on) at a minimum rate of 100 times per second.

With columns to be addressed, this refresh rate then gives a value for the time T+t of: 1/[5x(100)] =2 msec. If the device is operated at 5.0 MHz clock rate maximum, it is possible to maintain t<<T. For short display strings, the duty factor will then approach 20%.

Maximum Ratings

Supply Voltage V_{CC} to GND .... –0.5 V to + 7.0 V
Inputs, Data Out and V_B .... –0.5 V to V_{CC} + 0.5 V
Column Input Voltage, V_{COL} .... –0.5 V to + 6.0 V
Operating Temperature Range .... –40°C to +85°C
Storage Temperature Range .... –40°C to + 100°C
Maximum Solder Temperature, 0.063" (1.59 mm)
below Seating Plane, t<5 sec .... 260°C
Maximum Allowable Power Dissipation
at T_{amb}=25 C°(1) .... 0.86 W

Note:
1. Maximum allowable dissipation is derived from V_{CC}=5.25 V, V_B=2.4 V, V_{COL}=3.5 V, 20 LEDs on per character, 20% DF.

Figure 1. Timing Characteristics

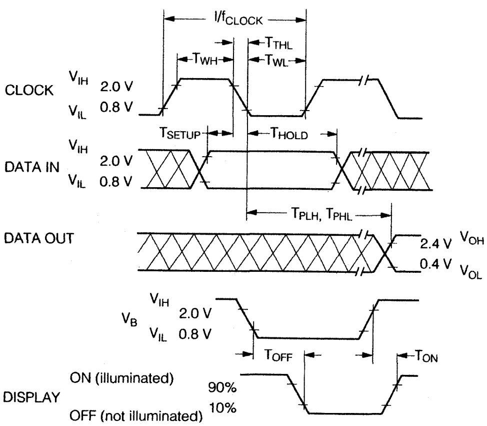
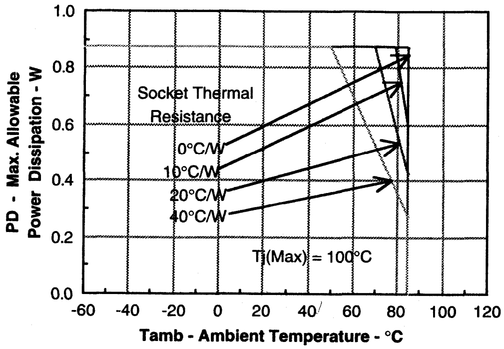


Figure 2. Maximum Allowable Power Dissipation versus Temperature



AC Electrical Characteristics

(V_{CC}=4.75 to 5.25 V, T_{amb}=–40C° to 85°C)

Symbol	Description	Min.	Typ.	Max.(1)	Units	Fig.
T_{SETUP}	Setup Time	50			ns	1
T_{HOLD}	Hold Time	25			ns	1
T_{WL}	Clock Width Low	75			ns	1
T_{WH}	Clock Width High	75			ns	1
$F_{(CLK)}$	Clock Frequency	0		5	MHz	1
T_{THL} T_{TLH}	Clock Transition Time			200	ns	1
T_{PHL} T_{PLH}	Propagation Delay Clock to Data Out			125	ns	1

Note:
1. V_B Pulse Width Modulation Frequency—50 KHz (max).

Cleaning the Displays

IMPORTANT—Do not use cleaning agents containing alcohol of any type with this display. The least offensive cleaning solution is hot D.I. water (60°C) for less than 15 minutes. Addition of mild saponifiers is acceptable. Do not use commercial dishwasher detergents.

For post solder cleaning use water or non-alcohol mixtures formulated for vapor cleaning processing or non-alcohol mixtures formulated for room temperature cleaning. Nonalcohol vapor cleaning processing for up to two minutes in vapors at boiling is permissible. For suggested solvents refer to Siemens Appnote 19.

Recommended Operating Conditions

Parameter	Symbol	Min.	Nom.	Max.	Units
Supply Voltage	V_{CC}	4.75	5.0	5.25	V
Data Out Current, Low State	I_{OL}			1.6	mA
Data Out Current, High State	I_{OH}	–0.5			mA
Column Input Voltage, Column On HDSP2000LP(1)	V_{COL}	2.4		3.5	V
Column Input Voltage, Column On, HDSP2001LP/2002LP/2003LP(1)	V_{COL}	2.75		3.5	V
Setup Time	T_{SETUP}	70			ns
Hold Time	T_{HOLD}	30			ns
Width of Clock	$T_{W(CLK)}$	75			ns
Clock Frequency	T_{CLK}			5	MHz
Clock Transition Time	T_{THL}			200	ns

Note: 1. See Figure 3: Peak Column Current vs. Column Voltage

Intelligent Display Devices 2

Optical Characteristics

Red HDSP2000LP

Description	Symbol	Min.	Typ.(4)	Max.	Units	Test Conditions
Peak Luminous Intensity per LED(1,3) (Character Average)	I_{VPEAK}	105	200		µcd	V_{CC} = 5.0 V, V_{COL} = 3.5 V T_{amb} = 25° C, V_B = 2.4 V
Peak Wavelength	λ_{VPEAK}		655		nm	
Dominant Wavelength(2)	λ_D		639		nm	

Yellow HDSP2001LP

Description	Symbol	Min.	Typ.(4)	Max.	Units	Test Conditions
PeakLuminousIntensityperLED(1,3) (Character Average)	I_{VPEAK}	400	1140		µcd	V_{CC} = 5.0 V, V_{COL} = 3.5 V T_{amb} = 25°C, V_B = 2.4 V
Peak Wavelength	λ_{VPEAK}		583		nm	
Dominant Wavelength(2)	λ_D		585		nm	

High Efficiency Red HDSP2002LP

Description	Symbol	Min.	Typ.(4)	Max.	Units	Test Conditions
Peak Luminous Intensity per LED(1,3) (Character Average)	I_{VPEAK}	400	1430		µcd	V_{CC} = 5.0 V, V_{COL} = 3.5 V T_{amb} = 25°C, V_B = 2.4 V
Peak Wavelength	$I\lambda_{VPEAK}$		635		nm	
Dominant Wavelength(2)	λ_D		626		nm	

Green HDSP2003LP

Description	Symbol	Min.	Typ.(4)	Max.	Units	Test Conditions
Peak Luminous Intensity per LED(1,3) Character Average)	I_{VPEAK}	650	1550		µcd	V_{CC} = 5.0 V, V_{COL} = 3.5 V T_{amb} = 25°C, V_B = 2.4 V
Peak Wavelength	λ_{VPEAK}		565		nm	
Dominant Wavelength(2)	λ_D		569		nm	

Notes:
1. The displays are categorized for luminous intensity with the intensity category designated by a letter code on the bottom of the package.
2. Dominant wavelength (λD) is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device
3. The luminous sterance of the LED may be calculated using the following relationships:
   L_V (cd/m²) = I_V (Candela)/A (Meter)²
   L_V (Footlamberts) = πI_V (Candela)/A (Foot)²
   HDSP2000LP, A = 5 58 x 10^{-8} m² = 6 x 10^{-7} ft.²
   HDSP2001/2/3LP, A = 7.8 x 10^{-8}m² = 8.4 x 10^{-7}ft.²
4. All typical values specified at V_{CC} = 5.0 V and T_{amb} = 25°C unless otherwise noted.

Electrical Characteristics (–40°C to +85°C, unless otherwise specified)

Description	Symbol	Min.	Typ.(1)	Max.	Units	Test Conditions	
Supply Current (quiescent)	I_{CC}		1	5	mA	V_B=0.4 V	V_{CC}=5.25 V V_{CLK}=V_{DATA}=2.4 V All SR Stages=Loglcal 1
			1	5	mA	V_B=2.4 V	
Supply Current (operating)	I_{CC}		1.5	10.0	mA	F_{CLK}=5 MHz	
Column Current at any Column Input(2)	I_{COL} (All)			10	µA	V_B=0.4 V	V_{CC}=5.25 V V_{COL}=3.5 V All SR Stages=Logical 1
	I_{COL}		335	410	mA	V_B=2 4 V	
V_B, Clock or Data Input Threshold Low	V_{IL}			0.8	V	V_{CC}= 4.75 V–5.25 V	
V_B, Clock or Data Input Threshold High	V_{IH}	2.0			V		
Data Out Voltage	V_{OH}	2.4			V	I_{OH}=–0.5 mA	V_{CC}=4.75 V
	V_{OL}			0.4	V	I_{OL}=1.6 mA	I_{COL}=0 mA
Input Current Logical 0 V_B only	I_{IL}	-30	–110	-300	µA	V_{CC}=4.75 V–5.25 V, V_{IL}=0.8 V	
Input Current Logical 0 Data, Clock	I_{IL}		–1	–10	µA		
Power Dissipation per Package(2)	P_D		0.4		W	V_{CC}=5.0, V_{COL}=3.5 V, 17.5% DF 15 LEDs on per character, V_B=2.4 V	
Thermal Resistance IC Junction-to-Ambient	$R\theta_{J-A}$		85		°C/W/ Device		

Notes:

1. All typical values specified at V_{CC}=5.0 V and T_{amb}=25°C unless otherwise noted.
2. See Figure 3–Peak Column Current vs. Column Voltage

Figure 3. Peak Column Current versus Column Voltage

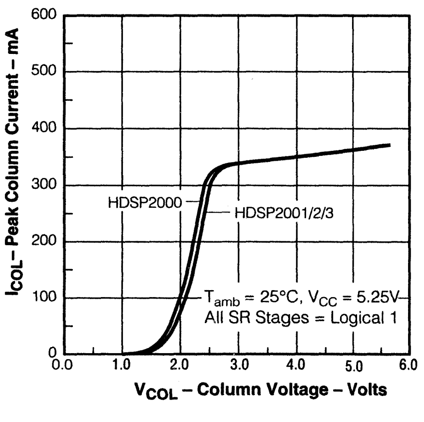
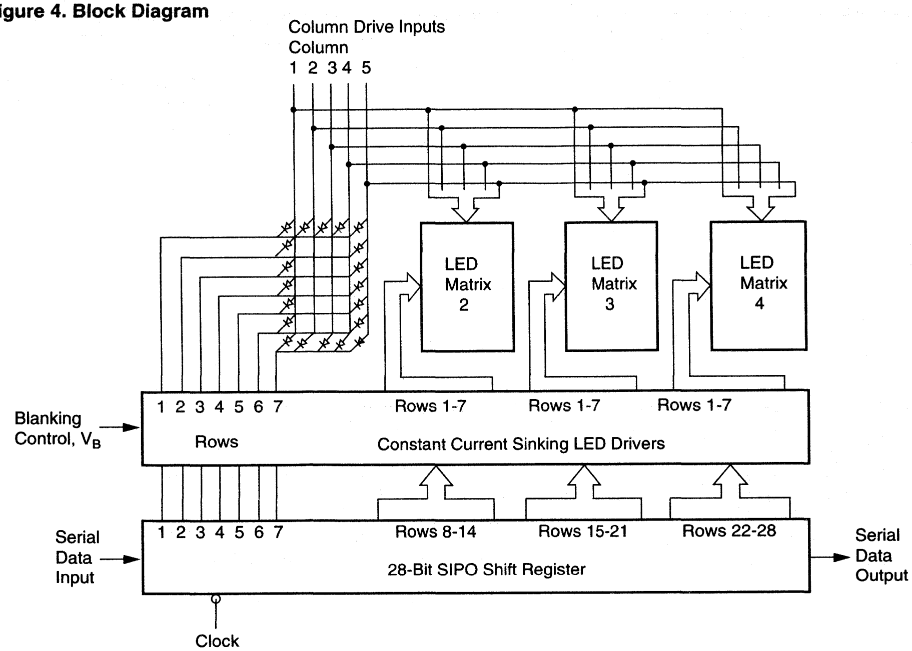


Figure 4. Block Diagram



Contrast Enhancement Filters

<table>
<tr><th rowspan="2">Display Color</th><th colspan="3">Ambient Lighting</th></tr>
<tr><th>Dim</th><th>Moderate</th><th>Bright</th></tr>
<tr><td>HDSP2000LP
Red</td><td>Panelgraphic Dark Red 63
Panelgraphic Ruby Red 60
Chequers Red 118
Plexiglass 2423</td><td rowspan="4">Polaroid HNCP37
3M Light Control Film
Panelgraphic Gray 10
Chequers Gray 105</td><td></td></tr>
<tr><td>HDSP2001LP
Yellow</td><td>Panelgraphic Yellow 27</td><td>Polaroid HNCP10-Glass*
Marks Polarized MPC 30-25C**</td></tr>
<tr><td>HDSP2002LP
HER</td><td>Panelgraphic Ruby Red 60
Chequers Red 112</td><td>Note 1
Polaroid HNCP10-Glass*
Marks Polarized MPC 20-15C**</td></tr>
<tr><td>HDSP2003LP
Bright Green</td><td>Panelgraphic Green 48
Chequers Green 107</td><td>Polaroid HNCP10-Glass*
Marks Polarized MPC 50-12C**</td></tr>
</table>

Note:
1. Optically coated circular polarized filters, such as Polaroid HNCP10.

* Polaroid Corp.
1 Upland Rd., Bldg #2
Norwood, MA 02062
800/225-2770

** Marks Polarized Corp.
25-B Jefryn Blvd. W
Deer Park, NY 11729
516/242-1300
FAX 516/242-1347
Marks Polarized Corp. manufactures to MIL-1-45208 inspection system.

General Quality Assurance Levels

Generic data available.

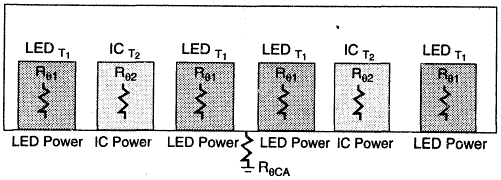
Thermal Considerations

The small alphanumeric displays are hybrid LED and CMOS assemblies that are designed for reliable operation in commercial, industrial, and military environments. Optimum reliability and optical performance will result when the junction temperature of the LEDs and CMOS ICs are kept as low as possible.

Thermal Modeling

HDSP200XLP displays consist of two driver ICs and four 5x7 LED matrixes. A thermal model of the display is shown in Figure 5. It illustrates that the junction temperature of the semiconductor = junction self heating + the case temperature rise + the ambient temperature. Equation 1 shows this relationship.

Figure 5. Thermal Model



See Equation 1 below.

The junction rise within the LED is the product of the thermal impedance of an individual LED (37°C/W, DF = 20%, F = 200 Hz), times the forward voltage, $V_{F(LED)}$, and forward current $I_{F(LED)}$, of 13 - 14.5 mA. This rise averages $T_{J(LED)}$ = 1°C. The table below shows the $V_{F(LED)}$ for the respective displays.

Model Number	VF		
	Min.	**Typ.**	**Max.**
HDSP2000LP	1.6	1.7	2.0
HDSP2001/2/3LP	1.9	2.2	3.0

The junction rise within the LED driver IC is the combination of the power dissipated by the IC quiescent current and the 28 row driver current sinks. The IC junction rise is given in Equation 2.

A thermal resistance of 28°C/W results in a typical junction rise of 6°C.

See Equation 2 below.

For ease of calculations the maximum allowable electrical operating condition is dependent upon the aggregate thermal resistance of the LED matrixes and the two driver ICs. All of the thermal management calculations are based upon the parallel combination of these two networks which is 15°C/W. Maximum allowable power dissipation is given in Equation 3.

Equation 3.

$$P_{DISPLAY} = \frac{T_{J(MAX)} - T_A}{R_{\theta JC} + R_{\theta CA}}$$

$$P_{DISPLAY} = 5\ V_{COL}\ I_{COL}\ (n/35)\ DF + V_{CC}\ I_{CC}$$

For further reference see Figures 2, 7, 8, 9, 10 and 11 .

Key to Equation Symbols

DF	Duty factor
I_{CC}	Quiescent IC current
I_{COL}	Column current
n	Number of LEDs on in a 5 x 7 array
P_{CASE}	Package power dissipation excluding LED under consideration
P_{COL}	Power dissipation of a column
$P_{DISPLAY}$	Power dissipation of the display
P_{LED}	Power dissipation of an LED
$R_{\theta CA}$	Thermal resistance case to ambient
$R_{\theta JC}$	Thermal resistance junction to case
T_A	Ambient temperature
$T_{J(IC)}$	Junction temperature of an IC
$T_{J(LED)}$	Junction temperature of a LED
$T_{J(MAX)}$	Maximum junction temperature
V_{CC}	IC voltage
V_{COL}	Column voltage
$V_{F(LED)}$	Forward voltage of LED
$Z_{\theta JC}$	Thermal impedance junction to case

Equation 1.

$$T_{J(LED)} = P_{LED}\ Z_{\theta JC} + P_{CASE}\ (R_{\theta JC} + R_{\theta CA}) + T_A$$

$$T_{J(LED)} = [(I_{COL}/28)\ V_{F(LED)}\ Z_{\theta JC}] + [(n/35)\ I_{COL}\ DF\ (5\ V_{COL}) + V_{CC}\ I_{CC}] \bullet [R_{\theta JC} + R_{\theta CA}] + T_A$$

Equation 2.

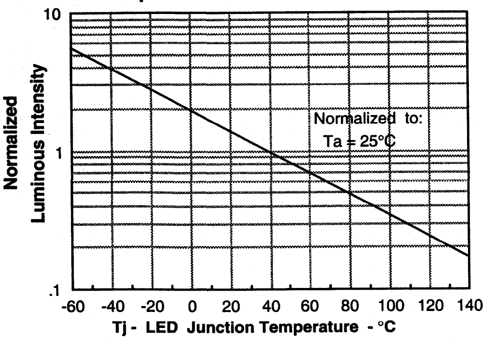
$$T_{J(IC)} = P_{COL}\ (R_{\theta JC} + R_{\theta CA}) + T_A$$

$$T_{J(IC)} = [5\ (V_{COL} - V_{F(LED)}) \bullet (I_{COL}/2) \bullet (n/35)\ DF + V_{CC} \bullet I_{CC}] \bullet [R_{\theta JC} + R_{\theta CA}] + T_A$$

Optical Considerations

The light output of the LEDs is inversely related to the LED diode's junction temperature as shown in Figure 6. For optimum light output, keep the thermal resistance of the socket or PC board as low as possible.

Figure 6. Normalized Luminous Intensity versus Junction Temperature



When mounted in a 10°C/W socket and operated at Absolute Maximum Electrical conditions, the HDSP200XLP will show anLED junction rise of 17°C. If T_A = 40°C, then the LED's TJ will be 57°C. Under these conditions Figure 7 shows that the I_V will be 75% of its 25°C value.

Figure 7. Maximum LED Junction Temperature versus Socket Thermal Resistance

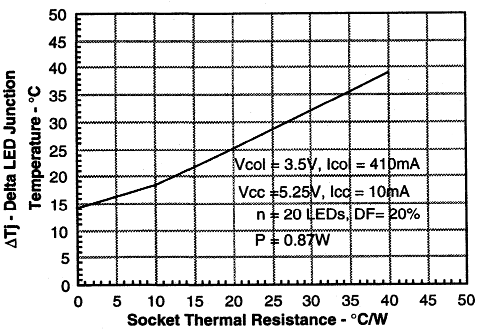


Figure 8. Maximum Package Power Dissipation

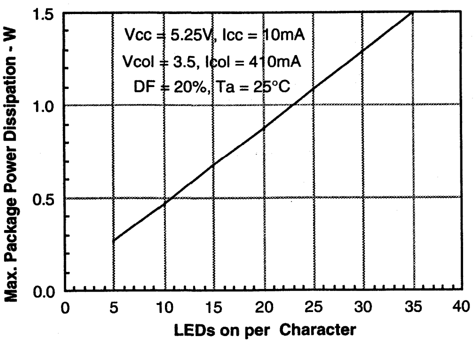


Figure 9. Package Power Dissipation

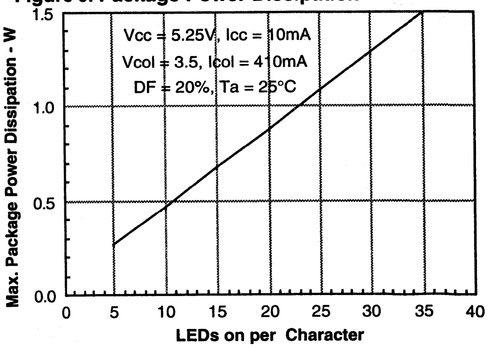


Figure 10. Maximum Character Power Dissipation

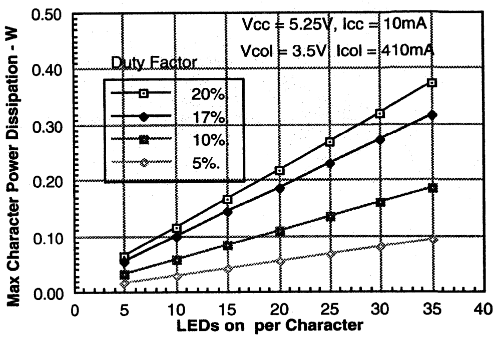
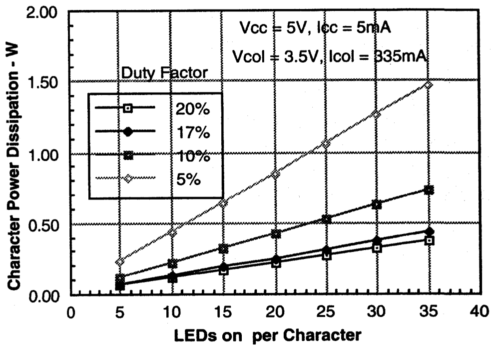


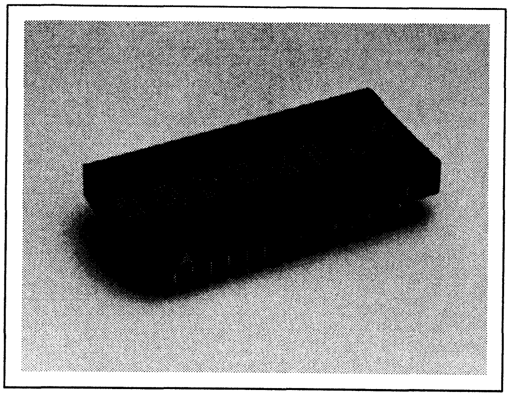
Figure 11. Character Power Dissipation



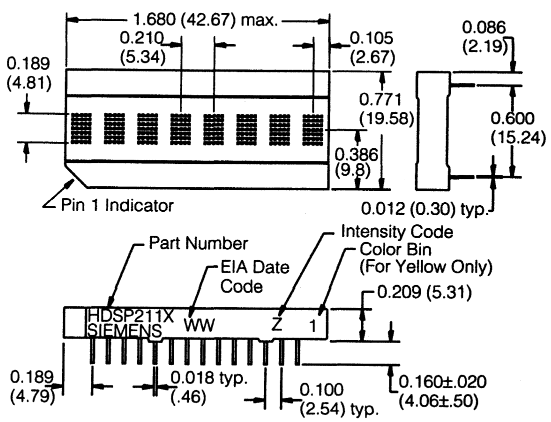
SIEMENS

RED HDSP2110S
YELLOW HDSP2111S
HIGH EFFICIENCY RED HDSP2112S
GREEN HDSP2113S
HIGH EFFICIENCY GREEN HDSP2114S
SOFT ORANGE HDSP2115S

0.200" 8-Character, 5x7 Dot Matrix Parallel Input Alphanumeric Intelligent Display™



Package Dimensions in inches (mm)



FEATURES

- Eight 0.200" Dot Matrix Characters in Red, Yellow, High Efficiency Red, Green, High Efficiency Green, or Soft Orange
- Built-in 128 Character ROM Mask Programmable for Custom Fonts
- Readable from 8 Feet (2.5 meters)
- Built-in Decoders, Multiplexers and Drivers
- Wide Viewing Angle, X Axis ±55°, Y Axis ±65°
- Programmable Features:
  - Individual Flashing Character
  - Full Display Blinking
  - Multi-Level Dimming and Blanking
  - Clear Function
  - Self Test
- Internal or External Clock
- End Stackable Dual-In-Line Plastic Package
- Read/Write Capability
- 16 User Definable Characters

Description

The HDSP2110S (Red), HDSP2111S (Yellow), HDSP2112S (High Efficiency Red), HDSP2113S (Green), HDSP2114S (High Efficiency Green), and HDSP2115S (Soft Orange) are eight digit, 5x7 dot matrix, alphanumeric Programmable Displays. The 0.20 inch high digits are packaged in a rugged, high quality, optically transparent, 0.6 inch lead spacing, 28 pin plastic DIP.

The on-board CMOS has a built-in 128 character ROM. The HDSP211XS also has a user definable character (UDC) feature, which uses a RAM that permits storage of 16 arbitrary characters, symbols or icons that are software-definable by the user. The character ROM itself is mask programmable and easily modified by the manufacturer to provide specified custom characters.

The HDSP211XS is designed for standard microprocessor interface techniques, and is fully TTL compatible. The Clock I/O and Clock Select pins allow the user to cascade multiple display modules.

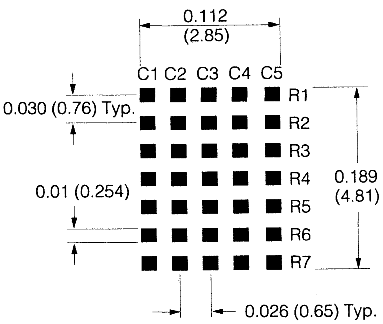
ESD Warning: Standard precaution for CMOS handling should be observed.

Maximum Rating, T_A=25°C

DC Supply Voltage, V_{CC} to GND
(max. voltage with no LEDs on) ....–0.3 to +7.0 VDC
Input Voltage Levels,
All Inputs ....–0.3 to V_{CC} + 0.3
Operating Temperature .... –40°C to 85°C
Storage Temperature .... –40°C to 100°C
Relative Humidity (non-condensing) 85%
Operating Voltage, V_{CC} to GND
(Max. voltage with 20 dots/digits on) .... 5.5 V
Maximum Solder Temperature................................. 260°C
(0.063" below seating plane, t<5 sec)
ESD Protection at 1.5 KΩ,
100 pF ....V_Z=4 KV (each pin)

Enlarged Character Font

Dimensions in inches (mm)

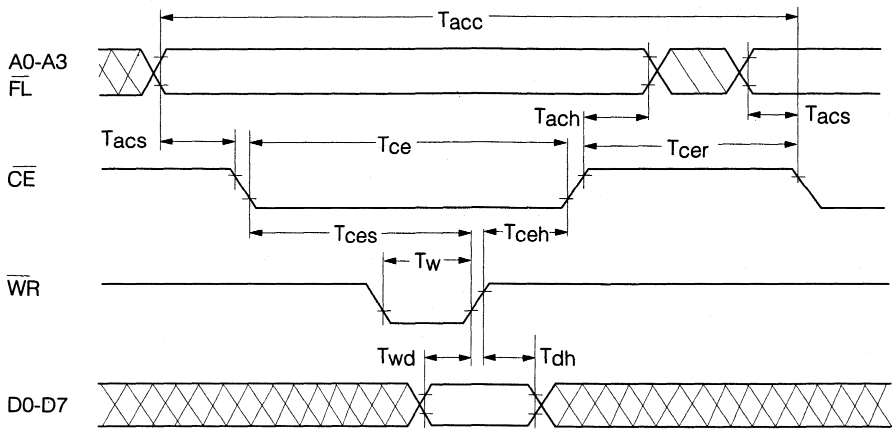


Switching Specifications

(over operating temperature range and V_{CC}=4.5 V)

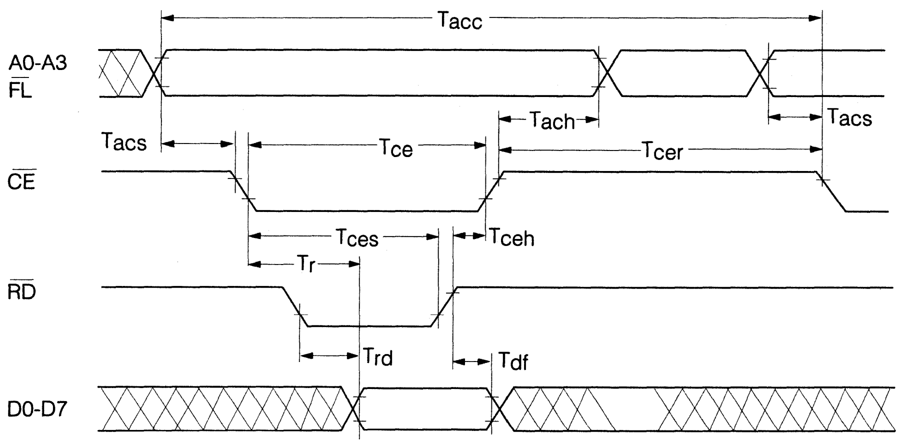
Symbol	Description	Min.	Units
Tacc	Display Access Time—Write	210	ns
Tacc	Display Access Time—Read	230	ns
Tacs	Address Setup Time to $\overline{CE}$	10	ns
Tce	Chip Enable Active Time—Write	140	ns
Tce	Chip Enable Active Time—Read	160	ns
Tach	Address Hold Time to $\overline{CE}$	20	ns
Tcer	Chip Enable Recovery Time	60	ns
Tces	Chip Enable Active Prior to Rising Edge—Write	140	ns
Tces	Chip Enable Active Prior to Rising Edge—Read	160	ns
Tceh	Chip Enable Hold to Rising Edge of Read/Write Signal	0	ns
Tw	Write Active Time	100	ns
Twd	Data Valid Prior to Rising Edge of Write Signal	50	ns
Tdh	Data Write Time	20	ns
Tr	Chip Enable Active Prior to Valid Data	160	ns
Trd	Read Active Prior to Valid Data	95	µs
Tdf	Read Data Float Delay	10	ns
Trc	Reset Active Time	300	ns

Write Cycle Timing Diagram



Input pulse levels –0.6 V to 2.4V

Read Cycle Timing Diagram



Optical Characteristics at 25°C, V_{CC}=5.0 V at Full Brightness

Red HDSP2110S

Description	Symbol	Min.	Typ.	Units
Peak Luminous Intensity[1]	I_{Vpeak}	70	90	µcd/dot
Peak Wavelength	λ(peak)		660	nm
Dominant Wavelength	λ(d)		639	nm

Yellow HDSP2111S

Description	Symbol	Min.	Typ.	Units
Peak Luminous Intensity[1]	I_{Vpeak}	130	210	µcd/dot
Peak Wavelength	λ(peak)		583	nm
Dominant Wavelength	λ(d)		585	nm

High Efficiency Red HDSP2112S

Description	Symbol	Min.	Typ.	Units
Peak Luminous Intensity[1]	I_{Vpeak}	150	330	µcd/dot
Peak Wavelength	λ(peak)		630	nm
Dominant Wavelength	λ(d)		620	nm

Green HDSP2113S

Description	Symbol	Min.	Typ.	Units
Peak Luminous Intensity[1]	I_{Vpeak}	150	260	µcd/dot
Peak Wavelength	λ(peak)		565	nm
Dominant Wavelength	λ(d)		570	nm

High Efficiency Green HDSP2114S

Description	Symbol	Min.	Typ.	Units
Peak Luminous Intensity[1]	I_{Vpeak}	200	510	µcd/dot
Peak Wavelength	λ(peak)		568	nm
Dominant Wavelength	λ(d)		574	nm

Soft Orange HDSP2115S

Description	Symbol	Min.	Typ.	Units
Peak Luminous Intensity[1]	I_{Vpeak}	150	270	µcd/dot
Peak Wavelength	λ(peak)		610	nm
Dominant Wavelength	λ(d)		604	nm

Note
1. Peak luminous intensity is meaaured at T_A=T_J=25°C. No time is allowed for the device to warm up prior to measurement.

Electrical Characteristics at 25°C

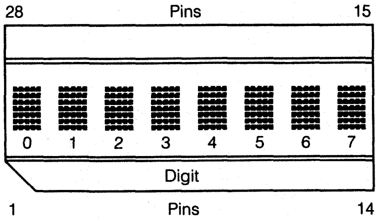
Parameters	Limits Min.	Typ.	Max.	Units	Conditions
V_{CC}	4.5	5.0	5.5	V	
I_{CC} Blank		0.65	1.0	mA	V_{CC}=5 V, V_{IN}=5 V
I_{CC} 12 dots/digit on (1) (2)		185	255	mA	V_{CC}=5 V, "V" in all 8 digits
I_{CC} 20 dots/digit on (1) (2)		284	370	mA	V_{CC}=5 V, "#" in all 8 digits
I_{ILP} (with pull-up) Input Leakage	–18	–11	–5	µA	V_{CC}=5 V, V_{IN}=0 V to V_{CC}, ($\overline{WR}$, $\overline{CE}$, $\overline{FL}$, $\overline{RST}$, $\overline{RD}$, $\overline{CLKSEL}$)
I_{IL} (no pull-up) Input Leakage	–1		+1	µA	V_{CC}=5 V, V_{IN}=0–5 V, (CLK, A0–A3, D0–D7)
V_{IH} Input Voltage High	2.0		V_{CC} +0.3	V	V_{CC}=4.5 V to 5.5 V
V_{IL} Input Voltage Low	GND –0.3			V	V_{CC}=4.5 V to 5.5 V
V_{OL} (D0–D7), Output Voltage Low			0.4	V	V_{CC}=4.5 V, I_{OL}=1.6 mA
V_{OL} (CLK), Output Voltage Low			0.4	V	V_{CC}=4.5 V, I_{OL}=40 µA
V_{OH} Output Voltage High	2.4			V	V_{CC}=4.5 V, I_{OH}=–40 µA
θ_{JC} Thermal Resistance, Junction to Case		25		°C/W	
Clock I/O Frequency	28	57.34	81.14	KHz	V_{CC}=4.5 to 5.5
FM, Digit Multiplex Frequency	125	256	362.5	Hz	V_{CC}=4.5 to 5.5
Blinking Rate	0.98	2.0	2.83	Hz	
Clock I/O Buss Loading			2.40	pF	
Clock Out Rise Time			500	nsec	V_{CC}=4.5 V, V_{OH}=2.4 V
Clock Out Fall Time			500	nsec	V_{CC}=4.5 V, V_{OH}=0.4 V

Notes:
1. I_{CC} is an average value.
2. I_{CC} is measured with the display at full brightness. Peak $I_{CC}={}^{28}/_{15}$ I_{CC} average (#displayed).

Recommended Operating Conditions (T_A=–40°C to +85°C)

Parameter	Symbol	Min.	Max.	Units
Supply Voltage	V_{CC}	4.5	5.5	V
Input Voltage Low	V_{IL}		0.8	V
Input Voltage High	V_{IH}	2.0		V
Output Voltage Low	V_{OL}		0.4	V
Output Voltage High	V_{OH}	2.4		V

Top View



Pin Assignment

Pin	Function	Definition
1	$\overline{RST}$	Used to initialize a display and sychronize blinking for multiple displays
2	$\overline{FL}$	Low input accesses the Flash RAM
3	A0	Address input LSB
4	A1	Address input
5	A2	Address input MSB
6	A3	Mode selector
7	V_{CC}	Optional connection to positive power supply input.
8	V_{CC}	
9	V_{CC}	
10	No Connect	Mode Selector

Pin Assignment (continued)

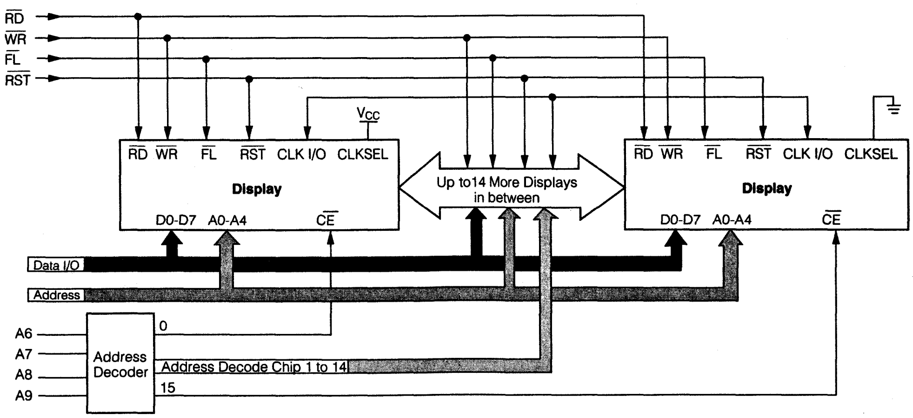
Pin	Function	Definition
11	$\overline{CLKSEL}$	Selects internal/high clock source
12	CLK I/O	Outputs master clock or inputs external clock
13	$\overline{WR}$	A low will write data into the display if $\overline{CE}$ is low
14	V_{CC}	Positive power supply input
15	GND supply	Analog Ground for LED drivers
16	GND logic	Digital Ground for internal drivers
17	$\overline{CE}$	Enables access to the display
18	$\overline{RD}$	A low will read data from the display if $\overline{CE}$ is low. If read from display is not required, then $\overline{RD}$ can be tied to V_{CC}
19	D0	Data input LSB
20	D1	Data input
21	No pin	
22	No pin	
23	D2	Data input
24	D3	Data input
25	D4	Data input
26	D5	Data input
27	D6	Data input
28	D7	Data input MSB, selects ROM, page 1 or 2

Cascading Displays

The HDSP211XS oscillator is designed to drive up to 16 other HDSP211XSs with input loading of 15 pF each.

The following are the general requirements for cascading 16 displays together:

- Determine the correct address for each display.
- Use CE from an address decoder to select the correct display.
- Select one of the Displays to provide the clock for the other displays. Connect CLKSEL to V_{CC} for this display.
- Tie CLKSEL to ground on other displays.
- Use $\overline{RST}$ to synchronize the blinking between the



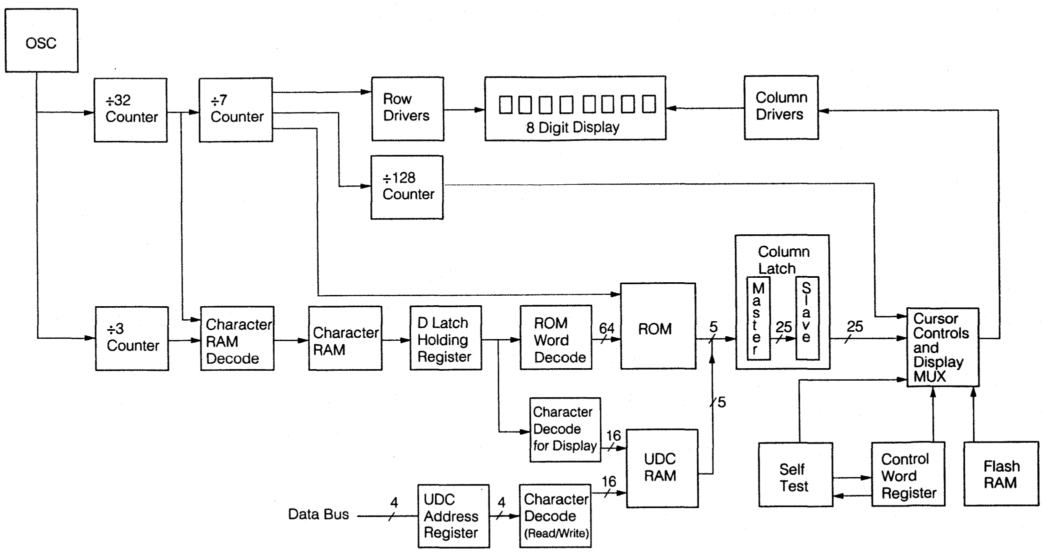
Character Set

ASCII CODE				D0	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
				D1	L	L	H	H	L	L	H	H	L	L	H	H	L	L	H	H
				D2	L	L	L	L	H	H	H	H	L	L	L	L	H	H	H	H
				D3	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H
D7	D6	D5	D4	HEX	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
L	L	L	L	0	◀	∠	X̄	N̄	n̄	α	∂	δ	Δ	η	θ	λ	μ	π	σ	Σ
L	L	L	H	1	τ	Φ	Ω	Å	å	Ä	ä	Ö	ö	Ü	ü	→	∫	²	£	¥
L	L	H	L	2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
L	L	H	H	3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
L	H	L	L	4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
L	H	L	H	5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	↑	_
L	H	H	L	6	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
L	H	H	H	7	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	▒
H	X	X	X	8	UDC 0	UDC 1	UDC 2	UDC 3	UDC 4	UDC 5	UDC 6	UDC 7	UDC 8	UDC 9	UDC 10	UDC 11	UDC 12	UDC 13	UDC 14	UDC 15

Notes

1. Upon power up, the device will initialize in a random state.
2. X=don't care.

Block Diagram



Functional Description

The display's user interface is organized into five memory areas. They are accessed using the Flash Input, FL, and address lines, A3 and A4. All the listed RAMs and Registers may be read or written through the data bus. See Table 1. Each input pin is described in Pin Definitions. The five basic memory areas are:

Character RAM	Stores either ASCII (Katakana) character data or an UDC RAM address
Flash RAM	1x 8 RAM which stores Flash data
User-Defined Character RAM (UDC RAM)	Stores dot pattern for custom characters.
User-Defined Address Register (UDC Address Register)	Provides address to UDC RAM when user is writing or reading custom character
Control Word Register	Enables adjustment of display brightness, flash individual charac ters, blink, self test or clearing the display.

RST can be used to initialize display operation upon power up or during normal operation. When activated, RST will clear the Flash RAM and Control Word Register (00H) and reset the internal counter. All eight display memory locations will be set to 20H to show blanks in all digits.

FL pin enables access to the **Flash RAM**. The **Flash RAM** will set (D0=1) or reset (D0=0) flashing of the character addressed by A0-A2.

The 1 x 8 bit **Control Word Register** is loaded with attribute data if A3=0.

The **Control Word Logic** decodes attribute data for proper implementation.

Character ROM is designed for 128 ASCII characters. The ROM is Mask Programmable for custom fonts.

The **Clock Source** could either be the internal oscillator (CLKSEL=1) of the device or an external clock (CLKSEL=0) could be an input from another HDSP211X display for the synchronization of blinking for multiple displays.

The **Display Multiplexer** controls the Row Drivers so no additional logic is required for a display system.

The **Display** has eight digits. Each digit has 35 LEDs clustered into a 5 x 7 dot matrix.

Table 1. Memory Selection

FL	A2	A3	Section of Memory	A2–A0	Data Bits Used
0	X	X	Flash RAM	Character Address	D0
1	0	0	UDC Address Register	Don't Care	D3–D0
1	0	1	UDC RAM	Row Address	D4–D0
1	1	1	Character RAM	Character Address	D7–D0
1	1	0	Control Word Register	Don't Care	D7–D0

Theory of Operation

The HDSP211XS Programmable Display is designed to work with all major microprocessors. Data entry is via an eight bit parallel bus. Three bits of address route the data to the proper digit location in the RAM. Standard control signals like $\overline{WR}$ and $\overline{CE}$ allow the data to be written into the display.

D0–D7 data bits are used for both Character RAM and control word data input. A3 acts as the mode selector.

If A3=1, character RAM is selected. Then input data bit D7 will determine whether input data bits D0–D6 is ASCII coded data (D7=0) or UDC data (D7=1). See section on UDC Address Register and RAM.

For normal operation $\overline{FL}$ pin should be held high. When $\overline{FL}$ is held low, Flash RAM is accessed to set character blinking.

The seven bit ASCII code is decoded by the Character ROM to generate Column data. Twenty columns worth of data is sent out each display cycle, and it takes fourteen display cycles to write into eight digits.

The rows are multiplexed in two sets of seven rows each. The internal timing and control logic synchronizes the turning on of rows and presentation of column data to assure proper display operation.

Power Up Sequence

Upon power up display will come on at random. Thus the display should be reset on power-up. The reset will clear the Flash RAM, Control Word Register and reset the internal counter. All the digits will show blanks and display brightness level will be 100%.

The display must not be accessed until three clock pulses (110 μseconds minimum using the internal clock) after the rising edge of the reset line.

Microprocessor Interface

The interface to a microprocessor is through the 8-bit data bus (D0–D7), the 4-bit address bus (A0–A3) and control lines $\overline{FL}$, $\overline{CE}$ and $\overline{WR}$.

To write data (ASCII/Control Word) into the display $\overline{CE}$ should be held low, address and data signals stable and $\overline{WR}$ should be brought low. The data is written on the low to high transition of $\overline{WR}$.

The Control Word is decoded by the Control Word Decode Logic. Each code has a different function. The code for display brightness changes the duty cycle for the column drivers. The peak LED current stays the same but the average LED current diminishes depending on the intensity level.

The character Flash Enable causes 2 Hz coming out of the counter to be ANDED with column drive signal and makes the column driver to cycle at 2 Hz. Thus the character flashes at 2 Hz.

The display Blink works the same way as the Flash Enable but causes all twenty column drivers to cycle at 2 Hz thereby making all eight digits to blink at 2 Hz.

The Self Test function of the IC consists of two internal routines which exercise major portions of the IC and illuminates all the LEDs.

Clear bit clears the character RAM and writes a blank into the display memory. It however does not clear the control word.

ASCII Data or Control Word Data can be written into the display at this point. For multiple display operation, CLK I/O must be properly selected. CLK I/O will output the internal clock if CLKSEL=1, or will allow input from an external clock if CLKSEL=0.

Character RAM

The Character RAM is selected when $\overline{\text{FL}}$, A4 and A3 are set to 1,1,1 during a read or write cycle. The Character RAM is a 8 by 8 bit RAM with each of the eight locations corresponding to a digit on the display. Digit 0 is on the left side of the display and digit 7 is on the right side of the display. Address lines, A2–A0 select the digit address with A2 being the most significant bit and A0 being the least significant bit. The two types of data stored in the Character RAM are the ASCII coded data and the UDC Address Data. The type of data stored in the Character RAM is determined by data bit, D7. If D7 is low, then ASCII coded data is stored in data bits D6–D0. If D7 is high, then UDC Address Data is stored in data bit D3–D0.

The ASCII coded data is a 7 bit code used to select one of 128 ASCII characters permanently stored in the ASCII ROM.

The UDC Address data is a 4 bit code used to select one of the UDC characters in the UDC RAM. There are up to 16 characters available. See Figure 1.

UDC Address Register and UDC RAM

The UDC Address Register and UDC RAM allows the user to generate and store up to 16 custom characters. Each custom character is defined in 5 x 7 dot matrix pattern. It takes 8 write cycles to define a custom character, one cycle to load the UDC Address Register and 7 cycles to define the character. The contents of the UDC Address Register will store the 4 bit address for one of the 16 UDC RAM locations. The UDC RAM is used to store the custom character.

UDC Address Register

The UDC Address Register is selected by setting $\overline{\text{FL}}$=1, A4=0, A3=0. It is a 4 bit register and uses data bits, D3–D0 to store the 4 bit address code (D7–D4 are ignored). The address code selects one of 16 UDC RAM locations for custom character generation.

UDC RAM

The UDC RAM is selected by setting $\overline{\text{FL}}$=1, A4=0, A3=1. The RAM is comprised of a 7 x 5 bit RAM. As shown in Figure 4, address lines, A2–A0 select one of the 7 rows of the custom character. Data bits, D4–D0 determine the 5 bits of column data in each row. Each data bit corresponds to a LED. If the data bit is high, then the LED is on. If the data bit is low, the LED is off. To create a character, each of the 7 rows of column data need to be defined. See Figures 2 and 3 for logic.

Flash RAM

The Flash RAM allows the display to flash one or more of the characters being displayed. The Flash Ram is accessed by setting $\overline{\text{FL}}$ low. A4 and A3 are ignored. The Flash RAM is a 8 x 1 bit RAM with each bit corresponding to a digit address. Digit 0 is on the left side of the display and digit 7 is on the right side of the display. Address lines, A2–A0 select the digit address with A2 being the most significant digit and A0 being the least significant digit. Data bit, D0, sets and resets the flash bit for each digit. When D0 is high, the flash bit is set and when D0 is low, it is reset. See Figure 4.

Figure 1. Character RAM Access Logic

$\overline{\text{RST}}$	$\overline{\text{CE}}$	$\overline{\text{WR}}$	$\overline{\text{RD}}$	$\overline{\text{FL}}$	A4	A3	A2 A1 A0	D7 D6 D5 D4 D3 D2 D1 D0
1	0	0	1	1	1	1	Character Address for Digits 0–7	0 7 bit ASCII code for a Write Cycle
1	0	1	0	1	1	1	Character Address for Digits 0–7	0 7 bit ASCII code read during a Read Cycle
1	0	0	1	1	0	0	Character Address for Digits 0–7	1 D3–D0=UDC address for a Write Cycle
1	0	1	0	1	0	0	Character Address for Digits 0–7	1 D3–D0=UDC address for Read Data

Figure 2. UDC Address Register and UDC Character RAM

$\overline{\text{RST}}$	$\overline{\text{CE}}$	$\overline{\text{WR}}$	$\overline{\text{RD}}$	$\overline{\text{FL}}$	A4	A3	A2 A1 A0	D7 D6 D5 D4 D3 D2 D1 D0	
1	0	0	1	1	0	0	Not used for UDC Address Register	D3–D0=UDC RAM Address Code for Write Cycle	UDC Address Register
1	0	1	0	1	0	0	Not used for UDC Address Register	D3–D0=UDC RAM Address Code for Read Cycle	
1	0	0	1	1	0	1	A2–A0=Character Row Address	D4–D0=Character Column Data for Write Cycle	UDC RAM
1	0	1	0	1	0	1	A2–A0=Character Row Address	D4–D0=Character Column Data read during a Read Cycle	

Control Word

The Control Word is used to set up the attributes required by the user. It is addressed by setting $\overline{FL}$=1, A4=1, A3=0. The Control Word is an 8 bit register and is accessed using data bits, D7–D0. See Figures 5 and 6 for the logic and attributed control. The Control Word has 5 functions. They are brightness control, flashing character enable, blinking character enable, self test, and clear (Flash and Character RAMS only).

Brightness Control

Control Word bits, D2–D0, control the brightness of the display with a binary code of 000 being 100% brightness and 111 being display blank. See Figure 6 for brightness level versus binary code. The average I_{CC} can be calculated by multiplying the 100% brightness level I_{CC} value by the display's brightness level. For example, a display set to 80% brightness with a 100% average I_{CC} value of 200 mA will have an average I_{CC} value of 200 mA x 80%=160 mA.

Flash Function

Control Word bit, D3, enables or disables the Flash Function. When D3 is 1, the Flash Function is enabled and any digit with its corresponding bit set in the Flash RAM will flash at approximately 2 hertz. When using an external clock, the flash rate can be determined by dividing the clock rate by 28,672. When D3 is 0, the Flash Function is disabled and the contents of the Flash RAM is ignored. For synchronized flashing on multiple displays, see the Reset Section.

Blink Function

Control Word bit, D4, enables or disables the Blink Function. When D4 is 1, the Blink Function is enabled and all characters on the display will blink at approximately 2 hertz. The Blink Function will override the Flash Function if both functions are enabled. When D4 is 0, the Blink Function is disabled. When using an external clock, the blink rate can be determined by dividing the clock rate by 28,672. For synchronized blinking on multiple displays, see the Reset Section.

Self Test

Before starting Self Test, Reset must first be activated. Control Word bits, D6 and D5, are used for the Self Test Function.

Figure 3. UDC Character Map

Row Data				Column Data
				C1 C2 C3 C4 C5
A2	A1	A0	Row #	D4 D3 D2 D1 D0
0	0	0	1	5 x 7 Dot Matrix Pattern
0	0	1	2	
0	1	0	3	
0	1	1	4	
1	0	0	5	
1	0	1	6	
1	1	0	7	

When D6 is 1, the Self Test is initiated. Results of the Self Test are stored in bits D5. Control Word bit, D5, is a read only bit. When D5 is 1, Self Test passed is indicated. When D5 is 0, Self Test failed is indicated. The Self Test function of the IC consists of two internal routines which exercise major portions of the IC and illuminates all of the LEDs. The first routine cycles the ASCII decoder ROM through all states and performs a check sum on the output. If the check sum agrees with the correct value, D5 is set to a 1.

The second routine provides a visual test of the LEDs using the drive circuitry. This is accomplished by writing checkered and inverse checkered patterns to the display. Each pattern is displayed for approximately 2 seconds. During the self test function the display must not be accessed. The time needed to execute the self test function is calculated by multiplying the clock time by 262,144 (typical time≈4.6 sec.). At the end of the self test function, the Character RAM is loaded with blanks; the Control Word Register is set to zeroes except D5, and the Flash RAM is cleared and the UDC Address Register is set to all 1s.

Figure 4. Flash RAM Access Logic

$\overline{RST}$	$\overline{CE}$	$\overline{WR}$	$\overline{RD}$	$\overline{FL}$	A4	A3	A2 A1 A0	D7 D6 D5 D4 D3 D2 D1 D0
1	0	0	1	1	X	X	Flash RAM Address for Digits 0–7	D0=Flash Data, 0-Flash Off and 1=Flash On (Write Cycle)
1	0	1	1	0	X	X	Flash RAM Address for Digits 0–7	D0=Flash Data, 0-Flash Off and 1=Flash On (Read Cycle)

Figure 5. Control Word Access Logic

$\overline{RST}$	$\overline{CE}$	$\overline{WR}$	$\overline{RD}$	$\overline{FL}$	A4	A3	A2 A1 A0	D7 D6 D5 D4 D3 D2 D1 D0
1	0	0	1	1	1	0	Not used for Control Word	Control Word data for a Write Cycle, see Figure 6.
1	0	1	0	1	1	0	Not used for Control Word	Control Word data for a Read during a Read Cycle.

Clear Function (see Figures 6 and 7)

Control Word bit, D7 clears the character RAM to 20 hex and the flash RAM to all zeroes. The RAMs are cleared within three clock cycles (110 µs minimum, using the internal clock) when D7 is set to 1. During the clear time the display must not be accessed. When the clear function is finished, bit 7 of the Control Word RAM will be reset to a "0".

Reset Function

The display should be reset on power up of the display ($\overline{RST}$=LOW). When the display is reset, the Character RAM, Flash RAM, and Control Word Register are cleared. The display's internal counters are reset. Reset cycle takes three clock cycles (110 µseconds minimum using the internal clock). The display must not be accessed during this time.

To synchronize the flashing and blinking of multiple displays, it is necessary for the display to use a common clock source and reset all the displays at the same time to start the internal counters at the same place.

While $\overline{RST}$ is low, the display must not be accessed by RD nor $\overline{WR}$.

Figure 6. Control Word Data Definition

D7	D6	D5	D4	D3	D2	D1	D0
C	ST	ST	BL	FL	Br	Br	Br

D2	D1	D0	
0	0	0	100% Brightness
0	0	1	80% Brightness
0	1	0	53% Brightness
0	1	1	40% Brightness
1	0	0	27% Brightness
1	0	0	20% Brightness
1	1	0	13% Brightness
1	1	1	Blank Display

D3 (FL):
- 0 Flash Function Disabled
- 1 Flash Function Enabled

D4 (BL):
- 0 Blink Function Disabled
- 1 Blink Function Enabled (overrides Flash Function)

D6, D5 (ST):
- 0 X Normal Operation X=bit ignored
- 1 R Run Self Test, R=Test Result, R=1/pass, 0=fail

D7 (C):
- 0 Normal Operation
- 1 Clear Flash RAM & Character RAM (Character RAM=20 Hex)

Key

C	Clear Function
ST	Self test
BL	Blink function
FL	Flash function
Br	Brightness control

Figure 7. Clear Function

$\overline{CE}$ $\overline{WR}$ $\overline{FL}$	A3 A2 A1 A0	D7 D6 D5 D4 D3 D2 D1 D0	Operation
0 0 1	0 X X X	0 X X X X X X X	Clear Disabled
0 0 1	0 X X X	1 X X X X X X X	Clear User RAM, Flash RAM and Display

X=don't care

Figure 8. Display Cycle Using Built-in ROM Example

Display message "Showtime." Digit 0 is leftmost—closest to pin 1.
Logic levels: 0=Low, 1=High, X=Don't care.

$\overline{RST}$	$\overline{CE}$	$\overline{WR}$	$\overline{RD}$	$\overline{FL}$	A4	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Operation	Display
0	X	1	1	1	X	X	X	X	X	X	X	X	X	X	X	X	X	Reset. No Read/Write Within 3 Clock Cycles	All Blank
1	0	0	1	1	1	0	X	X	X	0	0	X	0	0	0	1	1	53% Brightness Selected	All Blank
1	0	0	1	1	1	1	0	0	0	0	1	0	1	0	0	1	1	Write "S" to Digit 0	S
1	0	0	1	1	1	1	0	0	1	0	1	0	0	1	0	0	0	Write "H" to Digit 1	SH
1	0	0	1	1	1	1	0	1	0	0	1	0	0	1	1	1	1	Write "O" to Digit 2	SHO
1	0	0	1	1	1	1	0	1	1	0	1	0	1	0	1	1	1	Write "W" to Digit 3	SHOW
1	0	0	1	1	1	1	1	0	0	0	1	0	1	0	1	0	0	Write "T" to Digit 4	SHOWT
1	0	0	1	1	1	1	1	0	1	0	1	0	0	1	0	0	1	Write "I" to Digit 5	SHOWTI
1	0	0	1	1	1	1	1	1	0	0	1	0	0	1	1	0	1	Write "M" to Digit 6	SHOWTIM
1	0	0	1	1	1	1	1	1	1	0	1	0	0	0	1	0	1	Write "E" to Digit 7	SHOWTIME

Figure 9. Displaying User Defined Character Example

Load character "A" into UDC-5 and then display it in digit 2
Logic levels: 0=Low, 1=High, X=Don't care

$\overline{RST}$	$\overline{CE}$	$\overline{WR}$	$\overline{RD}$	$\overline{FL}$	A4	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Operation	Display
0	X	1	1	1	X	X	X	X	X	X	X	X	X	X	X	X	X	Reset. No Read/Write Within 3 Clock Cycles	All Blank
1	0	0	1	1	0	0	X	X	X	X	X	X	X	0	1	0	1	Select UDC-5	All Blank
1	0	0	1	1	0	1	0	0	0	X	X	X	0	1	1	1	0	Write into Row 1 of UDC-5	All Blank
1	0	0	1	1	0	1	0	0	1	X	X	X	1	0	0	0	1	Write into Row 2 of UDC-5	All Blank
1	0	0	1	1	0	1	0	1	0	X	X	X	1	0	0	0	1	Write into Row 3 of UDC-5	All Blank
1	0	0	1	1	0	1	0	1	1	X	X	X	1	1	1	1	1	Write into Row 4 of UDC-5	All Blank
1	0	0	1	1	0	1	1	0	0	X	X	X	1	0	0	0	1	Write into Row 5 of UDC-5	All Blank
1	0	0	1	1	0	1	1	0	1	X	X	X	1	0	0	0	1	Write into Row 6 of UDC-5	All Blank
1	0	0	1	1	0	1	1	1	0	X	X	X	1	0	0	0	1	Write into Row 7 of UDC-5	All Blank
1	0	0	1	1	1	1	0	1	0	1	X	X	X	0	1	0	1	Write UDC-5 Into Digit 2	(Digit 2) A

Electrical and Mechanical Considerations

Voltage Transient Suppression

For best results power the display and the components that interface with the display to avoid logic inputs higher than V_{CC}. Additionally, the LEDs may cause transients in the power supply line while they change display states. The common practice is to place a parallel combination of a .01 µF and a 22 µF capacitor between V_{CC} and GND for all display packages.

ESD Protection

The input protection structure of the HDSP211XS provides significant protection against ESD damage. It is capable of withstanding discharges greater than 2 KV. Take all the standard precautions, normal for CMOS components. These include properly grounding personnel, tools, tables, and transport carriers that come in contact with unshielded parts. If these conditions are not, or cannot be met, keep the leads of the device shorted together or the parts in antistatic packaging.

Soldering Considerations

The HDSP211XS can be hand soldered with SN63 solder using a grounded iron set to 260°C.

Wave soldering is also possible following these conditions: Preheat that does not exceed 93°C on the solder side of the PC board or a package surface temperature of 85°C. Water soluble organic acid flux (except carboxylic acid) or resin-based RMA flux without alcohol can be used.

Direct contact with alcohol or alcohol vapor will cause degradation of the package.

Wave temperature of 245°C ±5°C with a dwell between 1.5 sec. to 3.0 sec. Exposure to the wave should not exceed temperatures above 260°C for five seconds at 0.063" below the seating plane. The packages should not be immersed in the wave.

Post Solder Cleaning Procedures

The least offensive cleaning solution is hot D.I. water (60°C) for less than 15 minutes. Addition of mild saponifiers is acceptable. Do not use commercial dishwasher detergents.

For faster cleaning, solvents may be used. Exercise care in choosing solvents as some may chemically attack the nylon package. Maximum exposure should not exceed two minutes at elevated temperatures. Acceptable solvents are TF (trichorotrifluorethane), TA, 111 Trichloroethane, and unheated acetone.(1)

Note: 1. Acceptable commercial solvents are: Basic TF, Arklone, P. Genesolv, D. Genesolv DA, Blaco-Tron TF, Blaco-Tron TA, and Freon TA.

Unacceptable solvents contain alcohol, methanol, methylene chloride, ethanol, TP35, TCM, TMC, TMS+, TE, or TES. Since many commercial mixtures exist, contact a solvent vendor for chemical composition information. Some major solvent manufacturers are: Allied Chemical Corporation, Specialty Chemical Division, Morristown, NJ; Baron-Blakeslee, Chicago, IL; Dow Chemical, Midland, MI; E.I. DuPont de Nemours & Co., Wilmington, DE.

For further information refer to Appnotes 18 and 19 in the current Siemens Optoelectronic Data Book.

An alternative to soldering and cleaning the display modules is to use sockets. Naturally, 28 pin DIP sockets .600" wide with .100" centers work well for single displays. Multiple display assemblies are best handled by longer SIP sockets or DIP sockets when available for uniform package alignment. Socket manufacturers are Aries Electronics, Inc., Frenchtown, NJ; Garry Manufacturing, New Brunswick, NJ; Robinson-Nugent, New Albany, IN; and Samtec Electronic Hardward, New Albany, IN.

For further information refer to Appnote 22 in the current Siemens Optoelectronic Data Book.

Optical Considerations

The .200" high character of the HDSP211XS gives readability up to eight feet. Proper filter selection enhances readability over this distance.

Using filters emphasizes the contrast ratio between a lit LED and the character background. This will increase the discrimination of different characters. The only limitation is cost. Take into consideration the ambient lighting environment for the best cost/benefit ratio for filters.

Incandescent (with almost no green) or fluorescent (with almost no red) lights do not have the flat spectral response of sunlight. Plastic band-pass filters are an inexpensive and effective way to strengthen contrast ratios. The HDSP2110/2112S are red/high efficiency red displays and should be matched with long wavelength pass filter in the 570 nm to 590 nm range. The HDSP2113S should be matched with a yellow-green band-pass filter that peaks at 565 nm. For displays of multiple colors, neutral density grey filters offer the best compromise.

Additional contrast enhancement is gained by shading the displays. Plastic band-pass filters with built-in louvers offer the next step up in contrast improvement. Plastic filters can be improved further with anti-reflective coatings to reduce glare. The trade-off is fuzzy characters. Mounting the filters close to the display reduces this effect. Take care not to overheat the plastic filter by allowing for proper air flow.

Optimal filter enhancements are gained by using circular polarized, anti-reflective, band-pass filters. The circular polarizing further enhances contrast by reducing the light that travels through the filter and reflects back off the display to less than 1%.

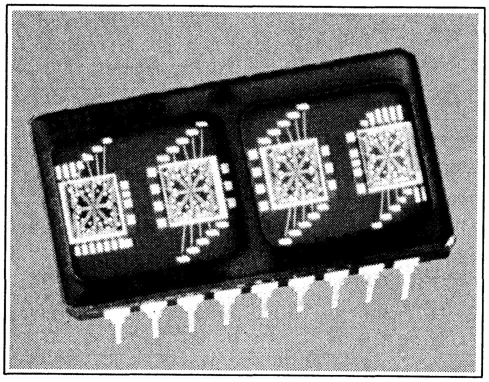
Several filter manufacturers supply quality filter materials. Some of them are: Panelgraphic Corporation, W. Caldwell, NJ; SGL Homalite, Wilmington, DE; 3M Company, Visual Products Division, St. Paul, MN; Polaroid Corporation, Polarizer Division, Cambridge, MA; Marks Polarized Corporation, Deer Park, NY, Hoya Optics, Inc., Fremont, CA.

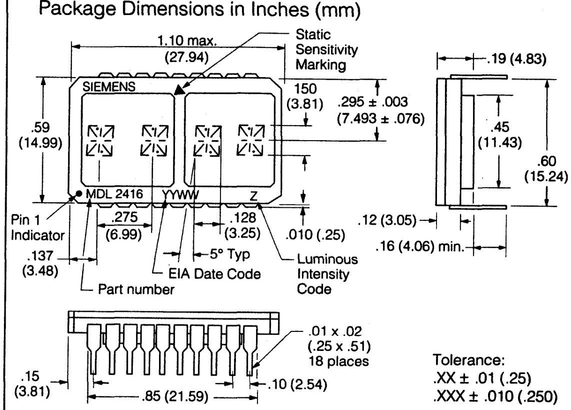
One last note on mounting filters: recessing displays and bezel assemblies is an inexpensive way to provide a shading effect in overhead lighting situations. Several bezel manufacturers are: R.M.F. Products, Baklava, IL; Nobody Components, Griffith Plastic Corp., Burningly, CA; Photo Chemical Products of California, Santa Monica, CA; I.E.E.-Atlas, Van Nuys, CA.

SIEMENS

MDL2416C
MDL2416TXVB

.15" Red, 4-Digit, 16 Segment Plus Decimal HI-REL Alphanumeric Intelligent Display® With Memory/Decoder/Driver





FEATURES

- **150 Mil High, Non-Magnified Monolithic Character**
- **Rugged Ceramic Package, Hermetically Sealed Flat Glass Window**
- **Low Profile Package**
- **Dual in Line Configuration**
- **Close Vertical Row Spacing, 0.600"**
- **100 Mil Pin Spacing**
- **Wide Viewing Angle**
- **Wide Temperature Operating Range, -55°C to +100°C**
- **Fully Integrated CMOS Drive Electronics**
- **Direct Access to Each Digit Independently and Asynchronously**
- **TTL Compatible, 5 Volt Power Supply**
- **Independent Cursor Function**
- **17th Segment for Improved Punctuation Marks**
- **Two Chip Enables**
- **Interdigit Blanking**
- **Display Blank Function**
- **Memory Clear Function**
- **End-Stackable, Four Character Package**
- **Intensity Coded for Display Uniformity**
- **MDL2416C Process Conforms to MIL-D-87157 Quality Level A Test Tables I, II and also can meet Groups B and C Testing Specified in MIL-D-87157**
- **MDL2416 TXVB Process Conforms to MIL-D-87157 Quality Level A Test Tables I, II, IIIa and IVa (See High Reliability Test Tables)**

DESCRIPTION

The MDL2416 is a military alphanumeric four digit display module with a 17 segment font and a built-in CMOS drive circuitry that is TTL and microprocessor compatible.

The integrated circuit contains memory, ASCII ROM decoder, multiplexing circuitry and drivers. The MDL2416 is designed for use in extremely harsh environments where only the most reliable product is acceptable.

Data entry is asynchronous and can be random. A display system can be built using any number of MDL2416s since each digit in any MDL2416 can be addressed independently and will continue to display the character last stored until replaced by another.

System interconnection is straightforward. The least significant two address bits (A0, A1) are normally connected to the like named inputs of all MDL2416s in the system. With two chip enables ($\overline{CE1}$ and $\overline{CE2}$), four MDL2416s (16 characters) can easily be interconnected without an external decoder.

Important: *Since this is a CMOS device, normal precautions should be taken to avoid static damage due to high static voltages or electric fields. See Appnote 18 for further information.*

Optoelectronic Characteristics at 25°C

Absolute Maximum Ratings

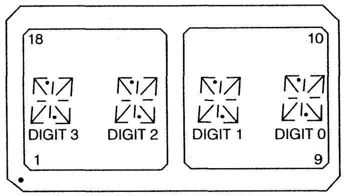
DC Supply Voltage .... –0.5 to +6.0 VDC
Input Voltage Relative to Gnd
(all inputs) .... –0.5 to V_{CC} +0.5 VDC
Operating Temperature .... –55°C to +100°C
Storage Temperature .... –65°C to +125°C

Optical Characteristics

Spectral Peak Wavelength .... 660 nm typ.
Spectral Line Half-Width .... 40 nm typ.
Viewing Angle (see Note) .... ±50°
Digit Size .... 0.15"
Luminous Intensity (typ.) ..... 0.1 mcd/segment at V_{CC}=5 V
Intensity Matching,
Segment to Segment .... 1.8:1 at V_{CC}=5 V

Note: "Off axis viewing angle" is defined as, the minimum angle in any direction from the normal to the display surface at which any part of any segment in the display is not visible.

Top View



Pin	Function	Pin	Function
1	$\overline{CE1}$ Chip Enable	10	GND
2	$\overline{CE2}$ Chip Enable	11	D0 Data Input
3	$\overline{CLR}$ Clear	12	D1 Data Input
4	$\overline{CUE}$ Cursor Enable	13	D2 Data Input
5	$\overline{CU}$ Cursor Select	14	D3 Data Input
6	$\overline{WR}$ Write	15	D6 Data Input
7	A1 Digit Select	16	D5 Data Input
8	A0 Digit Select	17	D4 Data Input
9	V_{CC}	18	BL Display Blank

DC Characteristics at 25°C

Parameter	Min.	Typ.	Max.	Units	Conditions
V_{CC}	4.5	5.0	5.5	V	25°C
I_{CC} (Blank)(1)	0.10	1.5	4.0	mA	V_{CC}=5 V, WR=V_{CC}, V_{IN}= 0 V all other pins
I_{CC} (10 segments/character 4 digits on)	65	85	115	mA	V_{CC}=5 V
I_{CC} (all segments on cursor in 4 digits)(1,2)	85	120	165	mA	V_{CC}=5 V meausred at 5 sec., 60 sec. max.
V_{IL} (all inputs)			0.6	V	V_{CC}=5 V ±0.5 V
V_{IH} (all inputs)	2.4			V	V_{CC}=5 V ±0.5 V
I_{IL} (all inputs)		60	160	µA	V_{CC}=5 V, V_{IN}=0.8 V

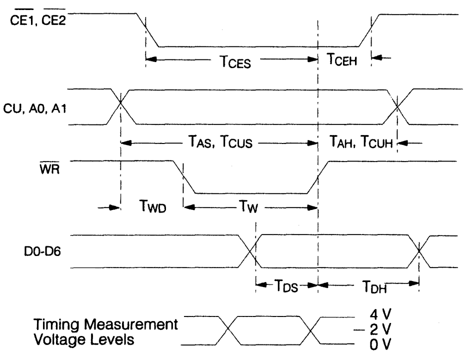
1. Measured at 5 seconds.
2. 60 seconds maximum duration.

AC Characteristics

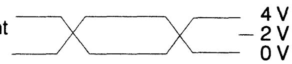
Parameter	Symbol	–55°C	+25°C	+100°C	Units
Chip Enable Set Up Time	T_{CES}	190	275	410	ns
Address Set Up Time	T_{AS}	190	275	410	ns
Cursor Set Up Time	T_{CUS}	190	275	410	ns
Chip Enable Hold Time	T_{CEH}	25	25	25	ns
Address Hold Time	T_{AH}	25	25	25	ns
Cursor Hold Time	T_{CUH}	25	25	25	ns
Write Delay Time	T_{WD}	40	50	60	ns
Write Pulse	T_W	150	225	350	ns
Data Set Up Time	T_{DS}	100	150	300	ns
Data Hold Time	T_{DH}	25	25	25	ns
Clear Pulse	T_{CLR}	0.9	1	1.2	µs

Note: 1. Unused inputs must be tied to an appropriate logic voltage level (either V+ or V-).

Timing Characteristics
Write Cycle Waveforms

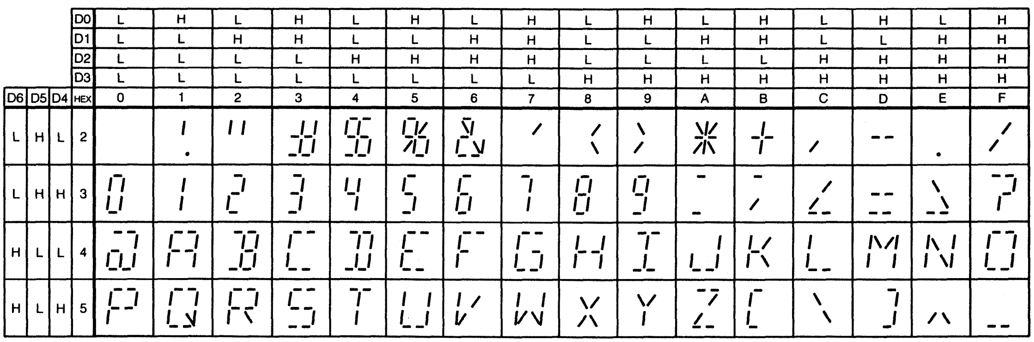


Timing Measurement
Voltage Levels



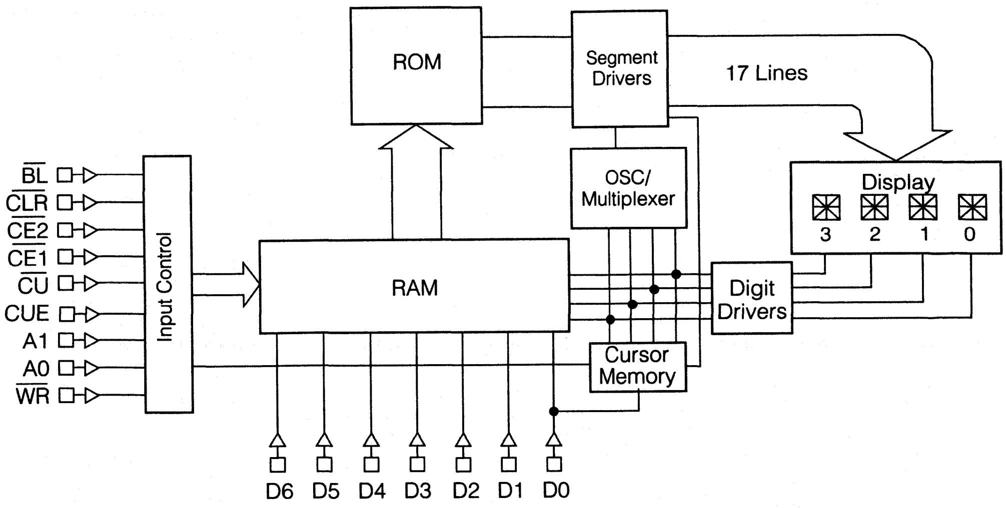
(for tester calibration only)

Character Set

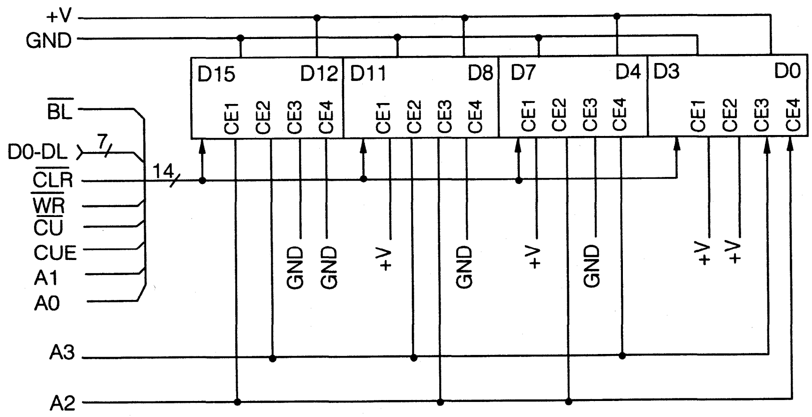


All other input codes display "blank"

Internal Block Diagram



Typical Schematic for 16 Digit System



Loading Data

Setting the chip enable (CE1, CE2) to their true state will enable data loading. The desired data code (D0-D6) and digit address (A0, A1) must be held stable during the write cycle for storing new data.

Data entry may be asynchronous and random. (Digit 0 is defined as right hand digit with A1 = A2 = 0.)

Clearing the entire internal four-digit memory can be accomplished by holding the clear (CLR) low for one µS minimum. The clear function will clear both the ASCII RAM and the cursor RAM. Loading an illegal data code will display a blank.

Loading Cursor

Setting the chip enables (CE1, CE2) and cursor select (CU) to their true state will enable cursor loading. A write (WR) pulse will now store or remove a cursor into the digit location addressed by A0, A1, as defined in data entry. A cursor will be stored if D0=1; and will be removed if D0=0. The cursor (CU) pulse width should not be less than the write (WR) pulse or erroneous data may appear in the display.

If the cursor isn't required, the cursor enable signal (CUE) may be tied low to disable the display of the cursor function. For a flashing cursor, simply pulse CUE. If the cursor has been loaded to any or all positions in the display, then CUE will control whether the cursor(s) or the characters appear. CUE does not affect the contents of cursor memory.

Display Blanking

To blank the display, load a blank or space into each digit of the display or use the (BL) display blank input.

Setting the (BL) input low does not affect the contents of either data or cursor memory. A flashing display will result by pulsing (BL).

A flashing circuit can be easily constructed using a 555 astable multivibrator. Figure 1 illustrates a circuit in which varying R1 (100K~10K) will have a flash rate of 1Hz~10Hz.

The display can be dimmed by pulse width modulating the (BL) at a frequency sufficiently fast not to interfere with the internal clock. This clock frequency may vary from 200 Hz to 1.3KHz. The dimming signal frequency should be 2.5KHz or higher. Dimming the display also reduces power consumption.

Typical Loading Data State Table

Control							Address		Data							Display Digit			
BL	CE1	CE2	CUE	CU	WR	CLR	A1	A0	D6	D5	D4	D3	D2	D1	D0	3	2	1	0
H	X	X	L	X	H	H	previously loaded display									G	R	E	Y
H	H	X	L	X	X	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	X	H	L	X	X	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	L	L	L	H	L	H	L	L	H	L	L	L	H	L	H	G	R	E	E
H	L	L	L	H	L	H	L	H	H	L	H	L	H	L	H	G	R	U	E
H	L	L	L	H	L	H	H	L	H	L	L	H	H	L	L	G	L	U	E
H	L	L	L	H	L	H	H	H	H	L	L	L	L	H	L	B	L	U	E
L	X	X	X	X	H	H	X	X	blank display										
H	L	L	L	H	L	H	H	H	H	L	L	L	H	H	H	G	L	U	E
H	X	X	L	X	H	L	X	X	clears character displays							see character set			
H	L	L	L	H	L	H	X	X	see character code										

X = don't care

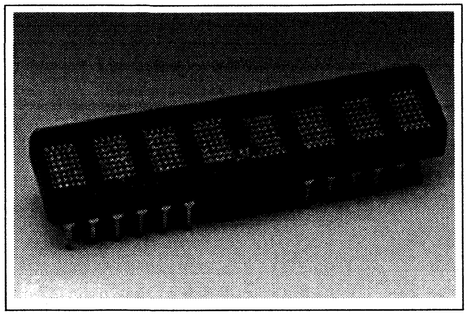
Loading Cursor State Table

Control							Address		Data							Display Digit			
BL	CE1	CE2	CUE	CU	WR	CLR	A1	A0	D6	D5	D4	D3	D2	D1	D0	3	2	1	0
H	X	X	L	X	H	H	previously loaded display									B	E	A	R
H	X	X	H	X	H	H	display previously stored cursors									B	E	A	R
H	L	L	H	L	L	H	L	L	X	X	X	X	X	X	H	B	E	A	■
H	L	L	H	L	L	H	L	H	X	X	X	X	X	X	H	B	E	■	■
H	L	L	H	L	L	H	H	L	X	X	X	X	X	X	H	B	■	■	■
H	L	L	H	L	L	H	H	H	X	X	X	X	X	X	H	■	■	■	■
H	L	L	H	L	L	H	H	L	X	X	X	X	X	X	L	■	E	■	■
H	X	X	L	X	H	H	disable cursor display									B	E	A	R
H	L	L	L	L	L	H	H	H	X	X	X	X	X	X	L	B	E	A	R
H	X	X	H	X	H	H	display stored cursors									B	E	■	■

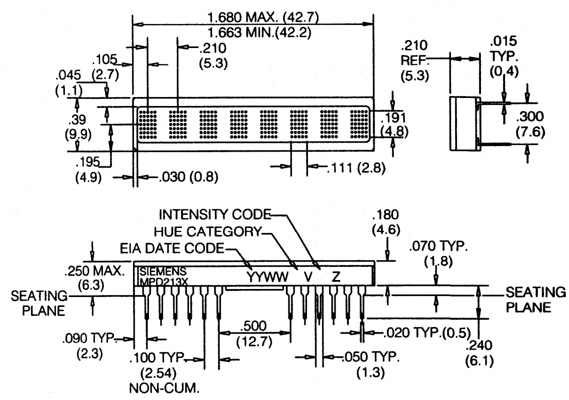
■ = ⊠

SIEMENS YELLOW MPD2131 TXVB, IPD2131
HER MPD2132 TXVB, IPD2132
HIGH EFF. GREEN MPD2133 TXVB, IPD2133

0.200" 8-Character 5 X 7 Dot Matrix X-Y Stackable, HI-REL Alphanumeric Programmable Display™



Package Dimensions in inches (mm)



Tolerance = .XXX ±0.015 (0.30)

FEATURES

- **Eight .2" Dot Matrix Characters in a Ceramic Package**
- **True Hermetic Glass Frit Seal for all Colors**
- **Internal ROM with 128 ASCII Characters**
- **Internal RAM for up to 16 User Definable Characters**
- **Programable Control Word Allows user to select from 8 Brightness Levels, Display Blink, Character Flash, Self Test, or Clear Functions**
- **Intemal or Extenal Clock Capability**
- **8 Bit Bidirectional Data Bus Allows for Read/Write Capability**
- **Contains all Display Drive and Multiplexing Circuitry**
- **Reset Pin for Display Initialization, Multiple Display Blinking and Flashing Synchronization**
- **TTL Compatible**
- **Operating Temperature Range: -55 to +100°C Storage Temperature: -65 to +125°C**
- **Categorized for Luminous Intensity and Color**
- **X–Y Stackable**
- **MPD2131/2/3 Process Conforms to MIL-D-87157, Quality Level A Test Tables I and Group A Table II and can meet Groups B and C Testing Specified in MIL-D-87157**
- **MPD2131/2/3 TXVB Process Conforms to MIL-D-87157 Quality Level A Test Tables I, II, IIIa, IVa (See High Reliability Test Tables).**

DESCRIPTION

The MPD2131 (yellow), MPD2132 (High Efficiency Red) and MPD2133 (High Efficiency Green) are eight-digit high reliability 5 x 7 dot matrix Programable DIsplays that are aimed at satisfying the most demanding military display requirements. They are designed for use in extremely harsh environments where only the most reliable parts are acceptable. These devices are processed to meet the requirements of High-Rel applications. The devices are constructed in ceramic packages with eight .20 inch high 5x7 dot matrix digits. The devices incorporate the latest in CMOS technology which is the heart of the device intelligence. The CMOS IC is controll-ed by a user supplied eight-bit data word on a bidirectional BUS. The ASCII data and attribute data are word driven. This approach allows the displays to interface using similar techniques as a microprocessor peripheral.

APPLICATIONS

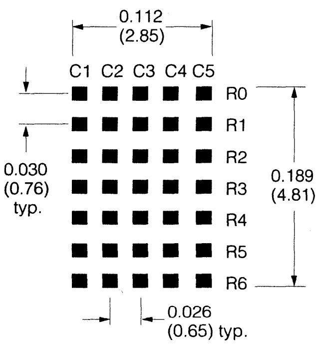
- **Military Control Panels**
- **Night Viewing Applications**
- **Cockpit Monitors**
- **Portable and Vehicle Technology**
- **Industrial Controllers**

ESD Warning: Standard precautions for CMOS handling should be observed.

Maximum Rating, T_A=25°C

DC Supply Voltage,
V_{CC} to GND (max. voltage with no LEDs on) .... –0.3 to +7.0 VDC
Input Voltage Levels,
All Inputs .... –0.3 V to (V_{CC}+0.3) V
Operating Temperature .... –55°C to 100°C
Storage Temperature .... –65°C to 125°C
Relative Humidity (non-condensing) 85%
Operating Voltage, V_{CC} to GND
(Max. voltage with 20 dots/digits on) 5.5V
Maximum Solder Temperature .... 260°C
(0.063 inch below the seating plane, t<5 sec.)
ESD Protection at 1.5 KΩ,
100 pF .... V_Z=4 KV (each pin)

Enlarged Character Font
Dimensions in inches (mm)



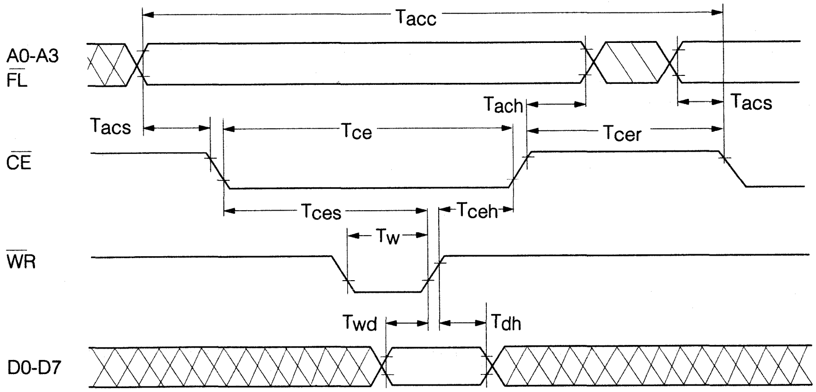
Switching Specifications
(over operating temperature range and V_{CC} = 4.5V to 5.5V)

Symbol	Description	Min.	Units
Tacc	Display Access Time - Write	210	ns
Tacc	Display Access Time - Read	230	ns
Tacs	Address Setup Time to CE	10	ns
Tce	Chip Enable Active Time - Write	140	ns
Tce	Chip Enable Active Time - Read	160	ns
Tach	Address Hold Time to CE	20	ns
Tcer	Chip Enable Recovery Time	60	ns
Tces	Chip Enable Active Prior to Rising Edge - Write	140	ns
Tces	Chip Enable Active Prior to Rising Edge - Read	160	ns
Tceh	Chip Enable Hold to Rising Edge of Read/Write Signal	0	ns
Tw	Write Active Time	100	ns
Twd	Data Valid Prior to Rising Edge of Write Signal	50	ns
Tdh	Data Write Time	20	ns
Tr	Chip Enable Active Prior to Valid Data	160	ns
Trd	Read Active Prior to Valid Data	95	ns
Tdf	Read Data Float Delay	10	ns
Trc	Reset Active Time	300	ns

Oscillator, Refresh, Flash and Self Test Characteristics

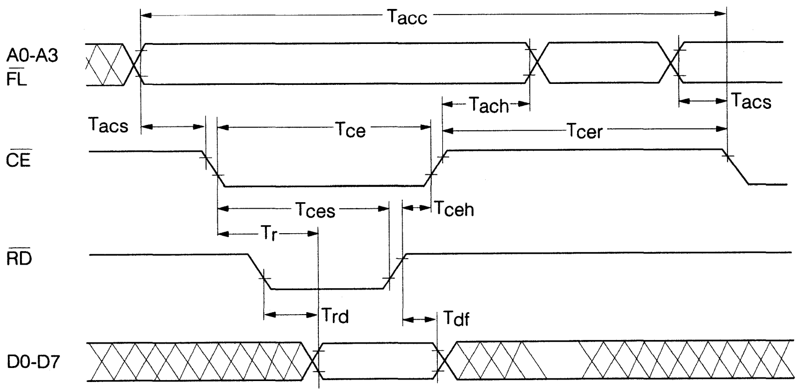
Parameters	Min	Typ	Max	Units	Conditions
Clock I/O Frequency	28	57.34	81.14	KHz	V_{CC}=4.5 V to 5.5 V
External Clock Frequency	25		640	KHz	V_{CC}=4.5 V to 5.5 V
FM, Digit Multiplex Frequency	125	256	362.5	Hz	V_{CC}=4.5 V to 5.5 V
Blinking Rate	0.98	2.0	2.83	Hz	
Clock I/O Bus Loading			2.40	pF	
Clock Out Rise Time			500	nsec	V_{CC}=4.5 V, V_{OH}=2.4 V
Clock Out Fall Time			500	nsec	V_{CC}=4.5 V, V_{OH}=0.4 V

Write Cycle Timing Diagram

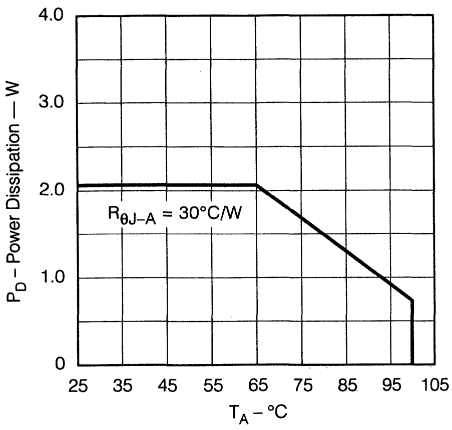


Input pulse levels -0.6 V to 2.4 V

Read Cycle Timing Diagram



Maximum Power Dissipation vs. Ambient Temperature
Derating Based on T_JMax = 125°C



Optical Characteristics at 25°C V_{CC}=5.0 V at Full Brightness

Yellow IPD/MPD2131

Description	Symbol	Min.	Typ.	Max.	Units
Luminous Intensity	I_V	125	205		µcd/dot
Peak Wavelength	λ(peak)		583		nm
Dominant Wavelength	λ(d)		585		nm

High Efficiency Red IPD/MPD2132

Description	Symbol	Min.	Typ.	Max.	Units
Luminous Intensity	I_V	125	350		µcd/dot
Peak Wavelength	λ(peak)		635		nm
Dominant Wavelength	λ(d)		626		nm

High Efficiency Green IPD/MPD2133

Description	Symbol	Min.	Typ.	Max.	Units
Luminous Intensity	I_V	150	500		µcd/dot
Peak Wavelength	λ(peak)		568		nm
Dominant Wavelength	λ(d)		574		nm.

DC ELECTRICAL CHARACTERSTICS at 25°C

Parameters	Limits Min	Typ	Max	Units	Conditions
V_{CC}	4.5	5.0	5.5	V	
I_{CC} Blank		0.5	1.0	mA	V_{CC} =5 V, V_{IN}=5V
I_{CC} 12 dots/digit on(1) (2)		200	255	mA	V_{CC}=5 V, "V" in all 8 digits
I_{CC} 20 dots/digit on(1) (2)		300	370	mA	V_{CC}=5 V, "#" in all 8 digits
I_{ILP} (with pull-up) Input Leakage	–1	–11	–18	µA	V_{CC}=5 V, V_{IN}=0 V to V_{CC} ($\overline{WR}$, $\overline{CE}$, $\overline{FL}$, $\overline{RST}$, $\overline{RD}$, CLKSEL)
I_{IL} (no pull-up) Input Leakage	–1		+1	µA	V_{CC}=5 V, V_{IN}=0–5 V (CLK, A0-A4, D0-D7)
V_{IH} Input Voltage High	2.0		V_{CC} +0.3	V	V_{CC}=4.5 V to 5.5 V
V_{IL} Input Voltage Low	Gnd –0.3		0.8	V	V_{CC}=4.5 V to 5.5 V
V_{OL} (D0-D7) Output Voltage Low			0.4	V	V_{CC}=4.5 V, I_{OL} = 1.6 mA
V_{OL} (CLK) Output Voltage Low			0.4	V	V_{CC}=4.5 V, I_{OL} = 40 µA
V_{OH} Output Voltage High	2.4			V	V_{CC}=4.5 V, I_{OH}=–40 µA
θ_{JC} Thermal Resistance Junction to Case		15		°C/W	

Notes: 1. I_{CC} is an average value.
2. I_{CC} is measured with the display at full brightness. Peak I_{CC}=$^{28}/_{15}$ I_{CC} average (#displayed).

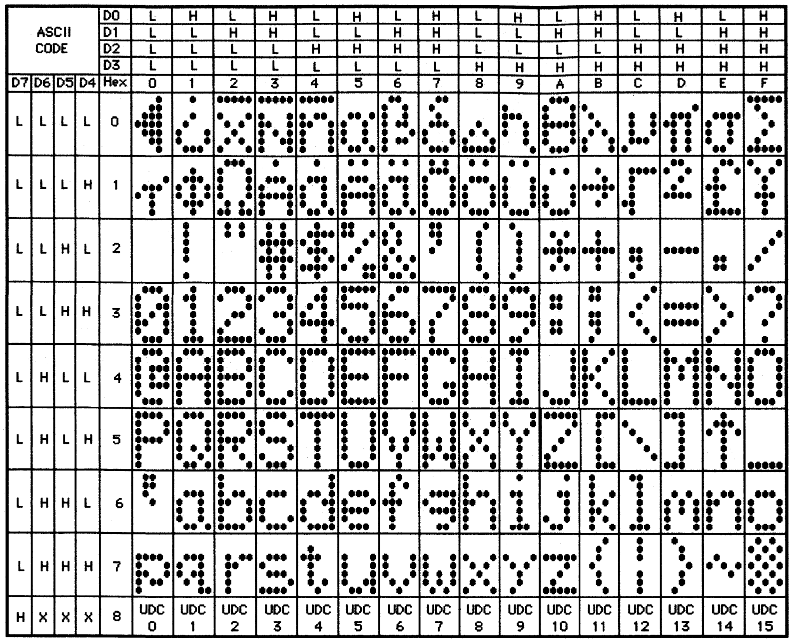
Recommended Operating Conditions (T_A=–55°C to +100°C)

Parameter	Symbol	Min.	Max.	Units
Supply Voltage	V_{CC}	4.5	5.5	V
Input Voltage Low	V_{IL}		0.8	V
Input Voltage High	V_{IH}	2.0		V
Output Voltage Low	V_{OL}		0.4	V
Output Voltage High	V_{OH}	2.4		V

Pin Description

Pin No.	Function	Description	Explanation
1	CLS	Clock Select	Selects an internal or external clock source. CLS=1 the internal clock selected (master clock), CLS=0 then external clock selected (slave operation).
2	CLK	Clock I/O	Inputs or outputs the clock as determined by the CLS pin.
3	$\overline{WR}$	Write	Writes data into the display when $\overline{WR}$=0 and $\overline{CE}$=0.
4	$\overline{CE}$	Chip Enable	Enables the read/write access when low.
5	$\overline{RST}$	Reset	Initializes the display; clears the Character RAM (20 Hex), Flash RAM (00 Hex), Control Word (00 Hex) and resets the internal counters. UDC Address Register and UDC RAM are unaffected.
6	$\overline{RD}$	Read	Outputs data from the display when $\overline{RD}$=0 and $\overline{CE}$=0.
7	No Pin		
8.	No Pin		
9.	No Pin		
10	No Pin		
11	D0	Data Bus	8 bit bidirectional data bus. Character RAM and Control Word uses D7–D0, UDC Address Register uses D3–D0, UDC RAM uses D4–D0, and Flash RAM uses D0.
12	D1	Data Bus	Same as D0
13	D2	Data Bus	Same as D0
14.	D3	Data Bus	Same as D0
15	NC		
16	V_{CC}		Positive power supply.
17	GND	Supply	Analog ground for the LED drivers.
18	GND	Logic	Digital ground for the logic circuitry.
19	D4	Data Bus	Same as D0
20	D5	Data Bus	Same as D0
21	D6	Data Bus	Same as D0
22	D7	Data Bus	Same as D0
23	No Pin		
24	No Pin		
25	No Pin		
26	No Pin		
27	$\overline{FL}$	Flash	Accesses the Flash RAM. Address inputs, A2–A0, select the digit address while data bit D0 sets (D0=1) or resets (D0=0) the Flash bit. A4 and A3 are ignored.
28	A0	Address Inputs	A4 and A3 select a section of the display's memory. A2–A0 select specific locations in the different sections. If $\overline{FL}$ is low the Flash RAM is accessed regardless of the status of A4 and A3.
29	A1	Address Inputs	Same as A0
30	A2	Address Inputs	Same as A0
31	A3	Address Inputs	Same as A0
32	A4	Address Inputs	Same as A0

CHARACTER SET



Notes:

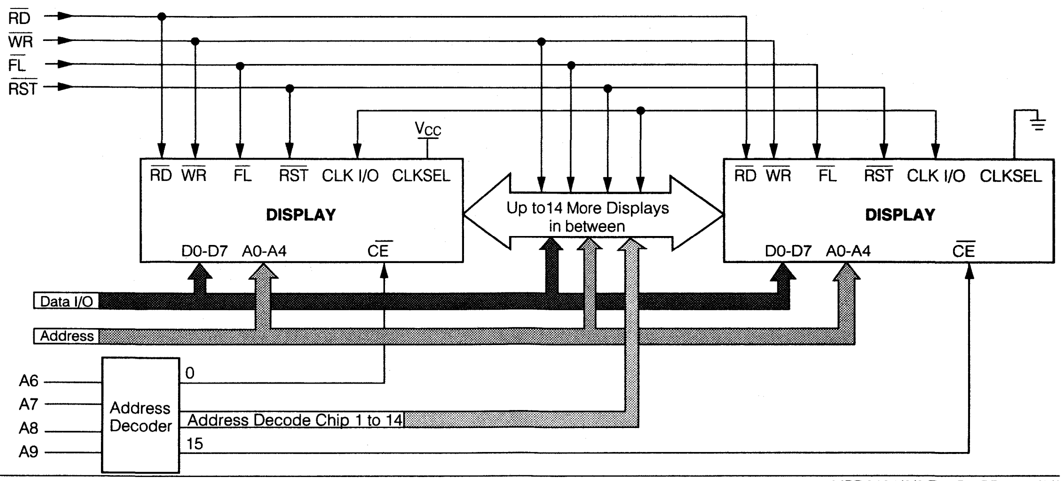
1. On power up, the device will initialize in a random state.
2. X = don't care

Cascading Displays

The display's oscillator is designed to drive up to 16 other displays with input loading of 15 pF each.

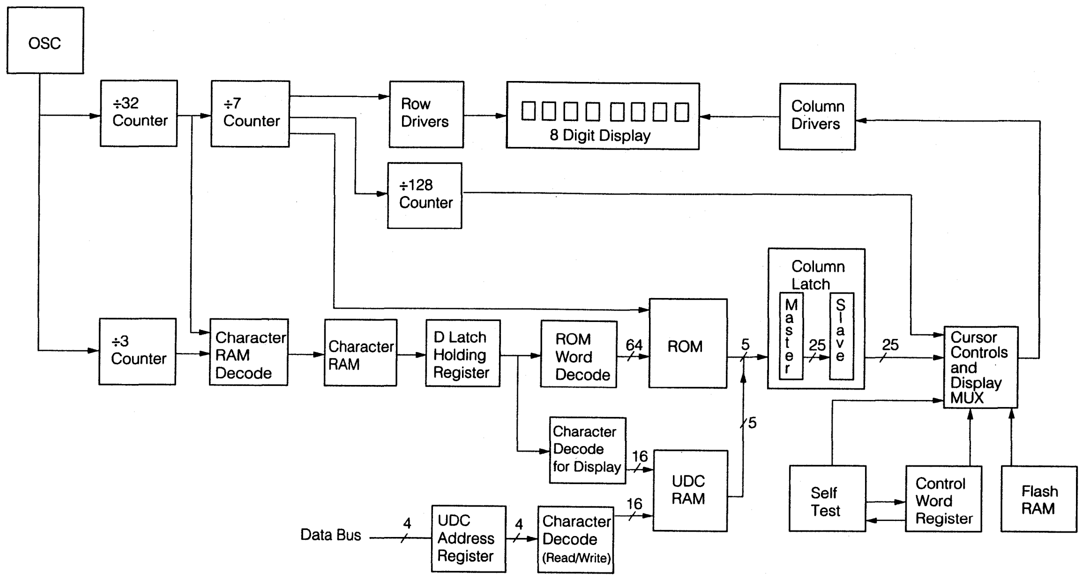
The following are the general requirements for cascading 16 displays together:

- Determine the correct address for each display.
- Use $\overline{CE}$ from an address decoder to select the correct display.
- Select one of the Displays to provide the Clock for the other displays. Connect CLKSEL to V_{CC} for this display.
- Tie CLKSEL to ground on other displays.
- Use $\overline{RST}$ to synchronize the blinking between the displays.



Intelligent Display Devices 2

BLOCK DIAGRAM



FUNCTIONAL DESCRIPTION

The display's user interface is organized into five memory areas. They are accessed using the Flash Input, $\overline{FL}$, and address lines, A3 and A4. All the listed RAMs and Registers may be read or written through the data bus. See Table 1. Each input pin is described in Pin Definitions. The five basic memory areas are:

Character RAM	Stores either ASCII character data or an UDC RAM address
Flash RAM	1x 8 RAM which stores Flash data
User-Defined Character RAM (UDC RAM)	Stores dot pattern for custom characters.
User-Defined Character Address Register (UDC Address Register)	Provides an address to UDC RAM when user is writing or reading a custom character
Control Word Register	Enables adjustment of display brightness, flash individual characters, blink, self test or clearing the display.

$\overline{RST}$ can be used to initialize display operation upon power up or during normal operation. When activated, $\overline{RST}$ will clear the Flash RAM and Control Word Register (00H) and reset the internal counter. All eight display memory locations will be set to 20H to show blanks in all digits.

$\overline{FL}$ pin enables access to the **Flash RAM**. The **Flash RAM** will set (D0=1) or reset (D0=0) flashing of the character addressed by A0-A2.

The 1 x 8 bit **Control Word Register** is loaded with attribute data if A3=0.

The **Control Word Logic** decodes attribute data for proper implementation.

Character ROM is designed for 128 ASCII characters. The ROM is Mask Programmable for custom fonts.

The **Clock Source** could either be the internal oscillator (CLKSEL=1) of the device or an external clock (CLKSEL=0) could be an input from another MPD213X display for the synchronization of blinking for multiple displays.

The **Display Multiplexer** controls the Row Drivers so no additional logic is required for a display system.

The **Display** has eight digits. Each digit has 35 LEDs

FL	A4	A3	Section of Memory	A2–A0	Data Bits Used
0	X	X	Flash RAM	Character Address	D0
1	0	0	UDC Address Register	Don't Care	D3–D0
1	0	1	UDC RAM	Row Address	D4–D0
1	1	1	Character RAM	Character Address	D7–D0
1	1	0	Control Word Register	Don't Care	D7–D0

TABLE 1. MEMORY SELECTION

THEORY OF OPERATION

The IPD/MPD213X Display is designed to work with all major microprocessors. Data entry is via an eight bit parallel bus. Three bits of address route the data to the proper digit location in the RAM. Standard control signals like $\overline{WR}$ and $\overline{CE}$ allow the data to be written into the display.

D0–D7 data bits are used for both Character RAM and control word data input. A3 acts as the mode selector. If A3=1, character RAM is selected. Then input data bit D7 will determine whether input data bits D0–D6 is ASCII coded data (D7=0) or UDC data (D7=1). See section on UDC Address Register and RAM.

For normal operation $\overline{FL}$ pin should be held high. When $\overline{FL}$ is held low, Flash RAM is accessed to set character blinking.

The seven bit ASCII code is decoded by the Character ROM to generate Column data. Twenty columns worth of data is sent out each display cycle, and it takes fourteen display cycles to write into eight digits.

The rows are multiplexed in two sets of seven rows each. The internal timing and control logic synchronizes the turning on of rows and presentation of column data to assure proper display operation.

POWER UP SEQUENCE

Upon power up the display will come on at random. Thus the display should be reset on power-up. Reset will clear the Flash RAM, Control Word Register and reset the internal counter. All the digits will show blanks and display brightness level will be 100%.

The display must not be accessed until three clock pulses (110 µseconds minimum using the internal clock) after the rising edge of the reset line.

MICROPROCESSOR INTERFACE

The interface to a microprocessor is through the 8-bit data bus (D0-D7), the 4-bit address bus (A0-A3) and control lines $\overline{FL}$, $\overline{CE}$ and $\overline{WR}$.

To write data (ASCII/Control Word) into the display $\overline{CE}$ should be held low, address and data signals stable and $\overline{WR}$ should be brought low. The data is written on the low to high transistion of $\overline{WR}$.

The Control Word is decoded by the Control Word Decode Logic. Each code has a different function. The code for display brightness changes the duty cycle for the column drivers. The peak LED current stays the same but the average LED current diminishes depending on the intensity level.

The character Flash Enable causes 2 Hz coming out of the counter to be ANDED with the column drive signal to make the column driver cycle at 2 Hz. Thus the character flashes at 2 Hz.

The display Blink works the same way as the Flash Enable but causes all twenty column drivers to cycle at 2 Hz thereby making all eight digits blink at 2 Hz.

The Self Test function of the IC consists of two internal routines which exercise major portions of the IC and illuminates all the LEDs.

Clear bit clears the character RAM and writes a blank into the display memory. It however does not clear the control word.

ASCII Data or Control Word Data can be written into the display at this point. For multiple display operation, CLK I/O must be properly selected. CLK I/O will output the internal clock if CLKSEL=1, or will allow input from an external clock if CLKSEL=0.

Character RAM

The Character RAM is selected when $\overline{FL}$, A4 and A3 are set to 1,1,1 during a read or write cycle. The Character RAM is a 8 by 8 bit RAM with each of the eight locations corresponding to a digit on the display. Digit 0 is on the left side of the display and digit 7 is on the right side of the display. Address lines, A2–A0 select the digit address with A2 being the most significant bit and A0 being the least significant bit. The two types of data stored in the Character RAM are the ASCII coded data and the UDC Address Data. The type of data stored in the Character RAM is determined by data bit, D7. If D7 is low, then ASCII coded data is stored in data bits D6–D0. If D7 is high, then UDC Address Data is stored in data bit D3–D0.

The ASCII coded data is a 7 bit code used to select one of 128 ASCII characters permanently stored in the ASCII ROM.

The UDC Address data is a 4 bit code used to select one of the UDC characters in the UDC RAM. There are up to 16 characters available. See Figure 1.

UDC Address Register and UDC RAM

The UDC Address Register and UDC RAM allows the user to generate and store up to 16 custom characters. Each custom character is defined in 5 x 7 dot matrix pattern. It takes 8 write cycles to define a custom character, one cycle to load the UDC Address Register and 7 cycles to define the character. The contents of the UDC Address Register will store the 4 bit address for one of the 16 UDC RAM locations. The UDC RAM is used to store the custom character.

UDC Address Register

The UDC Address Register is selected by setting $\overline{FL}$=1, A4=0, A3=0. It is a 4 bit register and uses data bits, D3–D0 to store the 4 bit address code (D7–D4 are ignored). The address code selects one of 16 UDC RAM locations for custom character generation.

UDC RAM

The UDC RAM is selected by setting $\overline{FL}$=1, A4=0, A3=1. The RAM is comprised of a 7 x 5 bit RAM. As shown in Figure 3, address lines, A2–A0 select one of the 7 rows of the custom character. Data bits, D4–D0 determine the 5 bits of column data in each row. Each data bit corresponds to a LED. If the data bit is high, then the LED is on. If the data bit is low, the LED is off. To create a character, each of the 7 rows of column data need to be defined. See Figures 2 and 3 for logic.

Flash RAM

The Flash RAM allows the display to flash one or more of the characters being displayed. The Flash Ram is accessed by setting $\overline{FL}$ low. A4 and A3 are ignored. The Flash RAM is a 8 x 1 bit RAM with each bit corresponding to a digit address. Digit 0 is on the left side of the display and digit 7 is on the right side of the display. Address lines, A2–A0 select the digit address with A2 being the most significant digit and A0 being the least significant digit. Data bit, D0, sets and resets the flash bit for each digit. When D0 is high, the flash bit is set and when D0 is low, it is reset. See Figure 4.

$\overline{RST}$	$\overline{CE}$	$\overline{WR}$	$\overline{RD}$	$\overline{FL}$	A4	A3	A2 A1 A0	D7 D6 D5 D4 D3 D2 D1 D0
1	0	0	1	1	1	1	Character Address for Digits 0–7	0 7 bit ASCII code for a Write Cycle
1	0	1	0	1	1	1	Character Address for Digits 0–7	0 7 bit ASCII code read during a Read Cycle
1	0	0	1	1	0	0	Character Address for Digits 0–7	1 D3–D0=UDC address for a Write Cycle
1	0	1	0	1	0	0	Character Address for Digits 0–7	1 D3–D0=UDC address for Read Cycle

FIGURE 1. CHARACTER RAM ACCESS LOGIC

$\overline{RST}$	$\overline{CE}$	$\overline{WR}$	$\overline{RD}$	$\overline{FL}$	A4	A3	A2 A1 A0	D7 D6 D5 D4 D3 D2 D1 D0	
1	0	0	1	1	0	0	Not used for UDC Address Register	D3–D0=UDC RAM Address Code for the Write Cycle	UDC Address Register
1	0	1	0	1	0	0	Not used for UDC Address Register	D3–D0=UDC RAM Address Code during a Read Cycle	
1	0	0	1	1	0	1	A2–A0=Character Row Address	D4–D0=Character Column Data for Write Cycle	UDC RAM
1	0	1	0	1	0	1	A2–A0=Character Row Address	D4–D0=Character Column Data read during a Read Cycle	

FIGURE 2. UDC ADDRESS REGISTER AND UDC CHARACTER RAM

Control Word

The Control Word is used to set up the attributes required by the user. It is addressed by setting $\overline{FL}$=1, A4=1, A3=0. The Control Word is an 8 bit register and is accessed using data bits, D7–D0. See Figures 5 and 6 for the logic and attributed control. The Control Word has 5 functions. They are brightness control, flashing character enable, blinking character enable, self test, and clear (Flash and Character RAMS only).

Brightness Control

Control Word bits, D2–D0, control the brightness of the display with a binary code of 000 being 100% brightness and 111 being display blank. See Figure 6 for brightness level versus binary code. The average I_{CC} can be calculated by multiplying the 100% brightness level I_{CC} value by the display's brightness level. For example, a display set to 80% brightness with a 100% average I_{CC} value of 200 mA will have an average I_{CC} value of 200 mA x 80%=160 mA.

Flash Function

Control Word bit, D3, enables or disables the Flash Function. When D3 is 1, the Flash Function is enabled and any digit with its corresponding bit set in the Flash RAM will flash at approximately 2 hertz. When using an external clock, the flash rate can be determined by dividing the clock rate by 28,672. When D3 is 0, the Flash Function is disabled and the contents of the Flash RAM is ignored. For synchronized flashing on multiple displays, see the Reset Section.

Blink Function

Control Word bit, D4, enables or disables the Blink Function. When D4 is 1, the Blink Function is enabled and all characters on the display will blink at approximately 2 hertz. The Blink Function will override the Flash Function if both functions are enabled. When D4 is 0, the Blink Function is disabled. When using an external clock, the blink rate can be determined by dividing the clock rate by 28,672. For synchronized blinking on multiple displays, see the Reset Section.

Row Data				Column Data				
				C1	C2	C3	C4	C5
A2	A1	A0	Row #	D4	D3	D2	D1	D0
0	0	0	1	5 x 7 Dot Matrix Pattern				
0	0	1	2					
0	1	0	3					
0	1	1	4					
1	0	0	5					
1	0	1	6					
1	1	0	7					

FIGURE 3. UDC CHARACTER MAP

Self Test

Control Word bits, D6 and D5, are used for the Self Test Function. When D6 is 1, the Self Test is initiated. Results of the Self Test are stored in bit D5. Control Word bit, D5, is a read only bit. When D5 is 1, Self Test has passed. When D5 is 0, Self Test failed is indicated. The Self Test function of the IC consists of two internal routines which exercise major portions of the IC and illuminates all of the LEDs. The first routine cycles the ASCII decoder ROM through all states and performs a check sum on the out-put. If the check sum is correct , D5 is set to a 1 (Pass).

The second routine provides a visual test of the LEDs. This is accomplished by writing checkered and inversed checkered patterns to the display. Each pattern is displayed for approximately 2 seconds. During the self test function the display must not be accessed. The time needed to execute the self test function is calculated by multiplying the clock time by 262,144 (typical time≈4.6 sec.). At the end of the self test, the Character RAM is loaded with blanks; the Control Word Register is set to zeroes except D5; the Flash RAM is cleared and the UDC Address Register is set to all 1s.

$\overline{RST}$	$\overline{CE}$	$\overline{WR}$	$\overline{RD}$	$\overline{FL}$	A4	A3	A2 A1 A0	D7 D6 D5 D4 D3 D2 D1 D0
1	0	0	1	1	X	X	Flash RAM Address for Digits 0–7	D0=Flash Data, 0=Flash Off and 1=Flash On (Write Cycle)
1	0	1	1	0	X	X	Flash RAM Address for Digits 0–7	D0=Flash Data, 0=Flash Off and 1=Flash On (Read Cycle)

FIGURE 4. FLASH RAM ACCESS LOGIC

$\overline{RST}$	$\overline{CE}$	$\overline{WR}$	$\overline{RD}$	$\overline{FL}$	A4	A3	A2 A1 A0	D7 D6 D5 D4 D3 D2 D1 D0
1	0	0	1	1	1	0	Not used for Control Word	Control Word data for a Write Cycle, see Figure 6.
1	0	1	0	1	1	0	Not used for Control Word	Control Word data for a Read during a Read Cycle.

FIGURE 5. CONTROL WORD ACCESS LOGIC

Clear Function (see Figures 6 and 7)
Control Word bit, D7 clears the character RAM to 20 hex and the flash RAM to all zeroes. The RAMs are cleared within three clock cycles (110 µs minimum, using the internal clock) when D7 is set to 1. During the clear time the display must not be accessed. When the clear function is finished, bit 7 of the Control Word RAM will be reset to a "0".

Reset Function
The display should be reset on power up of the display ($\overline{\text{RST}}$=LOW). When the display is reset, the Character RAM, Flash RAM, and Control Word Register are cleared. The display's internal counters are reset. Reset cycle takes three clock cycles (110 µseconds minimum using the internal clock). The display must not be accessed during this time.

To synchronize the flashing and blinking of multiple displays, it is necessary for the display to use a common clock source and reset all the displays at the same time to start the internal counters at the same place.

While $\overline{\text{RST}}$ is low, the display must not be accessed by RD nor $\overline{\text{WR}}$.

D7	D6	D5	D4	D3	D2	D1	D0
C	ST	ST	BL	FL	Br	Br	Br

D2	D1	D0	
0	0	0	100% Brightness
0	0	1	80% Brightness
0	1	0	53% Brightness
0	1	1	40% Brightness
1	0	0	27% Brightness
1	0	1	20% Brightness
1	1	0	13% Brightness
1	1	1	Blank Display

D3:
0 Flash Function Disabled
1 Flash Function Enabled

D4:
0 Blink Function Disabled
1 Blink Function Enabled (overrides Flash Function)

D6, D5:
0 X Normal Operation X=bit ignored
1 R Run Self Test, R=Test Result, R=1/pass, 0=fail

D7:
0 Normal Operation
1 Clear Flash RAM & Character RAM (Character RAM=20 Hex)

Key

C	Clear function
ST	Self test
BL	Blink function
FL	Flash function
Br	Brightness control

FIGURE 6. CONTROL WORD DATA DEFINITION

$\overline{\text{CE}}$	$\overline{\text{WR}}$	$\overline{\text{FL}}$	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Operation
0	0	1	0	X	X	X	0	X	X	X	X	X	X	X	Clear Disabled
0	0	1	0	X	X	X	1	X	X	X	X	X	X	X	Clear User RAM, Flash RAM and Display

FIGURE 7. CLEAR FUNCTION

X=don't care

FIG 8. DISPLAY CYCLE USING BUILT-IN ROM EXAMPLE

Display message "Showtime." Digit 0 is leftmost–Closest to Pin 1.
Logic levels; 0=Low, 1=High, X=Don't care.

$\overline{RST}$	$\overline{CE}$	$\overline{WR}$	$\overline{RD}$	$\overline{FL}$	A4	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Operation	Display
0	X	1	1	1	X	X	X	X	X	X	X	X	X	X	X	X	X	Reset. No Read/Write Within 3 Clock Cycles	All Blank
1	0	0	1	1	1	0	X	X	X	0	0	X	0	0	0	1	1	53% Brightness Selected	All Blank
1	0	0	1	1	1	1	0	0	0	0	1	0	1	0	0	1	1	Write "S"to Digit 0	S
1	0	0	1	1	1	1	0	0	1	0	1	0	0	1	0	0	0	Write "H" to Digit 1	SH
1	0	0	1	1	1	1	0	1	0	0	1	0	0	1	1	1	1	Write "O" to Digit 2	SHO
1	0	0	1	1	1	1	0	1	1	0	1	0	1	0	1	1	1	Write "W" to Digit 3	SHOW
1	0	0	1	1	1	1	1	0	0	0	1	0	1	0	1	0	0	Write "T" to Digit 4	SHOWT
1	0	0	1	1	1	1	1	0	1	0	1	0	0	1	0	0	1	Write "I" to Ditgit 5	SHOWTI
1	0	0	1	1	1	1	1	1	0	0	1	0	0	1	1	0	1	Write "M" to Digit 6	SHOWTIM
1	0	0	1	1	1	1	1	1	1	0	1	0	0	0	1	0	1	Write "E" to Digit 7	SHOWTIME

FIG 9. DISPLAYING USER DEFINED CHARACTER EXAMPLE

Load character "A" into UDC-5 and then display it in digit 2
Logic levels: 0=Low, 1=High, X=Don't care.

$\overline{RST}$	$\overline{CE}$	$\overline{WR}$	$\overline{RD}$	$\overline{FL}$	A4	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Operation	Display
0	X	1	1	1	X	X	X	X	X	X	X	X	X	X	X	X	X	Reset. No Read/Write Within 3 Clock Cycles	All Blank
1	0	0	1	1	0	0	X	X	X	X	X	X	X	0	1	0	1	Select UDC-5	All Blank
1	0	0	1	1	0	1	0	0	0	X	X	X	0	1	1	1	0	Write Into Row 1 of UDC-5	All Blank
1	0	0	1	1	0	1	0	0	1	X	X	X	1	0	0	0	1	Write Into Row 2 of UDC-5	All Blank
1	0	0	1	1	0	1	0	1	0	X	X	X	1	0	0	0	1	Write Into Row 3 of UDC-5	All Blank
1	0	0	1	1	0	1	0	1	1	X	X	X	1	1	1	1	1	Write Into Row 4 of UDC-5	All Blank
1	0	0	1	1	0	1	1	0	0	X	X	X	1	0	0	0	1	Write Into Row 5 of UDC-5	All Blank
1	0	0	1	1	0	1	1	0	1	X	X	X	1	0	0	0	1	Write Into Row 6 of UDC-5	All Blank
1	0	0	1	1	0	1	1	1	0	X	X	X	1	0	0	0	1	Write Into Row 7 of UDC-5	All Blank
1	0	0	1	1	1	1	0	1	0	1	X	X	X	0	1	0	1	Write UDC-5 Into Digit 2	(DIigit2) A

ELECTRICAL & MECHANICAL CONSIDERATIONS

VOLTAGE TRANSIENT SUPPRESSION

For best results power the display and the components that interface with the display to avoid logic inputs higher than V_{CC}. Additionally, the LEDs may cause transients in the power supply line while they change display states. The common practice is to place a parallel combination of a .01 µF and a 22 µF capacitor between V_{CC} and GND for all display packages.

ESD PROTECTION

The input protection structure of the IPD/MPD2131X provides significant protection against ESD damage. It is capable of withstanding discharges greater than 4 KV. Take all the standard precautions normal for CMOS components. These include properly grounding personnel, tools, tables, and transport carriers that come in contact with unshielded parts. If these conditions are not, or cannot be met, keep the leads of the device shorted together or the parts in anti-static packaging.

SOLDERING CONSIDERATIONS

THE IPD/MPD213X can be hand soldered with SN63 solder using a grounded iron set to 260°C.

Wave soldering is also possible. Use water soluble organic acid flux or resin based RMA flux.

A wave temperature of 245°C ±5°C with a dwell between 1.5 sec. to 3.0 sec. can be used. Exposure to the wave should not exceed temperatures above 260°C for five seconds at 0.063" below the seating plane. The packages should not be immersed in the wave.

POST SOLDER CLEANING PROCEDURES

The least offensive cleaning solution is hot D.I. water (60°C) for less than 15 minutes. Addition of mild saponifiers is acceptable. Do not use commercial diswasher detergents.

For faster cleaning, solvents may be used. Suggested solvents include Freon TE, Freon TF, Genesolv DE-15, Genesolv DI-15, and Genesolv DES.

An alternative to soldering and cleaning the display modules is to use sockets. Multiple display assemblies are best handled by longer SIP sockets or DIP sockets when available for uniform package alignment. Socket manufacturers are Aries Electronics, Inc., Frenchtown, NJ; Garry Manufacturing, New Brunswick, NJ; Robinson-Nugent, New Albany, IN; and Samtec Electronic Hardward, New Albany, IN.

For further information refer to Appnote 22 in the current Siemens Optoelectronic Data Book.

OPTICAL CONSIDERATIONS

The .200" high character of the IPD/MPD213X gives readability up to eight feet. Proper filter selection enhances readability over this distance.

Using filters emphasizes the contrast ratio between a lit LED and the character background. This will increase the discrimination of different characters. The only limitation is cost. Take into consideration the ambient lighting environment for the best cost/benefit ratio for filters.

Incandescent (with almost no green) or fluorescent (with almost no red) lights do not have the flat spectral response of sunlight. Plastic band-pass filters are an inexpensive and effective way to strengthen contrast ratios. The high efficiency red displays should be matched with a long wavelength pass filter in the 570 nm to 590 nm range. The IPD/MPD2133 should be matched with a yellow-green band-pass filter that peaks at 565 nm. For displays of multiple colors, neutral density grey filters offer the best compromise.

Additional contrast enhancement is gained by shading the displays. Plastic band-pass filters with built-in louvers offer the next step up in contrast improvement. Plastic filters can be improved further with anti-reflective coatings to reduce glare. The trade-off is fuzzy characters. Mounting the filters close to the display reduces this effect. Take care not to overheat the plastic filter by allowing for proper air flow.

Optimal filter enhancements are gained by using circular polarized, anti-reflective, band-pass filters. The circular polarzing further enhances contrast by reducing the light that travels through the filter and reflects back off the display to less than 1%.

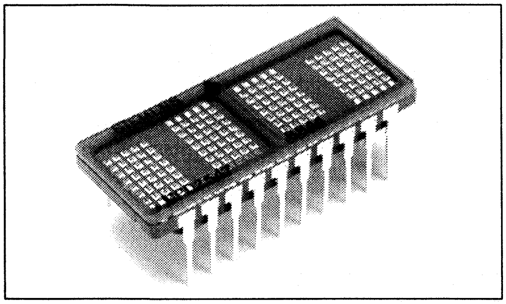
Several filter manufacturers supply quality filter materials. Some of them are: Panelgraphic Corporation, W. Caldwell, NJ; SGL Homalite, Wilmington, DE; 3M Company, Visual Products Division, St. Paul, MN; Polaroid Corporation, Polarizer Division, Cambridge, MA; Marks Polarized Corporation, Deer Park, NY, Hoya Optics, Inc., Fremont, CA.

One last note on mounting filters: recessing displays and bezel assemblies is an inexpensive way to provide a shading effect in overhead lighting situations. Several bezel manufacturers are: R.M.F. Products, Batavia, IL; Nobex Components, Griffith Plastic Corp., Burlingame, CA; Photo Chemical Products of California, Santa Monica, CA; I.E.E.–Atlas, Van Nuys, CA.

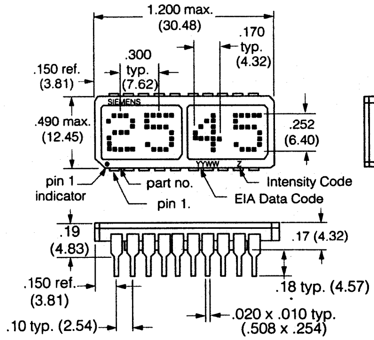
SIEMENS

HER MPD2545A TXVB, IPD2545A
GREEN MPD2547A TXVB, IPD2547A
YELLOW MPD2548A TXVB, IPD2548A

.25" 4 Character 5x7 Dot Matrix, X-Y Stackable Industrial and HI-REL/Military Alphanumeric Programmable Display™ with Built-in CMOS Control Functions



Package Dimensions in Inches (mm)



TOLERANCE:
.XX=.01 (.254)
.XXX=.005 (.127)

FEATURES

- **Four .25" Dot Matrix Characters in Hermetic Package**
- **Built-in Memory, Decoders, Multiplexer and Drivers**
- **Viewing Angle, X Axis ±40°, Y Axis ±75°**
- **128 Character ASCII Format (Upper and Lower Case Characters)**
- **Rugged Ceramic Package, Hermetic Sealed Flat Glass Window**
- **Wide Temperature Operating Range for Industrial and HI-REL Use, -55°C to +100°C**
- **8 Bit Bidirectional Data BUS**
- **READ/WRITE Capability**
- **Built-in Character Generator ROM**
- **TTL Compatible**
- **Easily Cascaded for Multidisplay Operation**
- **Less CPU Time Required**
- **Software Controlled Features:**
  - **Programmable Highlight Attribute (Blinking, Non-Blinking)**
  - **Asynchronous Memory Clear Function**
  - **Lamp Test**
  - **Display Blank Function**
  - **Single or Multiple Character Blinking Function**
  - **Three Programmable Brightness Levels**
- **MPD2545/7/8A Process Conforms to MIL-D-87157, Quality Level A Test Tables I, and Group A Table II and can meet Groups B and C Testing Specified in MIL-D-87157**
- **MPD2545/7/8A TXVB Process Conforms to MIL-D-87157 Quality Level A Test Tables I, II, IIIa, IVa (See High Reliability Test Tables)**

DESCRIPTION

The IPD2545A, MPD2545A (high efficiency red), IPD2547A, MPD2547A (green), and IPD2548A, MPD2548A (yellow) are four digit, Industrial/High Reliability, dot matrix, Programmable Displays that are aimed at satisfying the most demanding industrial/ military display requirements.

They are designed for use in extremely harsh environments where only the most reliable product is acceptable. These devices are processed to meet the requirements of HI-REL/ Military applications. The devices are contructed in a hermetic package using four 0.25-inch high 5x7 dot matrix displays.

The devices incorporate the latest in CMOS technology which is the heart of the device intelligence. The CMOS controller chip is controlled by a user supplied eight bit data word on the bidirectional BUS. The ASCII data and attribute data are word driven. This approach allows the IPD254XA and MPD254XA to interface using the same techniques as a microprocessor peripheral.

Applications include: military control panels, night viewing applications (red light), cockpit monitors, night vision goggle viewable displays (green), portable and vehicle technology as well as industrial controllers.

Maximum Ratings

DC Supply	-0.5 V to +6.0 Vdc
Input Voltage Relative to GND (all inputs)	-0.5 V to Vcc +0.5 Vdc
Operating Temperature	-55°C to +100°C
Storage Temperature	-65°C to +125°C
Thermal Resistance (θ_{JC})	30°C/W

Important: Refer to Appnote 18, "Using and Handling Intelligent Displays." Since this is a CMOS device, normal precautions should be taken to avoid static damage.

Optical Characteristics

High Efficiency Red IPD/MPD2545A

Description	Symbol	Min.	Typ. (4)	Max.	Units	Test Conditions
Peak Luminous Intensity per LED (1,3) (Character Average)	I_{Vave}	75	150		µcd	V_{CC}= 5.0 V, # sign "ON" on all digits at full brightness, T_A=25°C
Peak Wavelength	λ_{PEAK}		635		nm	
Dominant Wavelength (2)	λ_D		626		nm	

High Efficiency Green IPD/MPD2547A

Description	Symbol	Min.	Typ. (4)	Max.	Units	Test Conditions
Peak Luminous Intensity per LED (1,3) (Character Average)	I_{Vave}	75	150		µcd	V_{CC}= 5.0 V, # sign "ON" on all digits at full brightness, T_A=25°C
Peak Wavelength	λ_{PEAK}		568		nm	
Dominant Wavelength (2)	λ_D		574		nm	

Yellow IPD/MPD2548A

Description	Symbol	Min.	Typ. (4)	Max.	Units	Test Conditions
Peak Luminous Intensity per LED (1,3) (Character Average)	I_{Vave}	75	150		µcd	V_{CC}= 5.0 V, # sign "ON" on all digits at full brightness, T_A=25°C
Peak Wavelength	λ_{PEAK}		585		nm	
Dominant Wavelength (2)	λ_D		590		nm	

Notes:

1. The displays are categorized for luminous intensity with the intensity category designated by a letter code on the bottom of the package.
2. Dominant wavelength λ_D is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device.
3. The lumious stearance of the LED may be calculated using the following relationships.
   LV (cd/m^2) = IV (Candela)/A (Meter)^2
   LV (Footlamberts) = πIV (Candela)/A (Foot)^2
   A=8.4x10^{-7} ft^2, 7.8x10^{-8} m^2
4. All typical values specified at V_{CC}=5.0 V and T_A=25°C unless otherwise noted.

DC Characteristics

Parameter	-55°C			+25°C			+100°C				
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Units	Conditions
I_{CC} Blank (All Inputs Low)		4	10		2.0	5.0		1	2.5	mA	V_{CC}=5 V
I_{CC} 80 dots/units (100% Brightness)		220	250		160	190		125	160	mA	V_{CC}=5 V
V_{IL} (all inputs)			0.8			0.8			0.8	V	V_{CC}=5 V ±0.5 V
V_{IH} (all inputs)	2.0			2.0			2.0			V	V_{CC}=5 V ±0.5 V
I_{IL} (all inputs)		70	120		60	100		50	80	µA	V_{IH}=0.8 V V_{CC}=5.0 V

Switching Specifications (V_{CC}=4.5 V)

Write Cycle Timing					
		Specification Minimum			
Parameter	Description	–55°C	+25°C	+100°C	Units
T_{CLR}[1]	Clear RAM	1	1	1	µs
T_{CLRD}[1]	Clear RAM Disable	1	1	1	µs
T_{AS}	Address Setup	10	10	10	ns
T_{CES}	Chip Enable Setup	0	0	0	ns
T_{RS}	Read Enable Setup	10	10	10	ns
T_{DS}	Data Setup	20	30	50	ns
T_{W}	Write Pulse	60	70	90	ns
T_{AH}	Address Hold	20	30	40	ns
T_{DH}	Data Hold	20	30	40	ns
T_{CEH}	Chip Enable Hold	0	0	0	ns
T_{RH}	Read Enable Hold	20	30	40	ns
T_{ACC}	Total Access Time=Setup Time + Write Time + Hold Time	90	110	140	ns

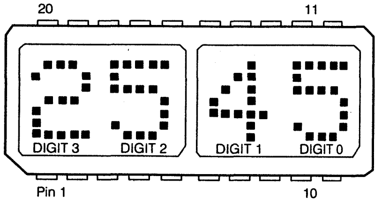
Switching Specifications (V_{CC}=4.5 V)

Read Cycle Timing					
		Specification Minimum			
Parameter	Description	–55°C	+25°C	+100°C	Units
T_{AS}	Address Setup	0	0	0	ns
T_{CES}	Chip Enable	0	0	0	ns
T_{WS}	Write Enable Setup	20	30	40	ns
T_{DD}	Data Delay Time	100	150	175	ns
T_{R}	Read Pulse	150	175	200	ns
T_{AH}	Address Hold	0	0	0	ns
T_{DH}	Data Hold	0	0	0	ns
T_{TRI}	Time to Tristate (Max. time)	30	40	50	ns
T_{CEH}	Chip Enable Hold	0	0	0	ns
T_{WH}	Write Enable Hold	30	40	50	ns
T_{RACC}	Total Access Time=Setup Time + Read Time +Time to Tristate	200	245	290	ns
T_{WAIT}[1]	Wait Time between Reads	0	0	0	ns

Notes:

1. Wait 1 µs between any Reads or Writes after writing a Control Word with a Clear (D7=1). Wait 1 µs between any Reads or Writes after clearing a Control Word with a Clear (D7=0). All other Reads and Writes can be back to back.
2. All input voltages are (V_{IL}=0.8 V, V_{IH}=2.0 V)
3. Data out voltages are measured with 100 pF on the data bus and the ability to source=–40 µA and sink=1.6 mA The rise and fall tlmes are 60 ns. V_{OL}=0.4 V, V_{OH}=2.4 V.

Top View



Pin Assignments

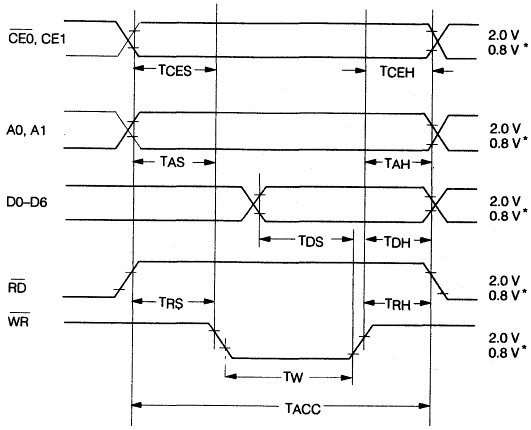
1	$\overline{\text{RD}}$	Read	11	$\overline{\text{WR}}$	Write
2	CLK I/O	Clock I/O	12	D7	Data MSB
3	CLKSEL	Clock Select	13	D6	Data
4	$\overline{\text{RST}}$	Reset	14	D5	Data
5	CE1	Chip Enable	15	D4	Data
6	$\overline{\text{CE0}}$	Chip Enable	16	D3	Data
7	A2	Address MSB	17	D2	Data
8	A1	Address	18	D1	Data
9	A0	Address LSB	19	D0	Data LSB
10	GND		20	V_{CC}	

Pin Definitions

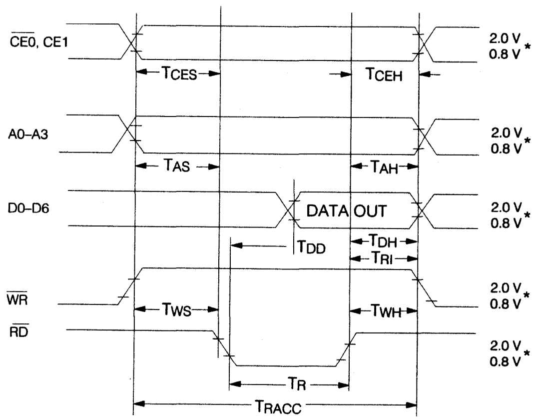
1	$\overline{\text{RD}}$	Active low, will enable a processor to read all registers.
2.	CLK I/O	If CLK SEL (pin 3) is low, then expect an external clock source into this pin. If CLK SEL is high, then this pin will be the master or source for all other devices which have CLK SEL low.
3.	CLK SEL	CLocK SELect determines the action of pin 2, CLK I/O. See the section on Cascading for an example.
4.	$\overline{\text{RST}}$	Reset. Must be held low until $V_{CC} > 4.5$ V. Reset is used only to synchronize blinking and will not clear the display.
5.	CE1	Chip enable (active high).
6.	$\overline{\text{CE0}}$	Chip enable (active low).
7.	A2	Address input (MSB).
8.	A1	Address input.
9.	A0	Address input (LSB).
10.	GND	Ground.
11.	$\overline{\text{WR}}$	Write. Active low. If the device is selected, a low on the write input loads the data into memory.
12.	D7	Data Bus bit 7 (MSB).
13.	D6	Data Bus bit 6.
14.	D5	Data Bus bit 5.
15.	D4	Data Bus bit 4.
16.	D3	Data Bus bit 3.
17.	D2	Data Bus bit 2.
18.	D1	Data Bus bit 1.
19.	D0	Data Bus bit 0 (LSB).
20.	V_{CC}	Positive power pin.

Timing Characteristics

Data "Write" Cycle



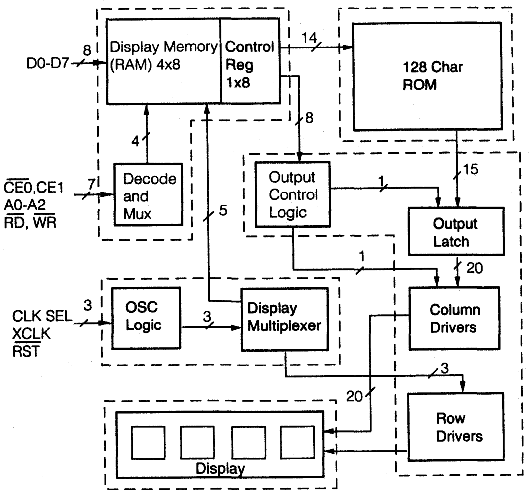
Data "Read" Cycle



***Notes:**

1. All input voltages are V_{IL}=0.8 v, V_{IH}=2.0 V.
2. These waveforms are not edge triggered.

Block Diagram



Functional Description

The block diagram includes 5 major blocks and internal registers (indicated by dotted lines).

Display Memory consists of a 5x8 bit RAM block. Each of the four 8-bit words holds the 7-bits of ASCII data (bits D0-D6) and an attribute select bit (Bit D7). The fifth 8-bit memory word is used as a control word register. A detailed description of the control register and its functions can be found under the heading Control Word. Each 8-bit word is addressable and can be read from or written to.

The **Control Logic** dictates all of the features of the display device and is discussed in the Control Word section of this data sheet.

The **Character Generator** converts the 7-bit ASCII data into the proper dot pattern for the 128 characters shown in the character set chart.

The **Clock Source** can originate either from the internal oscillator clock or from an external source–usually from the output of another IPD2545/7/8A and MPD2545/7/8A in a multiple module display.

The **Display Multiplexer** controls all display output to the digit drivers so no additional logic is required for a display system.

The **Column Drivers** are connected directly to the display.

The **Display** has four digits. Each of the four digits is comprised of 35 LEDs in a 5 x 7 dot array which makes up the alphanumeric characters.

The intensity of the display can be varied by the Control Word in steps of 0% (Blank), 25%, 50%, and full brightness.

Microprocessor Interface

The interface to the microprocessor is through the address lines. (A0–A2), the data bus (D0–D7), two chip select lines (CE0, CE1), and read (RD) and write (WR) lines.

The CE0 should be held low when executing a read, or write operation. CE1 must be held high.

The read and write lines are both active low. During a valid read the data lines (D0–D7) become outputs. A valid write will enable the data lines as inputs.

Input Buffering

If a cable length of 6 inches or more is used, all inputs to the display should be buffered with a tri-state non-inverting buffer mounted as close to the display as conveniently possible. Recommended buffers are: 74LS245 for the data lines and 74LS244 for the control lines.

Mode Selection

CE0	CE1	RD	WR	OPERATION
0	1	0	0	None
1	X	X	X	None
X	0	X	X	None
X	X	1	1	None

Note: 0 = Low Logic Level, 1 = High Logic Level, X = Don't Care.

Data Input Commands

CE0	CE1	RD	WR	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	OPERATION
1	0	X	X	X	X	X	X	X	X	X	X	X	X	X	No Change
0	1	0	1	1	0	0	X	X	X	X	X	X	X	X	Read Digit 0 Data to Bus
0	1	1	0	1	0	0	0	0	1	0	0	1	0	0	($) Written to Digit 0
0	1	1	0	1	0	1	0	1	0	1	0	1	1	1	(W) Written to Digit 1
0	1	1	0	1	1	0	0	1	1	0	0	1	1	0	(f) Written to Digit 2
0	1	1	0	1	1	1	0	0	1	1	0	0	1	1	(3) Written to Digit 3
0	1	1	0	1	0	0	1	X	X	X	X	X	X	X	Char Written to Digit 0 and Cursor Enabled

Programming the IPD2545/7/8A and MPD2545/7/8A

There are five registers within the IPD2545/7/8A and MPD2545/78A display. Four of these registers are used to hold the ASCII/attribute code of the four display characters. The fifth register is the Control Word, which is used to blink, blank, clear, or dim the entire display, or to change the presentation (attributes) of individual characters.

Addressing

The addresses within the display device are shown below. Digit 0 is the rightmost digit of the display, while digit 3 is on the left. Although there is only one Control Word, it is duplicated at the four address locations 0-3. Data can be read from any of these locations. When one of these locations is written to, all of them will change together.

Address			Contents
A2	A1	A0	
0	X	X	Control Word
1	0	0	Digit 0 (rightmost)
1	0	1	Digit 1
1	1	0	Digit 2
1	1	1	Digit 3 (leftmost)

Bit D7 of any of the display digit locations is used to allow an attribute to be assigned to that digit. The attributes are discussed in the next section. If Bit D7 is set to a one, that character will be displayed using the attribute. If bit D7 is cleared, the character will display normally.

Control Word

When address bit A2 is taken low, the Control Word is accessed. The same Control Word appears in all four of the lower address spaces of the display. Through the Control Word, the display can be cleared, the lamps can be tested, display brightness can be selected, and attributes can be set for any characters which have been loaded with their most significant bit (D7) set high.

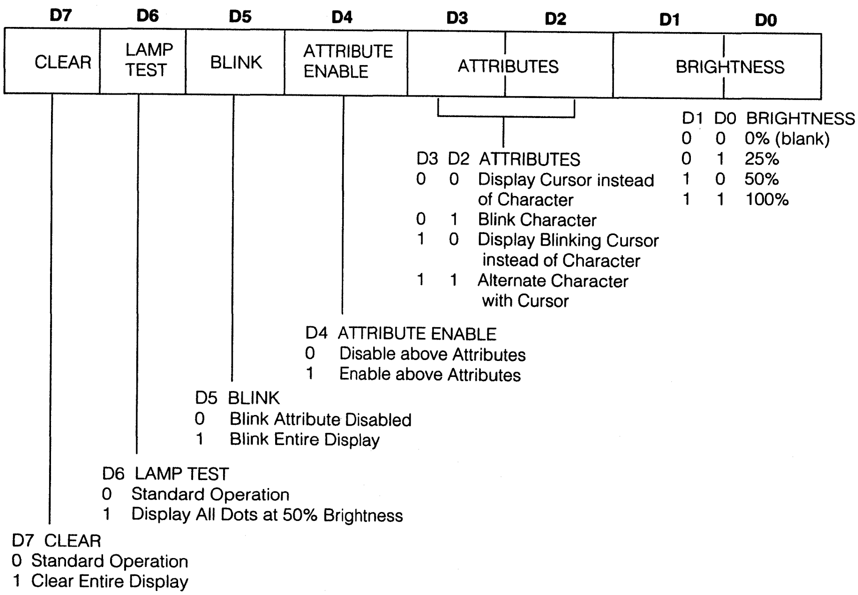
Brightness (D0, D1): The state of the lower two bits of the Control Word are used to set the brightness of the entire display, from 0% to 100%. The table below shows the correspondence of these bits to the brightness.

D7	D6	D5	D4	D3	D2	D1	D0	Operation
0	0	X	X	X	X	0	0	Blank
0	0	X	X	X	X	0	1	25% brightness
0	0	X	X	X	X	1	0	50% brightness
0	0	X	X	X	X	1	1	Full brightness

X = don't care

Attributes (D2–D4): Bits D2, D3, and D4 control the visual attributes (i.e., blinking, alternate) of those display digits which have been written with bit D7 set high. In order to use any of the four attributes, the Cursor Enable bit (D4 in the Control Word) must be set. When the Cursor Enable bit is set, and bit D7 in a character location is set, the character will take on one of the following display attributes.

Control Word Format



D7	D6	D5	D4	D3	D2	D1	D0	Operation
0	0	0	0	X	X	B	B	Disable highlight attribute
0	0	0	1	0	0	B	B	Display cursor* instead of character
0	0	0	1	0	1	B	B	Blink single character
0	0	0	1	1	0	B	B	Display blinking cursor* instead of character
0	0	0	1	1	1	B	B	Alternate character with cursor*

*"Cursor" refers to a condition when all dots in a single character space are lit to half birghtness.
X = don't care
B = depends on the selected brightness

Attributes are non-destructive. If a character with bit D7 set is replaced by a cursor (Control Word bit D4 is set, and D3=D2=0) the character will remain in memory and can be revealed again by clearing D4 in the Control Word.

Blink (D5): The entire display can be caused to blink at a rate of approximately 2 Hz by setting bit D5 in the Control Word. This blinking is independent of the state of D7 in all character locations.

To synchronize the blink rate in a bank of these devices, it is necessary to tie all devices' clocks and resets together as described in a later section of this data sheet.

D7	D6	D5	D4	D3	D2	D1	D0	Operation
0	0	1	X	X	X	B	B	Blinking display

Lamp Test (D6): When the Lamp Test bit is set, all dots in the entire display are lit at half brightness. When this bit is cleared, the display returns to the characters that were showing before the lamp test.

D7	D6	D5	D4	D3	D2	D1	D0	Operation
0	1	0	0	X	X	X	X	Lamp test

Clear Data (D7): When D7 (D7=1) is set in the Control Word, all display memory bits are reset to zero. A second Control Word must be written into the chip with D7 (D7=0) reset to set up attributes and brightness levels.

D7	D6	D5	D4	D3	D2	D1	D0	Operation
1	0	X	X	X	X	X	X	Clear

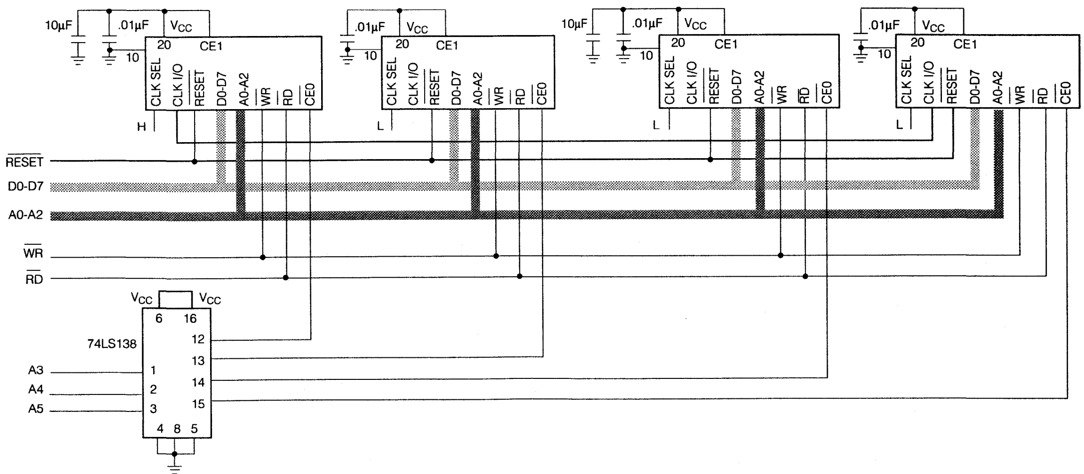
Cascading

Cascading the display is a simple operation. The requirements for cascading are: 1) decoding the correct address to determine the chip select for each additional device, 2) assuring that all devices are reset simultaneously, and 3) selecting one display as the clock source and setting all others to accept clock input (the reason for cascading the clock is to synchronize the flashing of multiple displays). One display as a source is capable of driving six other displays. If more displays are required, a buffer will be necessary. The source display must have pin 3 tied high to output clock signals. All other displays must have pin 3 tied low.

Voltage Transients

It has become common practice to provide 0.01 µf bypass capacitors liberally in digital systems. Like other CMOS circuitry, the Intelligent Display controller chip has very low power consumption and the usual 0.01 µf would be adequate were it not for the LEDs. To prevent power supply transients, capacitors with low inductance and high capacitance at high frequencies are required. This suggests a solid tantalum or ceramic disc for high frquency bypass. For larger displays, distribute the bypass capacitors evenly, keeping capacitors as close to the power pins as possible. We recommend a 10 µf and 0.01 µf for every Intelligent Display to decouple the displays themselves, at the display.

Cascading the Display



How to Load Information into the IPD25545/7/8A and the MPD2545A/7/8A

Information loaded into the IPD2545/7/8A and the MPD2545A/7/8A can be either ASCII data or Control Word data. The following procedure (see also Typical Loading Sequence) will demonstrate a typical loading sequence and the resulting visual display. The word STOP is used in all of the following examples.

Set Brightness

Step 1 Set the brightness level of the entire display to your preference (example: 100%)

Load Four Characters

Step 2 Load a "S" in the left hand digit.

Step 3 Load a "T" in the next digit.

Step 4 Load an "O" in the next digit.

Step 5 Load a "P" in the right hand digit.
If you loaded the information correctly, the MPD2545A now should show the word "STOP."

Blink a Single Character

Step 6 Into the digit, second from the right, load the hex code "CF," which is the code for an "O" with the D7 bit added as a control bit.

Note: the "O" is the only digit which has the control bit (D7) added to normal ASCII data.

Step 7 Load enable blinking character into the control word register. The display now should show "STOP" with a flashing "O".

Add Another Blinking Character

Step 8 Into the left hand digit, load the hex code "D3" which gives an "S" with the D7 bit added as a control bit. The display should show "STOP" with flashing "O" and a flashing "S."

Alternate Character/Cursor Enable

Step 9 Load enable alternate character/cusor into the control word register. The display now should show "STOP" with the "O" and the "S" alternating between the letter and cursor (all dots lit).

Initiate Four Character Blinking
(Regardless of Control Bit setting)

Step 10 Load enable display blinking. The display now should show the entire word "STOP" blinking.

Typical Loading Sequence

	$\overline{\text{CE0}}$	CE1	$\overline{\text{RD}}$	$\overline{\text{WR}}$	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	DISPLAY
1.	L	H	H	L	L	X	X	0	0	0	0	0	0	1	1	
2.	L	H	H	L	H	H	H	0	1	0	1	0	0	1	1	S
3.	L	H	H	L	H	H	L	0	1	0	1	0	1	0	0	ST
4.	L	H	H	L	H	L	H	0	1	0	0	1	1	1	1	STO
5.	L	H	H	L	H	L	L	0	1	0	1	0	0	0	0	STOP
6.	L	H	H	L	H	L	H	1	1	0	0	1	1	1	1	STOP
7.	L	H	H	L	L	X	X	0	0	0	1	0	1	1	1	STO*P
8.	L	H	H	L	H	H	H	1	1	0	1	0	0	1	1	S*TO*P
9.	L	H	H	L	L	X	X	0	0	0	1	1	1	1	1	S†TO†P
10.	L	H	H	L	L	X	X	0	0	1	0	0	0	1	1	S*T*O*P*

* Blinking character
† Character alternating with cursor (all dots lit)

Electrical and Mechanical Considerations

The CMOS IC of the IPD2545/7/8A and the MPD2545/7/8A are designed to provide resistance to both Electrostatic and Discharge Damage and Latch Up due to voltage or current surges. Several precautions are strongly recommended for the user, to avoid overstressing these built-in safeguards.

ESD Protection

Users of the IPD2545/7/8A and the MPD2545/7/8A should be careful to handle the devices consistent with standard ESD protection procedures. Operators should wear appropriate wrist, ankle or feet ground straps and avoid clothing that collects static charges. Work surfaces, tools and transport carriers that come into contact with unshielded devices or assemblies also should be appropriately grounded.

Latch up Protection

Latch up is condition that occurs in CMOS ICs after the input protection diodes have been broken down. These diodes can be reversed through several means.

V_{IN} < GND, V_{IN} > V_{CC} +0.5 V, or through excessive currents begin forced on the inputs. When these situations exist, the IC may develop the response of an SCR and begin conducting as much as one amp through the V_{CC} pin. This destructive condition will persist (latched) until device fauilure or the device is turned off.

The Voltage Transient Suppression Techniques and buffer interfaces for longer cable runs help considerably to prevent latch conditions from occuring. Additionally, the following Power Up and Power Down sequence should be observed.

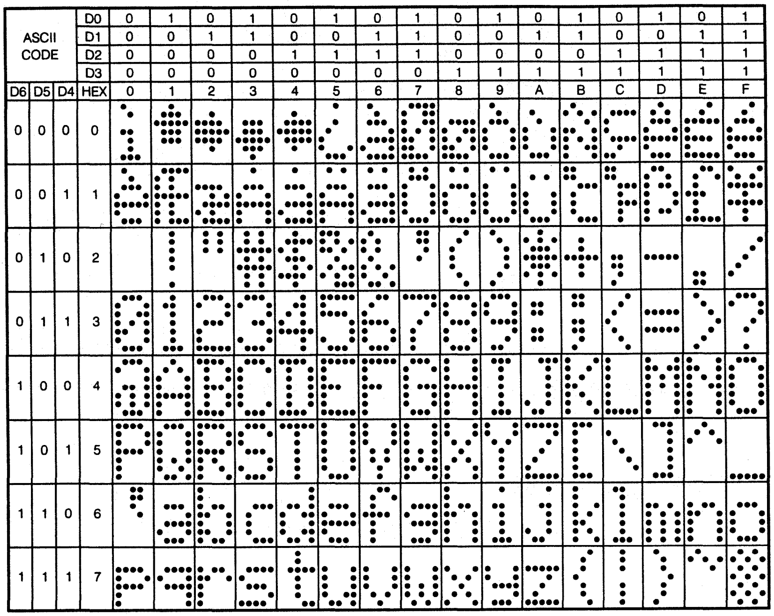
Power up Sequence

1. Float all active signals by tri-stating the inputs to the displays.
2. Apply V_{CC} and GND to the display.
3. Apply active signals to the displays by enabling all input signals per applications.

Power Down Sequence

1. Float all active signals by tri-stating the inputs to the displays.
2. Turn off the power to the display.

Character Set



Notes:
1. A2 must be held high for ASCII data.
2. Bit D7 = 1 enables attributes for the assigned digit.

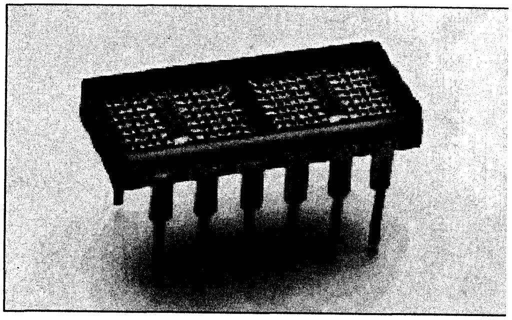
1. High=1 level. 2. Low=0 level. 3. Upon power up, device will initialize in a random state.

General Quality Assurance Levels
The parts are tested in conformance with Quality Level A of MIL-D-87157 for hermetically sealed LED displays with100% screening.

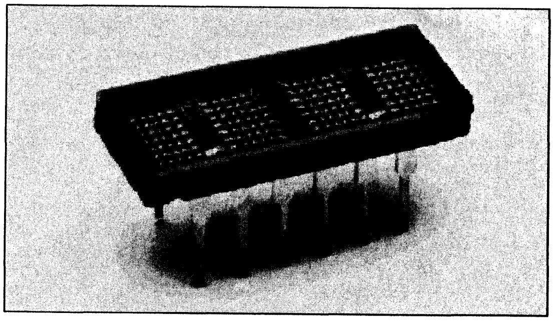
SIEMENS

RED MSD2010/2310 TXVB
YELLOW MSD2011/2311/2351 TXVB
HIGH EFFICEINCY RED MSD2012/2312/2352 TXVB
HIGH EFF. GREEN MSD2013/2313/2353 TXVB
RED ISD2010/2310
YELLOW ISD2011/2311/2351
HIGH EFFICEINCY RED ISD2012/2312/2352
HIGH EFFICEINCY GREEN ISD2013/2313/2353

4-Character 5x7 Dot Matrix
Serial Input Alphanumeric Industrial/HI-REL Display
Sunlight Viewable: MSD235X, ISD235X



MSD201X



MSD231X/235X

FEATURES

- **Four Dot Matrix Characters**
- **Character Height**
  MSD201X — 0.150"
  MSD231X/235X — 0.200"
- **MSD/ISD201X/231X, Four Colors: Red, Yellow, High Efficiency Red, High Efficiency Green**
- **MSD/ISD235X, Three Colors: Yellow, High Efficiency Red, High Efficiency Green**
- **Wide Viewing Angle**
- **Built-in CMOS Shift Registers with Constant Current LED Row Drivers**
- **Shift Registers Allow Custom Fonts**
- **Easily Cascaded for Multiple Displays**
- **TTL Compatible**
- **End Stackable**
- **HI-REL Operating Temperature Range: –55°C to +100°C**
- **Categorized for Luminous Intensity**
- **Ceramic Package, Hermetically Sealed Flat Glass Window**
- **MSD Process Conforms to MIL-D-87157 Quality Level A Test Tables I and II and also can meet Groups B and C Testing Specified in MIL-D-87157**
- **MSD TXVB Conforms to MIL-D-87157 Quality Level A Test Tables I, II, III and IVa (See High Reliability Test Tables)**

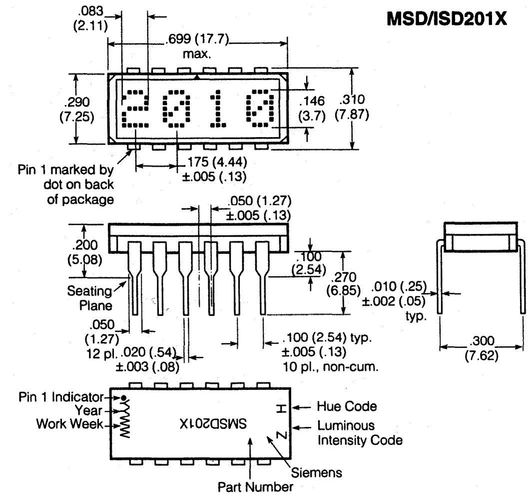
DESCRIPTION

The MSD201X/231X/235X TXVB, ISD201X/231X/235X are four digit 5x7 dot matrix serial input alphanumeric displays. The displays are available in red, yellow, high efficiency red, or high efficiency green. The package is a standard twelve-pin hermetic DIP with glass lens. The display can be stacked horizontally or vertically to form messages of any length.

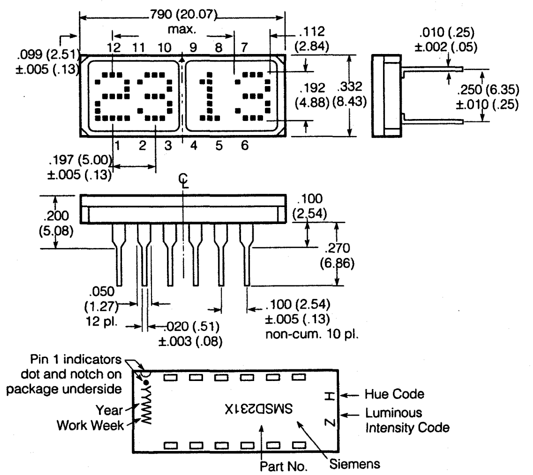
—continued

Package Dimensions in Inches (mm)

MSD/ISD201X



MSD/ISD231X/235X



Pin	Function	Pin	Function
1	Column 1	7	Data Out
2	Column 2	8	V_B
3	Column 3	9	V_{CC}
4	Column 4	10	Clock
5	Column 5	11	Ground
6	No connection	12	Data In

DESCRIPTION (continued)

These displays have two fourteen-bit CMOS shift registers with built-in row drivers. These shift registers drive twenty-eight rows and enable the design of customized fonts. Cascading multiple displays is possible because of the Data In and Data Out pins. Data In and Out are easily input with the clock signal and displayed in parallel on the row drivers. Data Out represents the

DESCRIPTION (continued)

output of the 7th bit of digit number four shift register The shift register is level triggered. The like columns of each character in a display cluster are tied to a single pin (see Block Diagram). High true data in the shift register enables the output current mirror driver stage associated with each row of LEDs in the 5x7 diode array.

The TTL compatible VB input may either be tied to VCC for maximum display intensity or pulse width modulated to achieve intensity control and reduce power consumption.

In the normal mode of operation, input data for digit four, column one is loaded into the seven on-board shift register locations one through seven. Column one data for digits 3, 2, and 1 is shifted into the display shift register locations. Then column one input is enabled for an appropriate period of time, T. A similar process is repeated for columns 2, 3, 4, and 5. If the decode time and load data time into the shift register is t, then with five columns, each column of the display is operating at a duty factor of:

$$DF = \frac{T}{5(T+T)}$$

T+t, allotted to each display column, is generally chosen to provide the maximum duty factor consistent with the minimum refresh rate necessary to achieve a flicker free display. For most strobed display systems, each column of the display should be refreshed (turned on) at a minimum rate of 100 times per second.

With columns to be addressed, this refresh rate then gives a value for the time T+t of: 1/[5x(100)]=2 msec. If the device is operated at 5.0 MHz clock rate maximum, it is possible to maintain t<<T. For short display strings, the duty factor will then approach 20%.
See Appnote 44 for application information and Appnotes 18, 19, 22, 23 for additional information.

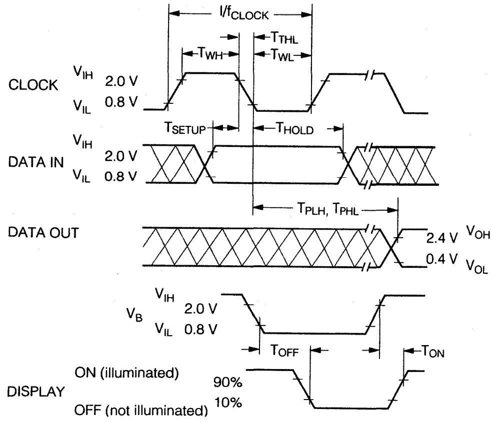
See Appnote 44 for application information and Appnotes 18, 19, 22, 23 for additional information.

Maximum Ratings

Supply Voltage V_{CC} to GND . . . . –0.5 V to + 7.0 V
Inputs, Data Out and V_B . . . . –0.5 V to VCC + 0.5 V
Column Input Voltage, V_{COL} . . . . –0.5 V to + 6.0 V
Operating Temperature Range . . . . –55°C to +100°C
Storage Temperature Range . . . . –65°C to + 125°C
Maximum Solder Temperature, 0.063" (1.59 mm) below Seating Plane, t<5 sec . . . . 260°C
Maximum Allowable Power Dissipation, T_A=25 C°[(2)]
MSD/ISD2010 . . . . 0.91 W
MSD/ISD2011/2/3 . . . . 0.86 W
MSD/ISD231X . . . . 1.1 W
MSD/ISD235X . . . . 1.35 W

Notes
1. Operation above +100°C ambient is possible if the following conditions are met. The junction should not exceed T_J=125°C and the case temperature (as measured at pin 1 or the back of the display) should not exceed TC = 100°C.
2. Maximum allowable dissipation is derived from V_{CC}=5.25 V, V_B=2.4 V, V_{COL}=3.5 V 20 LEDs on per character, 20% DF.

Figure 1. Timing Characteristics



AC Electrical Characteristics

(V_{CC}=4.75 to 5.25 V, T_A=–55°C to 100°C)

Symbol	Description	Min.	Typ.	Max.[1]	Units	Fig.
T_{SETUP}	Setup Time	50	10		ns	1
T_{HOLD}	Hold Time	25	20		ns	1
T_{WL}	Clock Width Low	75	45		ns	1
T_{WH}	Clock Width High	75	45		ns	1
$F_{(CLK)}$	Clock Frequency			5	MHz	1
T_{THL} T_{TLH}	Clock Transition Time		75	200	ns	1
T_{PHL} T_{PLH}	Propagation Delay Clock to Data Out		50	125	ns	1

Notes

1. All typical values specified at VCC=5.0 V and T_A=25°C unless otherwise noted.
2. V_B Pulse Width Frequency — 50 KHz (max.)

Figure 2a. Maximum Allowable Power Dissipation vs. Temperature, MSD/ISD201X

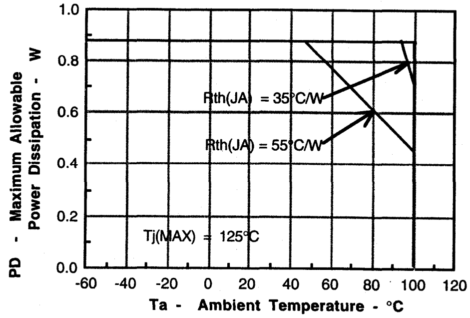


Figure 2b. Maximum Allowable Power Dissipation vs. Temperature, MSD/ISD231X

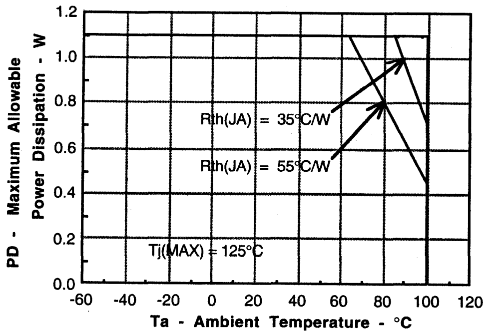
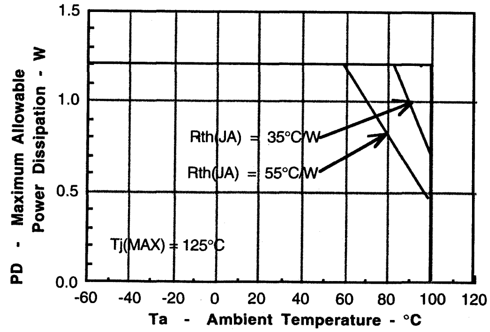


Figure 2c. Maximum Allowable Power Dissipation vs. Temperature, MSD/ISD235X



Recommended Operating Conditions (Guaranteed over operating temperature range)

Parameter	Symbol	Min.	Nom.	Max.	Units
Supply Voltage	V_{CC}	4.75	5.0	5.25	V
Data Out Current, Low State	I_{OL}				mA
Data Out Current, High State	I_{OH}				mA
Column Input Voltage, Column On (1)	V_{COL}	2.75		3.5	V
Setup Time	T_{SETUP}	70	45		ns
Hold Time	T_{HOLD}	30			ns
Width of Clock	$T_{W(CLK)}$	75			ns
Clock Frequency	T_{CLK}			5	MHz
Clock Transition Time	T_{THL}			200	ns
Free Air Operating Temperature Range	T_A	–55		+100	°C

Note: 1. See Figure 3, Peak Column Current vs. Column Voltage

Optical Characteristics
Red MSD/ISD2010, MSD/ISD2310

Description		Symbol	Min.	Typ.(4)	Max.	Units	Test Conditions
Peak Luminous Intensity per LED (1,3) (Character Average)	MSD/ ISD2010	I_{VPEAK}	105	200		µcd	V_{CC}=5.0 V, V_{COL}=3.5 V T_J(5)=25°C, V_B=2.4 V
	MSD/ ISD2310		220	370			
Peak Wavelength		λ_{VPEAK}		655		nm	
Dominant Wavelength(2)		λ_D		639		nm	

Yellow MSD/ISD2011, MSD/IDS2311, MSD/ISD2351

Description		Symbol	Min.	Typ.(4)	Max.	Units	Test Conditions
Peak Luminous Intensity per LED (1,3) (Character Average)	MSD/ ISD2011	I_{VPEAK}	400	750		µcd	V_{CC}=5.0 V, V_{COL}=3.5 V T_J(5)=25°C, V_B=2.4 V
	MSD/ ISD2311		650	1140			
	MSD/ ISD2351		2400	3400			
Peak Wavelength		λ_{VPEAK}		655		nm	
Dominant Wavelength(2)		λ_D		639		nm	

Optical Characteristics

High Efficiency Red MSD/IDS2012, MSD/ISD2312, MSD/IDS2352

Description		Symbol	Min.	Typ.[4]	Max.	Units	Test Conditions
Peak Luminous Intensity per LED [1,3] (Character Average)	MSD/ ISD2012	I_{VPEAK}	400	1430		μcd	V_{CC}=5.0 V, V_{COL}=3.5 V T_J[5]=25°C, V_B=2.4 V
	MSD/ ISD2312		650	1430			
	MSD/ ISD2352		853	2500			
Peak Wavelength		λ_{VPEAK}		655		nm	
Dominant Wavelength[2]		λ_D		639		nm	

High Efficiency Green MSD/IDS2013, MSD/ISD2313, MSD/IDS2353

Description		Symbol	Min.	Typ.[4]	Max.	Units	Test Conditions
Peak Luminous Intensity per LED [1,3] (Character Average)	MSD/ ISD2013	I_{VPEAK}	850	1550		μcd	V_{CC}=5.0 V, V_{COL}=3.5 V T_J[5]=25°C, V_B=2.4 V
	MSD/ ISD2313		1280	2410			
	MSD/ ISD2353		2400	3000			
Peak Wavelength		λ_{VPEAK}		655		nm	
Dominant Wavelength[2]		λ_D		639		nm	

Notes

1. The displays are categorized for luminous intensity with the intensity category designated by a letter code on the bottom of the package.
2. Dominant wavelength (λD) is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device
3. The luminous sterance of the LED may be calculated using the following relationships:
   L_V (cd/m^2) = I_V (Candela)/A (Meter)^2
   L_V (Footlamberts) = πI_V (Candela)/A (Foot)^2
   A = 5.3 x 10^{-8} M2 = 5.8 x 10^{-7} (Foot)^2
4. All typical values specified at V_{CC} = 5.0 V and T_A = 25°C unless otherwise noted.
5. The luminous intensity is measured at T_A = T_J = 25°C. No time is allowed for the device to warm up prior to measurement.

Figure3a. Peak Column Current vs. Column Voltage—MSD201X

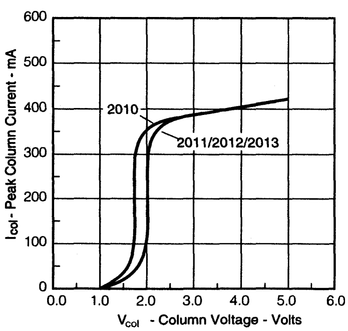


Figure3a. Peak Column Current vs. Column Voltage—MSD231X

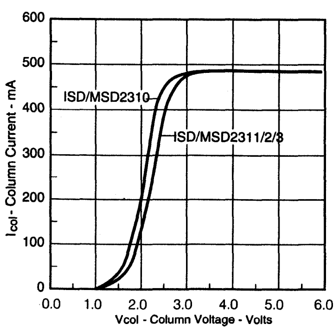
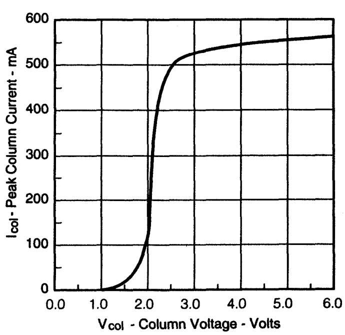


Figure3a. Peak Column Current vs. Column Voltage—MSD235X

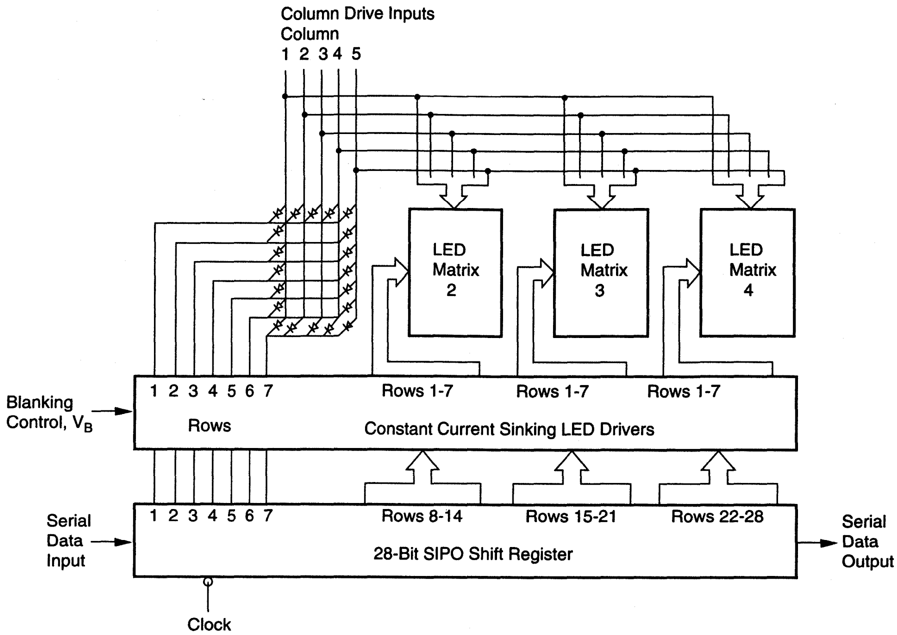


Electrical Characteristics (–55°C to +100°C, unless otherwise specified)

Description	Symbol	Min.	Typ.(1)	Max.	Units	Test Conditions	
Supply Current (quiescent)	I_{CC}			5.0	mA	V_B=0.4 V	V_{CC}=5.25 V V_{CLK}=V_{DATA}=2.4 V All SR Stages=Logical 1
				5.0		V_B=2.4 V	
Supply Current (operating)	I_{CC}			10.0	mA	F_{CLK}=5 MHz	
Column Current at Any Column Input(2)	I_{COL}			10	µA	V_B=0.4 V	V_{CC}=5.25 V V_{COL}=3.5 V All SR Stages=Logical 1
Column Current at Any Column Input(2) MSD/ISD2010, red MSD/ISD2011/2/3: yellow, HER, green MSD/ISD231X: red, yellow, HER, green MSD/ISD235X: yellow, HER, green	I_{COL}		 350 335 380 550	 435 410 520 650	mA		
V_B, Clock or Data Input Threshold Low	V_{IL}			0.8	V	V_{CC}=4.75 V–5.25 V	
V_B, Clock or Data Input Threshold High	V_{IH}	2.0			V		
Data Out Voltage	V_{OH}	2.4	3.6		V	I_{OH}=0.5 mA	V_{CC}=5.25 V I_{COL}=0 mA
	V_{OL}					I_{OL}=1.6 mA	
Input Current Ogical 0, V_B only	I_{IL}	–30	–110	–300	µA	V_{CC}=4.75 V–5.25 V, V_{IL}=0.8 V	
Input Current Ogical 0, Data, Clock	I_{IL}						
Power Dissipation per Package MSD/ISD201X MSD/ISD231X MSD/ISD235X	PD	 0.44 0.52 0.74			W	V_{CC}=5.0 V, V_{COL}=3.5 V, 17.5% DF 15 LEDs on per character, V_B=2.4 V	
Thermal Resistance IC, Junction-to-Pin MSD/ISD201X MSD/ISD231X MSD/ISD235X	$R\theta_{J\text{-}PIN}$		 30 20 25		°C/W/ Device		

Notes
1. All typical values specified at V_{CC}=5.0 V and T_A=25°C unless otherwise noted.
2. See Figure 3-Peak Column Current vs. Column Voltage

Figure 4. Block Diagram



Contrast Enhancement Filters for Sunlight Readability

Display Color	Filter Color	Marks Polarized Corp.*	Optical Characteristics of Filter
Red, HER	Red	MPC 20-15C	25% at 635 nm, Circular Polarizer
Yellow	Amber	MPC 30-25C	25% at 583 nm, Circular Polarizer
Green	Yellow/Green	MPC 50-122C	22% at 568 nm, Circular Polarizer
Multiple Colors High Ambient Light	Neutral Gray	MPC 80-10C	10% Neutral, Circular Polarizer
Multiple Colors	Neutral Gray	MPC 80-37C	37% Neutral, Circular Polarizer

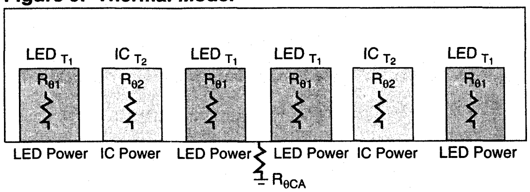
* Marks Polarized Corp.
25-B Jefryn Blvd. W.
Deer Park, NY 11729
516/242-1300
FAX 516/242-1347
Marks Polarized Corp. manufactures
to MIL-1-45208 inspection system.

The small alphanumeric displays are hybrid LED and CMOS assemblies that are designed for reliable operation in commercial, industrial, and military environments. Optimum reliability and optical performance will result when the junction temperature of the LEDs and CMOS ICs are kept as low as possible.

Thermal Modeling

MSD/ISD displays consist of two driver ICs and four 5x7 LED matrixes. A thermal model of the display is shown in Figure 5. It illustrates that the junction temperature of the semiconductor = junction self heating + the case temperature rise + the ambient temperature. Equation 1 shows this relationship.

Figure 5. Thermal Model



See Equation 1 below.

The junction rise within the LED is the product of the thermal impedance of an individual LED (37°C/W, DF=20%, F=200 Hz), times the forward voltage, $VF_{(LED)}$, and forward current IF(LED), of 13 - 14.5 mA. This rise averages $TJ_{(LED)}$=1°C. The table below shows the $V_{F(LED)}$ for the respective displays.

Model Number	VF		
	Min.	**Typ.**	**Max.**
MSD/ISD2010 MSD2310	1.6	1.7	2.0
MSD/ISD2011/2/3 MSD/ISD2311/2/3 MSD/ISD2351/2/3	1.9	2.2	3.0

The junction rise within the LED driver IC is the combination of the power dissipated by the IC quiescent current and the 28 row driver current sinks. The IC junction rise is given in Equation 2.

A thermal resistance of 28°C/W results in a typical junction rise of 6°C.

See Equation 2 below.

For ease of calculations the maximum allowable electrical operating condition is dependent upon the aggregate thermal resistance of the LED matrixes and the two driver ICs. All of the thermal management calculations are based upon the parallel combination of these two networks which is 15°C/W. Maximum allowable power dissipation is given in Equation 3.

Equation 3.

$$P_{DISPLAY} = \frac{T_{J(MAX)} - T_A}{R_{\theta JC} + R_{\theta CA}}$$

$$P_{DISPLAY} = 5\ V_{COL}\ I_{COL}\ (n/35)\ DF + V_{CC}\ I_{CC}$$

For further reference see Figures 2, 7, 8, 9, 10 and 11 .

KEY TO EQUATION SYMBOLS

DF	Duty factor
I_{CC}	Quiescent IC current
I_{COL}	Column current
n	Number of LEDs on in a 5 x 7 array
P_{CASE} under	Package power dissipation excluding LED consideration
P_{COL}	Power dissipation of a column
PD_{ISPLAY}	Power dissipation of the display
P_{LED}	Power dissipation of an LED
$R_{\theta CA}$	Thermal resistance case to ambient
RqJC	Thermal resistance junction to case
T_A	Ambient temperature
$T_{J(IC)}$	Junction temperature of an IC
$T_{J(LED)}$	Junction temperature of a LED
$TJ_{(MAX)}$	Maximum junction temperature
V_{CC}	IC voltage
V_{COL}	Column voltage
$V_{F(LED)}$	Forward voltage of LED
$Z_{\theta JC}$	Thermal impedance junction to case

Equation 1.

$$T_{J(LED)} = P_{LED}\ Z_{\theta JC} + PC_{ASE}\ (R_{\theta JC} + R_{\theta CA}) + T_A$$

$$T_{J(LED)} = [(I_{COL}/28)\ V_{F(LED)}\ Z_{\theta JC}] + [(n/35)\ I_{COL}\ DF\ (5\ V_{COL}) + V_{CC}\ I_{CC}]\ \Sigma\ [R_{\theta JC} + R_{\theta CA}] + T_A$$

Equation 2.

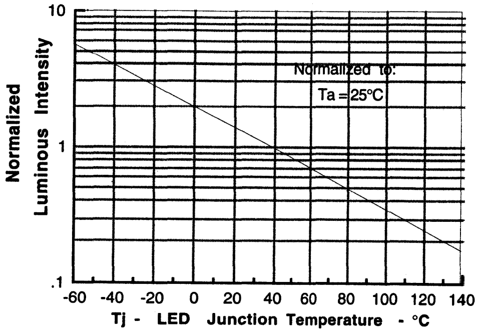
$$T_{J(IC)} = P_{COL}\ (R_{\theta JC} + R_{\theta CA}) + TA$$

$$T_{J(IC)} = [5\ (V_{COL} - V_{F(LED)}) \bullet (I_{COL}/2) \bullet (n/35)\ DF + V_{CC} \bullet I_{CC}] \bullet [R_{\theta JC} + R_{\theta CA}] + T_A$$

Optical Considerations

The light output of the LEDs is inversely related to the LED diode's junction temperature as shown in Figure 6. For optimum light output, keep the thermal resistance of the socket or PC board as low as possible.

Figure 6. Normalized Luminous Intensity vs. Junction Temperature



When mounted in a 10°C/W socket and operated at Absolute Maximum Electrical conditions, the HDSP230XLP will show anLED junction rise of 17°C. If T_A=40°C, then the LED's TJ will be 57°C. Under these conditions Figure 7 shows that the IV will be 75% of its 25°C value.

Figure 7. Max. LED Junction Temperature vs. Socket Thermal Resistance

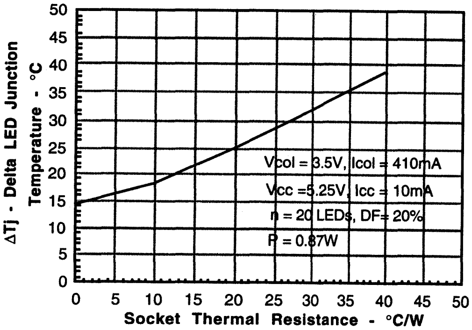


Figure 8a. Max. Package Power Dissipation, MSD/ISD201X

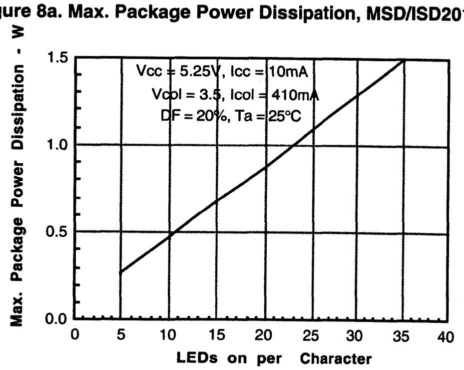


Figure 8b. Max. Package Power Dissipation, MSD/ISD231X

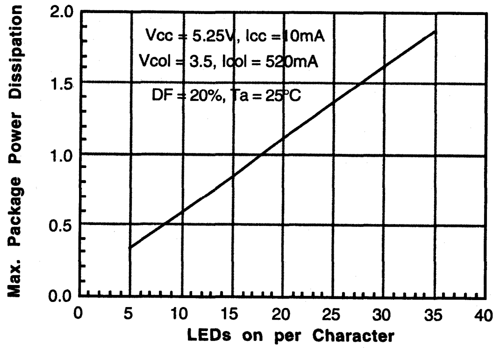


Figure 8c. Max. Package Power Dissipation, MSD/ISD235X

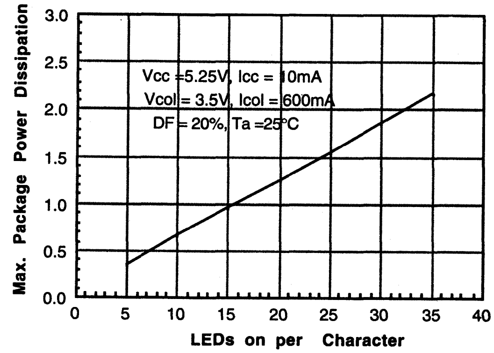


Figure 9a. Package Power Dissipation, MSD/ISD201X

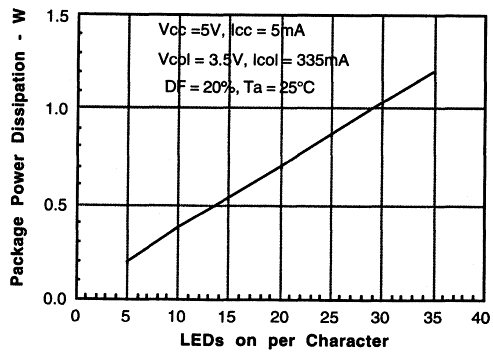


Figure 9b. Max. Package Power Dissipation, MSD/ISD231X

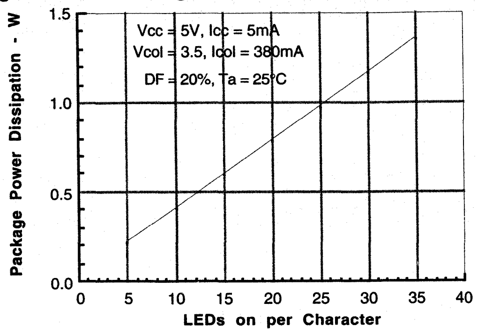


Figure 9c. Max. Package Power Dissipation, MSD/ISD235X

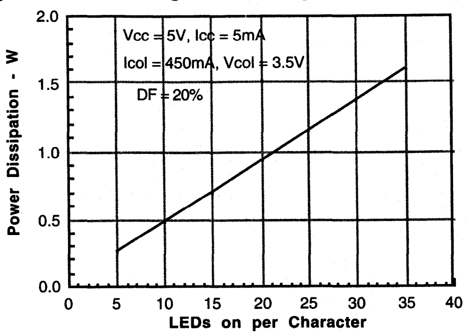


Figure 10a. Max. Character Power Dissipation, MSD/ISD201X

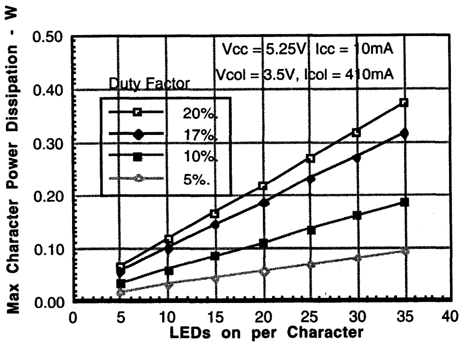


Figure 10b. Max. Character Power Dissipation, MSD/ISD231X

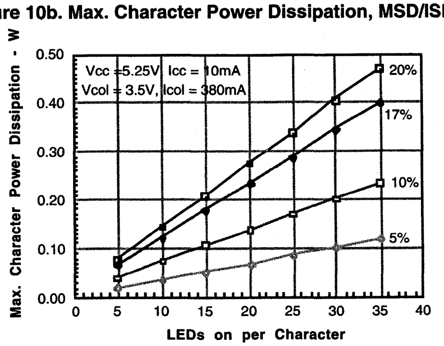


Figure 10c. Max. Character Power Dissipation, MSD/ISD235X

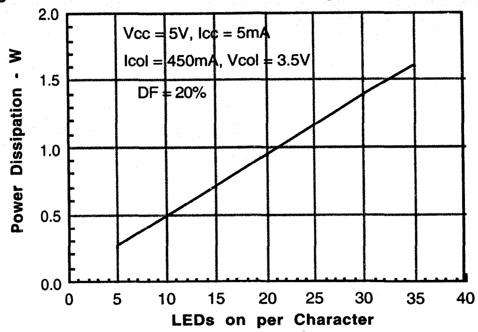


Figure 11a. Character Power Dissipation, MSD/ISD201X

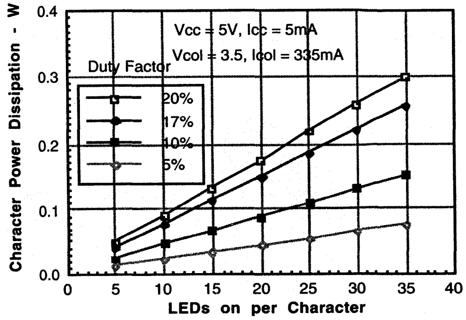


Figure 11b. Character Power Dissipation, MSD/ISD231X

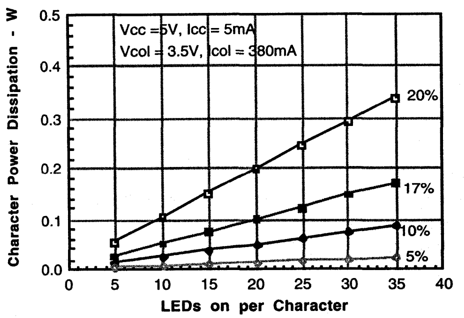
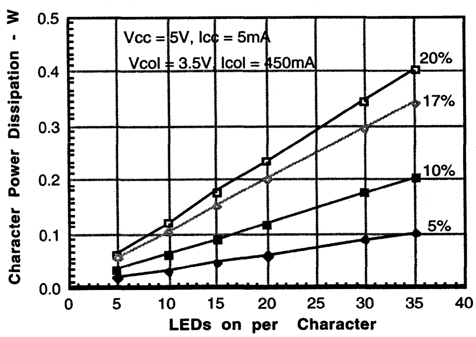


Figure 11c. Character Power Dissipation, MSD/ISD235X

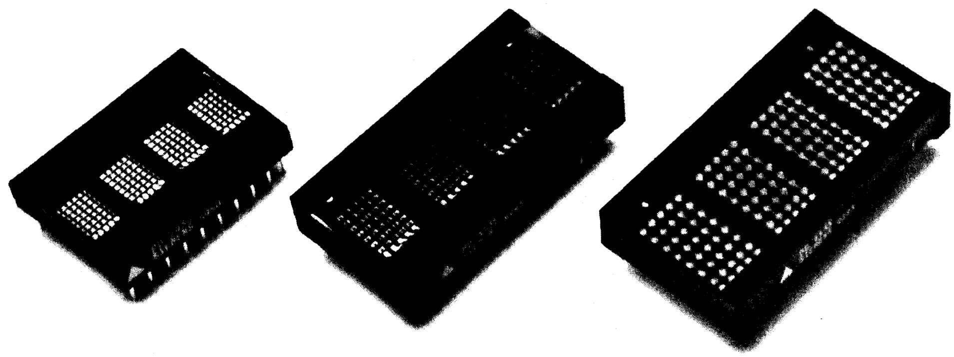


SIEMENS

HER PD2435/PD3535/PD4435
RED PD2436/PD3536/PD4436
BRIGHT GREEN PD2437/PD3537/PD4437

.200" Character, PD2435/6/7
.270"Character, PD3535/6/7
.45" Character, PD4435/6/7

Four Character 5x7 Dot Matrix Alphanumeric Programmable Display™ with Built-in CMOS Control Functions

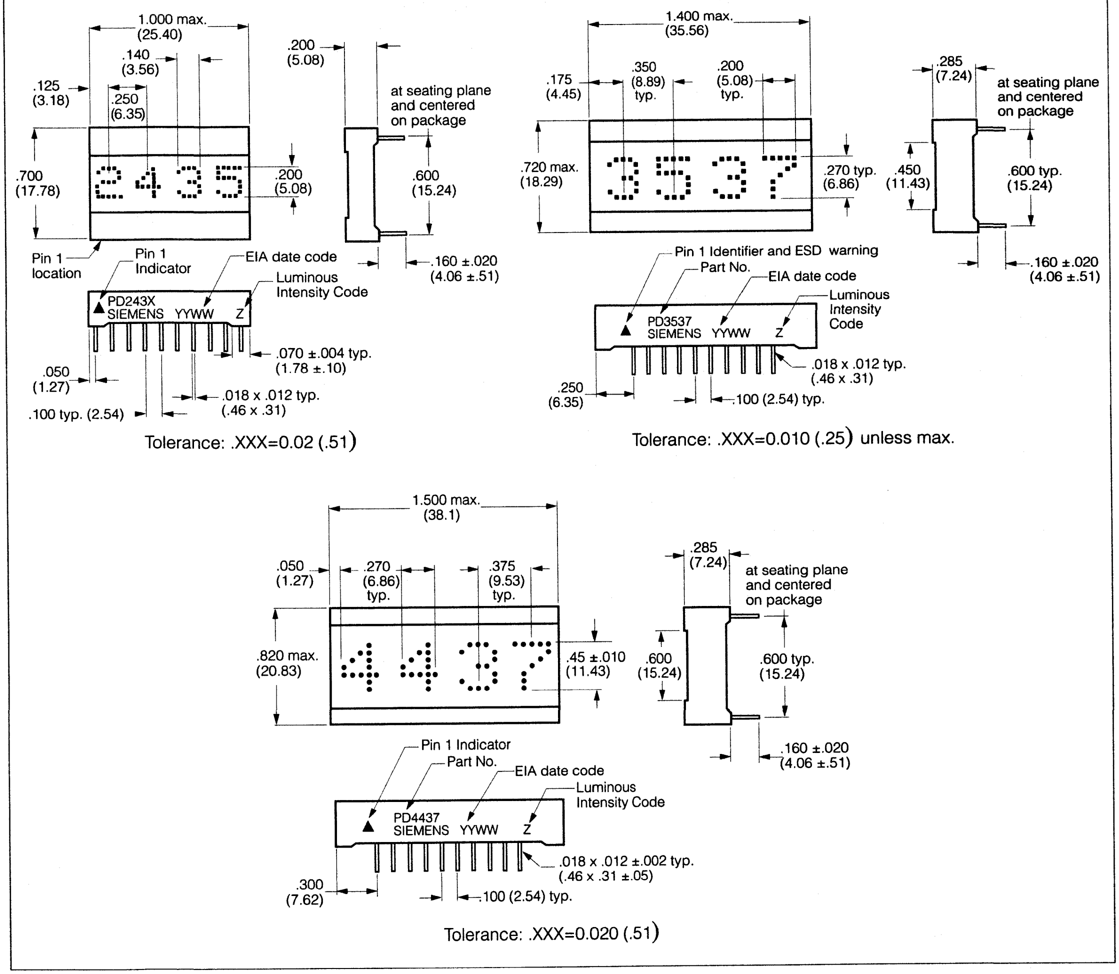


PD243X   PD353X   PD443X

FEATURES

- Four Dot Matrix Characters in High Efficiency Red, Red, and Bright Green
  - PD2435/6/7, 0.200" High
  - PD3535/6/7, 0.270" High
  - PD4435/6/7, 0.45" High
- Built-in Memory, Decoders, Multiplexer and Drivers
- Wide Viewing Angle, X Axis ±55°, Y Axis ±65°
- Categorized for Luminous Intensity
- 128 Character ASCII Format (Upper and Lower Case Characters)
- 8 Bit Bidirectional Data BUS
- READ/WRITE Capability
- Dual In-Line Package Configuration, 0.600" Wide, 0.100" Pin Centers
- End-Stackable Package
- Internal or External Clock
- Built-in Character Generator ROM
- TTL Compatible
- Easily Cascaded for Multidisplay Operation
- Less CPU Time Required
- Software Controlled Features:
  - Programmable Highlight Attribute (Blinking, Non-Blinking)
  - Asynchronous Memory Clear Function
  - Lamp Test
  - Display Blank Function
  - Single or Multiple Character Blinking Function
  - Programmable Intensity Three Brightness Levels
- Extended Operating Temperature Range:
  - PD243X, PD353X: –40°C to +85°C
  - PD443X: –40°C to +70°C

Package Dimensions in Inches (mm)



DESCRIPTION

These Programmable Displays are four digit display system modules. The characters are 0.20" by 0.14" (PD243X), 0.27" by 0.20" (PD353X), and 0.45" by 0.27" (PD443X) 5x7 dot matrix arrays constructed with the latest solid state technology in light emitting diodes. Driving and controlling the LED arrays is a silicon gate CMOS integrated circuit. This integrated circuit provides all necessary LED drivers and complete multiplexing control logic.

Additionally, the IC has the necessary ROM to decode 128 ASCII alphanumeric characters and enough RAM to store the display's complete four digit ASCII message with special attributes. These attributes, all software programmable at the user's discretion, include a lamp test, brightness control, displaying cursors, alternating cursors and characters, and flashing cursors or characters.

The CMOS IC also incorporates special interface control circuitry to allow the user to control the module as a fully supported microprocessor peripheral. The module, under internal or external clock control, has asynchronous read, write, and memory clear over an eight bit parallel, TTL compatible, bidirectional data bus. Each module is fully encapsulated within a package 1.0" x 0.7" x 0.2" (PD253X), 1.4" x 0.72" x 0.285" (PD353X), and 1.5" x 0.82" x 0.285" (PD443X). The standard 20 pin DIP construction with two rows spaced at 0.6" on 0.1" centers is wave solderable.

See the end of this data sheet or refer to Appnotes 18, 19, 22, and 23 for further details on handling and assembling Siemens Programmable Displays.

Maximum Ratings

DC Supply Voltage .... –0.5 V to +7.0 Vdc
Input Voltage Relative
 to GND (all inputs) .... –0.5 V to V_{CC} +0.5 Vdc
Operating Temperature
 PD243X/353X .... –40°C to +85°C
 PD443X .... –40°C to +70°C
Storage Temperature .... –40°C to +100°C
Maximum Solder Temperature, .063" (1.59 mm)
 below Seating Plane, t<5 sec. .... 260°C

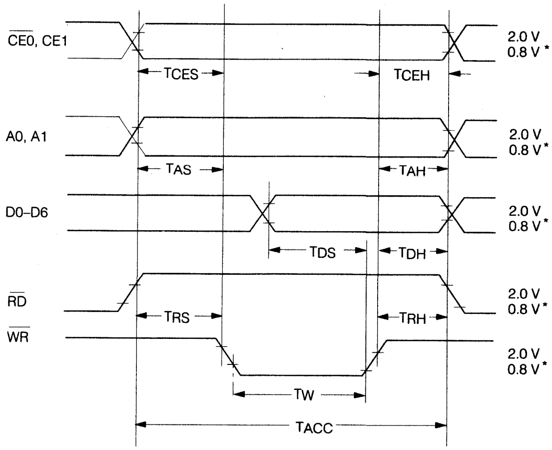
Optical Characteristics at 25°C

Spectral Peak Wavelength .... (HER) 635 nm typ.
 .... (Red) 660 nm typ.
 .... (Green) 565 nm typ.
Viewing Angle
 Horizontal
 PD243X/353X .... ±55°
 PD443X .... ±40°
 Vertical (off normal axis) .... ±65°
Digit Height
 PD243X .... 0.200" (5.08 mm)
 PD353X .... 0.270" (6.86 mm)
 PD443X .... 0.45" (11.43 mm)
Time Averaged Luminous Intensity[1]
 Red .... 30 μcd/LED min.
 HER/Green .... 90 μcd/LED min.
LED to LED Intensity Matching .... 1.8:1.0 max.
Device to Device (one bin) .... 1.5:1.0 max.
Bin to Bin (adjacent bins) .... 1.9:1.0 max.

Note: 1. Peak luminous intensity values can be calculated by multiplying these values by 7.

Timing Characteristics

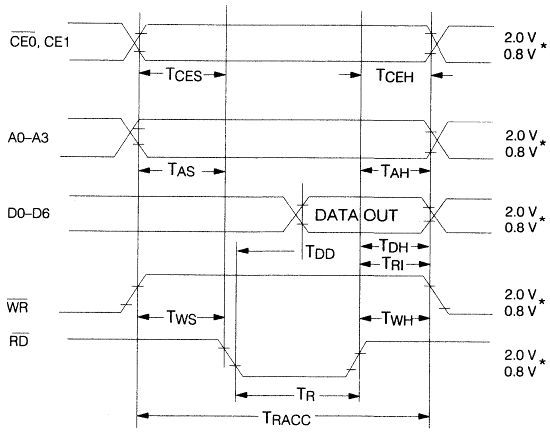
Data "Write" Cycle



Notes:

1. All input voltages are V_{IL}=0.8 V, V_{IH}=2.0 V.
2. These waveforms are not edge triggered.

Data "Read" Cycle



Switching Specifications (V_{CC}=4.5 V)

Write Cycle Timing					
Parameter	**Description**	**Specification Minimum**			
		–40°C	**25°C**	**85°C**	**Units**
T_{CLR} (1)	Clear RAM	1	1	1	µs
T_{CLRD} (1)	Clear RAM Disable	1	1	1	µs
T_{AS}	Address Setup	10	10	10	ns
T_{CES}	Chip Enable Setup	0	0	0	ns
T_{RS}	Read Enable Setup	10	10	10	ns
T_{DS}	Data Setup	20	30	50	ns
T_{W}	Write Pulse	60	70	90	ns
T_{AH}	Address Hold	20	30	40	ns
T_{DH}	Data Hold	20	30	40	ns
T_{CEH}	Chip Enable Hold	0	0	0	ns
T_{RH}	Read Enable Hold	20	30	40	ns
T_{ACC}	Total Access Time=Setup Time + Write Time + Hold Time	90	110	140	ns

Switching Specifications (V_{CC}=4.5 V)

Read Cycle Timing					
Parameter	**Description**	**Specification Minimum**			
		–40°C	**25°C**	**85°C**	**Units**
T_{AS}	Address Setup	0	0	0	ns
T_{CES}	Chip Enable	0	0	0	ns
T_{WS}	Write Enable Setup	20	30	40	ns
T_{DD}	Data DelayTime	100	150	175	ns
T_{R}	Read Pulse	150	175	200	ns
T_{AH}	Address Hold	0	0	0	ns
T_{DH}	Data Hold	0	0	0	ns
TRI	Time to Tristate (Max. time)	30	40	50	ns
T_{CEH}	Chip Enable Hold	0	0	0	ns
T_{WH}	Write Enable Hold	30	40	50	ns
T_{ACC}	Total Access Time=Setup Time + Read Time + Time to Tristate	200	245	290	ns
T_{WAIT} (2)	Wait Time between Reads	0	0	0	ns

Notes:

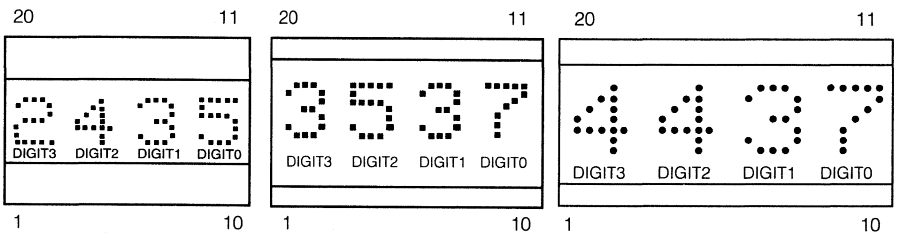
1. Wait 1 µs between any Reads or Writes after writing a Control Word with a Clear (D7=1). Wait 1 µs between any Reads or Writes after Clearing a Control Word with a Clear (D7=0). All other Reads and Writes can be back to back.
2. Wait 1 µs between any Reads or Writes after writing a Control Word with a Clear (D7=1). Wait 1 µs between any Reads or Writes after clearing a Control Word with a Clear (D7=0). All other Reads and Writes can be back to back.
3. All input voltages are (V_{IL}=0.8 V, V_{IH}=2.0 V)
4. Data out voltages are measured with 100 pF on the data bus and the ability to source=–40 µA and sink=1.6 mA The rise and fall tImes are 60 ns. V_{OL}=0.4 V, V_{OH}=2.4 V.

DC Characteristics at 25°C

Parameter	Limits				Conditions
	Min.	Typ.	Max.	Units	
V_{CC}	4.5	5.0	5.5	Volts	Nominal
Blank (All Inputs Low)		2.5	3.5	mA	V_{CC}=5 V, All inputs =0.8 V
I_{CC} 80 LEDs/unit (100% Bright) PD243X PD353X PD443X		 115 145 150	 130 165 170	 mA mA mA	 V_{CC}=5 V V_{CC}=5 V V_{CC}=5 V
V_{IL}			0.8	Volts	V_{CC}=4.5 V to 5.5 V
V_{IH}	2.0			Volts	V_{CC}=4.5 V to 5.5 V
I_{IL} (except D0 to D7)[(1)]	25		100	µA	V_{CC}=4.5 V to 5.5 V, V_{IN} =0.8 V
V_{OL}			0.4	Volts	V_{CC}=4.5 V to 5.5 V
V_{OH}	2.4			Volts	V_{CC}=4.5 V to 5.5 V
I_{OH}	–8.9			mA	V_{CC}=4.5 V, V_{OH}=2.4 V
I_{OL}	1.6			mA	V_{CC}=4.5 V, V_{OL}=0.4 V
Data I/O Bus Loading			100	pF	
Clock I/O Bus Loading			240	pF	

Note: 1. D0 to D7 have no pull-up resistors so current is negligible.

Top View



Pin Assignments and Definitions

1	$\overline{RD}$	Active low, will enable a processor to read all registers in the display.
2	CLK I/O	If CLK SEL (pin 3) is low, then expect an external clock source into this pin. If CIK SEL is high, then this pin will be the master or source into this pin. If CLK SEL is high, then this pin will be the master or source for all other devices which have CLK SEL low.
3	CLK SEL	CLOCK SELECT determines the action of pin 2. CLK I/O, see the section on Cascading for an example.
4	$\overline{RST}$	Reset. Must be held low until V_{CC} > 4.5 V. Reset is used only to synchronize blinking and will not clear the display.
5	CE1	Chip enable (active high).
6	$\overline{CE0}$	Chip enable (active low).
7	A2	Address input (MSB).

8	A1	Address input.
9	A0	Address input (LSB).
10	GND	Ground.
11	$\overline{WR}$	Write. Active low. If the device is selected, a low on the write input loads the data into memory.
12	D7	Data Bus bit 7 (MSB).
13	D6	Data Bus bit 6.
14	D5	Data Bus bit 5.
15	D4	Data Bus bit 4.
16	D3	Data Bus bit 3.
17	D2	Data Bus bit 2.
18	D1	Data Bus bit 1.
19	D0	Data Bus bit 0 (LSB).
20	V_{CC}	Positive power pin.

Functional Description

The block diagram includes 5 major blocks and internal registers (indicated by dotted lines).

Display Memory consists of a 5x8 bit RAM block. Each of the four 8-bit words holds 7-bits of ASCII data (bits D0–D6) and an attribute select bit (Bit D6). The fifth 8-bit memory word is used as a control word register. A detailed description of the control register and its functions can be found in the Control Word section. Each 8-bit word is addressable and can be read from or written to.

The **Control Logic** dictates all of the features of the display device and is discussed in the Control Word section of this data sheet.

The **Character Generator** converts the 7-bit ASCII data into the proper dot pattern for the 128 characters shown in the character set chart.

The **Clock Source** can originate either from the internal oscillator clock or from an external source — usually from the output of another display in a multiple module array.

The **Display Multiplexer** controls all display output to the digit drivers so no additional logic is required for a display system.

The **Column Drivers** are connected directly to the display.

The **Display** has four digits. Each of the four digits is comprised of 35 LEDs in a 5 x 7 dot array which makes up the alphanumeric characters.

The intensity of the display can be varied by the Control Word in steps of 0% (Blank), 25%, 50%, and full brightness.

Microprocessor Interface

The interface to the microprocessor is through the address lines. (A0–A2), the data bus (D0–D7), two chip select lines ($\overline{\text{CE0}}$, CE1), and read ($\overline{\text{RD}}$) and write ($\overline{\text{WR}}$) lines.

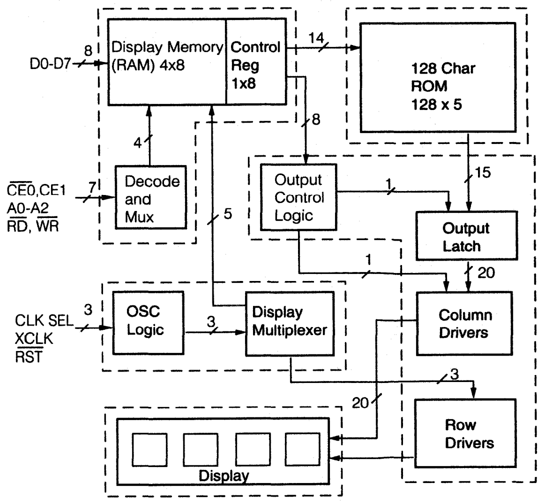
The $\overline{\text{CE0}}$ should be held low when executing a read, or write operation. CE1 must be held high.

The read and write lines are both active low. During a valid read the data input lines (D0-D7) become outputs. A valid write will enable the data as input lines.

Input Buffering

If a cable length of 6 inches or more is used, all inputs to the display should be buffered with a tri-state non-inverting buffer mounted as close to the display as conveniently possible. Recommended buffers are: 74LS245 for the data lines and 74LS244 for the control lines.

Block Diagram



Mode Selection

$\overline{\text{CE0}}$	CE1	$\overline{\text{RD}}$	$\overline{\text{WR}}$	OPERATION
0	1	0	0	None
1	X	X	X	None
X	0	X	X	None
X	X	1	1	None

0=Low logic level, 1=High logic level, X=Don't care.

Data Input Commands

$\overline{\text{CE0}}$	CE1	$\overline{\text{RD}}$	$\overline{\text{WR}}$	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	OPERATION
1	0	X	X	X	X	X	X	X	X	X	X	X	X	X	No Change
0	1	0	1	1	0	0	X	X	X	X	X	X	X	X	Read Digit 0 Data to Bus
0	1	1	0	1	0	0	0	0	1	0	0	1	0	0	($) Written to Digit 0
0	1	1	0	1	0	1	0	1	0	1	0	1	1	1	(W) Written to Digit 1
0	1	1	0	1	1	0	0	1	1	0	0	1	1	0	(f) Written to Digit 2
0	1	1	0	1	1	1	0	0	1	1	0	0	1	1	(3) Written to Digit 3
0	1	1	0	1	0	0	1	X	X	X	X	X	X	X	Char Written to Digit 0 and Cursor Enabled

There are five registers within the display. Four of these registers are used to hold the ASCII/attribute code of the four display characters. The fifth register is the Control Word, which is used to blink, blank, clear, or dim the entire display, or to change the presentation (attributes) of individual characters.

Addressing

The addresses within the display device are shown below. Digit 0 is the rightmost digit of the display, while digit 3 is on the left. Although there is only one Control Word, it is duplicated at the four address locations 0–3. Data can be read from any of these locations. When one of these locations is written to, all of them will change together.

Address			**Contents**
A2	A1	A0	
0	X	X	Control Word
1	0	0	Digit 0 (rightmost)
1	0	1	Digit 1
1	1	0	Digit 2
1	1	1	Digit 3 (leftmost)

Bit D7 of any of the display digit locations is used to allow an attribute to be assigned to that digit. The attributes are discussed in the next section. If Bit D7 is set to a one, that character will be displayed using the attribute. If bit D7 is cleared, the character will display normally.

Control Word

When address bit A2 is taken low, the Control Word is accessed. The same Control Word appears in all four of the lower address spaces of the display. Through the Control Word, the display can be cleared, the lamps can be tested, display brightness can be selected, and attributes can be set for any characters which have been loaded with their most significant bit (D7) set high.

Brightness (D0, D1): The state of the lower two bits of the Control Word are used to set the brightness of the entire display, from 0% to 100%. The table below shows the correspondence of these bits to the brightness.

D7	D6	D5	D4	D3	D2	D1	D0	Operation
0	0	X	X	X	X	0	0	Blank
0	0	X	X	X	X	0	1	25% brightness
0	0	X	X	X	X	1	0	50% brightness
0	0	X	X	X	X	1	1	Full brightness

X = don't care

Attributes (D2–D4): Bits D2, D3, and D4 control the visual attributes (i.e., blinking) of those display digits which have been written with bit D7 set high. In order to use any of the four attributes, the Cursor Enable bit (D4 in the Control Word) must be set. When the Cursor Enable bit is set, and bit D7 in a character location is set, the character will take on one of the following display attributes.

Control Word Format

D7	D6	D5	D4	D3	D2	D1	D0
CLEAR	LAMP TEST	BLINK	ATTRIBUTE ENABLE	ATTRIBUTES		BRIGHTNESS	

D1	D0	BRIGHTNESS
0	0	0% (blank)
0	1	25%
1	0	50%
1	1	100%

D3	D2	ATTRIBUTES
0	0	Display Cursor instead of Character
0	1	Blink Character
1	0	Display Blinking Cursor instead of Character
1	1	Alternate Character with Cursor

D4 ATTRIBUTE ENABLE
0 Disable above Attributes
1 Enable above Attributes

D5 BLINK
0 Blink Attribute Disabled
1 Blink Entire Display

D6 LAMP TEST
0 Standard Operation
1 Display All Dots at 50% Brightness

D7 CLEAR
0 Standard Operation
1 Clear Entire Display

D7	D6	D5	D4	D3	D2	D1	D0	Operation
0	0	0	0	X	X	B	B	Disable highlight attribute
0	0	0	1	0	0	B	B	Display cursor* instead of character
0	0	0	1	0	1	B	B	Blink single character
0	0	0	1	1	0	B	B	Display blinking cursor* instead of character
0	0	0	1	1	1	B	B	Alternate character with cursor*

*"Cursor"=all dots in a single character space lit to half brightness, X=Don't care, B=Depends on the selected brightness.

Attributes are non-destructive. If a character with bit D7 set is replaced by a cursor (Control Word bit D4 is set, and D3=D2=0) the character will remain in memory and can be revealed again by clearing D4 in the Control Word.

Blink (D5): The entire display can be caused to blink at a rate of approximately 2 Hz by setting bit D5 in the Control Word. This blinking is independent of the state of D7 in all character locations.

To synchronize the blink rate in a bank of these devices, it is necessary to tie all devices' clocks and resets together as described in a later section of this data sheet.

D7	D6	D5	D4	D3	D2	D1	D0	Operation
0	0	1	X	X	X	B	B	Blinking display

Lamp Test (D6): When the Lamp Test bit is set, all dots in the entire display are lit at half brightness. When this bit is cleared, the display returns to the characters that were showing before the lamp test.

D7	D6	D5	D4	D3	D2	D1	D0	Operation
0	1	0	X	X	X	X	X	Lamp test

Clear Data (D7): When D7 is set (D7=1) in the Control Word, all (display) memory bits are reset to zero and the display goes blank.

D7	D6	D5	D4	D3	D2	D1	D0	Operation
1	0	X	X	X	X	X	X	Clear

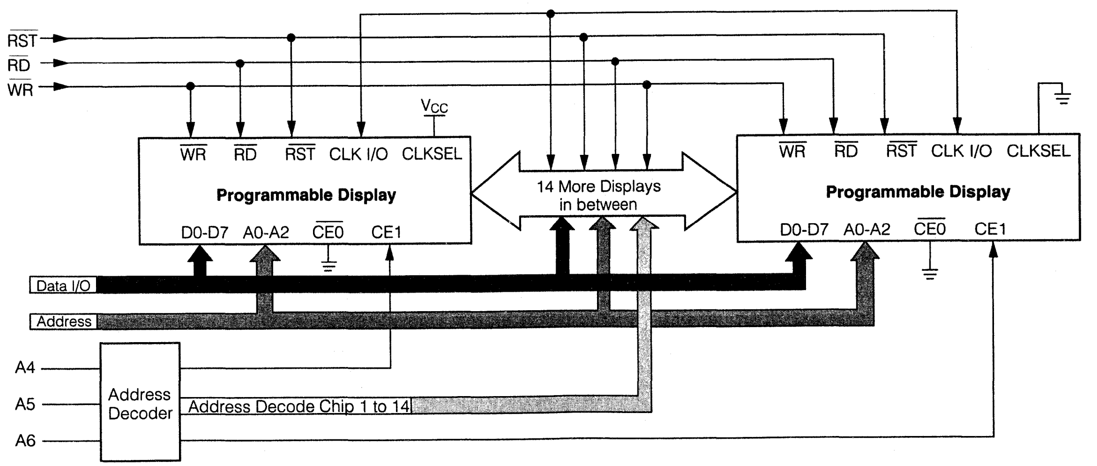
A second control word must be written into the chip with D7 reset (D7=0) to set up attributes and brightness levels.

The SMC-4740 oscillator is designed to drive up to 16 displays with input loading of 15 pF each.

The general requirements for cascading 16 displays are:

1. Determine the correct address for each display
2. Tie CE0 to ground and use CE1 from an address.
3. Select one of the displays to provide the clock for the other displays.
4. Tie CLK SEL to ground on other displays.
5. Use RST to synchronize the blinking between the displays.

Cascading Diagram



How to Load Information Into the Display

Information loaded into the display can be either ASCII data or Control Word data. The following procedure (see also Typical Loading Sequence) will demonstrate a typical loading sequence and the resulting visual display. The word STOP is used in all of the following examples.

Set Brightness

Step 1 Set the brightness level of the entire display to your preference (example: 100%)

Load Four Characters

Step 2 Load an "S" in the left hand digit.

Step 3 Load a "T" in the next digit.

Step 4 Load an "O" in the next digit.

Step 5 Load a "P" in the right hand digit.
If you loaded the information correctly, the display now should show the word "STOP."

Blink a Single Character

Step 6 Into the digit, second from the right, load the hex code "CF," which is the code for an "O" with the D7 bit added as a control bit.

Note: the "O" is the only digit which has the control bit (D7) added to normal ASCII data.

Step 7 Load enable blinking character into the control word register. The display should show "STOP" with a flashing "O".

Add Another Blinking Character

Step 8 Into the left hand digit, load the hex code "D3" which gives an "S" with the D7 bit added as a control bit. The display should show "STOP" with flashing "O" and a flashing "S."

Alternate Character/Cursor Enable

Step 9 Load enable alternate character/cusor into the control word register. The display now should show "STOP" with the "O" and the "S" alternating between the letter and cursor (all dots lit).

Initiate Four Character Blinking

(Regardless of Control Bit setting)

Step 10 Load enable display blinking. The display now should show the entire word "STOP" blinking.

Typical Loading Sequence

	$\overline{\text{CE0}}$	CE1	$\overline{\text{RD}}$	$\overline{\text{WR}}$	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	DISPLAY
1.	L	H	H	L	L	X	X	0	0	0	0	0	0	1	1	
2.	L	H	H	L	H	H	H	0	1	0	1	0	0	1	1	S
3.	L	H	H	L	H	H	L	0	1	0	1	0	1	0	0	ST
4.	L	H	H	L	H	L	H	0	1	0	0	1	1	1	1	STO
5.	L	H	H	L	H	L	L	0	1	0	1	0	0	0	0	STOP
6.	L	H	H	L	H	L	H	1	1	0	0	1	1	1	1	STOP
7.	L	H	H	L	L	X	X	0	0	0	1	0	1	1	1	STO*P
8.	L	H	H	L	H	H	H	1	1	0	1	0	0	1	1	S*TO*P
9.	L	H	H	L	L	X	X	0	0	0	1	1	1	1	1	S†TO†P
10.	L	H	H	L	L	X	X	0	0	1	0	0	0	1	1	S*T*O*P*

* Blinking character†Character alternating with cursor (all dots lit)

ELECTRICAL AND MECHANICAL CONSIDERATIONS

The CMOS IC of the display is designed to provide resistance to both Electrostatic Discharge Damage and Latch Up due to voltage or current surges. Several precautions are strongly recommended to avoid overstressing these built-in safeguards.

ESD Protection

Display users should be careful to handle the devices consistent with Standard ESD protection procedures. Operators should wear appropriate wrist, ankle or feet ground straps and avoid clothing that collects static charges. Work surfaces, tools and transport carriers that come into contact with unshielded devices or assemblies should also be appropriately grounded.

Latch up Protection

Latch up is a condition that occurs in CMOS ICs after the input protection diodes have been broken down. These diodes can be reversed through several means:

V_{IN} < GND, V_{IN} > V_{CC} + 0.5 V, or through excessive currents forced on the inputs. When these situations exist, the IC may develop the response of an SCR and begin conducting as much as one amp through the V_{CC} pin. This destructive condition will persist (latched) until device failure or the device is turned off.

The Voltage Transient Suppression Techniques and buffer interfaces for longer cable runs help considerably to prevent latch conditions from occuring. Additionally, the following Power Up and Power Down sequence should be observed.

Power up Sequence

1. Float all active signals by tri-stating inputs to displays.
2. Apply V_{CC} and GND to the display.
3. Apply active signals to the displays by enabling all input signals per application.

Power Down Sequence

1. Float all active signals by tri-stating the inputs to the display.
2. Turn off the power to the display.

Soldering Considerations

These displays can be hand soldered with SN63 solder using a grounded iron set to 260°C.

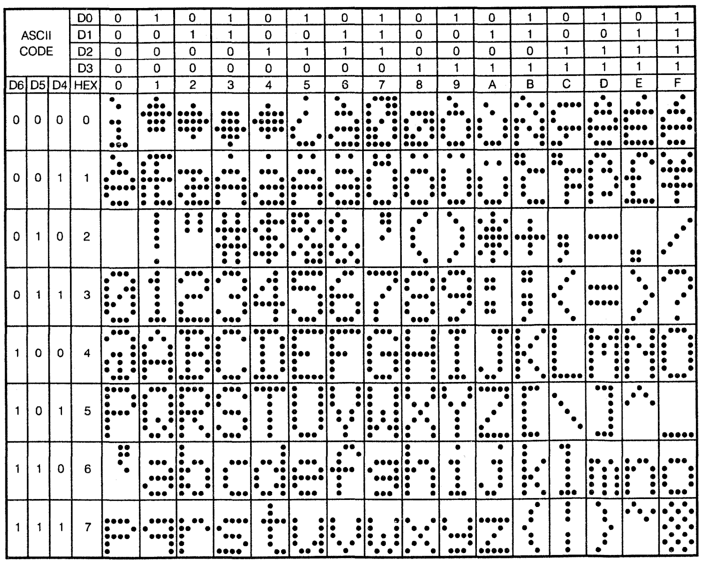
Wave soldering is also possible following these conditions: Preheat that does not exceed 93°C on the solder side of the PC board or a package surface temperature of 85°C. Water soluble organic acid flux (except carboxylic acid) or resin-based RMA flux without alcohol can be used.

Wave temperature is 245°C ±5°C with a dwell between 1.5 seconds to 3.0 seconds. Exposure to the wave should not exceed temperatures above 260°C, for 5 seconds at 0.063" below the seating plane. The packages should not be immersed in the wave.

Voltage Transient Suppression

It has become common practice to provide 0.01 µf bypass capacitors liberally in digital systems. Like other CMOS circuitry, the Intelligent Display controller chip has very low power consumption and the usual 0.01 µf would be adequate were it not for the LEDs. To prevent power supply transients, capacitors with low inductance and high capacitance at high frequencies are required. This suggests a solid tantalum or ceramic disc for high frquency bypass. For multiple display module systems distribute the bypass capacitors evenly, keeping capacitors as close to the power pins as possible. Use a 0.01 µF capcitor for each display module and a 22 µF for every third display module.

Character Set



Notes:

1. A2 must be held high for ASCII data.
2. Bit D7=1 enables attributes for the assigned digit.

Post Solder Cleaning Procedures

The least offensive cleaning solution is hot D.I. water (60°C) for less than 15 minutes. Addition of mild saponifiers is acceptable. Do not use commercial dishwasher detergents.

For faster cleaning, solvents may be used. Carefully choose the solvents as some may chemically attack the package. Maximum exposure should not exceed two minutes at elevated temperatures. Acceptable solvents are: TF (trichlorotrifluoroethane), TA, 111 Trichloroethane, and unheated acetone.[1]

Note: 1. Acceptable commercial solvents are: Basic TF Arklone P. Genesolv D, Genesolv DA, BlacoTron TF, Blaco-Tron TA and, Freon TA.

Do not use solvents containing alcohol, methanol, methylene chloride, ethanol, TP35, TCM, TMC, TMS+, TE, and TES. Since many commercial mixtures exist, you should contact your preferred solvent vendor for chemical composition information. Some major solvent manufacturers are: Allied Chemical Corporation, Specialty Chemical Division, Morristown, NJ; Baron-Blakeslee, Chicago, IL; Dow Chemical, Midland, MI; E.I. DuPont de Nemours & Co., Wilmington, DE.

For further information refer to Appnotes 18 and 19 in the current Siemens Optoelectronics Data Book.

An alternative to soldering and cleaning the display modules is to use sockets. Naturally, 20 pin DIP sockets 0.600" wide with 0.100" centers work well for single displays. Multiple display assemblies are best handled by longer SIP sockets or DIP sockets when available for uniform package alignment. Socket manufacturers include: Aries Electronics, Inc., Frenchtown, NJ; Garry Manufacturing, New Brunswick, NJ; Robinson-Nugent, New Albany, IN; and Samtec Electronic Hardware, New Albany, IN.

For further information refer to Appnote 22 in the current Siemens Optoelectronics Data Book.

Optical Considerations

The character heights of these displays allows readability up to eight feet. Proper filter selection allows the user to build a display that can be used over this distance.

Filters allow the user to enhance the contrast ratio between a lit LED and the character background. This will maximize discrimination of different characters as perceived by the display user. The only limitation is cost. So first consider the ambient lighting environment to maximize the cost benefit ratio for using filters.

Incandescent (with almost no green) or fluorescent (with almost no red) lights do not have the flat spectral response of sunlight. Plastic band-pass filters are inexpensive and effective in optimizing contrast ratios. The PD2435/3535/4435 is high efficiency red display and should be matched with a long wavelength pass filter in the 570 nm to 590 nm range. The PD2436/3536/4436 is a standard red display and should be matched with a long wavelength pass filter in the 600 nm to 620 nm range. The PD2437/3537/4437 should be matched with a yellow-green band-pass filter that peaks at 565 nm. For displays of multiple colors, neutral density grey filters offer the best compromise.

Additional contrast enhancement can be gained through shading the displays. Plastic band-pass filters with built-in louvers offer the "next step up" in contrast improvement. Plastic filters can be further improved with anti-reflective coatings to reduce glare. The trade-off is "fuzzy" characters. Mounting the filters close to the display reduces this effect. Care should be taken not to overheat the plastic filters by allowing for proper air flow.

Optimal filter enhancements for any condition can be gained through the use of circular polarized, anti-reflective, band-pass filters. The circular polarizing further enhances contrast by reducing the light that travels through the filter and reflects back off the display to less than 1%. Proper intensity selection of the displays will allow 10,000 foot candle sunlight viewability.

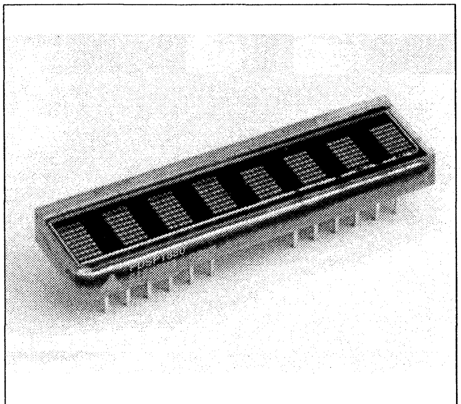
Several filter manufacturers supply quality filter materials. Some of them are: Panelgraphic Corporation, W. Caldwell, NJ; SGL Homalite, Wilmington, DE; 3M Company, Visual Products Division, St. Paul, MN; Polaroid Corporation, Polarizer Division, Cambridge, MA; Marks Polarized Corporation, Deer Park, NY; Hoya Optics, Inc., Fremont, CA.

One last note on mounting filters: recessing display and bezel assemblies is an inexpensive way to provide a shading effect in overhead lighting situations. Several Bezel manufacturers are: R.M.F. Products, Batavia, IL; Nobex Components, Griffith Plastic Corp., Burlingame, CA; Photo Chemical Products of California, Santa Monica, CA; I.E.E.Atlas, Van Nuys, CA.

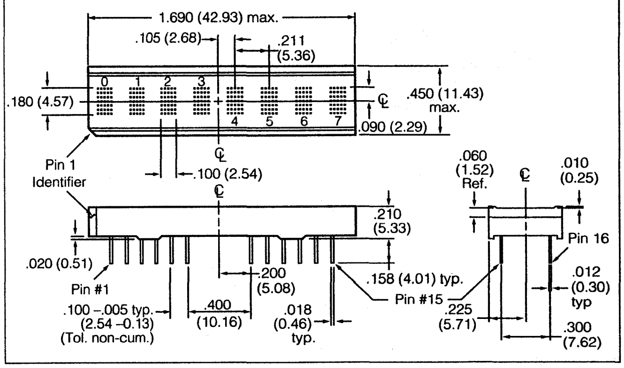
See Siemens Appnote 23 for further information.

SIEMENS

RED PDSP1880
YELLOW PDSP1881
HIGH EFFICIENCY RED PDSP1882
GREEN PDSP1883
HIGH EFFICIENCY GREEN PDSP1884
0.180" 8-Character 5x7 Dot Matrix Alphanumeric Programmable Display™



Package Dimensions in Inches (mm)



FEATURES

- **Eight 0.180" Dot Matrix Characters in Red, Yellow, High Efficiency Red, Green, or High Efficiency Green**
- **Built-in 128 Character ROM, Mask Programmable for Custom Fonts**
- **Readable from 8 Feet (2.5 meters)**
- **Built-in Decoders, Multiplexers and Drivers**
- **Wide Viewing Angle, X Axis ± 55°, Y Axis ± 65°**
- **Programmable Features:**
  - **Individual Flashing Character**
  - **Full Display Blinking**
  - **Multi-Level Dimming and Blanking**
  - **Clear Function**
  - **Self Test**
- **Internal or External Clock**
- **End Stackable Dual-In-Line Plastic Package**
- **Read/Write Capability**
- **16 User Definable Characters**

DESCRIPTION

The PDSP1880 (Red), PDSP1881 (Yellow), PDSP1882 (High Efficiency Red), PDSP1883 (Green), and PDSP1884 (High Efficiency Green) are eight digit, 5x7 dot matrix, alphanumeric Programmable Displays. The 0.180 inch high digits are packaged in a rugged, high quality, optically transparent, 0.300 inch lead spacing, 30 pin plastic DIP.

The on-board CMOS has a built-in 128 character ROM. The PDSP188X also has a user definable character (UDC) feature, which uses a RAM that permits storage of 16 arbitrary characters, symbols or icons that are software-definable by the user. The character ROM itself is mask programmable and easily modified by the manufacturer to provide specified custom characters.

The PDSP188X is designed for standard microprocessor interface techniques, and is fully TTL compatible. The Clock I/O and Clock Select pins allow the user to cascade multiple display modules.

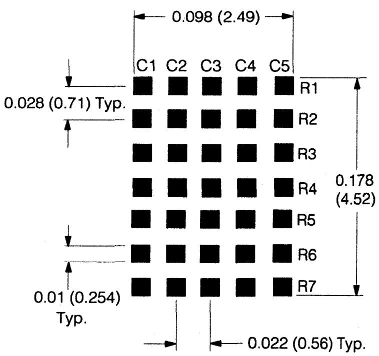
ESD Warning: Standard precautions for CMOS handling should be observed.

Maximum Rating, T_A=25°C

DC Supply Voltage,
  V_{CC} to GND (max. voltage with no LEDs on) .... –0.3 to +7.0 VDC
Input Voltage Levels,
  All Inputs .... –0.3 V to V_{CC}+0.3 V
Operating Temperature .... –40°C to +85°C
Storage Temperature .... –40°C to +100°C
Relative Humidity (non-condensing) 85%
Operating Voltage, V_{CC} to GND
  (Max. voltage with 20 dots/digits on) 5.5V
Maximum Solder Temperature .... 260°C
  (0.063" below the seating plane, t<5 sec.)
ESD Protection at 1.5 KΩ,
  100 pF .... V_Z=4 KV (each pin)

Enlarged Character Font

Dimensions in inches (mm)

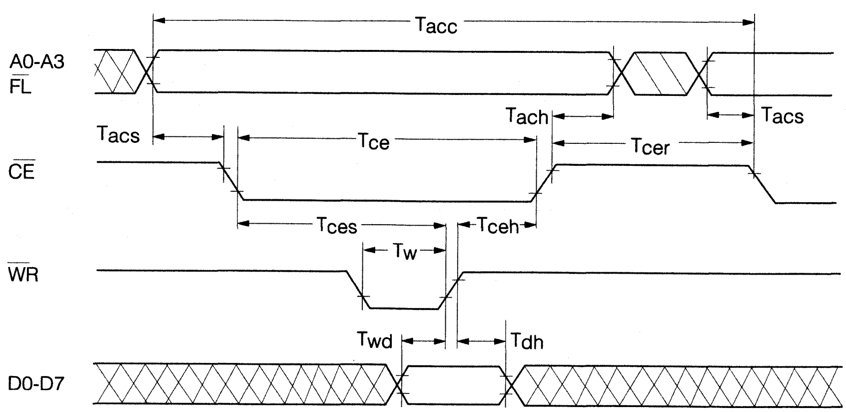


Switching Specifications

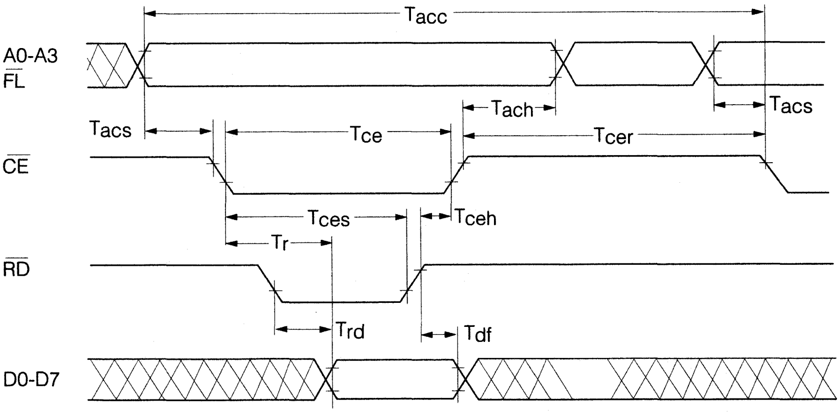
(over operating temperature range and V_{CC}=4.5 V)

Symbol	Description	Min.	Units
Tacc	Display Access Time–Write	210	ns
Tacc	Display Access Time–Read	230	ns
Tacs	Address Setup Time to CE	10	ns
Tce	Chip Enable Active Time–Write	140	ns
Tce	Chip Enable Active Time–Read	160	ns
Tach	Address Hold Time to CE	20	ns
Tcer	Chip Enable Recovery Time	60	ns
Tces	Chip Enable Active Prior to Rising Edge–Write	140	ns
Tces	Chip Enable Hold Prior to Rising Edge–Read	160	ns
Tceh	Chip Enable Hold to Rising Edge of Read/Write Signal	0	ns
Tw	Write Active Time	100	ns
Twd	Data Valid Prior to Rising Edge of Write Signal	50	ns
Tdh	Data Write Time	20	ns
Tr	Chip Enable Active Prior to Valid Data	160	ns
Trd	Read Active Prior to Valid Data	95	ns
Tdf	Read Data Float Delay	10	ns
Trc	Reset Active Time	300	ns

Write Cycle Timing Diagram



Read Cycle Timing Diagram



Character Set

ASCII CODE				D0	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
				D1	L	L	H	H	L	L	H	H	L	L	H	H	L	L	H	H
				D2	L	L	L	L	H	H	H	H	L	L	L	L	H	H	H	H
				D3	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H
D7	D6	D5	D4	HEX	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
L	L	L	L	0	◆	¿	x̄	Ñ	ñ	α	β	δ	Δ	η	θ	λ	μ	π	σ	Σ
L	L	L	H	1	τ	¤	Ω	Å	å	Ä	ä	Ö	ö	Ü	ü	→	√	²	£	¥
L	L	H	L	2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
L	L	H	H	3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
L	H	L	L	4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
L	H	L	H	5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	↑	_
L	H	H	L	6	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
L	H	H	H	7	p	q	r	s	t	u	v	w	x	y	z	{	|	}	→	▒
H	X	X	X	8	UDC 0	UDC 1	UDC 2	UDC 3	UDC 4	UDC 5	UDC 6	UDC 7	UDC 8	UDC 9	UDC 10	UDC 11	UDC 12	UDC 13	UDC 14	UDC 15

Notes: 1. Upon power up, device will initialize in a random state
2. X=Don't care.

Intelligent Display Devices 2

Optical Characteristics at 25°C V_{CC}=5.0 V at Full Brightness

Red PDSP1880

Description	Symbol	Min.	Typ.	Max.	Units
Luminous Intensity	I_V	70	125		μcd/dot
Peak Wavelength	λ(peak)		660		nm
Dominant Wavelength	λ(d)		639		nm

Yellow PDSP1881

Description	Symbol	Min.	Typ.	Max.	Units
Luminous Intensity	I_V	125	205		μcd/dot
Peak Wavelength	λ(peak)		583		nm
Dominant Wavelength	λ(d)		585		nm

High Efficiency Red PDSP1882

Description	Symbol	Min.	Typ.	Max.	Units
Luminous Intensity	I_V	125	350		μcd/dot
Peak Wavelength	λ(peak)		630		nm
Dominant Wavelength	λ(d)		626		nm

Green PDSP1883

Description	Symbol	Min.	Typ.	Max.	Units
Luminous Intensity	I_V	125	275		μcd/dot
Peak Wavelength	λ(peak)		565		nm
Dominant Wavelength	λ(d)		570		nm

High Efficiency Green PDSP1884

Description	Symbol	Min.	Typ.	Max.	Units
Luminous Intensity	I_V	125	500		μcd/dot
Peak Wavelength	λ(peak)		568		nm
Dominant Wavelength	λ(d)		574		nm

DC Electrical Characteristics at 25°C

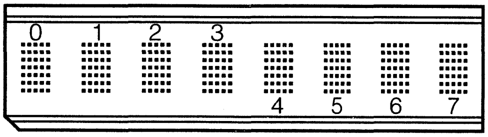
Parameter	Limits				Conditions
	Min.	Typ.	Max.	Units	
V_{CC}	4.5	5.0	5.5	V	
I_{CC} Blank		0.65	1.0	mA	V_{CC}=5 V, V_{IN}=5 V
I_{CC} 12 dots/digit on (1, 2)		200	255	mA	V_{CC}=5 V, "V" in all 8 digits
I_{CC} 20 dots/digit on (1, 2)		300	370	mA	V_{CC}=5 V, "#" in all 8 digits
I_{ILP} (with pull-up) Input Leakage	–18	–11	–5	µA	V_{CC}=5 V, V_{IN}=0 V to V_{CC} ($\overline{WR}$, $\overline{CE}$, $\overline{FL}$, $\overline{RST}$, $\overline{RD}$, CLKSEL)
I_{IL} (no pull-up) Input Leakage	–1		+1	µA	V_{CC}=5 V, V_{IN}=5 V (CLK, A0–A3, D0–D7)
V_{IH} Input Voltage High	2.0		V_{CC} +0.3	V	V_{CC}=4.5 V to 5.5 V
V_{IL} Input Voltage Low	Gnd –0.3			V	V_{CC}=4.5 V to 5.5 V
V_{OL} (D0 to D7) Output Voltage Low			0.4	V	V_{CC}=4.5 V, I_{OL}=1.6 mA
V_{OL} (CLK) Output Voltage Low			0.4	V	V_{CC}=4.5 V, I_{OL}=40 µA
V_{OH} Output Voltage High	2.4			V	V_{CC}=4.5 V, I_{OH}=40 µA
θ_{JC} Thermal Resistance, Junction to Case		60		°C/W	
Clock I/O Frequency	28	57.34	81.14	KHz	V_{CC}=4.5 V to 5.5 V
FM, Digit Multiplex Frequency	125	256	362.5	Hz	V_{CC}=4.5 V to 5.5 V
Blinking Rate	0.98	2.0	2.83	Hz	
Clock I/O Bus Loading			2.40	pF	
Clock Out Rise Time			500	nsec	V_{CC}=4.5 V, V_{OH}=2.4 V
Clock Out Fall Time			500	nsec	V_{CC}=4.5 V, V_{OH}=0.4 V

Notes: 1. I_{CC} is an average value.
2. I_{CC} is measured with the display at full brightness. Peak I_{CC}=$^{28}/_{15}$ I_{CC} average (# displayed).

Recommended Operating Conditions (T_A=–40°C to +85°C)

Parameter	Symbol	Min.	Max.	Units
Supply Voltage	V_{CC}	4.5	5.5	V
Input Voltage Low	V_{IL}		0.8	V
Input Voltage High	V_{IH}	2.0		V
Output Voltage Low	V_{OL}		0.4	V
Output Voltage High	V_{OH}	2.4		V

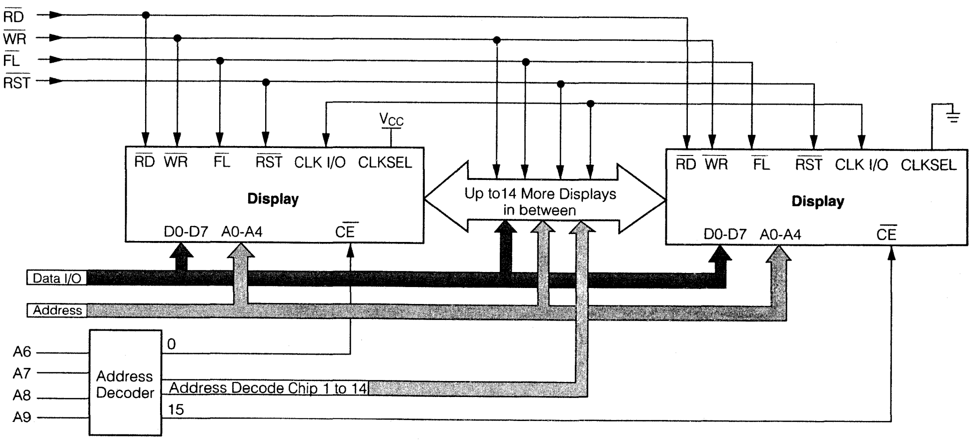
Top View



Pin Assignments

Pin #	Name	Sym-bol	Definition
1	Reset	$\overline{RST}$	Initializes display: clears character RAM (20 Hex), Flash RAM (00 Hex), control word (00 Hex), and resets internal counters.
2	Flash	$\overline{FL}$	Access Flash RAM. Address lines (A2–A0) select character RAM while data bit, D0 sets (D0=1) or resets (D0=0) Flash bit.
3-6 & 10	Addr.	A4–A0	A4 and A3 selects a section of display's memory. A2–A0 selects specific locations in the different sections. If $\overline{FL}$ is low, flash RAM is accessed regardless of status of A4 and A3. See Table 2.

Pin #	Name	Sym-bol	Definition
11	Clock Select	CLS	Selects internal or external clock source. CLS=1 then internal clock (master clock). CLS=0 then external clock (slave operation).
12	Clock In/Out	CLK	Inputs or outputs clock source as determined by CLS pin.
13	Write	$\overline{WR}$	Writes data into display when $\overline{WR}$=0 ($\overline{CE}$=0 to enable write cycle).
14	Chip Enable	$\overline{CE}$	Enables display's read and write cycles when low.
15	V_{CCPWR}	V_{CC}	Positive power supply input.
16	GND_{SUP}	GND	Analog ground for LED drivers
17	—	NC	No connection
18	GND_{LOG}	GND	Digital ground for logic circuitry
19	Read	$\overline{RD}$	Reads data into display when $\overline{RD}$=0 ($\overline{CE}$=0 to enable read cycle.)
20 21 25–30	Data Bus, D7–D0	D7–D0	Used to read and write data to display. Control Word and Character RAM use D7–D0, UDC Address Register uses D3–D0, UDC RAM uses D4–D0, and Flash RAM uses D0.



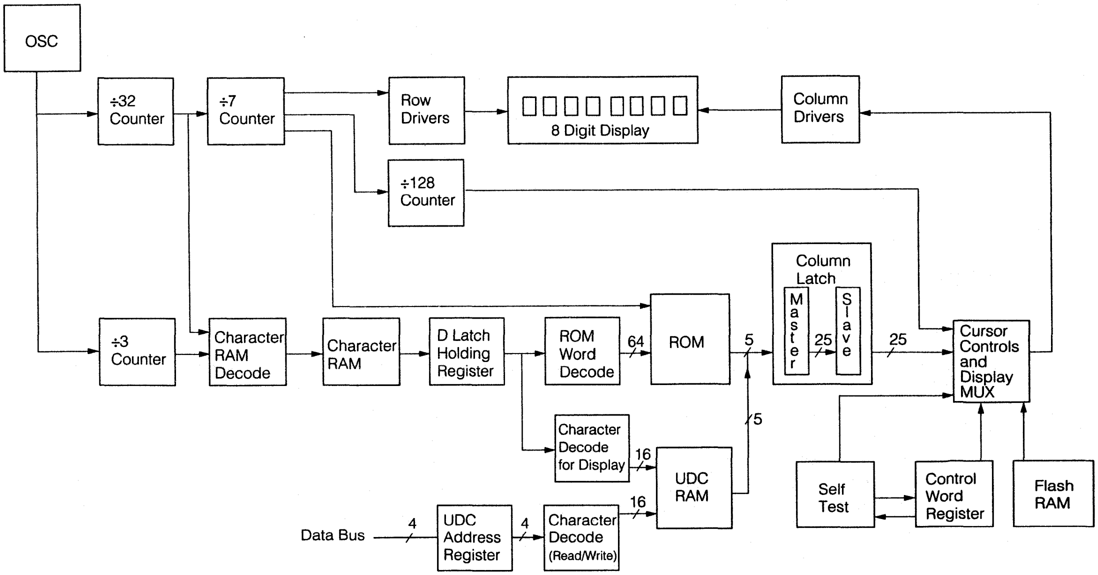
Cascading Displays

The PDSP188X is designed to drive up to 16 other PDSP188Xs with input loading of 15 pF each.

General requirements for cascading 16 displays together:

- Determine the correct address for each display.
- Use $\overline{CE}$ from an adrress decoder to select the correct display.
- Use CE from an adrress decoder to select the correct display.
- Select one of the Displays to provide the Clock for the other displays. Connect CLKSEL to V_{CC} for this display.
- Tie CLKSEL to ground on other displays.
- Use $\overline{RST}$ to synchronize the blinking between the displays.

Block Diagram



Functional Description

The display's user interface is organized into five memory areas. They are accessed using the Flash Input, $\overline{FL}$, and address lines, A3 and A4. All the listed RAMs and Registers may be read or written through the data bus. See Table 1. Each input pin is described in Pin Definitions. The five basic memory areas are:

Character RAM	Stores either ASCII (Katakana) character data or an UDC RAM address
Flash RAM	1x 8 RAM which stores Flash data
User-Defined Character RAM (UDC RAM)	Stores dot pattern for custom characters.
User-Defined Address Register (UDC Address Register)	Provides address to UDC RAM when user is writing or reading a custom character
Control Word Register	Enables adjustment of display brightness, flash individual characters, blink, self test or clearing the display.

$\overline{RST}$ can be used to initialize display operation upon power up or during normal operation. When activated, $\overline{RST}$ will clear the Flash RAM and Control Word Register (00H) and reset the internal counter. All eight display memory locations will be set to 20H to show blanks in all digits.

$\overline{FL}$ pin enables access to the **Flash RAM**. The **Flash RAM** will set (D0=1) or reset (D0=0) flashing of the character addressed by A0-A2.

The 1 x 8 bit **Control Word Register** is loaded with attribute data if A3=0.

The **Control Word Logic** decodes attribute data for proper implementation.

Character ROM is designed for 128 ASCII characters. The ROM is Mask Programmable for custom fonts.

The **Clock Source** could either be the internal oscillator (CLKSEL=1) of the device or an external clock (CLKSEL=0) could be an input from another HDSP211X display for the synchronization of blinking for multiple displays.

The **Display Multiplexer** controls the Row Drivers so no additional logic is required for a display system.

The **Display** has eight digits. Each digit has 35 LEDs clustered into a 5 x 7 dot matrix.

$\overline{FL}$	A4	A3	Section of Memory	A2–A0	Data Bits Used
0	X	X	Flash RAM	Character Address	D0
1	0	0	UDC Address Register	Don't Care	D3–D0
1	0	1	UDC RAM	Row Address	D4–D0
1	1	1	Character RAM	Character Address	D7–D0
1	1	0	Control Word Register	Don't Care	D7–D0

Table 1. Memory Selection

Theory of Operation

The PDSP188X Programmable Display is designed to work with all major microprocessors. Data entry is via an eight bit parallel bus. Three bits of address route the data to the proper digit location in the RAM. Standard control signals like $\overline{WR}$ and $\overline{CE}$ allow the data to be written into the display.

D0-D7 data bits are used for both Character RAM and control word data input. A3 acts as the mode selector. If A3=1, character RAM is selected. Then input data bit D7 will determine whether input data bits D0-D6 is ASCII coded data (D7=0) or UDC data (D7=1). See section on UDC Address Register and RAM.

For normal operation $\overline{FL}$ pin should be held high. When $\overline{FL}$ is held low, Flash RAM is accessed to set character blinking.

The seven bit ASCII code is decoded by the Character ROM to generate Column data. Twenty columns worth of data is sent out each display cycle, and it takes fourteen display cycles to write into eight digits.

The rows are multiplexed in two sets of seven rows each. The internal timing and control logic synchronizes the turning on of rows and presentation of column data to assure proper display operation.

Power Up Sequence

Upon power up display will come on at random. Thus the display should be reset on power-up. The reset will clear the Flash RAM, Control Word Register and reset the internal counter. All the digits will show blanks and display brightness level will be 100%.

The display must not be accessed until three clock pulses (110 μseconds minimum using the internal clock) after the rising edge of the reset line.

Microprocessor Interface

The interface to a micrprocessor is through the 8-bit data bus (D0-D7), the 4-bit address bus (A0-A3) and control lines $\overline{FL}$, $\overline{CE}$ and $\overline{WR}$.

To write data (ASCII/Control Word) into the display $\overline{CE}$ should be held low, address and data signals stable and $\overline{WR}$ should be brought low. The data is written on the low to high transistion of $\overline{WR}$.

The Control Word is decoded by the Control Word Decode Logic. Each code has a different function. The code for display brightness changes the duty cycle for the column drivers. The peak LED current stays the same but the average LED current diminishes depending on the intensity level.

The character Flash Enable causes 2 Hz coming out of the counter to be ANDED with column drive signal and makes the column driver to cycle at 2 Hz. Thus the character flashes at 2 Hz.

The display Blink works the same way as the Flash Enable but causes all twenty column drivers to cycle at 2 Hz thereby making all eight digits to blink at 2 Hz.

The Self Test function of the IC consists of two internal routines which exercise major portions of the IC and illuminates all the LEDs.

Clear bit clears the character RAM and writes a blank into the display memory. It however does not clear the control word.

ASCII Data or Control Word Data can be written into the display at this point. For multiple display operation, CLK I/O must be properly selected. CLK I/O will output the internal clock if CLKSEL=1, or will allow input from an external clock if CLKSEL=0.

Character RAM

The Character RAM is selected when $\overline{FL}$, A4 and A3 are set to 1,1,1 during a read or write cycle. The Character RAM is a 8 by 8 bit RAM with each of the eight locations corresponding to a digit on the display. Digit 0 is on the left side of the display and digit 7 is on the right side of the display. Address lines, A2-A0 select the digit address with A2 being the most significant bit and A0 being the least significant bit. The two types of data stored in the Character RAM are the ASCII coded data and the UDC Address Data. The type of data stored in the Character RAM is determined by data bit, D7. If D7 is low, then ASCII coded data is stored in data bits D6-D0. If D7 is high, then UDC Address Data is stored in data bit D3-D0.

The ASCII coded data is a 7 bit code used to select one of 128 ASCII characters permanently stored in the ASCII ROM.

The UDC Address data is a 4 bit code used to select one of the UDC characters in the UDC RAM. There are up to 16 characters available. See Figure 1.

UDC Address Register and UDC RAM

The UDC Address Register and UDC RAM allows the user to generate and store up to 16 custom characters. Each custom character is defined in 5 x 7 dot matrix pattern. It takes 8 write cycles to define a custom character, one cycle to load the UDC Address Register and 7 cycles to define the character. The contents of the UDC Address Register will store the 4 bit address for one of the 16 UDC RAM locations. The UDC RAM is used to store the custom character.

UDC Address Register

The UDC Address Register is selected by setting $\overline{FL}$=1, A4=0, A3=0. It is a 4 bit register and uses data bits, D3-D0 to store the 4 bit address code (D7-D4 are ignored). The address code selects one of 16 UDC RAM locations for custom character generation.

UDC RAM

The UDC RAM is selected by setting $\overline{FL}$=1, A4=0, A3=1. The RAM is comprised of a 7 x 5 bit RAM. As shown in Figure 4, address lines, A2-A0 select one of the 7 rows of the custom character. Data bits, D4-D0 determine the 5 bits of column data in each row. Each data bit corresponds to a LED. If the data bit is high, then the LED is on. If the data bit is low, the LED is off. To create a character, each of the 7 rows of column data need to be defined. See Figures 2 and 3 for logic.

Flash RAM

The Flash RAM allows the display to flash one or more of the characters being displayed. The Flash Ram is accessed by setting $\overline{FL}$ low. A4 and A3 are ignored. The Flash RAM is a 8 x 1 bit RAM with each bit corresponding to a digit address. Digit 0 is on the left side of the display and digit 7 is on the right side of the display. Address lines, A2-A0 select the digit address with A2 being the most significant digit and A0 being the least significant digit. Data bit, D0, sets and resets the flash bit for each digit. When D0 is high, the flash bit is set and when D0 is low, it is reset. See Figure 4.

$\overline{RST}$	$\overline{CE}$	$\overline{WR}$	$\overline{RD}$	$\overline{FL}$	A4	A3	A2 A1 A0	D7 D6 D5 D4 D3 D2 D1 D0
1	0	0	1	1	1	1	Character Address, Digits 0–7	0 7 bit ASCII code, Write Cycle
1	0	1	0	1	1	1	Character Address, Digits 0–7	0 7 bit ASCII code read during a Read Cycle
1	0	0	1	1	0	0	Character Address, Digits 0–7	1 D3–D0=UDC address, Write Cycle
1	0	1	0	1	0	0	Character Address, Digits 0–7	1 D3–D0=UDC address, Read Data

Figure 1. Character RAM Access Logic

$\overline{RST}$	$\overline{CE}$	$\overline{WR}$	$\overline{RD}$	$\overline{FL}$	A4	A3	A2 A1 A0	D7 D6 D5 D4 D3 D2 D1 D0	
1	0	0	1	1	0	0	Not used for UDC Address Register	D3–D0=UDC RAM Address Code, Write Cycle	UDC Address Register
1	0	1	0	1	0	0	Not used for UDC Address Register	D3–D0=UDC RAM Address Code, Read Cycle	
1	0	0	1	1	0	1	A2–A0=Character Row Address	D4–D0=Character Column Data, Write Cycle	UDC RAM
1	0	1	0	1	0	1	A2–A0=Character Row Address	D4–D0=Character Column Data, Read Cycle	

Figure 2. UDC Address Register and UDC Character RAM

Control Word

The Control Word is used to set up the attributes required by the user. It is addressed by setting $\overline{FL}$=1, A4=1, A3=0. The Control Word is an 8 bit register and is accessed using data bits, D7–D0. See Figures 5 and 6 for the logic and attributed control. The Control Word has 5 functions. They are brightness control, flashing character enable, blinking character enable, self test, and clear (Flash and Character RAMS only).

Brightness Control

Control Word bits, D2–D0, control the brightness of the display with a binary code of 000 being 100% brightness and 111 being display blank. See Figure 6 for brightness level versus binary code. The average ICC can be calculated by multiplying the 100% brightness level I_{CC} value by the display's brightness level. For example, a display set to 80% brightness with a 100% average I_{CC} value of 200 mA will have an average I_{CC} value of 200 mA x 80%=160 mA.

Flash Function

Control Word bit, D3, enables or disables the Flash Function. When D3 is 1, the Flash Function is enabled and any digit with its corresponding bit set in the Flash RAM will flash at approximately 2 hertz. When using an external clock, the flash rate can be determined by dividing the clock rate by 28,672. When D3 is 0, the Flash Function is disabled and the contents of the Flash RAM is ignored. For synchronized flashing on multiple displays, see the Reset Section.

Blink Function

Control Word bit, D4, enables or disables the Blink Function. When D4 is 1, the Blink Function is enabled and all characters on the display will blink at approximately 2 hertz. The Blink Function will override the Flash Function if both functions are enabled. When D4 is 0, the Blink Function is disabled. When using an external clock, the blink rate can be determined by dividing the clock rate by 28,672. For synchronized blinking on multiple displays, see the Reset Section.

Row Data	Column Data
	C1 C2 C3 C4 C5
A2 A1 A0 Row#	**D4 D3 D2 D1 D0**
0 0 0 1	5 x 7 Dot Matrix Pattern
0 0 1 2	
0 1 0 3	
0 1 1 4	
1 0 0 5	
1 0 1 6	
1 1 0 7	

Self Test

Before starting Self Test, Reset must first be activated. Control Word bits, D6 and D5, are used for the Self Test Function. When D6 is 1, the Self Test is initiated. Results of the Self Test are stored in bits D5. Control Word bit, D5, is a read only bit. When D5 is 1, Self Test passed is indicated. When D5 is 0, Self Test failed is indicated. The Self Test function of the IC consists of two internal routines which exercise major portions of the IC and illuminates all of the LEDs. The first routine cycles the ASCII decoder ROM through all states and performs a check sum on the output. If the check sum agrees with the correct value, D5 is set to a 1.

The second routine provides a visual test of the LEDs using the drive circuitry. This is accomplished by writing checkered and inversed checkered patterns to the display. Each pattern is displayed for approximately 2 seconds. During the self test function the display must not be accessed. The time needed to execute the self test function is calculated by multiplying the clock time by 262,144 (typical time≈4.6 sec.). At the end of the self test function, the Character RAM is loaded with blanks; the Control Word Register is set to zeroes except D5, and the Flash RAM is cleared and the UDC Address Register is set to all 1s.

$\overline{RST}$	$\overline{CE}$	$\overline{WR}$	$\overline{RD}$	$\overline{FL}$	A4	A3	A2 A1 A0	D7 D6 D5 D4 D3 D2 D1 D0
1	0	0	1	1	X	X	Flash RAM Address, Digits 0–7	D0=Flash Data, 0=Flash Off and 1=Flash On (Write Cycle)
1	0	1	1	0	X	X	Character Address, Digits 0–7	D0=Flash Data, 0=Flash Off and 1=Flash On (Read Cycle)

Figure 4. Flash RAM Access Logic

$\overline{RST}$	$\overline{CE}$	$\overline{WR}$	$\overline{RD}$	$\overline{FL}$	A4	A3	A2 A1 A0	D7 D6 D5 D4 D3 D2 D1 D0
1	0	0	1	1	1	0	Not used for Control Word	Control Word data, Write Cycle. See Figure 6.
1	0	1	0	1	1	0	Not used for Control Word	Control Word data for a Read during a Read Cycle.

Figure 5. Control Word Access Logi

Clear Function (see Figures 6 and 7)

Control Word bit, D7 clears the character RAM to 20 hex and the flash RAM to all zeroes. The RAMs are cleared within three clock cycles (110 µs minimum, using the internal clock) when D7 is set to 1. During the clear time the display must not be accessed. When the clear function is finished, bit 7 of the Control Word RAM will be reset to a "0".

Reset Function

The display should be reset on power up of the display ($\overline{RST}$=LOW). When the display is reset, the Character RAM, Flash RAM, and Control Word Register are cleared. The display's internal counters are reset. Reset cycle takes three clock cycles (110 µseconds minimum using the internal clock). The display must not be accessed during this time.

To synchronize the flashing and blinking of multiple displays, it is necessary for the display to use a common clock source and reset all the displays at the same time to start the internal counters at the same place.

While $\overline{RST}$ is low, the display must not be accessed by RD nor $\overline{WR}$.

D7	D6	D5	D4	D3	D2	D1	D0
C	ST	ST	BL	FL	Br	Br	Br

D2	D1	D0	
0	0	0	100% Brightness
0	0	1	80% Brightness
0	1	0	53% Brightness
0	1	1	40% Brightness
1	0	0	27% Brightness
1	0	0	20% Brightness
1	1	0	13% Brightness
1	1	1	Blank Display

D3: 0 Flash Function Disabled
D3: 1 Flash Function Enabled

D4: 0 Blink Function Disabled
D4: 1 Blink Function Enabled (overrides Flash Function)

D6 D5: 0 X Normal Operation X=bit ignored
D6 D5: 1 R Run Self Test, R=Test Result, R=1/pass, 0=fail

D7: 0 Normal Operation
D7: 1 Clear Flash RAM & Character RAM (Character RAM=20 Hex)

Key

C	Clear function
ST	Self test
BL	Blink function
FL	Flash function
Br	Brightness control

Figure 6. Control Word Data Definition

$\overline{CE}$	$\overline{WR}$	$\overline{FL}$	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Operation
0	0	1	0	X	X	X	0	X	X	X	X	X	X	X	Clear Disabled
0	1	0	0	X	X	X	1	X	X	X	X	X	X	X	Clear User RAM, Flash RAM and Dispaly

Figure 7. Clear Function

Figure 8. Display Cycle Using Built-in ROM Example

Display message "Showtime." Digit 0 is leftmost—Closest to Pin 1.
Logic levels: 0=Low, 1=High, X=Don't care.

$\overline{\text{RST}}$	$\overline{\text{CE}}$	$\overline{\text{WR}}$	$\overline{\text{RD}}$	$\overline{\text{FL}}$	A4	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Operation	Display
0	0	1	1	1	X	X	X	X	X	X	X	X	X	X	X	X	X	Reset. No Read/Write withhin 3 Clock Cycles	All blank
1	0	0	1	1	1	0	X	X	X	0	0	X	0	0	0	1	1	53% Brightness Selected	All blank
1	0	0	1	1	1	1	0	0	0	0	1	0	1	0	0	1	1	Write "S" to Digit 0	S
1	0	0	1	1	1	1	0	0	1	0	1	0	0	1	0	0	0	Write "H" to Digit 1	SH
1	0	0	1	1	1	1	0	1	0	0	1	0	0	1	1	1	1	Write "O" to Digit 2	SHO
1	0	0	1	1	1	1	0	1	1	0	1	0	1	0	1	1	1	Write "W" to Digit 3	SHOW
1	0	0	1	1	1	1	1	0	0	0	1	0	1	0	1	0	0	Write "T" to Digit 4	SHOWT
1	0	0	1	1	1	1	1	0	1	0	1	0	0	1	0	0	1	Write "I" to Digit 5	SHOWTI
1	0	0	1	1	1	1	1	1	0	0	1	0	0	1	1	0	1	Write "M" to Digit 6	SHOWTIM
1	0	0	1	1	1	1	1	1	1	0	1	0	0	0	1	0	1	Write "E" to Digit 7	SHOWTIME

Figure 9. Displaying User Defined Character Example

Load character "A" into UDC-5 and then display it in digit 2
Logic levels: 0=Low, 1=High, X=Don't care.

$\overline{\text{RST}}$	$\overline{\text{CE}}$	$\overline{\text{WR}}$	$\overline{\text{RD}}$	$\overline{\text{FL}}$	A4	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Operation	Display
0	X	1	1	1	X	X	X	X	X	X	X	X	X	X	X	X	X	Reset. No Read/Write withhin 3 Clock Cycles	All blank
1	0	0	1	1	0	0	X	X	X	X	X	X	X	0	1	0	1	Select UDC-5	All blank
1	0	0	1	1	0	1	0	0	0	X	X	X	0	1	1	1	0	Write into Row 1, UDC-5	All blank
1	0	0	1	1	0	1	0	0	1	X	X	X	1	0	0	0	1	Write into Row 2, UDC-5	All blank
1	0	0	1	1	0	1	0	1	0	X	X	X	1	0	0	0	1	Write into Row 3, UDC-5	All blank
1	0	0	1	1	0	1	0	1	1	X	X	X	1	1	1	1	1	Write into Row 4, UDC-5	All blank
1	0	0	1	1	0	1	1	0	0	X	X	X	1	0	0	0	1	Write into Row 5, UDC-5	All blank
1	0	0	1	1	0	1	1	0	1	X	X	X	1	0	0	0	1	Write into Row 6, UDC-5	All blank
1	0	0	1	1	0	1	1	1	0	X	X	X	1	0	0	0	1	Write into Row 7, UDC-5	All blank
1	0	0	1	1	1	1	0	1	0	1	X	X	X	0	1	0	1	Write UDC-5 into Digit 2	(Digit2) A

ELECTRICAL AND MECHANICAL CONSIDERATIONS

Voltage Transient Suppression

For best results power the display and the components that interface with the display to avoid logic inputs higher than V_{CC}. Additionally, the LEDs may cause transients in the power supply line while they change display states. The common practice is to place a parallel combination of a .01 μF and a 22 μF capacitor between V_{CC} and GND for all display packages.

ESD Protection

The input protection structure of the PDSP188X provides significant protection against ESD damage. It is capable of withstanding discharges greater than 4 KV. Take all the standard precautions, normal for CMOS components. These include properly grounding personnel, tools, tables, and transport carriers that come in contact with unshielded parts. If these conditions are not, or cannot be met, keep the leads of the device shorted together or the parts in anti-static packaging. Refer to Appnote 18 in the current Siemens Optoelectronics Data Book.

Soldering Considerations

The PDSP188X can be hand soldered with SN63 solder using a grounded iron set to 260°C.

Wave soldering is also possible following these conditions: Preheat that does not exceed 93°C on the solder side of the PC board or a package surface temperature of 85°C. Water soluble organic acid flux (except carboxylic acid) or resin-based RMA flux without alcohol can be used.

Direct contact with alcohol or alcohol vapor will cause degradation of the package.

Wave temperature of 245°C ±5°C with a dwell between 1.5 sec. to 3.0 sec. Exposure to the wave should not exceed temperatures above 260°C for five seconds at 0.063" below the seating plane. The packages should not be immersed in the wave.

Post Solder Cleaning Procedures

The least offensive cleaning solution is hot D.I. water (60°C) for less than 15 minutes. Addition of mild saponifiers is acceptable. Do not use commercial diswasher detergents.

For faster cleaning, solvents may be used. Exercise care in choosing solvents as some may chemically attack the polycarbonate package. Maximum exposure should not exceed two minutes at elevated temperatures. Acceptable solvents are TF (trichorotrifluorethane), and IPA.

Some major solvent manufacturers are: Allied Chemical Corportation, Specialty Chemical Division, Morristown, NJ; Baron-Blakeslee, Chicago, IL; Dow Chemical, Midland, MI; E.I. DuPont de Nemours & Co., Wilmington, DE.

For further information refer to Appnote 19 in the current Siemens Optoelectronic Data Book (Display group1 in Table I applies).

An alternative to soldering and cleaning the display modules is to use sockets. Naturally, 28 pin DIP sockets .300" wide with .100" centers work well for single displays. Multiple display assemblies are best handled by longer SIP sockets or DIP sockets when available for uniform package alignment. Socket manufacturers are Aries Electronics, Inc., Frenchtown, NJ; Garry Manufacturing, New Brunswick, NJ; Robinson-Nugent, New Albany, IN; and Samtec Electronic Hardward, New Albany, IN.

For further information refer to Appnote 22 in the current Siemens Optoelectronic Data Book.

Optical Considerations

The .180" high character of the PDSP188XS gives readability up to eight feet. Proper filter selection enhances readability over this distance.

Using filters emphasizes the contrast ratio between a lit LED and the character background. This will increase the discrimination of different characters. The only limitation is cost. Take into consideration the ambient lighting environment for the best cost/benefit ratio for filters.

Incandescent (with almost no green) or fluorescent (with almost no red) lights do not have the flat spectral response of sunlight. Plastic band-pass filters are an inexpensive and effective way to strengthen contrast ratios. The PDSP1880 / 1882 are red/high efficiency red displays and should be matched with long wavelength pass filter in the 570 nm to 590 nm range. The PDSP1883 should be matched with a yellow-green band-pass filter that peaks at 565 nm. For displays of multiple colors, neutral density grey filters offer the best compromise.

Additional contrast enhancement is gained by shading the displays. Plastic band-pass filters with built-in louvers offer the next step up in contrast improvement. Plastic filters can be improved further with anti-reflective coatings to reduce glare. The trade-off is fuzzy characters. Mounting the filters close to the display reduces this effect. Take care not to overheat the plastic filter by allowing for proper air flow.

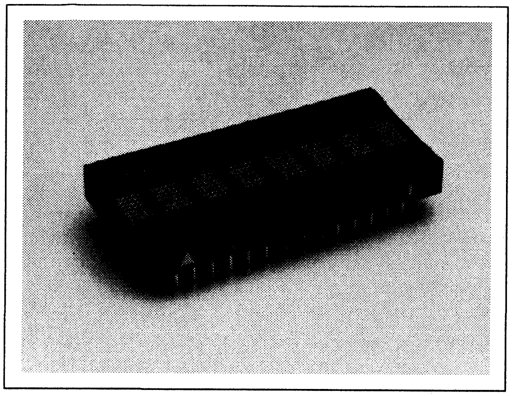
Optimal filter enhancements are gained by using circular polarized, anti-reflective, band-pass filters. The circular polarzing further enhances contrast by reducing the light that travels through the filter and reflects back off the display to less than 1%.

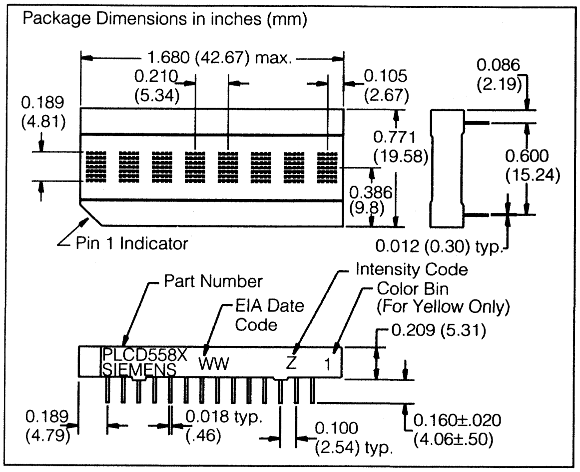
Several filter manufacturers supply quality filter materials. Some of them are: Panelgraphic Corporation, W. Caldwell, NJ; SGL Homalite, Wilmington, DE; 3M Company, Visual Products Division, St. Paul, MN; Polaroid Corporation, Polarizer Division, Cambridge, MA; Marks Polarized Corporation, Deer Park, NY, Hoya Optics, Inc., Fremont, CA.

One last note on mounting filters: recessing displays and bezel assemblies is an inexpensive way to provide a shading effect in overhead lighting situations. Several bezel manufacturers are: R.M.F. Products, Batavia, IL; Nobex Components, Griffith Plastic Corp., Burlingame, CA; Photo Chemical Products of California, Santa Monica, CA; I.E.E.-Atlas, Van Nuys, CA.

SIEMENS

RED PDSP2110
YELLOW PDSP2111
HIGH EFFICIENCY RED PDSP2112
GREEN PDSP2113
HIGH EFFICIENCY GREEN PDSP2114
0.200" 8-Character, 5x7 Dot Matrix Parallel Input Alphanumeric Intelligent Display™





FEATURES

- **Eight 0.200" Dot Matrix Characters in Red, Yellow, High Efficiency Red, Green, High Efficiency Green**
- **Built-in 2 Page, 256 Character ROM. Both pages are Mask Programmable for Custom Fonts**
- **Readable from 8 Feet (2.5 meters)**
- **Built-in Decoders, Multiplexers and Drivers**
- **Wide Viewing Angle, X Axis ±55°, Y Axis ±65°**
- **Programmable Features:**
  - **Individual Flashing Character**
  - **Full Display Blinking**
  - **Multi-Level Dimming and Blanking**
  - **Clear Function**
  - **Lamp Test**
- **Internal or External Clock**
- **End Stackable Dual-In-Line Plastic Package**

Description

The PDSP2110 (Red), PDSP2111 (Yellow), PDSP2112 (High Efficiency Red), PDSP2113 (Green), PDSP2114 (High Efficiency Green), and PDSP2115 (Soft Orange) are eight digit, 5x7 dot matrix, parallel input, alphanumeric Intelligent Displays. The 0.20 inch high digits are packaged in a rugged, high quality, optically transparent, 0.6 inch lead spacing, 28 pin plastic DIP.

The on-board CMOS has a built-in 256 character ROM. Both pages are mask programmable for 256 custom characters.The first page of ROM of a standard product contains 128 characters including ASCII, selected European and Scientific symbols. The second page contains Katakana Japanese characters, more European characters, Avionics, and other graphic symbols.

The PSP211X is designed for standard microprocessor interface techniques, and is fully TTL compatible. The Clock I/O and Clock Select pins allow the user to cascade multiple display modules.

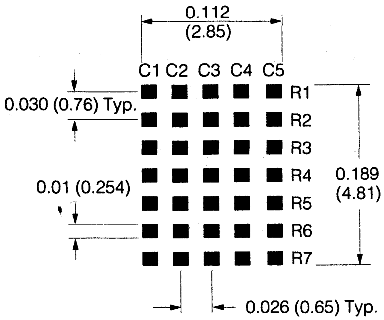
Maximum Rating,

DC Supply Voltage, V_{CC} to GND .... –0.5 to +7.0 Vdc

Input Voltage Levels Relative to Ground .... –0.5 to V_{CC} + 0.5 Vdc
Operating Temperature .... –40°C to +85°C
Storage Temperature .... –40°C to +100°C
Maximum Solder Temperature 0.063" below seating plane, t<5 sec) .... 260°C
Relative Humidity at 85°C 85%

Note: Maximum voltage is with no LEDs illuminated

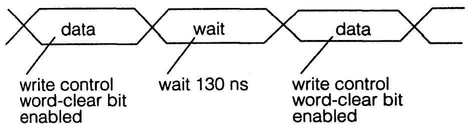
Enlarged Character Font
Dimensions in inches (mm)



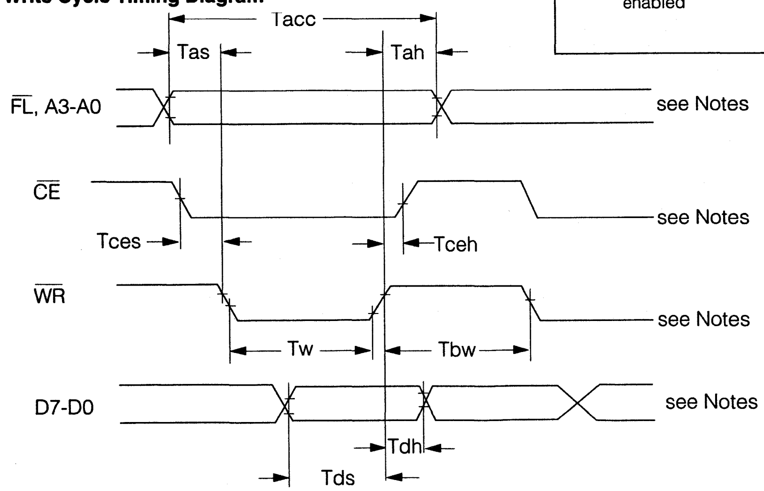
Switching Specifications
(over operating temperature range and V_{CC}=4.5 V)

Symbol	Description	Min.	Units
Tbw	Time Between Writes	30	ns
Tacc(2)	Display Access Time	130	ns
Tas	Address Setup Time	10	ns
Tces	Chip Enable Setup Time	0	ns
Tah	Address Hold Time	20	ns
Tceh	Chip Enable Hold Time	0	ns
Tw	Write Active Time	100	ns
Tds	Data Valid Prior to Rising Edge of Write	50	ns
Tdh	Data Hold Time	20	ns
Trc(1)	Reset Active Time	300	ns
Tclr(3)	Clear Cycle Time	3	µs

1. Wait 300 ns min. after the reset function is turned off.
2. Tacc=Tas + Tw + Tah
3. The Clear Cycle Time may be shortened by writing a second Control Word with the Clear Bit disabled, 160 ns after the first control word that enabled the Clear Bit.



Write Cycle Timing Diagram



*Notes:
1. All input voltages are (VIL=0.8 V, VIH=2.0 V).
2. These wave forms are not edge triggered.
3. Tbw=Tas + Tah

Optical Characteristics at 25°C, V_{CC}=5.0 V at Full Brightness

Red PDSP2110

Description	**Symbol**	**Min.**	**Typ.**	**Units**
Peak Luminous Intensity[(1)]	I_{Vpeak}	70	90	µcd/dot
Peak Wavelength	λ(peak)		660	nm
Dominant Wavelength	λ(d)		639	nm

Yellow PDSP2111

Description	**Symbol**	**Min.**	**Typ.**	**Units**
Peak Luminous Intensity[(1)]	I_{Vpeak}	130	210	µcd/dot
Peak Wavelength	λ(peak)		583	nm
Dominant Wavelength	λ(d)		585	nm

High Efficiency Red PDSP2112

Description	**Symbol**	**Min.**	**Typ.**	**Units**
Peak Luminous Intensity[(1)]	I_{Vpeak}	150	330	µcd/dot
Peak Wavelength	λ(peak)		630	nm
Dominant Wavelength	λ(d)		626	nm

Green PDSP2113

Description	**Symbol**	**Min.**	**Typ.**	**Units**
Peak Luminous Intensity[(1)]	I_{Vpeak}	150	260	µcd/dot
Peak Wavelength	λ(peak)		565	nm
Dominant Wavelength	λ(d)		570	nm

High Efficiency Green PDSP2114

Description	**Symbol**	**Min.**	**Typ.**	**Units**
Peak Luminous Intensity[(1)]	I_{Vpeak}	200	510	µcd/dot
Peak Wavelength	λ(peak)		568	nm
Dominant Wavelength	λ(d)		574	nm

Note

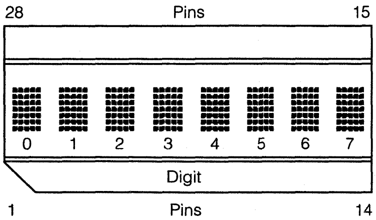
1. Peak luminous intensity is meaaured at T_A=T_J=25°C. No time is allowed for the device to warm up prior to measurement.

Electrical Characteristics at 25°C

Parameters	Limits				Conditions
	Min.	Typ.	Max.	Units	
V_{CC}	4.5	5.0	5.5	V	
I_{CC} Blank		0.5	1.0	mA	V_{CC}=5 V, V_{IN}=5 V
I_{CC} 8 digits(1) 12 dots/character		200	255	mA	V_{CC}=5 V, "V" displayed in all eight digits
I_{CC} 8 digits(1) 20 dots/character		300	370	mA	V_{CC}=5 V, "#" displayed in all eight digits
I_{IP} Current (with pull-up)		11	18	µA	V_{CC}=5 V, V_{IN}=0 V to V_{CC}, ($\overline{WR}$, $\overline{CE}$, $\overline{FL}$, $\overline{RST}$, $\overline{CLKSEL}$)
I, Input Leakage Current (no pull-up)			±1	µA	V_{CC}=5 V,V_{IN}=0 V to V_{CC}, (Clk I/O, A0-A3, D0-D7)
V_{IH} Input Voltage High	2.0		V_{CC} +0.3	V	V_{CC}=4.5 V to 5.5 V
V_{IL} Input Voltage Low	GND –0.3		0.8	V	V_{CC}=4.5 V to 5.5 V
V_{OL} Output Voltage Low (Clock Pin)			0.4	V	V_{CC}=4.5 V to 5.5 V, I_{OL}=1.6 mA
V_{OH} Output Voltage High (Clock Pin)	2.4			V	V_{CC}=4.5 V to 5.5 V, I_{OH}=40mA
I_{OH} Output Current High (Clock I/O)	–0.9			mA	V_{CC}=4.5 V, V_{OH}=–2.4 V
I_{OL} Output Current Low (Clock I/O)	1.6	2		mA	V_{CC}=4.5 V, V_{OL}=–0.4 V
θ_{JC} Thermal Resistance Junction to Case		25		°C/W	
F_{EXT} External Clock Input Frequency (2)	28		81.14	KHz	V_{CC}=5.0 V, $\overline{CLKSEL}$=0
F_{OSC} Internal Clock Output Frequency (2)	28		81.14	KHz	V_{CC}=5.0 V, $\overline{CLKSEL}$=1
Clock I/O Buss Loading			240	pF	
Clock Out Rise Time			500	ns	V_{CC}=4.5 V, V_{OH}=2.4 V
Clock Out Fall Time			500	ns	V_{CC}=4.5 V, V_{OL}=0.4 V
FM, Digit Multiplex Frequency	125	256	362.5	Hz	
Blinking Rate	0.98	2	2.83	Hz	

Note: 1. Average I_{CC} measured at full brightness. Peak I_{CC}=2 X I_{AVG} I_{CC} (# displayed).
2. Internal/external frequency duty factor is 50%.

Top View



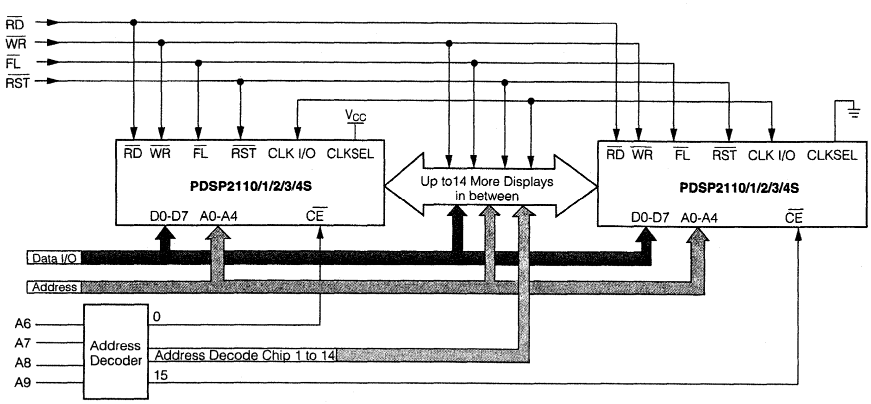
Pin Assignments

Pin	Function	Pin	Function
1	$\overline{\text{RST}}$	28	D7
2	$\overline{\text{FL}}$	27	D6
3	A0	26	D5
4	A1	25	D4
5	A2	24	D3
6	A3	23	D2
7	Substr. bias	22	No Pin
8		21	
9		20	D1
10	No Connect	19	D0
11	$\overline{\text{CLKSEL}}$	18	No Connect
12	CLK I/O	17	CE
13	$\overline{\text{WR}}$	16	GND (logic)
14	V_{CC}	15	GND (supply)

Pin Definitions

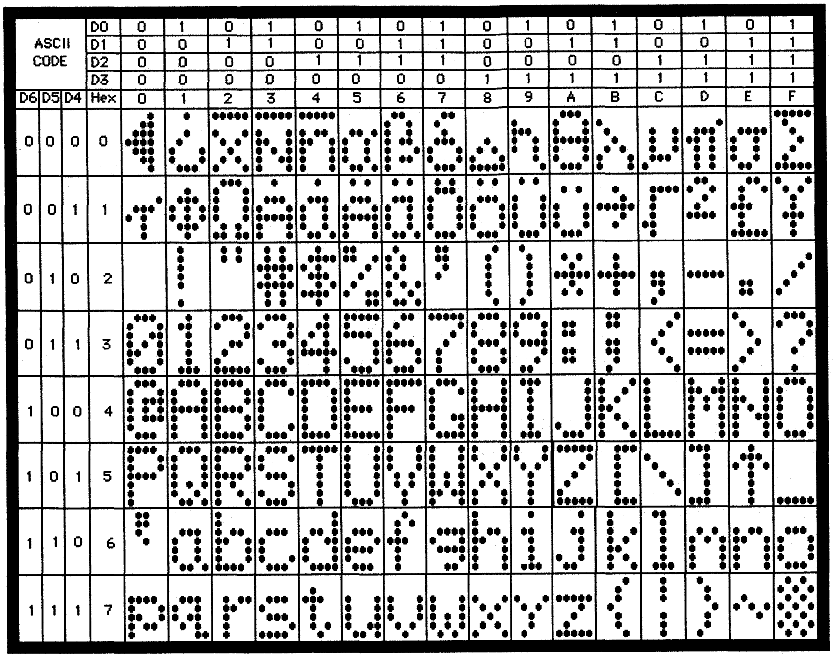
Pin	Function	Definition
1	$\overline{\text{RST}}$	Used for initiallization of a display and sy-chronization of blinking for multiple displays
2	$\overline{\text{FL}}$	Low input accesses the Flash RAM
3	A0	Address input LSB
4	A1	Address input
5	A2	Address input MSB
6	A3	Mode selector
7	Substr. bias	Used to bias IC substrate, must be connected to V_{CC}. Can't be used to supply power to display.
8		
9		
10	No connect	
11	$\overline{\text{CLKSEL}}$	Selects internal/external clock source
12	CLK I/O	Ouputs master clock or inputs externa l clock
13	$\overline{\text{WR}}$	A low will write data into the display if $\overline{\text{CE}}$ is low
14	V_{CC}	Positive power supply input
15	GND	Analog Ground for LED drivers
16	GND	Digital Ground for internal logic
17	$\overline{\text{CE}}$	Enables access to the display
18	No Connect	
19	D0	Data input LSB
20	D1	Data input
21	No pin	
22		
23	D2	Data input
24	D3	
25	D4	
26	D5	
27	D6	
28	D7	Data input MSB, selects ROM, page 1 or 2

Cascading the PDSP211X Displays

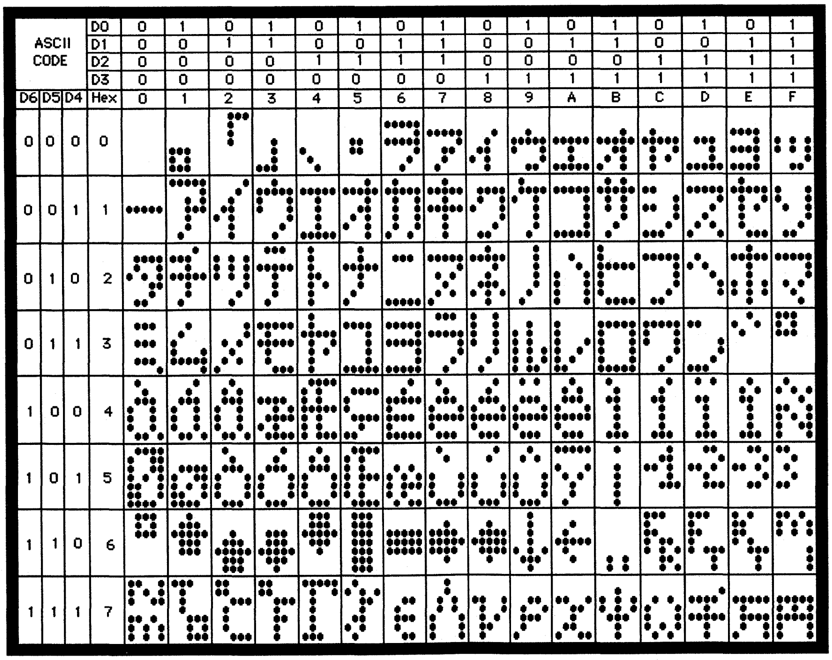


Character Set

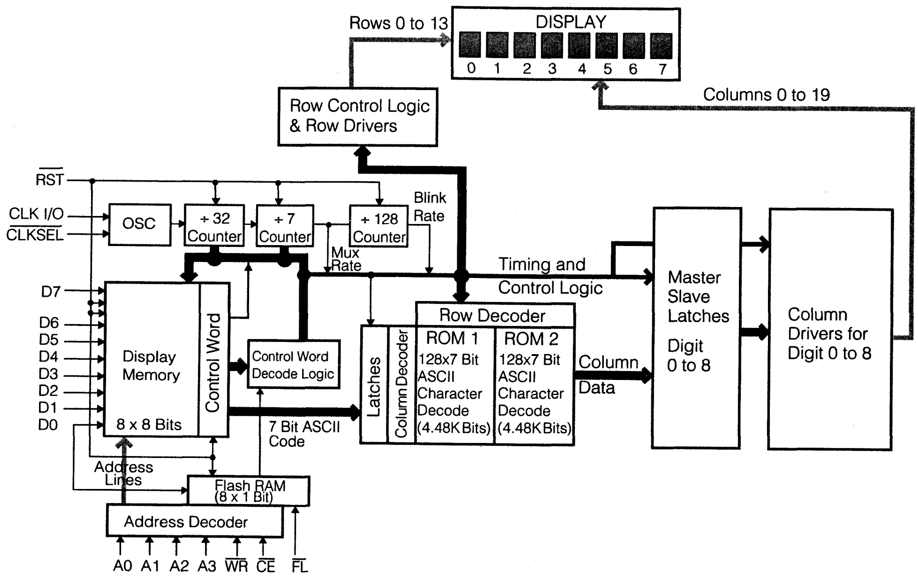
ROM Page 1 (D7 = 0)



ROM Page 2 (D7 = 1)



Block Diagram



Functional Description

The PDSP211X block diagram is comprised of the following major blocks and registers.

Display Memory consists of a 8x8 bit RAM block. Each of the eight 8-bit words holds the 7-bit ASCII data (bit D0-D6). The 8th bit, D7 selects 1 of the 2 pages of character ROM. D7=0 selects Page 1 of the ROM and D7=1 selects Page 2 of the ROM. A3=1.

RST can be used to initialize display operation upon power up or during normal operation. When activated, RST will clear the Flash RAM and Conrol Word Register (00H) and reset the internal counter. All eight display memory locations will be set to 20H to show blanks in all digits.

FL pin enables access to the **Flash RAM**. The **Flash RAM** will set (D0=1)or reset (D0=0) flashing of the character addressed by A0-A2.

The 1x8 bit **Control Word RAM** is loaded with attribute data if A3=0.

The **Control Word Logic** decodes attribute data for proper implementation.

Character ROM is designed for two pages of 128 characters each. Both pages of the ROM are Mask Programmable for custom fonts. On the standard product page one contains standard ASCII, selected European characters and some scientific symbols. Page two contains Katakana characters, more European characters, avionics, and other graphic symbols.

The **Clock Source** could either be the internal oscillator (CLKSEL=1) of the device or an external clock (CLKSEL=0) could be an input from another PDSP211X display for the synchronization of blinking for multiple displays.

The **Display Multiplexer** controls the Row Drivers so no additional logic is required for a display system.

The **Display** has eight digits. Each digit has 35 LEDs clustered into a 5x7 dot matrix.

Theory of Operation

The PDSP211X Programmable display is designed to work with all major microprocessors. Data entry is via an eight bit parallel bus. Three bits of address route the data to the proper digit location in the RAM. Standard control signals like WR and CE allow the data to be written into the display.

D0 – D7 data bits are used for both ASCII and control word data input. A3 acts as the mode selector. If A3=0, D0 – D7 load the RAM with control word data. If A3=1, D0 – D7 will load the RAM with ASCII and page select data. In the later mode, D7=0 selects Page 1 of Character ROM and D7=1 selects Page 2 of Character ROM.

For normal operation FL pin should be held high. When FL is held low, Flash RAM is accessed to set character blinking.

The seven bit ASCII code is decoded by the Character ROM to generate Column data. Twenty columns worth of data is sent out each display cycle and it takes fourteen display cycles to write into eight digits.

The rows are being multiplexed in two sets of seven rows each. The internal timing and control logic synchronizes the turning on of rows and presentation of column data to assure proper display operation.

Data Input Commands

Signals								
$\overline{CE}$	$\overline{WR}$	$\overline{FL}$	A3	A2	A1	A0	Operation	
1	X	X	X	X	X	X	No operation	
X	1	X	X	X	X	X	No operation	
0	0	1	0	0	0	0	Write Control Register	
0	0	1	1	0	0	0	Digit 0 (left)	Write display data to user RAM and Page Select Register
0	0	1	1	0	0	1	Digit 1	
0	0	1	1	0	1	0	Digit 2	
0	0	1	1	0	1	1	Digit 3	
0	0	1	1	1	0	0	Digit 4	
0	0	1	1	1	0	1	Digit 5	D0–D6=ASCII Data
0	1	1	1	1	0	0	Digit 6	D7=0 Select ROM 1
0	0	1	1	1	1	1	Digit 7 (right)	D7=1 Select ROM 2
0	0	0	X	0	0	0	Digit 0 (left)	Write Flash RAM Register
0	0	0	X	0	0	1	Digit 1	
0	0	0	X	0	1	0	Digit 2	
0	0	0	X	1	1	1	Digit 3	
0	0	0	X	1	0	0	Digit 4	
0	0	0	X	1	0	1	Digit 5	D0=0 Flashing Charac. off
0	0	0	X	1	1	0	Digit 6	D0=1 Flashing Charac. on
0	0	0	X	1	1	1	Digit 7 (right)	D1–D7=X

X = Don't care

Power up Sequence

Upon power up display will come on at random. Thus the display should be reset on power-up. The reset will clear the Flash RAM, Control Word Register and reset the internal counter. All the digits will show blanks and display brightness level will be 100%.

Microprocessor Interface

The interface to a micrprocessor is through the 8-bit data bus (D0-D7), the 4-bit address bus (A0-A3) and control lines $\overline{FL}$, $\overline{CE}$ and $\overline{WR}$.

To write data (ASCII/ Control Word) into the display $\overline{CE}$ should be held low, address and data signals stable and $\overline{WR}$ should be brought low.

The Control Word is decoded by the Control Word Decode Logic. Each code has a different function. The code for display brightness changes the duty cycle for the column drivers. The peak LED current stays the same but the average LED current diminishes depending on the intensity level.

The character Flash Enable causes 2 Hz coming out of the counter to be ANDED with column drive signal and makes the column driver to cycle at 2 Hz. Thus the character flashes at 2 Hz.

The display Blink works the same way as the Flash Enable but causes all twenty column drivers to cycle at 2 Hz thereby making all eight digits to blink at 2 Hz.

The Lamp Test causes the column drivers to run at 1/2 duty cycle thus all the LEDs in all eight digits turn on at 50% intensity.

Clear bit clears the character RAM and writes a blank into the display memory. It however does not clear the control word.

ASCII Data or Control Word Data can be written into the display at this point. For multiple display operation, CLK I/O must be properly selected. CLK I/O will output the internal clock if $\overline{CLKSEL}$=1, or will allow input from an external clock if $\overline{CLKSEL}$=0.

Control Word Format

Display Brightness

The display can be programmed to vary between blank, 13%, 20%, 27%, 40%, 53%, 80% and full brightness. Bits D0, D1 and D2 control the display brightness.

$\overline{CE}$	$\overline{WR}$	$\overline{FL}$	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Display Brightness
0	0	1	0	X	X	X	0	0	X	X	X	0	0	0	100% Brightness
0	0	1	0	X	X	X	0	0	X	X	X	0	0	1	80% Brightness
0	0	1	0	X	X	X	0	0	X	X	X	0	1	0	53% Brightness
0	0	1	0	X	X	X	0	0	X	X	X	0	1	1	40% Brightness
0	0	1	0	X	X	X	0	0	X	X	X	1	0	0	27% Brightness
0	0	1	0	X	X	X	0	0	X	X	X	1	0	1	20% Brightness
0	0	1	0	X	X	X	0	0	X	X	X	1	1	0	13% Brightness
0	0	1	0	X	X	X	0	0	X	X	X	1	1	1	Blank Display

X = Don't Care

Flash RAM Function

Character Flash is controlled by $\overline{FL}$ pin, bit D0 and control word bit D3. Combination of $\overline{FL}$ being low, proper digit address and D0 being high will write a flash bit into the Flash RAM Register. In the control word mode when D3 is brought high, the above mentioned character will flash.

Setting the Flash Bit

$\overline{CE}$	$\overline{WR}$	$\overline{FL}$	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Operation
0	0	0	X	A	A	A	X	X	X	X	X	X	X	0	Flash RAM Disabled
0	0	0	X	A	A	A	X	X	X	X	X	X	X	1	Flash RAM Enabled

X = Don't Care   A = Selected Address

Character Flash Control Word

$\overline{CE}$	$\overline{WR}$	$\overline{FL}$	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Operation
0	0	1	0	X	X	X	0	0	X	0	0	B	B	B	Disable Flashing Character
0	0	1	0	X	X	X	0	0	X	0	1	B	B	B	Enable Flashing Character

X = Don't Care   B = Selected Brightness

Display Blinking

Blinking Function is independant of Flash function. When D4 is held high, entire display blinks at 2 Hz.

$\overline{CE}$	$\overline{WR}$	$\overline{FL}$	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Operation
0	0	1	0	X	X	X	0	0	X	0	0	B	B	B	Display Blinking Disabled
0	0	1	0	X	X	X	0	0	X	1	0	B	B	B	Display Blinking Enabled

X = Don't Care   B = Selected Brightness

Lamp Test

Bit D6 when brought high will cause all the LEDs in all eight digits to light up at 53% brightness. Selecting or de-selecting Lamp Test bit has no effect on the display memory.

$\overline{CE}$	$\overline{WR}$	$\overline{FL}$	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Operation
0	0	1	0	X	X	X	0	0	X	0	X	X	X	X	Lamp Test Disabled
0	0	1	0	X	X	X	0	1	X	0	0	X	X	X	Lamp Test Disabled

X = Don't Care

Clear Function

Clear function will clear the display. The Flash RAM will be set to all zeros. An ASCII blank code (20H) will be written into the display memory. The user must wait 3 ms or write a new control word to the display with conrol word bit D7 = 0 to disable clear before writing any data to the display memory, otherwise all new data to the display memory will remain cleared. See Switching Specifications for clear function timing.

$\overline{CE}$	$\overline{WR}$	$\overline{FL}$	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Operation
0	0	1	0	X	X	X	0	X	X	X	X	X	X	X	Clear Disabled
0	0	1	0	X	X	X	1	X	X	X	X	X	X	X	Clear User RAM, Page RAM, Flash RAM and Display

X = Don't Care

Control Word Format

D7	D6	D5	D4	D3	D2	D1	D0
Clear Enable	Lamp Test	Not Used	Blink Enable	Flash Enable	Brightness Control		

D2	D1	D0	Brightness
0	0	0	100%
0	0	1	80%
0	1	0	53%
0	1	1	40%
1	0	0	27%
1	0	1	20%
1	1	0	13%
1	1	1	0% Blank

D3 Flash Enable
0 Disable Flashing Character
1 Enable Flashing Character

D4 Blinking Display
0 Disable Blinking Display
1 Enable Blinking Display

D6 Lamp Test
0 Disable Lamp Test
1 Enable Lamp Test (all dots on at 53% brightness)

D7 Clear Enable
0 Disable Clear
1 Enable Clear (Clear Data RAM, Page RAM, Flash RAM)

Electrical and Mechanical Considerations

Voltage Transient Suppression

For best results power the display and the components that interface with the display to avoid logic inputs higher than VCC. Additionally, the LEDs may cause transients in the power supply line while they change display states. The common practice is to place a parallel combination of a .01 μF and a 22 μF capacitor between V_{CC} and GND for all display packages.

ESD Protection

The input protection structure of the PDSP2110/1/2/3/4 provides significant protection against ESD damage. It is capable of withstanding discharges greater than 2 KV. Take all the standard precautions, normal for CMOS components. These include properly grounding personnel, tools, tables, and transport carriers that come in contact with unshielded parts. If these conditions are not, or cannot be met, keep the leads of the device shorted together or the parts in anti-static packaging.

Soldering Considerations

The PDSP2110/1/2/3/4 can be hand soldered with SN63 solder using a grounded iron set to 260°C.

Wave soldering is also possible following these conditions: Preheat that does not exceed 93°C on the solder side of the PC board or a package surface temperature of 85°C. Water soluble organic acid flux (except carboxylic acid) or resin-based RMA flux without alcohol can be used.

Wave temperature of 245°C ±5°C with a dwell between 1.5 sec. to 3.0 sec. Exposure to the wave should not exceed temperatures above 260°C for five seconds at 0.063" below the seating plane. The packages should not be immersed in the wave.

Post Solder Cleaning Procedures

The least offensive cleaning solution is hot D.I. water (60°C) for less than 15 minutes. Addition of mild saponifiers is acceptable. Do not use commercial diswasher detergents.

For faster cleaning, solvents may be used. Exercise care in choosing solvents as some may chemically attack the nylon package. Maximum exposure should not exceed two minutes at elevated temperatures. Acceptable solvents are TF (trichorotrifluorethane), TA, 111 Trichloroethane, and unheated acetone.(1)

Note: 1. Acceptable commercial solvents are: Basic TF, Arklone, P. Genesolv, D. Genesolv DA, Blaco-Tron TF, Blaco-Tron TA, and Freon TA.

Unacceptable solvents contain alcohol, methnol, methylene chloride, ethanol, TP35, TCM, TMC, TMS+, TE, or TES. Since many commercial mixtures exist, contact a solvent vendor for chemical composition information. Some major solvent manufacturers are: Allied Chemical Corportation, Specialty Chemical Division, Morristown, NJ; Baron-Blakeslee, Chicago, IL; Dow Chemical, Midland, MI; E.I. DuPont de Nemours & Co., Wilmington, DE.

For further information refer to Appnotes 18 and 19 in the current Siemens Optoelectronic Data Book.

An alternative to soldering and cleaning the display modules is to use sockets. Naturally, 28 pin DIP sockets .600" wide with .100" centers work well for single displays.

Multiple display assemblies are best handled by longer SIP sockets or DIP sockets when available for uniform package alignment. Socket manufacturers are Aries Electronics, Inc., Frenchtown, NJ; Garry Manufacturing, New Brunswick, NJ; Robinson-Nugent, New Albany, IN; and Samtec Electronic Hardward, New Albany, IN.

For further information refer to Appnote 22 in the current Siemens Optoelectronic Data Book.

Optical Considerations

The .200" high character of the PDSP211X gives readability up to eight feet. Proper filter selection enhances readability over this distance.

Using filters emphasizes the contrast ratio between a lit LED and the character background. This will increase the discrimination of different characters. The only limitation is cost. Take into consideration the ambient lighting environment for the best cost/benefit ratio for filters.

Incandescent (with almost no green) or fluorescent (with almost no red) lights do not have the flat spectral response of sunlight. Plastic band-pass filters are an inexpensive and effective way to strengthen contrast ratios. The PDSP2110/2112 are red/high efficiency red displays and should be matched with long wavelength pass filter in the 570 nm to 590 nm range. The PDSP2111/2113/2114 should be matched with a yellow-green band-pass filter that peaks at 565 nm. For displays of multiple colors, neutral density grey filters offer the best compromise.

Additional contrast enhancement is gained by shading the displays. Plastic band-pass filters with built-in louvers offer the next step up in contrast improvement. Plastic filters can be improved further with anti-reflective coatings to reduce glare. The trade-off is fuzzy characters. Mounting the filters close to the display reduces this effect. Take care not to overheat the plastic filter by allowing for proper air flow.

Optimal filter enhancements are gained by using circular polarized, anti-reflective, band-pass filters. The circular polarzing further enhances contrast by reducing the light that travels through the filter and reflects back off the display to less than 1%. Selecting the proper intensity of the displays allows 10,000 foot candle sunlight viewability.

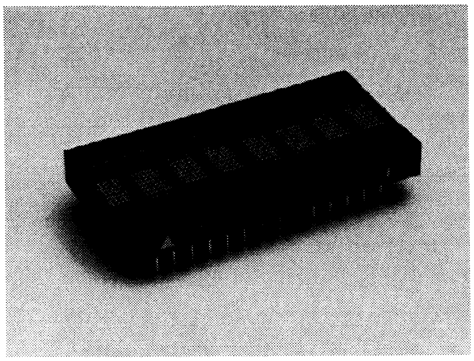
Several filter manufacturers supply quality filter materials. Some of them are: Panelgraphic Corporation, W. Caldwell, NJ; SGL Homalite, Wilmington, DE; 3M Company, Visual Products Division, St. Paul, MN; Polaroid Corporation, Polarizer Division, Cambridge, MA; Marks Polarized Corporation, Deer Park, NY, Hoya Optics, Inc., Fremont, CA.

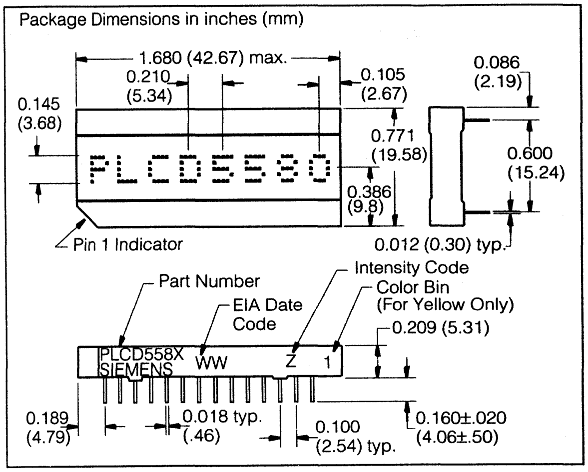
One last note on mounting filters: recessing displays and bezel assemblies is an inexpensive way to provide a shading effect in overhead lighting situations. Several bezel manufacturers are: R.M.F. Products, Batavia, IL; Nobex Components, Griffith Plastic Corp., Burlingame, CA; Photo Chemical Products of California, Santa Monica, CA; I.E.E.-Atlas, Van Nuys, CA.

SIEMENS

RED PLCD5580
YELLOW PLCD5581
HIGH EFFICIENCY RED PLCD5582
GREEN PLCD5583
HIGH EFFICIENCY GREEN PLCD5584

Low Power 0.145" 8-Character, 5x5 Dot Matrix Parallel Input Alphanumeric Intelligent Display™





FEATURES

- Eight 0.145" (3.68 mm) High 5 x 5 Dot Matrix Characters in Red, Yellow, High Efficiency Red, Green, or High Efficiency Green
- Built-in 2 Page, 256 Character ROM. Both Pages Mask Programmable for Custom Fonts
- Built-in Decoders, Multiplexers and Drivers
- Wide Viewing Angle, X Axis ±50°, Y Axis ±65°
- Programmable Features:
  - Individual Flashing Character
  - Full Display Blinking
  - Multi-Level Dimming and Blanking
  - Clear Function
  - Lamp Test
- Internal or External Clock
- End Stackable Dual-In-Line Plastic Package
- Low Power: 20% Less Power Consumption Than 5 X 7 Format

DESCRIPTION

The PLCD5580 (Red), PLCD5581 (Yellow), PLCD5582 (High Efficiency Red), PLCD5583 (Green), and PLCD5584 (High Efficiency Green) are eight digit, 5x5 dot matrix, alphanumeric Programmable Displays. The 0.145 inch high digits are packaged in a rugged, high quality, optically transparent, standard 0.6 inch 28 pin plastic DIP.

The on-board CMOS has a built-in two page, 256 character ROM. Both pages are mask programmable for 256 custom characters. The first page of ROM of the standard product contains 128 characters including ASCII, selected European and Scientific symbols. The second page contains Katakana Japanese characters, more European characters, Avionics, and other graphic symbols.

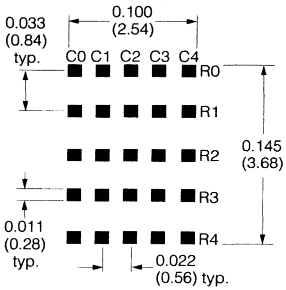
The PLCD558X is designed for standard microprocessor interface techniques and is fully TTL compatible. The Clock I/O and Clock Select pins allow the user to synchronize multiple display modules.

Maximum Rating

DC Supply Voltage .... –0.5 to +7.0 Vdc
Input Voltage Levels Relative
to Ground .... –0.5 to V_{CC}+0.5 Vdc
Operating Temperature .... –40°C to +85°C
Storage Temperature .... –40°C to +100°C
Maximum Solder Temperature 0.063"
below Seating Plane, t<5 sec .... 260°C
Relative Humidity at 85°C 85%

Note: Maximum voltage is with no LEDs illuminated.

Enlarged Character Font

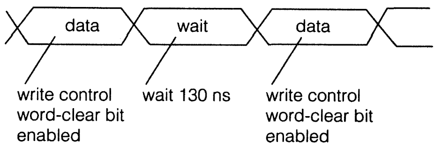


Dimensions in inches (mm)
Tolerance: .XXX=±.010 (.25)

Switching Specifications
(over operating temperature range and V_{CC}=4.5 V).

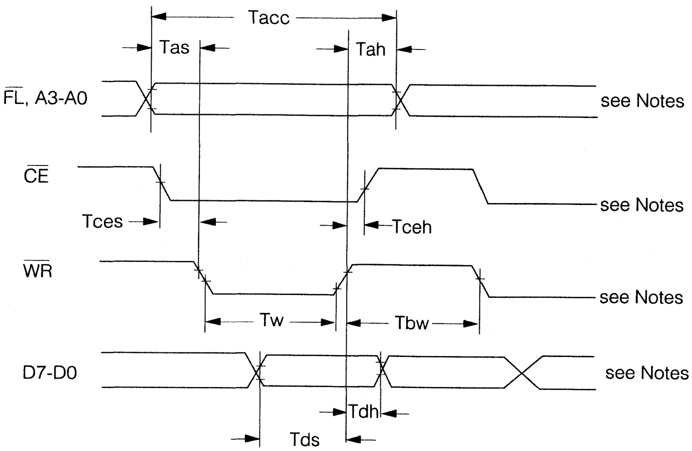
Symbol	Description	Min.	Units
Tbw	Time Between Writes	30	ns
Tacc[(2)]	Display Access Time	130	ns
Tas	Address Setup Time	10	ns
Tces	Chip Enable Hold Time	0	ns
Tah	Address Hold Time	20	ns
Tceh	Chip Enable Hold Time	0	ns
Tw	Write Active Time	100	ns
Tds	Data Valid Prior to Rising Edge of Write	50	ns
Tdh	Data Hold Time	20	ns
Trc[(1)]	Reset Active Time	300	ns
Tclr[(3)]	Clear Cycle Time	3	µs

1. Wait 300 ns min. after the reset function is turned off.
2. Tacc=Tas + Tw + Tah
3. The Clear Cycle Time may be shortened by writing a second Control Word with the Clear Bit disabled, 160 ns after the first control word that enabled the Clear Bit.



The Flash RAM and Character RAM may not be accessed until the Clear Cycle is complete.

Write Cycle Timing Diagram



Notes
1. All input voltages are (V_{IL}=0.8 V, V_{IH}=2.0 V)
2. These wave forms are not edge triggered.
3. Tbw=Tas + Tah

Optical Characteristics at 25°C
V_{CC}=5.0 V at Full Brightness

Red PLCD5580

Description	Symbol	Min.	Typ.	Units
Peak Luminous Intensity(1)	I_{Vpeak}	70	90	µcd/dot
Peak Wavelength	λ(peak)		660	nm
Dominant Wavelength	λ(d)		639	nm

Yellow PLCD5581

Description	Symbol	Min.	Typ.	Units
Peak Luminous Intensity(1)	I_{Vpeak}	130	210	µcd/dot
Peak Wavelength	λ(peak)		583	nm
Dominant Wavelength	λ(d)		585	nm

High Efficiency Red PLCD5582

Description	Symbol	Min.	Typ.	Units
Peak Luminous Intensity(1)	I_{Vpeak}	150	330	µcd/dot
Peak Wavelength	λ(peak)		630	nm
Dominant Wavelength	λ(d)		626	nm

Green PLCD5583

Description	Symbol	Min.	Typ.	Units
Peak Luminous Intensity(1)	I_{Vpeak}	150	260	µcd/dot
Peak Wavelength	λ(peak)		565	nm
Dominant Wavelength	λ(d)		570	nm

High Efficiency Green PLCD5584

Description	Symbol	Min.	Typ.	Units
Peak Luminous Intensity(1)	I_{Vpeak}	200	510	µcd/dot
Peak Wavelength	λ(peak)		568	nm
Dominant Wavelength	λ(d)		574	nm

Note
1. Peak luminous intensity is meaaured at T_A=T_J=25°C. No time is allowed for the device to warm up prior to measurement.

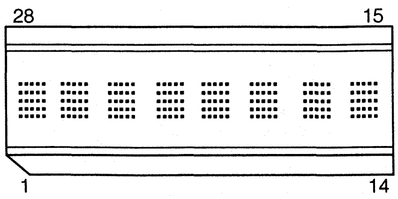
Electrical Characteristics at 25°C

Parameters	Limits				Conditions
	Min.	Typ.	Max.	Units	
V_{CC}	4.5	5.0	5.5	V	
I_{CC} Blank		0.5	1.0	mA	V_{CC}=5 V, V_{IN}=5 V
I_{CC} 8 digits (1), 16 dots/character		240	290	mA	V_{CC}=5 V, "#" displayed in all eight digits
I_{IP} Current (with pull-up)		11	18	µA	V_{CC}=5 V, V_{IN}=0 V to V_{CC}, ($\overline{WR}$, $\overline{CE}$, $\overline{FL}$, $\overline{RST}$, $\overline{ClkSel}$)
I_I Input leakage current (without pull-up)			±1	µA	V_{CC}=5 V, V_{IN}=0 V to V_{CC}, (Clk I/O, A0–A3, D0–D7)
V_{IH} Input Voltage High	2.0		V_{CC} +0.3	V	V_{CC}=4.5 V to 5.5 V
V_{IL} Input Voltage Low	GND –0.3		0.8	V	V_{CC}=4.5 V to 5.5 V
V_{OL} Output Voltage Low (Clock Pin)			0.4	V	V_{CC}=4.5 V to 5.5 V, I_{OL}=1.6 mA
V_{OH} Output Voltage High (Clock Pin)	2.4			V	V_{CC}=4.5 V to 5.5 V, I_{OH}=40 µA
I_{OH} Output Current High (Clock I/O)	–0.9			mA	V_{CC}=4.5 V, V_{OH}=2.4 V
I_{OL} Output Current Low (Clock I/O)	1.6	2		mA	V_{CC}=4.5 V, V_{OL}=0.4 V
θ_{JC} Thermal Resistance, Junction to Case		25		°C/W	
F_{ext} External Clock, Input Frequency(2)	28		81.14	KHz	V_{CC}=5.0 V, $\overline{CLKSEL}$=0
F_{osc} Internal Clock, Output Frequency(2)	28		81.14	KHz	V_{CC}=5.0 V, $\overline{CLKSEL}$=1
Clock I/O Buss Loading			240	pF	
Clock Out Rise Time			500	ns	V_{CC}=4.5 V, V_{OH}=2.4 V
Clock Out Fall Time			500	ns	V_{CC}=4.5 V, V_{OL}=0.4 V
FM, Digit Multiplex Frequency	125	256	362.5	Hz	
Blinking Rate	0.98	2	2.83	Hz	

Notes:

1. Average I_{CC} measured at full brightness. Peak I_{CC}=5/8 x I_{AVG} I_{CC} (# displayed).
2. Internal/external frequency duty factor is 50%.

Top View



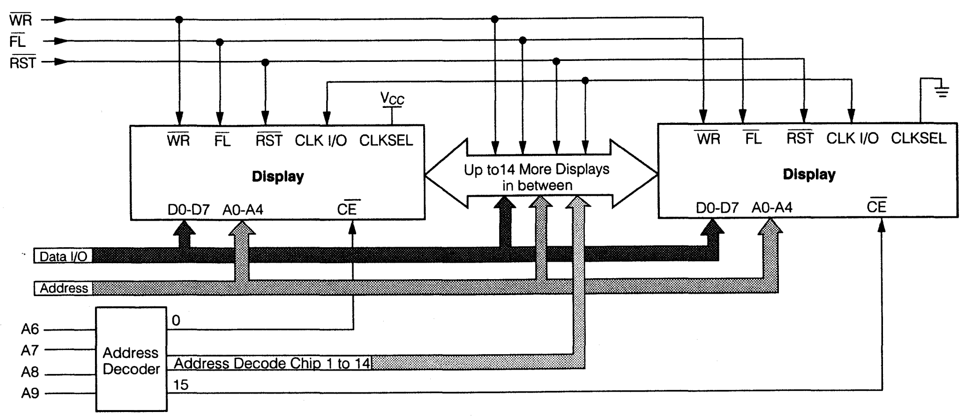
Pin Assignment

Pin	Function	Pin	Function
1	$\overline{RST}$	28	D7
2	$\overline{FL}$	27	D6
3	A0	26	D5
4	A1	25	D4
5	A2	24	D3
6	A3	23	D2
7	Substr. bias	22	No Pin
8	Substr. bias	21	No Pin
9	Substr. bias	20	D1
10	No Connect	19	D0
11	$\overline{CLKSEL}$	18	No Connect
12	CLK I/O	17	$\overline{CE}$
13	$\overline{WR}$	16	GND (logic)
14	V_{CC}	15	GND (supply)

TOP VIEW

Pin	Function	Definition
1	$\overline{RST}$	Used to initialize a display and synchronize blinking for multiple displays
2	$\overline{FL}$	Low input accesses the Flash RAM
3	A0	Address input LSB
4	A1	Address input
5	A2	Address input MSB
6	A3	Mode selector
7	Substr. bias	Optional connection to V_{CC}. Can't be used to supply power to display.
8	Substr. bias	See Definition 7
9	Substr. bias	See Definition 7
10	No connect	
11	$\overline{CLKSEL}$	Selects internal/external clock source
12	CLK I/O	Outputs master clock or inputs external clock
13	$\overline{WR}$	A low will write data into the display if $\overline{CE}$ is low
14	V_{CC}	Positive power supply input
15	GND	Analog Ground for LED drivers
16	GND	Digital Ground for internal drivers
17	$\overline{CE}$	Enables access to the display
18	No connect	
19	D0	Data input LSB
20	D1	Data input
21	No pin	
22	No pin	
23	D2	Data input
24	D3	Data input
25	D4	Data input
26	D5	Data input
27	D6	Data input
28	D7	Data input MSB, selects ROM, page 1 or 2

Cascading the PLCD558X Displays



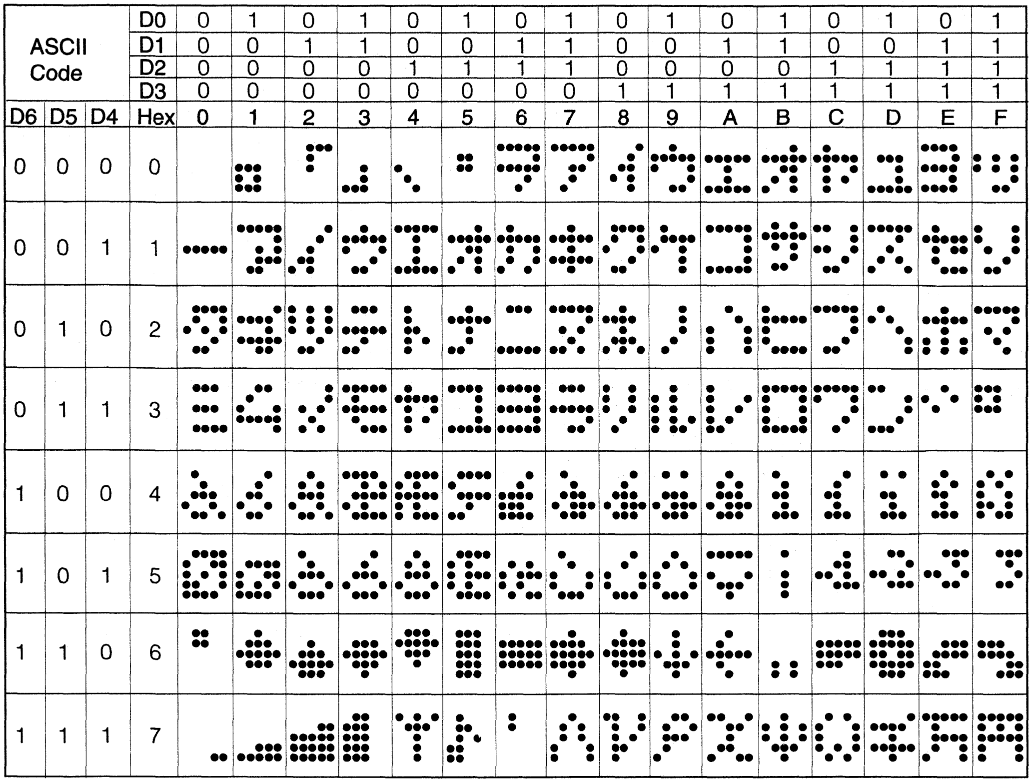
Character Set–ROM Page 1

ASCII Code			D0	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
			D1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
			D2	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
			D3	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
D6	D5	D4	Hex	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	0	0	0																
0	0	1	1																
0	1	0	2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
0	1	1	3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
1	0	0	4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	0	1	5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	↑	_
1	1	0	6	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
1	1	1	7	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	▒

Notes

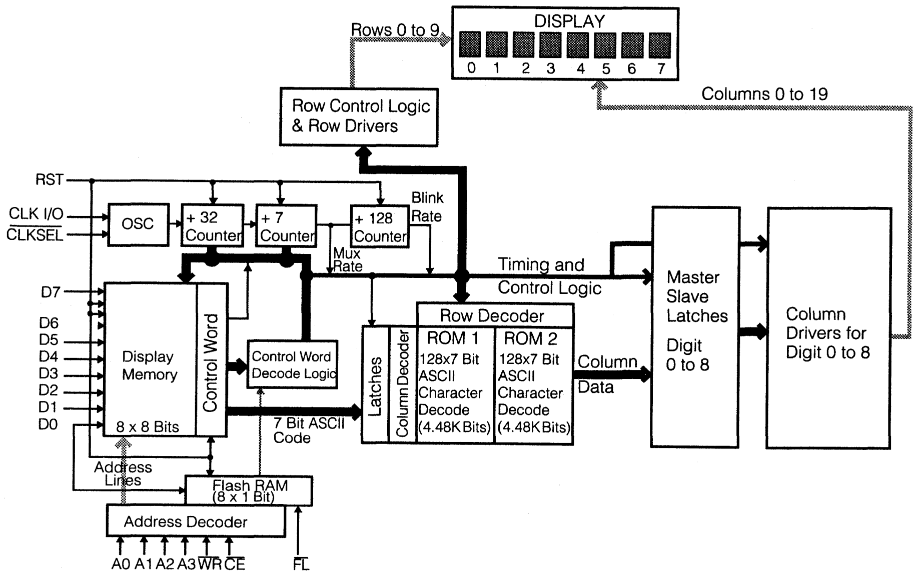
1. D7=0
2. High=1 level. Low=0 level.

Character Set–ROM Page 2



Notes
1. D7=1
2. High=1 level. Low=0 level.

Block Diagram



Functional Description

The PLCD558X block diagram is comprised of the following major blocks and registers.

Display Memory consists of a 8x8 bit RAM block. Each of the eight 8-bit words holds the 7-bit ASCII data (bit D0-D6). The 8th bit, D7 selects 1 of the 2 pages of character ROM. D7=0 selects Page 1 of the ROM and D7=1 selects Page 2 of the ROM. A3=1.

RST can be used to initialize display operation upon power up or during normal operation. When activated, RST will clear the Flash RAM and Control Word Register (00H) and reset the internal counter. All eight display memory locations will be set to 20H to show blanks in all digits.

FL pin enables access to the Flash RAM. The Flash RAM will set (D0=1)or reset (D0=0) flashing of the character addressed by A0–A2.

The 1x8 bit **Control Word RAM** is loaded with attribute data if A3=0.

The **Control Word Logic** decodes attribute data for proper implementation.

Character ROM is designed for two pages of 128 characters each. Both pages of the ROM are Mask Programmable for custom fonts. On the standard product page one contains standard ASCII, selected European characters and some scientific symbols. Page two contains Katakana characters, more European characters, avionics, and other graphic symbols.

The **Clock Source** could either be the internal oscillator (CLKSEL=1) of the device or an external clock (CLKSEL=0) could be an input from another PLCD211X display for the synchronization of blinking for multiple displays.

The **Display Multiplexer** controls the Row Drivers so no additional logic is required for a display system.

The **Display** has eight digits. Each digit has 25 LEDs clustered into a 5x5 dot matrix.

Theory of Operation

The PLCD558X Programmable display is designed to work with all major microprocessors. Data entry is via an eight bit parallel bus. Three bits of address route the data to the proper digit location in the RAM. Standard control signals like WR and CE allow the data to be written into the display.

D0–D7 data bits are used for both ASCII and control word data input. A3 acts as the mode selector. If A3=0, D0–D7 load the RAM with control word data. If A3=1, D0–D7 will load the RAM with ASCII and page select data. In the later mode, D7=0 selects Page 1 of Character ROM and D7=1 selects Page 2 of Character ROM.

For normal operation FL pin should be held high. When FL is held low, Flash RAM is accessed to set character blinking.

The seven bit ASCII code is decoded by the Character ROM to generate Column data. Twenty columns worth of data is sent out each display cycle and it takes fourteen display cycles to write into eight digits.

The rows are being multiplexed in two sets of five rows each. The internal timing and control logic synchronizes the turning on of rows and presentation of column data to assure proper display operation.

Data Input Commands

Signals							Operation	
$\overline{CE}$	$\overline{WR}$	$\overline{FL}$	A3	A2	A1	A0		
1	x	x	x	x	x	x	No operation	
X	1	x	x	x	x	x	No operation	
0	0	1	0	0	0	0	Write Control Register	
0	0	1	1	0	0	0	Digit 0 (left)	Write display data to user RAM and Page Select Register
0	0	1	1	0	0	1	Digit 1	
0	0	1	1	0	1	0	Digit 2	
0	0	1	1	0	1	1	Digit 3	
0	0	1	1	1	0	0	Digit 4	D0–D6=ASCII Data
0	0	1	1	1	0	1	Digit 5	D7=0 Select ROM1
0	0	1	1	1	1	0	Digit 6	D7=1 Select ROM 2
0	0	1	1	1	1	1	Digit 7 (right)	
0	0	0	X	0	0	0	Digit 0 (left)	Write Flash RAM Register
0	0	0	X	0	0	1	Digit 1	
0	0	0	X	0	1	0	Digit 2	
0	0	0	X	1	1	1	Digit 3	
0	0	0	X	1	0	0	Digit 4	D0=0 Flashing Character off
0	0	0	X	1	0	1	Digit 5	D0=1 Flashing Character on
0	0	0	X	1	1	0	Digit 6	D1–D7=X
0	0	0	X	1	1	1	Digit 7 (right)	

X=don't care

Power up Sequence

Upon power up display will come on at random. Thus the display should be reset on power-up. The reset will clear the Flash RAM, Control Word Register and reset the internal counter. All the digits will show blanks and display brightness level will be 100%.

Microprocessor Interface

The interface to a microprocessor is through the 8-bit data bus (D0-D7), the 4-bit address bus (A0–A3) and control lines $\overline{FL}$, $\overline{CE}$ and $\overline{WR}$.

To write data (ASCII/ Control Word) into the display $\overline{CE}$ should be held low, address and data signals stable and $\overline{WR}$ should be brought low.

The Control Word is decoded by the Control Word Decode Logic. Each code has a different function. The code for display brightness changes the duty cycle for the column drivers. The peak LED current stays the same but the average LED current diminishes depending on the intensity level.

The character Flash Enable causes 2 Hz coming out of the counter to be ANDED with column drive signal and makes the column driver to cycle at 2 Hz. Thus the character flashes at 2 Hz.

The display Blink works the same way as the Flash Enable but causes all twenty column drivers to cycle at 2 Hz thereby making all eight digits to blink at 2 Hz.

The Lamp Test causes the column drivers to run at 1/2 duty cycle thus all the LEDs in all eight digits turn on at 50% intensity.

Clear bit clears the character RAM and writes a blank into the display memory. It however does not clear the control word.

ASCII Data or Control Word Data can be written into the display at this point. For multiple display operation, CLK I/O must be properly selected. CLK I/O will output the internal clock if $\overline{CLKSEL}$=1, or will allow input from an external clock if $\overline{CLKSEL}$=0.

Control Word Format

Display Brightness

The display can be programmed to vary between blank, 13%, 20%, 27%, 40%, 53%, 80%, and full brightness. Bits D0, D1 and D2 control the display brightness.

$\overline{CE}$	$\overline{WR}$	$\overline{FL}$	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Display Brightness
0	0	1	0	X	X	X	0	0	X	X	X	0	0	0	100% Brightness
0	0	1	0	X	X	X	0	0	X	X	X	0	0	1	80% Brightness
0	0	1	0	X	X	X	0	0	X	X	X	0	1	0	53% Brightness
0	0	1	0	X	X	X	0	0	X	X	X	0	1	1	40% Brightness
0	0	1	0	X	X	X	0	0	X	X	X	1	0	0	27% Brightness
0	0	1	0	X	X	X	0	0	X	X	X	1	0	1	20% Brightness
0	0	1	0	X	X	X	0	0	X	X	X	1	1	0	13% Brightness
0	0	1	0	X	X	X	0	0	X	X	X	1	1	1	Blank Display

X= Don't care

Flash RAM Function

Character Flash is controlled by $\overline{FL}$ pin, bit D0 and control word bit D3. Combination of $\overline{FL}$ being low, proper digit address and D0 being high will write a flash bit into the Flash RAM Register. In the control word mode when D3 is brought high, the above mentioned character will flash.

Setting the Flash Bit

$\overline{CE}$	$\overline{WR}$	$\overline{FL}$	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Operation
0	0	0	X	A	A	A	X	X	X	X	X	X	X	0	Flash RAM disabled
0	0	0	X	A	A	A	X	X	X	X	X	X	X	1	Flash RAM enabled

X=Don't care A=Selected address

Character Flash Control Word

$\overline{CE}$	$\overline{WR}$	$\overline{FL}$	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Operation
0	0	1	0	X	X	X	0	0	X	0	0	B	B	B	Disable Flashing Char.
0	0	1	0	X	X	X	0	0	X	0	1	B	B	B	Enabled Flashing Char.

X=Don't care B=Selected brightness

Display Blinking

Blinking function is independent of Flash function. When D4 is held high, entire display blinks at 2 Hz.

$\overline{CE}$	$\overline{WR}$	$\overline{FL}$	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Operation
0	0	1	0	X	X	X	0	0	X	0	0	B	B	B	Display Blinking disabled
0	0	1	0	X	X	X	0	0	X	1	0	B	B	B	Display Blinking enabled

X=Don't care B=Selected brightness

Lamp Test

Bit D6 when brought high will cause all the LEDs in all eight digits to light up at 53% brightness. Selecting or de-selecting Lamp Test has no effect on the display memory.

$\overline{CE}$	$\overline{WR}$	$\overline{FL}$	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Operation
0	0	1	0	X	X	X	0	0	X	0	X	X	X	X	Lamp Test disabled
0	0	1	0	X	X	X	0	0	X	0	0	X	X	X	Lamp Test enabled

X=Don't care

Clear Function

Clear function will clear the display. The Flash RAM will be set to all zeros. An ASCII blank code (20H) will be written into the display memory. The user must 3 µs or write a new control word to the display with control word bit D7=0 to disable clear before writing any data to the display memory, otherwise all new data to the display memory will remain cleared. See Switching Specifications for clear function timing.

$\overline{CE}$	$\overline{WR}$	$\overline{FL}$	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Operation
0	0	1	0	X	X	X	0	X	X	X	X	X	X	X	Clear disabled
0	0	1	0	X	X	X	1	X	X	X	X	X	X	X	Clear user RAM, page RAM, flash RAM and display

X=Don't care

Control Word Format

D7	D6	D5	D4	D3	D2	D1	D0
CLEAR ENABLE	LAMP TEST	NOT USED	BLINK ENABLE	FLASH ENABLE	BRIGHTNESS CONTROL		

D2	D1	D0	BRIGHTNESS
0	0	0	100%
0	0	1	80%
0	1	0	53%
0	1	1	40%
1	0	0	27%
1	0	1	20%
1	1	0	13%
1	1	1	0% Blank

D3 FLASH ENABLE
- 0 Disable Flashing Character
- 1 Enable Blinking Character

D4 BLINKING DISPLAY
- 0 Disable Blinking Character
- 1 Enable Blinking Character

D6 LAMP TEST
- 0 Disable Lamp Test
- 1 Enable Lamp Test (all dots on at 53% brightness)

D7 CLEAR ENABLE
- 0 Disable Clear
- 1 Enable Clear (Clear Data RAM, Page RAM, Flash RAM)

Electrical and Mechanical Considerations

Voltage Transient Suppression

For best results power the display and the components that interface with the display to avoid logic inputs higher than V_{CC}. Additionally, the LEDs may cause transients in the power supply line while they change display states. The common practice is to place a parallel combination of a .01 µF and a 22 µF capacitor between V_{CC} and GND for all display packages.

ESD Protection

The input protection structure of the PLCD5580/1/2/3/4 provides significant protection against ESD damage. It is capable of withstanding discharges greater than 2 KV. Take all the standard precautions, normal for CMOS components. These include properly grounding personnel, tools, tables, and transport carriers that come in contact with unshielded parts. If these conditions are not, or cannot be met, keep the leads of the device shorted together or the parts in anti-static packaging.

Soldering Considerations

THE PLCD5580/1/2/3/4 can be hand soldered with SN63 solder using a grounded iron set to 260°C.

Wave soldering is also possible following these conditions: Preheat that does not exceed 93°C on the solder side of the PC board or a package surface temperature of 85°C. Water soluble organic acid flux (except carboxylic acid) or resin-based RMA flux without alcohol can be used.

Wave temperature of 245°C ±5°C with a dwell between 1.5 sec. to 3.0 sec. Exposure to the wave should not exceed temperatures above 260°C for five seconds at 0.063" below the seating plane. The packages should not be immersed in the wave.

Post Solder Cleaning Procedures

The least offensive cleaning solution is hot D.I. water (60°C) for less than 15 minutes. Addition of mild saponifiers is acceptable. Do not use commercial dishwasher detergents.

For faster cleaning, solvents may be used. Exercise care in choosing solvents as some may chemically attack the nylon package. Maximum exposure should not exceed two minutes at elevated temperatures. Acceptable solvents are TF (trichorotrifluorethane), TA, 111 Trichloroethane, and unheated acetone.(1)

Note: 1. Acceptable commercial solvents are: Basic TF, Arklone, P. Genesolv, D. Genesolv DA, Blaco-Tron TF, Blaco-Tron TA, and Freon TA.

Unacceptable solvents contain alcohol, methanol, methylene chloride, ethanol, TP35, TCM, TMC, TMS+, TE, or TES. Since many commercial mixtures exist, contact a solvent vendor for chemical composition information. Some major solvent manufacturers are: Allied Chemical Corporation, Specialty Chemical Division, Morristown, NJ; Baron-Blakeslee, Chicago, IL; Dow Chemical, Midland, MI; E.I. DuPont de Nemours & Co., Wilmington, DE.

For further information refer to Appnotes 18 and 19 in the current Siemens Optoelectronic Data Book.

An alternative to soldering and cleaning the display modules is to use sockets. Naturally, 28 pin DIP sockets .600" wide with .100" centers work well for single displays. Multiple display assemblies are best handled by longer SIP sockets or DIP sockets when available for uniform package alignment. Socket manufacturers are Aries Electronics, Inc., Frenchtown, NJ; Garry Manufacturing, New Brunswick, NJ; Robinson-Nugent, New Albany, IN; and Samtec Electronic Hardward, New Albany, IN.

For further information refer to Appnote 22 in the current Siemens Optoelectronic Data Book.

Optical Considerations

The .200" high character of the PLCD588X gives readability up to eight feet. Proper filter selection enhances readability over this distance.

Using filters emphasizes the contrast ratio between a lit LED and the character background. This will increase the discrimination of different characters. The only limitation is cost. Take into consideration the ambient lighting environment for the best cost/benefit ratio for filters.

Incandescent (with almost no green) or fluorescent (with almost no red) lights do not have the flat spectral response of sunlight. Plastic band-pass filters are an inexpensive and effective way to strengthen contrast ratios. The PLCD5880/5882 are red/high efficiency red displays and should be matched with long wavelength pass filter in the 570 nm to 590 nm range. The PLCD5881/5883/5884 should be matched with a yellow-green band-pass filter that peaks at 565 nm. For displays of multiple colors, neutral density grey filters offer the best compromise.

Additional contrast enhancement is gained by shading the displays. Plastic band-pass filters with built-in louvers offer the next step up in contrast improvement. Plastic filters can be improved further with anti-reflective coatings to reduce glare. The trade-off is fuzzy characters. Mounting the filters close to the display reduces this effect. Take care not to overheat the plastic filter by allowing for proper air flow.

Optimal filter enhancements are gained by using circular polarized, anti-reflective, band-pass filters. The circular polarizing further enhances contrast by reducing the light that travels through the filter and reflects back off the display to less than 1%. Selecting the proper intensity of the displays allows 10,000 foot candle sunlight viewability.

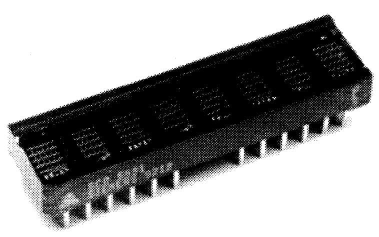
Several filter manufacturers supply quality filter materials. Some of them are: Panelgraphic Corporation, W. Caldwell, NJ; SGL Homalite, Wilmington, DE; 3M Company, Visual Products Division, St. Paul, MN; Polaroid Corporation, Polarizer Division, Cambridge, MA; Marks Polarized Corporation, Deer Park, NY, Hoya Optics, Inc., Fremont, CA.

One last note on mounting filters: recessing displays and bezel assemblies is an inexpensive way to provide a shading effect in overhead lighting situations. Several bezel manufacturers are: R.M.F. Products, Batavia, IL; Nobex Components, Griffith Plastic Corp., Burlingame, CA; Photo Chemical Products of California, Santa Monica, CA; I.E.E.-Atlas, Van Nuys, CA.

SIEMENS

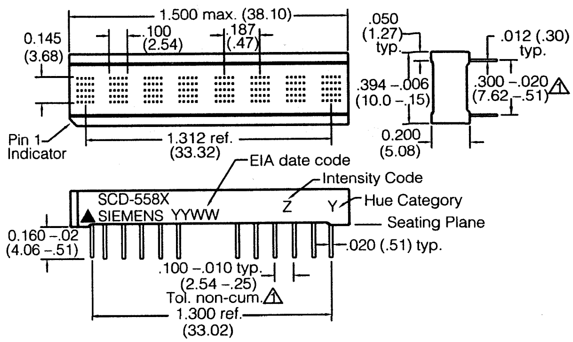
STANDARD RED SCD5580
YELLOW SCD5581
HIGH EFFICIENCY RED SCD5582
GREEN SCD5583
HIGH EFFICIENCY GREEN SCD5584

0.145" 8-Character, 5 x 5 Dot Matrix
Slimline Serial Input Dot Addressable Intelligent Display®



- **Low Profile Package**
  60% Smaller than Industry Standard
  8 Digit Display

Package Dimensions in Inches (mm)



1. Dimension is at Seating Plane
2. Display matrix and pins centered on package outline.
3. Display matrix centered to pin array.
4. Tolerance: .XXX = ±.010 (.25)

FEATURES

- **Eight 0.145" (3.68 mm) 5 X 5 Dot Matrix Characters in Red, Yellow, High Efficiency Red, Green, or High Efficiency Green**
- **Optimum Display Surface Efficiency (display area to package ratio)**
- **Low Power–30% Less Power Dissipation than 5 X 7 Format**
- **High Speed Data Input Rate–5 MHz**
- **ROMless Serial Input, Dot Addressable Display–Ideal for User Defined Characters**
- **Built-in Decoders, Multiplexers and LED Drivers**
- **Readable from 6 Feet (1.8 meters)**
- **Wide Viewing Angle, X Axis ±55°, Y Axis ±65°**
- **Attributes**
  - **200 Bit RAM For User Defined Characters**
  - **Eight Dimming Levels**
  - **Power Down Mode (<250 μW)**
  - **Hardware/Software Clear Function**
  - **Lamp Test**
- **Internal or External Clock**
- **End-Stackable Dual-In-Line Plastic Package**
- **3.3 V Capability**

DESCRIPTION

The SCD5580 (Red), SCD5581 (Yellow), SCD5582 (HER), SCD5583 (Green) and SCD5584 (HEG) are eight digit dot addressable 5 X 5 matrix, Serial Input, Intelligent Displays. The eight 0.145" (3.68 mm) high digits are packaged in a rugged, high quality optically transparent, standard 0.3" pin spacing 28 pin plastic DIP.

The on-board CMOS has a 200 bit RAM, one bit associated with one LED, each to generate User Defined Characters. Due to the reduced LED count, power requirement and heat dissipation are reduced by 30%. Additionally in Power Down Mode quiescent current is <50 μA.

The SCD558X is designed to work with the Serial port of most common microprocessors. The multiplex Clock I/O (CLK I/O) and multiplex Clock Select (CLK SEL) pins offer the user the capability to supply a high speed external multiplex clock. This feature can minimize audio in-band interference for portable communication equipment or eliminate the visual synchroniza-tion effects found in high vibration environments such as avionic equipment.

Maximum Rating

DC Supply Voltage .... –0.5 to +7.0 Vdc
Input Voltage Levels Relative
to Ground .... –0.5 to V_{CC}+0.5 Vdc
Operating Temperature .... –40°C to +85°C
Storage Temperature .... –40°C to +100°C
Maximum Solder Temperature 0.063"
below Seating Plane, t<5 sec .... 260°C
Relative Humidity at 85°C 85%
Maximum Number of LEDs on at 100% Brightness 128
Maximum Power Dissipation .... 1.7 Watts
IC Junction Temperature .... 125°C
ESD (100 pF, 1.5 KΩ) .... 2 KV
Maximum Input Current .... ±100 mA

Switching Specifications

(over operating temperature range and V_{CC}=4.5 V to 5.5 V

Symbol	Description	Min.	Units
T_{RC}	Reset Active Time	600	ns
T_{LDS}	Load Setup Time	50	ns
T_{DS}	Data Setup Time	50	ns
T_{SDCLK}	Clock Period	200	ns
T_{SDCW}	Clock Width	70	ns
T_{LDH}	Load Hold Time	0	ns
T_{DH}	Data Hold Time	25	ns
T_{WR}	Total Write Time	2.2	µs
T_{BL}	Time Between Loads	600	ns

Note:
TSDCW is the minimum time the SDCLK may be low or high. The SDCLK period must be a minimum of 200 ns.

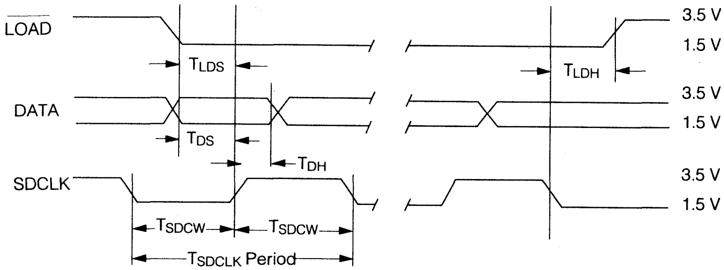


Figure 1a. Data Write Cycle

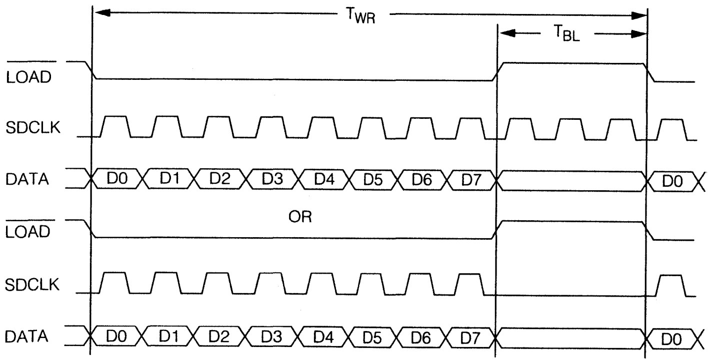


Figure 1b. Instruction Cycle

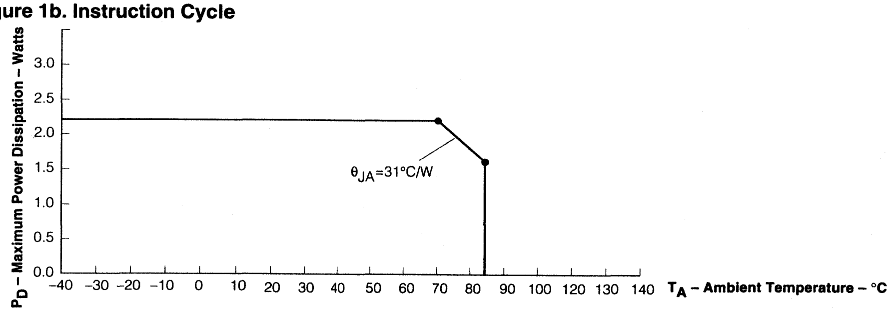


Figure 2. Maximum Power Dissipation Versus Temperature

Electrical Characteristics (over Operating Temperature)

Parameters	Min.	Typ.	Max.	Units	Conditions
V_{CC}	4.5	5.0	5.5	V	
I_{CC} (Pwr Dwn Mode)(4)			50	µA	V_{CC}=5 V, all inputs=0 V or V_{CC}
I_{CC} 8 digits 16 dots/character		200	290	mA	V_{CC}=5 V, "#" displayed in all 8 digits at 100% brightness at 25°C
I_{IL} Input current			-10	µA	V_{CC}=5 V, V_{IN}=0 V (all inputs)
I_{IH} Input current			+10	µA	V_{CC}=V_{IN}=5.0 V (all inputs)
V_{IH}	3.5			V	V_{CC}=4.5 to 5.5 V
V_{IL}			1.5	V	V_{CC}=4.5 to 5.5 V
I_{OH} (Clk I/O)		-8.9		mA	V_{CC}=4.5, V_{OH}=2.4 V
I_{OL} (Clk I/O)		1.6		mA	V_{CC}=4.5, V_{OL}=0.4 V
$\theta_{JC\text{-}PIN}$			31	°C/W	
F_{ext} External Clock Input Frequency	120		347	KHz	V_{CC}=5.0 V, $\overline{CLKSEL}$=0
F_{osc} Internal Clock Input Frequency	120		347	KHz	V_{CC}=5.0 V, $\overline{CLKSEL}$=1
Clock I/O Bus Loading			240	pF	
Clock Out Rise Time			500	ns	V_{CC}=4.5, V_{OH}=2.4 V
Clock Out Fall Time			500	ns	V_{CC}=4.5, V_{OH}=0.4 V
FM, Digit	375	768	1086	Hz	

Notes:
1. Peak current=5⁄3 X I_{CC}.
2. Unused inputs must be tied high.
3. Contact Siemens for 3.3 volt operation.
4. External oscillator must be stopped if being used to maintain an I_{CC}<50 µA.

Input/Output Circuits

Figures 3 and 4 show the input and output resistor/diode networks used for ESD protection and to eliminate substrate latch-up caused by input voltage over/under shoot.

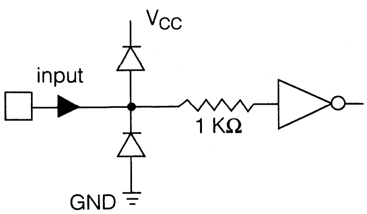


Figure 3. Inputs

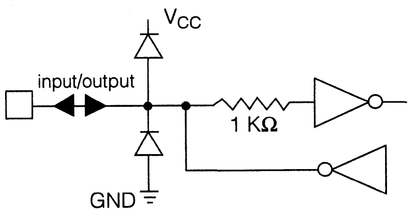


Figure 4. Clock I/O

Optical Characteristics at 25 °C

V_{CC}=5.0 V at 100% Brightness Level, Viewing Angle: X Axis ±55°, Y Axis ±65°

Red SCD5580

Description	Symbol	Min.	Typ.	Units
Luminous Intensity	I_V	36	90	µcd/dot
Peak Wavelength	λ(peak)		665	nm
Dominant Wavelength	λ(d)		639	nm

Yellow SCD5581

Description	Symbol	Min.	Typ.	Units
Luminous Intensity	I_V	124	213	µcd/dot
Peak Wavelength	λ(peak)		583	nm
Dominant Wavelength	λ(d)		584	nm

High Efficiency Red SCD5582

Description	Symbol	Min.	Typ.	Units
Luminous Intensity	I_V	124	265	µcd/dot
Peak Wavelength	λ(peak)		630	nm
Dominant Wavelength	λ(d)		626	nm

Green SCD5583

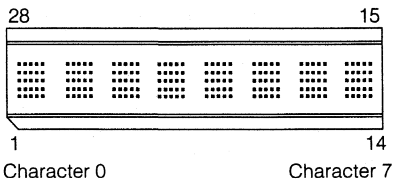
Description	Symbol	Min.	Typ.	Units
Luminous Intensity	I_V	124	221	µcd/dot
Peak Wavelength	λ(peak)		565	nm
Dominant Wavelength	λ(d)		569	nm.

High Efficiency Green SCD5584

Description	Symbol	Min.	Typ.	Units
Luminous Intensity	I_V	124	505	µcd/dot
Peak Wavelength	λ(peak)		568	nm
Dominant Wavelength	λ(d)		572	nm

Notes:
1. Dot to dot intensity matching at 100% brightness is 1.8:1.
2. Displays are binned for hue at 2 nm intervals.
3. Displays within a given intensity category have an intensity matching of 1.5:1 (max.).

Top View



Pin Assignments

Pin	Function	Pin	Function
1	SDCLK	28	GND
2	LOAD	27	DATA
3	NC	26	NC
4	NC	25	NC
5	NC	24	NC
6	V_{CC}	23	V_{CC}
7	NP	22	NP
8	NP	21	NP
9	V_{CC}	20	V_{CC}
10	NC	19	V_{CC}
11	NC	18	NC
12	NC	17	NC
13	RST	16	CLKSEL
14	GND	15	CLK I/O

Display Column and Row Format

	C0	C1	C2	C3	C4
ROW 0	1	1	1	1	1
ROW 1	0	0	1	0	0
ROW 2	0	0	1	0	0
ROW 3	0	0	1	0	0
ROW 4	0	0	1	0	0

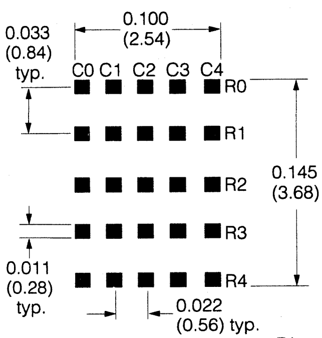
1 = Display Dot "On"
0 = Display Dot "Off"

Column Data Ranges

Row 0 : 00H to 1FH
Row 1 : 20H to 3FH
Row 2 : 40H to 5FH
Row 3 : 60H to 7FH
Row 4 : 80H to 9FH

Pin Definitions

Pin	Function	Definition
1	SDCLK	Used for loading data into the 8-bit serial data register on a low to high transition.
2	LOAD	Low input enables data clocking into 8-bit serial shift register. When LOAD goes high, the contents of 8-bit serial Shift Register will be decoded.
3	NC	No connection
4	NC	No connection
5	NC	No connection
6	V_{CC}	Power supply/heat sink
7	NP	No pin
8	NP	No pin
9	V_{CC}	Power supply/heat sink
10	NC	No connection
11	NC	No connection
12	NC	No connection
13	RST	Asynchronous input, when low will clear the Multiplex Counter, User RAM and Data Register. Control Word Register is set to 100% brightness and the Address Register is set to select Digit 0. The display is blanked.
14	GND	Power supply ground
15	CLK I/O	Outputs master clock or inputs external clock.
16	CLKSEL	H = internal clock, L = external clock
17	NC	No connection
18	NC	No connection
19	V_{CC}	Power supply/heat sink
20	V_{CC}	Power supply/heat sink
21	NP	No pin
22	NP	No pin
23	V_{CC}	Power supply/heat sink
24	NC	No connection
25	NC	No connection
26	NC	No connection
27	DATA	Serial data input
28	GND	Power supply ground



Dimensions in Inches (mm)
TOLERANCE: .XXX = ±.010 (.25)

Figure 5. Dot Matrix Format

Operation of the SCD558X

The SCD558X display consists of a CMOS IC containing control logic and drivers for eight 5 X 5 characters. These components are assembled in a compact (38 mm x 10 mm) plastic package.

Individual LED dot addressablity allows the user great freedom in creating special characters or mini-icons. The User Definable Character Set Examples illustrate 200 different character and symbol possibilities.

The use of a serial data interface provides a highly efficient interconnection between the display and the mother board. The SCD558X requires only 4 lines as compared to 15 for an equivalent 8 character parallel input part.

The on-board CMOS IC is the electronic heart of the display. The IC accepts decoded serial data, which is stored in the internal RAM . Asynchronously the RAM is read by the character multiplexer at a strobe rate that results in a flicker free display. Figure 6 shows the three functional areas of the IC. These include: the input serial data register and control logic, a 200 bits two port RAM, and an internal multiplexer/display driver.

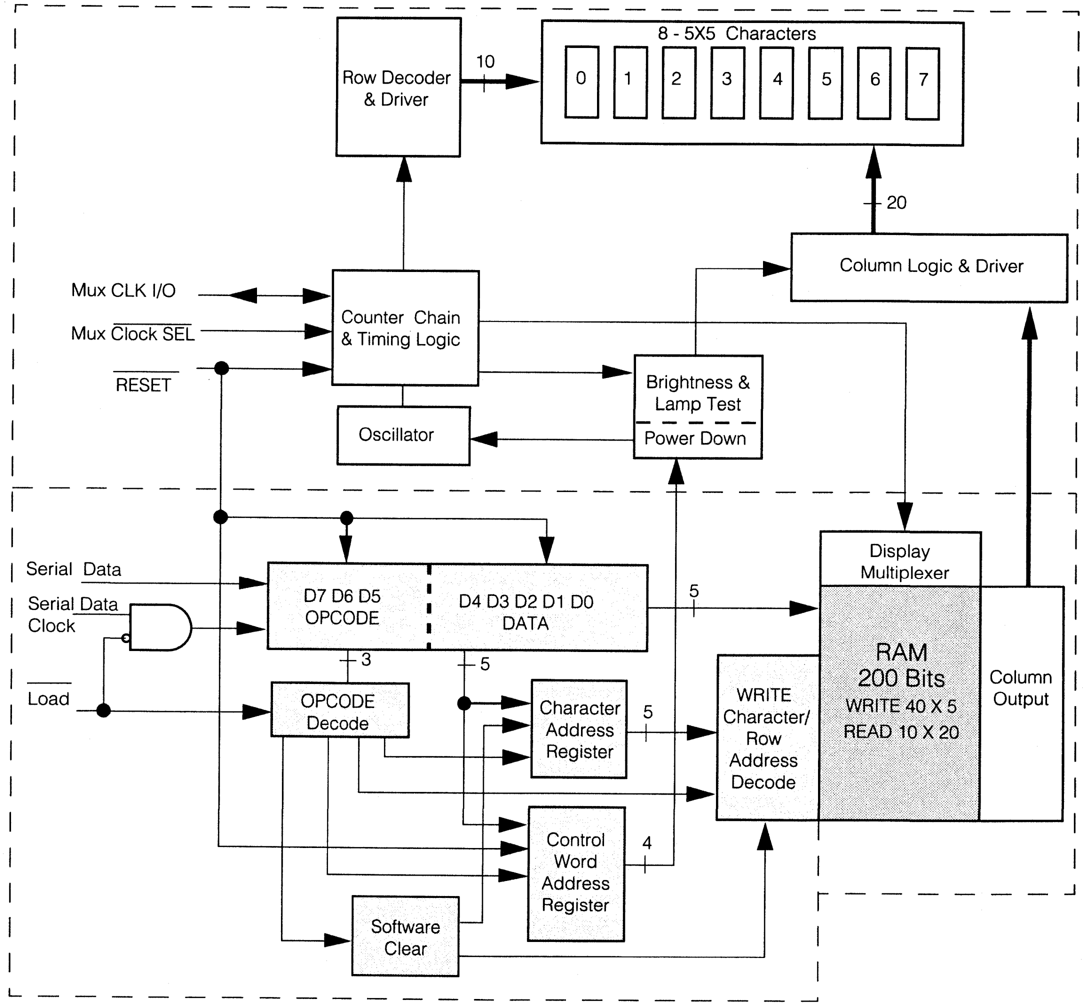


Figure 6. SCD558X Block Diagram

The following explains how to format the serial data to be loaded into the display. The user supplies a string of bit mapped decoded characters. The contents of this string is shown in Figure 7a. Figure 7b shows that each character consist of six 8 bit words. The first word encodes the display character location and the succeeding five bytes are row data. The row data represents the status (On, Off) of individual column LEDs. Figure 7c shows that each that each 8 bit word is formatted to include a three bit Operational Code (OPCODE) defined by bits D7-D5 and five bits (D4-D0) representing Column Data, Character Address, or Control Word Data.

Figure 7d shows the sequence for loading the bytes of data. Bringing the $\overline{LOAD}$ line low enables the serial register to accept data. The shift action occurs on the low to high transition of the serial data clock (SDCLK). The least significant bit (D0) is loaded first. After eight clock pulses the $\overline{LOAD}$ line is brought high. With this transition the OPCODE is decoded. The decoded OPCODE directs D4-D0 to be latched in the Character Address register, stored in the RAM as Column data, or latched in the Control Word register. The control IC requires a minimum 600 ns delay between successive byte loads. As indicated in Figure 7a, a total of 528 bits of data are required to load all eight characters into the display.

The Character Address Register bits, D4-D0 (Table 2), and Row Address Register bits, D7–D5 (Table 3), direct the Column Data bits, D4-D0 (Table 3) to specific RAM location. Table 1 shows the Row Address for the example character "D." Column data is written and read asynchronously from the 200 bit RAM. Once loaded the internal oscillator and character multiplexer reads the data from the RAM. These characters are row strobed with column data as shown in Figures 8 and 9. The character strobe rate is determined by the internal or user supplied external MUX Clock and the IC's ÷ 320 counter.

Table 1. Character "D"

	Opcode D7	D6	D5	Column Data D4 C0	D3 C1	D2 C2	D1 C3	D0 C4	Hex
Row 0	0	0	0	1	1	1	1	0	1E
Row 1	0	0	1	1	0	0	0	1	31
Row 2	0	1	0	1	0	0	0	1	51
Row 3	0	1	1	1	0	0	0	1	71
Row 4	1	0	0	1	1	1	1	0	9E

Intelligent Display Devices

2

Example: Serial Clock = 5 MHz, Clock Period = 200 ns

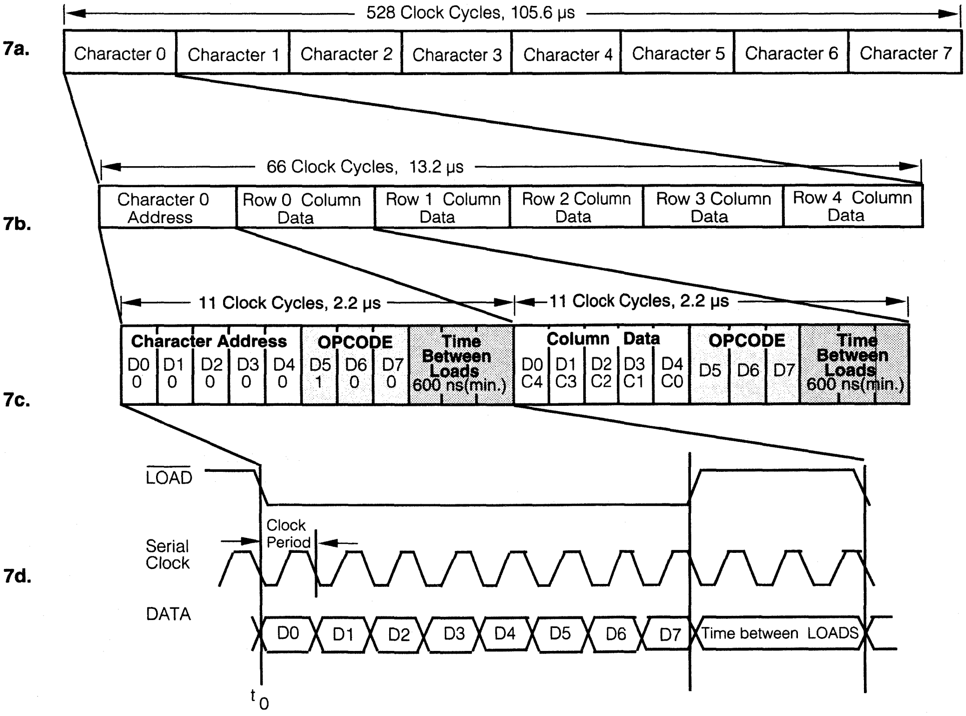


Figure 7a–d. Loading Serial Character Data

The user can activate four Control functions. These include: LED Brightness Level, Lamp Test, IC Power Down, or Display Clear. OPCODEs and five bit words are used to initiate these functions. The OPCODEs and Control Words for the Character Address and Loading Column Data are shown in Tables 2 and 3.

Table 2. Load Character Address

Opcode D7	D6	D5	Character Address D4	D3	D2	D1	D0		Operation Load
1	0	1	0	0	0	0	0	A0	Character 0
1	0	1	0	0	0	0	1	A1	Character 1
1	0	1	0	0	0	1	0	A2	Character 2
1	0	1	0	0	0	1	1	A3	Character 3
1	0	1	0	0	1	0	0	A4	Character 4
1	0	1	0	0	1	0	1	A5	Character 5
1	0	1	0	0	1	1	0	A6	Character 6
1	0	1	0	0	1	1	1	A7	Character 7

Table 3. Load Column Data

Opcode D7	D6	D5	Column Data D4	D3	D2	D1	D0	Operation Load
0	0	0	C0	C1	C2	C3	C4	Row 0
0	0	1	C0	C1	C2	C3	C4	Row 1
0	1	0	C0	C1	C2	C3	C4	Row 2
0	1	1	C0	C1	C2	C3	C4	Row 3
1	0	0	C0	C1	C2	C3	C4	Row 4

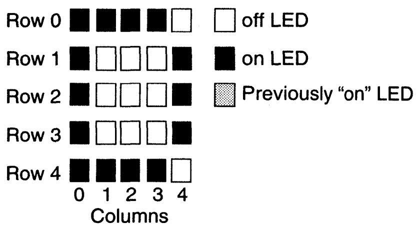


Figure 8. Row and Column Location

The user can select seven specific LED brightness levels, Table 4. These brightness levels (in percentages of full brightness of the display) include: 100% ($F0_{HEX}$), 53% ($F1_{HEX}$), 40% ($F2_{HEX}$), 27% ($F3_{HEX}$), 20% ($F4_{HEX}$), 13% ($F5_{HEX}$), and 6.6% ($F6_{HEX}$). The brightness levels are controlled by changing the duty factor of the row strobe pulse.

Table 4. Display Brightness

Opcode D7	D6	D5	Control Word D4	D3	D2	D1	D0	Hex	Operation Level
1	1	1	1	0	0	0	0	F0	100%
1	1	1	1	0	0	0	1	F1	53%
1	1	1	1	0	0	1	0	F2	40%
1	1	1	1	0	0	1	1	F3	27%
1	1	1	1	0	1	0	0	F4	20%
1	1	1	1	0	1	0	1	F5	13%
1	1	1	1	0	1	1	0	F6	6.6%

The SCD558X offers a unique Display Power Down feature which reduces I_{CC} to less than 50 μA. When FF_{HEX} is loaded, as shown in Table 5, the display is set to 0% brightness and the internal multiplex clock is stopped. When in the Power Down mode data may still be written into the RAM. The display is reactivated by loading a new Brightness Level Control Word into the display.

Table 5. Power Down

Opcode D7	D6	D5	Control Word D4	D3	D2	D1	D0	Hex	Operation
1	1	1	1	1	1	1	1	FF	0% Brightness

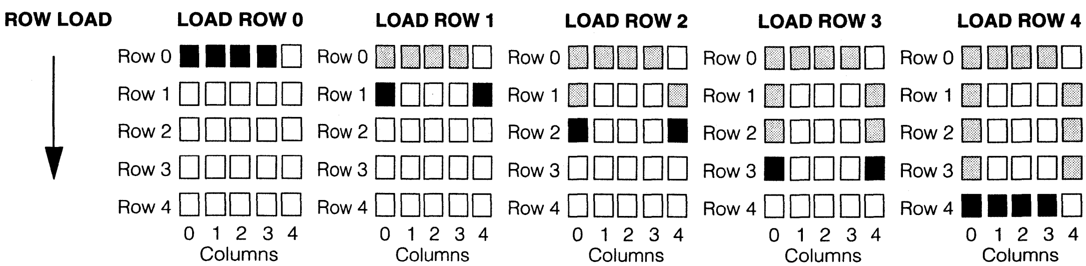


Figure 9. Row Strobing

The Lamp Test is enabled by loading $F8_{HEX}$, Table 6, into the serial shift register. This Control Word sets all of the LEDs to a 53% brightness level. Operation of the Lamp Test has no affect on the RAM and is cleared by loading a Brightness Control Word.

Table 6. Lamp test

Opcode D7	D6	D5	Control Word D4	D3	D2	D1	D0	Hex	Operation
1	1	1	1	0	B	B	B		Lamp Test(OFF)
1	1	1	1	1	0	0	0	F8	Lamp Test (ON)

The Software Clear ($C0_{HEX}$), given in Table 7, clears the Address Register and the RAM. The display is blanked and the Character Address Register will be set to Character 0. The internal counter and the Control Word Register are unaffected. The Software Clear will remain active until the next data input cycle is initiated.

Table 7. Software Clear

Opcode D7	D6	D5	Control Word D4	D3	D2	D1	D0	Hex	Operation
1	1	0	0	0	0	0	0	C0	CLEAR

Multiplexer and Display Driver

The eight characters are row multiplexed with RAM resident column data. The strobe rate is established by the internal or external MUX Clock rate. The MUX Clock frequency is divided by a 320 counter chain. This results in a typical strobe rate of 750Hz. By pulling the Clock SEL line low, the display can be operated from an external MUX Clock. The external clock is attached to the CLK I/O connection (pin 15). The maximum external MUX Clock frequency should be limited to 1 MHz.

An asynchronous hardware Reset (pin 13) is also provided. Bringing this pin low will clear the Character Address Register, Control Word Register, RAM, and blanks the display. This action leaves the display set at Character Address 0, and the Brightness Level set at 100%.

Electrical & Mechanical Considerations

Interconnect Considerations

Optimum product performance can be had when the following electrical and mechanical recommendations are adopted. The SCD558X's IC is constructed in a high speed CMOS process, consequently high speed noise on the SERIAL DATA, SERIAL DATA CLOCK, $\overline{LOAD}$ and $\overline{RESET}$ lines may cause incorrect data to be written into the serial shift register. Adhere to transmission line termination procedures when using fast line drivers and long cables (>10 cm).

Good digital grounds (pins 14, 28) and power supply decoupling (pins 6, 9, 20, 23) will insure that Icc (<400 mA peak) switching currents do not generate localized ground bounce. Therefore it is recommended that each display package use a 0.1 µF and 20 µF capacitor between V_{CC} and ground.

When the internal MUX Clock is being used connect the $\overline{CLKSEL}$ pin to V_{CC}. In those applications where $\overline{RESET}$ will not be connected to the system's reset control, it is recommended that this pin be connected to the center node of a series 0.1, µF and 100 KΩ RC network. Thus upon initial power up the $\overline{RESET}$ will be held low for 10 ms allowing adequate time for the system power supply to stabilize.

The SCD558X allows up to 1.7 W of power dissipation at 70° and 1.29 W power dissipation at a maximum operating temperature of 85°C. Approximately 60% of this power is dissipated by the IC to the PC board via the Vcc connection (pins 6, 9, 20, 23). Optimum thermal reliability is obtained by connecting all of the V_{CC} pins to a common pad located on both sides of the PC board. This technique offers a low thermal resistance for IC to system ambient.

ESD Protection

The input protection structure of the SCD5580/1/2/3/4 provides significant protection against ESD damage. It is capable of withstanding discharges greater than 2 KV. Take all the standard precautions, normal for CMOS components. These include properly grounding personnel, tools, tables, and transport carriers that come in contact with unshielded parts. If these conditions are not, or cannot be met, keep the leads of the device shorted together or the parts in anti-static packaging.

Soldering Considerations

THE SCD5580/1/2/3/4 can be hand soldered with SN63 solder using a grounded iron set to 260°C.

Wave soldering is also possible following these conditions: Preheat that does not exceed 93°C on the solder side of the PC board or a package surface temperature of 85°C. Water soluble organic acid flux (except carboxylic acid) or resin-based RMA flux without alcohol can be used.

Wave temperature of 245°C ±5°C with a dwell between 1.5 sec. to 3.0 sec. Exposure to the wave should not exceed temperatures above 260°C for five seconds at 0.063" below the seating plane. The packages should not be immersed in the wave.

Post Solder Cleaning Procedures

The least offensive cleaning solution is hot D.I. water (60°C) for less than 15 minutes. Addition of mild saponifiers is acceptable. Do not use commercial dishwasher detergents.

For faster cleaning, solvents may be used. Exercise care in choosing solvents as some may chemically attack the nylon package. Maximum exposure should not exceed two minutes at elevated temperatures. Acceptable solvents are TF (trichorotrifluorethane), TA, 111 Trichloroethane, and unheated acetone.[1]

Note: 1. Acceptable commercial solvents are: Basic TF, Arklone, P. Genesolv, D. Genesolv DA, Blaco-Tron TF, Blaco-Tron TA, and Freon TA.

Unacceptable solvents contain alcohol, methanol, methylene chloride, ethanol, TP35, TCM, TMC, TMS+, TE, or TES. Since many commercial mixtures exist, contact a solvent vendor for chemical composition information. Some major solvent manufacturers are: Allied Chemical Corporation, Specialty Chemical Division, Morristown, NJ; Baron-Blakeslee, Chicago, IL; Dow Chemical, Midland, MI; E.I. DuPont de Nemours & Co., Wilmington, DE.

For further information refer to Appnotes 18 and 19 in the current Siemens Optoelectronic Data Book.

An alternative to soldering and cleaning the display modules is to use sockets. Naturally, 28 pin DIP sockets .300" wide with .100" centers work well for single displays. Multiple display assemblies are best handled by longer SIP sockets or DIP sockets when available for uniform package alignment. Socket manufacturers are Aries Electronics, Inc., Frenchtown, NJ; Garry Manufacturing, New Brunswick, NJ; Robinson-Nugent, New Albany, IN; and Samtec Electronic Hardward, New Albany, IN.

For further information refer to Appnote 22 in the current Siemens Optoelectronic Data Book.

Optical Considerations
The 0.145" high character of the SCD558X gives readability up to eight feet. Proper filter selection enhances readability over this distance.

Using filters emphasizes the contrast ratio between a lit LED and the character background. This will increase the discrimination of different characters. The only limitation is cost. Take into consideration the ambient lighting environment for the best cost/benefit ratio for filters.

Incandescent (with almost no green) or fluorescent (with almost no red) lights do not have the flat spectral response of sunlight. Plastic band-pass filters are an inexpensive and effective way to strengthen contrast ratios. The SCD5580/2 are red/high efficiency red displays and should be matched with long wavelength pass filter in the 570 nm to 590 nm range. The SCD5583/4 should be matched with a yellow-green band-pass filter that peaks at 565 nm. For displays of multiple colors, neutral density grey filters offer the best compromise.

Additional contrast enhancement is gained by shading the displays. Plastic band-pass filters with built-in louvers offer the next step up in contrast improvement. Plastic filters can be improved further with anti-reflective coatings to reduce glare. The trade-off is fuzzy characters. Mounting the filters close to the display reduces this effect. Take care not to overheat the plastic filter by allowing for proper air flow.

Optimal filter enhancements are gained by using circular polarized, anti-reflective, band-pass filters. The circular polarizing further enhances contrast by reducing the light that travels through the filter and reflects back off the display to less than 1%.

Several filter manufacturers supply quality filter materials. Some of them are: Panelgraphic Corporation, W. Caldwell, NJ; SGL Homalite, Wilmington, DE; 3M Company, Visual Products Division, St. Paul, MN; Polaroid Corporation, Polarizer Division, Cambridge, MA; Marks Polarized Corporation, Deer Park, NY, Hoya Optics, Inc., Fremont, CA.

One last note on mounting filters: recessing displays and bezel assemblies is an inexpensive way to provide a shading effect in overhead lighting situations. Several Bezel manufacturers are: R.M.F. Products, Batavia, IL; Nobex Components, Griffith Plastic Corp., Burlingame, CA; Photo Chemical Products of California, Santa Monica, CA; I.E.E.–Atlas, Van Nuys, CA.

Microprocessor Interface

The microprocessor interface is through the serial port, SPI port or one out of eight data bits on the eight bit parallel port and also control lines $\overline{SDCLK}$ and $\overline{LOAD}$.

Power Up Sequence

Upon power up display will come on at random. Thus the display should be reset at power-up. The reset will set the Address Register to Digit 0, User RAM is set to 0 (display blank) the Control Word is set to 0 (100% brightness with Lamp Test off) and the internal counters are reset.

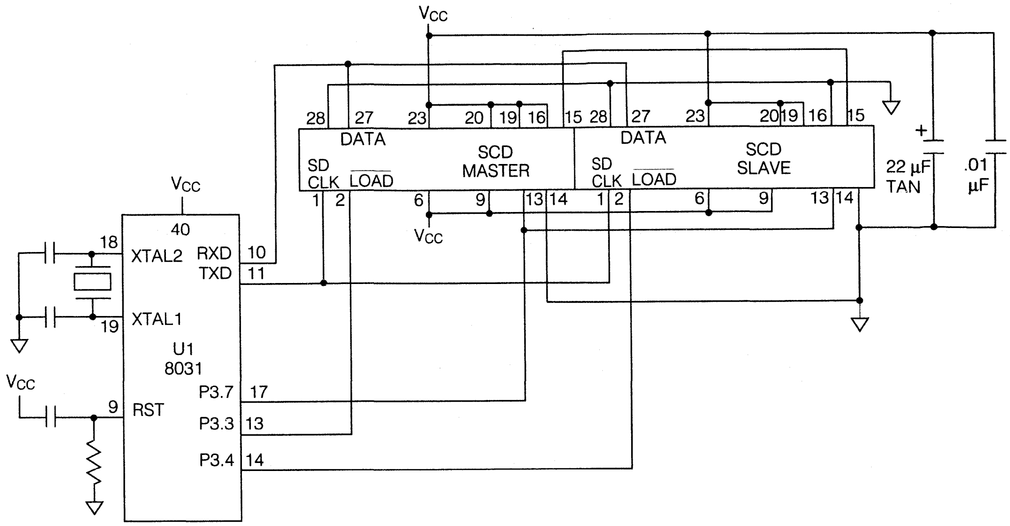


Figure 10. SCD Interface to Siemens/Intel 8031 Microprocessor (using serial port in mode 0)

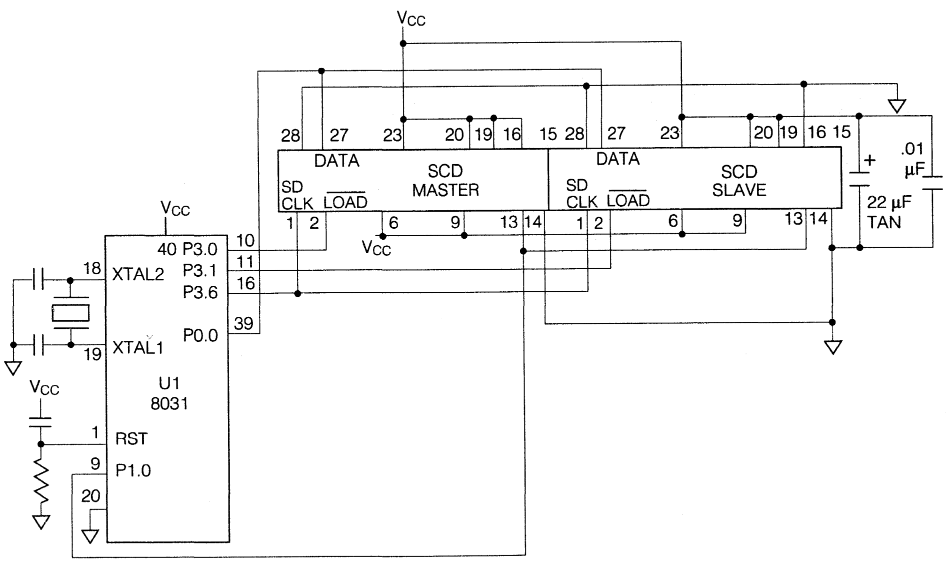


Figure 11. SCD558X Interface with INTEL/Siemens 8031 Microprocessor (using one bit of parallel port as serial input)

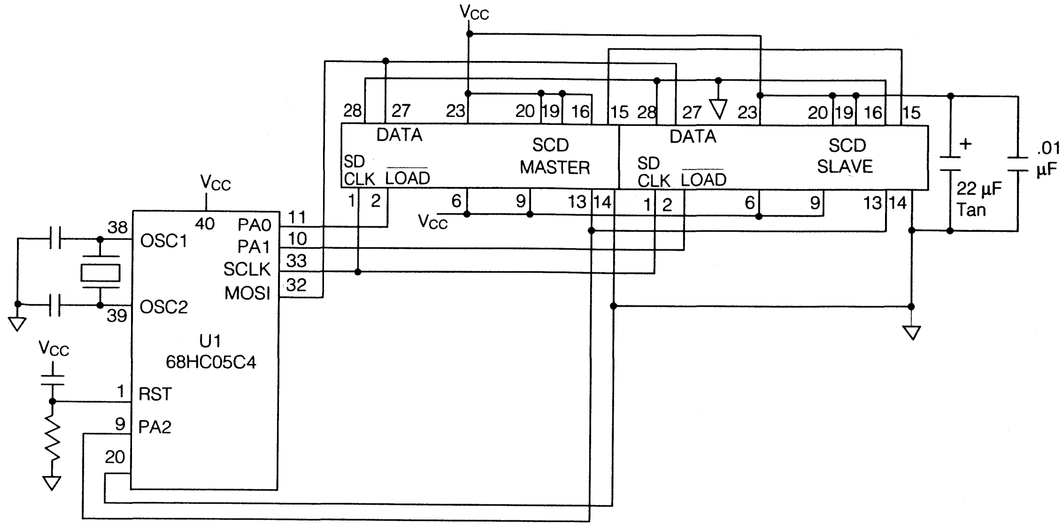


Figure 12. SCD558X Interface with Motorola 68HC05C4 Microprocessor (using SPI Port)

Cascading Multiple Displays

Multiple displays can be cascaded using the $\overline{\text{CLK SEL}}$ and CLK I/O pins as shown below. The display designated as the Master Clock source should have its $\overline{\text{CLK SEL}}$ pin tied high and the slaves should have their $\overline{\text{CLK SEL}}$ pins tied low. All CLK I/O pins should be tied together. One display CLK I/O can drive 15 slave CLK I/Os. Use $\overline{\text{RST}}$ to synchronize all display counters.

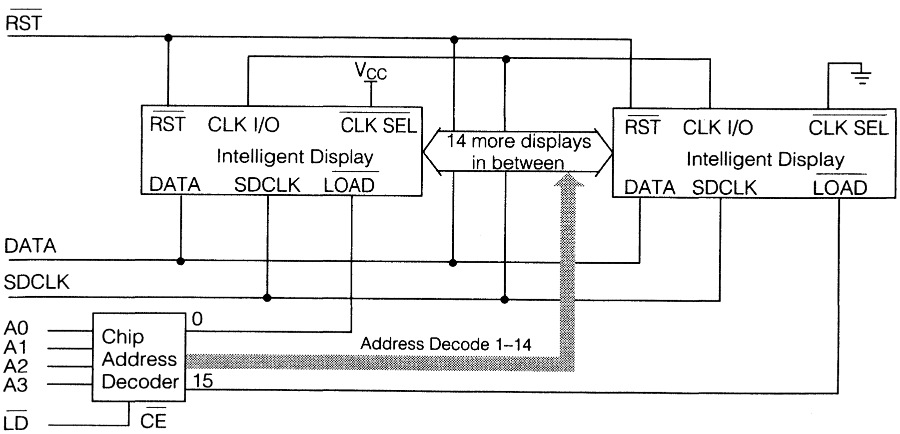


Figure 13. Cascading Multiple Displays

Loading Data Into the Display

Use following procedure to load data into the display:

1. Power up the display.
2. Bring $\overline{RST}$ low (600 ns duration minimum) to clear the Multiplex Counter, Address Register, Control Word Register, User Ram and Data Register. The display will be blank. Display brightness is set to 100%.
3. If a different brightness is desired, load the proper brightness opcode into the Control Word Register.
4. Load the Digit Address into the display.
5. Load display row and column data for the selected digit.
6. Repeat steps 4 and 5 for all digits.

Data Contents for the Word "Displays"

Step	D7	D6	D5	D4	D3	D2	D1	D0	Function
A	1	1	0	0	0	0	0	0	CLEAR
B (optional)	1	1	1	1	0	B	B	B	BRIGHTNESS SELECT
1	1	0	1	0	0	0	0	0	DIGIT D0 SELECT
2	0	0	0	1	1	1	1	0	ROW 0 D0 (D)
3	0	0	1	1	0	0	0	1	ROW 1 D0 (D)
4	0	1	0	1	0	0	0	1	ROW 2 D0 (D)
5	0	1	1	1	0	0	0	1	ROW 3 D0 (D)
6	1	0	0	1	1	1	1	0	ROW 4 D0 (D)
7	1	0	1	0	0	0	0	1	DIGIT DI SELECT
8	0	0	0	0	1	1	1	0	ROW 0 D1 (I)
9	0	0	1	0	0	1	0	0	ROW 1 D1 (I)
10	0	1	0	0	0	1	0	0	ROW 2 D1 (I)
11	0	1	1	0	0	1	0	0	ROW 3 D1 (I)
12	1	0	0	0	1	1	1	0	ROW 4 D1 (I)
13	1	0	1	0	0	0	1	0	DIGIT D2 SELECT
14	0	0	0	0	1	1	1	1	ROW 0 D2 (S)
15	0	0	1	1	0	0	0	0	ROW 1 D2 (S)
16	0	1	0	0	1	1	1	0	ROW 2 D2 (S)
17	0	1	1	0	0	0	0	1	ROW 3 D2 (S)
18	1	0	0	1	1	1	1	0	ROW 4 D2 (S)
19	1	0	1	0	0	0	1	1	DIGIT D3 SELECT
20	0	0	0	1	1	1	1	0	ROW 0 D3 (P)
21	0	0	1	1	0	0	0	1	ROW 1 D3 (P)
22	0	1	0	1	1	1	1	0	ROW 2 D3 (P)
23	0	1	1	1	0	0	0	0	ROW 3 D3 (P)
24	1	0	0	1	0	0	0	0	ROW 4 D3 (P)
25	1	0	1	0	0	1	0	0	DIGIT D4 SELECT
26	0	0	0	1	0	0	0	0	ROW 0 D4 (L)
27	0	0	1	1	0	0	0	0	ROW 1 D4 (L)
28	0	1	0	1	0	0	0	0	ROW 2 D4 (L)
29	0	1	1	1	0	0	0	0	ROW 3 D4 (L)
30	1	0	0	1	1	1	1	1	ROW 4 D4 (L)
31	1	0	1	0	0	1	0	1	DIGIT D5 SELECT
32	0	0	0	0	0	1	0	0	ROW 0 D5 (A)
33	0	0	1	0	1	0	1	0	ROW 1 D5 (A)
34	0	1	0	1	1	1	1	1	ROW 2 D5 (A)
35	0	1	1	1	0	0	0	1	ROW 3 D5 (A)
36	1	0	0	1	0	0	0	1	ROW 4 D5 (A)
37	1	0	1	0	0	1	1	0	DIGIT D6 SELECT
38	0	0	0	1	0	0	0	1	ROW 0 D6 (Y)
39	0	0	1	0	1	0	1	0	ROW 1 D6 (Y)
40	0	1	0	0	0	1	0	0	ROW 2 D6 (Y)
41	0	1	1	0	0	1	0	0	ROW 3 D6 (Y)
42	1	0	0	0	0	1	0	0	ROW 4 D6 (Y)
43	1	0	1	0	0	1	1	1	DIGIT D7 SELECT
44	0	0	0	0	1	1	1	1	ROW 0 D7 (S)
45	0	0	1	1	0	0	0	0	ROW 1 D7 (S)
46	0	1	0	0	1	1	1	0	ROW 2 D7 (S)
47	0	1	1	0	0	0	0	1	ROW 3 D7 (S)
48	1	0	0	1	1	1	1	0	ROW 4 D7 (S)

Note:
If the display is already reset at Power Up, there is no need for Software Clear.

User Definable Character Set Examples*

Upper and Lower Case Alphabets

HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE	
04 2A 5F 71 91		1E 29 4E 69 9E		0F 30 50 70 8F		1E 29 49 69 9E		1F 30 5E 70 9F		1F 30 5E 70 90		0F 30 53 71 8F		11 31 5F 71 91		0E 24 44 64 8E	
01 21 41 71 8E		13 34 58 74 93		10 30 50 70 9F		11 3B 55 71 91		11 39 55 73 91		0E 31 51 71 8E		1E 31 5E 70 90		0C 32 56 72 8D		1E 31 5E 74 92	
0F 30 4E 61 9E		1F 24 44 64 84		11 31 51 71 8E		11 31 51 6A 84		11 31 55 7B 91		11 2A 44 6A 91		11 2A 44 64 84		1F 22 44 68 9F			
00 2E 52 72 8D		10 30 5E 71 9E		00 2F 50 70 8F		01 21 4F 71 8F		00 2E 5F 70 8E		04 2A 48 7C 88		00 2F 50 73 8F		10 30 56 79 91		04 20 4C 64 8E	
00 26 42 72 8C		10 30 56 78 96		0C 24 44 64 8E		00 2A 55 71 91		00 36 59 71 91		00 2E 51 71 8E		00 3E 51 7E 90		00 2F 51 6F 81		00 33 54 78 90	
00 23 44 62 8C		08 3C 48 6A 84		00 32 52 72 8D		00 31 51 6A 84		00 31 55 7B 91		00 32 4C 6C 92		00 31 4A 64 98		00 3E 44 68 9E			

DOT ON = 1
DOT OFF = 0

Numerals and Punctuation

HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE	
0E 33 55 79 8E		04 2C 44 64 8E		1E 21 46 68 9F		1E 21 4E 61 9E		06 2A 5F 62 82		1F 30 5E 61 9E		06 28 5E 71 8E		1F 22 44 68 88		0E 31 4E 71 8E	
0E 31 4F 62 8C		0A 3F 4A 7F 8A		0F 34 4E 65 9E		06 29 5C 68 9F		19 3A 44 6B 93		08 34 4D 72 8D		0C 2C 44 68 80		02 24 44 64 82		08 24 44 64 88	
0C 2C 48 64 80		04 24 5F 64 84		00 2C 4C 64 88		00 20 5F 60 80		00 20 40 6C 8C		01 22 44 68 90		04 24 44 60 84		0A 2A 40 60 80		07 24 44 64 87	
10 28 44 62 81		1C 24 44 64 9C		0E 35 57 70 8E		00 20 40 60 9F		0C 2C 40 6C 8C		0C 20 4C 64 88		02 24 48 64 82		00 3F 40 7F 80		08 24 42 64 88	
0E 31 42 64 88		06 24 48 64 86		0C 24 42 64 8C		04 24 40 64 84		11 2A 44 6E 84		15 2E 5F 6E 95		04 2A 51 60 80		08 35 42 60 80			

DOT ON = 1
DOT OFF = 0

CAUTION: No more than 128 LEDs "on" at one time at 100% brightness.

User Definable Character Set Examples* (continued)

Scientific Notations, etc.

HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE	
06 2E 5E 6E 86		04 24 48 71 8E		1F 20 59 75 93		1F 20 56 79 91		0E 20 4A 64 8A		0D 32 52 72 8D		0C 32 56 71 96		0E 24 4E 71 8E		00 24 4A 71 9F	
10 3C 52 72 81		0E 31 5F 71 8E		10 28 44 6A 91		09 29 49 6E 90		01 2E 54 64 84		04 2E 55 6E 84		0E 31 51 6A 9B		01 2E 5A 6A 8A		0F 32 52 72 8C	
1F 28 44 68 9F		18 24 48 7C 80		1C 28 44 78 80		12 36 5A 67 80		06 21 5A 67 80		07 22 59 66 80		1C 34 5C 60 80		0F 28 48 78 88		04 2E 5F 6E 80	
00 24 4E 7F 8E		00 2E 5F 6E 84		0E 3F 4E 64 80		04 3E 5F 7E 84		04 2F 5F 6F 84		0E 2E 4E 6E 8E		00 3F 5F 7F 80		04 2E 55 64 84		04 24 55 6E 84	
04 22 5F 62 84		04 28 5F 68 84		1F 31 51 71 9F		08 2C 4A 78 98		0A 35 4A 75 8A		15 2A 55 6A 95		1F 35 5F 75 9F		00 3F 5F 7C 80		0E 3F 5B 7F 8E	
00 27 4F 78 9C		00 3C 5F 63 87		00 20 40 60 83		00 20 40 67 9F		00 23 5F 7F 9F		0C 3C 5C 7C 9C		15 2E 44 64 84					

DOT ON = 1
DOT OFF = 0

Foreign Characters

HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE	
1F 21 5F 62 84		1F 21 46 64 88		01 22 46 6A 82		04 3F 51 61 86		00 3F 44 64 9F		02 3F 46 6A 92		08 3F 49 6A 88		1F 21 45 67 8C		02 3F 51 62 8C	
08 3F 49 69 92		04 3F 44 7F 84		0F 29 51 62 8C		08 2F 52 62 82		0F 21 41 61 9F		0A 3F 4A 62 8C		19 21 59 62 9C		0F 29 55 63 8C		01 3E 42 7F 86	
15 35 55 62 8C		0E 20 5F 64 98		08 28 4C 6A 88		04 3F 44 64 98		0E 20 40 60 9F		1F 21 4A 64 9A		04 3E 44 6E 95		04 24 44 68 90		04 22 51 71 91	
10 3F 50 70 8F		1F 21 41 62 8C		0E 20 4E 60 8F		04 28 51 7F 81		01 21 4A 64 8A		1F 28 5F 68 87		1E 22 42 62 9F		1F 21 5F 61 9F		0E 20 5F 61 8E	
12 32 52 64 88		04 34 54 75 96		1E 25 4F 74 8F		0F 34 5F 74 97		0F 30 4F 64 98		0F 33 55 79 9E		0F 34 57 74 8F		00 2A 5F 74 8B		08 24 4E 72 8F	
0A 2E 51 7F 91		02 24 4C 64 8E		04 2A 4E 71 8E		0A 34 52 7A 96		08 24 51 71 8E		02 24 51 71 8E		04 2A 51 71 8E					

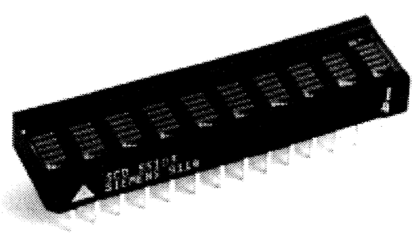
DOT ON = 1
DOT OFF = 0

* CAUTION: No more than 128 LEDs “on” at one time at 100% brightness.

SIEMENS

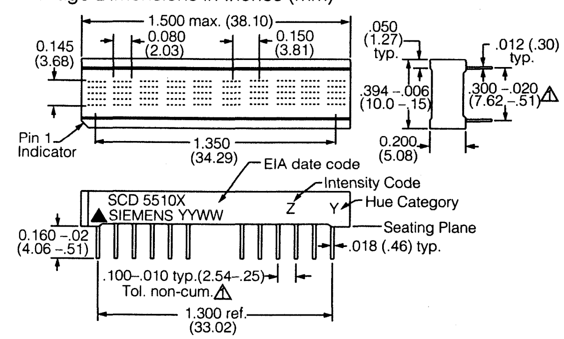
STANDARD RED SCD55100
YELLOW SCD55101
HIGH EFFICIENCY RED SCD55102
GREEN SCD55103
HIGH EFFICIENCY GREEN SCD55104

0.145" 10-Character, 5 x 5 Dot Matrix
Slimline Serial Input Dot Addressable Intelligent Display®



- **Low Profile Package**
  60% Smaller than Industry Standard
  10 Digit Display

Package Dimensions in Inches (mm)



(2.54 –.25)

1. Dimension at Seating Plane.
2. Display matrix and pins centered on package outline.
3. Display matrix centered to pin array.
4. Tolerance: .XXX = ±.010 (.25)

FEATURES

- **Ten 0.145" (3.68 mm) 5 X 5 Dot Matrix Characters in Red, Yellow, High Efficiency Red, Green, or High Efficiency Green**
- **Optimum Display Surface Efficiency (display area to package ratio)**
- **Low Power–30% Less Power Dissipation than 5 X 7 Format**
- **High Speed Data Input Rate–5 MHz**
- **ROMless Serial Input, Dot Addressable Display–Ideal for User Defined Characters**
- **Built-in Decoders, Multiplexers and LED Drivers**
- **Readable from 6 Feet (1.8 meters)**
- **Wide Viewing Angle, X Axis ±55°, Y Axis ±65°**
- **Attributes**
  - **250 Bit RAM For User Defined Characters**
  - **Eight Dimming Levels**
  - **Power Down Mode (<250 μW)**
  - **Hardware/Software Clear Function**
  - **Lamp Test**
- **Internal or External Clock**
- **End-Stackable Dual-In-Line Plastic Package**
- **3.3 V Capability**

DESCRIPTION

The SCD55100 (Red), SCD55101 (Yellow), SCD55102 (HER), SCD55103 (Green) and SCD55104 (HEG) are ten digit dot addressable 5 X 5 matrix, Serial Input, Intelligent Displays. The ten 0.145" (3.68mm) high digits are packaged in a rugged, high quality optically transparent, standard 0.3" pin spacing 28 pin plastic DIP.

The on-board CMOS has a 250 bit RAM, one bit associated with one LED, each to generate User Defined Characters. Due to the reduced LED count, power requirement and heat dissipation are reduced by 30%. Additionally in Power Down Mode quiescent current is <50 μA.

The SCD5510X is designed to work with the Serial port of most common microprocessors. The multiplex Clock I/O (CLK I/O) and multiplex Clock Select (CLK SEL) pins offer the user the capability to supply a high speed external multiplex clock. This feature can minimize audio in-band interference for portable communication equipment or eliminate the visual synchronization effects found in high vibration environments such as avionic equipment.

Maximum Rating

DC Supply Voltage .... –0.5 to +7.0 Vdc
Input Voltage Levels Relative
to Ground .... –0.5 to V_{CC}+0.5 Vdc
Operating Temperature .... –40°C to +85°C
Storage Temperature .... –40°C to +100°C
Maximum Solder Temperature 0.063"
below Seating Plane, t<5sec .... 260°C
Relative Humidity at 85°C 85%
Maximum Number of LEDs on at 100% Brightness....... 160
Maximum Power Dissipation .... 1.7 Watts
IC Junction Temperature .... 125°C
ESD (100 pF, 1.5 KΩ) .... 2 KV
Maximum Input Current .... ±100 mA

Switching Specifications

(over operating temperature range and V_{CC}=4.5 V to 5.5 V

Symbol	Description	Min.	Units
T_{RC}	Reset Active Time	600	ns
T_{LDS}	Load Setup Time	50	ns
T_{DS}	Data Setup Time	50	ns
T_{SDCLK}	Clock Period	200	ns
T_{SDCW}	Clock Width	70	ns
T_{LDH}	Load Hold Time	0	ns
T_{DH}	Data Hold Time	25	ns
T_{WR}	Total Write Time	2.2	µs
T_{BL}	Time Between Loads	600	ns

Note:
TSDCW is the minimum time the SDCLK may be low or high. The SDCLK period must be a minimum of 200 ns.

Intelligent Display Devices

2

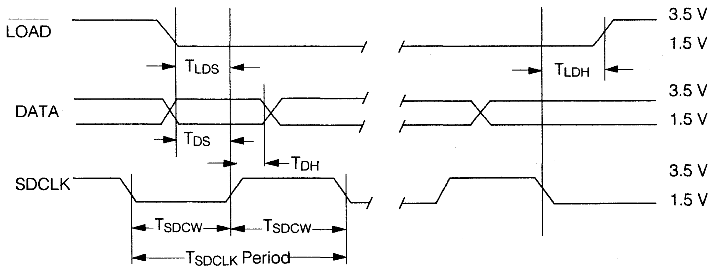


Figure 1a. Data Write Cycle

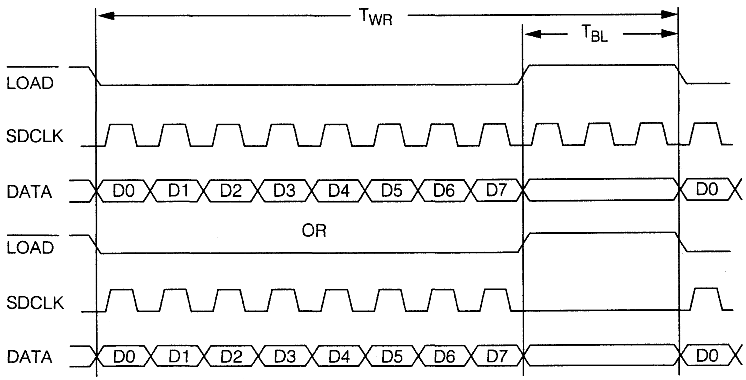


Figure 1b. Instruction Cycle

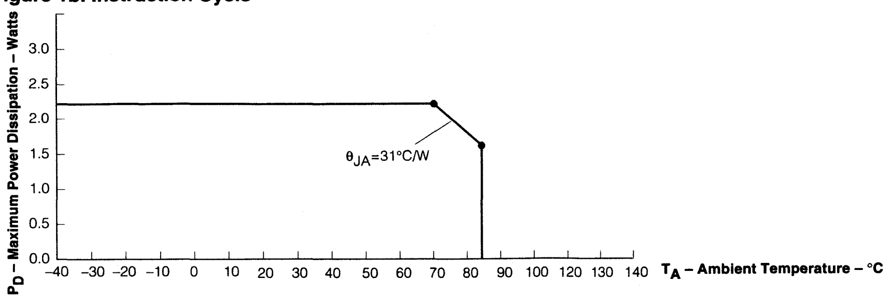


Figure 2. Maximum Power Dissipation Versus Temperature

Electrical Characteristics (over Operating Temperature)

Parameters	Min.	Typ.	Max.	Units	Conditions
V_{CC}	4.5	5.0	5.5	V	
I_{CC} (Pwr Dwn Mode)(4)		50		µA	V_{CC}=5 V, all inputs=0 V or V_{CC}
I_{CC} 10 digits 16 dots/character		250	365	mA	V_{CC}=5 V, "#" displayed in all 10 digits at 100% brightness at 25°C
I_{IL} Input current			-10	µA	V_{CC}=5 V, V_{IN}=0 V (all inputs)
I_{IH} Input current			+10	µA	V_{CC}=V_{IN}=5.0 V (all inputs)
V_{IH}	3.5			V	V_{CC}=4.5 to 5.5 V
V_{IL}			1.5	V	V_{CC}=4.5 to 5.5 V
I_{OH} (Clk I/O)		-8.9		mA	V_{CC}=4.5, V_{OH}=2.4 V
I_{OL} (Clk I/O)		1.6		mA	V_{CC}=4.5, V_{OL}=0.4 V
θ_{JA}			31	°C/W	
F_{ext} External Clock Input Frequency	120		347	KHz	V_{CC}=5.0 V, $\overline{CLKSEL}$=0
F_{osc} Internal Clock Input Frequency	120		347	KHz	V_{CC}=5.0 V, $\overline{CLKSEL}$ =1
Clock I/O Bus Loading			240	pF	
Clock Out Rise Time			500	ns	V_{CC}=4.5, V_{OH}=2.4 V
Clock Out Fall Time			500	ns	V_{CC}=4.5, V_{OH}=0.4 V
FM, Digit	375	768	1086	Hz	

Notes:
1. Peak current=5⁄3 X I_{CC}.
2. Unused inputs must be tied high.
3. Contact Siemens for 3.3 volt operation.
4. External oscillator must be stopped if being used to maintain an I_{CC}<50 µA.

Input/Output Circuits

Figures 3 and 4 show the input and output resistor/diode networks used for ESD protection and to eliminate substrate latch-up caused by input voltage over/under shoot.

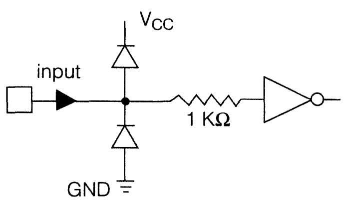


Figure 3. Inputs

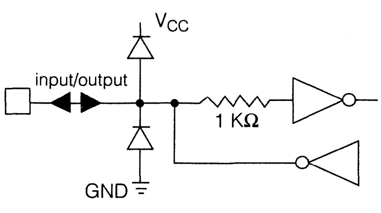


Figure 4. Clock I/O

Optical Characteristics at 25 °C

V_{CC}=5.0 V at 100% Brightness Level, Viewing Angle: X Axis ±55°, Y Axis ±65°

Red SCD55100

Description	Symbol	Min.	Typ.	Units
Luminous Intensity	I_V	36	78	µcd/dot
Peak Wavelength	λ(peak)		665	nm
Dominant Wavelength	λ(d)		639	nm

Yellow SCD55101

Description	Symbol	Min.	Typ.	Units
Luminous Intensity	I_V	124	208	µcd/dot
Peak Wavelength	λ(peak)		583	nm
Dominant Wavelength	λ(d)		584	nm

High Efficiency Red SCD55102

Description	Symbol	Min.	Typ.	Units
Luminous Intensity	I_V	124	237	µcd/dot
Peak Wavelength	λ(peak)		630	nm
Dominant Wavelength	λ(d)		626	nm

Green SCD55103

Description	Symbol	Min.	Typ.	Units
Luminous Intensity	I_V	124	238	µcd/dot
Peak Wavelength	λ(peak)		565	nm
Dominant Wavelength	λ(d)		569	nm.

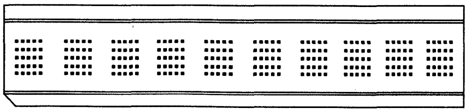
High Efficiency Green SCD55104

Description	Symbol	Min.	Typ.	Units
Luminous Intensity	I_V	124	500	µcd/dot
Peak Wavelength	λ(peak)		568	nm
Dominant Wavelength	λ(d)		572	nm

Notes:
1. Dot to dot intensity matching at 100% brightness is 1.8:1.
2. Displays are binned for hue at 2 nm intervals.
3. Displays within a given intensity category have an intensity matching of 1.5:1 (max.).

Top View

28 15



1 14

Character 0 Character 9

Pin Assignments

Pin	Function	Pin	Function
1	SDCLK	28	GND
2	$\overline{LOAD}$	27	DATA
3	NC	26	NC
4	NC	25	NC
5	NC	24	NC
6	V_{CC}	23	V_{CC}
7	NP	22	NP
8	NP	21	NP
9	V_{CC}	20	V_{CC}
10	NC	19	V_{CC}
11	NC	18	NC
12	NC	17	NC
13	$\overline{RST}$	16	$\overline{CLKSEL}$
14	GND	15	CLK I/O

Display Column and Row Format

	C 0	C 1	C 2	C 3	C 4
ROW 0	1	1	1	1	1
ROW 1	0	0	1	0	0
ROW 2	0	0	1	0	0
ROW 3	0	0	1	0	0
ROW 4	0	0	1	0	0

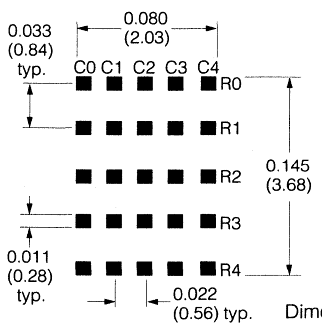
1 = Display Dot "On"
0 = Display Dot "Off"

Column Data Ranges

Row 0 : 00H to 1FH
Row 1 : 20H to 3FH
Row 2 : 40H to 5FH
Row 3 : 60H to 7FH
Row 4 : 80H to 9FH

Pin Definitions

Pin	Function	Definition
1	SDCLK	Used for loading data into the 8-bit serial data register on a low to high transition.
2	$\overline{LOAD}$	Low input enables data clocking into 8-bit serial shift register. When LOAD goes high, the contents of 8-bit serial Shift Register will be decoded.
3	NC	No connection
4	NC	No connection
5	NC	No connection
6	V_{CC}	Power supply/heat sink
7	NP	No Pin
8	NP	No Pin
9	V_{CC}	Power supply/heat sink
10	NC	No connection
11	NC	No connection
12	NC	No connection
13	$\overline{RST}$	Asynchronous input, when low will clear the Multiplex Counter, User RAM and Data Register. Control Word Register is set to 100% brightness and the Address Register is set to select Digit 0. The display is blanked.
14	GND	Power supply ground
15	CLK I/O	Outputs master clock or inputs external clock.
16	$\overline{CLKSEL}$	H = internal clock, L = external clock
17	NC	No connection
18	NC	No connection
19	V_{CC}	Power supply/heat sink
20	V_{CC}	Power supply/heat sink
21	NP	No Pin
22	NP	No Pin
23	V_{CC}	Power supply/heat sink
24	NC	No connection
25	NC	No connection
26	NC	No connection
27	DATA	Serial data input
28	GND	Power supply ground



Dimensions in Inches (mm)
TOLERANCE: .XXX = ±.010 (.254)

Figure 5. Dot Matrix Format

Operation of the SCD5510X

The SCD5510X display consists of a CMOS IC containing control logic and drivers for ten 5 X 5 characters. These components are assembled in a compact (38 mm x 10 mm) plastic package.

Individual LED dot addressablity allows the user great freedom in creating special characters or mini-icons. The User Definable Character Set Examples illustrate 200 different character and symbol possibilities.

The use of a serial data interface provides a highly efficient interconnection between the display and the mother board. The SCD5510X requires only 4 lines as compared to 15 for an equivalent 8 character parallel input part.

The on-board CMOS IC is the electronic heart of the display. The IC accepts decoded serial data, which is stored in the internal RAM. Asynchronously the RAM is read by the character multiplexer at a strobe rate that results in a flicker free display. Figure 6 shows the three functional areas of the IC. These include: the input serial data register and control logic, a 250 bits two port RAM, and an internal multiplexer/display driver.

Intelligent Display Devices
2

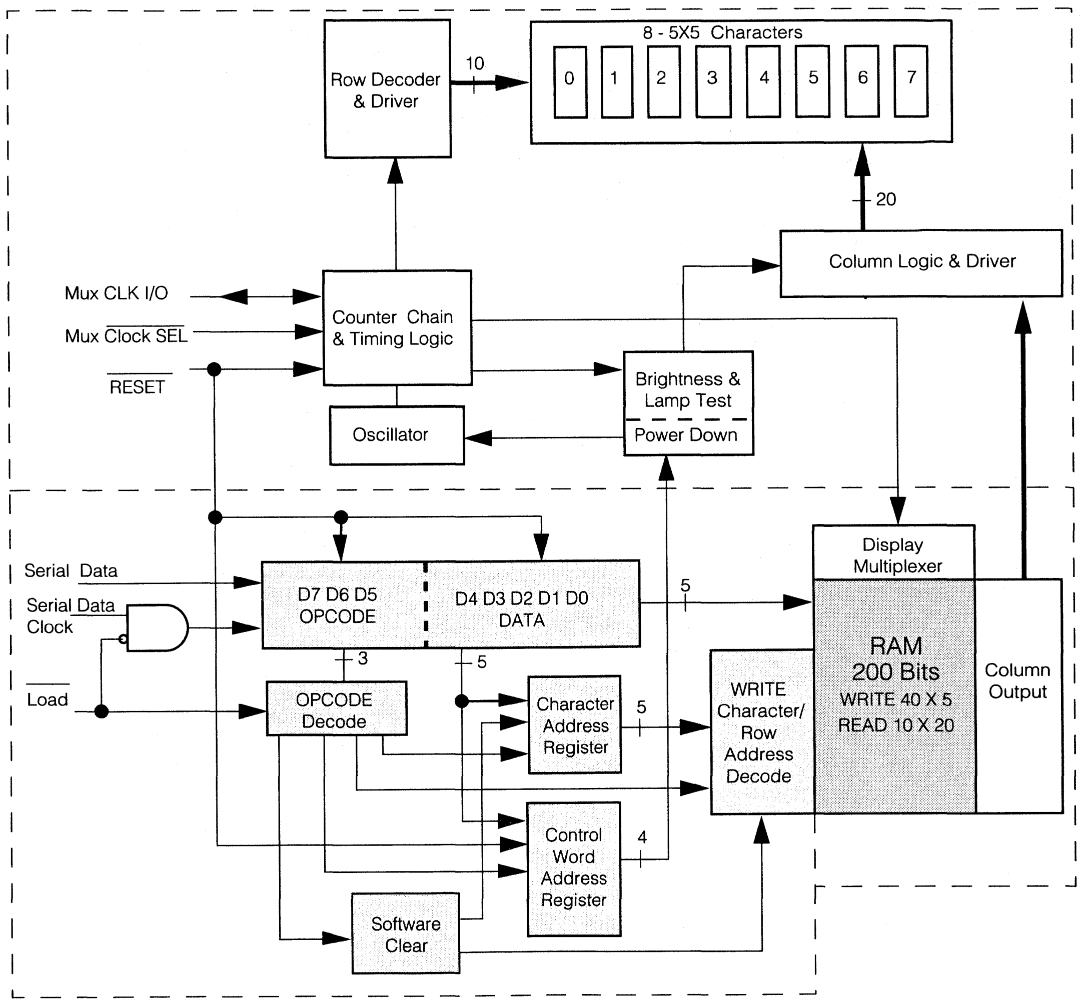


Figure 6. SCD5510X Block Diagram

The following explains how to format the serial data to be loaded into the display. The user supplies a string of bit mapped decoded characters. The contents of this string is shown in Figure 7a. Figure 7b shows that each character consist of six 8 bit words. The first word encodes the display character location and the succeeding five bytes are row data. The row data represents the status (On, Off) of individual column LEDs. Figure 7c shows that each that each 8 bit word is formatted to include a three bit Operational Code (OPCODE) defined by bits D7-D5 and five bits (D4-D0) representing Column Data, Character Address, or Control Word Data.

Figure 7d shows the sequence for loading the bytes of data. Bringing the $\overline{\text{LOAD}}$ line low enables the serial register to accept data. The shift action occurs on the low to high transition of the serial data clock (SDCLK). The least significant bit (D0) is loaded first. After eight clock pulses the $\overline{\text{LOAD}}$ line is brought high. With this transition the OPCODE is decoded. The decoded OPCODE directs D4-D0 to be latched in the Character Address register, stored in the RAM as Column data, or latched in the Control Word register. The control IC requires a minimum 600 ns delay between successive byte loads. As indicated in Figure 7a, a total of 660 clock cycles (60-8 bit words) are required to load all ten characters into the display.

The Character Address Register bits, D4-D0 (Table 2), and Row Address Register bits, D7–D5 (Table 3), direct the Column Data bits, D4-D0 (Table 3) to specific RAM location. Table 1 shows the Row Address for the example character "D." Column data is written and read asynchronously from the 250 bit RAM. Once loaded the internal oscillator and character multiplexer reads the data from the RAM. These characters are row strobed with column data as shown in Figures 8 and 9. The character strobe rate is determined by the internal or user supplied external MUX Clock and the IC's ÷ 320 counter.

Table 1. Character "D"

	Opcode D7	D6	D5	Column Data D4 C0	D3 C1	D2 C2	D1 C3	D0 C4	Hex
Row 0	0	0	0	1	1	1	1	0	1E
Row 1	0	0	1	1	0	0	0	1	31
Row 2	0	1	0	1	0	0	0	1	51
Row 3	0	1	1	1	0	0	0	1	71
Row 4	1	0	0	1	1	1	1	0	9E

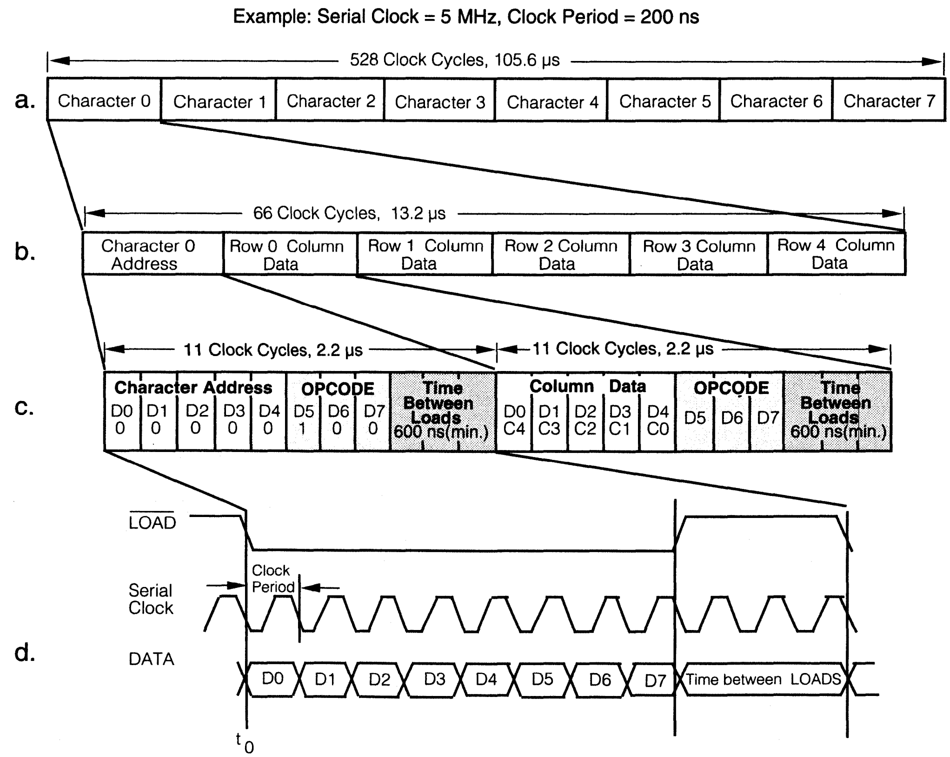


Figure 7a–d. Loading Serial Character Data

The user can activate four Control functions. These include: LED Brightness Level, Lamp Test, IC Power Down, or Display Clear. OPCODEs and five bit words are used to initiate these functions. The OPCODEs and Control Words for the Character Address and Loading Column Data are shown in Tables 2 and 3 .

Table 2. Load Character Address

Opcode D7	D6	D5	Character Address D4	D3	D2	D1	D0	Hex	Operation Load
1	0	1	1	0	0	0	0	B0	Character 0
1	0	1	1	0	0	0	1	B1	Character 1
1	0	1	1	0	0	1	0	B2	Character 2
1	0	1	1	0	0	1	1	B3	Character 3
1	0	1	1	0	1	0	0	B4	Character 4
1	0	1	1	0	1	0	1	B5	Character 5
1	0	1	1	0	1	1	0	B6	Character 6
1	0	1	1	0	1	1	1	B7	Character 7
1	0	1	1	1	0	0	0	B8	Character 8
1	0	1	1	1	0	0	1	B9	Character 9

Table 3. Load Column Data

Opcode D7	D6	D5	Column Data D4	D3	D2	D1	D0	Operation Load
0	0	0	C0	C1	C2	C3	C4	Row 0
0	0	1	C0	C1	C2	C3	C4	Row 1
0	1	0	C0	C1	C2	C3	C4	Row 2
0	1	1	C0	C1	C2	C3	C4	Row 3
1	0	0	C0	C1	C2	C3	C4	Row 4

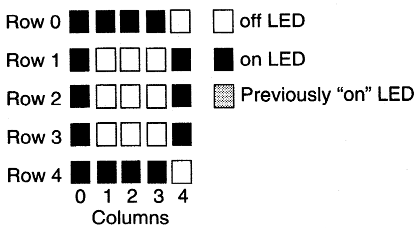


Figure 8. Row and Column Location

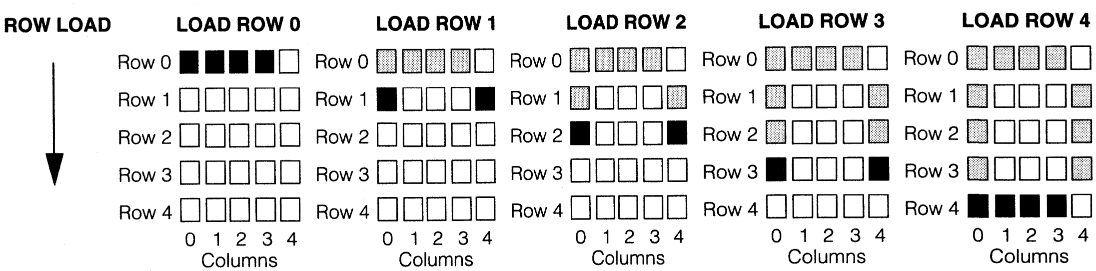


Figure 9. Row Strobing

The user can select seven specific LED brightness levels, Table 4. These brightness levels (in percentages of full brightness of the display) include: 100% ($F0_{HEX}$), 53% ($F1_{HEX}$), 40% ($F2_{HEX}$), 27% ($F3_{HEX}$), 20% ($F4_{HEX}$), 13% ($F5_{HEX}$), and 6.6% ($F6_{HEX}$). The brightness levels are controlled by changing the duty factor of the row strobe pulse.

Table 4. Display Brightness

Opcode D7	D6	D5	Control Word D4	D3	D2	D1	D0	Hex	Operation Level
1	1	1	1	0	0	0	0	F0	100%
1	1	1	1	0	0	0	1	F1	53%
1	1	1	1	0	0	1	0	F2	40%
1	1	1	1	0	0	1	1	F3	27%
1	1	1	1	0	1	0	0	F4	20%
1	1	1	1	0	1	0	1	F5	13%
1	1	1	1	0	1	1	0	F6	6.6%

The SCD5510X offers a unique Display Power Down feature which reduces I_{CC} to less than 50 µA. When FF_{HEX} is loaded, as shown in Table 5, the display is set to 0% brightness and the internal multiplex clock is stopped. When in the Power Down mode data may still be written into the RAM. The display is reactivated by loading a new Brightness Level Control Word into the display.

Table 5. Power Down

Opcode D7	D6	D5	Control Word D4	D3	D2	D1	D0	Hex	Operation
1	1	1	1	1	1	1	1	FF	0% Brightness

The Lamp Test is enabled by loading $F8_{HEX}$, Table 6, into the serial shift register. This Control Word sets all of the LEDs to a 53% brightness level. Operation of the Lamp Test has no affect on the RAM and is cleared by loading a Brightness Control Word.

Table 6. Lamp Test

Opcode D7	D6	D5	Control Word D4	D3	D2	D1	D0	Hex	Operation
1	1	1	1	0	B	B	B		Lamp Test (OFF)
1	1	1	1	1	0	0	0	F8	Lamp Test (ON)

The Software Clear ($C0_{HEX}$), given in Table 7, clears the Address Register and the RAM. The display is blanked and the Character Address Register will be set to Character 0. The internal counter and the Control Word Register are unaffected. The Software Clear will remain active until the next data input cycle is initiated.

Table 7. Software Clear

Opcode D7	D6	D5	Control Word D4	D3	D2	D1	D0	Hex	Operation
1	1	0	0	0	0	0	0	C0	CLEAR

Multiplexer and Display Driver
The eight characters are row multiplexed with RAM resident column data. The strobe rate is established by the internal or external MUX Clock rate. The MUX Clock frequency is divided by a 320 counter chain. This results in a typical strobe rate of 750Hz. By pulling the Clock SEL line low, the display can be operated from an external MUX Clock. The external clock is attached to the CLK I/O connection (pin 15). The maximum external MUX Clock frequency should be limited to 1 MHz.

An asynchronous hardware Reset (pin 13) is also provided. Bringing this pin low will clear the Character Address Register, Control Word Register, RAM, and blanks the display. This action leaves the display set at Character Address 0, and the Brightness Level set at 100%.

Electrical and Mechanical Considerations

Iinterconnect Considerations
Optimum product performance can be had when the following electrical and mechanical recommendations are adopted. The SCD5510X's IC is constructed in a high speed CMOS process, consequently high speed noise on the SERIAL DATA, SERIAL DATA CLOCK, LOAD and RESET lines may cause incorrect data to be written into the serial shift register. Adhere to transmission line termination procedures when using fast line drivers and long cables (>10 cm).

Good digital grounds (pins 14, 28) and power supply decoupling (pins 6, 9, 20, 23) will insure that Icc (<400 mA peak) switching currents do not generate localized ground bounce. Therefore it is recommended that each display package use a 0.1µF and 20 µF capacitor between V_{CC} and ground.

When the internal MUX Clock is being used connect the CLKSEL pin to V_{CC}. In those applications where RESET will not be connected to the system's reset control, it is recommended that this pin be connected to the center node of a series 0.1, µF and 100 KΩ RC network. Thus upon initial power up the RESET will be held low for 10 ms allowing adequate time for the system power supply to stabilize.

The SCD5510X allows up to 1.7 W of power dissipation at 70°C and 1.29 W of power dissipation at a maximum operating temperature of 85°C. Approximately 60% of this power is dissipated by the IC to the PC board via the Vcc connection (pins 6, 7,20, 23). Optimum thermal reliability is obtained by connecting all of the V_{CC} pins to a common pad located on both sides of the PC board. This technique offers a low thermal resistance for IC to system ambient.

ESD Protection
The input protection structure of the SCD55100/1/2/3/4 provides significant protection against ESD damage. It is capable of withstanding discharges greater than 2 KV. Take all the standard precautions, normal for CMOS components. These include properly grounding personnel, tools, tables, and transport carriers that come in contact with unshielded parts. If these conditions are not, or cannot be met, keep the leads of the device shorted together or the parts in anti-static packaging.

Soldering Considerations
THE SCD55100/1/2/3/4 can be hand soldered with SN63 solder using a grounded iron set to 260°C.

Wave soldering is also possible following these conditions: Preheat that does not exceed 93°C on the solder side of the PC board or a package surface temperature of 85°C. Water soluble organic acid flux (except carboxylic acid) or resin-based RMA flux without alcohol can be used.

Wave temperature of 245°C ±5°C with a dwell between 1.5 sec. to 3.0 sec. Exposure to the wave should not exceed temperatures above 260°C for five seconds at 0.063" below the seating plane. The packages should not be immersed in the wave.

Post Solder Cleaning Procedures
The least offensive cleaning solution is hot D.I. water (60°C) for less than 15 minutes. Addition of mild saponifiers is acceptable. Do not use commercial dishwasher detergents.

For faster cleaning, solvents may be used. Exercise care in choosing solvents as some may chemically attack the nylon package. Maximum exposure should not exceed two minutes at elevated temperatures. Acceptable solvents are TF (trichorotrifluorethane), TA, 111 Trichloroethane, and unheated acetone.[1]

Note: 1. Acceptable commercial solvents are: Basic TF, Arklone, P. Genesolv, D. Genesolv DA, Blaco-Tron TF, Blaco-Tron TA, and Freon TA.

Unacceptable solvents contain alcohol, methanol, methylene chloride, ethanol, TP35, TCM, TMC, TMS+, TE, or TES. Since many commercial mixtures exist, contact a solvent vendor for chemical composition information. Some major solvent manufacturers are: Allied Chemical Corporation, Specialty Chemical Division, Morristown, NJ; Baron-Blakeslee, Chicago, IL; Dow Chemical, Midland, MI; E.I. DuPont de Nemours & Co., Wilmington, DE.

For further information refer to Appnotes 18 and 19 in the current Siemens Optoelectronic Data Book.

An alternative to soldering and cleaning the display modules is to use sockets. Naturally, 28 pin DIP sockets .300" wide with .100" centers work well for single displays. Multiple display assemblies are best handled by longer SIP sockets or DIP sockets when available for uniform package alignment. Socket manufacturers are Aries Electronics, Inc., Frenchtown, NJ; Garry Manufacturing, New Brunswick, NJ; Robinson-Nugent, New Albany, IN; and Samtec Electronic Hardward, New Albany, IN.

For further information refer to Appnote 22 in the current Siemens Optoelectronic Data Book.

Optical Considerations

The 0.145" high character of the SCD5510X gives readability up to eight feet. Proper filter selection enhances readability over this distance.

Using filters emphasizes the contrast ratio between a lit LED and the character background. This will increase the discrimination of different characters. The only limitation is cost. Take into consideration the ambient lighting environment for the best cost/benefit ratio for filters.

Incandescent (with almost no green) or fluorescent (with almost no red) lights do not have the flat spectral response of sunlight. Plastic band-pass filters are an inexpensive and effective way to strengthen contrast ratios. The SCD55100/2 are red/high efficiency red displays and should be matched with long wavelength pass filter in the 570 nm to 590 nm range. The SCD55103/4 should be matched with a yellow-green band-pass filter that peaks at 565 nm. For displays of multiple colors, neutral density grey filters offer the best compromise.

Additional contrast enhancement is gained by shading the displays. Plastic band-pass filters with built-in louvers offer the next step up in contrast improvement. Plastic filters can be improved further with anti-reflective coatings to reduce glare. The trade-off is fuzzy characters. Mounting the filters close to the display reduces this effect. Take care not to overheat the plastic filter by allowing for proper air flow.

Optimal filter enhancements are gained by using circular polarized, anti-reflective, band-pass filters. The circular polarizing further enhances contrast by reducing the light that travels through the filter and reflects back off the display to less than 1%.

Several filter manufacturers supply quality filter materials. Some of them are: Panelgraphic Corporation, W. Caldwell, NJ; SGL Homalite, Wilmington, DE; 3M Company, Visual Products Division, St. Paul, MN; Polaroid Corporation, Polarizer Division, Cambridge, MA; Marks Polarized Corporation, Deer Park, NY, Hoya Optics, Inc., Fremont, CA.

One last note on mounting filters: recessing displays and bezel assemblies is an inexpensive way to provide a shading effect in overhead lighting situations. Several Bezel manufacturers are: R.M.F. Products, Batavia, IL; Nobex Components, Griffith Plastic Corp., Burlingame, CA; Photo Chemical Products of California, Santa Monica, CA; I.E.E.–Atlas, Van Nuys, CA.

Microprocessor Interface

The microprocessor interface is through the serial port, SPI port or one out of eight data bits on the eight bit parallel port and also control lines SDCLK and LOAD.

Power up Sequence

Upon power up display will come on at random. Thus the display should be reset at power-up. The reset will set the Address Register to Digit 0, User RAM is set to 0 (display blank) the Control Word is set to 0 (100% brightness with Lamp Test off) and the internal counters are reset.

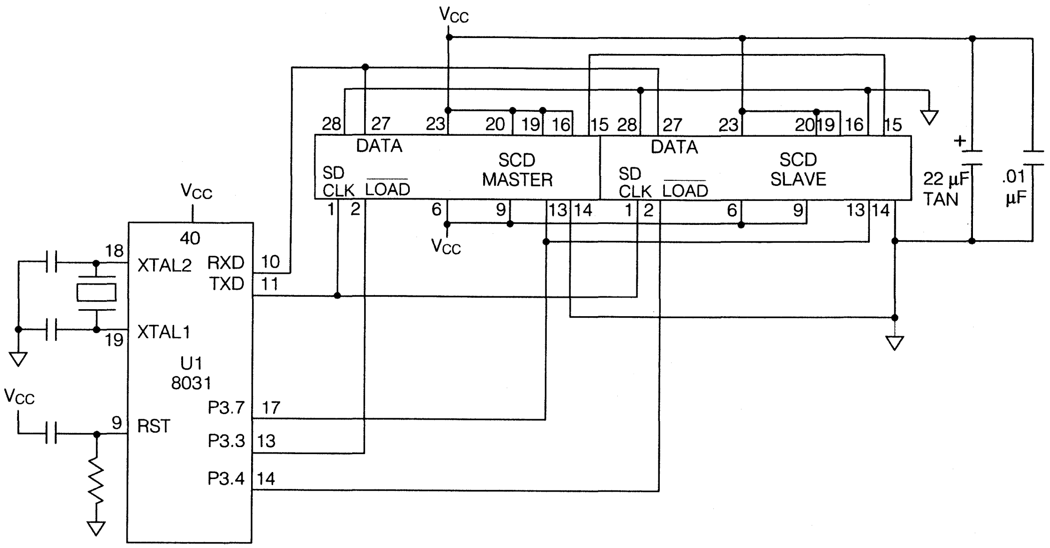


Figure 10. SCD Interface to Siemens/Intel 8031 Microprocessor (using serial port in mode 0)

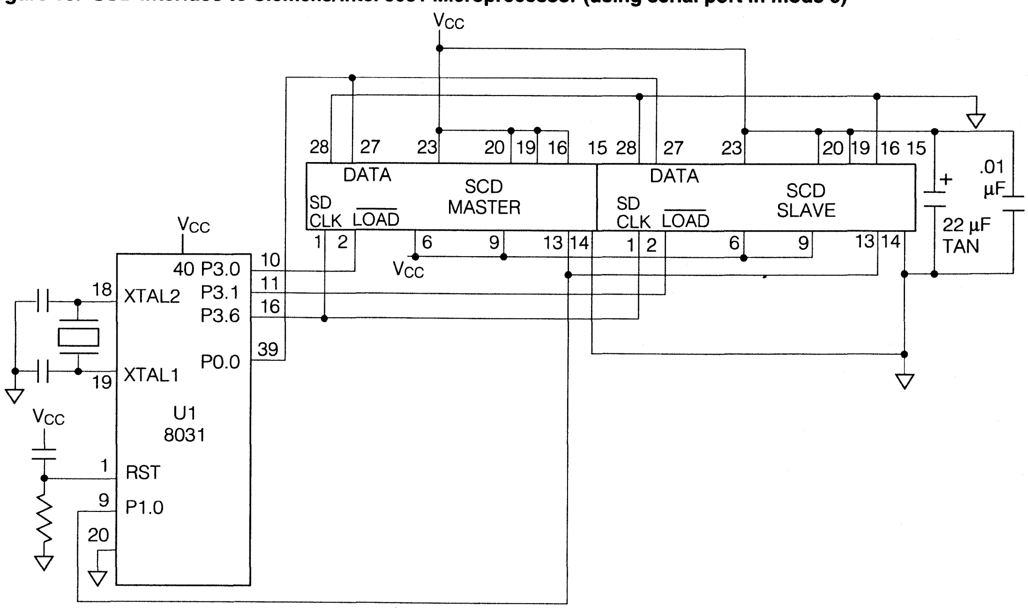


Figure 11. SCD5510X Interface with Intel/Siemens 8031 Microprocessor

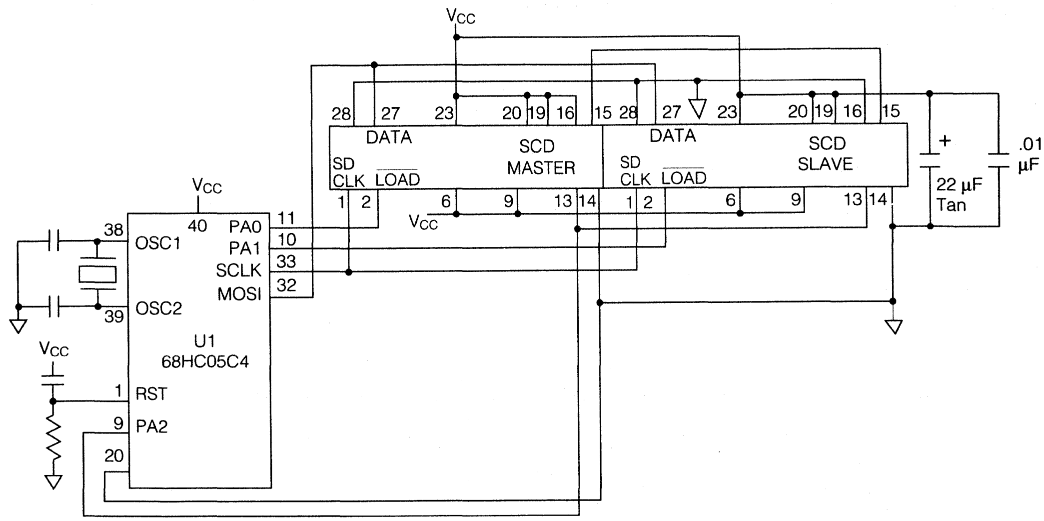


Figure 12. SCD558X Interface with Motorola 68HC05C4 Microprocessor (using SPI Port)

Cascading Multiple Displays

Multiple displays can be cascaded using the $\overline{\text{CLK SEL}}$ and CLK I/O pins as shown below. The display designated as the Master Clock source should have its $\overline{\text{CLK SEL}}$ pin tied high and the slaves should have their $\overline{\text{CLK SEL}}$ pins tied low. All CLK I/O pins should be tied together. One display CLK I/O can drive 15 slave CLK I/Os. Use $\overline{\text{RST}}$ to synchronize all display counters.

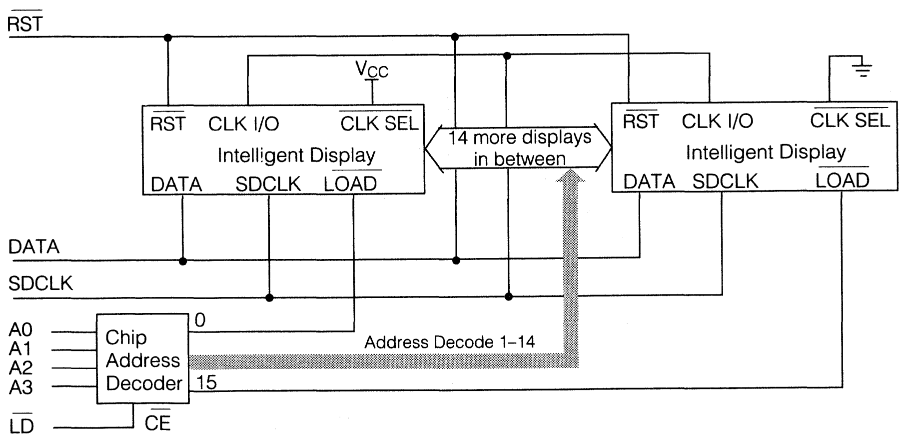


Figure 13. Cascading Multiple Displays

Loading Data Into the Display

Use following procedure to load data into the display:

1. Power up the display.
2. Bring $\overline{RST}$ low (600 ns duration minimum) to clear the Multiplex Counter, Address Register, Control Word Register, User Ram and Data Register. The display will be blank. Display brightness is set to 100%.
3. If a different brightness is desired, load the proper brightness opcode into the Control Word Register.
4. Load the Digit Address into the display.
5. Load display row and column data for the selected digit.
6. Repeat steps 4 and 5 for all digits.

Data Contents for the Word "Displays"

Step	D7	D6	D5	D4	D3	D2	D1	D0	Function
A	1	1	0	0	0	0	0	0	CLEAR
B(optional)	1	1	1	1	0	B	B	B	BRIGHTNESS SELECT
1	1	0	1	1	0	0	0	0	DIGIT D0 SELECT
2	0	0	0	1	1	1	1	0	ROW 0 D0 (D)
3	0	0	1	1	0	0	0	1	ROW 1 D0 (D)
4	0	1	0	1	0	0	0	1	ROW 2 D0 (D)
5	0	1	1	1	0	0	0	1	ROW 3 D0 (D)
6	1	0	0	1	1	1	1	0	ROW 4 D0 (D)
7	1	0	1	1	0	0	0	1	DIGIT DI SELECT
8	0	0	0	0	1	1	1	0	ROW 0 D1 (I)
9	0	0	1	0	0	1	0	0	ROW 1 D1 (I)
10	0	1	0	0	0	1	0	0	ROW 2 D1 (I)
11	0	1	1	0	0	1	0	0	ROW 3 D1 (I)
12	1	0	0	0	1	1	1	0	ROW 4 D1 (I)
13	1	0	1	1	0	0	1	0	DIGIT D2 SELECT
14	0	0	0	0	1	1	1	1	ROW 0 D2 (S)
15	0	0	1	1	0	0	0	0	ROW 1 D2 (S)
16	0	1	0	0	1	1	1	0	ROW 2 D2 (S)
17	0	1	1	0	0	0	0	1	ROW 3 D2 (S)
18	1	0	0	1	1	1	1	0	ROW 4 D2 (S)
19	1	0	1	1	0	0	1	1	DIGIT D3 SELECT
20	0	0	0	1	1	1	1	0	ROW 0 D3 (P)
21	0	0	1	1	0	0	0	1	ROW 1 D3 (P)
22	0	1	0	1	1	1	1	0	ROW 2 D3 (P)
23	0	1	1	1	0	0	0	0	ROW 3 D3 (P)
24	1	0	0	1	0	0	0	0	ROW 4 D3 (P)
25	1	0	1	1	0	1	0	0	DIGIT D4 SELECT
26	0	0	0	1	0	0	0	0	ROW 0 D4 (L)
27	0	0	1	1	0	0	0	0	ROW 1 D4 (L)
28	0	1	0	1	0	0	0	0	ROW 2 D4 (L)
29	0	1	1	1	0	0	0	0	ROW 3 D4 (L)
30	1	0	0	1	1	1	1	1	ROW 4 D4 (L)
31	1	0	1	1	0	1	0	1	DIGIT D5 SELECT
32	0	0	0	0	0	1	0	0	ROW 0 D5 (A)
33	0	0	1	0	1	0	1	0	ROW 1 D5 (A)
34	0	1	0	1	1	1	1	1	ROW 2 D5 (A)
35	0	1	1	1	0	0	0	1	ROW 3 D5 (A)
36	1	0	0	1	0	0	0	1	ROW 4 D5 (A)
37	1	0	1	1	0	1	1	0	DIGIT D6 SELECT
38	0	0	0	1	0	0	0	1	ROW 0 D6 (Y)
39	0	0	1	0	1	0	1	0	ROW 1 D6 (Y)
40	0	1	0	0	0	1	0	0	ROW 2 D6 (Y)
41	0	1	1	0	0	1	0	0	ROW 3 D6 (Y)
42	1	0	0	0	0	1	0	0	ROW 4 D6 (Y)
43	1	0	1	1	0	1	1	1	DIGIT D7 SELECT
44	0	0	0	0	1	1	1	1	ROW 0 D7 (S)
45	0	0	1	1	0	0	0	0	ROW 1 D7 (S)
46	0	1	0	0	1	1	1	0	ROW 2 D7 (S)
47	0	1	1	0	0	0	0	1	ROW 3 D7 (S)
48	1	0	0	1	1	1	1	0	ROW 4 D7 (S)

Note:
If the display is already reset at Power Up, there is no need for Software Clear.

User Definable Character Set Examples*

Upper and Lower Case Alphabets

HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE	
04 2A 5F 71 91		1E 29 4E 69 9E		0F 30 50 70 8F		1E 29 49 69 9E		1F 30 5E 70 9F		1F 30 5E 70 90		0F 30 53 71 8F		11 31 5F 71 91		0E 24 44 64 8E	
01 21 41 71 8E		13 34 58 74 93		10 30 50 70 9F		11 3B 55 71 91		11 39 55 73 91		0E 31 51 71 8E		1E 31 5E 70 90		0C 32 56 72 8D		1E 31 5E 74 92	
0F 30 4E 61 9E		1F 24 44 64 84		11 31 51 71 8E		11 31 51 6A 84		11 31 55 7B 91		11 2A 44 6A 91		11 2A 44 64 84		1F 22 44 68 9F			
00 2E 52 72 8D		10 30 5E 71 9E		00 2F 50 70 8F		01 21 4F 71 8F		00 2E 5F 70 8E		04 2A 48 7C 88		00 2F 50 73 8F		10 30 56 79 91		04 20 4C 64 8E	
00 26 42 72 8C		10 30 56 78 96		0C 24 44 64 8E		00 2A 55 71 91		00 36 59 71 91		00 2E 51 71 8E		00 3E 51 7E 90		00 2F 51 6F 81		00 33 54 78 90	
00 23 44 62 8C		08 3C 48 6A 84		00 32 52 72 8D		00 31 51 6A 84		00 31 55 7B 91		00 32 4C 6C 92		00 31 4A 64 98		00 3E 44 68 9E			

Dot on = 1
Dot off = 0

Numerals and Punctuation

HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE	
0E 33 55 79 8E		04 2C 44 64 8E		1E 21 46 68 9F		1E 21 4E 61 9E		06 2A 5F 62 82		1F 30 5E 61 9E		06 28 5E 71 8E		1F 22 44 68 88		0E 31 4E 71 8E	
0E 31 4F 62 8C		0A 3F 4A 7F 8A		0F 34 4E 65 9E		06 29 5C 68 9F		19 3A 44 6B 93		08 34 4D 72 8D		0C 2C 44 68 80		02 24 44 64 82		08 24 44 64 88	
0C 2C 48 64 80		04 24 5F 64 84		00 2C 4C 64 88		00 20 5F 60 80		00 20 40 6C 8C		01 22 44 68 90		04 24 44 60 84		0A 2A 40 60 80		07 24 44 64 87	
10 28 44 62 81		1C 24 44 64 9C		0E 35 57 70 8E		00 20 40 60 9F		0C 2C 40 6C 8C		0C 20 4C 64 88		02 24 48 64 82		00 3F 40 7F 80		08 24 42 64 88	
0E 31 42 64 88		06 24 48 64 86		0C 24 42 64 8C		04 24 40 64 84		11 2A 44 6E 84		15 2E 5F 6E 95		04 2A 51 60 80		08 35 42 60 80			

Dot on = 1
Dot off = 0
* CAUTION: No more than 128 LEDs "on" at one time at 100% brightness.

User Definable Character Set Examples* (continued)

Scientific Notations, etc.

HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE	
06 2E 5E 6E 86		04 24 48 71 8E		1F 20 59 75 93		1F 20 56 79 91		0E 20 4A 64 8A		0D 32 52 72 8D		0C 32 56 71 96		0E 24 4E 71 8E		00 24 4A 71 9F	
10 3C 52 72 81		0E 31 5F 71 8E		10 28 44 6A 91		09 29 49 6E 90		01 2E 54 64 84		04 2E 55 6E 84		0E 31 51 6A 9B		01 2E 5A 6A 8A		0F 32 52 72 8C	
1F 28 44 68 9F		18 24 48 7C 80		1C 28 44 78 80		12 36 5A 67 80		06 21 5A 67 80		07 22 59 66 80		1C 34 5C 60 80		0F 28 48 78 88		04 2E 5F 6E 80	
00 24 4E 7F 8E		00 2E 5F 6E 84		0E 3F 4E 64 80		04 3E 5F 7E 84		04 2F 5F 6F 84		0E 2E 4E 6E 8E		00 3F 5F 7F 80		04 2E 55 64 84		04 24 55 6E 84	
04 22 5F 62 84		04 28 5F 68 84		1F 31 51 71 9F		08 2C 4A 78 98		0A 35 4A 75 8A		15 2A 55 6A 95		1F 35 5F 75 9F		00 3F 5F 7C 80		0E 3F 5B 7F 8E	
00 27 4F 78 9C		00 3C 5F 63 87		00 20 40 60 83		00 20 40 67 9F		00 23 5F 7F 9F		0C 3C 5C 7C 9C		15 2E 44 64 84					

Dot on = 1
Dot off = 0

Foreign Characters

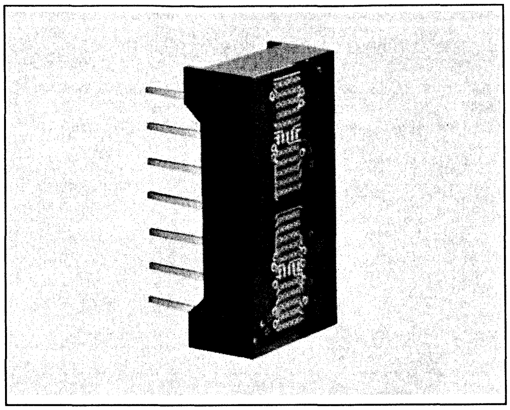
HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE	
1F 21 5F 62 84		1F 21 46 64 88		01 22 46 6A 82		04 3F 51 61 86		00 3F 44 64 9F		02 3F 46 6A 92		08 3F 49 6A 88		1F 21 45 67 8C		02 3F 51 62 8C	
08 3F 49 69 92		04 3F 44 7F 84		0F 29 51 62 8C		08 2F 52 62 82		0F 21 41 61 9F		0A 3F 4A 62 8C		19 21 59 62 9C		0F 29 55 63 8C		01 3E 42 7F 86	
15 35 55 62 8C		0E 20 5F 64 98		08 28 4C 6A 88		04 3F 44 64 98		0E 20 40 60 9F		1F 21 4A 64 9A		04 3E 44 6E 95		04 24 44 68 90		04 22 51 71 91	
10 3F 50 70 8F		1F 21 41 62 8C		0E 20 4E 60 8F		04 28 51 7F 81		01 21 4A 64 8A		1F 28 5F 68 87		1E 22 42 62 9F		1F 21 5F 61 9F		0E 20 5F 61 8E	
12 32 52 64 88		04 34 54 75 96		1E 25 4F 74 8F		0F 34 5F 74 97		0F 30 4F 64 98		0F 33 55 79 9E		0F 34 57 74 8F		00 2A 5F 74 8B		08 24 4E 72 8F	
0A 2E 51 7F 91		02 24 4C 64 8E		04 2A 4E 71 8E		0A 34 52 7A 96		08 24 51 71 8E		02 24 51 71 8E		04 2A 51 71 8E					

Dot on = 1
Dot off = 0
* CAUTION: No more than 160 LEDs "on" at one time at 100% brightness.

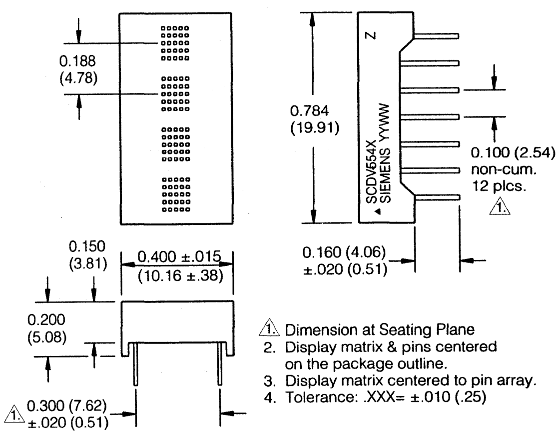
SIEMENS

STANDARD RED SCDV5540
YELLOW SCDV5541
HIGH EFFICIENCY RED SCDV5542
GREEN SCDV5543
HIGH EFFICIENCY GREEN SCDV5544

Vertical Format, 0.123" 4-Character, 5x5 Dot Matrix Serial Input Dot Addressable Intelligent Display™



Package Dimensions in Inches (mm)



FEATURES

- **Vertical Format, Four 0.123" (3.12 mm) 5 x 5 Dot Matrix Characters in Red, Yellow, High Efficiency Red, Green, or High Efficiency Green**
- **Optimum Display Surface Efficiency (display area to package ratio)**
- **High Speed Data Input Rate: 5 MHz**
- **ROMless Serial Input, Dot Addressable Display Ideal for User Defined Characters**
- **Built-in Decoders, Multiplexers and LED Drivers**
- **Readable from 6 Feet (1.8 meters)**
- **Wide Viewing Angle, X Axis ±55°, Y Axis ±55°**
- **Attributes**
  - **100 Bit RAM for User Defined Characters**
  - **Eight Dimming Levels**
  - **Power Down Model (<250 µW)**
  - **Hardware/Software Clear Functions**
  - **Lamp Test**
  - **Internal or External Clock**
- **3.3 V Capability**

DESCRIPTION

The SCDV5540 (Red), SCDV5541 (Yellow), SCDV5542 (High Efficiency Red), SCDV5543 (Green), and SCDV5544 (High Efficiency Green) are four digit, dot addressable 5x5 dot matrix, serial input, alphanumeric Intelligent Displays in a vertical format. The four digits are packaged in a rugged, high quality, optically transparent, plastic 14 pin DIP with 0.3" pin spacing.

The on-board CMOS has a 100 bit RAM, one bit associated with one LED, each to generate User Defined Characters. In Power Down Mode, quiescent current is <50 µA.

The SCDV554X is designed for work with the serial port of most common microprocessors. Data is transferred into the display through the Serial Data Input (DATA), clocked by the Serial Data Clock (SDCLK), and enabled by the Load Input (LOAD).

The Clock I/O (CLK I/O) and Clock Select ($\overline{\text{CLK SEL}}$) pins offer the user the capability to supply a high speed external multiplex clock. This feature can minimize audio in-band interference for portable communication equipment or eliminate the visual sychronization effects found in high vibration environments such as avionic equipment.

Maximum Rating

DC Supply Voltage ....–0.5 to +7.0 Vdc
Input Voltage Levels Relative
to Ground ....–0.5 to V_{CC}+0.5 Vdc
Operating Temperature .... –40°C to +85°C
Storage Temperature .... –40°C to +100°C
Maximum Solder Temperature 0.063"
below Seating Plane, t<5 sec .... 260°C
Relative Humidity at 85°C 85%
Maximum Number of LEDs at 100% Brightness 64
Maximum Power Dissipation .... 0.65 W
ESD (100 pF, 1.5 KΩ) .... 2 KV
Maximum Input Current .... ±100 mA

Switching Specifications

(over operating temperature range and V_{CC}=4.5 V to 5.5 V)

Symbol	Description	Min.	Units
T_{RC}	Reset Active Time	600	ns
T_{LDS}	Load Setup Time	50	ns
T_{DS}	Data Setup Time	50	ns
T_{SDCLK}	Clock Period	200	ns
T_{SDCW}	Clock Width	70	ns
T_{LDH}	Load Hold Time	0	ns
T_{DH}	Data Hold Time	25	ns
T_{WR}	Total Write Time	2.2	µs
T_{BL}	Time Between Loads	600	ns

Note:
TSDCW is the minimum time the SDCLK may be low or high. The SDCLK period must be a minimum of 200 ns.

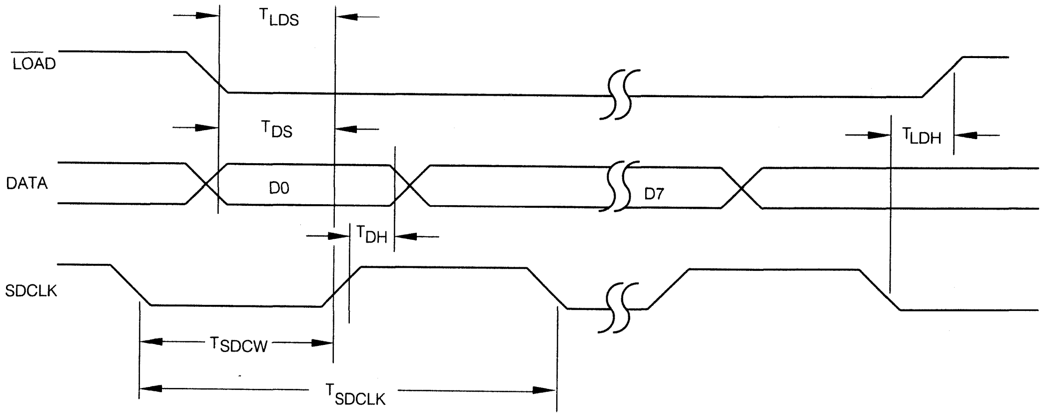


Figure 1. Timing diagram–Data write cycle

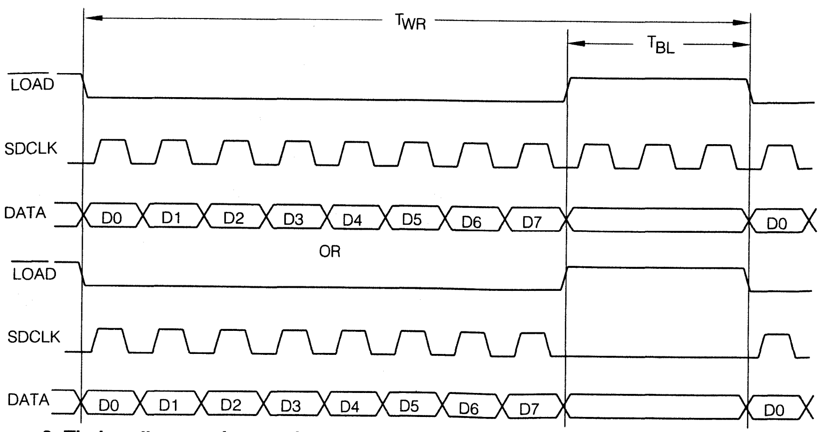


Figure 2. Timing diagram–Instruction cycle

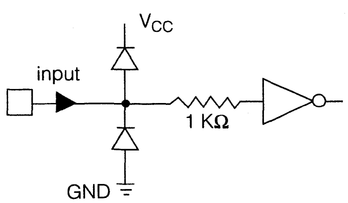
Electrical Characteristics (over Operating Temperature)

Parameter	Min.	Typ.	Max.	Units	Conditions
V_{CC}	4.5	5.0	5.5	V	
I_{CC} (Pwr Dwn Mode)[4]			50	µA	V_{CC}=5 V, all inputs=0 V or V_{CC}
I_{CC} 4 digits 16 dots/character		100	140	mA	V_CC=5 V, "#" displayed in all 4 digits at 100% brightness at 25°C
I_{IL} Input current			–10	µA	V_{CC}=5 V, V_{IN}=0 V (all inputs)
I_{IH} Input current			+10	µA	V_{CC}=V_{IN}=5.0 V=0 V (all inputs)
V_{IH}	3.5			V	V_{CC}=4.5 V to 5.5 V
V_{IL}			1.5	V	V_{CC}=4.5 V to 5.5 V
I_{OH} (CLK I/O)		–8.9		mA	V_{CC}=4.5 V, V_{OH}=2.4 V
I_{OL} (CLK I/O)		1.6		mA	V_{CC}=4.5 V, V_{OL}=0.4 V
$\theta_{JC\text{-}PIN}$			64	°C/W	
F_{ext} External Clock Input Frequency	120		347	KHz	V_{CC}=5.0 V, $\overline{CLKSEL}$=0
F_{osc} Internal Clock Input Frequency	120		347	KHz	V_{CC}=5.0 V, $\overline{CLKSEL}$=1
Clock I/O Bus Loading			240	pF	
Clock Out Rise Time			500	ns	V_{CC}=4.5 V, V_{OH}=2.4 V
Clock Out Fall Time			500	ns	V_{CC}=4.5 V, V_{OH}=0.4 V
FM, Digit	375	768	1086	Hz	

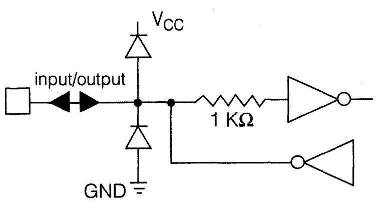
Notes
1. Peak current $^5/_3$ x I_{CC}.
2. Unused inputs must be tied high.
3. Contact Siemens for 3.3 volt operation.
4. External oscillator must be stopped if being used to maintain an I_{CC} <50µA.

Input/Output Circuits

Figures 3 and 4 show the input and output resistor/diode networks used for ESD protection and to eliminate substrate latch-up caused by input voltage over/under shoot.



Inputs



Clock I/O

Figures 3 and 4.

Optical Characteristics at 25°C

V_{CC}=5.0 V at 100% Brightness Level, Viewing Angle: X Axis ±55°, Y Axis ±65°

Red SCDV5540

Description	Symbol	Min.	Typ.	Units
Luminous Intensity Character Average (# displayed all digits)	I_V	0.48	1.8	mcd
Peak Wavelength	λ(peak)		665	nm
Dominant Wavelength	λ(d)		639	nm

Yellow SCDV5541

Description	Symbol	Min.	Typ.	Units
Luminous Intensity Character Average (# displayed all digits)	I_V	1.8	5.4	mcd
Peak Wavelength	λ(peak)		583	nm
Dominant Wavelength	λ(d)		585	nm

High Efficiency Red SCDV5542

Description	Symbol	Min.	Typ.	Units
Luminous Intensity Character Average (# displayed all digits)	I_V	1.8	5.4	mcd
Peak Wavelength	λ(peak)		630	nm
Dominant Wavelength	λ(d)		620	nm

Green SCDV5543

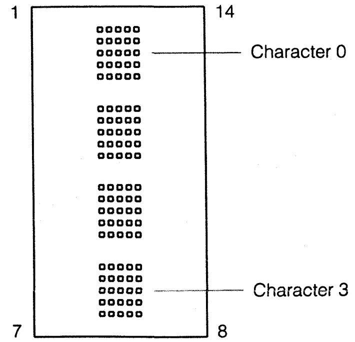
Description	Symbol	Min.	Typ.	Units
Luminous Intensity Character Average (# displayed all digits)	I_V	1.8	5.4	mcd
Peak Wavelength	λ(peak)		565	nm
Dominant Wavelength	λ(d)		570	nm

High Efficiency Green SCDV5544

Description	Symbol	Min.	Typ.	Units
Luminous Intensity Character Average (# displayed all digits)	I_V	2.1	6.4	mcd
Peak Wavelength	λ(peak)		568	nm
Dominant Wavelength	λ(d)		574	nm

Notes
1. Dot to dot intensity matching at 100% brightness is 1.8:1.
2. Displays are binned for hue at 2 nm intervals for yellow, green, and high efficiency green.
3. Displays within a given intensity category have an intensity matching of 1.5:1 (max.).

Top View



Pin Assignment

Pin	Function	Pin	Function
1	SDCLK	14	GND
2	$\overline{LOAD}$	13	DATA
3	NP	12	V_{CC}
4	NP	11	V_{CC}
5	NP	10	V_{CC}
6	$\overline{RST}$	9	CLKSEL
7	GND	8	CLK I/O

Display Column and Row Format

	C 0	C 1	C 2	C 3	C 4
Row 0	1	1	1	1	1
Row 1	0	0	1	0	0
Row 2	0	0	1	0	0
Row 3	0	0	1	0	0
Row 4	0	0	1	0	0

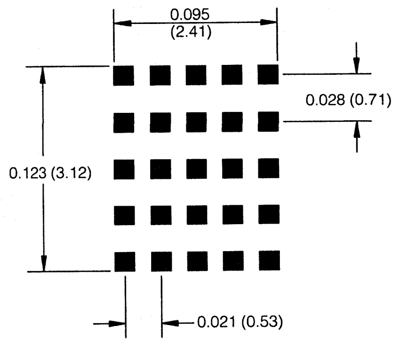
1=Display dot "On"
0=Display dot "Off"

Column Data Ranges

Row 0 : 00H to 1FH
Row 1 : 20H to 3FH
Row 2 : 40H to 5FH
Row 3 : 60H to 7FH
Row 4 : 80H to 9FH

Pin Definitions

Pin	Function	Definitions
1	SDCLK	For loading data into the 8-bit serial data register on a low to high transition.
2	$\overline{LOAD}$	Low input enables data clocking into 8-bit serial shift register. When LOAD goes high, the contents of 8-bit serial Shift Register will be decoded.
3	NP	No pin
4	NP	No pin
5	NP	No pin
6	$\overline{RST}$	Asyncronous input, when low will clear the Multiplex Counter, User Ram and Data Register. Control Word Register is set to 100% brightness and Address Register is set to select Digit 0. The display is blanked.
7	GND	Power supply ground
8	CLK I/O	Outputs master clock or inputs external clock.
9	CLK SEL	H=internal clock, L=external clock
10	V_{CC}	Power supply
11	V_{CC}	Power supply
12	V_{CC}	Power supply
13	DATA	Serial data input
14	GND	Power supply ground



Dimensions in inches (mm)
Tolerance: .XXX ±.010 (.25)

Figure 5. Dot matrix format

Operation of the SCDV554X

The SCDV554X display consists of a CMOS IC containing control logic and drivers for four 5x5 characters. These components are assembled in a compact plastic package.

Individual LED dot addressability allows the user great freedom in creating special characters or mini-icons. The User Definable Character Set examples illustrate 200 different character and symbol possibilities.

The serial data interface provides a highly efficient interconnection between the display and the mother board. The SCDV554X requires only four lines as compared to 15 for an equivalent four character parallel input part.

The on-board CMOS IC is the electronic heart of the display. The IC accepts decoded serial data, which is stored in the internal RAM. Asynchronously the RAM is read by the character multiplexer at a strobe rate that results in a flicker free display. Figure 6 shows the three functional areas of the IC. These include: the input serial data register and control logic, a 100 bits two port RAM, and an internal multiplexer/display driver.

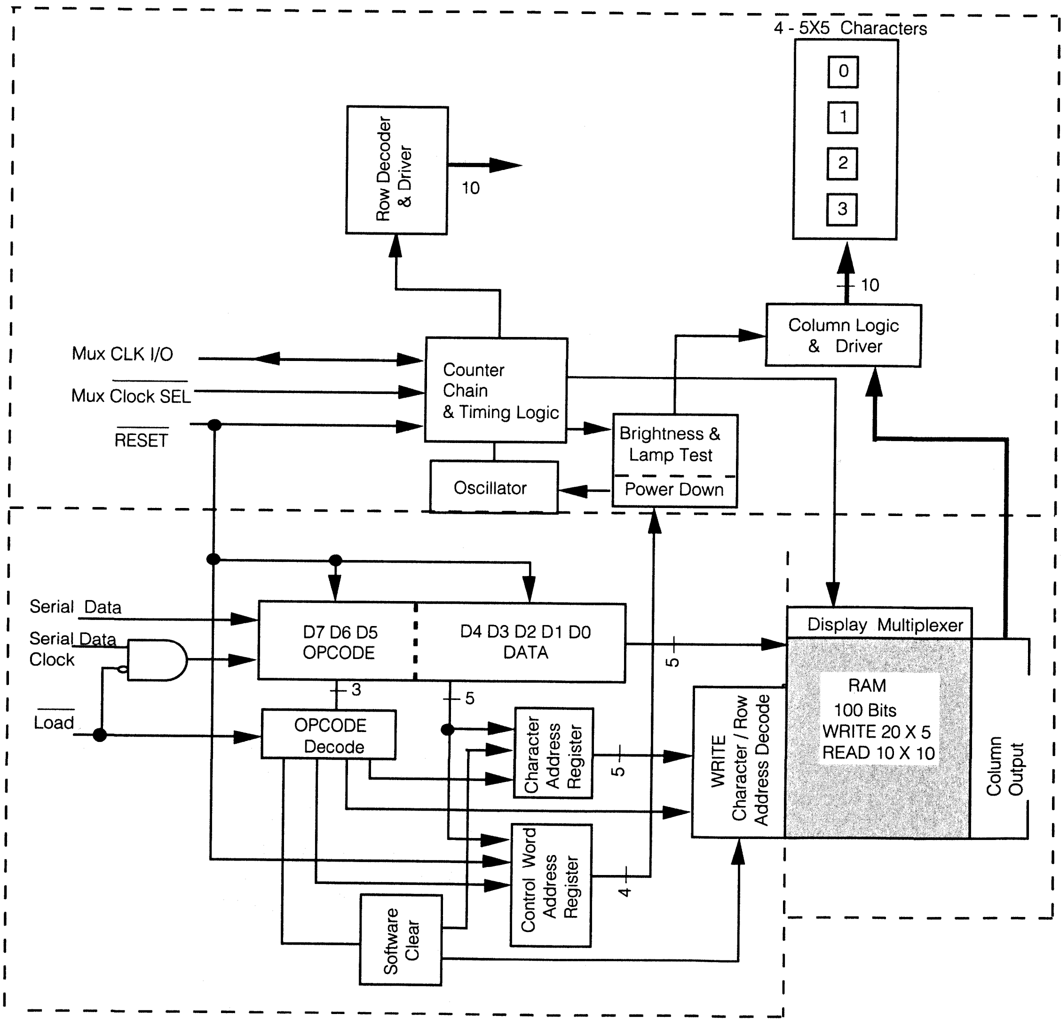


Figure 6. SCDV554X block diagram

The following explains how to format the serial data to be loaded into the display. The user supplies a string of bit mapped decoded characters. The contents of this string is shown in Figure 7a. Figure 7b shows that each character consists of six 8 bit words. The first word encodes the display character location and the succeeding five bytes are row data. The row data represents the status (On, Off) of individual column LEDs. Figure 7c shows that each that each 8 bit word is formatted to include a three bit Operational Code (OPCODE) defined by bits D7–D5 and five bits (D4–D0) representing Column Data, Character Address, or Control Word Data.

Figure 7d shows the sequence for loading the bytes of data. Bringing the $\overline{\text{LOAD}}$ line low enables the serial register to accept data. The shift action occurs on the low to high transition of the serial data clock (SDCLK). The least significant bit (D0) is loaded first. After eight clock pulses the $\overline{\text{LOAD}}$ line is brought high. With this transition the OPCODE is decoded. The decoded OPCODE directs D4–D0 to be latched in the Character Address register, stored in the RAM as Column data, or latched in the Control Word register. The control IC requires a minimum 600 ns delay between successive byte loads. As indicated in Figure 7a, a total of 264 bits of data are required to load all eight characters into the display.

The Character Address Register bits, D4–D0 (Table 2), and Row Address Register bits, D7–D5 (Table 3), direct the Column Data bits, D4–D0 (Table 3) to specific RAM location. Table 1 shows the Row Address for the example character "D." Column data is written and read asynchronously from the 200 bit RAM. Once loaded the internal oscillator and character multiplexer reads the data from the RAM. These characters are row strobed with column data as shown in Figures 8 and 9. The character strobe rate is determined by the internal or user supplied external MUX Clock and the IC's ÷ 320 counter.

Table 1. Character "D"

	Op code D7 D6 D5	Column Data D4 D3 D2 D1 D0 C0 C1 C2 C3 C4	Hex
Row 0	0 0 0	1 1 1 1 0	1E
Row 1	0 0 1	1 0 0 0 1	31
Row 2	0 1 0	1 0 0 0 1	51
Row 3	0 1 1	1 0 0 0 1	71
Row 4	1 0 0	1 1 1 1 0	9E

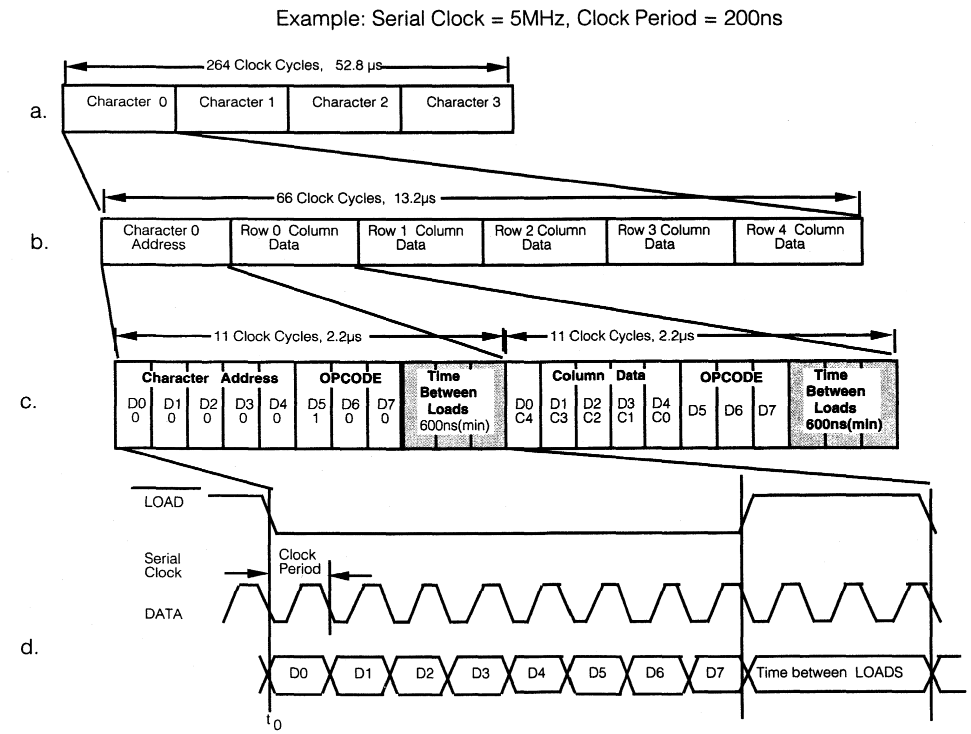


Figure 7a–d. Loading serial character data

The user can activate four Control functions. These include: LED Brightness Level, Lamp Test, IC Power Down, or Display Clear. OPCODEs and five bit words are used to initiate these functions. The OPCODEs and Control Words for the Character Address and Loading Column Data are shown in Tables 2 and 3 .

Table 2. Load Character Address

Op code D7 D6 D5	Character Address D4 D3 D2 D1 D0	Hex	Operation Load
1 0 1	0 0 0 0 0	A0	Character 0
1 0 1	0 0 0 0 1	A1	Character 1
1 0 1	0 0 0 1 0	A2	Character 2
1 0 1	0 0 0 1 1	A3	Character 3

Table 3. Load Column Data

Op code D7 D6 D5	Column Data D4 D3 D2 D1 D0	Operation Load
0 0 0	C0 C1 C2 C3 C4	Row 0
0 0 1	C0 C1 C2 C3 C4	Row 1
0 1 0	C0 C1 C2 C3 C4	Row 2
0 1 1	C0 C1 C2 C3 C4	Row 3
1 0 0	C0 C1 C2 C3 C4	Row 4

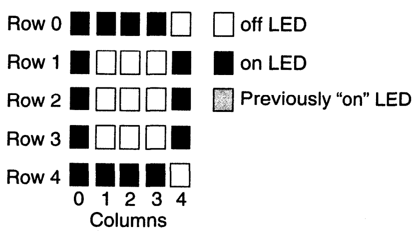


Figure 8. Row and column locations

The user can select seven specific LED brightness levels, Table 4. These brightness levels (in percentages of full brightness of the display) include: 100% ($F0_{HEX}$), 53% ($F1_{HEX}$), 40% ($F2_{HEX}$), 27% ($F3_{HEX}$), 20% ($F4_{HEX}$), 13% ($F5_{HEX}$), and 6.6% ($F6_{HEX}$). The brightness levels are controlled by changing the duty factor of the row strobe pulse.

Table 4. Display Brightness

Op code D7 D6 D5	Control Word D4 D3 D2 D1 D0	Hex	Operation Level
1 1 1	1 0 0 0 0	F0	100%
1 1 1	1 0 0 0 1	F1	53%
1 1 1	1 0 0 1 0	F2	40%
1 1 1	1 0 0 1 1	F3	27%
1 1 1	1 0 1 0 0	F4	20%
1 1 1	1 0 1 0 1	F5	13%
1 1 1	1 0 1 1 0	F6	6.6%

The SCDV554X offers a unique Display Power Down feature which reduces ICC to less than 50 μA. When FF_{HEX} is loaded (Table 5) the display is set to 0% brightness and the internal multiplex clock is stopped. When in the Power Down mode data may still be written into the RAM. The display is reactivated by loading a new rightness Level Control Word into the display.

Table 5. Power Down

Op code D7 D6 D5	Control Word D4 D3 D2 D1 D0	Hex	Operation Level
1 1 1	1 1 1 1 1	FF	0% brightness

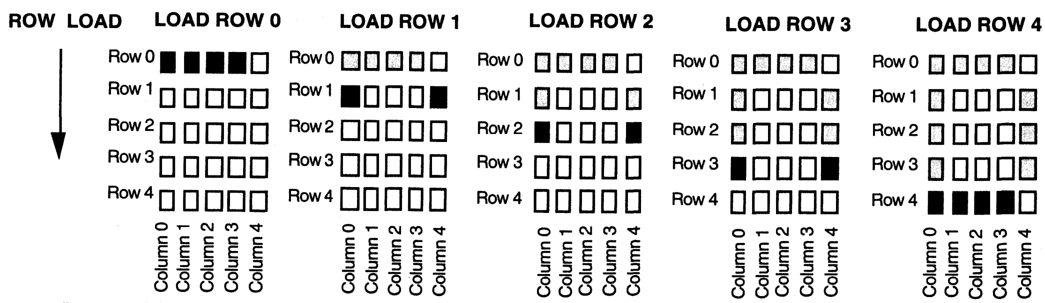


Figure 9. Row strobing

The Lamp Test is enabled by loading F8$_{HEX}$, Table 6, into the serial shift register. This Control Word sets all of the LEDs to a 53% brightness level. Operation of the Lamp Test has no affect on the RAM and is cleared by loading a Brightness Control Word.

Table 6. Lamp Test

Op code D7 D6 D5	Control Word D4 D3 D2 D1 D0	Hex	Operation
1 1 1	1 0 B B B		Lamp Test (OFF)
1 1 1	1 1 0 0 0	F8	Lamp Test (ON)

The Software Clear (C0$_{HEX}$), given in Table 7, clears the Address Register and the RAM. The display is blanked and the Character Address Register will be set to Character 0. The internal counter and the Control Word Register are unaffected. The Software Clear will remain active until the next data input cycle is initiated.

Table 7. Software Clear

Op code D7 D6 D5	Control Word D4 D3 D2 D1 D0	Hex	Operation
1 1 0	0 0 0 0 0	C0	CLEAR

Multiplexer and Display Driver

The four characters are row multiplexed with RAM resident column data. The strobe rate is established by the internal or external MUX Clock rate. The MUX Clock frequency is divided by a 320 counter chain. This results in a typical strobe rate of 750Hz. By pulling the Clock SEL line low, the display can be operated from an external MUX Clock. The external clock is attached to the CLK I/O connection (pin 8). The maximum external MUX Clock frequency should be limited to 1 MHz.

An asynchronous hardware Reset (pin 9) is also provided. Bringing this pin low will clear the Character Address Register, Control Word Register, RAM, and blanks the display. This action leaves the display set at Character Address 0, and the Brightness Level set at 100%.

ELECTRICAL & MECHANICAL CONSIDERATIONS

Interconnect Considerations

Optimum product performance can be had when the following electrical and mechanical recommendations are adopted. The SCDV554X's IC is constructed in a high speed CMOS process, consequently high speed noise on the SERIAL DATA, SERIAL DATA CLOCK, $\overline{\text{LOAD}}$ and $\overline{\text{RESET}}$ lines may cause incorrect data to be written into the serial shift register. Adhere to transmission line termination procedures when using fast line drivers and long cables (>10 cm).

Good digital grounds (pins 7 and 14) and power supply decoupling (pins 11 and 12) will insure that Icc (<400 mA peak) switching currents do not generate localized ground bounce. Therefore it is recommended that each display package use a 0.1μF and 20 μF capacitor between VCC and ground.

When the internal MUX Clock is being used connect the $\overline{\text{CLK-SEL}}$ pin to V_{CC}. In those applications where $\overline{\text{RESET}}$ will not be connected to the system's reset control, it is recommended that this pin be connected to the center node of a series 0.1, μF and 100 KΩ RC network. Thus upon initial power up the $\overline{\text{RESET}}$ will be held low for 10 ms allowing adequate time for the system power supply to stabilize.

ESD Protection

The input protection structure of the SCDV5540/1/2/3/4 provides significant protection against ESD damage. It is capable of withstanding discharges greater than 2 KV. Take all the standard precautions, normal for CMOS components. These include properly grounding personnel, tools, tables, and transport carriers that come in contact with unshielded parts. If these conditions are not, or cannot be met, keep the leads of the device shorted together or the parts in anti-static packaging.

Soldering Considerations

The SCDV5540/1/2/3/4 can be hand soldered with SN63 solder using a grounded iron set to 260°C.

Wave soldering is also possible following these conditions: Preheat that does not exceed 93°C on the solder side of the PC board or a package surface temperature of 85°C. Water soluble organic acid flux (except carboxylic acid) or resin-based RMA flux without alcohol can be used.

Wave temperature of 245°C ±5°C with a dwell between 1.5 sec. to 3.0 sec. Exposure to the wave should not exceed temperatures above 260°C for five seconds at 0.063" below the seating plane. The packages should not be immersed in the wave.

Post Solder Cleaning Procedures

The least offensive cleaning solution is hot D.I. water (60°C) for less than 15 minutes. Addition of mild saponifers is acceptable. Do not use commercial dishwasher detergents.

For faster cleaning, solvents may be used. Exercise care in choosing solvents as some may chemically attack the nylon package. For further information refer to Appnotes 18 and 19 in the current Siemens Optoelectronic Data Book. See Appnote 19, Table 1, "Displays–Group 2" for the SCDV554X.

An alternative to soldering and cleaning the display modules is to use sockets. Naturally, 14 pin DIP sockets .300" wide with .100" centers work well for single displays. Multiple display assemblies are best handled by longer SIP sockets or DIP sockets when available for uniform package alignment. Socket manufacturers are Aries Electronics, Inc., Frenchtown, NJ; Garry Manufacturing, New Brunswick, NJ; Robinson-Nugent, New Albany, IN; and Samtec Electronic Hardward, New Albany, IN.

For further information refer to Appnote 22 in the current Siemens Optoelectronic Data Book.

Griffith Plastic Corp., Burlingame, CA; Photo Chemical Products of California, Santa Monica, CA; I.E.E.-Atlas, Van Nuys, CA.

Optical Considerations

The 0.123" high character of the SCDV554X gives readability up to five feet. Proper filter selection enhances readability over this distance.

Using filters emphasizes the contrast ratio between a lit LED and the character background. This will increase the discrimination of different characters. The only limitation is cost. Take into consideration the ambient lighting environment for the best cost/benefit ratio for filters.

Incandescent (with almost no green) or fluorescent (with almost no red) lights do not have the flat spectral response of sunlight. Plastic band-pass filters are an inexpensive and effective way to strengthen contrast ratios. The SCDV5540/2 are red/high efficiency red displays and should be matched with long wavelength pass filter in the 570 nm to 590 nm range. The SCDV5543/4 should be matched with a yellow-green band-pass filter that peaks at 565 nm. For displays of multiple colors, neutral density grey filters offer the best compromise.

Additional contrast enhancement is gained by shading the displays. Plastic band-pass filters with built-in louvers offer the next step up in contrast improvement. Plastic filters can be improved further with anti-reflective coatings to reduce glare. The trade-off is fuzzy characters. Mounting the filters close to the display reduces this effect. Take care not to overheat the plastic filter by allowing for proper air flow.

Optimal filter enhancements are gained by using circular polarized, anti-reflective, band-pass filters. The circular polarizing further enhances contrast by reducing the light that travels through the filter and reflects back off the display to less than 1%.

Several filter manufacturers supply quality filter materials. Some of them are: Panelgraphic Corporation, W. Caldwell, NJ; SGL Homalite, Wilmington, DE; 3M Company, Visual Products Division, St. Paul, MN; Polaroid Corporation, Polarizer Division, Cambridge, MA; Marks Polarized Corporation, Deer Park, NY, Hoya Optics, Inc., Fremont, CA.

One last note on mounting filters: recessing displays and bezel assemblies is an inexpensive way to provide a shading effect in overhead lighting situations. Several Bezel manufacturers are: R.M.F. Products, Batavia, IL; Nobex Components,

Microprocessor Interface

The microprocessor interface is through the serial port, SPI port or one out of eight data bits on the eight bit parallel port and also control lines $\overline{SDCLK}$ and $\overline{LOAD}$.

Power Up Sequence

Upon power up display will come on at random. Thus the display should be reset at power-up. The reset will set the Address Register to Digit 0, User RAM is set to 0 (display blank) the Control Word is set to 0 (100% brightness with Lamp Test off) and the internal counters are reset.

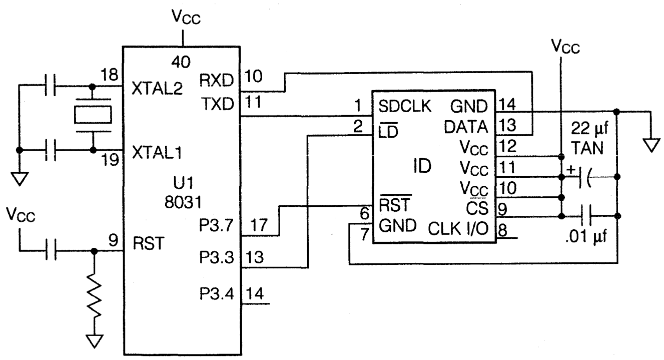


Figure 10. SCDV Interface to Siemens/Intel 8031 Microprocessor (using serial port in mode 0)

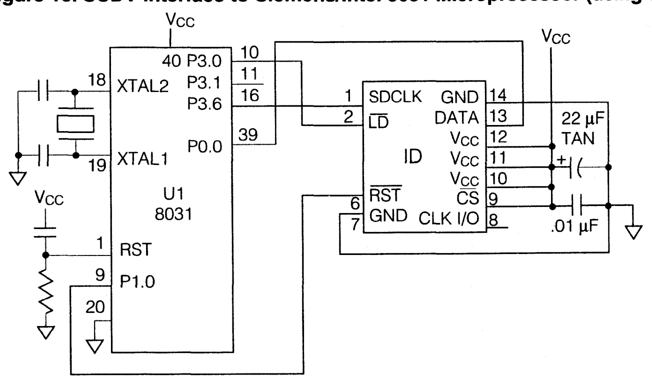


Figure 11. SCDV Interface to Siemens/Intel 8031 Microprocessor (using one bit of parallel port as serial input)

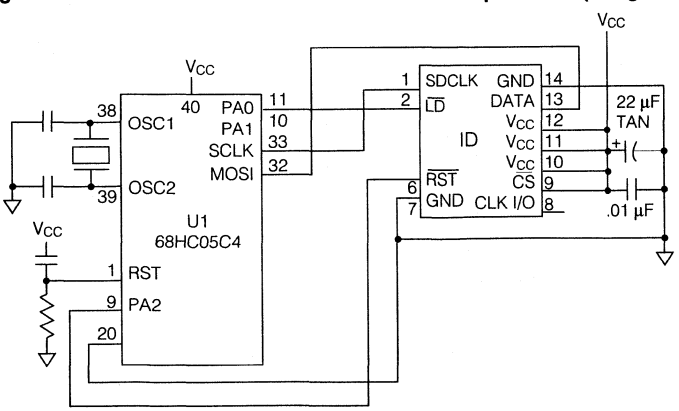


Figure 12. SCDV554X Interface with Motorola 68HC05C4 Microprocessor (using SPI Port)

Multiple displays can be cascaded using the $\overline{\text{CLK SEL}}$ and CLK I/O pins as shown below. The display designated as the Master Clock source should have its $\overline{\text{CLK SEL}}$ pin tied high and the slaves should have their $\overline{\text{CLK SEL}}$ pins tied low. All CLK I/O pins should be tied together. One display CLK I/O can drive 15 slave CLK I/Os. Use $\overline{\text{RST}}$ to synchronize all display counters.

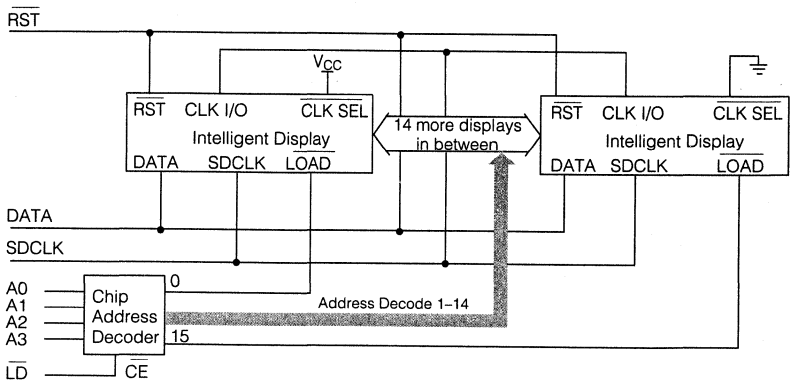


Figure 13. Cascading Multiple Displays

Loading Data into the Display

Use following procedure to load data into the display:

1. Power up the display.
2. Bring $\overline{\text{RST}}$ low (600 ns duration minimum) to clear the Multiplex Counter, Address Register, Control Word Register, User Ram and Data Register. The display will be blank. Display brightness is set to 100%.
3. If a different brightness is desired, load the proper brightness opcode into the Control Word Register.
4. Load the Digit Address into the display.
5. Load display row and column data for the selected digit.
6. Repeat steps 4 and 5 for all digits.

Data Contents for the Display in a Vertical Format "↑AB↓"

Step	D7	D6	D5	D4	D3	D2	D1	D0	Function
A	1	1	0	0	0	0	0	0	CLEAR
B (optional)	1	1	1	1	0	B	B	B	BRIGHTNESS SELECT
1	1	0	1	0	0	0	0	0	DIGIT D0 SELECT
2	0	0	0	0	0	1	0	0	ROW 0 D0 (↑)
3	0	0	1	0	1	1	1	0	ROW 1 D0 (↑)
4	0	1	0	1	0	1	0	1	ROW 2 D0 (↑)
5	0	1	1	0	0	1	0	0	ROW 3 D0 (↑)
6	1	0	0	0	0	1	0	0	ROW 4 D0 (↑)
7	1	0	1	0	0	0	0	1	DIGIT D1 SELECT
8	0	0	0	0	0	1	0	0	ROW 0 D1 (A)
9	0	0	1	0	1	0	1	0	ROW 1 D1 (A)
10	0	1	0	1	1	1	1	1	ROW 2 D1 (A)
11	0	1	1	1	0	0	0	1	ROW 3 D1 (A)
12	1	0	0	1	0	0	0	1	ROW 4 D1 (A)
13	1	0	1	0	0	0	1	0	DIGIT D2 SELECT
14	0	0	0	1	1	1	1	0	ROW 0 D2 (B)
15	0	0	1	0	1	0	0	1	ROW 1 D2 (B)
16	0	1	0	0	1	1	1	0	ROW 2 D2 (B)
17	0	1	1	0	1	0	0	1	ROW 3 D2 (B)
18	1	0	0	1	1	1	1	0	ROW 4 D2 (B)
19	1	0	1	0	0	0	1	1	DIGIT D3 SELECT
20	0	0	0	0	0	1	0	0	ROW 0 D3 (↓)
21	0	0	1	0	0	1	0	0	ROW 1 D3 (↓)
22	0	1	0	1	0	1	0	1	ROW 2 D3 (↓)
23	0	1	1	0	1	1	1	0	ROW 3 D3 (↓)
24	1	0	0	0	0	1	0	0	ROW 4 D3 (↓)

Note: If the display is already reset at Power Up, there is no need for Software Clear.

USER DEFINABLE CHARACTER SET EXAMPLES*

Upper and Lower Case Alphabets

HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE	
04 2A 5F 71 91		1E 29 4E 69 9E		0F 30 50 70 8F		1E 29 49 69 9E		1F 30 5E 70 9F		1F 30 5E 70 90		0F 30 53 71 8F		11 31 5F 71 91		0E 24 44 64 8E	
01 21 41 71 8E		13 34 58 74 93		10 30 50 70 9F		11 3B 55 71 91		11 39 55 73 91		0E 31 51 71 8E		1E 31 5E 70 90		0C 32 56 72 8D		1E 31 5E 74 92	
0F 30 4E 61 9E		1F 24 44 64 84		11 31 51 71 8E		11 31 51 6A 84		11 31 55 7B 91		11 2A 44 6A 91		11 2A 44 64 84		1F 22 44 68 9F			
00 2E 52 72 8D		10 30 5E 71 9E		00 2F 50 70 8F		01 21 4F 71 8F		00 2E 5F 70 8E		04 2A 48 7C 88		00 2F 50 73 8F		10 30 56 79 91		04 20 4C 64 8E	
00 26 42 72 8C		10 30 56 78 96		0C 24 44 64 8E		00 2A 55 71 91		00 36 59 71 91		00 2E 51 71 8E		00 3E 51 7E 90		00 2F 51 6F 81		00 33 54 78 90	
00 23 44 62 8C		08 3C 48 6A 84		00 32 52 72 8D		00 31 51 6A 84		00 31 55 7B 91		00 32 4C 6C 92		00 31 4A 64 98		00 3E 44 68 9E			

DOT ON = 1
DOT OFF = 0

Numerals and Punctuation

HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE	
0E 33 55 79 8E		04 2C 44 64 8E		1E 21 46 68 9F		1E 21 4E 61 9E		06 2A 5F 62 82		1F 30 5E 61 9E		06 28 5E 71 8E		1F 22 44 68 88		0E 31 4E 71 8E	
0E 31 4F 62 8C		0A 3F 4A 7F 8A		0F 34 4E 65 9E		06 29 5C 68 9F		19 3A 44 6B 93		08 34 4D 72 8D		0C 2C 44 68 80		02 24 44 64 82		08 24 44 64 88	
0C 2C 48 64 80		04 24 5F 64 84		00 2C 4C 64 88		00 20 5F 60 80		00 20 40 6C 8C		01 22 44 68 90		04 24 44 60 84		0A 2A 40 60 80		07 24 44 64 87	
10 28 44 62 81		1C 24 44 64 9C		0E 35 57 70 8E		00 20 40 60 9F		0C 2C 40 6C 8C		0C 20 4C 64 88		02 24 48 64 82		00 3F 40 7F 80		08 24 42 64 88	
0E 31 42 64 88		06 24 48 64 86		0C 24 42 64 8C		04 24 40 64 84		11 2A 44 6E 84		15 2E 5F 6E 95		04 2A 51 60 80		08 35 42 60 80			

DOT ON = 1
DOT OFF = 0

*CAUTION: No more than 128 LEDs "on" at one time at 100% brightness.

USER DEFINABLE CHARACTER SET EXAMPLES* (continued)

Scientific Notations, etc.

HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE	
06 2E 5E 6E 86		04 24 48 71 8E		1F 20 59 75 93		1F 20 56 79 91		0E 20 4A 64 8A		0D 32 52 72 8D		0C 32 56 71 96		0E 24 4E 71 8E		00 24 4A 71 9F	
10 3C 52 72 81		0E 31 5F 71 8E		10 28 44 6A 91		09 29 49 6E 90		01 2E 54 64 84		04 2E 55 6E 84		0E 31 51 6A 9B		01 2E 5A 6A 8A		0F 32 52 72 8C	
1F 28 44 68 9F		18 24 48 7C 80		1C 28 44 78 80		12 36 5A 67 80		06 21 5A 67 80		07 22 59 66 80		1C 34 5C 60 80		0F 28 48 78 88		04 2E 5F 6E 80	
00 24 4E 7F 8E		00 2E 5F 6E 84		0E 3F 4E 64 80		04 3E 5F 7E 84		04 2F 5F 6F 84		0E 2E 4E 6E 8E		00 3F 5F 7F 80		04 2E 55 64 84		04 24 55 6E 84	
04 22 5F 62 84		04 28 5F 68 84		1F 31 51 71 9F		08 2C 4A 78 98		0A 35 4A 75 8A		15 2A 55 6A 95		1F 35 5F 75 9F		00 3F 5F 7C 80		0E 3F 5B 7F 8E	
00 27 4F 78 9C		00 3C 5F 63 87		00 20 40 60 83		00 20 40 67 9F		00 23 5F 7F 9F		0C 3C 5C 7C 9C		15 2E 44 64 84					

DOT ON = 1
DOT OFF = 0

Foreign Characters

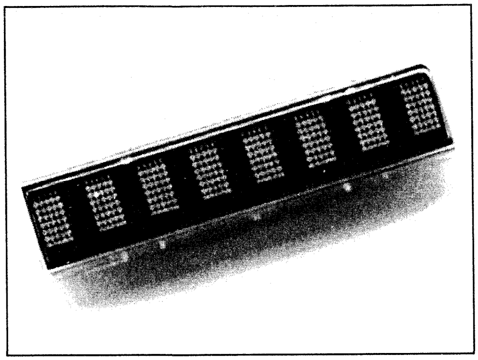
HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE	
1F 21 5F 62 84		1F 21 46 64 88		01 22 46 6A 82		04 3F 51 61 86		00 3F 44 64 9F		02 3F 46 6A 92		08 3F 49 6A 88		1F 21 45 67 8C		02 3F 51 62 8C	
08 3F 49 69 92		04 3F 44 7F 84		0F 29 51 62 8C		08 2F 52 62 82		0F 21 41 61 9F		0A 3F 4A 62 8C		19 21 59 62 9C		0F 29 55 63 8C		01 3E 42 7F 86	
15 35 55 62 8C		0E 20 5F 64 98		08 28 4C 6A 88		04 3F 44 64 98		0E 20 40 60 9F		1F 21 4A 64 9A		04 3E 44 6E 95		04 24 44 68 90		04 22 51 71 91	
10 3F 50 70 8F		1F 21 41 62 8C		0E 20 4E 60 8F		04 28 51 7F 81		01 21 4A 64 8A		1F 28 5F 68 87		1E 22 42 62 9F		1F 21 5F 61 9F		0E 20 5F 61 8E	
12 32 52 64 88		04 34 54 75 96		1E 25 4F 74 8F		0F 34 5F 74 97		0F 30 4F 64 98		0F 33 55 79 9E		0F 34 57 74 8F		00 2A 5F 74 8B		08 24 4E 72 8F	
0A 2E 51 7F 91		02 24 4C 64 8E		04 2A 4E 71 8E		0A 34 52 7A 96		08 24 51 71 8E		02 24 51 71 8E		04 2A 51 71 8E					

DOT ON = 1
DOT OFF = 0

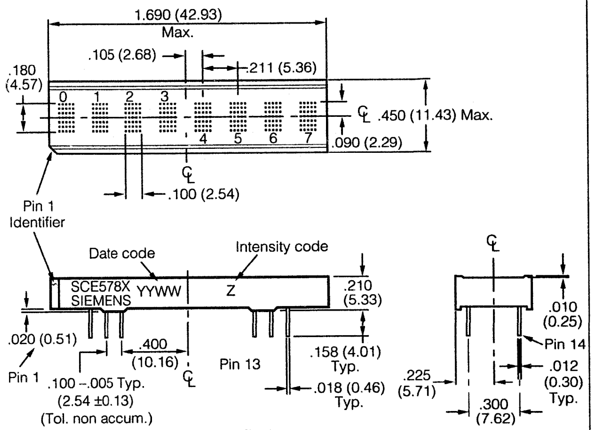
SIEMENS

RED SCE5780
YELLOW SCE5781
HIGH EFFICIENCY RED SCE5782
GREEN SCE5783
HIGH EFFICIENCY GREEN SCE5784
SOFT ORANGE SCE5785

0.180" 8-Character, 5x7 Dot Matrix Serial Input Dot Addressable Intelligent Display™



Package Dimensions in Inches (mm)



Note: Unless otherwise specified,
dimension tolerance=±0.010 inches (0.25 mm)

FEATURES

- **Eight 0.180" (4.57 mm) 5 x 7 Dot Matrix Characters in Red, Yellow, High Efficiency Red, Green, High Efficiency Green, or Soft Orange**
- **ROMless Serial Input, Dot Addressable Display Ideal for User Defined Characters**
- **Built-in Decoders, Multiplexers and LED Drivers**
- **Readable from 8 Feet (2.5 meters)**
- **Programmable Features:**
  - **Clear Function**
  - **Eight Dimming Levels**
  - **Peak Current Select (12.5% or Full Peak Current)**
  - **Prescaler Function (External Oscillator Divided by 16 or 1)**
  - **Internal or External Clock**

DESCRIPTION

The SCE5780 (red), SCE5781 (yellow), SCE5782 (HER), SCE5783 (green), SCE5784 (HEG), and SCE5785 (orange) are eight digit, dot addressable 5x7 dot matrix, serial input, Intelligent Displays. The eight 0.180" (4.57 mm) high digits are packaged in a rugged, high quality, optically transparent, plastic 26 pin DIP with 0.3" pin spacing.

The on-board CMOS has a 280 bit RAM, one bit associated with one LED, each to generate User Defined Characters.

The SCE578X is designed to work with the serial port of most common microprocessors. Data is transferred into the display through the Serial Data Input (DATA), clocked by the Serial Data Clock (SDCLK), and enabled by the Load Input (LOAD).

The Clock I/O (CLK I/O) and Clock Select (CLK SEL) pins offer the user the capability to supply a high speed external multiplex clock. This feature can minimize audio in-band interference for portable communication equipment or eliminate the visual synchronization effects found in high vibration environments such as avionic equipment. The prescaler function allows for a higher speed external multiplex clock when set to divide by 16.

Maximum Rating

V_{CC}, Logic Supply Voltage (non-operating) .. –0.5 to +7.0 VDC
V_{LL}, LED Supply Voltage (non-operating) .... –0.5 to 5.5 VDC
Input Voltage Levels Relative
to Ground ....–0.5 to V_{CC}+0.5 VDC
Operating Temperature[1] .... –40°C to +85°C
Storage Temperature .... –40°C to +100°C
Maximum Solder Temperature 0.063"
below Seating Plane, t<5 sec .... 260°C
Relative Humidity at 85°C 85%
Maximum Power Dissipation
70°C .... 1.7 W
85°C .... 1.25 W
ESD (100 pF, 1.5 KΩ) .... 2 KV
Maximum Input Current .... ±100 mA

Note:
1. For operation at high temperature, see Thermal Considerations.

Switching Specifications
(over operating temperature range and V_{CC}=4.5 V to 5.5 V)

Symbol	Description	Min.	Units
T_{RC}	Reset Active Time	600	ns
T_{LDS}	Load Setup Time	50	ns
T_{DS}	Data Setup Time	50	ns
T_{SDCLK}	Clock Period	200	ns
T_{SDCW}	Clock Width	70	ns
T_{LDH}	Load Hold Time	0	ns
T_{DH}	Data Hold Time	25	ns
T_{WR}	Total Write Time	2.2	µs
T_{BL}	Time Between Loads	600	ns

Note:
TSDCW is the minimum time the SDCLK may be low or high. The SDCLK period must be a minimum of 200 ns.

Figure 1. Timing Diagram–Data Write Cycle

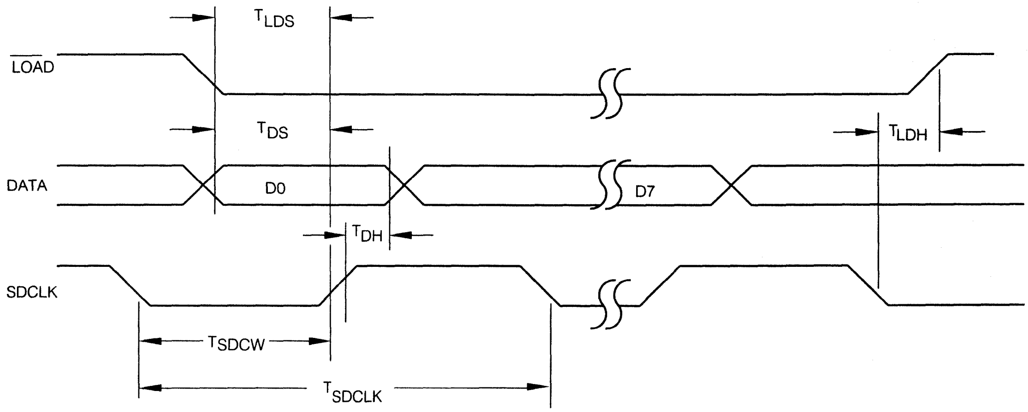
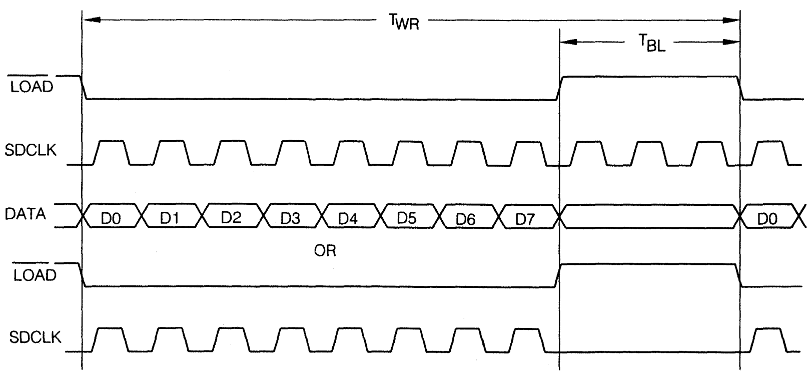


Figure 2. Timing Diagram–Instruction Cycle



Electrical Characteristics (over Operating Temperature)

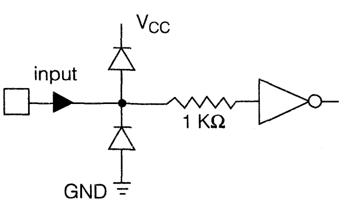
Parameter	Min.	Typ.	Max.	Units	Conditions
V_{CC}	4.5	5.0	5.5	V	
V_{LL}	3.0		5.5	V	
I_{CC} (PWR DWN)(4)			100	µA	V_{CC}=V_{LL}=5.0 V, all inputs=0 V or V_{CC}
I_{LL} (PWR DWN)(4)			50	µA	
I_{CC}			2	mA	V_{CC}=5.0 V
I_{LL} (20 dots/char)(1)		240	345	mA	V_{CC}=V_{LL}=5.0 V, "#" displayed in 8 digits, brightness=100%, I_P=100% at 25°C
I_{IL}			–10	µA	V_{CC}=5 V, all inputs=0 V
I_{IH}			10	µA	V_{CC}=V_{IN}=5.0 V (all inputs)
V_{IH}	3.5			V	V_{CC}=4.5 V to 5.5 V
V_{IL}			1.5	V	V_{CC}=4.5 V to 5.5 V
I_{OH} (CLK I/O)		–8.9		mA	V_{CC}=4.5 V, V_{OH}=2.4 V
I_{OL} (CLK I/O)		1.6		mA	V_{CC}=4.5 V, V_{OH}=0.4 V
$\theta_{JC\text{-}pin}$		34		°C/W	
Internal OSC Frequency	120		347	KHz	V_{CC}=5.0 V, CLKSEL=1, Prescale=÷1
External OSC Frequency	120		347	KHz	V_{CC}=5.0 V, CLKSEL=0, Prescale=÷1
External OSC Frequency with Prescale	1.92		5.55	MHz	V_{CC}=5.0 V, CLKSEL=0, Prescale=÷16
Mux Frequency(3)	375	768	1086	Hz	

Notes
1. Peak current=1.87 X I_{LL}. I_{LL} varies with V_{LL} Normalized curve, Figure 11.
2. Unused inputs must be tied high.
3. Mux rate=[OSC Frequency/(64 x 7)].
4. External oscillator must be stopped during power down mode for minimum current.

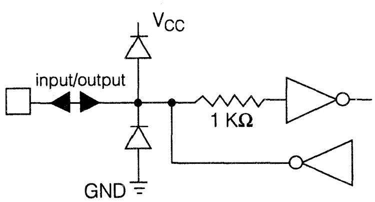
Input/Output Circuits

Figures 3 and 4 show the input and output resistor/diode networks used for ESD protection and to eliminate substrate latch-up caused by input voltage over/under shoot.

Figures 3 and 4.



Inputs



Clock I/O

Optical Characteristics at 25°C

$V_{LL}=V_{CC}$=5.0 V at 100% Brightness Level, Viewing Angle: X Axis±55°, Y Axis ±65°

Red SCE5780

Description	Symbol	Min.	Typ.	Units
Luminous Intensity	I_V	37.5	9.0	µcd/dot
Peak Wavelength	λ(peak)		660	nm
Dominant Wavelength	λ(d)		639	nm

Yellow SCE5781

Description	Symbol	Min.	Typ.	Units
Luminous Intensity	I_V	75	110	µcd/dot
Peak Wavelength	λ(peak)		585	nm
Dominant Wavelength	λ(d)		583	nm

High Efficiency Red SCE5782

Description	Symbol	Min.	Typ.	Units
Luminous Intensity	I_V	75	190	µcd/dot
Peak Wavelength	λ(peak)		630	nm
Dominant Wavelength	λ(d)		626	nm

Green SCE5783

Description	Symbol	Min.	Typ.	Units
Luminous Intensity	I_V	75	150	µcd/dot
Peak Wavelength	λ(peak)		565	nm
Dominant Wavelength	λ(d)		570	nm

High Efficiency Green SCE5784

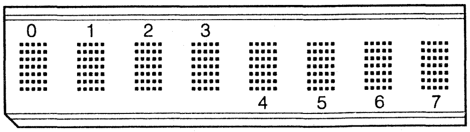
Description	Symbol	Min.	Typ.	Units
Luminous Intensity	I_V	120	215	µcd/dot
Peak Wavelength	λ(peak)		568	nm
Dominant Wavelength	λ(d)		574	nm

Soft Orange SCE5785

Description	Symbol	Min.	Typ.	Units
Luminous Intensity	I_V	120	150	µcd/dot
Peak Wavelength	λ(peak)		635	nm
Dominant Wavelength	λ(d)		626	nm

Notes
1. Dot to dot intensity matching at 100% brightness is 1.8:1.
2. Display are binned for hue at 2 nm intervals for yellow, green, and high efficiency green.
3. Displays within a given intensity category have an intensity matching of 1.5:1 (max.)

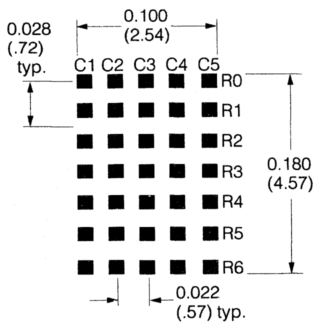
Top View



Pin Assignment

Pin	Function	Pin	Function
1	CLKSEL	14	Serial Data
2	V_{CC} (Logic)	15	No connect
3	V_{LL} (LED)	16	Serial CLK
4	No pin	17	No pin
5	No pin	18	No pin
6	No pin	19	No pin
7	No pin	20	No pin
8	No pin	21	No pin
9	No pin	22	No pin
10	No pin	23	No pin
11	Load	24	Reset
12	GND	25	CLK I/O
13	GND	26	No connect

Figure 5. Dot Matrix Format



Pin Definitions

Pin	Function	Definitions
1	CLKSEL	H=internal clock, L=external clock
2	V_{CC} (Logic)	Logic power supply
3	V_{LL} (LED)	LED power supply
4–10	No pin	No pins in these postions
11	Load	Low input enables data clocking into the 8-bit serial shift register. When Load goes high, the contents of the 8-bit serial shift register will be decoded.
12,13	GND	Power supply ground
14	Serial Data	Serial data input
15, 16	No connect	Pins have no function
16	Serial CLK	For loading data into the 8-bit serial register on a low to high transition.
17–23	No pin	No pins in these positions
24	Reset	Asynchronous input, when low will clear the Multiplex Counter, User RAM, and Data Register. Control Word Register is set to 100% brightness, maximum peak current, and oscillator divided by 1. The display blanked.
25	CLK I/O	Outputs master clock or input external clock for display multiplexing.

Display Column and Row Format

	C 0	C 1	C 2	C 3	C 4
Row 0	1	1	1	1	1
Row 1	0	0	1	0	0
Row 2	0	0	1	0	0
Row 3	0	0	1	0	0
Row 4	0	0	1	0	0
Row 5	0	0	1	0	0
Row 6	0	0	1	0	0

1=Display dot "On"
0=Display dot "Off"

Column Data Ranges

Row 0	00H to 1FH
Row 1	00H to 1FH
Row 2	00H to 1FH
Row 3	00H to 1FH
Row 4	00H to 1FH
Row 5	00H to 1FH
Row 6	00H to 1FH

Operation of the SCE578X

The SCE578X display consists of two CMOS ICs containing control logic and drivers for eight 5x7 characters. The first IC controls characters 0 through 3 and the second IC controls characters 4 through 7. These components are assembled in a compact plastic package.

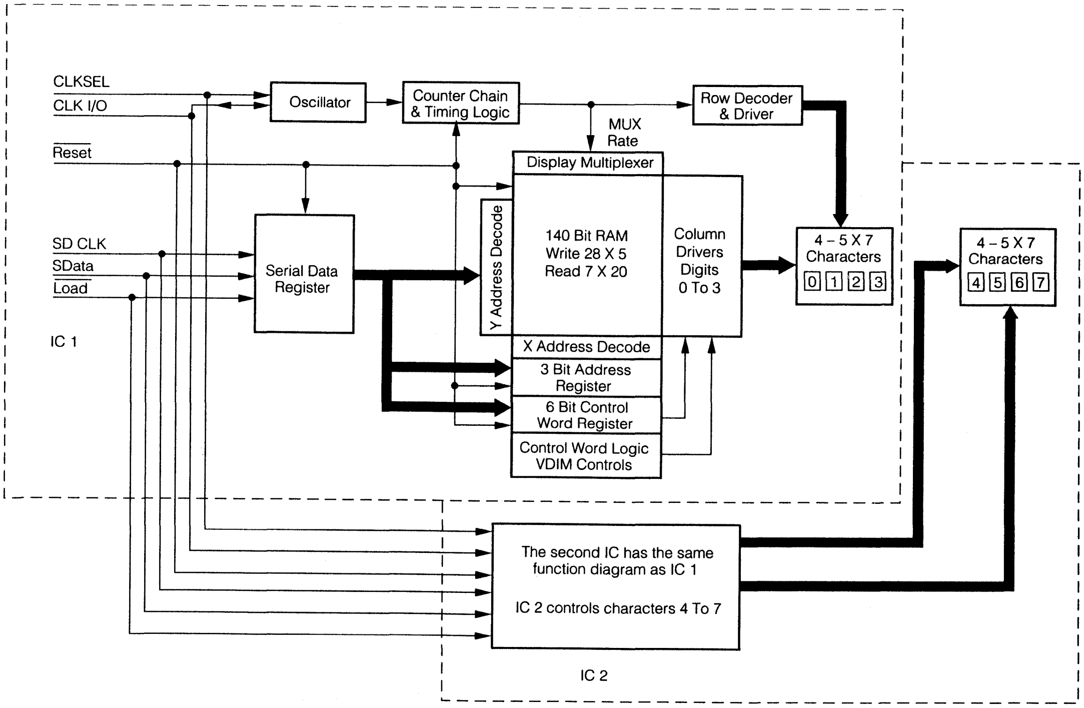
Individual LED dot addressability allows the user great freedom in creating special characters or mini-icons.

The serial data interface provides a highly efficient interconnection between the display and the mother board. The SCE578X requires a minimum three input lines as compared to fourteen for an equivalent eight character parallel input part.

The on-board CMOS IC is the electronic heart of the display. Each IC accepts serially formatted data, which is stored in the internal RAM. The IC accepts data based on the character address selected. The first IC is selected when addressing characters 0 through 3, the second IC is selected when addressing characters 4 though 7, and both ICs are selected when the Control Word is addressed.

Asynchronously the RAM is read by the character multiplexer at a strobe rate that results in a flicker free display. Figure 6 shows the three functional areas of the IC. These include: the input serial data register and control logic, a 140 bit two port RAM, and an internal multiplexer/display driver. The second IC is identical except characters 4 though 7 are driven.

Figure 6. Block Diagram



The following explains how to format the serial data to be loaded into the display. The user supplies a string of bit mapped decoded characters. The contents of this string is shown in Figure 7a. Figure 7b shows that each character consist of eight 8 bit words. The first word encodes the display character location and the succeeding seven bytes are row data. The row data represents the status (On, Off) of individual column LEDs. Figure 7c shows that each 8 bit word is formatted to represent Character Address, or Column Data.

Figure 7d shows the sequence for loading the bytes of data. Bringing the LOAD line low enables the serial register to accept data. The shift action occurs on the low to high transition of the serial data clock (SDCLK). The least significant bit (D0) is loaded first. After eight clock pulses the LOAD line is brought high. With this transition the OPCODE is decoded. The decoded OPCODE directs D4–D0 to be latched in the Character Address register, stored in the RAM as Column data, or latched in the Control Word register. The control IC requires a minimum 600 ns delay between successive byte loads. As indicated in Figure 7a, a total of 512 bits of data are required to load all eight characters into the display.

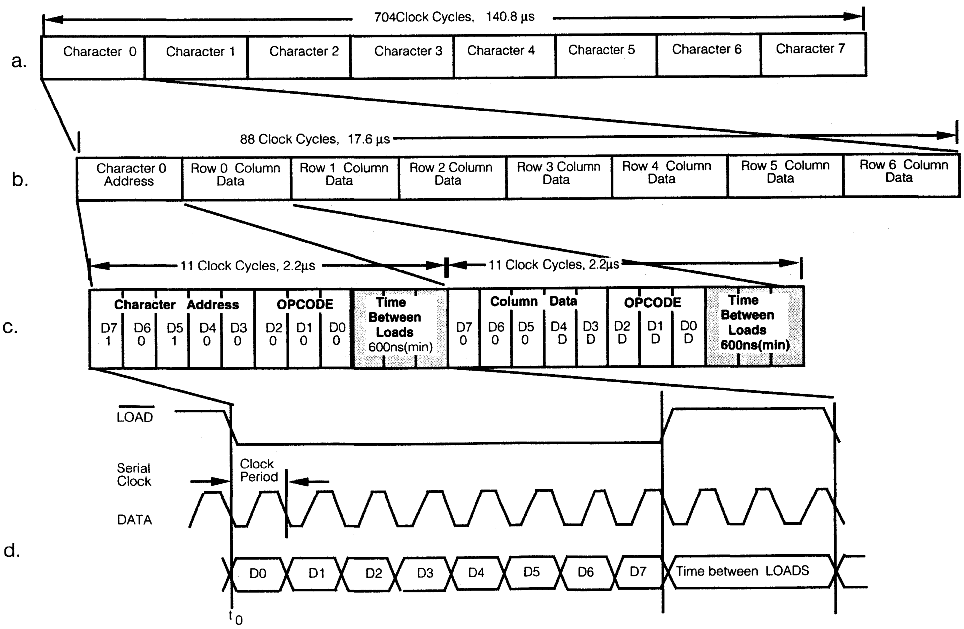
The Character Address Register selects the character address that the row and column data will be written to. See Table 2 for opcode and character addressing. After loading the Character Address Register, the next seven bytes load the column data, one row at a time, starting with row 0 (top row) and ending with row 6 (bottom row). Each character address has a 7 x 5 bit User RAM formatted as seven rows, each containing five column data bits. The three most significant bits, D7–D5 represent the opcode for the row data and the least significant five bits, D4–D0 represent the column data. See Table 3 for the column data format. If an address is loaded before all seven rows are written, the next column data will be loaded into Row 0 of the new address. The remaining rows of the old address are not changed.

Table 7 shows the Row Address for the example character, "D." Column data is written and read asynchronously from the 280 bit RAM. Once loaded, the internal oscillator and character multiplexer reads the data from the RAM. These characters are row strobed with column data as shown in Figures 8 and 9. The character strobe rate is determined by the internal or user supplied external MUX Clock and the ICs÷ 320 counter.

Table 7. Character "D"

	Op code D7 D6 D5	Column Data D4 D3 D2 D1 D0 C0 C1 C2 C3 C4	Hex
Row 0	0 0 0	1 1 1 1 0	1E
Row 1	0 0 0	1 0 0 0 1	11
Row 2	0 0 0	1 0 0 0 1	11
Row 3	0 0 0	1 0 0 0 1	11
Row 4	0 0 0	1 0 0 0 1	11
Row 5	0 0 0	1 0 0 0 1	11
Row 6	0 0 0	1 1 1 1 0	1E

Figure 7a–d. Loading Serial Character Data



The user can activate four Control functions. These include: LED Brightness Level, IC Power Down, Prescaler, or Display Clear. OPCODEs and six bit words are used to initiate these functions. The OPCODEs and Control Words for the Character Address and Loading Column Data are shown in Tables 2 and 3 .

Table 2. Load Character Address

Op code D7 D6 D5	Character Address D4 D3 D2 D1 D0	Hex	Operation Load
1 0 1	0 0 0 0 0	A0	Character 0
1 0 1	0 0 0 0 1	A1	Character 1
1 0 1	0 0 0 1 0	A2	Character 2
1 0 1	0 0 0 1 1	A3	Character 3
1 0 1	0 0 1 0 0	A4	Character 4
1 0 1	0 0 1 0 1	A5	Character 5
1 0 1	0 0 1 1 0	A6	Character 6
1 0 1	0 0 1 1 1	A7	Character 7

Table 3. Load Column Data

Op code D7 D6 D5	Column Data D4 D3 D2 D1 D0	Operation Load
0 0 0	C0 C1 C2 C3 C4	Row 0
0 0 0	C0 C1 C2 C3 C4	Row 1
0 0 0	C0 C1 C2 C3 C4	Row 2
0 0 0	C0 C1 C2 C3 C4	Row 3
0 0 0	C0 C1 C2 C3 C4	Row 4
0 0 0	C0 C1 C2 C3 C4	Row 5
0 0 0	C0 C1 C2 C3 C4	Row 6

The user can select eight specific LED brightness levels, Table 4. Depending on how D3 is selected either one (1) for maximum peak current or zero (0) for 12.5% of maximum peak current in the control word per Table 4a and 4b, the user can select 16 specific LED brightness levels. These brightness levels (in percentages of full brightness of the display) depending on how the user selects D3 can be one (1) or zero (0) are as follows: 100% ($E0_{HEX}$ or $E8_{HEX}$), 53% ($E1_{HEX}$ or $E9_{HEX}$), 40% ($E2_{HEX}$ or EA_{HEX}), 27% ($E3_{HEX}$ or EB_{HEX}), 20% ($E4_{HEX}$ or EC_{HEX}), 13% ($E5_{HEX}$ or ED_{HEX}), and 6.6% ($E6_{HEX}$ or EE_{HEX}), 0.0% ($E7_{HEX}$ or EF_{HEX}). The brightness levels are controlled by changing the duty factor of the row strobe pulse.

Table 4a. Display Brightness

Op code D7 D6	Control Word D5 D4 D3 D2 D1 D0	Hex	Operation Level
1 1	1 0 0 0 0 0	E0	100%
1 1	1 0 0 0 0 1	E1	53%
1 1	1 0 0 0 1 0	E2	40%
1 1	1 0 0 0 1 1	E3	27%
1 1	1 0 0 1 0 0	E4	20%
1 1	1 0 0 1 0 1	E5	13%
1 1	1 0 0 1 1 0	E6	6.6%
1 1	1 0 0 1 1 1	E7	0.0%

Table 4b. Display Brightness

Op code D7 D6	Control Word D5 D4 D3 D2 D1 D0	Hex	Operation Level
1 1	1 0 1 0 0 0	E0	100%
1 1	1 0 1 0 0 1	E1	53%
1 1	1 0 1 0 1 0	E2	40%
1 1	1 0 1 0 1 1	E3	27%
1 1	1 0 1 1 0 0	E4	20%
1 1	1 0 1 1 0 1	E5	13%
1 1	1 0 1 1 1 0	E6	6.6%
1 1	1 0 1 1 1 1	E7	0.0%

The SCE578X offers a unique Display Power Down feature which reduces I_{CC} to less than 150 µA total. When EF_{HEX} is loaded (Table 5) the display is set to 0% brightness. When in the Power Down mode data may still be written into the RAM. The display is reactivated by loading a new brightness Level Control Word into the display.

Table 5. Power Down

Op code D7 D6	Control Word D5 D4 D3 D2 D1 D0	Hex	Operation Level
1 1	1 0 1 1 1 1 1	EF	0% brightness

Figure 8. Row and Column Locations for a Character "D"

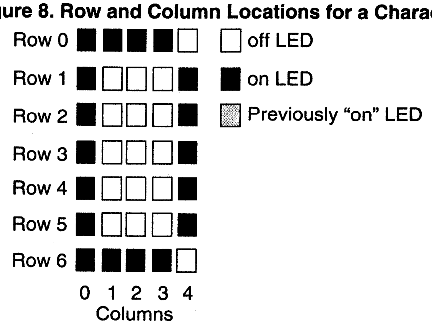
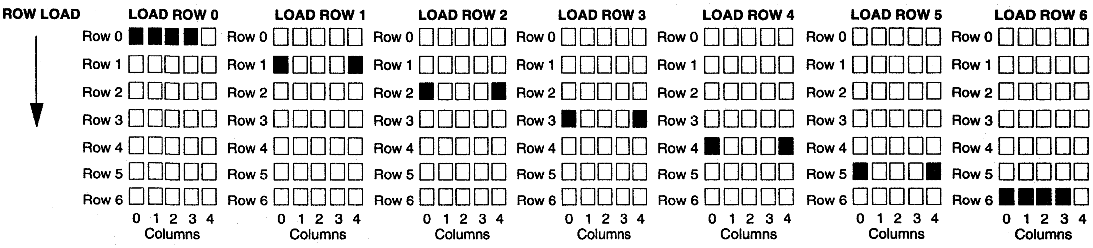


Figure 9. Row Strobing



The SCE578X allows a high frequency external oscillator source to drive the display. Data bit, D4, in the control word format controls the prescaler function. The prescaler allows the oscillator source to be divided by 16 by setting D4=1. However, the prescaler should not be used, i.e., when using the internal oscillator source.

The Software Clear ($C0_{HEX}$), given in Table 6, clears the Address Register and the RAM. The display is blanked and the Character Address Register will be set to Character 0. The internal counter and the Control Word Register are unaffected. The Software Clear will remain active until the next data input cycle is initiated.

Table 6. Software Clear

Op code D7 D6	Control Word D5 D4 D3 D2 D1 D0	Hex	Operation
1 1	0 0 0 0 0 0	C0	CLEAR

Multiplexer and Display Driver

The eight characters are row multiplexed with RAM resident column data. The strobe rate is established by the internal or external MUX Clock rate. The MUX Clock frequency is divided by a 320 counter chain. This results in a typical strobe rate of 768 Hz. By pulling the Clock SEL line low, the display can be operated from an external MUX Clock. The external clock is attached to the CLK I/O connection.

An asynchronous hardware Reset (pin 8) is also provided. Bringing this pin low will clear the Character Address Register, Control Word Register, RAM, and blanks the display. This action leaves the display set at Character Address 0, and the Brightness Level set at 100%, prescaler ÷ 1.

ELECTRICAL & MECHANICAL CONSIDERATIONS

Thermal Considerations

The display's power usage may need to be reduced to operate at high ambient temperatures. The power may be reduced by lowering the brightness level. reducing the total number of LEDs illuminated, or lowering V_{LED}. The V_{CC} supply, relative to the V_{LED} supply, has little effect on the power dissipation of the display and is not considered when determining the power dissipation.

Tot determine the power deration with a given ambient temperature, use the following formula:

$T_j max = T_A + P_D \bullet \theta_{ja}$

where: $T_j max$=maximum IC junction temperature
P_D=power dissipated by the ICs
θ_{ja}=thermal resistance, junction to ambient

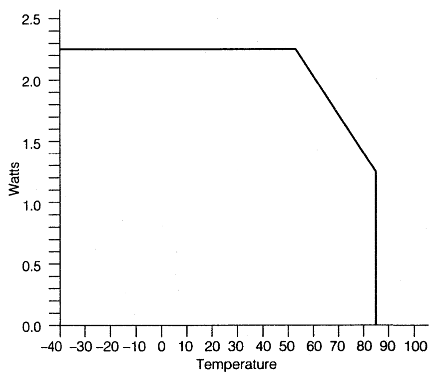
To determine the power dissipation of the display, use the following formula:

$P_D = N \bullet I_{LL}/140 \bullet RB$

where: N=number of LEDs on
$I_{LL}/140$=average current for a single LED
RB=relative brightness level

A typical thermal resistance vaule (θ_{ja}) for this display is 50°c/W when mounted in a socket soldered ona 0.062" thick PCB with 0.020", 1 ounce copper traces and the display covered by a plastic filter. The display's maximum IC junction temperature is 125°C. Paragraph 6.2.5, Power Deration Curve is based on these typical values.

Figure 10. Power Deration Curve (θ_{ja}=50°C/W)

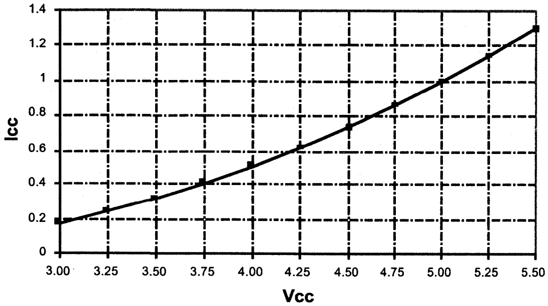


V_{CC} and V_{LL} are two separate power supplies sharing a common ground. V_{CC} supplies power for all the display logic. V_{LL} supplies the power for the LEDs. By separating the two supplies, $V_{CC}$and V_{LL} can be varied independently and keeps the logic supply clean.

V_{LL} can be varied between 3 volts and 5.5 volts. The LED drive current will vary with changes in V_{LL}. See Figure 11 for I_{LL} variance.

V_{CC} can vary between 3 volts and 5.5 volts. Operation below 4.5 volts will change the timing and switching levels of the inputs. Using 25% x V_{CC} for V_{IL} and 75% of V_{CC} for V_{IH} will work down to a V_{CC} level of 3 volts.

Figure 11. I_{LL} Variance



Interconnect Considerations

Optimum product performance can be had when the following electrical and mechanical recommendations are adopted. The SCE578X's IC is constructed in a high speed CMOS process, consequently high speed noise on the SERIAL DATA, SERIAL DATA CLOCK, $\overline{\text{LOAD}}$ and $\overline{\text{RESET}}$ lines may cause incorrect data to be written into the serial shift register. Adhere to transmission line termination procedures when using fast line drivers and long cables (>10 cm).

Good ground (pin 2) and power supply decoupling (pins 9 and 10) will insure that Icc (<800 mA peak) switching currents do not generate localized ground bounce. Therefore it is recommended that each display package use a 0.1µF and 20 µF tanulum capacitor between V_{CC} and ground.

When the internal MUX Clock is being used connect the $\overline{\text{CLKSEL}}$ pin to V_{CC}. In those applications where $\overline{\text{RESET}}$ will not be connected to the system's reset control, it is recommended that this pin be connected to the center node of a series 0.1, µF and 100 KΩ RC network. Thus upon initial power up the $\overline{\text{RESET}}$ will be held low for 10 ms allowing adequate time for the system power supply to stabilize.

ESD Protection

The input protection structure of the SCE578X provides significant protection against ESD damage. It is capable of withstanding discharges greater than 2 KV. Take all the standard precautions, normal for CMOS components. These include properly grounding personnel, tools, tables, and transport carriers that come in contact with unshielded parts. If these conditions are not, or cannot be met, keep the leads of the device shorted together or the parts in anti-static packaging.

Soldering Considerations

The SCE578X can be hand soldered with SN63 solder using a grounded iron set to 260°C.

Wave soldering is also possible following these conditions: Preheat that does not exceed 93°C on the solder side of the PC board or a package surface temperature of 85°C. Water soluble organic acid flux (except carboxylic acid) or resin-based RMA flux without alcohol can be used.

Wave temperature of 245°C ±5°C with a dwell between 1.5 sec. to 3.0 sec. Exposure to the wave should not exceed temperatures above 260°C for five seconds at 0.063" below the seating plane. The packages should not be immersed in the wave.

Post Solder Cleaning Procedures

The least offensive cleaning solution is hot D.I. water (60°C) for less than 15 minutes. Addition of mild saponifers is acceptable. Do not use commercial dishwasher detergents.

For faster cleaning, solvents may be used. Exercise care in choosing solvents as some may chemically attack the nylon package. For further information refer to Appnotes 18 and 19 in the current Siemens Optoelectronic Data Book. See Appnote 19, Table 1, "Displays–Group 2."

An alternative to soldering and cleaning the display modules is to use sockets. Naturally, 14 pin DIP sockets .300" wide with .100" centers work well for single displays. Multiple display assemblies are best handled by longer SIP sockets or DIP sockets when available for uniform package alignment. Socket manufacturers are Aries Electronics, Inc., Frenchtown, NJ; Garry Manufacturing, New Brunswick, NJ; Robinson-Nugent, New Albany, IN; and Samtec Electronic Hardward, New Albany, IN.

For further information refer to Appnote 22 in the current Siemens Optoelectronic Data Book.

Optical Considerations

The 0.180" high character of the SCE578X gives readability up to five feet. Proper filter selection enhances readability over this distance.

Using filters emphasizes the contrast ratio between a lit LED and the character background. This will increase the discrimination of different characters. The only limitation is cost. Take into consideration the ambient lighting environment for the best cost/benefit ratio for filters.

Incandescent (with almost no green) or fluorescent (with almost no red) lights do not have the flat spectral response of sunlight. Plastic band-pass filters are an inexpensive and effective way to strengthen contrast ratios. The SCE5780 is a red display and should be used with long wavelength pass filter having a sharp cut-off in the 600 nm to 620 nm range. The SCE5782 is a high efficiency red display and should be used with long wavelength pass filter having a sharp cut-off in the 570 nm to 600 nm range. The SCE5784 is a high efficiency green display and should be used with long wavelength pass filter that peaks at 565 nm.

Additional contrast enhancement is gained by shading the displays. Plastic band-pass filters with built-in louvers offer the next step up in contrast improvement. Plastic filters can be improved further with anti-reflective coatings to reduce glare. The trade-off is fuzzy characters. Mounting the filters close to the display reduces this effect. Take care not to overheat the plastic filter by allowing for proper air flow.

Optimal filter enhancements are gained by using circular polarized, anti-reflective, band-pass filters. The circular polarizing further enhances contrast by reducing the light that travels through the filter and reflects back off the display to less than 1%.

Several filter manufacturers supply quality filter materials. Some of them are: Panelgraphic Corporation, W. Caldwell, NJ; SGL Homalite, Wilmington, DE; 3M Company, Visual Products Division, St. Paul, MN; Polaroid Corporation, St. Paul, MN; Polaroid Corporation, Polarizer Division, Cambridge, MA; Marks Polarized Corporation, Deer Park, NY, Hoya Optics, Inc., Fremont, CA.

One last note on mounting filters: recessing displays and bezel assemblies is an inexpensive way to provide a shading effect in overhead lighting situations. Several Bezel manufacturers are: R.M.F. Products, Batavia, IL; Nobex Components, Griffith Plastic Corp., Burlingame, CA; Photo Chemical Products of California, Santa Monica, CA; I.E.E.-Atlas, Van Nuys, CA.

Microprocessor Interface

The microprocessor interface is through the serial port, SPI port or one out of eight data bits on the eight bit parallel port and also control lines $\overline{SDCLK}$ and $\overline{LOAD}$.

Power Up Sequence

Upon power up display will come on at random. Thus the display should be reset at power-up. The reset will set the Address Register to Digit 0, User RAM is set to 0 (display blank) the Control Word is set to 0 (100% brightness) and the internal counters are reset.

Loading Data into the Display

Use following procedure to load data into the display:

1. Power up the display.
2. Bring $\overline{RST}$ low (600 ns duration minimum) to clear the Multiplex Counter, Address Register, Control Word Register, User Ram and Data Register. The display will be blank. Display brightness is set to 100%.
3. If a different brightness is desired, load the proper brightness opcode into the Control Word Register.
4. Load the Digit Address into the display.
5. Load display row and column data for the selected digit.
6. Repeat steps 4 and 5 for all digits.

Data Contents for the Word "ABCDEFG"

Step	D7	D6	D5	D4	D3	D2	D1	D0	Function
A	1	1	0	0	0	0	0	0	CLEAR
B	1	1	1	0	0	0	0	0	100% BRIGHTNESS
1	1	0	1	0	0	0	0	0	DIGIT D0 SELECT
2	0	0	0	0	0	1	0	0	ROW 0 (A)
3	0	0	0	0	1	0	1	0	ROW 1 A)
4	0	0	0	1	0	0	0	1	ROW 2 (A)
5	0	0	0	1	1	1	1	1	ROW 3 (A)
6	0	0	0	1	0	0	0	1	ROW 4 (A)
7	0	0	0	1	0	0	0	1	ROW 5 (A)
8	0	0	0	1	0	0	0	1	ROW 6 (A)
9	1	0	1	0	0	0	0	1	DIGIT D1 SELECT
10	0	0	0	1	1	1	1	1	ROW 0 (B)
11	0	0	0	1	0	0	0	1	ROW 1 (B)
12	0	0	0	1	0	0	0	1	ROW 2 (B)
13	0	0	0	1	1	1	1	0	ROW 3 (B)
14	0	0	0	1	0	0	0	1	ROW 4 (B)
15	0	0	0	1	0	0	0	1	ROW 5 (B)
16	0	0	0	1	1	1	1	1	ROW 6 (B)
17	1	0	1	0	0	0	1	0	DIGIT D2 SELECT
18	0	0	0	0	0	1	1	1	ROW 0 (C)
19	0	0	0	0	1	0	0	0	ROW 1 (C)
20	0	0	0	1	0	0	0	0	ROW 2 (C)
21	0	0	0	1	0	0	0	0	ROW 3 (C)
22	0	0	0	1	0	0	0	0	ROW 4 (C)
23	0	0	0	0	1	0	0	0	ROW 5 (C)
24	0	0	0	0	0	1	1	1	ROW 6 (C)
25	1	0	1	0	0	0	1	1	DIGIT D3 SELECT
26	0	0	0	1	1	1	1	0	ROW 0 (D)
27	0	0	0	1	0	0	0	1	ROW 1 (D)
28	0	0	0	1	0	0	0	1	ROW 2 (D)
29	0	0	0	1	0	0	0	1	ROW 3 (D)
30	0	0	0	1	0	0	0	1	ROW 4 (D)
31	0	0	0	1	0	0	0	1	ROW 5 (D)
32	0	0	0	1	1	1	1	0	ROW 6 (D)
33	1	0	1	0	0	1	0	0	DIGIT D4 SELECT
34	0	0	0	1	1	1	1	1	ROW 0 (E)
35	0	0	0	1	0	0	0	0	ROW 1 (E)
36	0	0	0	1	0	0	0	0	ROW 2 (E)
37	0	0	0	1	1	1	1	0	ROW 3 (E)
38	0	0	0	1	0	0	0	0	ROW 4 (E)
39	0	0	0	1	0	0	0	0	ROW 5 (E)
40	0	0	0	1	1	1	1	1	ROW 6 (E)
41	1	0	1	0	0	1	0	1	DIGIT D5 SELECT
42	0	0	0	1	1	1	1	1	ROW 0 (F)
43	0	0	0	1	0	0	0	0	ROW 1 (F)
44	0	0	0	1	0	0	0	0	ROW 2 (F)
45	0	0	0	1	1	1	1	0	ROW 3 (F)
46	0	0	0	1	0	0	0	0	ROW 4 (F)
47	0	0	0	1	0	0	0	0	ROW 5 (F)
48	0	0	0	1	0	0	0	0	ROW 6 (F)
49	1	0	1	0	0	1	1	0	DIGIT D6 SELECT
50	0	0	0	0	1	1	1	0	ROW 0 (G)
51	0	0	0	1	0	0	0	1	ROW 1 (G)
52	0	0	0	1	0	0	0	0	ROW 2 (G)
53	0	0	0	1	0	0	0	0	ROW 3 (G)
54	0	0	0	1	0	0	1	1	ROW 4 (G)
55	0	0	0	1	0	0	0	1	ROW 5 (G)
56	0	0	0	0	1	1	1	0	ROW 6 (G)
57	1	0	1	0	0	1	1	1	DIGIT D7 SELECT
58	0	0	0	1	0	0	0	1	ROW 0 (H)
59	0	0	0	1	0	0	0	1	ROW 1 (H)
60	0	0	0	1	0	0	0	1	ROW 2 (H)
61	0	0	0	1	1	1	1	1	ROW 3 (H)
61	0	0	0	1	0	0	0	1	ROW 4 (H)
62	0	0	0	1	0	0	0	1	ROW 5 (H)
63	0	0	0	1	0	0	0	1	ROW 6 (H)

Figure 12. Display Interface to Siemens/Intel 8031 Microprocessor (using serial port in mode 0)

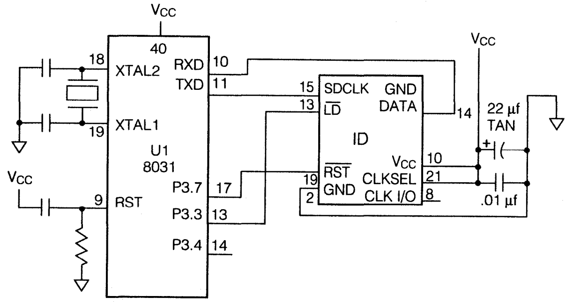


Figure 13. Display Interface to Siemens/Intel 8031 Microprocessor (using one bit of parallel port as serial port)

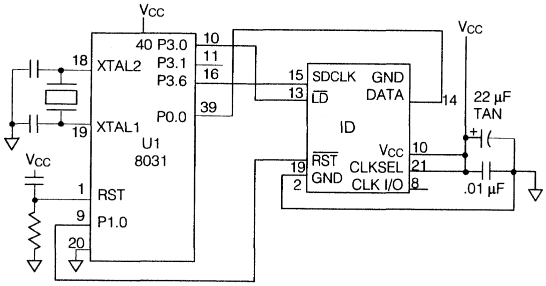


Figure 14. Display Interface with Motoroal 68HC05C4 Microprocessor (using SPI Port)

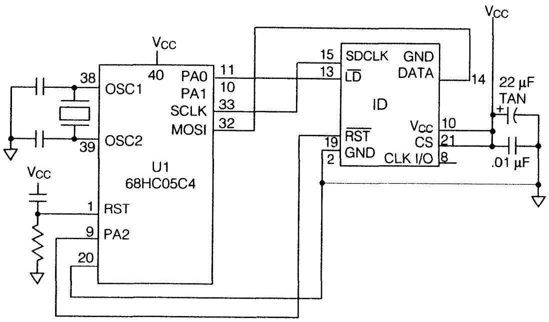
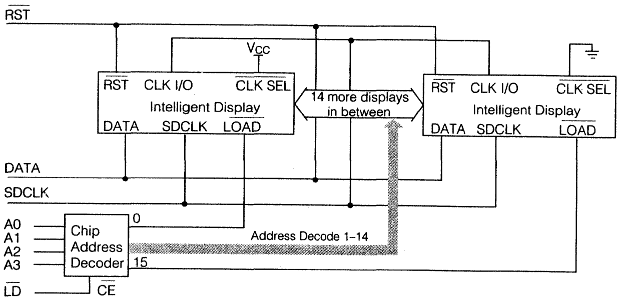


Figure 15. Cascading Multiple Displays



Multiple displays can be cascaded using the $\overline{\text{CLK SEL}}$ and CLK I/O pins (Figure 15). The display designated as the Master-Clock source should have its $\overline{\text{CLK SEL}}$ pin tied high and the slaves should have their $\overline{\text{CLK SEL}}$ pins tied low. All CLK I/O pins should be tied together. One display CLK I/O can drive 15 slave CLK I/Os. Use $\overline{\text{RST}}$ to synchronize all display counters.

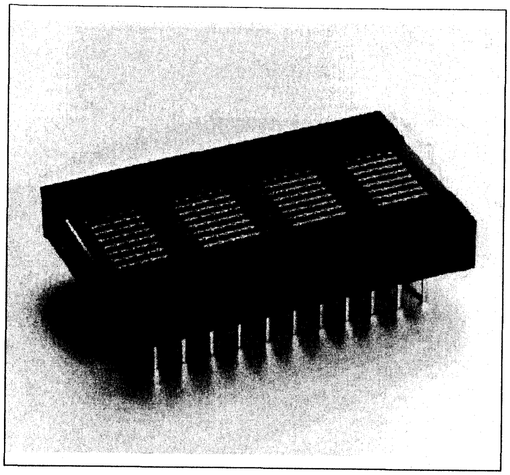
Character Set

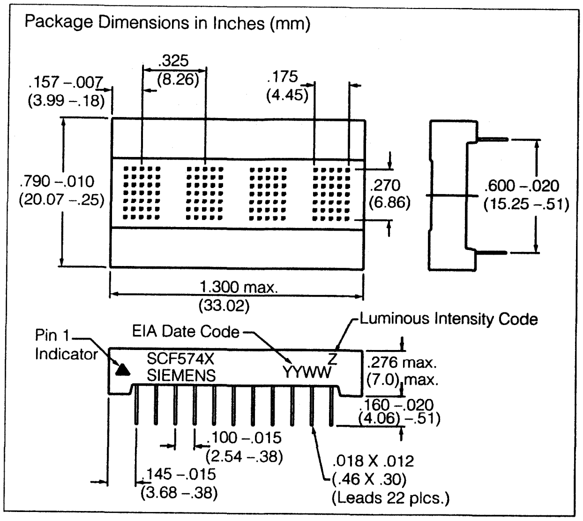
HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE		HEX CODE	
02 06 0E 1E 0E 06 02		04 00 04 08 11 11 0E		1F 00 11 0A 04 0A 11		1F 00 11 19 15 13 11		1F 00 16 19 11 11 11		00 00 0D 12 12 12 0D		0C 12 12 16 11 16 10		06 08 04 0E 11 11 0E	
00 00 00 04 0A 11 1F		00 10 1C 12 12 02 01		0E 11 11 1F 11 11 0E		00 10 08 04 0A 11 11		00 00 09 09 09 0E 10		00 01 0E 1A 0A 0A 0A		00 00 0F 12 12 12 0C		1F 08 04 02 04 08 1F	
00 00 01 0E 14 04 04		00 04 0E 15 15 0E 04		0E 11 11 11 11 0A 1B		04 00 0E 11 1F 11 11		04 00 0E 12 12 12 0D		0A 00 0E 11 1F 11 11		0A 00 0E 12 12 12 0D		0A 0E 11 11 11 11 0E	
0A 00 0E 11 11 11 0E		0A 00 11 11 11 11 0E		00 0A 00 11 11 11 0E		00 04 02 1F 02 04 00		00 0F 08 08 08 18 08		0C 12 04 08 1E 00 00		06 09 08 1C 08 08 1F		11 0A 04 04 0E 04 04	
00 00 00 00 00 00 00		04 04 04 04 04 00 04		0A 0A 00 00 00 00 00		0A 0A 1F 0A 1F 0A 0A		04 0F 14 0E 05 1E 04		18 19 02 04 08 13 03		08 14 14 08 15 12 0D		0C 0C 04 08 00 00 00	
02 04 04 04 04 04 02		08 04 04 04 04 04 08		00 0A 04 1F 04 0A 00		00 04 04 1F 04 04 00		00 00 00 18 18 08 10		00 00 00 1F 00 00 00		00 00 00 00 00 0C 0C		00 01 02 04 08 10 00	
0E 11 13 15 19 11 0E		04 0C 04 04 04 04 0E		0E 11 01 06 08 10 1F		0E 11 01 0E 01 11 0E		02 06 0A 12 1F 02 02		1F 10 1E 01 01 01 1E		06 08 10 1E 11 11 0E		1F 01 02 04 08 08 08	
0E 11 11 0E 11 11 0E		0E 11 11 0F 01 02 0C		00 0C 0C 00 0C 0C 00		0C 0C 00 0C 0C 04 08		01 02 04 08 04 02 01		00 00 1F 00 1F 00 00		10 08 04 02 04 08 10		0E 11 01 02 04 00 04	
0E 11 17 15 17 10 0E		0E 11 11 1F 11 11 11		1E 11 11 1E 11 11 1E		0E 11 10 10 10 11 0E		1E 11 11 11 11 11 1E		1F 10 10 1E 10 10 1F		1F 10 10 1E 10 10 10		0E 11 10 10 13 11 0E	
11 11 11 1F 11 11 11		07 04 04 04 04 04 07		01 01 01 01 01 11 0E		11 12 14 18 14 12 11		10 10 10 10 10 10 1F		11 1B 15 15 11 11 11		11 11 19 15 13 11 11		0E 11 11 11 11 11 0E	
1E 11 11 1E 10 10 10		0E 11 11 11 15 12 0D		1E 11 11 1E 14 12 11		0E 11 10 0E 01 11 0E		1F 04 04 04 04 04 04		11 11 11 11 11 11 0E		11 11 11 0A 0A 04 04		11 11 11 15 15 1B 11	
11 11 0A 04 0A 11 11		11 11 0A 04 04 04 04		1F 01 02 04 08 10 1F		07 04 04 04 04 04 07		00 10 08 04 02 01 00		1C 04 04 04 04 04 1C		04 0E 15 04 04 04 04		00 00 00 00 00 00 1F	
0C 0C 08 04 00 00 00		00 00 0E 12 12 12 0D		10 10 10 16 19 11 1E		00 00 0E 10 10 11 0E		01 01 01 0D 13 11 0F		00 00 0E 11 1E 10 0E		04 0A 08 1C 08 08 08		00 00 0F 11 0F 01 06	
10 10 16 19 11 11 11		00 04 00 0C 04 04 0E		02 00 06 02 02 12 0C		10 10 12 14 18 14 12		0C 04 04 04 04 04 0E		00 00 0A 15 11 11 11		00 00 16 19 11 11 11		00 00 0E 11 11 11 0E	
00 00 1E 11 19 16 10		00 00 0F 11 13 0D 01		00 00 0B 0C 08 08 08		00 00 0E 10 0E 01 1E		08 08 1C 08 08 0A 04		00 00 11 11 11 13 0D		00 00 11 11 11 0A 04		00 00 11 11 15 15 0A	
00 00 11 0A 04 0A 11		00 00 11 0A 04 04 08		00 00 1F 02 04 08 1F		02 04 04 08 04 04 02		04 04 04 00 04 04 04		18 04 04 02 04 04 08		00 00 08 15 02 00 00		0A 15 0A 15 0A 15 0A	

SIEMENS

STANDARD RED SCF5740
HIGH EFFICIENCY RED SCF5742
HIGH EFFICIENCY GREEN SCF5744

0.270" 4-Character, 5x7 Dot Matrix Serial Input Dot Addressable Intelligent Display™





FEATURES

- **Four 0.270" (6.85 mm) 5 x 7 Dot Matrix Characters in Red, High Efficiency Red, High Efficiency Green**
- **Optimum Display Surface Efficiency (display area to package ratio)**
- **High Speed Data Input Rate: 5 MHz**
- **ROMless Serial Input, Dot Addressable Display Ideal for User Defined Characters**
- **Built-in Decoders, Multiplexers and LED Drivers**
- **Readable from 6 Feet (1.8 meters)**
- **Wide Viewing Angle, X Axis ±55°, Y Axis ±55°**
- **Attributes**
  - **140 Bit RAM for User Defined Characters**
  - **Eight Dimming Levels**
  - **Power Down Model (<250 µW)**
  - **Hardware/Software Clear Functions**
  - **Internal or External Clock**

DESCRIPTION

The SCF574X is a four digit, dot addressable 5x7 dot matrix, serial input, alphanumeric Intelligent Display. The four digits are packaged in a rugged, high quality, optically transparent, plastic 22 pin DIP with 0.1" pin spacing.

The on-board CMOS has a 140 bit RAM, one bit associated with one LED, each to generate User Defined Characters. In Power Down Mode, quiescent current is <50 µA.

The SCF574X is designed for work with the serial port of most common microprocessors. Data is transferred into the display through the Serial Data Input (DATA), clocked by the Serial Data Clock (SDCLK), and enabled by the Load Input (LOAD).

The Clock I/O (CLK I/O) and Clock Select ($\overline{\text{CLK SEL}}$) pins offer the user the capability to supply a high speed external multiplex clock. This feature can minimize audio in-band interference for portable communication equipment or eliminate the visual sychronization effects found in high vibration environments such as avionic equipment.

Maximum Rating

DC Supply Voltage .... –0.5 to +7.0 Vdc
Input Voltage Levels Relative
to Ground .... –0.5 to V_{CC}+0.5 Vdc
Operating Temperature .... –40°C to +85°C
Storage Temperature .... –40°C to +100°C
Maximum Solder Temperature 0.063"
below Seating Plane, t<5 sec .... 260°C
Relative Humidity at 85°C 85%
Maximum Number of LEDs at 100% Brightness 64
Maximum Power Dissipation .... 0.65 W
ESD (100 pF, 1.5 KΩ) .... 2 KV
Maximum Input Current .... ±186 mA

Switching Specifications
(over operating temperature range and V_{CC}=4.5 V to 5.5 V)

Symbol	Description	Min.	Units
T_{RC}	Reset Active Time	600	ns
T_{LDS}	Load Setup Time	50	ns
T_{DS}	Data Setup Time	50	ns
T_{SDCLK}	Clock Period	200	ns
T_{SDCW}	Clock Width	70	ns
T_{LDH}	Load Hold Time	0	ns
T_{DH}	Data Hold Time	25	ns
T_{WR}	Total Write Time	2.2	µs
T_{BL}	Time Between Loads	600	ns

Note:
TSDCW is the minimum time the SDCLK may be low or high. The SDCLK period must be a minimum of 200 ns.

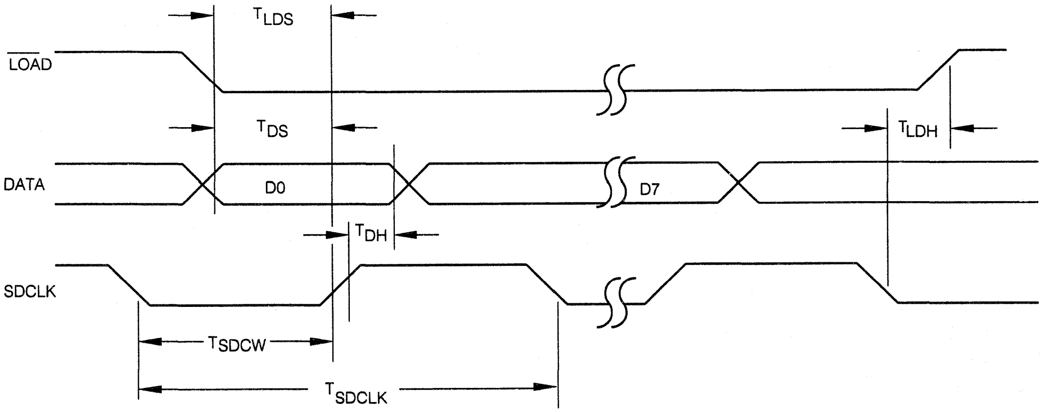


Figure 1. Timing diagram–Data write cycle

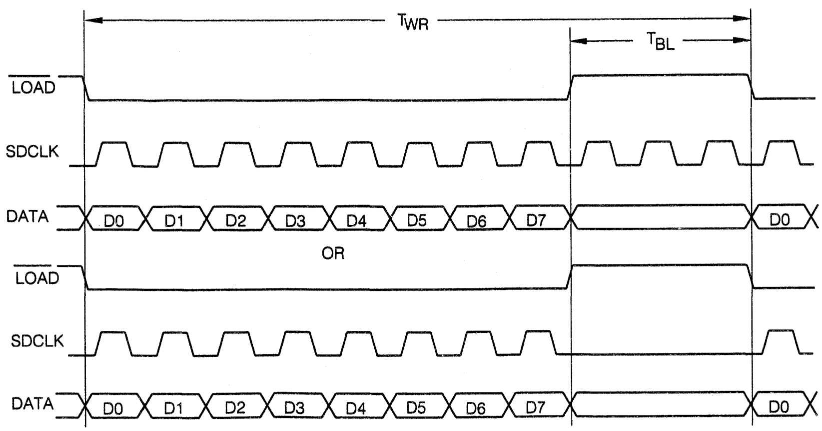


Figure 2. Timing diagram–Instruction cycle

Intelligent Display Devices 2

SCF5740/2/4

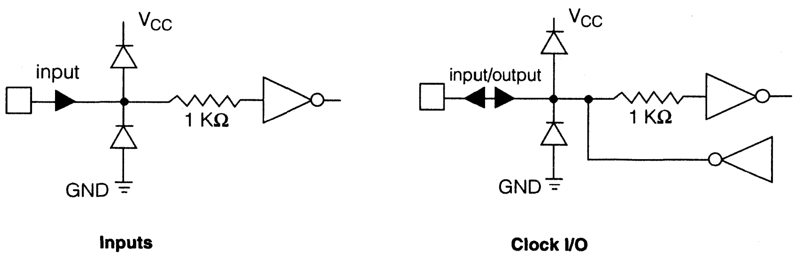
Electrical Characteristics (over Operating Temperature)

Parameter	Min.	Typ.	Max.	Units	Conditions
V_{CC}	4.5	5.0	5.5	V	
I_{CC} (Pwr Dwn Mode)(4)			50	µA	V_{CC}=5 V, all inputs=0 V or V_{CC}
I_{CC} 4 digits 20 dots/character		150	186	mA	V_CC=5 V, "#" displayed in all 4 digits at 100% brightness at 25°C
I_{IL} Input current			–10	µA	V_{CC}=5 V, V_{IN}=0 V (all inputs)
I_{IH} Input current			+10	µA	V_{CC}=V_{IN}=5.0 V=0 V (all inputs)
V_{IH}	3.5			V	V_{CC}=4.5 V to 5.5 V
V_{IL}			1.5	V	V_{CC}=4.5 V to 5.5 V
I_{OH} (CLK I/O)		–28		mA	V_{CC}=4.5 V, V_{OH}=2.4 V
I_{OL} (CLK I/O)		23		mA	V_{CC}=4.5 V, V_{OL}=0.4 V
θ_{JC-PIN}			32	°C/W	
F_{ext} External Clock Input Frequency	120		347	KHz	V_{CC}=5.0 V, $\overline{CLKSEL}$=0
F_{osc} Internal Clock Input Frequency	120		347	KHz	V_{CC}=5.0 V, $\overline{CLKSEL}$=1
Clock I/O Bus Loading			240	pF	
Clock Out Rise Time			500	ns	V_{CC}=4.5 V, V_{OH}=2.4 V
Clock Out Fall Time			500	ns	V_{CC}=4.5 V, V_{OH}=0.4 V
FM, Digit	375	768	1086	Hz	

Notes
1. Peak current $^5/_3$ x I_{CC}.
2. Unused inputs must be tied high.
3. Contact Siemens for 3.3 volt operation.
4. External oscillator must be stopped if being used to maintain an I_{CC} <50µA.

Input/Output Circuits

Figures 3 and 4 show the input and output resistor/diode networks used for ESD protection and to eliminate substrate latch-up caused by input voltage over/under shoot.



Figures 3 and 4.

Optical Characteristics at 25°C

V_{CC}=5.0 V at 100% Brightness Level, Viewing Angle: X Axis ±55°, Y Axis ±65°

Red SCF5740

Description	Symbol	Min.	Typ.	Units
Luminous Intensity per dot	I_V	55		µcd/dot
Peak Wavelength	λ(peak)		655	nm
Dominant Wavelength	λ(d)		639	nm

High Efficiency Red SCF5742

Description	Symbol	Min.	Typ.	Units
Luminous Intensity per dot	I_V	110		µcd/dot
Peak Wavelength	λ(peak)		630	nm
Dominant Wavelength	λ(d)		626	nm

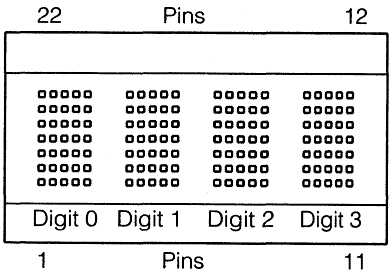
High Efficiency Green SCF5744

Description	Symbol	Min.	Typ.	Units
Luminous Intensity per dot	I_V	110		µcd/dot
Peak Wavelength	λ(peak)		568	nm
Dominant Wavelength	λ(d)		574	nm

Notes

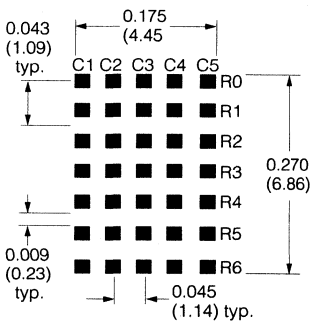
1. Dot to dot intensity matching at 100% brightness is 1.8:1.
2. Displays within a given intensity category have an intensity matching of 1.5:1 (max.)

Top View



Pin Assignment

Pin	Function	Pin	Function
1	N/C	22	N/C
2	GND	21	CLKSEL
3	N/C	20	CLK I/O
4	N/C	19	$\overline{RST}$
5	N/C	18	N/C
6	N/C	17	N/C
7	N/C	16	N/C
8	N/C	15	SCLK
9	V_{LL}	14	DATA
10	V_{CC}	13	$\overline{LOAD}$
11	N/C	12	N/C



Dimensions in inches (mm)
Tolerance: .XXX ±.010 (.25)

Figure 5. Dot Matrix Format

Pin Definitions

Pin	Function	Definitions
1	N/C	
2	GND	Power supply ground
3	N/C	
4	N/C	
5	N/C	
6	N/C	
7	N/C	
8	N/C	
9	V_{LL}	LED supply
10	V_{CC}	Logic supply
11	N/C	
12	N/C	
13	$\overline{LOAD}$	Low input enables data clocking into 8-bit serial shift register. When load goes high, the contents of 8-bit serial shift register will be decoded.
14	DATA	Serial data input
15	SDCLK	For loading data into the 8-bit serial data register
16	N/C	
17	N/C	
18	N/C	
19	$\overline{RST}$	Asynchronous input, when low clears the multiplex counter, address register, control word register, user RAM and data registe. Control word register is set to 100% brightness. The display will be blank.
20	CLK I/O	Outputs Master Clock or inputs External Clock
21	CLKSEL	High=Internal Clock (Master) Low=External Clock (Slave)
22	N/C	

Display Column and Row Format

	C 0	C 1	C 2	C 3	C 4
Row 0	1	1	1	1	1
Row 1	0	0	1	0	0
Row 2	0	0	1	0	0
Row 3	0	0	1	0	0
Row 4	0	0	1	0	0
Row 5	0	0	1	0	0
Row 6	0	0	1	0	0

1=Display dot "On"
0=Display dot "Off'

Column Data Ranges

Row 0	00H to 1FH
Row 1	00H to LFH
Row 2	00H to LFH
Row 3	00H to LFH
Row 4	00H to LFH
Row 5	00H to LFH
Row 6	00H to LFH

Operation of the SCF574X

The SCF574X display consists of a CMOS IC containing control logic and drivers for four 5x7 characters. Theres components are assembled in a compact plastic package.

Individual LED dot addressability allows the user great freedom in creating special characters or mini-icons.

The serial data interface provides a highly efficient interconnection between the display and the mother board. The SCF574X requires only three lines as compared to 14 for an equivalent four character parallel input part.

The on-board CMOS IC is the electronic heart of the display. The IC accepts decoded serial data, which is stored in the internal RAM. Asynchronously the RAM is read by the character multiplexer at a strobe rate that results in a flicker free display. Figure 6 shows the three functional areas of the IC. These include: the input serial data register and control logic, a 140 bits two port RAM, and an internal multiplexer/display driver.

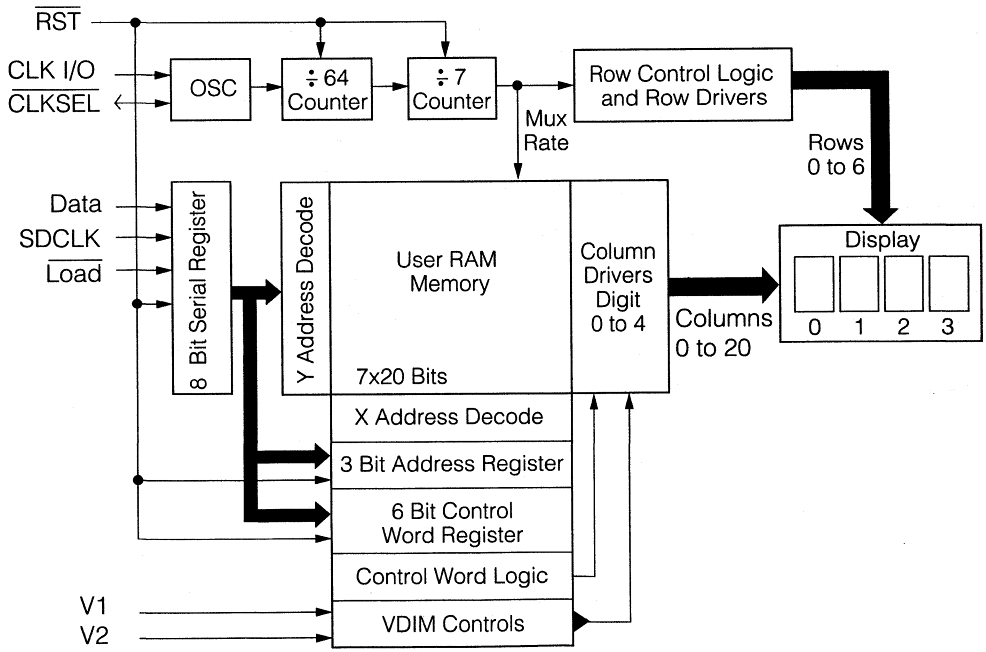


Figure 6. Block Diagram

The following explains how to format the serial data to be loaded into the display. The user supplies a string of bit mapped decoded characters. The contents of this string is shown in Figure 7a. Figure 7b shows that each character consist of eight 8 bit words. The first word encodes the display character location and the succeeding seven bytes are row data. The row data represents the status (On, Off) of individual column LEDs. Figure 7c shows that each 8 bit word is formatted to represent Character Address, or Column Data.

Figure 7d shows the sequence for loading the bytes of data. Bringing the $\overline{LOAD}$ line low enables the serial register to accept data. The shift action occurs on the low to high transition of the serial data clock (SDCLK). The least significant bit (D0) is loaded first. After eight clock pulses the $\overline{LOAD}$ line is brought high. With this transition the OPCODE is decoded. The decoded OPCODE directs D4–D0 to be latched in the Character Address register, stored in the RAM as Column data, or latched in the Control Word register. The control IC requires a minimum 600 ns delay between successive byte loads. As indicated in Figure 7a, a total of 256 bits of data are required to load all four characters into the display.

The Character Address Register bits, D4–D0 (Table 2), and Row Address Register bits, D7–D5 (Table 3), direct the Column Data bits, D4–D0 (Table 3) to specific RAM location.

Table 7 shows the Row Address for the example character "D." Column data is written and read asynchronously from the 140 bit RAM. Once loaded the internal oscillator and character multiplexer reads the data from the RAM. These characters are row strobed with column data as shown in Figures 8 and 9. The character strobe rate is determined by the internal or user supplied external MUX Clock and the IC's ÷ 320 counter.

Table 7. Character "D"

	Op code D7 D6 D5	Column Data D4 D3 D2 D1 D0 C0 C1 C2 C3 C4	Hex
Row 0	0 0 0	1 1 1 1 0	1E
Row 1	0 0 0	1 0 0 0 1	11
Row 2	0 0 0	1 0 0 0 1	11
Row 3	0 0 0	1 0 0 0 1	11
Row 4	0 0 0	1 0 0 0 1	11
Row 5	0 0 0	1 0 0 0 1	11
Row 6	0 0 0	1 1 1 1 0	1E

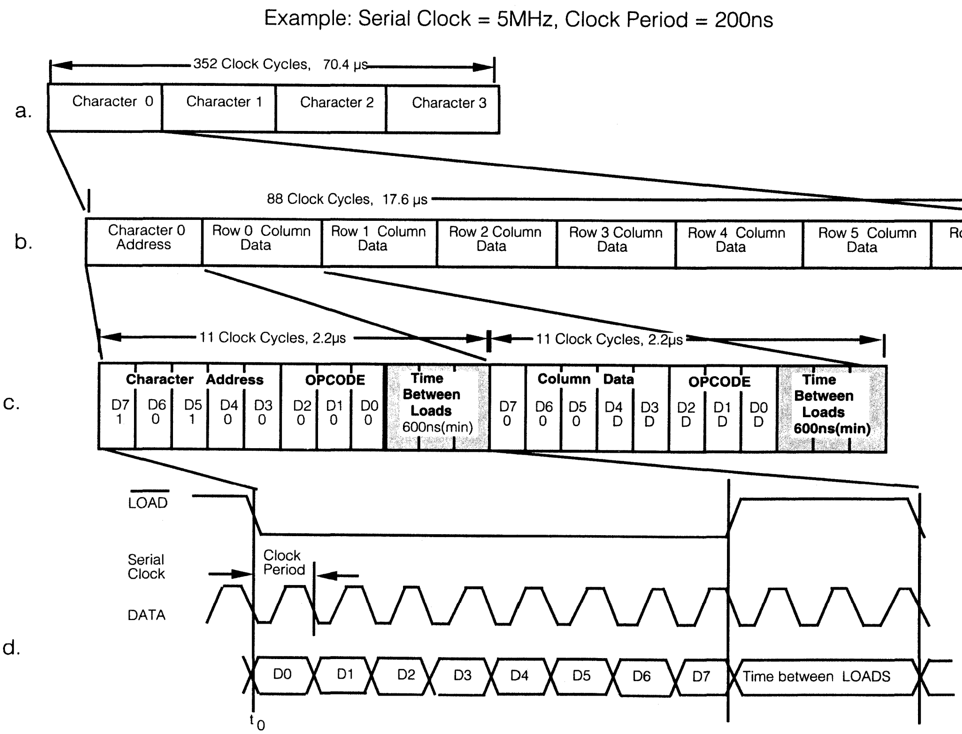


Figure 7a–d. Loading Serial Character Data

The user can activate four Control functions. These include: LED Brightness Level, IC Power Down, Prescaler, or Display Clear. OPCODEs and six bit words are used to initiate these functions. The OPCODEs and Control Words for the Character Address and Loading Column Data are shown in Tables 2 and 3 .

Table 2. Load Character Address

Op code D7 D6 D5	Character Address D4 D3 D2 D1 D0	Hex	Operation Load
1 0 1	0 0 0 0 0	A0	Character 0
1 0 1	0 0 0 0 1	A1	Character 1
1 0 1	0 0 0 1 0	A2	Character 2
1 0 1	0 0 0 1 1	A3	Character 3

Table 3. Load Column Data

Op code D7 D6 D5	Column Data D4 D3 D2 D1 D0	Operation Load
0 0 0	C0 C1 C2 C3 C4	Row 0
0 0 0	C0 C1 C2 C3 C4	Row 1
0 0 0	C0 C1 C2 C3 C4	Row 2
0 0 0	C0 C1 C2 C3 C4	Row 3
0 0 0	C0 C1 C2 C3 C4	Row 4
0 0 0	C0 C1 C2 C3 C4	Row 5
0 0 0	C0 C1 C2 C3 C4	Row 6

The user can select eight specific LED brightness levels, Table 4. Depending on how D3 is selected either one (1) for maximum peak current or zero (0) for 12.5% of maximum peak current in the control word per Table 4a and 4b, the user can select 16 specific LED brightness levels. These brightness levels (in percentages of full brightness of the display) depending on how the user selects D3 can be one (1) or zero (0) are as follows: 100% ($E0_{HEX}$ or $E8_{HEX}$), 53% ($E1_{HEX}$ or $E9_{HEX}$), 40% ($E2_{HEX}$ or EA_{HEX}), 27% ($E3_{HEX}$ or EB_{HEX}), 20% ($E4_{HEX}$ or EC_{HEX}), 13% ($E5_{HEX}$ or ED_{HEX}), and 6.6% ($E6_{HEX}$ or EE_{HEX}), 0.0% ($E7_{HEX}$ or EF_{HEX}). The brightness levels are controlled by changing the duty factor of the row strobe pulse.

Table 4a. Display Brightness

Op code D7 D6	Control Word D5 D4 D3 D2 D1 D0	Hex	Operation Level
1 1	1 0 0 0 0 0	E0	100%
1 1	1 0 0 0 0 1	E1	53%
1 1	1 0 0 0 1 0	E2	40%
1 1	1 0 0 0 1 1	E3	27%
1 1	1 0 0 1 0 0	E4	20%
1 1	1 0 0 1 0 1	E5	13%
1 1	1 0 0 1 1 0	E6	6.6%
1 1	1 0 0 1 1 1	E7	0.0%

Table 4b. Display Brightness

Op code D7 D6	Control Word D5 D4 D3 D2 D1 D0	Hex	Operation Level
1 1	1 0 1 0 0 0	E0	100%
1 1	1 0 1 0 0 1	E1	53%
1 1	1 0 1 0 1 0	E2	40%
1 1	1 0 1 0 1 1	E3	27%
1 1	1 0 1 1 0 0	E4	20%
1 1	1 0 1 1 0 1	E5	13%
1 1	1 0 1 1 1 0	E6	6.6%
1 1	1 0 1 1 1 1	E7	0.0%

The SCF574X offers a unique Display Power Down feature which reduces ICC to less than 50 µA. When EF_{HEX} is loaded (Table 5) the display is set to 0% brightness. When in the Power Down mode data may still be written into the RAM. The display is reactivated by loading a new brightness Level Control Word into the display.

Table 5. Power Down

Op code D7 D6	Control Word D5 D4 D3 D2 D1 D0	Hex	Operation Level
1 1	1 0 1 1 1 1	EF	0% brightness

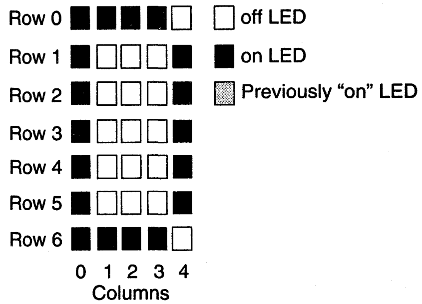


Figure 8. Row and Column Locations for a Character "D"

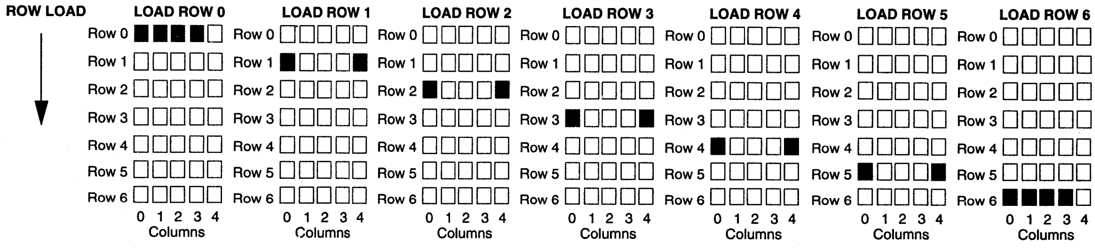


Figure 9. Row Strobing

The SCF574X allows a high frequency external oscillator source to drive the display. Data bit, D4, in the control word format controls the prescaler function. The prescaler allows the oscillator source to be divided by 16 by setting D4=1. However, the prescaler should not be used, i.e., when using the internal oscillator source.

The Software Clear ($C0_{HEX}$), given in Table 6, clears the Address Register and the RAM. The display is blanked and the Character Address Register will be set to Character 0. The internal counter and the Control Word Register are unaffected. The Software Clear will remain active until the next data input cycle is initiated.

Table 6. Software Clear

Op code D7	D6	Control Word D5	D4	D3	D2	D1	D0	Hex	Operation
1	1	0	0	0	0	0	0	C0	CLEAR

Multiplexer and Display Driver

The four characters are row multiplexed with RAM resident column data. The strobe rate is established by the internal or external MUX Clock rate. The MUX Clock frequency is divided by a 448 counter chain. This results in a typical strobe rate of 768 Hz. By pulling the Clock SEL line low, the display can be operated from an external MUX Clock. The external clock is attached to the CLK I/O connection (pin 9). The maximum external MUX Clock frequency should be limited to 1 MHz.

An asynchronous hardware Reset (pin 8) is also provided. Bringing this pin low will clear the Character Address Register, Control Word Register, RAM, and blanks the display. This action leaves the display set at Character Address 0, and the Brightness Level set at 100%.

ELECTRICAL & MECHANICAL CONSIDERATIONS

Interconnect Considerations

Optimum product performance can be had when the following electrical and mechanical recommendations are adopted. The SCF574X's IC is constructed in a high speed CMOS process, consequently high speed noise on the SERIAL DATA, SERIAL DATA CLOCK, $\overline{\text{LOAD}}$ and $\overline{\text{RESET}}$ lines may cause incorrect data to be written into the serial shift register. Adhere to transmission line termination procedures when using fast line drivers and long cables (>10 cm).

Good ground (pin 2) and power supply decoupling (pins 9 and 10) will insure that Icc (<400 mA peak) switching currents do not generate localized ground bounce. Therefore it is recommended that each display package use a 0.1µF and 20 µF capacitor between V_{CC} and ground.

When the internal MUX Clock is being used connect the $\overline{\text{CLK-SEL}}$ pin to V_{CC}. In those applications where $\overline{\text{RESET}}$ will not be connected to the system's reset control, it is recommended that this pin be connected to the center node of a series 0.1, µF and 100 KΩ RC network. Thus upon initial power up the $\overline{\text{RESET}}$ will be held low for 10 ms allowing adequate time for the system power supply to stabilize.

ESD Protection

The input protection structure of the SCF574X provides significant protection against ESD damage. It is capable of withstanding discharges greater than 2 KV. Take all the standard precautions, normal for CMOS components. These include properly grounding personnel, tools, tables, and transport carriers that come in contact with unshielded parts. If these conditions are not, or cannot be met, keep the leads of the device shorted together or the parts in anti-static packaging.

Soldering Considerations

The SCF574X can be hand soldered with SN63 solder using a grounded iron set to 260°C.

Wave soldering is also possible following these conditions: Preheat that does not exceed 93°C on the solder side of the PC board or a package surface temperature of 85°C. Water soluble organic acid flux (except carboxylic acid) or resin-based RMA flux without alcohol can be used.

Wave temperature of 245°C ±5°C with a dwell between 1.5 sec. to 3.0 sec. Exposure to the wave should not exceed temperatures above 260°C for five seconds at 0.063" below the seating plane. The packages should not be immersed in the wave.

Post Solder Cleaning Procedures

The least offensive cleaning solution is hot D.I. water (60°C) for less than 15 minutes. Addition of mild saponifers is acceptable. Do not use commercial dishwasher detergents.

For faster cleaning, solvents may be used. Exercise care in choosing solvents as some may chemically attack the nylon package. For further information refer to Appnotes 18 and 19 in the current Siemens Optoelectronic Data Book. See Appnote 19, Table 1, "Displays–Group 2" for the SCDV554X.

An alternative to soldering and cleaning the display modules is to use sockets. Naturally, 14 pin DIP sockets .300" wide with .100" centers work well for single displays. Multiple display assemblies are best handled by longer SIP sockets or DIP sockets when available for uniform package alignment. Socket manufacturers are Aries Electronics, Inc., Frenchtown, NJ; Garry Manufacturing, New Brunswick, NJ; Robinson-Nugent, New Albany, IN; and Samtec Electronic Hardward, New Albany, IN.

For further information refer to Appnote 22 in the current Siemens Optoelectronic Data Book.

Optical Considerations

The 0.270" high character of the SCF574X gives readability up to five feet. Proper filter selection enhances readability over this distance.

Using filters emphasizes the contrast ratio between a lit LED and the character background. This will increase the discrimination of different characters. The only limitation is cost. Take into consideration the ambient lighting environment for the best cost/benefit ratio for filters.

Incandescent (with almost no green) or fluorescent (with almost no red) lights do not have the flat spectral response of sunlight. Plastic band-pass filters are an inexpensive and effective way to strengthen contrast ratios. The SCF5740 is a red display and should be used with long wavelength pass filter having a sharp cut-off in the 600 nm to 620 nm range. The SCF5742 is a high efficiency red display and should be used with long wavelength pass filter having a sharp cut-off in the 570 nm to 600 nm range. The SCF5744 is a high efficiency green display and should be used with long wavelength pass filter that peaks at 565 nm.

Additional contrast enhancement is gained by shading the displays. Plastic band-pass filters with built-in louvers offer the next step up in contrast improvement. Plastic filters can be improved further with anti-reflective coatings to reduce glare. The trade-off is fuzzy characters. Mounting the filters close to the display reduces this effect. Take care not to overheat the plastic filter by allowing for proper air flow.

Optimal filter enhancements are gained by using circular polarized, anti-reflective, band-pass filters. The circular polarizing further enhances contrast by reducing the light that travels through the filter and reflects back off the display to less than 1%.

Several filter manufacturers supply quality filter materials. Some of them are: Panelgraphic Corporation, W. Caldwell, NJ; SGL Homalite, Wilmington, DE; 3M Company, Visual Products Division, St. Paul, MN; Polaroid Corporation, Polarizer Division, Cambridge, MA; Marks Polarized Corporation, Deer Park, NY, Hoya Optics, Inc., Fremont, CA.

One last note on mounting filters: recessing displays and bezel assemblies is an inexpensive way to provide a shading effect in overhead lighting situations. Several Bezel manufacturers are: R.M.F. Products, Batavia, IL; Nobex Components, Griffith Plastic Corp., Burlingame, CA; Photo Chemical Products of California, Santa Monica, CA; I.E.E.-Atlas, Van Nuys, CA.

Microprocessor Interface

The microprocessor interface is through the serial port, SPI port or one out of eight data bits on the eight bit parallel port and also control lines $\overline{\text{SDCLK}}$ and $\overline{\text{LOAD}}$.

Power Up Sequence

Upon power up display will come on at random. Thus the display should be reset at power-up. The reset will set the Address Register to Digit 0, User RAM is set to 0 (display blank) the Control Word is set to 0 (100% brightness) and the internal counters are reset

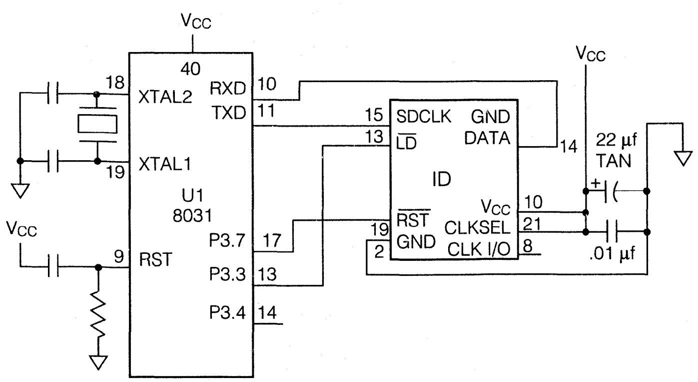


Figure 10. Display Interface to Siemens/Intel 8031 Microprocessor (using serial port in mode 0)

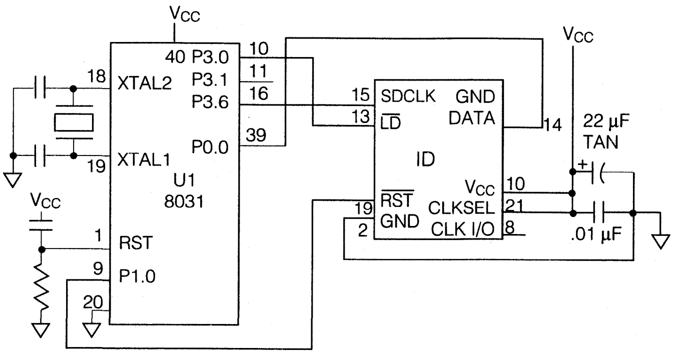


Figure 11. Display Interface to Siemens/Intel 8031 Microprocessor (using one bit of parallel port as serial port)

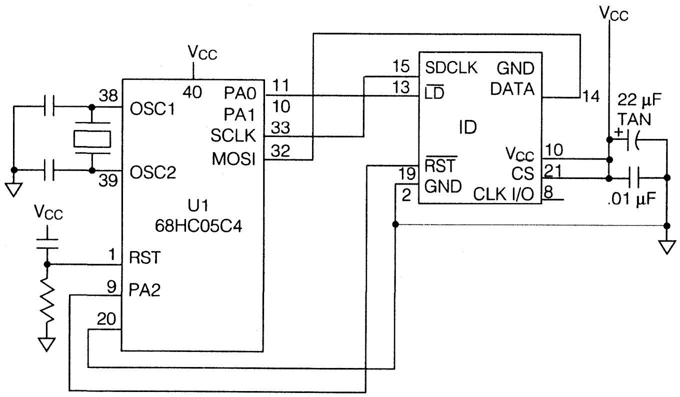


Figure 12. Display Interface with Motoroal 68HC05C4 Microprocessor (using SPI Port)

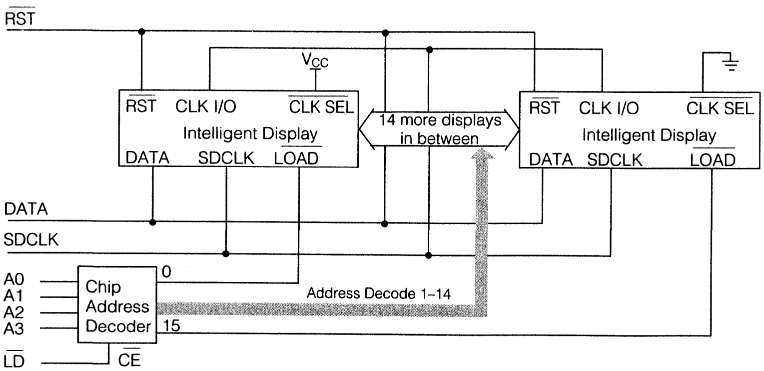


Figure 13. Cascading Multiple Displays

Multiple displays can be cascaded using the CLK SEL and CLK I/O pins (Figure 13). The display designated as the Master-Clock source should have its CLK SEL pin tied high and the slaves should have their CLK SEL pins tied low. All CLK I/O pins should be tied together. One display CLK I/O can drive 15 slave CLK I/Os. Use RST to synchronize all display counters.

Loading Data into the Display

Use following procedure to load data into the display:

1. Power up the display.
2. Bring $\overline{RST}$ low (600 ns duration minimum) to clear the Multiplex Counter, Address Register, Control Word Register, User Ram and Data Register. The display will be blank. Display brightness is set to 100%.
3. If a different brightness is desired, load the proper brightness opcode into the Control Word Register.
4. Load the Digit Address into the display.
5. Load display row and column data for the selected digit.
6. Repeat steps 4 and 5 for all digits.

Intelligent Display Devices

2

Data Contents for the Word "ABCD"

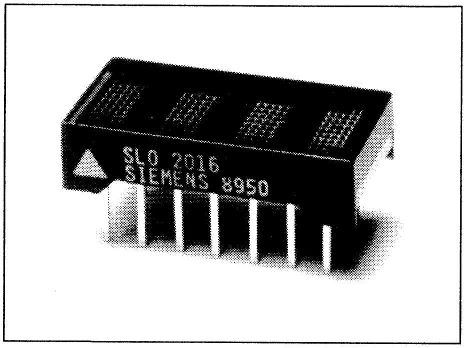
Step	D7	D6	D5	D4	D3	D2	D1	D0	Function
A	1	1	0	0	0	0	0	0	CLEAR
B (optional)	1	1	1	0	0	0	0	0	100% BRIGHTNESS
1	1	0	1	0	0	0	0	0	DIGIT D0 SELECT
2	0	0	0	0	0	1	0	0	ROW 0 (A)
3	0	0	0	0	1	0	1	0	ROW 1 A)
4	0	0	0	1	0	0	0	1	ROW 2 (A)
5	0	0	0	1	1	1	1	1	ROW 3 (A)
6	0	0	0	1	0	0	0	1	ROW 4 (A)
7	0	0	0	1	0	0	0	1	ROW 5 (A)
8	0	0	0	1	0	0	0	1	ROW 6 (A)
9	1	0	1	0	0	0	0	1	DIGIT D1 SELECT
10	0	0	0	1	1	1	1	1	ROW 0 (B)
11	0	0	0	1	0	0	0	1	ROW 1 (B)
12	0	0	0	1	0	0	0	1	ROW 2 (B)
13	0	0	0	1	1	1	1	0	ROW 3 (B)
14	0	0	0	1	0	0	0	1	ROW 4 (B)
15	0	0	0	1	0	0	0	1	ROW 5 (B)
16	0	0	0	1	1	1	1	1	ROW 6 (B)
17	1	0	1	0	0	0	1	0	DIGIT D2 SELECT
18	0	0	0	0	0	1	1	1	ROW 0 (C)
19	0	0	0	0	1	0	0	0	ROW 1 (C)
20	0	0	0	1	0	0	0	0	ROW 2 (C)
21	0	0	0	1	0	0	0	0	ROW 3 (C)
22	0	0	0	1	0	0	0	0	ROW 4 (C)
23	0	0	0	0	1	0	0	0	ROW 5 (C)
24	0	0	0	0	0	1	1	1	ROW 6 (C)
25	1	0	1	0	0	0	1	1	DIGIT D3 SELECT
26	0	0	0	1	1	1	1	0	ROW 0 (D)
27	0	0	0	1	0	0	0	1	ROW 1 (D)
28	0	0	0	1	0	0	0	1	ROW 2 (D)
29	0	0	0	1	0	0	0	1	ROW 3 (D)
30	0	0	0	1	0	0	0	1	ROW 4 (D)
31	0	0	0	1	0	0	0	1	ROW 5 (D)
32	0	0	0	1	1	1	1	0	ROW 6 (D)

SIEMENS

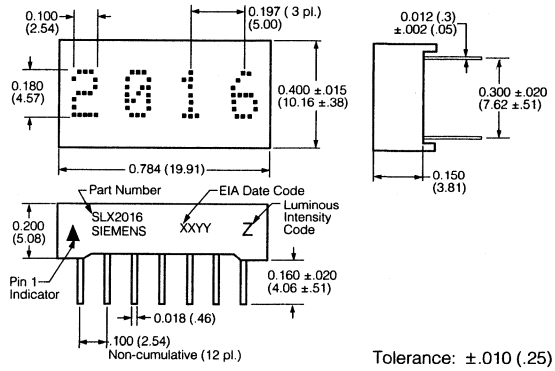
RED SLR2016
HIGH EFFICIENCY RED SLO2016
GREEN SLG2016
YELLOW SLY2016

X/Y Stackable .180" 4-Digit 5 x 7 Dot Matrix ALPHANUMERIC Intelligent Display with Memory/Decoder/Driver

Preliminary



Package Dimensions in Inches (mm)



Tolerance: ±.010 (.25)

FEATURES

- **Very Close Multi-line Spacing, 0.4" Centers**
- **.180" 5 x 7 Dot Matrix Characters**
- **128 Special ASCII Characters for English, German, Italian, Swedish, Danish, and Norwegian Languages**
- **Wide Viewing Angle: X Axis 50° Maximum, Y Axis ±75° Maximum**
- **Fast Access Time, 110 ns at 25°C**
- **Full Size Display for Stationary Equipment**
- **Built-in Memory**
- **Built-in Character Generator**
- **Built-in Multiplex and LED Drive Circuitry**
- **Direct Access to Each Digit Independently and Asynchronously**
- **Clear Function that Clears Character Memory**
- **True Blanking for Intensity Dimming Applications**
- **End-Stackable, 4-Character Package**
- **Intensity Coded for Display Uniformity**
- **Extended Operating Temperature Range: -40°C to +85°C**
- **Superior ESD Immunity**
- **100% Burned In and Tested**
- **Wave Solderable**
- **TTL Compatible over Operating Temperature Range**

DESCRIPTION

The SLR/SLO/SLG/SLY2016 is a four digit 5x7 dot matrix display module with a built-in CMOS integrated circuit. This display is X/Y stackable.

The integrated circuit contains memory, a 128 ASCII ROM decoder, multiplexing circuitry and drivers. Data entry is asynchronous. A display system can be built using any number of SLR/SLO/SLG/SLY2016 since each digit can be addressed independently and will continue to display the character last stored until replaced by another.

System interconnection is very straightforward. Two address bits (A0, A1) are normally connected to the like-named inputs of all displays in the system.

Data lines are connected to all SLR/SLO/SLG/SLY2016s directly and in parallel as is the write line ($\overline{WR}$). The display will then behave as a write-only memory.

The SLR/SLO/SLG/SLY2016 has several features superior to competitive devices. 100% burn-in processing insures that the SLR/SLO/SLG/SLY2016 will function in more stressful assembly and use environments. True "blanking" allows the designer to dim the display for more flexibility of display presentation. Finally the $\overline{CLR}$ clear function will clear the ASCII character RAM.

—Continued

See Appnotes 18, 19, 22, and 23 for additional information.

Description (Continued)

The character set consists of 128 special ASCII characters for English, German, Italian, Swedish, Danish, and Norwegian.

All products are 100% burned-in and tested, then subjected to out-going AQL's of .25% for brightness matching, visual alignment and dimensions, .065% for electrical and functional.

Maximum Ratings

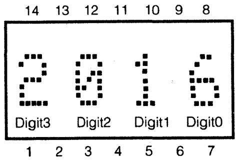
DC Supply Voltage .... –0.5 V to +7.0 Vdc
Input Voltage, Respect to GND
(all inputs) .... –0.5 V to V_{CC} +0.5 Vdc
Operating Temperature .... –40°C to +85°C
Storage Temperature .... –40°C to +100°C
Relative Humidity at 85°C 85%
Maximum Solder Temperature, 0.063" (1.59 mm)
below Seating Plane, t<5 sec .... 260 °C

Optical Characteristics

Spectral Peak Wavelength
Red .... 660 nm typ.
HER .... 635 nm typ.
Green .... 565 nm typ.
Yellow .... 585 nm typ.
Digit Height .... 0.180" (4.57 mm)
Time Averaged Luminous Intensity(1)
at V_{CC}=5 V
Red .... 50 µcd/LED min.
HER/Yellow .... 60 µcd/LED min.
Green .... 75 µcd/LED min.
LED to LED Intensity Matching, V_{CC}=5 V .... 1.8:1.0 max.
Viewing Angle (off normal axis)
Horizontal .... ±50° max.
Vertical .... ±75° max.

Note 1: Peak luminous intensity values can be calculated by multiplying these values by 7.

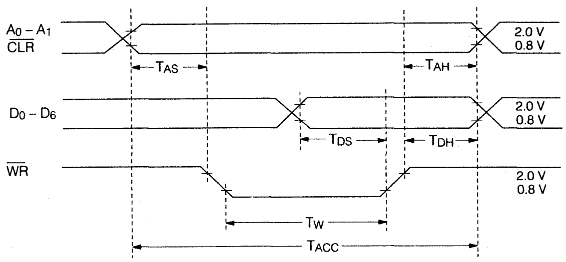
Top View



Pin	Function
1	$\overline{WR}$ Write
2	A1 Digit Select
3	A0 Digit Select
4	V_{CC}
5	D0 Data
6	D1 Data
7	D2 Data

Pin	Function
8	D3 Data
9	D4 Data
10	D5 Data
11	D6 Data
12	$\overline{BL}$ Display Blank
13	$\overline{CLR}$ Clear
14	GND

Timing Characteristics
Write Cycle Waveforms



DC Characteristics at 25°C

Parameters	Min.	Typ.	Max.	Units	Conditions
V_{CC}	4.5	5.0	5.5	V	
I_{CC} Blank		2.3	3.0	mA	V_{CC}=5.0 V
I_{CC} (80 dots on)		80	105	mA	V_{CC}=5.0 V
V_{IL} (all inputs)			0.8	V	4.5 V <V_{CC} <5.5 V
V_{IH} (all inputs)	2.0			V	4.5 V <V_{CC} <5.5 V
I_{IL} (all inputs)	25		100	µA	4.5 V <V_{CC} <5.5 V, V_{IN}=0.8 V

AC Characteristics Guaranteed Minimum Timing Parameters at V_{CC} = 5.0 V ±0.5 V

Parameter	Symbol	–40°C	+25°C	+85°C	Units
Address Set Up Time	T_{AS}	10	10	10	ns
Write Time	T_{W}	60	70	90	ns
Data Set Up Time	T_{DS}	20	30	50	ns
Address Hold Time	T_{AH}	20	30	40	ns
Data Hold Time	T_{DH}	20	30	40	ns
Access Time	T_{ACC}(1)	90	110	140	ns
Clear Disable Time	T_{CLRD}	1	1	1	µs
Clear Time	T_{CLR}	1	1	1	ms

Note: 1. T_{ACC}=Set Up Time + Write Time + Hold Time.

Loading Data

The desired data code (D0-D6) and digit address (A0, A1) must be held stable during the write cycle for storing new data.

Data entry may be asynchronous. Digit 0 is defined as right hand digit with A1=A2=0.

Clearing the entire internal four-digit memory can be accomplished by holding the clear ($\overline{CLR}$) low for 1 msec minimum. The clear function will clear the ASCII RAM. Loading an illegal data code will display a blank.

Typical Loading State Table

WR	A1	A0	D6	D5	D4	D3	D2	D1	D0	DIGIT 3	2	1	0
H			previously loaded display							G	R	E	Y
L	L	L	H	L	L	L	H	L	H	G	R	E	E
L	L	H	H	L	H	L	H	L	H	G	R	U	E
L	H	L	H	L	L	H	H	L	L	G	L	U	E
L	H	H	H	L	L	L	L	H	L	B	L	U	E
L	L	H	H	L	L	L	H	L	H	B	L	E	E
L	L	L	H	L	H	L	H	H	H	B	L	E	W
L	X	X	see character code							see character set			

Figure 1. Flashing Circuit Using a 555

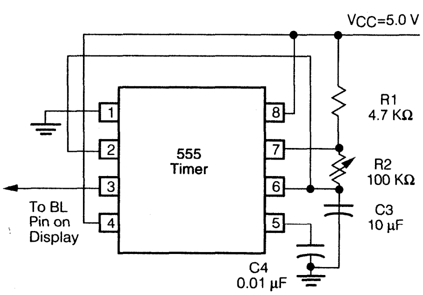
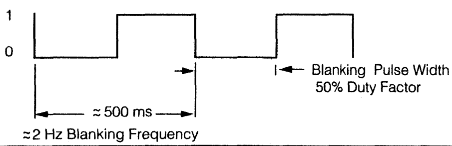


Figure 1a. Flashing (Blanking) Timing



Display Blanking

Blank the display by loading a blank or space into each digit of the display or by using the ($\overline{BL}$) display blank input. Setting the ($\overline{BL}$) input low does not affect the contents of data memory.

A flashing circuit can easily be constructed using a 555 astable multivibrator. Figure 1 illustrates a circuit in which varying R1 (100K~10K) will have a flash rate of 1 Hz~10 Hz.

The display can be dimmed by pulse width modulating the ($\overline{BL}$) at a frequency sufficiently fast to not interfere with the internal clock. The dimming signal frequency should be 2.5 KHz or higher. Dimming the display also reduces power consumption.

An example of a simple dimming circuit using a 556 is illustrated in Figure 2. Adjusting potentiometer R3 will dim the display by changing the blanking pulse duty cycle.

Figure 2. Dimming Circuit Using a 556

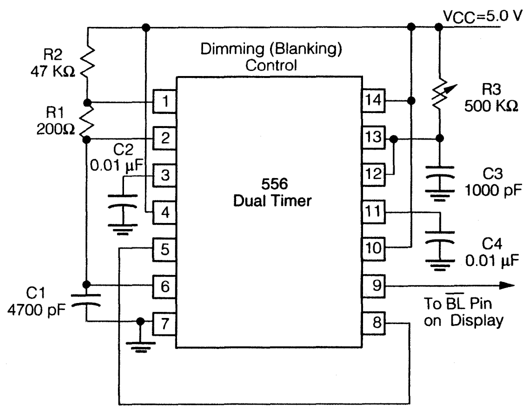
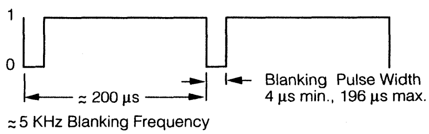
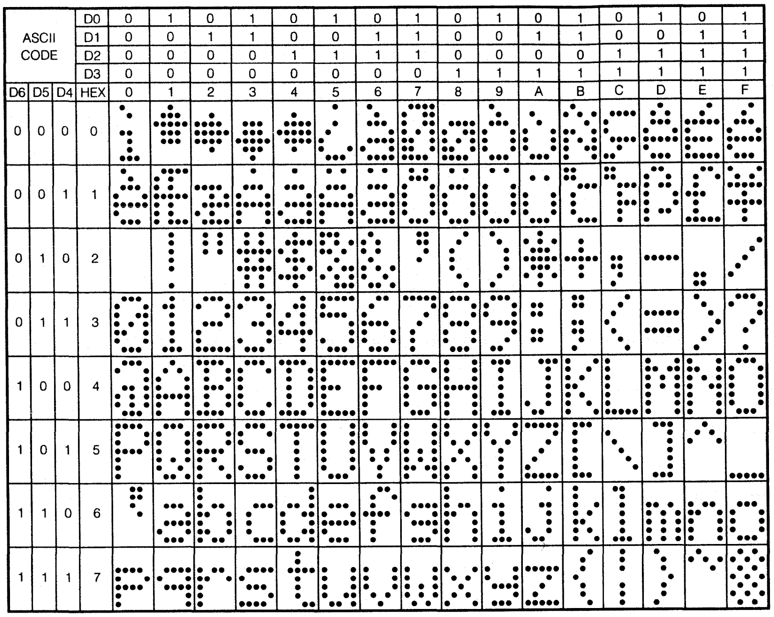


Figure 2a. Dimming (Blanking) Timing

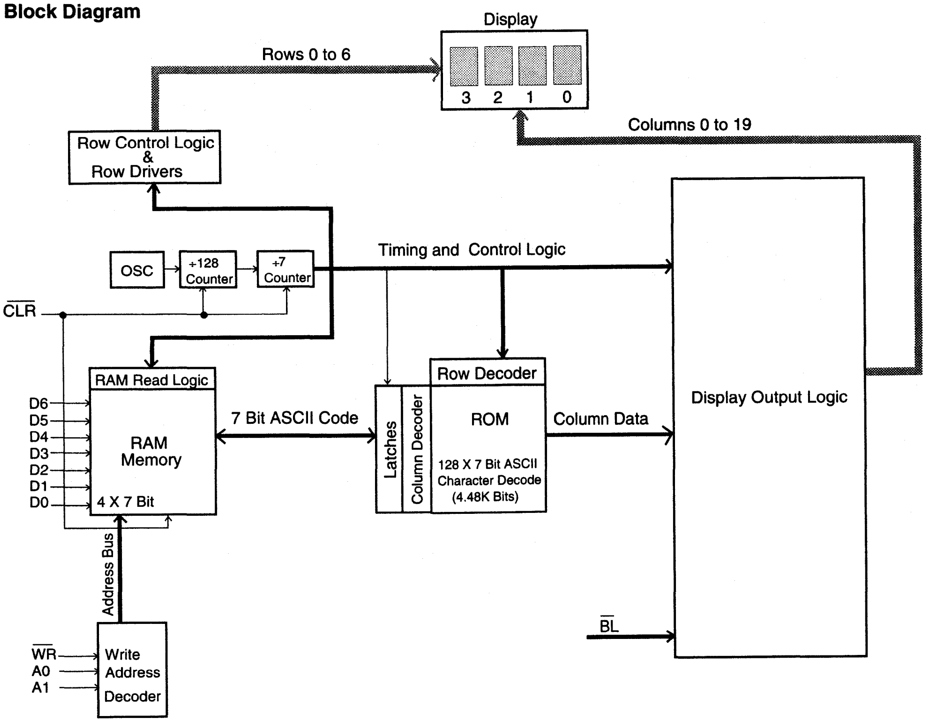


Character Set



1. High=1 level. 2. Low=0 level. 3. Upon power up, device will initialize in a random state.

Block Diagram



Design Considerations
For details on design and applications of the SLX2016 in multiple display systems, refer to Appnote 15 in the current Siemens Optoelectronics Data Book.

Electrical & Mechanical Considerations

Voltage Transient Supression
We recommend that the same power supply be used for the display and the components that interface with the display to avoid logic inputs higher than V_{CC}. Additionally, the LEDs may cause transients in the power supply line while they change display states. The common practice is to place .01 µF capacitors close to the displays across V_{CC} and GND, one for each display, and one 10 µF capacitor for every second display.

ESD Protection
The CMOS IC of the SLX2016 is resistant to ESD damage and capable of withstanding discharges less than 2 KV. However, take all the standard precautions, normal for CMOS components. These include properly grounding personnel, tools, tables, and transport carriers that come in contact with unshielded parts. If these conditions are not, or cannot be met, keep the leads of the device shorted together or the parts in anti-static packaging.

Soldering Considerations
The SLX2016 can be hand soldered with SN63 solder using a grounded iron set to 260°C.

Wave soldering is also possible following these conditions: Preheat that does not exceed 93°C on the solder side of the PC board or a package surface temperature of 85°C. Water soluble organic acid flux (except carboxylic acid) or resin-based RMA flux without alcohol can be used.

Wave temperature of 245°C ±5°C with a dwell between 1.5 sec. to 3.0 sec. Exposure to the wave should not exceed temperatures above 260°C for five seconds at 0.063" below the seating plane. The packages should not be immersed in the wave.

Post Solder Cleaning Procedures
The least offensive cleaning solution is hot D.I. water (60°C) for less than 15 minutes. Addition of mild saponifiers is acceptable. Do not use commercial dishwasher detergents.

For faster cleaning, solvents may be used. Carefully select any solvent as some may chemically attack the nylon package. Maximum exposure should not exceed two minutes at elevated temperatures. Acceptable solvents are TF (trichorotrifluorethane), TA, 111 Trichloroethane, and unheated acetone.

Note: Acceptable commercial solvents are: Basic TF, Arklone, P. Genesolv, D. Genesolv DA, Blaco-Tron TF, Blaco-Tron TA, and Freon TA.

Unacceptable solvents contain alcohol, methanol, methylene chloride, ethanol, TP35, TCM, TMC, TMS+, TE, or TES. Since many commercial mixtures exist, contact a solvent vendor for chemical composition information. Some major solvent manufacturers are: Allied Chemical Corportation, Specialty Chemical Division, Morristown, NJ; Baron-Blakeslee, Chicago, IL; Dow Chemical, Midland, MI; E.I. DuPont de Nemours & Co., Wilmington, DE.

For further information refer to Siemens Appnotes 18 and 19.

An alternative to soldering and cleaning the display modules is to use sockets. Standard pin DIP sockets .300" wide with .100" centers work well for single displays. Multiple display assemblies are best handled by longer SIP sockets or DIP sockets when available for uniform package alignment. Socket manufacturers are Aries Electronics, Inc., Frenchtown, NJ; Garry Manufacturing, New Brunswick, NJ; Robinson-Nugent, New Albany, IN; and Samtec Electronic Hardware, New Albany, IN.

For further information refer to Siemens Appnote 22.

Optical Considerations
The .180" high characters of the SLX2016 gives readability up to eight feet. Proper filter selection enhances readability over this distance.

Filters enhance the contrast ratio between a lit LED and the character background intensifying the discrimination of different characters.The only limitation is cost. Take into consideration the ambient lighting environment for the best cost/benefit ratio for filters.

Incandescent (with almost no green) or fluorescent (with almost no red) lights do not have the flat spectral response of sunlight. Plastic band-pass filters are an inexpensive and effective way to strengthen contrast ratios.The SLR2016 is a standard red display and should be matched with long wavelength pass filter in the 600 nm to 620 nm range.

The SLO2016 is a high efficiency red display and should be matched with a long wavelength pass filter in the 470 nm to 590 range. The SLG/SLY2016 should be matched with a yellow-green band-pass filter that peaks at 565 nm. For displays of multiple colors, neutral density gray filters offer the best compromise.

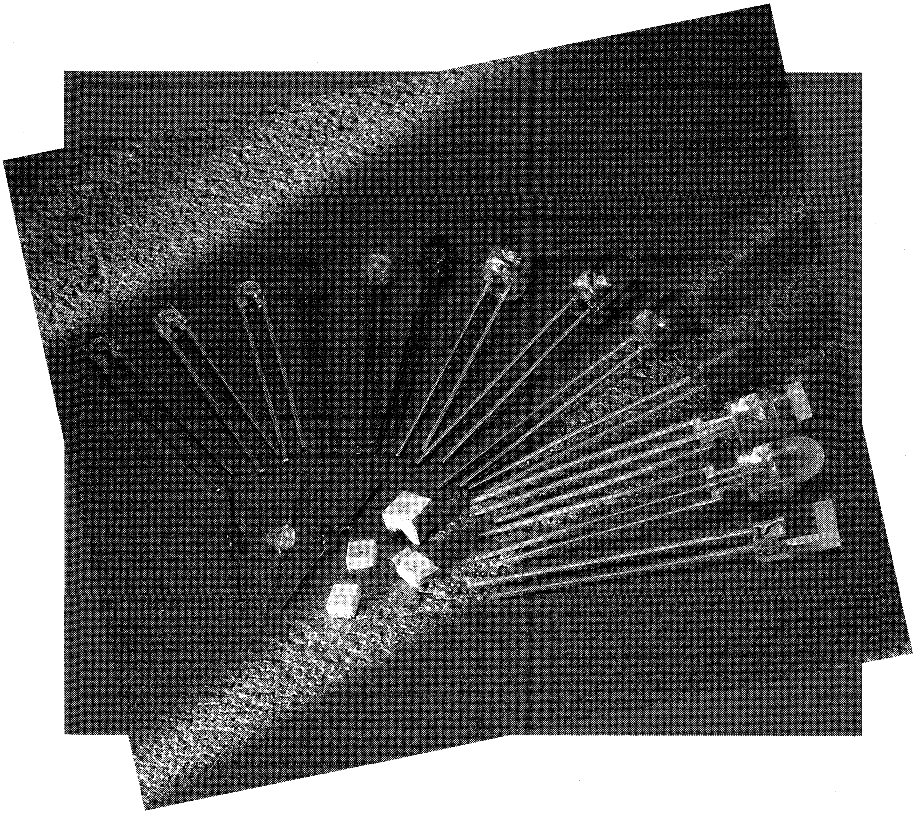
Additional contrast enhancement is gained by shading the displays. Plastic band-pass filters with built-in louvers offer the next step up in contrast improvement. Plastic filters can be improved further with anti-reflective coatings to reduce glare. The trade-off is fuzzy characters. Mounting the filters close to the display reduces this effect. Take care not to overheat the plastic filter by allowing for proper air flow.

Optimal filter enhancements are gained by using circular polarized, anti-reflective, band-pass filters. Circular polarizing further enhances contrast by reducing the light that travels through the filter and relfects back off the display to less than 1%.

Several filter manufacturers supply quality filter materials. Some of them are: Panelgraphic Corporation, W. Caldwell, NJ; SGL Homalite, Wilmington, DE; 3M Company, Visual Products Division, St. Paul, MN; Polaroid Corporation, Polarizer Division, Cambridge, MA; Marks Polarized Corporation, Deer Park, NY, Hoya Optics, Inc., Fremont, CA.

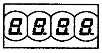
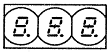
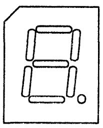
One last note on mounting filters: recessing displays and bezel assemblies is an inexpensive way to provide a shading effect in overhead lighting situations. Several Bezel manufacturers are: R.M.F. Products, Batavia, IL; Nobex Components, Griffith Plastic Corp., Burlingame, CA; Photo Chemical Products of California, Santa Monica, CA; I.E.E.-Atlas, Van Nuys, CA.

Refer to Siemens Appnote 23 for further information.



Numeric Displays
LED Lamps

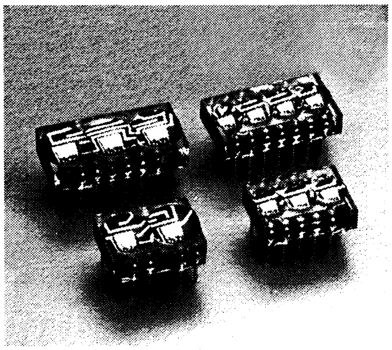
LED Numeric Displays

Package Type	Package Outline	Part Number	Character Height	Description	Polarity	Color	Luminous Intensity per Segment		Page
							µcd (typ.)	mA	
Multi-digit magnified monolithic		DL-330M	0.11" (2.8 mm)	7 segment 3 digit	C.C. multi-plex	Red	2500 per digit	5	3–1
		DL-340M		7 segment 4 digit					
		DL-430M	0.15" (3.8 mm)	7 segment 3 digit					
		DL-440M		7 segment 2 digit					
Compact single digit encapsu-lated (filled reflector)		HD1075R HD1077R	0.28" (7 mm)	7 segment, decimal point right	C.A. C.C.	Red	550	10	3–3
		HD1075O HD1077O			C.A. C.C.	Super-red	2500		
		HD1075G HD1077G			C.A. C.C.	Green	3000		
Compact single digit encapsu-lated (filled reflector)		HD1105R HD1107R	0.39" (10 mm)	7 segment, decimal point right	C.A. C.C.	Red	550	10	3–5
		HD1105O HD1107O			C.A. C.C.	Super-red	2500		
		HD1105G HD1107G			C.A. C.C.	Green	3000		
Compact single digit encapsu-lated (filled reflector)		HD1131R HD1133R	0.53" (13.5 mm)	7 segment, decimal point right	C.A. C.C.	Red	550	10	3–7
		HD1131O HD1133O			C.A. C.C.	Super-red	1100		
		HD1131G HD1133G			C.A. C.C.	Green			
Single digit encapsu-lated (filled reflector), low current		HDN1075O HDN1077O	0.28" (7 mm)	7 segment, decimal point right	C.A. C.C.	Super-red	260	10	3–9
Single digit encapsu-lated (filled reflector), low current		HDN1105O HDN1107O	0.39" (10 mm)	7 segment, decimal point right	C.A. C.C.	Super-red	260	10	3–10
Single digit encapsu-lated (filled reflector), low current		HDN1131O HDN1133O	0.53" (13.5 mm)	7 segment, decimal point right	C.A. C.C.	Super-red	260	10	3–11

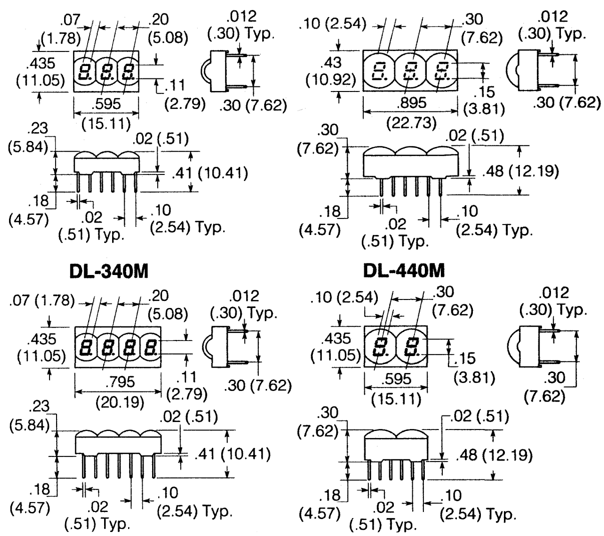
SIEMENS

.11" 3 DIGIT DL-330M
.11" 4 DIGIT DL-340M
.15" 3 DIGIT DL-430M
.15" 2 DIGIT DL-440M

Red Seven Segment
Magnified Monolithic Numeric Display



Package Dimensions in Inches (mm)



FEATURES

- **Rugged Encapsulated Package**
- **Integrated Magnifier Lens**
- **Monolithic Construction for Maximum Brightness at Minimum Power**
- **Common Cathode for Mulitiplexing Ease**
- **Standard Dual-In-Line Package**
- **Categorized for Brightness Uniformity**

DESCRIPTION

The DL-330M/340M and DL-430/440M are numeric red LED displays with a right hand decimal point. Low cost is achieved through minimum use of monolithic GaAsP material and magnification to full height using a simple integrated lens construction. A red plexiglass or circularly polarized filter is recommended to enhance visibility and to eliminate glare from the surface of the package.

These displays are designed for multiplex operation; the desired digit is displayed by selecting the appropriate cathode.

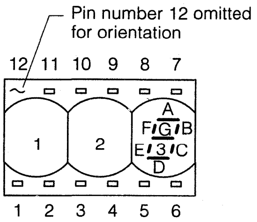
All devices are optimized for low power portable battery operated equipment using MOS and CMOS integrated logic circuits such as DMMs and digital thermometers.

Maximum Ratings (at 25°C)

Operating Temperature and Storage Temperature .... –20°C to +70°C
Continuous Forward Current per Segment and Decimal ....7 mA
Peak Pulse Current (10 µs) ....50 mA
Peak Inverse Voltage per Segment and Decimal ....3 V
Power Dissipation ....320 mW
Derating Factor from 25°C/Digit ....4.3 mW/°C

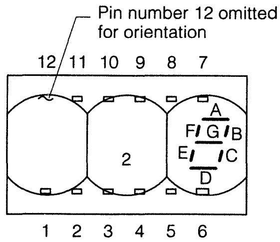
Characteristics (T_A=25°C)

Parameter	Min.	Typ.	Max.	Unit	Test Condition
Luminous Intensity (Total Digit)	1.0	2.5		mcd	I_F=5 mA/segment
Peak Emission Wavelength			660	nm	
Line Half-Width	40			nm	
Forward Voltage		1.7	2.0		I_F=20 mA/digit, V=0
Reverse Current			100	µA	V_R=3.0 V



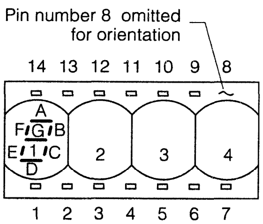
DL-330M

Pin	Function
1	Cathode D1
2	Anode E
3	Anode D
4	Cathode D2
5	Anode C
6	Anode DP
7	Cathode D3
8	Anode B
9	Anode G
10	Anode A
11	Anode F
12	No pin



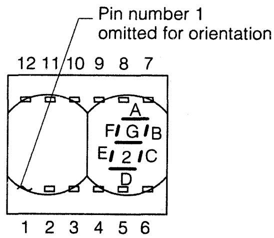
DL-430M

Pin	Function
1	Cathode D1
2	Anode E
3	Anode D
4	Cathode D2
5	Anode C
6	Anode DP
7	Cathode D3
8	Anode B
9	Anode G
10	Anode A
11	Anode F
12	No pin



DL-340M

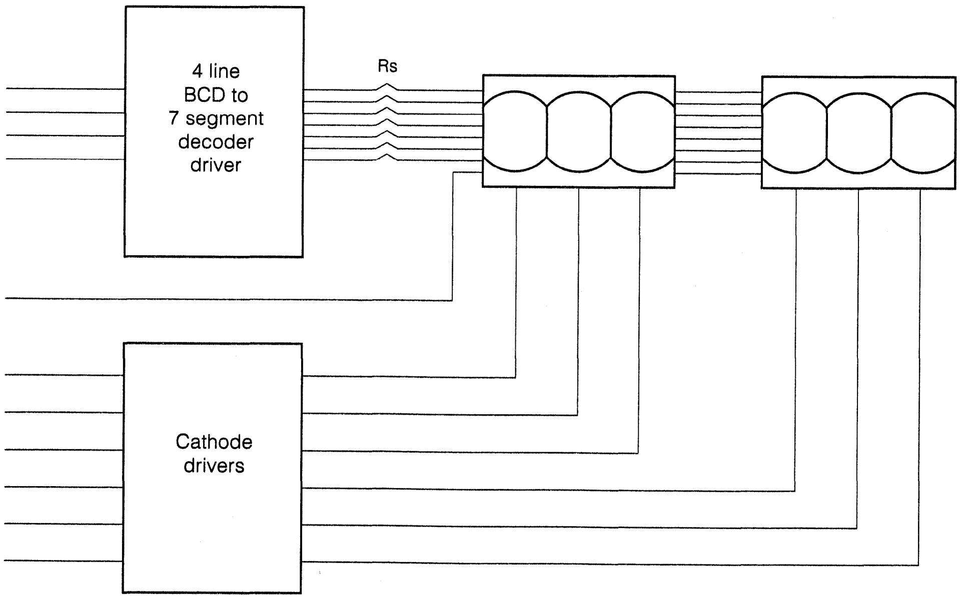
Pin	Function
1	No connection
2	Anode E
3	Anode D
4	Anode C
5	Anode DP
6	Anode G
7	Cathode 4
8	No pin
9	Anode B
10	Cathode 3
11	Anode F
12	Cathode 2
13	Anode A
14	Cathode 1



DL-340M

Pin	Function
1	No pin
2	Anode E
3	Anode D
4	No pin
5	Anode C
6	Anode DP
7	Cathode D2
8	Anode B
9	Anode G
10	Anode A
11	Anode F
12	Cathode D1

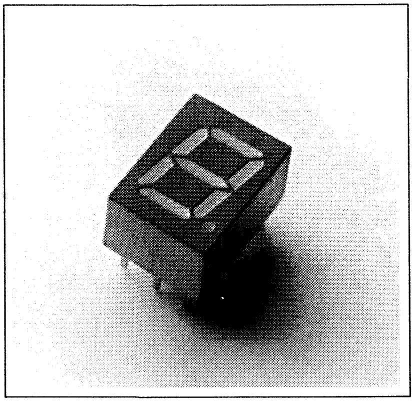
Block Diagram for Typical Display Drive Circuitry



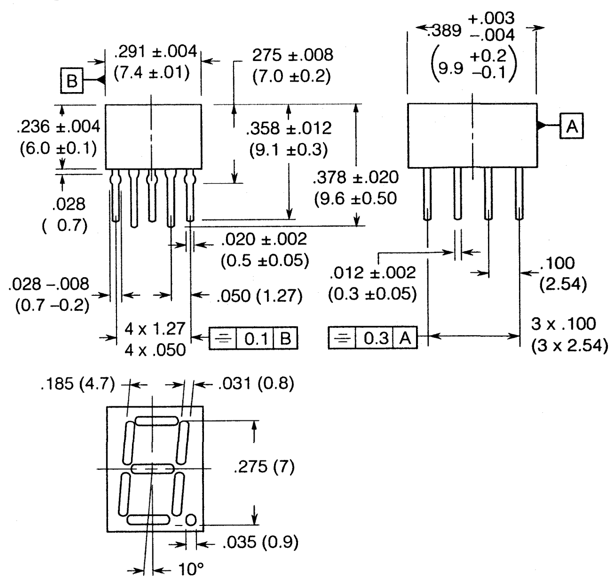
SIEMENS

RED HD1075R/1077R
SUPER-RED HD1075O/1077O
GREEN HD1075G/1077G

Common Anode/Common Cathode
0.28″ (7 mm) Seven Segment Numeric Display



Package Dimensions in Inches (mm)



FEATURES

- **Rugged Encapsulated Package**
- **0.28 Inch (7 mm) Digit Height**
- **Choice of Colors: Red, Super-Red, Green**
- **Common Anode or Common Cathode**
- **Wide Viewing**
- **Intensity Coded for Display Uniformity**

DESCRIPTION

The HD1075X/1077X are displays with 0.28 inch (7 mm) digits with either a common anode or common cathode and a right hand decimal point.

These displays have good viewing and can be used in electronic instruments, point-of-sale systems, clocks, and other general industrial and consumer applications. All displays have a light gray face.

Contrast enhancement filters are recommended for use with these displays.

Maximum Ratings

Operating Temperature (T_{OP})	0°C to +85°C
Storage Temperature (T_{STG})	–40°C to +85°C
Lead Soldering Tempterature, 2 mm from base (T_S) t=3 s	260°C
Peak Forward Current per Segment or DP (1) (I_{FM}) $t_P \leq 10$ µs	
HD1075/7R	500 mA
HD1075/7O/G	150 mA
DC Forward Current per Segment or DP (2) (I_F)	
HD1075/7R	25 mA
HD1075/7O/G	17 mA
Pulse Peak Forward Current per Segment (I_{FM})	
20% Duty Cycle	100 mA
Reverse Voltage per Segment or DP (V_R)	6 V
Total Power Dissipation (P_{TOT}) $T_A \leq 45$°C	400 mW

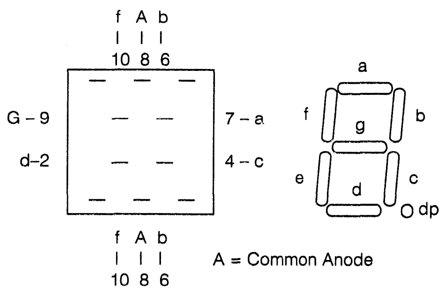
Notes:
1. Do not exceed maximum average current per segment (see graph of permissible pulse handling capability).
2. Derate maximum average current above T_A=75°C at 0.5 mA/°C per segment.

See graph numbers 1A, 2A, 3A, 5A, 6A, 7A, 8B, 9A, 11A at the end of this section.

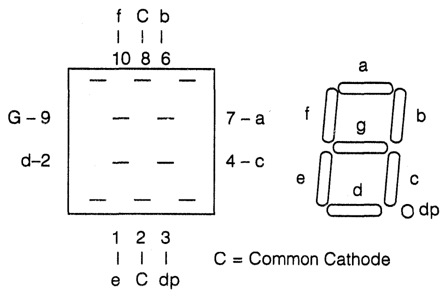
Characteristics (T_A=25°C)

Parameter	Symbol	Min.	Values Typ.	Max.	Unit
Luminous Intensity					
per Segment (I_F=10 mA)					
HD1075/7R	I_V	180	550		µcd
HD1075/7O	I_V	700	2500		µcd
HD1075/7G	I_V	700	3000		µcd
Peak Wavelength					
(I_F=10 mA)					
HD1075/7R	λ_{PEAK}		660		nm
HD1075/7O	λ_{PEAK}		630		nm
HD1075/7G	λ_{PEAK}		565		nm
Dominant Wavelength					
Digit Average					
HD1075/7R	λ_{DOM}		645		nm
HD1075/7O	λ_{DOM}	612		625	nm
HD1075/7G	λ_{DOM}	562		575	nm
Forward Voltage					
per Segment (1)(I_F=20 mA)					
HD1075/7R	V_F		1.6	2.0	V
HD1075/7O	V_F		2.0	3.0	V
HD1075/7G	V_F		2.4	3.0	V
Breakdown Voltage					
per Segment (1)(I_R=10 µA)	V_{BR}	6	15		V
Thermal Resistance	R_{thJA}			140	°C/W/Seg.

Notes:
1. AQL=0.4%.
2. Deviation of the absolute values within one digit I_{VMAX}/I_{VMIN} ≤2.



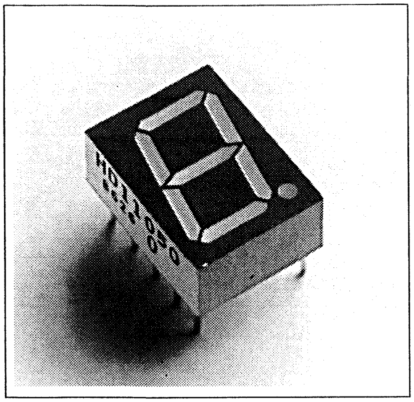
HD1075
1 Cathode E
2 Cathode D
3 Common Anode
4 Cathode C
5 Cathode DP
6 Cathode B
7 Cathode A
8 Common Anode
9 Cathode G
10 Cathode F



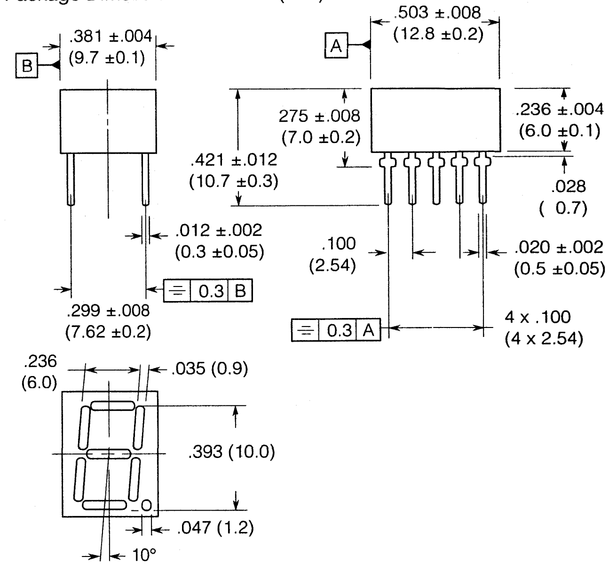
HD1077
1 Anode E
2 Anode D
3 Common Cathode
4 Anode C
5 Anode DP
6 Anode B
7 Anode A
8 Common Cathode
9 Anode G
10 Anode F

SIEMENS

RED HD1105R/1107R
SUPER-RED HD1105O/1107O
GREEN HD1105G/1107G
Common Anode/Common Cathode
0.39″ (10 mm) Seven Segment Numeric Display



Package Dimensions in Inches (mm)



FEATURES

- **Rugged Encapsulated Package**
- **0.39" (10 mm) Digit Height**
- **Choice of Colors: Red, Super-Red, Green**
- **Common Anode or Common Cathode**
- **Wide Viewing**
- **Intensity Coded for Display Uniformity**

DESCRIPTION

The HD1105X/1107X are displays with 0.39 inch (10 mm) digits with either a common anode or common cathode and a right hand decimal point.

These displays were designed for viewing distances of up to 10 feet and can be used in electronic instruments, point-of-sale systems, clocks, and other general industrial and consumer applications. All displays have a light gray face.

Contrast enhancement filters are recommended for use with these displays.

Maximum Ratings

Operating Temperature (T_{OP}) .... 0°C to +85°C
Storage Temperature (T_{STG}) .... –40°C to +85°C
Lead Soldering Tempterature, 2 mm from base (T_S) t=3 s .... 260°C
Peak Forward Current per Segment or DP (1) (I_{FM}) $t_P \leq 10$ µs
HD1105/7R .... 500 mA
HD1105/7O/G .... 150 mA
DC Forward Current per Segment or DP (2) (I_F)
HD1105/7R .... 30 mA
HD1105/7O/G .... 20 mA
Reverse Voltage per Segment or DP (V_R) .... 6 V
Total Power Dissipation (P_{TOT}) $T_A \leq 45$°C .... 480 mW

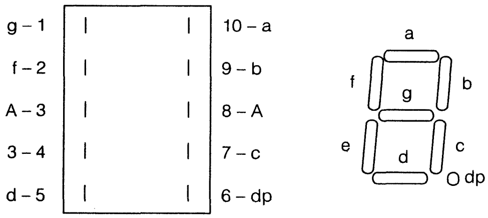
Notes:
1. Do not exceed maximum average current per segment (see graph of permissible pulse handling capability).
2. Derate maximum average current above T_A=75°C at 0.5 mA/°C per segment.

See graph numbers 1A, 2A, 3A, 5A, 6A, 8C, 8D, 9B, 11B at the end of this section.

Characteristics (T_A=25°C)

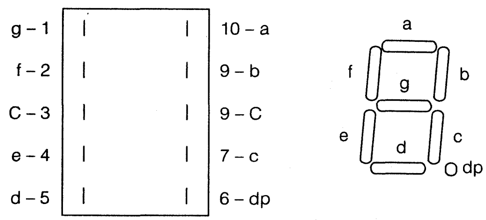
			Values		
Parameter	**Symbol**	**Min.**	**Typ.**	**Max.**	**Unit**
Luminous Intensity					
per Segment (I_F=10 mA)					
HD1105/7R	I_V	180	550		µcd
HD1105/7O	I_V	1100	3500		µcd
HD1105/7G	I_V	1100	4000		µcd
Peak Wavelength					
(I_F=10 mA)					
HD1105/7R	λ_{PEAK}		660		nm
HD1105/7O	λ_{PEAK}		630		nm
HD1105/7G	λ_{PEAK}		565		nm
Dominant Wavelength					
Digit Average					
HD1105/7R	λ_{DOM}		645		nm
HD1105/7O	λ_{DOM}	612		625	nm
HD1105/7G	λ_{DOM}	562		575	nm
Forward Voltage					
per Segment [(1)](I_F=20 mA)					
HD1105/7R	V_F		1.6	2.0	V
HD1105/7O	V_F		2.0	3.0	V
HD1105/7G	V_F		2.4	3.0	V
Breakdown Voltage					
per Segment [(1)](I_R=10 µA)	V_{BR}	6	15		V
Thermal Resistance	R_{thJA}			120	°C/W/Seg.

Notes:
1. AQL=0.4%.
2. Deviation of the absolute values within one digit $I_{VMAX}/I_{VMIN} \leq 2$.



A = Common Anode

HD1105
1 Cathode G
2 Cathode F
3 Common Anode
4 Cathode E
5 Cathode D
6 Cathode DP
7 Cathode C
8 Common Anode
9 Cathode B
10 Cathode A

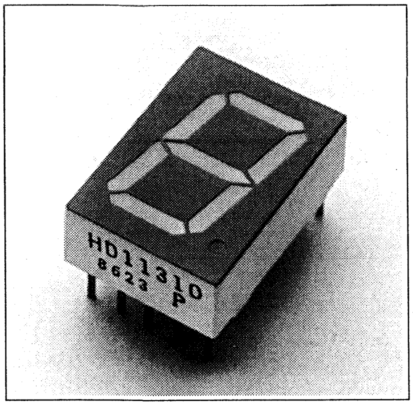


C = Common Cathode

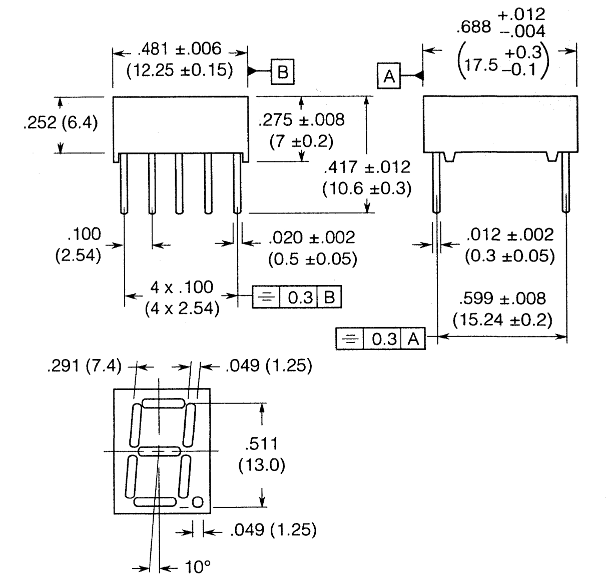
HD1107
1 Anode G
2 Anode F
3 Common Cathode
4 Anode E
5 Anode D
6 Anode DP
7 Anode C
8 Common Cathode
9 Anode B
10 Anode A

SIEMENS

RED HD1131R/1133R
SUPER-RED HD1131O/1133O
GREEN HD1131G/1133G
Common Anode/Common Cathode
0.53″ (13.5 mm) Seven Segment Numeric Display



Package Dimensions in Inches (mm)



FEATURES

- **Rugged Encapsulated Package**
- **0.39" (10 mm) Digit Height**
- **Choice of Colors: Red, Super-Red, Green**
- **Common Anode or Common Cathode**
- **Wide Viewing**
- **Intensity Coded for Display Uniformity**

DESCRIPTION

The HD1131X/1133X are displays with 0.53 inch (13.5 mm) digits with either a common anode or common cathode and a right hand decimal point.

These displays were designed for viewing distances of up to 20 feet and can be used in electronic instruments, point-of-sale systems, clocks, and other general industrial and consumer applications. All displays have a light grey face.

Contrast enhancement filters are recommended for use with these displays.

Maximum Ratings

Operating Temperature (T_{OP}) .... 0°C to +85°C
Storage Temperature (T_{STG}) .... −40°C to +85°C
Lead Soldering Tempterature, 2 mm from base (T_S) t=3 s .... 260°C
Peak Forward Current per Segment or DP [(1)] (I_{FM}) $t_P \leq 10$ µs
HD1131/3R .... 500 mA
HD1131/3O/G .... 150 mA
DC Forward Current per Segment or DP [(2)] (I_F)
HD1131/3R .... 35 mA
HD1131/3O/G .... 25 mA
Reverse Voltage per Segment or DP (V_R) .... 6 V
Total Power Dissipation (P_{TOT}) $T_A \leq 45$°C .... 600 mW

Notes:

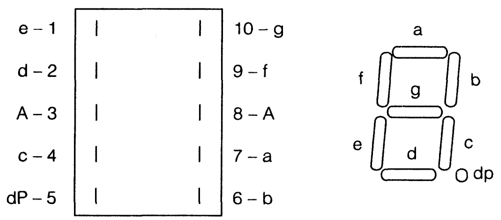
1. Do not exceed maximum average current per segment (see graph of permissible pulse handling capability).
2. Derate maximum average current above T_A=75°C at 0.5 mA/°C per segment.

See graph numbers 1A, 2A, 3A, 5A, 6A, 8E, 8F, 9C, 11C at the end of this section.

Characteristics (T_A=25°C)

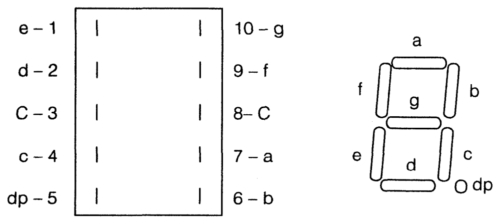
Parameter	Symbol	Min.	Values Typ.	Max.	Unit
Luminous Intensity					
per Segment (I_F=10 mA)					
HD1131/3R	I_V	180	550		µcd
HD1131/3O	I_V	1100	4000		µcd
HD1131/3G	I_V	1100	4500		µcd
Peak Wavelength					
(I_F=10 mA)					
HD1131/3R	λ_{PEAK}		660		nm
HD1131/3O	λ_{PEAK}		630		nm
HD1131/3G	λ_{PEAK}		565		nm
Dominant Wavelength					
Digit Average					
HD1131/3R	λ_{DOM}		645		nm
HD1131/3O	λ_{DOM}	612		625	nm
HD1131/3G	λ_{DOM}	562		575	nm
Forward Voltage					
per Segment (1)(I_F=20 mA)					
HD1131/3R	V_F		1.6	2.0	V
HD1131/3O	V_F		2.0	3.0	V
HD1105/7G	V_F		2.4	3.0	V
Breakdown Voltage					
per Segment (1)(I_R=10 µA)	V_{BR}	6	15		V
Thermal Resistance	R_{thJA}			100	°c/W/Seg.

Notes:
1. AQL=0.4%.
2. Deviation of the absolute values within one digit $I_{VMAX}/I_{VMIN} \leq 2$.



A = Common Anode

HD1131
1 Cathode E
2 Cathode D
3 Common Anode
4 Cathode C
5 Cathode DP
6 Cathode B
7 Cathode A
8 Common Anode
9 Cathode F
10 Cathode G



C = Common Cathode

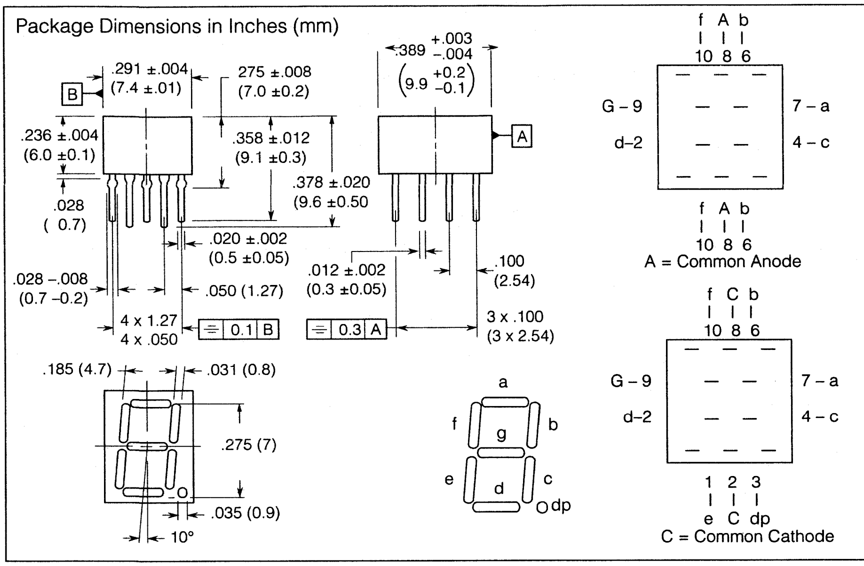
HD1133
1 Anode E
2 Anode D
3 Common Cathode
4 Anode C
5 Anode DP
6 Anode B
7 Anode A
8 Common Cathode
9 Anode F
10 Anode G

SIEMENS

SUPER-RED HDN1075O/1077O

0.28″ (7 mm) Seven Segment Numeric Display
Low Current

Package Dimensions in Inches (mm)



HDN1075
1 Cathode E
2 Cathode D
3 Common Anode
4 Cathode C
5 Cathode DP
6 Cathode B
7 Cathode A
8 Common Anode
9 Cathode G
10 Cathode F

HDN1077
1 Anode E
2 Anode D
3 Common Cathode
4 Anode C
5 Anode DP
6 Anode B
7 Anode A
8 Common Cathode
9 Anode G
10 Anode F

FEATURES

- **Current Consumption 2 mA**
- **Direct Drive by CMOS Microprocessor, Gate and LSTTL Modules**
- **Space Saving**
- **Lower Assembly Costs**
- **No Display and LED Driver Modules**
- **Good Readability in Unfavorable Lighting Conditions**
- **Climate Proof**
- **High Packing Density**
- **Gray Package for Optimal Contrast**
- **Long Service Life**
- **Shock and Vibration Resistant**

DESCRIPTION

The HDN1075/1077 are one digit, seven segment, low current LED displays. The character height is 0.28" (7 mm). The displays are available in super-red.

Applications include state-of-the-art industrial and consumer electronics, especially where low current consumption is required, i.e., portable applicances and battery-operated appliances.

See graph numbers 1A, 2A, 4A, 5B, 7A, 9D, 10A, 12A at the end of this section.

Maximum Ratings

Operating Temperature (T_{OP}) .... 0°C to +85°C
Storage Temperature (T_{STG}) .... –40°C to +85°C
Lead Soldering Tempterature, 2 mm from base (T_S) ....260°C
Peak Forward Current per Segment or DP [(1)] (I_{FM}) .... 100 mA
DC Forward Current per Segment or DP [(2)] (I_F) .... 15 mA
Reverse Voltage per Segment or DP (V_R) ....6 V
Total Power Dissipation (P_{TOT}) ....320 mW

Notes:
1. Do not exceed maximum average current per segment (see graph of peak forward current).
2. Derate maximum average current above T_A=75°C at 0.5 mA/°C per segment.

Characteristics (T_A=25°C)

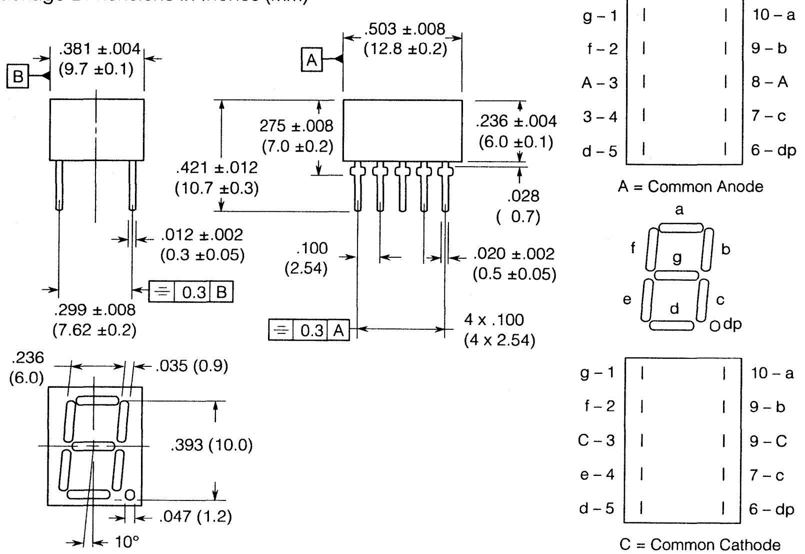
Parameter	Symbol	Values Min.	Typ.	Max.	Unit
Luminous Intensity per Segment (Digit Ave.) 2 mA	I_V	180	260		µcd
5 mA	I_V		1000		µcd
20 mA PK: 1:4 Duty Factor	I_V		1300		µcd
Peak Wavelength	λ_{PEAK}		635		nm
Dominant Wavelength (Digit Average)	λ_{DOM}	612		625	nm
Forward Voltage per Segment or DP (I_F=2 mA)	V_F		1.8		V
Breakdown Voltage per Segment (I_R=10 µA)	V_{BR}	6	15		V
Thermal Resistance LED Junction to Pin	R_{thJPIN}			180	°C/W/Seg.

SIEMENS

SUPER-RED HDN1105O/1107O

0.39″ (10 mm) Seven Segment Numeric Display
Low Current

Package Dimensions in Inches (mm)



HDN1105
1 Cathode G
2 Cathode F
3 Common Anode
4 Cathode E
5 Cathode D
6 Cathode DP
7 Cathode C
8 Common Anode
9 Cathode B
10 Cathode A

HDN1107
1 Anode G
2 Anode F
3 Common Cathode
4 Anode E
5 Anode D
6 Anode DP
7 Anode C
8 Common Cathode
9 Anode B
10 Anode A

FEATURES

- **Current Consumption 2 mA**
- **Direct Drive by CMOS Microprocessor, Gate and LSTTL Modules**
- **Space Saving**
- **Lower Assembly Costs**
- **No Display and LED Driver Modules**
- **Good Readability in Unfavorable Lighting Conditions**
- **Climate Proof**
- **High Packing Density**
- **Gray Package for Optimal Contrast**
- **Long Service Life**
- **Shock and Vibration Resistant**

DESCRIPTION

The HDN1105/1107 are one digit, seven segment, low current LED displays. The character height is 0.39" (10 mm). The displays are available in super-red.

Applications include state-of-the-art industrial and consumer electronics, especially where low current consumption is required, i.e., portable applicances and battery-operated appliances.

See graph numbers 1A, 2A, 4A, 5B, 7A, 9D, 10A, 12A at the end of this section.

Maximum Ratings

Operating Temperature (T_{OP}) .... 0°C to +85°C
Storage Temperature (T_{STG}) .... –40°C to +85°C
Lead Soldering Tempterature, 2 mm from base (T_S) .... 260°C
Peak Forward Current per Segment or DP (1) (I_{FM}) .... 100 mA
DC Forward Current per Segment or DP (2) (I_F) .... 15 mA
Reverse Voltage per Segment or DP (V_R) .... 6 V
Total Power Dissipation (P_{TOT}) .... 320 mW

Notes:
1. Do not exceed maximum average current per segment (see graph of peak forward current).
2. Derate maximum average current above T_A=75°C at 0.5 mA/°C per segment.

Characteristics (T_A=25°C)

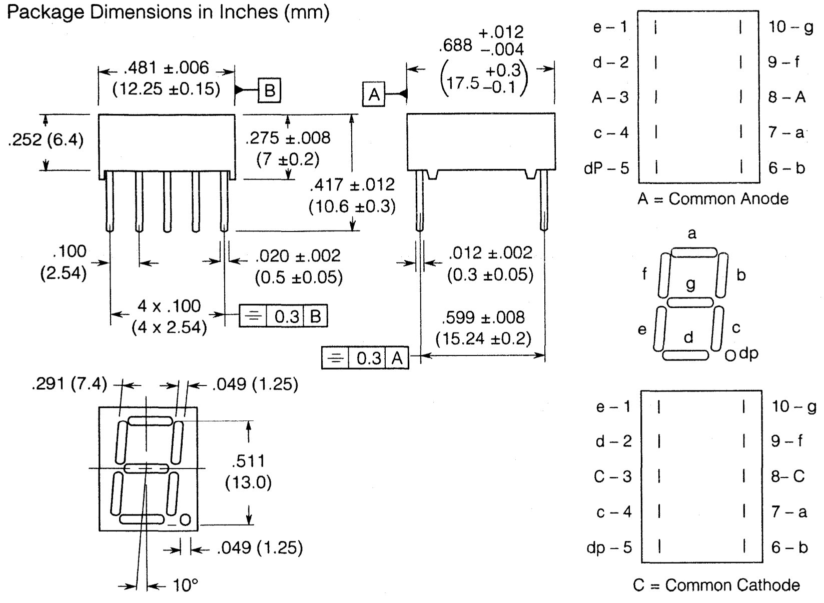
Parameter	Symbol	Values Min.	Typ.	Max.	Unit
Luminous Intensity per Segment (Digit Ave.)					
2 mA	I_V	180	260		μcd
5 mA	I_V		1000		μcd
20 mA PK: 1:4 Duty Factor	I_V		1300		μcd
Peak Wavelength	λ_{PEAK}		635		nm
Dominant Wavelength (Digit Average)	λ_{DOM}	612		625	nm
Forward Voltage per Segment or DP (I_F=2 mA)	V_F		1.8		V
Breakdown Voltage per Segment (I_R=10 μA)	V_{BR}	6	15		V
Thermal Resistance LED Junction to Pin	R_{thJPIN}			180	°C/W/Seg.

SIEMENS

SUPER-RED HDN1131O/1133O

0.59″ (13 mm) Seven Segment Numeric Display
Low Current

Package Dimensions in Inches (mm)



HDN1131
1 Cathode E
2 Cathode D
3 Common Anode
4 Cathode C
5 Cathode DP
6 Cathode B
7 Cathode A
8 Common Anode
9 Cathode F
10 Cathode G

HDN1133
1 Anode E
2 Anode D
3 Common Cathode
4 Anode C
5 Anode DP
6 Anode B
7 Anode A
8 Common Cathode
9 Anode F
10 Anode G

FEATURES

- **Current Consumption 2 mA**
- **Direct Drive by CMOS Microprocessor, Gate and LSTTL Modules**
- **Space Saving**
- **Lower Assembly Costs**
- **No Display and LED Driver Modules**
- **Good Readability in Unfavorable Lighting Conditions**
- **Climate Proof**
- **High Packing Density**
- **Gray Package for Optimal Contrast**
- **Long Service Life**
- **Shock and Vibration Resistant**

DESCRIPTION

The HDN1131/1133 are one digit, seven segment, low current LED displays. The character height is 0.59" (13 mm). The displays are available in super-red.

Applications include state-of-the-art industrial and consumer electronics, especially where low current consumption is required, i.e., portable applicances and battery-operated appliances.

See graph numbers 1A, 2A, 4A, 5B, 7B, 9D, 10A, 12A at the end of this section.

Maximum Ratings

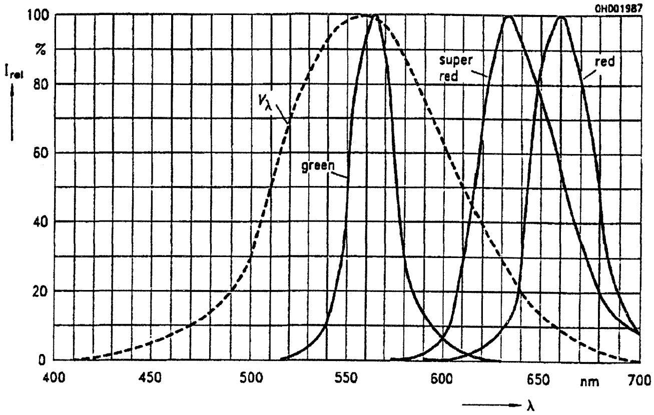
Operating Temperature (T_{OP}) .... 0°C to +85°C
Storage Temperature (T_{STG}) .... –40°C to +85°C
Lead Soldering Tempterature, 2 mm from base (T_S) .... 260°C
Peak Forward Current per Segment or DP [(1)] (I_{FM}) .... 100 mA
DC Forward Current per Segment or DP [(2)] (I_F) .... 15 mA
Reverse Voltage per Segment or DP (V_R) .... 6 V
Total Power Dissipation (P_{TOT}) .... 320 mW

Notes:
1. Do not exceed maximum average current per segment (see graph of peak forward current).
2. Derate maximum average current above T_A=75°C at 0.5 mA/°C per segment.

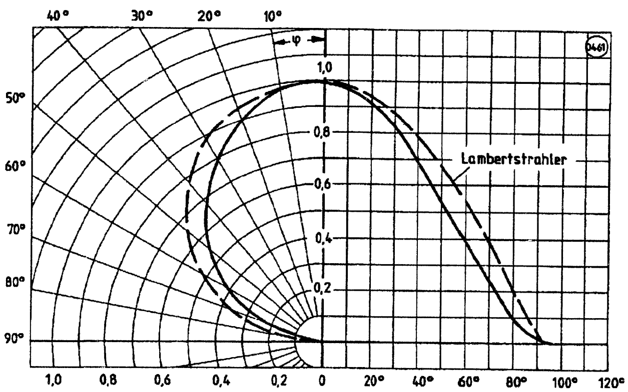
Characteristics (T_A=25°C)

Parameter	Symbol	Values Min.	Typ.	Max.	Unit
Luminous Intensity per Segment (Digit Ave.)					
2 mA	I_V	180	260		µcd
5 mA	I_V		1000		µcd
20 mA PK: 1:4 Duty Factor	I_V		1300		µcd
Peak Wavelength	λ_{PEAK}		635		nm
Dominant Wavelength (Digit Average)	λ_{DOM}	612		625	nm
Forward Voltage per Segment or DP (I_F=2 mA)	V_F		1.8		V
Breakdown Voltage per Segment (I_R=10 µA)	V_{BR}	6	15		V
Thermal Resistance LED Junction to Pin	R_{thJPIN}			180	°C/W/Seg.

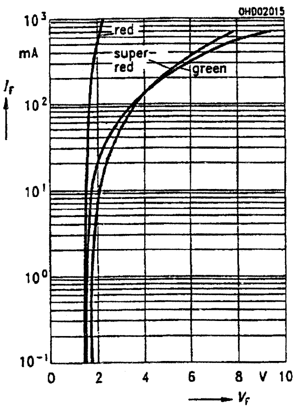
1A Relative spectral emission $I_{REL}=f(\lambda)$; $T_A=25°$ C, $V(\lambda)$=standard eye response curve



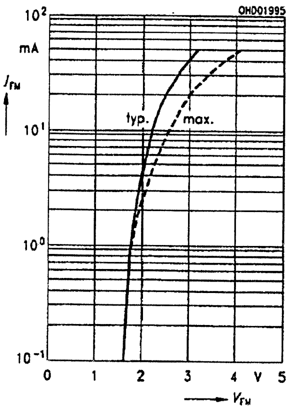
2A Relative spectral emission $I_{REL}=f(\lambda)$; $T_A=25°$ C, $V(\lambda)$=standard eye response curve



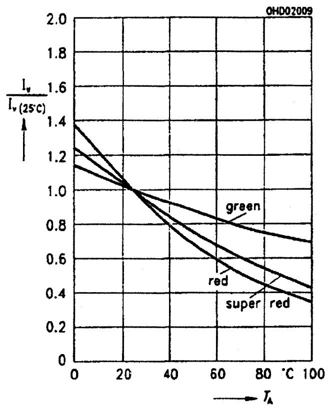
3A Forward current $I_F=f(V_F)$, $T_A=25°C$



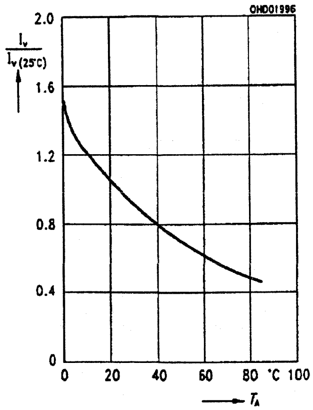
4A Peak forward current
$I_{FM}=f(V_{FM})$, $T_A=25°C$



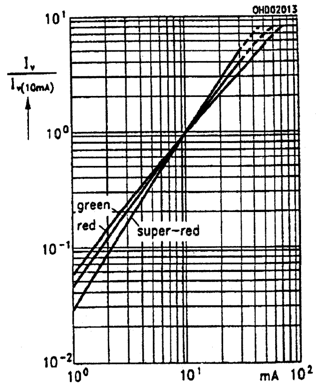
5A Relative luminous intensity
$I_V/I_{V25°C}=f(V_{FM})$, $T_A=25°C$



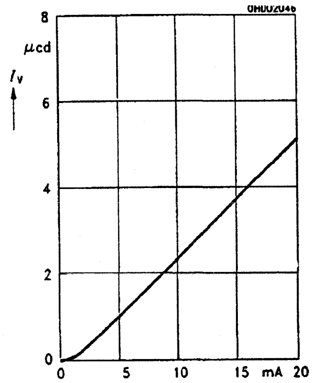
5B Relative luminous intensity
$I_V/I_{V25°C}=f(V_{FM})$, T_A=25°C



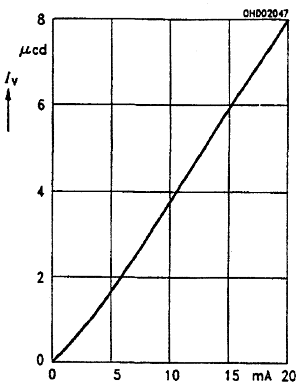
6A Relative luminous intensity
$I_V/I_{V(10mA)}=f(I_F)$, T_A=25°C



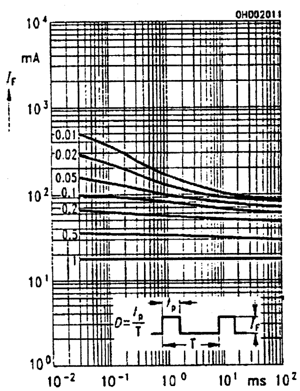
7A Luminous intensity $I_V=f(I_F)$, T_A=25°C



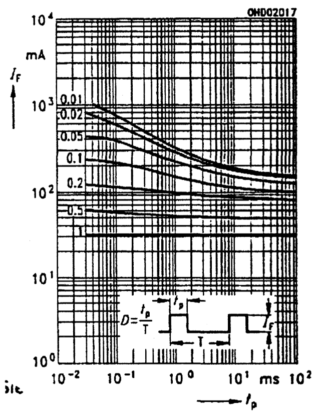
7B Luminous intensity $I_V=f(I_F)$, T_A=25°C



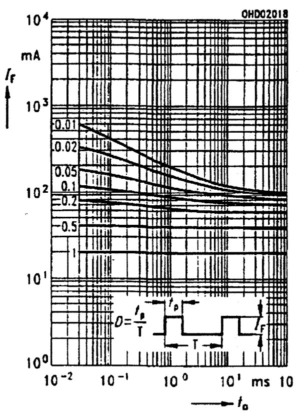
8B Permissible pulse handling capability
$I_F=f(t_P)$, T_A=25°C; Duty cycle D=parameter



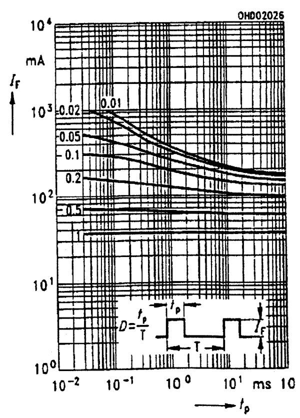
8C Permissible pulse handling capability
$I_F=f(t_P)$, T_A=25°C; Duty cycle D=parameter



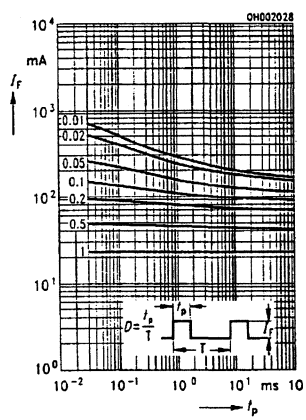
8D Permissible pulse handling capability
$I_F=f(t_P)$, T_A=25°C; Duty cycle D=parameter



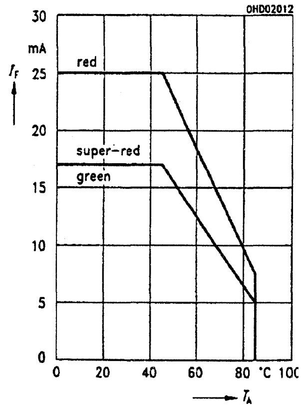
8E Permissible pulse handling capability
$I_F=f(t_P)$, T_A=25°C; Duty cycle D=parameter



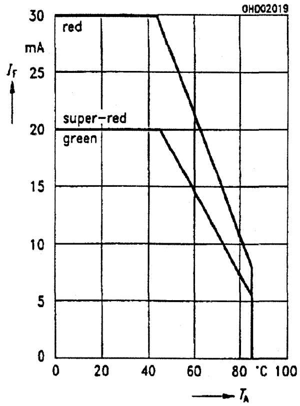
8F Permissible pulse handling capability
$I_F=f(t_P)$, T_A=25°C; Duty cycle D=parameter



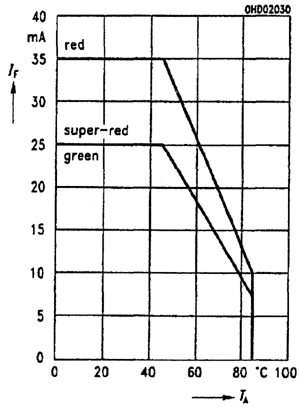
9A Maximum permissible forward current $I_F=f(T_A)$



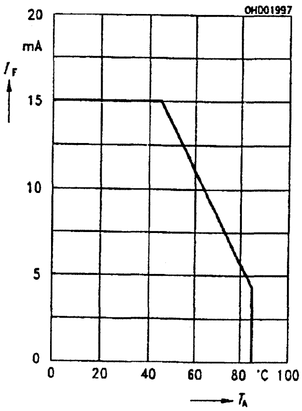
9B Maximum permissible forward current $I_F=f(T_A)$



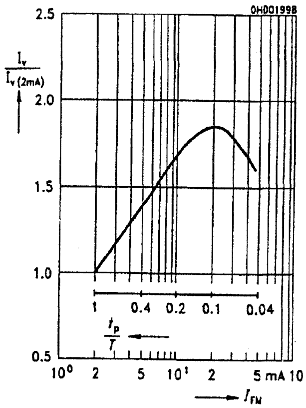
9C Maximum permissible forward current $I_F=f(T_A)$



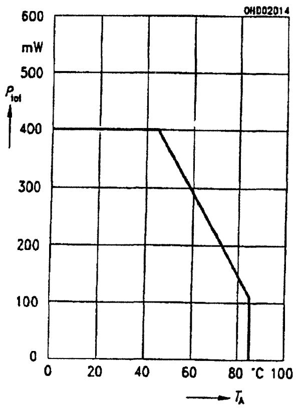
9D Maximum permissible forward current $I_F=f(T_A)$



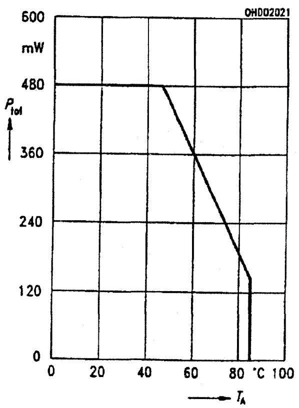
10A Relative efficiency $I_V/I_{V(...mA)}=f(I_{FM})$, $T_A=25°C$



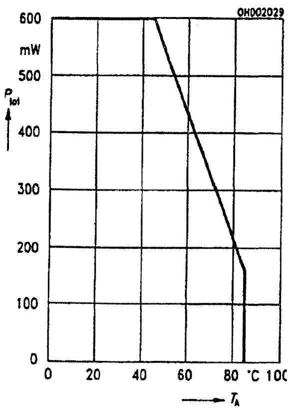
11A Total power dissipation $P_{TOT}=f(T_A)$



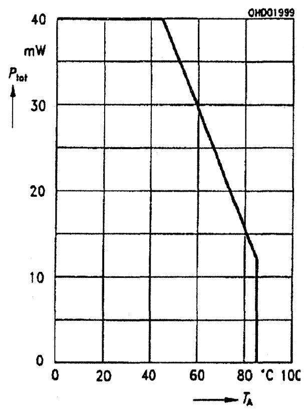
11B Total power dissipation $P_{TOT}=f(T_A)$



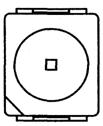
11C Total power dissipation $P_{TOT}=f(T_A)$



12A Total power dissipation per segment $P_{TOT}=f(T_A)$

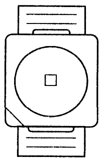
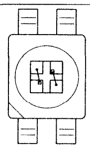
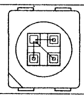
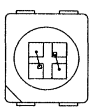


LED Lamps

Package & Type	Package Outline	Part Number	Color	Lens	λ Peak nm	Viewing Angle Degrees	Luminous Intensity		Page
							mcd	mA	
SMT-TOP-LED		LH T674-KM LH T674-L LH T674-M LH T674-LN	Hyper-red	Colorless clear	660	120	6.3–32 10–20 16–32 10–50	10	4–11
		LB T670-BO	Blue	Colorless clear	467	120	≥.25	20	4–7
		LG T670-HK LG T670-J LG T670-K LG T670-JL	Green	Colorless clear	565	120	2.5–12.5 4–8 6.3–12.5 4–20	10	4–53
		LO T670-HK LO T670-J LO T670-K LO T670-JL	Orange		610		2.5–12.5 4–8 6.3–12.5 4–20		
		LP T670-FJ LP T670-G LP T670-H LP T670-GK	Pure green		557		1–8 1.6–3.2 2.5–5 1.6–12.5		
		LS T670-HK LS T670-J LS T670-K LS T670-JL	Super-red		635		2.5–12.5 4–8 6.3–12.5 4–20		
		LY T670-HK LY T670-H LY T670-J LY T670-JL	Yellow		586		2.5–12.5 2.5–5 4–8 4–20		
SMT Super TOP-LED High Current		LG T672-LN LG T672-N LG T672-P LG T672-MQ	Green	Colorless clear	565	120	10–50 25–50 40–80 16–125	50	4–55
		LO T672-LN LO T672-N LO T672-P LO T672-MQ	Orange		610		10–50 25–50 40–80 16–125		
		LS T672-LN LS T672-M LS T672-N LS T672-MQ	Super-red		635		10–50 16–32 25–50 16–125		
		LP T672-KM LP T672-L LP T672-M LP T672-LP	Pure green		557		6.3–32 10–20 16–32 10–80		
		LY T672-LN LY T672-N LY T672-P LY T672-MQ	Yellow		586		10–50 25–50 40–80 16–125		
SMT-TOP-LED Low Current		LG T679-CO	Green	Colorless clear	565	120	1 (≥0.25)	2	4–57
		LS T679-CO	Super-red		635				
		LY T679-CO	Yellow		586				

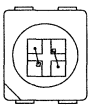
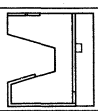
There may be dash numbers in the Selector Guide that are not depicted in the data sheets.

LED Lamps

Package & Type	Package Outline	Part Number	Color	Lens	λ Peak nm	Viewing Angle Degrees	Luminous Intensity mcd	Luminous Intensity mA	Page
SMT-MULTILED Reverse Gullwing		LH T774-KM LH T774-L LH T774-M LH T774-LN	Hyper-red	Colorless clear	660	120	6.3–32 10–20 16–32 10–50	10	4–12
		LB T770-BO	Blue	Colorless clear	467	120	≥.25	20	4–7
		LG T770-HK LG T770-J LG T770-K LG T770-JL	Green	Colorless clear	565	120	2.5–12.5 4–8 6.3–12.5 4–20	10	4–53
		LO T770-HK LO T770-J LO T770-K LO T770-JL	Orange		610		2.5–12.5 4–8 6.3–12.5 4–20		
		LP T770-FJ LP T770-G LP T770-H LP T770-GK	Pure green		557		1–8 1.6–3.2 2.5–5 1.6–12.5		
		LS T770-HK LS T770-J LS T770-K LS T770-JL	Super-red		635		2.5–12.5 4–8 6.3–12.5 4–20		
		LY T770-HK LY T770-H LY T770-J LY T770-JL	Yellow		586		2.5–12.5 2.5–5 4–8 4–20		
		LSG T770-HK LSG T770-J LSG T770-K LSG T770-JL	Super-red/ green	Colorless clear	635/565	120	2.5–12.5 4–8 6.3–12.5 4–20	10	4–40
SMT-MULTILED		LSPB T670	Super-red/ pure green/ blue	Colorless clear	635/557/ 467	120	0.7 2.5 0.6	2/10/ 50	4–45
SMT-MULTILED		LOG T670-HK LOG T670-J LOG T670-K LOG T670-JL	Orange/ green	Colorless clear	610/565	120	2.5–12.5 4–8 6.3–12.5 4–20	10	4–38
		LOP T670-FJ LOP T670-G LOP T670-H LOP T670-GK	Orange/ pure green		610/557		1–8 1.6–3.2 2.5–5 1.6–12.5		
		LSG T670-HK LSG T670-J LSG T670-K LSG T670-JL	Super-red/ green		635/565		2.5–12.5 4–8 6.3–12.5 4–20		
		LSP T670-FJ LSP T670-G LSP T670-H LSP T670-GK	Super-red/ pure green		635/557		1–8 1.6–3.2 2.5–5 1.6–12.5		

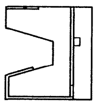
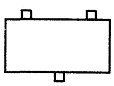
There may be dash numbers in the Selector Guide that are not depicted in the data sheets.

LED Lamps

Package & Type	Package Outline	Part Number	Color	Lens	λ Peak nm	Viewing Angle Degrees	Luminous Intensity mcd	Luminous Intensity mA	Page
SMT-MULTILED		LSY T670-HO	Super-red/ yellow	Colorless clear	635/586	120	≥2.5	10	4–38
		LYP T670-FJ LYP T670-G LYP T670-H LYP T670-GK	Yellow/ pure green		586/557		1–8 1.6–3.2 2.5–5 1.6–12.5		
		LBB T670-CO	Blue/blue	Colorless clear	467/467	120	≥0.25	10	4–49
		LGG T670-JO	Green/ green		565/565		≥12.5		
		LOO T670-JO	Orange/ orange		610/610		≥12.5		
		LPP T670-HO	Pure green/ pure green		557/557		≥6		
		LSS T670-JO	Super-red/ super-red		635/635		≥12.5		
		LYY T670-JO	Yellow/ yellow		586/586		≥12.5		
SMT Super MULTILED High Current		LGG T672-NO	Green/ green	Colorless clear	565/565	120	60 (≥25)	50	4–51
		LOO T672-NO	Orange/ orange		610/610		60 (≥25)		
		LPP T672-MO	Pure green/ pure green		557/557		40 (≥16)		
		LSS T672-NO	Super-red/ super-red		635/635		60 (≥25)		
		LYY T672-NO	Yellow/ yellow		586/586		60 (≥25)		
		LOG T672-MO	Orange/ green	Colorless clear	610/565	120	30 (≥16)	50	4–13
		LOP T672-LO	Orange/ pure green		610/557		20 (≥10)		
		LOY T672-MO	Orange/ yellow		610/586		45 (≥16)		
		LSG T672-MO	Super-red/ green		635/565		30 (≥16.0)		
		LSP T672-LO	Super-red/ pure green		635/557		20 (≥10)		
		LSY T672-MO	Super-red/ yellow		635/586		45 (≥16)		
		LYP T672-LO	Yellow/ pure green		586/557		20 (≥10)		
SMT-SIDELED		LO A670-GJ LO A670-H LO A670-J LO A670-JL	Orange	Colorless clear	610	120	1.6–12.5 2.5–5 4–8 4–20	10	4–30

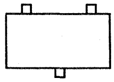
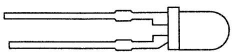
There may be dash numbers in the Selector Guide that are not depicted in the data sheets.

LED Lamps

Package & Type	Package Outline	Part Number	Color	Lens	λ Peak nm	Viewing Angle Degrees	Luminous Intensity		Page
							mcd	mA	
SMT-SIDELED		LG A670-HK LG A670-J LG A670-K LG A670-JL	Green	Colorless clear	565	120	2.5–12.5 4–8 6.3–12.5 4–20	10	4–30
		LP A670-FJ LP A670-G LP A670-H LP A670-GK	Pure green		557		1–8 1.6–3.2 2.5–5 1.6–12.5		
		LS A670-HK LS A670-J LS A670-K LS A670-JL	Super red		635		2.5–12.5 4–8 6.3–12.5 4–20		
		LY A670-HK LY A670-J LY A670-K LY A670-JL	Yellow		586		2.5–12.5 4–8 6.3–12.5 4–20		
SMT Super SIDELED High-Current		LO A672-LN LO A672-N LO A672-P LO A672-MQ	Orange	Colorless clear	610	120	10–50 25–50 40–80 16–125	50	4–32
		LG A672-LN LG A672-N LG A672-P LG A672-MQ	Green		565		10–50 25–50 40–80 16–125		
		LP A672-KM LP A672-L LP A672-M LP A672-LP	Pure green		557		6.3–32 10–20 16–32 10–80		
		LS A672-LN LS A672-M LS A672-N LS A672-MQ	Super red		635		10–50 16–32 25–50 16–125		
		LY A672-LN LY A672-N LY A672-P LY A672-MQ	Yellow		586		10–50 25–50 40–80 16–125		
SMT-SIDELED Low Current		LG A679-CO	Green	Colorless clear	565	120	1 (≥0.25)	2	4–34
		LS A679-CO	Super red		635				
		LY A679-CO	Yellow		586				
SMT-SOT-23		LS S260-DO	Super-red	Red diffused	635	140	≥0.4	10	4–47
		LY S260-DO	Yellow	Yellow diffused	586				
		LG S260-DO	Green	Green diffused	565				
SMT-SOT-23 MULTI-LED		LU S250-DO	Super-red/ green	Colorless diffused	635/565				

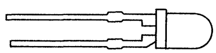
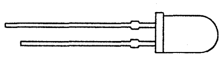
There may be dash numbers in the Selector Guide that are not depicted in the data sheets.

LED Lamps

Package & Type	Package Outline	Part Number	Color	Lens	λ Peak nm	Viewing Angle Degrees	Luminous Intensity mcd	Luminous Intensity mA	Page
SMT-SOT-23 Low current		LS S269-BO	Super-red	Red diffused	635	140	≥0.16	2	4–48
		LY S269-BO	Yellow	Yellow diffused	586				
		LG S269-BO	Green	Green diffused	565				
T1 (3 mm)		LH 3344-QO	Hyper-red	Red clear	660	25	150 (≥63)	10	4–9
		LH 3364-MO		Red diffused		45	40 (≥10)		
T1 (3 mm)		LG 3341-JM LG 3341-L LG 3341-M LG 3341-LP	Green	Green clear	565	40	4–32 10–20 16–32 10–80	10	4–23
		LS 3341-KN LS 3341-M LS 3341-N LS 3341-MQ	Super-red	Red clear	635		6.3–50 16–32 25–50 16–125		
		LY 3341-JM LY 3341-L LY 3341-M LY 3341-LP	Yellow	Yellow clear	586		4–32 10–20 16–32 10–80		
T1 (3 mm)		LS 3340-KN LS 3340-M LS 3340-N LS 3340-MP	Super-red	Red clear	635	50	6.3–50 16–32 25-50 16–80	10	4–22
		LO 3340-KN LO 3340-M LO 3340-MP LO 3340-N	Orange	Orange clear	610		6.3–50 16–32 16–80 25–50		
		LY 3340-JM LY 3340-L LY 3340-M LY 3340-LP	Yellow	Yellow clear	586		4–32 10–20 16–32 10–80		
		LG 3330-KN LG 3330-L LG 3330-M LG 3330-N LG 3330-LP	Green	Colorless clear	565		6.3–50 10–20 16–32 25–50 10–80		
		LP 3340-HO	Pure green		557		8–(≥2.5)		
T1 (3 mm)		LR 3360-DG LR 3360-F LR 3360-G LR 3360-FJ	Red	Red diffused	660	70	0.4–3.2 1–2 1.6-3–2 1–8	10	4–15
		LS 3360-HL LS 3360-J LS 3360-K LS 3360-KN	Super Red	Red diffused	635		2.5–20 4–8 6.3–12.5 6.3–50		

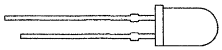
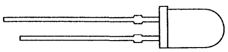
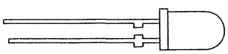
There may be dash numbers in the Selector Guide that are not depicted in the data sheets.

LED Lamps

Package & Type	Package Outline	Part Number	Color	Lens	λ Peak nm	Viewing Angle Degrees	Luminous Intensity mcd	Luminous Intensity mA	Page
T1 (3 mm)		LO 3360-HL LO 3360-J LO 3360-K LO 3360-JM	Orange	Orange diffused	610	70	2.5–20 4–8 6.3–12.5 4–32	10	4–15
		LY 3360-HL LY 3360-J LY 3360-K LY 3360-JM	Yellow	Yellow diffused	586		2.5–20 4–8 6.3–12.5 4–32		
		LG 3360-GK LG 3360-H LG 3360-J LG 3360-K LG 3360-JM	Green	Green diffused	565		1.6–12.5 2.5-5 4–8 6.3–12.5 4–32		
		LP 3360-GK	Pure green	Green diffused	557		1.6–12.5		
T1 (3 mm)		LS 3380-FJ LS 3380-H LS 3380-J LS 3380-HL	Super-red	Red diffused	635	100	1–8 2.5–5 4–8 2.5–20	10	4–25
		LY 3380-FJ LY 3380-H LY 3380-J LY 3380-HL	Yellow	Yellow diffused	586		1–8 2.5–5 4–8 2.5–20		
		LG 3380-GK LG 3380-H LG 3380-J LG 3380-HL	Green	Green diffused	565		1.6–12.5 2.5–5 4–8 2.5–20		
T1 (3 mm) Low current		LS 3369-EH LS 3369-FH	Super-red	Red diffused	635	60	0.63–5 1–5	2	4–24
		LY 3369-EH LY 3369-FH	Yellow	Yellow diffused	586		0.63–5 1–5		
		LG 3369-EH LG 3369-FH	Green	Green diffused	565		0.63–5 1–5		
T1 (3 mm) MULTI-LED		LSG 3331-JO	Super-red/ green	Colorless clear	635/565	40	18 (≥4)	10	4–35
		LSG 3351-HO			635/565	50	≥2.5		
T $1^3/4$ (5 mm)		LH 5424-QO	Hyper-red	Red clear	660	16	320 (≥63)	10	4–10
		LH 5464-LO		Red diffused		35	60 (≥10)		
T $1^3/4$ (5 mm)		LB 5410-GO	Blue	Colorless clear	480	16	≥1.6	20	4–6
T $1^3/4$ (5 mm)		LS 5420-MQ LS 5420-P LS 5420-Q LS 5420-R LS 5420-PS	Super-red	Red clear	635	24	16–125 40–80 63–125 100–200 40–320	10	4–27

There may be dash numbers in the Selector Guide that are not depicted in the data sheets.

LED Lamps

Package & Type	Package Outline	Part Number	Color	Lens	λ Peak nm	Viewing Angle Degrees	Luminous Intensity		Page
							mcd	mA	
T $1^{3}/4$ (5 mm)		LY 5420-MQ LY 5420-P LY 5420-Q LY 5420-PS	Yellow	Yellow clear	586	24	16–125 40–80 63–125 40–320	10	4–27
		LG 5410-MQ LG 5410-P LG 5410-Q LG 5410-R LG 5410-PS	Green	Colorless clear	565		16–125 40–80 63–125 100–200 40–320		
T $1^{3}/4$ (5 mm)		LS 5421-NR LS 5421-Q LS 5421-R LS 5421-QT	Super-red	Red clear	635	20	25–200 63–125 100–200 63–500	10	4–28
		LY 5421-NR LY 5421-Q LY 5421-R LY 5421-QT	Yellow	Yellow clear	586		25–200 63–125 100-200 65-500		
		LG 5411-NR LG 5411-Q LG 5411-R LG 5411-S LG 5411-QT	Green	Colorless clear	565		25–200 63–125 100–200 160–320 63–500		
T $1^{3}/4$ (5 mm)		LR 5360-DG LR 5360-F LR 5360-G LR 5360-FJ	Red	Red diffused	660	50	0.4–3.2 1–2 1.6–3.2 1–8	10	4–16
		LS 5360-HL LS 5360-J LS 5360-K LS 5360-L LS 5360-KN	Super red	Red diffused	635		2.5–20 4–8 6.3–12.5 10–20 6.3–50		
		LY 5360-HL LY 5360-J LY 5360-K LY 5360-L LY5360-JM	Yellow	Yellow diffused	586		2.5–20 4–8 6.3–12.5 10–20 4–32		
		LG 5360-GK LG 5360-H LG 5360-J LG 5360-K LG 5360-JM	Green	Green diffused	565		1.6–12.5 2.5–5 4–8 6.3–12.5 4–32		

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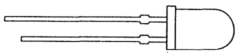
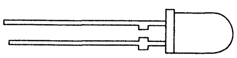
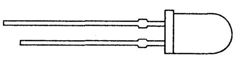
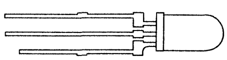
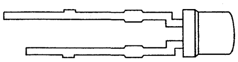
LED Lamps

Package & Type	Package Outline	Part Number	Color	Lens	λ Peak nm	Viewing Angle Degrees	Luminous Intensity mcd	mA	Page
T 1 3/4 (5 mm)		LR 5460-DG LR 5460-F LR 5460-G LR 5460-FJ	Red	Red diffused	660	50	0.4–3.2 1–2 1.6–3.2 1–8	10	4–17
		LS 5460-HL LS 5460-J LS 5460-K LS 5460-L LS 5460-KN	Super-red	Red diffused	635		2.5–20 4–8 6.3–12.5 10–20 6.3–50		
		LY 5460-HL LY 5460-J LY 5460-K LY 5460-L LY 5460-JM	Yellow	Yellow diffused	586		2.5–20 4–8 6.3–12.5 10–20 4–32		
		LG 5460-GK LG 5460-H LG 5460-J LG 5460-K LG 5460-JM	Green	Green diffused	565		1.6–12.5 2.5–5 4–8 6.3–12.5 4–32		
T 1 3/4 (5 mm)		LR 5480-CF LR 5480-E LR 5480-F LR 5480-DG	Red	Red diffused	660	80	0.25–2.0 .63–1.25 1–2 0.4–3.2	10	4–18
		LS 5480-GK LS 5480-J LS 5480-K LS 5480-JM	Super-red	Red diffused	635		1.6–12.5 4–8 6.3–12.5 4–32		
		LY 5480-GK LY 5480-K LY 5480-L LY 5480-JM	Yellow	Yellow diffused	586		1.6–12.5 6.3–12.5 10-20 4–32		
		LG 5480-GK LG 5480-H LG 5480-J LG 5480-K LG 5480-JM	Green	Green diffused	565		1.6–12.5 2.5–5 4-8 6.3–12.5 4–32		
T 1 3/4 (5 mm)		LS 5380-FJ LS 5380-H LS 5380-J LS 5380-HL	Super-red	Red diffused	635	80	1–8 2.5–5 4–8 2.5–20	10	4–26
		LY 5380-FJ LY 5380-H LY 5380-J LY 5380-HL	Yellow	Yellow diffused	586		1–8 2.5–5 4–8 2.5–20		
		LG 5380-FJ LG 5380-H LG 5380-J LG 5380-HL	Green	Green diffused	565		1–8 2.5–5 4–8 2.5–20		
T 1 3/4 (5 mm) Low current		LS 5469-EH LS 5469-FH	Super-red	Red diffused	635	50	0.63–5 1–5	2	4–29
		LY 5469-EH LY 5469-FH	Yellow	Yellow diffused	586		0.63–5 1–5		
		LG 5469-EH LG 5469-FH	Green	Green diffused	565		0.63–5 1–5		
T 1 3/4 (5 mm) MULTI-LED		LU 5351-GL LU 5351-JM	Super-red and green	Colorless clear, partly diffused	635/565	50	1.6–20 4–32	10	4–59

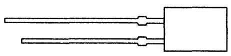
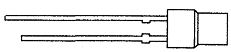
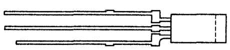
There may be dash numbers in the Selector Guide that are not depicted in the data sheets.

LED Lamps

Package & Type	Package Outline	Part Number	Color	Lens	λ Peak nm	Viewing Angle Degrees	Luminous Intensity		Page
							mcd	mA	
T1 (3 mm) ARGUS		LS K380-LP LS K380-N LS K380-P LS K380-NR	Super-red	Red clear	635	—	mlm Φ 10–80 25–50 40–80 25–200	15	4–41
		LO K380-LP LO K380-N LO K380-NR LO K380-P	Orange	Orange clear	610		10–80 25–50 25-200 40–80		
		LY K380-LP LY K380-N LY K380-P LY K380-NR	Yellow	Yellow clear	586		10–80 25–50 40–80 25–200		
		LG K380-LP LG K380-N LG K380-P LG K380-NR	Green	Green clear	565		10–80 25–50 40–80 25–200		
		LP K380-KO	Pure green	Colorless clear	557		10 (63)		
T1 (3 mm) Super ARGUS		LS K382-QT LS K382-R LS K382-S LS K382-RU	Super-red	Red clear	635	—	mlm Φ 63–500 100–200 160–320 100–800	50	4–43
		LO K382-QT LO K382-R LO K382-S LO K382-RU	Orange	Orange clear	610		63–500 100–200 160–320 100–800		
		LY K382-QT LY K382-R LY K382-S LY K382-RU	Yellow	Yellow clear	586		63–500 100–200 160–320 100–800		
		LG K382-QT LG K382-R LG K382-S LG K382-T LG K382-RU	Green	Green clear	565		63–500 100–200 160–320 250–500 100–800		
		LP K382-NR LP K382-P LP K382-Q LP K382-R LP K382-PS	Pure green	Colorless clear	557		25–200 40–80 63–125 100–200 40–320		
T1 (3 mm) Low current ARGUS		LS K389-FO	Super-red	Red clear	635	—	mlm Φ 5 (≥1)	2	4–44
		LY K389-FO	Yellow	Yellow clear	586		3.2 (≥1)		
		LG K389-FO	Green	Green clear	565				
T1 (3 mm) MULTI-LED ARGUS		LOG K370-LP LOG K370-N LOG K370-P LOG K370-NR	Orange green	Colorless clear	610/565	—	mlm Φ 10-80 25-50 40-80 25-200	15	4–36

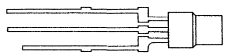
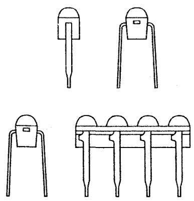
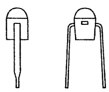
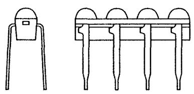
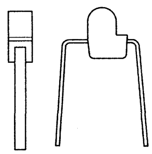
There may be dash numbers in the Selector Guide that are not depicted in the data sheets.

LED Lamps

Package & Type	Package Outline	Part Number	Color	Lens	λ Peak nm	Viewing Angle Degrees	Luminous Intensity mcd	Luminous Intensity mA	Page
T1 (3 mm) MULTI-LED ARGUS		LOP K370-KN LOP K370-M LOP K370-N LOPK370-MQ	Orange/ pure green	Colorless clear	610/557	—	**mlm Φ** 6.3–50 16–32 25–50 16–125	15	4–36
		LSG K370-LP LSG K370-N LSG K370-P LSG K370-NR	Super-red/ green		635/565		10–80 25–50 40–80 25–200		
		LSP K370-KN LSP K370-M LSP K370-N LSP K370-NR	Super-red/pure green		635/557		6.3–50 16–32 25–50 25-200		
T1 (3 mm) MULTI-LED Super ARGUS		LSG K372-RO	Super-red/green	Colorless clear	635/565	—	**mlm Φ** 160 (≥100)	50	4–37
		LSP K372-PO	Sup-red/ pure green		635/557		100 (≥40)		
Rectangular (5 mm)		LR B480-BD LR B480-C LR B480-D	Red	Red, partly diffused	660	100	0.16–0.8 0.25–0.5 0.4–0.8	10	4–19
		LS B480-EH LS B480-G LS B480-H LS B480-GK	Super-red	Red, partly diffused	635		0.63–5 1.6–3.2 2.5–5 1.6–12.5		
		LY B480-EH LY B480-G LY B480-H LY B480-GK	Yellow	Yellow, partly dif-fused	586		0.63–5 1.6–3.2 2.5–5 1.6–12.5		
		LG B480-EH LG B480-G LG B480-H LG B480-GK	Green	Green, partly diffused	565		0.63–5 1.6–3.2 2.5–5 1.6–12.5		
Cylindrical (5 mm)		LR H380-BD LR H380-C LR H380-D	Red	Red, partly diffused	660	100	0.16–0.8 0.25–0.5 0.40–0.8	10	4–20
		LS H380-EH LS H380-G LS H380-H LS H380-GK	Super-red	Red, partly diffused	635		0.63–5 1.6–3.2 2.5–5 1.6–12.5		
		LY H380-EH LY H380-G LY H380-H LY H380-GK	Yellow	Yellow, partly diffused	586		0.63–5 1.6–3.2 2.5–5 1.6–12.5		
		LG H380-EH LG H380-G LG H380-H LG H380-GK	Green	Green, partly diffused	565		0.63–5 1.6–3.2 2.5–5 1.6–12.5		
Rectangular MULTI-LED		LU B371-FJ	Super-red/ green	Colorless clear, partly diffused	635	100	1–8	10	4–59
		LU B371-GK			565		1.6–12.5		

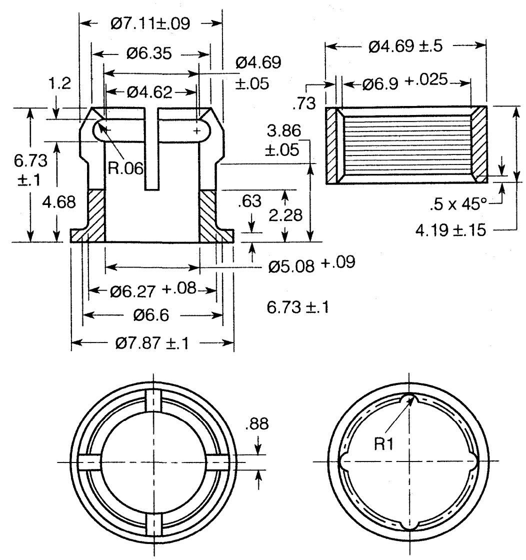
There may be dash numbers in the Selector Guide that are not depicted in the data sheets.

LED Lamps

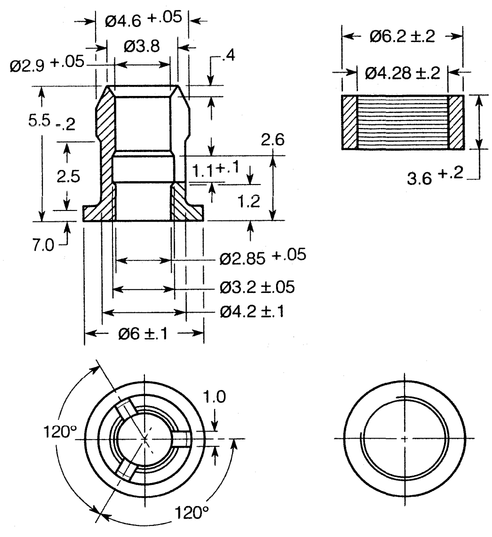
Package & Type	Package Outline	Part Number	Color	Lens	λ Peak nm	Viewing Angle Degrees	Luminous Intensity		Page
							mcd	mA	
Cylindrical MULTI-LED		LU H371-FJ	Super-red/ green	Colorless clear, partly diffused	635	100	1–8	10	4–59
		LU H371-GK			565		1.6–12.5		
1 diode 2 diodes 3 diodes 4 diodes 5 diodes 6 diodes 7 diodes 8 diodes 9 diodes 10 diodes		LR Z181-CO LR Z182-CO LR Z183-CO LR Z184-CO LR Z185-CO LR Z186-CO LR Z187-CO LR Z188-CO LR Z189-CO LR Z180-CO	Red	Red diffused	660	100	≥0.25	10	4–21
1 diode		LY Z181-CO	Yellow	Yellow diffused	586	100	≥0.25	10	4–61
1 diode 2 diodes 3 diodes 4 diodes 5 diodes 6 diodes 8 diodes 10 diodes		LG Z181-CO LG Z182-CO LG Z183-CO LG Z184-CO LG Z185-CO LG Z186-CO LG Z188-CO LG Z180-CO	Green	Green diffused	565	100	≥0.25	10	4–8
Miniature (1 mm)		LS U260-EO	Super-red	Red diffused	635	60	≥0.63	10	4–58
		LY U260-EO	Yellow	Yellow diffused	586				
		LG U260-EO	Green	Green diffused	565				
Miniature, axial leads		RL50	Red	Water Clear	660	90°	≥0.5	10	4–62
		RL54		Red diffused			≥0.4		
Miniature, axial leads, high domes lens		RL55	Red	Red diffused	660	50°	≥2.0	10	4–64
		YL56	Yelllow	Yellow diffused	585	40°			
		GL56	Green	Green diffused	565		≥1.0		
		RRL-5601	Red	Red diffused	650	20	≥0.3	5 V	4-66
		RRL-5621					≥0.6		
		RRL-5641					≥1.0		

There may be dash numbers in the Selector Guide that are not depicted in the data sheets.

Mounting Clip & Collar for T1¾ (5 mm) LED
Q 62901-B64, Clear and Q 62901-B65, Black

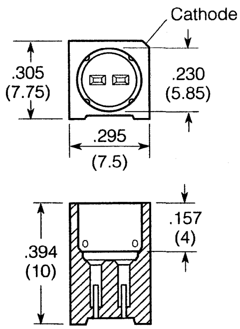


Mounting Clip & Collar for T1 (3 mm) LED
Q 62901-B61, Clear and Q 62901-B62, Black

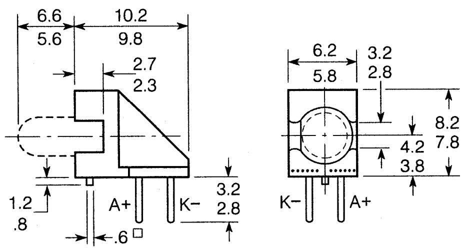


Material: Polypropylene

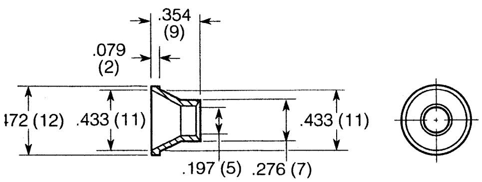
Right Angle Mount
Q 62902-B156-F222, Black



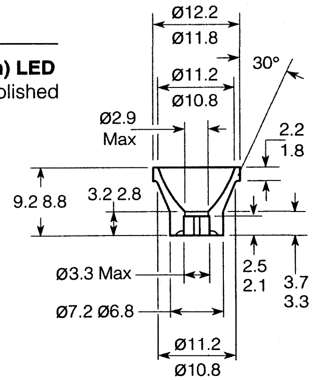
Angular Mount
Q 62902-B155-F222, Black



Reflector for T1¾ (5 mm) LED
Q 62902-B141-F222, Polished



Reflector for T1 (3 mm) LED
Q 62902-B154-F222, Polished



LED Lamps 4

LED Lamp Part Numbering System

New LED type designation system

The range of Siemens light emitting diodes has received new type designations and ordering codes. The new type designation now indicates the most important characteristics of an LED.

LED type designation system

Wavelength / Emission Color

Wavelength λ peak typ.		Emission Color
M	635/557 nm	super-red/pure green
T	635/586 nm	super-red/yellow
U	635/565 nm	super-red/green
V	635 nm	super-red/super-red
W	565 nm	green/green
B	467 nm	SiC blue
P	557 nm	pure green
G	565 nm	green
Y	586 nm	yellow
O	610 nm	orange
S	635 nm	super-red
R	66 nm	GaAsP red
H	66 nm	hyper-red

Product

L–light emitting diode

Type

Type		
3	3 mm	round (standard version)
5	5 mm	round (standard version)
B	2.5 x 2.5 mm	rectangular (symbol LED)
H	4 mm	round (symbol LED)
S	SOT-23 package	SMT-LED
U	1 mm	Mini-LED
Z	2 mm	round (array version)
K	3 mm	ARGUS®-LED/Super ARGUS®-LED
T	PL-CC-2 package	SMT-TOP-LED™

L S 3 3 6 0 - K N

Length of leads

Length of leads		
3	<30 mm	with stand-off
4	<30 mm	without stand-off
5	gull-wing leads	
6	J-leads	

Case

Case		Viewing angle (typ.)
1	colorless clear	15 to 30 degrees
2	colored clear	15 to 30 degrees
3	colorless clear	30 to 70 degrees
4	colored clear	30 to 70 degrees
5	colorless diffused	40 to 80 degrees
6	colored diffused	40 to 80 degrees
7	colorless diffused	>80 degrees
8	colored diffused	>80 degrees

(SOT-23 requires no angle)

Special versions

Special versions	
1	aspherical lenses
2	high-current LED
3	GaAlAs single hetero LED
4	GaAlAs double hetero LED
7	resistor LED
8	constant current LED
9	low-current LED

Array versions: digit 4=Z

Number of lamps per array

Luminous intensity groups

A	0.1 to 0.2	P	40 to 80
B	0.16 to 0.34	Q	63 to 125
C	0.25 to 0.5	R	100 to 200
D	0.4 to 0.8	S	160 to 320
E	0.63 to 1.25	T	250 to 500
F	1 to 2	U	400 to 800
G	1.6 to 3.2	V	630 to 1250
H	2.5 to 5	W	1000 to 2000
J	4 to 8	X	1600 to 3200
K	6.3 to 12.5	Y	2500 to 5000
L	10 to 20	Z	>5000
M	16 to 32	O	open top
N	25 to 50		

Value of standard LEDs in luminous intensity I_V in mcd.

Value of ARGUS LEDs in luminous flux Φ_V in mlm.

Explanation of example:

LS 3360-KN		
	L	Light emitting diode
	S	Emission color: super-red, λpeak=635 nm (typ.)
	3	Standard version: 3 mm
	3	Length of leads <30 mm with stand-off
	6	Colored case, diffused; viewing angle 70 degrees (typ.)
	0	No special version
	KN	Luminous intensity of family group, minimum 6.3 mcd, maximum 50 mcd

Grouping of luminous intensities (I_V)

The different luminous intensities throughout one type family are grouped according to the following plan (I_F = 10 mA)[1]:

Group	A	B	C	D	E	F	G	H	J	K	L	M	N
Iv mcd	0,1...0,2	0,16...0,32	0,25...0,50	0,40...0,80	0,63...1,25	1...2	1,6...3,2	2,5...5	4...8	6,3...12,5	10...20	16...32	25...50

Group	P	Q	R	S	T	U	V	W	X	Y	Z	O
Iv mcd	40...80	63...125	100...200	160...320	250...500	400...800	630...1250	1000...2000	1600...3200	2500...5000	> 5000	top open

[1]) For blue LED: I_F = 20 mA;
ARGUS LED: Luminous flux Φv in mlm at I_F=15 mA (at low current I_F=2 mA). Super ARGUS, I_F=50 mA.

LED Lamps 4

Matching factor of brightness–Single-color LEDs/MULITLED

	Ivmin/Ivmax, Phivmin/Phivmax	
	within one packing unit	within one LED
LEDs	'1/2'	–
MULTILED	'1/2'	'1/3'
MULTILED, with pure green	'1/2'	'1/4'
LU 5351-GL, LU B371-FJ, LU H371-FJ	'1/2'	'1/4'
LU 5351-JM, LU B371-GK, LU H371-GK	'1/2'	'1/2'
LU S250-DO	'1/2'	'1/4

The brightness of the darker chip in one package determines the brightness group of the LED.
In case of MULTILED with two chips of the same color, the mean value of the chips determines the brightness of the LED.

Soldering conditions for LEDs

When soldering the component into position, make sure that it is not thermally overloaded.
The maximum junction temperature may only be exceeded briefly (for no more than 1 min.).
Maximum permissible soldering temperatures and soldering times are:

Types	Dip, wave and drag soldering			Iron soldering (with 1.5 mm iron tip)			Reflow soldering	
	Temperature of the soldering bath	Max. perm. soldering time	Distance between solder joint and case	Temperature of soldering iron	Max. perm. soldering time	Distance between solder joint and case	Temperature of soldering zone	Max. transit time
3 mm dia	235 °C 260 °C	8 s 5 s	≥ 2 mm	300 °C	3 s	≥ 2 mm	–	–
5 mm dia Symbol LED Two-color LED	235 °C 260 °C	8 s 5 s	≥ 1,5 mm	300 °C	3 s	≥ 1,5 mm	–	–
LED arrays	235 °C 260 °C	5 s 3 s	≥ 2 mm	300 °C	3 s	≥ 2 mm	–	–
SOT-23 LED SMT-TOP-LED®	260 °C	8 s	–	–	–	–	260 °C : 215 °C Preheating: 150 °C	10 s : 30 s Approx. 1 min

Cleaning solvents for soldered-in LEDs

Organic solvents consisting of alcohols or hydrocarbon-fluorides or a mixture of both groups are suitable for cleaning soldered-in LEDs. In no way should solvents or solvent mixtures be used which contain chlorinated hydrocarbons or ketones. This type of solvents may attack or corrode the display housing or casting.

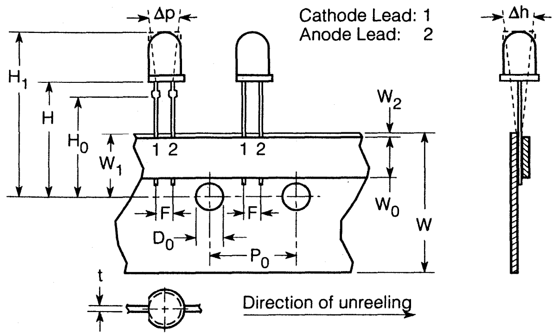
Lamp–Tape and Packaging

Light emitting diodes are available in taped form. Packaging of LEDs on continuous tapes is based on IEC standard 286.2.

The component tapes are wound on reels and supplied in boxes containing two reels each. One reel consists 1000 pieces of the 5 mm type or 2000 pieces of the 3 mm type.

For components with 2.54 mm lead spacing add "E7500" to the last position of the part number, e.g., LR 5460-DG E7500.

For components with 5.08 mm spacing add "E7501" to the last position of the part number, e.g., LG 5460-GK E7500.

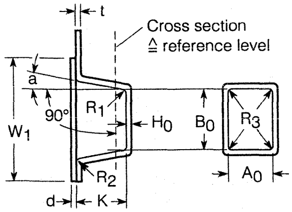


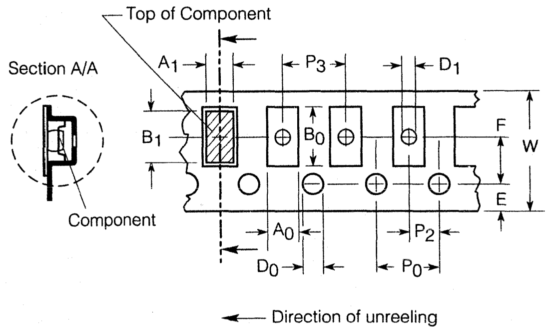
Symbol	Designation	Dimensions		Tolerance	
		inch	mm	inch	mm
W	Carrier tape width	.709	18	+.039 –.020	+1 –0.5
W_0	Hold down tape width	.236	6	±.12	±0.3
W_1	Sprocket hole position	.354	9	+.030 –.020	+0.75 –0.5
W_2	Hold down tape position	≤.118	≤3		
t	Total thickmess of carrier and hold down tape	.035 max.	0.9 max.		
D_0	Sprocket hole diameter	.157	4	±.008	±0.2
H	Sprocket hole center to bottom of component	.709	18	+.079	+2
H_0	Sprocket hole center of seating plane	.630	16	±.020	±0.5
H_1	Sprocket hole center to top of component body	1.268 max.	32.2 max.		
P_0	Sprocket hole pitch	.500	12.7	±.012	±0.3
F	Component lead pitch	.100 or .200	2.54 or 5.08	+.024 –.004	+0.6 –0.1
Δp	Maximum deviation of component in tape plane			+.040	±1
Δh	Maximum deviation of component vertical to tape plane			±.079	±2

Packaging of Surface Mount LEDs

LED in SOT 23 and TOP-LED packages are available on continuous tapes— IEC publication 40 (secretariat) 458 applies.

The 8 mm broad tape is wound on an 18 cm or 33 cm film reel. The reels have either 3000 or 10,000 components.





Blister Tape

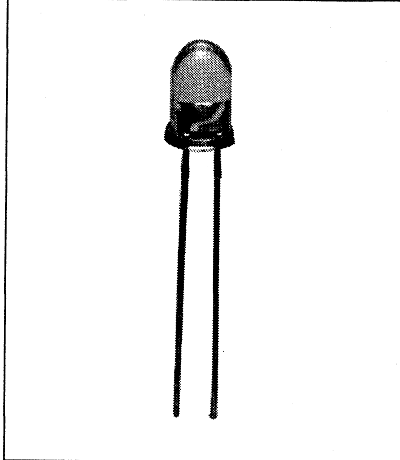
Dimensional Table for Blister Tape

Designation	Symbol	Dimensions in inches (mm)	Notes
Tape width	W	.315 ± .012 (8 ± .3)	—
Carrier tape thickness	t	.012 max. (.3)	—
Pitch of sprocket holes	P_0	.157 ± .004 (4 ± .1)	Cumulative pitch error +.2 mm/ 10 pitches
Diameter of sprocket holes	D_0	.039 +.008 (1 +.2)	—
Distance of sprocket holes	E	.069 ± .004 (1.75 ± .1)	—
Distance of components	F	.138 ± .002 (3.5 ± .05)	Center hole to center compartment
	P_2	.079 ± .002 (2 ± .05)	
Distance compartment to compartment	P_3	.157 (4)	—
Compartment dimensions	K	.098 max. (2.5)	Exact dimensions are given with component dimensions
	a	15° max.	
	R_1, R_2	.012 max. (.3)	
	H_0	.012 +.004/ –.002 (0.3 +.1/–.05)	Between inner side of the compartment bottom and reference level for measuring A_0, B_0
Compartment	A_0 B_0	The tolerances are chosen so that the components can only move within permissible limits, yet still be easily removed from the tape.	
Hole in compartment	D_1	.039 +.008/–.002 (1 +.2/–.05)	Tolerance to the center of the sprocket hole: .1 mm
Width of fixing tape	W_1 d	.217 typ. (5.5) .004 max. (.1)	Fixing tape shall not cover sprocket holes, nor protrude beyond carrier tape so as not to exceed maximum tape width
Device tilt in compartment	—	15° max.	
Minimum bending radius	—	1.181 min. (30)	—

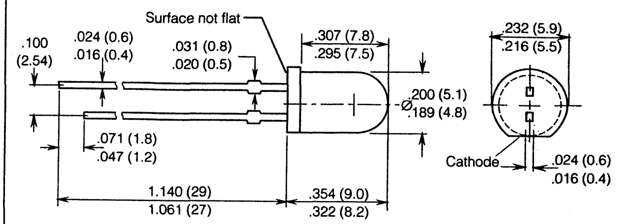
SIEMENS

LB 5410-GO

Blue T1¾ (5 mm) LED Lamp



Package Dimensions in Inches (mm)



FEATURES

- **Pure Blue Light (480 nm)**
- **Clear T1¾ (5 mm) Plastic Package**
- **1" Minimum Lead Length**
- **High Brightness**
- **TTL Compatible**

DESCRIPTION

The LB 5410 is a Silicon Carbide (SiC) LED, emitting a pure blue light from a clear T1¾ (5 mm) plastic package. The LB 5410 is ideal for such applications as: spectroscopy, calibration, and light sources in medical equipment.

Maximum Ratings

Operating Temperature Range (T_{OP}) .... –55°C to +100°C
Storage Temperature Range (T_{STG}) .... –55°C to +100°C
Junction Temperature (T_J) .... +100°C
Forward Current (I_F) .... 50 mA
Surge Current (I_{FM}) t_P=10 µs .... 0.5 A
Reverse Voltage (V_R) .... 5 V
Power Dissipation (P_{TOT}), T_A=25°C .... 200 mW
Thermal Resistance, Junction-to-Air (R_{THJA}) .... 400 K/W

Characteristics (T=25°C) All values typical unless otherwise noted.

Parameter	Symbol	Value	Unit	Condition
Peak Wavelength	λ_{PEAK}	467	nm	I_F=20 mA
Dominant Wavelength	λ_{DOM}	480	nm	I_F=20 mA
Spectral Bandwidth				
50% I_{RELMAX}	$\Delta\lambda$	75	nm	I_F=20 mA
Viewing Angle, 50% I_V	2φ	35	Deg.	
Forward Voltage (typ.)	V_F	3.1	V	I_F=20 mA
(max.)	V_F	4.5	V	I_F=20 mA
Switching Time				I_F=100 mA,
I_V, 10% to 90%	t_R	800	ns	t_P=10 µs,
I_V, 90% to 10%	t_F	800	ns	R_L=50 Ω
Luminous Intensity*	I_V	3.0(≥1.6)	mcd	I_F=20 mA

* Luminous intensity ratio of one packaging unit $I_{VMAX}/I_{VMIN} \leq 2$

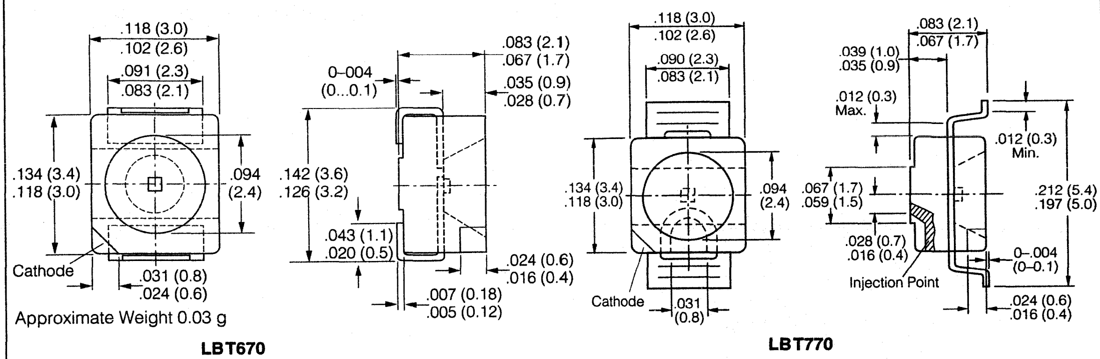
See graph numbers 1, 2J, 3C, 4C, 5B, 6B in the back of this section.

SIEMENS

LBT670/770

BLUE SMT-TOP-LED®
BLUE LINE™

Package Dimensions in Inches (mm)



LED Lamps

4

FEATURES

- LBT770: Reverse Gullwing
- PL-CC-2 Package
- White Package
- Optical Indicator
- Colorless Clear Window
- Ideal for Backlighting, and Optical Coupling into Light Pipes and Lenses
- SIC Chip Technology
- For use in Spectrometry
- Suitable for all Surface Mounting Methods (SMT)
- Available on Tape and Reel
- Load Dump Resistant acc. to DIN 40839

Maximum Ratings

Operating Temperature Range (T_{OP}) .... –55 to +100°C
Storage Temperature Range (T_{STG}) .... –55 to +100°C
Junction Temperature (T_J) .... +100°C
Forward Current (I_F)... 40 mA
Surge Current (I_{FM}) t≤10 µs D=0.005 .... 0.5 A
Reverse Voltage (V_R) .... 5 V
Power Dissipation (P_{TOT}) T_A≤25°C .... 160 mW
Thermal Resistance, Junction Air,
Mounted on PC Board: pad size 16 mm²
(R_{THJA}) .... 400 K/W

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter		Symbol	Values	Unit
Peak Wavelength (I_F=20 mA)		λ_{PEAK}	467	nm
Dominant Wavelength (I_F=20 mA)		λ_{DOM}	480	nm
Spectral Bandwidth (50% I_{RELMAX}) (I_F=20 mA)		$\Delta\lambda$	75	nm
Viewing Angle, 50%, I_V		2φ	120	Deg.
Forward Voltage (I_F=20 mA)	Typ. Max	V_F	3.1 4.5	V
Reverse Current (V_R=5 V)	Typ. Max	I_R	0.01 10	µA
Capacitance (V_R=0 V, f=1 MHz)		C_0	50	pF

Luminous Intensity Ratio in One Packaging Unit I_{VMAX}/I_{VMIN}≥2

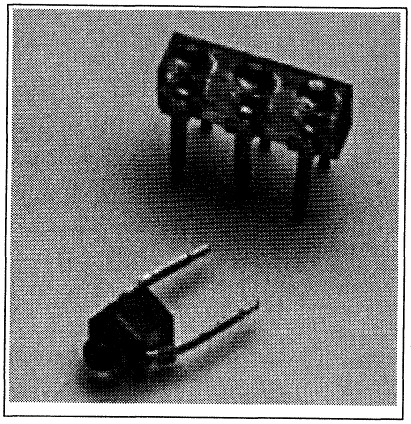
Type	Light Emitting Color	Luminous Intensity I_F=20 mA, I_V (mcd)
		Min.
LBT670-BO	Blue	0.25
LBT770-BO	Blue	0.25

See graph numbers 1, 2V, 3C, 4C, 5B, 6A in the back of this section.

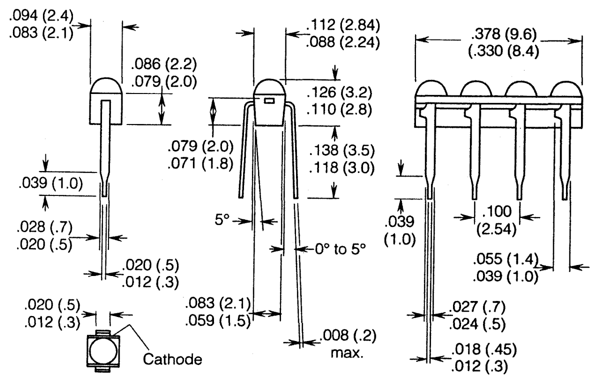
SIEMENS

SINGLE LG Z181
2 to 6 DIODE ARRAYS LG Z182–186
8, 10 DIODE ARRAYS LG Z188, 180

Green Miniature LED Lamp



Package Dimensions in Inches (mm)



FEATURES

- **Green Diffused Lens**
- **Miniature Size**
- **0.100" (2.54 mm) Lead Spacing**
- **End Stackable to Arrays of Any Length**
- **IC Compatible**

DESCRIPTION

The LG Z18X series are green gallium arsenide phosphide LED solid state lamps, single and arrays. They have a green plastic encapsulation formed as a lens where the light is emitted. The single lamps or arrays may be used individually or stacked together to form arrays of any length. Typical applications are position indicators such as meters and scales.

Maximum Ratings (Individual Diode)

Operating/Storage Temperature
Range (T_{OP},T_{STG}) .... –40°C to +80°C
Junction Temperature (T_J) .... 100°C
Forward Current (I_F) .... 30 mA
Surge Current (I_{FM}), t≤10 µs .... 0.5 A
Reverse Voltage (V_R) .... 5 V
Power Dissipation (P_{TOT}), T_A=25°C .... 90 mW
Thermal Resistance
Junction to Air (R_{THJA}) .... 750 K/W

Note:
Soldered on PC board: pad size ≥16 mm²

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter	Symbol	Value	Unit	Condition
Wavelength, Peak Emission	λ_{PEAK}	565	nm	I_F=20 mA
Dominant Wavelength	λ_{DOM}	570	nm	I_F=20 mA
Spectral Bandwidth, 50% I_{RELMAX}	$\Delta\lambda$	25	nm	I_F=20 mA
Viewing Angle, 50% I_V	φ	100	Deg.	
Forward Voltage (typ.)	V_F	2.0	V	I_F=10 mA
(max.)	V_F	2.6	V	I_F=10 mA
Reverse Current (typ.)	I_R	0.01	µA	V_R=5 V
(max.)	I_R	10	µA	V_R=5 V
Capacitance	C_0	15	pF	V_R=0 V, f=1 MHz
Switching Time				I_F=100 mA,
I_V, 10% to 90% (typ.)	t_R	450	ns	t_P=10 µs,
I_V, 90% to 10% (max.)	t_F	200	ns	R_L=50 Ω

Luminous Intensity (mcd)*

Part Number	*No. of LEDs*	*I_V Min.*	*Test Condition*
LG Z181-CO	1	0.25	10 mA
LG Z182-CO	2	0.25	10 mA
LG Z183-CO	3	0.25	10 mA
LG Z184-CO	4	0.25	10 mA
LG Z185-CO	5	0.25	10 mA
LG Z186-CO	6	0.25	10 mA
LG Z188-CO	8	0.25	10 mA
LG Z180-CO	10	0.25	10 mA

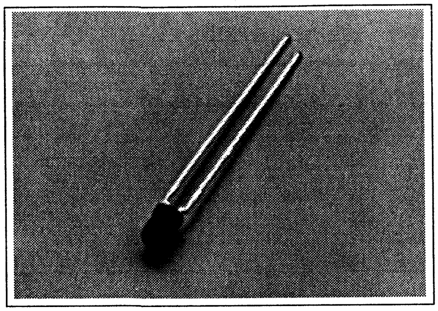
* Luminous intensity ratio of one packaging unit I_{VMAX}/I_{VMIN} ≤2.

See graph numbers 1, 2U, 3A, 4A, 5G, 6F, 7A, 8A, 9A, 10A in the back of this section.

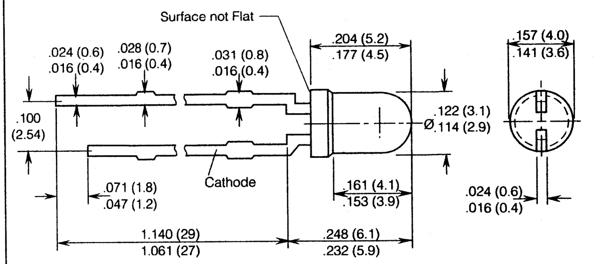
SIEMENS

DOUBLE HETERO JUNCTION LH 3344-QO
DOUBLE HETERO JUNCTION LH 3364-MO

Hyper-Red GaAlAs T1 (3mm) LED Lamp



Package Dimensions in Inches (mm)



FEATURES

- **T1 (3mm) Package**
- **Double Hetero Junction Technology**
- **Choice of Diffused Lens–LH3364 or Red Clear Lens-LH 3344**
- **High Luminous Intensity**
- **Excellent Light Efficiency for Low Current Operation**
- **IC Compatible**

DESCRIPTION

The T1 hyper-red GaAlAs LED lamps use double hetero junction material to produce very high luminous intensities. When operated at very low currents (1 mA) these lamps can produce luminous intensities comparable to standard and high efficiency LEDs that operate at 10 mA to 20 mA.

Luminous Intensity and Lens Type

Part No.	Lens Type	Luminous Intensity* I_F = 10 mA, I_V (mcd)	
		Typ.	Min.
LH 3344-QO	red clear	150	63
LH 3364-MO	red diffused	40	16

See graph numbers 1, 2G (LH 3344), 2H (LH 3364), 3A, 4B, 5A, 6A, 7A, 8A, 9A, 10A, 10B (LH3344, LH 3364) in the back of this section.

Maximum Ratings

Operating Temperature Range (T_{OP}) .... –55°C to + 100°C
Storage Temperature Range (T_{STG}) .... –55°C to +100°C
Junction Temperature (T_J) .... + 100°C
Reverse Voltage (V_R) .... 3 V
Forward Current (I_F) .... 40 mA
Surge Current (I_{FM}) .... 0.5 A
Power Dissipation (P_{TOT}) T_A=25°C .... 120 mW
Thermal Resistance, Junction to Air (R_{thJA}) .... 400 K/W

Characteristics (T_A=25°C) **All values typical unless otherwise noted.**

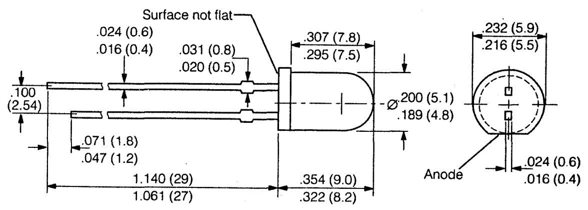
Parameter	Symbol		Unit
Peak Wavelength (I_F=20 mA)	λ_{PEAK}	660	nm
Dominant Wavelength (I_F=20 mA)	λ_{DOM}	645	nm
Spectral Bandwidth (50% I_{RELMAX}, I_F= 20 mA)	$\Delta\lambda$	22	nm
Viewing Angle 50% I_V			
LH3344	2 φ	25	Deg.
LH3364	2 φ	45	Deg.
Forward Voltage	V_F	1.75	V
(I_F=10 mA)	V_F	(≤2.6)	V
Reverse Current	I_R	0.01	µA
(V_R= 3 V)	I_R	(≤10)	µA
Capacitance (V_R=0 V, f=1 MHz)	C_0	25	pF
Switching Times (I_F=100 mA, t_p=10 µs, R_L=50 Ω)			
Rise time–10% to 90%	t_R	140	ns
Fall time–90% to 10%	t_F	110	ns

* Luminous intensity ratio of one packaging unit $I_{VMAX}/I_{VMIN} \leq 2$

SIEMENS

DOUBLE HETERO JUNCTION LH 5424-QO
DOUBLE HETERO JUNCTION LH 5464-LO
HYPER RED GaAlAs T1¾ (5mm) LED LAMP

Package Dimensions in Inches (mm)



FEATURES

- **T1¾ (5mm) Package**
- **Double Hetero Junction Technology**
- **Choice of Diffused Lens–LH 5464 or Red Clear Lens–LH 5424**
- **High Luminous Intensity**
- **Excellent Light Efficiency for Low Current Operation**
- **IC Compatible**

DESCRIPTION

The T1¾ hyper red GaAlAs LED lamps use double hetero junction material to produce very high luminous intensities. When operated at very low currents (1 mA) these lamps can produce luminous intensities comparable to standard and high efficiency LEDs that operate at 10 mA to 20 mA.

Luminous Intensity and Lens Type

Part No.	Lens Type	Luminous Intensity* I_F = 10 mA, I_V (mcd)	
		Typ.	**Min.**
LH 5424-QO	red clear	320	63
LH 5464-LO	red diffused	60	10

Maximum Ratings

Operating Temperature Range (T_{OP}) .... -55°C to + 100°C
Storage Temperature Range (T_{STG}) .... -55°C to +100°C
Junction Temperature (T_J) .... + 100°C
Reverse Voltage (V_R) .... 3 V
Forward Current (I_F) .... 40 mA
Surge Current (I_{FM}) .... 0.5 A
Power Dissipation (P_{TOT}) T_A=25°C .... 120 mW
Thermal Resistance, Junction to Air (R_{thJA}) .... 400 K/W

Characteristics (T_A=25°C) All values typical unless otherwise noted.

Parameter	Symbol	Value	Unit	Test Condition
Peak Wavelength	λ_{PEAK}	660	nm	I_F=20 V
Dominant Wavelength	λ_{DOM}	645	nm	I_F=20 V
Spectral Bandwidth 50% I_V	$\Delta\lambda$	22	nm	I_F= 20 mA
Viewing Angle 50% I_V				
LH 5424	2 φ	16	Deg.	
LH 5464	2 φ	35	Deg.	
Forward Voltage	V_F	1.75 (≤2.6)	V	I_F=10 mA
Reverse Current	I_R	0.01 (≤10)	µA	V_R= 3 V
Capacitance	C_0	25	pF	V_R=0, f=1 MHz
Switching Times				I_F=100 mA,
Rise time–10% to 90%	t_R	140	ns	t_p=10 µs,
Fall time–90% to 10%				R_L=50 Ω
LH5424/5464	t_F	110	ns	

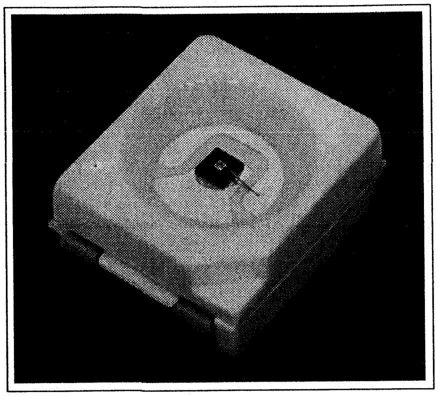
* Luminous intensity ratio of one packaging unit I_{VMAX}/I_{VMIN} ≤2

See graph numbers 1, 2I (LH5424), 2J (LH5464), 3A, 4B, 5A, 6A, 7A, 8A, 9A, 10B in the back of this section.

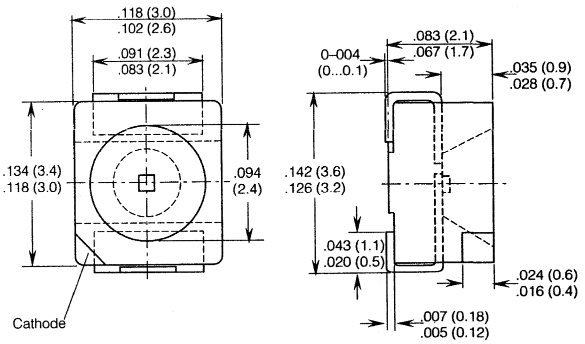
SIEMENS

DOUBLE HETEROJUNCTION LH T674

Hyper Red, SMT-TOP-LED™ Surface Mount LED Lamp



Package Dimensions in Inches (mm)



FEATURES

- **PL-CC-2 Package**
- **Internal Reflector**
- **Colorless Clear Window**
- **Low Power Dissipation**
- **Wide Viewing Angle**
- **Compatible with Automatic Placement Equipment**
- **Suitable for Vapor-Phase Reflow, Infrared Reflow and Wave Solder Processes**
- **Ideal for Backlight and Light Pipe Applications**
- **Available on Tape and Reel (8 mm Tape)**

DESCRIPTION

The LH T674 is a double heterojunction LED with a package that incorporates an internal reflector to optimize light coupling. This feature makes the SMT-TOPLED ideal for light pipe applications.

Maximum Ratings

Operating Temperature Range (T_{OP}) ....–55°C to +100°C
Storage Temperature Range (T_{STG}) ....–55°C to +100°C
Junction Temperature (T_J) .... +100°C
Reverse Voltage (V_R) .... 3 V
Forward Current (I_F) .... 30 mA
Surge Current (I_{FS}) t_p=10 ms .... 0.5 A
Power Dissipation (P_{TOT}) T_A≤25°C .... 100 mW
Thermal Resistance, Junction to Ambient
For mounting on PC Board, ≥16 mm² (R_{thJA}) .... 400 K/W

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter	Symbol	Value	Units	Test Condition
Peak Wavelength	λ_{PEAK}	660	nm	I_F=10 mA
Dominant Wavelength	λ_{DOM}	645	nm	I_F=10 mA
Spectral Bandwidth 50% I_{RELMAX}	$\Delta\lambda$	22	nm	I_F=10 mA
Viewing Angle, 50% I_V	2 φ	120	Deg.	
Forward Voltage	V_F	1.75 (≤2.6)	V	I_F=10 mA
Reverse Current	I_R	0.01 (≤10)	µA	V_R=5 V
Capacitance	C_O	25	pF	V_R=0 V, f=1 MHz
Response Time				I_F=100 mA, tp=10 µs, R_L=50 Ω
Rise Time/I_V, 10%-90%	t_R	140	ns	
Fall Time/I_V, 10%-90%	t_F	110	ns	

Luminous Intensity (mcd)*

Part Number	*Symbol*	*Min.*	*Max.*	*Test Condition*
LH T674-KM	I_V	6.3	32.0	10 mA
LH T674-L	I_V	10.0	20.0	10 mA
LH T674-LN	I_V	10.0	50.0	10 mA
LH T674-M	I_V	16.0	32.0	10 mA

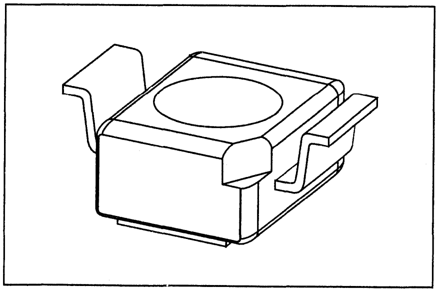
* Luminous intensity ratio of one packaging unit I_{VMAX}/I_{VMIN} ≤2

See graph numbers 1, 2V, 3A, 4B, 5G, 6H, 7A, 8A, 9A, 10B in the back of this section.

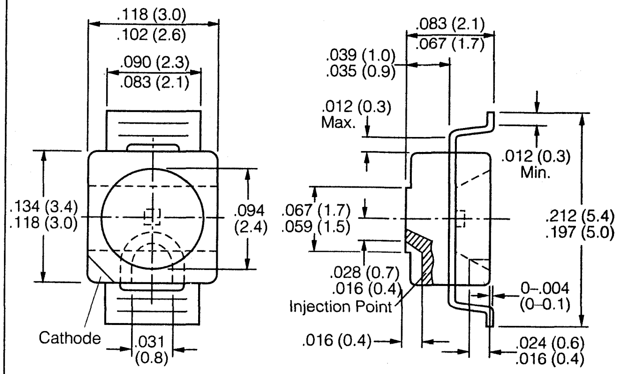
SIEMENS

LHT774

SMT-TOP-LED® REVERSE GULLWING SUPERBRIGHT HYPER-RED GaAlAs



Package Dimensions in Inches (mm)



FEATURES

- **White Package**
- **Double Heterojunction in GaAlAs Technology**
- **Superior Luminous Intensity**
- **Optical Indicator**
- **Ideal for Backlighting, Optical Coupling into Light Pipes and Lenses**
- **Colorless Clear Window**
- **Suitable for all SMT Assembly Solder Processes**
- **Available on Tape and Reel (12 mm Tape)**
- **Load Dump Resistant acc. to DIN 40839**

Maximum Ratings

Operating Temperature Range(T_{OP}) .... –55 to +100°C
Storage Temperature Range (T_{STG}) .... –55 to +100°C
Junction Temperature (T_J) .... +100°C
Forward Current (I_F) .... 30 mA
Surge Current (I_{FM}) t≤10 µs D=0.005 .... 0.5 A
Reverse Voltage (V_R) .... 3 V
Power Dissipation (P_{TOT}) .... 100 mW
Thermal Resistance, Junction Air, Mounted on PC Board(1) (pad size 16 mm²) (R_{THJA}) .... 400 K/W
Junction Solderpoint (R_{THJS}) .... 300 K/W

Note: PC board G30/FR4

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter		Symbol	Values	Unit
Peak Wavelength (I_F=10 mA)		λ_{PEAK}	660	nm
Dominant Wavelength (I_F=10 mA)		λ_{DOM}	645	nm
Spectral Bandwidth (50% I_{RELMAX}) (I_F=10 mA)		$\Delta\lambda$	22	nm
Viewing Angle, 50%, I_V		2φ	120	Deg
Forward Voltage (I_F=10 mA)	Typ.	V_F	1,75	V
	Max		2.6	
Reverse Current (V_R=3 V)	Typ.	I_R	0.01	µA
	Max		10	
Capacitance (V_R=0 V, f=1 MHz)		C_0	25	pF
Switching times (I_F=100 mA) (t_P=10 µs, R_L=50 Ω)	I_V, 10%–90%	t_R	140	ns
	I_V, 90%–10%	t_F	110	

Luminous Intensity Ratio in One Packaging Unit $I_{VMAX}/I_{VMIN} \geq 2.0$

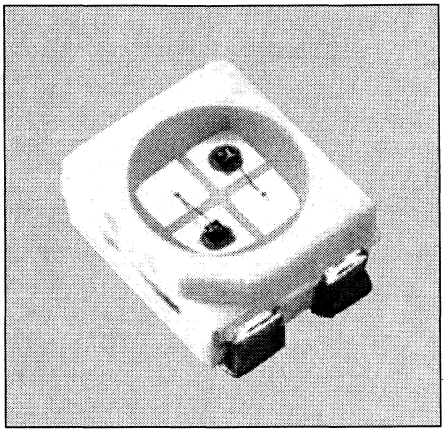
Types	Light Emitting Color	Luminous Intensity I_F=10 mA, I_V (mcd) Min.	Max.
LHT774-KM	Hyper-red	6.3	32
LHT774-L		10	20
LHT774-M		16	32
LHT774-LN		10	50

Note: In case of MULTILED®, the brightness of the darker chip in one package determines the brightness group of the LED.

See graph numbers 1, 2V, 3I, 4B, 5G, 6G, 7A, 8A, 9A, 10B in the back of this section.

SIEMENS

ORANGE/YELLOW LOYT672
SUPER-RED/GREEN LSGT672
SUPER-RED/PURE GREEN LSPT672
SUPER-RED/YELLOW LSYT672
ORANGE/PURE GREEN LOPT672
ORANGE/GREEN LOGT672
YELLOW/PURE GREEN LYPT672
HIGH-CURRENT SUPER SMT-MULTILED®

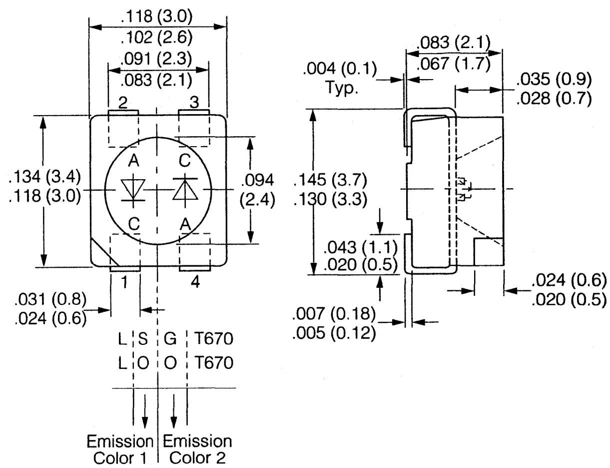


FEATURES

- P-LCC-4 Package
- White Package
- Optical Indicator
- Appropriate for High Ambient Light Due to the Higher Operation Current (≤50 mA DC)
- Ideal for Backlighting, Optical Coupling into Light Pipes and Lenses
- Both Chips can be Controlled Separately
- High Signal Efficiency Possible by Color Change of the LED
- Colorless Clear Window
- Suitable for all SMT Assembly and Solder Processes
- Available on Tape and Reel (8 mm Tape)
- Load Dump Resistant acc. to DIN 40839

See graph numbers 1, 2V, 3H, 4F, 5D, 6B, 7A, 8A, 9D, 10E in the back of this section.

Package Dimensions in Inches (mm)



Maximum Ratings

Operating Temperature Range (T_{OP}) ... –55 to +100°C
Storage Temperature Range (T_{STG}) ... –55 to +100°C
Junction Temperature (T_J) ... +100°C
Forward Current (I_F) ... 50 mA
Surge Current (I_{FM}) t≤10 µs D=0.005 ... 1A
Reverse Voltage (V_R) ... 5 V
Power Dissipation (P_{TOT}) ... 190 mW
Thermal Resistance, Junction Air,
Mounted on PC Board[1] (pad size 16 mm^2)
(R_{THJA}) ... 350 K/W
Junction Solderpoint (R_{THJS}) ... 300 K/W

Note: PC board G30/FR4

The stated maximum ratings refer to the specified chip, regardless of the other one's operating status.

With simultaneous operation of both diodes of two-color LEDs the sum of the currents as well as the power dissipation must not exceed the specified limits.

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter		Symbol	Values					Unit
			Super Red	Orange	Yellow	Green	Pure Green	
Peak Wavelength (I_F=10 mA)		λ_{PEAK}	635	610	586	565	557	nm
Dominant Wavelength (I_F=10 mA)		λ_{DOM}	628	605	590	570	560	nm
Spectral Bandwidth (50% $I_{REL MAX}$) (I_F=10 mA)		$\Delta\lambda$	45	40	45	25	22	nm
Viewing Angle, 50%, I_V		2φ	120					Deg.
Forward Voltage (I_F=50 mA)	Typ.	V_F	2.0	2.4	2.4	2.6	2.6	V
	Max		3.8					
Reverse Current (V_R=5 V)	Typ.	I_R	0.01					µA
	Max		10					
Capacitance (V_R=0 V, f=1 MHz)		C_0	40	35	35	60	80	pF
Switching times (I_F=100 mA) (t_P=10 µs, RL=50 Ω)	I_V, 10%–90%	t_R	350	500	350	500	500	ns
	I_V, 90%–10%	t_F	200	250	200	250	250	

Luminous Intensity Ratio in One Packaging Unit $I_{VMAX}/I_{VMIN} \geq 2.0$[1]
Luminous Intensity Ratio in One LED I_{VMAX}/I_{VMIN} ≤3.0 (LOY, LSG, LOG, LSYT672)
≤4.0 (LSP, LOP, LYPT672)

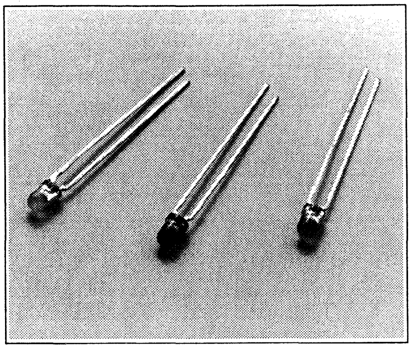
Type	Light Emitting Color	Luminous Intensity I_F=50 mA, I_V (mcd)	
		Min.	Typ.
LSG, LOGT672-MO	Super-red/Green Orange/Green	16	30
LSY, LOYT672-MO	Super-red/Yellow Orange/Yellow	16	45
LOP, LSP, LYPT672-LO	Orange/Pure Green Super-red/Pure Green Yellow/Pure Green	10	20

Note: In case of MULTILED with two chips of the same color in one package, the sum of the brightness determines the brightness group of the LED.

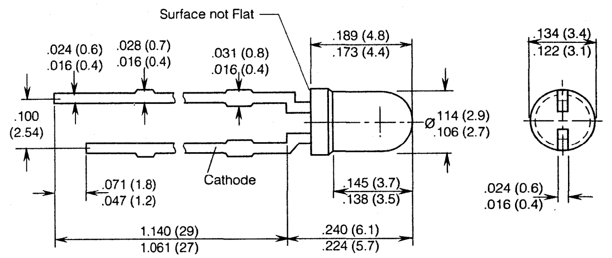
SIEMENS

RED LR 3360
SUPER-RED LS 3360
ORANGE LO 3360
YELLOW LY 3360
GREEN LG 3360
PURE GREEN LP 3360

T1 (3 mm) LED Lamp



Package Dimensions in Inches (mm)



FEATURES

- **High Light Output**
- **Diffused Lens**
- **Wide Viewing Angle 70°**
- **With Standoffs**
- **T1 (3 mm) Package Size**
- **1" Lead Length**
- **IC Compatible**

DESCRIPTION

The LR 3360 series is a standard red gallium arsenide phosphide (GaAsP) LED lamp. The LS 3360 super-red, LY 3360 yellow and LO 3360 orange are premium high efficiency light emitting diode lamps fabricated with TSN (transparent substrate nitrogen) technology. The LG 3360 green and LP 3360 pure green are gallium phosphide (GaP) lamps. All have a diffused plastic lens which emits a full flooded intense light.

Maximum Ratings

Operating and Storage Temperature
Range T_{OP}, (T_{STG}) .... −55°C to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 40 mA
Surge Current (I_{FS}) t≤10 µs .... 0.5 A
Total Power Dissipation (P_{TOT}) T_A=25°C 140 mW
Thermal Resistance,
Junction to Air (R_{THJA}) .... 400 K/W

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter	Sym	Super-Red	Red	Orange	Yellow	Green	Pure Green	Unit
Peak Wavelength (typ.)	λ_{PEAK}	660	635	610	586	565	557	nm
Dominant Wavelength (typ.)	λ_{DOM}	645	628	605	590	570	560	nm
Spectral Bandwidth 50%I_{RELMAX}, I_F=20 mA	Δλ	35	45	40	45	25	22	nm
Viewing Angle (50%, I_V)	2φ	70	70	70	70	70	70	Deg.
Forward Voltage	V_F	1.6	2.0	2.0	2.0	2.0	2.0	V
(I_F=10 mA)	V_F	(≤2.0)	(≤2.6)	(≤2.6)	(≤2.6)	(≤2.6)	(≤2.6)	V
Reverse Current	I_R	0.01	0.01	0.01	0.01	0.01	0.01	µA
(V_R=5 V)	I_R	(≤10)	(≤10)	(≤10)	(≤10)	(≤10)	(≤10)	µA
Capacitance (V_R=0 V, f =1 MHz)	C_0	25	12	8	10	15	15	pF
Rise Time	t_R	120	300	300	300	450	450	ns
Fall Time	t_F	50	150	150	150	200	200	ns

Luminous Intensity (mcd)

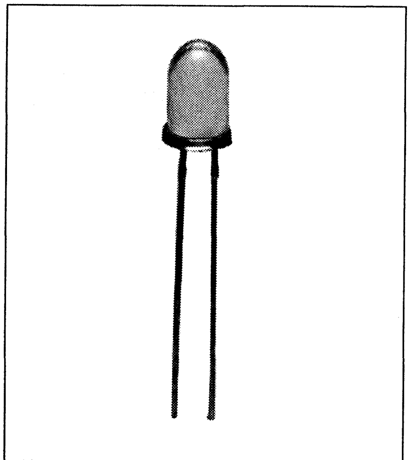
Part Number	*Min.*	*Max.*	*Test Condition*	*Part Number*	*Min.*	*Max.*	*Test Condition*
LR 3360-DG	0.4	3.2	10 mA	LY 3360-HL	2.5	20	10 mA
LR 3360-F	1	2	10 mA	LY 3360-J	4	8	10 mA
LR 3360-FJ	1	8	10 mA	LY 3360-JM	4	32	10 mA
LR 3360-G	1.6	3.2	10 mA	LY 3360-K	6.3	12.5	10 mA
LS 3360-HL	2.5	20	10 mA	LG 3360-GK	1.6	12.5	10 mA
LS 3360-J	4	8	10 mA	LG 3360-J	4	8	10 mA
LS 3360-K	6.3	12.5	10 mA	LG 3360-JM	4	32	10 mA
LS 3360-KN	6.3	50	10 mA	LG 3360-K	6.3	12.5	10 mA
LO 3360-HL	2.5	20.0	10 mA	LP 3360-GK	1.6	12.5	10 mA
LO 3360-J	4	8	10 mA				
LO-3360-K	6.3	12.5	10 mA				
LO-3360JM	4	32	10 mA				

* Luminous intensity ratio of one packaging unit I_{VMAX}/I_{VMIN} ≤2

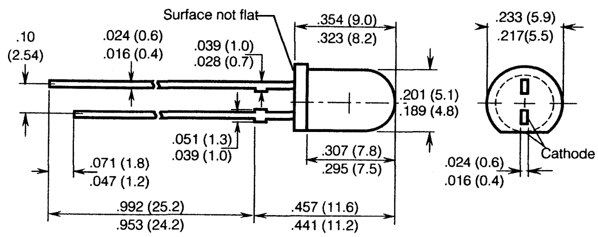
See graph numbers 1, 2A, 3A, 4A, 5A, 6A, 7A, 8A, 9A, 10A in the back of this section.

SIEMENS

RED LR 5360
SUPER-RED LS 5360
YELLOW LY 5360
GREEN LG 5360
T1¾ (5 mm) LED Lamp



Package Dimensions in Inches (mm)



FEATURES

- **High Light Output**
- **Diffused Lens**
- **Wide Viewing Angle 50°**
- **With Standoffs**
- **T1¾ (5 mm) Package Size**
- **1" Lead Length**
- **IC Compatible**

DESCRIPTION

The LR 5360 is a standard red gallium arsenide phosphide (GaAsP) LED lamp. The LS 5360 super-red and LY 5360 yellow are premium high efficiency light emitting diode lamps fabricated with TSN (transparent substrate nitrogen) technology. The LG 5360 green is a gallium phosphide (GaP) lamp. All have a diffused plastic lens which emits a full flooded intense light.

See graph numbers 1, 2D, 3A, 4A, 5A, 6A, 7A, 8A, 9A, 10A in the back of this section.

Maximum Ratings

Operating Temperature Range (T_{OP})	–55°C to +100°C
Storage Temperature Range (T_{STG})	–55°C to +100°C
Junction Temperature (T_J)	100°C
Reverse Voltage (V_R)	5 V
Forward Current (I_F)	40 mA
Surge Current (I_{FS}) t≤10 µs	0.5 A
Total Power Dissipation (P_{TOT}) T_A=25°C	140 mW
Thermal Resistance Junction to Air (R_{THJA})	400 K/W

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter	Symbol	LR 5360 Red	LS 5360 Super-Red	LY 5360 Yellow	LG 5360 Green	Unit
Peak Wavelength	λ_{PEAK}	660	635	586	565	nm
Dominant Wavelength	λ_{DOM}	645	628	590	570	nm
Spectral Bandwidth (50% I_{RELMAX}, I_F=20 mA)	$\Delta\lambda$	35	45	45	25	nm
Viewing Angle 50%I_V	2 φ	50	50	50	50	Deg.
Forward Voltage (I_F=10 mA)	V_F	1.6(≤2.0)	2.0(≤2.6)	2.0(≤2.6)	2.0(≤2.6)	V
Reverse Current (V_R=5 V)	I_R	0.01(≤10)	0.01(≤10)	0.01(≤10)	0.01(≤10)	µA
Capacitance (V_R=0 V, f =1 MHz)	C_0	25	12	10	15	pF
Rise Time	t_R	120	300	300	450	ns
Fall Time	t_F	50	150	150	200	ns

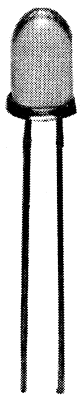
Luminous Intensity (mcd)*

Part Number	*Min.*	*Max.*	*Test Condition*	*Part Number*	*Min.*	*Max.*	*Test Condition*
LR 5360-DG	0.4	3.2	10 mA	LY 5360-HL	2.5	20	10 mA
LR 5360-F	1	2	10 mA	LY 5360-JM	4	32	10 mA
LR 5360-FJ	1	8	10 mA	LY 5360-J	4	8	10 mA
LR 5360-G	1.6	3.2	10 mA	LY 5360-K	6.3	12.5	10 mA
LS 5360-HL	2.5	20	10 mA	LY5360-L	10	20	10 mA
LS 5360-J	4	8	10 mA	LG 5360-GK	1.6	12.5	10 mA
LS 5360-K	6.3	12.5	10mA	LG 5360-H	2.5	5	10 mA
LS 5360-KN	6.3	50	10 mA	LG 5360-J	4	8	10 mA
LS 5360-L	10	20	10 mA	LG 5360-JM	4	32	10 mA
				LG 5360-K	6.3	12.5	10 mA

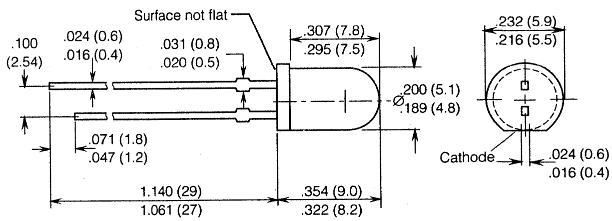
* Luminous intensity ratio of one packaging unit I_{VMAX}/I_{VMIN} ≤2

SIEMENS

RED LR 5460
SUPER-RED LS 5460
YELLOW LY 5460
GREEN LG 5460
T1¾ (5 mm) LED Lamp



Package Dimensions in Inches (mm)



FEATURES

- High Light Output
- Diffused Lens
- Wide Viewing Angle 50°
- Without Standoffs
- T1¾ (5 mm) Package Size
- 1" Lead Length
- IC Compatible

DESCRIPTION

The LR 5460 series is a standard red gallium arsenide phosphide (GaAsP) LED lamp. The LS 5460 super-red and LY 5460 yellow are premium high efficiency light emitting diode lamps fabricated with TSN (transparent substrate nitrogen) technology. The LG 5460 green is a gallium phosphide (GaP) lamp. All have a diffused plastic lens which emits a full flooded intense light.

See graph numbers 1, 2D, 3A, 4A, 5A, 6A, 7A, 8A, 9A, 10A in the back of this section.

Maximum Ratings

Operating Temperature Range (T_{OP}) .... –55°C to +100°C
Storage Temperature Range (T_{STG}) .... –55°C to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 40 mA
Surge Current (I_{FS}), t ≤10 µs .... 0.5 A
Total Power Dissipation (P_{TOT}), T_A=25°C .... 140 mW
Thermal Resistance Junction to Air (R_{THJA}) .... 400 K/W

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter	Sym	Red	Super-Red	Yellow	Green	Unit
Peak Wavelength	λ_{PEAK}	660	635	586	565	nm
Dominant Wavelength	λ_{DOM}	645	628	590	570	nm
Spectral Bandwidth (50% I_{RELMAX}, I_F=20 mA)	$\Delta\lambda$	35	45	45	25	nm
Viewing Angle (50% I_V)	2φ	50	50	50	50	Deg.
Forward Voltage (I_F=10 mA)	V_F	1.6(≤2.0)	2.0(≤2.6)	2.0(≤2.6)	2.0(≤2.6)	V
Reverse Current (V_R=5 V)	I_R	0.01(≤10)	0.01(≤10)	0.01(≤10)	0.01(≤10)	µA
Capacitance (V_R=0 V, f=1 MHz)	C_0	25	12	10	15	pF
Rise Time	t_R	120	300	300	450	ns
Fall Time	t_F	50	150	150	200	ns

Luminous Intensity (mcd)*

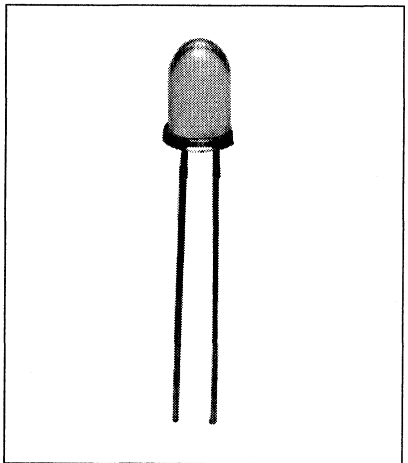
Part Number	*Min.*	*Max.*	*Test Condition*	*Part Number*	*Min.*	*Max.*	*Test Condition*
LR 5460-DG	0.4	3.2	10 mA	LY 5460-HL	2.5	20	10 mA
LR 5460-F	1	2	10 mA	LY 5460-J	4	8	10 mA
LR 5460-FJ	1	8	10 mA	LY 5460-JM	4	32	10 mA
LR 5460-G	1.6	3.2	10 mA	LY 5460-K	6.3	12.5	10 mA
				LY 5460-L	10	20	10 mA
LS 5460-HL	2.5	20	10 mA	LG 5460-GK	1.6	12.5	10 mA
LS 5460-J	4	8	10 mA	LG 5460-H	2.5	5	10 mA
LS 5460-K	6.3	12.5	10 mA	LG 5460-J	4	8	10 mA
LS 5460-KN	6.3	50	10 mA	LG 5460-JM	4	32	10 mA
LS 5460-L	10	20	10 mA	LG 5460-K	6.3	12.5	10 mA

*Luminous intensity ratio of one packaging unit I_{VMAX}/I_{VMIN} ≤2

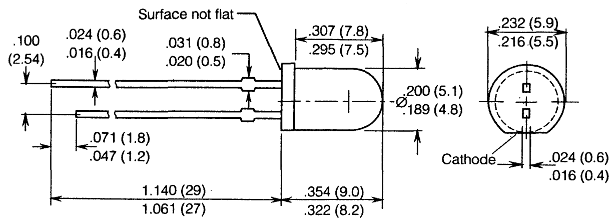
SIEMENS

RED LR 5480
SUPER-RED LS 5480
YELLOW LY 5480
GREEN LG 5480

T1 ¾ (5 mm) LED LAMP



Package Dimensions in Inches (mm)



FEATURES

- **Diffused Lens**
- **Wide Viewing Angle 80°**
- **Without Standoffs**
- **T1¾ (5 mm) Package Size**
- **1≤ Lead Length**
- **IC Compatible**

DESCRIPTION

The LR 5480 series is a standard red gallium arsenide phosphide (GaAsP) LED lamp. The LS 5480 super-red and LY 5480 yellow are premium high efficiency light emitting diode lamps fabricated with TSN (transparent substrate nitrogen) technology. The LG 5480 green is a gallium phosphide (GaP) lamp. All have a diffused plastic lens, which emits a full flooded intense light.

See graph numbers 1, 2R, 3A, 4A, 5A, 6A, 7A, 8A, 9A, 10A in the back of this section.

Maximum Ratings

Storage Temperature Range (T_{STG}) .... –55°C to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 40 mA
Surge Current (t ≤10 µs) (I_{FS}) .... 0.5 A
Total Power Dissipation (P_{TOT}) (T_A=25°C) .... 140 mW
Thermal Resistance Junction to Air (R_{THJA}) .... 400 K/W

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter	Sym	LR 5480 Red	LS 5480 Super-Red	LY 5480 Yellow	LG 5480 Green	Unit
Wavelength at Peak Emission	λ_{PEAK}	660	635	586	565	nm
Dominant Wavelength	λ_{DOM}	645	628	590	570	nm
Spectral Bandwidth (50% I_{RELMAX}, I_F=20 mA)	$\Delta\lambda$	35	45	45	25	nm
Viewing Angle (Limits for 50% of Luminous Intensity I_V)	φ	80	80	80	80	Deg.
Forward Voltage (I_F=10 mA)	V_F	1.6(≤2.0)	2.0(≤2.6)	2.0(≤2.6)	2.0(≤2.6)	V
Reverse Current (V_R=5 V)	I_R	0.01(≤10)	0.01(≤10)	0.01(≤10)	0.01(≤10)	µA
Capacitance (V_R=0 V, f =1 MHz)	C_0	25	12	10	15	pF
Rise Time	t_R	120	300	300	450	ns
Fall Time	t_F	50	150	150	200	ns

Luminous Intensity (mcd)*

Part Number	*Min.*	*Max.*	*Test Condition*
LR 5480-CF	0.25	2	10 mA
LR 5480-DG	0.4	3.2	10 m A
LR 5480-E	0.63	1.25	10 mA
LR 5480-F	1	2	10 mA
LS 5480-GK	1.6	12.5	10 mA
LS 5480-J	4	8	10 mA
LS 5480-JM	4	32	10 mA
LS 5480-K	6.3	12.5	10 mA

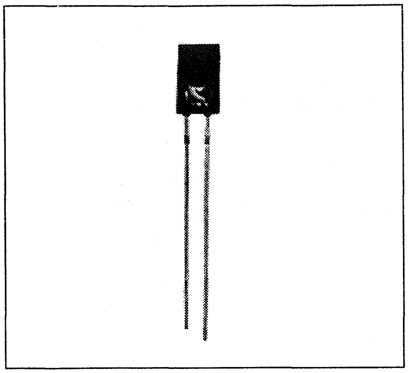
Part Number	*Min.*	*Max.*	*Test Condition*
LY 5480-GK	1.6	12.5	10 mA
LY 5480-L	10	20	10 mA
LY 5480-JM	4	32	10 mA
LY 5480-K	6.3	12.5	10 mA
LG 5480-GK	1.6	12.5	10 mA
LG 5480-H	2.5	5	10 mA
LG 5480-J	4	8	10 mA
LG 5480-JM	4	32	10 mA
LG 5480-K	6.3	12.5	10 mA

* Luminous intensity ratio of I_V of one packaging unit I_{VMAX}/I_{VMIN} ≤2.

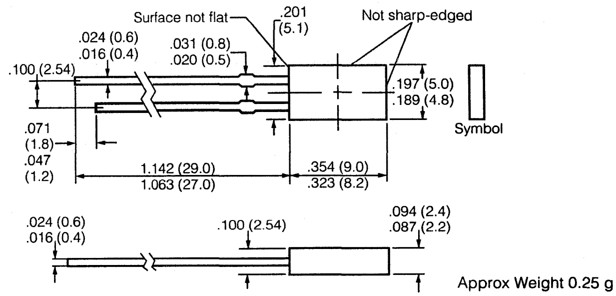
SIEMENS

RED LR B480
SUPER-RED LS B480
YELLOW LY B480
GREEN LG B480

Rectangular LED Lamp



Package Dimensions in Inches (mm)



Approx Weight 0.25 g

LED Lamps 4

FEATURES

- **Partly Diffused Colored Lens**
- **Rectangular Shape**
- **1" Minimum Lead Length**
- **.100" Lead Spacing**
- **IC Compatible**

DESCRIPTION

The LR B480 is a standard red GaAsP LED lamp. The LS B480 super-red and LY B480 yellow are light emitting diode lamps fabricated with TSN (transparent substrate nitrogen) technology. The LGB480 green is a gallium phosphide LED lamp. All these lamps have a diffused lens which forms an evenly dispersed rectangular head-on light. They can be used separately as indicators or stacked together to form arrays.

See graph numbers 1, 2P, 3A, 4A, 5A, 6A, 7A, 8A, 9A, 10A in the back of this section.

Maximum Ratings

Operating Temperature Range (T_{OP})	–55°C to +100°C
Storage Temperature Range (T_{STG})	–55°C to +100°C
Junction Temperature (T_J)	100°C
Reverse Voltage (V_R)	5 V
Forward Current (I_F)	40 mA
Surge Current (I_{FS}) t≤10 µs	0.5 A
Total Power Dissipation (P_{TOT}) T_A=25°C	140 mW
Thermal Resistance, Junction/Air (R_{THJA})	400 K/W

Characteristics (T_A=25°C)

Parameter	Sym	LR B480 Red	LS B480 Super-Red	LY B480 Yellow	LG B480 Green	Unit
Wavelength of Emitted Light	λ_{PEAK}	660	635	586	565	nm
Dominant Wavelength	λ_{DOM}	645	628	590	570	nm
Spectral Bandwidth (50% I_{RELMAX}, I_F=20 mA)	$\Delta\lambda$	35	45	45	25	nm
Viewing Angle 50% I_V	2 φ	100	100	100	100	Deg.
Forward Voltage (I_F=10 mA)	V_F	1.6(≤2.0)	2.0(≤2.6)	2.0(≤2.6)	2.0(≤2.6)	V
Reverse Current (V_R=5 V)	I_R	0.1(≤10)	0.01(≤10)	0.01(≤10)	0.01(≤10)	µA
Capacitance (V_R=0 V)	C_0	25	12	10	15	pF
Rise Time	t_R	120	300	300	450	ns
Fall Time	t_F	50	150	150	200	ns

Luminous Intensity (mcd)*

Part Number	*Min.*	*Max.*	*Test Condition*
LR B480-BD	0.16	0.8	10 mA
LR B480-C	0.25	0.5	10 mA
LR B480-D	0.4	0.8	10 mA
LS B480-EH	0.63	5	10 mA
LS B480-G	1.6	3.2	10 mA
LS B480-GK	1.6	12.5	10 mA
LS B480-H	2.5	5	10 mA

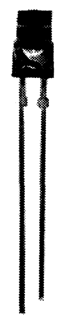
Part Number	*Min.*	*Max.*	*Test Condition*
LY B480-EH	0.63	5	10 mA
LY B480-G	1.6	3.2	10 mA
LY B480-GK	1.6	12.5	10 mA
LY B480-H	2.5	5.0	10 mA
LG B480-EH	0.63	5	10 mA
LG B480-G	1.6	3.2	10 mA
LG B480-GK	1.6	12.5	10 mA
LG B480-H	2.5	5.0	10 mA

* Luminous intensity ratio of one packaging unit I_{VMAX}/I_{VMIN} ≤2

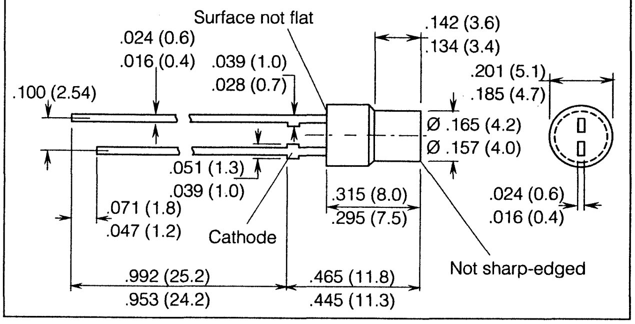
SIEMENS

RED LR H380
SUPER-RED LS H380
YELLOW LY H380
GREEN LG H380

Cylindrical LED Lamp



Package Dimensions in Inches (mm)



FEATURES

- **Lens, Partly Diffused**
  - **Red, LR H380 and LS H380**
  - **Yellow, LY H380**
  - **Green, LG H380**
- **Cylindrical Shape**
- **1" Minimum Lead Length**
- **0.100" (2.54 mm) Lead Spacing**
- **IC Compatible**

DESCRIPTION

The LR H380 is a standard red GaAsP LED lamp. The LS H380 and LY H380 are light emitting diode lamps fabricated with TSN (transparent substrate nitrogen) technology. The LG H380 is a gallium phosphate LED lamp. All the series have a diffused lens which forms an evenly dispersed circular head-on light.

See graph numbers 1, 2P, 3A, 4A, 5A, 6A, 7A, 8A, 9A, 10A in the back of this section.

Maximum Ratings

Operating Temperature Range (T_{OP}) .... –55°C to +100°C
Storage Temperature Range (T_{STG}) .... –55°C to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 40 mA
Surge Current (I_{FS}) t≤10 µs .... 0.5 A
Power Dissipation (P_{TOT}) T_A=25°C .... 140 mW
Thermal Resistance Junction to Air (R_{THJA}) .... 400 K/W

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter	Sym	LR H380 Red	LS H380 Super-Red	LY H380 Yellow	LG H380 Green	Unit
Wavelength of Emitted Light	λ_{PEAK}	660	635	586	565	nm
Dominant Wavelength	λ_{DOM}	645	628	590	570	nm
Spectral Bandwidth, (50% I_{RELMAX}, I_F=20 mA)	$\Delta\lambda$	35	45	45	25	nm
Viewing Angle (50% I_V)	2φ	100	100	100	100	Deg.
Forward Voltage (I_F=10 mA)	V_F	1.6(≤2.0)	2.0(≤2.6)	2.0(≤2.6)	2.0(≤2.6)	V
Reverse Current (V_R=5 V)	I_R	0.01(≤10)	0.01(≤10)	0.01(≤10)	0.01(≤10)	µA
Capacitance (V_R=0 V)	C_0	25	12	10	15	pF
Rise Time	t_R	120	300	300	450	ns
Fall Time	t_F	50	150	150	200	ns

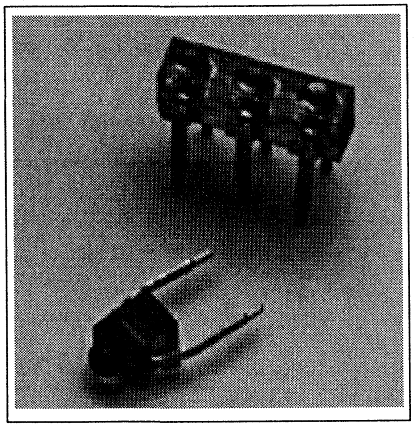
Luminous Intensity (mcd)*

Part Number	*Min.*	*Max.*	*Test Condition*	*Part Number*	*Min.*	*Max.*	*Test Condition*
LR H380-BD	0.16	0.8	10 mA	LY H380-EH	0.63	5	10 mA
LR H380-C	0.25	0.5	10 mA	LY H380-G	1.6	3.2	10 mA
LR H380-D	0.4	0.8	10 mA	LY H380-GK	1.6	12.5	10 mA
LS H380-EH	0.63	0.5	10 mA	LY H380-H	2.5	5	10 mA
LS H380-G	1.6	3.2	10 mA	LG H380-EH	0.63	5	10 mA
LS H380-GK	1.6	12.5	10 mA	LG H380-G	1.6	3.2	10 mA
LS H380-H	2.5	5	10 mA	LG H380-GK	1.6	12.5	10 mA
				LG H380-H	2.5	5.0	10 mA

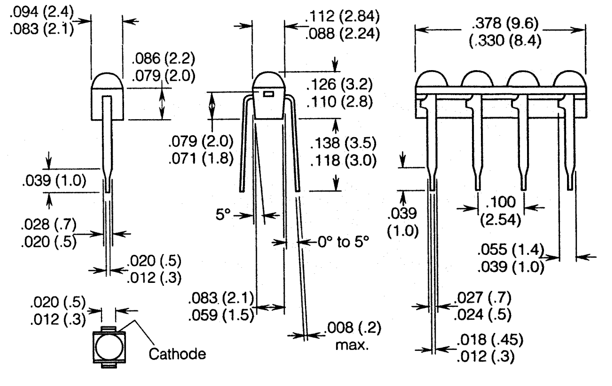
* Luminous intensity ratio of one packaging unit I_{VMAX}/I_{VMIN} ≤2

SIEMENS

SINGLE LR Z181
2 to 10 DIODE ARRAYS LR Z182–189/180
Red Miniature LED Lamp



Package Dimensions in Inches (mm)



FEATURES

- **Red Diffused Lens, Emits Red Light**
- **Miniature Size**
- **Single Lamp and 2 to 10 Diode Arrays**
- **0.100" (2.54 mm) Lead Spacing**
- **End Stackable to Arrays of Any Length**
- **IC Compatible**

DESCRIPTION

The LR Z18X series are red gallium arsenide phosphide LED solid state lamps. The single lamps or arrays may be used individually or stacked together to form arrays of any length. Typical applications are position indicators such as meters and scales.

Maximum Ratings (Individual Diode)

Operating/Storage Temperature Range (T_{OP},T_{STG})	−40°C to +80°C
Junction Temperature (T_J)	100°C
Forward Current (I_F)	30 mA
Surge Current (I_{FM}) t≤10 µs	0.5 A
Reverse Voltage (V_R)	5 V
Power Dissipation (P_{TOT}), T_A=25°C	90 mW
Thermal Resistance Junction to Air (R_{THJA})	750 K/W

Note:
Mounted on PC board: pad size ≥16 mm²

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter	Symbol	Value	Unit	Condition
Wavelength, Peak Emission	λ_{PEAK}	660	nm	I_F=20 mA
Dominant Wavelength	λ_{DOM}	645	nm	I_F=20 mA
Spectral Bandwidth 50% I_{RELMAX}	$\Delta\lambda$	35	nm	I_F=20 mA
Viewing Angle, 50% I_V	2φ	100	Deg.	
Forward Voltage (typ.)	V_F	1.6	V	I_F=10 mA
(max.)	V_F	2.0	V	I_F=10 mA
Reverse Current (typ.)	I_R	0.01	µA	V_R=5 V
(max.)	I_R	10	µA	V_R=5 V
Capacitance	C_0	25	pF	V_R=0 V, f=1 MHz
Switching Time				I_F=100 mA,
I_V, 10% to 90% (typ.)	t_R	120	ns	t_P=10 µs,
I_V, 90% to 10% (max.)	t_F	50	ns	R_L=50 Ω

Luminous Intensity*

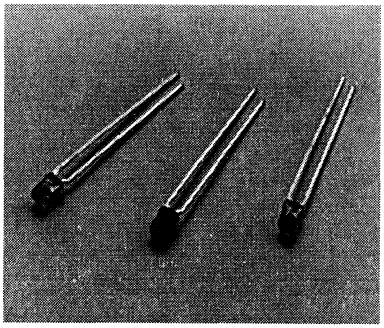
Part Number	*No. of LEDs*	*I_V Min.*	*Test Condition*	*Part Number*	*No. of LEDs*	*I_V Min.*	*Test Condition*
LR Z181-CO	1	0.25	10 mA	LR Z186-CO	6	0.25	10 mA
LR Z182-CO	2	0.25	10 mA	LR Z187-CO	7	0.25	10 mA
LR Z183-CO	3	0.25	10 mA	LR Z188-CO	8	0.25	10 mA
LR Z184-CO	4	0.25	10 mA	LR Z189-CO	9	0.25	10 mA
LR Z185-CO	5	0.25	10 mA	LR Z180-CO	10	0.25	10 mA

* Luminous intensity ratio of one packaging unit I_{VMAX}/I_{VMIN} ≤2

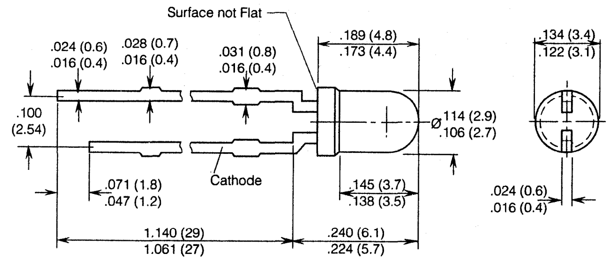
See graph numbers 1, 2U, 3A, 4A, 6F, 7A, 8A, 9A, 10A in the back of this section.

SIEMENS

SUPER-RED LS 3340
ORANGE LO 3340
YELLOW LY 3340
PURE GREEN LP 3340
GREEN LG 3330
T1 (3 mm) LED Lamp



Package Dimensions in Inches (mm)



FEATURES

- **High Light Output**
- **Lens:**
  - **Super-Red, Orange, Yellow: Tinted Clear**
  - **Green: Colorless Clear**
- **Viewing Angle 50°**
- **T1 (3 mm) Package Size**
- **1" Lead Length**
- **IC Compatible**

DESCRIPTION

The LS 3340 super-red, LO 3340 orange and the LY 3340 yellow are premium high efficiency light emitting diode lamps fabricated with TSN (transparent substrate nitrogen) technology. The LG 3330 and LP 3340 green series are gallium phosphide (GaP) lamps. All have tinted colored lenses (except green/pure green–colorless lens).

Maximum Ratings

Operating Temperature Range (T_{OP}) .... –55°C to +100°C
Storage Temperature Range (T_{STG}) .... –55°C to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 40 mA
Surge Current (I_{FS}) t=10 µs .... 0.5 A
Total Power Dissipation (P_{TOT}) T_A=25°C .... 140 mW
Thermal Resistance Junction to Air (R_{THJA}) .... 400 K/W

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter	Symbol	Super-Red	Yellow	Orange	Green	Pure Green	Unit
Peak Wavelength	λ_{PEAK}	635	586	610	565	557	nm
Dominant Wavelength	λ_{DOM}	628.	590	605	570	560	nm
Spectral Bandwidth (50% I_{RELMAX}, I_F=20 mA)	$\Delta\lambda$	45	45	40	25	22	nm
Forward Voltage	V_F	2.0	2.0	2.0	2.0	2.0	V
(I_F=10 mA)		(≤2.6)	(≤2.6)	(≤2.6)	(≤2.6)	(≤2.6)	V
Reverse Current	I_R	0.01	0.01	0.01	0.01	0.01	
(V_R=5 V)		(≤10)	(≤10)	(≤10)	(≤10)	(≤10)	µA
Capacitance (V_R=0 V, f=1 MHz)	C_0	12	10	8	15	15	pF
Rise Time	t_R	300	300	300	450	450	ns
Fall Time	t_F	150	150	150	200	200	ns

Luminous Intensity (mcd)*

Part Number	*Min.*	*Max.*	*Test Condition*	*Part Number*	*Min.*	*Max.*	*Test Condition*
LS 3340-KN	6.3	50	10 mA	LY3340-JM	4	32	10 mA
LS 3340-MP	16	80	10 mA	LY 3340-LP	10	80	10 mA
LS 3340-M	16	32	10 mA	LY 3340-L	10	20	10 mA
LS 3340-N	25	50	10 mA	LY 3340-M	16	32	10 mA
LO 3340-KN	6.3	20	10 mA	LG 3330-KN	6.3	50	10 mA
LO 3340-M	10	20	10 mA	LG 3330-L	10	20	10 mA
LO 3340-MP	10	80	10 mA	LG 3330-LP	10	80	10 mA
LO 3340-N	16	32	10 mA	LG 3330-M	16	32	10 mA
				LG 3330-N	25	50	10 mA
				LP 3340-HO	2.5		10 mA

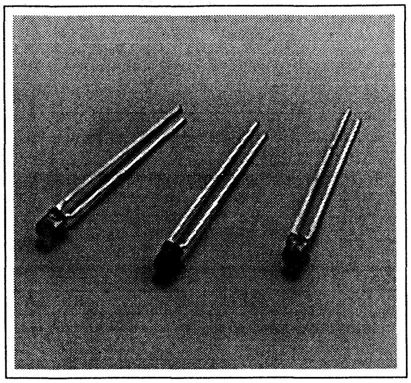
* Luminous intensity ratio of one packaging unit I_{VMAX}/I_{VMIN} ≤2.

See graphs 1, 2B, 3A, 4A, 5A, 6A, 7B, 8A, 9A, 10A in the back of this section.

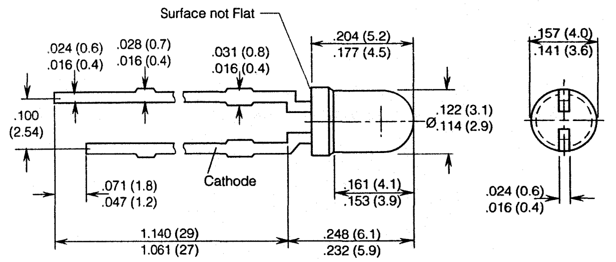
SIEMENS

SUPER-RED LS 3341
YELLOW LY 3341
GREEN LG 3341

T1 (3 mm) LED Lamp



Package Dimensions in Inches (mm)



FEATURES

- **High Light Output**
- **Lens–Tinted Clear**
- **Viewing Angle 40°**
- **T1 (3 mm) Package Size**
- **1" Lead Length**
- **IC Compatible**

DESCRIPTION

The LS 3341 super-red series and the LY 3341 yellow are premium high efficiency light emitting diode lamps fabricated with TSN (transparent substrate nitrogen) technology. The LG 3341 green series is a gallium phosphide (GaP) lamp. All have a clear plastic lens.

Maximum Ratings

Operating Temperature
Range (T_{OP}) .... –55°C to +100°C
Storage Temperature
Range (T_{STG}) .... –55°C to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 40 mA
Surge Current (I_{FS}) t=10 µs .... 0.5 A
Total Power Dissipation
(P_{TOT}) T_A=25°C .... 140 mW
Thermal Resistance
Junction to Air (R_{THJA}) .... 400 K/W

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter	Sym	LS 3341 Super-Red	LY 3341 Yellow	LG 3341 Green	Unit
Peak Wavelength (I_F=20 mA)	λ_{PEAK}	635	586	565	nm
Dominant Wavelength (I_F=20 mA)	λ_{DOM}	628	590	570	nm
Spectral Bandwidth (50%I_{RELMAX}, I_F=20 mA)	$\Delta\lambda$	45	45	25	nm
Viewing Angle (50% I_V)	2φ	40	40	40	Deg.
Forward Voltage (I_F=10 mA)	V_F	2.0(≤2.6)	2.0(≤2.6)	2.0(≤2.6)	V
Reverse Current (V_R=5 V)	I_R	0.01(≤10)	0.01(≤10)	0.01(≤10)	µA
Capacitance (V_R=0 V, f=1 MHz)	C_0	12	10	15	pF
Rise Time	t_R	300	300	450	ns
Fall Time	t_F	150	150	200	ns

Luminous Intensity (mcd)*

Part Number	*Min.*	*Max.*	*Test Condition*	*Part Number*	*Min.*	*Max.*	*Test Condition*
LS 3341-KN	6.3	50	10 mA	LG 3341-JM	4	32	10 mA
LS3341-M	16	32	10 mA	LG 3341-L	10	20	10 mA
LS 3341-MQ	16	125	10 mA	LG 3341-LP	10	80	10 mA
LS 3341-N	25	50	10 mA	LG 3341-M	16	32	10 mA
LY3341-JM	4	32	10 mA				
LY 3341-L	10	20	10 mA				
LY 3341-LP	10	80	10 mA				
LY3341-M	16	32	10 mA				

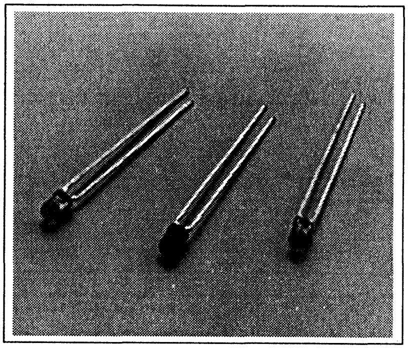
* Luminous intensity ratio of one packaging unit I_{VMAX}/I_{VMIN} ≤2

See graph numbers 1, 2C, 3A, 4A, 5A, 6A, 7A, 8A, 9A, 10A in the back of this section.

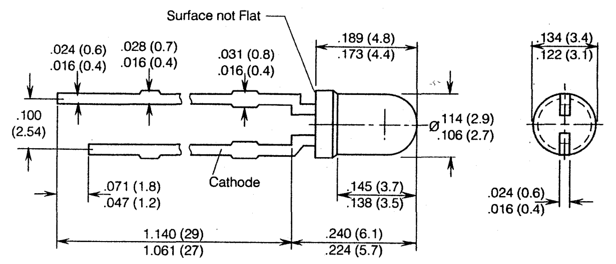
SIEMENS

SUPER-RED LS 3369
YELLOW LY 3369
GREEN LG 3369

Low Current T1 (3 mm) LED Lamp



Package Dimensions in Inches (mm)



FEATURES

- **Low Power Requirement**
- **60° Viewing Angle**
- **Diffused Lens**
- **1" Lead Length**
- **IC Compatible**

DESCRIPTION

The 3369 series are low current LED lamps that have been designed to optimize light output at very low currents. These parts are ideally suited for applications where power is at a premium, such as portable equipment.

See graph numbers 1, 2L, 3B, 4D, 5C, 6C, 7A, 8A, 9B, 10A in the back of this section

Maximum Ratings

Operating Temperature Range (T_{OP}) .... –55°C to +100°C
Storage Temperature Range (T_{STG}) .... –55°C to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 7.5 mA
Surge Current (I_{FS}) t=10 µs/D≤0.005 .... 150 mA
Total Power Dissipation (P_{TOT}) T_A=25°C .... 20 mW
Thermal Resistance Junction to Air (R_{THJA}) .... 750 K/W
Note:
Soldered on PC board: pad size ≥16 mm².

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter	Sym	LS 3369 Super-Red	LY 3369 Yellow	LG 3369 Green	Unit
Peak Wavelength (I_F=7.5 mA)	λ_{PEAK}	635	586	565	nm
Dominant Wavelength (I_F=7.5 mA)	λ_{DOM}	628	590	570	nm
Spectral Bandwidth (50%I_{RELMAX}, I_F=7.5 mA)	$\Delta\lambda$	45	45	25	nm
Viewing Angle	2φ	60	60	60	Deg.
Forward Voltage (I_F=2 mA)	V_F	1.8(≤2.6)	2.0(≤2.7)	1.9(≤2.6)	V
Reverse Current (V_R=5 V)	I_R	0.01(≤10)	0.01(≤10)	0.01(≤10)	µA
Capacitance (V_R=0 V, f=1 MHz)	C_0	3	3	15	pF
Response Time (I_F=100 mA, t =10 µs R_L=50Ω)					
Rise Time I_V, from 10% to 90%	t_R	200	200	450	ns
Fall Time I_V from 90% to 10%	t_F	150	150	200	ns

Luminous Intensity*

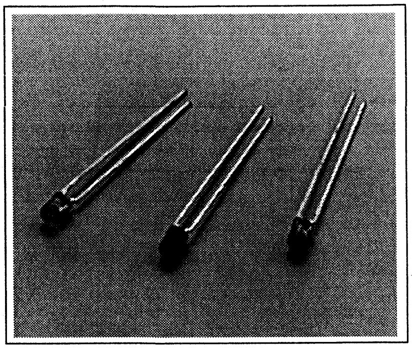
Part Number	*Min.*	*Typ.*	*Unit*	*Test Condition*
LS/LY/LG 3369-EH	0.63	5	mcd	2 mA
LS/LY/LG 3369-FH	1	5	mcd	2 mA

Luminous intensity ratio of one packaging unit I_{VMAX}/I_{VMIN} ≤2

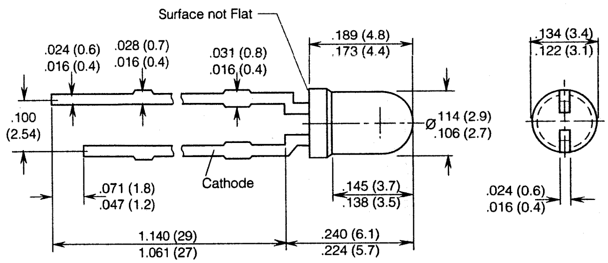
SIEMENS

SUPER-RED LS 3380
YELLOW LY 3380
GREEN LG 3380

T1 (3 mm) Wide Angle LED Lamp



Package Dimensions in Inches (mm)



FEATURES

- **Colors: Super-Red, Yellow, Green**
- **Lens: Red Diffused, Yellow Diffused, Green Diffused**
- **Low Power Dissipation**
- **Suitable for Multiplex Operation**
- **Wide Angle 100°**

DESCRIPTION

The LS/LY/LG 3380 are T1 (3 mm) wide angle LED lamps. The 3 mm plastic package has colored diffused lenses to match the emission color and 2.54 mm lead spacing.

Maximum Ratings

Operating Temperature
Range (T_{OP}) .... −55°C to +100°C
Storage Temperature
Range (T_{STG}) .... −55°C to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F)......................... 40 mA
Surge Current (I_{FS}) t=10 µs .... 0.5 A
Total Power Dissipation
(P_{TOT}) T_A=25°C .... 140 mW
Thermal Resistance
Junction to Air (R_{THJA}) ....400 K/W

See graph numbers 1, 2P, 3A, 4A, 5A, 6A, 7A, 8A, 9A, 10A in the back of this section.

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter	Sym	LS 3380 Super-Red	LY 3380 Yellow	LG 3380 Green	Unit
Peak Wavelength (I_F=20 mA)	λ_{PEAK}	635	586	565	nm
Dominant Wavelength	λ_{DOM}	628	590	570	nm
Spectral Bandwidth (typ.) (50% I_{RELMAX}, I_F=20 mA)	$\Delta\lambda$	45	45	25	nm
Viewing Angle 50% I_V	2φ	100	100	100	Deg.
Forward Voltage (I_F=10 mA)	V_F	2.0(≤2.6)	2.0(≤2.6)	2.0(≤2.6)	V
Reverse Current (V_R=5 V)	I_R	0.01(≤10)	0.01(≤10)	0.01(≤10)	µA
Capacitance (V_R=0 V, f=1 MHz)	C_0	12	10	45	pF
Rise Time, I_V — I_V from 10% to 90%	t_R	300	300	450	ns
Fall Time, I_V — I_V from 90% to 10%	t_F	150	150	200	ns

Luminous Intensity (mcd)*

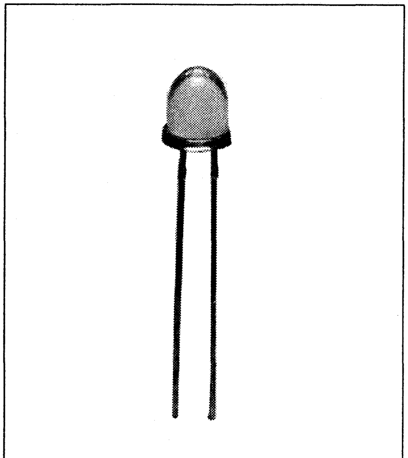
Part Number	*Min.*	*Max.*	*Test Condition*	*Part Number*	*Min.*	*Max.*	*Test Condition*
LS 3380-FJ	1.0	8.0	10 mA	LG 3380-GK	1.6	12.5	10 mA
LS 3380-H	2.5	5	10 mA	LG 3380-HL	2.5	2.0	10 mA
LS 3380-J	4	8	10 mA	LG 3380-H	2.5	5	10 mA
LS 3380-HL	2.5	20	10 mA	LG 3380-J	4.0	8.0	10 mA
LY 3380-FJ	1	8	10 mA				
LY 3380-H	2.5	5	10 mA				
LY 3380-HL	2.5	20	10 mA				
LY 3380-J	4	32	10 mA				
LY 3380-K	6.3	12.5	10 mA				

*Luminous intensity ratio of one packaging unit $I_{V\,MAX}/I_{V\,MIN}$ ≤ 2.

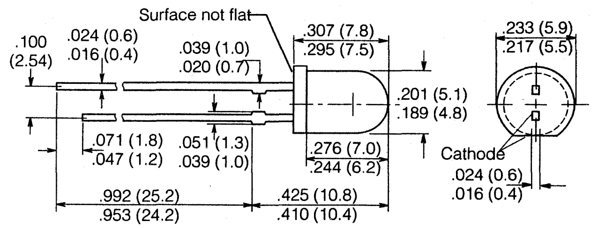
SIEMENS

SUPER-RED LS 5380
YELLOW LY 5380
GREEN LG 5380

T1³/4 (5 mm) LED Lamp



Package Dimensions in Inches (mm)



FEATURES

- **Diffused Lens**
- **Wide Viewing Angle 140°**
- **With Standoffs**
- **T1³/4 (5 mm) Package Size**
- **1″ Lead Length**
- **IC Compatible**

DESCRIPTION

The LS 5380 super-red and LY 5380 yellow are premium high efficiency light emitting diode lamps fabricated with TSN (transparent substrate nitrogen) technology. The LG 5380 green is a gallium phosphide (GaP) lamp. All have a diffused plastic lens which emits a full flooded intense light.

See graph numbers 1, 2Q, 3A, 4A, 5A, 6A, 7A, 8A, 9A, 10A in the back of this section.

Maximum Ratings

Operating Temperature Range (T_{OP}) .... –55°C to +100°C
Storage Temperature Range (T_{STG}) .... –55°C to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 40 mA
Surge Current (I_{FS}) t=10 µs .... 0.5 A
Total Power Dissipation (P_{TOT}) T_A=25°C .... 140 mW
Thermal Resistance Junction to Air (R_{THJA}) .... 400 K/W

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter	Sym	LS 5380 Super-Red	LY 5380 Yellow	LG 5380 Green	Unit
Peak Wavelength	λ_{PEAK}	635	586	565	nm
Dominant Wavelength	λ_{DOM}	628	590	570	nm
Spectral Bandwidth (50% I_{RELMAX}, I_F=20 mA)	$\Delta\lambda$	45	45	25	nm
Viewing Angle (50%, I_V)	2 φ	140	140	140	Deg.
Forward Voltage (I_F=10 mA)	V_F	2.0 (≤2.6)	2.0 (≤2.6)	2.0 (≤2.6)	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤10)	0.01 (≤10)	0.01 (≤10)	µA
Capacitance (V_R=0 V, f=1 MHz)	C_0	12	10	15	pF
Rise Time	t_R	300	300	450	ns
Fall Time	t_F	150	150	200	ns

Luminous Intensity (mcd)*

Part Number	*Min.*	*Max.*	*Test Condition*
LS 5380-FJ	1	8	10 mA
LS 5380-H	2.5	5	10 mA
LS 5380-HL	2.5	20	10 mA
LS 5380-J	4	8	10 mA
LY 5380-FJ	1	8	10 mA
LY 5380-H	2.5	5	10 mA
LY 5380-HL	2.5	20	10 mA
LY 5380-J	4	8	10 mA

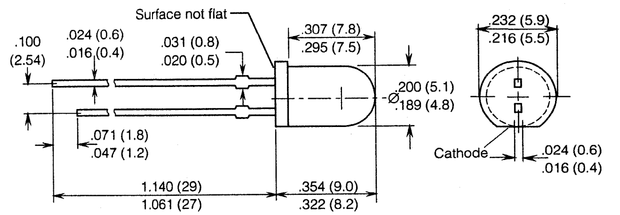
Part Number	*Min.*	*Max.*	*Test Condition*
LG 5380-FJ	1	8	10 mA
LG 5380-H	2.5	5	10 mA
LG 5380-HL	2.5	20	10 mA
LG 5380-J	4	8	10 mA

* Luminous intensity ratio of one packaging unit $I_{V\,MAX}/I_{V\,MIN}$ ≤2.

SIEMENS

SUPER-RED LS 5420
YELLOW LY 5420
GREEN LG 5410
T1¾ (5 mm) LED Lamp

Package Dimensions in Inches (mm)



Approx Weight 0.35 g

FEATURES

- **High Light Output**
- **Green: Water Clear Lens Super-red, Yellow: Clear Lens Lightly Tinted**
- **Viewing Angle, 24°**
- **T1¾ (5 mm) Package Size**
- **1" Lead Length**
- **Front Panel Mounting Snap-in Mounting Clips Available**
- **IC Compatible**

DESCRIPTION

The LS 5420 super-red and LY 5420 yellow lamps are fabricated with TSN (transparent substrate nitrogen) technology. The LG 5410 is a gallium phosphide LED lamp. All three have a narrow viewing angle for the concentration of intense brightness in a head-on position. This is particularly desirable for legend back lighting applications.

See graph numbers 1, 2E, 3A, 4A, 5A, 6A, 7A, 8A, 9A, 10A in the back of this section.

Maximum Ratings

Operating Temperature Range (T_{OP}) .... –55°C to +100°C
Storage Temperature Range (T_{STG}) .... –55°C to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 40 mA
Surge Current (I_{FS}) t=10 µs .... 0.5 A
Total Power Dissipation (P_{TOT}) T_A=25°C .... 140 mW
Thermal Resistance: Junction/Air (R_{THJA}) .... 400 K/W

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter	Symbol	LS 5420 Super-Red	LY 5420 Yellow	LG 5410 Green	Unit
Peak Wavelength	λ_{PEAK}	635	586	565	nm
Dominant Wavelength	λ_{DOM}	628	590	570	nm
Spectral Bandwidth (50% I_{RELMAX}, I_F=20 mA)	$\Delta\lambda$	45	45	25	nm
Viewing Angle 50% I_V	2 φ	24	24	24	Deg.
Forward Voltage (I_F=10 mA)	V_F	2.0 (≤2.6)	2.0 (≤2.6)	2.0 (≤2.6)	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤10)	0.01 (≤10)	0.01 (≤10)	µA
Capacitance (V_R=0 V, f=1 MHz)	C_0	12	10	15	pF
Rise Time	t_R	300	300	450	ns
Fall Time	t_F	150	150	200	ns

Luminous Intensity (mcd)*

Part Number	*Min.*	*Max.*	*Test Condition*
LS 5420-MQ	16	125	10 mA
LS 5420-PS	40	320	10 mA
LS 5420-P	40	80	10 mA
LS 5420Q	63	125	10 mA
LS 5420-R	100	200	10 mA
LY 5420-MQ	16	125	10 mA
LY 5420-PS	40	320	10 mA

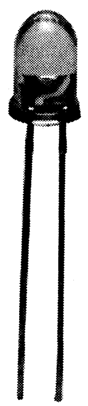
Part Number	*Min.*	*Max.*	*Test Condition*
LY 5420-P	40	80	10 mA
LY 5420-Q	63	125	10 mA
LG 5410-MQ	16	125	10 mA
LG 5410-P	40	80	10 mA
LG 5410PS	40	320	10 mA
LG 5410-Q	63	125	10 m
LG 5410-R	100	200	10 mA

* Luminous intensity ratio of one packaging unit I_{VMAX}/I_{VMIN} ≤2.

SIEMENS

SUPER-RED LS 5421
YELLOW LY 5421
GREEN LG 5411

Superbright T1¾ (5 mm) LED Lamp



FEATURES

- **High Light Output**
- **New Lens to Optimize Output**
- **20° Viewing Angle**
- **Green: Water Clear Lens Super-red, Yellow: Clear Lens Lightly Tinted**
- **1" Lead Length**

DESCRIPTION

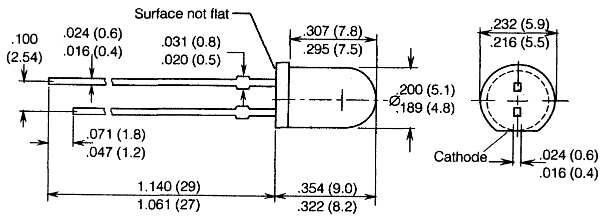
The 5421/5411 series are superbright T1¾ (5mm) LED lamps. Improvements in materials and optimization of lens and reflectors have resulted in a dramatic increase in luminous intensity.

Maximum Ratings

Operating Temperature
Range (T_{OP}) ....−55°C to +100°C
Storage Temperature
Range (T_{STG}) ....−55°C to +100°C
Junction Temperature (T_J) .... +100°C
Reverse Voltage (V_R) .... 5 V
Continuous Forward Current (I_F) .... 40 mA
Surge Current (t=10 µs) (I_{FS}) .... 0.5 A
Power Dissipation (P_{TOT})
T_{OP}=25°C .... 140 mW
Thermal Resistance,
Junction to Air (R_{THJA}) .... 400 K/W

See graph numbers 1, 2F, 3A, 4A, 5A, 6A, 7A, 8A, 9A, 10A in the back of this section.

Package Dimensions in Inches (mm)



Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter	Symbol	LS 5421 Super-Red	LY 5421 Yellow	LG 5411 Green	Unit
Peak Wavelength (I_F=10 mA) (typ.)	λ_{PEAK}	635	586	565	nm
Dominant Wavelength (I_F=20 mA) (typ.)	λ_{DOM}	628	590	570	nm
Spectral Bandwidth (typ.) (50% I_{RELMAX}, I_F=20 mA)	$\Delta\lambda$	45	45	25	nm
Viewing Angle	2φ	20	20	20	Deg.
Forward Voltage (I_F=10 mA)	V_F	2.0 (≤2.6)	2.0 (≤2.6)	2.0 (≤2.6)	V
Reverse Current (I_R=5 V)	I_R	0.01 (≤100)	0.01 (≤100)	0.01 (≤100)	µA
Capacitance (V_R=5 V) (typ.)	C_0	12	10	15	pF
Switching Time (I_F=100 mA, t_P=10 µs, R_L=50 Ω)					
I_V, 10% to 90%	t_R	300	300	450	ns
I_V, 90% to 10%	t_R	150	150	200	ns

Luminous Intensity*

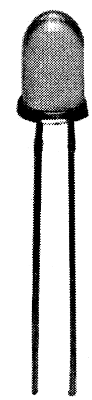
Part Number	*Min.*	*Typ.*	*Unit*	*Test Condition*
LS 5421-NR	25	200	mcd	10 mA
LS 5421-Q	63	125	mcd	10 mA
LS 5421-QT	63	500	mcd	10 mA
LS 5421-R	100	200	mcd	10 mA
LY 5421-NR	25	200	mcd	10 mA
LY 5421-QT	63	500	mcd	10 mA
LY 5421-Q	63	125	mcd	10 mA
LY 5421-R	100	200	mcd	10 mA
LG 5411-NR	25	200	mcd	10 mA
LG 5411-Q	63	125	mcd	10 mA
LG 5411-QT	63	500	mcd	10 mA
LG 5411-R	100	200	mcd	10 mA
LG 5411-S	160	320	mcd	10 mA

* Luminous intensity ratio of one packaging unit I_{VMAX}/I_{VMIN} ≤2.

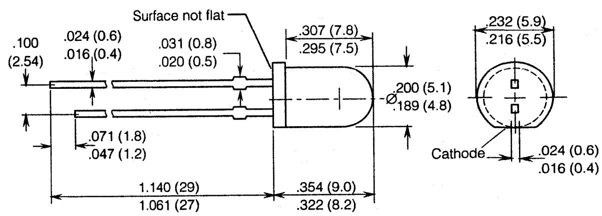
SIEMENS

SUPER-RED LS 5469
YELLOW LY 5469
GREEN LG 5469

Low Current T1¾ (5 mm) LED Lamp



Package Dimensions in Inches (mm)



FEATURES

- **Low Power Requirement**
- **50° Viewing Angle**
- **Diffused Lens**
- **1" Lead Length**
- **IC Compatible**

DESCRIPTION

The 5469 series are low current LED lamps that have been designed to optimize light output at very low currents. These parts are ideally suited for applications where power is at a premium, such as portable equipment.

Both the super-red and yellow lamps utilize GaAsP on GaP semiconductor materials while the green lamps utilize GaP on GaP.

See graph numbers 1, 2D, 3B, 4D, 5C, 6C, 7A, 8A, 9B, 10A in the back of this section.

Maximum Ratings

Operating Temperature Range (T_{OP}) ....−55°C to +100°C
Storage Temperature Range (T_{STG}) ....−55°C to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 7.5 mA
Surge Current (I_{FS}), t=10 µs/D ≤ 0.005 .... 150 mA
Total Power Dissipation (P_{TOT}), T_A=25°C .... 20 mW
Thermal Resistance Junction to Air (R_{THJA}) ....750 K/W

Note: Soldered on PC board: pad size ≥16 mm²

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter	Sym	LS 5469 Super-Red	LY 5469 Yellow	LG 5469 Green	Unit
Peak Wavelength (I_F=2 mA)	λ_{PEAK}	635	586	565	nm
Dominant Wavelength (I_F=2 mA)	λ_{DOM}	628	590	570	nm
Spectral Bandwidth (50% I_{RELMAX}, I_F=7.5 mA)	Δ_λ	45	45	25	nm
Viewing Angle	2φ	50	50	50	Deg.
Forward Voltage (I_F=2 mA)	V_F	1.8 (≤2.5)	2.0 (≤2.7)	1.9 (≤2.6)	V
Reverse Current (V_R=5 V)	I_R	.01 (≤10)	.01 (≤10)	.01 (≤10)	µA
Capacitance (V_R=0 V, f=1 MHz)	C_0	3	3	15	pF
Response Time (I_F=25 mA, t=1 µs)					
Rise Time I_V, 10% to 90%	t_R	200	200	450	ns
Fall Time I_V, 90% to 10%	t_F	150	150	200	ns

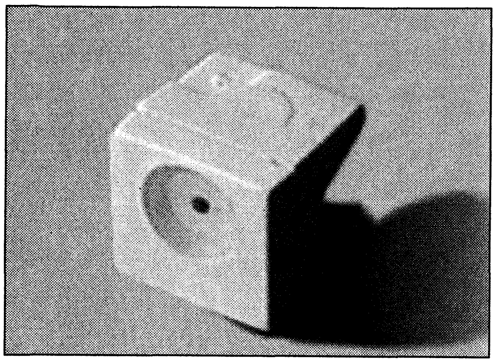
Luminous Intensity

Part Number	*Min.*	*Typ.*	*Unit*	*Test Condition*
LS/LY/LG 5469-EH	0.63	5	mcd	I_F=2 mA
LS/LY/LG 5469-FH	1	5	mcd	I_F=2 mA

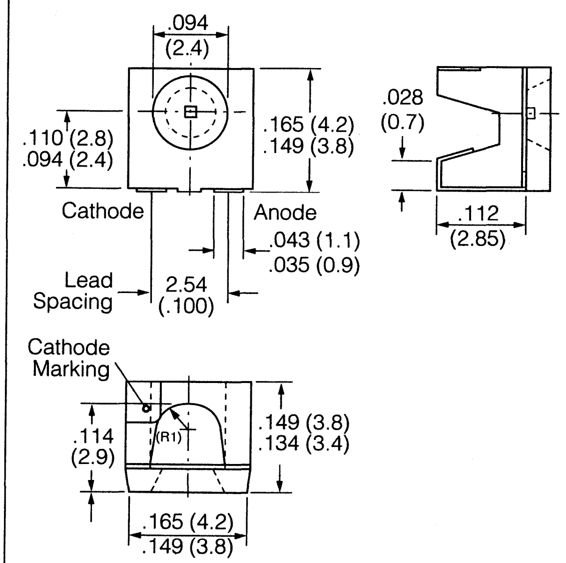
* Luminous intensity ratio of one packaging unit I_{VMAX}/I_{VMIN} ≤2.

SIEMENS

SUPER-RED LS A670
ORANGE LO A670
YELLOW LY A670
GREEN LG A670
PURE GREEN LP A670
SMT-SIDELED®
Preliminary Data



Package Dimensions in Inches (mm)



FEATURES

- White Package
- Internal Reflector
- Wide Viewing Angle
- Ideal for Backlighting, Optical Coupling into Light Pipes and Lenses
- Colorless Clear Window
- Available on Tape and Reel (12 mm Tape)
- Load Dump Resistant acc. to DIN 40839
- Low Power Dissipation
- Compatible with Automatic Placement Equipment
- Suitable for Vapor-Phase Reflow and Infrared Reflow Processes

See graph numbers 1, 2V, 3D, 4I, 5G, 6G, 7A, 8A, 9A, 10A in the back of this section.

DESCRIPTION

The LX A670 (SMT-SIDELED for surface mount applications) is available in super-red, orange, yellow, green, and pure green. The right angle package incorporates an internal reflector to optimize light coupling. This feature makes the SMT-SIDELED ideal for light pipe applications.

Maximum Ratings

Operating Temperature Range (T_{OP}) .... –55 to +100°C
Storage Temperature Range (T_{STG}) .... –55 to +100°C
Junction Temperature (T_J) .... +100°C
Forward Current (I_F) .... 30 mA
Surge Current (I_{FM}) tp≤10 µs D=0.005 .... 0.5 A
Reverse Voltage (V_R) .... 5 V
Power Dissipation (P_{TOT}) .... 100 mW
Thermal Resistance, Junction Air,
Mounted on PC Board (pad size 16 mm^2 (1)
(R_{THJA}) .... 400 K/W
Junction Solderpoint (R_{THJS}) .... 300 K/W

Note: PC board G30/FR4

Characteristics (T_A=25°C) All values typical unless otherwise noted

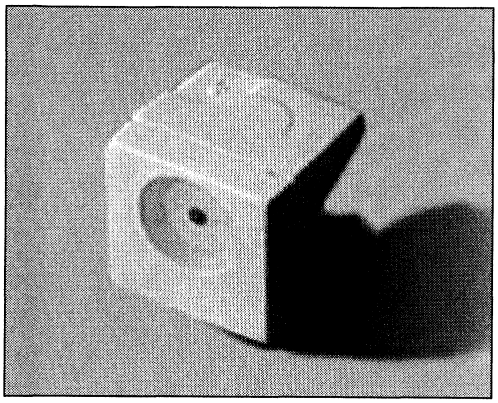
Parameter		Symbol	Values: Super Red	Orange	Yellow	Green	Pure Green	Unit
Peak Wavelength (I_F=10 mA)		λ_{PEAK}	635	610	586	565	557	nm
Dominant Wavelength (I_F=10 mA)		λ_{DOM}	628	605	590	570	560	nm
Spectral Bandwidth (50% I_{RELMAX}) (I_F=10 mA)		$\Delta\lambda$	45	40	45	25	22	nm
Viewing Angle, 50%, I_V		2φ	120	120	120	120	120	Deg.
Forward Voltage (I_F=10 mA)	Typ.	V_F	2.0	2.0	2.0	2.0	2.0	V
	Max		2.6	2.6	2.6	2.6	2.6	
Reverse Current (V_R=5 V)	Typ.	I_R	0.01	0.01	0.01	0.01	0.01	µA
	Max		10	10	10	10	10	
Capacitance (V_R=0 V, f=1 MHz)		C_0	12	8	10	15	15	pF
Switching times (I_F=100 mA) (t_P=10 µs, R_L=50 Ω)	I_V, 10%–90%	t_R	300	300	300	450	450	ns
	I_V, 90%–10%	t_F	150	150	150	200	200	

Luminous Intensity Ratio in One Packaging Unit $I_{VMAX}/I_{VMIN} \geq 2.0$

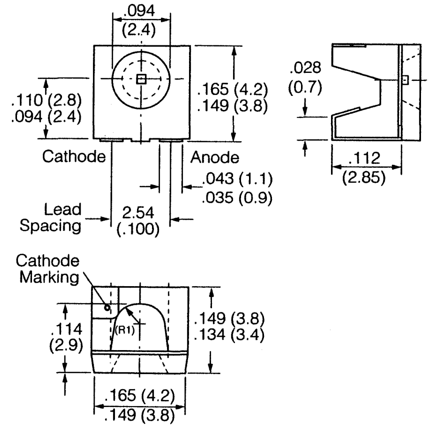
Type	Light Emitting Color	Luminous Intensity I_F=50 mA, I_V (mcd) Min.	Max.
LSA670-HK	Super-red, Yellow	2.5	12.5
LSA670-J		4	8
LSA670-K		6.3	12.5
LSA670-JL		4	20
LOA670-GJ	Orange	1.6	12.5
LOA670-H		2.5	5
LOA670-J		4	8
LOA670-JL		4	20
LYA670-HK	Yellow	2.5	12.5
LYA670-J		4	8
LYA670-K		6.3	12.5
LYA670-JL		4	20
LGA670-HK	Green	2.5	12.5
LGA670-J		4	8
LGA670-K		6.3	12.5
LGA670-JL		4	20
LPA670-FJ	Pure Green	1	8
LPA670-G		1.6	3.2
LPA670-H		2.5	5
LPA670-GK		1.6	12.5

SIEMENS

SUPER-RED LS A672
ORANGE LO A672
YELLOW LY A672
GREEN LG A672
PURE GREEN LP A672
HIGH-CURRENT SUPER SMT-SIDELED®



Package Dimensions in Inches (mm)



FEATURES

- **White Package**
- **Optical Indicator**
- **Colorless Clear Window**
- **Appropriate for High Ambient Light Due to Higher Operating Current (≤50 mA DC)**
- **Ideal for Backlighting, Optical Coupling into Light Pipes and Lenses**
- **Load Dump Resistant acc. to DIN 40839**

Maximum Ratings

Operating Temperature Range (T_{OP}) .... –55 to +100°C
Storage Temperature Range (T_{STG}) .... –55 to +100°C
Junction Temperature (T_J) .... +100°C
Forward Current (I_F) .... 50 mA
Surge Current (I_{FM}) t≤10 µs D=0.005 .... 1 A
Reverse Voltage (V_R) .... 5 V
Power Dissipation (P_{TOT}) T_A≤25°C .... 190 mW
Thermal Resistance, Junction Air,
Mounted on PC Board, pad size 16 mm^2 (1)
(R_{THJA}) .... 300 K/W
Junction Solderpoint (R_{THJS}) .... 250 K/W
Note: PC board G30/FR4

See graph numbers 1, 2V, 3H, 4F, 5D, 6B, 7A, 8A, 9D, 10E in the back of this section.

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter		Symbol	Values					Unit
			Super Red	Orange	Yellow	Green	Pure Green	
Peak Wavelength (I_F=10 mA)		λ_{PEAK}	635	610	586	565	557	nm
Dominant Wavelength (I_F=10 mA)		λ_{DOM}	628	605	590	570	560	nm
Spectral Bandwidth (50% I_{RELMAX}) (I_F=10mA)		$\Delta\lambda$	45	40	45	25	22	nm
Viewing Angle, 50%, I_V		2φ	120	120	120	120	120	Deg.
Forward Voltage (I_F=50 mA)	Typ.	V_F	2.0	2.4	2.4	2.6	2.6	V
	Max		3.8	3.8	3.8	3.8	3.8	
Reverse Current (V_R=5 V)	Typ.	I_R	0.01	0.01	0.01	0.01	0.01	µA
	Max		10	10	10	10	10	
Capacitance (V_R=0 V, f=1 MHz)		C_0	40	35	35	60	80	pF
Switching times (I_F=100 mA) (t_P=10 µs, R_L=50 Ω)	I_V, 10%–90%	t_R	350	500	350	500	500	ns
	I_V, 90%–10%	t_F	200	250	200	250	250	

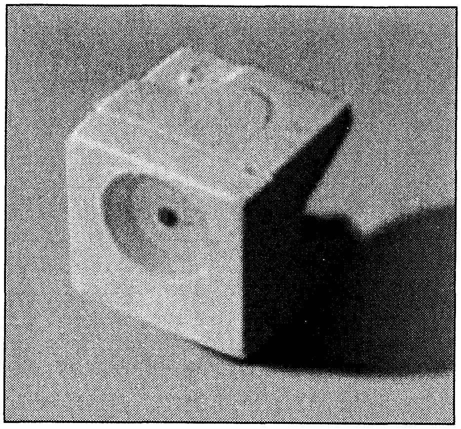
Luminous Intensity Ratio in One Packaging Unit $I_{VMAX}/I_{VMIN} \geq 2.0$(1)

Type	Light Emitting Color	Luminous Intensity, I_F=50 mA, I_V (mcd)	
		Min.	Max.
LSA672-LN	Super-red	10	50
LSA672-M		16	32
LSA672-N		25	50
LSA672-MQ		16	125
LO,LY,LG A672-LN	Orange, Yellow, Green	10	50
LO,LY,LG A672-N		25	50
LO,LY,LG A672-P		40	80
LO,LY,LG A672-MQ		16	125
LPA672-KM	Pure Green	6.3	32
LPA672-L		10	20
LPA672-M		16	32
LPA672-LP		10	80

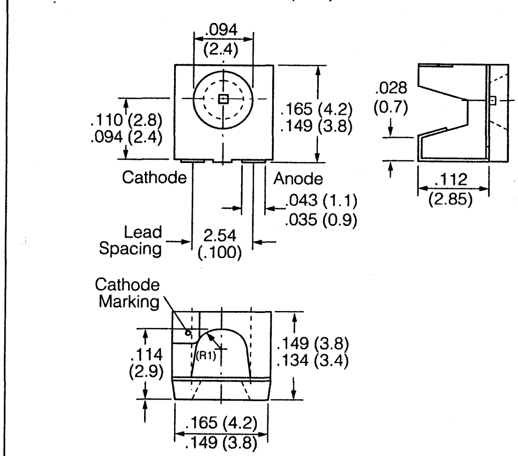
Note: In case of MULTILED® with two chips of the same emission wavelength, the sum of the brightness determines the brightness group of the LED.

SIEMENS

SUPER-RED LS A679
YELLOW LY A679
GREEN LG A679
LOW CURRENT SMT-SIDELED®



Package Dimensions in Inches (mm)



FEATURES

- **White Package**
- **Optical Indicator**
- **Colorless Clear Window**
- **Ideal for Backlighting, Optical Coupling into Light Pipes and Lenses**
- **Load Dump Resistant acc. to DIN 40839**
- **Available on Tape and Reel (12 mm Tape)**

Maximum Ratings

Operating Temperature Range (T_{OP}) . –55 to +100°C
Storage Temperature Range (T_{STG}) ... –55 to +100°C
Junction Temperature (T_J) .... +100°C
Forward Current (I_F) .... 7.5 mA
Surge Current (I_{FM}) t≤10 µs D=0.005............. 0.15 A
Reverse Voltage (V_R).. 5 V
Power Dissipation (P_{TOT}) T_A≤25°C .... 20 mW
Thermal Resistance, Junction Air,
Mounted on PC Board (pad size 16 mm²)
(R_{THJA}).. 500 K/W

See graph numbers 1, 2V, 3B, 4D, 5C, 6C, 7A, 8A, 9B, 10A in the back of this section.

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter		Symbol	Values			Unit
			Super Red	Yellow	Green	
Peak Wavelength (I_F=7.5 mA)		λ_{PEAK}	635	586	565	nm
Dominant Wavelength (I_F=7.5 mA)		λ_{DOM}	628	590	570	nm
Spectral Bandwidth (50% I_{RELMAX}) (I_F=7.5 mA)		$\Delta\lambda$	45	45	25	nm
Viewing Angle, 50%, I_V		2φ	120	120	120	Deg.
Forward Voltage (I_F=2 mA)	Typ.	V_F	1.8	2.0	1.9	V
	Max		2.6	2.7	2.6	
Reverse Current (V_R=5 V)	Typ.	I_R	0.01	0.01	0.01	µA
	Max		10	10	10	
Capacitance (V_R=0 V, f=1 MHz)		C_0	3	3	15	pF
Switching times (I_F=100 mA) (t_P=10 µs, R_L=50 Ω)						ns
I_V, 10%–90%		t_R	200	200	450	
I_V, 90%–10%		t_F	150	150	200	

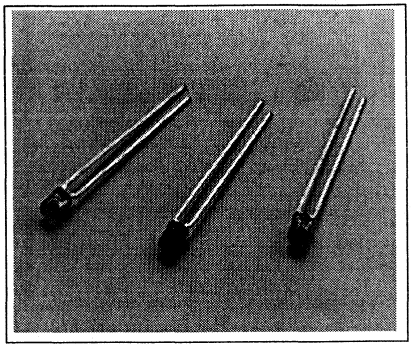
Luminous Intensity Ratio in One Packaging Unit I_{VMAX}/I_{VMIN}≥2

Type	Light Emitting Color	Luminous Intensity I_F=2 mA, I_V (mcd) Min.
LS A679-CO	Super-red	0.25
LY A679-CO	Yellow	
LG A679-CO	Green	

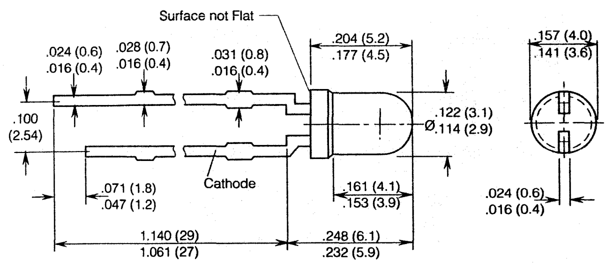
SIEMENS

SUPER-RED/ GREEN LSG 3331-JO
SUPER-RED/ GREEN LSG 3351-HO

T1 (3mm) Two Color, Red and Green LED Lamp



Package Dimensions in Inches (mm)



FEATURES
- **High Light Output**
- **Lens**
  - **– LSG 3331: Colorless Clear**
  - **– LSG 3351: Colorless Diffused**
- **Viewing Angle 40°/50°**
- **T1 (3mm) Package Size**
- **1" Lead Length**
- **IC Compatible**

DESCRIPTION
The LSG 3331 and LSG 3351 are both super-red/green, two color LED lamps with their chips in an anti-parallel arrangement. By reversing the current the lamp can be switched from super-red to green. With the appropriate circuitry, it is also possible to produce orange and yellow.

See graph numbers 1, 2C (LSG 3331), 2B (LSG 3351), 3A, 4A, 5A, 6A, 7A, 8A, 9A, 10A in the back of this section.

Maximum Ratings

Operating Temperature (T_{OP}) .... –55°C to +100°C
Storage Temperature (T_{STG}) .... –55°C to +100°C
Junction Temperature (T_J) .... 100°C
Forward Current (I_F) .... 40 mA
Surge Current (I_{FS}), t=10 µS .... 0.5 A
Power Dissipation (P_{TOT}), T_A=25°C .... 140 mW
Thermal Resistance Junction-to-Air (R_{THJA}) .... 400 K/W

Note 1. With simultaneous operation of both diodes of two-color LEDs the sum of the currents as well as the power dissipation must not exceed the specified limits.

Characteristics (T_A=25°C) **All values typical unless otherwise noted**

Parameter	Symbol	Red	Green	Unit
Peak Wavelength (I_F=20 mA)	λ_{PEAK}	635	565	nm
Dominant Wavelength (I_F=20 mA)	λ_{DOM}	628	570	nm
Spectral Bandwidth (50% I_{RELMAX}, I_F=20 mA)	$\Delta\lambda$	45	25	nm
Viewing Angle, 50% I_V				
LSG 3331	2 φ	40	40	Deg.
LSG 3351	2 φ	50	50	Deg.
Forward Voltage (I_F=10 mA)	V_F	2.0 (≤2.6)	2.0 (≤2.6)	V
Capacitance (V_R=0 V, f=1 MHz)	C_O	27	27	pF
Rise Time	t_R	300	450	ns
Fall Time	t_F	150	200	ns

Luminous Intensity (mcd)

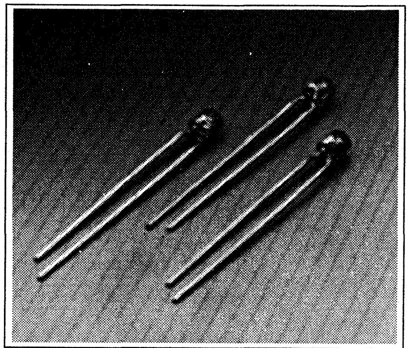
Part Number	*Min.*	*Typ.*	*Unit*	*Test Condition*
LSG 3331-JO	4	18	mcd	10 mA
LSG 3351-HO	2.5	–	mcd	10 mA

Note
1. Luminous intensity ratio in one packaging unit I_{VMAX}/I_{VMIN} ≤2
2. Luminous intensity rati in one LED $I_{VMAX}/_{VMIN}$ ≤3.0.
3. The brightness of the darker chip in one package determines the brightness group of the LED.

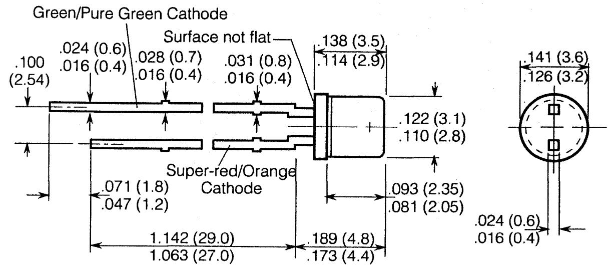
SIEMENS

SUPER-RED/GREEN LSG K370
SUPER-RED/PURE GREEN LSP K370
ORANGE/PURE GREEN LOP K370
ORANGE/GREEN LOG K370

Two-Color, T1 (3 mm) ARGUS LED Lamp



Package Dimensions in Inches (mm)



FEATURES

- **Clear Colorless Lens**
- **High Luminous Flux**
- **Rugged Design**
- **Applications–Backlighting Display Panels**
  - **Front Panels**
  - **Graphic Control and Display Boards**
  - **Sealed Keyboards**

DESCRIPTION

The LSG K370 is a T1 (3mm) two leaded bicolor (super-red/green) ARGUS LED lamp with their chips in an anti-parallel arrangement. The LSP K370 is a super-red/pure green ARGUS LED, the LOP K370 is an orange/pure green unit, and the LOG K370 is an orange/pure green unit..

ARGUS lamps are used with an additional custom built reflector (i.e., white plastic, such as Pocan B7375). The front end of the reflector is covered by a diffuser (see package dimensions). Uniform illuminations can be enhanced by the reflector design tailored to the LED and/or by using appropriate diffuser material.

Note: Siemens does not supply the reflector or diffuser.

Maximum Ratings

Operating Temperature Range(T_{OP}) .... –55°C to +100°C
Storage Temperature Range (T_{STG}) .... –55°C to +100°C
Junction Temperature (T_J) .... +100°C
Forward Current (I_F) .... 40 mA
Surge Current (I_{FM}), t ≤10 µS .... 0.5 A
Power Dissipation (P_{TOT}), T_A=25°C .... 140 mW
Thermal Resistance Junction to Air (R_{THJA}) .... 400 K/W

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter	Symbol	Super-Red	Orange	Green	Pure Green	Unit
Peak Wavelength (I_F=20 mA)	λ_{PEAK}	635	610	565	557	nm
Dominant Wavelength (I_F=20 mA)	λ_{DOM}	628	605	570	560	nm
Spectral Bandwidth 50% I_V (I_F=20 mA)	$\Delta\lambda$	45	40	25	22	nm
Forward Voltage	V_F	2.0	2.0	2.0	2.0	V
(I_F=10 mA)	V_F	(≤2.6)	(≤2.6)	(≤2.6)	(≤2.6)	V
Capacitance (V_R=0 V, f=1 MHz)	C_0	12	8	8	15	pF
Switching Times (I_F=100 mA, t_P=10 µs, R_L=50 Ω)						
Rise Time, 10% to 90%	t_R	300	300	450	450	ns
Fall Time, 90% to 10%	t_F	150	150	200	200	ns
Luminous Flux(1)	Φ_V	32	20	32	20	mlm
(I_F=15 mA)	Φ_V	(≥10)	(≥6.3)	(≥10)	(≥6.3)	mlm

See selector guide for Luminous Intensity information.

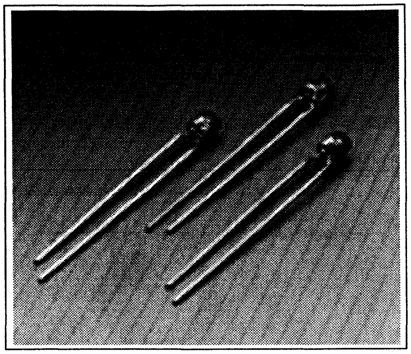
Notes:
1. Luminous flux ratio in one packaging unit Φ_V max/Φ_V min. ≤2.
   Luminous flux ratio in one LED unit Φ_V max/Φ_V min. ≤4. (LSP...)
   Luminous flux ratio in one LED unit Φ_V max/Φ_V min. ≤3. (LSG...)
2. The brightness of the darker chip in one package determines the brightness group of the LED.

See graph numbers 1, 2W, 3A, 4H, 5A, 6A, 7A, 8A, 9A,10D in the back of this section.

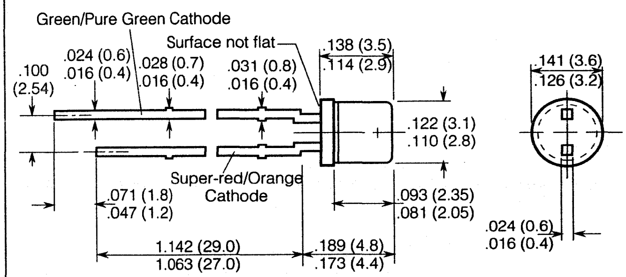
SIEMENS

SUPER-RED/GREEN LSG K372-RO
SUPER-RED/PURE GREEN LSP K372-PO

Two-Color, T1 (3 mm) Super ARGUS LED Lamp



Package Dimensions in Inches (mm)



FEATURES

- **Super-Red/Green and Super-Red/Pure Green LEDs in One Package**
- **Clear Colorless Lens**
- **High Luminous Flux**
- **Rugged Design**
- **Cathode Designations**
  Shorter Lead: Super-Red Cathode
  Longer Lead: Green or Pure Green Cathode
- **Applications–Backlighting Display Panels**
  - **Front Panels**
  - **Graphic Control and Display Boards**
  - **Sealed Keyboards**
  - **Large Scale Displays, Dot Matrix Displays**

DESCRIPTION

The LSG K372 is a T1 (3mm) two leaded bicolor (super-red/green) Super ARGUS LED lamp with their chips in an anti-parallel arrangement. The LSP K372 is a super-red/pure green Super ARGUS LED.

ARGUS lamps are used with an additional custom built reflector (i.e., white plastic, such as Pocan B7375). The front end of the reflector is covered by a diffuser (see package dimensions). Uniform illuminations can be enhanced by the reflector design tailored to the LED and/or by using appropriate diffuser material.

Super ARGUS LEDs are designed to operate at 50 mA and provide as much as 10X luminous flux as standard ARGUS LEDs.

Note: Siemens does not supply the reflector or diffuser.

Maximum Ratings

Operating Temperature Range(T_{OP})	–55°C to +100°C
Storage Temperature Range (T_{STG})	–55°C to +100°C
Junction Temperature (T_J)	+100°C
Forward Current (I_F)	75 mA
Pulse Current (I_{FM}), t≤10 µS	1 A
Power Dissipation (P_{TOT}), T_A=25°C	300 mW
Thermal Resistance Junction to Air (R_{THJA})(1)	250 K/W

Note 1. Mounted on PC board up to stand off pad size ≥16 mm^2.

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter	Symbol	Super-Red	Green	Pure Green	Unit
Peak Wavelength (I_F=20 mA)	λ_{PEAK}	635	565	557	nm
Dominant Wavelength (I_F=20 mA)	λ_{DOM}	628	570	560	nm
Spectral Bandwidth 50%, I_V (I_F=20 mA)	$\Delta\lambda$	45	25	22	nm
Forward Voltage	V_F	2.4	2.4	2.4	V
(I_F=50 mA)	V_F	(≤3.8)	(≤3.8)	(≤3.8)	V
Capacitance (V_R=0 V, f=1 MHz)	C_0	55	55	80	pF
Switching Times (I_F=100 mA, t_P=10 µs, R_L=50 Ω)					
Rise Time, 10% to 90%	t_R	300	450	450	ns
Fall Time, 90% to 10%	t_F	150	200	200	ns
Luminous Flux(1)	Φ_V	160	160	100	mlm
(I_F=50 mA)	Φ_V	(≥100)	(≥100)	(≥40)	mlm

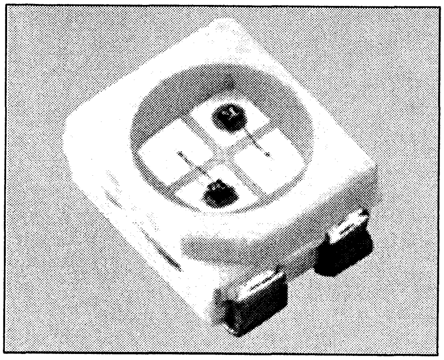
Notes:
1. Luminous flux ratio in one packaging unit Φ_{VMAX}/Φ_{VMIN} ≤2.
2. Luminous flux ratio of one packaging unit I_{VMAX}/I_{VMIN} ≤2.

See graph numbers 1, 2X, 3E, 3F, 4F, 5D (super-red), 5E (green), 6D, 7A, 8A, 9E, 10C in the back of this section.

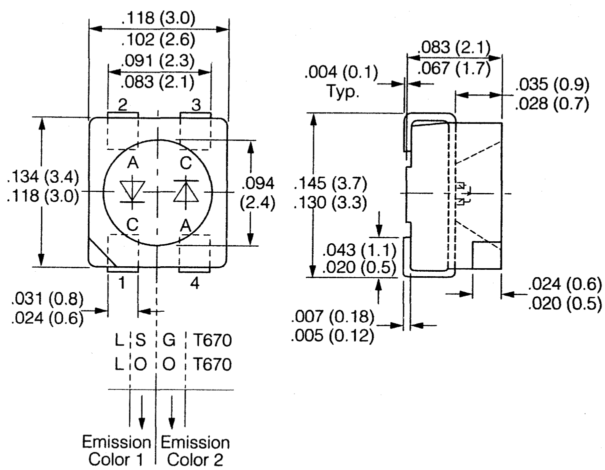
SIEMENS

SUPER-RED/GREEN LSG T670
SUPER-RED/PURE GREEN LSP T670
SUPER-RED/YELLOW LSY T670
ORANGE/PURE GREEN LOP T670
ORANGE/GREEN LOG T670
YELLOW/PURE GREEN LYP T670

SMT-MULTILED®
Preliminary Data



Package Dimensions in Inches (mm)



FEATURES

- P-LCC-4 Package
- White Package
- Optical Indicator
- Ideal for Backlighting, Optical Coupling into Light Pipes and Lenses
- Both Chips can be Controlled Separately
- High Signal Efficiency Possible by Color Change of the LED
- With Appropriate Controlling it is Possible to Change Color from Green to Yellow and Orange to Super-red
- Colorless Clear Window
- Suitable for all SMT Assembly and Solder Processes
- Available on Tape and Reel (8 mm Tape)
- Load Dump Resistant acc. to DIN 40839

See graph numbers 1, 2V, 3D, 4I, 5G, 6G, 7A, 8A, 9A, 10A in the back of this section.

Maximum Ratings

Operating Temperature Range (T_{OP})	–55 to +100°C
Storage Temperature Range (T_{STG})	–55 to +100°C
Junction Temperature (T_J)	+100°C
Forward Current (I_F)	30 mA
Surge Current (I_{FM}) t≤10 µs D=0.005	0.5 A
Reverse Voltage (V_R)	5 V
Power Dissipation (P_{TOT})	100 mW
Thermal Resistance, Junction Air, Mounted on PC Board pad size 16 mm² (1) (R_{THJA})	450 K/W
Junction Solderpoint (R_{THJS})	350 K/W

Note: PC board G30/FR4

The stated maximum ratings refer to the specified chip, regardless of the other one's operating status.

With simultaneous operation of both diodes of two-color of two-color LEDs the sum of the currents as well as the power dissipation must not exceed the specified limits.

LOP/**Characteristics** (T_A=25°C) All values typical unless otherwise noted

Parameter		Symbol	Values					Unit
			Super-red	Orange	Green	Pure-Green	Yellow	
Peak Wavelength (I_F=10 mA)		λ_{PEAK}	635	610	565	557	586	nm
Dominant Wavelength (I_F=10 mA)		λ_{DOM}	628	605	570	560	590	nm
Spectral Bandwidth (50% I_{RELMAX}) (I_F=10 mA)		$\Delta\lambda$	45	40	25	22	45	nm
Viewing Angle, 50%, I_V		2φ	120					Deg.
Forward Voltage (I_F=10 mA)	Typ.	V_F	2.0					V
	Max		2.6					
Reverse Current (V_R=5 V)	Typ.	I_R	0.01					µA
	Max		10					
Capacitance (V_R=0 V, f=1 MHz)		C_0	12	8	15	15	10	pF
Switching times (I_F=100 mA) (t_P=10 µs, R_L=50 Ω)	I_V, 10%–90%	t_R	300	450	450	450	300	ns
	I_V, 90%–10%	t_F	150	200	200	200	150	

Luminous Intensity Ratio in One Packaging Unit $I_{VMAX}/I_{VMIN} \geq 2$[1]
Luminous Intensity Ratio in One LED I_{VMAX}/I_{VMIN} ≤3.0 (LSGT670, LOGT670, LSYT670)
≤4.0 (LSPT670, LOPT670, LYPT670)

Typ	Light Emitting Color	Luminous Intensity I_F=10 mA, I_V (mcd) Min.	Max.
LSG/LOGT670-HK	Super-red/Green	2.5	12.5
LSG/LOGT670-J	Orange/Green	4	8
LSG/LOGT670-K		6.3	12.5
LSG/LOGT670-JL		4	20
LOP/LSP/LYPT670-FJ	Super-red/Pure Green	1	8
LOP/LSP/LYPT670-G	Yellow/Pure Green	1.6	3.2
LOP/LSP/LYPT670-H		2.5	5
LOP/LSP/LYPT670-GK		1.6	12.5
LSYT670-HO	Super-red/Yellow	≥2.5	

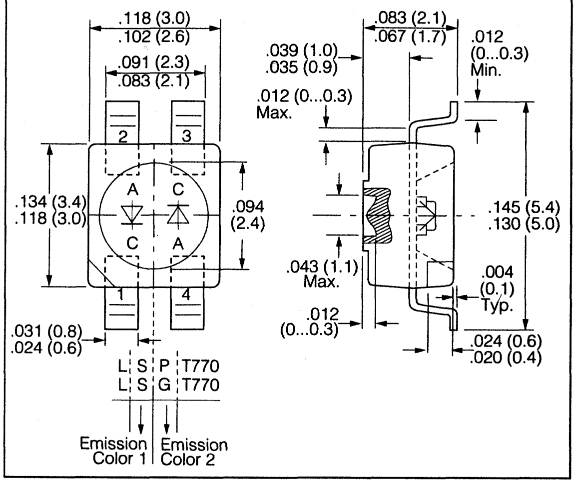
Note: In case of MULTILED®, the brightness of the darker chip in one package determines the brightness group of the LED.

SIEMENS

SUPER-RED/GREEN LSGT770
SMT-MULTILED®
REVERSE GULLWING

FEATURES
- **P-LCC-4 Package**
- **White Package**
- **Optical Indicator**
- **Ideal for Backlighting, Optical Coupling into Light Pipes and Lenses**
- **Both Chips can be Controlled Separately**
- **High Signal Efficiency Possible by Color Change of the LED**
- **With Appropriate Controlling it is Possible to Change Color from Green to Yellow and Orange to Super-red**
- **Colorless Clear Window**
- **Suitable for all SMT Assembly Solder Processes**
- **Available on Tape and Reel (12 mm Tape)**
- **Load Dump Resistant acc. to DIN 40839**

Package Dimensions in Inches (mm)



Note: PC board G30/FR4
Soldered on PC board—pad size 16 mm^2.
The stated maximum ratings refer to the specified chip, regardless of the other one's operating status.
With simultaneous operation of both diodes of two-color of two-color LEDs the sum of the currents as well as the power dissipation must not exceed the specified limits.

See graph numbers 1, 2V, 3D, 4I, 5G, 6G, 7A, 8A, 9A, 10A in the back of this section.

Maximum Ratings
Operating Temperature Range (T_{OP}) .... –55 to +100°C
Storage Temperature Range (T_{STG}) .... –55 to +100°C
Junction Temperature (T_J) .... +100°C
Forward Current (I_F) .... 30 mA
Surge Current (I_{FM}) t≤10 µs D=0.005 .... 0.5 A
Reverse Voltage (V_R) .... 5 V
Power Dissipation (P_{TOT}) .... 100 mW
Thermal Resistance, Junction Air[1] R_{THJA} .... 450 K/W
R_{THJS} ....350 K/W

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter		Symbol	Values Super-red	Values Green	Unit
Peak Wavelength (I_F=10 mA)		λ_{PEAK}	635	565	nm
Dominant Wavelength (I_F=10 mA)		λ_{DOM}	628	570	nm
Spectral Bandwidth (50% I_{RELMAX}) (I_F=10 mA)		$\Delta\lambda$	45	25	nm
Viewing Angle, 50%, I_V		2φ	120	120	Deg
Forward Voltage (I_F=10 mA)	Typ	V_F	2.0	2.0	V
	Max		2.6	2.6	
Reverse Current (V_R=5 V)	Typ	I_R	0.01	0.01	µA
	Max		10	10	
Capacitance (V_R=0 V, f=1 MHz)		C_0	12	15	pF
Switching times (I_F=100 mA) (tP=10 µs, R_L=50 Ω)	I_V, 10%–90%	t_R	300	450	ns
	I_V, 90%–10%	t_F	150	200	

Luminous Intensity Ratio in One Packaging Unit $I_{VMAX}/I_{VMIN} \geq 2.0$[1]
Luminous Intensity Ratio in One LED $I_{VMAX}/I_{VMIN} \leq 3.0$

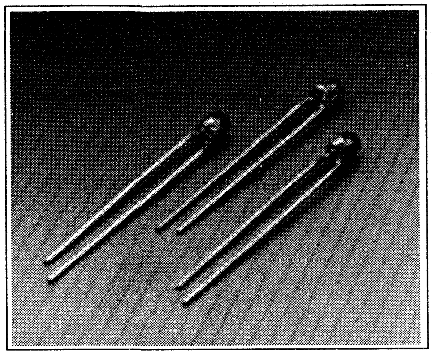
Types	Light Emiting Color	Luminous Intensity I_F=10 mA, I_V (mcd) Min.	Max.
LSGT770-HK	Super-red/ Green	2.5	12.5
LSGT770-J		4	8
LSGT770-K		6.3	12.5
LSGT770-JL		4	20

Note: In case of MULTILED®, the brightness of the darker chip in one package determines the brightness group of the LED.

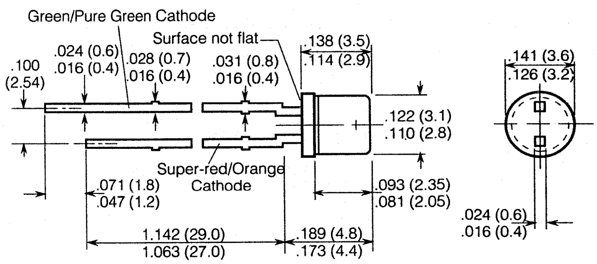
SIEMENS

SUPER-RED LS K380
ORANGE LO K380
YELLOW LY K380
GREEN LG K380
PURE GREEN LP K380

T1 (3mm) ARGUS LED Lamp



Package Dimensions in Inches (mm)



FEATURES

- **Colors: Super-Red, Orange, Yellow, Green, Pure Green**
- **Lens: Tinted Transparent**
- **Low Power Dissipation**
- **Low Self-Heating**
- **Rugged Design**
- **Applications–Backlighting Display Panels**
  - **– Front Panels**
  - **– Graphic Control and Displays Boards**
  - **– Sealed Keyboards**

DESCRIPTION

ARGUS lamps can be used only with an additional, customer supplied reflector (i.e., white plastic, such as Pocan B7375). The front end of the reflector is covered by a diffuser (see package dimensions). Uniform illumination can be enhanced by the reflector design tailored to the LED and/or by the use of appropriate diffuser material. If the diffuser is tinted, the spectral transmission must be adjusted to the wavelength emitted by the LED.

Maximum Ratings

Operating and Storage Temperature
Range (T_A, T_{STG}) .... –55°C to + 100°C
Junction Temperature (T_J) . ... + 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 40 mA
Surge Current (I_{FM}) t_P <10 µs .... 0.5 A
Total Power Dissipation (P_{TOT}) T_A=25°C ... 140 mW
Thermal Resistance
Junction to Air (R_{THJA}) .... 400 K/W

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter	Sym	Super-Red	Orange	Yellow	Green	Pure Green	Unit
Wavelength at Peak Emission (I_F=20 mA)	λ_{PEAK}	635	610	586	565	557	nm
Dominant Wavelength	λ_{DOM}	628.	605	590	570	560	nm
Spectral Bandwidth 50% Φ_V (I_F=20 mA)	$\Delta\lambda$	45	40	45	25	22	nm
Forward Voltage (I_F=15 mA)	V_F	2.1 (≤2.6)	2.1 (≤2.6)	2.1 (≤2.6)	2.1 (≤2.6)	2.1 (≤2.6)	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤10)	0.01 (≤10)	0.01 (≤10)	0.01 (≤10)	0.01 (≤10)	µA
Capacitance (V_R=0V, f=1 MHz)	C_0	12	8	10	15	15	pF
Switching Times (I_F=100 mA, t_P=10 µs)							
Rise Time, 10% to 90%	t_R	200	300	300	450	450	ns
Fall Time, 90% to 10%	t_F	150	150	150	200	200	ns

Luminous Flux*

Part Number	Φ_V (mlm) Min.	I_F=15 mA Max.	Part Number	Φ_V (mlm) Min.	I_F=15 mA Max.
LS K380-LP	10	80	LY K380-LP	10	80
LS K380-N	25	50	LY K380-N	25	50
LS K380-P	40	80	LY K 380-P	40	80
LS K380-NR	25	200	LY K380-NR	25	200
LO K380-LP	10	80	LG K380-LP	10	80
LO K380-N	25	50	LG K380-N	25	50
LO K380-P	40	80	LG K380-P	40	80
LO K380-NR	25	200	LG K380-NR	25	200
LP K380-KO	10	63 typ.			

* Luminous flux ratio of one packaging unit I_{VMAX}/I_{VMIN} ≤2

See graph numbers 1, 2N, 3E, 4H, 5A, 6A, 7A, 8A, 9C, 10D in the back of this section.

Back Lighting Using ARGUS LEDs

Siemens developed ARGUS® LEDs for applications requiring uniform light over large areas. Their light emission covers a fairly large solid angle versus conventional LEDs which concentrate their radiation in the axial direction.

Construction

ARGUS diodes are fabricated on the same production line and with the same design concepts as Siemens standard LEDs. The difference between the two is the radiation characteristic. The radiation from standard LEDs is focused in the axial direction (Fig. 1a). The chip is mounted into a reflector cup. The leadframe is placed into a mold and the body is formed with a spherical lens.

The ARGUS LED, however, is designed to produce light over an enlarged viewing angle (Fig. 1b). This is done by eliminating the reflector cup and molding a concave shaped lens into the body instead of the normal spherical type. To avoid hot spots within the illuminated area, the light emitted in the axial direction is reduced to about 20% of the maximum luminous intensity.

Applications and Benefits of ARGUS LEDs

The full benefit of ARGUS LEDs is achieved when used with an external reflector and diffuser. When properly configured, a large area of evenly distributed light is produced (1cm²/lamp) that can be used to back light symbols, characters, and LCD displays.

- No longer will designers of systems such as dashboard instrumentation and car radios have to provide access for replacing incandescent bulbs. With extended warranties being offered by most auto makers, the labor cost to replace an incandescent bulb makes the ARGUS LED a cost effective alternative.
- With its ability to evenly illuminate a large area and its low heat generation, ARGUS LEDs provide an excellent source of light for LCD displays.
- ARGUS' compact size, large light area, low heat generation and reliability make it an ideal choice for illuminated switches instead of incandescent bulbs.
- ARGUS LEDs can be supplied on tape and reel for auto-insertion, eliminating the need to hand insert odd shaped light bars for large area back lighting applications.
- Reflectors for ARGUS LEDs can be designed to have a height from the board that equals the height of most seven-segment displays, so that panels with mechanically matched components can be built.

ARGUS LEDs as Substitutes for Lamps

In many cases incandescent lamps are easily replaced directly by ARGUS LEDs, but for best results, an appropriately shaped reflector (Figure 2) with a high diffuse reflection characteristic (above 90%) should be used. Pocan B7375 and Pocan B7376 thermoplastics have been used successfully in many applications. Requirements differ for individual applications. For optimum results, reflectors and diffusers must be matched.

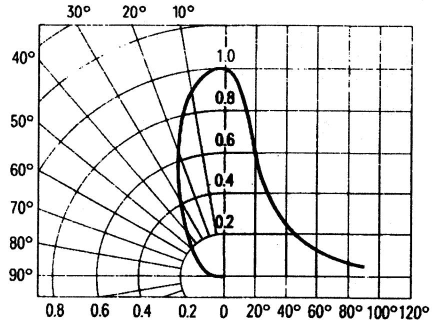
Lumens (lm) Versus Candela (cd)*

One major difference between the ARGUS LED standard LEDs is that the light output for ARGUS is measured in millilumens (mlm) while standard LEDs are measured in millicandela (mcd). The ARGUS is designed to use almost all of the light produced over a large area while standard LEDs have a focusing lens and for most applications is a point source.

* See Appnote 1, "LEDs and Photometry" for detailed information.

Figure 1. ARGUS LEDs emit their light over an enlarged solid angle. Both graphs show polar coordinates on the left and rectangular coordinates on the right. a) Standard LED–viewing angle b) ARGUS LED–radiation characteristic. Relative spatial emission vs. half angle.

a



b

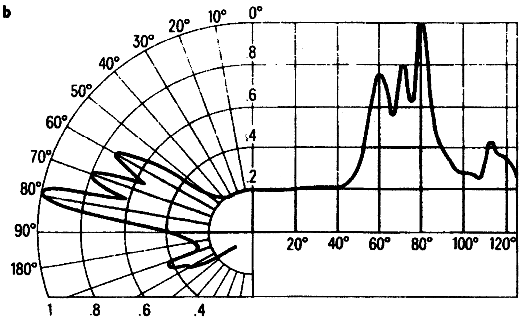
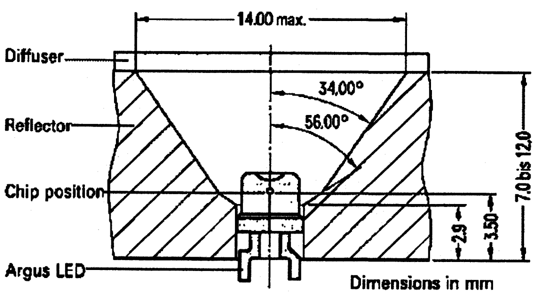


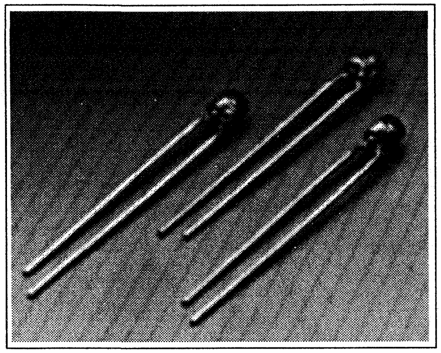
Figure 2. Section through a reflector with an ARGUS LED.



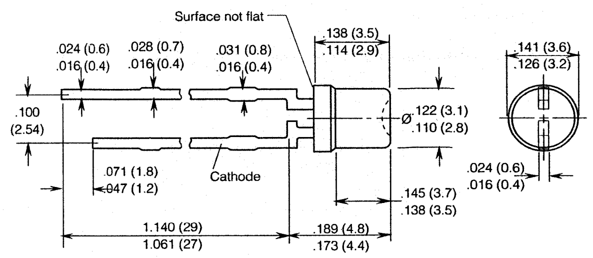
SIEMENS

SUPER-RED LS K382
YELLOW LY K382
GREEN LG K382
ORANGE LO K382
PURE GREEN LP K382

T1 (3mm) Super ARGUS LED Lamp



Package Dimensions in Inches (mm)



FEATURES

- **Colors: Super-Red, Yellow, Green, Orange, Pure Green**
- **Lens: Tinted Transparent**
- **High Luminous Flux**
- **Rugged Design**
- **Cathode: Shorter Lead**
- **Applications–Backlighting Display Panels**
  - **Front Panels**
  - **Graphic Control and Display Boards**
  - **Sealed Keyboards**

DESCRIPTION

The LS/LY/LG/LO/LP K382 are T1 (3 mm) Super ARGUS LED lamps. ARGUS lamps are used with an additional, custom-built reflector (i.e., white plastic, such as Pocan B7375). The front end of the reflector is covered by a diffuser (see illustration). Uniform illumination can be enhanced by the reflector design tailored to the LED and/or by the use of appropriate diffuser material.

Super ARGUS LEDs are designed to operate at 50 mA and provide as much as 10X luminous flux as standard ARGUS LEDs.

Note: Siemens does not supply the reflector or diffuser.

Maximum Ratings

Operating Temperature Range (T_A) .... –55°C to + 100°C
Storage Temperature Range (T_{STG}) .... –55°C to +100°C
Junction Temperature (T_J) .... + 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 75 mA
Surge Current (I_{FM}) .... 1 A
Total Power Dissipation (P_{TOT}) T_A=25°C .... 300 mW
Thermal Resistance Junction to Air (R_{THJA}) .... 250 K/W

Note: Mounted on PC board up to stand-off; pad size ≤16 mm^2.

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter	Symbol	Super-Red	Yellow	Green	Orange	Pure Green	Unit
Peak Wavelength (I_F=20 mA)	λ_{PEAK}	635	586	565	610	557	nm
Dominant Wavelength	λ_{DOM}	628.	590	570	605	560	nm
Spectral Bandwidth 50% Φ_v (I_F=20 mA)	$\Delta\lambda$	45	45	25	40	22	nm
Forward Voltage	V_F	2.4	2.4	2.4	2.4	2.5	V
(I_F=50 mA)		(≤3.8)	(≤3.8)	(≤3.8)	(≤3.8)	(≤3.8)	V
Reverse Current	I_R	0.01	0.01	0.01	0.01	0.01	
(V_R=5 V)		(≤10)	(≤10)	(≤10)	(≤10)	(≤10)	µA
Capacitance (V_R=0V, f=1 MHz)	C_0	55	30	55	40	120	pF
Luminous Flux* (I_F=50 mA)	Φ_V	160	160	160	160	100	
		(≥100)	(≥100)	(≥100)	(≥100)	(≥40)	mlm

* Luminous flux ratio in one packaging unit $\frac{\Phi_{V MAX}}{\Phi_{V MIN}} \leq 2$.

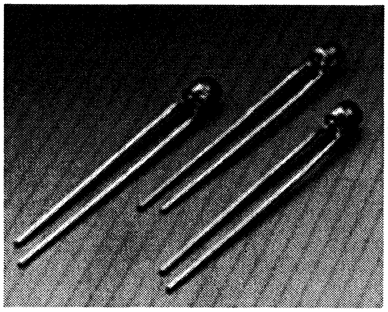
See selector guide for Luminous Intensity information.

See graph numbers 1, 2S, 3F, 4F, 5D, 6D, 7A, 8A, 9D in the back of this section.

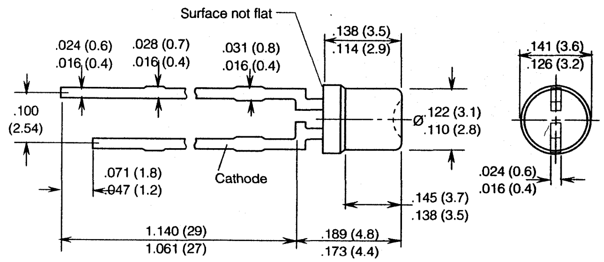
SIEMENS

SUPER-RED LS K389-FO
YELLOW LY K389-FO
GREEN LG K389-FO

T1 (3mm) ARGUS Low Current LED Lamp



Package Dimensions in Inches (mm)



FEATURES

- **Colors: Super-Red, Yellow, Green**
- **Lens: Tinted Transparent**
- **Direct Drive is Possible by Means of CMOS Microprocessor, Gate and LSTTL Components**
- **Prolonged Service Life of Batteries in Mobile Equipment**
- **Low Power Dissipation in the Driving Circuitry as well as in the LED**
- **Suitable for Multiplex Operation**
- **Cathode: Shorter Solder Tab**

DESCRIPTION

The LS/LY/LG K389-FO are T1 (3 mm) ARGUS LED lamps. ARGUS lamps can be used only with an additional, customer supplied reflector (i.e., white plastic, such as Pocan B7375). The front end of the reflector is covered by a diffuser (see package dimensions). Uniform illumination can be enhanced by the reflector design tailored to the LED and/or by the use of appropriate diffuser material. If the diffuser is tinted, the spectral transmission must be adjusted to the wavelength emitted by the LED.

Applications include backlighting of display panels, e.g. front panels, graphic control and display boards, sealed keyboards, large-scale displays, dot matrix displays.

See graph numbers 1, 2N, 3B, 4D, 5C, 6C, 7A, 8A, 9B, 10A in the back of this section.

Maximum Ratings

Operating Temperature Range (T_A) .... –55°C to +100°C
Storage Temperature Range (T_{STG}) .... –55°C to +100°C
Junction Temperature (T_J) .... +100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 7.5 mA
Surge Current (I_{FM}) t_P=10 µs .... 150 mA
Total Power Dissipation (P_{TOT}) T_A=25°C .... 20 mW
Thermal Resistance: Junction/Air (R_{THJA}) .... 750 K/W

Note: Soldered on PC board: pad size ≥16 mm².

Characteristics (T_A=25°C) All values typical unless otherwise noted

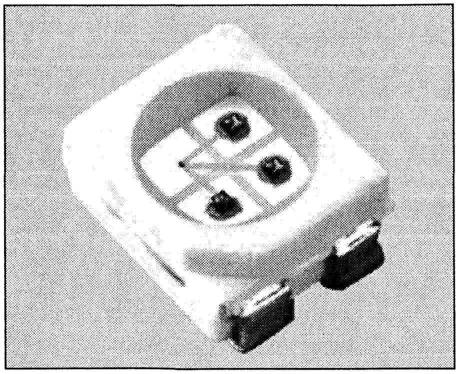
Parameter	Sym	LS K389-FO Super-Red	LY K389-FO Yellow	LG K389-FO Green	Unit
Peak Wavelength (I_F=2 mA) typ.	λ_{PEAK}	635	586	565	nm
Dominant Wavelength, typ.	λ_{DOM}	628	590	570	nm
Spectral Bandwidth at 50% ϕ_V (I_F=2 mA)	$\Delta\lambda$	45	45	25	nm
Forward Voltage (I_F=2 mA)	V_F	1.8 (≤2.6)	2.0 (≤2.7)	1.9 (≤2.6)	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤10)	0.01 (≤10)	0.01 (≤10)	µA
Capacitance (V_R=0 V, f=1 MHz)	C_0	3	3	15	pF
Switching Times (I_F=25 mA, t_P=1 µs)					
Rise Time from 10% to 90%	t_R	200	200	450	ns
Fall Time from 90% to 10%	t_F	150	150	200	ns
Luminous Flux * (I_F=2 mA)	ϕ_V	5 (≥1)	3.2 (≥1)	3.2 (≥1)	mlm

* Luminous flux ratio in one packaging unit $\phi_{VMAX}/\phi_{VMIN} \leq 2$.

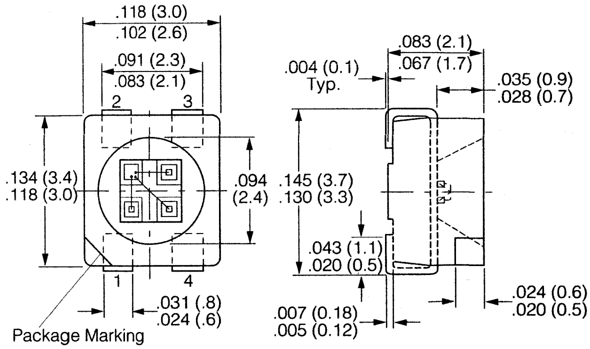
SIEMENS

LSPBT670

SUPER-RED/PURE GREEN/BLUE SMT-MULTILED®
Preliminary Data



Package Dimensions in Inches (mm)



Pinning:
1. Cathode Super-red
2. Anode Super-red, Pure Green, Blue
3. Cathode Blue
4. Cathode Pure Green

FEATURES

- **P-LCC-4 Package**
- **White Package**
- **Complete Color Spectrum: Blue-green-red-purple-white**
- **Three separate Light Sources (Dies) Blue (480 nm), Green (560 nm), Red (630 nm)**
- **Excellent Color Mixture Due to Small Distances Between the Dies (0.5 mm) and a Common Reflector ∅ of 2.4 mm**
- **Suitable for Matrix-Displays with High Packing Density and High Resolution (Pixel Graphic), Respectively**
- **Ideal for Backlighting, Optical Coupling into Light Pipes and Lenses**
- **High Signal Efficiency Possible by Color Change of the LED**
- **Colorimeter**
- **Medical Analysis**
- **High Signal Ratio Possible by Color Change**
- **Suitable for all SMT Placement and Solder Processes**
- **Available on Tape and Reel (8 mm Tape)**
- **Load Dump Resistant (acc. to DIN 40839)**

Maximum Ratings

Operating Temperature Range (T_{OP})	–55 to +100°C
Storage Temperature Range (T_{STG})	–55 to +100°C
Junction Temperature (T_J)	+100°C
Forward Current(1) (I_F)	
LS	30 mA
LP	30 mA
LB	50 mA
Forward Current(2) (I_F)	
LS	7.5 mA
LP	15 mA
LB	50 mA
Reverse Voltage (V_R)	5 V
Power Dissipation (P_{TOT})	250 mW
Thermal Resistance, Junction Air(1)	
R_{THJA} LS, LP	450 K/W
LB	400 K/W

Note: Soldered on PC board—pad size 16 mm^2.

(1) The stated maximum ratings refer to one die with the others turned off.

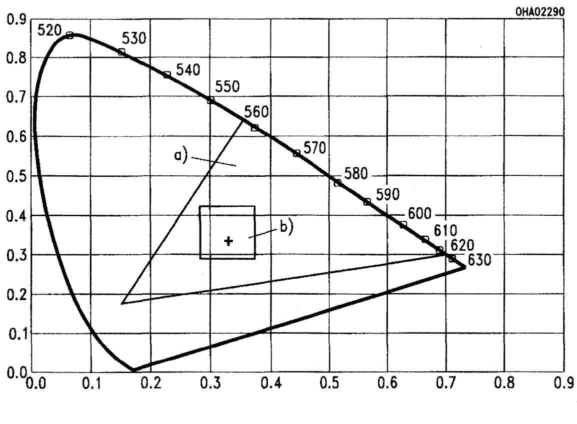
(2) The stated maximum ratings refer to all dies turned on.

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter			Symbol	Values Super-red	Pure Green	Blue	Unit
Peak Wavelength (I_F=10 mA)			λ_{PEAK}	635	557	467	nm
Dominant Wavelength (I_F=10 mA)			λ_{DOM}	628	560	590	
Spectral Bandwidth (50% I_{RELMAX}) (I_F=10 mA)			$\Delta\lambda$	45	22	75	
Visual Efficiency	(I_F=2 mA)		η_V	130	–	–	lm/W
	(I_F=10 mA)			–	625	–	
	(I_F=50 mA)			–	–	165	
Viewing Angle, 50%, I_V			2φ	120	120	120	Deg.
Forward Voltage	(I_F=2 mA)	Typ.	V_F	1.8	–	–	V
		Max		2.4	–	–	
	(I_F=10mA)	Typ.	V_F	–	2.0	–	V
		Max		–	2.6		
	(I_F=50 mA)	Typ.	V_F	–	–	4.1	V
		Max		–	–	5.0	
Reverse Current (V_R=5 V)		Typ.	I_R	0.01	0.01	0.01	µA
		Max		10	10	10	
Capacitance (V_R=0 V, f=1 MHz)			C_0	12	15	50	pF

Type	Light Emitting Color	Forward Current I_F mA	Radiant Intensity I_E µW/sr	Luminous Intensity I_V (mcd)
LSPBT670	Super-red/ Pure Green/ Blue	2 10 50	5.5 (2.5) 4.0 (2.0) 4.0 (2.0)	0.7 2.5 0.6

Note: In case of MULTILED®, the brightness of the darker chip in one package determines the brightness group of the LED.



Additive mixture of color stimuli by random driving of each chip.

The color coordinates of the mixed light can be expected within the area of the color triangle marked a).

The Achromatic point (x=0.33) is marked "+".

With LED operating currents of:

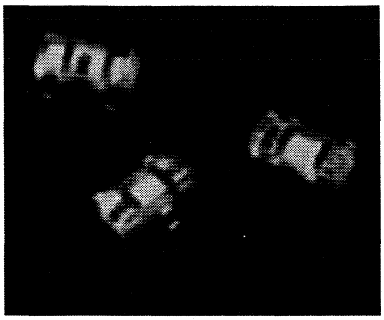
Super-red	2 mA
Pure Green	10 mA
Blue	50 mA

the color coordinates of the emitted light can be expected in the area of the color triangle (s=0.275–0.37; y=0.295–0.42) marked b)

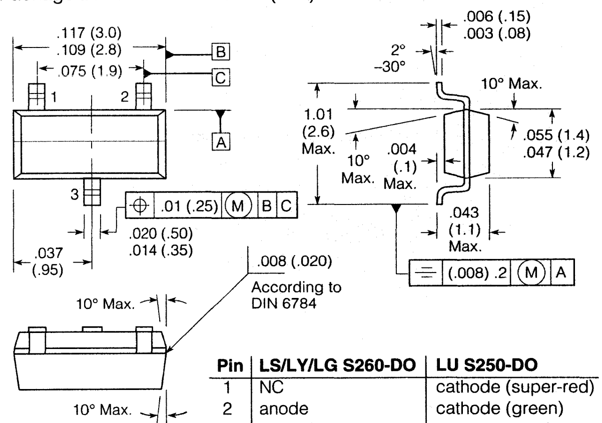
SIEMENS

SUPER-RED LS S260-DO
YELLOW LY S260-DO
GREEN LG S260-DO
SUPER-RED/GREEN LU S250-DO

SOT23 Surface Mount LED Lamp



Package Dimensions in Inches (mm)



Pin	LS/LY/LG S260-DO	LU S250-DO
1	NC	cathode (super-red)
2	anode	cathode (green)
3	cathode	common anode

FEATURES

- **Colors:**
  Super-Red, LS S260-DO
  Yellow, LY S260-DO
  Green, LG S260-DO
  Super-Red/Green, LU S250-DO
- **Rectangular Package, 1.3 mm by 3 mm by 1 mm thick**
- **Wide Viewing Angle 140°**
- **Ideal for Use as Failure Indicators Mounted on Printed Circuit Boards**
- **IC Compatible**

DESCRIPTION

The SOT23 LED is available in super-red, green, and yellow package. Supplied on 8 mm wide reels with 3,000 components per reel, the packaging conforms to IEC standards and can be used on all commercial automatic surface mount insertion equipment. Standard reels are 18 cm in diameter, however, special 38 cm reels with 10,000 components per reel are available.

For 3,000 pieces per reel option add suffix E7502 to the part number. For 10,000 pieces per reel option, add E7503 to the part number.

See graphs number 1, 2M, 3A, 4A, 5G, 6G, 7A, 8A, 9A, 10A in the back of this section.

Maximum Ratings (All Devices)

(For LU S250: the following operating conditions apply when one diode is on while the other diode is off)

Operating Temperature Range (T_{OP})	–55°C to +100°C
Storage Temperature Range (T_{STG})	–55°C to +100°C
Junction Temperature (T_J)	100°C
Reverse Voltage (V_R)	5 V
Forward Current (I_F)	30 mA
Surge Current (I_{FS}) t=10 µs	0.5 A
Power Dissipation (P_{TOT})	100 mW
Thermal Resistance Junction to Air T_A (R_{THJV}) (1)	750 K/W

Notes: 1. Soldered on PC board: pad size ≥16 mm².
2. With simultaneous operation of both diodes of two-color LEDs, the sum of the currents as well as the power dissipation must not exceed the specified limits.

Characteristics (T_A=25°C) **All values typical unless otherwise noted.**

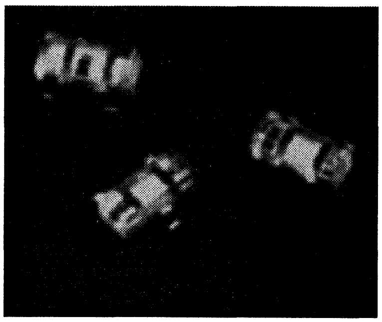
Parameter	Sym	Super-Red	Yellow	Green	Unit
Wavelength of Emitted Light (I_F=20 mA)	λ_{PEAK}	635	586	565	nm
Dominant Wavelength (I_F=20 mA)	λ_{DOM}	628	590	570	nm
Spectral Bandwidth (50% I_{RELMAX}, I_F=20 mA)	$\Delta\lambda$	45	45	25	nm
Viewing Angle (50%,I_V)	2φ	140	140	140	Deg.
Forward Voltage (I_F=10 mA)	V_F	2.0 (≤2.6)	2.0 (≤2.6)	2.0 (≤2.6)	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤10)	0.01 (≤10)	0.01 (≤10)	µA
Capacitance (V_R=0 V, f=1 MHz)	C_0	12	10	15	pF
Switching Time					
I_V, 10% to 90%	t_R	300	300	450	µs
I_V, 90% to 10%	t_F	150	150	200	µs
Luminous Intensity* (I_F=10 mA)	I_V	1.0 (≥0.4)	1.0 (≥0.4)	1.0 (≥0.4)	mcd

* Luminous intensity ratio of one packaging unit I_{VMAX}/I_{VMIN} ≤2.

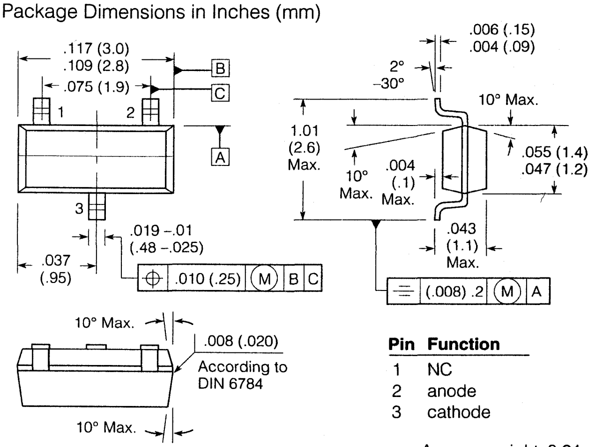
SIEMENS

SUPER-RED LS S269-BO
YELLOW LY S269-BO
GREEN LG S269-BO

SOT23 Low Current Surface Mount LED Lamp



Package Dimensions in Inches (mm)



Pin	Function
1	NC
2	anode
3	cathode

Approx. weight 0.01 g

FEATURES

- **Lens: Colored Diffused**
- **Can Be Directly Driven by CMOS Microprocessors, Gate and LSTTL Components**
- **Prolongs Service Life of Batteries in Mobile Equipment**
- **Low Power Dissipation**

DESCRIPTION

The LS/LY/LG S269-BO are low current, plastic SOT23 surface mountable LED lamps. They are available in three colors: LS S269-BO: super-red, LY S269-BO: yellow, LG S269-BO: green.

These SOT23 LEDs are supplied only on tape and reel. Standard reels are 18 cm in diameter with tape width of 8 mm and 3,000 pieces per reel. Special 38 cm reels with 10,000 pieces per reel are also available.

To order reels with 3,000 pieces, add suffix E7502 to the part number. To order reels with 10,000 pieces, add suffix E7503 to the part number.

See graph numbers 1, 2M, 3B, 4D, 5C, 6C, 7A, 8A, 9B, 10A in the back of this section.

Maximum Ratings

Operating Temperature (T_{OP})	–55°C to +100°C
Storage Temperature (T_{STG})	–55°C to +100°C
Junction Temperature (T_J)	+100°C
Reverse Voltage (V_R)	5 V
Forward Current (I_F)	7.5 mA
Surge Current (I_{FS}) $t \leq 10$ µs, $D \leq 0.005$	150 mA
Power Dissipation (P_{TOT}) T_A=25°C	20 mW
Thermal Resistance: Junction/Air (R_{THJA})(1)	750 K/W

Note: 1. Soldered on PC board: pad size ≥16 mm².

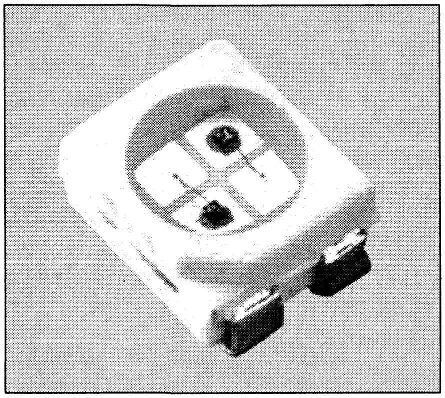
Characteristics (T_A=25°C) Values are typical unless otherwise noted

Parameter	Sym	LS S269-BO Super-Red	LY S269-BO Yellow	LG S269-BO Green	Unit
Wavelength, Emitted Light (I_F=7.5 mA)	λ_{PEAK}	635	586	565	nm
Dominant Wavelength (I_F=7.5 mA)	λ_{DOM}	628	590	570	nm
Spectral Bandwidth (50%, I_{RELMAX}, I_F=7.5 mA)	$\Delta\lambda$	45	45	25	nm
Viewing Angle, 50% I_V	2φ	140	140	140	Deg.
Forward Voltage (I_F=2 mA)	V_F	1.8 (≤2.6)	2.0 (≤2.7)	1.9 (≤2.6)	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤10)	0.01 (≤10)	0.01 (≤10)	µA
Switching Times (I_F=100 mA, t_P=10 µs R_L=50 Ω)					
I_V from 10% to 90%	t_R	200	200	450	ns
I_V from 90% to 10%	t_F	150	150	200	ns
Capacitance (V_R=0 V, f=1 MHz)	C_O	3	3	15	pF
Luminous Intensity (I_F=2 mA)	I_V	≥ 0.16	≥ 0.16	≥ 0.16	mcd

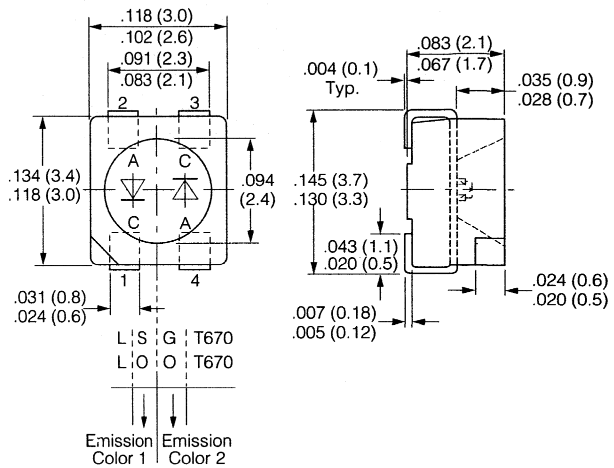
* Luminous intensity ratio of one packaging unit $I_{VMAX}/I_{VMIN} \leq 2$.

SIEMENS

SUPER-RED/SUPER-RED LSST670
ORANGE/ORANGE LOOT670
YELLOW/YELLOW LYYT670
GREEN/GREEN LGGT670
PURE GREEN/PURE GREEN LPPT670
BLUE/BLUE LBBT670
SMT-MULTILED®
Preliminary Data



Package Dimensions in Inches (mm)



FEATURES

- P-LCC-2 Package
- White Package
- Optical Indicator
- Both Chips can be Controlled Separately
- Ideal for Backlighting, Optical Coupling into Light Pipes and Lenses
- Colorless Clear Window
- Suitable for all SMT Assembly and Solder Processes
- Available on Tape and Reel (8 mm Tape)
- Load Dump Resistant acc. to DIN 40839

See graph numbers 1, 2V, 3D, 4I, 5G, 6G, 7A, 8A, 9A, 10A in the back of this section.

Maximum Ratings

Operating Temperature Range (T_{OP}) .... –55 to +100°C
Storage Temperature Range (T_{STG}) .... –55 to +100°C
Junction Temperature (T_J) .... +100°C
Forward Current (I_F) .... 30 mA
Surge Current (I_{FM}) t≤10 µs D=0.005 .... 0.5 A
Reverse Voltage (V_R) .... 5 V
Power Dissipation (P_{TOT}) .... 100 mW
Thermal Resistance, Junction Air,
Mounted on PC Board (pad size 16 mm^2 (1)
(R_{THJA}) .... 450 K/W
Junction Solderpoint (R_{THJS}) .... 350 K/W

Note: PC board G30/FR4

The stated maximum ratings refer to the specified chip, regardless of the other one's operating status.

With simultaneous operation of both diodes of two-color of two-color LEDs the sum of the currents as well as the power dissipation must not exceed the specified limits.

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter		Symbol	Values						Unit
			Super Red	Orange	Yellow	Green	Pure-Green	Blue	
Peak Wavelength (I_F=10 mA)		λ_{PEAK}	635	610	586	565	557	467	nm
Dominant Wavelength (I_F=10 mA)		λ_{DOM}	628	605	590	570	560	480	nm
Spectral Bandwidth (50% I_{RELMAX}) (I_F=10 mA)		$\Delta\lambda$	45	40	45	25	22	75	nm
Viewing Angle, 50%, I_V		2φ	120	120	120	120	120	120	Deg.
Forward Voltage (I_F=10 mA)	Typ.	V_F	2.0	2.4	2.4	2.6	2.6	3.1	V
	Max		3.8	3.8	3.8	3.8	3.8	4.5	
Reverse Current (V_R=5 V)	Typ.	I_R	0.01	0.01	0.01	0.01	0.01	0.01	µA
	Max		10	10	10	10	10	10	
Capacitance (V_R=0 V, f=1 MHz)		C_0	40	35	35	60	80	50	pF
Switching times (I_F=100 mA) (t_P=10 µs, R_L=50 Ω)	I_V, 10%–90%	t_R	350	500	350	500	500	–	ns
	I_V, 90%–10%	t_F	200	250	200	250	250	–	

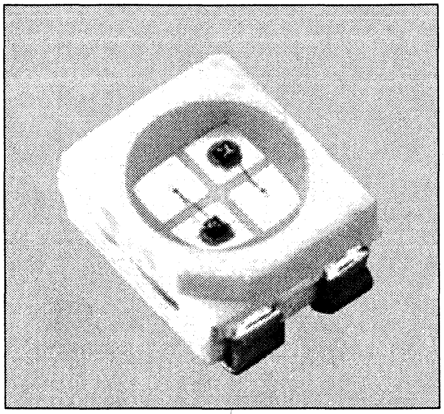
Luminous Intensity Ratio in One Packaging Unit $I_{VMAX}/I_{VMIN} \geq 2.0^{(1)}$
Luminous Intensity Ratio in One LED $I_{VMAX}/I_{VMIN} \geq 2.0$

Type	Light Emitting Color	Luminous Intensity I_F=10 mA, I_V (mcd)
LSS, LOO, LYY, LGGT670-JO	Super-red/Super-red, Orange/Orange, Yellow/Yellow Green/Green	≥12.5
LPPT670-HO	Pure Green/Pure Green	≥6
LBBT670-CO	Blue/Blue	≥0.25

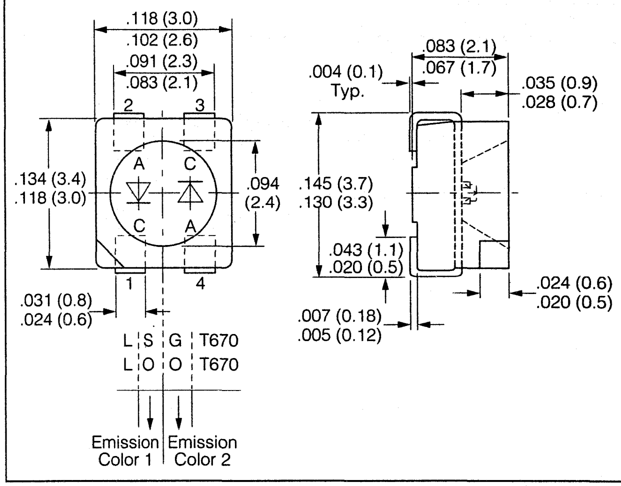
Note: In case of MULTILED® with two chips of the same color in one package, the sum of the brightness determines the brightness group of the LED.

SIEMENS

SUPER-RED/SUPER-RED LSST672
ORANGE/ORANGE LOOT672
YELLOW/YELLOW LYYT672
GREEN/GREEN LGGT672
PURE GREEN/PURE GREEN LPPT672
HIGH-CURRENT SUPER SMT-MULTILED®



Package Dimensions in Inches (mm)



FEATURES

- **P-LCC-4 Package**
- **White Package**
- **Optical Indicator**
- **Appropriate for High Ambient Light Because of the Higher Operation Current (≤50 mA DC)**
- **Ideal for Backlighting, Optical Coupling into Light Pipes and Lenses**
- **Both Chips Can be Controlled Separately**
- **Colorless Clear Window**
- **Suitable for all SMT Assembly and Solder Processes**
- **Available on Tape and Reel (8 mm Tape)**
- **Load Dump Resistant acc. to DIN 40839**

Maximum Ratings

Operating Temperature Range (T_{OP})................................–55 to +100°C
Storage Temperature Range (T_{STG})................................–55 to +100°C
Junction Temperature (T_J) ....+100°C
Forward Current (I_F)................................50 mA
Surge Current (I_{FM}) t≤10 µs D=0.005 ....1 A
Reverse Voltage (V_R) ....5 V
Power Dissipation (P_{TOT})................................190 mW
Thermal Resistance, Junction Air,
Mounted on PC Board(1) (pad size 16 mm²)
(R_{THJA}) ....350 K/W
Junction Solderpoint (R_{THJS})................................300 K/W

Note: PC board G30/FR4

The stated maximum ratings refer to the specified chip, regardless of the other one's operating status.

With simultaneous operation of both diodes of two-color LEDs the sum of the currents as well as the power dissipation must not exceed the specified limits.

See graph numbers 1, 2V, 3H, 4F, 5D, 6B, 7A, 8A, 9D, 10E in the back of this section.

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter		Symbol	Values					Unit
			Super-Red	Orange	Yellow	Green	Pure Green	
Peak Wavelength (I_F=10 mA)		λ_{PEAK}	635	610	586	565	557	nm
Dominant Wavelength (I_F=10 mA)		λ_{DOM}	628	605	590	570	560	nm
Spectral Bandwidth (50% I_{RELMAX}) (I_F=10mA)		$\Delta\lambda$	45	40	45	25	22	nm
Viewing Angle, 50%, I_V		2φ	120	120	120	120	120	Deg.
Forward Voltage (I_F=50 mA)	Typ.	V_F	2.0	2.4	2.4	2.6	2.6	V
	Max		3.8	3.8`	3.8	3.8	3.8	
Reverse Current (V_R=5 V)	Typ.	I_R	0.01	0.01	0.01	0.01	0.01	µA
	Max		10	10	10	10	10	
Capacitance (V_R=0 V, f=1 MHz)		C_0	40	35	35	60	80	pF
Switching times (I_F=100 mA) (t_P=10 µs, R_L=50 Ω)	I_V, 10%–90%	t_R	350	500	350	500	500	ns
	I_V, 90%–10%	t_F	200	250	200	250	250	

Luminous Intensity Ratio in One Packaging Unit $I_{VMAX}/I_{VMIN}\geq 2^{(1)}$
Luminous Intensity Ratio in One LED $I_{VMAX}/I_{VMIN}\geq 2$

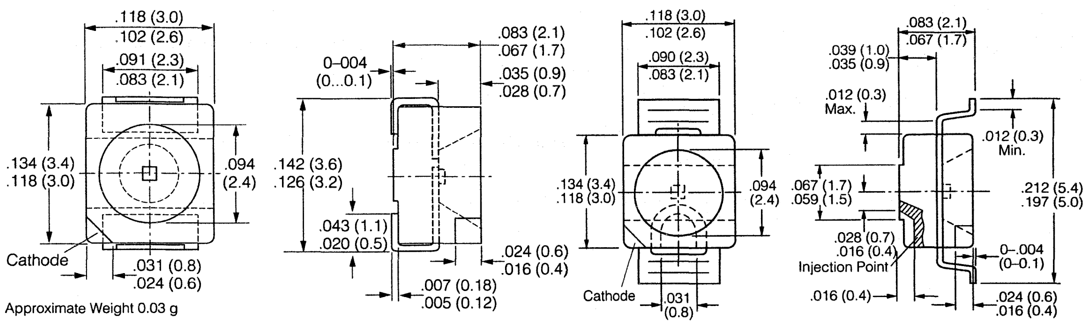
Type	Light Emitting Color	Luminous Intensity I_F=50 mA, I_V (mcd)	
		Min.	Max.
LSS, LOO, LYY, LGGT672-NO	Super-red/Super-red Orange/Orange Yellow/Yellow Green/Green	25	60
LPPT672-MO	Pure Green/Pure Green	16	40

Note: In case of MULTILED with two chips of the same emission wavelength, the sum of the brightness determines the brightness group of the LED.

SIEMENS

SUPER-RED LST670/770
ORANGE LOT670/770
YELLOW LYT670/770
GREEN LGT670/770
PURE GREEN LPT670/770
SMT-TOP-LED®

Package Dimensions in Inches (mm)



LS/LO/LY/LG/LPT670 **LS/LO/LY/LG/LPT770**

FEATURES

- **LXT770: Reverse Gullwing TOP-LED**
- **P-LCC-2 Package**
- **White Package**
- **Optical Indicator**
- **Ideal for Backlighting, Optical Coupling into Light Pipes and Lenses**
- **Colorless Clear Window**
- **Suitable for all SMT Solder Processes**
- **Available on Tape and Reel**
- **Load Dump Resistant acc. to DIN 40839**

Maximum Ratings

Operating Temperature Range (T_{OP}) .... –55 to +100°C
Storage Temperature Range (T_{STG}) .... –55 to +150°C
Junction Temperature (T_J) .... +100°C
Forward Current (I_F) .... 30 mA
Surge Current (I_{FS}) t≤10 µs, D=0.005 .... 0.5 A
Reverse Voltage (V_R) .... 5 V
Power Dissipation (P_{TOT}) T_A≤25°C .... 100 mW
Thermal Resistance, Junction Air,
Mounted on PC Board[1] (pad size 16 mm^2)
(R_{THJA}) .... 400 K/W
Junction Solderpoint (R_{THJS}) .... 300 K/W
Note: PC board G30/FR4

See graph numbers 1, 2V, 3D, 4I, 5G, 6G, 7A, 8A, 9A, 10A in the back of this section.

Characteristics (T_A=25°C) All values typical unless otherwise noted

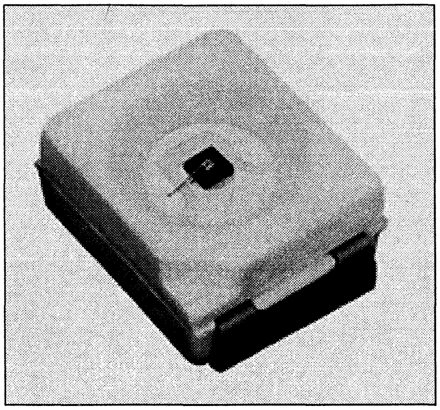
Parameter			Symbol	Values					Unit
				Super-red	**Orange**	**yellow**	**Green**	**Pure Green**	
Peak Wavelength (I_F=10 mA)			λ_{PEAK}	635	610	586	565	557	nm
Dominant Wavelength (I_F=10 mA)			λ_{DOM}	628	605	590	570	560	nm
Spectral Bandwidth (50% I_{RELMAX}) (I_F=10 mA)			$\Delta\lambda$	45	40	45	25	22	nm
Viewing Angle, 50%, I_V			2φ	120					Deg.
Forward Voltage (I_F=10 mA)		Typ.	V_F	2.0					V
		Max		2.6					
Reverse Current (V_R=5 V)		Typ.	I_R	0.01					µA
		Max		10					
Capacitance (V_R=0 V, f=1 MHz)			C_0	12	8	10	15	15	pF
Switching times (I_F=100 mA) (t_P=10 µs, R_L=50 Ω)	I_V, 10%–90%		t_R	300	300	300	450	450	ns
	I_V, 90%–10%		t_F	150	150	150	200	200	

Luminous Intensity Ratio in One Packaging Unit $I_{VMAX}/I_{VMIN} \geq 2.0$

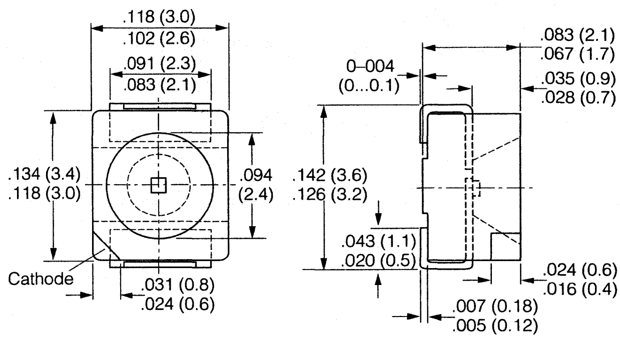
Type	Light Emitting Color	Luminous Intensity I_F=10 mA, I_V (mcd)	
		Min.	**Max.**
LS, LO, LGT670/T770-HK LS, LO, LGT670/T770-J LS, LO, LG T670/T770-K LS, LO, LG T670/T770-JL	Super-red, Orange, Green	2.5 4 6.3 4	12.5 8 12.5 20
LYT670/T770-HK LYT670/T770-H LYT670/T770-J LYT670/T770-JL	Yellow	2.5 2.5 4 4	12.5 5 8 20
LPT670/T770-FJ LPT670/T770-G LPT670/T770-H LPT670/T770-GK	Pure Green	1 1.6 2.5 1.6	8 3.2 5 12.5

SIEMENS

SUPER-RED LS T672
ORANGE LO T672
YELLOW LY T672
GREEN LG T672
PURE GREEN LP T672
HIGH-CURRENT SUPER SMT-TOP-LED®



Package Dimensions in Inches (mm)



FEATURES

- **White Package**
- **PL-CC-2 Package**
- **Internal Reflector**
- **Low Power Dissipation**
- **Wide Viewing Angle**
- **Suitable for Vapor-Phase Reflow, Infrared Reflow and Wave Solder Processes**
- **Compatible with Automatic Placement Equipment**
- **Optical Indicator**
- **Colorless Clear Window**
- **Appropriate for High Ambient Light Due to Higher Operating Current (≤50 mA DC)**
- **Ideal for Backlighting, Optical Coupling into Light Pipes and Lenses**
- **Load Dump Resistant acc. to DIN 40839**

See graph numbers 1, 2V, 3H, 4F, 5D, 6B, 7A, 8A, 9D, 10E in the back of this section.

DESCRIPTION

The LX T672 (Super-TOP-LED for surface mount applications) is available in super-red, orange, yellow, green, and pure green. The package incorporates an internal reflector to optimize light coupling. This feature makes the SMT-TOP-LED ideal for light pipe applications.

The large LED chip allows the part to be driven at a current of 50 mA for increased luminous intensity.

Maximum Ratings

Operating Temperature Range (T_{OP}	–55 to +100°C
Storage Temperature Range (T_{STG})	–55 to +100°C
Junction Temperature (T_J)	+100°C
Forward Current (I_F)	50 mA
Surge Current (I_{FM}) t≤10 µs D=0.005	1 A
Reverse Voltage (V_R)	5 V
Power Dissipation (P_{TOT}) T_A≤25°C	190 mW
Thermal Resistance, Junction Air, Mounted on PC Board, pad size 16 mm^2 (1) (R_{THJA})	300 K/W
Junction Solderpoint (R_{THJS})	250 K/W

Note: PC board G30/FR4

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter		Symbol	Values					Unit
			Super Red	Orange	Yellow	Green	Pure Green	
Peak Wavelength (I_F=10 mA)		λ_{PEAK}	635	610	586	565	557	nm
Dominant Wavelength (I_F=10 mA)		λ_{DOM}	628	605	590	570	560	nm
Spectral Bandwidth (50% I_{RELMAX}) (I_F=10mA)		$\Delta\lambda$	45	40	45	25	22	nm
Viewing Angle, 50%, I_V		2φ	120	120	120	120	120	Deg.
Forward Voltage (I_F=50 mA)	Typ.	V_F	2.0	2.4	2.4	2.6	2.6	V
	Max		3.8	3.8	3.8	3.8	3.8	
Reverse Current (V_R=5 V)	Typ.	I_R	0.01	0.01	0.01	0.01	0.01	µA
	Max		10	10	10	10	10	
Capacitance (V_R=0 V, f=1 MHz)		C_0	40	35	35	60	80	pF
Switching times (I_F=100 mA) (t_P=10 µs, R_L=50 Ω)	I_V, 10%–90%	t_R	350	500	350	500	500	ns
	I_V, 90%–10%	t_F	200	250	200	250	250	

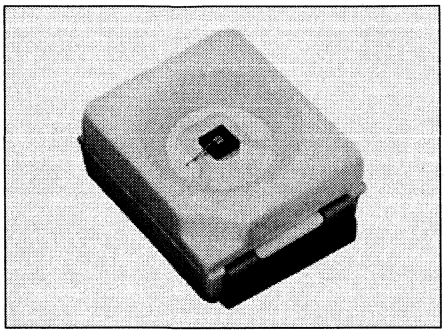
Luminous Intensity Ratio in One Packaging Unit $I_{VMAX}/I_{VMIN} \geq 2.0^{(1)}$

Type	Light Emitting Color	Luminous Intensity, I_F=50 mA, I_V (mcd)	
		Min.	Max.
LST672-LN	Super-red	10	50
LST672-M		16	32
LST672-N		25	50
LST672-MQ		16	125
LO,LY,LG T672-LN	Orange, Yellow, Green	10	50
LO,LY,LG T672-N		25	50
LO,LY,LG T672-P		40	80
LO,LY,LG T672-MQ		16	125
LPT672-KM	Pure Green	6.3	32
LPT672-L		10	20
LPT672-M		16	32
LPT672-LP		10	80

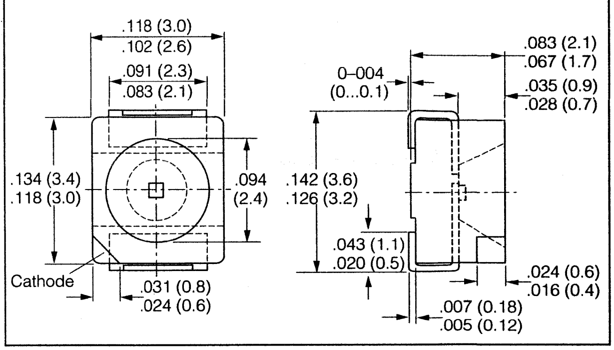
Note: In case of MULTILED® with two chips of the same emission wavelength, the sum of the brightness determines the brightness group of the LED.

SIEMENS

SUPER-RED LS T679
YELLOW LY T679
GREEN LG T679
LOW CURRENT SMT-TOP-LED®



Package Dimensions in Inches (mm)



FEATURES

- **PL-CC-2 Package**
- **White Package**
- **Optical Indicator**
- **Colorless Clear Window**
- **Ideal for Backlight and Light Pipe Applications**
- **Internal Reflector**
- **Low (2 mA) Current Operation**
- **Wide Viewing Angle**
- **Compatible with Automatic Placement Equipment**
- **Suitable for Vapor-Phase Reflow, Infrared Reflow and Wave Solder Processes**
- **Available on Tape and Reel (8 mm Tape)**
- **Load Dump Resistant acc. to DIN 40839**

DESCRIPTION

The LX T679-CO (SMT-TOP-LED for surface mount applications) is available in super-red, yellow, and green. The package incorporates an internal reflector to optimize light coupling. This feature makes the SMT-TOP-LED ideal for light pipe applications.

The low current requirement makes this part ideal for portable equipment or any other application where power is at a premium.

Maximum Ratings

Operating Temperature Range (T_{OP}) . –55 to +100°C
Storage Temperature Range (T_{STG}) ... –55 to +100°C
Junction Temperature (T_J) .... +100°C
Forward Current (I_F) .... 7.5 mA
Surge Current (I_{FM}) $t \leq 10$ µs D=0.005 .... 0.15 A
Reverse Voltage (V_R) .... 5 V
Power Dissipation (P_{TOT}) $T_A \leq 25$°C .... 20 mW
Thermal Resistance, Junction to Ambient(1) 500 K/W

Note:
1. Soldered on PC board: pad size ≥16 mm^2.

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter		Symbol	Values: Super Red	Values: Yel-low	Values: Green	Unit
Peak Wavelength (I_F=7.5 mA)		λ_{PEAK}	635	586	565	nm
Dominant Wavelength (I_F=7.5 mA)		λ_{DOM}	628	590	570	nm
Spectral Bandwidth (50% I_{RELMAX}) (I_F=7.5 mA)		$\Delta\lambda$	45	45	25	nm
Viewing Angle, 50%, I_V		2φ	120	120	120	Deg.
Forward Voltage (I_F=2 mA)	Typ.	V_F	1.8	2.0	1.9	V
	Max		2.6	2.7	2.6	
Reverse Current (V_R=5 V)	Typ.	I_R	0.01	0.01	0.01	µA
	Max		10	10	10	
Capacitance (V_R=0 V, f=1 MHz)		C_0	3	3	15	pF
Switching times (I_F=100 mA) (t_P=10 µs, R_L=50 Ω)						ns
I_V, 10%–90%		t_R	200	200	450	
I_V, 90%–10%		t_F	150	150	200	

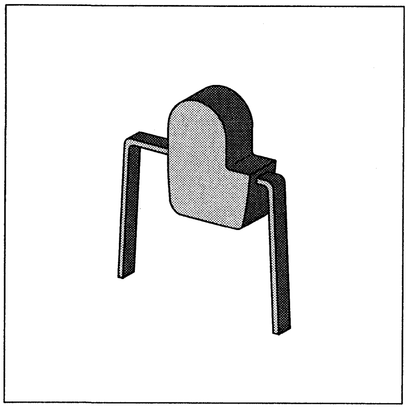
Luminous Intensity Ratio in One Packaging Unit $I_{VMAX}/I_{VMIN} \geq 2$

Type	Light Emitting Color	Luminous Intensity I_F=2 mA, I_V (mcd) Min.
LS T679-CO	Super-red	0.25
LY T679-CO	Yellow	
LG T679-CO	Green	

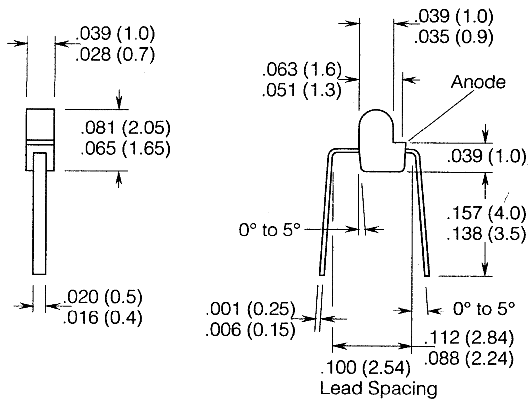
See graph numbers 1, 2V, 3B, 4D, 5C, 6C, 7A, 8A, 9B, 10A in the back of this section.

SIEMENS

SUPER-RED LS U260-EO
YELLOW LY U260-EO
GREEN LG U260-EO
Miniature LED Lamp



Package Dimensions in Inches (mm)



FEATURES
- **Diffused Lens**
- **Miniature Size, 1 mm Package**
- **0.100" (2.54 mm) Lead Spacing**
- **IC Compatible**

DESCRIPTION
The LS U260 super-red and LY U260 yellow are high efficiency lamps fabricated with TSN (transparent substrate nitrogen) technology. The LG U260 is a gallium phosphide (GaP) lamp.

See graph numbers 1, 2T, 3A, 4A, 5F, 6E, 7A, 8A, 9A, 10A in the back of this section.

Maximum Ratings
Operating Temperature Range (T_{OP}) .... −40°C to +80°C
Storage Temperature Range (T_{STG}) .... −40°C to +80°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 15 mA
Surge Current (I_{FS}) t=10 µs .... 0.35 A
Total Power Dissipation (P_{TOT}) T_A=25 °C .... 50 mW
Thermal Resistance Junction to Air (R_{THJA}) .... 1100 K/W

Characteristics (T_A=25°C) **All values typical unless otherwise noted**

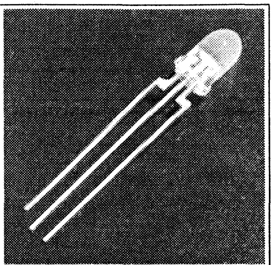
Parameter	Sym	LS U260 Super-Red	LY U260 Yellow	LG U260 Green	Unit
Peak Wavelength (I_F=20 mA)	λ_{PEAK}	635	586	565	nm
Dominant Wavelength (I_F=20 mA)	λ_{DOM}	628	590	570	nm
Spectral Bandwidth (50% I_{RELMAX}, I_F=20 mA)	$\Delta\lambda$	45	45	25	nm
Viewing Angle 50% I_V	2φ	60	60	60	Deg.
Forward Voltage (I_F=10 mA)	V_F	2.0(≤2.6)	2.0(≤2.6)	2.0(≤2.6)	V
Reverse Current (V_R=5 V)	I_R	0.01(≤10)	0.01(≤10)	0.01(≤10)	µA
Capacitance (V_R=0 V, f=1 MHz)	C_0	12	10	15	pF
Rise Time, I_V I_V from 10% to 90%	t_R	300	300	450	ns
Fall Time, I_V I_V from 90% to 10%	t_F	150	150	200	ns
Luminous Intensity* (I_F=10 mA)	I_V	≥0.63	≥0.63	≥0.63	mcd

* Luminous intensity ratio of one packaging unit I_{VMAX}/I_{VMIN} ≤2

SIEMENS

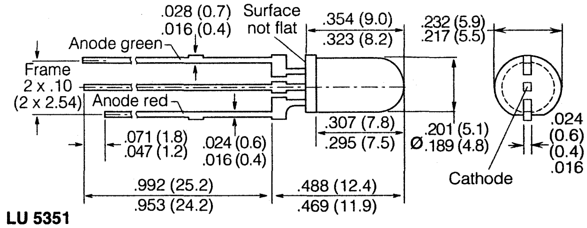
T1³/4 (5mm) LU 5351-GL/-JM
RECTANGULAR LU B371-EJ/-GK
CYLINDRICAL LU H371-EJ/-GK

Two Color Super Red and Green LED Lamp

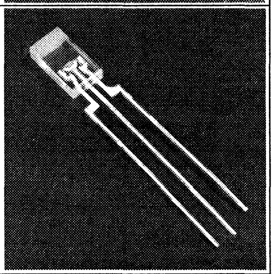


LU 5351

Package Dimensions in Inches (mm)

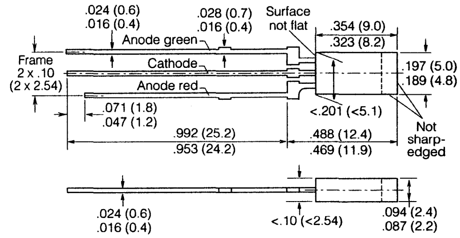


LU 5351

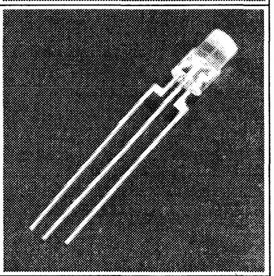


LU B371

Package Dimensions in Inches (mm)

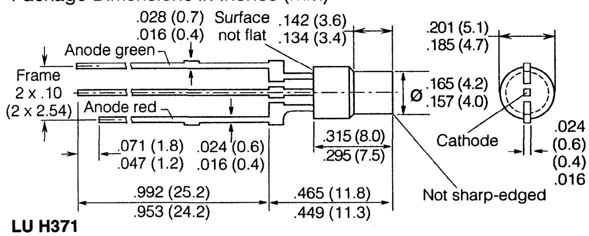


LU B371



LU H371

Package Dimensions in Inches (mm)



LU H371

FEATURES

- **LU 5351 – T13/4**
- **LU B371 – Rectangular**
- **LU H371 – Cylindrical**
- **Two Color Operation, Red and Green**
- **Lens: Colorless Partly Diffused**
- **Three Leads, Middle Lead Is Common Cathode**
- **Minimum Lead Length 1"**
- **0.100" Lead Spacing**

DESCRIPTION

These LED lamps have a colorless lens with a diffused surface. Two chips (green and super red) allow for use as an optical indicator with multiple functions.

See graph numbers 1, 2D (LU 5351), 2P (LU B371, LU H371), 3A, 4A, 5A, 6A, 7A, 8A, 9A, 10A in the back of this section.

Maximum Ratings

Forward Current* (I_F) .... 40 mA
Surge Current* (I_{FM}) t_P <10 µs .... 0.5 A
Operating Temperature Range (T_{OP}) .. −55°C to + 100°C
Storage Temperature Range (T_{STG}) ..... −55°C to +100°C
Junction Temperature (T_J) .... + 100°C
Reverse Voltage (V_R) .... 5 V
Total Power Dissipation* (P_{TOT}) T_A=25°C .... 140 mW
Thermal Resistance, Junction to Air (R_{THJA}) ...... 400 K/W

* The ratings indicated for the forward current I_F, the surge current I_{FS} or power dissipation P_{TOT}, respectively, are maximum ratings of the component. If both chips are operated simultaneously, the sum of the forward current ratings is not allowed to exceed the indicated maximum value.

Characteristics (T_A=25°C) All values typical unless otherwise noted

Parameter	Symbol	Super Red	Green	Unit
Wavelength of Emitted Light	λ_{PEAK}	635	565	nm
Dominant Wavelength	λ_{DOM}	628.	570	nm
Sprectral Bandwidth (50% I_{RELMAX}, I_F=20 mA)	$\Delta\lambda$	45	25	nm
Viewing Angle 50%				
LU 5351	φ	50	50	Deg.
LU B371, LUH371	φ	100	100	Deg.
Forward Voltage (I_F=10 mA)	V_F	2.0 (≤2.6)	2.0 (≤2.6)	V
Capacitance (V_R=0 V, f=1 MHz)	C_0	12	15	pF
Rise Time	t_R	300	450	ns
Fall Time	t_F	150	200	ns
Luminous Intensity* (I_F=10 mA)	Min.	Max.	Unit	
LU 5351-GL	1.6	20	mcd	
LU 5351-JM	4	32	mcd	
LU B371-FJ, LU H371-FJ	1	8	mcd	
LU B371-GK, LU H371-GK	1.6	12.5	mcd	

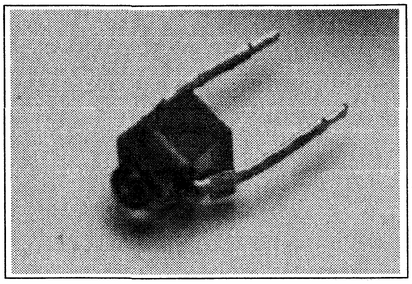
Notes

1. *Luminous intensity ratio of one LED:
   LU I5351-GL, LU B 371-FJ, LU H371-FJ: I_{VMAX}/I_{VMIN} ≤4
   LU I5351-JM, LU B 371-GK, LU H371-GK: I_{VMAX}/I_{VMIN} ≤2
2. Luminous intensity ratio of one packaging unit: I_{VMAX}/I_{VMIN} ≤2
3. The brightness of the darker chip in one package determines the brightness of the entire LED.

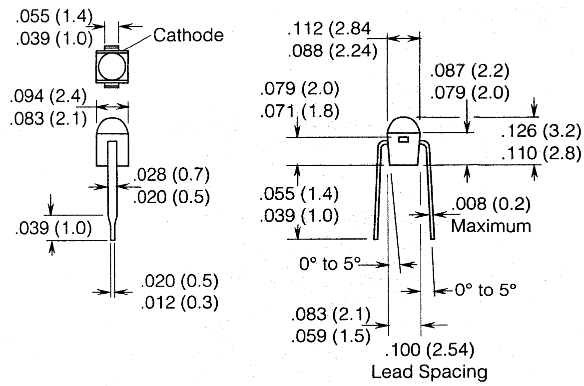
SIEMENS

LY Z181-CO

Yellow Miniature Single LED Lamp



Package Dimensions in Inches (mm)



FEATURES

- **Yellow Diffused Lens**
- **Miniature Size**
- **0.100" (2.54 mm) Lead Spacing**
- **End Stackable to Arrays of Any Length**
- **I/C Compatible**

DESCRIPTION

The LY Z181-CO is a gallium arsenide phosphide LED solid state lamp. It has a yellow plastic encapsulated lens where the light is emitted.

See graph numbers 1, 2U, 3A, 4A, 5G, 6F, 7A, 8A, 9A, 10A in the back of this section.

Maximum Ratings (Individual Diode)

Operating Temperature (T_{OP})	–40°C to +80°C
Storage Temperature (T_{STG})	–40°C to +80°C
Junction Temperature (T_J)	100 °C
Soldering Temperature, 2 mm from case bottom (T_S), t≤3 sec.	230°C
Forward Current (I_F)	30 mA
Surge Current (I_{FM}), t≤10 µs	0.5 A
Reverse Voltage (V_R)	5 V
Power Dissipation (P_{TOT}), T_A=25°C	90 mW
Thermal Resistance Junction to Air (R_{THJA})	750 K/W

Note: Soldered on PC board, pad size ≥16 mm^2.

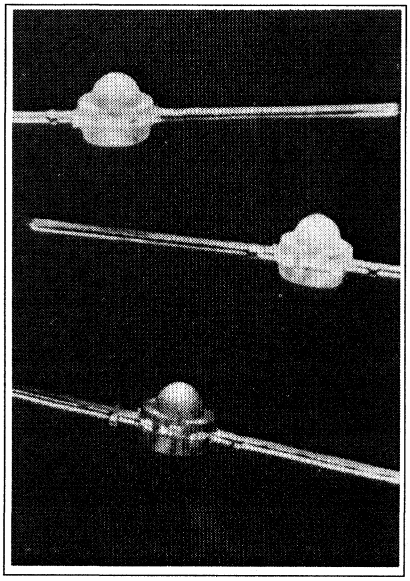
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit	Condition
Wavelength, Peak Emission (typ.)	λ_{PEAK}	586	nm	I_F=20 mA
Dominant Wavelength (typ.)	λ_{DOM}	590	nm	I_F=20 mA
Spectral Bandwidth (typ.) 50% I_{RELMAX},	$\Delta\lambda$	45	nm	I_F=20 mA
Viewing Angle, 50% I_V	2φ	100	Deg.	
Forward Voltage (typ.)	V_F	2.0	V	I_F=10 mA
(max.)	V_F	2.6	V	I_F=10 mA
Reverse Current (typ.)	I_R	0.01	µA	V_R=5 V
(max.)	I_R	10	µA	V_R=5 V
Capacitance (typ.)	C_0	10	pF	V_R=0 V, f=1 MHz
Switching Time				I_F=100 mA,
I_V, 10% to 90% (typ.)	t_R	300	ns	t_P=10 µs,
I_V, 90% to 10% (max.)	t_F	150	ns	R_L=50 Ω
Luminous Intensity	I_V	≥0.25	mcd	I_F=10 mA

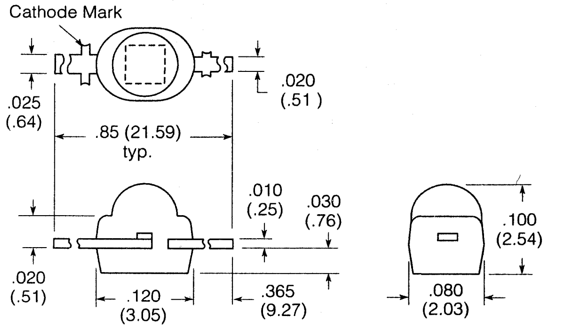
* Luminous intensity ratio of one packaging unit I_{VMAX}/I_{VMIN} ≤2

SIEMENS

WATER CLEAR DIFFUSED LENS RL-50
RED DIFFUSED LENS RL-54
Red Miniature Axial Lead LED Lamp



Package Dimensions in inches (mm)



FEATURES

- **High Luminance–1.0 mcd at 20 mA, typical**
- **Optimum Packaging Design for Maximum Strength at Minimum Linear Spacing**
- **Operates from 5 Volt IC Logic Supply**
- **Small Size**
- **High Reliability**
- **Lens**
  RL-50: Water Clear
  RL-54: Red Diffused

DESCRIPTION

The RL-50 and RL-55 are intended for high volume use in array and indicator light applications. Major advantages of these devices are high luminance at low currents, long life and low cost.

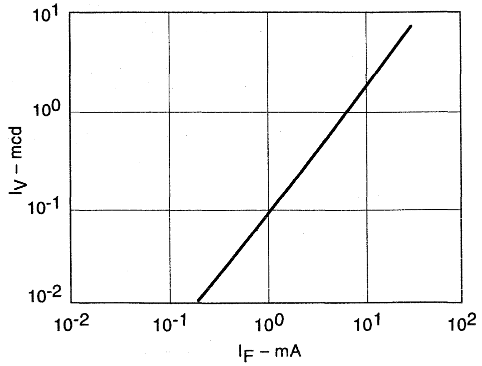
Maximum Ratings

Operating and Storage Temperature Range .... –55°C to +100°C
Lead Solder Time, 260°C (.063" from case) ....5 sec.
Peak Reverse Voltage .... 3 V
Continuous Forward Current .... 40 mA
Power Dissipation (T_A=25 °C) .... 80 mW
Derate Linearly from 25°C .... –1.1 mW/°C

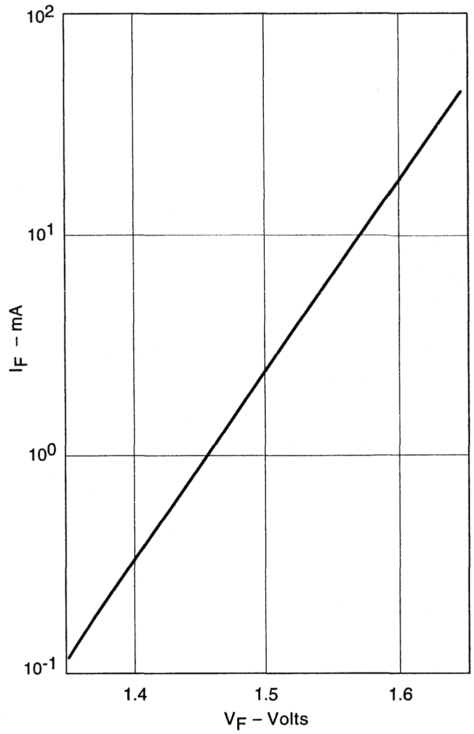
Electrical/Optical Characteristics (T_A=25°C)

Parameter	Min.	Typ.	Max.	Unit	Test Condition
Wavelength, Peak Emission		660		nm	
Viewing Angle		90		Deg.	
Forward Voltage		1.6	2.0	V	I_F=20 mA
Reverse Current			100	µA	V_R=3 V
Luminous Intensity					
RL-50	0.5	1.0		mcd	I_F=20 mA
RL-54	0.4	0.6		mcd	I_F=20 mA

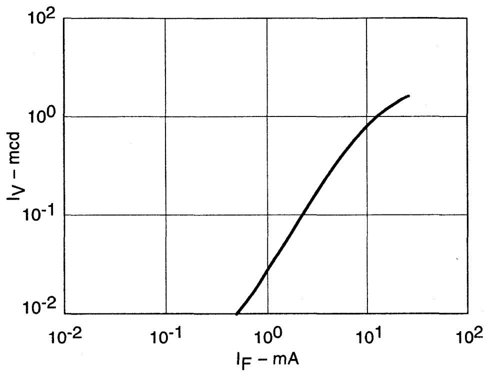
Luminous intensity versus forward current RL-50



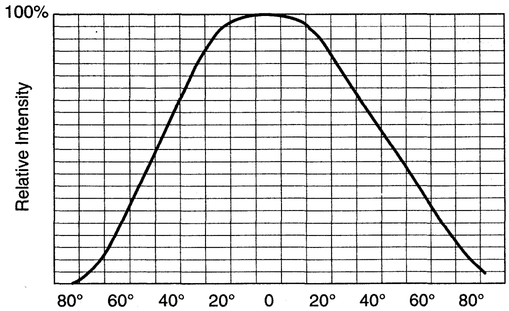
Forward Current versus forward voltage



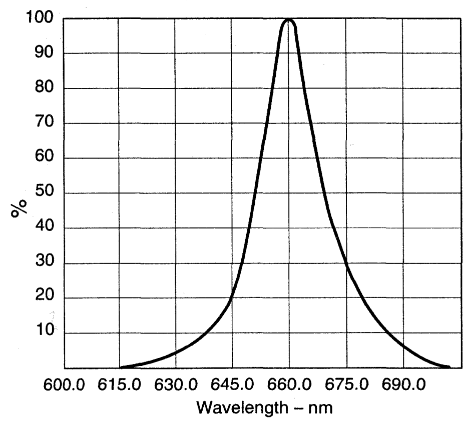
Luminous intensity versus forward current RL-54



Radiation characteristics



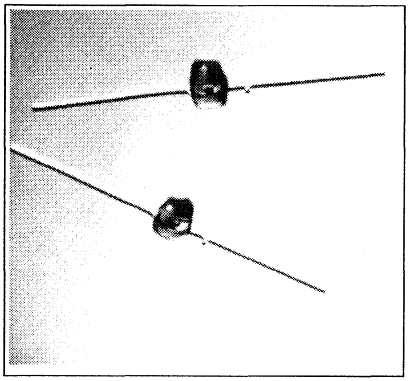
Relative spectral emission

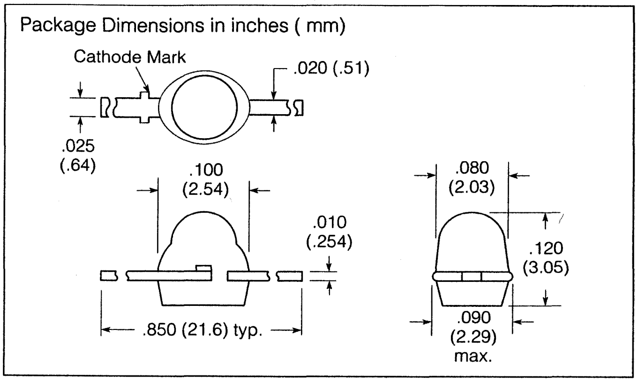


SIEMENS

RED RL-55
YELLOW YL-56
GREEN GL-56

Miniature Axial Lead LED Lamp





FEATURES

- **High on Axis Intensity**
- **Optimum Packaging Design for Maximum Strength at Minimum Linear Spacing**
- **Operates from 5 Volt IC Logic Supply**
- **Miniature Axial Lead**
- **High Reliability**
- **Low Cost Version (Red), RL-55-5**

DESCRIPTION

The RL-55 is a gallium arsenide phosphide lamp and the GL-56/YL-56 are gallium phosphide lamps that have on-axis intensity, long life and low cost. They have diffused lenses and provide a full 0.080" flooded light with good constrast.

Applications include mounting on PC boards at low current as diagnostic and circuit status indicators.

Maximum Ratings

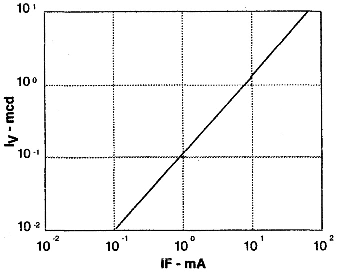
Operating and Storage Temperature Range .... −55°C to +100°C
Lead Solder Time, 260°C (.063" from case) .... 5 sec.
Peak Inverse Voltage .... 3 V
Continuous Forward Current
RL-55 .... 40 mA
GL-56, YL-56 .... 25 mA
Peak Forward Current (1 µs pulse, 0.1% duty cycle) .... 250 mA
Power Dissipation (T_A=25°C) .... 80 mW
Derate Linearly from 25°C .... −1.1 mW/°C

Electrical/Optical Characteristics (T_A=25°C)

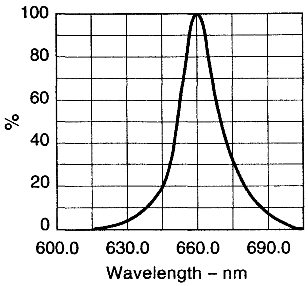
Parameter	Min.	Typ.	Max.	Unit	Test Condition
Wavelength, Peak Emission					
RL-55		660		nm	
GL-56		565		nm	
YL-56		585		nm	
Spectral Line Half Width		40		nm	
Viewing Angle					
RL-55		50		Deg.	
GL-56, YL-56		40		Deg.	
Forward Voltage					
RL-55		1.6	2.0	V	I_F=20 mA
GL-56		2.2	3.5	V	I_F=20 mA
YL-56		2.4	3.5	V	I_F=20 mA
Reverse Current		0.15	10	µA	V_R=3 V
Luminous Intensity					
RL-55	2.0	2.2		mcd	I_F=10 mA
GL-56	1.0	1.3		mcd	I_F=10 mA
YL-56	2.0	2.2		mcd	I_F=10 mA

Red, RL-55

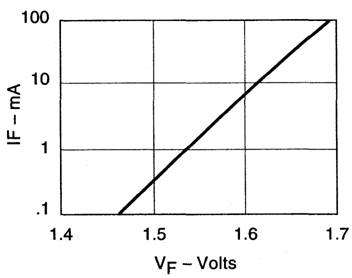
Luminous intensity versus forward current



Relative spectral emission

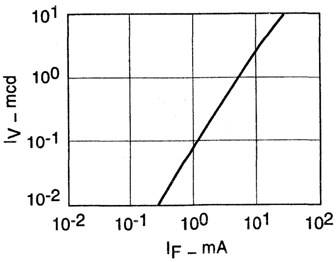


Forward current versus forward voltage

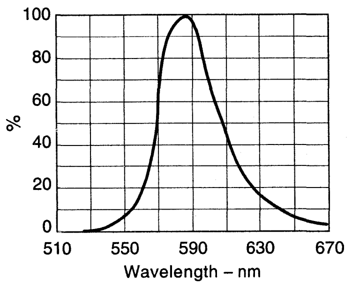


Yellow, YL-56

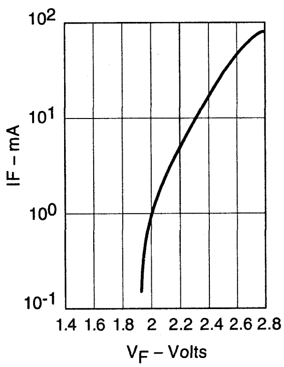
Luminous intensity versus forward current



Relative spectral emission

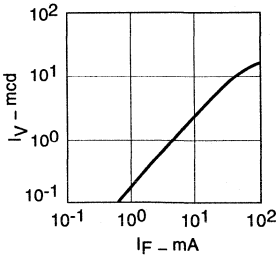


Forward current versus forward voltage

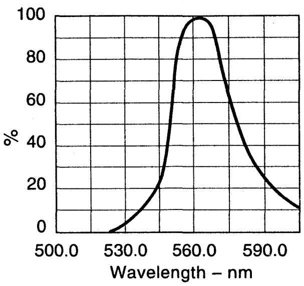


Green, GL-56

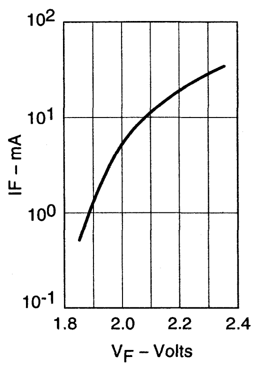
Luminous intensity versus forward current



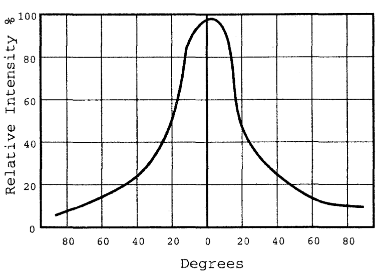
Relative spectral emission



Forward current vs. forward voltage



Radiation characteristics



SIEMENS

RRL-5601
RRL-5621
RRL-5641

Red, Resistor, Miniature Axial Lead LED Lamp

FEATURES

- **Integral Current Limiting Resistor**
- **No External Resistor Required with 5 Volt Supply**
- **Miniature Axial Lead Package**
- **Red Diffused Lens**
- **Three Light Intensity Ranges**
- **High Reliability**

DESCRIPTION

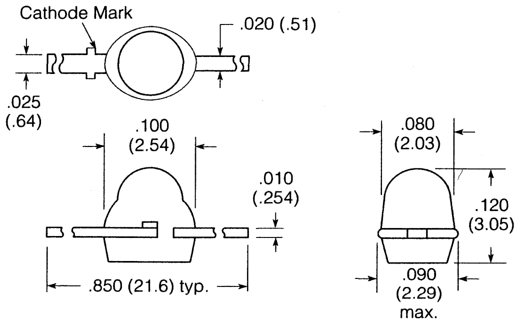
The RRL-5601/-5621/-5641are gallium arsenide phosphide LED red lamps with integral resistor chips in series with the LED. This construction allows operation from a 5 volt source without an external current limiting resistor.

Applications include mounting on PC boards as diagnostic and circuit status indicators.

Maximum Ratings

Operating Temperature Range...−55°C to +100°C
Storage Temperature Range ......−55°C to +100°C
Soldering Time, 260°C (.063" from case)....5 sec.
Reverse Voltage ....6 V
DC Forward Voltage ....6 V

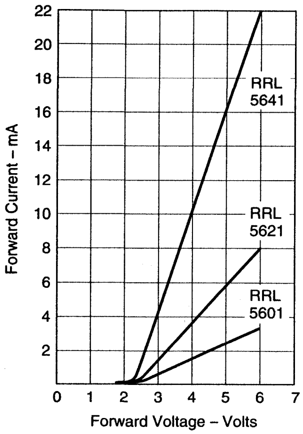
Package Dimensions in inches (mm)



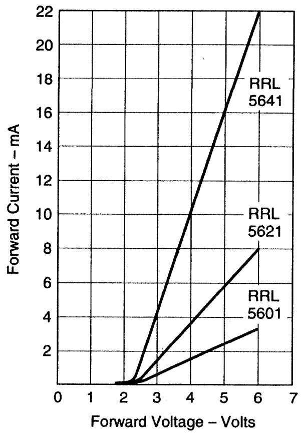
Optoelectronic Characteristics (T_A=25°C)

Parameter	Min.	Typ.	Max.	Unit	Test Condition
Wavelength, Peak Emission		650		nm	
Half Angle		20		Deg.	
Forward Current					
RRL-5601	2.0	3.0	4.0	mA	5 V
RRL-5621	4.0	6.0	8.0	mA	5 V
RRL-5641	13.0	16.0	21.0	mA	5 V
Reverse Current		0.1	10	µA	6 V
Luminous Intensity					
RRL-5601	0.3			mcd	5 V
RRL-5621	0.6	1.2		mcd	5 V
RRL-5641	1.0	2.0		mcd	5 V

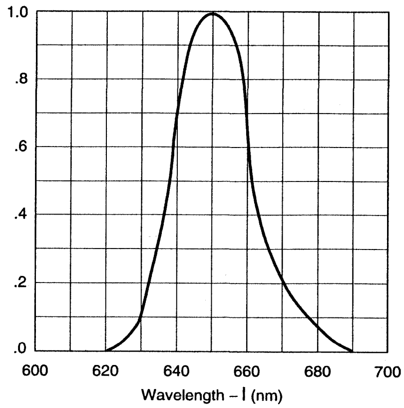
Forward current versus forward voltage



Forward current versus forward voltage



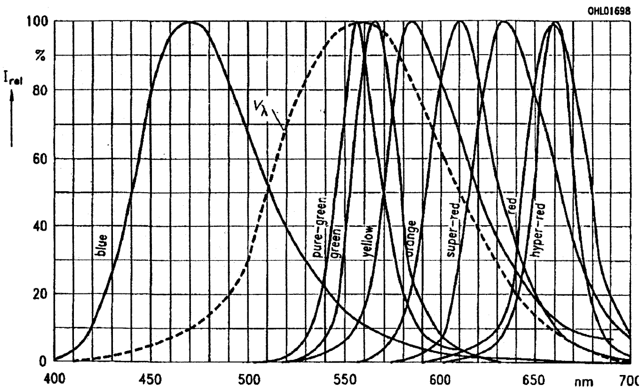
Spectral distribution



1

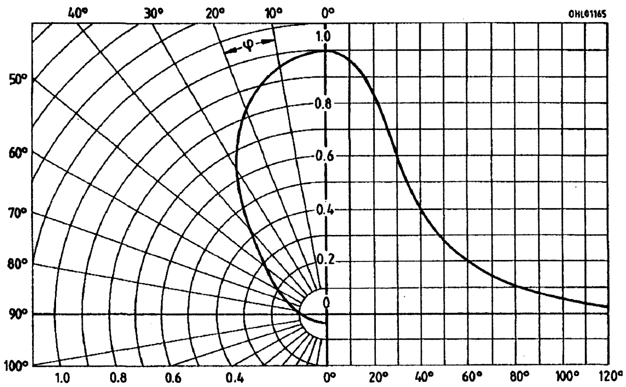
Relative spectral emission $I_{rel}=f(\lambda)$, $T_A=25°C$

$V(\lambda)$=standard eye response curve



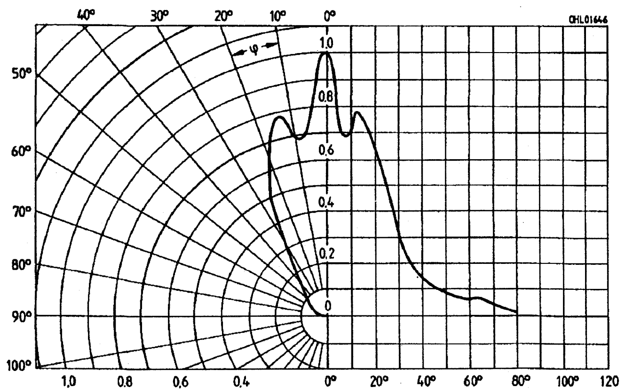
2A

Radiation characteristics $I_{rel}=f(\rho)$



2B

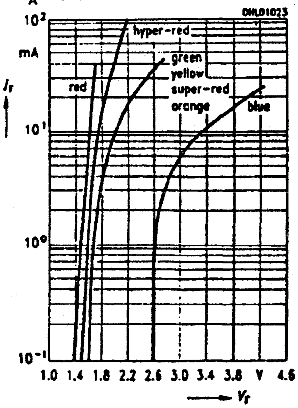
Radiation characteristics $I_{rel}=f(\rho)$



3A

Forward current $I_F=f(V_F)$

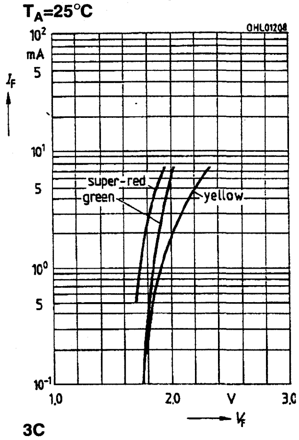
$T_A=25°C$



3B

Forward current $I_F=f(V_F)$

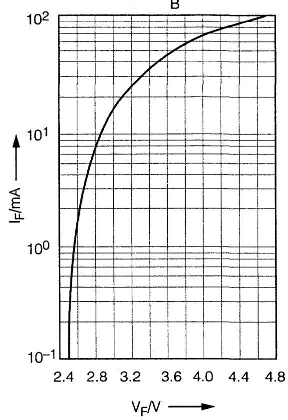
$T_A=25°C$



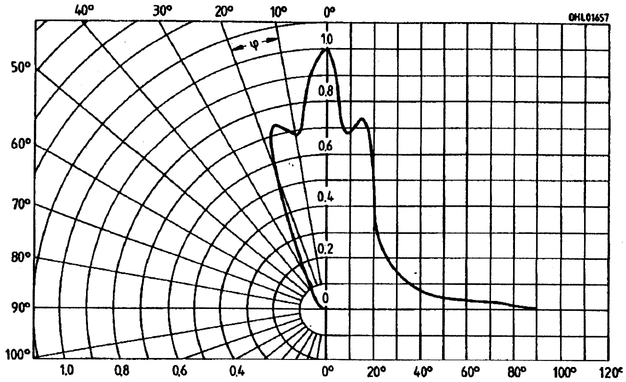
3C

Forward current $I_F=f(V_F)$

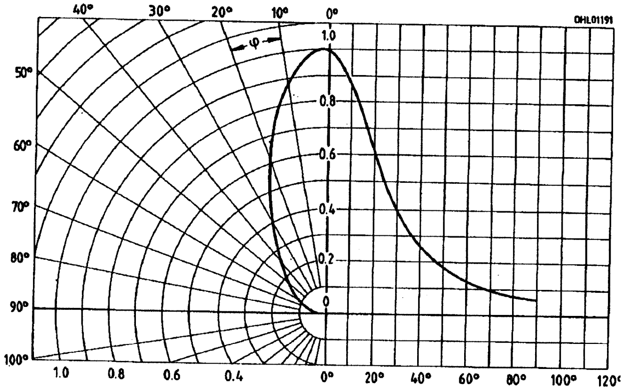
$T_A=25°C$



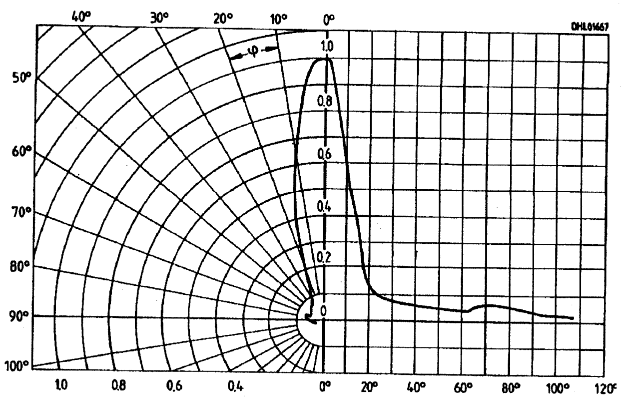
2C
Radiation characteristics $I_{rel}=f(\rho)$



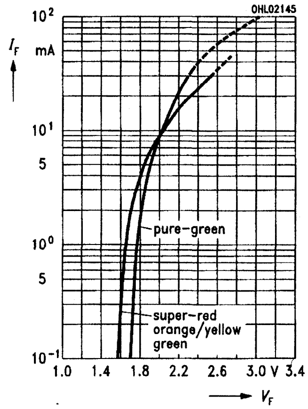
2D
Radiation characteristics $I_{rel}=f(\rho)$



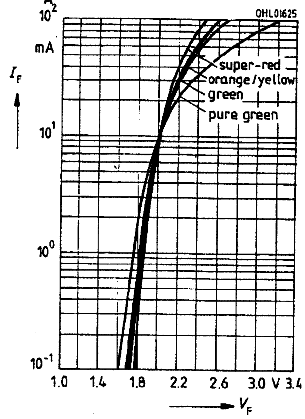
2E
Radiation characteristics $I_{rel}=f(\rho)$



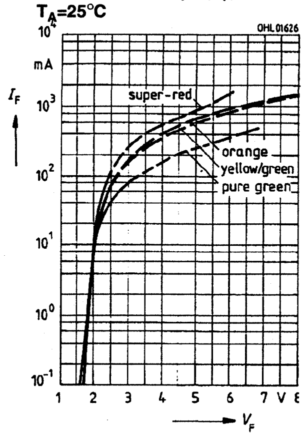
3D
Forward current $I_F=f(V_F)$
T_A=25°C



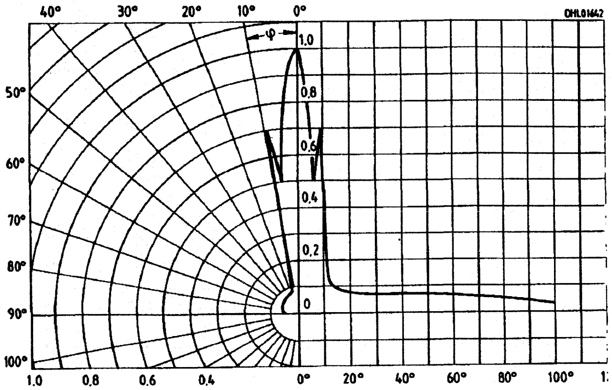
3E
Forward current $I_F=f(V_F)$
T_A=25°C



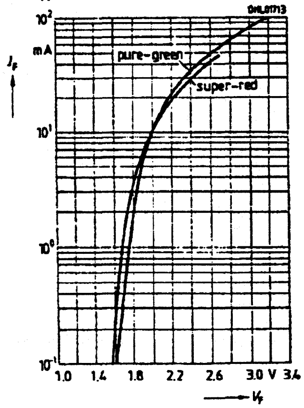
3F
Forward current $I_F=f(V_F)$
T_A=25°C



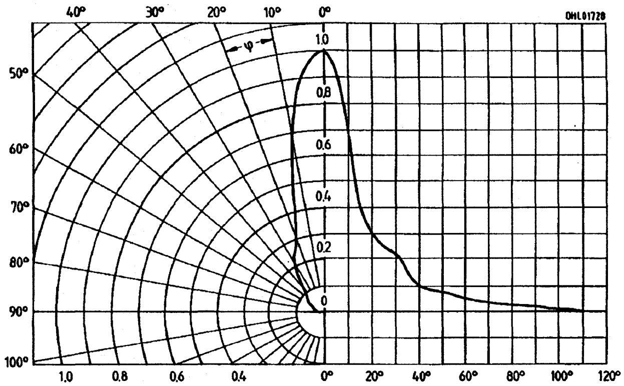
2F
Radiation characteristics $I_{rel}=f(\rho)$



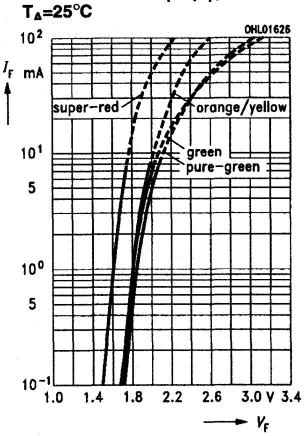
3G
Forward current $I_F=f(V_F)$
$T_A=25°C$



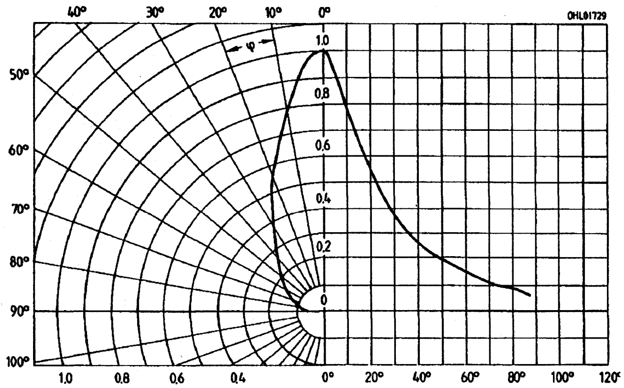
2G
Radiation characteristics $I_{rel}=f(\rho)$



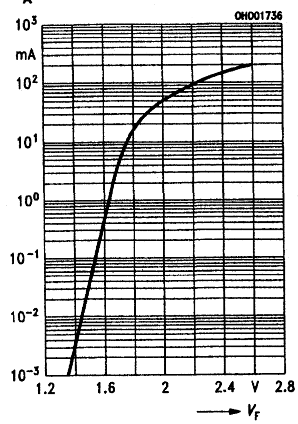
3H
Forward current $I_F=f(V_F)$
$T_A=25°C$



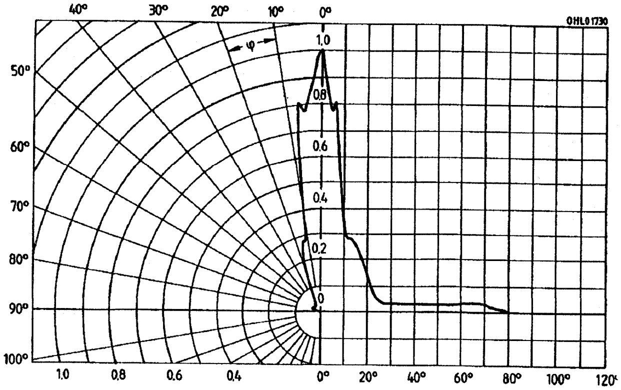
2H
Radiation characteristics $I_{rel}=f(\rho)$



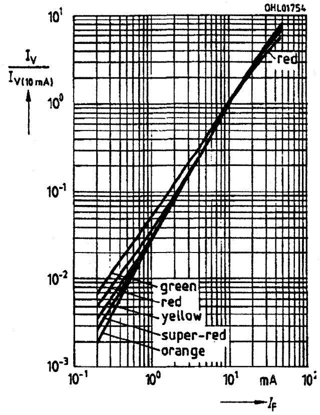
3I
Forward current $I_F=f(V_F)$
$T_A=25°C$



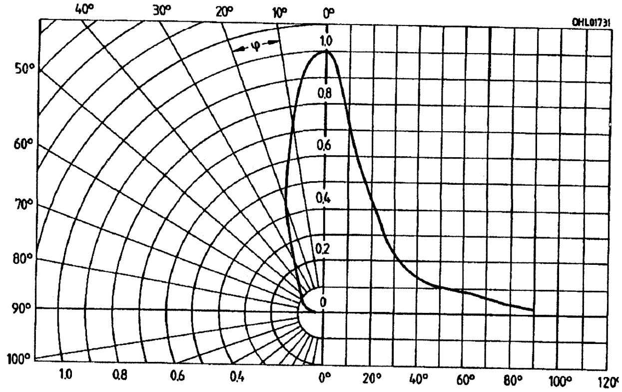
2I
Radiation characteristics $I_{rel}=f(\rho)$



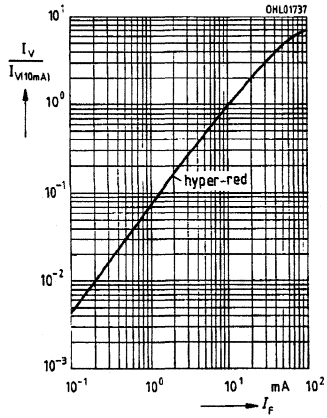
4A
Rel. luminous intensity I_V/I_V(10 mA)=f(I_F)



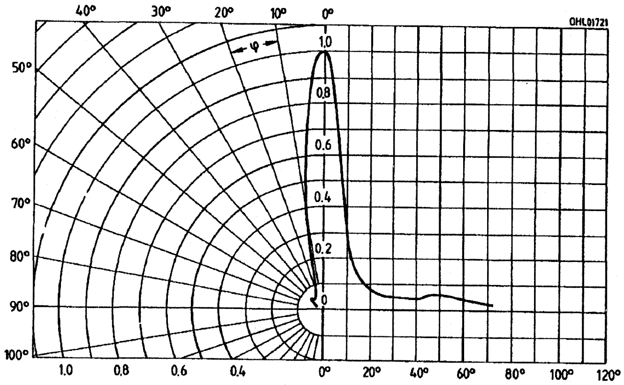
2J
Radiation characteristics $I_{rel}=f(\rho)$



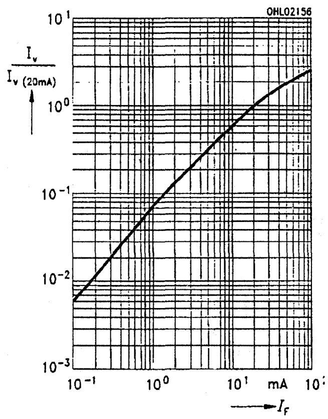
4B
Rel. luminous intensity I_V/I_V(10 mA)=f(I_F)



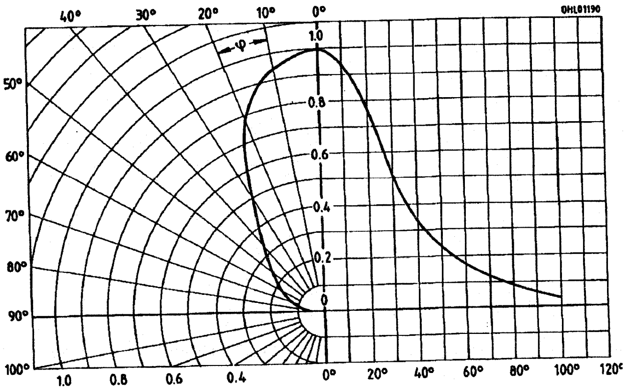
2K
Radiation characteristics $I_{rel}=f(\rho)$



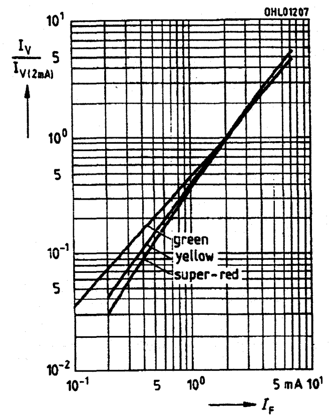
4C
Rel. luminous intensity I_V/I_V(10 mA)=f(I_F)



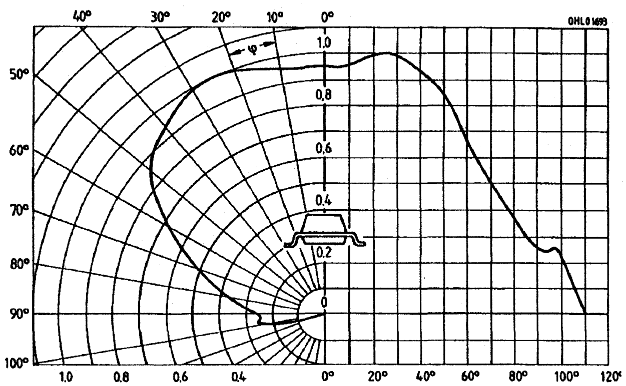
2L
Radiation characteristics $I_{rel}=f(\rho)$



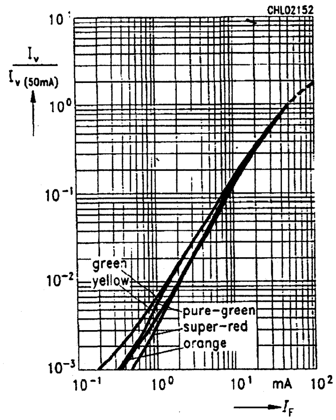
4D
Rel. luminous intensity $I_V/I_V(10\ mA)=f(I_F)$



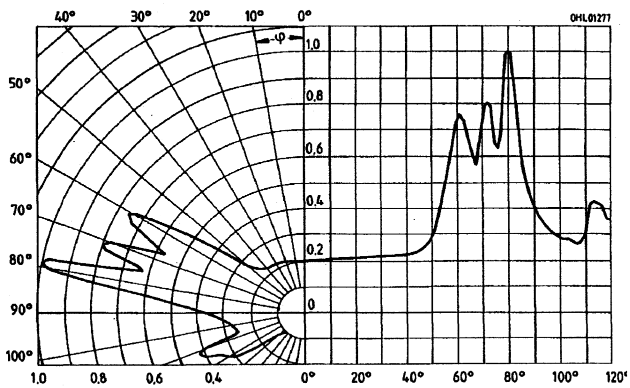
2M
Radiation characteristics $I_{rel}=f(\rho)$



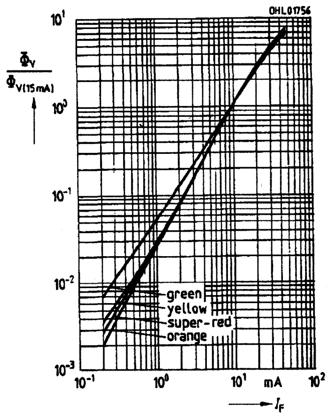
4F
Rel. luminous intensity $I_V/I_V(50\ mA)=f(I_F)$



2K
Radiation characteristics $I_{rel}=f(\rho)$

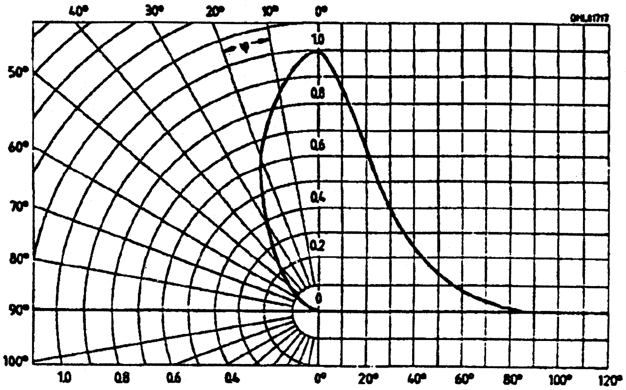


4H
Rel. luminous flux $I\Phi/I\Phi(15\ mA)=f(I_F)$

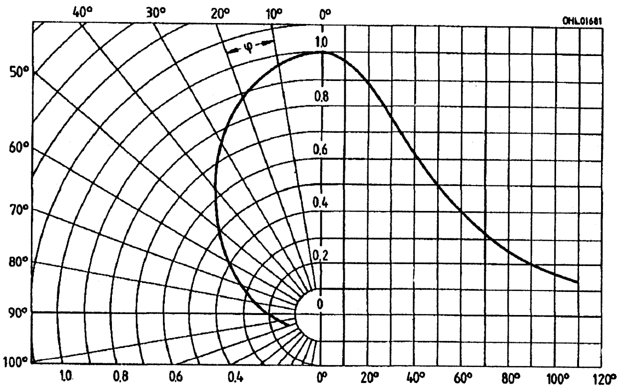


4 LED Lamps

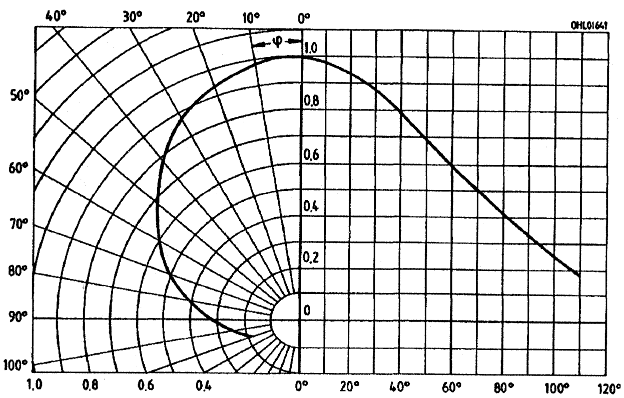
2O
Radiation characteristics $I_{rel}=f(\rho)$



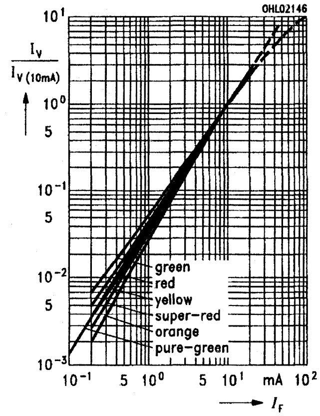
2P
Radiation characteristics $I_{rel}=f(\rho)$



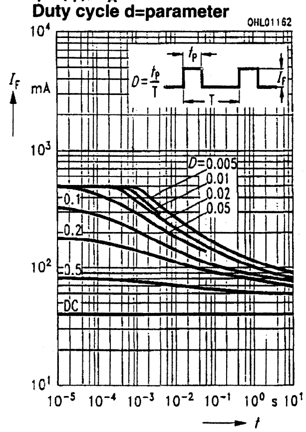
2Q
Radiation characteristics $I_{rel}=f(\rho)$



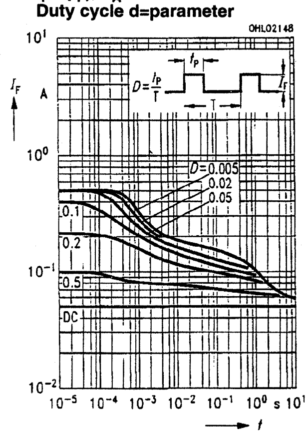
4I
Rel. luminous intensity $I_V/I_V(10\ mA)=f(I_F)$



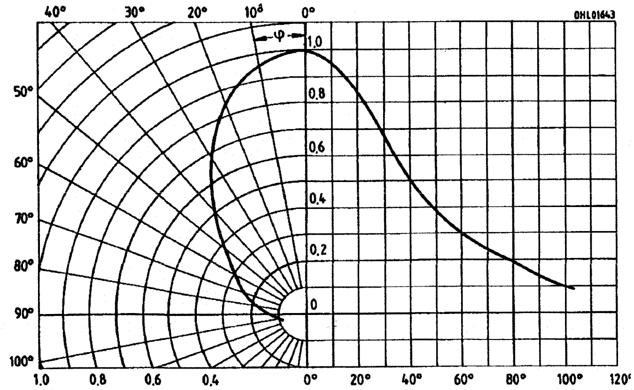
5A
Permissible pulse handling capability
$I_F=f(t_P)$, $T_A=25°C$
Duty cycle d=parameter



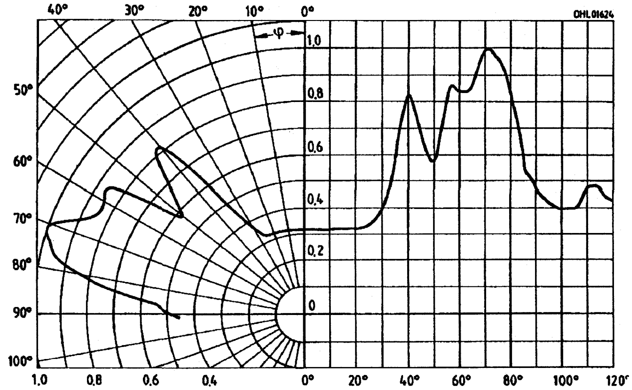
5B
Permissible pulse handling capability
$I_F=f(t_P)$, $T_A=25°C$
Duty cycle d=parameter



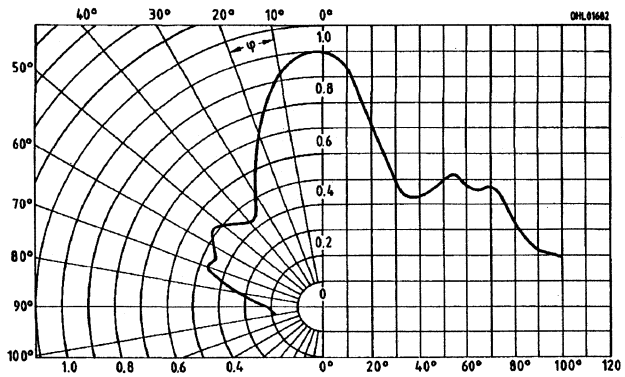
2R
Radiation characteristics $I_{rel}=f(\rho)$



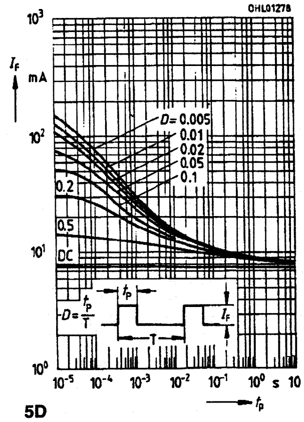
2S
Radiation characteristics $I_{rel}=f(\rho)$



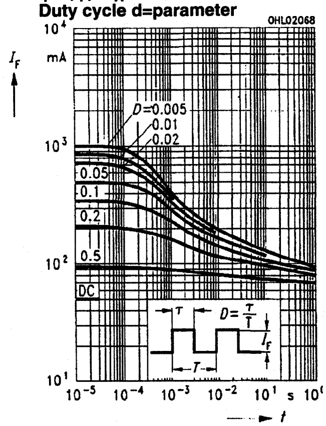
2T
Radiation characteristics $I_{rel}=f(\rho)$



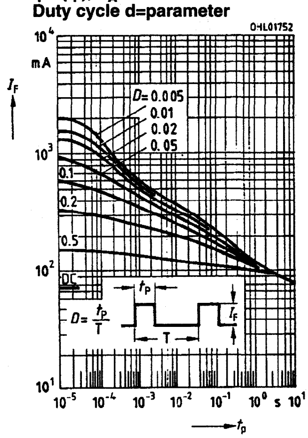
5C
Permissible pulse handling capability
$I_F=f(t_P)$, $T_A=25°C$
Duty cycle d=parameter



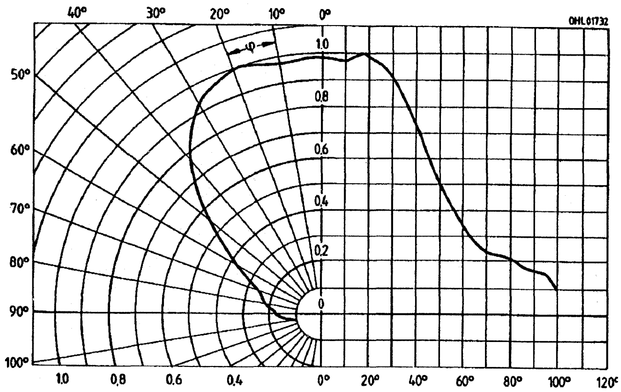
5D
Permissible pulse handling capability
$I_F=f(t_P)$, $T_A=25°C$
Duty cycle d=parameter



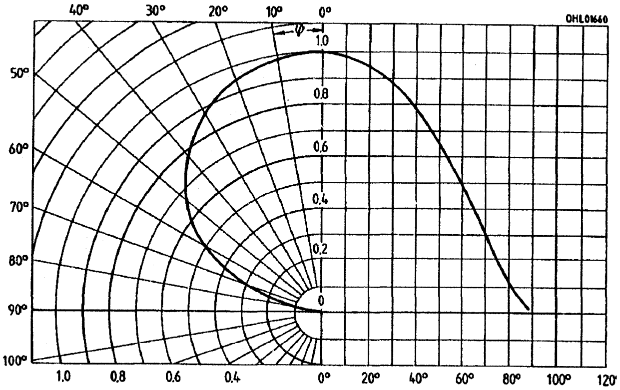
5E
Permissible pulse handling capability
$I_F=f(t_P)$, $T_A=25°C$
Duty cycle d=parameter



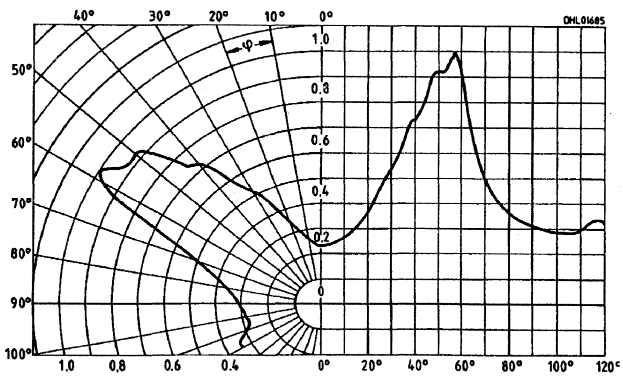
2U
Radiation characteristics $I_{rel}=f(\rho)$



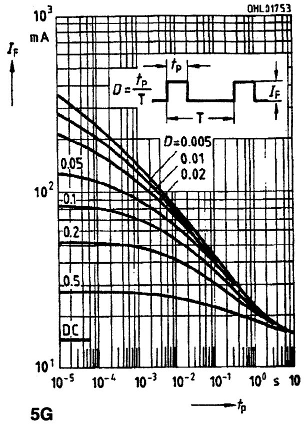
2V
Radiation characteristics $I_{rel}=f(\rho)$



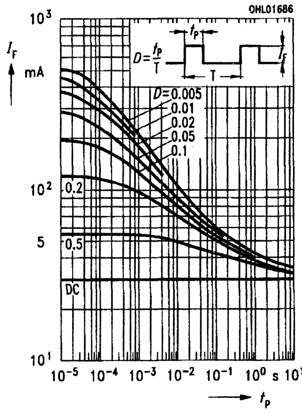
2W
Radiation characteristics $I_{rel}=f(\rho)$



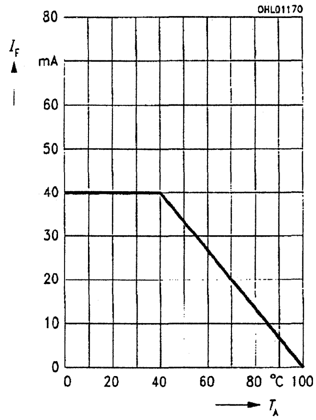
5F
Permissible pulse handling capability
$I_F=f(t_P)$, $T_A=25°C$
Duty cycle d=parameter



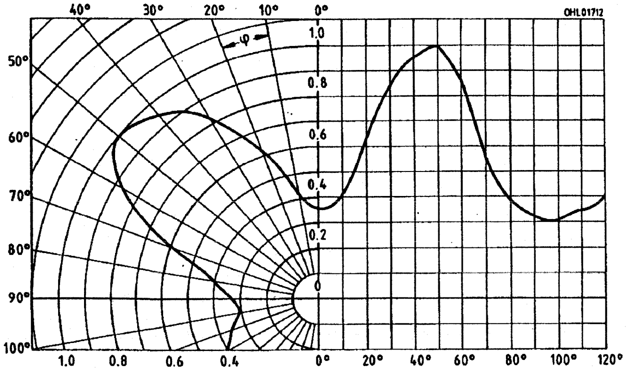
5G
Permissible pulse handling capability
$I_F=f(t_P)$, $T_A=25°C$
Duty cycle d=parameter



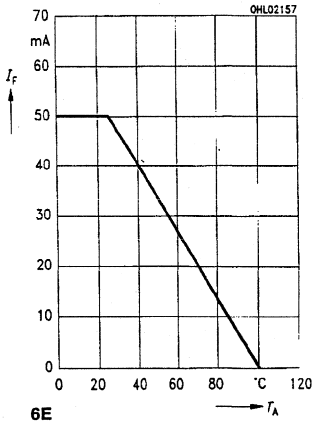
6A
Max. permissible forward current
$I_F=f(T_A)$



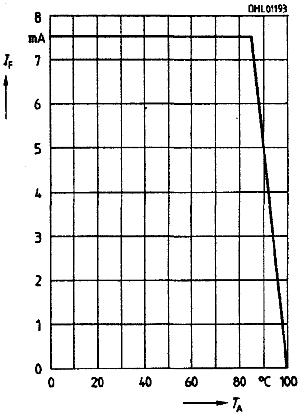
2X
Radiation characteristics $I_{rel}=f(\rho)$



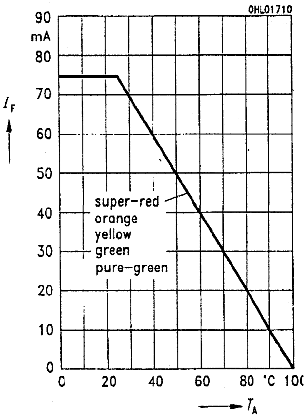
6B
Max. permissible forward current
$I_F=f(T_A)$



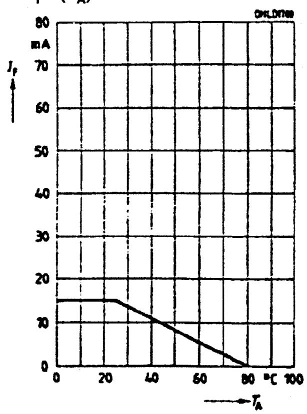
6C
Max. Permissible forward current
$I_F=f(T_A)$



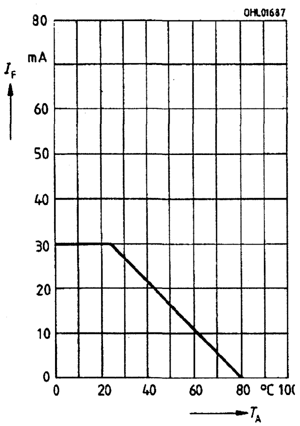
6D
Max. Permissible forward current
$I_F=f(T_A)$



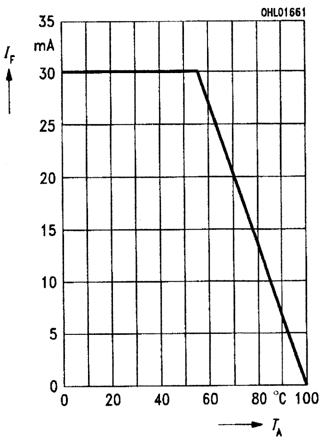
6E
Max. Permissible forward current
$I_F=f(T_A)$



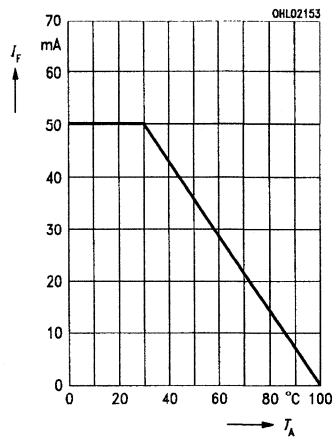
6F
Max. Permissible forward current
$I_F=f(T_A)$



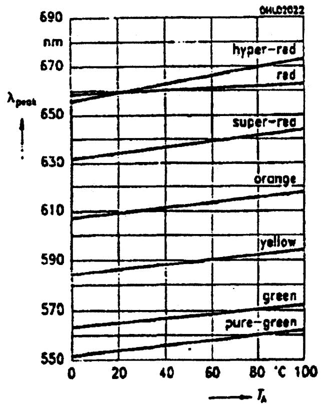
6G
Max. Permissible forward current
$I_F=f(T_A)$



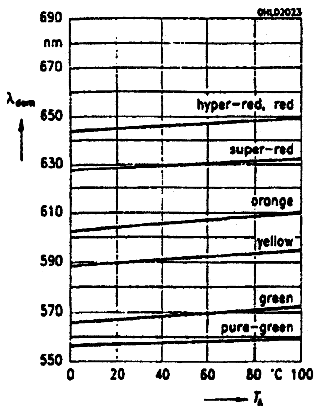
6H
Max. Permissible forward current
$I_F=f(T_A)$



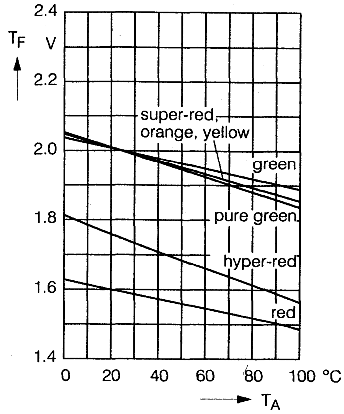
7A
Wavelength at peak emission
$\lambda_{PEAK}=f(T_A)$



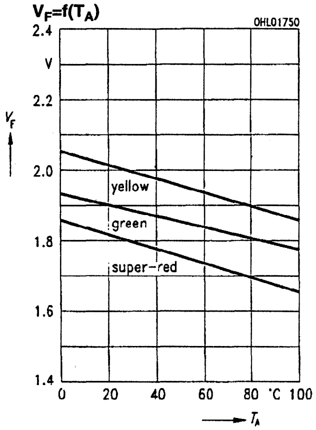
8A
Dominant wavelength
$\lambda_{DOM}=f(T_A)$



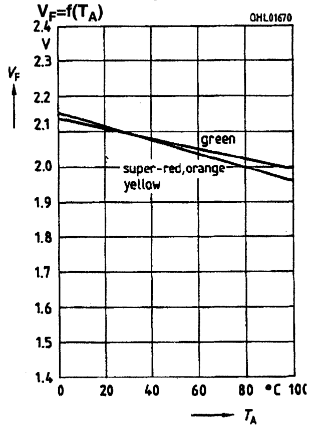
9A
Forward voltage
$V_F=f(T_A)$



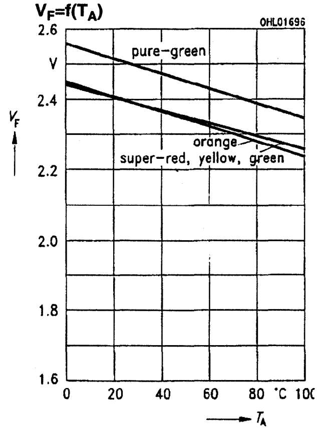
9B
Forward voltage
$V_F=f(T_A)$



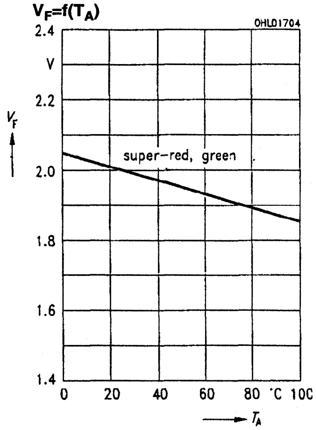
9C
Forward voltage
$V_F=f(T_A)$



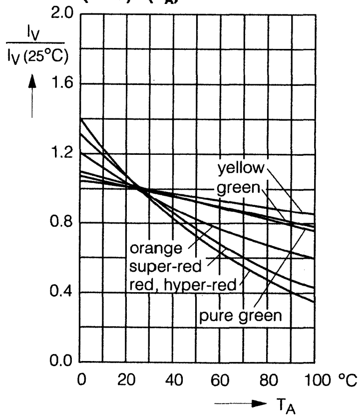
9D
Forward voltage
$V_F=f(T_A)$



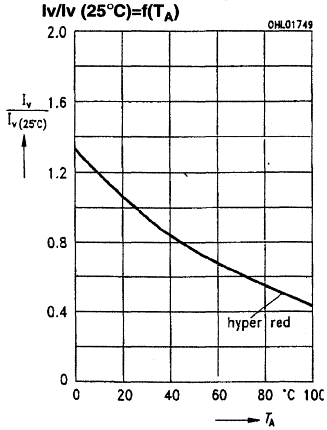
9E
Forward voltage
$V_F=f(T_A)$



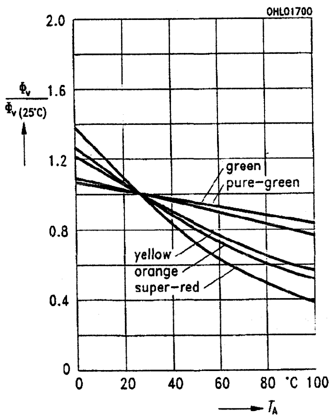
10A
Rel. luminous intensity
Iv/Iv (25°C)=f(T_A)



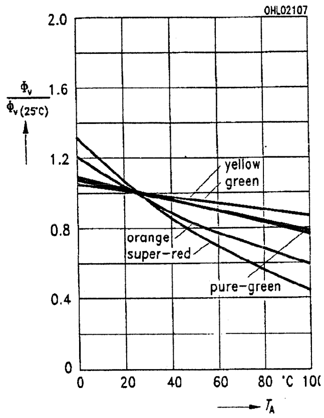
10B
Rel. luminous intensity
Iv/Iv (25°C)=f(T_A)



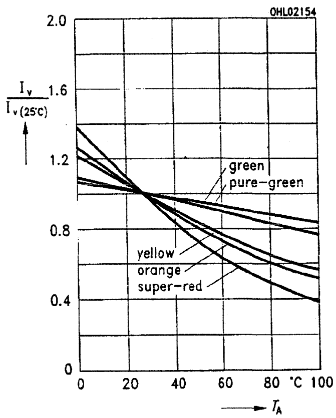
10C
Rel. luminous flux
Φv/Φv (25°C)=f(T$_A$)



10D
Rel. luminous flux
Φv/Φv (25°C)=f(T$_A$)

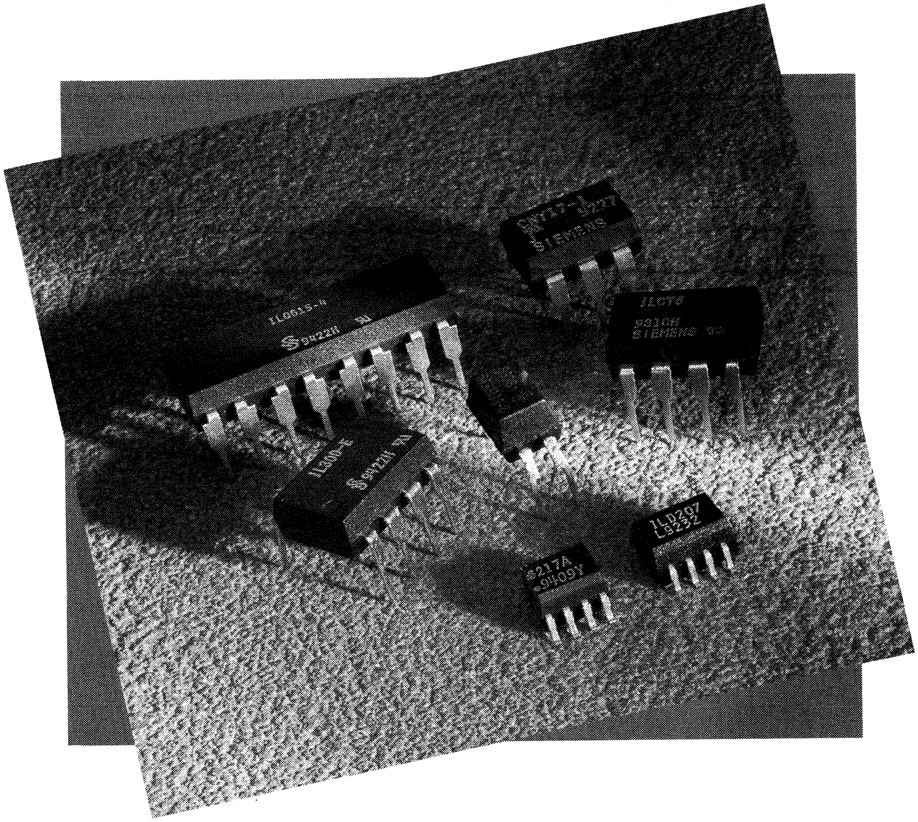


10E
Rel. luminous intensity
Iv/Iv (25°C)=f(T$_A$)



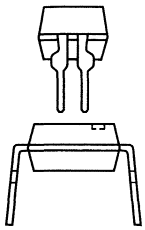
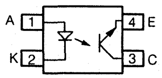
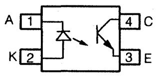
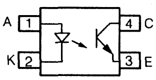
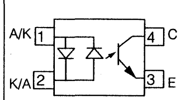
LED Lamps

4

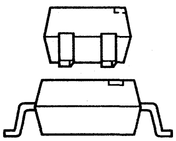
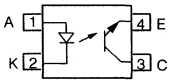
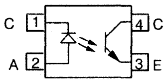
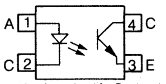
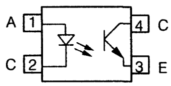
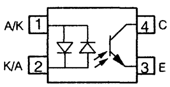
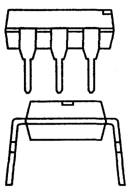
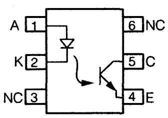
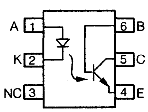


Optocouplers

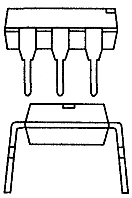
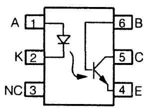
Optocouplers

Package Outline	Type	Schematic	Part Number	Current Transfer Ratio (%) I_F=10 mA	Isolation Test Voltage	BV_{CEO}	Features	Page
4 Pin DIP 	Phototransistor/Single	 A=Anode K=Cathode	SFH610A-1	40–80	$5300V_{RMS}$	70	TRIOS (TRansparent IOn Shield).	5–236
			SFH610A-2	63–125				
			SFH610A-3	100–200				
			SFH610A-4	160–320				
		 A=Anode K=Cathode	SFH611A-1	40–80				
			SFH611A-2	63–125				
			SFH611A-3	100–200				
			SFH611A-4	160–320				
		 A=Anode K=Cathode	SFH615A-1	40–80				
			SFH615A-2	63–125				
			SFH615A-3	100–200				
			SFH615A-4	160–320				5–239
			SFH615AA	50–600 (I_F=5 mA)				
			SFH615AGB	100–600 (I_F=5 mA)				
			SFH617A-1	40–80				5–236
			SFH617A-2	63–125				
			SFH617A-3	100–200				
			SFH617A-4	160–320				
			SFH618A-2	63–125 (I_F=1 mA)	$5300V_{RMS}$	55	Low current input. TRIOS (TRansparent IOn Shield).	5–246
			SFH618A-3	100–200 (I_F=1 mA)				
			SFH618A-4	160–320 (I_F=1 mA)				
			SFH618A-5	250–500 (I_F=1 mA)				
	AC/bidirectional	 A=Anode K=Cathode	SFH620A-1	40–125	$5300V_{RMS}$	70	TRIOS (TRansparent IOn Shield).	5–252
			SFH620A-2	63–200				
			SFH620A-3	100–320				
			SFH620AA	50–600 (I_F=5 mA)	$5300V_{RMS}$	70	TRIOS (TRansparent IOn Shield).	5–255
			SFH620AGB	100–600 (I_F=5 mA)				
			SFH628A-2	63–200 (I_F=1 mA)	$5300V_{RMS}$	55	TRIOS (TRansparent IOn Shield).	5–246
			SFH628A-3	100–320 (I_F=1 mA)				
			SFH628A-4	160–500 (I_F=1 mA)				

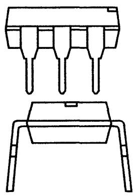
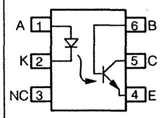
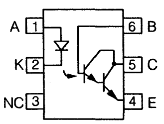
Optocouplers (Continued)

Package Outline	Type	Schematic	Part Number	Current Transfer Ratio (%) I_F=10 mA	Isolation Test Voltage	BV_{CEO}	Features	Page
4 Pin DIP SMD Leads 	Phototransistor/Surface mount	 A=Anode K=Cathode	SFH6106-1	40–80	$5300V_{RMS}$	70	TRIOS (TRansparent IOn Shield).	5–266
			SFH6106-2	63–125				
			SFH6106-3	100–200				
			SFH6106-4	160–320				
		 A=Anode K=Cathode	SFH6116-1	40–80	$5300V_{RMS}$	70	TRIOS (TRansparent IOn Shield).	
			SFH6116-2	63–125				
			SFH6116-3	100–200				
			SFH6116-4	160–320				
	Phototransistor/Surface mount	 A=Anode K=Cathode	SFH6156-1	40–80	$5300V_{RMS}$	70	TRIOS (TRansparent IOn Shield).	
			SFH6156-2	63–125				
			SFH6156-3	100–200				
			SFH6156-4	160–320				
		 A=Anode K=Cathode	SFH6186-2	63–125	$5300V_{RMS}$	55	TRIOS (TRansparent IOn Shield).	
			SFH6186-3	100–200				
			SFH6186-4	160–320				
			SFH6186-5	250–500				
	AC/bidirectional/Surf Mount	 A=Anode K=Cathode	SFH6206-1	40–125	$5300V_{RMS}$	70	TRIOS (TRansparent IOn Shield).	
			SFH6206-2	63–200				
			SFH6206-3	100–320				
			SFH6286-2	63–200 (I_F=1 mA)	$5300V_{RMS}$	55	TRIOS (TRansparent IOn Shield).	
			SFH6286-3	100–320				
			SFH6286-4	160–500				
6 Pin DIP 	Phototransistor/Single	 A=Anode K=Cathode	CNY17F-1	40–80	5300 V_{RMS}	70	No base pin connection. CTR groupings.	5–46
			CNY17F-2	63–125				
			CNY17F-3	100–200				
			CNY17F-4	160–320				
			MOC8111	20 Min.	5300 V_{RMS}	30	No base connection	5–221
		 A=Anode K=Cathode	CNY17-1	40–80	5300 V_{RMS}	70	CTR groupings.	5–42
			CNY17-2	63–125				
			CNY17-3	100–200				
			CNY17-4	160–320				

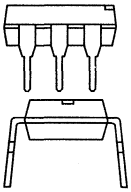
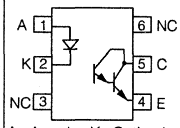
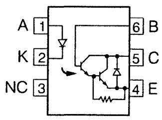
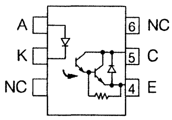
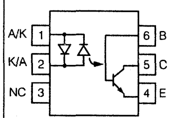
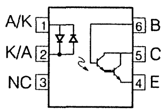
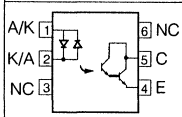
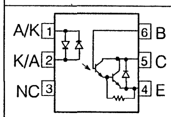
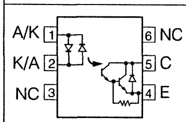
Optocouplers (Continued)

Package Outline	Type	Schematic	Part Number	Current Transfer Ratio (%) I_F=10 mA	Isolation Test Voltage	BV_{CEO}	Features	Page
6 Pin DIP 	Phototransistor/Single	 A=Anode K=Cathode	SFH600-0	40–80	5300 V_{RMS}	70	CTR groupings.	5–223
			SFH600-1	63–125				
			SFH600-2	100–200				
			SFH600-3	160–320				
			SFH601-1	40–80	5300 V_{RMS}	100	CTR groupings.	5–227
			SFH601-2	63–125				
			SFH601-3	100–200				
			SFH601-4	160–320				
			SFH608-2	63–125 (I_F=1 mA)	5300 V_{RMS}	55	Low current. TRIOS (TRansparent IOn Shield).	5–231
			SFH608-3	100–200 (I_F=1 mA)				
			SFH608-4	160–320 (I_F=1 mA)				
			SFH608-5	250–500 (I_F=1 mA)				
			SFH640-1	40–80	5300 V_{RMS}	300	High BV_{CER} voltage. TRIOS (TRansparent IOn Shield).	5–263
			SFH640-2	63–125				
			SFH640-3	100–200				
			4N25	20 Min.	5300 V_{RMS}	30	Low cost industry standard.	5–27
			4N26					
			4N27	10 Min.				
			4N28					
			4N35	100 Min.	5300 V_{RMS}	30	Low cost industry standard.	
			4N36					
			4N37					
			4N38	10 Min.				
			H11A1	50 Min.	5300 V_{RMS}	30	Low cost industry standard.	
			H11A2	20 Min.				
			H11A3	20 Min.				
			H11A4	10 Min.				
			H11A5	30 Min.				
			H11D1	20 Min.	5300 V_{RMS}	300	High BV_{CER} voltage. TRIOS (TRansparent IOn Shield).	5–56
			H11D2			300		
			H11D3			200		

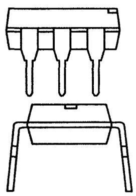
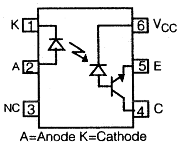
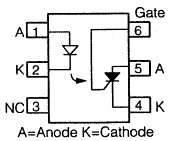
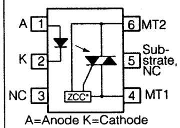
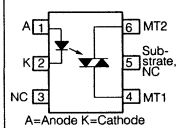
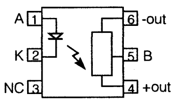
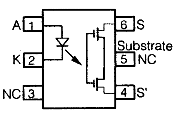
Optocouplers (Continued)

Package Outline	Type	Schematic	Part Number	Current Transfer Ratio (%) I_F=10 mA	Isolation Test Voltage	BV_{CEO}	Features	Page
6 Pin DIP 	Phototransistor/Single	 A=Anode K=Cathode	IL1	20–300	5300 V_{RMS}	30	TRIOS (TRansparent IOn Shield).	5–59
			IL2	100–500		70		
			IL5	50–400				
			IL74	12.5 Min.		20		5–73
			MCT2	20 Min.	5300 V_{RMS}	30	Low cost industry standard.	5–27
			MCT2E	20 Min.				
			MCT270	50 Min.	5300 V_{RMS}	30	Low cost industry standard.	
			MCT271	45–90				
			MCT272	75–150				
			MCT273	125–250				
			MCT274	225–400				
			MCT275	70–210				
			MCT276	15–60				
			MCT277	100 Min.				
			MCT5210	7 Min., I_F=3.0 mA	5300 V_{RMS}	70	Low input forward current.	5–216
			MCT5211	110 Min., I_F=1 mA				
			IL201	10 Min. (I_F=1 mA)	5300 V_{RMS}	70	Low input forward current.	5–77
			IL202	30 Min. (I_F=1 mA)				
			IL203	50 Min. (I_F=1 mA)				
	Photodarlington/Single	 A=Anode K=Cathode	IL30	100 Min.	5300 V_{RMS}	30	High gain.	5–64
			IL31	200 Min.				
			IL55	100 Min.		55		
			4N32	500 Min.	5300 V_{RMS}	30	High gain.	5–34
			4N33					
			H11B1	500 Min. (I_F=1 mA)	5300 V_{RMS}	30	High gain. Low cost industry standard.	5–53
			H11B2	200 Min. (I_F=1 mA)				
			H11B3	100 Min. (I_F=1 mA)				
			MCA230	100 Min.	5300 V_{RMS}	30	High gain. Low cost industry standard.	5–211
			MCA231	200 Min.				
			MCA255	100 Min.		55		

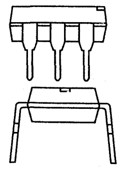
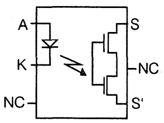
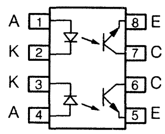
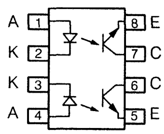
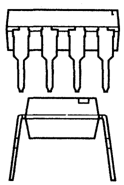
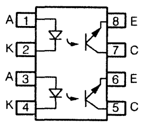
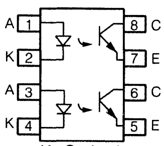
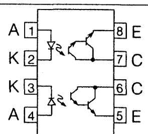
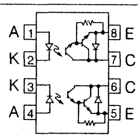
Optocouplers (Continued)

Package Outline	Type	Schematic	Part Number	Current Transfer Ratio (%) I_F=10 mA	Isolation Test Voltage	BV_{CEO}	Features	Page
6 Pin DIP 	Darlington/Single	 A=Anode K=Cathode	MOC8050	500 Min.	5300 V_{RMS}	80	High BV_{CEO}. No base lead.	5–219
			IL55B	500 Min.	5300 V_{RMS}	80	High BV_{CEO}.	5–67
			IL66-1	100 Min. I_F=2 mA	5300 V_{RMS}	60	Internal R_{BE} for high stability.	5–68
			IL66-2	300 Min. I_F=2 mA				
			IL66-3	400 Min. I_F=0.7 mA				
			IL66-4	500 Min. I_F=2 mA				
			IL66B-1	100 Min. I_F=2 mA	5300 V_{RMS}	60	Internal R_{BE} for high stability. No base lead.	5–71
			IL66B-2	300 Min. I_F=2 mA				
	AC/bidirectional		H11AA1	20 Min.	5300 V_{RMS}	70	3:1 CTR matching.	5–50
			IL250	50 Min.			2:1 CTR matching.	5–92
			IL251	20 Min.				
			IL252	100 Min.				
	AC/bidirectional/photodarlington	 A=Anode K= Cathode	IL755-1	750 Min., I_F=2 mA	5300 V_{RMS}	60	High CTR.	5–132
			IL755-2	1000 Min., I_F=1 mA				
		 A=Anode K= Cathode	IL755B-1	750 Min., I_F=2 mA	5300 V_{RMS}	70	No base pin connection.	5–135
			IL755B-2	1000 Min., I_F=1 mA				
		 A=Anode K= Cathode	IL766-1	500 Min., I_F=2 mA	5300 V_{RMS}	60	Internal R_{BE} for better stability.	5–137
			IL766-2	500 Min., I_F=1 mA				
		 A=Anode K=Cathode	IL766B-1	400 Min., I_F=1 mA	5300 V_{RMS}	60	No base pin connection.	5–140
			IL766B-2	900 Min., I_F=0.5 mA				

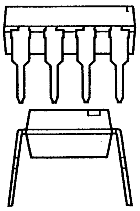
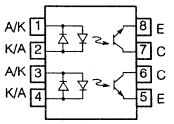
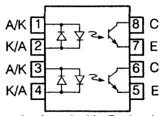
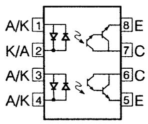
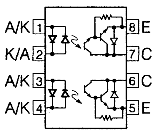
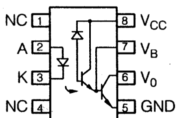
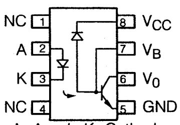
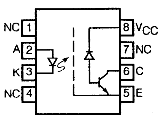
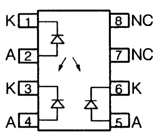
Optocouplers (Continued)

Package Outline	Type	Schematic	Part Number	Current Transfer Ratio (%) I_F=10 mA		Isolation Test Voltage	BV_{CEO}	Features	Page
6 Pin DIP 	Split collector transistor		SFH636	19 Min., I_F=16 mA		5300 V_{RMS}	NA	No base lead. High CMR. High speed.	5–260
	SCR output		H11C4	11 mA	LED trigger current	5300 V_{RMS}	Fwd. blocking voltage V_{DRM}=600 V	Optically coupled SCR	5–55
			H11C5	11 mA					
			H11C6	14 mA					
			IL400	10 mA					5–116
			4N39	14 mA					5–36
	Triac output		IL410	2 mA	LED trigger current	5300 V_{RMS}	600 V	Optically coupled triac driver. Zero crossing detector. High dv/dt.	5–117
			IL4108	2 mA		5300 V_{RMS}	800 V		5–141
			IL4116	1.3 mA max.		5300 V_{RMS}	600 V	Optically coupled triac driver. Zero crossing detector. AlGaAs LED. Very low input LED current.	5–143
			IL4117				700 V		
			IL4118				800 V		
			IL420	2 mA max.		5300 V_{RMS}	600 V	Optically coupled triac driver. High dv/dt. Low input required.	5–123
			IL440	10 mA max.		3750VAC$_{RMS}$	600 V		5–127
			IL4208	2 mA max.		5300 V_{RMS}	800 V		5–146
			IL4216	1.3 mA max.		5300 V_{RMS}	600 V	Optically coupled triac driver. AlGaAs LED. Very low input LED current.	5–148
			IL4217				700 V		
			IL4218				800 V		
	MOSFET driver		IL485	8 V min. output		5300 V_{RMS}	300 V be-tween pins 5 and 6	Fast turn-on, turn-off.	5–129
	Solid state relay		LH1056 Normally open	I_{FT}=2.5 mA max.	Turn-on current	3750V_{RMS}	350	Solid state relay. Single pole single throw (SPST) solid state relay. Controls AC or DC load current up to 100 mA.	5–198
			LH1298 Normally closed	I_{FT}=2.5 mA max.		3750V_{RMS}	350		5–201

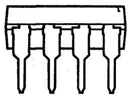
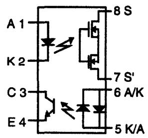
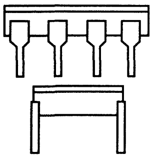
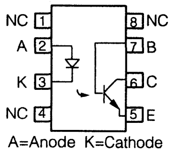
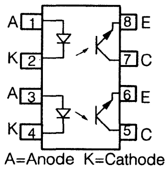
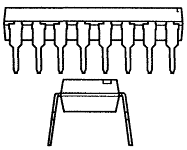
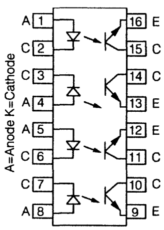
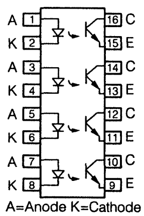
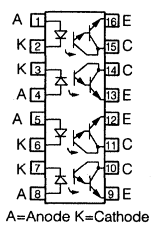
Optocouplers (Continued)

Package Outline	Type	Schematic	Part Number	Current Transfer Ratio (%) I_F=10 mA	Isolation Test Voltage	BV_{CEO}	Features	Page
6 Pin DIP 	Solid state relay		LH1540	I_{FT}=2.0 mA	3750V_{RMS}	350	High voltage solid state relay.	5–205
			LH1550	I_{FT}=2.5 mA	3750V_{RMS}	350	High voltage solid state relay.	5–208
	Phototransistor/Dual	 A=Anode K=Cathode	ILCT6	20 Min.	5300V_{RMS}	30	TRIOS (TRansparent IOn Shield).	5–151
			ILD1	20–300	5300V_{RMS}	50		5–154
			ILD2	100–500				
			ILD5	50–400		70		
	Phototransistor/Dual	 A=Anode K=Cathode	ILD3	300, I_F=1.6 mA	5300V_{RMS}	50	High CTR at low current.	5–158
			ILD74	12.5	5300V_{RMS}	20	TRIOS (TRansparent IOn Shield).	5–73
			MCT6	20 Min.	5300 V_{RMS}	30	Low cost industry standard.	5–213
8 Pin DIP 	Phototransistor/Dual	 K=Cathode	ILD610-1	40–80	5300V_{RMS}	70	Repetitive pinout of emitter and detector. CTR groupings.	5–171
			ILD610-2	63–125				
			ILD610-3	100–200				
			ILD610-4	160–320				
		 K=Cathode	ILD615-1	160–320	5300V_{RMS}	70	Repetitive pinout—emitter and detector. CTR groupings.	5–174
			ILD615-2	63–125				
			ILD615-3	100–200				
			ILD615-4	160–320				
			ILD621	50–600 (I_F=5 mA)	5300V_{RMS}	70	Repetitive pinout—emitter and detector. CTR groupings.	5–183
			ILD621GB	100–600 (I_F=5 mA)				
	Photodarlington/Dual	 A=Anode K=Cathode	ILD30	100 Min.	5300V_{RMS}	30	High gain.	5–64
			ILD31	200 Min.				
			ILD55	100 Min.		55		
			ILD32	500 Min.		30		5–160
		 A=Anode K=Cathode	ILD66-1	100 Min., I_F=2 mA	5300V_{RMS}	60	Internal R_{BE} for high stability.	5–68
			ILD66-2	300 Min., I_F=2 mA				
			ILD66-3	400 Min., I_F=0.7 mA				
			ILD66-4	500 Min., I_F=2 mA				

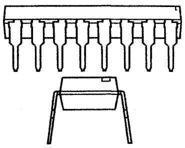
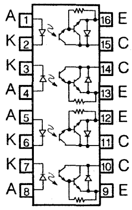
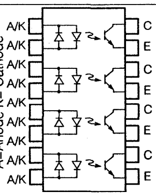
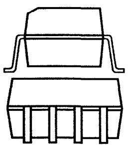
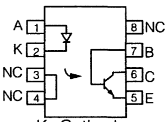
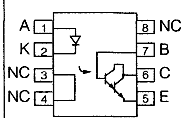
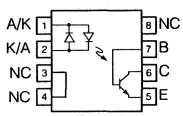
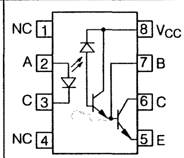
Optocouplers (Continued)

Package Outline	Type	Schematic	Part Number	Current Transfer Ratio (%) I_F=10 mA		Isolation Test Voltage	BV_{CEO}	Features	Page
8 Pin DIP 	AC/bidirectional/Dual	 A=Anode K= Cathode	ILD250	50 Min.		$5300V_{RMS}$	70	2:1 CTR matching.	5–92
			ILD251	20 Min.					
			ILD252	100 Min.					
			ILD255	50 Min.		$5300V_{RMS}$	70	Bidirectional input.	5–166
		 A=Anode K=Cathode	ILD620	50–600	I_F=5 mA	$5300V_{RMS}$	70	Repetitive pinout—emitter and detector.	5–179
			ILD620GB	100–600					
	AC/bidirect/Darlington	 A=Anode K=Cathode	ILD755-1	750 Min., I_F=2 mA		$5300V_{RMS}$	60	High CTR. AC/bidirect/Darlington	5–132
			ILD755-2	1000 Min., I_F=1 mA					
	AC/bidirect/Darlington	 A=Anode K=Cathode	ILD766-1	500 Min., I_F=2 mA		$5300V_{RMS}$	60	Internal R_{BE} for better stability.	5–137
			ILD766-2	500 Min., I_F=1 mA					
	Photo IC Output/Single	 A=Anode K=Cathode	6N138	300 Min.	I_F=1.6 mA	$2500V_{RMS}$	NA	High gain. Low input forward current.	5–40
			6N139	500 Min.					
			SFH6138	300 Min.		$5300V_{RMS}$	NA	High gain. Low input forward current.	5–270
			SFH6139	500 Min.					
		 A=Anode K=Cathode	6N135	16 (≥7)	I_F=16 mA	$2500V_{RMS}$	NA	High speed, high bit rates—1 Mbits.	5–37
			6N136	35 (≥19)					
			SFH6135	16 (≥7)		$5300V_{RMS}$	NA	High speed, high bit rates—1 Mbits.	5–267
			SFH6136	35 (≥19)					
		 A=anode K=Cathode	SFH6345	30 (≥19)	I_F=16 mA	$5300V_{RMS}$	NA	15 KV/µs common mode immunity.	5–279
	Linear		IL300	Gain Ratio Categories: A,B,C,D,E,F,G,H,I,J		$5300V_{RMS}$	15	0.05% servo linearity.	5–98

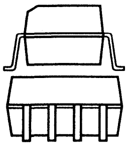
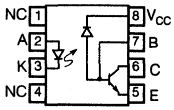
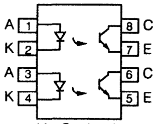
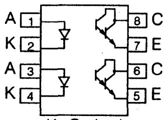
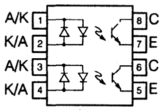
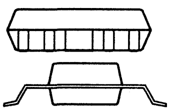
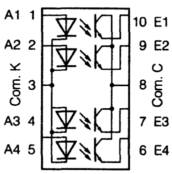
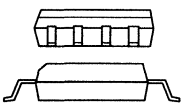
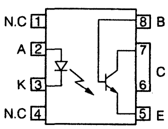
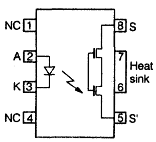
Optocouplers (Continued)

Package Outline	Type	Schematic	Part Number	Current Transfer Ratio (%) I_F=10 mA	Isolation Test Voltage	BV_{CEO}	Features	Page
8 Pin DIP 	Telecom switch		LH1529	I_{FT}=2.0 mA max. (Turn-on current)	3750 V_{RMS}	350	Solid state relay and optocoupler in one package.	5–202
8 Pin DIP Ceramic 	Hermetic		ILH100	100 Min.	3000 V_{RMS}	70	Single channel. hermetically sealed, ceramic package. High CTR at low input current.	5–187
	Hermetic		ILH200	100 Min.	3000 V_{RMS}	70	Dual channel. hermetically sealed, ceramic package. High CTR at low input current.	5–194
16 Pin DIP 	Phototransistor/Quad		ILQ1	20–300	5300 V_{RMS}	50	TRIOS (TRansparent IOn Shield).	5–154
			ILQ2	100–500		70		
			ILQ5	50–400		50		
			ILQ3	300 Min. I_F=1.6 mA	5300 V_{RMS}	70	High CTR at low current.	5–158
			ILQ74	12.5 Min.	5300 V_{RMS}	20	TRIOS (TRansparent IOn Shield).	5–73
	Phototransistor/Quad		ILQ615-1	40–80	5300 V_{RMS}	70	Repetitive pinout—emitter and detector.	5–174
			ILQ615-2	63–125				
			ILQ615-3	100–200				
			ILQ615-4	160–132				
			ILQ621	50–600 (I_F=5 mA)	5300 V_{RMS}	70	Repetitive pinout—emitter and detector.	5–183
			ILQ621GB	100–600 (I_F=5 mA)				
	Photodarlington/Quad		ILQ30	100 Min.	5300 V_{RMS}	30	High gain.	5–64
			ILQ31	200 Min.		30		
			ILQ55	100 Min.		55		
			ILQ32	500 Min.		30		5–160

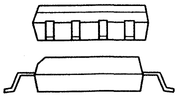
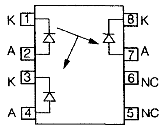
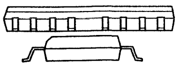
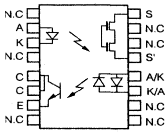
Optocouplers (Continued)

Package Outline	Type	Schematic	Part Number	Current Transfer Ratio (%) I_F=10 mA		Isolation Test Voltage	BV_{CEO}	Features	Page
16 Pin DIP 	Photodarlington/Quad		ILQ66-1	100 Min., I_F=2 mA		5300V_{RMS}	60	Internal R_{BE} for high stability.	5–68
			ILQ66-2	300 Min., I_F=2 mA					
			ILQ66-3	400 Min., I_F=0.7 mA					
			ILQ66-4	500 Min., I_F=2 mA					
	AC/bidirectional		ILQ620	50–600	I_F=5 mA	5300V_{RMS}	70	Repetitive pinout—emitter and detector.	5–179
			ILQ620GB	100–600					
SOIC-8 	Phototransistor/Single		IL205A	40–80		2500 V_{RMS}	70	Double molded package. Small outline surface mount. 0.05” standard lead spacing. Available on tape and reel, add “T” suffix to part number.	5–80
			IL206A	63–125					
			IL207A	100–200					
			IL208A	160–320					
			IL211A	20 Min.		2500 V_{RMS}	30		5–83
			IL212A	50 Min.					
			IL213A	100 Min.					
			IL215A	20 Min.	I_F=1mA	2500 V_{RMS}	30		5–86
			IL216A	50 Min.					
			IL217A	100 Min.					
	Photodarlington		IL221A	100 Min.	I_F=1mA	2500 V_{RMS}	30	Double molded package. Small outline surface mount. 0.05” standard lead spacing. Available on tape and reel, add “T” suffix to part number.	5–89
			IL222A	200 Min.					
			IL223A	500 Min.					
	Bidirectional		IL256A	20 Min.		2500 V_{RMS}	30		5–95
	Photo IC		SFH6318	300-2000	I_F=1.6 mA	2500 V_{RMS}	NA	High gain, low input forward current.	5–276
			SFH6319	500–3500					

Optocouplers (Continued)

Package Outline	Type	Schematic	Part Number	Current Transfer Ratio (%) I_F=10 mA		Isolation Test Voltage	BV_{CEO}	Features	Page
SOIC-8 	Photo IC		SFH6315	7–50	I_F=1.6 mA	2500 V_{RMS}	NA	High speed 1 Mbit.	5–272
			SFH6316	19–50					
			SFH6343	36 (≥15)			NA	High speed 1 Mbit. High CMR, 15 kV/µsec.	
	Phototransistor/Dual	 K=Cathode	ILD205	40–80		2500V_{RMS}	70	Small outline surface mount SOIC-8 footprint. 0.05" standard lead spacing. Available on tape and reel.	5–162
			ILD206	63–125					
			ILD207	100–200					
			ILD211	20 Miin.		2500V_{RMS}	70		
			ILD213	100 Miin.					
			ILD217	100 Miin.					
	PD/Dual	 K=Cathode	ILD223	500 Min., I_F=1 mA		2500V_{RMS}	30		5–164
	AC/Bidirect/Dual	 K=Cathode	ILD256	20 Min.		2500V_{RMS}	30		5–168
SOT223/10 	Low current input		SFH6941-3	100–200	I_F=1 mA	2500 VDC		Ultra compact package, common cathode, common collector configuration.	5–282
			SFH6941-4	160–320					
			SFH6941-5	250–500					
PCMCIA package 2 mm high, 8 pin 	Phototransistor		IL352	100	I_F=1 mA	2500V_{RMS}	30	Application: PCMCIA fax/ modem.	5–111
	Solid Sate Relay		IL356	I_{FT}=0.3 mA	Turn-on current	2500V_{RMS}	350	Application: PCMCIA fax/ modem.	5–114

Optocouplers (Continued)

Package Outline	Type	Schematic	Part Number	K1, 2 mA	K3 bins	Withstand Test Voltage	Linearity	Application	Page
PCMCIA package 2 mm high, 8 pin 	Linear		IL350	0.003	A–J	2500V_{RMS}	0.01% servo linearity	Application: PCMCIA fax/ modem.	5–109
			IL351	0.005	D,E,F,G				
			IL358	0.008	D,E,F,G				
			IL359	0.008	E,F				
PCMCIA package 2 mm high, 18 pin 	Telecom switch		IL329	I_{FT}=0.5 mA	NA	2500V_{RMS}	NA	Application: PCMCIA fax/ modem.	5–106

Optocoupler–Agency Table

	UL E52744 System Code	CSA LRD93751	DIN VDE 0884	BSI IEC 65	BSI IEC950 EN60950	FIMKO IEC 65	FIMKO IEC950 EN60950	DEMKO	SEMKO	CECC
4N25/4N26/4N27/4N28	H or J	X	X	X	X	X	X			
4N32/4N33	H or J	X	X	X	X	X	X			
4N35/4N36/4N37	H or J	X	X	X	X	X	X			
4N38	H or J			X	X	X	X			
4N39	H or J			X	X	X	X			
6N135/6N136	H		X					X		
6N138/6N139	H		X							
CNY17/CNY17F	H or J	a	X	X	X	X	X	X		
H11A1/H11A2/H11A3/H11A4/H11A5	H or J	X	X	X	X	X	X			
H11AA1	H	X	X	X	X	X	X			
H11B1/H11B2/H11B3	H or J	X	X	X	X	X	X			
H11C4/H11C5/H11C6	H or J	a	X	X	X	X	X			
H11D1/H11D2/H11D3	H or J	a	X	X	X	X	X			
IL1/IL2/IL5	H or J	X	X	X	X	X	X			
IL30/IL31	H or J	X	X	X	X	X	X			
IL55	H or J	a	X	X	X	X	X			
IL55B	H or J	a	a	X	X	X	X			
IL66	H or J	X	X	X	X	X	X			
IL66B	H or J	a	X	X	X	X	X			
IL74	H or J	X	X	X	X	X	X			
IL201/IL202/IL203	H or J	X	X	X	X	X	X			
IL205A/IL206A/IL207A/IL208A	Y									
IL211A/IL212A/IL213A	Y									
IL215A/IL216A/IL217A	Y									
IL221A/IL222A/IL223A	Y									
IL250/IL251/IL252	H	X	X	X	X	X	X			
IL256A	Y									
IL300	H		X	X	X	X	X			
IL329										
IL350/351/352/356/358/359										
IL400	H	X	X	X	X	X	X			
IL410	H	X	X	X	X	X	X			
IL420	H	X	X	X	X	X	X			
IL440				X	X	X	X			
IL485	J									
IL755	H	X	X	X	X	X	X			
IL755B	H	a	X	X	X	X	X			
IL766	H	a	X	X	X	X	X			
IL766B	H	a	X	X	X	X	X			
IL4108/ IL4208	H			X	X	X	X			

Optocoupler–Agency Table	UL E52744 System Code	CSA LRD93751	DIN VDE 0884	BSI	BSI	FIMKO	FIMKO	DEMKO	SEMKO	CECC
				IEC 65	IEC950 EN60950	IEC 65	IEC950 EN60950			
IL4116/IL4117/IL4118	H	a	X	X	X	X	X			
IL4216/IL4217/IL4218	H	a	X	X	X	X	X			
ILCT6	H	X	X	X	X	X	X			
ILD1/ILD2/ILD5	H	X	X	X	X	X	X			
ILD3	H		a	X	X	X	X			
ILD30/ILD31/ILD32	H	X	X	X	X	X	X			
ILD55	H	X	X	X	X	X	X			
ILD66	H	X	X	X	X	X	X			
ILD74	H	X	X	X	X	X	X			
ILD205/ILD206/ILD207	Y									
ILD211/ILD213	Y									
ILD217	Y									
ILD223	Y									
ILD250/ILD251/ILD252	H	a	X	X	X	X	X			
ILD255	H	a	X	X	X	X	X			
ILD256	Y									
ILD610	H	X	X	X	X	X	X			
ILD615	H	a	X	X	X	X	X			
ILD620/ILD620GB	H	a	X	X	X	X	X			
ILD621/ILD621GB	H	a	X	X	X	X	X			
ILD755	H	a	X	X	X	X	X			
ILD766	H	a	X	X	X	X	X			
ILH100										
ILH200										
ILQ1/ILQ2/ILQ5	H	X	X	X	X	X	X			
ILQ3	H		a	X	X	X	X			
ILQ30/ILQ31/ILQ32	H	X	X	X	X	X	X			
ILQ55	H	X	X	X	X	X	X			
ILQ66	H	X	X	X	X	X	X			
ILQ74	H	X	X	X	X	X	X			
ILQ615	H	a	X	X	X	X	X			
ILQ620/ILQ620GB	H	a	X	X	X	X	X			
ILQ621/ILQ621GB	H	a	X	X	X	X	X			
LH1056	H	a		X	X	X	X			
LH1298	H	a		X	X	X	X			
LH1529	H	a		X	X	X	X			
LH1540	H	a								
LH1550	H									
MCA230/MCA231/MCA255	H or J	X	X	X	X	X	X			
MCT2	H or J	X	X							

Optocoupler–Agency Table	UL E52744 System Code	CSA LRD93751	DIN VDE 0884	BSI	BSI	FIMKO	FIMKO	DEMKO	SEMKO	CECC
				IEC 65	IEC950 EN60950	IEC 65	IEC950 EN60950			
MCT2E	H or J	X	X	X	X	X	X			
MCT6	H	X	X	X	X	X	X			
MCT270 - MCT275	H or J	X	X	X	X	X	X			
MCT276/277	H or J		X	X	X	X	X			
MCT5210/MCT5211	H or J	a	X	X	X	X	X			
MOC8050	H or J			X	X	X	X			
MOC8111	H or J			X	X	X	X			
SFH600	J	a	X	X	X	X	X	X		X
SFH601	J	a	X	X	X	X	X	X		
SFH608	J	a	X	X	X	X	X			
SFH610	N		X	X	X	X	X	X		X
SFH610A/611A	H or J		X	X	X	X	X			
SFH611	N		X	X	X			X		X
SFH615	N	a	X	X	X			X		
SFH615A/SFH617A	H or J		X	X	X	X	X			
SFH615AA/SFH615AGB	H or J		X	X	X	X	X			
SFH617G	N		X	X	X				X	
SFH618	N		X	X	X					
SFH618A/628A	H or J		X	X	X	X	X			
SFH620	N		X	X	X					
SFH620A	H or J		X	X	X	X	X			
SFH620AA/SFH620AGB	H or J		X	X	X	X	X			
SFH628	N		X	X	X					
SFH636	J	a	a							
SFH640	J	a	X	X	X	X	X			
SFH6106	H or J	a	X	X	X	X	X			
SFH6116	H or J	a	X	X	X	X	X			
SFH6135/SFH6136	H		X							
SFH6138/SFH6139	H or J		X							
SFH6156	H or J	a	X	X	X	X	X			
SFH6186	H or J	a	X	X	X	X	X			
SFH6206	H or J	a	X	X	X	X	X			
SFH6286	H or J	a	X	X	X	X	X			
SFH6315/16/18/19	Y									
SFH6343	Y									
SFH6345	H		a							
SFH6941										
		X=available	a=pending approval							

Optocoupler Options

Siemens offers couplers in single, dual, quad, and small outline surface mount packages. The coupler types offered are high reliability, high voltage, triacs and linear, and high current transfer ratio. In addition to our true surface mount couplers, most of the standard couplers can be ordered with optional gull wing, surface mount lead bends. All surface mount lead couplers are available on tape and reel.

All couplers are recognized under the Component Program of Underwriters Laboratories, File #E52744.

Options:
1. Safe electrical isolation per VDE #0884.
2. Very high long-term stability of coupling factor (CTR).
3. Specified characteristics from 0°C to 70°C.
4. Faster switching times.
6. Wide lead spacing: 0.4" (10.16).
7. Surface mount leads (SMD).
9. Surface mount leads (SMD).

Examples of ordering optocouplers with options:
1. IL420 with option 1: IL420-X001
2. IL420 with option 1 and option 6: IL420-X016

The following optocouplers have been replaced by options:

Old Part No.	**New Part No.**
4N25-004	4N25-X009
4N25-009	4N25-X009
CNY17GF	CNY17F-X006
SFH601G	SFH601-X006
SFH6016	SFH601-X007
SFH6011	SFH601-X003
SFH606	SFH600-1X004

Device	Option 1	Option 2	Option 3	Option 4	Option 6	Option 7	Option 9
4N25/26/27/28	X				X	X	X
4N32/33	X				X	X	X
4N35/36/37	X				X	X	X
4N38					X	X	X
4N39					X	X	X
6N135/136	X				X	X	X
6N138/139	X				X	X	X
CNY17/CNY17F	X	X			X	X	X
H11A1/2/3/4/5	X				X	X	X
H11AA1	X				X	X	X
H11B1/2/3	X				X	X	X
H11C4/5/6	X				X	X	X
H11D1/2/3	X				X	X	X
IL1/2/5	X				X	X	X
IL30/31/55	X				X	X	X
IL55B	X				X	X	X
IL66	X				X	X	X

Device	Option 1	Option 2	Option 3	Option 4	Option 6	Option 7	Option 9
IL66B	X				X	X	X
IL74	X				X	X	X
IL201/2/3	X				X	X	X
IL205/6/7/8A							
IL211/2/3A							
IL215/6/7A							
IL221/2/3A							
IL250/1/2	X				X	X	X
IL256A							
IL300	X				X	X	X
IL329							
IL350/1/8/9							
IL352							
IL356							
IL400	X				X	X	X
IL410	X				X	X	X
IL420	X				X	X	X
IL440					X	X	X
IL485					X	X	X
IL755	X				X	X	X
IL755B	X				X	X	X
IL766	X				X	X	X
IL766B	X				X	X	X
IL4108					X	X	X
IL4116/7/8	X				X	X	X
IL4208					X	X	X
IL4216/7/8	X				X	X	X
ILCT6	X				X	X	X
ILD1/2/5	X				X	X	X
ILD3	X				X	X	X
ILD30/31/55	X				X	X	X
ILD32	X				X	X	X
ILD66	X				X	X	X
ILD74	X				X	X	X
ILD205/6/7/11/13/17							
ILD223							
ILD250/1/2	X				X	X	X

Device	Option 1	Option 2	Option 3	Option 4	Option 6	Option 7	Option 9
ILD255	X				X	X	X
ILD256							
ILD610	X				X	X	X
ILD615	X				X	X	X
ILD620/ILD620GB	X				X	X	X
ILD621/ILD621GB	X				X	X	X
ILD755	X				X	X	X
ILD766	X				X	X	X
ILH100							
ILH200							
ILQ1/2/5	X				X	X	X
ILQ3	X				X	X	X
ILQ30/31/55	X				X	X	X
ILQ32	X				X	X	X
ILQ66	X				X	X	X
ILQ74	X				X	X	X
ILQ615	X				X	X	X
ILQ620/ILQ620GB	X				X	X	X
ILQ621/ILQ621GB	X				X	X	X
LH1056					X	X	X
LH1298					X	X	X
LH1529					X	X	X
LH1540					X	X	X
LH1550					X	X	X
MCA230/231/255	X				X	X	X
MCT2/MCT2E	X				X	X	X
MCT6	X				X	X	X
MCT270–MCT277	X				X	X	X
MCT5210/5211	X				X	X	X
MOC8050					X	X	X
MOC8111					X	X	X
SFH600	X	X	X	X	X	X	X
SFH601	X	X	X		X	X	X
SFH608	X				X	X	X
SFH610/11/15	X	X	X		X		
SFH610A/611A/615A/617A	X	X	X		X		
SFH615AA/AGB	X	X			X		

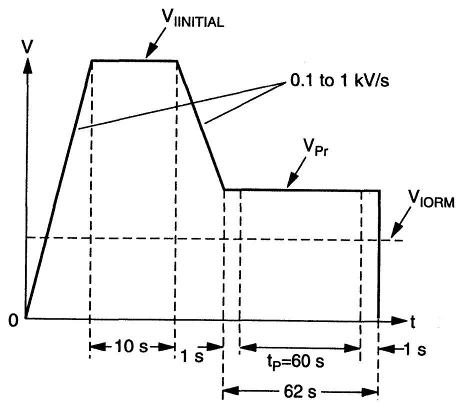
Device	Option 1	Option 2	Option 3	Option 4	Option 6	Option 7	Option 9
SFH617G	X	X	X				
SFH618	X				X		
SFH618A/628A	X				X		
SFH620	X				X		
SFH620A	X				X		
SFH620AA/AGB	X				X		
SFH628	X				X		
SFH636	X				X	X	X
SFH640	X				X	X	X
SFH6106	X						
SFH6116	X						
SFH6135/6136	X				X	X	X
SFH6138/6139	X				X	X	X
SFH6156	X						
SFH6206	X						
SFH6186	X						
SFH6286	X						
SFH6315/6316/6343							
SFH6318/6319							
SFH6345	X				X	X	X
SFH6941							

Option 1
Optocouplers for Safe Electrical Insulation per DIN VDE 0884*

These optocouplers are suitable for safe electrical insulation only within the safety maximum ratings. Compliance with the safety maximum ratings must be ensured by protective circuits.

The partial discharge measurement ensures that no partial discharge occurs during operation at maximum permissible operating insulation voltage (V_{IORM}). Permanent partial discharge affects the insulating materials and can result in a high-voltage breakdown.

Time-Test Voltage Diagram per DIN VDE 0884*

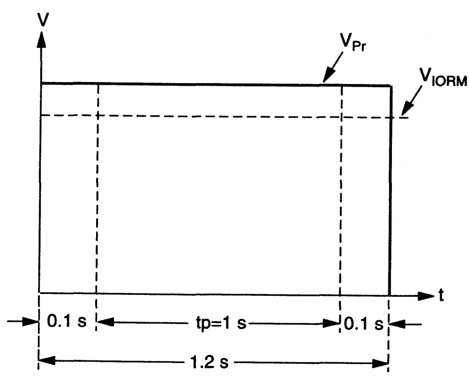


tp-measuring time for partial discharge

Procedure a. Type & sampling tests, destructive tests

It is recommended that tests with the insulation test voltage (V_{ISOL}) should not be made, otherwise partial discharge may occur impairing the insulation characteristics. Thus partial discharges also may occur at the maximum permissible operating insulation voltage.

The insulation test per DIN VDE 0884 is carried out after all the other high voltage tests.



tp-measuring time for partial discharge

Procedure b. Routine tests, non-destructive tests

* DIN VDE 0884, edition June 1992

Optocouplers for safe electrical insulation per DIN VDE 0884*

Option 1: Insulation Characteristics

Description	Symbol	System 1	System 2	System 3 **	System 4 **	System 4 **	System 5 **	Unit
		DIP 4	4N25/26/27/28	SFH610-..	IL410	IL300	6N135	
		SFH610A-..	4N35/36/37	SFH611-..	IL420		6N136	
		SFH611A-..	4N32/33	SFH615-..			SFH6135	
		SFH615A-..	CNY17-..	SFH617G-..			SFH6136	
		SFH615AA-..	CNY17F-..	SFH618-..			6N138	
		SFH615AGB-..	H11A-..	SFH620-..			SFH6138	
		SFH617A-..	H11AA1	SFH628-..			SFH6139	
		SFH618A-..	H11B1-..				6N139	
		SFH620A-..	H11C-..					
		SFH620AA-..	H11D-..					
		SFH620AGB-..	IL1/2/5/74					
		SFH628A-..	IL2B-..					
		SFH6106-..	IL30/31/55					
		SFH6116-..	IL66-..					
		SFH6156-..	IL66B-..					
		SFH6186-..	IL201/202/203					
		SFH6206-..	IL250/251/252					
		SFH6286-..	IL400					
		DIP 8	IL755-..					
		ILCT6	IL755B-..					
			IL766-..					
		ILD1/2/5/74	IL766B-..					
		ILD3	MCA230/231					
		ILD30/31/55	MCA255					
		ILD32	MCT2/2E					
		ILD66-..	MCT270/271/272					
		ILD250/1/2	MCT273/274/275					
		ILD255	MCT276/277					
		ILD610-..	MCT5210/5211					
		ILD615-..	SFH600-..					
		ILD620-..	SFH601-..					
		ILD621-..	SFH608-..					
		ILD755-..	SFH640-..					
		ILD766-..						
		MCT6						
		DIP 16						
		ILQ1/2/5/74						
		ILQ3						
		ILQ30/31/55						
		ILQ32						
		ILQ66-..						
		ILQ615-..						
		ILQ620-..						
		ILQ621-..						

Optocoupler Options

Description	Symbol	System 1	System 2	System 3 **	System 4 **	System 4 **	System 5 **	Unit
Installation Category (DIN VDE 0110) for rated line voltages ≤300 V_{RMS} for rated line voltages ≤600 V_{RMS} for rated line voltages ≤1000 V_{RMS}		 I–IV I–III –	 I–IV I–III –	 I–IV I–III –	 I–IV I–III –	 I–IV I–III –	 I–IV I–III –	
IEC climatic category (DIN IEC 68 part 1/9.80)		55/100/21	55/100/21	55/100/21	55/100/21	55/100/21	55/100/21	
Pollution degree (DIN VDE 0110 part 1/ 1.89)		2	2	2	2	2	2	
Maximum Operation Insulation Voltage (1)	V_{IORM}	890	890	890	850	850	630	V
Test voltage input/output, procedure b (1) V_{Pr}=1.875 x V_{IORM}, Routine 100% test, t_P=1 s Partial Discharge <5 pC	V_{Pr}	1669	1669	1669	1594	1594	1181	V
Test voltage input/output, procedure b (1) V_{Pr}=1.5 x V_{IORM}, Type and sampling test, t_P=60 s Partial Discharge <5 pC	V_{Pr}	1335	1335	1335	1275	1275	945	V
Maximum permissible overvoltage (Transient overvoltage)	V_{IOTM}	6000	8000	6000	6000	6000	6000	V
Partial Discharge Test Voltage(1)	$V_{INITIAL}$	6000	8000	6000	6000	6000	6000	V
Safety maximum ratings (maximum permissible ratings in case of a fault, also refer to diagram) Package temperature Current (input current I_F, P_{Si}=0, T_A=25°C) Derating with higher ambient temperature Power (Output or total power dissipation, T_A=25°C) Derating with higher ambient temperature	 T_{Si} I_{Si} ΔI_{Si} P_{Si} ΔP_{Si}	 175 400 –2.67 700 –4.67	 175 400 –2.67 700 –4.67	 175 400 –2.67 700 –4.67	 165 250 –1.79 500 –3.57	 165 235 –1.68 465 –3.32	 175 300 –2 500 –3.33	 °C mA mA/K mW mW/K
Insulation resistance at T_{Si} $V_{I/O}$=500 V	R_{IS}	≥10^9	≥10^9	≥10^9	≥10^9	≥10^9	≥10^9	Ω

All voltages referred to are peak values except otherwise specified.
1. See time-test voltage diagram
*DIN VDE 0884, edition June 1992
**Approved per DIN VDE edition August 1987
Testing input/output voltage requires all input pins and all output pins to be shorted.
Option1: Tested per DIN VDE 0884

Option 6: Wide lead spacing (10.16 mm, creepage/clearance distances >8 mm)
Option 7: Surface mount leads (creepage/clearance distances >8 mm)
Option 9: Surface mount leads
See CECC 00802, edition 1, for soldering conditions for SMT devices (option 7 and 9).
Systems 1 (4 pin coupler) and 2 are approved for class A
"-.." means dash selections.

Option 2
High-Rel Optocoupler With Very High Long-Term Stability of Coupling Factor (CTR)

Each optocoupler is tested for its degradation characteristics (change of current transfer ratio). The degradation behavior of the optocouplers tested during a short burn-in provides information on the long-term stability. Only optocouplers showing a minimum change in the current transfer ratio during burn-in are supplied. These optocouplers feature excellent long-term stability.

Test procedure:

• First data logging

The coupling factor (CTR_I) at I_F=1 mA, V_{CE}=5 V is logged.

• Load

Short-time burn-in: The emitter is loaded with a forward current of I_F=200 mA at room temperature (25°C) for 30 minutes.

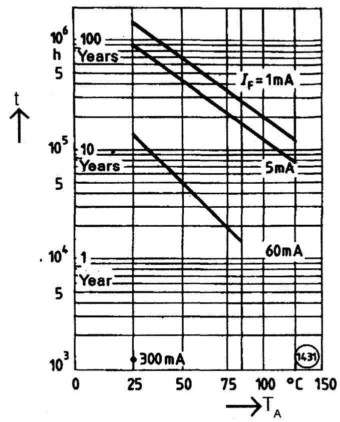
• Second data logging

The coupling factor (CTR_2) at I_F=1 mA, V_{CE}=5 V is logged.

• Evaluation

Determination of the relative change of the coupling factor: ΔCTR (%) = 100 x (1-CTR_2/CTR_I)

The change of the coupling factor ΔCTR caused by the burn-in may not be greater than a defined range. Thus the high long-term stability of the coupling factor shown in the graph can be specified. All couplers show a similar degradation behavior meaning that even after a longer operating time the coupling factor spread is not very wide.



Service life relative to temperature and current-load

Average expected service life extrapolated from laboratory tests. The end of the service life is defined as the time when the CTR falls to 50% of the initial value. Confidence level is 90%.

Optocouplers (Optoisolators)

5

Option 3
Optocouplers With Specified Characteristics From 0°C to 70°C

Parameter	Symbol	Values	Unit
Emitter (IR GaAs LED)			
Forward voltage (I_F = 60 mA)	V_F	1.25 (≤1.65)	V
Breakdown voltage (I_R = 10 μA)	V_{BR}	≥6	
Reverse current (V_R= 6 V)	I_R	0.01 (≤10)	μA
Detector (Si phototransistor)			
Collector-emitter breakdown voltage (I_{CE} = 10 μA)	V_{CEO}	≥70	V
Emitter-base breakdown voltage (I_{EBO} = 10 μA)	V_{EBO}	≥7	
Optocoupler			
Collector-emitter saturation voltage (I_F = 10 mA, I_C= 2.5 mA)	V_{CEsat}	0.25 (≤0.4)	V

These optocouplers are grouped according to their current transfer ratio I_C/I_F at V_{CE} = 5 V and are marked by dash numbers.

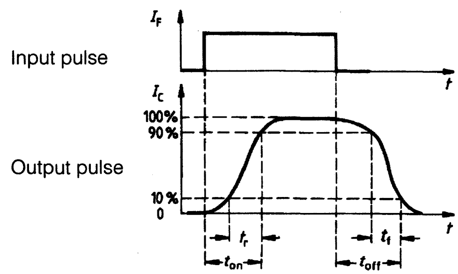
Parameter	Symbol	Values				Unit
Dash Numbers		**–1**	**–2**	**–3**	**–4**	
Dash Numbers for SFH600 only		**–0**	**–1**	**–2**	**–3**	
Current transfer ratio	I_C/I_F					
(I_F= 10 mA)		35–85	55–135	80–210	140–340	%
(I_F= 1 mA)		30 (>10)	45 (>17)	70 (>28)	90 (>45)	
Collector-emitter leakage current (V_{CE} = 10 V)	I_{CEO}	≤500	≤500	≤1000	≤1000	nA

Option 4
Selection of Optocouplers With Fast Switching Time (For SFH 600 Only)

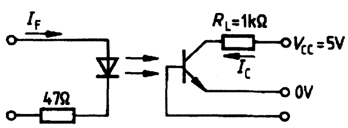
These optocouplers comply with the switching times listed in the table below. In addition, the devices are 100% tested to ensure the values.

Parameter	Symbol	Values			Unit
		-0 I_F = 20 mA	-1 I_F = 10 mA	-2 I_F = 10 mA	
Turn-on time	t_{on}	≤4.5	≤4.5	≤4.5	µs
Rise time	t_r	≤3	≤3	≤3	
Turn-off time	t_{off}	≤12	≤14	≤20	
Fall time	t_f	≤7	≤10	≤12	

Pulse Definition



Test circuit (saturated, V_{CEsat} ≤0.4 V)



Optocouplers (Optoisolators) 5

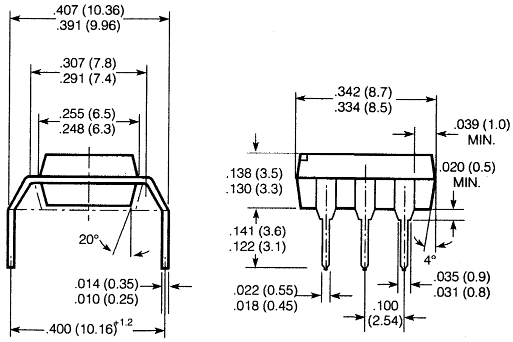
Option 6
Leads with 0.4" (10.16 mm) Spacing

The leads of the optocouplers are bent according to a spacing of 0.4" (10.16 mm). Dimensions deviating from the standard type are:

Lead spacing	10.16 mm (0.4")
Creepage distance	>8.0 mm
Clearance	>8.0 mm

This version additionally complies with the following standards:

- IEC 950 DIN VDE 0805/05 90 (System 2 and 3 only) Reinforced insulation up to an operating voltage of 400 V_{RMS} or DC



Clearance-creepage distance = 8.0 min

See standard version for pin configuration.

Option 7
Lead Bends for Surface Mount (SMD) Optocouplers

These optocouplers are suitable for surface mounting. Dimensions deviating from the standard type are:

Creepage distance	>8.0 mm
Clearance	>8.0 mm

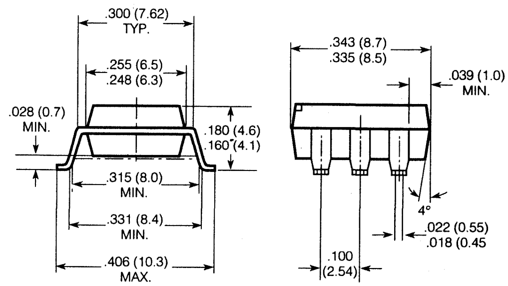
This version additionally complies with the following standards:

- IEC 950 DIN VDE 0805/05 90 (System 2 and 3 only) Reinforced insulation up to an operating voltage of 400 V_{RMS} or DC

During the soldering process, the package should not be wetted with tin-lead solder to prevent the impairment of the isolation features. Apart from iron soldering, only reflow soldering methods (vapor phase, infrared and hot gas) are permissible.

Permissible soldering conditions:
260°C at 10 seconds to 215°C at 30 seconds

The soldering process may be repeated two times at the most. Attention must be paid to the cooling down of the device to 25°C between the soldering processes.



Clearance and creepage distances must be considered for the solder pad design.

Clearance-creepage distance = 8.0 min.

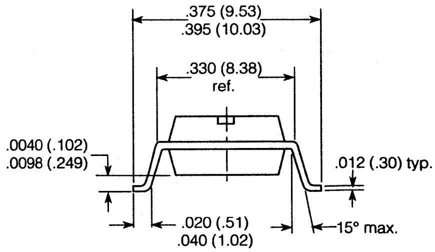
See standard version for pin configuration.

Option 9 Lead Bends for Surface Mount (SMD) Optocouplers

During the soldering process, the package should not be wetted with tin-lead solder to prevent the impairment of the isolation features. Apart from iron soldering, only reflow soldering methods (vapor phase, infrared and hot gas) are permissible.

Permissible soldering conditions:
260°C at 10 seconds to 215°C at 30 seconds

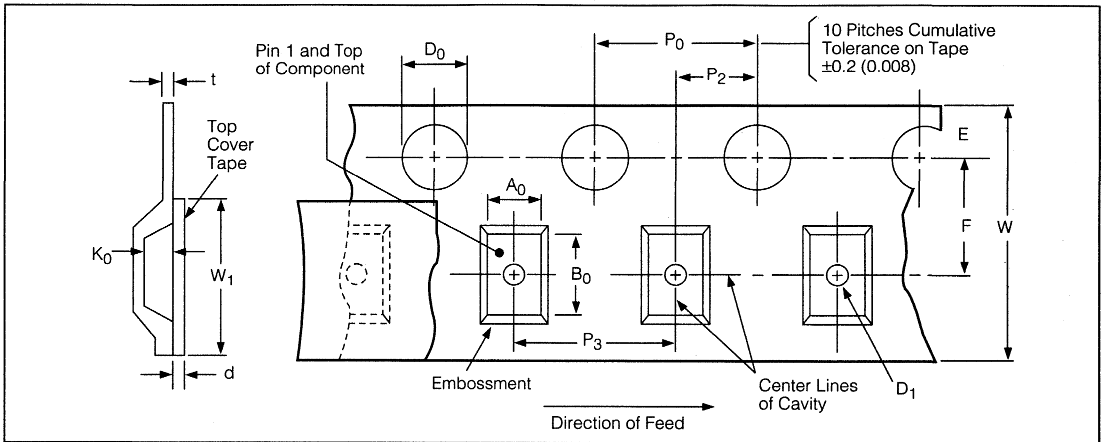
The soldering process may be repeated two times at the most. Attention must be paid to the cooling down of the device to 25°C between the soldering processes.



Tape and Reel Packaging for SOIC8-A Optocouplers

All SOIC8-A optocouplers are available in tape and reel format. To order any surface mount IL2XXA optocoupler on tape and reel, add a suffix "T" after the part number, i.e., IL207T.

The tape is 16 mm and is wound on a 33 cm reel. There are 2000 parts per reel. Taped and reeled SOIC8-A optocouplers conform to EIA-481-2.

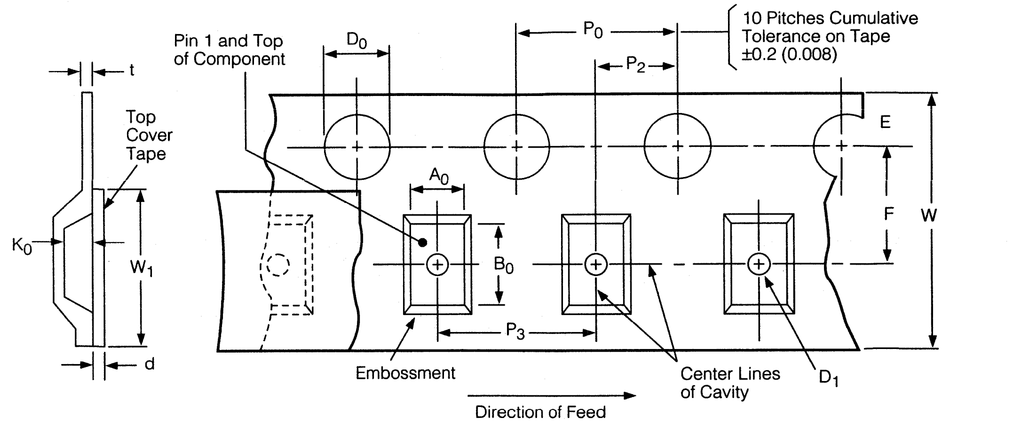


Description	Symbol	Dimensions in Inches (mm) SOIC8-A	Notes
Tape width	W	.630 ±.012 (16.0 ±.3)	
Carrier tape thickness	t	.012 (0.3) max.	
Pitch of sprocket holes	P_0	.157 ±.004 (4 ±0.1)	Cummulative pitch error +0.2 mm/10 pitches
Diameter of sprocket holes	D_0	.059 (1.5) min	
Distance of sprocket holes	E	.069 ±.004 (1.75 ±0.1)	
Distance of compartment	F P_2	.295 ±.004 (7.5 ±.05) .079 ±.002 (2 ±0.05)	Center hole to center compartment
Distance of compartment to compartment	P_3	.315 ±.004 (8.0 ±0.1)	
Compartment	K_0 A_0 B_0	.142 (3.6) .256 (6.5) .252 (6.4)	
Hole in compartment	D_1	.059 (1.5)	
Width of fixing tape	W_1 d	.523 (13.3) .004 (0.1) max.	The fixing tape shall not cover the sprocket holes, nor protrude beyond the carrier tape so not to exceed maximum tape width
Device tilt in the compartment		10° max.	
Minimum bending radius		1.18 (30)	

Tape and Reel Packaging for Dual SOIC8 Optocouplers

All dual SOIC8 optocouplers are available in tape and reel format. To order any surface mount ILD2XX optocoupler on tape and reel, add a suffix "T" after the part number, i.e., ILD207AT.

The tape is 16 mm and is wound on a 33 cm reel. There are 2000 parts per reel. Taped and reeled dual SOIC8 optocouplers conform to EIA-481-2.

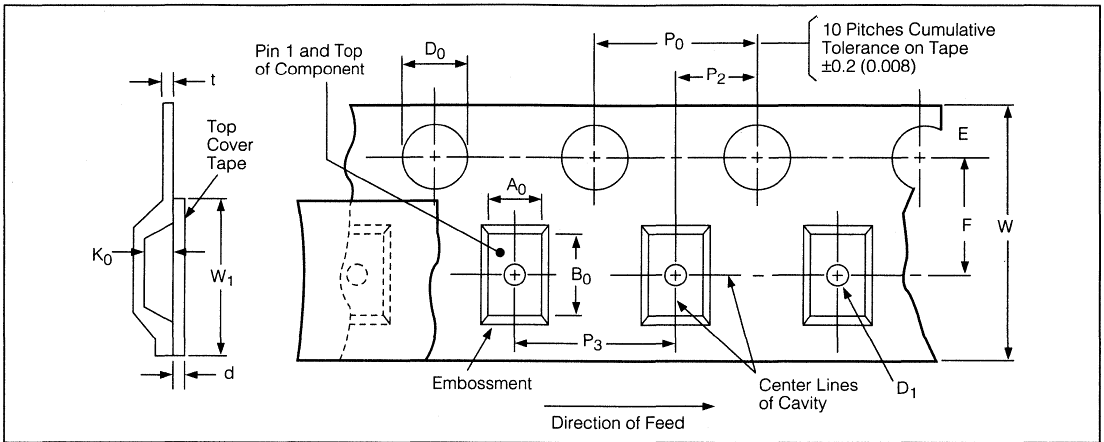


Description	Symbol	Dimensions in Inches (mm) Dual SOIC8	Notes
Tape width	W	.630 ±.012 (16.0 ±.3)	
Carrier tape thickness	t	.012 (0.3) max.	
Pitch of sprocket holes	P_0	.157 ±.004 (4 ±0.1)	Cummulative pitch error +0.2 mm/10 pitches
Diameter of sprocket holes	D_0	.059 (1.5) min	
Distance of sprocket holes	E	.069 ±.004 (1.75 ±0.1)	
Distance of compartment	F P_2	.300 ±.002 (7.5 ±.05) .079 ±.002 (2 ±0.05)	Center hole to center compartment
Distance of compartment to compartment	P_3	.480 ±.004 (12.0 ±0.1)	
Compartment	K_0 A_0 B_0	.155 (3.95) .266 (6.75) .256 (6.4)	
Hole in compartment	D_1	.059 (1.5)	
Width of fixing tape	W_1 d	.523 (13.3) .004 (0.1) max.	The fixing tape shall not cover the sprocket holes, nor protrude beyond the carrier tape so not to exceed maximum tape width
Device tilt in the compartment		10° max.	
Minimum bending radius		1.18 (30)	

Tape and Reel Packaging for 4-Pin Optocouplers

All 4-pin optocouplers are available in tape and reel format. To order any SFH6XX6 optocoupler on tape and reel, add a suffix "T" after the part number, i.e., SFH6156-3T.

The tape is 16 mm and is wound on a 33 cm reel. There are 1000 parts per reel. Taped and reeled 4-pin optocouplers conform to EIA-481-2.

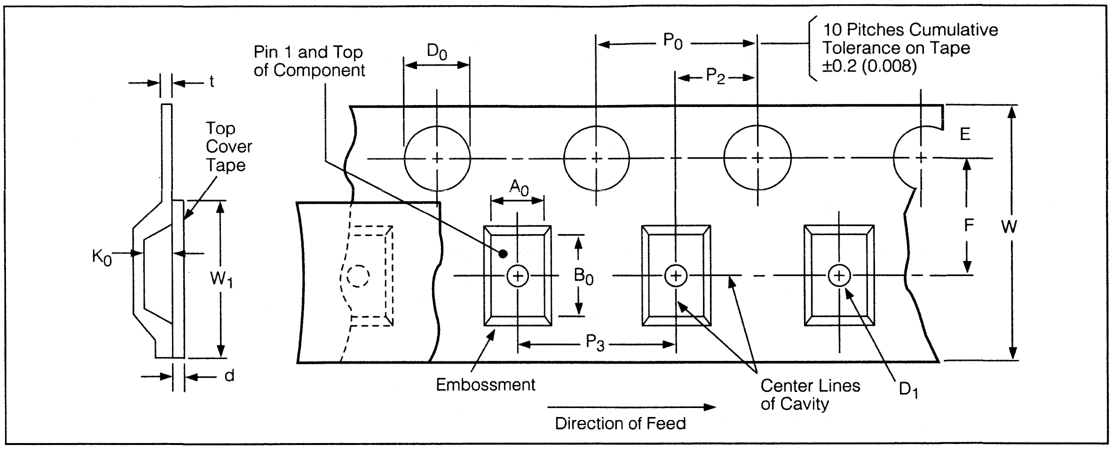


Description	Symbol	Dimensions in Inches (mm) 4-Pin	Notes
Tape width	W	.630 ±.012 (16.0 ±.3)	
Carrier tape thickness	t	.012 (0.3) max.	
Pitch of sprocket holes	P_0	.157 ±.004 (4 ±0.1)	Cummulative pitch error +0.2 mm/10 pitches
Diameter of sprocket holes	D_0	.059 (1.5) min	
Distance of sprocket holes	E	.069 ±.004 (1.75 ±0.1)	
Distance of compartment	F P_2	.295 ±.002 (7.5 ±.05) .079 ±.002 (2 ±0.05)	Center hole to center compartment
Distance of compartment to compartment	P_3	.472 (12.0)	
Compartment	K_0 A_0 B_0	.158 (4.01) .402 (10.21) .198 (5.03)	
Hole in compartment	D_1	.059 (1.5)	
Width of fixing tape	W_1 d	.523 (13.3) .004 (0.1) max.	The fixing tape shall not cover the sprocket holes, nor protrude beyond the carrier tape so not to exceed maximum tape width
Device tilt in the compartment		10° max.	
Minimum bending radius		1.18 (30)	

Tape and Reel Packaging for 6-Pin Optocouplers with Option 7

All 6-pin optocouplers with Option 7 are available in tape and reel format. To order any 6-pin optocoupler with Option 7 on tape and reel, add a suffix "T" after the option, i.e., CNY17-3X007T.

The tape is 16 mm and is wound on a 33 cm reel. There are 1000 parts per reel. Taped and reeled 6-pin optocouplers conform to EIA-481-2.

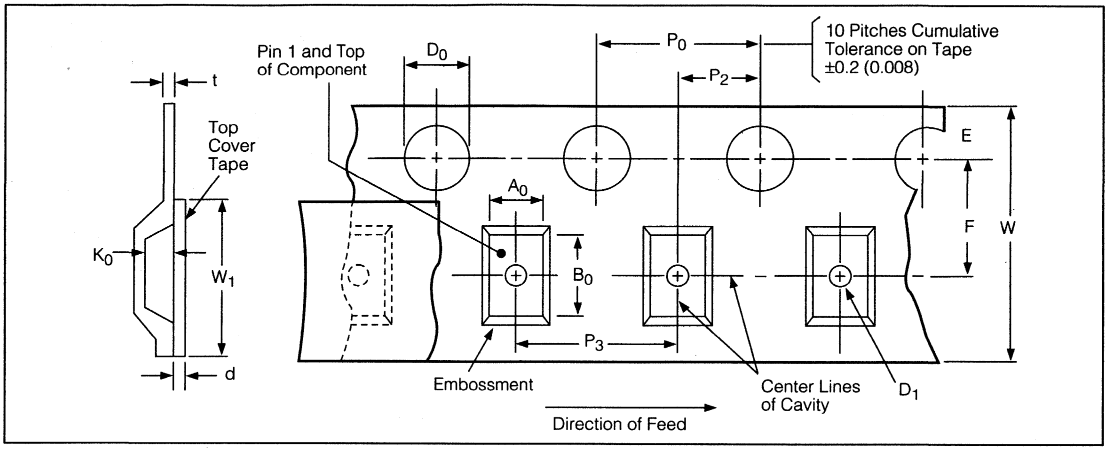


Description	Symbol	Dimensions in Inches (mm) 6-Pin with Option 7	Notes
Tape width	W	.630 ±.012 (16.0 ±.3)	
Carrier tape thickness	t	.012 (0.3) max.	
Pitch of sprocket holes	P_0	.157 ±.004 (4 ±0.1)	Cummulative pitch error +0.2 mm/10 pitches
Diameter of sprocket holes	D_0	.059 (1.5) min	
Distance of sprocket holes	E	.069 ±.004 (1.75 ±0.1)	
Distance of compartment	F P_2	.295 ±.002 (7.5 ±.05) .079 ±.002 (2 ±0.05)	Center hole to center compartment
Distance of compartment to compartment	P_3	.472 (12.0)	
Compartment	K_0 A_0 B_0	.180 (4.57) .410 (10.4) .362 (9.2)	
Hole in compartment	D_1	.059 (1.5)	
Width of fixing tape	W_1 d	.523 (13.3) .004 (0.1) max.	The fixing tape shall not cover the sprocket holes, nor protrude beyond the carrier tape so not to exceed maximum tape width
Device tilt in the compartment		10° max.	
Minimum bending radius		1.18 (30)	

Tape and Reel Packaging for 6-Pin Optocouplers with Option 9

All 6-pin optocouplers with Option 9 are available in tape and reel format. To order any 6-pin optocoupler with Option 9 on tape and reel, add a suffix "T" after the option, i.e., CNY17-3X009T.

The tape is 16 mm and is wound on a 33 cm reel. There are 1000 parts per reel. Taped and reeled 6-pin optocouplers conform to EIA-481-2.

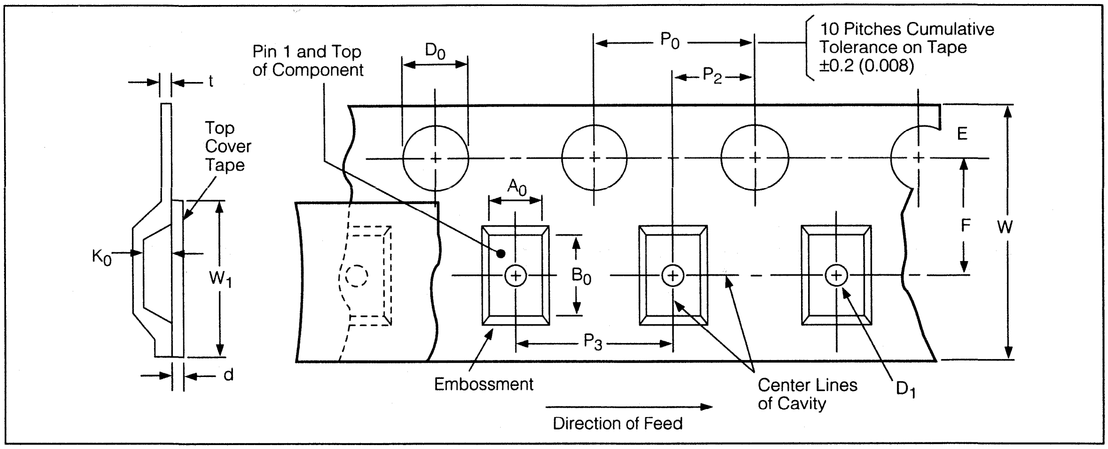


Description	Symbol	Dimensions in Inches (mm) 6-Pin with Option 9	Notes
Tape width	W	.630 ±.012 (16.0 ±.3)	
Carrier tape thickness	t	.012 (0.3) max.	
Pitch of sprocket holes	P_0	.157 ±.004 (4 ±0.1)	Cummulative pitch error +0.2 mm/10 pitches
Diameter of sprocket holes	D_0	.059 (1.5) min	
Distance of sprocket holes	E	.069 ±.004 (1.75 ±0.1)	
Distance of compartment	F P_2	.295 ±.002 (7.5 ±.05) .079 ±.002 (2 ±0.05)	Center hole to center compartment
Distance of compartment to compartment	P_3	.472 (12.0)	
Compartment	K_0 A_0 B_0	.158 (4.01) .402 (10.21) .362 (9.2)	
Hole in compartment	D_1	.059 (1.5)	
Width of fixing tape	W_1 d	.523 (13.3) .004 (0.1) max.	The fixing tape shall not cover the sprocket holes, nor protrude beyond the carrier tape so not to exceed maximum tape width
Device tilt in the compartment		10° max.	
Minimum bending radius		1.18 (30)	

Tape and Reel Packaging for 8-Pin Optocouplers with Option 7

All 8-pin optocouplers with Option 9 are available in tape and reel format. To order any 8-pin optocoupler with Option 7 on tape and reel, add a suffix "T" after the option, i.e., ILCT6-X007T.

The tape is 16 mm and is wound on a 33 cm reel. There are 1000 parts per reel. Taped and reeled 8-pin optocouplers conform to EIA-481-2.

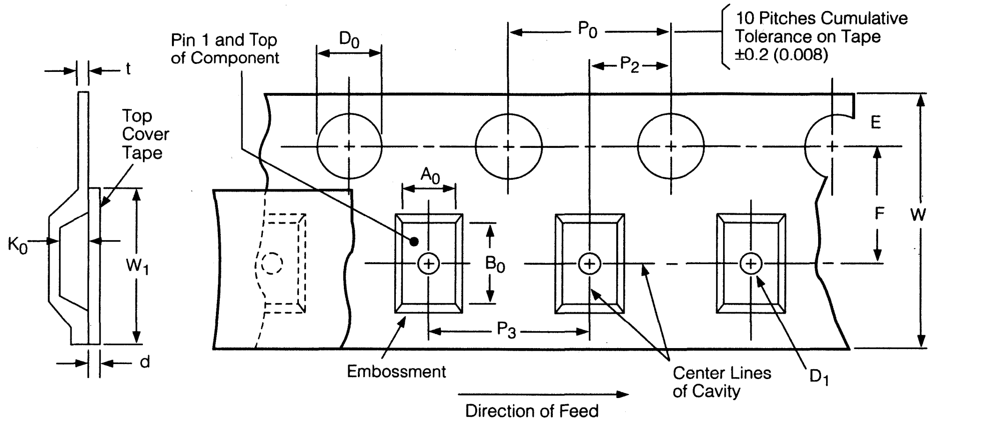


Description	Symbol	Dimensions in Inches (mm) 8-Pin with Option 7	Notes
Tape width	W	.630 ±.012 (16.0 ±.3)	
Carrier tape thickness	t	.012 (0.3) max.	
Pitch of sprocket holes	P_0	.157 ±.004 (4 ±0.1)	Cummulative pitch error +0.2 mm/10 pitches
Diameter of sprocket holes	D_0	.059 (1.5) min	
Distance of sprocket holes	E	.069 ±.004 (1.75 ±0.1)	
Distance of compartment	F P_2	.295 ±.002 (7.5 ±.05) .079 ±.002 (2 ±0.05)	Center hole to center compartment
Distance of compartment to compartment	P_3	.472 (12.0)	
Compartment	K_0 A_0 B_0	.180 (4.57) .410 (10.41) .406 (10.3)	
Hole in compartment	D_1	.059 (1.5)	
Width of fixing tape	W_1 d	.523 (13.3) .004 (0.1) max.	The fixing tape shall not cover the sprocket holes, nor protrude beyond the carrier tape so not to exceed maximum tape width
Device tilt in the compartment		10° max.	
Minimum bending radius		1.18 (30)	

Tape and Reel Packaging for 8-Pin Optocouplers with Option 9

All 8-pin optocouplers with Option 9 are available in tape and reel format. To order any 8-pin optocoupler with Option 9 on tape and reel, add a suffix "T" after the option, i.e., ILCT6-X009T.

The tape is 16 mm and is wound on a 33 cm reel. There are 1000 parts per reel. Taped and reeled 8-pin optocouplers conform to EIA-481-2.

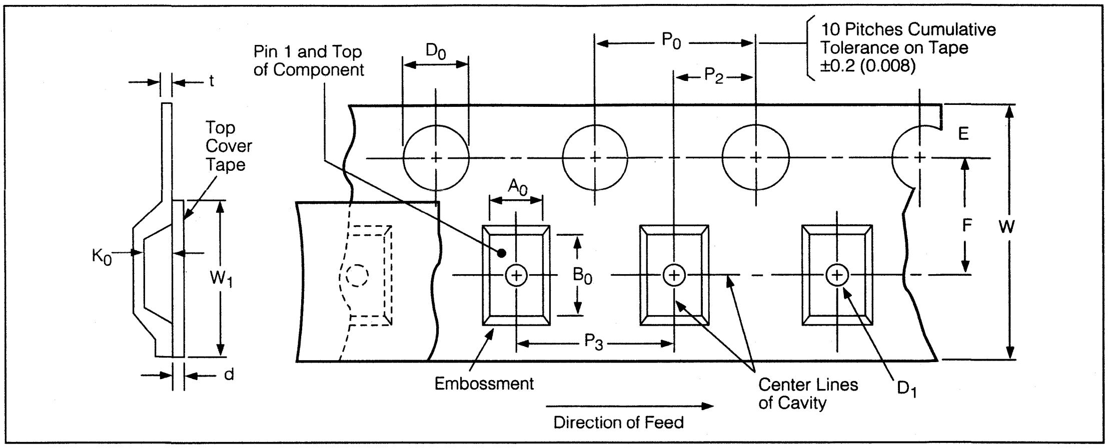


Description	Symbol	Dimensions in Inches (mm) 8-Pin with Option 9	Notes
Tape width	W	.630 ±.012 (16.0 ±.3)	
Carrier tape thickness	t	.012 (0.3) max.	
Pitch of sprocket holes	P_0	.157 ±.004 (4 ±0.1)	Cummulative pitch error +0.2 mm/10 pitches
Diameter of sprocket holes	D_0	.059 (1.5) min	
Distance of sprocket holes	E	.069 ±.004 (1.75 ±0.1)	
Distance of compartment	F P_2	.295 ±.002 (7.5 ±.05) .079 ±.002 (2 ±0.05)	Center hole to center compartment
Distance of compartment to compartment	P_3	.472 (12.0)	
Compartment	K_0 A_0 B_0	.167 (4.24) .402 (10.2) .406 (10.3)	
Hole in compartment	D_1	.059 (1.5)	
Width of fixing tape	W_1 d	.523 (13.3) .004 (0.1) max.	The fixing tape shall not cover the sprocket holes, nor protrude beyond the carrier tape so not to exceed maximum tape width
Device tilt in the compartment		10° max.	
Minimum bending radius		1.18 (30)	

Tape and Reel Packaging for 16-Pin Optocouplers with Option 7

All 16-pin optocouplers with Option 7 are available in tape and reel format. To order any 16-pin optocoupler with Option 7 on tape and reel, add a suffix "T" after the option, i.e., ILQ-X007T.

The tape is 32 mm and is wound on a 33 cm reel. There are 750 parts per reel. Taped and reeled 16-pin optocouplers conform to EIA-481.

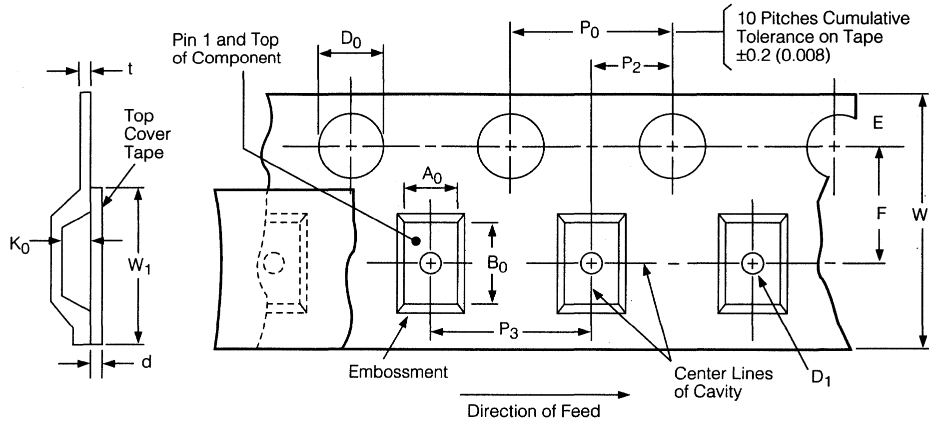


Description	Symbol	Dimensions in Inches (mm) 16-Pin with Option 7	Notes
Tape width	W	1.260 (32)	
Carrier tape thickness	t	.012 (0.3) max.	
Pitch of sprocket holes	P_0	.157 ±.004 (4 ±0.1)	Cummulative pitch error +0.2 mm/10 pitches
Diameter of sprocket holes	D_0	.059 (1.5) min	
Distance of sprocket holes	E	.069 ±.004 (1.75 ±0.1)	
Distance of compartment	F P_2	.559 ±.002 (14.2 ±.05) .079 ±.002 (2 ±0.05)	Center hole to center compartment
Distance of compartment to compartment	P_3	.630 (16.0)	
Compartment	K_0 A_0 B_0	.180 (4.57) .410 (10.41) .805 (20.45)	
Hole in compartment	D_1	.079 (2.0)	
Width of fixing tape	W_1 d	1.116 (28.4) .004 (0.1) max.	The fixing tape shall not cover the sprocket holes, nor protrude beyond the carrier tape so not to exceed maximum tape width
Device tilt in the compartment		10° max.	
Minimum bending radius		1.18 (30)	

Tape and Reel Packaging for 16-Pin Optocouplers with Option 9

All 16-pin optocouplers with Option 9 are available in tape and reel format. To order any 16-pin optocoupler with Option 9 on tape and reel, add a suffix "T" after the option, i.e., ILQ1-X009T.

The tape is 32 mm and is wound on a 33 cm reel. There are 750 parts per reel. Taped and reeled 16-pin optocouplers conform to EIA-481.

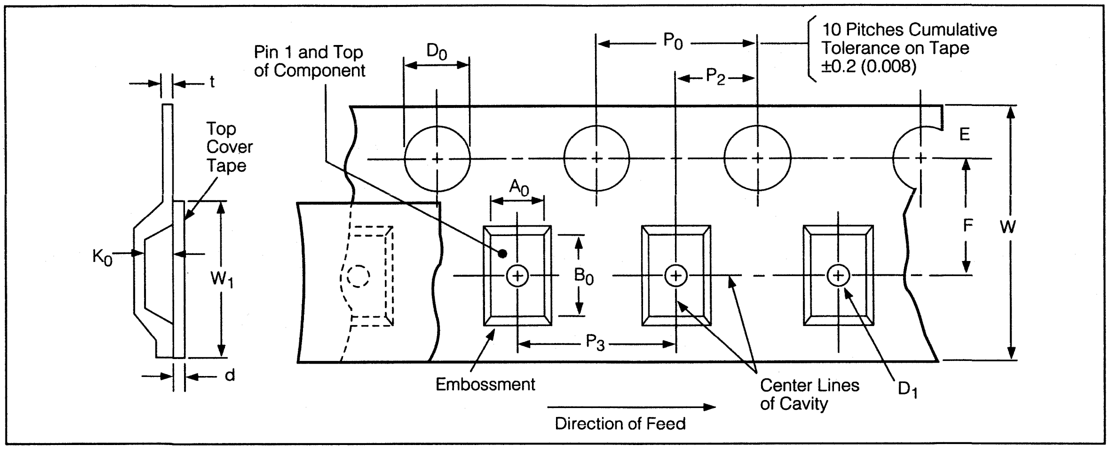


Description	Symbol	Dimensions in Inches (mm) 16-Pin with Option 9	Notes
Tape width	W	1.260 (32)	
Carrier tape thickness	t	.012 (0.3) max.	
Pitch of sprocket holes	P_0	.157 ±.004 (4 ±0.1)	Cummulative pitch error +0.2 mm/10 pitches
Diameter of sprocket holes	D_0	.059 (1.5) min	
Distance of sprocket holes	E	.069 ±.004 (1.75 ±0.1)	
Distance of compartment	F P_2	.559 ±.002 (14.2 ±.05) .079 ±.002 (2 ±0.05)	Center hole to center compartment
Distance of compartment to compartment	P_3	.630 (16.0)	
Compartment	K_0 A_0 B_0	.167 (4.25) .408 (10.35) .813 (20.65)	
Hole in compartment	D_1	.079 (2.0)	
Width of fixing tape	W_1 d	1.116 (28.4) .004 (0.1) max.	The fixing tape shall not cover the sprocket holes, nor protrude beyond the carrier tape so not to exceed maximum tape width
Device tilt in the compartment		10° max.	
Minimum bending radius		1.18 (30)	

Tape and Reel Packaging for 8-Pin 2 mm Optocouplers

All 8-pin 2 mm optocouplers are available in tape and reel format. To order any 8-pin 2 mm optocoupler on tape and reel, add a suffix "T" after the part number.

The tape is 16 mm and is wound on a 33 cm reel. There are 2000 parts per reel. Taped and reeled 8-pin 2mm optocouplers conform to EIA-481.

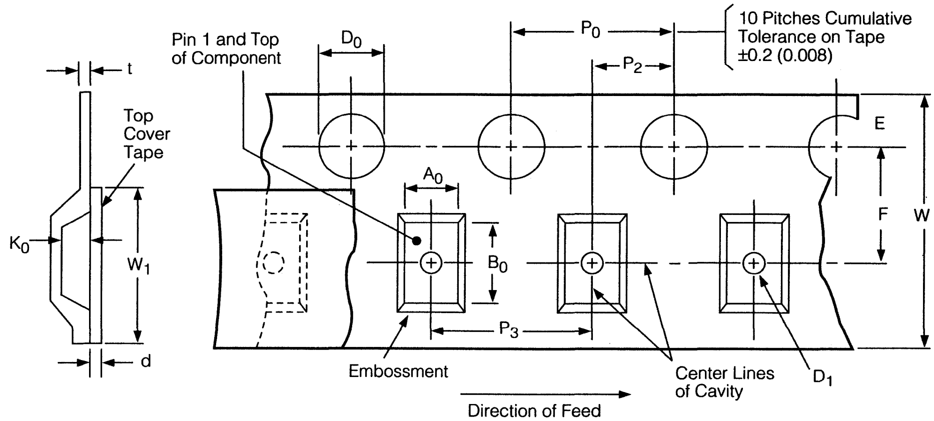


Description	Symbol	Dimensions in Inches (mm) 2 mm Package	Notes
Tape width	W	.630 ±.012 (16.0 ±.3)	
Carrier tape thickness	t	.012 (0.3) max.	
Pitch of sprocket holes	P_0	.157 ±.004 (4 ±0.1)	Cummulative pitch error +0.2 mm/10 pitches
Diameter of sprocket holes	D_0	.059 (1.5) min	
Distance of sprocket holes	E	.069 ±.004 (1.75 ±0.1)	
Distance of compartment	F P_2	.295 ±.002 (7.5 ±.05) .079 ±.002 (2 ±0.05)	Center hole to center compartment
Distance of compartment to compartment	P_3	.472 ±.004 (12.0 ±0.1)	
Compartment	K_0 A_0 B_0	.104 (2.65) .361 (9.17) .251 (6.38)	
Hole in compartment	D_1	.059 (1.5)	
Width of fixing tape	W_1 d	.523 (13.3) .004 (0.1) max.	The fixing tape shall not cover the sprocket holes, nor protrude beyond the carrier tape so not to exceed maximum tape width
Device tilt in the compartment		10° max.	
Minimum bending radius		1.18 (30)	

Tape and Reel Packaging for 10-Pin Mini-couplers

All 10-pin mini-couplers are available in tape and reel format. To order any surface mount optocoupler on tape and reel, add a suffix "T" after the part number.

The tape is 16 mm and is wound on a 33 cm reel. There are 2000 parts per reel. Taped and reeled 10-pin mini-couplers conform to EIA-481.



Description	Symbol	Dimensions in Inches (mm) 10-Pin Mini-coupler	Notes
Tape width	W	.630 (16.0)	
Carrier tape thickness	t	.012 (0.3) max.	
Pitch of sprocket holes	P_0	.157 ±.004 (4 ±0.1)	Cummulative pitch error +0.2 mm/10 pitches
Diameter of sprocket holes	D_0	.059 (1.5) min	
Distance of sprocket holes	E	.069 ±.004 (1.75 ±0.1)	
Distance of compartment	F P_2	.295 ±.002 (7.5 ±.05) .079 ±.002 (2 ±0.05)	Center hole to center compartment
Distance of compartment to compartment	P_3	.472 ±.004 (12.0 ±0.1)	
Compartment	K_0 A_0 B_0	.079 (2.0) .295 (7.5) .276 (7.0)	
Hole in compartment	D_1	.059 (1.5)	
Width of fixing tape	W_1 d	.523 (13.3) .004 (0.1) max.	The fixing tape shall not cover the sprocket holes, nor protrude beyond the carrier tape so not to exceed maximum tape width
Device tilt in the compartment		10° max.	
Minimum bending radius		1.18 (30)	

SIEMENS

PHOTOTRANSISTOR
INDUSTRY STANDARD SINGLE CHANNEL 6 PIN DIP OPTOCOUPLER

DEVICE TYPES

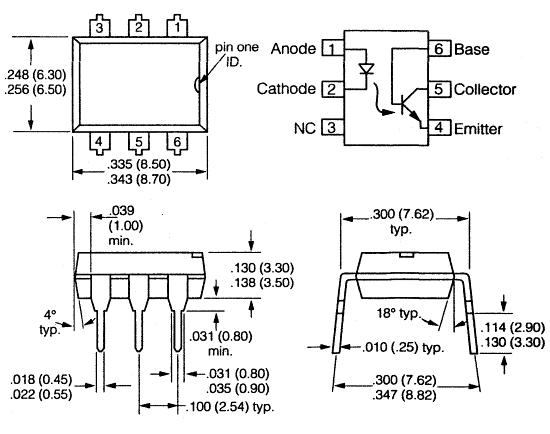
Part No.	CTR, % Min.	Part No.	CTR % Min.
4N25	20	MCT2	20
4N26	20	MCT2E	20
4N27	10	MCT270	50
4N28	10	MCT271	45–90
4N35	100	MCT272	75–150
4N36	100	MCT273	125–250
4N37	100	MCT274	225–400
4N38	10	MCT275	70–90
H11A1	50	MCT276	15–60
H11A2	20	MCT277	100
H11A3	20		
H11A4	10		
H11A5	30		

FEATURES
- **Interfaces with Common Logic Families**
- **Input-Output Coupling Capacitance < 0.5 pF**
- **Industry Standard Dual-in-Line 6 Pin Package**
- **Field Effect Stable by TRIOS**
- **5300 VAC_{RMS} Isolation Test Voltage**
- **Recognized under Underwriters Laboratory File #E52744**
- **VDE #0884 Approval Available with Option -001**

APPLICATIONS
- **AC Mains Detection**
- **Reed Relay Driving**
- **Switch mode Power Supply Feedback**
- **Telephone Ring Detection**
- **Logic Ground Isolation**
- **Logic Coupling with High Frequency Noise Rejection**

Notes:
1. TRIOS=TRansparent IOn Shield
2. Designing with data sheet is covered in Application Note 45, Application Notes section of Data Book.

Package Dimensions in Inches (mm)



DESCRIPTION

This data sheet presents five families of Siemens Industry Standard Single Channel Phototransistor Couplers. These families include the 4N25/26/27/28 types, the 4N35/36/37/38 couplers, the H11A1/A2/A3/A4/A5, the MCT2/2E, and MCT270/271/272/273/274/275/276/277 devices.Each optocoupler consists of Gallium Arsenide infrared LED and a silicon NPN phototransistor.

All couplers are Underwriters Laboratories (UL) listed to comply with a 7500 $V_{AC(PK)}$ Isolation Test Voltage. This isolation performance is accomplished through Siemens double molding isolation manufacturing process. Compliance to VDE 0884 partial discharge isolation specification is available for these families by ordering option -001. Phototransistor gain stability, in the presence of high isolation voltages, is insured by incorporating a TRansparent IOn Shield (TRIOS) on the phototransistor substrate. These isolation processes and the Siemens IS09001 Quality program results in the highest isolation performance available for a commercial plastic phototransistor optocoupler.

The devices are available in lead formed configuration suitable for surface mounting and are available either on tape and reel, or in standard tube shipping containers.

Maximum Ratings (T_A=25°C)

Emitter

Reverse Voltage .... 6 V

Forward Current .... 60 mA

Surge Current (t≤10 µs) .... 2.5 A

Power Dissipation .... 100 mW

Detector

Collector-Emitter Breakdown Voltage .... 70 V

Emitter-Base Breakdown Voltage .... 7 V

Collector Current .... 50 mA

Collector Current (t <1 ms) .... 100 mA

Power Dissipation .... 150 mW

Package

Isolation Test Voltage .... 5300 VAC_{RMS}

Maximum Ratings (continued)

Package (continued)

Creepage .... ≥7 mm

Clearance .... ≥7 mm

Isolation Thickness between
Emitter and Detector .... ≥0.4 mm

Comparative Tracking Index per DIN IEC
112/VDE0303, part 1 175

Isolation Resistance

V_{IO}=500 V, T_A=25°C .... 10^{12} Ω

V_{IO}=500 V, T_A=100°C .... 10^{11} Ω

Storage Temperature .... –55°C to +150°C

Operating Temperature .... –55°C to +100°C

Junction Temperature .... 100°C

Soldering Temperature (max. 10 s, dip soldering:
distance to seating plane ≥1.5 mm) .... 260°C

4N25/26/27/28

Characteristics (T_A=25°C)

Emitter	Symbol	Min.	Typ.	Max.	Unit	Condition
Forward Voltage*	V_F		1.3	1.5	V	I_F=50 mA
Reverse Current*	I_R		0.1	100	µA	V_R=3.0 V
Capacitance	C_0		25		pF	V_R=0
Detector						
Breakdown Voltage* Collector-Emitter Emitter-Collector Collector-Base	BV_{CEO} BV_{ECO} BV_{CBO}	30 7 70			V	I_C=1 mA I_E=100 µA I_C=100 µA
I_{CEO}(dark)* 4N25/26/27 4N28			5 10	50 100	nA	V_{CE}=10 V, (base open)
I_{CBO}(dark)*			2	20	nA	V_{CB}=10 V, (emitter open)
Capacitance, Collector-Emitter	C_{CE}		6		pF	V_{CE}=0
Package						
DC Current Transfer Ratio* 4N25/26 4N27/28	CTR	20 10	50 30		%	V_{CE}=10 V, I_F=10 mA
Isolation Voltage* 4N25 4N26/27 4N28	V_{IO}	2500 1500 500			V	Peak, 60 Hz
Saturation Voltage, Collector-Emitter	$V_{CE(sat)}$			0.5	V	I_{CE}=2.0 mA, I_F=50 mA
Resistance, Input to Output*	R_{IO}	100			GΩ	V_{IO}=500 V
Coupling Capacitance	C_{IO}		0.5		pF	f=1 MHz
Rise and Fall Times	t_R, t_F		2		µs	I_F=10 mA V_{CE}=10 V, R_E=100 Ω

* Indicates JEDEC registered values

Characteristics (T_A=25°C)

Emitter		Symbol	Min.	Typ.	Max.	Unit	Condition
Forward Voltage*		V_F	 0.9	1.3	1.5 1.7	V	I_F=10 mA I_F=10 mA, T_A=–55°C
Reverse Current*		I_R		0.1	10	µA	V_R=6.0 V
Capacitance		C_O		25		pF	V_R=0, f=1 MHz
Detector							
Breakdown Voltage, Collector-Emitter*	4N35/36/37 4N38	BV_{CEO}	30 80			V	I_C=1 mA
Breakdown Voltage, Emitter-Collector*		BV_{ECO}	7			V	I_E=100 µA
Breakdown Voltage, Collector-Base*	4N35/36/37 4N38	BV_{CBO}	70 80			V	I_C=100 µA, I_B=1 µA
Leakage Current, Collector-Emitter*	4N35/36/37 4N38	I_{CEO}		5	50 50	nA	V_{CE}=10 V, I_F=0 V_{CE}=60 V, I_F=0
Leakage Current, Collector-Emitter*	4N35/36/37 4N38	I_{CEO}		 6	500	µA	V_{CE}=30 V, I_F=0, T_A=100°C V_{CE}=60 V, I_F=0, T_A=100°C
Capacitance, Collector-Emitter		C_{CE}		6		pF	V_{CE}=0
Package							
DC Current Transfer Ratio*	4N35/36/37 4N38	CTR	100 20			%	V_{CE}=10 V, I_F=10 mA, V_{CE}=1 V, I_F=20 mA
DC Current Transfer Ratio*	4N35/36/37 4N38	CTR	40	50 30		%	V_{CE}=10 V, I_F=10 mA, T_A=–55 to 100°C
Resistance, Input to Output*		R_{IO}	10^{11}			Ω	V_{IO}=500 V
Coupling Capacitance*		C_{IO}		0.5		pF	f=1 MHz
Switching Time*		t_{ON}, t_{OFF}		10		µs	I_C=2 mA, R_E=100 Ω V_{CC}=10 V

* Indicates JEDEC registered values

Optocouplers (Optoisolators) 5

H11A1 through H11A5

Characteristics (T_A=25°C)

Emitter		Symbol	Min.	Typ.	Max.	Unit	Condition
Forward Voltage	H11A1–H11A4 H11A5	V_F		1.1 1.1	1.5 1.7	V	I_F=10 mA
Reverse Current		I_R			10	µA	V_R=3 V
Capacitance		C_0		50		pF	V_R=0, f=1 MHz
Detector							
Breakdown Voltage, Collector-Emitter		BV_{CEO}	30			V	I_C=1 mA, I_F=0 mA
Breakdown Voltage, Emitter-Collector		BV_{ECO}	7			V	I_E=100 µA, I_F=0 mA
Breakdown Voltage, Collector-Base		BV_{CBO}	70			V	I_C=10 µA, I_F=0 mA
Leakage Current, Collector-Emitter		I_{CEO}		5	50	nA	V_{CE}=10 V, I_F=0 mA
Capacitance, Collector-Emitter		C_{CE}		6		pF	V_{CE}=0
Package							
DC Current Transfer Ratio	H11A1 H11A2/3 H11A4 H11A5	CTR		50 20 10 30		%	V_{CE}=10 V, I_F=10 mA
Saturation Voltage, Collector-Emitter		V_{CEsat}			0.4	V	I_{CE}=0.5 mA, I_F=10 mA
Capacitance, Input to Output		C_{IO}		0.5		pF	
Switching Time		t_{ON}, t_{OFF}		3.0		µs	I_C=2 mA, R_E=100 Ω, V_{CE}=10 V

MCT2/MCT2E

Characteristics (T_A=25°C)

Emitter		Symbol	Min.	Typ.	Max.	Unit	Condition
Forward Voltage		V_F		1.1	1.5	V	I_F=20 mA
Reverse Current		I_R			10	µA	V_R=3 V
Capacitance		C_0		25		pF	V_R=0, f=1 MHz
Detector							
Breakdown Voltage	Collector-Emitter Emitter-Collector Collector-Base	BV_{CEO} BV_{ECO} BV_{CBO}	30 7 70			V	I_C=1 mA, I_F=0 mA I_E=100 µA, I_F=0 mA I_C=10 µA, I_F=0 mA
Leakage Current	Collector-Emitter Collector-Base	I_{CEO} I_{CBO}		5	50 20	nA	V_{CE}=10 V, I_F=0
Capacitance, Collector-Emitter		C_{CE}		10		pF	V_{CE}=0
Package							
DC Current Transfer Ratio		CTR	20	60		%	V_{CE}=10 V, I_F=10 mA
Capacitance, Input to Output		C_{IO}		0.5		pF	
Resistance, Input to Output		R_{IO}		100		GΩ	
Switching Time		t_{ON}, t_{OFF}		3.0		µs	I_C=2 mA, R_E=100 Ω, V_{CE}=10 V

MCT270 through MCT277

Characteristics (T_A=25°C)

Emitter		**Symbol**	**Min.**	**Typ.**	**Max.**	**Unit**	**Condition**
Forward Voltage		V_F			1.5	V	I_F=20 mA
Reverse Current		I_R			10	µA	V_R=3 V
Capacitance		C_O		25		pF	V_R=0, f=1 MHz
Detector							
Breakdown Voltage	Collector-Emitter	BV_{CEO}	30			V	I_C=10 µA, I_F=0 mA
	Emitter-Collector	BV_{ECO}	7				I_E=10 µA, I_F=0 mA
	Collector-Base	BV_{CBO}	70				I_C=10 µA, I_F=0 mA
Leakage Current, Collector-Emitter		I_{CEO}			50	nA	V_{CE}=10 V, I_F=0 mA
Package							
DC Current Transfer Ratio	MCT270	CTR	50			%	V_{CE}=10 V, I_F=10 mA
	MCT271		45	90			
	MCT272		75	150			
	MCT273		125	250			
	MCT274		225	400			
	MCT275		70	210			
	MCT276		15	60			
	MCT277		100				
Current Transfer Ratio Collector–Emitter	MCT271–276	CTR_{CE}	12.5			%	V_{CE}=0.4 V, I_F=16 mA
	MCT277		40				
Collector–Emitter Saturation Voltage		V_{CEsat}			0.4	V	I_{CE}=2 mA, I_F=16 mA
Capacitance, Input to Output		C_{IO}		0.5		pF	
Resistance, Input to Output		R_{IO}		10^{12}		Ω	V_{IO}=500 VDC
Switching Time	MCT270/272	t_{ON}, t_{OFF}		10		µs	I_C=2 mA, R_E=100 Ω, V_{CE}=5 V
	MCT271			7			
	MCT273			20			
	MCT274			25			
	MCT275/277			15			
	MCT276			3.5			

Figure 1. Forward voltage vs. forward current

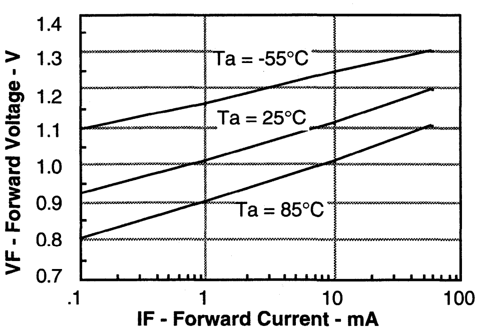
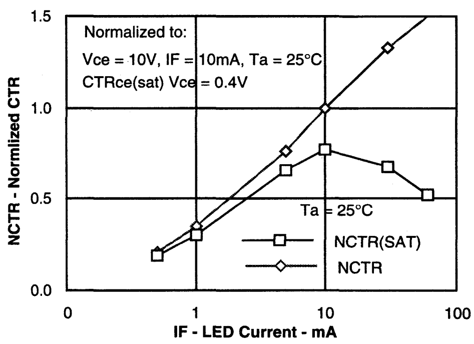


Figure 2. Normalized non-saturated and saturated CTR, T_A=25°C vs. LED current



Optocouplers (Optoisolators)
5

Figure 3. Normalized non-saturated and saturated CTR, T_A=50°C vs. LED current

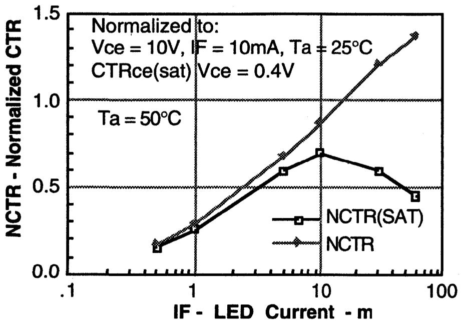


Figure 4. Normalized non-saturated and saturated CTR, T_A=70°C vs. LED current

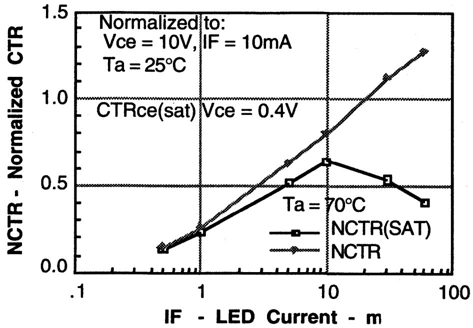


Figure 5. Normalized non-saturated and saturated CTR, T_A=85°C vs. LED current

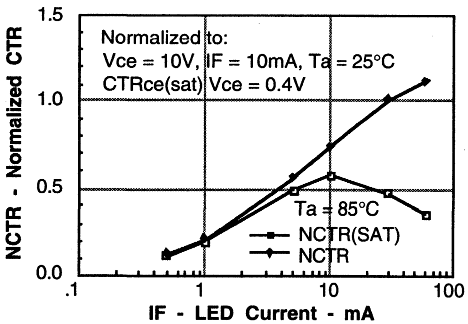


Figure 6. Collector-emitter current vs. temperature and LED current

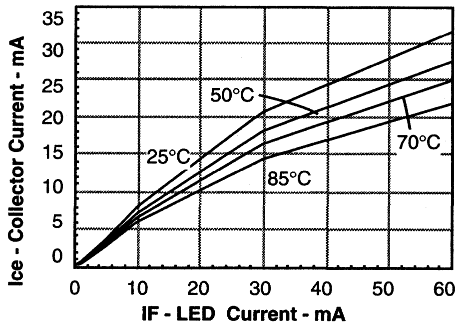


Figure 7. Collector-emitter leakage current vs. temp.

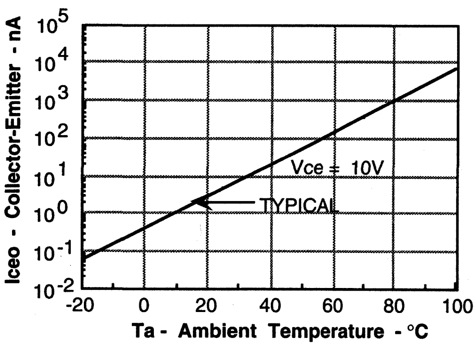


Figure 8. Normalized CTRcb vs. LED current and temp.

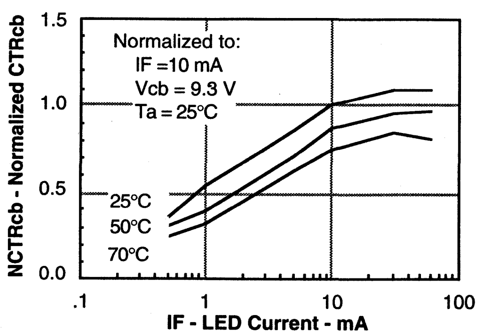


Figure 9. Normalized photocurrent and vs. If and temperature

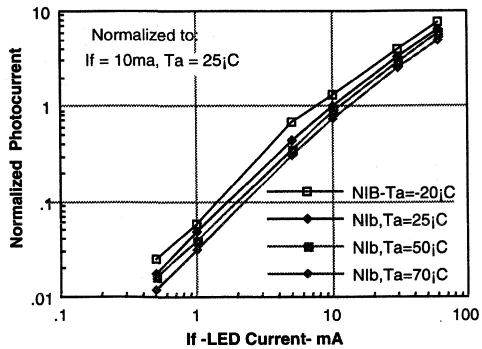


Figure 10. Normalized non-saturated HFE vs. base current and temperature

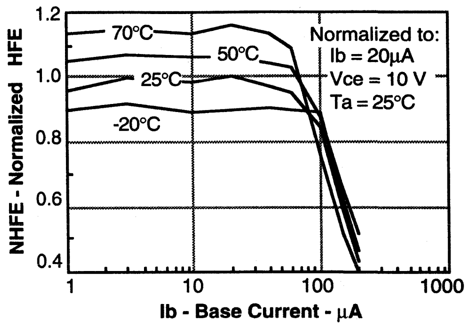


Figure 11. Normalized HFE vs. base current and temperature

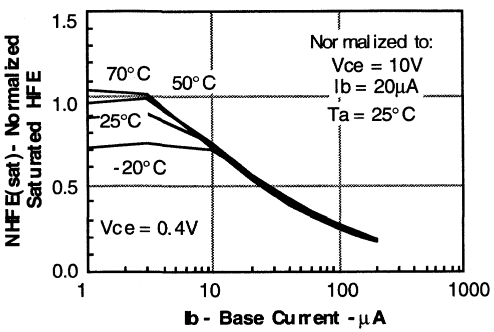


Figure 12. Propagation delay vs. collector load resistor

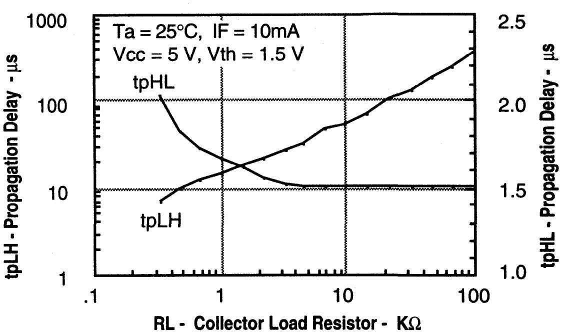


Figure 13. Switching timing

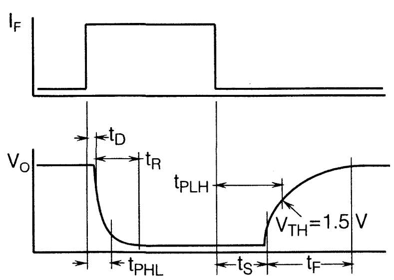
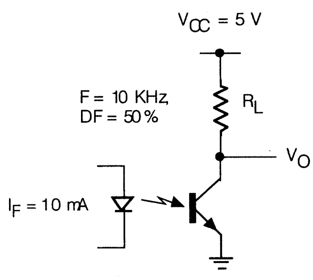


Figure 14. Switching schematic



5

Optocouplers (Optoisolators)

SIEMENS

4N32/4N33

PHOTODARLINGTON OPTOCOUPLER

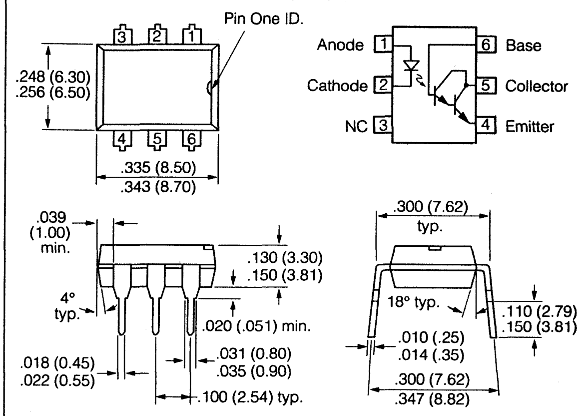
FEATURES

- **Very High Current Transfer Ratio, 500% Min.**
- **High Isolation Resistance, 10^{11} Ω Typical**
- **Standard Plastic DIP Package**
- **Underwriters Lab File #E52744**
- **VDE Approvals #0884 (Available with Option 1)**

DESCRIPTION

The 4N32 and 4N33 are optically coupled isolators with a Gallium Arsenide infrared LED and a silicon photodarlington sensor. Switching can be achieved while maintaining a high degree of isolation between driving and load circuits. These optocouplers can be used to replace reed and mercury relays with advantages of long life, high speed switching and elimination of magnetic fields.

Package Dimensions in Inches (mm)



Maximum Ratings

Emitter

Peak Reverse Voltage	3 V
Continuous Forward Current	60 mA
Power Dissipation at 25°C	100 mW
Derate Linearly from 55°C	1.33 mW/°C
Detector	
Collector-Emitter Breakdown Voltage, BV_{CEO}	30 V
Emitter-Base Breakdown Voltage, BV_{EBO}	8V
Collector-Base Breakdown Voltage, BV_{CBO}	50 V
Emiter-Collector Breakdown Voltage BV_{ECO}	5 V
Collector (load) Current	125 mA
Power Dissipation at 25°C Ambient	150 mW
Derate Linearly from 25°C	2.0 mW/°C
Package	
Total Dissipation at 25°C Ambient	250 mW
Derate Linearly from 25°C	3.3 mW/°C
Isolation Test Voltage Between Emitter and Detector Refered to Standard Climate 23°C/50%RH, DIN 50014	5300 VAC_{RMS}
Leakage Path	7 mm min.
Air Path	7 mm min.
Isolation Resitance	
V_{IO}=500 V/25°C	≥10^{12}Ω
V_{IO}=500 V/100°C	≥10^{11}Ω
Storage Temperature	–55°C to +150°C
Operating Temperature	–55°C to +100°C
Lead Soldering Time at 260°C	10 sec.

Electrical Characteristics (T_A=25°C)

Parameter	Min.	Typ.	Max.	Unit	Condition
Emitter					
Forward Voltage*		1.25	1.5	V	I_F=50 mA
Reverse Current*		0.1	100	µA	V_R=3.0 V
Capacitance		25		pF	V_R=0 V
Detector					
BV_{CEO}*	30			V	I_C=100 µA, I_F=0
BV_{CBO}*	50			V	I_C=100 µA, I_F=0
BV_{EBO}*	8			V	I_C=100 µA, I_F=0
BV_{ECO}*	5	10		V	I_E=100 µA, I_F=0
I_{CEO}		1.0	100	nA	V_{CE}=10 V, I_F=0
H_{FE}		13K			V_{CE}=5 V, I_C=0.5 mA
Package					
Current Transfer Ratio*	500			%	I_F=10 mA, V_{CE} =10 V
$V_{CE\ sat}$		1.0		V	I_C=2 mA, I_F=8 mA
Coupling Capacitance		1.5		pF	
Turn-On Time			5	µs	V_{CC}=10 V, I_C=50 mA
Turn -Off Time			100	µs	I_F=200 mA, R_L=180 Ω

**Indicates JEDEC registered values*

Figure 1. Forward voltage versus forward current

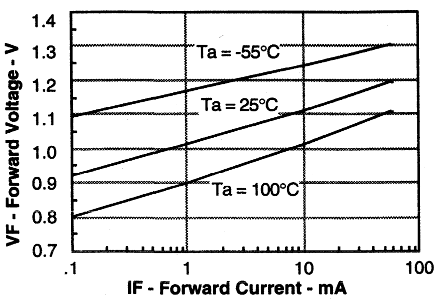


Figure 2. Normalized non-saturated and saturated CTRce versus LED current

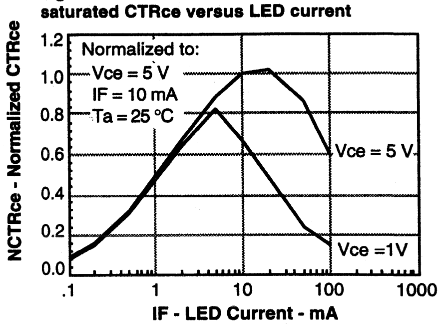


Figure 3. Normalized non-saturated and saturated collector-emitter current versus LED current

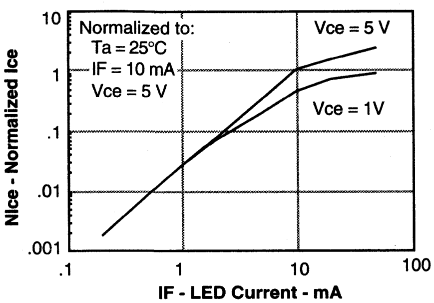


Figure 4. Normalized collector-base photocurrent versus LED current

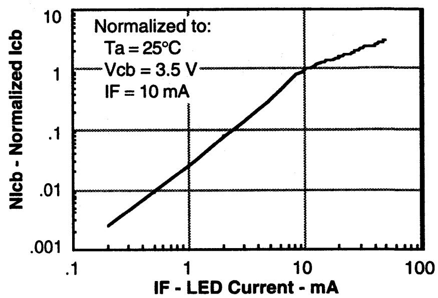


Figure 5. Non-saturated and saturated HFE versus base current

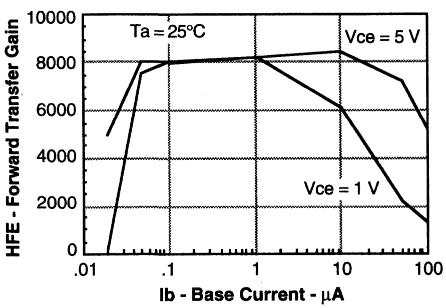


Figure 6. Low to high propagation delay versus collector load resistance and LED current

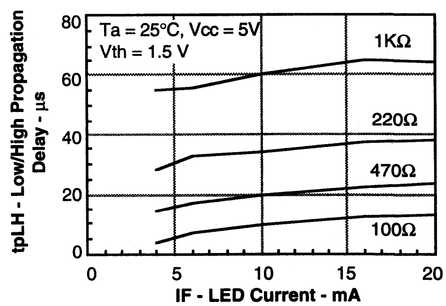


Figure 7. High to low propagation delay versus collector load resistance and LED current

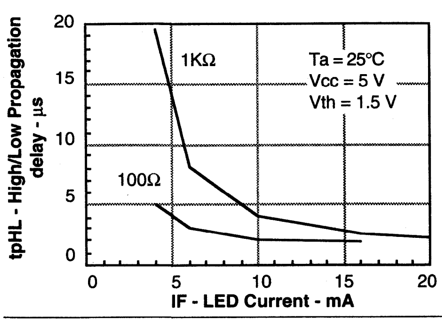
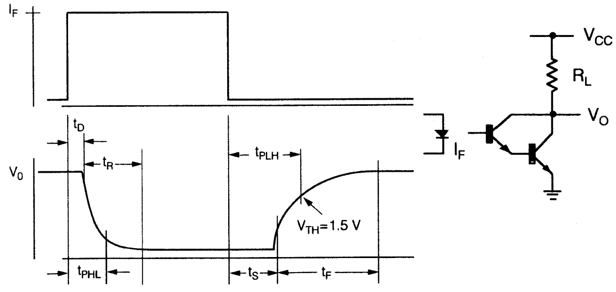


Figure 8. Switching waveform and switching schematic



Optocouplers (Optoisolators)

5

SIEMENS

NEW

4N39
PHOTO SCR OPTOCOUPLER

FEATURES
- **Turn On Current (I_{FT}), 5.0 mA Typical**
- **Gate Trigger Current (I_{GT}), 20 mA**
- **Surge Anode Current, 10 Amp**
- **Blocking Voltage, 200 VAC_{PK}**
- **Gate Trigger Voltage (V_{GT}), 0.6 Volt**
- **Isolation Voltage, 5300 VAC_{RMS}**
- **Solid State Reliability**
- **Standard DIP Package**
- **Underwriters Lab File #E52744**

DESCRIPTION
The 4N39 is an optically coupled SCR with a Gallium Arsenide infrared emitter and a silicon photo SCR sensor. Switching can be achieved while maintaining a high degree of isolation between triggering and load circuits. The 4N39 can be used in SCR triac and solid state relay applications where high blocking voltages and low input current sensitivity are required.

Maximum Ratings
Emitter

Peak Reverse Voltage .... 6.0 V
Peak Forward Current
(100 µs, 1% Duty Cycle) .... 1.0 A
Continuous Forward Current....................... 60 mA
Power Dissipation at 25°C .... 100 mW
Derate Linearly from 50°C .... 2 mW/°C

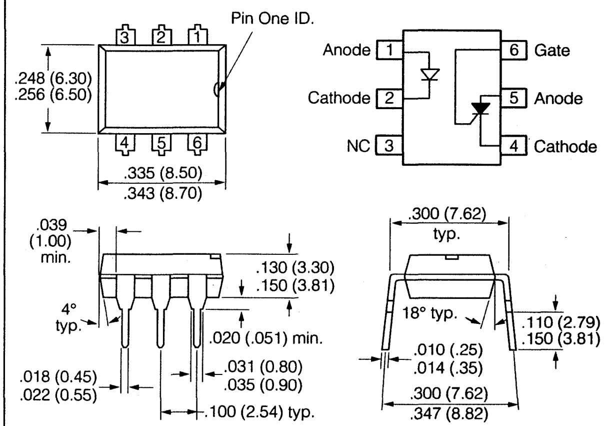
Detector

Reverse Gate Voltage.................................. 6.0 V
Anode Peak Blocking Voltage .... 200 V
Peak Reverse Gate Voltage............................ 6 V
Anode Current .... 300 mA
Surge Anode Current (100 µs duration) .... 10 A
Surge Gate Current (5 ms duration) .... 100 mA
Power Dissipation, 25°C ambient .... 400 mW
Derate Linearly from 25°C .... 8 mW/°C

Package

Isolation Test Voltage (1 sec.).......... 5300 VAC_{RMS}
Isolation Resistance
V_{IO}=500 V, T_A=25°C ....$\geq 10^{12}$ Ω
V_{IO}=500 V, T_A=100°C ....$\geq 10^{11}$ Ω
Total Package Dissipation .... 450 mW
Derate Linearly from 50°C .... 9 mW/°C
Operating Temperature .... –55°C to +100°C
Storage Temperature .... –55°C to +150°C
Soldering Temperature (10 s.) ....260°C

Package Dimensions in Inches (mm)



Characteristics (T_A=25°C)

	Sym	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.2	1.5	V	I_F=20 mA
Reverse Current	I_R			10	µA	V_R=5 V
Detector						
Forward Blocking Voltage	V_{DM}	200			V	R_{GK}=10 KΩ T_A=100°C I_d=150 µA
Reverse Blocking Voltage	V_{RM}	200			V	
On-state Voltage	V_{TM}			1.2	V	I_{TM}=300 mA
Holding Current	I_H			200	µA	R_{GK}=27 KΩ V_{FX}=50 V
Gate Trigger Voltage	V_{GT}		0.6	1.0	V	V_{FX}=100 V R_{GK}=27 KΩ R_L=10 KΩ
Forward Leakage Current	I_{DM}			50	µA	R_{GK}=10 KΩ V_{RX}=200 V I_F=0, T_A=100°C
Reverse Leakage Current	I_{RM}			50	µA	R_{GK}=27 KΩ V_{RX}=200 V I_F=0, T_A=100°C
Package						
Turn-On Current	I_{FT}		15	30	mA	V_{FX}=50 V R_{GK}=10 KΩ
			8	14		V_{FX}=100 V R_{GK}=27 KΩ
Isolation Capacitance			2		pF	f=1 MHz

SIEMENS

6N135
6N136

HIGH-SPEED 2.5 kV TRIOS® OPTOCOUPLER

FEATURES

- **Isolation Test Voltage: 2500 VAC_{RMS}**
- **TTL Compatible**
- **High Bit Rates: 1 Mbit/s**
- **High Common-Mode Interference Immunity**
- **Bandwidth 2 MHz**
- **Open-Collector Output**
- **External Base Wiring Possible**
- **Field-Effect Stable by TRIOS***
- **Underwriters Lab File #E52744**

DESCRIPTION

The 6N135 and 6N136 are optocouplers with a GaAIAs infrared emitting diode, optically coupled with an integrated photodetector which consists of a photodiode and a high-speed transistor in a DIP-8 plastic package.

Signals can be transmitted between two electrically separated circuits up to frequencies of 2 MHz. The potential difference between the circuits to be coupled is not allowed to exceed the maximum permissible reference voltages.

Maximum Ratings

Emitter

Reverse Voltage .... 5 V
Forward Current .... 25 mA
Peak Forward Current (t = 1 ms, duty cycle 50%) .... 50 mA
Maximum Surge Forward Current (t ≤ 1 µs, 300 pulses/s) . 1 A
Thermal Resistance .... 700 K/W
Total Power Dissipation (T_A≤70°C) .... 45 mW

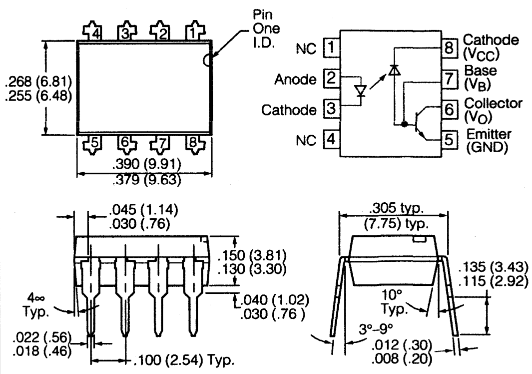
Detector

Supply Voltage .... –0.5 to 15 V
Output Voltage .... –0.5 to 15 V
Emitter-Base Voltage .... 5 V
Output Current .... 8 mA
Maximum Output Current .... 16 mA
Base Current .... 5 mA
Thermal Resistance .... 300 K/W
Total Power Dissipation (T_A≤70°C) .... 100 mW

Package

Isolation Test Voltage (between emitter and detector climate per DIN 40046, part 2, Nov. 74 (t=1min.) .... 2500 VAC_{RMS}
Pollution Degree (DIN VDE 0109) 2
Creepage .... ≥7 mm
Clearance .... ≥7 mm
Comparative Tracking Index per DIN IEC112/ VDE 0303 part 1, Group IIIa per DIN VDE 6110 175
Isolation Resistance
V_{IO}=500 V, T_A = 25°C .... ≥10^{12} Ω
V_{IO}=500 V, T_A = 100°C .... ≥10^{11} Ω
Storage Temperature Range .... –55°C to +125°C
Ambient Temperature Range .... –55°C to +100°C
Soldering Temperature (max. ≤10 sec., dip soldering ≥0.5 mm from case bottom) .... 260°C

Package Dimensions in Inches (mm)



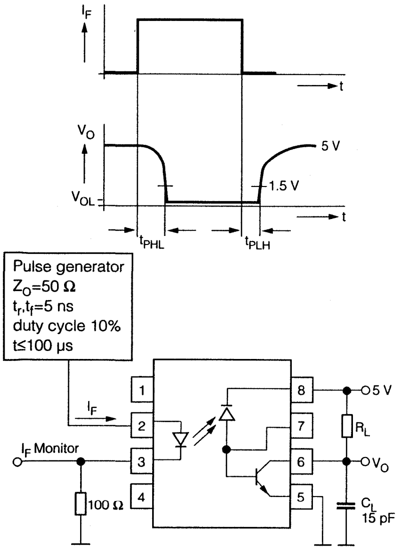
Characteristics

(T_A=0 to 70°C unless otherwise specified, T_A=25°C typ.)

Emitter	Symbol		Unit	Condition
Forward Voltage	V_F	1.6 (≤1.9)	V	I_F=16 mA
Breakdown Voltage	V_{BR}	≥5	V	I_R=10 µA
Reverse Current	I_R	0.5 (≤10)	µA	V_R=5 V
Capacitance	C_0	125	pF	V_R=0 V, f=1 MHz
Temperature Coefficient of Forward Voltage	$\Delta V_F/\Delta T_A$	-1.7	mV/°C	I_F=16 mA
Detector				
Supply Current Logic Low	I_{CCL}	150	µA	I_F=16 mA, V_O open, V_{CC}=15 V
Supply Current Logic High	I_{CCH}	0.01 (≤1)	µA	I_F=0 mA, V_O open, V_{CC}=15 V
Output Voltage Output Low				I_F=16 mA, V_{CC}=4.5 V
6N135	V_{OL}	0.1 (≤0.4)	V	I_O=1.1 mA
6N136	V_{OL}	0.1 (≤0.4)	V	I_O=2.4 mA
Output Current Output High	I_{OH}	3 (≤500)	nA	I_F=0 mA, V_O=V_{CC}=5.5 V
Output Current Output High	I_{OH}	0.01 (≤1)	µA	I_F=0 mA V_O=V_{CC}=15 V
Current Gain	H_{FE}	150		V_O=5 V, I_O=3 mA
Package				
Coupling Capacitance Input–Output	C_{IO}	0.6	pF	f=1 MHz
Current Transfer Ratio				I_F=16 mA, V_O=0.4 V,
6N135	CTR	16 (≥7)	%	V_{CC}=4.5 V, T_A=25°C
6N136	CTR	35 (≥19)	%	
Current Transfer Ratio				I_F=16 mA, V_O=0.5 V,
6N135	CTR	≥5	%	V_{CC}=4.5 V
6N136		≥15		

***TRIOS – TR**ansparent **IO**n **S**hield

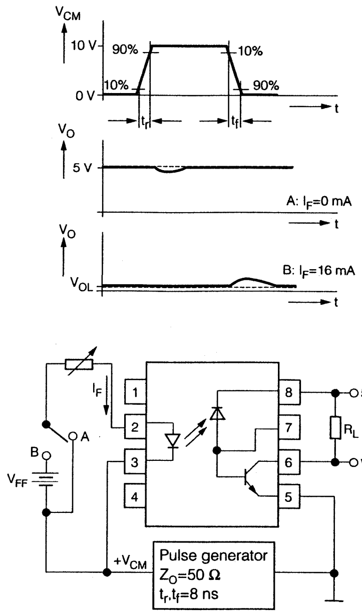
SWITCHING TIMES



Delay Time (I_F=16 mA, V_{CC}=5 V, T_A=25°C)

High – Low			
6N135 (R_L=4.1 kΩ)	t_{PHL}	0.3 (≤1.5)	µs
6N136 (R_L=1.9 kΩ)	t_{PHL}	0.2 (≤0.8)	µs
Low – High			
6N135 (R_L=4.1 kΩ)	t_{PHL}	0.3 (≤1.5)	µs
6N136 (R_L=1.9 kΩ)	t_{PHL}	0.2 (≤0.8)	µs

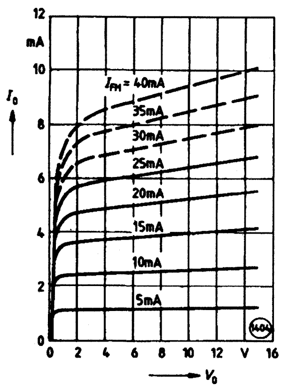
COMMON-MODE INTERFERENCE IMMUNITY



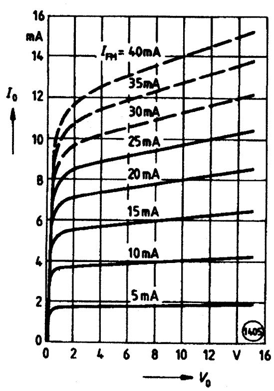
Common Mode Interference Immunity
(V_{CM}=10 V_{P-P}, V_{CC}=5 V, T_A=25°C)

High (I_F=0 mA)			
6N135 (R_L=4.1 kΩ)	CM_H	1000	V/µs
6N136 (R_L=1.9 kΩ)	CM_H	1000	V/µs
Low (I_F=16 mA)			
6N135 (R_L=4.1 kΩ)	CM_L	1000	V/µs
6N136 (R_L=1.9 kΩ)	CM_L	1000	V/µs

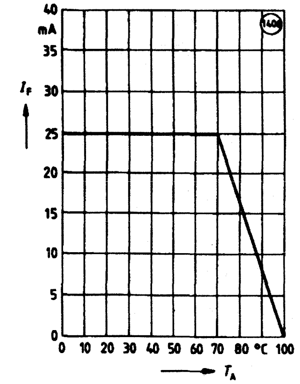
Output characteristics–6N135
Output current versus output voltage (T_A=25°C, V_{CC}=5 V)



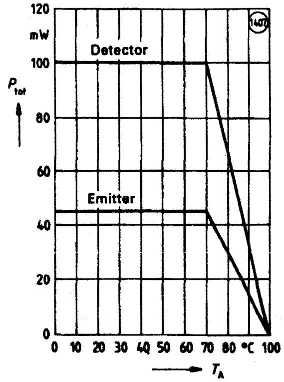
Output characteritics–6N136
Output current versus output voltage
(T_A=25°C, V_{CC}=5 V)



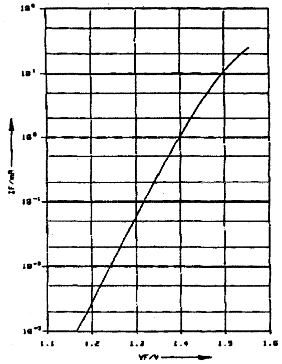
Permissible forward current of emitting diode versus ambient temperature



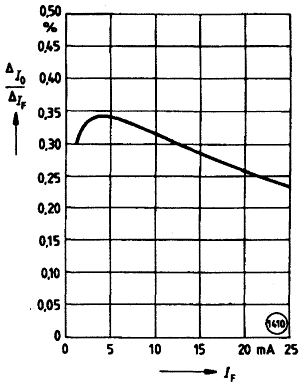
Permissible total power dissipation versus ambient temperature



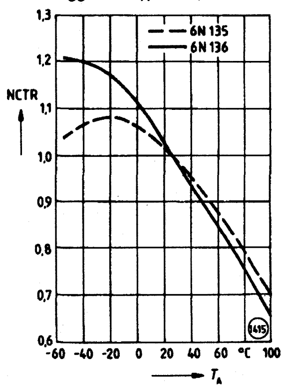
Forward current of emitting diode versus forward voltage (T_A=25°C)



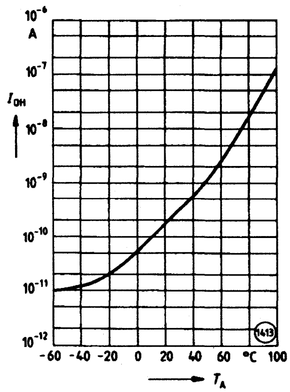
Small signal transfer ratio versus forward current (V_{CC}=5 V, T_A=25°C)



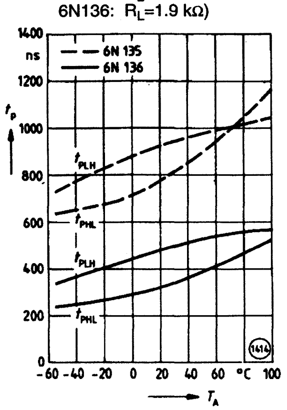
Current transfer ratio (normalized) versus ambient temperature (normalized to I_F=16 mA, V_O=0.4 V, V_{CC}=5 V, T_A=25°C)



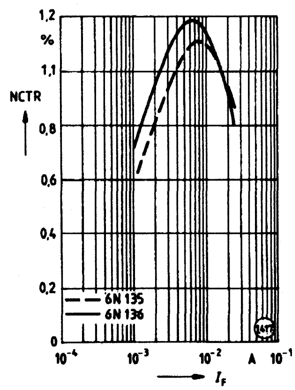
Output current (high) versus ambient temperature (V_O=V_{CC}=5 V, I_F=0)



Delay times versus ambient temperature (I_F=16 mA, V_{CC}=5 V, 6N135: R_L=4.1 kΩ, 6N136: R_L=1.9 kΩ)



Current transfer ratio (normalized) versus forward current (I_F=16 mA, V_O=0.4 V, V_{CC}=5 V, T_A=25°C)



SIEMENS

6N138
6N139

LOW INPUT CURRENT, HIGH GAIN OPTOCOUPLER

FEATURES
- High Current Transfer Ratio, 800%
- Low Input Current, 0.5mA
- High Output Current, 60mA
- Isolation Test Voltage, 2500 VAC_{RMS}
- TTL Compatible Output, V_{OL}=0.1 V
- High Common Mode Rejection, 500V/µsec.
- Adjustable Bandwidth–Access to Base
- Standard Molded Dip Plastic Package
- Underwriters Lab File #E52744

APPLICATIONS
- Logic Ground Isolation–TTL/TTL, TTL/CMOS, CMOS/CMOS, CMOS/TTL
- EIA RS 232C Line Receiver
- Low Input Current Line Receiver–Long Lines, Party Lines
- Telephone Ring Detector
- 117 VAC Line Voltage Status Indication–Low Input Power Dissipation
- Low Power Systems–Ground Isolation

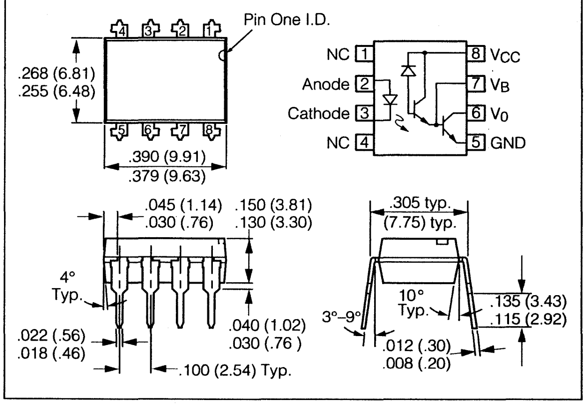
DESCRIPTION
High common mode transient immunity and very high current ratio together with 2500 VAC insulation are achieved by coupling an LED with an integrated high gain photo detector in an eight pin dual-in-line package. Separate pins for the photodiode and output stage enable TTL compatible saturation voltages with high speed operation. Photodarlington operation is achieved by tying the V_{CC} and V_O terminals together. Access to the base terminal allows adjustment to the gain bandwidth.

The 6N138 is ideal for TTL applications since the 300% minimum current transfer ratio with an LED current of 1.6 mA enables operation with one unit load-in and one unit load-out with a 2.2 KΩ pull-up resistor.

The 6N139 is best suited for low power logic applications involving CMOS and low power TTL. A 400% current transfer ratio with only 0.5 mA of LED current is guaranteed from 0°C to 70°C.

Caution:
Due to the small geometries of this device, it should be handled with Electrostatic Discharge (ESD) precautions. Proper grounding would prevent damage further and/or degradation which may be induced by ESD.

Package Dimensions in Inches (mm)



Maximum Ratings

Reverse Input Voltage .... 5 V
Supply and Output Voltage, V_{CC} (pin 8-5), V_O (pin 6-5)
  6N138 .... –0.5 to 7 V
  6N139 .... –0.5 to 18 V
Emitter-Base Reverse Voltage (pin 5-7) .... 0.5 V
Average Input Current .... 20 mA
Peak Input Current .... 40 mA
  (50% Duty Cycle–1 ms pulse width)
Peak Transient Input Current
  (tp≤1 µsec, 300 pps .... 1.0 A
Output Current I_O (pin 6) .... 60 mA
  Derate linearly above 25°C, free air temperature at 0.7 mA/°C
Input Power Dissipation .... 35 mW
  Derate linearly above 50%, free air temperature at 0.7 mW/°C
Output Power Dissipation .... 100 mW
  Derate linearly above 25°C, free air temperature at 0.2 mA/°C
Isolation Test Voltage .... 2500 VAC_{RMS}
Isolation Resistance
  V_{IO}=500 V, T_A=25°C .... $\geq 10^{12}\,\Omega$
  V_{IO}=500 V, T_A=100°C .... $\geq 10^{11}\,\Omega$
Storage Temperature .... –55°C to +125°C
Operating Temperature .... –55°C to +100°C
Lead Soldering Temperature (t=10 sec.) .... 260°C

Electro-Optical Characteristics (T_A=0°C to 70°C, T_A=25°C–Typical, unless otherwise specified)

Parameter	Device	Min	Typ	Max	Units	Test Conditions	Note
Current Transfer Ratio (CTR)	6N138	300	1600		%	I_F=1.6 mA, V_O=0.4 V, V_{CC}=4.5 V	5,6
	6N139	400 500	1600 2000		%	I_F=0.5 mA, V_O=0.4 V, V_{CC}=4.5 V I_F=1.6 mA, V_O=0.4 V, V_{CC}=4.5 V	5,6
Logic Low	6N138		0.1	0.4	V	I_F=1.6 mA, I_O=4.8 mA, V_{CC}=4.5 V	6
Output Voltage (V_{OL})	6N139 6N139 6N139		0.1 0.15 0.25	0.4 0.4 0.4	V	I_F=1.6 mA, I_O=8 mA, V_{CC}=4.5 V I_F=5 mA, I_O=15 mA, V_{CC}=4.5 V I_F=12 mA, I_O=24 mA, V_{CC}=4.5 V	6
Logic High	6N138		0.1	250	µA	I_F=0 mA, V_O=V_{CC}=7 V	6
Output Current (I_{OH})	6N139		0.05	100	µA	I_F=0 mA, V_O=V_{CC}=18 V	6
Logic Low Supply Current (I_{CCL})			0.2	1.5	mA	I_F=1.6 mA, V_O=OPEN, V_{CC}=18 V	6
Logic High Supply Current (I_{CCH})			0.001	10	µA	I_F=0 mA, V_O=OPEN, V_{CC}=18 V	6
Input Forward Voltage (VF)			1.4	1.7	V	I_F=1.6 mA, T_A=25°C	
Input Reverse Breakdown Voltage (BV_R)		5			V	I_R=10 µA	
Temperature Coefficient of Forward Voltage			−1.8		mV/°C	I_F=1.6 mA	
Input Capacitance (C_{IN})			25		pF	f=1 MHz, V_F=0	
Input-Output Insulation Leakage Current (I-0)				1.0	µA	45% Relative Humidity, T_A=25°C t=5_S, $V_{1\text{-}0}$=3000 VDC	7
Resistance (Input-Output) ($R_{I\text{-}O}$)			10^{12}		Ω	V_{IO}=500 VDC	7
Capacitance (Input-Output) ($C_{I\text{-}O}$)			0.6		pF	f=1 MHz	7

Switching Specifications (T_A=25°C)

Parameter	Device	Min	Typ	Max	Units	Test Conditions	Note
Propagation Delay Time	6N138		2	10	µS	I_F=1.6 mA, R_L=2.2 KΩ	
To Logic Low at Output t_{PHL}	6N139		6 0.6	25 1	µS	I_F=0.5 mA, R_L=4.7 KΩ I_F=12 mA, R_L=270 Ω	6,8
Propagation Delay Time	6N138		2	35	µS	I_F=1.6 mA, R_L=2.2 KΩ	
To Logic High at Output t_{PLH}	6N139		4 1.5	60 7	µS	I_F=0.5 mA, R_L=4.7 KΩ I_F=12 mA, R_L=270 Ω	6,8
Common Mode Transient Immunity at Logic High Level (CM_H) Output			500		V/µS	I_F=0 mA, R_L=2.2 KΩ R_{CC}=0/V_{CM}/=10 $V_{p\text{-}p}$	9,10
Common Mode Transient Immunity at Logic Low Level (CM_L) Ouput			-500		V/µS	I_F=1.6 mA, R_L=2.2 KΩ R_{CC}=0/V_{CM}/=10 $V_{p\text{-}p}$	9,10

Notes
1. Derate linearly above 50°C free-air temperature at a rate of 0.4 mA/°C.
2. Derate linearly above 50°C free-air temperature at a rate of 0.7 mW/°C.
3. Derate linearly above 25°C free-air temperature at a rate of 0.7 mA/°C.
4. Derate linearly above 25°C free-air temperature at a rate of 2.0 mW/°C.
5. DC current transfer ratio is defined as the ratio of outpput collector current, $I_{O,}$ to the forward LED input current, I_F times 100%.
6. Pin 7 open.
7. Device considered a two-terminal device: pins 1, 2, 3 and 4 shorted together and pins 5, 6, 7 and 8 shorted together.
8. Using a resistor between pin 5 and 7 will decrease gain and delay time.
9. Common mode transient immunity in logic high level is the maximum tolerable (positive) dV_{cm}/dt on the leading edge of the common mode pulse, V_{CM}, to assure that the output will remain in a logic high state (i.e. V_O>2.0 V) common mode transient immunity in logic low level is the maximum tolerable (negative) dV_{cm}/dt on the trailing edge of the common mode pulse signal, V_{CM}, to assure that the output will remain in a logic low state (i.e. V_O<0.8 V).
10. In applications where dv/dt may exceed 50,000 V/µs (such as state discharge) a series resistor, R_{CC} should be included to protect I_C from destructively high surge currents. The recommended value is $R_{CC} \cong \frac{IV}{0.15\ I_F\ (mA)}$ kΩ.

SIEMENS

CNY17 SERIES
TRIOS® PHOTOTRANSISTOR OPTOCOUPLER

FEATURES

- **High Current Transfer Ratio**
  CNY17-1, 40 to 80%
  CNY17-2, 63 to 125%
  CNY17-3, 100 to 200%
  CNY17-4, 160 to 320%
- **Breakdown Voltage, 5300 VAC_{RMS}**
- **Field-Effect Stable by TRIOS***
- **Long Term Stability**
- **Industry Standard Dual-in-Line Package**
- **Underwriters Lab File #E52744**
- **VDE #0884, Available with Option 1**

DESCRIPTION

The CNY17 is an optically coupled pair consisting of a Gallium Arsenide infrared emitting diode optically coupled to a silicon NPN phototransistor.

Signal information, including a DC level, can be transmitted by the device while maintaining a high degree of electrical isolation between input and output.

The CNY17 can be used to replace relays and transformers in many digital interface applications, as well as analog applications such as CRT modulation.

Maximum Ratings (T_A=25°C)

Emitter

Reverse Voltage .... 6 V
Forward Current .... 60 mA
Surge Current (t≤10µs) .... 2.5 A
Power Dissipation .... 100 mW

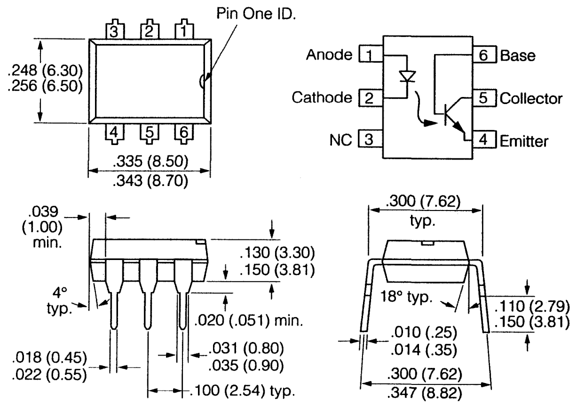
Detector

Collector-Emitter Breakdown Voltage .... 70 V
Emitter-Base Breakdown Voltage .... 7 V
Collector Current .... 50 mA
Collector Current (t <1 ms) .... 100 mA
Power Dissipation .... 150 mW

Package

Isolation Test Voltage (Between emitter & detector referred to climate DIN 40046, part 2, Nov. 74) .... 5300 VAC_{RMS}
Creepage Distance .... ≥7 mm
Clearance Distance .... ≥7 mm
Isolation Thickness between Emitter and Detector .... ≥0.4 mm
Comparative Tracking Index per DIN IEC 112/ VDE0303, part 1 175
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... ≥10^{12} Ω
V_{IO}=500 V, T_A=100°C .... ≥10^{11} Ω
Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Junction Temperature .... 100°C
Soldering Temperature (max . 10 s, dip soldering: distance to seating plane ≥1.5 mm) .... 260°C

Package Dimensions in Inches (mm)



Characteristics (T_A=25°C)

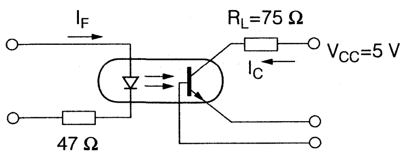
	Symbol		Unit	Condition
Emitter				
Forward Voltage	V_F	1.25 (≤1.65)	V	I_F = 60 mA
Breakdown Voltage	V_{BR}	≥6	V	I_R = 10 µA
Reverse Current	I_R	0.01 (≤10)	µA	V_R = 6 V
Capacitance		25	pF	V_R = 0 V, f =1 MHz
Thermal Resistance	R_{thjamb}	750	K/W	
Detector				
Capacitance	C_{CE}	5.2	pF	V_{CE} =5 V, f =1 MHz
	C_{CB}	6.5	pF	V_{CB} =5 V, f =1 MHz
	C_{EB}	7.5	pF	V_{EB} =5 V, f =1 MHz
Thermal Resistance	R_{thjamb}	500	K/W	
Package				
Collector-Emitter Saturation Voltage	V_{CEsat}	0.25 (≤0.4)	V	I_F = 10 mA, I_C=2.5 mA
Coupling Capacitance	C_C	0.6	pF	

***TRIOS–TR**ansparent **IO**n **S**hield

Current Transfer Ratio and Collector-Emitter Leakage Current by dash number (T_A=25°C)

	–1	–2	–3	–4	Unit
I_C/I_F at V_{CE}=5 V (I_F=10 mA)	40–80	63–125	100–200	160–320	%
I_C/I_F at V_{CE}=5 V (I_F=1 mA)	30 (>13)	45 (>22)	70 (>34)	90 (>56)	%
Collector-Emitter Leakage Current (V_{CE}=10 V) (I_{CEO})	2 (≤ 50)	2 (≤ 50)	5 (≤ 100)	5 (≤ 100)	nA

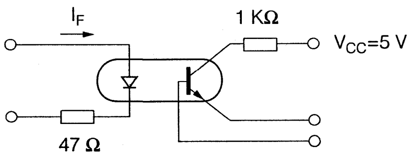
Linear Operation (without saturation)



I_F=10 mA, V_{CC}=5 V, T_A=25°C

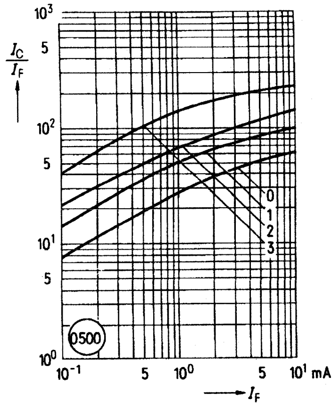
Load Resistance	R_L	75	Ω
Turn-On Time	t_{ON}	3.0	µs
Rise Time	t_R	2.0	µs
Turn-Off Time	t_{OFF}	2.3	µs
Fall Time	t_f	2.0	µs
Cut-Off Frequency	f_{CO}	250	kHz

Switching Operation (with saturation)

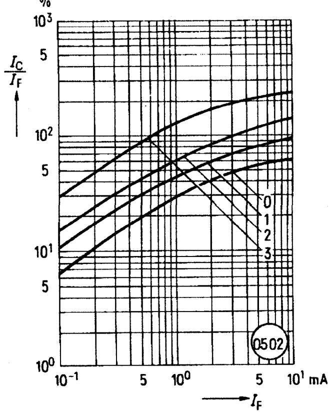


	–1 (I_F=20 mA)	–2 and –3 (I_F=10 mA)	–4 (I_F=5 mA)	
Turn-On Time t_{ON}	3.0	4.2	6.0	µs
Rise Time t_R	2.0	3.0	4.6	µs
Turn-Off Time t_{OFF}	18	23	25	µs
Fall Time t_F	11	14	15	µs

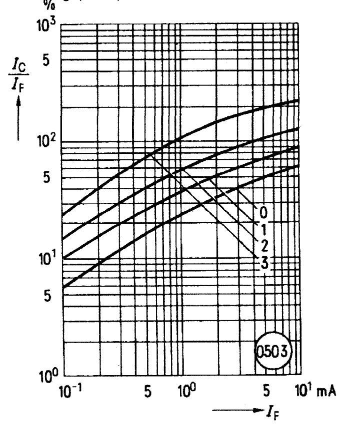
Current transfer ratio versus diode current (T_A=–25°C, V_{CE}=5 V)
I_C/I_F=f (I_F)



Current transfer ratio versus diode current (T_A=0°C, V_{CE}=5 V)
I_C/I_F=f (I_F)

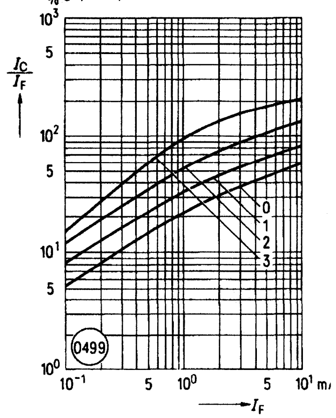


Current transfer ratio versus diode current (T_A=25°C, V_{CE}=5 V)
I_C/I_F=f (I_F)

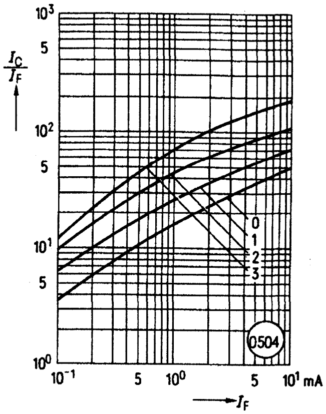


Current transfer ratio versus diode current (T_A=50°C) V_{CE}=5 V

% I_C/I_F=f (I_F)

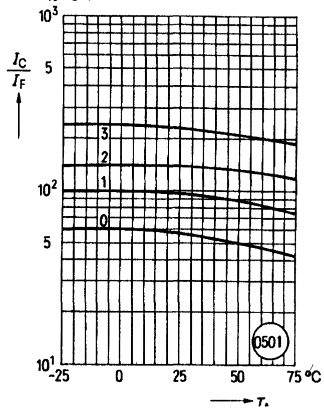


Current transfer ratio versus diode current (T_A=75°C) V_{CE}=5 V

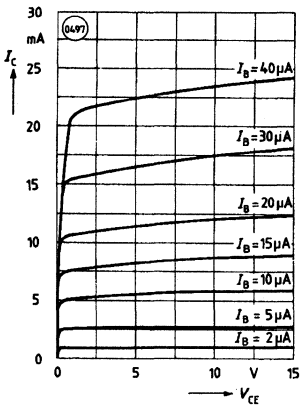


Current transfer ratio versus temperature (I_F=10 mA, V_{CE}=5 V)

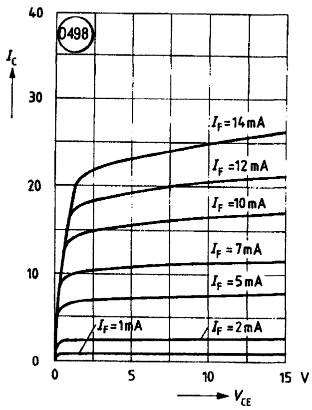
% I_C/I_F=f (T)



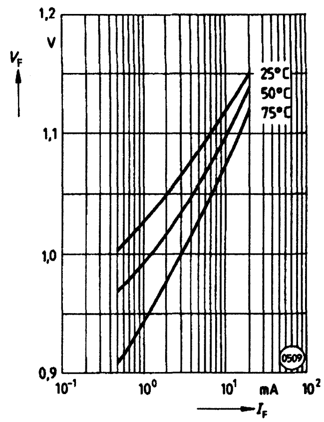
Transistor characteristics (B=550)
CNY17-3, -4 I_C=f(V_{CE}) (T_A=25°C, I_F=0)



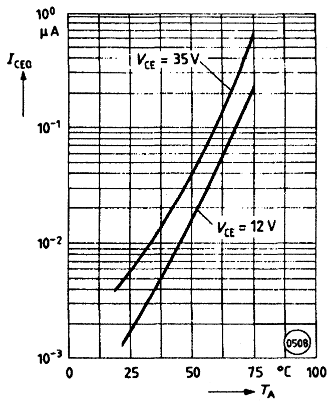
Output characteristics
CNY17-3, -4 (T_A=25°C) IC=f(V_{CE})



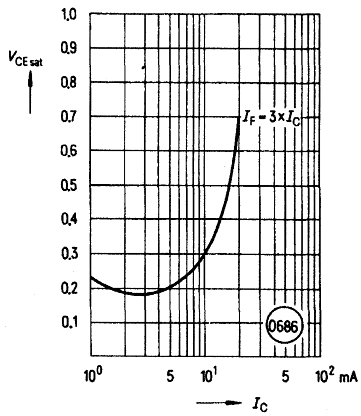
Forward voltage V_F=f (I_F)



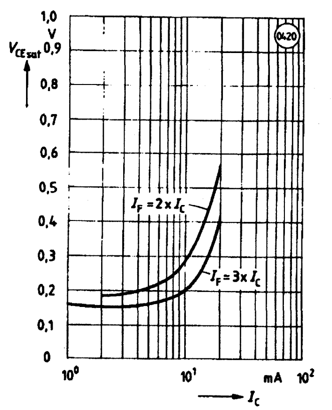
Collector emitter off-state current
I_{CEO}=f (V, T) (T_A=25°C, I_F=0)



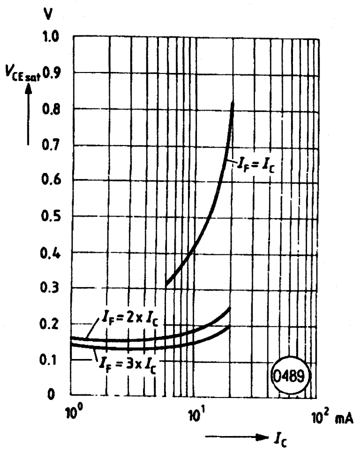
Saturation voltage versus collector current and modulation depth
CNY17-1 V_{CEsat}=f (I_C) (T_A=25°C)



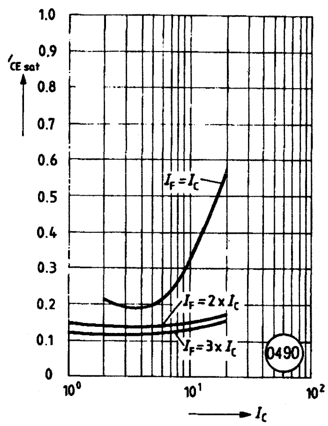
Saturation voltage versus collector current and modulation depth
CNY17-2 V_{CEsat}=f (I_C) (T_A=25°C)



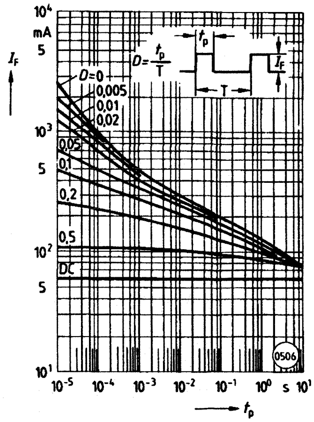
Saturation voltage versus collector current and modulation depth
CNY17-3 V_{CEsat}=f (I_C) (T_A=25°C)



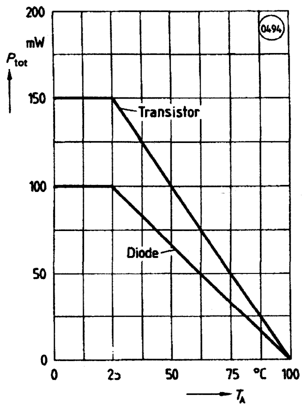
Saturation voltage versus collector current and modulation depth
CNY17-4 V_{CEsat}=f (I_C) (T_A=25°C)



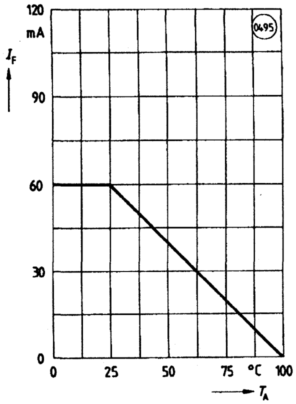
Permissible pulse load
D=parameter, T_A=25°C, I_F=f (t_p)



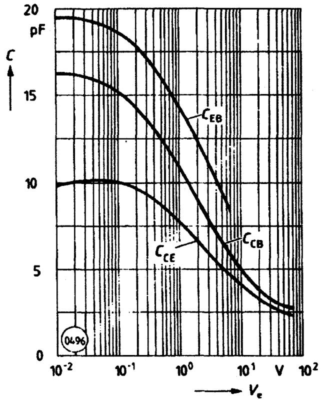
Permissible power dissipation transistor and diode P_{tot}=f (T_A)



Permissible forward current
P_{tot}=f (T_A)



Transistor capacitance
C=f(V_O) (T_A=25°C, f=1 MHz)



SIEMENS

CNY17F SERIES

PHOTOTRANSISTOR NO BASE CONNECTION OPTOCOUPLER

FEATURES

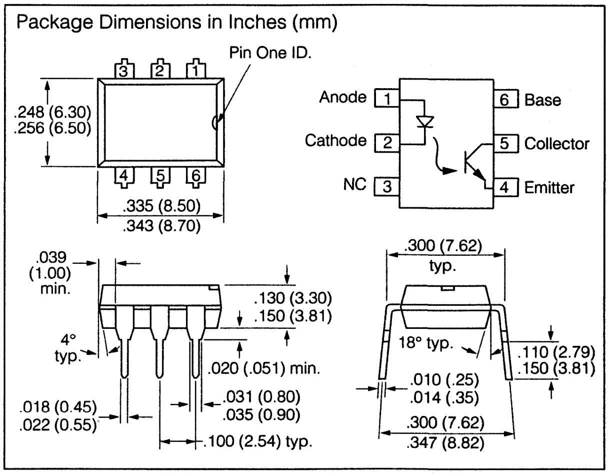
- **High Current Transfer Ratio**
  CNY17F-1, 40-80%
  CNY17F-2, 63-125%
  CNY17F-3, 100-200%
  CNY17F-4, 160-320%
- **Breakdown Voltage, 5300 VAC_{RMS}**
- **High Collector-Emitter Voltage**
- **V_{CEO}=70 V**
- **No Base Terminal Connection for Improved Common Mode Interface Immunity**
- **Field-Effect Stable by TRIOS***
- **Long Term Stability**
- **Industry Standard Dual-in-Line Package**
- **Underwriters Lab File #E52744**
- **VDE #0884, Available with Option 1**

DESCRIPTION

The CNY17F is an optocoupler consisting of a Gallium Arsenide infrared emitting diode optically coupled to a silicon planar phototransistor detector in a plastic plug-in DIP-6 package.

The coupling device is suitable for signal transmission between two electrically separated circuits. The potential difference between the circuits to be coupled is not allowed to exceed the maximum permissible reference voltages.

In contrast to the CNY17 Series, the base terminal of the F type is not connected, resulting in a substantially improved common-mode interference immunity.



Maximum Ratings (T_A=25°C)

Emitter

Reverse Voltage	6 V
DC Forward Current	60 mA
Surge Forward Current (t ≤10 µs)	2.5 A
Total Power Dissipation	100 mW

Detector

Collector-Emitter Breakdown Voltage	70 V
Collector Current	50 mA
Collector Current (t≤1 ms)	100 mA
Total Power Dissipation	150 mW

Package

Isolation Test Voltage (between emitter and detector referred to standard climate 23/50 DIN 50014)	5300 VAC_{RMS}
Creepage	>7 mm
Clearance	>7 mm
Isolation Thickness between Emitter and Detector	≥0.4 mm
Comparative Tracking Index per DIN IEC 112/ VDE 0303, part 1	175
Isolation Resistance (V_{IO}=500 V)	≥10^{11} Ω
Storage Temperature Range	–55 to +150°C
Ambient Temperature Range	–55 to +100°C
Junction Temperature	100°C
Soldering Temperature (max. 10 s, dip soldering: distance to seating plane ≥1.5 mm)	260°C

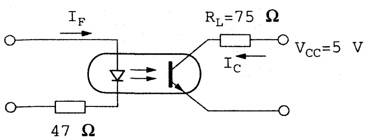
Characteristics (T_A=25°C)

	Symbol		Unit	Condition
Emitter				
Forward Voltage	V_F	1.25 (≤1.65)	V	I_F=60 mA
Breakdown Voltage	V_{BR}	≥6	V	I_R=10 µA
Reverse Current	I_R	0.01 (≤10)	µA	V_R=6 V
Capacitance	C_O	25	pF	V_R=0 V, f=1 MHz
Thermal Resistance	R_{thJA}	750	K/W	
Detector				
Capacitance	C_{CE}	5.2	pF	V_{CE}=5 V, f=1 MHz
Thermal Resistance	R_{thJA}	500	K/W	
Package				
Collector-Emitter Saturation Voltage	V_{CEsat}	0.25 (≤0.4)	V	I_F=10 mA, I_C=2.5 mA
Coupling Capacitance	C_C	0.6	pF	

Current Transfer Ratio (I_C/I_F at V_{CE}=5 V, 25°C)
and Collector-Emitter Leakage Current by dash number

	–1	–2	–3	–4	Unit
I_C/I_F at V_{CE}=5 V (I_F=10 mA)	40–80	63–125	100–200	160–320	%
I_C/I_F at V_{CE}=5 V (I_F=1 mA)	30 (>13)	45 (>22)	70 (>34)	90 (>56)	%
Collector-Emitter Leakage Current (V_{CE}=10 V) (I_{CEO})	2 (≤ 50)	2 (≤ 50)	5 (≤ 100)	5 (≤ 100)	nA

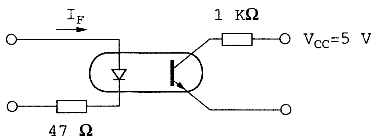
Linear Operation (without saturation)



I_F=10 mA, V_{CC}=5 V, T_A=25°C

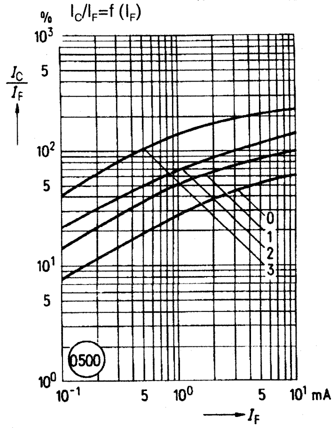
Load Resistance	R_L	75	Ω
Turn-On Time	t_{ON}	3.0	µs
Rise Time	t_R	2.0	µs
Turn-Off Time	t_{OFF}	2.3	µs
Fall Time	t_f	2.0	µs
Cut-Off Frequency	f_{CO}	250	kHz

Switching Operation (with saturation)

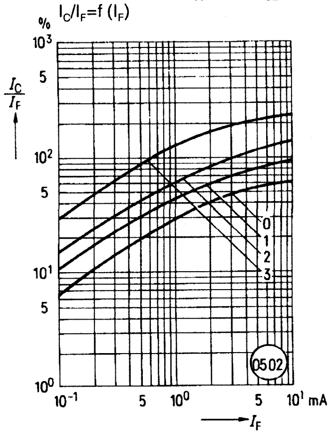


	–1 (I_F=20 mA)	–2 and –3 (I_F=10 mA)	–4 (I_F=5 mA)	
Turn-On Time t_{ON}	3.0	4.2	6.0	µs
Rise Time t_R	2.0	3.0	4.6	µs
Turn-Off Time t_{OFF}	18	23	25	µs
Fall Time t_F	11	14	15	µs

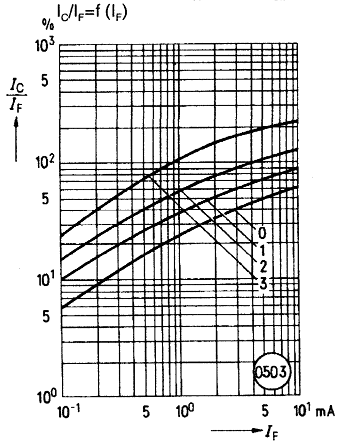
Current transfer ratio versus diode current (T_A=–25°C, V_{CE}=5 V)



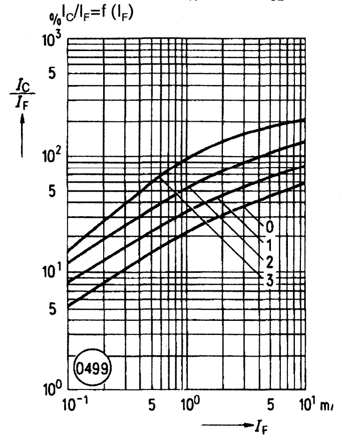
Current transfer ratio versus diode current (T_A=0°C, V_{CE}=5 V)



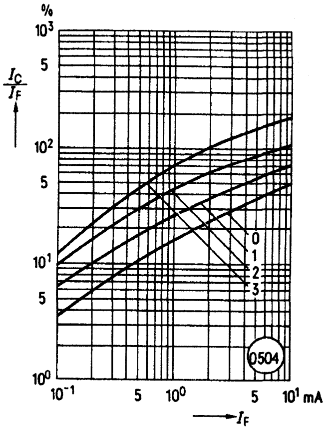
Current transfer ratio versus diode current (T_A=25°C, V_{CE}=5 V)



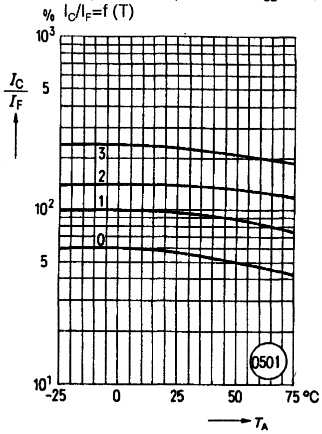
Current transfer ratio versus diode current (T_A=50°C) V_{CE}=5 V
I_C/I_F=f (I_F)



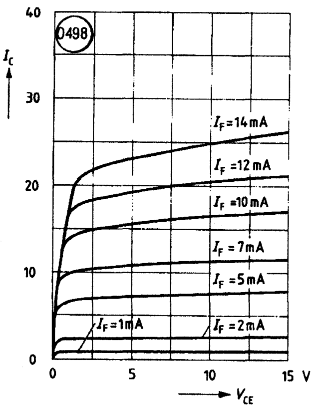
Current transfer ratio versus diode current (T_A=75°C) V_{CE}=5 V



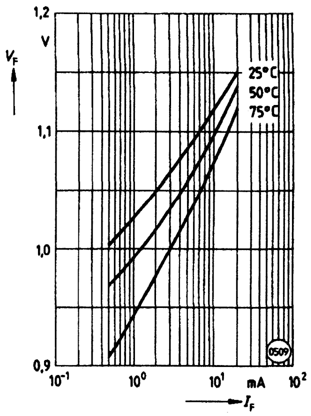
Current transfer ratio versus temperature (I_F=10 mA, V_{CE}=5 V)
I_C/I_F=f (T)



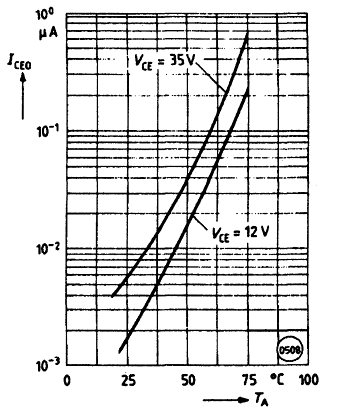
Output characteristics
CNY17F-2, -3 (T_A=25°C) IC=f(V_{CE})



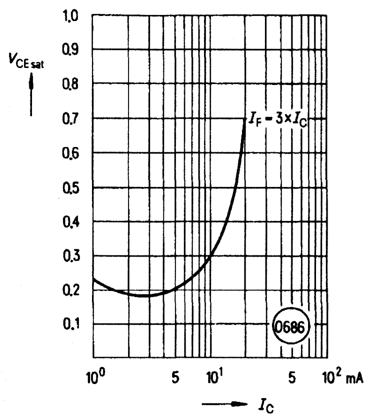
Forward voltage V_F=f (I_F)



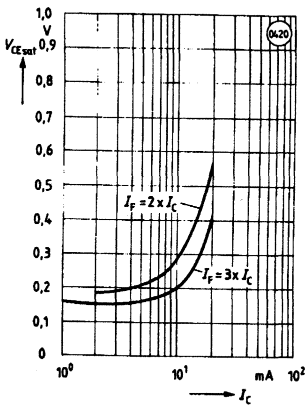
Collector emitter off-state current
I_{CEO}=f (V, T) (T_A=25°C, I_F=0)



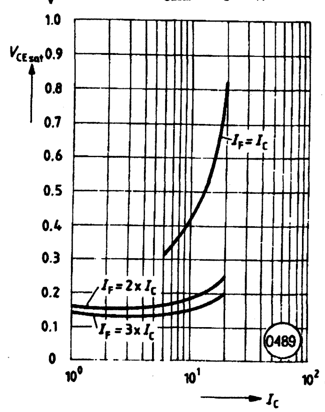
Saturation voltage versus collector current and modulation depth
CNY17F-1 V_{CEsat}=f (I_C) (T_A=25°C)



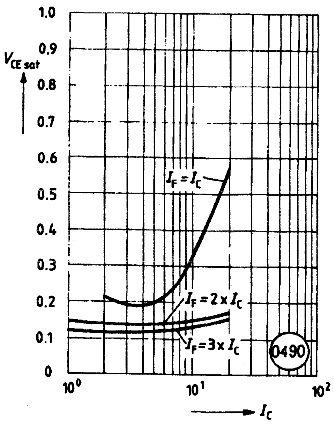
Saturation voltage versus collector current and modulation depth
CNY17F-2 V_{CEsat}=f (I_C) (T_A=25°C)



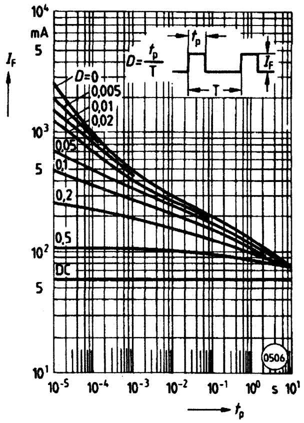
Saturation voltage versus collector current and modulation depth
CNY17F-3 V_{CEsat}=f (I_C) (T_A=25°C)



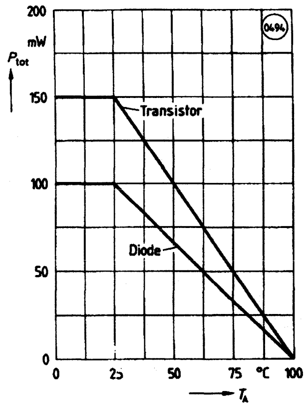
Saturation voltage versus collector current and modulation depth
CNY17F-4 V_{CEsat}=f (I_C) (T_A=25°C)



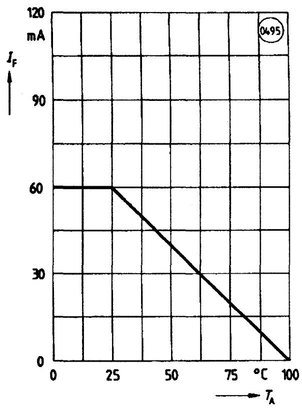
Permissible pulse load
D=parameter, T_A=25°C, I_F=f (t_p)



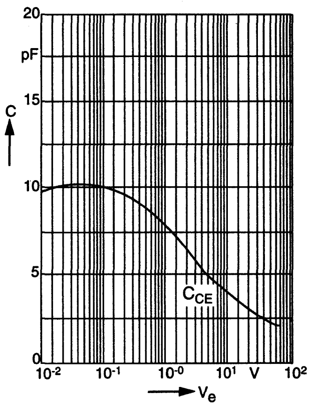
Permissible power dissipation transistor and diode P_{tot}=f (T_A)



Permissible forward current diode
I_F=f (T_A)



Transistor capacitance
C=f(V_O) (T_A=25°C, f=1 MHz)



Optocouplers (Optoisolators)

5

SIEMENS

H11AA1
BIDIRECTIONAL INPUT OPTOCOUPLER

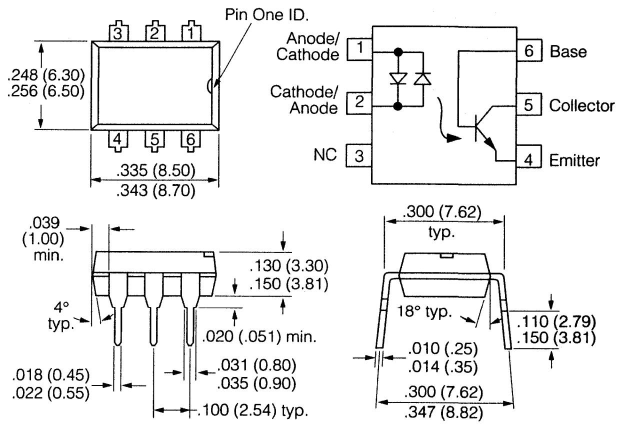
FEATURES

- **Current Transfer Ratio, 20% Min.**
- **AC or Polarity Insensitive Input**
- **Built-in Reverse Polarity Input Protection**
- **I/O Compatible with Integrated Circuits**
- **Industry Standard DIP Package**
- **Underwriters Lab File #E52744**
- **VDE Approval #0884 (Available with Option 1)**

DESCRIPTION

The H11AA1 is a bi-directional input optically coupled isolator consisting of two Gallium Arsenide infrared LEDs coupled to a silicon NPN phototransistor in a 6-pin DIP package. The H11AA1 has a minimum CTR of 20% and a CTR symmetry of 1:3 and is designed for applications requring detection or monitoring of AC signals.

Package Dimensions in Inches (mm)



Maximum Ratings

Emitter

Continuous Forward Current .... 60 mA
Power Dissipation at 25°C .... 100 mW
Derate Linearly from 25°C .... 1.3 mW/°C

Detector

Power Dissipation at 25°C Ambient .... 200 mW
Derate Linearly from 25°C .... 2.6 mW/°C
Collector-Emitter Breakdown Voltage, BV_{CEO} 30 V
Emitter-Base Breakdown Voltage, BV_{EBO} ....5 V
Collector-Base Breakdown Voltage, BV_{CBO} ... 70 V

Package

Isolation Test Voltage (between emitter and detector referred to standard climate 23°C/50%RH, DIN 50014) .... 5300 VAC_{RMS}
Creepage .... min. 7 mm
Clearance .... min. 7 mm
Comparative Tracking Index per DIN IEC 112/VDE 0303, part 1 175
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... $\geq 10^{12}\ \Omega$
V_{IO}=500 V, T_A=100°C .... $\geq 10^{11}\ \Omega$
Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Lead Soldering Time at 260°C .... 10 sec.

Electrical Characteristics (T_A=25°C)

Parameter	Min.	Typ.	Max.	Unit	Condition
Emitter					
Forward Voltage, V_F		1.2	1.5	V	I_F=±10 mA
Detector					
BV_{CEO}	30			V	I_C=1 m A
BV_{EBO}	7			V	I_E=100 µA
BV_{CBO}	70			V	I_C=100 µA
I_{CEO}		5	100	nA	V_{CE}=10 V
Package					
V_{CEsat}			0.4	V	I_F=±10 mA, I_C=0.5 mA
DC Current Transfer Ratio	20			%	I_F=±10 mA, V_{CE}=10 V
Symmetry CTR at +10 mA / CTR at - 10 mA	0.33	1.0	3.0		

Figure 1. LED forward current versus forward voltage

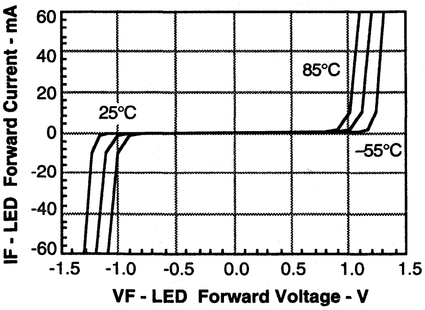


Figure 3. Normalized non-saturated and saturated CTR at T_A=50°C versus LED current

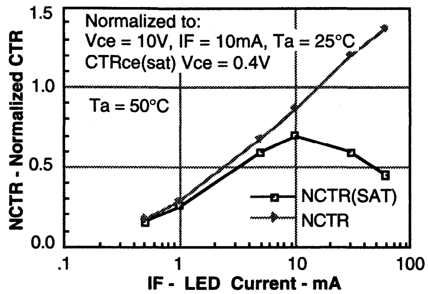


Figure 5. Normalized non-saturated and saturated CTR at T_A=85°C versus LED current

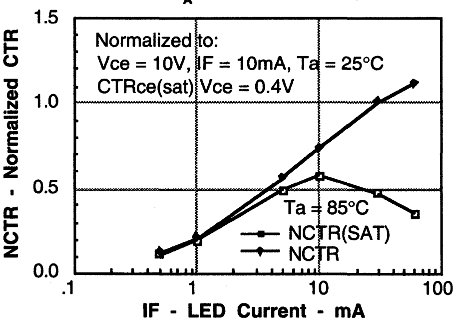


Figure 7. Collector-emitter leakage current versus temperature

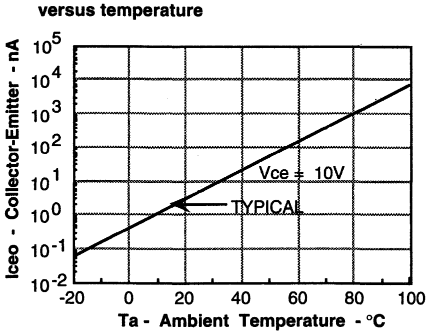


Figure 2. Normalized non-saturated and saturated CTR at T_A=25°C versus LED current

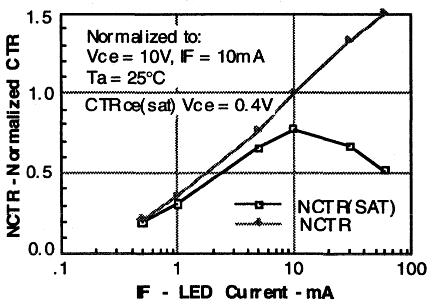


Figure 4. Normalized non-saturated and saturated CTR at T_A=70°C versus LED current

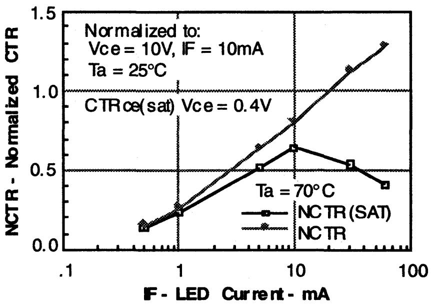


Figure 6. Collector-emitter current versus temperature and LED current

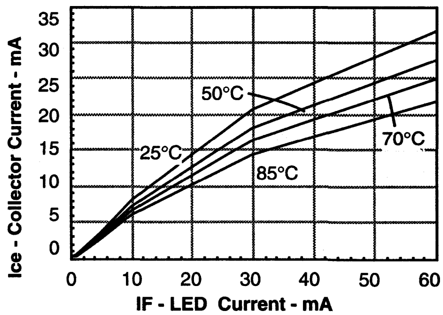
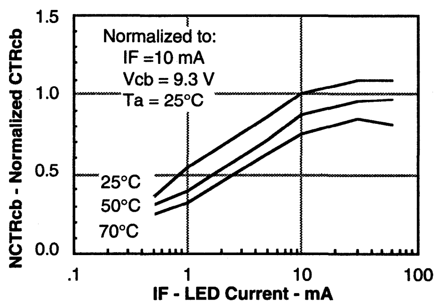


Figure 8. Normalized CTRcb versus LED current and temperature



Optocouplers (Optoisolators)

5

Figure 9. Collector base photocurrent versus LED current

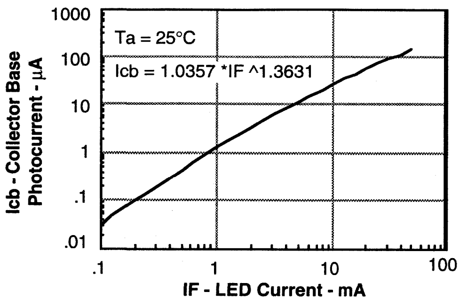


Figure 10. Normalized photocurrent versus LED current

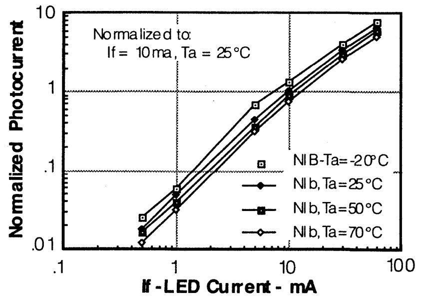


Figure 11. Normalized saturated HFE versus base current and temperature

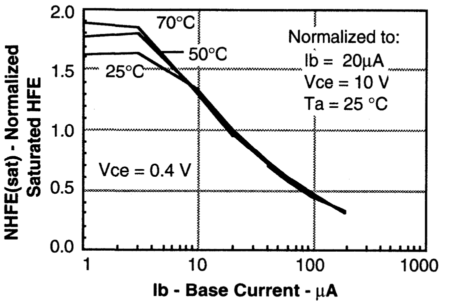


Figure 12. Normalized saturated HFE versus base current and temperature

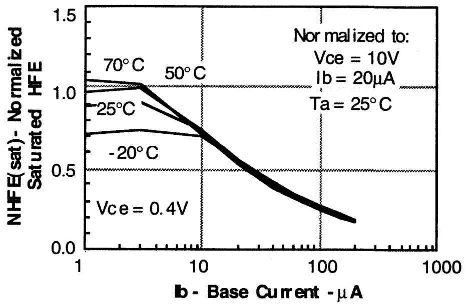


Figure 13. Propagation delay versus collector load resistor

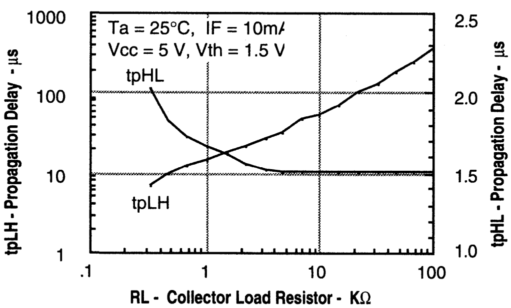


Figure 14. Switching waveform

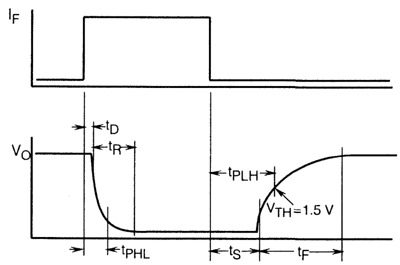
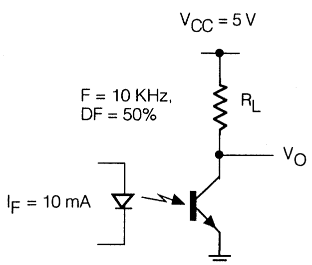


Figure 15. Switching schematic



SIEMENS

H11B1/H11B2/H11B3
PHOTODARLINGTON OPTOCOUPLER

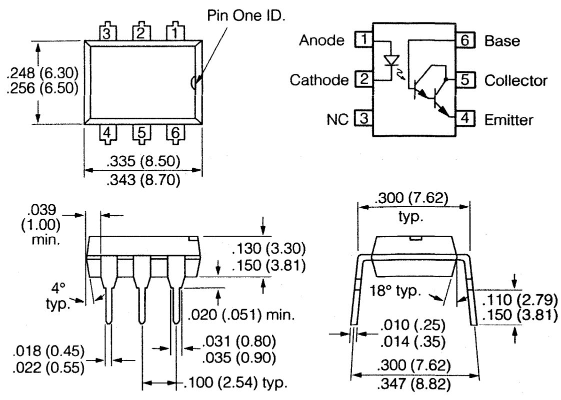
FEATURES

- **CTR Minimum at I_F = 1 mA**
  H11B1, 500%
  H11B2, 200%
  H11B3, 100%
- **Isolation Test Voltage, 5300 VAC_{RMS}**
- **Coupling Capacitance, 0.5 pF**
- **Underwriters Lab File #E52744**
- **VDE Approval #0884 (Available with Option 1)**

DESCRIPTION

The H11B1/H11B2/H11B3 are industry standard optocouplers, consisting of a Gallium Arsenide infrared LED and a silicon phototdarlington. These optocouplers are constructed with a high voltage insulation, double molded packaging process which offers 7.5 KV withstand test capability.

Package Dimensions in Inches (mm)



5

Optocouplers (Optoisolators)

Maximum Ratings

Emitter

Reverse Voltage .... 3 V
Continuous Forward Current .... 60 mA
Power Dissipation at 25°C .... 100 mW
Derate Linearly from 25°C .... 1.33 mW/°C

Detector

Collector-Emitter Breakdown Voltage, BV_{CEO} .... 25 V
Emitter-Collector Breakdown Voltage BV_{ECO} .... 7 V
Collector-Base Breakdown Voltage, BV_{CBO} .... 30 V
Collector-Current (Continuous) .... 100 mA
Power Dissipation at 25°C .... 150 mW
Derate Linearly from 25°C .... 2.0 mW/°C

Package

Isolation Test Voltage (between emitter and detector referred to standard climate 23°C/50%RH, DIN 50014) .... 5300 VAC_{RMS}
Creepage .... min. 7 mm
Clearance .... min. 7 mm
Comparative Tracking Index per DIN IEC 112/VDE 0303, part 1 175
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... $\geq 10^{12}\ \Omega$
V_{IO}=500 V, T_A=100°C .... $\geq 10^{11}\ \Omega$
Total Package Dissipation at 25°C (LED plus Detector) .... 260 mW
Derate Linearly from 25°C .... 3.5 mW/°C
Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Lead Soldering Time at 260°C .... 10 sec.

Characteristics (T_A=25°C)

	Sym	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage						
H11B1, B2	V_F		1.1	1.5	V	I_F=10 mA
H11B3	V_F		1.1	1.5	V	I_F=50 mA
Reverse Current	I_R			10	µA	V_R=3 V
Junction Capacitance	C_J		50		pF	V_F=0 V, f=1 MHz
Detector						
BV_{CEO}		30			V	I_C=1.0 mA, I_F=0 mA
BV_{ECO}		7			V	I_E=100 µA, I_F=0 mA
BV_{CBO}		30			V	I_C=100 µA, I_F=0 mA
I_{CEO}				100	nA	V_{CE}=10 V, I_F=0 mA
Package						
V_{CEsat}				1.0	V	I_C=1mA, I_C=1mA
DC Current Transfer Ratio						
H11B1	CTR	500			%	V_{CE}=5 V, I_F=1 mA
H11B2	CTR	200			%	V_{CE}=5 V, I_F=1 mA
H11B3	CTR	100			%	V_{CE}=5 V, I_F=1 mA
Capacitance Input to Output	C_{IO}		0.5		pF	
Switching Times						I_F=5 mA, V_{CE}=10 V, R_L=100 Ω
	t_{on}		5		µs	
	t_{off}		30		µs	

Figure 1. Forward voltage versus forward current

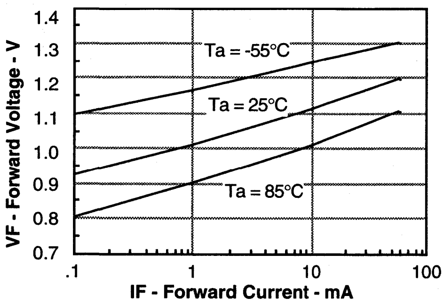


Figure 2. Normalized non-saturated and saturated CTRce versus LED current

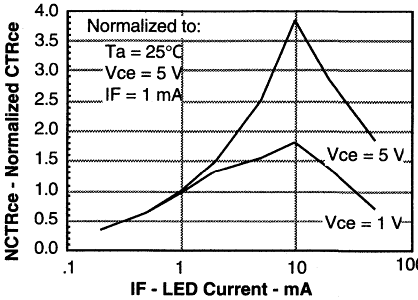


Figure 3. Normalized non-saturated and saturated Ice versus LED current

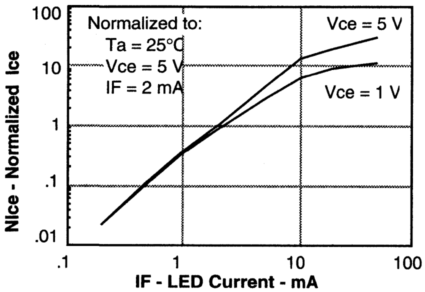


Figure 4. Normalized non-saturated and saturated collector-emitter current versus LED current

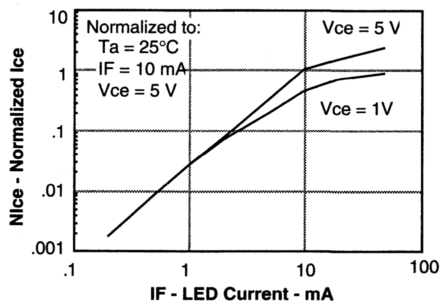


Figure 5. Non-saturated and saturated HFE versus base current

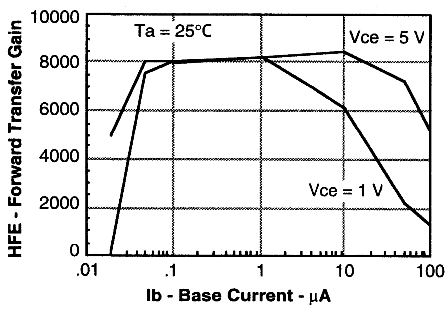


Figure 6. Low to high propagation delay versus collector load resistance and LED current

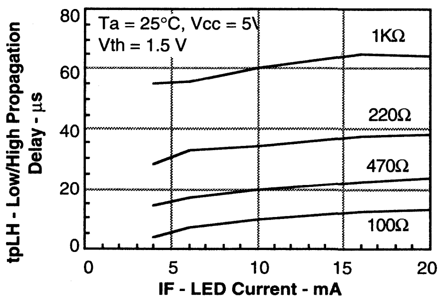


Figure 7. High to low propagation delay versus collector load resistance and LED current

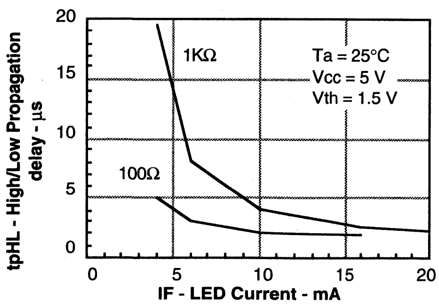
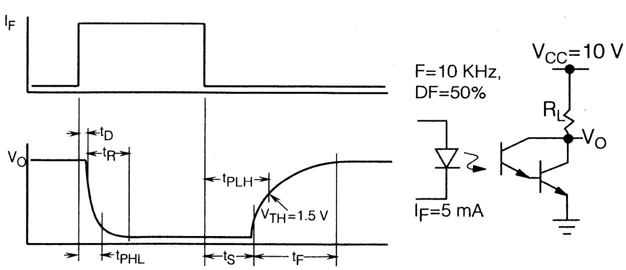


Figure 9. Switching waveform and schematic



SIEMENS

H11C4/H11C5/H11C6
PHOTO SCR OPTOCOUPLER

FEATURES
- **Turn On Current (I_{FT}), 5.0 mA Typical**
- **Gate Trigger Current (I_{GT}), 20 mA Typical**
- **Surge Anode Current, 5.0 A**
- **Blocking Voltage, 400 V**
- **Gate Trigger Voltage (V_{GT}), 0.6 V Typical**
- **Isolation Voltage, 5300 VAC_{RMS}**
- **Solid State Reliability**
- **Standard DIP Package**
- **Underwriters Lab File #E52744**

DESCRIPTION
The H11C4/H11C5/H11C6 are optically coupled SCRs with a Gallium Arsenide infrared emitter and a silicon photo SCR sensor. Switching can be achieved while maintaining a high degree of isolation between triggering and load circuits. These optocouplers can be used in SCR triac and solid state relay applications where high blocking voltages and low input current sensitivity are required.

The H11C4 and H11C5 has a maximum turn-on-current of 11 mA. The H11C6 has a maximum of 14 mA.

Maximum Ratings
Emitter

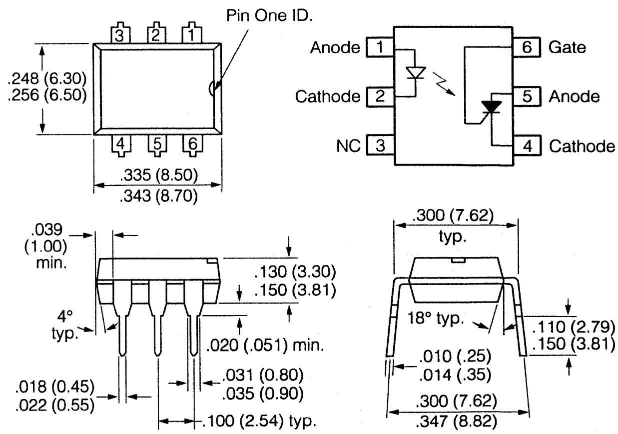
Peak Reverse Voltage .... 6.0 V
Continuous Forward Current....................... 60 mA
Peak Forward Current
(1 ms, 1% Duty Cycle) .... 3.0 A
Power Dissipation at 25°C .... 100 mW
Derate Linearly from 25°C .... 1.33 mW/°C

Detector

Reverse Gate Voltage .... 6.0 V
Anode Voltage (DC or AC Peak) .... 400 V
RMS Forward Current .... 300 mA
Surge Anode Current (10 ms duration) .... 5.0 A
Peak Forward Current
(100 µs, 1% Duty Cycle) .... 10 A
Surge Gate Current (5 ms duration) .... 200 mA
Power Dissipation, 25°C case .... 1000 mW
Derate Linearly from 25°C .... 13.3 mW/°C

Package

Isolation Test Voltage ....5300 VAC_{RMS}
Between Emitter and Detector
Referred to Standard Climate
23°C/50%RH, DIN 50014
Creepage...min.7 mm
Clearance ....min. 7 mm
Comparative Tracking Index per
DIN IEC 112/VDE 0303, part 1 175
Isolation Resistance
V_{IO}=500 V, T_A=25°C ....$\geq 10^{12}\ \Omega$
V_{IO}=500 V, T_A=100°C ....$\geq 10^{11}\ \Omega$
Total Package Dissipation .... 400 mW
Derate Linearly from 25°C .... 5.3 mW/°C
Operating Temperature Range.. –55°C to +100°C
Storage Temperature Range ..... –55°C to +150°C
Lead Soldering Time at 260°C .... 10 sec.



Characteristics (T_A=25°C)

	Sym	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.2	1.5	V	I_F=10 mA
Reverse Current	I_R			10	µA	V_R=3 V
Capacitance	C_O		50		pF	V_R=0, f=1 MHz
Detector						
Forward Blocking Voltage	V_{DM}	400			V	R_{GK}=10 KΩ, T_A=100°C, I_d=150 µA
Reverse Blocking Voltage	V_{DM}	400			V	
On-state Voltage	V_t		1.1	1.3	V	I_T=300 mA
Holding Current	I_H			500	µA	R_{GK}=27 KΩ, V_{FX}=50 V
Gate Trigger Voltage	V_{GT}		0.6	1.0	V	V_{FX}=100 V, R_{GK}=27 KΩ, R_L=10 KΩ
Forward Leakage Current	I_R		150		µA	R_{GK}=10 KΩ, V_{RM}=400 V, I_F=0, T_A=100°C
Reverse Leakage Current	I_R		150		µA	R_{GK}=10 KΩ, V_{RX}=400 V, I_F=0, T_A=100°C
Gate Trigger Current	I_{GT}		20	50	µA	V_{FX}=100 V, R_{GK}=27 KΩ, R_L=10 KΩ
Capacitance Anode to Gate Gate to Cathode			 20 350		 pF pF	V=0, f=1 MHz
Package						
Turn-On Current H11C4/H11C5 H11C6	I_{FT}			 20 30	 mA mA	V_{DM}=50 V, R_{GK}=10 KΩ
Turn-On Current H11C4/H11C5 H11C6	I_{FT}		 5 7	 11 14	 mA mA	V_{DM}=100 V, R_{GK}=27 KΩ

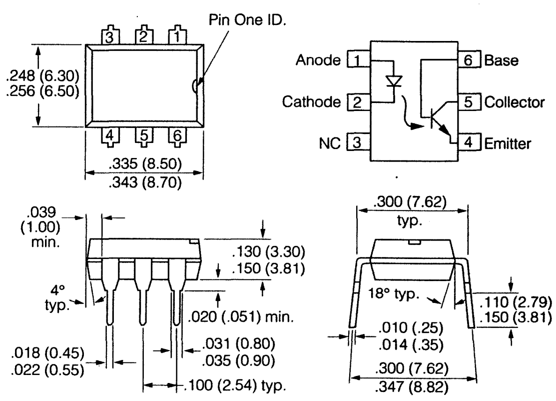
SIEMENS

H11D1/H11D2/H11D3

PHOTOTRANSISTOR, 5.3 KV, TRIOS®
HIGH BV_{CER} VOLTAGE
OPTOCOUPLER

FEATURES
- CTR at I_F=10 mA, BV_{CER}=10 V: ≥20%
- Good CTR Linearity with Forward Current
- Low CTR Degradation
- Very High Collector-Emitter Breakdown Voltage
  - H11D1/H11D2, BV_{CER}=300 V
  - H11D3, BV_{CER}=200 V
- Isolation Test Voltage: 5300 VAC_{RMS}
- Low Coupling Capacitance
- High Common Mode Transient Immunity
- Phototransistor Optocoupler in 6 Pin DIP Package with Base Connection
- Field Effect Stable: TRIOS*
- VDE 0884 Available with Option 1
- Underwriters Lab File #E52744
- Applications
  - Telecommunications
  - Replace Relays

Package Dimensions in Inches (mm)



DESCRIPTION
The H11D1/2/3 are optocouplers with very high BV_{CER}. They are intended for telecommunications applications or any DC application requiring a high blocking voltage.

Maximum Ratings (T_A=25°C)

Emitter

Reverse Voltage .... 6 V
DC Forward Current .... 60 mA
Surge Forward Current (tp ≤ 10 µs) .... 2.5 A
Total Power Dissipation .... 100 mW

Detector

Collector-Emitter Voltage
H11D1/2 .... 300 V
H11D3 .... 200 V
Collector-Base Voltage
H11D1/2 .... 300 V
H11D3 .... 200 V
Emitter-Base Voltage .... 7 V
Collector Current .... 100 mA
Total Power Dissipation .... 300 mW

Maximum Ratings (continued)

Package

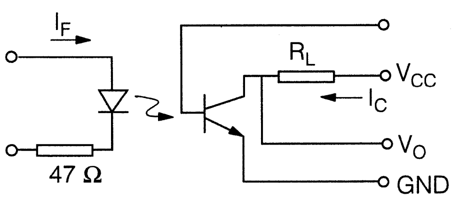
Isolation Test Voltage (between emitter and detector refer to climate DIN 40046, part 2, Nov. 74) .... 5300 VAC_{RMS}
Insulation Thickness between Emitter and Detector ..... ≥0.4 mm
Creepage Distance .... ≥7 mm
Clearance Distance .... ≥7 mm
Comparative Tracking Index (per DIN IEC 112/VDE 0303, part 1) 175
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... ≥10^{12} Ω
V_{IO}=500 V, T_A=100°C .... ≥10^{11} Ω
Storage Temperature Range ....–55°C to +150°C
Operating Temperature Range ....–55°C to +100°C
Junction Temperature .... 100°C
Soldering Temperature (max. 10 sec., dip soldering: distance to seating plane ≥ 1.5 mm)....... 260°C

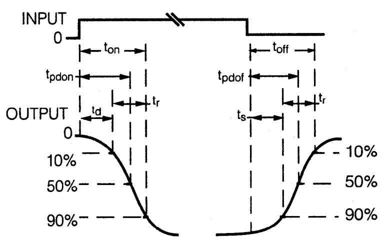
*TRIOS – **TR**ansparent **IO**n **S**hield

Characteristics (T_A = 25°C, unless otherwise specified)

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.1	1.5	V	I_F=10 mA
Reverse Voltage	V_R	6			V	I_R= 10 µA
Reverse Current	I_R		0.01	10	µA	V_R=6 V
Capacitance	C_O		25		pF	V_R=0 V, f=1 MHz
Thermal Resistance	R_{thJA}		750		K/W	
Detector						
Voltage						
Collector-Emitter	BV_{CER}					I_{CE}=1 mA, R_{BE}=1 MΩ
H11D1/H11D2		300			V	
H11D3		200			V	
Emitter-Base	BV_{EBO}	7			V	I_{EB}=100 µA
Capacitance	C_{CE}		7		pF	V_{CE}=10 V, f=1 MHz
	C_{CB}		8		pF	V_{CB}=10 V, f=1 MHz
	C_{EB}		38		pF	V_{EB}=5 V, f=1 MHz
Thermal Resistance	R_{thJA}		250		K/W	
Package						
Coupling Capacitance	C_C		0.6		pF	
Coupling Transfer Ratio	I_C/I_F	20			%	I_F=10 mA, V_{CE}=10 V, R_{BE}=1 MΩ
Collector-Emitter						
Saturation Voltage	V_{CEsat}		0.25	0.4	V	I_F=10 mA, I_C=0.5 mA, R_{BE}=1 MΩ
Leakage Current						
Collector-Emitter	I_{CER}					
H11D1/H11D2				100	nA	V_{CE}=200 V, R_{BE}=1 MΩ
H11D3				100	nA	V_{CE}=100 V, R_{BE}=1 MΩ
Collector-Emitter	I_{CER}					
H11D1/H11D2				250	µA	V_{CE}=200 V, R_{BE}=1 MΩ, T_A = 100°C
H11D3				250	µA	V_{CE}=100 V, R_{BE}=1 MΩ, T_A = 100°C

Switching Times Measurement—Test Circuit and Waveforms



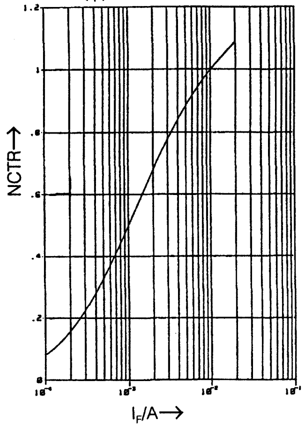


Switching Times (typ.)

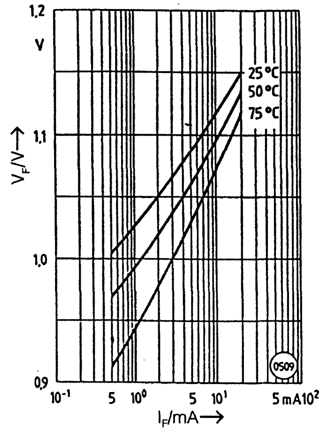
I_C=2 mA (to be adjusted by varying I_F), R_L=100 Ω,
T_A=25°C, V_{CC}=10 V

Description	Symbol	Values	Unit
Turn-On Time	t_{ON}	5	µs
Rise Time	t_R	2.5	µs
Turn-Off Time	t_{OFF}	6	µs
Fall Time	t_F	5.5	µs

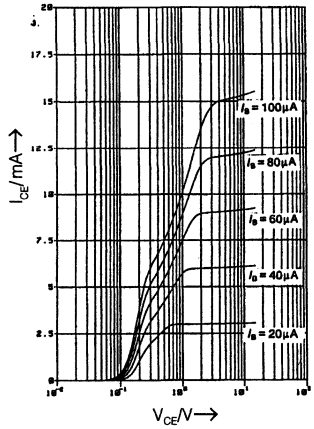
Current transfer ratio (typ.)
V_{CE}=10 V, T_A=25°C, normalized to I_F=10 mA
NCTR=f(I_F)



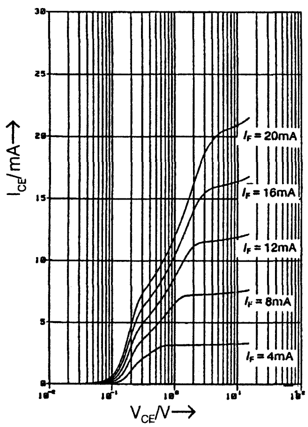
Diode forward voltage (typ.)
V_F=f(I_F,T_A)



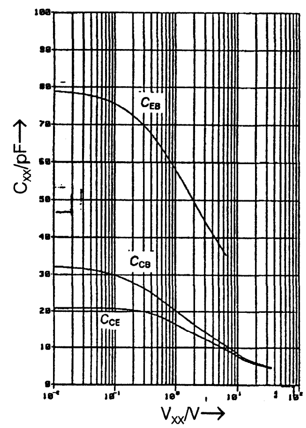
Output characteristics (typ.)
T_A=25°C, I_{CE}=f(V_{CE}, I_B)



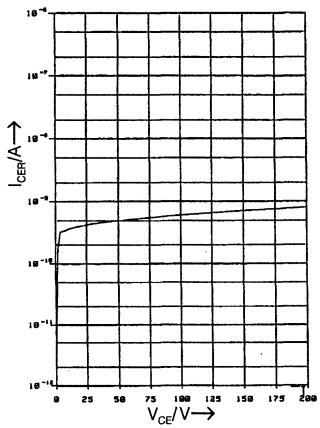
Output characteristics (typ.)
T_A=25°C, I_{CE}=f(V_{CE}, I_F)



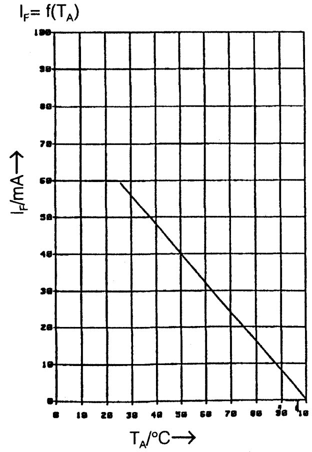
Transistor capacitances (typ.)
T_A=25°C, f=1 MHz, C_{CE}=f(V_{CE})
C_{CB}=f (V_{CB}), C_{EB}=f (V_{EB})



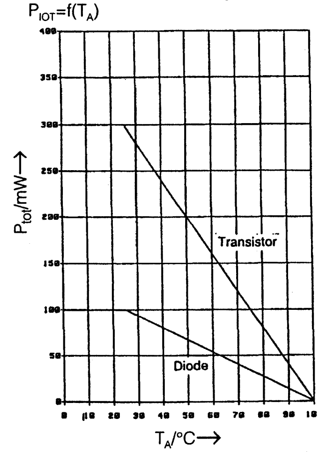
Collector-emitter leakage current (typ.)
I_F=0, R_{BE}=1 MΩ, I_{CER}=f(V_{CE})



Permissible loss diode
I_F= f(T_A)



Permissible power dissipation
P_{IOT}=f(T_A)



SIEMENS

IL1/2/5

PHOTOTRANSISTOR OPTOCOUPLER

FEATURES

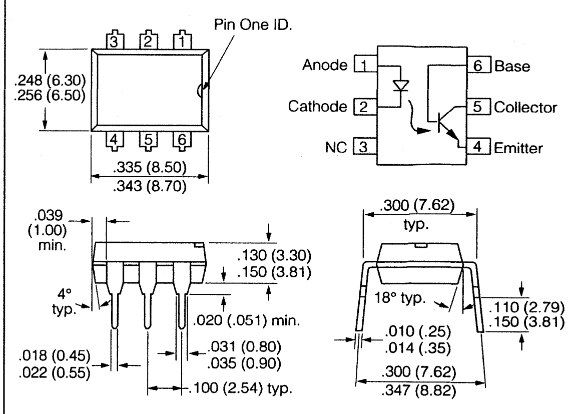
- **Current Transfer Ratio at I_F=10 mA**
  IL1, 20% Min.
  IL2, 100% Min.
  IL5, 50% Min.
- **High Collector-Emitter Voltage**
  IL1 – BV_{CEO}=50 V
  IL2, IL5 – BV_{CEO}=70 V
- **Field-Effect Stable by TRansparent IOn Shield (TRIOS)**
- **Double Molded Package Offers Isolation Test Voltage 5300 VAC_{RMS}**
- **Underwriters Lab File #E52744**
- **VDE Approval #0884 (Available with Option 1)**

DESCRIPTION

The IL1/2/5 are optically coupled isolated pairs employing GaAs infrared LEDs and silicon NPN phototransistor. Signal information, including a DC level, can be transmitted by the drive while maintaining a high degree of electrical isolation between input and output. The IL1/2/5 are especially designed for driving medium-speed logic and can be used to eliminate troublesome ground loop and noise problems. These couplers can be used also to replace relays and transformers in many digital interface applications such as CRT modulation.

See Appnote 45, "How to Use Optocoupler Normalized Curves."

Package Dimensions in Inches (mm)



Maximum Ratings

Emitter

Reverse Voltage	6 V
Forward Current	60 mA
Surge Current	2.5 A
Power Dissipation	100 mW
Derate Linearly from 25°C	1.33 mW/°C

Detector

Collector-Emitter Reverse Voltage	
IL1	50 V
IL2, IL5	70 V
Emitter-Base Reverse Voltage	7 V
Collector-Base Reverse Voltage	70 V
Collector Current	50 mA
Collector Current (t<1 ms)	400 mA
Power Dissipation	200 mW
Derate Linearly from 25°C	2.6 mW/°C

Package

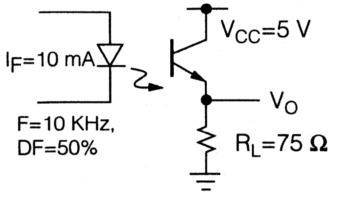
Package Power Dissipation	250 mW
Derate Linearly from 25°C	3.3 mW/°C
Isolation Test Voltage (between emitter and detector referred to standard climate 23°C/50%RH, DIN 50014)	5300 VAC_{RMS}
Creepage	min. 7 mm
Clearance	min. 7 mm
Comparative Tracking Index per DIN IEC 112/VDE 0303, part 1	175
Isolation Resistance	
V_{IO}=500 V, T_A=25°C	$\geq 10^{12}\ \Omega$
V_{IO}=500 V, T_A=100°C	$\geq 10^{11}\ \Omega$
Storage Temperature	–40°C to +150°C
Operating Temperature	–40°C to +100°C
Junction Temperature	100°C
Soldering Temperature (2 mm from case bottom)	260°C

Characteristics

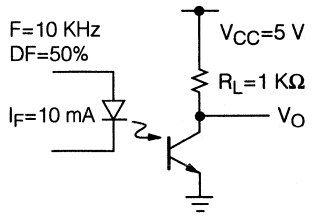
	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.25	1.65	V	I_F=60 mA
Breakdown Voltage	V_{BR}	6	30		V	I_R=10 μA
Reverse Current	I_R		0.01	10	μA	V_R=6 V
Capacitance	C_O		40		pF	V_R=0 V, f=1 MHz
Thermal Resistance Junction to Lead	R_{THJL}		750		°C/W	
Detector						
Capacitance	C_{CE}		6.8		pF	V_{CE}=5 V, f=1 MHz
	C_{CB}		8.5		pF	V_{CB}=5 V, f=1 MHz
	C_{EB}		11		pF	V_{EB}=5 V, f=1 MHz
Collector-Emitter Leakage Current	I_{CEO}		5	50	nA	V_{CE}=10 V
Collector-Emitter Saturation Voltage	V_{CESAT}		0.25	0.4		I_{CE}=1 mA, I_B=20 μA
Base-Emitter Voltage	V_{BE}		0.65		V	V_{CE}=10 V, I_B=20 μA
DC Forward Current Gain	HFE	200	650	1800		V_{CE}= 10 V, I_B=20 μA
Saturated DC Forward Current Gain	HFE_{SAT}	120	400	600		V_{CE}= 0.4 V, I_B=20 μA
Thermal Resistance Junction to Lead	R_{THJL}		500		°C/W	
Package Transfer Characteristics						
IL1						
Saturated Current Transfer Ratio (Collector-Emitter)	CTR_{CESAT}		75		%	I_F=10 mA, V_{CE}=0.4 V
Current Transfer Ratio (Collector-Emitter)	CTR_{CE}	20	80	300	%	I_F=10 mA, V_{CE}=10 V
Current Transfer Ratio (Collector-Base)	CTR_{CB}		0.25		%	I_F=10 mA, V_{CB}=9.3 V
IL2						
Saturated Current Transfer Ratio (Collector-Emitter)	CTR_{CESAT}		170		%	I_F=10 mA, V_{CE}=0.4 V
Current Transfer Ratio (Collector-Emitter)	CTR_{CE}	100	200	500	%	I_F=10 mA, V_{CE}=10 V
Current Transfer Ratio	CTR_{CB}		0.25		%	I_F=10 mA, V_{CB}=9.3 V
IL5						
Saturated Current Transfer Ratio (Collector-Emitter)	CTR_{CESAT}		100		%	I_F=10 mA, V_{CE}=0.4 V
Current Transfer Ratio (Collector-Emitter)	CTR_{CE}	50	130	400	%	I_F=10 mA, V_{CE}=10 V
Current Transfer Ratio	CTR_{CB}		0.25		%	I_F=10 mA, V_{CB}=9.3 V
Isolation and Insulation						
Common Mode Rejection Output High	CMH		5000		V/μs	V_{CM}=50 V_{P-P} , R_L=1 kΩ, I_F=0 mA
Common Mode Rejection Output Low	CML		5000		V/μs	V_{CM}=50 V_{P-P} ,R_L=1 kΩ, I_F=10 mA
Common Mode Coupling Capacitance	C_{CM}		0.01		pF	
Package Capacitance	C_{I-O}		0.6		pF	V_{I-O}=0 V, f=1 MHz.
Insulation Resistance	R_S		10^{+14}		Ω	V_{I-O}=500 V

SWITCHING TIMES

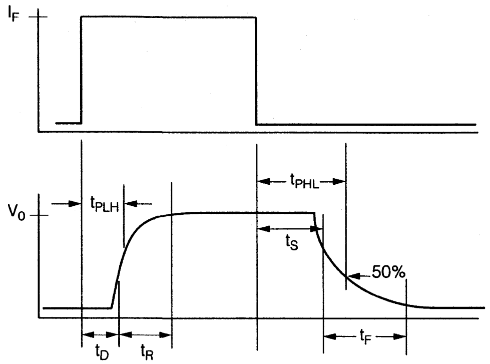
Non-Saturated Switching Timing



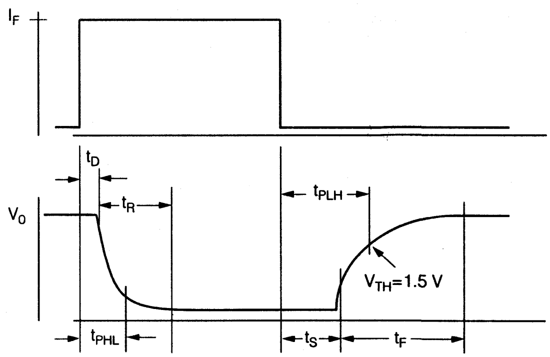
Saturated Switching Timing



Non-Saturated Switching Timing



Saturated Switching Timing



Non-Saturated Switching Time Table–Typical

Characteristic		IL1 I_F=20 mA	IL2 I_F=5 mA	IL5 I_F=10 mA	Unit	Test Condition
Delay	T_D	0.8	1.7	1.7	µs	
Rise Time	t_R	1.9	2.6	2.6	µs	V_{CC}=5 V
Storage	t_S	0.2	0.4	0.4	µs	R_L=75 Ω
Fall Time	t_F	1.4	2.2	2.2	µs	
Propagation H-L	t_{PHL}	0.7	1.2	1.1	µs	t_p measured at 50% of output
Propagation L-H	t_{PLH}	1.4	2.3	2.5	µs	

Saturated Switching Time Table–Typical

Characteristic		IL1 I_F=20 mA	IL2 I_F=5 mA	IL5 I_F=10 mA	Unit	Test Condition
Delay	T_D	0.8	1	1.7	µs	
Rise Time	t_R	1.2	2	7	µs	V_{CL} = 5.0 V
Storage	t_S	7.4	5.4	4.6	µs	V_{CE} = 0.4
Fall Time	t_F	7.6	13.5	20	µs	R_L = 1 K
Propagation H-L	t_{PHL}	1.6	5.4	2.6	µs	V_{TH}=1.5 V
Propagation L-H	t_{PLH}	8.6	7.4	7.2	µs	

Figure 1. Forward voltage versus forward current

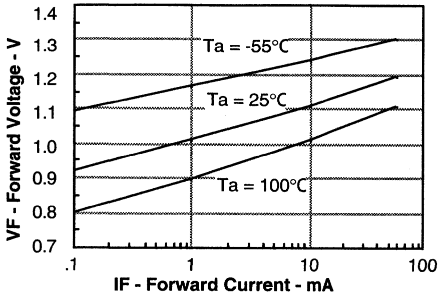


Figure 2. Normalized non-saturated and saturated CTR at T_A=25°C versus LED current

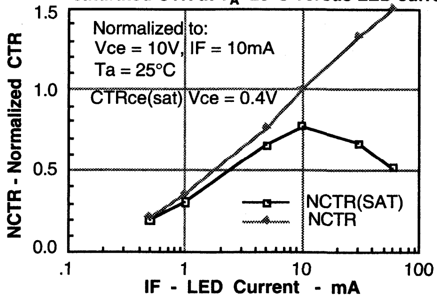


Figure 3. Normalized non-saturated and saturated CTR at T_A=50°C versus LED current

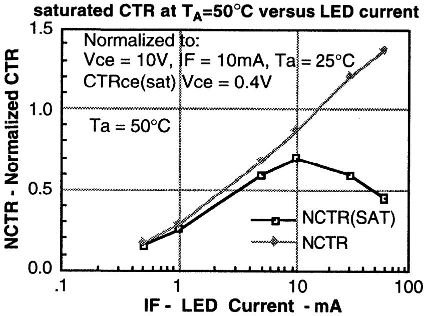


Figure 4. Normalized non-saturated and saturated CTR at T_A=70°C versus LED current

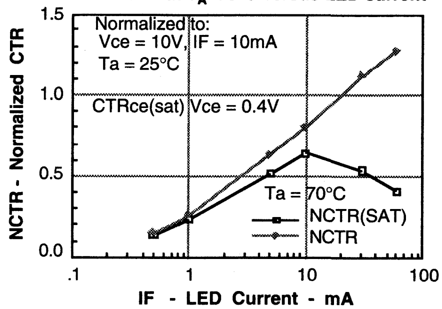


Figure 5. Normalized non-saturated and saturated CTR at T_A=100°C versus LED current

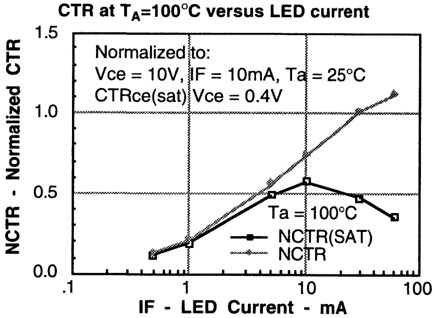


Figure 6. Collector-emitter current versus temperature and LED current

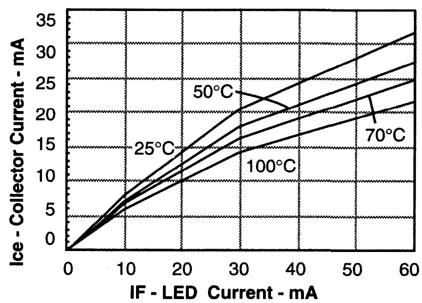


Figure 7. Collector-emitter leakage current versus temperature

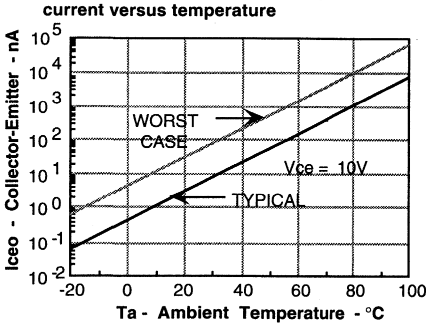


Figure 8. Normalized CTRcb versus LED current and temperature

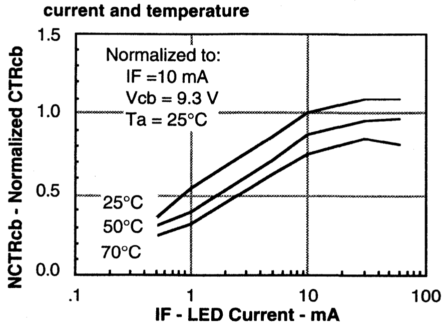


Figure 9. Collector base photocurrent versus LED current

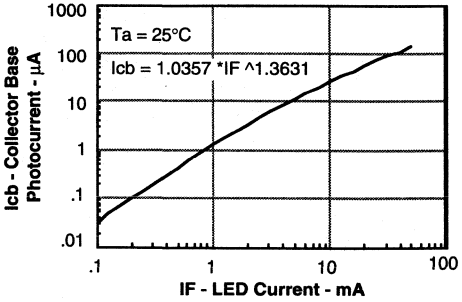


Figure 10. Normalized photocurrent versus If and temperature

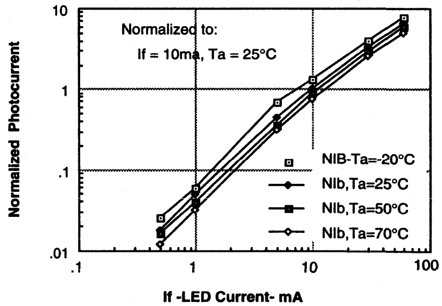


Figure 11. Normalized non-saturated HFE versus base current and temperature

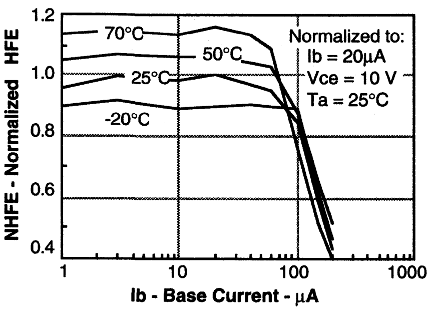


Figure 12. Normalized saturated HFE versus base current and temperature

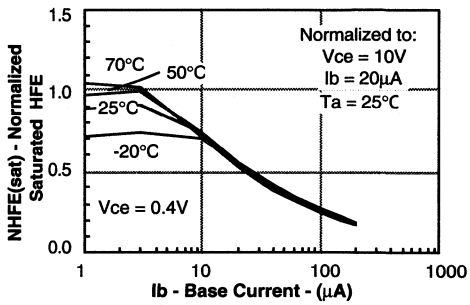
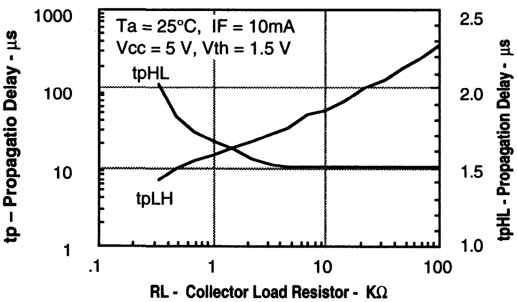


Figure 13. Propagation delay versus collector load resistor



SIEMENS

SINGLE CHANNEL IL30/31/55
DUAL CHANNEL ILD30/31/55
QUAD CHANNEL ILQ30/31/55
PHOTODARLINGTON OPTOCOUPLER

FEATURES

- **Current Transfer Ratio IL/D/Q30/55, 100% Min. IL/D/Q31, 200% Min.**
- **125 mA Load Current Rating**
- **Fast Rise Time, 10 μS**
- **Fast Fall Time, 35 μS**
- **Single, Dual, & Quad Channel**
- **Solid State Reliability**
- **Standard DIP Package**
- **Underwriters Lab File #E52744**
- **VDE 0884 Available with Option 1**

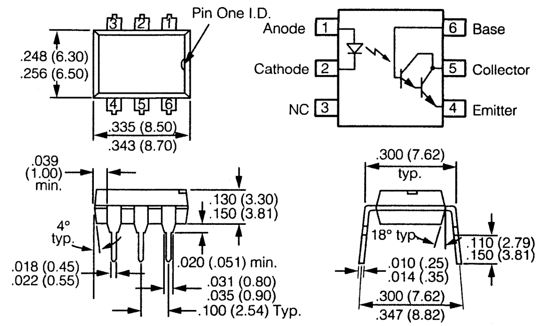
DESCRIPTION

The IL30/31/55, ILD30/31/55 and ILQ30/31/55 are optically coupled isolators with a Gallium Arsenide infrared emitter and a silicon photodarlington sensor. Switching can be achieved while maintaining a high degree of isolation between driving and load circuits, with no cross talk between channels. These optocouplers can be used to replace reed and mercury relays with advantages of long life, high speed switching and elimination of magnetic fields.

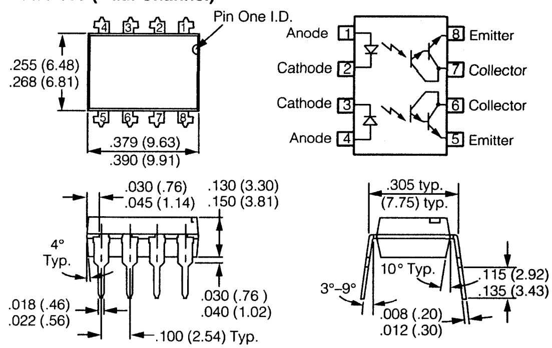
The IL30/31/55 are equivalent to MCA230/MCA231/MCA255. The ILD/Q30/31/55 are designed to reduce board space requirements in high density applications.

Package Dimensions in Inches (mm)

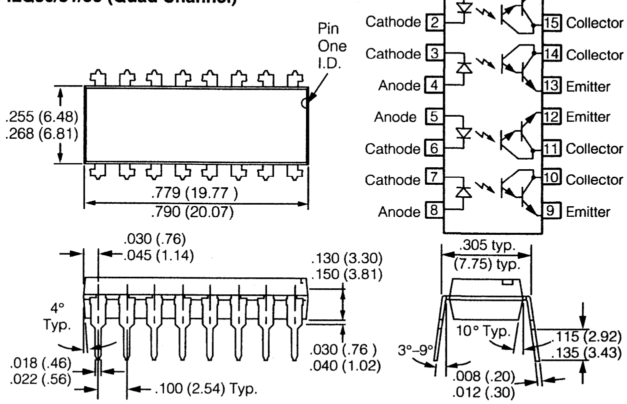
IL30/31/55 (Single Channel)



ILD30/31/55 (Dual Channel)



ILQ30/31/55 (Quad Channel)



Maximum Ratings

Emitter (each channel)

Peak Reverse Voltage .... 3 V
Continuous Forward Current .... 60 mA
Power Dissipationat 25°C .... 100 mW
Derate Linearly from 25°C .... 1.33mW/°C

Detector (each channel)

Collector-Emitter Breakdown Voltage
IL/D/Q30 .... 30 V
Collector-Emitter Breakdown Voltage
IL/D/Q55 .... 55 V
Collector (Load) Current .... 125 mA
Power Dissipation at 25°C Ambient .... 150 mW
Derate Linearly from 25°C .... 2.0 mW/°C

Package

Total Package Dissipation at 25°C
IL30/31/55 .... 250 mW
ILD30/31/55 .... 400 mW
IL7Q30/31/55 .... 500 mW
Derate Linearly from 25°C
IL30/31/55 .... 3.3 mW/°C
ILD30/31/55 .... 5.33 mW/°C
ILQ30/31/55 .... 6.67 mW/°C
Isolation Test Voltage .... 5300 VAC_{RMS}
Creepage .... 7 mm min.
Clearance .... 7 mm min
Comparative Tracking Index 175
Storage Temperature .... –55°C to +125°C
Operating Temperature .... –55°C to +100°C
Lead Soldering Time at 260°C .... 10 sec.

Electrical Characteristics (T_A=25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.25	1.5	V	I_F= 20 mA
Reverse Current	I_R		0.1	10	µA	V_R = 3.0 V
Capacitance	C_O		25		pF	V_R = 0
Detector						
Collector-Emitter Breakdown Voltage	BV_{CEO}	30/55			V	I_C = 100 µA
Collector-Emitter Leakeage Current	I_{CEO}		1.0	100	nA	V_{CE} = 10 V, I_F = 0
Collector-Emitter Capacitance	C_{CE}		3.4		pF	V_{CE} = 10 V f=1 MHz
Package						
Current Transfer Ratio	CTR					
IL/D/Q30/55		100	400		%	I_F = 10 mA, V_{CE} =5 V
IL/D/Q31		200	400		%	I_F = 10 mA, V_{CE} =5 V
Collector-Emitter Saturation Voltage	V_{CEsat}		0.9	1.0	V	I_C = 50 mA, I_F = 50 mA
Isolation Test Voltage		5300			VAC_{RMS}	
Isolation Resistance	R_{ISOL}		10^{12}		Ω	
Coupling Capacitance	C_{ISOL}		0.5		pF	
Rise Time	t_r		10		µs	V_{CC} = 13.5 V, I_F = 50 mA, R_C = 100 Ω
Fall Time	t_f		35		µs	V_{CC} = 13.5 V, I_F = 50 mA, R_C = 100 Ω

Figure 1. Forward voltage versus forward current

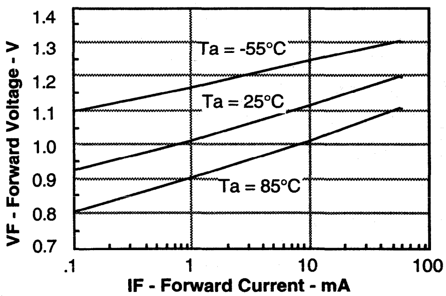


Figure 2. Normalized non-saturated and saturated CTRce at T_A=25°C versus LED current

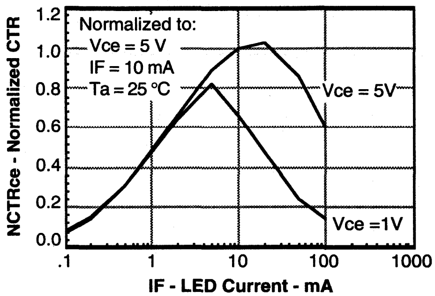


Figure 3. Normalized non-saturated and saturated collector-emitter current versus LED current

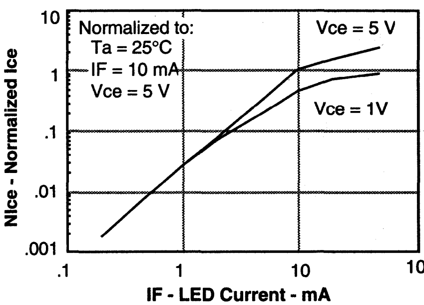


Figure 4. Normalized collector-base photocurrent versus LED current

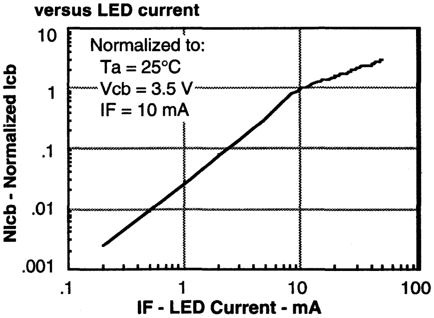


Figure 5. Hfe current gain vs. base current

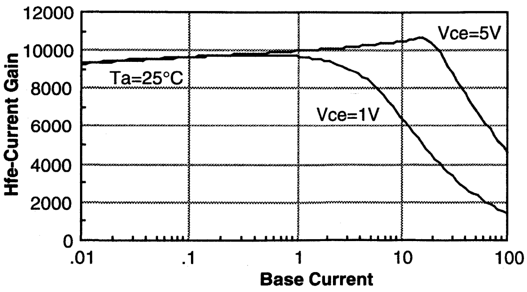


Figure 6. Low to high propagation delay versus collector load resistance and LED current

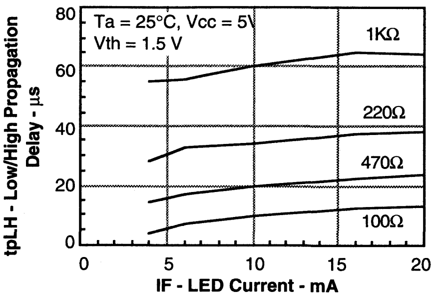


Figure 7. High to low propagation delay versus collector load resistance and LED current

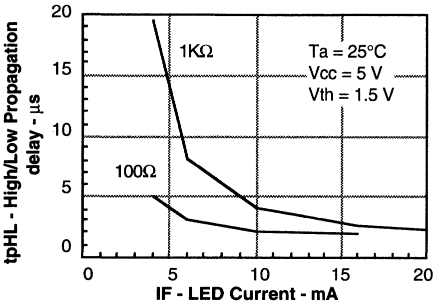


Figure 8. Switching waveforms

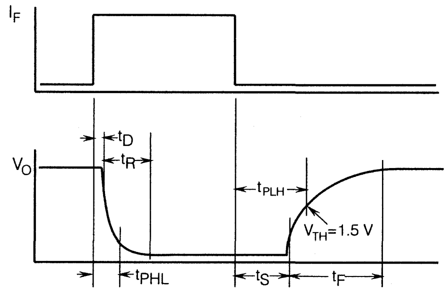
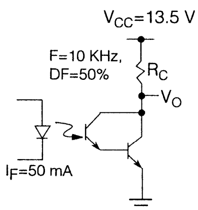


Figure 9. Switching schematic



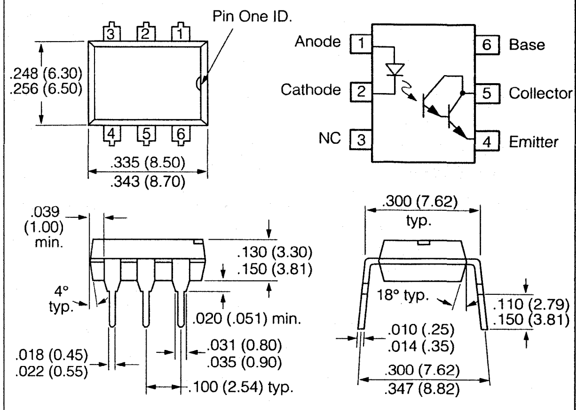
SIEMENS

NEW

IL55B

PHOTODARLINGTON OPTOCOUPLER

Package Dimensions in Inches (mm)



FEATURES

- **High Collector-Emitter Breakdown Voltage— 80 V Minimum**
- **High Isolation Resistance, 10^{11} Ω Typical**
- **Standard Plastic DIP Package**
- **Underwriters Lab File #E52744**
- **VDE 0884 Available with Option 1**

DESCRIPTION

The IL55B is an optically coupled isolator with a Gallium Arsenide infrared LED and a silicon photodarlington sensor. Switching can be achieved while maintaining a high degree of isolation between driving and load circuits. These optocouplers can be used to replace reed and mercury relays with advantages of long life, high speed switching and elimination of magnetic fields.

Maximum Ratings

Emitter

Peak Reverse Voltage .... 3 V
Continuous Forward Current .... 60 mA
Power Dissipation at 25°C .... 100 mW
Derate Linearly from 55°C .... 1.33 mW/°C

Detector

Collector-Emitter Breakdown Voltage, BV_{CEO} .... 80 V
Emitter-Base Breakdown Voltage, BV_{EBO} .... 8 V
Collector-Base Breakdown Voltage, BV_{CBO} .... 80 V
Emitter-Collector Breakdown Voltage BV_{ECO} .... 5 V
Collector (load) Current .... 125 mA
Power Dissipation at 25°C Ambient .... 150 mW
Derate Linearly from 25°C .... 2.0 mW/°C

Package

Total Dissipation at 25°C Ambient .... 250 mW
Derate Linearly from 25°C .... 3.3 mW/°C
Isolation Test Voltage (between emitter and detector refered to standard climate 23°C/50%RH, DIN 50014) .... 5300 VAC_{RMS}
Creepage .... 7 mm min.
Clearance .... 7 mm min.
Tracking Resitance, Group III (KC>600 per VDE 110 § 6, Table 3 and DIN 53480/ VDE 0330, Part 1
Isolation Resistance V_{IO}=500 V .... 10^{11} Ω
Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Lead Soldering Time at 260°C .... 10 sec.

Electrical Characteristics (T_A=25°C)

Parameter	Min.	Typ.	Max.	Unit	Condition
Emitter					
Forward Voltage*		1.25	1.5	V	I_F=50 mA
Reverse Current*		0.1	10	µA	V_R=3.0 V
Capacitance		25		pF	V_R=0 V
Detector					
BV_{CEO}	80			V	I_C=1 mA, I_F=0
BV_{ECO}	5	10		V	I_E=100 µA, I_F=0
I_{CEO}			1	µA	V_{CE}=60 V, I_F=0
Package					
Current Transfer Ratio	500			%	I_F=10 mA, V_{CE} =1.5 V
Coupling Capacitance		1.5		pF	
Turn-On Time		5		µs	V_{CC}=10 V
Turn -Off Time		100		µs	I_F=5 mA, R_L=100 W

SIEMENS

SINGLE CHANNEL IL66 SERIES
DUAL CHANNEL ILD66 SERIES
QUAD CHANNEL ILQ66 SERIES
PHOTODARLINGTON OPTOCOUPLER

FEATURES

- **Internal R_{BE} for High Stability**
- **Current Transfer Ratio is Tested at 2.0 mA and 0.7 mA Input IL/ILD/ILQ66 Series:**
  –1, 100% min. at I_F=2 mA, V_{CE}=10 V
  –2, 300% min. at I_F=2 mA, V_{CE}=10 V
  –3, 400% min. at I_F=0.7 mA, V_{CE}=10 V
  –4, 500% min. at I_F=2 mA, V_{CE}=5 V
- **Four Available CTR Categories per Package Type**
- **BV_{CEO}>60 V**
- **Standard DIP Packages**
- **Underwriters Lab File #E52744**
- **VDE 0884 Available with Option 1**

DESCRIPTION

IL66, ILD66, and ILQ66 are optically coupled isolators employing Gallium Arsenide infrared emitters and silicon photodarlington detectors. Switching can be accomplished while maintaining a high degree of isolation between driving and load circuits, with no crosstalk between channels.

Maximum Ratings

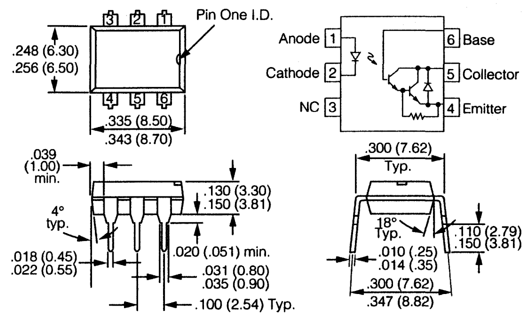
Emitter (Each Channel)
Peak Reverse Voltage .... 6 V
Continuous Forward Current .... 60 mA
Power Dissipation at 25°C .... 100 mW
Derate Linearly from 25°C .... 1.33 mW/°C

Detector (Each Channel)
Power Dissipation at 25°C Ambient .... 150 mW
Derate Linearly from 25°C .... 2.0 mW/°C

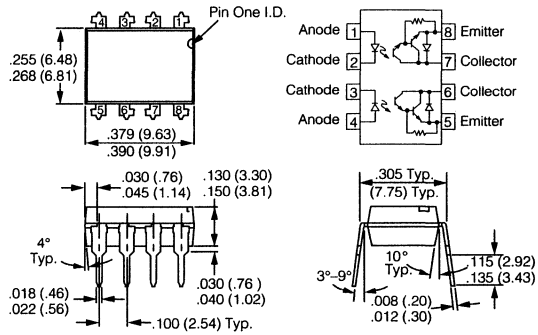
Package
Isolation Test Voltage
(t=1 sec.) .... 5300 VAC_{RMS}
Total Package Power Dissipation at 25°C
IL66 .... 250 mW
ILD66 .... 400 mW
ILQ66 .... 500 mW
Derate Linearly from 25°C
IL66 .... 3.3 mW/°C
ILD66 .... 5.33 mW/°C
ILQ66 .... 6.67 mW/°C
Creepage .... 7 min mm
Clearance .... 7 min mm
Comparative Tracking Index 175
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... $\geq 10^{12}\ \Omega$
V_{IO}=500 V, T_A=100°C .... $\geq 10^{11}\ \Omega$
Storage Temperature .... –55°C to +125°C
Operating Temperature .... –55°C to +100°C
Lead Soldering Time at 260°C .... 10 sec.

Package Dimensions in Inches (mm)

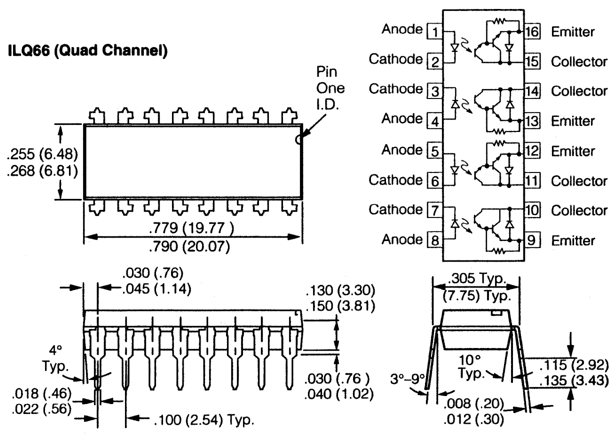
IL66 (Single Channel)



ILD66 (Dual Channel



ILQ66 (Quad Channel)



Electrical Characteristics (T_A=25°C)

	Symbol	Min.	Typ.	Max.	Unit	Condition
GaAs Emitter						
Forward Voltage	V_F		1.25	1.5	V	I_F=20 mA
Reverse Current	I_R		0.1	10	µA	V_R=6.0 V
Capacitance	C_O		25		pF	V_R=0 V
Photodarlington						
Breakdown Voltage						
Collector-Emitter	BV_{CEO}	60			V	I_C=1 mA, I_F=0
Collector-Base (IL66)	BV_{CBO}	60			V	I_C=10 µA
Collector-Emitter						
Leakage Current	I_{CEO}		1.0	100	nA	V_{CE}=50 V, I_F=0
Capacitance						
Collector-Emitter			3.4		pF	V_{CE}=10 V
Coupled Characteristics						
Current Transfer						
Ratio	CTR					
IL/ILD/ILQ66-1		100	400		%	I_F=2 mA, V_{CE}=10 V
IL/ILD/ILQ66-2		300	500		%	I_F=2 mA, V_{CE}=10 V
IL/ILD/ILQ66-3		400	500		%	I_F=0.7 mA, V_{CE}=10 V
IL/ILD/ILQ66-4		500	750		%	I_F=2 mA, V_{CE}=5 V
Collector-Emitter						
Saturation Voltage	V_{CEsat}		0.9	1.0	V	I_C=10 mA, I_F=10 mA
Rise Time -1, -2, -4	t_R			200	µs	V_{CC}=10 V
Fall Time -1, -2, -4	t_F			200	µs	I_F=2 mA, R_C=100 Ω
Rise Time -3	t_R			200	µs	I_F=0.7 mA
Fall Time -3	t_F			200	µs	V_{CC}=10 V, R_L=100 Ω

Figure 1. Forward voltage versus forward current

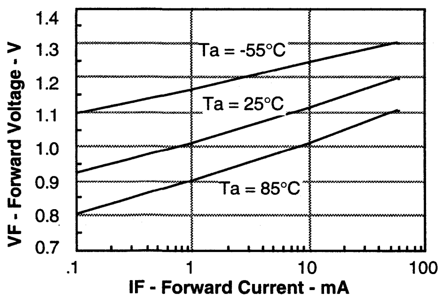


Figure 2. Normalized non-saturated and saturated CTRce versus LED current

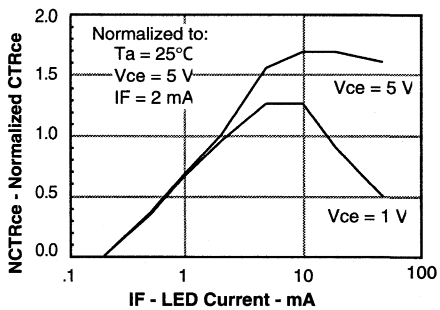


Figure 3. Normalized non-saturated and saturated CTRce versus LED current

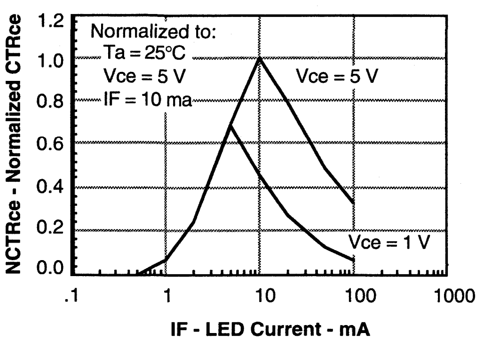


Figure 4. Non-saturated and saturated collector emitter current versus LED current

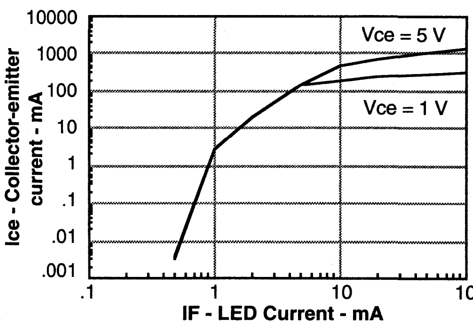


Figure 5. Collector-base photocurrent versus LED current

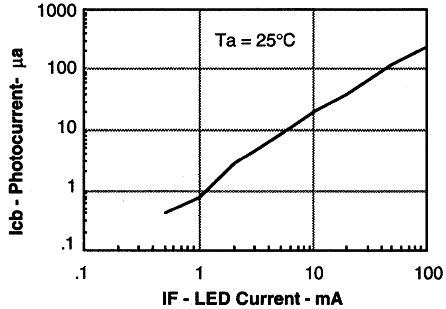


Figure 6. Collector-emitter current versus LED current

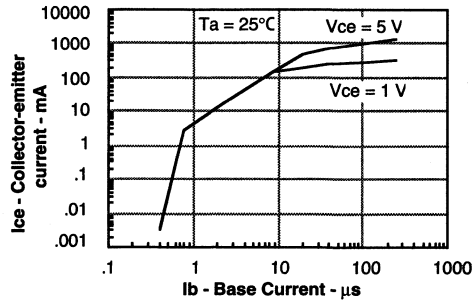


Figure 7. Non-saturated and saturated HFE versus LED current

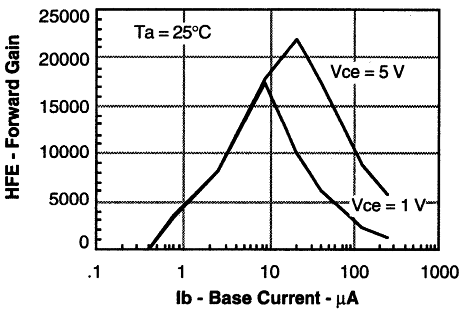


Figure 8. High/low propagation delay versus collector load resistance and LED current

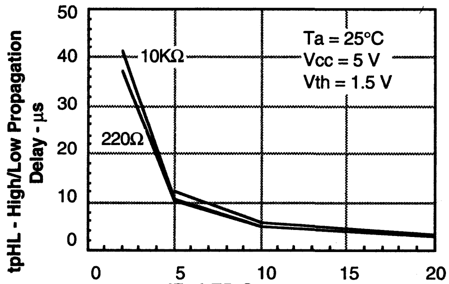


Figure 9. Low/high propagation delay versus collector load resistance and LED current

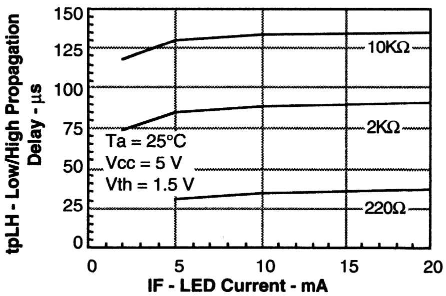


Figure 10. Switching Waveform

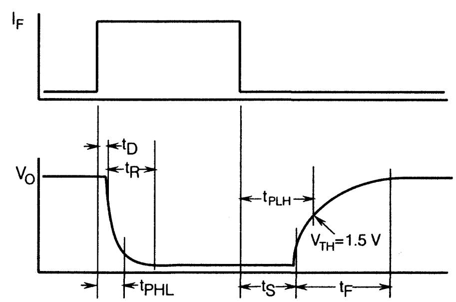
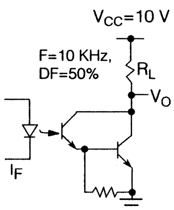


Figure 11. Switching Schematic



SIEMENS

IL66B

PHOTODARLINGTON OPTOCOUPLER

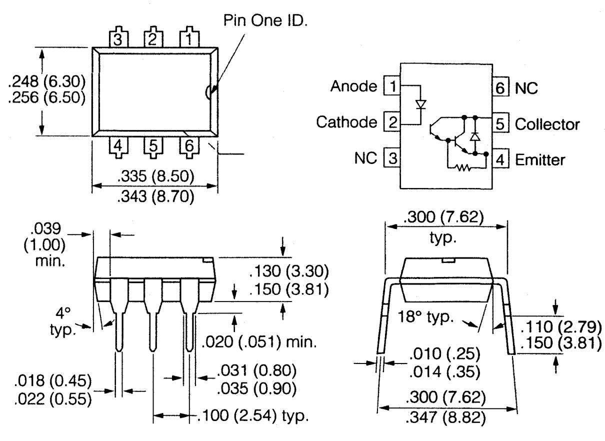
FEATURES

- **Internal R_{BE} for High Stability**
- **High Current Transfer Ratio at I_F=2 mA, V_{CE}=5 V**
  IL66B-1, 200% min.
  IL66B-2, 750% min.
- **Withstand Test Voltage, 5300 VAC_{RMS}**
- **No Base Connection**
- **High Isolation Resistance**
- **Standard Plastic DIP Package**
- **Underwriters Lab Approval #E52744**
- **VDE 0884 Available with Option 1**

DESCRIPTION

The IL66B is an optically coupled isolator employing a Gallium Arsenide infrared emitter and a silicon photodarlington detector. Switching can be accomplished while maintaining a high degree of isolation between driving and load circuits. They can be used to replace reed and mercury relays with advantages of long life, high speed switching and elimination of magnetic fields.

Package Dimensions in Inches (mm)



Maximum Ratings (at 25°C)

Emitter

Peak Reverse Voltage	6 V
Continuous Forward Current	60 mA
Power Dissipation at 25°C	100 mW
Derate Linearly from 55°C	1.33 mW/°C
Detector	
Collector-Emitter Breakdown Voltage	60 V
Emitter-Collector Breakdown Voltage	5 V
Power Dissipation at 25°C Ambient	200 mW
Derate Linearly from 25°C	2.6 mW/°C
Package	
Isolation Test Voltage (t=1 sec.)	5300 VAC_{RMS}
Isolation Resistance	
V_{IO}=500 V, T_A=25°C	≥10^{12} Ω
V_{IO}=500 V, T_A=100°C	≥10^{11} Ω
Total Dissipation at 25°C	250 mW
Derate Linearly from 25°C	3.3 mW/°C
Creepage Path	7 min mm
Clearance Path	7 min mm
Storage Temperature	–55°C to +150°C
Operating Temperature	–55°C to +100°C
Lead Soldering Time at 260°C	10 sec.

Electrical Characteristics (T_A=25°C)

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.25	1.5	V	I_F=10 mA
Reverse Current	I_R		0.01	100	µA	V_R=3.0 V
Capacitance	C_O		25		pF	V_R=0 V
Detector						
Breakdown Voltage Collector-Emitter	BV_{CEO}	60			V	I_C=100 µA, I_F=0
Leakage Current Collector-Emitter	I_{CEO}		1.0	100	nA	V_{CE}=50 V, I_F=0
Package						
Current Transfer Ratio	CTR					I_F=2 mA, V_{CE}=5 V
IL66B-1		200			%	
IL66B-2		750	1000		%	
Saturation Voltage Collector-Emitter	V_{CEsat}			1.0	V	I_C=10 mA, I_F=10 mA
Turn-On,Turn-Off Time	t_{on}, t_{off}			200	µs	V_{CC}=10 V, I_F=2 mA, R_L=100 Ω

Figure 1. Forward voltage versus forward current

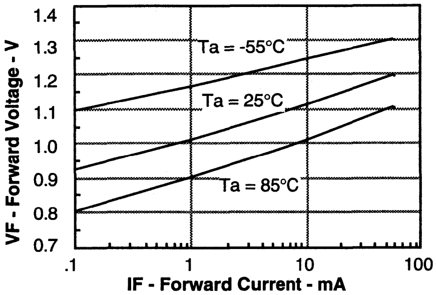


Figure 2. Normalized non-saturated and saturated CTRce versus LED current

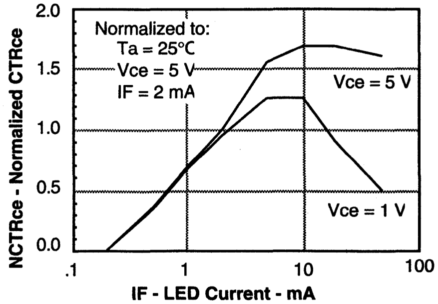


Figure 3. Normalized non-saturated and saturated CTRce versus LED current

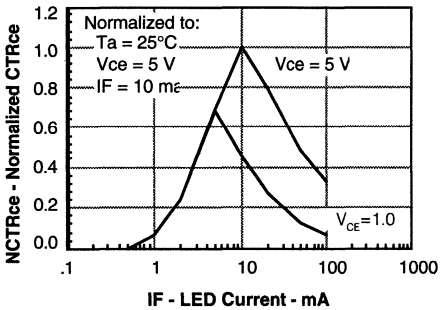


Figure 4. Non-saturated and saturated collector emitter current versus LED current

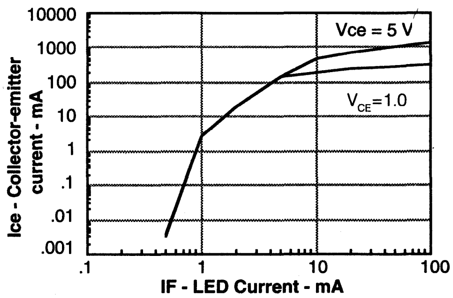


Figure 5. High/low propagation delay versus collector load resistance and LED current

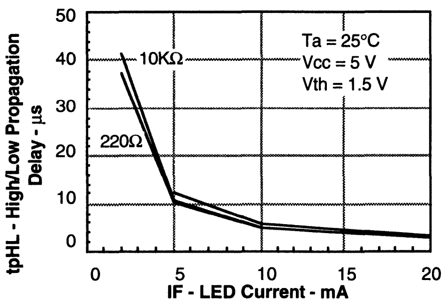
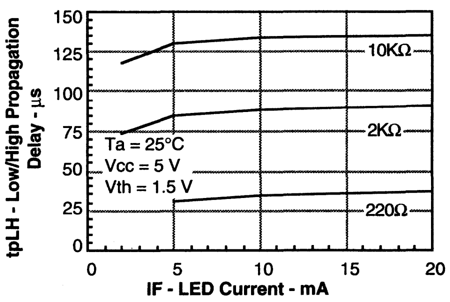


Figure 6. Low/high propagation delay versus collector load resistance and LED current



SIEMENS

SINGLE CHANNEL IL74
DUAL CHANNEL ILD74
QUAD CHANNEL ILQ74
PHOTOTRANSISTOR OPTOCOUPLER

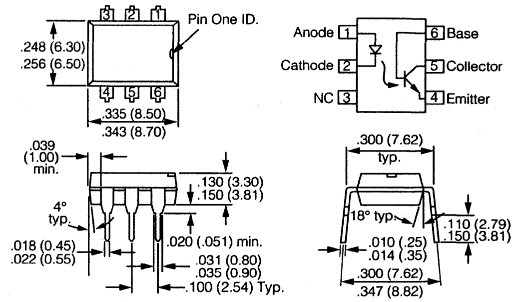
FEATURES
- **7400 Series T²L Compatible**
- **Transfer Ratio, 35% Typical**
- **Coupling Capacitance, 0.5 pF**
- **Single, Dual, & Quad Channel**
- **Industry Standard DIP Package**
- **Underwriters Lab File #E52744**
- **VDE Approvals #0884 (Optional with Option 1, Add -X001 Suffix)**

DESCRIPTION
The IL74 is an optically coupled pair with a Gallium Arsenide infrared LED and a silicon NPN phototransistor. Signal information, including a DC level, can be transmitted by the device while maintaining a high degree of electrical isolation between input and output. The IL74 is especially designed for driving medium-speed logic, where it may be used to eliminate troublesome gound loop and noise problems. Also it can be used to replace relays and transformers in many digital interface applications, as well as analog applications such as CRT modulation.

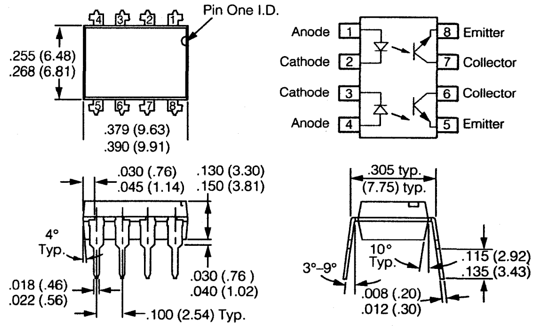
The ILD74 has two isolated channels in a single DIP package; the ILQ74 has four isolated channels per package.

Package Dimensions in Inches (mm)

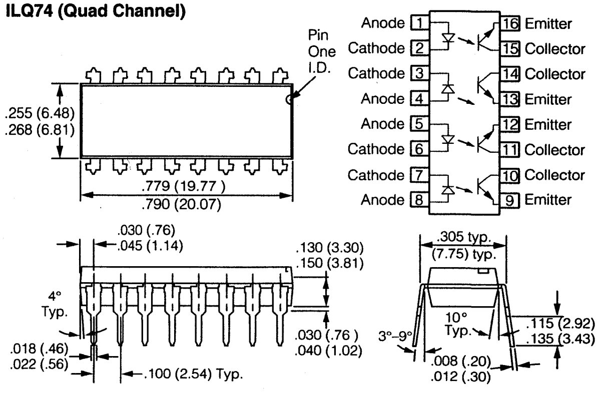
IL74 (Single Channel)



ILD74 (Dual Channel)



ILQ74 (Quad Channel)



Maximum Ratings

Emitter (each channel)

Peak Reverse Voltage .... 3.0 V
Continuous Forward Current .... 60 mA
Power Dissipationat 25°C .... 100 mW
Derate Linearly from 25°C .... 1.33 mW/°C

Detector (each channel)

Collector-Emitter Breakdown Voltage .... 20 V
Emitter-Base Breakdown Voltage .... 5 V
Collector-Base Breakdown Voltage .... 70 V
Power Dissipation at 25°C .... 150 mW
Derate Linearly from 25°C .... 2.0 mW/°C

Package

Isolation Test Voltage (t=1 sec.) .... 5300 VAC_{RMS}
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... $\geq 10^{12}\ \Omega$
V_{IO}=500 V, T_A=100°C .... $\geq 10^{11}\ \Omega$
Total Package Dissipation at 25°C Ambient
(LED Plus Detector)
IL74 .... 200 mW
ILD74 .... 400 mW
IL74Q .... 500 mW
Derate Linearly from 25°C
IL74 .... 2.7 mW/°C
ILD74 .... 5.33 mW/°C
ILQ74 .... 6.67 mW/°C
Creepage .... 7 mm min.
Clearance .... 7 mm min.
Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Lead Soldering Time at 260°C .... 10 sec.

Electrical Characteristics (T_A=25°C)

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.3	1.5	V	I_F=20 mA
Reverse Current	I_R		0.1	100	µA	V_R=3.0 V
Capacitance	C_O		25		pF	V_R=0
Detector						
Collector-Emitter Breakdown Voltage	BV_{CEO}	20	50		V	I_C=1 mA
Collector-Emitter Leakage Current	I_{CEO}		5.0	500	nA	V_{CE}=5 V, I_F=0
Collector-Emitter Capacitance	C_{CE}		10.0		pF	V_{CE}=0, F=1 MHz
Package						
DC Current Transfer Ratio	CTR_{DC}	12.5	35		%	I_F=16 mA, V_{CE}=5 V
Collector-Emitter Saturation Voltage	V_{CEsat}		0.3	0.5	V	I_C=2 mA, I_F=16 mA,
Resistance, Input to Output	R_{IO}		100		GΩ	
Capacitance, Input to Output	C_{IO}		0.5		pF	
Switching Times	t_{ON}, t_{OFF}		3.0		µs	R_E=100 Ω, V_{CE}=10 V, I_C=2 mA

Figure 1. Forward voltage versus forward current

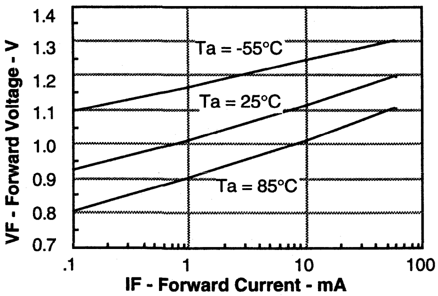


Figure 2. Normalized non-saturated and saturated CTR at T_A=25°C versus LED current

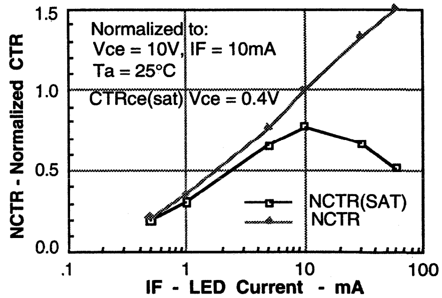


Figure 3. Normalized non-saturated and saturated CTR at T_A=50°C versus LED current

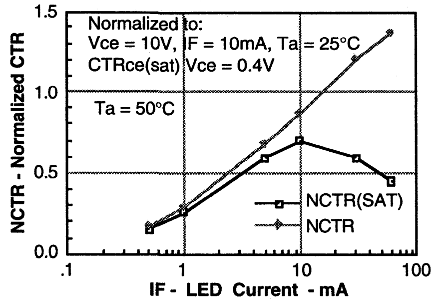


Figure 4. Normalized non-saturated and saturated CTR at T_A=70°C versus LED current

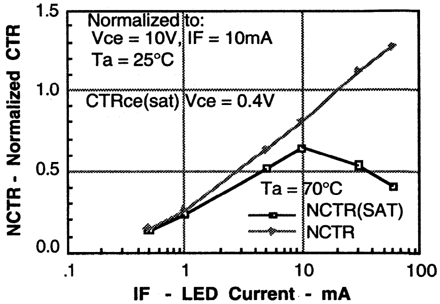


Figure 5. Normalized non-saturated and saturated CTR at T_A=85°C versus LED current

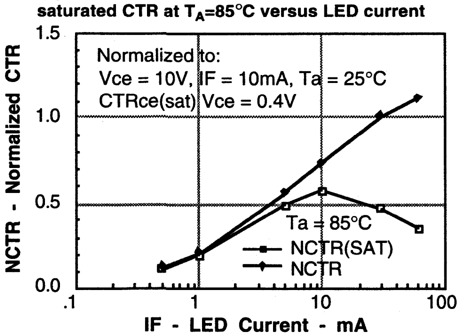
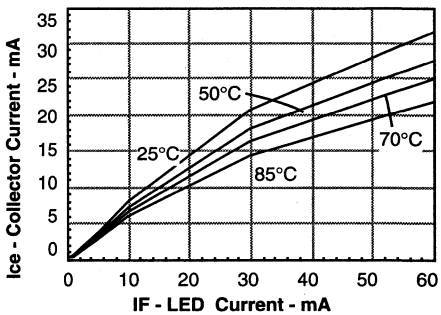


Figure 6. Collector-emitter current versus temperature and LED current



Optocouplers (Optoisolators)

5

Figure 7. Collector-emitter leakage current versus temperature

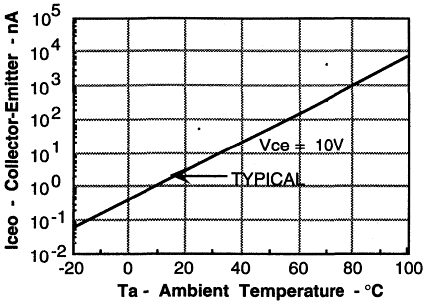


Figure 8. Normalized CTRcb versus LED current and temperature

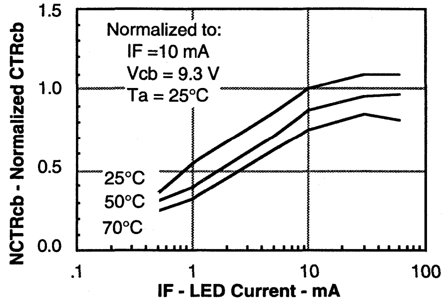


Figure 9. Collector base photocurrent versus LED current

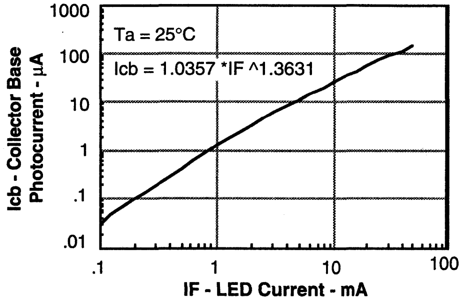


Figure 10. Normalized photocurrent versus If and temperature

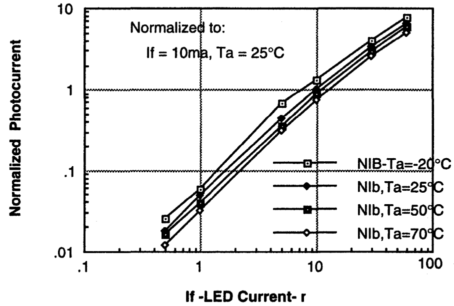


Figure 11. Normalized non-saturated HFE versus base current and temperature

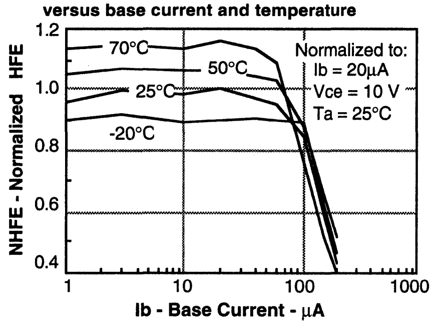


Figure 12. Normalized saturated HFE versus base current and temperature

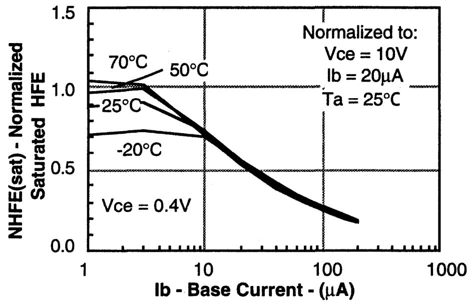


Figure 13. Propagation delay versus collector load resistor

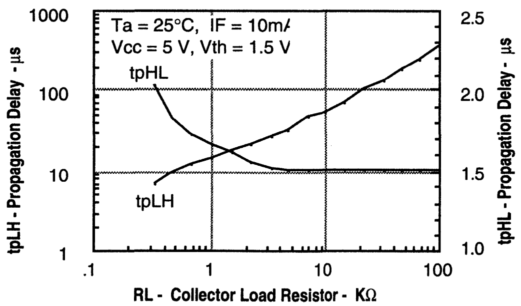
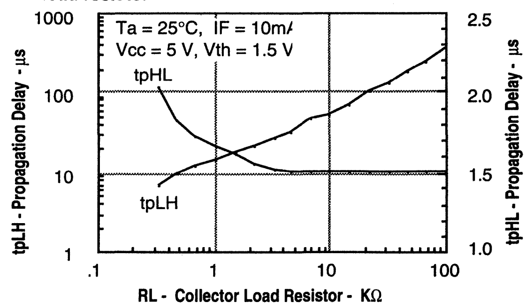


Figure 14. Propagation delay versus collector load resistor



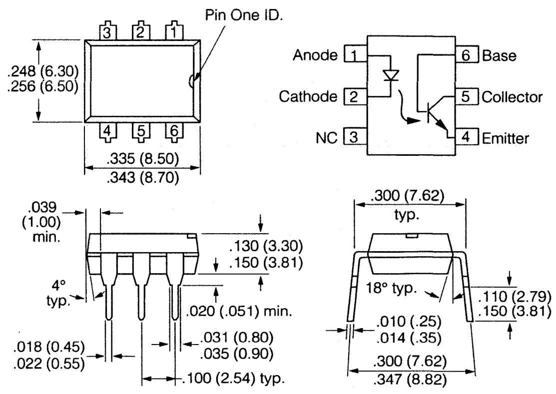
SIEMENS

IL201/IL202/IL203
PHOTOTRANSISTOR OPTOCOUPLER

FEATURES
- **High Current Transfer Ratio, 75% to 450%**
- **Minimum Current Transfer Ratio, 10% Guaranteed at I_F = 1mA**
- **High Collector-Emitter Voltage, BV_{CEO} = 70V**
- **Long Term Stability**
- **Industry Standard DIP Package**
- **Underwriters Lab File #E52744**
- **VDE 0884 Available with Option 1**

DESCRIPTION
The IL201/202/203 are optically coupled pairs employing a Gallium Arsenide infrared LED and a Silicon NPN phototransistor. Signal information, including a DC level, can be transmitted by the device while maintaining a high degree of electrical isolation between input and output. The IL201/202/203 can be used to replace relays and transformers in many digital interface applications, as well as analog applications such as CRT modulation.

Package Dimensions in Inches (mm)



Maximum Ratings
Emitter

Peak Reverse Voltage .... 6 V
Continuous Forward Current .... 60 mA
Power Dissipation at 25°C .... 100 mW
Derate Linearly from 25°C .... 1.33 mW/°C

Detector

Collector-Emitter Breakdown Voltage, BV_{CEO} ...... 70 V
Emitter-Collector Breakdown Voltage, BV_{ECO} .... 7 V
Collector-Base Breakdown Voltage, BV_{CBO} .... 70 V
Power Dissipation .... 200 mW
Derate Linearly from 25°C .... 2.6 mW/°C

Package

Isolation Test Voltage (t=1 sec.) .... 5300 VAC_{RMS}
Total Package Dissipation at 25°C A
(LED + Detector) .... 250 mW
Derate Linearly from 25°C .... 3.3 mW/°C
Creepage .... 7 min mm
Clearance .... 7 min mm
Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Lead Soldering Time at 260°C .... 10 sec.

Characteristics (0°C to 70°C unless otherwise specified)

	Symbol	Min.	Typ.	Max.	Unit	
Emitter						
Forward Voltage	V_F		1.2	1.5	V	I_F=20 mA
Forward Voltage	V_F		1.0	1.2	V	I_F=1 mA
Breakdown Voltage	V_R	6	20		V	I_R=10 µA
Reverse Current	I_R		0.1	10	µA	V_R=6 V, T_A=25°C
Detector						
	HFE	100	200			V_{CE}=5 V, I_C=100 µA
	BV_{CEO}	70			V	I_C=100 µA
	BV_{ECO}	7	10		V	I_E=100 µA
	BV_{CBO}	70	90		V	I_C=10 µA
	I_{CEO}		5	50	nA	V_{CE}=10 V, T_A=25°C
Package						
Base Current Transfer Ratio	CTR_{CB}	0.15			%	I_F=10 mA, V_{CB}=10 V
	V_{CEsat}			0.4	V	I_F=10 mA, I_C=2 mA
DC Current Transfer Ratio						
IL201	CTR	75	100	150	%	I_F=10 mA
IL202	CTR	125	200	250	%	V_{CE}=10 V
IL203	CTR	225	300	450	%	
DC Current Transfer Ratio						
IL201	CTR	10			%	I_F=1 mA
IL202	CTR	30			%	V_{CE}=10 V
IL203	CTR	50			%	

Optocouplers (Optoisolators) 5

Figure 1. Forward voltage versus forward current

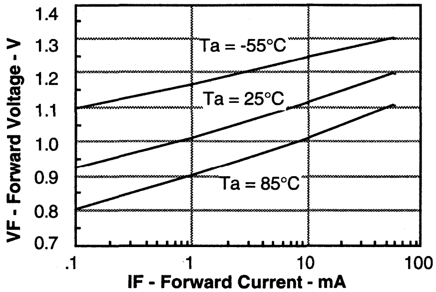


Figure 2. Normalized non-saturated and saturated CTR at Ta = 25°C versus LED current

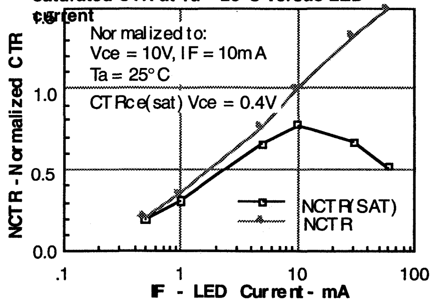


Figure 3. Normalized non-saturated and saturated CTR at Ta = 50°C versus LED current

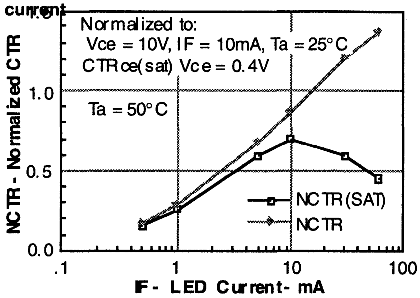


Figure 4. Normalized non-saturated and saturated CTR at Ta = 70°C versus LED current

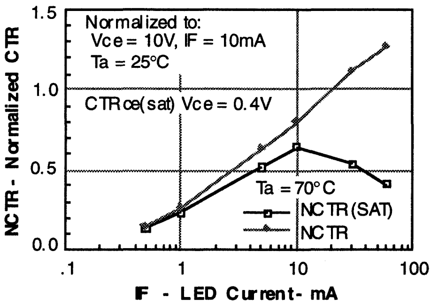


Figure 5. Normalized non-saturated and saturated CTR at Ta = 85°C versus LED current

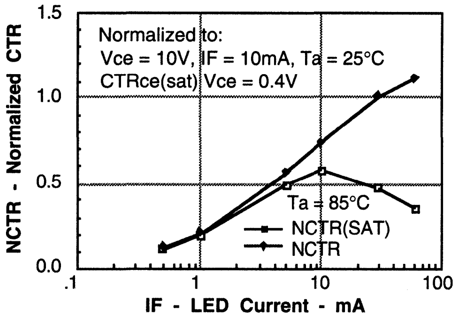


Figure 6. Collector-emitter current versus temperature and LED current

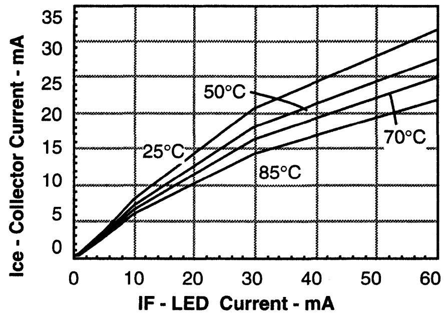


Figure 7. Collector-emitter leakage current versus temperature

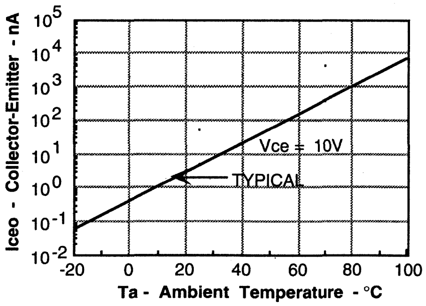


Figure 8. Normalized CTRcb versus LED current and temperature

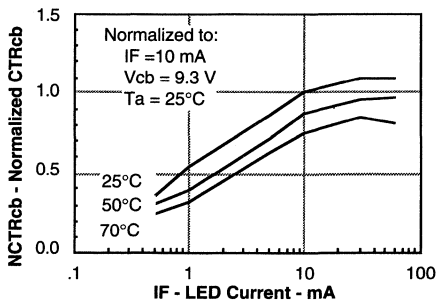


Figure 9. Collector base photocurrent versus LED current

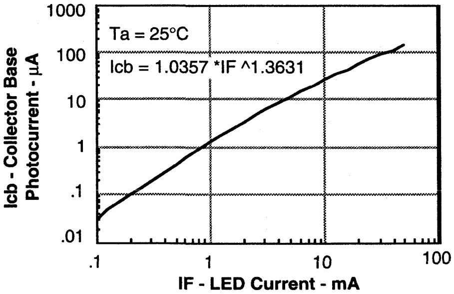


Figure 10. Normalized photocurrent versus If and temperature

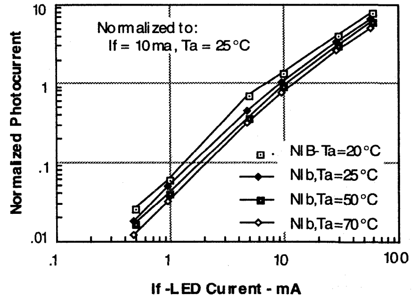


Figure 11. Normalized saturated HFE versus base current and temperature

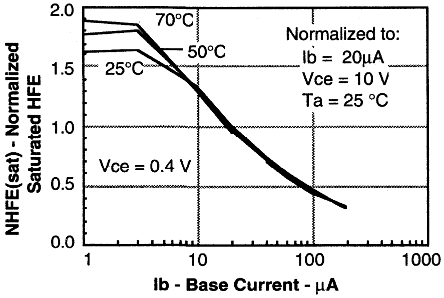


Figure 12. Propagation delay versus collector load resistor

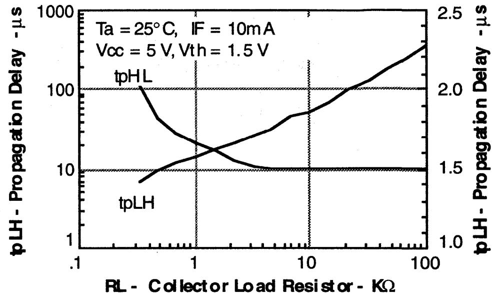


Figure 13. Normalized non-saturated and saturated CTRce versus LED current

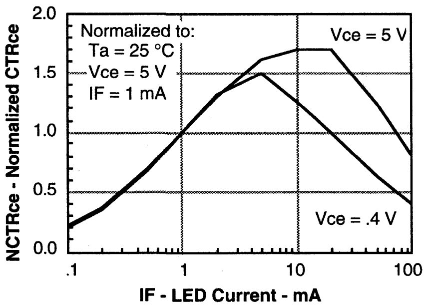
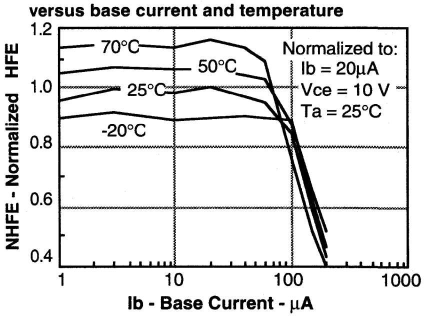


Figure 14. Normalized non-saturated HFE versus base current and temperature



Optocouplers (Optoisolators)

5

SIEMENS

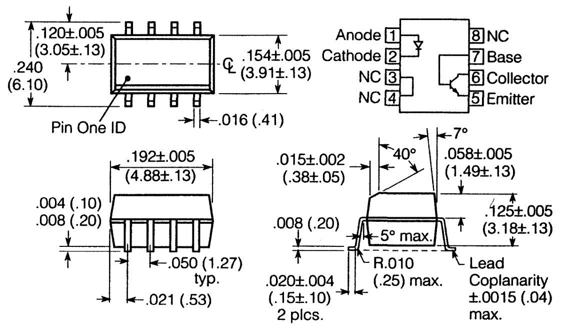
IL205A/206A/207A/208A

PHOTOTRANSISTOR SMALL OUTLINE SURFACE MOUNT OPTOCOUPLER

FEATURES

- **High Current Transfer Ratio, I_F=10mA, V_{CE}=5 V**
  IL205A, 40 – 80%
  IL206A, 63 –125%
  IL207A, 100 – 200%
  IL208A, 160 – 320%
- **High BV_{CEO}, 70 V**
- **Isolation Voltage, 2500 VAC_{RMS}**
- **Industry Standard SOIC-8 Surface Mountable Package**
- **Standard Lead Spacing, .05"**
- **Available in Tape and Reel Option–Suffix "T" (Conforms to EIA Standard RS481A)**
- **Compatible with Dual Wave, Vapor Phase and IR Reflow Soldering**
- **Underwriters Lab File #E52744 (Code Letter P)**

Package Dimensions in Inches (mm)



TOLERANCE: ±.005 (unless otherwise noted)

DESCRIPTION

The IL205A/206A/207A/208A are optically coupled pairs with a Gallium Arsenide infrared LED and a silicon NPN phototransistor. Signal information, including a DC level, can be transmitted by the device while maintaining a high degree of electrical isolation between input and output. The IL205/6/7/8 come in a standard SOIC-8 small outline package for surface mounting which makes them ideally suited for high density applications with limited space. In addition to eliminating through-holes requirements, this package conforms to standards for surface mounted devices.

A specified minimum and maximum CTR allows a narrow tolerance in the electrical design of the adjacent circuits. The high BV_{CEO} of 70 volts gives a higher safety margin compared to the industry standard 30 volts.

Maximum Ratings

Emitter

Peak Reverse Voltage .... 6.0 V
Continuous Forward Current .... 60 mA
Power Dissipation at 25°C .... 90 mW
Derate Linearly from 25°C .... 1.2 mW/°C

Detector

Collector-Emitter Breakdown Voltage .... 70 V
Emitter-Collector Breakdown Voltage .... 7 V
Collector-Base Breakdown Voltage .... 70 V
Power Dissipation .... 150 mW
Derate Linearly from 25°C .... 2.0 mW/°C

Package

Total Package Dissipation at 25°C Ambient (LED + Detector) .... 240 mW
Derate Linearly from 25°C .... 3.3 mW/°C
Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Soldering Time at 260°C .... 10 sec.

Characteristics (T_A=25°C)

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.3	1.5	V	I_F=10 mA
Reverse Current	I_R		0.1	100	µA	V_R=6.0 V
Capacitance	C_O		25		pF	V_R=0
Detector						
Breakdown Voltage Collector-Emitter	BV_{CEO}	70			V	I_C=100 µA
Emitter-Collector	BV_{ECO}	7	10		V	I_E=100 µA
Collector-Emitter Dark Current	$I_{CEOdark}$		5	50	nA	V_{CE}=10 V, I_F=0
Collector-Emitter Capacitance	C_{CE}		10		pF	V_{CE}=0
Package						
DC Current Transfer	CTR_{DC}				%	I_F=10 mA, V_{CE}=5 V
IL205A		40		80		
IL206A		63		125		
IL207A		100		200		
IL208A		160		320		
DC Current Transfer	CTR_{DC}				%	I_F=1 mA, V_{CE}=5 V
IL205A		13	25			
IL206A		22	40			
IL207A		34	60			
IL208A		56	95			
Collector-Emitter Saturation Voltage	$V_{CE\,sat}$			0.4		I_C=2.0 mA, I_F=10 mA
Isolation Test Voltage	V_{IO}	2500			VAC_{RMS}	
Equivalent DC Isolation Voltage		3535			VDC	
Capacitance, Input to Output	C_{IO}		0.5		pF	
Resistance, Input to Output	R_{IO}		100		GΩ	
Switching Time	t_{ON}, t_{OFF}		3.0		µs	I_C=2 mA, R_E=100 Ω, V_{CE}=10 V

Specifications subject to change.

Figure 1. Forward voltage versus forward current

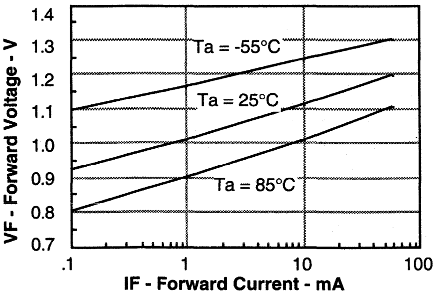


Figure 2. Normalized non-saturated and saturated CTRce versus LED current

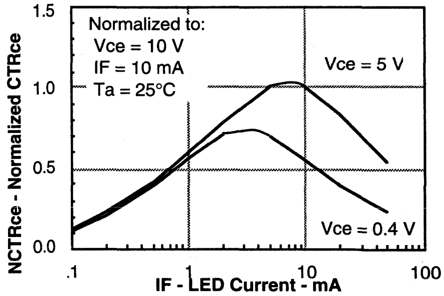


Figure 3. Collector-emitter current versus LED current

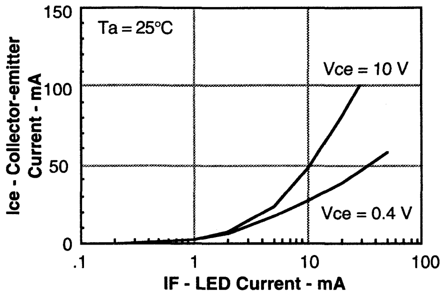


Figure 4. Normalized collector-base photocurrent versus LED current

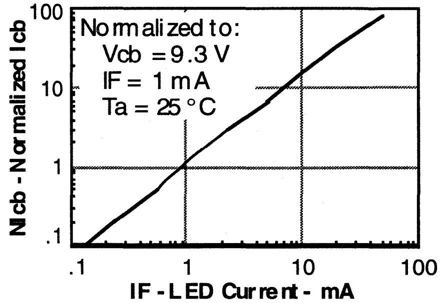


Figure 5. Normalized collector-base photocurrent versus LED current

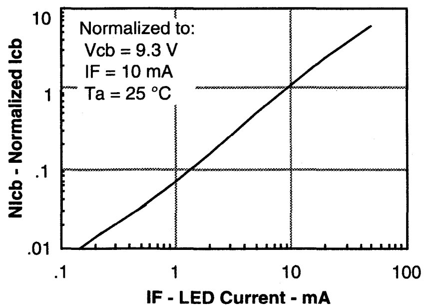


Figure 6. Collector-base photocurrent versus LED current

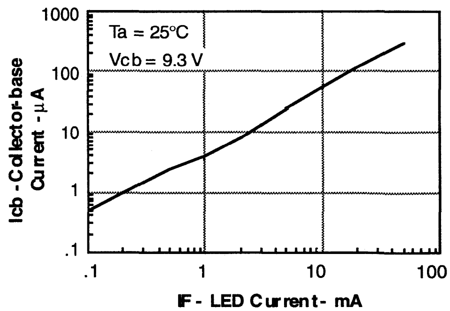


Figure 7. Collector-emitter leakage current versus temperature

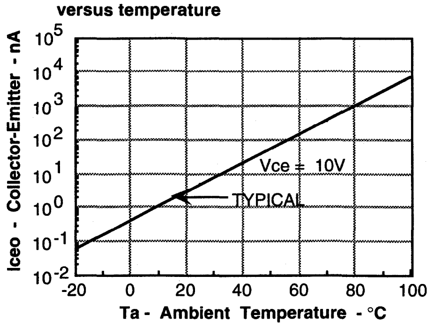


Figure 8. Normalized saturated HFE versus base current and temperature

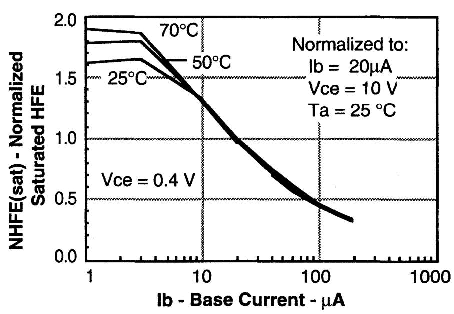


Figure 9. Typical switching characteristics versus base resistance (saturated operation)

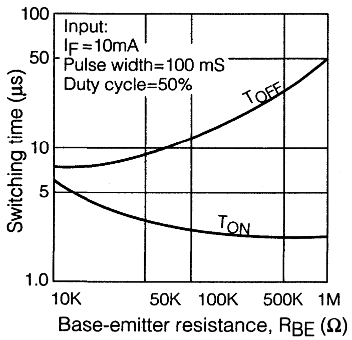
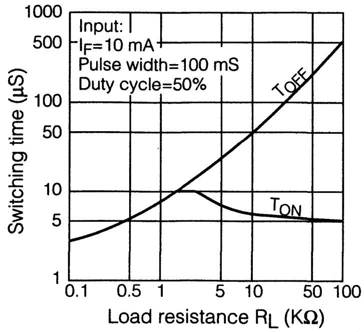


Figure 10. Typical switching times versus load resistance



SIEMENS

NEW

IL211A/IL212A/IL213A

PHOTOTRANSISTOR SMALL OUTLINE SURFACE MOUNT OPTOCOUPLER

FEATURES

- **High Current Transfer Ratio**
  IL211A—20% Minimum
  IL212A—50% Minimum
  IL213A—100% Minimum
- **Isolation Voltage, 2500 VAC_{RMS}**
- **Electrical Specifications Similar to Standard 6 Pin Coupler**
- **Industry Standard SOIC-8 Surface Mountable Package**
- **Standard Lead Spacing, .05"**
- **Available in Tape and Reel Option (Conforms to EIA Standard RS481A)**
- **Compatible with Dual Wave, Vapor Phase and IR Reflow Soldering**
- **Underwriters Lab File #E52744 (Code Letter P)**

DESCRIPTION

The IL211A/212A/213A are optically coupled pairs with a Gallium Arsenide infrared LED and a silicon NPN phototransistor. Signal information, including a DC level, can be transmitted by the device while maintaining a high degree of electrical isolation between input and output. The IL211A//212A/213A comes in a standard SOIC-8 small outline package for surface mounting which makes it ideally suited for high density applications with limited space. In addition to eliminating through-holes requirements, this package conforms to standards for surface mounted devices.

A choice of 20, 50, and 100% minimum CTR at I_F=10 mA makes these optocouplers suitable for a variety of different applications.

Maximum Ratings

Emitter

Peak Reverse Voltage .... 6.0 V
Continuous Forward Current .... 60 mA
Power Dissipation at 25°C .... 90 mW
Derate Linearly from 25°C .... 1.2 mW/°C

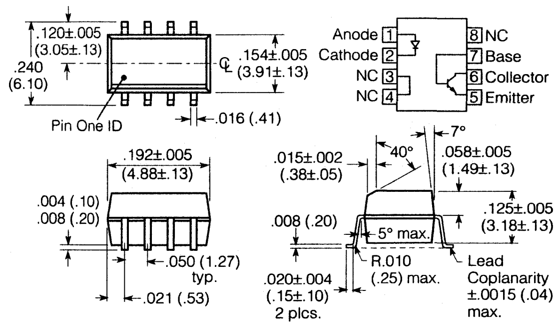
Detector

Collector-Emitter Breakdown Voltage .... 30 V
Emitter-Collector Breakdown Voltage .... 7 V
Collector-Base Breakdown Voltage .... 70 V
Power Dissipation .... 150 mW
Derate Linearly from 25°C .... 2.0 mW/°C

Package

Total Package Dissipation at 25°C Ambient
(LED + Detector) .... 280 mW
Derate Linearly from 25°C .... 3.3 mW/°C
Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Soldering Time at 260°C .... 10 sec.

Package Dimensions in Inches (mm)



TOLERANCE: ±.005 (unless otherwise noted)

Characteristics (T_A=25°C)

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.3	1.5	V	I_F=10 mA
Reverse Current	I_R		0.1	100	µA	V_R=6.0 V
Capacitance	C_O		25		pF	V_R=0
Detector						
Breakdown Voltage	BV_{CEO}		30		V	I_C=10 µA
	BV_{ECO}		7		V	I_E=10 µA
Collector-Emitter Dark Current	$I_{CEOdark}$		5	50	nA	V_{CE}=10 V, I_F=0
Collector-Emitter Capacitance	C_{CE}		10		pF	V_{CE}=0
Package						
DC Current Transfer	CTR_{DC}				%	I_F=10 mA V_{CE}=5 V
IL211A		20	50			
IL212A		50	80			
IL213A		100	130			
Collector-Emitter Saturation Voltage	$V_{CE\,sat}$			0.4		I_F=10 mA, I_C=2.0 mA
Isolation Test Voltage	V_{IO}	2500			VAC_{RMS}	
Capacitance, Input to Output	C_{IO}		0.5		pF	
Resistance, Input to Output	R_{IO}		100		GΩ	
Switching Time	t_{ON}, t_{OFF}		3.0		µs	I_C=2 mA, R_E=100 Ω, V_{CE}=10 V

Specifications subject to change.

Figure 1. Forward voltage versus forward current

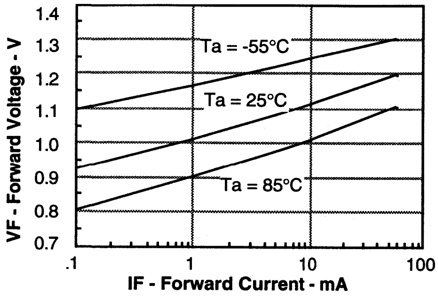


Figure 2. Normalized non-saturated and saturated CTRce versus LED current

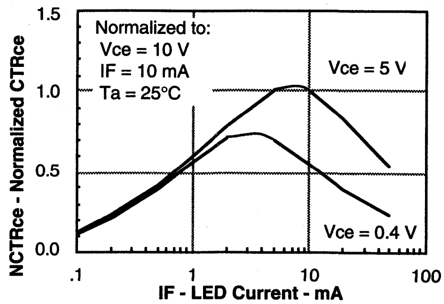


Figure 3. Collector-emitter current versus LED current

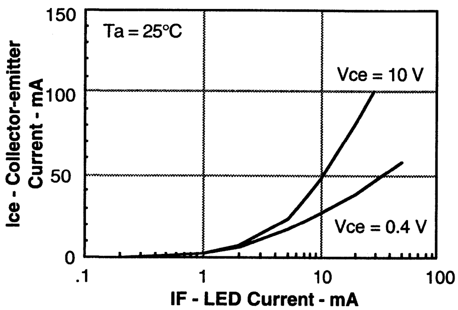


Figure 4. Normalized collector-base photocurrent versus LED current

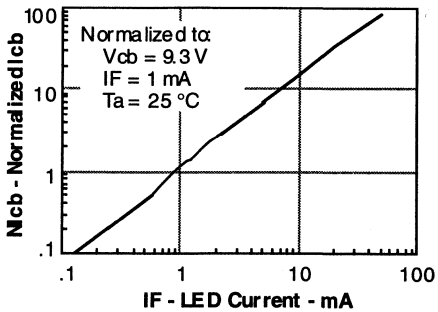


Figure 5. Normalized collector-base photocurrent versus LED current

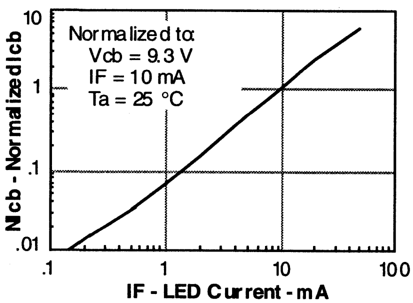


Figure 6. Collector-base photocurrent versus LED current

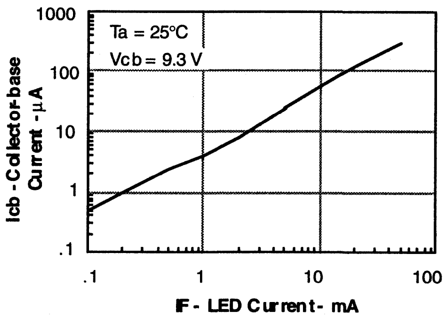


Figure 7. Collector-emitter leakage current versus temperature

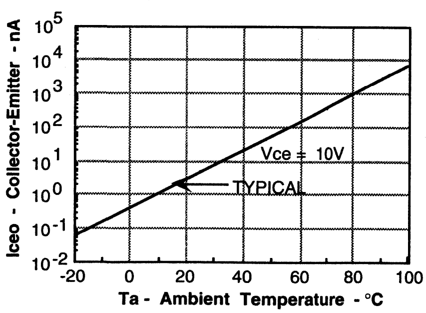


Figure 8. Normalized saturated HFE versus base current and temperature

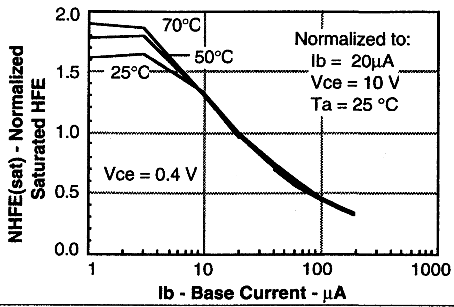


Figure 9. Typical switching characteristics versus base resistance (saturated operation)

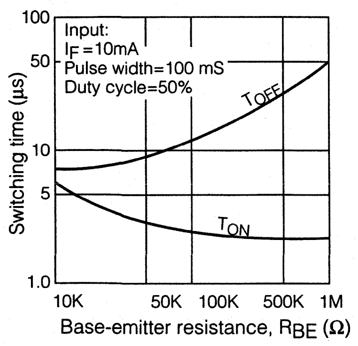
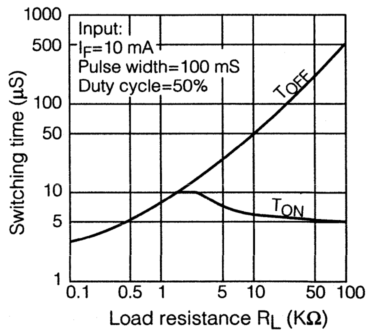


Figure 10. Typical switching times versus load resistance



Optocouplers (Optoisolators) 5

SIEMENS

IL215A/216A/217A

PHOTOTRANSISTOR SMALL OUTLINE SURFACE MOUNT OPTOCOUPLER

FEATURES

- **High Current Transfer Ratio, I_F=1 mA**
  IL215A, 20% Minimum
  IL216A, 50% Minimum
  IL217A, 100% Minimum
- **Isolation Voltage, 2500 VAC_{RMS}**
- **Electrical Specifications Similar to Standard 6 Pin Coupler**
- **Industry Standard SOIC-8 Surface Mountable Package**
- **Standard Lead Spacing, .05"**
- **Available in Tape and Reel Option (Conforms to EIA Standard RS481A)**
- **Compatible with Dual Wave, Vapor Phase and IR Reflow Soldering**
- **Underwriters Lab File #E52744 (Code Letter P)**

DESCRIPTION

The IL215A/216A/217A is an optically coupled pair with a Gallium Arsenide infrared LED and a silicon NPN phototransistor. Signal information, including a DC level, can be transmitted by the device while maintaining a high degree of electrical isolation between input and output. The IL215A/216A/217A comes in a standard SOIC-8 small outline package for surface mounting which makes it ideally suited for high density applications with limited space. In addition to eliminating through-holes requirements, this package conforms to standards for surface mounted devices.

The high CTR at low input current is designed for low power consumption requirements such as CMOS microprocessor interfaces.

Maximum Ratings

Emitter

Peak Reverse Voltage .... 6.0 V
Continuous Forward Current .... 60 mA
Power Dissipation at 25°C .... 90 mW
Derate Linearly from 25°C .... 1.2 mW/°C

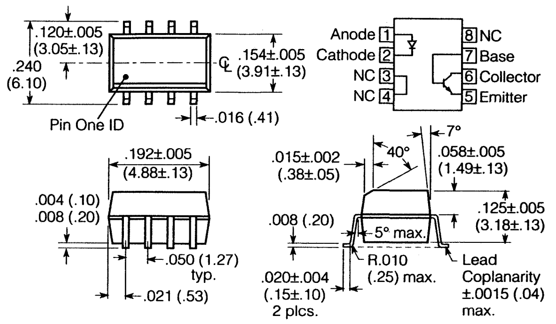
Detector

Collector-Emitter Breakdown Voltage .... 30 V
Emitter-Collector Breakdown Voltage .... 7 V
Collector-Base Breakdown Voltage .... 70 V
Power Dissipation .... 150 mW
Derate Linearly from 25°C .... 2.0 mW/°C

Package

Total Package Dissipation at 25°C Ambient (LED + Detector) .... 280 mW
Derate Linearly from 25°C .... 3.3 mW/°C
Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Soldering Time at 260°C .... 10 sec.

Package Dimensions in Inches (mm)



TOLERANCE: ±.005 (unless otherwise noted)

Characteristics (T_A=25°C)

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.0	1.5	V	I_F=1 mA
Reverse Current	I_R		0.1	100	µA	V_R=6.0 V
Capacitance	C_O		25		pF	V_R=0
Detector						
Breakdown Voltage						
Collector-Emitter	BV_{CEO}	30			V	I_C=10 µA
Emitter-Collector	BV_{ECO}	7			V	I_E=10 µA
Collector-Emitter Dark Current	$I_{CEOdark}$		5	50	nA	V_{CE}=10 V, I_F=0
Collector-Emitter Capacitance	C_{CE}		10		pF	V_{CE}=0
Package						
DC Current Transfer	CTR_{DC}				%	I_F=1 mA V_{CE}=5 V
IL215A		20	50			
IL216A		50	80			
IL217A		100	130			
Collector-Emitter Saturation Voltage	$V_{CE\,sat}$			0.4		I_C=0.1 mA, I_F=1 mA
Isolation Test Voltage	V_{IO}	2500			VAC_{RMS}	
Capacitance, Input to Output	C_{IO}		0.5		pF	
Resistance, Input to Output	R_{IO}		100		GΩ	
Switching Time	t_{ON}, t_{OFF}		3.0		µs	I_C=2 mA, R_E=100 Ω, V_{CE}=10 V

Specifications subject to change.

Figure 1. Forward voltage versus forward current

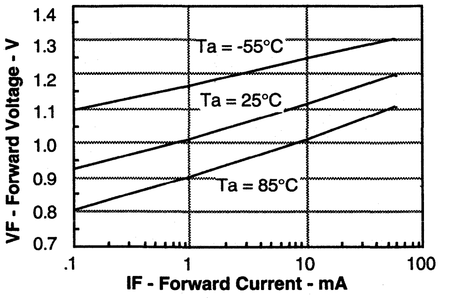


Figure 2. Normalized non-saturated and saturated CTRce versus LED current

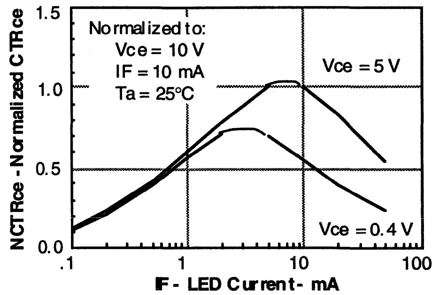


Figure 3. Collector-emitter current versus LED current

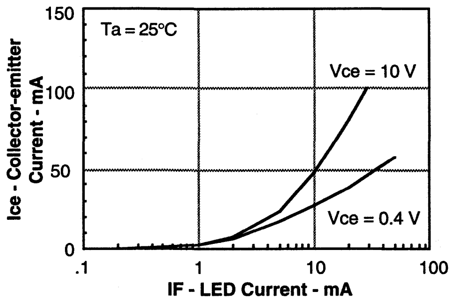


Figure 4. Normalized collector-base photocurrent versus LED current

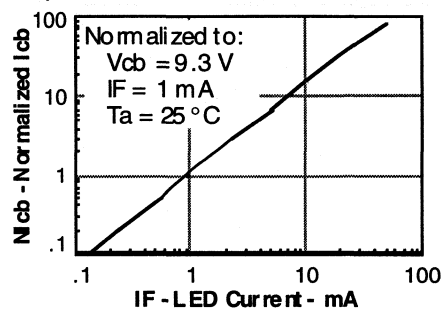


Figure 5. Collector-base photocurrent versus LED current

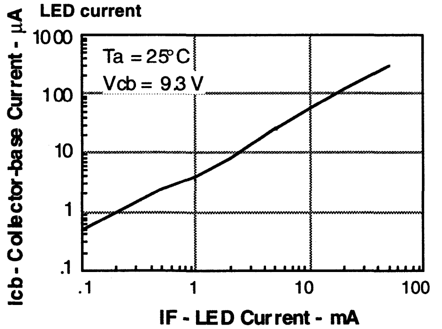


Figure 6. Collector-emitter leakage current versus temperature

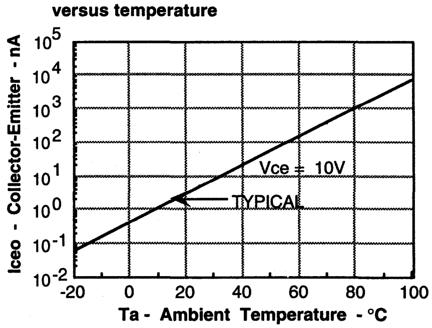


Figure 7. Normalized saturated HFE versus base current and temperature

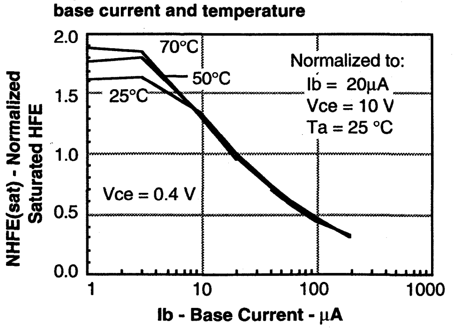


Figure 8. Normalized non-saturated and saturated CTRce versus LED current

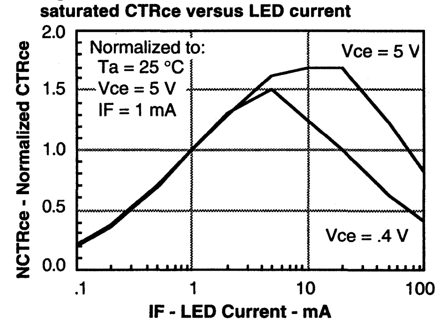


Figure 9. Normalized non-saturated and saturated collector-emitter current versus LED current

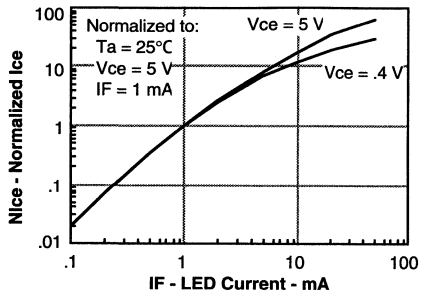


Figure 10. Normalized collector-base photocurrent versus LED current

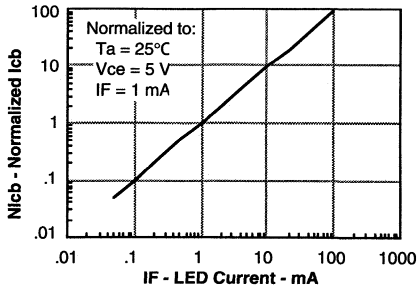


Figure 11. Collector-base photocurrent versus LED current

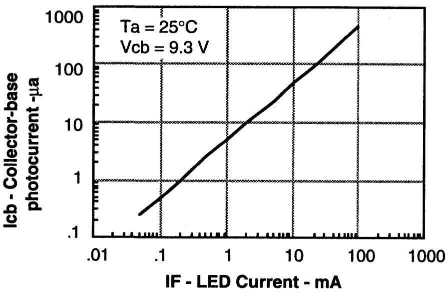


Figure 12. High to low propagation delay versus LED current and load resistor

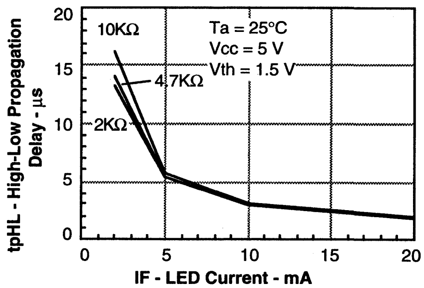


Figure 13. Low to high propagation delay versus LED current and load resistor

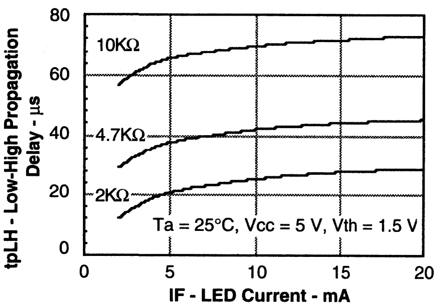


Figure 14. Normalized non-saturated HFE versus base current and temperature

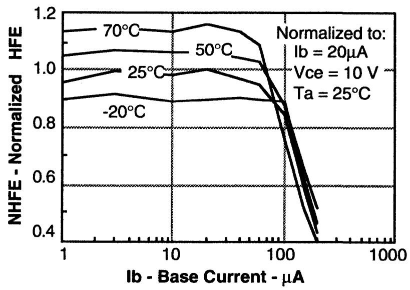


Figure 15. Typical switching characteristics versus base resistance (saturated operation)

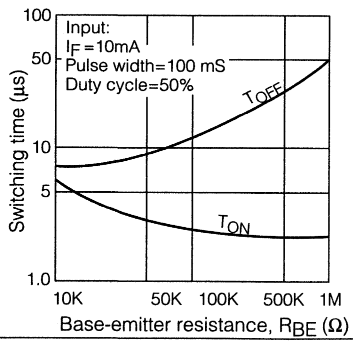
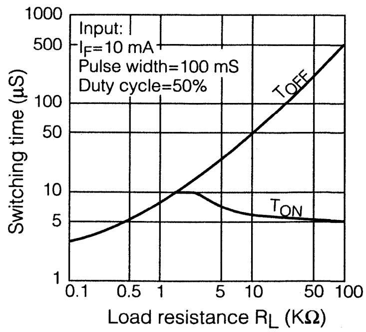


Figure 16. Typical switching times versus load resistance



SIEMENS

NEW

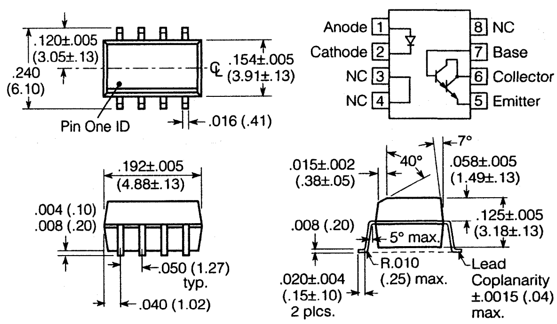
IL221A/IL222A/IL223A

PHOTODARLINGTON SMALL OUTLINE SURFACE MOUNT OPTOCOUPLER

FEATURES

- **High Current Transfer Ratio, I_F=1 mA, IL221A, 100% Minimum IL222A, 200% Minimum IL223A, 500% Minimum**
- **Withstand Test Voltage, 2500 VAC_{RMS}**
- **Electrical Specifications Similar to Standard 6 Pin Coupler**
- **Industry Standard SOIC-8 Surface Mountable Package**
- **Standard Lead Spacing, .05"**
- **Available in Tape and Reel Option (Conforms to EIA Standard RS481A)**
- **Compatible with Dual Wave, Vapor Phase and IR Reflow Soldering**
- **Underwriters Lab File #E52744 (Code Letter P)**

Package Dimensions in Inches (mm)



TOLERANCE: ±.005 (unless otherwise noted)

DESCRIPTION

The IL221A/IL222A/IL223A is a high current transfer ratio (CTR) optocoupler with a Gallium Arsenide infrared LED emitter and a silicon NPN photodarlington transistor detector.

This device has a CTR tested at an 1 mA LED current. This low drive current permits easy interfacing from CMOS to LSTTL or TTL.

This optocoupler is constructed in a standard SOIC-8 foot print which makes it ideally suited for high density applications. In addition to eliminating through-holes requirements, this package conforms to standards for surface mounted devices.

Maximum Ratings

Emitter

Peak Reverse Voltage .... 6.0 V
Continuous Forward Current .... 60 mA
Power Dissipation at 25°C .... 90 mW
Derate Linearly from 25°C .... 1.2 mW/°C

Detector

Collector-Emitter Breakdown Voltage .... 30 V
Emitter-Collector Breakdown Voltage .... 5 V
Collector-Base Breakdown Voltage .... 70 V
Power Dissipation .... 150 mW
Derate Linearly from 25°C .... 2.0 mW/°C

Package

Total Package Dissipation at 25°C Ambient (LED + Detector) .... 240 mW
Derate Linearly from 25°C .... 3.3 mW/°C
Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Soldering Time at 260°C .... 10 sec.

Characteristics (T_A=25°C)

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.0	1.5	V	I_F=1mA
Reverse Current	I_R		0.1	100	µA	V_R=6.0 V
Capacitance	C_O		25		pF	V_F=0 V, F=1 MHz
Detector						
Breakdown Voltage						
Collector-Emitter	BV_{CEO}	30			V	I_C=100 µA
Emitter-Collector	BV_{ECO}	5			V	I_E=100 µA
Collector-Base Voltage	BV_{CBO}	70				I_C=10 µA
Collector-Emitter Capacitance	C_{CE}		3.4		pF	V_{CE}=10 V
Package						
DC Current Transfer Ratio	CTR_{DC}					I_F=1 mA, V_{CE}=5 V
IL221A		100				
IL222A		200				
IL223A		500				
Collector-Emitter Saturation Voltage	$V_{CE\,sat}$			1	V	I_{CE}=0.5 mA, I_F=1 mA
Isolation Test Voltage	V_{IO}	2500			VAC_{RMS}	t=1 sec.
Capacitance, Input to Output	C_{IO}		0.5		pF	
Resistance, Input to Output	R_{IO}		100		GΩ	

Specifications subject to change.

Figure 1. Forward voltage versus forward current

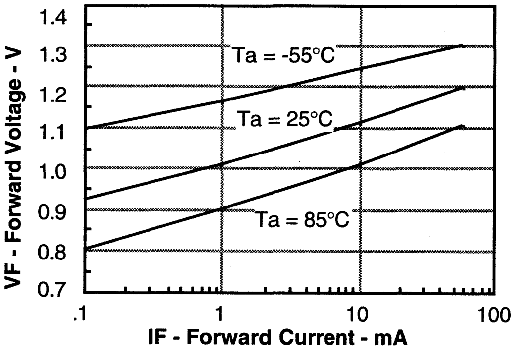


Figure 2. Peak LED current versus duty factor, Tau

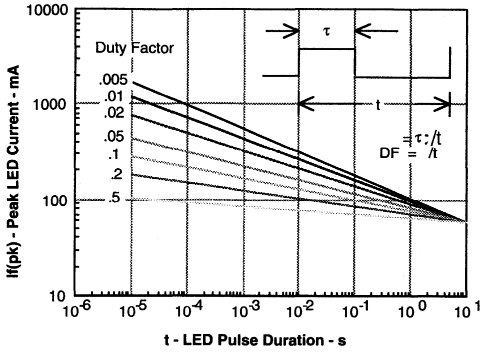


Figure 3. Normalized CTR_{CB} versus I_F

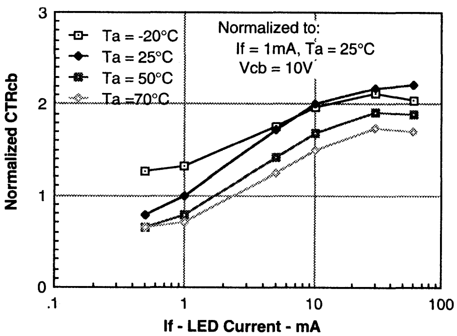


Figure 4. Normalized CTR_{CE} versus LED current

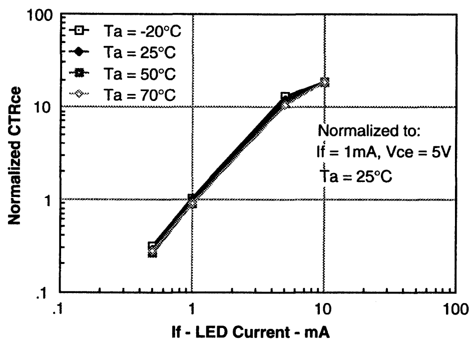


Figure 5. CTR_{CB} versus LED current

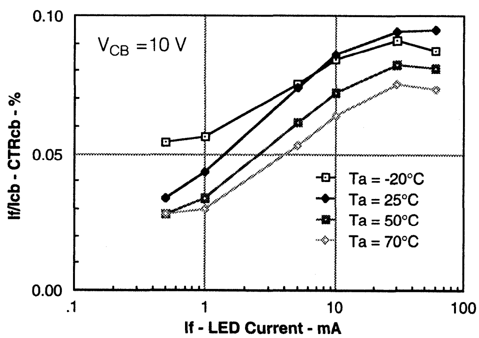


Figure 6. CTR versus LED current

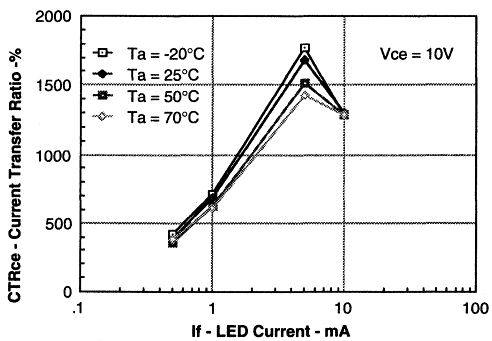


Figure 7. Collector current versus LED current

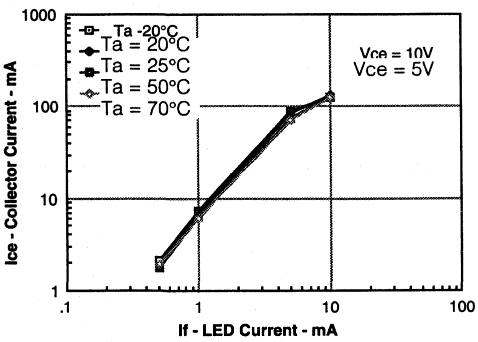


Figure 8. Photocurrent versus LED current

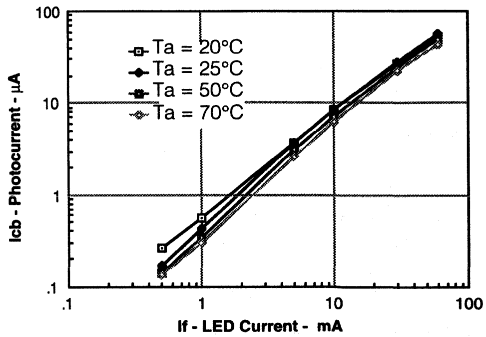


Figure 9. Normalized I_{CB} versus I_F

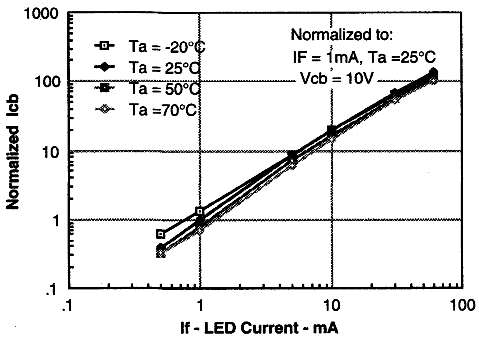


Figure 10. Switching Timing

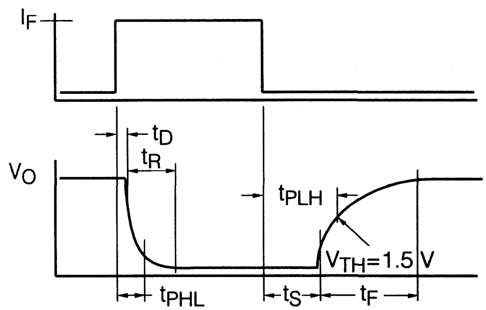
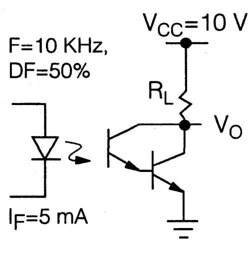


Figure 11. Switching schematic



Optocouplers (Optoisolators)

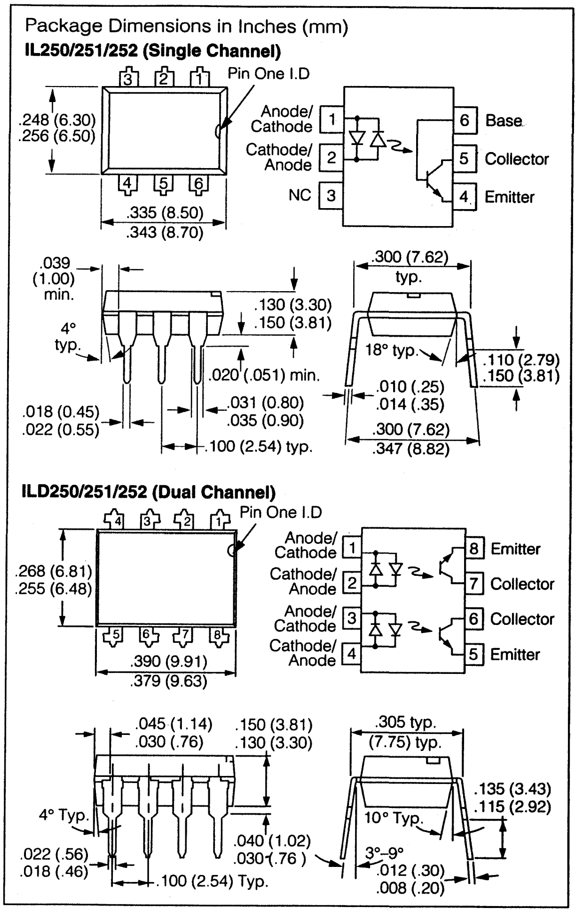
5

SIEMENS

SINGLE CHANNEL IL250/251/252
DUAL CHANNEL ILD250/251/252
BIDIRECTIONAL INPUT OPTOCOUPLER

FEATURES

- **Selected Current Transfer Ratios 20%, 50%, 100% Minimum**
- **AC or Polarity Insensitive Input**
- **Built-in Reverse Polarity Input Protection**
- **Improved CTR Symmetry**
- **Industry Standard DIP Package**
- **Underwriters Lab File #E52744**
- **VDE 0884 Available with Option 1**



Maximum Ratings (Each Channel)

Emitter

Continuous Forward Current .... 60 mA
Power Dissipation at 25°C .... 100 mW
Derate Linearly from 25°C .... 1.33 mW/°C

Detector

Collector-Emitter Breakdown Voltage .... 30 V
Emitter-Base Breakdown Voltage .... 5 V
Collector-Base Breakdown Voltage .... 70 V
Power Dissipation at 25°C
  Single Channel .... 200 mW
  Dual Channel .... 150 mW
Derate Linearly from 25°C
  Single Channel .... 2.6 mW/°C
  Dual Channel .... 2.0 mW/°C

Package

Isolation Test Voltage (between emitter and detector referred to standard climate 23°C/50%RH, DIN 50014) .... 5300 VAC_{RMS}
Creepage .... 7 mm min.
Clearance .... 7 mm min.
Isolation Resistance
  V_{IO}=500V, T_A=25°C .... 10^{12} Ω
  V_{IO}=500V, T_A=100°C .... 10^{11} Ω
Total Dissipation at 25°C
  Single Channel .... 250 mW
  Dual Channel .... 400 mW
Derate Linearly from 25°C
  Single Channel .... 3.3 mW/°C
  Dual Channel .... 5.3 mW/°C
Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Lead Soldering Time at 260°C .... 10 sec.

DESCRIPTION

The IL/ILD250/251/252 are bidirectional input optically coupled isolators consisting of two Gallium Arsenide infrared LEDs coupled to a silicon NPN phototransistor per channel.

The IL/ILD250 has a minimum CTR of 50%, the IL/ILD251 has a minimum CTR of 20%, and the IL/ILD252 has a minimum CTR of 100%.

The IL/IL250/1/2 are single channel optocouplers. The ILD250/1/2 has two isolated channels in a single DIP package.

These optocouplers are ideal for applications requiring AC signal detection and monitoring.

Electrical Characteristics (T_A=25°C)

Parameter	Min.	Typ.	Max.	Unit	Condition
Emitter					
Forward Voltage V_F		1.2	1.5	V	I_F=±10 mA
Detector					
BV_{CEO}	30	50		V	I_C=1 m A
BV_{EBO}	7	10		V	I_E=100 µA
BV_{CBO}	70	90		V	I_C=10 µA
I_{CEO}		5	50	nA	V_{CE}=10 V
Package					
V_{CEsat}			0.4	V	I_F=±16 mA, I_C=2 mA
DC Current Transfer Ratio				%	I_F=±10 mA, V_{CE}=10 V
IL/D250	50				
IL/D251	20				
IL/D252	100				
Symmetry					
CTR @ +10 mA / CTR @ - 10 mA	0.50	1.0	2.0		

Figure 1. LED forward current versus forward voltage

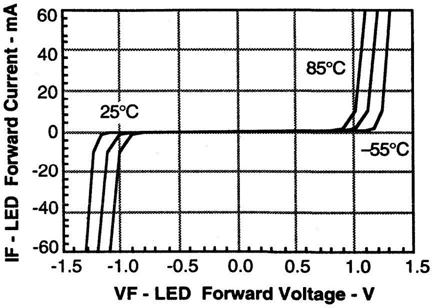


Figure 2. Normalized non-saturated and saturated CTR at T_A = 25°C versus LED current

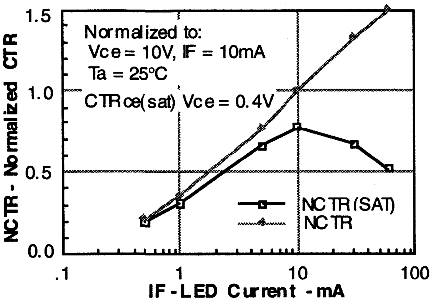


Figure 3. Normalized non-saturated and saturated CTR at T_A = 50°C versus LED current

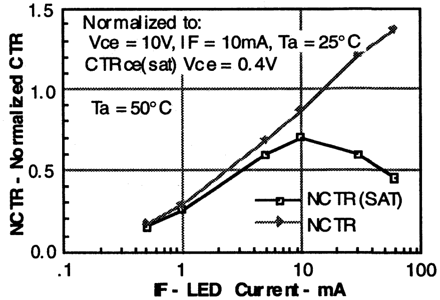


Figure 4. Normalized non-saturated and saturated CTR at T_A = 70°C versus LED current

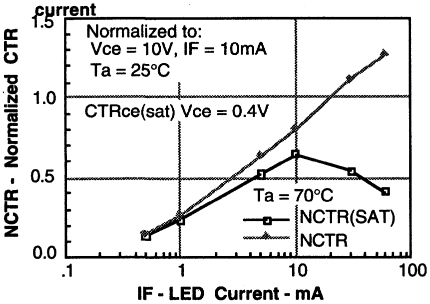


Figure 5. Normalized non-saturated and saturated CTR at T_A = 85°C versus LED current

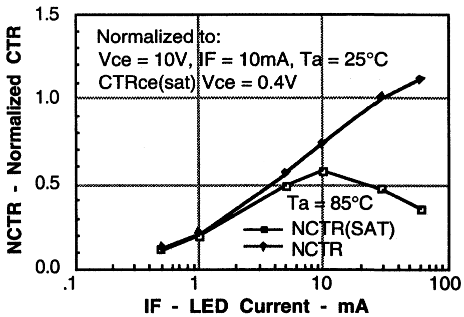


Figure 6. Collector-emitter current versus temperature and LED current

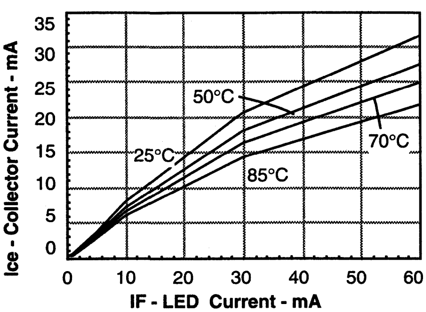


Figure 7. Collector-emitter leakage current versus temperature

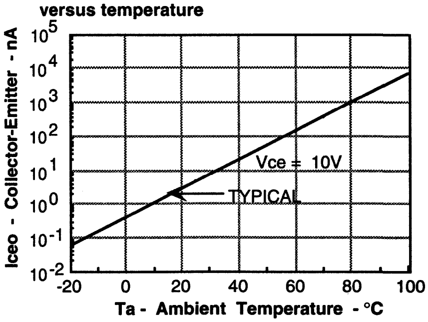


Figure 8. Normalized CTRcb versus LED current and temperature

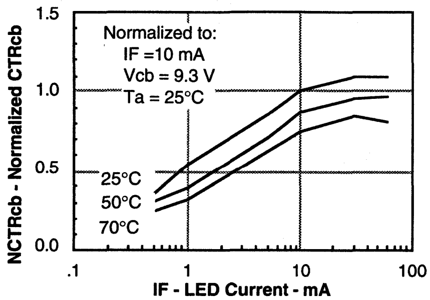


Figure 9. Collector base photocurrent versus LED current

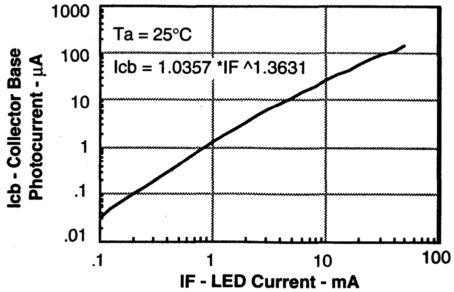


Figure 10. Normalized photocurrent versus If and temperature

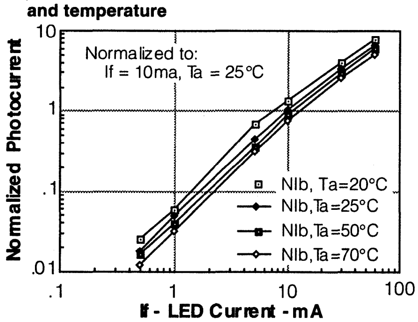


Figure 11. Normalized non-saturated HFE versus base current and temperature

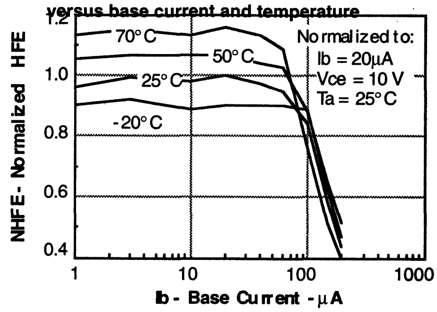


Figure 12. Normalized saturated HFE versus base current and temperature

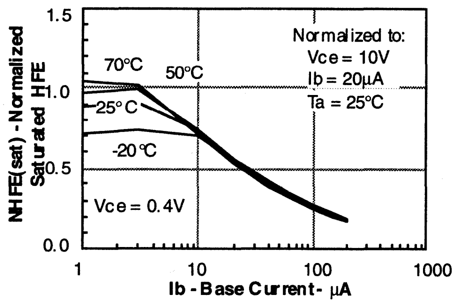


Figure 13. Propagation delay versus collector load resistor

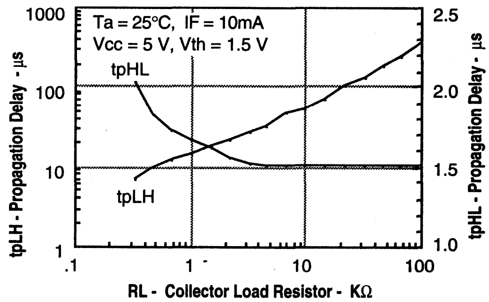


Figure 14. Switching timing

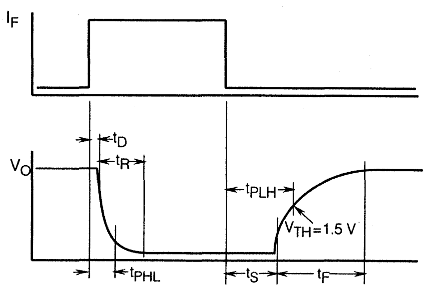
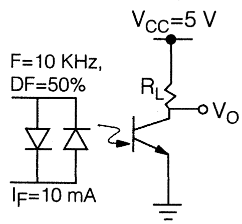


Figure 15. Switching schematic



SIEMENS

NEW

IL256A

AC INPUT PHOTOTRANSISTOR SMALL OUTLINE SURFACE MOUNT OPTOCOUPLER

FEATURES

- **Guranteed CTR Symmetry, 2:1 Maximum**
- **Bidirectional AC Input**
- **Industry Standard SOIC-8 Surface Mountable Package**
- **Standard Lead Spacing, .05"**
- **Available in Tape and Reel Option (Conforms to EIA Standard RS481A)**

DESCRIPTION

The IL256A is an AC input phototransistor optocoupler. The device consists of two infrared emitters connected in anti-parallel and coupled to a silicon NPN phototransistor detector.

These circuit elements are constructed with a standard SOIC-8 foot print.

The product is well suited for telecom applications such as ring detection or off/on hook status, given its bidirectional LED input and guaranteed current transfer ratio (CTR) minimum of 20% at I_F= 10 mA.

Maximum Ratings

Emitter

Continuous Forward Current .... 60 mA
Power Dissipation at 25°C ....90 mW
Derate Linearly from 25°C ....0.8 mW/°C

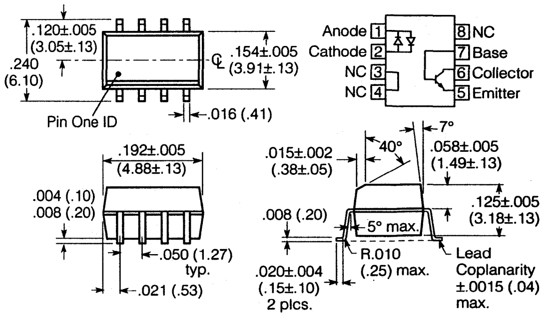
Detector

Collector-Emitter Breakdown Voltage ....30 V
Emitter-Collector Breakdown Voltage ....5 V
Collector-Base Breakdown Voltage ....70 V
Power Dissipation ....150 mW
Derate Linearly from 25°C ....2.0 mW/°C

Package

Total Package Dissipation at 25°C Ambient
(LED + Detector) ....240 mW
Derate Linearly from 25°C ....3.1 mW/°C
Storage Temperature ....–55°C to +150°C
Operating Temperature ....–55°C to +100°C
Soldering Time at 260°C .... 10 sec.

Package Dimensions in Inches (mm)



TOLERANCE: ±.005 (unless otherwise noted)

Characteristics (T_A=25°C)

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.2	1.5	V	I_F=±10 mA
Detector						
Breakdown Voltage						
Collector-Emitter	BV_{CEO}	30	50		V	I_C=1 mA
Emitter-Collector	BV_{ECO}	5	10		V	I_E=100 µA
Collector-Base	BV_{CBO}	70	90		V	I_C=100 µA
Collector-Emitter Leakage Current	I_{CEO}		5	50	nA	V_{CE}=10 V
Package						
DC Current Transfer	CTR	20			%	I_F=±10 mA, V_{CE}=5 V
Symmetry $\frac{\text{CTR at +10mA}}{\text{CTR at −10 mA}}$		0.5	1.0	2.0		
Collector-Emitter Saturation Voltage	$V_{CE\,sat}$			0.4		I_F=±16 mA, I_C=2 mA
Input to Output Isolation Voltage	V_{IO}	2500			VAC_{RMS}	

Optocouplers (Optoisolators)

5

Figure 1. LED forward current versus forward voltage

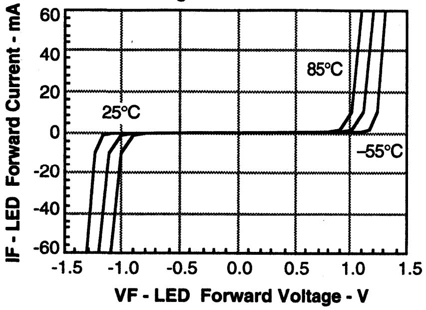


Figure 2. Forward voltage versus forward current

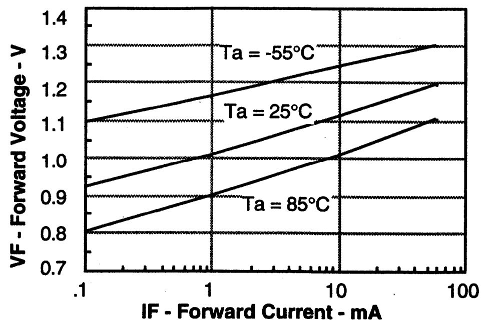


Figure 3. Peak LED current versus duty factor, Tau

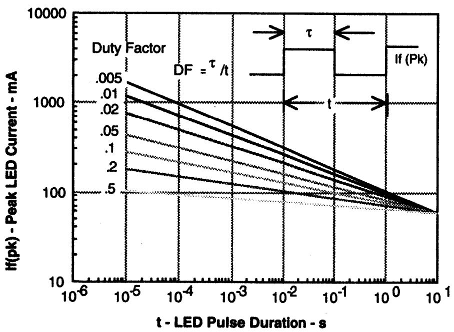


Figure 4. Normalized CTR versus If and Ta

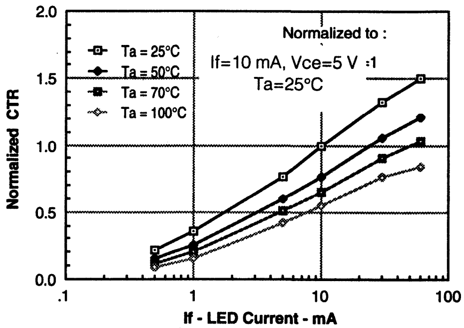


Figure 5. Normalized saturated CTR

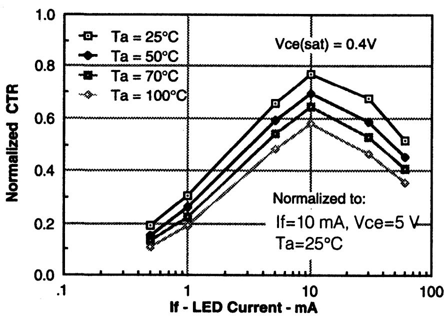


Figure 6. Normalized CTRcb

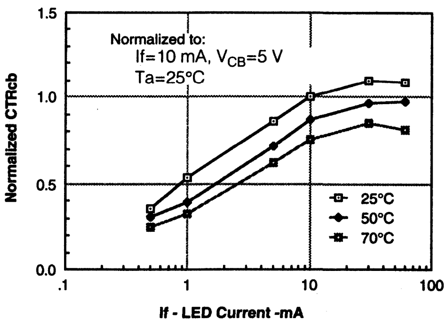


Figure 7. Photocurrent versus LED current

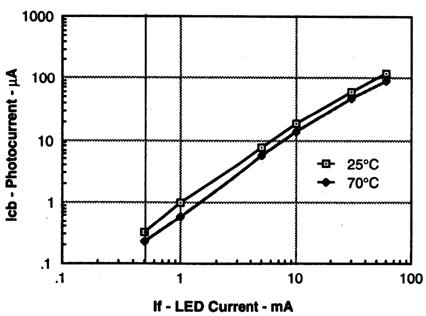


Figure 8. Base current versus If and HFE

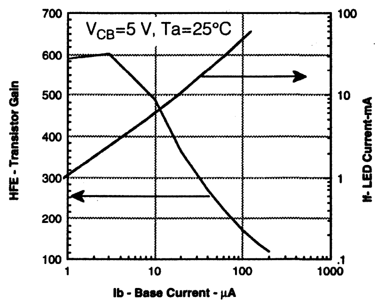


Figure 9. Normalized HFE versus Ib, Ta

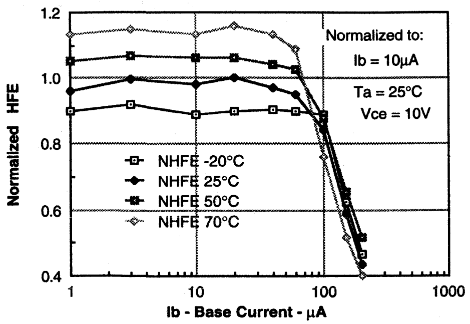


Figure 10. Normalized saturated HFE versus Ib

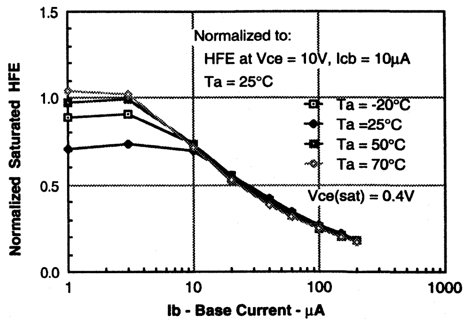


Figure 11. Base emitter voltage versus base current

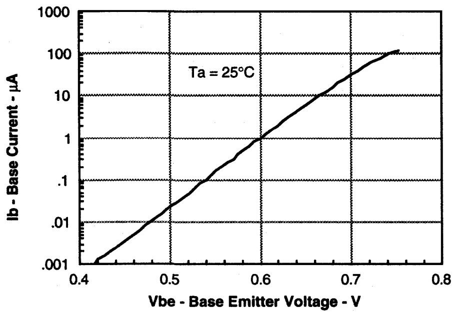
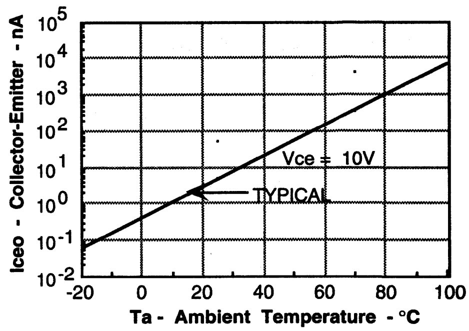


Figure 12.Collector-emitter leakage current versus temperature



5

Optocouplers (Optoisolators)

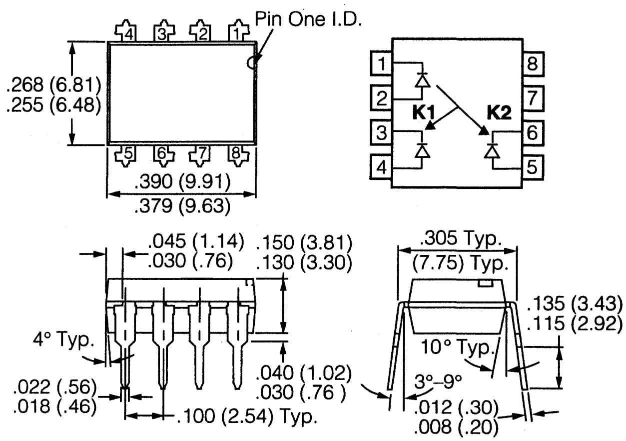
SIEMENS

IL300
LINEAR OPTOCOUPLERS

FEATURES
- Couples AC and DC signals
- 0.01% Servo Linearity
- Wide Bandwidth, >200 KHz
- High Gain Stability, ±0.005%/°C
- Low Input-Output Capacitance
- Low Power Consumption, < 15mw
- Isolation Test Voltage, 5300 VAC_{RMS}, 1 sec.
- Internal Insulation Distance, >0.4 mm for VDE
- Underwriters Lab File #E52744
- VDE Approval #0884 (Optional with Option 1, Add -X001 Suffix)
- IL300G Replaced by IL300-X006

APPLICATIONS
- Power Supply Feedback Voltage/Current
- Medical Sensor Isolation
- Audio Signal Interfacing
- Isolate Process Control Transducers
- Digital Telephone Isolation

Package Dimensions in Inches (mm)

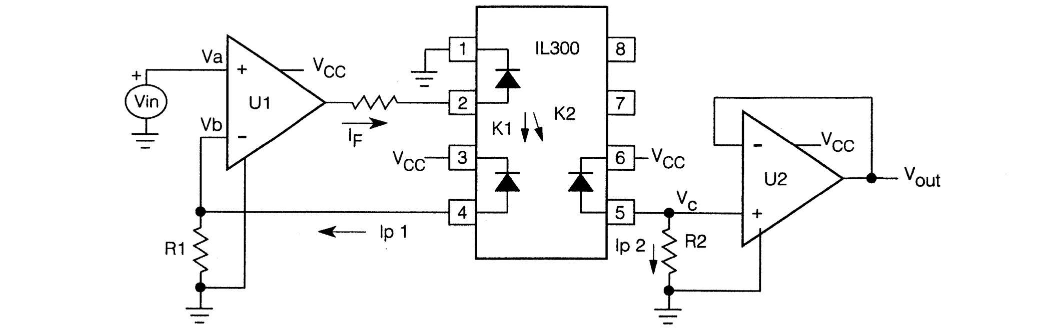


The IL300 Linear Optocoupler consists of an AlGaAs IRLED irradiating an isolated feedback and an output PIN photodiode in a bifurcated arrangement. The feedback photodiode captures a percentage of the LED's flux and generates a control signal (IP_1) that can be used to servo the LED drive current. This technique compensates for the LED's non-linear, time, and temperature characteristics. The output PIN photodiode produces an output signal (IP_2) that is linearly related to the servo optical flux created by the LED.

The time and temperature stability of the input-output coupler gain (K3) is insured by using matched PIN photodiodes that accurately track the output flux of the LED.

A typical application circuit (Figure 1) uses an operational amplifier at the circuit input to drive the LED. The feedback photodiode sources current to R1 connected to the inverting input of U1. The photocurrent, IP1, will be of a magnitude to satisfy the relationship of ($IP1=V_{IN}/R1$). The magnitude of this current is directly proportional to the feedback transfer gain (K1) times the LED drive current ($V_{IN}/R1=K1 \Sigma I_F$). The op-amp will supply LED current to force sufficient photocurrent to keep the node voltage (Vb) equal to Va.

Figure 1. Typical Application Circuit



DESCRIPTION (continued)

The output photodiode is connected to a non-inverting voltage follower amplifier. The photodiode load resistor, R2, performs the current to voltage conversion. The output amplifier voltage is the product of the output forward gain (K2) times the LED current and photodiode load, R2 ($V_O=I_F \Sigma K2 \Sigma R2$).

Therefore, the overall transfer gain (V_O/V_{IN}) becomes the ratio of the product of the output forward gain (K2) times the photodiode load resistor (R2) to the product of the feedback transfer gain (K1) times the input resistor (R1). This reduces to $V_O/V_{IN}=(K2 \Sigma R2)/(K1 \Sigma R1)$. The overall transfer gain is completely independent of the LED forward current. The IL300 transfer gain (K3) is expressed as the ratio of the ouput gain (K2) to the feedback gain (K1). This shows that the circuit gain becomes the product of the IL300 transfer gain times the ratio of the output to input resistors [$V_O/V_{IN}=K3 (R2/R1)$].

IL300 Terms

KI - Servo Gain
The ratio of the input photodiode current (I_{P1}) to the LED current(I_F). i.e., $K1 = I_{P1}/ I_F$.

K2 - Forward Gain
The ratio of the output photodiode current (I_{P2}) to the LED current (I_F), i.e., $K2 = I_{P2}/ I_F$.

K3 - Transfer Gain
The Transfer Gain is the ratio of the Forward Gain to the Servo gain, i.e., K3 = K2/K1.

ΔK3 - Transfer Gain Linearity
The percent deviation of the Transfer Gain, as a function of LED or temperature from a specific Transfer Gain at a fixed LED current and temperature.

Photodiode
A silicon diode operating as a current source. The output current is proportional to the incident optical flux supplied by the LED emitter. The diode is operated in the photovoltaic or photoconductive mode. In the photovoltaic mode the diode functions as a current source in parallel with a forward biased silicon diode.

The magnitude of the output current and voltage is dependant upon the load resistor and the incident LED optical flux. When operated in the photoconductive mode the diode is connected to a bias supply which reverse biases the silicon diode. The magnitude of the output current is directly proportional to the LED incident optical flux.

LED (Light Emitting Diode)
An infrared emitter constructed of AlGaAs that emits at 890 nm operates efficiently with drive current from 500 µA to 40 mA. Best linearity can be obtained at drive currents between 5 mA to 20 mA. Its output flux typically changes by -0.5%/°C over the above operational current range.

Absolute Maximum Ratings

	Symbol	Min.	Max.	Unit
Emitter				
Power Dissipation (T_A=25°C)	P_{LED}		160	mW
Derate Linearly from 25°C			2.13	mW/°C
Forward Current	If		60	mA
Surge Current (Pulse width <10 µs)	Ipk		250	mA
Reverse Voltage	V_R		5	V
Thermal Resistance	Rth		470	°C/W
Junction Temperature	T_J		100	°C
Detector				
Power Dissipation	P_{DET}		50	mW
Derate linearly from 25°C			0.65	mW/°C
Reverse Voltage	V_R		50	V
Junction Temperature	T_J		100	°C
Thermal Resistance	Rth		1500	°C/W
Coupler				
Total Package Dissipation at 25°C	P_T		210	mW
Derate linearly from 25°C			2.8	mW/°C
Storage Temperature	T_S	-55	150	°C
Operating Temp.	T_{op}	-55	100	°C
Isolation Test Voltage		5300		VAC_{RMS}
Isolation Resistance				
V_{IO}=500 V, T_A=25°C		10^{12}		Ω
V_{IO}=500 V, T_A=100°C		10^{11}		Ω

Characteristics (T_A=25°C)

	Symbol	Min.	Typ.	Max.	Unit	Test Condition
LED Emitter						
Forward Voltage	V_F		1.25	1.50	V	I_F=10 mA
V_F Temp. Coefficient	$\Delta V_F/\Delta$°C		–2.2		mV/°C	
Reverse Current	I_R		1	10	µA	V_R=5 V
Junction Capacitance	C_J		15		pF	V_F=0 V, f=1 MHz
Dynamic Resistance	$\Delta V_F/\Delta I_F$		6		Ω	I_F = 10 mA
Switching Time	t_R		1		µS	ΔI_F=2 mA, I_{Fq}=10 mA
	t_F		1		µS	ΔI_F=2 mA, I_{Fq}=10 mA
Detector						
Dark Current	I_D		1	25	nA	V_{det}=–15 V, I_F = 0 µA
Open Circuit Voltage	V_D		500		mV	I_F=10 mA
Short Circuit Current	I_{SC}		70		µA	I_F=10 mA
Junction Capacitance	C_J		12		pF	V_F=0 V, F=1 MHz
Noise Equivalent Power	NEP		4 X 10^{-14}		W/√Hz	V_{det}=–15 V
Coupled Characteristics						
K1, Servo Gain (I_{P1}/I_F)	K1	0.0050	0.007	0.011		I_F=10 mA, V_{det} =–15 V
Servo Current, see Note 1, 2	I_P1		70		µA	I_F=10 mA, V_{det}=–15 V
K2, Forward Gain (I_{P2}/I_F)	K2	0.0036	0.007	0.011		I_F=10 mA, V_{det}=–15 V
Forward Current	I_P2		70		µA	I_F=10 mA, V_{det}=–15 V
K3, Transfer Gain (K2/K1) See Note 1, 2	K3	0.56	1.00	1.65	K2/K1	I_F=10 mA, V_{det}=–15 V
Transfer Gain Linearity	ΔK3		±0.25		%	I_F=1 to 10 mA
Transfer Gain Linearity	ΔK3		±0.5		%	I_F=1 to 10 mA, T_A=0°C to 75°C
Photoconductive Operation						
Frequency Response	BW (-3 db)		200		KHz	I_{Fq}=10 mA, MOD=±4 mA, R_L=50 Ω,
Phase Response at 200 KHz			-45		Deg.	V_{det}=–15 V
Rise Time	t_R		1.75		µs	
Fall Time	t_F		1.75		µs	
Package						
Input-Output Capacitance	C_{IO}		1		pF	V_F=0 V, f=1 MHz
Common Mode Capacitance	C_{cm}		0.5		pF	V_F=0 V, f =1 MHz
Common Mode Rejection Ratio	CMRR		130		dB	f=60 Hz, R_L=2.2 KΩ

Notes

1. Bin Sorting:

   K3 (transfer gain) is sorted into bins that are ±5%, as follows:

   Bin A=0.557–0.626
   Bin B=0.620–0.696
   Bin C=0.690–0.773
   Bin D=0.765–0.859
   Bin E=0.851–0.955
   Bin F=0.945–1.061
   Bin G=1.051–1.181
   Bin H=1.169–1.311
   Bin I=1.297–1.456
   Bin J=1.442–1.618

   K3=K2/K1. K3 is tested at I_F=10 mA, V_{det}=–15 V.

2. Bin Categories: All IL300s are sorted into a K3 bin, indicated by an alpha character that is marked on the part. The bins range from "A" through "J".

   The IL300 is shipped in tubes of 50 each. Each tube contains only one category of K3. The category of the parts in the tube is marked on the tube label as well as on each individual part.

3. Category Options: Standard IL300 orders will be shipped from the categories that are available at the time of the order. Any of the ten categories may be shipped. For customers requiring a narrower selection of bins, four different bin option parts are offered.

   IL300-DEFG: Order this part number to receive categories D,E,F,G only.

   IL300-EF: Order this part number to receive categories E, F only.

   IL300-E: Order this part number to receive category E only.

   IL300-F: Order this part number to receive category F only

Figure 2. LED forward current vs. forward voltage

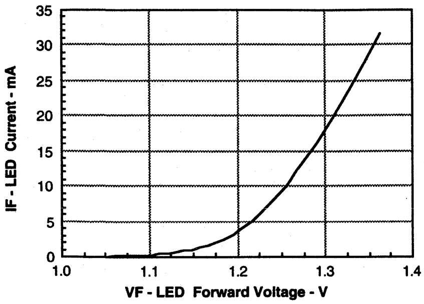


Figure 3. LED forward current vs. forward voltage

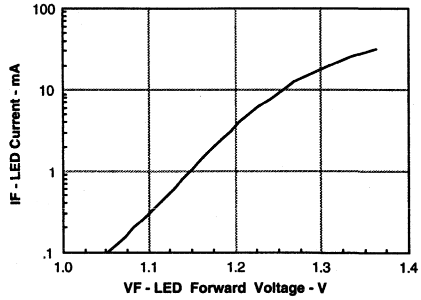


Figure 4. Servo photocurrent vs. LED current and temperature

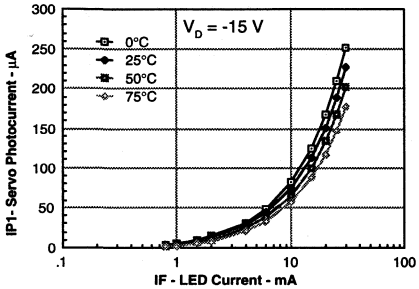


Figure 5. Servo photocurrent vs.LED current and temperature

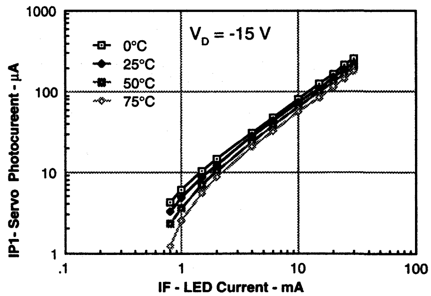


Figure 6. Normalized servo photocurrent vs. LED current and temperature

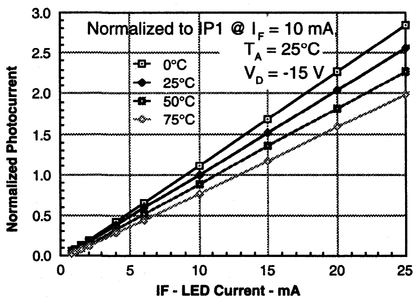


Figure 7. Normalized servo photocurrent vs.LED current and temperature

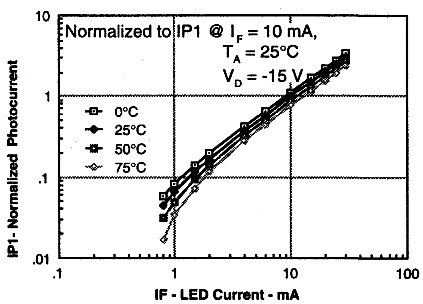


Figure 8. Servo gain vs. LED current and temperature

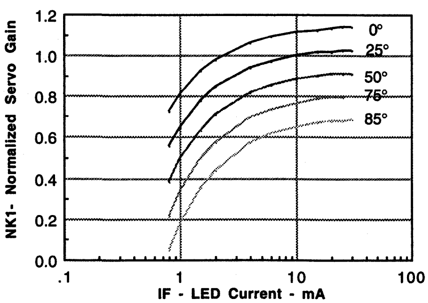


Figure 9. Normalized servo gain vs.LED urrent and temperature

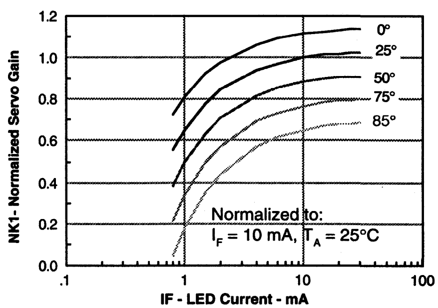


Figure 10. Transfer gain vs. LED current and temperature

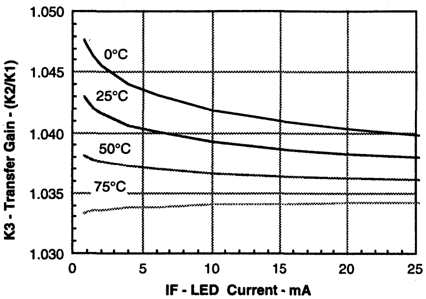


Figure 11. Normalized transfer gain vs. LED current and temperature

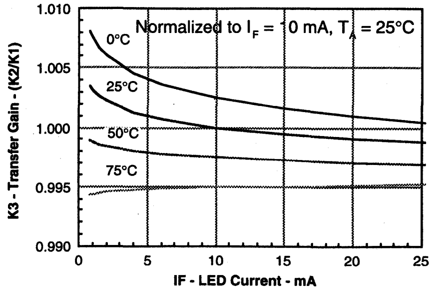


Figure 12. Amplitude response vs. frequency

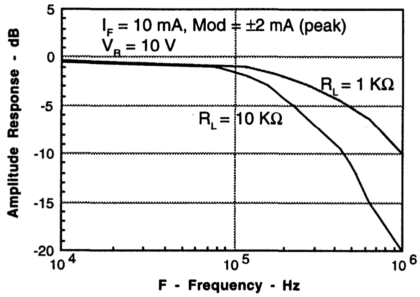


Figure 13. Amplitude and phase response vs. frequency

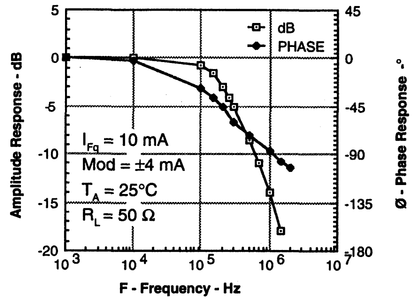


Figure 14. Common mode rejection

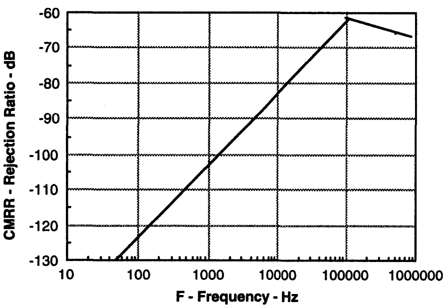
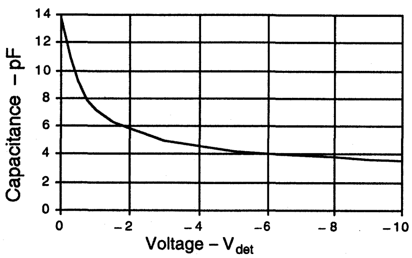


Figure 15. Photodiode junction capacitance vs. reverse voltage



Application Considerations

In applications such as monitoring the output voltage from a line powered switch mode power supply, measuring bioelectric signals, interfacing to industrial transducers, or making floating current measurements, a galvanically isolated, DC coupled interface is often essential. The IL300 can be used to construct an amplifier that will meet these needs.

The IL300 eliminates the problems of gain nonlinearity and drift induced by time and temperature, by monitoring LED output flux.

A PIN photodiode on the input side is optically coupled to the LED and produces a current directly proportional to flux falling on it . This photocurrent, when coupled to an amplifier, provides the servo signal that controls the LED drive current.

The LED flux is also coupled to an output PIN photodiode. The output photodiode current can be directly or amplified to satisfy the needs of succeeding circuits.

Isolated Feedback Amplifier

The IL300 was designed to be the central element of DC coupled isolation amplifiers. Designing the IL300 into an amplifier that provides a feedback control signal for a line powered switch mode power is quite simple, as the following example will illustrate.

See Figure 17 for the basic structure of the switch mode supply using the Siemens TDA4918 Push-Pull Switched Power Supply Control Chip. Line isolation and insulation is provided by the high frequency transformer. The voltage monitor isolation will be provided by the IL300.

The isolated amplifier provides the PWM control signal which is derived from the output supply voltage. Figure 16 more closely shows the basic function of the amplifier.

The control amplifier consists of a voltage divider and a non-inverting unity gain stage. The TDA4918 data sheet indicates that an input to the control amplifier is a high quality operational amplifier that typically requires a +3V signal. Given this information, the amplifier circuit topology shown in Figure 18 is selected.

The power supply voltage is scaled by R1 and R2 so that there is +3 V at the non-inverting input (Va) of U1. This voltage is offset by the voltage developed by photocurrent flowing through R3. This photocurrent is developed by the optical flux created by current flowing through the LED. Thus as the scaled monitor voltage (Va) varies it will cause a change in the LED current necessary to satisfy the differential voltage needed across R3 at the inverting input.

The first step in the design procedure is to select the value of R3 given the LED quiescent current (I_{Fq}) and the servo gain (K1). For this design, I_{Fq}=12 mA. Figure 4 shows the servo photocurrent at I_{Fq} is found to be 100 µA. With this data R3 can be calculated.

$$R3 = \frac{V_b}{I_{PI}} = \frac{3V}{100\mu A} = 30K\Omega$$

For best input offset compensation at U1, R2 will equal R3. The value of R1 can easily be calculated from the following:

$$R1 = R2\left(\frac{V_{MONITOR}}{V_a} - 1\right)$$

$$20K\Omega = 30K\Omega\left(\frac{5V}{3V} - 1\right)$$

The value of R5 depends upon the IL300 Transfer Gain (K3). K3 is targeted to be a unity gain device, however to minimize the part to part Transfer Gain variation, Siemens offers K3 graded into ±5% bins. R5 can be determined using the following equation, .

$$R5 = \frac{V_{OUT}}{V_{MONITOR}} \bullet \frac{R3\,(R1 + R2)}{R2\,K3}$$

Or if a unity gain amplifer is being designed ($V_{MONITOR}=V_{OUT}$, R1=0), the equation simplifies to :

$$R5 = \frac{R3}{K3}$$

Figure 16. Isolated Control Amplifier

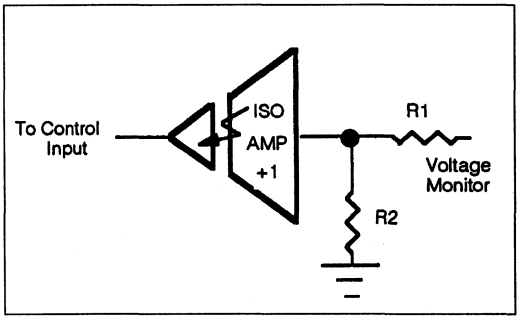


Figure 17. Switch Mode Power Supply

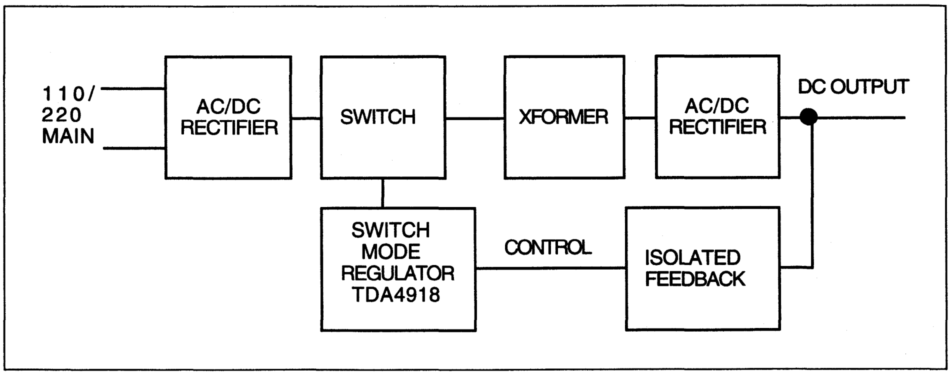


Figure 18. DC Coupled Power Supply Feedback Amplifier

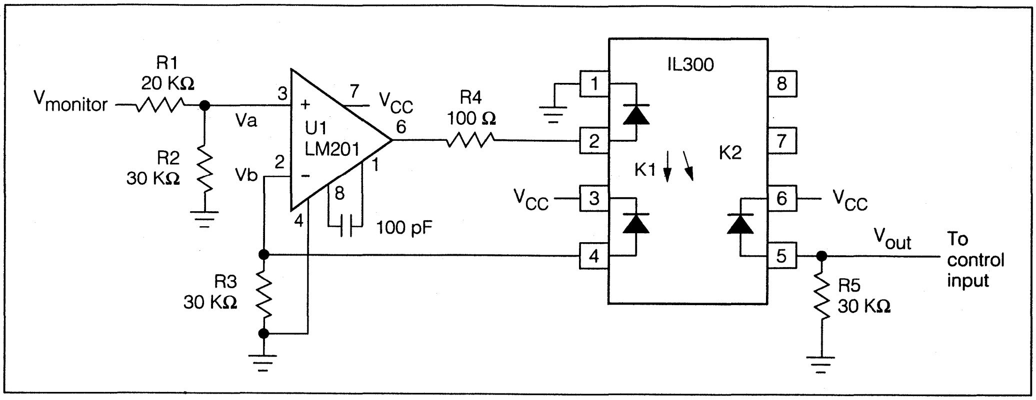


Table 1 gives the value of R5 given the production K3 bins.

Table 1. R5 Selection

Bins	Min.	Max.	K3 Typ.	R5 Resistor KΩ	1% KΩ
A	0.560	0.623	0.59	50.85	51.1
B	0.623	0.693	0.66	45.45	45.3
C	0.693	0.769	0.73	41.1	41.2
D	0.769	0.855	0.81	37.04	37.4
E	0.855	0.950	0.93	32.26	32.4
F	0.950	1.056	1.00	30.00	30.0
G	1.056	1.175	1.11	27.03	27.0
H	1.175	1.304	1.24	24.19	24.0
I	1.304	1.449	1.37	21.90	22.0
J	1.449	1.610	1.53	19.61	19.4

The last step in the design is selecting the LED current limiting resistor (R4). The output of the operational amplifier is targeted to be 50% of the Vcc, or 2.5 V. With an LED quiescent current of 12 mA the typical LED (V_F) is 1.3 V. Given this and the operational output voltage, R4 can be calculated.

$$R4 = \frac{V_{opamp} - V_F}{I_{Fq}} = \frac{2.5V - 1.3V}{12\,mA} = 100\Omega$$

The circuit was constructed with an LM201 differential operational amplifier using the resistors selected. The amplifier was compensated with a 100 pF capacitor connected between pins 1 and 8.

The DC transfer charateristics are shown in Figure 19. The amplifier was designed to have a gain of 0.6 and was measured to be 0.6036. Greater accurracy can be achieved by adding a balancing circuit, and potentiometer in the input divider, or at R5. The circuit shows exceptionally good gain linearity with an RMS error of only 0.0133% over the input voltage range of 4 V–6 V in a servo mode; see Figure 20.

Figure 19. Transfer gain

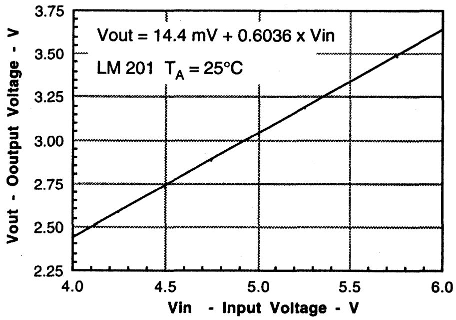
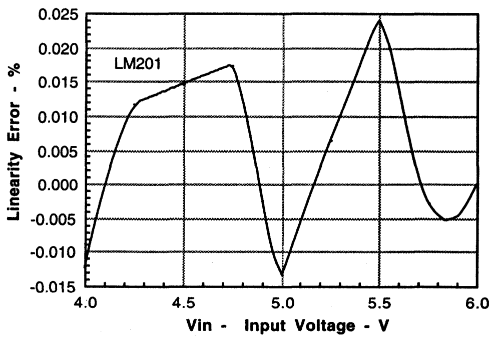
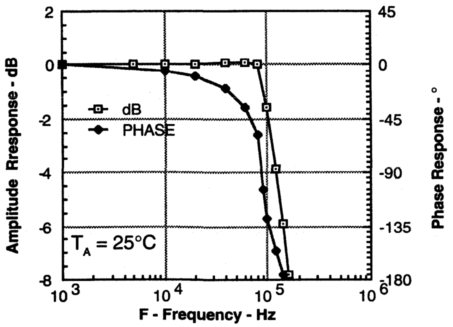


Figure 20. Linearity error vs. input voltage



The AC characteristics are also quite impressive offering a -3 dB bandwidth of 100 KHz, with a -45° phase shift at 80 KHz as shown in Figure 21.

Figure 21. Amplitude and phase power supply control



The same procedure can be used to design isolation amplifiers that accept biploar signals referenced to ground. These amplifiers circuit configurations are shown in Figure 22. In order for the amplifier to respond to a signal that swings above and below ground, the LED must be prebiased from a separate source by using a voltage reference source (Vref1). In these designs, R3 can be determined by the following equation.

$$R3 = \frac{V_{ref1}}{I_{P1}} = \frac{V_{ref1}}{K1\ I_{Fq}}$$

These amplifiers provide either an inverting or non-inverting transfer gain based upon the type of input and output amplifier. Table 2 shows the various configurations along with the specific transfer gain equations. The offset column refers to the calculation of the output offset or Vref2 necessary to provide a zero voltage output for a zero voltage input. The non-inverting input amplifier requires the use of a bipolar supply, while the inverting input stage can be implemented with single supply operational amplifiers that permit operation close to ground.

For best results, place a buffer transistor between the LED and output of the operational amplifier when a CMOS opamp is used or the LED I_{Fq} drive is targeted to operate beyond 15 mA. Finally the bandwidth is influenced by the magnitude of the closed loop gain of the input and output amplifiers. Best bandwidths result when the amplifier gain is designed for unity.

Figure 22. Non-Inverting and Inverting Amplifiers

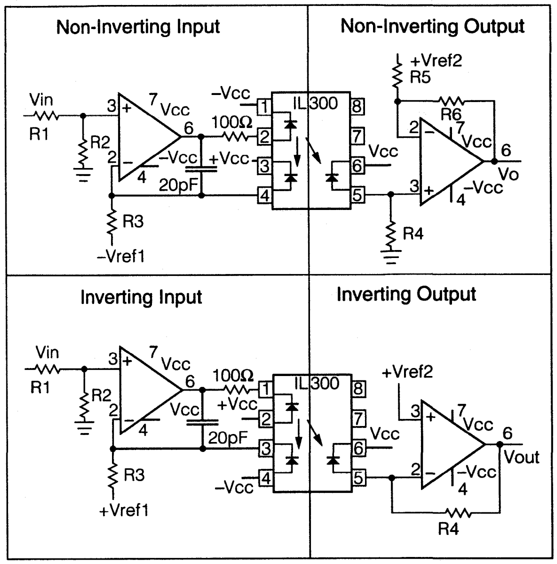


Table 2. Optolinear Amplifiers

Amplifier	Input	Output	Gain	Offset
Non-Inverting	Inverting	Inverting	$\frac{V_{OUT}}{V_{IN}} = \frac{K_3 R_4 R_2}{R_3 (R_1 + R_2)}$	$V_{ref2} = \frac{V_{ref1} R_4 K_3}{R_3}$
	Non-Inverting	Non-Inverting	$\frac{V_{OUT}}{V_{IN}} = \frac{K_3 R_4 R_2 (R_5 + R_6)}{R_3 R_5 (R_1 + R_2)}$	$V_{ref2} = \frac{-V_{ref1} R_4 (R_5+R_6) K_3}{R_3 R_6}$
Inverting	Inverting	Non-Inverting	$\frac{V_{OUT}}{V_{IN}} = \frac{-K_3 R_4 R_2 (R_5 + R_6)}{R_3 R_5 (R_1 + R_2)}$	$V_{ref2} = \frac{V_{ref1} R_4 (R_5+R_6) K_3}{R_3 R_6}$
	Non-Inverting	Inverting	$\frac{V_{OUT}}{V_{IN}} = \frac{- K_3 R_4 R_2}{R_3 (R_1 + R_2)}$	$V_{ref2} = \frac{-V_{ref1} R_4 K_3}{R_3}$

SIEMENS

IL329

OPTICALLY COUPLED TELECOM SWITCH

Preliminary Data Sheet

FEATURES

- **Solid state relay and AC input**
- **Optocoupler Package—Single 18 Pin**
- **I/O Isolation, 2500 V_{RMS}**
- **Surface Mountable**
- **Optocoupler**
  - **Bidirectional Current Detection**
- **Solid-state Relay**
  - **Typical R_{ON} 25 Ω**
  - **Load Voltage 400 V**
  - **Load Current 100 mA**
  - **Current Limit Protection**
  - **High Surge Capability**
  - **Linear, AC/DC Operation**
  - **Clean Bounce Free Switching**
  - **Low Power Consumption**
  - **High Reliability Monolithic Receptor**
- **Applications**
  General Telecom Switching
  - **On/off Hook Control**
  - **Dial Pulse**
  - **Ring Current Detection**
  - **Loop Current Sensing**

DESCRIPTION

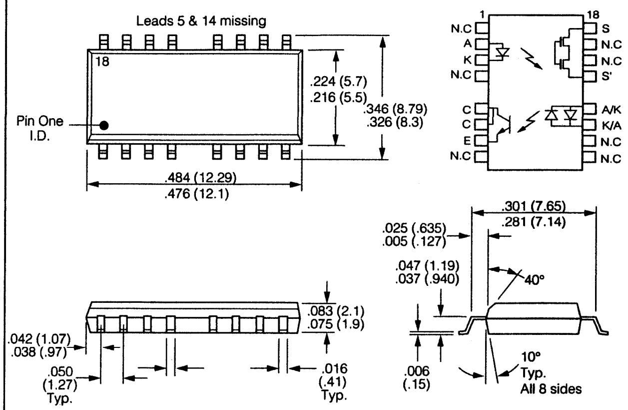
The IL329 Telecom switch consists of an optically coupled solid state relay (SSR) and a bidirectional input optocoupler. The SSR is ideal for performing switchhook and dial-pulse switching while the optocoupler performs ring detection and loop current sensing functions. Both the SSR and opto coupler provide 2500 V_{RMS} of input to ouput isolation.

The SSR is integrated on a monolithic receptor die using high voltage BCDMOS technology. The SSR features low ON-resistance, high breakdown voltage and current-limit circuitry that protects the relay from telephone line induced lightning surges.

The optocoupler provides bidirectional current sensing via two antiparallel GaAs infrared emitting diodes. The opto channel provides a minimum CTR of 33% at 6 mA.

The IL329 comes in a 18 pin, plastic surface mount package.

Package Dimensions in Inches (mm)



Absolute Maximum Ratings

Package

Ambient Temperature Range .... –40 to +85°C
Storage Temperature Range .... –40 to +150°C
Soldering Temperature (t=10 sec. max.) .... 260°C
Input/Output Isolation Voltage (t=60 sec. min.) .... 2500 V_{RMS}
Total Power Dissipation .... 500 mW
Isolation Test Voltage (between emitter and detector)..... 2500 VAC_{RMS}
Isolation Resistance
  V_{IO}=500 V, TA=25°C .... $\geq 10^{12}$ Ω
  V_{IO}=500 V, TA=100°C .... $\geq 10^{11}$ Ω
Storage Temperature Range .... –55°C to +125°C
Ambient Temperature Range .... –55°C to +100°C
Soldering Temperature (max. ≤10 sec.,
  dip soldering ≥0.5 mm from case bottom) .... 260°C

SSR

LED Continuous Forward Current .... 50 mA
LED Reverse Voltage (I_R≤10 µA) .... 5 V
DC or Peak AC Load Voltage (I_L≤50 µA) .... ±400 V
Continous DC Load Current .... 100 mA
Total Power Dissipation .... 350 mW

Optocoupler

LED Continuous Forward Current .... ±50 mA
Collector to Emitter Breakdown Voltage .... 30 V
Phototransistor Power Dissipation .... 150 mW

Electrical Characteristics (T_A=25°)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Condition
SSR						
LED Forward Current for Switch Turn-on	I_{Fon}		0.2	0.5	mA	I_L=100 mA, t=10 ms
LED Forward Current for Switch Turn-off	I_{Foff}	0.001			mA	V_L=±350 V
LED Forward Voltage	V_F	0.8	1.20	1.45	V	I_F=1.5 mA
ON-Resistance	R_{ON}	17	2.5	33	Ω	I_F=1.5 mA,I_L=±50 mA
OFF-Resistance	R_{OFF}		5000		GΩ	I_F=0 mA, V_L=±100 V
Current Limit	I_{limit}	170	210	270	mA	I_F=1.5 mA, t=5 ms
Output Off-state Leakage Current			0.1	200 1	nA µA	I_F=0 mA, V_L=±100 V I_F=0 mA, V_L=±400 V
Output Capacitance Pins 15 to 18			55 10		pF pF	I_F=0 mA, V_L=1 V I_F=0 mA, V_L=50 V
Turn-on Time	T_{on}		1.0		ms	I_F=1.5 mA, I_L=50 mA
				0.8	ms	I_F=5.0 mA, I_L=50 mA
Turn-off Time	T_{off}		0.1		ms	I_F=1.5 mA, I_L=50 V
				0.2	ms	I_F=5.0 mA, I_L=50 mA
Optocoupler						
LED Forward Voltage	V_F	0.9	1.25	1.5	V	I_F=10 mA
DC Current Transfer Ratio	CTR	33	165		%	I_F=6.0 mA, V_{CE}=0.5 V
Saturation Voltage	V_{CEsat}		.07	0.5	V	I_F=16.0 mA, I_C=2 mA
Dark Current Leakage	I_{CEO}			500	nA	I_F=0 mA, V_{CE}=5 V
Trickle Current Leakage	I_{CEO}			1	µA	I_F=5 µA, V_{CE}=5 V

SSR Characteristic Curves

Figure 1. SSR recommended operating conditions

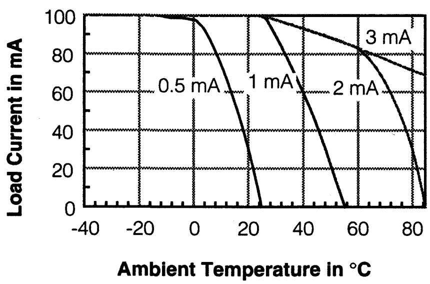


Figure 2. I_F versus V_F, typical

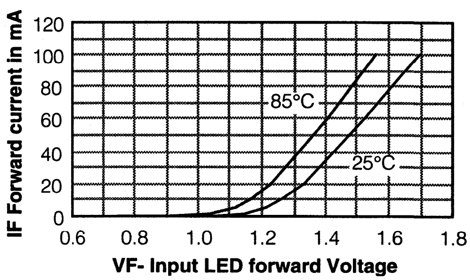


Figure 3. SSR turn-on current versus temperature

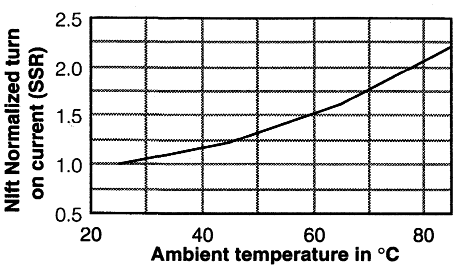
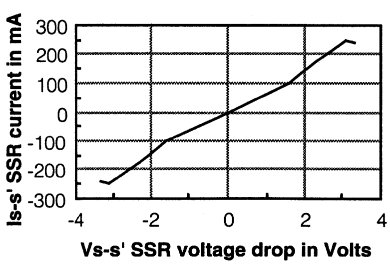


Figure 4. SSR current vs. voltage, typical



Optocouplers (Optoisolators)

5

Figure 5. SSR turn on time versus resistive load

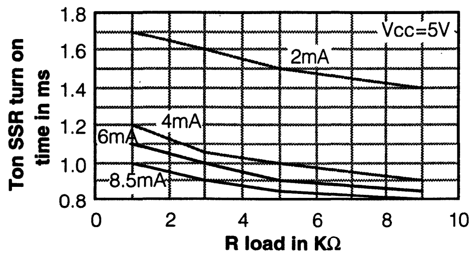
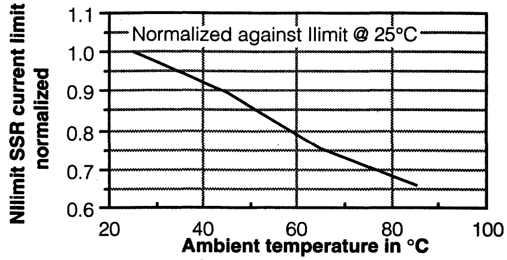


Figure 6. SSR current limit versus temperature



Typical Opto Channel Characteristic Curves

Figure 7. I_C versus V_{CE}, typical

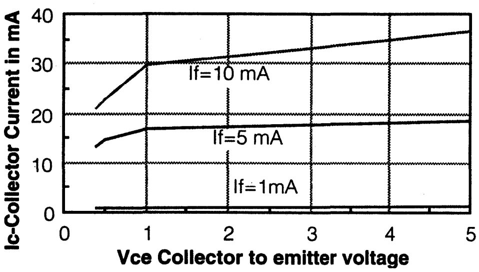


Figure 8. I_{CEO} leakage current versus temp.

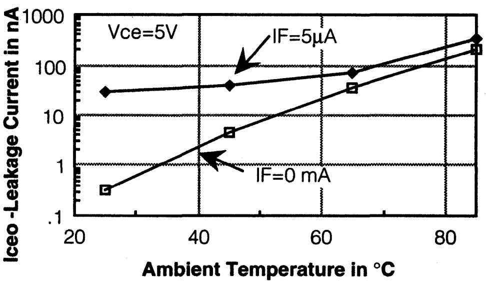


Figure 9. Saturated current transfer ratio, typical

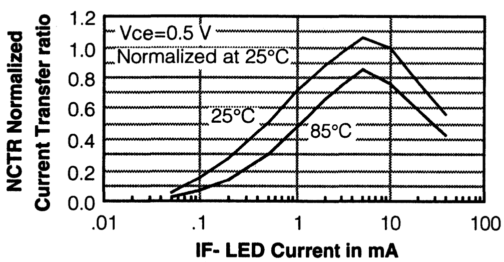


Figure 10. Non-saturated current transfer ratio, typical

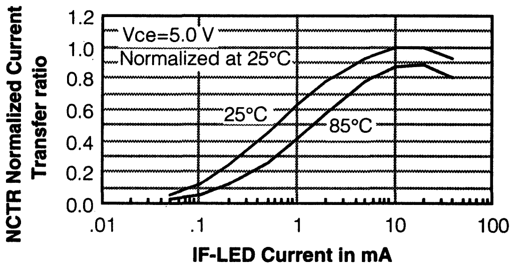


Figure 11. Switching test circuit for SSR channel

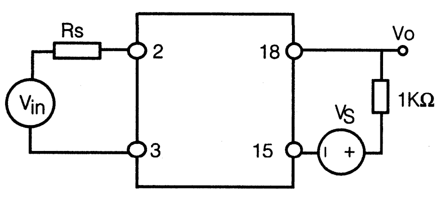
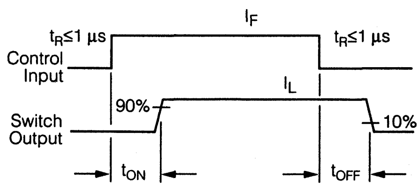


Figure 12. Switching waveform



SIEMENS

NEW

IL350/351/358/359

HIGH PERFORMANCE LINEAR OPTOCOUPLER for Optical DAA in Telecommunications

Preliminary Data Sheet

FEATURES

- **2 mm High SMT Package**
- **High Sensitivity (K1) at Low Operating LED Current**
- **Couples AC and DC Signals**
- **Low Input-Output Capacitance**
- **Isolation Voltage, 2500 V_{RMS}**
- **Low Distortion**

APPLICATIONS

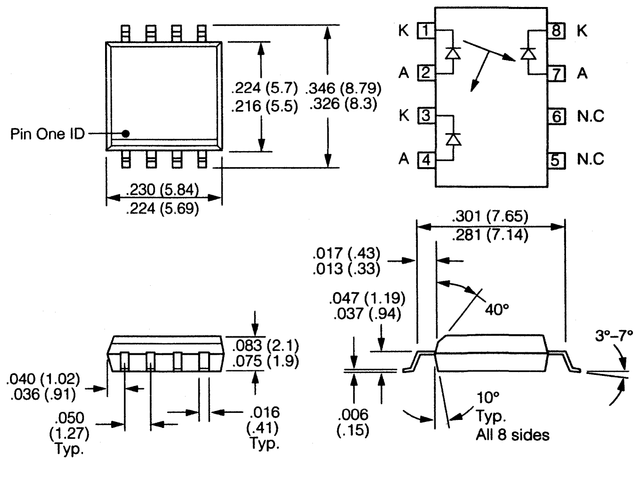
- **Optical DAA for V.34 FAX/Modem PCMCIA Cards**
- **Digital Telephone Line Isolation**

DESCRIPTION

The IL350/1/8/9 family of Linear Optocoupler consist of an IRLED optically coupled to two photodiodes. The emitter mechanically faces both diodes enabling them to receive approximately an equal amount of infrared light. The diodes produce a proportional amount of photocurrents. The ratio of the photocurrents stays constant with high accuracy when either the LED current changes or the ambient temperature changes. Thus one can control the output diode current optically by controlling the input photodiode current.

The IL350/1/8/9 optocouplers can be used with the aid of operational amplifiers in closed loop conditions to achieve highly linear and electrically isolated AC and or DC signal amplifiers.

Package Dimensions in Inches (mm)



Absolute Maximum Ratings

Emitter	Sym	Min.	Max.	Units
Reverse Voltage	V_R		3	V
Forward Current	I_F		30	mA
Surge Current Pulse Width <10 µs	I_{PK}		150	mA
Power Dissipation, T_A=25°C	P_{LED}		150	mW
Dearate Linearly from 25°C			2	mW/°C
Junction Temperature	T_J		100	°C
Detector (each)				
Reverse Voltage	V_R		15	V
Power Dissipation	P		50	mW
Derate Linearly from 25°C			0.65	mW/°C
Junction Temperature	T_J		100	°C
Coupler				
Isolation Test Voltage	V_{ISOL}	2500		V_{RMS}
Total Package Power Dissipation	Pt		250	mW
Derate Linearly from 25°C			2.8	mW/°C
Storage Temperature	T_S	–40	150	°C
Operating Temperature	T_{OP}	0	75	°C
Lead Soldering Time at 260°C			10	sec.
Isolation Resistance V_{IO}=500 V, TA=25°C V_{IO}=500 V, TA=100°C		 10^{12} Ω 10^{11} Ω		

Electrical Characteristics (T_A=25°C)

LED Emitter		Symbol	Min.	Typ.	Max.	Units	Test Conditions
Forward Voltage		V_F		1.8	2.1	V	I_F=10 mA
Reverse Current		I_R		.01	10	µA	V_R=3 V
V_F Temperature Coefficient		$\Delta V_F/\Delta°C$		–2.2		mV/°C	
Junction Capacitance		C_J		TBD		pF	V_F=0 V, f=1 MHz
Dynamic Resistance		$\Delta V_F/\Delta I_F$		6		Ω	I_F=2.5 mA ΔI_F=1 mA
Switching Time IL358/9		t_F		40		ns	
		t_R		40		ns	
Detector							
Junction Capacitance		C_J		12		pF	V_F=0 V, f=1 MHz
NEP				$<4^{-14}$		W/√Hz	V_{DET}=0 V
AC Characteristics Photovoltaic Mode							
Frequency Response	IL358/9	BW(–3dB)		1.0		MHz	I_{P1}=25 µA Modulation current ΔIP1=±6 µA
Phase Response				45		Deg.	
Rise Time				350		ns	
Package							
Input-Output Capacitance		C_{IO}		1		pF	V_F=0 V, f=1 MHz
Common Mode Capacitance		C_{cm}		0.5		pF	V_F=0 V, f=1 MHz
Coupled Characteristics							

	K1 at I_F=2 mA, V_D=0 V			K3 Bins
	Min.	**Typ.**	**Max.**	
IL350	0.003			A–J
IL351	0.005			D, E, F, G
IL358	0.008			D, E, F, G
IL359	0.008			E, F

Bin Table

Bin	Min.	Max.
A	0.557	0.626
B	0.620	0.696
C	0.690	0.773
D	0.765	0.859
E	0.851	0.955
F	0.945	1.061
G	1.051	1.181
H	1.169	1.311
I	1.297	1.456
J	1.442	1.618

SIEMENS NEW

IL352

PHOTOTRANSISTOR OPTOCOUPLER

Preliminary Data Sheet

FEATURES

- **Good CTR Linearity Depending on Forward Current**
- **Isolation Test Voltage, 2500 V_{RMS}**
- **High Collector-Emitter Voltage, V_{CEO}=30 V**
- **Low Saturation Voltage**
- **Fast Switching Times**
- **Field-Effect Stable by TRIOS***

DESCRIPTION

The IL352 is an optically coupled isolator that features a high current transfer ratio, low coupling capacitance and high isolation voltage. It has a GaAs infrared emitting diode emitter, which is optically coupled to a silicon planar phototransistor detector. The component is housed in a thin line package.

The coupling device is designed for signal transmission between two electrically separated circuits. The potential difference between the circuits to be coupled must not exceed the maximum permissible reference voltages.

Maximum Ratings

Emitter

Reverse Voltage .... 6 V
DC Forward Current .... 60 mA
Total Power Dissipation .... 50 mW
Derate Linearly from 25°C .... 0.66 mW/°C

Detector

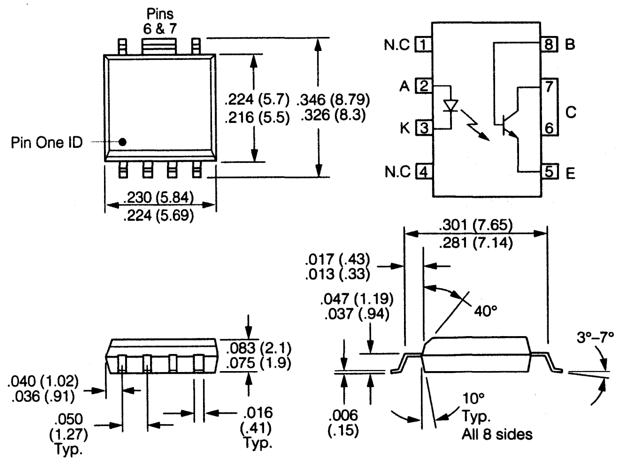
Collector-Emitter Voltage .... 70 V
Emitter-Base Voltage .... 7 V
Collector Current .... 50 mA
Collector Current (t ≤1 ms) .... 100 mA
Total Power Dissipation........................... 150 mW
Derate Linearly from 25°C .... 2.5 mW/°C

Package

Isolation Test Voltage (between emitter and detector referred to climate DIN 40046, part 2, Nov. 74) .... 2500 V_{RMS}
Isolation Resistance
V_{IO}=500 V, T_A=25°C.............................≥10^{12} Ω
V_{IO}=500 V, T_A=100°C...........................≥10^{11} Ω
Storage Temperature Range ..... –40°C to +150°C
Ambient Temperature Range....... –40°C to +85°C
Junction Temperature ....100°C
Soldering Temperature (max 10 s, Dip Soldering Distance to Seating Plane ≥1.5 mm).......................260°C

***TR**ansparent **IO**n **S**hield

Package Dimensions in Inches



Characteristics (T_A=25°C)

Emitter	Sym	Min.	Typ.	Max.	Units	Condition
Forward Voltage	V_F		1.3	1.5	V	I_F=10 mA
Reverse Current	I_R		0.1	10	µA	V_R=6.0 V
Capacitance	C_O		25		pF	V_R=0 f=1 MHz
Detector						
Breakdown Voltage Collector-Emitter Emitter-Collector	BV_{CEO} BV_{ECO}	30 7			V	I_C=1 mA I_E=100 µA
Collector-Emitter Leakage	I_{CEO}		5	50	nA	V_{CE}=10 V I_F=0 T_A=25°C
				500	µA	V_{CE}=30 V I_F=0 T_A=85°C
Collector to Base	BV_{CBO}	70			V	I_C=100 µA
Capacitance Collector-Emitter	C_{CE}		6		pF	V_{CE}=0

Characteristics (T_A=25°C) — continued

Package	Sym	Min.	Typ.	Max.	Units	Condition
DC Current Transfer Ratio	CTR	100			%	I_F=1 mA V_{CE}=10 V T_A=25°C
DC Current Transfer Ratio	CTR	40			%	I_F=10 mA V_{CE}=10 V T_A=–55° to 100°C
Saturation Voltage Collector-Emitter	V_{CEsat}			0.3	V	I_F=10 mA, I_C=0.5 mA
Coupling Capacitance	C_{IO}		0.5		pF	f=1.0 MHz
Switching Time, Non-Saturated	T_{on}, T_{off}		10		µs	I_C=2 mA R_E=100 Ω V_{CC}=10 V RH≤50%

Figure 1. Switching waveform

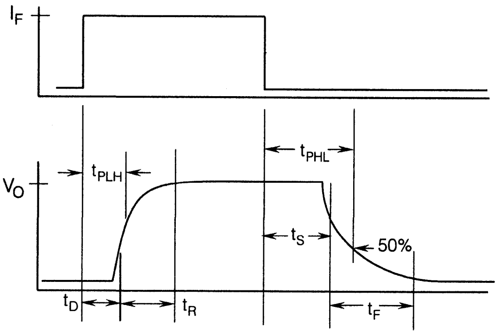


Figure 2. Switching schematic

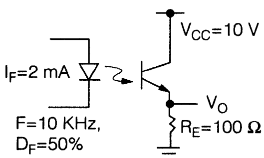


Figure 3. Forward voltage versus forward current

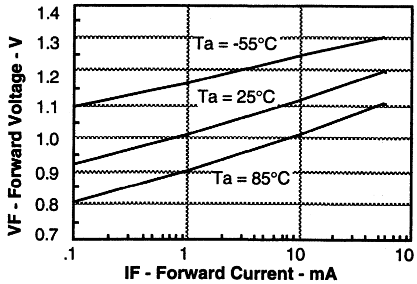


Figure 4. Normalized non-saturated and saturated CTR at T_A=25°C versus LED current

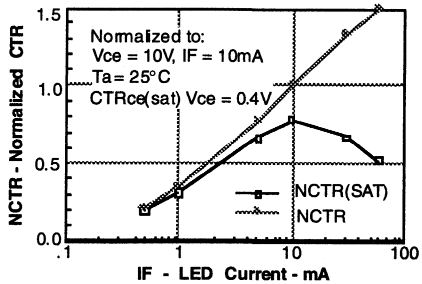


Figure 5. Normalized non-saturated and saturated CTR at T_A=50°C versus LED current

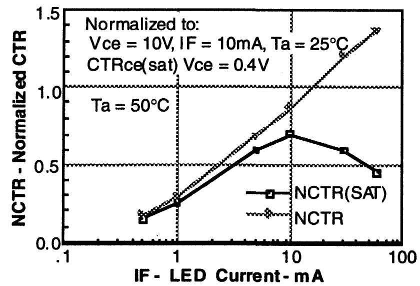


Figure 6. Normalized non-saturated and saturated CTR at T_A=70°C versus LED current

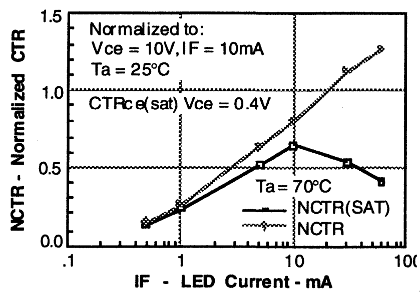


Figure 7. Normalized non-saturated and saturated CTR at T_A=85°C versus LED current

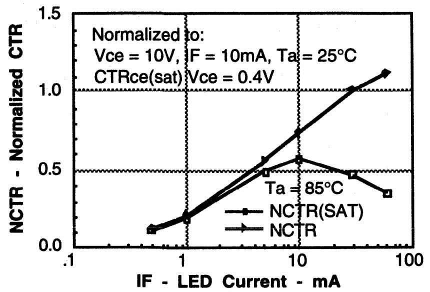


Figure 8. Collector-emitter current versus temperature and LED current

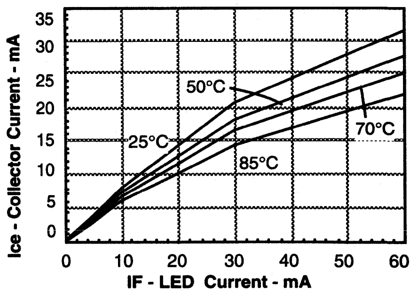


Figure 9. Collector-emitter leakage current versus temperature

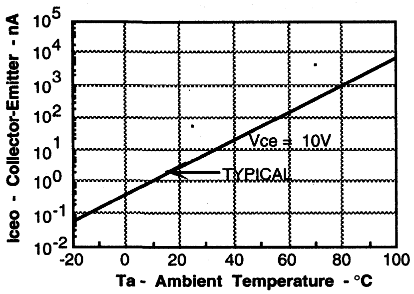


Figure 10. Normalized CTRcb versus LED current and temperature

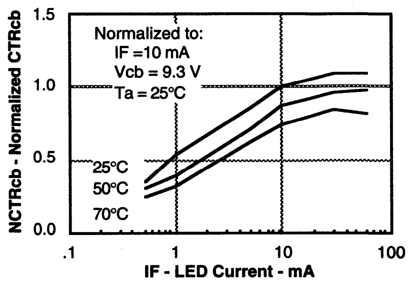


Figure 11 Collector base photocurrent versus LED current

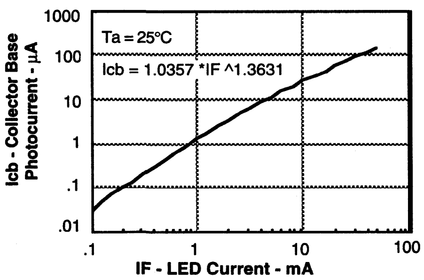


Figure 12. Normalized photocurrent versus I_F and temperature

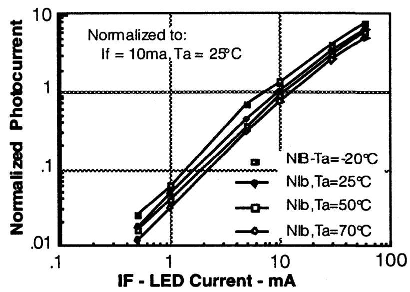
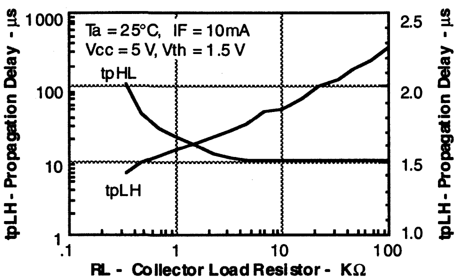


Figure 13. Propagation delay versus collector load resistor



SIEMENS

NEW

IL356

HIGH VOLTAGE SOLID STATE RELAY OPTOCOUPLER

Preliminary Data Sheet

FEATURES

- **Normally Open, Single Pole Single Throw Operation**
- **Control 400 VAC or DC Voltage**
- **Switch 100 mA Loads**
- **Low ON-Resistance**
- **dv/dt, > 500 V/ms**
- **Input and Output Isolation Voltage, 2500 V_{RMS}**
- **Current Limiting**
- **Low Profile—Thickness=0.080 Inches**
- **Applications**
  - **- Telephone Switch Hook**
  - **- Industrial Control Systems**
  - **- PCMCIA Card**

DESCRIPTION

The IL356 is a single pole single throw (SPST), normally open (NO), solid state relay. The relay can control AC or DC loads currents up to 100 mA, with a supply voltage up to 400 V. The device is packaged in a eight pin 2 mm surface mount package. This package offers an insulation dielectric withstand of 2500 V_{RMS}.

The coupler consists of an AlGaAs LED that is optically coupled to a dielectrically isolated photodiode array which drives two series connected high voltage MOS transistors. The typical ON-Resistance is 25 Ω at 25 mA lead current and is linear up to 50 mA. The incremental resistance drops to less than 20 Ω beyond 50 mA while reducing internal power dissipation at high load currents. There is built-in current limiting circuitry in the detector chip.

Absolute Maximum Ratings (T_A=25°C)

Emitter

Reverse Voltage..5.0 V
Continuous Forward Current..............................60 mA
Peak Forward Current, Non-repetitive (1 µs)..... 0.25 A
Power Dissipation...50 mW
Derate Linearly from 25°C .... .66 mW/°C

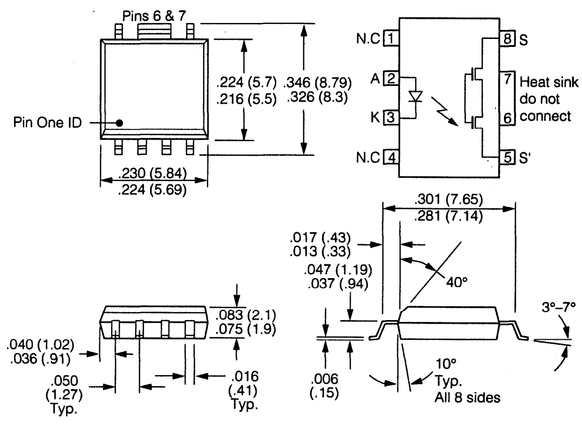
Detector

Output Breakdown Voltage..............................±400 V
Continous Load Current ....±100 mA
Power Dissipation...300 mW
Derate Linearly from 25°C ....5.8 mW/°C

Package

Input and Output Isolation Voltage.............2500 V_{RMS}
Total Power Dissipation...................................350 mW
Derate Linearly from 25°C ....5.3 mW/°C
Isolation Resistance
  V_{IO}=500 V, TA=25°C ....≥10^{12} Ω
  V_{IO}=500 V, TA=100°C ....≥10^{11} Ω
Storage Temperature Range ....–40 to +150°C
Operating Temperature Range................–40 to +85°C
Junction Temperature ....100°C
Soldering Temperature
  2 mm from case, 10 sec. ....260°C

Package Dimensions in Inches (mm)



Electrical Specifications at 25°C unless otherwise specified

Input (Emitter)	Symbol	Min.	Typ.	Max.	Units	Condition
Forward Voltage	V_F	1.15	1.26	1.45	V	I_F=10 mA
Reverse Voltage	V_R	5			V	I_R=10 µA
Capacitance	C_{LED}		25		pF	V_R=0 f=1 MHz
Output (S-S')						
Output Off-state Leakage Current	I_{LKG}		0.04	200	nA	I_F=0 mA V_L=±100 V
				1.0	µA	I_F=0 mA V_L=±400 V
OFF Resistance	R_{OFF}		5000		GΩ	
ON-Resistance	R_{ON}	17	25	33	Ω	I_F=1.5 mA I_L=±25 mA
Current Limit	I_{LMT}	170	210	270	mA	I_F=1.5 mA t=5 ms
Output Capacitance	C_O		37		pF	I_F=0 mA V_L=1 V
			13		pF	I_F=0 mA V_L=50 V
Switch Offset			0.25		µV	I_F=5 mA
Transfer Characteristics						
LED Forward Current, Switch Turn-on	I_{Fon}		0.12	0.3	mA	I_L=100 mA t=10 ms
LED Forward Current, Switch Turn-off	I_{Foff}	0.001	0.1		mA	V_L=±350 V t=100 ms

Electrical Specifications continued on next page.

Electrical Specifications (continued)

Transfer Characteristics (continued)	Sym-bol	Min.	Typ.	Max.	Units	Condition
Input/Output Capacitance	C_{ISO}		0.8		pF	V_{ISO}=1 V
Turn-on Time	t_{on}		1.00		ms	I_F=1.5 mA I_L=50 mA
			0.3	1	ms	I_F=5.0 mA I_L=50 mA
Turn-off Time	t_{off}		0.20		ms	I_F=1.5 mA I_L=50 mA
			0.25	0.5	ms	I_F=5.0 mA I_L=50 mA

Figure. 1 Timing test circuit

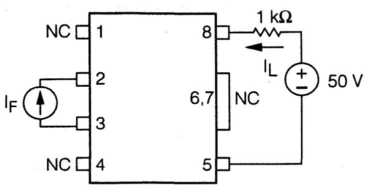


Figure. 2 Timing waveform

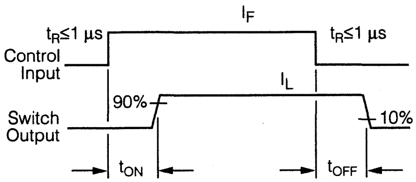


Figure 3. LED forward current vs. forward voltage

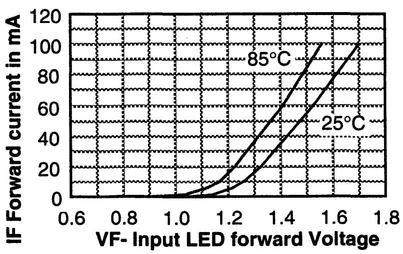


Figure 4. Recommended operating conditions

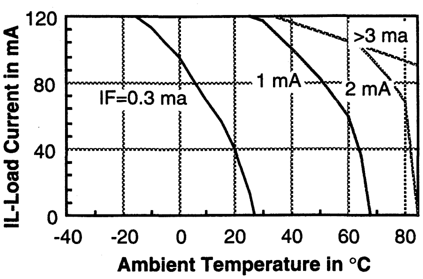


Figure 5. Change in current limit vs. temperature

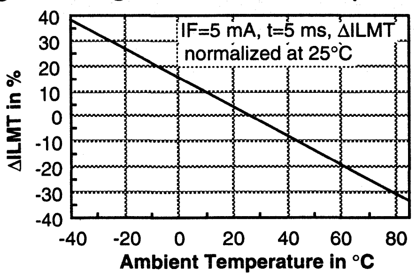


Figure 6. Min. LED current, switch turn-ON vs. temp.

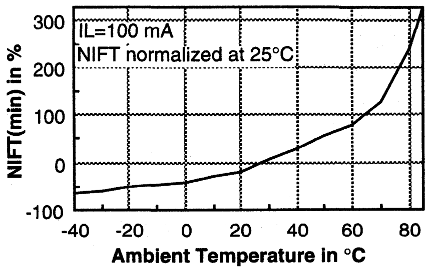


Figure 7. Change in ON resistance vs. temperature

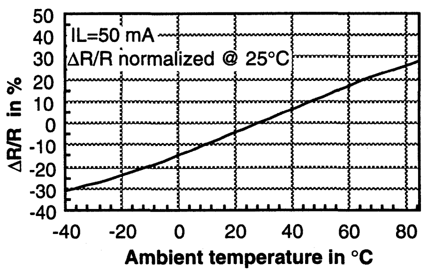
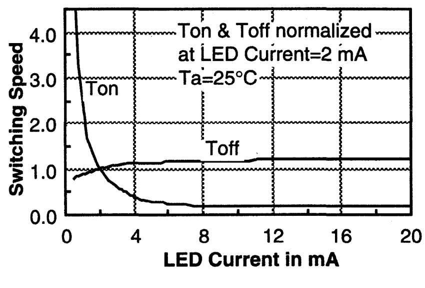


Figure 8. Switching speed vs. LED current



SIEMENS

IL400

PHOTO SCR OPTOCOUPLER

FEATURES
- **Turn On Current (I_{FT}), 5.0 mA Typical**
- **Gate Trigger Current (I_{GT}), 20 µA**
- **Surge Anode Current, 1.0 Amp**
- **Blocking Voltage, 400 V**
- **Gate Trigger Voltage (V_{GT}), 0.6 Volt**
- **Isolation Voltage, 5300 VAC_{RMS}**
- **Solid State Reliability**
- **Standard DIP Package**
- **Underwriters Lab File #E52744**

DESCRIPTION
The IL400 is an optically coupled SCR with a Gallium Arsenide infrared emitter and a silicon photo SCR sensor. Switching can be achieved while maintaining a high degree of isolation between triggering and load circuits. The IL400 can be used in SCR triac and solid state relay applications where high blocking voltages and low input current sensitivity are required.

Maximum Ratings
Emitter

Peak Reverse Voltage .... 6.0 V
Peak Forward Current
(100 µs, 1% Duty Cycle) .... 1.0 A
Continuous Forward Current....................... 60 mA
Power Dissipation at 25°C .... 100 mW
Derate Linearly from 25°C .... 1.3 mW/°C

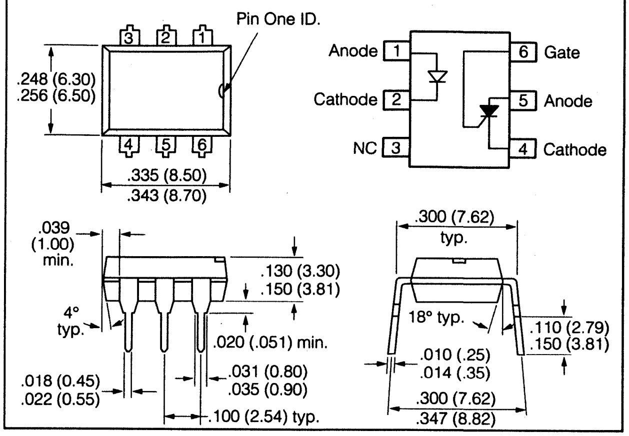
Detector

Reverse Gate Voltage.................................. 6.0 V
Anode Voltage (DC or AC Peak) .... 400 V
Anode Current .... 100 mA
Surge Anode Current (10 ms duration) .... 1.0 A
Surge Gate Current (5 ms duration) .... 200 mA
Power Dissipation, 25°C ambient .... 200 mW
Derate Linearly from 25°C .... 2.11 mW/°C

Package

Isolation Voltage .... 5300 VAC_{RMS}
Isolation Resistance
V_{IO}=500 V, T_A=25°C ....min. 10^{12} Ω
V_{IO}=500 V, T_A=100°C ....min. 10^{11} Ω
Total Package Dissipation .... 250 mW
Derate Linearly from 25°C .... 2.63 mW/°C
Operating Temperature .... –55°C to +100°C
Storage Temperature .... –55°C to +150°C

Package Dimensions in Inches (mm)



Characteristics (T_A=25°C)

	Sym	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.2	1.5	V	I_F=20 mA
Reverse Voltage	V_R	5.0			V	I_R=10 µA
Reverse Current	I_R			10	µA	V_R=5 V
Detector						
Forward Blocking Voltage	V_{DRM}	400			V	R_{GK}=10 KΩ T_A=100°C I_d=150 µA
Reverse Blocking Voltage	V_{DRRM}	400			V	R_{GK}=10 KΩ T_A=100°C I_d=150 µA
On-state Voltage	V_t			1.2	V	I_T=100 mA
Holding Current	I_H			500	µA	R_{GK}=27 KΩ V_{FX}=50 V
Gate Trigger Voltage	V_{GT}		0.6	1.0	V	V_{FX}=100 V R_{GK}=27 KΩ R_L=10 KΩ
Forward Leakage Current	I_D		0.2	2.0	µA	R_{GK}=27 KΩ V_{RX}=400 V I_F=0, T_A=25°C
Reverse Leakage Current	I_R		0.2	2.0	µA	R_{GK}=27 KΩ V_{RX}=400 V I_F=0, T_A=25°C
Gate Trigger Current	I_{GT}		20	50	µA	V_{FX}=100 V R_{GK}=27 KΩ, R_L=10 KΩ
Package						
Turn-On Current	I_{FT}	0.5	5.0	10.0	mA	V_{FX}=100 V R_{GK}=27 KΩ
Isolation Capacitance				2	pF	f=1 MHz

SIEMENS

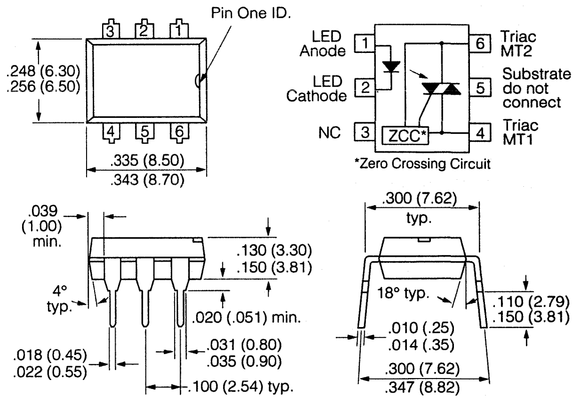
IL410

ZERO VOLTAGE CROSSING 600 V TRIAC DRIVER OPTOCOUPLER

FEATURES

- **On-State Current, 300 mA**
- **Zero Voltage Crossing**
- **Blocking Voltage, 600 V**
- **Isolation Test Voltage from Double Molded Package, 5300 VAC_{RMS}**
- **High Input Sensitivity**
  I_{FT}=2 mA, PF=1.0
  I_{FT}=5 mA, PF≤1.0
- **High Static dv/dt 10,000 V/µs**
- **Inverse Parallel SCRs Provide Commutating dv/dt >10K V/µs**
- **Very Low Leakage <10 µA**
- **Small 6-Pin DIP Package**
- **Underwriters Lab File #E52744**
- **VDE Approval #0884 (Optional with Option 1, Add -X001 Suffix)**

Package Dimensions in Inches (mm)



Maximum Ratings

Emitter

Reverse Voltage	6 V
Forward Current	60 mA
Surge Current	2.5 A
Thermal Resistance	750 °C/W
Power Dissipation	100 mW
Derate from 25°C	1.33 mW/°C

Detector

Peak Off-State Voltage	600 V
Peak Reverse Voltage	600 V
RMS On-State Current	300 mA
Single Cycle Surge	3 A
Thermal Resistance	125°C/W
Total Power Dissipation	500 mW
Derate from 25°C	6.6 mW/°C

Package

Isolation Test Voltage	5300 VAC_{RMS}
Storage Temperature	–55°C to +150°C
Operating Temperature	–55°C to +100°C
Lead Soldering Temperature	260°C/5 sec.

DESCRIPTION

The IL410 consists of a GaAs IRLED optically coupled to a photosensitive zero crossing TRIAC network. The TRIAC consists of two inverse parallel connected monolithic SCRs. These three semiconductors are assembled in a six pin 0.3 inch dual in-line package, using high insulation double molded, over/under leadframe construction.

High input sensitivity is achieved by using an emitter follower phototransistor and a cascaded SCR predriver resulting in an LED trigger current of less than 2 mA (DC).

The IL410 uses two discrete SCRs resulting in a commutating dV/dt greater than 10KV/µs. The use of a proprietary dv/dt clamp results in a static dV/dt of greater than 10KV/µs. This clamp circuit has a MOSFET that is enhanced when high dV/dt spikes occur between MT1 and MT2 of the TRIAC. When conducting, the FET clamps the base of the phototransistor, disabling the first stage SCR predriver.

The zero cross line voltage detection circuit consists of two enhancement MOSFETS and a photodiode. The inhibit voltage of the network is determined by the enhancement voltage of the N-channel FET. The P-channel FET is enabled by a photocurrent source that permits the FET to conduct the main voltage to gate on the N-channel FET. Once the main voltage can enable the N-channel, it clamps the base of the phototransistor, disabling the first stage SCR predriver.

The 600V blocking voltage permits control of off-line voltages up to 240VAC, with a safety factor of more than two, and is sufficient for as much as 380VAC.

The IL410 isolates low-voltage logic from 120, 240, and 380 VAC lines to control resistive, inductive, or capacitive loads including motors, solenoids, high current thyristors or TRIAC and relays.

Applications include solid-state relays, industrial controls, office equipment, and consumer appliances.

Characteristics

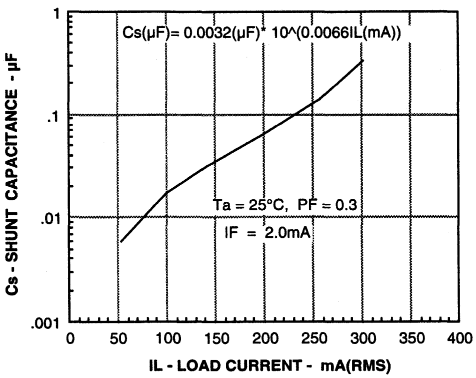
	Symbol	Min.	Typ.	Max	Unit	Condition
Emitter						
Forward Voltage	V_F		1.16	1.35	V	I_F=10 mA
Reverse Current	I_R		0.1	10	µA	V_R=6 V
Capacitance	C_O		25		pF	V_F=0 V, f=1 MHz
Thermal Resistance Junction to Lead	R_{THJL}		750		°C/W	
Output Detector						
Off-State Voltage	$V_{D(RMS)}$	424	460		V	$I_{D(RMS)}$=70 µA
Off-State Current	$I_{D(RMS)1}$		10	100	µA	V_D=600 V, T_A100°C, I_F=0mA
Off-State Current	$I_{D(RMS)2}$			200	µA	V_D=600 V, I_F= Rated I_{FT}
On-State Voltage	V_{TM}		1.7	3	V	I_T=300 mA
On-State Current	I_{TM}			300	mA	PF=1.0, $V_{T(RMS)}$=1.7 V
Surge (Non-Repetitive) On-State Current	I_{TSM}			3	A	f=50 Hz
Trigger Current 1	I_{FT1}			2.0	mA	V_D=5 V
Trigger Current 2	I_{FT2}			6.0	mA	V_{op}=220 V, f=50 Hz, T_j=100°C, t_{pF}>10 ms
Trigger Current Temp. Gradient	$\Delta I_{FT1}/\Delta T_j$		7	14	µA/K	
	$\Delta I_{FT2}/\Delta T_j$		7	14	µA/K	
Inhibit Voltage Temp. Gradient	$\Delta V_{DINH}/\Delta T_j$		–20		mV/K	
Off-state Current in Inhibit State	I_{DINH}		50	200	µA	I_F=I_{FT1}, V_{DRM}
Capacitance Between Input and Output Circuit	C_{IO}		2.0		pF	V_D=0, f=1 kHz
Holding Current	I_H		65	500	µA	
Latching Current	I_L		5		mA	V_T=2.2 V
Zero Cross Inhibit Voltage	V_{IH}		15	25	V	I_F=Rated I_{FT}
Turn-On Time	t_{ON}		35		µs	V_{RM}=V_{DM}=424 VAC
Turn-Off Time	t_{OFF}		50		µs	PF=1.0, I_T=300 mA
Critical Rate of Rise of Off-State Voltage	dv/dt_{cr}	10000			V/µs	V_D=0.67 V_{DRM}, T_j=25°C
	dv/dt_{cr}	5000			V/µs	T_j=80°C
Critical Rate of Rise of Voltage at Current Commutaton						V_D=0.67 V_{DRM}, di/dt_{crq} ≤ 15 A/ms
	dv/dt_{crq}	10000			V/µs	T_j=25°C
	dv/dt_{crq}	5000			V/µs	T_j=80°C
Critical Rate of Rise of On-State Current	di/dt_{cr}			8	A/µs	
Thermal Resistance Junction to Lead	R_{THJL}		150		°C/W	
Insulation and Isolation						
Critical Rate of Rise of Coupled Input/Output Voltage	$dv_{(IO)}/dt$		10000		V/µs	I_T=0 A, V_{RM}=V_{DM}=424 VAC
Common Mode Coupling Capacitor	C_{CM}		0.01		pF	
Package Capacitance	C_{IO}		0.8		pF	f=1 MHz, V_{IO}=0 V
Isolation Test Voltage Input-Output	V_{ISO}	5300			VAC_{RMS}	Relative Humidity ≤50%
Creepage		≥7			mm	
Clearance		≥7			mm	
Creepage Tracking Resistance per DIN IEC 112/VDE 0303, Part 1 Group IIIa per DIN VDE 0110	CTI		175			
Isolation Resistance	R_{is}		≥10^{12}		Ω	V_{IO}=500 V T_A=25 °C
	R_{is}		≥10^{11}		Ω	T_A +100 °C

Power Factor Considerations

A snubber isn't needed to eliminate false operation of the TRIAC driver because of the IL410's high static and commutating dv/dt with loads between 1 and 0.8 power factors. When inductive loads with power factors less than 0.8 are being driven, include a RC snubber or a single capacitor directly across the device to damp the peak commutating dv/dt spike. Normally a commutating dv/dt causes a turning-off device to stay on due to the stored energy remaining in the turning-off device.

But in the case of a zero voltage crossing optotriac, the commutating dv/dt spikes can inhibit one half of the TRIAC from turning on. If the spike potential exceeds the inhibit voltage of the zero cross detection circuit, half of the TRIAC will be held-off and not turn-on. This hold-off condition can be eliminated by using a snubber or capacitor placed directly across the optotriac as shown in Figure 1. Note that the value of the capacitor increases as a function of the load current.

Figure 1. Shunt capacitance versus load current



The hold-off condition also can be eliminated by providing a higher level of LED drive current. The higher LED drive provides a larger photocurrent which causes the phototransistor to turn-on before the commutating spike has activated the zero cross network. Figure 2 shows the relationship of the LED drive for power factors of less than 1.0. The curve shows that if a device requires 1.5 mA for a resistive load, then 1.8 times (2.7 mA) that amount would be required to control an inductive load whose power factor is less than 0.3.

Figure 2. Normalized LED trigger current versus power factor

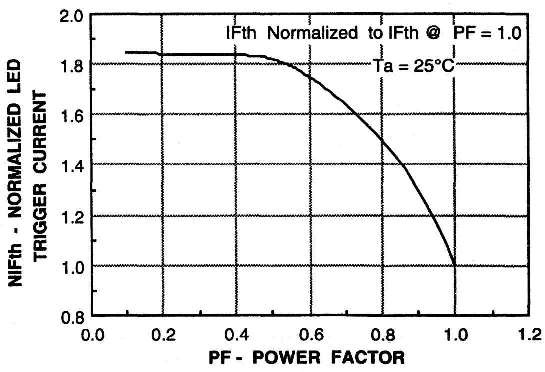


Figure 3. Forward voltage versus forward current

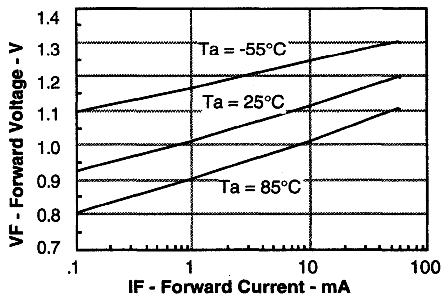


Figure 4. Peak LED current versus duty factor, Tau

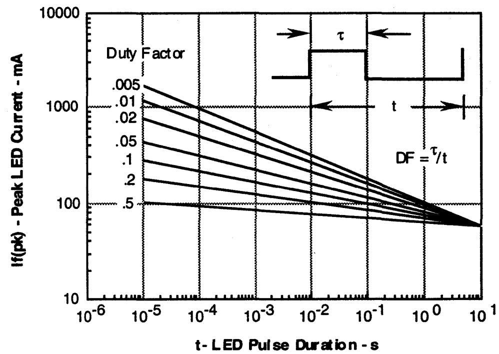


Figure 5. Maximum LED power dissipation

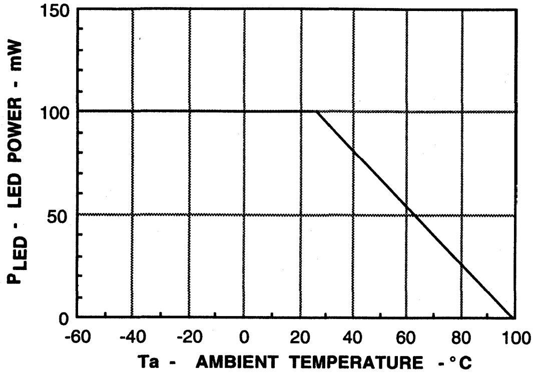


Figure 6. Typical output characteristics
$I_T = f(V_T)$, parameter: T_j

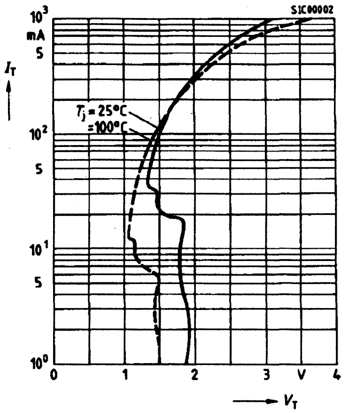


Figure 7. Current reduction
$I_{TRMS}=f(T_A)$, $R_{thJA}=125$ K/W
Device switch soldered in pcb or base plate.

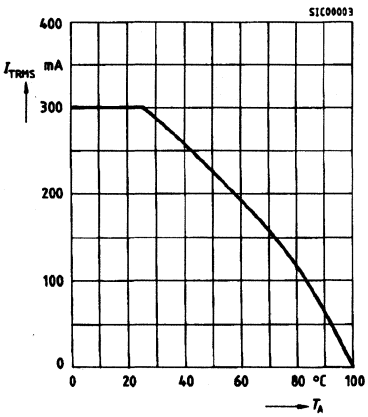


Figure 8. Current reduction
$I_{TRMS}=f(T_{PIN5})$, $R_{thJ-PIN5}=16.5$ K/W
Thermocouple measurement must be performed potentially separated to A1 and A2. Measuring junction as near as possible at the case.

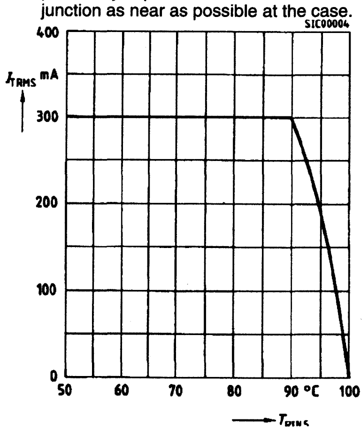


Figure 9. Typical trigger delay time
t_{gd}=f ($I_F I_{FT25°C}$), V_D=200 V, f=40 to 60 Hz, parameter: T_j

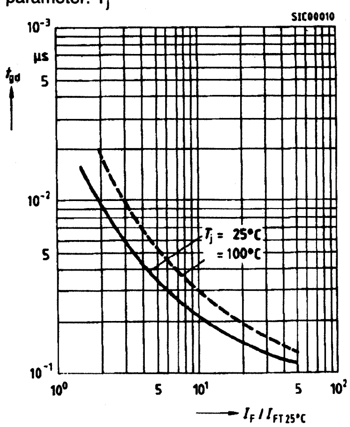


Figure 10. Typical inhibit current
I_{DINH} =f(I_F/$I_{FT25°C}$)
V_D=600 V, parameter: T_j

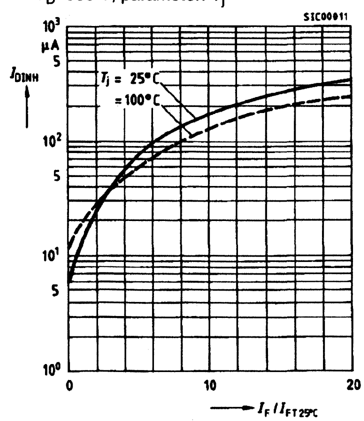


Figure 11. Power dissipation
40 to 60 Hz line operation, P_{TOT}=f(I_{TRMS})

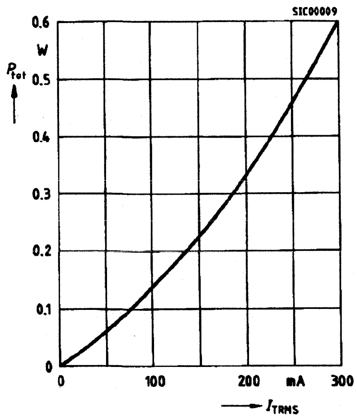
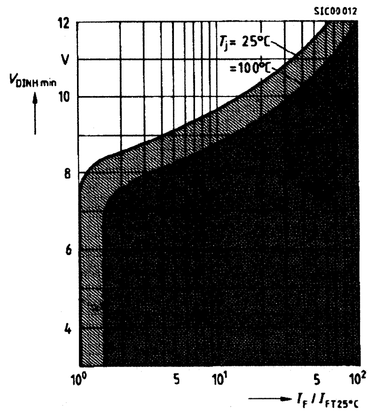
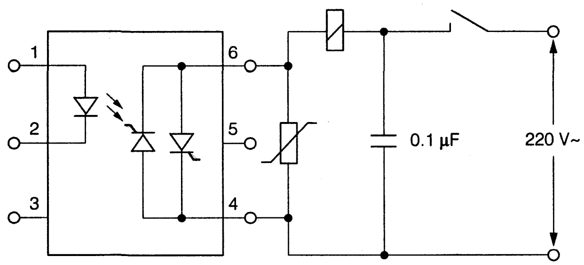


Figure 12. Typical static inhibit voltage limit
$V_{DINHmin}$= f(I_F/$I_{FT25°C}$), parameter: T_j
Device zero voltage switch can be triggered only in hatched area below T_j curves.

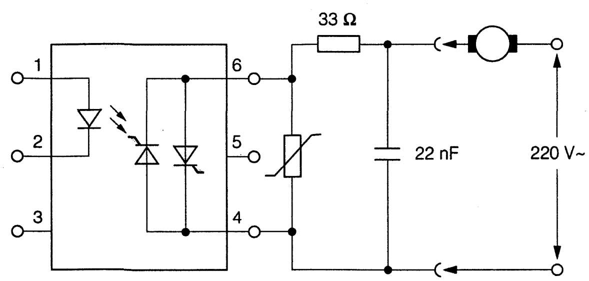


Current commutation:
The values 100 A/ms with following peak reverse recovery current > 80 mA should not be exceeded.

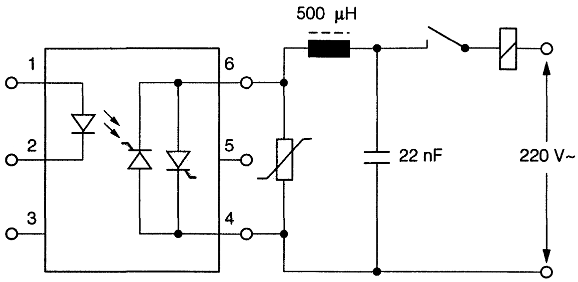
Avoiding high-frequency turn-off current oscillations:
This effect can occur when switching a circuit. Current oscillations which appear essentially with inductive loads of a higher winding capacity result in current commutation and can generate a relatively high peak reverse recovery current. The following alternating protective measures are recommended for the individual operating states:



1. Apply a capacitor to the supply pins at the load-side.



2. Connect a series resistor to the IL410 output and bridge both by a capacitor.



3. Connect a choke of low winding capacity in series e.g., a ringcore choke, with higher load currents.

Note:
Measures 2 to 3 are especially required for the load separated from the IL410 during operation. The above mentioned effects do not occur with IL410 circuits which are connected to the line by transformers and which are not mechanically interrupted.
In such cases as well as in applications with a resistive load the corresponding protective circuits can be neglected.

Technical Information

Commutating Behavior

The use of a triac at the output creates difficulties in commutation due to both the built-in coupled thyristor systems. The triac can remain conducting by parasitic triggering after turning off the control current. However, if the IL410 is equipped with two separate thyristor chips featuring high dv/dt strength, no *RC* circuit is needed in case of commutation.

Control And Turn-On Behavior

The trigger current of the IL410 has a positive temperature gradient. The time which expires from applying the control current to the turn-on of the load current is defined as the trigger delay time (tgd). On the whole this is a function of the overdrive meaning the ratio of the applied control current versus the trigger current (I_F/I_{FT}). If the value of the control current corresponds to that of the individual trigger current of IL410 turn-on delay times amounts to a few milliseconds only. The shortest times of 5 to 10 µs can be achieved for an overdrive greater or equal than 10. The trigger delay time rises with an increase in temperature.

For very short control current pulses ($t_{pIF} < 500$ µs) a correspondingly higher control current must be used. Only the IL410 without zero voltage switch is suitable for this operating mode.

Zero Voltage Switch

The IL410 with zero voltage switch can only be triggered during the zero crossing the sine AC voltage. This prevents current spikes, e. g. when turning-on cold lamps or capacitive loads.

Applications

Direct switching operation: The IL410 switch is mainly suited to control synchronous motors, valves, relays and solenoids in Grätz circuits. Due to the low latching current (500 µA) and the lack of an *RC* circuit at the output, very low load currents can easily be switched.

Indirect switching operation: The IL410 switch acts here as a driver and thus enables the driving of thyristors and triacs of higher performance by microprocessors. The driving current pulse should not exceed the maximum permissible surge current of the IL410. For this reason, the IL410 without zero voltage switch often requires current limiting by a series resistor.

The favorably low latching current in this operating mode results in AC current switches which can handle load currents from some milliamperes up to high currents.

Application Notes

- Over voltage protection: A voltage-limiting varistor (e.g. SIO VS05K250) which directly connected to the IL410 output can protect the component against overvoltage.

SIEMENS

IL420

600 V TRIAC DRIVER OPTOCOUPLER

FEATURES

- **High Input Sensitivity I_{FT}=2 mA**
- **Blocking Voltage, 600 V**
- **300 mA On-State Current**
- **High Static dv/dt 10,000 V/µs**
- **Inverse Parallel SCRs Provide Commutating dv/dt >2K V/µs**
- **Very Low Leakage <10 µA**
- **Isolation Test Voltage from Double Molded Package 5300 VAC_{RMS}**
- **Small 6-Pin DIP Package**
- **Underwriters Lab File #E52744**
- **VDE 0884 Available with Option 1**

Maximum Ratings

Emitter

Reverse Voltage .... 6 V
Forward Current .... 60 mA
Surge Current .... 2.5 A
Power Dissipation .... 100 mW
Derate from 25°C .... 1.33 mW/°C
Thermal Resistance .... 750 °C/W

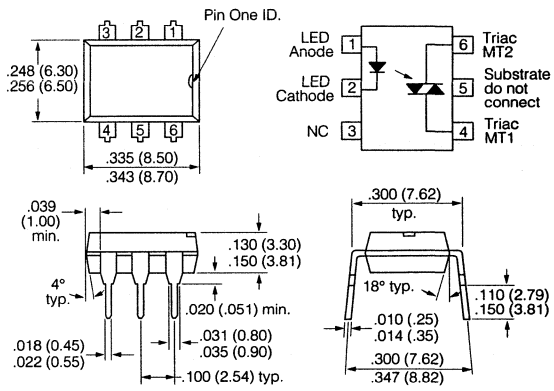
Detector

Peak Off-State Voltage .... 600 V
Peak Reverse Voltage .... 600 V
RMS On-State Current .... 300 mA
Single Cycle Surge .... 3 A
Total Power Dissipation .... 500 mW
Derate from 25°C .... 6.6 mW/°C
Thermal Resistance .... 150°C/W

Package

Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Lead Soldering Temperature .... 260°C/5 sec.
Isolation Test Voltage .... 5300 VAC_{RMS}

Package Dimensions in Inches (mm)



DESCRIPTION

The IL420 consists of a GaAs IRLED optically coupled to a photosensitive non-zero crossing TRIAC network. The TRIAC consists of two inverse parallel connected monolithic SCRs. These three semiconductors are assembled in a six pin 0.3 inch dual in-line package, using high insulation double molded, over/under leadframe construction.

High input sensitivity is achieved by using an emitter follower phototransistor and a cascaded SCR predriver resulting in an LED trigger current of less than 2 mA (DC).

The IL420 uses two discrete SCRs resulting in a commutating dV/dt of greater than 10KV/ms. The use of a proprietary *dv/dt clamp* results in a static dV/dt of greater than 10KV/ms. This clamp circuit has a MOSFET that is enhanced when high dV/dt spikes occur between MT1 and MT2 of the TRIAC. When conducting, the FET clamps the base of the phototransistor, disabling the first stage SCR predriver.

The 600 V blocking voltage permits control of off-line voltages up to 240 VAC, with a safety factor of more than two, and is sufficient for as much as 380 VAC.

The IL420 isolates low-voltage logic from 120, 240, and 380 VAC lines to control resistive, inductive, or capacitive loads including motors, solenoids, high current thyristors or TRIAC and relays.

Applications include solid-state relays, industrial controls, office equipment, and consumer appliances.

Characteristics

	Symbol	Min.	Typ.	Max	Unit	Condition
Emitter						
Forward Voltage	V_F		1.16	1.35	V	I_F=10 mA
Reverse Current	I_R		0.1	10	μA	V_R=6 V
Capacitance	C_0		40		pF	V_F=0 V, f=1 MHz
Thermal Resistance Junction to Lead	R_{THJL}		750		°C/W	
Output Detector						
Off-State Voltage	$V_{D(RMS)}$	424	460		V	$I_{D(RMS)}$=70 μA
Reverse Voltage	V_R	424	460		V	$I_{R(RMS)}$=70 μA
Off-State Current	$I_{D(RMS)}$		10	100	μA	V_D=600 V, T_A=100°C
Reverse Current	$I_{R(RMS)}$		10	100	μA	V_R=600 V, T_A=100°C
On-State Voltage	V_{TM}		1.7	3	V	I_T =300 mA
On-State Current	I_{TM}			300	mA	PF=1.0, $V_{T(RMS)}$=1.7 V
Surge (Non-Repetitive) On-State Current	I_{TSM}			3	A	f=50 Hz
Holding Current	I_H		65	500	μA	
Latching Current	I_L		5		mA	V_T=2.2 V
LED Trigger Current	I_{FT}		1	2	mA	V_{AK}=5 V
Turn-On Time	t_{ON}		35		μs	V_{RM}=V_{DM}= 424 VAC
Turn-Off Time	t_{OFF}		50		μs	PF=1.0, I_T= 300 mA
Critical Rate of Rise of Off-State Voltage						V_D=0.67 V_{DRM}
	dv/dt_{cr}	10000			V/μs	T_j = 25°C
	dv/dt_{cr}	5000			V/μs	T_j=80°C
Critical Rate of Rise of Voltage at Current Commutation						V_D=0.67 V_{DRM}, di/dt_{crq}≤15 A/ms
	dv/dt_{crq}	10000			V/μs	T_j = 25°C
	dv/dt_{crq}	5000			V/μs	T_j=80°C
Critical Rate of Rise of On-StateCurrent	di/dt_{cr}			8	A/μs	
Thermal Resistance Junction to Lead	R_{THJL}		150		°C/W	
Insulation and Isolation						
Critical Rate of Rise of Coupled Input/Output Voltage	$dv_{(IO)}/dt$		5000		V/μs	I_T=0 A, V_{RM}=V_{DM}=424 VAC
Common Mode Coupling Capacitor	C_{CM}		0.01		pF	
Package Capacitance	C_{IO}		0.8		pF	f =1 MHz, V_{IO}= 0 V
Isolation Test Voltage Input-Output	V_{ISO}	5300			VAC_{RMS}	Relative Humidity ≤50%
Creepage		≥7			mm	
Clearance		≥7			mm	
Creepage Tracking Resistance per DIN IEC 112/VDE 0303, Part 1 group IIIa per DIN VDE 0110		CTI		175		
Isolation Resistance						V_{IO}=500
	R_{is}		≥10^{12}		Ω	T_A=25°C
	R_{is}		≥10^{11}		Ω	T_A=100°C
Trigger Current Temperature Gradient	$\Delta I_{FT}/\Delta T_j$		7	14	μA/K	
Capacitance Between Input and Output Circuit	C_{IO}			2	pF	V_R=0, f=1 kHz

Figure 1. Forward voltage versus forward current

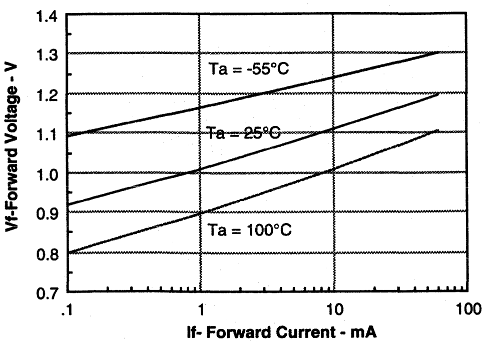


Figure 2. Peak LED current versus duty factor, Tau

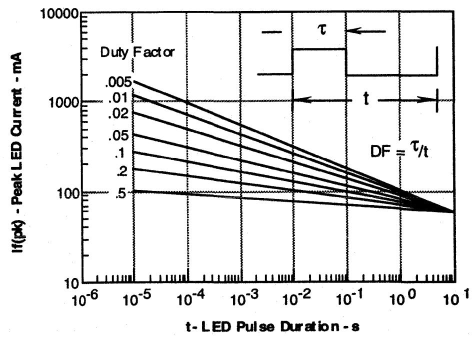


Figure 3. Maximum LED power dissipation

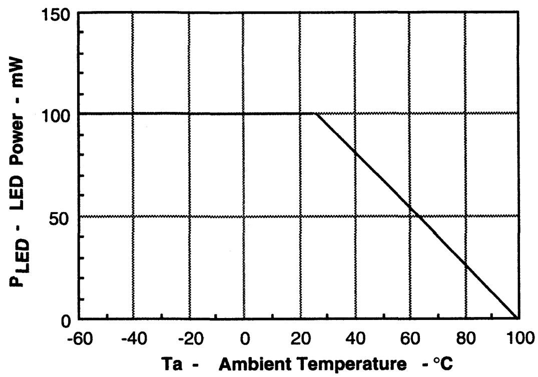


Figure 4. Typical output characteristics
I_T=f(V_t), parameter: T_j

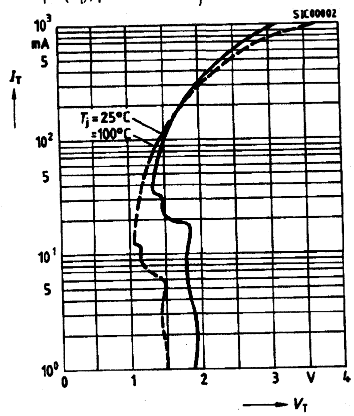


Figure 5. Current reduction I_{TRMS}=f(T_A)
R_{thJA}=125 K/W
Device switch is soldered in PCB or base plate

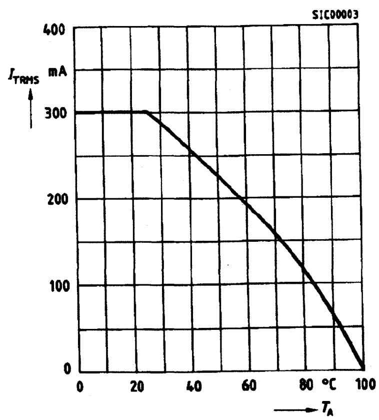
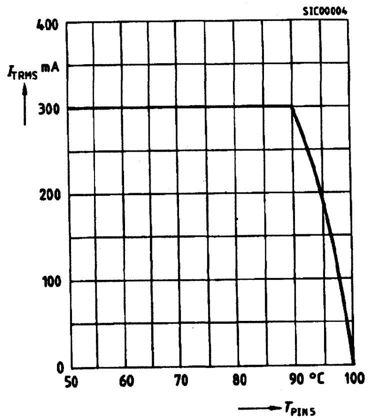


Figure 6. Current reduction
I_{TRMS}=f(T_{PIN5}), R_{thJ}=16.5 K/W
Thermocouple measurement must be performed potentially separated to A1 and A2. Measuring junction to be as near as possible at case.



Optocouplers (Optoisolators)

5

Figure 7. Typical trigger delay time
$t_{gd}=f(I_F/I_{FT25°C})$, V_D=200 V, parameter: T_j

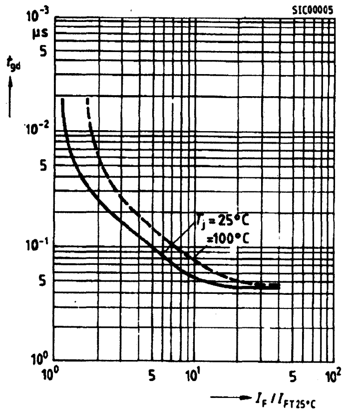


Figure 8. Typical off-state current
$I_D=f(T_j)$, V_D=800 V, parameter: T_j

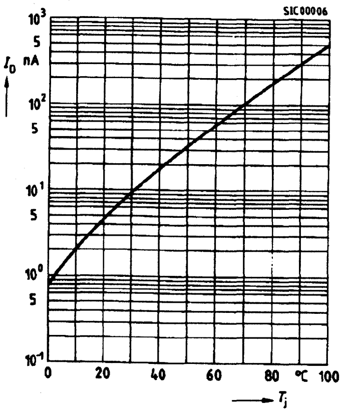


Figure 9. Power dissipation
for 40 to 60 Hz line operation
$P_{TOT}=f(I_{TRMS})$

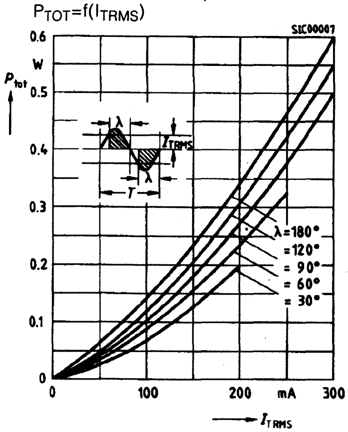
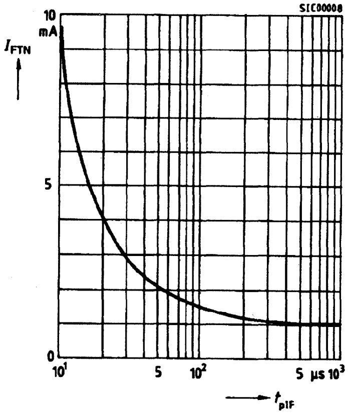


Figure 10. Pulse trigger current $I_{FTN}=f(t_{pIF})$
I_{FTN} normalized to I_{FT} referring to $t_{pIF}\geq$1 ms
V_{OP}=200 V, f=40 to 60 Hz typ.



SIEMENS

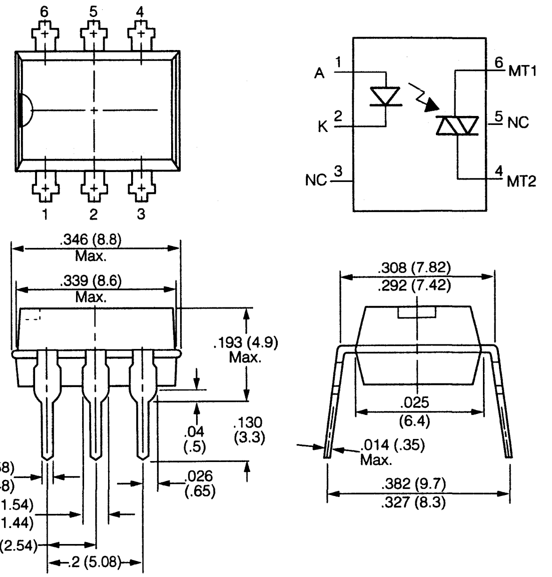
IL440

TRIAC PREDRIVER NON-ZERO CROSSING OPTOCOUPLER

FEATURES
- **600 V Blocking Voltage**
- **7 mA Maximum Trigger Current**
- **Isolation Voltage, 3750 VAC, t=1 sec.**
- **Isolation Materials per UL94**

APPLICATIONS
- **High Current Triac Driver**
- **Solid State Relays**
- **Switch Small AC Loads**

Package Dimensions in inches (mm)



DESCRIPTION

The IL440 consists of a GaAs infrared emitter optically coupled to a silicon planar triac chip with a non-zero crossing network. The two semiconductors are assembled in a 6 pin dual-in-line plastic package. The output detector is capable of blocking up to 600 volts which permits control of off-line voltages up to 240 VAC. The IL440 can handle currents up to 100 mA_{RMS}.

Maximum Ratings

Emitter

Reverse Voltage .... 5 V
Forward Current .... 60 mA
Surge Current (P.W.<10 µs) .... 3 A
Power Dissipation .... 100 mW
Junction Temperature .... 100 °C

Detector

Peak Off-state Voltage .... 600 V
On-state RMS Current .... 100 mA
Peak Surge Current (t_p≤10 ms) .... 1.2 A
Peak On-state Current .... 2 A
Power Dissipation .... 300 mW
Junction Temperature .... 125 °C

Package

Isolation Voltage, 1 sec..........................3750 VAC
per Standard Climate 23°C/50% RH, DIN 50014
Creepage..≥7 mm
Clearance ....≥7 mm
Isolation Resistance
V_{IO}=500 V, T_A=25°C..............................$\geq 10^{12}\ \Omega$
V_{IO}=500 V, T_A=100°C............................$\geq 10^{11}\ \Omega$
Total Power Dissipation, T_A=25°C............ 330 mW
Storage Temperature Range ..... –55°C to +125°C
Operating Temperature Range.. –40°C to +100°C
Junction Temperature ....100°C
Lead Soldering Temperature
(2 mm from case, t<10 s.)........................260°C

Maximum Safety Ratings

This device is used for protective separation against electrical shock within the maximum safety ratings. This must be ensured by protective circuits in the applications.

Parameter	Symbol	Max.	Unit	Test Condition
Emitter				
Forward Current	I_F	130	mA	
Detector				
Power Dissipation	P_D	300	mW	T_A≤25°C
Coupled Device				
Rated Impulse Voltage Sample Test	V_{IOTM}	6	kV	t_{T1}= 10 s, t_{test}=60 s

Electrical Characteristics, T_A=25°C

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Condition
Emitter						
Forward Voltage	V_F		1.25	1.6	V	I_F=50 mA
Breakdown Voltage	V_{BR}	5			V	I_R=10 µA
Junction Capacitance	C_J		50		pF	V_R=0 V, f=1 MHz
Detector						
Off-state Output Terminal Voltage	V_{DRM}	600			V	I_{DRM}=500 nA
Peak On-state Voltage	V_{TM}		1.5	3	V	I_{TM}=100 mA, I_{FT}=30 mA
Critical Rate of Rise of Off-state Voltage	$(dv/dt)_{cr}$		50		V/µs	I_F=0, V_S=240 V_{RMS}
	$(dv/dt)_{crq}$	0.13	0.25		V/µs	I_F=30 mA, V_S=60 V_{RMS}
Coupled Device						
Input Trigger Current	I_{FT}		5	7	mA	V_T=6 V, R_L=150 Ω
Holding Current	I_H			1	mA	I_F≥10 mA, V_S≥3 V

SIEMENS

NEW

IL485

OPTICALLY COUPLED HIGH SPEED MOSFET DRIVERS OPTOCOUPLER

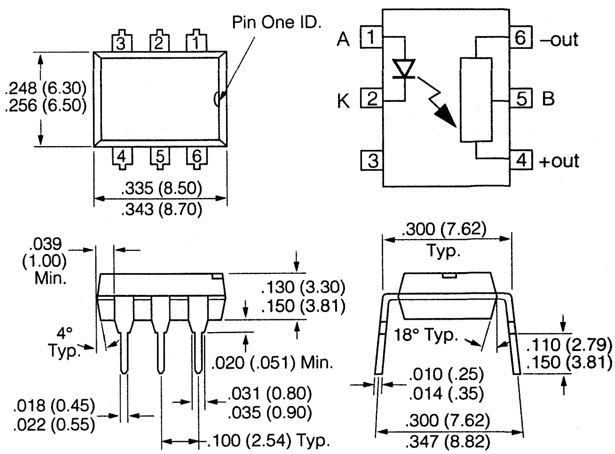
FEATURES
- **Fast Turn On**
- **Fast Turn Off**
- **Low Input Current**
- **Isolation Test Voltage, 5300 VAC_{RMS}**

APPLICATIONS
- **Motor Drive Controls**
- **IGBT-predrivers**
- **AC/DC Power Inverters**

DESCRIPTION

The IL485 is a photovoltatic generator (optically coupled) designed to drive highly capacitive loads such as the gate of a power MOSFET transistor and at the same time provide isolation and floating voltage supply capability. The coupler consists of a GaAIAs light emitting diode as input control and a custom photo IC chip with photodiode arrary (PDA) as output device. When the LED is turned on, the emitted light produces a voltage in the PDA. The output of the PDA is used to drive the gate of a power MOSFET. The photo IC chip contains additional circuitry to enhance the switching speeds, (both turn on turn off). The optocoupler is packaged in a 6 pin DIP.

Package Dimensions in inches (mm)



Maximum Ratings

Emitter

Reverse Voltage .... 6 V
Forward Current .... 60 mA
Peak Forward Current .... 600 mA
Power Dissipation .... 100 mW
Thermal Resistance .... 700 °C/W

Detector

Breakdown Voltage (pin 5 to 6) .... 300 V
Peak Input Current (pin 5 to 4) .... 50 mA
Reverse Current (pin 5 to 6, V=100 V) .... 200 nA
Power Dissipation (pin 5 to 4) .... 150 mW

Package

Insulation Thickness between Emitter and Detector .... ≥0.4 mm
Isolation Test Voltage (1 sec) .... 5300 VAC_{RMS}
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... $\geq 10^{12}$ Ω
V_{IO}=500 V, T_A=100°C .... $\geq 10^{11}$ Ω
Comparative Tracking Index
per DIN IEC 112/VDE 303, Part 1 .... ≥175
Total Power Dissipation .... 250 mW
Storage Temperature Range .... –55°C to +150°C
Operating Temperature Range .... –55°C to +100°C
Junction Temperature .... 100°C
Soldering Temperature (max. 10 sec., dip soldering
distance to seating plane >1.5 mm) .... 260°C

Electrical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Input — Emitter						
LED Forward Voltage	V_F	0.9	1.26	1.5	V	I_F=10 mA
LED Junction Capacitance	C_J		25		pF	V_R=0 V, f=1 MHz
MOSFET Driver Output with External Biasing (see Figure 1 and 3)						
Zener Voltage (pin 4 to 6)	V_Z		13		V	I_{ZT}=10 µA
Dynamic Output Voltage (pin 4 to 6)	V_{OUT}	9	11		V	C_L=2000 pF, V_B=20 V I_F=10 mA
Dynamic Output Current (pin 4 to 6)	I_{OUT}		 5 15		 mA mA	C_L=2000 pF, V_B=20 V I_F=10 mA I_F=40 mA
Dynamic Output Resistance Sourcing (pin 4) Sinking (pin 4)	R_{OUT}		 300 20		 Ω Ω	I_F=10 mA
Turn-on Time	t_{ON}		3.5	5	µs	C_L=2000 pF, I_F=40 mA Measure at V_{OUT}=5 V, V_B=20 V
Turn-off Time	t_{OFF}		3.5	5	µs	C_L=2000 pF, I_F=40 mA Measure at V_{OUT}=2 V, V_B=20 V
MOSFET Driver Output without External Biasing (see Figure 2 and 3)						
Output Open Circuit Voltage (pin 4 to 6)	V_{OC}	8	10		V	I_F=10 mA
Output Short Circuit Current (pin 4 to 6)	I_{SC}	 2.5 10	 4 16		 µA µA	 I_F=10 mA I_F=40 mA
Dynamic Output Resistance Sinking (pin 4)	R_{OUT}		20		Ω	I_F=10 mA
Turn-on Time	t_{ON}		650	1000	µs	C_L=2000 pF (see Figure 3) Measure at V_{OUT}=5 V, I_F=40 mA
Turn-off Time	t_{OFF}		3	5	µs	C_L=2000 pF (see Figure 3) Measure at V_{OUT}=2 V, I_F=40 mA
MOSFET Driver Output Switching Speed (see Figure 3, 4, 5)						
Rise time	t_R		500		ns	M1 Cgs=2000 pF, V_S=50 V Measure at 90%–10% M1 V_{DS} (see Figure 4)
Turn-on Time	t_{ON}		3.5		µs	
Fall time	t_F		300		ns	
Turn-off Time	t_{OFF}		3.5		µs	
Package Isolation Characteristics						
Input-Output CMRR	dv/dt		15 kV		V/µs	V_{CM}=1000 V
Coupling Capacitance	C_{IO}		1		pF	f=1 MHz

Figure 1. Switching time measurement with external voltage bias

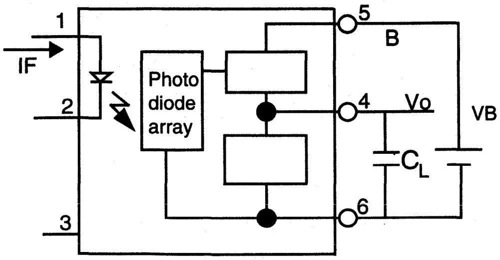


Figure 2. Switching time measurement without voltage bias

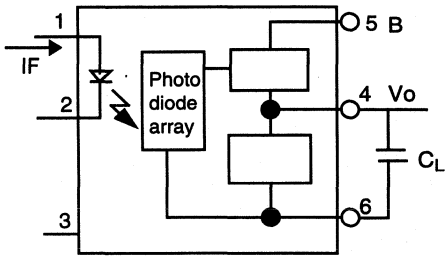


Figure 3. Switching time measurement

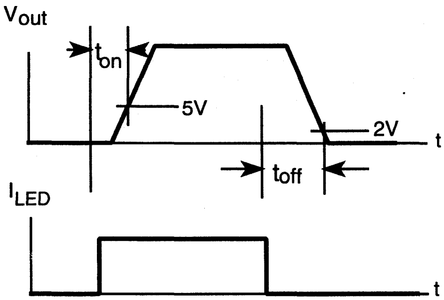


Figure 4. IL485 connected in DC load switching configuration

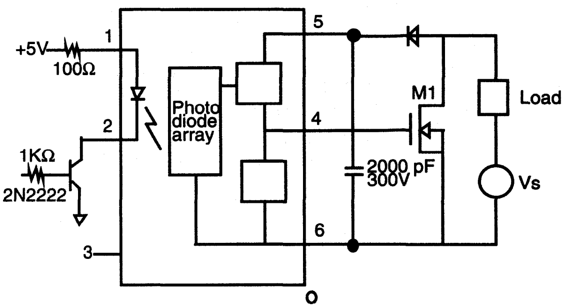
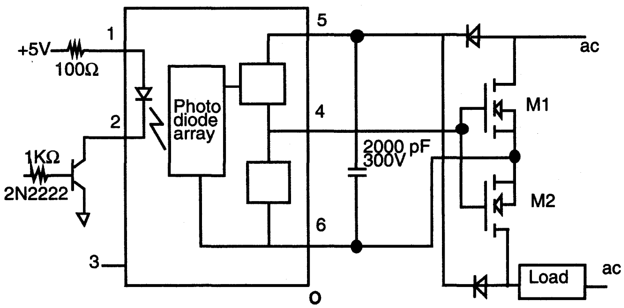


Figure 5. IL485 connected in AC load switching configuration



Optocouplers (Optoisolators)

5

SIEMENS

SINGLE CHANNEL IL755
DUAL CHANNEL ILD755

BIDIRECTIONAL INPUT DARLINGTON OPTOCOUPLERS

FEATURES

- **High Current Transfer Ratios, V_{CE}=5 V**
  IL/ILD755-1: 750% at I_F=2 mA
  IL/ILD755-2: 1000% at I_F=1 mA
- **BV_{CEO} >60 V**
- **AC or Polarity Insensitive Inputs**
- **Built-In Reverse Polarity Input Protection**
- **Industry Standard DIP Package**
- **Underwriters Lab File #E52744**
- **VDE #0884 Available with Option 1**

DESCRIPTION

The IL/ILD755 are bidirectional input optically coupled isolators. They consist of two Gallium Arsenide infrared emitting diodes coupled to a silicon NPN photodarlington per channel.

The IL755 are single channel Darlington optocouplers. The ILD755 has two isolated channels in a single DIP package.

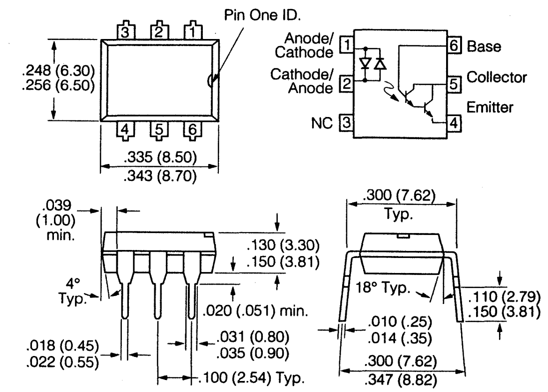
They are designed for applications requiring detection or monitoring of AC signals.

Maximum Ratings

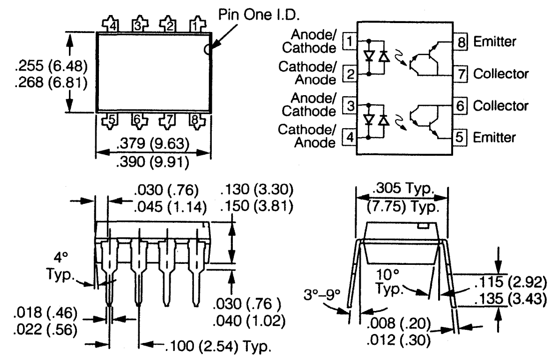
Emitter (Each Channel)
Continuous Forward Current .... 60 mA
Power Dissipation at 25°C .... 100 mW
Derate Linearly from 25°C .... 1.33 mW/°C
Detector (Each Channel)
Collector-Emitter Breakdown Voltage .... 60 V
Collector-Base Breakdown Voltage .... 60 V
Power Dissipation at 25°C
IL755 .... 200 mW
ILD755 .... 150 mW
Derate Linearly from 25°C
IL755 .... 2.6 mW/°C
ILD755 .... 2.0 mW/°C
Package
Isolation Test Voltage (PK)
(t= 1 sec.) .... 7500 VAC_{PK}/5300 VAC_{RMS}
Total Power Dissipation at 25°C Ambient
(LED Plus Detector)
IL755 .... 250 mW
ILD755 .... 400 mW
Derate Linearly from 25°C
IL755 .... 3.3 mW/°C
ILD755 .... 5.3 mW/°C
Creepage .... 7 mm min.
Clearance .... 7 mm min.
Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Lead Soldering Time at 260°C .... 10 sec.

Package Dimensions in Inches (mm)

Single Channel



Dual Channel



Electrical Characteristics (T_A=25°C)

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.2	1.5	V	I_F=±10 mA
Detector						
	BV_{CEO}	60	75		V	I_C=1 mA
	BV_{CBO}	60	90		V	I_C=10 µA
	I_{CEO}		10	100	nA	V_{CE}=10 V
Package						
	V_{CEsat}			1.0	V	I_F=±10 mA, I_C=10 mA
DC Current Transfer Ratio	CTR					
IL755/ILD755-1		750			%	I_F=±2 mA, V_{CE}=5 V
IL755/ILD755-2		1000			%	I_F=±1 mA, V_{CE}=5 V
Rise Time/Fall Time IL/ILD755-1			50		µs	V_{CC}=10 V, I_F=2 mA, R_L=100 Ω
Rise Time/Fall Time IL/ILD755-2			70		µs	V_{CC}=10 V, I_F=1 mA, R_L=100 Ω

Figure 1. LED forward current versus forward voltage

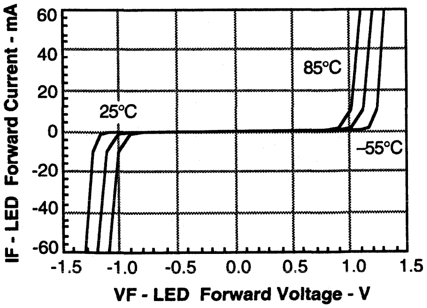


Figure 2. Normalized non-saturated and saturated CTRce versus LED current

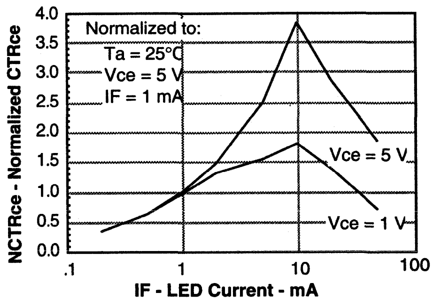


Figure 3. Normalized non-saturated and saturated CTRce versus LED current

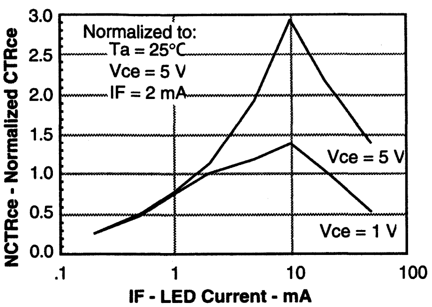


Figure 4. Normalized non-saturated and saturated Ice versus LED current

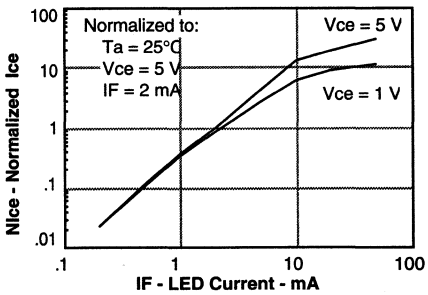


Figure 5. Normalized non-saturated and saturated collector-emitter current versus LED current

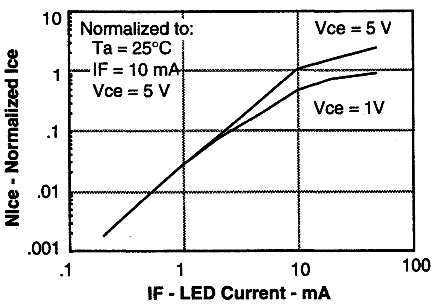


Figure 6. Non-saturated and saturated HFE versus base current

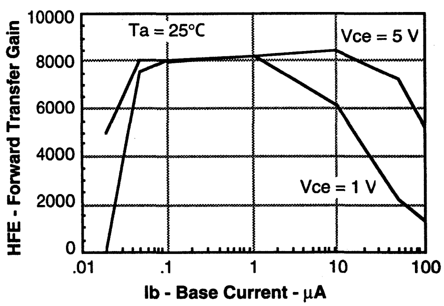


Figure 7. Low to high propagation delay versus collector load resistance and LED current

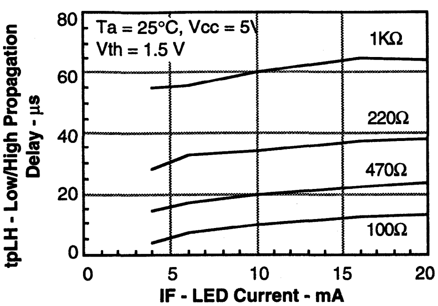


Figure 8. High to low propagation delay versus collector load resistance and LED current

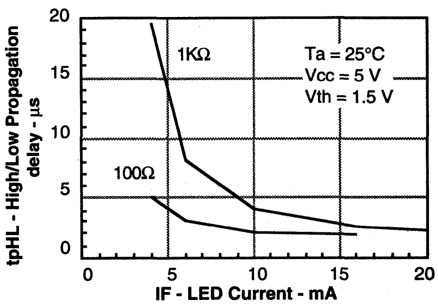


Figure 9. Switching waveform

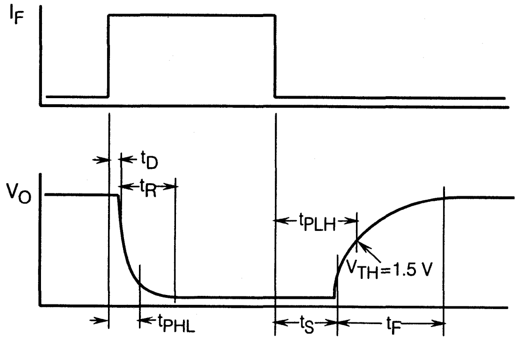
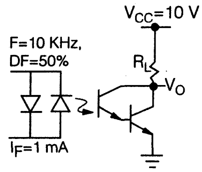


Figure 10. Normalized non-saturated and saturated CTRce versus LED current



SIEMENS

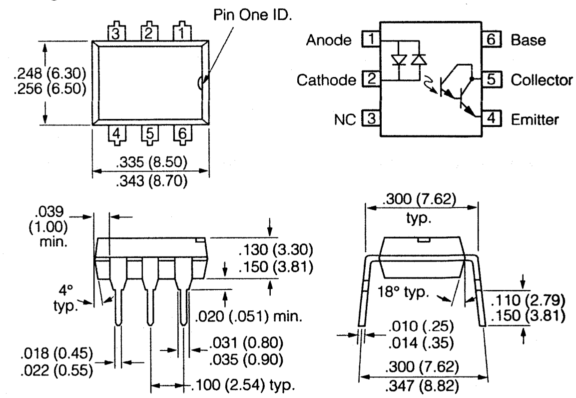
IL755B

BIDIRECTIONAL INPUT DARLINGTON OPTOCOUPLER

FEATURES

- **Very High Current Transfer Ratio (500% min.)**
  IL755B-1: 750% at I_F=2 mA, V_{CE}=5 V
  IL755B-2: 1000% at I_F=1 mA, V_{CE}=5 V
- **BV_{CEO} >60 V**
- **Isolation Test Voltage, 5300 VAC_{RMS}**
- **AC or Polarity Insensitive Inputs**
- **No Base Connection**
- **High Isolation Resistance, 10^{12} Ω**
- **Low Coupling Capacitance**
- **Standard Plastic DIP Package**
- **Underwriters Lab Approval #E52744**
- **VDE #0884 Available with Option 1**

Package Dimensions in Inches (mm)



DESCRIPTION

The IL755B is a bidirectional input, optically coupled isolator consisting of two Gallium Arsenide infrared emitters and a silicon photodarlington sensor.

Maximum Ratings (at 25°C)

Emitter (Drive Circuit)

Continuous Forward Current .... 60 mA
Power Dissipation at 25°C .... 100 mW
Derate Linearly from 55°C .... 1.33 mW/°C

Detector

Collector-Emitter Breakdown Voltage .... 60 V
Emitter-Collector Breakdown Voltage .... 12 V
Power Dissipation at 25°C Ambient .... 200 mW
Derate Linearly from 25°C .... 2.6 mW/°C

Package

Isolation Test Voltage
(PK) (t=1 sec.) .... 5300 VAC_{RMS}
Dissipation at 25°C .... 250 mW
Derate Linearly from 25°C(2) .... 3.3 mW/°C
Creepage .... 7 min mm
Clearance .... 7 min mm
Isolation Resistance
T_A=25°C .... ≥10^{12} Ω
T_A=100°C .... ≥10^{11} Ω
Storage Temperature(2) .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Lead Soldering Time at 260°C .... 10 sec.

Electrical Characteristics (T_A=25°C)

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage(1)	V_F		1.25	1.5	V	I_F=10 mA
Detector(2)						
Collector-Emitter Breakdown Voltage	BV_{CEO}	60	75		V	I_C=1 mA, I_F=0
Collector-Emitter Leakage Current	I_{CEO}		1.0	100	nA	V_{CE}=10 V, I_F=0
Package						
Current Transfer Ratio(2)	CTR					
IL755B–1		750			%	I_F=±2 mA, V_{CE}=5 V
IL755B–2		1000			%	I_F=±1 mA, V_{CE}=5 V
Collector-Emitter Saturation Voltage	V_{CEsat}			1.0	V	I_C=10 mA, I_F=±10 mA
Turn-On Time	t_{on}			200	µs	V_{CC}=10 V
Turn-Off Time	t_{off}			200	µs	I_F=±2 mA, R_L=100 Ω

Notes:
1. Indicates JEDEC registered data.

Optocouplers (Optoisolators) 5

Figure 1. LED forward current versus forward voltage

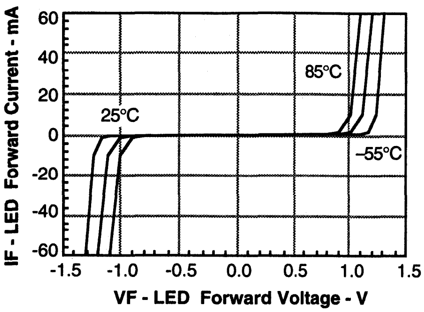


Figure 2. Normalized non-saturated and saturated CTRce versus LED current

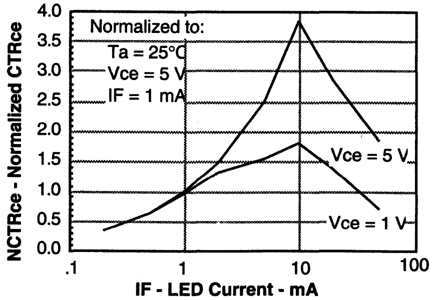


Figure 3. Normalized non-saturated and saturated CTRce versus LED current

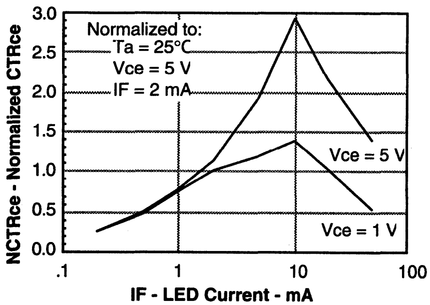


Figure 4. Normalized non-saturated and saturated Ice versus LED current

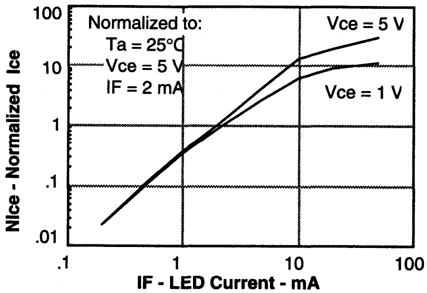


Figure 5. Normalized non-saturated and saturated collector-emitter current versus LED current

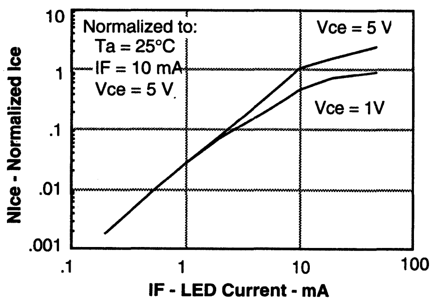


Figure 6. Low to high propagation delay versus collector load resistance and LED current

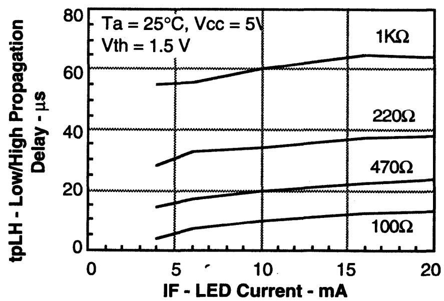


Figure 7. High to low propagation delay versus collector load resistance and LED current

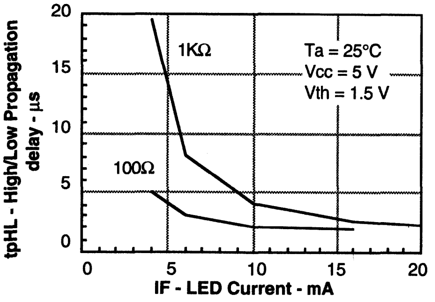


Figure 8. Switching waveform

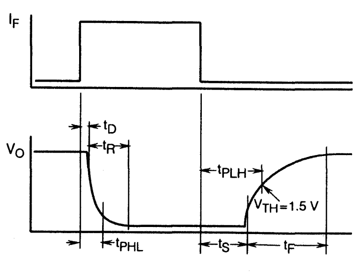
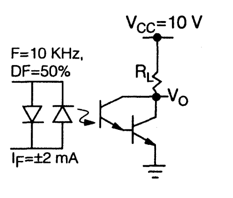


Figure 9. Normalized non-saturated and saturated CTRce versus LED current



SIEMENS

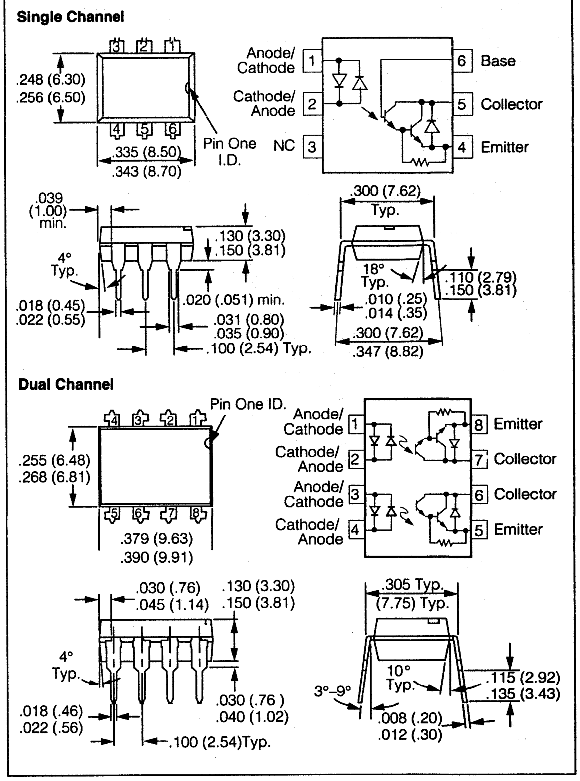
SINGLE CHANNEL IL766
DUAL CHANNEL ILD766
BIDIRECTIONAL INPUT DARLINGTON OPTOCOUPLERS

FEATURES
- **Internal R_{BE} for Better Stability**
- **High Current Transfer Ratios, V_{CE}=5 V**
  IL/ILD766-1: 500% at I_F=2 mA
  IL/ILD766-2: 500% at I_F=1.0 mA
- **BV_{CEO} >60 V**
- **AC or Polarity Insensitive Inputs**
- **Built-In Reverse Polarity Input Protection**
- **Industry Standard DIP Package**
- **Underwriters Lab File #E52744**

DESCRIPTION
The IL/ILD766 are bidirectional input optically coupled isolators. They consist of two Gallium Arsenide infrared emitting diodes coupled to a silicon NPN photodarlington per channel.

The IL766 are single channel optocouplers. The ILD766 has two isolated channels in a single DIP package. They are designed for applications requiring detection or monitoring of AC signals.

Package Dimensions in Inches (mm)



Maximum Ratings

Emitter (Each Channel)

Continuous Forward Current	60 mA
Power Dissipation at 25°C	
Single Channel	200 mW
Dual Channel	90 mW
Derate Linearly from 25°C	
Single Channel	2.6 mW/°C
Dual Channel	1.2 mW/°C

Detector (Each Channel)

Collector-Emitter Breakdown Voltage	60 V
Collector-Base Breakdown Voltage	70 V
Power Dissipation at 25°C	100 mW
Derate Linearly from 25°C	1.33 mW/°C

Package

Isolation Test Voltage (t= 1 sec.)	7500 VAC_{PK}/5300 VAC_{RMS}
Isolation Resistance	
T_A=25°C	≥10^{12} Ω
T_A=100°C	≥10^{11} Ω
Total Power Dissipation at 25°C Ambient (LED Plus Detector)	
Single Channel	250 mW
Dual Channel	400 mW
Derate Linearly from 25°C	
Single Channel	3.3 mW/°C
Dual Channel	5.3 mW/°C
Creepage	7 mm min.
Clearance	7 mm min.
Comparative Tracking Index per DIN IEC 112/VDE303, part 1	175
Storage Temperature	–55°C to +150°C
Operating Temperature	–55°C to +100°C
Lead Soldering Time at 260°C	10 sec.

Electrical Characteristics (T_A=25°C)

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.2	1.5	V	I_F=±10 mA
Detector						
Breakdown Voltage						
Collector-Emitter	BV_{CEO}	60	75		V	I_C=1 mA
Collector-Base	BV_{CBO}	60	90		V	I_C=10 µA
Leakage Current						
Collector-Emitter	I_{CEO}		10	100	nA	V_{CE}=10 V
Package						
V_{CEsat}				1.0	V	I_F=±10 mA, I_C=10 mA
DC Current Transfer Ratio	CTR					
IL766/ILD766-1		500			%	I_F=±2 mA, V_{CE}=5 V
IL766-2		500			%	I_F=±1.0 mA, V_{CE}=5 V
Rise Time, Fall Time			100		µs	V_{CC}=10 V, I_F=±2 mA, R_L=100 Ω

Figure 1. Input characteristics

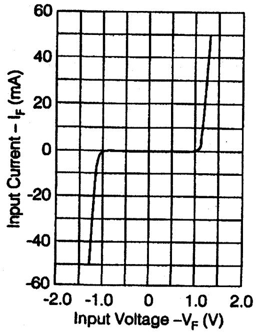


Figure 2. Transistor current versus voltage

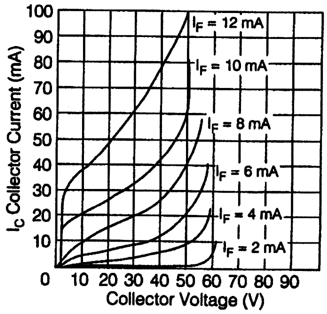


Figure 3. Transistor output current versus voltage

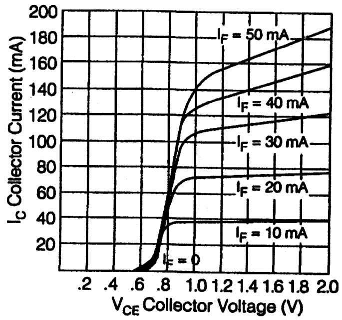


Figure 4. I_{CEO} at V_{CE}=10 V versus temperature

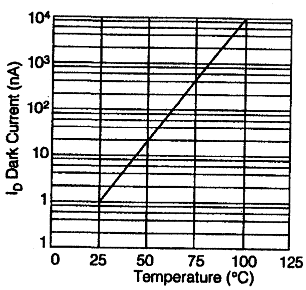


Figure 5. Normalized CTR versus forward current

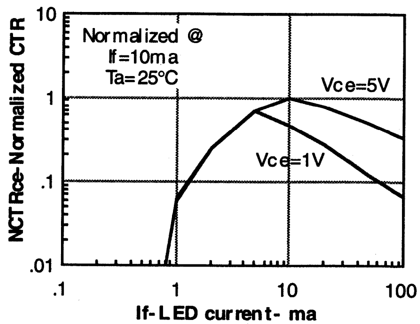


Figure 6. Tr versus forward current

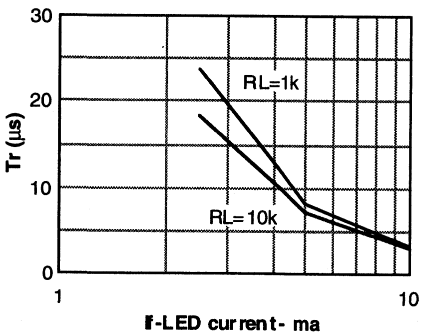


Figure 7. Saturated switching characteristics measurements–schematic and waveform

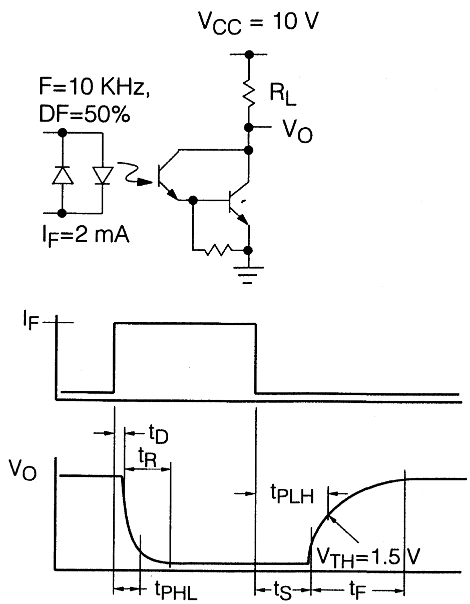


Figure 8. Tfall versus forward current

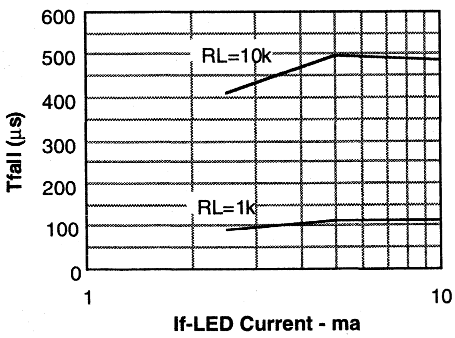


Figure 9. Ton versus forward current

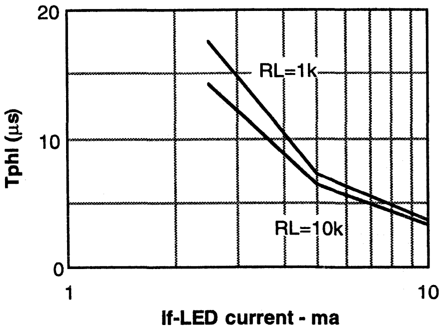


Figure 10. Toff versus forward current

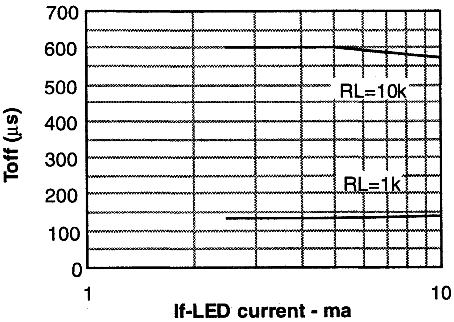


Figure 11. Tphl versus forward current

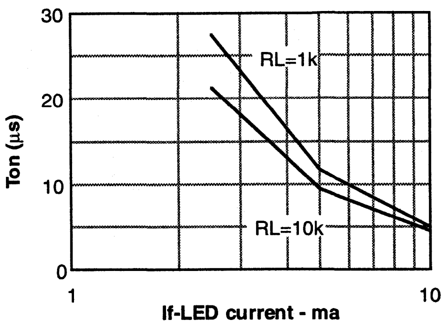
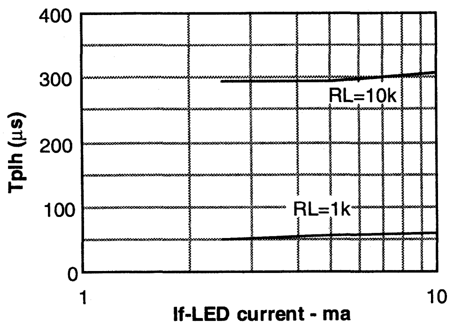


Figure 12. Tplh versus forward current



SIEMENS

IL766B

BIDIRECTIONAL INPUT OPTOCOUPLER

FEATURES

- **Very High Current Transfer Ratio**
  IL766B-1: 400% at I_F=1 mA, V_{CE}=5 V
  IL766B-2: 900% at I_F=0.5 mA, V_{CE}=5 V
- **Internal R_{BE} for Better Stability**
- **BV_{CEO} >60 V**
- **Isolation Test Voltage, 5300 VAC_{RMS}**
- **AC or Polarity Insensitive Inputs**
- **No Base Connection**
- **High Insulation Resistance, 10^{11} Ω Typical**
- **Standard Plastic DIP Package**
- **Underwriters Lab File #E52744**

DESCRIPTION

The IL766B is a bidirectional input, optically coupled isolator consisting of two Gallium Arsenide infrared emitters and a silicon photodarlington sensor.

Maximum Ratings (at 25°C)

Emitter (Drive Circuit)

Continuous Forward Current .... 60 mA
Power Dissipation at 25°C .... 200 mW
Derate Linearly from 55°C .... 2.6 mW/°C

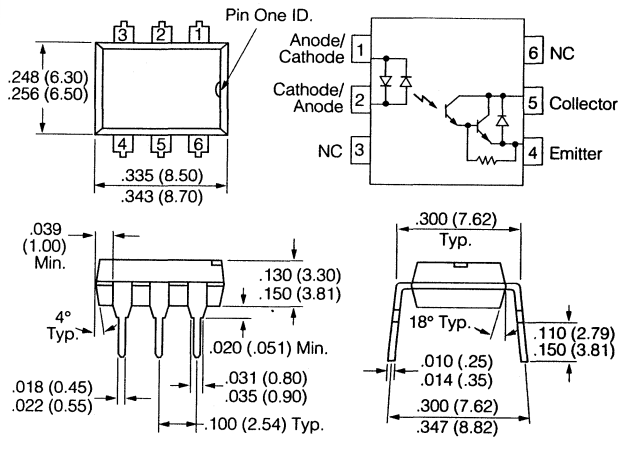
Detector (Load Circuit)

Collector-Emitter Breakdown Voltage .... 60 V
Collector-Base Breakdown Voltage .... 70 V
Power Dissipation at 25°C Ambient .... 200 mW
Derate Linearly from 25°C .... 2.6 mW/°C

Package

UL Isolation Test Voltage
(t=1 sec.) .... 5300 VAC_{RMS}
Dissipation at 25°C .... 250 mW
Derate Linearly from 25°C .... 3.3 mW/°C
Creepage .... 7 min mm
Clearance .... 7 min mm
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... 10^{12} Ω
V_{IO}=500 V, T_A=100°C .... 10^{11} Ω
Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Lead Soldering Time at 260°C .... 10 sec.

Package Dimensions in Inches (mm)



Electrical Characteristics (T_A=25°C)

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.25	1.5	V	I_F=±10 mA
Detector						
Breakdown Voltage Collector-Emitter	BV_{CEO}	60			V	I_C=1 mA, I_F=0
Leakage Current Collector-Emitter	I_{CEO}		1.0	100	nA	V_{CE}=10 V, I_F=0
Package						
Current Transfer Ratio	CTR					
IL766B–1		400			%	I_F=±1 mA, V_{CE}=5 V
IL766B–2		900			%	I_F=±0.5 mA, V_{CE}=5 V
Saturation Voltage Collector-Emitter	V_{CEsat}			1.0	V	I_C=10 mA, I_F=±10 mA
Turn-On,Turn-Off Time	t_{on}, t_{off}		200		µs	V_{CC}=5 V, I_F=±2 mA, R_L=100 Ω

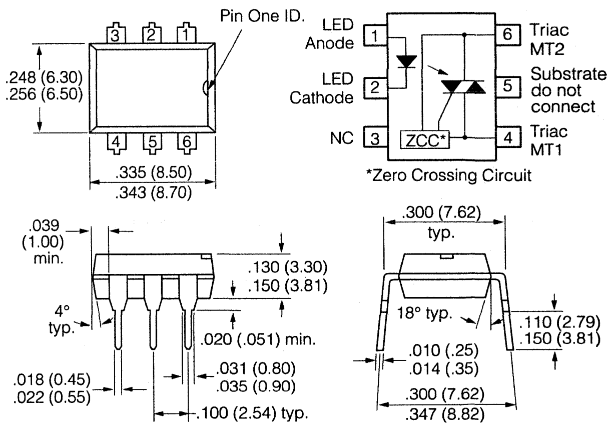
SIEMENS

IL4108

ZERO VOLTAGE CROSSING
800 V TRIAC DRIVER OPTOCOUPLER

FEATURES
- **On-State Current, 300 mA**
- **Zero Voltage Crossing**
- **Blocking Voltage, 800 V**
- **Isolation Test Voltage 5300 VAC_{RMS}**
- **High Input Sensitivity**
  I_{FT}=2 mA, PF=1.0
  I_{FT}=5 mA, PF≤1.0
- **High Static dv/dt 10,000 V/µs**
- **Inverse Parallel SCRs Provide Commutating dv/dt >10K V/µs**
- **Very Low Leakage <10 µA**
- **Small 6-Pin DIP Package**
- **Underwriters Lab File #E52744**
- **VDE Approval #0884 (Optional with Option 1, Add -X001 Suffix)**

Package Dimensions in inches (mm)



Maximum Ratings

Emitter

Reverse Voltage	6 V
Forward Current	60 mA
Surge Current	2.5 A
Thermal Resistance	750 °C/W
Derate from 25°C	1.33 mW/°C

Detector

Peak Off-state Voltage	800 V
Peak Reverse Voltage	800 V
RMS On-state Current	300 mA
Single Cycle Surge	3 A
Thermal Resistance	125 °C/W
Total Power Dissipation	500 mW
Derate from 25°C	6.6 mW/°C

Package

Isolation Test Voltage (between emitter and detector, climate per DIN 40046, part 2, Nov. 74 (t=1 min.)	5300 VAC_{RMS}
Pollution Degree (DIN VDE 0109)	2
Creepage Distance	≥7 mm
Clearance	≥7 mm
Comparative Tracking Index per DIN IEC 112/VDE 0303 part 1, Group IIIa per DIN VDE 6110	≥175
Isolation Resistance	
V_{IO}=500 V, T_A=25°C	≥10^{12} Ω
V_{IO}=500 V, T_A=100°C	≥10^{11} Ω
Storage Temperature Range	–55°C to +125°C
Ambient Temperature Range	–55°C to +100°C
Soldering Temperature (max. ≤10 sec. dip soldering ≥0.5 mm from case bottom)	260°C

DESCRIPTION

The IL4108 consists of a GaAs IRLED optically coupled to a photosensitive zero crossing TRIAC network. The TRIAC consists of two inverse parallel connected monolithic SCRs. These three semiconductors are assembled in a six pin 0.3 inch dual in-line package, using high insulation double molded, over/under leadframe construction.

High input sensitivity is achieved by using an emitter follower phototransistor and a cascaded SCR predriver resulting in an LED trigger current of less than 2 mA (DC).

The IL4108 uses two discrete SCRs resulting in a commutating dV/dt greater than 10KV/µs. The use of a proprietary dv/dt clamp results in a static dV/dt of greater than 10KV/µs. This clamp circuit has a MOSFET that is enhanced when high dV/dt spikes occur between MT1 and MT2 of the TRIAC. When conducting, the FET clamps the base of the phototransistor, disabling the first stage SCR predriver.

The zero cross line voltage detection circuit consists of two enhancement MOSFETS and a photodiode. The inhibit voltage of the network is determined by the enhancement voltage of the N-channel FET. The P-channel FET is enabled by a photocurrent source that permits the FET to conduct the main voltage to gate on the N-channel FET. Once the main voltage can enable the N-channel, it clamps the base of the phototransistor, disabling the first stage SCR predriver.

The 800V blocking voltage permits control of off-line voltages up to 240VAC, with a safety factor of more than two, and is sufficient for as much as 380VAC.

The IL4108 isolates low-voltage logic from 120, 240, and 380 VAC lines to control resistive, inductive, or capacitive loads including motors, solenoids, high current thyristors or TRIAC and relays.

Applications include solid-state relays, industrial controls, office equipment, and consumer appliances.

Electrical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.16	1.35	V	I_F=10 mA
Breakdown Voltage	V_{BR}	6	30		V	I_R=10 µA
Reverse Current	I_R		0.1	10	µA	V_R=6 V
Capacitance	C_0		25		pF	V_F=0 V, f=1 MHz
Thermal Resistance, Junction to Lead	R_{THJL}		750		°C/W	
Output Detector						
Repetitive Peak Off-state Voltage	V_{DRM}	800			V	I_{DRM}=100 µA
Off-state Voltage	$V_{D(RMS)}$	565			V	$I_{D(RMS)}$=70 µA
Off-state Current	$I_{D(RMS)1}$		10	100	µA	V_D=800 V, T_A100°C, I_F=0 mA
Off-state Current	$I_{D(RMS)2}$			200	µA	V_D=800 V, I_F=Rated I_{FT}
On-state Voltage	V_{TM}		1.7	3	V	I_T=300 mA
On-state Current	I_{TM}			300	mA	PF=1.0, $V_{T(RMS)}$=1.7 V
Surge (Non-repetitive On-state Current)	I_{TSM}			3	A	f=50 Hz
Trigger Current 1	I_{FT1}			2.0	mA	V_D=5 V
Trigger Current 2	I_{FT2}			6.0	mA	V_{op}=220 V, f=50 Hz, T_j=100°C, t_{pF}>10 ms
Trigger Current Termperature Gradient	$\Delta I_{FT1}/\Delta T_j$ $\Delta I_{FT2}/\Delta T_j$		7 7	14 14	µA/K µA/K	
Inhibit Voltage Temperature Gradient	$\Delta V_{DINH}/\Delta T_j$		–20		mV/K	
Off-state Current in Inhibit State	I_{DINH}		50	200	µA	I_F=I_{FT1}, V_{DRM}
Capacitance between Input and Output Circuit	C_{IO}		2.0		pF	V_D=0, f=1 kHz
Holding Current	I_H		65	500	µA	
Latching Current	I_L		5		mA	V_T=2.2 V
Zero Cross Inhibit Voltage	V_{IH}		15	25	V	I_F=Rated I_{FT}
Turn-on Time	t_{ON}		35		µs	V_{RM}=V_{DM}=565 VAC
Turn-off Time	t_{OFF}		50		µs	PF=1.0, I_T=300 mA
Critical Rate of Rise of Off-State Voltage	dv/dt_{cr} dv/dt_{cr}	10000 5000			V/µs V/µs	V_D=0.67 V_{DRM}, T_j=25°C T_j=80°C
Critical Rate of Rise of Voltage at Current Commutation	dv/dt_{crq} dv/dt_{crq}	10000 5000			V/µs V/µs	V_D=0.67 V_{DRM}, di/dt_{crq}<15 A/ms T_j=25°C T_j=80°C
Critical Rate of Rise of On-state Current	$di/dt/_{cr}$			8	A/µs	
Thermal Resistance, Junction to Lead	R_{THJL}		150		°C/W	
Package						
Critical Rate of Rise of Coupled Input/Output Voltage	$dv_{(IO)}/dt$		10000		V/µs	I_T=0 A, V_{RM}=V_{DM}=565 VAC
Common Mode Coupling Capacitor	C_{CM}		0.01		pF	
Package Capacitance	C_{IO}		0.8		pF	f=1 MHz, V_{IO}=0 V

SIEMENS

600 V IL4116
700 V IL4117
800 V IL4118
ZERO VOLTAGE CROSSING TRIAC DRIVER OPTOCOUPLER

FEATURES

- **High Input Sensitivity**
  I_{FT}=1.3 mA, PF=1.0
  I_{FT}=3.5 mA, Typical PF < 1.0
- **Zero Voltage Crossing**
- **600/700/800 V Blocking Voltage**
- **300 mA On-State Current**
- **High Static dv/dt 10,000 V/µsec., typical**
- **Inverse Parallel SCRs Provide Commutating dv/dt >10 KV/µsec.**
- **Very Low Leakage <10 µA**
- **Isolation Test Voltage from Double Molded Package 5300 VAC_{RMS}**
- **Package, 6-Pin DIP**
- **Underwriters Lab File #E52744**

DESCRIPTION

The IL411x consists of an AlGaAs IRLED optically coupled to a photosensitive zero crossing TRIAC network. The TRIAC consists of two inverse parallel connected monolithic SCRs. These three semiconductors are assembled in a six pin 0.3 inch dual in-line package, using high insulation double molded, over/under leadframe construction.

High input sensitivity is achieved by using an emitter follower phototransistor and a cascaded SCR predriver resulting in an LED trigger current of less than 1.3 mA(DC).

The IL411x uses two discrete SCRs resulting in a commutating dV/dt greater than 10 KV/µs The use of a proprietary dv/dt clamp results in a static dv/dt of greater than 10 KV/µs. This clamp circuit has a MOSFET that is enhanced when high dv/dt spikes occur between MT1 and MT2 of the TRIAC. When conducting, the FET clamps the base of the phototransistor, disabling the first stage SCR predriver.

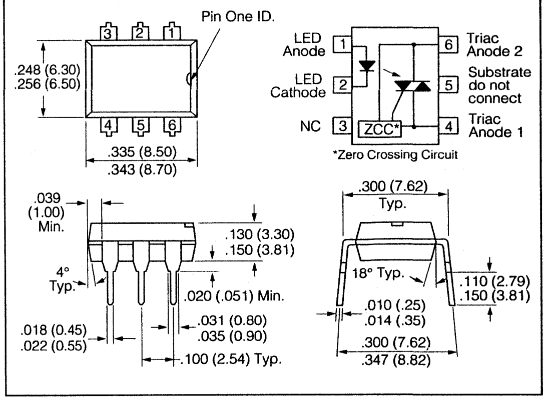
The zero cross line voltage detection circuit consists of two enhancement MOSFETS and a photodiode. The inhibit voltage of the network is determined by the enhancement voltage of the N-channel FET. The P-channel FET is enabled by a photocurrent source that permits the FET to conduct the main voltage to gate on the N-channel FET. Once the main voltage can enable the N-channel, it clamps the base of the phototransistor, disabling the first stage SCR predriver.

The blocking voltage of up to 800 V permits control of off-line voltages up to 240 VAC, with a safety factor of more than two, and is sufficient for as much as 380 VAC. Current handling capability is up to 300 mA RMS continuous at 25°C.

The IL411x isolates low-voltage logic from 120, 240, and 380 VAC lines to control resistive, inductive, or capacitive loads including motors, solenoids, high current thyristors or TRIAC and relays.

Applications include solid-state relays, industrial controls, office equipment, and consumer appliances.

Package Dimensions in Inches (mm)



Maximum Ratings

Emitter

Reverse Voltage	6 V
Forward Current	60 mA
Surge Current	2.5 A
Power Dissipation	100 mW
Derate Linearly from 25°C	1.33 mW/°C
Thermal Resistance	750 °C/W

Detector

Peak Off-State Voltage	
IL4116	600 V
IL4117	700 V
IL4118	800 V
RMS On-State Current	300 mA
Single Cycle Surge	3 A
Total Power Dissipation	500 mW
Derate Linearly from 25°C	6.6 mW/°C
Thermal Resistance	150°C/W

Package

Storage Temperature	–55°C to +150°C
Operating Temperature	–55°C to +100°C
Lead Soldering Temperature	260°C/5 sec.
Isolation Test Voltage	5300 VAC_{RMS}
Isolation Resistance	
V_{IO}=500 V, T_A=25°C	≥10^{12} Ω
V_{IO}=500 V, T_A=100°C	≥10^{11} Ω

Characteristics (T_A=25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.3	1.5	V	I_F=20 mA
Breakdown Voltage	V_{BR}	6	30		V	I_R=10 µA
Reverse Current	I_R		0.1	10	µA	V_R=6 V
Capacitance	C_0		40		pF	V_F=0 V, f=1 MHz
Thermal Resistance, Junction to Lead	R_{THJL}		750		°C/W	
Output Detector						
Repetitive Peak Off-State Voltage						
IL4116	V_{DRM}	600	650		V	I_{DRM}=100 µA
IL4117	V_{DRM}	700	750		V	I_{DRM}=100 µA
IL4118	V_{DRM}	800	850		V	I_{DRM}=100 µA
Off-State Voltage						
IL4116	$V_{D(RMS)}$	424	460		V	$I_{D(RMS)}$=70 µA
IL4117	$V_{D(RMS)}$	494	536		V	$I_{D(RMS)}$=70 µA
IL4118	$V_{D(RMS)}$	565	613		V	$I_{D(RMS)}$=70 µA
Off-State Current	$I_{D(RMS)}$		10	100	µA	V_D=600 V, T_A=100°C
On-State Voltage	V_{TM}		1.7	3	V	I_T=300 mA
On-State Current	I_{TM}			300	mA	PF=1.0, $V_{T(RMS)}$=1.7 V
Surge (Non-Repetitive) On-State Current)	I_{TSM}			3	A	f=50 Hz
Holding Current	I_H		65	200	µA	V_T=3 V
Latching Current	I_L		5		mA	V_T=2.2 V
LED Trigger Current	I_{FT}		0.7	1.3	mA	V_{AK}=5 V
Zero Cross Inhibit Voltage	V_{IH}		15	25	V	I_F=Rated I_{FT}
Turn-On Time	t_{ON}		35		µs	V_{RM}=V_{DM}= 424 VAC
Turn-Off Time	t_{OFF}		50		µs	PF=1.0, I_T=300 mA
Critical Rate of Rise:						
Off-State Voltage	$dv_{(MT)}/dt$	10,000			V/µs	V_{RM}, V_{DM}=400 VAC, T_A=25°C
			2000		V/µs	V_{RM}, V_{DM}=400 VAC, T_A=80°C
Commutating Voltage	$dv_{(COM)}/dt$	10,000			V/µs	V_{RM}, V_{DM}=400 VAC, T_A=25°C
			2000		V/µs	V_{RM}, V_{DM}=400 VAC, T_A=80°C
Commutating Current	di/dt		100		A/ms	I_T=300 mA
Thermal Resistance, Junction to Lead	R_{THJL}		150		°C/W	
Package						
Critical Rate of Rise of Coupled Input-Output Voltage	$dv_{(IO)}/dt$	10,000			V/µs	I_T=0 A, V_{RM}=V_{DM}=424 VAC
Common Mode Coupling Capacitor	C_{CM}		0.01		pF	
Package Capacitance	C_{IO}		0.8		pF	f=1 MHz, V_{IO}=0 V

Figure 1. LED forward current vs. forward voltage

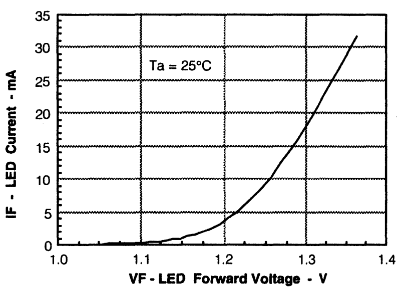


Figure 2. Forward voltage versus forward current

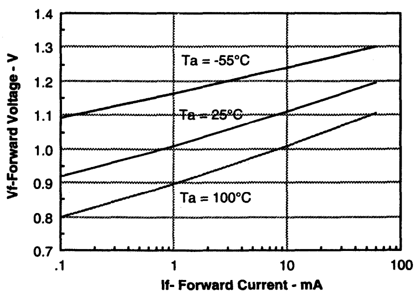


Figure 3. Peak LED current vs. duty factor, Tau

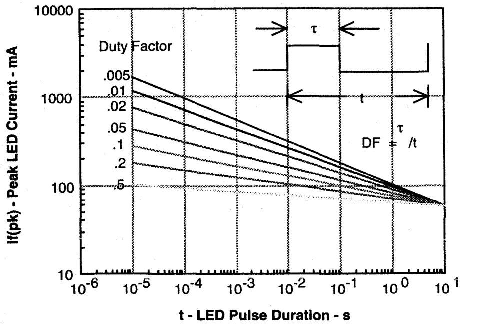


Figure 4. Maximum LED power dissipation

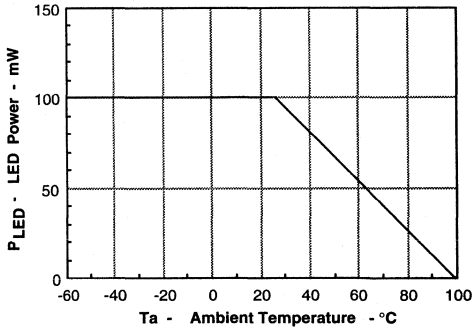


Figure 5. On-state terminal voltage vs. terminal current

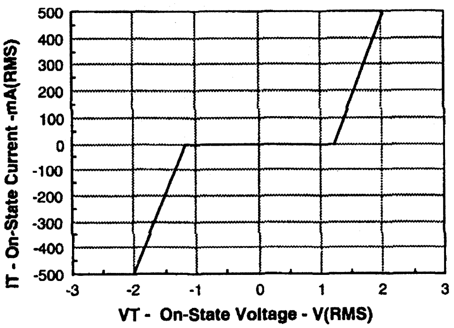
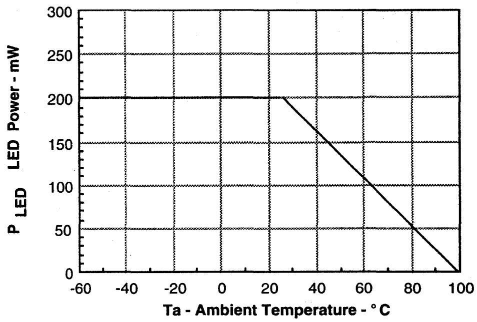


Figure 6. Maximum output power dissipation



Power Factor Considerations

A snubber isn't needed to eliminate false operation of the TRIAC driver because of the IL411's high static and commutating dv/dt with loads between 1 and 0.8 power factors. When inductive loads with power factors less than 0.8 are being driven, include a RC snubber or a single capacitor directly across the device to damp the peak commutating dv/dt spike. Normally a commutating dv/dt causes a turning-off device to stay on due to the stored energy remaining in the turning-off device.

But in the case of a zero voltage crossing optotriac, the commutating dv/dt spikes can inhibit one half of the TRIAC from turning on. If the spike potential exceeds the inhibit voltage of the zero cross detection circuit, half of the TRIAC will be held-off and not turn-on. This hold-off condition can be eliminated by using a snubber or capacitor placed directly across the optotriac as shown in Figure 7. Note that the value of the capacitor increases as a function of the load current.

The hold-off condition also can be eliminated by providing a higher level of LED drive current. The higher LED drive provides a larger photocurrent which causer. the phototransistor to turn-on before the commutating spike has activated the zero cross network. Figure 8 shows the relationship of the LED drive for power factors of less than 1.0. The curve shows that if a device requires 1.5 mA for a resistive load, then 1.8 times (2.7 mA) that amount would be required to control an inductive load whose power factor is less than 0.3.

Figure 7. Shunt capacitance versus load current versus power factor

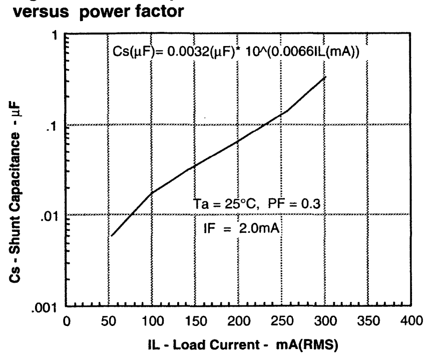
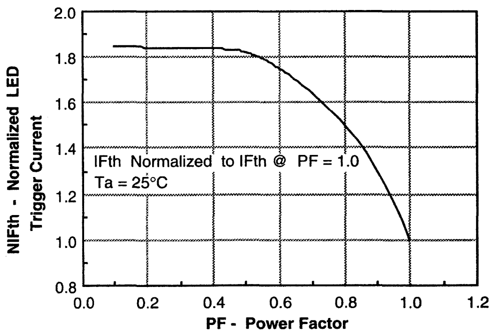


Figure 8. Normalized LED trigger current

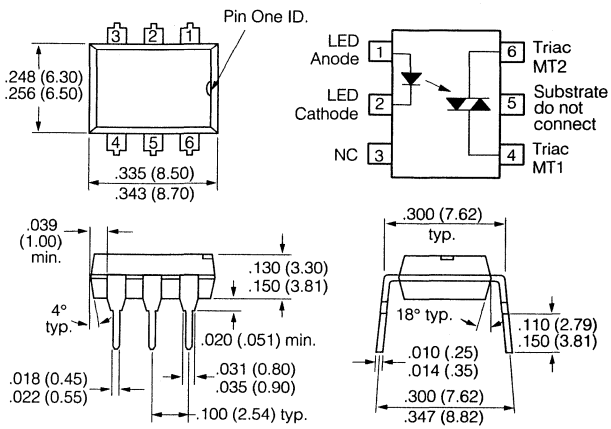


SIEMENS

IL4208

800 V TRIAC DRIVER OPTOCOUPLER

Package Dimensions in inches (mm)



FEATURES

- High Input Sensitivity, I_{FT}=2 mA
- Blocking Voltage, 800 V
- Isolation Test Voltage 5300 VAC_{RMS}
- 300 mA On-state Current
- High Static dv/dt 10,000 V/Ms
- Inverse Parallel SCRs Provide Commutating dv/dt >2K V/µs
- Very Low Leakage <10 µA
- Small 6-Pin DIP Package
- Underwriters Lab File #E52744
- VDE 0884 Available with Option 1

Maximum Ratings

Emitter

Reverse Voltage .... 6 V
Forward Current .... 60 mA
Surge Current .... 2.5 A
Thermal Resistance .... 750 °C/W
Derate from 25°C .... 1.33 mW/°C

Detector

Peak Off-state Voltage .... 800 V
Peak Reverse Voltage .... 800 V
RMS On-state Current .... 300 mA
Single Cycle Surge .... 3 A
Thermal Resistance .... 125 °C/W
Total Power Dissipation .... 500 mW
Derate from 25°C .... 6.6 mW/°C

Package

Isolation Test Voltage (between emitter and detector, climate per DIN 40046, part 2, Nov. 74 (t=1 min.) ....5300 VAC_{RMS}
Pollution Degree (DIN VDE 0109) 2
Creepage Distance ....≥7 mm
Clearance ....≥7 mm
Comparative Tracking Index per DIN IEC 112/VDE 0303 part 1, Group IIIa per DIN VDE 6110 175
Isolation Resistance
V_{IO}=500 V, T_A=25°C ....$\geq 10^{12}\ \Omega$
V_{IO}=500 V, T_A=100°C ....$\geq 10^{11}\ \Omega$
Storage Temperature Range ..... –55°C to +125°C
Ambient Temperature Range..... –55°C to +100°C
Soldering Temperature (max. ≤10 sec. dip soldering ≥0.5 mm from case bottom) ....260°C

DESCRIPTION

The IL4208 consists of a GaAs IRLED optically coupled to a photosensitive non-zero crossing TRIAC network. The TRIAC consists of two inverse parallel connected monolithic SCRs. These three semiconductors are assembled in a six pin 0.3 inch dual in-line package, using high insulation double molded, over/under leadframe construction.

High input sensitivity is achieved by using an emitter follower phototransistor and a cascaded SCR predriver resulting in an LED trigger current of less than 2 mA (DC).

The IL4208 uses two discrete SCRs resulting in a commutating dV/dt greater than 10 KV/µs. The use of a proprietary dv/dt clamp results in a static dV/dt of greater than 10KV/µs. This clamp circuit has a MOSFET that is enhanced when high dV/dt spikes occur between MT1 and MT2 of the TRIAC. When conducting, the FET clamps the base of the phototransistor, disabling the first stage SCR predriver.

The 800V blocking voltage permits control of off-line voltages up to 240VAC, with a safety factor of more than two, and is sufficient for as much as 380VAC.

The IL4208 isolates low-voltage logic from 120, 240, and 380 VAC lines to control resistive, inductive, or capacitive loads including motors, solenoids, high current thyristors or TRIAC and relays.

Applications include solid-state relays, industrial controls, office equipment, and consumer appliances.

Electrical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.16	1.35	V	I_F=10 mA
Reverse Current	I_R		0.1	10	µA	V_R=6 V
Capacitance	C_0		40		pF	V_F=0 V, f=1 MHz
Thermal Resistance, Junction to Lead	R_{THJL}		750		°C/W	
Output Detector						
Repetitive Peak Off-state Voltage	V_{DRM}	800			V	I_{DRM}=100 µA
Repetitive Peak Reverse Voltage	V_{RRM}	800			V	I_{RM}=100 µA
Off-state Voltage	$V_{D(RMS)}$	565			V	$I_{D(RMS)}$=70 µA
Reverse Voltage	V_R	565			V	$I_{R(RMS)}$=70 µA
Off-state Current	$I_{D(RMS)}$		10	100	µA	V_D=800 V, T_A100°C
Reverse Current	$I_{R(RMS)}$		10	100	µA	V_R=800 V, T_A=100°C
On-state Voltage	V_{TM}		1.7	3	V	I_T=300 mA
On-state Current	I_{TM}			300	mA	PF=1.0, $V_{T(RMS)}$=1.7 V
Surge (Non-repetitive On-state Current)	I_{TSM}			3	A	f=50 Hz
Holding Current	I_H		65	500	µA	
Latching Current	I_L		5		mA	V_T=2.2 V
LED Trigger Current	I_{FT}		1	2	mA	V_{AK}=5 V
Turn-on Time Turn-off Time	t_{ON} t_{OFF}		35 50		µs µs	V_{RM}=V_{DM}=565 VAC, PF=1.0, I_T=300 mA
Critical Rate of Rise of Off-State Voltage	dv/dt_{cr} dv/dt_{cr}	10000 5000			V/µ V/µss	V_D=0.67 V_{DRM}, T_j=25°C V_D=0.67 V_{DRM}, T_j=80°C
Critical Rate of Rise of Voltage at Current Commutation	dv/dt_{crq} dv/dt_{crq}	10000 5000			V/µs	V_D=0.67 V_{DRM}, di/dt_{crq}<15 A/ms T_j=25°C T_j=80°C
Critical Rate of Rise of On-state Current	$di/dt/_{cr}$			8	A/µs	
Thermal Resistance, Junction to Lead	R_{THJL}		150		°C/W	
Package						
Critical Rate of Rise of Coupled Input/Output Voltage	$dv_{(IO)}/dt$		5000		V/µs	I_T=0 A, V_{RM}=V_{DM}=565 VAC
Common Mode Coupling Capacitor	C_{CM}		0.01		pF	
Package Capacitance	C_{IO}		0.8		pF	f=1 MHz, V_{IO}=0 V
Trigger Current Temperature Gradient	$\Delta I_{FT}/\Delta T_j$		7	14	µA/K	

SIEMENS

600 V IL4216
700 V IL4217
800 V IL4218
TRIAC DRIVER OPTOCOUPLER

FEATURES

- **High Input Sensitivity I_{FT}=1.3 mA**
- **600/700/800 V Blocking Voltage**
- **300 mA On-State Current**
- **High Static dv/dt 10,000 V/µsec., typical**
- **Inverse Parallel SCRs Provide Commutating dv/dt >10 KV/µsec**
- **Very Low Leakage <10 µA**
- **Isolation Test Voltage from Double Molded Package 5300 VAC_{RMS}**
- **Package, 6-Pin DIP**
- **Underwriters Lab File #E52744**

DESCRIPTION

The IL421x consists of an AlGaAs IRLED optically coupled to a pair of photosensitive non-zero crossing SCR chips and are connected inversely parallel to form a TRIAC. These three semiconductors are assembled in a six pin 0.3 inch dual in-line package, using high insulation double molded, over/under leadframe construction.

High input sensitivity is achieved by using an emitter follower phototransistor and a cascaded SCR predriver resulting in an LED trigger current of less than 1.3 mA (DC).

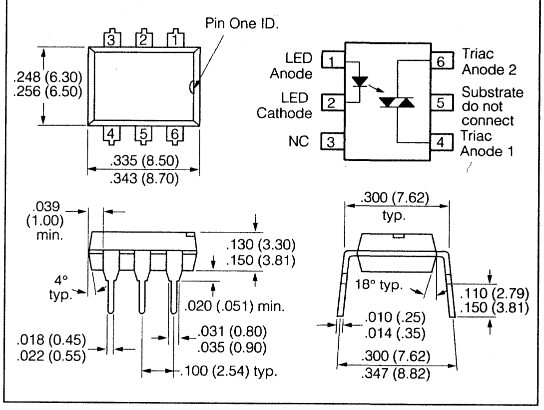
The IL421x uses two discrete SCRs resulting in a commutating dv/dt of greater than 10KV/µs. The use of a proprietary *dv/dt clamp* results in a static dv/dt of greater than 10KV/µs. This clamp circuit has a MOSFET that is enhanced when high dv/dt spikes occur between MT1 and MT2 of the TRIAC. The FET clamps the base of the phototransistor when conducting, disabling the internal SCR predriver.

The blocking voltage of up to 800 V permits control of off-line voltages up to 240 VAC, with a safety factor of more than two, and is sufficient for as much as 380 VAC. Current handling capability is up to 300 mA RMS, continuous at 25°C.

The IL421x isolates low-voltage logic from 120, 240, and 380 VAC lines to control resistive inductive, or capacitive loads including motors solenoids, high current thyristors or TRIAC and relays.

Applications include solid-state relays, industrial controls, office equipment, and consumer appliances.

Package Dimensions in Inches (mm)



Maximum Ratings

Emitter

Reverse Voltage	6 V
Forward Current	60 mA
Surge Current	2.5 A
Power Dissipation	100 mW
Derate Linearly from 25°C	1.33 mW/°C
Thermal Resistance	750 °C/W

Detector

Peak Off-State Voltage	
IL4216	600 V
IL4217	700 V
IL4218	800 V
RMS On-State Current	300 mA
Single Cycle Surge	3 A
Total Power Dissipation	500 mW
Derate Linearly from 25°C	6.6 mW/°C
Thermal Resistance	150°C/W

Package

Isolation Test Voltage	5300 VAC_{RMS}
Storage Temperature	–55°C to +150°C
Operating Temperature	–55°C to +100°C
Lead Soldering Temperature	260°C/5 sec.
Isolation Resistance	
V_{IO}=500 V, T_A=25°C	$\geq 10^{12}\ \Omega$
V_{IO}=500 V, T_A=100°C	$\geq 10^{11}\ \Omega$

Characteristics (T_A=25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.3	1.5	V	I_F=20 mA
Breakdown Voltage	V_{BR}	6	30		V	I_R=10 µA
Reverse Current	I_R		0.1	10	µA	V_R =6 V
Capacitance	C_O		40		pF	V_F=0 V, f=1 MHz
Thermal Resistance, Junction to Lead	R_{THJL}		750		°C/W	
Output Detector						
Repetitive Peak						
Off-State Voltage						
IL4216	V_{DRM}	600	650		V	I_{DRM}=100 µA
IL4217	V_{DRM}	700	750		V	I_{DRM}=100 µA
IL4218	V_{DRM}	800	850		V	I_{DRM}=100 µA
Off-State Voltage						
IL4216	$V_{D(RMS)}$	424	460		V	$I_{D(RMS)}$=70 µA
IL4217	$V_{D(RMS)}$	494	536		V	$I_{D(RMS)}$=70 µA
IL4218	$V_{D(RMS)}$	565	613		V	$I_{D(RMS)}$=70 µA
Off-State Current	$I_{D(RMS)}$		10	100	µA	V_D=600 V, T_A=100°C
Reverse Current	$I_{R(RMS)}$		10	100	µA	V_R=600 V, T_A=100°C
On-State Voltage	V_{TM}		1.7	3	V	I_T=300 mA
On-State Current	I_{TM}			300	mA	PF=1.0, $V_{T(RMS)}$=1.7 V
Surge (Non-Repetitive)						
On-State Current)	I_{TSM}			3	A	f=50 Hz
Holding Current	I_H		65	200	µA	V_T=3 V
Latching Current	I_L		5		mA	V_T=2.2 V
LED Trigger Current	I_{FT}		0.7	1.3	mA	V_{AK}=5 V
Turn-On Time	t_{ON}		35		µs	V_{RM}=V_{DM}=424 VAC
Turn-Off Time	t_{OFF}		50		µs	PF=1.0, I_T=300 mA
Critical Rate of Rise:						
Off-State Voltage	$dv_{(MT)}/dt$	10,000			V/µs	V_{RM}, V_{DM}=400 VAC, T_A=25°C
			2000		V/µs	V_{RM}, V_{DM}=400 VAC, T_A=80°C
Communtating Voltage	$dv_{(COM)}/dt$	10,000			V/µs	V_{RM}, V_{DM}=400 VAC, T_A=25°C
			2000		V/µs	V_{RM}, V_{DM}=400 VAC, T_A=80°C
Off-State Current	di/dt		100		A/ms	I_T=300 mA
Thermal Resistance, Junction to Lead	R_{THJL}		150		°C/W	
Package						
Critical Rate of Rise of Coupled						I_T=0 A,
Input-Output Voltage	$dv_{(IO)}/dt$	5000			V/µs	V_{RM}=V_{DM}=300 VAC
Common Mode						
Coupling Capacitor	C_{CM}		0.01		pF	
Package Capacitance	C_{IO}		0.8		pF	f=1MHz, V_{IO}=0 V

Figure 1. LED forward current vs. forward voltage

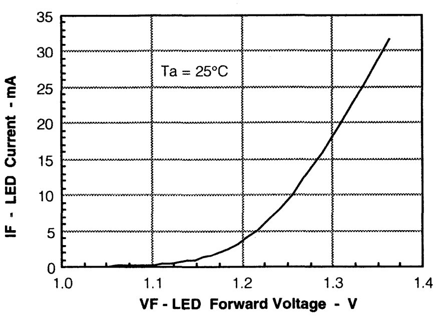


Figure 2. Forward voltage versus forward current

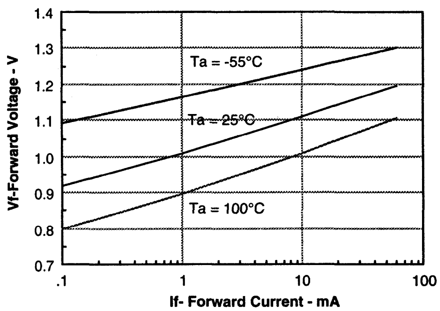


Figure 3. Peak LED current vs. duty factor, Tau

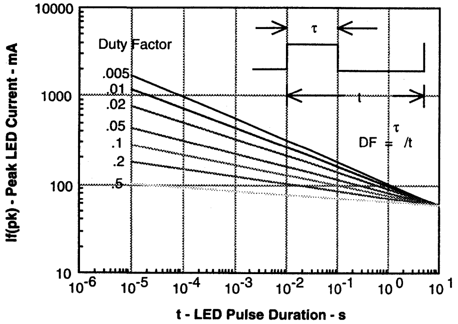


Figure 4. Maximum LED power dissipation

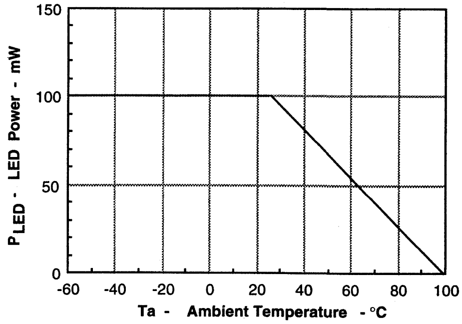


Figure 5. On-state terminal voltage vs. terminal current

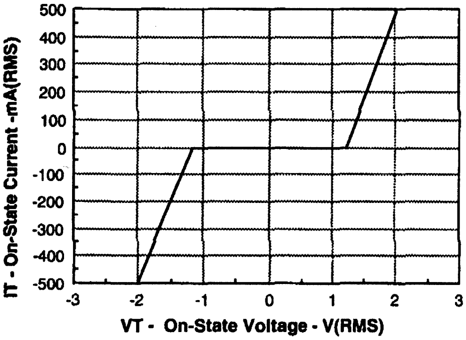
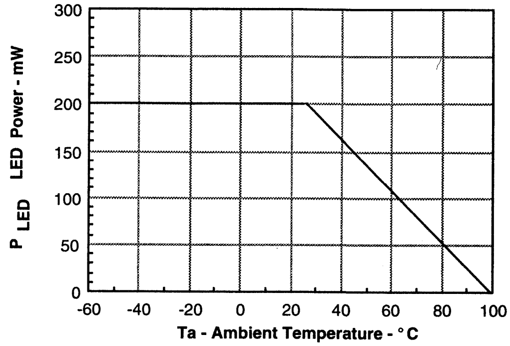


Figure 6. Maximum output power dissipation



Power Factor Considerations

A snubber isn't needed to eliminate false operation of the TRIAC driver because of the IL411's high static and commutating dv/dt with loads between 1 and 0.8 power factors. When inductive loads with power factors less than 0.8 are being driven, include a RC snubber or a single capacitor directly across the device to damp the peak commutating dv/dt spike. Normally a commutating dv/dt causes a turning-off device to stay on due to the stored energy remaining in the turning-off device.

But in the case of a zero voltage crossing optotriac, the commutating dv/dt spikes can inhibit one half of the TRIAC from turning on. If the spike potential exceeds the inhibit voltage of the zero cross detection circuit, half of the TRIAC will be held-off and not turn-on. This hold-off condition can be eliminated by using a snubber or capacitor placed directly across the optotriac as shown in Figure 7. Note that the value of the capacitor increases as a function of the load current.

The hold-off condition also can be eliminated by providing a higher level of LED drive current. The higher LED drive provides a larger photocurrent which causer. the phototransistor to turn-on before the commutating spike has activated the zero cross network. Figure 8 shows the relationship of the LED drive for power factors of less than 1.0. The curve shows that if a device requires 1.5 mA for a resistive load, then 1.8 times (2.7 mA) that amount would be required to control an inductive load whose power factor is less than 0.3.

Figure 7. Shunt capacitance versus load current versus power factor

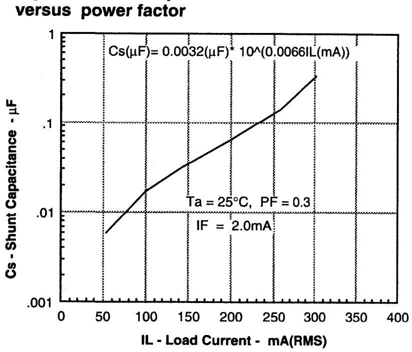
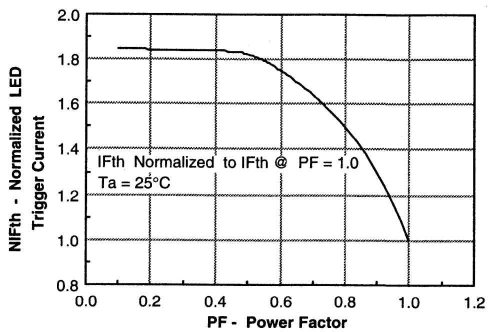


Figure 8. Normalized LED trigger current



SIEMENS

ILCT6
DUAL PHOTOTRANSISTOR OPTOCOUPLER

FEATURES

- **Current Transfer Ratio, 50% Typical**
- **Leakage Current, 1 nA Typ.**
- **Two Isolated Channels Per Package**
- **Direct Replacement for MCT6**
- **Underwriters Lab File #E52744**
- **VDE 0884 Available with Option1**

DESCRIPTION

The ILCT6 is a two channel opto isolator for high density applications. Each channel consists of an optically coupled pair with a gallium arsenide infrared LED and a silicon NPN phototransistor. Signal information, including a DC level, can be transmitted by the device while maintaining a high degree of electrical isolation between input and output.

The ILCT6 is especially designed for driving medium-speed logic, where it may be used to eliminate troublesome ground loop and noise problems. It can also be used to replace relays and transformers in many digital interface applications, as well as analog applications such as CRT modulation.

Maximum Ratings

Emitter (each channel)

Rated Forward Current, DC .... 60 mA
Peak Forward Current, DC
(1 µs pulse, 300 pps) .... 3 A
Power Dissipation at 25°C Ambient .... 100 mW
Derate Linearly from 25°C .... 1.3 mW/°C

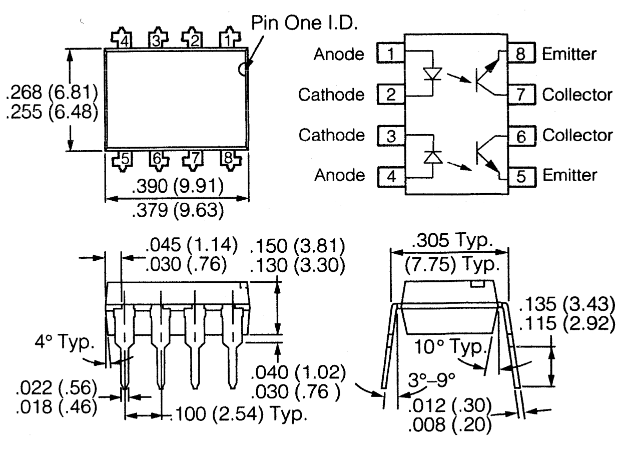
Detector (each channel)

Collector Current .... 30 mA
Collector-Emitter Breakdown Voltage .... 30 V
Power Dissipation at 25°C Ambient .... 150 mW
Derate Linearly from 25°C .... 2 mW/°C

Package

Isolation Test Voltage .... 5300 VAC_{RMS}
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... ≥10^{12} Ω
V_{IO}=500 V, T_A=100°C .... ≥10^{11} Ω
Creepage .... 7 mm min.
Clearance .... 7 mm min.
Total Package Dissipation
at 25°C Ambient. .... 400 mW
Derate Linearly from 25°C .... 5.33 mW/°C
Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Lead Soldering Time at 260°C .... 10 sec.

Package Dimensions in Inches (mm)



Electrical Characteristics (T_A=25°C)

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.25	1.50	V	I_F=20 mA
Reverse Current	I_R		0.1	10	µA	V_R=3.0 V
Junction Capacitance	C_J		25		pF	V_F=0 V
Detector						
Breakdown Voltage						
Collector-Emitter	BV_{CEO}	30	65		V	I_C=10 µA
Emitter-Collector	BV_{ECO}	7.0	10		V	I_E=10 µA
Leakage Current						
Collector-Emitter	I_{CEO}		1.0	100	nA	V_{CE}=10 V
Capacitance						
Collector-Emitter	C_{CE}		8.0		pF	V_{CE}=0 V
Package						
DC Current Transfer Ratio	CTR	20	50		%	I_F=10 mA, V_{CE}=10 V
Saturation Voltage Collector-Emitter	V_{CEsat}			0.40	V	I_C=2.0 mA, I_F=16 mA
Ilsolation Capacitance	C_{ISOL}		0.5		pF	f=1.0 MHz
Capacitance between Channels			0.4		pF	f=1.0 MHz
Bandwidth			150		KHz	I_C=2.0 mA, V_{CC}=10 V, R_L=100 Ω
Switching Times Output Transistor	t_{on}, t_{off}		3.0		µs	I_C=2 mA, R_E=100 Ω, V_{CE}=10 V

Optocouplers (Optoisolators) 5

Figure 1. Forward voltage versus forward current

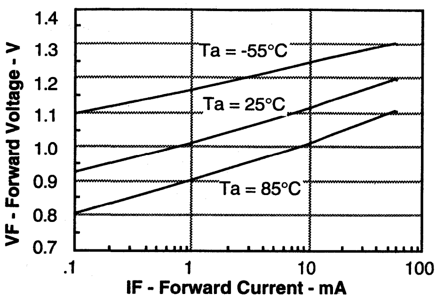


Figure 2. Normalized non-saturated and saturated CTR at Ta = 25°C versus LED current

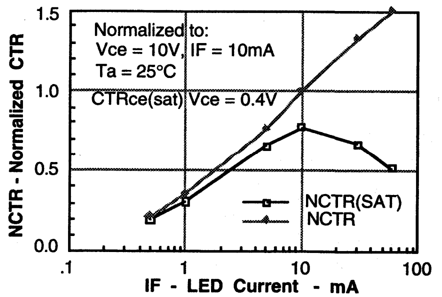


Figure 3. Normalized non-saturated and saturated CTR at Ta = 50°C versus LED current

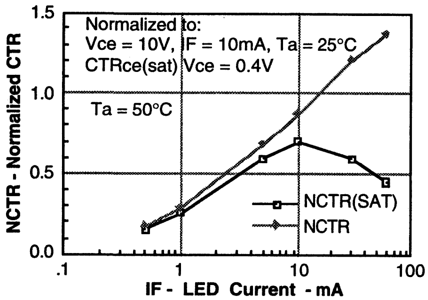


Figure 4. Normalized non-saturated and saturated CTR at Ta = 70°C versus LED current

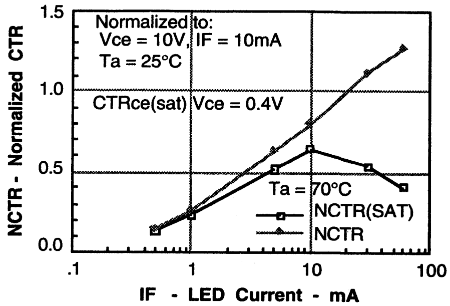


Figure 5. Normalized non-saturated and saturated CTR at Ta = 85°C versus LED current

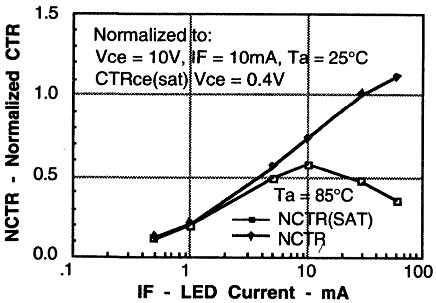


Figure 6. Collector-emitter current versus temperature and LED current

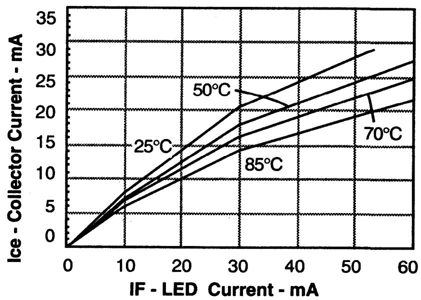


Figure 7. Collector-emitter leakage current versus temperature

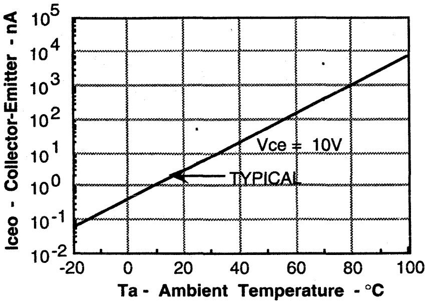


Figure 8. Propagation delay versus collector load resistor

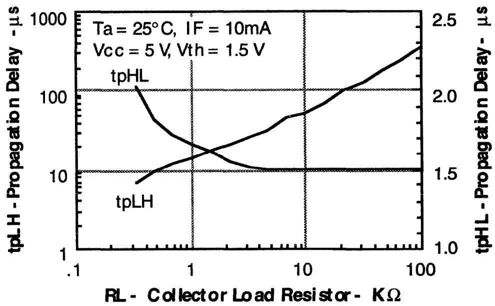


Figure 9. Switching Timing

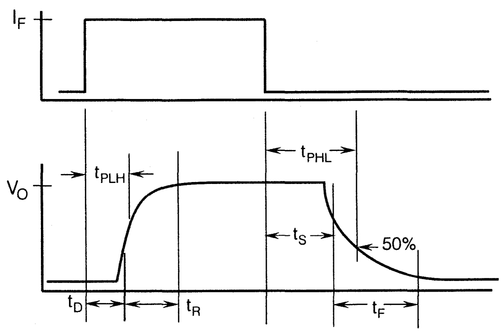
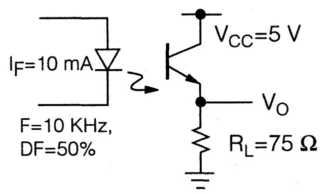


Figure 10. Switching schematic



Optocouplers (Optoisolators)

5

SIEMENS

DUAL CHANNEL ILD1/2/5
QUAD CHANNEL ILQ1/2/5
PHOTOTRANSISTOR OPTOCOUPLER

FEATURES

- **Current Transfer Ratio at I_F=10 mA**
  ILD/Q1, 20% Min.
  ILD/Q2, 100% Min.
  ILD/Q5, 50% Min.
- **High Collector-Emitter Voltage**
  ILD/Q1 – BV_{CEO}=50 V
  ILD/Q2, ILD/Q5 – BV_{CEO}=70 V
- **Field-Effect Stable by TRansparent IOn Shield (TRIOS)**
- **Isolation Test Voltage, 5300 VAC_{RMS}**
- **Underwriters Lab File #E52744**
- **VDE 0884 Available with Option 1**

Maximum Ratings (Each Channel)

Emitter

Reverse Voltage .... 6 V
Forward Current .... 60 mA
Surge Current .... 2.5 A
Power Dissipation .... 100 mW
Derate Linearly from 25°C .... 1.3 mW/°C

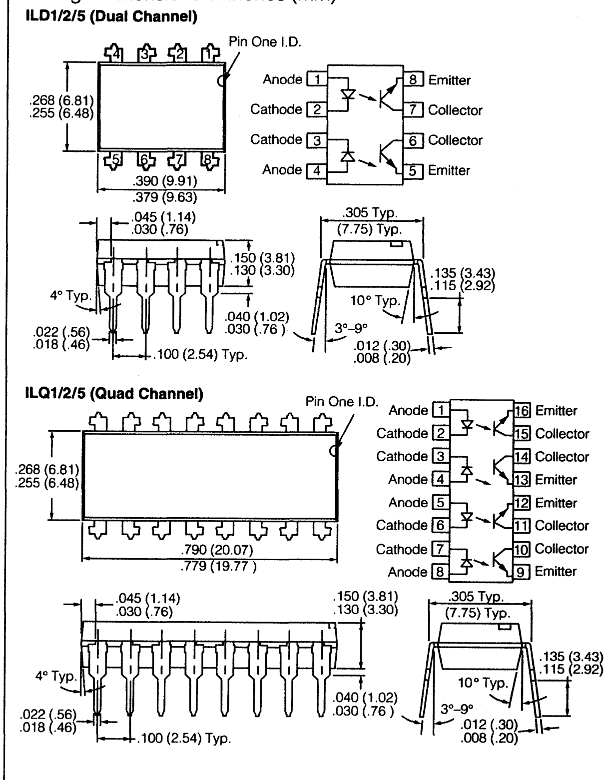
Detector

Collector-Emitter Reverse Voltage
ILD/Q1 .... 50 V
ILD/Q2, ILD/Q5 .... 70 V
Collector Current .... 50 mA
Collector Current (t<1 ms) .... 400 mA
Power Dissipation .... 200 mW
Derate Linearly from 25°C .... 2.6 mW/°C

Package

Isolation Test Voltage (between emitter and detector referred to standard climate 23°C/50%RH, DIN 50014) .... 5300 VAC_{RMS}
Creepage .... min. 7 mm
Clearance .... min. 7 mm
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... $R_{IO}=10^{12}\ \Omega$
V_{IO}=500 V, T_A=100°C .... $R_{IO}=10^{11}\ \Omega$
Package Power Dissipation .... 250 mW
Derate Linearly from 25°C .... 3.3 mW/°C
Storage Temperature .... –40°C to +150°C
Operating Temperature .... –40°C to +100°C
Junction Temperature .... 100°C
Soldering Temperature
(2 mm from case bottom) .... 260°C

Package Dimensions in Inches (mm)



DESCRIPTION

The ILD/Q1/2/5 are optically coupled isolated pairs employing GaAs infrared LEDs and silicon NPN phototransistor. Signal information, including a DC level, can be transmitted by the drive while maintaining a high degree of electrical isolation between input and output. The ILD/Q1/2/5 are especially designed for driving medium-speed logic and can be used to eliminate troublesome ground loop and noise problems. Also these couplers can be used to replace relays and transformers in many digital interface applications such as CRT modulation. The ILD1/2/5 has two isolated channels in a single DIP package and the ILQ1/2/5 has four isolated channels per package.

See Appnote 45, "How to Use Optocoupler Normalized Curves."

Characteristics

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.25	1.65	V	I_F=60 mA
Reverse Current	I_R		0.01	10	µA	V_R=6 V
Capacitance	C_0		25		pF	V_R=0 V, f=1 MHz
Thermal Resistance Junction to Lead	R_{THJL}		750		°C/W	
Detector						
Capacitance	C_{CE}		6.8		pF	V_{CE}=5 V, f=1 MHz
Collector-Emitter Leakage Current	I_{CEO}		5	50	nA	V_{CE}=10 V
Collector-Emitter Saturation Voltage	V_{CESAT}		0.25	0.4		I_{CE}=1 mA, I_B=20 µA
DC Forward Current Gain	HFE	200	650	1800		V_{CE}= 10 V, I_B=20 µA
Saturated DC Forward Current Gain	HFE_{SAT}	120	400	600		V_{CE}= 0.4 V, I_B=20 µA
Thermal Resistance Junction to Lead	R_{THJL}		500		°C/W	

Package Transfer Characteristics (Each Channel)

	Symbol	Min.	Typ.	Max.	Unit	Condition
ILD/Q1						
Saturated Current Transfer Ratio (Collector-Emitter)	CTR_{CESAT}		75		%	I_F=10 mA, V_{CE}=0.4 V
Current Transfer Ratio (Collector-Emitter)	CTR_{CE}	20	80	300	%	I_F=10 mA, V_{CE}=10 V
ILD/Q2						
Saturated Current Transfer Ratio (Collector-Emitter)	CTR_{CESAT}		170		%	I_F=10 mA, V_{CE}=0.4 V
Current Transfer Ratio (Collector-Emitter)	CTR_{CE}	100	200	500	%	I_F=10 mA, V_{CE}=10 V
ILD/Q5						
Saturated Current Transfer Ratio (Collector-Emitter)	CTR_{CESAT}		100		%	I_F=10 mA, V_{CE}=0.4 V
Current Transfer Ratio (Collector-Emitter)	CTR_{CE}	50	130	400	%	I_F=10 mA, V_{CE}=10 V
Isolation and Insulation						
Common Mode Rejection Output High	CMH		5000		V/µs	V_{CM}=50 V_{P-P} , R_L=1 kΩ, I_F=0 mA
Common Mode Rejection Output Low	CML		5000		V/µs	V_{CM}=50 V_{P-P} , R_L=1 kΩ, I_F=10 mA
Common Mode Coupling Capacitance	C_{CM}		0.01		pF	
Package Capacitance	C_{IO}		0.8		pF	V_{IO}=0 V, f=1 MHz

Typical Switching Times

Figure 1. Non-saturated switching timing

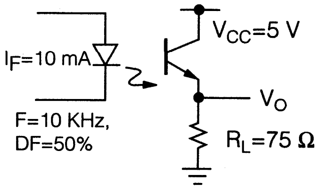


Figure 2. Saturated switching timing

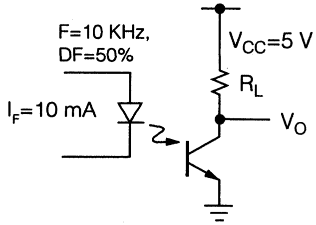


Figure 3. Non-saturated switching timing

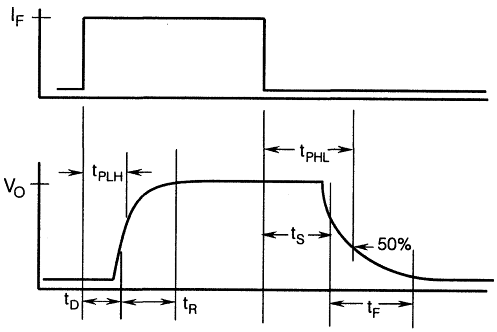
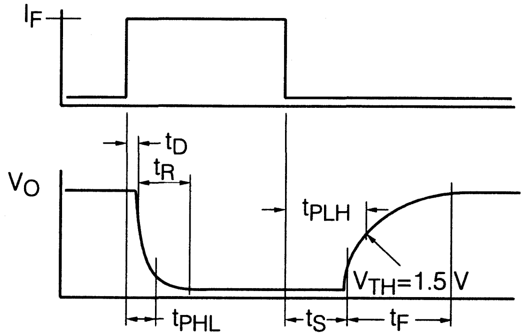


Figure 4. Saturated switching timing



Characteristic	ILD/Q1 I_F=20 mA	ILD/Q2 I_F=5 mA	ILD/Q5 I_F=10 mA	Unit	Condition
Delay, t_D	0.8	1.7	1.7	µs	
Rise Time , t_R	1.9	2.6	2.6	µs	V_{CC}=5 V
Storage, t_S	0.2	0.4	0.4	µs	R_L=75 Ω
Fall Time, t_F	1.4	2.2	2.2	µs	50% of V_{PP}
Propagation H-L, t_{PHL}	0.7	1.2	1.1	µs	
Propagation L-H, t_{PLH}	1.4	2.3	2.5	µs	

Characteristic	ILD/Q1 I_F=20 mA	ILD/Q2 I_F=5 mA	ILD/Q5 I_F=10 mA	Unit	Condition
Delay, t_D	0.8	1	1.7	µs	
Rise Time, t_R	1.2	2	7	µs	V_{CE}=0.4 V
Storage, t_S	7.4	5.4	4.6	µs	R_L=1 kΩ
Fall Time, t_F	7.6	13.5	20	µs	V_{CC}=5 V
Propagation H-L, t_{PHL}	1.6	5.4	2.6	µs	V_{TH}=1.5 V
Propagation L-H, t_{PLH}	8.6	7.4	7.2	µs	

Figure 5. Forward voltage versus forward current

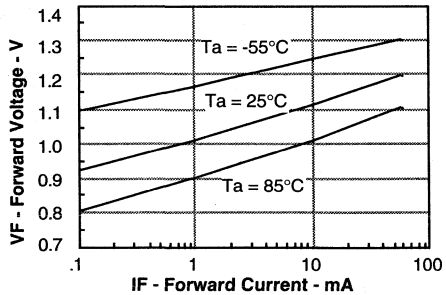


Figure 6. Normalized non-saturated and saturated CTR at T_A = 25°C versus LED current

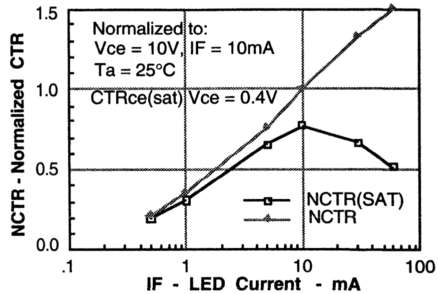


Figure 7. Normalized non-saturated and saturated CTR at T_A = 50°C versus LED current

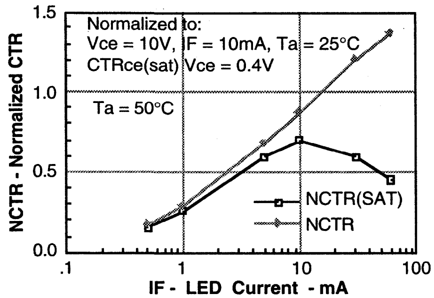


Figure 8. Normalized non-saturated and saturated CTR at T_A = 70°C versus LED current

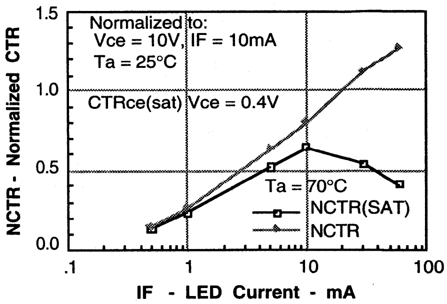


Figure 9. Normalized non-saturated and saturated CTR at T_A = 85°C versus LED current

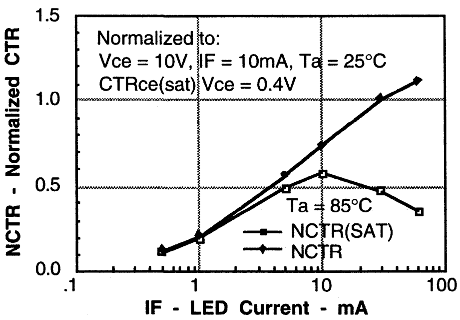


Figure 10. Collector-emitter current versus temperature and LED current

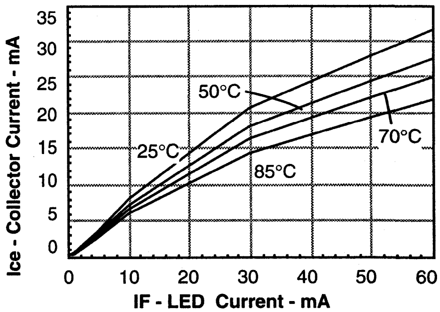


Figure 11. Collector-emitter leakage current versus temperature

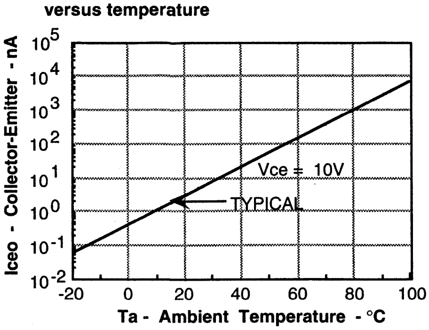
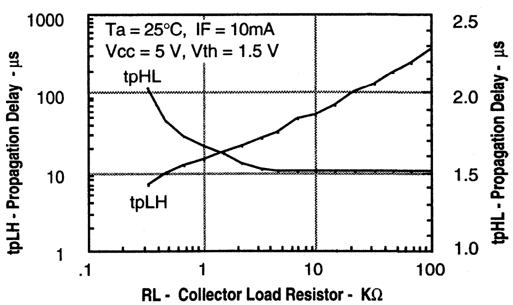


Figure 12. Propagation delay versus collector load resistor



SIEMENS

NEW

DUAL CHANNEL ILD3
QUAD CHANNEL ILQ3
PHOTOTRANSISTOR OPTOCOUPLER

FEATURES
- **Current Transfer Ratio at I_F=1.6 mA, 300% Min.**
- **High Collector-Emitter Voltage**
- **BV_{CEO}=50 V**
- **Field-Effect Stable by TRansparent IOn Shield (TRIOS)**
- **Double Molded Package Offers Isolation Test Voltage 5300 VAC_{RMS}, 1 sec.**
- **Underwriters Lab File #E52744**
- **VDE 0884 Available with Option 1**

Maximum Ratings (Each Channel)

Emitter

Reverse Voltage..6 V
Continuous Forward Current...............................60 mA
Surge Current .... 2.5 A
Power Dissipation...100 mW
Derate Linearly from 25°C ....1.3 mW/°C

Detector

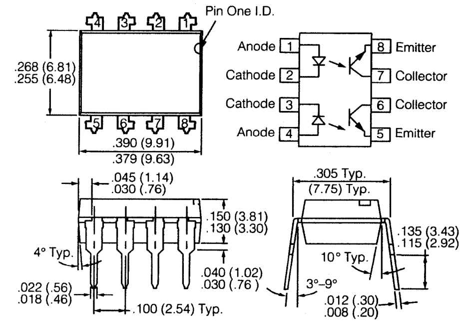
Collector-Emitter Reverse Voltage ....50 V
Collector Current ....50 mA
Collector Current (t<1 ms)................................400 mA
Total Power Dissipation....................................200 mW
Derate Linearly from 25°C ....2.6 mW/°C

Package

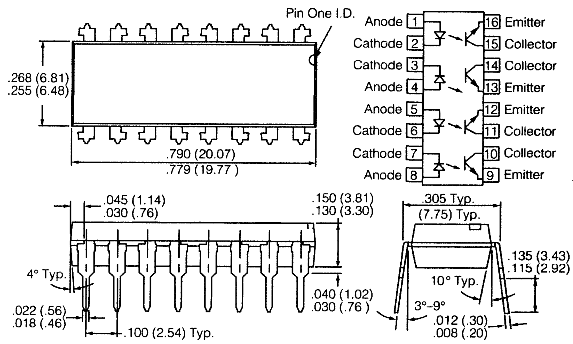
Isolation Test Voltage (between emitter and detector, refer to standard climate 23°C/50% RH, DIN50014)................................... V_{IO}=5300 VAC_{RMS}
Creepage... min. 7 mm
Clearance .... min. 7 mm
Isolation Resistance
V_{IO}=500 V, T_A=25°C............................... $R_{IO}=10^{12}$ Ω
V_{IO}=500 V, T_A=100°C............................ $R_{IO}=10^{11}$ Ω
Power Dissipation...250 mW
Derate Linearly from 25°C ....3.3 mW/°C
Storage Temperature Range ....–40 to +150°C
Operating Temperature Range..............–40 to +100°C
Junction Temperature .... 100°C
Soldering Temperature,
2 mm from case bottom. ....260°C

Package Dimensions in Inches (mm)

ILD3—Dual Channel



ILQ3—Quad Channel



DESCRIPTION

The ILD/Q3 are optically coupled isolated pairs employing GaAs infrared LEDs and silicon NPN phototransistor. Signal information, including a DC level, can be transmitted by the drive while maintaining a high degree of electrical isolation between input and output. The ILD/Q3 are especially designed for driving medium-speed logic and can be used to eliminate troublesome ground loop and noise problems. Also these couplers can be used to replace relays and transformers in many digital interface applications such as CRT modulation. The ILD3 has two isolated channels in a single DIP package and the ILQ3 has four isolated channels per package.

See Appnote 45, *"How to Use Optocoupler Normalized Curves."*

Characteristics

Emitter (IR GaAs)	Symbol	Min.	Typ.	Max.	Unit	Test Condition
Forward Voltage	V_F		1.25	1.65	V	I_F=60 mA
Reverse Current	I_R		0.01	10	µA	V_R=6 V
Capacitance	C_0		25		pF	V_R=0 V, f=1 MHz
Thermal Resistance, Junction to Lead	R_{THJL}		750		°C/W	
Detector						
Collector-Emitter Leakage Current	I_{CEO}		5	70	nA	V_{CE}=15 V
Capacitance	C_{CE}		6.8		pF	V_{CE}=5 V, f=1 MHz
Thermal Resistance, Junction to Lead	R_{THJL}		500		°C/W	
Package Transfer Characteristics (Each Channel)						
Saturated Current Transfer Ratio, ILD/Q3-1	CTR_{SAT}	300			%	I_F=1.6 mA, V_{CE}=0.4 V
Saturated Current Transfer Ratio, ILD/Q3-2	CTR_{SAT}	100			%	I_F=1.0 mA, V_{CE}=0.4 V
Common Mode Rejection Output High	CMH		5000		V/µs	V_{CM}=50 V_{P-P}, R_L=10 kΩ, I_F=0 mA
Common Mode Rejection Output Low	CML		5000		V/µs	V_{CM}=50 V_{P-P}, R_L=10 kΩ, I_F=0 mA
Common Mode Coupling Capacitance	C_{CM}		0.01		pF	
Package Capacitance	C_{IO}		0.8		pF	V_{IO}=0 V, f=1 MHz

SIEMENS

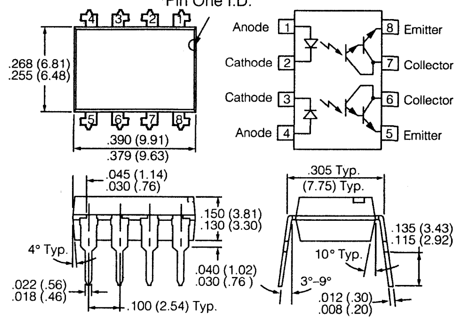
DUAL CHANNEL ILD32
QUAD CHANNEL ILQ32
PHOTODARLINGTON OPTOCOUPLER

FEATURES

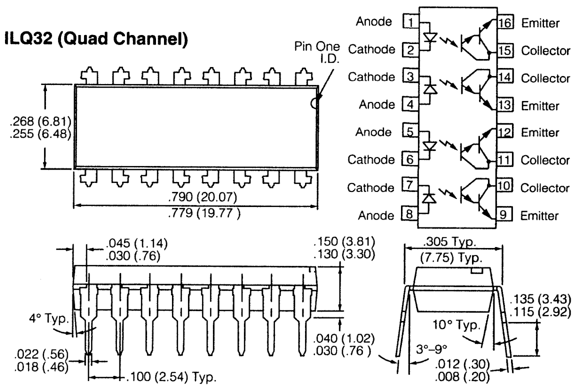
- **Very High Current Transfer Ratio, 500% Min.**
- **Isolation Test Voltage, 5300 VAC_{RMS}**
- **High Isolation Resistance, 10^{11} Ω Typical**
- **Low Coupling Capacitance**
- **Standard Plastic DIP Package**
- **Underwriters Lab File #E52744**
- **VDE 0884 Available with Option 1**

Package Dimensions in Inches (mm)

ILD32 (Dual Channel)



ILQ32 (Quad Channel)



Maximum Ratings (Each Channel)

Emitter

Peak Reverse Voltage .... 3 V
Continuous Forward Current .... 60 mA
Power Dissipation at 25°C .... 100 mW
Derate Linearly from 25°C .... 1.33 mW/°C

Detector

Collector-Emitter Breakdown Voltage .... 30 V
Collector (Load) Current .... 125 mA
Power Dissipation at 25°C Ambient .... 150 mW
Derate Linearly from 25°C .... 2.0 mW/°C

Package

Isolation Test Voltage (between emitter and detector refered to standard climate 23°C/50%RH, DIN 50014) (t=1 sec.) .... 5300 VAC_{RMS}
Creepage .... 7 mm min.
Clearance .... 7 mm min.
Comparative Tracking Index per DIN IEC 112/VDE303, part 1 .... ≥175
Isolation Resistance
V_{IO}=500V, T_A=25°C .... $R_{IO}=10^{12}Ω$
V_{IO}=500V, T_A=100°C .... $R_{IO}=10^{11}Ω$
Total Dissipation at 25°C Ambient
ILD32 .... 400 mW
ILQ32 .... 500 mW
Derate Linearly from 25°C
ILD32 .... 5.33 mW/°C
ILQ32 .... 6.67 mW/°C
Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Lead Soldering Time at 260°C .... 10 sec.

DESCRIPTION

The ILD32/ILQ32 are optically coupled isolators with a Gallium Arsenide infrared LED and a silicon photodarlington sensor. Switching can be achieved while maintaining a high degree of isolation between driving and load circuits. These optocouplers can be used to replace reed and mercury relays with advantages of long life, high speed switching and elimination of magnetic fields.

The ILD32 has two isolated channels in a DIP package, and the ILQ32 has four channels. These devices can be used to replace 4N32s or 4N33s in applications calling for several single channel optocouplers on a board.

Electrical Characteristics (T_A=25°C)

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.25	1.5	V	I_F=10 mA
Reverse Current	I_R		0.1	100	µA	V_R=3.0 V
Capacitance	C_O		25		pF	V_R=0 V
Detector						
Breakdown Voltage Collector-Emitter	BV_{CEO}	30			V	I_C=100 µA, I_F=0
Emitter-Collector	BV_{ECO}	5	10		V	I_E=100 µA
Collector-Emitter Leakage Current	I_{CEO}		1.0	100	nA	V_{CE}=10 V, I_F=0
Package						
Current Transfer Ratio	CTR	500			%	I_F=10 mA, V_{CE}=10 V
Collector-Emitter Saturation Voltage	V_{CEsat}			1.0	V	I_C=2 mA, I_F=8 mA
Isolation Capacitance	C_{ISOL}		0.5		pF	
Turn-On Time	t_{on}		15		µs	V_{CC}=10 V
Turn -Off Time	t_{off}		30		µs	I_F=5 mA, R_L=100 Ω

Figure 1. Forward voltage versus forward current

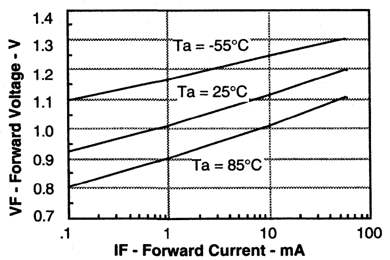


Figure 2. Normalized non-saturated and saturated CTRce at T_A = 25°C versus LED current

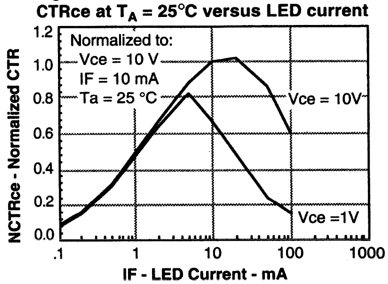


Figure 3. Normalized non-saturated and saturated collector-emitter current versus LED current

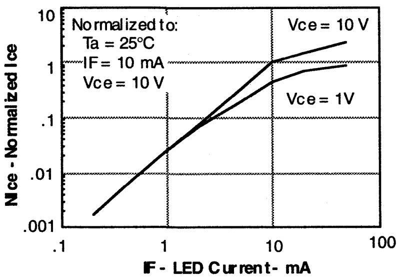


Figure 4. Low to high propagation delay versus collector load resistance and LED current

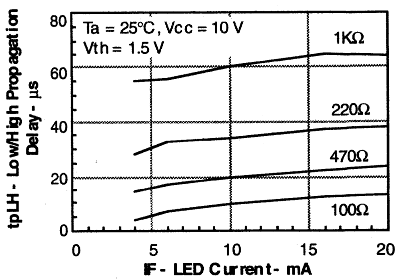


Figure 5. High to low propagation delay versus collector load resistance and LED current

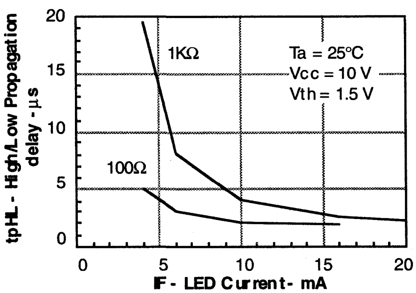


Figure 6. Switching timing

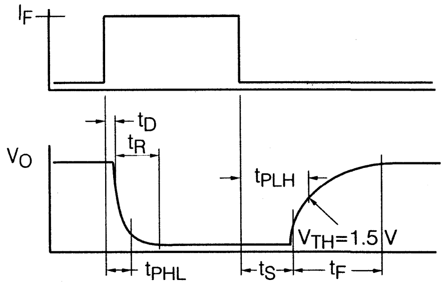
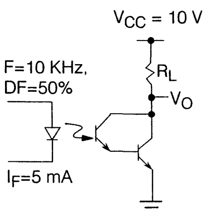


Figure 7. Switching schematic



SIEMENS

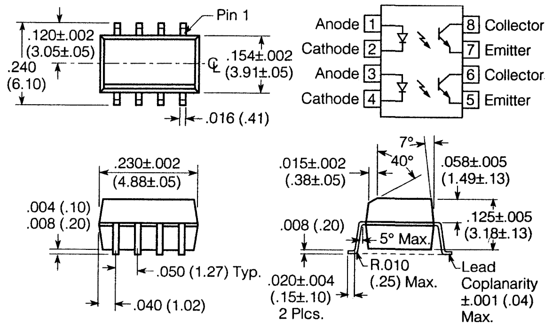
ILD205/206/207/211/213/217

DUAL PHOTOTRANSISTOR SMALL OUTLINE SURFACE MOUNT OPTOCOUPLER

FEATURES

- Two Channel Coupler
- Industry Standard SOIC-8 Surface Mountable Package
- Standard Lead Spacing of .05"
- Available in Tape and Reel Option (Conforms to EIA Standard 481-2)
- Isolation Test Voltage, 2500 VRMS
- High Current Transfer Ratios
  ILD205, 40 – 80%
  ILD206, 63 –125%
  ILD207, 100 – 200%
  ILD211, 20% Minimum
  ILD213, 100% Minimum
  ILD217, 100% Minimum at 1 mA
- High BV_{CEO}, 70 V
- Compatible with Dual Wave, Vapor Phase and IR Reflow Soldering

Package Dimensions in Inches (mm)



TOLERANCE: ±.005 (unless otherwise noted)

DESCRIPTION

The ILD205/206/207/211/213/217 are optically coupled pairs with a gallium arsenide infrared LED and a silicon NPN phototransistor. Signal information, including a DC level, can be transmitted by the device while maintaining a high degree of electrical isolation between input and output. The ILD205/6/7 /11/13/17 come in a standard SOIC-8 small outline package for surface mounting which makes it ideally suited for high density applications with limited space. In addition to eliminating through-holes requirements, this package conforms to standards for surface mounted devices.

A specified minimum and maximum CTR allows a narrow tolerance in the electrical design of the adjacent circuits. The high BV_{CEO} of 70 volts gives a higher safety margin compared to the industry standard of 30 volts.

Maximum Ratings (Each Channel)

Emitter

Peak Reverse Voltage .... 6.0 V
Peak Pulsed Current (1 µs, 300 pps) .... 1 A
Continuous Forward Current per Channel .... 30 mA
Power Dissipation at 25°C .... 45 mW
Derate Linearly from 25°C .... 0.5 mW/°C

Detector

Collector-Emitter Breakdown Voltage .... 70 V
Emitter-Collector Breakdown Voltage .... 7 V
Power Dissipation per Channel .... 55 mW
Derate Linearly from 25°C .... 0.55 mW/°C

Package

Total Package Dissipation at 25°C Ambient
(2 LEDs + 2 Detectors, 2 Channels) .... 200 mW
Derate Linearly from 25°C .... 2.0 mW/°C
Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Soldering Time at 260°C .... 10 sec.

Characteristics (T_A=25°C)

Parameter	Min.	Typ.	Max.	Unit	Test Condition
Emitter					
Forward Voltage		1.2	1.55	V	I_F=10 mA
Reverse Current		0.1	100	µA	V_R=6.0 V
Capacitance		25		pF	V_R=0
Detector					
BV_{CEO}	70			V	I_C=10 µA
BV_{ECO}	7			V	I_E=10 µA
I_{CEO}		5	50	nA	V_{CE}=10 V, I_F=0
Collector-Emitter Capacitance		10		pF	V_{CE}=0
Package					
DC Current Transfer					V_{CE}=5 V
ILD205	40		80	%	I_F=10 mA
ILD206	63		125	%	I_F=10 mA
ILD207	100		200	%	I_F=10 mA
ILD211	20				I_F=10 mA
ILD213	100			%	I_F=10 mA
ILD205	13	30		%	I_F=1 mA
ILD206	22	45		%	I_F=1 mA
ILD207	34	70		%	I_F=1 mA
ILD217	100	130		%	I_F=1 mA
Collector-Emitter Saturation Voltage $V_{CE\,(sat)}$			0.4	V	I_F=10 mA, I_C=2.5 mA
Capacitance, Input to Output		0.5		pF	
Isolation Test Voltage	2500			VAC_{RMS}	t=1 min.
Resistance, Input to Output		100		GΩ	
Turn-on Time		5.0		µs	I_C=2 mA, R_E=100 Ω, V_{CE}=5 V
Turn-off Time		4.0		µs	

Figure 1. Forward current versus forward voltage

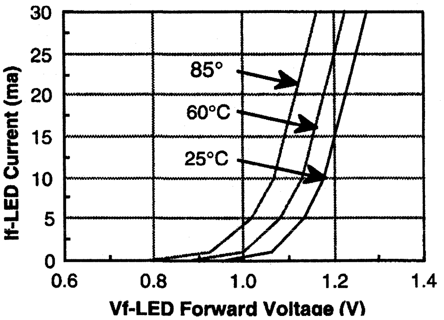


Figure 2. Collector-emitter current versus temperature

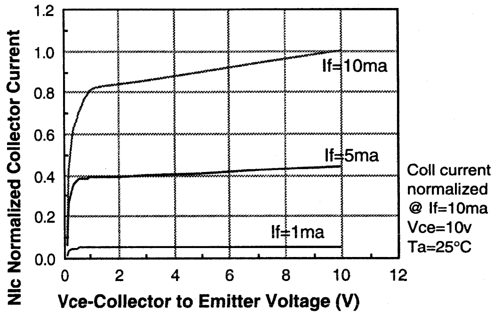


Figure 3. Normalized CTRce versus forward current

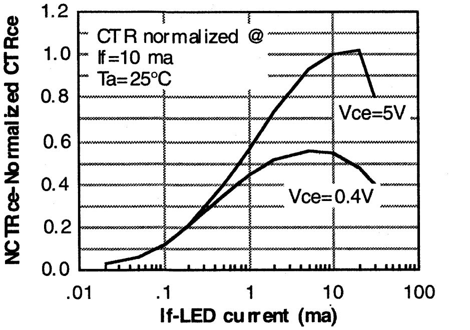


Figure 4. CTR (normalized) versus temperature

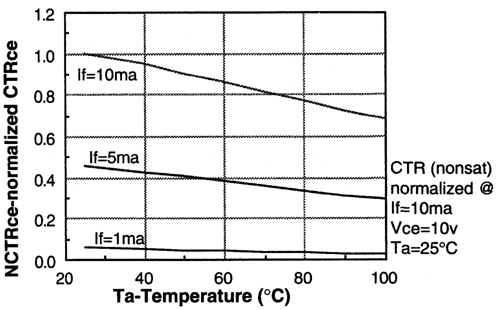


Figure 5. Switching speed versus load resistor

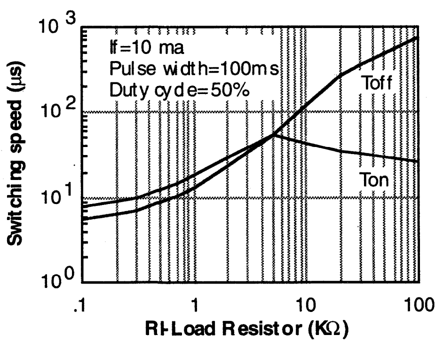


Figure 6. Collector current versus temperature

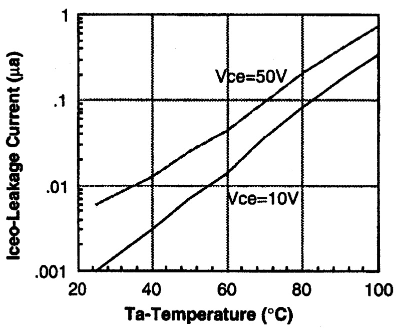


Figure 7. Power dissipation versus ambient temperature

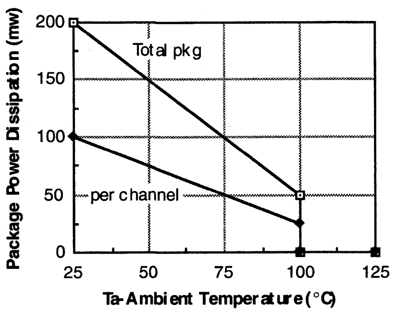
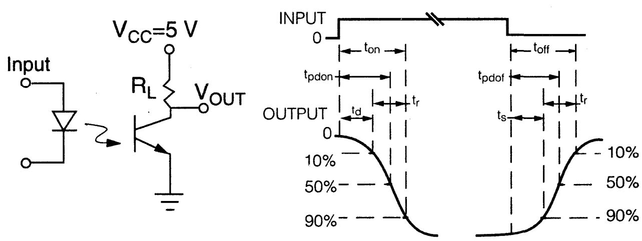


Figure 8. Switching time test schematic and waveform



Optocouplers (Optoisolators)

5

SIEMENS

ILD223

DUAL PHOTODARLINGTON SMALL OUTLINE SURFACE MOUNT OPTOCOUPLER

FEATURES

- **Two Channel Optocoupler**
- **High Current Transfer Ratio at I_F=1 mA, 500% Min.**
- **Isolation Test Voltage, 2500 VRMS**
- **Electrical Specifications Similar to Standard 6 Pin Coupler**
- **Compatible with Dual Wave, Vapor Phase and IR Reflow Soldering**
- **Industry Standard SOIC-8 Surface Mountable Package**
- **Standard Lead Spacing, .05"**
- **Available in Tape and Reel Option (Conforms to EIA Standard 481-2)**
- **Underwriters Lab File #E52744**

DESCRIPTION

The ILD223 is a high current transfer ratio (CTR) optocoupler. It has a Gallium Arsenide infrared LED emitter and a silicon NPN photodarlington transistor detector.

This device has CTRs tested at an LED current of 1 mA. This low drive current permits easy interfacing from CMOS to LSTTL or TTL.

The ILD223 is constructed in a standard SOIC-8 foot print which makes it ideally suited for high density applications. In addition to eliminating through-holes requirements, this package conforms to standards for surface mounted devices.

Maximum Ratings (Each Channel)

Emitter

Peak Reverse Voltage .... 6.0 V
Peak Pulsed Current (1 µs, 300 pps) .... 3 A
Continuous Forward Current per Channel .... 30 mA
Power Dissipation at 25°C .... 45 mW
Derate Linearly from 25°C .... 0.4 mW/°C

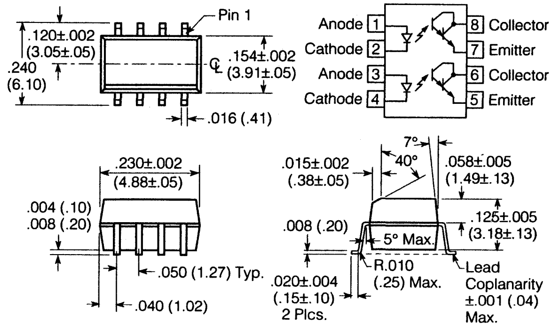
Detector

Collector-Emitter Breakdown Voltage .... 30 V
Emitter-Collector Breakdown Voltage .... 5 V
Power Dissipation per Channel .... 75 mW
Derate Linearly from 25°C .... 3.1 mW/°C

Package

Total Package Dissipation at 25°C Ambient (2 LEDs + 2 Detectors,2 Channels) .... 240 mW
Derate Linearly from 25°C .... 2 mW/°C
Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Soldering Time at 260°C .... 10 sec.

Package Dimensions in Inches (mm)



Tolerance: ±.005 (unless otherwise noted)

Characteristics (T_A=25°C)

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F			1.3	V	I_F=1 mA
Reverse Current	I_R		0.1	100	µA	V_R=6.0 V
Capacitance	C_O		25		pF	V_F=0 V, F=1 MHz
Detector						
Breakdown Voltage						
Collector-Emitter	BV_{CEO}	30			V	V I_C=10 µA
Emitter-Collector	BV_{ECO}	5			V	V I_E=10 µA
Collector-Emitter Current	I_{CEO}			50	nA	V_{CE}=5 V, I_F= 0
Collector-Emitter Capacitance	C_{CE}		3.4		pF	V_{CE} =5 V
Package						
DC Current Transfer	CTR_{DC}	500			%	I_F=1 mA, V_{CE}=5 V
Collector-Emitter Saturation Voltage	$V_{CE\ sat}$			1	V	I_F=1 mA, I_{CE}=0.5 mA
Capacitance, Input to Output	C_{IO}	0.5		pF		
Resistance, Input to Output	R_{IO}	100		GΩ		
Turn-On Time	t_{on}	15		µs		V_{CC}=10 V, R_L=100 Ω, I_F=5 mA
Turn-Off Time	t_{off}	30		µs		V_{CC}=10 V, R_L=100 Ω, I_F=5 mA
Isolation Test Voltage	V_{IO}					(t=1 min.) 2500 VAC_{RMS}

Figure 1. Forward voltage versus forward current

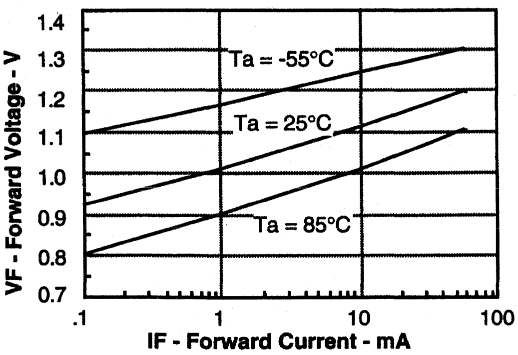


Figure 2. Peak LED current versus duty factor, Tau

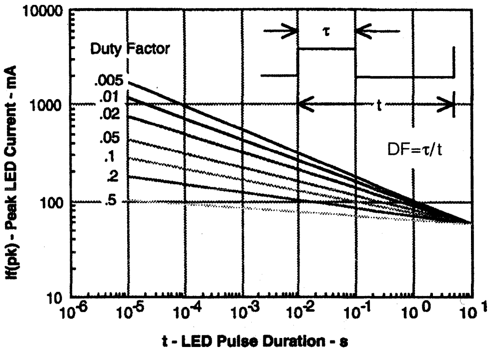


Figure 3. Normalized CTR_{CE} versus LED current

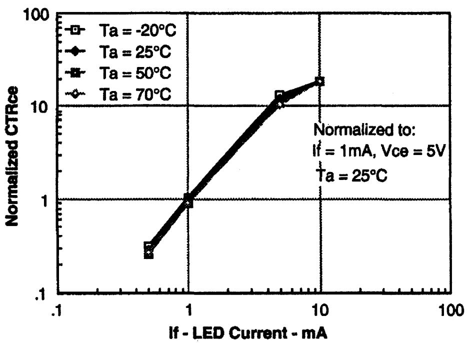


Figure 4. CTR versus LED current

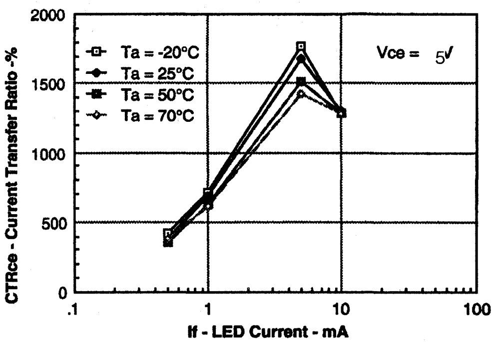


Figure 5. Collector current versus LED current

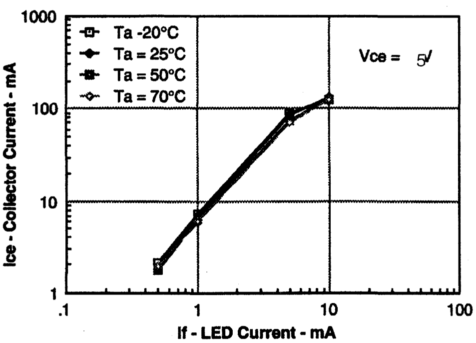
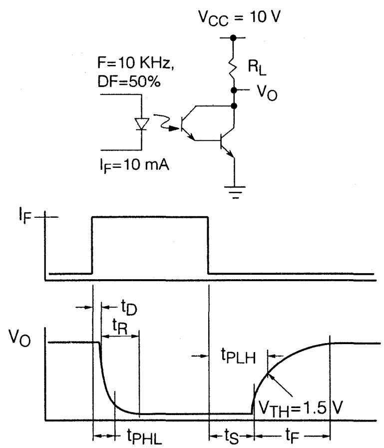


Figure 6. Switching schematic and switching timing



Optocouplers (Optoisolators)

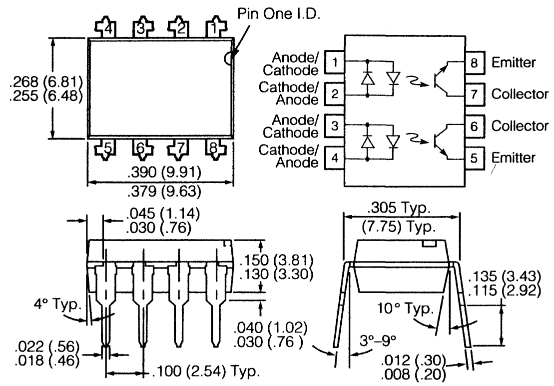
5

SIEMENS

DUAL CHANNEL ILD255
BIDIRECTIONAL INPUT OPTOCOUPLER

FEATURES
- **AC or Polarity Insensitive Inputs**
- **Continuous Forward Current, 130 mA**
- **Applications—Telecommunications**
  - **– Ring Detection**
  - **– Loop Current Detector**
- **Built-in Reverse Polarity Input Protection**
- **Improved CTR Symmetry**
- **Industry Standard DIP Package**
- **Underwriters Lab File #E52744**
- **VDE 0884 Available with Option 1**

Package Dimensions in Inches (mm)



DESCRIPTION
The ILD255 is a bidirectional input optically coupled isolator consisting of two high current Gallium Arsenide infrared LEDs coupled to a silicon NPN phototransistor per channel. The ILD255 has a minimum CTR of 50%

These optocouplers are ideal for applications requiring AC signal detection and monitoring.

Maximum Ratings (Each Channel)

Emitter

Peak Pulsed Current (1 μs, 300 pps) .... 3 A
Continuous Forward Current .... 130 mA RMS
Power Dissipation at 25°C .... 175 mW
Derate Linearly from 25°C .... 2.3 mW/°C

Detector

Collector-Emitter Breakdown Voltage .... 30 V
Emitter-Base Breakdown Voltage .... 5 V
Power Dissipation at 25°C .... 200 mW
Derate Linearly from 25°C .... 2.6 mW/°C

Package

Isolation Test Voltage (between emitter and detector referred to standard climate 23°C/50%RH, DIN 50014) .... 5300 VAC_{RMS}
Creepage .... min. 7 mm
Clearance .... min. 7 mm
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... $R_{IO}\geq10^{12}\,\Omega$
V_{IO}=500 V, T_A=100°C .... $R_{IO}\geq10^{11}\,\Omega$
Total Dissipation at 25°C .... 400 mW
Derate Linearly from 25°C .... 5.3 mW/°C
Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Lead Soldering Time at 260°C .... 10 sec.

Electrical Characteristics (T_A=25°C)

Parameter	Min.	Typ.	Max.	Unit	Condition
Emitter					
Forward Voltage V_F		1.2	1.5	V	I_F=±10 mA
Detector					
BV_{CEO}	30	50		V	I_C=10 mA
BV_{ECO}	7	10		V	I_E=10 μA
I_{CEO}		5	50	nA	V_{CE}=10 V
Package					
V_{CEsat}			0.4	V	I_F=±16 mA, I_C=2 mA
DC Current Transfer Ratio	50			%	I_F=±10 mA, V_{CE}=10 V
Symmetry CTR at +10 mA / CTR at –10 mA	0.50	1.0	2.0		

Figure 1. LED forward current versus forward voltage

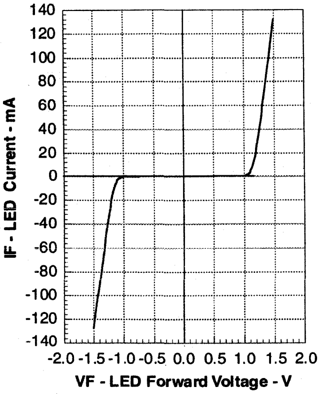


Figure 2. Maximum LED current versus ambient temperature

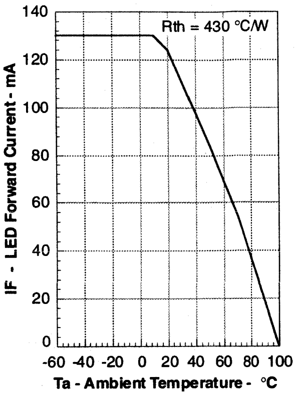


Figure 3. Maximum LED power dissipation

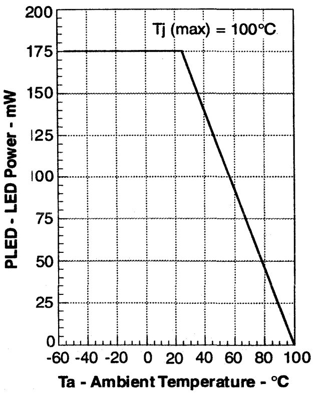


Figure 4. Current transfer ratio versus LED current and collector-emitter voltage

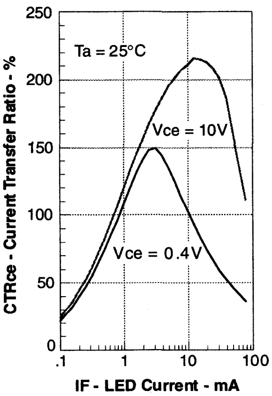


Figure 5. Saturated and nonsaturated collector-emitter current versus LED current

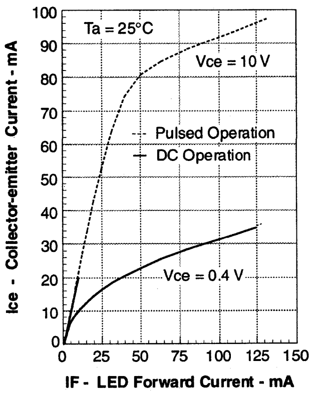


Figure 6. Saturated and nonsaturated collector-emitter current versus LED current

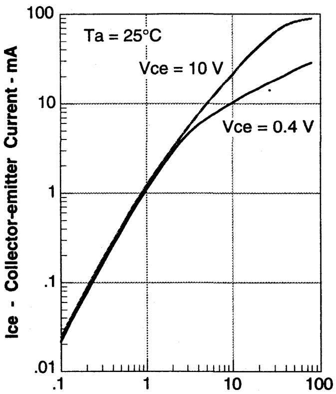
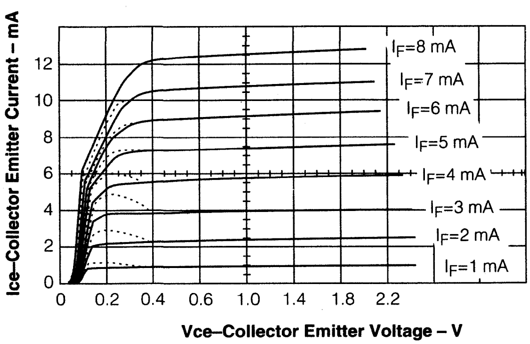


Figure 7. Collector emitter current versus collector emitter voltage



SIEMENS

NEW

ILD256

DUAL AC INPUT PHOTOTRANSISTOR SMALL OUTLINE SURFACE MOUNT OPTOCOUPLER

FEATURES

- **Each Channel: Guaranteed CTR Symmetry, 2:1 Maximum**
- **Bidirectional AC Input**
- **Industry Standard SOIC-8 Surface Mountable Package**
- **Standard Lead Spacing, .05"**
- **Available in Tape and Reel Option (Conforms to EIA Standard 481-2)**

DESCRIPTION

The ILD256 is a dual channel optocoupler. Each channel consists of two infrared emitters connected in anti-parallel and coupled to a silicon NPN phototransistor detector.

These circuit elements are constructed with a standard SOIC-8 foot print.

The product is well suited for telecom applications such as ring detection or off/on hook status, given its bidirectional LED input and guaranteed current transfer ratio (CTR) of 20% at I_F= 10 mA.

Maximum Ratings

Emitter (Each Channel)

Continuous Forward Current .... 30 mA
Power Dissipation at 25°C .... 45 mW
Derate Linearly from 25°C .... 0.5 mW/°C

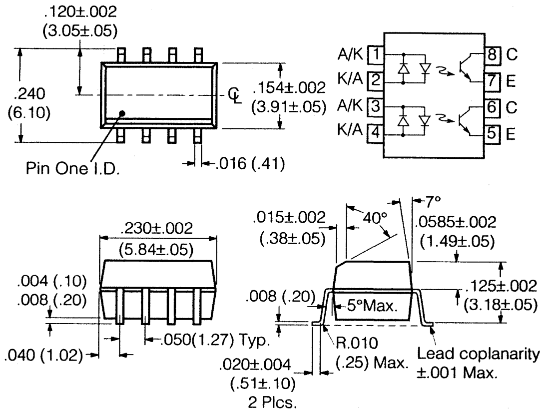
Detector (Each Channel)

Collector-Emitter Breakdown Voltage .... 70 V
Emitter-Collector Breakdown Voltage .... 7 V
Power Dissipation .... 55 mW
Derate Linearly from 25°C .... 0.55 mW/°C

Package

Total Package Dissipation at 25°C Ambient
(LED + Detector) .... 200 mW
Derate Linearly from 25°C .... 2.0 mW/°C
Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Soldering Time at 260°C .... 10 sec.

Package Dimensions in Inches (mm)



TOLERANCE: ±.005 (.13) unless otherwise noted

Characteristics (T_A=25°C)

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter (Each Channel)						
Forward Voltage	V_F		1.2	1.55	V	I_F=±10 mA
Reverse Current	I_R		0.1	100	µA	V_R=6.0 V
Detector (Each Channel)						
Breakdown Voltage						
Collector-Emitter	BV_{CEO}	70			V	I_C=10 µA
Emitter-Collector	BV_{ECO}	7			V	I_E=10 µA
Collector-Emitter Leakage Current	I_{CEO}		5	50	nA	V_{CE}=10 V
Package (Each Channel)						
DC Current Transfer	CTR	20			%	I_F=±10 mA, V_{CE}=5 V
Symmetry CTR at +10mA / CTR at –10 mA		0.5	1.0	2.0		
Collector-Emitter Saturation Voltage	$V_{CE\,sat}$			0.4		I_F=±16 mA, I_C=2 mA
Input to Output Isolation Voltage	V_{IO}	2500			VAC_{RMS}	t=1 min.

Figure 1. LED forward current versus forward voltage

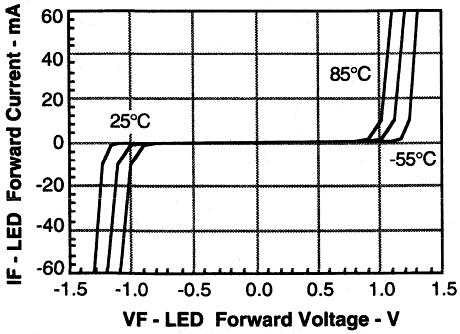


Figure 2. Forward voltage versus forward current

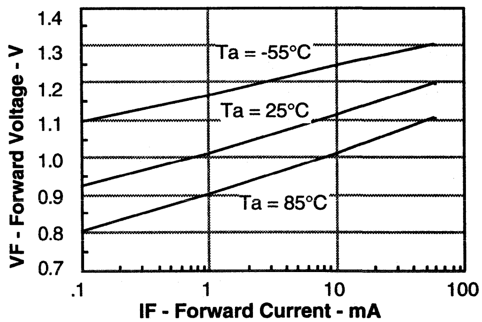


Figure 3. Peak LED current versus duty factor, Tau

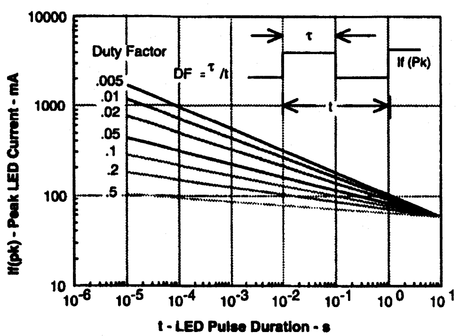


Figure 4. Normalized CTR versus If and Ta

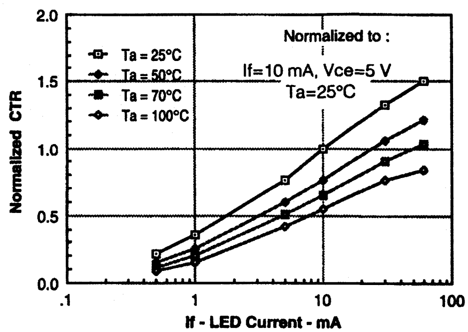


Figure 5. Normalized saturated CTR

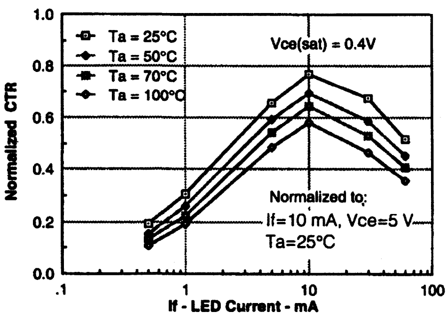


Figure 6. Normalized CTRcb

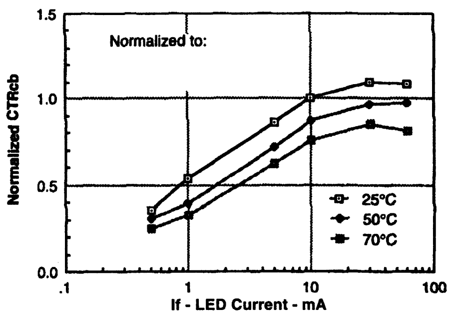


Figure 7. Photocurrent versus LED current

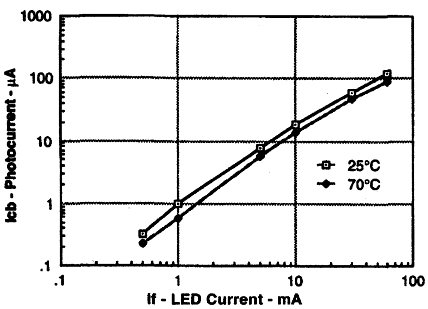


Figure 8. Base current versus If and HFE

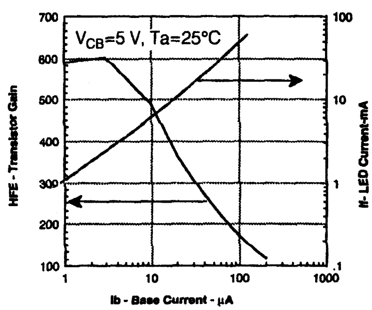


Figure 9. Normalized HFE versus Ib, Ta

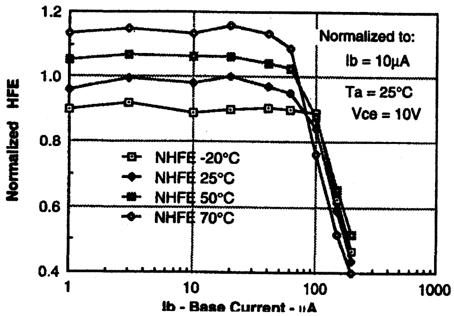


Figure 10. Normalized saturated HFE versus Ib

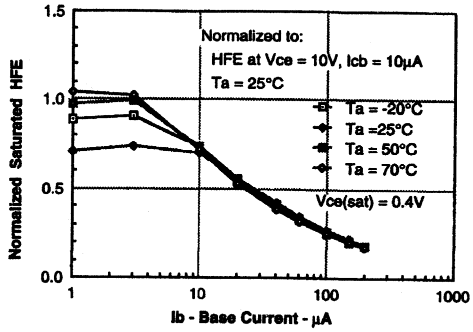


Figure 11. Base emitter voltage versus base

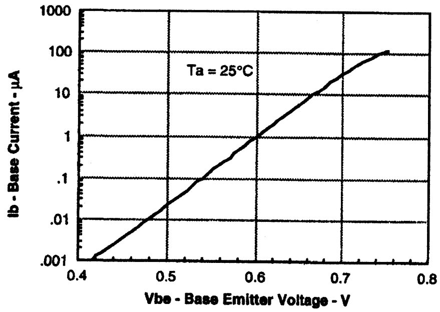
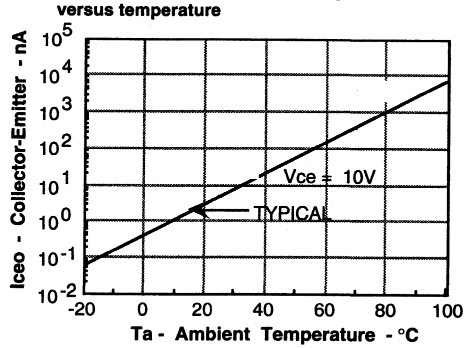


Figure 12.Collector-emitter leakage current versus temperature



SIEMENS

ILD610 SERIES
DUAL PHOTOTRANSISTOR OPTOCOUPLER

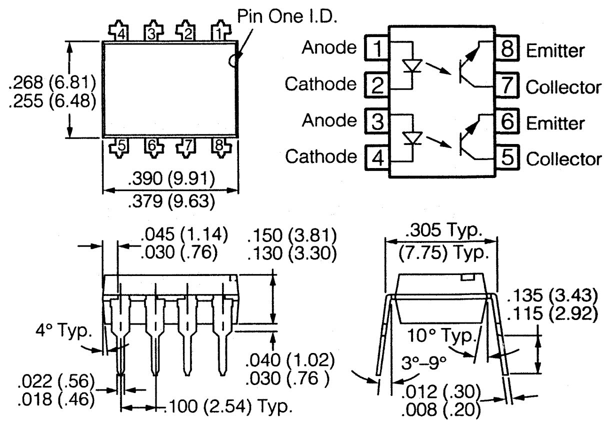
FEATURES

- **Dual Version of SFH610 Series**
- **High Current Transfer Ratios**
  ILD610-1, 40-80%
  ILD610-2, 63-125%
  ILD610-3, 100-200%
  ILD610-4, 160-320%
- **Isolation Test Voltage, 5300 V_{RMS}**
- **V_{CEsat} 0.25 (≤0.4) V at I_F=10 mA, I_C=2.5 mA**
- **V_{CEO}=70 V**
- **Underwriters Lab File #E52744**
- **VDE #0884 Available with Option 1**

DESCRIPTION

The ILD610 Series is a dual channel optocoupler series for high density applications. Each channel consists of an optically coupled pair with a Gallium Arsenide infrared LED and a silicon NPN phototransistor. Signal information, including a DC level, can be transmitted by the device while maintaining a high degree of electrical isolation between input and output. The ILD610 Series is the dual version of SFH610 Series and uses a repetitive pin-out configuration instead of the more common alternating pin-out used in most dual couplers.

Package Dimensions in Inches (mm)



Maximum Ratings (Each Channel)

Emitter

Reverse Voltage	6 V
Surge Forward Current (t≤10 µs)	1.5 A
Total Power Dissipation	100 mW
Derate Linearly from 25°C	1.3 mW/°C
DC Forward Current	60 mA
Detector	
Collector-Emitter Voltage	70 V
Collector Current	50 mA
Collector Current (t ≤1 ms)	100 mA
Total Power Dissipation	150 mW
Derate Linearly from 25°C	2.0 mW/°C
Package	
Isolation Test Voltage (t=1 sec.)	5300 VAC_{RMS}
Isolation Resistance	
V_{IO}=500 V, T_A=25°C	≥10^{12} Ω
V_{IO}=500 V, T_A=100°C	≥10^{11} Ω
Storage Temperature	–55°C to +150°C
Operating Temperature	–55°C to +100°C
Junction Temperature	100°C
Lead Soldering Time at 260°C	10 sec.

Electrical Characteristics (T_A=25°C)

	Symbol	Typ.	Unit	Condition
Emitter				
Forward Voltage	V_F	1.25 (≤1.65)	V	I_F=60 mA
Reverse Current	I_R	0.01(≤10)	µA	V_R=6 V
Capacitance	C_O	25	pF	V_R= 0 V, f=1 MHz
Detector				
Breakdown Voltage				
Collector- Emitter	BV_{CEO}	90 (≥70)	V	I_C=10 µA
Emitter-Collector	BV_{ECO}	7.0 (≥6.0)	V	I_E=10 µA
Collector-Emitter Dark Current	I_{CEO}	2 (≤50)	nA	V_{CE}=10 V
Capacitance	C_{CE}	7	pF	V_{CE}=5 V, f=1 MHz
Package				
Collector-Emitter Saturation Voltage	V_{CEsat}	0.25(<0.40)	V	I_F=10 mA, I_C=2.5 mA
Coupling Capacitance	C_C	0.35	pF	

	-1	-2	-3	-4	
CTR[1], I_F = 10 mA, V_{CE} = 5 V	40–80	63–125	100–200	160–320	%
CTR[1], I_F = 1 mA, V_{CE} = 5 V	13 min.	22 min.	34 min.	56 min.	%
I_{CEO} (V_{CE} = 10 V)	2 (≤50)	2 (≤50)	5 (≤100)	5 (≤100)	nA

CTR will match within a ratio of 1.7:1

Switching Characteristics

Linear Operation (without saturation) I_F = 10 mA, V_{CC} = 5 V, R_C = 75 Ω, Typical

		-1	-2	-3	-4	
Turn on time	t_{on}	3.0	3.2	3.6	4.1	µs
Rise time	t_r	2.0	2.5	2.9	3.3	µs
Turn off time	t_{off}	2.3	2.9	3.4	3.7	µs
Fall time	t_f	2.0	2.6	3.1	3.5	µs

Switching Operation (with saturation) V_{CC} = 5 V, R_C = 1 KΩ, Typical

		-1 I_F = 20 mA	-2 I_F = 10 mA	-3 I_F = 10 mA	-4 I_F = 5 mA	
Turn on time	t_{on}	3.0	4.3	4.6	6.0	µs
Rise time	t_r	2.0	2.8	3.3	4.6	µs
Turn off time	t_{off}	18	2.9	3.4	25	µs
Fall time	t_f.	11	2.6	3.1	15	µs

Figure 1. Forward voltage versus forward current

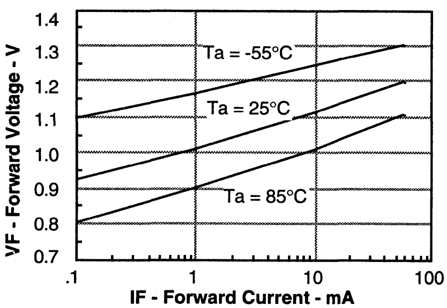


Figure 2. Normalized non-saturated and saturated CTR at T_A=25°C versus LED current

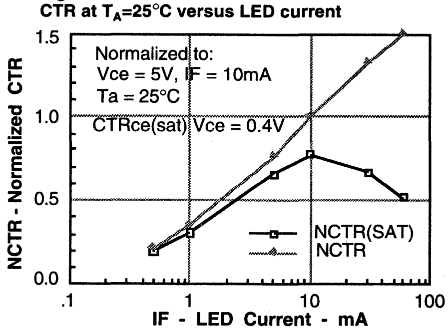


Figure 3. Normalized non-saturated and saturated CTR at T_A=50°C versus LED current

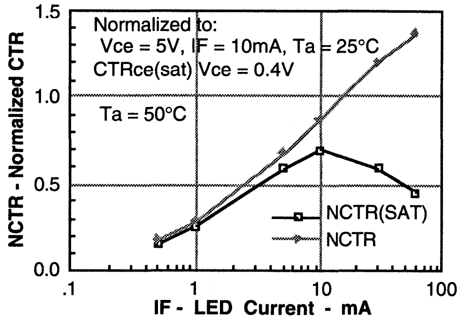


Figure 4. Normalized non-saturated and saturated CTR at T_A=70°C versus LED current

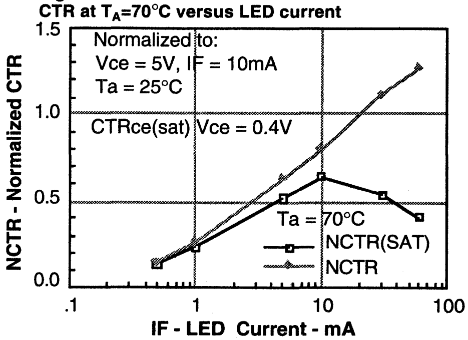


Figure 5. Normalized non-saturated and saturated CTR at T_A = 85°C versus LED current

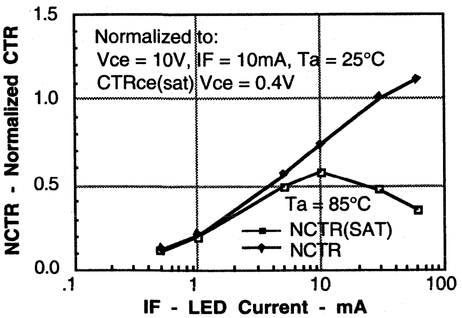


Figure 6. Collector-emitter current versus temperature and LED current

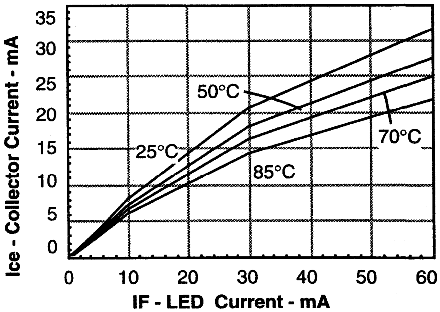


Figure 7. Collector-emitter leakage current versus temperature

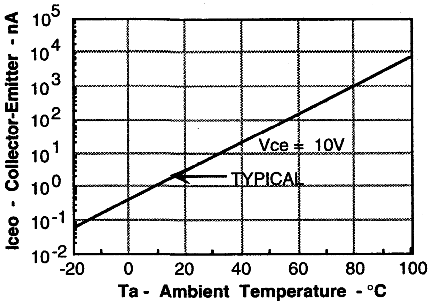


Figure 8. Propagation delay versus collector load resistor

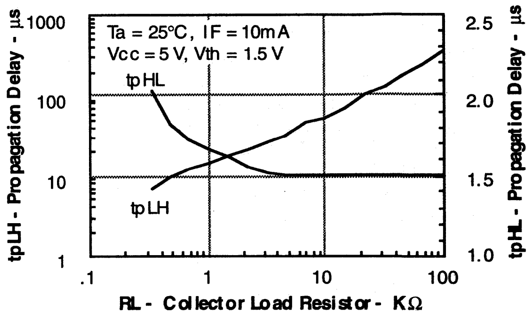


Figure 9. Switching timing

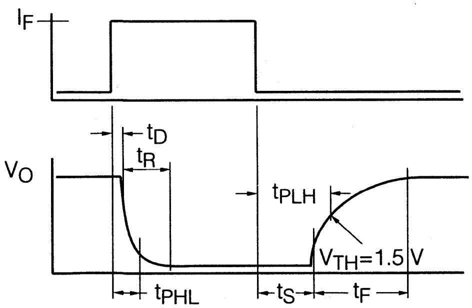


Figure 10. Non-saturated switching schematic

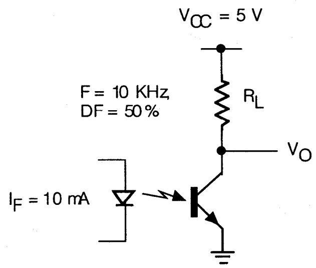
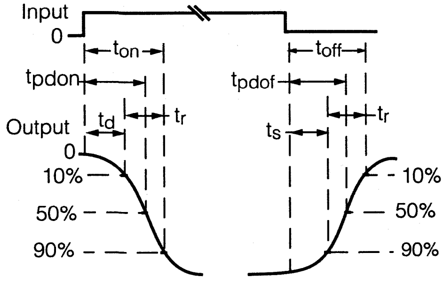


Figure 11. Saturated switching time test waveform and schematic



SIEMENS

DUAL CHANNEL ILD615
QUAD CHANNEL ILQ615
PHOTOTRANSISTOR OPTOCOUPLER

FEATURES

- **Identical Channel to Channel Footprint**
- **Current Transfer Ratio (CTR) Range at I_F= 10 mA**
  ILD/Q615-1: 40 – 80% Min.
  ILD/Q615-2: 63 – 125% Min.
  ILD/Q615-3: 100 – 200% Min.
  ILD/Q615-4: 160 – 320% Min.
- **Guaranteed CTR at I_F=1 mA**
  ILD/Q615-1: 13% Min.
  ILD/Q615-2: 22% Min.
  ILD/Q615-3: 34% Min.
  ILD/Q615-4: 56% Min.
- **High Collector-Emitter Voltage BV_{CEO}=70 V**
- **Dual and Quad Packages Feature:**
  - **Reduced Board Space**
  - **Lower Pin and Parts Count**
  - **Better Channel to Channel CTR Match**
  - **Improved Common Mode Rejection**
- **Field-Effect Stable by TRansparent IOn Shield (TRIOS)**
- **Isolation Test Voltage from Double Molded Package 5300 VAC_{RMS}**
- **UL Approval #E52744**
- **VDE #0884 Available with Option 1**

Maximum Ratings (Each Channel)

Emitter

Reverse Voltage .... 6 V
Forward Current .... 60 mA
Surge Current .... 1.5 A
Power Dissipation .... 100 mW
Derate Linearly from 25°C .... 1.33 mW/°C

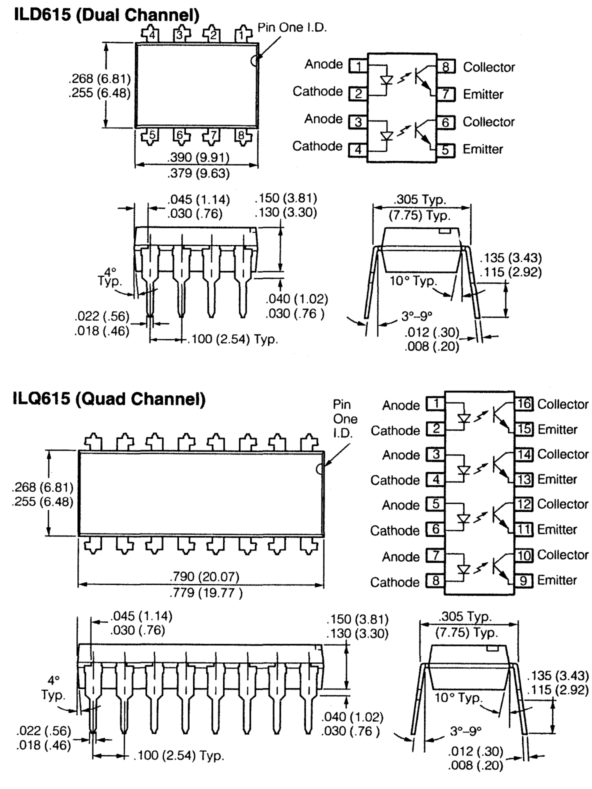
Detector

Collector-Emitter Reverse Voltage .... 70 V
Emitter-Collector Reverse Voltage .... 7 V
Collector Current .... 50 mA
Collector Current (t <1 ms) .... 100 mA
Power Dissipation .... 150 mW
Derate Linearly from 25°C .... 2 mW/°C

Package

Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Junction Temperature .... 100°C
Soldering Temperature
(2 mm distance from case bottom) .... 260°C
Package Power Dissipation, ILD615 .... 400 mW
Derate Linearly from 25°C .... 5.33 mW/°C
Package Power Dissipation, ILQ615 .... 500 mW
Derate Linearly from 25°C .... 6.67 mW/°C
Isolation Test Voltage
(t=1 sec.) .... 5300 VAC_{RMS}
Creepage .... 7 mm min.
Clearance .... 7 mm min.
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... ≥10^{12} Ω
V_{IO}=500 V, T_A=100°C .... ≥10^{11} Ω

Package Dimensions in Inches (mm)



DESCRIPTION

The ILD/Q615 are multi-channel phototransistor optocouplers that use GaAs IRLED emitters and high gain NPN phototransistors. These devices are constructed using over/under leadframe optical coupling and double molded insulation technology resulting a Withstand Test Voltage of 7500 VAC_{PEAK} and a Working Voltage of 1700 VAC_{RMS}.

The binned min./max. and linear CTR characteristics combined with the TRIOS (**TR**ansparent **IO**n **S**hield) field-effect process make these devices well suited for DC or AC voltage detection. Eliminating the phototransistor base connection provides added electrical noise immunity from the transients found in many industrial control environments.

Because of guaranteed maximum non-saturated and saturated switching characteristics, the ILD/Q615 can be used in medium speed data I/O and control systems. The binned min./max. CTR specification allow easy worst case interface calculations for both level detection and switching applications. Interfacing with a CMOS logic is enhanced by the guaranteed CTR at an I_F=1 mA.

See Appnote 45, "How to Use Optocoupler Normalized Curves."

Characteristics (T_A=25°C)

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F	1	1.15	1.3	V	I_F=10 mA
Breakdown Voltage	V_{BR}	6	30		V	I_R=10 µA
Reverse Current	I_R		0.01	10	µA	V_R=6 V
Capacitance	C_0		25		pF	V_R=0 V, f=1 MHz
Thermal Resistance, Junction to Lead	R_{THJL}		750		°C/W	
Detector						
Capacitance	C_{CE}		6.8		pF	V_{CE}=5 V, f=1 MHz
Collector-Emitter Leakage Current, –1, –2	I_{CEO}		2	50	nA	V_{CE}=10 V
Collector-Emitter Leakage Current, –3, –4	I_{CEO}		5	100	nA	V_{CE}=10 V
Collector-Emitter Breakdown Voltage	BV_{CEO}	70			V	I_{CE}=0.5 mA
Emitter-Collector Breakdown Voltage	BV_{ECO}	7			V	I_E=0.1 mA
Thermal Resistance Junction to Lead	R_{THJL}		500		C°/W	
Package Transfer Characteristics						
Channel/Channel CTR Match	CTRX/CTRY	1 to 1		2 to 1		I_F=10 mA, V_{CE}=5 V
ILD/Q615-1						
Saturated Current Transfer Ratio	CTR_{CEsat}		25		%	I_F=10 mA, V_{CE}=0.4 V
Current Transfer Ratio	CTR_{CE}	40	60	80	%	I_F=10 mA, V_{CE}=5 V
Current Transfer Ratio	CTR_{CE}	13	30		%	I_F=1 mA, V_{CE}=5 V
ILD/Q615-2						
Saturated Current Transfer Ratio	CTR_{CEsat}		40		%	I_F=10 mA, V_{CE}=0.4 V
Current Transfer Ratio	CTR_{CE}	63	80	125	%	I_F=10 mA, V_{CE}=5 V
Current Transfer Ratio	CTR_{CE}	22	45		%	I_F=1 mA, V_{CE}=5 V
ILD/Q615-3						
Saturated Current Transfer Ratio	CTR_{CEsat}		60		%	I_F=10 mA, V_{CE}=0.4 V
Current Transfer Ratio	CTR_{CE}	100	150	200	%	I_F=10 mA, V_{CE}=5 V
Current Transfer Ratio	CTR_{CE}	34	70		%	I_F=1 mA, V_{CE}=5 V
ILD/Q615-4						
Saturated Current Transfer Ratio	CTR_{CEsat}		100		%	I_F=10 mA, V_{CE}=0.4 V
Current Transfer Ratio	CTR_{CE}	160	200	320	%	I_F=10 mA, V_{CE}=5 V
Current Transfer Ratio	CTR_{CE}	56	90		%	I_F=1 mA, V_{CE}=5 V
Isolation and Insulation						
Common Mode Rejection Output High	CMH		5000		V/µs	V_{CM}=50 V_{P-P}, R_L=1 kΩ, I_F=0 mA
Common Mode Rejection Output Low	CML		5000		V/µs	V_{CM}=50 V_{P-P}, R_L=1 kΩ, I_F=10 mA
Common Mode Coupling Capacitance	C_{CM}		0.01		pF	
Package Capacitance	CI-O	0.8			pF	V_{IO}=0 V, f=1 MHz.
Insulation Resistance	R_S		10^{14}		Ω	V_{IO}=500 V, T_A=25°C
Channel to Channel Isolation		500			VAC	

Optocouplers (Optoisolators) 5

SWITCHING TIMES

Figure 1. Non-saturated switching timing

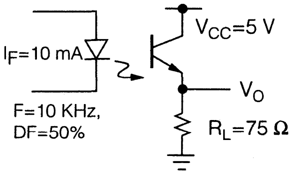


Figure 2. Saturated switching timing

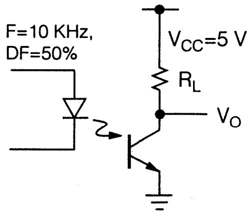


Figure 3. Non-saturated switching timing

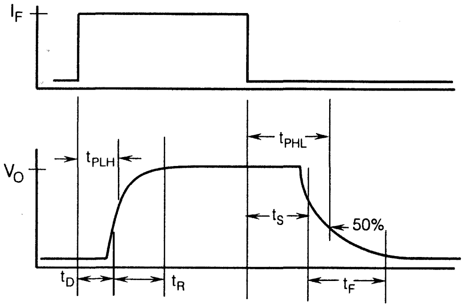
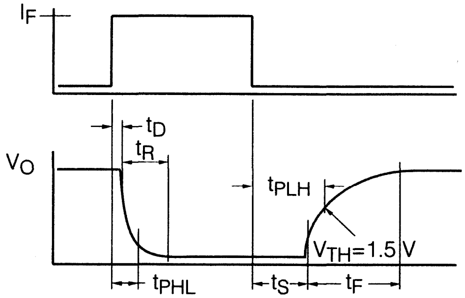


Figure 4. Saturated switching timing



Parameter	Typ.	Unit	Test Condition
t_{ON}	3.0	µs	
t_R	2.0	µs	R_L=75 Ω
t_{OFF}	2.3	µs	I_F=10 mA
t_F	2.0	µs	V_{CC}=5 V
t_{PHL} Propagation H-L (50% of V_{PP})	1.1	µs	
t_{PLH} Propagation L-H	2.5	µs	

Parameter	–1 I_F=20 mA	–2, –3 I_F=10 mA	–4 I_F=5 mA		Test Condition
	Typ.	Typ.	Typ.	Unit	
t_{ON}	3.0	4.3	6.0	µs	
t_R	2.0	2.8	4.6	µs	R_L=1 kΩ
t_{OFF}	18	25	25	µs	V_{CC}=5 V
t_F	11	14	15	µs	V_{TH}=1.5 V
t_{PHL} Propagation H-L	1.6	2.6	5.4	µs	
t_{PLH} Propagation L-H	8.6	7.2	7.4	µs	

Figure 5. Maximum LED current versus ambient temperature

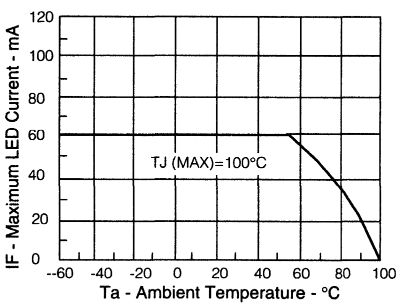


Figure 6. Maximum LED power dissipation

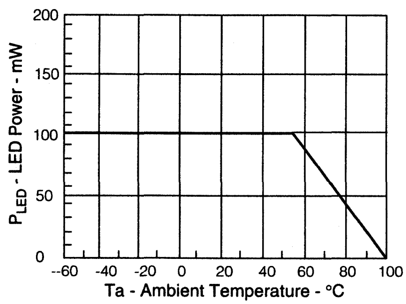


Figure 7. Forward voltage versus forward current

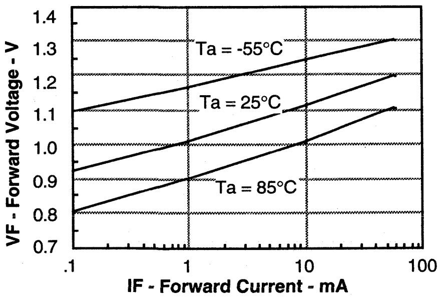


Figure 8. Peak LED current versus pulse duration, Tau

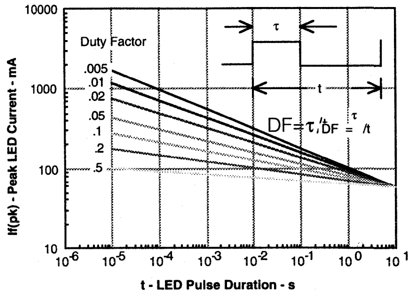


Figure 9. Maximum detector power dissipation

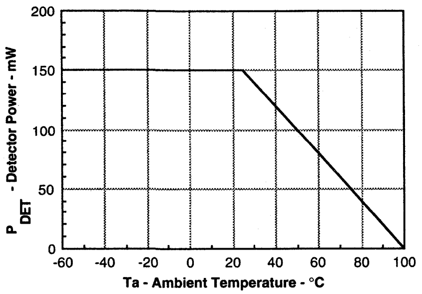


Figure 10. Maximum collector current versus collector voltage

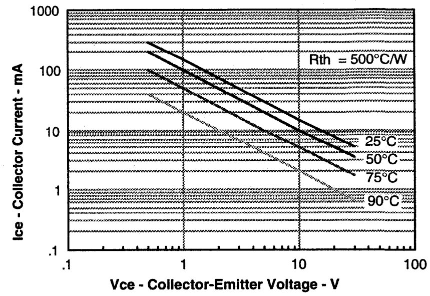


Figure 11. Normalization factor for non-saturated and saturated CTR T_A=25°C versus If

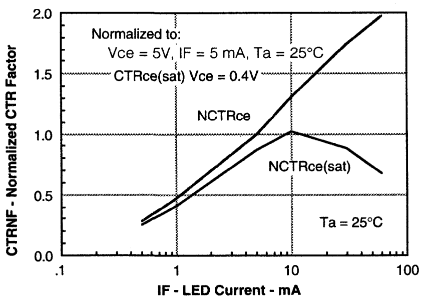


Figure 12. Normalization factor for non-saturated and saturated CTR T_A=50°C versus If

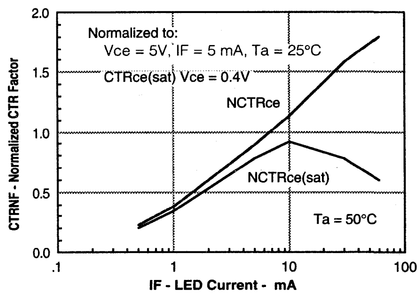


Figure 13. Normalization factor for non-saturated and saturated CTR T_A=70°C versus If

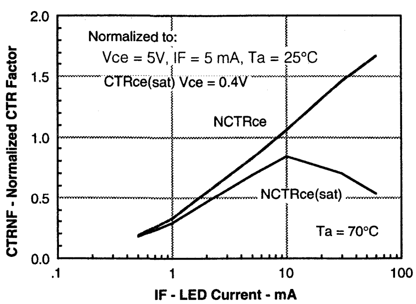


Figure 14. Normalization factor for non-saturated and saturated CTR T_A=85°C versus If

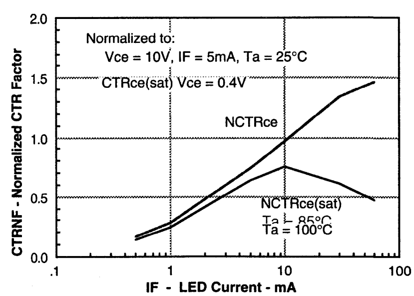


Figure 15. Collector-emitter current versus temperature and LED current

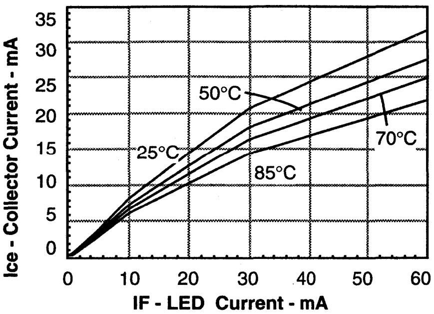


Figure 16. Collector-emitter leakage versus temperature

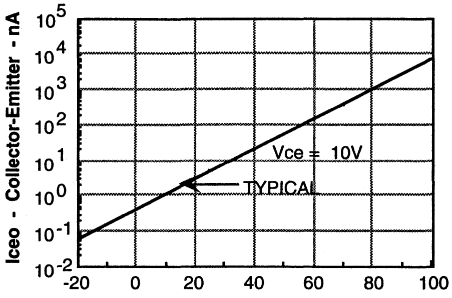


Figure 17. –1 Propagation delay versus collector load resistor

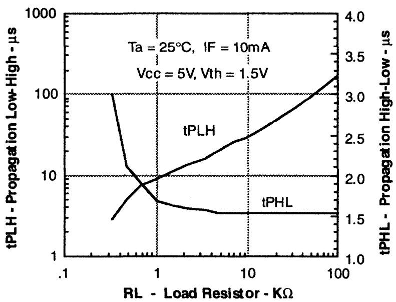


Figure 18. –2, –3 Propagation delay versus collector load resistor

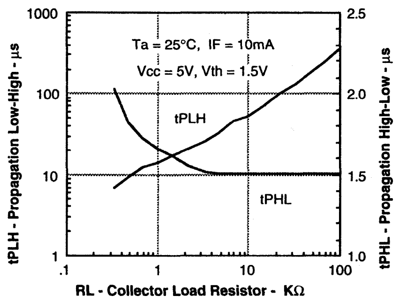
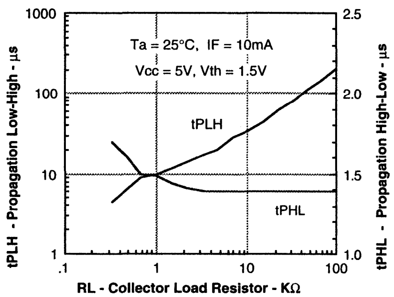


Figure 19. –4 Propagation delay versus collector load resistor



SIEMENS

DUAL CHANNEL ILD620/620GB
QUAD CHANNEL ILQ620/620GB
AC INPUT PHOTOTRANSISTOR OPTOCOUPLER

FEATURES
- **Identical Channel to Channel Footprint**
  ILD620 Crosses to TLP620-2
  ILQ620 Crosses to TLP620-4
- **Current Transfer Ratio (CTR) at I_F= ±5 mA**
  ILD/Q620: 50% Min.
  ILD/Q620GB: 100% Min.
- **Saturated Current Transfer Ratio (CTR_{SAT}) at I_F= ±1 mA**
  ILD/Q620: 60% Typ.
  ILD/Q620GB: 30% Min.
- **High Collector-Emitter Voltage, BV_{CEO}=70 V**
- **Dual and Quad Packages Feature:**
  - **Reduced Board Space**
  - **Lower Pin and Parts Count**
  - **Better Channel to Channel CTR Match**
  - **Improved Common Mode Rejection**
- **Field-Effect Stable by TRIOS (TRansparent IOn Shield)**
- **Isolation Test Voltage from Double Molded Package**
- **Underwriters Lab File #E52744**
- **VDE 0884 Available with Option 1**

Maximum Ratings (Each Channel)

Emitter

Forward Current	±60 mA
Surge Current	±1.5 A
Power Dissipation	100 mW
Derate from 25°C	1.3 mW/°C

Detector

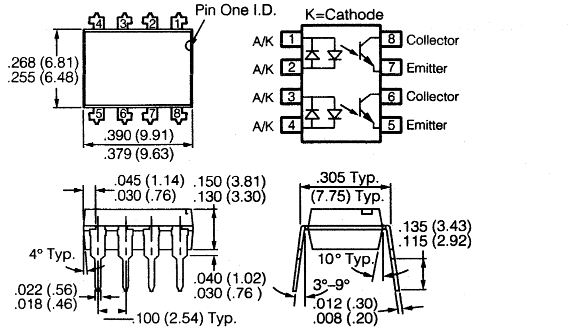
Collector-Emitter Breakdown Voltage	70 V
Collector Current	50 mA
Collector Current (t <1 ms)	100 mA
Power Dissipation	150 mW
Derate from 25°C	2 mW/°C

Package

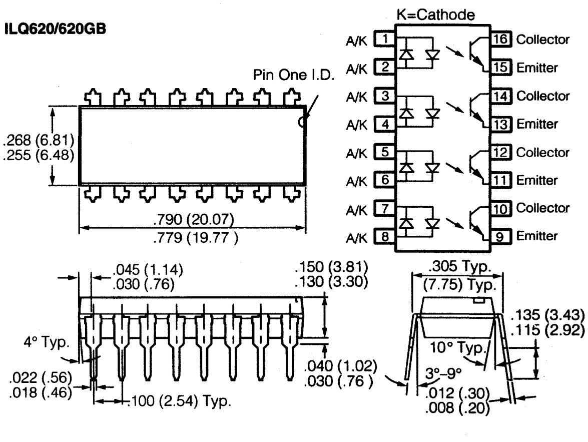
Isolation Test Voltage (t=1 sec.)	5300 VAC_{RMS}
Package Dissipation, ILD620/GB	400 mW
Derate from 25°C	5.33 mW/°C
Package Dissipation, ILQ620/GB	500 mW
Derate from 25°C	6.67 mW/°C
Creepage	7 mm min.
Clearance	7 mm min.
Isolation Resistance	
V_{IO}=500 V, T_A=25°C	$\geq 10^{12}\ \Omega$
V_{IO}=500 V, T_A=100°C	$\geq 10^{11}\ \Omega$
Storage Temperature	–55°C to +150°C
Operating Temperature	–55°C to +100°C
Junction Temperature	100°C
Soldering Temperature (2 mm from case bottom)	260°C

Package Dimensions in Inches (mm)

ILD620/620GB



ILQ620/620GB



DESCRIPTION

The ILD/Q620 and ILD/Q620GB are multi-channel input phototransistor optocouplers that use inverse parallel GaAs IRLED emitters and high gain NPN silicon phototransistors per channel. These devices are constructed using over/under leadframe optical coupling and double molded insulation resulting in a Withstand Test Voltage of 7500 VAC_{PEAK}.

The LED parameters and the linear CTR characteristics combined with the TRIOS field-effect process make these devices well suited for AC voltage detection. The ILD/Q620GB with its low I_F guaranteed CTR_{CEsat} minimizes power dissipation of the AC voltage detection network that is placed in series with the LEDs. Eliminating the phototransistor base connection provides added electrical noise immunity from the transients found in many industrial control environments.

Characteristics

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F	1	1.15	1.3	V	I_F=±10 mA
Forward Current	I_F		2.5	20	µA	V_F=±0.7 V
Capacitance	C_O		25		pF	V_F=0 V, f=1 MHz
Thermal Resistance Junction to Lead	R_{THJL}		750		°C/W	
Detector						
Capacitance	C_{CE}		6.8		pF	V_{CE}=5 V, f=1 MHz
Collector-Emitter Leakage Current	I_{CEO}		10	100	nA	V_{CE}=24 V
Collector-Emitter Leakage Current	I_{CEO}		2	50	µA	T_A=85°C, V_{CE}=24 V
Thermal Resistance Junction to Lead	R_{THJL}		500		C°/W	
Package Transfer Characteristics						
Channel/Channel CTR Match	CTRX/CTRY	1 to 1		3 to 1		I_F=±5 mA, V_{CE}=5 V
CTR Symmetry	$I_{CE(RATIO)}$	0.5		2		$I_{CE}(I_F=-5\text{ mA})/I_F(=+5\text{ mA})$
Off-State Collector Current	$I_{CE(OFF)}$		1	10	µA	V_F=±0.7 V, V_{CE}=24 V
ILD/Q620						
Saturated Current Transfer Ratio	CTR_{CEsat}		60		%	I_F=±1 mA, V_{CE}=0.4 V
Current Transfer Ratio	CTR_{CE}	50	80	600	%	I_F=±5 mA, V_{CE}=5 V
Collector-Emitter Saturation Voltage	V_{CEsat}			0.4	V	I_F=±8 mA, I_{CE}=2.4 mA
ILD/Q620GB						
Saturated Current Transfer Ratio	CTR_{CEsat}	30			%	I_F=±1 mA, V_{CE}=0.4 V
Current Transfer Ratio	CTR_{CE}	100	200	600	%	I_F=±5 mA, V_{CE}=5 V
Collector-Emitter Saturation Voltage	V_{CEsat}			0.4	V	I_F=±1 mA, I_{CE}=0.2 mA
Isolation and Insulation						
Common Mode Rejection, Output High	CMH		5000		V/µs	V_{CM}=50 V_{P-P}, R_L=1 kΩ, I_F=0 mA
Common Mode Rejection, Output Low	CML		5000		V/µs	V_{CM}=50 V_{P-P}, R_L=1 kΩ, I_F=10mA
Common Mode Coupling Capacitance	C_{CM}		0.01		pF	
Package Capacitance	CI-O	0.8			pF	V_{I-O}=0 V, f=1 MHz
Insulation Resistance	R_S		10^{12}		Ω	V_{I-O}=500 V
Channel to Channel Insulation		500			VAC	

Switching Times

Figure 1. Non-saturated switching timing

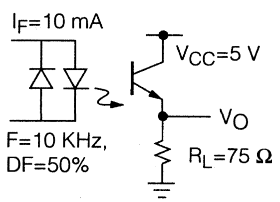


Figure 2. Saturated switching timing

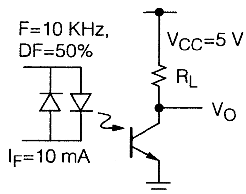


Figure 3. Non-saturated switching timing

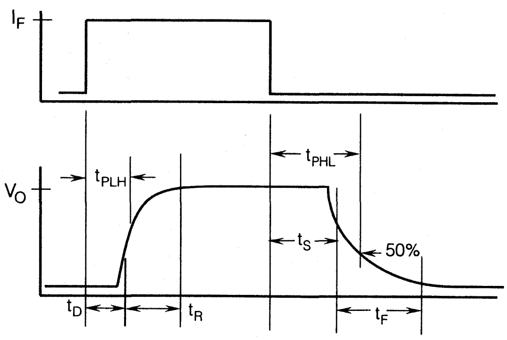
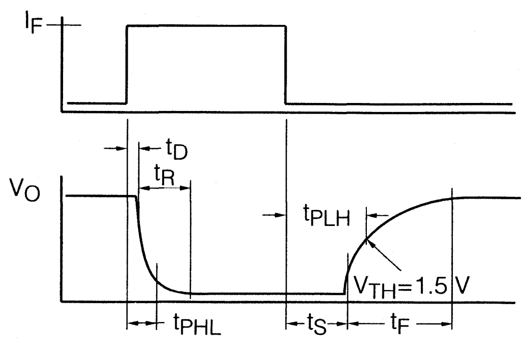


Figure 4. Saturated switching timing



Characteristic	Symbol	Typ.	Unit	Test Condition
On Time	T_{ON}	3.0	µs	I_F=±10 mA
Rise Time	t_R	20	µs	V_{CC}=5 V
Off Time	t_{OFF}	2.3	µs	R_L=75 Ω
Fall Time	t_F	2.0	µs	
Propagation H-L	t_{PHL}	1.1	µs	50% of V_{PP}
Propagation L-H	t_{PLH}	2.5	µs	

Characteristic	Symbol	Typ.	Unit	Test Condition
On Time	T_{ON}	4.3	µs	I_F=±10 mA
Rise Time	t_R	2.8	µs	V_{CC}=5 V
Off Time	t_{OFF}	2.5	µs	R_L=1 kΩ
Fall Time	t_F	11	µs	
Propagation H-L	t_{PHL}	2.6	µs	V_{TH}=1.5 V
Propagation L-H	t_{PLH}	7.2	µs	

Figure 5. LED forward current versus forward voltage

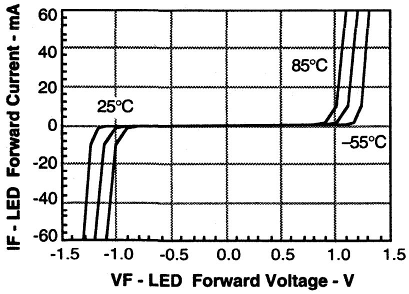


Figure 6. Collector-emitter leakage versus temperature

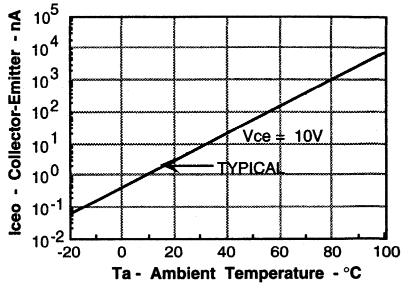


Figure 7. Maximum LED current versus ambient temperature

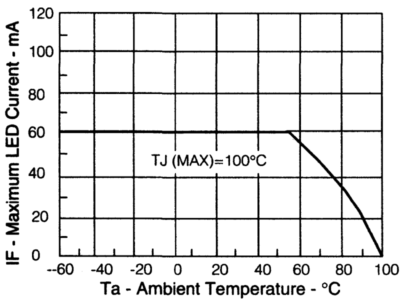


Figure 8. Maximum LED power dissipation

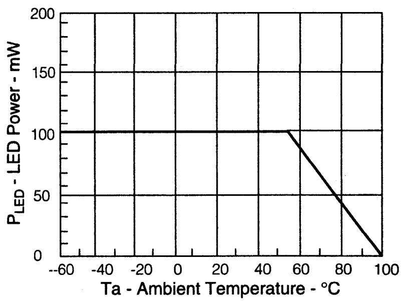


Figure 9. Collector current versus diode forward current

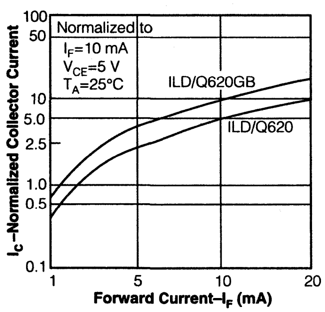


Figure 10. Normalization factor for non-saturated and saturated CTR T_A=50°C versus If

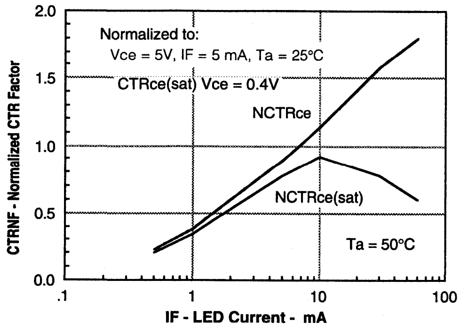


Figure 11. Normalization factor for non-saturated and saturated CTR T_A=70°C versus If

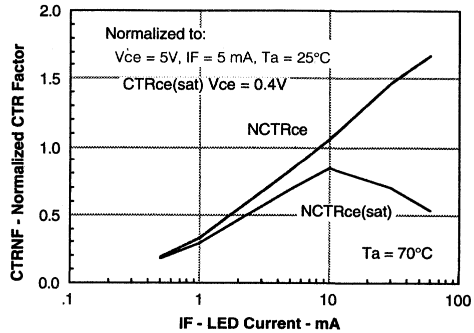


Figure 12. Normalization factor for non-saturated and saturated CTR T_A=100°C versus If

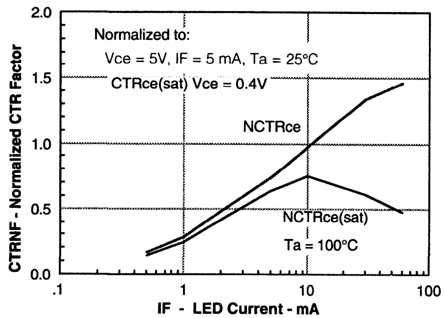


Figure 13. Peak LED current versus peak duration, Tau

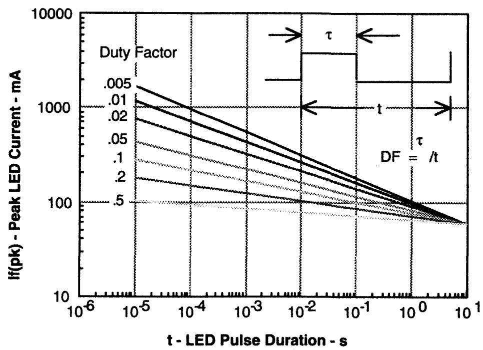


Figure 14. Maximum detector power dissipation

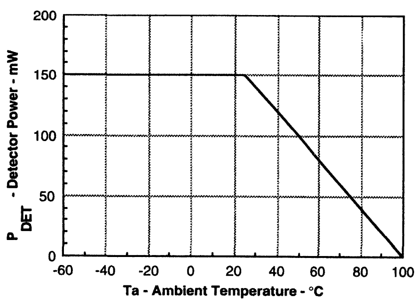
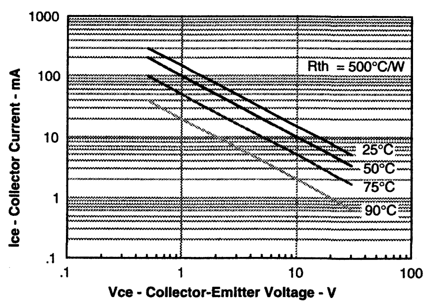


Figure 15. Maximum collector current versus collector voltage



SIEMENS

DUAL CHANNEL ILD621/621GB
QUAD CHANNEL ILQ621/621GB
MULTI-CHANNEL PHOTOTRANSISTOR OPTOCOUPLER

FEATURES
- **Alternate Source to TLP621-2/-4 and TLP621GB-2/-4**
- **Current Transfer Ratio (CTR) at I_F= 5 mA**
  ILD/Q621: 50% Min.
  ILD/Q621GB: 100% Min.
- **Saturated Current Transfer Ratio (CTR_{SAT}) at I_F=1 mA**
  ILD/Q621: 60% Typ.
  ILD/Q621GB: 30% Min.
- **High Collector-Emitter Voltage, BV_{CEO}=70 V**
- **Dual and Quad Packages Feature:**
  - **Reduced Board Space**
  - **Lower Pin and Parts Count**
  - **Better Channel to Channel CTR Match**
  - **Improved Common Mode Rejection**
- **Field-Effect Stable by TRIOS (TR**ansparent **IO**n **S**hield)
- **Isolation Test Voltage from Double Molded Package, 5300 VAC_{RMS}**
- **Underwriters Lab File #E52744**
- **VDE 0884 Available with Option 1**

Maximum Ratings (Each Channel)

Emitter

Reverse Voltage .... 6 V
Forward Current .... 60 mA
Surge Current .... 1.5 A
Power Dissipation .... 100 mW
Derate from 25°C .... 1.33 mW/°C

Detector

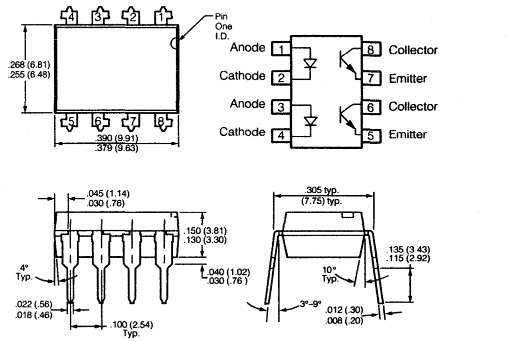
Collector-Emitter Reverse Voltage .... 70 V
Collector Current .... 50 mA
Collector Current (t <1 ms) .... 100 mA
Power Dissipation .... 150 mW
Derate from 25°C .... –2 mW/°C

Package

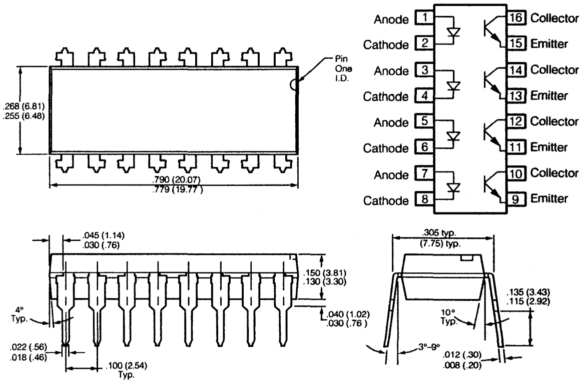
Isolation Test Voltage
(t=1 sec.) .... 7500 VAC_{PK}
(t=1 min.) .... 5300 VAC_{RMS}
Package Dissipation ILD620/GB .... 400 mW
Derate from 25°C .... 5.33 mW/°C
Package Dissipation ILQ620/GB .... 500 mW
Derate from 25°C .... 6.67 mW/°C
Creepage .... 7 mm min.
Clearance .... 7 min min.
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... ≥10^{12} Ω
V_{IO}=500 V, T_A=100°C .... ≥10^{11} Ω
Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Junction Temperature .... 100°C
Soldering Temperature
(2 mm from case bottom) .... 260°C

Package Dimensions in Inches (mm)

ILD621/621GB



ILQ621/621GB



DESCRIPTION
The ILD/Q621 and ILD/Q621GB are multi-channel phototransistor optocouplers that use GaAs IRLED emitters and high gain NPN silicon phototransistors. These devices are constructed using over/under leadframe optical coupling and double molded insulation technology. This assembly process offers a withstand test voltage of 7500 VDC.

The ILD/Q621GB is well suited for CMOS interfacing given the CTR_{CEsat} of 30% minimum at I_F of 1 mA. High gain linear operation is guaranteed by a minimum CTR_{CE} of 100% at 5 mA. The ILD/Q621 has a guaranteed CTR_{CE} of 50% minimum at 5 mA. The **TR**ansparent **IO**n **S**hield insures stable DC gain in applications such as power supply feedback circuits, where constant DC V_{IO} voltages are present.

Characteristics

Emitter	Symbol	Min.	Typ.	Max.	Unit	Condition
Forward Voltage	V_F	1	1.15	1.3	V	I_F=10 mA
Reverse Current	I_R		0.01	10	µA	V_R=6 V
Capacitance	C_0		40		pF	V_F=0 V, f=1 MHz
Thermal Resistance Junction to Lead	R_{THJL}		750		°C/W	
Detector						
Capacitance	C_{CE}		6.8		pF	V_{CE}=5 V, f=1 MHz
Collector-Emitter Leakage Current	I_{CEO}		10	100	nA	V_{CE}=24 V
Collector-Emitter Leakage Current	I_{CEO}		2	50	µA	T_A=85°C, V_{CE}=24 V
Thermal Resistance Junction to Lead	R_{THJL}		500		C°/W	
Package Transfer Characteristics						
Channel/Channel CTR Match	CTRX/CTRY	1 to 1		3 to 1		I_F=5 mA, V_{CE}=5 V
ILD/Q621						
Saturated Current Transfer Ratio	CTR_{CEsat}		60		%	I_F=1 mA, V_{CE}=0.4 V
Current Transfer Ratio	CTR_{CE}	50	80	600	%	I_F=5 mA, V_{CE}=5 V
Collector-Emitter Saturation Voltage	V_{CEsat}			0.4	V	I_F=8 mA, I_{CE}=2.4 mA
ILD/Q621GB						
Saturated Current Transfer Ratio	CTR_{CEsat}	30			%	I_F=1 mA, V_{CE}=0.4 V
Current Transfer Ratio (Collector-Emitter)	CTR_{CE}	100	200	600	%	I_F=5 mA, V_{CE}=5 V
Collector-Emitter Saturation Voltage	V_{CEsat}			0.4	V	I_F=1 mA, I_{CE}=0.2 mA
Isolation and Insulation						
Common Mode Rejection, Output High	CMH		5000		V/µs	V_{CM}=50 V_{P-P}, R_L=1 kΩ, I_F=0 mA
Common Mode Rejection, Output Low	CML		5000		V/µs	V_{CM}=50 V_{P-P}, R_L=1 kΩ, I_F=10 mA
Common Mode Coupling Capacitance	C_{CM}		0.01		pF	
Package Capacitance	CI-O	0.8			pF	V_{IO}=0 V, f=1 MHz
Insulation Resistance	R_S	10^{12}			Ω	V_{IO}=500 V, T_A=25°C
Channel to Channel Insulation		500			VAC	

Switching Times

Figure 1. Non-saturated switching timing

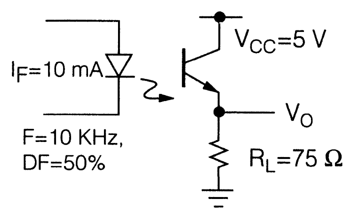


Figure 2. Saturated switching timing

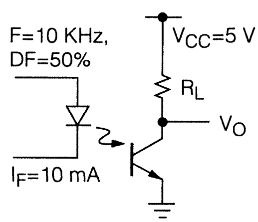


Figure 3. Non-saturated switching timing

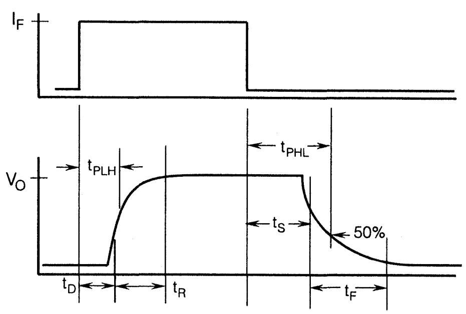
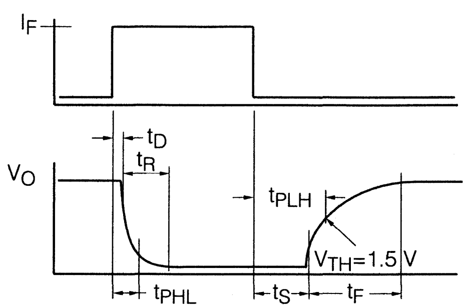


Figure 4. Saturated switching timing



Characteristic	Symbol	Typ.	Unit	Test Condition
On Time	T_{ON}	3.0	µs	I_F=±10 mA
Rise Time	t_R	20	µs	V_{CC}=5 V
Off Time	t_{OFF}	2.3	µs	R_L=75 Ω
Fall Time	t_F	2.0	µs	50% of V_{PP}
Propagation H-L	t_{PHL}	1.1	µs	
Propagation L-H	t_{PLH}	2.5	µs	

Characteristic	Symbol	Typ.	Unit	Test Condition
On Time	T_{ON}	4.3	µs	I_F=±10 mA
Rise Time	t_R	2.8	µs	V_{CC}=5 V
Off Time	t_{OFF}	2.5	µs	R_L=1 kΩ
Fall Time	t_F	11	µs	V_{TH}=1.5 V
Propagation H-L	t_{PHL}	2.6	µs	
Propagation L-H	t_{PLH}	7.2	µs	

Figure 5. Maximum LED current versus ambient temperature

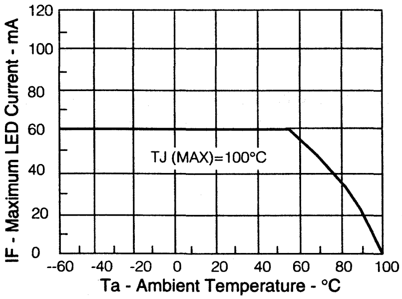


Figure 6. Maximum LED power dissipation

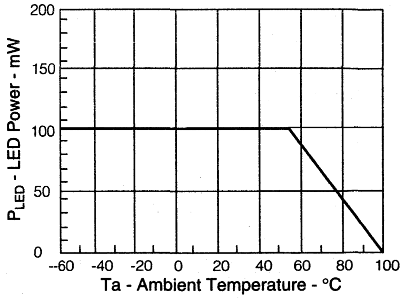


Figure 7. Forward voltage versus forward current

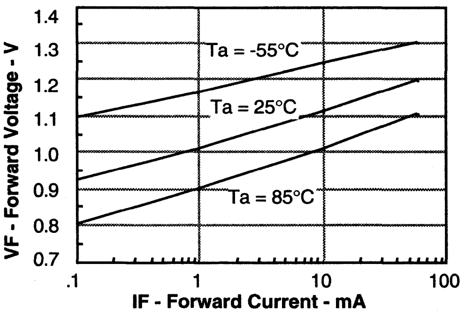


Figure 8. Collector-emitter current versus temperature and LED current

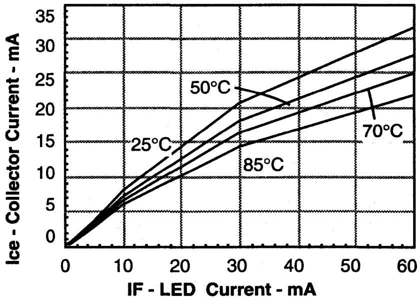


Figure 9. Collector-emitter leakage versus temperature

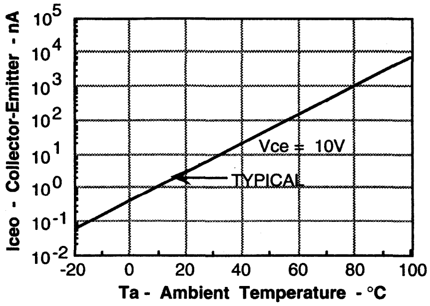


Figure 10. Propagation delay versus collector load resistor

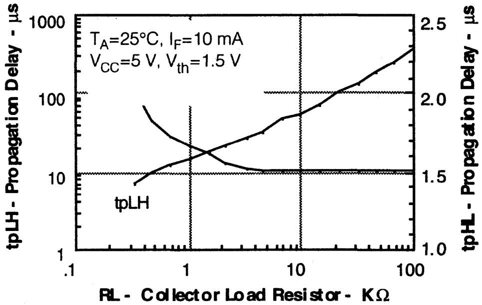


Figure 11. Maximum detector power dissipation

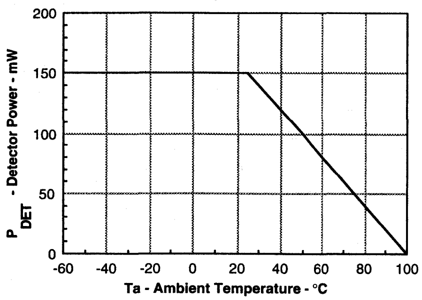


Figure 12. Maximum collector current versus collector voltage

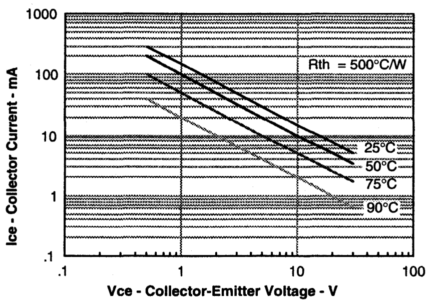


Figure 13. Normalization factor for non-saturated and saturated CTR T_A=50°C versus If

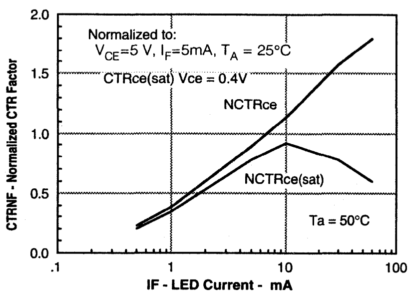


Figure 14. Normalization factor for non-saturated and saturated CTR T_A=70°C versus If

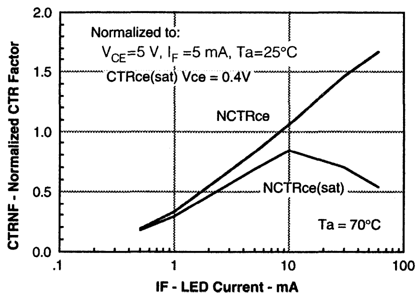


Figure 15. Normalization factor for non-saturated and saturated CTR T_A=100°C versus If

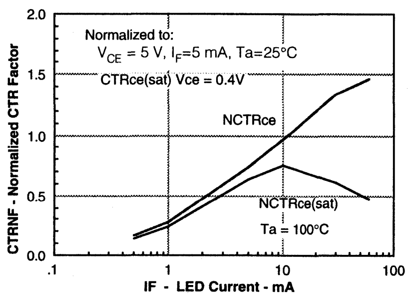
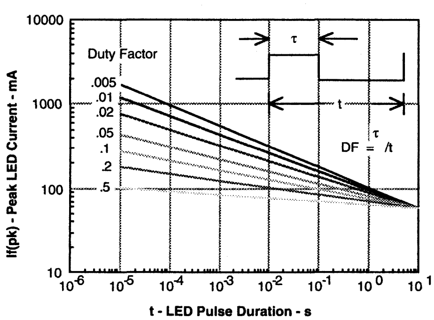


Figure 16. Peak LED current versus pulse duration, Tau



SIEMENS

ILH100

HERMETIC PHOTOTRANSISTOR OPTOCOUPLER

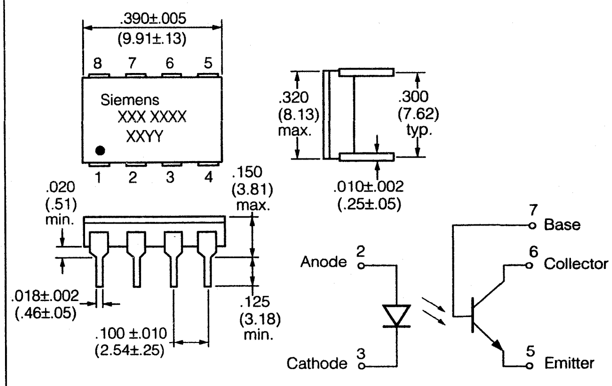
FEATURES

- **Operating Temperature Range, –55°C to +125°C**
- **Current Transfer Ratio Guaranteed from –55°C to +100°C Ambient Temperature Range**
- **High Current Transfer Ratio at Low Input Current**
- **Isolation Test Voltage, 3000 VDC**
- **Base Lead Available for Transistor Biasing**
- **Standard 8 Pin DIP Package**

DESCRIPTION

The ILH100 is designed especially for hi-rel applications requiring optical isolation with high current transfer ratio and low saturation V_{CE}. Each optocoupler consists of a light emitting diode and a NPN silicon phototransistor mounted and coupled in an 8 pin hermetically sealed DIP package. The ILH100's low input current makes it well suited for direct CMOS to LSTTL/TTL interfaces.

Package Dimensions in Inches (mm)



Maximum Ratings

Emitter

Reverse Voltage .... 6.0 V
Forward Current .... 60 mA
Peak Forward Current(1) .... 1 A
Power Dissipation .... 150 mW
Derate Linearly from 25°C .... 1.5 mW/°C

Detector

Collector–Emitter Voltage .... 70 V
Emitter–Base Voltage .... 7 V
Collector–Base Voltage .... 70 V
Continuous Collector Current .... 50 mA
Power Dissipation .... 300 mW
Derate Linearly from 25°C .... 3.0 mW/°C

Package

Input–Output Isolation Test Voltage(2) .... 3000 VDC
Storage Temperature Range .... –65°C to +150°C
Operating Temperature Range .... –55 to +125°C
Junction Temperature .... 150°C
Soldering Time at 240°C, 1.6 mm from case .... 10 sec.
Power Dissipation .... 350 mW
Derate Linearly from 25°C .... 3.5 mW/°C

Notes:
1. Values applies for $P_W \leq 1$ ms, PRR≤300 pps.
2. Measured between pins 1,2,3 and 4 shorted together and pins 5,6,7 and 8 shorted together. T_A=25°C and duration=1 second, RH=45%.

Characteristics (T_A=25°C, unless otherwise specified)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.45	1.7	V	I_F=60 mA
Reverse Breakdown Voltage	V_{BR}	6			V	I_R=10 μA
Reverse Current	I_R		0.01	10	μA	V_R=6 V
Capacitance	C_J		20		pF	V_F=0 V, f=1 MHz
Thermal Resistance	R_{TH}		220		°C/W	Junction to Lead
Detector						
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$		0.25	0.4	V	I_B=20 μA, I_{CE}=1 mA
Base-Emitter Voltage	V_{BE}		0.65		V	I_B=20 μA
Collector-Emitter Leakage Current	I_{CEO}		5	50	nA	V_{CE}=10 V
DC Forward Current Gain	HFE	250	400	750		V_{CE}=10 V, I_B=20 μA
Saturated DC Forward Current Gain	$HFE_{(sat)}$	125	200	325		V_{CE}=0.4 V, I_B=20 μA
Capacitance	C_{CE}		6.8		pF	V_{CE}=5 V, f=1 MHz
	C_{CB}		8.5		pF	
	C_{EB}		11		pF	
Thermal Resistance	R_{TH}		220		°C/W	Junction to Lead
Coupled Characteristics (–55°C to 100°C)						
Saturated Current Transfer Ratio	$CTR_{(sat)}$	70	210	250	%	I_F=10 mA, V_{CE}=0.4 V
Current Transfer Ratio Collector-Emitter	CTR_{ce}	100	300	450	%	I_F=10 mA, V_{CE}=10 V
Current Transfer Ratio Collector-Base	CTR_{cb}	0.4	0.7	0.9	%	I_F=10 mA, V_{CB}=9.3 V
Isolation and Insulation						
Common Mode Rejection Output High	CM_H	1000	2000		V/μs	V_{CM}=500 V_{p-p}, V_{CC}=5 V, R_L=1 KΩ, I_F=0 mA
Common Mode Rejection Output High	CM_L	1000	2000		V/μs	V_{CM}=500 V_{p-p}, V_{CC}=5 V, R_L=1 KΩ, I_F=10 mA
Package Capacitance	C_{IO}		1.5		pF	V_{IO}=0 V, 1 MHz
Insulation Resistance	R_{IO}	10^{11}	10^{14}		Ω	V_{IO}=500 VDC
Leakage Current Input–Output	I_{IO}			10	μA	Relative Humidity ≤50%, V_{IO} 3000 VDC, 5 sec.

Typical Switching Speeds (T_A=25°C)

Non-Saturated Switching	Symbol	Typ.	Max.	Unit	Test Condition
Delay	td	0.8	2	μs	
Rise	tr	2	5	μs	V_{CC}=5 V
Storage	ts	0.4	1.5	μs	R_L=75 Ω
Fall	tf	2	5	μs	I_F=10 mA
Propagation–High to Low	tpHL	1	3	μs	50% of V_{PP}
Propagation–Low to High	tpLH	1.5	4	μs	R_{BE}=open
Saturated Switching(1)					
Delay	td	0.7	2	μs	
Rise	tr	1	3	μs	V_{CE}=0.4 V
Storage	ts	13.5	30	μs	R_L=1 KΩ
Fall	tf	12	30	μs	I_F=10 mA
Propagation–High to Low	tpHL	1.4	5	μs	V_{CC}=5 V, V_{TH}=1.5 V
Propagation–Low to High	tpLH	15	40	μs	R_{BE}=open

Figure 1. Switching time waveform and test schematic—non-saturated test condition

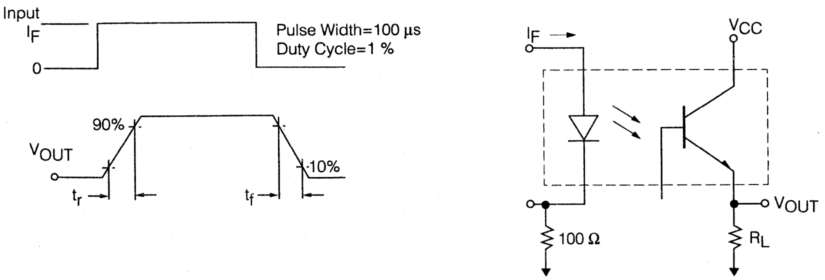


Figure 2. Forward current versus forward voltage and temperature

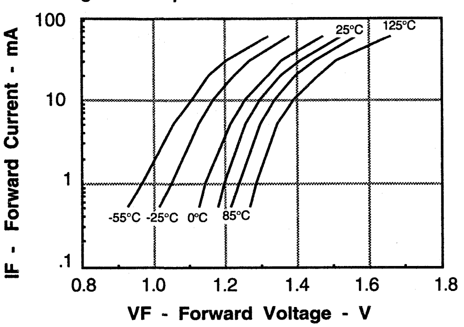


Figure 3. Peak LED current versus duty factor refresh rate and temperature

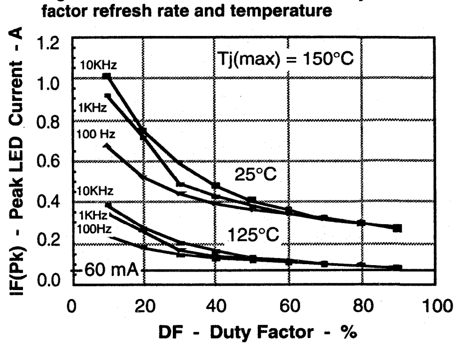


Figure 4. Normalized non-saturated current transfer ratio versus temperature and LED current

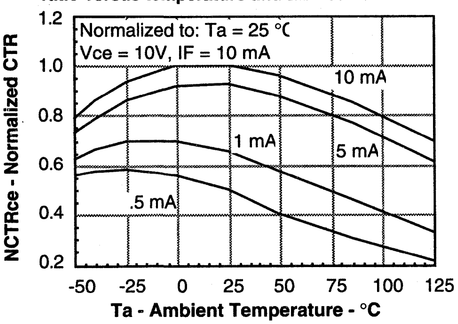


Figure 5. Normalized non-saturated current transfer ratio versus temperature and LED current

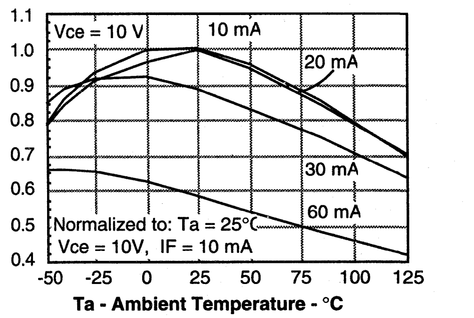


Figure 6. Normalized saturated current transfer ratio versus temperature and LED current

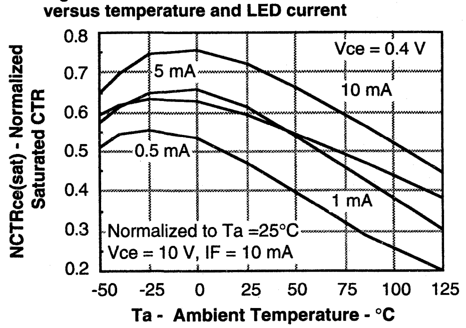


Figure 7. Normalized saturated current transfer ratio versus temperature and LED current

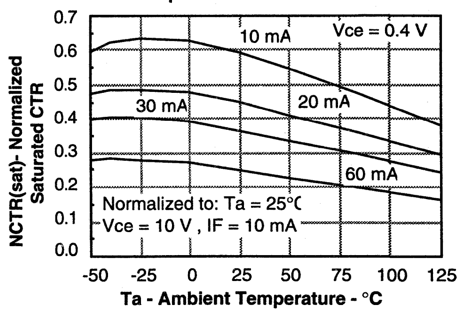


Figure 8. Collector-emitter current versus temperature and LED current

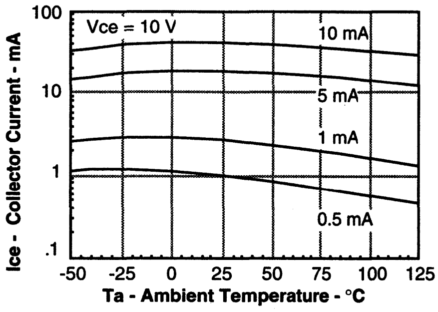


Figure 9. Collector-emitter current versus temperature and LED current

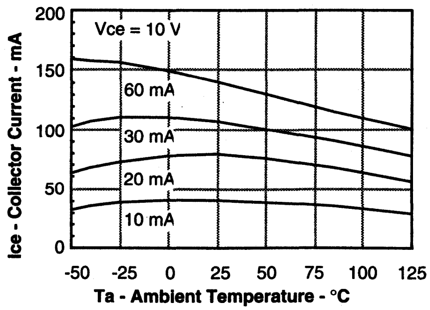


Figure 10. Saturated collector-emitter current versus temperature and LED current

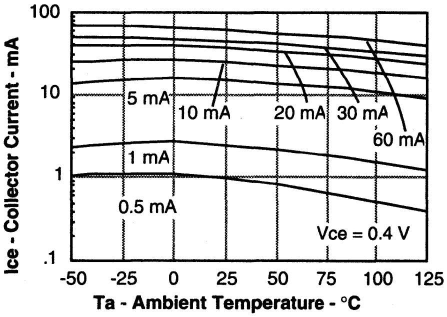


Figure 11. Saturated collector-emitter current versus temperature and LED current

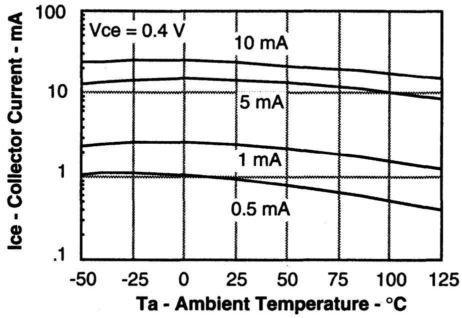


Figure 12. Normalized collector base CRT versus temperature and LED current

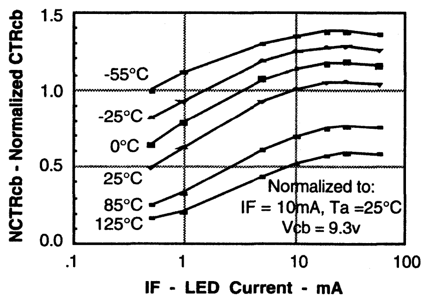


Figure 13. Normalizied Icb photocurrent versus temperature and LED current

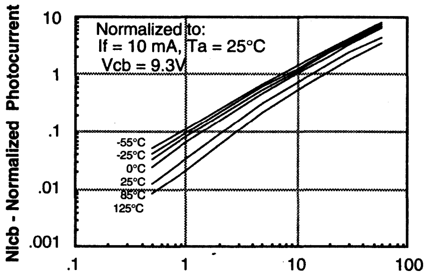


Figure 14. Normalized non-saturated and saturated HFE at T_A=25°C versus base current

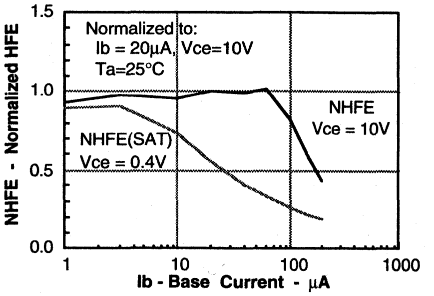


Figure 15. Normalizied non-saturated and saturated HFE at T_A=50°C versus base current

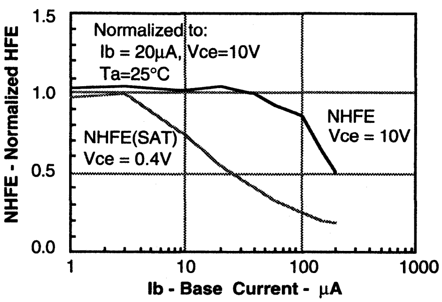


Figure 16. Normalized non-saturated and saturated HFE at T_A=70°C versus base current

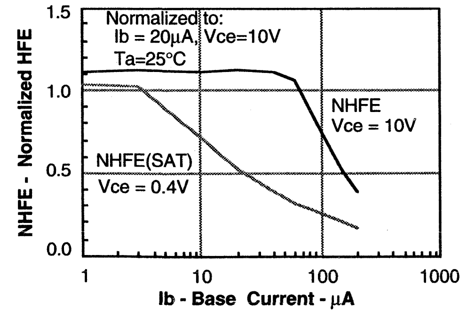


Figure 17. Collector-emitter leakage current versus temperature

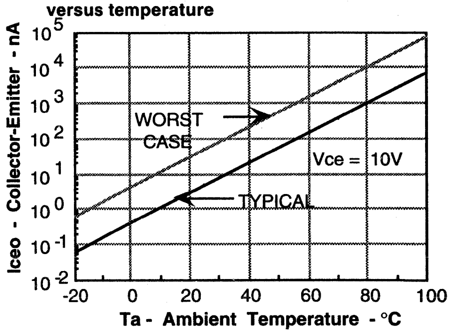


Figure 18. Base emitter voltage versus base current

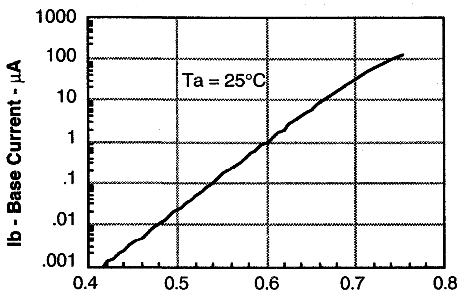


Figure 19. Base emitter capacitance versus base emitter voltage

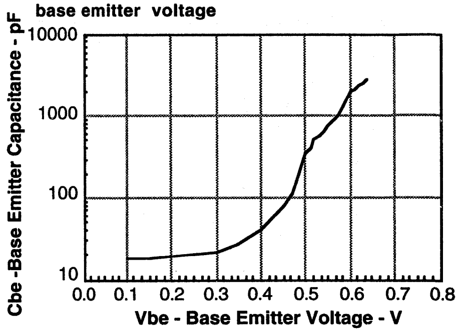


Figure 20. Propagation delay versus temperature and collector load resistance for I_F=5 mA

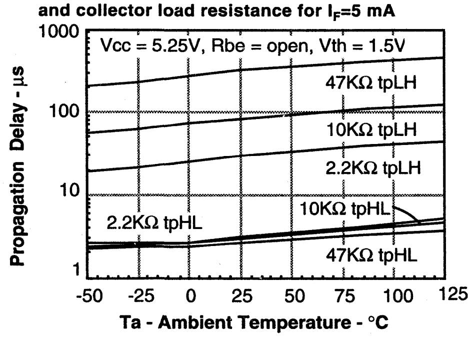


Figure 21. Propagation delay versus temperature and collector load resistance for I_F=10 mA

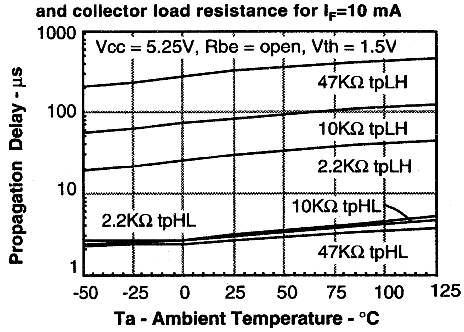


Figure 22. Propagation delay versus temperature and collector load resistance for I_F=20 mA

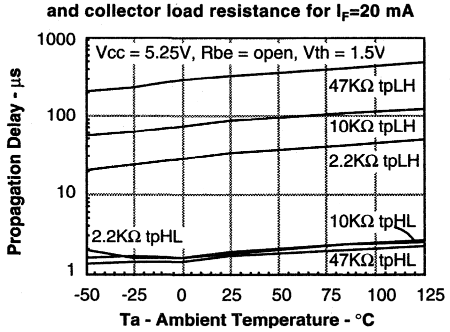


Figure 23. Propagation delay versus temperature and collector load resistance for I_F=5 mA

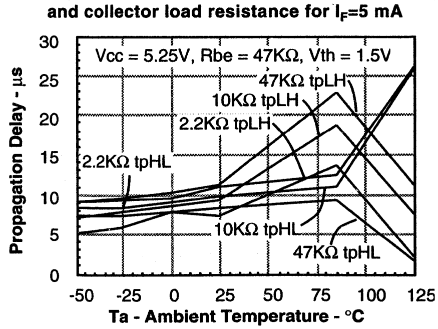


Figure 24. Switching time waveform and test schematic—saturated test condition

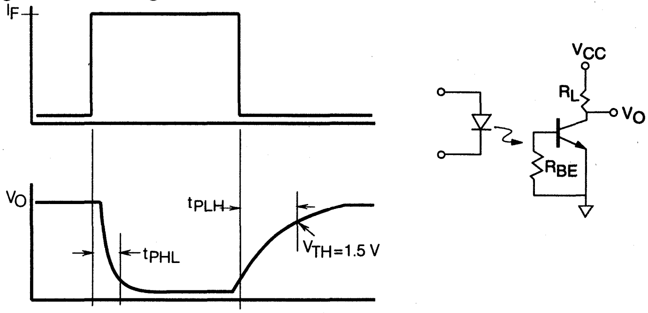


Figure 25. Propagation delay versus temperature and collector load resistance for I_F=10 mA

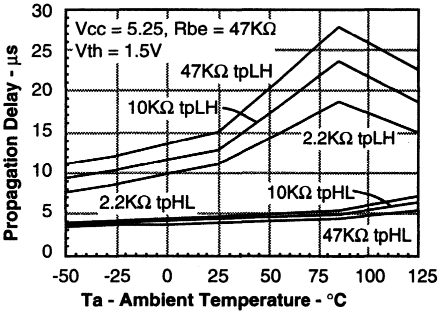


Figure 26. Propagation delay versus temperature and collector load resistance for I_F=20 mA

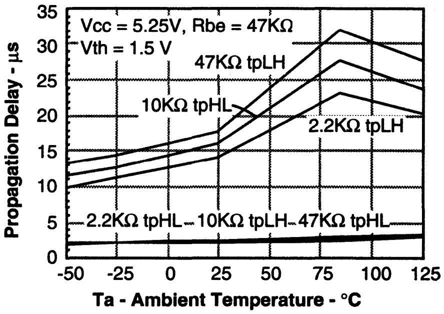


Figure 27. Propagation delay versus collector load and base-emitter resistance for I_F=5 mA

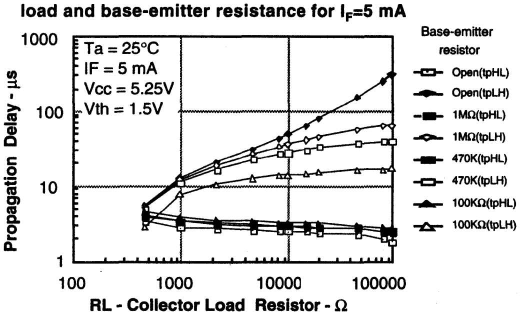


Figure 28. Propagation delay versus collector load and base-emitter resistance for I_F=5 mA

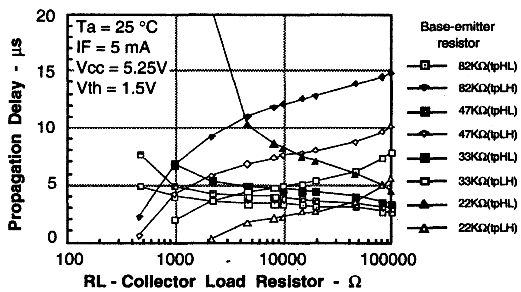


Figure 29. Propagation delay versus collector load and base-emitter resistance for I_F=10 mA

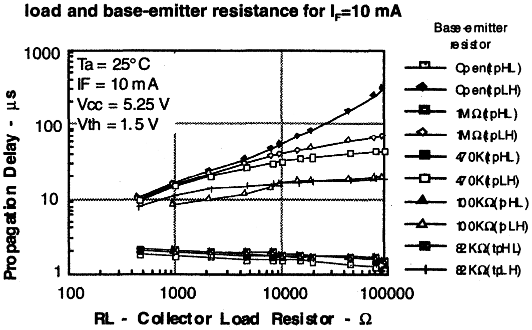


Figure 30. Propagation delay versus collector load and base-emitter resistance for I_F=10 mA

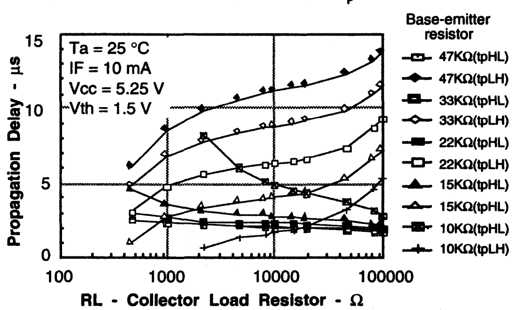


Figure 31. Propagation delay versus collector load and base-emitter resistance for I_F=15 mA

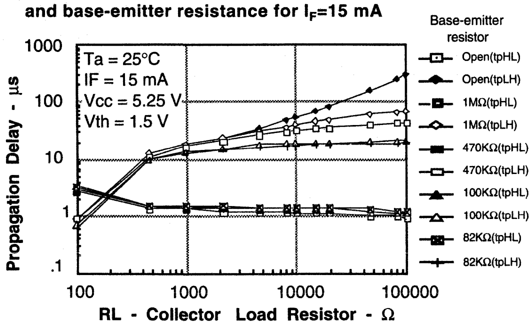


Figure 32. Propagation delay versus collector load and base-emitter resistance for I_F=15 mA

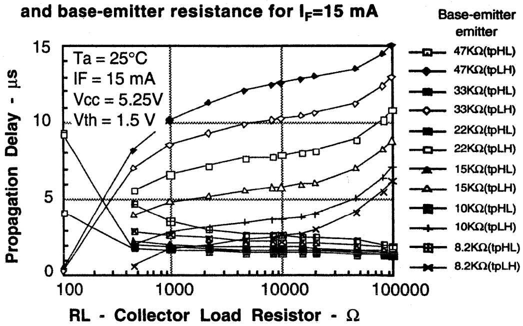


Figure 33. Propagation delay versus collector load and base-emitter resistance for I_F=15 mA

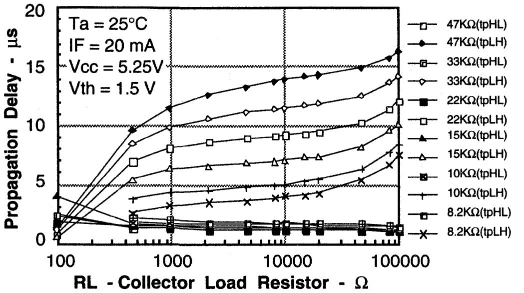


Figure 34. Propagation delay versus collector load and base-emitter resistance for I_F=15 mA

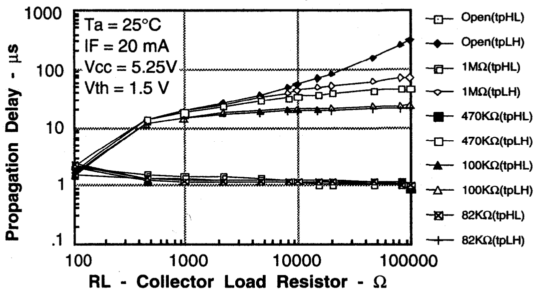
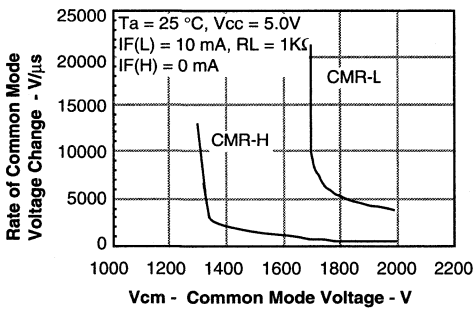


Figure 35. Common mode transient rejection



SIEMENS

ILH200

HERMETIC PHOTOTRANSISTOR DUAL CHANNEL OPTOCOUPLER

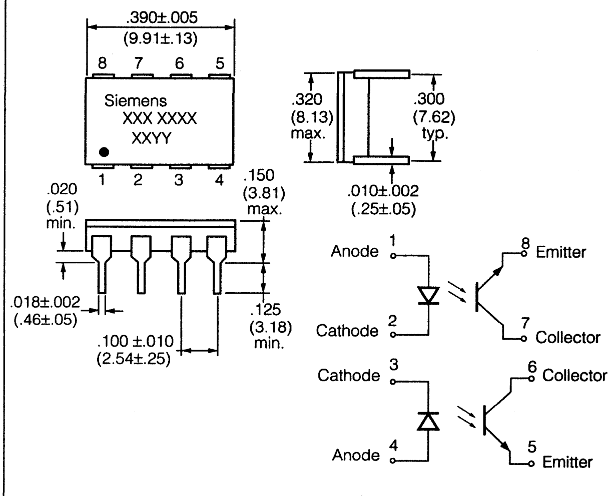
FEATURES

- **Operating Temperature Range, –55°C to +125°C**
- **Current Transfer Ratio Guaranteed from –55°C to +100°C Ambient Temperature Range**
- **High Current Transfer Ratio at Low Input Current**
- **Isolation Test Voltage, 3000 VDC**
- **Two Isolated Channels per Package**
- **Standard 8 Pin DIP Package**

DESCRIPTION

The ILH200 is designed especially for hi-rel applications requiring optical isolation with high current transfer ratio and low saturation V_{CE}. Each channel of the optocoupler consists of a light emitting diode and a NPN silicon phototransistor mounted and coupled in an 8 pin hermetically sealed DIP package. The low input current makes the ILH200 well suited for direct CMOS to LSTTL/TTL interfaces.

Package Dimensions in Inches (mm)



Maximum Ratings

Emitter (per channel)

Reverse Voltage .... 6.0 V
Forward Current .... 60 mA
Peak Forward Current[1] .... 1 A
Power Dissipation .... 75 mW
Derate Linearly from 25°C .... 0.75 mW/°C

Detector (per channel)

Collector-Emitter Voltage .... 70 V
Emitter-Collector Voltage .... 7 V
Continuous Collector Current .... 50 mA
Power Dissipation .... 100 mW
Derate Linearly from 25°C .... 1.0 mW/°C

Package

Input to Output Isolation Test Voltage[2] .... 3000 VDC
Storage Temperature Range .... –65°C to +150°C
Operating Temperature Range .... –55°C to +125°C
Junction Temperature .... 150°C
Soldering Time at 240°C, 1.6 mm from case .... 10 sec.
Power Dissipation .... 350 mW
Derate Linearly from 25°C .... 3.5 mW/°C

Notes:
1. Values applies for $P_W \leq 1$ ms, PRR≤300 pps.
2. Measured between pins 1,2,3 and 4 shorted together and pins 5,6,7 and 8 shorted together. T_A=25°C and duration=1 second, RH=45%.

Characteristics (Each Channel) (T_A=25°C, unless otherwise specified)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.46	1.7	V	I_F=60 mA
Reverse Breakdown Voltage	V_{BR}	6			V	I_R=10 µA
Reverse Current	I_R		0.01	10	µA	V_R=6 V
Capacitance	C_J		20		pF	V_F=0 V, f=1 MHz
Thermal Resistance	R_{TH}		220		°C/W	Junction to Lead
Detector						
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$		0.25	0.4	V	I_B=20 µA, I_{CE}=1 mA
Collector-Emitter Leakage Current	I_{CEO}		5	50	nA	V_{CE}=10 V
Capacitance	C_{CE}		6.8		pF	V_{CE}=5 V, f=1 MHz
Thermal Resistance	R_{TH}		220		°C/W	Junction to Lead
Coupled Characteristics -55°C to 100°C						
Saturated Current Transfer Ratio	$CTR_{(sat)}$	70	210	250	%	I_F=10 mA, V_{CE}=0.4 V
Current Transfer Ratio Collector-Emitter	CTR_{ce}	100	300	450	%	I_F=10 mA, V_{CE}=10 V
Isolation and Insulation						
Common Mode Rejection Output High	CM_H	1000	2000		V/µs	V_{CM}=500 V_{p-p}, V_{CC}=5 V, R_L=1 KΩ, I_F=0 mA
Common Mode Rejection Output High	CM_L	1000	2000		V/µs	V_{CM}=500 V_{p-p}, V_{CC}=5 V, R_L=1 KΩ, I_F=10 mA
Package Capacitance	C_{IO}		1.5		pF	V_{IO}=0 V, 1 MHz
Insulation Resistance	R_{IO}	10^{11}	10^{14}		Ω	V_{IO}=500 VDC
Leakage Current Input–Output	I_{IO}			10	µA	Relative Humidity ≤50%, V_{IO} 3000 VDC, 5 sec.

Optocouplers (Optoisolators)

5

Typical Switching Speeds (T_A=25°C)

Non-Saturated Switching	Symbol	Typ.	Max.	Unit	Test Condition
Delay	td	0.8	2	µs	
Rise	tr	2	5	µs	V_{CC}=5 V
Storage	ts	0.4	1.5	µs	R_L=75 Ω
Fall	tf	2	5	µs	I_F=10 mA
Propagation–High to Low	tpHL	1	3	µs	50% of V_{PP}
Propagation–Low to High	tpLH	1.5	4	µs	
Saturated Switching(1)	**Symbol**	**Typ.**	**Max.**	**Unit**	**Test Condition**
Delay	td	0.7	2	µs	
Rise	tr	1	3	µs	V_{CE}=0.4 V
Storage	ts	13.5	30	µs	R_L=1 KΩ
Fall	tf	12	30	µs	I_F=10 mA
Propagation–High to Low	tpHL	1.4	5	µs	V_{CC}=5 V, V_{TH}=1.5 V
Propagation–Low to High	tpLH	15	40	µs	

Figure 1. Forward current versus forward voltage and temperature

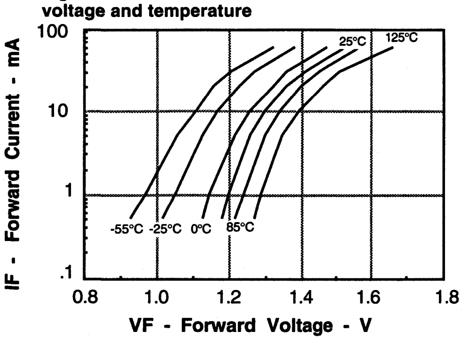


Figure 2. Peak LED current versus duty factor refresh rate and temperature

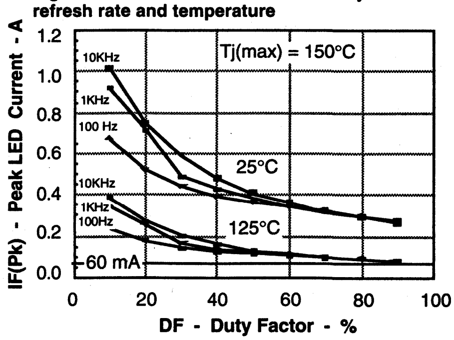


Figure 3. Normalized non-saturated current transfer ratio versus temperature and LED current

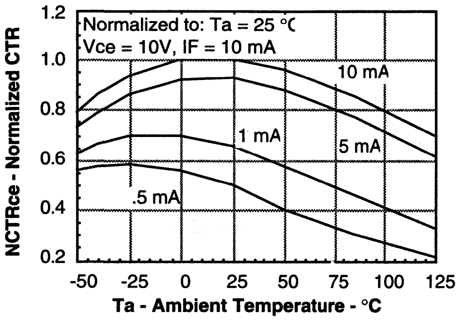


Figure 4. Normalized non-saturated current transfer ratio versus temperature and LED current

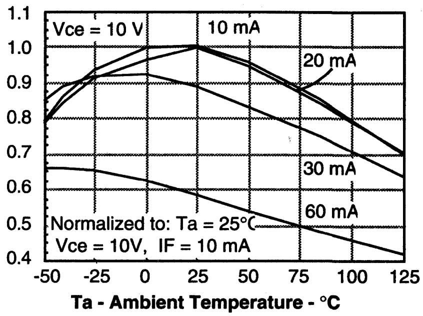


Figure 5. Normalized saturated current transfer ratio versus temperature and LED current

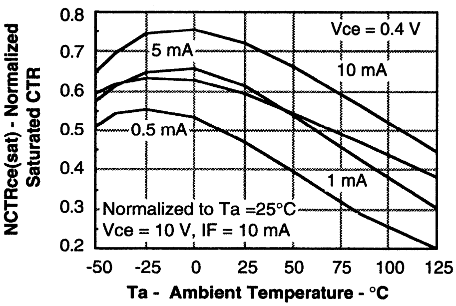


Figure 6. Normalized saturated current transfer ratio versus temperature and LED current

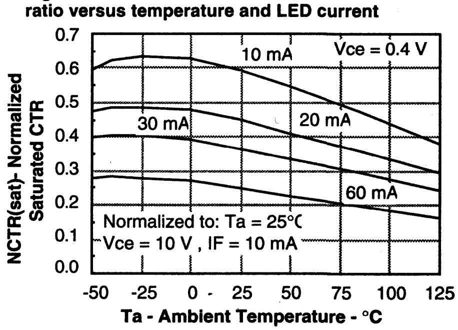


Figure 7. Collector-emitter current versus temperature and LED current

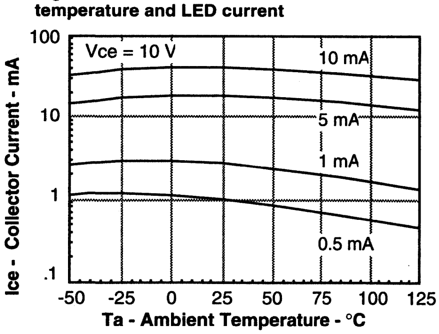


Figure 8. Collector-emitter current versus temperature and LED current

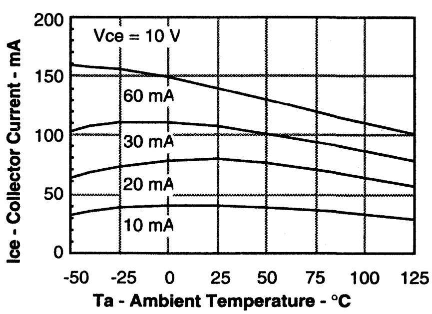


Figure 9. Saturated collector-emitter current versus temperature and LED current

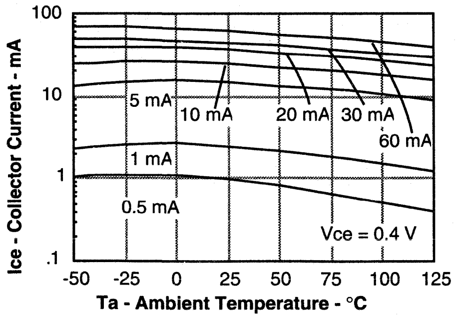


Figure 10. Saturated collector-emitter current versus temperature and LED current

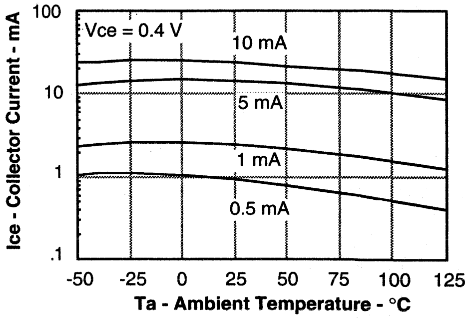


Figure 11. Collector-emitter leakage current versus emperature

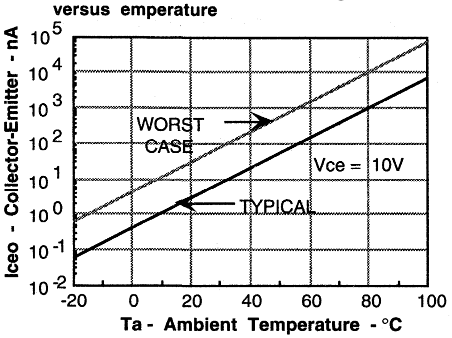


Figure 12. Propagation delay versus temperature and collector load resistance for I_F=5 mA

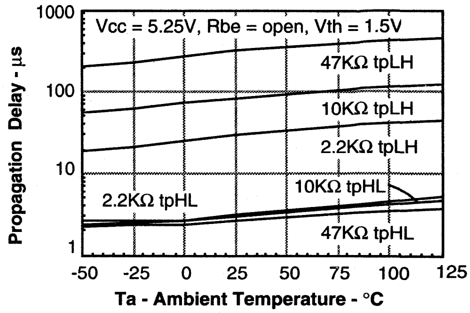


Figure 13. Propagation delay versus temperature and collector load resistance for I_F=10 mA

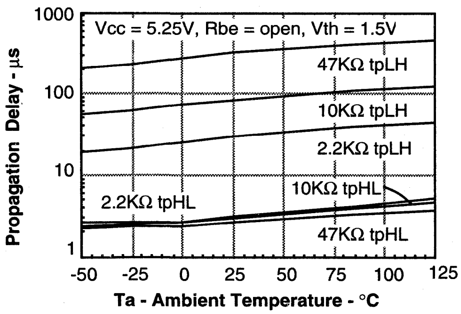


Figure 14. Propagation delay versus temperature and collector load resistance for I_F=20 mA

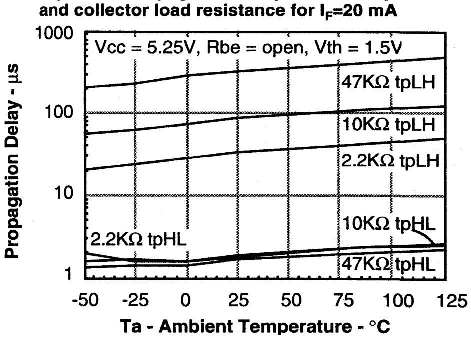


Figure 15. Common mode transient rejection

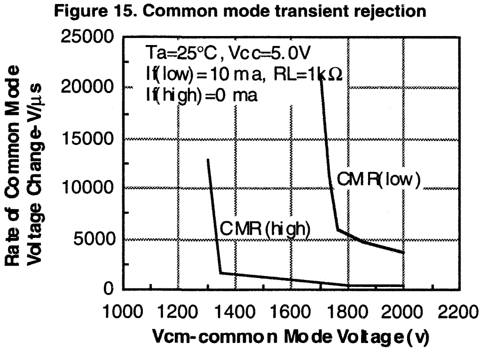
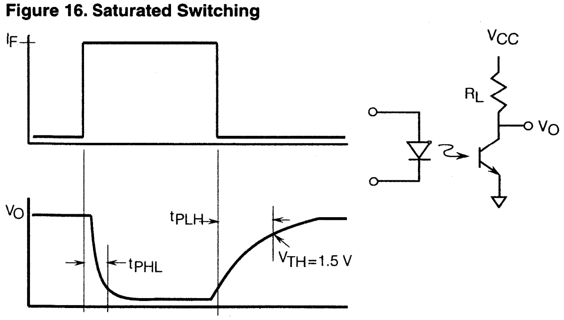


Figure 16. Saturated Switching



Optocouplers (Optoisolators)

5

SIEMENS

LH1056

HIGH VOLTAGE, SOLID STATE RELAY OPTOCOUPLER

FEATURES

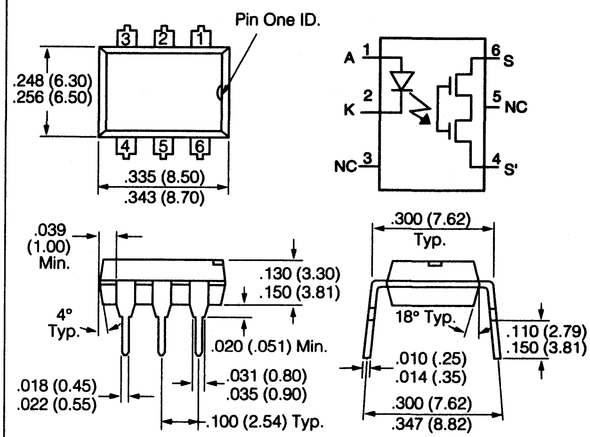
- **Normally Open, Single Pole Single Throw Operation**
- **Control 350 VAC or DC Voltage**
- **Switch 100 mA Loads**
- **LED Control Current, 1.5 mA**
- **Low ON-Resistance**
- **dv/dt, >500 V/ms**
- **Isolation Test Voltage, 3750 VAC_{RMS}**
- **Current Limiting**
- **Underwriters Lab File # E52744**
- **Applications**
  - **Telephone Switch Hook**
  - **High Voltage Test Equipment**
  - **TRIAC Driver**
  - **Motor Control**
  - **Industrial Control Systems**

DESCRIPTION

The LH1056 is a single pole single throw (SPST), normally open (NO), solid state relay. The relay can control AC or DC loads currents up to 100 mA, with a supply voltage up to 350 V. The device is packaged in a six pin 0.3 inch dual-in line package. This package offers an insulation dielectric withstand of 7500 VAC_{PK}.

The coupler consists of a AlGaAs LED that is optically coupled to a dielectrically isolated photodiode array which drives two series connected high voltage MOS transistors. The typical ON-Resistance is 30 Ω at 25 mA and is linear up to 50 mA. The incremental resistance drops to less than 20 Ω beyond 50 mA while reducing internal power dissipation at high load currents. There is built-in current limiting circuitry in the detector chip.

Package Dimensions in Inches (mm)



Absolute Maximum Ratings (T_A=25°C)

Emitter

Reverse Voltage .... 6.0 V
Continuous Forward Current .... 60 mA
Peak Forward Current (1 µs) .... 1 A
Power Dissipation .... 100 mW
Derate Linearly from 25°C .... 1.3 mW/°C

Detector

Output Breakdown Voltage .... ±350 V
Continuous Load Current .... ±100 mA
Total Power Dissipation .... 500 mW
Derate Linearly from 25°C .... See Figure 7

Package

Isolation Test Voltage .... 3750 VAC_{RMS}
Isolation Resistance
  V_{IO}=500 V, T_A=25°C .... $\geq 10^{12}$ Ω
  V_{IO}=500 V, T_A=100°C .... $\geq 10^{11}$ Ω
Power Dissipation .... 500 mW
Derate Linearly from 25°C .... 2.5 mW/°C
Storage Temperature Range .... –40 to +150°C
Operating Temperature Range .... –40 to +85°C
Junction Temperature .... 100°C
Soldering Temperature, 2 mm from case, 10 sec. .... 260°C

Characteristics (T_A=25°C)

Description	Symbol	Min.	Typ.	Max.	Unit	Test Condition
Emitter						
Forward Voltage	V_F		1.25	1.5	V	I_F=10 mA
V_F Temperature Coefficient	$\Delta V_F/\Delta T$		–2.2		mV/°C	
Reverse Current	I_R		1	10	µA	V_R=6 V
Junction Capacitance	C_J		15		pF	V_F=0 V, f=1 MHz
Dynamic Resistance	$\Delta V_F/\Delta I_F$		6		Ω	I_F=10 mA
Switching Time	t_R, t_F		1		µs	I_F=10 mA
Detector						
Output Breakdown Voltage	V_B	350	380		V	I_B=50 µA
Output Off-State Leakage Current	$I_{T(OFF)}$		.03	200	nA	V_T=100 V, I_F=0 mA
Feed through Capacitance, pins 4 to 6	C_T		24		pF	I_F=0, f=1 KHz, V_L=4 VP-P
Current Limit	I_{LMT}	100	150	210	mA	I_F=5 mA, V_L=±7 V, t=10 ms
Package						
LED Forward Current for Turn-on	I_{FON}		2.5	3.5	mA	V_L=±7 V, I_L=100 mA, t=10 ms
LED Forward Current for Turn-off	I_{FOFF}	0.2		1.3	mA	V_L=±300 V, I_F=<5 µA
ON Resistance	R_{ON}	20	30	50	Ω	I_T=±25 mA, I_F=5 mA
Turn-on Time	t_{ON}		0.9	2.0	ms	I_F=10 mA, V_L=+50 V R_L=1 kΩ
Turn-off Time	t_{OFF}		0.7	2.0	ms	

Figure 1. Timing test circuit

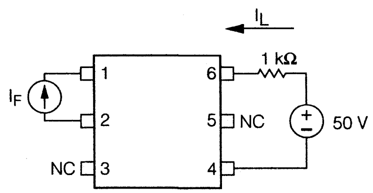


Figure 2. Timing waveform

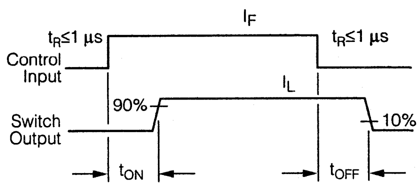


Figure 3. LED forward current vs. forward voltage

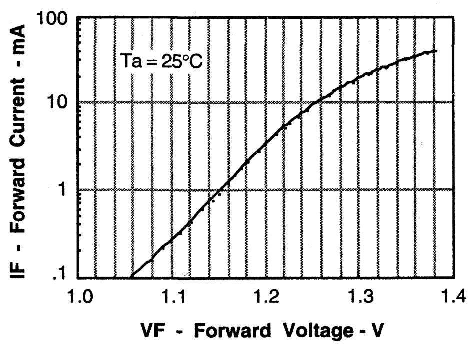


Figure 4. Terminal current vs. terminal voltage

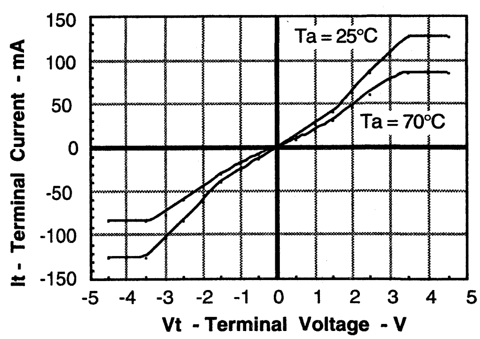


Figure 5. Turn on current vs. temperature

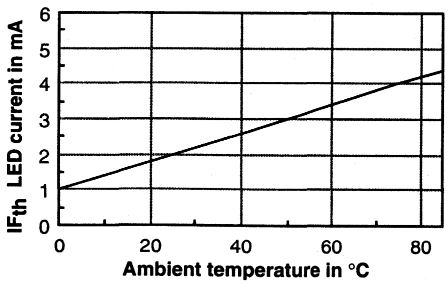


Figure 6. Load current vs. temperature

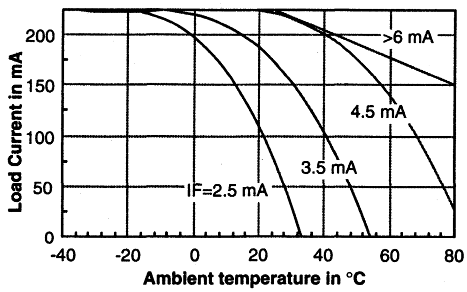


Figure 7. Derating of ILoad vs. temperature

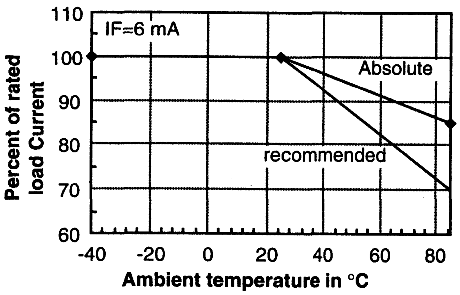


Figure 8. Change in I_{limit} vs. temperature

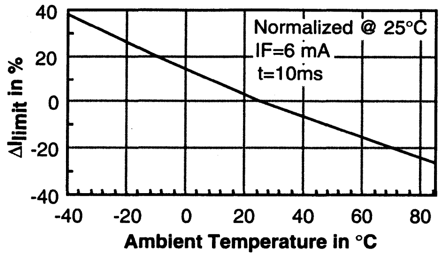


Figure 9. ΔRon vs. temperature

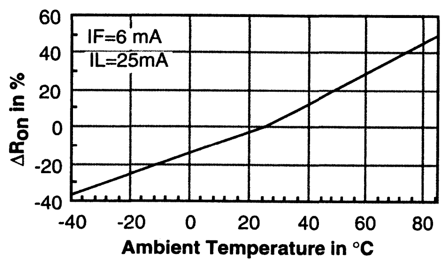


Figure 10. ΔToff vs. temperature

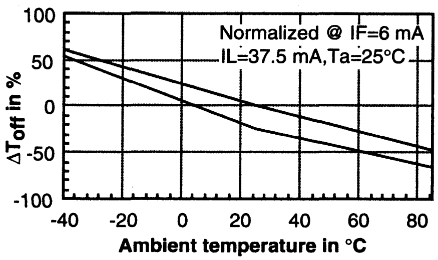


Figure 11. Change in Ton vs. temperature

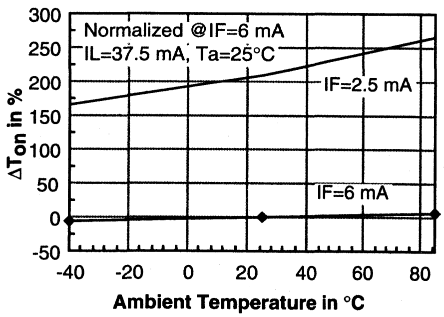
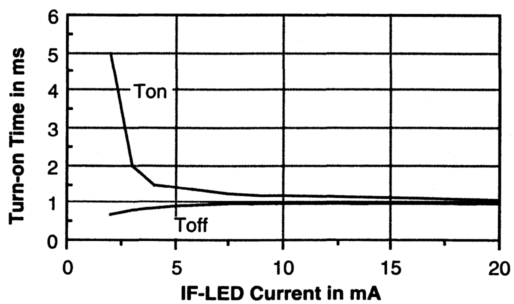


Figure 12. Turn-on and turn-off time vs. LED current



SIEMENS

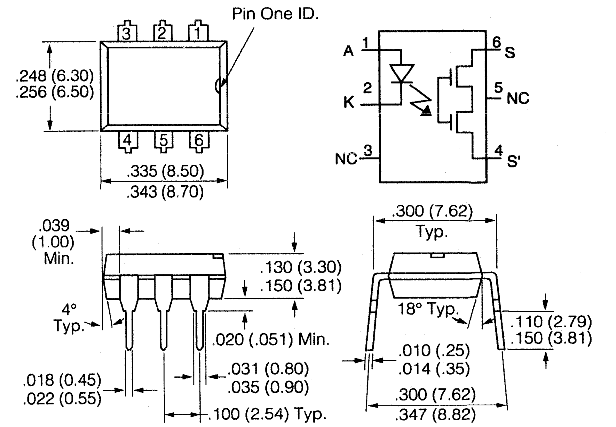
LH1298

HIGH VOLTAGE, SOLID STATE RELAY OPTOCOUPLER

FEATURES

- **Normally Closed, Single Pole Single Throw Operation**
- **Control 350 VAC or DC Voltage**
- **Switch 100 mA Loads**
- **LED Control Current, 1.5 mA**
- **Low ON-Resistance**
- **dv/dt, >500 V/ms**
- **Isolation Test Voltage, 3750 VAC_{RMS}**
- **Current Limiting**
- **Underwriters Lab File # E52744**
- **Applications**
  - **– Telephone Switch Hook**
  - **– High Voltage Test Equipment**
  - **– TRIAC Driver**
  - **– Motor Control**
  - **– Industrial Control Systems**

Package Dimensions in Inches (mm)



DESCRIPTION

The LH1298 is a single pole single throw (SPST), normally closed (NC), solid state relay. The relay can control AC or DC loads currents up to 100 mA, with a supply voltage up to 350 V. The device is packaged in a six pin 0.3 inch dual-in line package. This package offers an insulation dielectric withstand of 3750 VAC_{RMS}.

The coupler consists of a AlGaAs LED that is optically coupled to a dielectrically isolated monolithic integrated circuit. The IC chip consists of a photodiode array, control circuitry and high voltage DMOS transistors. The typical ON resistance between the output terminals is 30 Ω at 0 mA LED current. The switch offers low off-state leakage current at LED current of 5 mA or greater. There is on board output current limiting circuitry.

Maximum Ratings

Terminal Voltage .... 350 V
Terminal Current .... 100 mA
LED Forward Current .... 60 mA
LED Reverse Current .... 6 mA
Isolation Test Voltage ....3750 VAC_{RMS}
Isolation Resistance
V_{IO}=500 V, T_A=25°C ....$\geq 10^{12}$ Ω
V_{IO}=500 V, T_A=100°C ....$\geq 10^{11}$ Ω
Operating Temperature Range .... –40 to +85°C
Storage Temperature Range......... –40 to +150°C
Lead Soldering Temperature
at 260°C, 2 mm from case ....5 sec.

Characteristics (T_A=25°C)

Emitter	**Sym**	**Min.**	**Typ.**	**Max.**	**Units**	**Condition**
Forward Voltage	V_F		1.25	1.5	V	I_F=10 mA
V_F Temperature Coefficient	$\Delta V_F/\Delta T_A$		–2.2		mV/°C	
Reverse Current	I_R		1	10	µA	V_R=6 V
Junction Capacitance	C_J		15		pF	V_R=0 V f=1 MHz
Dynamic Resistance	$\Delta V_F/\Delta I_F$		6		Ω	I_F=10 mA
Switching Time	t_R, t_F		1		µs	I_F=10 mA
Detector						
Output Breakdown Voltage	VB	350			V	I_B=50 µA
Output OFF-State Leakage Current	$I_{T(OFF)}$		0.1 0.1	1 5	µA µA	V_T=100 V, I_F=5 mA V_T=300 V, I_F=2.5 mA
Terminal Capacitance	C_T		24		pF	V_T=0, f= MHz
Current Limit			150		mA	
Package						
LED Forward Current, Turn-Off	I_{Fth}		1.5	2.5	mA	V_L=±300 V, T_A=25°C
ON-resistance	R_{ON}	20	30	50	Ω	I_T=±25 mA, I_F=0 mA
Turn-on Time	T_{ON}			3	ms	I_F=5 mA, V_L=50 V, R_L=1 kΩ
Turn-off Time	T_{OFF}			2	ms	

SIEMENS

LH1529

OPTICALLY COUPLED TELECOM SWITCH

Preliminary Data Sheet

FEATURES

- **Solid State Relay and Optocoupler in One Package**
- **Package—Single 8 Pin DIP**
- **I/O Isolation, 3750 V_{RMS}**
- **Surface Mount Option**
- **Optocoupler**
  - **– Bidirectional Current Detection**
- **Solid-state Relay**
  - **– Typical R_{ON} 20 Ω**
  - **– Load Voltage 350 V**
  - **– Load Current 120 mA**
  - **– Current Limit Protection**
  - **– High Surge Capability**
  - **– Linear, AC/DC Operation**
  - **– Clean Bounce Free Switching**
  - **– Low Power Consumption**
  - **– High Reliability Monolithic Receptor**
- **Applications**
  - **General Telecom Switching**
  - **– On/off Hook Control**
  - **– Dial Pulse**
  - **– Ring Current Detection**
  - **– Loop Current Sensing**

DESCRIPTION

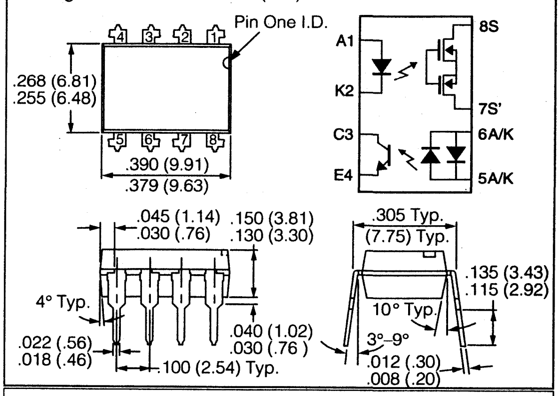
The LH1529 Telecom switch consists of an optically coupled solid state relay (SSR) and a bidirectional input optocoupler. The SSR is ideal for performing switchhook and dial-pulse switching while the optocoupler performs ring detection and loop current sensing functions. Both the SSR and opto coupler provide 3750 V_{RMS} of input to ouput isolation.

The SSR is integrated on a monolithic receptor die using high voltage BCDMOS technology. The SSR features low ON-resistance, high breakdown voltage and current-limit circuitry that protects the relay from telephone line induced lightning surges.

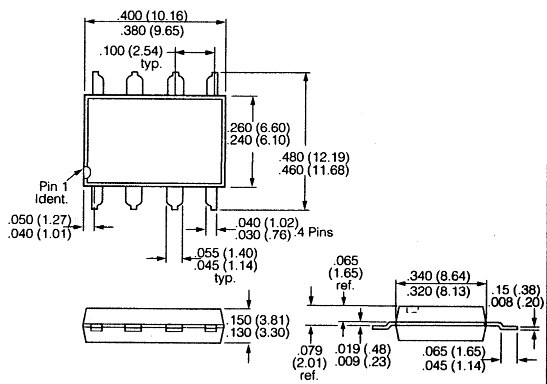
The optocoupler provides bidirectional current sensing via two antiparallel GaAs infrared emitting diodes. The opto channel provides a minimum CTR of 33% at 6 mA.

The LH1529 comes in a 8 pin, plastic DIP. To order packages with "S" bend leads, specify LH1529X00S.

Package Dimensions in Inches (mm)



"S" Bend Leads: Package Dimensions in Inches (mm)



Absolute Maximum Ratings

Package

Ambient Temperature Range: .... –40 to +85°C
Storage Temperature Range .... –40 to +150°C
Soldering Temperature (t=10 sec. max.) .... 260°C
Isolation Test Voltage .... 3750 V_{RMS}
Isolation Resistance
  V_{IO}=500 V, T_A=25°C .... ≥10^{12} Ω
  V_{IO}=500 V, T_A=100°C .... ≥10^{11} Ω
Total Power Dissipation .... 600 mW

SSR

LED Continuous Forward Current .... 50 mA
LED Reverse Voltage (I_R≤10 µA) .... 8 V
DC or Peak AC Load Voltage (I_L≤50 µA) .... 350 V
Continous DC Load Current .... 120 mA

Optocoupler

LED Continuous Forward Current .... 50 mA
LED Reverse Voltage (I_R≤10 µA) .... 3 V
Collector to Emitter Breakdown Voltage .... 30 V
Phototransistor Power Dissipation .... 150 mW

Electrical Characteristics (T_A=25°)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Condition
SSR						
LED Forward Current for Switch Turn-on	I_{Fon}		0.7	2.0	mA	I_L=100 mA, t=10 ms
LED Forward Current for Switch Turn-off	I_{Foff}	0.2	0.6		mA	V_L=±300 V
LED Forward Voltage	V_F	1.15	1.26	1.45	V	I_F=10 mA
ON-Resistance	R_{ON}	12	20	25	Ω	I_F=5 mA,I_L=±50 mA
OFF-Resistance	R_{OFF}		5000		GΩ	I_F=0 mA, V_L=±100 V
Current Limit	I_{limit}	170	210	250	mA	I_F=5 mA, t=5 ms
Output Off-state Leakage Current			0.02	200 1.0	nA µA	I_F=0 mA, V_L=±100 V I_F=0 mA, V_L=±350 V
Output Capacitance Pins 7 to 8			55 10		pF pF	I_F=0 mA, V_L=1 V I_F=0 mA, V_L=50 V
Turn-on Time	T_{on}		1.3	2.5	ms	I_F=5 mA, I_L=50 mA
Turn-off Time	T_{off}		0.6	2.5	ms	I_F=5 mA, I_L=50 V
Optocoupler						
LED Forward Voltage	V_F	0.9	1.2	1.5	V	I_F=10 mA
DC Current Transfer Ratio	CTR	33	165		%	I_F=6.0 mA, V_{CE}=0.5 V
Saturation Voltage	V_{CEsat}		.07	0.5	V	I_F=16.0 mA, I_C=2 mA
Dark Current Leakage	I_{CEO}			500	nA	I_F=0 mA, V_{CE}=5 V
Trickle Current Leakage	I_{CEO}			1	µA	I_F=5 µA, V_{CE}=5 V

Figure 1. Recommended operating conditions

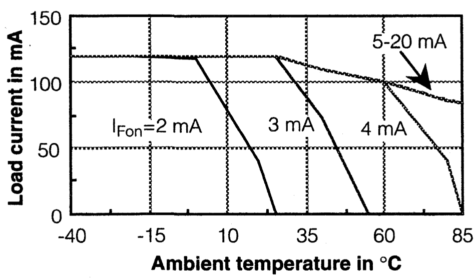


Figure 2. LED forward current vs. forward voltage

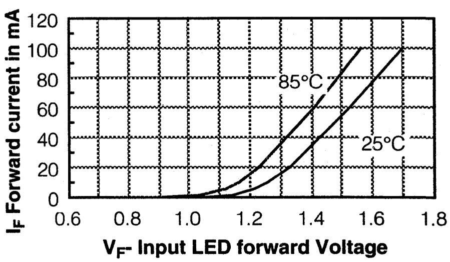


Figure 3. Typical SSR current vs. voltage

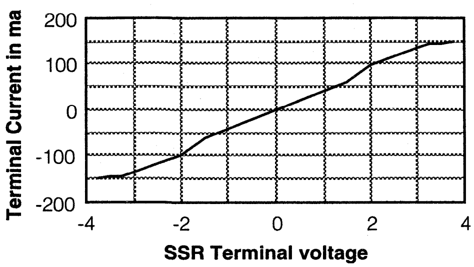


Figure 4. Change in ON-resistance vs. LED current

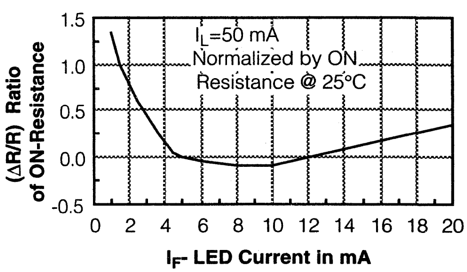


Figure 5. Change in ON-resistance vs. temp.

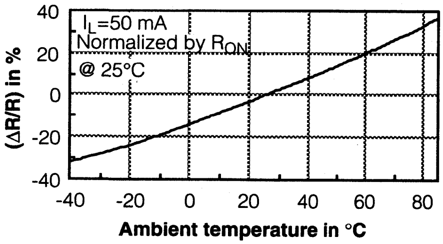


Figure 6. Turn-on current vs. temperature

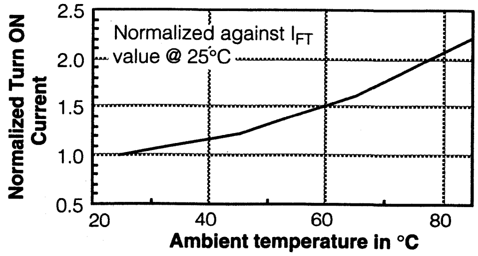


Figure 7. Current limit vs. temperature

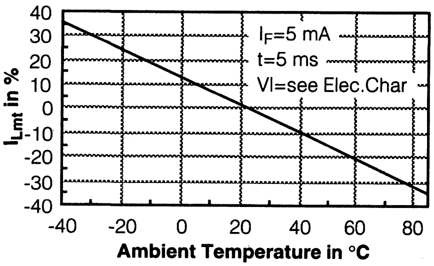


Figure 8. SSR turn-on time vs. resistive load

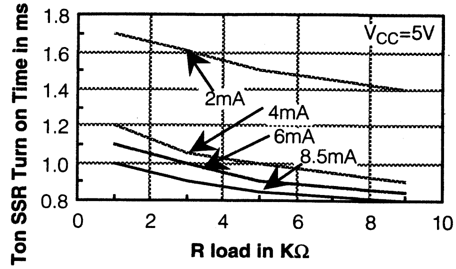


Figure 9. Collector current vs. collector voltage

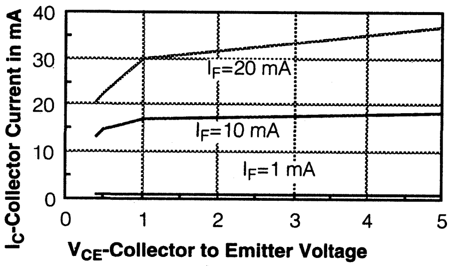


Figure 10. I_{CEO} leakage current vs. temperature

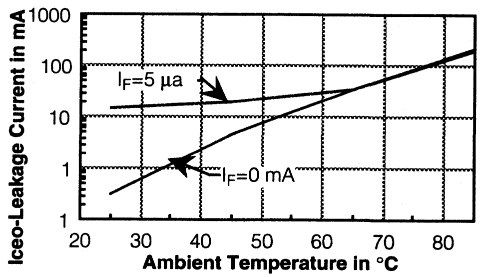


Figure 11. Non-saturated current transfer ratio

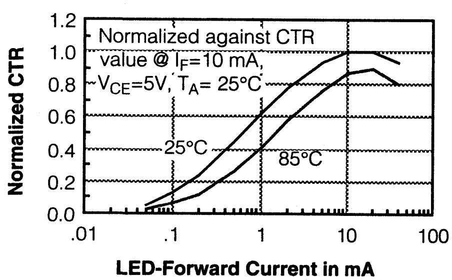


Figure 12. Saturated current transfer ratio

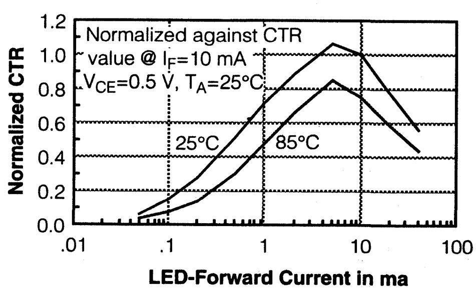


Figure 13. Switching test circuit for SSR channel

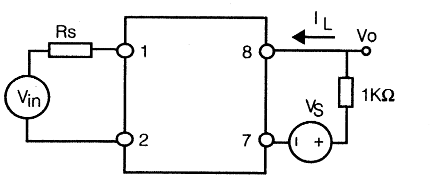
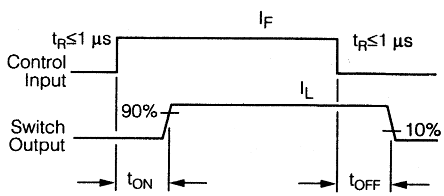


Figure 14. Switching waveform



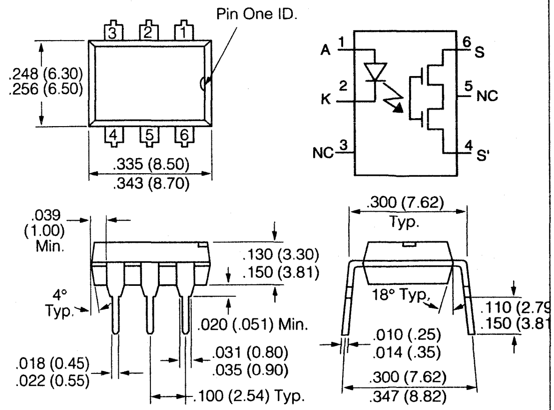
LH1529

SIEMENS

LH1540

HIGH VOLTAGE, SOLID STATE RELAY OPTOCOUPLER

Package Dimensions in Inches (mm)



FEATURES

- **Normally Open, Single Pole Single Throw Operation**
- **Control 350 VAC or DC Voltage**
- **Switch 150 mA Loads**
- **LED Control Current, 1 mA, Typical**
- **Low ON-Resistance, 20 Ω Typ. at 50 mA**
- **Isolation Test Voltage, 3750 VAC_{RMS}**
- **Current Limit Protection**
- **Underwriters Lab File # E52744**
- **Applications**
  - **Telephone Switch Hook**
  - **High Voltage Test Equipment**
  - **TRIAC Driver**
  - **Motor Control**
  - **Industrial Control Systems**

DESCRIPTION

The LH1540 is a single pole single throw (SPST), normally open (NO), solid state relay. The relay can control AC or DC loads currents up to 100 mA, with a supply voltage up to 350 V. The device is packaged in a six pin 0.3 inch dual-in line package. This package offers an insulation dielectric withstand of 3750 VAC_{RMS}.

The coupler consists of a AlGaAs LED that is optically coupled to a dielectrically isolated photodiode array which drives two series connected high voltage MOS transistors. The typical ON-resistance is 20 Ω at 25 mA and is linear up to 50 mA. There is built-in current limiting circuitry in the detector chip, enabling it to pass FCC 68-302 and other regulatory voltage surge requirements when over voltage protection is provided.

Absolute Maximum Ratings (T_A=25°C)

Emitter

Reverse Voltage .... 6.0 V
Continuous Forward Current .... 60 mA
Peak Forward Current (1 µs) .... 1 A
Power Dissipation .... 100 mW
Derate Linearly from 25°C .... 1.3 mW/°C

Detector

Output Breakdown Voltage .... 350 V
Continous Load Current .... 150 mA
Total Power Dissipation .... 400 mW
Derate Linearly from 25°C .... See Figure 3

Package

Isolation Test Voltage .... 3750 VAC_{RMS}
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... $\geq 10^{12}$ Ω
V_{IO}=500 V, T_A=100°C .... $\geq 10^{11}$ Ω
Power Dissipation .... 500 mW
Derate Linearly from 25°C .... 2.5 mW/°C
Storage Temperature Range .... –40 to +150°C
Operating Temperature Range .... –40 to +85°C
Junction Temperature .... 100°C
Soldering Temperature, 2 mm from case, 10 sec. .... 260°C

Characteristics (T_A=25°C)

Description	Symbol	Min.	Typ.	Max.	Unit	Test Condition
Emitter						
Forward Voltage	V_F		1.25	1.5	V	I_F=10 mA
V_F Temperature Coefficient	$\Delta V_F/\Delta T$		–2.2		mV/°C	
Reverse Current	I_R		1	10	µA	V_R=6 V
Junction Capacitance	C_J		15		pF	V_F=0 V, f=1 MHz
Dynamic Resistance	$\Delta V_F/\Delta I_F$		6		Ω	I_F=10 mA
Switching Time	t_R, t_F		1		µs	I_F=10 mA
Detector						
Output Breakdown Voltage	V_B	350			V	I_B=50 µA
Output Off-State Leakage Current	$I_{T(OFF)}$		.02	200	nA	V_T=±100 V, I_F=0 mA
Feed through Capacitance, pins 4 to 6	C_T		55		pF	I_F=0, f=1 KHz, V_L=1 VP-P
Current Limit	I_{LMT}	170	210	250	mA	I_F=5 mA, t=5 ms
Package						
LED Forward Current for Turn-on	I_{FTh}		1	2	mA	I_L=100 mA, t=10 ms
LED Forward Current for Turn-off	I_{FOFF}		0.2	0.9	mA	V_L=±300 V, I_L=<5 µA
ON-resistance	R_{ON}	12	20	25	W	I_F=5 mA, I_L=50 mA
Turn-on Time	t_{ON}		1.2	2.0	ms	I_F=5 mA, V_L=+50 V R_L=1 kΩ
Turn-off Time	t_{OFF}		0.5	2.0	ms	

Figure 1. LED forward current vs. forward voltage

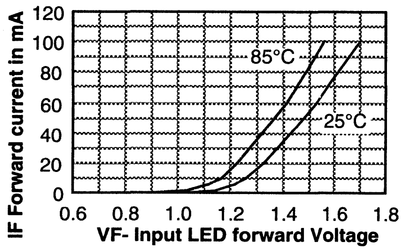


Figure 2. Forward current vs. forward voltage

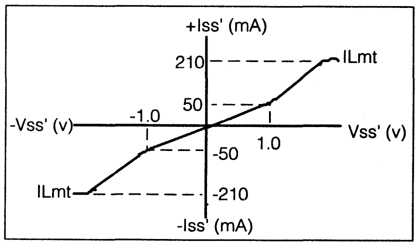


Figure 3. Recommended load current vs. temp.

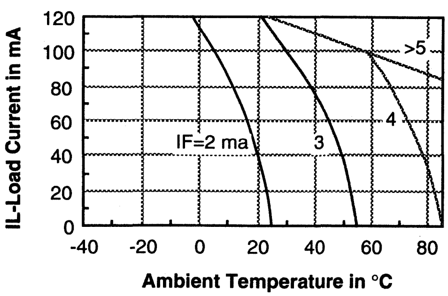


Figure 4. Current limit vs. temperature

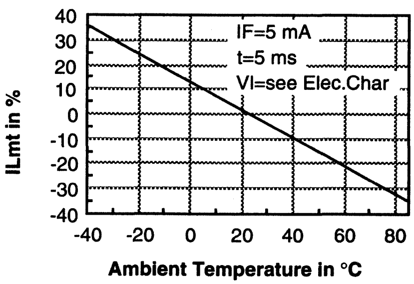


Figure 5. Minimum IRT required vs. temp.

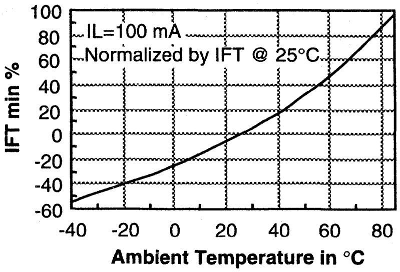


Figure 6. Change in ON-resistance vs. temperature

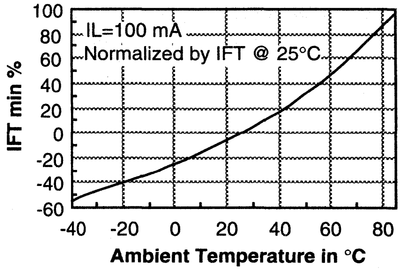


Figure 7. Change in ON-resistance vs. LED current

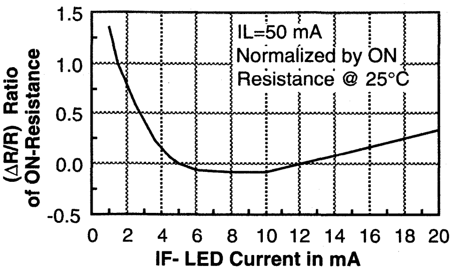


Figure 8. Turn on time vs. LED current and temp.

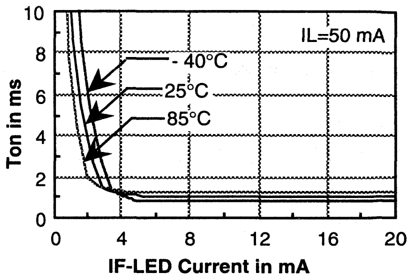


Figure 9. t_{OFF} vs. LED current and temperature

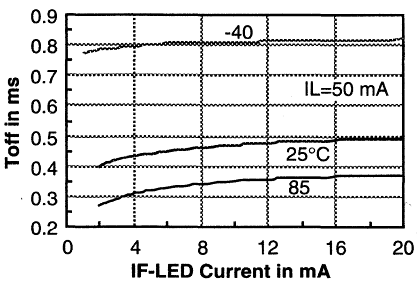


Figure 10. Change in t_{ON} vs. temperature

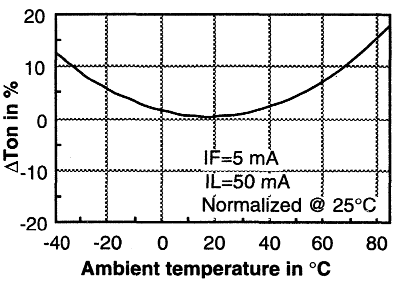


Figure 11. Change in t_{OFF} vs. temperature

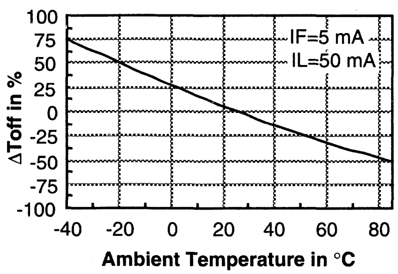
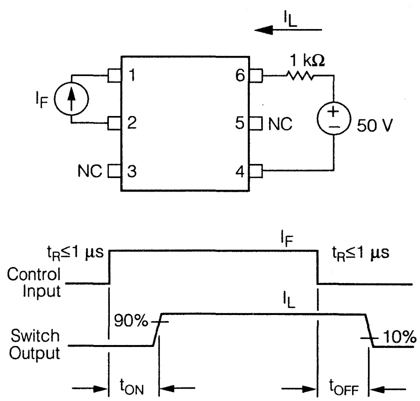


Figure 12. Timing test circuit and timing waveform



SIEMENS

NEW

LH1550

HIGH VOLTAGE, SOLID STATE RELAY OPTOCOUPLER

FEATURES

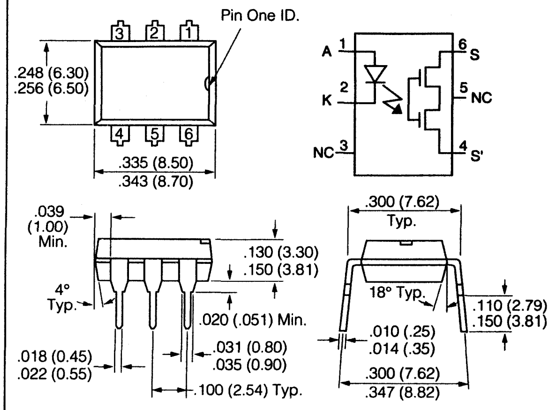
- **Normally Open, Single Pole Single Throw Operation**
- **Control 350 VAC or DC Voltage**
- **Switch 100 mA Loads**
- **LED Control Current, 2.5 mA**
- **Low ON-Resistance, 37 Ω Typ. at 100 mA**
- **Isolation Test Voltage, 3750 VAC_{RMS}**
- **Current Limit Protection**
- **Underwriters Lab File # E52744**
- **Applications**
  - **Telephone Switch Hook**
  - **High Voltage Test Equipment**
  - **TRIAC Driver**
  - **Motor Control**
  - **Industrial Control Systems**

DESCRIPTION

The LH1550 is a single pole single throw (SPST), normally open (NO), solid state relay. The relay can control AC or DC loads currents up to 100 mA, with a supply voltage up to 350 V. The device is packaged in a six pin 0.3 inch dual-in line package. This package offers an insulation dielectric withstand of 3750 V_{RMS}.

The coupler consists of a AlGaAs LED that is optically coupled to a dielectrically isolated photodiode array which drives two series connected high voltage MOS transistors. The typical ON-Resistance is 37 Ω at 25 mA and is linear up to 50 mA. There is built-in current limiting circuitry in the detector chip, enabling it to pass FCC 68-302 and other regulatory voltage surge requirements when over voltage protection is provided.

Package Dimensions in Inches (mm)



Absolute Maximum Ratings (T_A=25°C)

Emitter

Reverse Voltage	5.0 V
Continuous Forward Current	50 mA
Peak Forward Current (1 μs)	1 A
Power Dissipation	100 mW
Derate Linearly from 25°C	1.3 mW/°C

Detector

Output Breakdown Voltage	350 V
Continous Load Current	100 mA
Total Power Dissipation	300 mW
Derate Linearly from 25°C	See Figure 4

Package

Isolation Test Voltage	3750 VAC_{RMS}
Power Dissipation	400 mW
Derate Linearly from 25°C	2.5 mW/°C
Isolation Resistance	
V_{IO}=500 V, T_A=25°C	$\geq 10^{12}$ Ω
V_{IO}=500 V, T_A=100°C	$\geq 10^{11}$ Ω
Storage Temperature Range	–40 to +150°C
Operating Temperature Range	–40 to +85°C
Junction Temperature	100°C
Soldering Temperature, 2 mm from case, 10 sec.	260°C

Characteristics (T_A=25°C)

Description	Symbol	Min.	Typ.	Max.	Unit	Test Condition
Emitter						
Forward Voltage	V_F	0.9	1.25	1.4	V	I_F=5 mA
Reverse Current	I_R		1	10	µA	V_R=5 V
Junction Capacitance	C_J		15		pF	V_F=0 V, f=1 MHz
Dynamic Resistance	$\Delta V_F/\Delta I_F$		6		Ω	I_F=10 mA
Switching Time	t_R, t_F		1		µs	I_F=10 mA
Detector						
Output Breakdown Voltage	V_B	350	380		V	I_B=50 µA
Output Off-State Leakage Current	$I_{T(OFF)}$		.03	1.0	µA	V_T=±100 V, I_F=0 mA
Feed through Capacitance, pins 4 to 6	C_T		TBD			I_F=0, f=1 KHz, V_L=4 VP-P
Current Limit	I_{LMT}	150	190	270	mA	I_F=5 mA, t=5 ms
Package						
LED Forward Current for Turn-on	I_{FON}			2.5	mA	I_L=100 mA, t=10 ms
LED Forward Current for Turn-off	I_{FOFF}		0.2		mA	V_L=±300 V, I_L=<5 µA
ON-resistance	R_{ON}	25	37	50	Ω	I_F=5 mA, I_L=100 mA
Turn-on Time	t_{ON}		0.8	3.0	ms	I_F=5 mA, V_L=+50 V R_L=1 kΩ
Turn-off Time	t_{OFF}		0.04	3.0	ms	

Figure 1. Timing test circuit

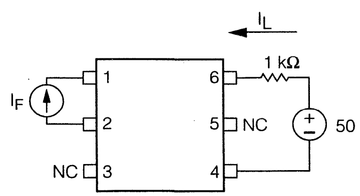


Figure 2. Timing waveform

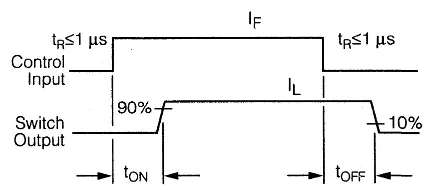


Figure 3. LED forward current vs. forward voltage

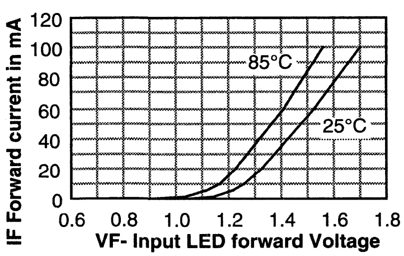


Figure 4. Recommended load current vs. temperature

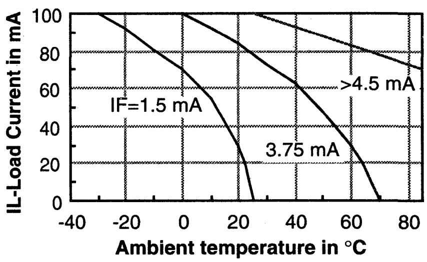


Figure 5. Turn on current vs. temperature

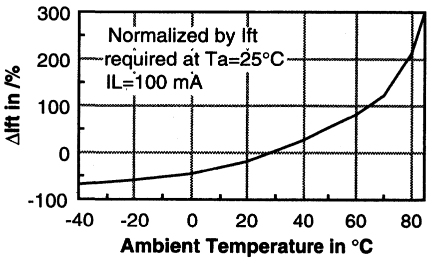


Figure 6. Change in current limit vs. temperature

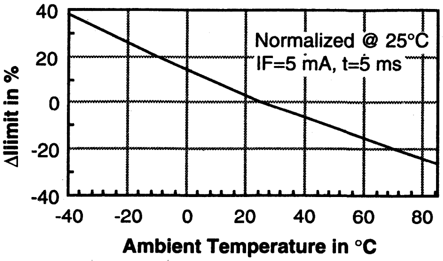


Figure 7. Change in ON resistance vs. temp.

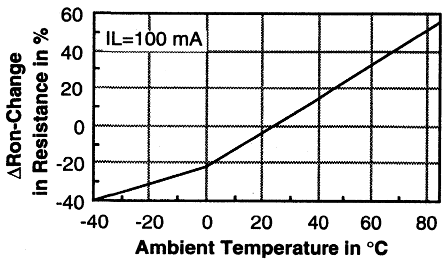


Figure 8. Change in t_{OFF} vs. temperature

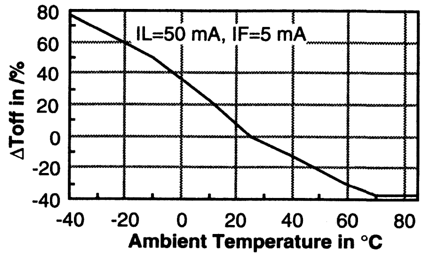
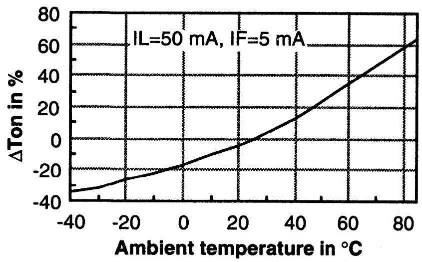


Figure 9. Change in t_{ON} vs. temperature



SIEMENS

MCA230/231/255
PHOTODARLINGTON OPTOCOUPLER

FEATURES

- **CTR Minimum**
  MCA230/255, 100%
  MCA231, 200%
- **Isolation Test Voltage, 5300 VAC$_{RMS}$**
- **Coupling Capacitance, 0.5 pF**
- **Fast Rise Time, 10 µs**
- **Fast Fall Time, 35 µs**
- **Underwriters Lab File #E52744**
- **VDE #0884 Available with Option 1**

DESCRIPTION

The MCA230/231/255 are industry standard optocouplers, consisting of a Gallium Arsenide infrared LED and a silicon phototdarlington. These optocouplers are constructed with a high voltage insulation, double molded packaging process which offers 7.5 KV withstand test capability.

Maximum Ratings

Emitter

Reverse Voltage .... 6 V
Continuous Forward Current .... 60 mA
Power Dissipation at 25°C .... 135 mW
Derate Linearly from 25°C .... 1.8 mW/°C

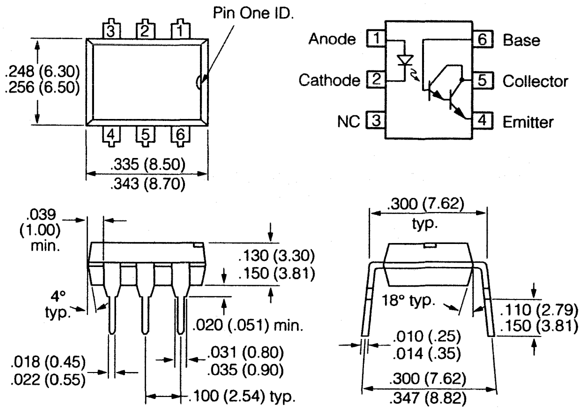
Detector

Collector-Emitter Breakdown Voltage
  MCA230/231 .... 30 V
  MCA255 .... 55 V
Emitter-Collector Breakdown Voltage .... 7 V
Collector-Base Breakdown Voltage
  MCA230/231 .... 30 V
  MCA255 .... 55 V
Power Dissipation at 25°C .... 210 mW
Derate Linearly from 25°C .... 2.8 mW/°C

Package

Total Package Dissipation at 25°C
  (LED plus Detector) .... 260 mW
Derate Linearly from 25°C .... 3.5 mW/°C
Storage Temperature .... –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Lead Soldering Time at 260°C .... 10 sec.
Isolation Test Voltage .... 5300 VAC$_{RMS}$
Isolation Resistance
  V_{IO}=500 V, T_A=25°C .... 10^{12} Ω
  V_{IO}=500 V, T_A=100°C .... 10^{11} Ω

Package Dimensions in Inches (mm)



Characteristics (T_A=25°C)

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.1	1.5	V	I_F=50 mA
Reverse Current	I_R			10	µA	V_R=3 V
Junction Capacitance	C_J		50		pF	V_F=0 V, f=1 MHz
Detector						
BV_{CEO}, MCA230/231		30			V	I_C=100 µA, I_F=0 mA
MCA255		30			V	I_C=100 µA, I_F=0 mA
BV_{ECO}		7			V	I_E=10 µA, I_F=0 mA
BV_{CBO}, MCA230/231		30			V	I_C=10 µA, I_F=0 mA
MCA55		55			V	I_C=10 µA, I_F=0 mA
I_{CEO}				100	nA	V_{CE}=10 V, I_F=0 mA
Package						
V_{CEsat}				0.8	V	I_{CE}=2mA, I_F=16 mA
				1.0	V	I_C=I_F=50 mA
				1.0	V	I_C=2 mA, I_F=1 mA
				1.0	V	I_C=10 mA, I_F=5 mA
				1.2	V	I_C=50 mA, I_F=10 mA
DC Current Transfer Ratio						
MCA230/255	CTR	100			%	V_{CE}=5 V, I_F=10 mA
MCA231	CTR	200			%	V_{CE}=5 V, I_F=1 mA
Capacitance Input to Output	C_{IO}		0.5		pF	
Switching Times	t_{on}		10		µs	R_L=100 Ω
	t_{off}		35		µs	V_{CE}=10 V

Figure 1. Forward voltage versus forward current

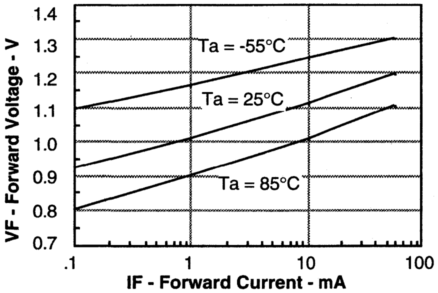


Figure 2. Normalized non-saturated and saturated CTRce at T_A = 25°C versus LED current

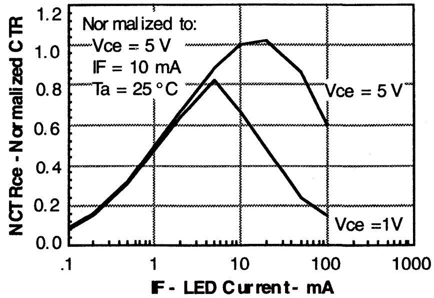


Figure 3. Normalized non-saturated and saturated collector-emitter current versus LED current

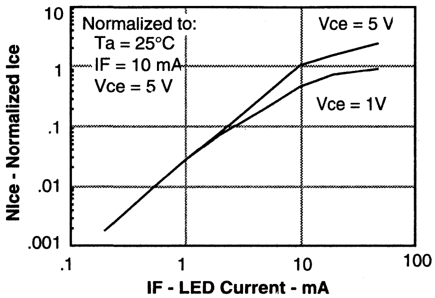


Figure 4. Normalized collector-base photocurrent versus LED current

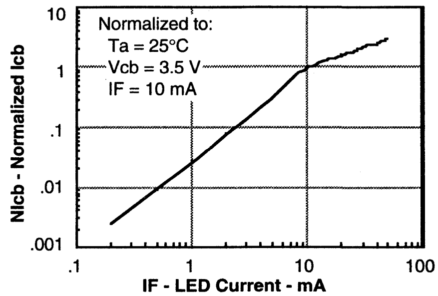


Figure 5. Non-saturated and saturated HFE versus base current

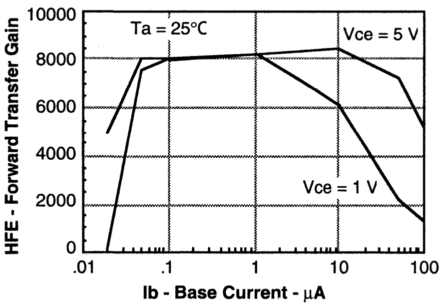


Figure 6. Low to high propagation delay versus collector load resistance and LED current

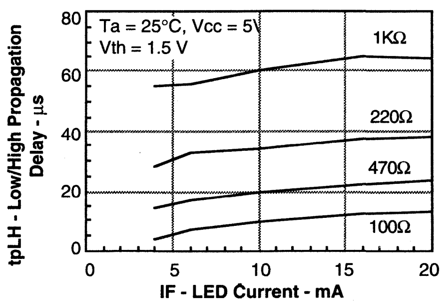


Figure 7. High to low propagation delay versus collector load resistance and LED current

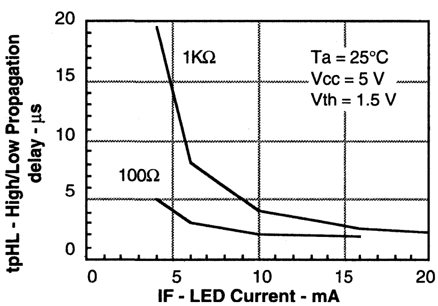
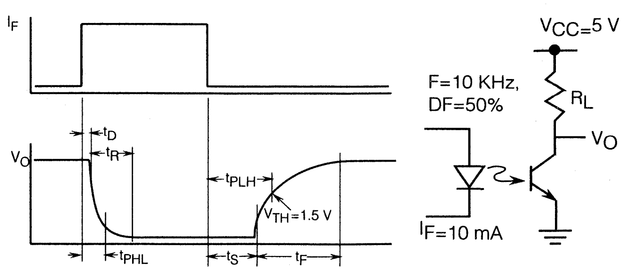


Figure 8. Switching timing waveform and schematic



MCT6
DUAL PHOTOTRANSISTOR OPTOCOUPLER

FEATURES
- **Current Transfer Ratio, 20% Minimum**
- **Two Isolated Channels Per Package**
- **Isolation Text Voltage, 5300 VAC_{RMS}**
- **Underwriters Lab File #E52744**
- **VDE #0884 Available with Option 1**

DESCRIPTION
The MCT6 is an industry standard dual optocoupler consisting of a Gallium Arsenide infrared LED and a silicon phototransistor. The MCT6 is constructed with a high voltage insulation, double molded packaging process which offers 5300 VAC_{RMS} isolation test capability.

Maximum Ratings

Emitter (each channel)

Reverse Voltage .... 3 V
Continuous Forward Current .... 60 mA
Power Dissipation at 25°C Ambient .... 100 mW
Derate Linearly from 25°C .... 1.3 mW/°C

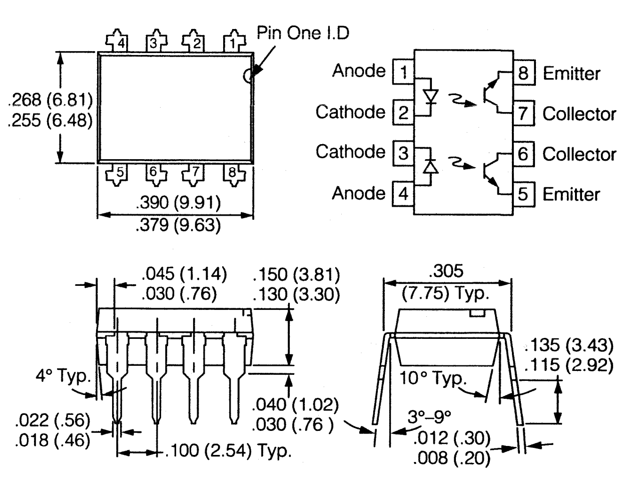
Detector (each channel)

Collector-Emitter Breakdown Voltage 30V
Emitter-Collector Breakdown Voltage 6V
Power Dissipation at 25°C Ambient .... 150 mW
Derate Linearly from 25°C .... 2 mW/°C

Package

Total Package Dissipation
at 25°C (LED + Detector). .... 400 mW
Derate Linearly from 25°C .... 5.33 mW/°C
Storage Temperature.................. –55°C to +150°C
Operating Temperature .... –55°C to +100°C
Lead Soldering Time at 260°C .... 10 sec.
Isolation Test Voltage ....5300 VAC_{RMS}
Pollution Degree (DIN VDE 0110) 2
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... $R_{IO}=10^{12}\,\Omega$
V_{IO}=500 V, T_A=100°C .... $R_{IO}=10^{11}\,\Omega$

Package Dimensions in Inches (mm)



Electrical Characteristics (T_A=25°C)

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.1	1.5	V	I_F=20 mA
Reverse Current	I_R			10	µA	V_R=3 V
Junction Capacitance	C_J		25		pF	V_F=0 V, f=1 MHz
Detector						
Breakdown Voltage						
Collector-Emitter	BV_{CEO}	30			V	I_C=10 µA, I_F=0 mA
Emitter-Collector	BV_{ECO}	6			V	I_E=10 µA, I_F=0 mA
Package						
DC Current Transfer Ratio	CTR_{DC}	20	50		%	V_{CE}=10 V, I_F=10 mA
Saturation Voltage Collector-Emitter	V_{CEsat}			0.4	V	I_{CE}=2 mA, I_F=16 mA
Switching Times	t_{on}		3		µs	R_E=100 Ω, V_{CE}=10 V
	t_{off}		15		µs	I_C=2 mA

Figure 1. Forward voltage versus forward current

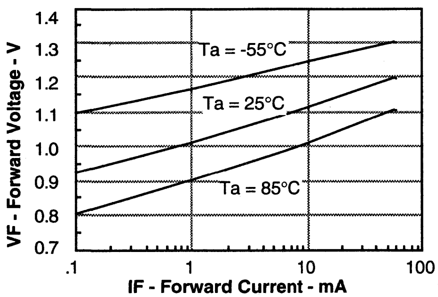


Figure 2. Normalized non-saturated and saturated CTR at T_A = 25°C versus LED current

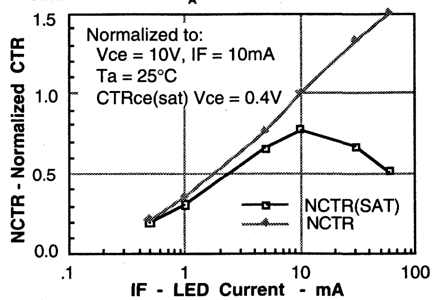


Figure 3. Normalized non-saturated and saturated CTR at T_A = 50°C versus LED current

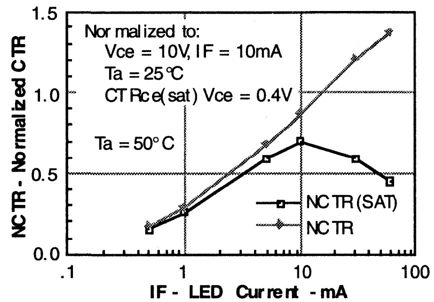


Figure 4. Normalized non-saturated and saturated CTR at T_A = 70°C versus LED current

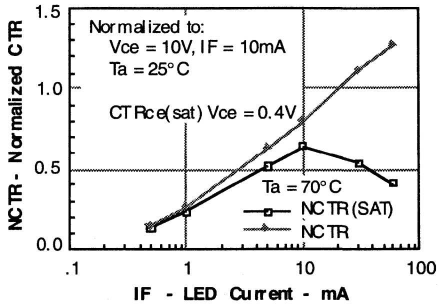


Figure 5. Normalized non-saturated and saturated CTR at T_A= 85°C versus LED current

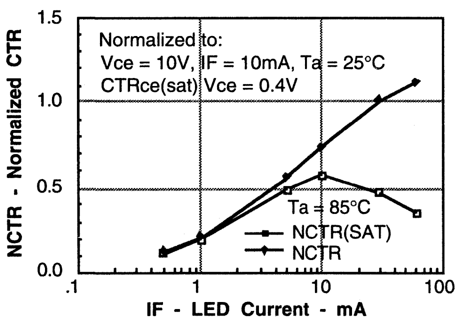


Figure 6. Collector-emitter current versus temperature and LED current

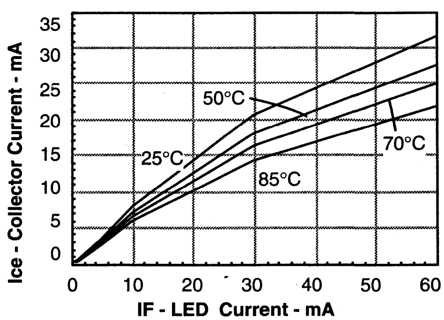


Figure 7. Collector-emitter leakage current versus temperature

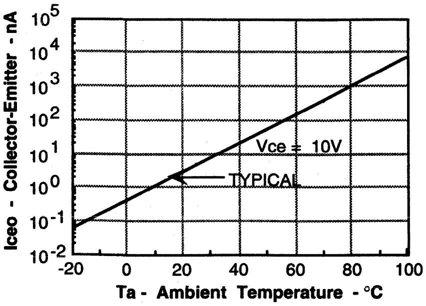


Figure 8. Propagation delay versus collector load resistor

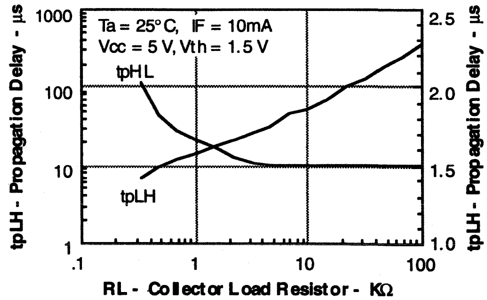


Figure 9. Non-saturated Switching Timing

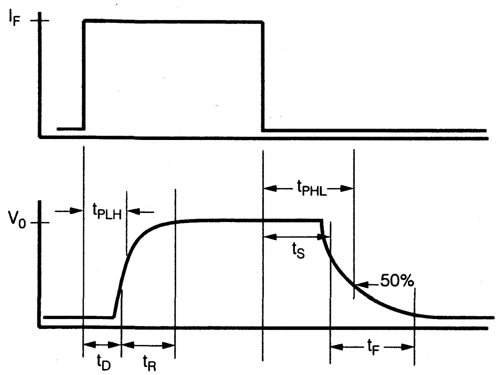
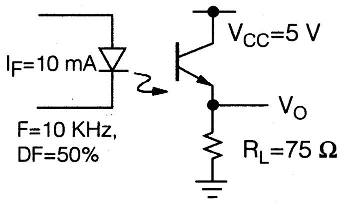


Figure 10. Switching Schematic



SIEMENS

MCT5210
MCT5211

AlGaAs LED/ PHOTOTRANSISTOR OPTOCOUPLER

FEATURES

- **Current Transfer Ratio**
  MCT5210, >70% at I_F=3.0 mA
- **MCT5211, >110% at I_F=1.0 mA**
- **Saturation CTR–MCT5211, >100% at I_F=1.6 mA**
- **High Isolation Voltage, 5300 VAC_{RMS}**
- **Underwriters Lab File #E52744**
- **VDE #0884 Available with Option 1**

DESCRIPTION

The MCT5210/5211 are optocouplers with a high efficiency AlGaAs LED optically coupled to a NPN phototransistor. The high performance LED makes operation at low input currents practical. The coupler is housed in a double molded, six pin DIP package. Isolation test voltage is 5300 VAC_{RMS}.

Because these parts have guaranteed CTRs at one and three mA, they are ideally suitable for interfacing from CMOS to TTL or LSTTL to TTL. They are also ideal for telecommunications applications such as ring or off-hook detection.

Maximum Ratings

Emitter

Peak Reverse Voltage .... 6 V
Continuous Forward Current .... 40 mA
Power Dissipation at 25°C .... 75 mW
Derate Linearly from 25°C .... 1.0 mW/°C

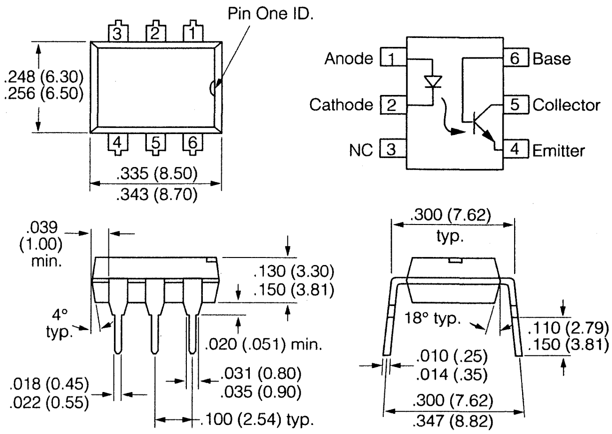
Detector

Collector-Emitter Breakdown Voltage .... 30 V
Emitter-Collector Breakdown Voltage .... 7 V
Collector-Base Breakdown Voltage .... 70 V
Power Dissipation .... 200 mW
Derate Linearly from 25°C .... 2.6 mW/°C

Package

Isolation Test Voltage ....5300 VAC_{RMS}
Total Package Dissipation
at 25°C Ambient (LED + Detector) ...... 260 mW
Derate Linearly from 25°C .... 3.5 mW/°C
Leakage Path....................................... 7 mm min.
Clearance Path ....7 mm min.
Comparative Tracking Index per
DIN IEC 112/VDE 0303, part 1.....................175
Isolation Resistance
V_{IO}=500 V, T_A=25°C.............................≥10^{12} Ω
V_{IO}=500 V, T_A=100°C...........................≥10^{11} Ω
Operating Temperature .... –55°C to +100°C
Storage Temperature .... –55°C to +150°C

Package Dimensions in inches (mm)



Electrical Characteristics (25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.2	1.5	V	I_F=5 mA
Reverse Voltage	V_R	6			V	I_R=10 µA
Detector						
	HFE	100	200			V_{CE}=5 V I_C=100 µA
	BV_{CEO}	30			V	I_C=100 µA
	BV_{ECO}	7			V	I_E=100 µA
	BV_{CBO}	70			V	I_E=10 µA
	I_{CEO}		5	100	nA	V_{CE}=10 V
Package (0–70°C)						
Saturated Current Transfer Ratio						V_{CE}=0.4 V
MCT5210	CTR_{CEsat}	60	120		%	I_F=3.0 mA
MCT5211	CTR_{CEsat}	100	200		%	I_F=1.6 mA
MCT5211	CTR_{CEsat}	75	150		%	I_F=1.0 mA
Current Transfer Ratio						V_{CE}=5.0 V
MCT5210	CTR	70	150		%	I_F=3.0 mA
MCT5211	CTR	150	300		%	I_F=1.6 mA
MCT5211	CTR	110	225		%	I_F=1.0 mA
Collector-Base Current Transfer Ratio						V_{CE}=4.3 V
MCT5210	CTR_{CB}	0.2	0.4		%	I_F=3.0 mA
MCT5211	CTR_{CB}	0.3	0.6		%	I_F=1.6 mA
MCT5211	CTR_{CB}	0.25	0.5		%	I_F=1.0 mA
Saturation Voltage						
MCT5210	V_{CEsat}		0.25	0.4	V	I_F=3.0 mA I_C=1.8 mA
MCT5211	V_{CEsat}		0.25	0.4	V	I_F=1.6 mA I_C=1.6 mA

Characteristics — *continued*

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Switching Characteristics (25°C)						
Propagation Delay —High to Low						
MCT5210	tPHL		10		µs	R_L=330 Ω, I_F=3.0 mA, V_{CC}=5.0 V
MCT5211	tPHL		20		µs	R_L=750 Ω, I_F=1.6 mA, V_{CC}=5.0 V
MCT5211	tPHL		40		µs	R_L=1.5 Ω, I_F=1.0 mA, V_{CC}=5.0 V
Propagation Delay —Low to High						
MCT5210	tPLH		10		µs	R_L=330 Ω, I_F=3.0 mA, V_{CC}=5.0 V
MCT5211	tPLH		20		µs	R_L=750 Ω, I_F=1.6 mA, V_{CC}=5.0 V
MCT5211	tPLH		40		µs	R_L=1.5 Ω, I_F=1.0 mA, V_{CC}=5.0 V

Figure 1. Forward current vs. forward voltage

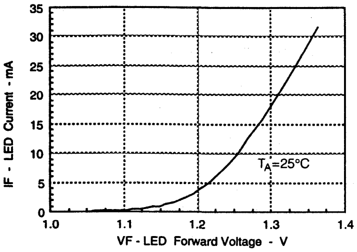


Figure 2. LED forward current vs. forward voltage

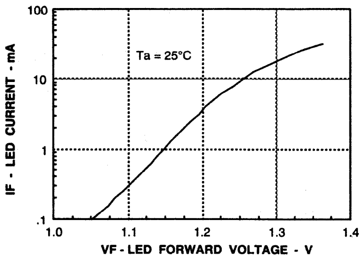


Figure 3. Switching waveform

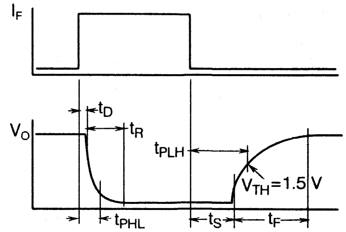


Figure 4. Collector base photocurrent vs. LED current

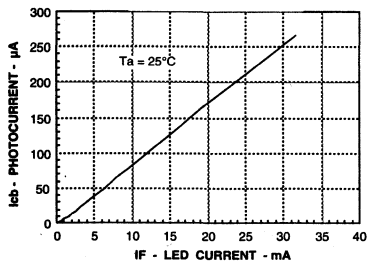


Figure 5. Photocurrent vs. LED current

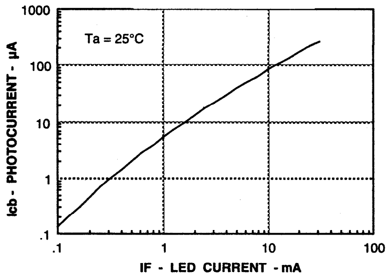


Figure 6. Switching schematic

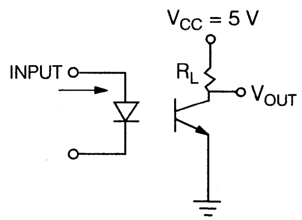


Figure 7. Collector base current transfer ratio vs. LED current

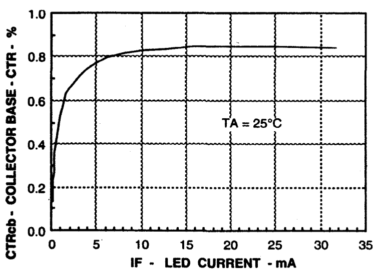


Figure 8. Collector base current transfer ratio vs. LED current 2

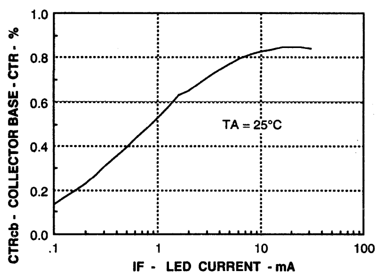
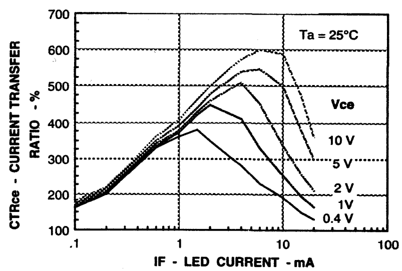


Figure 9. Current transfer ratio 2 versus LED current



Optocouplers (Optoisolators)

5

Figure 10. Collector current versus LED current

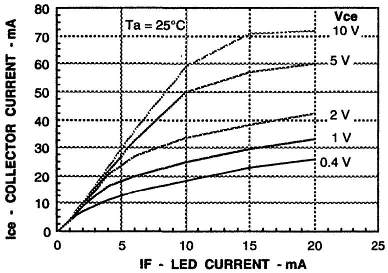


Figure 11. Collector current versus LED current

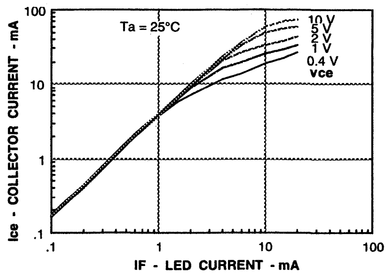


Figure 12. Transistor current gain versus base current

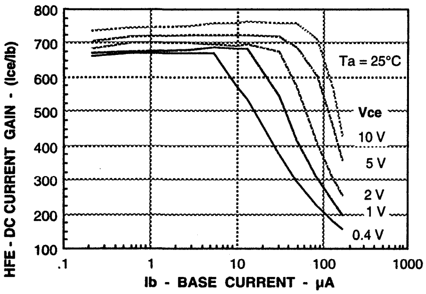


Figure 13. Transfer curve

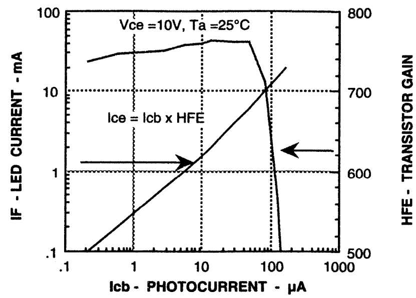


Figure 14. Transfer curve

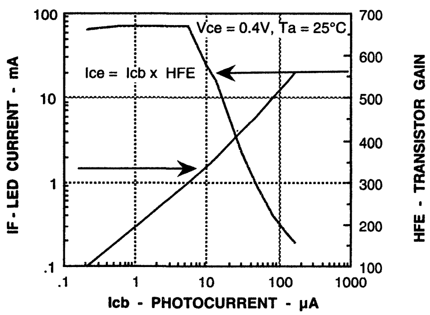


Figure 15. Propagation delay versus base emitter resistor

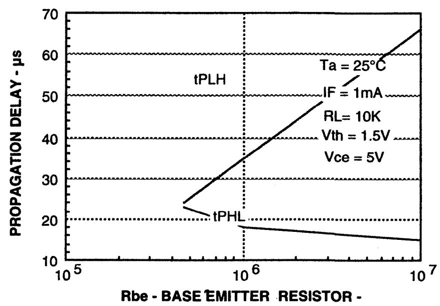


Figure 16. Propagation delay versus base emitter resistor

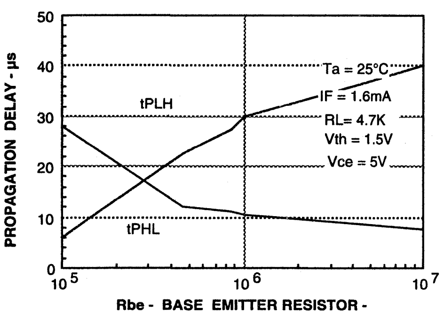
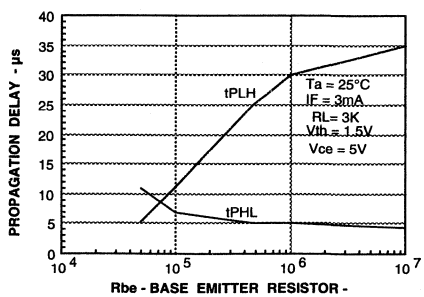


Figure 17. Propagation delay versus base emitter resistor



SIEMENS

MOC8050

PHOTODARLINGTON OPTOCOUPLER

FEATURES

- **High Current Transfer Ratio 500% at 50 mA Output**
- **High Collector to Emitter Breakdown Voltage — 80 V Min.**
- **High Isolation Voltage V_{ISO}=5300 VAC_{RMS}**
- **Base Lead Not Connected**
- **Solid State Reliability**
- **Standard DIP Package**
- **Underwriters Lab File #E52744**
- **VDE 0884 Availablle with Option 1**

DESCRIPTION

The MOC8050 is an optically coupled isolator with a Gallium Arsenide infrared emitter and a silicon photodarlington sensor. Switching can be achieved while maintaining a high degree of isolation between driving and load circuits, with no cross talk between channels. These optocouplers can be used to replace reed and mercury relays with advantages of long life, high speed switching and elimination of magnetic fields.

Maximum Ratings

Emitter

Peak Reverse Voltage .... 3 V
Continuous Forward Current .... 60 mA
Power Dissipation at 25°C .... 100 mW
Derate Linearly from 25°C .... 1.33 mW/°C

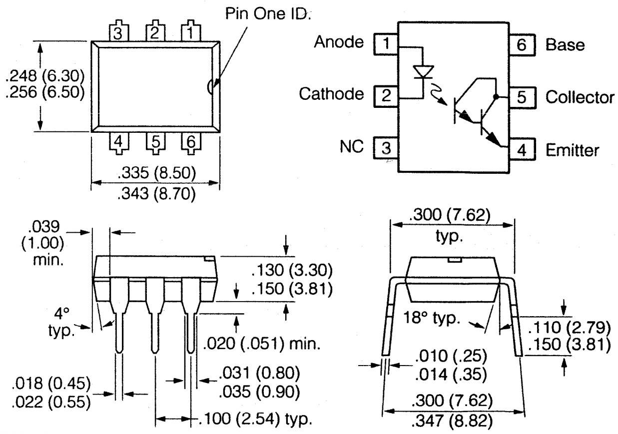
Detector

Collector-Emitter Reverse Voltage .... 80 V
Collector Load Current .... 125 mA
Power Dissipation at 25°C Ambient......... 150 mW
Derate Linearly from 25°C .... 2.0 mW/°C

Package

Total Package Dissipation at 25°C .... 250 mW
Derate Linearly from 25°C .... 3.3 mW/°C
Isolation Test Voltage ....5300 VAC_{RMS}
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... 10^{12} Ω
V_{IO}=500 V, T_A=100°C .... 10^{11} Ω
Creepage Path .... 8 mm min.
Clearance Path .... 7 mm min.
Comparative Tracking Index............................175
Storage Temperature Range ..... –55°C to +125°C
Operating Temperature Range.. –55°C to +100°C
Lead Soldering Time at 260°C .... 10 sec.

Package Dimensions in inches (mm)



Electrical Characteristics (T_A=25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.25	1.5	V	I_F=20 mA
Reverse Current	I_R		0.1	10	µA	V_R=3.0 V
Capacitance	C_O		25		pF	V_R=0
Detector						
Collector-Emitter Breakdown Voltage	BV_{CEO}	80			V	I_C=10 µA
Collector-Emitter Leakage Current	I_{CEO}		25	1000	nA	V_{CE}=60 V I_F=0
Emitter-Collector Breakdown Voltage	V_{ECO}	5.0	8.0		V	I_C=10 µA
Package						
Current Transfer Ratio	CTR	500			%	I_F=10 mA V_{CE}=1.5 V
Collector-Emitter Saturation Voltage	V_{CEsat}		0.9	1.0	V	I_C=50 mA I_F=50 mA
Isolation Test Voltage	VISO	5300			VAC_{RMS}	1 sec., 60 Hz
Coupling Capacitance	C_{ISOL}		0.5		pF	
Rise Time	T_r		10		µs	V_{CC}=13.5 V I_F=50 mA R_L=100 Ω
Fall Time	T_f		35		µs	

Figure 1. Forward voltage vs. forward current

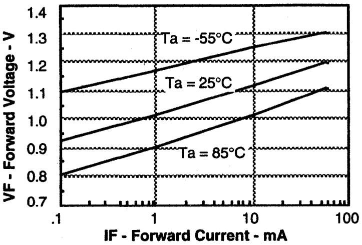


Figure 2. Typical Ic vs. Vce

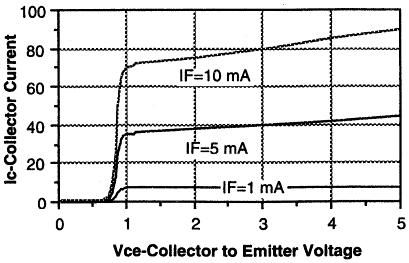


Figure 3. Switching waveform

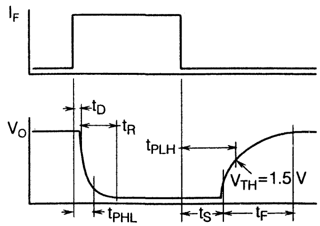


Figure 4. Typical Ic vs. Vce vs. temperature

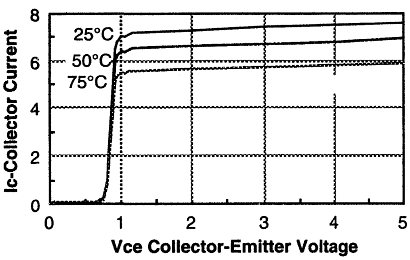


Figure 5. Typical NCTR vs. LED current

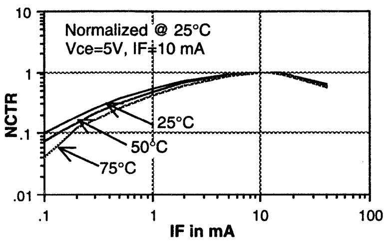


Figure 6. Switching schematic

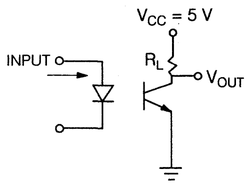


Figure 7. Typical Ic vs. Vce (sat. region)

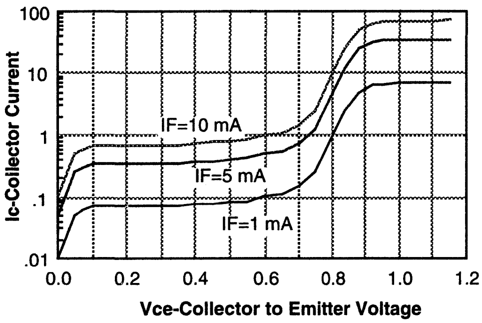


Figure 8. Typical Iceo vs. temperature

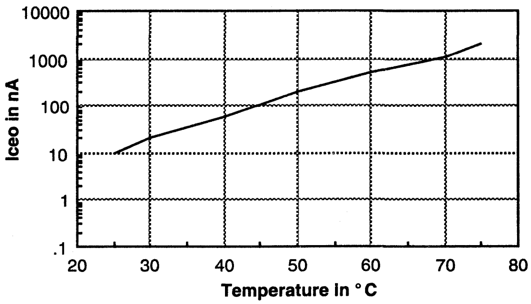


Figure 9. Low to high propagation delay vs. collector load resistance and LED current

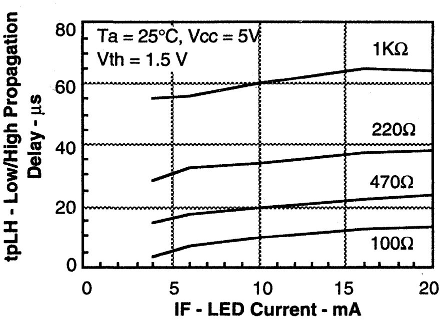
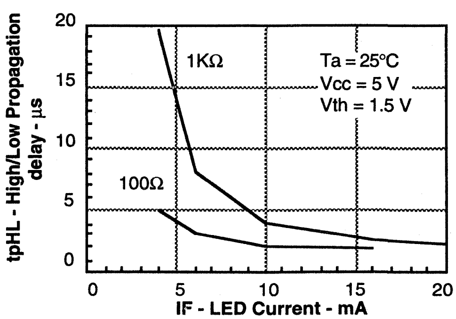


Figure 10. High to low propagation delay vs. collector load resistance and LED current



SIEMENS

MOC8111
PHOTOTRANSISTOR NO BASE CONNECTION OPTOCOUPLER

FEATURES

- **Current Transfer Ratio 20% Min.**
- **No Base Terminal Connection for Improved Common Mode Interface Immunity**
- **Field-Effect Stable by TRIOS (TRansparent IOn Shield)**
- **Long Term Stability**
- **Industry Standard Dual-in-Line Package**
- **Underwriters Lab File #E52744**
- **VDE 0884 Available with Option 1**

DESCRIPTION

The MOC8111 is an optocoupler consisting of a Gallium Arsenide infrared emitting diode optically coupled to a silicon planar phototransistor detector in a plastic plug-in DIP 6 pin package.

The coupling device is suitable for signal transmission between two electrically separated circuits. The potential difference between the circuits to be coupled is not allowed to exceed the maximum permissible reference voltages.

In contrast to the IL1 the base terminal is not connected, resulting in a substantially improved common-mode interference immunity.

Maximum Ratings (T_A=25°C)

Emitter

Reverse Voltage .... 6 V
DC Forward Current .... 60 mA
Surge Forward Current (t≤10 µs)................. 2.5 A
Total Power Dissipation........................... 100 mW

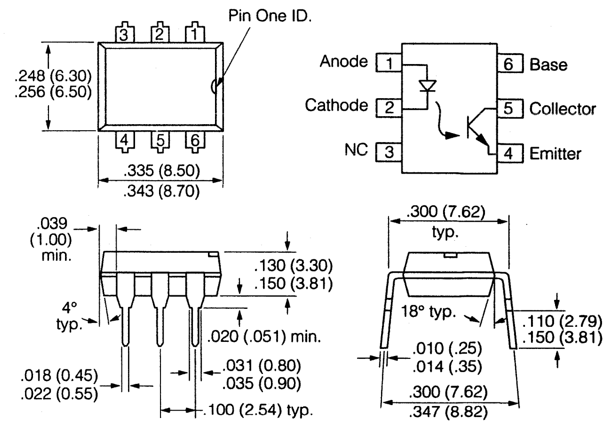
Detector

Collector-Emitter Breakdown Voltage .... 30 V
Collector Current .... 50 mA
Collector Current (t≤1 ms) .... 150 mA
Total Power Dissipation........................... 150 mW

Package

Isolation Test Voltage between Emitter and Detector, Refer to Standard Climate 23/50 DIN 50014 ....5300 VAC_{RMS}
Creepage ....≥7 mm
Clearance ....≥7 mm
Isolation Thickness between Emitter and Detector ....≥0.4 mm
Comparative Tracking Index per DIN IEC 112/VDE 0303, part 1 175
Isolation Resistance
V_{IO}=500 V, T_A=25°C................................$10^{12}\Omega$
V_{IO}=500 V, T_A=100°C..............................$10^{11}\Omega$
Storage Temperature Range ..... –55°C to +150°C
Ambient Temperature Range..... –55°C to +100°C
Soldering Temperature (max. 10 s, dip soldering distance to seating plane ≥1.5 mm) ....260°C

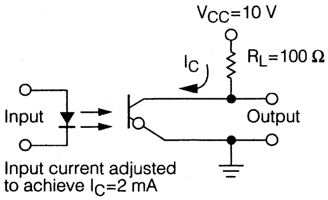
Package Dimensions in inches (mm)



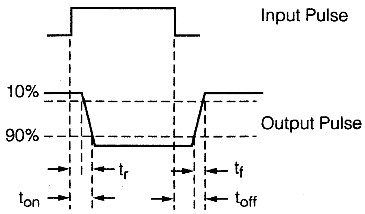
Electrical Characteristics (T_A=25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.15	1.5	V	I_F=10 mA
Reverse Leakage Current	I_R		0.05	10	µA	V_R=6 V
Capacitance	C_J		25		pF	V=0, f=1 MHz
Detector						
Collector-Emitter Breakdown Voltage	BV_{CEO}	30			V	I_C=1 µA
Collector-Emitter Leakage Current	I_{CEO}		1	50	nA	V_{CE}=10 V
Emitter-Collector Breakdown Voltage	V_{ECO}	7			V	I_E=10 µA
Collector-Emitter Capacitance	C_{CE}		7		pF	V_{CE}=0 V, f=1 MHz
Package						
Collector Saturation Voltage	V_{CESAT}		0.15	0.4	V	I_C=500 µA I_F=10 mA
Output Collector Current	I_C	2	5		mA	I_F=10 mA V_{CE}=10 V
Turn On Time	T_{ON}		7.5	20	µs	V_{CC}=10 V R_L=100 Ω,
Turn Off Time	T_{OFF}		5.7	20	µs	I_C=2 mA, see Figure 1

Figure 1. Switching times



Test Circuit



Waveforms

SIEMENS

SFH600 SERIES
TRIOS®* PHOTOTRANSISTOR OPTOCOUPLER

FEATURES
- **High Current Transfer Ratios**
  SFH600-0, 40 to 80%
  SFH600-1, 63 to 125%
  SFH600-2, 100 to 200%
  SFH600-3, 160 to 320%
- **Isolation Test Voltage (1 Sec.), 5300 VAC_{RMS}**
- **V_{CEsat} 0.25 (≤0.4) V, I_F=10 mA, I_C=2.5 mA**
- **High Quality Premium Device**
- **Long Term Stability**
- **Storage Temperature, –55° to +150°C**
- **Underwriters Lab File #E52744**
- **VDE 0884 Available with Option 1**

DESCRIPTION
The SFH600 is an optocoupler with a GaAs LED emitter which is optically coupled with a silicon planar phototransistor detector. The component is packaged in a plastic plug-in case, 20 AB DIN 41866.

The coupler transmits signals between two electrically isolated circuits. The potential difference between the circuits to be coupled is not allowed to exceed the maximum permissible insulating voltage.

Maximum Ratings
Emitter

Reverse Voltage .... 6 V
DC Forward Current .... 60 mA
Surge Forward Current (t_p=10 µs) .... 2.5 A
Total Power Dissipation .... 100 mW

Detector

Collector-Emitter Voltage .... 70 V
Emitter-Base Voltage .... 7 V
Collector Current .... 50 mA
Collector Current (t=1 ms) .... 100 mA
Power Dissipation .... 150 mW

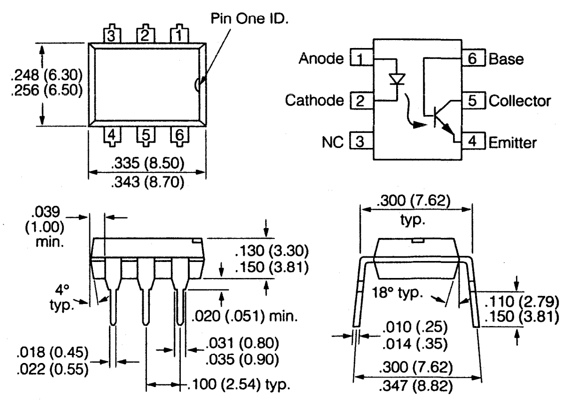
Package

Isolation Test Voltage (between emitter and detector referred to climate DIN 40046, part 2, Nov. 74) (t=1 sec.) .... 5300 VAC_{RMS}
Creepage .... ≥7 mm
Clearance .... ≥7 mm
Isolation Thickness between Emitter & Detector .. ≥0.4 mm
Comparative Tracking Index per DIN IEC 112/VDE0303, part 1 175
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... $\geq 10^{12}\ \Omega$
V_{IO}=500 V, T_A=100°C .... $\geq 10^{11}\ \Omega$

Package

Storage Temperature Range .... –55°C to +150°C
Ambient Temperature Range .... –55°C to +100°C
Junction Temperature .... 100°C
Soldering Temperature (max. 10 s, dip soldering: distance to seating plane ≥1.5 mm) .... 260°C

Package Dimensions in Inches (mm)



Characteristics (T_A=25°C)

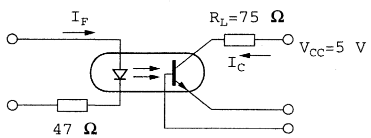
Emitter	Symbol		Unit	Condition
Forward Voltage	V_F	1.25 (≤1.65)	V	I_F=60 mA
Breakdown Voltage	V_{BR}	≥6	V	I_R=10 µA
Reverse Current	I_R	0.01 (≤10)	µA	V_R=6 V
Capacitance	C_O	25	pF	V_F=0 V, f=1 MHz
Thermal Resistance	R_{THJamb}	750	°C/W	
Detector				
Capacitance			pF	f=1 MHz
Collector-Emitter	C_{CE}	5.2		V_{CE}=5 V
Collector-Base	C_{CB}	6.5		V_{CB}=5 V
Emitter-Base	C_{EB}	9.5		V_{EB}=5 V
Thermal Resistance	R_{THJamb}	500	°C/W	
Package				
Collector-Emitter Saturation Voltage	V_{CEsat}	0.25 (≤0.4)	V	I_F=10 mA, I_C=2.5 mA
Coupling Capacitance	C_{IO}	0.6	pF	V_{IO}=0, f=1 MHz

***TRIOS–TR**ansparent **IO**n **S**hield

Current Transfer Ratio and Collector-Emitter Leakage Current by dash number

	–0	–1	–2	–3	Unit
I_C/I_F at V_{CE}=5 V (I_F=10 mA)	40–80	63–125	100–200	160–320	%
I_C/I_F at V_{CE}=5 V (I_F=1 mA)	30 (>13)	45 (>22)	70 (>34)	90 (>56)	%
Collector-Emitter Leakage Current (V_{CE}=10 V) (I_{CEO})	2 (≤ 35)	2 (≤ 35)	2 (≤ 35)	5 (≤ 70)	nA

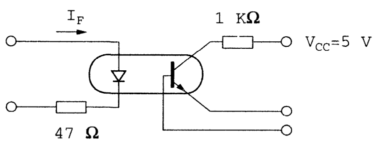
Linear Operation (without saturation)



I_F=10 mA, V_{CC}=5 V, T_A=25°C, Typical

Load Resistance	R_L	75	Ω
Turn-On Time	t_{ON}	3.2	µs
Rise Time	t_R	2.0	µs
Turn-Off Time	t_{OFF}	3.0	µs
Fall Time	t_f	2.5	µs
Cut-Off Frequency	F_{CO}	250	kHz

Switching Operation (with saturation)



Typical

	–0 (I_F=20 mA)	–1 and –2 (I_F=10 mA)	–3 (I_F=5 mA)	
Turn-On Time t_{ON}	3.7	4.5	5.8	µs
Rise Time t_R	2.5	3.0	4.0	µs
Turn-Off Time t_{OFF}	19	21	24	µs
Fall Time t_f	11	12	14	µs
V_{CESAT}	0.25 (≤ 0.4)			V

Figure 1. Current transfer ratio versus diode current (T_A=–25°C, V_{CE}=5 V)
I_C/I_F=f (I_F)

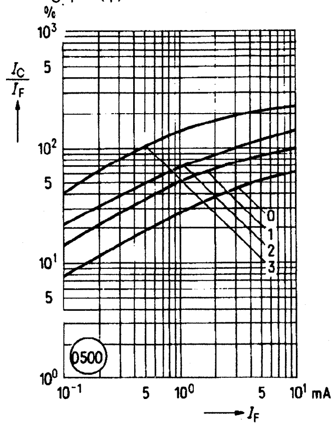


Figure 2. Current Transfer ratio versus diode current (T_A=0°C, V_{CE}=5 V)
I_C/I_F=f (I_F)

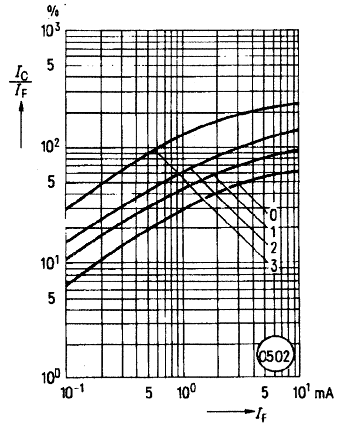


Figure 3. Current Transfer ratio versus diode current (T_A=25°C, V_{CE}=5 V)
I_C/I_F=f (I_F),

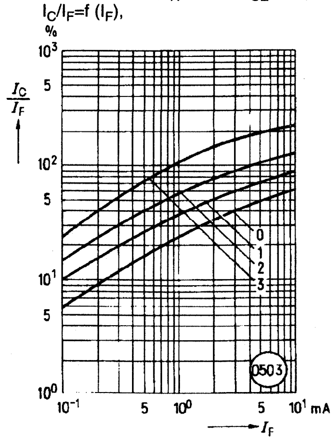


Figure 4. Current transfer ratio versus diode current (T_A=50°C) V_{CE}=5 V
I_C/I_F=f (I_F)

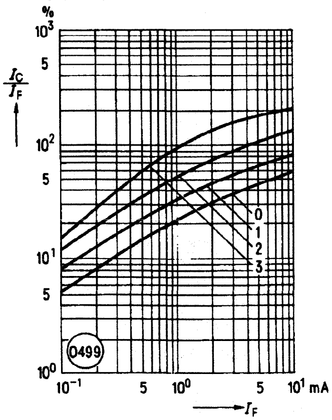


Figure 5. Current transfer ratio versus diode current (T_A=75°C) V_{CE}=5 V
I_C/I_F=f (I_F)

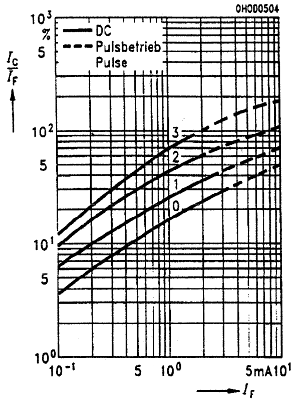


Figure 6. Current transfer ratio versus temperature (I_F=10 mA, V_{CE}=5 V)
I_C/I_F=f (T)

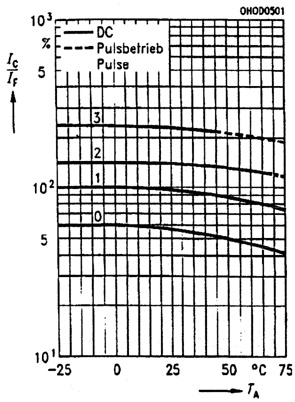


Figure 7. Transistor characteristics (HFE =550)
SFH600-2, -3 I_C=f(V_{CE}) (T_A=25°C, I_F=0)

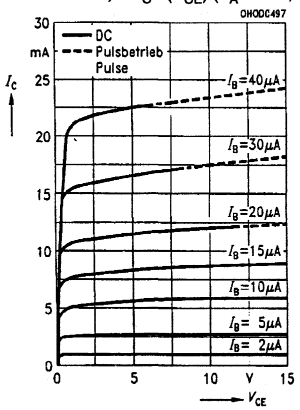


Figure 8. Output characteristics
SFH600-2, -3 (T_A=25°C) IC=f(V_{CE})

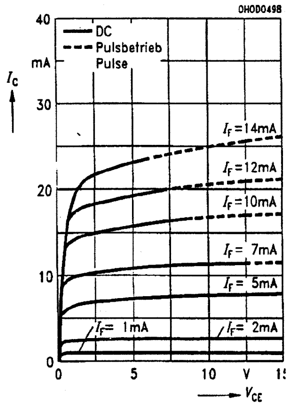


Figure 9. Forward voltage V_F=f (I_F)

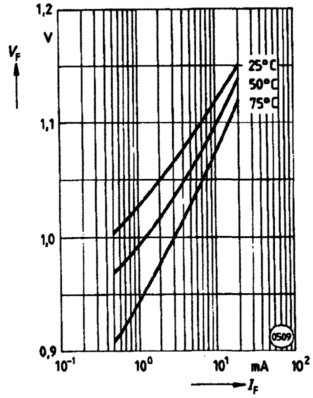


Figure 10. Collector emitter off-state current I_{CEO}=f (V, T) (T_A=25°C, I_F=0)

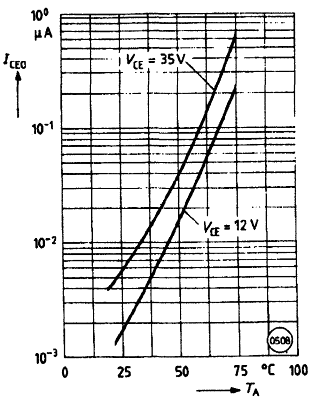


Figure 11. Saturation voltage versus collector current and modulation depth
SFH600-0 V_{CEsat}=f (I_C) (T_A=25°C)

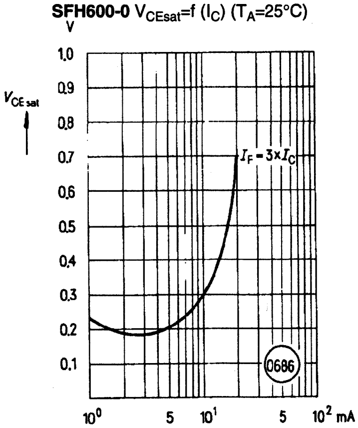


Figure 12. Saturation voltage versus collector current and modulation depth
SFH600-1 V_{CEsat}=f (I_C) (T_A=25°C)

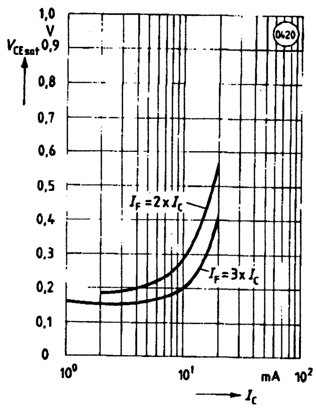


Figure 13. Saturation voltage versus collectorcurrent and modulation depth SFH600-2 V_{CEsat}=f (I_C) (T_A=25°C)

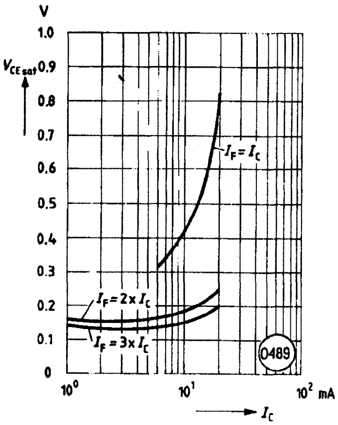


Figure 14. Saturation voltage versus collectorcurrent and modulation depth SFH600-3 V_{CEsat}=f (I_C) (T_A=25°C)

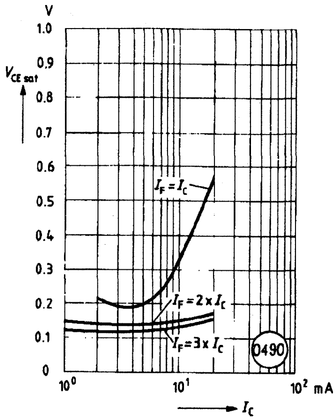


Figure 15. Permissible pulse load
D=parameter, T_A=25°C, I_F=f (t_p)

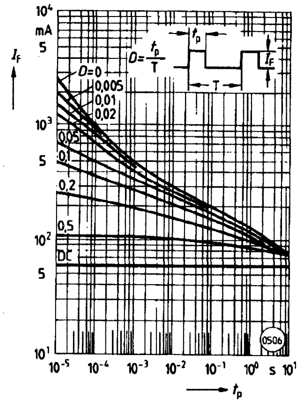


Figure 16. Permissible power dissipation for transistor and diode P_{tot}=f (T_A)

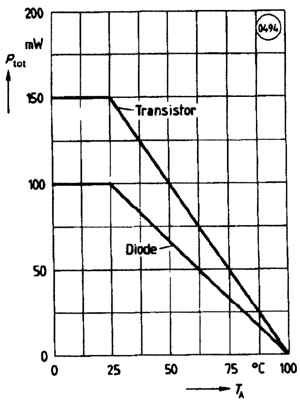


Figure 17. Permissible forward current diode P_{tot}=f (T_A)

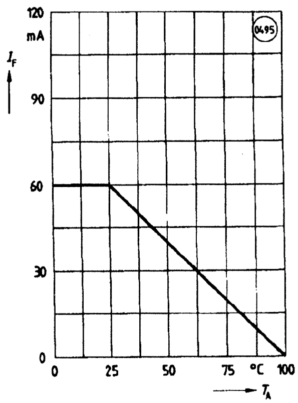
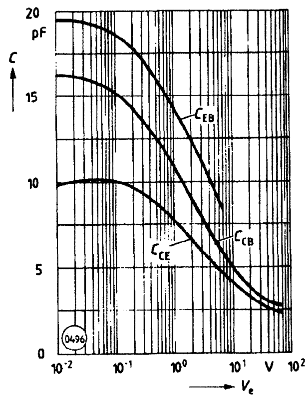


Figure 18. Transistor capacitance
C=f(V_O) (T_A=25°C, f=1 MHz)



SIEMENS

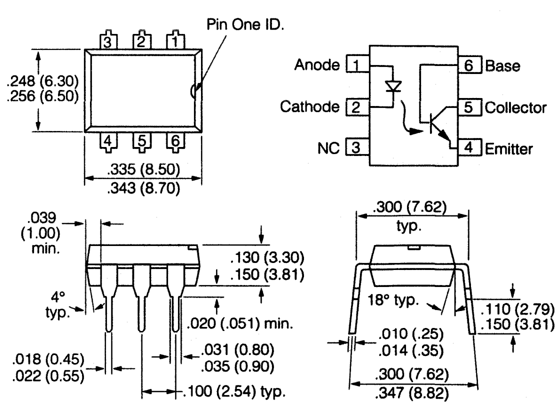
SFH601 SERIES

TRIOS®* PHOTOTRANSISTOR OPTOCOUPLER

FEATURES

- **High Current Transfer Ratios**
  SFH601-1, 40 to 80%
  SFH601-2, 63 to 125%
  SFH601-3, 100 to 200%
  SFH601-4, 160 to 320%
- **Isolation Test Voltage (1 Sec.), 5300 VAC_{RMS}**
- **V_{CEsat} 0.25 (≤0.4) V at I_F=10 mA, I_C=2.5 mA**
- **Built to Conform to VDE Requirements**
- **Highest Quality Premium Device**
- **Long Term Stability**
- **Storage Temperature: –55° to +150°C**
- **Underwriters Lab File #E52744**
- **CECC Approved**
- **VDE 0884 Available with Option 1**

Package Dimensions in Inches (mm)



Maximum Ratings

Emitter

Reverse Voltage	6 V
DC Forward Current	60 mA
Surge Forward Current (t_p=10 µs)	2.5 A
Total Power Dissipation	100 mW

Detector

Collector-Emitter Voltage	100 V
Emitter-Base Voltage	7 V
Collector Current	50 mA
Collector Current (t=1 ms)	100 mA
Power Dissipation	150 mW

Package

Isolation Test Voltage (between emitter and detector referred to climate DIN 40046, part 2, Nov. 74) (t=1 sec.).	5300 VAC_{RMS}
Creepage	≥7 mm
Clearance	≥7 mm
Isolation Thickness between Emitter and Detector	≥0.4 mm
Comparative Tracking Index per DIN IEC 112/VDE0303, part 1	175
Isolation Resistance	
V_{IO}=500 V, T_A=25°C	$\geq 10^{12}\ \Omega$
V_{IO}=500 V, T_A=100°C	$\geq 10^{11}\ \Omega$

Package

Storage Temperature Range	–55°C to +150°C
Ambient Temperature Range	–55°C to +100°C
Junction Temperature	100°C
Soldering Temperature (max. 10 s, dip soldering: distance to seating plane ≥1.5 mm)	260°C

DESCRIPTION

The SFH601 is an optocoupler with a Gallium Arsenide LED emitter which is optically coupled with a silicon planar phototransistor detector. The component is packaged in a plastic plug-in case 20 AB DIN 41866.

The coupler transmits signals between two electrically isolated circuits.

Characteristics (T_A=25°C)

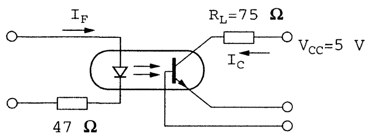
Emitter	**Symbol**		**Unit**	**Condition**
Forward Voltage	V_F	1.25 (≤1.65)	V	I_F=60 mA
Breakdown Voltage	V_{BR}	≥6	V	I_R=10 µA
Reverse Current	I_R	0.01 (≤10)	µA	V_R=6 V
Capacitance	C_{J0}	25	pF	V_F=0 V, f=1 MHz
Thermal Resistance	R_{THJamb}	750	°C/W	
Detector				
Capacitance			pF	f=1 MHz
Collector-Emitter	C_{CE}	6.8		V_{CE}=5 V
Collector-Base	C_{CB}	8.5		V_{CB}=5 V
Emitter-Base	C_{EB}	11		V_{EB}=5 V
Thermal Resistance	R_{THJamb}	500	°C/W	
Package				
Collector-Emitter Saturation Voltage	V_{CEsat}	0.25 (<0.4)		I_F=10 mA, I_C=2.5 mA
Coupling Capacitance	C_{IO}	0.6	pF	$V_{I\text{-}O}$=0, f=1 MHz

***TRIOS–TR**ansparent **IO**n **S**hield

Current Transfer Ratio and Collector-Emitter Leakage Current by dash number

	–1	–2	–3	–4	Unit
I_C/I_F at V_{CE}=5 V (I_F=10 mA)	40–80	63–125	100–200	160–320	%
I_C/I_F at V_{CE}=5 V (I_F=1 mA)	30 (>13)	45 (>22)	70 (>34)	90 (>56)	%
Collector-Emitter Leakage Current (V_{CE}=10 V) (I_{CEO})	2 (≤ 50)	2 (≤ 50)	5 (≤ 100)	5 (≤ 100)	nA

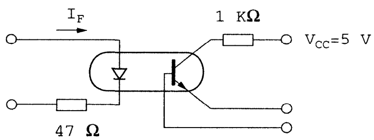
Linear Operation (without saturation)



I_F=10 mA, V_{CC}=5 V, T_A=25°C, Typical

Load Resistance	R_L	75	Ω
Turn-On Time	t_{ON}	3.0	µs
Rise Time	t_R	2.0	µs
Turn-Off Time	t_{OFF}	2.3	µs
Fall Time	t_f	2.0	µs
Cut-Off Frequency	F_{CO}	250	kHz

Switching Operation (with saturation)



Typical

	–1 (I_F=20 mA)	–2 and –3 (I_F=10 mA)	–4 (I_F=5 mA)	
Turn-On Time t_{ON}	3.0	4.2	6.0	µs
Rise Time t_R	2.0	3.0	4.6	µs
Turn-Off Time t_{OFF}	18	23	25	µs
Fall Time t_f	11	14	15	µs
V_{CESAT}	0.25 (≤ 0.4)			V

Figure 1. Current transfer ratio versus diode current (T_A=–25°C, V_{CE}=5 V) I_C/I_F=f (I_F)

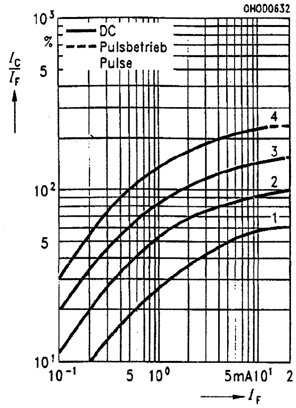


Figure 2. Current transfer ratio versus diode current (T_A=0°C, V_{CE}=5 V) I_C/I_F=f (I_F),

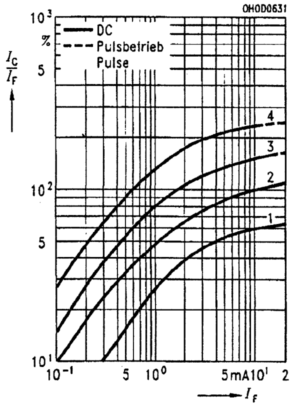


Figure 3. Current transfer ratio versus diode current (T_A=25°C, V_{CE}=5 V) I_C/I_F=f (I_F),

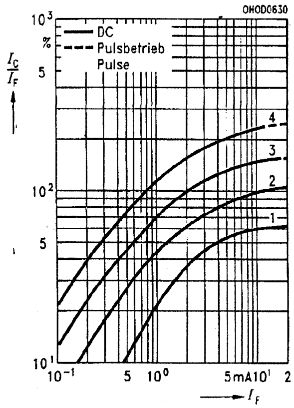


Figure 4. Current transfer ratio versus diode current (T_A=50°C, V_{CE}=5 V) I_C/I_F=f (I_F),

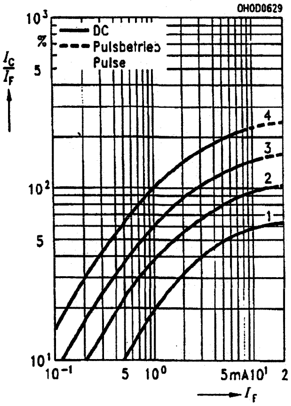


Figure 5. Current transfer ratio versus diode current (T_A=75°C, V_{CE}=5 V) I_C/I_F=f (I_F)

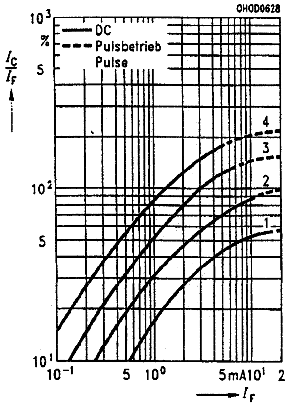


Figure 6. Current transfer ratio versus temperature (I_F=10 mA, V_{CE}=5 V) I_C/I_F=f (T)

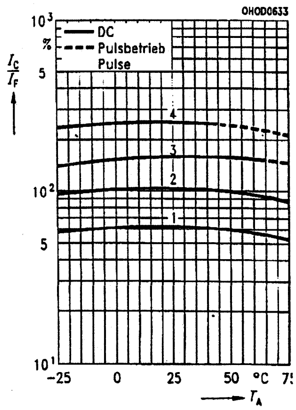


Figure 7. Transistor characteristics (HFE=550) I_C=f(V_{CE}) (T_A=25°C, I_F=0)

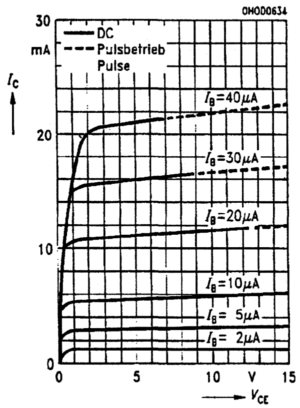


Figure 8. Output characteristics I_C=f (V_{CE}) (T_A=25°C)

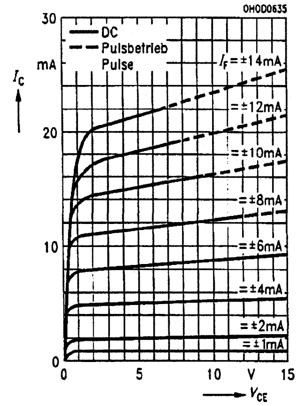


Figure 9. Forward voltage V_F=f (I_F)

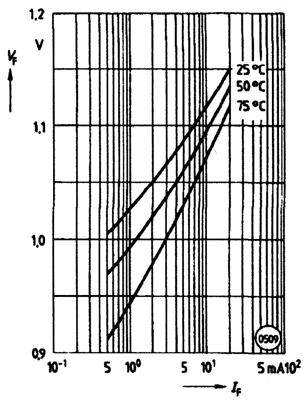


Figure 10. Collector emitter off-state current I_{CEO}=f (V, T) (T_A=25°C, I_F=0)

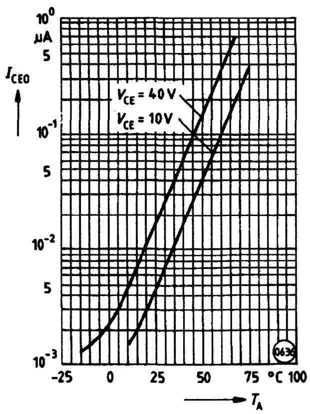


Figure 11. Saturation voltage versus collector current and modulation depth SFH601-1 V_{CEsat}=f (I_C) (T_A=25°C)

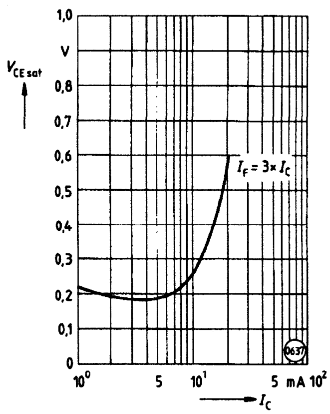


Figure 12. Saturation voltage versus collectorcurrent and modulation depth SFH601-2 V_{CEsat}=f (I_C) (T_A=25°C)

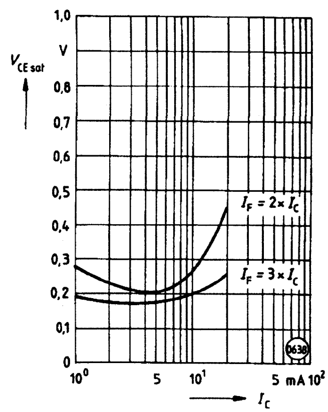


Figure 13. Saturation voltage versus collector current and modulation depth SFH601-3 V_{CEsat}=f (I_C) (T_A=25°C)

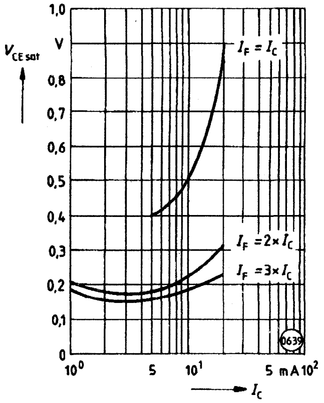


Figure 14. Saturation voltage versus collector current and modulation depth SFH601-4 V_{CEsat}=f (I_C) (T_A=25°C)

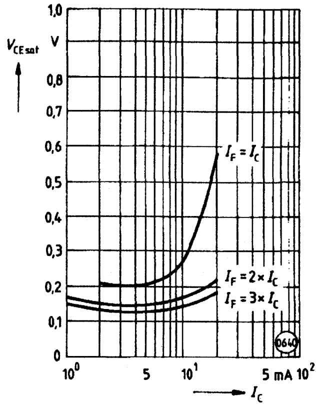


Figure 15. Permissible pulse load D=parameter, T_A=25°C, I_F=f (t)

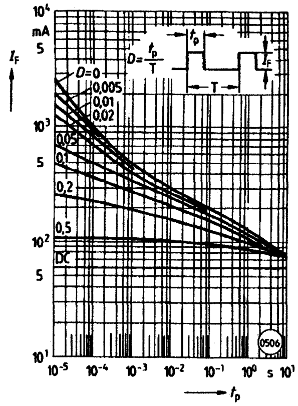


Figure 16. Permissible power dissipation for transistor and diode P_{tot}=f (T_A)

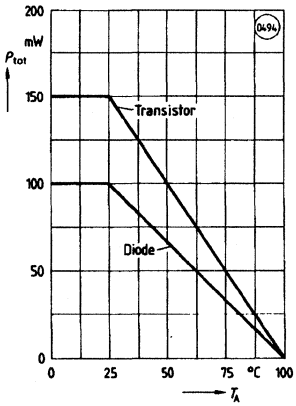


Figure 17. Permissible forward current diode P_{tot}=f (T_A)

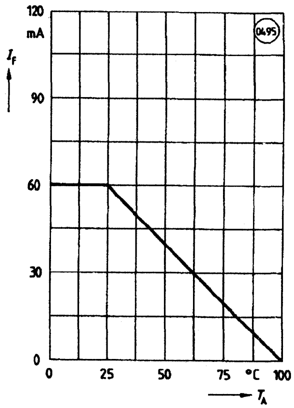
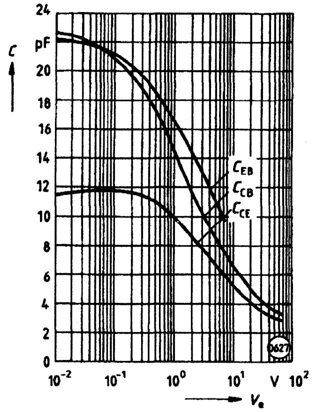


Figure 18. Transistor capacitance C=f(V_O) (T_A=25°C, f=1 MHz)



SIEMENS

SFH 608

PHOTOTRANSISTOR, 5.3 KV, TRIOS®
LOW CURRENT
OPTOCOUPLER

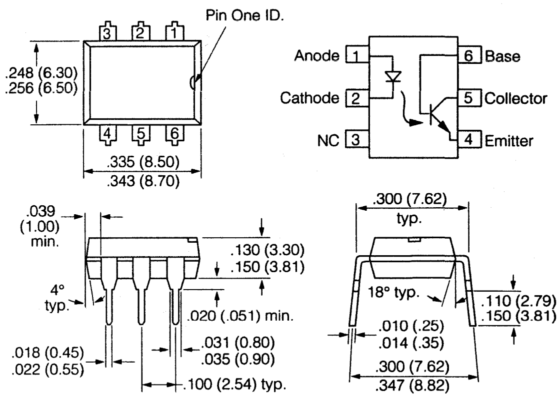
FEATURES

- Very High CTR at I_F=1 mA, V_{CE}=0.5 V
  - SFH608-2, 63-125%
  - SFH608-3, 100-200%
  - SFH608-4, 160-320%
  - SFH608-5, 250-500%
- Specified Minimum CTR at I_F=0.5 mA, V_{CE}=1.5 V: ≥32% (typ. 120%)
- Good CTR Linearity with Forward Current
- Low CTR Degradation
- High Collector-Emitter Voltage V_{CEO}=55 V
- Isolation Test Voltage: 5300 VAC_{RMS}
- Low Current Input
- Low Coupling Capacitance
- High Common Mode Transient Immunity
- Phototransistor Optocoupler in 6 Pin DIP Package
- Field Effect Stable: TRIOS*
- VDE 0884 Available with Option 1
- Underwriters Lab File #E52744
- Applications
  - Telecommunications
  - Industrial Controls
  - Office Machines
  - Microprocessor System Interfaces

DESCRIPTION

The SFH 608 is an optocoupler designed for high current transfer ratio at low input currents with the output transistor saturated. This makes the device ideal for low current switching applications. The SFH608 is packaged in a six pin plastic DIP.

Package Dimensions in Inches (mm)



Maximum Ratings (T_A=25°C)

Emitter

Reverse Voltage	6 V
DC Forward Current	50 mA
Surge Forward Current (tp≤10 µs)	2.5 A
Total Power Dissipation	70 mW

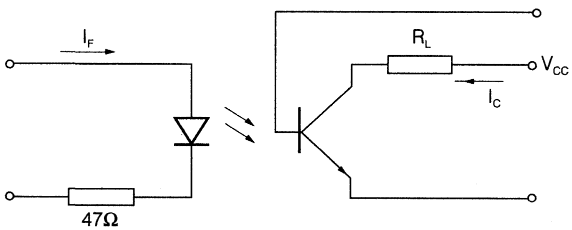
Detector

Collector-Emitter Voltage	55 V
Collector-Base Voltage	55 V
Emitter-Base Voltage	7 V
Collector Current	50 mA
Surge Collector Current (tp≤1 ms)	100 mA
Total Power Dissipation	150 mW
Isolation Test Voltage (between emitter and detectorreferred to climate DIN 40046 part 2 Nov. 74) (t=1 sec.)	5300 VAC_{RMS}
Creepage	≥7 mm
Clearance	≥7 mm
Comparative Tracking Index per DIN IEC 112/VDE 0303, part1	175
Isolation Resistance	
V_{IO}=500 V, T_A=25°C	$≥10^{12}$ Ω
V_{IO}=500 V, T_A=100°C	$≥10^{11}$ Ω
Storage Temperature Range	-55°C to +150°C
Operating Temperature Range	-55°C to +100°C
Junction Temperature	100°C
Soldering Temperature (max. 10 sec., dip soldering: distance to seating plane≥1.5 mm)	260°C

*TRIOS–TRansparent IOn Shield

Characteristics (T_A=25°C, unless otherwise specified)

	Symbol	Typ.	Unit	Condition
Emitter				
Forward Voltage	V_F	1.1 (≤ 1.5)	V	I_F=5 mA
Reverse Voltage	V_R	(≥ 6)	V	I_R= 10 µA
Reverse Current	I_R	0.01 (≤ 10)	µA	V_R=6 V
Capacitance	C_O	25	pF	V_R=0 V, f=1 MHz
Thermal Resistance	R_{thJA}	1070	K/W	
Detector				
Collector-Emitter Voltage	V_{CEO}	≥ 55	V	I_{CE}=10 µA
Emitter-Base Voltage	V_{EBO}	≥ 7	V	I_{EB}=10 µA
Capacitance	C_{CE}	10	pF	V_{CE}=5 V, f=1 MHz
Capacitance	C_{CB}	16	pF	V_{CB}=5 V, f=1 MHz
Capacitance	C_{EB}	10	pF	V_{EB}=5 V, f=1 MHz
Thermal Resistance	R_{thJA}	500	K/W	
Package				
Coupling Capacitance	C_C	0.60	pF	
Coupling Transfer Ratio				
SFH 608–2	I_C/I_F	63–125	%	I_F=1 mA, V_{CE}=0.5 V
		75 (≥ 32)	%	I_F=0.5 mA, V_{CE}=1.5 V
SFH 608–3	I_C/I_F	100–200	%	I_F=1 mA, V_{CE}=0.5 V
		120 (≥ 50)	%	I_F=0.5 mA, V_{CE}=1.5 V
SFH 608–4	I_C/I_F	160–320	%	I_F=1 mA, V_{CE}=0.5 V
		200 (≥ 80)	%	I_F=0.5 mA, V_{CE}=1.5 V
SFH 608–5	I_C/I_F	250–500	%	I_F=1 mA, V_{CE}=0.5 V
		300 (≥ 125)	%	I_F=0.5 mA, V_{CE}=1.5 V
Collector-Emitter Saturation Voltage				
SFH 608–2	V_{CEsat}	0.25 (≤ 0.4)	V	I_C=0.32 mA, I_F=1 mA
SFH 608–3	V_{CEsat}	0.25 (≤ 0.4)	V	I_C= 0.5 mA, I_F=1 mA
SFH 608–4	V_{CEsat}	0.25 (≤ 0.4)	V	I_C= 0.8 mA, I_F=1 mA
SFH 608–5	V_{CEsat}	0.25 (≤ 0.4)	V	I_C=1.25 mA, I_F=1 mA
Collector-Emitter Leakage Current	I_{CEO}	10 (≤ 200)	nA	V_{CE}=10 V



I_C=2 mA (to adjust by I_F), R_L=100 Ω, T_A=25°C, V_{CC}=5 V

Description	Symbol	Values	Unit
Turn-On Time	t_{ON}	8	µs
Rise Time	t_R	5	µs
Turn-Off Time	t_{OFF}	7.5	µs
Fall Time	t_F	7	µs

Figure 1. Switching times T_A=25°C, I_F=1 mA, V_{CC}=5 V, t_{ON}, t_R, t_{OFF}, t_F, =f(R_L)

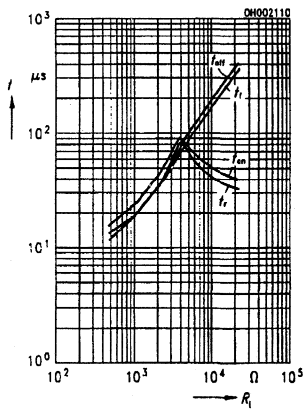


Figure 2. Current transfer ratio (typ.) V_{CE}=0.5 V, CTR=f(T_A, I_F)

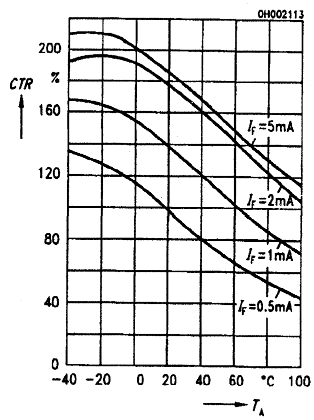


Figure 3. Current transfer ratio (typ.) V_{CE}=1.5 V, CTR=f(T_A, I_F)

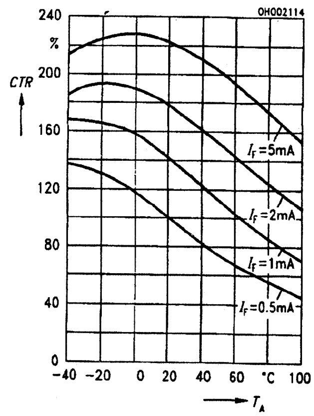


Figure 4. Diode forward voltage (typ.) T_A=25°C, V_F=f(I_F)

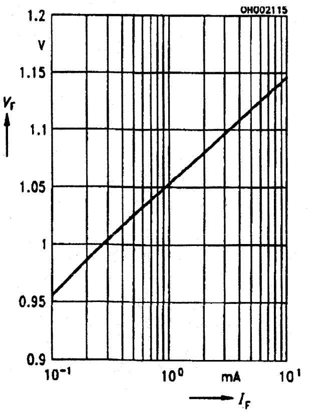


Figure 5. Diode forward voltage (typ.) I_F =1 mA, V_F=f(T_A)

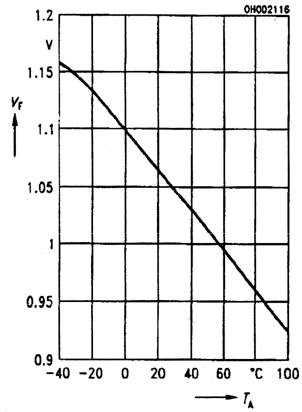


Figure 6. Output characteristics (typ.) T_A=25°C, I_{CE}=f(V_{CE}, I_B)

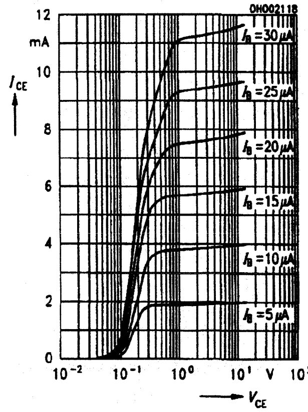


Figure 7. Output characteristics (typ.) T_A=25°C, I_{CE}=f(V_{CE}, I_F)

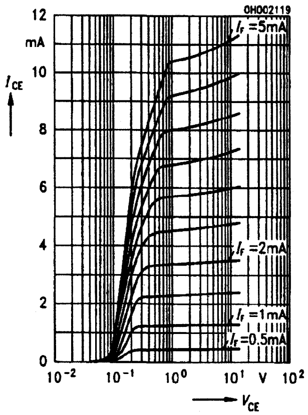


Figure 8. Permissible forward current diode I_F=f(T_A)

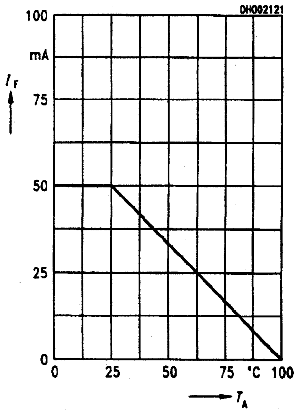


Figure 9. Permissible power dissipation P_{IOT}=f(T_A)

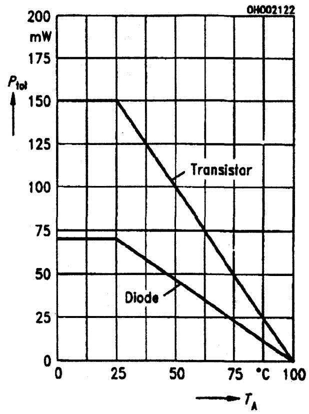


Figure 10. Transistor capacitance (typ.) T_A=25°C, f=1 MHz, C_{CE}=f(V_{CE}) C_{CB}=f (V_{CB}), C_{EB}=f (V_{EB})

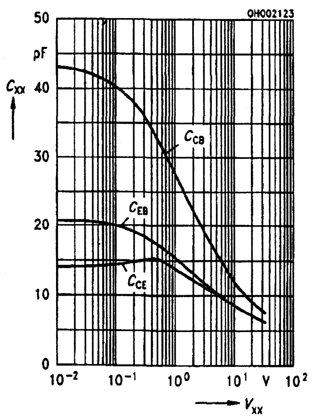
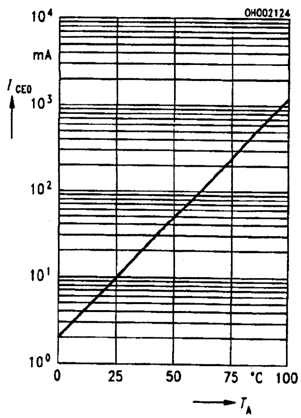


Figure 11. Collector-emitter leakage current I_F=0, V_{CE}=10 V, I_{CEO}=f(T_A)



SIEMENS

SFH 610/611/615

5.3 kV TRIOS® OPTOCOUPLER HIGH RELIABILITY

FEATURES

- **High Current Transfer Ratios at 10 mA: 40-320% at 1 mA: 60% typical (>13)**
- **Low CTR Degradation**
- **Good CTR Linearity Depending on Forward Current**
- **Isolation Test Voltage, 5300 VAC_{RMS}**
- **High Collector-Emitter Voltage, V_{CEO}=70 V**
- **Low Saturation Voltage**
- **Fast Switching Times**
- **Field-Effect Stable by TRIOS***
- **Temperature Stable**
- **Low Coupling Capacitance**
- **End-Stackable, .100"(2.54 mm) Spacing**
- **High Common-Mode Interference Immunity (Unconnected Base)**
- **Underwriters Lab File #52744**
- **VDE 0884 Available with Option 1**

DESCRIPTION

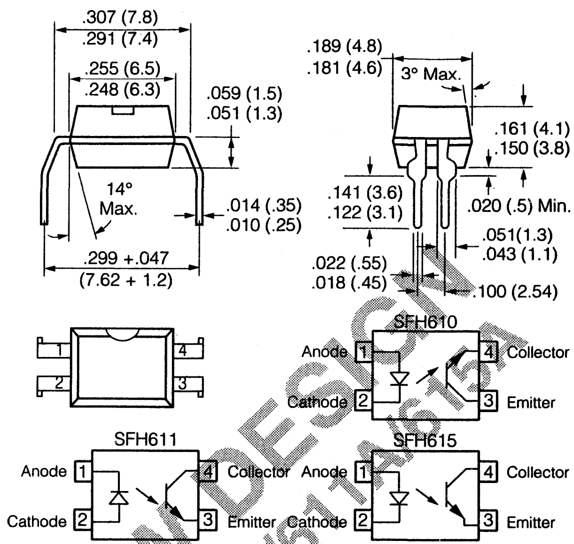
SFH 610/611/615 are optically coupled isolators that feature a high current transfer ratio, low coupling capacitance and high isolation voltage. They have a GaAs infrared emitting diode emitter, which is optically coupled to a silicon planar phototransistor detector. The component is incorporated in a plastic plug-in DIP-4 package.

The coupling devices are designed for signal transmission between two electrically separated circuits. The potential difference between the circuits to be coupled must not exceed the maximum permissible reference voltages.

The couplers are end-stackable with 2.54 mm spacing and are successor types for optocouplers in metal cases. The SFH610/611/615 differ in their arrangement of the terminal pins. Therefore multicouplers can easily be implemented and conventional multicouplers can be replaced.

***TR**ansparent **IO**n **S**hield

Package Dimensions in Inches (mm)



Maximum Ratings

Emitter

Reverse Voltage .... 6 V
DC Forward Current .... 60 mA
Surge Forward Current (t ≤10 µs) .... 2.5 A
Total Power Dissipation .... 100 mW

Detector

Collector-Emitter Voltage .... 70 V
Collector Current .... 50 mA
Collector Current (t ≤1 ms) .... 100 mA
Total Power Dissipation .... 150 mW

Package

Insulation Test Voltage (between emitter and detector referred to climate DIN 40046, part 2, Nov. 74) (t= 1 sec.) .... 5300 VAC_{RMS}
Creepage .... ≥7 mm
Clearance .... ≥7 mm
Insulation Thickness between Emitter and Detector .... ≥0.8 mm
Comparative Tracking Index per
DIN IEC 112/VDE 0303, part 1 175
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... $\geq 10^{12}\,\Omega$
V_{IO}=500 V, T_A=100°C .... $\geq 10^{11}\,\Omega$
Storage Temperature Range .... –55°C to +150°C
Ambient Temperature Range .... –55°C to +100°C
Junction Temperature .... 100°C
Soldering Temperature (max 10 s, Dip Soldering Distance to Seating Plane ≥1.5 mm) .... 260°C

Notes:
1. Dip soldering minimum clearance from bottom edge of package, 1.5 mm. Special soldering conditions apply when through-contacted circuit boards are used. Request appropriate specification.

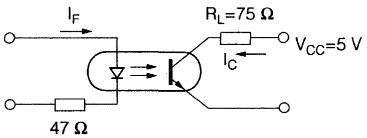
Characteristics (T_A=25°C)

Emitter	Symbol		Units	Condition
Forward Voltage	V_F	1.25 (≤1.65)	V	I_F=60 mA
Breakdown Voltage	V_{BR}	(≥6)	V	I_R=10 µA
Reverse Current	I_R	0.01 (≤10)	µA	V_R=6 V
Capacitance	C_0	25	pF	V_R=0 V, f=1 MHz
Thermal Resistance	R_{THJA}	750	K/W	
Detector				
Capacitance	C_{CE}	6.8	pF	V_{CE}=5 V, f=1 MHz
Thermal Resistance	R_{THJA}	500	K/W	
Package				
Collector-Emitter Saturation Voltage	V_{CESAT}	0.25 (≤0.4)	V	I_F=10 mA, I_C=2.5 mA
Coupling Capacitance	C_C	0.2	pF	

Current Transfer Ratio (I_C/I_F at V_{CE}=5 V) **and Collector-Emitter Leakage Current by dash number**

	–1	–2	–3	–4	
I_C/I_F (I_F=10 mA)	40–80	63–125	100–200	160–320	%
I_C/I_F (I_F=1 mA)	30 (>13)	45 (>22)	70 (>34)	90 (>56)	%
Collector-Emitter Leakage Current (V_{CE}=10 V) (I_{CEO})	2 (≤50)	2 (≤50)	5 (≤100)	5 (≤100)	nA

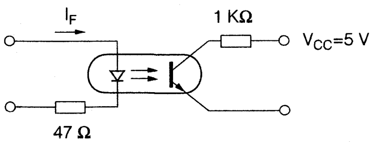
Switching Times
Linear Operation (without saturation)



I_F=10 mA, V_{CC}=5 V, T_A=25°C

Load Resistance	R_L	75	Ω
Turn-On Time	t_{ON}	3.0	µs
Rise Time	t_R	2.0	µs
Turn-Off Time	t_{OFF}	2.3	µs
Fall Time	t_f	2.0	µs
Cut-Off Frequency	F_{CO}	250	kHz

Switching Operation (with saturation)



	–1 (I_F=20 mA)	–2 and –3 (I_F=10 mA)	–4 (I_F=5 mA)	
Turn-On Time t_{ON}	3.0	4.2	6.0	µs
Rise Time t_R	2.0	3.0	4.6	µs
Turn-Off Time t_{OFF}	18	23	25	µs
Fall Time t_f	11	14	15	µs

SIEMENS

SFH610A/611A/615A/617A

5.3 kV TRIOS® OPTOCOUPLER
HIGH RELIABILITY

FEATURES
- **High Current Transfer Ratios at 10 mA: 40–320% at 1 mA: 60% typical (>13)**
- **Low CTR Degradation**
- **Good CTR Linearity Depending on Forward Current**
- **Withstand Test Voltage, 5300 VAC_{RMS}**
- **High Collector-Emitter Voltage, V_{CEO}=70 V**
- **Low Saturation Voltage**
- **Fast Switching Times**
- **Field-Effect Stable by TRIOS (TRansparent IOn Shield)**
- **Temperature Stable**
- **Low Coupling Capacitance**
- **End-Stackable, .100"(2.54 mm) Spacing**
- **High Common-Mode Interference Immunity (Unconnected Base)**
- **Underwriters Lab File #52744**
- **VDE 0884 Available with Option 1**
  SMD Option – See SFH6106/16/56 Data Sheet

DESCRIPTION
The SFH61XA features a high current transfer ratio, low coupling capacitance and high isolation voltage. These couplers have a GaAs infrared emitting diode emitter, which is optically coupled to a silicon planar phototransistor detector, and is incorporated in a plastic DIP-4 package.

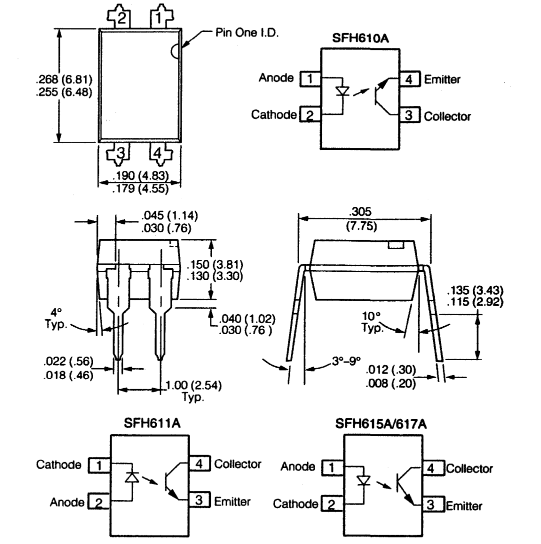
The coupling devices are designed for signal transmission between two electrically separated circuits.

The couplers are end-stackable with 2.54 mm spacing.

Creepage and clearance distances of >8 mm are achieved with option 6. This version complies with IEC 950 (DIN VDE 0805) for reinforced insulation up to an operation voltage of 400 V_{RMS} or DC.

Specifications subject to change.

Package Dimensions in Inches (mm)



Maximum Ratings
Emitter

Reverse Voltage .... 6 V
DC Forward Current .... 60 mA
Surge Forward Current (t_P≤10 µs) .... 2.5 A
Total Power Dissipation .... 100 mW

Detector

Collector-Emitter Voltage .... 70 V
Emitter-Collector Voltage .... 7 V
Collector Current .... 50 mA
Collector Current (t_P≤1 ms) .... 100 mA
Total Power Dissipation .... 150 mW

Package

Isolation Test Voltage between Emitter and Detector, refer to Climate DIN 40046, part 2, Nov. 74 .... 5300 VAC_{RMS}
Creepage .... ≥7 mm
Clearance .... ≥7 mm
Insulation Thickness between Emitter and Detector ... ≥0.4 mm
Comparative Tracking Index per DIN IEC 112/VDE0 303, part 1 .... ≥175
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... $\geq 10^{12}\ \Omega$
V_{IO}=500 V, T_A=100°C .... $\geq 10^{11}\ \Omega$
Storage Temperature Range .... –55 to +150°C
Ambient Temperature Range .... –55 to +100°C
Junction Temperature .... 100°C
Soldering Temperature (max. 10 s. Dip Soldering Distance to Seating Plane ≥1.5 mm) .... 260°C

Characteristics (T_A=25°C)

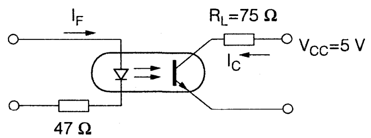
Description	Symbol		Unit	Condition
Emitter (IR GaAs)				
Forward Voltage	V_F	1.25 (≤1.65)	V	I_F=60 mA
Reverse Current	I_R	0.01 (≤10)	µA	V_R=6 V
Capacitance	C_0	13	pF	V_R=0 V, f=1 MHz
Thermal Resistance	R_{thJA}	750	K/W	
Detector (Si Phototransistor)				
Capacitance	C_{CE}	5.2	pF	V_{CE}=5 V, f=1 MHz
Thermal Resistance	R_{thJA}	500	K/W	
Package				
Collector-Emitter Saturation Voltage	V_{CESAT}	0.25 (≤0.4)	V	I_F=10 mA, I_C=2.5 mA
Coupling Capacitance	C_C	0.4	pF	

Current Transfer Ratio (I_C/I_F at V_{CE}=5 V) **and Collector-Emitter Leakage Current by Dash Number**

Description	-1	-2	-3	-4	
I_C/I_F (I_F=10 mA)	40–80	63–125	100–200	160–320	%
I_C/I_F (I_F=1 mA)	30 (>13)	45 (>22)	70 (>34)	90 (>56)	%
Collector-Emitter Leakage Current, I_{CEO} V_{CE}=10 V	2 (≤50)	2 (≤50)	5 (≤100)	5 (≤100)	nA

Switching Times (Typical)

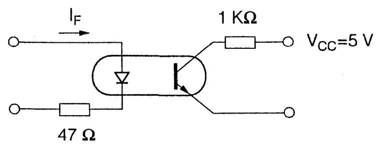
Linear Operation (without saturation)



I_F=10 mA, V_{CC}=5 V, T_A=25°C

Load Resistance	R_L	75	Ω
Turn-on Time	t_{ON}	3.0	µs
Rise Time	t_R	2.0	µs
Turn-off Time	t_{OFF}	2.3	µs
Fall Time	t_F	2.0	µs
Cut-off Frequency	F_{CO}	250	kHz

Switching Operation (with saturation)



		-1 I_F=20 mA	-2 and -3 I_F=10 mA	-4 I_F=5 mA	
Turn-on Time	t_{ON}	3.0	4.2	6.0	µs
Rise Time	t_R	2.0	3.0	4.6	µs
Turn-off Time	t_{OFF}	18	23	25	µs
Fall Time	t_F	11	14	15	µs

Figure 1. Current transfer ratio (typ.) vs. temperature
I_F=10 mA, V_{CE}=0.5 V

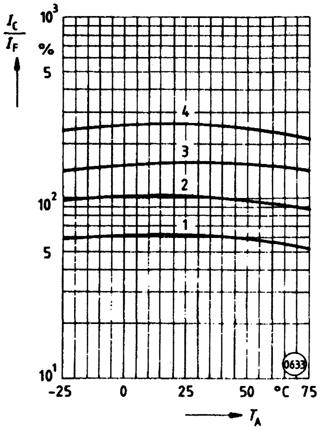


Figure 2. Output characteristics (typ.) Collector current vs. collector-emitter voltage T_A=25°C

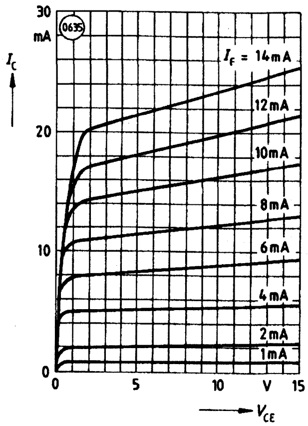


Figure 3. Diode forward voltage (typ.) vs. forward current

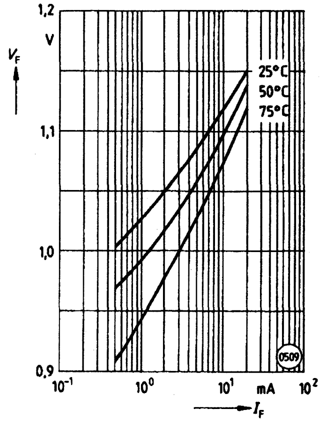


Figure 4. Transistor capacitance (typ.) vs. collector-emitter voltage
T_A=25°C, f=1 MHz

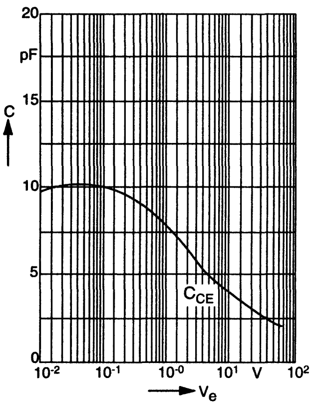


Figure 5. Permissiable pulse handling capability. Fwd. current vs. pulse width Pulse cycle D=parameter, T_A=25°C

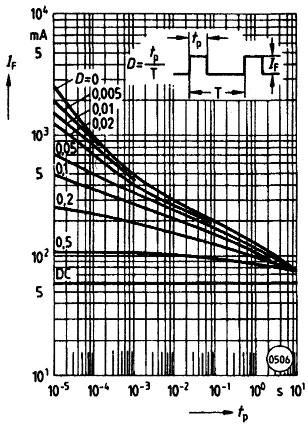


Figure 6. Permissible power dissipation vs. ambient temp.

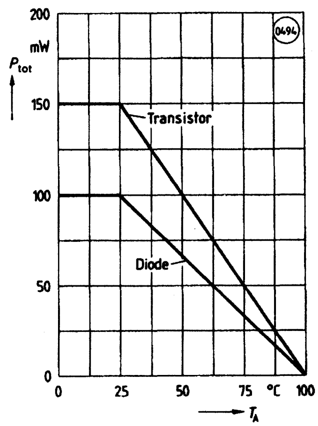
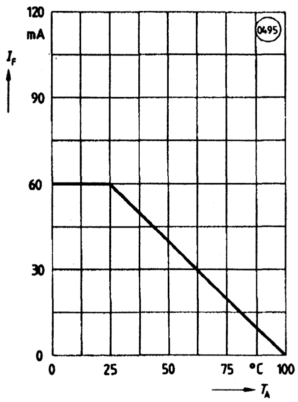


Figure 7. Permissible diode forward current vs. ambient temp.



SIEMENS

SFH615AA/AGB

5.3 kV TRIOS® OPTOCOUPLER HIGH RELIABILITY

FEATURES

- **High Current Transfer Ratios**
  at 5 mA: 50–600%
  at 1 mA: 60% typical (>13)
- **Low CTR Degradation**
- **Good CTR Linearity Depending on Forward Current**
- **Isolation Test Voltage, 5300 VAC_{RMS}**
- **High Collector-Emitter Voltage, V_{CEO}=70 V**
- **Low Saturation Voltage**
- **Fast Switching Times**
- **Field-Effect Stable by TRIOS (TRansparent IOn Shield)**
- **Temperature Stable**
- **Low Coupling Capacitance**
- **End-Stackable, .100"(2.54 mm) Spacing**
- **High Common-Mode Interference Immunity (Unconnected Base)**
- **Underwriters Lab File #52744**
- **VDE 0884 Available with Option 1**
  SMD Option – See SFH6106/16/56 Data Sheet

DESCRIPTION

The SFH615AA/AGB features a high current transfer ratio, low coupling capacitance and high isolation voltage. These couplers have a GaAs infrared emitting diode emitter, which is optically coupled to a silicon planar phototransistor detector, and is incorporated in a plastic DIP-4 package.

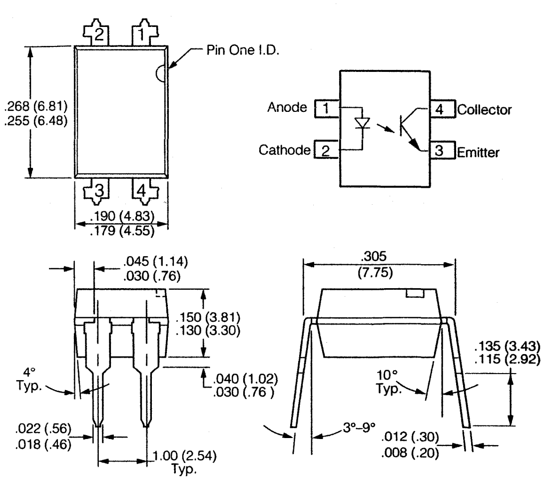
The coupling devices are designed for signal transmission between two electrically separated circuits.

The couplers are end-stackable with 2.54 mm spacing.

Creepage and clearance distances of >8 mm are achieved with option 6. This version complies with IEC 950 (DIN VDE 0805) for reinforced insulation up to an operation voltage of 400 V_{RMS} or DC.

Specifications subject to change.

Package Dimensions in Inches (mm)



Maximum Ratings

Emitter

Reverse Voltage	6 V
DC Forward Current	60 mA
Surge Forward Current (t_P≤10 µs)	2.5 A
Total Power Dissipation	100 mW

Detector

Collector-Emitter Voltage	70 V
Emitter-Collector Voltage	7 V
Collector Current	50 mA
Collector Current (t_P≤1 ms)	100 mA
Total Power Dissipation	150 mW

Package

Isolation Test Voltage between Emitter and Detector, refer to Climate DIN 40046, part 2, Nov. 74	5300 VAC_{RMS}
Creepage	≥7 mm
Clearance	≥7 mm
Insulation Thickness between Emitter and Detector	≥0.4 mm
Comparative Tracking Index per DIN IEC 112/VDE0 303, part 1	≥175
Isolation Resistance V_{IO}=500 V, T_A=25°C	≥10^{12} Ω
V_{IO}=500 V, T_A=100°C	≥10^{11} Ω
Storage Temperature Range	–55 to +150°C
Ambient Temperature Range	–55 to +100°C
Junction Temperature	100°C
Soldering Temperature (max. 10 s. Dip Soldering Distance to Seating Plane ≥1.5 mm)	260°C

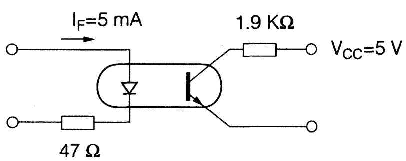
Characteristics (T_A=25°C)

Description	Symbol		Unit	Condition
Emitter (IR GaAs)				
Forward Voltage	V_F	1.25 (≤1.65)	V	I_F=60 mA
Reverse Current	I_R	0.01 (≤10)	µA	V_R=6 V
Capacitance	C_0	13	pF	V_R=0 V, f=1 MHz
Thermal Resistance	R_{thJA}	750	K/W	
Detector (Si Phototransistor)				
Capacitance	C_{CE}	5.2	pF	V_{CE}=5 V, f=1 MHz
Thermal Resistance	R_{thJA}	500	K/W	
Package				
Collector-Emitter Saturation Voltage	V_{CESAT}	0.25 (≤0.4)	V	I_F=10 mA, I_C=2.5 mA
Coupling Capacitance	C_C	0.4	pF	

Current Transfer Ratio (I_C/I_F at V_{CE}=5 V) **and Collector-Emitter Leakage Current**

Description	AA	AGB	
I_C/ I_F (I_F=5 mA)	50–600	100–600	%
Collector-Emitter Leakage Current, I_{CEO} V_{CE}=10 V	10 (≤100)	10 (≤100)	nA

Switching Operation (with saturation)



		I_F=5 mA	
Turn-on Time	t_{ON}	2.0	µs
Turn-off Time	t_{OFF}	25	µs

Figure 1. Current transfer ratio (typ.) vs. temperature
I_F=10 mA, V_{CE}=0.5 V

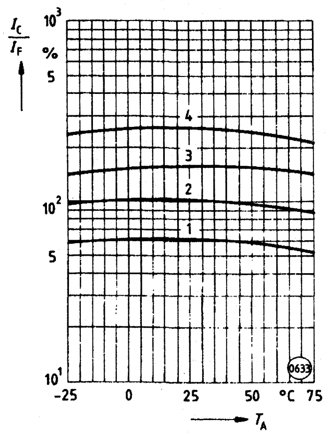


Figure 2. Output characteristics (typ.) Collector current vs. collector-emitter voltage T_A=25°C

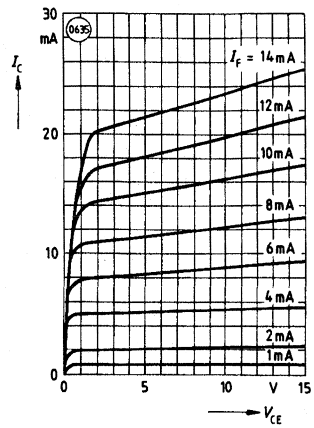


Figure 3. Diode forward voltage (typ.) vs. forward current

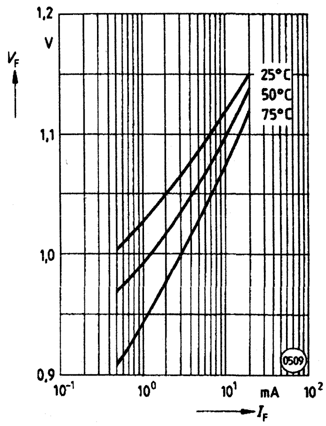


Figure 4. Transistor capacitance (typ.) vs. collector-emitter voltage
T_A=25°C, f=1 MHz

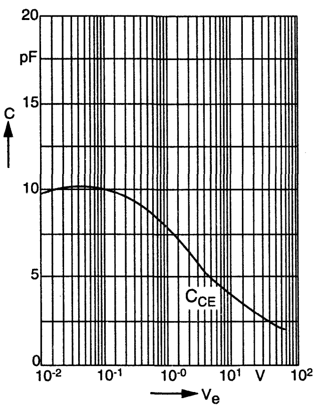


Figure 5. Permissiable pulse handling capability. Fwd. current vs. pulse width Pulse cycle D=parameter, T_A=25°C

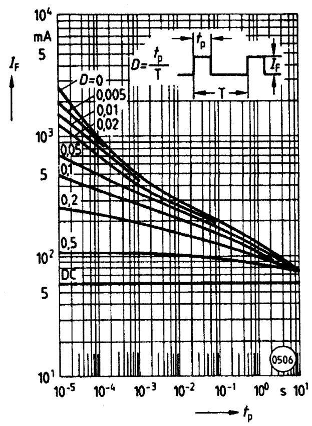


Figure 6. Permissible power dissipation vs. ambient temp.

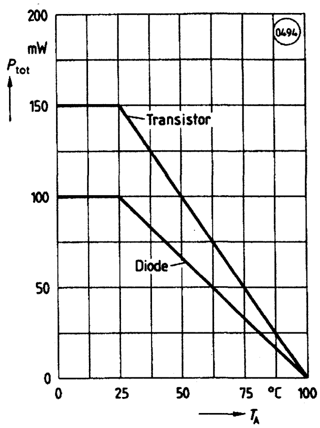
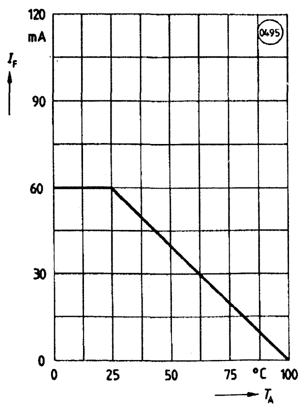


Figure 7. Permissible diode forward current vs. ambient temp.



SIEMENS

SFH617G

5.3 kV TRIOS®* OPTOCOUPLER

FEATURES

- **Current Transfer Ratios:**
  SFH 617G-1, 40-80%
  SFH 617G-2, 63-125%
  SFH 617G-3, 100-200%
  SFH 617G-4, 160-320%
- **Creepage Distances and Clearances per VDE 0110**
- **Insulation Thickness ≥0.7 mm**
- **Creepage Distance ≥7 mm**
- **High Common-Mode Rejection**
- **E52744**
- **Fulfills VDE Standards: 0804/0805/0806/0860**
- **VDE 0884 Available with Option 1**

DESCRIPTION

The SFH 617G line isolating optocoupler has been designed for especially demanding applications. The reflective coupler without base connection and a 0.80 mm separation between electrically conducting parts results in an excellent high-voltage safety. Despite the small size of the package, modified pins ensure a creepage distance of 8 mm. The pins have been bent up to a spacing of 0.4", which also maintains a creepage distance ≥8 mm on the PC board for use in circuits requiring safe electrical isolation in accordance with protection class II.

Maximum Ratings

Emitter

Reverse Voltage .... 6 V
DC Forward Current .... 60 mA
Surge Forward Current (t≤10 µs) .... 2.5 A
Total Power Dissipation .... 100 mW

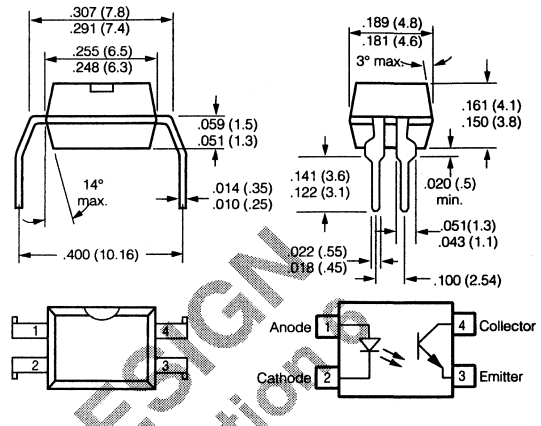
Detector

Collector-Emitter Voltage .... 70 V
Emitter-Base Voltage .... 7 V
Collector Current .... 50 mA
Collector Current (t≤1 ms) .... 100 mA
Total Power Dissipation .... 150 mW

Package

Isolation Test Voltage (between emitter and detector referred to climate DIN 40046, part 2, Nov. 74) (t=1 sec.) .... 5300 VAC_{RMS}
Creepage .... ≥7.0 mm
Clearance .... ≥8.0 mm
Insulation Thickness between Emitter and Detector .... ≥0.8 mm
Comparative Tracking Index per DIN IEC 112/VDE0303, part 1 175
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... 10^{12} Ω
V_{IO}=500 V, T_A=100°C .... 10^{11} Ω
Storage Temperature Range .... –55°C to +150°C
Operating Temperature Range .... –55°C to +100°C
Junction Temperature .... 100°C
Soldering Temperature (max. 10 s, dip soldering: distance to seating plane≥1.5 mm) .... 260°C

Package Dimensions in Inches (mm)



Characteristics (T_A=25°C)

	Symbol		Unit	Condition
Emitter				
Forward Voltage	V_F	1.25 (≤1.65)	V	I_F=60 mA
Reverse Current	I_R	0.01 (≥10)	µA	V_R=6 V
Capacitance	C_O	25	pF	V_R=0 V f=1 MHz
Thermal Resistance	R_{THJamb}	750	°C/W	
Detector				
Capacitance	C_{CE}	6.8	pF	V_{CE}=5 V f=1 MHz
Thermal Resistance	R_{THJamb}	500	°C/W	
Package				
Collector-Emitter Saturation Voltage	V_{CEsat}	0.25 (<0.4)	V	I_F=10 mA I_C=2.5mA
Coupling Capacitance	C_C	0.2	pF	

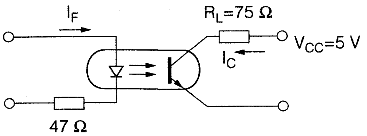
Notes:
1. Dip soldering minimum clearance from bottom edge of package, 1.5 mm. Special soldering conditions apply when through-contacted circuit boards are used. Request appropriate specification.

***TR**ansparent **IO**n **S**hield

Current Transfer Ratio and Collector-Emitter Leakage Current by dash number

	–1	–2	–3	–4	Unit
I_C/I_F at V_{CE}=5 V (I_F=10 mA)	40–80	63–125	100–200	160–320	%
I_C/I_F at V_{CE}=5 V (I_F=1 mA)	30 (>13)	45 (>22)	70 (>34)	90 (>56)	%
Collector-Emitter Leakage Current (V_{CE}=10 V) (I_{CEO})	2 (≤ 35)	2 (≤ 35)	5 (≤ 35)	5 (≤ 70)	nA

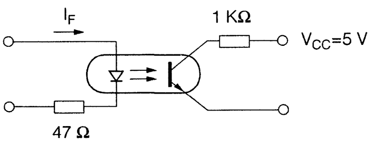
Linear Operation (without saturation)



I_F=10 mA, V_{CC}=5 V, T_A=25°C

Load Resistance	R_L	75	Ω
Turn-On Time	t_{ON}	3.0	µs
Rise Time	t_R	2.0	µs
Turn-Off Time	t_{OFF}	2.3	µs
Fall Time	t_F	2.0	µs

Switching Operation (with saturation)



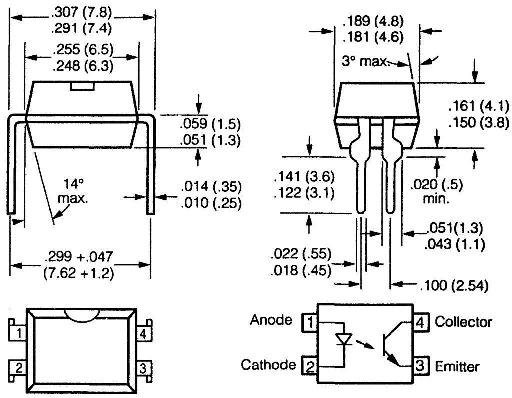
	–1 (I_F=20 mA)	–2 and –3 (I_F=10 mA)	–4 (I_F=5 mA)	
Turn-On Time t_{ON}	3.0	4.2	6.0	µs
Rise Time t_R	2.0	3.0	4.6	µs
Turn-Off Time t_{OFF}	18	23	25	µs
Fall Time t_F	11	14	15	µs
V_{CESAT}	0.25 (≤ 0.4)			V

SIEMENS

SFH618

PHOTOTRANSISTOR, 5.3 kV TRIOS®
LOW CURRENT INPUT
OPTOCOUPLER

Package Dimensions in Inches (mm)



FEATURES

- Very High CTR at I_F=1 mA, V_{CE}=0.5 V
  - SFH618-2, 63–125%
  - SFH618-3, 100–200%
  - SFH618-4, 160–320%
  - SFH618-5, 250–500%
- Specified Minimum CTR at I_F=-0.5 mA V_{CE}=1.5 V: ≥32% (typical 120%)
- Good CTR Linearity Depending on Forward Current
- Low CTR Degradation
- High Collector-Emitter Voltage, V_{CEO}=55 V
- Isolation Test Voltage, 5300 VAC_{RMS}
- Low Current Input
- Low Coupling Capacitance
- High Common-Mode Transient Immunity
- Phototransistor Optocoupler in 4 Pin DIP Package
- End-Stackable, 0.100"(2.54 mm) Spacing

APPLICATIONS

- Telecom
- Industrial Controls
- Battery Powered Equipment
- Office Machines
- VDE #0884 Available with Option 1

DESCRIPTION

The SFH618 is an optical coupler with a AlGaAs infrared LED and a silicon NPN photo transistor

Maximum Ratings

Emitter

Reverse Voltage ....6 V
DC Forward Current ....50 mA
Surge Forward Current (t_P≤10 µs)..2.5 A
Total Power Dissipation ....70 mW

Detector

Collector-Emitter Voltage ....55 V
Emitter-Collector Voltage ....7 V
Collector Current ....50 mA
Collector Current (t_P≤1 ms) ....100 mA
Total Power Dissipation ....150 mW

Package

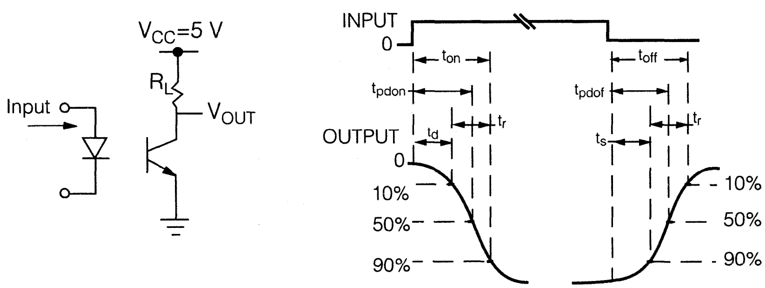
Isolation Test Voltage (between emitter and detector, refer to climate DIN 40046, part 2, Nov. 74) (t=1 sec.)................................5300 VAC_{RMS}
Isolation Resistance
V_{IO}=500 V, T_A=25°C..≥10^{12} Ω
V_{IO}=500 V, T_A=100°C..≥10^{11} Ω
Creepage..≥7 mm
Clearance ....≥7 mm
Isolation Distance, Emitter to Detector ....≥0.8 mm
Comparative Tracking Index per DIN IEC 112/VDE 0303, part 1 175
Storage Temperature Range ....–55 to +150°C
Operating Temperature Range...........................–55 to +100°C
Junction Temperature .... 100°C
Soldering Temperature (max. 10 sec., dip soldering: distance solder joint/case bottom ≥1.5 mm) .... 260°C

Notes:
Dip soldering minimum clearance from bottom edge of package, 1.5 mm. Special soldering conditions apply when through-contacted circuit boards are used. Request appropriate specification.

Characteristics (T_A=25°C)

Emitter		Symbol	Min.	Typ.	Max.	Unit	Condition
Forward Voltage		V_F		1.1	1.5	V	I_F=5 mA
Reverse Voltage		V_R		≥6			I_R=10
Reverse Current		I_R		.01	10		V_R=6 V
Capacitance		C_O		25		pF	V_R=0 V, f=1 MHz
Thermal Resistance		R_{thJA}		750		K/W	
Detector							
Collector-Emitter Voltage		V_{CEO}		≥55		V	I_{CE}=10 µA
Emitter-Collector Voltage		V_{CEO}		≥7		V	I_{EC}=10 µA
Capacitance		C_{CE}		7		pF	V_{CE}=5 V, f=1 MHz
Thermal Resistance		R_{thJA}		500		K/W	
Package							
Coupling Capacitance		C_C		0.25		pF	
Coupling Transfer Ratio	SFH618-2	I_C/I_F	63		125	%	I_F=1 mA, V_{CE}=0.5 V
			32	75			I_F=0.5 mA, V_{CE}=1.5 V
	SFH618-3	I_C/I_F	100		200	%	I_F=1 mA, V_{CE}=0.5 V
			50	120			I_F=0.5 mA, V_{CE}=1.5 V
	SFH618-4	I_C/I_F	160		320	%	I_F=1 mA, V_{CE}=0.5 V
			80	200			I_F=0.5 mA, V_{CE}=1.5 V
	SFH618-5	I_C/I_F	250		500	%	I_F=1 mA, V_{CE}=0.5 V
			125	300			I_F=0.5 mA, V_{CE}=1.5 V
Collector-Emitter Saturation Voltage	SFH618-2	V_{CESAT}		0.25	0.4	V	I_C=0.32 mA, I_F=1 mA
	SFH618-3			0.25	0.4		I_C=0.5 mA, I_F=1 mA
	SFH618-4			0.25	0.4		I_C=0.8 mA, I_F=1 mA
	SFH618-5			0.25	0.4		I_C=1.25 mA, I_F=1 mA
Collector-Emitter Leakage Current		I_{CEO}		10	0.4	nA	V_{CE}=10 V

Switching Times Measurement–Test Circuit and Waveforms

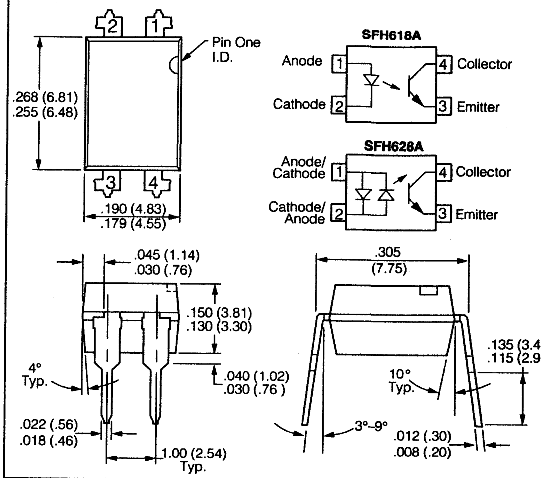


SIEMENS

SFH618A/628A

PHOTOTRANSISTOR, 5.3 kV TRIOS®
LOW CURRENT INPUT
OPTOCOUPLER

Package Dimensions in Inches (mm)



FEATURES

- **Very High CTR at I_F=1 mA, V_{CE}=0.5 V**
  - **SFH618A-2, 63–125%**
  - **SFH618A-3, 100–200%**
  - **SFH618A-4, 160–320%**
  - **SFH618A-5, 250–500%**
  - **SFH628A-2, 63–200%**
  - **SFH628A-3, 100–320%**
  - **SFH628A-4, 160–500%**
- **Specified Minimum CTR at I_F=-0.5 mA**
  - **SFH618A, V_{CE}=1.5 V: ≥32% (typical 120%)**
  - **SFH628A, V_{CE}=1.5 V: ≥50% (typical 160%)**
- **Good CTR Linearity Depending on Forward Current**
- **Low CTR Degradation**
- **High Collector-Emitter Voltage, V_{CEO}=55 V**
- **Isolation Test Voltage, 5300 VAC_{RMS}**
- **Low Coupling Capacitance**
- **Field-Effect Stable by TRIOS (TRansparent IOn Shield)**
- **End-Stackable, 0.100"(2.54 mm) Spacing**
- **High Common-Mode Interference Immunity (Unconnected Base)**
- **Underwriters Lab File #52744**
- **VDE 0884 Available with Option 1**
  SMD Option — See SFH6186/6286 Data Sheet

APPLICATIONS

- **Telecom**
- **Industrial Controls**
- **Battery Powered Equipment**
- **Office Machines**

DESCRIPTION

The SFH618A/628A feature a high current transfer ratio, low coupling capacitance and high isolation voltage. These couplers have a GaAs infrared emitting diode emitter, which is optically coupled to a silicon planar phototransistor detector, and is incorporated in a plastic DIP-4 package.

The coupling devices are designed for signal transmission between two electrically separated circuits.

The couplers are end-stackable with 2.54 mm spacing. Therefore multicouplers can easily be implemented and conventional multicouplers can be replaced.

Creepage and clearance distances of >8 mm are achieved with option 6. This version complies with IEC 950 (DIN VDE 0805) for reinforced insulation up to an operation voltage of 400 V_{RMS} or DC.

Maximum Ratings

Emitter

Reverse Voltage (SFH618A)6 V
DC Forward Current (SFH628A: ±) 50 mA
Surge Forward Current (t_P≤10 µs) (SFH628A: ±)2.5 A
Total Power Dissipation70 mW

Detector

Collector-Emitter Voltage55 V
Emitter-Collector Voltage7 V
Collector Current50 mA
Collector Current (t_P≤1 ms)100 mA
Total Power Dissipation150 mW

Package

Isolation Test Voltage between Emitter and Detector, refer to Climate DIN 40046, part 2, Nov. 745300 VAC_{RMS}
Creepage≥7 mm
Clearance≥7 mm
Insulation Thickness between Emitter and Detector≥0.4 mm
Comparative Tracking Index per DIN IEC 112/VDE0 303, part 1175
Isolation Resistance
V_{IO}=500 V, T_A=25°C≥10^{12} Ω
V_{IO}=500 V, T_A=100°C≥10^{11} Ω
Storage Temperature Range–55 to +150°C
Ambient Temperature Range–55 to +100°C
Junction Temperature100°C
Soldering Temperature (max. 10 s. Dip Soldering Distance to Seating Plane ≥1.5 mm)260°C

Specifications subject to change.

Characteristics (T_A=25°C)

Description		Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter							
Forward Voltage		V_F		1.1	1.5	V	I_F=5 mA
Reverse Current	SFH618A	I_R		.01	10		V_R=6 V
Capacitance	SFH618A SFH628A	C_0		25 45		pF	V_R=0 V, f=1 MHz
Thermal Resistance		R_{thJA}		1070		K/W	
Detector							
Collector-Emitter Leakage Current		I_{CEO}		10	200	nA	V_{CE}=10 V
Capacitance		C_{CE}		7		pF	V_{CE}=5 V, f=1 MHz
Thermal Resistance		R_{thJA}		500		K/W	
Package							
Collector-Emitter Saturation Voltage	SFH618A-2	V_{CESAT}		0.25	0.4	V	I_C=0.32 mA, I_F=1 mA
	SFH618A-3			0.25	0.4		I_C=0.5 mA, I_F=1 mA
	SFH618A-4			0.25	0.4		I_C=0.8 mA, I_F=1 mA
	SFH618A-5			0.25	0.4		I_C=1.25 mA, I_F=1 mA
Collector-Emitter Saturation Voltage	SFH628A-2	V_{CESAT}		0.25	0.4	V	I_C=0.5 mA, I_F=±1 mA
	SFH628A-3			0.25	0.4		I_C=0.8 mA, I_F=±1 mA
	SFH628A-4			0.25	0.4		I_C=1.25 mA, I_F=±1 mA
Coupling Capacitance		C_C		0.25		pF	
Coupling Transfer Ratio	SFH618A-2	I_C/I_F	63		125	%	I_F=1 mA, V_{CE}=0.5 V
	SFH618A-2		32	75			I_F=0.5 mA, V_{CE}=1.5 V
	SFH618A-3	I_C/I_F	100		200	%	I_F=1 mA, V_{CE}=0.5 V
	SFH618A-3		50	120			I_F=0.5 mA, V_{CE}=1.5 V
	SFH618A-4	I_C/I_F	160		320	%	I_F=1 mA, V_{CE}=0.5 V
	SFH618A-4		80	200			I_F=0.5 mA, V_{CE}=1.5 V
	SFH618A-5	I_C/I_F	250		500	%	I_F=1 mA, V_{CE}=0.5 V
	SFH618A-5		125	300			I_F=0.5 mA, V_{CE}=1.5 V
Coupling Transfer Ratio	SFH628A-2	I_C/I_F	63		200	%	I_F=±1 mA, V_{CE}=0.5 V
	SFH628A-2		32	100			I_F=±0.5 mA, V_{CE}=1.5 V
	SFH628A-3	I_C/I_F	100		320	%	I_F=±1 mA, V_{CE}=0.5 V
	SFH628A-3		50	160			I_F=±0.5 mA, V_{CE}=1.5 V
	SFH628A-4	I_C/I_F	160		500	%	I_F=±1 mA, V_{CE}=0.5 V
	SFH628A-4		80	250			I_F=±0.5 mA, V_{CE}=1.5 V

Switching Times Measurement

Figure 1. Test circuit—SFH618A

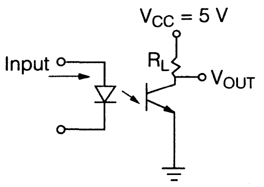


Figure 2. Test circuit—SFH628A

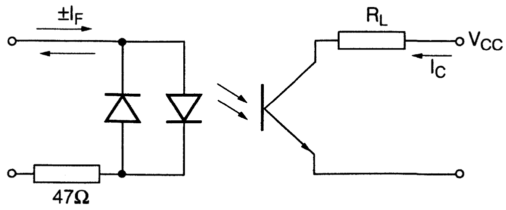


Figure 3. Switching times, typical
V_{CC}=5 V, I_C=2 mA, R_L=100Ω, T_A=25°C

Turn-on Time	t_{ON}	6.0	µs
Rise Time	t_R	3.5	µs
Turn-off Time	t_{OFF}	5.5	µs
Fall Time	t_F	5.0	µs

Figure 4. Test circuit and waveforms

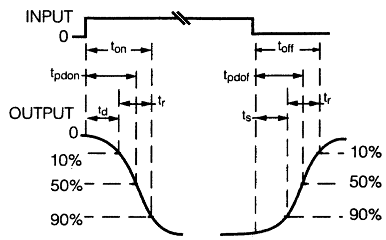


Figure 1. Current transfer ratio (typ.)
V_{CE}=0.5 V, CTR=f(T_A)

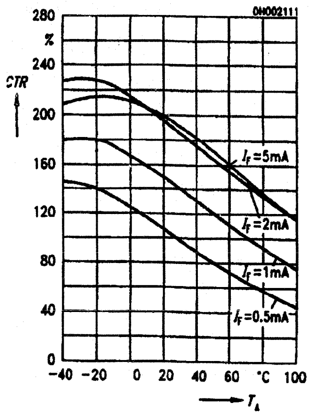


Figure 2. Current transfer ratio (typ.)
V_{CE}=1.5 V, CTR=f(T_A)

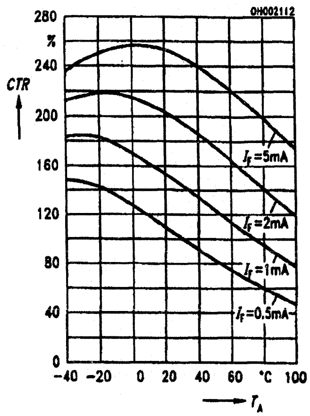


Figure 3. Diode forward voltage
T_A=25°C, V_F=f(I_F)

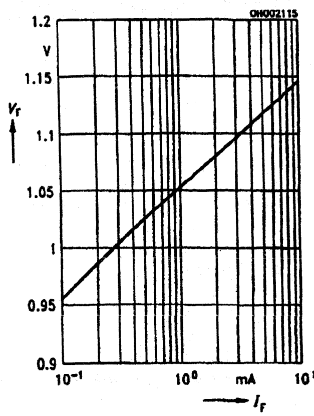


Figure 4. Diode forward voltage
I_F=1 mA, V_F=f(T_A)

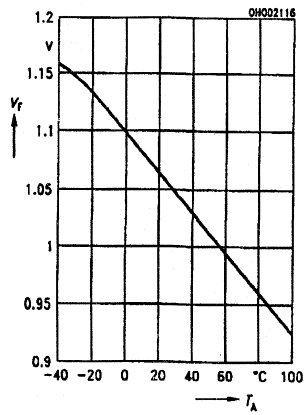


Figure 5. Transistor capacitance
T_A=25°C, f=1 MHz, C_{CE}=f(V_{CE})

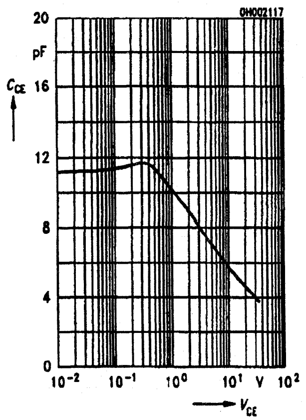


Figure 6. Output characteristics
T_A=25°C, $_{CE}$=f(V_{CE}, I_F)

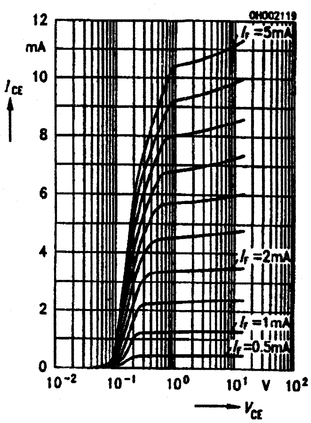


Figure 7. Permissible forward current diode I_F=f(T_A)

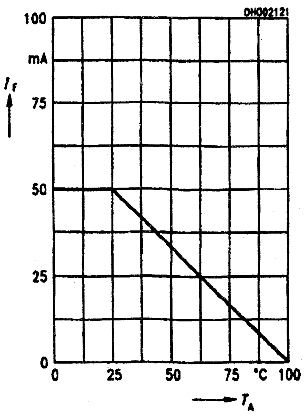


Figure 8. Permissible power dissipation P_{TOT}=f(T_A)

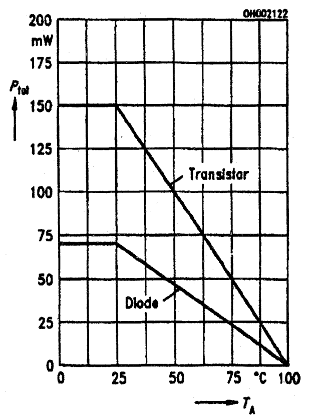
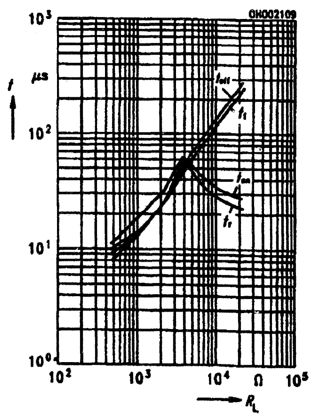


Figure 9. Switching times (typ.)
T_A=25°C, I_F=1 mA, V_{CC}=5 V
t_{on}, t_r, t_{off}, t_f=f(R_L)



SIEMENS

SFH 620

5.3 kV TRIOS® OPTOCOUPLER AC VOLTAGE INPUT

FEATURES

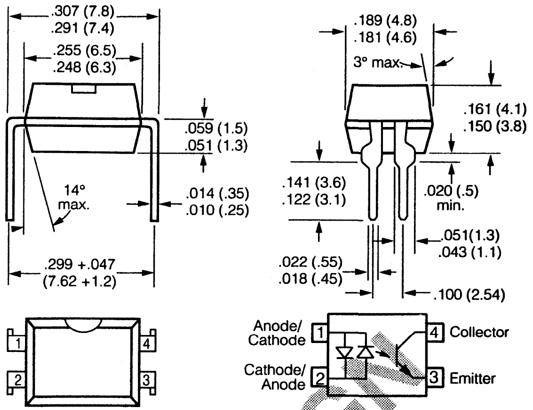
- **High Current Transfer Ratios at 10 mA: 40-320% at 1 mA: 45% typical (>13)**
- **Low CTR Degradation**
- **Good CTR Linearity Depending on Forward Current**
- **Isolation Test Voltage, 5300 VAC_{RMS}**
- **High Collector-Emitter Voltage, V_{CEO}=70 V**
- **Low Saturation Voltage**
- **Fast Switching Times**
- **Field-Effect Stable by TRIOS***
- **Temperature Stable**
- **Low Coupling Capacitance**
- **End-Stackable, 0.100" (2.54 mm) Spacing**
- **High Common-Mode Interference Immunity (Unconnected Base)**
- **VDE #0884 Available with Option 1**

DESCRIPTION

The SFH 620 is a DIP-4 optocoupler which has two bidirectional infrared emitters. This enables the transmission of AC voltage signals while the circuits are electrically isolated.

High isolation test voltage and high current transfer ratios characterize this reflective-mode device.

Package Dimensions in Inches (mm)



Maximum Ratings

Emitter

DC Forward Current .... ±60 mA
Surge Forward Current (t ≤10 µs) .... ±2.5 A
Total Power Dissipation .... 100 mW

Detector

Collector-Emitter Voltage .... 70 V
Emitter-Collector Voltage .... 7 V
Collector Current .... 50 mA
Collector Current (t ≤1 ms) .... 100 mA
Total Power Dissipation .... 150 mW

Package

Isolation Test Voltage between Emitter and Detector referred to Climate DIN 40046, part 2, Nov. 74
(t=1 sec.) .... 7500 VAC_{PK}/5300 VAC_{RMS}
Creepage .... ≥7 mm
Clearance .... ≥7 mm
Isolation Thickness between Emitter and Detector .... ≥0.8 mm
Comparative Tracking Index per DIN IEC 112/VDE 0303, part 1 175
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... $\geq 10^{12}\,\Omega$
V_{IO}=500 V, T_A=100°C .... $\geq 10^{11}\,\Omega$
Storage Temperature Range .... –55°C to +150°C
Ambient Temperature Range .... –55°C to +100°C
Junction Temperature .... 100°C
Soldering Temperature (max. 10 s, dip soldering distance: to seating plane ≥1.5 mm) .... 260°C

Notes:
1. Dip soldering minimum clearance from bottom edge of package, 1.5 mm. Special soldering conditions apply when through-contacted circuit boards are used. Request appropriate specification.

*TRansparent IOn Shield

Characteristics (T_A=25°C)

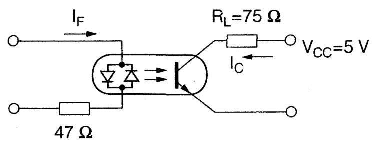
Emitter	Symbol		Units	Condition
Forward Voltage	V_F	±1.25 (≤1.65)	V	I_F=±60 mA
Capacitance	C_O	50	pF	V_R=0 V, f=1 MHz
Thermal Resistance	R_{THJA}	750	K/W	
Detector				
Capacitance	C_{CE}	6.8	pF	V_{CE}=5 V, f=1 MHz
Thermal Resistance	R_{THJA}	500	K/W	
Package				
Collector-Emitter Saturation Voltage	V_{CESAT}	0.25 (≤0.4)	V	I_F=10 mA, I_C=2.5 mA
Coupling Capacitance	C_C	0.2	pF	

Note:
1. Still air, coupler soldered to PCB or base.

Current Transfer Ratio (I_C/I_F at V_{CE}=5 V) and Collector-Emitter Leakage Current by dash number

	–1	–2	–3	
I_C/I_F (I_F=±10 mA)	40–125	63–200	100–320	%
I_C/I_F (I_F=±1 mA)	30 (>13)	45 (>22)	70 (>34)	%
Collector-Emitter Leakage Current (V_{CE}=10 V) (I_{CEO})	2 (≤50)	2 (≤50)	5 (≤100)	nA

SWITCHING TIMES
Linear Operation (without saturation)



I_F=±10 mA, V_{CC}=5 V, T_A=25°C

Load Resistance	R_L	75	Ω
Turn-On Time	t_{ON}	3.0	µs
Rise Time	t_R	2.0	µs
Turn-Off Time	t_{OFF}	2.3	µs
Fall Time	t_f	2.0	µs
Cut-Off Frequency	F_{CO}	250	kHz

SIEMENS

SFH620A

5.3 kV TRIOS® OPTOCOUPLER
AC VOLTAGE INPUT

FEATURES

- **High Current Transfer Ratios**
  at 10 mA: 40–320%
  at 1 mA: 45% typical (>13)
- **Low CTR Degradation**
- **Good CTR Linearity Depending on Forward Current**
- **Isolation Test Voltage, 5300 VAC_{RMS}**
- **High Collector-Emitter Voltage, V_{CEO}=70 V**
- **Low Saturation Voltage**
- **Fast Switching Times**
- **Field-Effect Stable by TRIOS (TRansparent IOn Shield)**
- **Temperature Stable**
- **Low Coupling Capacitance**
- **End-Stackable, .100"(2.54 mm) Spacing**
- **High Common-Mode Interference Immunity (Unconnected Base)**
- **Underwriters Lab File #52744**
- **VDE 0884 Available with Option 1**
- **SMD Option, See SFH6206 Data Sheet**

DESCRIPTION

The SFH620A features a high current transfer ratio, low coupling capacitance and high isolation voltage. These couplers have a GaAs infrared emitting diode emitter, which is optically coupled to a silicon planar phototransistor detector, and is incorporated in a plastic DIP-4 package.

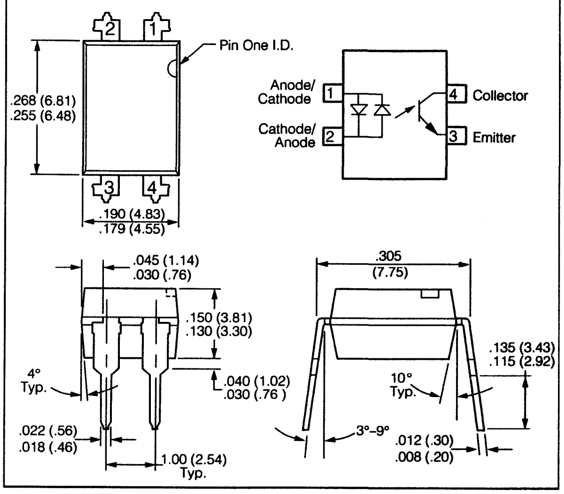
The coupling devices are designed for signal transmission between two electrically separated circuits.

The couplers are end-stackable with 2.54 mm spacing.

Creepage and clearance distances of >8 mm are achieved with option 6. This version complies with IEC 950 (DIN VDE 0805) for reinforced insulation up to an operation voltage of 400 V_{RMS} or DC.

Specifications subject to change.

Package Dimensions in Inches (mm)



Maximum Ratings

Emitter

Reverse Voltage .... 6 V
DC Forward Current .... ±60 mA
Surge Forward Current (t_P≤10 µs) .... ±2.5 A
Total Power Dissipation .... 100 mW

Detector

Collector-Emitter Voltage .... 70 V
Emitter-Collector Voltage .... 7 V
Collector Current .... 50 mA
Collector Current (t_P≤1 ms) .... 100 mA
Total Power Dissipation .... 150 mW

Package

Isolation Test Voltage between Emitter and
Detector, refer to Climate DIN 40046,
part 2, Nov. 74 .... 5300 VAC_{RMS}
Creepage .... ≥7 mm
Clearance .... ≥7 mm
Insulation Thickness between Emitter and Detector ... ≥0.4 mm
Comparative Tracking Index
per DIN IEC 112/VDE0 303, part 1 175
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... ≥10^{12} Ω
V_{IO}=500 V, T_A=100°C .... ≥10^{11} Ω
Storage Temperature Range .... –55 to +150°C
Ambient Temperature Range .... –55 to +100°C
Junction Temperature .... 100°C
Soldering Temperature (max. 10 s. Dip Soldering
Distance to Seating Plane ≥1.5 mm) .... 260°C

Characteristics (T_A=25°C)

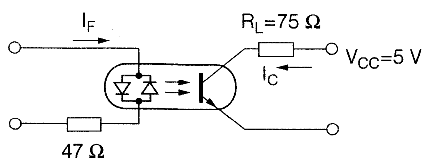
Description	Symbol		Unit	Condition
Emitter				
Forward Voltage	V_F	1.25 (≤1.65)	V	I_F=±60 mA
Capacitance	C_0	50	pF	V_R=0 V, f=1 MHz
Thermal Resistance	R_{thJA}	750	K/W	
Detector				
Capacitance	C_{CE}	6.8	pF	V_{CE}=5 V, f=1 MHz
Thermal Resistance	R_{thJA}	500	K/W	
Package				
Collector-Emitter Saturation Voltage	V_{CESAT}	0.25 (≤0.4)	V	I_F=10 mA, I_C=2.5 mA
Coupling Capacitance	C_C	0.2	pF	

Note: 1. Still air, coupler soldered to PCB or base.

Current Transfer Ration (I_C/I_F at V_{CE}=5 V) **and Collector-Emitter Leakage Current by Dash Number**

Description	-1	-2	-3	
I_C/I_F (I_F=±10 mA)	40–125	63–200	100–320	%
I_C/I_F (I_F=±1 mA)	30 (>13)	45 (>22)	70 (>34)	%
Collector-Emitter Leakage Current, I_{CEO} V_{CE}=10 V	2 (≤50)	2 (≤50)	5 (≤100)	nA

Switching Times
Linear Operation (without saturation)



I_F=10 mA, V_{CC}=5 V, T_A=25°C

Load Resistance	R_L	75	Ω
Turn-on Time	t_{ON}	3.0	µs
Rise Time	t_R	2.0	µs
Turn-off Time	t_{OFF}	2.3	µs
Fall Time	t_F	2.0	µs
Cut-off Frequency	F_{CO}	250	kHz

Figure 1. Current transfer ratio (typ.) vs. temperature
I_F=10 mA, V_{CE}=0.5 V

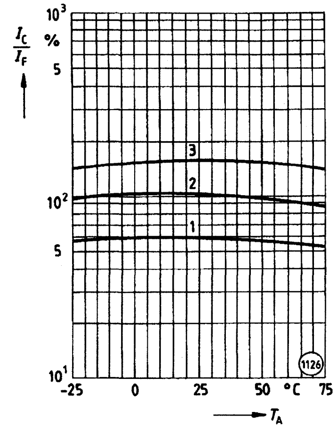


Figure 2. Output characteristics (typ.) Collector current vs. collector-emitter voltage T_A=25°C

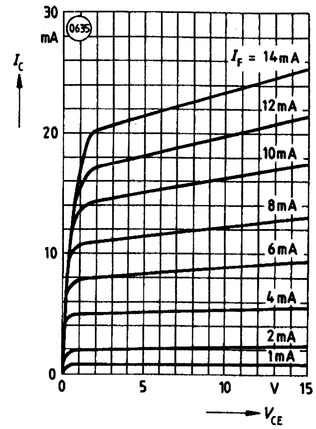


Figure 3. Diode forward voltage (typ.) vs. forward current

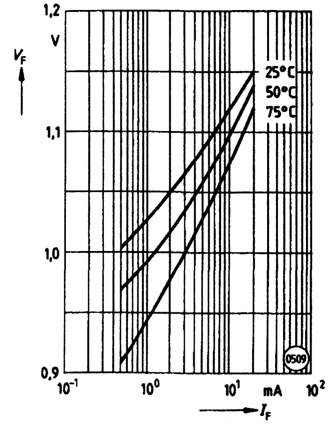


Figure 4. Transistor capacitance (typ.) vs. collector-emitter voltage
T_A=25°C, f=1 MHz

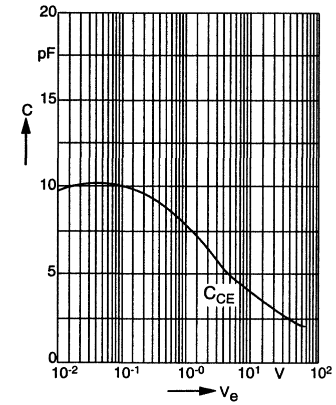


Figure 5. Permissiable pulse handling capability. Fwd. current vs. pulse width Pulse cycle D=parameter, T_A=25°C

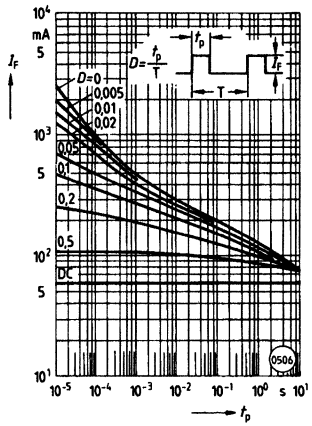


Figure 6. Permissible power dissipation vs. ambient temp.

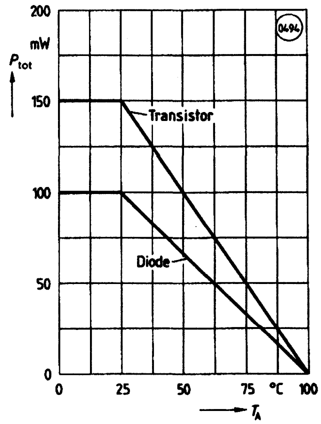
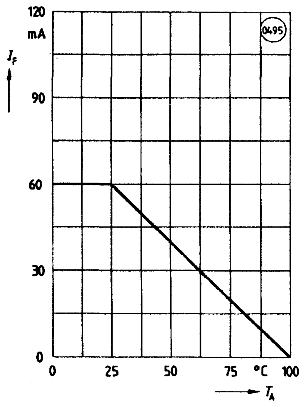


Figure 7. Permissible diode forward current vs. ambient temp.



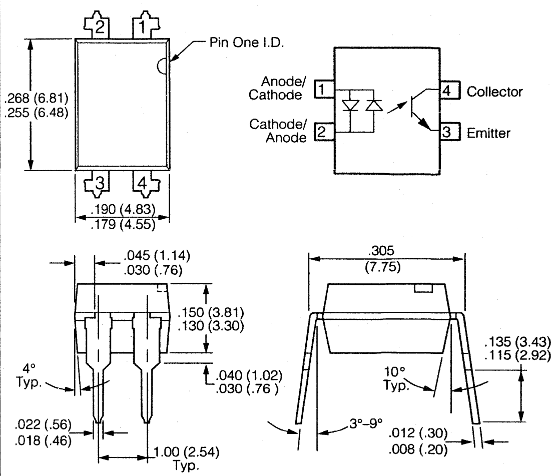
SIEMENS

NEW

SFH620AA/AGB

5.3 kV TRIOS® OPTOCOUPLER AC VOLTAGE INPUT

Package Dimensions in Inches (mm)



5
Optocouplers (Optoisolators)

FEATURES

- **High Current Transfer Ratios at 5 mA: 50–600% at 1 mA: 45% typical (>13)**
- **Low CTR Degradation**
- **Good CTR Linearity Depending on Forward Current**
- **Isolation Test Voltage, 5300 VAC_{RMS}**
- **High Collector-Emitter Voltage, V_{CEO}=70 V**
- **Low Saturation Voltage**
- **Fast Switching Times**
- **Field-Effect Stable by TRIOS (TRansparent IOn Shield)**
- **Temperature Stable**
- **Low Coupling Capacitance**
- **End-Stackable, .100"(2.54 mm) Spacing**
- **High Common-Mode Interference Immunity (Unconnected Base)**
- **Underwriters Lab File #52744**
- **VDE 0884 Available with Option 1**
- **SMD Option, See SFH6206 Data Sheet**

DESCRIPTION

The SFH620AA/AGB features a high current transfer ratio, low coupling capacitance and high isolation voltage. These couplers have a GaAs infrared emitting diode emitter, which is optically coupled to a silicon planar phototransistor detector, and is incorporated in a plastic DIP-4 package.

The coupling devices are designed for signal transmission between two electrically separated circuits.

The couplers are end-stackable with 2.54 mm spacing.

Creepage and clearance distances of >8 mm are achieved with option 6. This version complies with IEC 950 (DIN VDE 0805) for reinforced insulation up to an operation voltage of 400 V_{RMS} or DC.

Specifications subject to change.

Maximum Ratings

Emitter

Reverse Voltage .... ±60 mA
Surge Forward Current (t_P≤10 µs) .... ±2.5 A
Total Power Dissipation .... 100 mW

Detector

Collector-Emitter Voltage .... 70 V
Emitter-Collector Voltage .... 7 V
Collector Current .... 50 mA
Collector Current (t_P≤1 ms) .... 100 mA
Total Power Dissipation .... 150 mW

Package

Isolation Test Voltage between Emitter and Detector, refer to Climate DIN 40046, part 2, Nov. 74 .... 5300 VAC_{RMS}
Creepage.. ≥7 mm
Clearance .... ≥7 mm
Insulation Thickness between Emitter and Detector ..... 0.4 mm
Comparative Tracking Index per DIN IEC 112/VDE0 303, part 1 175
Isolation Resistance
V_{IO}=500 V, T_A=25°C.. $\geq 10^{12}\ \Omega$
V_{IO}=500 V, T_A=100°C... $\geq 10^{11}\ \Omega$
Storage Temperature Range .... –55 to +150°C
Ambient Temperature Range............................. –55 to +100°C
Junction Temperature .... 100°C
Soldering Temperature (max. 10 s. Dip Soldering Distance to Seating Plane ≥1.5 mm) .... 260°C

Characteristics (T_A=25°C)

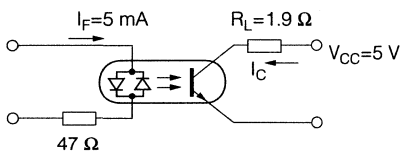
Description	Symbol		Unit	Condition
Emitter				
Forward Voltage	V_F	1.25 (≤1.65)	V	I_F=±60 mA
Capacitance	C_0	50	pF	V_R=0 V, f=1 MHz
Thermal Resistance	R_{thJA}	750	K/W	
Detector				
Capacitance	C_{CE}	6.8	pF	V_{CE}=5 V, f=1 MHz
Thermal Resistance	R_{thJA}	500	K/W	
Package				
Collector-Emitter Saturation Voltage	V_{CESAT}	0.25 (≤0.4)	V	I_F=10 mA, I_C=2.5 mA
Coupling Capacitance	C_C	0.2	pF	

Note: 1. Still air, coupler soldered to PCB or base.

Current Transfer Ratio (I_C/I_F at V_{CE}=5 V) **and Collector-Emitter Leakage Current**

Description	AA	AGB	Unit
I_C/ I_F (I_F=±5 mA)	50–600	100–600	%
Collector-Emitter Leakage Current, I_{CEO} V_{CE}=10 V	10 (≤100)	10 (≤100)	nA

Switching Times (Typical Values)
Linear Operation (saturated)



Turn-on Time	t_{ON}	2.0	µs
Turn-off Time	t_{OFF}	25	µs

Figure 1. Current transfer ratio (typ.) vs. temperature
I_F=10 mA, V_{CE}=0.5 V

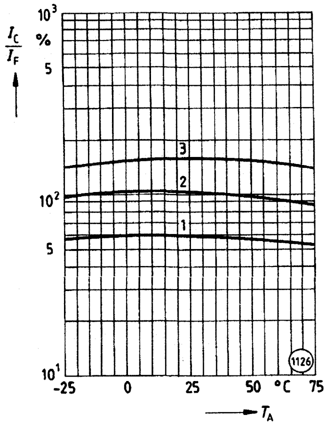


Figure 2. Output characteristics (typ.) Collector current vs. collector-emitter voltage T_A=25°C

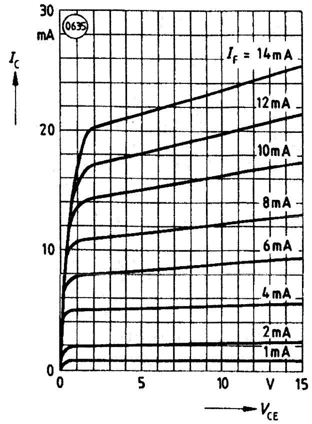


Figure 3. Diode forward voltage (typ.) vs. forward current

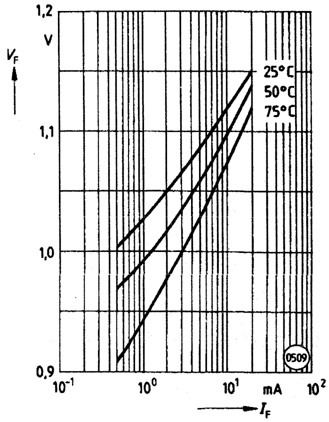


Figure 4. Transistor capacitance (typ.) vs. collector-emitter voltage
T_A=25°C, f=1 MHz

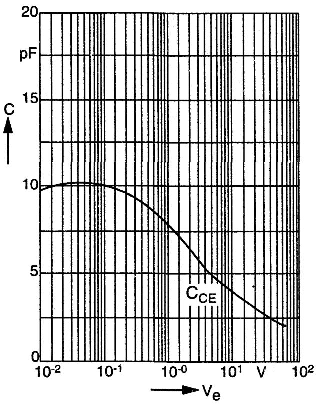


Figure 5. Permissiable pulse handling capability. Fwd. current vs. pulse width Pulse cycle D=parameter, T_A=25°C

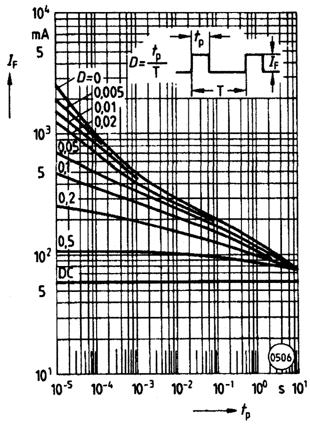


Figure 6. Permissible power dissipation vs. ambient temp.

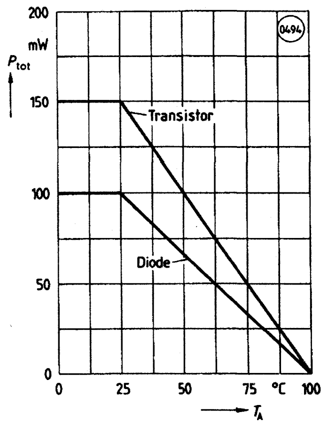
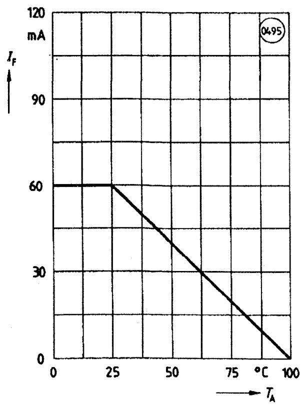


Figure 7. Permissible diode forward current vs. ambient temp.



SIEMENS

SFH 628

PHOTOTRANSISTOR, 5.3 KV, TRIOS®* LOW CURRENT, AC INPUT OPTOCOUPLER

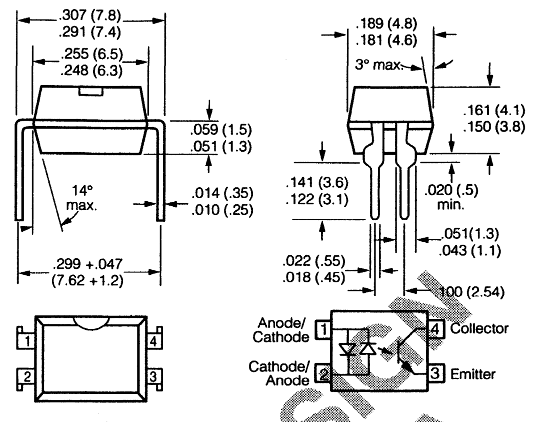
FEATURES

- **Very High CTR at I_F=1 mA**
  SFH628-2, 63-200%
  SFH628-3, 100-320%
  SFH628-4, 160-500%
- **Specified Minimum CTR at I_F=0.5 mA, V_{CE}=1.5 V: ≥50% (typ. 160%)**
- **Good CTR Linearity with Forward Current**
- **Low CTR Degradation**
- **High Collector-Emitter Voltage V_{CEO}=55 V**
- **Isolation Test Voltage: 5300 V**
- **AC-Input with Two Bidirectional GaAs-IR-Emitters**
- **Low Coupling Capacitance**
- **High Common Mode Transient Immunity**
- **Phototransistor Optocoupler in 4 Pin DIP Package**
- **End-stackable, 0.100" (2.54 mm) Spacing**
- **Applications**
  - **Telecom**
  - **Industrial Controls**
  - **Line Monitoring**
- **VDE #0884 Available with Option 1**

DESCRIPTION

The SFH 628 is an optical coupler with two GaAs infrared LEDs and a silicon NPN phototransistor. Signal information, including a DC level, can be transmitted by the device while maintaining a high degree of electrical isolation between input and output.

Package Dimensions in Inches (mm)



Maximum Ratings (T_A=25°C)

Emitter

DC Forward Current .... ±50 mA
Surge Forward Current (tp ≤10 µs) .... 2.5 A
Total Power Dissipation at 25°C .... 70 mW

Detector

Collector-Emitter Voltage .... 55 V
Emitter-Collector Voltage .... 7 V
Collector Current .... 50 mA
Surge Collector Current, I_{CSM} (tp ≤10 ms) .... 100 mA
Total Power Dissipation at 25°C .... 150 mW

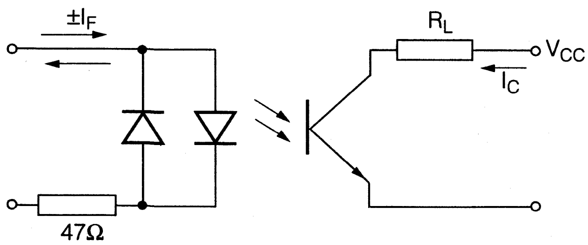
Package

Isolation Test Voltage (between emitter and detector referred to climate DIN 40046 part 2 Nov. 74) (t=1 sec.) .... 7500 VAC_{PK}/5300 VAC_{RMS}
Isolation Resistance
V_{IO}=500 V, T_A=25°C .... ≥10^{12} Ω
V_{IO}=500 V, T_A=100°C .... ≥10^{11} Ω
Creepage .... 7 mm
Clearance .... 7 mm
Comparative Tracking Index per DIN IEC 112/VDE 0303, part 1 175
Storage Temperature Range .... –55°C to +150°C
Operating Temperature Range .... –55°C to +100°C
Junction Temperature .... 100°C
Soldering Temperature (max. 10 sec., dip soldering: distance to seating plane >1.5 mm) .... 260°C

***TR**ansparent **IO**n **S**hield

Characteristics (T_A=25°C, if not otherwise specified)

	Symbol	Typ.	Unit	Condition
Emitter				
Forward Voltage	V_F	±1.1 (≤ 1.5)	V	I_F=±5 mA
Capacitance	C_O	45	pF	V_R=0 V, f=1 MHz
Thermal Resistance	R_{thJA}	1070	K/W	
Detector				
Collector-Emitter Voltage	V_{CEO}	≥ 55	V	I_{CE}=10 µA
Emitter-Collector Voltage	V_{ECO}	≥ 7	V	I_{EC}=10 µA
Capacitance	C_{CE}	7	pF	V_{CE}=5 V, f=1 MHz
Thermal Resistance	R_{thJA}	500	K/W	
Package				
Coupling-Capacitance	C_C	0.25	pF	
Coupling Transfer Ratio				
SFH 628–2	I_C/I_F	63–200	%	I_F= ±1 mA, V_{CE}=0.5 V
		100 (≥ 32)	%	I_F= ±0.5 mA, V_{CE}=1.5 V
SFH 628–3	I_C/I_F	100–320	%	I_F= ±1 mA, V_{CE}=0.5 V
		160 (≥ 50)	%	I_F= ±0.5 mA, V_{CE} =1.5 V
SFH 628–4	I_C/I_F	160–500	%	I_F= ±1 mA, V_{CE}=0.5 V
		250 (≥ 80)	%	I_F= ±0.5 mA, V_{CE}=1.5 V
Collector-Emitter Saturation Voltage				
SFH 628–2	V_{CEsat}	0.25 (≤ 0.4)	V	I_C=0.5 mA, I_F=±1 mA
SFH 628–3	V_{CEsat}	0.25 (≤ 0.4)	V	I_C=0.8 mA, I_F=±1 mA
SFH 628–4	V_{CEsat}	0.25 (≤ 0.4)	V	I_C=1.25 mA, I_F=±1 mA



Switching Times, Typical

V_{CC}=5 V, I_C=2 mA, R_L=100 Ω, T_A=25°C

Turn-On Time	t_{ON}	6.0	µs
Rise Time	t_R	3.5	µs
Turn-Off Time	t_{OFF}	5.5	µs
Fall Time	t_F	5.0	µs

SIEMENS

SFH636

HIGH SPEED 5.3 kV OPTOCOUPLER

Preliminary Data Sheet

FEATURES

- **High Speed Optocoupler without Base Connection**
- **GaAlAs Emitter**
- **Integrated Detector with Photodiode and Transistor**
- **High Data Transmission Rate: 1 MBit/s**
- **TTL Compatible**
- **Open Collector Output**
- **CTR at I_F=16 mA, V_O=0.4 V, V_{CC}=4.5 V, T_A=25°C: ≥19%**
- **Good CTR Linearity Relative to Forward Current**
- **Field Effect Stable by TRIOS®** **(TRansparent IOn Shield)**
- **Low Coupling Capacitance**
- **dV/dt: typ. 10 kV/μs**
- **Isolation Test Voltage: 5300 VAC_{RMS}**
- **VDE 0884 Available with Option 1**
- **UL Approval, File #E52744**

APPLICATIONS

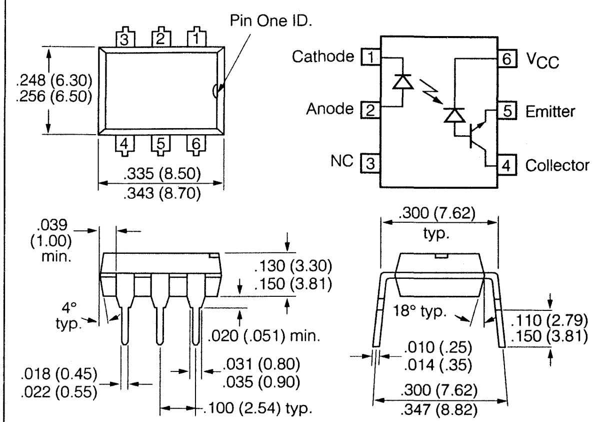
- **IGBT Drivers**
- **Data Communications**
- **Programmable Controllers**

DESCRIPTION

The SFH636 is an optocoupler with a GaAlAs infrared emitting diode, optically coupled to an integrated photodetector consisting of a photodiode and a high speed transistor in a DIP-6 plastic package. The device is functionally similar to 6N136 except there is no base connection, and the electrical foot print is different. Noise and dv/dt performance is enhanced by not bringing out the base connection.

Signals can be transmitted between two electrically separated circuits up to frequencies of 2 MHz. The potential difference between the circuits to be coupled should not exceed the maximum permissible reference voltages.

Package Dimensions in Inches (mm)



Absolute Maximum Ratings

Emitter (GaAlAs)

Reverse Voltage .... 3 V
DC Forward Current .... 25 mA
Surge Forward Current .... 1 A
  tp≤1 μs, 300 pulses/sec.
Total Power Dissipation .... 45 mW

Detector (Si Photodiode + Transistor)

Supply Voltage .... –0.5 to 30 V
Output Voltage .... –0.5 to 20 V
Output Current .... 8 mA
Total Power Dissipation .... 100 mW

Package Insulation

Isolation Test Voltage
  between emitter and detector
  (refer to climate DIN 40046, part 2, Nov. 74) .... 5300 VAC_{RMS}
Creepage .... 7 mm min.
Clearance .... 7 mm min.
Comparative Tracking Index
  per DIN IEC 112/VDE0303, part 1 175
Isolation Resistance
  V_{IO}=500 V, T_A=25°C .... $\geq 10^{12}\ \Omega$
  V_{IO}=500 V, T_A=100°C .... $\geq 10^{11}\ \Omega$
Storage Temperature Range .... –55 to +150°C
Ambient Temperature Range .... –55 to +100°C
Junction Temperature .... 100°C
Soldering Temperature (t=10 sec. max.) .... 260°C
  Dip soldering: distance to seating plane ≥1.5 mm

Characteristics (T_A=0° to 70°C, unless otherwise specified,typical values T_A=25°C)

Description	Symbol	Min.	Typ.	Max.	Unit
Emitter (IR GaAlAs)					
Forward Voltage, I_F=16 mA	V_F		1.5	1.8	V
Reverse Current, V_R=3 V	I_R		0.5	10	µA
Capacitance, V_R=0 V, f=1 MHz	C_O		125		pF
Thermal Resistance	R_{thJA}		700		°K/W
Detector (Si Photodiode + Transistor)					
Supply Current, Logic High I_F=0, V_O (open), V_{CC}=15 V, T_A=25°C I_F=0, V_O (open), V_{CC}=15 V	I_{CCH}		 0.01	 1 2	µA
Output Current, Output High I_F=0, V_O (open), V_{CC}=5.5 V, T_A=25°C I_F=0, V_O (open), V_{CC}=15 V, T_A=25°C I_F=0, V_O (open), V_{CC}=15 V	I_{OH}		 .003 .01 —	 0.5 1 50	µA
Capacitance, V_{CE}=5 V, f=1 MHz	C_{CE}		3		pF
Thermal Resistance	R_{thJA}		300		°K/W
Package					
Coupling Capacitance	C_C		0.6		pF
Coupling Transfer Ratio I_F=16 mA, V_O=0.4 V, V_{CC}=4.5 V, T_A=25°C I_F=16 mA, V_O=0.5 V, V_{CC}=4.5 V	I_C/I_F	 19 15	 30 —		%
Collector Emitter Saturation Voltage I_F=16 mA, I_O=2.4 mA, V_{CC}=4.5 V, T_A=25°C	V_{OL}		0.1	0.4	V
Supply Current, Logic Low I_F=16 mA, V_O open, V_{CC}=15 V	I_{CCL}		80		µA

Figure 1. Test set-up

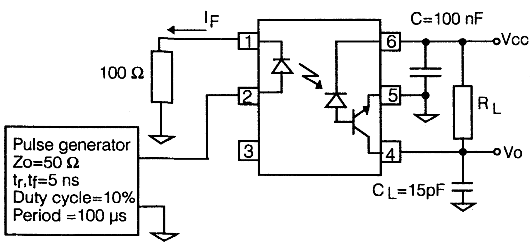
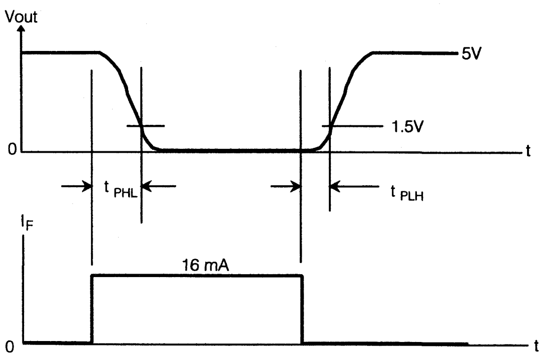


Figure 2. Switching time measurement



Description	Symbol	Min.	Typ.	Max.	Unit
Propagation Delay Time (High–Low) I_F=16 mA, V_{CC}=5 V, R_L=1.9 kΩ, T_A=25°C	t_{PHL}		0.3	0.8	µs
Propagation Delay Time (Low–High) I_F=16 mA, V_{CC}=5 V, R_L=1.9 kΩ, T_A=25°C	t_{PLH}		0.3	0.8	µs

Figure 3. Common mode transient test

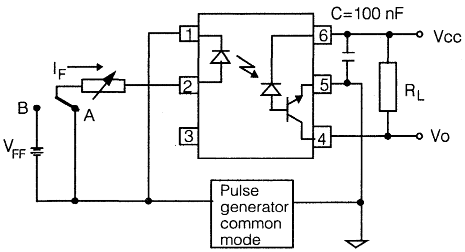
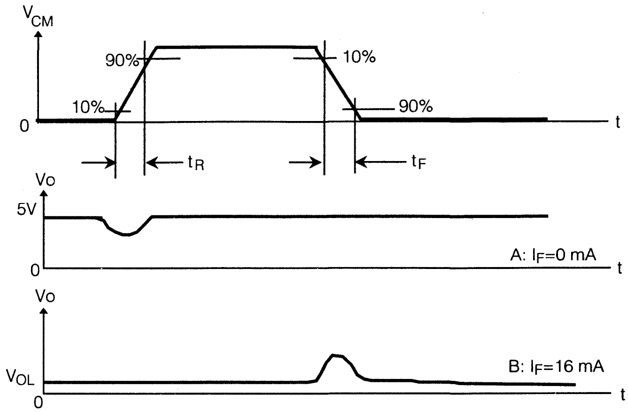


Figure 4. Measurement waveform of CMR



Description	Symbol	Min.	Typ.	Max.	Unit
Common Mode Transient Immunity (High) I_F=0, V_{CM}=1500 V_{P-P}, R_L=1.9 kΩ, V_{CC}=5 V, T_A=25°C	CM_H		10		kV/µs
Common Mode Transient Immunity (Low) I_F=16 mA, V_{CM}=1500 V_{P-P}, R_L=1.9 kΩ, V_{CC}=5 V, T_A=25°C	CM_L		10		kV/µs

SIEMENS

SFH 640

PHOTOTRANSISTOR 5.3 KV TRIOS® HIGH BV_{CER} VOLTAGE OPTOCOUPLER

FEATURES

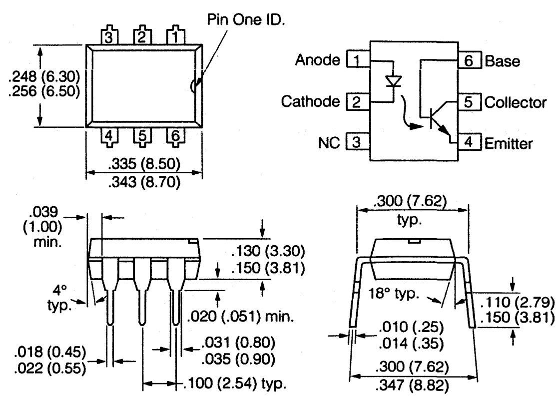
- **CTR at I_F=10 mA, V_{CE}=10 V**
  SFH640-1, 40-80%
  SFH640-2, 63-125%
  SFH640-3*, 100-200%
- **Good CTR Linearity with Forward Current**
- **Low CTR Degradation**
- **Very High Collector-Emitter Breakdown Voltage, BV_{CER}=300 V**
- **Isolation Test Voltage: 5300 VAC_{RMS}**
- **Low Coupling Capacitance**
- **High Common Mode Transient Immunity**
- **Phototransistor Optocoupler**
  6 Pin DIP Package with Base Connection
- **Field Effect Stable: TRIOS⁺**
- **VDE 0884 Available with Option 1**
- **Underwriters Lab File #E52744**

DESCRIPTION

The SFH 640 is an optocoupler with very high BV_{CER}, a minimum of 300 volts. It is intended for telecommunications applications or any DC application requiring a high blocking voltage. The SFH640 is a "better than" replacement for H11D1.

*Supplies from this group can't always be guranteed due to unforseeable yield spread.
⁺**TRIOS–TR**ansparent **IO**n **S**hield

Package Dimensions in Inches (mm)



Maximum Ratings (T_A=25°C)

Emitter

Reverse Voltage	6 V
DC Forward Current	60 mA
Surge Forward Current (tp≤10 µs)	2.5 A
Total Power Dissipation	100 mW

Detector

Collector-Emitter Voltage	300 V
Collector-Base Voltage	300 V
Emitter-Base Voltage	7 V
Collector Current	100 mA
Total Power Dissipation	300 mW

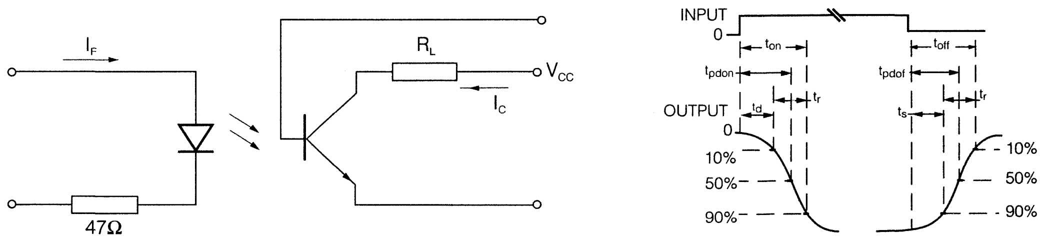
Package

Isolation Test Voltage (between emitter and detector referred to climate DIN 40046 part 2 Nov. 74)	5300 VAC_{RMS}/7500 VAC_{PK}
Isolation Resistance	
V_{IO}=500 V, T_A=25°C	≥10^{12} Ω
V_{IO}=500 V, T_A=100°C	≥10^{11} Ω
Insulation Thickness between Emitter and Detector	≥0.4 mm
Creepage	≥7 mm
Clearance	≥7 mm
Comparative Tracking Index, per DIN IEC 112/VDE 0303, part1	175
Storage Temperature Range	–55°C to +150°C
Operating Temperature Range	–55°C to +100°C
Junction Temperature	100°C
Soldering Temperature (max. 10 sec., dip soldering: distance to seating plane ≥ 1.5 mm)	260°C

Characteristics (T_A=25°C, unless otherwise specified)

	Symbol	Min.	Typ.	Max.	Unit	Condition
Emitter						
Forward Voltage	V_F		1.1	1.5	V	I_F=10 mA
Reverse Voltage	V_R	6			V	I_R= 10 µA
Reverse Current	I_R		0.01	10	µA	V_R=6 V
Capacitance	C_O		25		pF	V_R=0 V, f=1 MHz
Thermal Resistance	R_{thJA}		750		K/W	
Detector						
Voltage						
Collector-Emitter	BV_{CER}	300			V	I_{CE}=1 mA, R_{BE}=1 MΩ
Emitter-Base	BV_{EBO}	7			V	I_{EB}=10 µA
Capacitance	C_{CE}		7		pF	V_{CE}=10 V, f=1 MHz
	C_{CB}		8		pF	V_{CB}=10 V, f=1 MHz
	C_{EB}		38		pF	V_{EB}=5 V, f=1 MHz
Thermal Resistance	R_{thJA}		250		K/W	
Package						
Coupling Capacitance	C_C		0.6		pF	
Coupling Transfer Ratio						
SFH640-1	I_C/I_F	40		80	%	I_F=10 mA, V_{CE}=10 V
		13	30			I_F=1 mA, V_{CE}=10 V
SFH640-2	I_C/I_F	63		125	%	I_F=10 mA, V_{CE}=10 V
		22	45			I_F=1 mA, V_{CE}=10 V
SFH640-3	I_C/I_F	100		200	%	I_F=10 mA, V_{CE}=10 V
		34	70			I_F=1 mA, V_{CE}=10 V
Saturation Voltage						
Collector-Emitter						
SFH640-1	V_{CEsat}		0.25	0.4	V	I_F=10 mA, I_C=2 mA
SFH640-2	V_{CEsat}		0.25	0.4	V	I_F=10 mA, I_C=3.2 mA
SFH640-3	V_{CEsat}		0.25	0.4	V	I_F=10 mA, I_C=5 mA
Leakage Current						
Collector-Emitter	I_{CER}		1	100	nA	V_{CE}=200 V, R_{BE}=1 MΩ

Switching Times Measurement –Test Circuit and Waveform



Switching Times (Typical)

I_C=2 mA (to adjust by I_F), R_L=100 Ω, T_A=25°C, V_{CC}=10 V

Description	Symbol	Values	Unit
Turn-On Time	t_{ON}	5	µs
Rise Time	t_R	2.5	µs
Turn-Off Time	t_{OFF}	6	µs
Fall Time	t_F	5.5	µs

Figure 1. Current transfer ratio (typ.) V_{CE}=10 V, T_A=25°C, normalized to I_F=10 mA NCTR=f(I_F)

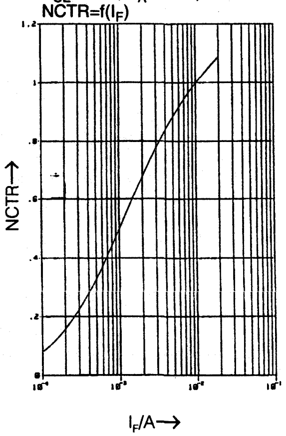


Figure 2. Diode forward voltage (typ.) V_F=f(I_F,T_A)

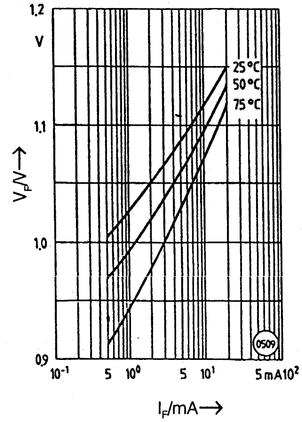


Figure 3. Output characteristics (typ.) T_A=25°C, I_{CE}=f(V_{CE}, I_B)

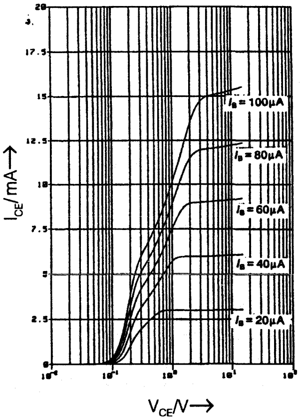


Figure 4. Output characteristics (typ.) T_A=25°C, I_{CE}=f(V_{CE}, I_F)

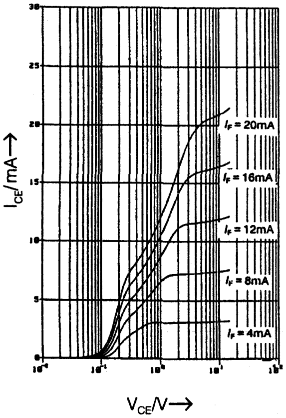


Figure 5. Transistor capacitances (typ.) T_A=25°C, f=1 MHz, C_{CE}=f(V_{CE}) C_{CB}=f (V_{CB}), C_{EB}=f (V_{EB})

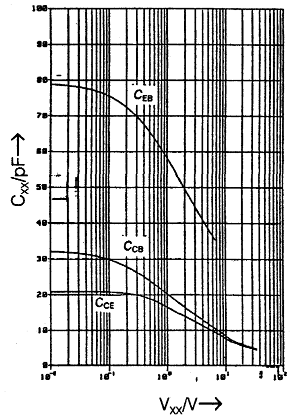


Figure 6. Collector-emitter leakage current (typ.) I_F=0, R_{BE}=1 MW, I_{CER}=f(V_{CE})

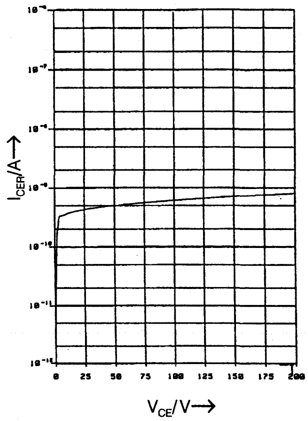


Figure 7. Permissible loss diode I_F= f(T_A)

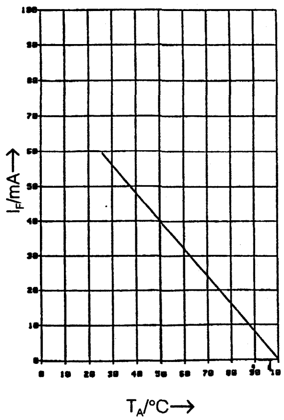
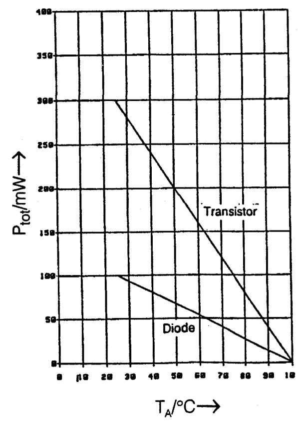


Figure 7. Permissible power dissipation P_{IOT}=f(T_A)



SIEMENS

SFH6106
SFH6116
SFH6156
SFH6186
SFH6206
SFH6286

5.3 kV TRIOS® HIGH RELIABILITY OPTOCOUPLERS

FEATURES

- **SMD Versions of SFH610, 611, 615, 618, 620, 628**
- **Available on Tape and Reel– To Order Use Suffix "T"**
- **TRIOS — Transparent IOn Shield**

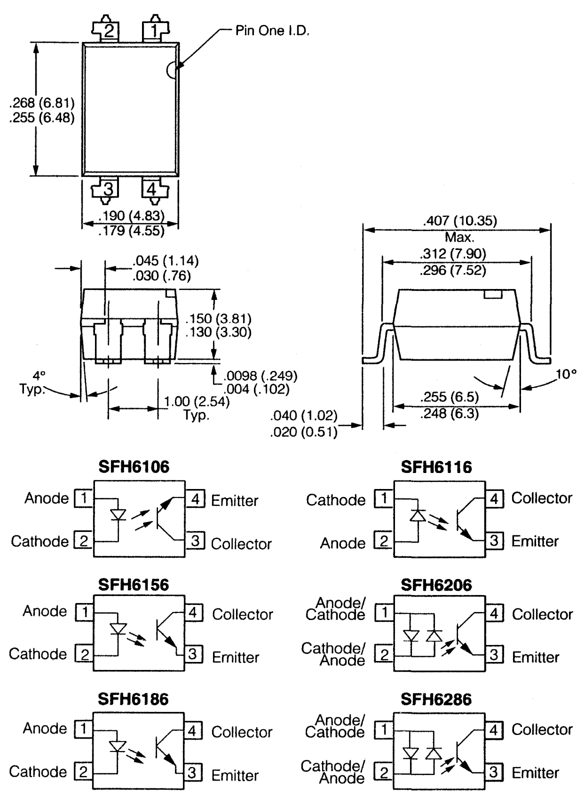
DESCRIPTION

The SFH6106, 6116, 6156, 6186, 6206, 6286 families of optocouplers are lead bent for SMD applications. They are electrically equivalent to the SFH610, 611, 615, 618, 620, and 628 families of optocouplers.

CROSS REFERENCE

SMD	Thru-hole	
	New Designs	Not for New Design
SFH6106-1 SFH6106-2 SFH6106-3 SFH6106-4	SFH610A-1 SFH610A-2 SFH610A-3 SFH610A-4	SFH610-1 SFH610-2 SFH610-3 SFH610-4
SFH6116-1 SFH6116-2 SFH6116-3 SFH6116-4	SFH611A-1 SFH611A-2 SFH611A-3 SFH611A-4	SFH611-1 SFH611-2 SFH611-3 SFH611-4
SFH6156-1 SFH6156-2 SFH6156-3 SFH6156-4	SFH615A-1 SFH615A-2 SFH615A-3 SFH615A-4	SFH615-1 SFH615-2 SFH615-3 SFH615-4
SFH6186-2 SFH6186-3 SFH6186-4 SFH6186-5	SFH618A-2 SFH618A-3 SFH618A-4 SFH618A-5	SFH618-2 SFH618-3 SFH618-4 SFH618-5
SFH6206-1 SFH6206-2 SFH6206-3	SFH620A-1 SFH620A-2 SFH620A-3	SFH620-1 SFH620-2 SFH620-3
SFH6286-2 SFH6286-3 SFH6286-4	SFH628A-2 SFH628A-3 SFH628A-4	SFH628-2 SFH628-3 SFH628-4

Package Dimensions in Inches (mm)



SIEMENS

SFH6135
SFH6136

HIGH-SPEED 5.3 kV TRIOS®
OPTOCOUPLER

FEATURES

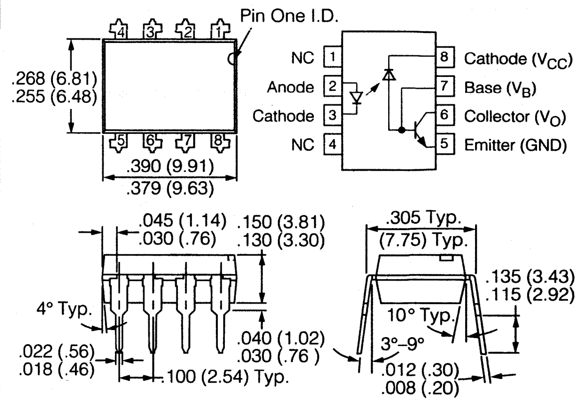
- **Isolation Test Voltage: 5300 VAC_{RMS}**
- **TTL Compatible**
- **High Bit Rates: 1 Mbit/s**
- **High Common-Mode Interference Immunity**
- **Bandwidth 2 MHz**
- **Open-Collector Output**
- **External Base Wiring Possible**
- **Field-Effect Stable by TRIOS (TRansparent IOn Shield)**
- **Underwriters Lab File #52744**
- **VDE 0884 Available with Option 1**

DESCRIPTION

The SFH6135 and SFH6136 optocouplers feature a high signal transmission rate and a high isolation resistance. They have a GaAlAs infrared emitting diode, optically coupled with an integrated photodetector which consists of a photodiode and a high-speed transistor in a DIP-8 plastic package.

Signals can be transmitted between two electrically separated circuits up to frequencies of 2 MHz. The potential difference between the circuits to be coupled is not allowed to exceed the maximum permissible reference voltages.

Package Dimensions in Inches (mm)



Maximum Ratings

Emitter

Reverse Voltage .... 3 V
Forward Current .... 25 mA
Peak Forward Current (t = 1 ms, duty cycle 50%) .... 50 mA
Maximum Surge Forward Current (t ≤ 1 µs, 300 pulses/s) .... 1 A
Thermal Resistance .... 700 K/W
Total Power Dissipation (T_A ≤ 70°C) .... 45 mW

Detector

Supply Voltage .... -0.5 to 15 V
Output Voltage .... -0.5 to 15 V
Emitter-Base Voltage .... 5 V
Output Current .... 8 mA
Maximum Output Current .... 16 mA
Base Current .... 5 mA
Thermal Resistance .... 300 K/W
Total Power Dissipation (T_A ≤ 70°C) .... 100 mW

Package

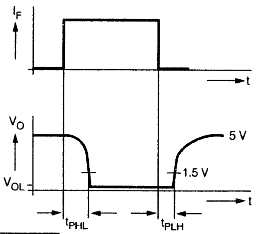
Isolation Test Voltage .... 5300 VAC_{RMS}
Pollution Degree (DIN VDE 0110) 2
Creepage .... ≥7 mm
Clearance .... ≥7 mm
Comparative Tracking Index per DIN IEC112/VDE 0303 part 1 175
Isolation Resistance
V_{IO}=500 V, T_A = 25°C .... ≥10^{12} Ω
V_{IO}=500 V, T_A = 100°C .... ≥10^{11} Ω
Storage Temperature Range .... –55°C to +125°C
Ambient Temperature Range .... –55°C to +100°C
Soldering Temperature (max. ≤10 s. dip soldering ≥0.5 mm distance from case bottom) .... 260°C

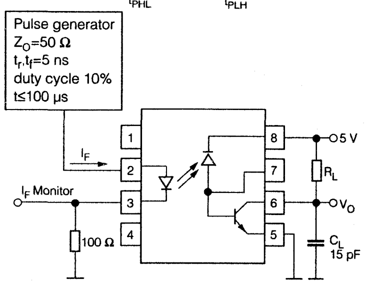
Characteristics

(T$_A$=0 to 70°C unless otherwise specified)

Emitter	Symbol		Unit	Condition
Forward Voltage	V_F	1.6 (≤1.9)	V	I_F=16 mA
Breakdown Voltage	V_{BR}	≥3	V	I_R=10 µA
Reverse Current	I_R	0.5 (≤10)	µA	V_R=3 V
Capacitance	C_0	125	pF	V_R=0 V, f=1 MHz
Temperature Coefficient of Forward Voltage	$\Delta V_F/\Delta T_A$	-1.7	mV/°C	I_F=16 mA
Detector				
Supply Current Logic Low	I_{CCL}	150	µA	I_F=16 mA, V_O open, V_{CC}=15 V
Supply Current Logic High	I_{CCH}	0.01 (≤1)	µA	I_F=0 mA, V_O open, V_{CC}=15 V
Output Voltage Output Low				I_F=16 mA, V_{CC}=4.5 V
SFH6135	V_{OL}	0.1 (≤0.4)	V	I_O=1.1 mA
SFH6136	V_{OL}	0.1 (≤0.4)	V	I_O=2.4 mA
Output Current Output High	I_{OH}	3 (≤500)	nA	I_F=0 mA, V_O=V_{CC}=5.5 V
Output Current Output High	I_{OH}	0.01 (≤1)	µA	I_F=0 mA V_O=V_{CC}=15 V
Current Gain	H_{FE}	150		V_O=5 V, I_O=3 mA
Package				
Coupling Capacitance Input–Output	C_{IO}	0.6	pF	f=1 MHz
Current Transfer Ratio				I_F=16 mA, V_O=0.4 V, V_{CC}=4.5 V, T_A=25°C
SFH6135	CTR	16 (≥7)	%	
SFH6136	CTR	35 (≥19)	%	
Current Transfer Ratio				I_F=16 mA, V_O=0.5 V, V_{CC}=4.5 V
SFH6135	CTR	≥5	%	
SFH6136	CTR	≥15	%	

SWITCHING TIMES

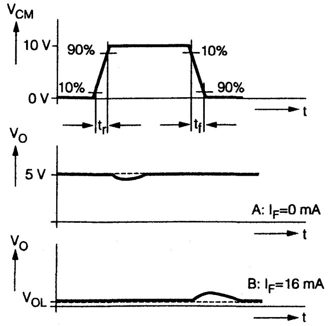


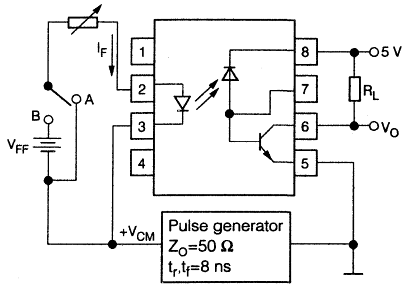


Delay Time (I_F=16 mA, V_{CC}=5 V, T_A=25°C)

High – Low			
SFH6135 (R_L=4.1 kΩ)	t_{PHL}	0.3 (≤1.5)	µs
SFH6136 (R_L=1.9 kΩ)	t_{PHL}	0.2 (≤0.8)	µs
Low – High			
SFH6135 (R_L=4.1 kΩ)	t_{PLH}	0.3 (≤1.5)	µs
SFH6136 (R_L=1.9 kΩ)	t_{PLH}	0.2 (≤0.8)	µs

Common-mode Interference Immunity





Common Mode Interference Immunity
(V_{CM}=10 V_{P-P}, V_{CC}=5 V, T_A=25°C)

High (I_F=0 mA)			
SFH6135 (R_L=4.1 kΩ) CM_H		1000	V/µs
SFH6136 (R_L=1.9 kΩ) CM_H		1000	V/µs
Low (I_F=16 mA)			
SFH6135 (R_L=4.1 kΩ) CM_L		1000	V/µs
SFH6136 (R_L=1.9 kΩ) CM_L		1000	V/µs

Figure 1. Output characteristics–SFH6135
Output current versus output voltage
(T_A=25°C, V_{CC}=5 V)

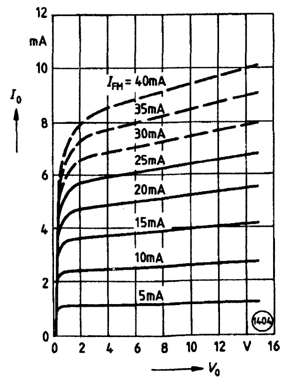


Figure 2. Output characteritics–SFH6136 Output current versus output voltage (T_A=25°C, V_{CC}=5 V)

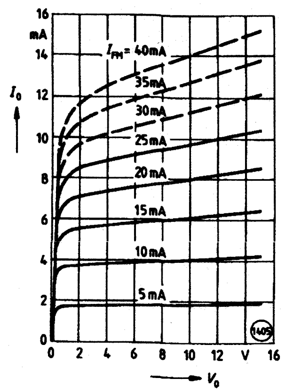


Figure 3. Permissible forward current of emitting diode versus ambient temperature

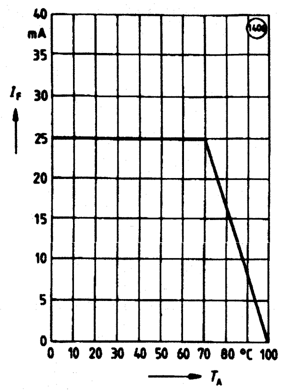


Figure 4. Permissible total power dissipation versus ambient temperature

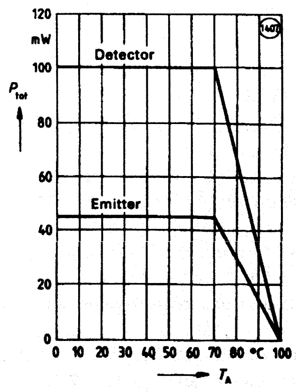


Figure 5. Forward current of emitting diode versus forward voltage (T_A=25°C)

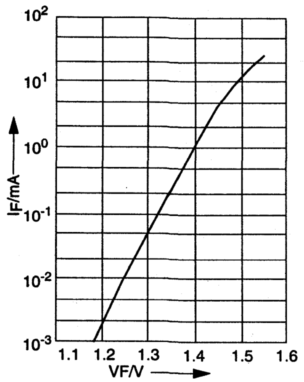


Figure 6. Small signal transfer ratio versus forward current (V_{CC}=5 V, T_A=25°C)

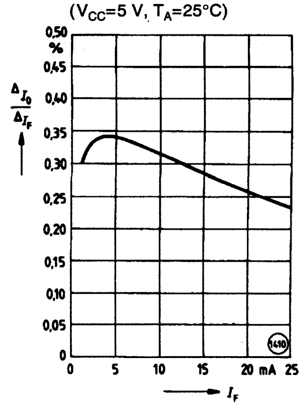


Figure 7. Current transfer ratio (normalized) versus ambient temperature (I_F=16 mA, V_O=0.4 V, V_{CC}=5 V, T_A=25°C)

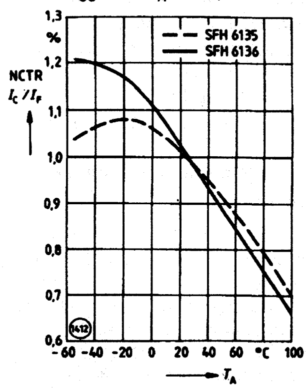


Figure 8. Output current (high) versus ambient temperature (V_O=V_{CC}=5 V, I_F=0)

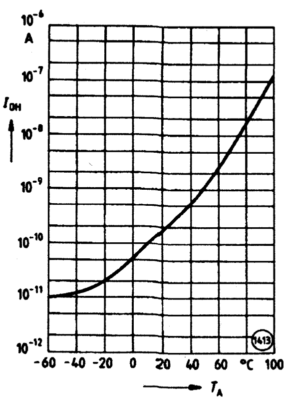


Figure 9. Delay times versus ambient temperature (I_F=16 mA, V_{CC}=5 V, SFH6135: R_L=4.1 kΩ, SFH6136: R_L=1.9 kΩ)

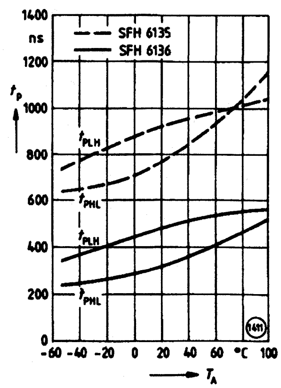
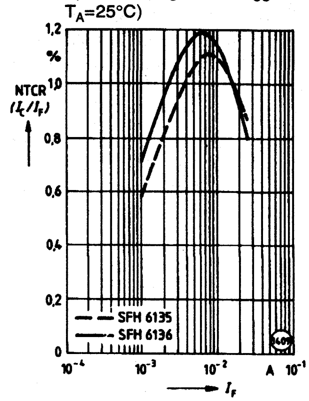


Figure 10. Current transfer ratio (normalized) versus forward current (I_F=16 mA, V_O=0.4 V, V_{CC}=5 V, T_A=25°C)



SIEMENS

SFH6138
SFH6139

LOW INPUT CURRENT, HIGH GAIN TRIOS® OPTOCOUPLER

FEATURES

- **High Current Transfer Ratio, 800%**
- **Low Input Current Requirement, 0.5 mA**
- **High Output Current, 60 mA**
- **Isolation Test Voltage, 5300 VAC_{RMS}**
- **TTL Compatible Output, 0.1V V_{OL}**
- **High Common Mode Rejection, 500V/µsec.**
- **DC to 0.1 Megabit/Sec. Operation**
- **Adjustable Bandwidth–Access to Base**
- **TRIOS (TRansparent IOn Shield)**
- **Standard Molded Dip Plastic Package**
- **Underwriters Lab File #E52744**
- **VDE 0884 Available with Option 1**

APPLICATIONS

- **Logic Ground Isolation–TTL/TTL, TTL/ CMOS, CMOS/CMOS, CMOS/TTL**
- **EIA RS 232C Line Receiver**
- **Low Input Current Line Receiver–Long Lines, Party Lines**
- **Telephone Ring Detector**
- **117 VAC Line Voltage Status Indication–Low Input Power Dissipation**
- **Low Power Systems–Ground Isolation**

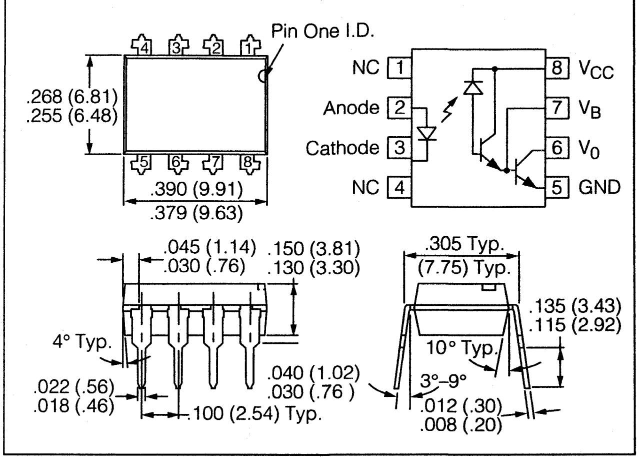
DESCRIPTION

High common mode transient immunity and very high current ratio together with 5300 VAC_{RMS} insulation are achieved by coupling an LED with an integrated high gain photon detector in an eight pin dual-in-line package. Separate pins for the photodiode and output stage enable TTL compatible saturation voltages with high speed operation. Photodarlington operation is achieved by tying the V_{CC} and V_O terminals together. Access to the base terminal allows adjustment to the gain bandwidth.

The SFH6138 is ideal for TTL applications since the 300% minimum current transfer ratio with an LED current of 1.6 mA enables operation with one unit load-in and one unit load-out with a 2.2 KΩ pull-up resistor.

The SFH6139 is best suited for low power logic applications involving CMOS and low power TTL. A 400% current transfer ratio with only 0.5 mA of LED current is guaranteed from 0°C to 70°C.

Package Dimensions in Inches (mm)



Maximum Ratings

Reverse Input Voltage .... 5 V

Supply and Output Voltage, V_{CC} (pin 8-5), V_O (pin 6-5)

SFH6138 .... –0.5 to 7 V

SFH6139 .... –0.5 to 18 V

Emitter-Base Reverse Voltage (pin 5-7) .... 0.5 V

Average Input Current .... 20 mA

Peak Input Current .... 40 mA

(50% Duty Cycle–1 ms pulse width)

Peak Transient Input Current

(tp≤1 µsec, 300 pps) .... 1.0 A

Output Current IO (pin 6) .... 60 mA

Derate linearly above 25°C, free air temperature at 0.7 mA/°C

Input Power Dissipation .... 35 mW

Derate linearly above 50%, free air temperature at 0.7 mW/°C

Output Power Dissipation .... 100 mW

Derate linearly above 25°C, free air temperature at 0.2 mA/°C

Storage Temperature .... –55°C to +125°C

Operating Temperature .... –55°C to +100°C

Lead Soldering Temperature (t=10 sec.) .... 260°C

Isolation Test Voltage (t=1 sec.) .... 5300 VAC_{RMS}

Isolation Resistance

V_{IO}=500 V, T_A=25°C .... ≥1012 Ω

V_{IO}=500 V, T_A=100°C .... ≥1011 Ω

Electro-Optical Characteristics (T_A=0° to 70°C, unless otherwise specified)

Parameter	**Device**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Condition**	**Note**
Current Transfer Ratio (CTR)	SFH6138 SFH6139	300 400 500	1600 1600 2000		% %	I_F=1.6 mA, V_O=0.4 V, V_{CC}=4.5 V I_F=0.5 mA, V_O=0.4 V, V_{CC}=4.5 V I_F=1.6 mA, V_O=0.4 V, V_{CC}=4.5 V	1,2 1,2
Logic Low—Output Voltage (V_{OL})	SFH6138 SFH6139 SFH6139 SFH6139		0.1 0.1 0.15 0.25	0.4 0.4 0.4 0.4	V V	I_F=1.6 mA, I_O=4.8 mA, V_{CC}=4.5 V I_F=1.6 mA, I_O=8 mA, V_{CC}=4.5 V I_F=5 mA, I_O=15 mA, V_{CC}=4.5 V I_F=12 mA, I_O=24 mA, V_{CC}=4.5 V	2 2
Logic High—Output Current (I_{OH})	SFH6138 SFH6139		0.1 0.05	250 100	µA µA	I_F=0 mA, V_O=V_{CC}=7 V I_F=0 mA, V_O=V_{CC}=18 V	2 2
Logic Low Supply Current (I_{CCL})			0.2	1.5.	mA	I_F=1.6 mA, V_O=OPEN, V_{CC}=18 V	2
Logic High Supply Current (I_{CCH})			0.001	10	µA	I_F=0 mA, V_O=OPEN, V_{CC}=18 V	
Input Forward Voltage (V_F)			1.4	1.7	V	I_F=1.6 mA, T_A=25°C	
Input Reverse Breakdown Voltage (BV_R)		5			V	I_R=10 µA	
Temperature Coefficient of Forward Voltage			–1.8		mV/°C	I_F=1.6 mA	
Input Capacitance (C_{IN})			25		pF	f=1 MHz, V_F=0	
Capacitance (Input-Output)			0.6		pF	f=1 MHz	3

Switching Specifications (T_A=0° to 70°C, unless otherwise specified)

Parameter	**Device**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Condition**	**Note**
Propagation Delay Time	SFH6138		2	10	µs	I_F=1.6 mA,R_L=2.2 KΩ	
To Logic Low at Output tPHL	SFH6139		6 0.6	25 1	µs	I_F=0.5 mA,R_L=4.7 KΩ I_F=12 mA,R_L=270 KΩ	2,4
Propagation Delay Time	SFH6138		4	35	µs	I_F=1.6 mA,R_L=2.2 KΩ	
To Logic High at Output tPLH	SFH6139		5 1	60 7	µs	I_F=0.5 mA,R_L=4.7 KΩ I_F=12 mA,R_L=270 KΩ	2,4
Common Mode Transient Immunity at Logic High Level (CM_H) Output			500		V/µs	I_F=0 mA,R_L=2.2 KΩ R_{CC}=0/V_{CM}=10 V_{p-p}	5,6
Common Mode Transient Immunity at Logic Low Level (CM_L) Output			–500		V/µs	I_F=1.6 mA,R_L=2.2 KΩ R_{CC}=0/V_{CM}=10 V_{p-p}	5,6

Notes

1. DC current transfer ratio is defined as the ratio of outppput collector current, I_O, to the forward LED input current, I_F times 100%.
2. Pin 7 open.
3. Device considered a two-terminal device: pins 1, 2, 3 and 4 shorted together and pins 5, 6, 7 and 8 shorted together.
4. Using a resistor between pin 5 and 7 will decrease gain and delay time.
5. Common mode transient immunity in logic high level is the maximum tolerable (positive) dV_{cm}/dt on the leading edge of the common mode pulse, V_{CM}, to assure that the output will remain in a logic high state (i.e. V_O>2.0 V) common mode transient immunity in logic low level is the maximum tolerable (negative) dV_{cm}/dt on the trailing edge of the common mode puse signal, V_{CM}, to assure that the output will remain in a logic low state (i.e. V_O<0.8 V).
6. In applications where dv/dt may exceed 50,000 V/µs (such as state discharge) a series resistor, R_{CC} should be included to protect I_C from destructively high surge currents. The recommended value is $R_{CC} \cong \frac{1V}{0.15\, I_F\,(mA)}$ kΩ.

SIEMENS

NEW

SFH6315
SFH6316
SFH6343

HIGH SPEED OPTOCOUPLER

FEATURES

- **Surface Mountable**
- **Industry Standard SOIC-8 Footprint**
- **Compatible with Infrared Vapor Phase Reflow and Wave Soldering Processes**
- **Isolation Voltage, 2500 V_{RMS}**
- **Very High Common Mode Transient Immunity: 15000 V/µs at V_{CM}=1500 V Guaranteed (SFH6343)**
- **High Speed: 1 Mb/s**
- **TTL Compatible**
- **Guaranteed AC and DC Performance Over Temperature: 0°C to 70°C**
- **Open Collector Output**
- **Pin Compatible with HP Optocouplers**
  SFH6315—HCPL0500
  SFH6316—HCPL0501
  SFH6343—HCPL0453

APPLICATIONS

- **Line Receivers**
- **Logic Ground Isolation**
- **Analog Signal Ground Isolation**
- **Replace Pulse Transformers**

DESCRIPTION

The SFH6315/16/43, high speed optocouplers, each consists of a GaAlAs infrared emitting diode, optically coupled with an integrated photodetector and a high speed transistor. The photodetector is junction isolated from the transistor to reduce miller capacitance effects. The open collector output function allows circuit designers to adjust the load conditions when interfacing with different logic systems such as TTL, CMOS, etc.

Because the SFH6343 has a Faraday shield on the detector chip, it can also reject and minimize high input to output common mode transient voltages. There is no base connection, further reducing the potential electrical noise entering the package.

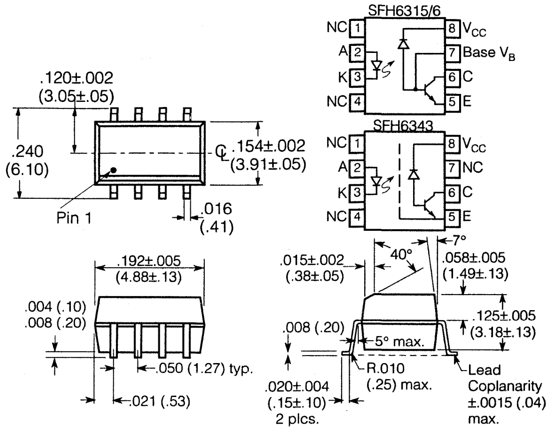
The SFH6315/16/43 are packaged in industry standard SOIC-8 packages and are suitable for surface mounting.

Absolute Maximum Ratings

Emitter (GaAlAs)

Reverse Voltage .... 3 V
DC Forward Current .... 25 mA
Surge Forward Current .... 1 A
  tp≤1 µs, 300 pulses/sec.
Total Power Dissipation (T_A≤70°C) .... 45 mW

Package Dimensions in Inches (mm)



TOLERANCE: ±.005 (unless otherwise noted)

Absolute Maximum Ratings (continued)

Detector(Si Photodiode + Transistor)

Supply Voltage .... –0.5 to 30 V
Output Voltage .... –0.5 to ≥20 V
Output Current .... 8 mA
Total Power Dissipation (T_A≤70°C) .... 100 mW

Package

Isolation Test Voltage
  between emitter and detector .... 2500 VAC_{RMS}
  (refer to climate DIN 40046, part 2, Nov. 74)
Pollution Degree (DIN VDE0110) 2
Creepage .... ≥4 mm
Clearance .... ≥4 mm
Comparative Tracking Index
  per DIN IEC 112/VDE 0303, part 1 175
Isolation Resistance
  V_{IO}=500 V, T_A=25°C, R_{ISOL} (Note 2) .... $\geq 10^{12}\ \Omega$
  V_{IO}=500 V, T_A=100°C, R_{ISOL} (Note 2) .... $\geq 10^{11}\ \Omega$
Storage Temperature Range .... –55°C to +150°C
Ambient Temperature Range .... –55°C to +100°C
Junction Temperature .... 100°C
Soldering Temperature (t=10 sec. max.) .... 260°C
  Dip soldering: distance to seating plane ≥1.5 mm

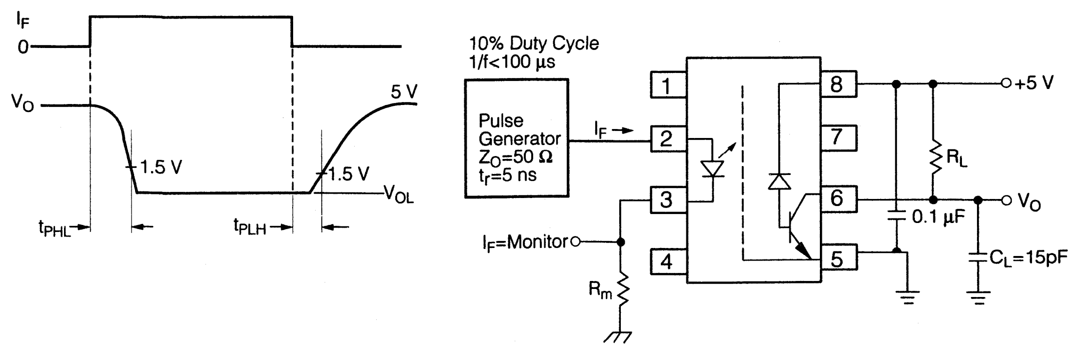
Specifications subject to change.

Electrical Characteristics

Over recommended temperature (T_A=0°C to 70°C) unless otherwise specified. See note 6. *All typical values at T_A=25°C.

Parameter	Symbol	Device	Min.	Typ.*	Max.	Units	Test Conditions	Note
Input Forward Voltage	V_F			1.6	1.8	V	T_A=25°C, I_F=16 mA	
					1.9		I_F=16 mA	
Input Reverse Current	I_R			0.5	10	µA	V_R=3 V	
Input Capacitance	C_{IN}			75		pF	f=1 MHz, V_F=0 V	
Temperature Coefficient of Forward Voltage	$\frac{\Delta V_F}{\Delta T_A}$			−1.7		mV/°C	I_F=16 mA	
Logic Low Supply Current	I_{CCL}			100		µA	I_F=16 mA, V_O=Open, V_{CC}=15 V	
Logic High Supply Current	I_{CCH}			0.001	1	µA	T_A=25°C, I_F=0 mA, V_O=Open, V_{CC}=15 V	
					2		I_F=0 mA, V_O=Open, V_{CC}=15 V	
Logic Low Output Voltage	V_{OL}	SFH6315		0.15	0.4	V	T_A=25°C, I_O=1.1 mA, I_F=16 mA, V_{CC}=4.5 V	
					0.5		I_O=0.8 mA, I_F=16 mA, V_{CC}=4.5 V	
		SFH6316 SFH6343		0.15	0.4	V	T_A=25°C, I_O=3.0 mA, I_F=16 mA, V_{CC}=4.5 V	
					0.5		I_O=2.4 mA, I_F=16 mA, V_{CC}=4.5 V	
Logic High Output Current	I_{OH}			0.003	0.5	µA	T_A=25°C, V_O=V_{CC}=5.5 V, I_F=0 mA	
				0.01	1		T_A=25°C, V_O=V_{CC}=15.0 V, I_F=0 mA	
					50		T_A=0–70°C, V_O=V_{CC}=15.0 V, I_F=0 mA	
Transistor DC Current Gain	h_{FE}			150			V_O=5 V, I_O=3 mA	
Capacitance (Input-Output)	$C_{I\text{-}O}$			0.4		pF	f=1 MHz	6
Current Transfer Ratio	CTR	SFH6315	7	16	50	%	T_A=25°C, V_O=0.4 V, I_F=16 mA, V_{CC}=4.5 V	1, 6
			5	17			V_O=0.5 V, I_F=16 mA, V_{CC}=4.5 V	
		SFH6316 SFH6343	19	35	50	%	T_A=25°C, V_O=0.4 V, I_F=16 mA, V_{CC}=4.5 V	
			15	36			V_O=0.5 V, I_F=16 mA, V_{CC}=4.5 V	

Figure 1. Test circuit for switching times



Optocouplers (Optoisolators)

5

Switching Specifications

Over recommended temperature (T_A=0°C to 70°C), V_{CC}=5 V, I_F=16 mA unless otherwise specified. *All typical values, T_A=25°C

Parameter	Symbol	Device	Min.	Typ.*	Max.	Units	Test Conditions		Fig.	Note
Propagation Delay Time to Logic Low at Output	t_{PHL}	SFH6315		0.5	1.5	µs	T_A=25°C	R_L=4.1 KΩ	1	4, 5
					2.0					
		SFH6316 SFH6343		0.25	0.8		T_A=25°C	R_L=1.9 KΩ		
					1.0					
Propagation Delay Time to Logic High at Output	t_{PLH}	SFH6315		0.5	1.5	µs	T_A=25°C	R_L=4.1 KΩ	1	4, 5
					2.0					
		SFH6316 SFH6343		0.5	0.8		T_A=25°C	R_L=1.9 KΩ		
					1.0					
Common Mode Transient Immunity at Logic High Level Output	$\|CM_H\|$	SFH6315		1		kV/µs	R_L=4.1 KΩ	I_F=0 mA T_A=25°C V_{CM}=10 V_{P-P}	2	3, 4, 5
		SFH6316		1			R_L=1.9 KΩ			
		SFH6343	15	30			R_L=1.9 KΩ	I_F=0 mA T_A=25°C V_{CM}=1500 V_{P-P}		
Common Mode Transient Immunity at Logic Low Level Output	$\|CM_L\|$	SFH6315		1		kV/µs	R_L=4.1 KΩ	I_F=16 mA T_A=25°C V_{CM}=10 V_{P-P}	2	3, 4, 5
		SFH6316		1			R_L=1.9 KΩ			
		SFH6343	15	30			R_L=1.9 KΩ	I_F=16 mA T_A=25°C V_{CM}=1500 V_{P-P}		

Notes

1. Current transfer ratio in percent equals the ratio of output collector current (I_O) to the forward LED input current (I_F) times 100.
2. Device considered a two-terminal device: pins 1, 2, 3, and 4 shorted together and pins 5, 6, 7, and 8 shorted together.
3. Common mode transient immunity in a Logic High level is the maximum tolerable (positive) dV_{cm}/dt on the leading edge of the common mode pulse (V_{CM}) to assure that the output will remain in a Logic High state (i.e., V_O>2.0 V). Common mode transient immunity in a Logic Low level is the maximum tolerable (negative) dVcm/dt on the trailing edge of the common mode pulse signal (V_{CM} to assure that the output will remain in a Logic Low state (i.e., V_O<0.8 V).
4. The 1.9 KΩ load represents 1 TTL unit load of 1.6 mA and the 5.6 kΩ pull-up resistor.
5. The 4.1 KΩ load represents 1 LSTTL unit load of 0.36 mA and the 6.1 kΩ pull-up resistor.
6. A 0.1 µf bypass capacitor connected between pins 5 and 8 is recommended.

Figure 2. Test circuit for transient immunity and typical waveforms

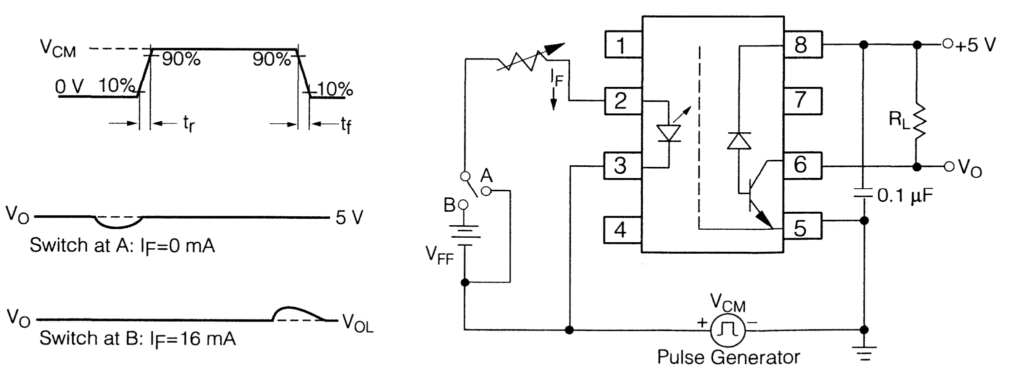


Figure 3. LED forward current vs. forward voltage

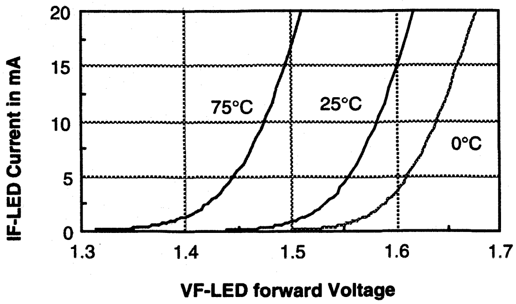


Figure 4. Permissible forward LED current vs. temperature

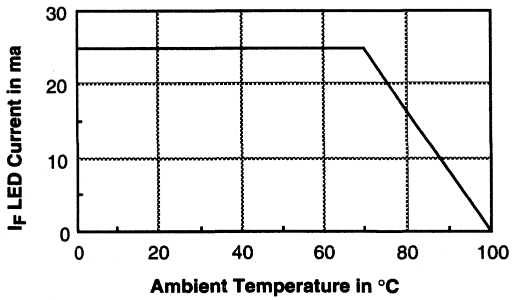


Figure 5. Permissible power dissipation vs. temp.

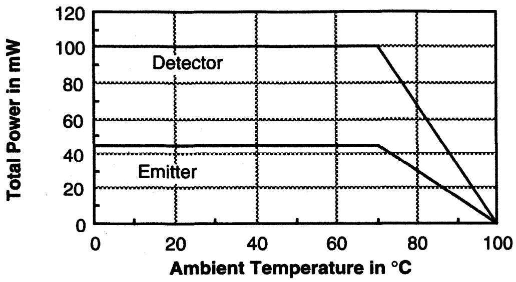
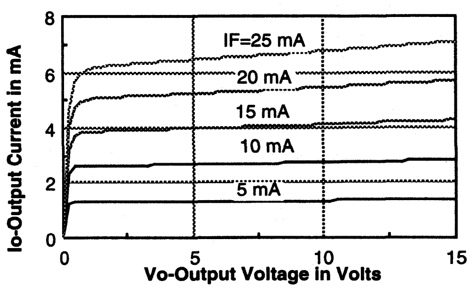


Figure 6. Output current vs. output voltage



Optocouplers (Optoisolators)

5

Figure 7. Output current (high) vs. temperature

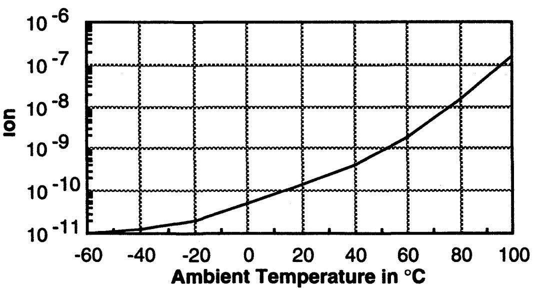


Figure 8. NCTR vs. IF

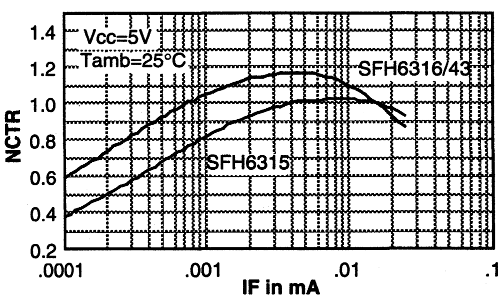


Figure 9. NCTR vs. temperature (SFH6316/43)

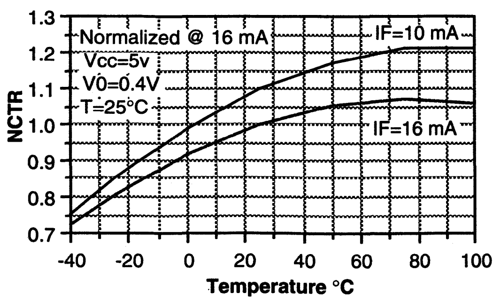
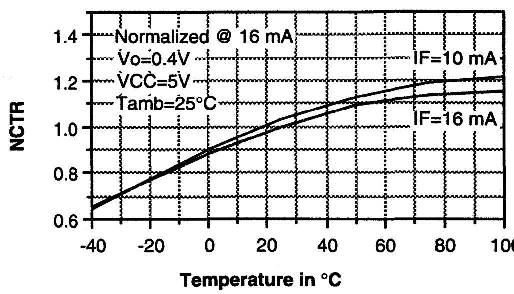


Figure 10. NCTR vs. temperature (SFH6315)

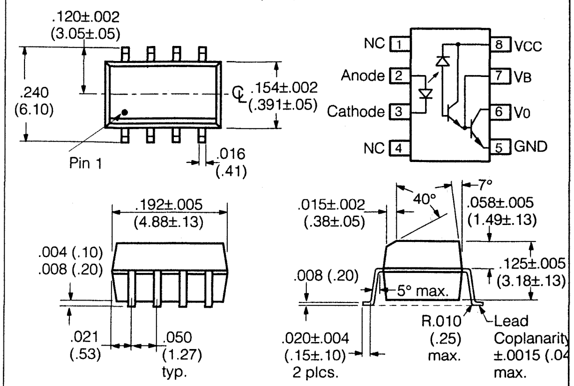


SIEMENS

NEW

SFH6318
SFH6319
LOW CURRENT, HIGH GAIN OPTOCOUPLER

Package Dimensions in Inches (mm)



TOLERANCE: ±.005 (unless otherwise noted)

FEATURES
- **Industry Standard SOIC-8 Surface Mountable Package**
- **High Current Transfer Ratio, 800%**
- **Low Input Current, 0.5mA**
- **High Output Current, 60mA**
- **Isolation Test Voltage, 2500 VAC_{RMS}**
- **TTL Compatible Output, V_{OL}=0.1 V**
- **Adjustable Bandwidth-Access to Base**
- **Underwriters Lab File #E52744**

APPLICATIONS
- **Logic Ground Isolation-TTL/TTL, TTL/CMOS, CMOS/CMOS, CMOS/TTL**
- **EIA RS 232C Line Receiver**
- **Low Input Current Line Receiver-Long Lines, Party Lines**
- **Telephone Ring Detector**
- **117 VAC Line Voltage Status Indication-Low Input Power Dissipation**
- **Low Power Systems-Ground Isolation**

DESCRIPTION
Very high current ratio together with 2500 VAC isolation are achieved by coupling an LED with an integrated high gain photodetector in a SOIC-8 package. Separate pins for the photodiode and output stage enable TTL compatible saturation voltages with high speed operation. Photodarlington operation is achieved by tying the VCC and VO terminals together. Access to the base terminal allows adjustment to the gain bandwidth.

The SFH6318 is ideal for TTL applications since the 300% minimum current transfer ratio with an LED current of 1.6 mA enables operation with one unit load-in and one unit load-out with a 2.2 KΩ pull-up resistor.

The SFH6319 is best suited for low power logic applications involving CMOS and low power TTL. A 400% current transfer ratio with only 0.5 mA of LED current is guaranteed from 0°C to 70°C.

Caution:
Due to the small geometries of this device, it should be handled with Electrostatic Discharge (ESD) precautions. Proper grounding would prevent damage further and/or degradation which may be induced by ESD.

Maximum Ratings (25°)

Emitter

Reverse Input Voltage .... 3 V
Supply and Output Voltage, V_{CC} (pin 8-5), V_O (pin 6-5)
  SFH6318 .... –0.5 to 7 V
  SFH6319 .... –0.5 to 18 V
Input Power Dissipation .... 35 mW
  Derate Linearly above 50°C
  Free Air Temperature .... 0.7 mW/°C
Average Input Current .... 20 mA
Peak Input Current .... 40 mA
  (50% Duty Cycle-1 ms pulse width)
Peak Transient Input Current
  (tp≤1 µsec, 300 pps) .... 1.0 A

Detector (Si Photodiode + Photodarlington)

Output Current I_O (pin 6) .... 60 mA
Emitter-Base Reverse Voltage (pin 5-7) .... 0.5 V
Output Power Dissipation .... 150 mW
  Derate Linearly from 25°C .... 2 mW/°C

Package

Storage Temperature .... –55°C to +125°C
Operating Temperature .... –40°C to +85°C
Lead Soldering Temperature (t=10 sec.) .... 260°C
Junction Temperature .... 100°C
Ambient Temperature Range .... –55°C to +100°C
IsolationTest Voltage between
  Emitter and Detector .... 2500 VAC_{RMS}
  (refer to climate DIN 40046, part 2, Nov. 74)
Pollution Degree (DIN VDE 0110) 2
Creepage Distance .... ≥4 mm
Clearance .... ≥4 mm
Comparative Tracking Index
  per DIN IEC 112/VDE 0303, part 1 175
Isolation Resistance
  V_{IO}=500 V, T_A=25°C R_{ISOL} .... $\geq 10^{12}\Omega$
  V_{IO}=500 V, T_A=100°C R_{ISOL} .... $\geq 10^{11}\Omega$

Electro-Optical Characteristics (T_A=0°C to 70°C, T_A=25°C-Typical, unless otherwise specified)

Parameter	Symbol	Device	Min	Typ	Max	Units	Test Conditions	Note
Current Transfer Ratio	CTR	SFH6318	300	1600	2600	%	I_F=1.6 mA, V_O=0.4 V, V_{CC}=4.5 V	1,2
		SFH6319	400 500	1600 2000	2600 3500	%	I_F=0.5 mA, V_O=0.4 V, V_{CC}=4.5 V I_F=1.6 mA, V_O=0.4 V, V_{CC}=4.5 V	1,2
Logic Low Output Voltage	V_{OL}	SFH6318		0.1	0.4	V	I_F=1.6 mA, I_O=4.8 mA, V_{CC}=4.5 V	2
		SFH6319		0.1 0.15 0.25	0.4 0.4 0.4	V	I_F=1.6 mA, I_O=8 mA, V_{CC}=4.5 V I_F=5 mA, I_O=15 mA, V_{CC}=4.5 V I_F=12 mA, I_O=24 mA, V_{CC}=4.5 V	2
Logic High Output Current	I_{OH}	SFH6318		0.1	250	µA	I_F=0 mA, V_O=V_{CC}=7 V	2
		SFH6319		0.05	100	µA	I_F=0 mA, V_O=V_{CC}=18 V	2
Logic Low Supply Current	I_{CCL}			0.2	1.5	mA	I_F=1.6 mA, V_O=OPEN, V_{CC}=18 V	2
Logic High Supply Current	I_{CCH}			0.01	10	µA	I_F=0 mA, V_O=OPEN, V_{CC}=18 V	2
Input Forward Voltage	V_F			1.4	1.7	V	I_F=1.6 mA, T_A=25°C	
Temperature Coefficient, Forward Voltage	$\Delta V_F/\Delta T_A$			−1.8		mV/°C	I_F=1.6 mA	
Input Capacitance	C_{IN}			25		pF	f=1 MHz, V_F=0	
Resistance (Input-Output)	R_{I-O}			10^{12} 10^{11}		Ω Ω	V_{IO}=500 VDC, T_A=25°C V_{IO}=500 VDC, T_A=100°C	3
Capacitance (Input-Output)	C_{I-O}			0.6		pF	f=1 MHz	3

Switching Specifications (T_A=25°C)

Parameter	Symbol	Device	Min	Typ	Max	Units	Test Conditions	Note
Propagation Delay Time To Logic Low at Output	t_{PHL}	SFH6318		2	10	µs	I_F=1.6 mA, R_L=2.2 KΩ	
		SFH6319		6 0.6	25 1	µs	I_F=0.5 mA, R_L=4.7 KΩ I_F=12 mA, R_L=270 Ω	2,4
Propagation Delay Time To Logic High at Output	t_{PLH}	SFH6318		2	35	µs	I_F=1.6 mA, R_L=2.2 KΩ	
		SFH6319		4 1.5	60 7	µs	I_F=0.5 mA, R_L=4.7 KΩ I_F=12 mA, R_L=270 Ω	2,4
Common Mode Transient Immunity at Logic High Level Output	$\lvert CM_H \rvert$			1 K		V/µs	I_F=0 mA, R_L=2.2 KΩ V_{CM}=10 V_{p-p}	5,6
Common Mode Transient Immunity at Logic Low Level Output	$\lvert CM_L \rvert$			1 K		V/µs	I_F=1.6 mA, R_L=2.2 KΩ V_{CM}=10 V_{p-p}	5,6

Notes

1. DC current transfer ratio is defined as the ratio of outpput collector current, I_O, to the forward LED input current, I_F times 100%.
2. Pin 7 open.
3. Device considered a two-terminal device: pins 1, 2, 3 and 4 shorted together and pins 5, 6, 7 and 8 shorted together.
4. Using a resistor between pin 5 and 7 will decrease gain and delay time.
5. Common mode transient immunity in logic high level is the maximum tolerable (positive) dV_{cm}/dt on the leading edge of the commomode pulse, V_{CM}, to assure that the output will remain in a logic high state (i.e. V_O>2.0 V) common mode transient immunity in logic low level is the maximum tolerable (negative) dV_{cm}/dt on the trailing edge of the common mode puse signal, V_{CM}, to assure that the output will remain in a logic low state (i.e. V_O<0.8 V).
6. In applications where dv/dt may exceed 50,000 V/µs (such as state discharge) a series resistor, R_{CC} should be included to protect IC from destructively high surge currents. The recommended value is $R_{CC} \cong \frac{IV}{0.15\ I_F(mA)}$ kΩ. Refer to Figure 2.

Optocouplers (Optoisolators) 5

Figure 1. Switching test circuit

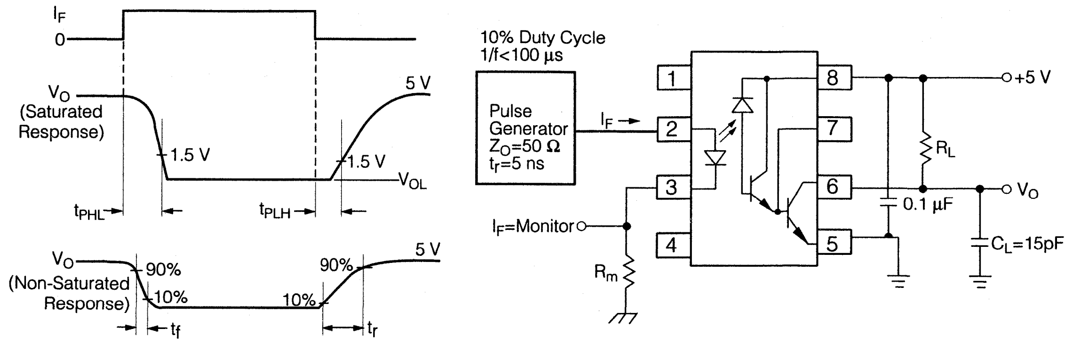
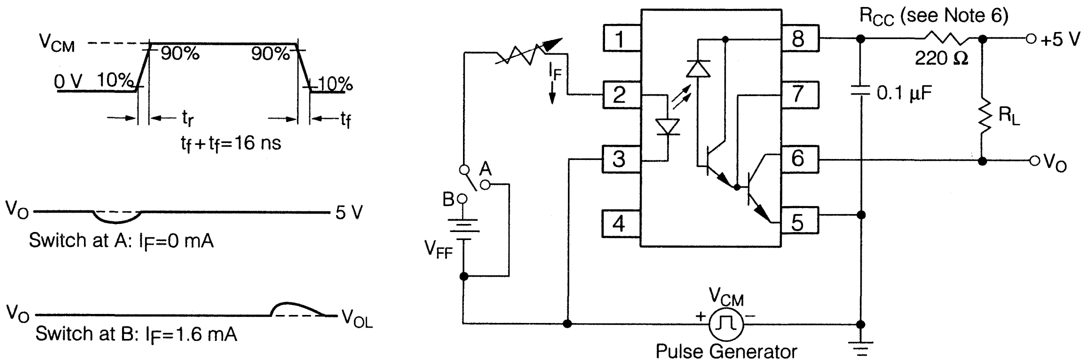


Figure 2. Test circuit for transient immunity and typical waveforms



SIEMENS

NEW

SFH6345

HIGH SPEED 5.3 kV OPTOCOUPLER

FEATURES

- **Direct Replacement for HCPL4503**
- **High Speed Optocoupler without Base Connection**
- **GaAIAs Emitter**
- **Integrated Detector with Photodiode and Transistor**
- **High Data Transmission Rate: 1 MBit/s**
- **TTL Compatible**
- **Open Collector Output**
- **CTR at I_F=16 mA, V_O=0.4 V, V_{CC}=4.5 V, T_A=25°C: ≥19%**
- **Good CTR Linearity Relative to Forward Current**
- **Field Effect Stable**
- **Low Coupling Capacitance**
- **Very High Common Mode Transient Immunity dV/dt: ≥15 kV/µs at V_{CM}=1500 V**
- **Insulation Test Voltage: 5300 VAC_{PK}**
- **VDE 0884 Available with Option 1**
- **UL Approval, File #E52744**

APPLICATIONS

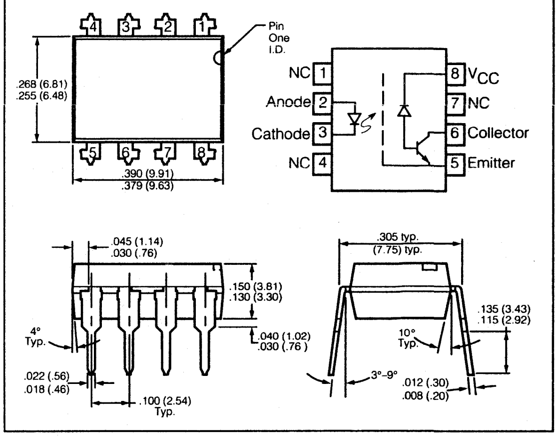
- **Data Communications**
- **IGBT Drivers**
- **Programmable Controllers**

DESCRIPTION

The SFH6345 is an optocoupler with a GaAlAs infrared emitting diode, optically coupled to an integrated photodetector consisting of a photodiode and a high speed transistor in a DIP-8 plastic package. The device is similar to the 6N135 but has an additional Faraday shield on the detector which enhances the input-output dv/dt immunity.

Signals can be transmitted between two electrically separated circuits up to frequencies of 2 MHz. The potential difference between the circuits to be coupled should not exceed the maximum permissible reference voltages.

Package Dimensions in Inches (mm)



Absolute Maximum Ratings

Emitter (GaAlAs)

Reverse Voltage .... 3 V
DC Forward Current .... 25 mA
Surge Forward Current .... 1 A
  tp≤1 µs, 300 pulses/sec.
Total Power Dissipation .... 45 mW

Detector (Si Photodiode + Transistor)

Supply Voltage .... –0.5 to 30 V
Output Voltage .... –0.5 to ≥25 V
Output Current .... 8 mA
Total Power Dissipation .... 100 mW

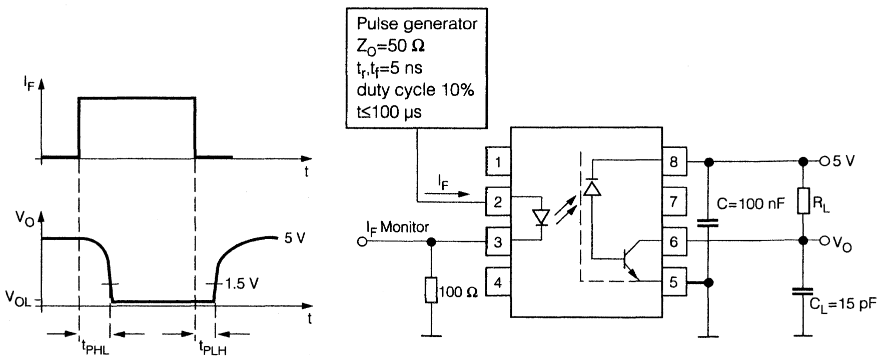
Package Insulation

Isolation Test Voltage
  between emitter and detector .... 5300 VAC_{PK}
  (refer to climate DIN 40046, part 2, Nov. 74)
Creepage .... ≥7 mm min.
Clearance .... ≥7 mm min.
Comparative Tracking Index
  per DIN IEC 112/VDE0303, part 1 .... ≥175
Isolation Resistance
  V_{IO}=500 V, T_A=25°C, R_{ISOL} .... $\geq 10^{12}\ \Omega$
  V_{IO}=500 V, T_A=100°C, R_{ISOL} .... $\geq 10^{11}\ \Omega$
Storage Temperature Range .... –55 to +150°C
Ambient Temperature Range .... –55 to +100°C
Junction Temperature .... 100°C
Soldering Temperature (t=10 sec. max.) .... 260°C
  Dip soldering: distance to seating plane ≥1.5 mm

Characteristics (T_A=0° to 70°C, unless otherwise specified,typical values T_A=25°C)

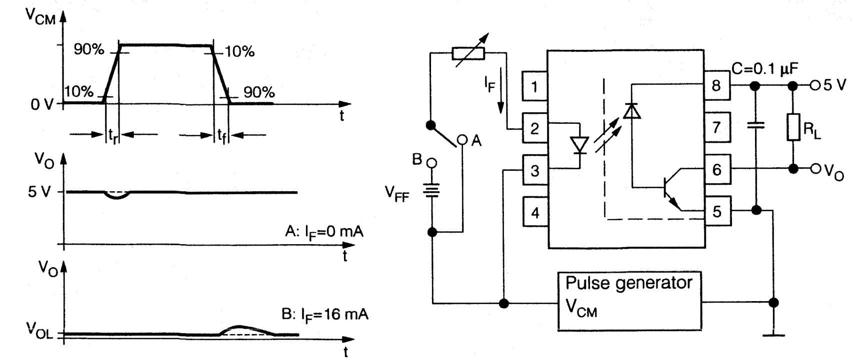
Description	Symbol	Min.	Typ.	Max.	Unit
Emitter (IR GaAlAs)					
Forward Voltage, I_F=16 mA	V_F		1.6	1.9	V
Reverse Current, V_R=3 V	I_R		0.5	10	µA
Capacitance, V_R=0 V, f=1 MHz	C_0		75		pF
Thermal Resistance	R_{thJA}		700		°K/W
Detector (Si Photodiode + Transistor)					
Supply Current, Logic High I_F=0, V_O (open), V_{CC}=15 V, T_A=25°C I_F=0, V_O (open), V_{CC}=15 V	I_{CCH}		 0.01	 1 2	µA
Output Current, Output High I_F=0, V_O (open), V_{CC}=5.5 V, T_A=25°C I_F=0, V_O (open), V_{CC}=15 V, T_A=25°C I_F=0, V_O (open), V_{CC}=15 V	I_{OH}		 .003 .01 —	 0.5 1 50	µA
Capacitance, V_{CE}=5 V, f=1 MHz	C_{CE}		3		pF
Thermal Resistance	R_{thJA}		300		°K/W
Package					
Coupling Capacitance	C_C		0.6		pF
Coupling Transfer Ratio I_F=16 mA, V_O=0.4 V, V_{CC}=4.5 V, T_A=25°C I_F=16 mA, V_O=0.5 V, V_{CC}=4.5 V	I_C/I_F	 19 15	 30 —		%
Collector Emitter Saturation Voltage I_F=16 mA, I_O=2.4 mA, V_{CC}=4.5 V, T_A=25°C	V_{OL}		0.1	0.4	V
Supply Current, Logic Low I_F=16 mA, V_O open, V_{CC}=15 V	I_{CCL}		80	200	µA

Switching Times (typ.)



Description	Symbol	Min.	Typ.	Max.	Unit
Propagation Delay Time (High–Low) I_F=16 mA, V_{CC}=5 V, R_L=1.9 kΩ, T_A=25°C	t_{PHL}		0.3	0.8	µs
Propagation Delay Time (Low–High) I_F=16 mA, V_{CC}=5 V, R_L=1.9 kΩ, T_A=25°C	t_{PLH}		0.3	0.8	µs

Common Mode Transient Immunity



Description	Symbol	Min.	Typ.	Max.	Unit
Common Mode Transient Immunity (High) I_F=0, V_{CM}=1500 $V_{P\text{-}P}$, R_L=1.9 kΩ, V_{CC}=5 V, T_A=25°C	$\|CM_H\|$	15	30		kV/µs
Common Mode Transient Immunity (Low) I_F=16 mA, V_{CM}=1500 $V_{P\text{-}P}$, R_L=1.9 kΩ, V_{CC}=5 V, T_A=25°C	$\|CM_L\|$	15	30		kV/µs

SIEMENS

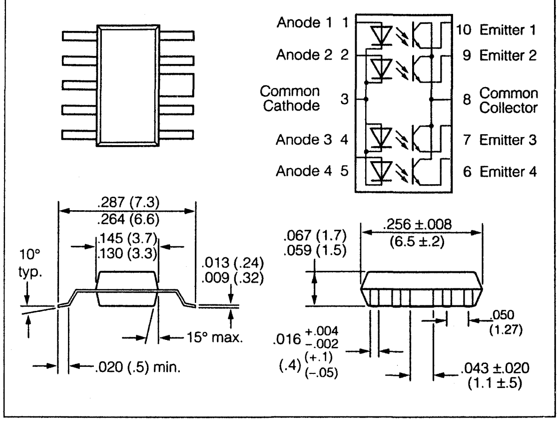
NEW

SFH6941

LOW CURRENT INPUT MINI OPTOCOUPLER

Preliminary Data Sheet

Package Dimensions in Inches (mm)



FEATURES

- **Transistor Optocoupler in SOT223 Package**
- **End Stackable, 1.27 mm Spacing**
- **Low Current Input**
- **Very High CTR, 150% Typical at I_F=1 mA, V_{CE}=0.5 V**
- **Good CTR Linearity Versus Forward Current**
- **Minor CTR Degradation**
- **Field Effect Stable by TRIOS® (TRansparent IOn Shield)**
- **High Collector-Emitter Voltage, V_{CEO}=70 V**
- **Low Coupling Capacitance**
- **High Common Mode Transient Immunity**
- **Isolation Test Voltage: 2500 VDC**

APPLICATIONS

- **Telecommunication**
- **SMT**
- **PCMCIA**
- **Instrumentation**

DESCRIPTION

The SFH6941 is a four channel mini-optocoupler suitable for high density packaged PCB application. It has a minimum of 2500 VDC isolation from input to output. The device consists of four phototransistors as detectors. Each channel is individually controlled. The optocoupler is housed in a SOT223 package. All the cathodes of the input LEDs and all the collectors of the output transistors are commoned enabling a pin count reduction from 16 pins to 10 pins—a significant space savings as compared to four channels that are electrically isolated individually.

Absolute Maximum Ratings

Emitter (GaAlAs)

Reverse Voltage .... 3 V
DC Forward Current .... 5 mA
Surge Forward Current (t_P≤10 µs) .... 100 mA
Total Power Dissipation .... 10 mW

Detector (Si Phototransistor)

Collector-Emitter Voltage .... 70 V
Emitter-Collector Voltage .... 7 V
Collector Current .... 10 mA
Surge Collector Current (t_P≤1 ms) .... 20 mA
Total Power Dissipation .... 20 mW

Package Insulation

Isolation Test Voltage
(between emitter and detector,
refer to climate DIN 40046, part 2, Nov. 74) .... 2500 VDC
Creepage .... ≥4 mm
Clearance .... ≥4 mm
Comparative Tracking Index
per DIN IEC 112/VDE0303, part 1 175
Isolation Resistance
V_{IO}=100 V, T_A=25°C .... $\geq 10^{11}\ \Omega$
V_{IO}=100 V, T_A=100°C .... $\geq 10^{10}\ \Omega$
Storage Temperature Range .... –55 to +150°C
Ambient Temperature Range .... –55 to +100°C
Junction Temperature .... 100°C
Soldering Temperature (t=10 sec. max.) .... 260°C
Dip soldering plus reflow soldering processes

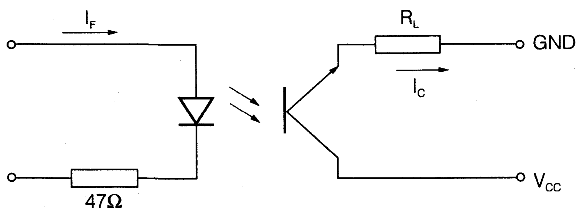
Specifications subject to change.

Characteristics (T_A=25°C, unless otherwise specified)

Description	Symbol	Min.	Typ.	Max.	Unit
Emitter (IR GaAs)					
Forward Voltage, I_F=5 mA	V_F		1.25		V
Reverse Current, V_R=3 V	I_R		0.01	10	µA
Capacitance, V_R=0 V, f=1 MHz	C_0		5		pF
Thermal Resistance	R_{thJA}		1000		°K/W
Detector (Si Phototransistor)					
Collector-Emitter Voltage, I_{CE}=10 µA	V_{CEO}	70			V
Emitter-Collector Voltage, I_{EC}=10 µA	V_{ECO}	7			V
Capacitance, V_{CE}=5 V, f=1 MHz	C_{CE}		6		pF
Thermal Resistance	R_{thJA}		500		°K/W
Package					
Coupling Capacitance	C_C		1		pF

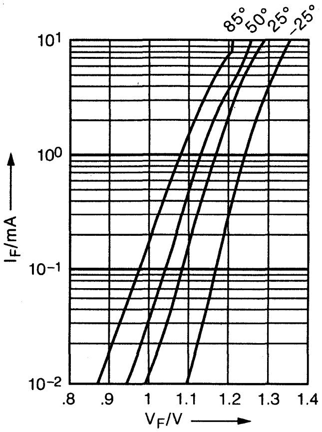
Description	Symbol	Values			Unit
		-3	-4	-5	
Coupling Transfer Ratio I_F=1 mA, V_{CE}=0.5 V I_F=0.5 mA, V_{CE}=1.5 V	 I_C/I_F I_C/I_F	 100–200 120 (≥50)	 160–320 200 (≥80)	 250–500 300 (≥125)	%
Collector-Emitter Saturation Voltage I_F=1 mA	V_{CEsat}	0.25 (≤0.4) (I_C=0.5 mA)	0.25 (≤0.4) (I_C=0.8 mA)	0.25 (≤0.4) (I_C=1.25 mA)	V
Collector-Emitter Leakage Current V_{CE}=10 V	I_{CEO}	50	50	50	nA

Switching times, typical

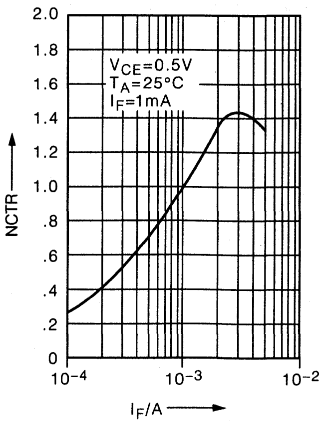


Description	Symbol	Values	Unit	Test Conditions
Turn-on Time	t_{on}	3	µs	I_F=2 mA R_L=100 Ω T_A=25°C V_{CC}=5 V
Rise Time	t_r	2.6		
Turn-off Time	t_{off}	3.1		
Fall Time	t_f	2.8		

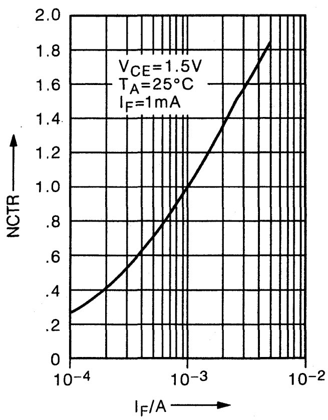
LED current versus LED voltage
$V_F = f(I_F)$



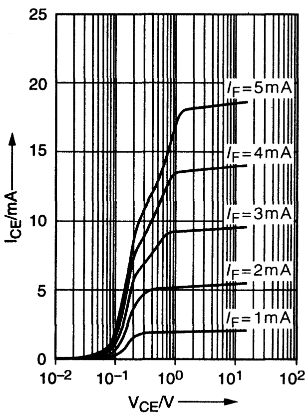
Saturated current transfer ratio
normalized to I_F=1 mA, NCTR=f(I_F)



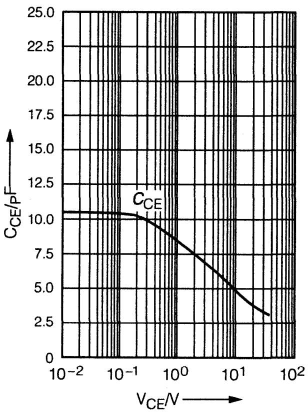
Non-saturated current transfer
normalized to I_F=1 mA, NCTR=f(I_F)



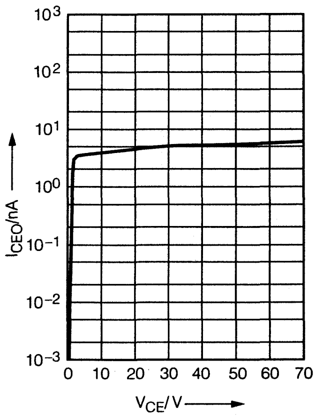
Transistor output characteristics
T_A=25°C, I_{CE}=f(V_{CE}, I_F)



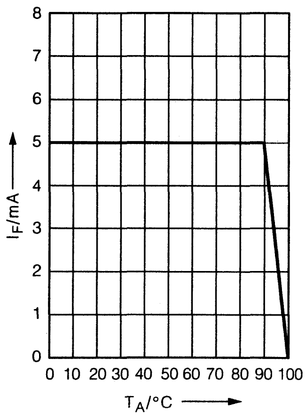
Transistor capacitance (typ.)
T_A=25°C, f=1MHz, C_{CE}=f(V_{CE})



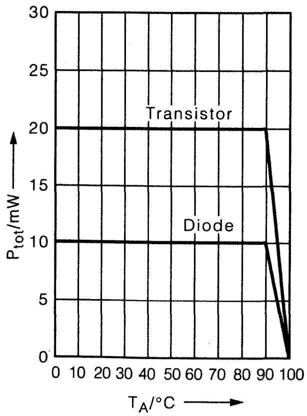
Collector-emitter leakage current (typ.)
I_F=0, T_A=25°C, I_{CEO}=f(V_{CE})



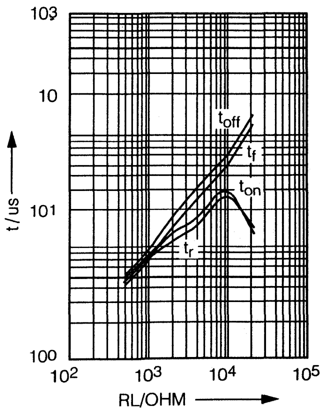
Permissible forward current diode
I_F=f(T_A=25°C)

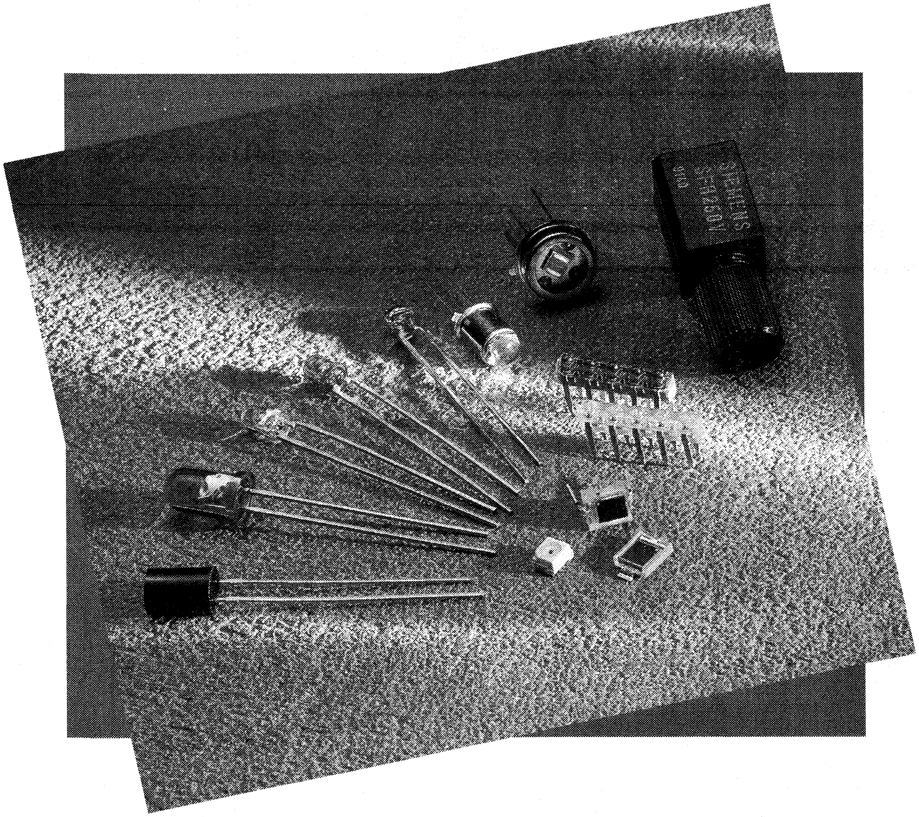


Permissible power dissipation
P_{tot}=f(T_A)



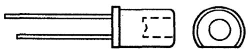
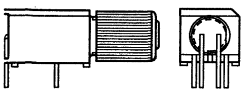
T_A=25°C, I_F=1 mA, V_{CC}=5 V,
t_{on}, t_r, t_{off}, t_f=f(R_L)



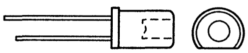
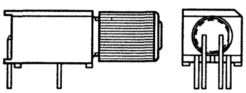
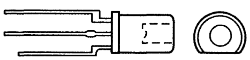
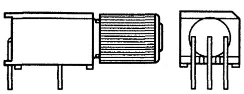
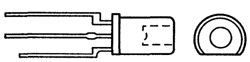
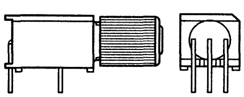


Components for Plastic Fiber Applications
Components for Glass Fiber Applications
High Power Laser Diodes
Infrared Emitters
Photodiodes
Phototransistors
Photovoltaic Cells

Components for Plastic Fiber Applications
Emitters

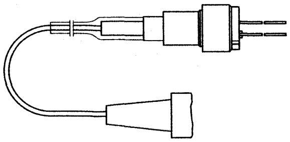
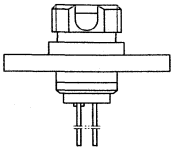
Package Outline	Part No.	Package Type	Infrared/ Visible (Color)	Wave-length nm	Φ_{in} (μW) I_F=10 mA	Features	Page
	SFH450	T1¾ gray plastic	Infrared	950 GaAs	90	Fiber optic short distance data transmission. 2.2 mm aperture holds 1000 micron plastic fiber. Matches SFH250/V or SFH350/V, or SFH551/V.	6–5
	SFH750	T1¾ plastic	Visible (Red)	660 GaAs	9		6–8
	SFH756			660	200		6–10
	SFH450V	Gray plastic connector housing.	Infrared	950 GaAs	90		6–5
	SFH750V		Visible (Red)	660	9		6–8
	SFH756V			660	200		6–10

Photodetectors

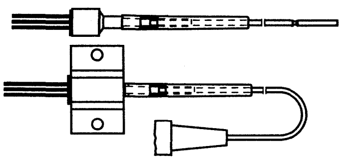
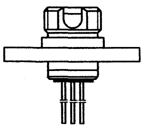
Package Outline	Part No.	Package Type	Photocurrent Φ_{out}=10 μW λ=660 nm	Wavelength of Max. Sensitivity λ_{smax} (nm)	Features	Page
	SFH250	T1¾ clear plastic	V_R=5 V 3 (≥1.6) μA 4 (≥2.5), 950 nm	850	**PIN Photodiode** Fiber optic short distance data transmission. 2.2 mm aperture holds 1000 micron plastic fiber. Matches SFH450/450V and SFH750/750V.	6–1
	SFH250V	Black plastic connector housing.		850		
	SFH350	T1¾ clear plastic	V_{CE}=5 V 0.8 (≥0.16) mA	850	**PIN Phototransistor** Fiber optic short distance data transmission. 2.2 mm aperture holds 1000 micron plastic fiber. Matches SFH450/V and SFH750V.	6–3
	SFH350V	Black plastic connector housing.				
	SFH551	T1¾ clear plastic.	NA	NA	**Integrated Photodetector** DC coupled transmpedance amplifier with TTL compatible open collector output.	6–7
	SFH551V	Black plastic connector housing.				

Components for Glass Fiber Applications

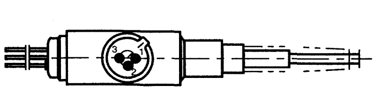
Laser Diodes

Package Outline	Part Number	Package Type	Description	Page
	STL51004G STM51004x STH51004G	TO-18 type with pigtail	1300 nm MQW laser diode.	6–34
	STL51005G STM51005x STH51005G	TO-18 type with pigtail and flange		
	STL51007G STM51007G STH51007G	TO-18 receptacle package with 2 hole flange	1300 nm MQW laser diode.	6–36
	STL81007G STM81007G	TO-18 receptacle package with 2 hole flange	1500 nm MQW laser diode.	6–38

Photodiodes

Package Outline	Part Number	Package Type	Description	Page
	SRD00214x	With pigtail	Ternary PIN diode.	6–32
	SRD00215x	With pigtail and flange		
	SRD00217x	Receptacle and 2 hole flange	Ternary PIN diode.	

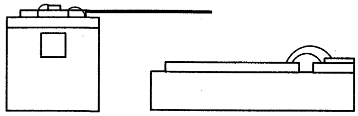
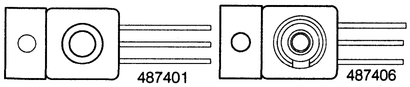
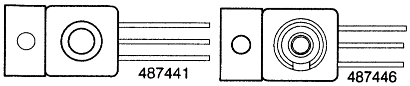
Bidirectional Modules

Package Outline	Part Number	Package Type	Description	Page
	SBL51214G SBM51214G	TO-18 subcomponents	1300 nm emitting /1300 receiving.	6–13
	SBL51414G SBM51414G SBH51414G	TO-18 subcomponents	1300 nm emitting /1300 receiving.	6–16

Note

Siemens offers a wide variety of connector, receptacle and pinning options. Please refer to part numbering matrix on page 6–12 for available options or contact your local Siemens Components sales office (see inside back cover).

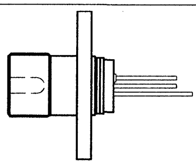
High Power Laser Diodes

Package Outline	Part Number	Package Type	Description	Page
 SFH480402/42 SFH480403/43	SFH480402 SFH480403	Chip on carrier	InAlGaAs 808 nm laser diode, 1000 mW.	6–21
	SFH480442 SFH480443		InAlGaAs 940 nm laser diode, 1000 mW.	6–23
	SFH487401 SFH487406	TO 220 SFH487406–FC connector (750 mW)	InAlGaAs 808 nm laser diode, 1000 mW.	6–26
	SFH487441 SFH487446	TO 220 SFH487446–FC connector (750 mW)	InAlGaAs 940 nm laser diode, 1000 mW.	6–29

Laser Bars

Package Outline	Part Number	Package Type	Description	Page
No package drawing	SFH485721 SFH485400 SFH485600	Unmounted bars	In(Al)GaAs laser diode arrays.	6–25

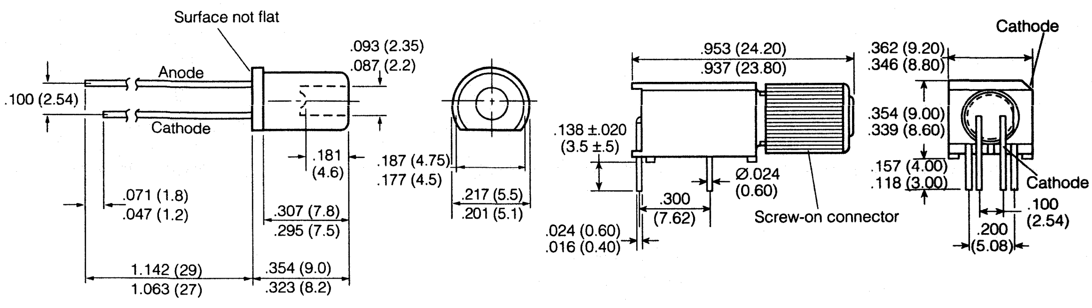
Energy Converter

Package Outline	Part Number	Package Type	Description	Page
	SFH2115	Similar to TO 18	GaAs energy converter. 8 diodes connected in series. For optical power and data delivery.	6–19

SIEMENS

5 mm LED PACKAGE SFH250
PLASTIC CONNECTOR HOUSING SFH250V
PLASTIC FIBER OPTIC PHOTODIODE DETECTOR

Package Dimensions in inches (mm)



SFH250 SFH250V

FEATURES

- **2.2 mm Aperture Holds Standard 1000 Micron Plastic Fiber**
- **No Fiber Stripping Required**
- **Fast Switching Time**
- **Very Good Linearity**
- **Sensitive in Visible and Near IR Range**
- **Molded Microlens for Efficient Coupling**
- **SFH250V Only**
  - **– Plastic Connector Housing**
  - **– Mounting Screw Attached to Connector**
  - **– Interference Free Transmission from Light-Tight Housing**
  - **– Transmitter and Receiver Can Be Flexibly Positioned**
  - **– No Cross Talk**
  - **– Auto Insertable and Wave Solderable**
  - **– Supplied in Tubes**

APPLICATIONS

- **Household Electronics**
- **Power Electronics**
- **Optical Networks**
- **Medical Instruments**
- **Automotive Electronics**
- **Light Barriers**

Maximum Ratings

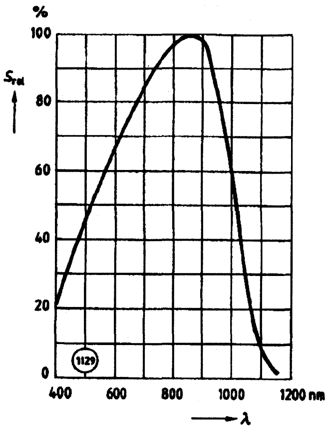
Operating and Storage Temperature Range (T_{OP}, T_{STG})..–55° to +100°C
Soldering Temperature (2 mm from case bottom) (T_S) t≤5 s .... 260°C
Reverse Voltage (V_R) .... 30 V
Power Dissipation (P_{TOT}) T_A=25°C .... 100 mW
Thermal Resistance (R_{thJA}).................................... 750 K/W
Junction Temperature (T_J)....................................... 100°C

Characteristics (T_A=25°C)

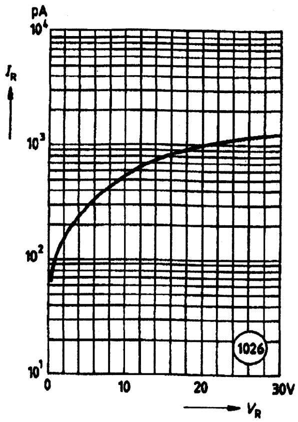
Parameter	Symbol	Value	Unit
Maximum Photosensitivity Wavelength	λS_{MAX}	850	nm
Photosensitivity Spectral Range (S=10% of S_{MAX})	λ	400 to 1100	nm
Dark Current (V_R=20 V)	I_R	1(≤10)	nA
Capacitance (V_R=0 V, f=1 mHz, E_V=0 lx)	C_0	11	pF
Rise and Fall Time of Photocurrent 10% to 90% and 90% to 10% (R_L=50 Ω, V_R=30 V, λ=880 nm)	t_R, t_F	10	ns
Noise Equivalent Power	NEP	2.9 x 10^{-14}	W/√Hz
Detection Limit (V_R=20m)	D*	3.5 x 10^{12}	cm•√Hz/W
Photocurrent (V_R=5 V, λ=660 nm) (V_R=5 V, λ=950 nm)	I_P	 3(≥1.6) 4(≥2.5)	µA
Open Circuit Voltage	V_O	300	mV
Temperature Coefficient I_P (V_R=5 V, λ=560 to 660 nm) (V_R=5 V, λ=830 nm) (V_R=5 V, λ=950 nm)	TC_I	 –0.04 0.04 0.2	%/K
Temperature Coefficient V_L	TC_V	–2.6	mV/K

See Appnote 40, 41, 43 for application information.

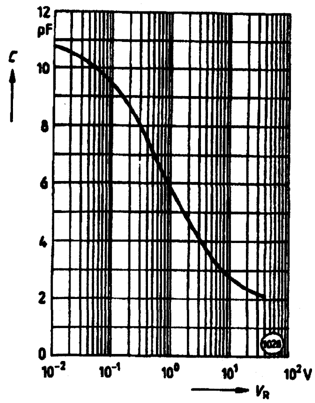
Relative spectral sensitivity $S_{REL}=f(\lambda)$



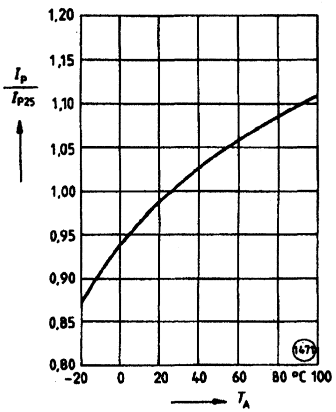
Dark current $I_R=f(V_R)$, $T_A=25°C$



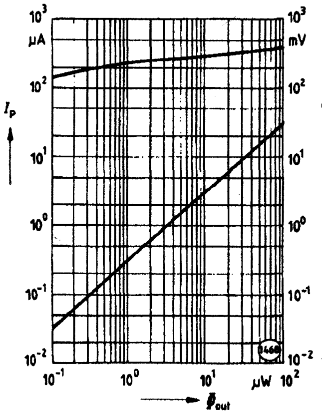
Capacitance $C=f(V_R)$, f=1 MHz
$E_V=0$



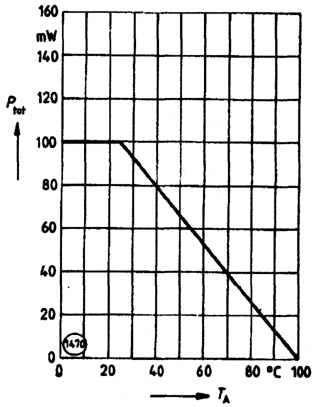
Photocurrent $I_P/I_{P25}=f(T_A)$,
λ=950 nm



Photocurrent $I_P=f(\Phi_{OUT})$,
Open circuit voltage $V_O=f(\Phi_{OUT})$
λ=560 to 660 nm



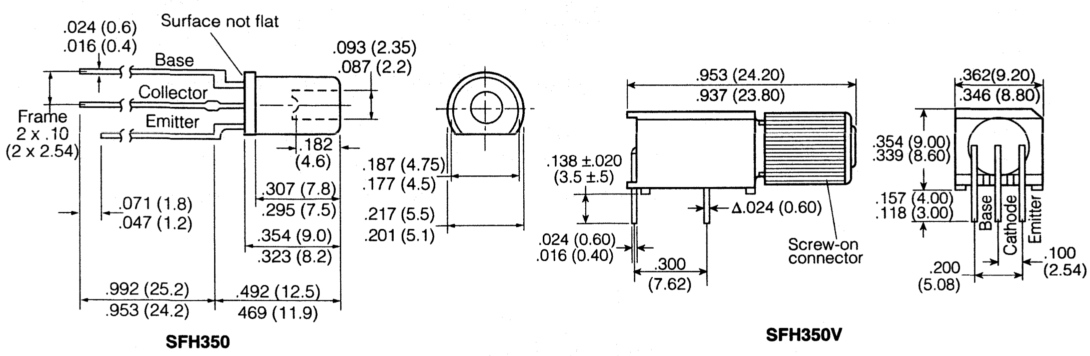
Power dissipation $P_{TOT}=f(T_A)$



SIEMENS

5 mm LED PACKAGE SFH350
PLASTIC CONNECTOR HOUSING SFH350V
PLASTIC FIBER OPTIC PHOTOTRANSISTOR DETECTOR

Package Dimensions in inches (mm)



FEATURES

- **2.2 mm Aperture Holds Standard 1000 Micron Plastic Fiber**
- **No Fiber Stripping Required**
- **Good Linearity**
- **Sensitive in Visible and Near IR Range**
- **Molded Microlens for Efficient Coupling**
- **SFH350V Only**
  - **Plastic Connector Housing**
  - **Mounting Screw Attached to Connector**
  - **Interference Free Transmission from Light-Tight Housing**
  - **Transmitter and Receiver Can Be Flexibly Positioned**
  - **No Cross Talk**
  - **Auto Insertable and Wave Solderable**
  - **Supplied in Tubes**

APPLICATIONS

- **Household Electronics**
- **Power Electronics**
- **Optical Networks**
- **Medical Instruments**
- **Automotive Electronics**
- **Light Barriers**

Maximum Ratings

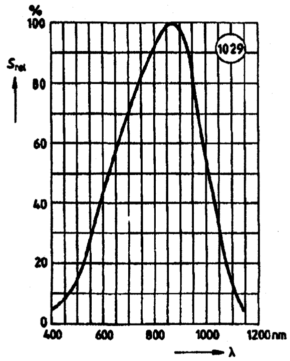
Operating and Storage Temperature Range (T_{OP}, T_{STG}).... –55° to 100°C
Soldering Temperature (2 mm from case bottom) (T_S) t≤5 s .... 260°C
Collector-emitterVoltage (V_{CE}) .... 50 V
Collector Current (I_C) .... 50 mA
Collector Peak Current (I_{CP}) ≤10 sec. .... 100 mA
Emitter Base Voltage (V_{EB}) 7V
Power Dissipation (P_{TOT}) T_A=25°C .... 200 mW
Thermal Resistance (R_{thJA})..375 K/W
Reverse Voltage (V_R) .... 30 V

Characteristics (T_A=25°C)

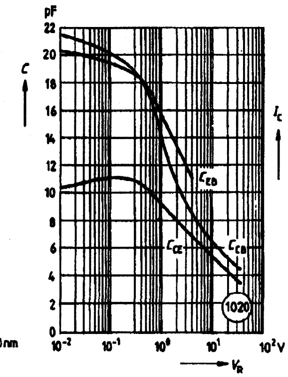
Parameter	**Symbol**	**Value**	**Unit**
Maximum Photosensitivity Wavelength	λS_{MAX}	850	nm
Photosensitivity Spectral Range (S=10% of S_{MAX})	λ	400 to 1100	nm
Capacitance (V_{CE}=0 V, f=1 MHz, E_V=0 lx) (V_{CB}=0 V, f=1 MHz, E_V=0 lx) (V_{EB}=0 V, f=1 MHz, E_V=0 lx)	 C_{CE} C_{CB} C_{EB}	 10.5 21.5 20.5	pF
Rise and Fall Time of Photocurrent (R_L=1 KΩ, I_C=1.0 mA, V_{CE}=5 V, λ=959 nm)	t_R, t_F	20	µs
Current Gain	HFE	500	–
Collector Dark Current V_{CE}=10 V	I_{CEO}	2 (≤50)	nA
Photocurrent (V_{CE}=5 V, λ=660 nm)	I_{CE}	0.8 (≥0.16)	mA
Temperature Coefficient, HFE	TC_{HFE}	0.55	%/K
Temperature Coefficient I_{CE} (λ=560 to 660 nm) (λ=830 nm) (λ=950 nm)	TC_I	 0.34 0.49 0.66	%/K

See Appnote 40, 41, 43 for application information.

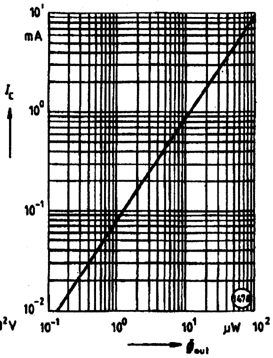
Relative spectral sensitivity $S_{REL}=f(\lambda)$



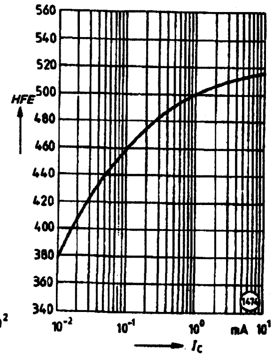
Capacitance $C=f(V_R)$, f=1 MHz, $E_V=0$



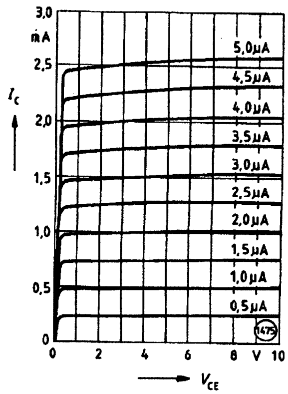
Photocurrent $I_C=f(\Phi_{OUT})$, V_{CE}=5 V, λ=560 to 950 nm



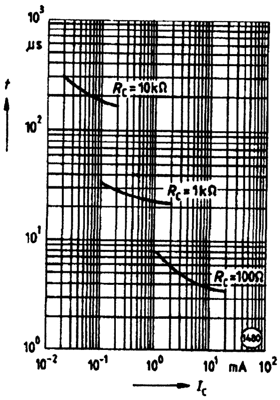
Current gain $HFE=f(I_C)$, V_{CE}=5 V, T_A=25°C



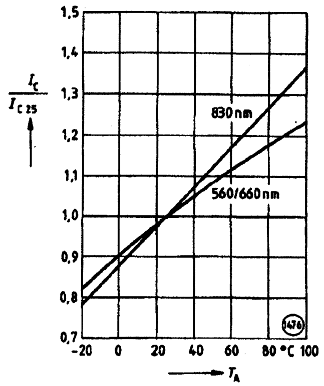
Output characteristics $I_C=f(V_{CE})$ I_B=parameter



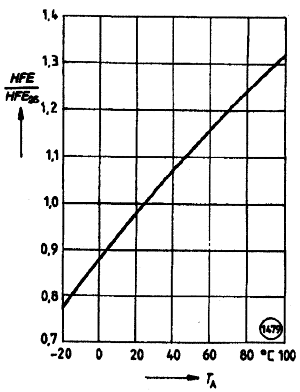
Response time $t=f(I_C)$, V_{CC}=5 V, λ=950 nm



Photocurrent $I_C/I_{C25}=f(T_A)$, V_{CE}=5 V, λ=parameter



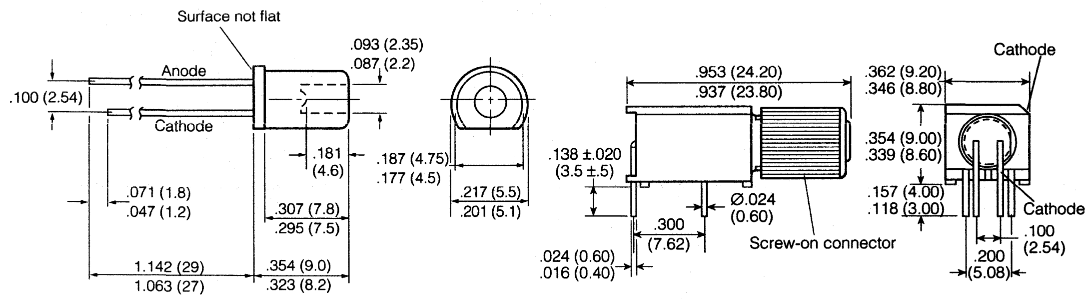
Current gain $HFE/HFE_{25}=f(T_A)$, V_{CE}=5 V, I_C=1 mA



SIEMENS

5 mm LED PACKAGE SFH450
PLASTIC CONNECTOR HOUSING SFH450V
PLASTIC FIBER OPTIC EMITTER

Package Dimensions in inches (mm)



SFH450 SFH450V

FEATURES

- **2.2 mm Aperture Holds Standard 1000 Micron Plastic Fiber**
- **No Fiber Stripping Required**
- **Good Linearity**
- **Sensitive in Visible and Near IR Range**
- **Molded Microlens for Efficient Coupling**
- **SFH450V Only**
  - **Plastic Connector Housing**
  - **Mounting Screw Attached to Connector**
  - **Interference Free Transmission from Light-Tight Housing**
  - **Transmitter and Receiver Can Be Flexibly Positioned**
  - **No Cross Talk**
  - **Auto Insertable and Wave Solderable**
  - **Supplied in Tubes**

APPLICATIONS

- **Household Electronics**
- **Power Electronics**
- **Optical Networks**
- **Medical Instruments**
- **Automotive Electronics**
- **Light Barriers**

Maximum Ratings

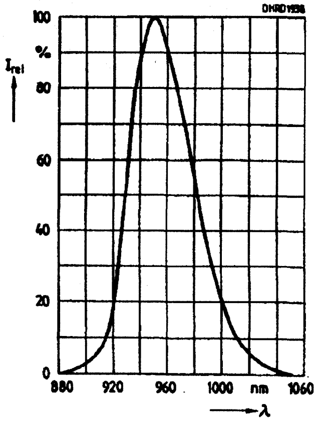
Operating and Storage
Temperature Range (T_{OP}, T_{STG}) .... –55° to 100°C
Junction Temperature (T_J) .... 100°C
Soldering Temperature
(2 mm from case bottom) (T_S) t≤5 s .... 260°C
Reverse Voltage (V_R) .... 5 V
Forward Current, DC (I_F) .... 130 mA
Surge Current (I_{FSM}) t≤10 µsec, D=0 .... 3.5 A
Power Dissipation (P_{TOT}) T_A=25°C .... 200 mW
Thermal Resistance, Junction/Air (R_{thJA}) .... 375 K/W

Characteristics (T_A=25°C)

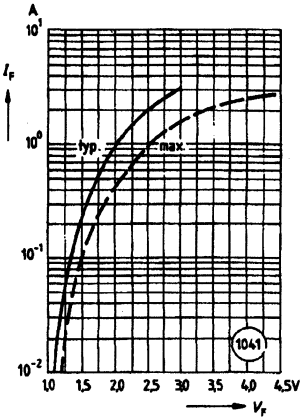
Parameter	Symbol	Value	Unit
Peak Wavelength	λ_{PEAK}	950	nm
Spectral Bandwidth	$\Delta\lambda$	55	nm
Switching Times (10% to 90% and 90% to 10%) (R_L=47 Ω, I_F=10 mA)	t_R, t_F	1	µs
Capacitance	C_0	40	pF
Forward Voltage (I_F=100 mA)	V_F	1.3 (≤1.5)	V
Output Power Coupled into Plastic Fiber (1 mm core diameter), distance lens to fiber ≤0.1 mm, polished fiber, I_F=10 mA	Φ_{IN}	90 (≥25)	µW
Temperature Coefficient, Φ_{IN}	TC_{Φ}	–0.5	%/K
Temperature Coefficient, V_F	TC_V	–1.5	mV/K
Temperature Coefficient, λ_{PEAK}	TC_{λ}	0.3	nm/K

See Appnote 40, 41, 43 for application information.

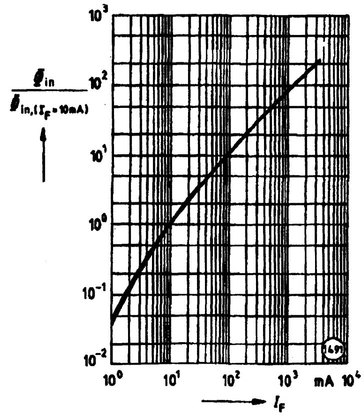
Relative spectral emission
$I_{REL}=f(\lambda)$



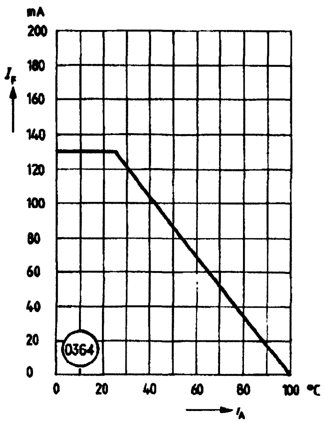
Forward current $I_F=f(V_F)$–SFH450
(Single pulse, duration=20µs)–SFH450V



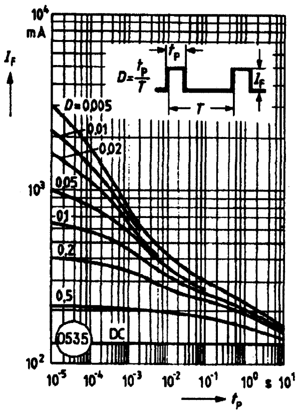
Relative output power
$\Phi_{IN}/\Phi_{IN(10\ mA)}=f(I_F)$



Maximum permissible forward current $I_F=f(T_A)$



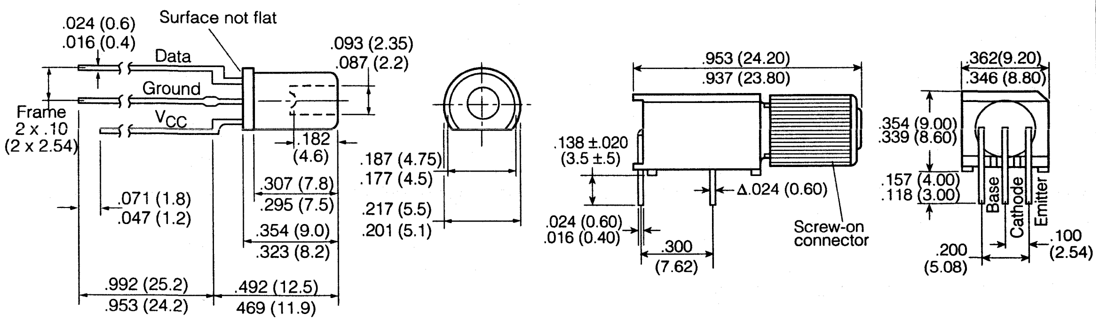
Permissible pulse load–SFH450V
$I_F=f(t_P)$, duty cycle D=parameter, T_A=25°C



SIEMENS

5 mm LED PACKAGE SFH551
RIGHT ANGLE HOUSING SFH551V
PLASTIC FIBER OPTIC INTEGRATED PHOTODETECTOR

Package Dimensions in inches (mm)



SFH551 **SFH551V**

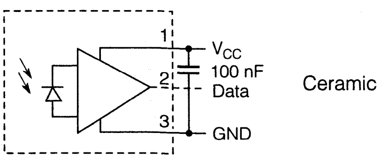
FEATURES

- **Bipolar IC with Open-Collector Output**
- **Digital Output, TTL Compatible, Open Collector**
- **Suitable for 2.2 mm Plastic Fiber with 1 mm Core Diameter**
- **Transfer Rate ≤5 MBit/s**
- **Low Switching Threshold**
- **High Sensitivity from Integrated µLens**
- **SFH551–5 mm Package**
- **SFH551V–Right Angle Plastic Housing**
- **SFH551V–Simple and Fast Reversible Connection between Fiber and Component**
- **SFH551V–Easy Coupling to Plastic Fiber without Stripping or Decladding**

Maximum Ratings

Storage Temperature Range (T_{STG}) ....–55 to 100°C
Operating Temperature Range (T_{OP}) ....–40 to 85°C
Supply Voltage (V_{CC}) ....0.5 to 7 V
Output Voltage (V_O).....................................0.5 to 7 V
Output Current (I_O)... 50 mA
Power Dissipation (output) (P_O) ....85 mW

Block Diagram



A bypass capacitor (100 nF) near the device is necessary between V_{CC} and ground.

See Appnote 40, 41, 43 for application information.

DESCRIPTION

The SFH551/V is a photodetector intended for use with 1000 micron plastic optical fiber. This device amplifies incoming signals via a DC coupled trans-impedance amplifier, and its open collector output is TTL compatible.

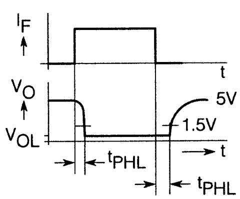
The SFH551 comes in a T1$^3/_4$ plastic package with a tubular aperture wide enough to accomodate fiber and cladding. The SFH551V is housed in a unique plastic right angle package for easy coupling between the fiber and the photodetector.

The SFH551/V is suitable for data communication uses such as: LANs, medical equipment, and automotive electronics.

Characteristics (T_A=25°C, V_{CC}=4.75 V to 5.25 V)

Parameter	Symbol	Value	Unit
Current Consumption (V_{CC}=5 V)	I_{CC}	12 (≤18)	mA
Output Voltage, Low (I_{OL}=13 mA, Φ_{outL}≥4 mW)	V_{OL}	0.4 (≤0.6)	V
Output Current, High (V_{OH}=5.25 V, Φ_{outH}≤0.1 mW)	I_{OH}	5 (≤300)	µA
Optical Power, Low (λ=660 nm)	Φ_{outL}	4 to 50 –24 to –13	µW dBm
Optical Power, High (λ=660 nm)	Φ_{outH}	≤0.1 –40	µW dBm
Delay Times (Φ_{outL}=4 µW to 50 µW, R_L=350 Ω, C_L=15 pF, l=1 m)	t_{PHL} t_{PLH}	75 75	ns ns

Delay Time



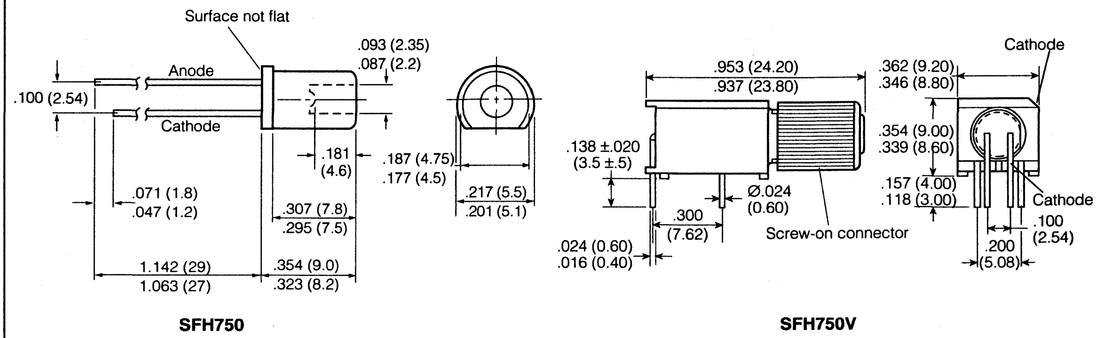
Fiber Optics & High Power Laser Diodes

6

SIEMENS

5 mm LED PACKAGE SFH750
PLASTIC CONNECTOR HOUSING SFH750V
PLASTIC FIBER OPTIC EMITTER

Package Dimensions in inches (mm)



FEATURES

- **2.2 mm Aperture Holds Standard 1000 Micron Plastic Fiber**
- **No Fiber Stripping Required**
- **Good Linearity**
- **Sensitive in Visible and Near IR Range**
- **Molded Microlens for Efficient Coupling**
- **SFH750V Only**
  - **Plastic Connector Housing**
  - **Mounting Screw Attached to Connector**
  - **Interference Free Transmission from Light-Tight Housing**
  - **Transmitter and Receiver Can Be Flexibly Positioned**
  - **No Cross Talk**
  - **Auto Insertable and Wave Solderable**
  - **Supplied in Tubes**

APPLICATIONS

- **Household Electronics**
- **Power Electronics**
- **Optical Networks**
- **Medical Instruments**
- **Automotive Electronics**
- **Light Barriers**
- **Motor Control**

Maximum Ratings

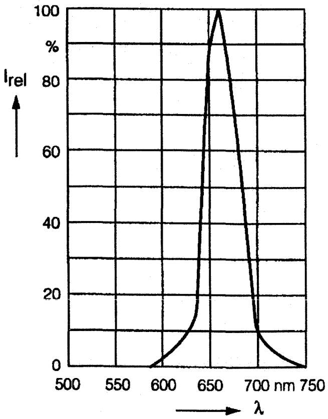
Operating and Storage
Temperature Range (T_{OP}, T_{STG}) .... –55° to 100°C
Junction Temperature (T_J) .... 100°C
Soldering Temperature
(2 mm from case bottom) (T_S) t≤5 s .... 260°C
Reverse Voltage (V_R) .... 5 V
Forward Current, (I_F) .... 45 mA
Surge Current (I_{FSM}) t≤10 µsec, D=0 .... 1 A
Power Dissipation (P_{TOT}) .... 150 mW
Thermal Resistance, Junction/Air (R_{thJA}) .... 500 K/W

Characteristics (T_A=25°C)

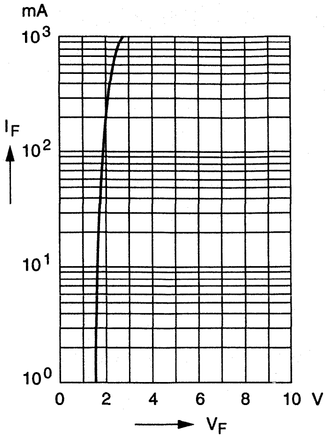
Parameter	Symbol	Value	Unit
Peak Wavelength	λ_{PEAK}	660	nm
Spectral Bandwidth	$\Delta\lambda$	35	nm
Switching Times (R_L=47 Ω, I_F=10 mA) (10% to 90%) (90% to 10%)	 t_R t_F	 0.12 0.05	µs
Capacitance (f=1 MHz, V_R=0 V)	C_0	25	pF
Forward Voltage (I_F=10 mA)	V_F	1.6 (≤2.0)	V
Output Power Coupled into Plastic Fiber (1 mm core diameter), distance lens to fiber ≤0.1 mm, polished fiber, I_F=10 mA	Φ_{IN}	9 (≥25)	µW
Temperature Coefficient, Φ_{IN}	TC_{Φ}	–0.8	%/K
Temperature Coefficient, V_F	TC_V	–1.5	mV/K
Temperature Coefficient, λ_{PEAK}	TC_{λ}	0.17	nm/K

See Appnote 40, 41, 43 for application information.

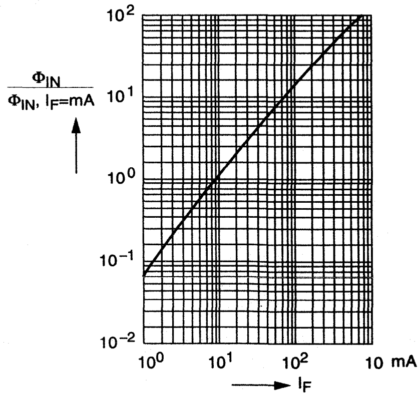
Relative spectral emission–SFH750V
$I_{REL}=f(\lambda)$



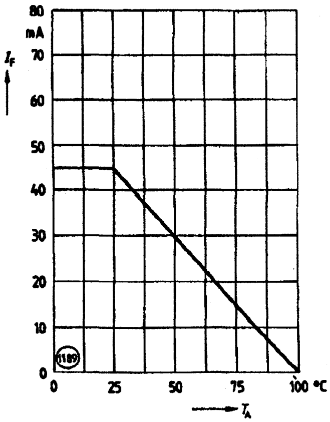
Forward current $I_F=f(V_F)$,
single pulse, duration=20 µs



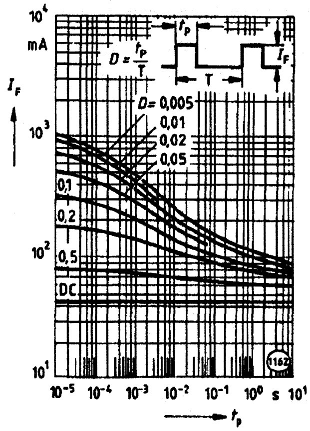
Relative optical output power
$\Phi_{IN}/\Phi_{IN(10\ mA)}=f(I_F)$



Maximum permissible forward current $I_F=f\ (T_A)$

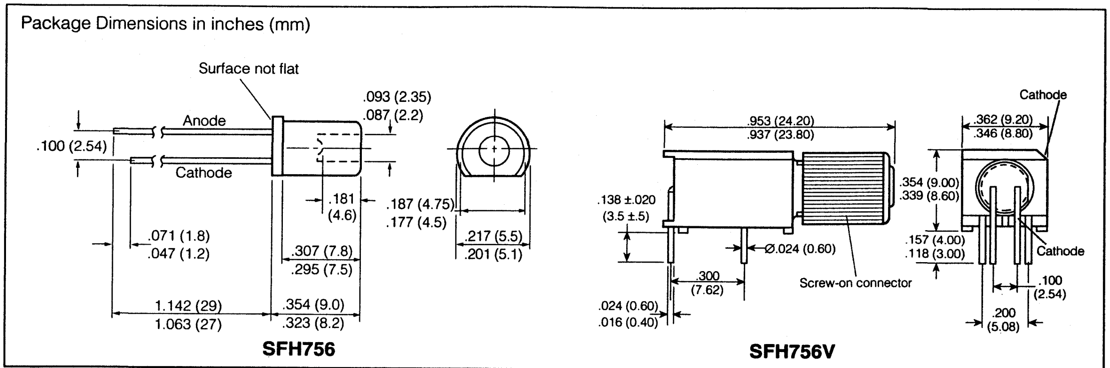


Permissible pulse load $I_F=f\ (T_A)$
duty cycle D=parameter, T_A=25°C



SIEMENS

5 mm LED PACKAGE SFH756
PLASTIC CONNECTOR HOUSING SFH756V
PLASTIC FIBER OPTIC EMITTER



FEATURES

- **2.2 mm Aperture Holds Standard 1000 Micron Plastic Fiber**
- **No Fiber Stripping Required**
- **Good Linearity**
- **Molded Microlens for Efficient Coupling**
- **SFH756V Only**
  - **Plastic Connector Housing**
  - **Mounting Screw Attached to Connector**
  - **Interference Free Transmission from Light-tight Housing**
  - **Transmitter and Receiver: Flexible Positioning**
  - **No Cross Talk**
  - **Auto Inseratable and Wave Solderable**
  - **Supplied in Tubes**

APPLICATIONS

- **Household Electronics**
- **Power Electronics**
- **Optical Networks**
- **Medical Instruments**
- **Automotive Electronics**
- **Light Barriers**
- **Motor Controls**

Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG})... –55 to +100°C
Junction Temperature (T_J)............ 100°C
Soldering Temperature (2 mm from case bottom) (T_S) t≤5 s .... 260°C
Reverse Voltage (V_R) .... 3 V
Surge Current t≤10 µs, D=0 (I_{FSM})............ 1 A
Power Dissipation (P_{TOT}) T_A=25°C .... 120 mW
Thermal Resistance, Junction to Air (R_{thJA}) .... 450 K/W

Characteristics (T_A=25°C)

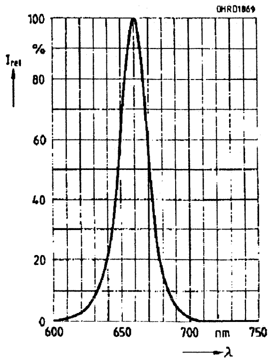
Parameter	Symbol	Value	Unit
Peak Wavelength	λ_{Peak}	660	nm
Spectral Bandwidth	$\Delta\lambda$	25	nm
Switching Times (R_L=50 Ω, I_F=50 mA) 10% to 90% 90% to 10%	 t_R t_F	 0.1 0.1	 µs µs
Capacitance (f=1 mHz, V_R=0 V)	C_0	30	pF
Forward Voltage (I_F=50 mA)	V_F	2.1 (≤2.8)	V
Output Power Coupled into Plastic Fiber (I_F=50 mA) see Note 1	Φ_{IN}	200 (≥100)	µW
Temperature Coefficient Φ_{IN}	TC_Φ	–0.4	%/K
Temperature Coefficient V_F	TC_V	–3	mV/K
Temperature Coefficient λ_{Peak}	TC_λ	0.16	nm/K

Note

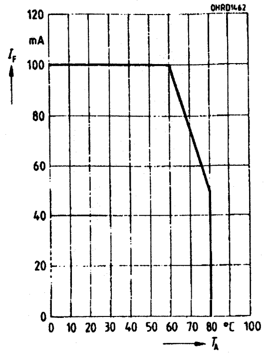
1. The output power coupled into plastic fiber is measured using a large area detector at the end of a short length of fiber (about 30 cm). This value must not be used for calculating the power budget for a fiber optic system with a long fiber because the numerical aperture of plastic fiber decreases in the first few meters. Therefore the fiber seems to display higher attenuation over the first few meters than specified.

See Appnote 40, 41, 43 for application information.

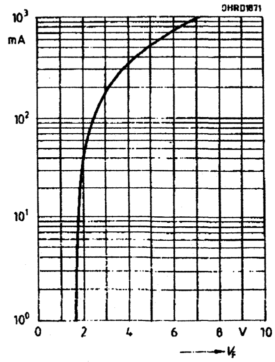
Relative spectral emission $I_{rel}=f(\lambda)$



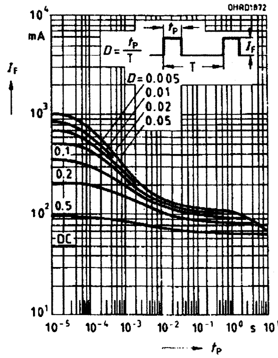
Max. permissible forward current
$I_F=f(T_A)$, R_{thJA}=450 K/W



Forward current $I_F=f(V_F)$
Single pulse τ=20 µs



Permissible pulse handling capability
$I_F=f(t_p)$, T_A=25°C, duty cycle D= Parameter



Fiber Optics & High Power Laser Diodes
6

SIEMENS

New Numbering System for Fiber Optic Devices

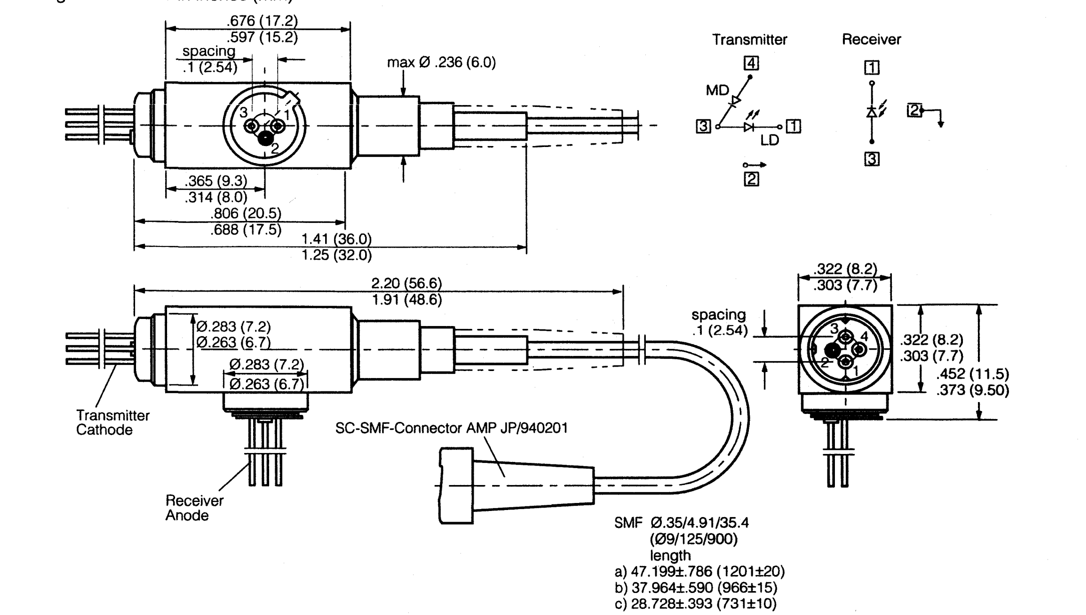
Index 1	Index 2	Index 3	Index 4	Index 5	Index 6	Index 7	Index 8	Index 9
	Fundamental type of device	General Information transmitter/receiver	Transmitter type in detail a: Type and wavelength range	Transmitter type in detail b: Pinning	Receiver type in detail a: Type and wavelength range	Receiver type in detail b: Pinning	Package type	Type of connector/receptacle
S SIEMENS	B BIDI R Receiver T Transmitter	A Analog application B C D Digital application E F G H High power (≥2 mW) I K L Low power (<1 mW) M Medium power (≥1 mW) N O P with preamp in receiver Q R S	0 Receiver 1 IRED (800nm) 2 Laser (800nm) 3 IRED (1300nm) 4 5 Laser (1300nm) 6 DFB (1300nm) 7 8 Laser (1550nm) 9 DFB (1550nm)	0 Receiver 1 Pinning a 2 Pinning b 3 Pinning c 4 Pinning d 5 6 7 8 9 Pinning IRED	0 Transmitter 1 Pin-photodiode 800nm 2 1300 and 1550 nm broadband 3 1300 nm (blocking 1500 nm) 4 1550 nm (blocking 1300 nm) 5 Ge APD 6 7 Monitordiode with receiving function 8 9	0 Transmitter 1 Pinning A 2 Pinning B 3 Pinning C (central pin) 4 Pinning D (w. Preamp) 5 6 7 8 9	0 Special package 1 TO-can without lens 2 TO-can with lens 3 4 Pigtail 5 Pigtail with flange 6 7 Receptacle with 2 hole flange 8 9	A DIN47256 SM B DIN47256 SM HRL C DIN47256 MM D E F G FC/PC SM H FC/PC MM I K L M N O P SC SM Q SC MM R S Optoclip Z without connector

SM = Single Mode
MM = Multi Mode
HRL = High Return Loss

SIEMENS

LOW POWER SBL51214G
MEDIUM POWER SBM51214G
1300/1300 nm BIDI™ TRANSCEIVER OPTICAL MODULE

Package Dimensions in inches (mm)



FEATURES

- **SBL51214G: FC/PC Connector** (see Note)
- **SBM51214G: FC/PC Connector** (see Note)
- **Designed for Passive Optical Networks**
- **Integrated Beam Splitter**
- **Bidirectional Transmission in one Optical Window**
- **Laser Diode with Multi-quantum Well Structure**
- **Suitable for Bit Rates up to Gbit/s**
- **Ternary Photodiode at Rear Mirror to Monitor and Control Radiant Power**
- **Low Noise/High Bandwidth PIN Diode**
- **Hermetically Sealed Subcomponents, Similar to TO 18**
- **With Single Mode Fiber Pigtail**

Note

Siemens offers a wide variety of connector, receptacle and pinning options. Please refer to part numbering matrix on page 6–12 for available options or contact your local Siemens Components sales office (see inside back cover).

Maximum Ratings

Output power ratings refer to the optical port. The operating temperature of the submount is identical to the case temperature.

Module

Operating Temperature Range at Case(T_C) .... –40 to +85°C
Storage Temperature Range (T_{STG})............................ –40 to +85°C
Soldering Temperature (T_S), t_{max}=30 s
2mm from bottom edge of case .... 260°C

Laser Diode

Forward Current (I_{Fmax}) .... 150 mA
Radiant Power CW (Φ_e) .... 1 mW
Reverse Voltage (V_{Rmax}) .... 2 V

Monitor Diode

Forward Current (I_{Fmax}) .... 2 mA
Reverse Voltage (V_{Rmax}) .... 10 V

PIN Photodiode

Forward Current (I_{Fmax}) .... 2 mA
Reverse Voltage (V_{RR}) .... 10 V
Maximum Optical Power into Optical Port ($\Phi_{port\ max}$) .... 1.5 mW

Characteristics, All optical data refer to the optical port

Parameter		Symbol	Value	Unit
Laser Diode				
Optical Output Power	SBL51214x SBM51214x	Φ_e	>0.4 >1.2	mW
Emission Wavelength, Center of Range	SBL51214x, $\Phi_{e=}$0.2 mW SBM51214x, $\Phi_{e=}$0.5 mW	λ	1270–1350	nm
Spectral Bandwidth	SBL51214x, $\Phi_{e=}$0.2 mW (RMS) SBM51214x, $\Phi_{e=}$0.5 mW (RMS)	$\Delta\lambda$	<5	nm
Threshold Current (–40 to +85°C)		I_{th}	2–45	mA
Forward Voltage	SBL51214x, $\Phi_{e=}$0.2 mW SBM51214x, $\Phi_{e=}$0.5 mW	V_F	<1.5	V
Radiant Power at I_{th}	SBL51214x SBM51214x	Φ_{eth}	<20 <50	µW
Current above Threshold, 25°C	SBL51214x, $\Phi_{e=}$0.4 mW SBM51214x, $\Phi_{e=}$1 mW	ΔI_F	10–35	mA
Current above Threshold	SBL51214x, $\Phi_{e=}$0.4 mW SBM51214x, $\Phi_{e=}$1 mW	ΔI_F	7–50	mA
Variation of 1st Derivative of P/I (0.05 –0.4 mW) (0.1 –1 mW)	 SBL51214x SBM51214x	dP/dI	–30 to 30	%
Differential Series Resistance		r_S	<8	Ω
Rise Time/Fall Time (10%–90%)		t_R,t_F	<1	ns
Temperature Coefficient, Wavelength		TC_λ	<0.5	nm/K
Monitor Diode				
Dark Current, V_R=2 V, $\Phi_{e=}$0		I_R	200	nA
Photocurrent, V_R=2 V	SBL51214x, $\Phi_{e=}$0.2 mW SBM51214x, $\Phi_{e=}$0.5 mW	I_P	100–1000 200–1200	µA
Capacitance, V_R=2 V, f=1 MHz		C_2	<10	pF
Tracking Error, V_R=2 V (see Note 1)		TE	–1 to 1	dB
Detector				
Dark Current, V_R=2 V, $\Phi_{e=}$0		I_R	<50	nA
Spectral Sensitivity, V_R=2 V, λ=1300 nm		S_λ	>0.30	A/W
Capacitance, V_R=2 V, f=1 MHz		C_2	<1.5	pF
Rise Time/Fall Time, V_R=2 V (10%–90%)		t_R,t_F	<1	ns
Module				
Optical Crosstalk (see Note 2)		CRT	<–22	dB

Notes

1. The tracking error TE is the variation rate of Φ_e at constant current I_{mon} over a specified temperature range and relative to the reference point: $I_{mon,\ ref}=I_{mon}$(T=25°C, Φ_e=0.2 mW). Thus, TE is given by:

$$TE\ [dB]=10 \times \log \frac{\Phi_e\ [T_c\} - \Phi_e\ [25°C]}{\Phi_e\ [25°C]}$$

2. Optical cross talk is defined as CRT=10 • log ($I_{Det,0}/I_{Det,1}$) with: $I_{Det,0}$ the photocurrent with Φ_e=0.2 mW, CW laser operation, V_R=2 V and $ID_{Det,1}$ the photocurrent without Φ_e, but 0.2 mW optical input power, λ=1380 nm.

Additional Information

T=25°C Threshold current, current above threshold for 0.4 mW output power, monitor current for 0.2 mW output power, peak wavelength.

T=85°C Threshold current, current above threshold for 0.4 mW output power, monitor current for 0.2 mW output power.

End of Life Values

Threshold Current at T=85°C	**Ith**	**<60**	**mA**
Current above Threshold, over full temperature range, at $I_{mon.ref}=I_{mon}$ (T=25°C, Φ_e=0.4 mW, BOL)	ΔI_F	7–70	mA
Tracking Error (see Note 1)	TE	–1.5 to 1.5	dB
Detector Dark Current V_R=2 V, T=85°C	I_R	<400	nA
Monitor Dark Current, V_R=2 V, T=85°C	I_R	<1	µA

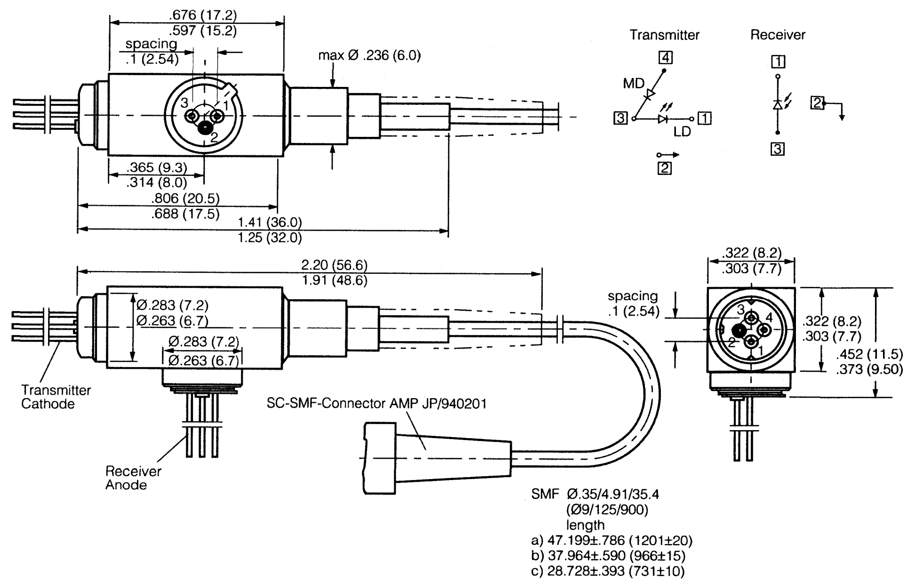
Type: Single Mode, Silica

Mode Field Diameter	9±1	µm
Cladding Diameter	125±2	µm
Mode Field/Cladding Concentricity Error	<1	µm
Cladding Non-circularity	<2	%
Mode Field Non-circularity	<6	%
Cut-off Wavelength	>1270	nm
Jacket Diameter	0.9 ±0.1	mm
Bending Radius	>30	mm
Tensile Strength Fiber Case	>5	N
Length	1 ±0.2	m

SIEMENS

LOW POWER SBL51414G
MEDIUM POWER SBM51414G
HIGH POWER SBH51414G
1300 nm EMITTING, 1550 nm RECEIVING BIDI™ TRANSCEIVER OPTICAL MODULE

Package Dimensions in inches (mm)



FEATURES

- **SBL51414G: FC/PC Connector** (see Note)
- **SBM51414G: FC/PC Connector** (see Note)
- **SBH51414G: FC/PC Connector** (see Note)
- **Designed for Passive Optical Networks**
- **Integrated Wavelength Division Multiplexer**
- **Bidirectional Transmission in 2nd and 3rd Optical Window**
- **Laser Diode with Multi-quantum Well Structure**
- **Suitable for Bit Rates up to Gbit/s**
- **Ternary Photodiode at Rear Mirror to Monitor and Control Radiant Power**
- **Low Noise/High Bandwidth PIN Diode**
- **Hermetically Sealed Subcomponents, Similar to TO 18**
- **With Single Mode Fiber Pigtail**

Note

Siemens offers a wide variety of connector, receptacle and pinning options. Please refer to part numbering matrix on page 6–12 for available options or contact your local Siemens Components sales office (see inside back cover).

Maximum Ratings

Output power ratings refer to the optical port. The operating temperature of the submount is identical to the case temperature.

Module

Operating Temperature Range at Case(T_C) .... –40 to +85°C
Storage Temperature Range (T_{STG}) .... –40 to +85°C
Soldering Temperature (T_S), t_{max}=30 s
2mm from bottom edge of case .... 260°C

Laser Diode

Forward Current (I_{Fmax})... 150 mA
Radiant Power CW (Φ_e).. 1 mW
Reverse Voltage (V_{Rmax}).. 2 V

Monitor Diode

Forward Current (I_{Fmax})... 2 mA
Reverse Voltage (V_R)... 10 V

PIN Photodiode

Forward Current (I_{Fmax})... 2 mA
Reverse Voltage (V_{RR})... 10 V
Maximum Optical Power into Optical Port ($\Phi_{por\ tmax}$)........ 1.5 mW

Characteristics, All optical data refer to the optical port

Parameter		Symbol	Value	Unit
Laser Diode				
Optical Output Power	SBL51414x SBM51414x SBH51414x	Φ_e	>0.4 >1.2 >2.4	mW
Emission Wavelength, Center of Range	SBL51414x, Φ_e=0.2 mW SBM51414x, Φ_e=0.5 mW SBH51414x, Φ_e=1 mW	λ	1270–1350	nm
Spectral Bandwidth	SBL51414x, Φ_e=0.2 mW (RMS) SBM51414x, Φ_e=0.5 mW (RMS) SBH51414x, Φ_e=1 mW (RMS)	$\Delta\lambda$	5	nm
Threshold Current (–40 to +85°C)		I_{th}	2–45	mA
Forward Voltage	SBL51414x, Φ_e=0.2 mW SBM51414x, Φ_e=0.5 mW SBH51414x, Φ_e=1 mW	V_F	<1.5	V
Radiant Power at I_{th}	SBL51414x SBM51414x SBH51414x	Φ_{eth}	<20 <50 <80	µW
Current above Threshold, 25°C	SBL51414x, Φ_e=0.4 mW SBM51414x, Φ_e=1 mW SBH51414x, Φ_e=2 mW	ΔI_F	10–35	mA
Current above Threshold	SBL51414x, Φ_e=0.4 mW SBM51414x, Φ_e=1 mW SBH51414x, Φ_e=2 mW	ΔI_F	7–50	mA
Variation of 1st Derivative of P/I (0.05–0.4 mW) (0.1–1 mW) (0.2–2 mW)	 SBL51414x SBM51414x SBH51414x	dP/dI	–30 to 30	%
Differential Series Resistance		r_S	<8	Ω
Rise Time/Fall Time (10%–90%)		t_R,t_F	<1	ns
Temperature Coefficient, Wavelength		TC_λ	<0.5	nm/K
Monitor Diode				
Dark Current, V_R=2 V, Φ_e=0		I_R	200	nA
Photocurrent, V_R=2 V	SBL51414x, Φ_e=0.2 mW SBM51414x, Φ_e=0.5 mW SBH51414x, Φ_e=1 mW	I_P	100–1000 200–1200 100–1000	µA
Capacitance, V_R=2 V, f=1 MHz		C_2	<10	pF
Tracking Error, V_R=2 V (see Note 1)		TE	–1 to 1	dB
Detector				
Dark Current, V_R=2 V, Φ_e=0		I_R	<50	nA
Spectral Sensitivity, V_R=2 V, λ=1550 nm		S_λ	>0.65	A/W
Capacitance, V_R=2 V, f=1 MHz		C_2	<1.5	pF
Rise Time/Fall Time, V_R=2 V (10%–90%)		t_R,t_F	<1	ns
Module				
Optical Crosstalk (see Note 2)		CRT	<–47	dB

Notes

1. The tracking error TE is the variation rate of Φ_e at constant current I_{mon} over a specified temperature range and relative to the reference point: $I_{mon, ref}=I_{mon}(T=25°C, \Phi_e=0.2\ mW)$. Thus, TE is given by:

$$TE\ [dB]=10 \times \log \frac{\Phi_e\ [Tc\} - \Phi_e\ [25°C]}{\Phi_e\ [25°C]}$$

2. Optical cross talk is defined as $CRT=10 \bullet \log (I_{Det,0}/I_{Det,1})$ with: $I_{Det,0}$ the photocurrent with Φ_e=0.2 mW, CW laser operation, V_R=2 V and $ID_{Det,1}$ the photocurrent without Φ_e, but 0.2 mW optical input power, λ=1550 nm.

Additional Information

T=25°C Threshold current, current above threshold for 0.4 mW output power, monitor current for 0.2 mW output power, peak wavelength.

T=85°C Threshold current, current above threshold for 0.4 mW output power, monitor current for 0.2 mW output power.

End of Life Values

Threshold Current at T=85°C	Ith	<60	mA
Current above Threshold, over full temperature range, at $I_{mon.ref}=I_{mon}$ (T=25°C, Φ_e=0.4 mW, BOL)	ΔI_F	7–70	mA
Tracking Error (see Note 1)	TE	–1.5 to 1.5	dB
Detector Dark Current V_R=2 V, T=85°C	I_R	<400	nA
Monitor Dark Current, V_R=2 V, T=85°C	I_R	<1	µA

Type: Single Mode, Silica

Mode Field Diameter	9±1	µm
Cladding Diameter	125±2	µm
Mode Field/Cladding Concentricity Error	<1	µm
Cladding Non-circularity	<2	%
Mode Field Non-circularity	<6	%
Cut-off Wavelength	>1270	nm
Jacket Diameter	0.9 ±0.1	mm
Bending Radius	>30	mm
Tensile Strength Fiber Case	>5	N
Length	1 ±0.2	m

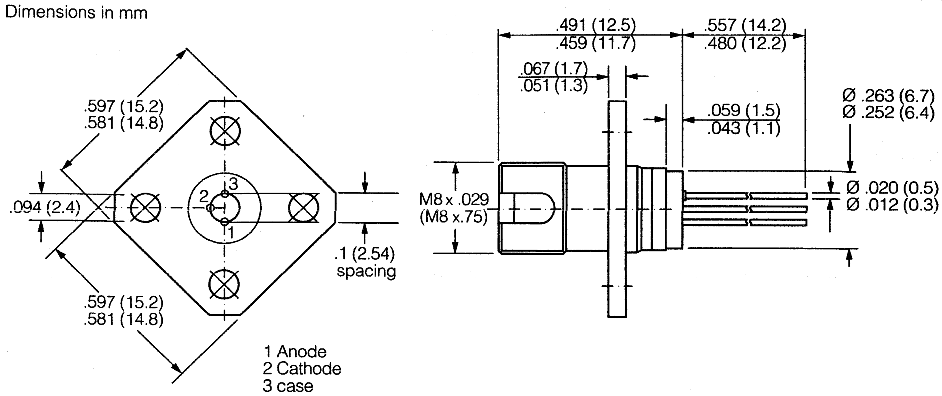
SIEMENS

SFH 2115

GaAs ENERGY CONVERTER

Preliminary Data Sheet

Package Dimensions in mm



FEATURES

- **8 Diodes Connected in Series**
- **TO 18 Package**
- **Floating Output**
- **FC Connector for use with 200 µm Fiber, NA=0.37**

APPLICATIONS

- **Sensors in:**
  - **– High-Voltage Environments**
  - **– Chemical Environments**
  - **– Explosive Environments**
  - **– EMF-Sensitive Environments**
  - **– Medical Engineering**
  - **– Avionics**
- **Couplers**
- **Telecommunications**

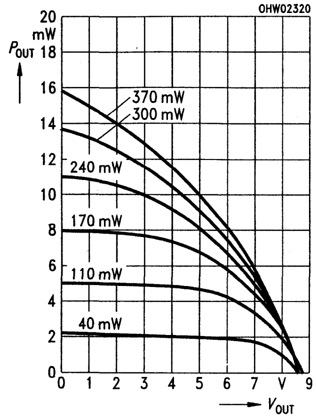
DESCRIPTION

Used in combination with a high power laser diode, such as the SFH487406, SFH2115 is intended for use in fiber optic power delivery systems. Light emitted by the laser diode may be transmitted along optic fiber over distances of up to 1 km to the SFH2115, where the light is converted into electrical power for powering sensor head electronics and the optical return path for data transmission in remote sensor applications. The laser diode light may also be modulated, enabling data and power to be delivered over the same optical path.

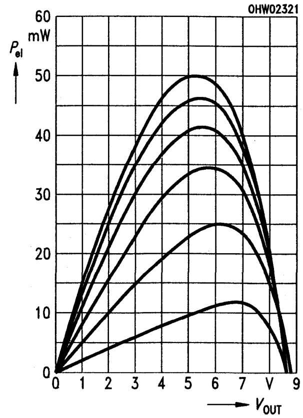
Characteristics (T_A=25°C, λ=800 nm)

Parameter	Symbol	Value	Unit
Radiant Input Power	P_{IN}	10–500	mW
Electrical Output Power	P_{EL}	3–60	mW
Open Circuit Voltage	V_O	>8	V
Short Circuit Voltage P_{IN}=10 mW P_{IN}=250 mW P_{IN}=500 mW	I_{SC}	 0.5 11 19	mA
Maximum Output Power at		5	V
Power Efficiency P_{IN}=40 mW P_{IN}=350 mW	h	 28 14	%
Temperature Coefficient, Short Circuit Current	TC_I	–0.05	%/K
Temperature Coefficient, Open Circuit Voltage	TC_V	–16	mV/K

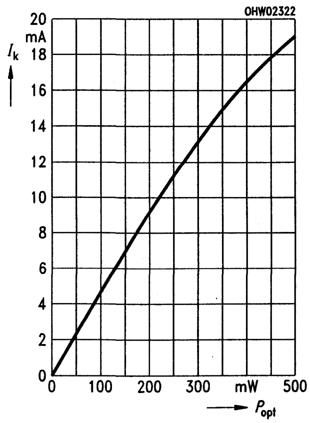
Output characteristics in element operation



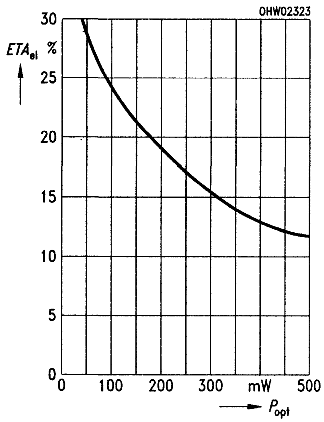
Electrical output power in element operation



Short circuit current I_{SC}=f(P_{opt})

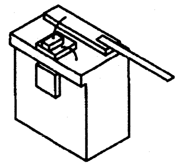


Power efficiency η=f(P_{opt})

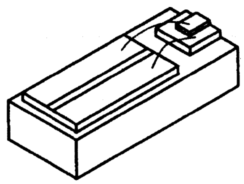


SIEMENS

SFH 480402
SFH 480403
809 nm LASER DIODE 1000 mW



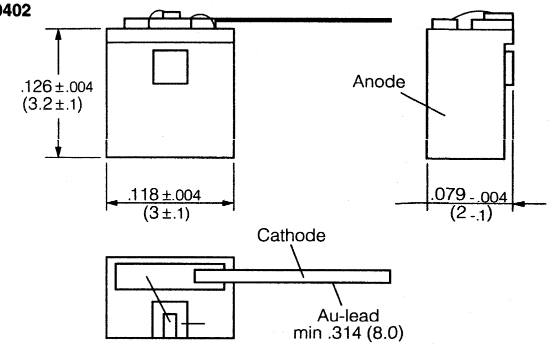
SFH480402



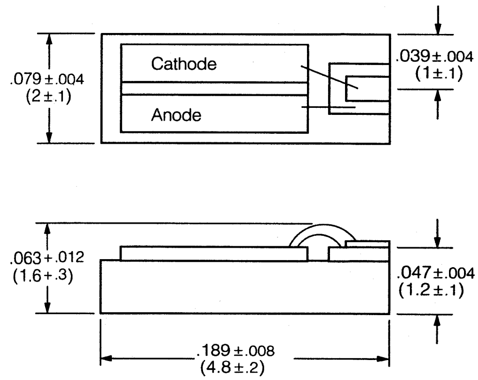
SFH480403

Package Dimensions in inches (mm)

SFH480402



SFH480403



Floating case isolated mounted

FEATURES
- **Monochromatic, Coherent Radiation Source for Pulse and CW-operation**
- **MOCVD Quantum-well Structure**
- **Strained Layer Material**
- **Dielectric Asymmetric Coated Laser Mirrors**
- **Emission Width: 200µm**

APPLICATIONS
- **Pumping of Nd-YAG Lasers**
- **Medical Applications**
- **Testing and Measurement Applications**

Maximum Ratings T_{sub}=25°C

CW-output Power(1) Φ_{eCW} .... 1050 mW
Pulse-output Power(1) Φ_{epuls} .... 1300 mW
Reverse Voltage (V_R) .... 3 V
Operating Temperature (T_{SUB})(2) ..... –10 to +60°C
Storage Temperature (T_{STG})(2) .... (–40) to +70°C
Soldering Temperature, Max.
(T_S) 10 s max. .... 140°C

1. in NA=0.6
2. Bedewing is exluded.

Test Certificate

Each laser diode is supplied with technical information about:

- Radiant power
- Threshold current
- Differential efficiency
- Operating current and operating voltage

Notes for Operation

Overload Protection

The specified values apply only as long as the diode is not overloaded.

Pulse spikes from the power supply unit, for example, even if they last only a few nanoseconds may cause irreversible damage to the laser diode. Such spikes may occur when the power supply is turned on or off or they may reach the laser diode from the line via coupling capacitance of electronically controlled devices.

The power supply should threrefore be provided with appropriate protection circuits.

Handling of Package

Observe the same rules as for handling MOS-devices to avoid electrostatic induced damage.

Eye Protection

This laser diode is a **Class 4 Laser** product.

For safety measures refer to the relevant safety regulations.

Characteristics (T_{sub}=25°C)

Parameter	Symbol	Value	Unit
Laser Diode, CW-operations			
Recommended Operating Temperature	T	+10 to +35	°C
Emission Wavelength	λ_{peak}	809 ±5	nm
Spectral Width	$\Delta\lambda$	2	nm
CW-output Power(1)	Φ_{eCW}	1000	mW
Threshold Current	I_{th}	450	mA
Differential Efficiency(1)	η	0.75	W/A
Operating Current	I_{op}	1700	mA
Operating Voltage	V_{op}	2	V
Differential Serial Resistance	r_S	0.2(<0.4)	Ω
Characteristic Temperature for Threshold Current(2)	T_O	150	K
Temperature Coefficient, Operating Current	TC_I	0.5	%/K
Temperature Coefficient, Wavelength	TC_λ	0.25 to 0.30	nm/K
Thermal Resistance, pn-junction—Heat Sink	$R_{thJ\ NTC}$	9	K/W

1. in NA=0.6
2. Thermal behavior of I_{th} can be modeled as $I_{th2}=I_{th1}\exp(T_2-T_1)/T_0$

Handling Notes

1. Mounting

Follow these guidelines for soldering, glueing or clamping:

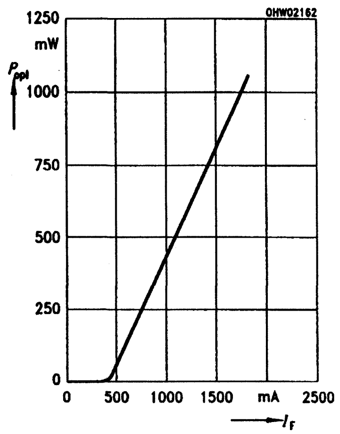
- Maximum soldering temperature140°C
- Maximum soldering time10 s
- Maximum curing temperature, adhesives 100°C

Be careful to avoid deforming the heat sink by clamping.

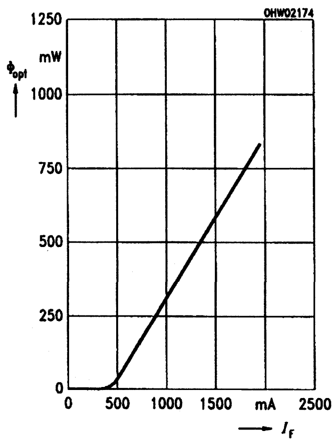
2. Electrical Connection

The cathode can be bonded by spot welding, clamping or soldering. In all cases the ESD guidelines must be followed. When soldering the cathode (Au-lead) use only SN-free solder to avoid making the Au-lead brittle.

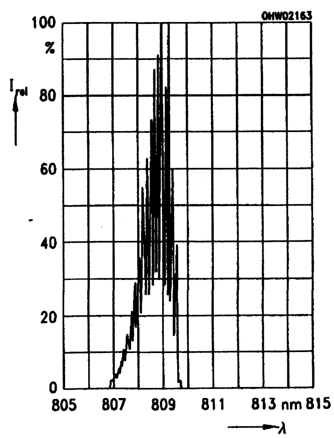
Optical characteristics (T_{SUB}=25°C)
Radiant power $\Phi_{opt}=f(I_F)$



Mode spectrum $I_{REL}=f(\lambda)$

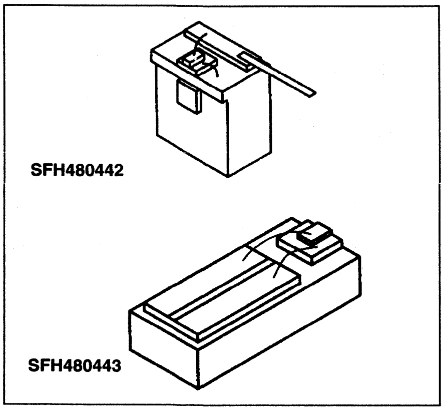


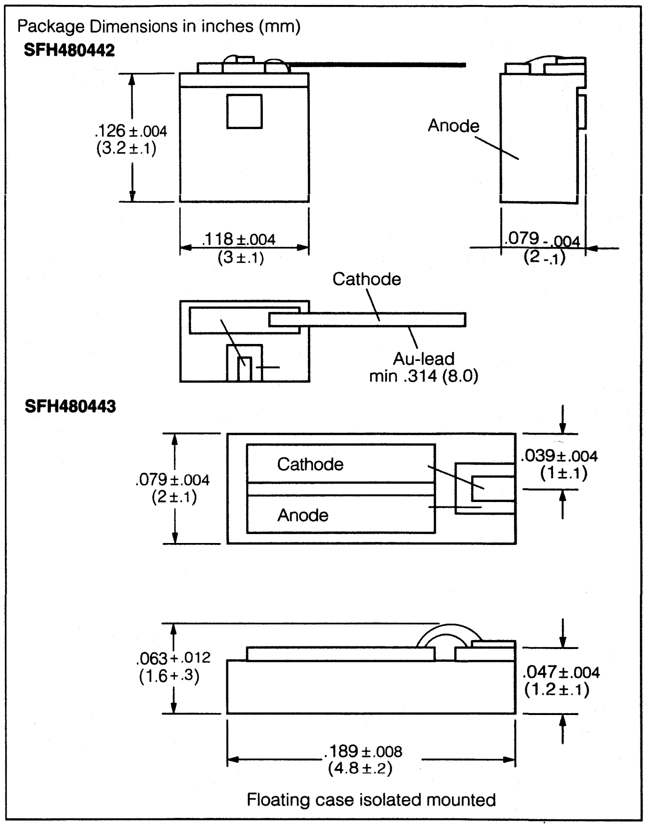
Farfield distribution $I_{REL}=f(\varphi)$
parallel to pn-junction



SIEMENS

SFH 480442
SFH 480443
940 nm LASER DIODE 1000 mW





FEATURES

- **Monochromatic, Coherent Radiation Source for Pulse and CW-operation**
- **MOCVD Quantum-well Structure**
- **Strained Layer Technology**
- **Dielectric Asymmetric Coated Laser Mirrors**
- **Emission Width: 200µm**

APPLICATIONS

- **Pumping of Yb-YAG Lasers**
- **Medical Applications**
- **Testing and Measurement Applications**

Maximum Ratings T_{sub}=25°C

CW-output Power(1) Φ_{eCW} .... 1050 mW
Pulse-output Power(1) Φ_{epuls} .... 1300 mW
Reverse Voltage (V_R) .... 3 V
Operating Temperature (T_{SUB})(2)..... –10 to +60°C
Storage Temperature (T_{STG})(2)....... (–40) to +70°C
Soldering Temperature, Max.
(T_S) 10 s max. .... 140°C

1. in NA=0.6
2. Bedewing is exluded.

Test Certificate

Each laser diode is supplied with technical information about:

- Radiant power
- Threshold current
- Differential efficiency
- Operating current and operating voltage

Notes for Operation

Overload Protection

The specified values apply only as long as the diode is not overloaded.

Pulse spikes from the power supply unit, for example, even if they last only a few nanoseconds may cause irreversible damage to the laser diode. Such spikes may occur when the power supply is turned on or off or they may reach the laser diode from the line via coupling capacitance of electronically controlled devices.

The power supply should threrefore be provided with appropriate protection circuits.

Handling of Package

Observe the same rules as for handling MOS-devices to avoid electrostatic induced damage.

Eye Protection

This laser diode is a **Class 4 Laser** product.

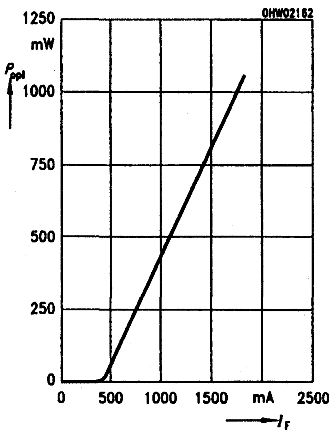
For safety measures refer to the relevant safety regulations.

Characteristics (T_{sub}=25°C)

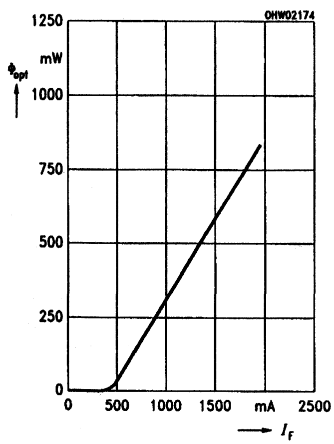
Parameter	**Symbol**	**Value**	**Unit**
Laser Diode, CW-operations			
Recommended Operating Temperature	T	+10 to +35	°C
Emission Wavelength	λ_{peak}	941 ±10	nm
Spectral Width	$\Delta\lambda$	3	nm
CW-output Power[1]	Φ_{eCW}	1000	mW
Threshold Current	I_{th}	450	mA
Differential Efficiency[1]	η	0.75	W/A
Operating Current	I_{op}	1700	mA
Operating Voltage	V_{op}	2	V
Differential Serial Resistance	r_S	0.2(<0.4)	Ω
Characteristic Temperature for Threshold Current[2]	T_O	150	K
Temperature Coefficient, Operating Current	TC_I	0.5	%/K
Temperature Coefficient, Wavelength	TC_λ	0.25 to 0.30	nm/K
Thermal Resistance, pn-junction—Heat Sink	$R_{thJ\ NTC}$	9	K/W

1. in NA=0.6
2. Thermal behavior of I_{th} can be modeled as $I_{th2}=I_{th1}\ \exp\ (T_2 - T_1)/T_0$

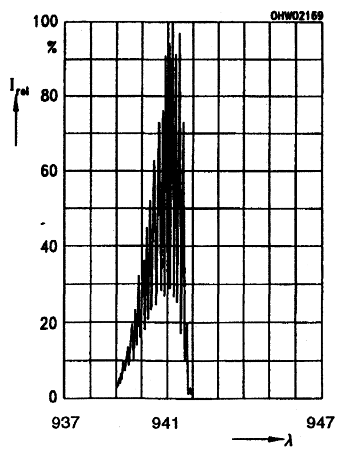
Optical characteristics (T_{SUB}=25°C)
Radiant power $\Phi_{opt}=f(I_F)$



Mode spectrum $I_{REL}=f(\lambda)$



Farfield distribution $I_{REL}=f(\varphi)$
parallel to pn-junction



Handling Notes

1. Mounting

Follow these guidelines for soldering, glueing or clamping:

- Maximum soldering temperature140°C
- Maximum soldering time10 s
- Maximum curing temperature, adhesives 100°C

Be careful to avoid deforming the heat sink by clamping.

2. Electrical Connection

The cathode can be bonded by spot welding, clamping or soldering. In all cases the ESD guidelines must be followed. When soldering the cathode (Au-lead) use only SN-free solder to avoid making the Au-lead brittle.

SIEMENS

SFH 48 5721
SFH 48 5400
SFH 48 5600
LASER BARS, UNMOUNTED

FEATURES

- **Monolithic Linear Array, Unmounted**
- **High Efficiency Quantum Well Structure**
- **Highly Reliable Strained Layer Material: InGaAlAs/GaAs for λ=808 nm InGaAs/GaAs for λ=940 nm**
- **Wavelength Range: 780 nm to 960 nm Standard Wavelength Selection: ±4 nm Other Selections on Request**
- **Temperature Coefficient of Wavelength: 0.25 to 0.30 nm/K**
- **Solderable p- and n-side Metalizations**

Characteristics (Typical values at 25°C)

Type	SFH485721	SFH485400	SFH485600
Recommended Output Power(1)	10–15 W CW	20–30 W CW	50–100 W QCW
Total Conversion Efficiency(1)	≥30%	≥30%	≥30%
Threshold Current(2)	≤8.2 A	≤12 A	≤15 A
Differential Efficiency(2)	≥0.85 W/A	≥0.85 W/A	≥0.85 W/A
Beam Divergence FWHM $\theta_{\perp}$, $\theta_{\parallel}$	40°, 12°	40°, 12°	40°, 12°
Spectral Width(1)	≤ 4 nm	≤ 4 nm	≤ 4 nm
Structure	60 μm broad area with 200 μm center–center spacing	20 stripe array with 400 μm center–center spacing	100 μm broad area with 200 μm center–center spacing
Fill Factor	30%	50%	80%
Emitter per Bar	48	25	77
Emitter Width	60 μm	200 μm	100 μm
Bar Width	9.8 mm	10 mm	10 mm
Cavity Length	600 mm	600 mm	300 mm
Bar Thickness	115 μm	115 μm	115 μm

1. Depends on mounting
2. Measurement conditions: 1 μs pulse width, repetition rate 1 kHz, measured on a single emitter from unmounted bars.

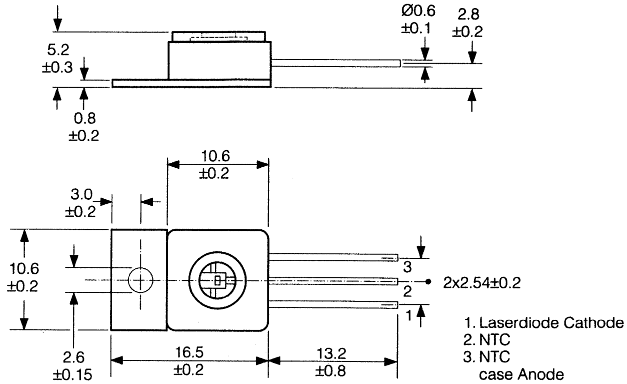
SIEMENS

SFH 487401
SFH 487406

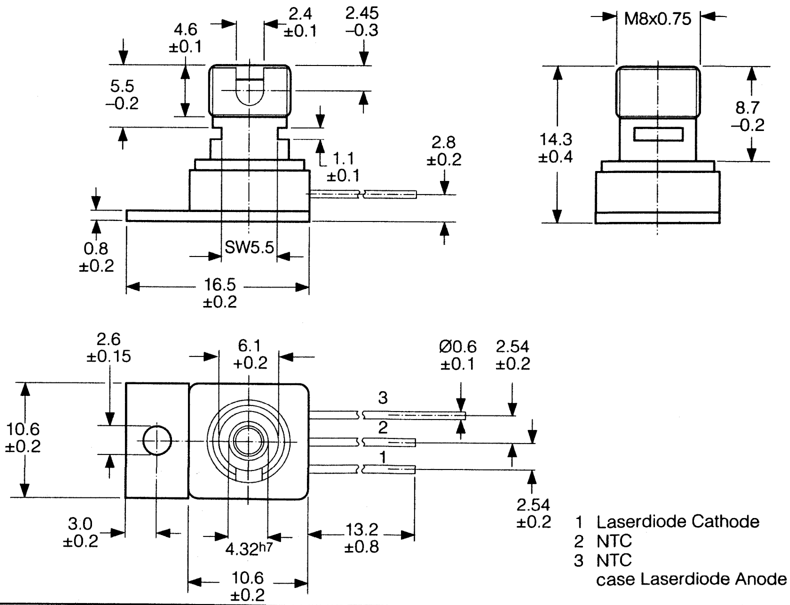
808 nm InAlGaAs LASER DIODE 1000 mW with FC-connector 750 mW(2)

Package Dimensions in inches (mm)

SFH487401



SFH487406



FEATURES

- **Monochromatic, Coherent Radiation Source for Pulse and CW-operation**
- **MOCVD Quantum-well Structure**
- **Strained Layer Technology**
- **Small Size Package for Efficient Thermal Coupling**
- **SFH487401: Microoptics for Improved Farfield Pattern**
- **SFH487406: Microoptics for Efficient Fiber Coupling**
- **Package: To 220-Package**
  SFH487401—Antireflecting Window
  SFH487406—FC-Connector

APPLICATIONS

- **Pumping of Nd-YAG Lasers**
- **Medical**
- **Laser Soldering**
- **Energy Transmission**
- **Testing and Measurement**
- **Trigger High Power Thyristors via Glass Fiber**

NOTES FOR OPERATION

Overload Protection

The specified values apply only as long as the diodes are not overloaded. Pulse spikes from the power supply unit, for example, even if they last only a few nanoseconds may cause irreversible damage to the laser diode. Such spikes may occur when the power supply is turned on or off or they may reach the laser diode from the line via coupling capacitance of electronically controlled devices.

The power supply should therefore be provided with appropriate protection circuits.

Handling of Package

Observe the same rules as for handling MOS-devices to avoid electrostatic-induced damage.

Eye Protection

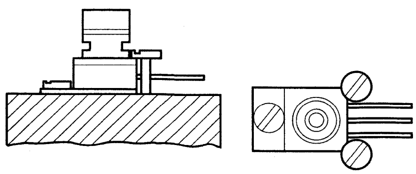
This laser diode is a Class 4 Laser product. For safety measures refer to the relevant safety regulations.

MOUNTING NOTES TO 220

1. Mechanical attachment

1.1 Mounting hole (suitable for M 2.5)
Because of the good thermal conductivity of the TO 220 base (material: copper), the heat loss that is produced is properly dissipated even if the component is only attached on one side.

1.2 For exact positioning of the TO component, like when attaching other parts, e.g. lenses, separately from the laser, it is possible to attach the TO 220 package additionally with an appropriate clamping device or by screws (max. M2.5).



2. Soldering

When soldering the TO base to a heatsink, observe the following guidelines:

Max. soldering temperature: 125°C

Max. soldering duration: 1 min

Maximum Ratings T_{sub}=25°C

CW-output Power (Φ_{eCW})(1) .... 1100 (800)(2) mW
Pulse-output Power (Φ_{epuls})(1) .... 1500 (1100)(2) mW
t≤150 µs, Duty Cycle ≤1%
Reverse Voltage (V_R) .... 3 V
Operating Temperature (T_{SUB}) .... –10 to +60°C
Junction Temperature (T_J) .... max. 65°C
Storage Temperature (T_{STG}) .... –40 to +70°C
Maximum Lead Soldering Temperature (T_S) max. for 5 s .... 250°C

1. In NA=0.6
2. Measured with a fiber NA=0.35, core diameter=125 µm, length=5 m, with attenuation=8 dB/km.

Characteristics (T_{sub}=25°C)

Parameter		Symbol	Value	Unit
Laser Diode, CW-operations				
Recommended Operating Temperature		T	–10 to +35	°C
Emission Wavelength		λ_{peak}	809 ±5	nm
Spectral Width		$\Delta\lambda$	2	nm
CW-output Power(1)	SFH487401 SFH487406	Φ_{eCW} Φ_{eCW}	1000 (2) 750 (2)	mW
Threshold Current		I_{th}	450	mA
Differential Efficiency(1)	SFH487401 SFH487406	η η	0.9 (2) 0.6 (2)	W/A W/A
Operating Current	SFH487401 SFH487406	I_{op} I_{op}	1560 (2) 1700 (2)	mA mA
Operating Voltage		V_{op}	2.1	V
Differential Serial Resistance		r_S	0.3(<0.4)	Ω
Characteristic Temperature for Threshold Current(3)		T_O	150	K
Temperature Coefficient, Operating Current		TC_I	0.5	%/K
Temperature Coefficient, Wavelength		TC_λ	0.25	nm/K
Thermal Resistance, PN-junction—Case		$R_{thJ\ NTC}$	9	K/W
NTC Thermistor				
Resistance		R_{NTC}	10	kΩ

1. in NA=0.6
2. Measured with a fiber NA=0.35, core diameter=125 µm, length=5 m, attenuation=8 dB/km.
3. Thermal behavior of I_{th} can be modeled as $I_{th2}=I_{th1}\exp(T_2-T_1)/T_0$

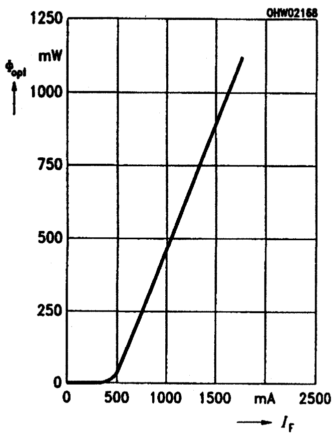
Test Certificate

Each laser diode is supplied with technical information about:

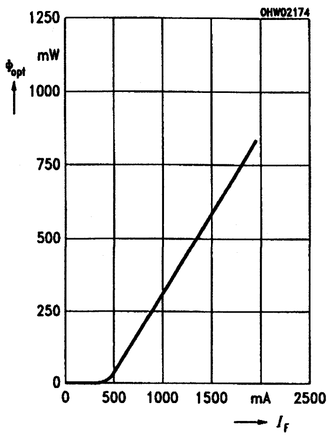
- Radiant power
- Threshold current
- Differential efficiency
- Operating current and operating voltage
- Emission wavelength

Optical Characteristics (T_{SUB}=25°C)

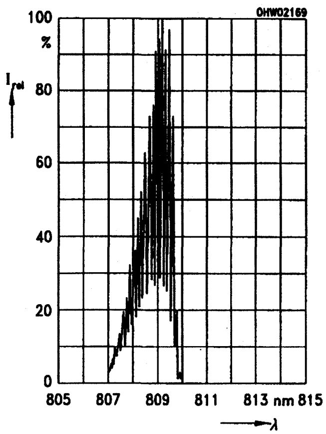
Radiant power $\Phi_{opt}=f(I_F)$, SFH487401



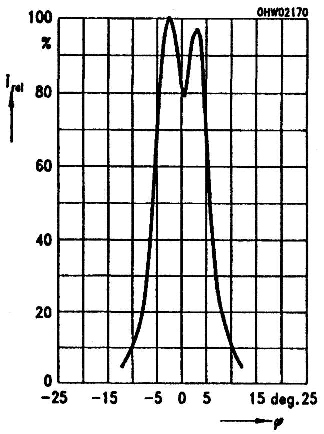
Radiant power $\Phi_{opt}=f(I_F)$, SFH487406



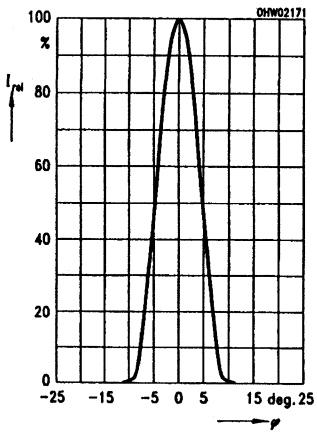
Mode spectrum $I_{REL}=f(\lambda)$



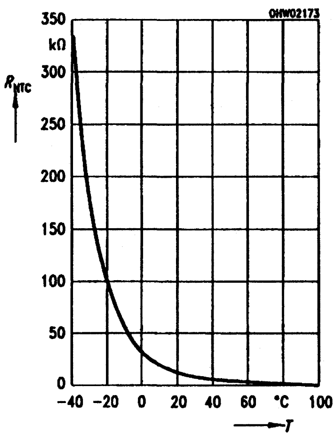
Farfield distribution $I_{REL}=f(\varphi)$
parallel to pn-junction, SFH487401



Farfield distribution $I_{REL}=f(\varphi)$
parallel to pn-junction, SFH487406



NTC Thermistor $R_T=f(T_A)$
$R_{T25°C}$=10 kΩ ±1%



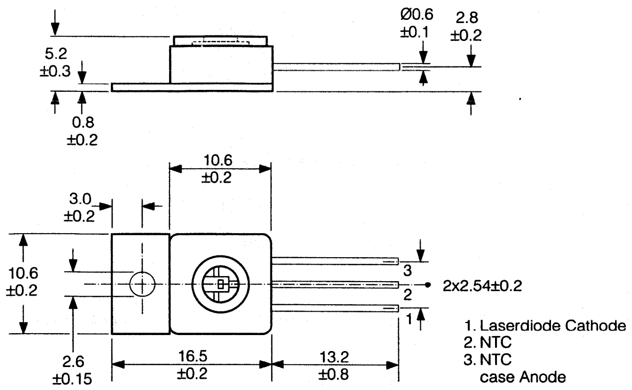
SIEMENS

SFH 487441
SFH 487446

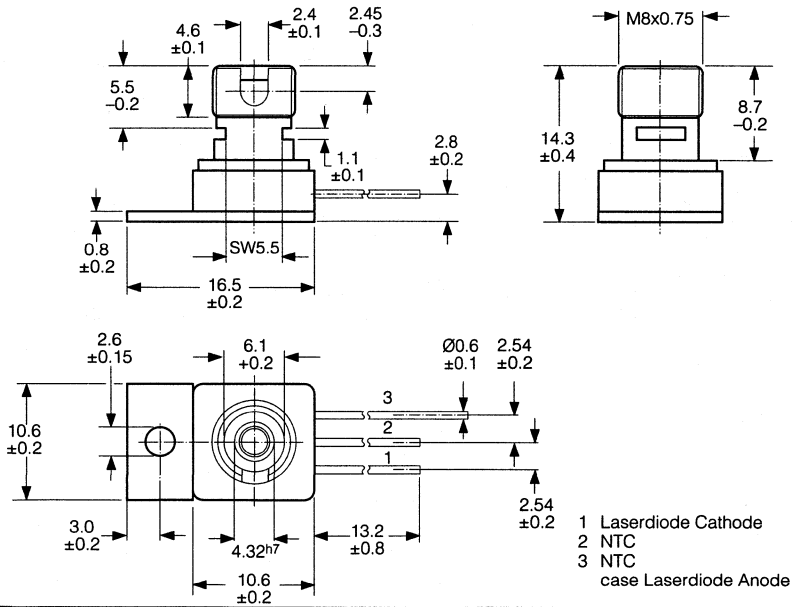
940 nm InGaAs LASER DIODE 1000 mW with FC-connector 750 mW(2)

Package Dimensions in inches (mm)

SFH487441



SFH487441



FEATURES

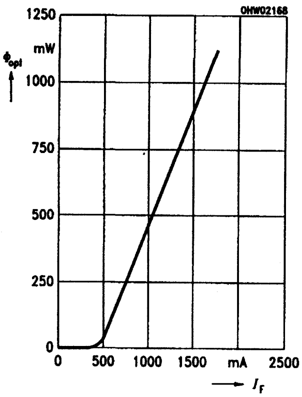
- Monochromatic, Coherent Radiation Source for Pulse and CW-operation
- MOCVD Quantum-well Structure
- Strained Layer Technology
- Small Size Package for Efficient Thermal Coupling
- SFH487441: Microoptics for Improved Farfield Pattern
- SFH487446: Microoptics for Efficient Fiber Coupling
- Package: To 220-Package
  SFH487441—Antireflecting Window
  SFH487446—FC-Connector

APPLICATIONS

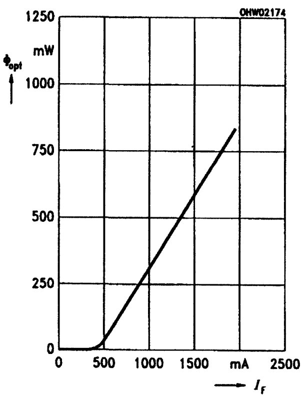
- **Pumping of Yb-YAG Lasers**
- **Medical**
- **Laser Soldering**
- **Energy Transmission**
- **Testing and Measurement**
- **Trigger High Power Thyristors via Glass Fiber**

Optical Characteristics (T_{SUB}=25°C)

Radiant power $\Phi_{opt}=f(I_F)$, SFH487441



Radiant power $\Phi_{opt}=f(I_F)$, SFH487446



Maximum Ratings T_{sub}=25°C

CW-output Power (Φ_{eCW})(1) .... 1100 (800)(2) mW
Pulse-output Power (Φ_{epuls})(1) .... 1500 (1100)(2) mW
t≤150 µs, Duty Cycle ≤1%
Reverse Voltage (V_R) .... 3 V
Operating Temperature (T_{SUB}) .... –10 to +60°C
Junction Temperature (T_J) .... max. 65°C
Storage Temperature (T_{STG}) .... –40 to +70°C
Maximum Lead Soldering Temperature (T_S) max. for 5 s .... 250°C

1. In NA=0.6
2. Measured with a fiber NA=0.35, core diameter=125 µm, length=5 m, with attenuation=8 dB/km.

Characteristics (T_{sub}=25°C)

Parameter		Symbol	Value	Unit
Laser Diode, CW-operations				
Recommended Operating Temperature		T	–10 to +35	°C
Emission Wavelength		λ_{peak}	941 ±10	nm
Spectral Width		$\Delta\lambda$	3	nm
CW-output Power(1)	SFH487441 SFH487446	Φ_{eCW} Φ_{eCW}	1000 750	mW mW
Threshold Current		I_{th}	450	mA
Differential Efficiency(1)	SFH487441 SFH487446	η η	0.9 0.6	W/A W/A
Operating Current	SFH487441 SFH487446	I_{op} I_{op}	1560 1700	mA mA
Operating Voltage		V_{op}	2.1	V
Differential Serial Resistance		r_S	0.3(<0.4)	Ω
Characteristic Temperature for Threshold Current(3)		T_O	150	K
Temperature Coefficient, Operating Current		TC_I	0.5	%/K
Temperature Coefficient, Wavelength		TC_λ	0.30	nm/K
Thermal Resistance, PN-junction—Case		$R_{thJ\ NTC}$	10	K/W
NTC Thermistor				
Resistance		R_{NTC}	10	kΩ

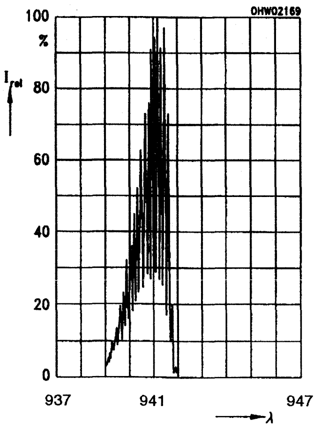
1. in NA=0.6
2. Measured with a fiber NA=0.35, core diameter=125 µm, length=5 m, attenuation=8 dB/km.
3. Thermal behavior of I_{th} can be modeled as $I_{th2}=I_{th1}\exp(T_2-T_1)/T_0$

Test Certificate

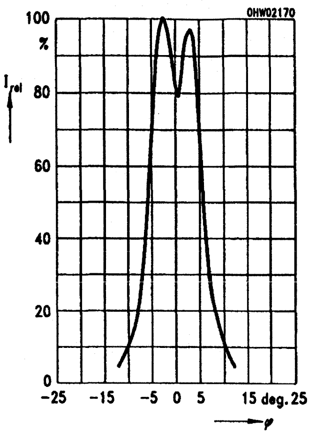
Each laser diode is supplied with technical information about:

- Radiant power
- Threshold current
- Differential efficiency
- Operating current and operating voltage
- Emission wavelength

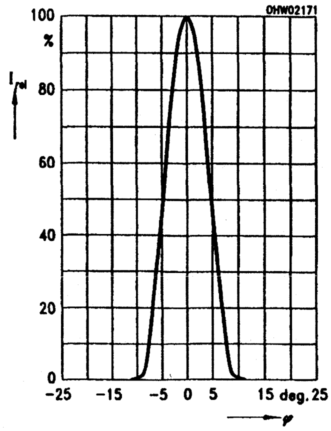
Mode spectrum $I_{REL}=f(\lambda)$



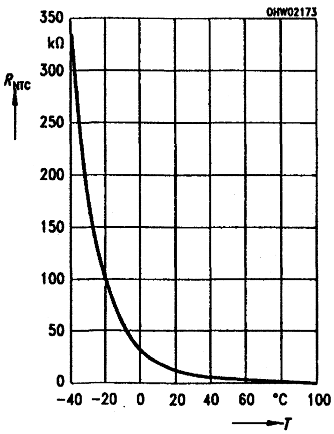
Farfield distribution $I_{REL}=f(\varphi)$
parallel to pn-junction, SFH487441



Farfield distribution $I_{REL}=f(\varphi)$
parallel to pn-junction, SFH487446



NTC Thermistor $R_T=f(T_A)$
$R_{T25°C}$=10 kΩ ±1%

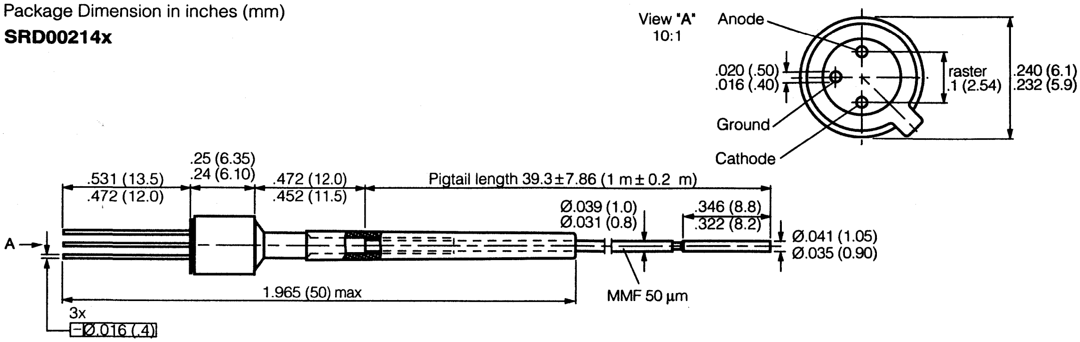


SIEMENS

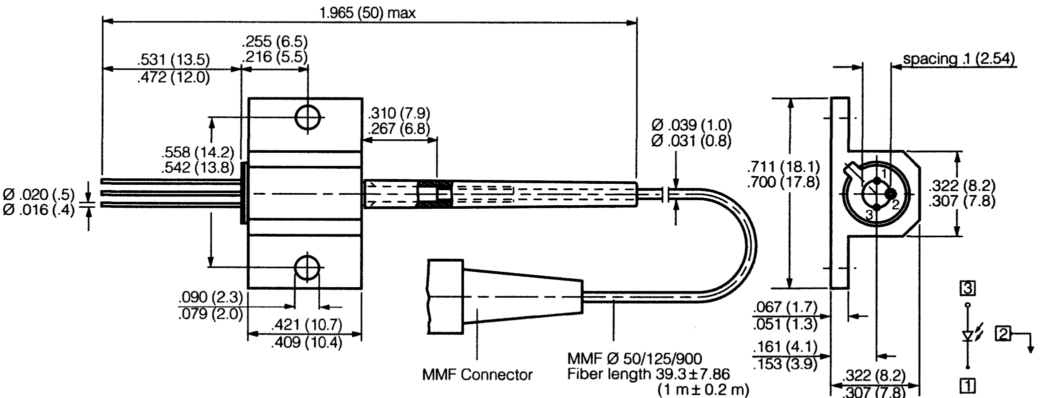
with PIGTAIL SRD00214x
with PIGTAIL and FLANGE SRD00215x
RECEPTACLE and FLANGE SRD00217x
TERNARY PIN PHOTODIODE

Package Dimension in inches (mm)

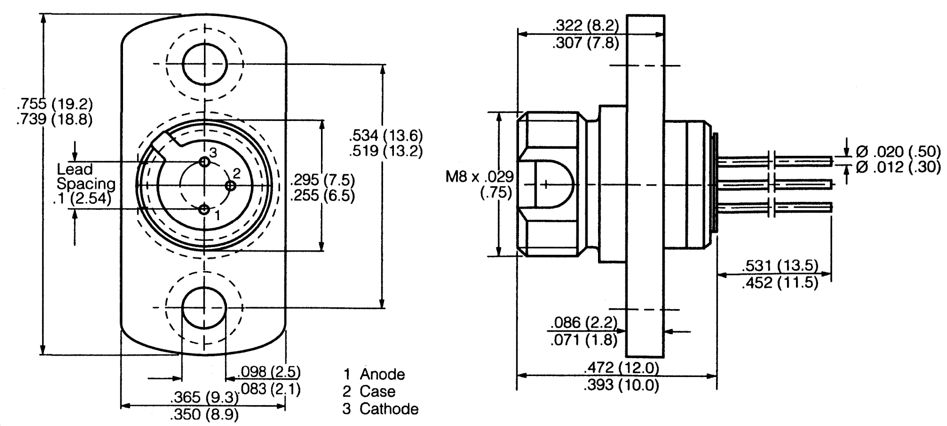
SRD00214x



SRD00215x



SRD00217x



1 Anode
2 Case
3 Cathode

FEATURES

- **SRD00214H: Pigtail, FC/PC Multimode Connector**
- **SRD00215H: Pigtail with Flange, FC/PC Multimode Connector**
- **SRD00215H, SRD00217H: FC, 2 Hole**
- **InGaAs/InP, PIN Photodiode**
- **Designed for Telecom Applications**
- **Sensitive Receiver for 2nd and 3rd Optical Window (1300 nm and 1500 nm)**
- **Suitable for Bit Rates up to 1.2 Gbit/s**
- **Low Junction and Low Package Capacitance**
- **Fast Switching Times**
- **Low Dark Current**
- **Low Noise**
- **High Reverse Current Stability from Planar Structure**
- **Hermetically Sealed 3 Pin Metal Case**
- **SRD00214x/SRD00215x:**
  – Optimally Coupled Multimode Fiber Pigtail
- **SRD00217x:**
  – High Spectral Sensitivity by Built-in Optics
  – FC-SM Receptacle with 2 Hole Flange

Maximum Ratings

Forward Current (I_F) .... 10 mA
Reverse Voltage (V_R) .... 20 V
Operating and Storage Temperature (T_A, T_{STG}) ....–40 to +85°C
Maximum Radiant Power in Optical Port, V_R=5 V (Φ_{port}) ...... 1 mW
Soldering Time (wave/dip soldering) (t_S) .... 10 s
distance bet. solder point and base plate ≥ 2mm, 260°C

Characteristics All optical data refer to a coupled 10/125 µm SM fiber, T_A=25°C, unless otherwise specified

Parameter		Symbol	Value	Unit
Spectral Sensitivity λ=1310 nm, V_R= 2 V λ=1300 nm, V_R= 5 V	 SRD00214/5x SRD00217x	S_λ	0.9 (≥0.75)	A/W
Change in Spectral Spectral Sensitivity in Operating Temperature Range		S_λ	≤0.2	%/K
Rise Time/Fall Time (10%–90%) R_L=50 Ω, λ=1310 nm, Φ_{port}=100 µW V_R=2 V V_R=5 V	 SRD00214/5x SRD00217x	t_R,t_F	 ≤0.3 (≤1.0) ≤0.3 (≤0.5)	ns
Total Capacitance (Φ_{port}=0, f=1 MHz) V_R=2 V V_R=5 V	 SRD00214/5x SRD00217x	C_2	1 (≤1.5)	pF
Dark Current (T_A=85°C Φ_e=0) V_R=2 V V_R=5 V	 SRD00214/5x SRD00217x	I_D	1 (<50)	nA
Back Reflection of Optical Power into Optical Port		R	≤–20	dB

Note

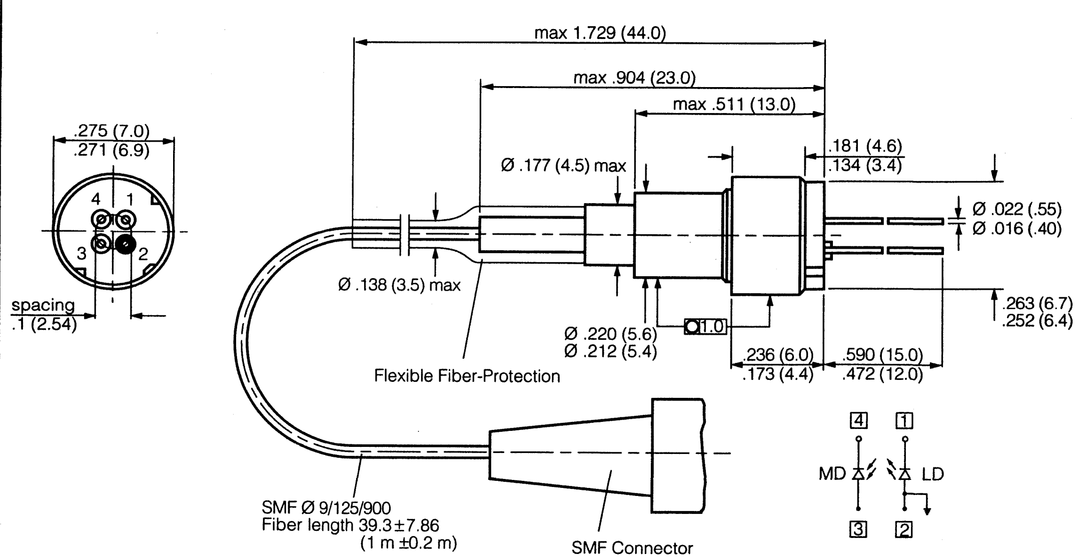
Siemens offers a wide variety of connector, receptacle and pinning options.
Please refer to part numbering matrix on page 6–12 for available options
or contact your local Siemens Components sales office (see inside back cover).

SIEMENS

LOW POWER STL51004/51005G
MEDIUM POWER STM51004/51005x
HIGH POWER STH51004/51005G
1300 nm LASER in COAXIAL PACKAGE with SM-PIGTAIL

Package Dimensions in inches (mm)

Without Flange



FEATURES

- **STL51004G: FC without Flange** (see Note)
- **STL51005G: FC with Flange** (see Note)
- **STM51004H: FC without Flange** (see Note)
- **STM51005H: FC with Flange** (see Note)
- **STH51004G: FC without Flange** (see Note)
- **STH51005G: FC with Flange** (see Note)
- **Designed for Fiber Optic Networks**
- **Laser Diode with Multi-quantum Well Structure**
- **Suitable for Bit Rates up to 1 Gbit/s**
- **Ternary Photodiode at Rear Mirror to Monitor and Control Radiant Power**
- **Hermetically Sealed Subcomponents, Similar to TO 18**
- **SM Pigtail with Optional Flange**

Note

Siemens offers a wide variety of connector, receptacle and pinning options. Please refer to part numbering matrix on page 6–12 for available options or contact your local Siemens Components sales office (see inside back cover).

Maximum Ratings

Output power ratings refer to the SM fiber output. The operating temperature of the submount is identical to the case temperature.

Module

Operating Temperature Range at Case(T_C) ....–40 to +85°C
Storage Temperature Range (T_{STG})...........................–40 to +85°C
Soldering Temperature (T_S) ....260°C
tmax=10 s, 2mm from bottom edge of case

Laser Diode

Direct Forward Current (I_{Fmax})... 120 mA
Radinat Power CW (Φ_e)..1 mW
Reverse Voltage (V_{Rmax}) ....2 V

Monitor Diode

Reverse Voltage (V_{Rmax}) ....10 V

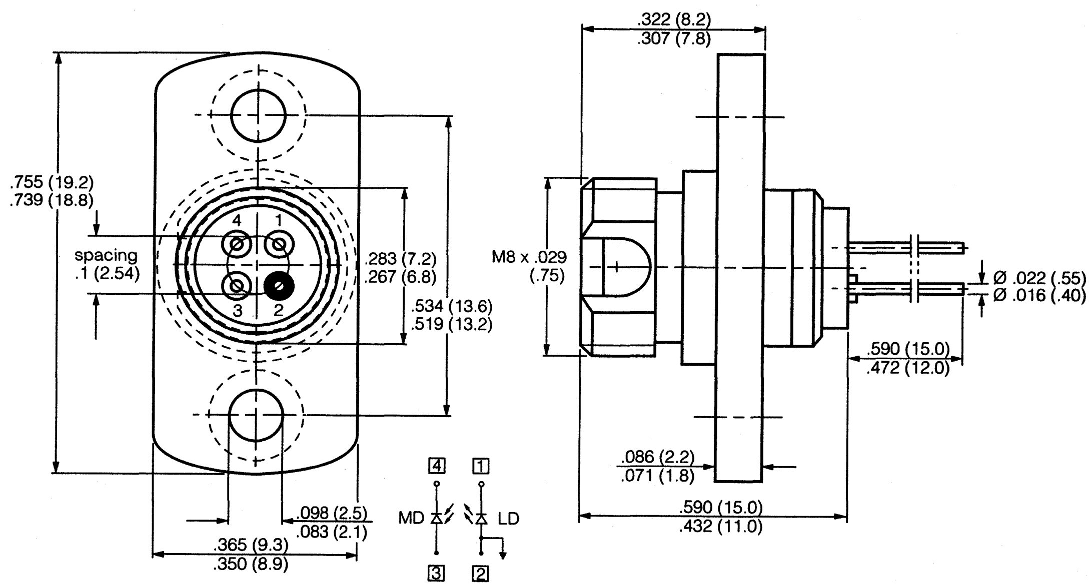
Characteristics
All optical data refer to a coupled 10/125 µm SM fiber, TC=25°C

Parameter		Symbol	Value	Unit
Laser Diode				
Optical Output Power	STL51004/5x STM51004/5x STH51004/5x	Φ_e	>0.4 >1.2 >2.4	mW
Emission Wavelength, Center of Range	STL51004/5x, $\Phi_{e=}0.2$mW STM51004/5x, $\Phi_{e=}0.5$mW STH51004/5x, $\Phi_{e=}1$mW	λ	1280–1330	nm
Spectral Bandwidth	STL51004/5x, $\Phi_{e=}0.2$ mW (RMS) STM51004/5x, $\Phi_{e=}0.5$ mW (RMS) STH51004/5x, $\Phi_{e=}1$ mW (RMS)	$\Delta\lambda$	<5	nm
Threshold Current (–40 to +85°C)		I_{th}	2–45	mA
Forward Voltage	STL51004/5x, $\Phi_{e=}0.2$ mW STM51004/5x, $\Phi_{e=}0.5$ mW STH51004/5x, $\Phi_{e=}1$ mW	V_F	<1.5	V
Radiant Power at Threshold	STL51004/5x STM51004/5x STH51004/5x	Φ_{eth}	<10 <40 <80	µW
Slope Efficiency	STL51004/5x STM51004/5x STH51004/5x	η	8–60 20–100 40–160	mW/A
Differential Series Resistance		r_S	<8	Ω
Rise Time/Fall Time		t_R, t_F	<1	ns
Monitor Diode				
Dark Current, VR=5 V, $\Phi_{e=}0$		I_R	<500	nA
Photocurrent	STL51004/5x, $\Phi_{e=}0.2$ mW STL51004/5x, $\Phi_{e=}0.5$ mW STL51004/5x, $\Phi_{e=}1$ mW	I_P	100–1000	µA

SIEMENS

LOW POWER STL51007G
MEDIUM POWER STM51007G
HIGH POWER STH51007G
1300 nm LASER in RECEPTACLE PACKAGE

Package Dimensions in inches (mm)



FEATURES

- **Designed for Fiber Optic Networks**
- **Laser Diode with Multi-quantum Well Structure**
- **Suitable for Bit Rates up to 1 Gbit/s**
- **Ternary Photodiode at Rear Mirror to Monitor and Control Radiant Power**
- **Hermetically Sealed Subcomponents, Similar to TO 18**
- **SM Receptacle with 2-hole Flange**

Note

Siemens offers a wide variety of connector, receptacle and pinning options. Please refer to part numbering matrix on page 6–12 for available options or contact your local Siemens Components sales office (see inside back cover).

Maximum Ratings

Output power ratings refer to the SM fiber output. The operating temperature of the submount is identical to the case temperature.

Module

Operating Temperature Range at Case(T_C) .... –40 to +85°C
Storage Temperature Range (T_{STG}) .... –40 to +85°C
Soldering Temperature (T_S) .... 260°C
tmax=10 s, 2mm from bottom edge of case

Laser Diode

Direct Forward Current (I_{Fmax}) .... 120 mA
Radinat Power CW (Φ_e) .... 1 mW
Reverse Voltage (V_{Rmax}) .... 2 V

Monitor Diode

Reverse Voltage (V_{Rmax}) .... 10 V

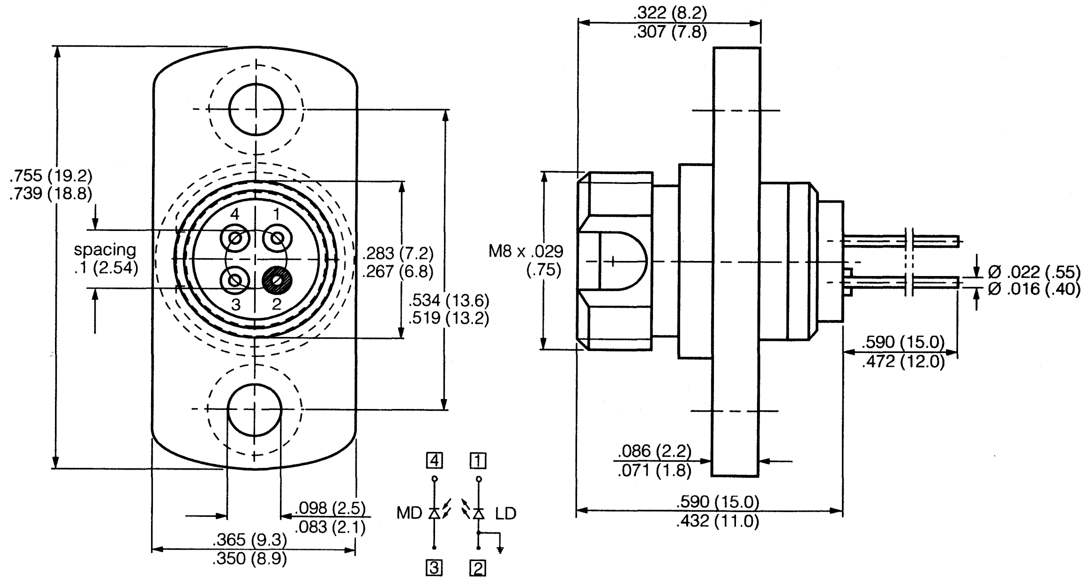
Characteristics
All optical data refer to a coupled 10/125 µm SM fiber, TC=25°C

Parameter		Symbol	Value	Unit
Laser Diode				
Optical Output Power	STL51007G STM51007G STH51007G	Φ_e	>0.4 >1.2 >2.4	mW
Emission Wavelength, Center of Range	STL51007G, $\Phi_{e=}$0.2mW STM51007G, $\Phi_{e=}$0.5mW STH51007G, $\Phi_{e=}$1mW	λ	1280–1330	nm
Spectral Bandwidth	STL51007G, $\Phi_{e=}$0.2 mW (RMS) STM51007G, $\Phi_{e=}$0.5 mW (RMS) STH51007G, $\Phi_{e=}$1 mW (RMS)	$\Delta\lambda$	<5	nm
Threshold Current (–40 to +85°C)		I_{th}	2–45	mA
Forward Voltage	STL51007G, $\Phi_{e=}$0.2 mW STM51007G, $\Phi_{e=}$0.5 mW STH51007G, $\Phi_{e=}$1 mW	V_F	<1.5	V
Radiant Power at Threshold	STL51007G STM51007G STH51007G	Φ_{eth}	<10 <40 <80	µW
Slope Efficiency	STL51007G STM51007G STH51007G	η	8–60 20–100 40–160	mW/A
Differential Series Resistance		r_S	<8	Ω
Rise Time/Fall Time		t_R,t_F	<1	ns
Monitor Diode				
Dark Current, VR=5 V, $\Phi_{e=}$0		I_R	<500	nA
Photocurrent	STL51007G, $\Phi_{e=}$0.2 mW STL51007G, $\Phi_{e=}$0.5 mW STL51007G, $\Phi_{e=}$1 mW	I_P	100–1000	µA

SIEMENS

LOW POWER STL81007G
MEDIUM POWER STM81007G
1500 nm LASER in RECEPTACLE PACKAGE

Package Dimensions in inches (mm)



FEATURES

- **Designed for Fiber Optic Networks**
- **Laser Diode with Multi-quantum Well Structure**
- **Suitable for Bit Rates up to 1 Gbit/s**
- **Ternary Photodiode at Rear Mirror to Monitor and Control Radiant Power**
- **Hermetically Sealed Subcomponents, Similar to TO 18**
- **SM Receptacle with 2-hole Flange**

Note

Siemens offers a wide variety of connector, receptacle and pinning options. Please refer to part numbering matrix on page 6–12 for available options or contact your local Siemens Components sales office (see inside back cover).

Maximum Ratings

Output power ratings refer to the SM fiber output. The operating temperature of the submount is identical to the case temperature.

Module

Operating Temperature Range at Case(T_C) ....–40 to +85°C
Storage Temperature Range (T_{STG})...........................–40 to +85°C
Soldering Temperature (T_S) ....260°C
tmax=10 s, 2mm from bottom edge of case

Laser Diode

Direct Forward Current (I_{Fmax})... 120 mA
Radinat Power CW (Φ_e)...1 mW
Reverse Voltage (V_{Rmax}) ....2 V

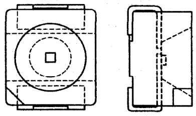
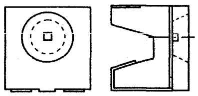
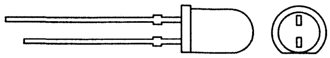
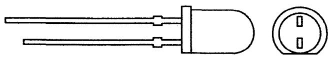
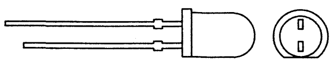
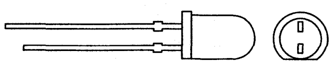
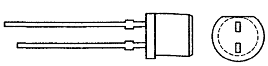
Monitor Diode

Reverse Voltage (V_{Rmax}) ....10 V

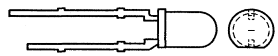
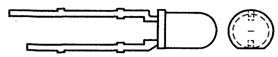
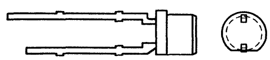
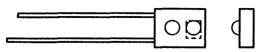
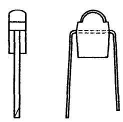
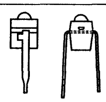
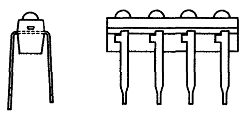
Characteristics
All optical data refer to a coupled 10/125 µm SM fiber, TC=25°C

Parameter		Symbol	Value	Unit
Laser Diode				
Optical Output Power	STL81007G STM51007G	Φ_e	>0.4 >1.2	mW
Emission Wavelength, Center of Range $\Phi_{e=}$0.2mW $\Phi_{e=}$0.5mW	 STL81007G STM81007G	λ	1510–1590	nm
Spectral Bandwidth $\Phi_{e=}$0.2 mW (RMS) $\Phi_{e=}$0.5 mW (RMS)	 STL81007G STM81007G	Δλ	<5	nm
Threshold Current (–40 to +85°C)		I_{th}	2–45	mA
Forward Voltage $\Phi_{e=}$0.2 mW $\Phi_{e=}$0.5 mW	 STL81007G STM81007G	V_F	<1.5	V
Radiant Power at Threshold	STL81007G STM81007G	Φ_{eth}	<10 <40	µW
Slope Efficiency	STL81007G STM81007G	η	8–60 20–100	mW/A
Differential Series Resistance		r_S	<8	Ω
Rise Time/Fall Time		t_R,t_F	<1	ns
Monitor Diode				
Dark Current, V_R=5 V, $\Phi_{e=}$0		I_R	<500	nA
Photocurrent $\Phi_{e=}$0.2 mW $\Phi_{e=}$0.5 mW	 STL81007G STL81007G	I_P	100–1000	µA

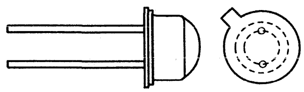
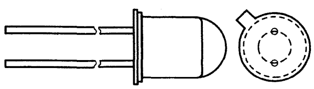
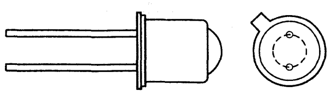
Infrared Emitters

Package Outline	Part Number	Package Type	Half Angle	Radiant Intensity		Surge Current (t<10µs) A	Features	Page
				I_E(mW/sr)	mA			
	SFH420	SMT-TOP-LED	±60°	≥2.5	100	3.0	GaAs, 950 nm. On tape and reel.	7–20
	SFH421	SMT-TOP-LED	±60°	≥4	100	2.5	GaAlAs, 880 nm. On tape and reel.	7–22
	SFH425	SMT-SIDE-LED	±60°	≥2.5	100	—	GaAs, 950 nm.	7–24
	SFH426	SMT-SIDE-LED	±60°	≥4	100	2.5	GaAlAs, 880 nm.	7–26
	LD271	T1 3/4 (5 mm) gray plastic	±25°	15 (≥10)	100	3.5	IR remote control. Wide angle high power. GaAs, 950 nm. Matches photodiode SFH205 , BP104 or phototransistor BP103.	7–7
	LD271L			15(≥10)				
	LD274-2	T1 3/4 (5 mm) gray plastic	±10°	50–100	100	3.0	IR remote control GaAs, 950 nm, very high intensity, narrow angle. Matches phototransistors SFH205, BP104, BP103B.	7–9
	LD274-3			≥80				
	SFH415-T	T1 3/4 (5 mm) plastic	±17°	25–50	100	3	GaAs, 950 nm. Fast switching time.	7–18
	SFH415-U			≥40				
	SFH416-R		±28°	10–20				
	SFH484-1	T1 3/4 (5 mm) clear blue tinted plastic	±8°	50–100	100	2.5	IR remote control, GaAlAs, 880 nm. Extremely high intensity, narrow angle.	7–37
	SFH484-2			≥80				
	SFH485-1	T1 3/4 (5 mm) clear blue tinted plastic	±20°	16–32	100	2.5	IR remote control, GaAlAs, 880 nm. High intensity, medium angle.	
	SFH485-2			≥25				
	SFH485P	T1 3/4 (5 mm) clear plastic	±40°	>3.15	100	2.5	IR remote control, GaAlAs, 880 nm. Wide angle remote control. Shaft encoder IR sound transmission. Low cost replacement for metal can package.	7–39

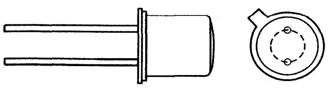
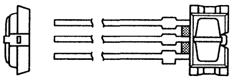
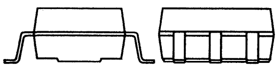
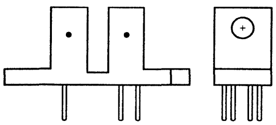
Infrared Emitters (Continued)

Package Outline	Part Number	Package Type	Half Angle	Radiant Intensity I_E(mW/sr)	Radiant Intensity mA	Surge Current (t<10μs) A	Features	Page
	SFH409-1	T1 (3 mm) gray plastic	±20°	6.3–12.5	100	3	IR remote control. GaAs, 950 nm. Matches phototransistor SFH309.	7–16
	SFH409-2			≥10				
	SFH487-1	T1 (3 mm) clear blue-tinted plastic.	±20°	12.5–25	100	2.5	IR remote control. GaAs, 880 nm. High intensity, medium angle.	7–41
	SFH487-2			≥20				
	SFH487P	T1 (3 mm) clear blue-tinted plastic.	±65°	>2	100	2.5	Wide angle. GaAs, 880 nm. Low cost replacement for metal can package.	7–43
	IRL80A	Miniature-clear plastic, side-facing.	±30°	≥0.4	20	3	IRL80A–GaAs, 950 nm. IRL81A–GaAlAs, 880 nm. Matches phototransistor LPT80A.	7–1
	IRL81A		±25°	≥1.0		2.5		
	SFH405	Miniature.039" (1 mm) wide, radial leads	±16°	≥1.6	40	1.6	Ideal for very short range light barriers. GaAs, 950 nm. Matches phototransistor SFH305.	7–14
	LD261	Single diode	±30°	5	50	1.6	GaAs, 950 nm. Miiniature, radial leads.	7–5
	LD262	2 diodes	±30°	5	50	1.6	GaAs, 950 nm. Miniature, radial leads. Ideal for card readers. Matches phototransistors BPX81, BPX80 series.	
	LD263	3 diodes						
	LD264	4 diodes						
	LD265	5 diodes						
	LD266	6 diodes						
	LD267	7diodes						
	LD268	8 diodes						
	LD269	9 diodes						
	LD260	10 diodes						

Infrared Emitters (Continued)

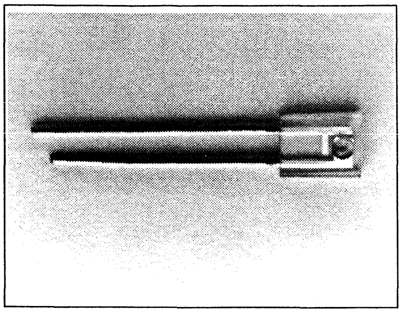
Package Outline	Part Number	Package Type	Half Angle	Radiant Intensity I_E(mW/sr)	Radiant Intensity mA	Surge Current (t<10μs) A	Features	Page
	LD242-2	TO-18 epoxy glob top.	±40°	4–8	100	3	Very wide angle, GaAs, 950 nm. Suitable for sound transmission. Ideal for short range light barriers. Matches phototransistor BP103 or photodiode BPX63.	7–3
	LD242-3			≥6.3				
	SFH462	TO-18 epoxy glob top.	±23°	—	—	1	GaAlAs, 660 nm.	7–30
	SFH483	TO-18 epoxy glob top.	±23°	—	—	2.5	GaAlAs, 880 nm.	7–35
	SFH400-3	TO-18 round glass lens.	±6°	≥32	100	3	Hermetic seal for high rel. use. Very narrow angle. GaAs, 950 nm. Matches phototransistor BPX43.	7–11
	SFH460	TO-18 round glass lens.	±6°	30 typ.	50	1	GaAlAs, 660 nm.	7–28
	SFH480-2	TO-18 round glass lens.	±6°	≥40	100	2.5	Hermetic seal for high rel. use. Very narrow beam. Narrow angle, very high intensity. GaAlAs, 880 nm.	7–32
	SFH401-3	TO-18 dome glass lens.	±15°	≥16	100	3	Hermetic seal for high rel. use. Medium angle. GaAs, 950 nm. Matches phototransistor BPY62.	7–11
	SFH481-1	TO-18 dome glass lens.	±15°	10–20	100	2.5	Hermetic seal for high rel. use. Medium angle. GaAlAs, 880 nm.	7–32
	SFH481-2			≥16				
	SFH481-3			≥25				

Infrared Emitters (Continued)

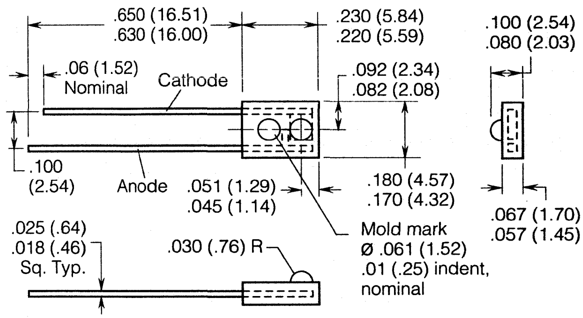
Package Outline	Part Number	Package Type	Half Angle	Radiant Intensity I_E(mW/sr)	Radiant Intensity mA	Surge Current (t<10µs) A	Features	Page
	SFH402-2	TO-18 flat glass lens.	±40°	≥2.5	100	3	Hermetic seal for high rel. use. Wide angle. GaAs, 950 nm. Matches phototransistor BPX38 or photodiodes BPX65/66.	7–11
	SFH402-3			≥4.0				
	SFH482-2	TO-18 flat glass lens.	±30°	≥5	100	2.5	Hermetic seal for high rel. use. Wide angle. GaAlAs, 880 nm.	7–32
	SFH482-3			≥8				
	SFH900-1	Miniature plastic, daylight filter.	—	0.25–0.5	I_C (mA), I_F=10 mA/reflector, 1 mm distance	1.5	Reflective light barrier for short (≤5 mm) distances.	7–45
	SFH900-2			0.4–0.8				
	SFH900-3			.63–1.25				
	SFH900-4			≥1.0				
	SFH905-1	Miniature plastic, daylight filter.	—	40–125 µA		1.5	Reflective light barrier for short (≤5 mm) distances.	
	SFH905-2			≥100 µA				
	SFH901 SFH902	6 pin SMT.	—	—	—	1.5	Light reflection switch. No cross talk.	7–49
	SFH910	Plastic, dalyight filter.	Output: Counting pulse Z Directional signal R Resolution ≥0.33"			1	Differential photo interrrupter.	7–53
	2004-9053	Plastic disk, 96 slots.					Slotted disk–can order separately.	

SIEMENS

GaAs IRL 80A
GaAlAs IRL 81A
INFRARED EMITTER



Package Dimensions in Inches (mm)



FEATURES

- **Low Cost**
- **Miniature, Clear Plastic, Side Facing Package**
- **Long Term Stability**
- **Wide Beam: IRL 80A, 60°; IRL 81A, 50°**
- **Matches Phototransistor LPT 80A**

DESCRIPTION

The IRL 80A is a GaAs infrared emitting diode while the IRL 81A is a GaAlAs IRED. The miniature side-facing device has a chip that emits radiation from the side of the clear package. It matches the phototransistor LPT 80A, and was designed for applications requiring beam interruption.

Maximum Ratings (T_A=25°C)

Operating/Storage Temperature Range (T_{OP}, T_{STG}) .... –40° to +100°C
Lead Soldering Temperature (.063" from case) t=5 sec .... 240°C

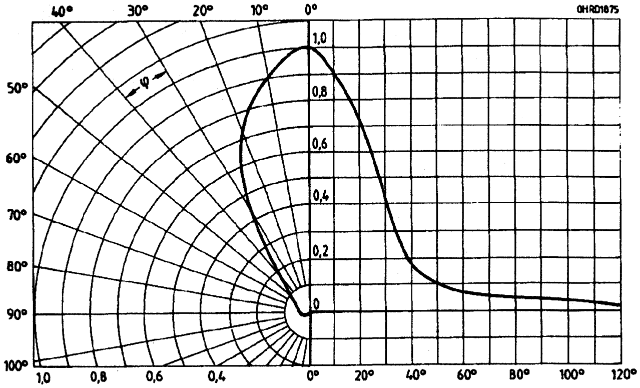
	IRL 80A	IRL 81A
Reverse Voltage (V_R)	3 V	5 V
Forward Current (I_F)	60 mA	100 mA
Power Dissipation (P_{TOT})	100 mW	200 mW
Derate Above 25°C	1.33 mW/°C	2.67 mW/°C

Characteristics (T_A=25°C)

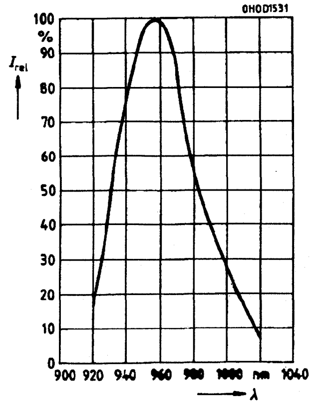
Parameter	Symbol	IRL 80A	IRL 81A	Unit
Radiation Wavelength, I_{MAX}	λ_{PEAK}	950	880	nm
Spectral Bandwidth, 50% I_{MAX}	$\Delta\lambda$	20	36 to 44	nm
Half Angle	φ	±30	±25	Deg.
Forward Voltage (I_F=20 mA)	V_F	1.5 max.	1.5 (≤2.0)	V
Breakdown Voltage (I_R=10 µA)	I_R	(≤3)	30 (≥5)	V
Radiant Intensity (I_F=20 mA) (1)	I_E	≥0.4	≥1.0	mW/sr

Note
1. A 1 cm² silicon detector is aligned with the mechanical axis. No aperature is used.

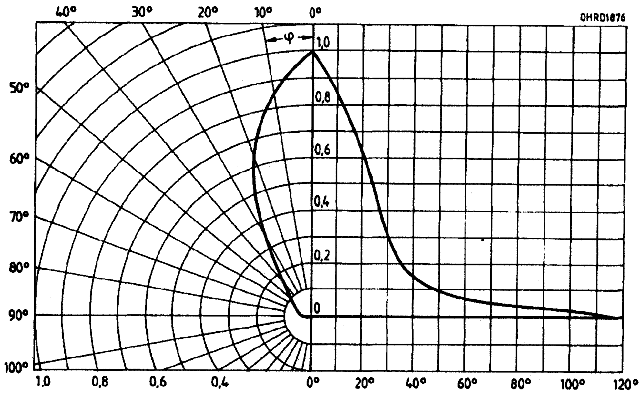
Radiation characteristics–IRL 80A $I_{REL}=f\ (\varphi)$



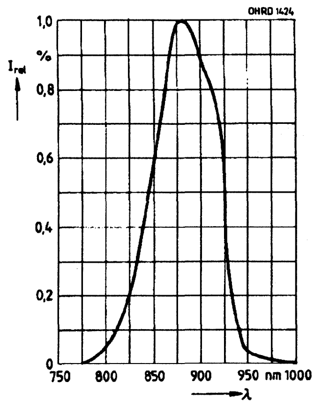
Relative spectral emission–IRL 80A $I_{REL}=f\ (\lambda)$



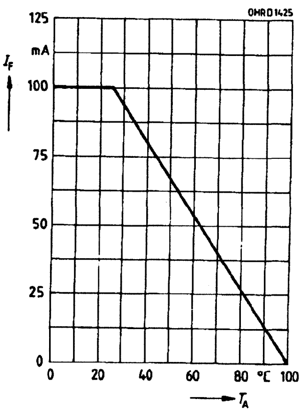
Radiation characteristics–IRL 81A $I_{REL}=f\ (\varphi)$



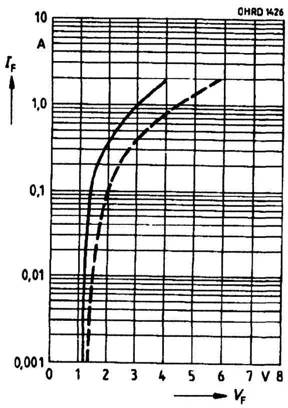
Relative spectral emission–IRL 81A $I_{REL}=f\ (\lambda)$



Maximum permissible forward current– IRL 81A $I_F=f\ (T_A)$



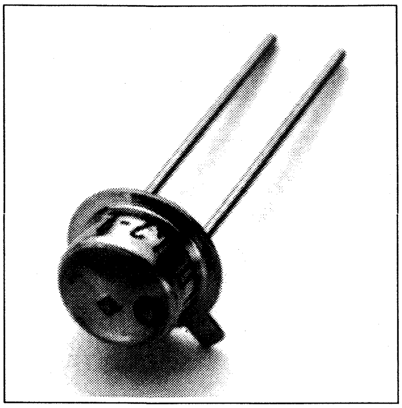
Forward current–IRL 81A $I_F=f\ (V_F)$



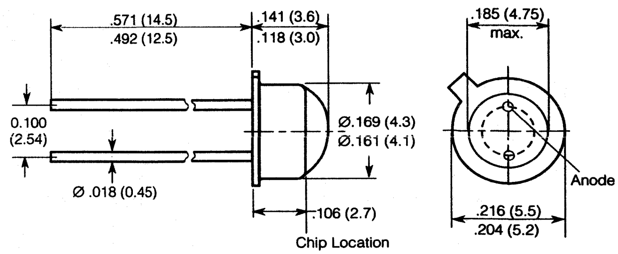
SIEMENS

LD242

GaAs INFRARED EMITTER



Package Dimensions in Inches (mm)



FEATURES

- **GaAs Infrared Emitting Diode, Fabricated in a Liquid Phase Epitaxy Process**
- **Emits Radiation in Near Infrared Range**
- **Cathode Electrically Connected to Case**
- **High Efficiency**
- **High Reliability**
- **Long Lifetime**
- **Wide Beam**
- **High Pulse Power**
- **Same Package as BP103, BPX63**
- **DIN Humidity Category per DIN 40040 GQG**
- **Applications**
  - **IR Remote Control and Sound Transmission**
  - **Light Reflecting Switches**
- **Package**
  - **Base Plate per 18 A3 DIN 41876 (TO 18)**
  - **Transparent Epoxy Resin Lens**
  - **Lead Spacing 0.100" (2.54 mm)**
- **Cathode Marking: Tab at Case Bottom**

Note:
1. An aperture is used in front of the component for measuring the radiant intensity and the half angle (diameter of the aperture: 1.1 mm; distance of aperture to case back side: 4 mm). This ensures that only the radiation in axial direction emitting directly from the chip surface will be evaluated during radiant intensity measurement. This measurement is denoted by "E7800" added to the part number.

Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) .. –40° to +80°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F)T_C=25°C .... 300 mA
Surge Current (I_{FSM}) t=10 µs, D=0 .... 3 A
Power Dissipation (P_{TOT})T_C=25°C .... 470 mW
Thermal Resistance (R_{thJA}) .... 450 K/W
(R_{thJC}) .... 160 K/W

Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Peak Wavelength (I_F=100 mA, t_P=20 ms)	λ_{PEAK}	950±20	nm
Spectral Bandwidth, 50% I_{MAX} (I_F=100 mA, t_P=20 ms)	Δλ	55	nm
Half Angle	φ	±40	Deg.
Active Chip Area	A	0.25	mm²
Active Chip Area Dimensions	L x W	0.5 x 0.5	mm
Distance, Chip Surface to Case Surface	H	0.3 to 0.7	mm
Swtching Times, I_E 10% to 90% and 90% to 10% (I_F=100 mA, R_L=50 Ω)	t_R, t_F	1	µs
Capacitance (V_R=0 V)	C_0	40	pF
Forward Voltage (I_F=100 mA)	V_F	1.3 (≤1.5)	V
(I_F=1 A, t_P=100 µs)	V_F	1.9 (≤2.5)	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤1)	µA
Radiant Flux, Total (I_F=100 mA, t_P=20 ms)		16	mW
Temperature Coefficient, I_E or Φ_E (I_F=100 mA)	TC_I	–0.55	%/K
Temperature Coefficient, V_F (I_F=100 mA)	TC_V	–1.5	mV/K
Temperature Coefficient, λ_{PEAK} (I_F=100 mA)	TC_λ	0.3	nm/K

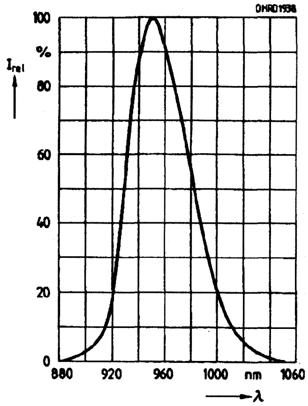
Radiant Intensity Selections

I_E in axial direction at solid angle of Ω=0.01 sr

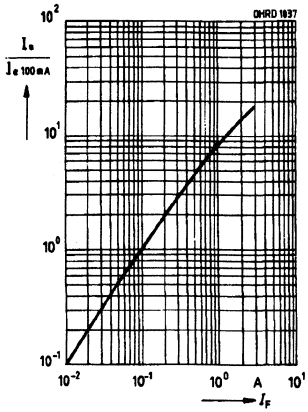
	Symbol	LD242 -2	LD242 -3	LD242 E7800[1]	Unit
I_F=100 mA, t_P=20 ms	I_E	4 to 8	>6.3	1 to 3.2	mW/sr
I_F=1 A, t_P=100 µs	I_{Etyp}	50	75	–	mW/sr

Infrared Emitters 7

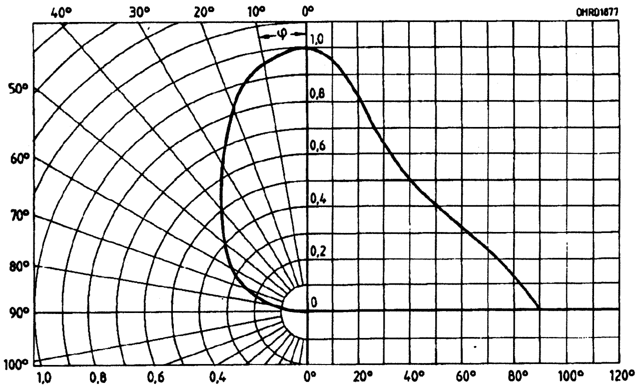
Relative spectral emission
$I_{REL}=f(\lambda)$



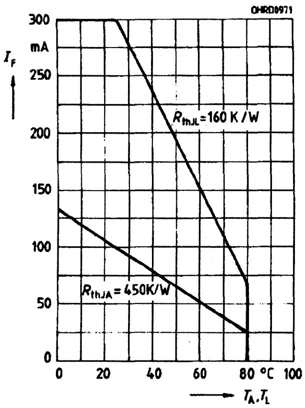
Radiant Intensity $I_E/I_{E50mA}=f(I_F)$
Single pulse, τ= 20 µs



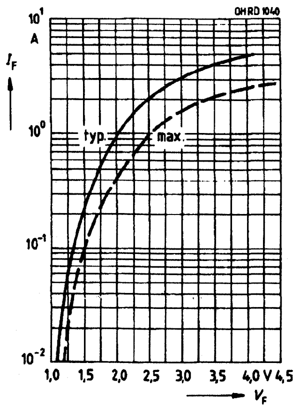
Radiation characteristic
$I_{REL}=f(\varphi)$



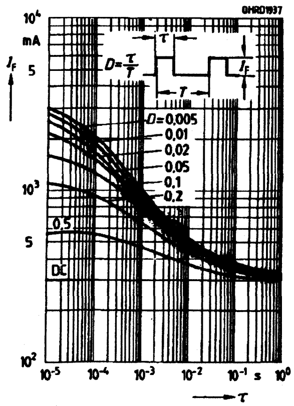
Maximum permissible forward current $I_F=f(T_A)$



Forward current $I_F=f(V_F)$

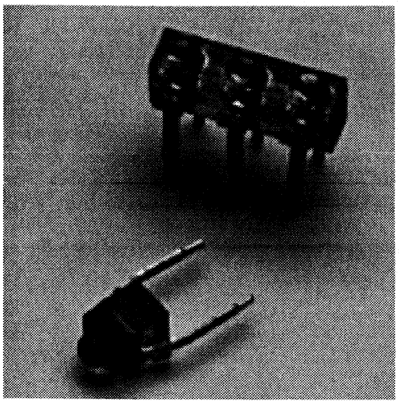


Permissible pulse handling capability $I_F=f(\tau)$, T_C=25°C
duty cycle D=Parameter

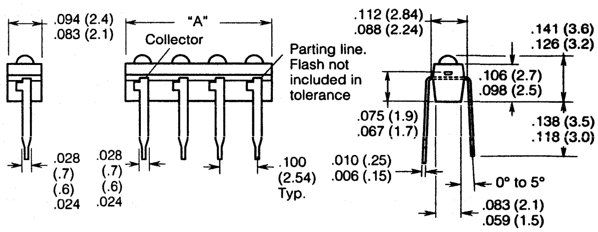


SIEMENS

SINGLE DIODE LD 261
ARRAYS LD 262–269/260
INFRARED EMITTER DIODES



Package Dimensions in Inches (mm)



FEATURES

- **Low Cost**
- **Miniature Size**
- **Availability:**

"A" Dimension (in mm)		**Min.**	**Max.**
One Diode	**LD 261**	**2.1**	**2.4**
Two Diodes	**LD 262**	**4.5**	**4.9**
Three Diodes	**LD 263**	**7.0**	**7.4**
Four Diodes	**LD 264**	**9.6**	**10.0**
Five Diodes	**LD 265**	**12.1**	**12.5**
Six Diodes	**LD 266**	**14.6**	**15.0**
Seven Diodes	**LD 267**	**17.2**	**17.6**
Eight Diodes	**LD 268**	**19.7**	**20.1**
Nine Diodes	**LD 269**	**22.3**	**22.7**
Ten Diodes	**LD 260**	**24.8**	**25.2**

- **Medium Beam, ±30°**

DESCRIPTION

The LD260–269 series, GaAs infrared emitting diodes, emit radiation at a wavelength in the near infrared range. These miniature devices come in a grey plastic package and are available as a single diode or as two- through ten-element arrays. The terminals are solder pins with 0.10" lead spacing. The LD260-269 series is designed for use with BPX 80-89 phototransistor when the spacing between each is approximately 10 mm. These devices can easily be mounted on PC boards and in thick film circuits for simple or complex scanning systems.

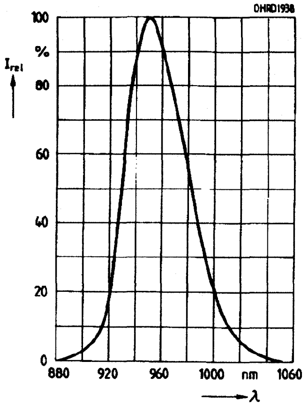
Maximum Ratings

Storage Temperature (T) .... –40° + 80°C
Soldering Temperature
(Distance from solder joint to package ≥2 mm)
Soldering Time, t ≤ 3 sec (T_S) .... 230°C
Junction Temperture (T_j) .... 80°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 50 mA
Surge Current (I_{FSM}) t=10 µs, D=0 .... 1.6 A
Power Dissipation (P_{TOT}) .... 70 mW
Thermal Resistance (R_{thJA}, R_{thJL}) .... 750, 650 K/W

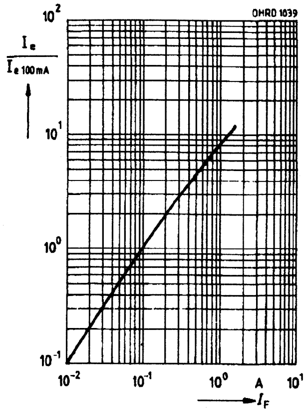
Characteristics (T_A=25°C)

	Symbol	Value	Unit	Condition
Wavelength	λ	950±20	nm	I_F=50 mA, t_p=20 ms
Spectral Bandwidth	$\Delta\lambda$	55	nm	I_F=50 mA, t_p=20 ms
Half Angle	φ	±30	Deg.	
Active Area	A	0.25	mm^2	
Active Die Area per Die	LxW	0.5x0.5	mm	
Distance Die Surface to Package Surface	H	1.3 to 1.9	mm	
Switching Time I_e from 10% to 90% and from 90% to 10%				I_F=50 mA
Capacitance	C_0	40	pF	V_R=0 V
Forward Voltage	V_F	1.25 (≤1.4)	V	I_F=50 mA, t_p=20 ms
Breakdown Voltage	V_{BR}	30 (≥5)	V	I_R=10µA
Reverse Current	I_R	0.01 (≤1)	µA	V_R=5 V
Temperature Coefficient of I_e or Φ_e	TC_I	–0.55	%/K	
Temperature Coefficient of V_F	TC_V	–1.5	mV/K	
Temperature Coefficient of λ peak	TC_λ	0.3	nm/K	
Radiant Intensity	I_e	2 to 8	mW/sr	I_F=50 mA, t_p=20 ms

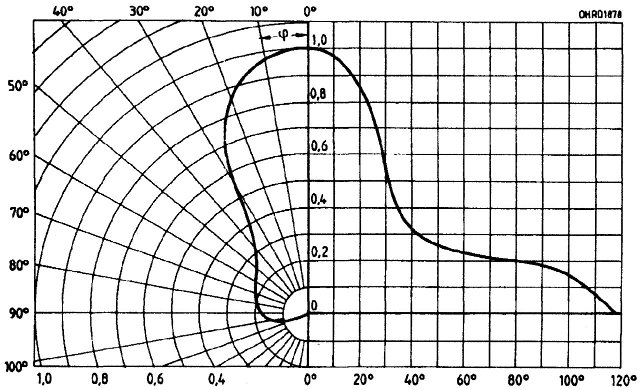
Relative spectral emission
$I_{REL}=f(\lambda)$



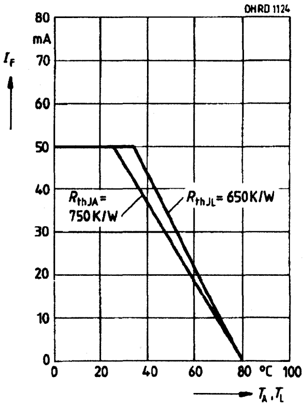
Radiant Intensity $I_E/I_{E50mA}=f(I_F)$
Single pulse, τ= 20 µs



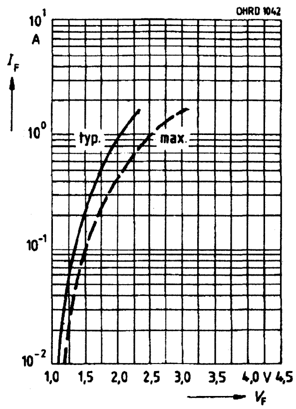
Radiation characteristic $I_{REL}=f(\varphi)$



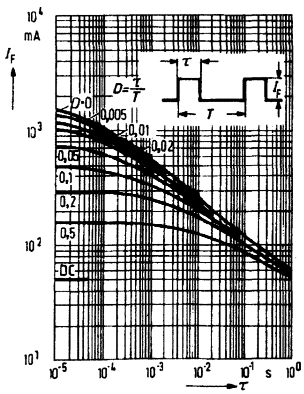
Maximum permissible forward current $I_F=f(T_A)$



Forward current $I_F=f(V_F)$



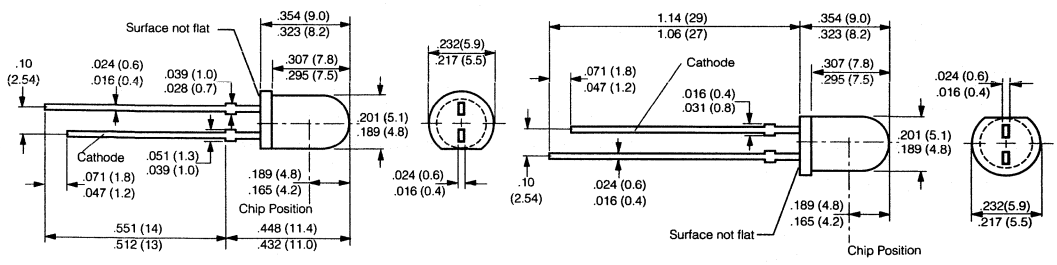
Permissible pulse handling capability $I_F=f(\tau)$, T_C=25°C
duty cycle D=Parameter



SIEMENS

LD271
1" LEADS LD271L
GaAs INFRARED EMITTER

Package Dimensions in Inches (mm)



FEATURES

- **T1¾ (5 mm) Package**
- **Lightly Diffused Gray Plastic Lens**
- **LD271L, 1" Leads**
- **Long Term Stability**
- **Medium Beam, ±25°**
- **High Power**
- **Matches Photodiodes SFH205 or BP104 or Phototransistors BP103B**

DESCRIPTION

LD271/L is an infrared emitting diode and emits radiation in the near infrared range (950 nm peak). The emitted radiation, which can be modulated, is generated by forward flowing current. The device is enclosed in a T1¾ (5 mm) plastic package.

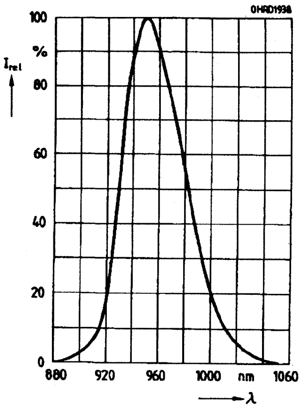
Maximum Ratings

Operating/Storage Temperature Range (T_{OP}, T_{STG}) .... –55° to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 130 mA
Surge Current (I_{FSM}) t=10 µs, D=0 .... 3.5 A
Power Dissipation (P_{TOT}) .... 210 mW
Thermal Resistance (R_{thJA}) .... 210 K/W

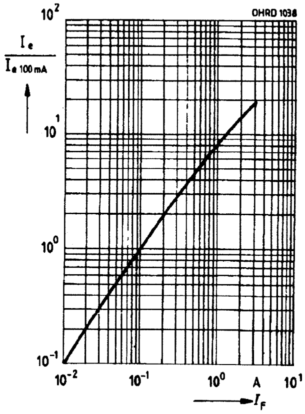
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Peak Wavelength (I_F=100 mA, t_P=20 ms)	λ_{PEAK}	950±20	nm
Spectral Bandwidth, 50% I_{MAX} (I_F=100 mA, t_P=20 ms)	$\Delta\lambda$	55	nm
Half Angle	φ	±25	Deg.
Active Chip Area	A	0.25	mm²
Active Chip Area Dimensions	L x W	0.5 x 0.5	mm
Distance, Chip Surface to Case Surface	H	4.0 to 4.6	mm
Swtching Times, I_E 10% to 90% and 90% to 10% (I_F=50 mA, R_L=50 Ω)	t_R, t_F	1	µs
Capacitance (V_R=0 V, f=1 MHz)	C_0	40	pF
Forward Voltage (I_F=100 mA, t_P=20 µs)	V_F	1.30 (≤1.5)	V
(I_F=1 A, t_P=100 µs)	V_F	1.90 (≤2.5)	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤1)	µA
Radiant Flux, Total (I_F=100 mA, t_P=20 ms)	Φ_E	18	mW
Temperature Coefficient, I_E or Φ_E (I_F=100 mA)	TC_I	–0.55	%/K
Temperature Coefficient, V_F (I_F=100 mA)	TC_V	–1.5	mV/K
Temperature Coefficient, λ (I_F=100 mA)	TC_λ	0.3	nm/K
Radiant Intensity, I_E in axial direction at solid angle of Ω=0.01 sr (I_F=100 mA, t_P=20 ms)	I_E	15 (≥10)	mW/sr
(I_F=1 A, t_P=100 µs)	I_{Etyp}	120	mW/sr

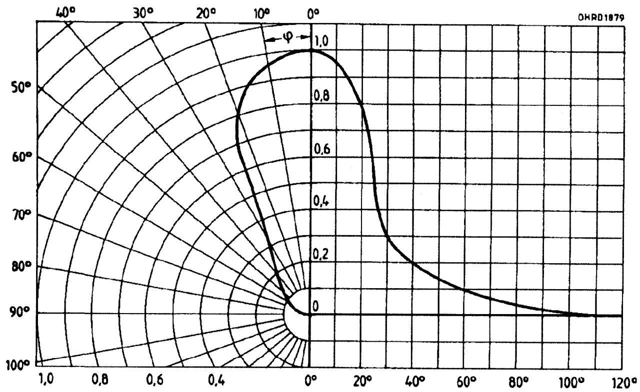
Relative spectral emission
$I_{REL}=f(\lambda)$



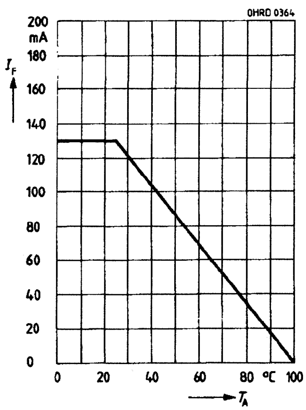
Radiant Intensity
$I_E/I_{E100mA}=f(I_F)$
Single pulse, τ= 20 µs



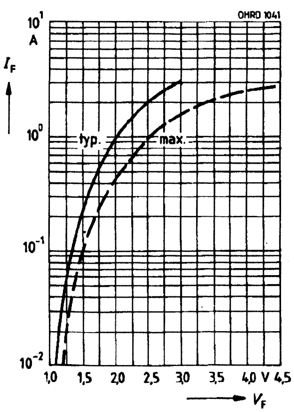
Radiation characteristic $I_{REL}=f(\varphi)$



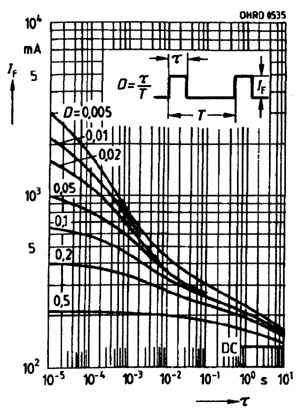
Maximum permissible forward current $I_F=f(T_A)$



Forward current
Single pulse, τ= 20 µs



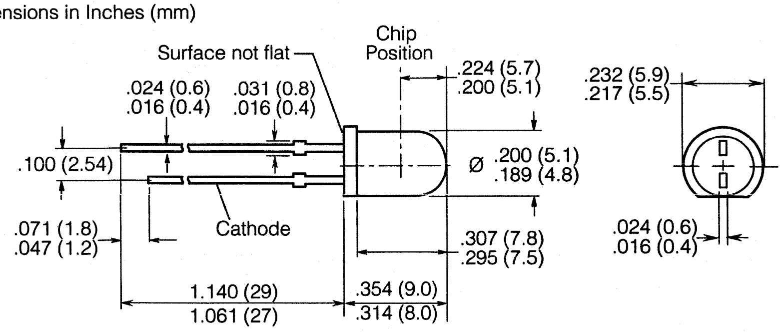
Permissible pulse handling capability $I_F=f(\tau)$, $T_A \leq 25°C$
duty cycle D=Parameter



LD274

GaAs INFRARED EMITTER

Package Dimensions in Inches (mm)



FEATURES

- **GaAs Infrared Emitting Diode, Fabricated in a Liquid Phase Epitaxy Process**
- **Emits Radiation in Near Infrared Range**
- **High Efficiency**
- **High Reliability**
- **Long Lifetime**
- **Very High Radiant Intensity**
- **High Pulse Power**
- **Radiant Intensity Selections**
- **Same Package as SFH484**
- **DIN Humidity Category per DIN 40040 GQG**
- **Package**
  - **T1¾ (5 mm) LED Package**
  - **Gray Epoxy Resin Lens**
  - **Lead Spacing 0.100" (2.54 mm)**
- **Cathode Marking: Shorter Solder Tab, Flat**

DESCRIPTION

The LD274 is a GaAs IR emitter with an emitted wavelength of 950 nm. The LD274 has a narrow beam. This high power device is suitable for remote control applications.

Maximum Ratings

Operating/Storage Temperature Range (T_{OP}, T_{STG}) .... –55° to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 100 mA
Surge Current (I_{FSM}) t=10 µs, D=0 .... 3 A
Power Dissipation (P_{TOT}) .... 165 mW
Thermal Resistance (R_{thJA}) .... 450 K/W

Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Peak Wavelength (I_F=100 mA, t_P=20 ms)	λ_{PEAK}	950±20	nm
Spectral Bandwidth, 50% I_{MAX} (I_F=100 mA, t_P=20 ms)	$\Delta\lambda$	55	nm
Half Angle	φ	±10	Deg.
Active Chip Area	A	0.09	mm^2
Active Chip Area Dimensions	L x W	0.3 x 0.3	mm
Distance, Chip Surface to Case Surface	H	4.9 to 5.5	mm
Switching Times, I_E 10% to 90% and 90% to 10% (I_F=100 mA, R_L=50 Ω)	t_R, t_F	1	µs
Capacitance (V_R=0 V, f=1 mHz)	C_0	25	pF
Forward Voltage (I_F=100 mA, t_P=20 µs)	V_F	1.30 (≤1.5)	V
(I_F=1 A, t_P=100 µs)	V_F	1.90 (≤2.5)	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤1)	µA
Radiant Flux, Total (I_F=100 mA, t_P=20 ms)	Φ_E	15	mW
Temperature Coefficient, I_E or Φ_E (I_F=100 mA)	TC_I	–0.55	%/K
Temperature Coefficient, V_F (I_F=100 mA)	TC_V	–1.5	mV/K
Temperature Coefficient, λ (I_F=100 mA)	TC_λ	0.3	nm/K

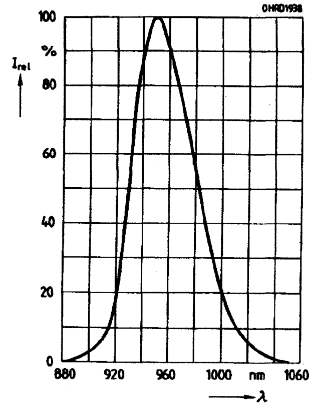
Radiant Intensity Selections

I_E in axial direction at solid angle of Ω=0.001 sr (LD274)

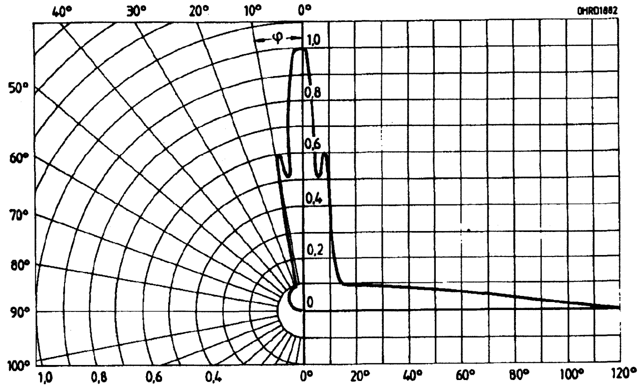
	Symbol	**LD 274-2**	**LD 274-3***	**Unit**
I_F=100 mA, t_P=20 ms	I_{Emin}	50	80	mW/sr
I_F=100 mA, t_P=20 ms	I_{Emax}	100	–	mW/sr
I_F=1 A, t_P=100 ms	I_{Etyp}	600	800	mW/sr

* Availability subject to yield.

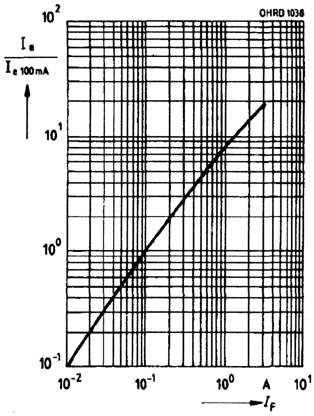
Relative spectral emission
$I_{REL}=f(\lambda)$



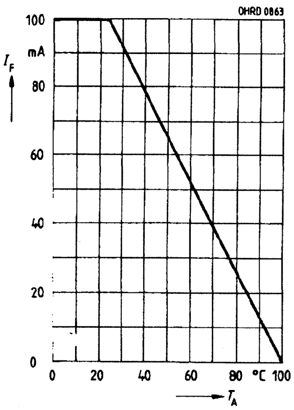
Radiation characteristic–LD274
$I_{REL}=f(\varphi)$



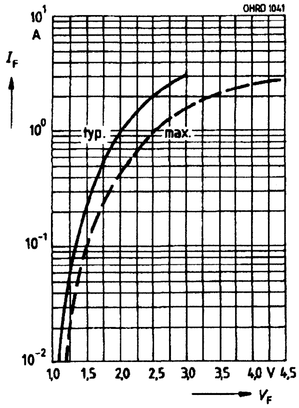
Radiant Intensity $I_E/I_{E50mA}=f(I_F)$
Single pulse, τ= 20 µs



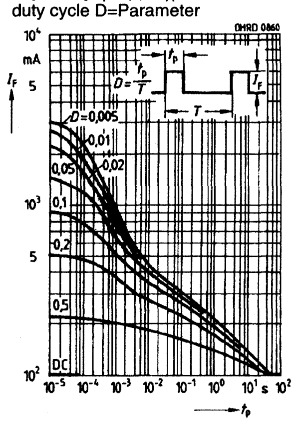
Maximum permissible forward current $I_F=f(T_A)$



Forward current $I_F=f(V_F)$
Single pulse, τ= 20 µs

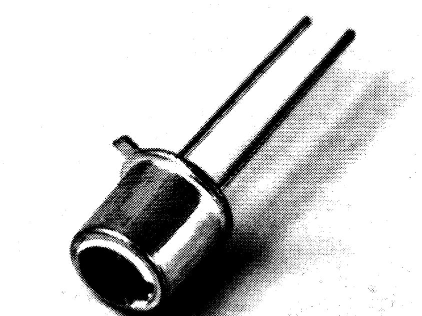


Permissible pulse handling capability $I_F=f(\tau)$, $T_A \leq 25°C$
duty cycle D=Parameter

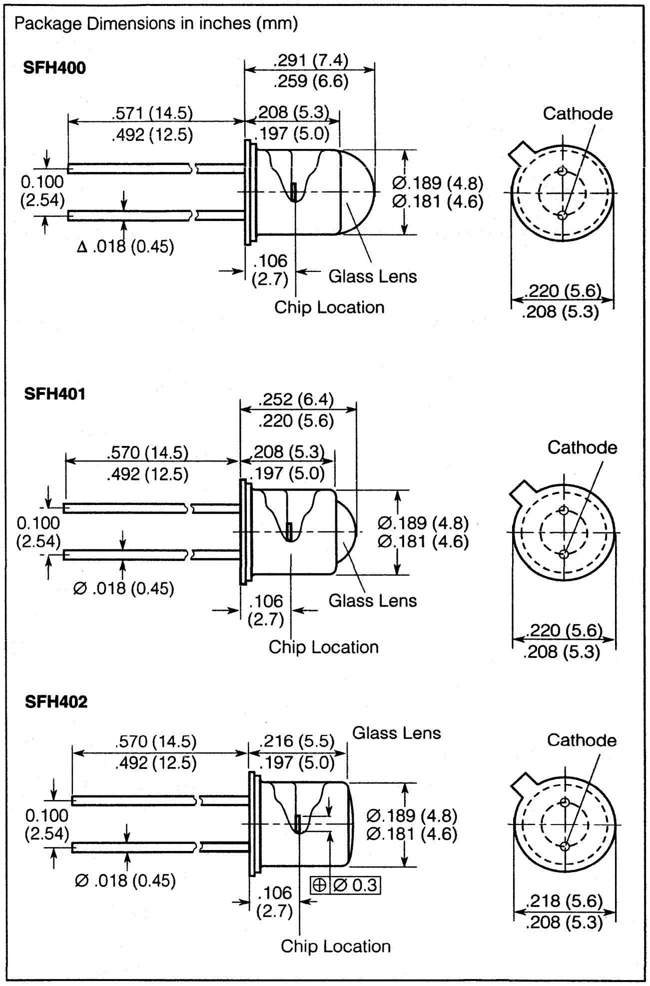


SIEMENS

SFH400
SFH401
SFH402
GaAs INFRARED EMITTER



SFH401



FEATURES

- **Half Angle**
  - **SFH400, ±6°**
  - **SFH401, ±15°**
  - **SFH402, ±40°**
- **GaAs Infrared Emitting Diode, Fabricated in a Liquid Phase Epitaxy Process**
- **Emits Radiation in Near Infrared Range**
- **Cathode Electrically Connected to Case**
- **High Efficiency**
- **High Reliability**
- **Long Lifetime**
- **SFH400/401: High Radiant Intensity**
- **SFH402: Wide Beam**
- **High Pulse Power**
- **Radiant Intensity Selections**
- **SFH400: Same Package as SFH480**
- **SFH401: Same Package as SFH481**
- **SFH402: Same Package as SFH482**
- **Applications**
  - **Light-reflecting Switches**
  - **IR Remote Control**
  - **Measurement and Control**
  - **Use in Extreme Environments**
- **Package**
  - **18 A 3 DIN 876 (TO 18), Hermetically Sealed**
  - **Glass Lens**
  - **Lead Spacing 0.100" (2.54 mm)**
- **Cathode Marking: Tab at Case Bottom**

Maximum Ratings

Operating and Storage Temperature (T_A, T_{STG})	–55 to +100°C
Junction Temperature (T_J)	100°C
Reverse Voltage (V_R)	5 V
Forward Current (I_F)	300 mA
Surge Current (I_{FSM}) t=10 ms, D=0	3 A
Power Dissipation (P_{TOT})	470 mW
Thermal Resistance (R_{thJA})	450 K/W
(R_{thJC})	200 K/W

Characteristics (T_A=25°C)

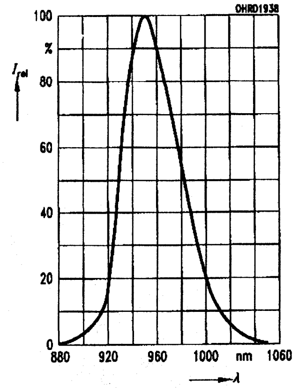
Parameter	Symbol	Value	Unit
Peak wavelength (I_F=100 mA, t_p=20 ms)	λ_{peak}	950 ±20	nm
Spectral Bandwidth, 50% of I_{MAX} (I_F=100 mA, t_p=20 ms)	$\Delta\lambda$	55	nm
Half Angle			
SFH400	φ	±6	Deg.
SFH401	φ	±15	Deg.
SFH402	φ	±40	Deg.
Active Chip Area	A	0.25	mm^2
Active Chip Area Dimensions	L x W	0.5 x 0.5	mm
Distance, Chip Surface to Case Surface			
SFH400	H	4.0 to 4.8	mm
SFH401	H	2.8 to 3.7	mm
SFH402	H	2.1 to 2.7	mm
Switching Time, I_E 10% to 90%, 90% to 10% (I_F=100 mA, R_L=50 Ω)	t_R, t_F	1	µs
Capacitance (V_R=0 V, f=1 MHz)	C_0	40	pF
Forward Voltage			
(I_F=100 mA, t_p=20 ms)	V_F	1.30 (≤1.5)	V
(I_F=1 A, t_p=100 µs)	V_F	1.90 (≤2.5)	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤1)	µA
Radiant Flux, Total (I_F=100 mA, t_p=20 ms)	Φ_E	8	mW
Temperature Coefficient, I_E or Φ_E (I_F=100 mA)	TC_I	–0.55	%/K
Temperature Coefficient, V_F (I_F=100 mA)	TC_V	–1.5	mV/K
Temperature Coefficient, λ (I_F=100 mA)	TC_λ	+0.3	nm/K

Radiant Intensity Selections
I_E in axial direction at solid angle, Ω=0.01 sr

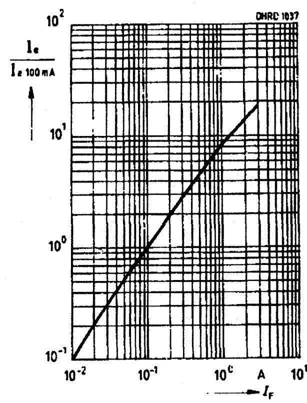
	Symbol	SFH 400-3*	SFH 401-3	SFH 402-2	SFH 402-3	Unit
I_F=100 mA, t_p=20 ms	I_{Emin}	32	16	2.5	4	mW/sr
I_F=100 mA, t_p=20 ms	I_{Emax}	—	—	—	—	mW/sr
I_F=1 mA, t_p=100 µs	I_{Etyp}	320	190	30	40	mW/sr

*Availability subject to yield.

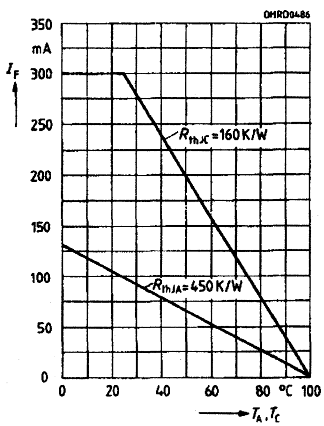
Relative spectral emission I_{REL}=f(λ)



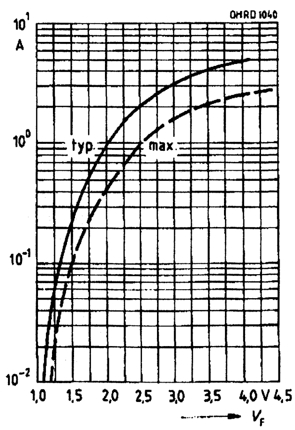
Relative radiant intensity
$I_E/I_{E50\ mA}$=f(I_E, single pulse, τ=20 µs



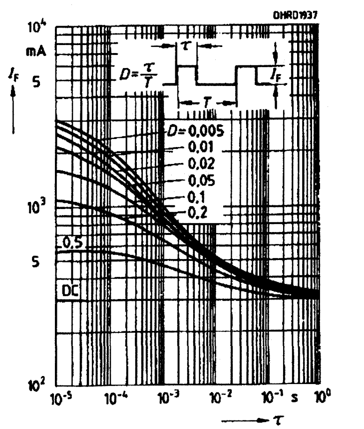
Maximum permissible forward current I_F=f(T_A)Single pulse, τ=20 µs



Forward current I_F=f(V_F) **capability**

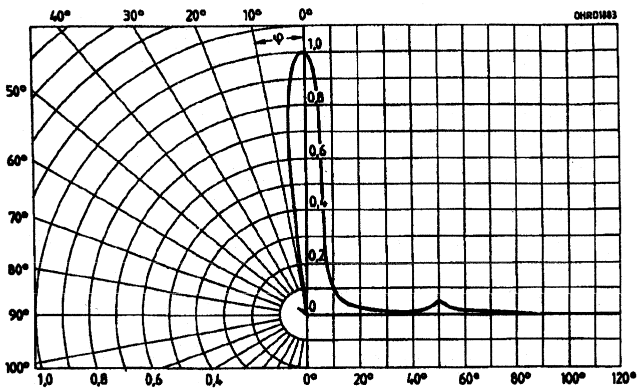


Permissible pulse handling
I_F=f(τ), T_A≤25°C duty cycle D=Parameter



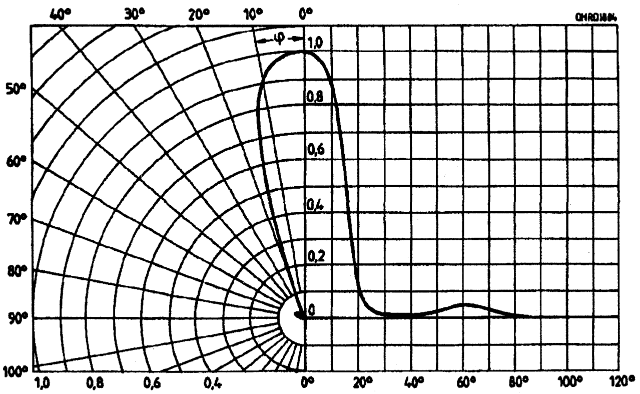
Radiation characteristic—SFH400

$I_{REL}=f(\varphi)$



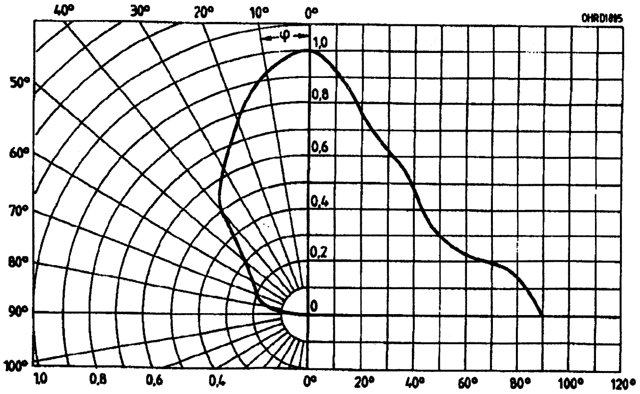
Radiation characteristic—SFH401

$I_{REL}=f(\varphi)$



Radiation characteristic—SFH402

$I_{REL}=f(\varphi)$



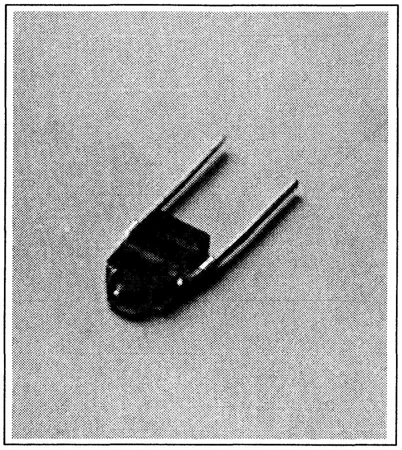
Infrared Emitters

7

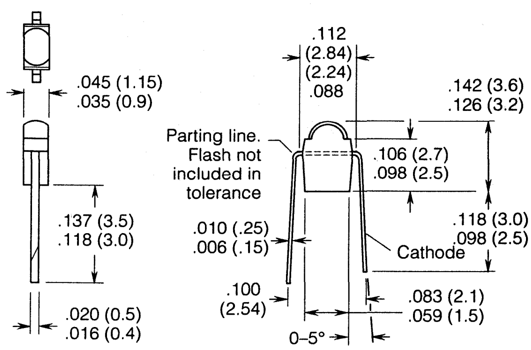
SIEMENS

SFH 405

INFRARED EMITTER



Package Dimensions in Inches (mm)



FEATURES

- **GaAs Infrared Emitting Diode, Fabricated in a Liquid Phase Epitaxy Process**
- **Emits Radiation in Near Infrared Range**
- **High Efficiency**
- **High Reliability**
- **Long Lifetime**
- **High Radiant Intensity**
- **Same Package as SFH 305**

DESCRIPTION

The SFH 405 is a GaAs infrared diode which emits radiation in the near infrared range.

The case is transparent plastic with a lens. The plastic is slightly smoke colored in order to differentiate between phototransistors of the same type (SFH 305). The terminals are solder pins in 0.100" (2.54 mm) lead spacing. There are two radiant intensity selections. SFH 405 can be used with thephototransistor SFH 305. The cathode marking is the beveled lead.

They can be used effectively in miniature light barriers with close spacing between emitter and receiver.

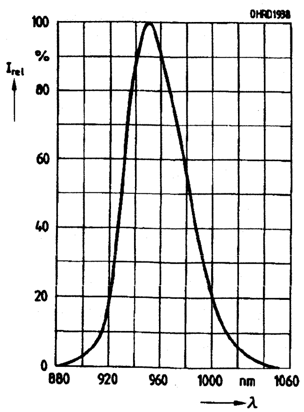
Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) .. –40° to +80°C
Junction Temperature (T_J) .... 80°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 40 mA
Surge Current (I_{FSM}) t=10 µs, D=0 .... 1.6 A
Power Dissipation (P_{TOT}) .... 65 mW
Thermal Resistance (R_{thJA}) .... 950 K/W
(R_{thJL}) .... 850 K/W

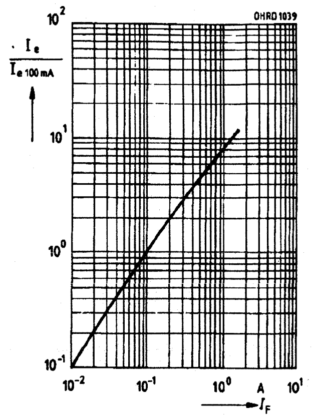
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Peak Wavelength (I_F=40 mA, t_P=20 ms)	$\lambda_{S\ PEAK}$	950±20	nm
Spectral Bandwidth, 50% I_{MAX} (I_F=40 mA, t_P=20 ms)	$\Delta\lambda$	55	nm
Half Angle	φ	±16	Deg.
Active Chip Area	A	0.25	mm²
Active Chip Area Dimensions	L x W	0.5 x 0.5	mm
Distance, Chip Surface to Case Surface	H	1.3 to 1.9	mm
Swtching Times, I_E 10% to 90% and 90% to 10% (I_F=40 mA)	t_R, t_F	1	µs
Capacitance (V_R=0 V)	C_0	40	pF
Forward Voltage (I_F=40 mA)	V_F	1.25 (≤1.4)	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤1)	µA
Temperature Coefficient I_E or Φ_E, (I_F=40 mA)	TC_I	–0.55	%/K
Temperature Coefficient V_F	TC_V	–1.5	mV/K
Temperature Coefficient λ_{PEAK}	TC_λ	0.3	nm/K
Radiant Intensity, I_E in Axial Direction at a solid angle of Ω=0.01 sr (I_F=40 mA, t_P=20 ms)		2.5 (>1.6)	mW/sr

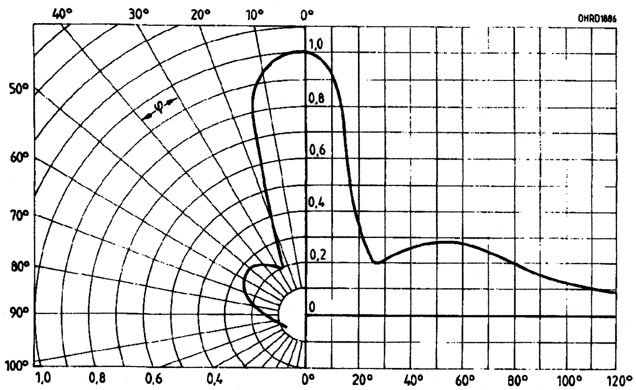
Relative spectral emission I_{REL}=f (λ)



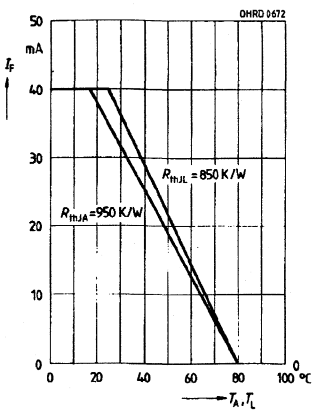
Radiant intensity $\frac{I_E}{I_{E\ 100\ mA}}$=f ($I_F$)
Single pulse, τ=20 µs



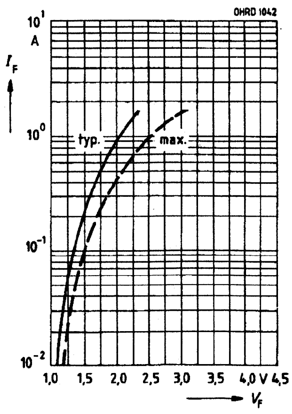
Radiation characteristics I_{REL}=f (φ)



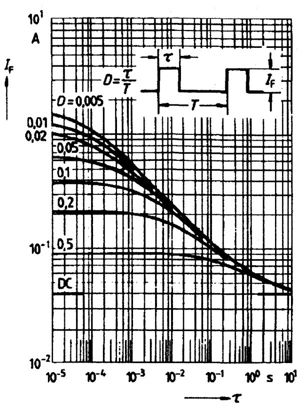
Maximum permissible forward current
I_F=f (T_A)



Forward current I_F=f (V_F)
Single pulse, τ=20 µs



Permissible pulse handling capability
I_F=f (τ), T_A=25° C duty cycle D=Parameter



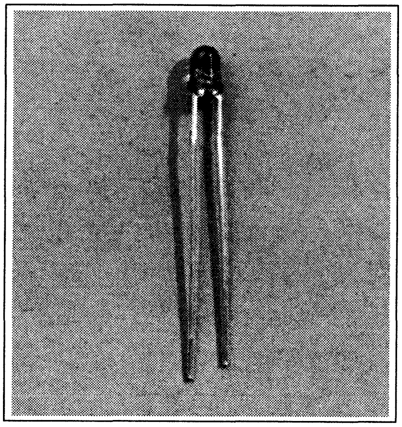
Infrared Emitters

7

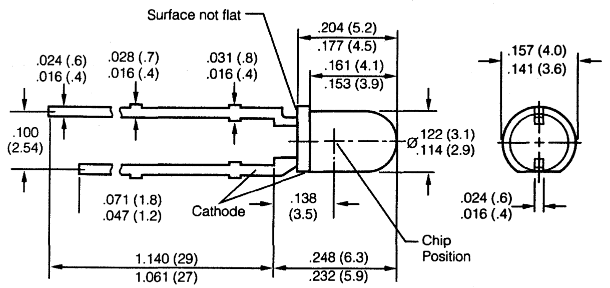
SIEMENS

SFH 409

INFRARED EMITTER



Package Dimensions in Inches (mm)



FEATURES

- **Radiant Intensity Selections**
  SFH 409-1, 6.3–12.5 mW/sr
  SFH 409-2, ≥10 mW/sr
- **High Reliability**
- **T1 (3 mm) Package**
- **.100" (2.54 mm) Lead Spacing**
- **High Pulse Power**
- **Long Term Stability**
- **Medium Beam, ±20°**
- **Excellent Match with Photodetector SFH 309**

DESCRIPTION

The SFH 409 is a GaAs Infrared Emitting Diode in a standard T1 plastic package. It is designed for a variety of low cost, high volume applications such as IR remote control and other consumer and entertainment products.

Maximum Ratings

Operating and Storage Temperature
Range (T_{OP}, T_{STG}) .... –55° to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 100 mA
Surge Current (I_{FSM}) t=10 µs .... 3 A
Power Dissipation (P_{TOT}) T=25°C .... 165 mW
Thermal Resistance (R_{thJA}) .... 450 K/W

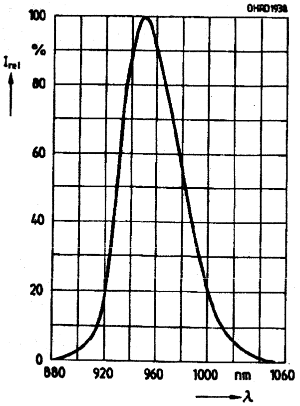
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Peak Wavelength (I_F=100 mA, t_P=20 ms)	λ_{PEAK}	950±20	nm
Spectral Bandwidth, 50% I_{MAX} (I_F=100 mA, t_P=20 ms)	$\Delta\lambda$	55	nm
Half Angle	φ	±20	Deg.
Active Chip Area	A	0.09	mm²
Active Chip Area Dimensions	L x W	0.3 x 0.3	mm
Distance, Chip Surface to Case Surface	D	2.6	mm
Swtching Times, I_E 10% to 90% (I_F=50 mA)	t_R, t_F	1	µs
Capacitance (V_R=0 V, f=1 MHz)	C_0	25	pF
Forward Voltage (I_F=100 mA)	V_F	1.30 (≤1.5)	V
(I_F=1 mA, t_P=100 µs)	V_F	1.90 (≤2.5)	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤1)	µA
Temperature Coefficient, I_E or Φ_E	TC_I	–0.55	%/K
Temperature Coefficient, V_F	TC_V	–1.5	mV/K
Temperature Coefficient, λ_{peak}	TC_λ	0.3	nm/K

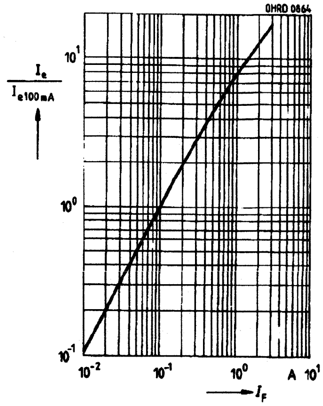
Radiant Intensity, I_E in Axial Direction at a solid angle of Ω=0.01 sr

	SFH 409-1	SFH 409-2	
Radiant Intensity I_E (I_F=100 mA, t_P=20 ms)	6.3–12.5	≥10	mW/sr
(I_F=1 A, t_P=100 µs)	75	120	mW/sr
Total Radiant Flux Φ_E (typ) (I_F=100 mA, t_P=20 ms)	15	15	mW

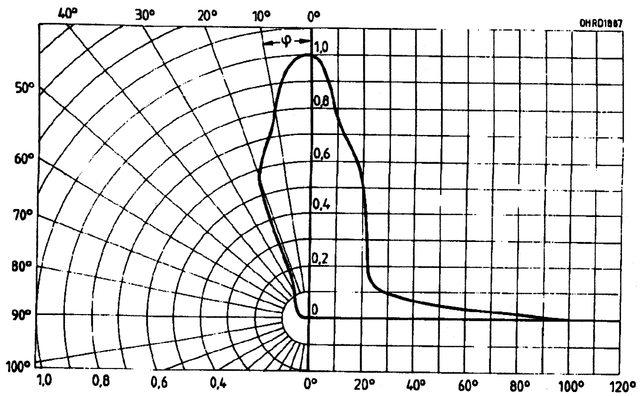
Relative spectral emission $I_{REL}=f(\lambda)$



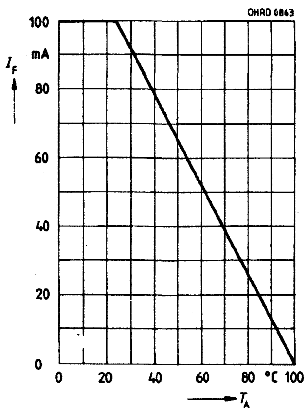
Radiant intensity $\frac{I_E}{I_E\ 100\ mA}=f(I_F)$
Single pulse, τ=20 µs



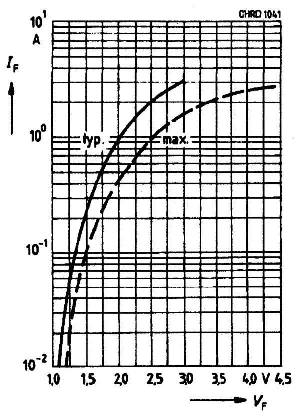
Radiation characteristics $I_{REL}=f(\varphi)$



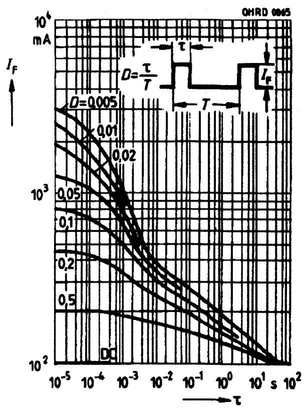
Maximum permissible forward current
$I_F=f(T_A)$



Forward current $I_F=f(V_F)$
Single pulse, τ=20 µs



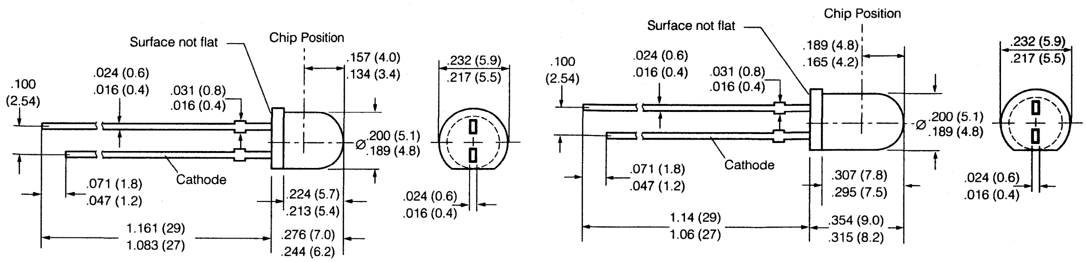
Permissible pulse handling capability
$I_F=f(\tau)$, T_A=25° C duty cycle D=Parameter



SIEMENS

SFH415
SFH416
GaAs INFRARED EMITTER

Package Dimensions in inches (mm)



FEATURES

- **Half Angle**
  SFH 415: ±17°
  SFH 416: ±28°
- **T1¾ Package**
- **Highly Efficient GaAs LEDs**
- **Good Linearity (I_E=f(I_F)) at High Currents**
- **Radiation in the Near Infrared Range**
- **High Pulse Handling Capability**

DESCRIPTION

The SFH415/416 are T1¾ (5 mm) epoxy packaged infrared emitters with a peak wavelength of 950 nm. The unique chip used in these devices is GaAs with a GaAlAs "window." This construction allows for a low forward voltage while maintaining strong output power, efficiency, and linearity. Suitable for remote control for TV sets and similar consumer applications.

Maximum Ratings

Operating and Storage
Temperature (T_{OP}, T_{STG})............ –55 to +100°C
Junction Temperature (T_J)........................100°C
Reverse Voltage (V_R).................................... 5 V
Forward Current (I_F)............................... 100 mA
Surge Current (I_{FSM}) t_p≤10 µs, D=0 .... 3 A
Power Dissipation (P_{tot}) T_A=25°C .... 165 mW
Thermal Resistance (T_{thJA})..................... 450 K/W

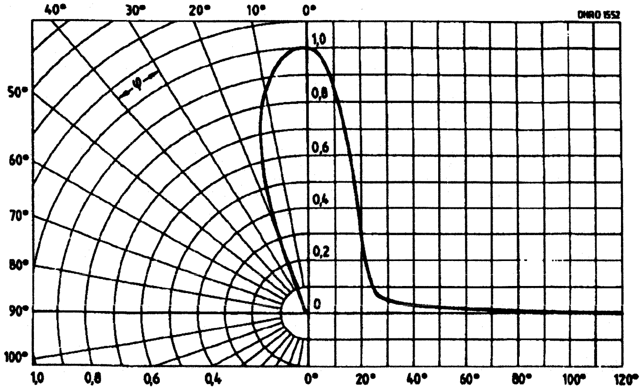
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Peak wavelength (I_F=100 mA, t_p=20 ms)	λ	950 ±20	nm
Spectral Bandwidth, 50% of I_{REL} (I_F=100 mA)	Δλ	55	nm
Half Angle			
SFH415	φ	±17	Deg.
SFH416	φ	±28	Deg.
Active Chip Area	A	0.09	mm^2
Active Chip Area Dimensions	L x W	0.3 x 0.3	mm
Distance Chip Surface to Case Surface			
SFH415	H	4.2 to 4.8	mm
SFH416	H	3.4 to 4.0	mm
Switching Times (I_F=100 mA) I_e from 10% to 90% or from 90% to 10%	t_R, t_F	0.5	µs
Capacitance (V_R=0 V, f=1 MHz)	C_0	25	pF
Forward Voltage (I_F=100 mA, t_p=20 ms)	V_F	1.3 (≤1.5)	V
(I_F=1 A, t_p=100 µs)		2.3 (≤2.8)	V
Breakdown Voltage (I_R=1 µA)	V_{BR}	≥5	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤1)	µA
Total Radiant Flux (I_F=100 mA, t_p=20 ms)	Φ_e	22	mW
Temperature Coefficient, I_e or Φ_e	TC_I	–0.5	%/K
Temperature Coefficient, V_F	TC_V	–2	mV/K
Temperature Coefficient, λ	TC_λ	+0.3	nm/K

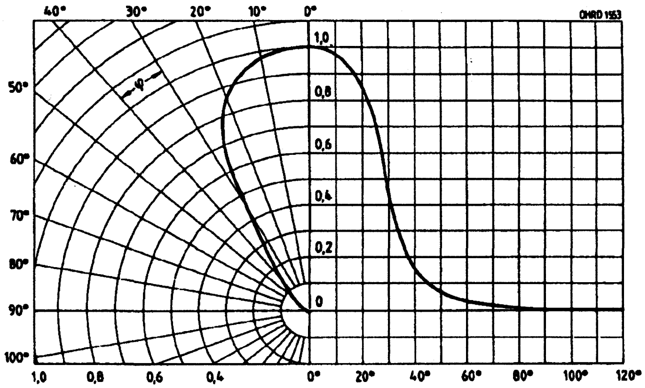
Radiant Intensity Selections, I_E in axial direction at solid angle Ω=0.01 sr

	Symbol	SFH 416-R	SFH 415-T	SFH 415-U	Unit
I_F=100 mA, t_p=20 ms	I_{Emin}	10	25	40	mW/sr
I_F=100 mA, t_p=20 ms	I_{Emax}	–	50	–	mW/sr
I_F=1 mA, t_p=100 ms	I_{Etyp}	150	380	600	mW/sr

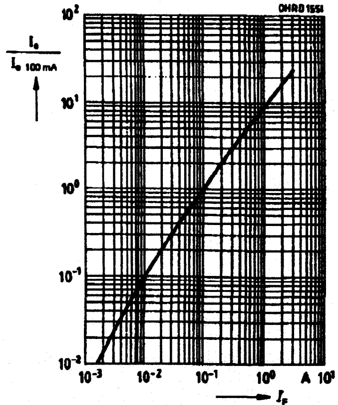
Radiation characteristics–SFH415
$I_{REL}=f(\varphi)$



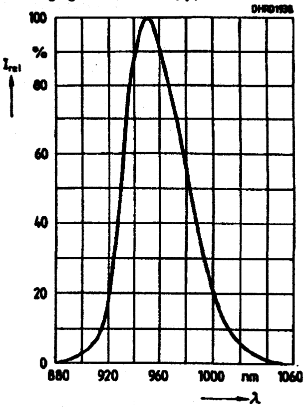
Radiation characteristics–SFH416
$I_{REL}=f(\varphi)$



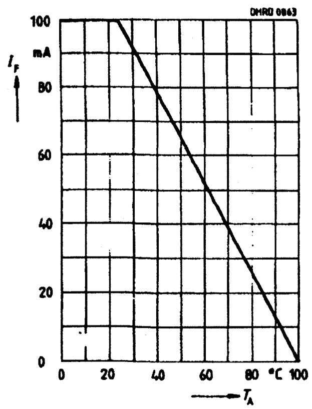
Relative spectral emission
$I_{REL}=f(\lambda)$



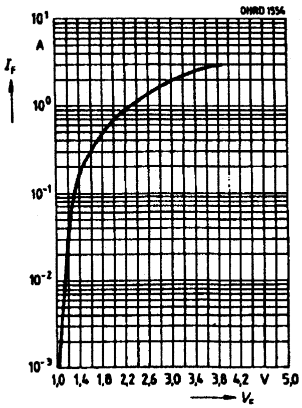
Relative radiant intensity
I_e/I_e 100 mA=$f(I_F)$



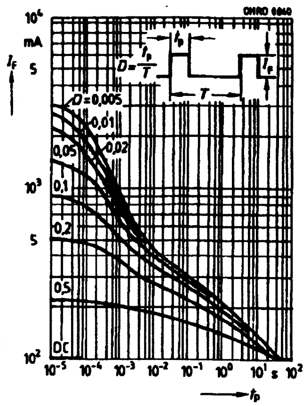
Max. permissible forward current
$I_F=f(T_A)$



Forward current $I_F=f(V_F)$
Single pulse, τ=20 µs



Permissible pulse handling capability
$I_F=f(t_p)$, Duty cycle D=Parameter
Single pulse, τ=20 µs

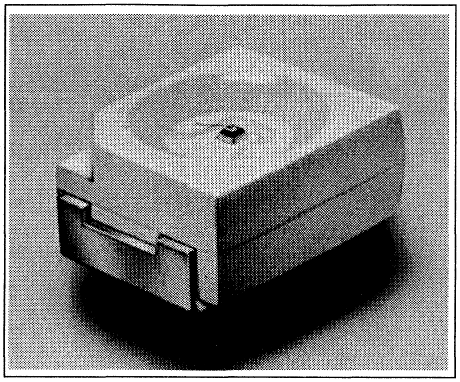


Infrared Emitters
7

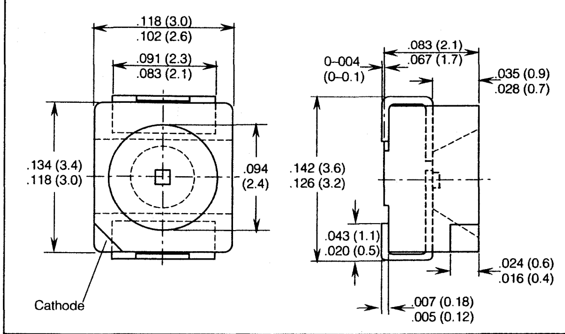
SIEMENS

SFH420

GaAs Infrared Emitter
SMT-TOP-LED™



Package Dimensions in Inches (mm)



FEATURES

- **Surface Mountable PL-CC-2 Package**
- **Suitable for Vapor-Phase Reflow, Infrared Reflow, Wave Solder Processes**
- **Compatible with Automatic Placement Equipment**
- **GaAs IR LED with Wide Viewing Angle**
- **Good Linearity [Ie = f (I_F)] at High Currents**
- **High Reliability/Long Lifetime**
- **Fast Response Time**
- **Matches with SFH320/SFH320F Phototransistor**
- **Applications**
  - **Measurement and Control**
  - **Touch Screens**
  - **Light Curtains**

DESCRIPTION

The SFH420 is a wide angle GaAs LED in a compact surface mountable package. The device is compatible with automatic placement equipment and can withstand IR reflow, vapor phase reflow and solder processes. Their small size makes them suitable for dense packaging in array applications such as touch screens and precise position measurement.

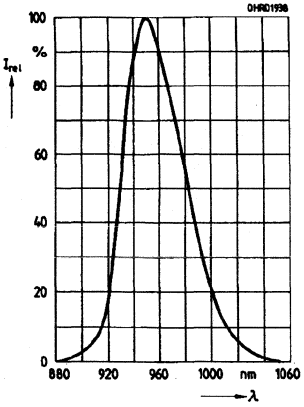
Maximum Ratings

Operating and Storage
Temperature (T_A, T_{STG}) .... –55 to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 100 mA
Pulse Current (I_{FSM}) τ=10 µs, D=0 .... 3 A
Power Dissipation (P_{tot}) T_A=25°C .... 160 mW
Thermal Resistance, Junction to Ambient
Mounting on PC Board (R_{thJA}) .... 450 K/W
Thermal Resistance, Junction to Solder Area
Mounting on Metal Block (R_{thJS}) .... 200 K/W

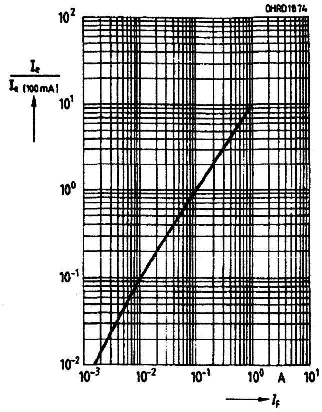
Characteristics (T_A=25 °C)

Parameter	**Symbol**	**Value**	**Unit**
Peak Wavelength (I_F=100 mA, t_p=20 ms)	λpeak	950±20	nm
Spectral Bandwidth (50% of I_{max}, I_F=100 mA)	Δλ	55	nm
Half Angle	φ	±60	Deg.
Radiant Sensitive Area	A	0.09	mm^2
Radiant Sensitive Area Dimensions	L x W	0.3 x 0.3	mm
Response Time (I_F=100 mA, R_L=50 Ω, from 10% to 90% or 90% to 10% of I_E)	t_R, t_F	0.5	µs
Capacitance (V_R=0 V, f=1 MHz)	C_O	25	pF
Forward Voltage			
(I_F=100 mA, t_p=20 ms)	V_F	1.3 (≤1.5)	V
(I_F=1 A, t_p=100 µs)	V_F	2.3 (≤2.8)	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤1)	µA
Total Radiant Flux (I_F=100 mA, t_p=20 ms)	Φ_e	14	mW
Temperature Coefficient, (I_e or Φ_e)(I_F=100 mA)	TC_I	–0.5	%/K
Temperature Coefficient, V_F (I_F=100 mA)	TC_V	–2	mV/K
Temperature Coefficient, λpeak (I_F=100 mA)	TC_λ	+0.3	nm/K
Radiant Intensity			
(I_F=100 mA, t_p=20 ms)	I_E		mW/sr
SFH420-N		2.5 to 5	
(I_F=1 A, t_p=100 µs)	I_{Etyp}	38	mW/sr

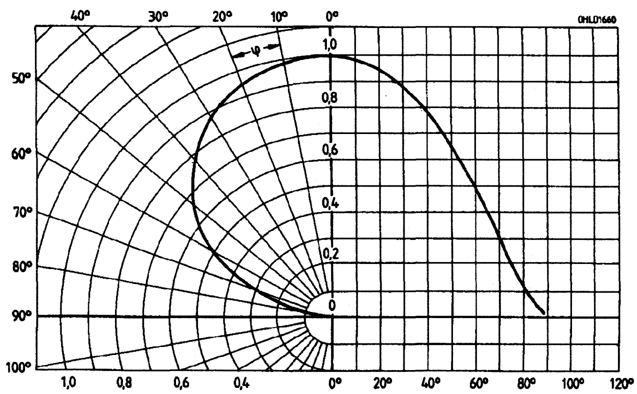
Relative spectral emission
$I_{REL}=f(\lambda)$



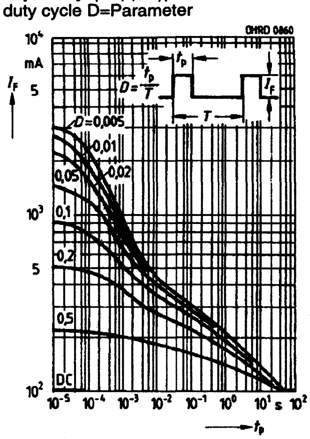
Relative radiant intensity
I_E/I_E 100 mA = $f(I_F)$, one pulse, τ = 20 µs



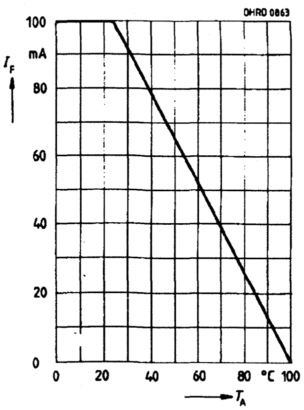
Radiation characteristics $I_{REL}=f(\varphi)$



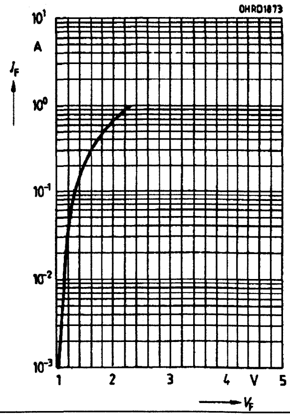
Permissible pulse handling capability $I_F=f(\tau)$, $T_A \leq 25°C$
duty cycle D=Parameter



Maximum permissible forward current $I_F=f(T_A)$



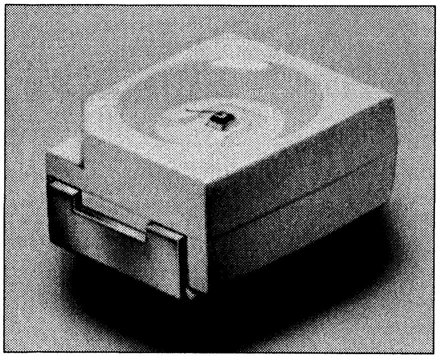
Forward current
$I_F=f(V_F)$, one pulse, τ = 20 µs



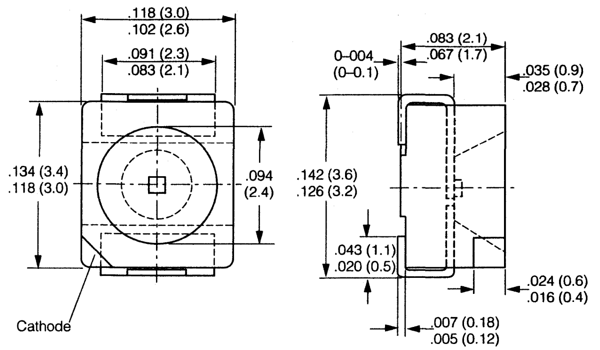
SIEMENS

SFH421

GaAlAs Infrared Emitter
SMT-TOPLED^{TM} Package



Package Dimensions in inches (mm)



FEATURES

- **Surface Mountable Package PL-CC-2**
- **Very High Efficiency GaAlAs IR IRED**
- **Good Linearity [Ie = f (IF)]**
- **Radiation in Near Infrared Range, 880 nm**
- **High Reliability**
- **Long Term Stability**
- **Fast Switching Time**
- **High Pulse Handling Capability**
- **On Tape and Reel**
- **Same Package as SFH320 and SFH420**
- **Applications**
  - **Miniature Light Barriers**
  - **Punched Tape Readers**
  - **Industrial Electronics**
  - **Measurement and Control**

DESCRIPTION

The SFH421 is a GaAlAs IRED in a compact surface mountable package. The device is compatible with automatic placement equipment and can withstand IR reflow, vapor phase reflow and solder processes. Their small size makes them suitable for dense packaging in array applications such as touch screens and precise position measurement.

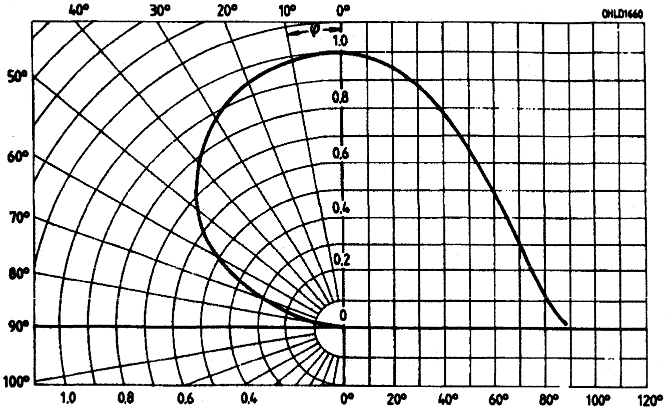
Maximum Ratings

Operating and Storage
Temperature (T_A, T_{STG}) .... –55 to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 100 mA
Surge Current (I_{FSM}) t=10 ms, D=0 .... 2.5 A
Total Power Dissipation (P_{tot}) .... 180 mW
Thermal Resistance, Junction to Ambient
Mounted on PC Board (R_{thJA}) .... 450 K/W
Thermal Resistance, Junction to Solder
Area, Mounted on Metal Block .... 200 K/W

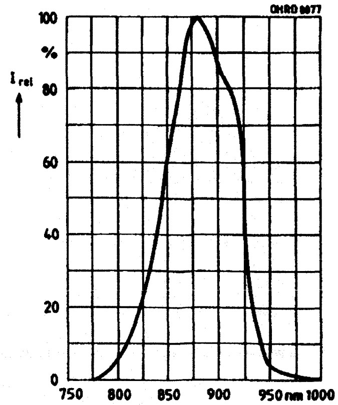
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Peak wavelength (I_F=100 mA, t_p=20 ms)	λ_{peak}	880 ±20	nm
Spectral Bandwidth (50% of I_{REL}, I_F=100 mA)	$\Delta\lambda$	80	nm
Half Angle	φ	±60	Deg.
Radiant Sensitive Area	A	0.16	mm^2
Radiant Sensitive Area Dimensions	L x W	0.4 x 0.4	mm
Switching Time (I_F=100 mA, R_L=50 Ω) I_E 10% to 90%, 90% to 10%	t_r, t_f	0.5	µs
Capacitance (V_R=0 V, f=1 MHz)	C_0	25	pF
Forward Voltage (I_F=100 mA, t_p=20 ms)	V_F	1.5 (≤1.8)	V
(I_F=1 A, t_p=100 µs)		3.0 (≤3.8)	
Reverse Current (V_R=5 V)	I_R	0.01 (≤1)	µA
Total Radiant Flux (I_F=100 mA, t_p=20 ms)	Φ_e	17	mW
Temperature Coefficient, I_e or Φ_e (I_F=100 mA)	TC_I	–0.5	%/K
Temperature Coefficient, V_F (I_F=100 mA)	TC_V	–2	mV/K
Temperature Coefficient, λ (I_F=100 mA)	TC_λ	+0.25	nm/K
Soldering Bath Temperature		260	°C
Soldering Time, Maximum Permissible		8	s
Distance between Solder Joint and Case		–	
Soldering Zone Temperature Preheating: 150°C		215	°C
Transit Time, Maximum		40	s
Radiant Intensity, I_E in axial direction measured at a solid angle, Ω=0.01 sr			
I_F=100 mA, t_p=20 ms	I_E		mW/sr
SFH421-P		4–8	
I_F=1 mA, t_p=100 µs	I_{Etyp}	48	mW/sr

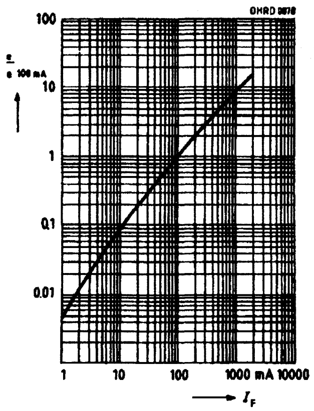
Radiation characteristics
$I_{rel}=f(\varphi)$



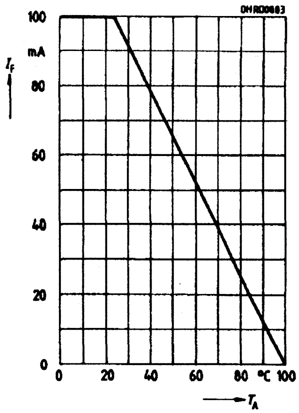
Relative spectral emission
$I_{rel}=f(\lambda)$



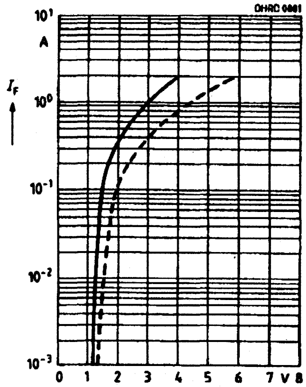
Relative radiant intensity
I_e/I_e (100 mA)$=f(I_F)$, one pulse, $\tau=20\ \mu s$



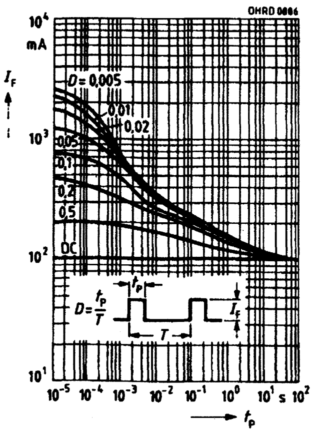
Max. permissible forward current
$I_F=f(T_A)$



Forward current
$I_F=f(V_F)$, one pulse, $\tau=20\ \mu s$



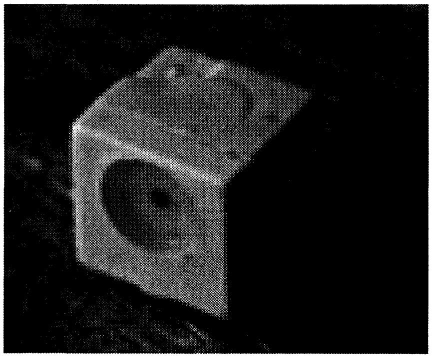
Permissible pulse handling capability
Duty cycle D=Parameter, $T_A=25°C$



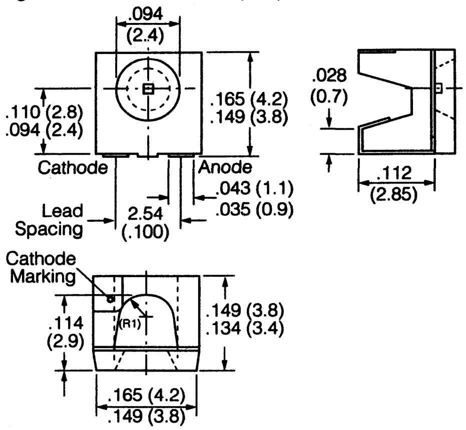
SIEMENS

SFH425

GaAs INFRARED EMITTER SMT-SIDELED



Package Dimensions in Inches (mm)



FEATURES

- **Surface Mountable PL-CC-2 Package**
- **Suitable for Vapor-Phase Reflow and Infrared Reflow Processes**
- **Compatible with Automatic Placement Equipment**
- **GaAs IR LED with Wide Viewing Angle**
- **Good Linearity [Ie = f (I_F)] at High Currents**
- **High Reliability/Long Lifetime**
- **Fast Response Time**
- **Matches with SFH320/SFH320F Phototransistor**
- **Applications**
  - **Measurement and Control**
  - **Touch Screens**
  - **Light Curtains**

DESCRIPTION

The SFH425 is a right angle GaAs LED in a compact surface mountable package. The device is compatible with automatic placement equipment and can withstand IR reflow and vapor phase reflow processes. Their small size makes them suitable for dense packaging in array applications such as touch screens and precise position measurement.

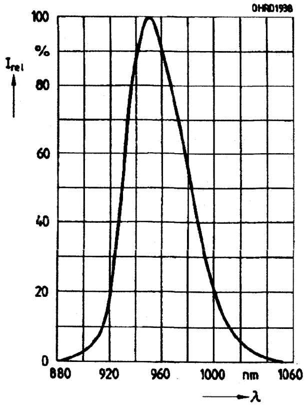
Maximum Ratings

Operating and Storage Temperature (T_A, T_{STG})	–55 to +100°C
Junction Temperature (T_J)	100°C
Reverse Voltage (V_R)	5 V
Forward Current (I_F)	100 mA
Pulse Current (I_{FSM}) τ=10 µs, D=0	3 A
Power Dissipation (P_{tot}) T_A=25°C	160 mW
Thermal Resistance, Junction to Ambient Mounting on PC Board (R_{thJA})	450 K/W
Thermal Resistance, Junction to Solder Area Chip to Solder Area (R_{thJS})	200 K/W

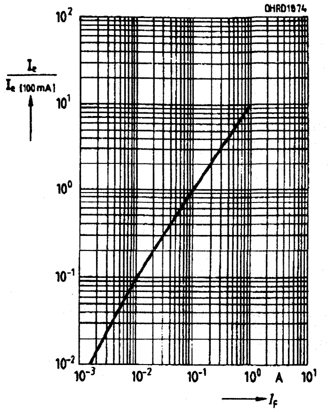
Characteristics (T_A=25 °C)

Parameter	**Symbol**	**Value**	**Unit**
Peak Wavelength (I_F=100 mA, t_p=20 ms)	λpeak	950±20	nm
Spectral Bandwidth (50% of I_{max}, I_F=100 mA)	$\Delta\lambda$	55	nm
Half Angle	φ	±60	Deg.
Radiant Sensitive Area	A	0.09	mm^2
Radiant Sensitive Area Dimensions	L x W	0.3 x 0.3	mm
Response Time (I_F=100 mA, R_L=50 Ω, from 10% to 90% or 90% to 10% of I_E)	t_R, t_F	0.5	µs
Capacitance (V_R=0 V, f=1 MHz)	C_O	25	pF
Forward Voltage (I_F=100 mA, t_p=20 ms)	V_F	1.3 (≤1.5)	V
(I_F=1 A, t_p=100 µs)	V_F	2.3 (≤2.8)	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤1)	µA
Total Radiant Flux (I_F=100 mA, t_p=20 ms)	Φ_e	22	mW
Temperature Coefficient, (I_e or Φ_e)(I_F=100 mA)	TC_I	–0.5	%/K
Temperature Coefficient, V_F (I_F=100 mA)	TC_V	–2	mV/K
Temperature Coefficient, λpeak (I_F=100 mA)	TC_λ	+0.3	nm/K
Radiant Intensity			
(I_F=100 mA, t_p=20 ms)	I_E	≥2.5	mW/sr
(I_F=1 A, t_p=100 µs)	I_{Etyp}	38	mW/sr

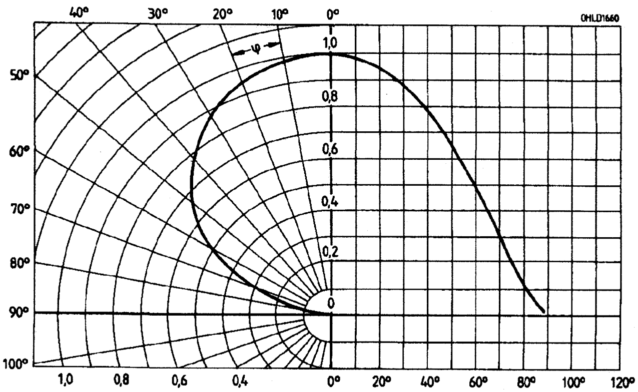
Relative spectral emission
$I_{REL} = f(\lambda)$



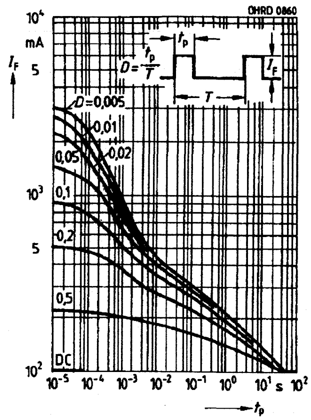
Relative radiant intensity
I_E / I_E 100 mA = $f(I_F)$, one pulse, τ = 20 µs



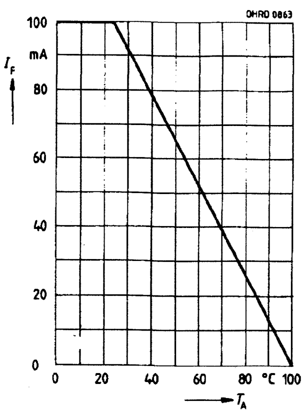
Radiation characteristics $I_{REL} = f(\varphi)$



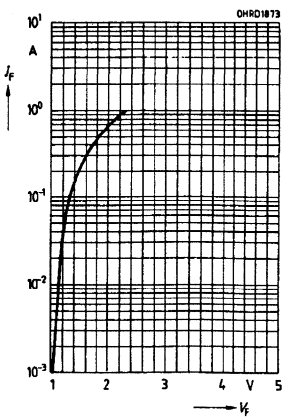
Permissible pulse handling capability $I_F = f(\tau)$, $T_A \leq 25°C$
duty cycle D=Parameter



Maximum permissible forward current $I_F = f(T_A)$



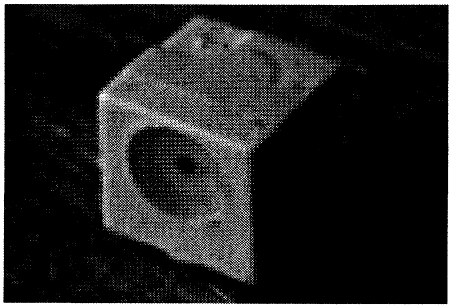
Forward current
$I_F = f(V_F)$, one pulse, τ = 20 µs



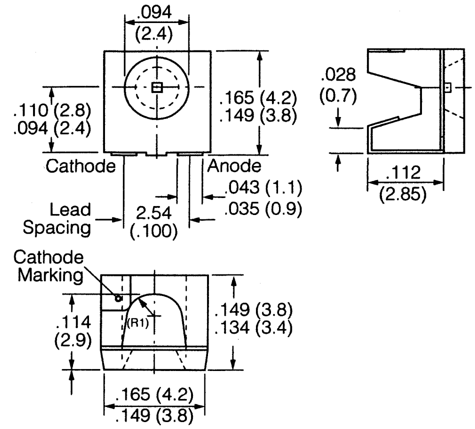
SIEMENS

SFH426

GaAlAs INFRARED EMITTER SMT-SIDELED



Package Dimensions in Inches (mm)



FEATURES

- **Surface Mountable Package PL-CC-2**
- **Very High Efficiency GaAlAs IR IRED**
- **Good Linearity [Ie = f (I_F)]**
- **Radiation in Near Infrared Range, 880 nm**
- **High Reliability**
- **Long Term Stability**
- **Fast Switching Time**
- **High Pulse Handling Capability**
- **On Tape and Reel**
- **Same Package as SFH325 and SFH425**
- **Applications**
  - **Miniature Light Barriers**
  - **Industrial Electronics**
  - **Measurement and Control**

DESCRIPTION

The SFH426 is a GaAlAs IRED in a compact right angle surface mountable package. The device is compatible with automatic placement equipment and can withstand IR reflow and vapor phase reflow processes. Their small size makes them suitable for dense packaging in array applications such as touch screens and precise position measurement.

Maximum Ratings

Operating and Storage
Temperature (T_A, T_{STG}) .... –55 to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 100 mA
Surge Current (I_{FSM}) τ=10 µs, D=0 .... 2.5 A
Total Power Dissipation (P_{tot}) .... 180 mW
Thermal Resistance
On PC Board (R_{thJA}) .... 450 K/W
Thermal Resistance, Junction to Solder Area
Chip to Solder Area (R_{thJS}) .... 200 K/W
Dip, Wave, and Drag Soldering
Soldering Bath Temperature .... 260°C
Maximum Permissible Soldering Time .... 8 sec.
Reflow Soldering Temperature
at Soldering Zone, t=10 sec. .... 260°C
t=30 sec. .... 215°C
Preheating Temp. (approx. 1 min.) .... 150°C

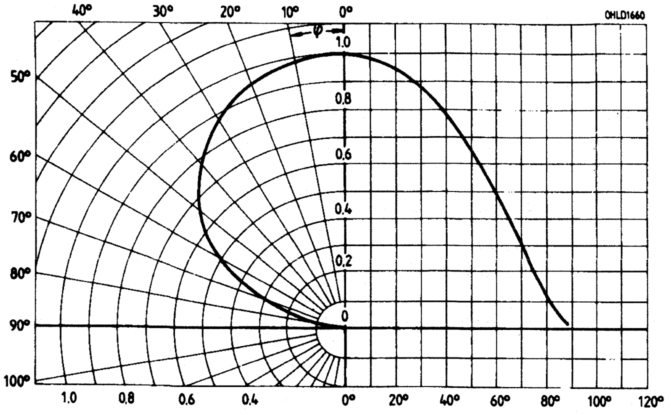
Characteristics (T_A=25°C)

Parameter	**Symbol**	**Value**	**Unit**
Peak Wavelength (I_F =100 mA, t_p=20 ms)	λpeak	880±20	nm
Spectral Bandwidth (50% of I_{REL}, I_F=100 mA)	Δλ	80	nm
Half Angle	φ	±60	Deg.
Radiant Sensitive Area	A	0.16	mm^2
Radiant Sensitive Area	L x W	0.4 x 0.4	mm
Switching Time (I_E 10% to 90%, 90% to 10%) (I_F=100 mA, R_L=50 Ω)	t_r,t_f	0.5	µs
Capacitance (V_R=0 V, f=1 MHz)	C_0	25	pF
Forward Voltage			
(I_F=100 mA, t_p=20 ms)	V_F	1.5 (≤1.8)	V
(I_F=1 A, t_p=100 µs)	V_F	3.0 (≤3.8)	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤1)	µA
Total Radiant Flux (I_F=100 mA, t_p=20 ms)	Φ_e	17	mW
Temperature Coefficient, I_e or Φ_e (I_F=100 mA)	TC_I	–0.5	%/K
Temperature Coefficient, V_F (I_F=100 mA)	TC_V	–2	mV/K
Temperature Coefficient, λ (I_F=100 mA)	TC_λ	+0.25	nm/K

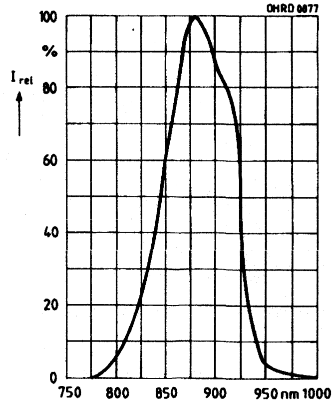
Radiant Intensity,
I_E in axial direction measured at a solid angle of Ω=0.01 sr

(I_F=100 mA, t_p=20 ms)	I_E	≥4	mW/sr
(I_F=1 A, t_p=100 µs)	I_{Etyp}	48	mW/sr

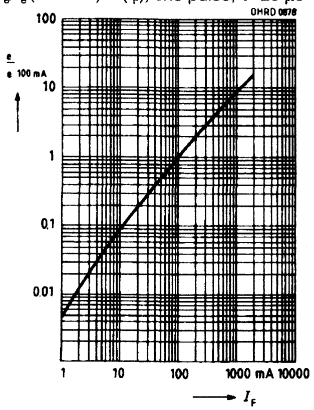
Radiation characteristics
$I_{REL} = f(\varphi)$



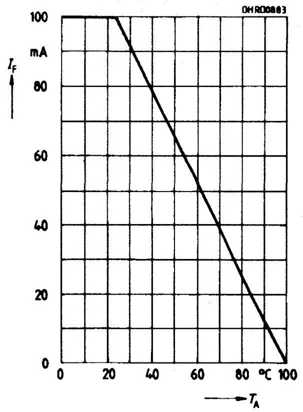
Relative spectral emission
$I_{REL} = f(\lambda)$



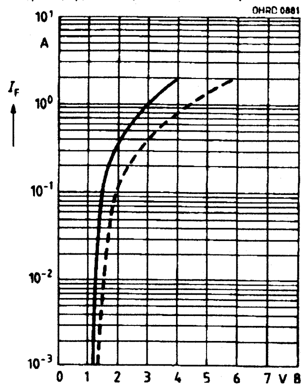
Relative radiant intensity
$I_e/I_e(100\ mA) = f(I_F)$, one pulse, $\tau = 20\ \mu s$



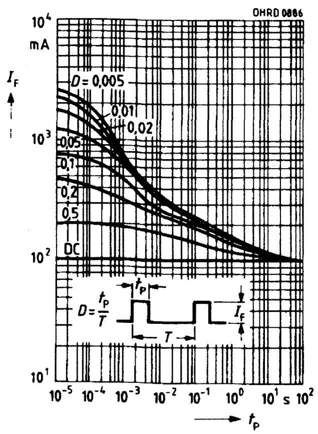
Maximum permissible forward current $I_F = f(T_A)$



Forward current
$I_F = f(V_F)$, one pulse, $\tau = 20\ \mu s$

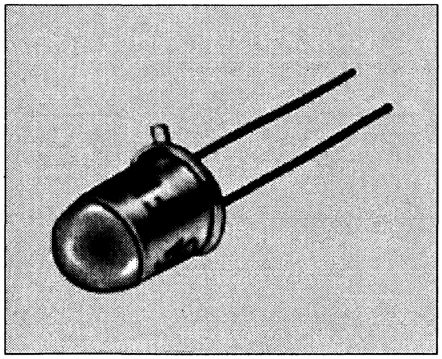


Permissible pulse handling capability
Duty cycle D=Parameter, $T_A = 25°C$

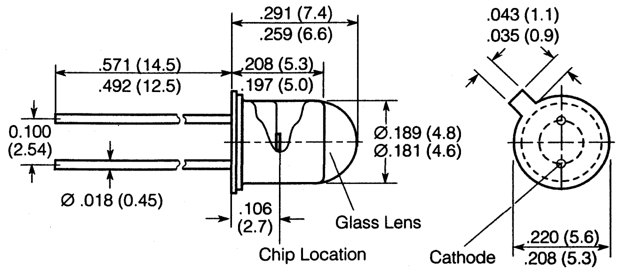


SIEMENS

SFH460
GaAlAs RED EMITTER



Package Dimensions in inches (mm)



FEATURES

- **Radiation Without IR in the Visible Red Range**
- **Cathode Electrically Connected to Case**
- **Very High Efficiency**
- **High Reliability**
- **Short Switching Time**
- **Same Package as SFH216, SFH400, and SFH480**

APPLICATIONS

- **Light-reflecting Switches for Constant and Pulsating Light Operation**

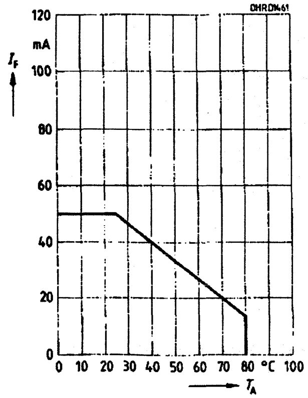
Maximum Ratings (T_A=25°C)

Operating and Storage Temperature Range (T_{OP}, T_{STG}) .....–55 to 100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 3 V
Forward Current (I_F) .... 50 mA
Surge Current (I_{FSM}) τ=10 µs, D=0 .... 1 A
Power Dissipation (P_{TOT}) .... 120 mW
Thermal Resistance (R_{thJA}) .... 450 K/W
(R_{thJC}) .... 160 K/W

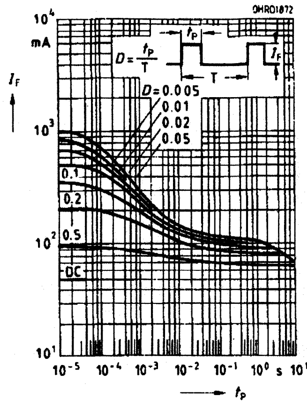
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Wavelength at Peak Emission I_F= 50 mA, t_p=20 ms	λ_{peak}	660±20	nm
Spectral Bandwith at 50% of I_{max} I_F=50 mA	$\Delta\lambda$	25	nm
Half Angle	φ	±6	Deg.
Active Chip Area	A	0.106	mm^2
Dimension of Active Chip Area	L x W	0.325 x 0.325	mm
Distance Chip Front to Case Surface	H	4.0 to 4.8	mm
Switching Times, I_e from 10% to 90% and from 90% to 10%, I_F=50 mA, R_L=50 Ω	t_r,t_f	100	ns
Capacitance V_R=0 V, f=1 MHz	C_0	30	pF
Forward Voltage, I_F=50 mA, t_p=20 ms	V_F	2.1 (≤2.8)	V
Reverse Current V_R=3 V	I_R	0.01 (≤10)	µA
Total Radiant Flux, I_F=50 mA, t_p=20 ms	Φ_e	4	mW
Temperature Coefficient T_e or Φ_e, I_F=50 mA	TC_I	–0.4	%/K
Temperature Coefficient V_F, I_F=50 mA	TC_V	-3	mV/K
Temperature Coefficient λ, I_F=50 mA	TC_λ	0.16	nm/K
Radiant Intensity, I_F=50 mA, t_p=20 ms	I_e	30 typ.	mW/sr

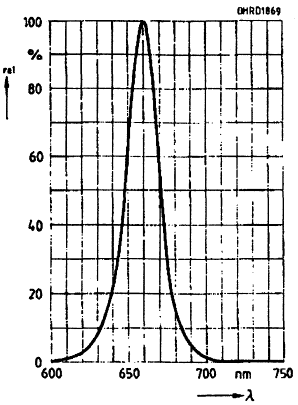
Maximum permissible forward current I_F=f (T_C), R_{thJC}=450 k/W



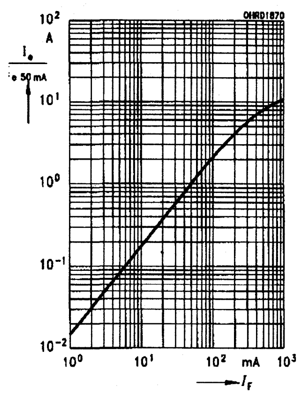
Permissible pulse handling capability
I_F=(τ), T_C=25°C, duty cycle D=parameter



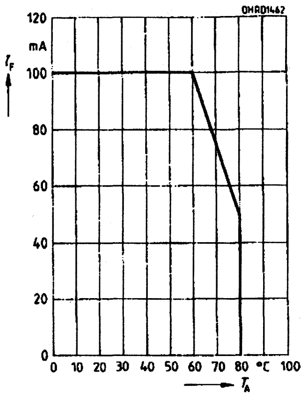
Relative spectral emmission
I_{REL}=f (λ)



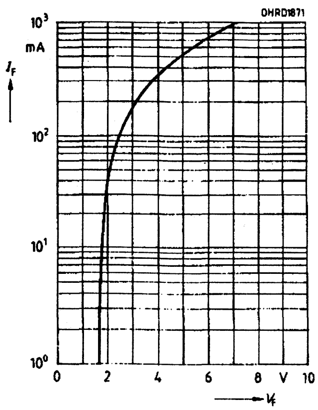
Radiant intensity I_e/I_e 50 mA=f (I_F)
Single pulse, τ=20 µs



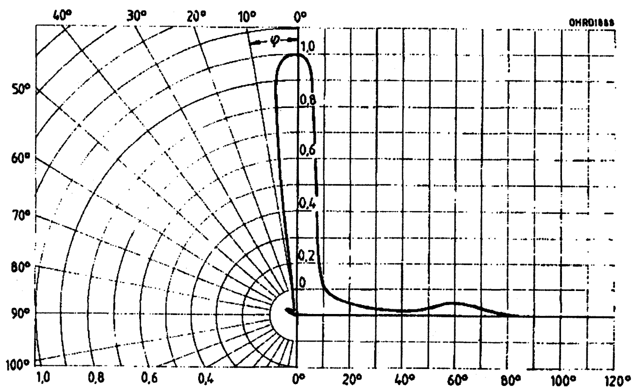
Maximum permissible forward current
I_F=f (T_C), R_{thJC}=160 k/W



Forward current
I_F=f (V_F), single pulse, τ=20 µs



Directional characteristics S_{REL}=f (φ)

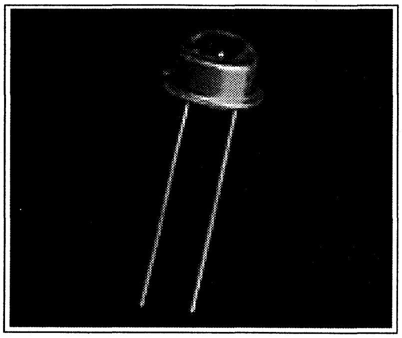


Infrared Emitters
7

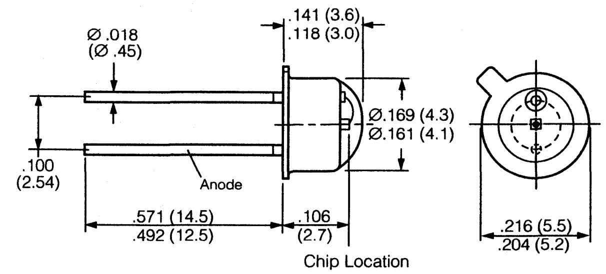
SIEMENS

SFH462

GaAlAs RED EMITTER



Package Dimensions in Inches (mm)



FEATURES

- **Radiation: Visible Red Range**
- **Anode Electrically Connected to Case**
- **Very High Efficiency**
- **Short Switching Time**
- **High Pulse Power**
- **High Reliability**
- **Long Life**
- **Same Package as BP103, LD 242, SFH 483**
- **Package: 18 A 3 DIN 870 (TO 18), Clear Epoxy Resin, 0.1" (2.54 mm) Lead Spacing**
- **DIN Humidity Category per DIN 40040 GQG**
- **Component Subjected to Aperture Measurement**
- **Anode Marking: Projection at Case Bottom**
- **Application**
  - **Long Range Light Reflecting Switches**

Radiant Intensity Note:

1. An aperture is used in front of the component for measuring the radiant intensity and the half angle (diameter of the aperture: 1.1 mm; distance of aperture to case back side: 4 mm). This ensures that only the radiation in axial direction emitting directly from the chip surface will be evaluated during radiant intensity measurement. This measurement is denoted by "E7800" added to the part number.

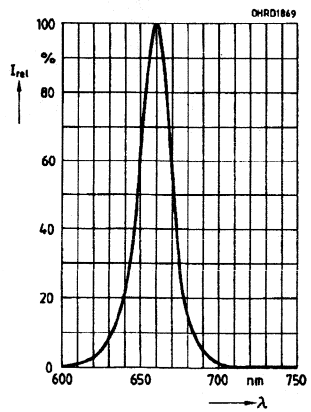
Maximum Ratings

Operating and Storage Temperature Range (T_{OP},T_{STG}) −40 to +80°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 3 V
Forward Current (I_F) .... 50 mA
Power Dissipation (P_{TOT}) .... 120 mW
Surge Current (I_{FSM}) t_p=10µs, D=0 .... 1 A
Thermal Resistance (R_{thJA}) .... 450 K/W
(R_{thJC}) .... 160 K/W

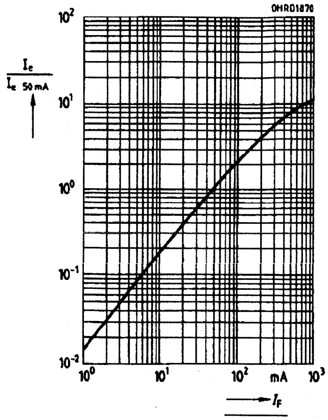
Characteristics (T_A=25°C)

Parameter	Sym	Value	Unit	Condition
Wavelength, Peak Emission	λ_{PEAK}	660±20	nm	I_F=50 mA, t_p=20 ms
Spectral Bandwidth at 50%	$\Delta\lambda$	25	nm	I_F=50 mA
Half Angle(1)	φ	±23	Deg.	
Active Chip Area	A	0.106	mm^2	
Chip Area Dimension	LxW	.325x.325	mm	
Distance Chip Surface to Case Surface	H	0.3 to 0.7	mm	
Switching Times, I_e from 10% to 90% and from 90% to 10%,	t_r/t_f	100	ns	I_F=50 mA, R_L=50 Ω
Capacitance	C_O	30	pF	V_R=0 V, f=1 MHZ
Forward Voltage	V_F	2.1 (≤2.8)	V	I_F=50 mA, t_p=20 ms
Reverse Current	I_R	0.01 (≤10)	µA	V_R=3 V
Radiant Flux (Total)	Φ_e	11	mW	I_F=50 mA, t_p=20 ms
Temperature Coefficient of I_e Resp. Φ_e	TC_I	−0.4	%/K	I_F =50 mA
Temperature Coefficient of V_F	TCv	−3	mV/K	I_F=50 mA
Temperature Coefficient of λ	TC_λ	+0.16	nm/K	I_F=50 mA
Radiant Intensity Groupings(1)				
I_E in Axial Direction at solid angle of Ω=0.01 sr				
SFH462 E 7800	I_E	0.63 to 2.0	mW/sr	I_F=50 mA, tp=20 ms

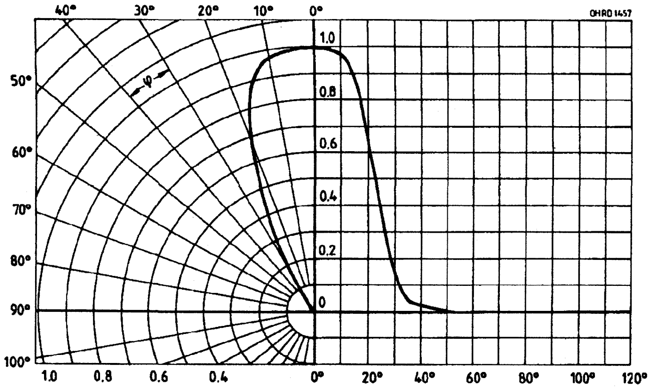
Relative spectral emission
$I_{rel} = f(\lambda)$



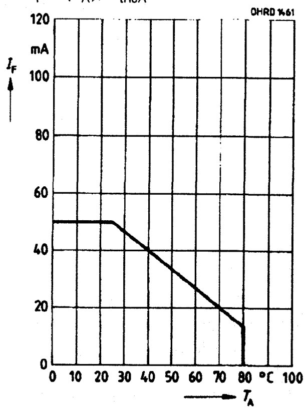
Radiant intensity $\frac{I_E}{I_{e\,50\,mA}} = f(I_F)$
Single Pulse $\tau = 20\,\mu s$



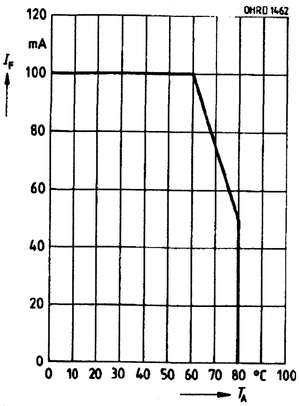
Radiation characteristic $I_{ref} = f(\varphi)^{(1)}$



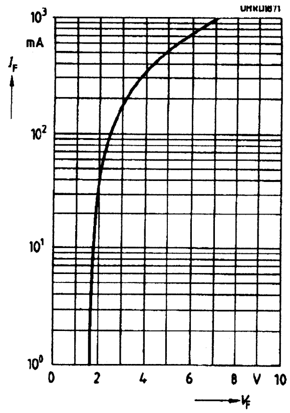
Maximum permissible forward current
$I_F = f(T_A)$, $R_{thJA} = 450$ K/W



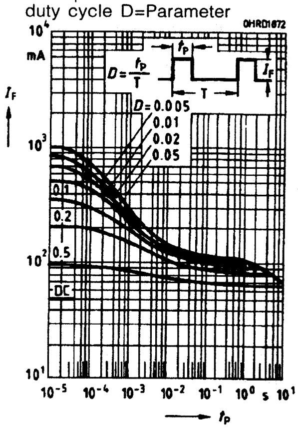
Maximum permisible forward current
$I_F = f(T_C)$, $R_{thJC} = 160$ K/W



Forward Current $I_F = f(V_F)$,
Single pulse $\tau = 20\,\mu s$



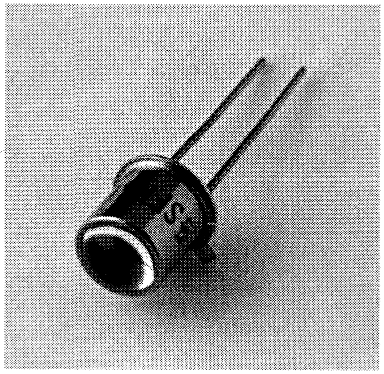
Permissible pulse handling capability
$I_F = f(t_p)$, $T_A = 25$ °C
duty cycle D=Parameter



Infrared Emitters
7

SIEMENS

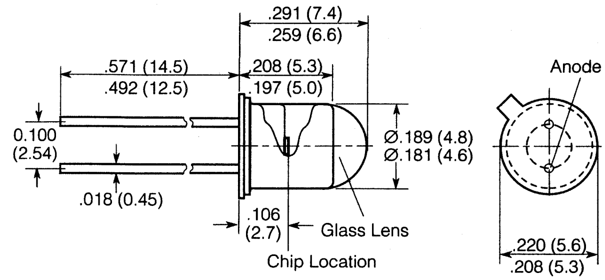
SFH480
SFH481
SFH482
GaAlAs INFRARED EMITTER



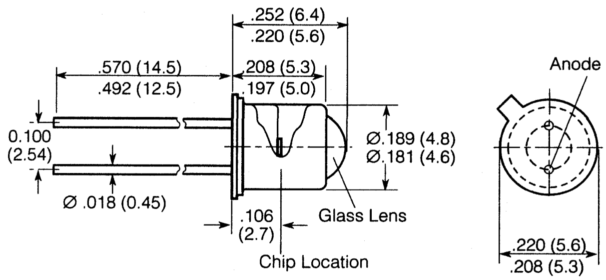
SFH482

Package Dimensions in Inches (mm)

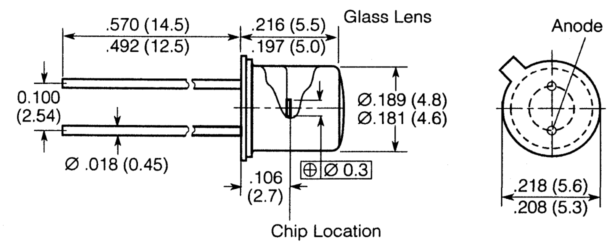
SFH480



SFH481



SFH482



FEATURES

- **Half Angle**
  - **SFH480, ±6°**
  - **SFH481, ±15°**
  - **SFH482, ±30°**
- **GaAlAs Infrared Emitting Diode, Fabricated in a Liquid Phase Epitaxy Process**
- **Emits Radiation in Near Infrared Range**
- **Anode Electrically Connected to Case**
- **High Reliability**
- **Long Term Stability**
- **SFH480/481: High Radiant Intensity**
- **SFH482: Wide Beam**
- **High Pulse Power**
- **Radiant Intensity Selections**
- **SFH480: Same Package as SFH216**
- **SFH481: Same Package as BPX43**
- **SFH482: Same Package as BPX38, BPX65, BPX66, SFH402**
- **Applications**
  - **Light-reflecting Switches**
  - **IR Remote Control**
- **Package**
  - **18 A 3 DIN 876 (TO 18)**
  - **Hermetically Sealed**
  - **Lead Spacing 0.100" (2.54 mm)**
- **Cathode Marking: Tab at Case Bottom**

Maximum Ratings

Operating/Storage Temperature Range (T_{OP}, T_{STG}) .... –55° to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 200 mA
Surge Current (I_{FSM}) t=10 µs, D=0 .... 2.5 A
Power Dissipation (P_{TOT}) .... 470 mW
Thermal Resistance (R_{thJA}) .... 450 K/W
(R_{thJC}) .... 160 K/W

Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Peak Wavelength			
(I_F=100 mA)	λ_{PEAK}	880±20	nm
Spectral Bandwidth, 50% I_{MAX}			
(I_F=100 mA)	$\Delta\lambda$	80	nm
Half Angle			
SFH480	φ	±6	Deg.
SFH481	φ	±15	Deg.
SFH482	φ	±30	Deg.
Active Chip Area	A	0.16	mm^2
Active Chip Area Dimensions	L x W	0.4 x 0.4	mm
Distance, Chip Surface to Case Surface			
SFH480	H	4.0 to 4.8	mm
SFH481	H	2.8 to 3.7	mm
SFH482	H	2.1 to 2.7	mm
Swtching Times, I_E			
10% to 90% and 90% to 10%			
(I_F=100 mA, R_L=50 Ω)	t_R, t_F	0.6/0.5	µs
Capacitance (V_R=0 V, f=1 MHz)	C_0	25	pF
Forward Voltage			
(I_F=100 mA, t_P=20 µs)	V_F	1.5 (≤1.8)	V
(I_F=1 A, t_P=100 µs)	V_F	3 (≤3.8)	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤1)	µA
Radiant Flux, Total (I_F=100 mA, t_P=20 ms)	Φ_E	12	mW
Temperature Coefficient, I_E or Φ_E (I_F=100 mA)	TC_I	–0.5	%/K
Temperature Coefficient, V_F (I_F=100 mA)	TC_V	–2	mV/K
Temperature Coefficient, λ (I_F=100 mA)	TC_λ	0.25	nm/K

Radiant Intensity Selections

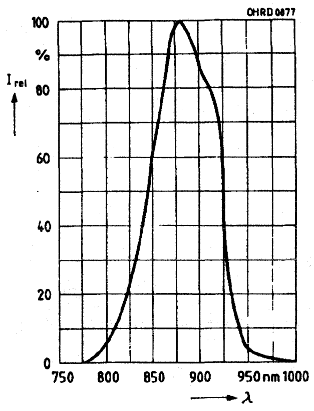
I_E in axial direction at solid angle of Ω=0.01 sr

	Symbol	SFH 480-2	SFH 481-1	SFH 481-2	SFH 481-3(2)	Unit
I_F=100 mA,t_P=20 ms	I_{Emin}	40	10	16	25	mW/sr
I_F=100 mA,t_P=20 ms	I_{Emax}	–	20	–	–	mW/sr
I_F=1 A,t_P=100 µs	I_{Etyp}	540	130	220	250	mW/sr

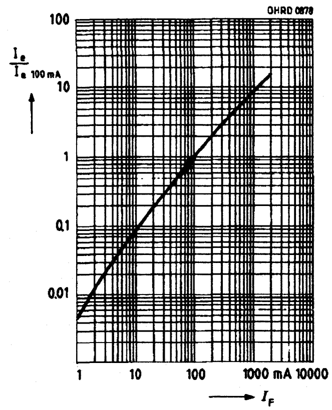
	Symbol	SFH 482-2	SFH 482-3(2)	SFH 482 E7800(1)	Unit
I_F=100 mA,t_P=20 ms	I_{Emin}	5	8	1 to 3.2	mW/sr
I_F=100 mA,t_P=20 ms	I_{Emax}	–	–	–	mW/sr
I_F=1 A,t_P=100 µs	I_{Etyp}	65	80	–	mW/sr

Note:
1. An aperture is used in front of the component for measuring the radiant intensity and the half angle (diameter of the aperture: 2.0 mm; distance of aperture to case back side: 5.4 mm). This ensures that only the radiation in axial direction emitting directly from the chip surface will be evaluated during radiant intensity measurement. This measurement is denoted by "E7800" added to the part number.
2. Availability subject to yield.

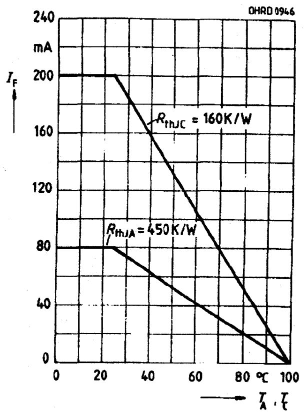
Relative spectral emission
I_{REL}=f(λ)



Radiant Intensity I_E/I_{E100mA}=f(I_F)
Single pulse, τ= 20 µs

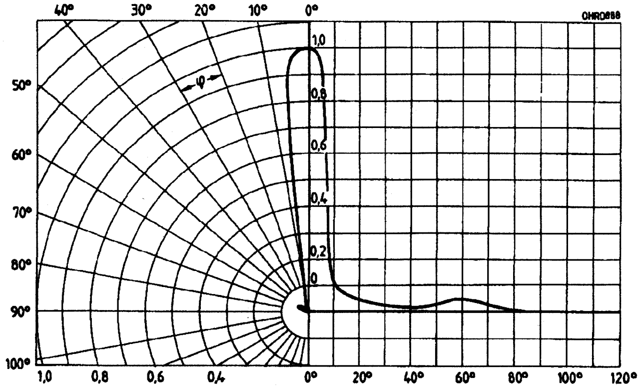


Maximum permissible forward current I_F=f(T_A)

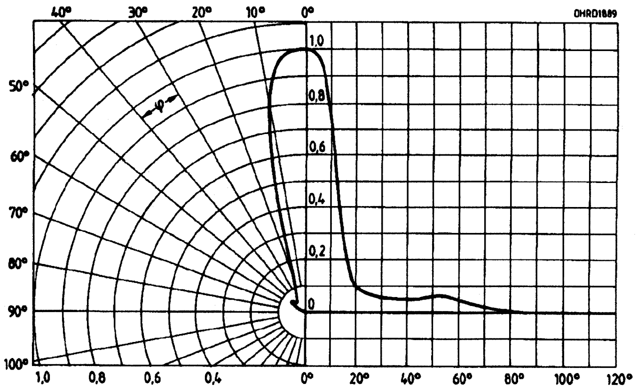


Infrared Emitters 7

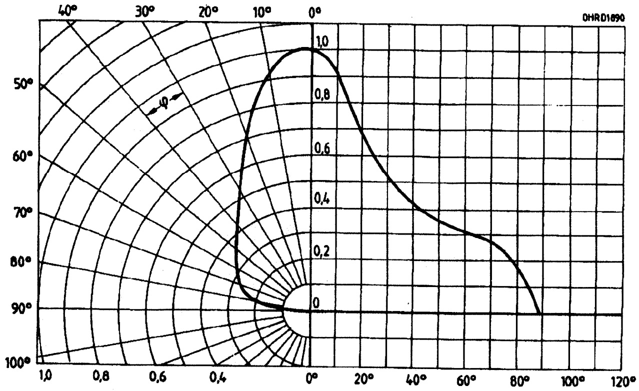
Radiation characteristic–SFH480
$I_{REL}=f(\varphi)$



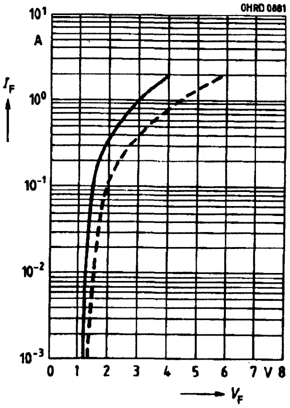
Radiation characteristic–SFH481
$I_{REL}=f(\varphi)$



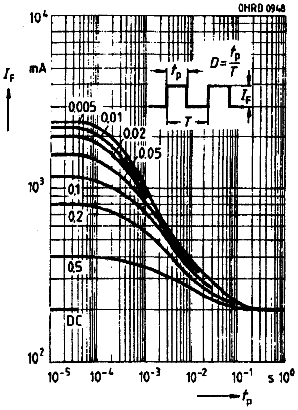
Radiation characteristic–SFH482
$I_{REL}=f(\varphi)$



Forward current $I_F=f(V_F)$
Single pulse, τ= 20 µs



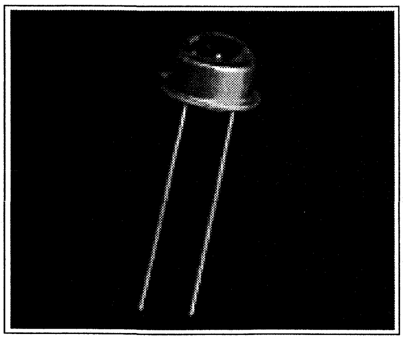
Permissible pulse handling capability $I_F=f(\tau)$, $T_A\leq25°C$
duty cycle D=Parameter



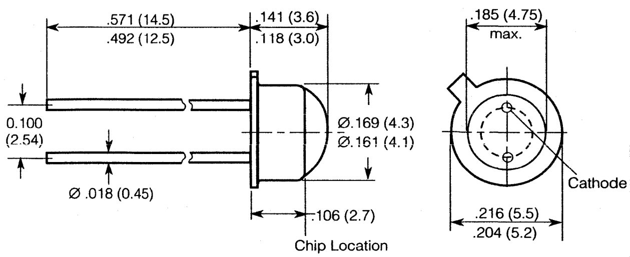
SIEMENS

SFH483

GaAlAs INFRARED EMITTER



Package Dimensions in Inches (mm)



FEATURES

- **Highly Efficient GaAlAs LED**
- **Radiation in Near Infrared Range**
- **Anode Electrically Connected to Case**
- **Short Switching Time**
- **High Pulse Power**
- **High Reliability**
- **Long-Term Stability**
- **Same Package as BPX63, BP103, LD 242, SFH 462**
- **Package: 18 A 3 DIN 870 (TO 18), Clear Epoxy Resin, 0.1" (2.54 mm) Lead Spacing**
- **DIN Humidity Category per DIN 40040 GQG**
- **Applications**
  - **IR Remote Controls**
  - **Light-Reflecting Switches**
  - **Use with Apertures**

Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) −40 to + 80°C
Junction Temperature (T_j) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) $T_C \leq 25°C$ .... 200 mA
Power Dissipation (P_{TOT}) T_C=25°C .... 470 mW
Surge Current (I_{FSM}) t_p=10µs, D=0; T_C=25°C .... 2.5 A
Thermal Resistance (R_{thJA}) .... 450 K/W
(R_{thJC}) .... 160 K/W

Characteristics (T_A=25°C)

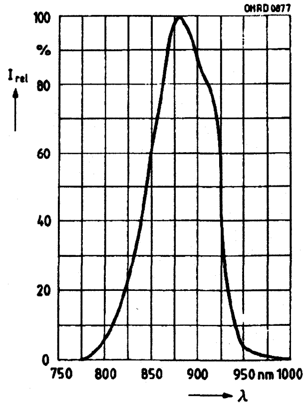
Parameter	Sym	Value	Unit	Condition
Wavelength at Peak Emission	λ_{peak}	880±20	nm	I_F=100 mA
Spectral Bandwidth at 50%	$\Delta\lambda$	80	nm	I_F=100 mA
Half Angle(1)	φ	±23	Deg.	
Active Chip Area	A	0.16	mm^2	
Chip Area Dimension	LxW	0.4x0.4	mm	
Distance Chip Surface to Case Surface	H	2.7 to 2.9	mm	
Switching Times, I_e from 10% to 90% and from 90% to 10%,	t_r/t_f	0.6/0.5	µs	I_F=100 mA, R_L=50 Ω
Capacitance	C_O	25	pF	V_R=0 V, f=1 MHZ
Forward Voltage	V_F	1.5 (≤1.8)	V	I_F=100 mA, t_p=20 ms
	V_F	3.0 (≤3.8)	V	I_F=1 A, t_p=100 µs
Reverse Current	I_R	0.01 (≤1)	µA	V_R=5 V
Radiant Flux (Total)	Φ_e	23	mW	I_F=100 mA, t_p=20 ms
Temperature Coefficient of I_e Resp. Φ_e	TC_I	−0.5	%/K	I_F =100 mA
Temperature Coefficient of V_F	TCv	−2.5	mV/K	I_F=100 mA
Temperature Coefficient of λ	TC_λ	+0.25	nm/K	I_F=100 mA

Characteristics (T_A=25 °C)

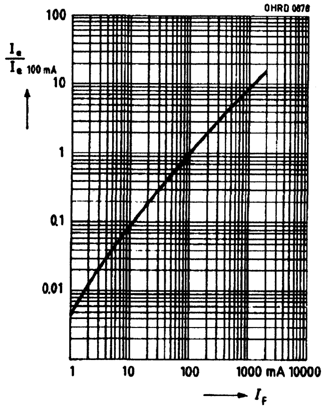
Parameter	Sym	Value	Unit	Condition
Radiant Intensity Groupings(1)				
I_e in Axial Direction at a Solid Angle of Ω=0.01 sr				
SFH483 E7800	$I_{e\,min}$	1	mW/sr	I_F=100 mA, t_p=20 ms
	$I_{e\,max}$	3.2	mW/sr	I_F=100 mA, t_p=20 ms
	$I_{e\,typ.}$	20	mW/sr	I_F=1 A, t_p=100 ms

Notes:
1. An aperture is used in front of the component for measuring the radiant intensity and the half angle (diameter of the aperture: 1.1 mm; distance of aperture to case back side: 4 mm). This ensures that only the radiation in axial direction emitting directly from the chip surface will be evaluated during radiant intensity measurement. This measurement is denoted by "E7800" added to the part number.
2. Availability subject to yield.

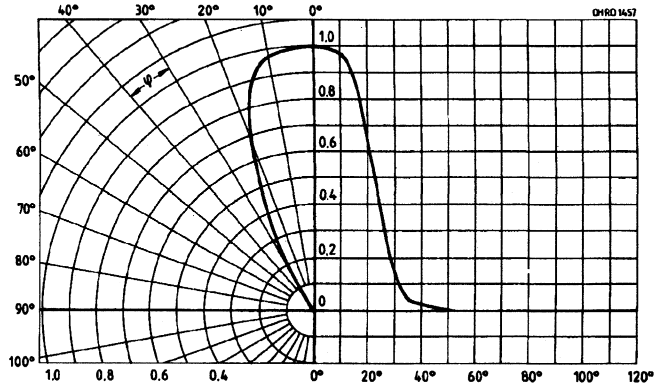
Relative spectral emission
I_{rel} = f (λ)



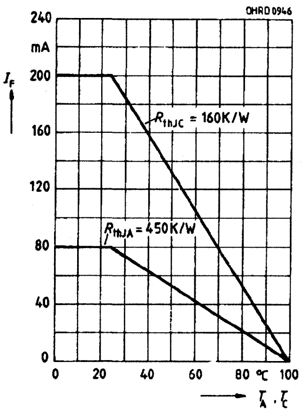
Radiant intensity $\frac{I_e}{I_e\ 100\ mA}$ = f (I_F)
Single Pulse τ =20μs



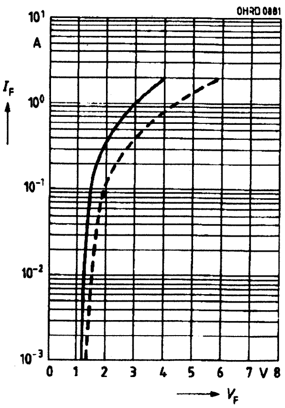
Radiation characteristic
I_{ref} = f (φ)



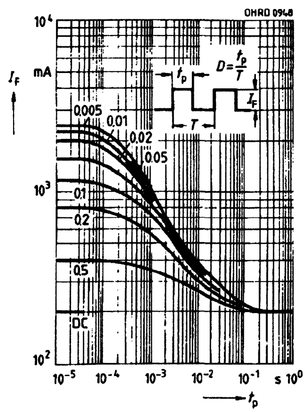
Maximum permisible forward current
I_F = f (T_A), R_{thJA} = 450 K/W
I_F = f (T_A), R_{thJC} = 160 K/W



Forward Current I_F = f (V_F),
Single pulse τ = 20 μs



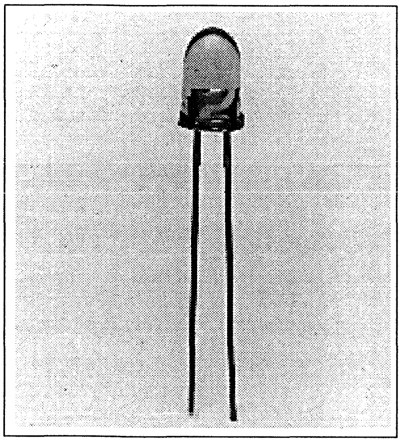
Permissible pulse handling capability
I_F = f (t_p), T_C = 25 °C
duty cycle D = Parameter



SIEMENS

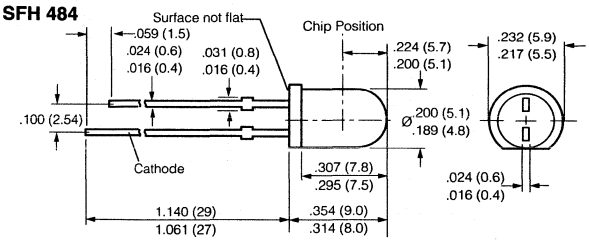
SFH 484
SFH 485

GaAlAs INFRARED EMITTER

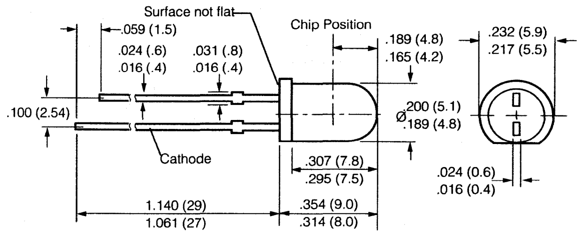


Package Dimensions in Inches (mm)

SFH 484



SFH 485



FEATURES

- **T1¾ Package**
- **Clear Plastic Lens**
- **Long Term Stability**
- **Very High Power, 25 mW Typical at 100 mA**
- **Good Spectral Match with Silicon Photo Detector**
- **Gallium Aluminum Arsenide Material**
- **SFH 484–16° Narrow Beam, SFH 485–40° Medium Beam**
- **Smoke Detection Application: SFH484-E7517 (UL Recognized)**

DESCRIPTION

SFH 484, an infrared emitting diode, emits radiation in the near infrared range (880 nm peak). The device comes in a T1¾ (5 mm) plastic package. Uses for SFH 484 include IR remote control, smoke detectors, and other applications requiring high power, such as IR touch screens.

The SFH 485 contains the same IR emitter chip as the SFH 484 but features a wider beam.

Maximum Ratings

Operating and Storage Temperature
Range (T_{OP}, T_{STG}) .... –55° to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 100 mA
Surge Current (I_{FSM})
t=10 µs .... 2.5 A
Power Dissipation (P_{TOT}) .... 200 mW
Thermal Resistance (R_{thJA}) .... 375 K/W

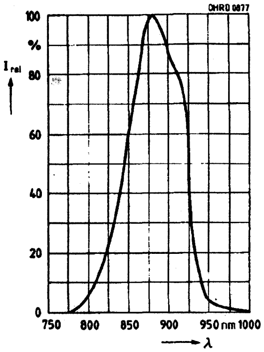
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Peak Wavelength (I_F=100 mA, t_P=20 ms)	λ_{PEAK}	880±20	nm
Spectral Bandwidth (I_F=100 mA)	$\Delta\lambda$	80	nm
Half Angle			
SFH 484	φ	±8	Deg.
SFH 485	φ	±20	Deg.
Active Chip Area	A	0.16	mm^2
Active Chip Area Dimensions	L x W	0.4 x 0.4	mm
Distance, Chip Surface to Case Surface			
SFH 484	D	5.1 to 5.7	mm
SFH 485	D	4.2 to 4.8	mm
Swtching Times, I_E 10% to 90% and 90% to 10% (I_F=100 mA)	t_R, t_F	0.6/0.5	µs
Capacitance (V_R=0 V, f=1 MHz)	C_O	25	pF
Forward Voltage			
(I_F=100 mA, t_P=20 µs)	V_F	1.5 (≤1.8)	V
(I_F=1 mA, t_P=100 µs)	V_F	3.0 (≤3.8)	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤1)	µA
Temperature Coefficient, I_E or Φ_E	TC_I	–0.5	%/K
Temperature Coefficient, V_F	TC_V	–2	mV/K
Temperature Coefficient, λ	TC_λ	0.25	nm/K

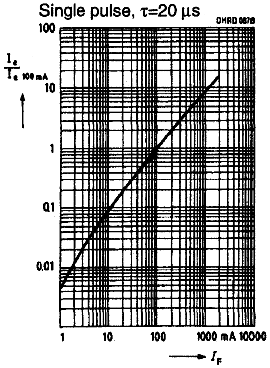
Radiant Intensity, I_E in Axial Direction at a solid angle of Ω=0.01 sr

	Sym	SFH 484-1	SFH 484-2	SFH 485-1	SFH 485-2	Unit
I_F=100 mA,	$I_{E\ min}$	50	80	16	25	mW/sr
t_P=20 ms	$I_{E\ max}$	100	–	32	–	mW/sr
I_F=1 A, t_P=100 µs	$I_{E\ typ}$	700	900	220	340	mW/sr

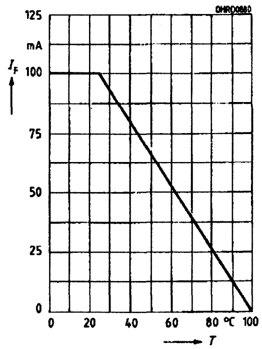
Relative spectral emission
I_{REL}=f (l)



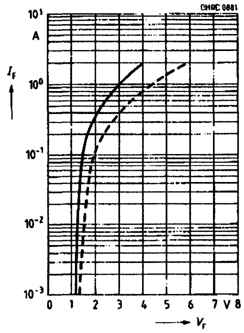
Radiant intensity
I_E/I_E 100 mA=f (I_F)
Single pulse, τ=20 µs



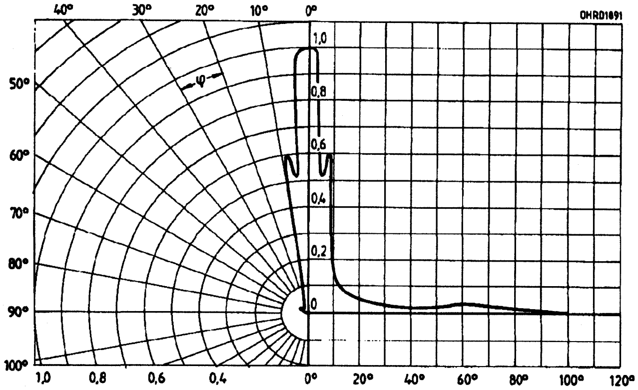
Maximum permissible forward current I_F=f (T_A)



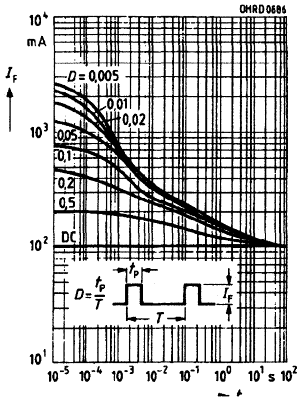
Forward current I_F=f (V_F)
Single pulse, τ=20 µs



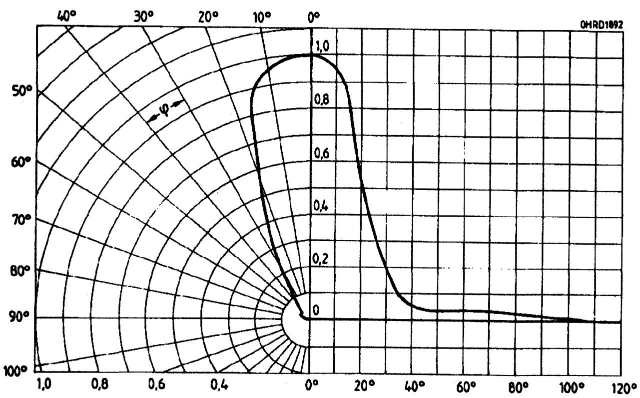
SFH 484–Radiation characteristic
I_{REL}=f (φ)



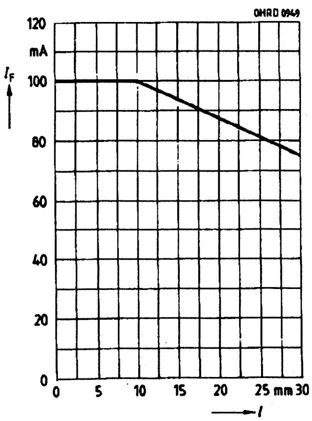
Permissible pulse handling capability
I_F=f (τ), T_A=25°C duty cycle D=Parameter



SFH 485–Radiation characteristic
I_{REL}=f (φ)



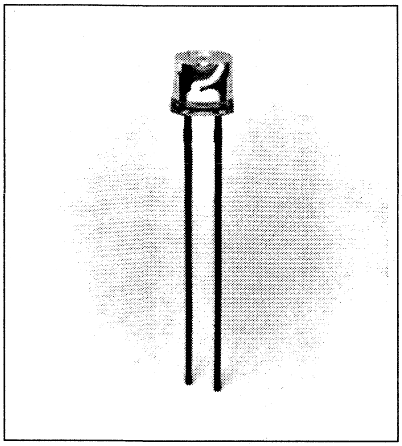
Maximum forward current vs. lead length, package bottom and PC-board
I_F=f (l), T_A=25° C



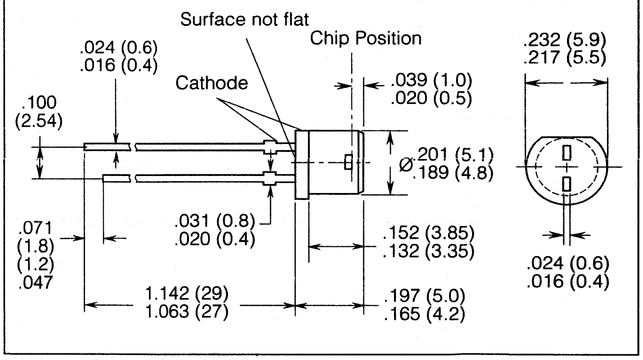
SIEMENS

SFH 485P

GaAlAs INFRARED EMITTER



Package Dimensions in Inches (mm)



FEATURES

- **T1¾ (5 mm) Plastic Package**
- **Flat Lens**
- **Long Term Stability**
- **Good Spectral Match with Silicon Photo Detector**
- **Gallium Aluminum Arsenide Material**
- **Wide Beam, 80°**
- **High Efficiency**
- **High Reliability**
- **880 nm Peak Wavelength**

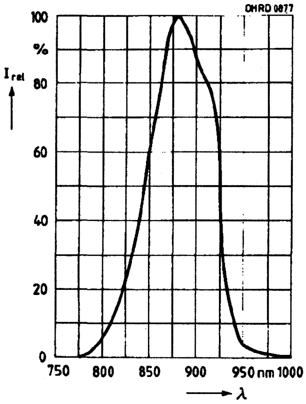
Maximum Ratings

Operating and Storage Temperature
Range (T_{OP}, T_{STG}) .... –55° to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 100 mA
Surge Current (I_{FSM}) t≤10 µs .... 2.5 A
Power Dissipation (P_{TOT}) .... 200 mW
Thermal Resistance (R_{thJA}) .... 375 K/W

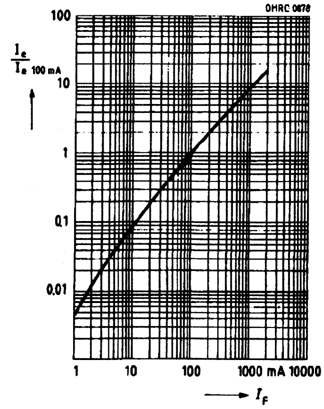
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Peak Wavelength (I_F=100 mA)	λ_{PEAK}	880±20	nm
Spectral Bandwidth (I_F=100 mA)	$\Delta\lambda$	80	nm
Half Angle	φ	±40	Deg.
Active Chip Area	A	0.16	mm^2
Active Chip Area Dimensions	L x W	0.4 x 0.4	mm
Distance, Chip Surface to Case Surface	D	0.5 to 1.0	mm
Swtching Times, I_E			
10% to 90% and 90% to 10%			
(I_F=100 mA, R_L=50 Ω)	t_R, t_F	0.6/0.5	µs
Capacitance (V_R=0 V, f=1 MHz)	C_0	25	pF
Forward Voltage			
(I_F=100 mA, t_P=20 µs)	V_F	1.5 (≤1.8)	V
(I_F=1 A, t_P=100 µs)	V_F	3.0 (≤3.8)	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤1)	µA
Temperature Coefficient, I_E or Φ_E	TC_I	–0.5	%/K
Temperature Coefficient, V_F	TC_V	–2	mV/K
Temperature Coefficient, λ	TC_λ	0.25	nm/K
Radiant Intensity, I_E in Axial Direction at a solid angle of Ω=0.01 sr			
Radiant Intensity			
I_F=100 mA, t_P=20 ms	I_E	≥3.15	mW/sr
I_F=1 A, t_P=100 µs	I_E	42	mW/sr
Total Radiant Flux			
I_F=100 mA, t_P=20 ms	Φ_E	25	mW

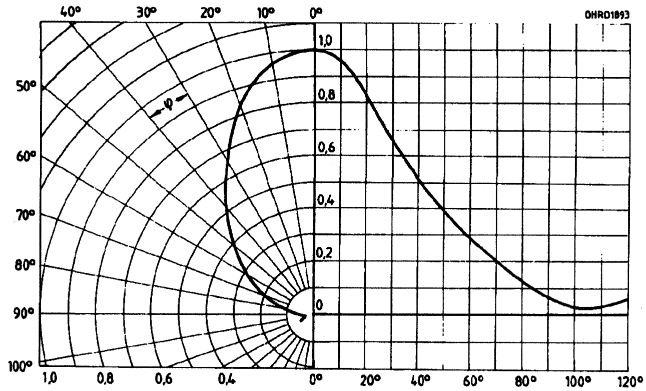
Relative spectral sensitivity
I_{REL}=f (l)



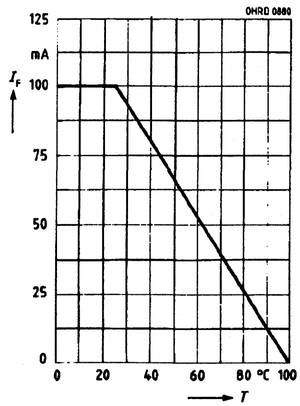
Radiant intensity $\frac{I_E}{I_E\ 100\ mA}$ =f (I_F)
Single pulse, τ=20 µ



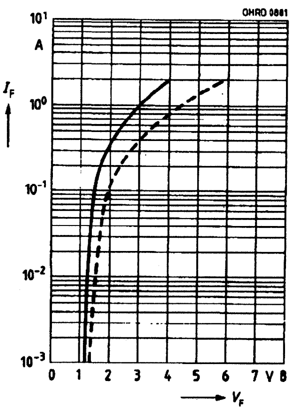
Radiation characteristic
I_{REL}=f (φ)



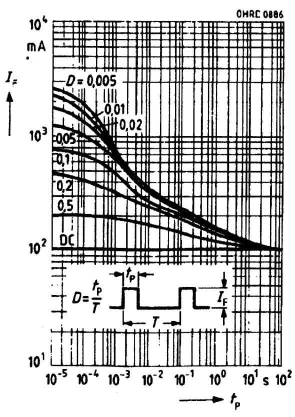
Maximum permissible forward current I_F=f (T_A)



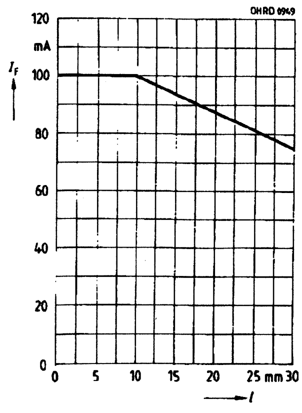
Forward current I_F=f (V_F)
Single pulse, τ=20 µs



Permissible pulse handling capability
I_F=f (τ), T_A=25°C
duty cycle D=Parameter



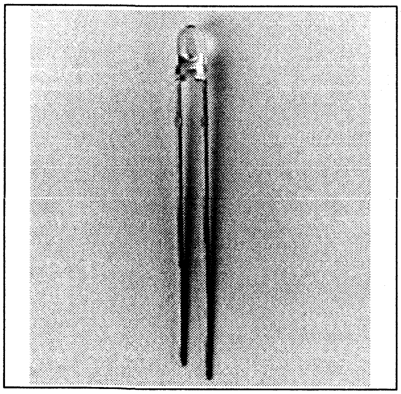
Maximum forward current vs. lead length, package bottom and PC-board
I_F=f (l), T_A=25° C



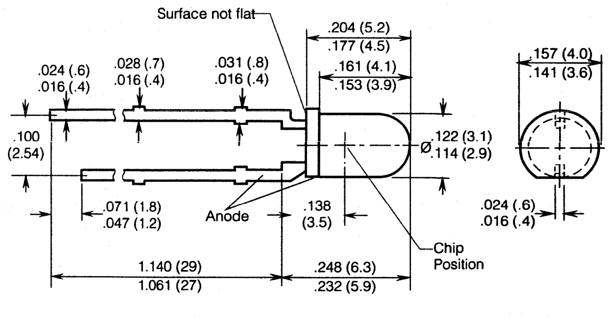
SIEMENS

SFH 487

GaAlAs INFRARED EMITTER



Package Dimensions in Inches (mm)



FEATURES

- **Radiant Intensity Selections**
  SFH 487-1, 12.5–25 mW/sr
  SFH 487-2, ≥20 mW/sr
- **T1 (3mm) Package**
- **Clear Blue Tinted Plastic Lens**
- **Long Term Stability**
- **Good Spectral Match with Silicon Photo Detector**
- **Gallium Aluminum Arsenide Material**
- **Medium Beam, 40°**

DESCRIPTION

SFH 487, an infrared emitting diode, emits radiation in the near infrared range (880 nm peak). The emitted radiation, which can be modulated, is generated by forward flowing current. The device is enclosed in a T1 (3 mm) plastic package. Uses for SFH 487 include: IR remote control for color TVs, smoke detectors, and other applications requiring very high power, such as IR touch screens.

Maximum Ratings

Operating and Storage Temperature
  Range (T_{OP}, T_{STG}) .... –55° to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 100 mA
Surge Current (I_{FSM})
  t=10 µs .... 2.5 A
Power Dissipation (P_{TOT}) .... 200 mW
Thermal Resistance (R_{thJA}) .... 375 K/W

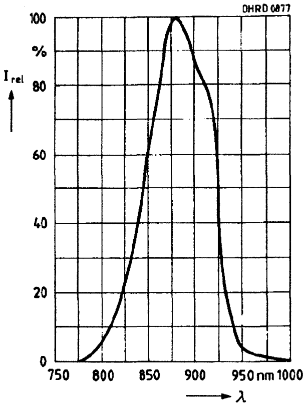
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Peak Wavelength (I_F=100 mA)	λ_{PEAK}	880±20	nm
Spectral Bandwidth (I_F=100 mA)	$\Delta\lambda$	80	nm
Half Angle	φ	±20	Deg.
Active Chip Area	A	0.16	mm^2
Active Chip Area Dimensions	L x W	0.4 x 0.4	mm
Distance, Chip Surface to Case Surface	D	2.6	mm
Swtching Times, I_E 10% to 90% and 90% to 10% (I_F=100 mA)	t_R, t_F	0.6/0.5	µs
Capacitance (V_R=0 V, f=1 MHz)	C_0	25	pF
Forward Voltage			
(I_F=100 mA, t_P=20 µs)	V_F	1.5 (≤1.8)	V
(I_F=1 A, t_P=100 µs)	V_F	3.0 (≤3.8)	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤1)	µA
Temperature Coefficient, I_E or Φ_E	TC_I	–0.5	%/K
Temperature Coefficient, V_F	TC_V	–0.2	mV/K
Temperature Coefficient, λ	TC_λ	0.25	nm/K

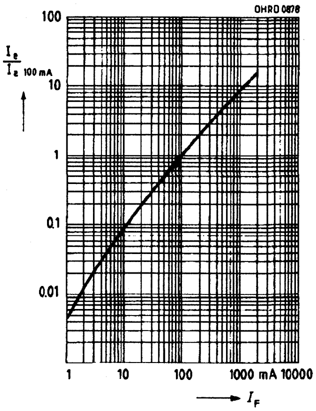
Radiant Intensity, I_E in Axial Direction at a solid angle of Ω=0.01 sr

	SFH 487-1	SFH 487-2	Unit
Radiant Intensity I_E			
I_F=100 mA, t_P=20 ms	12.5–25	≥20	mW/sr
I_F=1 A, t_P=100 µs	140	270	mW/sr
Total Radiant Flux Φ_E (typ.)			
I_F=100 mA, t_P=20 ms	23	25	mW

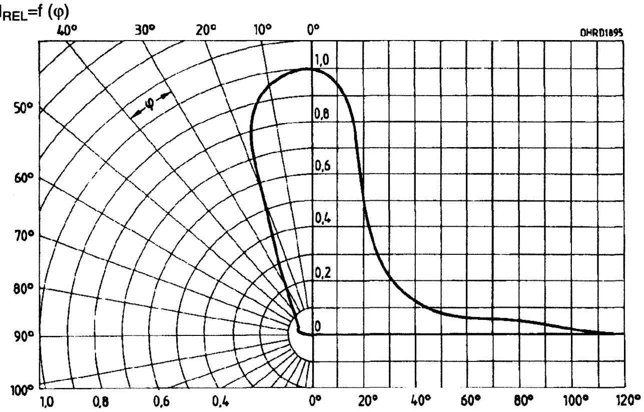
Relative spectral sensitivity
I_{REL}=f (λ)



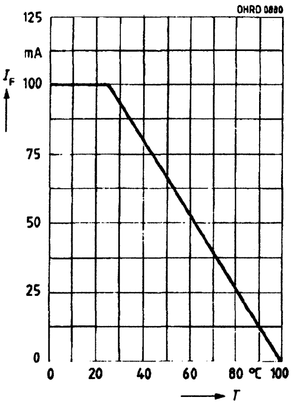
Radiant intensity $\frac{I_E}{I_E\ 100\ mA}$=f (I_F)
Single pulse, τ=20 µs



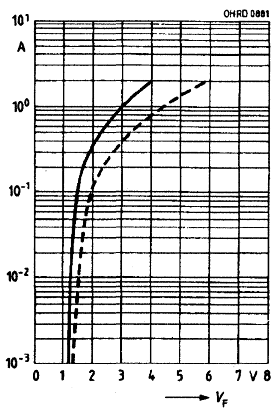
Radiation characteristic
I_{REL}=f (φ)



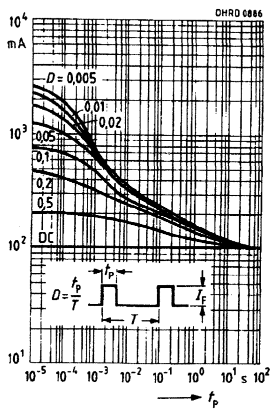
Maximum permissible forward current
I_F=f (T_A)



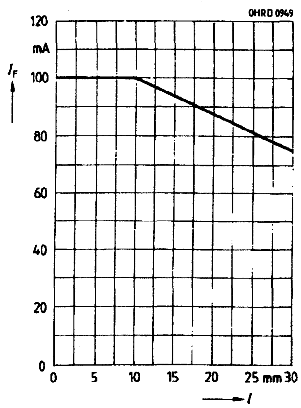
Forward current I_F=f (V_F)
Single pulse, τ=20 µs



Permissible pulse handling capability
I_F=f (τ), T_A=25° C
Duty cycle D=Parameter



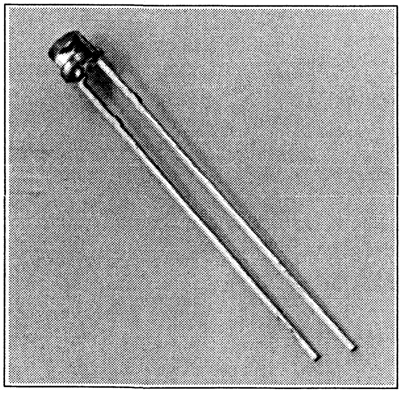
Forward current vs. lead length, package bottom and PC-board
I_F=f (l), T_A=25°



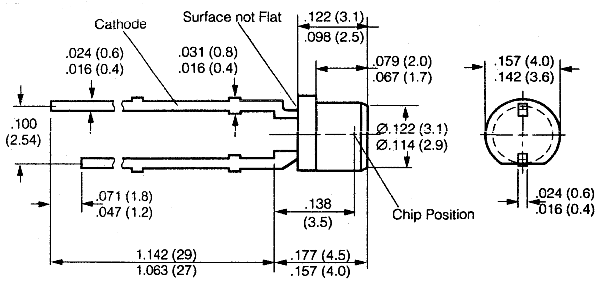
SIEMENS

SFH 487P

GaAlAs INFRARED EMITTER



Package Dimensions in Inches (mm)



FEATURES

- **T1 (3mm) Package**
- **Flat Plastic Lens**
- **Long Term Stability**
- **Good Spectral Match with Silicon Photo Detector**
- **Gallium Aluminum Arsenide Material**
- **Very Wide Beam, 130°**
- **Very High Power, 15 mW Typical at 100 mA**

DESCRIPTION

SFH 487P, an infrared emitting diode, emits radiation in the near infrared range (880 nm peak). The emitted radiation, which can be modulated, is generated by forward flowing current. The device is enclosed in a T1 (3 mm) diameter plastic package with a flat lens. Typical applications are digital shaft encoders and light interruptors for DC and AC operation.

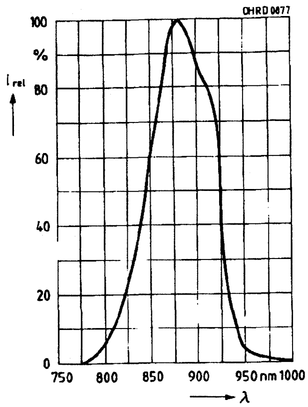
Maximum Ratings

Storage Temperature
Range (T_{OP}, T_{STG}) .... –55° to +100°C
Junction Temperature (T_J) .... 100°C
Reverse Voltage (V_R) .... 5 V
Forward Current (I_F) .... 100 mA
Surge Current (I_{FSM}) t=10 µs .... 2.5 A
Power Dissipation (P_{TOT}) T=25° C ... 200 mW
Thermal Resistance (R_{thJA}) .... 375 K/W

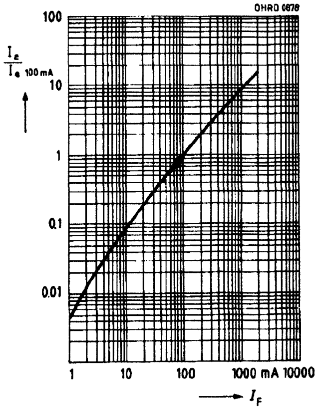
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Peak Wavelength (I_F=100 mA)	λ_{PEAK}	880±20	nm
Spectral Bandwidth (I_F=100 mA)	$\Delta\lambda$	80	nm
Half Angle	φ	±65	Deg.
Active Chip Area	A	0.16	mm^2
Active Chip Area Dimensions	L x W	0.4 x 0.4	mm
Distance, Chip Surface to Case Surface	D	0.4 to 0.8	mm
Switching Times, I_E			
10% to 90% and 90% to 10%			
(I_F=100 mA)	t_R, t_F	0.6/0.5	µs
Capacitance (V_R=0 V, f=1 MHz)	C_0	25	pF
Forward Voltage			
(I_F=100 mA, t_P=20 µs)	V_F	1.5 (≤1.8)	V
(I_F=1 A, t_P=100 µs)	V_F	3.0 (≤3.8)	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤1)	µA
Temperature Coefficient, I_E or Φ_E			
(I_F=100 mA)	TC_I	–0.5	%/K
Temperature Coefficient, V_F			
(I_F=100 mA)	TC_V	–0.2	mV/K
Temperature Coefficient, λ			
(I_F=100 mA)	TC_λ	0.25	nm/K
Radiant Intensity, I_E in Axial Direction at a solid angle of Ω=0.01 sr			
Radiant Intensity			
I_F=100 mA, t_P=20 ms	I_E	>2	mW/sr
I_F=1 A, t_P=100 µs	I_E	25	mW/sr
Total Radiant Flux (typ.)			
I_F=100 mA, t_P=20 ms	Φ_E	25	mW

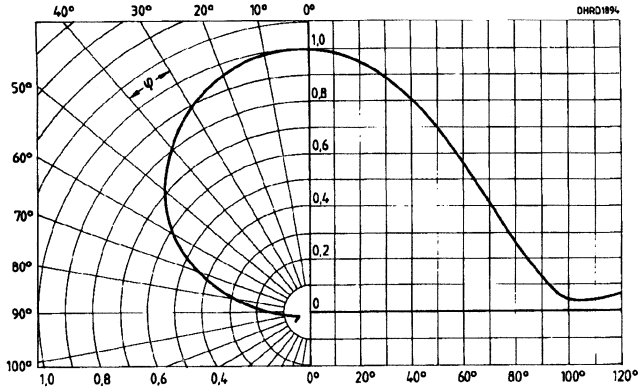
Relative spectral sensitivity
$I_{REL}=f(\lambda)$



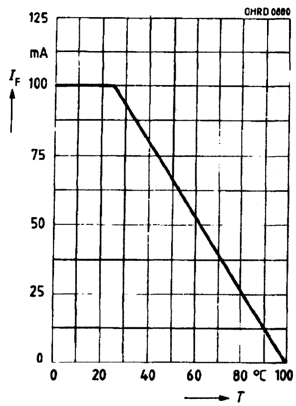
Radiant intensity $\frac{I_E}{I_E\ 100\ mA}=f(I_F)$
Single pulse, τ =20 µs



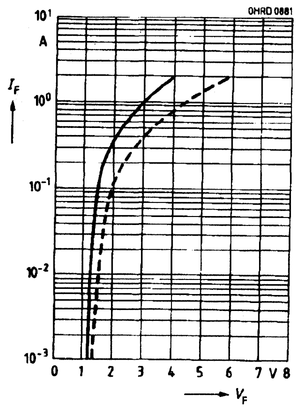
Radiation characteristic
$I_{REL}=f(\varphi)$



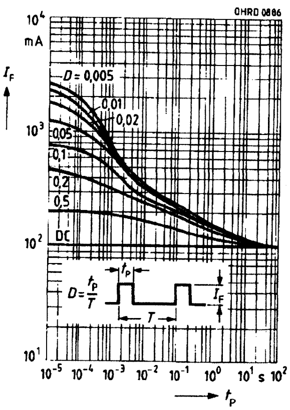
Maximum permissible forward current
$I_F=f(T_A)$



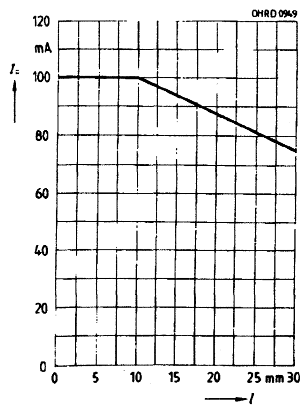
Forward current $I_F=f(V_F)$
Single pulse, τ=20 µs



Permissible pulse handling capability
$I_F=f(\tau)$, T_A=25° C
Duty cycle D=Parameter



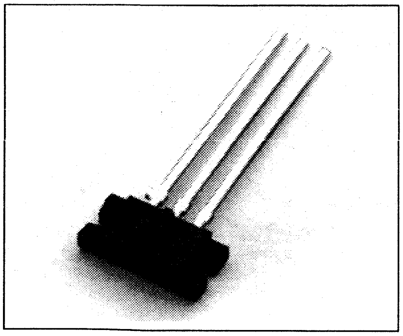
Forward current vs. lead length, package bottom and PC-board
$I_F=f(l)$, T_A=25° C



SIEMENS

SFH 900 SERIES
SFH 905 SERIES

MINIATURE LIGHT REFLECTION EMITTER/SENSOR



FEATURES

- **IR Emitter and NPN Phototransistor Detector**
- **High Sensitivity (SFH900)**
- **Low Saturation Voltage**
- **No Cross Talk (SFH900)**
  Negligible Cross Talk (SFH905)
- **Designed for Short Distances, ≤ 5 mm**
- **Current Transfer Ratio Groups**
  SFH900-1 — I_{CE} 0.25 to 0.5 mA
  SFH900-2 — I_{CE} 0.4 to 0.8 mA
  SFH900-3 — I_{CE} 0.63 to 1.25 mA
  SFH900-4 — I_{CE} ≥ 1.0 mA
  SFH905-1 — I_{CE} 40 to 125 μA
  SFH905-2 — I_{CE} ≥ 100 μA

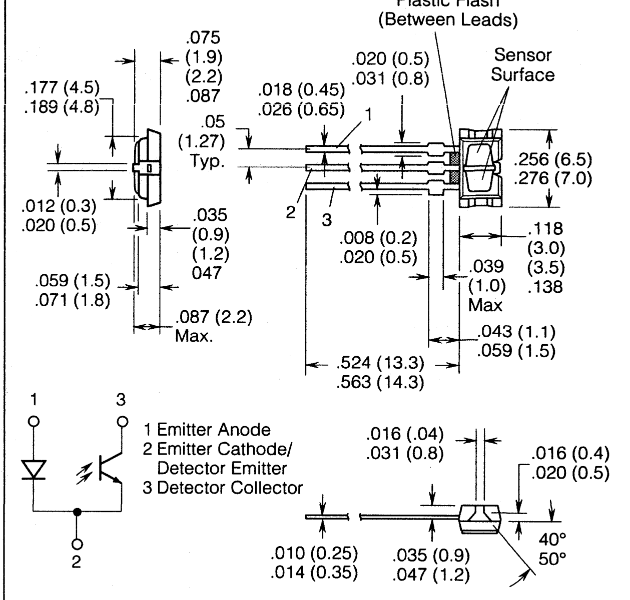
DESCRIPTION

The SFH900/SFH905 are light reflection switches which include a GaAs IRLED transmitter and an NPN photo-transistor with a high photosensitive receiver for short distances, operating in the infrared range. Both components are manufactured in modern strip-line technique and are mounted side-by-side in a plastic package. A daylight filter screens against undesired light effects. The SFH905 has lower current transfer ratios than the SFH900.

The SFH900/905 are designed for applications in industrial and entertainment electronics, e.g., as position reporting devices and end position switches, for speed monitoring or in general, as sensor elements in various types of motion transmitters.

For applications information see Appnote 26.

Package Dimensions in Inches (mm)



Maximum Ratings (T_A=40°C)

Emitter (GaAs Infrared Diode)

Reverse Voltage (V_R) .... 6 V
Forward DC Current (I_F) .... 50 mA
Surge Current (I_{FSM}) T_P≤10 μs .... 1.5 A
Total Power Dissipation (P_{TOT}) .... 80 mW

Detector (Silicon Phototransistor)

Collector Emitter Voltage (V_{CEO}) .... 30 V
Emitter Collector Voltage (V_{ECO}) .... 7 V
Collector Current (I_C) .... 10 mA
Power Dissipation (P_{TOT}) .... 100 mW

Light Reflection Switch

Storage and Ambient Temperature Range (T_{STG}, T_A) .... –40° to +85°C
Junction Temperature (T_J) .... 100°C
Soldering Temperature (T_S) 3 s max.(1) .... 235°C
With Heat Sink Between Case and Soldering (T_S) .... 260°C
Total Power Dissipation (P_{TOT}) .... 150 mW

Note: 1. Dip soldering: 3 mm from case bottom.

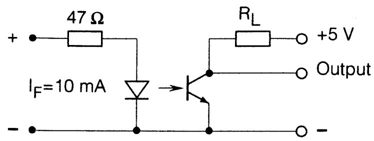
Characteristics (T_A=25°C)

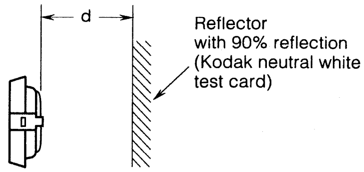
Parameter	Symbol	Value	Unit
Emitter (GaAs Infrared Diode			
Forward Voltage (I_F=50 mA)	V_F	1.25 (≤1.65)	V
Breakdown Voltage (I_R=10 μA)	V_{BR}	(≥6)	V
Reverse Current (V_R=6 V)	I_R	.01 (≤10)	μA
Capacitance (V_R=0 V, f=1 MHz)			
SFH900	C_0	40	pF
SFH905	C_0	25	pF
Thermal Resistance	R_{thJA}	750	K/W
Detector (Silicon Phototransistor)			
Capacitance (V_{CE}=5 V, f=1 MHz)			
SFH900	C_{CE}	11	pF
SFH905	C_{CE}	5	pF
Collector Emitter Leakage Current (V_{CE}=10 V)			
SFH900	C_{CEO}	20 (≤200)	nA
SFH905	C_{CEO}	20 (≤100)	nA
Photourrent (Outside Light Sensitivity) (V_{CE}=5 V, E_V=1000 Lx)			
SFH900	I_P	3.5	mA
SFH905	I_P	0.5	mA
Thermal Resistance	R_{thJA}	600	K/W
Light Reflection Switch			
Collector Emitter Current (I_F=10 mA; V_{CE}=5 V; d=1 mm)			
SFH900-1	I_{CE}	.25 to .50	mA
SFH900-2	I_{CE}	.40 to .80	mA
SFH900-3	I_{CE}	.63 to 1.25	mA
SFH900-4	I_{CE}	≥1.0	mA
SFH905-1	I_{CE}	.40 to 125	μA
SFH905-2	I_{CE}	≥100	μA
Collector Emitter Saturation Voltage (I_F=10 mA; d=1 mm)			
(I_C=85 μA) SFH900-1	VCE_{SAT}	.2 (≤.6)	V
(I_C=135 μA) SFH900-2	VCE_{SAT}	.2 (≤.6)	V
(I_C=215 μA) SFH900-3	VCE_{SAT}	.2 (≤.6)	V
(I_C=335 μA) SFH900-4	VCE_{SAT}	.2 (≤.6)	V
(I_C=13 μA) SFH905-1	VCE_{SAT}	.2 (≤.6)	V
(I_C=34 μA) SFH905-2	VCE_{SAT}	.2 (≤.6)	V

DESCRIPTION	SFH900	SFH905	UNIT
Load Resistance (R_L)	1	1	kΩ
Turn-On Time (T_{ON})	65	40	μs
Rise Time (T_R)	50	30	μs
Turn-Off Time (T_{OFF})	55	45	μs
Fall Time (T_F)	50	40	μs

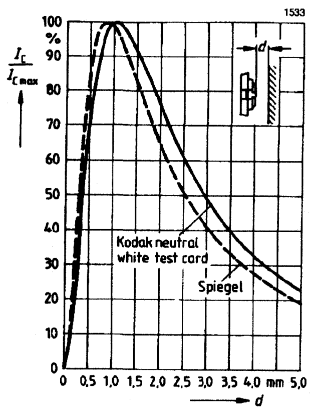
Note: SFH900: I_C=1 mA
SFH905: I_C=100 μA, V_S=5 V, I_F=10 mA

TEST CIRCUIT

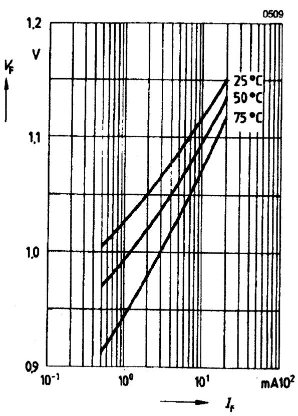




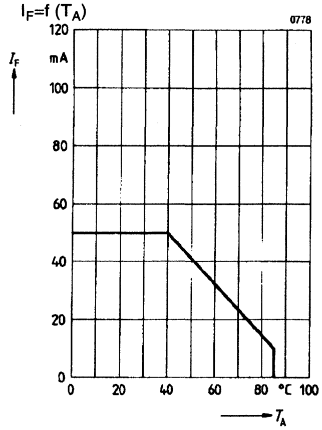
Collector current $\frac{I_C}{I_{C\,max}}$ =f (d)



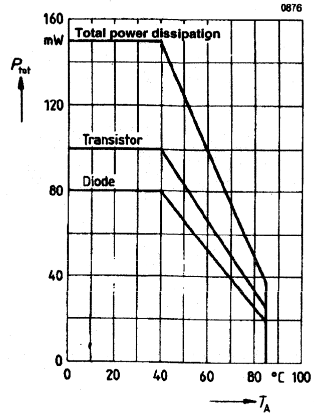
Diode forward voltage (typ.)
V_F=f (I_F)



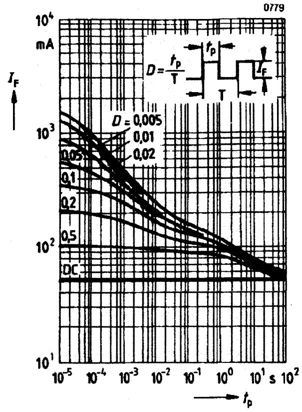
Maximum permissible forward current
I_F=f (T_A)



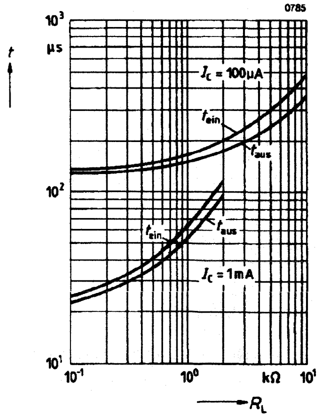
Diode and transistor permissible power dissipation $P_{TOT}=f(T_A)$



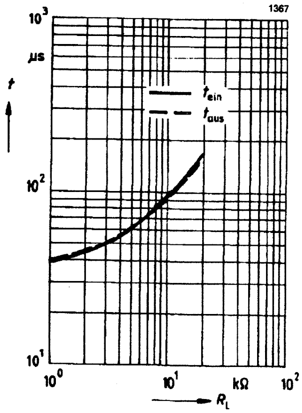
Permissible pulse handling capability
$I_F=f(t_P)$, D=Parameter, $T_A=25°C$



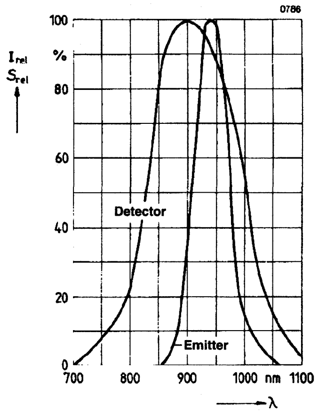
Switching characteristics–SFH900
$t=f(R_L)$, $T_A=25°C$, $I_F=10$ mA



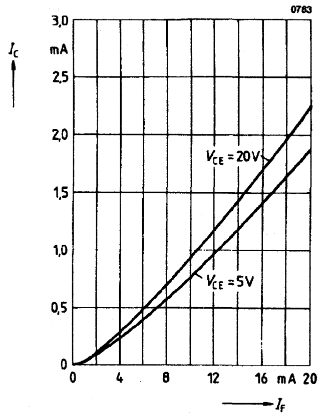
Switching characteristics–SFH905
$t=f(R_L)$, $T_A=25°C$, $I_F=10$ mA



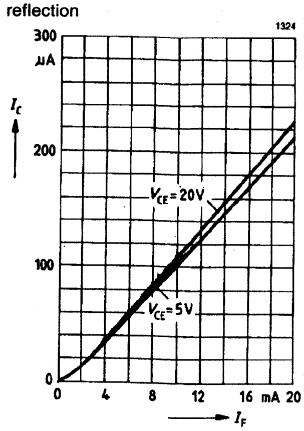
Relative spectral characteristics, emitter (GaAs) and detector (Si)
Detector: $I_{REL}=f(\lambda)$, Emitter: $S_{REL}=f(\lambda)$



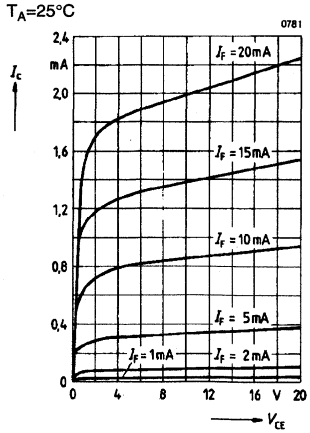
Collector current–SFH900 $I_C=f(I_F)$
Spacing d to reflector=1 mm, 90% reflection



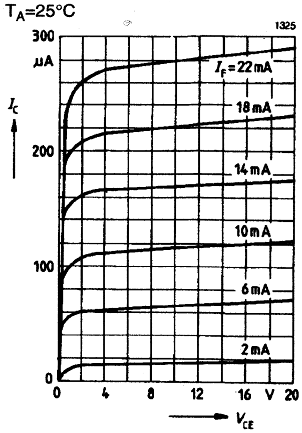
Collector current–SFH905 $I_C=f(I_F)$
Spacing d to reflector=1 mm, 90% reflection



Output characteristics–SFH900 $I_C=f(V_{CE})$
Spacing to reflector: d=1 mm, 90% reflection, $T_A=25°C$

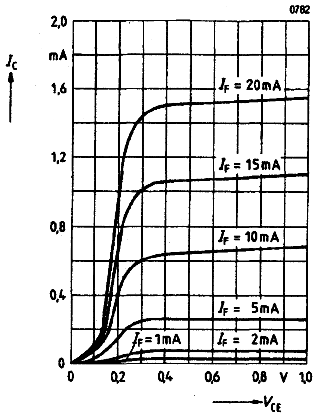


Output characteristics–SFH905 $I_C=f(V_{CE})$
Spacing to reflector: d=1 mm, 90% reflection, $T_A=25°C$

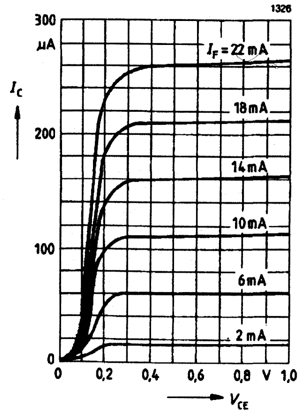


Infrared Emitters 7

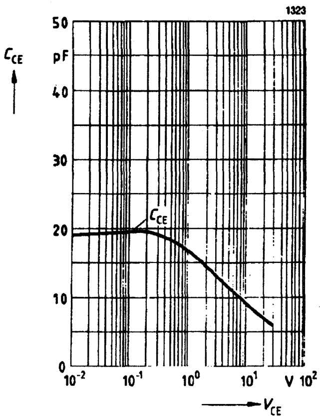
Output characteristics (typ.)–SFH900
I_C=f (V_{CE}), spacing to reflector: d=1 mm, 90% reflection, T_A=25°C



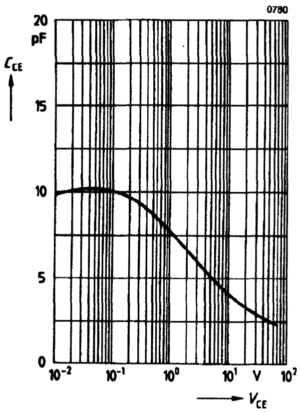
Output characteristics (typ.)–SFH905
I_C=f (V_{CE}), spacing to reflector: d=1 mm, 90% reflection, T_A=25°C



Transistor capacitance (typ.)–SFH900
C_{CE}=f (V_{CE}), T_A=25°C, f=1 MHz



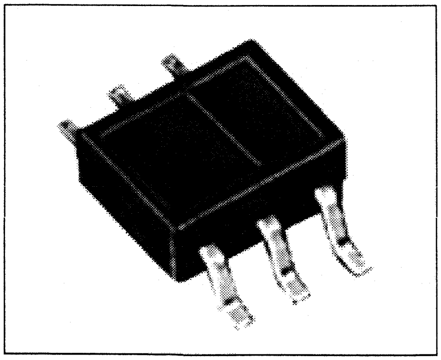
Transistor capacitance (typ.)–SFH905
C_{CE}=f (V_{CE}), T_A=25°C, f=1 MHz

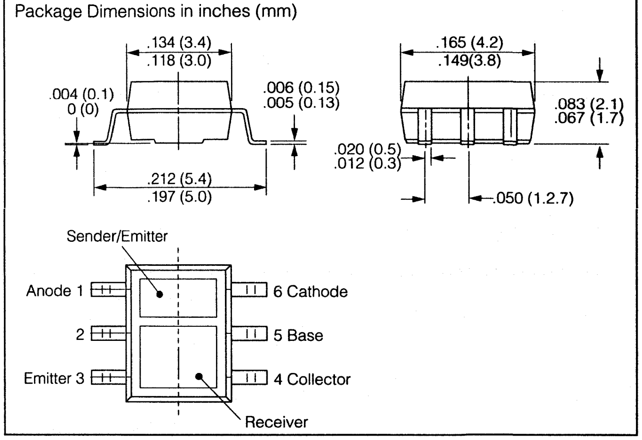


SIEMENS

SFH901/902

LIGHT REFLECTION SWITCH IN SMT PACKAGE





FEATURES

- Light Reflection Switch for 1 mm to 5 mm Operating Distance
- IR GaAs Emitter
- Silicon NPN Phototransistor Detector
- Daylight Filter Against Undesired Light Effects
- High Collector-emitter Current SFH901, 0.25 to ≥1.0 mA
- Collector-emitter Current SFH902, 40 to ≥100 µA
- Low Saturation Voltage
- No Cross-talk
- * SFH901
  Emitter and Detector Electrically Isolated
  Base Connection

APPLICATIONS

- Position Reporting
- End Position Switch
- Speed Monitoring and Regulating–SFH901
- Speed Monitoring–SFH902
- Motion Transmitter

Maximum Ratings

Emitter (IR GaAs Diode)

Reverse Voltage (V_R) .... 6 V
Forward Current (I_F) .... 50 mA
Surge Current (I_{FSM}) t_p≤10 µs .... 1.5 A
Power Dissipation (P_{TOT}) .... 80 mW

Detector (Silicon Phototransistor)

Collector Emitter Voltage (V_{CEO}) .... 30 V
Emitter Collector Voltage (V_{ECO}) .... 7 V
Collector Current (I_C) .... 10 mA
Power Dissipation (P_{TOT}) .... 100 mW

Light Reflection Switch

Storage and Ambient Temperature Range (T_{STG}, T_A) .... –40 to 85°C
Junction Temperature (T_J) .... 100°C

Soldering Conditions

Dip, Wave and Drag Soldering
Soldering Bath Temperature, t≤8s .... 260°C
Reflow Soldering
Temperature of Soldering Zone, t≤10s .... 260°C
t≤40s .... 215°C
Preheating (t=approx. 1 min) .... 150°C

Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Emitter (IR-GaAs Infrared Diode)			
Forward Voltage (I_F=50 mA)	V_F	1.25 (≤1.65)	V
Breakdown Voltage (I_R=10 µA)	V_{BR}	≥6	V
Reverse Current (V_R=6 V)	I_R	0.01 (≤10)	µA
Capacitance (V_R=0 V, f=1 MHz)	C_0	25	pF
Thermal Resistance(1)	R_{thJA}	500	K/W

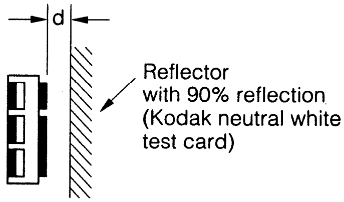
1. Mounting on PCB with >5 mm^2 pad size

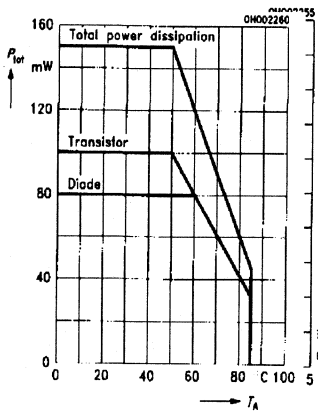
Infrared Emitters 7

Characteristics (T_A=25°C) Continued

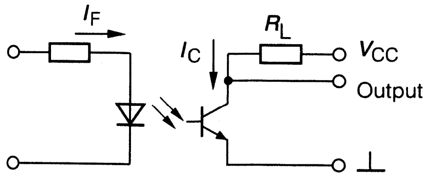
Parameter	Symbol	Value	Unit
Detector (Silicon Phototransistor)			
Capacitance (V_{CE}=5 V, f=1 MHz) SFH901 SFH902	C_{CE}	 11 5	pF
Collector Emitter Leakage Current (V_{CE}=10 V) SFH901 SFH902	I_{CEO}	 20 (≤200) 20 (≤100)	nA
Photocurrent (Outside Light Density) (V_{CE}=5 V, E_V=1000 Lx) SFH901 SFH902	I_P	 3.5 0.5	mA
Thermal Resistance[1]	R_{thJA}	500	K/W
Light Reflection Switch			
Collector Emitter Current Kodak Neutral WhiteTest Card, 90% Reflection (I_F=10 mA; V_{CE}=5 V; d=1 mm) SFH901 SFH902	 I_{CEmin} I_{CEtyp} I_{CEmin} I_{CEtyp}	 0.25 0.70 63 200	 mA mA µA µA
Collector Emitter Saturation Voltage, Kodak Neutral WhiteTest Card, 90% Reflection (I_F=10 mA; d=1 mm) SFH901 (I_C=85 µA) SFH901 (I_C=13µA)	V_{CEsat}	0.2 (≤0.6)	V

1. Mounting on PCB with >5 mm² pad size





L=1 kΩ)
A(1)



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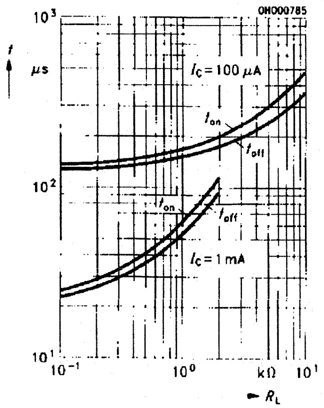
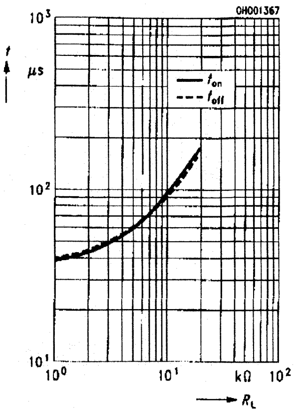
ent (d)

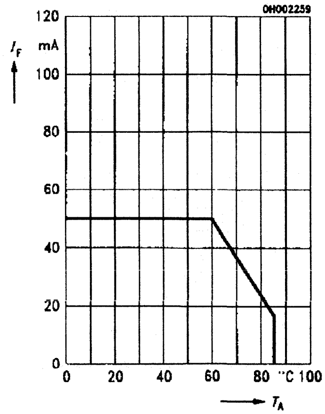
Switching characteristics SFH901
t=f (R_L) T_A=25°C, I_F=10 mA



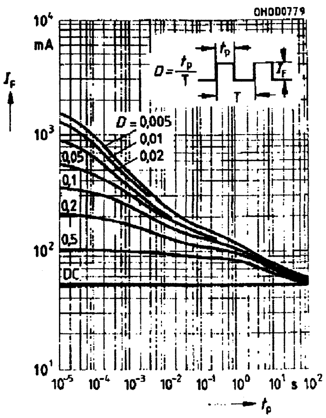
Switching characteristics SFH902
t=f (R_L) T_A=25°C, I_F=10 mA



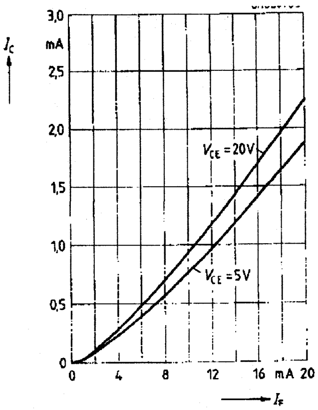
Maximum permissible forward current I_F=f (T_A)



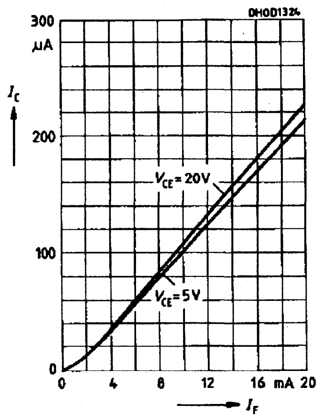
Permissible pulse handling capability I_F=f (t_p),
D=Parameter, T_A=25°C



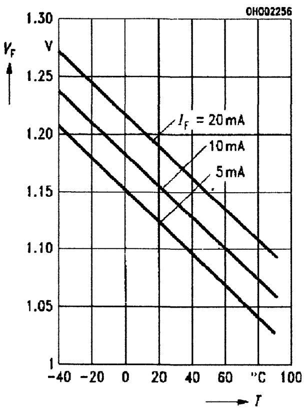
Collector current SFH901
I_C=f (I_F), spacing d to reflector=1 mm,
90% reflection



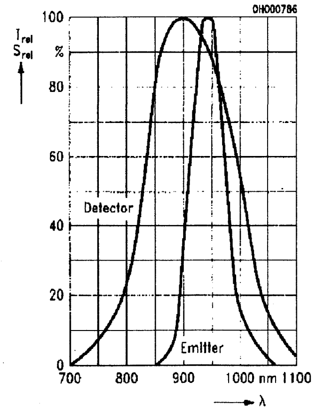
Collector current SFH902
I_C=f (I_F), spacing d to reflector=1 mm,
90% reflection



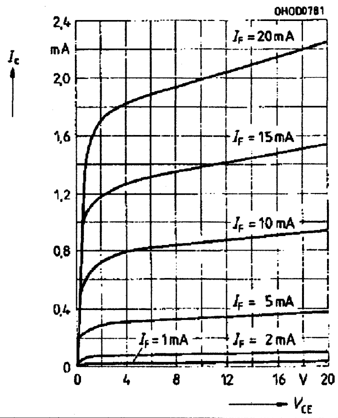
Forward voltage (typ.) of the diode
V_F=f (T)



Relative spectral emission of emitter (GaAs) I_{REL}=f (λ)
and detector (Si) S_{REL}=f (λ)

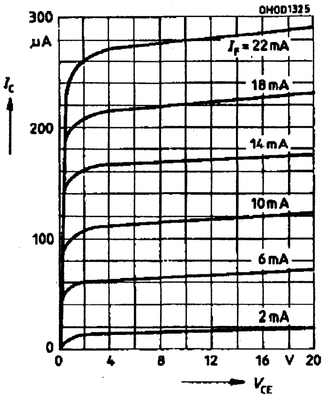


Output characteristics SFH901
I_C=f (V_{CE}), spacing to reflector:
d=1 mm, 90% reflection, T_A=25°C



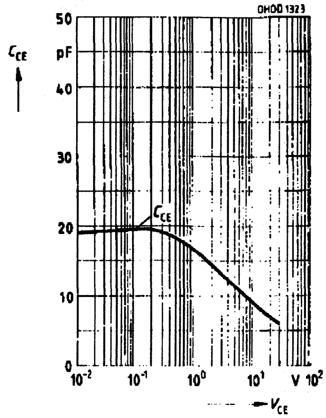
Infrared Emitters
7

Output characteristics SFH902
SFH902
I_C=f (V_{CE}), spacing to reflector:
d=1 mm, 90% reflection, T_A=25°C



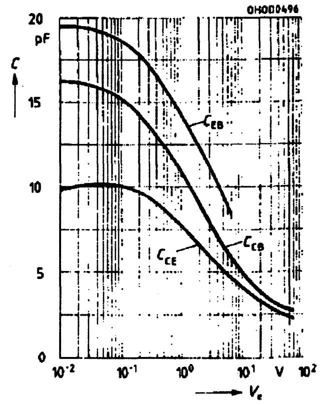
Transistor capacitance (typ.) SFH901

C_{CE}=f (V_{CE}), T_A=25°C, f=1 MHz

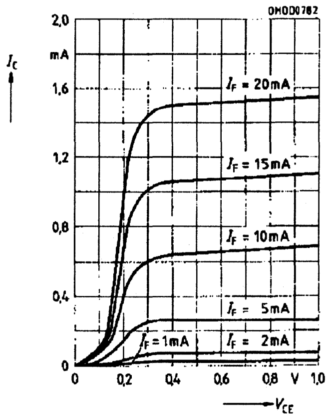


Transistor capacitance (typ.)

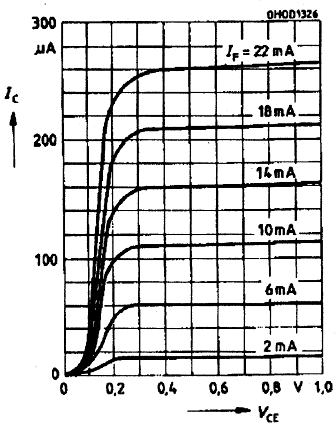
C_{CE}=f (V_{CE}), T_A=25°C, f=1 MHz



Output characteristics (typ.) SFH901
I_C=f (V_{CE}), spacing to reflector:
d=1 mm, 90% reflection, T_A=25°C



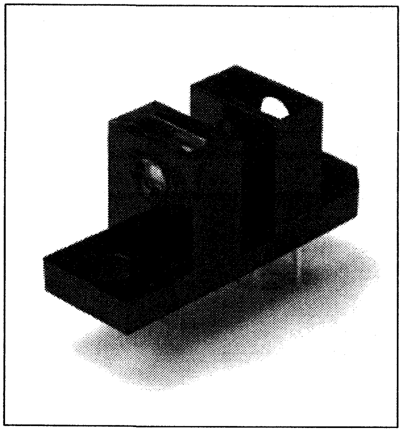
Output characteristics (typ.) SFH902
I_C=f (V_{CE}), spacing to reflector:
d=1 mm, 90% reflection, T_A=25°C



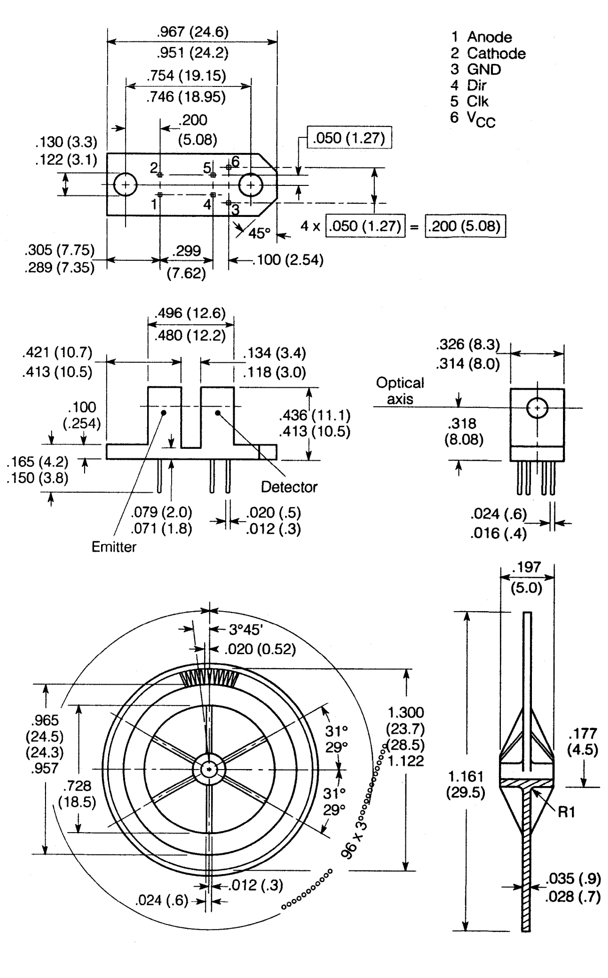
SIEMENS

SFH 910

DIFFERENTIAL PHOTO INTERRUPTER WITH COUNTING PULSE & DIRECTION RECOGNITION



Package Dimensions in Inches (mm)



FEATURES

- **Counting Mechanism**
- **Movement Direction Display**
- **Slot Width: 1.26_0 (3.2 mm)**
- **Maximum Output Current I_{OL}: 20 mA**
- **Switching Times t_R, t_F: 0.3 µs**
- **96 Slot Code Wheel Available (Part Number 2004-9053)**

DESCRIPTION

The SFH 910 is a differential photo interrupter with daylight-suppression filter and spherical lens, operating in the infrared range.

A GaAIAs IRED is used as an emitter.

The receiver circuit consists of two narrow photodiodes, next to each other, with amplifiers and Schmitt triggers, and a logic which produces a counting pulse signal and a directional signal. The width of the counting pulse remains constant. The counting pulse (Z) and the directional recognition (R) outputs are open NPN collectors, which are TTL-compatible.

The SFH 910 is used to encode mechanical shaft rotational speed and direction. The Differential Photo Interrupter will accept code wheels with slot widths as small as 0.033" (0.85 mm). An optional 96 slot code wheel as described in the data sheet is available.

Maximum Ratings (T_A=25° C)

Emitter (GaAs IRED)

Reverse Voltage (V_R)	5 V
Forward Current (I_F) T_A=55°C	50 mA
Surge Current (I_{FSM})	1 A
Total Power Dissipation (P_{TOT}) T_A=55°C	85 mW

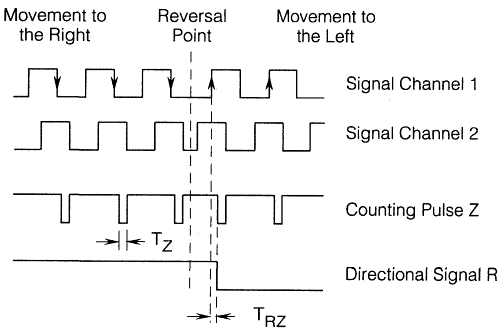
Detector (Detector IC)

Supply Voltage (V_{CC})	4 to 18 V
Output Current, Output/Low (I_{OL})	20 mA
Output Voltage, Output/High (V_{OH})	16 V
Total Power Dissipation (P_{TOT}) T_A=25°C	200 mW

Photo Interrupter

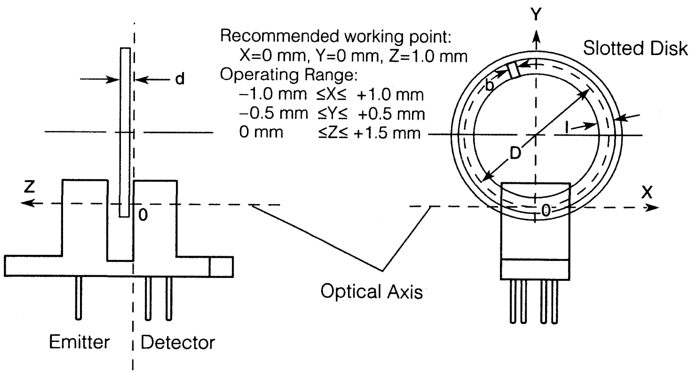
Operating Temperature (T_{OP})	–20° to +85°C
Storage Temperature (T_{STG})	–40 to +100°C
Junction Temperature (T_J)	+100°C
Soldering Temperature (1 mm soldering distance from the case bottom: t≤5 s	260°C

Pulse Diagram



Channels 1 and 2 represent the out-of-phase signals after the Schmitt triggers (see block diagram). This diagram is for reference only and can't be verified by using the output pins of the device.

Positioning of the slotted disk within the photo interrupter



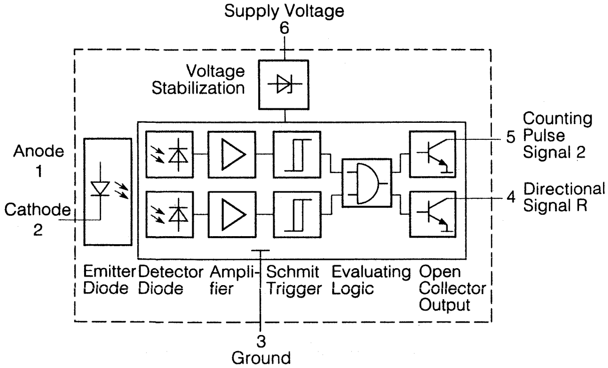
Number of slots on the slotted disk	n = 96
Thickness of the slotted disk	d = .031" (0.8 mm)
Width of the slot center	b = .015" (0.38 mm)
Slot length	l = .079" (2.0 mm)
Diameter of the slotted disk (from slot center to slot center)	D = 1.043" (26.50 mm)

Characteristics (T_A=25°C)

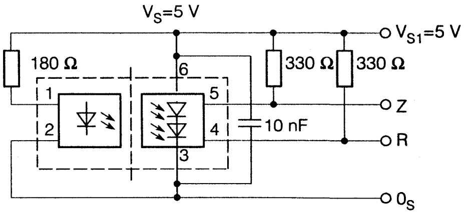
Parameter	Symbol	Value	Unit
Emitter (GaAs IRED)			
Forward Voltage (I_F=20 mA)	V_F	1.3 (≤1.6)	V
Breakdown Voltage (I_R=10 µA)	V_{BR}	(≥5)	V
Reverse Current (V_R=5 V)	I_R	0.01 (≤10)	µA
Capacitance (V_R=0 V, f=1 MHz)	C_0	40	pF
Thermal Resistance	R_{thJA}	500	K/W
Detector (Detector IC)			
Supply Voltage	V_{CC}	4.5 to 16	V
Supply Current (V_{CC}=5 V, Outputs Open)	I_S	5 (≤10)	mA
Output Voltage (Counting Pulse) (I_{OLZ}=16 mA, V_{CC}=5 V, I_F=20 mA)	V_{OLZ}	.2 (≤.4)	V
Output Voltage (Direction) (I_{OLR}=16 mA, V_{CC}=5 V; I_F=20 mA)	V_{OLR}	.2 (≤.4)	V
Output Current(2) (Counting Pulse) (V_{OHZ}=V_{CC}=16 V; I_F=0)	I_{OHZ}	.01 (≤10)	µA
Output Current(2) (Direction) (V_{OHR}=V_{CC}=16 V; I_F=0)	I_{OHR}	.01 (≤10)	µA
Thermal Resistance	R_{thJA}	375	K/W
Photo Interrupter			
Operating Range	I_F	20 ±5	mA
Rise Time, Fall Time (R_L=280 Ω, V_S=V_{S1}=5 V; I_F=20 mA)	t_R, t_F	.3	µs
Counting Pulse Width	T_Z	10 (≤20)	µs
Delay Time (Change of Direction/Counting Pulse)	T_{RZ}	1	µs
Hysteresis of Schmitt Triggers	P_H	25	%

1. All characteristics have been measured by means of a slotted disk, as described previously.
2. Without ambient light.

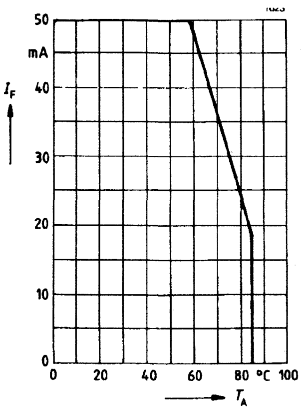
Block Diagram



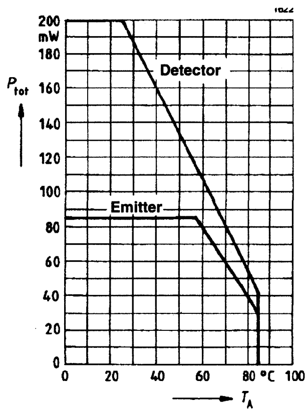
Application



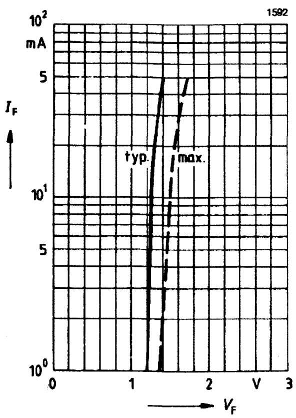
Maximum permissible forward current (Emitter) I_F=f (T_A)



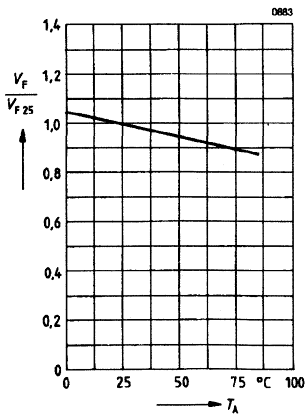
Permissible power dissipation P_{TOT}=f (T_A)



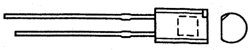
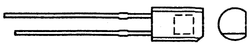
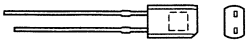
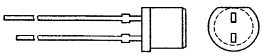
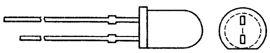
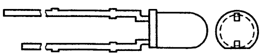
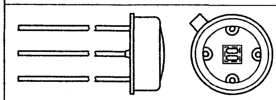
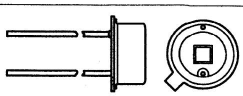
Forward current I_F=f (V_F)



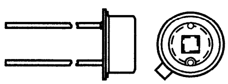
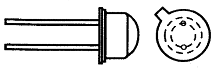
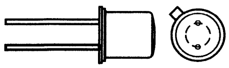
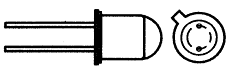
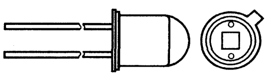
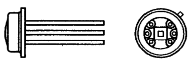
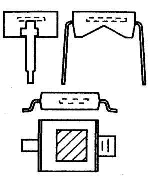
Forward voltage V_F/V_{F25}=f (T_A)



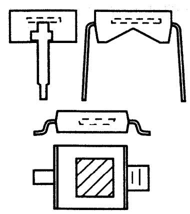
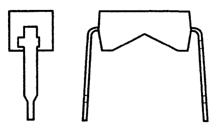
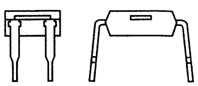
Photodiodes

Package Outline	Part Number	Package Type	Half Angle	Dark Current V_R=10 V nA	Photosensitvity λ=950 nm 0.5 mW/cm² µA		Radiant Sensitive Area mm²	Peak Wave-length nm	Features	Page
	SFH205F SFH205FA	Plastic, daylight-filter, solder tabs	±60°	2 (≤30)	25(≥15)		7.00	950 900	PIN type, built-in filter.	8–44
	SFH206K	Clear plastic, solder tabs	±60°	2 (≤30)	80(≥50)	E_V=1000 lx	7.00	850	PIN type.	8–46
	SFH225FA	Plastic, daylight-filter	±60°	2 (≤30)	17 (≥12.5)		4.84	900	PIN type. Short switching time.	8–52
	SFH235FA	TOD67 daylight filter	±65°	2 (≤30)	24(≥20)	λ=870 mn	7	900	PIN type. Short switching time.	8–60
	SFH203P	T1³/4 flat, clear plastic	±75°	1 (≤10) 20 V	9.5(≥5)	E_V=1000 lx	1	850	PIN type.	8–42
	SFH203PFA	T1³/4 flat, plastic, daylight-filter			3.1 (≥1.8)			900		
	SFH203	T1³/4 clear plastic	±20°	1 (≤5) 20 V	80(≥50)	E_V=1000 lx	1	850	Short switching time. Low capacitance, high spectral sensitivity.	8–40
	SFH203FA	T1³/4 plastic, daylight-filter			25(≥15)			900		
	SFH229	T1 clear plastic	±17°	50 pA	28 (≥18)	E_V=1000 lx	0.3	860	PIN type. Short switching time.	8–54
	SFH229FA	T1 daylight filter			10 (≥5.4)			900		
	SFH221	TO-5 hermetic	±55°	10 (≤100)	24(≥15)	E_V=1000 lx	1.54	900	Short switching time. Low luminance differential detector.	8–50
	SFH291	TO-5 hermetic	±55°	0.3 (≤1) 5 V	50	E_V=1000 lx	7.45	850	UV enhanced.	8–64

Photodiodes (Continued)

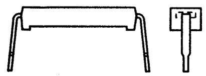
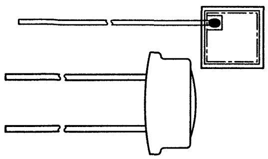
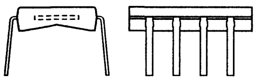
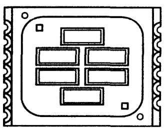
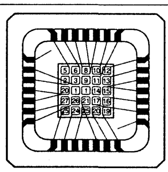
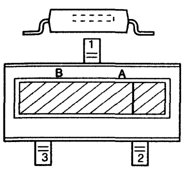
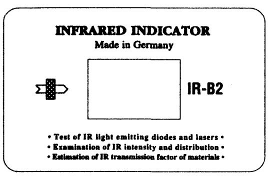
Package Outline	Part Number	Package Type	Half Angle	Dark Current V_R=10 V nA	Photosensitvity λ=950 nm 0.5 mW/cm² μA		Radiant Sensitive Area mm²	Peak Wave-length nm	Features	Page
	BPW21	TO-5, hermetic	±60°	2(≤30) 5 V	10(≥5.5)	E_V=1000 lx	7.34	550	High reliability, Vλ filter.	8–3
	BPX60		±55°	7(≤55)	70	E_V=1000 lx	7.34	850	High reliability. Blue enhanced.	8–17
	BPX61		±55°	2(≤30)	70(≥50)		7.00	850	High reliability. PIN type.	8–19
	BPX63	TO-18, plastic lens	±75°	5(≤20) pA 1 V	10(≥8)	E_V=1000 lx	0.97	800	Extremely low dark current. Matches emitter LD242.	8–21
	BPX65	TO-18 hermetic	±40°	1(≤5) 20 V	10 (≥5.5)	E_V=1000 lx	1	850	PIN type. Very high speed. Low dark current	8–23
	SFH216	TO-18 hermetic	±12°	1(≤5) 20 V	50(≥35)	E_V=1000 lx	1	850	Low noise. High cutoff frequency. Low capacitance.	8–48
	SFH231	TO-18 hermetic	±10°	10 (≤50) μA 1 V	13(≥8)	λ=1300 mn E_e=0.25mW/cm²	1	1550	High photosensitiv-ity. High cutoff fre-quency. Short switching time. Germanium.	8–56
	SFH234	TO-39 hermetic	±60°	0.1 (≤1)	1.85 (≥1.2)	E_V=1000 lx	0.25	800	Four quadrant.	8–58
	SFH244	TO-39 hermetic	±60°	0.2 (≤1)	7.4 (≥4.8)	E_V=1000 lx	1	800	Four quadrant.	8–62
 Surface Mount Package	BP104F	Plastic, solder tabs	±60°	2(≤30)	17 (≥12.5)		4.84	950	Daylight filter. IR remote control. PIN type.	8–1
	BP104FS	Surface mount								

Photodiodes (Continued)

Package Outline	Part Number	Package Type	Half Angle	Dark Current V_R= 10 V nA	Photosensitivity λ=950 nm 0.5mW/cm² μA		Radiant Senstive Area mm²	Peak Wave-length nm	Features	Page
 Surface Mount Package	BPW33	Clear plastic, solder tabs.	±60°	2 (≤100) pA 1 V	72 (≥35)	E_V=1000 lx	7.34	800	Low dark current. Light measuring applications.	8–5
	BPW33S	Surface mount								
	BPW34	Clear plastic, solder tabs.	±60°	2(≤30)	80 (≥50)	E_V=1000 lx	7.00	850	PIN type. Low junction capaci-tance.	8–7
	BPW34S	Surface mount								
	BPW34B	Clear plastic.	±60°	2(≤30)	75	E_V=1000 lx	7.45	850	PIN type. High blue sensitivity.	8–9
	BPW34F	Plastic, daylight filter.	±60°	2(≤30)	25 (≥16)		7.00	950	PIN type.	8–11
	BPW34FS	Surface mount								
	BPW34FA	Plastic, daylight filter.	±60°	2(≤30)	25(≥20)	λ=870 nm	7.00	880	PIN type.	8–13
	BPW34FAS	Surface mount								
	BPX90	Clear plastic, solder tabs.	±60°	5 (≤200)	45 (≥32)	E_V=1000 lx	5.5	850	High sensitivity.	8–25
	BPX90F	Plastic, daylight filter, solder tabs.			13(≥8)			950		
	BPX48	Clear plastic, solder tabs.	±60°	10 (≤100)	24(≥15)	E_V=1000 lx	2x1.54	900	Fast response, dif-ferential type, 90 μm die distance. Precision applica-tions.	8–15
	BPX48F	Plastic, daylight filter, solder tabs.			7.5 (≥4.0)			920		

Photodiodes 8

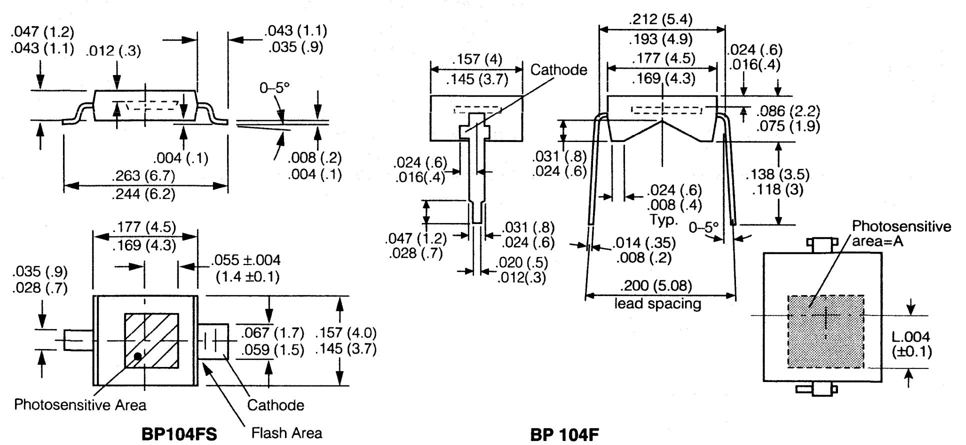
Photodiodes (Continued)

Package Outline	Part Number	Package Type	Half Angle	Dark Current V_R= 10 V nA	Photosensitivity λ=950 nm 0.5mW/cm² μA		Radiant Senstive Area mm²	Peak Wave-length nm	Features	Page
	SFH100	Clear plastic, solder tabs.	±60°	0.4	175	E_V=1000 lx	21.2	850	Blue enhanced, high sensitivity. superior signal/ noise ratio at low luminance.	8–38
	BPY12 BPY12-H1	Chip with 2 leads.	±60°	10 (≤100) 20 V	180 (≥100)	E_V=1000 lx	20	920	High spectal sensitivity.	8–27
	KOM 2057L	3 chip array.	±60°	2(≤30)	80(≥50)	E_V=1000 lx	7	880	Low reverse current. N-Si material=positive front & negative back.	8–29
	KOM 2100B	6 chip array.	±60°	1(≤10)	9(≥7)		2.5	870	Low reverse current. N-Si material=positive front & negative back. Short switching time.	8–31
	KOM 2100BF	6 chip array, daylight-filter.			8.5(≥6.6)					
	KOM 2108	5 x 5 Silicon photo-diode array.	±60°	0.05 (≤1)	1.1(≥0.8)		0.3	850	Low noise. Can be used in visible and near IR range.	8–34
	KOM 2125	Clear plastic SMT.	±60°	A 5(≤30)	A 40(≥30)	E_V=1000 lx	4	850	Two chips A and B. Short switching time.	8–36
				B 10 (≤30)	B 100(≥75)		10			
	IR-B2	Infrared-indicator card.	—	—	—		—	—	An application: check output of IR LEDs and IR laser diodes.	8–66

SIEMENS

*BP 104F
SURFACE MOUNT BP 104FS
SILICON PIN PHOTODIODE DAYLIGHT FILTER

Package Dimensions in Inches (mm)



FEATURES

- Silicon Planar PIN Photodiode
- Daylight Filter
- High Spectral Sensitivity
- Short Switching Time
- Usage: Near Infrared Range (780 to 1100 nm)
- Wide Temperature Range
- High Reliability
- No Testable Degradation
- High Cutoff Frequency
- High Packing Density
- Use as Photodiode or Photovoltaic Cell
- N-Si Material: Anode=Front Contact, Cathode=Back Contact
- Low Capacitance
- Applications
  - IR Remote Control
  - IR Sound Transmission
  - Reflective Switches
- Package: Black Epoxy Resin BP104F: 0.200" (5.08 mm) Lead Spacing BP104FS: Surface Mount Package
- Cathode Marking: Projection on Solder Tab

***Formerly BP 104**

Maximum Ratings

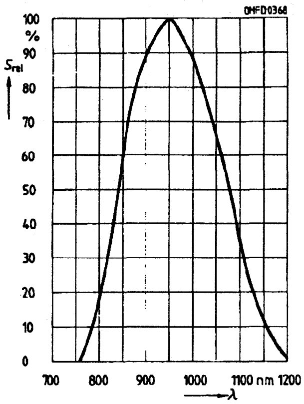
Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –40° to +80°C
Soldering Temperature (2 mm from case bottom), (T_S) t≤3 s .... 230°C
Reverse Voltage (V_R) .... 20 V
Power Dissipation (P_{TOT}) T_A=25°C .... 150 mW

Characteristics (T_A=25°C, λ=950 nm)

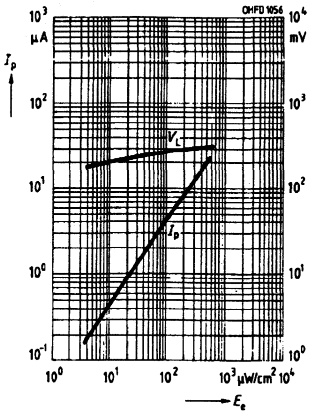
Parameter	Symbol	Value	Unit
Photosensitivity (V_R=5 V, E_E=1 mW/cm²)	S	34 (≥25)	µA
Maximum Sensitivity Wavelength	λ_{Smax}	950	nm
Photosensitivity Spectral Range (S=10% of S_{MAX})	λ	780 to 1100	nm
Radiant Sensitive Area	A	4.84	mm²
Radiant Sensitive Area Dimensions	L x W	2.20 x 2.20	mm
Distance, Chip Surface to Case Surface	H	0.5	mm
Half Angle	φ	±60	Deg.
Dark Current (V_R=10 V)	I_R	2 (≤30)	nA
Spectral Sensitivity	S_λ	0.70	A/W
Quantum Yield	η	0.90	electrons/photon
Open Circuit Voltage (E_e=0.5 mW/cm²)	V_O	330 (≥250)	mV
Short Circuit Current (E_e=0.5 mW/cm²)	I_{SC}	17	µA
Photocurrent Rise and Fall Time 10% to 90%, and 90% to 10% of Final Value (R_L=50 Ω, V_R=5 V, λ=850 nm, I_P=800 µA)	t_R,t_F	20	ns
Forward Voltage (I_F=100 mA, E =0)	V_F	1.3	V
Capacitance (V_R=0 V, f=1 MHz, E_V=0 lx)	C_0	48	pF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.18	%/K
Noise Equivalent Power (V_R=10 V)	NEP	3.6 x 10^{-14}	W/√Hz
Detection Limit (V_R=10 V)	D*	6.1 x 10^{12}	cm•√Hz/W

Photodiodes 8

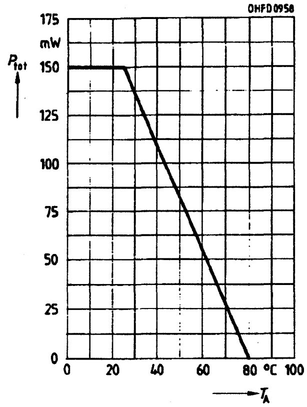
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



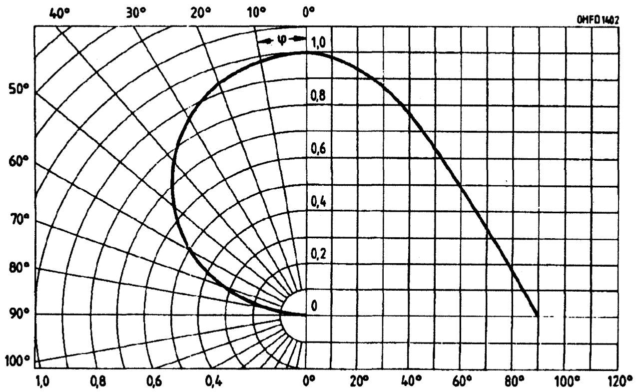
Photocurrent $I_P=f(E_e)$
Open circuit voltage $V_O=f(E_e)$



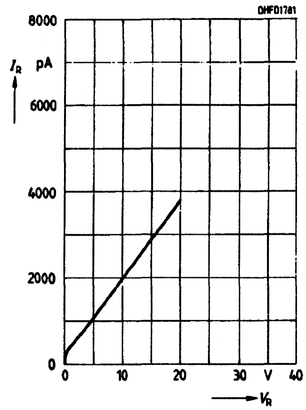
Power dissipation $P_{TOT}=f(T_A)$



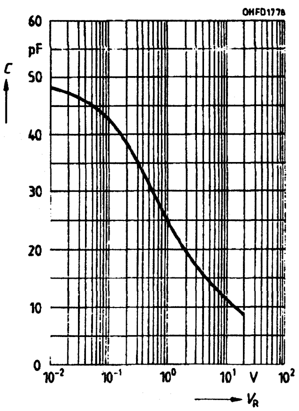
Directional characteristic
$S_{REL}=f(\varphi)$



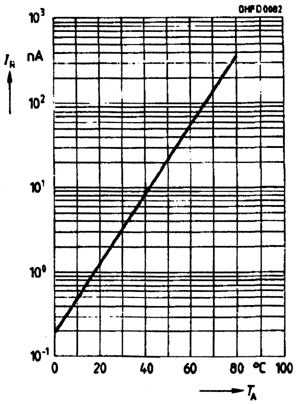
Dark current $I_R=f(V_R)$
$T_A=25°C$, $E=0$



Capacitance $C=f(V_R)$
f=1 MHz, E=0

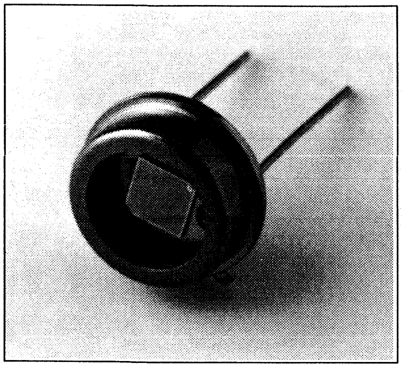


Dark current $I_R=f(T_A)$
$V_R=10$, $E=0$

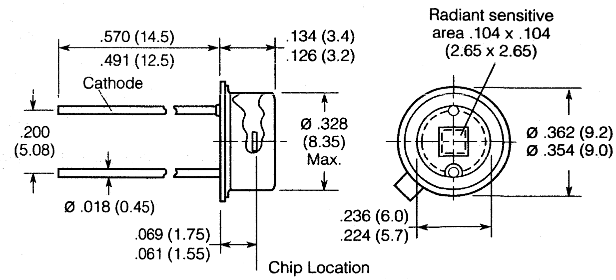


SIEMENS

BPW 21
SILICON PHOTODIODE
Vλ FILTER



Package Dimensions in Inches (mm)



FEATURES

- **Incorporates Vλ Filter**
- **Usage: Visible Light Range (350 to 820 nm)**
- **High Photosensitivity**
- **High Reliability**
- **Wide Temperature Range**
- **Strong Linearity of Photocurrent vs. Light Level (10^{-2} to 10^{5} lux)**
- **Low Noise**
- **Silicon Planar Photodiode**
- **N-Si Material: Anode=Front Contact, Cathode=Back Contact**
- **Applications**
  - **Exposure Meters**
  - **Color Detection and Analysis**
  - **Visible Light Detection**
- **Package: Hermetically Sealed—Similar to TO-5, Solder Tabs, Glass Lens (Schott)**
- **Anode Marking: Tab at Package Bottom**

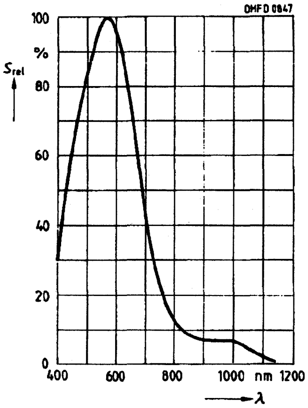
Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –40° to +80°C
Soldering Temperature (1.5 mm from case bottom) (T_S) t≤3 s .... 235°C
Reverse Voltage (V_R) .... 10 V
Power Dissipation (P_{TOT}) .... 250 mW

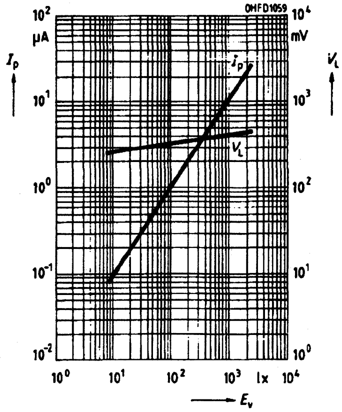
Characteristics (T_A=25°C, Standard Light A, T=2856 K)

Parameter	Symbol	Value	Unit
Photosensitivity (V_R=5 V)	S	10 (≥5.5)	nA/lx
Maximum Photosensitivity Wavelength	λ_{Smax}	550	nm
Photosensitivity Spectral Range (S=10% of S_{MAX})	λ	350 to 820	nm
Radiant Sensitive Area	A	7.34	mm^2
Radiant Sensitive Area Dimensions	L x W	2.73 x 2.73	mm
Distance, Chip Surface to Case Surface	H	1.9 to 2.3	mm
Half Angle	φ	±55	Deg.
Dark Current (V_R=5 V)	I_R	2 (≤30)	nA
(V_R=10 mV)	I_R	8 (≤200)	pA
Spectral Photosensitivity (λ=550 nm)	S_λ	0.34	A/W
Quantum Yield (λ=550 nm)	η	0.80	electrons / photon
Open Circuit Voltage (E_V=1000 lx)	V_O	400(≥320)	mV
Short Circuit Current (E_V=1000 lx)	I_{SC}	10	µA
Rise and Fall Time of Photocurrent (R_L=1 KΩ, V_R=5 V, λ=550 nm, I_P=10 µA)	t_R, t_F	1.5	µs
Forward Voltage (I_F=100 mA, E_E=0)	V_F	1.2	V
Capacitance (V_R=0 V, f=1 MHz, E_V=0 lx)	C_0	580	pF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_S	TC_I	0.12	%/K
Noise Equivalent Power (V_R=5 V, λ=550 nm)	NEP	7.2×10^{-14}	W/√Hz
Detection Limit (V_R=5 V, λ=550 nm)	D*	1×10^{12}	cm•√Hz/W

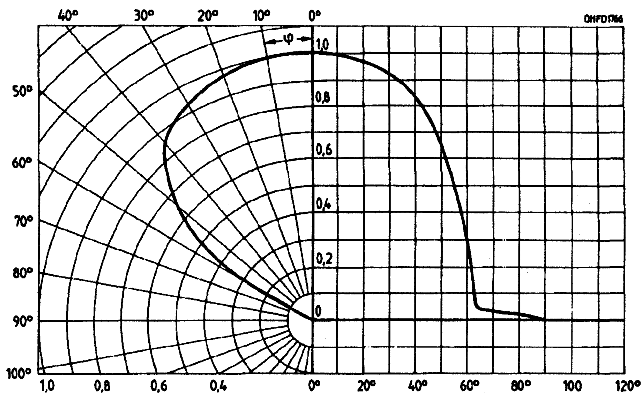
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



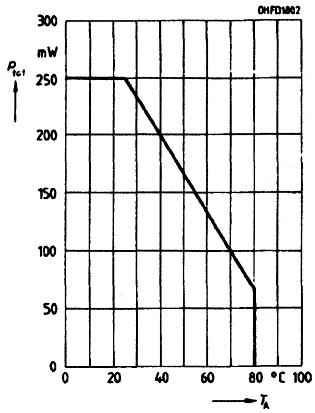
Photocurrent $I_P=f(E_V)$
Open circuit voltage $V_O=f(E_V)$



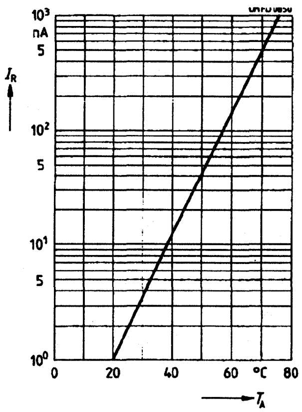
Directional characteristic
$S_{REL}=f(\varphi)$



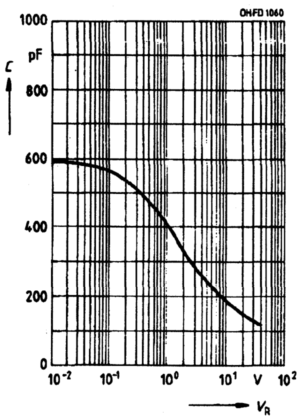
Total power dissipation
$P_{TOT}=f(T_A)$



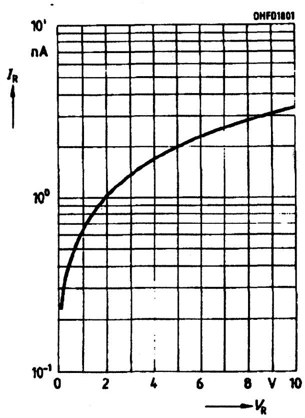
Dark current
$I_R=f(T_A)$, $V_R=5$ V, E=0



Capacitance $C=f(V_R)$, f=1 MHz
E=0



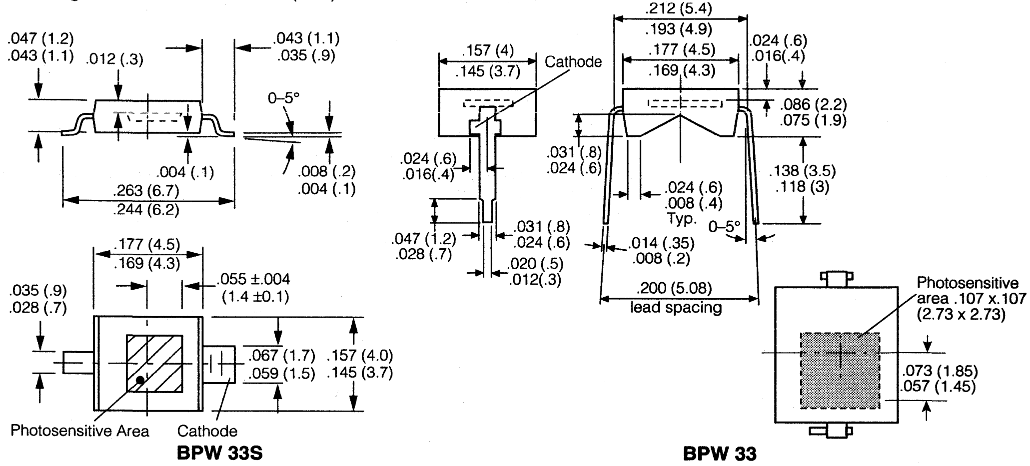
Dark current $I_R=f(V_R)$
E=0



SIEMENS

BPW 33
SURFACE MOUNT BPW 33S
SILICON PHOTODIODE
VERY LOW DARK CURRENT

Package Dimensions in Inches (mm)



FEATURES

- **Silicon Planar Photodiode**
- **N-Si Material: Anode=Front Contact, Cathode=Back Contact**
- **High Reliability**
- **No Testable Degradation**
- **Low Noise**
- **High Packing Density**
- **High Spectral Sensitivity**
- **Wide Temperature Range**
- **Usage: Visible and Near Infrared Range (350 to 1100 nm)**
- **Very Low Dark Current**
- **Applications**
  - **Color Analysis**
  - **Detector for Low Light Levels**
  - **Photography—Exposure Meters**
- **Package: Transparent Epoxy Resin BPW33: 0.200" (5.08 mm) Lead Spacing BPW33S: Surface Mount Package**
- **Cathode Marking: Projection on Solder Tab**

Maximum Ratings

Operating and Storage Temperature
Range (T_{OP}, T_{STG}) .... −40° to +80°C
Soldering Temperature
(2 mm from case bottom) (T_S) t≤3 s ...... 230°C
Reverse Voltage (V_R) .... 7 V
Power Dissipation (P_{TOT}) T_A=25°C .... 150 mW

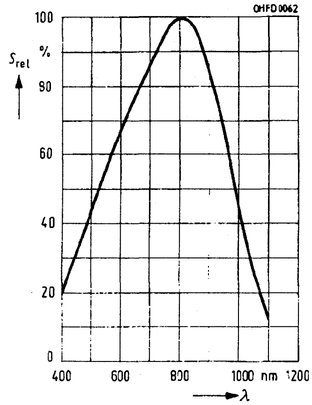
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Photosensitivity (V_R=5 V)(1)	S	75 (≥35)	nA/lx
Maximum Photosensitivity Wavelength	λ_{Smax}	800	nm
Photosensitivity Spectral Range	λ	350 to 1100	nm
Radiant Sensitive Area	A	7.34	mm²
Radiant Sensitive Area Dimensions	L x W	2.71 x 2.71	mm
Distance, Chip Surface to Case Surface	H	0.5	mm
Half Angle	φ	±60	Deg.
Dark Current (V_R=1 V)	I_R	20 (≤100)	pA
Zero Cross Over (E=0)	S_0	≤2.5	pA/mV
Spectral Sensitivity (λ=850 nm)	S	0.59	A/W
Quantum Yield (λ=850 nm)	η	0.86	electrons / photon
Open Circuit Voltage (E_V=1000 lx)(1)	V_O	440 (≥375)	mV
Short Circuit Current (E_V=1000 lx)(1)	I_{SC}	72	µA
Rise and Fall Time of Photocurrent (R_L=1 KΩ, V_R=5 V, λ=850 nm, I_P=70 µA)	t_R, t_F	1.5	µs
Forward Voltage (I_F=100 mA, E=0)	V_F	1.3	V
Capacitance (V_R=0 V, E=0, f=1 MHz)	C_0	630	pF
Temperature Coefficient V_O	TC_V	−2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.2	%/K
Noise Equivalent Power (V_R=1 V, λ=850 nm)	NEP	4.3×10^{-15}	W/√Hz
Detection Limit (V_R=1 V, λ=850 nm)	D*	6.3×10^{13}	cm•√Hz/W

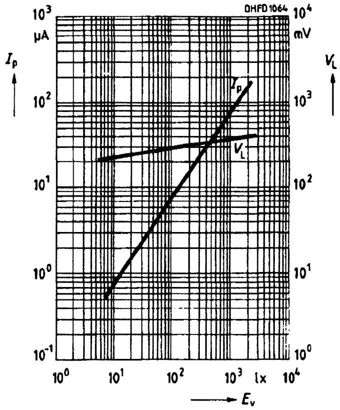
Note

1. Illuminance shown refers to unfiltered radiation of tungsten filament lamp at color temperature of 2856 K (standard light A per DIN 5040 and IEC publication 306-1).

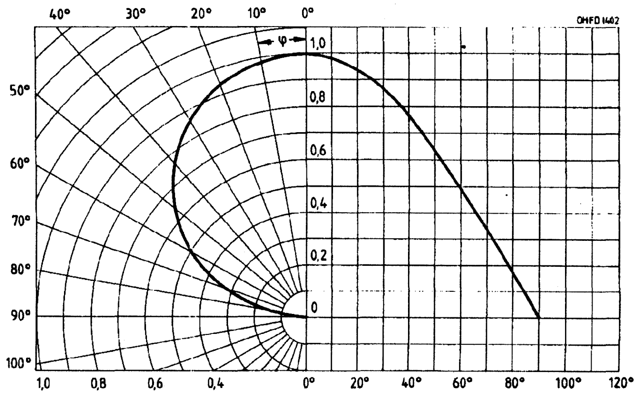
Relative spectral sensitivity $S_{REL}=f(\lambda)$



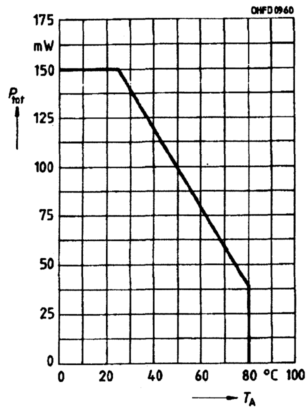
Photocurrent $I_P=f(E_V)$
Open circuit voltage $V_O=f(E_V)$



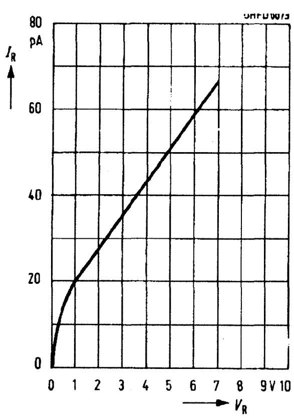
Directional characteristic $S_{REL}=f(\varphi)$



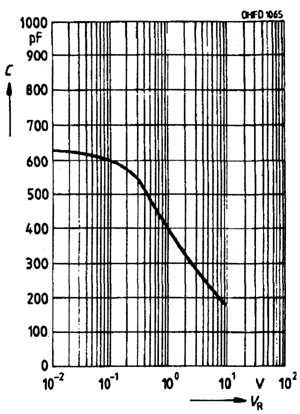
Power dissipation $P_{TOT}=f(T_A)$



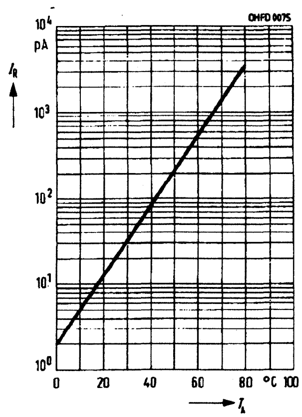
Dark current $I_R=f(V_R)$
T_A=25°C, E=0



Capacitance $C=f(V_R)$
F=1 MHz, E=0



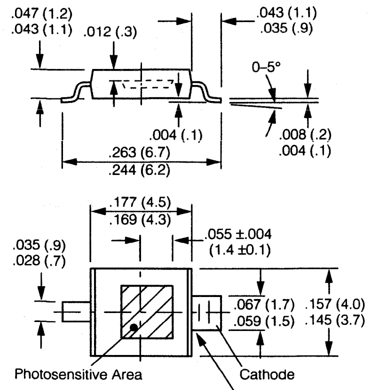
Dark current $I_R=f(T_A)$
V_R=1 V, E=0



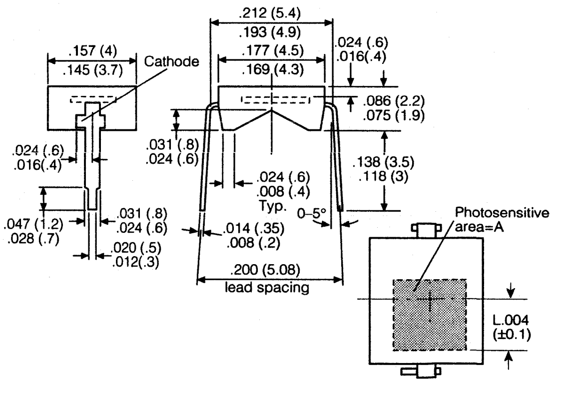
SIEMENS

BPW 34
SURFACE MOUNT BPW 34S
SILICON PIN PHOTODIODE

Package Dimensions in Inches (mm)



BPW 34S



BPW 34

FEATURES

- **Large Active Area Photodiode**
- **Silicon PIN Planar Photodiode**
- **N-Si Material: Anode=Front Contact, Cathode=Back Contact**
- **High Reliability**
- **No Testable Degradation**
- **High Cutoff Frequency**
- **High Packing Density**
- **Short Switching Time**
- **Low Capacitance**
- **High Spectral Sensitivity**
- **Wide Temperature Range**
- **Usage: Visible and Near Infrared Range**
- **Applications**
  - **Light Reflecting Switches**
  - **IR Remote Controls**
  - **Measurement and Control**
  - **Light Curtains**
  - **IR Data Transmission**
- **Package: Transparent Epoxy Resin BPW 34: 0.200" (5.08 mm) Lead Spacing BPW 34S: Surface Mount Package**
- **Cathode Marking: Projection on Solder Tab**

Maximum Ratings

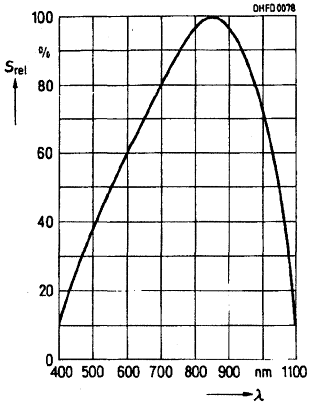
Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –40° to +80°C
Soldering Temperature (2 mm from case bottom) (T_S) t≤3 s .... 230°C
Reverse Voltage (V_R) .... 32 V
Power Dissipation (P_{TOT}) T_A=25°C .... 150 mW

Characteristics (T_A=25°C)

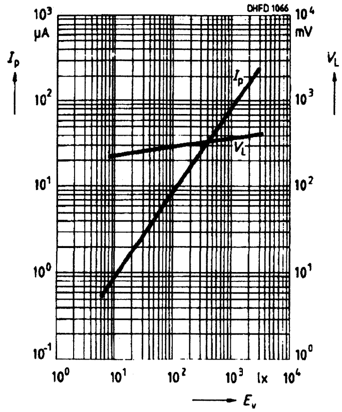
Parameter	Symbol	Value	Unit
Photosensitivity (V_R=5 V)(1)	S	80(≥50)	nA/lx
Maximum Photosensitivity Wavelength	λ_{Smax}	850	nm
Photosensitivity Spectral Range (S=10% of S_{MAX})	λ	400 to 1100	nm
Radiant Sensitive Area	A	7.00	mm^2
Radiant Sensitive Area Dimensions	L x W	2.65 x 2.65	mm
Distance, Chip Surface to Case Surface	H	0.5	mm
Half Angle	φ	±60	Deg.
Dark Current (V_R=10 V)	I_R	2(≤30)	nA
Spectral Photosensitivity (λ=850 nm)	S	0.62	A/W
Quantum Efficiency (λ=850 nm)	η	0.90	electrons / photon
Open Circuit Voltage (E_V=1000 lx)(1)	V_O	365(≥300)	mV
Short Circuit Current (E_V=1000 lx)(1)	I_{SC}	80	µA
Rise and Fall Time of Photocurrent (R_L=50 Ω, V_R=5 V, λ=850 nm, I_P=800 µA)	t_R, t_F	20	ns
Forward Voltage (I_F=100 mA, E=0)	V_F	1.3	V
Capacitance (V_R=0 V, f=1 MHz, E=0)	C_0	72	pF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_{SC} or I_P	TC_I	0.18	%/K
Noise Equivalent Power (V_R=10 V, λ=850 nm)	NEP	4.1×10^{-14}	W/√Hz
Detection Limit (V_R=10 V, λ=850 nm)	D*	6.6×10^{12}	cm•√Hz/W

Note
1. Illuminance shown refers to unfiltered radiation of tungsten filament lamp at color temperature of 2856 K (standard light A per DIN 5033 and IEC publication 306-1).

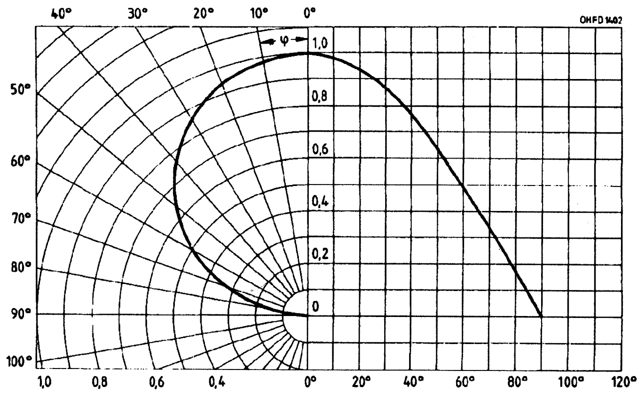
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



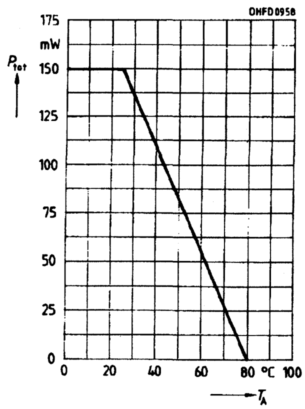
Photocurrent $I_P=f(E_V)$
Open circuit voltage $V_O=f(E_V)$



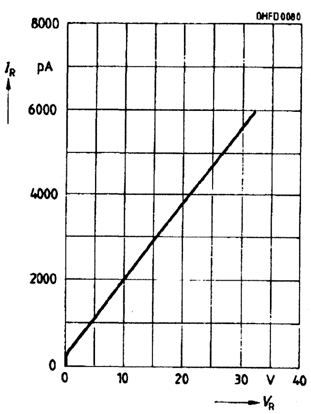
Directional characteristic $S_{REL}=f(\varphi)$



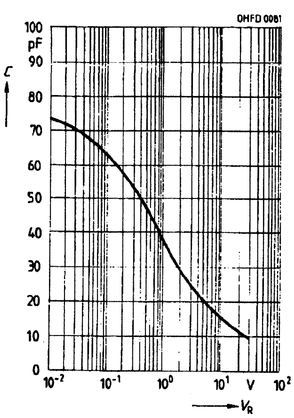
Power dissipation $P_{TOT}=f(T_A)$



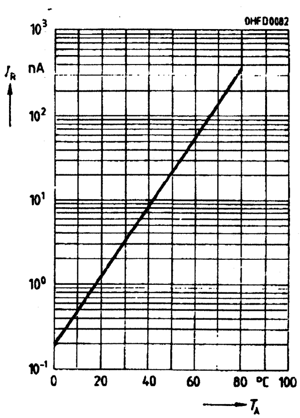
Dark current $I_R=f(V_R)$
$T_A=25°C$, E=0



Capacitance $C=f(V_R)$
E=0, f=1 MHz



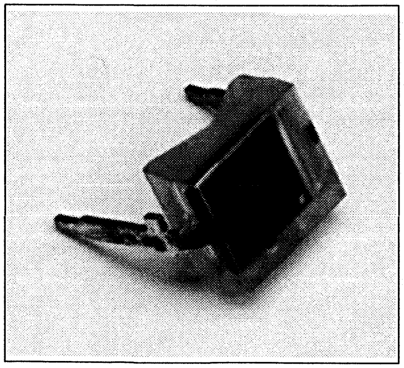
Dark current $I_R=f(T_A)$
$V_R=10$ V, E=0



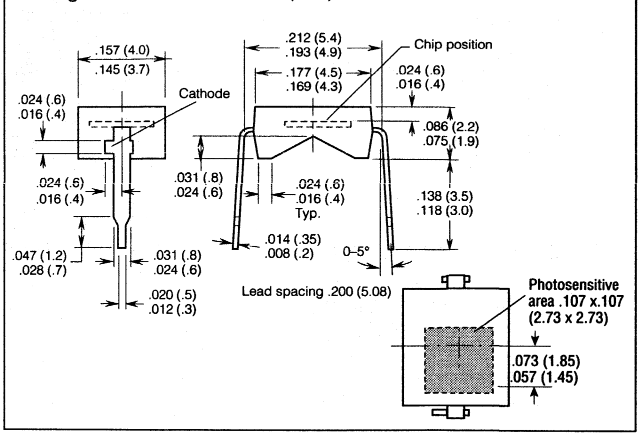
SIEMENS

BPW 34B

SILICON PIN PHOTODIODE ENHANCED BLUE SENSITIVITY



Package Dimensions in Inches (mm)



FEATURES

- Large Active Area Photodiode
- Silicon Planar PIN Photodiode
- N-Si Material: Anode=Front Contact, Cathode=Back Contact
- No Testable Degradation
- High Cutoff Frequency
- High Packing Density
- Short Switching Time
- Low Capacitance
- High Spectral Sensitivity
- Wide Temperature Range
- Usage: Visible and Near Infrared Range
- Enhanced Blue Sensitivity
- Applications
  - Detection of Halogen Lamps
  - Light Reflecting Switches
  - Detection of Visible Light Sources
  - Measurement and Control
- Package: Lead Frame, Transparent Epoxy Resin, Solder Tabs, 0.200" (5.08 mm) Lead Spacing
- Cathode Marking: Projection on Solder Tab

Maximum Ratings

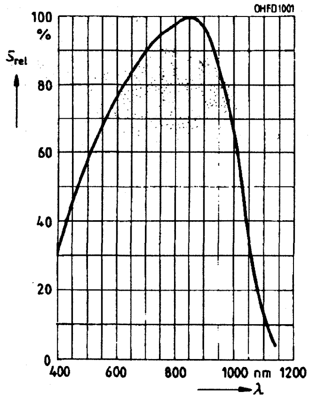
Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –40° to +80°C
Soldering Temperature (2 mm from case bottom) (T_S) t≤3 s .... 230°C
Reverse Voltage (V_R) .... 32 V
Power Dissipation (P_{TOT}) T_A=25°C .... 150 mW

Characteristics (T_A=25°C)

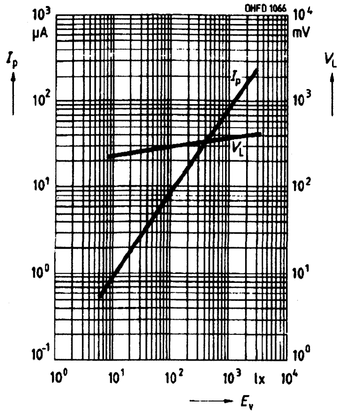
Parameter	Symbol	Value	Unit
Photosensitivity (V_R=5 V)	S	75	nA/lx
Maximum Photosensitivity Wavelength	λ_{Smax}	850	nm
Photosensitivity Spectral Range (S=10% of S_{MAX})	λ	350 to 1100	nm
Radiant Sensitive Area	A	7.45	mm^2
Radiant Sensitive Area Dimensions	L x W	2.73 x 2.73	mm
Distance, Chip Surface to Case Surface	H	0.5	mm
Half Angle	φ	±60	Deg.
Dark Current (V_R=10 V, E=0)	I_R	2(≤30)	nA
Spectral Photosensitivity (λ=400 nm)	S_λ	0.2	A/W
Quantum Efficiency (λ=400 nm)	η	0.62	electrons / photon
Open Circuit Voltage (E_V=1000 lx)(1)	V_O	390	mV
Short Circuit Current (E_E=0.5 mW/cm², λ=400 nm)	I_{SC}	7.4(≥5.4)	µA
Rise and Fall Time of Photocurrent (R_L=50 Ω, V_R=5 V, λ=850 nm, I_P=800 µA)	t_R, t_F	25	ns
Forward Voltage (I_F=100 mA, E=0)	V_F	1.3	V
Capacitance (V_R=0 V, f=1 MHz, E=0)	C_0	72	pF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_{sc}	TC_I	0.18	%/K
Noise Equivalent Power (V_R=10 V, λ=400 nm)	NEP	1.3×10^{-13}	W/√Hz
Detection Limit (V_R=10 V, λ=400 nm)	D*	2.1×10^{12}	cm•√Hz/W

Note
1. Illuminance shown refers to unfiltered radiation of tungsten filament lamp at color temperature of 2856 K (standard light A per DIN 5033 and IEC publication 306-1).

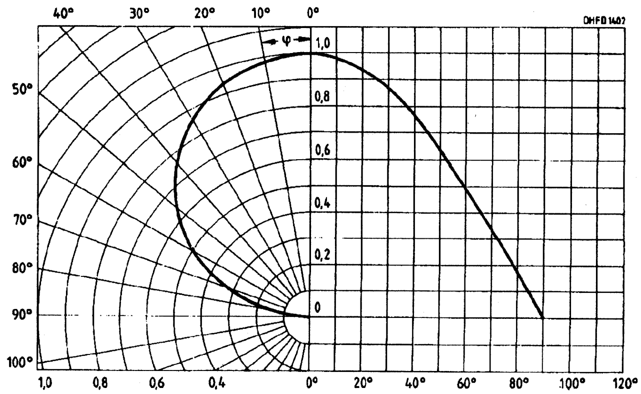
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



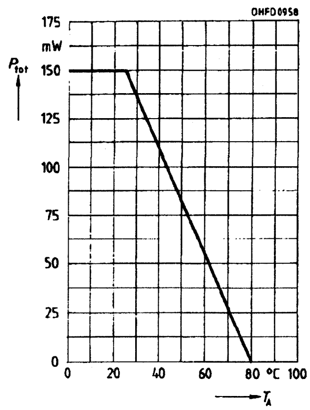
Photocurrent $I_P=f(E_V)$
Open circuit voltage $V_O=f(E_V)$



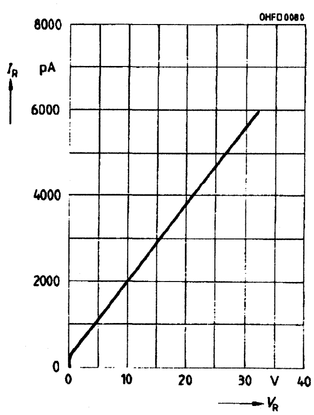
Directional characteristic $S_{REL}=f(\varphi)$



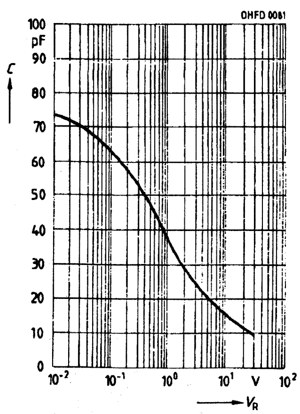
Power dissipation $P_{TOT}=f(T_A)$



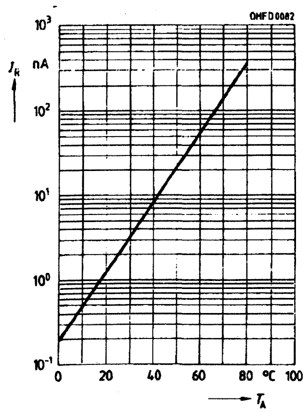
Dark current $I_R=f(V_R)$, E=0



Capacitance $C=f(V_R)$, f=1 MHz, E=0



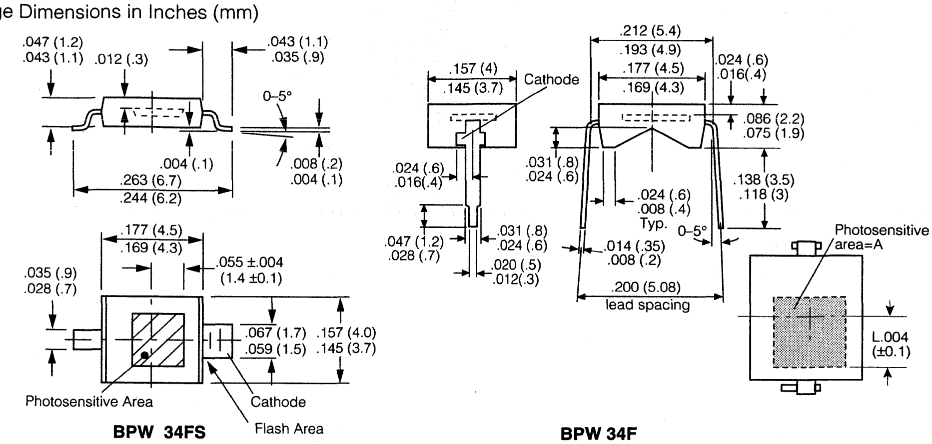
Dark current $I_R=f(T_A)$
V_R=10 V, E=0



SIEMENS

BPW 34F
SURFACE MOUNT BPW 34FS
SILICON PIN PHOTODIODE
DAYLIGHT FILTER

Package Dimensions in Inches (mm)



BPW 34FS **BPW 34F**

FEATURES

- **Silicon Planar PIN Photodiode**
- **Daylight Filter**
- **High Spectral Sensitivity**
- **Short Switching Time**
- **Usage: Near Infrared Range (780 to 1100 nm)**
- **Wide Temperature Range**
- **High Reliability**
- **No Testable Degradation**
- **High Cutoff Frequency**
- **High Packing Density**
- **Use as Photodiode or Photovoltaic Cell**
- **N-Si Material: Anode=Front Contact, Cathode=Back Contact**
- **Low Capacitance**
- **Applications**
  - **IR Remote Control**
  - **IR Sound Transmission**
  - **Reflective Switches**
- **Package: Black Epoxy Resin BPW 34F: 0.200" (5.08 mm) Lead Spacing BPW 34FAS: Surface Mount Package**
- **Cathode Marking: Projection on Solder Tab**

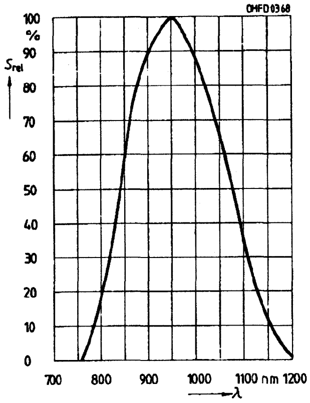
Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG})	–40° to +80°C
Soldering Temperature (2 mm from case bottom) (T_S) t≤3 s	230°C
Reverse Voltage (V_R)	32 V
Power Dissipation (P_{TOT}) T_A=25°C	150 mW

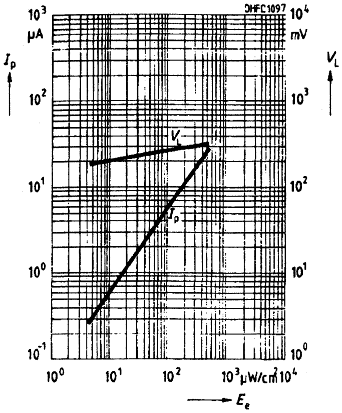
Characteristics (T_A=25°C, λ=950 nm)

Parameter	Symbol	Value	Unit
Photosensitivity (V_R=5 V, E_E=1 mW/cm²)	S	50 (≥30)	µA
Maximum Photosensitivity Wavelength	λ_{Smax}	950	nm
Photosensitivity Spectral Range (S=10% of S_{MAX})	λ	780 to 1100	nm
Radiant Sensitive Area	A	7.00	mm²
Radiant Sensitive Area Dimensions	L x W	2.65 x 2.65	mm
Distance, Chip Surface to Case Surface	H	0.5	mm
Half Angle	φ	±60	Deg.
Dark Current (V_R=10 V)	I_R	2 (≤30)	nA
Spectral Photosensitivity	S_λ	0.59	A/W
Quantum Yield	η	0.77	electrons/photon
Open Circuit Voltage (E_e=0.5 mW/cm²)	V_O	330 (≥275)	mV
Short Circuit Current (E_e=0.5 mW/cm²)	I_{SC}	25	µA
Rise and Fall Time of Photocurrent 10% to 90%, and 90% to 10% of Final Value, (R_L=50 Ω, V_R=5 V, λ=850 nm, I_P=800 µA)	t_R, t_F	20	ns
Forward Voltage (I_F=100 mA, E=0, T_A=25°C)	V_F	1.3	V
Capacitance (V_R=0 V, E=0, f=1 MHz)	C_0	72	pF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.18	%/K
Noise Equivalent Power (V_R=10 V)	NEP	4.3 x 10^{-14}	W/√Hz
Detection Limit (V_R=10 V)	D*	6.2 x 10^{12}	cm•√Hz/W

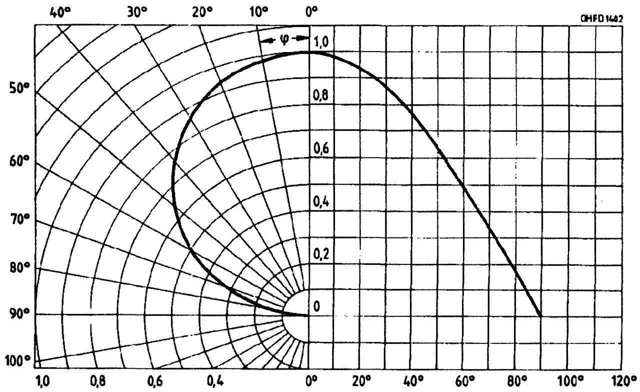
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



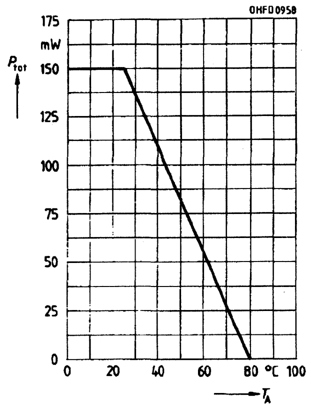
Photocurrent $I_P=f(E_e)$
Open circuit voltage $V_O=f(E_e)$



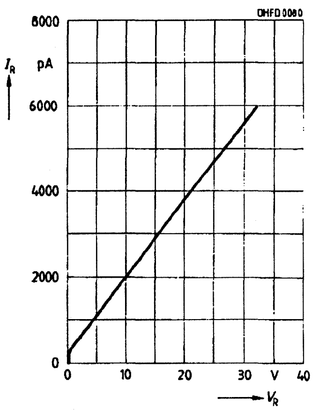
Directional characteristic
$S_{REL}=f(\varphi)$



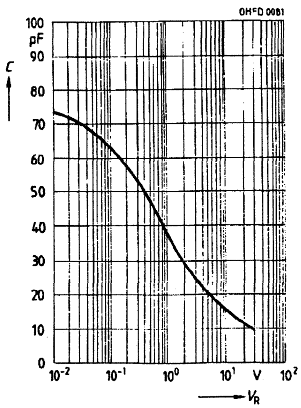
Power dissipation $P_{TOT}=f(T_A)$



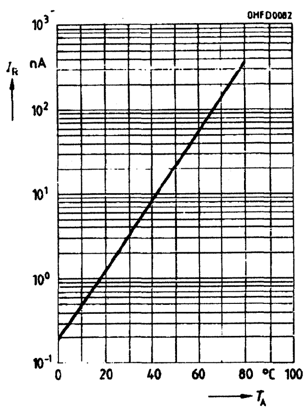
Dark current $I_R=f(V_R)$
$T_A=25°C$, E=0



Capacitance $C=f(V_R)$
f=1 MHz, E=0



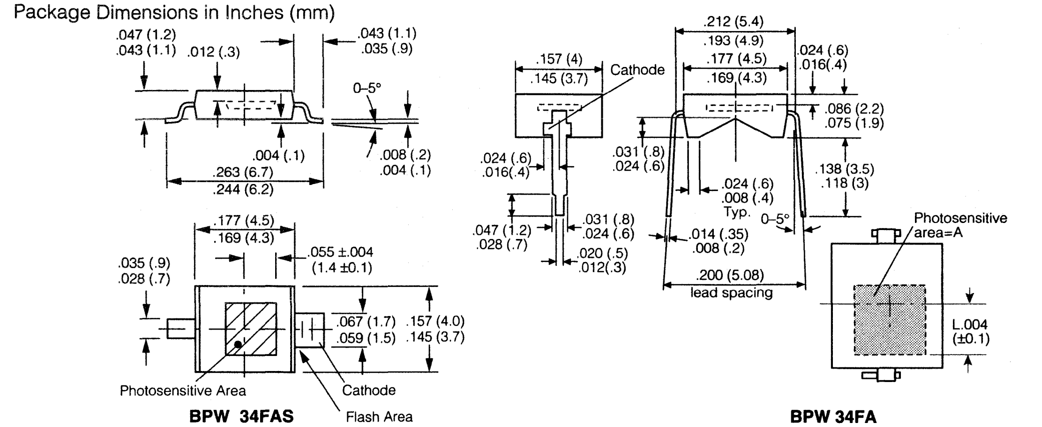
Dark current $I_R=f(T_A)$
$V_R=10$, E=0



SIEMENS

BPW 34FA
SURFACE MOUNT BPW 34FAS
SILICON PIN PHOTODIODE
DAYLIGHT FILTER, 830–880 nm RANGE

Package Dimensions in Inches (mm)



FEATURES

- **Silicon Planar PIN Photodiode**
- **Daylight Filter**
- **Sensitivity Optimized for 830 to 880 nm Range**
- **N-Si Material: Anode=Front Contact, Cathode=Back Contact**
- **High Reliability**
- **No Testable Degradation**
- **High Cutoff Frequency**
- **High Packing Density**
- **Short Switching Time**
- **Low Capacitance**
- **High Sensitivity**
- **Wide Temperature Range**
- **Package: Black Epoxy Resin**
  BPW 34FA: .200 (5.08 mm) Lead Spacing
  BPW 34FAS: Surface Mount Package

DESCRIPTION

The BPW 34FA/FAS is a silicon planar PIN photodiode in a filtered plastic package with 0.200" (5.08 mm) lead spacing.

The spectral sensitivity is maximized in the 830 to 880 range, which makes it an ideal match for GaAlAs IR emitters with λpeak at 880 nm (SFH 484, SFH 485, SFH 487).

The BPW 34FA's high sensitivity, fast switching times, low capacitance, compact size, and lack of measurable degradation make it suitable for diverse applications, such as TV and appliance remote control, IR sound transmission, video recorders, and measurement and control.

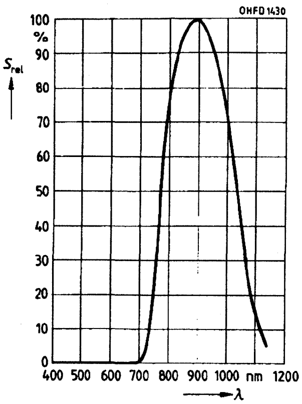
Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –40° to +80°C
Reverse Voltage (V_R) .... 32 V
Power Dissipation (P_{TOT}) T_A=25°C .... 150 mW

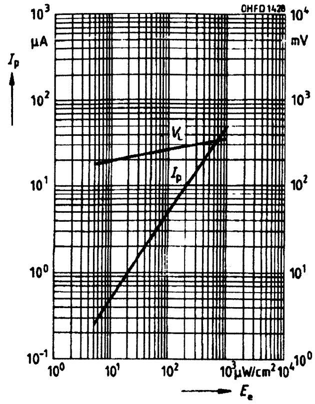
Characteristics (T_A=25°C, 870 nm))

Parameter	Symbol	Value	Unit
Photosensitivity (V_R=5 V, E_e=1 mW/cm²)	S	50(≥40)	µA
Maximum Photosensitivity Wavelength	λ_{Smax}	880	nm
Photosensitivity Spectral Range (S=10% of S_{MAX})	λ	730 to 1100	nm
Radiant Sensitive Area	A	7	mm²
Radiant Sensitive Area Dimensions	L x W	2.65 x 2.65	mm
Distance, Chip Surface to Lens Surface	H	0.5	mm
Half Angle	φ	±60	Deg.
Dark Current (V_R=10 V)	I_R	2(≤30)	nA
Spectral Sensitivity	S_λ	0.65	A/W
Quantum Yield	η	0.93	electrons / photon
Open Circuit Voltage (E_e=0.5 mW/cm²)	V_O	320(≥250)	mV
Short Circuit Current (E_e=0.5 mW/cm²)	I_{SC}	23	µA
Rise and Fall Time of Photocurrent 10% to 90% and 90% to 10% of Final Value (R_L=50 Ω, V_R=5 V, λ=830 nm, I_P=800 µA)	t_R, t_F	20	ns
Forward Voltage (I_F=100 mA, E=0)	V_F	1.3	V
Capacitance (V_R=0 V, f=1 MHz, E=0)	C_0	72	pF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_P	TC_I	0.03	%/K
Noise Equivalent Power (V_R=10 V)	NEP	3.9×10^{-14}	W/√Hz
Detection Limit (V_R=10 V)	D*	6.8×10^{12}	cm•√Hz/W

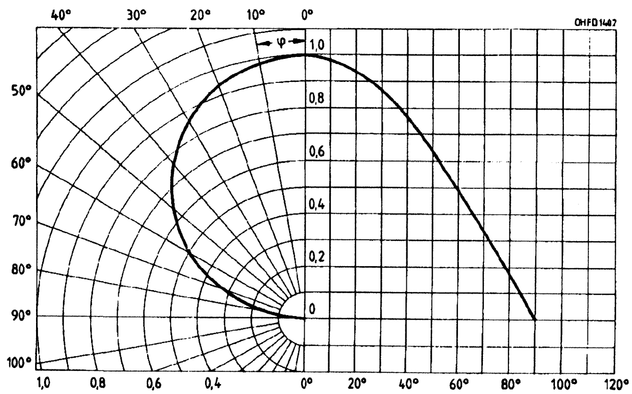
Relative spectral sensitivity $S_{REL}=f(\lambda)$



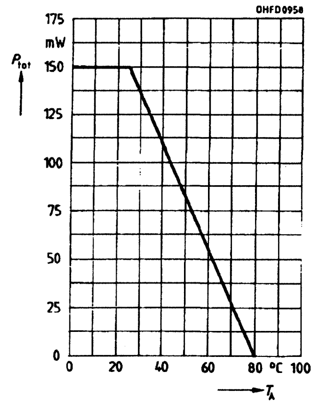
Photocurrent $I_P=f(E_e)$, $V_R=5$ V
Open circuit voltage $V_O=f(E_e)$



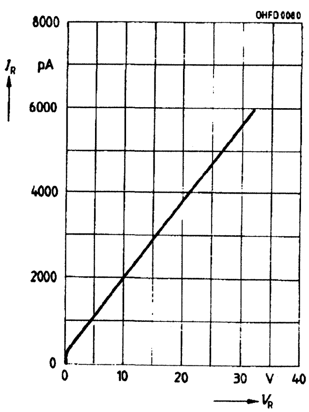
Directional characteristic $S_{REL}=f(\varphi)$



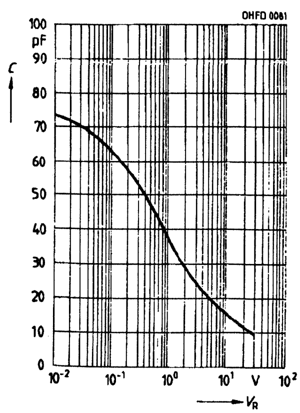
Total power dissipation $P_{TOT}=f(T_A)$



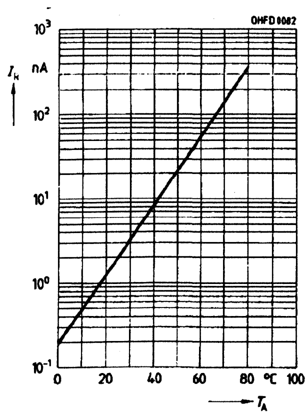
Dark current $I_R=f(V_R)$, E=0



Capacitance $C=f(V_R)$, f=1 MHz, E=0

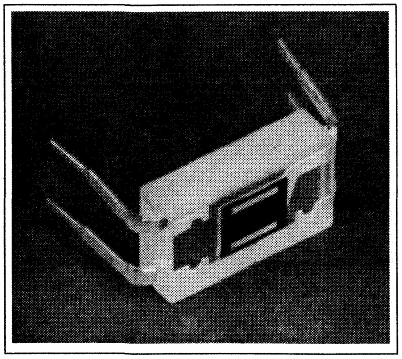


Dark current $I_R=f(T_A)$, $V_R=10$ V, E=0

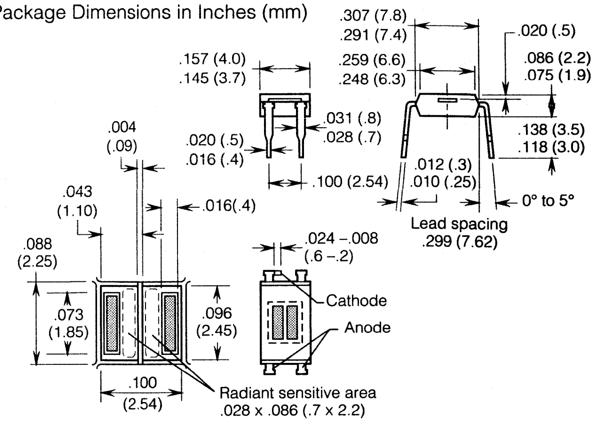


SIEMENS

BPX 48
DAYLIGHT FILTER BPX 48F
SILICON DIFFERENTIAL PHOTODIODE



Package Dimensions in Inches (mm)



FEATURES

- **Differential Photodiode**
- **Plastic Encapsulated, Strip Line Technique**
- **Tightly Spaced Diodes for Precise Positional Indication**

DESCRIPTION

The differential photodiode BPX 48 is designed for special industrial electronic applications, such as edge detection and path and angle scanning. The individual diodes are spaced 90 µm apart, resulting in a highly precise positional indication. Silicon planar ensures low dark current, low noise, and excellent signal-to-noise relationships.

Maximum Ratings

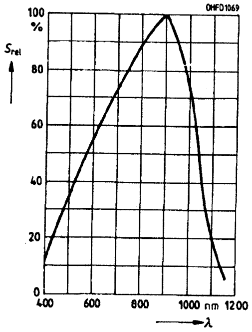
Operating and Storage Temperature Range
(T_{OP}, T_{STG}) .... –40° to +80°C
Soldering Temperature
(2 mm from case bottom) (T_S) t≤3 s .... 230°C
Reverse Voltage (V_R) .... 10 V
Power Dissipation (P_{TOT}) T_A=25°C .... 50 mW

Characteristics Single Diode (T_A=25°C)

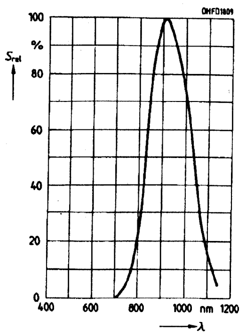
Parameter	Symbol	Value BPX48	Value BPX48F	Unit
Spectral Sensitivity				
(V_R=5 V)	S	24(≥15)	–	nA/lx
(V_R=5 V, λ=950 nm, E_E=0.5 mW/cm²)	S	–	7.5(≥4.0)	µA
Maximum Photosensitivity Wavelength	λ_{Smax}	900	920	nm
Sensitivity Spectral Range				
(S=10% of S_{MAX})	λ	400 to 1150	750 to 1150	nm
Radiant Sensitive Area	A	1.54	1.54	mm²
Radiant Sensitive Area Dimensions	L x B	0.7 x 2.2	0.7 x 2.2	mm
Distance, Chip Surface to Case Surface	H	0.5	0.5	mm
Half Angle	φ	±60	±60	Deg.
Dark Current (V_R=10 V)	I_R	10(≤100)	10(≤100)	nA
Spectral Sensitivity				
λ=850 nm	S_λ	0.55	–	A/W
λ=950 nm	S_λ	–	0.65	
Maximum Deviation, Systems Spectral Sensitivity from Mean	ΔS	±5	±5	%
Quantum Efficiency				
λ=850 nm	η	0.8	–	electrons
λ=950 nm		–	0.95	photon
Open Circuit Voltage				
(E_V=1000 lx)(1)	V_O	330(≥280)	–	mV
(E_E=0.5 mW/cm², λ=950 nm)	V_O	–	300(≥280)	mV
Short Circuit Current				
(E_V=1000 lx)(1)	I_{SC}	24	–	µA
(E_E=0.5 mW/cm², λ=950 nm)	I_{SC}	–	7	µA
Rise and Fall Time of Photocurrent (R_L=1 KΩ, V_R=5 V, λ=850 nm, I_P=20 µA)	t_R, t_F	500	500	ns
Forward Voltage (I_F=40 mA, E=0)	V_F	1.3	1.3	V
Capacitance (V_R=0 V, f=1 MHz, E=0)	C_0	25	25	pF
Temperature Coefficient V_O	TC_V	–2.6	–2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.18	–	%/K
Temperature Coefficient I_{SC} (λ=950 nm)	TC_I	–	0.2	%/K
Noise Equivalent Power (V_R=10 V, λ=950 nm)	NEP	1.0×10^{-13}	1.0×10^{-13}	W/√Hz
Detection Limit (V_R=10 V, λ=950 nm)	D*	1.2×10^{12}	1.2×10^{12}	cm•√Hz/W

Note
1. Illuminance shown refers to unfiltered radiation of tungsten filament lamp at color temperature of 2856 K (standard light A per DIN 5033 and IEC publication 306-1).

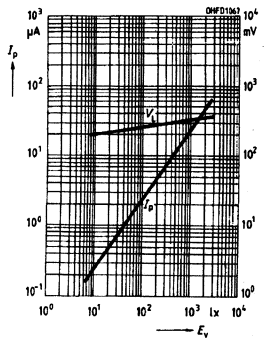
BPX 48
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



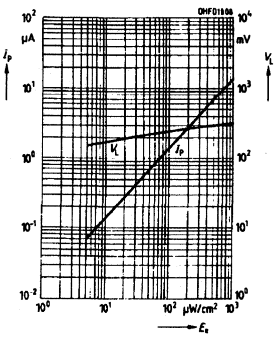
BPX 48F
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



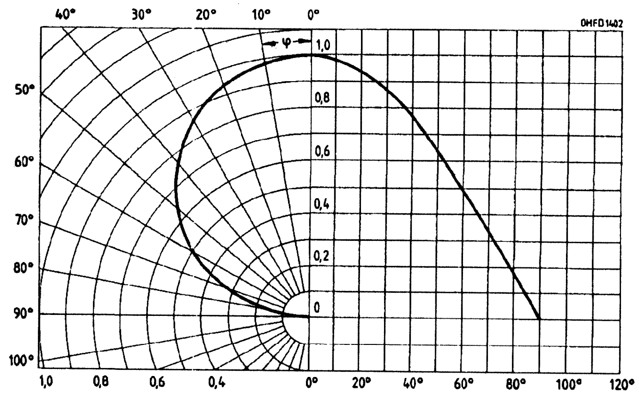
BPX 48
Photocurrent $I_P=f(E_V)$
Open circuit voltage $V_O=f(E_V)$



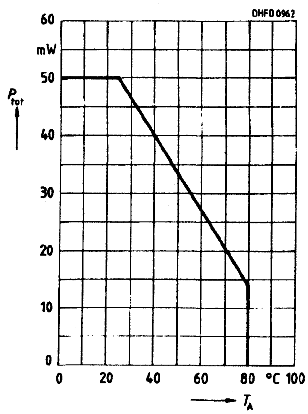
BPX 48F
Photocurrent $I_P=f(E_e)$, $V_R=5$ V
Open circuit voltage $V_O=f(E_e)$



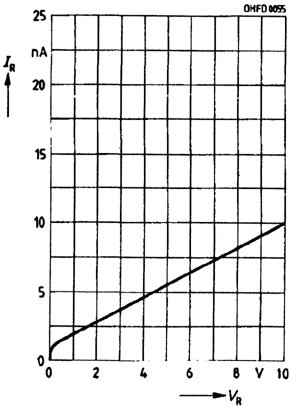
Directional characteristic $S_{REL}=f(\varphi)$



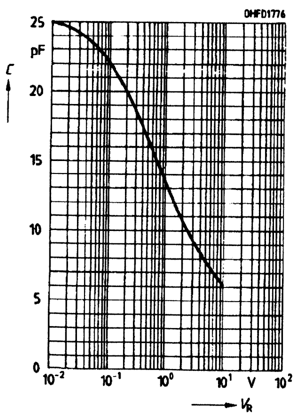
Power dissipation $P_{TOT}=f(T_A)$



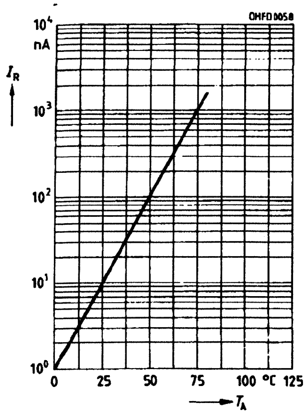
Dark current $I_R=f(V_R)$,
E=0



Capacitance $C=f(V_R)$, f=1 MHz



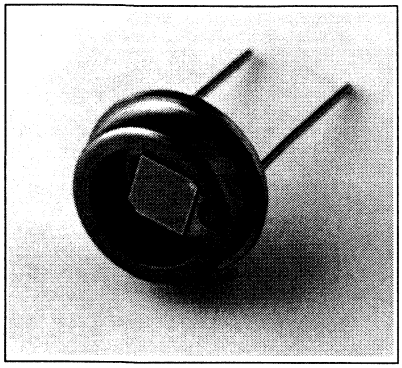
Dark current $I_R=f(T_A)$, $V_R=10$ V
E=0



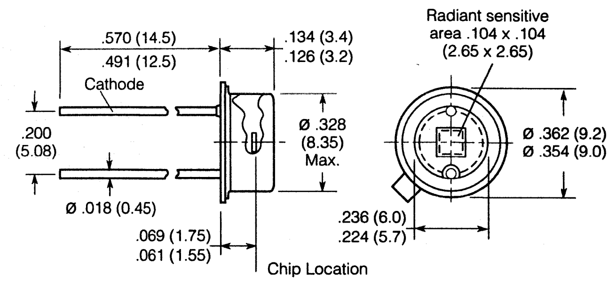
SIEMENS

BPX 60

SILICON PHOTODIODE ENHANCED BLUE SENSITIVITY



Package Dimensions in Inches (mm)



FEATURES

- **Silicon Planar Photodiode**
- **Premium, High-Reliability Device**
- **Modified TO-5 Hermetic Case**
- **Flat Glass Lens**
- **Large Photosensitive Area**
- **Usage: Visible and IR Ranges**

DESCRIPTION

The BPX 60 is a silicon planar photodiode. The hermetically sealed case—a TO-5 modification with a flat glass window—allows use at extreme operating conditions. The signal/noise ratio is favorable, even at low light levels. The open circuit voltage at low light levels is higher than with comparable mesa photovoltaic cells.

Maximum Ratings

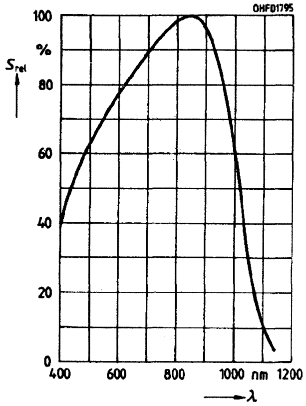
Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –40° to +80°C
Soldering Temperature (≥2 mm from case bottom) (T_S) t≤3 s .... 230°C
Reverse Voltage (V_R) .... 32 V
Power Dissipation (P_{TOT}) T_A=25°C .... 250 mW

Characteristics (T_A=25°C)

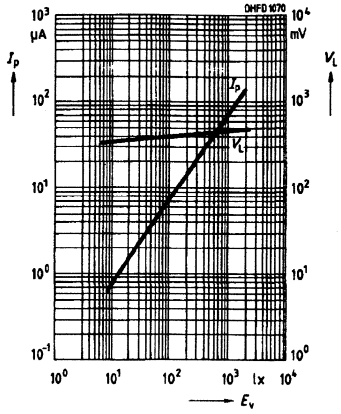
Parameter	Symbol	Value	Unit
Photosensitivity (V_R=5 V)(1)	S	70	nA/lx
Maximum Photosensitivity Wavelength	λ_{Smax}	850	nm
Photosensitivity Spectral Range (S=10% of S_{MAX})	λ	350 to 1100	nm
Radiant Sensitive Area	A	7.45	mm^2
Radiant Sensitive Area Dimensions	L x W	2.73 x 2.73	mm
Distance, Chip Surface to Case Surface	H	1.9 to 2.3	mm
Half Angle	φ	±55	Deg.
Dark Current (V_R=10 V)	I_R	7(≤55)	nA
Spectral Photosensitivity (λ=400 nm)	S_λ	0.20	A/W
Quantum Efficiency (λ=400 nm)	η	0.62	electrons / photon
Open Circuit Voltage (E_V=1000 lx)(1)	V_O	460	mV
Short Circuit Current (E_e=0.5 mW/cm², λ=400 nm)	I_{SC}	7.4(≥5.4)	µA
Rise and Fall Time of Photocurrent (R_L=1 kΩ, V_R=5 V, λ=850 nm, I_P=70 µA)	t_R, t_F	3.0	µs
Forward Voltage (I_F=100 mA, E=0)	V_F	1.3	V
Capacitance (V_R=0 V, f=1 MHz, E_V=0 lx)	C_0	580	pF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.18	%/K
Noise Equivalent Power (V_R=10 V, λ=400 nm)	NEP	2.4×10^{-13}	W/√Hz
Detection Limit (V_R=10 V, λ=400 nm)	D*	1.2×10^{12}	cm•√Hz/W

Note
1. Illuminance shown refers to unfiltered radiation of tungsten filament lamp at color temperature of 2856 K (standard light A per DIN 5033 and IEC publication 306-1).

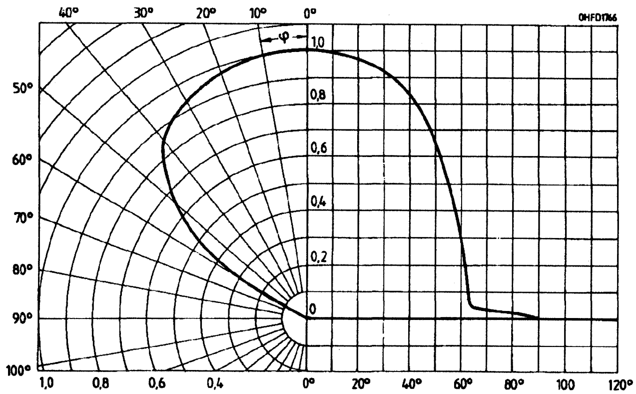
Relative spectral sensitivity $S_{REL}=f(\lambda)$



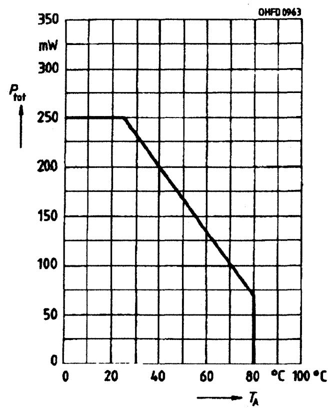
Photocurrent $I_P=f(E_V)$
Open circuit voltage $V_O=f(E_V)$



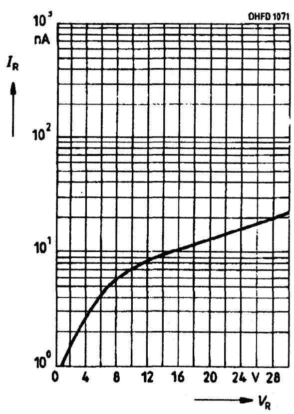
Directional characteristic $S_{REL}=f(\varphi)$



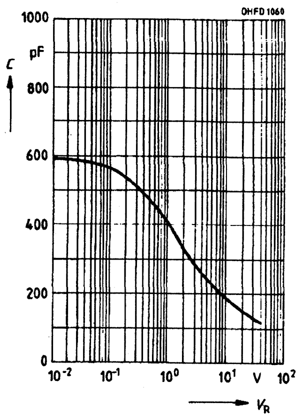
Power dissipation $P_{TOT}=f(T_A)$



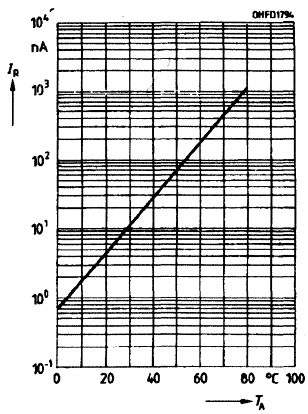
Dark current $I_R=f(V_R)$, E=0



Capacitance $C=f(V_R)$, f=1 MHz, E=0



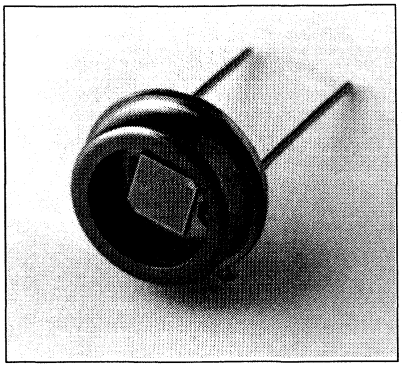
Dark current $I_R=f(T_A)$, V_R=10 V



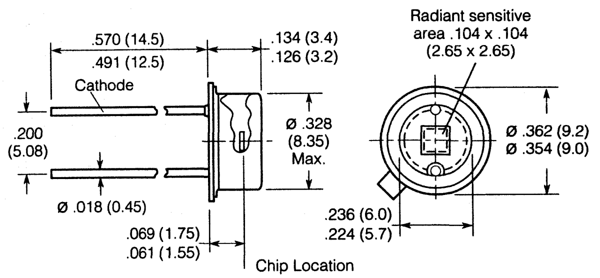
SIEMENS

BPX 61

SILICON PIN PHOTODIODE



Package Dimensions in Inches (mm)



FEATURES

- **Silicon Planar PIN Photodiode**
- **Premium, High-Reliability Device**
- **Modified TO-5 Hermetic Case**
- **Flat Glass Lens**
- **Large Photosensitive Area**
- **Usage: Visible and IR Ranges**
- **Short Switching Time**

DESCRIPTION

The BPX 61 is a silicon planar PIN photodiode with low reverse current. Its low capacitance permits use up to 10 MHz. The hermetically sealed package—a TO-5 modification with a flat glass window—allows use at extreme operating conditions. The signal/noise ratio is favorable, even at low light levels. The open circuit voltage at low light levels is higher than with comparable mesa photovoltaic cells. The PIN photodiode provides outstanding low junction capacitance, high cut-off frequency, and short switching times.

Maximum Ratings

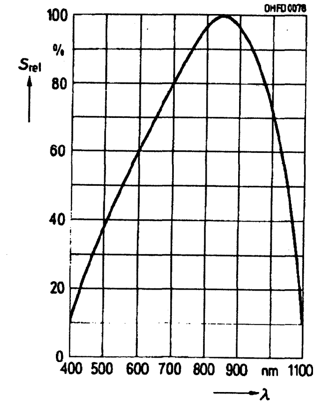
Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –40° to +80°C
Soldering Temperature (≥2 mm from case bottom) (T_S) t≤3 s .... 230°C
Reverse Voltage (V_R) .... 32 V
Power Dissipation (P_{TOT}) T_A=25°C .... 250 mW

Characteristics (T_A=25°C)

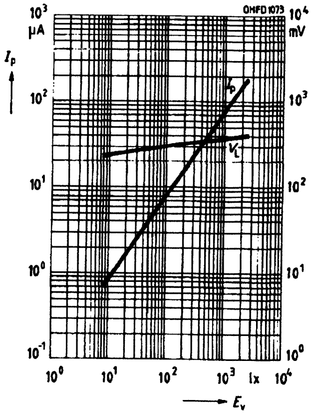
Parameter	Symbol	Value	Unit
Photosensitivity (V_R=5 V)(1)	S	70(≥50)	nA/lx
Maximum Photosensitivity Wavelength	λ_{Smax}	850	nm
Photosensitivity Spectral Range (S=10% of S_{MAX})	λ	400 to 1100	nm
Radiant Sensitive Area	A	7.00	mm²
Radiant Sensitive Area Dimensions	L x W	2.65 x 2.65	mm
Distance, Chip Surface to Case Surface	H	1.9 to 2.3	mm
Half Angle	φ	±55	Deg.
Dark Current (V_R=10 V)	I_R	2(≤30)	nA
Spectral Photosensitivity (λ=850 nm)	S_λ	0.62	A/W
Quantum Efficiency (λ=850 nm)	η	0.90	electrons / photon
Open Circuit Voltage (E_v=1000 lx)(1)	V_O	375(≥320)	mV
Short Circuit Current (E_V=1000 lx)(1)	I_{SC}	70	µA
Rise and Fall Time of Photocurrent (R_L=50 Ω, V_R=5 V, λ=850 nm, I_P=800 µA)	t_R, t_F	20	ns
Forward Voltage (I_F=100 mA, E_E=0)	V_F	1.3	V
Capacitance (V_R=0 V, f=1 MHz, E_V=0 lx)	C_O	72	pF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.18	%/K
Noise Equivalent Power (V_R=10 V, λ=850 nm)	NEP	4.1×10^{-14}	W/√Hz
Detection Limit (V_R=10 V, λ=850 nm)	D*	6.6×10^{12}	cm•√Hz/W

Note
1. Illuminance shown refers to unfiltered radiation of tungsten filament lamp at color temperature of 2856 K (standard light A per DIN 5033 and IEC publication 306-1).

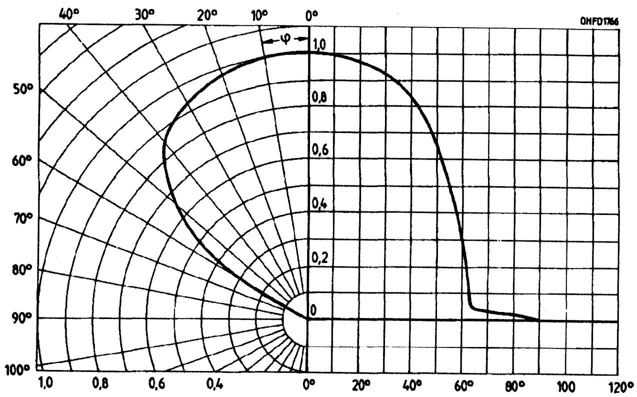
Relative spectral sensitivity $S_{REL}=f(\lambda)$



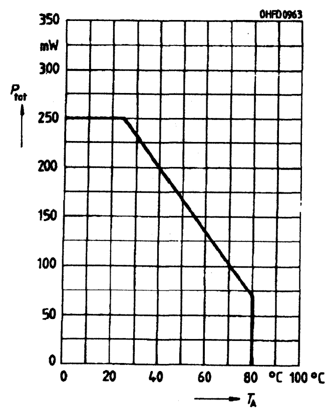
Photocurrent $I_P=f(E_V)$, $V_R=5$ V
Open circuit voltage $V_0=f(E_V)$



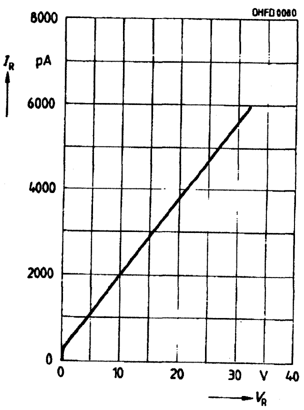
Directional characteristic $S_{REL}=f(\varphi)$



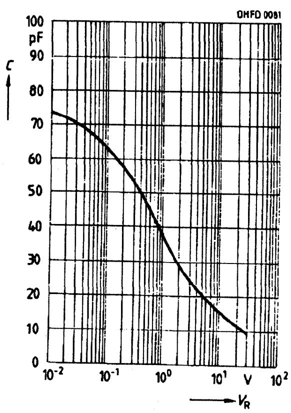
Power dissipation $P_{TOT}=f(T_A)$



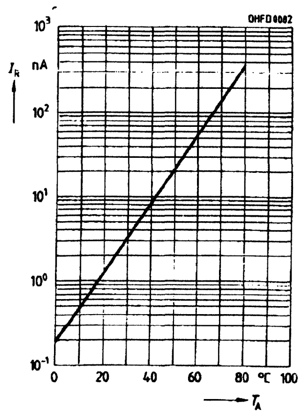
Dark current $I_R=f(V_R)$, $E=0$



Capacitance $C=f(V_R)$, $f=1$ MHz, $E=0$



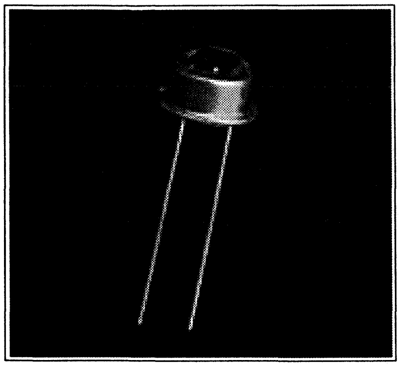
Dark current $I_R=f(T_A)$, $V_R=10$, $E=0$



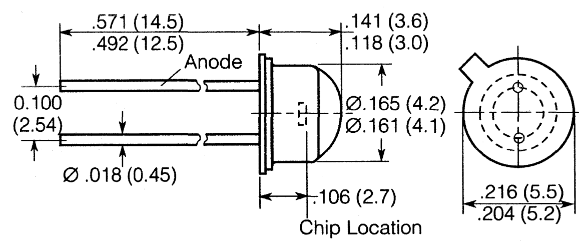
SIEMENS

BPX 63

SILICON PHOTODIODE
VERY LOW DARK CURRENT



Package Dimensions in Inches (mm)



FEATURES

- **Silicon Planar Photodiode**
- **Modified TO18 Hermetic Case**
- **Very Low Dark Current**
- **Metal Case and Plastic Lens**

DESCRIPTION

The BPX 63 is a silicon planar photodiode, mounted on a TO18 base plate and covered with transparent plastic. The BPX 63 has been developed as a detector for low light levels. It is outstanding for low dark currents and, when used as a voltaic cell, for a high open circuit voltage at low light levels. The cathode of the BPX 63 is electrically connected to the package.

Maximum Ratings

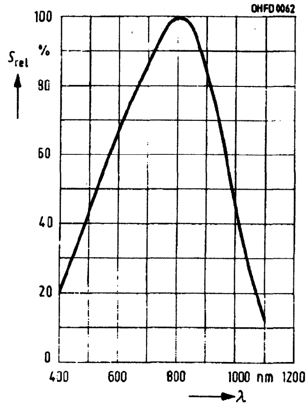
Operating and Storage Temperature Range (T_{OP}, T_{STG}) ....−40° to +80°C
Soldering Temperature (≥2 mm from case bottom) (T_S) t≤3 s .... 230°C
Reverse Voltage (V_R) .... 7 V
Power Dissipation (P_{TOT}) T_A=25°C .... 200 mW

Characteristics (T_A=25°C)

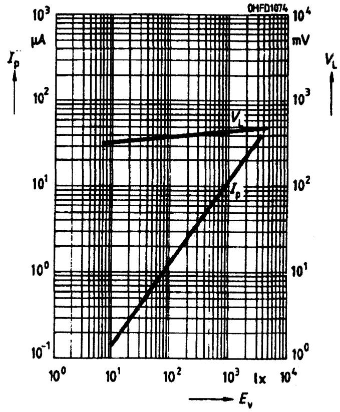
Parameter	**Symbol**	**Value**	**Unit**
Photosensitivity (V_R=5 V)(1)	S	10(≥8)	nA/lx
Maximum Photosensitivity Wavelength	λ_{Smax}	800	nm
Photosensitivity Spectral Range (S=10% of S_{MAX})	λ	350 to 1100	nm
Radiant Sensitive Area	A	0.97	mm^2
Radiant Sensitive Area Dimensions	L x W	0.985 x 0.985	mm
Distance, Chip Surface to Case Surface	H	0.2 to 0.8	mm
Half Angle	φ	±75	Deg.
Dark Current (V_R=10 V)	I_R	5(≤20)	pA
Zero Cross Over (E=0)	S_0	≤0.4	pA/mV
Spectral Photosensitivity (λ=850 nm)	S_λ	0.50	A/W
Quantum Efficiency (λ=850 nm)	η	0.73	electrons/photon
Open Circuit Voltage (E_V=1000 lx)(1)	V_0	450(≥380)	mV
Short Circuit Current (E_V=1000 lx)(1)	I_{SC}	10	µA
Rise and Fall Time of Photocurrent (R_L=1 kΩ, V_R=5 V, λ=850 nm, I_P=10 µA)	t_R, t_F	1.3	µs
Forward Voltage (I_F=100 mA, E=0)	V_F	1.3	V
Capacitance (V_R=0 V, f=1 MHz, E=0)	C_0	100	pF
Temperature Coefficient V_0	TC_V	−2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.16	%/K
Noise Equivalent Power (V_R=1 V, λ=850 nm)	NEP	2.5×10^{-15}	W/√Hz
Detection Limit (V_R=1 V, λ=850 nm)	D*	3.9×10^{13}	cm•√Hz/W

Note
1. Illuminance shown refers to unfiltered radiation of tungsten filament lamp at color temperature of 2856 K (standard light A per DIN 5033 and IEC publication 306-1).

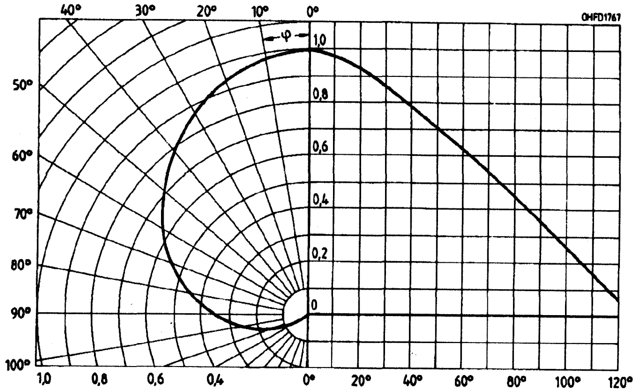
Relative spectral sensitivity $S_{REL}=f(\lambda)$



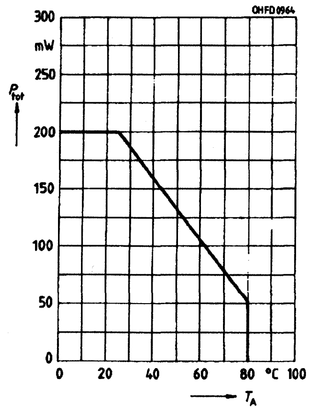
Photocurrent $I_P=f(E_V)$, $V_R=5$ V
Open circuit voltage $V_0=f(E_V)$



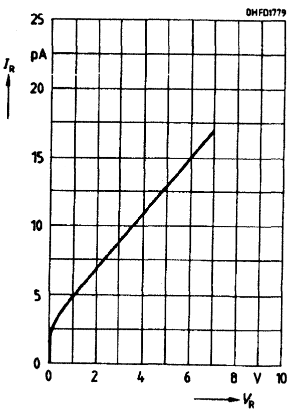
Directional characteristic $S_{REL}=f(\varphi)$



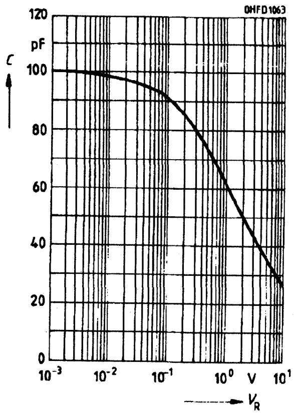
Power dissipation $P_{TOT}=f(T_A)$



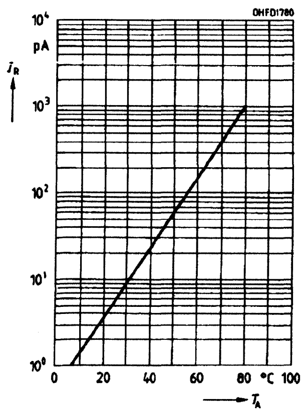
Dark current $I_R=f(V_R)$, E=0



Capacitance $C=f(V_R)$, f=1 MHz, E=0

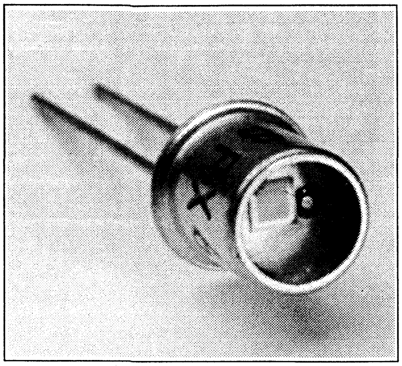


Dark current $I_R=f(T_A)$, $E_V=0$, $V_R=1$ V

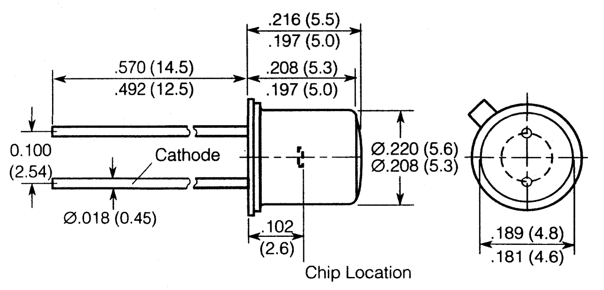


SIEMENS

BPX 65
SILICON PIN PHOTODIODE



Package Dimensions in Inches (mm)



FEATURES

- **Silicon Planar PIN Photodiode**
- **Premium, High-Reliability Device**
- **TO18 Size Package**
- **Flat Glass Lens**
- **High Speed**
- **Usage: Visible and IR Ranges**

DESCRIPTION

The BPX 65 is a silicon planar PIN photodiode in an 18 A 2 DIN 41876 package (similar to TO18) with a flat window. The cathode is electrically connected to the package. The flat window has no affect on the beam path of optical lens systems. Because of its high cut-off frequency, this diode is well-suited for use as a high-modulation bandwidth optical sensor. The PIN photodiode provides low junction capacitance and short switching times.

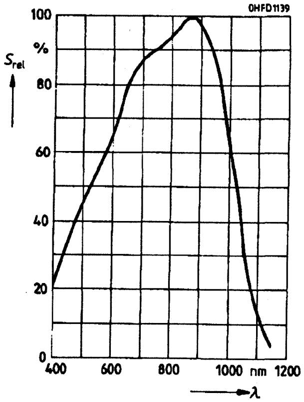
Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) ....–40° to +125°C
Soldering Temperature (≥2 mm from case bottom) (T_S) t≤3 s .... 230°C
Reverse Voltage (V_R) .... 50 V
Power Dissipation (P_{TOT}) .... 230 mW

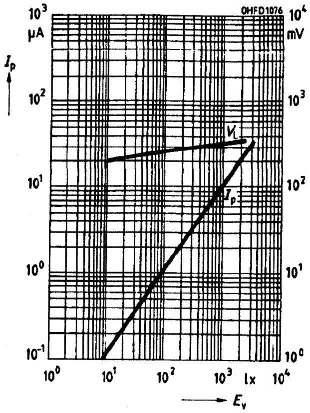
Characteristics (T_A=25°C, Standard Light A, T=2856 k)

Parameter	Symbol	Value	Unit
Photosensitivity (V_R=5 V)	S	10(≥5.5)	nA/lx
Maximum Photosensitivity Wavelength	λ_{Smax}	850	nm
Photosensitivity Spectral Range (S=10% of S_{MAX})	λ	350 to 1100	nm
Radiant Sensitive Area	A	1.00	mm²
Radiant Sensitive Area Dimensions	L x B	1 x 1	mm
Distance, Chip Surface to Case Surface	H	2.25 to 2.25	mm
Half Angle	φ	±40	Deg.
Dark Current (V_R=20 V)	I_R	1(≤5)	nA
Spectral Sensitivity (λ=850 nm)	S_λ	0.55	A/W
Quantum Yield (λ=850 nm)	η	0.80	electrons/photon
Open Circuit Voltage (E_v=1000 lx)	V_O	320(≥270)	mV
Short Circuit Current (E_V=1000 lx)	I_{SC}	10	μA
Rise and Fall Time of Photocurrent (R_L=50 Ω, V_R=5 V, λ=850 nm, I_P=800 μA)	t_R, t_F	12	ns
Forward Voltage (I_F=100 mA, E=0)	V_F	1.3	V
Capacitance (V_R=0 V, f=1 MHz, E=0)	C_0	11	pF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.2	%/K
Noise Equivalent Power (V_R=20 V, λ=850 nm)	NEP	3.3×10^{-14}	W/√Hz
Detection Limit (V_R=20 V, λ=850 nm)	D*	3.1×10^{12}	cm•√Hz/W

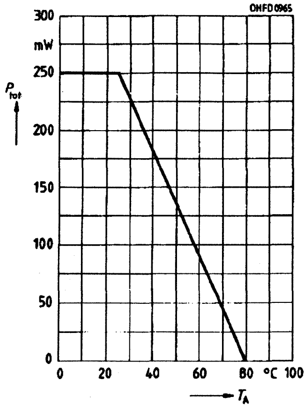
Relative spectral sensitivity $S_{REL}=f(\lambda)$



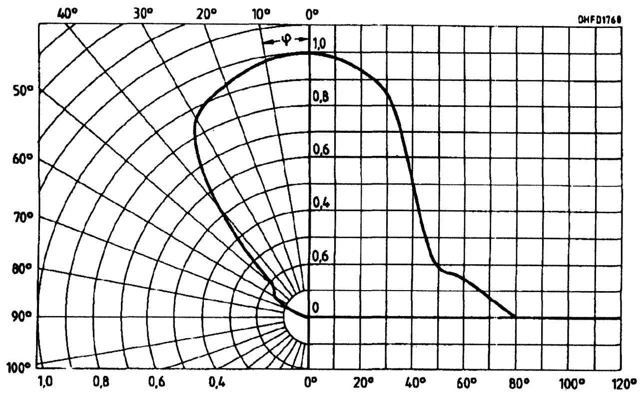
Photocurrent $I_P=f(E_V)$, $V_R=5$ V
Open circuit voltage $V_O=f(E_V)$



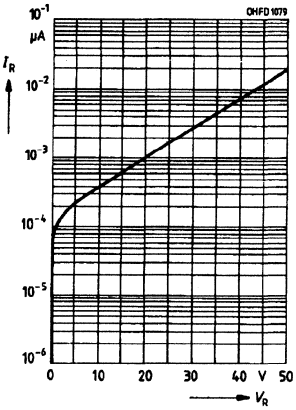
Power dissipation $P_{TOT}=f(T_A)$



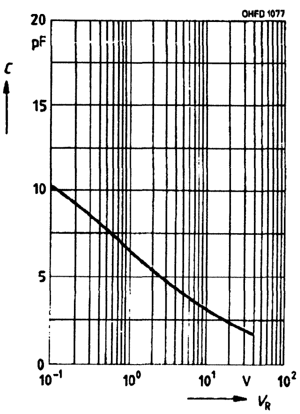
Directional characteristic $S_{REL}=f(\varphi)$



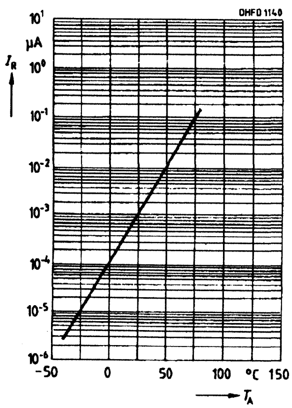
Dark current $I_R=f(V_R)$, E=0



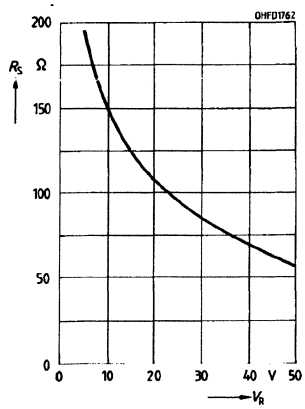
Capacitance $C=f(V_R)$, E=0, f=1 MHz



Dark current $I_R=f(T_A)$, E=0, $V_R=20$ V

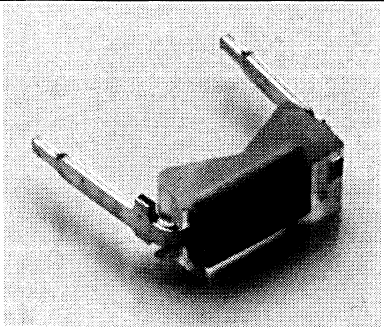


Series resistance $R_S=f(V_R)$, E=0, f=100 MHz



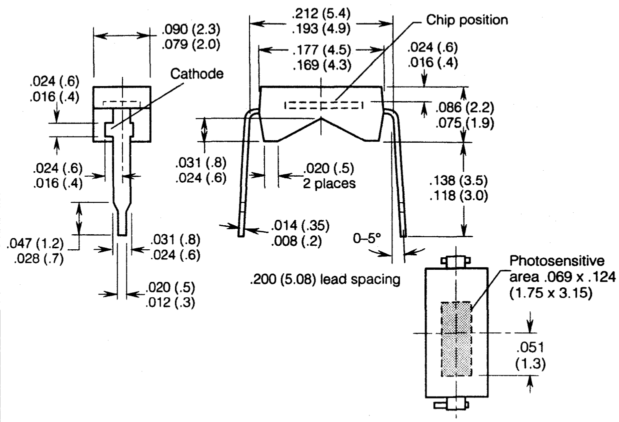
SIEMENS

BPX 90
DAYLIGHT FILTER BPX 90F
SILICON PLANAR PHOTODIODE



BPX 90

Package Dimensions in Inches (mm)



FEATURES

- **Silicon Planar Photodiode**
- **Package**
  - **BPX 90: Transparent Plastic**
  - **BPX 90F: Daylight Filter**
- **0.2" (5.08 mm) Spacing**
- **High Sensitivity**
  - **BPX 90: 45 nA/lx**
  - **BPX 90F: 13 µA**

DESCRIPTION

The BPX 90 and BPX 90F are silicon planar photodiodes. The BPX 90 is in a transparent plastic package. The BPX 90F is in a black plastic package with IR filter. Its terminals are soldering tabs with 0.2" (5.08 mm) lead spacing.

This versatile photodetector is suitable for diode as well as voltaic cell operation, providing an excellent signal/noise ratio, even at low light levels. The open circuit voltage at low light levels is higher than with comparable mesa photovoltaic cells.

Maximum Ratings

Operating and Storage Temperature Range
(T_{OP}, T_{STG}) .... –40° to +80°C

Soldering Temperature
(2 mm from case bottom) (T_S) t≤3 s .... 230°C

Reverse Voltage (V_R) .... 32 V

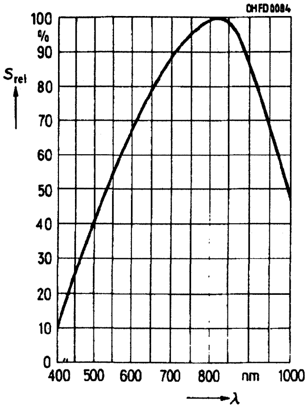
Power Dissipation (P_{TOT}) T_A=25°C .... 100 mW

Characteristics (T_A=25°C)

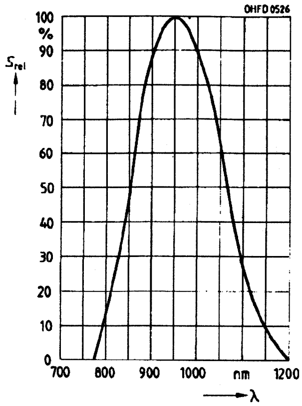
Parameter	Symbol	Value BPX90	Value BPX90F	Unit
Photosensitivity				
(V_R=5 V, Standard Light A, T=2856 K)	S	45(≥25)	–	nA/lx
(V_R=5 V, λ=950 nm, E_e=0.5 mW/cm²)	S	–	13(≥8)	µA
Maximum Photosensitivity Wavelength	λ_{Smax}	850	950	nm
Photosensitivity Spectral Range				
(S=10% of S_{MAX})	λ	400 to 1100	800 to 1150	nm
Radiant Sensitive Area	A	5.5	5.5	mm²
Radiant Sensitive Area Dimensions	L x W	1.75 x 3.15	1.75 x 3.15	mm
Distance, Chip Surface to Case Surface	H	0.5	0.5	mm
Half Angle	φ	±60	±60	Deg.
Dark Current (V_R=10 V)	I_R	5(≤200)	5(≤200)	nA
Spectral Photosensitivity (λ=950 nm)	S_λ	0.48	0.48	A/W
Quantum Yield (λ=950 nm)	η	0.62	0.62	electrons/photon
Open Circuit Voltage				
E_V=1000 lx, standard light A T=2856 K	V_L	450 (≥ 380)	–	mV
E_e=0.5 mW/cm², λ=950 nm	V_L	–	400(≥340)	mV
Short Circuit Current				
E_V=1000 lx, standard light A T=2856 K	I_K	45	–	µA
E_e=0.5 mW/cm², λ=950 nm	I_K	–	13	µA
Rise and Fall Time of Photocurrent (R_L=1 kΩ, V_R=5 V, λ=850 nm, I_P=30 µA)	t_R, t_F	1.3	1.3	µs
Forward Voltage (I_F=100 mA, E=0)	V_F	1.3	1.3	V
Capacitance (V_R=0 V, f=1 MHz, E=0)	C_0	430	430	pF
Temperature Coefficient V_0	TC_V	–2.6	–2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.18	0.2	%/K
Noise Equivalent Power (V_R=10 V)	NEP	8×10^{-14}	8×10^{-14}	W/√Hz
Detection Limit (V_R=10 V)	D*	2.9×10^{12}	2.9×10^{12}	cm•√Hz/W

Note
1. Illuminance shown refers to unfiltered radiation of tungsten filament lamp at color temperature of 2856 K (standard light A per DIN 5033 and IEC publication 306-1).

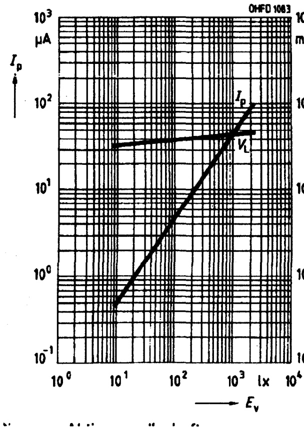
BPX 90
Relative spectral sensitivity $S_{REL}=f(\lambda)$



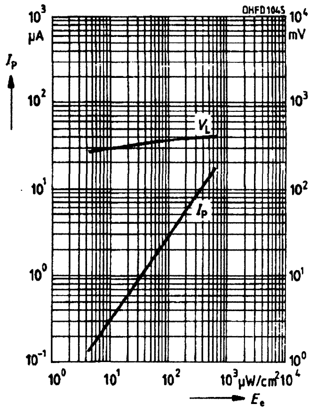
BPX 90F
Relative spectral sensitivity $S_{REL}=f(\lambda)$



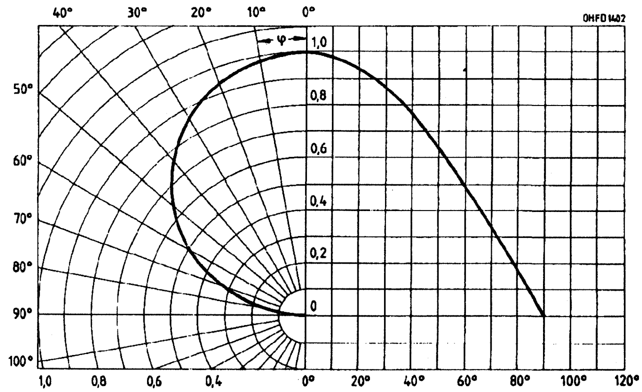
BPX 90
Photocurrent $I_P=f(E_V)$, $V_R=5$ V
Open current $V_O=f(E_V)$



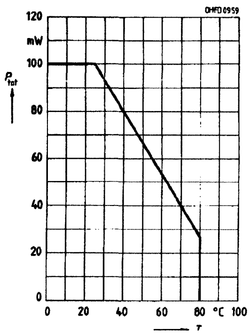
BPX 90F
Photocurrent $I_P=f(E_e)$, $V_R=5$ V
Open current $V_O=f(E_e)$



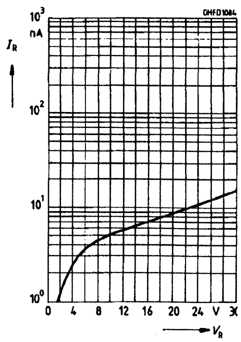
Directional characteristic $S_{REL}=f(\varphi)$



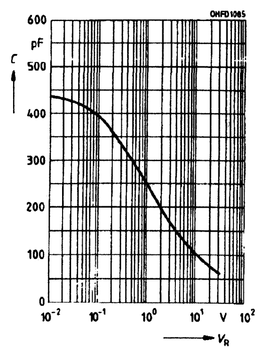
Power dissipation
$P_{TOT}=f(T_A)$



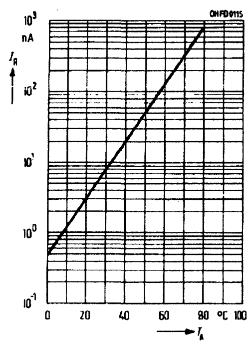
Dark current $I_R=f(V_R)$, E=0



Capacitance $C=f(V_R)$,
f=1 MHz, E=0



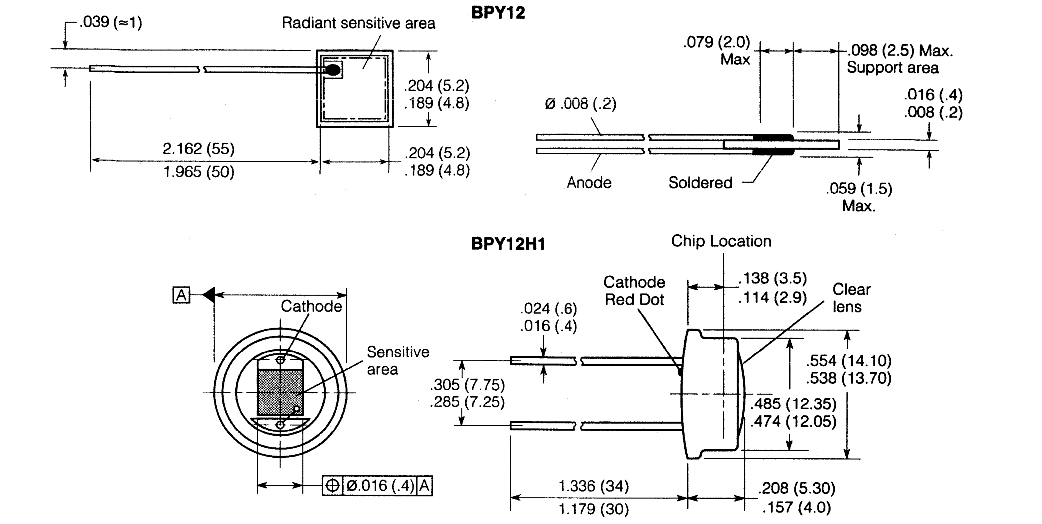
Dark current $I_R=f(T_A)$, $V_R=10$ V
E=0



SIEMENS

BPY 12
BPY 12H1
SILICON PIN PHOTODIODE

Package Dimensions in Inches (mm)



FEATURES

- **Package: Silicon Chip with Two Leads**
- **High Reliability**
- **No Testable Degradation**
- **High Packing Density**
- **High Open-Circuit Voltage as Photovoltaic Cells**
- **Short Switching Time**
- **High Spectral Sensitivity**
- **Wide Temperature Range**
- **Usage: Visible Light and Near Infrared Range**

DESCRIPTION

The BPY 12 is a silicon planar PIN photodiode. N-Si material provides positive front and negative back contact. These photodetectors can operate as reverse voltage photodiodes or as photovoltaic cells.

Applications include industrial electronics, measurement and control, and particle detection.

Maximum Ratings

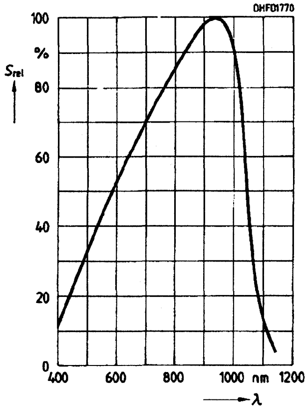
Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –55° to +100°C
Reverse Voltage (V_R) .... 20 V
Power Dissipation (P_{TOT}) T_A=25°C .... 150 mW

Characteristics (T_A=25°C)

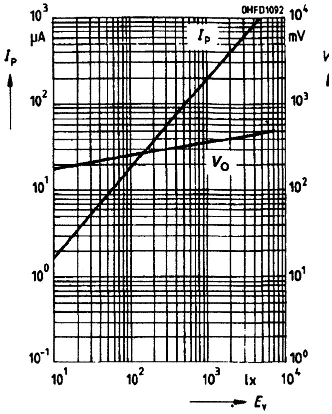
Parameter	Symbol	Value	Unit
Spectral Sensitivity (V_R=5 V, standard light A, T=2856 K)	S	180(≥100)	nA/lx
Maximum Photosensitivity Wavelength	λ_{Smax}	920	nm
Spectral Sensitivity Range (S=10% of S_{MAX})	λ	400 to 1100	nm
Radiant Sensitive Area	A	20	mm²
Radiant Sensitive Area Dimensions	L x W	4.47x 4.47	mm
Half Angle	φ	±60	Deg.
Dark Current (V_R=20 V)	I_R	10(≤100)	nA
Spectral Sensitivity (λ=850 nm)	S_λ	0.60	A/W
Quantum Yield (λ=850 nm)	η	0.86	electrons / photon
Open Circuit Voltage (E_v=1000 lx)(1)	V_O	365(≥310)	mV
Short Circuit Current (E_v=1000 lx)(1)	I_{SC}	180	µA
Rise and Fall Time of Photocurrent (R_L=50 Ω, V_R=5 V, λ=850 nm, I_P=800 µA)	t_R, t_F	25	ns
Forward Voltage (I_F=100 mA, E=0)	V_F	1.3	V
Capacitance (V_R=0 V, f=1 MHz, E=0)	C_0	140	pF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.15	%/K
Noise Equivalent Power (V_R=20 V, λ=850 nm)	NEP	9.4×10^{-14}	W/√Hz
Detection Limit (V_R=20 V, λ=850 nm)	D*	4.7×10^{12}	cm•√Hz/W

Note
1. Illuminance shown refers to unfiltered radiation of tungsten filament lamp at color temperature of 2856 K (standard light A per DIN 5033 and IEC publication 306-1).

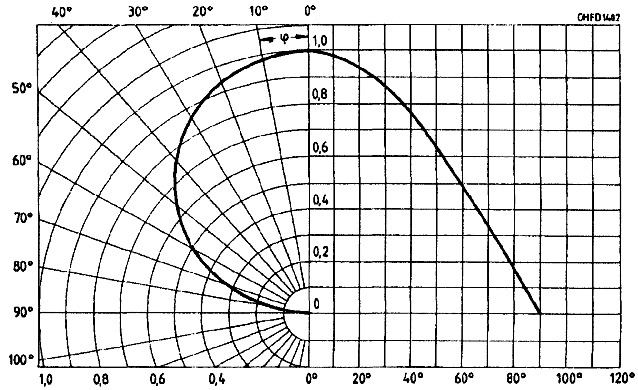
Relative spectral sensitivity $S_{REL}=f(\lambda)$



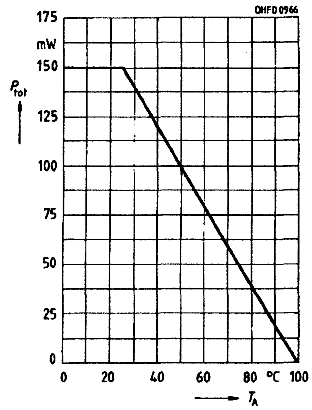
Photocurrent $I_P=f(E_V)$ $V_R=5$ V
Open circuit voltage $V_O=f(E_V)$



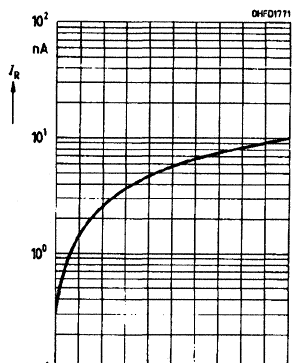
Directional characteristic $S_{REL}=f(\varphi)$



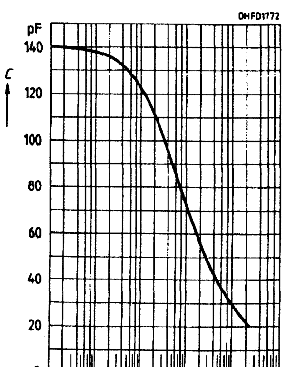
Power dissipation $P_{TOT}=f(T_A)$



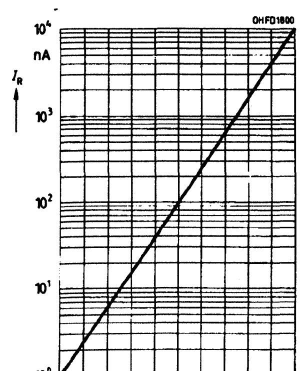
Dark current $I_R=f(V_R)$, E=0



Capacitance $C=f(V_R)$, f=1 MHz, E=0



Dark current $I_R=f(T_A)$, $V_R=20$ V, E=0



SIEMENS

KOM 2057 L

3-CHIP SILICON PIN PHOTODIODE ARRAY

FEATURES

- **Silicon Photodiode in Planar Technology**
- **N-Si Material**
  Anode, Front Contact
  Cathode, Back Contact
- **High Reliability**
- **High Packing Density**
- **No Testable Degradation**
- **Short Switching Time**
- **Low Capacitance**
- **High Spectral Sensitivity**
- **Wide Temperature Range**
- **Visible Light and Near Infrared Range Usage**
- **Package: Lead Frame, Transparent Epoxy Resin, Solder Tabs, Lead Spacing 7.62 mm**
- **Cathode Marking: Solder Tab Projection**
- **Applications**
  - **Scanning Arrays**
  - **Edge Detection**
  - **Path and Corner Scanning**
  - **Position Detection**
  - **Measurement and Control**

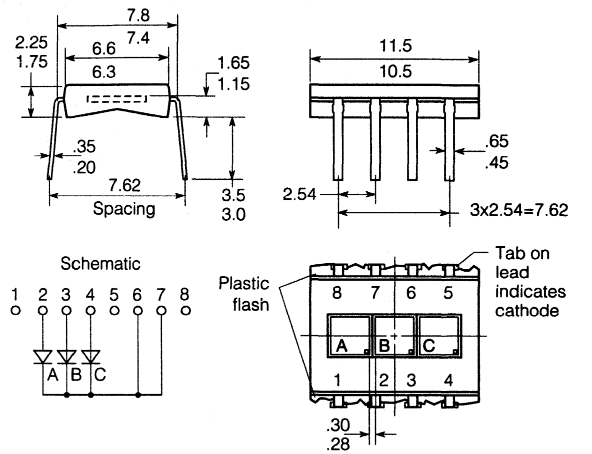
DESCRIPTION

The KOM 2057 L is a 3-chip photodiode array fabricated in planar technology. Rugged construction and large area photodiode chips result in a general purpose postion detector.

Maximum Ratings

Operating/Storage Temperature
Range (T_{OP}, T_{STG}) .... –40 + 80°C
Soldering Temperature,
2 mm from case bottom, t≤3 s .... 230°C
Reverse Voltage (V_R) .... 32 V
Power Dissipation (P_{TOT}) T_A=25°C ..... 150 mW

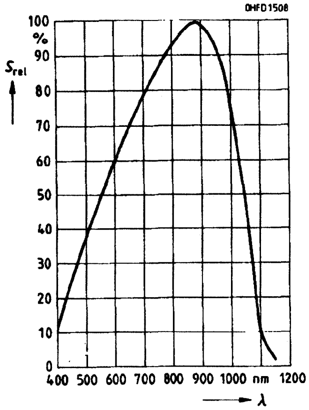
Package Dimensions in mm



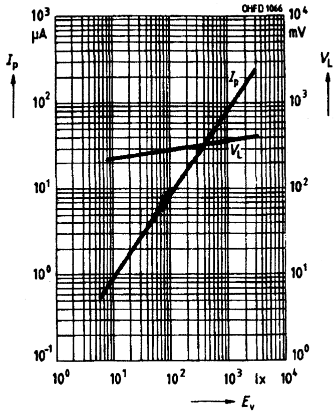
Characteristics, Single Segment (T_A=25°C, std. light A, T=2856 K)

Parameter	Symbol	Value	Unit
Spectral Sensitivity (V_R=5 V)	S	80(≥50)	nA/lx
Maximum Sensitivity Wavelength	λ_{Smax}	880	nm
Sensitivity, Spectral Range (S=10%, S_{max})	λ	400 –1100	nm
Radiant Sensitive Area	A	7	mm^2
Radiant Sensitive Area Dimension	LxW	2.65x2.65	mm
Chip Surface to Seal Surface Distance	H	0.4–0.6	mm
Half Angle	φ	±60	Deg.
Dark Current (V_R=10 V)	I_R	2 (≤30)	nA
Spectral Sensitivity (λ=850 nm)	Sλ	0.62	A/W
Quantum Yield	η	0.90	Electrons / Photons
Maximum Spectral Sensitivity Tolerance	ΔS	±10	%
Short Circuit Current (E_V=1000 lx)	I_{SC}	80	μA
Open-Circuit Voltage (E_V=1000 lx)	V_O	365 (≥300)	mV
Rise and Fall Time, Photocurrent (R_L=50 Ω, V_R=10 V, λ=850 nm, I_P=800 μA)	t_R, t_F	14	ns
Forward Voltage (I_F=100 mA, E=0)	V_F	1.3	V
Capacitance (V_R=0 V, f=1 MHz, E=0)	C_O	72	pF
Temperature Coefficient, V_O	TC_V	–2.6	mV/K
Temperature Coefficient, I_{SC}	TC_I	0.18	%/K
Noise Equivalent Power (V_R=10 V, λ=850 nm)	NEP	4.1×10^{-14}	$\frac{W}{\sqrt{Hz}}$
Detection Limit (V_R=10 V, λ=850 nm)	D*	6.6×10^{12}	$\frac{cm\cdot\sqrt{Hz}}{W}$

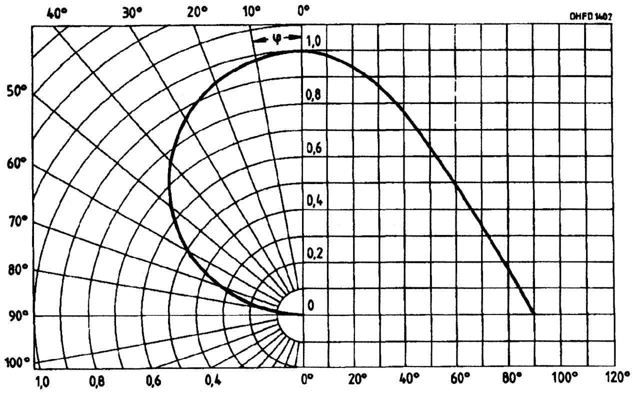
Relative spectral sensitivity
Srel=f(λ)



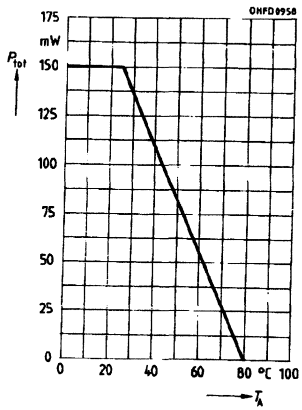
Photocurrent, $I_P=f(E_V)$, $V_R=5$ V
Open circuit voltage, $V_O=f(E_V)$



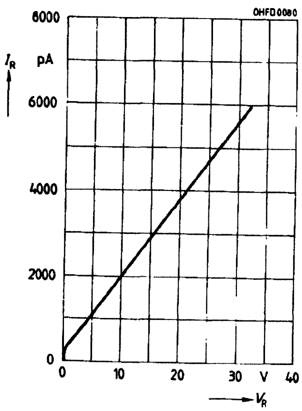
Directional characteristics
$S_{rel}=f(\varphi)$



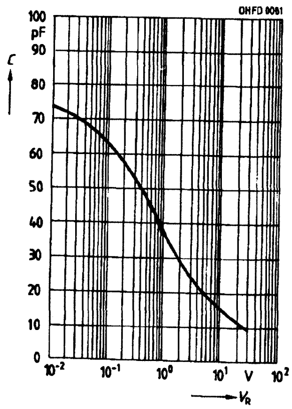
Power dissipation
$P_{TOT}=f(T_A)$



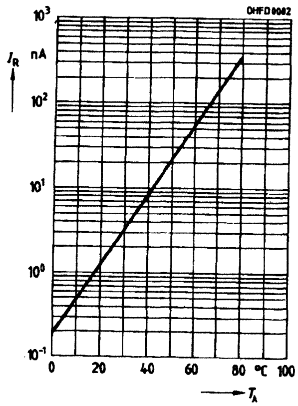
Dark current, $I_R=f(V_R)$, E=0



Capacitance, $C=f(V_R)$, f=1 MHz, E=0



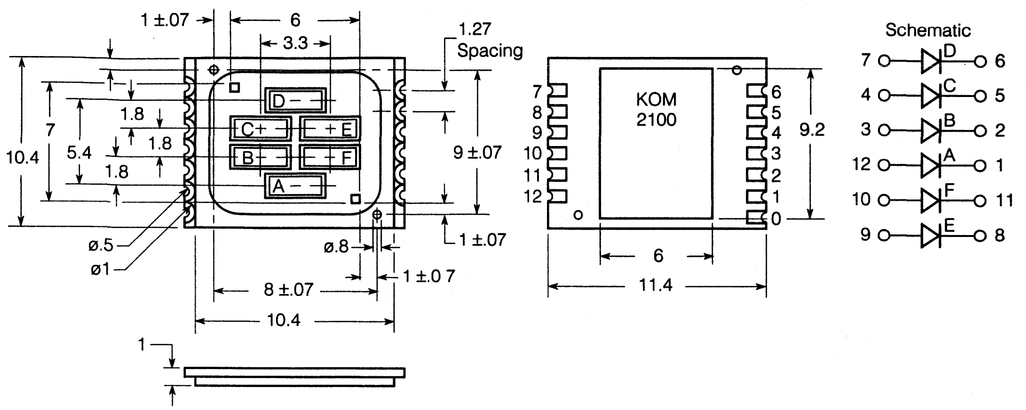
Dark current, $I_R=f(T_A)$, $V_R=10$ V, E=0



SIEMENS

KOM 2100 B
DAYLIGHT FILTER KOM 2100 BF
6-CHIP SILICON PIN PHOTODIODE ARRAY

Package Dimensions in mm



FEATURES

- **Silicon Photodiode in Planar Technology**
- **N-Si Material**
  Anode, Front Contact
  Cathode, Back Contact
- **High Reliability**
- **No Testable Degradation**
- **Short Switching Time**
- **Low Capacitance**
- **High Spectral Sensitivity**
- **Wide Temperature Range**
- **Visible Light and Near Infrared Range Usage (B Version)**
- **Daylight Filter (BF Version)**
- **Package: PC Board with Solder Lugs, with Clear or Black Epoxy Seal, Suitable for SMD**
- **Application: Shaft Encoders, Position Detection**

DESCRIPTION

These devices are 6-chip photodiode arrays fabricated in planar technology with low reverse current. The N-Si material used results in a positive front and negative back contact. These photodetectors are suitable for diode operation (with reverse voltage) as well as for photo-element operation.

The package consists of a PC board with solder lugs and a clear epoxy seal. See drawing for cathode marking.

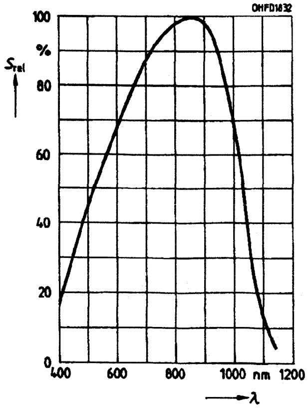
Maximum Ratings

Operating/Storage Temperature Range (T_{OP}, T_{STG}) .... –40 to +80°C
Reverse Voltage (V_R) .... 20 V
Power Dissipation (P_{TOT}) T_A=25°C .... 150 mW

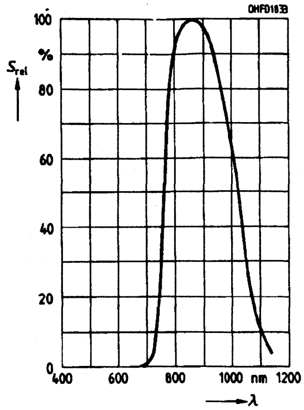
Characteristics, Single Segment (T_A=25°C, λ=950 nm)

Parameter	**Symbol**	**Value**	**Unit**
Spectral Sensitivity			
(V_R=5 V, E_e=0.5 mW/cm^2)			
2100B	S	9 (≥7)	μA
2100BF	S	8.5 (≥6.6)	μA
Maximum Sensitivity Wavelength	λ_{Smax}	870	nm
Sensitivity, Spectral Range			
(S=10%, S_{max})			
2100B	λ	400 – 1100	nm
2100BF	λ	730 – 1100	nm
Radiant Sensitive Area	A	2.5	mm^2
Radiant Sensitive Area Dimension	LxW	1x2.5	mm
Chip Surface to Seal Surface Distance	H	0.4–0.6	mm
Half Angle	φ	±60	Deg.
Dark Current (V_R=10 V)	I_R	1 (≤10)	nA
Spectral Sensitivity (λ=850 nm)			
2100B	Sλ	0.68	A/W
2100BF	Sλ	0.64	A/W
Quantum Yield			
2100B	η	0.9	Electrons
2100B	η	0.85	Photon
Maximum Spectral Sensitivity Tolerance	ΔS	± 10	%
Short Circuit Current (E_e=0.5 mW/cm^2)			
2100B	I_{SC}	8.5	μA
2100BF	I_{SC}	8	μA
Open-Circuit Voltage (E_e=0.5 mW/cm^2)	V_O	320 (≥250)	mV
Rise and Fall Time, Photocurrent			
(R_L=50 Ω, V_R=10 V, λ=850 nm,			
I_P=800 μA)	t_R, t_F	13	ns
Forward Voltage (I_F=100 mA, E=0)	V_F	1.2	V
Capacitance, Chip			
(V_R=0 V, f=1 MHz, E=0)	C_O	25	pF
Temperature Coefficient, V_O	TC_V	–2.6	mV/K
Temperature Coefficient, I_{SC}	TC_I	0.18	%/K
Noise Equivalent Power (V_R=10 V)			
2100B	NEP	2.6×10^{-14}	W
2100BF	NEP	2.8×10^{-14}	√Hz
Detection Limit (V_R=10 V, λ=850 nm)			
2100B	D*	6.1×10^{12}	cm•√Hz
2100BF	D*	5.7×10^{12}	W

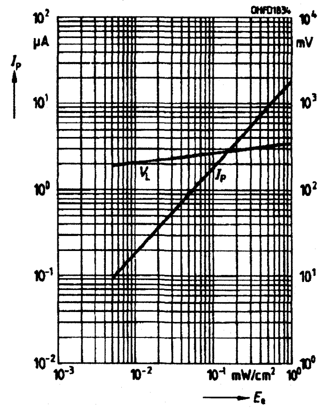
Relative spectral sensitivity
Srel=f(λ)



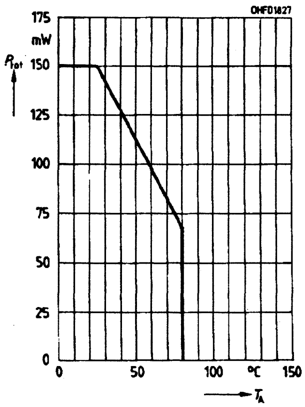
Relative spectral sensitivity
Srel=f(λ)



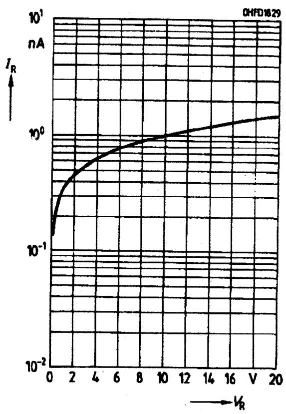
Photocurrent, $I_P=f(E_e)$, $V_R=5$ V
Open circuit voltage, $V_O=f(E_e)$



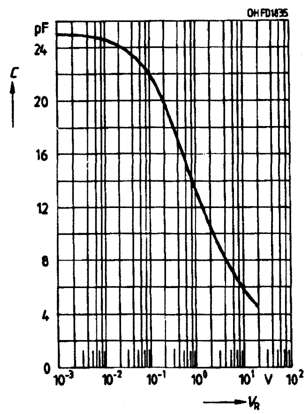
Power dissipation
$P_{TOT}=f(T_A)$



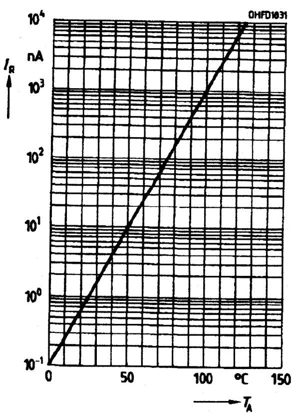
Dark current, $I_R=f(V_R)$, E=0



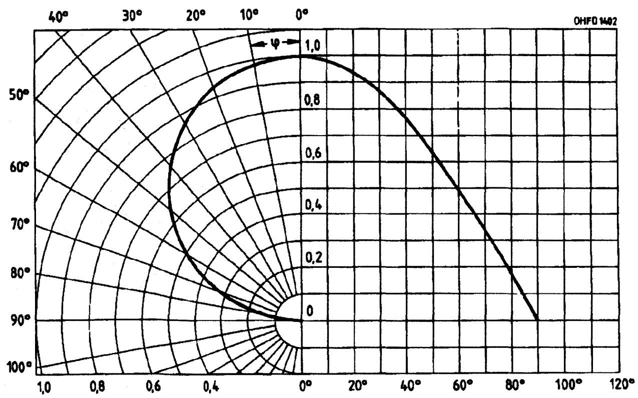
Capacitance, $C=f(V_R)$, f=1 MHz, E=0



Dark current, $I_R=f(T_A)$, $V_R=10$ V, E=0



Directional characteristics $S_{REL}=f(φ)$



SIEMENS

KOM2108
5 x 5 SILICON PIN PHOTODIODE ARRAY

FEATURES
- **Usable in the Visible and Near Infrared Range**
- **Low Noise**
- **Short Switching Time (10 ns, typical)**
- **Every Diode Can Be Activated**

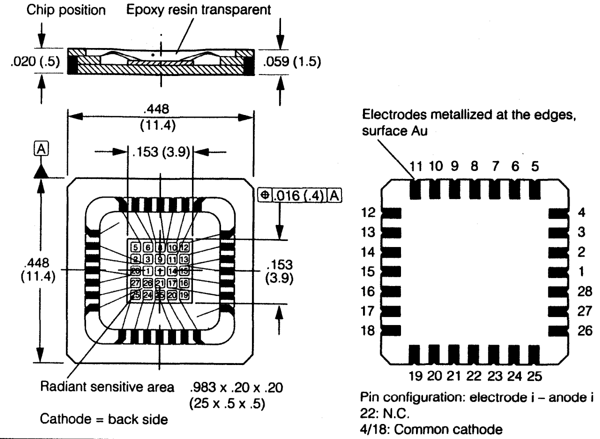
APPLICATIONS
- **Universal PCB for Two-dimensional Resolution**
- **Follow-up Controls**
- **Positioning**
- **Path and Corner Scanning**
- **Industrial Electronics**
- **Drive and Control Circuits**

DESCRIPTION
Description text

Maximum Ratings

Operating and Storage Temperature
Range (T_{OP}, T_{STG}) .... –40 to +80°C
Reverse Voltage (V_R) .... 20 V
Total Power Dissipation per Single
Diode (P_{TOT}) T_A=25°C .... 30 mW

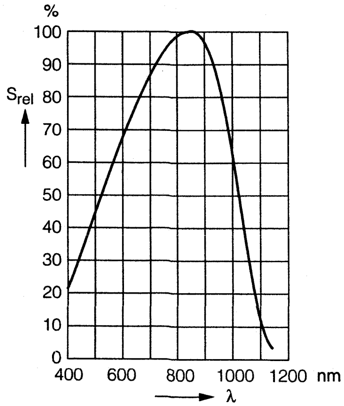
Package Dimensions in inches (mm)



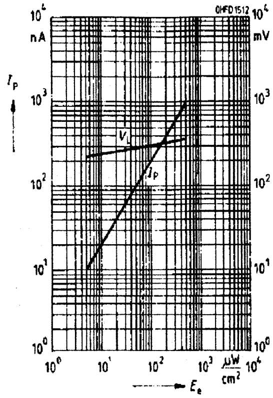
Characteristics (T_A=25°C, λ=950 nm)

Parameter	Symbol	Value	Unit
Spectral Sensitivity (V_R=5 V, E_e=0.5 mW/cm^2)	S	1.1 (≥0.8)	µA
Wavelength, Maximum Sensitivity	λ_{Smax}	850	nm
Sensitivity, Spectral Range (S=10% of S_{MAX})	λ	380 to 1100	nm
Radiant Sensitive Area	A	0.3	mm^2
Radiant Sensitive Area, Dimension	L x W	0.56 x 0.56	mm
Distance, Chip Front to Case Seal	H	0.6 to 0.9	mm
Half Angle	φ	±60	Deg.
Dark Current (V_R=10 V)	I_R	0.05(≤1)	nA
Spectral Sensitivity	S_λ	0.59	A/W
Spectral Sensitivity, Maximum Deviation from Average	ΔS	±10	%
Quantum Yield	η	0.77	electrons/photon
Open Circuit Voltage (E_e=0.5 mW/cm^2)	V_L	360(≥320)	mV
Short Circuit Current (E_e=0.5 mW/cm^2)	I_{SC}	1	µA
Rise and Fall Time, Photocurrent (R_L=50 Ω, V_R=10 V, λ=850 nm, I_P=800 µA)	t_R, t_F	10	ns
Forward Voltage (I_F=100 mA, E=0)	V_F	1.3	V
Capacitance (V_R=0 V, f=1 MHz, E=0)	C_0	13	pF
Temperature Coefficient V_L	TC_V	–2.6	mV/K
Temperature Coefficient I_P	TC_I	0.2	%/K
Noise Equivalent Power (V_R=10 V)	NEP	6.5 x 10^{-15}	W/√Hz
Detection Limit (V_R=10 V)	D*	8.4 x 10^{12}	cm•√Hz/W

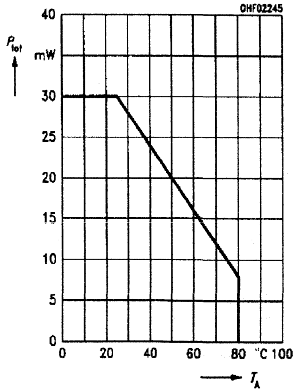
Relative spectral sensitivity $S_{REL}=f(\lambda)$



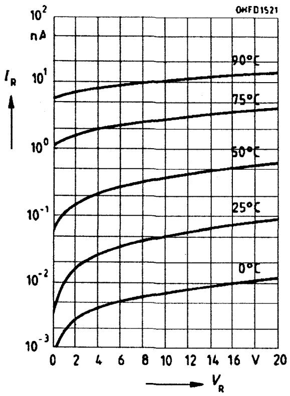
Photocurrent $I_P=f(E_E)$ $V_R=5$ V
Open circuit voltage $V_L=f(E_E)$



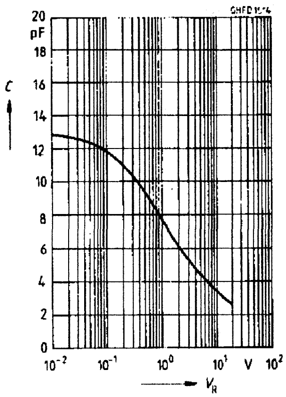
Total power dissipation $P_{tot}=f(T_A)$



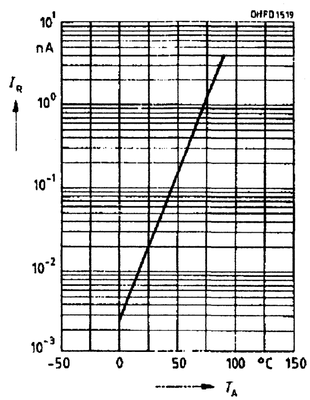
Dark current $I_R=f(V_R)$, E=0



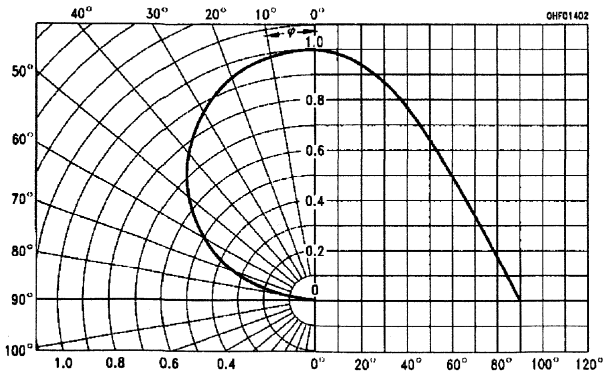
Capacitance $C=f(V_R)$, f=1 MHz, E=0



Dark current $I_R=f(T_A)$, $V_R=10$ V, E=0



Directional characteristics $S_{REL}=f(\varphi)$



SIEMENS

KOM2125
2 CHIP SILICON PIN PHOTODIODE SURFACE MOUNT PACKAGE

FEATURES
- **Suitable for Applications from 400 nm to 1100 nm**
- **Short Switching Time (25 ns, typical)**
- **Suitable for Surface Mount**

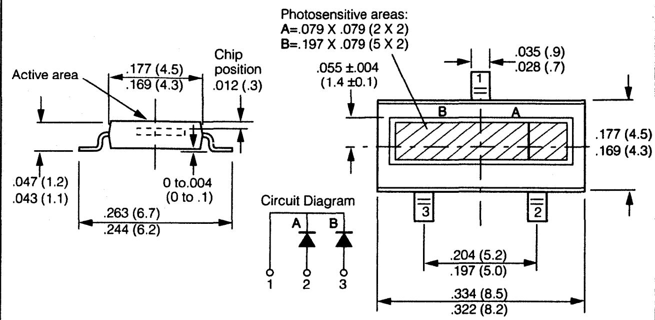
APPLICATIONS
- **Follow-up Controls**
- **Edge Drives**
- **Industrial Electronics**
- **Drive and Control Circuits**

DESCRIPTION
Description text

Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –40 TO +80°C
Reverse Voltage (V_R) .... 60 V
Total Power Dissipation (P_{TOT}) T_A=25°C .... 150 mW

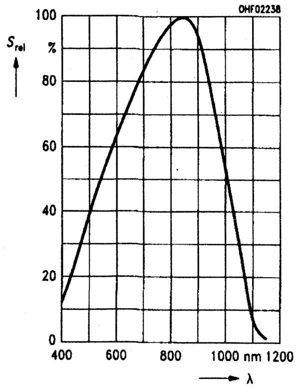
Package Dimensions in inches (mm)



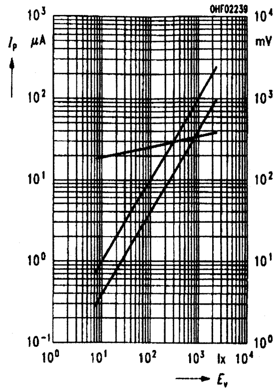
Characteristics (T_A=25°C, Standard Light A, 2856 K)

Parameter	Symbol	Value	Unit
Spectral Sensitivity (V_R=5 V) Diode A Diode B	S	 40 (≥30) 100 (≥75)	nA/lx
Wavelength, Maximum Sensitivity	λ_{Smax}	850	nm
Sensitivity, Spectral Range (S=10% of S_{MAX})	λ	400 to 1100	nm
Radiant Sensitive Area Diode A Diode B	A	 4 10	mm^2
Radiant Sensitive Area, Dimension	L x W	2 x 2, 2 x 5	mm x mm
Distance, Chip Front to Case Seal	H	0.3 to 0.35	mm
Half Angle	φ	±60	Deg.
Dark Current (V_R=10 V) Diode A Diode B	I_R	 5(≤30) 10(≤30)	nA
Spectral Sensitivity	S_λ	0.62	A/W
Quantum Yield	η	0.90	electrons / photon
Open Circuit Voltage (E_V=1000 lx)	V_L	350(≥300)	mV
Short Circuit Current (E_V=1000 lx) Diode A Diode B	I_{SC}	 38 95	µA
Rise and Fall Time (R_L=50 Ω, V_R=5 V, λ=850 nm, I_P=800 µA) Diode A Diode B	t_R, t_F	 18 25	ns
Forward Voltage (I_F=100 mA, E=0)	V_F	1.0	V
Capacitance (V_R=5 V, f=1 MHz, E=0) Diode A Diode B	C_0	 40 100	pF
Temperature Coefficient V_L	TC_V	–2.6	mV/K
Temperature Coefficient I_P	TC_I	0.18	%/K
Noise Equivalent Power (V_R=10 V) Diode A Diode B	NEP	 6.4×10^{-14} 9.1×10^{-14}	$W/\sqrt{Hz}$
Detection Limit (V_R=10 V) Diode A Diode B	D*	 3.1×10^{12} 3.5×10^{12}	$cm \cdot \sqrt{Hz}/W$

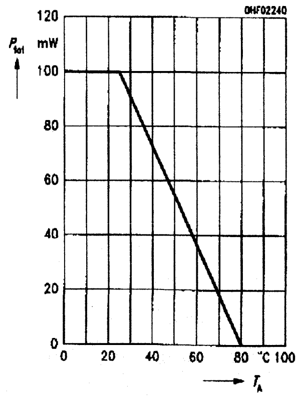
Relative spectral sensitivity $S_{REL}=f(\lambda)$



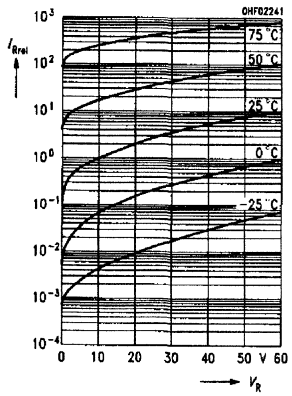
Photocurrent $I_P=f(E_E)$ $V_R=5$ V
Open circuit voltage $V_L=f(E_E)$



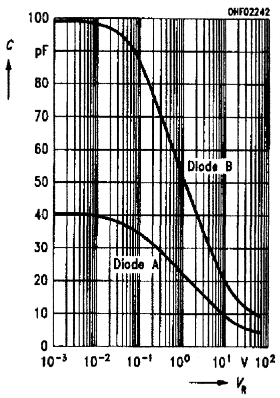
Total power dissipation
$P_{tot}=f\ (T_A)$



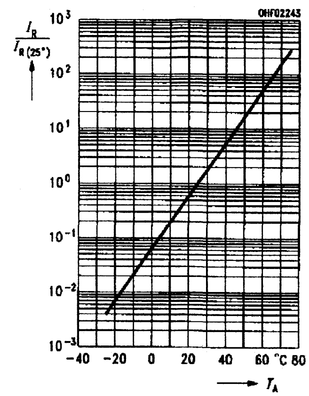
Dark current $I_R=f(V_R)$, E=0



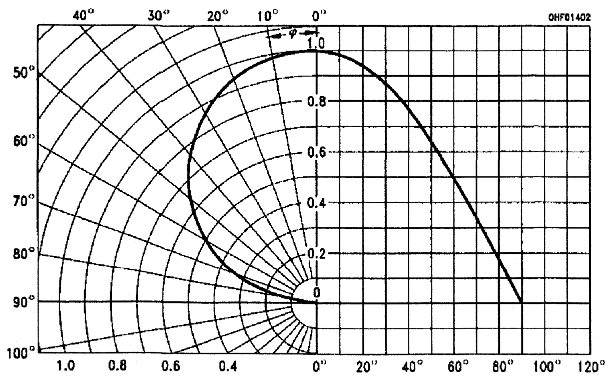
Capacitance $C=f(V_R)$,f=1 MHz, E=0



Dark current $I_R=f(T_A)$, $V_R=10$ V, E=0



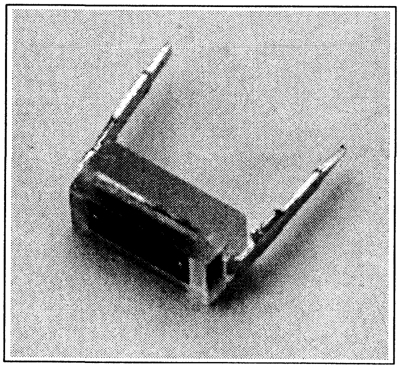
Directional characteristics $S_{REL}=f(\varphi)$



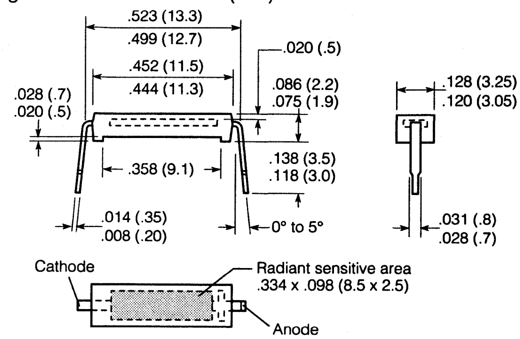
Photodiodes
8

SIEMENS

SFH 100
SILICON PHOTODIODE
HIGH BLUE SENSITIVITY



Package Dimensions in Inches (mm)



FEATURES

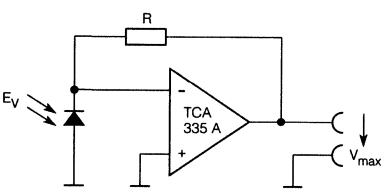
- **High Blue Sensitivity**
- **High Reliability**
- **Low Noise**
- **Transparent Plastic Package**
- **Low Dark Current**
- **Wide Temperature Range**

DESCRIPTION

The SFH 100 silicon planar photodiode is suitable for universal applications, particularly with small reverse voltage (approximately 0.1 V) for detecting very limited light levels.

The component comes in a transparent plastic package with solder tabs spaced at 0.500" (12.7 mm).

Switching Applications



Use operational amplifier with small input current.

Maximum Ratings

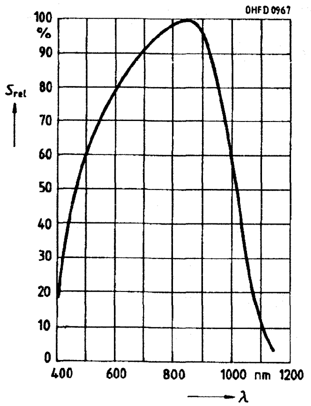
Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –40° to +80°C
Soldering Temperature (≥2 mm from case bottom) (T_S) t≤3 s .... 230°C
Reverse Voltage (V_R) .... 7 V
Power Dissipation (P_{TOT}) T_A=25°C .... 100 mW

Characteristics (T_A=25°C)

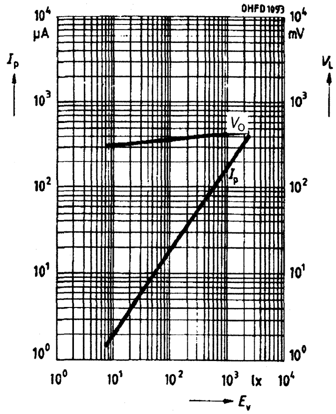
Parameter	Symbol	Value	Unit
Photosensitivity (V_R=5 V, Standard Light A, T=2856 K)	S	175	nA/lx
Maximum Photosensitivity Wavelength	λ_{Smax}	850	nm
Photosensitivity Spectral Range (S=10% of S_{MAX})	λ	350 to 1100	nm
Radiant Sensitive Area	A	21.2	mm^2
Radiant Sensitive Area Dimensions	L x W	8.5 x 2.5	mm
Distance, Chip Surface to Case Surface	H	0.5	mm
Half Angle	φ	±60	Deg.
Dark Current (V_R=7 V)	I_R	0.4(≤10)	nA
Spectral Sensitivity (λ=400 nm)	S_λ	0.2	A/W
Quantum Yield (λ=400 nm)	η	0.62	electrons / photon
Open Circuit Voltage (E_V=1000 lx) (1)	V_O	430	mV
Short Circuit Current (E_e=0.5 mW/cm², λ=400 nm))	I_{SC}	21(≥15)	µA
Rise and Fall Time of Photocurrent (R_L=1 kΩ, V_R=5 V, λ=850 nm, I_P=200 µA)	t_R, t_F	1.8	µs
Forward Voltage (I_F=100 mA, E=0)	V_F	1.3	V
Capacitance (V_R=0 V, f=1 MHz, E=0)	C_0	1000	pF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.2	%/K
Noise Equivalent Power (V_R=7 V, λ=400 nm)	NEP	5.7×10^{-14}	W/√Hz
Detection Limit (V_R=7 V, λ=400 nm)	D*	8.1×10^{13}	cm•√Hz/W

Note
1. Illuminance shown refers to unfiltered radiation of tungsten filament lamp at color temperature of 2856 K (standard light A per DIN 5033 and IEC publication 306-1).

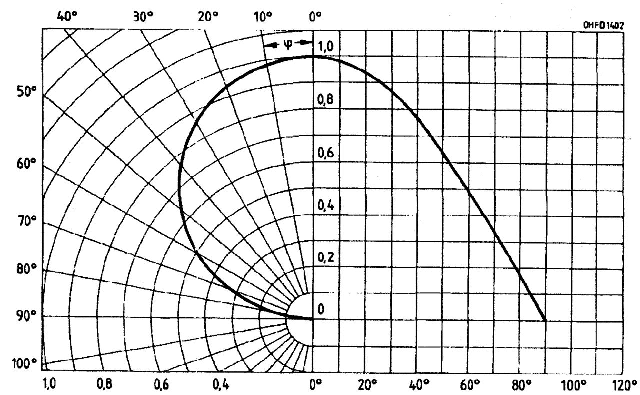
Relative spectral sensitivity $S_{REL}=f(\lambda)$



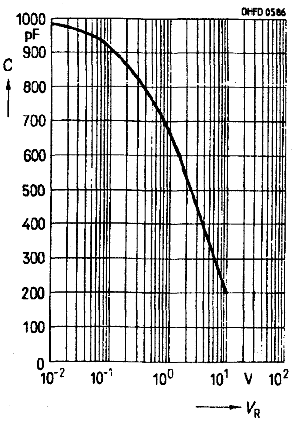
Photocurrent $I_P=f(E_V)$, $V_R=5$ V
Open circuit voltage $V_O=f(E_V)$



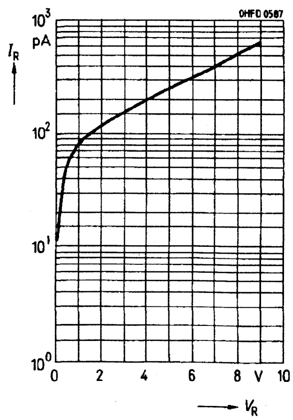
Directional characteristic $S_{REL}=f(\varphi)$



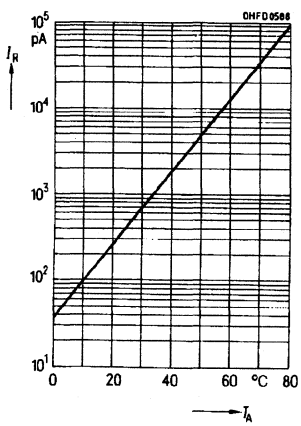
Capacitance $C=f(V_R)$, f=1 MHz, E=0



Dark current $I_R=f(V_R)$, E=0

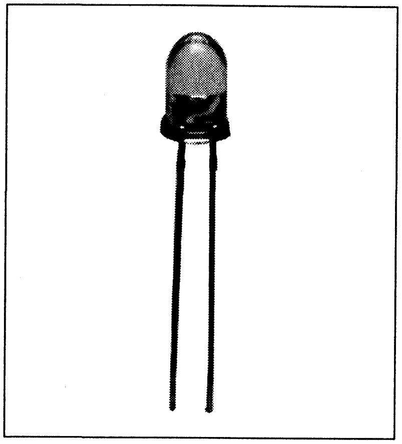


Dark current $I_R=f(T_A)$, $V_R=7$ V, E=0

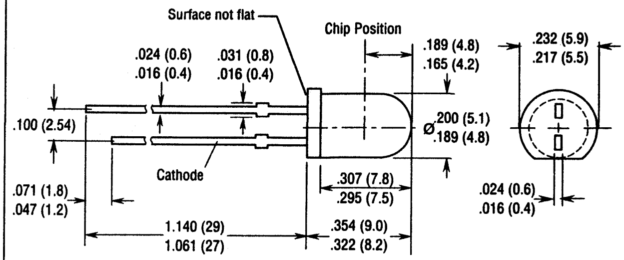


SIEMENS

*SFH 203
DAYLIGHT FILTER **SFH 203FA
SILICON PIN PHOTODIODE



Package Dimensions in Inches (mm)



FEATURES

- **High Reliability**
- **Low Noise**
- **High Open Circuit Voltage as Photo-voltaic Cells**
- **Short Switching Time**
- **High Spectral Sensitivity**
- **Wide Temperature Range**
- **Low Capacitance**
- **Usage: Visible and Near IR Ranges**
- **Clear Plastic Lens (SFH 203)**
- **Daylight Filter Option (SFH 203FA)**

DESCRIPTION

SFH 203 and SFH 203FA are silicon planar PIN photodiodes in T1 3/4 packages. They can be used as photodiodes with reverse voltage, or as photovoltaic cells. The terminals are solder tabs with 0.1" (2.54 mm) lead spacing.

Applications include industrial electronics, light-activated switches, fiber optic transmission systems, and measurement and control.

Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –55° to +100°C
Soldering Temperature (2 mm from case bottom) (T_s) t≤3 s .... 300°C
Reverse Voltage (V_R) .... 50 V
Power Dissipation (P_{TOT}) T_A=25°C ..... 100 mW

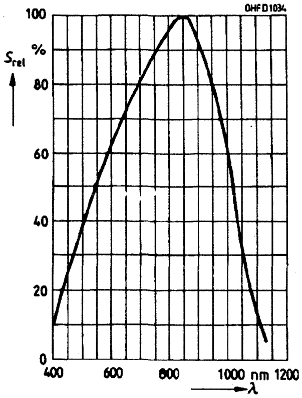
***Formerly SFH2030, **formerly SFH2030F**

Characteristics (T_A=25°C)

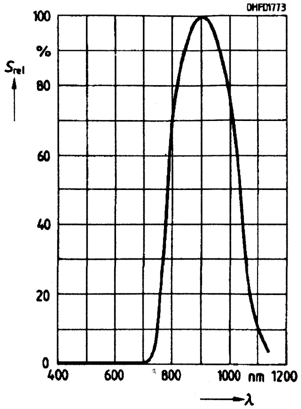
Parameter	Symbol	Value SFH203	Value SFH203FA	Unit
Photosensitivity				
(V_R=5 V, Standard Light A, T=2856 K)	S	80(≥50)		nA/lx
(V_R=5 V, λ=950 nm, E_e=1 mW/cm²)	S		50(≥30)	µA
Maximum Photosensitivity Wavelength	λ_{Smax}	850	900	nm
Photosensitivity Spectral Range				
(S=10% of S_{MAX})	λ	400 to 1100	800 to 1100	nm
Radiant Sensitive Area	A	1	1	mm²
Radiant Sensitive Area Dimensions	L x W	1 x 1	1 x 1	mm
Distance, Chip Surface to Case Surface	H	4.0 to 4.6	4.0 to 4.6	mm
Half Angle	φ	±20	±20	Deg.
Dark Current (V_R=20 V)	I_R	1(≤5)	1(≤5)	nA
Spectral Sensitivity (λ=850 nm)	S_λ	0.62	0.59	A/W
Quantum Yield (λ=850 nm)	η	0.89	0.86	electrons / photon
Open Circuit Voltage				
(E_V=1000 lx)(1)	V_O	420(≥350)		mV
(E_e=0.5 mW/cm², λ=950 nm)	V_O		370(≥300)	mV
Short Circuit Current				
(E_V=1000 lx)(1)	I_{SC}	80		µA
(E_e=0.5 mW/cm², λ=950 nm)	I_{SC}		25	µA
Rise and Fall Time of Photocurrent				
(R_L=50 Ω, V_R=20 V, λ=850 nm, I_P=800 µA)	t_R, t_F	5	5	ns
Forward Voltage (I_F=80 mA, E=0)	V_F	1.3	1.3	V
Capacitance				
(V_R=0 V, f=1 MHz, E=0)	C_O	11	11	pF
Temperature Coefficient V_O	TC_V	–2.6	–2.6	mV/K
Temperature Coefficient I_{SC}				
(Standard Light A)	TC_I	0.18		%/K
Temperature Coefficient I_{SC}				
(λ=950 nm)	TC_I		0.2	%/K
Noise Equivalent Power				
(V_R=20 V, λ=850 nm)	NEP	2.9 x10⁻¹⁴	2.9 x10⁻¹⁴	W/√Hz
Detection Limit				
(V_R=20 V, λ=850 nm)	D*	3.5 x10¹²	3.5 x10¹²	cm•√Hz/W

Note
1. Illuminance shown refers to unfiltered radiation of tungsten filament lamp at color temperature of 2856 K (standard light A per DIN 5033 and IEC publication 306-1).

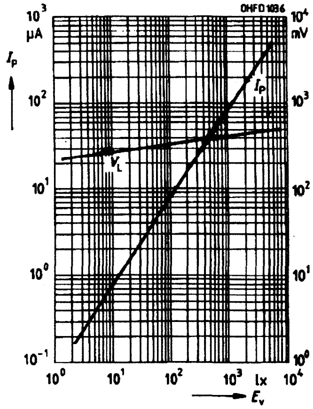
SFH 203
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



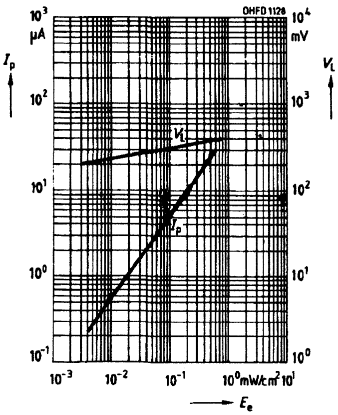
SFH 203FA
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



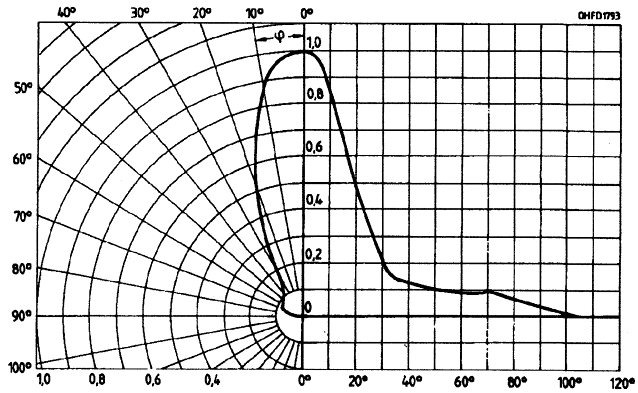
SFH 203
Photocurrent $I_P=f(E_V)$ $V_R=5$ V
Open circuit voltage $V_O=f(E_V)$



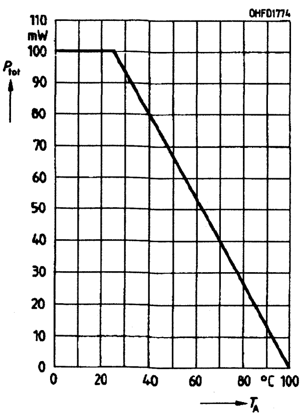
SFH 203FA
Photocurrent $I_P=f(E_e)$ $V_R=5$ V
Open circuit voltage $V_O=f(E_e)$



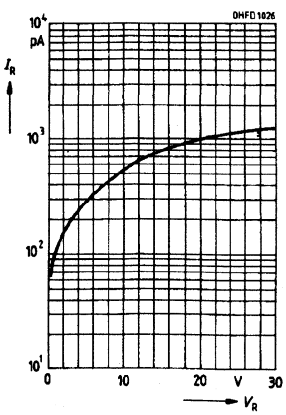
Directional characteristic $S_{REL}=f(\varphi)$



Power dissipation $P_{TOT}=f(T_A)$



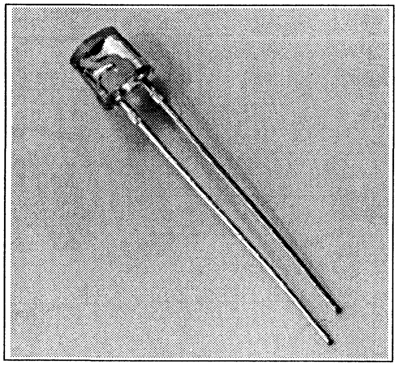
Dark current $I_R=f(V_R)$, E=0



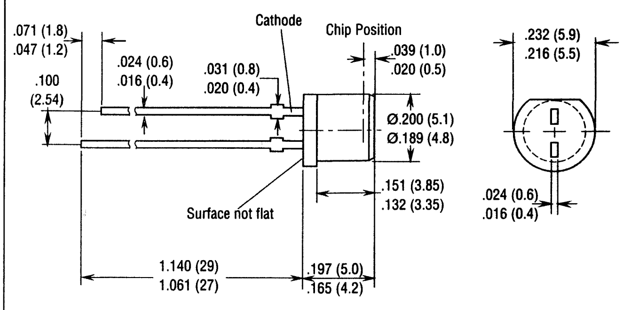
Photodiodes 8

SIEMENS

*SFH 203P
DAYLIGHT FILTER **SFH 203PFA
SILICON PIN PHOTODIODE



Package Dimensions in Inches (mm)



FEATURES

- Silicon Planar PIN Photodiode
- High Speed
- T1 3/4 Package
- Cost Effective
- Flat Top
- IR Filter (SFH 203PFA)

DESCRIPTION

The SFH 203P and SFH 203PFA are planar PIN photodiodes in a plastic T1 3/4 package with a flat lens. This flat window has no affect on the beam path of optical lens systems. The cathode is denoted by a shorter lead.

Features include low junction capacitance and fast switching speeds.

Because of its high cutoff frequency, this diode is particularly well-suited for use as a high-modulation bandwidth optical sensor.

Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –55° to +100°C
Soldering Temperature (2 mm from case bottom) .... (T_s) t≤3 s300°C
Reverse Voltage (V_R) .... 50 V
Power Dissipation (P_{TOT}) T_A=25°C .... 100 mW

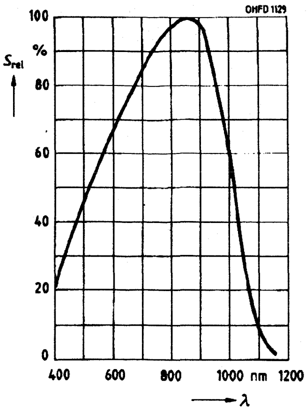
Characteristics (T_A=25°C)

Parameter	Symbol	Value 203P	203PFA	Unit
Photosensitivity				
(V_R=5 V, Standard Light A, T=2856 K)	S	9.5(≥5)	–	nA/lx
(V_R=5 V, λ=950 nm, E_e=1 mW/cm²)	S	–	6.2(≥3.6)	μA
Maximum Photosensitivity Wavelength	λ_{Smax}	850	900	nm
Photosensitivity Spectral Range				
(S=10% of S_{MAX})	λ	400 to 1100	750 to 1100	nm
Radiant Sensitive Area	A	1	1	mm²
Radiant Sensitive Area Dimensions	L x W	1 x 1	1 x 1	mm
Distance, Chip Surface to Case Surface	H	0.4 to 0.7	0.4 to 0.7	mm
Half Angle	φ	±75	±75	Deg.
Dark Current (V_R=20 V, E=0)	I_R	1(≤10)	1(≤10)	nA
Spectral Sensitivity (λ=850 nm)	S_λ	0.62	0.59	A/W
Quantum Yield				electrons
(Electrons per Photon) (λ=850 nm)	η	0.89	0.86	photon
Open Circuit Voltage				
E_V=1000 lx, standard light A T=2856 K	V_L	350 (≥ 300)	–	mV
E_e=0.5 mW/cm², λ=950 nm	V_L	–	300(≥250)	mV
Short Circuit Current				
E_V=1000 lx, standard light A T=2856 K	I_K	9.3	–	μA
E_e=0.5 mW/cm², λ=950 nm	I_K	–	3.0	μA
Rise and Fall Time of Photocurrent				
(R_L=50 Ω, V_R=20 V, λ=850 nm, I_P=800 μA)	t_R, t_F	5	5	ns
Forward Voltage				
(I_F=80 mA, E_e=0)	V_F	1.3	1.3	V
Capacitance (V_R=0 V, f=1 MHz, E=0)	C_0	11	11	pF
Temperature Coefficient V_0	TC_V	–2.6	–2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.18	0.2	%/K
Noise Equivalent Power				
(V_R=20 V, λ=850 nm)	NEP	2.9×10^{-14}	2.9×10^{-14}	W/√Hz
Detection Limit (V_R=20 V, λ=850 nm)	D*	3.5×10^{12}	3.5×10^{12}	cm•√Hz/W

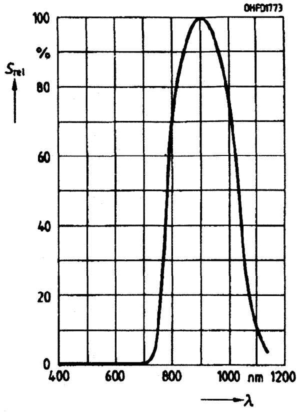
Note
1. Illuminance shown refers to unfiltered radiation of tungsten filament lamp at color temperature of 2856 K (standard light A per DIN 5033 and IEC publication 306-1).

***Formerly SFH217, **formerly SFH217F**

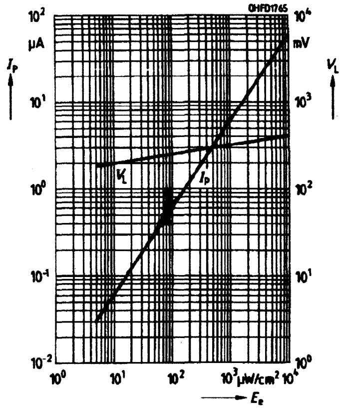
SFH 203P
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



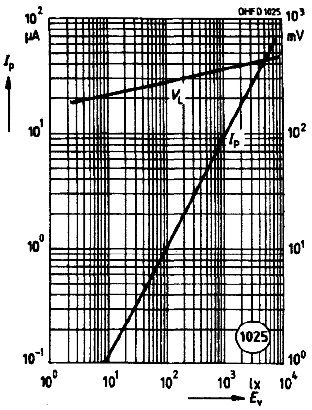
SFH 203PFA
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



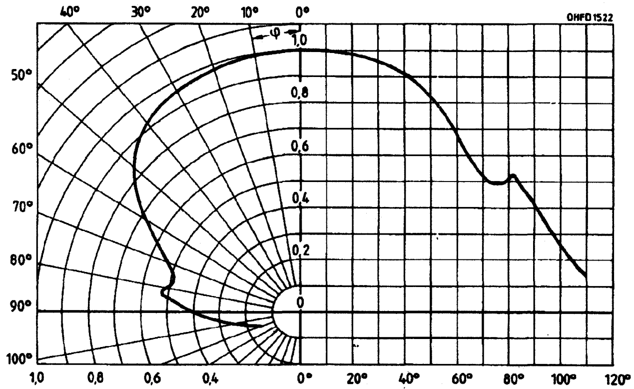
SFH 203PFA
Photocurrent $I_P=f(E_e)$, $V_R=5$ V
Open circuit voltage $V_O=f(E_e)$



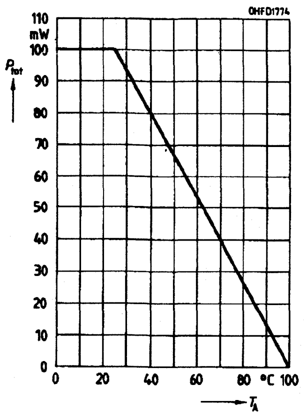
SFH 203
Photocurrent $I_P=f(E_V)$, $V_R=5$ V
Open circuit voltage $V_O=f(E_V)$



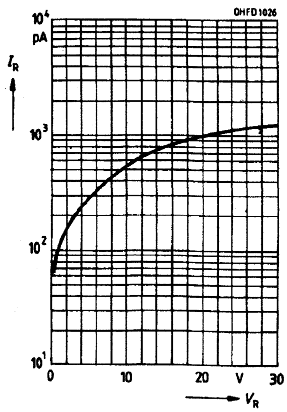
Directional characteristics $S_{REL}=f(\varphi)$



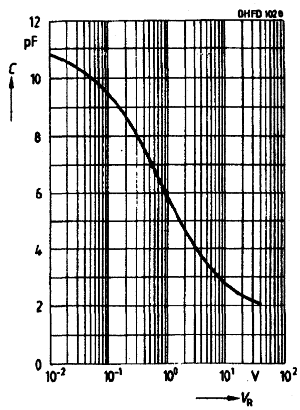
Power dissipation $P_{TOT}=f(T_A)$



Dark current $I_R=f(V_R)$, E=0



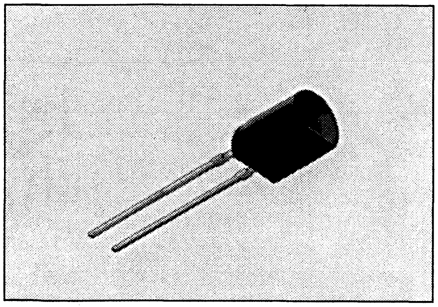
Capacitance $C=f(V_R)$, f=1 MHz, E=0



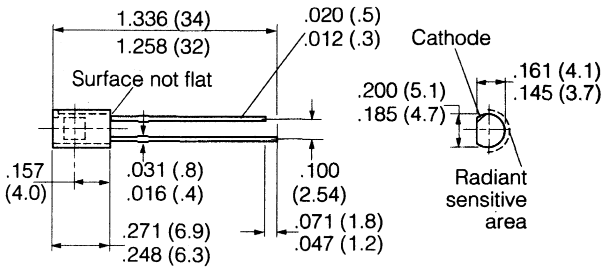
Photodiodes 8

SIEMENS

*SFH205F
SFH205FA
SILICON PIN PHOTODIODE
DAYLIGHT FILTER



Package Dimensions in inches (mm)



FEATURES

- **Built-in Daylight Filter**
- **High Reliability**
- **0.1" (2.54 mm) Lead Spacing**
- **Fast Switching Time**
- **Black Plastic Encapsulated Package**
- **Suitable for IR Sound Transmission**

APPLICATIONS

- **IR Remote Control of Hi-Fi, TVs, VCRs, Dimmers, etc.**
- **Light Reflecting Switches for Steady and Varying Intensity**

DESCRIPTION

The SFH 205F/205FA silicon planar PIN photodiode is housed in a plastic package that serves as both a filter and a window for infrared emission. Its terminals are solder tabs at 0.1" (2.54 mm) lead spacing. The cathode marking is stamped at the package edge.

Key features include low junction capacitance, high cut-off frequency, short switching times.

This versatile photodetector can be used as either a diode or as a voltaic cell.

Maximum Ratings

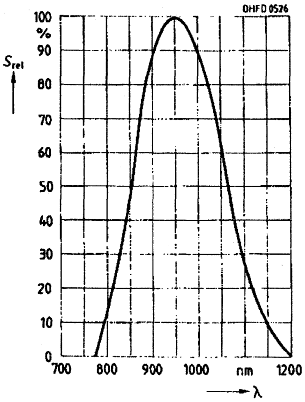
Operating and Storage Temperature
Range (T_{OP}, T_{STG}) .... –55 to +80°C
Soldering Temperature
(≥2 mm from case bottom) (T_S) t≤3 s.......230°C
Reverse Voltage (V_R) .... 32 V
Power Dissipation (P_{TOT}) T_A=25°C .... 150 mW

*** Formerly SFH205**

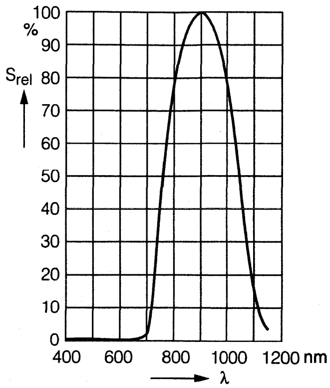
Characteristics (T_A=25°C)

Parameter	**Symbol**	**Value**	**Unit**
Spectral Sensitivity (V_R=5 V) (E_E=1.0 mW/cm^2)	S	60 (≥42)	µA
Wavelength, Maximum Photosensitivity SFH205F SFH205F A	λ_{Smax} λ_{Smax}	950 900	nm nm
Photosensitivity, Spectral Range (S=10% of S_{MAX}) SFH205F SFH205FA	λ λ	800 to 1100 740 to 1100	nm nm
Radiant Sensitive Area	A	7.00	mm^2
Radiant Sensitive Area Dimensions	L x W	2.65 x 2.65	mm
Distance, Chip Surface to Case Surface	H	2.3 to 2.5	mm
Half Angle	φ	±60	Deg.
Dark Current (V_R=10 V)	I_R	2(≤30)	nA
Spectral Sensitivity (λ=950 nm) SFH205F (λ=870 nm) SFH205FA	S_λ S_λ	0.59 0.63	A/W A/W
Quantum Yield (λ=950 nm) SFH205F (λ=870 nm) SFH205FA	η η	0.77 0.9	electrons/photon
Open Circuit Voltage (E_E=0.5 mW/cm^2) SFH205F (E_E=1 mW/cm^2) SFH205FA	V_O V_O	330(≥250) 350(≥280)	mV mV
Short Circuit Current (E_E=1 mW/cm^2) SFH205F (E_E=1 mW/cm^2) SFH205FA	I_{SC}	56 56	µA µA
Rise and Fall Time, Photocurrent (R_L=50 Ω, V_R=5 V, λ=850 nm, I_P=800 µA)	t_R, t_F	20	ns
Forward Voltage (I_F=100 mA, E_E=0)	V_F	1.3	V
Capacitance (V_R=0 V, f=1 MHz, E=0)	C_O	72	pF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_{SC} (λ=950 nm) SFH205F (λ=870 nm) SFH205FA	TC_I	0.18 0.03	%/K
Noise Equivalent Power (V_R=10 V) SFH205F SFH205FA	NEP	4.3 x 10^{-14} 4.0 x 10^{-14}	W/√Hz
Detection Limit (V_R=10 V) SFH205F SFH205FA	D*	6.2 x 10^{12}	cm•√Hz/W

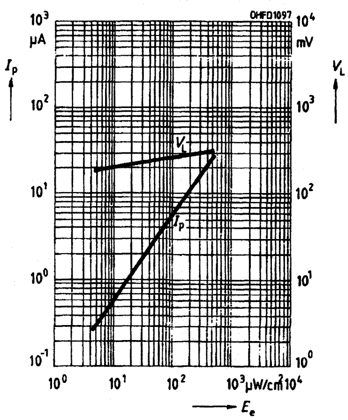
Relative spectral sensitivity $S_{REL}=f(\lambda)$
SFH205



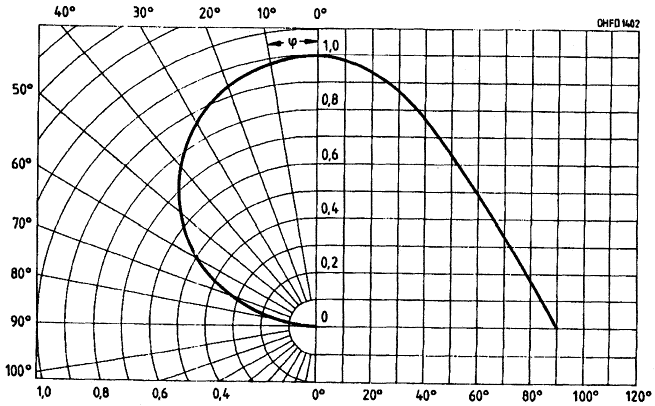
Relative spectral sensitivity $S_{REL}=f(\lambda)$
SFH205FA



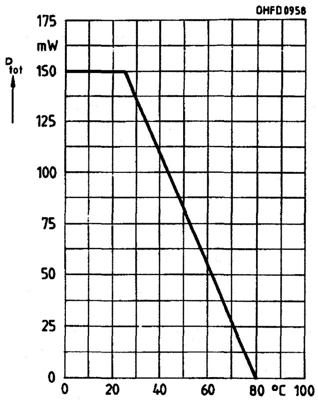
Photocurrent $I_P=f(E_E)$ $V_R=5$ V
Open circuit voltage $V_O=f(E_E)$



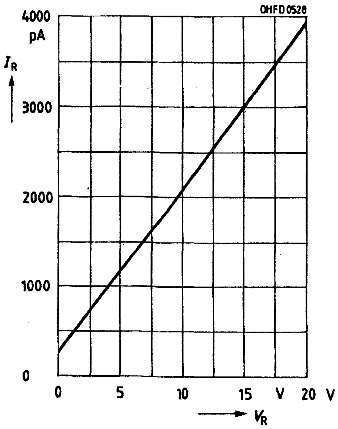
Directional characteristic $S_{REL}=f(\varphi)$



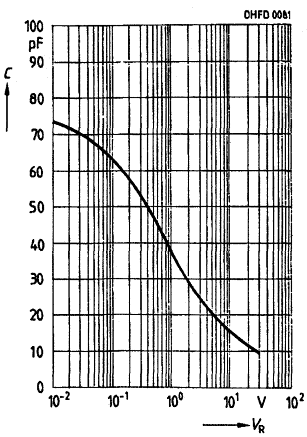
Power dissipation $P_{TOT}=f(T_A)$



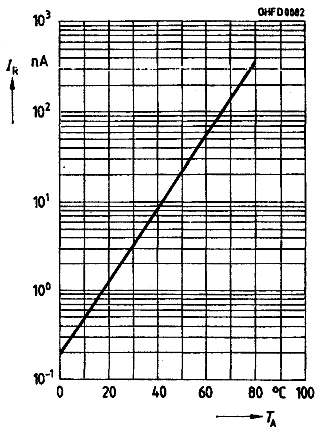
Dark current $I_R=f(V_R)$, E=0



Capacitance $C=f(V_R)$,f=1 MHz, E=0



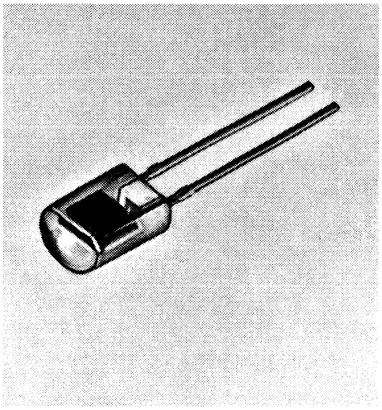
Dark current $I_R=f(T_A)$, $V_R=10$ V, E=0



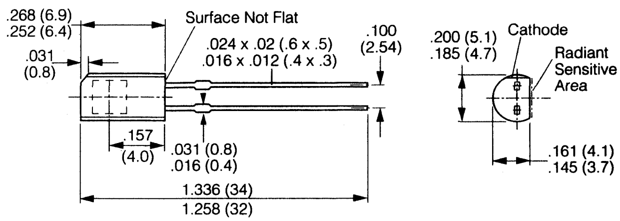
Photodiodes 8

SIEMENS

SFH 206K
PIN PHOTODIODE



Package Dimensions in Inches (mm)



FEATURES

- **Colorless Transparent Plastic Package**
- **Suitable for IR Sound Transmission**
- **High Reliability**
- **0.1" (2.54 mm) Lead Spacing**

DESCRIPTION

The SFH 206K silicon planar PIN photodiode is housed in a colorless transparent plastic package. Its terminals are solder tabs at 0.1" (2.54 mm) lead spacing. The cathode marking is stamped at the package edge.

Key features include low junction capacitance, high cutoff frequency, short switching times.

This versatile photodetector can be used as either a diode or as a voltaic cell. Applications include IR sound transmission and remote control.

Maximum Ratings

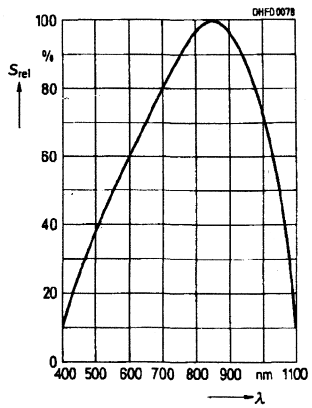
Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –40° to +80°C
Soldering Temperature (≥2 mm from case bottom) (T_S) t≤3 s .... 230°C
Reverse Voltage (V_R) .... 32 V
Power Dissipation (P_{TOT}) T_A=25°C .... 150 mW

Characteristics (T_A=25°C)

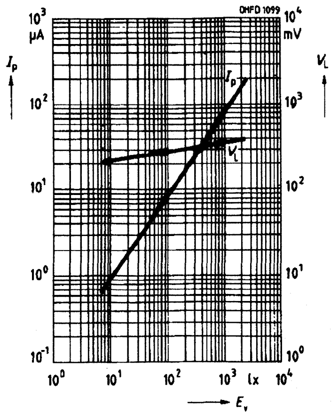
Parameter	Symbol	Value	Unit
Photosensitivity (V_R=5 V, Standard Light A, T=2856 K)	S	80(≥50)	nA/lx
Maximum Photosensitivity Wavelength	λ_{Smax}	850	nm
Photosensitivity Spectral Range (S=10% of S_{MAX})	λ	400 to 1100	nm
Radiant Sensitive Area	A	7.00	mm^2
Radiant Sensitive Area Dimensions	L x W	2.65 x 2.65	mm
Distance, Chip Surface to Case Surface	H	1.2 to 1.4	mm
Half Angle	φ	±60	Deg.
Dark Current (V_R=10 V)	I_R	2(≤30)	nA
Spectral Sensitivity (λ=850 nm)	Sλ	0.62	A/W
Quantum Yield (λ=850 nm)	η	0.9	electrons/photon
Open Circuit Voltage (E_V=1000 lx)(1)	V_O	365(≥310)	mV
Short Circuit Current (E_V=1000 lx)(1)	I_{SC}	80	µA
Rise and Fall Time of Photocurrent (R_L=50 Ω, V_R=5 V, λ=850 nm, I_P=800 µA)	t_R, t_F	20	ns
Forward Voltage (I_F=100 mA, E_E=0)	V_F	1.3	V
Capacitance (V_R=0 V, f=1 MHz, E_V=0 lx)	C_0	72	pF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.18	%/K
Noise Equivalent Power (V_R=10 V, λ=850 nm)	NEP	4.2×10^{-14}	W/√Hz
Detection Limit (V_R=10 V, λ=850 nm)	D*	6.3×10^{12}	cm•√Hz/W

Note
1. Illuminance shown refers to unfiltered radiation of tungsten filament lamp at color temperature of 2856 K (standard light A per DIN 5033 and IEC publication 306-1).

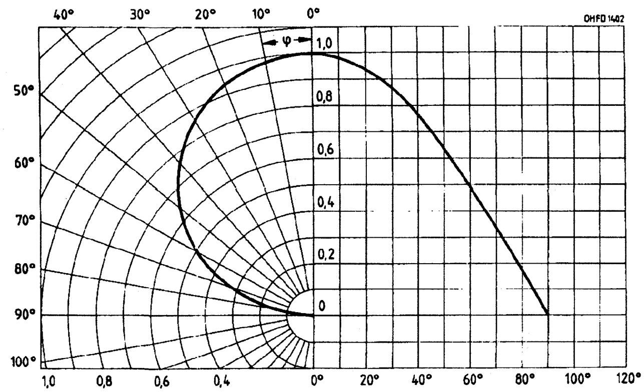
Relative spectral sensitivity $S_{REL}=f(\lambda)$



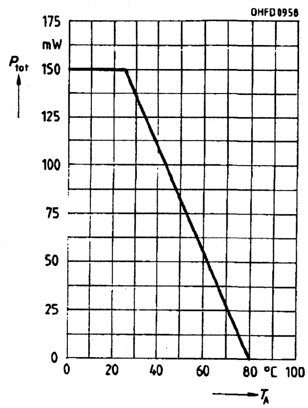
Photocurrent $I_P=f(E_V)$
Open circuit voltage $V_O=f(E_V)$



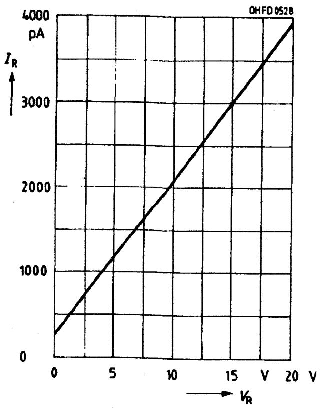
Directional characteristic $S_{REL}=f(\varphi)$



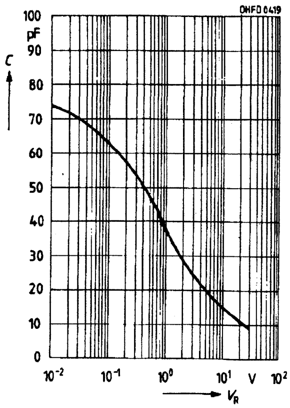
Power dissipation $P_{TOT}=f(T_A)$



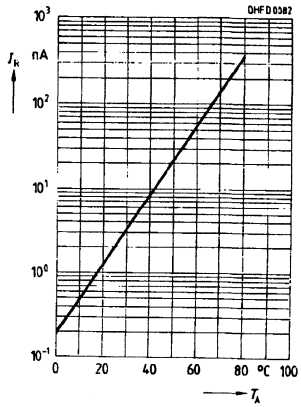
Dark current $I_R=f(V_R)$, E=0



Capacitance $C=f(V_R)$, f=1 MHz, E=0

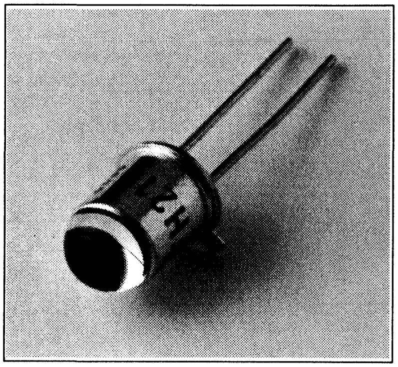


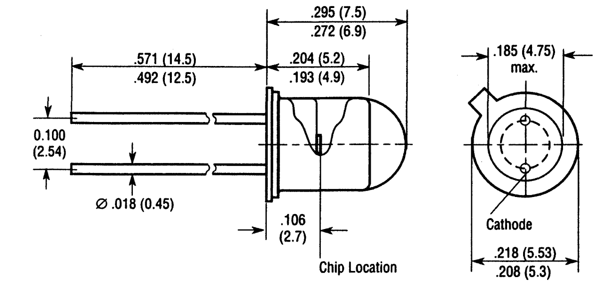
Dark current $I_R=f(T_A)$, V_R=10 V, E=0



SIEMENS

SFH 216
SILICON PIN PHOTODIODE





FEATURES

- **Package: 18 A3 DIN 41870 (TO18), Glass Lens, Hermetically Sealed, Solder Tabs, Lead Spacing 0.1" (2.54 mm)**
- **High Reliability**
- **No Testable Degradation**
- **Anode Marking: Tab at Package Bottom**
- **High Open Circuit Voltage as Voltaic Cells**
- **Very Short Switching Time**
- **High Spectral Sensitivity**
- **Wide Temperature Range**
- **Usage: Visible and Near Infrared Range**
- **Low Capacitance**
- **High Cutoff Frequency**

DESCRIPTION

The SFH 216 silicon planar PIN photodiode includes N-Si material, which provides positive front and negative back contact. This photodetector can be used as either a diode with reverse voltage or as a voltaic cell.

Applications include high-modulation bandwidth optical sensor for light pens.

Maximum Ratings

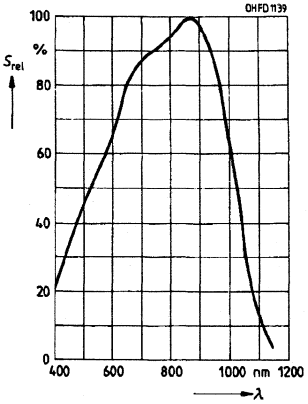
Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... −40° to +125°C
Soldering Temperature (2 mm from case bottom) (T_S) t≤3 s .... 230°C
Reverse Voltage (V_R) .... 50 V
Power Dissipation (P_{TOT}) T_A=25°C .... 250 mW

Characteristics (T_A=25°C)

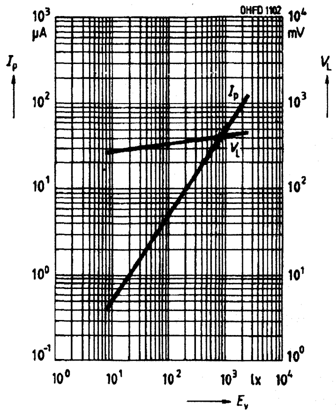
Parameter	Symbol	Value	Unit
Photosensitivity (V_R=5 V, Standard Light A, T=2856 K)	S	50(≥35)	nA/lx
Maximum Photosensitivity Wavelength	λ_{Smax}	850	nm
Photosensitivity Spectral Range (S=10% of S_{MAX})	λ	350 to 1150	nm
Radiant Sensitive Area	A	1	mm^2
Radiant Sensitive Area Dimensions	L x W	1 x 1	mm
Distance, Chip Surface to Case Top Edge	D	4.2 to 5.0	mm
Half Angle	φ	±12	Deg.
Dark Current (V_R=20 V)	I_R	1(≤5)	nA
Spectral Photosensitivity (λ=850 nm)	S_λ	0.55	A/W
Quantum Yield (λ=850 nm)	η	0.80	electrons / photon
Open Circuit Voltage (E_V=1000 lx)(1)	V_O	410(≥350)	mV
Short Circuit Current (E_V=1000 lx)(1)	I_{SC}	50	µA
Rise and Fall Time of Photocurrent (R_L=50 Ω, V_R=20 V, λ=850 nm, I_P=800 µA)	t_R, t_F	5	ns
Forward Voltage (I_F=100 mA, E=0)	V_F	1.3	V
Capacitance (V_R=0 V, f=1 MHz, E=0)	C_0	11	pF
Temperature Coefficient V_O	TC_V	−2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.2	%/K
Noise Equivalent Power (V_R=20 V, λ=850 nm)	NEP	3.3×10^{-14}	W/√Hz
Detection Limit (V_R=20 V, λ=850 nm)	D*	3.1×10^{12}	cm•√Hz/W

Note
1. Illuminance shown refers to unfiltered radiation of tungsten filament lamp at color temperature of 2856 K (standard light A per DIN 5033 and IEC publication 306-1).

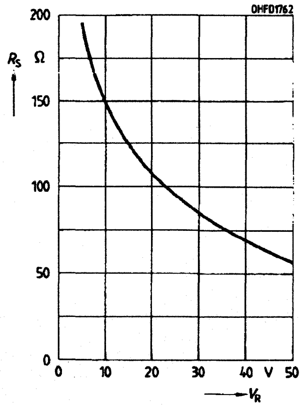
Relative spectral sensitivity $S_{REL}=f(\lambda)$



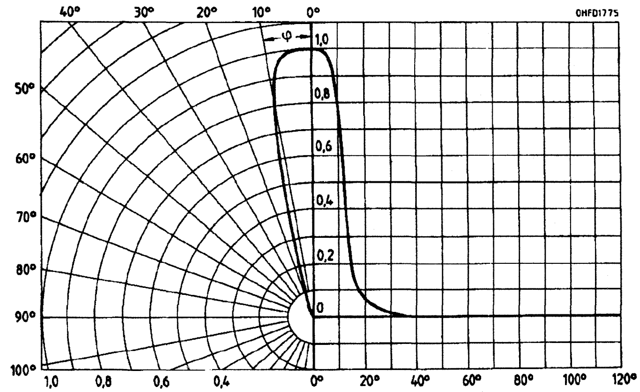
Photocurrent $I_P=f(E_V)$ $V_R=5$ V
Open circuit voltage $V_O=f(E_V)$



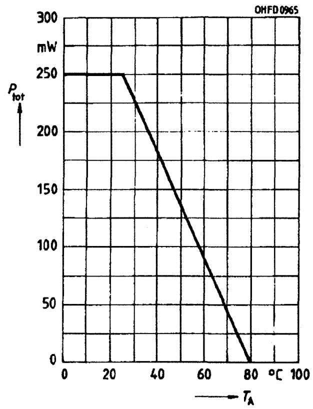
Series resistance $R_S=f(V_R)$, f=100 MHz, E=0



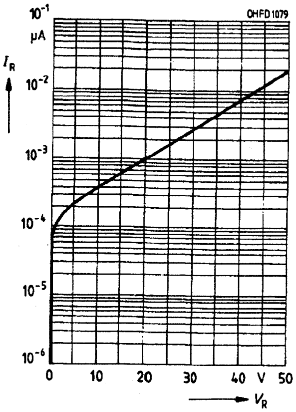
Directional characteristic $S_{REL}=f(\varphi)$



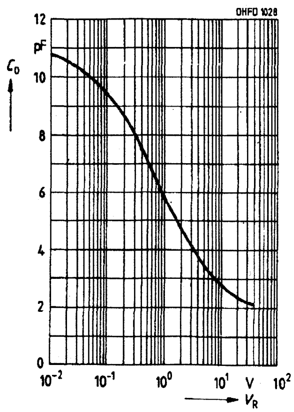
Power dissipation $P_{TOT}=f(T_A)$



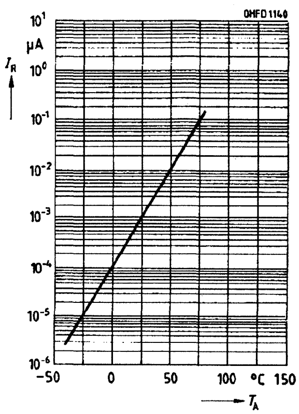
Dark current $I_R=f(V_R)$, E=0



Capacitance $C=f(V_R)$,f=1 MHz, E=0



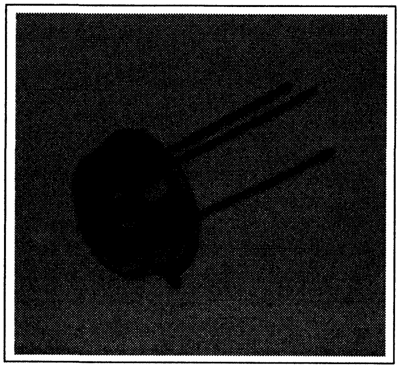
Dark current $I_R=f(T_A)$, $V_R=20$ V, E=0



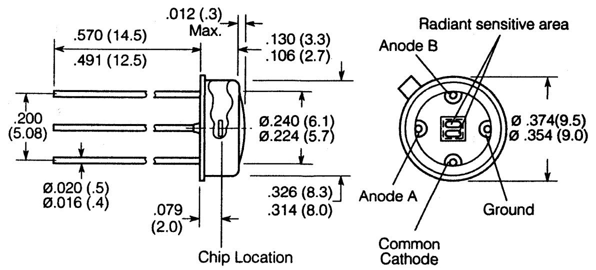
SIEMENS

*SFH 221

SILICON DIFFERENTIAL PHOTODIODE



Package Dimensions in Inches (mm)



FEATURES

- **High Open Circuit Voltage as Photovoltaic Cells**
- **Usage: Visible Light and Near Infrared Range**
- **High Spectral Sensitivity**
- **High Reliability**
- **Short Switching Time**
- **Wide Temperature Range**
- **Low Capacitance**
- **No Testable Degradation**
- **High Packing Density**
- **Package: Hermetically Sealed, Similar to TO5, Solder Tabs, Lead Spacing 0.20" (5.08 mm)**

DESCRIPTION

The SFH 221 is a silicon planar photodiode that can be operated as a photodiode with reverse voltage or as a photovoltaic cell. N-Si material provides positive front and negative back contacts.

Applications include follow-up controls, edge drives, path and corner scanning, industrial electronics, and measurement and control.

Note
1. Illuminance shown refers to unfiltered radiation of tungsten filament lamp at color temperature of 2856 K (standard light A per DIN 5033 and IEC publication 306-1).

***Formerly SFH221S**

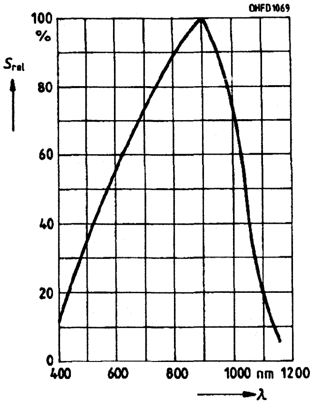
Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –40° to +80°C
Soldering Temperature (1.5 mm from case bottom) (T_S) t≤3 s .... 230°C
Reverse Voltage (V_R) .... 10 V
Power Dissipation (P_{TOT}) .... 50 mW
Insulation Voltage Versus Package (V_{IS}) .... 100 V

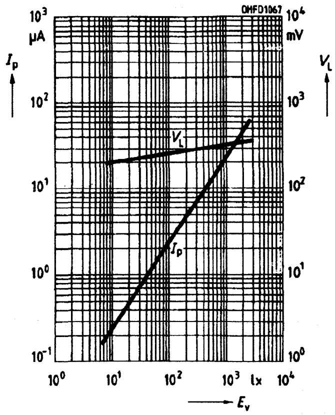
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Photosensitivity (V_R=5 V, Standard Light A, T=2856 K)	S	24 (≥15)	nA/lx
Maximum Photosensitivity Wavelength	λ_{Smax}	900	nm
Spectral Sensitivity Range (S=10% S_{MAX})	λ	400 to 1100	nm
Radiant Sensitive Area	A	1.54	mm²
Radiant Sensitive Area Dimensions	L x W	0.7 x 2.2	mm
Distance, Chip Surface to Case Top	H	1.1 to 1.6	mm
Half Angle	φ	±55	Deg.
Dark Current (V_R=10 V)	I_R	10 (≤100)	nA
Spectral Sensitivity (λ=850 nm)	S_λ	0.55	A/W
Maximum Deviation, Spectral Sensitivity of Systems from Mean	Δ_S	±5	%
Quantum Yield (λ=850 nm)	η	0.80	electrons/photon
Open Circuit Voltage (E_V=1000 lx)(1)	V_O	330(≥280)	mV
Short Circuit Current (E_V=1000 lx)(1)	I_{SC}	24	µA
Rise and Fall Time of Photocurrent 10% to 90% and 90% to 10% of Final Value (R_L=1 kΩ, V_R=5 V, λ=850 nm, I_P=10 µA)	t_R, t_F	500	ns
Forward Voltage (I_F=40 mA, E=0)	V_F	1.0	V
Capacitance (V_R=0 V, f=1 MHz, E=0)	C_0	25	pF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.18	%/K
Noise Equivalent Power (V_R=10 V, λ=850 nm)	NEP	1.0×10^{-13}	W/√Hz
Detection Limit (V_R=10 V, λ=850 nm)	D*	1.2×10^{12}	cm•√Hz/W
Insulation Current (V_{IS}=100 V)	I_{IS}	0.1 (≤1)	nA

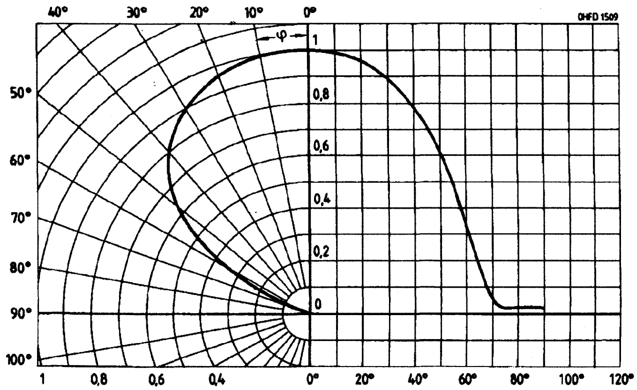
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



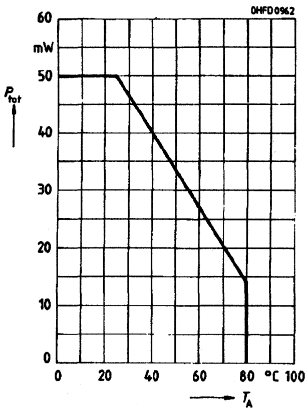
Photocurrent $I_P=f(E_V)$ $V_R=5$ V
Open circuit voltage $V_O=f(E_V)$



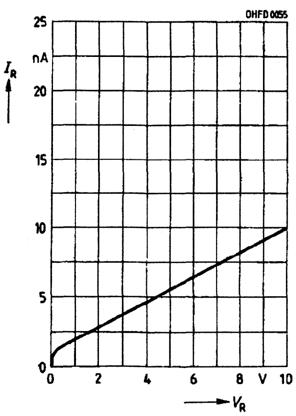
Directional characteristic $S_{REL}=f(\varphi)$



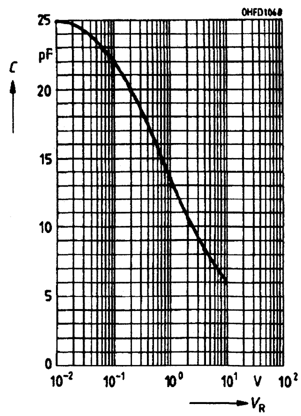
Power dissipation $P_{TOT}=f(T_A)$



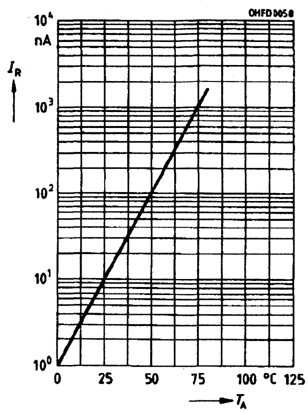
Dark current $I_R=f(V_R)$, E=0



Capacitance $C=f(V_R)$,
f=1 MHz, E=0



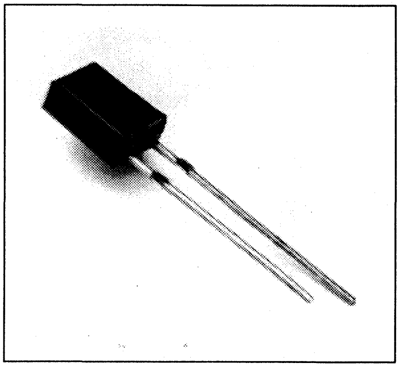
Dark current $I_R=f(T_A)$,
$V_R=10$ V, E=0



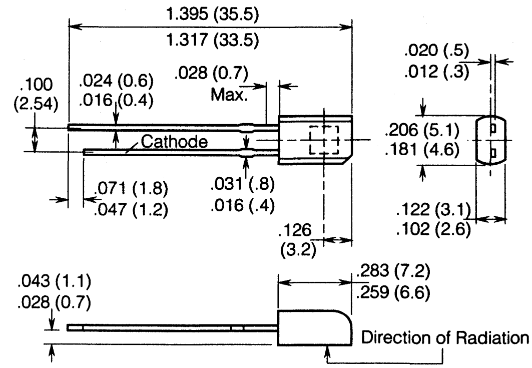
SIEMENS

*SFH 225FA

SILICON PIN PHOTODIODE DAYLIGHT FILTER



Package Dimensions in Inches (mm)



FEATURES

- **Built-In IR Filter**
- **Usage: Near IR Range (880 nm to 950 nm)**
- **Spectrally Matched to Emitters SFH 484/485 and LD 271/274**
- **High Reliability**
- **Short Switching Time: 20 ns Typical**
- **No Testable Degradation**
- **High Cutoff Frequency**
- **Package: SOD 67**

DESCRIPTION

The SFH 225FA is a silicon planar PIN photodiode housed in a black epoxy package that acts as a daylight rejection filter. It can be operated as a photodiode with reverse voltage or as a photovoltaic cell.

Features include low junction capacitance, short switching times, and a high cutoff frequency. Its small package and 0.1" (2.54 mm) lead spacing make it suitable for high density packaging. Due to its low signal/noise ratio and IR filter, it is also effective at low light levels.

Applications include remote control, IR sound transmission, dimmers, and light-reflective switches.

Maximum Ratings

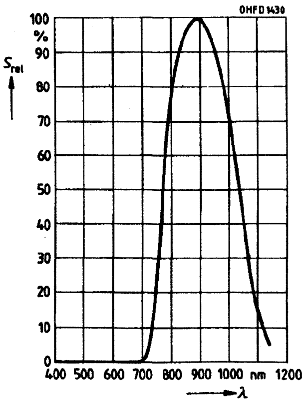
Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –40° to +80°C
Soldering Temperature (1.5 mm from case bottom) (T_S) t≤3 s .... 230°C
Reverse Voltage (V_R) .... 20 V
Power Dissipation (P_{TOT}) .... 150 mW

Characteristics (T_A=25°C)

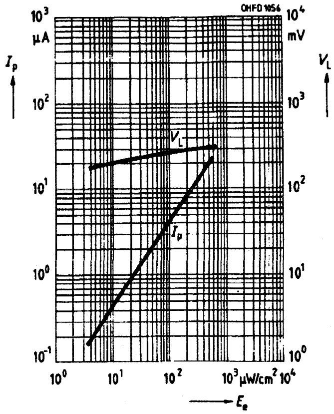
Parameter	Symbol	Value	Unit
Photosensitivity (V_R=5 V, λ=950 nm, E_E=1 mW/cm²)	S	34 (≥25)	µA
Maximum Photosensitivity Wavelength	λ_{Smax}	900	nm
Spectral Sensitivity Range (S=10% S_{MAX})	λ	740 to 1120	nm
Radiant Sensitive Area	A	4.84	mm²
Radiant Sensitive Area Dimensions	L x W	2.20 x 2.20	mm
Distance, Chip Surface to Case Surface	H	0.6 to 0.8	mm
Half Angle	φ	±60	Deg.
Dark Current (V_R=10 V)	I_R	2 (≤30)	nA
Spectral Sensitivity (λ=950 nm)	S_λ	0.70	A/W
Quantum Yield (λ=950 nm)	η	0.90	electrons/photon
Open Circuit Voltage (λ=950 nm, E_E=0.5 mW/cm²)	V_O	330(≥250)	mV
Short Circuit Current (λ=950 nm, E_E=0.5 mW/cm²)	I_{SC}	17	µA
Rise and Fall Time of Photocurrent (R_L=50 Ω, V_R=5 V, λ=850 nm, I_P=800 µA)	t_R, t_F	20	ns
Forward Voltage (I_F=100 mA, E=0,)	V_F	1.3	V
Capacitance (V_R=0 V, f=1 MHz, E=0)	C_0	48	pF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.18	%/K
Noise Equivalent Power (V_R=10 V)	NEP	3.6×10^{-14}	W/√Hz
Detection Limit (V_R=10 V)	D*	6.1×10^{12}	cm•√Hz/W

***Formerly SFH225**

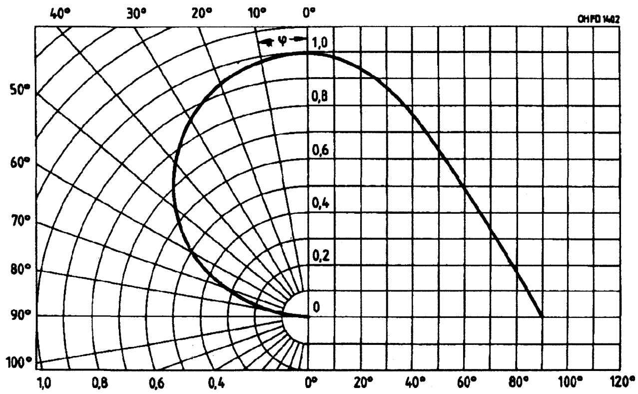
Relative spectral sensitivity $S_{REL}=f(\lambda)$



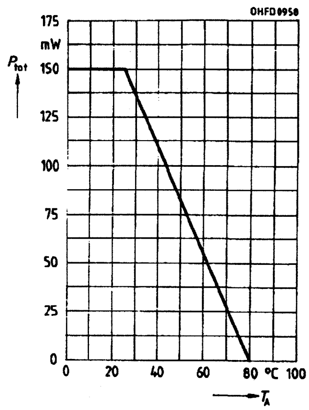
Photocurrent $I_P=f(E_e)$ $V_R=5$ V
Open circuit voltage $V_O=f(E_e)$



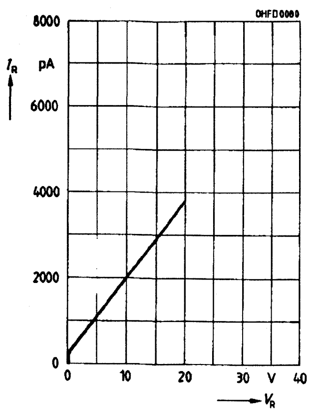
Directional characteristic $S_{REL}=f(\varphi)$



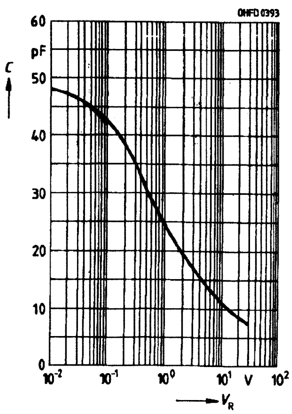
Power dissipation $P_{TOT}=f(T_A)$



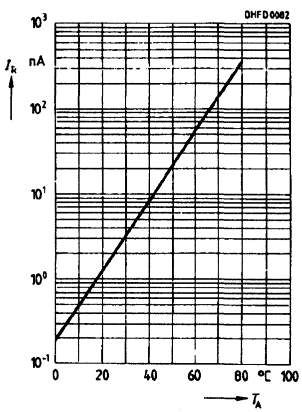
Dark current $I_R=f(V_R)$, E=0



Capacitance $C=f(V_R)$, f=1 MHz, E=0

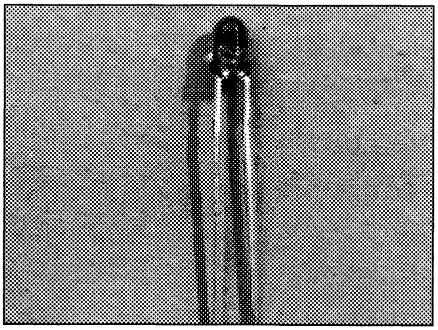


Dark current $I_R=f(T_A)$, $V_R=10$ V, E=0

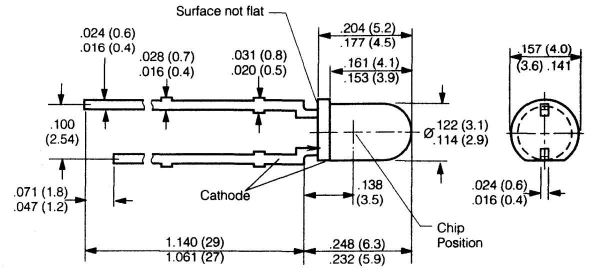


SIEMENS

SFH229
DAYLIGHT FILTER *SFH229FA
SILICON PIN PHOTODIODE



Package Dimensions in inches (mm)



FEATURES

- **Silicon Photodiode in PIN Planar Technology**
- **N-Si Material:**
- **– Anode, Front Contact**
- **– Cathode, Back Contact**
- **High Reliability**
- **No Testable Degradation**
- **Short Switching Time**
- **Low Capacitance**
- **High Spectral Sensitivity**
- **Wide Temperature Range**
- **SFH229: Visible Light and Near Infrared Range Usage**
- **SFH229FA: Near Infrared Range**
- **Package: T1 (3 mm) LED Package, Solder Tabs, 0.1" (2.54 mm) Lead Spacing**
  - **– SFH229, Transparent Epoxy**
  - **– SFH229FA, Black Epoxy**
- **Cathode Marking: Shorter Lead**
- **Applications**
  - **– Light-Reflecting Switches**
  - **– Interrupter Switches**
  - **– Measurement and Control**

Maximum Ratings

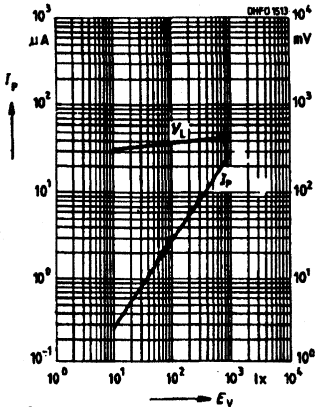
Operating and Storage Temperature
Range (T_{OP}, T_{STG}) .... –55 to +100°C
Soldering Temperature
(≥2 mm from case bottom) (T_S) t≤3 s.......230°C
Reverse Voltage (V_R) .... 20 V
Total Power Dissipation (P_{TOT})
T_A=25°C .... 150 mW

*** Formerly SFH229F**

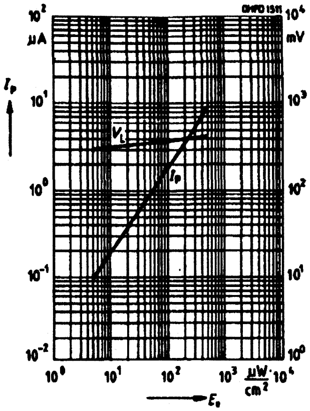
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Spectral Sensitivity (V_R=5 V) (Standard Light A, T=2856 K) SFH229 (E_e=1 mW/cm^2, λ=950 nm) SFH229FA	S S	28 (≥18) 10 (≥5.4)	nA/lx µA
Wavelength, Max. Sensitivity SFH229 SFH229FA	λ_{Smax} λ_{Smax}	860 900	nm nm
Photosensitivity, Spectral SFH229 Range (S=10%, S_{max}) SFH229FA	λ λ	380 to 1100 730 to 1100	nm nm
Radiant Sensitive Area	A	0.3	mm^2
Radiant Sensitive Area Dimensions	L x W	0.56 x 0.56	mm
Distance, Chip Surface to Case Surface	H	2.4 to 2.8	mm
Half Angle	φ	±17	Deg.
Dark Current (V_R=10 V)	I_R	50 (≤5000)	pA
Spectral Photosensitivity SFH229 (λ=850 nm) SFH229FA	S_λ S_λ	0.62 0.60	A/W A/W
Quantum Yield (λ=850 nm) SFH229 SFH229FA	η η	0.90 0.88	electrons / photon
Open Circuit Voltage (E_V=1000 lx, Std. Light A, T=2856 K) SFH229 (E_e=0.5 mW/cm^2, λ=950 nm) SFH229FA	 V_O V_O	 450 (≥400) 420 (≥370)	 mV mV
Short Circuit Current (E_V=1000 lx, Std. Light A, T=2856 K) SFH229 (E_e=0.5 mW/cm^2, λ=950 nm) SFH229FA	I_{SC}	 27 9	 µA µA
Rise and Fall Time, Photocurrent (R_L=50 Ω, V_R=10 V, λ=850 nm, I_P=800 µA)	t_R, t_F	10	ns
Forward Voltage (I_F=100 mA, E=0)	V_F	1.3	V
Capacitance (V_R=0 V, f=1 MHz, E=0)	C_0	13	pF
Temperature Coefficient, V_O	TC_V	–2.6	mV/K
Temperature Coefficient (I_K, Std. Light A) SFH229 (I_K, λ=950 nm) SFH229FA	TC_I	 0.18 0.03	%/K
Noise Equivalent Power (V_R=10 V, λ=850 nm)	NEP	6.5 x 10^{-15}	W/√Hz
Detection Limit (V_R=10 V, λ=850 nm)	D*	8.4 x 10^{12}	cm•√Hz/W

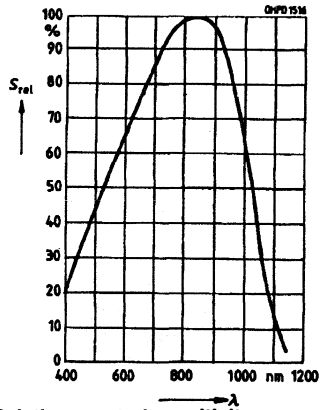
Photocurrent, $I_P=f(E_V)$, $V_R=5$ V
Open circuit voltage $V_L=f(E_V)$
SFH229



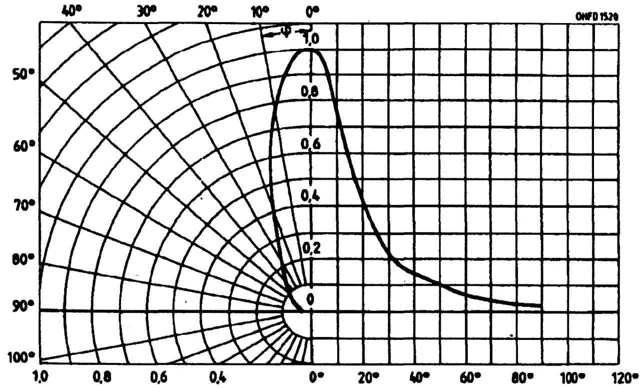
Photocurrent, $I_P=f(E_V)$, $V_R=5$ V
Open circuit voltage $V_L=f(E_V)$
SFH229FA



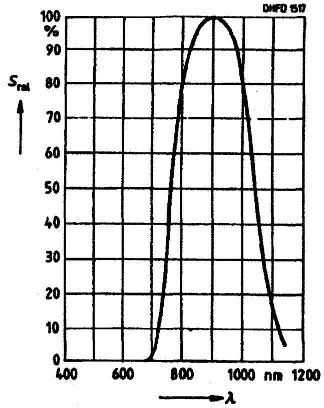
Relative spectral sensitivity –SFH229
$S_{rel}=f(\lambda)$



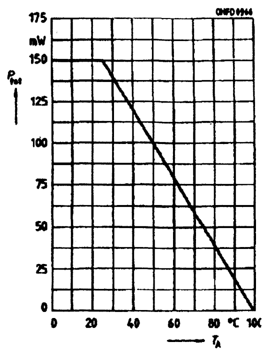
Directional characteristic $S_{rel}=f(\varphi)$



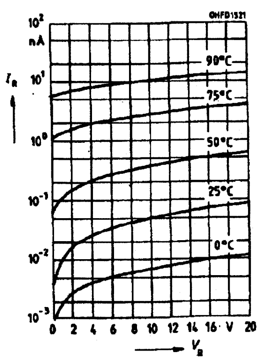
Relative spectral sensitivity
SFH229FA $S_{rel}=f(\lambda)$



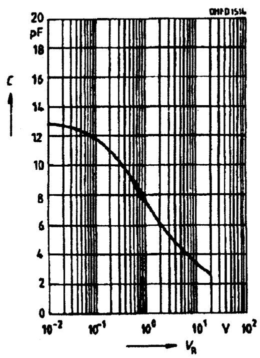
Power dissipation
$P_{TOT}=f(T_A)$



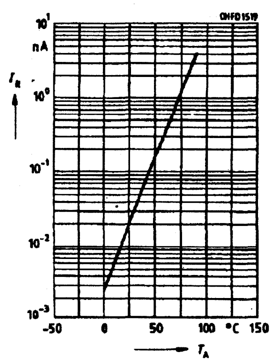
Dark current
$I_R=f(V_R)$, E=0



Capacitance $C=f(V_R)$
f=1 MHz, E=0



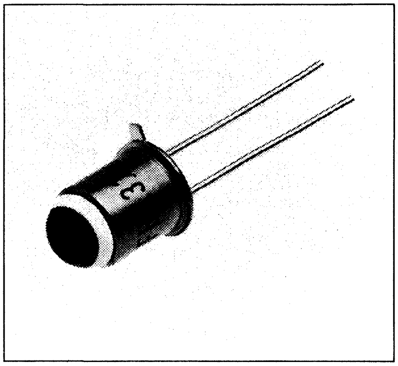
Dark current $I_R=f(T_A)$
$V_R=10$ V, E=0



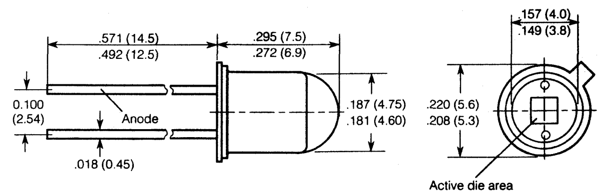
Photodiodes 8

SIEMENS

SFH 231
GERMANIUM PIN PHOTODIODE



Package Dimensions in Inches (mm)



FEATURES

- **Anode Marking: Projection at Package Bottom**
- **Usage: Visible Light and Near Infrared Range**
- **High Spectral Sensitivity**
- **High Reliability**
- **Very Short Switching Time**
- **Wide Temperature Range**
- **Very High Cutoff Frequency**
- **No Testable Degradation**
- **Package: Hermetically Sealed, Similar to TO18 with Lens Cap, Lead Spacing 0.10" (2.54 mm)**

DESCRIPTION

The SFH 231 is a germanium planar PIN photodiode, designed for the 1100 to 1700 nm wavelength range. It can be used as a diode with reverse voltage or for element operation. N-Ge material provides positive front and negative back contacts.

Applications include spectrophotometers, IR laser detector systems, IR distance measuring equipment, optical information transmission, and measuring instruments.

This is a replacement type for APY 12 and APY 13.

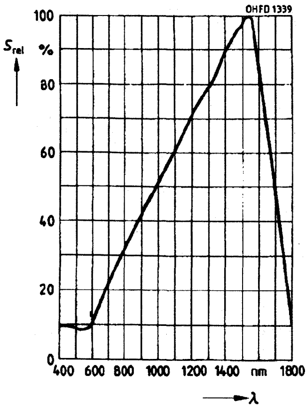
Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –40° to +80°C
Reverse Voltage (V_R) .... 15 V
Power Dissipation (P_{TOT}) .... 150 mW
Thermal Resistance (R_{THJA}) .... 450 K/W

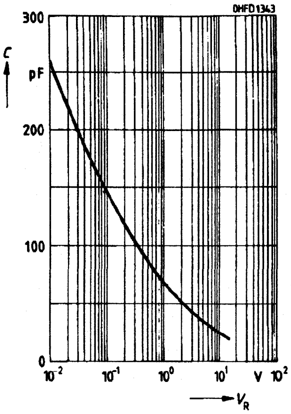
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Photosensitivity			
(V_R=0 V, Standard Light A, T=2856 K)	S_V	130	nA/lx
(V_R=0 V, λ=1300 nm)	S_E	52 (≥32)	µA•cm²/mW
Maximum Photosensitivity Wavelength	λ_{Smax}	1550	nm
Spectral Sensitivity Range (S=10% S_{MAX})	λ	600 to 1800	nm
Radiant Sensitive Area	A	1	mm²
Radiant Sensitive Area Dimensions	L x W	1 x 1	mm
Distance, Chip Surface to Case Surface	H	4.2 to 5	mm
Half Angle	φ	±10	Deg.
Dark Current (V_R=1 V, E=0)	I_R	10 (≤50)	µA
Spectral Sensitivity (λ=1300 nm)	S_λ	0.68	A/W
Quantum Yield (λ=1300 nm)	η	0.65	electrons / photon
Short Circuit Current			
(E_e=0.25 mW/cm², λ=1300 nm)	I_{SC}	13 (≥8)	µA
Rise and Fall Time of Photocurrent (R_L=50 Ω, V_R=1 V, λ=1300 nm, I_P=100 µA)	t_R, t_F	9	ns
Forward Voltage (I_F=100 mA, E=0)	V_F	1	V
Capacitance			
(V_R=1 V, f=1 MHz, E=0)	C_0	62	pF
Noise Equivalent Power			
(V_R=1 V, λ=1300 nm)	NEP	2.6×10^{-12}	W/√Hz
Detection Limit (V_R=1 V, λ=1300 nm)	D*	3.8×10^{10}	cm•√Hz/W

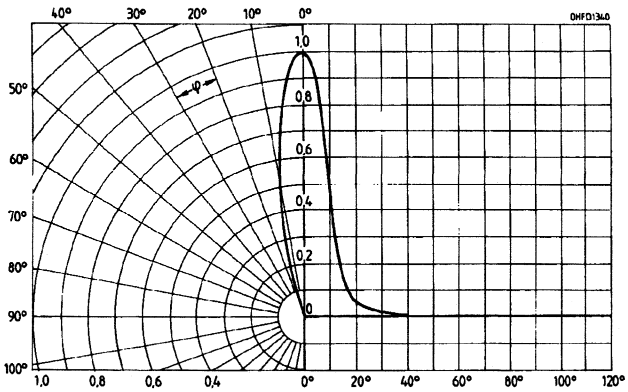
Relative spectral sensitivity $S_{REL}=f(\lambda)$



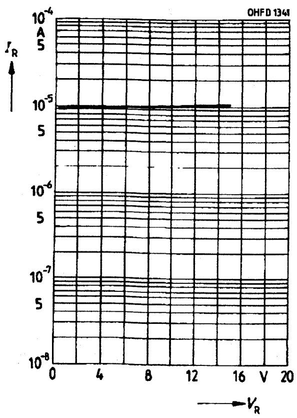
Capacitance $C=f(V_R)$, f=1 MHz, E=0



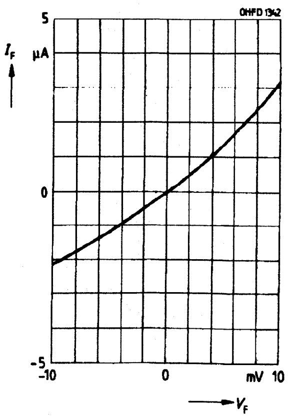
Directional characteristic $S_{REL}=f(\varphi)$



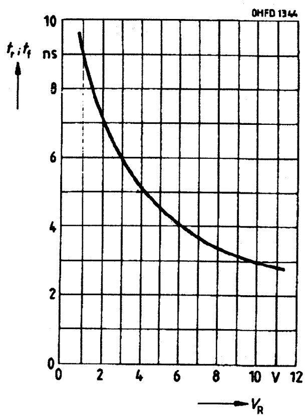
Dark current $I_R=f(V_R)$, E=0



Zero crossover $I_F=f(V_R)$, E=0



Switching times t_R/ $t_F=f(V_R)$, $R_L=50\ \Omega$

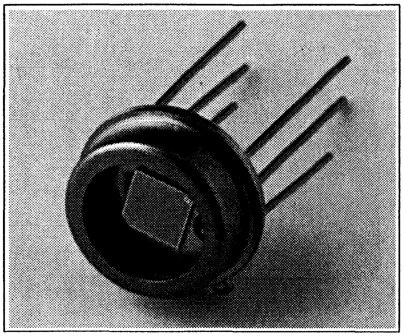


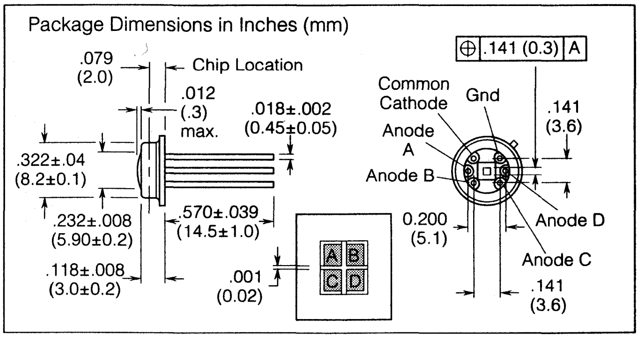
Photodiodes 8

SIEMENS

*SFH 234

SILICON FOUR-QUADRANT PHOTODIODE





FEATURES

- **Silicon Photodiode in Planar Technology**
- **N-Si Material:**
  - **Anode, Front Contact**
  - **Cathode, Back Contact**
- **Cathode Electrically Isolated**
- ***Available* as Photodiodes with Reverse Voltage or Photovoltaic Cells**
- **High Reliability**
- **No Testable Degradation**
- **Low Capacitance**
- **High Spectral Sensitivity**
- **Wide Temperature Range**
- **Visible Light and Near Infrared Range Usage**
- **Package: Hermetically Sealed, TO 39 with Glass Window**

Applications

- **Edge Detection**
- **Path and Corner Scanning**
- **Industrial Electronics**
- **Measurement and Control**

***Formerly SFH234S**

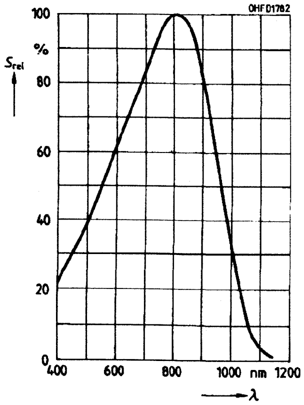
Maximum Ratings

Operating and Storage Temperature (T_{OP}, T_{STG}) .... –40°C to +80°C
Isolation Voltage (V_{IS}) .... 100 V
Reverse Voltage (V_R) .... 20 V
Total Power Dissipation (P_{TOT}) T_A= 25°C .... 50 mW

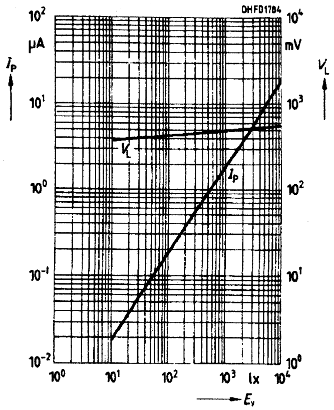
Characteristics (T_A=25°C, Standard Light A, T=2856 K)

Parameter	Sym	Value	Unit	Condition
Spectral Sensitivity	S	1.85 (≥1.2)	nA/lx	
Maximum Photosensitivity Wavelength	λ_{Smax}	800	nm	
Photosensitivity Spectral Range	λ	350 to 1050	nm	S=10% of S_{MAX}
Radiant Sensitive Area	A	0.25	mm^2	
Radiant Sensitive Area Dimension	L x W	0.5x0.5	mm	
Distance Chip Surface to Case Surface	H	2.2 to 2.5	mm	
Half Angle	φ	±60	Deg.	
Dark Current	I_R	0.1 (≤ 1)	nA	V_R=10 V
Isolation Current	I_{IS}	0.1 (≤1)	nA	V_{IS}=100 V
Spectral Sensitivity	S_λ	0.6	A/W	λ=850 nm
Maximum Spectral Sensitivity Tolerance	ΔS	±10	%	
Quantum Yield	η	0.87	Electrons/Photon	λ=850 nm
Open-Circuit Voltage	V_O	480 (≥400)	mV	E_V=1000 lx
Short-Circuit Voltage	I_{SC}	1.85	µA	E_V=1000 IX
Rise and Fall Time, Photocurrent	t_R, t_F	1	µs	R_L=1 kΩ, V_R=5 V, λ=850 nm, I_P=150 µA
Forward Voltage	V_F	1.0	V	I_F=40 mA, E=0
Capacitance	C_O	34	pF	V_R=0 V, f=1 MHz, E=0
Temperature Coefficient, V_O	TC_V	–2.6	mV/K	
Temperature Coefficient, I_{SC}	TC_I	0.18	%/K	
Noise Equivalent Power	NEP	9.43×10^{-15}	W/√Hz	V_R=1 V, λ=850 nm
Detection Limit	D*	5.3×10^{12}	cm • √Hz/W	V_R=1 V, λ=850 nm

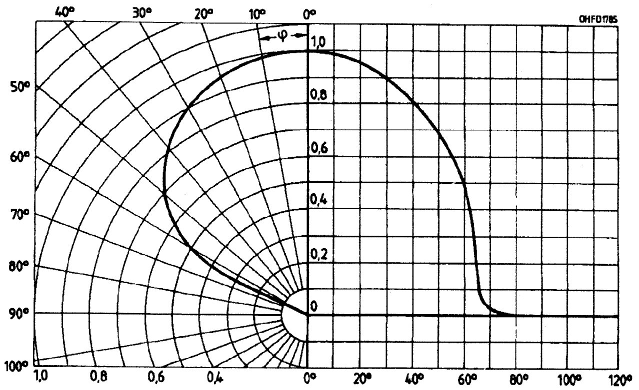
Relative spectral sensitivity
$S_{rel}=f(\lambda)$



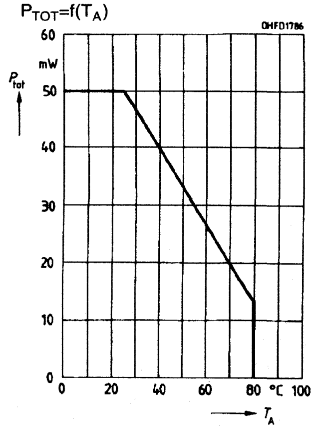
Photocurrent $I_P=f(E_v)$, $V_R=5$ V
Open-circuit voltage $V_L=f(E_v)$



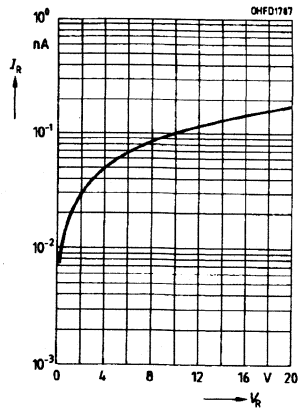
Directional characteristic $S_{rel}=f(\varphi)$



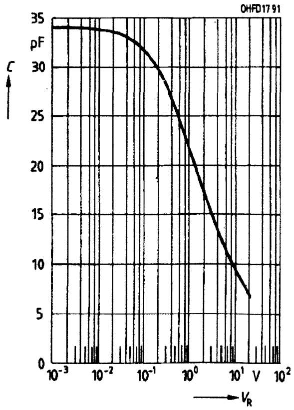
Power dissipation
$P_{TOT}=f(T_A)$



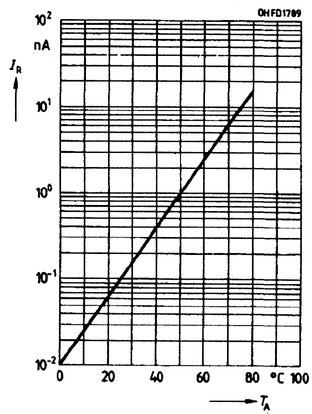
Dark current $I_R=f(V_R)$, E=0



Capacitance $C=f(V_R)$, f=1 MHz, E=0



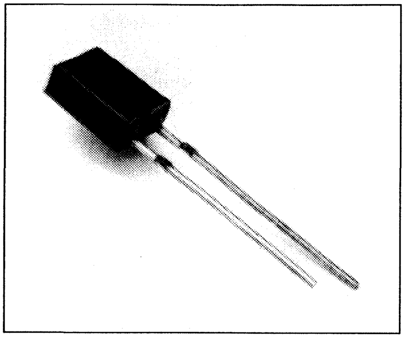
Dark current $I_R=f(T_A)$
$V_R=10$ V, E=0



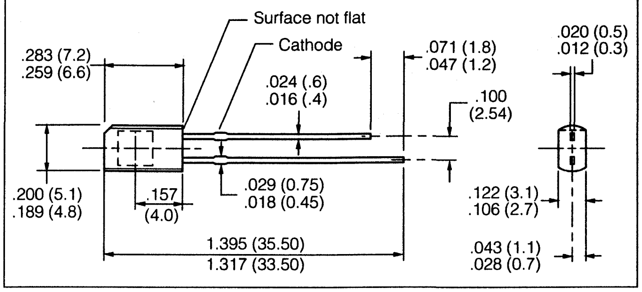
SIEMENS

*SFH235FA

SILICON PIN PHOTODIODE DAYLIGHT FILTER



Package Dimensions in Inches (mm)



FEATURES

- **Silicon Photodiode in PIN Planar Technology**
- **N-Si Material:**
  - **Anode, Front Contact**
  - **Cathode, Back Contact**
- **High Reliability**
- **No Testable Degradation**
- **High Packing Density**
- **Short Switching Time**
- **Low Capacitance**
- **High Spectral Sensitivity**
- **Wide Temperature Range**
- **Near Infrared Range Usage**
- **Package: SOD 67 Case, Black Epoxy Resin, 0.1" (2.54 mm) Lead Spacing**
- **Cathode Marking: Shorter Lead**
- **Applications**
  - **IR-Remote Control of Hi-Fi and TV Sets, Video Tape Recorders, Dimmers, Remote Control**
  - **Light Reflecting Switches**

***Formerly SFH235**

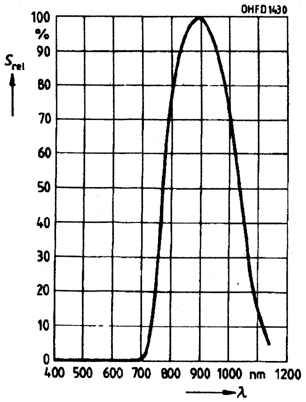
Maximum Ratings

Operating and Storage Temperature (T_{OP}, T_{STG}) .... –40°C to +80°C
Soldering Temperature (2 mm from case bottom) (T_S) $t \leq 3$ sec ...... 230°C
Reverse Voltage (V_R) .... 32 V
Total Power Dissipation (P_{TOT}) T_A=25°C .... 150 mW

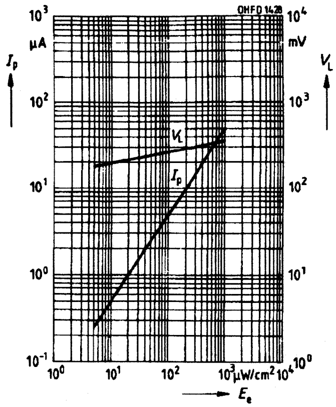
Characteristics (T_A=25°C, λ=870 nm)

Parameter	Symbol	Value	Unit	Condition
Photocurrent	I_P	50 (≥25)	µA	V_R=5 V, E_e=1 mW/cm²
Maximum Photosensitivity Wavelength	λ_{Smax}	900	nm	
Photosensitivity Spectral Range	λ	740 to 1120	nm	S=10% of S_{MAX}
Radiant Sensitive Area	A	7	mm²	
Radiant Sensitive Area Dimension	L x W	2.65x2.65	mm	
Distance Chip Surface to Case Surface	H	0.6 to 0.8	mm	
Half Angle	φ	±65	Deg.	
Dark Current	I_R	2(≤30)	nA	V_R=10 V
Spectral Sensitivity	S_λ	0.63	A/W	
Quantum Yield	η	0.9	Electrons / Photon	
Open-Circuit Voltage	V_O	320(≥250)	mV	E_e=0.5 mW/cm²
Short-Circuit Current	I_{SC}	22	µA	E_e=0.5 mW/cm²
Rise and Fall Time, Photocurrent	t_R, t_F	20	ns	R_L=50 Ω, V_R=5 V, λ=850 nm, I_P=800 µA
Forward Voltage	V_F	1.3	V	I_F=100 mA, E=0
Capacitance	C_O	72	pF	V_R=0 V, f=1 MHz, E=0
Temperature Coefficient, V_L	TC_V	-2.6	mV/K	
Temperature Coefficient, I_{SC}	TC_I	0.03	%/K	
Noise Equivalent Power	NEP	4.0×10^{-14}	W/√Hz	V_R=10 V
Detection Limit	D*	6.6×10^{12}	cm • √Hz/w	V_R=10 V

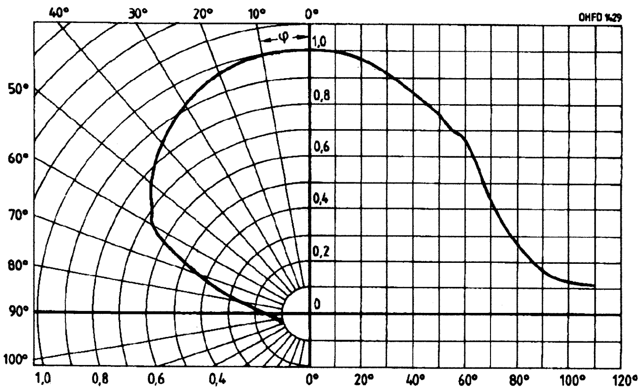
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



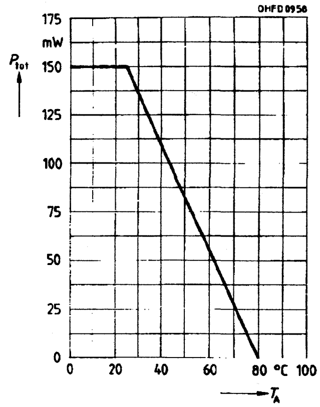
Photocurrent $I_P=f(E_e)$, $V_R=5$ V
Open-circuit voltage $V_L=f(E_e)$



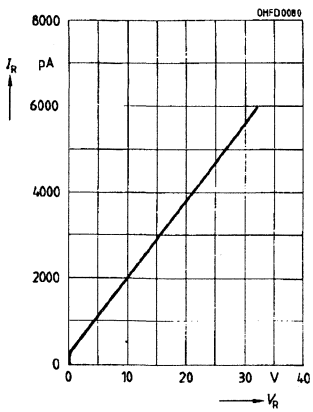
Directional characteristic $S_{REL}=f(\varphi)$



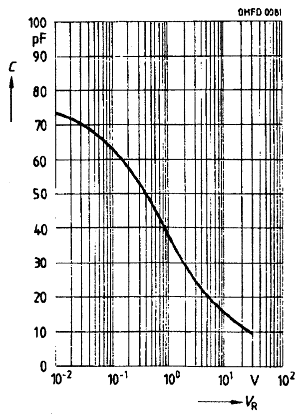
Power dissipation
$P_{TOT}=f(T_A)$



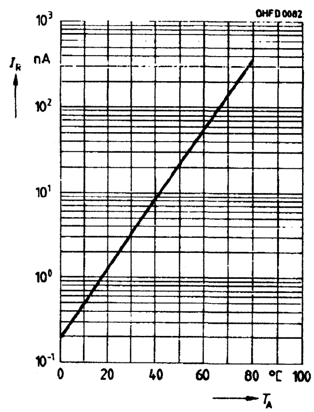
Dark current $I_R=f(V_R)$
E=0



Capacitance $C=f(V_R)$
f=1 MHz, E=0



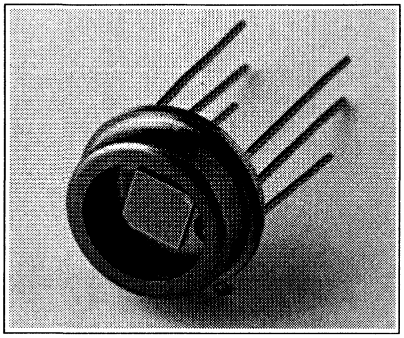
Dark current $I_R=f(T_A)$
$V_R=10$ V, E=0

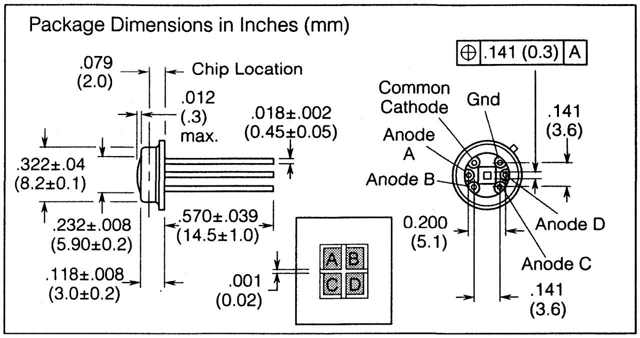


SIEMENS

*SFH244

SILICON FOUR QUADRANT PHOTODIODE





FEATURES

- Silicon Photodiode in Planar Technology
- N-Si Material:
  - Anode, Front Contact
  - Cathode, Back Contact
- Cathode Electrically Isolated
- High Reliability
- No Testable Degradation
- Low Noise
- Low Capacitance
- High Spectral Sensitivity
- Wide Temperature Range
- Visible Light and Near Infrared Range Usage
- Package: Hermetically Sealed, TO39 with Glass Window
- Applications
  - Edge Detection
  - Path and Corner Scanning
  - Measurement and Control

***Formerly SFH244S**

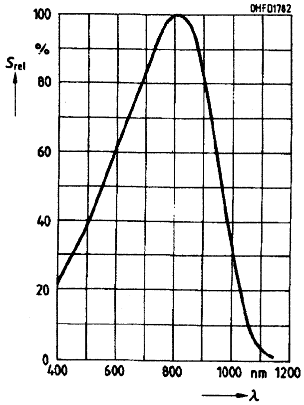
Maximum Ratings

Operating and Storage Temperature (T_{OP}, T_{STG}) .... –40°C to +80°C
Isolation Voltage (V_{IS}) .... 100 V
Reverse Voltage (V_R) .... 20 V
Total Power Dissipation (P_{TOT}) T_A= 25°C .... 50 mW

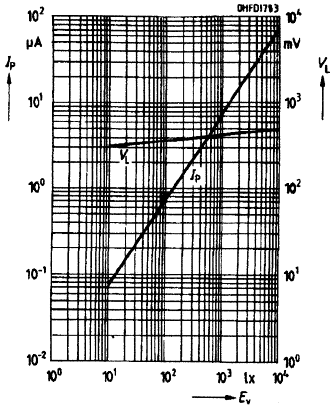
Characteristics (T_A=25°C, standard light A, T=2856 K)

Parameter	Sym	Value	Unit	Condition
Spectral Sensitivity	S	7.4 (≥4.8)	nA/lx	
Maximum Photosensitivity Wavelength	λ_{Smax}	800	nm	
Photosensitivity Spectral Range	λ	350 to 1050	nm	S=10% of S_{MAX}
Radiant Sensitive Area	A	1	mm^2	
Radiant Sensitive Area Dimension	L x W	1x1	mm	
Distance Chip Surface to Case Surface	H	2.2 to 2.5	mm	
Half Angle	φ	±60	Deg.	
Dark Current	I_R	0.2 (≤1)	nA	V_R=10 V
Isolation Current	I_{IS}	0.1 (≤1)	nA	V_{IS}=100 V
Spectral Sensitivity	S_λ	0.6	A/W	λ=850 nm
Maximum Spectral Sensitivity Tolerance	ΔS	±10	%	
Quantum Yield	η	0.87	Electrons / Photon	λ=850 nm
Open-Circuit Voltage	V_O	420 (≥360)	mV	E_V=1000 lx
Short-Circuit Current	I_{SC}	7.4	µA	E_V=1000 lx
Rise and Fall Time, Photocurrent	t_R, t_F	1.5	µs	R_L=1 kΩ, V_R=5 V, λ=850 nm, I_P=50 µA
Forward Voltage	V_F	1.0	V	I_F=40 mA, E=0
Capacitance	C_O	120	pF	V_R=0 V, f=1 MHz, E=0
Temperature Coefficient, V_O	TC_V	–2.6	mV/K	
Temperature Coefficient, I_{SC}	TC_I	0.18	%/K	
Noise Equivalent Power	NEP	1.33×10^{-14}	W/√Hz	V_R=10V, λ=850 nm
Detection Limit	D*	7.5×10^{12}	cm • √Hz/W	V_R=10V, λ=850 nm

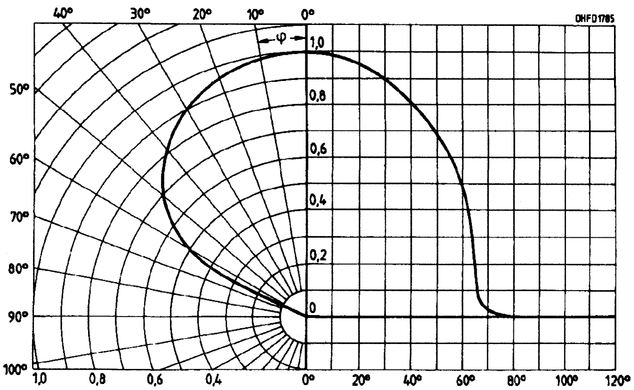
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



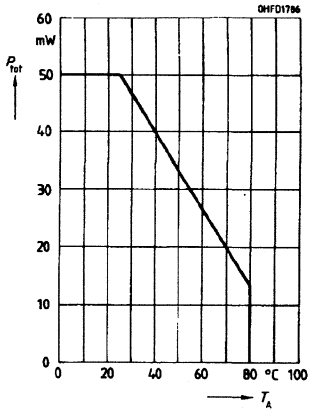
Photocurrent $I_P=f(E_V)$, $V_R=5$ V
Open-circuit voltage $V_L=f(E_V)$



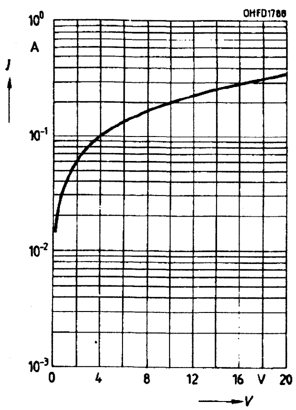
Directional characteristic $S_{REL}=f(\varphi)$



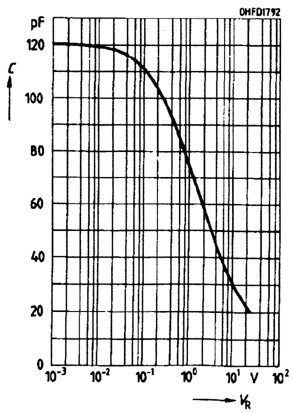
Total power dissipation
$P_{TOT}=f(T_A)$



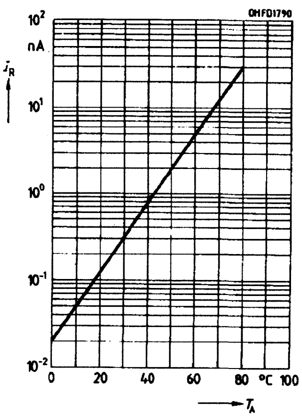
Dark current $I_R=f(V_R)$
E=0



Capacitance C=f (V_R)
f=1 MHz, E=0



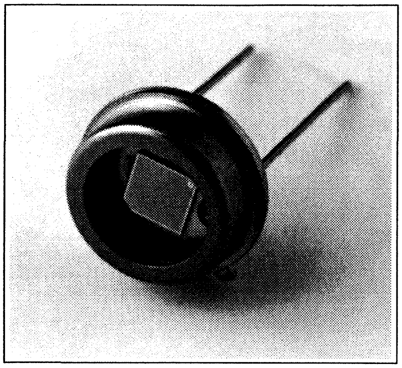
Dark current $I_R=f(T_A)$
$V_R=10$ V, E=0



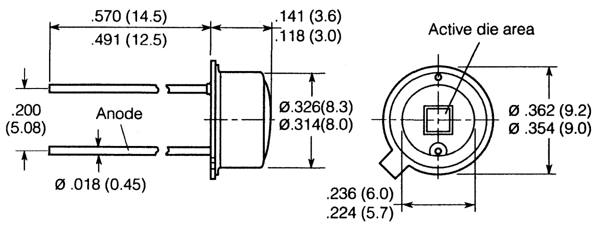
SIEMENS

SFH 291

SILICON PHOTODIODE HIGH UV SENSITIVITY



Package Dimensions in Inches (mm)



FEATURES

- **Anode Marking: Tab at Package Bottom**
- **Usage: Visible Light and Near IR Ranges**
- **High Spectral Sensitivity in UV Range S_λ=0.15 A/W at λ=350 nm**
- **High Reliability**
- **Wide Temperature Range**
- **High Open Circuit Voltage During Element Operation**
- **No Testable Degradation**
- **Package: Hermetically Sealed, Similar to TO5, Window Cap with Special UV Glass, Lead Spacing 0.20" (5.08 mm)**
- **High Linearity**
- **Low Noise**

DESCRIPTION

The SFH 291 is a silicon planar photodiode that can be used as a diode with reverse voltage or for element operation. N-Si material provides positive front and negative back contacts.

Applications include spectrophotometers, UV lasers, industrial electronics, UVA and UVB radiation control in solariums, EPROM eraser instruments, gas burner flame monitoring, arc monitoring, UV water purification facilities, and measurement and control.

Maximum Ratings

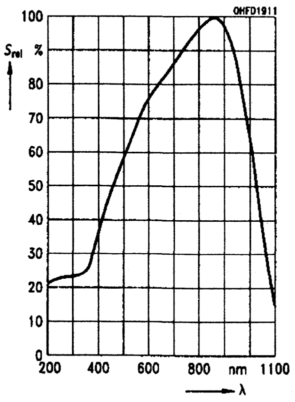
Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –40° to +80°C
Soldering Temperature (2 mm from case bottom) (T_S) t≤3 s .... 230°C
Reverse Voltage (V_R) .... 10 V
Power Dissipation (P_{TOT}) .... 250 mW

Characteristics (T_A=25°C)

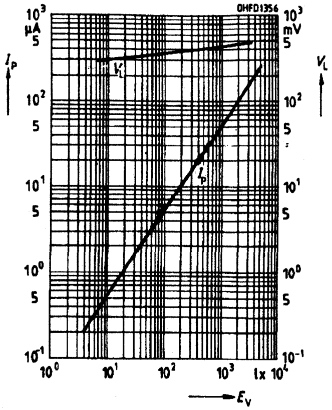
Parameter	Symbol	Value	Unit
Photosensitivity (V_R=5 V, Standard Light A, T=2856 K)	S_V	50	nA/lx
Maximum Photosensitivity Wavelength	λ_{Smax}	850	nm
Spectral Sensitivity Range (S=10% S_{MAX})	λ	230 to 1100	nm
Radiant Sensitive Area	A	7.45	mm²
Radiant Sensitive Area Dimensions	L x W	2.73 x 2.73	mm
Distance, Chip Surface to Case Surface	H	1.9 to 2.3	mm
Half Angle	φ	±55	Deg.
Dark Current (V_R=5 V, E=0)	I_R	0.3 (≤1)	nA
Spectral Sensitivity (λ=350 nm)	S_λ	0.15	A/W
Quantum Yield (λ=350 nm)	η	0.55	electrons/photon
Open Circuit Voltage (E_V=1000 lx)(1)	V_O	420	mV
Short Circuit Current (E_e=0.1 mW/cm², λ=350 nm)	I_{SC}	1 (≥0.6)	µA
(E_V=1000 lx)(1)	I_{SC}	50	µA
Rise and Fall Time of Photocurrent (R_L=1 kΩ, V_R=5 V, λ=850 nm, I_P=50 µA)	t_R, t_F	3	µs
Forward Voltage (I_F=100 mA, E=0)	V_F	1.2	V
Capacitance (V_R=0 V, f=1 MHz, E=0)	C_0	600	pF
Temperature Coefficient of V_O (Standard Light A)	TC_O	–2.6	mV/K
Temperature Coefficient of I_{SC} (Standard Light A)	TC_S	0.2	%/K
Noise Equivalent Power (V_R=5 V, λ=350 nm)	NEP	4.9 x 10^{-14}	W/√Hz
Detection Limit (V_R=5 V, λ=350 nm)	D*	5.6 x 10^{12}	cm•√Hz/W

Note
1. Illuminance shown refers to unfiltered radiation of tungsten filament lamp at color temperature of 2856 K (standard light A per DIN 5033 and IEC publication 306-1).

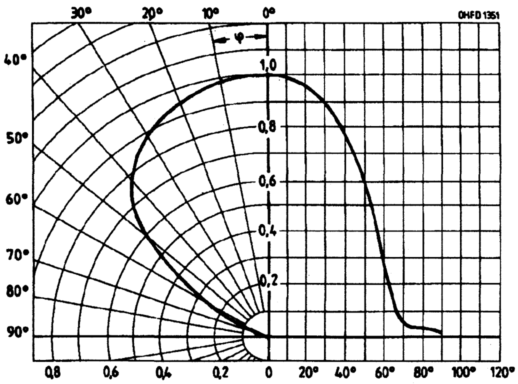
Relative spectral sensitivity $S_{REL}=f(\lambda)$



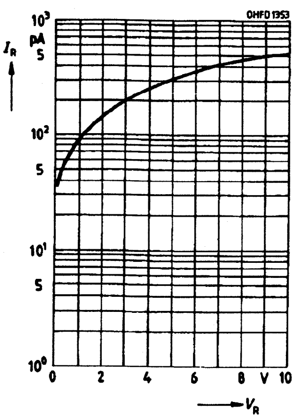
Photocurrent $I_P=f(E_V)$ $V_R=5$ V
Open circuit voltage $V_O=f(E_V)$



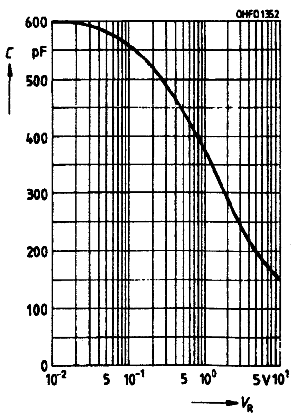
Directional characteristic $S_{REL}=f(\varphi)$



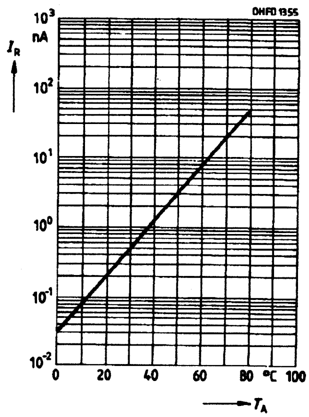
Dark current $I_R=f(V_R)$, E=0



Capacitance $C=f(V_R)$,
f=1 MHz, E=0



Dark current $I_R=f(T_A)$,
$V_R=5$ V, E=0



Photodiodes 8

SIEMENS

IR-B2
INFRARED INDICATOR CARD

APPLICATIONS

- **Check Output of IR LEDs and IR Laser Diodes**
- **In Test Set-ups, Remote Control Devices, Tone Transmitters, Light Reflection Switches, Light Pens, Optical Fiber Systems, etc.**
- **Estimate IR Radiant Intensity and Radiation Pattern**
- **Evaluate IR Transmissiveness of Materials**

Operating principle

The active luminous area of the IR-B2 infrared indicator card consists of fine crystalline semiconductor material doped with rare-earth metals, Europium and Samarium. This material is capable of being charged (stimulated) with light and responds best to blue light. When subjected to IR stimulation, this material emits visible light. The brightness of this emitted light is directly proportional to the intensity of the IR stimulation.

Charging

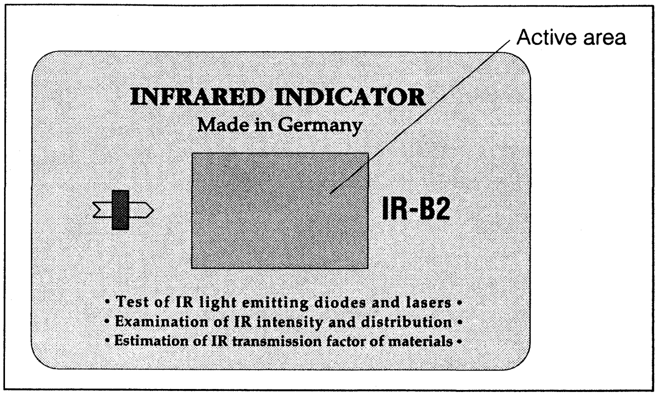
The charging time depends on the intensity of the light source used. A few seconds are sufficient when charging with sunlight, several minutes, however, may be necessary in case of dim light. One should be careful in charging with an incandescent source, as the IR segment of this light source serves to elicit emission, even as the card is excited. So, IR-free light is best and can be obtained by using an IR filter such as a 'SCHOTT' BG39.

Indicator Operation

The indicator card is charged with IR light and emits visible light. The emitted light will be proportional to the intensity ot the IR light. The intensity of the emitted light, however, is not constant but declines over time with each stimulation. The rise and fall time for emission is in the microsecond range. Filters such as RG780 through RG1000 from SCHOTT can be used to isolate specific segments of the IR light to be tested.

Self-Discharge

Like any other energy storing device, the infrared indicator card IR-B2 tends to a self-discharge, resulting in an extremely low emission. An (almost) complete self-discharge takes several months; the saturation charge is stored for about ten minutes.



Service Life

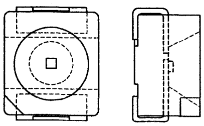
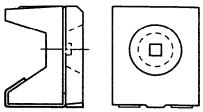
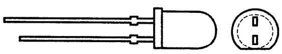
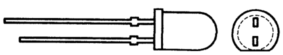
The charge/discharge cycles and full discharge cause no perceptible aging. Overloading is not possible. Strong, steady UV radiation will cause an irreversible decline in sensitivity. The sudden, abrupt failure of the card is impossible.

Further Notes on Use

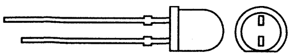
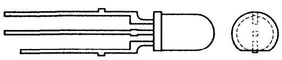
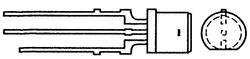
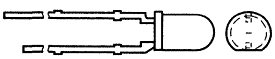
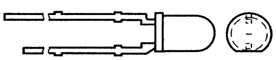
The card has to be charged with daylight or fluorescent light. In case of self-discharge or decline in sensitivity after IR stimulation, the card must be recharged. If the IR source is weak, shield the card from ambient light. The card is humidity resistant and can be used in transmissive or reflective mode. The use of an IR-blocking filter is recommended if using an incandescent source (e. g. SCHOTT BG39).

Parameter	Values	Unit
Peak λ for max. charge (excitation)	approx. 480 (blue)	nm
Indication λ (under fluourescent light)	400 to 700nm (visible light)	nm
Low-end λ of sensitivity to IR (stimulation) (10% of max. sensitivity)	approx. 700 (dark-red)	nm
High-end λ of sensitivity to IR (stimulation) (10% of max. sensitivity)	approx. 1300 (medium IR)	nm
Peak λ for IR sensitivity	approx. 1020 (near IR)	nm
Active area	30 x 20	mm
Outside dimensions (credit-card size)	85.5 x 54.0 x 0.8	mm
Temperature range	–30 to 70°C short-term usage: 100	°C

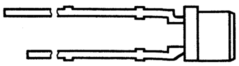
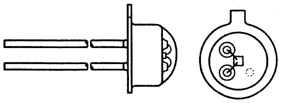
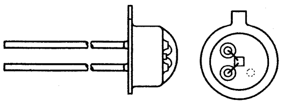
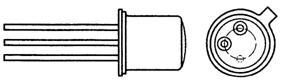
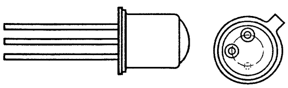
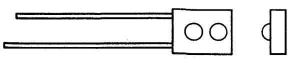
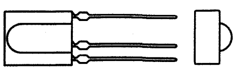
Phototransistors

Package Outline	Part Number	Package Type	Half Angle	Photocurrent λ=950 nm E_E=0.5 mW/cm^2 V_{CE}=5 V mA	Collector Emitter Voltage V	Radiant Sensitive Area mm^2	Features	Page
	SFH320-2	SMT-TOP-LED	±60°	16–32 µA (E_E=0.1 mW/cm^2)	35	0.045	Surface mount PL-CC-2 package. Compatible with automatic placement equipment. Matches IR emitter SFH420.	9–42
	SFH320-3			25–50 µA				
	SFH320-4			≥40 µA				
	SFH320FA-2	SMT-TOP-LED, day-light filter		16–32 µA				
	SFH320FA-3			≥25–50 µA				
	SFH320FA-4			≥40 µA				
	SFH325-1	SMT-SIDE-LED	±60°	10–20 µA	35	0.045	Surface mount PL-CC-2 package. Compatible with automatic placement equipment.	9–45
	SFH325-2			16–32 µA				
	SFH325-3			25–50 µA				
	SFH325-4			≥40 µA				
	SFH325FA-1	SMT-SIDE-LED, day-light filter		10–20 µA				
	SFH325FA-2			16–3 µA2				
	SFH325FA-3			25–50 µA				
	SFH325FA-4			≥40 µA				
	SFH300-2	T1 3/4 (5 mm) clear plastic	±25°	0.63–1.25	35	0.12	IR remote control, high gain. λsmax 850 nm. Matches IR emitter LD271, LD273, SFH484, or SFH485.	9–17
	SFH300-3			1.0–2.0				
	SFH300-4			≥1.6				
	SFH300FA-2	T1 3/4 (5 mm) daylight filter		0.63–1.25				
	SFH300FA-3			1.0–2.0				
	SFH300FA-4			≥1.6				
	SFH313	T1 3/4 (5 mm) clear plastic	±10°	≥4.0	150	0.55	For applications in 460 to 1080 nm range (SFH313) and 880 nm (SFH313FA)	9–36
	SFH313FA	T1 3/4 (5 mm) plastic, daylight filter		≥4.0				

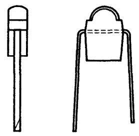
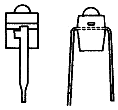
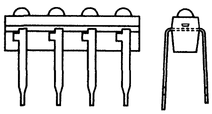
Phototransistors (Continued)

Package Outline	Part Number	Package Type	Half Angle	Photocurrent λ=950 nm E_E=0.5 mW/cm^2 V_{CE}=5 V mA	Collector Emitter Voltage V	Radiant Sensitive Area mm^2	Features	Page
	SFH314	T1 $^3/_4$ (5 mm) clear plastic	±40°	≥0.63	150	0.55	For applications in 460 to 1080 nm range (SFH314) and 880 nm (SFH314FA)	9–39
	SFH314FA	T1 $^3/_4$ (5 mm) plastic, daylight filter						
	SFH303-2	T1 $^3/_4$ (5 mm) clear plastic	±20°	1.0–2.0	50	0.30	Good linearity, high photosensitivity. Visual and near IR range usage.	9–21
	SFH303-3			1.6–3.2				
	SFH303-4			≥2.5				
	SFH303FA-2	T1 $^3/_4$ (5 mm) plastic, daylight filter		1.0–2.0				
	SFH303FA-3			1.6–3.2				
	SFH303FA-4			≥2.5				
	SFH303P	Clear plastic	±75°	≥0.16	50	0.30	T1 $^3/_4$ flat (5 mm). Good linearity, high photosensitivity. Visual and near IR range usage.	9–23
	SFH303PFA	Plastic, daylight filter		≥0.16				
	SFH309-2	T1 (3 mm) clear plastic	±12°	0.4–0.8	35	0.45	IR remote control. Narrow acceptance angle. Matches IR emitter SFH409.	9–27
	SFH309-3			0.63–1.25				
	SFH309-4			1.0–2.0				
	SFH309-5			≥1.6				
	SFH309-6			≥2.5				
	SFH309FA-2			0.4–0.8				
	SFH309FA-3			0.63–1.25				
	SFH309FA-4			1.0–2.0				
	SFH309FA-5			≥1.6				
	SFH310	T1 (3 mm) plastic	±25°	≥0.4	150	0.19	For applications in 400 to 1100 nm range (SFH310) and 880 nm (SFH310FA)	9–33
	SFH310FA	T1 (3 mm) plastic, daylight filter		≥0.4				

Phototransistors (Continued)

Package Outline	Part Number	Package Type	Half Angle	Photocurrent λ=950 nm E_E=0.5 mW/cm^2 V_{CE}=5 V mA	Collector Emitter Voltage V	Radiant Sensitive Area mm^2	Features	Page
	SFH309P	T1 (3 mm) clear plastic	±75°	420 μA	35	0.045	No base connection. Applications: light-reflecting switches, measurement and control.	9–30
	SFH309PFA	T1 (3 mm) plastic, daylight filter		200 μA				
	BP103-2	Similar to TO-18, clear plastic lens	±55°	0.08–0.16	50	0.12	IR remote control. λsmax 850 nm. Matches IR emitter LD242.	9–1
	BP103-3			0.125–0.25				
	BP103-4			0.2–0.4				
	BP103-5			≥0.32				
	SFH302-2	Hermetic TO-18 with base connection	±40°	0.4–0.8	50	0.675	450 nm to 1100 nm applications: light reflecting switches, industrial electronics.	9–19
	SFH302-3			0.63–1.25				
	SFH302-4			1–2				
	SFH302-5			1.6–3.2				
	SFH302-6			≥2.5				
	BPX38-2	TO-18 hermetic package, flat glass lens	±40°	02.–0.4	50	0.675	Wide acceptance angle 80°. λsmax 880 nm. Matches IR emitter SFH402.	9–4
	BPX38-3			0.32.–0.63				
	BPX38-4			0.5–1.0				
	BPX38-5			≥0.8				
	BPX43-2	TO-18 hermetic package, glass lens	±15°	0.8–1.6	50	0.675	Narrow acceptance angle 30°. λsmax 880 nm. Matches IR emitter SFH401.	9–7
	BPX43-3			1.25–2.5				
	BPX43-4			2.0–4.0				
	BPX43-5			≥3.2				
	BPY62-2	TO-18 hermetic package, glass lens	±8°	0.5–1.0	32	0.12	Very narrow acceptance angle 16°. λsmax 850 nm. Matches IR emitter SFH400.	9–12
	BPY62-3			0.8–1.6				
	BPY62-4			1.25–2.5				
	BPY62-5			≥2.0				
	LPT-80A	Rectangular clear plastic. Side facing	±40°	≥0.2	30	—	λsmax 870 nm. Matches IR emitters IRL80A/81A.	9–15
	SFH506	Daylight filter	±55°	—	—	—	Photodiode with hybrid IC for remote control.	9–48

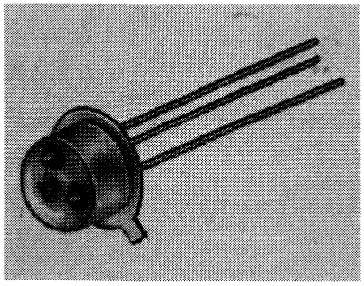
Phototransistors (Continued)

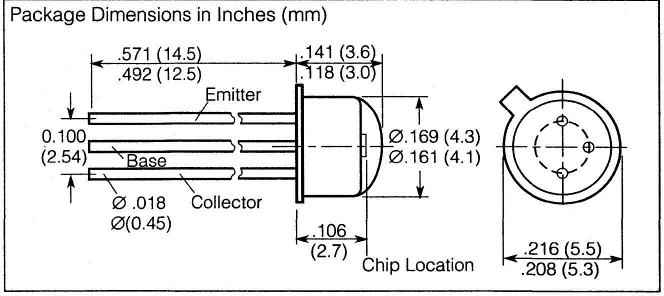
Package Outline	Part Number	Package Type		Half Angle	Photocurrent λ=950 nm E_E=0.5 mW/cm^2 V_{CE}=5 V mA	Collector Emitter Voltage V	Radiant Sensitive Area mm^2	Features	Page
	SFH305-2	Minitature-clear plastic, axial leads		±16°	0.25–0.5	32	0.17	Narrow acceptance angle 32°. λsmax 850 nm. Matches IR emitter SFH405.	9–25
	SFH305-3				0.4–0.8				
	BPX81-2	1	transistor	±18°	0.25–0.5	32	0.17	Array package. Axial leads. λsmax 850 nm. BPX81–matches IR emitter LD261. BPX82-89, BPX80–matches IR emitters LD262–9, LD260.	9–10
	BPX81-3				0.4–0.8				
	BPX81-4				≥0.63				
	BPX82	2	transistors		≥0.32		0.17 per transistor		
	BPX83	3							
	BPX84	4							
	BPX85	5							
	BPX86	6							
	BPX87	7							
	BPX88	8							
	BPX89	9							
	BPX80	10							

SIEMENS

BP 103

SILICON NPN PHOTOTRANSISTOR





FEATURES

- **Silicon NPN Epitaxial Phototransistor**
- **Wide Acceptance Angle, 110°**
- **Four Sensitivity Ranges**
- **High Reliability**
- **Short Switching Time**
- **Good Linearity**
- **Matches IR Emitter LD242**
- **Package: Modified TO18**
- **Clear Plastic Lens**

DESCRIPTION

The BP103 is an epitaxial NPN silicon planar phototransistor in a modified TO18 (18 A 3 DIN 41876) package with a clear plastic lens. The lens provides a wide angle for incident light.

The emitter lead is marked by a tab on the case bottom. The collector is electrically connected to the metallic case.

Applications include: electronic flashes, light reflecting switches, light curtains, and measurement and control.

Maximum Ratings

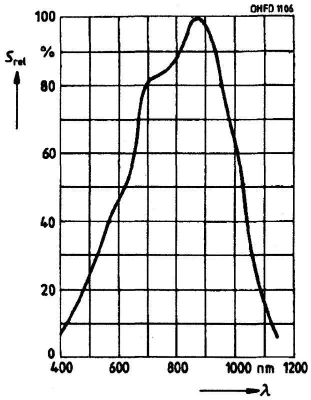
Operating and Storage Temperature Range (T_{OP}, T_{STG}) ....–40° to +80°C
Soldering Temperature (≥2 mm from case bottom)
Dip Soldering Time (T_s) t≤5 s .... 260°C
Iron Soldering Time (T_s) t≤3 s .... 300°C
Collector Emitter Voltage (V_{CEO}) .... 50 V
Emitter Base Voltage (V_{EB}) .... 7 V
Collector Current (I_C) .... 100 mA
Collector Peak Current (I_{PK}) t<10 µs .... 200 mA
Power Dissipation (P_{TOT}) T_A=25°C .... 150 mW
Thermal Resistance (R_{THJA}) .... 500 K/W

Characteristics (T_A=25°C)

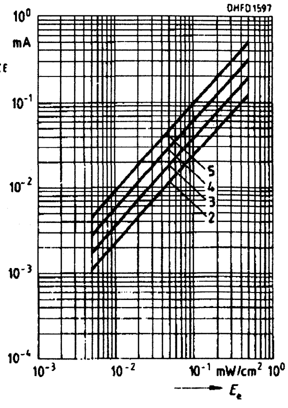
Parameter	**Symbol**	**Value**	**Unit**
Maximum Sensitivity Wavelength	λ_{Smax}	850	nm
Spectral Range, Photosensitivity	λ	420 to 1130	nm
Radiant Sensitive Area	A	0.12	mm²
Die Area Dimensions	L x W	0.5 x 0.5	mm
Distance, Die Surface to Case Surface	H	0.2 to 0.8	mm
Half Angle	φ	±55	Deg.
Photocurrent, Collector–Base Diode			
(E=0.5 mW/cm², V_{CB}=5 V)	I_{PCB}	0.9	µA
(E_V=1000 lx, std. light A, V_{CB}=5 V)	I_{PCB}	2.7	µA
Capacitance			
(V_{CE}=0 V, f=1 MHz, E=0)	C_{CE}	8	pF
(V_{CB}=0 V, f=1 MHz, E=0)	C_{CB}	11	pF
(V_{EB}=0 V, f=1 MHz, E=0)	C_{EB}	19	pF
Collector Emitter Leakage Current			
(V_{CEO}=35 V, E=0)	I_{CEO}	5 (≤100)	nA

Parameter	–2	–3	–4	–5	Unit
Photocurrent, Collector–Emitter (E_e=0.5 mW/cm², λ=950 nm V_{CE}=5 V) I_{PCE}	.08 –.16	.125 –.25	.20 –.40	≥0.32	mA
(E_V=1000 lx, standard light A, V_{CE}=5 V) I_{PCE}	0.38	0.60	0.95	1.4	mA
Rise/Fall Time (I_C=1 mA, V_{CC}=5 V, R_L=1 kΩ) t_R, t_F	5	7	9	12	µs
Collector Emitter Saturation Voltage (I_C=I_{PCEmin}[1] x 0.3, λ=950 nm) V_{CEsat}	150	150	150	150	mV
Current Gain (E=0.5 mW/cm², λ=950 nm, V_{CE}=5 V) $\frac{I_{PCE}}{I_{PCB}}$	140	210	340	530	

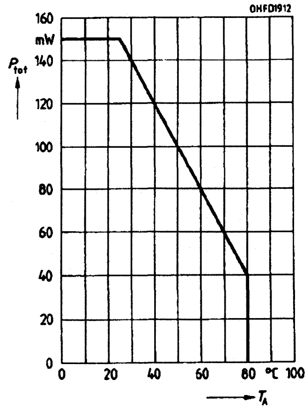
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



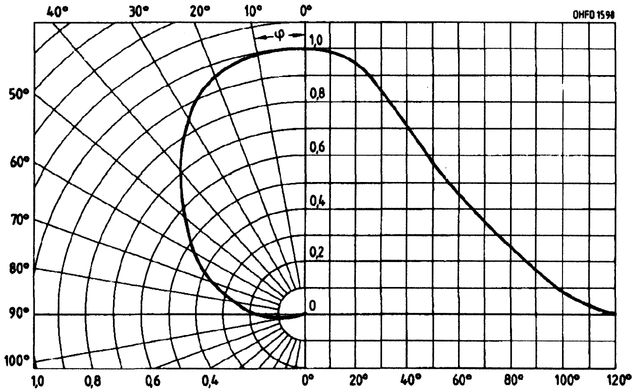
Photocurrent $I_{PCE}=f(E_e)$, $V_{CE}=5$ V



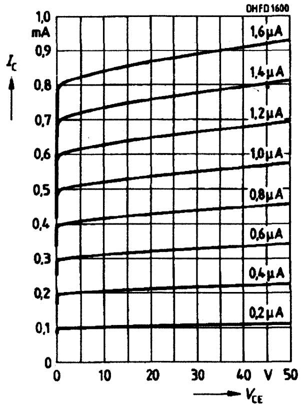
Total power dissipation
$P_{TOT}=f(T_A)$



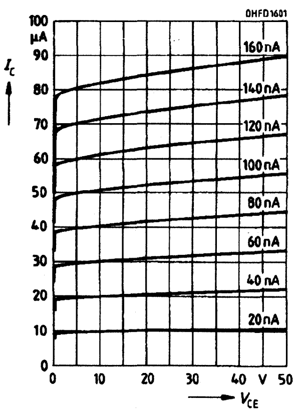
Directional characteristic
$S_{REL}=f(\varphi)$



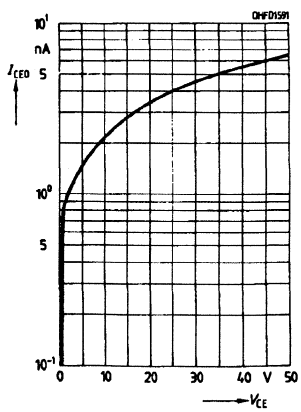
Output characteristics
$I_C=f(V_{CE})$, I_B=Parameter



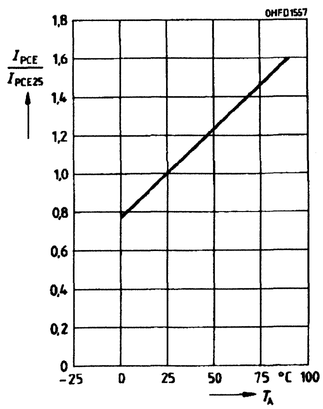
Output characteristics
$I_C=f(V_{CE})$, I_B=Parameter



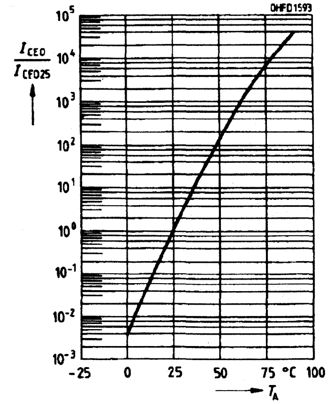
Dark current $I_{CEO}=f(V_{CE})$, E=0



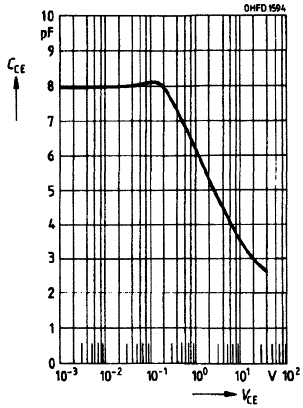
Photocurrent $I_{PCE}/I_{PCE25}=f(T_A)$,
$V_{CE}=5$ V



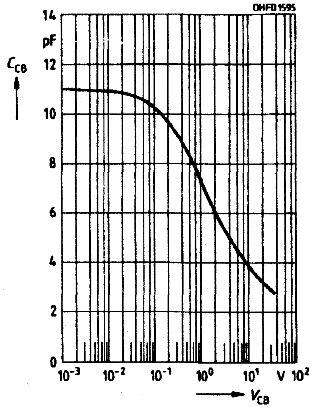
Dark current $I_{CEO}/I_{CEO25}=f(T_A)$, V_{CE}=25 V, E=0



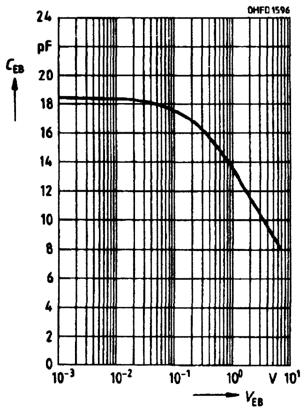
Collector emitter capacitance
$C_{CE}=f(V_{CE})$, f=1 MHz, E=0



Collector base capacitance
$C_{CB}=f(V_{CB})$, f=1 MHz, E=0



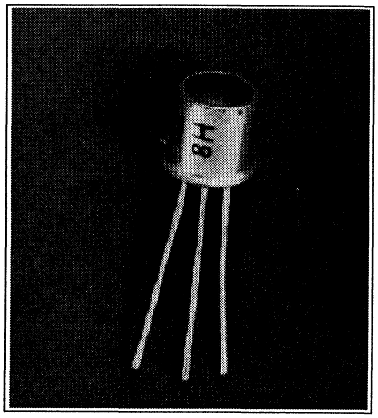
Emitter base capacitance
$C_{EB}=f(V_{EB})$, f=1 MHz, E=0



SIEMENS

BPX38

SILICON NPN PHOTOTRANSISTOR



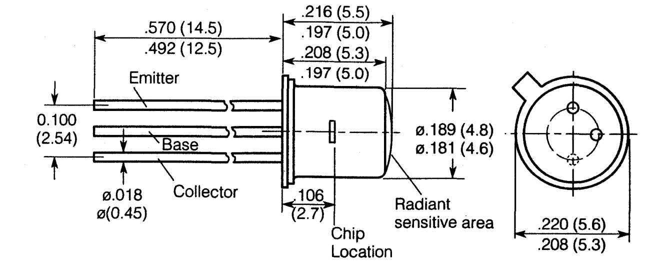
FEATURES

- **Silicon NPN Epitaxial Phototransistor**
- **Premium Hi-Rel Device**
- **Moderate Gain**
- **Short Switching Time**
- **Four Sensitivity Ranges**
- **Package: TO18 Hermetic**
- **Flat Glass Lens**
- **Visible and IR Range Usage**

DESCRIPTION

The BPX38 is an high-sensitivity epitaxial NPN silicon planar phototransistor in a TO18 (18 A 3 DIN 41876) package with a flat lens. The collector is electrically connected to the metallic case.

Package Dimensions in Inches (mm)



Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –55° to +125°C
Soldering Temperature (≥2 mm from case bottom)
Dip Soldering Time (T_s) t≤5 s .... 260°C
Iron Soldering Time (T_s) t≤3 s .... 300°C
Collector Emitter Voltage (V_{CEO}) .... 50 V
Emitter Base Voltage (V_{EB}) .... 7 V
Collector Current (I_C) .... 50 mA
Collector Peak Current (I_{PK}) t<10 µs .... 200 mA
Power Dissipation (P_{TOT}) T_A=25°C .... 220 mW
Thermal Resistance (R_{THJA}) .... 450 K/W

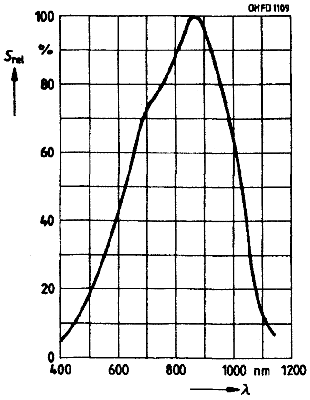
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Maximum Sensitivity Wavelength	λ_{Smax}	880	nm
Spectral Range, Photosensitivity	λ	450 to 1120	nm
Radiant Sensitive Area	A	0.675	mm²
Die Area Dimensions	L x W	1 x 1	mm
Distance, Die Surface to Case Surface	H	2.05 to 2.35	mm
Half Angle	φ	±40	Deg.
Photocurrent, Collector–Base Diode			
(E_e=0.5 mW/cm², V_{CB}=5 V)	I_{PCB}	1.8	µA
(E_V=1000 lx, V_{CB}=5 V)	I_{PCB}	5.5	µA
Capacitance			
(V_{CE}=0 V, f=1 MHz, E=0)	C_{CE}	23	pF
(V_{CB}=0 V, f=1 MHz, E=0)	C_{CB}	39	pF
(V_{EB}=0 V, f=1 MHz, E=0)	C_{EB}	47	pF
Collector Emitter Leakage Current			
(V_{CE}=25 V, E=0)	I_{CEO}	20 (≤300)	nA

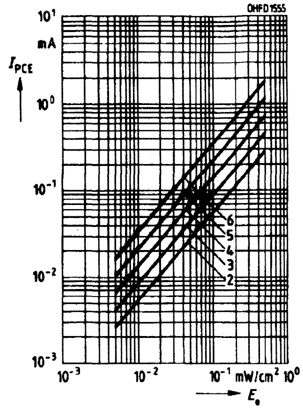
Parameter	–2	–3	–4	–5 (1)	Unit
Photocurrent, Collector–Emitter (E_V=1000 lx, standard light A, V_{CE}=5 V) I_{PCE}	0.95	1.5	2.3	3.6	mA
(E=0.5 mW/cm², λ=950 nm, V_{CE}=5 V) I_{PCE}	.2 to .4	.32 to .63	.5 to 1.0	.8 to 1.6	mA
Rise/Fall Time (I_C=1 mA, V_{CC}=5 V, R_L=1 kΩ) t_R, t_F	9	12	15	18	µs
Collector Emitter Saturation Voltage (I_C=I_{PCEmin}[1] x 0.3, λ=950nm E_e=0.5 mW/cm²) V_{CEsat}	200	200	200	200	mV
Current Gain (E_e=0.5 mW/cm², λ=950 nm, V_{CE}=5 V) $\frac{I_{PCE}}{I_{PCB}}$	170	280	420	650	

Notes
1. Availability subject to yield.

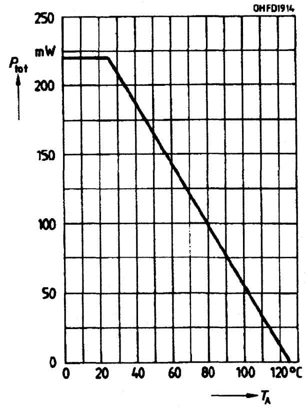
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



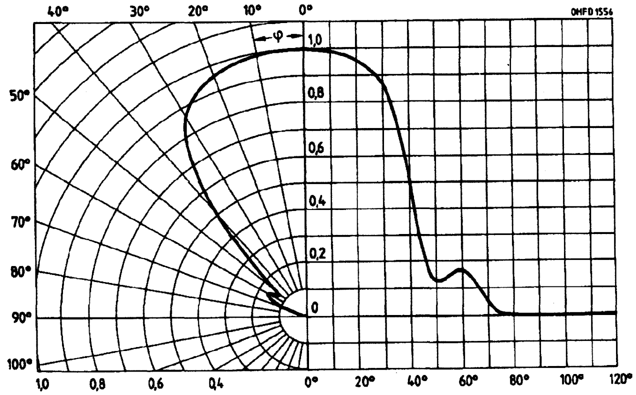
Photocurrent $I_{PCE}=f(E_e)$, $V_{CE}=5$ V



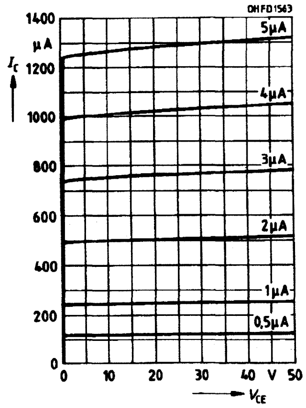
Total power dissipation
$P_{TOT}=f(T_A)$



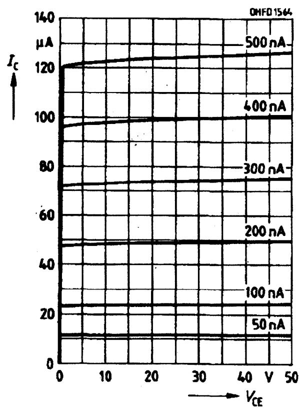
Directional characteristic
$S_{REL}=f(\varphi)$



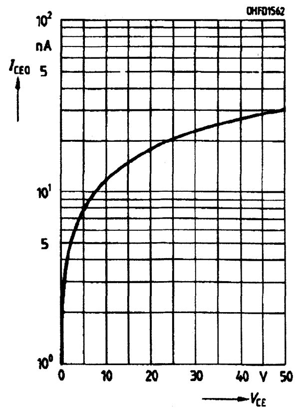
Output characteristics
$I_C=f(V_{CE})$, I_B=Parameter



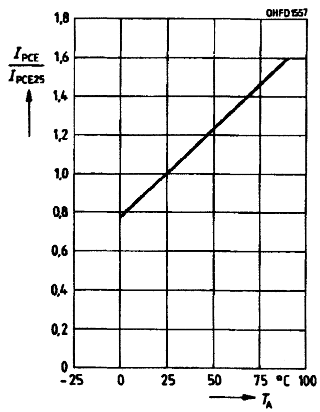
Output characteristics
$I_C=f(V_{CE})$, I_B=Parameter



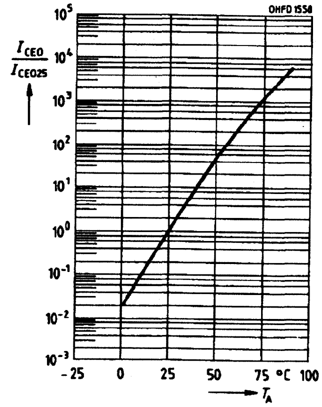
Dark current $I_{CEO}=f(V_{CE})$, E=0



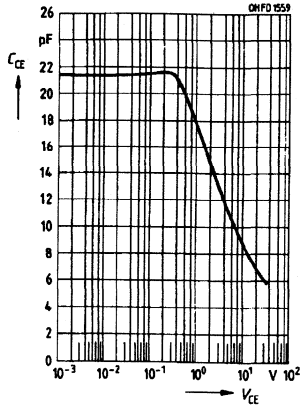
Photocurrent $I_{PCE}/I_{PCE25}=f(T_A)$,
$V_{CE}=5$ V



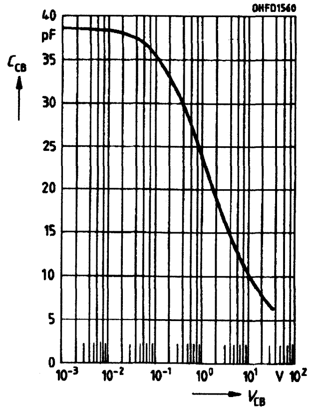
Dark current $I_{CEO}/I_{CEO25}=f(T_A)$, $V_{CE}=25$ V, E=0



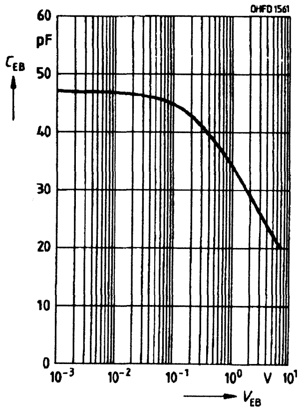
Collector emitter capacitance
$C_{CE}=f(V_{CE})$, f=1 MHz, E=0



Collector base capacitance
$C_{CB}=f(V_{CB})$, f=1 MHz, E=0



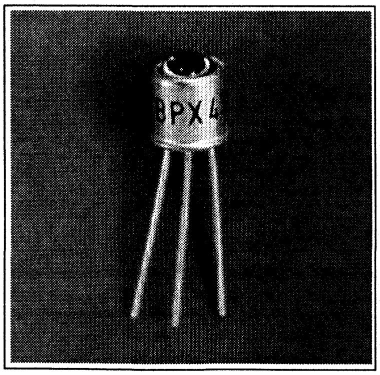
Emitter base capacitance
$C_{EB}=f(V_{EB})$, f=1 MHz, E=0



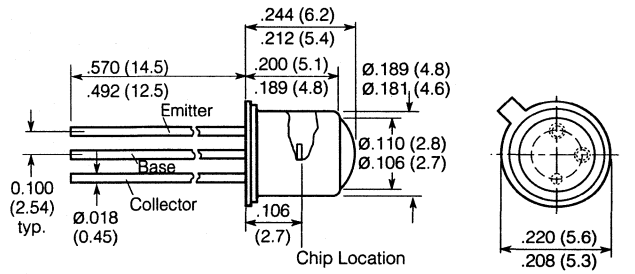
SIEMENS

BPX43

SILICON NPN PHOTOTRANSISTOR



Package Dimensions in Inches (mm)



FEATURES

- **Silicon NPN Epitaxial Phototransistor**
- **Narrow Acceptance Angle, 30°**
- **Premium Hi-Rel Device**
- **Very High Gain**
- **Short Switching Time**
- **Good Linearity**
- **High Spectral Sensitivity**
- **Four Sensitivity Ranges**
- **Package: TO18 Hermetic**
- **Rounded Glass Lens**

DESCRIPTION

The BPX43 is an epitaxial NPN silicon planar phototransistor in a TO18 (18 A 3 DIN 41876) package with a glass lens. The collector is electrically connected to the metallic case.

Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –55° to +125°C
Soldering Temperature (≥2 mm from case bottom)
  Dip Soldering Time (T_s) t≤5 s .... 260°C
  Iron Soldering Time (T_s) t≤3 s .... 300°C
Collector Emitter Voltage (V_{CEO}) .... 50 V
Emitter Base Voltage (V_{EB}) .... 7 V
Collector Current (I_C) .... 50 mA
Collector Peak Current (I_{PK}) t<10 µs .... 200 mA
Power Dissipation (P_{TOT}) T_A=25°C .... 220 mW
Thermal Resistance (R_{THJA}) .... 450 K/W

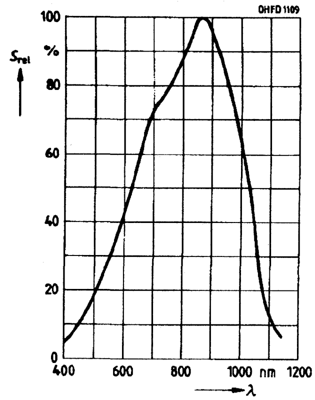
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Maximum Sensitivity Wavelength	λ_{Smax}	880	nm
Spectral Range, Photosensitivity	λ	450 to 1100	nm
Radiant Sensitive Area	A	0.675	mm²
Die Area Dimensions	L x W	1 x 1	mm
Distance, Die Surface to Case Surface	H	2.4 to 3.0	mm
Half Angle	φ	±15	Deg.
Photocurrent, Collector–Base Diode			
(E_e=0.5 mW/cm², V_{CB}=5 V)	I_{PCB}	11	µA
(E_V=1000 lx, V_{CB}=5 V)	I_{PCB}	35	µA
Capacitance			
(V_{CE}=0 V, f=1 MHz, E=0)	C_{CE}	23	pF
(V_{CB}=0 V, f=1 MHz, E=0)	C_{CB}	39	pF
(V_{EB}=0 V, f=1 MHz, E=0)	C_{EB}	47	pF
Collector Emitter Leakage Current			
(V_{CE}=25 V, E=0)	I_{CEO}	20 (≤300)	nA

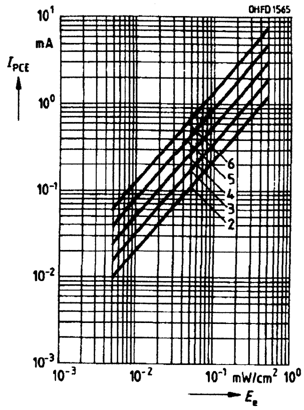
Parameter	–2	–3	–4	–5 (1)	Unit
Photocurrent, Collector–Emitter (E_e=0.5 mW/cm², λ=950 nm, V_{CE}=5 V) I_{PCE}	.8 to 1.6	1.25 to 2.5	2 to 4	3.2 to 6.3	mA
(E_V=1000 lx, standard light A, V_{CE}=5 V) I_{PCE}	3.8	6.0	9.5	15.0	mA
Rise/Fall Time (I_C=1 mA, V_{CC}=5 V, R_L=1 kΩ) t_R,t_F	9	12	15	18	µs
Collector Emitter Saturation Voltage (I_C=I_{PCEmin}[1] x 0.3, λ=950 nm, E_e=0.5 mW/cm²) V_{CEsat}	200	220	240	260	mV
Current Gain (E_e=0.5 mW/cm², λ=950 nm, V_{CE}=5 V) $\frac{I_{PCE}}{I_{PCB}}$	110	170	270	430	640

Notes
1. Availability subject to yield.

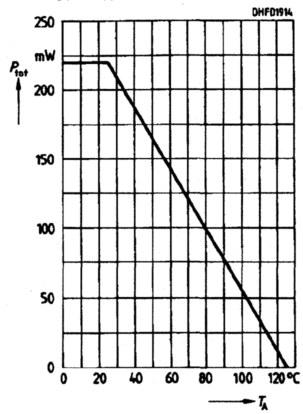
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



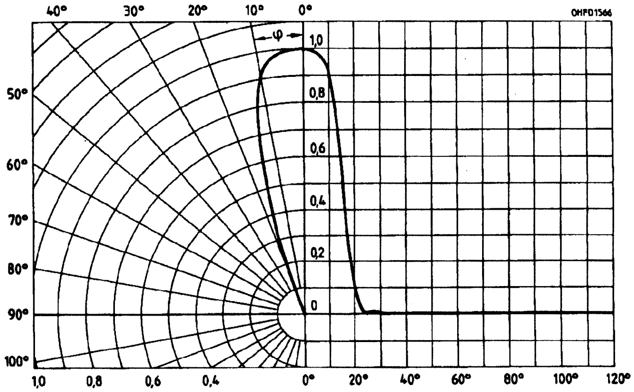
Photocurrent $I_{PCE}=f(E_e)$



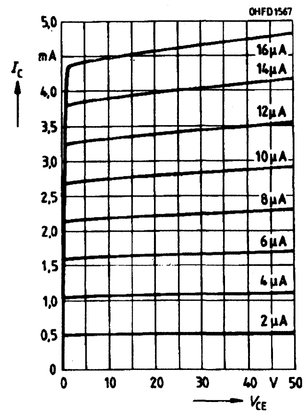
Total power dissipation
$P_{TOT}=f(T_A)$



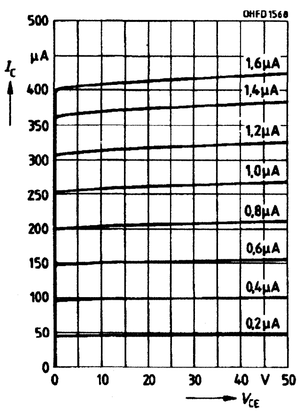
Directional characteristic
$S_{REL}=f(\varphi)$



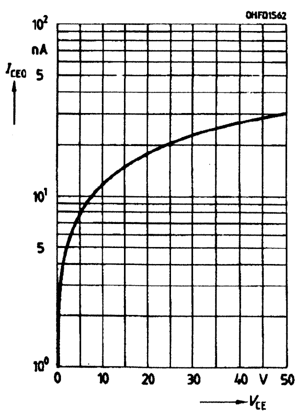
Output characteristics
$I_C=f(V_{CE})$, I_B=Parameter



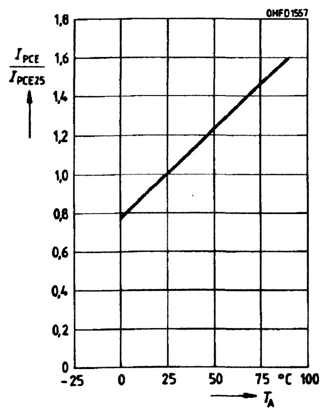
Output characteristics
$I_C=f(V_{CE})$, I_B=Parameter



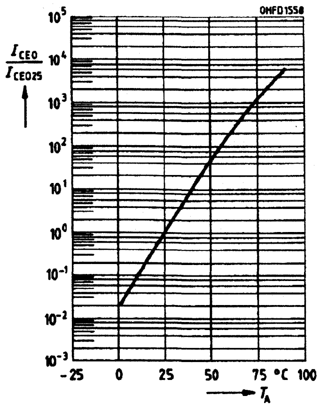
Dark current $I_{CEO}=f(V_{CE})$, E=0



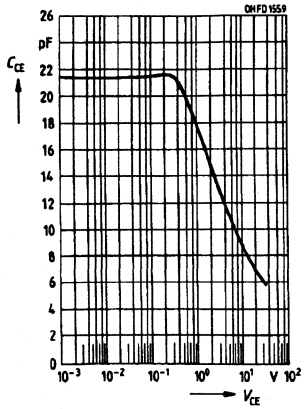
Photocurrent $I_{PCE}/I_{PCE25}=f(T_A)$,
V_{CE}=5 V



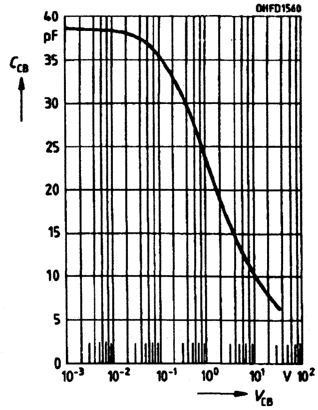
Dark current $I_{CEO}/I_{CEO25}=f(T_A)$,
$V_{CE}=25$ V, E=0



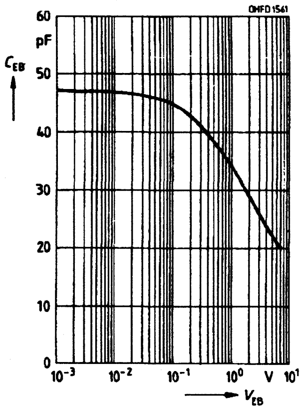
Collector emitter capacitance
$C_{CE}=f(V_{CE})$, f=1 MHz, E=0



Collector base capacitance
$C_{CB}=f(V_{CB})$, f=1 MHz, E=0



Emitter base capacitance
$C_{EB}=f(V_{EB})$, f=1 MHz, E=0

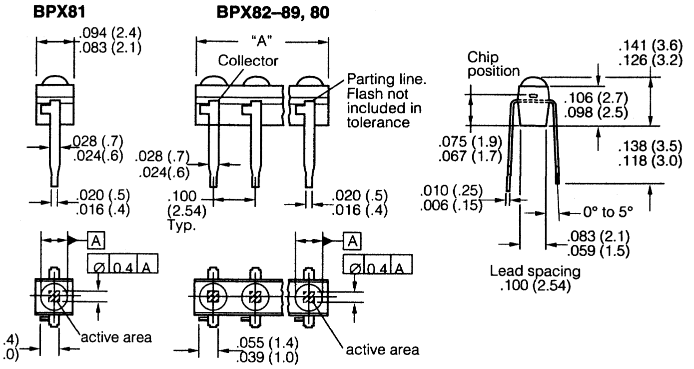


SIEMENS

SINGLE TRANSISTOR BPX81
2–10 TRANSISTOR ARRAYS BPX82–89, 80
SILICON NPN PHOTOTRANSISTOR

Package Dimensions in Inches (mm)

Part No.	Dimension "A". Min.		Max.	
BPX 82	.177	(4.5)	.193	(4.9)
BPX 83	.275	(7.0)	.291	(7.4)
BPX 84	.377	(9.6)	.393	(10)
BPX 85	.476	(12.1)	.491	(12.5)
BPX 86	.574	(14.6)	.590	(15)
BPX 87	.676	(17.2)	.692	(17.6)
BPX 88	.774	(19.7)	.790	(20.1)
BPX 89	.876	(22.3)	.892	(22.7)
BPX 80	.975	(24.8)	.990	(25.2)



FEATURES

- **Silicon NPN Epitaxial Phototransistor**
- **Narrow Acceptance Angle, 36°**
- **Low Cost**
- **High Gain**
- **Miniature Size**
- **Available as Single Transistor (BPX81) or Arrays**
  - **BPX82, Two Transistors**
  - **BPX83, Three Transistors**
  - **BPX84, Four Transistors**
  - **BPX85, Five Transistors**
  - **BPX86, Six Transistors**
  - **BPX87, Seven Transistors**
  - **BPX88, Eight Transistors**
  - **BPX89, Nine Transistors**
  - **BPX80, Ten Transistors**
- **Matches IR Emitter LD261**

DESCRIPTION

The BPX81 is a single transistor plastic encapsulated phototransistor; the BPX82 to BPX89, BPX80 are arrays. These silicon NPN epitaxial planar phototransistors have standard lead spacing of 0.100" (2.54 mm).

The small angle of the lens-shaped window avoids optical "cross modulation" from an adjacent system. The collector leads are marked by tabs.

Applications include use with filament lamps and infrared light. The BPX81 can be mounted on PC boards and also can be used as a detector with IR emitter LD261 in miniature light barriers.

Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –40° to +80°C
Soldering Temperature (≥2 mm from case bottom)
Dip Soldering Time (T_s) t≤5 s .... 230°C
Iron Soldering Time (T_s) t≤3 s .... 300°C
Collector Emitter Voltage (V_{CEO}) .... 32 V
Collector Current (I_C) .... 50 mA
Collector Peak Current (I_{PK}) t<10 µs .... 200 mA
Power Dissipation (P_{TOT}) T_A=25°C .... 90 mW
Thermal Resistance (R_{THJA}) .... 750 K/W

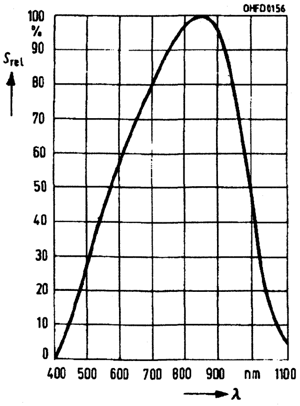
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Maximum Sensitivity Wavelength	λ_{Smax}	850	nm
Spectral Range, Photosensitivity	λ	440 to 1070	nm
Radiant Sensitive Area	A	0.17	mm^2
Die Area Dimensions	L x W	0.6 x 0.6	mm
Distance, Die Surface to Case Surface	H	1.3 to 1.9	mm
Half Angle	φ	±18	Deg.
Capacitance (V_{CE}=0 V, f=1 MHz, E=0)	C_{CE}	6	pF
Collector Emitter Leakage Current (V_{CE}=25 V, E=0)	I_{CEO}	25 (≤200)	nA

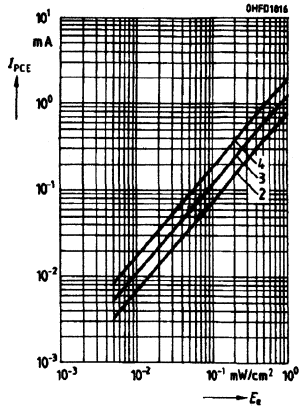
Parameter	BPX81-2	BPX81-3	BPX81-4 (2)	BPX82–89 BPX80	Unit
Transistor Photocurrent, Collector–Emitter (E_e=0.5 mW/cm², λ=950 nm V_{CE}=5 V) I_{PCE}	.25 to .50	.40 to .80	≥.63	.32 to <1.0	mA
(E_V=1000 lx, standard light A, V_{CE}=5 V) I_{PCE}	1.4	2.2	3.4	2	mA
Rise/Fall Time (I_C=1 mA, V_{CE}=5 V, R_L=1 kΩ) t_R, t_F	5.5	6	8	6	µs
Collector Emitter Saturation Voltage V_{CEsat} (I_C=I_{PCEmin}[1] x 0.3, λ=950 nm E_e=0.5 mW/cm², V_{CE}=5 V)	150	150	150	150	mV

Notes
1. Availability subject to yield.

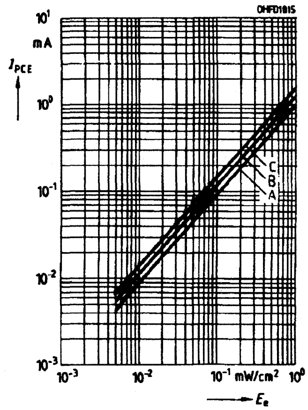
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



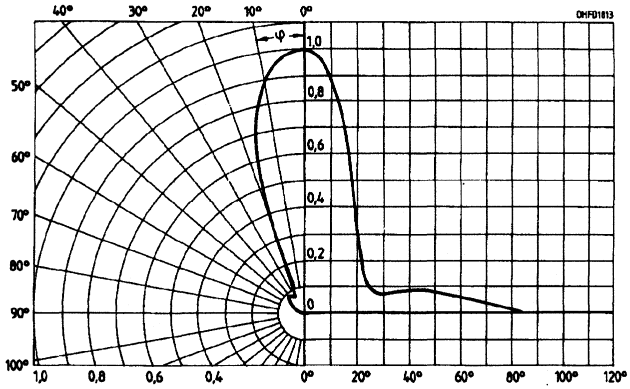
Photocurrent–BPX81 $I_{PCE}=f(E_e)$



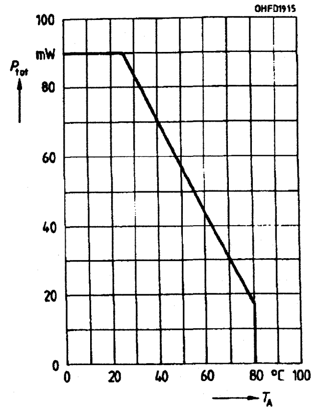
Photocurrent–BPX82–89, 80 $I_{PCE}=f(E_e)$



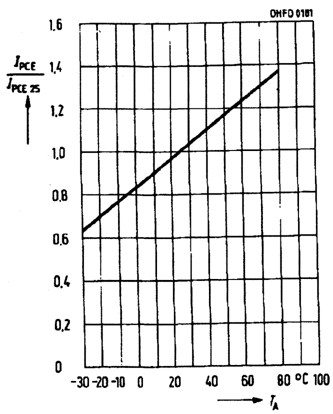
Directional characteristic
$S_{REL}=f(\varphi)$



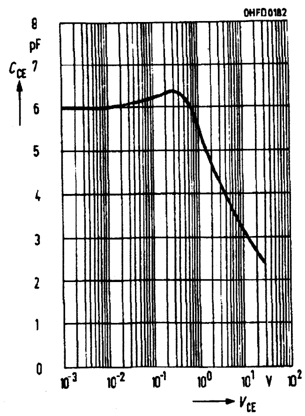
Total power dissipation
$P_{TOT}=f(T_A)$



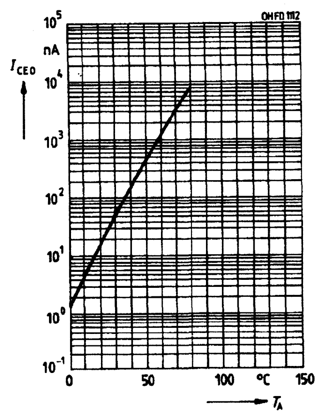
Photocurrent $I_{PCE}/I_{PCE25}=f(T_A)$,
V_{CE}=5 V



Collector emitter capacitance
$C_{CE}=f(V_{CE})$, f=1 MHz, E=0



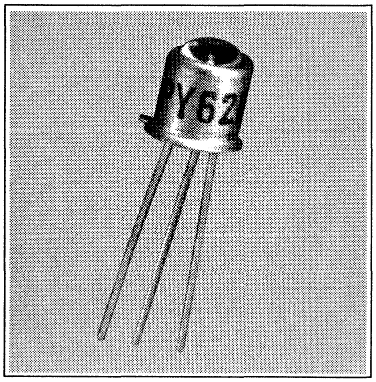
Dark current–BPX81
$I_{CEO}=f(T_A)$, V_{CE}=25 V, E=0



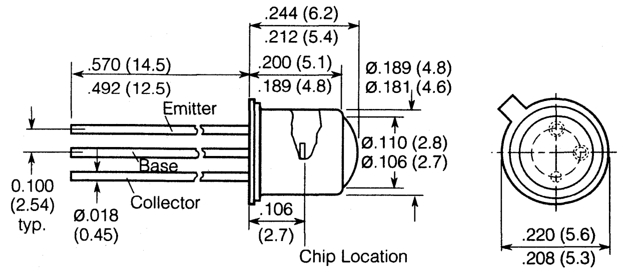
SIEMENS

BPY62

SILICON NPN PHOTOTRANSISTOR



Package Dimensions in Inches (mm)



FEATURES

- **Silicon NPN Epitaxial Phototransistor**
- **Very Narrow Acceptance Angle, 16°**
- **Premium Hi-Rel Device**
- **Very High Gain**
- **Short Switching Time**
- **Good Linearity**
- **Four Sensitivity Ranges**
- **Package: TO18 Hermetic**
- **Rounded Glass Lens**

DESCRIPTION

The BPY62 is an epitaxial NPN silicon planar phototransistor in a TO18 (18 A 3 DIN 41876) package with a glass lens.

There is an external base connection. The emitter is marked by a tab on the case bottom. The collector is electrically connected to the metallic case.

The BPY62 is suitable for use with filament lamp light where sensitive photoelectric detectors are required.

Notes
1. Availability subject to yield.

Maximum Ratings

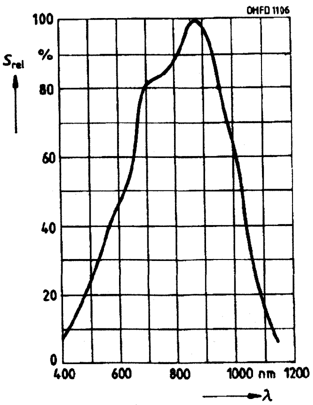
Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –55° to +125°C
Soldering Temperature (≥2 mm from case bottom)
  Dip Soldering Time (T_s) t≤5 s .... 260°C
  Iron Soldering Time (T_s) t≤3 s .... 300°C
Collector Emitter Voltage (V_{CEO}) .... 50 V
Emitter Base Voltage (V_{EB}) .... 7 V
Collector Current (I_C) .... 100 mA
Collector Peak Current (I_{PK}) t<10 µs .... 200 mA
Power Dissipation (P_{TOT}) T_A=25°C .... 200 mW
Thermal Resistance (R_{THJA}) .... 500 K/W

Characteristics (T_A=25°C)

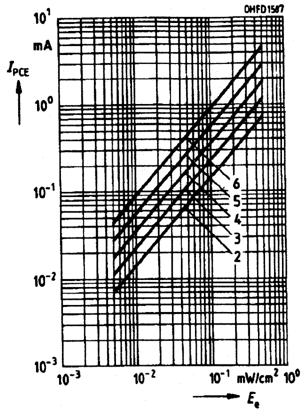
Parameter	Symbol	Value	Unit
Maximum Sensitivity Wavelength	λ_{Smax}	850	nm
Spectral Range, Photosensitivity	λ	420 to 1130	nm
Radiant Sensitive Area	A	0.12	mm²
Die Area Dimensions	L x W	0.5 x 0.5	mm
Distance, Die Surface to Case Surface	H	2.4 to 3.0	mm
Half Angle	φ	±8	Deg.
Photocurrent, Collector–Base Diode			
(E_e=0.5 mW/cm², λ=950 nm, V_{CB}=5 V)	I_{PCB}	4.5	µA
(E_V=1000 lx, V_{CB}=5 V)	I_{PCB}	17	µA
Capacitance			
(V_{CE}=0 V, f=1 MHz, E=0)	C_{CE}	8	pF
(V_{CB}=0 V, f=1 MHz, E=0)	C_{CB}	11	pF
(V_{EB}=0 V, f=1 MHz, E=0)	C_{EB}	19	pF
Collector Emitter Leakage Current			
(V_{CE}=35 V, E=0)	I_{CEO}	5 (≤100)	nA

Parameter		–2	–3	–4	–5 (1)	Unit
Photocurrent, Collector–Emitter (E_e=0.5 mW/cm², λ=950nm V_{CE}=5 V)	I_{PCE}	.5 to 1	.8 to 1.6	1.25 to2.5	2 to 4	mA
(E_V=1000 lx, standard light A, V_{CE}=5 V)	I_{PCE}	3.0	4.6	7.2	11.4	mA
Rise/Fall Time (I_C=1 mA, V_{CC}=5 V, R_L=1 kΩ)	t_R,t_F	5	7	9	12	µs
Collector Emitter Saturation Voltage (I_C=I_{PCEmin}¹ x 0.3, λ=950 nm E_e=0.5 mW/cm²)	V_{CEsat}	150	150	160	180	mV
Current Gain (E_e=0.5 mW/cm², V_{CE}=5 V, λ=950 nm)	$\frac{I_{PCE}}{I_{PCB}}$	170	270	420	670	

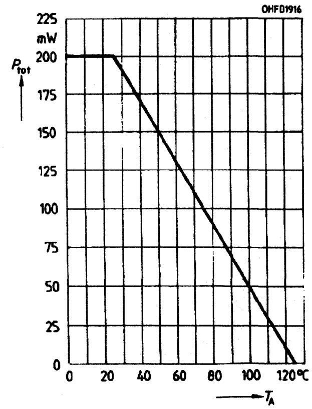
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



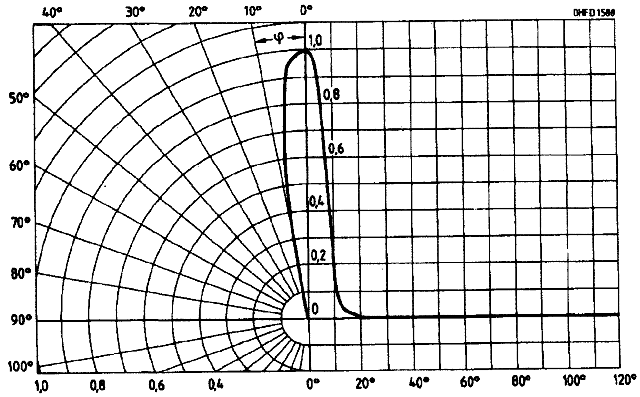
Photocurrent $I_{PCE}=f(E_e)$, $V_{CE}=5$ V



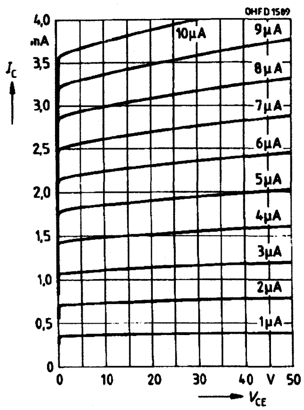
Total power dissipation
$P_{TOT}=f(T_A)$



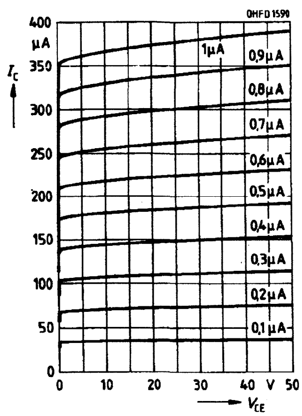
Directional characteristic
$S_{REL}=f(\varphi)$



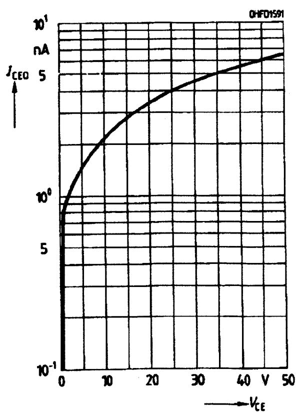
Output characteristics
$I_C=f(V_{CE})$, I_B=Parameter



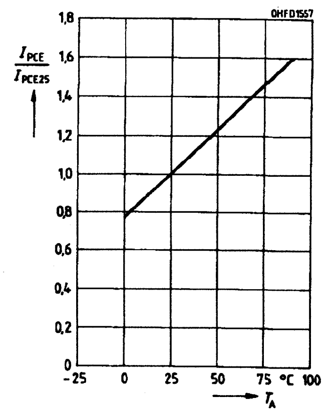
Output characteristics
$I_C=f(V_{CE})$, I_B=Parameter



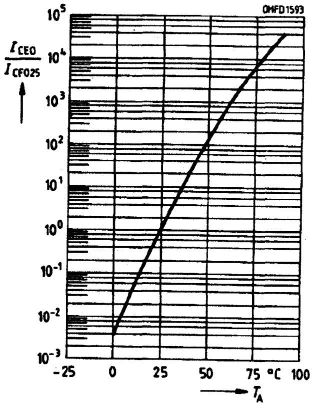
Dark current $I_{CEO}=f(V_{CE})$, E=0



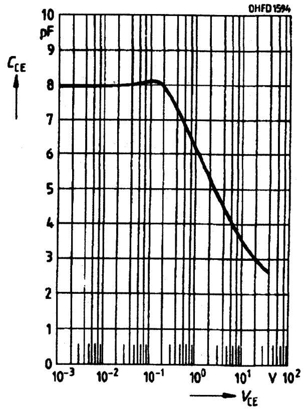
Photocurrent $I_{PCE}/I_{PCE25}=f(T_A)$,
$V_{CE}=5$ V



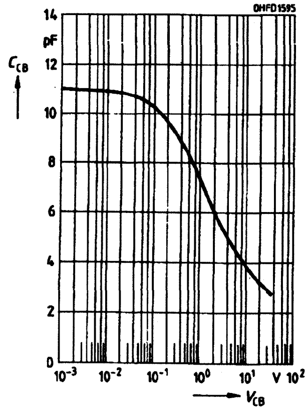
Dark current $I_{CEO}/I_{CEO25}=f(T_A)$,
V_{CE}=25 V, E=0



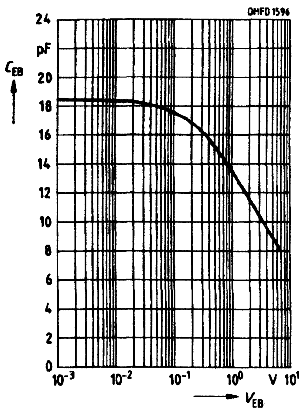
Collector emitter capacitance
$C_{CE}=f(V_{CE})$, f=1 MHz, E=0



Collector base capacitance
$C_{CB}=f(V_{CB})$, f=1 MHz, E=0



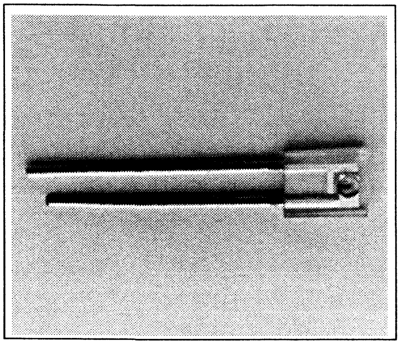
Emitter base capacitance
$C_{EB}=f(V_{EB})$, f=1 MHz, E=0



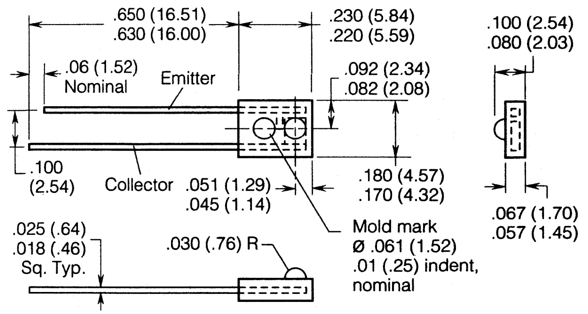
SIEMENS

LPT-80A

PHOTOTRANSISTOR



Package Dimensions in Inches (mm)



FEATURES

- **Low Cost Plastic, Side Facing Package**
- **High Sensitivity**
- **Matches Infrared Emitter IRL-80A, IRL-81A**

DESCRIPTION

The LPT-80A is a plastic, NPN phototransistor. It comes in a lensed, clear plastic, side-facing, miniature package. The lens accepts light from very wide angles, ±40°. This detector is ideal for industrial processing and control applications requiring beam interruption.

Maximum Ratings

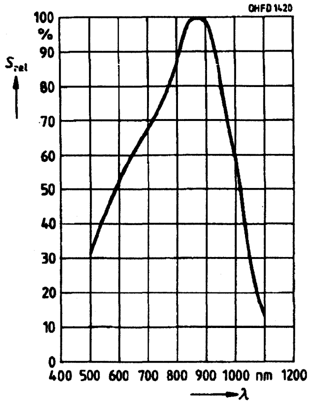
Operating/Storage Temperature Range (T_{OP}, T_{STG}) .... –40° to +100°C
Soldering Temperature, t=5 sec .... 240°C
Collector Emitter Voltage (V_{CEO}) .... 30 V
Emitter Collector Voltage (V_{ECO}) .... 5 V
Collector Current (I_C) .... 50 mA
Collector Peak Current (I_{CM}) t=1 ms .... 100 mA
Power Dissipation (P_{TOT}) T_A=25°C .... 100 mW*
*Derate Linearly Above 25°C .... 1.33 mW/°C

Characteristics (T_A=25°C)

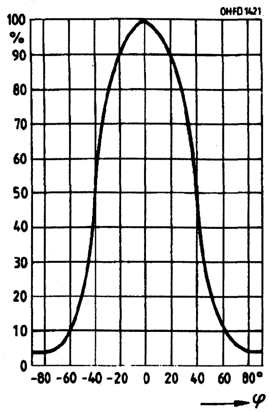
Parameter	**Symbol**	**Value**	**Unit**
Maximum Sensitivity Wavelength		870	nm
Acceptance Half Angle	φ	±40	Deg.
Collector Emitter Leakage Current (V_{CE}=15 V, H=0)	I_{CEO}	≤100	nA
Photocurrent (1) (V_{CE}=5 V, H=0.5 mW/cm²)	I_P	≥200	µA
Breakdown Voltage (I_C=100 µA)	BV_{CEO}	≥30	V
(I_C=100 µA)	BV_{ECO}	≥5	V
Saturation Voltage (I_C=250 µA, H=0.5 mW/cm²)	V_{CEsat}	0.15	V
		(≤0.4).	V

Note
1. The light source is a tungsten filament bulb used with a 950 ±30 nm filter. The mechanical axis is aligned with the light source.

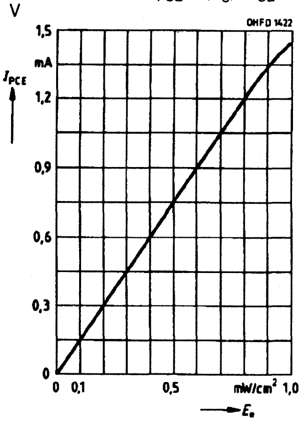
Relative spectral emission S_{REL}=f (λ)



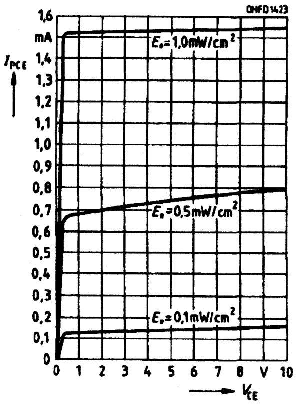
Radiation characteristics S_{REL}=f (φ)



Forward current I_{PCE}=f (E_e), V_{CE}=5 V

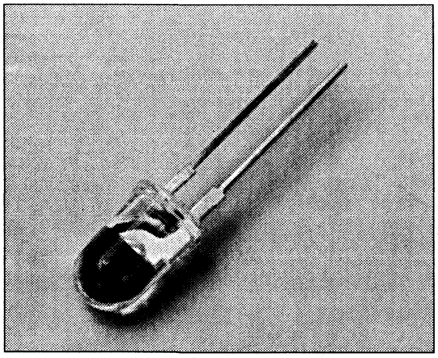


Forward current I_{PCE}=f (V_{CE}), Parameter=E_e

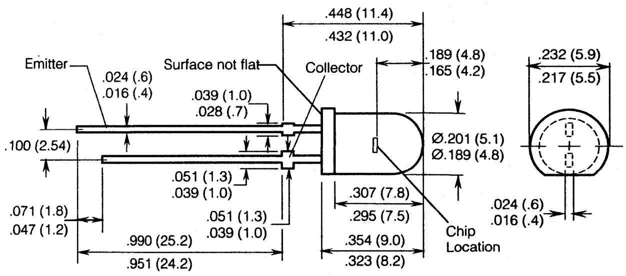


SIEMENS

*SFH300
DAYLIGHT FILTER **SFH300FA
SILICON NPN PHOTOTRANSISTOR



Package Dimensions in inches (mm)



FEATURES

- **Silicon NPN Epitaxial Phototransistor**
- **Acceptance Angle, 50°**
- **Low Cost**
- **Very High Gain**
- **Short Switching Time**
- **Good Linearity**
- **Matches IR Emitters LD271, LD273, SFH484 and SFH485**
- **Package: T1¾ (5 mm)**
- **Clear Plastic Lens**

APPLICATIONS

- **Computer-controlled Flashes**
- **Light-reflecting Swiches for Steady and Varying Intensities**
- **Industrial Electronics**
- **Control and Drive Circuits**

DESCRIPTION

The SFH300 and SFH300FA are high-sensitivity epitaxial NPN silicon planar phototransistors. They are enclosed in a T1¾ (5 mm) clear plastic package.

The collector is denoted by a "flat" on the case bottom.

Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –55° to +100°C

Soldering Temperature (≥2 mm from case bottom)

Dip Soldering Time (T_s) t ≤5 s .... 260°C

Iron Soldering Time (T_s) t ≤3 s .... 300°C

Collector Emitter Voltage (V_{CE}) .... 35 V

Collector Current (I_C) .... 50 mA

Collector Peak Current (I_{CS}) t<10 µs .... 100 mA

Emitter Collector Voltage (V_{EC}) .... 7 V

Power Dissipation (P_{TOT}) TA=25°C .... 200 mW

Thermal Resistance (R_{thJA}) .... 375 K/W

Characteristics (T_A=25°C)

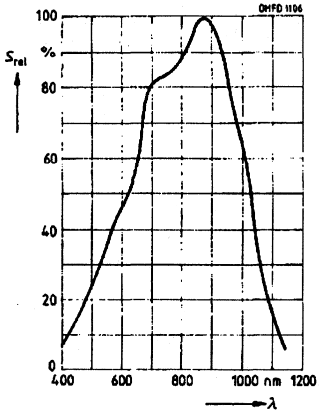
Parameter	Symbol	Value		Unit
		SFH300	SFH300FA	
Wavelength, Maximum Sensitivity	λ_{Smax}	850	900	nm
Spectral Range, Photosensitivity	λ	420 – 1130	730 –1120	nm
Radiant Sensitive Area	A	0.12	0.12	mm^2
Chip Area Dimensions	L x W	0.5 x 0.5	0.5 x 0.5	mm
Distance, Chip Surface to Case Surface	H	4.1 – 4.7	4.1 – 4.7	mm
Half Angle	φ	±25	±25	Deg.
Capacitance (V_{CE}=0 V, f=1 MHz, E=0)	C_{CE}	6.5	6.5	pF
Dark Current (V_{CE}=35 V, E=0)	I_{CEO}	5 (≤100)	5 (≤100)	nA

Parameter	Symbol	–2	–3	–4	Unit
Photocurrent λ=950 nm (E_E=0.5 mW/cm², V_{CE}=5 V), (E_V=1000 lx, Normal Standard Light V_{CE}=5 V)	I_{PCE} I_{PCE}	.63 – 1.25 3.4	1 – 2 5.4	≥1.6 8.6	mA mA
Rise/Fall Time (I_C=1 mA, V_{CC}=5 V, R_L=1 kΩ)	$t_R t_F$	7.5	10	10	µs
Collector Emitter Saturation Voltage (I_C=I_{PCEmin}[1] x 0.3, E_e=0.5 mW/cm²)	V_{CEsat}	130	140	150	mV

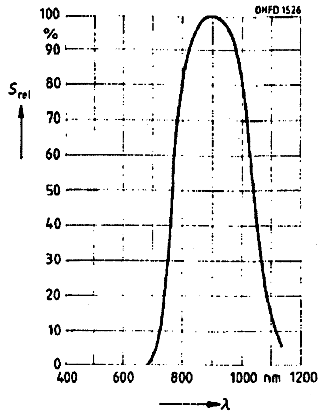
1. I_{PCEmin} is the minimum photocurrent of the specified group

***Formerly BP103B, **formerly BP103BF**

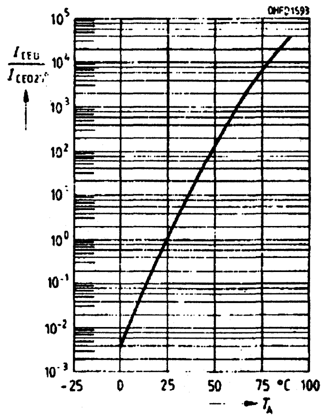
Relative spectral sensitivity SFH300
S_{REL}=f (λ)



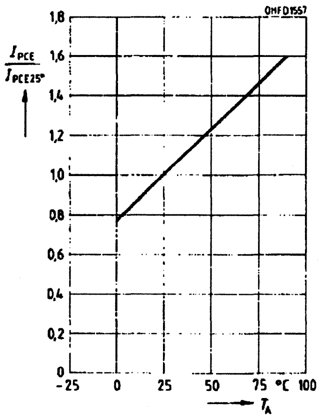
Relative spectral sensitivity SFH300FA
S_{REL}=f (λ)



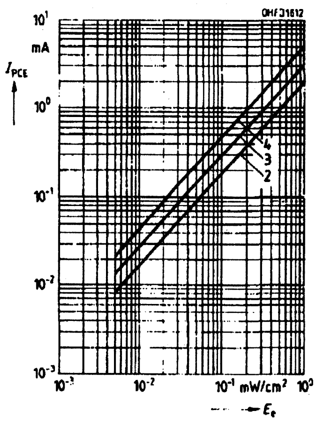
Dark current
$I_{CEO}/I_{CEO25°}$=f (T_A), V_{CE}=25 V
E=0



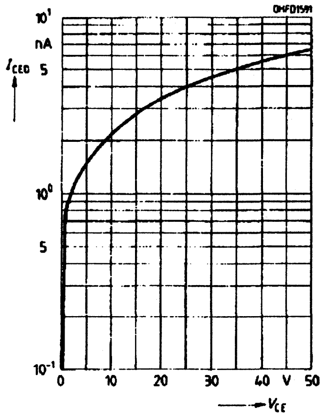
Photocurrent $I_{PCE}/I_{PCE\ 25°}$=f (T_A),
V_{CE}= 5 V



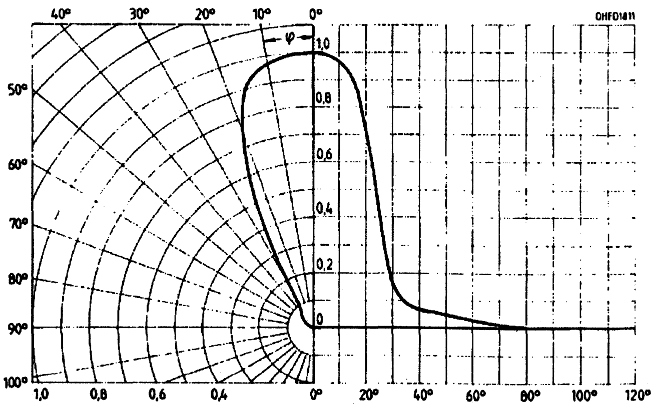
Photocurrent I_{PCE}=f (E_e), V_{CE}= 5 V



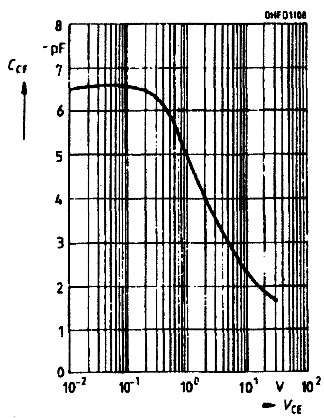
Dark current
I_{CEO}=f (V_{CE}), E=0



Directional characteristics S_{REL}=f(φ)



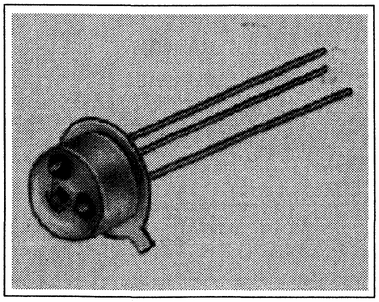
Collector emitter capacitance
C_{CE}=f (V_{CE}), f=1 MHz, E=0

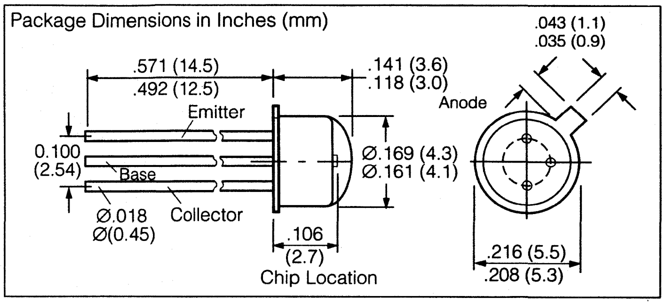


SIEMENS

SFH302

SILICON NPN PHOTOTRANSISTOR





FEATURES

- **Especially Suitable for Applications from 450 nm to 1100 nm**
- **High Linearity**
- **Package: Modified TO-18 with Clear Plastic Lens, Base Connection**
- **Available in Groups**
- **Applications**
  - **Light-reflecting Switches for Steady and Varying Intensity**
  - **Industrial Electronics**
  - **Control and Drive Circuits**

Maximum Ratings

Operating and Storage Temperature Range
(T_{OP}, T_{STG}) .... –40° to +80°C
Dip Soldering Temperature
(≥2 mm from case bottom)
Soldering Time (T_s) t≤5 s .... 260°C
Iron Soldering Time (T_s) t≤3 s .... 300°C
Collector Emitter Voltage (V_{CE}) .... 50 V
Collector Current (I_C) .... 50 mA
Collector Peak Current
(I_{CS}) t<10 µs .... 200 mA
Emitter Base Voltage (V_{EB}) .... 7 V
Power Dissipation
(P_{TOT}) T_A=25°C .... 150 mW
Thermal Resistance (R_{thJA}) .... 450 K/W

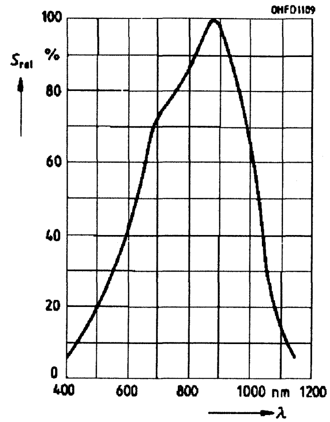
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Maximum Sensitivity Wavelength	λ_{Smax}	880	nm
Spectral Range Sensitivity S=10% of S_{max}	λ	450 to 1100	nm
Radiant Sensitive Area	A	0.675	mm²
Dimensions of Chip Area	L x W	1 x 1	mm x mm
Distance, Chip Front to Case Surface	H	0.2 to 0.8	mm
Half Angle	φ	±40	Deg.
Photocurrent, Collector–Base Photodiode			
(E_e=0.5 mW/cm², V_{CB}=5 V)	I_{PCB}	4.2	µA
(E_V=1000 lx, std. light A, V_{CB}=5 V)	I_{PCB}	12.5	µA
Capacitance			
(V_{CE}=0 V, f=1 MHz, E=0)	C_{CE}	23	pF
(V_{CB}=0 V, f=1 MHz, E=0)	C_{CB}	39	pF
(V_{EB}=0 V, f=1 MHz, E=0)	C_{EB}	47	pF
Dark Current			
(V_{CE}=10 V, E=0)	I_{CEO}	20 (≤200)	nA

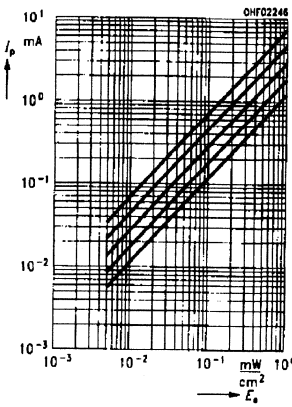
Parameter		–2	–3	–4	–5	–6	Unit
Photocurrent, Collector–Emitter(1) (E_e=0.5 mW/cm², λ=950 V_{CE}=5 V)	I_{PCE}	0.4–0.8	0.63–1.25	1–2	1.6–3.2	≥2.5	mA
(E_V=1000 lx, standard light A, V_{CE}=5 V)	I_{PCE}	1.75	2.8	4.5	7.1	9.5	mA
Rise/Fall Time (I_C=1 mA, V_{CC}=5 V, R_L=1 kΩ)	t_R,t_F	9	11	14	17	20	µs
Collector Emitter Saturation Voltage (I_C=I_{PCEmin}[1] x 0.3, E_e=0.5 mW/cm²)	V_{CEsat}	200	200	200	200	200	mV
Current Gain (E_e=0.5 mW/cm², V_{CE}=5 V)	$\frac{I_{PCE}}{I_{PCB}}$	140	230	360	570	750	

1. I_{PCEmin} is the minimum photocurrent of the specified group

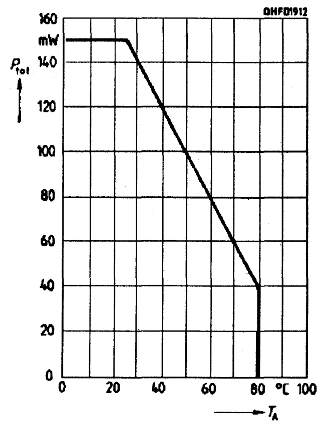
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



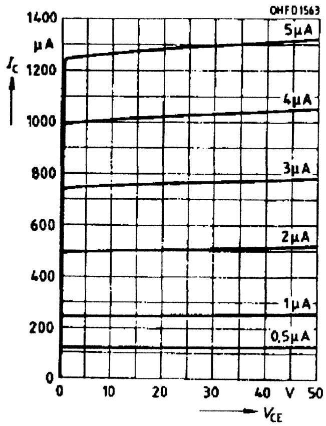
Photocurrent $I_{PCE}=f(E_e)$, $V_{CE}=5$ V



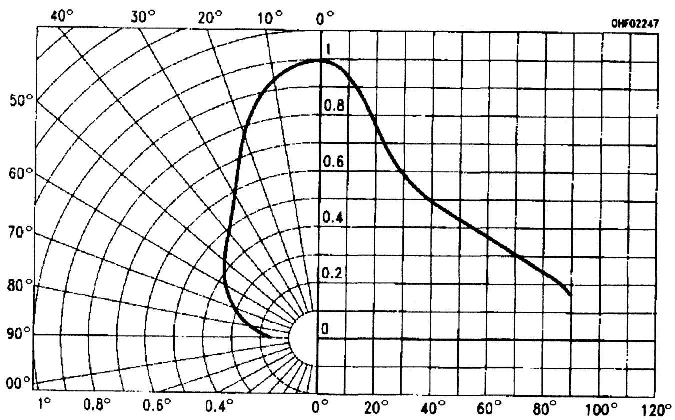
Total power dissipation
$P_{TOT}=f(T_A)$



Output characteristics
$I_C=f(V_{CE})$, I_B=Parameter

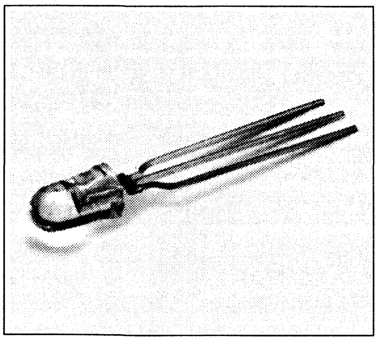


Directional characteristic
$S_{REL}=f(\varphi)$

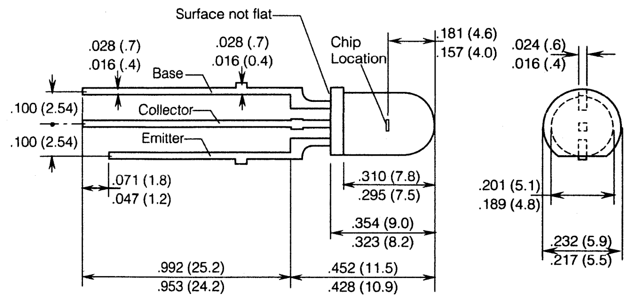


SIEMENS

SFH303
DAYLIGHT FILTER *SFH303FA
SILICON NPN PHOTOTRANSISTOR



Package Dimensions in Inches (mm)



FEATURES

- **Daylight Filter–SFH303F**
- **Acceptance Angle, 40°**
- **High Reliability**
- **Short Switching Time**
- **High Spectral Sensitivity**
- **Good Linearity**
- **High Photosensitivity**
- **Base Connection**
- **Matches IR Emitter SFH485**
- **Visible and Near IR Range Usage**

DESCRIPTION

The SFH303/303FA are silicon phototransistors with external base connections. The SFH303 comes in a standard T1¾ (5 mm) water-clear plastic package. The SFH303FA has a black daylight filter.

The emitter lead is the short lead; the collector lead is the middle lead.

The devices can be used in industrial control applications, light barriers, and reflective switches.

Notes

1. I_{PCEmin} is the minimum photocurrent of the specified group.
2. Availability subject to yield.

***Formerly SFH303F**

Maximum Ratings

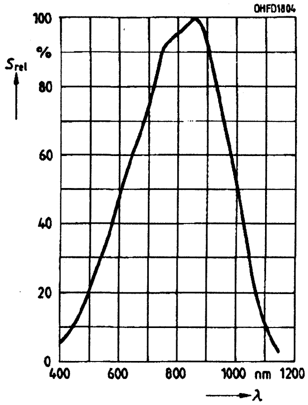
Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –55° to +100°C
Soldering Temperature (≥2 mm from case bottom)
Dip Soldering Time (T_s) t≤5 s .... 260°C
Iron Soldering Time (T_s) t≤3 s .... 300°C
Collector Emitter Voltage (V_{CEO}) .... 50 V
Emitter Base Voltage (V_{EB}) .... 7 V
Collector Current (I_C) .... 50 mA
Collector Peak Current (I_{PK}) t<10 µs .... 100 mA
Power Dissipation (P_{TOT}) T_A=25°C .... 200 mW
Thermal Resistance (R_{THJA}) .... 375 K/W

Characteristics (T_A=25°C)

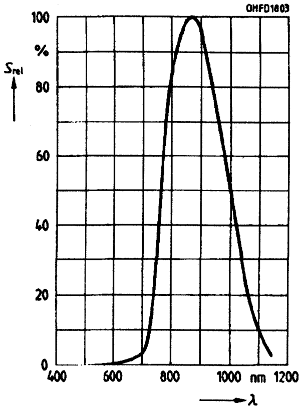
Parameter		Symbol	Value	Unit
Maximum Sensitivity Wavelength,	SFH303	λ_{Smax}	860	nm
	SFH303FA	λ_{Smax}	870	nm
Spectral Range, Photosensitivity,	SFH303	λ	450 to 1100	nm
(S=10% of S_{max})	SFH303FA	λ	720 to 1100	nm
Radiant Sensitive Area		A	0.30	mm²
Die Area Dimensions		L x W	0.75 x 0.75	mm
Half Angle		φ	±20	Deg.
Photocurrent, Collector Base Diode				
(E_e=0.5mW/cm², λ=950 nm, V_{CB}=5 V)		I_{PCB}	4.5	µA
(E_V=1000 lux, V_{CB}=5 V)		I_{PCB}	15.8	µA
Capacitance				
(V_{CE}=0 V, f=1 MHz, E=0 lx)		C_{CE}	10	pF
(V_{CB}=0 V, f=1 MHz, E=0 lx)		C_{CB}	22	pF
(V_{EB}=0 V, f=1 MHz, E=0 lx)		C_{EB}	21	pF

Parameter	Symbol	–2	–3	–4(2)	Unit
Photocurrent, Collector–Emitter (E_e=0.5 mW/cm², V_{CE}=5 V, λ=950 nm)	I_{PCE}	1.0 to 2.0	1.6 to 3.2	≥2.5	mA
SFH303: (E_V=1000 lx, std. light A, V_{CE}=5 V)	I_{PCE}	5.2	8.4	13.1	mA
Rise/Fall Time (I_C=1 mA, V_{CC}=5 V, R_L=1 kΩ)	t_R,t_F	11	13	15	µs
Collector Emitter Saturation Voltage (I_C=I_{PCEmin}(1) x 0.3 λ=950 nm, E_e=0.5 mW/cm²)	V_{CEsat}	150	150	150	mV
Current Gain (E_e=0.5 mW/cm² λ=950 nm, V_{CE}=5 V)	$\frac{I_{PCE}}{I_{PCB}}$	330	530	830	

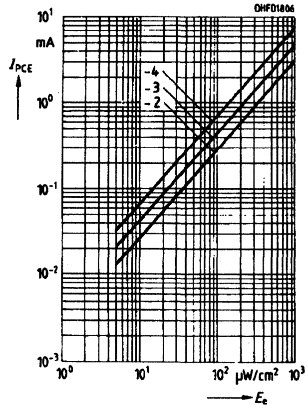
Relative spectral sensitivity–SFH303
$S_{REL}=f(\lambda)$



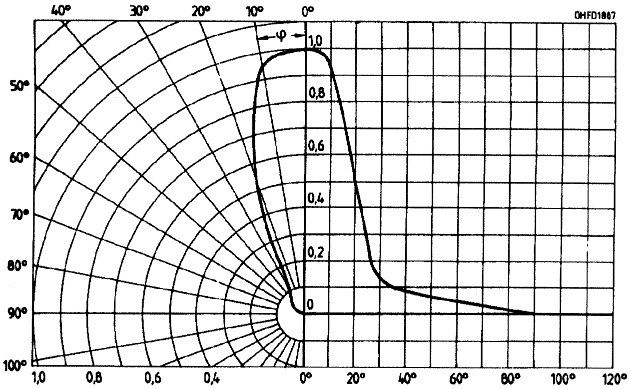
Relative spectral sensitivity–SFH303FA
$S_{REL}=f(\lambda)$



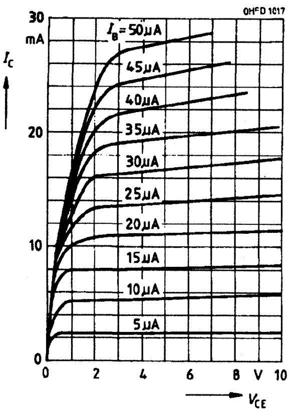
Photocurrent $I_{PCE}=f(E_e)$, $V_{CE}=5$ V



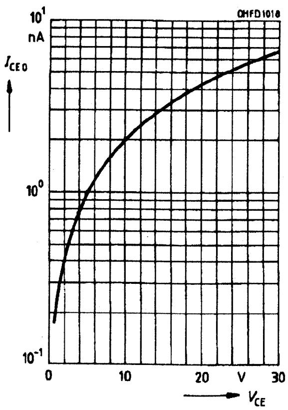
Directional characteristic
$S_{REL}=f(\varphi)$



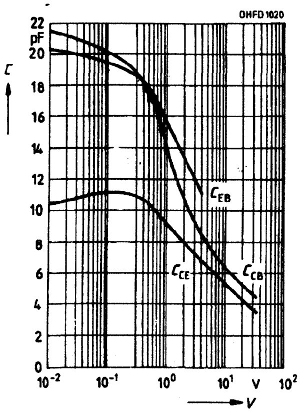
Output characteristics
$I_C=f(V_{CE})$, I_B=Parameter



Dark current $I_{CEO}=f(V_{CE})$, E=0

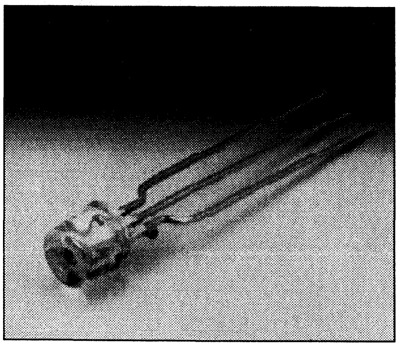


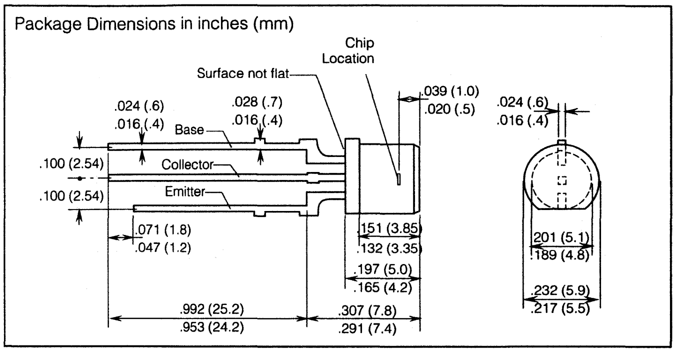
Capacitance
C=f(V), f=1 MHz, E=0



SIEMENS

*SFH303P
DAYLIGHT FILTER **SFH303PFA
SILICON NPN PHOTOTRANSISTOR





FEATURES

- **Daylight Filter—SFH303PFA**
- **Wide Acceptance Angle**
- **High Reliability**
- **High Rise and Fall Times**
- **Good Linearity**
- **High Photosensitivity**
- **No Testable Degradation**
- **Base Connection**

DESCRIPTION

The SFH303P and SFH303PFA are highly senstive silicon planar phototransistors with base connection in a standard T1¾ (5 mm) package. The SFH303P comes in a water-clear, no lens package; the SFH303PFA comes in black epoxy.

The emitter is the shorter lead; the collector lead is the middle lead.

Maximum Ratings

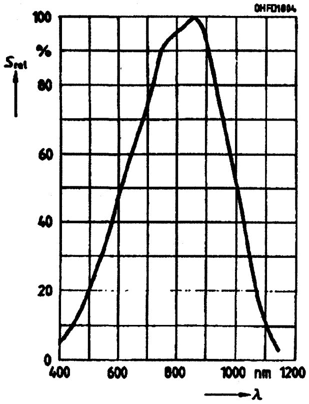
Operating and Storage Temperature
Range (T_{OP}, T_{STG}) .... –55° to +100°C
Soldering Temperature
(≥2 mm from case bottom)
Dip Soldering (T_s) t ≤5 s .... 260°C
Iron Soldering (T_s) t ≤3 s .... 300°C
Collector Emitter Voltage (V_{CEO})............. 50 V
Emitter Base Voltage (V_{EB}) .... 7 V
Collector Current (I_C) .... 50 mA
Collector Peak Current (I_{PK})
t ≤10 μs... 100 mA
Power Dissipation (P_{TOT})
T_A=25°C .... 200 mW
Thermal Resistance (R_{thJA}) ....375 K/W

***Formerly SFH317**
****Formerly SFH317F**

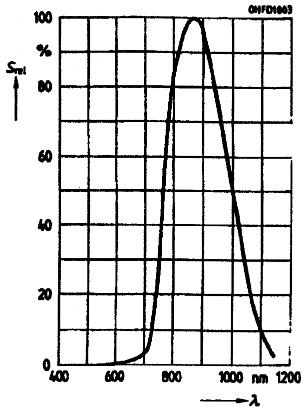
Characteristics (T_A=25°C)

Parameter	Symbol	Value		Unit
		SFH303P	SFH303PFA	
Wavelength, Maximum Sensitivity	λ_{Smax}	860	870	nm
Spectral Range, Photosensitivity (S=10% of S_{max})	λ	450 – 1100	720 –1100	nm
Radiant Sensitive Area	A	0.30	0.30	mm^2
Die Area Dimensions	L x W	0.75 x 0.75	0.75 x 0.75	mm
Distance, Chip Surface to Case Surface	H	0.5 to 1.0	0.5 to 1.0	mm
Half Angle	φ	±75	±75	Deg.
Photocurrent, Collector Base Diode (E_e=0.5 mW/cm², λ=950, V_{CB}=5 V) (E_V=1000 lx, V_{CE}=5 V)	 I_{PCB} I_{PCB}	 0.65 2.5	 0.65 2.5	μA
Capacitance (V_{CE}=0 V, f=1 MHz, E=0 lx) (V_{CB}=0 V, f=1 MHz, E=0 lx) (V_{EB}=0 V, f=1 MHz, E=0 lx)	 C_{CE} C_{CB} C_{EB}	 10 22 21	 10 22 21	pF
Leakage Current (V_{CE}=10 V, E=0)	I_{CEO}	2 (≤50)	2 (≤50)	nA
Parameter	**Symbol**	**Minimum**	**Typical**	**Unit**
Photocurrent, Collector-Emitter (E_e=0.5 mW/cm², V_{CE}=5 V, λ=950) SFH303P: (Ev=1000 lx, V_{CE}= 5 V)	 I_{PCE} I_{PCE}	 ≥.16 ≥.9	—	 mA mA
Rise/Fall Time (I_C= 1 mA, V_{CC}= 5 V, R_L=1 kΩ)	t_R, t_F	—	13	μs
Collector Emitter Saturation Voltage (I_C=I_{PCE}min(1)•0.3, E_e=0.5 mW/cm², λ=950 nm)	V_{CEsat}	—	130	mV
Current Gain (E_e=0.5 mW/cm², V_{CE}=5 V, λ=950 nm)	$\frac{I_{PCE}}{I_{PCB}}$	—	570	

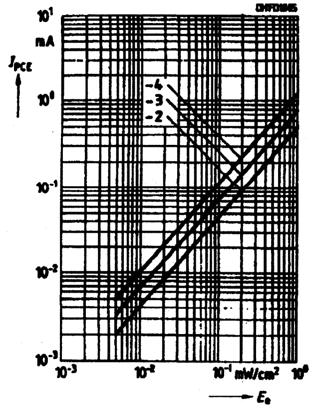
Relative spectral sensitivity, SFH303P
$S_{rel}=f(\lambda)$



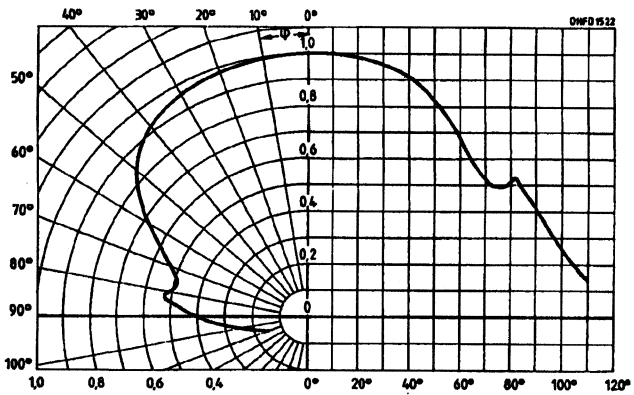
Relative spectral sensitivity, SFH303PFA
$S_{rel}=f(\lambda)$



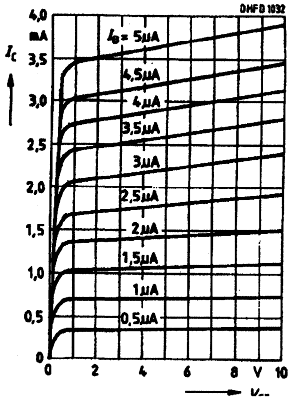
Photocurrent
$I_{PCE}=f(E_e)$, $V_{CE}=5$ V



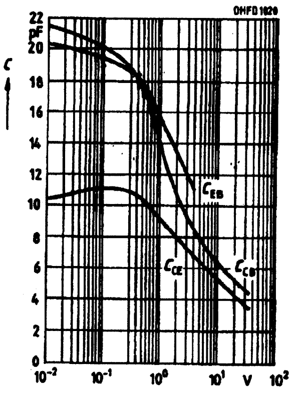
Directional characteristic $S_{rel}=f(\varphi)$



Output characteristics
$I_C=f(V_{CE})$, I_B=Parameter



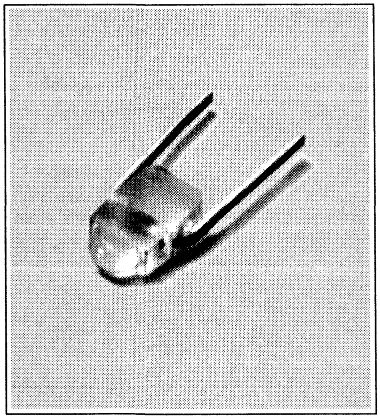
Capacitance
$C_{CE}=f(V)$, f=1 MHz, E=0



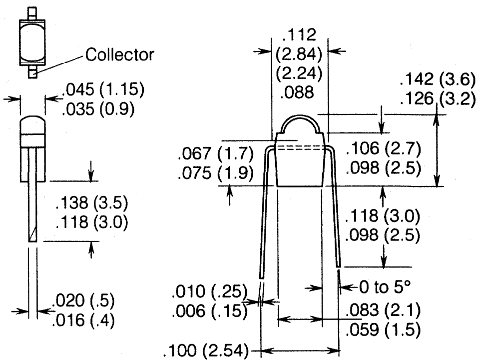
SIEMENS

SFH305

SILICON NPN PHOTOTRANSISTOR



Package Dimensions in Inches (mm)



FEATURES

- **Narrow Acceptance Angle, 32°**
- **High Reliability**
- **Short Switching Time**
- **Matches IR Emitter SFH405**
- **Miniature Plastic Package**
- **0.100" (2.54 mm) Lead Spacing**

FEATURES

The SFH305 is a NPN silicon planar phototransistor in clear plastic encapsulation with solder terminals and a marked collector. There are two photosensitivity ranges.

The SFH305 can be used as a detector with IR emitter SFH405 as a miniature light barrier with close spacing between emitter and detector.

Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –40° to +80°C
Soldering Temperature (≥2 mm from case bottom)
Dip Soldering Time (T_s) t≤5 s .... 230°C
Iron Soldering Time (T_s) t≤3 s .... 300°C
Collector Emitter Voltage (V_{CEO}) .... 32 V
Collector Current (I_C) .... 50 mA
Collector Peak Current (I_{PK}) t<10 µs .... 100 mA
Power Dissipation (P_{TOT}) T_A=25°C .... 70 mW
Thermal Resistance (R_{THJA}) .... 950 K/W

Characteristics (T_A=25°C)

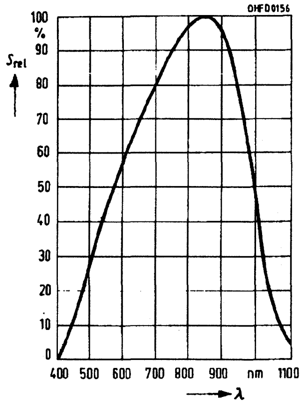
Parameter	**Symbol**	**Value**	**Unit**
Maximum Sensitivity Wavelength	λ_{Smax}	850	nm
Spectral Range, Photosensitivity	λ	460 to 1060	nm
Radiant Sensitive Area	A	0.17	mm²
Die Area Dimensions	L x W	0.6 x 0.6	mm
Half Angle	φ	±16	Deg.
Capacitance (V_{CE}=0 V, f=1 MHz, E=0 lx)	C_{CE}	5.5	pF
Collector Emitter Leakage Current (V_{CEO}=25 V, E=0 lx)	I_{CEO}	3(≤20)	nA

Parameter	Symbol	-2	-3	Unit
Photocurrent, Transistor Collector–Emitter (E_e=0.5 mW/cm² λ=950 nm, V_{CE}=5 V)	I_{PCE}	.25 to .5	.4 to .8	mA
(E_V=1000 lx, V_{CE}=5 V)	I_{PCE}	1.4	2.2	mA
Rise/Fall Time (I_C=1 mA, V_{CC}=5 V, R_L=1 kΩ)	t_R, t_F	5.5	6	µs
Collector Emitter Saturation Voltage (I_C=I_{PCEmin}[(1)]•0.3 λ=950 nm, E_e=0.5 mW/cm²)	V_{CEsat}	150	150	mV

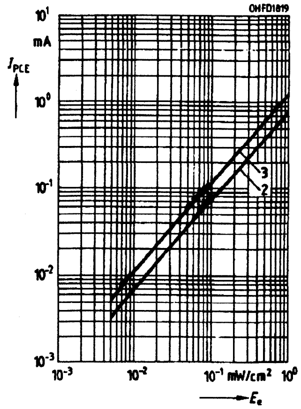
The illuminances refers to unfiltered radiation of a tungsten filament lamp at a color temperature of 2856 K (standard light A per DIN 5033 and IEC publication 306-11).

Notes
1. I_{PCEmin}=minimum photocurrent of the specified group.

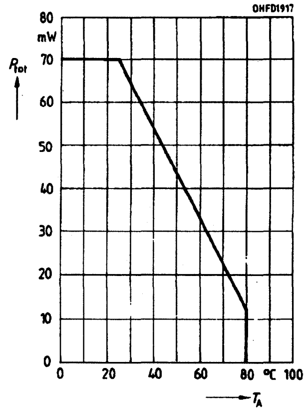
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



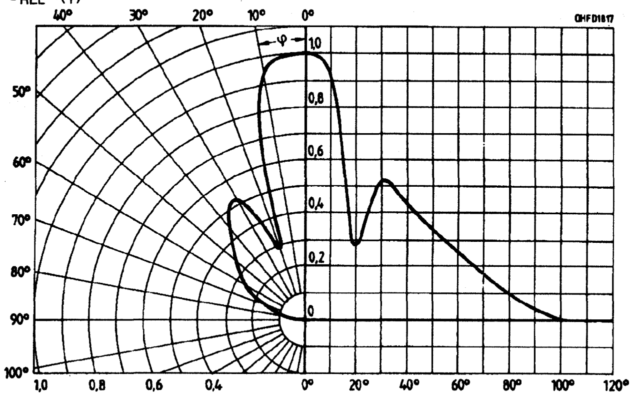
Photocurrent $I_{PCE}=f(E_E)$, $V_{CE}=5$ V



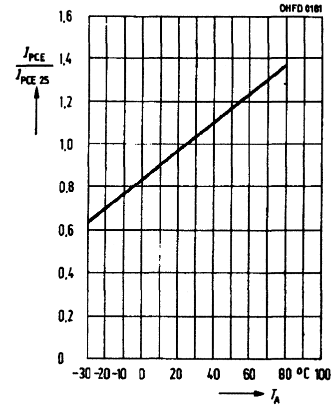
Total power dissipation $P_{TOT}=f(T_A)$



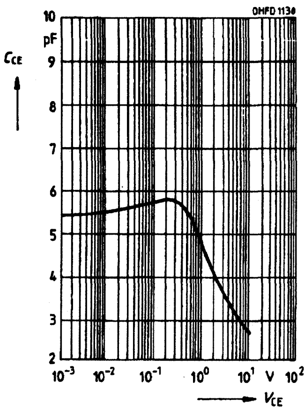
Directional characteristic
$S_{REL}=f(\varphi)$



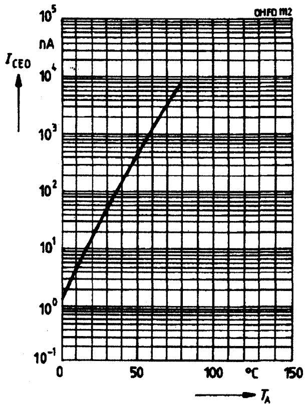
Photocurrent $I_{PCE}/I_{PCE\ 25}=f(T_A)$,
$V_{CE}=5$ V



Collector emitter capacitance
$C=f(V_R)$, f=1 MHz, E=0

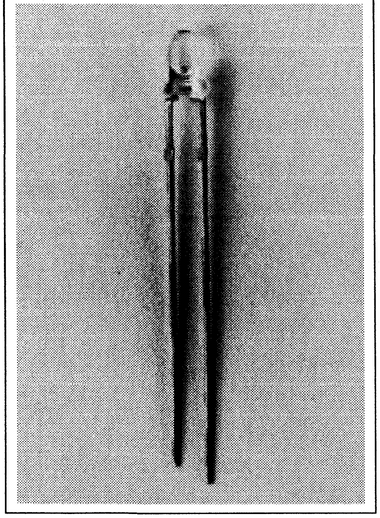


Dark current $I_{CEO}=f(T_A)$,
$V_{CE}=25$ V, E=0

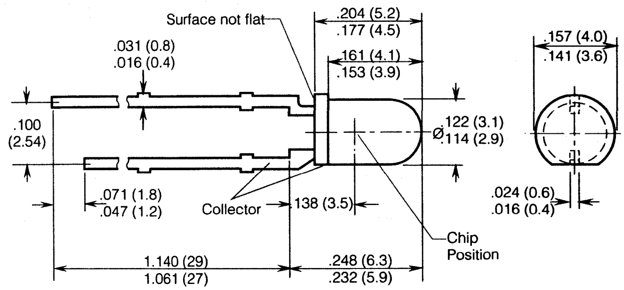


SIEMENS

SFH309
DAYLIGHT FILTER *SFH309FA
SILICON NPN PHOTOTRANSISTOR



Package Dimensions in Inches (mm)



FEATURES

- **Daylight Filter–SFH309FA**
- **Narrow Acceptance Angle, 24°**
- **High Reliability**
- **Low Cost**
- **Good Linearity**
- **No Testable Degradation**
- **Wide Temperature Range**
- **Matches IR Emitter SFH409, SFH487**
- **Package: T1 (3 mm)**
- **0.100" (2.54 mm) Lead Spacing**

FEATURES

The SFH309/309FA are silicon NPN phototransistors in a standard T1 (3 mm) plastic package. The SFH309F has a black daylight filter.

The devices can be used in a variety of low-cost, high-volume applications such as IR remote control and other consumer and entertainment products.

***Formerly SFH309F**

Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) ....–55° to +100°C
Soldering Temperature (≥2 mm from case bottom)
Dip Soldering Time (T_s) t≤5 s .... 260°C
Iron Soldering Time (T_s) t≤3 s .... 300°C
Collector Emitter Voltage (V_{CEO}) .... 35 V
Collector Current (I_C) .... 15 mA
Collector Peak Current (I_{PK}) t<10 µs .... 75 mA
Power Dissipation (P_{TOT}) T_A=25°C .... 165 mW
Thermal Resistance (R_{THJA}) .... 450 K/W

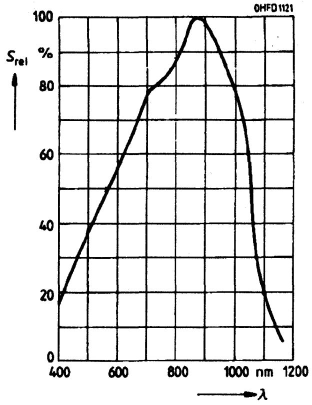
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Maximum Sensitivity Wavelength, SFH309	λ_{Smax}	860	nm
" " " , SFH309FA	λ_{Smax}	900	nm
Spectral Range, Photosensitivity, SFH309	λ	380 to 1150	nm
" " " , SFH309FA	λ	730 to 1120	nm
Radiant Sensitive Area	A	0.045	mm²
Distance, Chip Surface and Lens	H	2.4 to 2.8	mm
Half Angle	φ	±12	Deg.
Capacitance (V_{CE}=0 V, f=1 MHz, E=0 lux)	C_{CE}	5.0	pF
Leakage Current (V_{CE}=25 V, E=0 lx)	I_{CEO}	1 (≤200)	nA

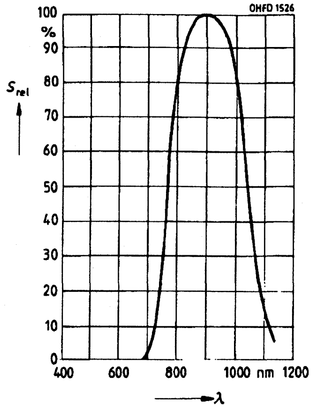
Parameter	Sym	-2	-3	-4	-5	-6(2)	Unit
Photocurrent, Collector–Emitter(1) (E_e=0.5 mW/cm², V_{CE}=5 V, λ=950 nm)	I_{PCE}	.4 to .8	.63 to 1.25	1.0 to 2.0	1.6 to 3.2	≥2.5	mA
SFH309: (E_V=1000 lx, std.light A, V_{CE}=5 V)	I_{PCE}	1.5	2.8	4.5	7.2	10.0	mA
Rise/Fall Time (I_C=1 mA, V_{CC}=5 V, R_L=1 kΩ)	t_R,t_F	5	6	7	8	9	µs
Collector Emitter Saturation Voltage (I_C=I_{PCEmin}(1) •0.3, λ=950 nm E_e=0.5 mW/cm²)	V_{CEsat}	200	200	200	200	mV	

Notes: 1. I_{PCEmin}=minimum photocurrent of the specified group.
2. Availability subject to yield.

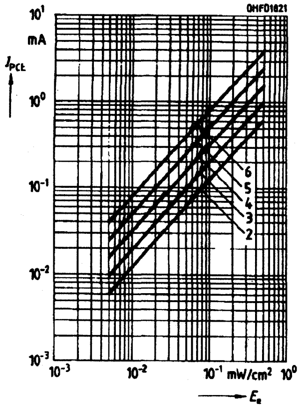
Relative spectral sensitivity–SFH309
$S_{REL}=f(\lambda)$



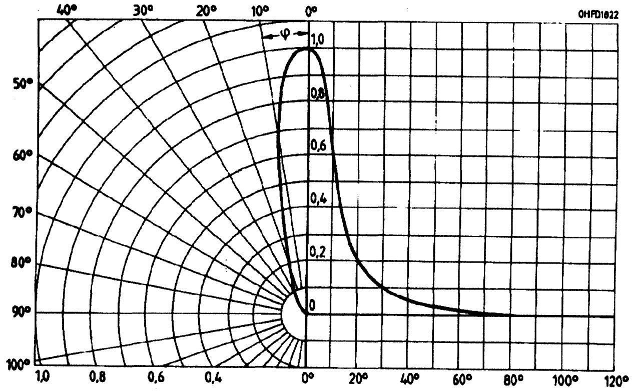
Relative spectral sensitivity–SFH309FA
$S_{REL}=f(\lambda)$



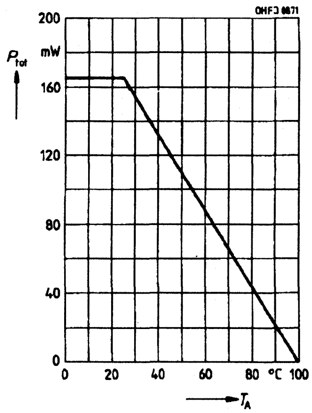
Photocurrent $I_{PCE}=f(E_e)$, $V_{CE}=5$ V



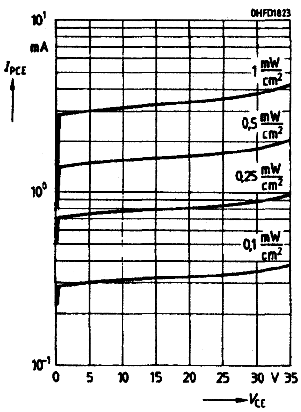
Directional characteristic
$S_{REL}=f(\varphi)$



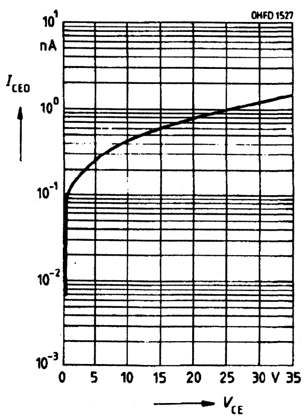
Total power dissipation
$P_{TOT}=f(T_A)$



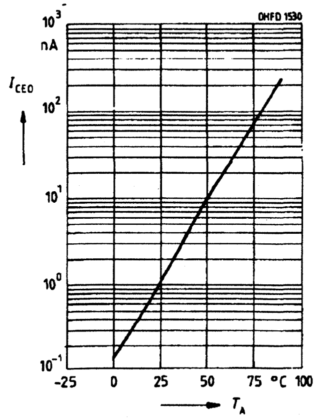
Photocurrent
$I_{PCE}=f(V_{CE})$, E_e=Parameter



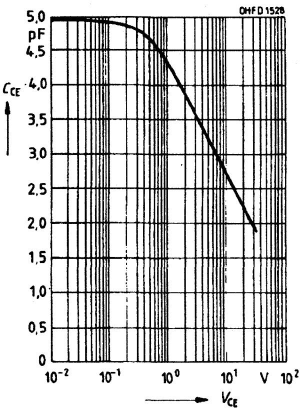
Dark current $I_{CEO}=f(V_{CE})$, E=0



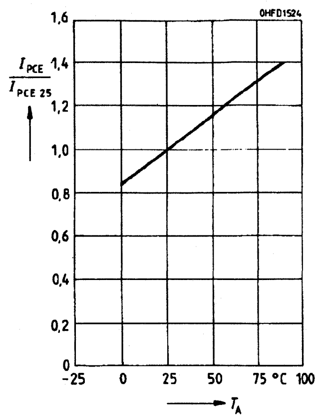
Dark current $I_{CEO}=f(T_A)$,
$V_{CE}=25$ V, E=0



Capacitance C_{CE}=f(V_{CE}), f=1 MHz, E=0



Dark current $I_{PCE}/I_{PCE\,25}$=f(T_A), V_{CE}=25 V

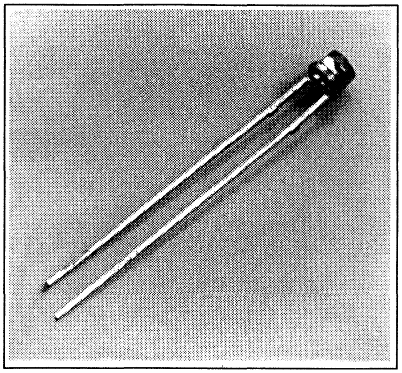


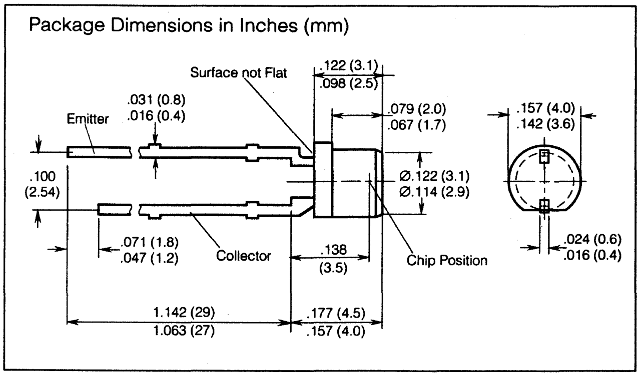
Phototransistors/
Photodarlington

9

SIEMENS

SFH309P
DAYLIGHT FILTER *SFH309PFA
SILICON NPN PHOTOTRANSISTOR





FEATURES

- **Silicon NPN Phototransistor in Epitaxial Planar Technology**
- **No Base Connection**
- **High Reliability**
- **No Testable Degradation**
- **High Spectral Sensitivity**
- **Good Linearity**
- **Wide Temperature Range**
- **SFH309P: Visible Light and Near Infrared Range Usage**
- **SFH309PFA: Daylight Filter**
- **Spectral Sensitivity Selections**
- **Same Package as IRED SFH487P**
- **Package: T1 (3mm) Flat Top LED Package, Transparent and Black Epoxy Resin, Solder Tabs, 0.1" (2.54 mm) Lead Spacing**
- **Collector Indicator: Shorter Lead, Flat at Case Bottom**

- **Applications**
  - **Light-reflecting Switches**
  - **Measurement and Control**

***Formerly SFH309PF**

DESCRIPTION

The SFH309P/309PFA are silicon NPN phototransistors in a standard T1 (3 mm) plastic package. The SFH309PFA has a black daylight filter.

The devices can be used in a variety of low-cost, high-volume applications, such as IR remote control and other consumer and entertainment products.

Maximum Ratings

Operating and Storage Temperature (T_{OP}, T_{STG}) ...... -55°C to +100°C
Soldering Temperature (≥2 mm from case bottom)
Dip Soldering Time (T_{ST}) t ≤ 5 sec. .... 260°C
Iron Soldering Time (T_{SK}) t ≤ 3 sec. .... 300°C
Collector Emitter Voltage (V_{CE}) .... 35 V
Collector Current (I_C) .... 15 mA
Collector Peak Current (I_{CS}) τ<10 µs .... 75 mA
Power Dissipation (P_{TOT}) T_A=25°C .... 165 mW
Thermal Resistance (R_{thJA}) .... 450 K/W

Characteristics (T_A=25°C, λ=950nm)

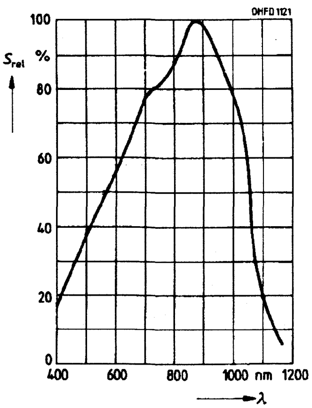
Parameter	**Symbol**	**Value**	**Unit**	**Condition**
Maximum Photosensitivity Wavelength				
SFH309P	λ_{Smax}	860	nm	
SFH309PFA	λ_{Smax}	900	nm	
Photosensitivity Spectral Range				S=10% of S_{MAX}
SFH309P	λ	380–1150	nm	
SFH309PFA	λ	730–1120	nm	
Radiant Sensitive Area	A	0.045	mm^2	Ø 240 μm
Distance Chip Surface to Case Surface	H	0.4 to 0.8	mm	
Half Angle	φ	±75	Deg.	
Capacitance	C_{CE}	5.0	pF	V_{CE}=0 V, f=1 MHz, E=0
Collector Emitter Leakage Current	I_{CEO}	1(≤200)	nA	V_{CEO}=25 V, E=0
Spectral Sensitivity Groupings				
Photocurrent				
SFH309PFA	I_{PCE}	200 (typ.)	μA	E_e=0.5 mW/cm², V_{CE}=5 V
SFH309P	I_{PCE}	420 (typ.)	μA	E_V=1000 lux, std. light A, V_{CE}=5 V
Rise and Fall Time	t_R,t_F	6 (typ.)	μs	I_C=1 mA, V_{CC}=5 V, R_L=1kΩ
Collector Emitter Saturation Voltage	V_{CEsat}	150	mV	I_{PCE}=I_{PCEmin}[1]x0.3, E_e=0.5 mW/cm²

Note:

1. I_{PCEmin} is the minimum photocurrent of the specified group.

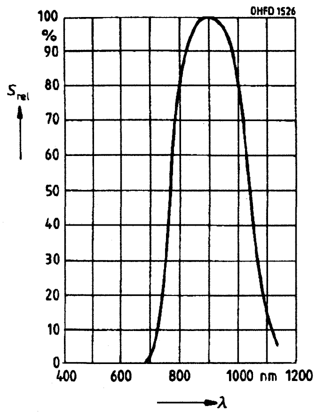
Relative spectral sensitivity–SFH309P

S_{REL}=f(λ)

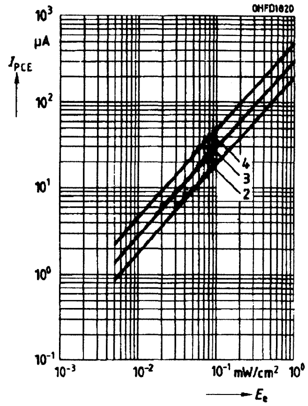


Relative spectral sensitivity–SFH309PFA

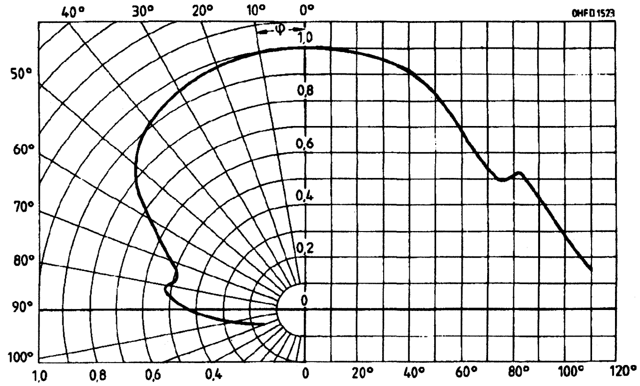
S_{rel}=f(λ)



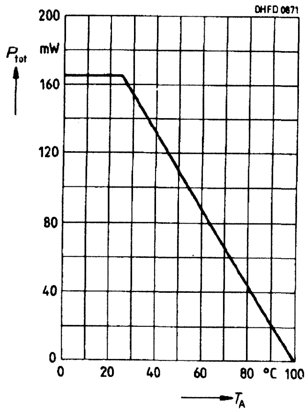
Photocurrent $I_{PCE}=f(E_e)$,
V_{CE}=5 V, λ=950 nm



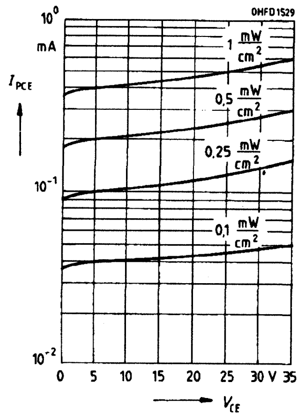
Directional characteristic $S_{REL}=f(φ)$



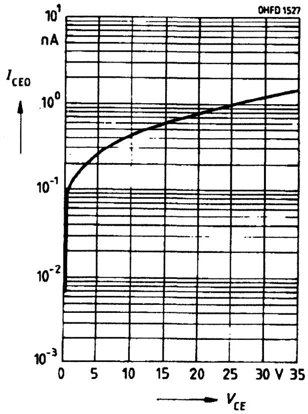
Total power dissipation
$P_{TOT}=f(T_A)$



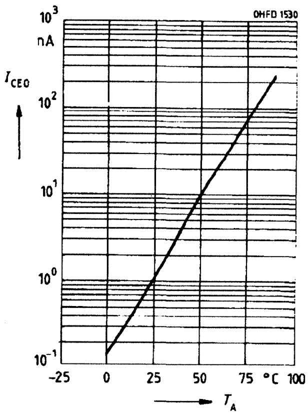
Photocurrent $I_{PCE}=f(V_{CE})$
E_e=Parameter



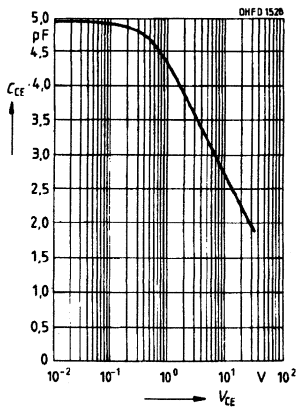
Dark current $I_{CEO}=f(V_{CE})$, E=0



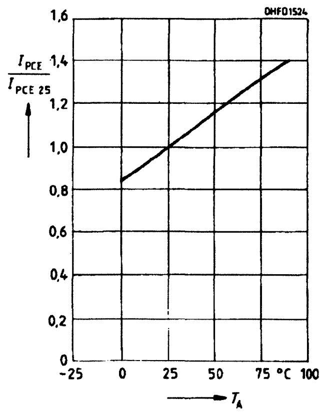
Dark current $I_{CEO}=f(T_A)$
V_{CE}=25 V, E=0



Capacitance $C_{CE}=f(V_{CE})$
f=1 MHz, E=0



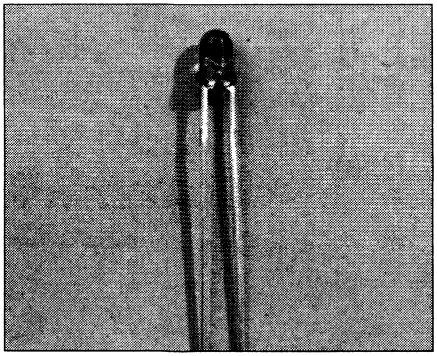
Photocurrent $I_{PCE}/I_{PCE\,25}=f(T_A)$
V_{CE}=5 V



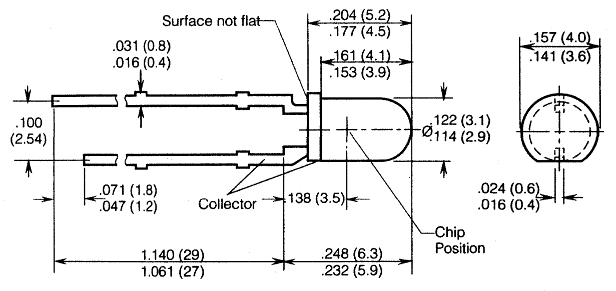
SIEMENS

NEW

SFH310
DAYLIGHT FILTER SFH310FA
SILICON NPN PHOTOTRANSISTOR



Package Dimensions in inches (mm)



FEATURES
- **SFH310 Suitable for Applications from 400 nm to 1100 nm**
- **SFH310FA Suitable for Applications at 880 nm**
- **High Linearity**
- **Package: T1 (3 mm)**

APPLICATIONS
- **Light-reflecting Swiches for Steady and Varying Intensities**
- **Industrial Electronics**
- **Control and Drive Circuits**

DESCRIPTION
The SFH310 and SFH310FA are NPN silicon planar phototransistors. They are enclosed in a T1 (3 mm) clear plastic package.

The collector is denoted by the shorter lead.

Maximum Ratings

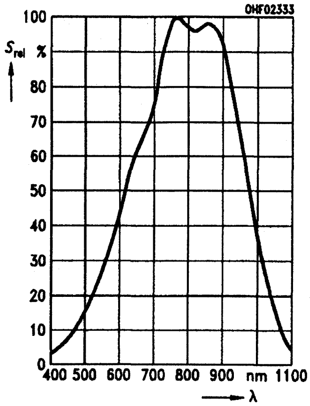
Operating and Storage Temperature Range
(T_{OP}, T_{STG}) .... –55° to +100°C
Soldering Temperature
(≥2 mm from case bottom)
Dip Soldering (T_s) t ≤5 s ....260°C
Iron Soldering (T_s) t ≤3 s ....300°C
Collector Emitter Voltage (V_{CE})......................70 V
Collector Current (I_C) .... 50 mA
Collector Surge Current (I_{CS}).................. 100 mA
Emitter Collector Voltage (V_{EC}).......................7 V
Total Power Dissipation (P_{TOT})
TA=25°C...165 mW
Thermal Resistance (R_{thJA}) .... 450 K/W

Characteristics (T_A=25°C)

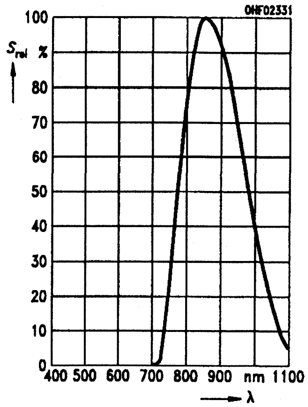
Parameter	Symbol	Value		Unit
		SFH310	SFH310FA	
Wavelength, Maximum Sensitivity	λ_{Smax}	780	880	nm
Spectral Range, Photosensitivity	λ	470 – 1070	740 –1070	nm
Radiant Sensitive Area	A	0.19	0.19	mm^2
Chip Area Dimensions	L x W	0.65 x 0.65	0.65 x 0.65	mm
Distance, Chip Surface to Case Surface	H	2.1 – 2.7	2.1 – 2.7	mm
Half Angle	φ	±25	±25	Deg.
Capacitance (V_{CE}=0 V, f=1 MHz, E=0)	C_{CE}	10	10	pF
Dark Current (V_{CE}=10 V, E=0)	I_{CEO}	5 (≤100)	5 (≤100)	nA
Photocurrent (E_E=0.5 mW/cm^2, V_{CE}=5 V) (E_V=1000 lx, Normal Standard Light V_{CE}=5 V)	I_{PCE}	≥4.0 4	≥4.0 —	mA
Rise/Fall Time (I_C=1 mA, V_{CC}=5 V, R_L=1 kΩ)	$t_R t_F$	7	7	µs
Collector Emitter Saturation Voltage (I_C=1.2 mA, E_e=0.5 mW/cm^2)	V_{CEsat}	150	150	mV

T_A=25°C, λ=950 nm

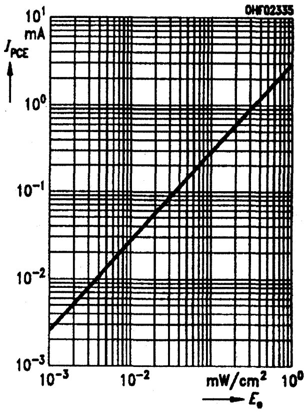
Relative spectral sensitivity, SFH310
S_{rel}=f(λ)



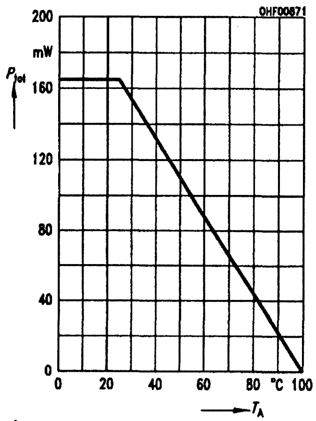
Relative spectral sensitivity, SFH310FA
S_{rel}=f(λ)



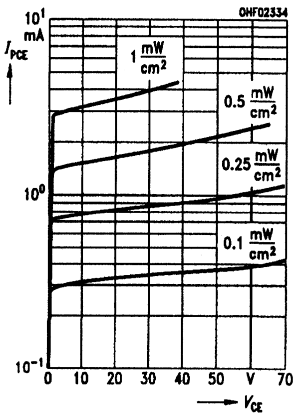
Photocurrent I_{PCE}=f(E_e), V_{CE}=5V



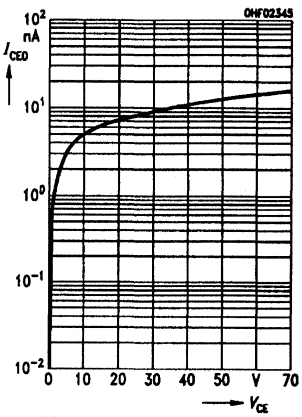
Total power dissipation P_{tot}=f(T_A)



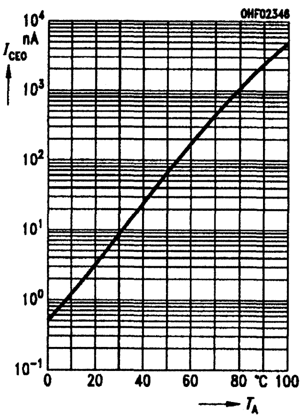
Photocurrent I_{PCE}=f(V_{CE}), E_e=Parameter



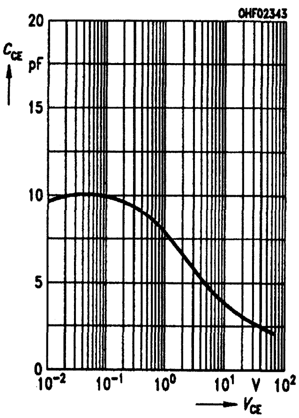
Dark current I_{CEO}=f(V_{CE}), E=0



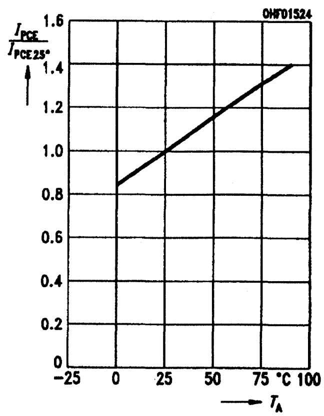
Dark current
I_{CEO}=f(T_A), V_{CE}=10 V, E=0



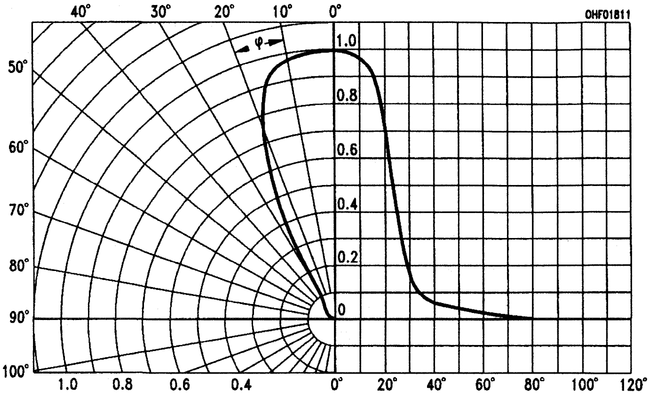
Capacitance
I_{CE}=f(V_{CE}), f=1 MHz



Photocurrent I_{PCE}=f(T_A)
V_{CE}=5 V, normalized to 25°C



Directional characterristics $S_{rel}=f(\varphi)$



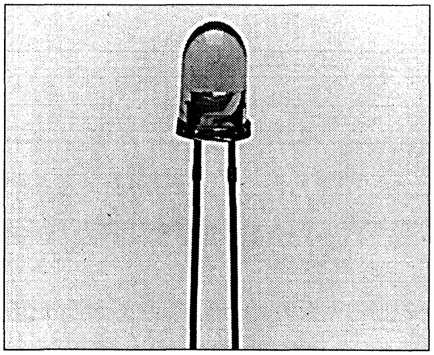
Phototransistors/ Photodarlington

9

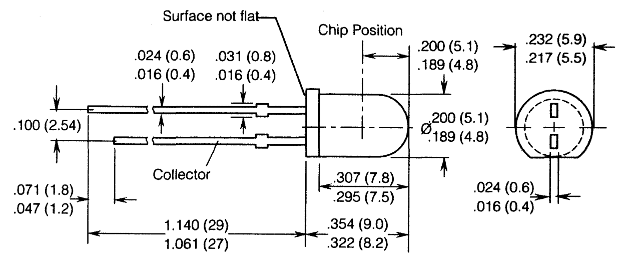
SIEMENS

NEW

SFH313
DAYLIGHT FILTER SFH313FA
SILICON NPN PHOTOTRANSISTOR



Package Dimensions in inches (mm)



FEATURES
- SFH313 Suitable for Applications from 460 nm to 1080 nm
- SFH313FA Suitable for Applications at 880 nm
- High Linearity
- Package: T1¾ (5 mm)

APPLICATIONS
- Computer-controlled Flashes
- Light-reflecting Swiches for Steady and Varying Intensities
- Industrial Electronics
- Control and Drive Circuits

DESCRIPTION
The SFH313 and SFH313FA are NPN silicon planar phototransistors. They are enclosed in a T1¾ (5 mm) clear plastic package.

The collector is the shorter lead.

Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –55° to +100°C

Soldering Temperature (≥2 mm from case bottom)

Dip Soldering (T_s) t ≤5 s ....260°C

Iron Soldering (T_s) t ≤3 s ....300°C

Collector Emitter Voltage (V_{CE})......................70 V

Collector Current (I_C)................................ 50 mA

Collector Surge Current (I_{CS})................... 100 mA

Emitter Collector Voltage (V_{EC})........................7 V

Total Power Dissipation (P_{TOT})

TA=25°C..200 mW

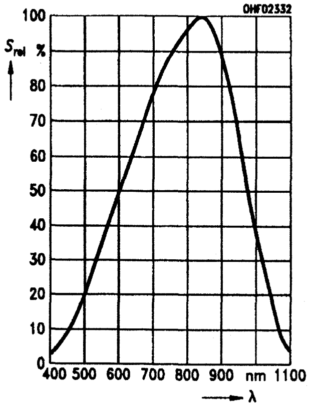
Thermal Resistance (R_{thJA}) .... 375 K/W

Characteristics (T_A=25°C)

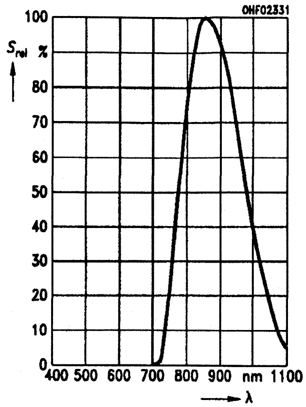
Parameter	Symbol	Value		Unit
		SFH313	SFH313FA	
Wavelength, Maximum Sensitivity	λ_{Smax}	850	870	nm
Spectral Range, Photosensitivity	λ	460 – 1080	740 –1080	nm
Radiant Sensitive Area	A	0.55	0.55	mm^2
Chip Area Dimensions	L x W	1 x 1	1 x 1	mm
Distance, Chip Surface to Case Surface	H	5.1 – 5.7	5.1 – 5.7	mm
Half Angle	φ	±10	±10	Deg.
Capacitance (V_{CE}=0 V, f=1 MHz, E=0)	C_{CE}	15	15	pF
Dark Current (V_{CE}=10 V, E=0)	I_{CEO}	10 (≤200)	10 (≤200)	nA
Photocurrent (E_E=0.5 mW/cm^2, V_{CE}=5 V) (E_V=1000 lx, Normal Standard Light V_{CE}=5 V)	I_{PCE}	≥4.0 30	≥4.0 —	mA
Rise/Fall Time (I_C=1 mA, V_{CC}=5 V, R_L=1 kΩ)	$t_R t_F$	12	12	µs
Collector Emitter Saturation Voltage (I_C=1.2 mA, E_e=0.5 mW/cm^2)	V_{CEsat}	150	150	mV

T_A=25°C, λ=950 nm

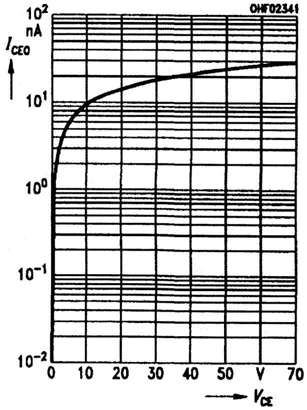
Relative spectral sensitivity, SFH313
S_{rel}=f(λ)



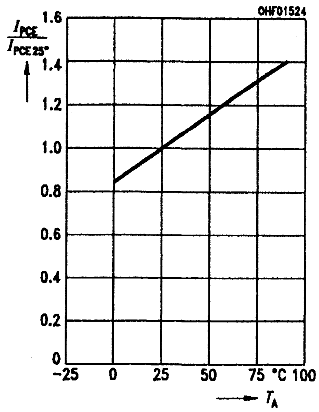
Relative spectral sensitivity, SFH313FA
S_{rel}=f(λ)



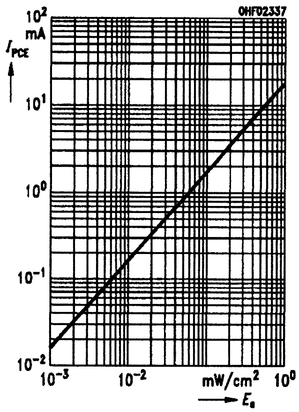
Dark current I_{CEO}=f(V_{CE}), E=0



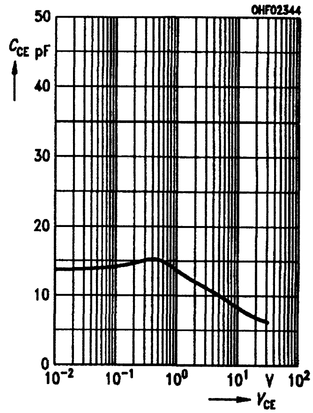
Photocurrent I_{PCE}=f(T_A),
V_{CE}=5 V, normalized to 25°C



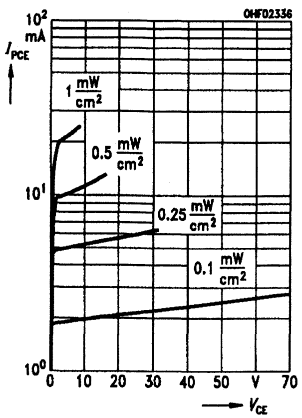
Photocurrent I_{PCE}=f(E_e), V_{CE}=5 V



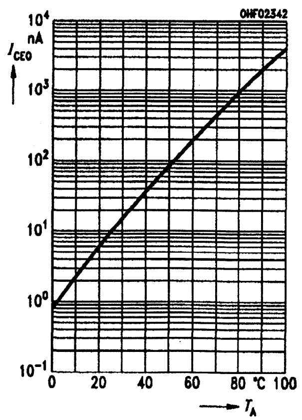
Collector-emitter capacitance
C_{CE}=f(V_{CE}), f=1 MHz



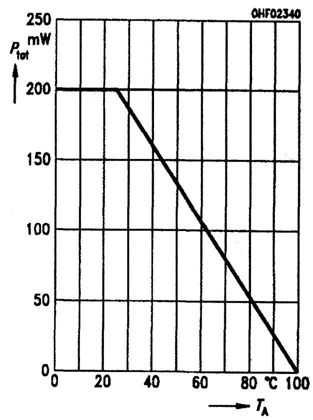
Photocurrent I_{PCE}=f(V_{CE}),
E=parameter



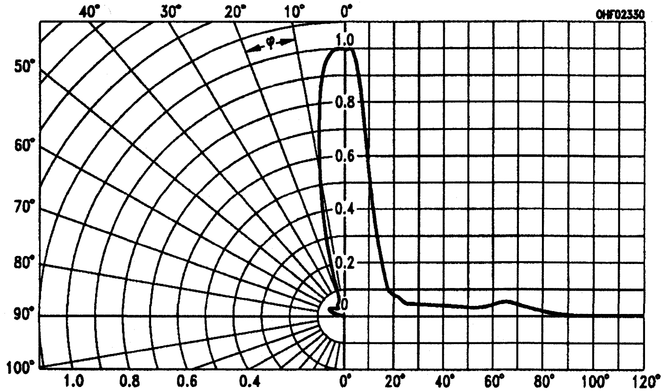
Dark current
I_{CE}=f(T_A), V_{CE}=10 V, E=0



Total power dissipation
P_{tot}=f(T_A)



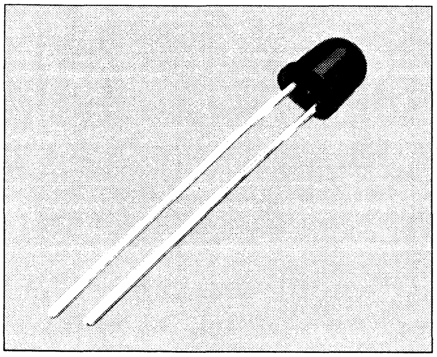
Directional characterristics $S_{rel}=f(\varphi)$



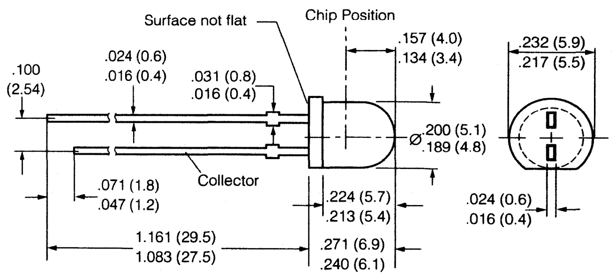
SIEMENS

NEW

SFH314
DAYLIGHT FILTER SFH314FA
SILICON NPN PHOTOTRANSISTOR



Package Dimensions in inches (mm)



FEATURES

- **SFH314 Suitable for Applications from 460 nm to 1080 nm**
- **SFH314FA Suitable for Applications at 880 nm**
- **High Linearity**
- **Package: T1¾ (5 mm)**

APPLICATIONS

- **Computer-controlled Flashes**
- **Light-reflecting Swiches for Steady and Varying Intensities**
- **Industrial Electronics**
- **Control and Drive Circuits**

DESCRIPTION

The SFH314 and SFH314FA are NPN silicon planar phototransistors. They are enclosed in a T1¾ (5 mm) clear plastic package.

The collector is denoted by the shorter lead.

Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –55° to +100°C

Soldering Temperature (≥2 mm from case bottom)

Dip Soldering (T_S) t ≤5 s .... 260°C

Iron Soldering (T_S) t ≤3 s .... 300°C

Collector Emitter Voltage (V_{CE}) .... 70 V

Collector Current (I_C) .... 50 mA

Collector Surge Current (I_{CS}) .... 100 mA

Emitter Collector Voltage (V_{EC}) .... 7 V

Total Power Dissipation (P_{TOT})

TA=25°C .... 200 mW

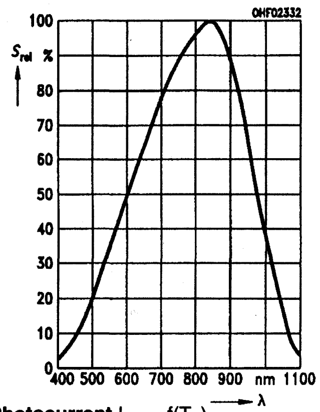
Thermal Resistance (R_{thJA}) .... 375 K/W

Characteristics (T_A=25°C)

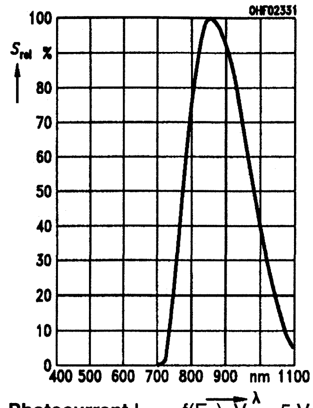
Parameter	Symbol	Value		Unit
		SFH313	SFH313FA	
Wavelength, Maximum Sensitivity	λ_{Smax}	850	870	nm
Spectral Range, Photosensitivity	λ	460 – 1080	740 –1080	nm
Radiant Sensitive Area	A	0.55	0.55	mm^2
Chip Area Dimensions	L x W	1 x 1	1 x 1	mm
Distance, Chip Surface to Case Surface	H	3.4 – 4.0	3.4 – 4.0	mm
Half Angle	φ	±40	±40	Deg.
Capacitance (V_{CE}=0 V, f=1 MHz, E=0)	C_{CE}	15	15	pF
Dark Current (V_{CE}=10 V, E=0)	I_{CEO}	10 (≤200)	10 (≤200)	nA
Photocurrent (E_E=0.5 mW/cm², V_{CE}=5 V) (E_V=1000 lx, Normal Standard Light V_{CE}=5 V)	I_{PCE}	≥0.63 7	≥0.63 —	mA
Rise/Fall Time (I_C=1 mA, V_{CC}=5 V, R_L=1 kΩ)	$t_R t_F$	12	12	µs
Collector Emitter Saturation Voltage (I_C=1.2 mA, E_e=0.5 mW/cm²)	V_{CEsat}	150	150	mV

T_A=25°C, λ=950 nm

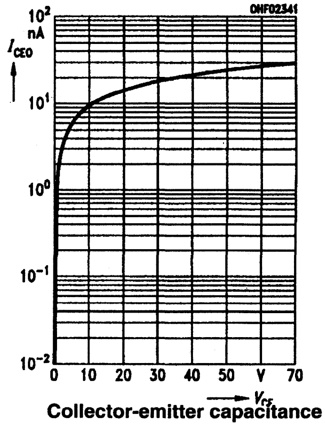
Relative spectral sensitivity, SFH314
$S_{rel}=f(\lambda)$



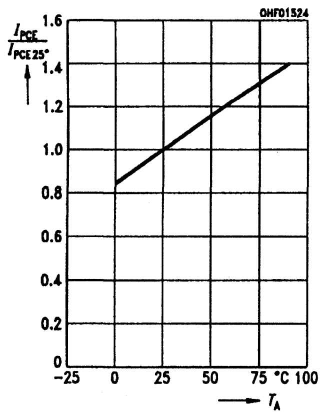
Relative spectral sensitivity, SFH314FA
$S_{rel}=f(\lambda)$



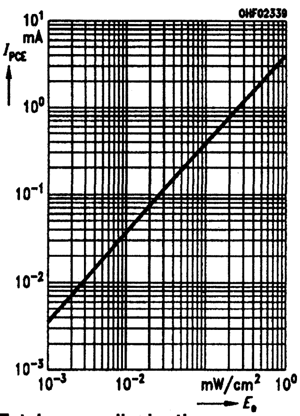
Dark current $I_{CEO}=f(V_{CE})$, E=0



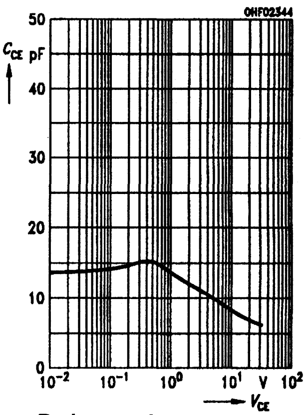
Photocurrent $I_{PCE}=f(T_A)$,
V_{CE}=5 V, normalized to 25°C



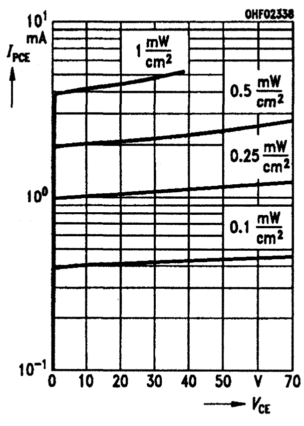
Photocurrent $I_{PCE}=f(E_e)$, V_{CE}=5 V



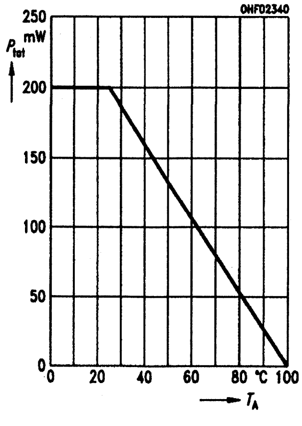
Collector-emitter capacitance
$C_{CE}=f(V_{CE})$, f=1 MHz



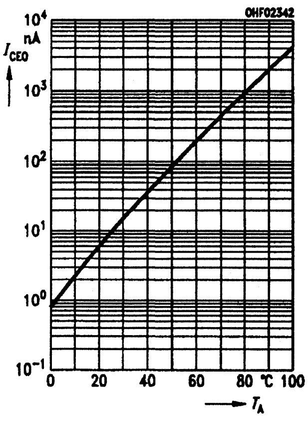
Photocurrent $I_{PCE}=f(V_{CE})$,
E=parameter



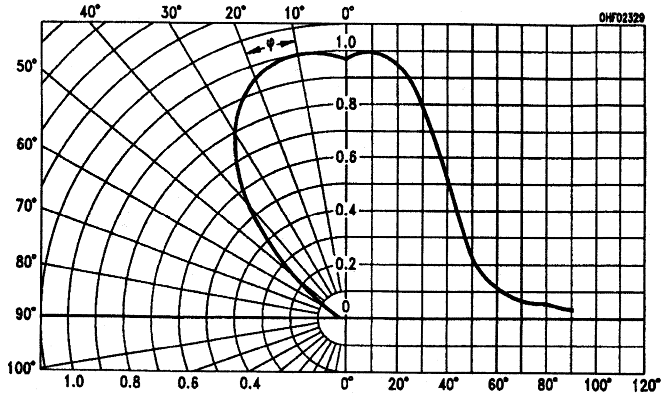
Total power dissipation
$P_{tot}=f(T_A)$



Dark current
$I_{CE}=f(T_A)$, V_{CE}=10 V, E=0



Directional characterristics $S_{rel}=f(\varphi)$

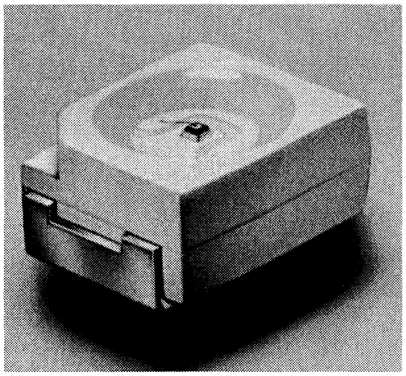


Phototransistors/ Photodarlington

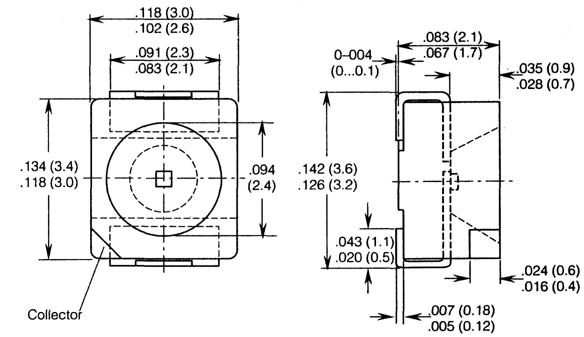
9

SIEMENS

SFH320
DAYLIGHT FILTER *SFH320FA
NPN Silicon Phototransistor
SMT-TOPLED™



Package Dimensions in Inches (mm)



FEATURES

- **NPN Silicon Phototransistor**
- **Daylight Filter Option–SFH320FA**
- **Suitable for Vapor-Phase Reflow, Infrared Reflow, Wave Solder Processes**
- **Compatible with Automatic Placement Equipment**
- **High Photosensitivity**
- **High Reliability**
- **No Measurable Degradation**
- **Four Photocurrent Bin Options**
- **Matches with SFH420–SMT IRED**
- **Surface Mountable PL-CC-2 Package**
- **Applications**
  - **Measurement and Control**
  - **Touch Screens**
  - **Miniature Light Curtains**

DESCRIPTION

The SFH320/320FA are high-sensitivity NPN silicon phototransistors in a compact surface-mountable package. Available with or without a daylight filter, they are compatible with automatic placement equipment and can withstand IR reflow, vapor phase reflow, and wave solder processes. Their small size makes them suitable for dense packaging in array applications such as touch screens and precise position measurement.

***Formerly SFH320F**

Maximum Ratings

Operating & Storage Temperature (T_{OP}, T_{STG}) ....–55 to +100°C
Collector-Emitter Voltage (V_{CE}) ....35 V
Collector Current (I_C) .... 15 mA
Peak Collector Current (I_{CS}) τ<10 µs .... 75 mA
Power Dissipation (P_{tot}) T_A=25°C .... 165 mW
Thermal Resistance, Junction to Ambient
Mounting on PC Board (R_{thJA}) .... 450 K/W

Characteristics (T_A=25 °C, λ=950 nm)

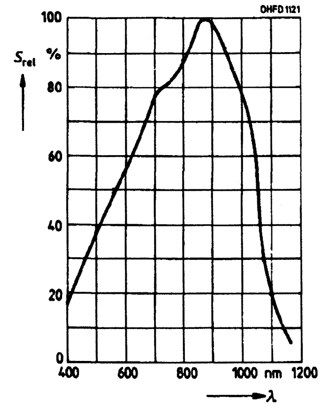
Parameter	Symbol	SFH320	SFH320FA	Unit
Maximum Sensitivity Wavelength	λ_{Smax}	860	900	nm
Spectral Range, Photosensitivity (S = 10% of S_{max})	λ	380 to 1150	730 to 1120	nm
Radiant Sensitive Area	A	0.045	0.045	mm^2
Radiant Sensitive Area Dimensions	L x W	0.45 x 0.45	0.45 x 0.45	mm
Distance, Chip Surface to Case Surface	H	0.5 to 0.7	0.5 to 0.7	mm
Half Angle	φ	±60	±60	Deg.
Capacitance (V_{CE}=0 V, f=1 MHz, E=0)	C_{CE}	5.0	5.0	pF
Dark Current (V_{CE}=25 V, E=0)	I_{CEO}	1(≤200)	1(≤200)	nA

Photosensitivity ranges by dash numbers.

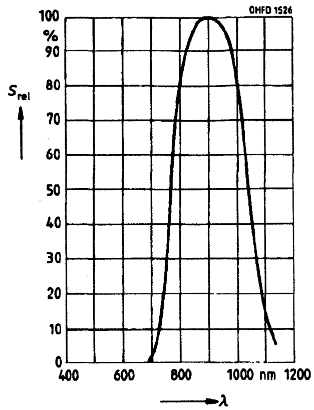
Parameter	Symbol	–2	–3	–4	Unit
Photocurrent (E_e=0.1 mW/cm^2, V_{CE}=5 v)	I_{PCE}	16–32	25–50	≥40	µA
SFH320: (E_V=1000 lx, std. light A, V_{CE}=5 V)	I_{PCE}	420	650	1000	µA
Rise Time/FallTime (I_C=1 mA, V_{CC}=5 V, R_L=1 kΩ)	t_r, t_f	6	7	8	µs
Collector-emitter Saturation Voltage (I_{PCE}=I_{PCEmin}(1) x 0.3, E_e=0.1 mW/cm^2)	V_{CEsat}	150	150	150	mV

Note: 1. I_{PCEmin} is the minimum photocurrent for each group.

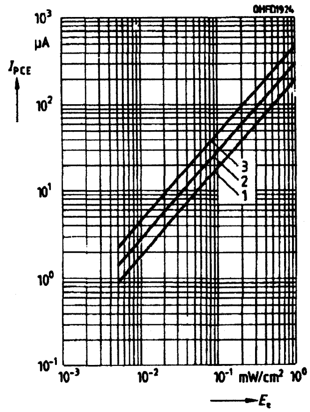
Relative spectral sensitivity–SFH320
$S_{REL}=f(\lambda)$



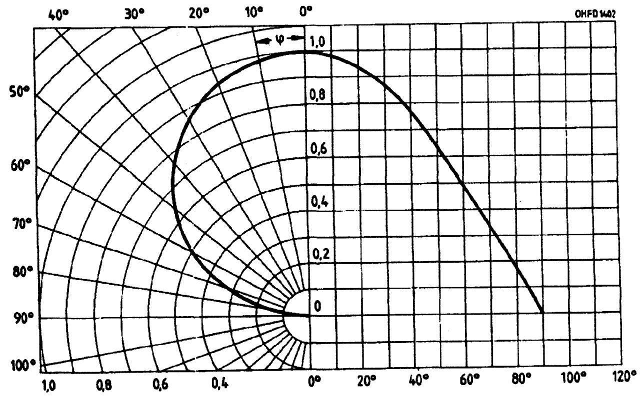
Relative spectral sensitivity–SFH320FA
$S_{REL}=f(\lambda)$



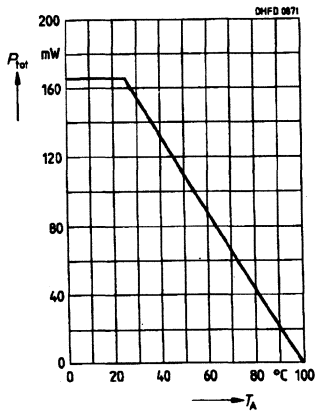
Photocurrent $I_{PCE}=f(E_e)$, V_{CE} =5 V



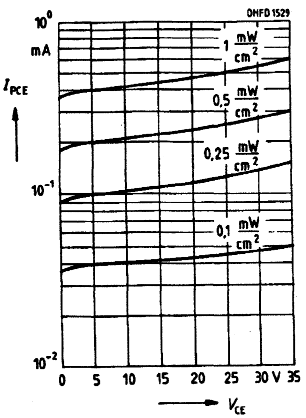
Directional characteristic
$S_{REL}=f(\varphi)$



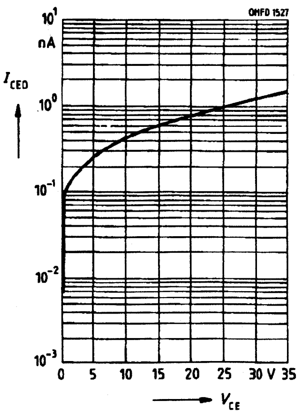
Total power dissipation
$P_{TOT}=f(T_A)$



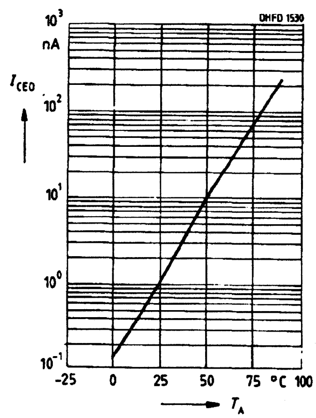
Photocurrent
$I_{PCE}=f(V_{CE})$, E_e=Parameter



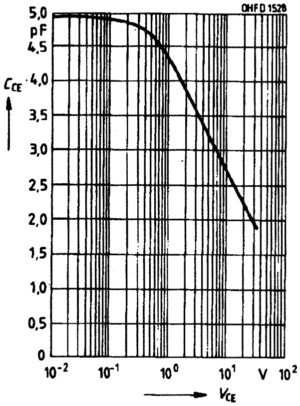
Dark current $I_{CEO}=f(V_{CE})$, E=0



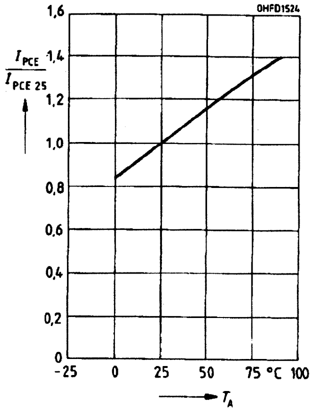
Dark current $I_{CEO}=f(T_A)$,
V_{CE}=25 V, E=0



Capacitance
C_{CE}=f(V), f=1 MHz, E=0

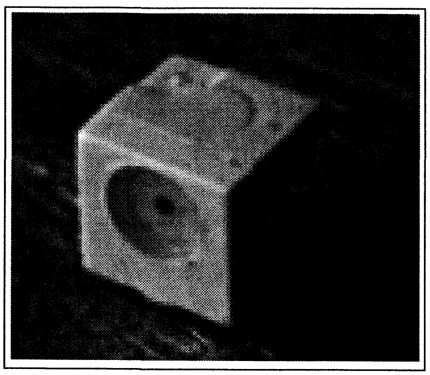


Photocurrent
I_{PCE}/I_{PCE25}=f(T_A), V_{CE}=5 V

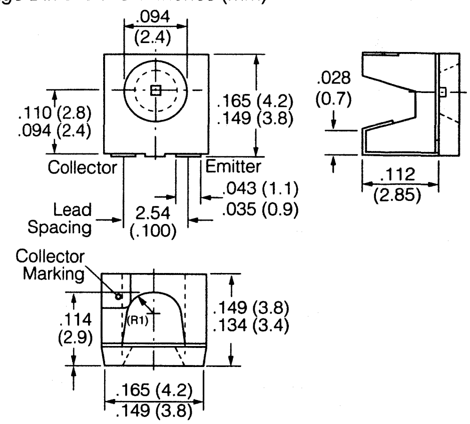


SIEMENS

SFH325
DAYLIGHT FILTER SFH325FA
NPN Silicon Phototransistor
SMT-SIDELED



Package Dimensions in Inches (mm)



FEATURES

- **NPN Silicon Phototransistor**
- **Daylight Filter Option–SFH325FA**
- **Suitable for Vapor-Phase Reflow and Infrared Reflow Processes**
- **Compatible with Automatic Placement Equipment**
- **High Photosensitivity**
- **High Reliability**
- **No Measurable Degradation**
- **Four Photocurrent Bin Options**
- **Matches with SFH425–SMT IRED**
- **Surface Mountable PL-CC-2 Package**
- **Applications**
  - **Measurement and Control**
  - **Touch Screens**
  - **Miniature Light Curtains**

DESCRIPTION

The SFH325/325FA are high-sensitivity NPN silicon phototransistors in a compact surface-mountable right angle package. Available with or without a daylight filter, they are compatible with automatic placement equipment and can withstand IR reflow and vapor phase reflow solder processes. Their small size makes them suitable for dense packaging in array applications such as touch screens and precise position measurement.

Maximum Ratings

Operating and Storage Temperature (T_{OP}, T_{STG}) ....–55 to +100°C
Collector-Emitter Voltage (V_{CE}) ....35 V
Collector Current (I_C) .... 15 mA
Peak Collector Current (I_{CS}) τ<10 µs .... 75 mA
Power Dissipation (P_{tot}) T_A=25°C .... 165 mW
Thermal Resistance, Junction to Ambient
Mounting on PC Board (R_{thJA}) .... 450 K/W

Characteristics (T_A=25 °C, λ=950 nm)

Parameter	Symbol	SFH325	SFH325F	Unit
Maximum Sensitivity Wavelength	λ_{Smax}	860	900	nm
Spectral Range, Photosensitivity (S=10% of S_{max})	λ	380 to 1150	730 to 1120	nm
Radiant Sensitive Area	A	0.045	0.045	mm²
Radiant Sensitive Area Dimensions	L x W	0.45 x 0.45	0.45 x 0.45	mm
Distance, Chip Surface to Case Surface	H	0.5 to 0.7	0.5 to 0.7	mm
Half Angle	φ	±60	±60	Deg.
Capacitance (V_{CE}=0 V, f=1 MHz, E=0)	C_{CE}	5.0	5.0	pF
Dark Current (V_{CEO}=25 V, E=0)	I_{CEO}	1(≤200)	1(≤200)	nA

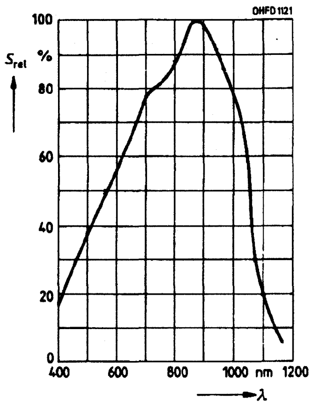
Photosensitivity ranges by dash numbers.

Parameter	Symbol	-1(1)	-2	-3	-4(1)	Unit
Photocurrent (E_e=0.1 mW/cm², V_{CE}=5 v)	I_{PCE}	10–20	16–32	25–50	≥40	µA
SFH325: (E_V=1000 lx, std. light A, V_{CE}=5 V)	I_{PCE}	260	420	650	1000	µA
Rise Time/FallTime (I_C=1 mA, V_{CC}=5 V, R_L=1 kΩ)	t_r, t_f	5	6	7	8	µs
Collector-emitter Saturation Voltage (I_{PCE}=I_{PCEmin}(2) • 0.3, E_e=0.1 mW/cm²)	V_{CEsat}	150	150	150	150	mV

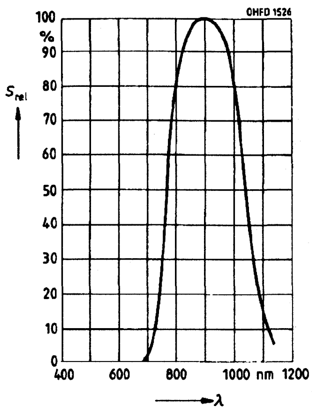
Notes: 1. Subject to yield. Contact factory.
2. I_{PCEmin} is the minimum photocurrent for each group.

Phototransistors/ Photodarlington 9

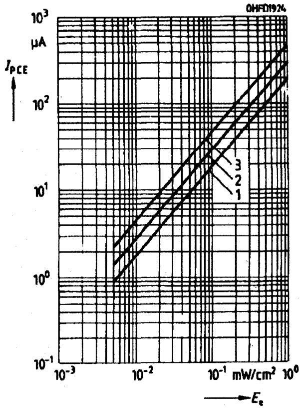
Relative spectral sensitivity–SFH325
$S_{REL}=f(\lambda)$



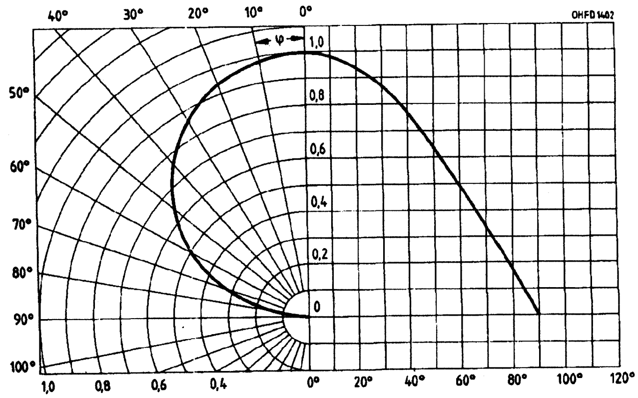
Relative spectral sensitivity–SFH325F
$S_{REL}=f(\lambda)$



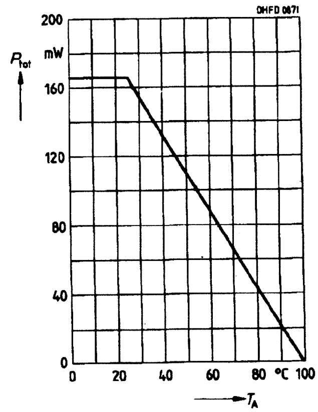
Photocurrent $I_{PCE}=f(E_e)$, $V_{CE}=5$ V



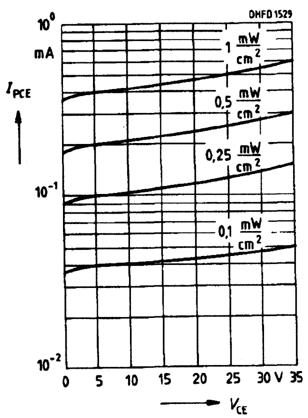
Directional characteristic
$S_{REL}=f(\varphi)$



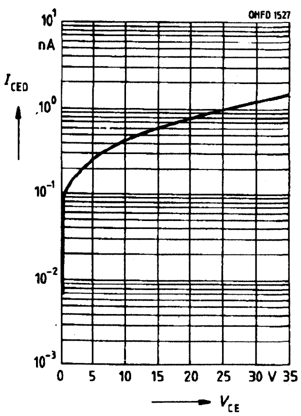
Total power dissipation
$P_{TOT}=f(T_A)$



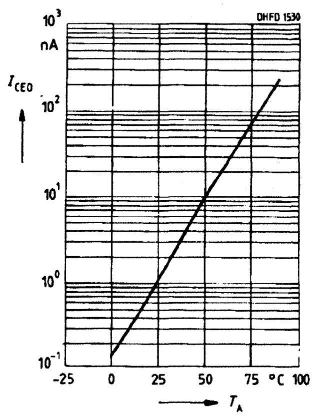
Photocurrent
$I_{PCE}=f(V_{CE})$, E_e=Parameter



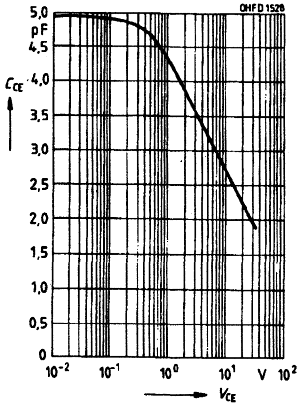
Dark current $I_{CEO}=f(V_{CE})$, E=0



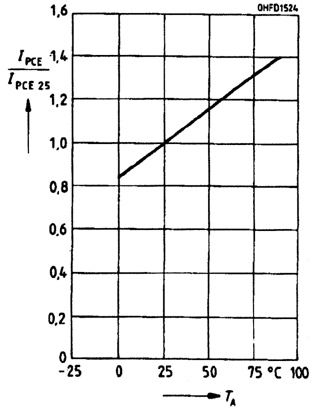
Dark current $I_{CEO}=f(T_A)$,
$V_{CE}=25$ V, E=0



Capacitance
$C_{CE}=f(V)$, f=1 MHz, E=0



Photocurrent
$I_{PCE}/I_{PCE25}=f(T_A)$, V_{CE}=5 V

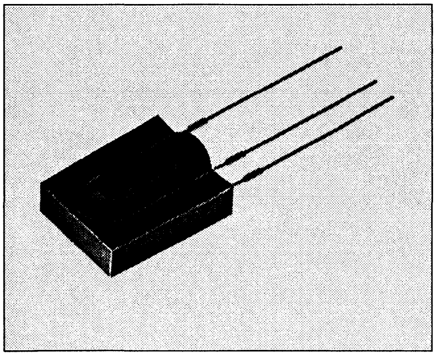


Phototransistors/ Photodarlington
9

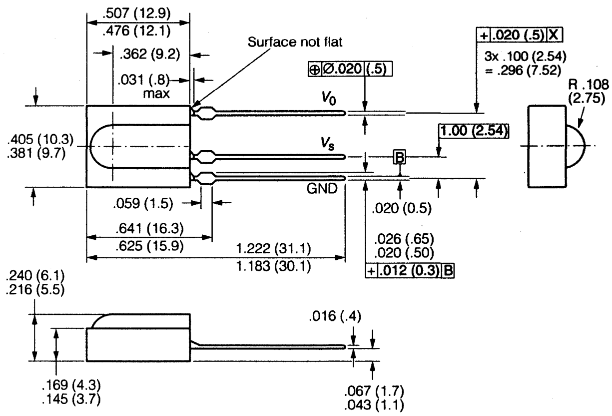
SIEMENS

SFH506

IR Receiver/Demodulator Device



Package Dimensions in inches (mm)



FEATURES

- **Photodiode with Hybrid Integrated Circuit**
- **Several Carrier Frequencies**
- **Black Epoxy Resin with Daylight Filter Optimized for 950 nm**
- **High Immunity Against Ambient Light**
- **Low Power Consumption**
- **5 V Supply Voltage**
- **High Sensitivity (Internal Shield Case)**
- **TTL and CMOS Compatibility**
- **Continuous Transmission Possible (tpi/T≤0.4)**
- **Application**
  - **IR Remote Control Preamplifier Module**

DESCRIPTION

The SFH506 is a family of miniaturized receivers for infrared remote control systems. The demodulated output signal can be directly decoded by a microprocessor.

Maximum Ratings

Operating/Storage Temperature
Range (T_A, T_{STG}) .... –25° to +85°C
Junction Temperature (T_J) .... +100°C
Soldering Temperature (solder joint ≥2 mm from package) .... +260°C
Soldering Time, t ≤5 s
Supply Voltage, Pin 2 (V_{CC}) .... –0.3 to +6.0 V
Supply Current, Pin 2 (I_{CC}) .... 5 mA
Output Voltage, Pin 3 (V_Q) .... –0.3 to +6.0 V
Output Current, Pin 3 (I_Q) .... 5 mA
Power Dissipation (P_{tot}) T_A≤85°C .... 50 mW

Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Threshold Irradiance, t_{po}=t_{pi}±160 µs (test signal, see Figure 3)	E_{emin}[(1)] E_{emax}[(1)]	0.35 typ. 0.5 max. 20	mW/m^2 W/m^2
Wavelength, Maximum Sensitivity	λ_{Smax}	950	nm
Spectral Sensitivity Range (S=10% of S_{MAX})	$\Delta\lambda$	830 to 1100	nm
Half Angle	φ	±55	Deg.
Current Consumption, Pin 2 V_S=5 V, E_V=0 V_S=5 V, E_V=4000 lx, Sunlight	 I_{CC} I_{CC}	 0.5 1.0	 mA mA
Output Voltage, Pin 3 (I_Q=0.5 A, E_e=0.5 mW/m^2, f=f_0, T_p/T=0.4)	V_{Qlow}	<250	mV

Part Number	Carrier Frequency, kHz
SFH506-30	30
SFH506-33	33
SFH506-36	36
SFH506-38	38
SFH506-40	40
SFH506-56	56

Note
1. An arrival distance of 35 m is possible when SFH506 is used with IRED SFH415 under operation conditions.

Figure 1. Block diagram

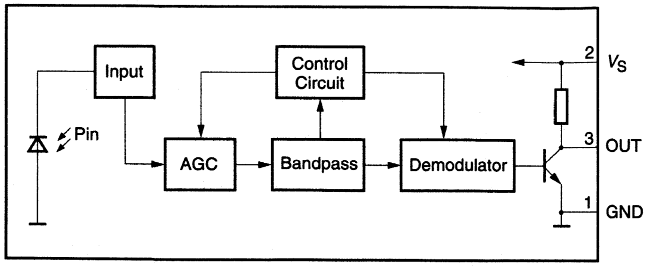
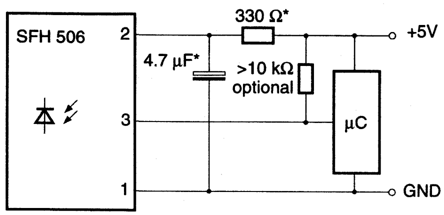
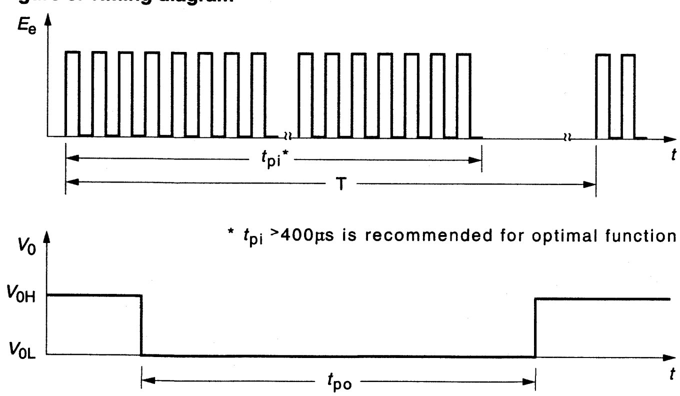


Figure 2. External circuit



* only necessary to suppress power supply disturbances

Figure 3. Timing diagram



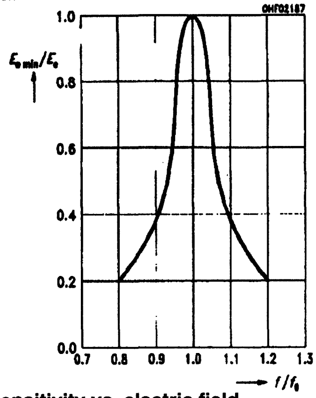
* t_{pi} >400µs is recommended for optimal function

$t_{po} = t_{pi} \pm 160\mu s$

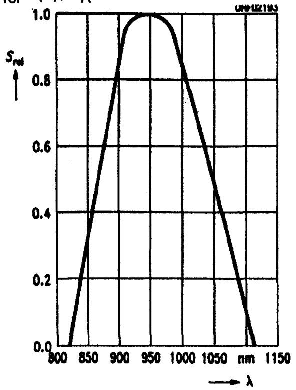
Phototransistors/ Photodarlington

9

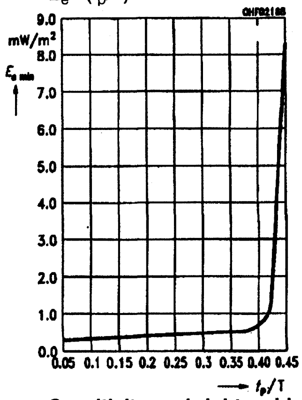
Relative sensitivity
$E_{emin}/E_e=f(f/f_0)$



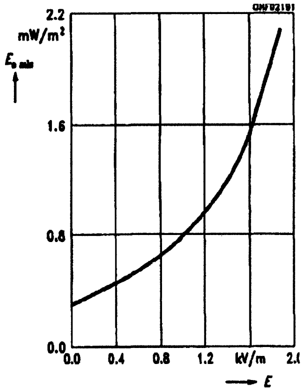
Relative luminous intensity
$S_{rel}=f(\lambda)$, T_A=25°C



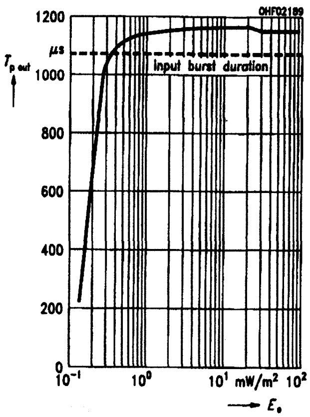
Sensitivity vs. duty cycle
$E_e=f(t_p/T)$



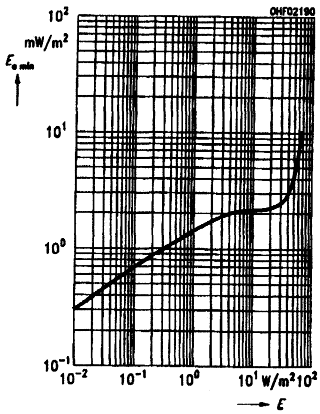
Sensitivity vs. electric field disturbance $E_{emin}=f(E)$, disturbance field strength, $f=f_0$



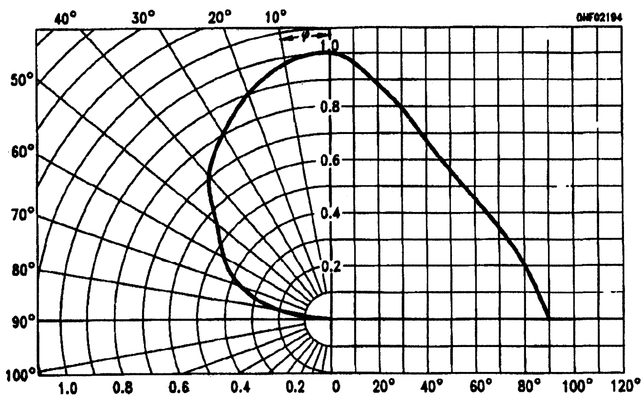
Sensitivity vs. dark ambient
$T_{pout}=f(E_e)$, λ=950 nm, optical test signal



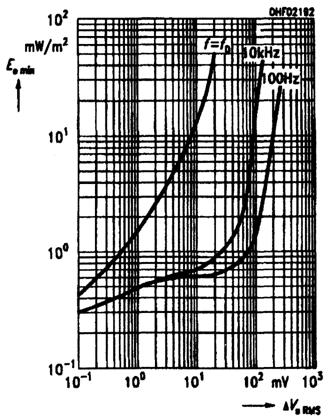
Sensitivity vs. bright ambient
$E_{emin}=f(E)$, λ=950 nm, ambient



Directional characteristic
$S_{rel}=f(\varphi)$

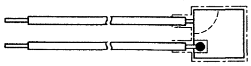
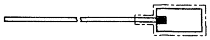
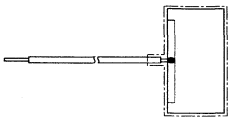
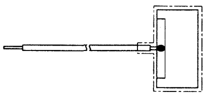
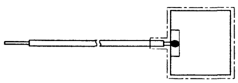
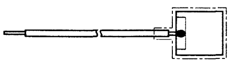
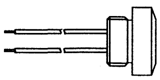
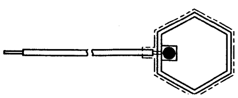


Sensitivity vs. supply voltage disturbance $E_{emin}=f(\Delta V_{SRMS})$



SFH506

Photovoltaic Cells

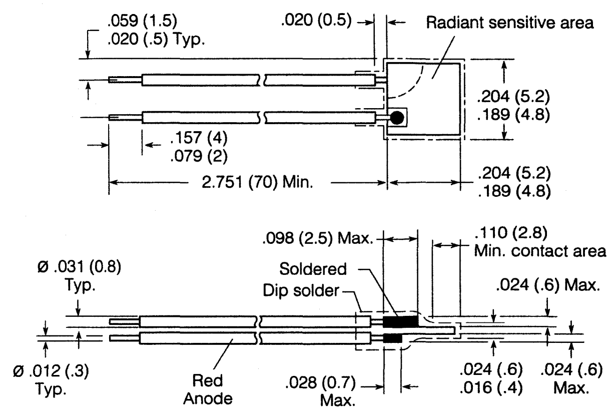
Package Outline	Part Number	Package Type	Half Angle	Sensitivity s(μA/lx)	Dark Current V_R=I V, E=0 μA	Radiant Sensitive Area mm^2	Peak Wave-length	Capacitance V_R=0 V, E=0 nF	Page
	BPX79	Chip with wires.	±60°	170 nA/lx	0.3 (<50)	20	800	2.5	10–1
	BPY11P-4	Chip with wires.	±60°	47-63 nA/lx	1 (≤10)	7.6	850	0.8	10–3
	BPY11P-5			≥56 nA/lx					
	BPY47P	Chip with wires.	±60°	1.4 (0.9)	25 (≤400)	190	850	16	10–5
	BPY48P	Chip with wires.	±60°	0.5 (≥0.35)	10 (≤180)	70	850	6	10–7
	BPY63P	Chip with wires.	±60°	0.65 (≥0.45)	10 (≤60)	94	850	8	10–9
	BPY64P	Chip with wires.	±60°	0.25 (≥0.18)	4 (≤80)	36	850	3	10–11
	TP60P	Plastic, threaded. Anode marked by red lead.	±60°	1 (≥0.7)	0.1 (≤2)	1300	900	11	10–13
	TP61P	Chip with wires. Anode marked by red lead.							

SIEMENS

BPX79

SILICON PHOTOVOLTAIC CELL
HIGH BLUE SENSITIVITY

Package Dimensions in Inches (mm)



FEATURES

- **Silicon Planar Photovoltaic Cell**
- **Medium Size Active Area**
- **High Blue Sensitivity**
- **High Reliability**
- **No Testable Degradation**
- **Wide Temperature Range**

DESCRIPTION

The BPX79 is a silicon planar photovoltaic cell. Its high sensitivity with shorter wavelengths makes it suitable for applications with high-blue light sources. The BPX79 is nitride-passivated and has an anti-reflection coating for a λ=450 nm wavelength.

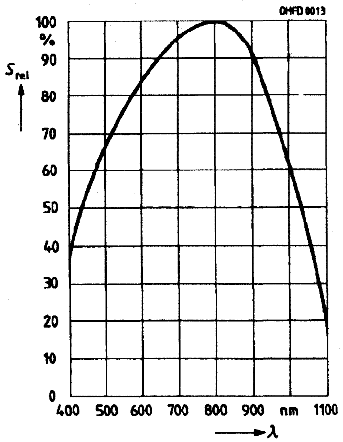
Maximum Ratings

Operating, Storage Temperature Range (T_{OP}, T_{STG}) .... –55° to +100°C
Reverse Voltage (V_R) .... 1 V

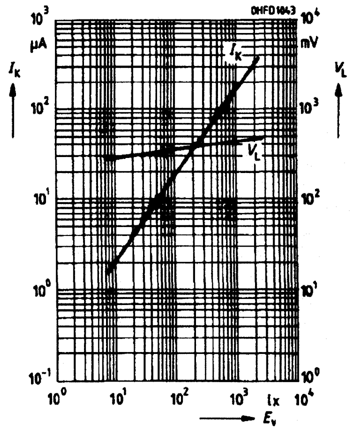
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Photosensitivity (standard light A, T=2856 K)	S	170	nA/lx
Maximum Photosensitivity Wavelength	λ_{Smax}	800	nm
Photosensitivity Spectral Range (S=10% of S_{MAX})	λ	350 to 1100	nm
Radiant Sensitive Area	A	20	mm^2
Radiant Sensitive Area Dimensions	L x W	4.47 x 4.47	mm
Half Angle	φ	±60	Deg.
Dark Current (V_R=1 V, E=0))	I_R	0.3 (≤50)	µA
Spectral Photosensitivity (λ=400 nm)	S_λ	0.19	A/W
Quantum Efficiency (λ=400 nm)	η	0.60	electrons/photon
Open Circuit Voltage (E_V=1000 lx, std. light A, T=2856 K)	V_O	450 (≥250)	mV
Short Circuit Current (E_e=0.5 mW/cm^2)	I_{SC}	19 (≥14)	µA
Photocurrent Rise and Fall Time 10% to 90%, and 90% to 10% of Final Value (R_L=1 kΩ, V_R=1 V, λ=850 nm, I_P=150 µA)	t_R,t_F	6	µs
Capacitance (V_R=0 V, f=1 MHz, E_V=0 lx)	C_O	2500	pF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.2	%/K

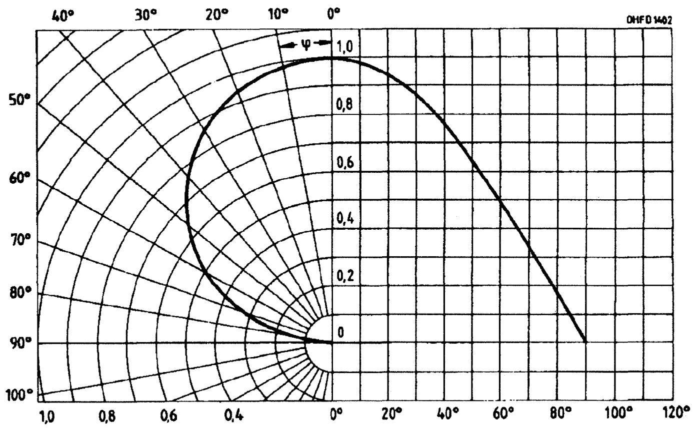
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



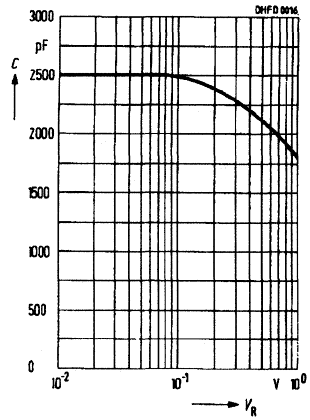
Open circuit voltage $V_O=f(E_V)$
Short circuit voltage $V_{SC}=f(E_V)$



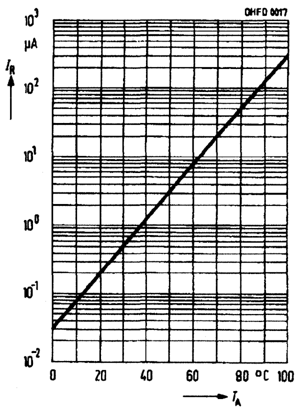
Directional characteristic
$S_{REL}=f(\varphi)$



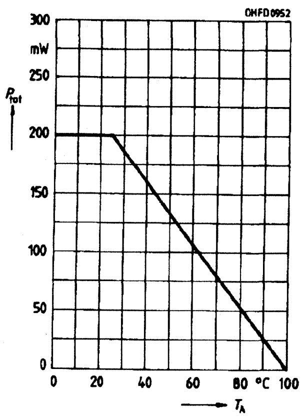
Capacitance
$C=f(V_R)$, f=1 MH, E=0



Dark current
$I_R=f(V_R)$, V_R=1 V, E=0



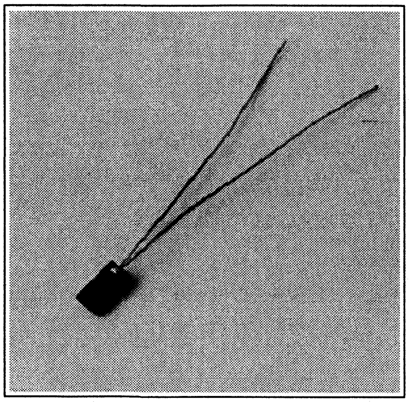
Power dissipation $P_{TOT}=f(T_A)$



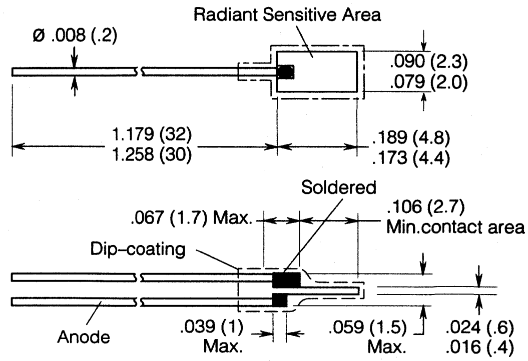
SIEMENS

BPY11P

SILICON PHOTOVOLTAIC CELL



Package Dimensions in Inches (mm)



FEATURES

- **Small Package**
- **Two Sensitivity Selections**
- **Fast Response Time**

DESCRIPTION

The BPY11P is a silicon planar photovoltaic cell, which can be used in control and drive circuits, for light pulse scanning, and for quantitative light measurements. Its rapid response, small dimensions, and high permissible operating temperature enable universal application.

Since this cell is not encased, it can be used for the assembly of high-efficiency scanning systems by cementing the cells closely together on suitable mounting assemblies.

Maximum Ratings

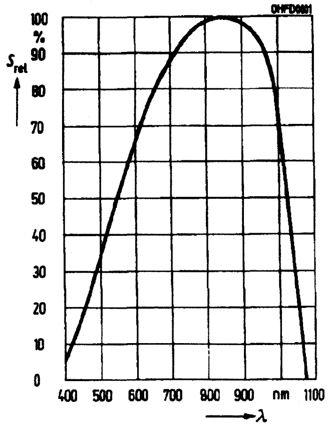
Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –55° to +100°C
Reverse Voltage (V_R) .... 1 V

Characteristics (T_A=25°C)

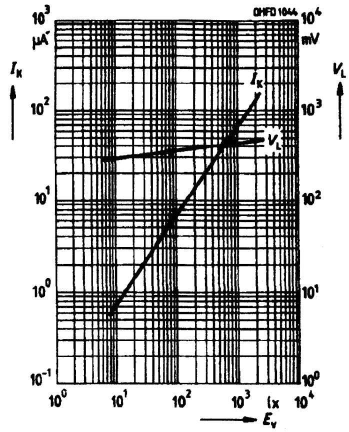
Parameter	**Symbol**	**Value**	**Unit**
Photosensitivity (standard light A, T=2856 K))	S	60 (≥47)	nA/lx
Maximum Photosensitivity Wavelength	λ_{Smax}	850	nm
Photosensitivity Spectral Range (S=10% of S_{MAX})	λ	420 to 1060	nm
Radiant Sensitive Area	A	7.6	mm^2
Radiant Sensitive Area Dimensions	L x W	1.95 x 4.45	mm
Half Angle	φ	±60	Deg.
Dark Current (V_R=1 V, E=0))	I_R	1 (≤10)	µA
Spectral Photosensitivity (λ=850 nm)	S_λ	0.55	A/W
Quantum Efficiency (λ=850 nm)	η	0.80	electrons / photon
Open Circuit Voltage (E_V=1000 lx, std. light A, T=2856 K)	V_O	440 (≥260)	mV
Short Circuit Current (E_V=1000 lx, std. light A, T=2856 K)	I_{SC}	60 (≥47)	µA
Photocurrent Rise and Fall Time 10% to 90%, and 90% to 10% of Final Value (R_L=1 kΩ, V_R=1 V, λ=850 nm, I_P=50 µA)	t_R,t_F	3	µs
Capacitance (V_R=0 V, f=1 MHz, E_V=0 lx)	C_0	0.8	nF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.2	%/K

Spectral Photosensitivity	**Symbol**	**-4**	**-5**	**Unit**
Short Circuit Current (E_V=1000 lx, std. light A, T=2856 K)	I_{SC}	47 to 63	≥56	µA

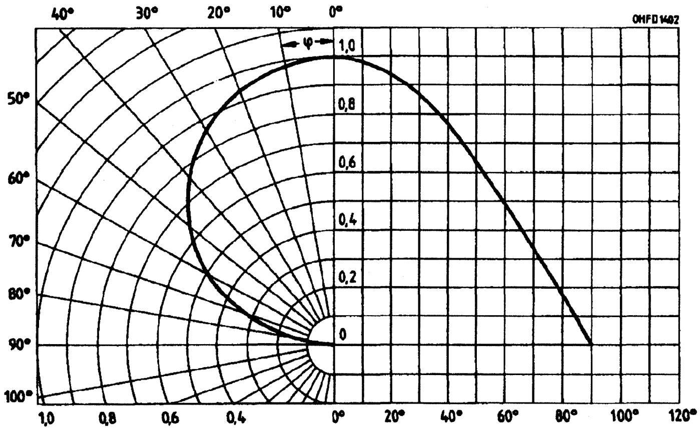
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



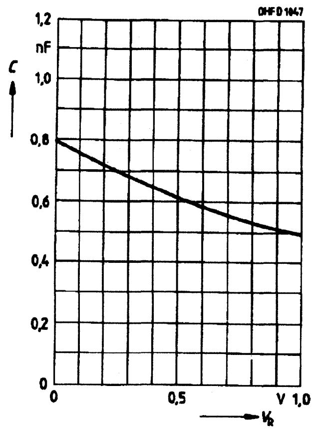
Open circuit voltage $V_O=f(E_V)$
Short circuit voltage $V_{SC}=f(E_V)$



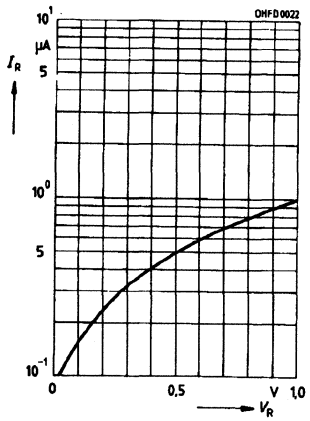
Directional characteristic
$S_{REL}=f(\varphi)$



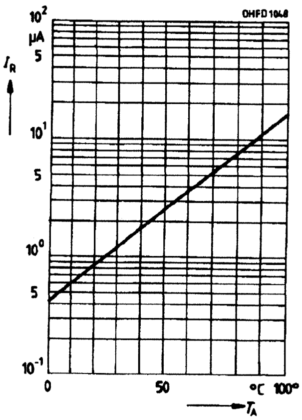
Capacitance
$C=f(V_R)$, f=1 MH, E=0



Dark current
$I_R=f(V_R)$, E=0



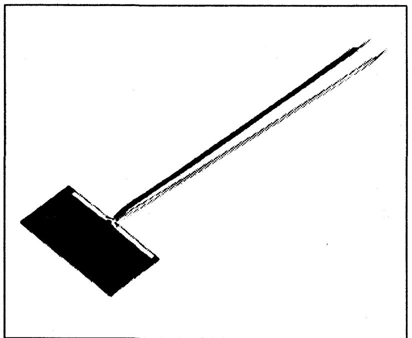
Dark current
$I_R=f(T_A)$, V_R=1 V, E=0



SIEMENS

BPY47P

SILICON PHOTOVOLTAIC CELL



FEATURES

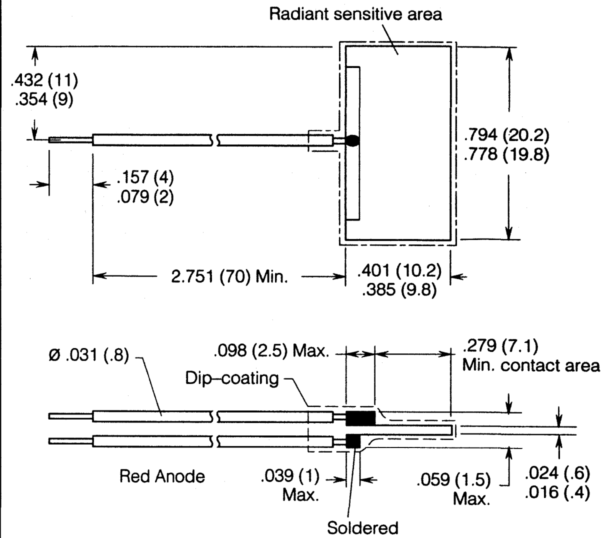
- **High Reliability**
- **No Testable Degradation**
- **High Packing Density**
- **Wide Temperature Range**

DESCRIPTION

The BPY47P is a silicon planar photovoltaic cell with N-Si material providing positive front and negative back contacts. The Si chip has two leads and is coated with a humidity-proof protective layer.

Applications include control and drive circuits, light pulse scanning, and quantitative light measurements in the visible and near infrared range.

Package Dimensions in Inches (mm)



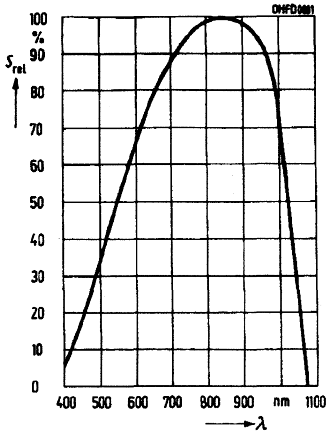
Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –55° to +100°C
Reverse Voltage (V_R) .... 1 V

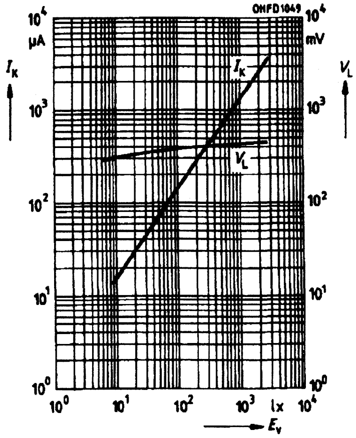
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Photosensitivity (standard light A, T=2856 K))	S	1.4 (≥0.9)	µA/lx
Maximum Photosensitivity Wavelength	λ_{Smax}	850	nm
Sensitivity Spectral Range (S=10% of S_{MAX})	λ	420 to 1060	nm
Radiant Sensitive Area	A	1.9	cm^2
Radiant Sensitive Area Dimensions	L x W	9.58 x 19.58	mm
Half Angle	φ	±60	Deg.
Dark Current (V_R=1 V, E=0))	I_R	25 (≤400)	µA
Spectral Sensitivity (λ=850 nm)	S_λ	0.51	A/W
Quantum Efficiency (λ=850 nm)	η	0.73	electrons / photon
Open Circuit Voltage (E_V=1000 lx, std. light A, T=2856 K)	V_O	450 (≥280)	mV
Short Circuit Current (E_V=1000 lx, std. light A, T=2856 K)	I_{SC}	1.4 (≥0.9)	mA
Photocurrent Rise and Fall Time 10% to 90%, and 90% to 10% of Final Value (R_L=1 kΩ, V_R=1 V, λ=850 nm, I_P=50 µA)	t_R,t_F	23	µs
Capacitance (V_R=0 V, f=1 MHz, E_V=0 lx)	C_O	16	nF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.2	%/K

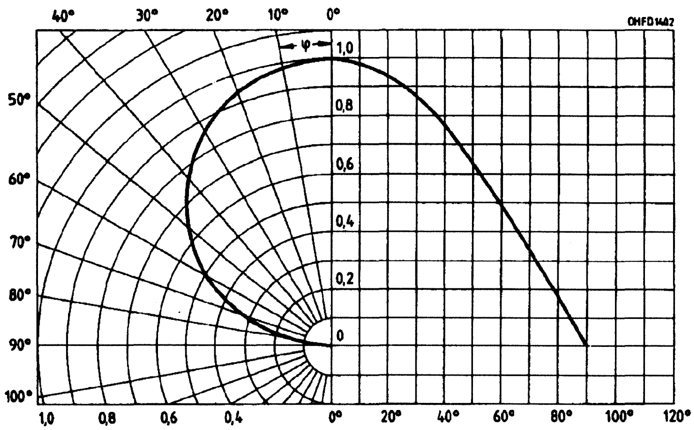
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



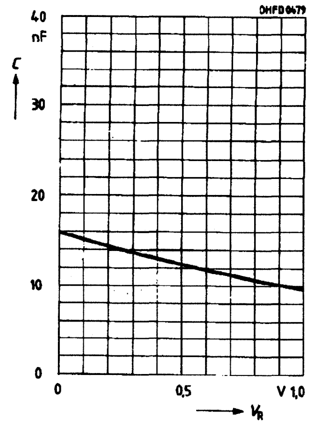
Open circuit voltage $V_O=f(E_V)$
Short circuit voltage $V_{SC}=f(E_V)$



Directional characteristic
$S_{REL}=f(\varphi)$



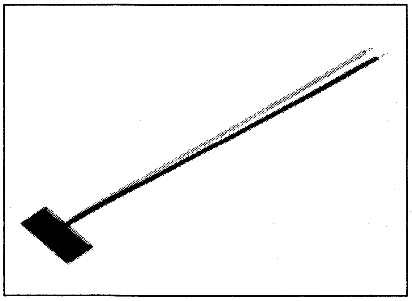
Capacitance
$C=f(V_R)$, f=1 MH, E=0



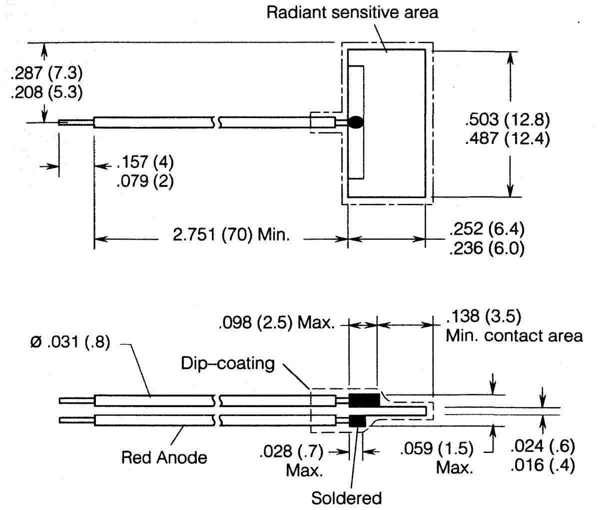
SIEMENS

BPY48P

SILICON PHOTOVOLTAIC CELL



Package Dimensions in Inches (mm)



FEATURES

- **High Reliability**
- **No Testable Degradation**
- **High Packing Density**
- **Wide Temperature Range**

DESCRIPTION

The BPY48P is a silicon planar photovoltaic cell, with N-Si material providing positive front and negative back contacts. The Si chip has two leads and is coated with a humidity-proof protective layer.

Applications include control and drive circuits, light pulse scanning, and quantitative light measurements in the visible and near infrared range.

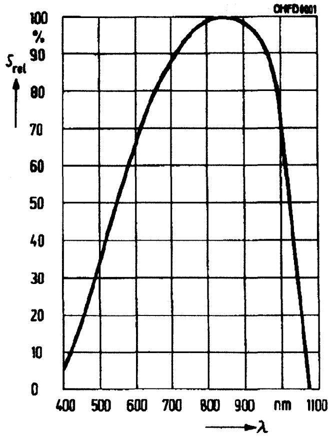
Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –55° to +100°C
Reverse Voltage (V_R) .... 1 V

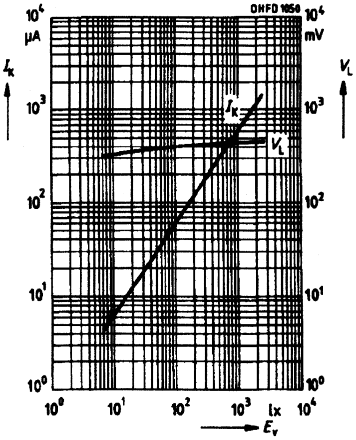
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Photosensitivity (standard light A, T=2856 K))	S	0.5 (≥0.35)	µA/lx
Maximum Photosensitivity Wavelength	λ_{Smax}	850	nm
Sensitivity Spectral Range (S=10% of S_{MAX})	λ	420 to 1060	nm
Radiant Sensitive Area	A	0.70	cm^2
Radiant Sensitive Area Dimensions	L x W	5.78 x 12.18	mm
Half Angle	φ	±60	Deg.
Dark Current (V_R=1 V, E=0))	I_R	10 (≤180)	µA
Spectral Sensitivity (λ=850 nm)	S_λ	0.55	A/W
Quantum Efficiency (λ=850 nm)	η	0.80	electrons / photon
Open Circuit Voltage (E_V=1000 lx, std. light A, T=2856 K)	V_O	460 (≥280)	mV
Short Circuit Current (E_V=1000 lx, std. light A, T=2856 K)	I_{SC}	0.5 (≥0.35)	mA
Photocurrent Rise and Fall Time 10% to 90%, and 90% to 10% of Final Value (R_L=1 kΩ, V_R=1 V, λ=850 nm, I_P=500 µA)	t_R,t_F	10	µs
Capacitance (V_R=0 V, f=1 MHz, E_V=0 lx)	C_O	6	nF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.2	%/K

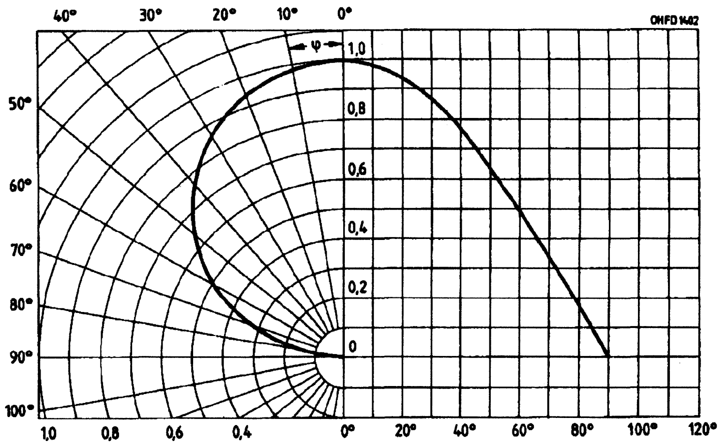
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



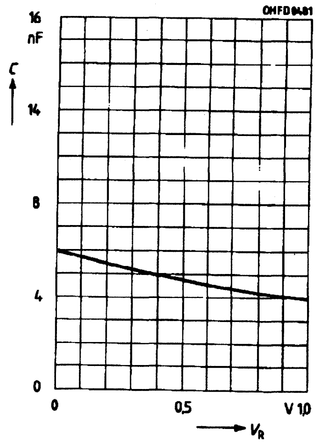
Open circuit voltage $V_O=f(E_V)$
Short circuit voltage $V_{SC}=f(E_V)$



Directional characteristic
$S_{REL}=f(\varphi)$

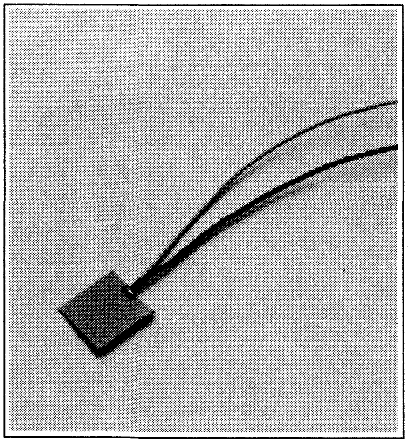


Capacitance
$C=f(V_R)$, f=1 MH, E=0

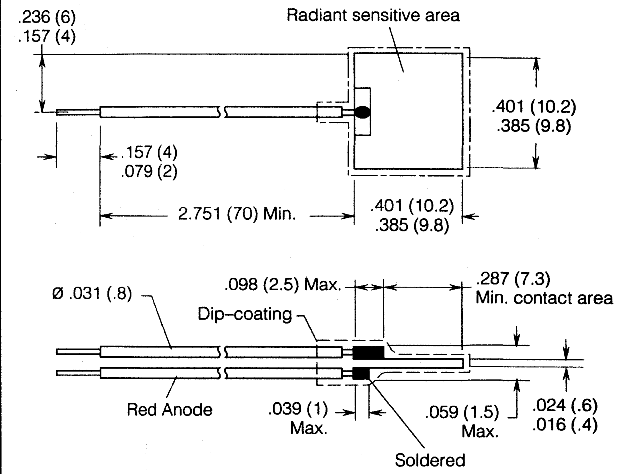


SIEMENS

BPY63P
SILICON PHOTOVOLTAIC CELL



Package Dimensions in Inches (mm)



FEATURES

- **High Reliability**
- **High Sensitivity**
- **Cost Effective Package**
- **Wide Temperature Range**

DESCRIPTION

The BPY63P is a silicon planar photovoltaic cell with two leads and a hydro-protective outer layer. The BPY63P can be used in control and regulation circuits and as a photoelement to detect incandescent light and daylight.

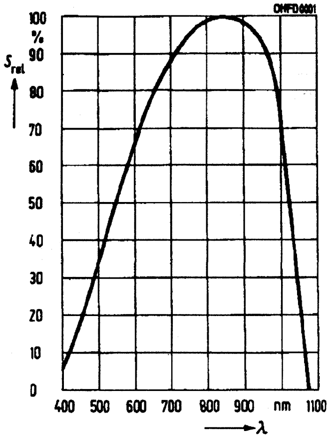
Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –55° to +100°C
Reverse Voltage (V_R) .... 1 V

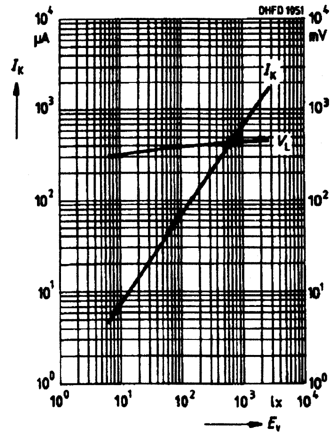
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Photosensitivity (standard light A, T=2856 K))	S	0.65 (≥0.45)	µA/lx
Maximum Photosensitivity Wavelength	λ_{Smax}	830	nm
Sensitivity Spectral Range (S=10% of S_{MAX})	λ	400 to 1100	nm
Radiant Sensitive Area	A	0.94	cm^2
Radiant Sensitive Area Dimensions	L x W	9.69 x 9.69	mm
Half Angle	φ	±60	Deg.
Dark Current (V_R=1 V, E=0))	I_R	10 (≤60)	µA
Spectral Sensitivity (λ=850 nm)	S_λ	0.5	A/W
Quantum Efficiency (λ=850 nm)	η	0.72	electrons / photon
Open Circuit Voltage (E_V=1000 lx, std. light A, T=2856 K)	V_O	430 (≥280)	mV
Short Circuit Current (E_V=1000 lx, std. light A, T=2856 K)	I_{SC}	0.65 (≥0.45)	mA
Photocurrent Rise and Fall Time 10% to 90%, and 90% to 10% of Final Value (R_L=1 kΩ, V_R=1 V, λ=850 nm, I_P=50 µA)	t_R,t_F	11	µs
Capacitance (V_R=0 V, f=1 MHz, E_V=0 lx)	C_O	8	nF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.2	%/K

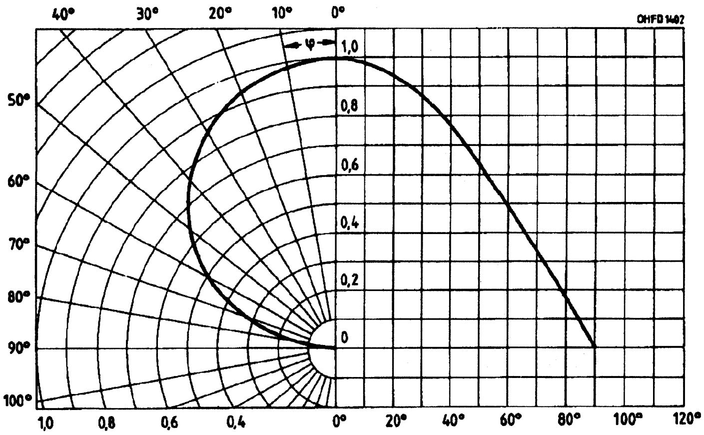
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



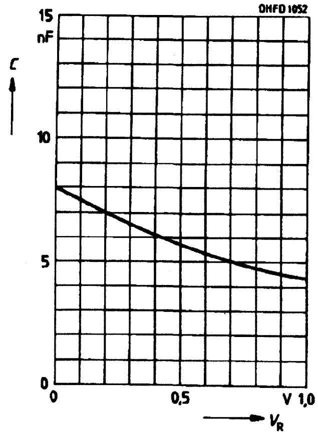
Open circuit voltage $V_O=f(E_V)$
Short circuit voltage $V_{SC}=f(E_V)$



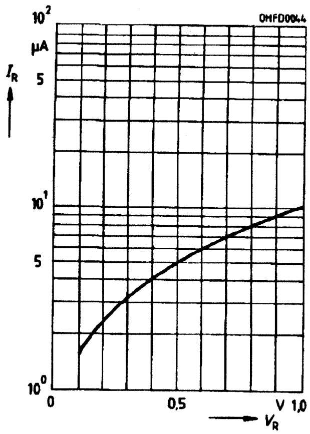
Directional characteristic
$S_{REL}=f(\varphi)$



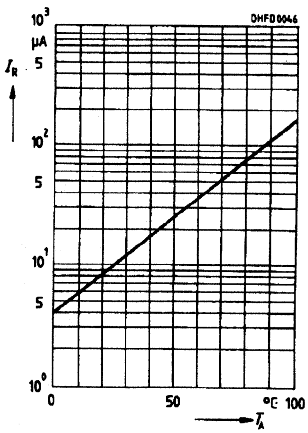
Capacitance
$C=f(V_R)$, f=1 MH, E=0



Dark current $I_R=f(V_R)$, E=0

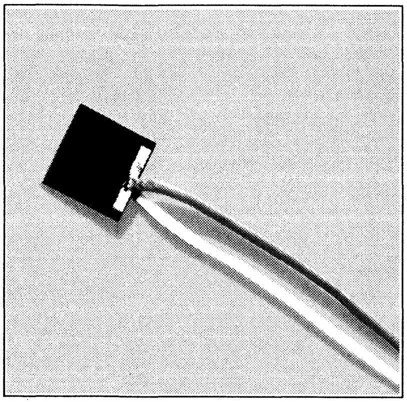


Dark current $I_R=f(T_A)$, V_R=1 V, E=0

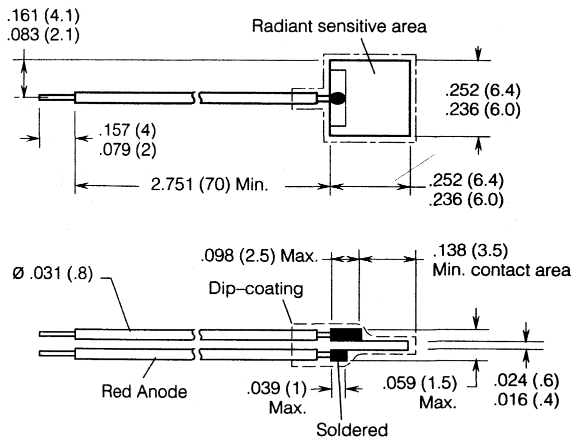


SIEMENS

BPY64P
SILICON PHOTOVOLTAIC CELL



Package Dimensions in Inches (mm)



FEATURES

- **Medium Size Radiant Sensitive Surface**
- **High Reliability**
- **High Sensitivity**
- **Wide Temperature Range**
- **No Testable Degradation**

DESCRIPTION

The BPY64P is a silicon photovoltaic cell. It can be used in control and drive circuits and as a detector for light of filament lamps or daylight.

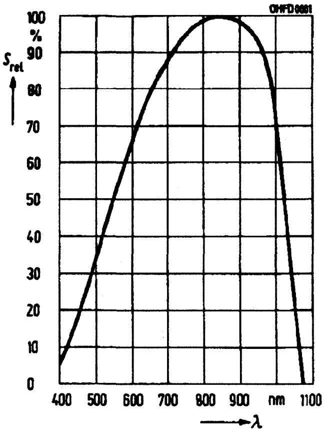
Maximum Ratings

Operating and Storage Temperature Range (T_{OP}, T_{STG}) .... –55° to +100°C
Reverse Voltage (V_R) .... 1 V

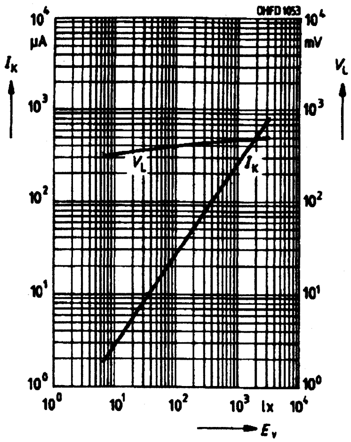
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Photosensitivity (standard light A, T=2856 K))	S	0.25 (≥0.18)	µA/lx
Maximum Photosensitivity Wavelength	λ_{Smax}	850	nm
Sensitivity Spectral Range (S=10% of S_{MAX})	λ	420 to 1060	nm
Radiant Sensitive Area	A	0.36	cm^2
Radiant Sensitive Area Dimensions	L x W	5.98 x 5.98	mm
Half Angle	φ	±60	Deg.
Dark Current (V_R=1 V, E=0))	I_R	4 (≤80)	µA
Spectral Sensitivity (λ=850 nm)	S_λ	0.5	A/W
Quantum Efficiency (λ=850 nm)	η	0.72	electrons / photon
Open Circuit Voltage (E_V=1000 lx, std. light A, T=2856 K)	V_O	450 (≥280)	mV
Short Circuit Current (E_V=1000 lx, std. light A, T=2856 K)	I_{SC}	0.25 (≥0.18)	mA
Photocurrent Rise and Fall Time 10% to 90%, and 90% to 10% of Final Value (R_L=1 kΩ, V_R=1 V, λ=840 nm, I_P=250 µA)	t_R,t_F	5	µs
Capacitance (V_R=0 V, f=1 MHz, E_V=0 lx)	C_0	3	nF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.2	%/K

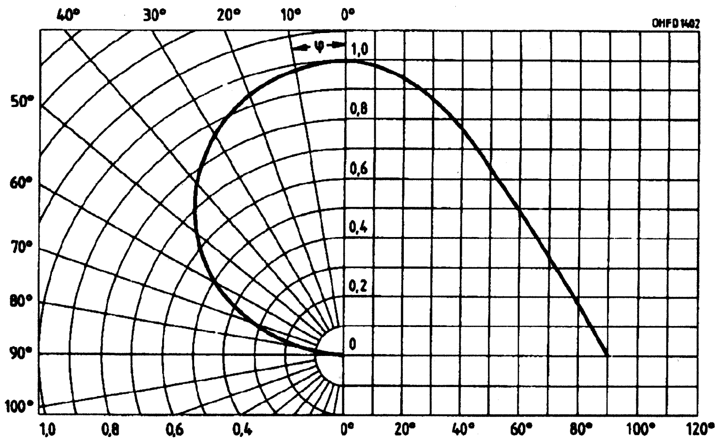
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



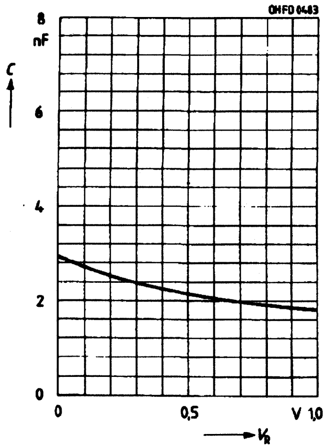
Open circuit voltage $V_O=f(E_V)$
Short circuit voltage $V_{SC}=f(E_V)$



Directional characteristic
$S_{REL}=f(\varphi)$



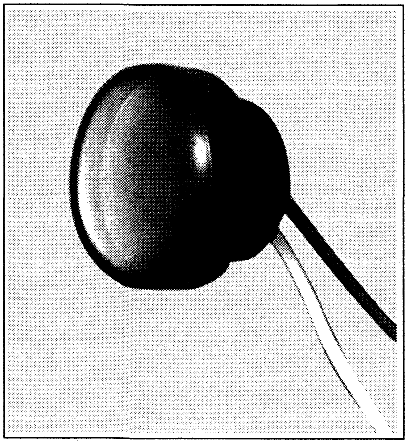
Capacitance
$C=f(V_R)$, f=1 MH, E=0



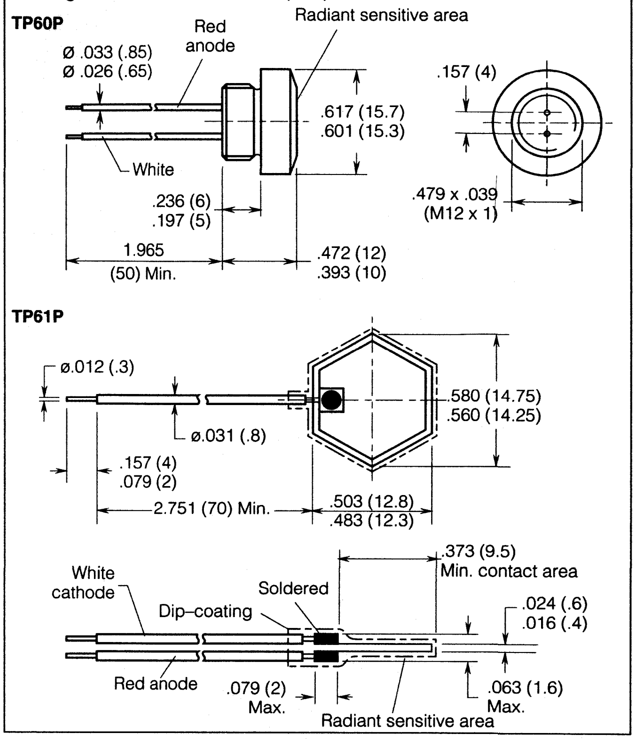
SIEMENS

TP60P
TP61P

SILICON PHOTOVOLTAIC CELL



Package Dimensions in Inches (mm)



FEATURES

- **High Reliability**
- **Very High Sensitivity, 1000 nA/lx Typical**
- **Wide Temperature Range: TP61P, –55° to +100° C**
- **No Testable Degradation**

DESCRIPTION

The TP60/61P are silicon photovoltaic cells with the same electrical characteristics; they differ only in packaging. The anode (positive pole of the cell) is denoted by a red lead. They can be used in control and drive circuits.

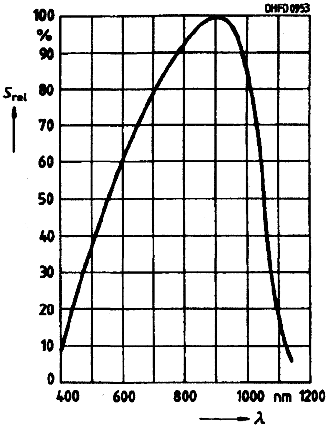
Maximum Ratings

Operating and Storage Temperature
Range (T_{OP}, T_{STG}) .... –55° to +100°C
Reverse Voltage (V_R) .... 1 V

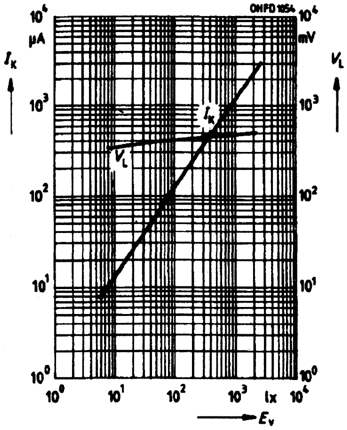
Characteristics (T_A=25°C)

Parameter	Symbol	Value	Unit
Photosensitivity (standard light A, T=2856 K))	S	1 (≥0.7)	µA/lx
Maximum Photosensitivity Wavelength	λ_{Smax}	900	nm
Sensitivity Spectral Range (S=10% of S_{MAX})	λ	40 to 1120	nm
Radiant Sensitive Area	A	1.3	cm^2
Half Angle	φ	±60	Deg.
Dark Current (V_R=1 V, E=0))	I_R	0.1 (≤2)	µA
Spectral Photosensitivity (λ=850 nm)	S_λ	0.55	A/W
Quantum Efficiency (λ=850 nm)	η	0.80	electrons/photon
Open Circuit Voltage (E_V=1000 lx, std. light A, T=2856 K)	V_O	450 (≥270)	mV
(E_E=0.5 mW/cm^2, λ=850 nm)	V_O	430	mV
Short Circuit Current (E_V=1000 lx, std. light A, T=2856 K)	I_{SC}	1 (≥0.7)	mA
Photocurrent Rise and Fall Time 10% to 90%, and 90% to 10% of Final Value (R_L=1 kΩ, V_R=1 V, λ=840 nm, I_P=50 µA)	t_R,t_F	18	µs
Capacitance (V_R=0 V, f=1 MHz, E_V=0 lx)	C_0	11	nF
Temperature Coefficient V_O	TC_V	–2.6	mV/K
Temperature Coefficient I_{SC}	TC_I	0.12	%/K

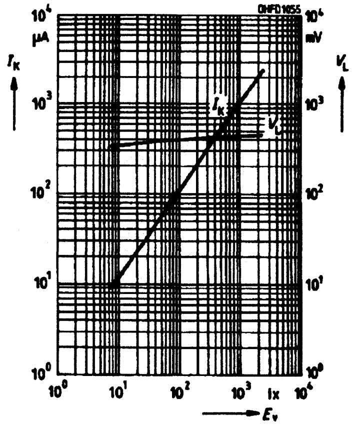
Relative spectral sensitivity
$S_{REL}=f(\lambda)$



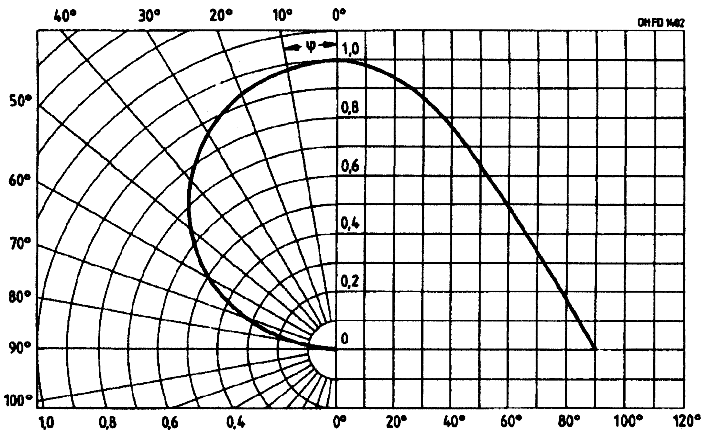
Open circuit voltage–TP60P $V_O=f(E_V)$
Short circuit voltage $V_{SC}=f(E_V)$



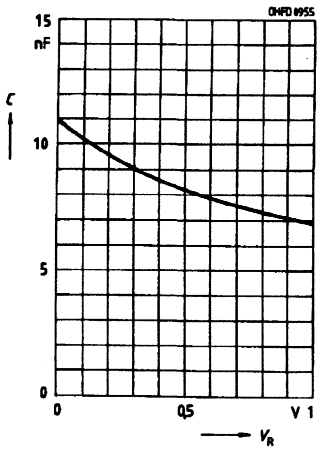
Open circuit voltage–TP61P $V_O=f(E_V)$
Short circuit voltage $V_{SC}=f(E_V)$



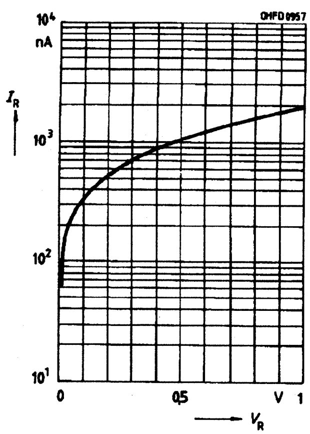
Directional characteristic
$S_{REL}=f(\varphi)$



Capacitance
$C=f(V_R)$, f=1 MH, E=0



Dark current $I_R=f(V_R)$, E=0



List of Application Notes

SIEMENS

LEDs and Photometry Appnote 1

by George Smith

The observed spectrum of electromagnetic radiations, extends from a few Hz to beyond 10^{24} Hz, covering some 80 octaves. The narrow channel from 430 THz to 750 THz would be entirely negligible, except that more information is communicated to human beings in this channel than from the rest of the spectrum. This radiation has a wavelength ranging from 400 nm to 700 nm and is detectable by the sensory mechanisms of the human eye. Radiation observable by the human eye is commonly called light.

Measurements of the physical properties of light and light sources can be described in the same terms as any other form of electromagnetic energy. Such measurements are commonly called radiometric measurements.

Measurements of the psychophysical attributes of the electromagnetic radiation we call light are in units, other than radiometric units. Those attributes which relate to the luminosity (sometimes called visibility) of light and light sources are called photometric quantities. The measurement of these aspects is the subject of *photometry.*

Electronics engineers who are starting to apply light emitting diodes and other optoelectronic devices to perform useful tasks will find the subject of photometry to be a confused mass of strange units, confusing names for photometric quantities, and general disagreement about the important requirements are for his/her application.

The photometric quantities are related to the corresponding radiometric quantities by the C.I.E. Standard Luminosity Function (Figure 1) or colloquially, the standard eyeball. We can think of the luminosity function as the transfer function of a filter which approximates the behavior of the average human eye under good lighting conditions.

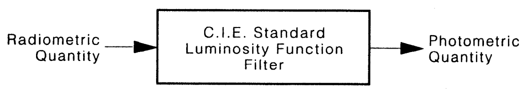


Figure 1. Relationship between Radiometric Units and Photometric Units

The eye responds to the rate at which radiant energy falls on the retina, i.e., on the radiant flux density expressed as Watts/m^2. The corresponding photometric quantity is Lumens/m^2. Therefore the standard luminosity function is a plot of Lumens/Watt as a function of wavelength.

The function has a maximum value of 680 Lumens/Watt at 555 nm and the half power points occur at 510 nm and 610 nm (Figure 2).

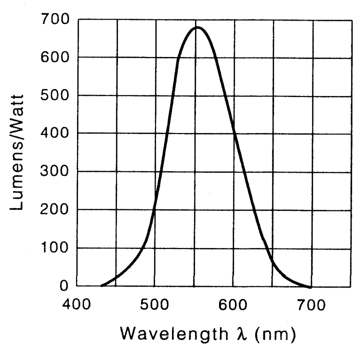


Figure 2. CIE Standard Photopic Luminosity Function

The lumen is the unit of luminous flux and corresponds to the watt as the unit of radiant flux.

Thus the total luminous flux emitted by a light source in all directions is measured in lumens, and can be traced back to the power consumed by the source to obtain an efficiency number.

Since it is generally not practical to collect all the flux from a light source and direct it in some desired direction, it is desirable to know how the flux is distributed spatially about the source. If we treat the source as a point (far field measurement), we can divide the space around the source into elements of solid angle ($d\omega$), and inquire as to the luminous flux (dF) contained in each element of solid angle ($df/d\omega$). The resultinq quantity is Lumens/Steradian and is called *luminous intensity* (I), Figure 3. The unit of luminous intensity is called the *candela*, sometimes loosely called the candle, or candle power.

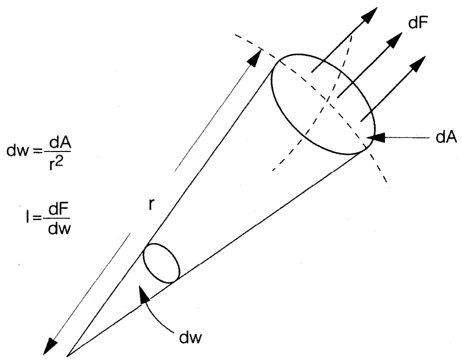


Figure 3. Solid Angles and Luminous Intensity

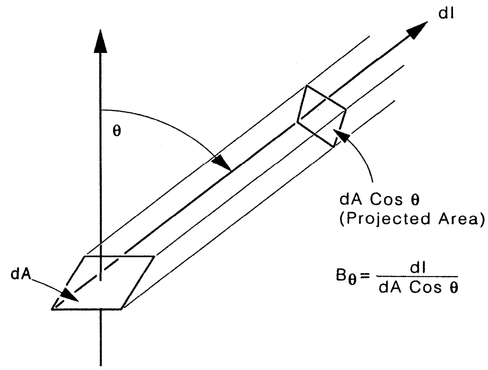


Figure 5. Definition of Luminance

Since the space surrounding a point contains 4 π steradians, it is apparent that an isotropic radiator of one candela intensity emits a total luminous flux of 4 π Lumens.

No real light source is isotropic, so it is quite common to show a plot of luminous intensity versus angle off the axis (Figure 4). If the source has no axis of symmetry, a more complex diagram is required.

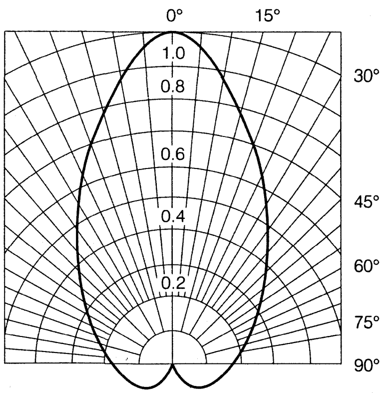


Figure 4. Spatial Distribution Pattern

For an extended radiating surface, (such as an LED chip), each element of area contributes to the luminous intensity of the source in any given direction. The luminous intensity contribution in the given direction divided by the projected area of the surface element in that direction is called the *luminance* (B) of the source (in that direction), Figure 5. The quantity is sometimes called photometric brightness, or simply brightness. Using the term brightness on its own should be discouraged as brightness involves various subjective properties such as texture, color, sparkle, apparent size, etc., that have psychological implications.

The fundamental quantitative standard of the photometric system of units is the standard of luminance.

The luminance of a black body radiator at the temperature of freezing platinum (2043.8°K) is 60 candela per square centimeter. A blackbody radiator is a perfect absorber of all electromagnetic energy incident on it. In thermal equilibrium at a given temperature, it emits radiation, spectrally distributed according to Planck's Formula.

$$\left(W\lambda = \frac{C_1 \lambda^{-5}}{\exp\left(\frac{C_2}{\lambda}\right) - 1}\right)$$

The units of luminance in present use are an engineering nightmare.

1 candela/cm^2 is called a *Stilb*
1 /π candela/cm^2 is called a *Lambert*
1 candela/m^2 is called a *Nit*
1/π candela/m^2 is called an *Apostilb*
1/π candela/ft^2 is called a *foot-Lambert*

The foot Lambert is the most commonly used unit in the U.S.

Of particular interest is a source whose angular distribution pattern is a circle (Figure 6). For such a source we have $I\theta = I_o \cos\theta$, the luminance of such a source in a given direction θ, is then given by:

$$B\theta = \frac{dI\theta}{dA\cos\theta} = \frac{dI_o Cos\theta}{dA Cos\theta} = \frac{dI_o}{dA}$$

The luminance is seen to be the same in all directions. Such a source is called a *lambertian source*. It can be shown that a perfectly diffusing surface behaves in this fashion. The formula governing a diffusing surface $I_\theta = I_O \cos\theta$ is called Lambert's Cosine Law.

It can be shown that a flat LED chip is a very good approximation to a Lambertiian Source.

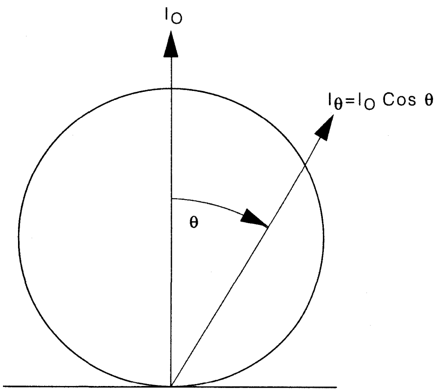


Figure 6. Lambertian Radiation Pattern

If we now take a surface element (dA) and determine the intensity contribution in each direction we can determine the total flux (dF) emitted by the surface element. The resultant ratio (dF/dA) Lumens/m^2 is called the *luminous emittance* (L). For a flat surface we may calculate L from:

$$L = 2\pi \int_0^{\pi/2} B_{(\theta)} \text{ SIN } \theta \text{ Cos } \theta \, d\theta$$

The corresponding radiant emittance in watts/m^2 is of considerable interest for GaAs infrared LEDs where total output power is an important parameter.

The total luminous flux emitted by a light source can then be calculated from $F_{total} = \int LdA$.

These photometric quantities are sufficient to describe the properties of light sources such as light emitting diodes.

When light falls on a receiving surface, it is either partially reflected in the case of a purely passive surface, or partly converted into some other form of energy by what we may describe as an active surface (such as a phototransistor or photomultiplier cathode). In either case we are interested in how much flux falls on each element of the surface; Lumens/m^2 in the case of a passive surface which we wish to illuminate, or the eye; and Watts/m^2 in the case of other active surfaces. The quantity Lumens/m^2 in this case is called the *illuminance* sometimes loosely referred to as the illumination. The unit of illuminance is the *lux* also referred to as the meter-candle. Another commonly used unit of illuminance, in the U.S. is the *foot candle*, equal to one lumen per square foot. One lumen per square cm is called a *phot*.

Many of these photometric quantities and units are in common use in the field of illumination engineering. While English units are the most common in the U.S., a mixed system of units is involved in common usage.

Application to Light Emitting Diodes

The above description of photometric quantities should indicate that there are many ways in which the photometric properties of LEDs can be stated. There is no general agreement among LED makers and users as to the best way to specify LED performance leading to much confusion and misunderstanding.

Many factors must be taken into account when evaluating LED specifications for a particular application, and electronic engineers will need to develop a knowledge of these factors to use LEDs effectively in new designs.

Presently available light emitting diodes are made from III-V, II-VI, and IV semiconductors, with Gallium Arsenide Phosphide and Gallium Phosphide being the major materials. Gallium Aluminum Arsenide is also used but is less common. Gallium Arsenide is commonly included in this group, but GaAs emits only infrared radiation around 900 nm which is not visible to the eye and can't properly be called light. All specifications of non-visible emitters must be in radiametric units.

GaP emits green light between 520 and 570 nm peaking at 550 nm, very close to the peak eye sensitivity. It also can emit red light between 630 and 790 nm peaking at 690 nm.

$GaAs_{(1-x)} P_X$ emits light over a broad range from green to infrared depending on the percentage of phosphorus in the material (x). For x in the 0.4 region, red light between 640 and 700 nm peaking at 660 nm is obtained. For x=0.5, amber light peaking around 610 nm is obtained.

$Ga_{(1-x)} Al_X AS$ as presently available emits red light between 650 and 700 nm peaking at 670 nm and also emits into the infrared range.

The efficiency of these materials is very dependent on the emitted wavelength, with drastic fall off in efficiency as the wavelength gets shorter. Fortunately the standard eyeball filter favors the shorter wavelength (down to 555 nm) and gives some measure of compensation. Some typical efficiencies reported by device makers, and the resulting overall luminous efficiency (Lumens/electrical watt) are as follows:

GaP.red .72% at 20 Lum/Watt=14 Lum/Watt overall
$GaAs_6P_4$ red .3% at 50 Lum/Watt=.15 Lum/Watt overall
GaAlAs red 1.5% at 40 Lum/Watt=.024 Lum/Watt overall
GaP green .006% at 675 Lum/Watt=.04 Lum/Watt overall
$GaAs_5P_5$ amber .0044% at 340 Lum/Watt
=.015 Lum/Watt overall

For simple status indicator applications, front panel lamps and similar applications, several factors must be considered:

1. Color—LED lamps and displays are available in a variety of standardized colors of emitted light: red, high efficiency red, soft orange, yellow, green and blue—although not every component is available in every color.
2. Apparent source size—Various combinations of chip size and optical systems are available so that apparent source sizes from about 5 mils to about 300 mils diameter are available as standard products. Other things being equal, a larger source size is more visible.

3. Angular distribution. GaAsP diode chips are nearly Lambertian, but GaP are nearly isotropic. With suitable optical design, the angular distribution pattern can be changed from very broad to quite narrow. By placing the chip at the focus of the lens system a narrow high intensity beam is obtained. The off axis visibility is drastically reduced. By using diffusing lens materials, a large area source with good off axis visibility is obtained but the luminance is reduced.
4. Luminous intensity. This will govern the visibility under optimum background contrast conditions, when viewed at normal distances. 1 millicandela is typical for red lamps of either GaAsP or GaP at normal operating conditions.
5. Luminance. When it is not possible to provide a dark contrasting background, or when the source is viewed at very close distances, the luminance becomes important. Values from 100 ft-L to 5000 ft-L are typical.

These factors are all related to the design of the device and the user should understand the trade offs. High luminance values in excess of 10,000 ft-L are easily obtained by running very high current densities in the LED chip but can lead to shortened life if carried too far.

For a given drive current the luminous intensity of two different chips will be similar, while the luminance will be inversely proportional to the active area of the chip.

If the designer can use filter screens or circularly polarizing filters in front of the light source, excellent protection from background illumination can be obtained. In this case a diffusive lens giving a large apparent source with lower luminance, is more visible than a high luminance point source.

When a LED is used with an optical system to activate a remote sensor such as a cadmium sulphide or cadmium selenide cell (red light), or a GaAs IR emitter is used with a silicon photo detector, the performance requirements are somewhat different. It can be shown that for a given optical arrangement the irradiance of the detector determines the detected signal and this is proportional to the radiance of the source, which is comparable to the luminance (brightness) of the source. The intensity of the source will not be a factor unless the detector active area is larger than the incident beam.

When average power consumption must be minimized but good visibility is required, or detection at a considerable distance is required, pulsed operation can be used. With GaAs and GaAsP emitters using low duty cycle short pulses, very high peak intensity levels can be reached permitting communication over considerable distances. This technique is not useful with GaP diodes since they do not exhibit a linear relationship between optical output and instantaneous forward current, becoming saturated at moderate current levels. GaPalso has a 50% higher rate of fall off in light output with temperature increase, than GaAsP which further inhibits high power applications.

Using LEDs to give a "heads up" projected display, such as for an automobile speedometer readout, or aircraft cockpit application places severe requirements on the display luminance. For easy visibility, the projected image must be sufficiently contrasted with the ambient illumination. This requires very high luminance values for the LEDs together with the use of photochromic windshields and probably polarizing screens.

The foregoing is a necessarily simplified description of a very complex subject. For more information read the standard textbook literature on these subjects.

References:

R. Kingslake, *Applied Optics & Optical Engineering Committee on Colorimetry of the O.S.A., The Science of Color.*
Warren J. Smith, *Modern Optical Engineering*

SIEMENS

Applications of Optocouplers
Appnote 2

The IL1 is the first in a family of optocouplers. These products are also called photon coupled isolators, photocouplers, photo-coupled pairs and optically coupled pairs. All of the characteristics of the IL1 are electrical: it has no external optical properties. Hence optoisolators are not *optoelectronic devices*; they are in fact one of the simplest of all *electro-optical systems*.

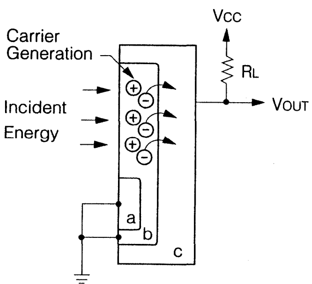
The IL1 consists of a Gallium Arsenide infrared emitting diode, and a silicon phototransistor mounted together in a DIP package.

When forward current (I_F) is passed through the Gallium Arsenide diode, it emits infrared radiation peaking at about 900 nm wavelength. This radiant energy is transmitted through an optical coupling medium and falls on the surface of the NPN phototransistor.

Phototransistors are designed to have large base areas; and hence a large base-collector junction area; and a small emitter area. Some fraction of the photons that strike the base area cause the formation of electron-hole pairs in the base region. This fraction is called the *quantum efficiency* of the photodetector.

If we ground the base and emitter, and apply a positive voltage to the collector of the phototransistor, the device operates as a photo diode.

The high field across the collector base junction quickly draws the electrons across into the collector region. The holes drift towards the base terminal attracting electrons from the terminal.

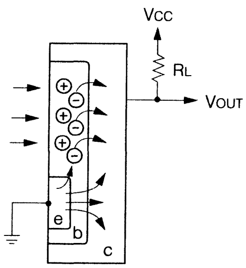


Thus a current flows from collector to base, causing a voltage drop across the load resistance (R_L).

The high junction capacitance, C_{cb}, results in an output circuit time constant $R_L C_{cb}$, with a corresponding output voltage rise time.

The output current in this configuration is quite small and hence this connection is not normally used.

The commonest circuit configuration is to leave the base connection open. With this connection, the holes generated in the base region cause the base potential to rise, forward biasing the base-emitter junction. Electrons are then injected into the base from the emitter, to try to neutralize the excess holes. Because of the close proximity of the collector junction, the probability of an electron recombining with a hole is small and most of the injected electrons are immediately swept into the collector region. As a result, the total collector current is much higher than the photogenerated current, and is in fact β times as great.



The total collector current is then several hundred times greater than for the previous connection.

This gain comes with a penalty of much slower operation. Any drop in collector voltage is coupled to the base via the collector-base capacitance tending to turn off the injected current. The only current available to charge this junction capacitance is the original photocurrent. Thus, the rate of change of the output voltage is the same for both the diode and transistor connections. In the latter case, the voltage swing is β times as great, so the total rise time is β times as great as for the diode connection. Thus the effective output time constant is $\beta R_L C_{cb}$.

For the IL1 a typical 2 μs rise time for 100 Ω results.

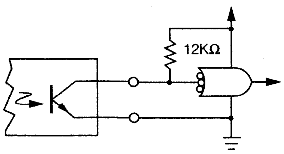
The ratio of the output current from the phototransistor (I_C or I_E), to the input current in the Gallium Arsenide diode is called the Current Transfer Ratio (CTR). For the IL1, CTR is specified at 20% minimum with 35% being typical at I_F=10 mA.* Thus for 10 mA input current the minimum output current is 2 mA. Other important parameters are V_F typically 1.25V at 60mA I_F

Digital Interfaces

Output Sensing Circuits

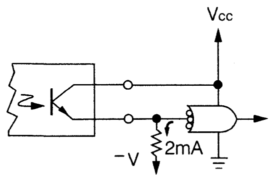
The output of the phototransistor can directly drive the input of standard logic circuits such as the 7400 TTL families. The worst case input current for the 74 series gate is −1.6 mA for V_{IN}=0.4 Volts. This can be easily supplied by the IL1, with 10 mA input to the infrared diode.

TTL Active Level Low (7400)

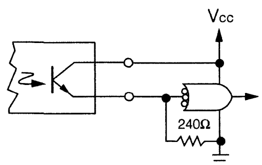


Note: Use smaller pull up resistor for higher speed.

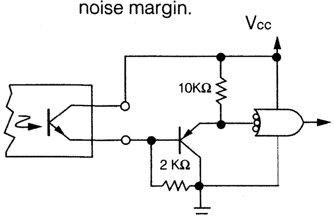
It is more difficult to operate into TTL gates in the active level high configuration. Some possible methods are as follows:



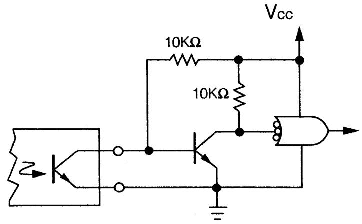
Note: Best method if negative supply is available.



Note: Requires 10 mA from transistor and sacrifices noise margin.

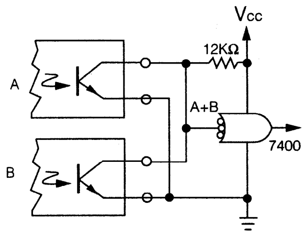


Note: High sensitivity but sacrifices noise margin. Needs extra parts.

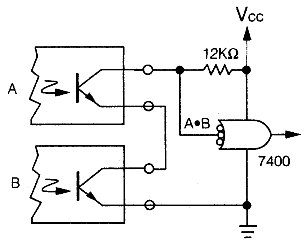


Note: Extra parts cost but high sensitivity.

Obviously, several optocoupler output transistors can be connected to perform logical functions.



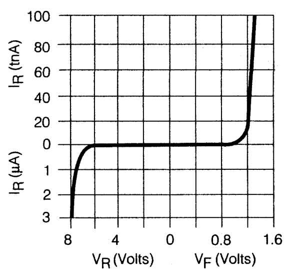
Note: Logical OR connection.



Note: Logical AND connection.

Input Driving Circuits

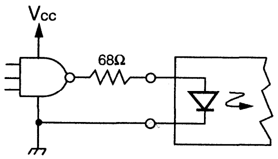
The input side of the IL1 has a diode characteristic as shown.



The forward current must be controlled to provide the desired operating condition.

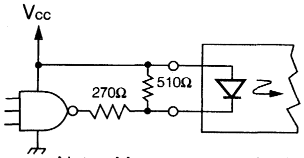
The input can be conveniently driven by integrated circuit logic elements in a number of different ways.

TTL Active Level High (7400 Series)

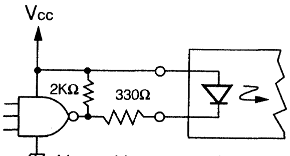


Note: Can omit resistor for about 15 mA into diode.

TTL Active Level Low (7400 Series)



Note: More parts required than above.



Note: Not as good as above circuit. Not recommended.

There are obviously many other ways to drive the device with logic signals, but the commonest needs can be met with the above circuits. All provide 10 mA into the LED giving 2 mA minimum out of the phototransistor. The 1 Volt diode knee and its high capacitance (typically 100 pF), provides good noise immunity. The rise time and propagation delay can be reduced by biasing the diode on to perhaps 1 mA forward current, but the noise performance will be worse.

All previous configurations show medium speed digital interfaces. These circuits have various advantages over other ways of doing the task.

(1) They can replace relays and reed relays, giving much faster switching speeds, no contact bounce, better reliability, and usually better electrical isolation except for special configurations. However relays have high current capability, higher output voltage, lower on resistance and offset voltage and higher off resistance.

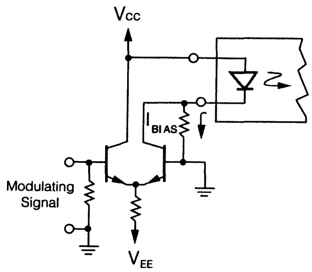
(2) They can replace pulse transformers in many floating applications. Opto-isolators can transmit DC signal components and low frequency AC, whereas pulse transformers couple only the high frequency components, and a latch is required to restore the DC information. Pulse transformers have faster rise time than phototransistor optocouplers.

(3) Integrated circuit line drivers and receivers are used to transmit digital information over long lines in the presence of common mode noise. The maximum common mode noise voltage permissible is usually in the 30 Volt range. There are many practical situations where common mode noise voltages of several hundred Volts can be induced in long lines. For these applications, optocouplers provide protection against several thousand volts.

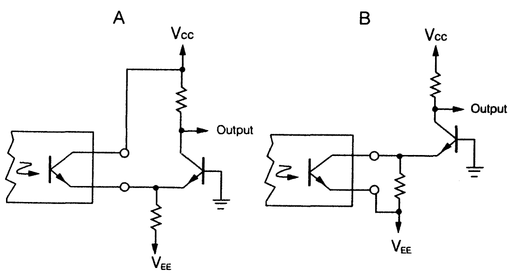
Linear Applications

The curve of input current versus output current for the IL1 is somewhat non-linear, because of the variation of β with current for the phototransistor, and the variation of infrared radiation out versus forward current in the GaAs diode. The useful range of input current is about 1 mA to 100 mA, but higher currents may be used for short duty cycles.

For linear applications the LED must be forward biased to some suitable current (usually 5 mA to 20 mA). Modulating signals can then be impressed on this DC bias. A differential amplifier is a good way to accomplish this.

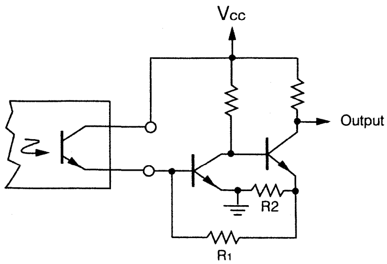


Sensing in linear applications can be done in several ways depending on the requirements. For high frequency performance, the phototransistor should be operated into a low impedance input current amplifier. The simplest such scheme is a grounded base amplifier.



The circuit will work equally well either way, with a phase inversion between the two. Obviously a PNP transistor would work as well.

A feedback amplifier could also be used to get a low impedance input.



The current gain is

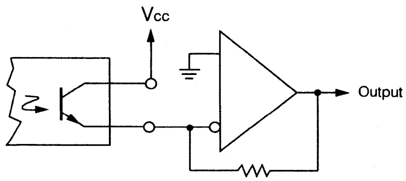
$$\left(1 + \frac{R1}{R2}\right)$$

The input impedance is approximately

$$\left(\frac{R1}{1 + \frac{V_{CC} - 2V_{BE}}{.026}}\right)$$

For example if R1=900 Ω, R2=100 Ω, V_{CC}=5 V, we would have a current gain of 10 and an input impedance of about 6.3 Ω. This would give a considerable speed improvement over a 100 Ω load.

A high speed operational amplifier could be used to give excellent performance.



Note that in all cases the output can be taken from either the collector or the emitter of the phototransistor depending on the polarity desired. The operating speed is the same in either case.

Conclusion

This appnote covers the most commonly used ways of applying phototransistor optocouplers. The design engineer will see many ways to expand on these circuits to achieve his end goals. The devices are extremely versatile, and can provide better solutions to many systems problems than other competing components. Special designs are possible to optimize certain parameters such as coupling capacitance, or transfer ratio.

Properties of Signal Coupling Devices

Device	**Advantages**	**Disadvantages**
Optocoupler	Economical Solid state reiiability Medium to high speed signal transmission DC & low frequency transmission High voltage isolation High isolation impedance Small size DIP Package No contact bounce Low power operation	Finite ON Resistance Finite OFF Resistance Limited ON state current Limited OFF state voltage Low transmission efficiency (Low CTR)
Relays	High power capability Low ON resistance DC transmission High voltage isolation	High cost High power consumption Unreliable Very slow operation Physically large
Pulse Transformers	High speed signal transmission Moderate size Good transmission efficiency	No DC or low frequency transmission Expensive for high isolation impedance or voltage
Differential Line Drivers and Receivers	Solid state reliability Small size DIP package High speed transmission DC transmission Low cost	Very low breakdown voltage Low isolation impedance

SIEMENS

Multiplexing LED Displays Appnote 3

by George Smith

In digital displays, such as would be used in a D.V.M. or counter of conventional design, all digits are operated in parallel, with a separate decoder-driver for each digit operated from data generally stored in a quad latch.

In many cases, a reduction in cost can be effected by operating the display in a time division multiplexed mode. The question of cost effectiveness depends on the particular application. As a general rule, the greater the number of digits in the display, the more advantageous the multiplex system becomes from the cost standpoint. Because of the great variety of situations possible, it is difficult to say at what number of digits the change should be made. In some circumstances, non-multiplexed operation of less than 8 digits is more economical. On the other hand, there are circumstances where multiplexing is used for three and four digit displays at a cost saving. This application note attempts to show some of the many ways of multiplexing digits. The designer can decide whether his/her own system application would be lower in cost by using a multiplex scheme.

The properties of light emitting diodes (LED) make them particulary suitable for multiplexed operation, and hence it is the preferred method to use, if a scheme can be designed which is cost competitive with non-multiplexed operation.

It will be generally assumed that we are talking of a system using TTL type logic families, with MSI functions being used where applicable. In most production situations this will be the most economical approach. There will be some cases where discrete gates and flip-flops may yield a lower cost. There are also cases where a single MOS chip contains all the necessary logic functions and only interface driver circuits are required.

The seven segment numeric displays with a common anode connection made by Siemens provide compatibility with the most widely available decoder-drivers, which are active level low outputs. The commonest device is SN7447 or similar. Any of these is suitable for driving displays: HD107XX, HD110XX or HD1131XX series. For common cathode displays, such as the Siemens DL330M, DL340M, DL430M, or DL440M, a SN7448 decoder can be used, and anode drivers become cathode drivers.

In a multiplex system, the corresponding cathodes of each digit are bussed together and driven from one seven segment decoder-driver via the usual current limiting resistors. The display data is presented serially by digit to the decoder-driver, together with an enable signal to the appropriate digit anode (Figure 1).

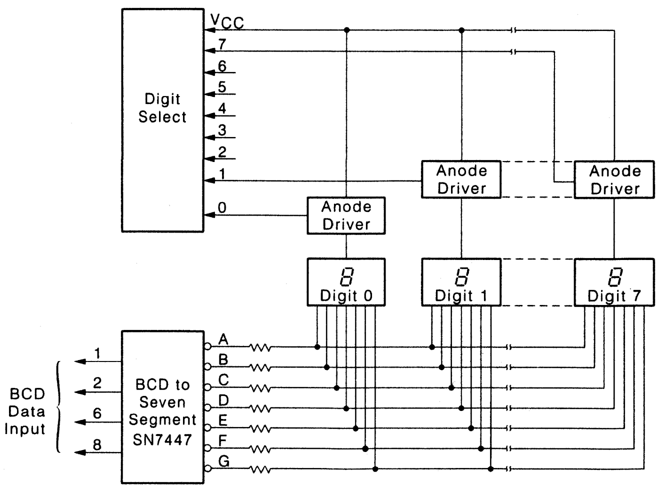


Figure 1

Each digit anode is driven by a switch, capable of passing the full current of all segments. The simplest switch would be a PNP high current switch or amplifier transistor, such as a core driver type.

In operation, the anode switches are activated one at a time, in the desired sequence, while the appropriate digital data is presented at the input to the decoder driver. The amount of circuitry required in Figure 1 is much less than that used in the non-multiplexed scheme. The question of overall economy depends on the amount of circuitry required to sequence the anodes and present the data at the decoder input. Let us consider some typical situations.

Case 1

An 8-digit counter-timer display with the data stored in multiple latch circuits is the most common situation present in a counter-timer of conventional design. A quad latch (SN7475) is used to store each digit, and this data is periodically updated. To scan this data, a 4 pole 8 position switch is required (SN74151). To select the appropriate digit, an octal counter (SN7493) and a BCD decoder (SN7442) are required. The complete circuit is shown in Figure 2.

The total package count is about half the same for this arrangement, as for non-multiplexed operation, but most of the packages are lower cost than the seven segment decoder. The scheme shown is a 20% cost reduction over non-multiplexed operation, based on O.E.M. prices for the components. For less than eight digits, it would be difficult to compete with non-multiplexed operation using this scheme.

Case 2

Multiplexing becomes more attractive when the data is stored in a shift register, rather than in latches. In this case the data is circulated around the register at some suitable rate and is sequentially presented at the input of the seven-segment decoder-driver. The anode drive can be obtained from a counter and decoder as in Figure 2, or from a parallel output shift register, Figure 3.

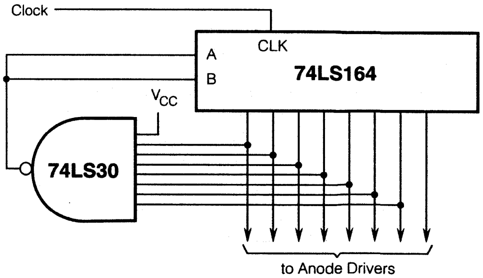


Figure 3

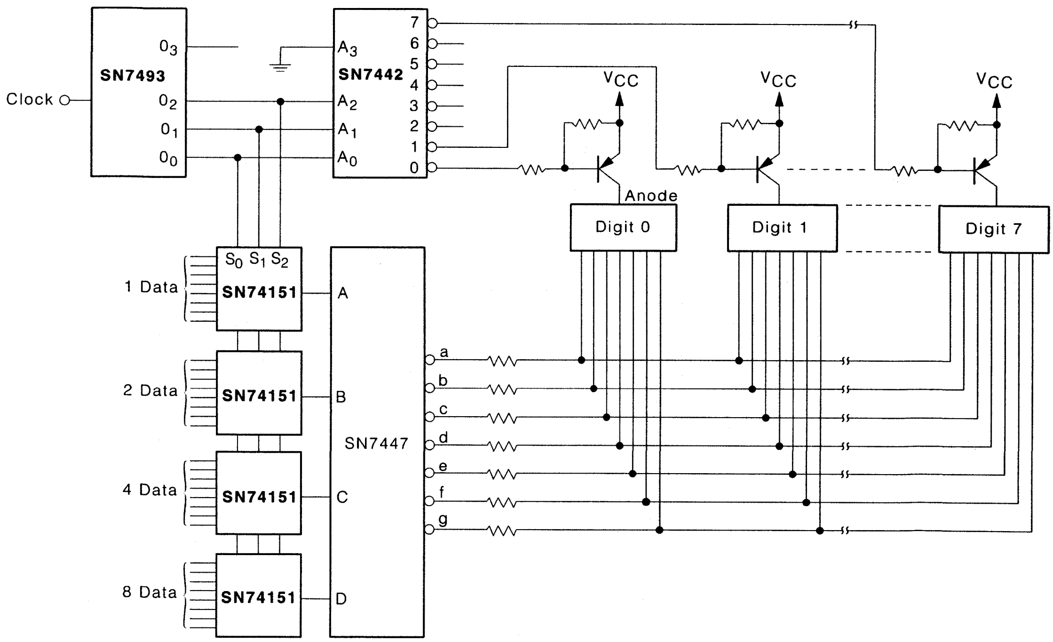


Figure 2

This circuit, which can be expanded to any number of digits, circulates a single zero, and can directly drive the PNP anode switches. Systems using recirculating memories generally require this digit timing circuitry for other reasons, so it is generally already available in the system.

For displays of eight digits; a very common number in counter-timer instruments, the 741648 bit shift register makes a very good circulating shift register.

The scheme can be extended to more digits by adding a four bit shift register, such as the 7494; the extra shift bits are inserted at the points marked⊗in Figure 4. The same circuit can be used for less than eight digits, if a 12½% duty cycle is satisfactory.

The preceding schemes demonstrate that systems containing recirculating data are very effectively coupled to multiplexed LED displays. Many multi-digit systems such as calculating machines use L.S.I. MOS circuits to provide their logic, and these naturally lend themselves to recirculating data. It is now practical to use microprocessors in instruments, which work well with Siemens Intelligent Display devices.

Apart from the strictly logical problems involved in a multiplexed display, the designer must choose suitable operating conditions for the LEDs. Peak forward current, current pulse width, duty cycle and repetition rate are all factors which the designer must determine.

The luminous intensity, or the luminance of GaAsP LEDs, is essentially proportional to forward current over a wide range, but certain phenomena modify this condition. At low currents, the presence of nonradiative recombination processes results in less light output than the linear relationship would predict. This effect is noticeable just below 5 mA per segment (for 1/4 inch characters). The result is that noticeable difference in luminance from segment to segment can occur at low currents. At high currents. the power dissipation in the chip causes substantial temperature rise, and this reduces the dissipation efficiency of the chip. As a result, the light output versus forward current curve falls below the straight line, at high currents (Figure 5). It should be emphasized that this latter effect is entirely due to self heating. If the power dissipation is limited, by running short pulses at low duty cycle, the output follows the straight line up to very high current densities. Whereas 100 A/cm^2 may be used in DC operation, as much as 10^4 A/cm^2 can be used under pulsed conditions, with a proportionate increase in peak intensity. (If this did not occur, GaAsP lasers could not be built.) Gallium Phosphide, however, has an inherent saturation mechanism that causes a drastic reduction in efficiency at high current densities even if the junction temperature remains constant. This effect is due to competing non-radiative recombination mechanisms at high current density.

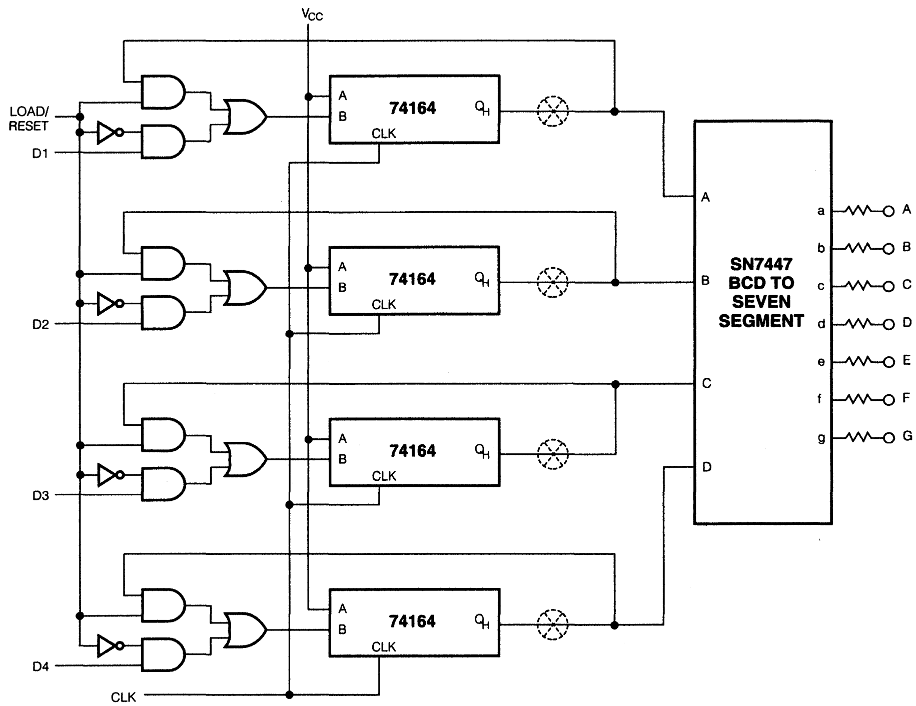


Figure 4

As a first approximation the brightness of a pulsed LED will be similar to being operated at a DC forward current equal to the average pulsed current. For example, for 40 mA peak current at 25% duty cycle, the brightness will be similar to DC operation at 10 mA. The actual brightness comparison will depend on the actual pulsing conditions. Under most legitimate conditions the brightness will be greater for pulsed operation.

Figure 5 shows how the actual light output at 5 mA DC is substantially less than expected from the ideal curve, because of the "foot" on the curve at low currents. Operation at 50 mA peak current and 10% duty cycle yields a high peak output as shown, and an integrated average output that is much closer to the ideal value. It should be obvious that variations in the "foot" from segment to segment cause a significant variation in light output at a low DC current, but a much smaller variation in the average output when operated in a pulsed mode. As well as an increase in luminance, or luminous intensity due to pulsing, there is an increase in brightness because of the behavior of the eye. The eye does not behave as an integrating photometer, but as a partially integrating and partially peak reading photometer. As a result, the eye perceives a brightness that is somewhere between the peak and the average brightness

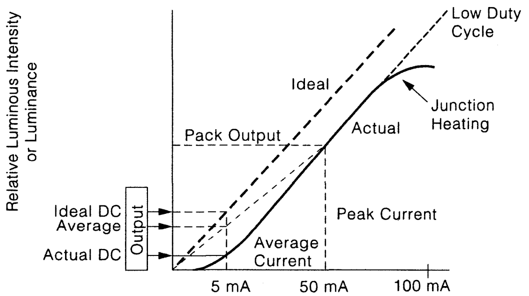


Figure 5

The net result is that a low duty cycle high intensity pulse of light looks brighter than a DC signal equal to the average of the pulsed signal. Therefore the practical benefit of multiplexed operation is an improvement in display visibility for a given average power consumption besides the lower cost. The brightness variation from segment to segment and digit to digit is also reduced by time-sharing. The gain in brightness over DC operation can be as much as a factor of 5 at low duty cycles of 1 or 2 percent, and peak currents of 50 to 100 mA.

A number of factors must be considered when deciding on the design of a multiplexed display. Besides the optical output, thermal considerations are very Important.

Most $^1/_4$" size LED numerics are rated at 30 mA DC maximum per segment. Under pulsed operation, higher currents can be used provided several thermal considerations are taken into account.

(1) The average power dessipation must not exceed the maximum rated power.

(2) The power pulse width must be short enough to prevent the junction from overheating during the pulse. This implies that the pulse width must get shorter as the amplitude increases.

Present experience indicates that for pulses of 10 μs, the amplitude should be limited to 100 mA maximum. Shorter pulses of higher amplitude may be used but the circuit problems become severe if the pulse width is very short.

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Driving High-Level Loads With Optocouplers Appnote 4

Frequently a load to be driven by an optocoupler requires more current, voltage, or both, than an optocoupler can provide at its output.

Available optocoupler output current is found by multiplying input (LED section) current by the "CTR" or current transfer ratio. For worst-case design, the minimum specified value would be used. The minimum CTR of the IL1 is 20%. Temperature derating is not usually necessary over the 0°C to +60°C range because the LED light output and transistor beta have approximately compensating coefficients.

Multiplying the minimum CTR by 0.9 would ensure a safe design over this temperature range. Over a wide range, more margin would be required.

The LED source current is limited by its rated power dissipation. Table 1 shows maximum allowable I_F versus maximum ambient temperature.

Values for Table 1 are based on a 1.33 mW/°C derate from the 100 mW at 25°C power rating.

Table 1

Maximum Temperature	I_F Maximum
40°C	50 mA
60°C	35 mA
80°C	17 mA

Obviously, one can increase the available output current either by choosing a higher CTR-rated optocoupler or by providing more current, or both. Table 2 shows the minimum available output current for the IL1, at T_A=60°C (from Table 1) and a 10 percent margin for temperature effects.

Table 2

P/N	I_{CE} (min) mA
IL1	6.3

If the IL1 is being operated from logic with 5 volt driving transistor and 0.2 volt V_{CE} saturation is assumed for the driving transistor; a 75 ohm R_{IF} resistor will provide the 48 mA. The forward voltage of the IR-emitting LED is about 1.2 volts. Figures 1A and iB show two such drive circuits.

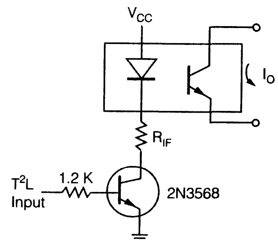

Figure 1A. NPN Driver

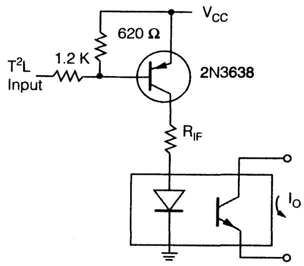

Figure 1B. PNP Driver

A "buffer-gate," such as the SN7440 provides a very good alternative to discrete transistor drivers. Figure 2 shows how this is done. Note that the gate is used in the "current-sinking" rather than the "current-sourcing" mode. In other words, conventional current flows into the buffer-gate to turn on the LED. This makes use of the fact that a T^2L gate will sink more current than it will source. The SN7440 is specified to drive thirty 1.6 mA loads or 48 mA. Changing R_{IF} from 75 to 68 ohms adjusts for the higher saturation voltage of the monolithic device.

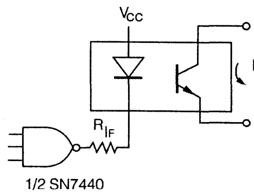

Figure 2. Buffer-Gate Drive

More Current

For load currents greater than 6.3 mA, a current amplifier is required. Figures 3A and 3B show two simple one-transistor current amplifier circuits.

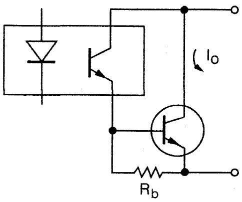

Figure 3A. NPN Current Booster

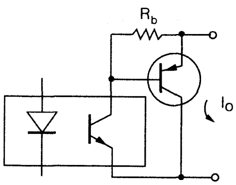

Figure 3B. PNP Current Booster

Since the transistor in the optocoupler is treated as a two-terminal device, no operational difference exists between the NPN and the PNP circuits. R_b provides a return path for I_{CBO} of the output transistor. Its value is: R_b = 400 mV/I_{CBO} (T) where I_{CBO}(T) is found for the highest *junction* temperature expected.

Assume that leakage currents double every ten degrees. Use the maximum dissipated power, the specified maximum iunction-to-ambient thermal resistance, and the maximum design ambient temperature in conjunction with the specified maximum 25° I_{CBO} to calculate I_{CBO}(T)

As an example, suppose a 2N3568 is used to provide a 100 mA load current. Also assume a maximum steady-state transistor power dissipation of 100 mW and a 60°C maximum ambient. The transistor junction-to-ambient thermal resistance is 333°C/watt, so a maximum junction temperature of 60 + 33 or 93°C is expected. This is about 7 decades above 25°C. Therefore, I_{CBO}(T)=I_{CBO}(max) x 27=50 nA x 128=6.5 µA. A safe value for R_b is 400 mV/6.5 µA=62 kilohms.

Working backwards, maximum base current under load will be I_O/h_{FE}(min)=100 mA/100=1 mA. Current in R_b is V_{BE}/R_b= 600 mV/60k=10 µA, which is negligible. An IL1 with a 9 mA drive would operate effectively.

If the load requires more current than can be obtained with the highest beta transistor available, then more than one transistor must be used in cascade. For example, suppose 3 amperes load current and 10 watt dissipation are needed. A Motorola MJE3055 might be used for the output transistor, driven by a MJE205 as shown in Figure 4. Using a 5°/watt heat sink and the rated MJE3055 junction-to-case thermal resistance of 1.4°/watt, we find that junction temperature rise is 6.4 x 10, or 64°. Therefore maximum junction temperature is 124°C. This is 10 decades above 25°C making I_{CBO}(T)= 2^{10} I_{CBO}(max)=10^3 I_{CBO}(max).

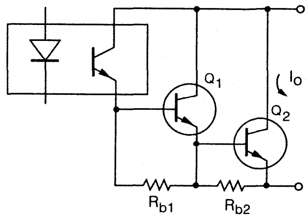

Figure 4. Two NPN Current Boosters

I_{CBO}(max) at 30 volts or less is not given, but I_{CEO} is. Using (for safety) a value of 20 for the minimum low current h_{FE} of the device, I_{CBO} could be as large as I_{CEO}/20=35 µA. Then I_{CBO}(T) is 35 mA and R_{b2}=400 mV/35 mA=11 ohms. For I_b use I_O/h_{FE} (min at 4 A)=3 A/20=150 mA. I_{Rb2}=600 mV/10 ohms=60 mA, so $I_{e(Q1)}$=210 mA.

Maximum power in Q_1 will be about 1/14 the power in Q_2 since its current is lower by that ratio and the two collector-to-emitter voltages are nearly the same. This means Q_1 must dissipate 700 mW.

Assuming a small "flag" heat sink having 50°/watt thermal resistance, we find the junction at about 95°C. The 150°C case temperature I_{CBO} rating for this device is 2 mA, so one can work backwards and assume about 1/30 of this value, or 70 µA. On the other hand, the 25° rated I_{CBO} is 100 µA. Choosing the larger of these contradictory specifications, R_{b1}=400 mV/0.1 mA=4k≈3.9 k. Q_1 base current is $I_{E(Q1)}$/ $h_{FE(Q1\text{-}mjn)}$=210 mA/50*=4.2 mA. Total current is $I_{b(Q1)}$ + I_{Rb1}=4.2 + 0.24=4.5 mA. Table 2 shows that an IL1 could be used here.

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*Minimum hFE is obtained using the specification at I_{CE}=2 A and the "Normalized DC Current Gain" graph given in Motorola's "Semiconductor Data Book", 5th edition, pp. 7–232 and 7–233

More Load Voltages

All of the current-gain circuits shown so far have one common feature: load voltage is limited by the 30 volt rating of the IL1 not by the voltage or power rating of the transistor(s).

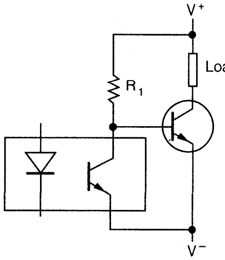


Figure 5A. NPN HV Booster

Figure 5A shows a method of overcoming this limitation. This circuit will stand off BV_{CEO} of Q_1. The voltage rating of the phototransistor is irrelevant since its maximum collector-emitter voltage is the base emitter voltage of Q_1 (about 0.7 volts).

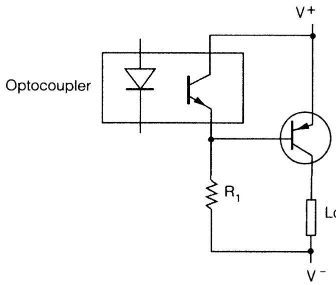


Figure 5B. PNP HV Booster

Unlike the "Darlington" configurations shown previously, this circuit operates "normally-ON." When no current flows in the LED the phototransistor, being OFF, allows R_2 current to flow into the base of Q_1, turning Q_1 ON. When the optocoupler is energized, its phototransistor "shorts out" the R_2 current turning Q_1 OFF.

The value of R_1 depends only on the load-supply voltage $V^+ - V^-$, and the maximum required Q_1 base current. This is derived from the minimurn beta Of Q_1 at minimum temperature and the load current. The required current-drive capability is the same as I_{R1}. since I_{R1} changes negligibly when the circuit goes between its "ON" and "OFF" states.

In some applications either more current gain will be required than one transistor can provide or the power dissipated in R_1 will be objectionable. In these cases, simply use the Darlington high-voltage boosters shown in Figure 6A.

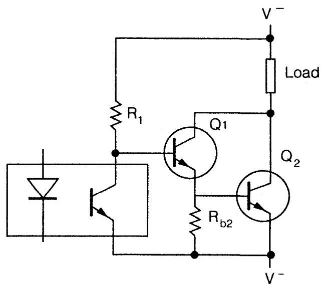


Figure 6A. NPN Darlington HV Booster

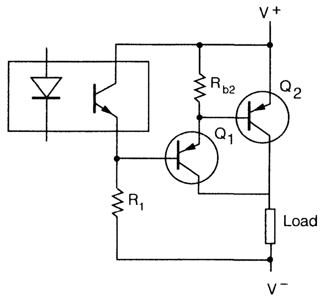


Figure 6B. PNP Darlington HV Booster

If more than one load is being driven and their negative terminals must be in common, use the PNP circuit (Figure 6B). Otherwise, the NPN is better because the transistors cost less. Performance characteristics of the NPN and PNP versions are identical if the device parameters are also the same.

Applications

Optocoupler isolated circuits are useful wherever ground loop problems exist in systems, or where dc voltage level translations are needed. In many systems so-called interpose relays are used between a logic circuit section (which may be a mini-computer) and the devices being controlled. Sometimes *two levels* of interpose relays are used in cascade either because of the load power level or because of extreme difficulties with EMI. Optocouplers aided by booster circuits such as those described can replace many of the relays in these systems.

The reed relays, typically used as the first level of interpose and mounted on the interface logic cards in the electronic part of the system, are almost always replaceable by optocouplers since their load is just the coil of a larger relay. This relay may have a coil power of 1/2 to 5 watts and operate on 12, 24 or 48 volts dc.

Assuming worst-case design techniques are carefully followed, system reliability should improve in proportion to the number of relays replaced.

SIEMENS

More Speed from Optocouplers Appnote 5

by David M. Barton

Figure 1 shows a typical circuit employing an optocoupler to transmit logic signals between electrically isolated parts of a system. In the circuit shown, the optocoupler must "sink" the current from one T^2L load plus a pull-up resistor to V_{CC}. The resistor in series with the LED half of the optocoupler must supply the worst case load current divided by the "current transfer ratio" or CTR of the optocoupler. If an IL1 optocoupler is used, having a minimum CTR of 0.2, and 80 percent variation in the load is allowed. 8.1 mA is required. This is supplied by the 430 Ω resistor.

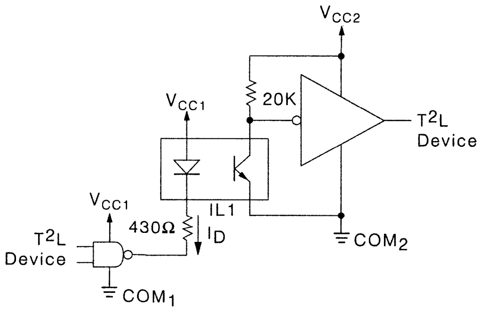


Figure 1.

The maximum repetition rate at which this circuit will operate is only about 8 kHz. The severe speed limitation is due entirely to the characteristics of the phototransistor half of the optocoupler. This device has a large base-collector junction area and a very thick base region in order to make it sensitive to light. C_{ob} is typically 25 pF. This capacitance is, in the circuit of Figure 1, effectively multiplied by a large factor due to the "Miller effect." Also, because the base region volume is large, so is base storage time.

A very simple method of reducing both of these effects is to add a resistor between the base and emitter as shown in Figure 2. This resistor helps by reducing the time constant due to C_{ob} and by removing stored charge from the base region faster than recombination can. When a base-emitter resistor is used, of course, the required LED drive is increased since much of the photo-current qenerated in the base-collector junction is now deliberately "dumped."

Using this method does not usually result in a large power supply current drain since average repetition rate is low in most applications.

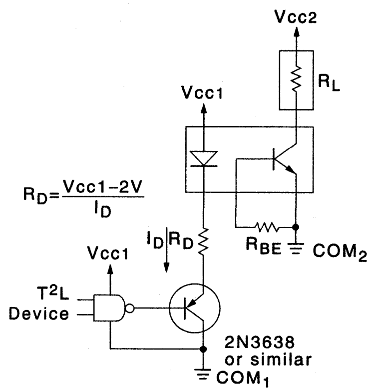


Figure 2.

As drive is increased and R_{BE} reduced, turn-on time and turn-off time both decrease. The total amount of charge stored can also be reduced by decreasing the LED drive pulse duration. Also, as higher drive levels are used, the load resistance, R_L can be reduced to further enhance the speed of the circuit. These parameters are related to each other such that all should be changed together for best results.

One important generalization can be made concerning their interdependence. The LED drive pulse duration, T_{in} output fall time (t_f) output rise time (t_r) and propagation delay (tp) should occur in a 1.5:1:1:1 ratio, approximately. If this relationship does not occur, the circuit will not operate at as high a repetition rate as it could at the same drive level. T_{out} equals T_{in} at low currents but stretches out at high currents.

Figure 3 is a graph relating the important parameters for a typical IL1 whose CTR is 0.25. The optimum values of T_{in}, R_{BE}, and R_L are shown versus LED pulse current as are the resultant output pulse width and maximum full-swinq freauencv. Rise, fall and propaqation time can be read as $^2/3$ of T_{in}.

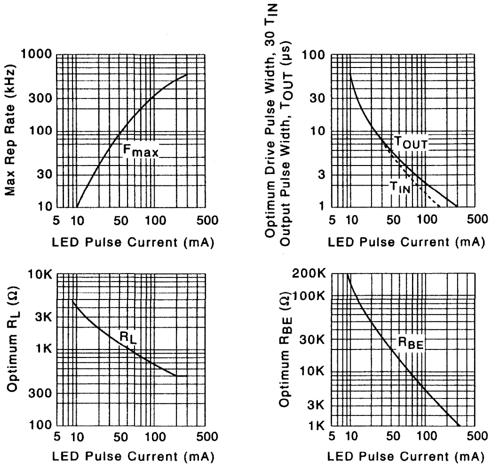


Figure 3. Parameters versus LED Pulse Current

Figure 3 shows that increasing drive to 200 mA and using optimum R_{BE} and R_L will increase the maximum repetition rate from 3 kHz to 500 kHz, a 167:1 improvement.

Lower grade optocouplers will behave similarly if the LED drive level is scaled appropriately to allow for a lower CTR.

Another method of increasing speed is to operate the phototransistor as a photo-diode. In this method, bias voltage is supplied between the collector and base terminal, the emitter being unused. Operation to at least 1.0 MHz is possible this way, but the price is the need for external amplification. Figure 4 is a graph showing peak output current versus drive pulse duration for 200 mA peak drive current.

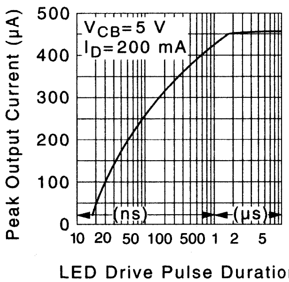


Figure 4. Diode Mode Output Current versus Drive Pulse Duration

Since output current is small, some type of widebandwidth amplifier must be employed in order to drive T^2L loads.

One simple solution for intermediate speed operation is the use of MOS inverter (1/6 74HC04), Figure 5.

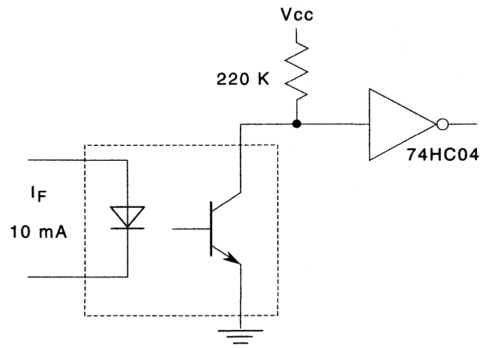


Figure 5.

Another device which will provide a good interface is an integrated comparator ampl if ier. The photo-transistor collector goes to V_{CC}. Its base has a 200 Ω load resistor to ground and goes to one input of the comparator. Also, a resistor oes from this node to the minus supply. This resistor is chosen to supply 50 µA. The other comparator input is grounded. The voltage at the comparator input will switch from −10 mV to +10 mV or more when the diode turns on and the output will drive the T^2L loads.

Of course discrete component amplifiers could be used and may be best in some applications.

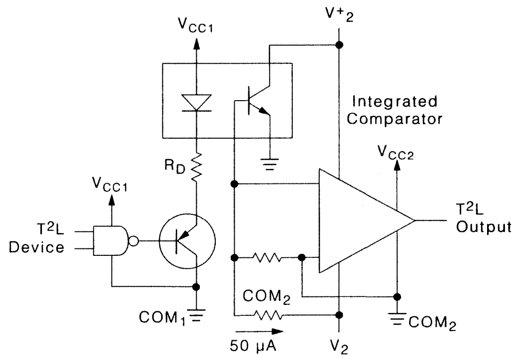


Figure 6.

Conclusion

For operation to 500 kHz, the addition of a base-emitter resistor and a high-current driver is probably the best method of increasing optocoupler speed. Above 500 kHz one must revert to photodiode mode and use an external amplifier to drive most loads, particularly T^2L.

SIEMENS

Operating LEDs on AC Power Appnote 6

by David M. Barton

Introduction

Frequently it is desirable to operate LEDs on AC power rather than DC. Typically, the power source is 120 VRMS 60 Hz. The most obvious method is to rectify this power with a series diode and use a resistor to limit LED current as shown in Figure 1.

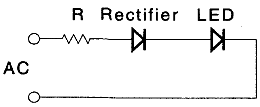


Figure 1. Power Resistor Method

This method, though sound, results in very high power dissipation in the resistor since the LED operates on only 1.6 volts.

The Method

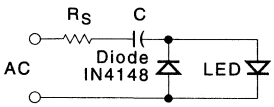


Figure 2. Capacitor Method

Figure 2 shows a better method—using a capacitor to control LED current and a shunt silicon diode provides rectification.

Since, for current in either direction, voltage drop across the LED or rectifier is a negligible part of the supply voltage, current in the capacitor is almost exactly equal to the AC supply voltage divided by the reactance of the capacitor. Average capacitor current is then:

1. $I_C\ (AV) = .9 \times VRMS/X_C$

   and average half-cycle LED or rectifier current is:

2. $I_{LED\ (AV)} = \frac{1}{2}\, I_D\ (AV) = .45\ VRMS/X_C$

   or, for 120 VRMS, 60 Hz operation,

3. $I_{LED\ (AV)} = 20\ mA \times C\mu F$

   or $C\mu F = \frac{I_{LED\ (AV)}}{20\ mA}$

Figure 3 shows the value of the series capacitor needed for a range of average LED currents assuming 60 Hz, 120 volt power

A resistor is necessary in series with the capacitor to limit turn-on transient currents. A value of 100 ohms will be adequate in most cases.

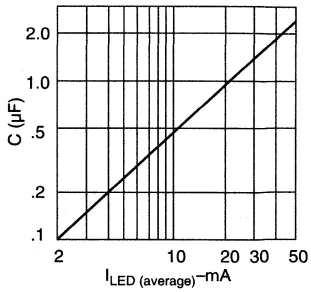


Figure 3. Series Capacitor Value versus Average LED Current for 120 VRMS 60 Hz

The current in the LED, of course, flows almost exactly in quadrature with the line voltage. For this reason, power dissipation is low, being limited to the expected LED and rectifier power loss, the loss in series resistor and to losses in the capacitor. The latter term will be extremely low if high quality capacitors are used. Although power consumption of a circuit may not be of much significance in terms of the cost of the power, it certainly can be important to reduce heat generation within an enclosure.

If more than one LED is to be operated from the same source, simply put the LEDs in series in the same circuit, as shown in Figure 4. For small numbers of LEDs the current will be, for practical purposes, the same as for one.

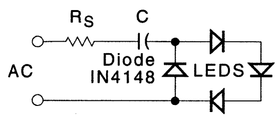


Figure 4. LEDs in Series

Conclusion

Cost of the series capacitor (mylar) will be similar to the cost of a series power resistor. The shunt diode, a IN4148 or similar, will cost about two cents; much less than a series rectifier which must have a several hundred volt PIV rating.

So the capacitor method is both lower in cost and lower in heat generation and power consumption than the resistor method.

SIEMENS

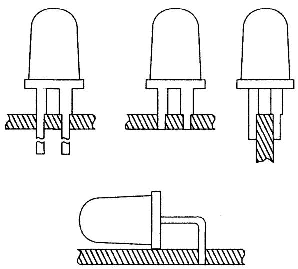
Mounting Considerations for LED Lamps and Displays Appnote 11

by Dave Takagishi

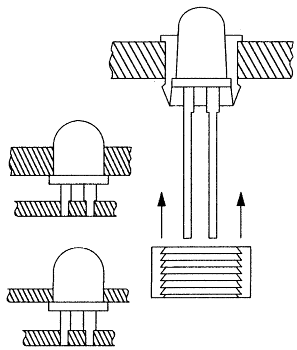
There are numerous ways to mount an LED lamp into a panel or a piece of equipment and this application note is written as an aid to designers and engineers when using LED lamps and displays.

Mounting Techiques

There are several ways to mount LED lamps such as the Siemens LS 5420 by soldering directly into PCBs, plugging into sockets, or panel mounting with or without clips. Bending leads is allowed keeping the following guidelines in mind. Leads must not be bent closer than 0.065 inches from the base of case when leads are not in excess of 0.020 inches in diameter. Leads should be clamped next to the case when lead bending to relieve stresses. Under no circumstances must any mechanical force be applied to the case while bending the leads. Also, incorrectly spaced holes in the printed circuit board will place mechanical stress on the plastic case which can cause failure during soldering.



Displays of the HD11XXX type can be soldered directly into a printed circuit board or be plugged into sockets. Many displays can be end-stacked (butted end-to-end) to obtain longer displays with more digits. This usually causes no break in digit spacing. In applications using screw-down mounting, a flexible washer should be used to avoid strain from misalignment or board warpage.



Connector/Socket Suppliers (Partial List)

Aries	Frenchtown, NJ
Augat	Attleboro, MA
Berg	New Cumberland, PA
EMC	Woonsocket, RI
Robinson Nugent	New Albany, IN
Precision Concept, Inc.	Bohemia, NY

Thermal Considerations

Most LED failures can be traced to excess thermal stress. A typical LED chip is mounted on a substrate or lead frame with a wire bond from the top of the chip to a metallized trace on the substrate and is encapsulated in epoxy. Temperature changes cause these various materials to expand and contract at different rates. Extreme low temperatures are most likely to cause structural failure. High temperatures usually cause reduced lifetime rather than immediate failures.

The internal LED junction temperature depends on ambient temperature, power applied to the LED, and the thermal resistance, LED chip-to-ambient.

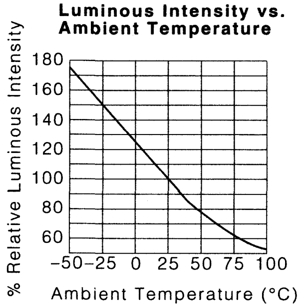
Long-term degradation of LED chips, causing reduced light output, will occur if junction temperature exceeds 125°C. Also the epoxy material overcoating the LED chips may gradually become opaque if it is subjected to temperatures above 125°C.

For these reasons, all Siemens LED products carry derating specifications designed to limit LED junction temperature to 100°C.

Particular care is needed in designing multiplexed systems. Increased forward voltage and the effects of the thermal time constant, chip to ambient (about 10 mS typical) can cause "thermal ripple" peak excursions above 100°C while calculated average temperature is much lower.

Another reason for keeping LED chip temperature down is the reduced light output (see graph). One can reach a point of diminishing returns, particularly in multiplexed systems, in which an increase in current reduces reliability while actually resulting in little or no increase in display visibility. In such cases, one would be well advised to use a higher brightness-grade displays.

Luminous Intensity vs. Ambient Temperature



A well-designed display system, especially if high power levels or multiplexed operations are involved, should:

1. Allow for convection airflow around the display.
2. Place other heat-generating components (i.e., display current-control resistors) either away from or above, but never below the display .
3. Take the increased forward voltage and "thermal ripple" peaks into account, in multiplexed systems, and not allow peak temperature to exceed 100°C.

In common with many semiconductor products, LED displays offer the user the most reliable and longest lifetime product available. These good properties do depend, however, on proper usage. Semiconductor products are well-known to be rather unforgiving of abuse when compared to the older technologies. LEDs are not different; they are, in fact, hybrid integrated circuits.

Soldering Considerations

Take care not to overheat LEDs when soldering. Effectiveness and safety in soldering are related to three basic parameters: temperature, time, and distance. In general, soldering time should not exceed 3 seconds at 1/16 inch from the case at 260°C. Some packages allow greater latitude, as indicated on individual data sheets.

Optical Considerations

Siemens recommends the use of a contrast enhancing filter in front of LED displays. These filters will increase the contrast ratio of digit to surrounding area and help remove reflected light and glare from the PCB and components around the display. In setting the display to reduce direct ambient light on the display should also be considered.

Rohm & Haas red Plexiglass #2423 makes a good general purpose filter for the 640-660 nm peak emission wavelength of red LEDs. A 1/16 inch thick sheet of this inexpensive material is quite effective. Additional information on this and other filter materials may be obtained by contacting the following suppliers.

Filter Manufacturers

Rohm & Haas	Philadelphia, PA
Homalite	Wilmington, DE
Panelgraphic	West Caldwell, NJ
3M	St. Paul, MN
Polaroid	Cambridge, MA

Filters

For Red LEDS	
Rohm & Haas	Plexiglass 2423
Homalite	1670, 1 605
Panelgraphic	Red 60, Red 63, Red 65, Purple 90
Polaroid	HRCP
For Green LEDs	
Rohm & Haas	Plexiglas 38168
Panelgraphic	Green 48
Homalite	1425, 1440
For Yellow LEDs	
Panelgraphic	Yellow 25, Amber 23
Homalite	1720, 1726
Neutral Density Filter	
Homalite	Neutral Gray 10

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Displaying Message Systems Without a Microprocessor Appnote 13

Any Siemens 4 digit, alphanumeric Intelligent Display device has on board memory, decoder and drive circuitry which makes these displays particularly well suited to connect directly to a microprocessor. However, small multi-message systems of 4, 8,12, 16 character length need not have a microprocessor to drive the Intelligent Display. With the aid of PROM, Intelligent Display devices can combine lighted indicators, status displays, annunciator messages or symbols, or a "canned message" into a single display.

Annunciator Displays

An automobile, for example, has several switches each lighting its own status or annunciator indicator. A single Intelligent Display could easily display messages alternately upon interrogation of the appropriate switches.

Figures 1, 2, and 3 show a DL1416 but any of our Intelligent Display devices can be substituted. The circuit shown in Figure 1 will display four character messages sequentially for each open switch and continue to display until switches are returned to their normally closed positions. The Counters U4 and U5 address the PROM U6 and select switches on U1. The Data Selector (U1) sequentially selects one of eight switches (oil, temperature, catalytic, generator, brake, door, belt, and null), The eighth switch or null state can display a blank for a normal or off condition. The output of U1 enables the display's CE. When this signal goes high, the Monostable (U2) will fire and inhibit the Oscillator U3 for approximately a two second display time. The PROM, U6, generates the ASCII code data for each word. Expansion of the display can easily be achieved by adding a PROM for each additional display.

Another annunciator type display is shown in Figure 2. This display has a message of up to 16 characters and will continue to display the same line until the 6 bit input code changes state. With this scheme, it can be seen that the 16 character X64 line message PROM easily can be adapted for other message and character length combinations.

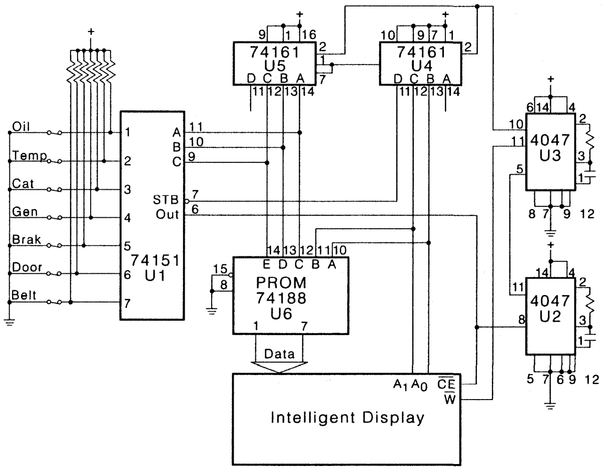

Figure 1

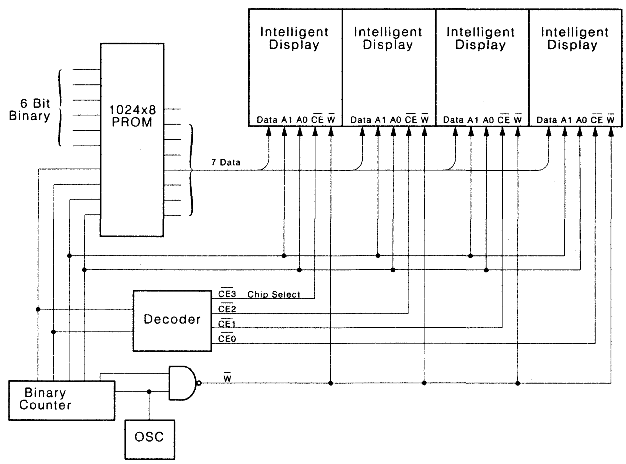

Figure 2. Typical Circuit for 64 Messages –16 Characters Long

Canned Messages

The canned message type display can be an ideal sales marketing or instructional aid. The message can be altered by replacing the PROM.

The technique for this display would be to sequentially display a word or group of words, depending on the character length of the display, through the entire message. The system could either continue to repeat itself or could go through the complete sequence once each time a switch is operated.

Figure 3 is the schematic for a sales demo box for the DL1416. A 256X8 PROM was used to display an 8 digit-32 word message. The oscillator (U1) increments the counters U2, U3, U4 providing the address for the DL1416s and PROM U9. After eight counts the monostable U10 is fired, inhibiting the oscillator for a two second display time. Devices U5 and U8 were added for cursor control. Decoder U8 will alternately enable or disable a data bit for a cursor to proceed writing new data into each digit. The multiplexer U5 will select the character data or the cursor data for the D0–D3 data lines. Inverters on the address lines cause data entry to occur from the left rather than from the right.

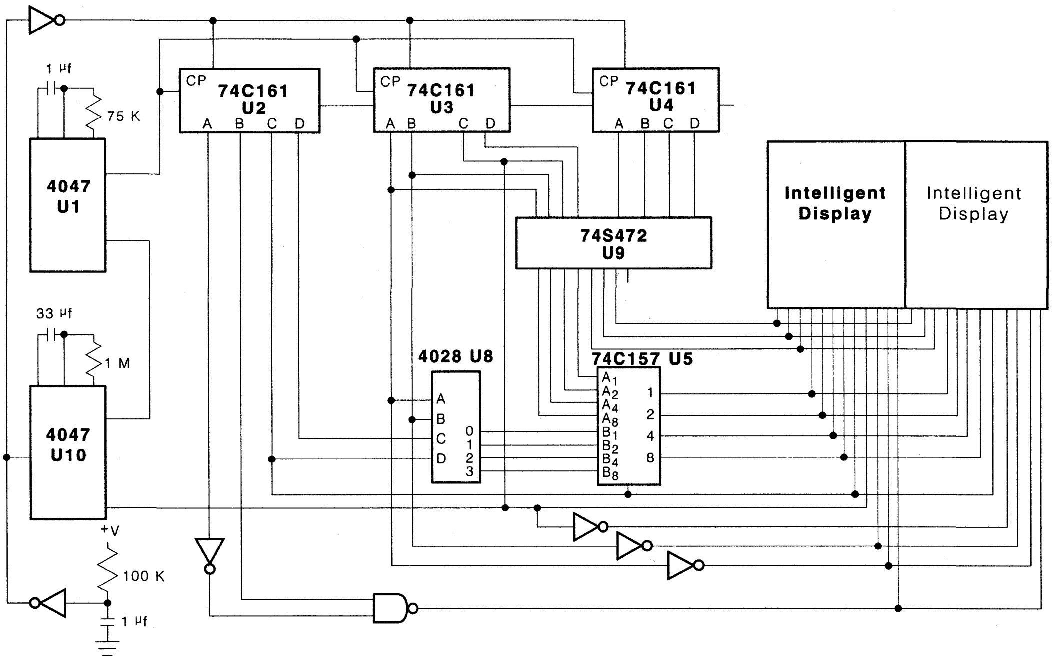

Figure 3. Schematic–Sales Demo Box

Application Notes 11

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Applying the DL2416T/DLX2416* Intelligent Display® Device Appnote 14

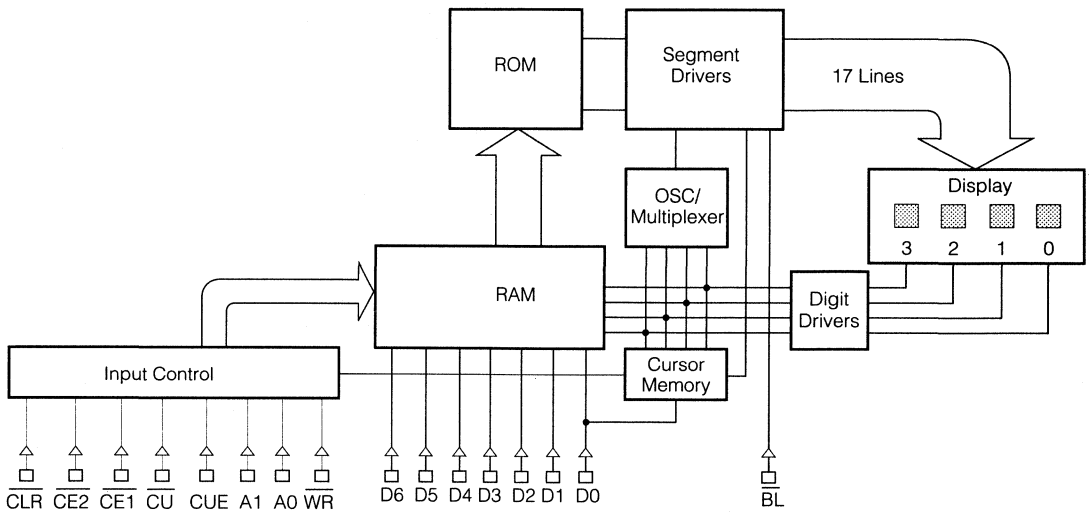
by Dave Takagishi

This application note is intended to serve as a design and application guide for the DL 2416T/DLX 2416 (the 2416) alphanumeric Intelligent Displays. The information presented covers device electrical description and operation, considerations for general circuit design, and interfacing the 2416 to microprocessors. Refer to the specific data sheet and other Siemens Appnotes for more details.

Electrical & Mechanical Description

The internal electronics in these Intelligent Displays eliminates all the traditional difficulties of using multi-digit light emitting displays (segment decoding, drivers, and multiplexing). The Intelligent Display also provides internal memory for the four digits. This approach allows the user to asynchronously address one of four digits, and load new data without regard to the LED multiplex timing.

Figure 1a is a block diagram of the DL2416T. The unit consists of four 17-segment monolithic LED dies and a single CMOS integrated circuit chip. The LED dies are magnified to a height of 160 mils by built-in lenses. The IC chip contains 17 segment drivers, four digit drivers, 64 character ROM, four word x 7 bit Random Access Memory, oscillator for multiplexing, multiplex counter/decoder, cursor memory, address decoder, and miscellaneous control logic.



*DL2416T–segmented display
DLX2416 (DLR/DLG/DLO2416)–dot matrix displays

Figure 1a. Block Diagram–DL2416T

Figure 1b is a block diagram of the DLX 2416. The unit consists of 4 (5x7) LEDs and a single CMOS integrated chip. The IC chip contains the column drivers and row drivers, 128 character ROM, four word x7 bit Random Access Memory, oscillator for multiplexing, multiplex counter/decoder, cursor memory, address decoder, and miscellaneous control logic.

Packaging

Packaging consists of a transfer-molded nylon lens which also serves as an "encapsulation shell" since it covers five of the six "faces." The assembled and tested substrate ("PTF" multilayer) is placed within the shell and the entire assembly is then filled with a water-clear IC-grade epoxy.

This yields a very rugged part, which is quite impervious to moisture, shock and vibration, Although not "hermetic", the device will easily withstand total immersion in water/detergent solutions.

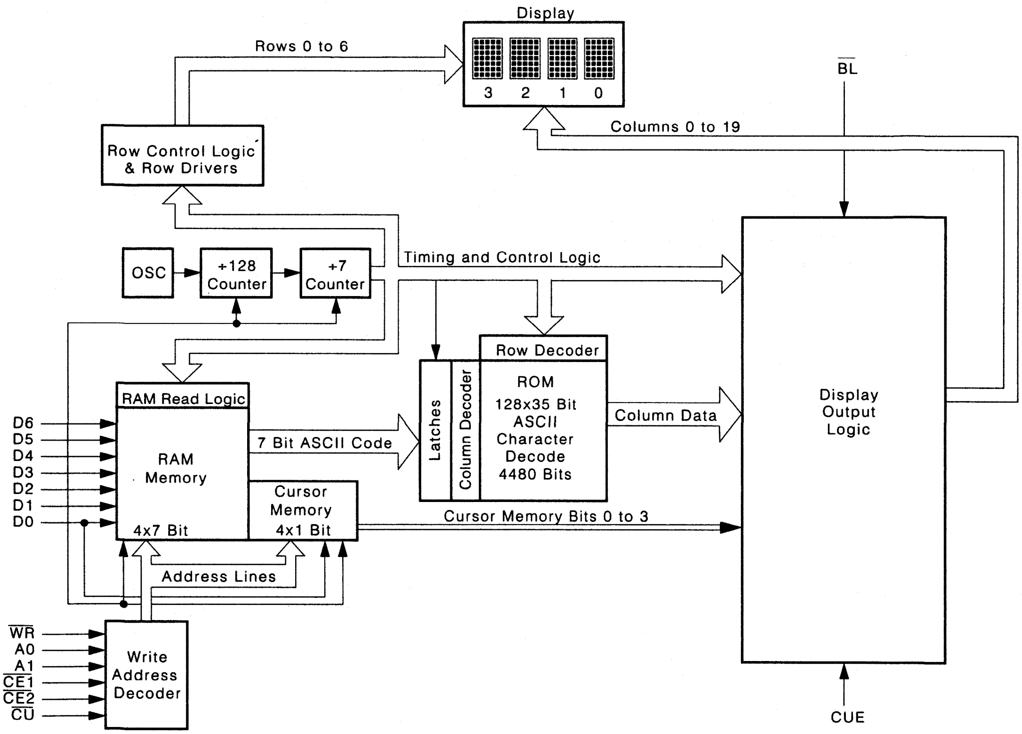
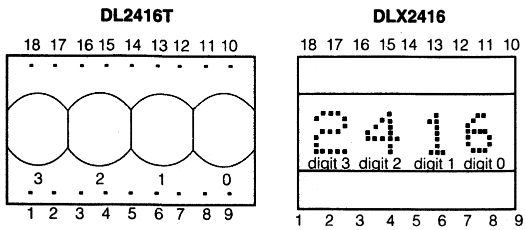


Figure 1b. Block Diagram–DLX21416

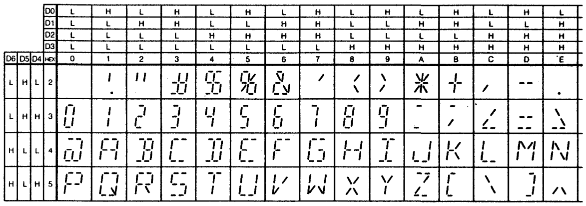


Pin	Function	Pin	Function
1	$\overline{CE1}$ Chip Enable	10	GND
2	$\overline{CE2}$ Chip Enable	11	D0 Data Input
3	$\overline{CLR}$ Clear	12	D1 Data Input
4	CUE Cursor Enable	13	D2 Data Input
5	$\overline{CU}$ Cursor Select	14	D3 Data Input
6	$\overline{WR}$ Write	15	D6 Data Input
7	A1 Digit Select	16	D5 Data Input
8	A0 Digit Select	17	D4 Data Input

Figure 2. Top Views and Pin Outs

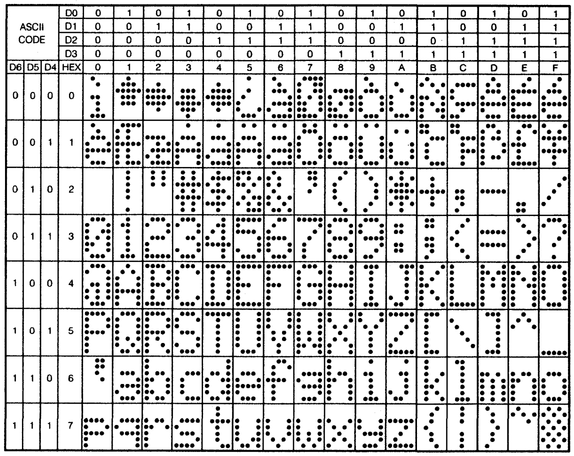
Electrical Inputs to the 2416

V_{CC}	Positive supply +5 V
GND	Ground
D0–D6	Data lines The seven data input lines are designed to accept the first 64 ASCII characters, See Figure 3a for character set. (The DL 2416T interprets all undefined codes as a blank). See Figure 3b for character set for DLX 2416.
A0, A1	Address Lines The address determines the digit position to which the data will be written. Address order is right to left for positive-true logic.
$\overline{WR}$	Write (Active Low) Data and address to be loaded must be present and stable before and after the trailing edge of write. (See data sheet for timing information).
$\overline{CE1}$, $\overline{CE2}$	Chip Enable (Active Low) This determines which device in an array will actually accept data. When either or both chip enable is in the high state, all inputs are inhibited.
$\overline{CLR}$	Clear (Active Low) The data RAM and cursor RAM for DL 2416T will be cleared when held low for 15 mS. For the DLX 2416 the minimum for $\overline{CLR}$ is 1 mS.
CUE	Cursor Enable. Activates Cursor function. Cursor will not be displayed regardless of cursor memory contents when cue is Low.
$\overline{CU}$	Cursor Select (Active Low) This input must be held high to store data in data memory and low to store data into the cursor memory.
$\overline{BL}$	Display Blank (Active Low) Blanking the entire display may be accomplished by holding the $\overline{BL}$ input low. This is not a stored function, however. When $\overline{BL}$ is released, the stored characters are again displayed. BL can be used for flashing or dimming.



All other input codes display "blank"

Figure 3a. Character Set–DL2416T



1. High=1 level. 2. Low=0 level. 3. Upon power up, device will initialize in a random state.

Figure 3b. Character Set–DLX2416

Clear Memory

Clearing of the entire internal four-digit memory may be accomplished by holding the clear line ($\overline{CLR}$) low for one complete internal display multiplex cycle, 15 mS minimum for DL 2416T, 1 mS for DLX 2416; less time may leave some data uncleared. $\overline{CLR}$ also clears the cursor memory.

Display Blanking

Blanking the display may be accomplished by loading a blank, space or illegal code into each digit of the display or by using the ($\overline{BL}$) display blank input. Setting the ($\overline{BL}$) input low does not affect the contents of either data or cursor memory. A flashing display can be realized by pulsing ($\overline{BL}$).

Operation

Multiplexed display systems sequentially read and display data from a memory device. In synchronous systems, control circuitry must compare the location of data to be read to the location or position of new data to be stored or displayed, i.e., synchronize before a Write can be done. This can be slow and cumbersome.

Data entry in "intelligent displays" is asynchronous and may be done in any random order. Loading data is similar to writing into a RAM. Each digit has its own memory location and will display until replaced by another code.

The waveforms of Figure 4 demonstrate the relationships of the signals required to generate a write cycle. (Check individual data sheet for minimum values). As can be seen from the waveforms, all signals are referenced from the rising or trailing edge of write.

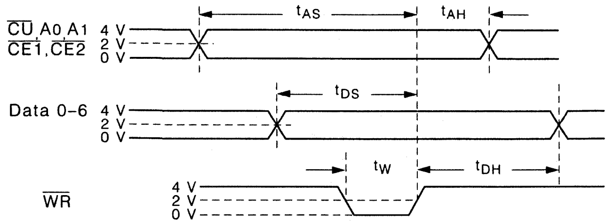


Figure 4. Write Cycle Waveforms

Cursor

The cursor function of the DL 2416T causes all 16 line-segments of a digit to light. For the DLX 2416 the cursor function causes all dots to light at 50% brightness. The cursor can be used to indicate the position in the display of the next character to be entered. The cursor is not a character but overrides the display of a stored character. Upon removal of the cursor, the display will again show the character stored in memory.

The cursor can be written into any digit position by setting the cursor enable (CUE) high, setting the digit address (A1, A0), enabling Chip Enable, ($\overline{\text{CE1}}$, $\overline{\text{CE2}}$), cursor select ($\overline{\text{CU}}$), Write ($\overline{\text{WR}}$) and Data (D0). A high on data line D0 will place a cursor into the position set by the address A0 and A1. Conversely, a low on D0 will remove the cursor. The cursor will remain displayed after the cursor ($\overline{\text{CU}}$) and write ($\overline{\text{WR}}$) signals have been removed. During the cursor-write sequence, data lines D1 through D6 are ignored by the 2416.

Loading Data

$\overline{\text{BL}}$	$\overline{\text{CE1}}$	$\overline{\text{CE2}}$	CUE	$\overline{\text{CU}}$	$\overline{\text{WR}}$	$\overline{\text{CLR}}$	A1	A0	D6	D5	D4	D3	D2	D1	D0	Digit 3	Digit 2	Digit 1	Digit 0
L	X	X	X	H	X	H	X	X	X	X	X	X	X	X	X	Blank			
H	H	X	L	H	X	H	X	X	X	X	X	X	X	X	X	Previous Characters			
H	X	H	L	H	X	H	X	X	X	X	X	X	X	X	X	NC	NC	NC	NC
H	X	X	L	H	H	H	X	X	X	X	X	X	X	X	X	NC	NC	NC	NC
H	L	L	L	H	L	H	L	L	H	L	L	L	L	L	H	NC	NC	NC	A
H	L	L	L	H	L	H	L	H	H	L	L	L	L	H	L	NC	NC	B	A
H	L	L	L	H	L	H	H	L	H	L	L	L	L	H	H	NC	C	B	NC
H	L	L	L	H	L	H	H	H	H	L	L	L	H	L	L	D	C	NC	A
H	L	L	L	H	L	H	L	L	H	L	L	L	H	L	H	D	C	B	E
H	L	L	L	H	L	H	H	L	H	L	L	H	L	H	H	D	K	B	E
H	L	L	L	H	L	H	–	–	–	–	–	–	–	–	–	See Character Set			

Loading Cursor

$\overline{\text{BL}}$	$\overline{\text{CE1}}$	$\overline{\text{CE2}}$	CUE	$\overline{\text{CU}}$	$\overline{\text{WR}}$	$\overline{\text{CLR}}$	A1	A0	D6	D5	D4	D3	D2	D1	D0	Digit 3	Digit 2	Digit 1	Digit 0
H	L	L	L	H	X	H	X	X	X	X	X	X	X	X	X	Normal Data Entry			
H	L	L	H	H	H	H	X	X	X	X	X	X	X	X	X	Enable Previous Stored Cursors			
H	L	L	H	L	L	H	L	L	X	X	X	X	X	X	H	NC	NC	NC	■
H	L	L	H	L	L	H	L	H	X	X	X	X	X	X	H	NC	NC	■	■
H	L	L	H	L	L	H	H	L	X	X	X	X	X	X	H	NC	■	■	■
H	L	L	H	L	L	H	H	H	X	X	X	X	X	X	H	■	■	■	■
H	L	L	L	H	H	H	X	X	X	X	X	X	X	X	X	D	K	B	E
H	L	L	L	L	L	H	L	L	X	X	X	X	X	X	L	D	K	B	E
H	L	L	H	H	H	H	X	X	X	X	X	X	X	X	X	■	■	■	E

X=Don't care
NC=No change from previously displayed characters
■=all dots/segments on at half brightness

Figure 5. Tables—Loading Data and Loading Cursor

If the user does not wish to use the cursor function, the cursor enable (CUE) can be tied low to disable the cursor function. For a flashing cursor, simply pulse the CUE line after cursor data has been stored.

General Design Considerations

Using Positive true logic, address order is from right to left. For left to right address order, use the "ones complement" or simple inversion of the addresses.

For systems with only a 6-bit (abbreviated ASCII) code format, Data Line D6 cannot be left open. Data D6 must be the complement of Data Line D5.

A "display test" or "lamp test" function can be realized by simply storing a cursor into all digits.

Because of the random state of the cursor RAM after power up, if the cursor function is to be used, it will be necessary to clear cursors initially to assure that all cursor memories contain its zero state. This is easily accomplished with the $\overline{\text{CLR}}$ input.

When using the 2416 on a separate display board having more than 6 inches of cable length, it may be necessary to buffer all inputs. This is most easily achieved with Hex

non-inverting buffers such as the 74365. The object is to prevent transient current in the protection diodes. The buffers should be located on the display board near the displays.

Local power supply bypass capacitors are also needed in many cases. These should be 6 or 10 volt, tantalum type having 10 µF or greater capacitance. Low internal resistance is important due to current steps which result from the internal multiplexing of the displays.

If small wire cables are used, it is good engineering practice to calculate the wire resistance of the ground plus the +5 volt wires. More than 0.1 volt drop, (at 25 mA per digit worst case) should be avoided, since this loss is in addition to any inaccuracies or load regulation limitations of the power supply.

The 5-volt power supply for the displays should be the same one supplying V_{CC} to all logic devices which drive the display devices. If a separate supply must be used, then local buffers using hex non-inverting gates should be used on all displays inputs and these buffers should be powered from the display power supply. This precaution is to avoid logic inputs higher than display V_{CC} during power up or line transients.

Interfacing the 2416

A general and straightforward interface circuit is shown in Figure 6 using the DL 2416T, but any 2416 display can be used interchangeably in these examples (also applies to Figures 7, 8, and 9). This scheme can easily interface to µP systems or any other systems which can provide the seven data lines, appropriate address and control lines.

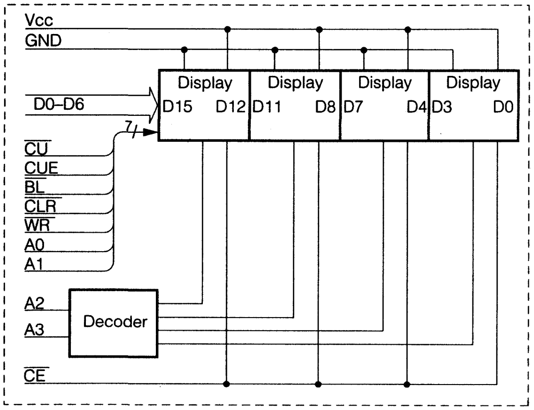


Figure 6. General Interface Circuit

Parallel I/O

The parallel I/O device of a microprocessor can easily be connected to the circuit in Figure 6. One eight bit output port can provide the seven input data bits and the cursor (CU). Another eight bit output port can contain the address and chip enable information and the other control signals.

Figure 7 illustrates a 16-character display with an 8080 system using the 8255 programmable peripheral interface I/O device. The following program will display a simple 16-character message using this interface.

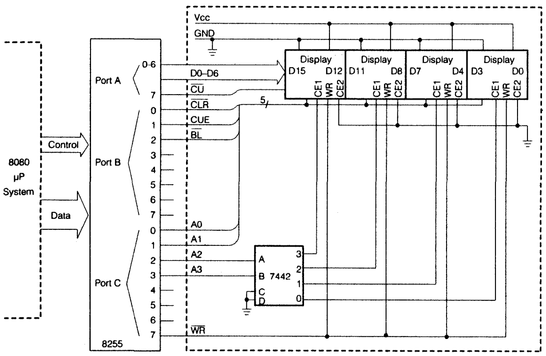


Figure 7. 16-Digit parallel I/O system

Program for 16-Character Message

INT:	MVI A,80H OUT CONTROL	;CONTROL DATA MODE ;LOAD CONTROL REGISTER
CUSR:	MVI A,00H OUT PORT A MVI B, 0FH	;CLEAR CURSOR DATA ;LOAD DATA PORT ;SET CHARACTER COUNTER
CUSRI:	MOV A, B CALL DSPWT DCR B JNZ CUSRI MOV A, B CALL DSPWT MVI A, FFH OUT PORT B	; ;WRITE SUBROUTINE ;DECREMENT COUNTER ;DIGIT 0? ; ; ;SET DATA FOR CONTROL ;LOAD CONTROL LINES
DISP:	LXI H, TABLE	;SET TABLE ADDRESS

DISP1:	MOV A, M
	
	OUT PORT A
	MOV A, B
	CALL DSPWT
	
	INX H
	
	INR B
	MVI A, 10H
	CMP B
	JNZ DISP1
	HALT
		;MOVE TABLE DATA INTO ACCUMULATOR
		;LOAD DATA PORT
		;
		;LOAD ADDRESS AND CONTROL
		;INCREMENT TABLE ADDRESS
		;INCREMENT COUNTER
		;SET # OF DIGITS
		;
		;16 CHARACTERS?
		;END OF PROGRAM

DSPWT:	ORI F0H OUT PORT C ANI 7FH OUT PORT C ORI F0H OUT PORT C RET	;SET CONTROL BITS OFF ;LOAD CONTROL ;SET WRITE BIT ON ;LOAD WRITE ;SET WRITE BIT OFF ;LOAD CONTROL
TABLE:	DB	;0C3H ;0C9H ;0D4H ;0D3 ;0C1H ;0D4H ;0CEH ;0C1H ;0C6H ;0A0H ;0D3H ;0D4H ;0C7H ;0C9H ;0CCH

I/O or Memory Mapped Addressing

Some designers may wish to avoid the additional cost of a parallel I/O in their system. Structuring the addressing architecture for the 2416 to look like a set of peripheral or output devices (I/O mapped) or RAM's and ROM's (memory mapped) is very easy. Figure 8 shows the simplicity of interfacing to microprocessors, such as 8080, Z80 and 6502 as examples.

The interface with the 6800 microprocessor in Figure 9 illustrates the need for designers to check the timing requirements of the 2416T and the μP. The typical data output hold time is only 30 ns for DBE=Ø2 timing; two inverters in the DBE line are added to increase the data output hold time for compatibility with the 50 nS minimum spec of the DL2416T.

Conclusion

Although other manufacturers' products are used in examples, this application note does not imply specific endorsement, or recommendation or warranty of other manufacturers' products by Siemens.

The interface schemes shown demonstrate the simplicity of using the 2416 with microprocessors. The slight differences encountered with various microprocessors to interface with the 2416 are similar to those encountered when using different RAMs. The techniques used in the examples were shown for their generality. The user will undoubtedly invent other schemes to optimize his particular system to its requirements.

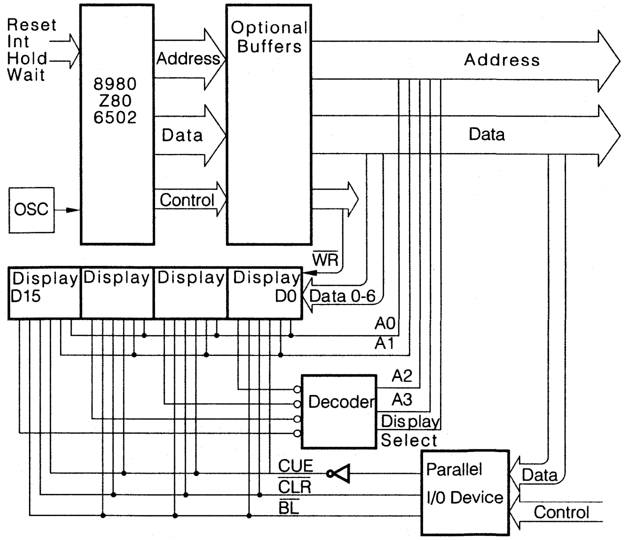


Figure 8. Mapped interface

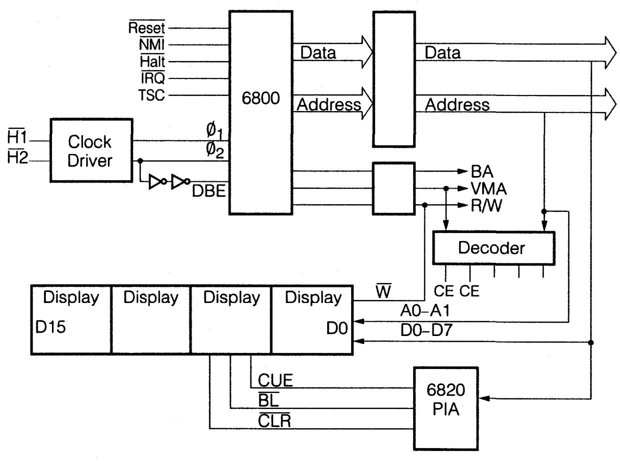


Figure 9. 6800 Microprocessor Interface

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Applying the DL1414/DLX1414* Intelligent Display® Device Appnote 15

by Dave Takagishi

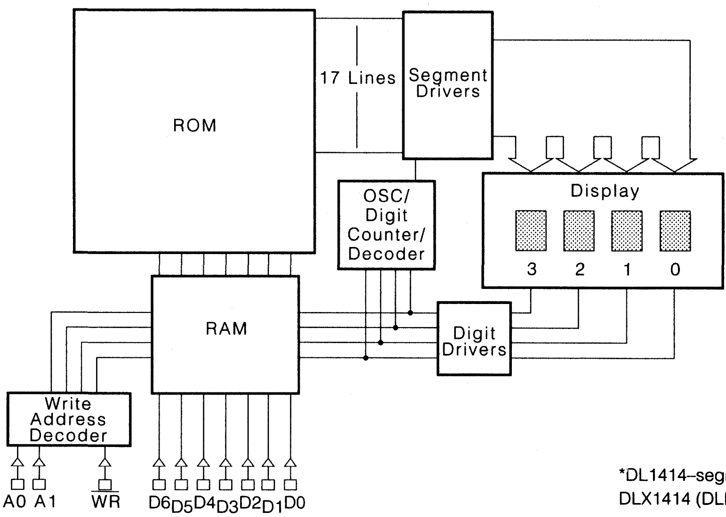
This application note is intended to serve as a design and application guide for users of the DL1414/DLX1414 (the 1414) alphanumeric Intelligent Display. The information presented covers device electrical description and operation, considerations for general circuit design, and interfacing the 1414 to microprocessors.

Electrical & Mechanical Description

General

The internal electronics in these Intelligent Displays eliminates all the traditional difficulties of using multi-digit light emitting displays (segment decoding, drivers and multiplexing). The Intelligent Display also provides internal memory for the four digits. With this approach the user can asynchronously address one of four digits and load new data without regard to the LED multiplex timing.

Figure 1a is a block diagram of the DL1414. The device consists of four 17 segment monolithic LED die and a single CMOS integrated circuit chip. The LED die are magnified to a height of 112 mils by the built-in lenses. The IC chip contains 17 segment drivers, four digit drivers, 64 character ROM, four word x7 bit Random Access Memory, oscillator for multiplexing, multiplex counter/decoder, address decoder and miscellaneous control logic.



*DL1414–segmented display
DLX1414 (DLR/DLG/DLO1414)–dot matrix displays

Figure 1a. Block Diagram–DL1414

Figure 1b is a block diagram of the DLX1414. The device consists of four (5x7) LED arrays and a single CMOS integrated chip. The IC chip contains the column drivers and row drivers, 128 character ROM, four word x7 bit Random Access Memory, oscillator for multiplexing, multiplex counter/ decoder, cursor memory, address decoder, and miscellaneous control logic.

Packaging

Packaging consists of an injection-molded plastic lens which covers five of the six "facesL The assembled and tested substrate (ceramic or "PTF multilayer) is placed within the shell and the entire assembly is then filled with a water-clear IC-grade epoxy.

This yields a very rugged part which is quite impervious to moisture, shock and vibration. Although not "hermetic, the device will easily withstand total immersion in water/ detergent solutions.

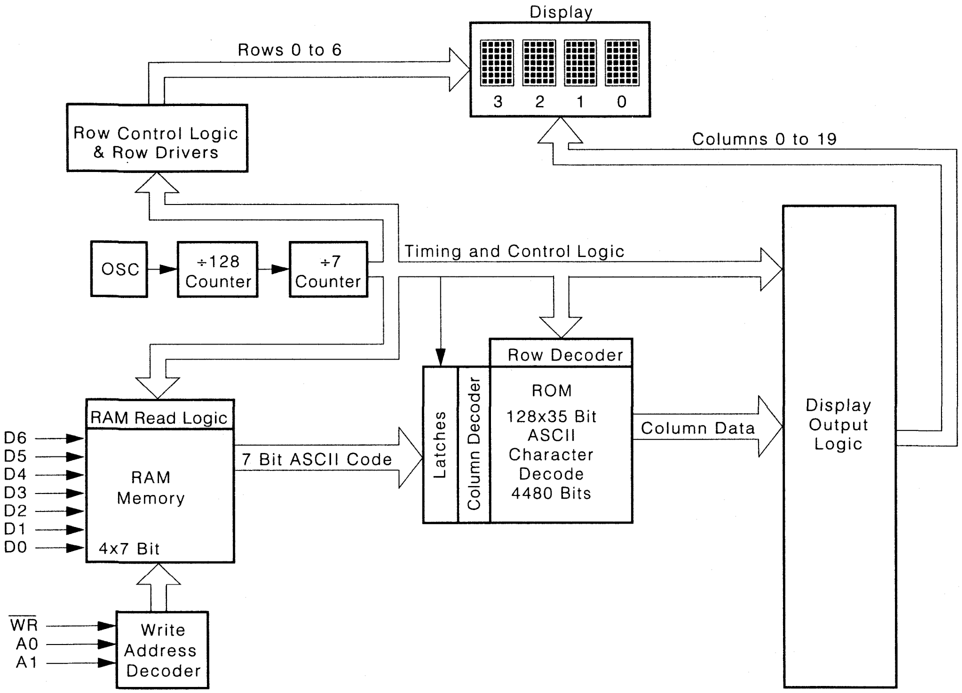
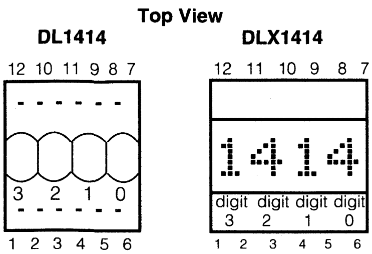


Figure 1b. Block Diagram–DLX1414



Pin	Function	Pin	Function
1	D5 Data Input	7	GND
2	D4 Data Input	8	D0 Data Input (LSB)
3	WR Write	9	D1 Data Input
4	A1 Digit Select	10	D2 Data Input
5	A0 Digit Select	11	D3 Data Input
6	V_{CC}	12	D6 Data Input (MSB)

Figure 2. Top Views and Pin Outs

Electrical Inputs to the 1414

V_{CC}	Positive supply +5 V
GND	Ground
D0–D6	Data lines The seven data input lines are designed to accept the first 64 ASCII characters. See Figure 3a for the character set for DL1414 and Figure 3b for the character set for DLX 1414. (The DL1414 interprets all undefined codes as a blank).
A0, A1	Address Lines The address determines the digit position to which the data will be written. Address order is right to left for positive-true logic.
$\overline{WR}$	Write (Active Low) Data and address to be loaded must be present and stable before and after the trailing edge of write. (See data sheet for timing info).

Operation

Multiplexed display systems sequentially read and display data from a memory device. In synchronous systems, control circuitry must compare the location of data to be read to the location or position of new data to be stored or displayed, i.e., synchronize before a Write can be done. This can be slow and cumbersome.

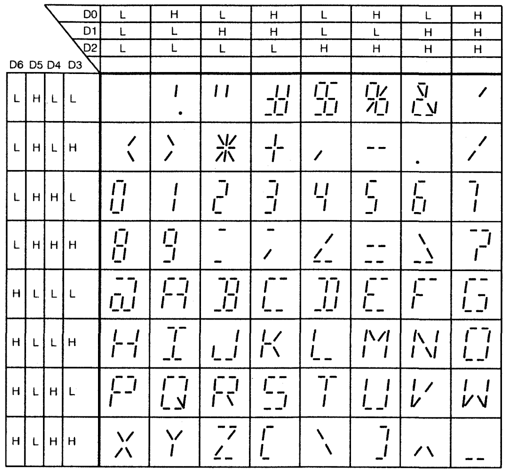
Data entry in Intelligent Displays is asynchronous and may be done in any random order. Loading data is similar to writing into a RAM. Each digit has its own memory location and will display until replaced by another code.

The waveforms in Figure 4 demonstrate the relationships of the signals required to generate a Write cycle. (Check individual data sheet for minimum values.) As can be seen from the waveforms, all signals are referenced from the rising or trailing edge of Write.

General Design Considerations

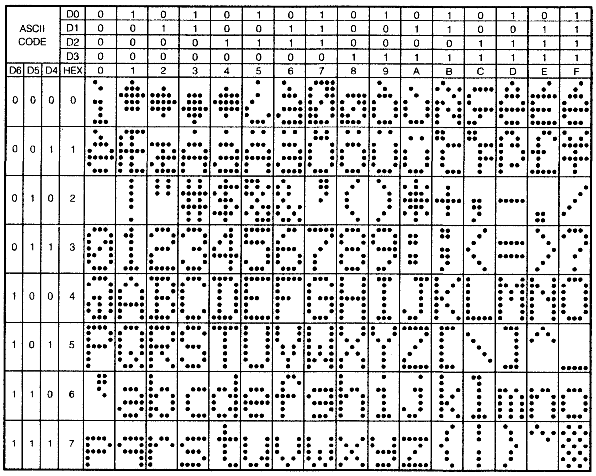
Using positive true logic, address order is from right to left. For left to right address order, use the ones complement or simple inversion of the addresses.

For systems with only a 6-bit (abbreviated ASCII) code format, Data Line D6 cannot be left open. Data D6 must be the complement of Data Line D5.



All other input codes display "blank"

Figure 3a. Character Set–DL1414



1. High=1 level. 2. Low=0 level. 3. Upon power up, device will initialize in a random state.

Figure 3b. Character Set–DLX1414

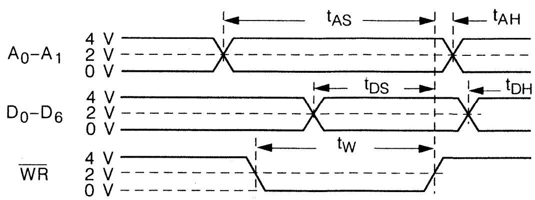


Figure 4. Write Cycle Waveform

When using the 1414 on a separate display board with more than 6 inches of cable length, it may be necessary to buffer all inputs. This is most easily achieved with Hex non-inverting buffers such as the 74365. The object is to prevent transient current in the protection diodes. The buffers should be located on the display board near the displays.

Local power supply bypass capacitors are also needed in many cases. These should be 6 or 10 volt, tantalum type with 10 µF or greater capacitance. Low internal resistance is important due to current steps which result from the internal multiplexing of the displays.

If small wire cables are used, good engineering practice is to calculate the wire resistance of the ground plus the +5 volt wires. More than 0.1 volt drop, (at 25 mA per digit worst case) should be avoided, since this loss is in addition to any inaccuracies or load regulation limitations of the power supply.

The 5-volt power supply for the displays should be the same one supplying V_{CC} to all logic devices which drive the display devices. If a separate supply must be used, then local buffers using hex, non-inverting gates should be used on all inputs and these buffers should be powered from the display power supply. This precaution is to avoid logic inputs higher than display V_{CC} during power up or line transients.

Interfacing the 1414

A general and straightforward interface circuit is shown in Figure 6 (any 1414 display can be used interchangeably in Figures 8, 9, and 10). This scheme can easily interface to LP systems or any other systems which can provide the seven data lines, appropriate address and control lines.

The 1414 does not have a chip enable input; therefore each display in a system requires its Write pulse be gated with appropriate address signals. Figure 7a shows the use of a 74154 decoder (4 lines to 16 lines) for up to a 64 character display. Using the G1 input for display select (address select in a memory mapped system) and the G2 input to gate the Write signal. Another approach (Figure 7b and 7c) which minimizes logic for a 16 or 32 digit display takes advantage of decoding scheme of the 7442 decoder.

Parallel I/O

The parallel I/O device of a microprocessor can be connected easily to the circuit in Figure 6. One eight bit output port can provide the seven input data bits. Another eight bit output port can contain the address and control signals.

	Address		Data Input							Digit	Digit	Digit	Digit
$\overline{WR}$	A1	A0	D6	D5	D4	D3	D2	D1	D0	3	2	1	0
H	X	X	X	X	X	X	X	X	X	NC	NC	NC	NC
L	L	L	H	L	L	L	L	L	H	NC	NC	NC	A
L	L	H	H	L	L	L	L	H	L	NC	L	B	A
L	H	L	H	L	L	L	L	H	H	NC	C	B	A
L	H	H	H	L	L	L	H	L	L	D	C	B	A
L	L	L	H	L	L	L	H	L	H	D	C	B	E
L	H	L	H	L	L	H	L	H	H	D	K	B	E
L	–	–	–	–	–	–	–	–	–	See Character Set			

X=Don't care NC=No change

Figure 5. Data Loading Table

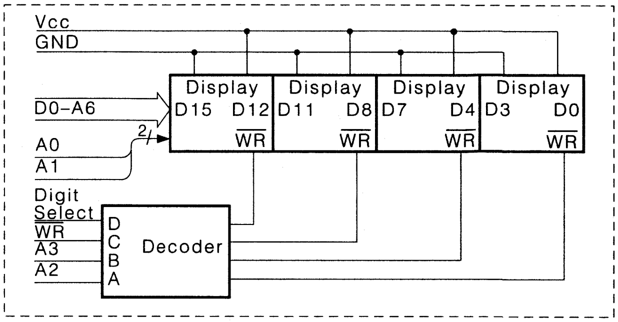


Figure 6. General Interface Circuit

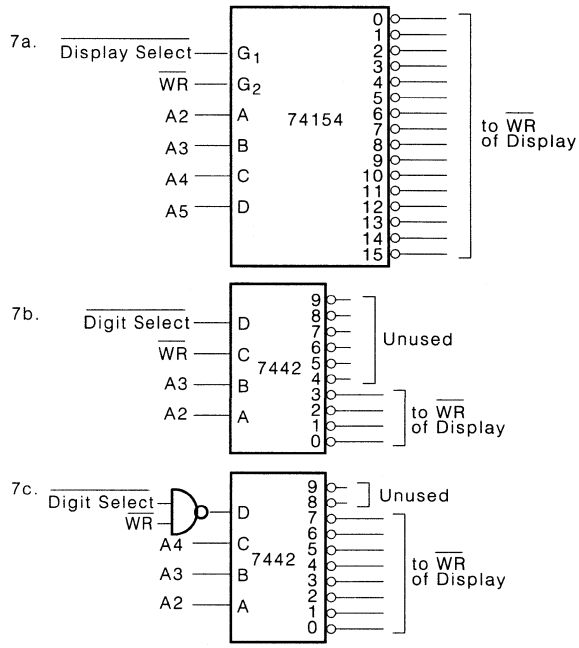


Figure 7. Gating the Write Pulse

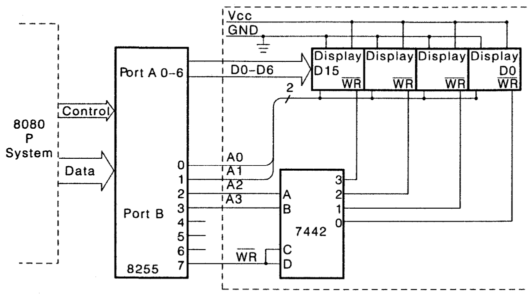


Figure 8. 16-Digit Parallel I/O

Figure 8 illustrates a 16-character display with an 8080 sys tem using the 8255 programmable peripheral interface I/O device. The following program will display a simple 16 character message using this interface.

Program for 16-Character Message

INT:	MVI A,80H OUT CON- TROLMVI B,00H	;CONTROL DATA MODE 0 ;LOAD CONTROL REGISTER ;SET COUNTER =0
DISP:	LXI H, TABLE	;SET TABLE ADDRESS

DISP1:	MOV A,M
	
	OUT PORTA
	MOV A, B
	CALL DSPWT
	
	INX H
	INR B
	MVI A, 10H
	CMP B
	JNZ DISP1
	HALT
		;MOVE TA8LE DATA TO
		ACCU MULATOR
		;LOAD DATA PORT
		
		;LOAD ADDRESS AND
		CONTROL
		;INCREMENT TABLE ADDRESS
		;INCREMENT COUNTER
		;SET # OF DIGITS
		
		;16 CHARACTERS ?
		;END OF PROGRAM

DSPWT:	ORI F0H OUT PORTB ANI 7FH OUT PORTB ORI F0H OUT PORTB RET	;SET CONTROL BITS OFF ;LOAD CONTROL ;SET WRITE BIT ON ;LOAD WRITE ;SET WRITE BIT OFF ;LOAD CONTROL
TABLE:	DL DB DB DB DB DB DB DB DB DB DB DB DB DB DB DB	;0C3H ;0C9H ;0D4H ;0D3H ;0C1H ;0D4H ;0CEH ;0C1H ;0C6H ;0A0H ;0D3H ;0D4H ;0C8H ;0C7H ;0C9H ;0CCH

I/O or Memory Mapped Addressing

Some designers may wish to avoid the additional cost of a parallel I/O in their svstem. Structuring the addressing architecture for the 1414 to look like a set of peripheral or output devices (I/O mapped) or RAMs and ROMs (memory mapped), is very easy. Figure 9 shows the simplicity of interfacing to microprocessors, such as 8080, Z80 and 6502 as examples.

The interface with the 6800 microprocessor in Figure 10 illustrates the need for designers to check the timing requirements of the 1414 and the LP. The typical data output hold time is only 30 ns for DBE=02 timing; two inverters in the DBE line are added to increase the data output hold time for compatibility with the 50 ns minimum spec of the 1414.

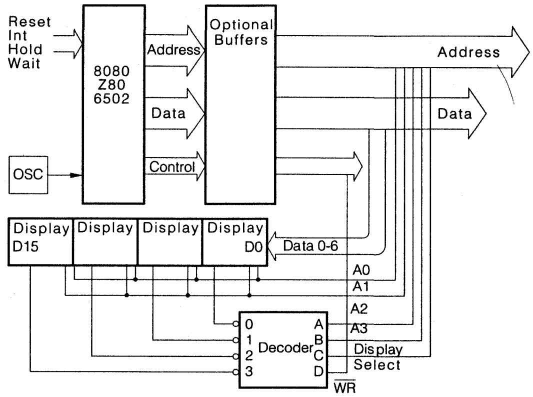


Figure 9. Mapped Iinterface

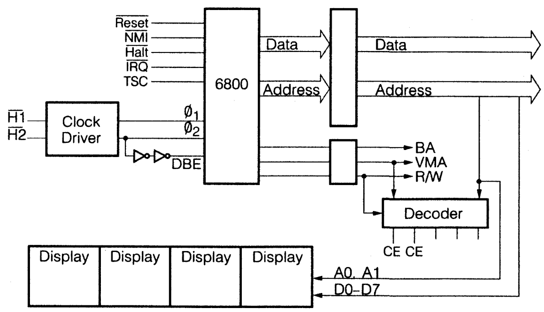


Figure 10. Gating the Write Pulse

Conclusion

Although other manufacturers' products are used in examples, this application note does not imply specific endorsement, or recommendation or warranty of other manufacturer's products by Siemens.

The interface schemes shown demonstrate the simplicity of using the 1414 with microprocessors. The slight differences encountered with different microprocessors to interface with the 1414 are similar to those encountered when usins different RAMs The techniques used in the examples were shown for their generality. The user will undoubtedly invent other schemes to optimize his particular system to its requirements.

SIEMENS

Silicon Photovoltaic Cells, Silicon Photodiodes and Phototransistors Appnote 16

Optoelectronic components are increasingly used in modern electronics. The main fields of application are light barriers for production control and safety devices, light control and regulating equipment like twilight switches, fire detectors and facilities for optical heat supervision, scanning punched cards and perforated tapes, positioning of machine tools (for measuring length, angle and position), of optical apparatus and ignition processes, for signal transmission at electrically separated input and output, as well as conversion of light into electrical energy.

Other applications for optoelectronic components are in the photographic industry for exposure and aperture control and for automatic electronic flashes. IR sound transmission and IR remote control are new modes in the radio industry. Computer diagnosis and LED displays in instrument panels are possible applications in the automotive industry.

Depending upon the application either photovoltaic cells or photodiodes can be used. Photodiodes are preferred wherever amplifiers with high input impedance are required.

Phototransistors are predominantly used in connection with transistor circuits or to drive integrated circuits, whereas photovoltaic cells are preferred to scan large surfaces if a strictly linear relation between light and signal level or optimum reliability is required.

Photovoltaic Cells

Photovoltaic cells are active two poles with a comparably low resistance that has its cause in the voltage of the voltaic cell, which may only be some tenth of a volt. For practical application, this characteristic requires special attention.

The open circuit voltage (V_L) rises almost logarithmically as a function of the illuminance, and particularly with planar photovoltaic cells, reaches high values already at very low illuminances. It is independent of the size of the photovoltaic cell.

The short circuit current (I_K) increases linearly with the illuminance and is proportional to the size of the exposed photosensitive area at uniform illuminance.

The maximum energy of the photovoltaic cell is yielded in a load resistance (R_L) of approximately V_L/I_K

Practical short circuit operation and thus proportionality between optical and electrical signal is given at load resistance up to $V_L/2\ I_K$ This relation can be applied to an open circuit voltage of ≥100 mV.

In any type of application the highest value of I_K has to be used. A simple way to determine the load resistance required is to measure V_L and I_K at given illumination conditions, irrespective of the radiation source.

If the voltage yielded by the photovoltaic cell is insufficient, it can also be used in diode operation at reverse voltages up to 1 volt, however the flowing dark current has to be taken into consideration.

The rise time of a signal voltage delivered to a load resistor by the voltaic cell primarily depends on the operating conditions. There are two distinctive borderline cases:

1. Load resistor smaller than the matching resistor (tendency toward short circuit operation).
2. Load resistor larger than the matching resistor (tendency to open circuit operation).

In case #1 the photovoltage rise is analogous to the charging of a capacitor via a resistor from a constant voltage source. In photovoltaic cells the junction capacitance Cj must be charged. The rise occurs by the time constant $r=R_L \bullet C_j$, R_L being the load resistor (the low ohmic resistance of the photovoltaic cell is considered negligible).

In case #2 the photovoltage rise is similar to the charging of a capacitor by a constant current mode. The rise time, t, of the photovoltage follows the equation:

$$T_r = \frac{V_P \times V_J}{I_K}$$

I_K is the short circuit current under given illumination conditions. This relation only holds true for values of V_P less than 80% of the final value of the open circuit voltage.

The principal characteristic of the rise time of photovoltaic cells is shown in Figure 1.

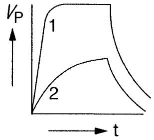


Figure1. Rise Time of Photovoltaic Cell

Case #1: Rise time according to the equation

$$V_P = I_K \bullet R_L \bullet \left(1 - e^{-\frac{t}{R_L \bullet C_j}}\right)$$

Time constant $r = R_L \bullet C_j$

Case #2: Rise time $t_r = \frac{V_P \bullet C_j}{I_K}$

fall time in both cases $\tau = R_L \bullet C_j$

Modulation transients can, under certain conditions, lead to a modification of the above diagram.

E.g. At very low time constants (particularly in short circuit operation) the actual pulse shape of the short circuit current that deviates from an ideal square pulse has to be noted. See diagram.

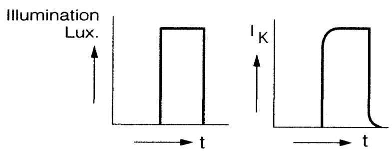


Figure 2. Pulse Shapes of Short Circuit Current

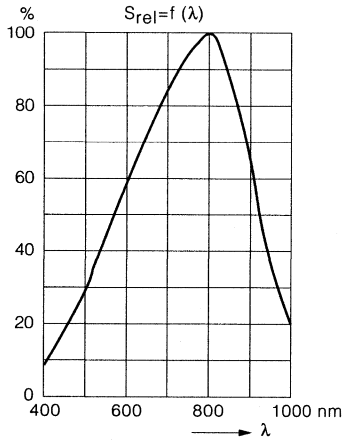


Figure 3. Relative Spectral Sensitivity

Silicon Photodiodes

These photodiodes have a PN junction poled by a reversed bias. The capacitance which decreases with a growing reverse voltage reduces the switching times. The PN junction is of easy access to the light.Without illumination a very small reverse current flows, the socalled darl current. Light falling onto the surrounding of the PN junction generates charge carrier pairs there that lead to an increase of the reverse current. This photocurrent is proportional to the illuminance. Therefore, photodiodes are particularly well suited for quantitative light measurements. The planar technique has 2 essential advantages: The dark currents are considerably smaller than for comparable photo electric components in non-planar technique. This leads to a reduction of the current noise and thus to a decisive improvement of the signal/ noise ratio.

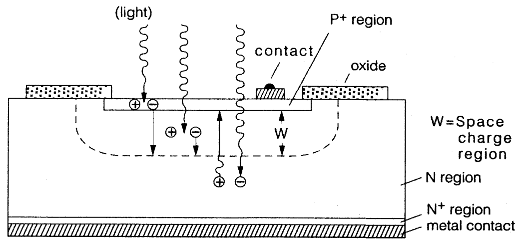


Figure 4. Photons of different wavelengths (blue, red, infrared)

Figure 4 shows the basic design of a photodiode. The limit of the space charge region is indicated by a dashed line.

Without illumination only a small dark current (I_D) flows through the PN junction as a result of thermally generated carriers.

With light, additional charge carrier pairs (hole electron pairs) are generated in the P and N region by the radiation quantum (internal photo effect). Carriers originating in the space charge region are immediately extracted because of the electrical field present there, i.e. the holes in the P and the electrons in the N direction. Carriers from the remaining field must first diffuse into the space charge region in order to be separated there. If holes and electrons recombine before, they do not contribute to the photocurrent. Thus, the photocurrent (I_P) is a combination of the drift current of the space charge region and the diffusion current of the P and N area.

I_P is proportional to the incident radiation intensity. Since I_D is very small for diodes, it can be neglected in the equaton $I_P = I_P + I_D$. Subsequently one gets a linear correlation between I_P and the incident radiation intensity over a very wide range.

Diodes with a small space charge width are termed PN diodes; diodes with a large space charge width, PIN diodes.

PN diodes have the diffusion current as the dominating part of the photocurrent; for PIN diodes, it is the drift current.

As the capacitance of the space charge width (W) is inversely proportional, the PIN diode is characterized by a smaller capacitance than a PN diode of identical surface. The capacitance of (most of) the diodes reads:

$$C_D \sim \sqrt{\frac{N}{D}}$$

The less the doping N of the basic material and the higher the applied voltage V, the lower the capacitance.

Figure 5 shows the capacitance as function of the voltage for a PIN diode, e.g. BPY 12.

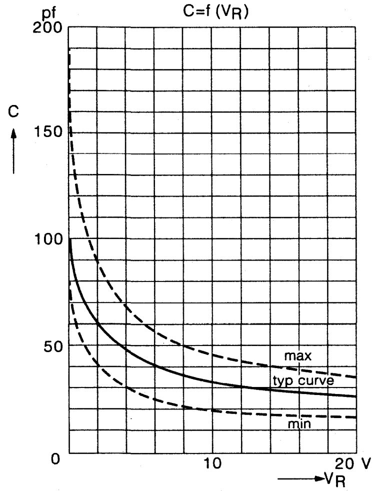


Figure 5. Junction Capacitance versus Reverse Voltage

Silicon Phototransistors

The introduction of the planar technique allows to produce phototransistors of small dimensions. They are used as photoelectric detectors in control and regulating devices. The photoelectric transistors are excellently suited as receivers for incandescent lamp light, as their maximal photosensitivity lies near the infrared limit of the light wave spectrum.

In its mode of operation a photoelectric transistor corresponds to that of a photodiode with built-in amplifier. It has a 100 to 500 times higher photosensitivity than a comparable photoelectric diode.

The photoelectric transistor is preferably operated in an emitter circuit and acts similar to an AF transistor.

Unilluminated, only a small collector-emitter leakage current flows. It amounts to approximately $I_d = B \bullet I_{CBO}$, B standing for the current amplification and I_{CBO} for the reverse current of the base diode.

At illumination the reverse current of the base diode (I_{CBO}) increases by the photocurrent I_P'. Thus, one receives for the photocurrent $I_P \sim B(I_{CBO} + I_P')$.

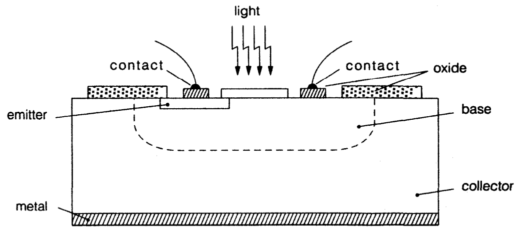


Figure 6. Phototransistor Design

Consequently, the photocurrent of a transistor is a function of the photocurrent I_P' of the base diode and the current amplification B. As B cannot be increased indefinitely, try for as high as possible photosensitivity of the base diode.

Figure 6 shows the design of a phototransistor. The emitter and base leads are affixed laterally to make the base diode most easily accessible to light. The large collector zone ensures that the most possible radiation quanta are absorbed there and will contribute to the photocurrent.

Contrary to a photodiode, a linear interconnection between the incident radiation intensity and the photocurrent (I_P) exists only in a small region, since the current gain B depends on the current. Figure 7 shows typical current voltage characteristics of a phototransistor.

Since the reverse current (I_{CBO}) of the base diode is amplified in the same way as the photocurrent (I_P), the signal/noise ratio of the phototransistor is the same as that of the photodiode.

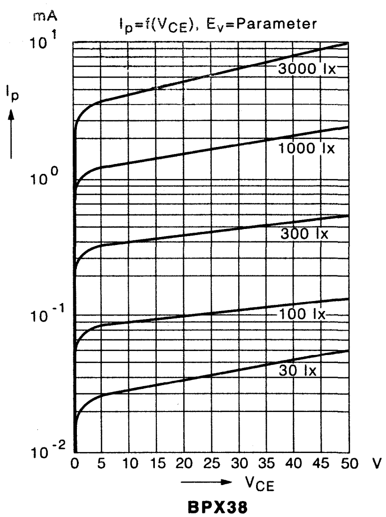


Figure 7. Photocurrent versus Collector-Emitter Voltage

For versatile applications, special type phototransistors are available. BPY 62, BPX 43, BP 101 and BP 102 requiring no lens on the receiver side are suitable for general applications.

BPY 62 is outstanding for a higher cut off frequency, BPX 43 for a higher photosensitivity.

For an application requiring a lens on the detector side. use the BPX 38. The flat window of the BPX38 makes a precise reproduction of the focal spot on the photosensitive surface of a transmitter system possible. Because of the larger system surface, the adjustment and alignment of the transistor case to the light emitter causes less difficulties.

Of the types mentioned, the user may preset the operating point of the phototransistor by wiring the base leads. The rapidity of response may thus be increased and the photosensitivity reduced. A fixed bias can reverse the phototransistor. Coincidence circuits can be achieved by scanning this bias.

The phototransistor BPY 61 meets the requirement for high packing density. It is enclosed in a miniature glass case of 13 mm x 2.1 mm Ø and its photosensitivity is by the factor 500 to 1000 higher than small surface silicon photovoltaic cells. Also the BPX 62 in a micro ceramic case can be used on PC boards at minimum space requirements. The tolerance range of light sensitivity is subdivided into four sensitivity groups. There is no base contact. Light is the controlling element which produces a correspondingly high collector current via the emitter-base path of the transmitter system, multipiied by the factor of the current gain. The rise and fall times depend on the illuminance and decrease with rising intensity.

Main applications are scanning of binary coded discs, films and punched cards.

Under limited mounting conditions the following amplifier must often be connected by relatively long leads. There is only little danger of interference pickup since a sufficiently large signal to noise ratio is ensured by high photoelectric currents.

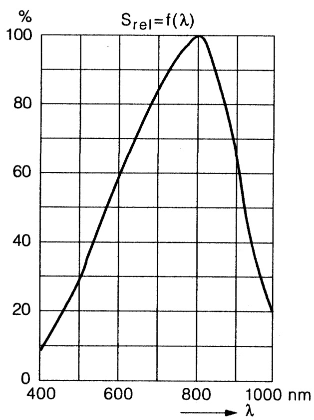


Figure 8. Relative Spectral Sensitivity

Mounting Instructions for Silicon Voltaic Cells and Photodiodes, Open Design without Casing

As silicon is an inherently brittle material, the photoelectronic component should be shielded from pressure or tension. Contact points are particularly vulnerable. Should tension come to bear on the solid wire leads, which for technological reasons are alloyed to a very thin P layer, it should only be parallel to the surface and must not exceed 200 p (pond). Leads may only be bent 3 mm off the outer edge of the photoelectric component. Photoelectric components can be cemented onto metallic or plastic supports but the expansion coefficient of the material has to be considered to prevent mechanical strain between support and photoelectric component at change of temperature. An epoxy resin is to be used to cement or encapsulate the photoelectric component. It has to be colorless and should not grow darker with time. After curing, the epoxy resin must not have any gas occlusions (filter effect).

The epoxy resin EPICOTE 162(1) together with the hardener LAROMIN-C 60(2) are well suited encapsulating photoelectric components. 100 weight parts EPICOTE 162, 38 weight parts LAROMIN-C 260 are to be mixed well and rerain workable for about 30 minutes. After 30 minutes the epoxy becomes viscid. All material to be encapsulated has to be dry, dust-free and grease-free. Should bubbles form after the encapsulation it is advisable to raise the curing process temperature to 100°C for a short time. Raising the temperature makes the bubbles come to the surface and burst. The normal curing temperature lies between 60 and 80°C. The curing time is one hour, it lessens with higher temperature. When working with epoxy great care should be taken that neither the resin nor the hardener touches the skin. The quick binding glue SICOMET 85(3) proves adequate to cement open-design Si diodes or photovoltaic cells. The light sensitive surface of photovoltaic cells are coated with a protective lacquer and should not be contaminated while cementing.

1) Registered trademark (Shell Chemical)

2) Registered trademark (BASF)

3) Registered trademark (Sichel-Werke, Hannover)

SIEMENS

Applying the DLX 3416* Intelligent Display® Device Appnote 17

by Dave Takagishi

This application note is intended to serve as a design and application guide for users of the DLX3416 (referred to as 3416 hereafter) alphanumeric Intelligent Displays. This appnote also covers device electrical description and operation, considerations for general circuit design, and interfacing the 3416 to microprocessors. Refer to the specific data sheet and other Siemens Appnotes for more details.

Electrical & Mechanical Description

The internal electronics in these Intelligent Displays eliminates all the traditional difficulties of using multi-digit light emitting displays (segment decoding, drivers, and multiplexing). An Intelligent Display also provides internal memory for the four digits. This approach allows the user to asynchronously address one of four digits, and load new data without regard to the LED multiplex timing.

Figure 1 is a block diagram of the DLX3416. The unit consists of four (5x7) LED arrays and a single CMOS integrated chip. The IC chip contains the column and row drivers, 128 character ROM, four word x7 bit Random Access Memory, oscillator for multiplexing, multiplex counter/decoder, cursor memory, address decoder, and miscellaneous control logic.

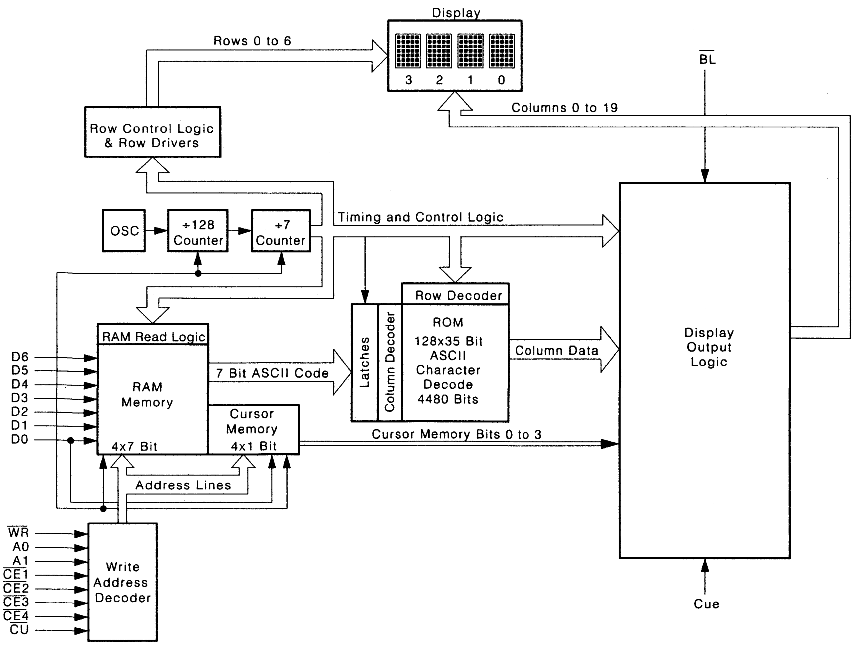
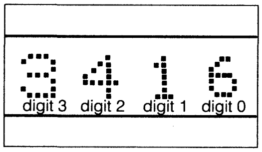


Figure 1. Block Diagram—DLX3416

Packaging

Packaging consists of a transfer molded nylon lens which also serves as an "encapsulation shell" since it covers five of the six "faces." The assembled and tested substrate ("PTF" multilayer), is placed within the shell and the entire assembly is then filled with a water clear IC grade epoxy.

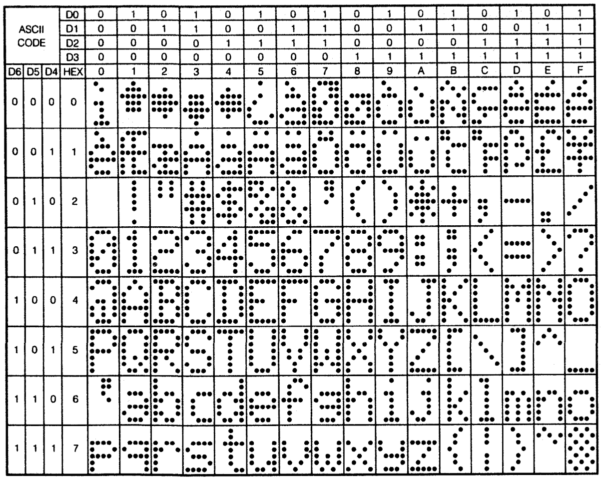
This yields a very rugged part, which is quite impervious to moisture, shock and vibration. Although not "hermetic," the device will easily withstand total immersion in water/detergent solutions.



Pin	Function
1	$\overline{CE1}$ Chip Enable
2	$\overline{CE2}$ Chip Enable
3	$\overline{CLR}$ Clear
4	CUE Cursor Enable
5	$\overline{CU}$ Cursor Select
6	$\overline{WR}$ Write
7	A1 Digit Select
8	A0 Digit Select
9	V_{CC}
10	GND
11	DO Data Input
12	D1 Data Input
13	D2 Data Input
14	D3 Data Input
15	D6 Data Input
16	D5 Data Input
17	D4 Data Input
18	$\overline{BL}$ Display Blank

Electrical Inputs to the 3416

V_{CC}	Positive supply +5 volts
GND	Ground
D0-D6	Data Lines The seven data input lines are designed to accept the first 64 ASCII characters. See Figure 3a for DL3416 character set (The DL3416 interprets all undefined codes as a blank). See Figure 3b for DLX3416 character set.
A0, A1	Address Lines The address determines the digit position to which the data will be written. Address order is right to left for positive-true logic.
$\overline{WR}$	Write (Active Low) Data and address to be loaded must be present and stable before and after the trailing edge of write. (See DL3416, DLX3416 data sheets for timing information).
$\overline{CE1}$, $\overline{CE2}$	Chip Enable (Active High)
$\overline{CE3}$, $\overline{CE4}$	Chip Enable (Active Low) Determines which device in an array will actually accept data. When either or both chip enable is in the high state, all inputs are inhibited.
$\overline{CLR}$	Clear (Active Low) The data RAM and cursor RAM of the DL 3416 will be cleared when held low for 15 mS. The minimum for the $\overline{CLR}$ is 1 mS for the DLX 3416.
CUE	Cursor Enable Activates Cursor function. Cursor will not be displayed regardless of cursor memory contents when cue is Low.
$\overline{CU}$	Cursor Select (Active Low) This input must be held high to store data in data memory and low to store data into the cursor memory.
$\overline{BL}$	Display Blank (Active Low) Blanking the entire display may be accomplished by holding the $\overline{BL}$ input low—not a stored function. When $\overline{BL}$ is released, the stored characters are again displayed. $\overline{BL}$ can be used for flashing or dimming.



Notes: 1. High = 1 level.
2. Low = 0 level.
3. Upon power up, the device will initialize in a random state.

Figure 3b. Character Set—DLX3416

Clear Memory

Clearing of the entire internal four digit memory may be accomplished by holding the clear line ($\overline{CLR}$) low for one complete internal display multiplex cycle, 15 mS minimum for DL 3416, 1 mS for DLX 3416. Less time may leave some data uncleared. $\overline{CLR}$ also clears the cursor memory.

Display Blanking

Blanking the display may be accomplished by loading a blank, space or illegal code into each digit of the display or by using the ($\overline{BL}$) display blank input. Setting the ($\overline{BL}$) input low does not affect the contents of either data or cursor memory. A flashing display can be realized by pulsing ($\overline{BL}$).

Operation

Multiplexed display systems sequentially read and display data from a memory device. In synchronous systems, control circuitry must compare the location of data to be read to the location or position of new data to be stored or displayed, i.e., synchronize before a Write can be done. This can be slow and cumbersome.

Data entry in Intelligent Displays is asynchronous and may be done in any random order. Loading data is similar to writing into a RAM. Each digit has its own memory location and will display until replaced by another code.

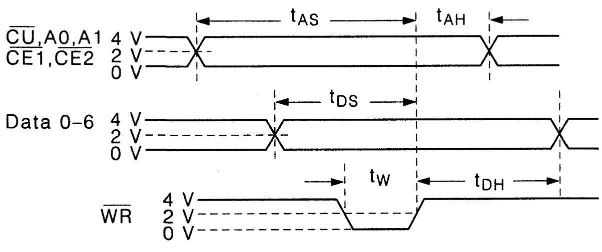


Figure 4. Write Cycle Waveforms

The waveforms of Figure 4 demonstrate the relationships of the signals required to generate a write cycle. (Check individual data sheet for minimum values). As can be seen from the waveforms, all signalsare referenced from the rising or trailing edge of write. edge of write.

Cursor

The DLX3416 cursor function causes all dots to light at 50% brightness. The cursor can be used to indicate the position in the display of the next character to be entered. The cursor is not a character but overrides the display of a stored character. Upon removal of the cursor, the display will again show the character stored in memory.

The cursor can be written into any digit position by setting the cursor enable (CUE) high, setting the digit address (A1, A0), enabling Chip Enable, ($\overline{CE1}$, $\overline{CE2}$), cursor select ($\overline{CU}$), Write ($\overline{WR}$) and Data (D0). A high on data line D0 will place a cursor into the position set by the address A0 and A1. Conversely, a low on D0 will remove the cursor. The cursor will remain displayed after the cursor ($\overline{CU}$) and write ($\overline{WR}$) signals have been removed. During the cursor-write sequence, data lines D1 through D6 are ignored by the 3416.

If the user does not wish to utilize the cursor function, the cursor enable (CUE) can be tied low to disable the cursor function. A flashing cursor can be realized by simply pulsing the CUE line after cursor data has been stored.

General Design Considerations

Using Positive true logic, address order is from right to left. For left to right address order, use the "ones complement" or simple inversion of the addresses.

For systems with only a 6 bit (abbreviated ASCII) code format, Data Line D6 cannot be left open. Data D6 must be the complement of Data Line D5.

A "display test" or "lamp test" function can be achieved by simply storing a cursor into all digits.

Because of the random state of the cursor RAM after power up, if the cursor function is to be used, it will be necessary to clear cursors initially to assure that all cursor memories contain its zero state. This is easily accomplished with the $\overline{CLR}$ input.

When using the 3416 on a separate display board having more than 6 inches of cable length, it may be necessary to buffer all inputs. This is most easily achieved with Hex

non-inverting buffers such as the 74365. The object is to prevent transient current in the protection diodes. The buffers should be located on the display board near the displays.

Local power supply bypass capacitors are also needed in many cases. These should be 6 or 10 volt, tantalum type with 10 µF or greater capacitance. Low internal resistance is important due to current steps which result from the internal multiplexing of the displays.

If small wire cables are used, it is good engineering practice to calculate the wire resistance of the ground plus the +5 volt wires. More than 0.1 volt drop, (at 25 mA per digit worst cast) should be avoided, since this loss is in addition to any inaccuracies or load regulation limitations of the power supply.

The 5 volt power supply for the displays should be the same one supplying V_{CC} to all logic devices which drive the display devices. If a separate supply must be used, then local buffers using hex non-inverting gates should be used on all inputs and these buffers should be powered from the display power supply. This precaution is to avoid logic inputs higher than display V_{CC} during power up or line transients.

Loading Data

$\overline{BL}$	$\overline{CE1}$	$\overline{CE2}$	CUE	$\overline{CU}$	$\overline{WR}$	$\overline{CLR}$	A_1	A_0	D6	D5	D4	D3	D2	D1	D0	Digit 3	Digit 2	Digit 1	D
L	X	X	X	H	X	H	X	X	X	X	X	X	X	X	X	Blank			
H	H	X	L	H	X	H	X	X	X	X	X	X	X	X	X	Previous Characte			
H	X	H	L	H	X	H	X	X	X	X	X	X	X	X	X	NC	NC	NC	
H	X	X	L	H	H	H	X	X	X	X	X	X	X	X	X	NC	NC	NC	
H	L	L	L	H	L	H	L	L	H	L	L	L	L	L	H	NC	NC	NC	
H	L	L	L	H	L	H	L	H	H	L	L	L	L	H	L	NC	NC	B	
H	L	L	L	H	L	H	H	L	H	L	L	L	L	H	H	NC	C	B	
H	L	L	L	H	L	H	H	H	H	L	L	L	H	L	L	D	C	NC	
H	L	L	L	H	L	H	L	L	H	L	L	L	H	L	H	D	C	B	
H	L	L	L	H	L	H	H	L	H	L	L	H	L	H	H	D	K	B	
H	L	L	L	H	L	H	–	–	–	–	–	–	–	–	–	See Character S			

Loading Cursor

H	L	L	L	H	X	H	X	X	X	X	X	X	X	X	X	Normal Data Entr			
H	L	L	H	H	H	H	X	X	X	X	X	X	X	X	X	Enable Previous Stored Cursors			
H	L	L	H	L	L	H	L	L	X	X	X	X	X	X	H	NC	NC	NC	
H	L	L	H	L	L	H	L	H	X	X	X	X	X	X	H	NC	NC	■	
H	L	L	H	L	L	H	H	L	X	X	X	X	X	X	H	NC	■	■	
H	L	L	H	L	L	H	H	H	X	X	X	X	X	X	H	■	■	■	
H	L	L	L	H	H	H	X	X	X	X	X	X	X	X	X	D	K	B	
H	L	L	L	L	L	H	L	L	X	X	X	X	X	X	L	D	K	B	
H	L	L	H	H	H	H	X	X	X	X	X	X	X	X	X	■	■	■	

X = Don't care
NC = No change from previously displayed characters
■ = all dots/segments on at half brightness

Figure 5

Interfacing the 3416

A general and straightforward interface circuit is shown in Figure 6. This scheme can easily interface to µP systems or any other systems which can provide the seven data lines, appropriate address, and control lines.

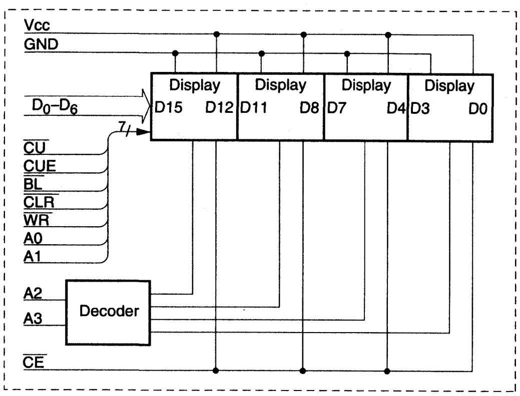


Figure 6. General Interface Circuit

Parallel I/O

The parallel I/O device of a microprocessor can easily be connected to the circuit in Figure 6. One eight bit output port can provide the seven input data bits and the cursor (CU). Another eight bit output port can contain the address and chip enable information and the other control signals.

Figure 6. General Interface Circuit

INIT:	MVI A,80H OUT CONTROL	;CONTROL DATA MODE 0 ;LOAD CONTROL REGISTER
CUSR:	MVI A,00H OUT PORT A MVI B, 0FH	;CLEAR CURSOR DATA ;LOAD DATA PORT ;SET CHARACTER COUNTER
CUSRI	:MOV A, B CALL DSPWT DCR B JNZ CUSRI MOV A, B CALL DSPWT MVI A, FFH OUT PORT B	; ;WRITE SUBROUTINE ;DECREMENT COUNTER ;DIGIT 0? ; ; ;SET DATA FOR CONTROL ;LOAD CONTROL LINES
DISP:	LXI H, TABLE	;SET TABLE ADDRESS

DISP1	MOV A, M
	OUT PORT A
	MOV A, B
	CALL DSPWT
	INX H
	INR B
	MVI A, 10H
	CMP B
	JNZ DISP1
	HALT
		;MOVE TABLE DATA INTO ACCUMULATOR
		;LOAD DATA PORT
		;
		;LOAD ADDRESS AND CONTROL
		;INCREMENT TABLE ADDRESS
		;INCREMENT COUNTER SET # OF DIGITS
		;
		;16 CHARACTERS?
		;END OF PROGRAM

DSPWT	:ORI F0H OUT PORT C ANI 7FH OUT PORT C ORI F0H OUT PORT C RET	;SET CONTROL BITS OFF ;LOAD CONTROL ;SET WRITE BIT ON ;LOAD WRITE ORI F0H ;LOAD CONTROL
TABLE:	DB DB DB DB DB DB DB DB DB DB DB DB DB DB DB DB	;0C3H ;0C9H ;0D4H ;0D3H ;0C1H ;0D4H ;0CEH ;0C1H ;0C6H ;0A0H ;0D3H ;0D4H ;0C8H ;0C7H ;0C9H ;0CCH

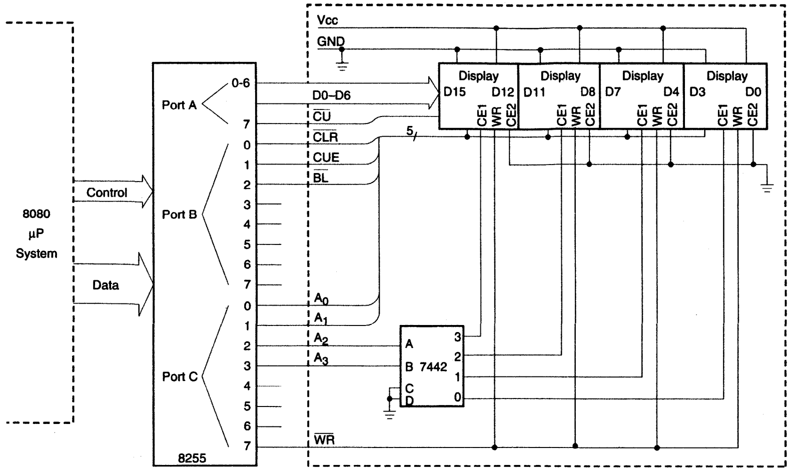


Figure 7. 16-Digit Parallel I/O System

Figure 7 illustrates a 16 character display with an 8080 system using the 8255 programmable peripheral interface I/O device. The following program will display a simple 16 character message using this interface.

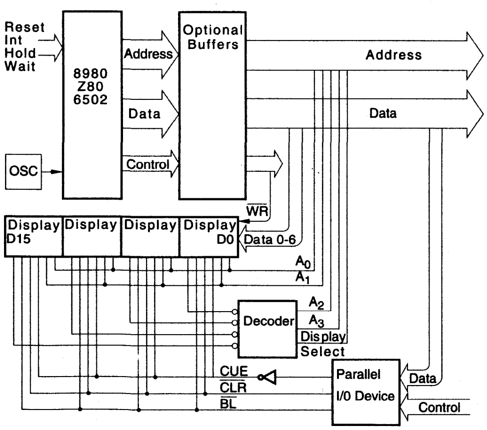


Figure 8. Mapped interface

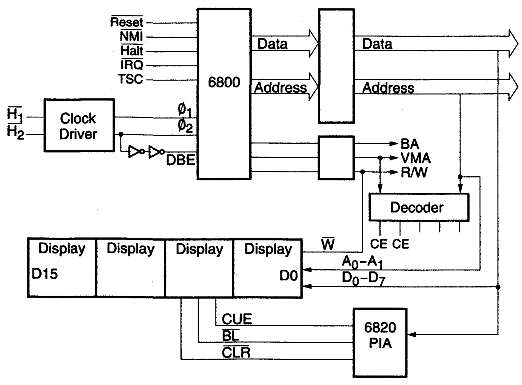


Figure 9. Interface with 6800 Microprocessor

I/O or Memory Mapped Addressing

Some designers may wish to avoid the additional cost of a parallel I/O in their system. Structuring the addressing architecture for the 3416 to look like a set of peripheral or output devices (I/O mapped) or RAM's and ROM's (memory mapped) is very easy. Figure 8 shows the simplicity of interfacing to microprocessors, such as 8080, Z80 and 6502 as examples.

The interface with the 6800 microprocessor in Figure 9 illustrates the need for designers to check the timing requirements of the 3416 and the µP. The typical data output hold time is only 30 ns for DBE=Ø2 timing; two inverters in the DBE line are added to increase the data output hold time for compatibility with the 50 nS minimum spec of the 3416.

Conclusion

Note that although other manufacturers' products are used in examples, this application note does not imply specific endorsement, or recommendation or warranty of other manufacturer's products by Siemens.

The interface schemes shown demonstrate the simplicity of using the 3416 with microprocessors. The slight differences encountered with various microprocessors to interface with the 3416 are similar to those encountered when using different RAMs. The techniques used in the examples were shown for their generality, and any display of this family are interchangeable in these examples. The user will undoubtedly invent other schemes to optimize his particular system to its requirements.

SIEMENS

Guidelines for Handling and Using Intelligent Display® Devices Appnote 18

by Malcolm Howard and Dave Takagishi

IMPORTANT!

This appnote contains vital information for optimum design and performance of Intelligent Displays.

Siemens Optoelectronics Intelligent Displays and Programmable Displays are one, four, eight, or ten digit LED display modules with 16 or 17 segment or dot matrix fonts and onboard CMOS integrated circuits. The CMOS chip provides segment decoding, drivers, multiplexing and memory for easy interfacing to most microprocessors

This application note is a guide for the design and handling considerations of Intelligent and Programmable Displays.

System Design Consideration

In the practical circuit (i.e., design of PCB, etc.) the voltage to any input must never exceed the power inputs (i.e., $GND<V_{IN}< V_{CC}$). If these conditions are not met, then malfunction, or at worst, device destruction can occur. The most common cause of these conditions is circuit noise on the inputs and transient power supply changes.

Good Circuit Layout

The principles of good circuit layout are identical to any logic circuitry, but the deviation tolerance of MOS devices is much less than that of bipolar logic. Keeping the signal path lengths as short as possible is important to reduce the coupling effect between signals.

Buffering

Although the use of parallel tracking is usually considered good design practice, avoid PCB designs which allow an interconnection track to run parallel to another. This is particularly true if one of the tracks is a high power bus when the fluctuations of power supply current can cause inductive or capacitive coupled charge onto an adjacent input signal.

Possibly the worst example of parallel tracking is the ribbon cable. While physically neat and convenient, ribbon cables can be electrically destructive for MOS circuits, It is often necessary, because of the very nature of Intelligent Displays, to use a ribbon cable from the CPU board to the display assembly board. In those circumstances for PCB trace lengths plus cable lengths over 15.5 cm (6 inches), use a buffer for each input. This is especially true for noisy systems which have motors, relays, etc. The buffers should be physically as close as possible to the displays, maintaining a minimum distance between their outputs and the display inputs. Long cables can be poor transmission lines for speed pulses. Line drivers, line receivers, or Schmitt trigger gates may be required to shape pulses.

Voltage Transients

It has become common practice to provide 0.01 µf bypass capacitors liberally in digital systems. For Intelligent Displays, the emphasis is on adequate decoupling. Like other CMOS circuitry, the Intelligent Display controller chip has a very low power consumption and the usual 0.01 µf capacitor would be adequate were it not for the LEDs. The module can, in some conditions (depending on the displayed characters), use up to 500 mA pk (average, multiplexed). To prevent power supply transients, use capacitors with low inductance and high capacitance at high frequencies, i.e., a solid tantalum or ceramic disc for high frequency bypass. For longer display lengths, distribute the bypass capacitors evenly keeping capacitors as close to display power pins as possible. Do not rely on into the board decoupling; use a 10 µf and a 0.01 µf capacitor for every three or four Intelligent Displays to decouple the displays themselves, at the displays. See Figure 1.

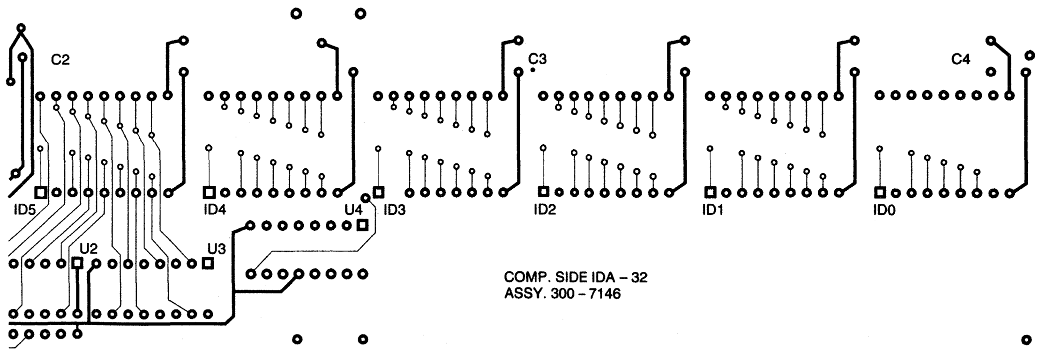


Figure 1. PCB layout of a line DL2416 Intelligent Displays.
Capacitors are spaced evenly and close to the displays with room for additional capacitors if required.

Functional Limitations

Several parameters of an Intelligent/Progammable Display which may affect your design are listed below. While some parameters may not be destructive, some may affect reliability and/or functional operation. (Check latest data sheets.)

1 . The length of *time that all cursors may be lit* (on the DL2416T and DL3416) should be 1 minute max.

1a. No more than 20 LEDs /character for HDSP200XLP, Serial Input Displays.

2. The timing parameters at 25°C will increase (slower) with increased temperature.

3. The timing parameters will decrease (faster) with increased V_{CC}.

Manufacturing Considerations

Handling

The static voltages generated by friction with synthetic materials (i.e., carpets, clothing, device carriers, etc.) are often measured in thousands of volts. Although these static charges usually have little energy, it is sufficient to cause destruction to CMOS circuitry if applied to circuit inputs. Our CMOS circuits have input protection diodes which can minimize their vulnerability to these static voltages, but there is a limit to their protection capabilities. Under certain conditions, static charges can exceed that limit. The most effective protection is to avoid generation of static charges. When static charges are unavoidable, prevent that charge from coming into contact with the device pins.

1. ***Avoid touching the pins; handle the body only.***
2. ***Keep the devices in anti-static tubes or conductive material when transporting.***
3. ***Use conductive and grounded working area*** (conductive flooring, conductive workbench tops, conductive individual wrist straps, etc.).

Intensity Brightness Codes

Display uniformity is a concern when two or more displays are in a system. Siemens has adopted a letter code (indicating a brightness range) to maintain a uniform display. We recommend a single letter code be used per system. Because this may be difficult to always achieve due to yield and delivery, adjacent codes (i.e., D with E or E with F) can be used with minimal problems. Jumping over a code (i.e., D with F) may be noticeable.

Soldering

Because of the plastic housing of the Intelligent Displays, it is necessary to control the solder temperature, soldering time, and soldering distance. A maximum of 260°C for three seconds at a distance greater than 1/16 inch is recommended. An additional requirement during wave soldering: the temperature of the plastic package should not exceed the maximum rated storage temperature of the device type.

Cleaning

Refer to Appnote 19, "Cleaning LED Opto Products."

SIEMENS

Cleaning LED Optoelectronic Products Appnote 19

by Jonathan Wafer

Now that you have selected the proper optoelectronic device for your application and designed the circuitry, the next step is to install the devices. This application note is a cleaning guide for Siemens Optoelectronic products.

Purpose of Cleaning

Removing both flux rosin or resin along with ionic residues after soldering is essential for good product and overall system performance and reliability. Optoelectronic components require special packaging materials with transmissive or reflective optical properties, therefore they must be treated differently than conventional semiconductor devices with respect to cleaning.

Cleaning Processes

Component cleaning or defluxing processes fall into four categories: aqueous, semiaqueous, solvent, and no clean. Both in-line and batch cleaning equipment employ one of the above processes. A brief description of each process, along with approved cleaning solutions from each group, is summarized below. Table 1 lists several cleaning solution suppliers.

Aqueous Cleaning

Siemens Optoelectronics components are compatible with most aqueous cleaning agents. These solutions are usually high pH alkyl amine-based products that also contain surfactants, saponifiers, buffers, and inhibitors. The solution reduces organics to form soaps, followed by a deionized water rinse. In its simplest form, aqueous processing using a deionized water rinse is useful for removing water-soluble flux residues. The following are approved aqueous cleaning agents and their suppliers:

Indusco Chemicals	WL 1000 Aqua Flux Strip
Altos Group	AQ 1534

Semiaqueous Cleaning

Semiaqueous cleaning uses hydrocarbon or citrus extract solutions to solubilize residues followed by a deionized water rinse and dry cycle. Semiaqueous cleaning agents compatible with Siemens Opto products are listed in Table 2 on the following page.

Solvent Cleaning

The most common solvent cleaning technique, vapor degreasing, involves placing parts within a vaporized solvent chamber—condensing the vapor into a liquid solvent and dissolving the soil. Many popular solvents used in this application are CFC 113 azeotropes that face regulation and eventual ban per the 1990 Clean Air Act. Compatibility of these and other solvents with Siemens Opto components is also listed in Table 2.

Conclusion

The list of solvents and cleaning solutions in Table 2 represents a small group of all the available cleaning agents on the market. Others may be compatible, but more likely, most will be incompatible. Usage of non-ozone depleting chemicals (ODCs) is highly recommended for environmental and long term safety reasons.

Siemens does not assume any responsibility for damage caused to products by use of the cleaning agents mentioned above. This application note is only a guide to products that have been found satisfactory when tested under our controlled lab conditions. We recommend that components be evaluated under client specific conditions before committing to use on a production basis.

Table 1. Cleaning Solution Suppliers

Supplier	Product
Allied Signal Inc. Engineered Solvent Systems	Genesolv CFC 113 Azeotropes
E I DuPont de Nemours	Freon CFC 113 Azeotropes Axarel Semiaqueous Cleaners
Petroferm Inc.	BioAct EC7R Terpene Semiaqueous Cleaners
Kyzen Corp.	Ionox Semiaqueous Cleaners

Table 2. Compatbility of Various Cleaning Solutions with Siemens Optoelectronics Products

	Cleaning Agents												
	CFC*					Non-CFC			Semiaqueous				
											Ionox		
Product Type	**TF**	**TE**	**TES**	**TA**	**TMS**	**Ace-tone**	**IPA**	**111 TCA**	**Axarel 38**	**EC7R**	**HC**	**LC**	**MC**
Visible Lamps	S	S	N	N	S	N	S	N	S	S	S	S	S
IR	S	S	N	N	S	N	S	N	S	S	S	S	S
Optocouplers	S	S	N	N	S	N	S	N	S	S	S	S	S
Displays Group 1 HD XXXX DLX413X DLX573X DLX713X PD443X XBG 1000 XBG 48XO	S	S	N	N	S	N	S	N	S	S	N	S	S
Displays Group 2 DL 3XXM/4XXM DL1416 DL1414 DLX1414 HDSP2000XLP DL2416 DLX2416 PDSP211X DL3416 DLX3416 SLX2016 PD243X PD353X SCD558X SCD5510X	S	S	N	S	N	S	N	N	S	S	N	S	S

S – Suitable for use
N – Not suitable for use
* – Denotes ozone-depleting substance. May be regulated by 1990 Clean Air Act.

SIEMENS

Moving Messages Using Intelligent Display® Devices and 8748 Microprocessor Appnote 20

Reprinted from Siemens Design Examples of Integrated Circuits Edition 1980/81

Output and display of texts including an important operator information are not only limited to devices of data processing systems but they are more and more applied in other fields of electronics, e.g. in industrial and consumer as well as control engineering. If data of different kinds (e.g. program results, error indications, decision criteria, test results, etc.) are displayed as moving news, they have a striking effect calling the operator's attention.

The text can easily be read when each character remains for 0.25 s on the display. A special advantage of a moving news panel being controlled by a microcomputer is in that the information can immediately be modified. The described circuit of Figure 1 operates with SAB 8748. Its program memory capacity (EPROM) is 1 KByte and up to 900 characters can be stored. If the microcomputer is replaced by another one incorporating a different program, the information which is to be displayed is also exchanged.

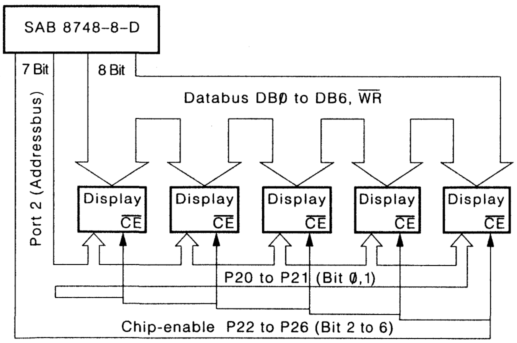


Figure 1.

The described circuit offers the advantage in requiring a minimum of components. The single chip microcomputer SAB 8748 operates in conjunction with an alphanumeric 16 segment LED display DL2416. It incorporates memory decoder and driver.

Hardware

The ASCII coded data is transferred from the SAB 8748 to the display ICs via the bus port (DB0 to DB6) and via the WR-output (strobe). The information at pins P20 and P21 signals at P22 to P26 select the individual ICs via the chip enable input CE1. When one pin of port 1 is connected to ground, the microcomputer supplies the corresponding text. An output of four different texts is possible.

The text may have any length as long as the memory capacity of 900 bytes is not exceeded. There are no additional components required than indicated in the circuit of Figure 2.

Software

The first 100 bytes of the EPROM are reserved for the program. As the program counter cany only be read as data memeory within 256 bytes, additional instructions are necessary (see listing). At the beginning of the program, port 1 is read. If a signal with low level is available at one of the pins, the starting address of the corresponding text is loaded to register 2 (low address) and 3 (high address). Now output registers 20H to 32H have to be filled with blanks. Then the first letter is transfered from text memory to data memory. Now the microprocessor operates in a waiting loop, determining the speed of the moving news. At an oscillator frequency of 3 MHz the timer has an overflow after $^1/_3 \times 10^{-6}$ µs X 15 X 32 X 256=40.96 ms. The moving news text is stepping four times per second after 6 overflows have occurred, that means the 900 characters need in total 3 $^3/_4$ minutes. If the 8 bit word zero (figure 0, not the ASCII character for O) is read as character, the text end is recognized by the program. Therefore a counting is not necessary, that means all characters have been transferred. Now the program returns to read port 1.

The flowchart is shown in Figure 3 .

Components for Circuit 2

1	8 bit single chip microcomputer (1 KByte EPROM, 3 MHz version)	SAB 8748-8-D
5	4 digit alphanumeric LED displays with memory, decoder and driver, (4 mm character height, 16 segments)	DL2416
1	Crystal	3 MHz
4	Push buttons for PC board mounting,	
2	break-make contacts, lateral operation	

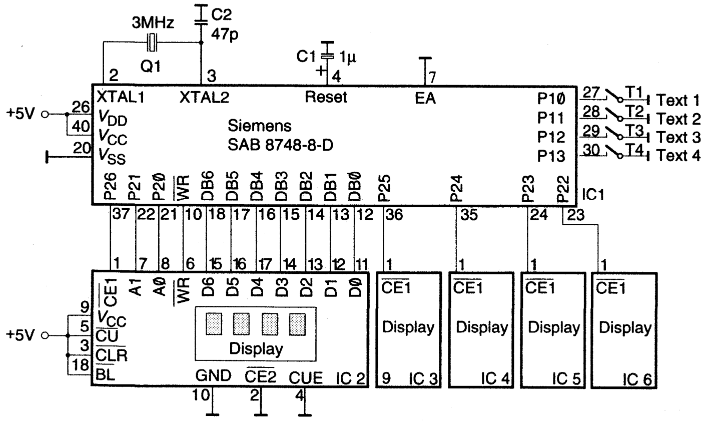


Figure 2.

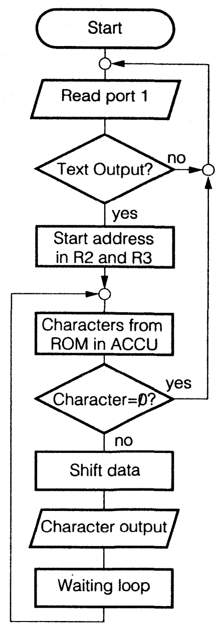


Figure 3. Flowchart

Application Notes 11

SIEMENS
Silver Plated Tarnished Leads
Appnote 21

by Dave Takagishi

This application note will discuss silver tarnish and solderability. Silver plating, as an alternative to gold plating, has excellent electrical conductivity, LED die attach, and wire bonding properties. But tarnished leads can cause soldering difficulties.

Effects of Tarnish

Solderability means the metals or surfaces to be soldered must be types that wili go into solution with tin-lead alloys. When exposed to the atmosphere, all metals form oxides or tarnish of varying degree which reduce the ability of solder alloys to adhere to the metals. Silver tarnish is formed when siiver chemically reacts with sulfur to form silver sulfide (Ag_2S). This tarnish is the reason for poor solderability of silver plated products. However, the amount of tarnish and the kind of solder flux used actually determine the solderability. As the tarnish increases, a more active flux must be used to penetrate and remove the tarnish.

Prevention and Handling

Prevention is the best method for inhibiting the formation of tarnish and insuring good solderability of silver plated devices. To inhibit silver tarnish, do not expose the silver plating to sulfur and sulfur compounds. One source of sulfur is free air. Another is paper products such as bags and cardboard. Listed below are a few suggestions for storing silver plated products.

1. Store the unused devices in polyethylene sheet to keep out free air.
2. Loose devices may be stored in zip-lock or sealed plastic bags.
3. For long term storage, place petroleum napthalene (mothballs) with product inside plastic packages to help keep out free air.
4. The silver leads may be wrapped in "Silver Saver" paper for protection. "Silver Saver" is manufactured by:

   Daubert Coated Products,1200 Jorie Drive
   Oak Brook, IL 60521, phone (312) 582-1000
5. Tapes such as adhesive, electrical, and masking should not be used because the adhesive may leave a film and will need to be removed before soldering.

The best defense against tarnish formation is to keep silver plated devices in protective packaging until just prior to soldering.

Fluxes

Depending on the amount of tarnish, different types of flux may be required. Below is a list of flux in order of increasing strength.

Type RMA: Mildly Activated Rosin Flux
A WW rosin flux with a small amount of activating agent. Flux and its residue are non-conductive and non-corrosive.

Type RA: Activated Rosin Flux
Similar to RMA flux but with greater amounts of activating agents. Flux and its residue are non-conductive & non-corrosive.

Types AC: Organic Acid Flux
A fully active organic flux with greater flux ability than a rosin flux. Due to its organic nature, the flux residues decompose at soldering temperatures but must be removed to prevent conductive and corrosive aftereffects.

Recommended flux types with respect to the various tarnish amount:

1. Tarnish free: solder with Alpha 100, Kester 135, or equivalent Type R flux (Identified by a bright surface).
2. Minor tarnish: use Alpha 611, Kester 197, or equivalent Type RMA flux (Identified by a medium bright surface).
3. Mild tarnish: use Alpha 711, Kester 1544, or equivalent Type RA flux (Identified by a light tint surface).
4. Moderate tarnish: use Alpha 830, Kester 1429, or equivalent Type AC flux (Identified by a light tan color surface).
5. If severe tarnish, identified by a dark tan to black color, is present a cleaner/surface conditioner Alpha 140, Kester 5560, or equivalent must be used. A few seconds at room temperature is all that is required. These conditioners are acidic, so wash and rinse thorougly. Immerse only the leads and not the body because optical properties can be damaged.

Soldering

To obtain reliable circuit operation, good soldering is necessary. For wave soldering. Sn60 is the most commonly used solder for electronic components. Two alternatives are Sn63 and Sn62 solder. A high quality rosin core flux is recommended for hand solder operations. Typically the core is an RMA type flux. Two major soldering suppliers are:

Alpha Metals
600 Rt. 440
Jersey City, NJ 07304, phone (201) 434-6778

Kester Solder
4201 Wrightwood Ave.
Chicago,11160639, phone (312) 235-1600

Regardless of the flux and solder technique used, take care to assure the optical properties of the optoelectronic product are not degraded in any manner.

Siemens does not assume any responsibility for damage caused by products mentioned above.

SIEMENS

Socket Selection Guide
Appnote 22

by Dave Takagishi

This application note is a guide to locate a suitable socket for various Siemens products. The selection of a socket is first based on the number of pins and the pin spacing required. Sockets for displays require an orientation and sometimes stackability. Other requirements may be:

Contact type (i.e., side vs. edge)
Plating type (i.e., tin vs. gold)
PCB mounting (i.e., solder vs. wirewrap)
Height of socket

To use this guide: 1. Find Siemens product part number in Table 1; 2. Note number of pins; 3. Note spacing and orientation: Example 300 H; 4. Go to Table 2, find number of pins with corresponding spacing/orientation and follow to suggested socket.

The purpose of this application note is to guide you to possible vendors and suggest one out of many possible socket choices. Use the given vendor's part numbers as a starting point for choosing a socket. The part number will depend on your requirement and application.

This guide is not intended to imply specific endorsement or warranty of other manufacturer's products by Siemens.

Table 1.

Part Number	No. of Pins	Spacing
DL330M	12	.300 H
DL340M	14	.300 H
DL430M	12	.300 H
DL440M	12	.300 H
HD1075X	10	(SPC)
HD1077X	10	(SPC)
HD1105X	10	.300 V
HD1107X	10	.300 V
HD1131X	10	.600 V
HD1133X	10	.600 V
DLX573X	12	.300 V
HDSP200XLP	12	.300 H
ISD235X	12	.250 H
ISD231X	12	.250 H
ISD201X	12	.250 H
Optocouplers: 6 pin	6	.300 B
8 pin	8	.300 B
16 pin	16	.300 B
Arrays	2–20	.100 B

Table 2.

Number of Pins	Row-Row Spacing	Aries	Garry Mfg.	Robinson-Nugent	Samtec
12	.300 H	12-513-10	(2) 102-06-X	(2)ICN-063-X	
14	.300 H	14-511-10	102-14-X-X-X	ICL-143-S6-X	ICC-314-T
18	.600 V	18-6511-10	300-18-X-X-X		IC-618-X
22	.600 V	24-6513-10	300-22-XX-X		ICC-624-X
22	SPC	—	—	—	—
13	SPC	—	—	—	—
12	.300 V	12-513-10			
14	.300 V	14-511-10	102-14-X-X-X	ICL-143-S6-X	ICC-314
14	.600 V	14-6511-10	300-14-X-X-X		IC-614-X
20	.300 H	20-511-10	102-20-CC-X-X	ICL-203-S6-X	ICC-320
10	SPC	—	—	—	—
10	.300 V				IC310-X
10	.600 V	10-6511-10			IC610-X
18	.300 V	18-511-10	102-18-X-X-X		ICC-318
6	.300 B	6-513-10	102-06-X	ICN-063-S3-X	IC-306-X
8	.300 B	8-511-10	102-8-X-X-X	ICN-083-S3-X	IC-308
16	.300 B				
2–20	.100 B	PIN-LINE SERIES	SERIES 200 SERIES 2002	SB-25-100X	SSA-1XX-X SERIES ICK-1XX-X SERIES
Others		Yes	Yes	Yes	

Notes:

1. All sockets are 0.100 pin-to-pin spacing.
2. Products listed are generally tin plated PCB solder lype. Contact vendor for other types.
3. Row-row spacing of pins: (H)-pins are horizontal with respect to viewing of display; (V)-pins are vertical with respect to viewing of display; (B)-pins can be either horizontal or vertical; (SPC)-pins not standard 0.100 or row-row spacing.
4. Others—Special sockets for display such as right angle, etc. Contact vendor for details
5. Consult vendor for stackability.
6. Strip in-line sockets may be used (cut to length required).
7. Vendor may have other products also suitable for your application.

List of Possible Vendors

Aries Electronics Co.
P.O. Box 130
Frenchtown, NJ 08825
201-996-6841

Garry Manufacturing
1010 Jersey Ave.
New Brunswick, NJ 08902
201-545-2424

Robinson-Nugent
800 E. Eighth St.
New Albany, IN 47150
812-945-0211

Samtec
810 Progress Blvd.
New Albany, IN 47150
812-944-6733

SIEMENS

LED Filter Selection Guide
Appnote 23

By Dave Takagishi

The most important design consideration for a piece of equipment using LED products is the ability to display information to an observer clearly. This information must be easily and accurately recognized in various ambient light conditions. This application note will discuss the design considerations and recommendations for filtering.

Since the quality of readability is very subjective, the best judge of the performance of a product is the human eye and in the user's conditions. To improve the readability of a display, use techniques such as contrast enhancement, wavelength filtering, special filtering, and mounting.

Contrast Enhancement

The objective of contrast enhancement is to maximize the contrast between the display segments "ON" and "OFF" states. This is done by reducing the ambient light reflected from the surface of the display and allowing as much of the emitted light to reach the observer. This can be accomplished by painting the front surface of the display to match as *close* as possible the color of an "OFF" segment. This reduces the distracting areas around the display and therefore enhances the "ON" segments.

Contrast enhancement may be improved further by using selected wavelength filters. Under bright ambient conditions, contrast enhancement is more difficult and additional techniques such as louvered filters and/or shading may be necessary.

Filters

The majority of display applications use plastic filter material for their low cost and ease of assembly. The filter requirements for different ambient lighting conditions and different color displays make it necessary to become familiar with the various relative transmittance characteristics. Most filter manufacturers will provide transmittance curves for their products.

When selecting a filter, the shape of the transmittance curve versus wavelength should be considered in relationship to the LED radiated spectrum to obtain maximum contrast enhancement. For standard red displays, a long wavelength pass filter having a sharp cutoff in the 600 nm to 620 nm range is ideal. The same applies for high efficiency red displays with a long wavelength pass filter in the 570 nm to 590 nm range.Yellow and green displays are more difficult to filter effectively. The most effective filter for yellow displays is a yellow-orange or amber filter. Yellow only filters are very poor for contrast enhancement. Green displays will require a band-pass yellow-green filter which peaks at 565 nm.

Choose among available filters on the basis of which filter and LED combination is most effective, but experiment with each choice to choose the most esthetic combination.

Effectiveness of Wavelength Filters with Different Lighting

Contrast is very dependent upon ambient lighting. If the ambient light is outside the spectrum of the LED, then it is very easy to reduce the reflected light. This is the case for a red LED display in fluorescent lighting or a green LED in incandescent lighting. Bright sunlight has a flat spectral distribution curve and when it is directly incident upon a display the background may meet or exceed the light output of the display. It should be obvious that a wavelength filter alone is not sufficient in daylight ambient conditions.

Other Techniques

An acceptable contrast is difficult to achieve if high ambient light is parallel to the viewing axis (the incident light is perpendicular to the face of the display). If the incident light is not parallel to the viewing axis, the use of louvered filters or shading and recessing is recommended. It is the shading of louvered filters that reduces the incident light to allow for more contrast. The drawback to this filter is the restricted viewing angle.

Circular polarizing filters are effective in reducing the reflected light from the highly reflective (glossy) surfaces of bubble lensed products, such as some Intelligent Displays.

Glare can still be present from the surface of filters, therefore, an anti-reflection surface is recommended. This can be incorporated into the filter. The trade-off is that both ambient and display light are diffused and the display may appear fuzzy if not mounted close enough to the filter.

Take care when designing the printed circuit board to keep all reflective surfaces away from display area or display side of the board or consider a dark coating on the reflective surfaces

Mounting Considerations

The designer should consider recessing the display and bezel assembly to add some shading effect. Shading will reduce indirect lighting for better contrast.

It is essential to design the unit to allow sufficient air flow for circulation and to mount current limiting resistors on another board or any heat generating components away from the displays.

Filter Recommendations

Visible Filters

Manufacturer	Red	HER	Yellow	Green	Specials
Homalite	1605	1670	1720 1726	1425 1440	
Panelgraphic	Red 60 Red 63	Red 65	Yellow 25 Amber 23	Green 48	Gray 10
Rohm & Haas	2423	2444			2412
3-M					Lovered Filters
Polaroid					Circular Polarizing

Near IR Filter

Manufacturer	Red
Rohm & Haas	Red 2711

U.S. Filter Manufacturers		European Filter Manufacturers
Filter Material Manufacturers	**Bezel and Filter Assembly Manufacturers**	
Panelgraphic Corporation 10 Henderson Drive West Caldwell, NJ 07006 201-227-1500	R.M.F. Products P.O. Box 413 Batavia, IL 60510 312-879-0020	3M Deutschland GmbH D-4040 NEUSS1, Box 100422 Carl Schurz-Straße 1 ☎ (02101) 140, TLX 8517511
SGL Homalite 11 Brookside Drive Wilmington, DE 19804 302-652-3686	Nobex Components Nobex Division Griffith Plastic Corp. 1027 California Dr. Burlingame, CA 94010 415-342-8170	CHEQUERS (U.K.) Limited 1-4 Christina Street LONDON, EC2A 4PA ☎ 01-739/6964-5, TLX 291673
3M Company Visual Products Division 3M Center, Bldg. 220-10W St. Paul, MN 55101 612-733-0128	Photo Chemical Products of California 1715 Berkeley St. Santa Monica, CA 90404 213-828-9561	RÖHM GmbH D-6000 DARMSTADT Kirschenallee ☎ (06151) 181
Rohm and Haas Independence Mall West Philadelphia, PA 19105 215-592-3000	I.E.E.-Atlas Industrial Electronic Engrs. Inc. 7740 Lemona Avenue Van Nuys, CA 91405 213-787-0311	POLARIZERS TECHNICAL PRODUCTS 1800 AL ALKMAAR P.O. BOX 489 Oude Gracht 90, The Netherlands ☎ 072-121553, TLX 57571
Polaroid Corporation Polarizer Division 549 Technology Square Cambridge, MA 02139 617-864-6000		BAYER AG, Geschäftsbereich KU D 5000 KÖLN 1 Konrad Adenauer Ufer 41 ☎ (0221) 16471 A1037 WIEN 3, Box 124 ☎ (0222) 732551 CH 8045 ZÜRICH, P.O. Box ☎ (01) 4658111
Dontech Inc. P.O. Box 889 Doylestown, PA 18901 215-348-5010		
ESCO Products Inc. 171 Oak Ridge Road Oak Ridge, NJ 07438 201-697-3700		

SIEMENS

Drivers For Light Emitting Displays
Appnote 24

by Dave Takagishi

The purpose of this application note is to provide some information on the integrated circuits presently available to drive Light Emitting Diodes (LED) displays and how to interface them to the various displays.

Background

LED displays come in various sizes (0.1" to 0.8"), colors (red, high-efficiency red, green, yellow), fonts (7/9/14/16 segment, dot-matrix, or bargraph), and types (common anode, common cathode. multi-digit). The brightness is essentially proportional to the current through an LED and each element within a display should have the same current or a brightness variation may be apparent. A display subsystem can be made up from several elements.

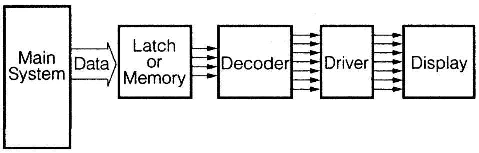


Figure 1. Display System

The partitioning of these elements are dependent on the drivers used; therefore the display driver chosen is dependent on the specifications of the display and the application. Also some types of displays require using a multiplexing technique because of the internal interconnections. This is only applicable for multi-digit displays.

Typical Circuits

Figure 2 shows a very basic circuit for driving an LED. The series resistance can be easily calculated from the following-formula. For circuits using TTL logic or transistors.

$$Rs = \frac{Vb - Vf}{If}$$

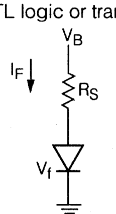


Figure 2. Basic Circuit to Drive an LED

For circuits using TTL logic or transistors, see Figure 3.

$$Rs = \frac{Vcc - Vce - Vf}{If}$$

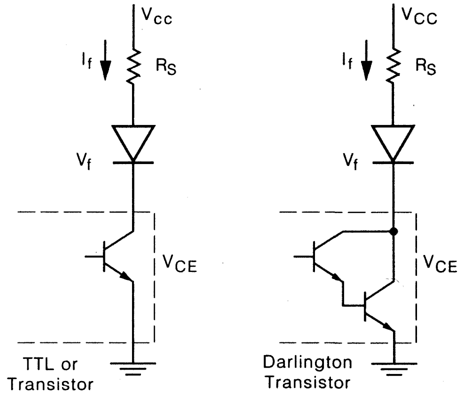


Figure 3. Circuits for TTL or Translstor and Darlington Transistor

It can be seen that Vce (saturation voltage) for the driver is going to be a factor in determining the series limiting resistor. Therefore a darlington versus a single output transistor will have different current limiting resistor values to maintain acontstant current through the LED.

Selection

One factor in choosing the display and/or driver will be whether the display is a common cathode or common anode type display.

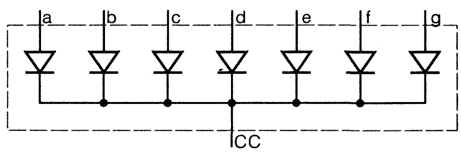


Figure 4. Common Cathode Display

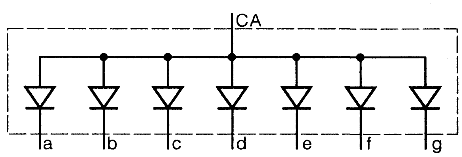


Figure 5. Common Anode Display

Another factor is that different drivers go low or high or can be wired into different configurations.

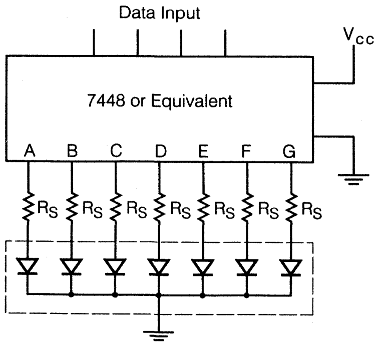


Figure 6. Common Cathode Display with Driver

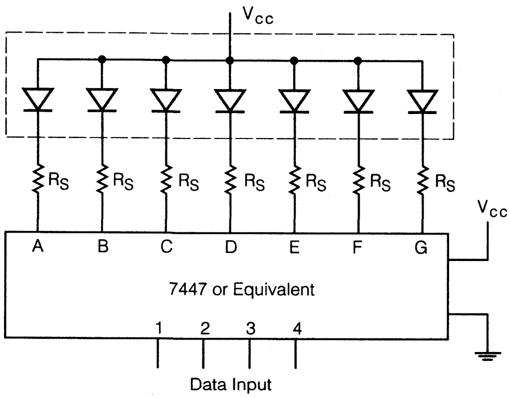


Figure 7. Common Anode Display with Driver

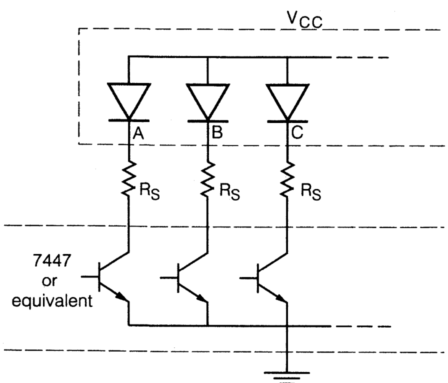


Figure 8. Open Collector Type Driver with Common Anode Display

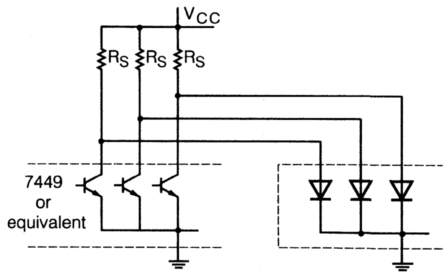


Figure 9. Open Collector Type Driver with Common Cathode Display

From Figures 6/7/8/9, it may appear obvious to combine the seven series resistors (Rs) into one common resistor in the-common line. However this should not be done because of the possible variation in Vf from segment to segment. Variation in Vf can cause a variation in current, resulting in segment brightness differences.

Table 1 is list of some of the most common LED drivers available. Besides having different current drive capabilities, one product may have a feature which may make them easier to use in a particular application.

— Serial versus parallel input data
— Data latching type drivers
— Blanking
— Drive ripple blanking input (rbo) with pulse width modulation to vary brightness
— Multi-digit drivers
— Constant current drivers
— Advantage of a constant current driver as Vf may not affect brightness, important with different color LEDs.

Multiplexing

In a multiplex system, the corresponding segment of each digit is bussed together and driven from one segment drive via the usual current limiting resistors. The display data is presented serially by digit to the decoder driver together with the appropriate digit signal (Figure 10). For rnore information multiplexing, see Appnote 3 (Multiplexing LED Displays).

One way to simplify the design procedure for alphanumeric displays would be to consider Siemens Intelligent Displays. This device family incorporates all necessary interface control with drivers and memory built-in with the display. This means the designer need not be concerned about the memory, multiplex circuitry, character generator, or drivers for these are provided inside a modular unit. More information on these products is available in Siemens Optoelectronics Data Book.

Circuits shown in this Appnote are for reference only and are not the responsibility of Siemens Optoelectronics4. Products are continually being improved by vendors and/or are obsoleted; therefore consult the factory.

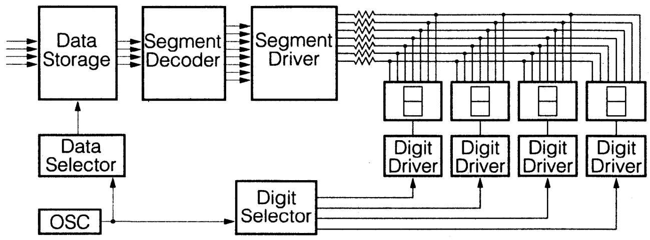


Figure 10. Block Diagram—4 Digit Multiplexed Display

Table 1.

Single Digit Decoder/Drivers				
Part Number	**Manufacturer**	**If/Segment**	**Type**	**Comments**
7447 74247 7446	Fairchild Hitachi Motorola National Signetics Teledyne TI	40 mA	CA	BCD-to-7 segment, open coll, ripple blnkng
7448 74248	Fairchild Hitachi Motorola National Signetics TI	6 mA	CC	BCD-to-7 segment, int pull-up, ripple blnkng
7449 74249	Fairchild Hitachi Motorola National Signetics TI	8 mA	CC	BCD-to-7 segment, open coll, ripple blnkng
DS8857	National	60 mA	CA	BCD-to-7 segment, decoder, ripple blnkng
DS8858	National	50 mA	CC	BCD-to-7 segment, decoder, ripple blnkng
CD4511 4511 B MC14511	Fairchild National Motorola	25 mA	CC	BCD-to-7-segment, latched, blnkng
DS8647 DS8648	National	10 mA	CC	9 segment drivers
NE587	Signetics	50 mA	CA	BCD-to-7-segment, latched, blnkng, vari current
NE589	Signetics	50 mA	CC	BCD-to-7-segment, latched, blnkng, vari current
CA3161E	RCA	25 mA	CA	BCD-to-7-segment, constant current drivers
9368	Fairchild	20 mA	CC	BCD-to-7-segment, ripple blnkng
9374	Fairchild	15 mA	CA	BCD-to-7-segment, ripple blnkng

Table 1. (continued)

Multi-Digit Display Drivers				
Part No.	**MFGR**	**If/Segment**	**Type**	**Comments**
MM5450	National	25 mA	CA	34 segment serial input, brightness control
MM5451	National	25 mA	CA	35 segment serial input, brightness control
MM74C912	National	100 mA	CC	6 digit, 7 segment+decimal, BCD decoder, output enble
MM74C911	National	100 mA	CC	4 digit, 8 segments controller/segment/driver
MM74917	National	100 mA	CC	6 digit, 7 segments+decimal, Hex decoder, output enble
DS8669	National	25 mA	CA	Dual BCD-to-7 segment decoder/driver
CA3168E	RCA	25 mA	CA	Dual BCD-to-7 segment decoder/driver
ICM7212 ICM7212A ICM7212M ICM7212AM	Intersil	8 mA	CA	4 digit, latched, 28 segment drivers, brightness cntl
ICM7218A	Intersil	20 mA	CA	8 digit, 8 segment (decoded/spcl), w/mem/drivers
ICM7218B	Intersil	10 mA	CC	8 digit, 8 segment (decoded/spcl), w/mem/drivers
ICM7218C	Intersil	20 mA	CA	8 digit, 8 segment (hex/bcd), w/mem/drivers
ICM7218D	Intersil	10 mA	CC	8 digit, 8 segment (hex/bcd), w/mem/drivers
ICM7218E	Intersil	20 mA	CA	8 digit, 8 segment (decoded/spcl), w/mem/drivers, cntls avble
TSC700A	Teledyne	11 mA	CA	4 digit decoder/driver, parallel output, brightness cntl
TSC7212A	Teledyne	5 mA	CA	4 digit decoder/driver, parallel output, brightness cntl
SAA1060	Signetics	40 mA	CA	16 element serial in/parallel out driver
SDA2014	Siemens	12 mA	CC	2 or 4 digit, serial bcd input
SDA2131	Siemens	20 mA	CA	16 element serial input
Other Drivers				
XR-2000	Exar	400 mA	sink	5 darlington transistors, MOS-to-LED
XR-2201 XR-2202 XR-2203 XR-2204	Exar	500 mA	sink	7 darlington transistors, open collector w/diodes, TTL-to-LED, compatible to Sprague (ULN-xxxx)
CA3081	RCA	100 mA	sink	7 common emitter transistor array
CA3082	RCA	100 mA	source	7 common emitter transistor array
9665 9667	Fairchild	250 mA	sink	7 common emitter darlington transistor array
Bar Graph Drivers				
UAA180	Siemens	10 mA	n.a.	12 element bar driver
LM3914	National	2–20 mA	n.a.	10 element dot/bar linear output driver
LM3915	National	1–30 mA	n.a.	10 element dot/bar linear output driver

SIEMENS

The DLX713X, 5x7 Dot Matrix Intelligent Display® Device Appnote 25

By Dave Takagishi

This application note is intended to serve as a design and application guide for users of the DLO7135 and DLG7137 Siemens Intelligent Displays. This appnote covers device electrical description, operation, general circuit design considerations. and interfacing to microprocessors

Electrical Description

The DLX713X intelligent alphanumeric 5x7 dot matrix display contains memory, character generator, multiplexing circuits, and drivers built into a single package.

Figure 1 is a block diagram of the DLX 713X. The unit consists of 35 LED die arranged in a 5x7 pattern and a single CMOS integrated circuit chip. The IC chip contains the column drivers, row drivers, 96 character generator ROM, memory, multiplex and blanking circuitry.

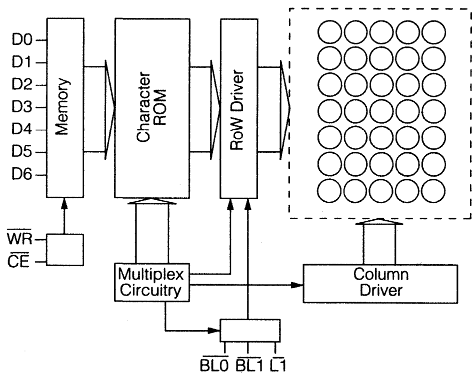


Figure 1. DLX713X Block Diagram

Package

Thirty-five dots form a 0.48 x 0.68 inch overall character size in a 0.700 x 0.800 inch dual-in-line package. The ±50 degree wide viewing angle complements the large display and is the ideal display for the industrial control application. Display construction is a filled reflector type with the intregrated circuit in the back and then filled with IC-grade epoxy. This results in a very rugged part which is quite impervious to moisture, shock, and vibration.

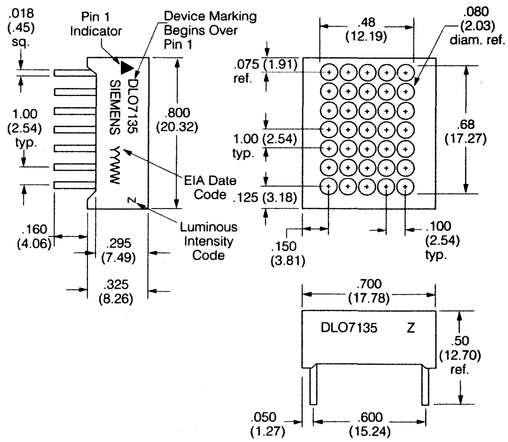


Figure 2. Physical Dimensions in Inches (mm)

Electrical Inputs

Pin	Name	Pin	Name
1	V_{CC}	14	D6 data input (MSD)
2	$\overline{LT}$ lamp test	13	D5 data input
3	$\overline{CE}$ chip enable	12	D4 data input
4	$\overline{WR}$ write	11	D3 data input
5	$\overline{BL1}$ brightness	10	D2 data input
6	$\overline{BL0}$ brightness	9	D1 data input
7	GND	8	D0 data input (LSD)

Pin Description

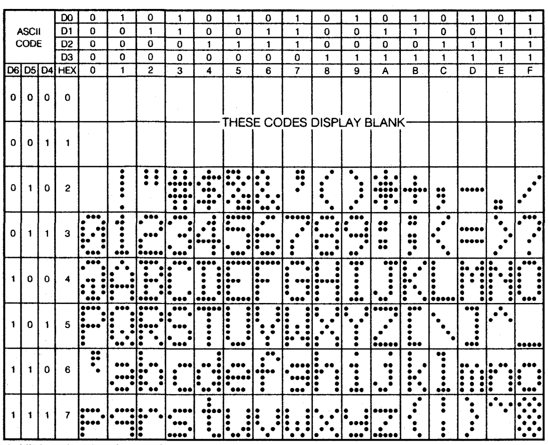
V_{CC}	Positive Supply +5 V
GND	Ground
D0–D6	Data Lines, see Figure 3 (Character Set)
$\overline{CE}$	Chip Enable (active low) Determines which device in an array will accept data
$\overline{WR}$	Write (active low) Data and chip enable must be present and stable before and after the write pulse (see DLX713X data sheet for timing)
$\overline{BL0}$, $\overline{BL1}$	Blanking Control Input (active low) Used to control level of display brightness
$\overline{LT}$	Lamp Test (active low) Causes all dots to light at 1/2 brightness

Operation

In a dot matrix display system, it is advantageous to use a multiplexed approach with 12 drivers (5 digit plus 7 segments) rather than 35 segment drivers, reducing the number of drives and interconnections required. A multiplexed system must be a synchronous system or the digits or elements may have different on (lit) times and therefore varying brightness.

The DLX713X is an internally multiplexed display but the data entry is asynchronous. Loading data is similar to writing into a RAM. Present the data, select the chip, and give a write signal. For a multidigit system, each digit has its own unique location and will display its contents until replaced by another code.

The waveforms of Figure 4 demonstrates the relationship of the signals required to generate a write cycle. Check the data sheet for minimum values required for each signal.



1. High=1 level. 2. Low=0 level. 3. Upon power up, the device will initialize in a random state.

Figure 3. Character Set

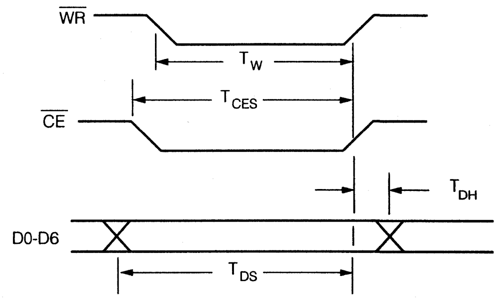


Figure 4. Timing Characteristics

Display Blanking and Dimming

The DLX 713x Intelligent Display has the capability of three levels of brightness plus blank. Figure 5 shows the combination of $\overline{BL0}$ and $\overline{BL1}$ for the different levels of brightness. The $\overline{BL0}$ and $\overline{BL1}$ inputs are independent of write and chip enable and does not affect the contents of the internal memory. A flashing display can be achieved by pulsing the blanking pins at a 1–2 hertz rate. Either $\overline{BL0}$ or $\overline{BL1}$ should be held high to light up the display.

Dimming and Blanking Control

Brightness Level	$\overline{BL1}$	$\overline{BL0}$
Blank	0	0
1/4 brightness	0	1
1/2 brightness	1	0
full brightness	1	1

Lamp Test

The lamp test when activated causes all dots on the display to be illuminated at half brightness. It does not destroy any previously stored characters. The lamp test function is independent of chip enable, write, and the settings of the blanking inputs.

This convenient test gives a visual indication that all dots are functioning properly. Because lamp test does not affect the display memory, it can be used as a cursor or pointer in a line of displays.

General Design Considerations

When using the DLX713X on a separate display board having more than six inches of cable length, it may be necessary to buffer all of the input lines. A non-inverting 74365 hex buffer can be used. The object is to prevent transient current into the DLX 713x protection diodes. The buffers should be located on the display board and as close to the displays as possible.

Because of high switching currents caused by the multiplexing, local powersupplyby-passcapacitors are also needed in many cases. These should be 6 or 10 volt, tantalum type having five 10 uf capacitance. The capacitors may only be required every 6–7 displays depending on the line regulation and other noise generators.

If small wire cables are used. it is good engineering practice to calculate the wire resistance of the ground and the +5 volt wires. More than 0.2 volt drop (at 100 ma per digit) should be avoided, since this loss is in addition to any inaccuracies or load regulation of the power supply.

The 5 volt power supply for the DLX71 3X should be the same one supplying the V_{CC} to all logic devices. If a separate supply must be used. then local buffers should be used on all the inputs and these buffers should be powered from the display power supply. This precaution is to avoid line transients or any logic signals to be higher than V_{CC} during power up.

Interfacing

For an eight digit display using the DLX713X, interfacing to a single chip microprocessor such as the 8748 is easy and straight forward. One approach may be to dedicate one port for the seven data signals and another 8-bit port for the write signals. The schematic is shown in Figure 5.

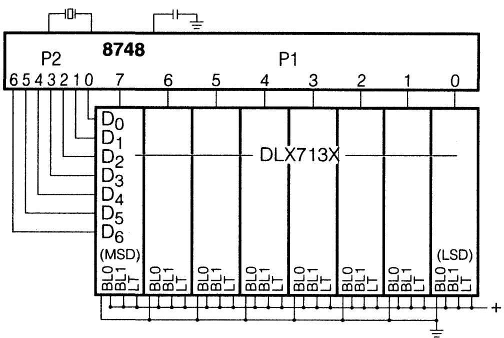


Figure 5. DLX 71 3x with 8748

```
                            ; SUBROUTINE TO LOAD AN 8
                              DIGIT
                            ; DISPLAY USING THE DLX7135
                            ; DATA IN RAM 10H-17H (MSD-LSD)
INIT:  ORL   P1,#0FFH       ; PORT 1 ALL HIGH (WRITE)
       ORL   P2,#00H        ; PORT 2 ALL LOW (DATA)
       MOV   R1,#OFH        ; RAM ADDRESS—1
       MOV   R2,#0FEH       ; WRITE PULSE
       MOV   R3,#08H        ; COUNTER
START: INC   R1             ; INCREMENT RAM POINTER
DATA:  MOV   A,@R1          ; FETCH DATA FROM RAM
       OUTL  02,A           ; LOAD PORT 2
       MOV   A,R2           ; RECALL WRITE
       RR    A              ; SHIFT A TO NEXT WRITE
       MOV   R2,A           ; SAVE WRITE
WRITE: OUTL  P1,A           ; SEND WRITE PULSE
       MOV   A,#OFFH        ; WAIT
       OUTL  P1,A           ; RESET WRITE PULSE
       DJNZ  R3,START       ; LOAD COMPLETE?
       RET                  ; RETURNTO MAIN PROGRAM
```

I/O or Memory Mapped System

For a memory mapped system using a processor such as the 8080 or 8085, the interfacing is also straight-forward. Each display is treated as a memory location with its own address, like another I/O or RAM location. See Figure 6.

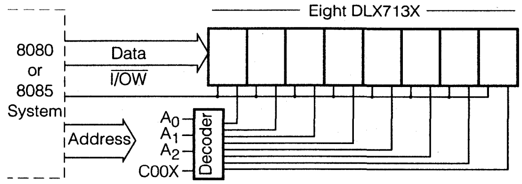


Figure 6. Block Diagram—Eight DLX 713x Dot Matrix Displays

```
                          ; ROUTINE  FOR AN 8 DIGIT
                            DISPLAY
                          ; USING THE DLX 713K AND
                          ; 8085 OR 8080 MICROPROCESSOR
                          ;
                          ; DATA TO BE DISPLAYED IS IN
                          ; A0 (LSD) THRU A8 (MSD)
                          ;
                          ; DISPLAY ADDRESS C00X
                          ; LSD IS RIGHT MOST DIGIT
                          ;
                          ; DOES NOT SAVE REG A,B.H,L,D,E
                          ;
DADD   EQU   0A000H       ; DATA ADDRESS LOCATION
DPAD   EQU   0C000H       ; DISPLAY ADDRESS LOCATION
LEN    EQU   08H          ; DISPLAY LENGTH
                          ;
ORG    100H
                          ;
DISP;  LXI   H,DADD       ; LOAD DATA ADDRESS
       LXI   D,DPAD       ; LOAD DISPLAY ADDRESS
       MVI   B,LEN        ; LOAD DISPLAY LENGTH
DISP1; MOV   A,M          ; GET DATA
       XCHG               ; XCHG H/L & D/E
       MOV   M,A          ; LOAD DISPLAY FROM REG A
       XCHG               ; RESTORE H/L & D/E
       INX   D            ; INCREMENT DISPLAY ADDRESS
       INX   H            ; INCREMENT DATA ADDRESS
       DCR   B            ; DECREMENT LENGTH COUNTE
       JNZ   DISP1        ; END OF DISPLAY?
       RET                ; RETURN TO MAIN PROGRAM
```

Conclusion

Note that although other manufacturers' products are used in the examples, this application note does not imply specific endorsement, or warranty of other manufacturers' products by Siemens. The interface schemes shown demonstrate the simplicity of using the DLX713X dot matrix Intelligent Display. Slight timing differences may be encountered for various microprocessors. but can be resolved similar to those encountered when using different RAM's. The techniques used in the examples were shown for their generality. The user will undoubtedly invent other schemes to optimize his particular system to its requirements.

SIEMENS

SFH900 — A Low-Cost Miniature Reflex Optical Sensor®
Appnote 26

Whether for an industrial plant or a hobbyist's drilling machine, an electric drive will hardly be acceptable nowadays without speed control. Incremental bar patterns simply applied to rotating shafts can be detected by the new Siemens reflex optical sensor, the SFH 900. The information can be processed with a minimum of circuitry, whether for a high rate of black-to-white transitions or just single, slow transitions.

Construction

The SFH 900 optical sensor is a remarkable component even by virtue of its shape alone. Its maximum height of 2.2 mm is in the trend of today's electronics, of putting a large number of functions into a very small space. The small dimensions allow it to be used where ordinary optical sensors run into space or other problems. Figure 1 is an enlarged picture of the device. Dimensions and pin configuration are shown in Figure 2.

Fabricated by lead frame technique in a thermoplastic package, the sensor uses a GaAs infrared diode as a radiation emitter and a large area phototransistor as the detector. High sensitivity is ensured by a 1 mm^2 radiation sensitive area and a current gain of almost 1000. The effect of unwanted ambient light is almost screened out by a filter.

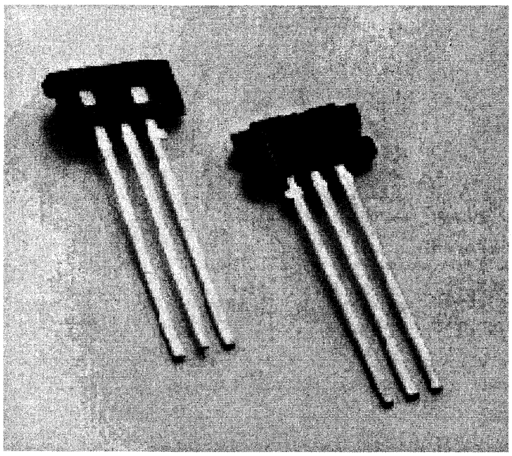


Figure 1. SFH900 Reflex Optical Sensor, Front and Back View.

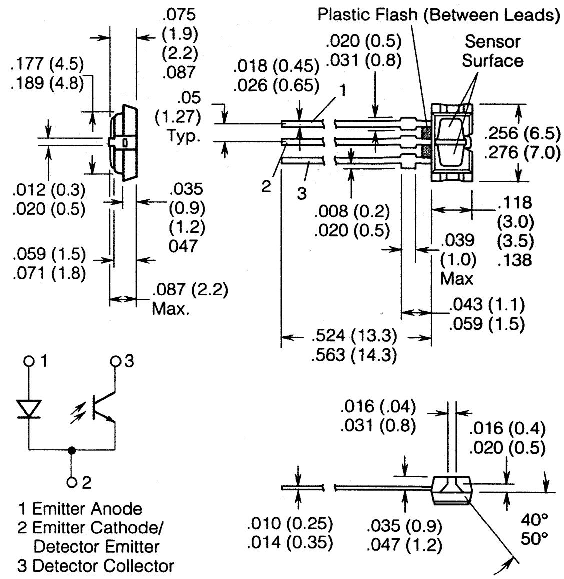
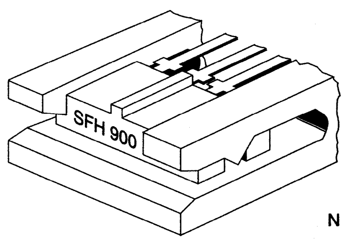


Figure 2. SFH900 Outline Dimensions and Pin Connections

Two fixing notches are a help in mounting the device. Lead frame technology accurately locates the optically active areas relative to these notches and thus to the component body. Figure 3 is an example of one form of mounting



Projections N in the flexible plastic clamp locate in corresponding notches in the body of the optical sensor

Figure 3. Suggestion for Mounting the SFH900

Characteristics

Main technical data are given in the Table. Turn-on and turn-off times are also important. These depend essentially on the collector current I_C and the load resistance R_L. Typical switching times for I_C=1 mA and R_L=1 kΩ are 50 to 70 µs.

The user will be mainly concerned with the following points:

- What collector current (I_C) can be expected under given static conditions?
- What are the signal amplitudes when scanning bar patterns of different pitches?
- What is the temperature dependence of the collector current and what is the repeatability of the measured values?

Collector Current

Dependence of collector current on emitter diode forward current (I_F) is almost linear at forward currents above 10 mA (Figure 4). At currents below 1 mA the dependency shows almost a square law. The measurement was made with a standard reflector (Kodak neutral white test card, r=90%) at a distance of 1 mm. Figure 5 shows I_C characteristics for distances of 0.2 to 10 mm at a constant forward current of 10 mA. The curves are for four different reflecting materials: two standard Kodak reflectors with 15% and 90% reflection, polished aluminium and a strongly absorbing foil. DC-fix adhesive tapes and other tapes commonly used for printed circuit layouts proved particularly suitable. It should be mentioned that the curve for polished aluminium in Figure 5 is very similar to the Kodak reflector response with r=90%, in spite of the reflection being mirrored by the metal and diffused by the standard reflector, as a result of the wide directional characteristics of the emitter and detector.

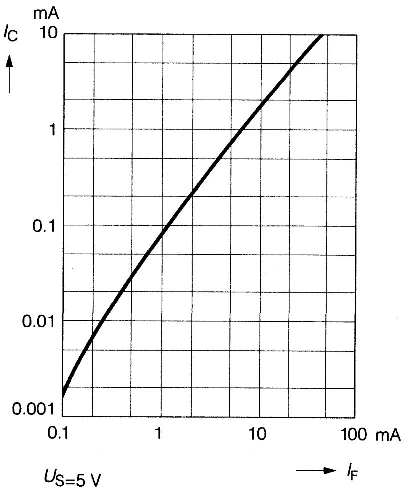
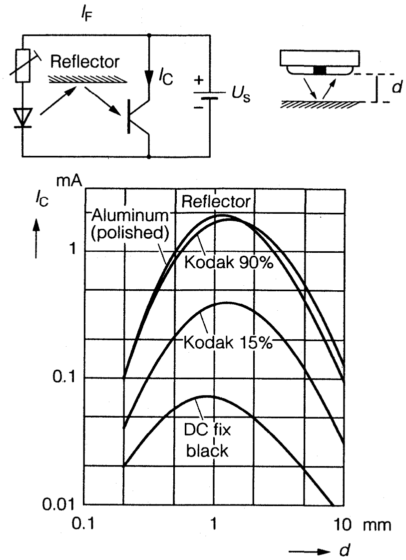


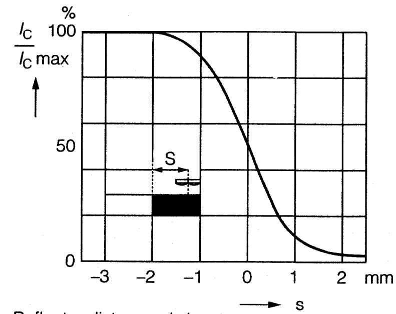
Figure 4. SFH900 Collector Current (I_C) Versus Forward Current (I_F) with 90% Diffuse Reflection at Distance d=1 mm and with U_S=5 V

At short distances (e.g., d=0.25 mm) very large changes of current per unit distance are obtained. Because of these steep edges, which can only be used dynamically, the SFH900 may also be utilized as a microphone.



Forward current I_F=10 mA
Operating voltage U_S = 5 V

Figure 5. SFH900 Collector Current I_C Versus Reflector Distance d with Different Reflector Materials



Reflector distance d=1 mm
Emitter diode current I_F=10 mA

Figure 6. Resolution of a Black to White Transition. Relative Collector Current Versus Sensor Position "s"

Emitter (GaAs infrared diode)				
Reverse Voltage		U_R	6	V
Forward dc Current		I_F	50	mA
Surge Current (t≤10 µs)		i_{FSM}	1.5	A
Power Dissipation (T_{amb}=40°C)		P_{tot}	80	mW
Thermal Resistance		R_{thJU}	750	K/W
Detector (Silicon Phototransistor)				
Collector-emitter voltage		U_{CEO}	30	V
Emitter-collector Voltage		U_{ECO}	7	V
Collector Current		I_C	10	mA
Total Power Dissipation (T_{amb}=40 °C)		P_{tot}	100	mW
Collector-emitter Leakage Current (U_{CE} =10 V)		I_{CEO}	20(≤200)	nA
Photocurrent Under Ambient Light (U_{CE}=5 V)				
(E_E=0.5 mW/cm^2		I_F	≤3	mA
Reflex Optical Sensor				
Storage Temperature Range		T_S	–40 to +85	°C
Ambient TemperatureRange		T_U	–40 to +85	°C
Junction Temperature		T_j	100	°C
Total Power Dissipation (T_{amb}=40°C)		P_{tot}	150	mW
Collector Current (I_F=10 mA; U_{CE}=5 V; d=1 mm)	SFH900-1 SFH900-2	I_{CE} I_{CE}	≥0.3 ≥0.5	mA mA

Table. Selective Characteristics of SFH900

Resolution of Black and White Patterns

As can be seen from Figure 5, strongly reflecting and badly reflecting materials give collector currents differing by a factor of about 25. Strongly reflecting means >>white<< badly reflecting >>black<<.

If a black to white transition is scanned, the displacement distance between the >>fully white<< signal and the >>fully black<< signal is 4 to 5 mm (Figure 6).

If, in contrast, a regular bar pattern is scanned, the signal amplitude becomes smaller the smaller the bar width. Figure 7 shows clearly how the excursion is affected: the maximum white signal becomes smaller with decreasing bar width, while the minimum black signal becomes larger. Figure 8 shows the signal excursion itself, to make it clearer. Here a regular pattern and a single white bar are compared. The excursion is referred to a single black to white transition corresponding to a 100% signal excursion.

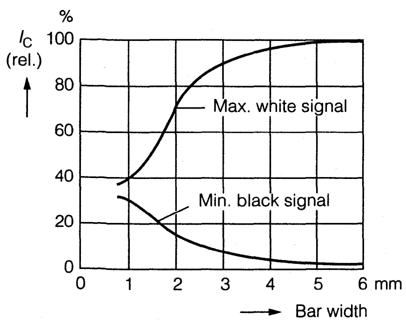


Figure 7. Maximum and Minimum Collector Current when Scanning a Black White Pattern

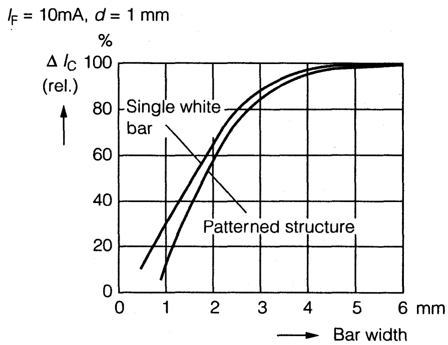


Figure 8. Relative Signal Excursion Versus White Bar Width

A bar width of 3 mm can thus be detected without significant loss of sensitivity. The signal excursion, however, drops to as low as 10% using a grid of 1 mm bar width. An apparently higher signal excursion is obtained when a single 1 mm wide white bar on a black background is scanned. The result is then about 30%, as shown in Figure 8.

The optical sensor can be used for scanning in any position, regardless of whether the emitter-detector axis is at right-angles to the scanning direction. Tests have shown that the device sensitivity is independent of direction. If a white spot on a black background (or vice versa) is to be detected without loss of sensitivity, this should have a minimum area of 5x5 mm. From this we can conclude that a pattern bar must not be larger than 5 mm.

Thus the resolution capability of the SFH900 seems to be limited to bar widths of 1 to 2 mm minimum. In fact, however, considerably higher resolutions can be obtained when gratings are used. An example is given below.

Temperature Dependence

The temperature dependence of the output signal is shown in Figure 9. This fortunately very small dependence results from the combination of the temperature dependent diode emission (approximately –0.55%/K) with the temperature dependent current gain of the phototransistor (approximately +0.9%/K). As these two parameters partly compensate for each other the temperature dependence of the output signal is fairly small.

There is a spread of characteristics in the different devices but they remain within the specified tolerance range, allowing for aging, with a probability of at least 95%.

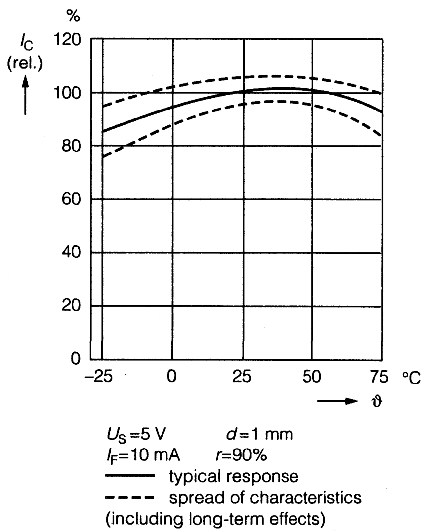


Figure 9. Relative Collector Current Versus Temperature

Applications

Speed Control for dc Motors

A simple speed regulator circuit for small dc motors can be designed using the TCA955 device. Figure 10 is an example. The teeth of a toothed wheel on the motor shaft serve as reflectors (40 teeth on a wheel of approximately 60 mm diameter). Pulses from the optical sensor are converted by the TCA955 into a dc voltage proportional to speed. The pulse signal is first amplified, then frequency doubled, then fed to a monostable which produces a square wave with a constant pulse duration determined by the R_1 C_1 product. The mean value of this pulse train is determined by capacitor C2 and an 8.7 kΩ internal resistor.

The voltage present at C2, still with a slight triangular modulation, is compared with an internal set value. The difference is amplified and determines the duty cycle in the subsequent mark-to-space ratio converter. The motor is connected to the operating voltage via a BD675 switching stage, which runs to the rhythm of the duty cycle. A larger mark-to-space ratio causes the speed to increase. The desired frequency can be set by P1 over a wide range.

Speed Control for ac Motors

This is mainly intended for use in the consumer field, in such things as kitchen appliances and drilling machines. It is important that the speed indicator should have a very low current consumption as it is supplied from a simple line rectifier circuit using a series resistor. The specimen circuit in Figure 11 has an emitter diode current of only 2 mA. Signal processing and triac triggering are done by the new TLB3101 phase control I_C. Total current needed for control is around 7 mA, including the SFH900.

Pulses from the optical sensor are first amplified, then converted by a monostable to constant pulse width and finally filtered to give a mean value. By comparison with a sawtooth voltage the gate trigger time for the triac is fixed. A soft start is given by transistor T1.

The range of speed regulation is 5000 to 15,000 rpm. The reflector is a disc mounted on the motor shaft, and at its periphery this disc has, as an example, 5 pairs of black and white segments.

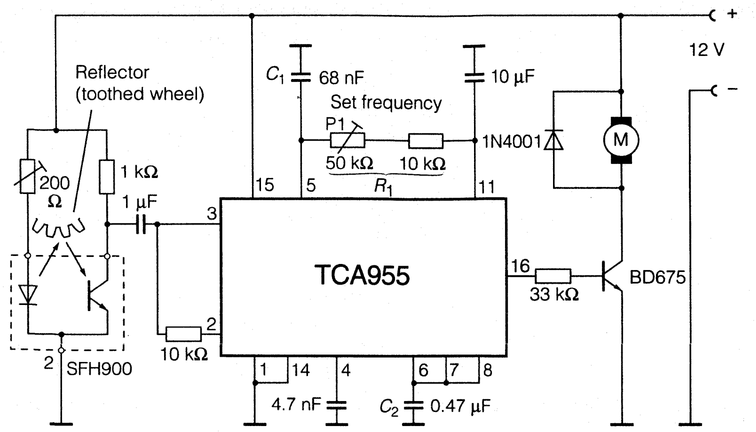


Figure 10. Speed Regulator using SFH900 and TCA955 Integrated Speed Control

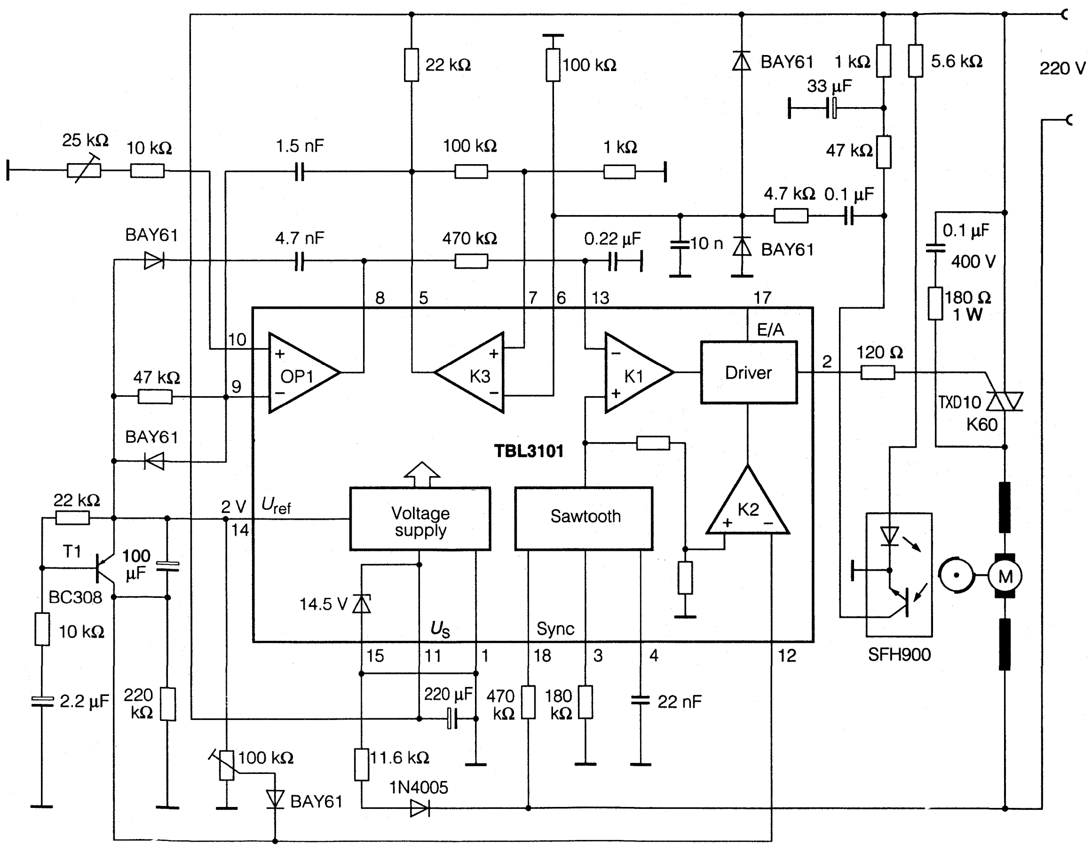


Figure 11. Speed Regulator for an ac Motor using SFH900 and TLB3101

Application Notes 11

Shaft Encoder with Direction Sensing

This example shows how gratings can be used to give a considerable increase in resolution. A transparent disc of about 130 mm diameter has an array of 200 opaque bars at its periphery (Figure 12a). The bar width is thus about 1 mm. A second grating with reflecting white bars is placed under the disc. If the disc pattern and the grating beneath are set gap to gap, the detector >>sees<< 100% black. If the bars of the two gratings are on top of each other the image appears as 50% white. So, when the disc is rotating the useful amplitude is therefore about 50% of the full black-to-white excursion.

The grating pattern is constructed so that one half is displaced by 90° of a grid period with respect to the other half. If a reflex optical sensor is assigned to each half, on rotation of the disc the output signals will be roughly sinusoidal and displaced by 90° from each other. This means that patterns of half bar width can be successfully resolved.

In further processing both sinewave voltages are converted into square waveforms, also phase-shifted by 90° (Figure 13).

The rising edge of on square-wave (signal 1) is used for counting: It triggers a monoflop which generates a pulse of short duration relative to the square-wave period. The other, 90° shifted, square-wave controls the direction of the counter (Low=forward, High=backward).

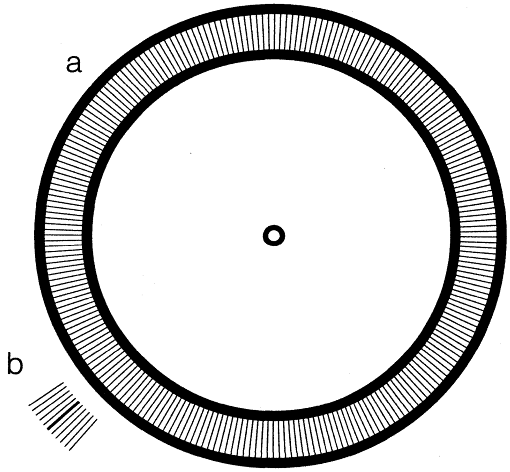


Figure 12. Example—Patterned Disc (a) and Counting Grid (b)

According to the direction command, the conditions in Figure 13 come into effect. The active clock edge coincides with either the low level or the high level of signal 2. Counting therefore takes place in accordance with forward or backward rotation of the shaft. Figure 14 gives the detailed circuit diagram of the shaft encoder. The counter used has a range of two decades and gives the BCD separately for each digit.

A 7-segment decoder-driver follows this for each of the two LED displays. The number of digits can be increased by cascading several stages.

For the purposes of explanation any bar in the pattern can be considered as the starting point and the counter reset to zero using the reset key. If now the disc is turned at any speed in either direction with respect to the stationary mark, the counter indicates the bar number difference with respect to the starting point. As only dc voltage coupling is used the rotational speed may have any arbitrary minimum value.

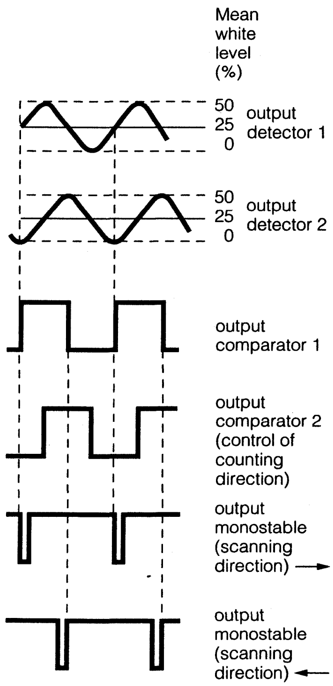


Figure 13. Waveforms—Shaft Encoder Operation with Direction Sensing

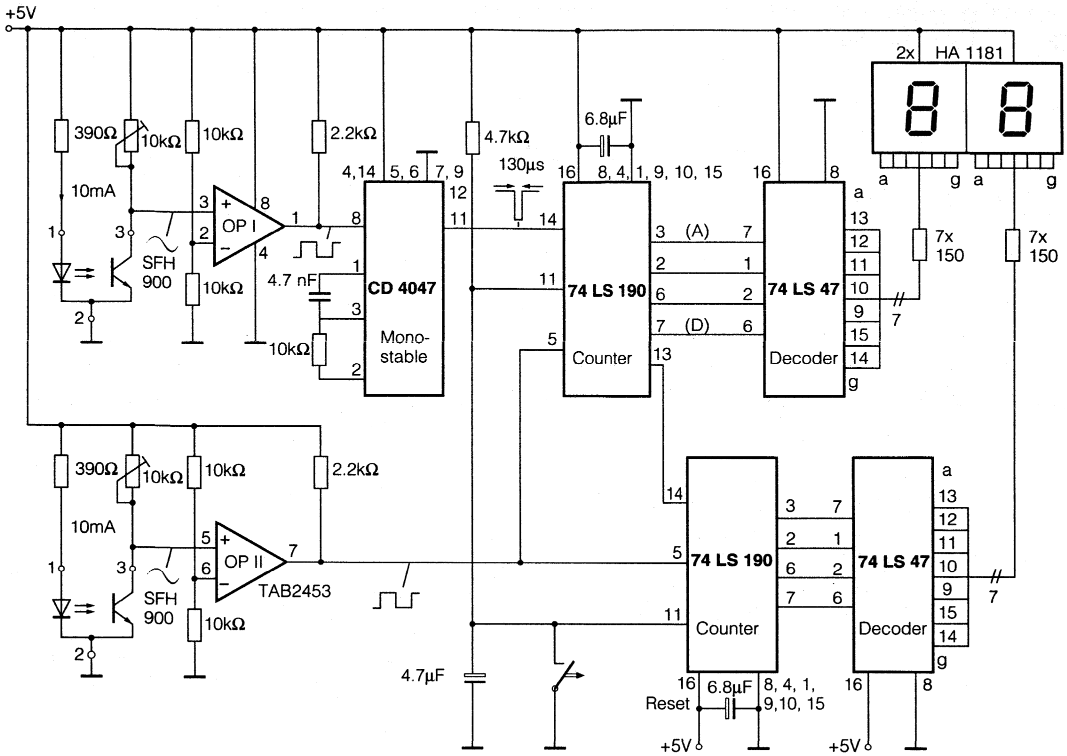


Figure 14. SFH900: Circuit for Shaft Encoder with Direction Sensing

SIEMENS

The DLO4135/DLG4137 5x7 Dot Matrix Intelligent Display® Appnote 28

by Dave Takagishi

This application note is intended to serve as a design and application guide for users of the DLO4135 and DLG4137 Siemens Intelligent Displays. This appnote covers device electrical description, operation, general circuit design considerations, and interfacing to microprocessors.

Electrical Description

The DLO4135/DLG4137 Intelligent Alphanumeric 5x7 Dot Matrix Display contains memory, character generator, multiplexing circuits, and drivers built into a single package.

Figure 1 is a block diagram of DLO4135/DLG4137. The unit consists of 35 LED die arranged in a 5x7 pattern and a single CMOS integrated circuit chip. The IC chip contains the column drivers, row drivers, 96 character generator ROM, memory, multiplex and blanking circuitry.

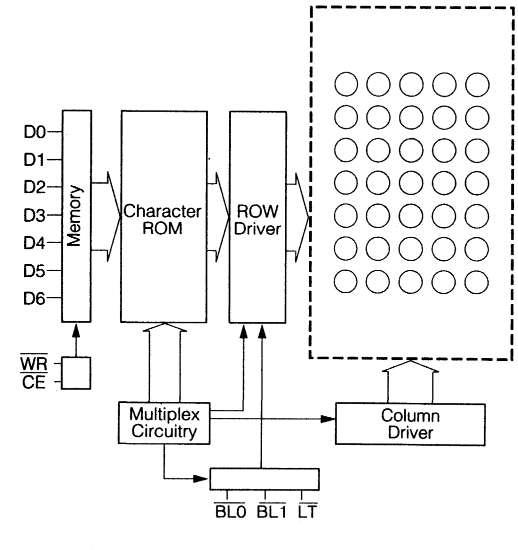


Figure 1. DLO4135/DLG4137 Block Diagram

Thirty-five dots form a 0.30 x 0.43 inch overall character size in a .500 x 1.00 inch dual-in-line package. The ±50 degree wide viewing angle complements the display and is the ideal display for industrial control applications. Display construction is a filled reflector type with the integrated circuit in the back and then filled with IC-grade epoxy. This results in a very rugged part which is quite impervious to moisture, shock and vibration.

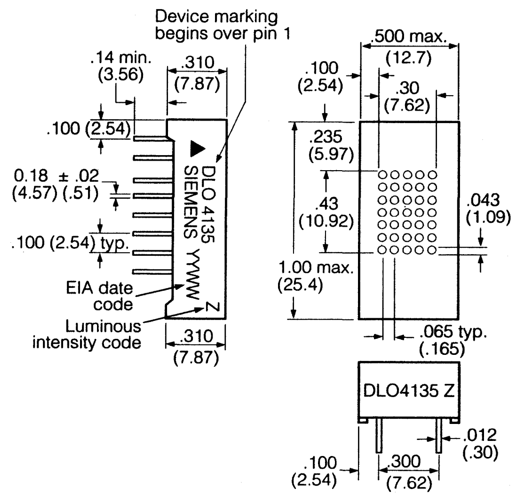


Figure 2. Physical Dimensions in Inches (mm)

DLO4135/DLG4137 Pin Functions

Pin	Function	Pin	Function
1	$\overline{LT}$ Lamp Test	9	D0 data LSB
2	$\overline{WR}$ Write	10	D1 data
3	BL1 Brightness	11	D2 data
4	$\overline{BL0}$ Brightness	12	D3 data
5	No Pin	13	D4 data
6	No Pin	14	D5 data
7	$\overline{CE}$ Chip Enable	15	D6 data MSB
8	GND	16	$+V_{CC}$

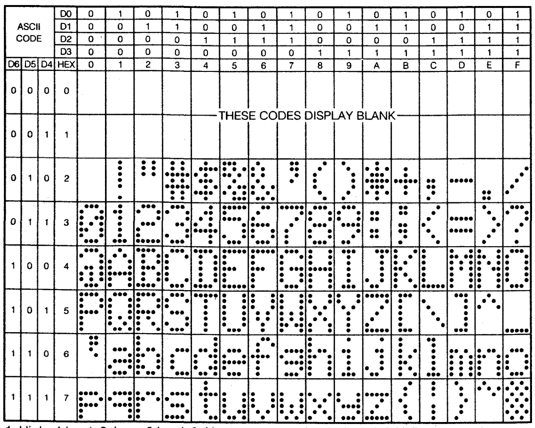
Pin Description

V_{CC}	Positive Supply +5 volts
GND	Ground
D0-D6	Data Lines, see Figure 3 (Character Set)
$\overline{CE}$	Chip Enable (active low) This determines which device in an array will accept data
$\overline{WR}$	Write (active low) Data and chip enable must be present and stable before and after the write pulse (see data sheet for timing)
$\overline{BL0}$,$\overline{BL1}$	Blanking Control Input (active low) Used to control the level of display brightness
$\overline{LT}$	**Lamp Test (active low)** **Causes all dots to light at** ½ brightness

Operation

In a dot matrix display system, it is advantageous to use a multiplexed approach with 12 drivers (5 digit plus 7 segments) rather than 35 segment drivers. This obviously reduces the number of drivers and interconnections required. A multiplexed system must be a synchronous system, or the digits or elements may have different on (lit) times and therefore varying brightness.

The DLO4135/DLG4137 is an internally multiplexed display, but the data entry is asynchronous. Loading data is similar to writing into a RAM. Present the data, select the chip, and give a write signal. For a multi digit system, each digit has its own unique address location and will display its contents until replaced by another code. The waveforms of Figure 4 shows the relationship of the signals required to generate a write cycle. Check the data sheet for minimum values required for each signal.



1. High=1 level. 2. Low=0 level. 3. Upon power up, the device will initialize in a random state.

Figure 3. Character Set

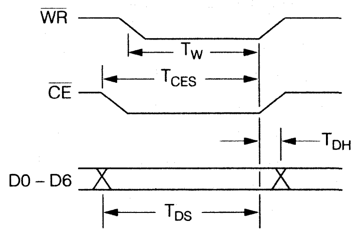


Figure 4. Timing Characteristics

Display Blanking and Dimming

The DLO4135/DLG4137 Intelligent Display has the capability of three levels of brightness plus blank. Figure 5 shows the combination of $\overline{BL0}$ and $\overline{BL1}$ for the different levels of brightness. The $\overline{BL0}$ and $\overline{BL1}$ inputs are independent of write and chip enable and does not affect the contents of the internal memory. A flashing display can be achieved by pulsing the blanking pins at a 1–2 hertz rate. Either $\overline{BL0}$ or $\overline{BL1}$ should be held high to light up the display.

Dimming and Blanking Control

Brightness Level	$\overline{BL1}$	$\overline{BL0}$
Blank	0	0
¼ brightness	0	1
½ brightness	1	0
full brightness	1	1

Lamp Test

The lamp test when activated causes all dots on the display to be illuminated at half brightness. It does not destroy any previously stored characters. The lamp test function is independent of chip enable, write, and the settings of the blanking inputs.

This convenient test gives a visual indication that all dots are functioning properly. The lamp test can be used as a cursor or pointer in a line of displays because it does not affect the display memory.

General Design Considerations

When using the DLO4135/DLG4137 on a separate display board having more than 6 inches of cable length, it may be necessary to buffer all of the input lines. A non-inverting 74365 hex buffer can be used. The object is to prevent current transient into the DLO4135/DLG4137 protection diodes. The buffers should be located on the display board and as close to the displays as possible.

Because of high switching currents caused by the multiplexing, local power supply by-pass-capacitors are also needed in many cases. These should be 10 volt, tantalum type having 5–10 uf capacitance. The capacitors may only be required every 6–7 displays depending on the line regulation and other noise generators.

If small wire cables are used, good engineering practice is to calculate the wire resistance of the ground and the +5 volt wires. More than 0.2 volt drop (at 100 ma per digit) should be avoided, since this loss is in addition to any inaccuracies or load regulation of the power supply.

The 5 volt power supply for the DLO4135/DLG4137 should be the same one supplying the V_{CC} to all logic devices. If a separate power supply must be used, then local buffers should be used on all the inputs. These buffers should be powered from the display power supply. This precaution is to avoid line transients or any logic signals to be higher than V_{CC} during power up.

Interfacing

For an eight digit display using the DLO4135/DLG4137, interfacing to a single chip microprocessor such as the 8748, is easy and straight forward. One approach may be to dedicate one port for the seven data signals and another 8-bit port for the write signals. The schematic is shown in Figure 6

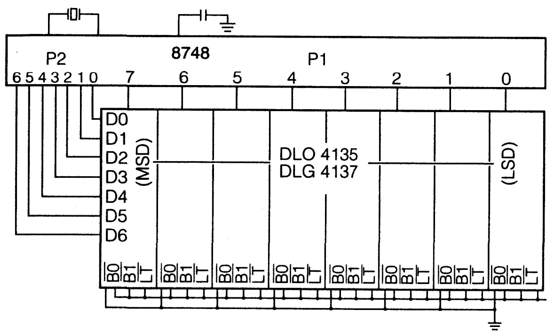


Figure 6. DLO4135/DLG4137 with 8748

I/O or Memory Mapped System

For a memory mapped system using a processor such as the 8080 or 8085, the interfacing is also straight-forward. Each display is treated as a memory location with its own address, like another I/O or RAM location. See Figure 7.

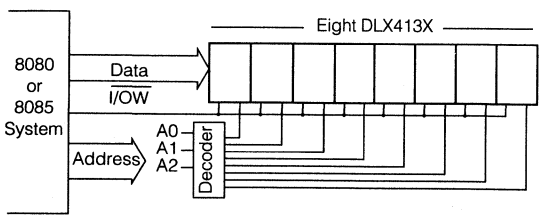


Figure 7. Block Diagram for 8-Digit DLO4135/DLG4137

Subroutine to Load an 8-digit Display using the DLO4135/ DLG4137

```
                                ; DATA IN RAM 10H-17H (MSD-
LSD)
INIT     ORL     P1,#0FFH       ; PORT 1 ALL HIGH (WRITE)
         ORL     P2,#00H        ; PORT 2 ALL LOW (DATA)
         MOV     R1,#OFH        ; RAM ADDRESS—1
         MOV     R2,#OFEH       ; WRITE PULSE
         MOV     R3,#08H        ; COUNTER
START:   INC     R1             ; INCREMENT RAM POINTER
DATA:    MOV     A,@R1          ; FETCH DATA FROM RAM
         OUTL    P2,A           ; LOAD PORT 2
         MOV     A,R2           ; RECALL WRITE
         RR      A              ; SHIFT A TO NEXT WRITE
         MOV     R2,A           ; SAVE WRITE
WRITE:   OUTL    P1,A           ; SEND WRITE PULSE
         MOV     A,#OFFH        ; WAIT
         OUTL    P1,A           ; RESET WRITE PULSE
         DJNZ    R3,START       ; LOAD COMPLETE?
         RET                    ; RETURN TO MAIN PROGRAM
```

Routine for an 8-Digit Display using the DLO4135/ DLG4137 and 8085 or 8080 Microprocessor

```
                          ; DATA TO BE DISPLAYED IS IN
                          ; A0 (LSD) THRU A7 (MSD)
                          ;
                          ; DISPLAY ADDRESS C00X
                          ; LSD IS RIGHT MOST DIGIT
                          ;
                          ; DOES NOT SAVE REG A,B,H,L,D,E
                          ;
DADD    EQU    0A000H     ; DATA ADDRESS LOCATION
DPAD    EQU    0C000H     ; DISPLAY ADDRESS
                            LOCATION
LEN     EQU    08H        ; DISPLAY LENGTH
                          ;
ORG     100H
                          ;
DISP:   LXI    H,DADD     ; LOAD DATA ADDRESS
        LXI    D,DPAD     ; LOAD DISPLAY ADDRESS
        MVI    B,LEN      ; LOAD DISPLAY LENGTH
DISP1:  MOV    A,M        ; GET DATA
        XCHG              ; XCHG H/L & D/E
        MOV    M,A        ; LOAD DISPLAY FROM REG A
        XCHG              ; RESTORE H/L & D/E
        INX    D          ; INCREMENT DISPLAY ADDRESS
        INX    H          ; INCREMENT DATA ADDRESS
        DCR    B          ; DECREMENT LENGTH COUNTER
        JNZ    DISP1      ; END OF DISPLAY?
        RET               ; RETURN TO MAIN PROGRAM
```

Conclusion

Note that although other manufacturers' products are used in the examples, this application note does not imply specific endorsement, or warranty of other manufacturer's products by Siemens. The interface schemes shown demonstrate the simplicity of using the DLO4135/DLG4137 dot matrix Intelligent Display. Slight timing differences may be encountered for various microprocessors, but can be resolved using similar methods as those used when using interfacing microprocessors with various RAMs. The techniques used in the examples were shown for their generality. The user will undoubtedly invent other schemes to optimize his particular system to its requirements.

SIEMENS

Serial Intelligent Display®
Appnote 29

by Dave Takagishi

This application note describes a method of obtaining a serial input display with a selected number of digits using an 8051/8031 microprocessor and DL2416 Intelligent Displays. The DL2416 has been used only as an example for this Appnote; other Intelligent Displays can be used instead.

Introduction

A parallel bus configuration is frequently used to transfer data to a microprocessor when it is used on a single card system. However, if the system is not physically small in number of chips or has multiple cards. data handling becomes cumbersome and costly. For long distances, serial communications over a two or four wire links is desirable and is economically attractive. However, the trade-off between cost and speed has to be considered by the designer.

Description

The DL2416 Intelligent Display is a .160" four character, 17 segment, LED display module with on-board memory, character generator, multiplexer and display drivers integrated into a custom integrated circuit. This eliminates the necessity to design external circuitry normally required to drive a multiplexed display. Using these important attributes of the Intelligent Display, the designer now only has to provide for interfacing, which is a seven-bit ASCII parallel code, a two-bit address, and a write signal. The procedure for writing these commands is similar to those used for an external Random Access Memory.

The serial/parallel and parallel/serial conversion is normally accomplished by using a UART (Universal Asynchronous Receiver/Transmitter) or a USART (Universal Synchronous/Asynchronous Receiver/Transmitter). The 8031 is a very attractive mircrocontroller to use in this application because it has an integral UART. This integral UART provides the designer with the means for controlling the conversion of serial into parallel information or vice-versa. The 8031 has more RAM than the popular 8048, but the operation and instruction sets are very similar. Refer to a 8031 data sheet for a complete description of the product.

Circuit Description

The block diagrams of the 8031 (Figure1) and the DL2416 (Figure 2) show the internal structure of these devices. By combining the DL2416, an easy to use peripheral device in a parallel system, and the 8031 results in a low cost, simple serial display system. A 32-digit system can be built using an 8031 microprocessor, an 8212 or equivalent latch, a 2716 EPROM, and a 75189 IC for interfacing to 20 mA or RS232 input lines. Buffers were added to minimize the long cable noise spikes and interface loading on the bus. See Figure 3 for system schematic.

Software Considerations

This system, as described, is set up to receive data only at 100 baud rate. Additional software is required for transmit routine. For a given data rate and (data format is start bit, 9-data bits and a stop bit) three sections of software and possibly a special crystal oscillator frequency may be required for a given transmit rate. On power-up or reset, the serial port and timer control words must be initialized.

Special control functions have been included in this program as follows:

- Power Up
- Return
- Backspace
- Line Feed

See Figure 5 for the actual program listing.

Conclusion

This Application Note has introduced the ease of interfacing the DL2416 to any microprocessor. By combining the DL2416 and the 8031, difficulties usually associated with serial conversion using software and its attendant timing problems can be easily overcome.

Siemens Optoelectronic Division does not endorse or guarantee other manufacturer's products used in this Application Note.

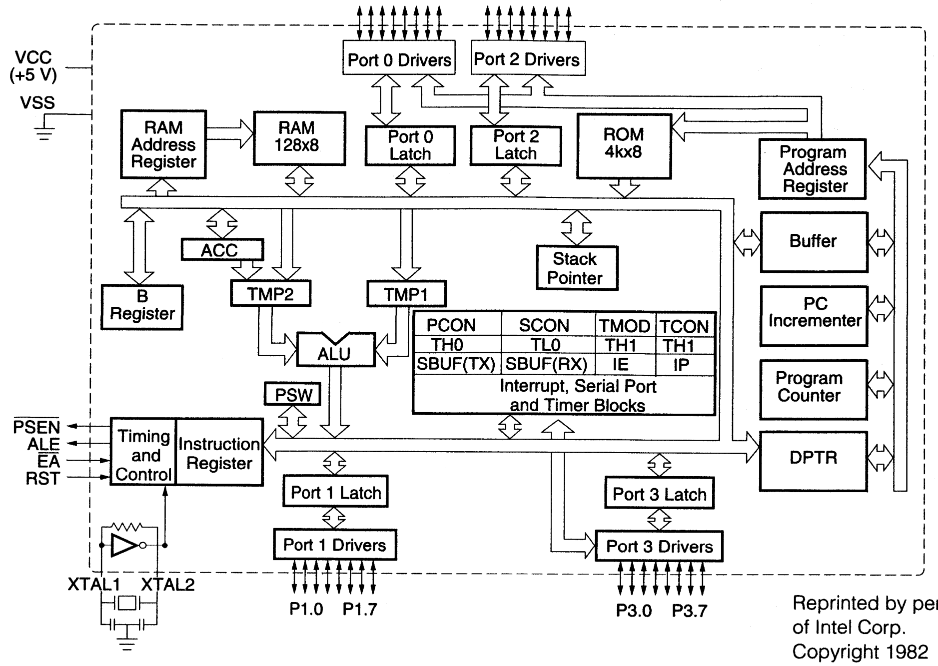


Figure 1. 8031 Block Diagram

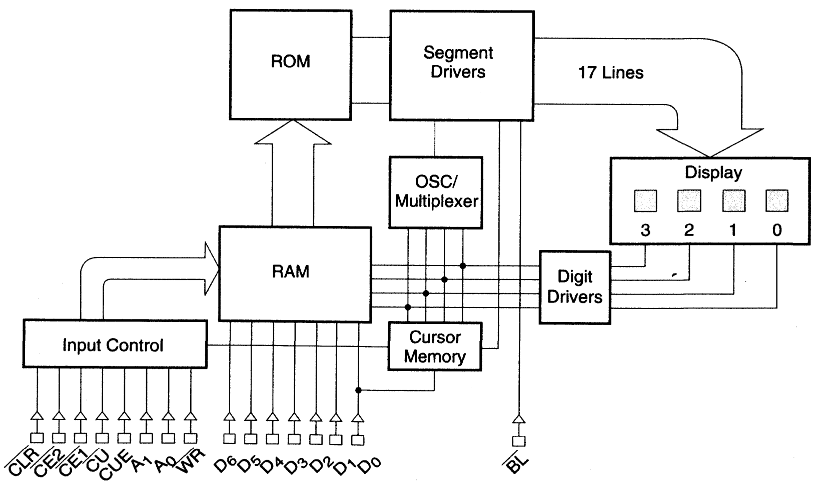


Figure 2. DL2416 Internal Block Diagram

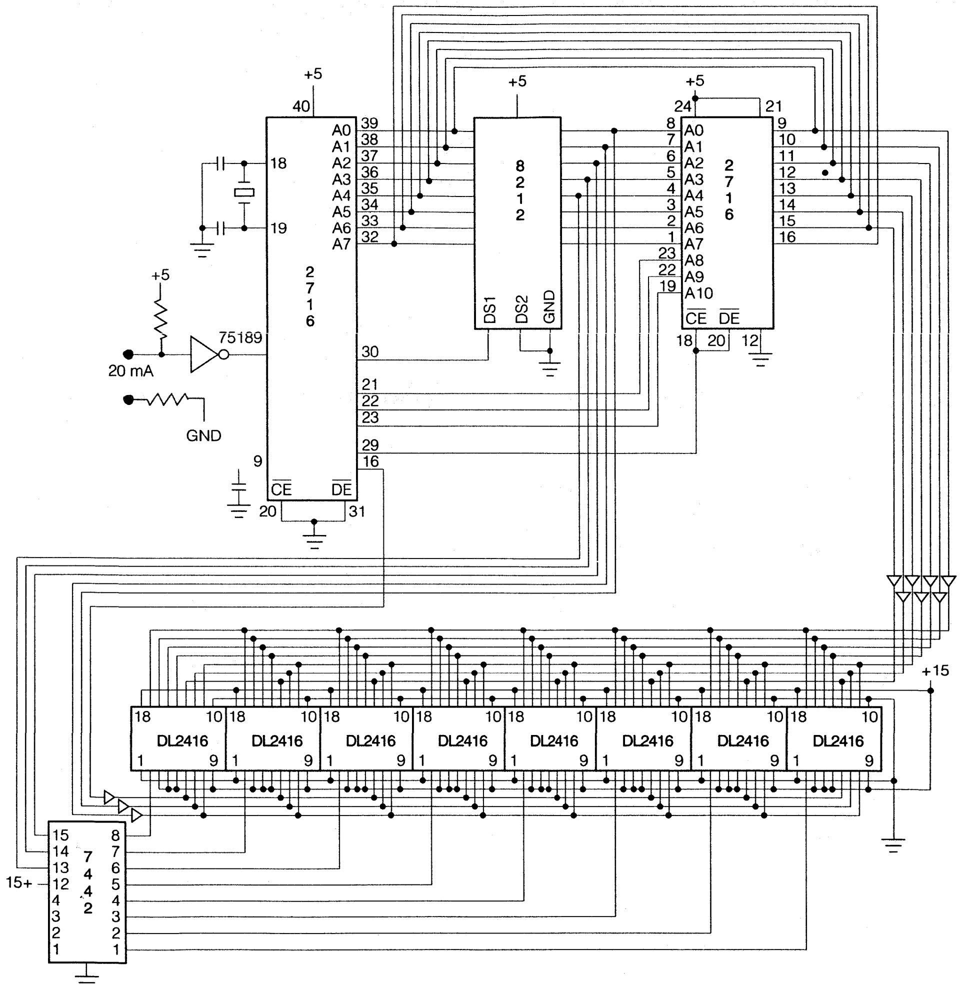


Figure 3. System Schematic

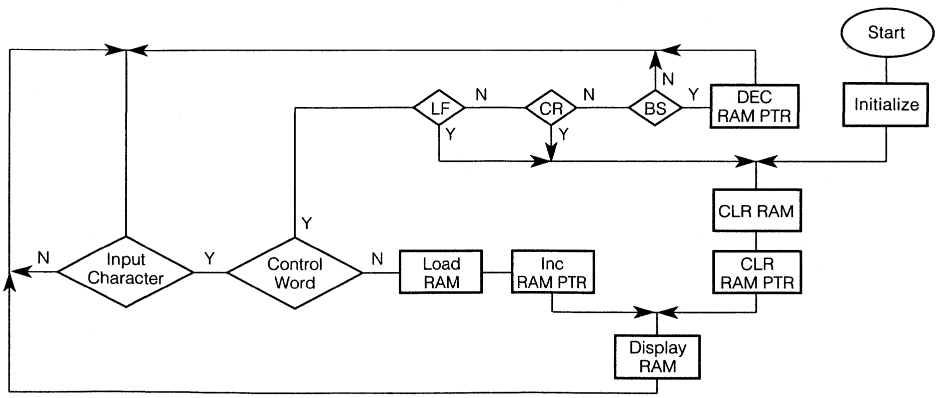


Figure 4. Serial IDA Flow Chart

```
                                                ;SERIAL IDA USING 8031 UP
                                                ;AND IEA2416-32
                          ORG      0000H
0000  020040              LJMP     INIT
                          ORG      0003H        ;EXTERNAL INTERRUPT 0
0003  32                  RTI
                          ORG      000BH        ;TIMER 0 OVERFLOW
000B  32                  RTI
                          ORG      0013H        ;EXTERNAL INTERRUPT 1       INTERRUPTS NOT USED
0013  32                  RTI
                          ORG      001BH        ;TIMER 1 OVERFLOW
001B  32                  RTI
                          ORG      0023H        ;SERIAL I/O INTERRUPT
0023  32                  RTI
                                                ;SETUP SERIAL PORT
                                                ;9 BIT UART MODE 3
                                                ;SET TIMER
                          ORG      0040H
0040  75A800    INIT:     MOV      IE,#00H      ;ENABLE INTERRUPTS
0043  758922              MOV      TMODE,#22H   ;TIMER 0 & 1 AUTO RELOAD
0046  758D72              MOV      TH1,#72H     ;RELOAD FOR 110             INITIALIZE 803 1 µP
0049  759870              MOV      SCON,#70H    ;MODE 3 RCV
004C  D28E                SETB     #8EH         ;TIMER 1 ON

004E  7920      CLRAM:    MOV      R1,#RAM      ;RAM INITIAL ADDRESS
0050  E4                  CLR      A
0051  7B20                MOV      R3,#CNTR     ;LOAD # OF DIGITS           CLR RAM
0053  F7        CLR1:     MOV      @R1,A        ;LOAD RAM
0054  09                  INC      R1
0055  DBFC                DJNZ     R3,CLR1
0057  7820                MOV      R0,#RAM      ;SET RAM INPUT PNTR TO INITIAL   CLR RAM PTR

0059  7B20      DISPRM:   MOV      R3,#CNTR     ;R3=COUNTER
005B  900000              MOV      DPTR,#DSPTR  ;DPTR=DISPLAY POINTER
005E  793F                MOV      R1,#RAM      ;R1=RAM DISPLAY POINTER+LENGTH   DISPLAY RAM
0060  E7        DISP1:    MOV      A,@R1        ;FETCH DATA FROM RAM
0061  F0                  MOVX     @DPTR,A      ;LOAD DISPLAY
0062  19                  DEC      R1
0063  A3                  INC      DPTR
0064  DBFA                DJNZ     R3,DISP1

0066  3098FD    SERIN:    JNB      RI,SERIN     ;WAIT UNTIL AN INPUT
0069  C298                CLR      RI                                       INPUT CHAR
006B  E599                MOV      A,SBUF

                                                ;CHECK FOR CONTROL WORDS
006D  FC        CNTLWD:   MOV      R4,A         ;SAVE A
006E  2460                ADD      A,#060H
0070  4013                JC       LDATA        ;JUMP IF DATA
0072  EC                  MOV      A,R4
0073  2473                ADD      A,#073H
0075  40D7      JC        CLRAM    ;CR
0077  EC                  MOV      A,R4
0078  2476                ADD      A,#076H                                  DATA=CR
007A  40D2                JC       CLRAM        ;LF
007C  EC                  MOV      A,R4                                     DATA=LF
007D  2478                ADD      A,#078H
007F  50E5                JNC      SERIN        ;OTHER CONTROL              DATA=BS
0081  18                  DEC      R0           ;BS
0082  020066              AJMP     SERIN

0085  EC        LDATA:    MOV      A,R4
0086  F6                  MOV      @R0,A        ;LOAD RAM
0087  08                  INC      R0
0088  E8                  MOV      A,R0                                     LOAD DATA INTO RAM
0089  24C0                ADD      A,#0C0H
008B  5002                JNC      LDAT1
008D  7820                MOV      R0,#RAM
008F  020059    LDAT1:    AJMP     DISPRM

END
```

SIEMENS

Blue Light Emitting Silicon-Carbide Diodes — Materials, Technology, Characteristics Appnote 31

by Dr. Claus Wyrich
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Introduction

Light-emitting diodes (LEDs) are widely used in the field of electronics as indicator lamps and seven-segment displays because of their excellent charactaristics such as high mechanical stability, low operating voltage. compatibility with semiconductor drive circuits, low operating temperature and long service life. LEDs are now mass produced in colors: red, super-red, yellow and green. The semiconductor materials that are used are III-V compounds such as gallium arsenide phosphide ($GaAs_{1-X}P_X$) gallium phosphide (GaP) and recently, also gallium aluminum arsenide ($Ga_{1-X}A1_XAs$). An extension of the color of LEDs into the blue region of the spectrum has been wished by many users. The materials that are suitable for blue-light diodes are discussed here, followed by a survey of the technology and characteristics of blue-light diodes based on silicon carbide (SiC), the material that is preferred for this application by the Siemens company.

Semiconductor Materials for Blue-light Emitting Diodes

For emission in the blue region of the spectrum $GaAs_{1-X}P_X$ or GaP is out of the question because the band gap is too small, limiting the wavelength of the emitted radiation towards the lower end. But there are other semiconducting compounds such as gallium nitride (GaN), zinc sulfide (ZnS), zinc selenide (ZnSe) and silicon carbide (SiC). GaN was investigated quite intensively for the purpose of creating blue-light LEDs at the beginning of the 70s. With but one exception however, industrial research into this semiconductor material was then discontinued. The major drawback is the fact that GaN cannot be pdoped with sufficiently low resistance. Thus the light in this semiconductor is not produced by the radiative recombination of injected charge carriers at the pn junction as with the other III-V materials, but by highly accelerated electrons that are generated in the very high-resistance i layer of a metal-i-GaN-n-GaN layer by collision-ionization processes and thus lead to the emission of light. The efficiency of this mechanism, which results in higher operating voltages of the device, decreases with increasing current density (and thus luminous intensity of the diode). The situation is similar in the case of blue-light diodes using ZnS and ZnSe materials, in which likewise no low-resistance pn junction can be produced. The result of this is that with all the materials mentioned, despite the direct band-gap structure that is favorable for the generation of light and which leads to very efficient photoluminescence or cathodoluminescence for instance, the efficiency of the internal conversion of electrical energy into light is lower in comparison. SiC is the only material that allows reproducible p and n doping and possesses a suitable band gap for the emission of light in the blue region of the spectrum. The advantage of a device that can easily be controlled in all its physical characteristics more than makes up for the fact that SiC has an indirect band-gap structure, which is less favorable for generating light.

Groundwork on SiC blue-emitting LEDs has been performed in Great Britain, the USSR, Japan and in the Federal Republic of Germany at Hannover Technical University. Proceeding from the work done in Hannover, the development of SiC blue-emitting LEDs was pursued in the Siemens research laboratories and diodes were created with the highest efficiencies known to date. Siemens is one of the first semiconductor manufacturers to have successfully produced such diodes in the laboratory.

Technology and Design of SiC LEDs

An essential feature of SiC is its appearance in several modifications with different band gaps. For the production of blue-light LEDs the hexagonal modification 6H (αSiC) is the most favorable. As with all known LEDs, with SiC LEDs too the active light zone consists of epitaxial, monocrystalline material deposited on a ptype substrate crystal. The layer is grown from an Si melt saturated with carbon (liquid-phase epitaxy) at temperatures between 1600 and 1700 °C, the p-type layer being doped with aluminum and the n-type layer additionally with nitrogen. The contacting and the diode structure are produced using the technologies already familiar with LEDs. The structure of an SiC lamp is shown in Figure 1.

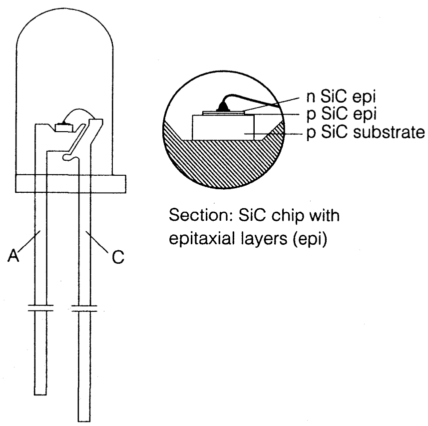
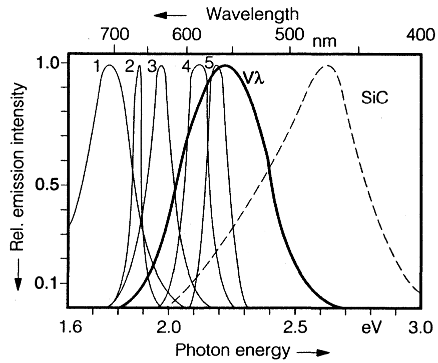


Figure 1. Schematic of an SiC LED (dia. 5 mm)

In additon to the high process temperatures, the major problem in SiC LED technology, compared to other semiconductor materials, is the lack of large-area substrate crystals — an absolute necessity where low manufacturing costs are concerned. Up to now it has been necessary to make do by preparing small crystal wafers of the appropriate modification from the kind of crystal clusters that appear as a by-product in the largescale industrial synthesis of SiC for producing grinding powder, but their diameter is no more than 10 to 14 mm. The big disadvantage of this is that the yield of suitable substrate crystals is only very small. At Siemens a substantial step towards a solution has now been taken. By means of a newly devised process, involving sublimation followed by condensation, monocrystals with a diameter of 15 mm and a length of 25 mm — that makes about 30 substrate wafers — were produced on a nucleus. This technology is, admittedly, considerably more elaborate than the technology of III-V semiconductors, so one cannot expect the price of blue-emitting diodes from SiC to fall to the level of more common LEDs; on the other hand though, an appreciable step towards mass production has thus been taken.

Characteristics of SiC LEDs

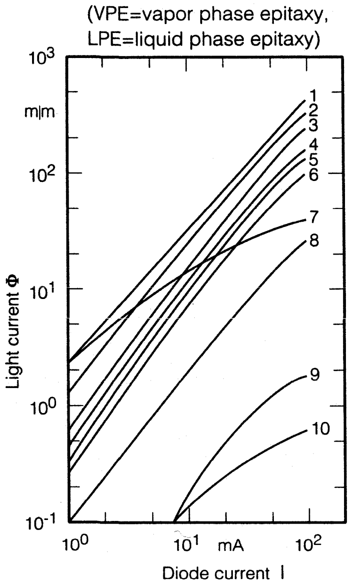
The emission spectrum of SiC LEDs and the dependence of the light current on diode current are illustrated in Figures 2 and 3 in comparison with other LEDs. Figure 4 shows the color locations of different LEDs on a standard color diagram. Whereas the red, yellow and green emitting diodes lie practically on the spectrum locus, the blue emitting SiC diodes exhibit two peculiarities. Their color location is not on the spectrum locus, and the dominant wavelength experienced by the observer shifts slightly with increasing diode current towards shorter wavelengths. Associated with this is a decrease in the rise and decay time of the luminescence from typically 0.9 ,µs (90-10%) at 5 mA to typically 0.5 µs at 50 mA. For a diode current of 20 mA the diodes have a luminous intensity of typically 4 mcd, the luminous efficiency being approximately 10^{-2} lm/V. A typical current/voltage characteristic is shown in Figure 5.



1 GaP:Zn,O
2 $GaAs_{0.6}P_{0.4}$ and $Ga_{0.65}Al_{0.35}As$
3 $GaAs_{0.35}P_{0.65}$:N
4 $GaAs_{0.15}P_{0.85}$:N
5 GaP:N

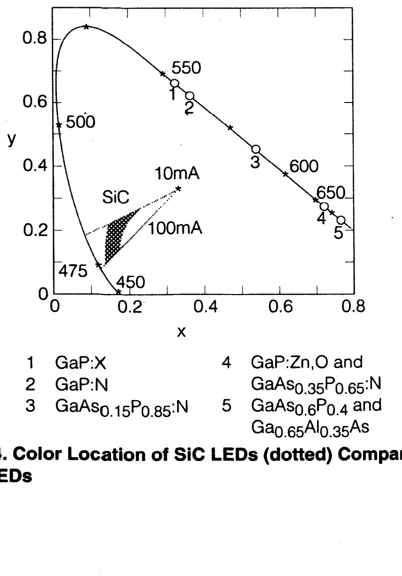
Based on $GaAs_{1-X}P_X$, GaP, $Ga_{1-X}Al_XAs$ and SiC in the visible spectral range

Figure 2. Photopic Luminosity (normal vision) V, and Emission Spectra of Different Light-emtting Diodes



1	$Ga_{0.65}Al_{0.35}As$-LPE	6	GaP:N-VPE
2	GaP:N-LPE	7	GaP:NZn,O-LPE
3	$GaAs_{0.35}P_{0.65}$:N-VPE	8	$GaAs_{0.6}P_{0.4}$-VPE
4	GaP:X-LPE	9	SiC:Al,N-LPE
5	$GaAs_{0.15}P_{0.85}$:N-VPE	10	GaN-MiS-VPE

Figure 3. Light Current/diode Current Characteristics Φ (I) of different LEDs



1	GaP:X	4	GaP:Zn,O and $GaAs_{0.35}P_{0.65}$:N
2	GaP:N	5	$GaAs_{0.6}P_{0.4}$ and $Ga_{0.65}Al_{0.35}As$
3	$GaAs_{0.15}P_{0.85}$:N		

Figure 4. Color Location of SiC LEDs (dotted) Compared to Other LEDs

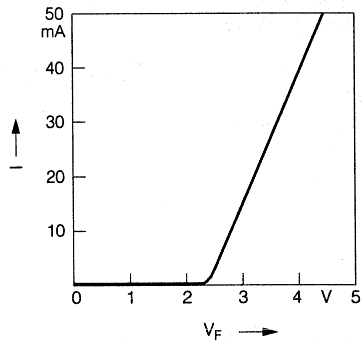


Figure 5. Current/voltage Characteristic I(V_F) of a Typical SiC LED

Applications and Prospects

The possible applications for SiC LEDs are all those in which small light emitters are required that are capable of emitting in the blue spectral range and are suitable for fast modulation (up to 500 kHz), in the scientific and technical field as a calibration light source for photomultipliers for example, in TV-camera engineering and photography, and as a radiation source in spectroscopy, biophysics and medicine.

It will no doubt be possible to make this technology cheaper through continuing development of the individual process steps that are involved. It should be emphasized once more, however, that the fundamental problems of SiC technology are such that the prices of conventional LEDs are not likely to be approached. This does not only apply to SiC, incidentally, but also to the other materials being considered for blue-light emitting diodes.

SIEMENS
Light Activated Switches
Appnote 33

1. Miniature Light Barrier for a Shaft Position Encoder or a Revolution Counter

Miniature light barriers are required for shaft position encoders, since light transmitter and receiver are closely facing each other by a distance of a few millimeters. For this application a practical combination is achieved by using the light emitting diode LD261 and the phototransistor BPX81. Both components have the same epoxy case with an edge length of 2.2 mm. The LED operates in the infrared range at about 950 nm, since the efficiency is essentially higher than that of the visible radiation. The circuit described in the following converts interruptions of a light beam into electrical pulses for counting.

The construction of a shaft position encoder is shown in Fig. 1.1. The distance between the transmitting and the receiving components is about 3 to 5 mm. Both are inserted in a hole with a diameter of 3 mm, whereby the opening is diminished to 1.4 mm at its front ends. A plastic disc carrying a line pattern at its circumference as shown in Fig. 1.2 is rotating between transmitter and receiver. A pervious section follows a non-pervious one and the angle position of the disc is determined by counting the quantity of sections having passed.

Fig. 1.1

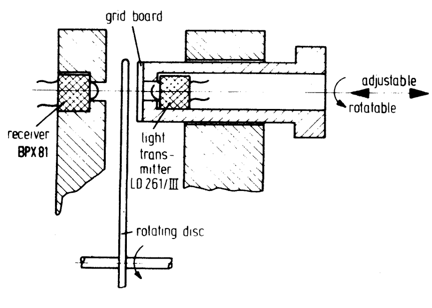
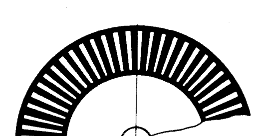


Fig. 1.2

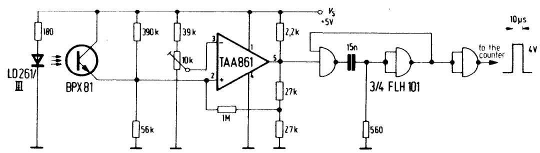


Assuming that the rotating disc with a diameter of about 50 mm has a pattern of 600 lines, the distance between two lines is about 0.25 mm. To increase the light-to-dark ratio at the receivers side a plate with the same grid structure is mounted in front of the transmitter-hole as shown in Fig. 1.3. If the position of the grid on the rotating disc coincides with the one of the plate, the phototransistor receives a maximum of light. If both grid patterns are displaced with half the distance of two lines, the received light becomes a minimum. As the transmitter is rotatable and adjustable in its position an efficiency maximum can be achieved.

Fig. 1.3

The circuit is shown in Fig. 1.4. The emitting diode LD261 is operated at a current of about 20 mA.

Fig. 1.4



Technical Data

Supply voltage V_s	5 V
Supply current (total) I_s	35 mA
Wave-length of the transmitted light	950 nm
Maximum counting frequency	40 kHz
Duration of the output pulses	10 µs
Amplitude of the output pulses	4 V

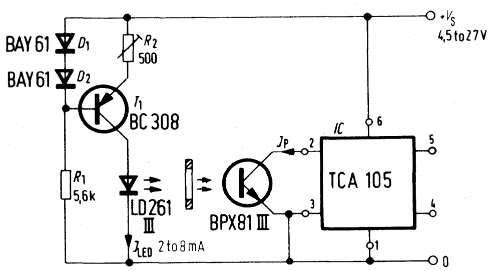
The collector current of the potentiometer varies between about 3µA (minimum) and about 12µA (maximum) when the disc is rotating. Since the minimum value is to be kept constant, strong ambient light influences have to be eliminated.

The current variation is sufficient to safely trigger the op amp TAA 861, which serves as a Schmitt-trigger. The following NAND-gates (FLH101) operating as monostable multivibrator produce a definite square pulse with a duration of about 10 μs, for each line passing the light barrier. The circuit operates up to a frequency of 40 kHz, which corresponds to about 4000 r.p.m. of the disc.

2. Light Barrier using TCA105

The light barrier shown in Fig. 2.1 consists of the GaAs light-emitting diode LD261, the phototransistor BPX81 and the integrated threshold switch TCA105. The LED is operated at a constant current to meet the total range of the power supply voltage being between 4.5 V and 27 V. The IC itself is specified for a wider range. The constant current source is realized by the transistor T_1, the diodes D_1 and D_2 as well as the two resistors R_1 and R_2. By the two diodes an independent, nearly constant voltage is achieved at the base of T_1. The constant current of the transistor can be adjusted by the potentiometer R_2.

Fig. 2.1

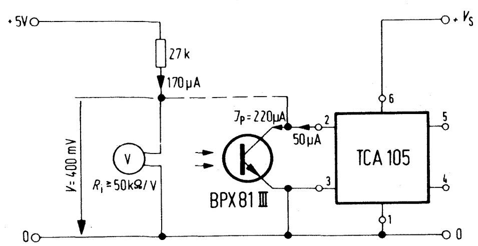


Parameter changes of the components created by temperature and aging effects are compensated for if the photocurrent of the phototransistor is chosen four times higher than the required input threshold current of the TCA105, i.e. about 200 μA. The output signal is available at the two antivalent outputs of the IC (pins 4 and 5).

Adjustment

The light barrier is adjusted by setting the LED-current. If the IC is operated in the test circuit as shown in Fig. 2.2, the current of the LED has to be set in such a way that a voltage of 400 mV is available between pins 1 and 2 of the TCA105.

Fig. 2.2



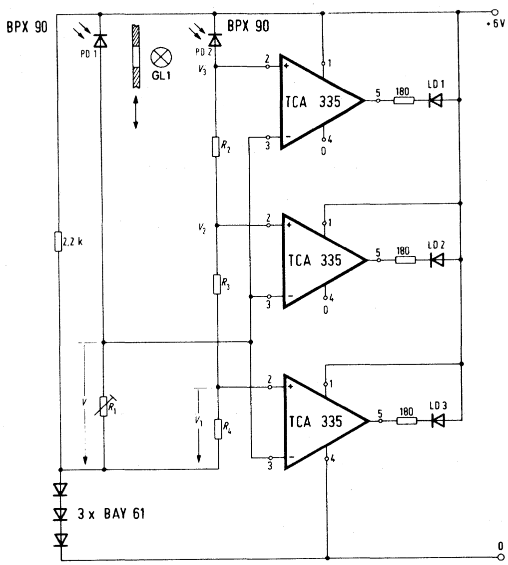
Technical Data

Supply voltage	4.5 to 27 V
Supply current	3.5 to 11.3 mA
LED current	2 to 8 mA
Supply current of the IC	3.3 mA
Ambient temperature range	−25 to +70 °C.

3. Optical Weight-Quantizer for Large Scales

The optoelectronic circuit described in Fig. 3.1 facilitates the weight quantization of large scales, whereby a 3-stage LED-display indicates the difference of the adjustment.

Fig. 3.1



The incandescent lamp Gl_1 illuminates the two photodiodes PD_1 and PD_2. The first is covered by a slot diaphragm, which is moved up and down by the balance arm of the scale with a stroke of 4.5 mm, corresponding to the balance difference. A voltage, being proportional to the balance difference, drops across the resistor R_1 and is supplied to the three op amps TCA335 operating as threshold switches. The reference voltages V_1, V_2 and V_3 are produced by the photocurrent of the photodiode PD_2 and drop across the resistors R_2, R_3 and R_4. They are supplied to the non-inverted inputs of the TCA335. If the voltage across the resistor R_1 exceeds the reference value then the corresponding LED's LD_1, LD_2 and LD_3 are switched on. An inverse function can be achieved by interchanging inputs 2 and 3 of the op amps. Since both photodiodes are illuminated by the same incandescent lamp, brightness changes created by aging or supply voltage variations are ineffective.

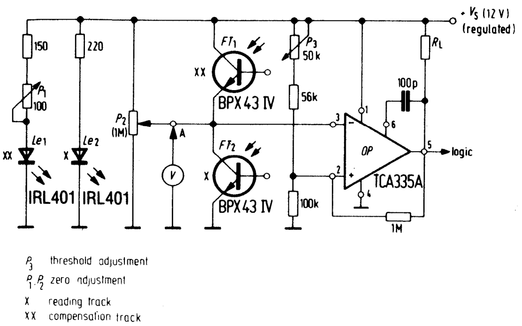
The common mode voltage, necessary for operating the op amps drops across the diodes $D1$, D_2 and D_3.

4. Optically Code Reading Regardless of whether Different Kinds of Papers have Different Reflexion Coefficients

When identifying stroke markings placed on different kinds of papers, the uncertainty exists that the code is erroneously read due to different reflexion coefficients.

The circuit described in the following and shown in Fig. 4.1 avoids this difficulty by means of an additional compensation track. The two phototransistors FT_1 and FT_2 being connected in series serve as a voltage divider, the center tap of which is joint to the inverted input of the amplifier OP. To each phototransistor belongs an LED.

Fig. 4.1



Both are connected in parallel, whereby the pair consisting of Le_1 and FT_1 serves for the compensation track and the one incorporating Le_2 and FT_2 functions for the reading track.

Therefore, the influence of a reflexion coefficient of the paper is eliminated and the reading result is determined only by the different reflexion of the strokes.

Adjustment Procedure

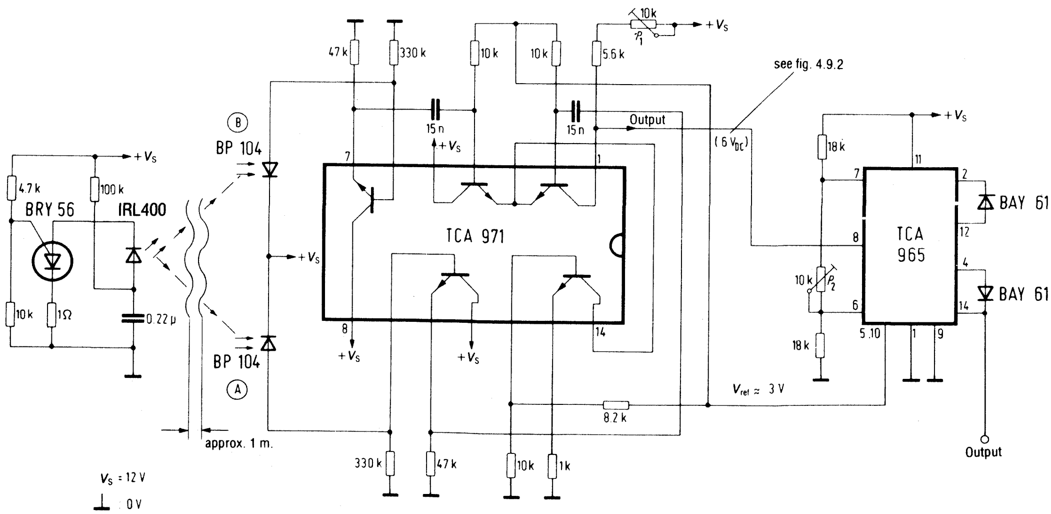
Firstly, the potentiometer P_2 is adjusted so that a level of $0.5 \times V_S$ is measured at point *A*. During this procedure the phototransistors have to be completely covered. Then a paper of any kind without stroke markings is inserted into the readchannel and P_1 is adjusted in such a way that point *A* has a level of $0.5 \times V_S$. The threshold for the stroke markings is determined by the potentiometer P_3.

5. Light Barrier Indicating the Direction of Interruption

It is generally important to know not only that a light barrier has been passed but also from which direction the passing occurred. These requirements can be met by using the window discriminator TCA965 with RS memory function. Two receiver diodes are necessary to indicate the passing direction (see Fig. 5.1).

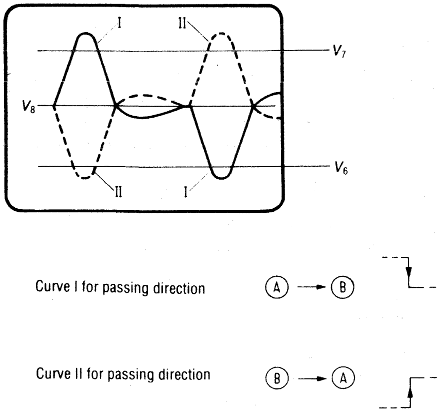
The LED IRL400 operates as a transmitter diode. It is supplied with short current pulses of approx. 1A peak value and a repetition period of 30 ms. These pulses are generated by the programmable unijunction transistor BRY56. The emitted light pulses are received by the diodes BP104. They are connected to two transistors operating as emitter followers. The transistors are connected to a differential amplifier via a 15 nF-capacitor each. The output signal of the TCA971 is supplied to pin 8 of the window discriminator.

Fig. 5.1



No signal is available from the differential amplifier if both receiver diodes are covered and when both receive light. If the diode A is not met by the light beam, the voltage V_8 at pin 8 is greater than that at pin 7. If the diode B is not met by the light beam, V_8 is lower than V_6 (see Fig. 5.2).

Fig. 5.2



If the light barrier is passed from A to B, an L-level is available at pin 14 (curve I). But if it is passed from B to A, pin 14 shows an H-level (curve II).

The sensitivity of the curcuit is adjustable by potentiometer P_2. Potentiometer P_1 sets the dc level of the output symmetrically to V_6 and V_7. The five transistors are combined in the transistor-array TCA971.

Thus, a very good temperature behaviour of the differential amplifier is obtained. The reference voltage V_{10} at pin 10 of the TCA965 is also utilized by the constant-current source of the TCA971.

6. Infrared Reflex-Light Barrier with IRL400 and TDA4050

The transmitter of this circuit is an IR-LED, type IRL400, emitting a strongly focused light beam. TDA4050B is used as receiving preamplifier. When using a triplet mirror with an area of about 20 cm^2 as reflector, the maximum distance is at least 10 m. The allowed interfering light in lens axis is up to 200 lux (incandescent lamp light). This corresponds to a white surface illuminated at 50 klx over the whole irradiation of the receiver. Emitter and receiver can be placed in the same housing. The circuit is particularly suited for decoding fast changing codes (e.g. running bar patterns) and as a light barrier.

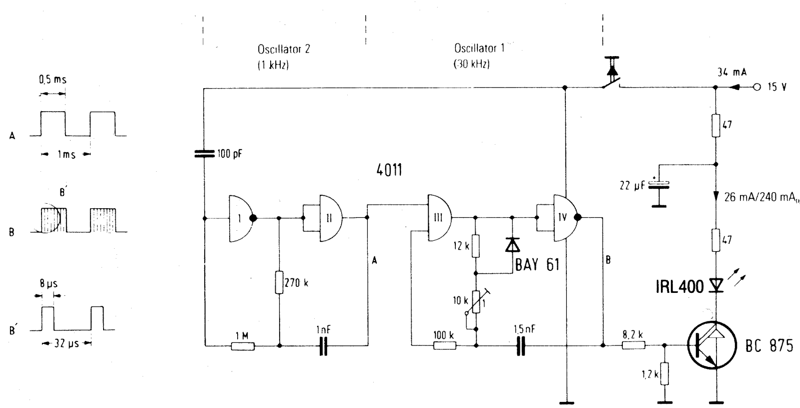
Contrary to IR remote controls, IR reflex-light barriers require only very narrow emitting and receiving characteristics. Because of the short reaction time required, a continuous emitter signal is also needed. Therefore, the pulse currents cannot be as high as with remote controls as this operation would exceed the admissible power dissipation.

Transmitter

A circuit consisting of 2 CMOS-NAND-gates (Fig. 6.1) generates a square-wave oscillation with a frequency of approx. 30 kHz. The pulse duty factor is fixed at 4:1. According to experience, a good efficiency is achieved herewith. To obtain the desired ratio between pulse duration and pulse space, the discharging resistor is partially bypassed by a diode. The 30 kHz-carrier is 1 kHz-modulated by a second pair of gates. When decoding running bar patterns, this modulation is not necessary as the object itself will be the source for the modulation.

A Darlington stage with BC875 drives the transmitter diode with peak currents of 200 to 250 mA, resulting in a mean diode current of around 25 mA. Without modulation, the mean diode current would reach twice this value.

Fig. 6.1



Receiver

The IR signal received by the photodiode BP104 (Fig. 6.2) is amplified through a transistor stage by 20 dB. The gain is determined by the collector resistance of 4.7 kΩ as well as by the 1.8 kΩ-input impedance of TDA4050B. The coupling capacitance of 22 nF and the RC circuit of the emitter reduce drastically low frequency-signals, especially the 50 and 100 Hz-components mainly present in artificial light.

The integrated circuit TDA4050B has a gain of about 60 dB between input and output. In order to limit the bandwidth, an active filter consisting of a double-T-section is connected between pin 4 and 5. Thus, the bandwidth is limited to approx. 10 kHz.

The gain of the TDA4050B depends on the potential at the control input (pin 2). Normally only a capacitor, being charged to a level of 1 V without signal, is connected to this terminal. In the circuit, according to Fig. 6.2, a bias of 1.85 V is set via a voltage divider and the gain is reduced by approx. 20 dB therewith. This is necessary as otherwise, with the increased gain at the output, short-time peaks could result from the control action and would disturb the function. Notwithstanding the adjustment of the basic gain at pin 2, the automatic control is preserved, avoiding an overdrive of the receiver. Due to different charging and discharging resistors of the TDA4050B, downward control is very fast but upward control is relatively slow. The controlling time-constant is determined by the capacitor connected to pin 2.

When the input signal at the photodiode exceeds a signal current of 5 nA_{pp}, the output at pin 3 becomes negative.

Acoustic Indication and Evaluation

Should the incoming signal be acoustically indicated, pin 3 has to be connected to an evaluation circuit. It consists, for example, of a loudspeaker with a transistor BC309. Besides that, with this circuit the limit range can be easily defined as the tone becomes undefined when the maximum range is exceeded.

Optics

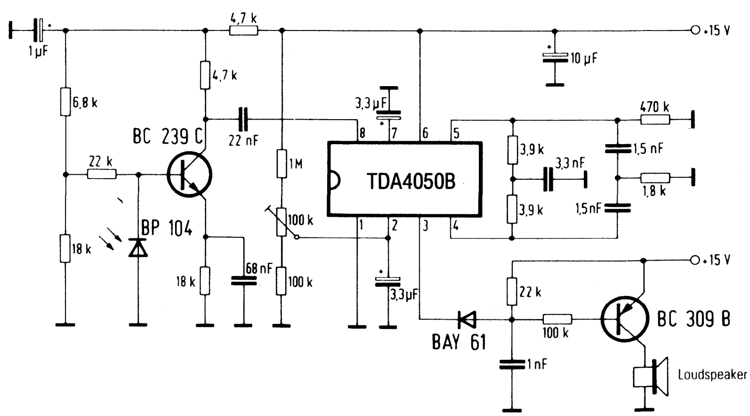
For the receiver, a collecting lens with a diameter of 15 mm and a focal length of 30 mm is used. Thus an effective receiver area 30 times larger than with photodiode BP104 is achieved. At the same time the angle of irradiation is restricted to $\pm 3°$. With an increase of the lens diameter the range increases proportionally. But an increase of the focal length at the same time will limit the angle of irradiation.

For the transmitter, no additional optic is used, but the parasitic radiation remainder outside the cone becomes inoperative by means of a blackened tubus.

Electrical Features

The transmitter must be well shielded against the receiver so that the highly-sensitive receiver input cannot be disturbed. The electrical separation of the lines signals is sufficiently obtained by the filter circuits mentioned.

Fig. 6.2



Technical Data

a) Transmitter

Supply current at $V_S = 15$ V	
unmodulated	60 mA
with 1 kHz-modulation, duty cycle 0.5	34 mA
Carrier frequency (square wave oscillation)	30 kHz
Duty cycle of carrier	0.25
Carrier-pulse-peak radiant intensity	100 mW/sr
Opt. wavelength	950 nm
Cone of radiation (half-angle)	6°

b) Receiver

Supply current at $V_S = 15$ V	
without load (loudspeaker)	10 mA
load (loudspeaker) only	18 mA
Angle of irradiation with lens	±3°
Intermediate frequency	30 kHz
Bandwidth (3 dB)	10 kHz
Min. pulse-peak-radiant-power to diode BP 104	10 nW
Max. modulation frequency	
at standard sensitivity	5 kHz
at reduced sensitivity	10 kHz
Dynamic range	60 dB
Max. interfering light (incandescent lamp light in lens axis)	200 lux

c) Total circuit

Supply current at $V_S = 15$ V	max. 70 mA[1])
Range with simple triplet mirrors as reflector	
Seize of reflector 20 cm^2	approx. 12 m
Seize of reflector 1000 cm^2	approx. 80 m
Range with top-quality pentaprism as reflector	
seize of reflector 25 cm^2	approx. 20 m

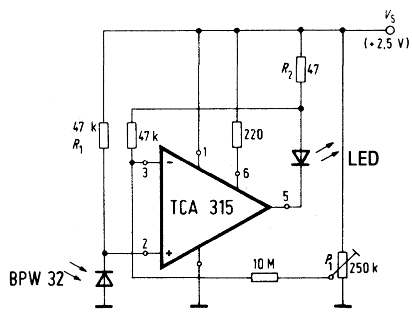
[1]) Without modulation and load (loudspeaker)

7. Current Control of LEDs as a Function of Ambient Light

A brightness control of LEDs is required especially when the ambient light intensity varies within a wide range. Fig. 7.1 shows a circuit for this application. It operates sufficiently even at a supply voltage of only 2.5 V. In complete darkness the LED is driven with a current of 100 μA. If the intensity of the ambient light rises, the current, i.e., the brightness of the LED, increases accordingly. At daylight the LED is operated by an impressed current of 5 mA/100 lux.

The ambient light intensity is sensored by the Silicon photodiode BPW32. The signal is amplified through the Darlington operational amplifier TCA315. The sensitivity of the circuit is determined by the resistances of R_1 and R_2. The LED current exceeds the one of the photodiode by a factor of 1000 with the exception of in darkness, where the LED-current is 100 μA, as described above.

Fig. 7.1

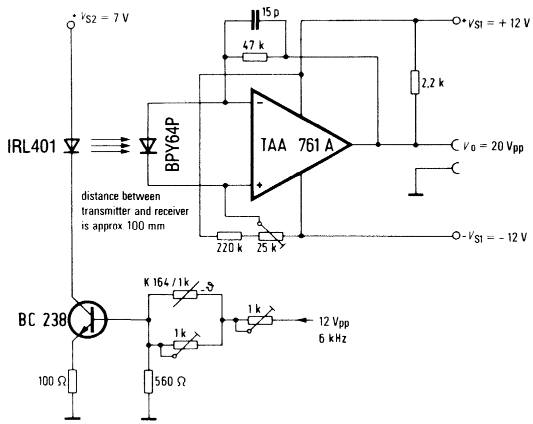


The current referring to a complete darkness is adjusted by the potentiometer P_1. The total supply current is 220 μA plus the LED-current (at V_S = 2.5 V).

8. Temperature-Response Compensation of the LED IRL401

Fig. 8.1 shows a circuit which is especially favored for compensating temperature effects of the LED IRL401. It is used in a light barrier operating with modulated light. The max. diode current is rated to 50 mA_{pp} and the temperature range is +10° to +55°C.

Fig. 8.1



The NTC-resistor K 164 has been connected to the base of the transistor BC238 and not directly to the LED as usually practiced. This measure reduces the self-heating of the thermistor. The control characteristic is adjustable by the two 1-kΩ-potentiometers. To obtain a temperature drift of only 2.5% for the complete circuit in the mentioned temperature range, the resistance of the potentiometers should be set to a value of approx. 500 Ω each.

It should be mentioned for comparison purposes that the output voltage shifts about 20% when the circuit has no compensation.

The photovoltaic cell BPY64P operates as a detector in conjunction with an amplifier circuit. For processing a square-wave voltage with a frequency of 6 kHz, it is recommended to drive the photovoltaic cell BPY64P in a short-circuit operation. This will advantageously be realized by using the operational amplifier TAA761A operating with an impressed input current.

9. Reflection Light Barrier

This circuit is applicable for realizing a reflection light barrier. If, however, there are no requirements for improved sensitivity and reduced immunity against undesired influence of ambient light, this circuit can be simplified.

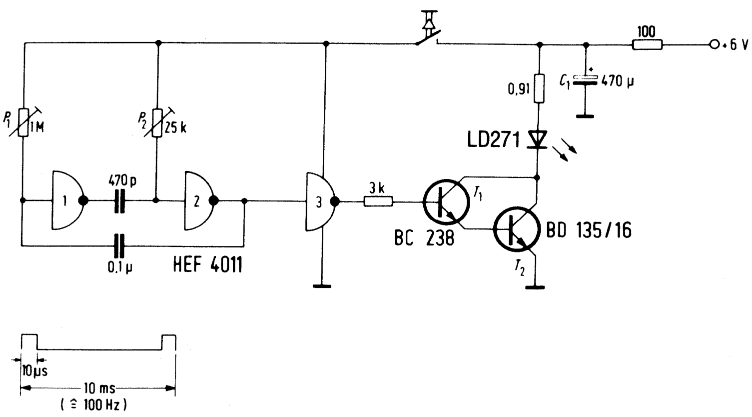
The circuit described in the following reacts within a range of 1 m, regardless as to whether the light is reflected from the human skin or from textiles.

Transmitter

The pulse generator of the transmitter circuit shown in Fig. 9.1 operates with a CMOS-gate, type HEF4011[1], and produces pulses with a duration of 10 µs and a repetition frequency of 100 Hz. The peak current of 1.5 A required by the LED, type LD27, is supplied by the Darlington stage consisting of T_1 and T_2. The electrolytic capacitor C_1 operates as a buffer. The pulse duration is adjustable by potentiometer P_2 and the repetition frequency is set by potentiometer P_1. Under the assumption of a duty cycle 1000:1, an average current of 1.7 mA is required for the complete transmitter circuit.

[1] HEF4011 refers to RCACD4011

Fig. 9.1



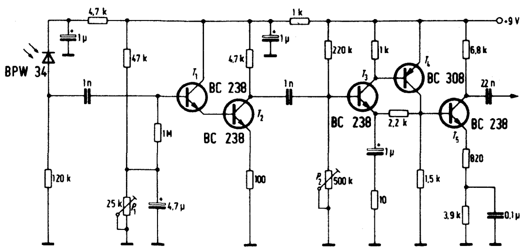
Characteristics

Supply voltage	6 V
Supply current	1.7 mA at V_s = 6 V
Pulse interval	10 ms
Pulse duration	10 µs
Half angle of the radiation cone	35°

Receiver

The broadband receiver circuit shown in Fig. 9.2 is applicable if the ambient light is less than 500 lx. For realizing the infrared filter in front of the photodiode BPW34 a non-exposed but developed color film, type CT18 (Agfa) is used. The signal supplied from the BPW34 is amplified by the transistors T_1 to T_5 and is available at the output with an amplitude of 6 V_{pp}. The gain is about 20,000. The operating point of T_5 is adjusted by the potentiometer P_2, setting a dc-level of 3 V to the base of T_5. The output signal is symmetrized by potentiometer P_1 which determines the operating point of the transistor T_2.

Fig. 9.2



Characteristics

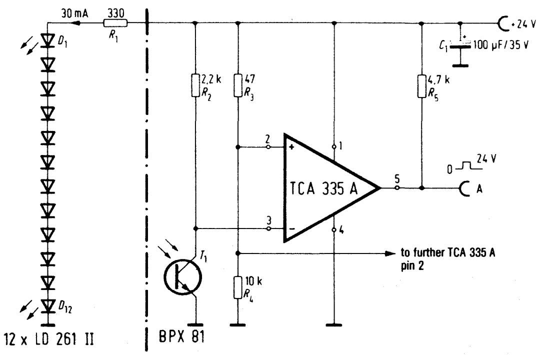
Supply voltage	9 V
Supply current	5 mA at Vs = 9 V
Gain	20,000
Output voltage	6 V_{pp}
Noise (without ambient light)	approx. 0.5 V
Operating range in conjunction with the above described transmitter, reflection from skin or textiles	max. 1 m

10. Optoelectronic Steel Tape Reader

Under more adverse conditions steel tape is often used instead of normal punched tape for reading control data into numerically controlled machine tools. The circuit proposed here is based on a configuration with 12 bit parallel read-in. The LEDs associated with the 12 bit are connected in series and supplied through the resistor R_1 from the 24 V supply. Each bit is allocated a phototransistor BPX81 and operational amplifier TCA335A. The phototransistor is connected to the inverting input of its associated operational amplifier, so with incident light (hole in the tape) the voltage at pin 3 of the TCA335A drops. A positive pulse then appears at the output.

Up to an ambient temperature of 40°C the LEDs require no additional cooling. Compared with tape readers employing light bulbs, the LED configuration is more robust, requires less maintenance and its power consumption is a factor of 10 lower. Reader errors cannot occur in practice because if a LED goes open circuit all 12 are without current and the fault is immediately apparent.

Fig. 10.1



Application Notes 11

SIEMENS

Remote Control
Appnote 34

1. Simple Infrared Remote Control with Low Current Consumption

For remote-controlled switch operation only a very simple circuit is needed. The infrared signal consists of a 20 kHz burst with a duration of approximately 1 ms. To reduce the interference by ambient light and flashes, an integrating circuit is connected to the receiver which will only supply a trigger pulse after having been applied by a series of pulses.

Transmitter

A 20 kHz oscillator consisting of two CMOS-NAND gates (Figure 1.1) is used. As long as gate 2 has L-level, the oscillation is interrupted. After pressing key T, H-potential is applied to the input of gate 1 as well as to the output of gate 2 and the oscillator starts operating. After a certain time, determined by the time constant of the R_1C_1 circuit, the voltage at the input of gate 1 drops below the minimum H-level threshold and thus the oscillation is interrupted. The time constant of R_1C_1-circuit is dimensioned for a burst length of 1 ms. The 1 nF capacitor, connected to output of gate 1, suppresses pulse spikes during turn-on.

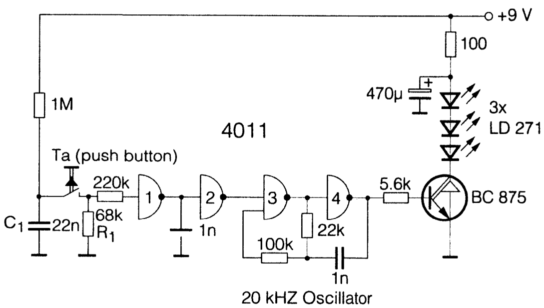


Figure 1.1

Due to the oscillation at the output of G_4, the Darlington transistor BC875 is periodically conductive. The transmitter diodes, type LD271 are operated at peak currents of up to 1 A. The energy is supplied during 1 ms by the 470 µF capacitor. Its voltage drops by a value of 1 V during the burst.

Receiver

The photodiode BP104 with integrated IR filter is used as a load with a resistance of 56 kΩ (Figure 1.2). At normal ambient light this resistance is low enough not to generate a voltage drop. The next stage is an emitter follower with an input impedance of approximately1 MΩ. In conjunction with the second stage a gain of 100 is achieved. The dc operating point is controlled by means of an inverse feedback. By the next two stages, being also part of the inverse feedback circuit, the signal is further amplified by a factor of approximately 100.

The input signal, amplified totally by a factor of 10,000 is supplied to an integrated rectifier circuit. At each pulse the 10 nF capacitor is charged by a voltage that depends on the ratio of the capacitors (680 pF and 10 nF). As soon as the threshold of the transistor being connected to the rectifying circuit is reached, a pulse with a positive switching edge is generated. It is steepened by means of four inverters. This edge triggers the following JK-flip-flop 4027 operating as a monoflop. At its output a defined pulse is available for triggering the following flip-flop 4027. In this case antivalent outputs are used to drive a red or a green LED.

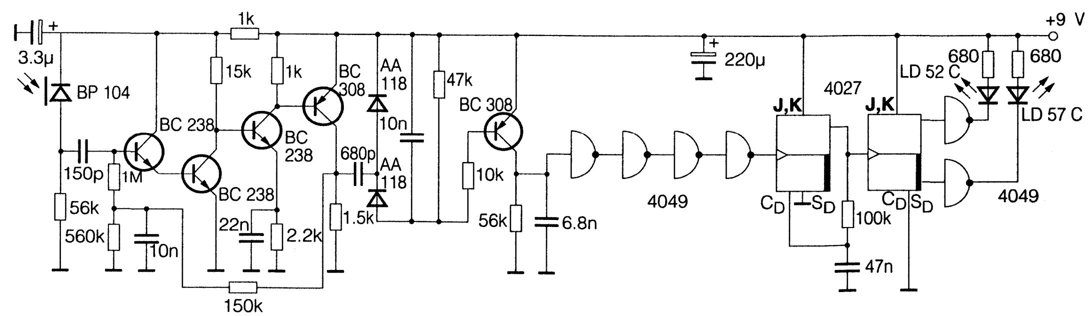


Figure 1.2

Technical Data

Transmitter	
Supply voltage	9 V
Pulse width (single pulse)	1 ms approx.
Carrier frequency	20 kHz approx.
Peak current	1 A approx.
Receiver	
Supply voltage	9 V
Supply current (without LED)	2 mA
Intermediate frequency	20 kHz approx.
Gain	80 dB approx.
Range	≥ 15 m

2. Power Saving Infrared Transmission — One Channel

With the transmitter receiver combination described in the following it is possible to transmit simple instructions, e.g. on-off, over a distance of about 20 m by using the light emitting diode LD271 and the receiving photodiode BPW34. Therefore this device is favored for remote control operations of electrical equipment, e.g. dimmers, motors, switches, model railways or even installations carrying high tensions. Besides that it can be advantageously used to realize light barriers, since the high carrier frequency guarantees a high interference immunity against continuous and low frequency modulated light. If an optical system is used for the transmitter as well as for the receiver, much greater distances than the above mentioned can be covered.

An extension to more than one channel is possible, but the current consumption will increase by the number of channels. Thus this operating principle is also applicable for remote control of TV receivers and of other devices demanding higher requirements. If the number of channels is n, 2^n-1 different instructions can be transmitted.

Since the information is only transmitted for a short period, the average power dissipation is reduced by a factor of 500 in comparison to the peak power. In the described application the repetition frequency is 10 Hz, i.e. the interval between two instructions is 100 ms.

By the ambient light a noise voltage is generated in the photodiode BPW34. Therefore, the input circuit of the receiver operates with a narrow band filter, keeping the noise influence low. Each instruction consists of a pulse train with constant pulse interval (e.g. 50 kHz). The number of pulses per train required for processing a statement depends on the amplifier. Therefore, it has to be considered that a narrow band amplifier has transient response which is not to be negligible. For instance, a resonant circuit with a determined quality factor Q needs pulses in a quantity of (Q/3) in order to reach 50% of the maximum resonant amplitude. Assuming a carrier frequency of 50 kHz, a quality factor of 16 and a bandwidth of 3 kHz, 5 pulses are required to obtain a value, which is 50% of the maximum resonant-circuit voltage. In the described circuit the interval for the total pulse train was chosen with 400 µs which refers to 20 pulses.

Transmitter

Only one CMOS-IC, type HEF4011 (RCA CD4011) has been utilized to realize the two oscillating circuits of the transmitter, operating at 10 Hz resp. 50 kHz (see Figure 2.1). The 10 Hz oscillator has a duty cycle of 250:1.

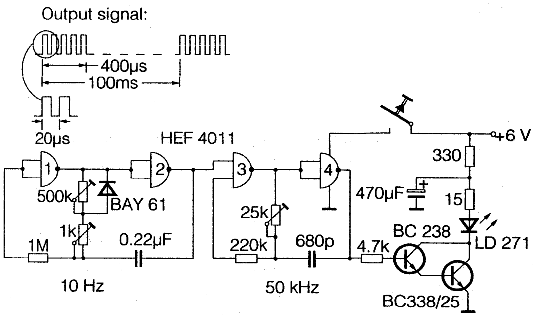


Figure 2.1

These different intervals are obtained through bypassing the charging capacitor by means of the diode BAY61. The 50 kHz oscillator is modulated by 10 Hz, i.e. it operates only during a time of 400 µs. The LD27, emitting infrared light, is square-wave modulated by a Darlington stage with reference to the rhythm of the output signal. If the peak current is a 1 A, the average value is only 2 mA. As this peak current is not available from the battery, it is supplied from a 470 µF capacitor, the voltage of which decreases by a value of 0.5 V for the duration of the pulse train. The diode current being higher at the start positively effects the resonant circuit of the receiver.

Characteristics

Supply voltage	6 V
Supply current	2 mA at 6 V
Subcarrier frequency	50 kHz
Duration of pulse train to train repetition period	400 µs:100 ms
Emitted peak power	80 mW/sr
Half angle of the radiation cone	35°

Receiver

The receiver shown in Figure 2.2 operates with the photodiode BPW34. which is matched to an input impedance of approximately 80 kΩ at 50 kHz. The dc diode current should not exceed a value of 20 µA. For the infrared filter placed in front of the photodiode, a non-exposed but developed color film, type CT18 (Agfa) has been used. In the following circuit the pulses are amplified, clipped, rectified and applied to a monostable multivibrator, which covers the space between two pulse trains. Therefore a dc voltage is available at the output of the receiver as long as the push button of the transmitter is operated. Thus the required function can be realized.

The amplifier consisting of transistors T_1 to T_5 offers a gain of 20,000. T_1 operates as an impedance former. The bandwidth is adjusted to a value of 3 kHz by a selective feedback between T_3 and T_4. T_6 operates as the threshold switch and limiter. The signal is integrated by the capacitor C_S and delayed, so that after the start of the pulse train three to four 50 kHz-oscillations pass before the following monostable multivibrator is triggered. Thus it is guaranteed that short pulse interferences do not trigger the monovibrator consisting of two NAND-gates, type HEF4011 (RCA CD4011). The duration of the monovibrator pulse is 100 ms. Thus it is assured that the steady state is obtained after a period of 100 ms, if the following pulse train is not emitted from the LED.

Characteristics

Supply voltage	9 V
Required current (without output circuit)	10 mA, V_S=9 V
Receiving bandwidth	3 kHz
Center frequency	50 kHz
Admissible ambient light day light incandescent light fluorescent lamp light	 4,000 lux max. 500 lux max. 10,000 lux max.
IR filter, cut off wavelength	870 nm

3. IR Preamplifier with IC TCA440 for Infrared Remote Control Systems

Preamplifiers for IR remote control systems with pulse code modulation must meet additional overdrive requirements compared with frequency coded systems.

Receiver overdrive in conjunction with tuned circuits results in falsification of the envelope pulse duration. However, the receiver can only process such pulse "distortion" to a certain degree. As the input signals can differ by a factor of more than 10^5, a control loop must be introduced to prevent overdrive. The control circuit must act fast enough to assure correct transmission of the first bit. This is especially important for the transmission of single instructions. The requirements are less critical for repetition instructions; here it suffices when the correct control state condition is achieved by the time transmission of the second instruction begins.

With single instructions, the signal AGC circuit must act within a fraction of the bit duration. This necessitates a response time of less than 100 µs. The dwell time in the control state must, however, be much longer, ideally more than 100 ms so that for repetition instructions a more or less steady control state condition already exists for the second instruction

In addition to this control loop driven by the useful signal for single instructions, a control circuit dependent on light level is also advisable. This assures maximum sensitivity under low ambient light conditions and reduces the amplification with increasing light level to maintain the light noise just below its disturbing level.

In practice, the operator can bring the transmitter very close to the receiver. When this form of overdrive occurs it must be assured that correct recognition of the signal is not prevented. For guidance purposes, a minimum separation of 5 cm can be assumed. The resulting level differences of more than 100 dB generally can not be fully handled by the internal control circuit of the IC; additional measures such as peak level limiting are therefore required to hold pulse distortion within the admissible limits.

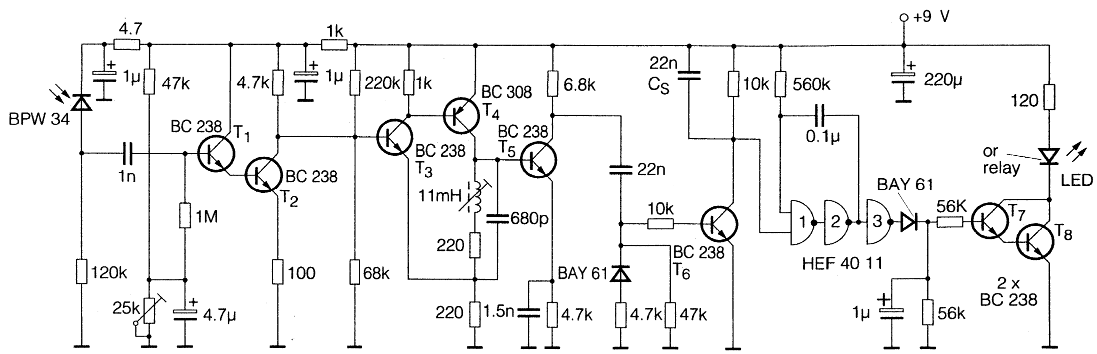


Figure 2.2

Figure 3.1 shows a circuit incorporating the IC TCA440 which essentially meets all the above requirements.

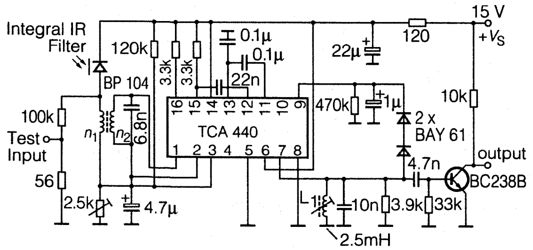


Figure 3.1

It is assumed that the transmitter radiates an IR signal with a carrier of approximately 30 kHz modulated with information as 7 bit instructions in biphase code. The bit length should be about 1 ms; the repetition frequency, if present, about 10 Hz.

In series with the IR diode BP104, which is similar to the photodiode BPW34 but with integral IR filter, is a resonant circuit tuned to 31.25 kHz and having a resonant impedance of 50 kΩ. Damping is provided by the 100 kΩ resistor and transformed input impedance of the TCA440. With a transformation ratio of 5:1, the TCA input impedance of about 4 kΩ appears as 100 kΩ on the primary side. The bandwidth of 10 to 12 kHz is relatively large, but this makes the input circuit design uncritical and assures short rise and fall times. The capacitive loading is mainly on the secondary side, only the BP104 junction capacitance loads the primary side. The bandwidth can be halved if required by removing the 100 kΩ resistor.

In the TCA440 the preamplifier stage with inputs 1, 2 and output 15 and the controlled IF amplifier with input 12 and output 7 are utilized. The latter requires a resonant circuit at the output, otherwise the output voltage is too low. The AGC starts to operate through pin 9 when the output circuit voltage exceeds 2.5 V_{pp}.

Under high ambient light conditions, the input amplifier gain can also be controlled. The DC output current of the BP104 causes a small voltage drop at the bottom end of the primary winding which is utilized for gain control. Input 3 is current biased such that the AGC already acts at relatively low photocurrent levels.

The output circuit bandwidth is about 4 kHz and contributes decisively to the receiver sensitivity. The output voltage is limited by the TCA440 to about 4 to 5 V_{pp}. When designing this circuit, care should be taken to prevent inductive feed- back from the circuit inductance L_1 to the input transformer.

Technical Data

Input IR irradiance (λ=950±30 nm) Minimum Maximum	 1 nW/mm^2 5 • 10^5 nW/mm^2
Range a) without wall influence (free room) Angle 0° Angle 30° b) with wall influence (corridor) Corridor 2 m wide x 2.5 m high Angle 0° Under the following conditions: – Transmitter peak power 160 mW (i e. 2 lower limit LD 271 with 1 A peak current) – Low outside light (Max. illumination 500 Lux, caused by daylight or fluorescent lamp)	 >12 m >8 m >20 m
Outside light influence With incandescent light E=1000 Lux Range reduction	 <50%
Admissible variation in pulse group length (rated value 500 or 1000 μs)	±10%
AGC time constants Gain reduction Gain increase	 <100 μs >100 ms
Center frequency	31.25 kHz
Bandwidth for small signals (AGC not operating) referred to output 7	3 kHz approx.
Output signal	15 V_{pp} modulated
Supply voltage Admissible ripple Input transformer: B65531-L0250-A028 Pot core 11 x 7, A_L=250 nH n_1 =565 turns, 0.07 dia. n_2 = 111 turns, 0.07 dia. Primary inductance approx. 85 mH L_1: B65517-A0250-A028 Pot core 9 x 5, A_L=250 nH n=100 turns, 0.1 dia.	15 V + 3 V, –5 V <2%

4. Single Channel IR Receiver with High Interference Resistance

Figure 4.1 shows an IR receiver circuit which is especially suitable for light barriers or simple IR transmission systems. It features increased resistance to extraneous light interference, for example the switch-on pulses of fluorescent lamps.

The pulse groups emitted by the transmitter (f_0=40 kHz, t=1 ms, T=100 ms) are received and amplified by approximately 60 dB on OP 1. P_3 sets the switching threshold for the following threshold switch OP 2, at the output of which the pulses are again available at TTL level. The first pulse received by the diode triggers MF1 which produces a pulse of duration t_1 (see Figure 4.2). This in turn releases after approximately 90 ms a pulse of duration t_2 (G_1 and G_2). The second transmitted pulse can only pass G_4 during the period t_2. The output signal A (continuous signal) is delivered by MF3, a post-triggered monoflop with t_3>T.

The circuit is therefore insensitive to incoming interference pulses for a time $T - t_2$ and only responds when at least two pulse groups are received with a spacing T.

It is possible to replace the TTL ICs MF1 to MF3 by CMOS monoflops (4047). This reduces the power requirements and permits the use of a higher supply voltage, for example from a 9 V battery. The Zener voltage of diode D_1 must in this case be about half the supply voltage.

Technical Data (TTL Version)

Supply voltage	5 V
Supply current	55 mA
Carrier center frequency f_0	40 kHz
Input circuit bandwidth	4 kHz
Pulse group duration t	1 ms
Pulse group repetition frequency 1/T	10 Hz
Response threshold (max sensitivity) referenced to photodiode useful current	3 nA approx.
Range measured with a transmitter with 3 x LD271, I_P=1 A	>12 m

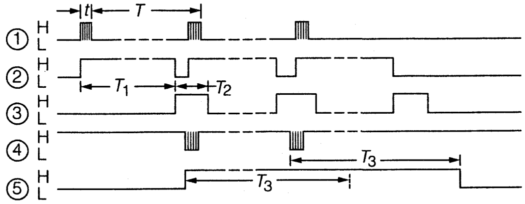


Figure 4.2

5. Simple Battery-Operated IR Remote Control Transmitter for Single Instructions

The IR transmitter circuit is shown in Figure 5.1. The capacity of a normal 9 V battery (240 mAh) suffices for about 30,000 switching operations; thus it is not the switching rate which normally determines the battery life but its storage capacity.

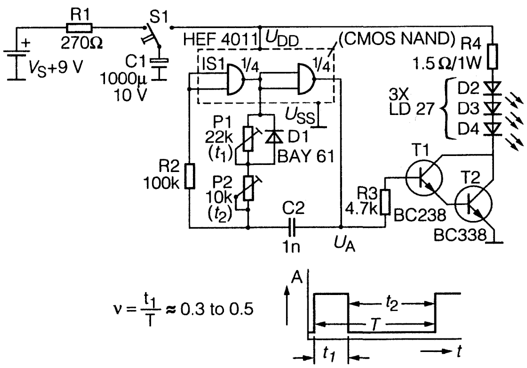


Figure 5.1

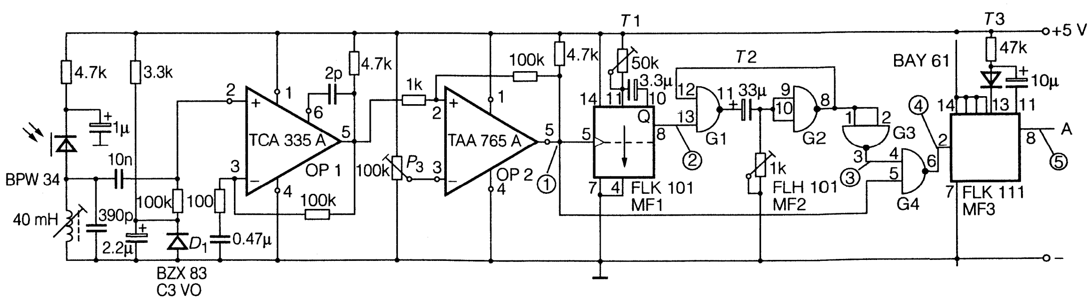


Figure 4.1

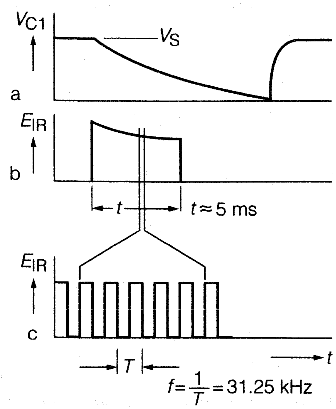


Figure 5.2

When the switch S_1 is operated, the transmitter radiates a single IR pulse of about 5 ms duration modulated with 31.25 kHz (see Figure 5.2). After demodulation of the signal, 5 ms square wave pulses corresponding to the envelope of the modulated pulses emitted by the transmitter appear at the receiver output. These can be used for various purposes, for example to change over a flip-flop state for switching equipment off or on, to drive counter circuits that actuate different switching processes, etc. The modulating frequency of 31.25 kHz is generated by a stable multivibrator incorporating CMOS NAND gates to minimize the power consumption. The multivibrator supplies the driver stage T_1, T_2 for the GaAs LEDs (IR radiators) D_2, D_3 and D_4. With S_1 in its rest position C_1 charges up through R_1. When S_1 is pushed, C_1 is connected as a voltage source to the transmitter circuit which then starts to oscillate. The current consumption of the circuit and the value of C_1 determine the duration of transmission.

The center frequency of 31.25 kHz is determined by P_1 and P_2: P_1 affects the pulse duration t_1 and P_2 the interval t_2.

The duty cycle $v = t_1/T$ should be between 0.3 and 0.5. This gives the longest range for minimum power consumption. Because of resistance tolerances within the CMOS circuit, the frequency can only be calculated roughly:

$$f = \frac{1}{T} \approx \frac{1}{1.1\,(P_1 + 2P_2)\,C_2}$$

Technical Data

DC supply voltage	9 V
Center frequency (adjustable)	31.25 kHz
Transmission duration per single pulse (C_1=1000 µF)	5 ms
Energy consumption per switching operation	25 mWs

6. Preamplifier for IR Remote Control Systems

Infrared remote control receivers with MOS-ICs usually require a digital input signal with TTL-levels. Therefore a preamplifier has to be connected between the photodiode and the MOS-circuit. Such a preamplifier has already been described (see Part 3). A description of a circuit using the IC DA4050 follows. The TDA4050 was especially developed for applications of IR remote control systems. It comprises a controlled prestage, an amplifier and a threshold amplifier. This IC offers excellent large-signal characteristics, an output with short-circuit protection and a simple driver circuit for active band-pass filters. Although solutions without coils are cheaper, an LC-network is connected to the input of the circuit shown in Figure 6.1 to obtain a higher selectivity. The photodiode SFH205 is connected directly to the resonant circuit. It is reversely operated and biased with 11 to 14 volts. The signal from the resonant circuit is supplied to the input of the IC via transistor BC414C. Thus, the signal-to-noise ratio is improved. An active filter is connected to pins 4 and 5. It is part of the reverse feedback circuit of the operational amplifier. The output signal is available at pin 3, offering a protection against short-circuits to ground (R_i=10 kΩ). At L-level, the output has a low impedance.

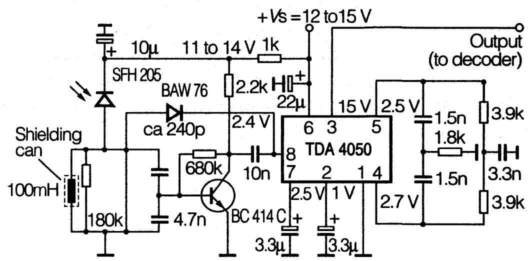


Figure 6.1

Figure 6.2 shows a circuit without coils. The large signal characteristics and noise immunity are improved by a network consisting of resistors and diodes.

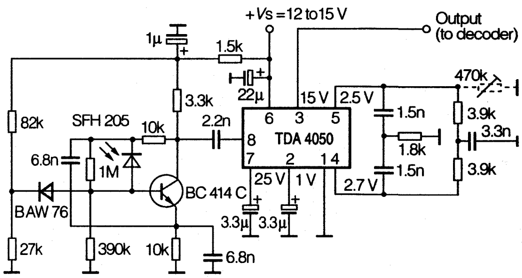


Figure 6.2

Both circuits should advantageously be mounted in a double-screened case.

Without any influence of extraneous light, a distance of 25 to 30 m between transmitter and receiver can be easily realized, whereas the distance is much higher if the circuit with LC-network is used.

The described preamplifier circuit is also applicable for IR remote control systems used in TV sets. In this case, only a range of 15 to 18 m is covered because of the wire-netting protection and the stray influences of the TV deflection coils.

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Photographic Aperture, Exposure Controls, and Electronic Flash Appnote 35

1. Solar Cell Generator for Exposure Control in Cameras without Moving Parts

Exposure meters normally work with a moving coil instrument. With a field effect liquid crystal display and a solar generator with two photovoltaic cells, type BPY64 a fully electronic light control without mechanical moving parts can be realized. The reversal point of the indicator is reached at an illumination of 100 lux (color temperature of 2850 K). Thus exposure-time display for low-priced cameras is possible.

Circuit Description

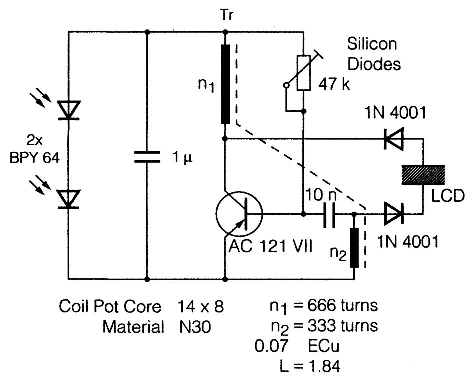

Figure 1.1

A basic requirement is an oscillator which starts oscillating at a voltage below 100 mV. Two photovoltaic cells, type BPY64, feed a blocking oscillator with transistor AC121 VII as shown in Figure 1.1. Because of the low photoelectric voltage available at low illuminations a germanium transistor with a low threshold voltage has to be used. In operation, the transistor is at first conductive so that a magnetic field can be built up in the primary winding of the transformer Tr. Through the secondary winding, a reverse voltage is induced to the base circuit which turns off the transistor. At this moment the magnetic field of the coil collapses. The potential difference between collector and base is momentarily approximately 5 V at the breakdown point of the liquid crystal display. To avoid a too strong damping of the base circuit by the capacitor of the display, two diodes are connected in series to the LCD. The pulse duration of the blocking oscillator signal is mainly defined by the self-inductance and self-capacitance of the coil, while the repeating frequency depends on the time constant of the base circuit. The optimum output voltage is achieved at a repeating frequency of approximately 3 kHz. The oscillations start at a collector voltage V_{CE} of –60 mV and a mean current I_C of 30 μA.

2. Phototransistor Used In a Computerized Photoflash Unit

A new circuit has been designed for the receiving part of the computerized photoflash unit. It offers the advantage in that it essentially compensates all the undesired influences produced by exposure time errors, ambient light, temperature, and tolerances of the photosensitivity. A phototransistor in conjunction with an integrating capacitor connected to the emitter serves as a photodetector.

A computerized photoflash unit differs from a standard one in that the duration of the photoflash is determined by a photodetector. Therefore, the exposure time for a camera film is constant and does not depend on the intensity of the reflected light, i.e. the flash is interrupted sooner or later in dependence on the quantity of reflected light. Figure 2.1 shows on principle the control circuit of a computerized photoflash unit. The photocurrent of the phototransistor charges the capacitor C_1 and thus the turnoff thyristor shown in the figure with broken lines is triggered.

A trial was conducted to find out how far exposure time errors of photoflash devices using the circuit of Figure 2.1 depend on the sensitivity of the phototransistor. It has been experienced that the sensitivity changes by about 25% in a distance between 0.9 m to 4.0 m. This variation is generated through the change of the current gain depending on the collector current.

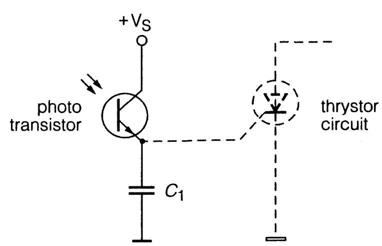

Figure 2.1

The compensation of the linearity error of a phototransistor is only partially possible because of its unavoidable characteristic tolerance. Therefore it is more convenient to use a circuit in which the value of the current gain does not essentially influence the exposure time of a computerized photoflash unit.

The base collector current dependence on the luminous intensity is completely linear whereas this is contrary to the one of the emitter collector current because the base-collector-junction serves as a photodiode. Therefore, a special circuit has been designed. The current generated through the light is integrated by capacitance not being connected to the emitter of the phototransistor but to its base as shown in Figure 1.1. At the beginning of the exposure the capacitor is not charged, i.e. the base-emitter-junction is not conductive. If the phototransistor is illuminated, charge carriers are generated. A hole moves to the base terminal and positively charges the capacitor C_1 with reference to ground potential. When the capacitor is charged so that the base-collector-junction becomes conductive, the phototransistor starts to amplify, i.e. the emitter current increases. The amplified photocurrent produces a voltage drop across the load resistor R_2 and thus the following turnoff thyristor is triggered.

The disadvantage of the circuit shown in Figure 2.1 is that the signal slewing rate is not fast enough, because the capacitance of the integrating capacitor, C_1 is increased by the gain of the phototransistor at that instant when the base-emitter-junction becomes conductive, i.e. when there is an amplification effect. In order to improve the signal slewing rate the circuit shown in Figure 2.2 is recommended. Here the capacitor C_1 is connected to the base and emitter. If the voltage across the load resistor R_4 increases, the level at the capacitors low end also rises with nearly the same amount as at the high end of C_1 connected to the base. Therefore, the capacitor C_1 usually requires no charge.

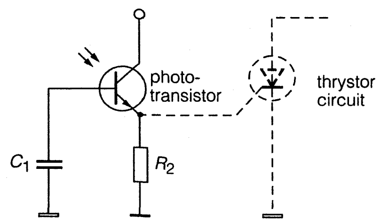

Figure 2.2

The circuit according to Figure 2.3 assures that at the beginning of each photoflash the capacitor C_1 always has the same charge impedance of the illumination which previously occurred. The resistors R_2 and R_3 serve as voltage divider, at which a positive voltage of 1 V referred to the level of the phototransistor emitter is disposable before the photoflash is started. The diode D_1 is turned off. Its voltage difference effects that a current flows via the resistor R_1 into the base of the phototransistor. At its base-emitter-junctions a voltage drop, not being essentially increased by the external illumination is produced. At the beginning of the photoflash, a negative pulse is applied via terminal B to the resistor R_2. By the current flowing through R_2 the diode D_1 becomes conductive and its level changes from +1 V to –0.7 V. This potential difference is fully transmitted via the integrating capacitor C_1 to the base of the phototransistor, which is therefore reversibly biased by this voltage. Thereafter, this bias is compensated by the photocurrent. The negative voltage pulse required at the beginning of the photoflash can be derived from the same voltage source, which generates the collector-emitter-voltage at the beginning of the photoflashing. The voltage at terminal A is taken from a divider being in parallel to the photoflash capacitor, i.e. also available before the photoflashing occurs.

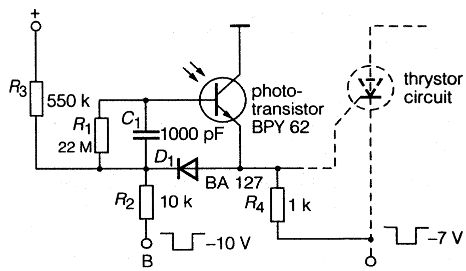

Figure 2.3

The advantages of the circuit shown in Figure 2.3 compared to the one of a conventionally computerized photoflash unit are as follows:

a. Exposure time failures are nearly not detectable presuming an objective lux meter (<5%).

b. The phototransistors must not be selected according to their photosensitivity since their base-collector-junction is utilized and there is no difference in sensitivity among the phototransistors.

c. No neutral absorber is required, since the internal base-collector-diode of the phototransistor operates linearly. Therefore, the photodetector is able to receive more light, i.e. signals with a higher amplitude are produced and the operation is trouble-free. The gate current of the thyristor does not influence the exposure time control. The total temperature coefficient is low (about 0.3% K^{-1}). If necessary the TC can be additionally decreased by applying at terminal B a pulse with a high amplitude. The charging of the integrating capacitor is extremely low when the supply voltage is suddenly applied to the phototransistor.

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General Photoelectric Application Circuits Appnote 36

1. Suppression of DC Component in Photocurrent of Phototransistors

In many applications, phototransistors are intended to transmit only intensity-modulated light signals. Non-modulated light intensity interferes; the dc component caused by it must be suppressed.

Two circuits are described here in which the dc component remains ineffective. In the first circuit the direct current is kept constant through an automatic control system, in the second an active, frequency-dependent external resistance is used which is much smaller at low frequencies than at high ones.

Phototransistors are particularly suitable as light detectors for many applications since they are economical and, due to their amplification, offer a larger output signal than photodiodes. Thus they are less sensitive to external interferences.

In optoelectronics, a number of applications are used in which an intensity-modulated signal is superimposed upon a non-modulated one, e.g. in optical flame control, in light barriers involving moving objects, and in computerized flashlight equipment as well as slave flashlight equipment in which the primary illumination can cause interference. In many instances the suppression of the dc component is required because of the danger of overdriving through unmodulated light intensity.

Using phototransistors, the dc component of the photocurrent cannot be suppressed by a coupling capacitor.

Circuit for Phototransistors with Base Terminal

In Fig. 1.1 phototransistor T_1 and transistor T_2 form an automatic control system which regulates the voltage drop at resistor R_1, maintaining it at a constant value, independent of the unmodulated light intensity at phototransistor T_1. When the light intensity rises, a larger photocurrent I_p flows through T_1, and the voltage drop at resistor R_1 becomes greater. As a result, a larger current flows to the base of T_2. The rising collector current T_2 keeps reducing the primary photocurrent of T_2 until the voltage drop at resistor R_1 reaches its original value.

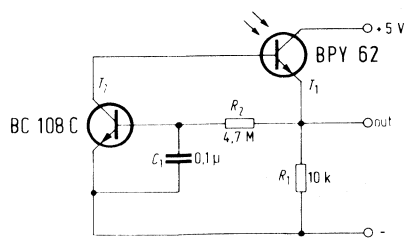
Due to the by-passing of the base-emitter junction of T_2 by capacitor C_1, this control mechanism is ineffective during rapid changes. The cut-off frequency above, which the control becomes ineffective, is determined by capacitor C_1 and resistor R_2.

Resistor R_1 determines the quiescent current. R_2 should be as large as possible to permit small values for C_1. However, when resistance of R_2 becomes too large, the drive of T_2 is too weak. As a result the maximum light intensity at which the control still works is reduced. The maximum light intensity is also limited by the power supply voltage, because the voltage drop at R_1 must not exceed a fixed maximum value.

For the dimensioning given in Fig. 1.1, the maximum light intensity can be 25,000 lx; the voltage drop at R_1 must not exceed the value V_{R1} = 4 V. The photosensitivity of phototransistor BPY62 is 2 mA/1000 lx. The dark current of the circuit is smaller than the dark current I_{CEO} of the simple phototransistor, because part of the dark current is split as residual current from T_2. The lower cut-off frequency of the circuit in the above dimensioning is f_{gu} = 16 Hz, the upper frequency f_{go} =2.5 kHz. If an increase in the upper cut-off frequency f_{go} is required, resistance of R_1 must become smaller.

To exclude interference signals, the connection between the collector of T_2 and the base of phototransistor T_1 must be held as short as possible.

Fig. 1.1



Circuit for Phototransistors Without Base Connection

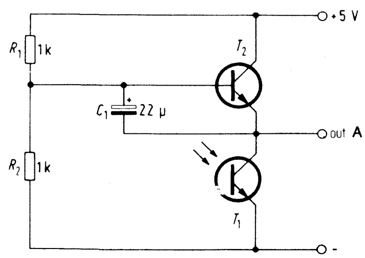
The circuit shown in Fig. 1.2 is intended for phototransistors without base connection. At low frequencies the base voltage of transistor T_2 remains constant, and is determined by the voltage divider of resistors R_1 and R_2. The collector resistance of phototransistor T_1 is determined by the relatively low diffusion resistance of the base-emitter junction of transistor T_2. A large collector current can flow without resulting in a substantial decrease of the collector voltage of phototransistor T_1. For the diffusion resistance it applies that

$$R_D = \frac{k \times T}{e \times I},$$

k standing for Boltzmann constant (1.38×10^{-23} WsK^{-1}); T for absolute temperature of phototransistor T_1, in Kelvin; e for elementary charge (1.6×10^{-19} As); and I for emitter current of transistor T_2 in Ampere.

At high frequencies the base-emitter junction is short-circuited by capacitor C_1. As a result the considerably larger differential resistance of the emitter-collector junction of transistors T_2 functions as external resistance. Parallel to it there is the series circuit consisting of capacitor C_1 and the resistors R_1 and R_2, parallel-connected through the power supply. In the circuit presented in Fig. 1.2, the maximum light intensity for the given dimensions can amount to 20,000 lx.

Fig. 1.2



The sensitivity of phototransistor BPX81, used in the experimental circuit, is 2.5 mA/1000 lx. The lower cut-off frequency is f_{gu} = 80 Hz, the upper frequency is f_{go} = 40 kHz. The ac voltage at point A can be raised by increasing the resistance of R_1 and R_2. For a maximum light intensity of 20,000 lx, resistances of up to 10 kΩ are permissible.

List of Capacitors Used in the Circuit 1.1

1 pc	Ceramic Capacitor	0.1 µF/63 V

List of Capacitors Used in the Circuit 1.2

1 pc	Electrolytic Capacitor	22 µF/40 V

2. Power Supply Using the Photovoltaic Cell BPY64P for Low-Consumption-Devices

In the following, a circuit using the photovoltaic cell BPY64P and a blocking oscillator is described. It is utilized for supplying energy to small electronic devices of low power consumption, e.g., transmitter of infrared remote control systems. Generally a buffer accumulator is connected in parallel to this circuit and thus an operation without any batteries or other power supplies is realized.

On sunny days, transmitted energy of approx. 1 mWh can be generated by a Silicon-diode area of 2 cm^2 (corresp. to 6 x BPY64P) even in standard-size living rooms. But on cloudy or winter days, a maximum value of only 0.2 mWh can be expected.

Assuming a current of 10 mA for the short operation period of an IR remote control transmitter, a power of 60 mW at a battery voltage of 6 V is necessary. As the sum of all operations for remote control of a TV set does not exceed one minute per day, an electric energy of 1 mWh per day is required.

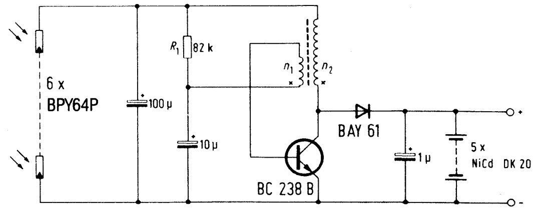
Under ideal conditions (i.e. power matching $R_i = R_o$, meeting exactly the color temperature for the sensitivity maximum) the photovoltaic cell BPY64P supplies approx. 60 µW at 1000 lx and at a color temperature of 2856 K. In practice, however, an average power generation between 15 and 16 µW can be obtained at diffused daylight and cloudy sky (E = 1000 lx).

Six photovoltaic cells, type BPY64P, connected in series as shown in Fig. 2.1 guarantee a safe starting of the blocking oscillator even at a low illuminance of 100 lx (daylight). The oscillator operates at 10 kHz. Its frequency strongly depends on the illuminance and the load. The basic current is adjusted by resistor R_1. A value of 82 kΩ can be considered as a good compromise especially at a low illuminance. The resistance of R_1 should be lower for higher illuminance values.

The circuit offers an efficiency of approx. 60 to 65%.

Five NiCd-cells (20 DK, Varta, ordering number 3910020001) can be suitably utilized as buffer accumulators. They supply an open-circuit voltage of approx. 6.2 V at a 100% charge. The capacity is 20 mAh.

Fig. 2.1



Application Notes 11

Fig. 2.2 shows the accumulator current as a function of illuminance at an open-circuit voltage of 5.8 V and at a charge without load. The two curves show the dependence on incandescent lighting (60 W-bulb, matt, with white reflector) and on daylight (diffuse, near the window).

Fig. 2.2

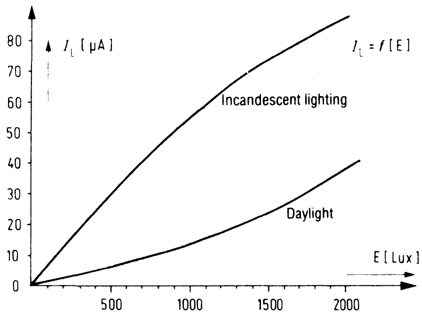
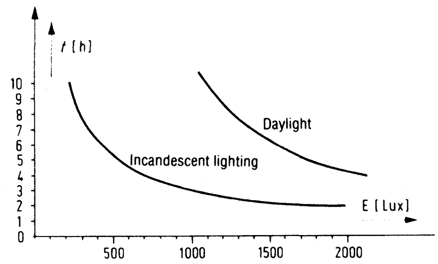


Fig. 2.3 shows the time necessary per day as a function of the illuminance. As reference an energy of 1000 μWh is assumed. This is required by the accumulator if the remote control transmitter is operated 60 times per day for a period of 1 s.

Fig. 2.3



Coil Data

n_1: 15 turns 0.07 enamelled copper wire
n_2: 340 turns 0.07 enamelled copper wire

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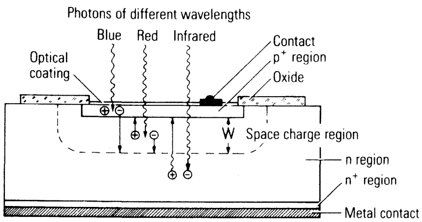
General IR and Photodetector Information Appnote 37

1. Detectors (Radiation-sensitive components)

Charge Carrier Generation in a Photodiode

Fig. 1.1 shows the basic design of a planar silicon photodiode with an abrupt pn transition. Due to the differing carrier concentrations, a field region free of mobile carriers,

Fig. 1.1
Planar silicon photodiode (schematic)



the space charge region, builds up between the p+ and n region, which only reaches into the n region if there is an abrupt p+ n transition. The following applies to the width of the space charge region:

$$w \sim \sqrt{\frac{V_D + V}{n_D}}. \quad (1)$$

In this case, V_D is the diffusion voltage, V is the external voltage and n_D is the donor concentration on the n side. For the junction capacitance $C_j \sim \frac{1}{w}$ with w from equation (1) the g is obtained:

$$C_j \sim \sqrt{\frac{n_D}{V_D + V}}. \quad (2)$$

If photons with an energy $hv \geq E_g$ penetrate into the diode, electron hole pairs are generated on both sides of the pn junction. The energy difference ($hv - E_g$) is dissipated to the grid on the form of heat. The electrical field in the space charge region repels the majority carriers and attracts the minority carriers on the other respective side (thus, holes from the n side to the p side and, vice versa, electrons from the p side to the n side). In this way, the charge carrier pairs are separated and a photocurrent flows through an external circuit, also without an additional voltage (photovoltaic effect). Carriers occurring in the space charge region are immediately sucked off due to the field prevailing in this layer. The carriers from the other regions must first of all diffuse into the space charge region in order to be separated. If they recombine beforehand, they are lost with respect to the photocurrent. Thus, the photocurrent I_p consists of a drift current I_{drift} of the space charge region and of a diffusion current I_D from the remaining regions.

Should the p+ region be far thinner than the penetration depth $\frac{1}{\alpha_\lambda}$ (α_λ = absorption coefficient) of the radiation, the photocurrent from the p+ region can be neglected and the following relationship can be derived for the photocurrent I_p.

$$I_p = q\,\Phi_0 \left[1 - \frac{e^{-\alpha_\lambda w}}{1 + \alpha_\lambda L_p}\right]. \quad (3)$$

L_0 is the diffusion length of the holes in the n region, q is the elementary charge and Φ_0 the radiant flux. The absorption coefficient α_λ is the only variable in the equation which depends on the wavelength. It predominantly determines the spectral characteristic of the diode's photosensitivity. In accordance with equation (1), the space charge region width w depends on the voltage and the doping which, in addition to the crystal quality, also influences L_D. High sensitivity is achieved with high values for w and/or L_D.

With respect to the electrical mode of operation, we differentiate between diode mode (with bias voltage) and cell mode (without bias voltage). In cell mode, the diode acts as a current generator which converts the radiant energy into electrical energy. If the photodiode is considered as a current source with the photocurrent I_p and a diode of equal polarity is connected in parallel to the load resistance R_{LE} (idealized equivalent circuit diagram), the relationship between the current and voltage can be expressed as follows:

$$I = I_S\left[e^{\frac{V}{n \cdot V_T}} - 1\right] - I_p. \quad (4)$$

In this case, I_p is the photocurrent, I_{sat} the saturation current, V the voltage between the p and n contact, V_T the voltage equivalent of the temperature and n is the diode factor.
In the case of I_p = 0, equation (4) is reduced to a normal diode equation and describes the dark characteristic (E_v = 0). When subjected to light, the characteristic is shifted downwards corresponding to the illuminance. The open-circuit voltage

$$V_L = n V_T \ln\left[1 + \frac{I_p}{I_S}\right] \quad (5)$$

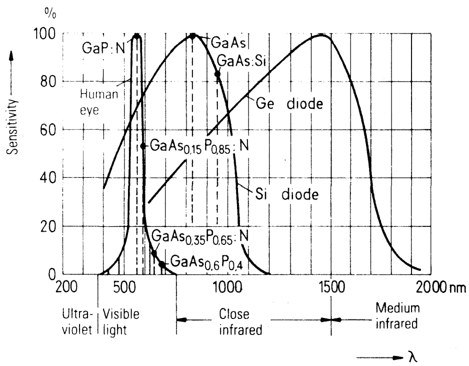
belongs to I = 0 ($R_{LE} = \infty$) and the short-circuit current $I_s = -I_p$ belongs to V = 0 (R_{LE} = 0).

There is a linear relationship, depending on the diode type, between the illuminance E_v and the photocurrent I_p, which covers several powers of ten (eight and more). However, due to $I_p \sim E_v$ and $I_p > I_s$, a logarithmic relationship prevails between the open-circuit voltage V_L and the illuminance E_v. The forward current I_F belonging to the open-circuit voltage V_L is equal to the impressed photocurrent. In diode mode, the photocurrent of one or the other diode type may slightly change together with the applied voltage. This is due to the voltage dependence of the space charge region. In the case of silicon photodiodes, the dark current [first term in equation (4)] once again only plays a role with extremely low illuminances (in the millilux range).

Spectral Sensitivity

Fig. 1.2 shows the graph of the spectral sensitivity of a silicon and a germanium photodiode. The positions of the emission maxima of the most important light emitting diodes and the sensitivity of the human eye are also shown.

Fig. 1.2
Relative sensitivity of a silicon and a germanium diode



The two photodiodes cover the wavelength band from approximately 300 to 1800 mm. In this case, the silicon diode is of greater significance; it covers the visible range and, with its maximum sensitivity in the near infrared area, is well matched to the GaAs infrared emitting diode, whose best-known field of application covers IR remote controls and light barriers.

The sensitivity limit of semiconductor detectors in the long wave spectral wave band λ_g is determined by the energy gap E_g.

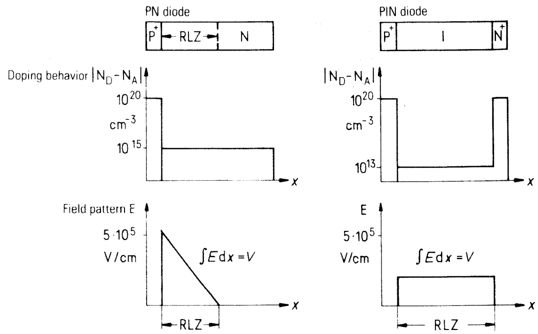
$$\lambda_g\,[\text{nm}] = \frac{h \cdot c}{E_g} = \frac{1{,}24}{E_g\,[\text{eV}]}$$

The run of the spectral sensitivity curve in the remaining wave band is determined by the absorption coefficient α_λ and the recombination relationships in the interior and on the surface of the semiconductor (carrier loss). The drop in the curve towards shorter wavelengths is due to the higher absorption for shortwave radiation; for this reason, carrier pairs are only generated in the regions near the surface but, due to the high prevalent recombination rate, are mostly lost with respect to the photocurrent.

Photodiodes (PN and PIN diodes)

Photodiodes can optimally be matched to the desired application by choosing the correct mode of operation and by means of a suitable internal structure. In addition to the schematic structure of each individual diode type, figure 1.3 shows the doping behavior and the field pattern as well as the region in which the avalanche effect takes place at a sufficiently high voltage (ionization region).

Fig. 1.3
Doping behavior and field pattern of photodiodes



In the case of the *PN photodiode*, the radiation which, as a rule, enters the p+ region vertically, is absorbed in the mainly quasi-neutral p and n regions due to the narrow space charge region; thus, the photocurrent predominantly consists of the diffusion current. As the characters are diffused relatively slowly, PN diodes are frequently used in applications in which the stress is placed rather more on low dark currents than on high speed. (For complete diffusion of a 5 μm thick p layer, an electron needs 3 ns, and a hole needs 15 ns for the same distance in the n region). Therefore, silicon PN diodes can be found in exposure meters which still operate perfectly under starlight; this presupposes dark currents of less than approximately 10^{-11} A/mm^2. Solar cells also belong to the group of PN photodiodes.

Contrary to the PN diode, in the case of *PIN photodiodes* most of the light is absorbed in the space charge region. These photodiodes are mostly used in applications requiring high speeds. In order to achieve a large space charge region, if possible, in accordance with equation (2), the semiconductor material must be intrinsic (intrinsic I) (mostly weak n or weak p doped) into which a p+ region is diffused on the one side and an n+ region is diffused on the other side. A P+ IN+ structure ("sandwich" structure) is obtained. In accordance with equation (3), the junction capacitance C_j is low due to the large space charge region of the PIN diode. C_j values are used between a few picofarad and a few tenths of a picofarad. The product from C_j and R_L (load resistance) is the time constant of the measurement circuit.

In order to achieve PIN diodes which are as "fast" as possible, the voltage is increased to such an extent that the carriers drift through the space charge region at saturation speed V_{sat}. In silicon and germanium, a saturation speed V_{sat} from 5 × 10^6 to 1 × 10^7 cm/sec is achieved with fields of approximately 2 × 10^4 V/cm. Accordingly, a carrier requires approximately 50 ps to completely drift through a 5 μm thick region.

Photovoltaic Cells

Voltaic cells are active dipole components which convert optical energy into electrical energy without requiring an external voltage source.

The properties of a voltaic cell are essentially characterized by the open-circuit voltage and the short-circuit current. In the case of a short circuit (V = 0), the current I_s is a linear function of the illluminance and thus also proportional to the area subjected to radiation. The open-circuit voltage V_O initially increases logarithmically with the luminous intensity.

This is independent of the size of the cell and amounts to approximately 0.5 V at 1000 lx. In order to extract the maximum amount of energy from a voltaic cell, the load resistance R_L must lie in the order of magnitude of $R_i = \sqrt{V_O/I_S}$. The internal resistance R_i of a voltaic cell should be as low as possible in order to prevent unnecessary loss.

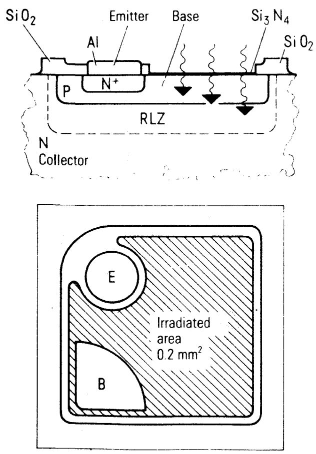
In order to measure the luminous intensity, the proportional relationship between the optical and electrical signals is important, and in practice, this applies up to a load resistance of $R_i \approx V_O/2\ I_S$.

In principle, voltaic cells can also be operated in diode mode by applying a voltage in reverse direction. Obviously, this voltage must not exceed the maximum reverse voltage.

Phototransistors

In principle, a phototransistor corresponds to a photodiode (collector-base diode) with a series-connected transistor as amplifier. The phototransistor is the simplest integrated photoelectric component. Figure 1.4 shows one of the practical designs of a bipolar phototransistor (cross-section and view) with emitter (n+), base (p) and collector (n); the latter is mostly subdivided into a weakly doped n and a highly doped n+ region. As the diffusion length L_D of the holes in the n+ region is low due to the high amount of doping, only the p and n regions provide the maximum amount to the primary photocurrent I_{CB} of the collector-base diode. This is due to the low photosensitivity (also in comparison with photodiodes) of epitaxial transistors in the long wave band. A large part of the long-wave radiation is absorbed in the n+ region as the n region is mostly extreme thin (10 to 20 μm) as a result of the requirement for extremely low conductor resistances. The view of the transistor shows a base with a large area in which the emitter and also the base connection are attached to the side; in this way, as uniform as possible a surface sensitivity is achieved. The gain of phototransistors normally lies between 100 and 1000. Gain deviations from the linearity and thus from the linear relationship between the illuminance and the photocurrent amount to (over approximately four powers of ten of the photocurrent I_p, from some 100 nA to some mA) less than 20% and mostly less than 10%. With regard to dynamic behavior, phototransistors are less favorable than photodiodes as, in addition to the collecting and charging processes in photodiodes, there is also a delay due to the amplification mechanism (Miller effect). In addition to the rise and fall times t_r and t_f, the transistor also has the delay time t_d. This is the time required until the photocurrent has reached 10% of its final value after activation of an optical square-wave pulse. For the rise and fall times of a phototransistor, the following relationship applies:

Fig. 1.4
Bipolar phototransistor



$$t_{r,f} = \sqrt{\left(\frac{1}{2_{f_T}}\right)^2 + a\,(R \cdot C_{CB} \cdot V)^2}$$

In this case, f_T is the transition frequency, R is the load resistance, C_{CB} is the collector-base capacitance, G is the gain, a is a constant whose value lies between four and five. The rise and fall times of usual phototransistors range from 1 to approximately 30 μs with 1 kOhm load resistance. Therefore, they are particularly suitable for utilization within a frequency range up to some 100 kHz, which suffices for important applications such as light barriers, punch tapes, and punch card readers.

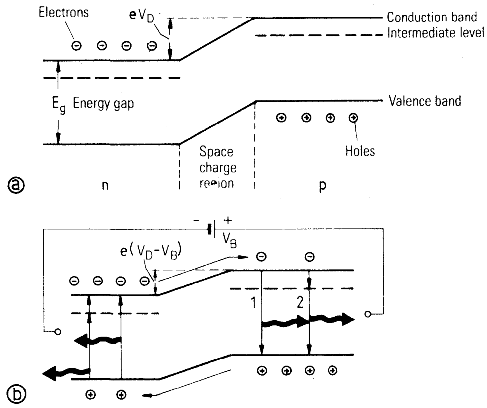
2. Emitters (Radiation emitting components)

Principle of Operation and Materials

Light emitting diodes operate in accordance with the principle of injection luminescence. Through a pn junction operated in forward direction, n-type charge carriers are injected into the neutral n and p region where they partially recombine for emission, sending out a photon with the energy $hv = hc/\lambda \leq E_g$ (h = Planck's constant, v = frequency,

c = speed of light, λ= wavelength, E_g = energy gap). This is shown in figure 2.1 in the energy diagram for a pn junction.

Fig. 2.1
The pn junction of a light emitting diode



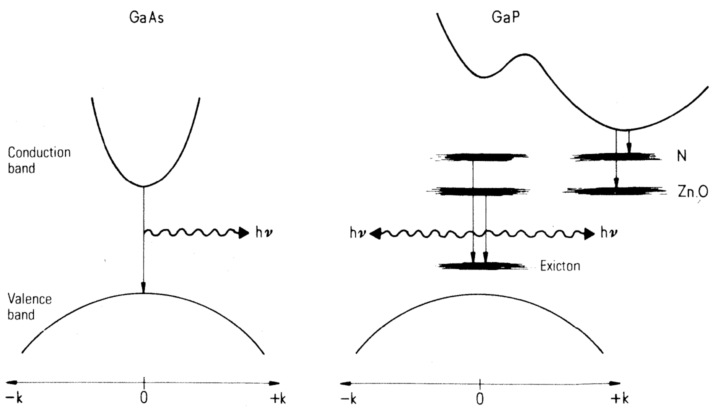
ⓐ without external voltage
ⓑ with externally applied voltage. Diode operated in forward direction (1 ≙ direct recombination. 2 ≙ indirect recombination)

The probability of radiant recombination essentially depends on the band structure type of the corresponding semiconductor material. In the case of direct semiconductors with GaAs as the most important representative, an electron can directly fall from the conduction band into a free state in the valence band (hole), in which case the released energy is given off as a photon (cp figure 2.2, left). In the case of the so-called indirect semiconductors with Si, Ge, and GaP as the most important representatives, however, this transition is linked with a pulse change of the electron. Recombination is then only possible with the participation of third partners, for example, phonons or impurities. These must ensure pulse compensation. The energy released during the transition is mainly dissipated as heat to the grid. In indirect semiconductors, this leads to the probability of radiant recombination being less by orders of magnitude than in direct semiconductors. Nevertheless, effective radiant recombination can be generated in some indirect semiconductors. This is achieved by doping with isoelectronic impurities. The two most efficient isoelectronic impurities in GaP are the nitrogen atom and the zinc-oxygen pair. Radiant recombination is then achieved by way of the decay of an electron hole pair (exciton) bonded to the isoelectronic impurity (cp figure 2.2, right).

A high degree of crystal perfection is a precondition for the creation of effectively radiant recombination as crystal defects act as centers for non-radiating recombination. For this reason, the active layers of light emitting diodes are produced epitaxially at temperatures far below the melting point of the semiconductor material.

III-V compound semiconductors and mixtures of these can be used as materials for light emitting diodes as their energy gaps cover wide spectrum and the band structure, contrary to the classical semiconductors Si and Ge, enable the creation of effective radiant recombination. Above all, the semiconductors GaAs, GaP, and the terniary mixtures Ga (As, P) and (Ga, Al) As have practical significance.

Fig. 2.2
Dependence of energy states on the wave number vector k in the case of direct (GaAs) and indirect (GaP) semiconductors.



Infrared Emitters (IR LEDs)

IR emitters are based on GaAs which has an energy gap of approximately 1.43 eV, corresponding to emission of approximately 900 nm. Higher external quantum efficiencies can be achieved with these diodes than with light emitting diodes for the visible wave band. The left-hand side of figure 2.3 shows the schematic of the diode body of a silicon-doped GaAs IRED. By means of liquid phase epitaxy (LPE), the active layer with a high crystal perfection can be grown onto a GaAs substrate. Due to the amphoteric characteristic of the silicon impurity, the pn junction forms automatically during the process of epitaxy. Due to the silicon doping, the emission lies at 950 nm and is thus so far underneath the band edge that the radiation created in the diode body is only absorbed to a slight extent. Part of the radiation leaves the diode body on a direct path through the near surface. However, radiation emitted in the direction of the substrate is also useful. For this purpose, the rear of the diode body is mirrored and serves as a reflection surface.

GaAs–IREDs are fitted in plastic packages or in hermetically sealed glass-metal housings.

An essential piece of information for the user is the radiation characteristic. If the light emitting diodes are used in an arrangement without optical lenses, for example, in a punch tape reading head, the radiation should have a small half angle. This is the case with LD260 to 269 and CQY77.

In conjunction with optical lens systems, designs are preferred in which the radiation leaves the component through a flat window (CQY78, SFH402).

Array designs are suitable for a wide range of applications as they can be rowed up in any configuration.

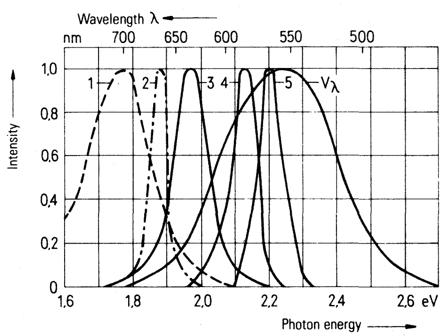
Further developments in the field of silicon-doped liquid phase epitaxial IREDs is aimed at expanding the wave band. The amphoteric character of the silicon doping is retained in the terniary mixed crystal (GaAl) As in that the energy gap can be varied by means of the amount of Al. In this way, it is possible to produce emission wave bands between 850 and 900 nm and to tune the emitter diodes to the maximum detector sensitivity. With selectively sensitive detectors, it would be possible to create transmission systems with two (or more) optically separate channels.

Electrical and Optical Characteristics of IR LEDs

Figure 2.4 shows the emission spectrum of the most important LEDs and the relative spectral contact sensitivity $V\lambda$. With respect to the emission spectrum of the IRED relative to the sensitivity curve of the silicon photodiode, see figure 1.2.

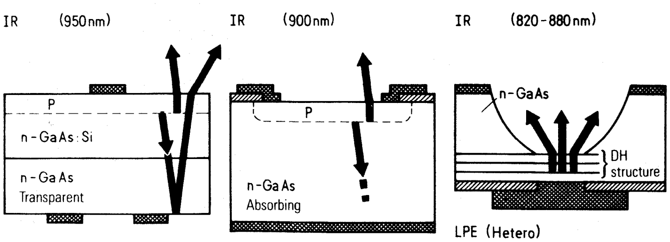
The emission spectrum of the GaP diode ranges from the yellow to the green wave band. By dying the plastic seal, the emission band can be limited in such a way that the emitted light appears yellow (λ_p = 575 nm) or green (λ_p = 560 nm) to the viewer.

Fig. 2.4
Emission spectra of the most important LEDs



1: GaP: Zn,O — Red
2: $GaAs_{0.6}P_{0.4}$ — Red
3: $GaAs_{0.35}P_{0.65}$: N — TSN-Red
4: $GaAs_{0.15}P_{0.85}$: N — TSN-Yellow
5: GaP: N — GaP-Green/yellow
V_λ: Spectral contact sensitivity curve

Fig. 2.3
Structure of the diode body of an IRED



Epitaxy	LPE	—	LPE (Hetero)
pn junction	LPE	Diffusion	LPE (Hetero)
Technology	GaAs-IRED	Diffused GaAs IRED	Burrus type
Switching time (typical)	1000 ns	50 ns	15 ns

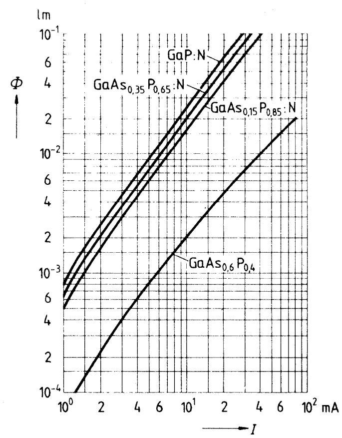
—— Semiconductor
Contact
Oxide

LPE = liquid phase epitaxy

Application Notes 11

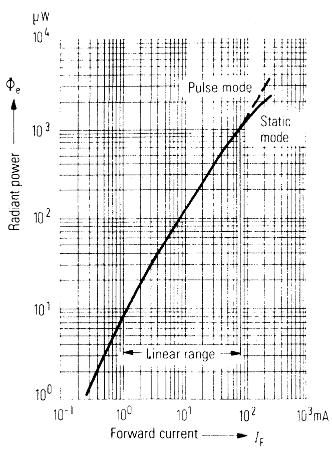
In the case of GaAs diodes and the red $GaAs_{0.6}P_{0.4}$ diode, the emitted radiation (or luminous intensity, respectively) of IREDs and LEDs changes in the normal operating range in a linear relationship with the forward current while, in the case of TSN diodes and GaP diodes, it rises slightly over-proportionally (figure 2.5).

Fig. 2.5
Light current – diode current characteristic



If the forward current is very high, the curve asymptotically approaches a threshold value. This is caused by a strong heating of the semiconductor system. The linearity range can be widened by switching from static to pulse operation. Non-linearity also turns up at small forward currents. It is caused by excess current not contributing to the radiation and cannot be influenced by the customer. Figure 2.6 shows the radiant power versus the forward current.

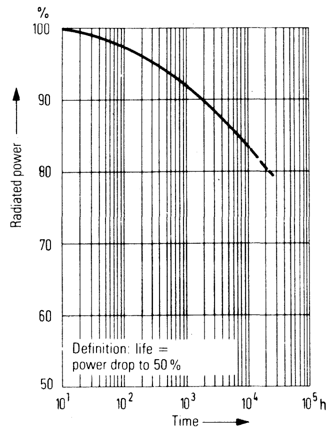
Fig. 2.6
Radiant power versus forward current



At constant current, the radiant intensity or luminous intensity, respectively, decreases with rising temperature. The temperature coefficient is –0.7% per degree for GaAs, –0.8% per degree for GaAsP, and –0.3% per degree for GaP. This is negligible for many applications. If the temperature dependence proves disturbing, it can widely be eliminated by compensation circuits.

The radiant power emitted by LEDs declines with increasing length of operation ("aging"). A "life" of components was introduced to describe the degree of degradation. It is defined as the time after which the radiant power has fallen to half the value. In the case of IREDs, for example, the average life dependent on the operating current and ambient temperature is approximately 10^5 h (extrapolated from continuous tests). Refer to figure 2.7.

Fig. 2.7
Radiated power versus operating life



3. Measuring Technique

Detectors **(Radiation sensitive components)**

Radiation-sensitive semiconductor devices serve to convert radiation energy into an electrical one. Radiation energy can be offered to the component in manifold forms, depending on the source of radiation. For measuring purposes only such radiation sources can be taken into consideration which, in their spectral energy distribution, can easily be covered and are reproducible, i.e. thermic radiation sources like the tungsten filament lamp, which at least in the wavelength range here of interest comes very close to the black body and monochromatic light sources that means those emitting radiation of only one wavelength or at least of a very narrow wavelength range, above all light emitting diodes and a combination of whatever emitters with narrow band filters. Especially for applications with infrared emitting diodes (IREDs), this measurement of the spectral photosensitivity is increasingly gaining significance and is taking the place of integral measurement with standard light A.

Because of its high energy, the tungsten filament lamp is mainly used for measuring the radiation sensitivity when set to a "color temperature" of 2856 K, corresponding to standard light A as per IEC306-1 part 1 and DIN5033 while light emitting diodes are primarily employed for cut-off frequency and switching time measurements as they can be modulated or pulsed up to high frequencies. At this instance, we want to draw your attention to the following. The definition "color temperature" is limited in its use for the optoelectronic measuring technique, quasi only as auxiliary. But unfortunately the term has come to stay. In practice the lamps are not calibrated to color temperature but to "relative temperature in the visible range", mostly to a green-red relation. An extension to a red-green-infrared relation and thus an approach to the, for our measuring technique solely correct, "distribution temperature" in the wavelength range 350 to 1200 nm, or even better 300 to 1800 nm, is worth aspiring after. This still meets with objections on the part of lamp manufacturers to extend their calibration equipment and the relatively small quantity of lamps required.

The tungsten filament lamps used for measuring purposes have to be set to a relative spectral energy distribution that corresponds to that of the black body at a temperature of normally 2856 K at least in the wavelength range 350 to 1200 nm, and have to be operated under very stable conditions. It is necessary to have the lamp operated with constant current, the deviation from the rated value must be kept less than ±0.1%. This requirement seems to be very high, but one has to consider that a deviation of the lamp current by 0.1% brings about a change of the radiant intensity by 0.7% and, of the color temperature, by 2 K. Naturally, the lamp can also be operated with constant voltage but this is hard to realize in practice because of the inevitable and varying contact resistances in the lamp socket, therefore an operation with constant current is to be preferred.

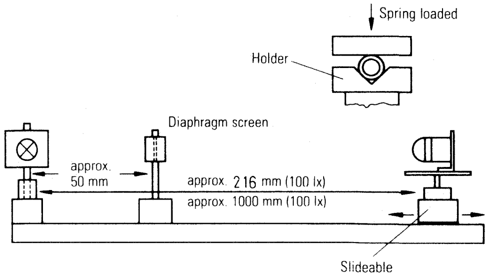
A lamp voltage check at the same time permits a control of the lamp with regard to a change in its characteristics, for example, by evaporating of coiled filament material which would point to the fact that the lamp is no longer suitable for measuring purposes and has either to be replaced or calibrated anew. This check is mainly recommended for the "standard lamps" which are standard for color temperature, radiant and/or luminous intensity.

For general measuring purposes, serial measurements in particular, the standard lamps gauged by the PTB or the manufacturer are usually not used because of the calibration costs. Therefore, the service lamps are set to the given ratings by a comparison with these standard lamps.

Photosensitivity

For photosensitivity measurements (photocurrent or photovoltage) the components to be measured are placed at the position predetermined for the specific irradiance and there they are held in such a way that the radiant sensitive surface of the semiconductor chip is vertical to the direction of light. Cylindric components such as in TO18, TO5 or similar plastic packages are put up so that the package axis coincide with the direction of radiation. This is of prime importance for components with a highly focusing lens. A holder with a sliding socket for the terminal wires proved useful (see figure 3.1).

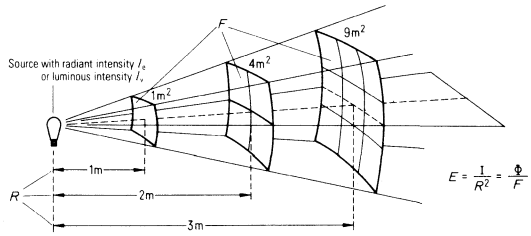
Fig. 3.1
I_p test set-up for photoelectric devices



Solid Angle

The solid angle is a part of space. It is limited by all the beams which radiate conically from one point (radiation source) and which end on a closed curve in the space. If this closed curve lies on the unitary sphere (radius R = 1 m) and envelopes an area of 1 m², and if all rays originate from the center point of the unitary sphere, the solid angle has one sterad (sr).

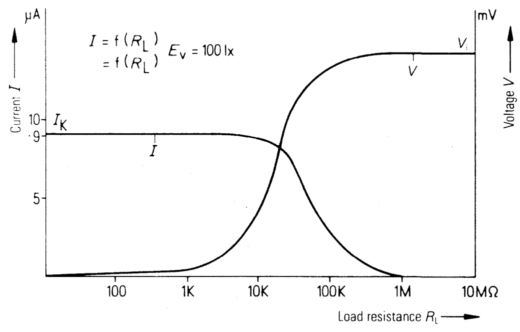
Fig. 3.2
Solid angle (1 sterad)



Short-circuit Current

When measuring the short-circuit current I_S of photovoltaic cells care has to be taken that the internal resistance of the measuring instrument used is small enough compared to the internal resistance of the photovoltaic cell. The same applies to measuring the open circuit, the internal resistance of the measuring instrument is large compared to the internal resistance of the photovoltaic cell.

Fig. 3.3
I or V versus load resistance for photovoltaic cell BPY11



Switching Times

The switching times are measured oscillographically by a set-up as shown in the circuit diagram below (figure 3.4) by means of a pulsed infrared emitting GaAs diode as a measuring source and a double-beam oscillograph. The switching times of the GaAs must, of course, be small compared to the switching times of the component to be measured.

Fig. 3.4
"Measuring the switching times of detectors"

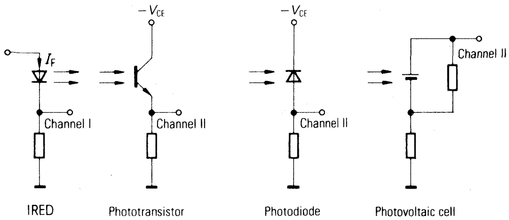
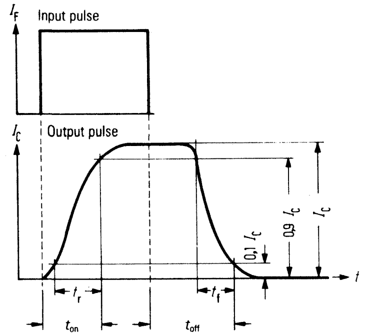


Fig. 3.5
Switching time definitions



Turn-on time t_{on}:
The time in which the collector current I_C rises to 90% of its maximum value after activation of the drive current I_F.

Rise time t_r:
The time in which the collector current I_C rises from 10% to 90% of its final value.

Turn-off time t_{off}:
The time in which the collector current I_C drops to 10% of its maximum value after deactivation of the drive current I_F.

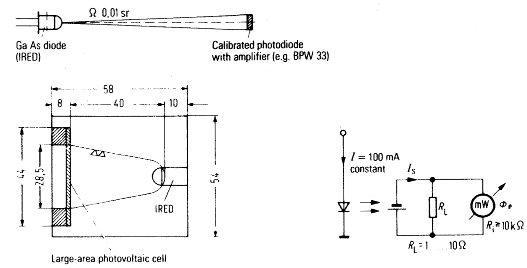
Fall time t_f:
The time in which the collector current I_C drops from 90% to 10% of its maximum value.

Radiation in the Infrared Range

The radiant intensity I_e in the direction of the case axis should be measured by a wavelength independent detector (thermocouple element) but low sensitivity, inertia, and temperature sensitivity cause difficulties. For this reason, one usually measures with a correspondingly calibrated photovoltaic cell. In such case, the spectral sensitivity curve of the photovoltaic cell has to be considered and the measuring result corrected with regard to the deviations in the emitted wavelength of the radiator to be measured (for example IRED with different production technology). If the total radiation of the component shall be measured, the IRED has to be fitted in a parabolic like reflector to ensure that all radiation emitted by the component reaches the photovoltaic cell that forms the end of the parabola.

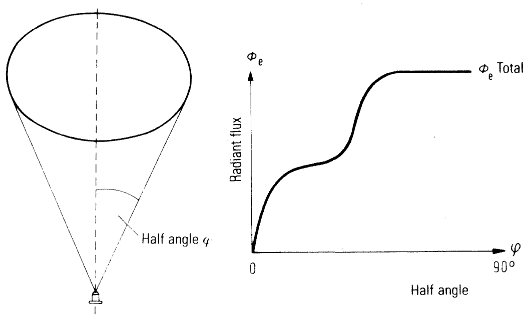
Figure 3.6 shows the outline of such a measuring parabola. As for the rest, the same requirements apply as for radiant intensity measurements.

Fig. 3.6
Calibrated photodiode with amplifier (for example BPW33)



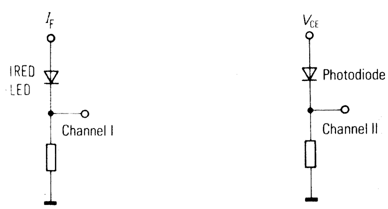
In cases where IRED emitting diodes are used in connection with mirrors or lenses, for example in light barriers, it can prove useful to state the radiant power (radiation capacity) Φ_e defined in a cone with the half angle φ, or the curve $\Phi_e = f(\varphi)$, respectively (see figure 3.7).

Fig. 3.7
Radiation cone and radiant flux Φ_e versus the half angle φ



Switching Times

For measuring the switching times the same applies as to the radiant sensitive components except that now a photodiode serves as detector and its switching time must be small compared to that of the IRED or LED to be measured.



4. Terms and Definitions

Radiation and Light Measurements

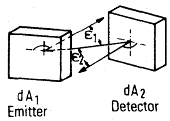
No.	Term	Symbol	Unit	Relation	Simplified definition
	Radiometric terms				
1	Radiant power	Φ_e, P	W		Radiant power is the total power given in the form of radiation
	Emitter				
2	Radiant intensity	I_e	$\frac{W}{sr}$	$I_e = \frac{d\Phi_e}{d\Omega_1}$	Radiant intensity is radiant power per solid angle
3	Radiance	L_e	$\frac{W}{m^2\ sr}$	$L_e = \frac{d^2\Phi_e}{dA_1 \cdot d\Omega_1}$	Radiance is radiant power per area and solid angle
	Sensor				
4	Irradiance	E_e	$\frac{W}{m^2}$	$E_e = \frac{d\Phi_e}{dA_2}$	Irradiance is incident radiant power per (sensor) surface

Indices "e" (= energetic) and "v" (= visual) may be omitted unless danger of confusion

DIN 1301, DIN 1304, DIN 5031, DIN 5496

International Dictionary of Light Engineering, 3rd Ed. publ. by CIE and IEC

No.	Spectral radiometric terms: Term	Symbol	Unit	Photometric terms: Term	Symbol	Unit
1	Spectral radiant power distribution	$\Phi_{e\lambda}$	$\frac{W}{nm}$	Luminous flux	Φ_v	lm Lumen
	Emitter					
2	Spectral radiant intensity distribution	$I_{e\lambda}$	$\frac{W}{sr\ nm}$	Luminous intensity	I_v	$\frac{lm}{sr} = cd$ Candela
3	Spectral radiance distribution	$L_{e\lambda}$	$\frac{W}{cm^2\ sr\ nm}$	Luminance	L_v	$\frac{cd}{cm^2} = sb$ Stilb
	Sensor					
4	Spectral irradiance distribution	$E_{e\lambda}$	$\frac{W}{m^2\ nm}$	Illuminance	E_v	$\frac{lm}{m^2} = lx$ Lux



dA_1 = element of area of emitter
dA_2 = element of area of detector
ε_1 = angle of radiation

Photometric Basic Law

$$d^2\Phi = L\ \frac{dA_1 \cdot \cos\varepsilon_1 \cdot dA_2 \cdot \cos\varepsilon_2}{R^2}\ \Omega_0$$

Inverse Square Law

$$E = \frac{I}{R^2} \cos\varepsilon_2\Omega_0$$

(r should be 10 times the max. spacing of emitter-detector to keep error below 1%).

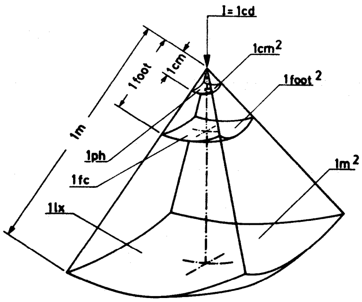
ε_2 = angle of irradiation
R = spacing emitter-detector
Ω_0 = sr

Radiation Characteristicr

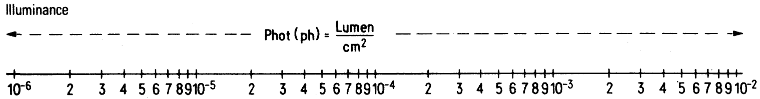
Designation	Symbol	Meas. quant.	Abbr.	Definition
Quantity of radiation	Q	Joule Wattsecond	J Ws	Quantity of radiation through a surface
Radiant power	Φ	Watt	W	Quantity of radiation Q per second through a surface
Point source of radiation	–	–	–	... is a source viewed from such a great distance R that all rays seem to emanate from one po The max. linear expansion of the source must be substantially smaller than the distance R (example: sun for observer on earth).
Solid angle	Ω	Sterad	sr	$\Omega = \frac{A_1}{R_1^2} = \frac{A_2}{R_2^2} = \frac{A_3}{R_3^2} = \frac{A}{R^2}$; the radiant power Φ[W] of a point source is constant in solid angle. (Prerequisite: homogenous, undamping medium.) $\Omega = 1$ is $A = R^2$ so that $\Omega_{hemisphere} = \Omega_{\bigcirc} = 2\pi$ sr; $\Omega_{full\ sphere} = \Omega_{\ominus} = 4\pi$ sr
Radiant intensity	I	$\frac{\text{Watt}}{\text{sterad}}$	$\frac{\text{W}}{\text{sr}}$	... is the solid angle density of the radiant power $\left(\frac{d\Phi}{d\Omega}\right)$ I of one source generally varies depending upon viewing direction. I only defined when $R \rightarrow \infty$
Total radiant power of a source	Φ_{tot}	Watt	W	$\Phi_{tot} = \int_0^{4.7} I \, d\Omega$
Irradiance	E	$\frac{\text{Watt}}{\text{meter}^2}$	$\frac{\text{W}}{\text{m}^2}$	... is the surface density of the radiant power (spherical surface) for a point source. $E = \frac{d\Phi}{dA}$; $dA = R^2 \, d\Omega$ $E = \frac{d\Phi}{d\Omega \, R^2} = \frac{I}{R^2}$; $I = ER^2$
Radiance	L	$\frac{\text{Watt}}{\text{m}^2 \text{ sterad}}$	$\frac{\text{W}}{\text{m}^2 \text{ sr}}$	... is the radiant intensity referred to the radiant surface viewed by the observer. (Surface projection $A_p = A \cos \varepsilon$, when ε is the angle by which the radiant surface is rotated against the connecting line to viewer. $L = \frac{I}{A_p} = \frac{I}{A \cos \varepsilon}$). Important optical quantity. 1) In an undamped beam path L is maintained and cannot be increased by any optical measure. 2) The human eye sees differences in radiance as differences in brightness.
Sensitivity of detector	$S = \frac{I}{E}$	$\frac{\text{Ampere}}{\text{irradiance}}$	$\frac{\text{A} \cdot \text{m}^2}{\text{W}}$	Electrical quantity (current, voltage or resistance) in relation to irradiance

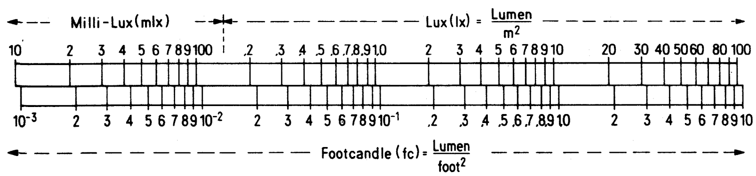
Illuminance (units and conversion factors)

		lx	mlx	ph	fc
1 Lux = lx	=	1	10^{-3}	10^{-4}	9.29×10^{-2}
1 Millilux = mlx	=	10^{-3}	1	10^{-7}	9.29×10^{-5}
1 Phot = ph	=	10^{4}	10^{7}	1	929
1 Footcandle = fc[1])	=	10.76	10760	1.076×10^{-3}	1



Illuminance





[1]) equivalent footcandle
apparent footcandle } footlambert (Luminous density) ≙ footcandle (Illuminance).

Application Notes 11

Figure 5.1
Conversion of illuminance E_v into irradiance E_e
(Planck's black body)

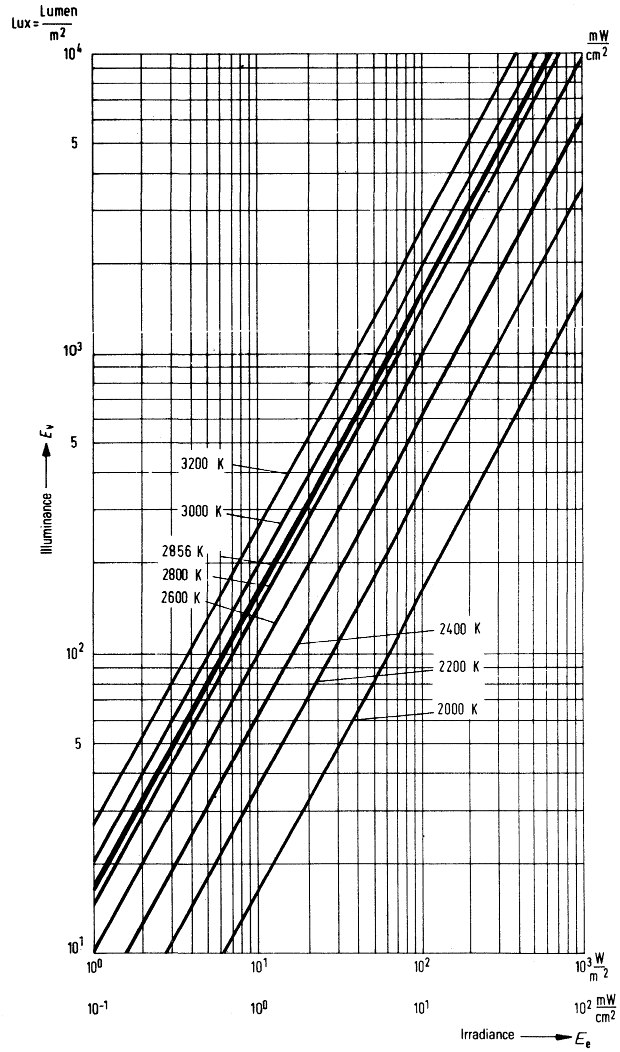
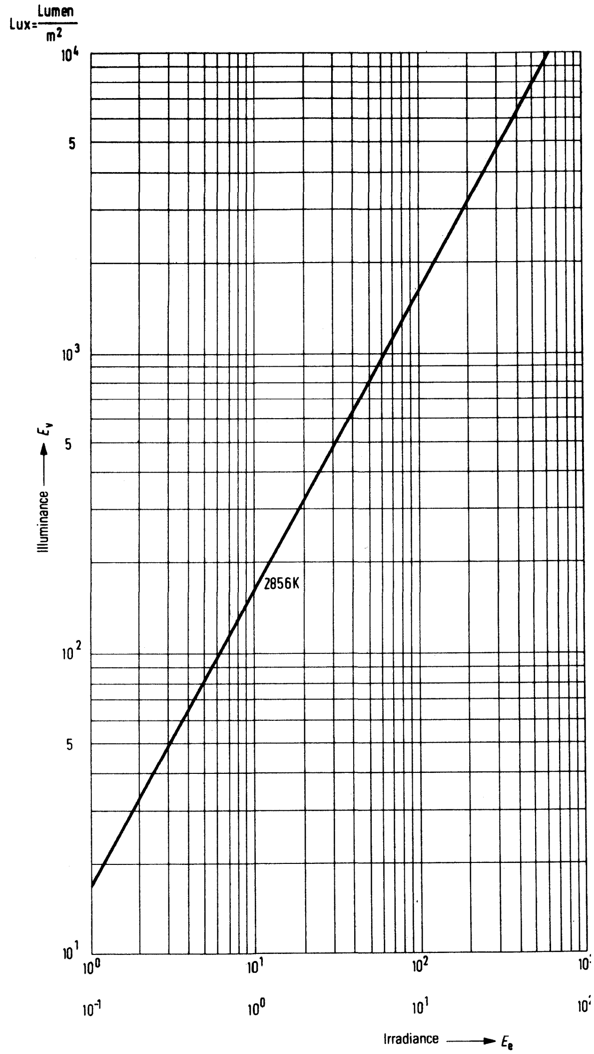
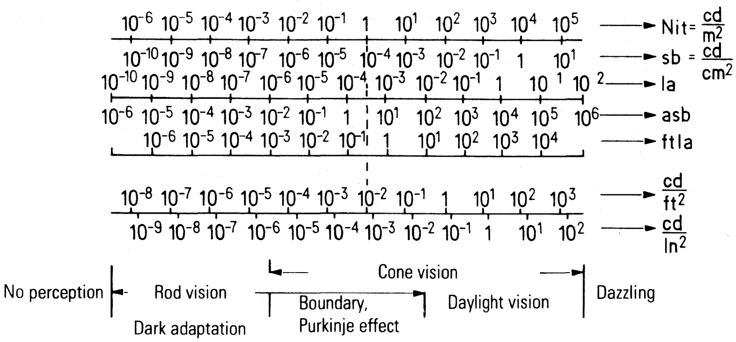


Figure 5.2
Conversion of illuminance E_v into irradiance E_e at 2856 K
(Planck's black body)



Luminous density (units and conversion factors)

Units		sb	cd/m²	cd/ft²	cd/in²	asb	L	Lm	ftL
1 Stilb = cd/cm^2 = sb	=	1	10^4	929	6.45	31400	3.14	3140	2920
1 cd/m^2 = Nit = nt	=	10^{-4}	1	9.29×10^{-2}	6.45×10^{-4}	3.14	3.14×10^{-4}	0.314	0.292
1 cd/ft^2	=	1.076×10^{-3}	10.76	1	6.94×10^{-3}	33.8	3.38×10^{-3}	3.38	3.14
1 cd/in^2	=	0.155	1550	144	1	4870	0.487	487	452
1 Apostilb = asb	=	3.18×10^{-5}	0.318	2.96×10^{-2}	2.05×10^{-4}	1	10^{-4}	0.1	9.29×10^{-2}
1 Lambert = L or la	=	0.318	3183	296	2.05	10^4	1	10^3	929
1 mL or mla	=	3.18×10^{-4}	3.18	0.296	2.05×10^{-3}	10	10^{-3}	1	0.929
1 footlambert	=								
1 equivalent footcandle	=								
1 apparent footcandle ftL or ftla	=	3.43×10^{-4}	3.43	0.318	2.21×10^{-3}	10.76	1.076×10^{-3}	1.076	1



Electromagnetic radiation

Figure 5.3
Frequency and wave bands

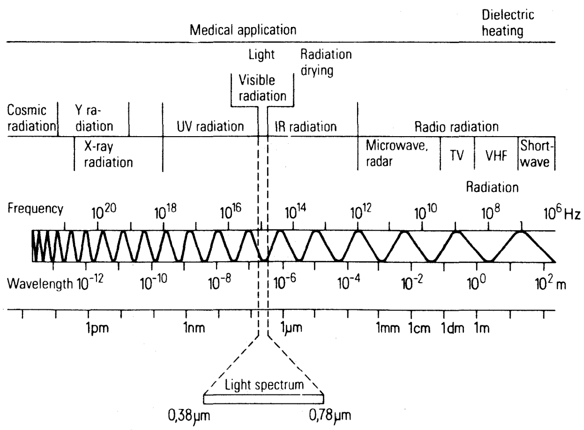


Figure 5.4
Relative sensitivity of different light-sensitive detectors

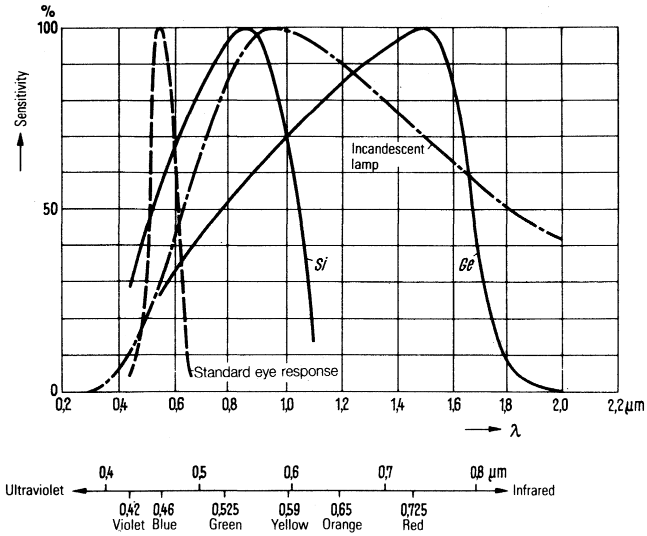


Figure 5.5
Nomogram for electromagnetic radiation

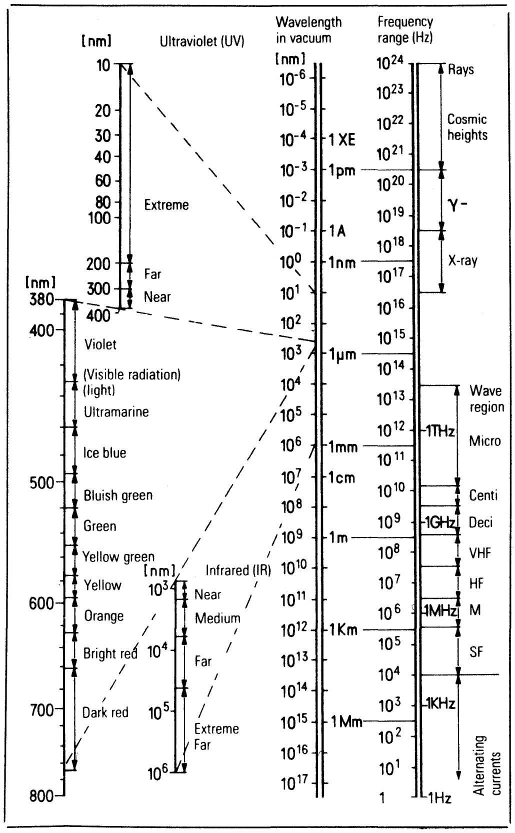
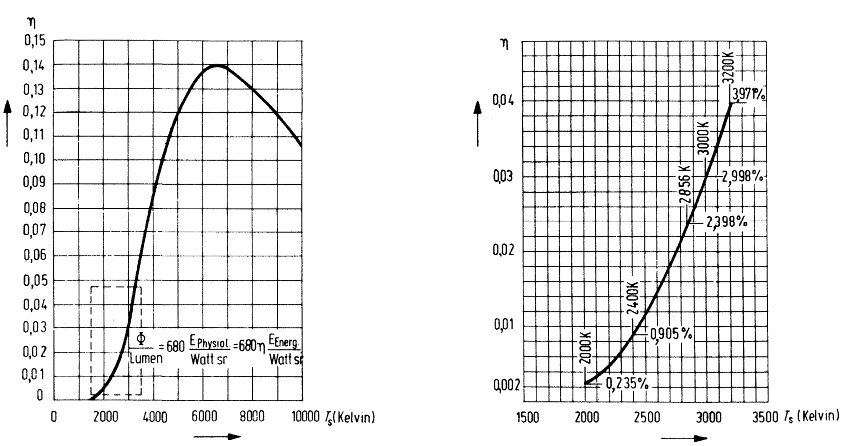


Figure 5.6
Visual efficiency η of the total radiation of a black body versus temperature



SIEMENS
Surface Mounting Appnote 38

1. What is Surface Mounting?

In conventional board assembly technology the component leads are inserted into holes through the PC board and connected to the solder pads by wave soldering on the reverse side (through-hole assembly).
In hybrid circuits (thick and thin film circuits) "chips", i.e. leadless components, are reflow soldered (see chapter 7.2) onto the ceramic or glass substrate in addition to the components already integrated on the substrate. Surface mounting evolved from these two techniques (fig. 1).

In through-hole technology the components are placed on one PCB side (component side) and soldered on the other (solder side) (fig. 1, top), whereas in surface mount technology the components can be assembled on both sides of the board (fig. 1, bottom). The components are attached to the PCB by solder paste or non-conductive glue and then soldered.

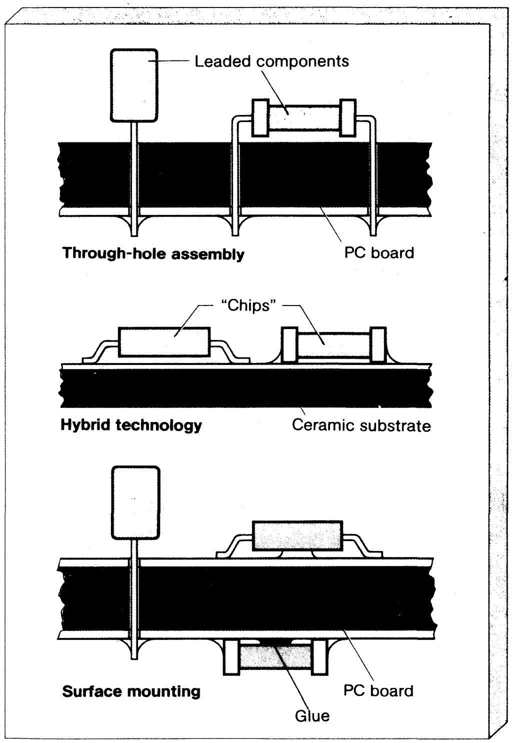
In the near future mixed assemblies, i.e. a combination of leaded and surface mounted components, will prevail, since not yet all component types are available as surface mount version.

Automatic assembly machines are a must for an expedient production; there are systems for simultaneous and for sequential assembly (see chapter 12).

The following explanations point out what actually new in surface mounting is:

- Up to now the connection of materials with large differences in the thermal coefficient of expansion, such as plastic boards and ceramic components, by rigid soldering has been regarded as a serious problem. Practice has shown, however, that this is feasible owing to the elasticity of board and solder; of course, component size and thermal stress are subject to certain restrictions (see chapter 4).
- Components for surface mounting have to withstand high thermal stress during the soldering procedure. Not all component types meet these requirements; therefore new components suitable for surface mounting are constantly developed (see chapter 4).
- In some cases the components are non-conductively glued to the PCB before soldering.
- As compared to through-hole technology there is a closer interrelation between the individual steps in design and production.
- Automatic assembly gains prior importance.

Figure 1 Through-hole assembly - Hybrid technology - Surface mounting



Application Notes 11

2. What are SMDs?

The abbreviation SMD* for **S**urface **M**ounted **D**evice is the most common designation for this new component. SMDs are designed with soldering pads or short leads and are much smaller than comparable leaded components. In contrast to conventional components, the leads of which must be inserted into holes, SMDs are directly attached to the surface of the PCB and then soldered. In figure 2 and the section below the various SMD types are summarized. Surface mountable components include "chips"** with cubic dimensions, cylindrical SMDs, plastic packages with solder pins (SOT, SO, VSO package), chip carrier packages, miniature IC packages (Quad Flat Pack, Flat Pack), TAB components and special SMDs such as inductors, trimmers, quartz crystals, switches, plugs, relays etc.

* Besides, the terms SMC (**S**urface **M**ounted **C**omponent), SMT (**S**urface **M**ount **T**echnology), SMA (**S**urface **M**ount **A**ssembly) are used.

** The designation "chip" should only be used when confusion with semiconductor chip as used in semiconductor technology can be excluded.

SMD types:
(see also chapter 13 "Siemens SMD Product Spectrum")

Cubic components ("chips")
Preference types 0805, 1206, 1210, 1812, 2220,...

Cylindrical components
MELF[1)], MINIMELF, MIKROMELF
TUBULAR (e.g. tubular capacitors)
SOD 80 (MELF-similar diodes)

SOT 23, 143, 89, 192

SO[2)] 4...28 pins (SOIC)

VSO[3)] 40 pins

CHIP CARRIER
Plastic case (PLCC[4)])
Ceramic case (LCCC[5)])

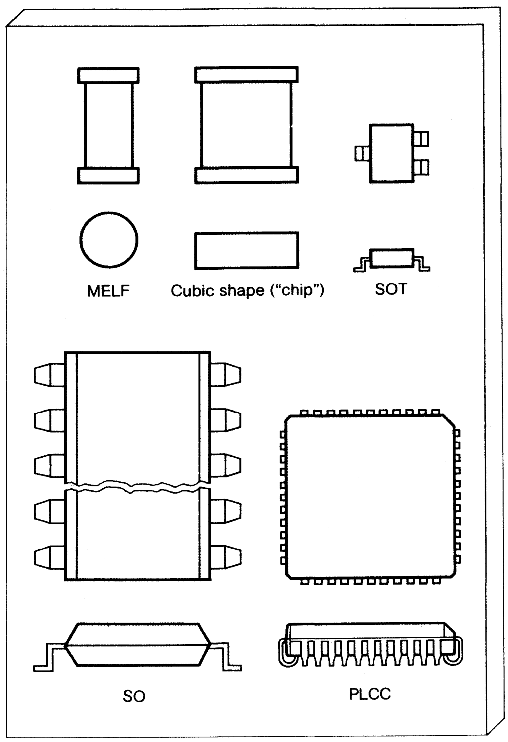
ICs with gull-wing leads
Flat Pack
Quad Flat Pack

MIKROPACK TAB[6)]

Special packages for:
Inductors, SAWs[7)], trimmers,
quartz crystals, switches, plugs, relays etc.

1) **M**etal **E**lectrode **F**ace Bonding
2) **S**mall **O**utline
3) **V**ery **S**mall **O**utline
4) **P**lastic **L**eaded **C**hip **C**arrier
5) **L**eadless **C**eramic **C**hip **C**arrier
6) **T**ape **A**utomated **B**onding
7) **S**urface **A**coustic **W**ave Filter

Figure 2 SMD types



Most of these components are suitable for dip soldering; chip carriers, TAB (MIKROPACK) and some special versions require other soldering methods.

Resistors, ceramic capacitors and discrete semiconductors represent at 80% the largest part of the SMD spectrum. In the range of SMDs the cubic shape prevails over cylindrical versions, as the latter can only have two pins thus being exclusively suitable for resistors, capacitors and diodes.

If development of a special SMD package is not advisable for electric or economic reasons, the DIP package can be converted into a surface mountable version by bending the leads (see chapter 13.2, optocouplers in DIP 6 SMD package).

SMD dimensions

Package	Dimensions (mm)	Standard	
0805	2.0 x 1.25		IEC
1206	3.2 x 1.6		IEC
1210	3.2 x 2.5		IEC
1812	4.5 x 3.2		IEC
2220	5.7 x 5.0		IEC
MELF	5.9 x 2.2 ⌀		
MINIMELF	3.6 x 1.4 ⌀		
MIKROMELF	2.0 x 1.27 ⌀		
SOD 80	3.5 x 1.6 ⌀		
SOT 23	3.0 x 1.3	DIN 23 A 3	JEDEC TO-236
SOT 143	3.0 x 1.3	DIN 23 A 3	
SOT 89	4.5 x 1.5		JEDEC TO-243
SOT 192	4.5 x 4.0		
SO 4...28[1]	spacing 1.27		JEDEC MO-046...
VSO (SOT 158)[2]	spacing 0.76		
PLCC	spacing 1.27		JEDEC MO-04...
LCCC	spacing 1.27		JEDEC MO-04...

[1] SO 6 3.9 x 4.0 or 3.9 x 6.2 (incl pins)
SO 8 5.2 x 4.0 or 5.2 x 6.2 (incl. pins)
SO 14 8.8 x 4.0 or 8.8 x 6.2 (incl. pins)
SO 20 L 12.8 x 7.6 or 12.8 x 10.7 (incl. pins)
[2] VSO 15.5 x 7.6 or 15.5 x 12.8 (incl. pins)

An important factor for automatic assembly is the components' adequate and uniform geometry. Some packages are already standardized (IEC) or are proposed for standardization (JEDEC Recommendation).

For more than ten years Siemens has offered its customers SMDs and thus has gained considerable experience in the field of SMD production through continual modernization and development. The spectrum of active and passive components available covers ICs, transistors, diodes, ceramic multilayer capacitors, NTC thermistors, as well as SIFERRIT miniature ferrites, and the product menu is growing larger almost daily.

3. Advantages of Surface Mounting

The three major benefits of surface mounting
- rationalization
- miniaturization
- reliability

are discussed in the following.

A consistent concept as regards components, board layout, assembly machines, processing and testing is essential for an efficient application of surface mount technology; in other words, the aim should be an optimized overall concept. The component price, for example, should not be seen isolated, but with regard to the total cost including placement, soldering and testing which may already be considerably lower than with conventional board assembly technology.

In the following the advantages of surface mounting are analyzed as to component, PC board, automatic assembly, reliability and rework.

3.1 Components

- SMDs are much smaller than leaded components, thus enabling smaller board size, higher packing density, reduced storage space and finally smaller equipment to be obtained.
- Light weight makes them ideal for mobile appliances.
- No leads means high resistance to shock and vibration.
- Cutting and bending of leads are eliminated.
- Parasitic inductance and capacitance due to leads are substantially lowered making SMDs particularly suitable for RF applications.
- Automatic assembly machines ensure accurate placement.
- MIKROPACKs, PLCCs and similar packages permit a considerably higher number of pins.
- Closer capacitance tolerances can easily be obtained for capacitors with low capacitance values.
- The growing demand for SMDs results in lower production costs, so that further cost reductions can be anticipated. The surface mount version of ceramic multilayer capacitors, for example, is even today cheaper than the leaded version.

3.2 Printed Circuit Board

- Surface mount technology makes PC boards smaller. When using SMDs on both sides of the board, size can be recuced by more than 50 per cent. On the other hand, maintaining the PCB size implies reduced packing density and thus higher yields and higer reliablity.
- In many cases the printed circuits can be shortened and reduced in number. Owing to the compact "leadless" construction the electrical characteristics can easily be reproduced, thus cutting the cost for adjusting RF circuits.
- Surface mount technology does not require a special PCB material; standard materials such as phenolic resin laminated paper and glass-fiber laminated epoxy material are quite suitable, but of course, special materials, e.g. for RF circuits, can be used, too. For normal packing density the printed circuit precision should meet current requirements.
- The elimination of through-holes entails a further cost reduction. This is quite an important factor, as the cost for the drilling of holes can amount up to 10% of the total PCB cost.
- Mixed assembly with leaded components is possible. The reason for using this assembly variation was explained in the beginning.

3.3 Assembly

The average cost per component for automatic assembly can be considerably cut by surface mounting, because the smaller number of assembly machines[1] entails less capital investment, maintenance, servicing and factory space.

- A major advantage of surface mounting are the high component placement rates attained by automatic placers. Fast machines can place several hundred thousand components on the PCBs per hour.
- Automatic placement systems for SMDs feature high placement reliability. Failure rates of less than or equal to 20 ppm (parts per million) can be obtained by machines capable of identity checking and defective recognition. This means that out of a million placed components only max. 20 are not at all or incorrectly assembled.
- In mixed assembly any ratio of SMDs and leaded components is possible, thus facilitating transition to the new technology.
- Some automatic placement systems can handle a wide range of different components. For details see chapter 12.3.

3.4 Reliability

The demands on quality and reliability of PCB assemblies increase steadily. It is a matter of fact, that in this respect SMDs have at least to meet the standard set by conventional through-hole technology.

As surface mount technology is a relatively new development, sufficient proven information on quality and reliability is not yet available. However, the following general statements can be made:

- The failure rate of SMDs does not exceed that of leaded components. Omission of leads means one point of contact less. Owing to their small size and light weight SMD assemblies feature a higher resistance to mechanical stress (vibration, shock) than the corresponding assemblies with leaded components.
- A quality approval for SMDs used in hybrid circuits can be usually applied to surface mounting, as well.
- High requirements are placed on the solderability of SMDs. The specifications for wetting, leaching and storage have to be observed (see chapter 7).
- In many cases the soldering methods are the same as with other mounting methods. The known advantages and disadvantages apply to surface mount technology as well. One should bear in mind, however, that the criteria for judging solder joints are different for wave soldering and reflow soldering (see chapter 7.2). For example, the filling of through-holes with solder is only possible with the wave soldering method, with reflow soldering the amount of solder is too small.
- If components have to be replaced because of incorrect assembly, reliablity of the board – although correctly assembled then – is diminished. Hence, automatic placement systems with their high degree of placement reliability enhance board reliability.

3.5 Rework

Elimination of component preparation, high placement reliability provided by automated systems, and careful planning of each step of the design and production process considerably reduce expensive rework of PCB assemblies with SMDs.

[1] At present three assembly machines are usually required for leaded components:
insertion machine for radial-leaded components,
insertion machine for axial-leaded components,
insertion machine for DIPs.

4. Restrictions and Special Features of Surface Mounting

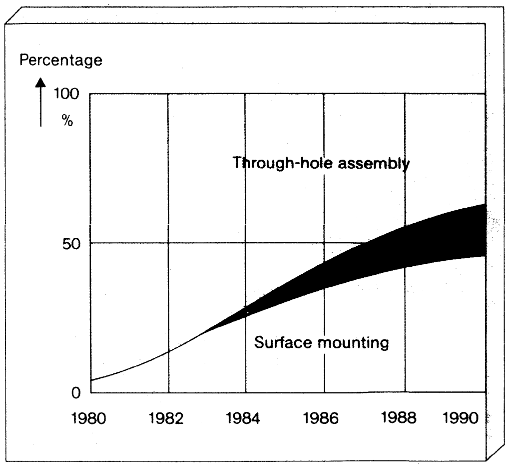
Maximum packing density – one of the primary goals in surface mount technology – requires the use of miniature components, i.e. certain IC packages (e.g. VSO or MIKROPACK). This involves problems, not necessarily resulting from surface mount technology as such, but from miniaturization in general.

- The use of high-pin-count ICs may require new PCB design (fine etching and super-fine etching) and an increased number of layers (multilayer) because the space between the IC pins is too narrow for printed circuits.
- Due regard must be paid to heat dissipation. The high packing density may cause thermal problems. Special PCBs with good thermal conductivity can aid heat removal, if necessary.
- The use of ceramic components is restricted. Due to the different thermal expansion coefficient of ceramic and PCB material, ceramic SMDs with edges longer than 6 mm should not be used on phenolic resin laminated paper and epoxy glass fiber boards.
- Not all SMDs are suitable for dip or wave soldering. This has to be considered when designing the PC board.
- Some components are not yet available as SMD version. Not all SMDs available are standardized.
- High voltages naturally require certain minimum spacings.
- Visual inspection of solder joints becomes difficult if the leads are partially beneath the component body. Therefore, soldering methods should be optimized so that visual inspection will become unnecessary.
- Test methods have to be adjusted to SMD assemblies. Development of new adapters may be required.
- Repair of SMD assemblies may be more costly as compared with conventional PCB assemblies.

5. Market Forecast for SMD Applications

Figure 3 shows the increasing share of surface mount technology in the market. Internationally, the replacement of leaded components on PCB assemblies by SMDs is expected to reach 50% by 1990.

Figure 3 Trends in mounting techniques



6. Fixing SMDs by Glue

New in surface mounting is the gluing procedure required for fixing the components when the PC board is to be turned upside down for soldering. The glue has to meet numerous requirements. It must provide reliable fixing of the components (also of heavy ones) on all kinds of PC boards. Furthermore, it should feature uniform viscosity to ensure easy handling; a pot life of at least several days is advisable. The glue should feature short curing time at low temperature. After curing the glue must not show chemical reactions in order not to impair board or components. On the one hand the adhesive is required to withstand high thermal stress, and on the other hand it must permit removal of SMDs from the assembled board in case of repair. For repairs the component body is heated, so that the adhesive becomes soft and allows the component to be removed without damaging the printed circuit below it. The glue has to be non-toxic, as odorless as possible, and free of solvents. Besides, it should feature good heat conductivity. Development of new adhesives is under way.

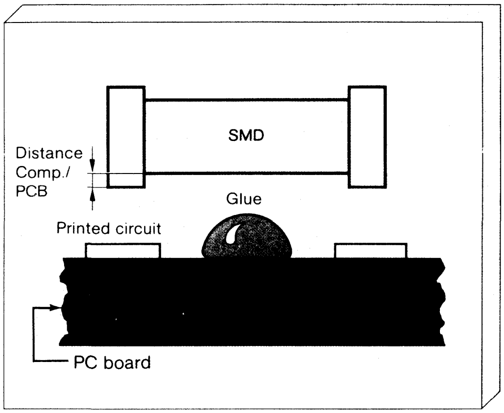
The component outline should be such that the adhesive can easily be applied, i.e. the distance between component body and board must be closely tolerated (fig. 4).

There are three methods of dispensing the glue
- by applicator
- by pin transfer
- by screen printing.

Not all adhesives are equally suitable for all methods.

The Siemens pick-and-place machine (see chapter 12.3) dispenses the glue by an applicator simultaneously with the placement process.

Figure 4 Form of the glue dot and component outline
Component and glue dot have to be shaped such that the component is reliably wetted while the contact area remains free of glue.



7. Soldering Techniques

An appropriate soldering method is particularly important for obtaining good electrical contact and inhibiting short circuits. The choice of the soldering procedure depends on the PCB design (single or double-clad, multilayer etc.), the components supplied, and the production facilities. While many SMDs are suitable for all soldering methods, the soldering technique for ICs, for example, has to be chosen very carefully. Besides manual soldering, which should only be used for repair purposes, there are several automated soldering methods such as bath soldering (wave and dip soldering) and reflow soldering.

With bath soldering the solder is applied during the soldering process itself, whereas with reflow soldering the solder is applied before. For this reason the preconditions for bath soldering, e.g. component orientation and configuration are quite different from those for reflow soldering. The reflow method is particularly advisible for soldering certain ICs (see chapter 9).

7.1 Wave soldering

Wave soldering is the most popular automated soldering process in the production of PCB assemblies. The solder bath temperature lies between 240 and 260 °C and the dwell time is 1 to 3 seconds. Before soldering the flux is applied.

High packing density on the PCB side to be wave soldered involves the problem of solder bridges and shadows (not completely wetted leads and pads). Therefore, PCB layout, i.e. component configuration, should match the soldering method used.

Dual-wave soldering best meets requirements of surface mounting. The first turbulent wave sends up a jet of solder to ensure good wetting of all metalization areas, while the second more laminar wave removes the excess solder (solder accumulations and bridges).

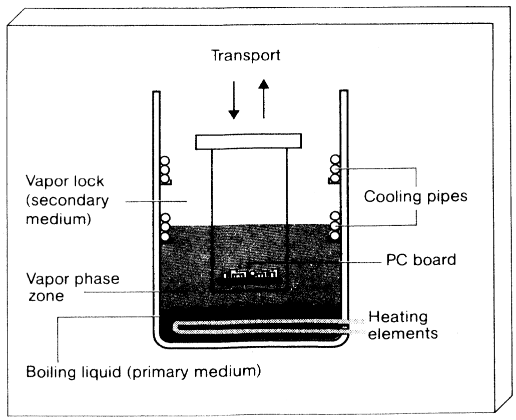
7.2 Reflow soldering

In reflow soldering a specific amount of solder, e.g. in form of solder paste, is applied to the PC board. After attaching the SMDs the reflow process is performed by one of the following methods:

- vapor phase soldering
- hot gas soldering
- heat collet soldering
- infrared soldering.

The latest reflow technique is vapor phase soldering, where the entire PC board is uniformly heated until a defined temperature is reached; there is no possibility of overheating. The defined temperature (e.g. 215°C) in a saturated vapor zone is obtained by heating an inert (neutral) fluid to the boiling point. A vapor lock above this primary vapor zone prevents the expensive primary medium from escaping (fig. 5).

Figure 5 Principle of vapor phase soldering



When the assembled PC board is immersed in the vapor zone the vapor condenses at the cold parts and transfers its heat to the workpiece. Adequate heating control ensures continuous vapor supply. Summing up, it can be said that vapor phase soldering is a very gentle method that excludes overheating. At present it is the best reflow soldering method, if components with different thermal capacity are densely positioned or if adequate heating cannot be provided otherwise.

Other methods are hot gas and infrared soldering in continuous-type furnace. As compared to vapor phase soldering these methods have the disadvantage of poor heat transfer and nonuniform heating effect on components with different thermal capacity.

For heat collet or pulse soldering a collet or a soldering iron is used to transfer the heat to the component leads. It is important to force the leads into reliable contact with the solder pads before and during the soldering process. This method is preferably used for MIKRO-PACK and Flat Pack packages.

7.3 Iron soldering

Manual soldering with temperature-controlled miniature iron should only be used in exceptional cases (repair, etc.), because this method is not only uneconomic, but can also damage components or PC board.

7.4 Fluxes, cleaning agents

Wave soldering requires no other fluxes than those used for conventional techniques (e.g. collophony F-SW32 in accordance with DIN 8511).

Most of the solder pastes required for reflow soldering, however, contain aggressive fluxes the residues of which must be removed by a cleaning process.

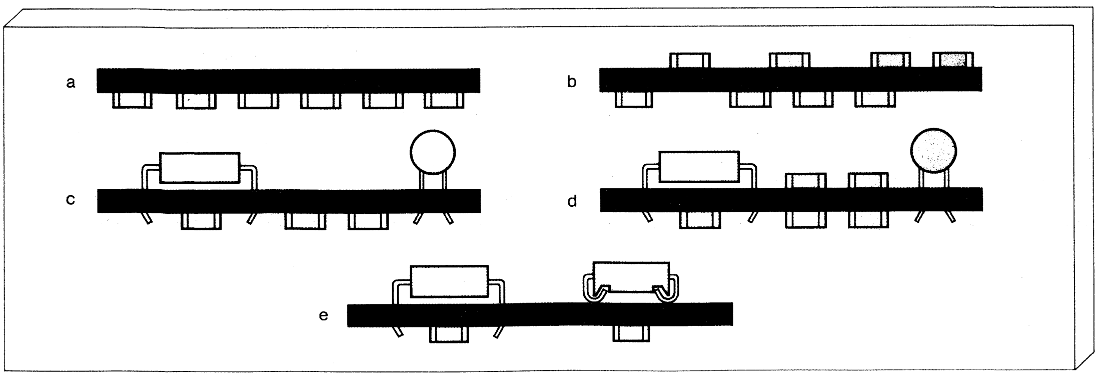
7.5 Conductive adhesion

Conductive adhesion is not a soldering process, but shall be described here for the sake of completeness. It is not very often used since most conventional PC boards with a surface of tin or solder tin are not suitable for gluing. If components or PC board permit gluing, silver-filled mixed epoxy resin adhesives can be recommended. These can be spread by an applicator, screen printing, or by pin transfer. The times required for curing are between 1 min and 12 h depending on the temperature. The thermal stress imposed on the components is less than with soldering, but the adhesion process must be performed separately after soldering the other components.

8. Assembly Variations

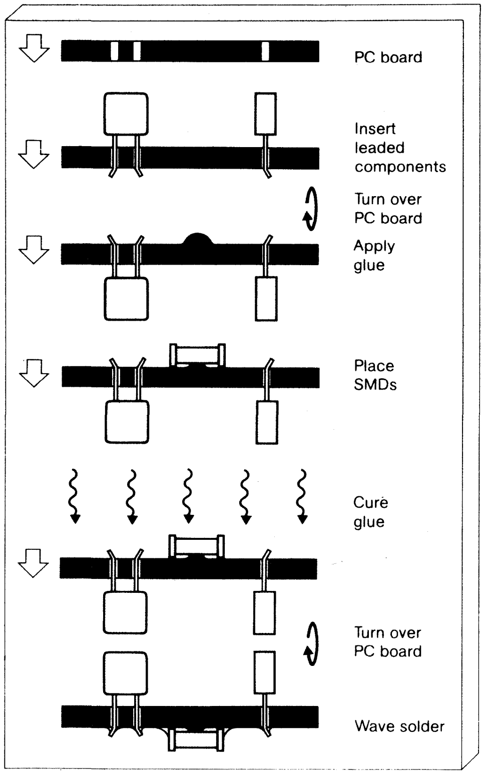
Figure 6 shows the PCB assembly variations possible with SMDs: Assemblies exclusively with SMDs in the top row (fig. 6a and 6b), mixed assemblies, i.e. SMDs combined with leaded components in the middle (fig. 6c and 6d), and mixed assembly consisting of dip solderable components (on solder side) and non-dip-solderable components (on component side) in the last row (fig. 6e). The versions illustrated in figures 6b, d, e require double-clad PC boards.

Figure 6 Variations of PCB assemblies



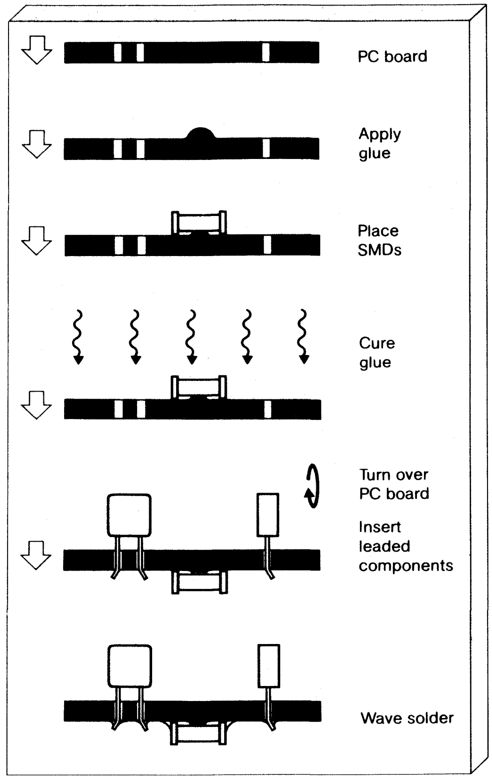
In mixed assemblies with SMDs and leaded components (fig. 6c and 7) the leaded components are usually placed first, then the board is turned over and the glue applied. Subsequently the SMDs are placed, the glue is cured and after a renewed turn over the board is wave soldered.

Figure 7 Mixed assembly of SMDs and leaded components (variant 1)



The second variant shown in figure 8 differs from the first in so far as the glue is applied by screen printing at first; the following production steps are executed as illustrated in figure 8. This procedure has the advantage that the glue can be applied by screen printing, however, it has to be taken into account that because of the already mounted SMDs vacant board space is required for the mounting tools of the insertion machines, which are needed for cutting and bending the leads of conventional components.

Figure 8 Mixed assembly of SMDs and leaded components (variant 2)



The procedure for double-sided SMD mounting is as follows:

- Screen printing of solder paste
- SMD placement
- Reflow soldering
- Insertion of leaded components
- PCB turn over
- Application of glue
- Placement of SMDs on the reverse side
- Curing of the glue
- PCB turn over
- Mounting of components requiring special handling
- Fluxing, wave soldering

Here both reflow and wave soldering are used. Assemblies including leaded components always require wave soldering.

The aim is a uniform mounting procedure with the exclusive use of SMDs. Figure 9 shows examples for totally surface mounted assemblies with reflow soldering (top) and wave soldering (bottom).

Figure 10 is a flow chart for the various assembly and soldering variants.

Figure 9 PC board exclusively with SMDs, reflow soldered or wave soldered

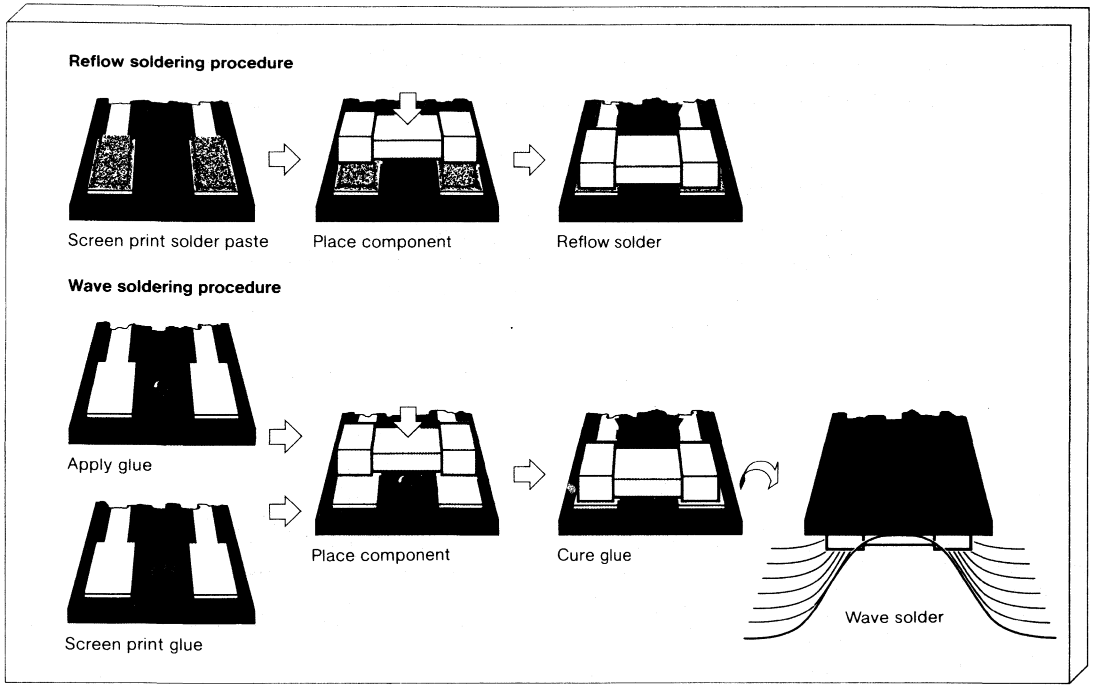
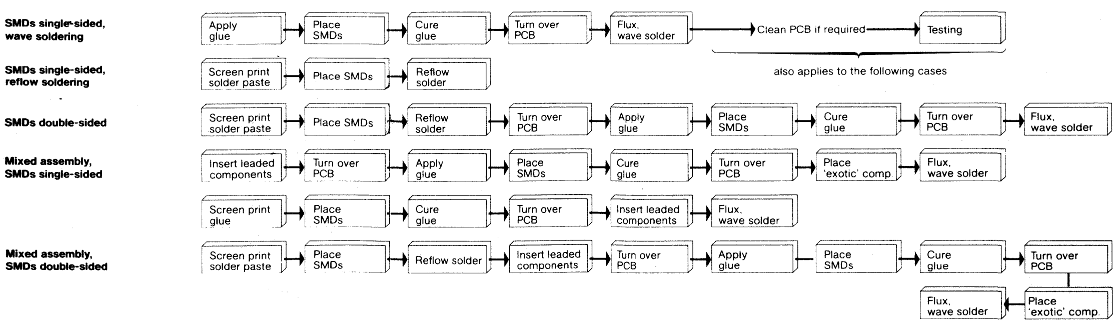


Figure 10 Possible assembly procedures for SMDs and leaded components



SIEMENS

Cost Effective Optical Signal Transmission Plastic Fiber Components (PFC) Using Siemens Light-Link Emitters and Detectors Appnote 40

Part 1 – Light-Link Emitters & Detectors—Features & Descriptions

by Klaus Panzer, Albrecht Mayer, and Nick Waegner

Optical communications links offer significant advantages over electrical links for the transmission of data. The following characteristics make the technology particularly attractive for a wide range of applications:

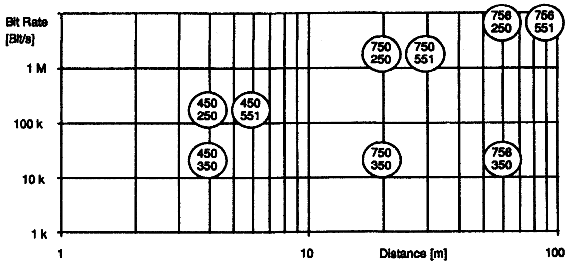
- Insensitivity to electromagnetic interference
- Voltage decoupling between emitter and detector
- Security against tapping
- No sparking at fiber ends or breaks
- No ground loops

Despite the many potential application areas arising from these advantages, the use of optical glass fiber is restricted due to its relatively high cost. Where system demands are for medium bit rates and distances, by far a more cost effective solution today is offered by **Plastic Optical Fiber (POF)** in combination with **Siemens Plastic Fiber Components (PFC)** emitters and detectors. These low cost components permit the use of plastic fibers even in the most cost sensitive applications, such as:

- Industrial and medical networks
- Motor controls, links between power and control units
- Replacement of connections with copper wire and opto coupler (within cabinets)
- High voltage opto couplers
- Automotive bus applications
- Building information and control systems

The Siemens PFC product range consists of three different emitter diodes (SFH450, SFH750, and SFH756) and three opto-detectors (SFH250, SFH350 and SFH551). Whatever the system requirements, a combination of Siemens PFCs may be selected to provide the optimal solution. The characteristics of various combinations of PFC emitters and detectors are shown in figure 0.1.

Figure 0.1. Bit Rate Versus Transmission Span

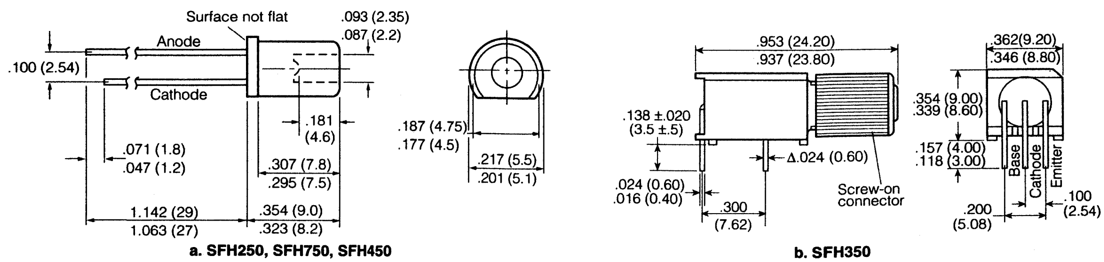


1. Optical–Mechanical Design

The product range builds upon proven fabrication technology 5 mm LEDs. The task of coupling the device to the fiber is given over to the housing, the design is shown in figure 1.1a.

A particular advantage of the Siemens PFCs is the housing aperture into which a standard plastic fiber (external diameter

Figure 1.1. Design of the PFC Housing



a. SFH250, SFH750, SFH450

b. SFH350

of 2.2 mm) may be introduced without having to remove the cladding. This has the additional benefit of automatically centering the fiber on the chip.

Sticking the component and the fiber together results in a permanent connection, which not only saves on space but also is very cost effective. Should a temporary connection be required, the PFCs are also available in a housing with a mounting screw (see figure 1.1b). This option has numerous advantages:

- The cladding need not be removed
- A connector on the fiber is not necessary
- The plastic fiber is connected by a simple turn of the screw cap
- The screw cap cannot be removed (loss-proof)
- The component is suitable for automatic board assembly
- The fiber itself does not turn when the cap is screwed tight
- Every plastic fiber with an external diameter of 2.2 mm and an internal diameter of 1 mm can be used
- Small housing dimensions
- The housing protects photodetectors from external light sources

The emitters are mounted in grey housing and the detectors in black. Two mounting pins are provided on the housing for firm attachment to boards.

2. Electrical and Optical Characteristics of PFCs

Both the emitters and detectors display the same electrical characteristics of standard optoelectronic devices. They may be operated in a temperature range of −40°C to 85°C.

2.1. Characteristics of the Emitter Diodes

Different technologies employed in chip fabrication lead to significant variation in parameters for the various emitter diodes. All the emitters distinguish themselves in offering high output power coupled into the plastic fiber, low fiber attenuation and long lifetimes. Table 2.1 gives a summary of the most important device parameters, where Pin is the output power coupled into the fiber, t_r and t_f are the rise and fall switching times for the optical signal.

Table 2.1a. Parameters of the PFC Emitters

Part	SFH450	SFH750	SFH752 old	SFH756 new	Dim
Wavelength	950	660	665	660	nm
Typ. Pin (I_F=10 mA)	90	9	60	200	µW
t_r 10%/90%	1000	120	150	80	ns
t_f 90%/10%	1000	50	80	80	ns

SFH450 emits in the infrared range, whereas SFH750 and the new part SFH756 emit visible light in the red range, namely at 660 nm, which is optimal for plastic fiber. The choice of emitter for a particular application is dealt with in section 3, where system issues are discussed.

The output power coupled into the fiber is measured using a standard plastic fiber of numerical aperture 0.47 and length approximately 30 cm, for a forward current of 10 mA. It should be noted that this power is not transmitted over long distances. Consequently the first few meters of a long length of fiber appear to have higher attenuation (see section 3.2).

The optical power does not rise linearly over the entire operating range. At low currents the optical power rises more than proportionately with the current; at higher currents, saturation sets in.

As regards the effect of device temperature, all emitter diodes have negative temperature coefficients. As a result the output power coupled into the fiber decreases at higher temperatures.

2.2. Characteristics of the Photodetectors

Within the PFC range, three photodetectors are available: a fast PIN-Photodiode (SFH250), a phototransistor (SFH350) and an integrated photodetector with TTL-output (SFH551).

The main parameters of the photodetectors are summarized In Table 2.1b.

2.2.1. Phototransistor SFH350

The phototransistor SFH350 is a very cost effective photodetector. In operation it yields a high output current even at low optical input power. Its performance is limited by low switching speeds. The external base connector on the SFH350 may be used to divert current using a base-emitter resistor, with the following advantages

- Reduction of the collector-emitter cutoff current
- Reduction of the switch off time
- Suppression of noise signals and signals with low power

As the temperature coefficient is positive for phototransistors, this in some measure compensates for the negative coefficient of the emitter diodes, assuming that the ambient temperature of the emitter and receiver are the same.

2.2.2. Photodiode SFH250

The photodiode SFH250 has a switching time of 10 ns (with 50 Ω for P_{opt}=50 µW), which makes it the fastest available detector. When driving a load of greater than 200 Ω, the capacitance of the diode also determines the switching time.

The temperature dependence of I_P is less than that of a phototransistor. The photodiode SFH250 has lower, negative temperature coefficients for wavelengths of 565 or 500 nm. At 950 nm wavelength, the coefficient becomes positive.

Table 2.1b. Parameters of PFC Photodetectors

	SFH250 PIN-Photodiode	SFH350 Phototransistor	SFH551 Integrated Photodetector	Dim
Sensitivity 660 nm (950 nm)	0.25 (0.3)	80 (120)		A/W
Switching level			4 (3.2)	µW

2.2.3. Digital Optodetector SFH551

SFH551 is a fast digital optodetector. It delivers a digital output which can be processed directly with little additional external circuitry.

The integrated circuit inside the SFH551 optodetector comprises the photodiode device, a trans-impedance amplifier, a comparator and a level shifter.

The **photodiode** converts the detected light into a photocurrent. With the aid of an integrated lens the light emanating from the plastic fiber is almost entirely brought to focus on the surface of the diode.

At the next stage, the **trans-impedance amplifier** converts the photocurrent into a voltage.

In the comparator, the voltage is compared to a reference voltage. Synchronism between the reference and the trans-impedance output voltages, is ensured by deriving the reference from a second circuit similar in kind, which incorporates a "blind" photodiode.

The **comparator** drives a level shifter with an open-collector output stage. Here a catch diode (similar to Schottky-TTL) prevents the saturation of the output transistor, thus limiting the output voltage to the supply voltage. As a consequence, there is no advantage to be gained in connecting the collector resistance at the output transistor to a higher voltage than the supply voltage.

Operation of the Optodetector SFH551

The form of the signal which the level comparator (with fixed threshold) receives internally from the trans-impedance detector has a decisive influence on the behavior of the dc-coupled detector. It is primarily determined by the input optical signal and is characterized by the following parameters:

- Background light, arising from scattered light or light from the emitter, which has not completely switched off.
- Rise and fall time, which are dependent on the driving signal of the emitter, the speed of the sender and possible influence of the transmission path.
- Pulse amplitude which is dependent on the emitted power and the optical transmission path.

Providing the SFH551's preamplifier with high-bandwidth, ensures that no signal distortion occurs in the linear operating region of the preamplifier.

Depending on where the set threshold cuts the detected impulse, the output impulse is distorted in various ways:

- If the input signal is too small, it fails to reach the threshold and the detector fails to switch. Should only the peak of the input impulse rise above the threshold, the output impulse appears shorter as a consequence.
- If the input signal is very large, the comparator threshold lies at the lower end of the input impulse. As a result the detector switches on early and off late relative to the input impulse, leading to an extended output pulse.
- If the emitter signal contains a dc portion or additional light reaches the detector, the noise may be raised into the threshold region or the detector remains on, in which case data transmission becomes impossible.

As these factors demonstrate, the characteristics of the SFH551 can only be described in reference to an optical input signal.

Dynamic Operating Range:

Of great importance for the application of the optodetector is the dynamic operation range, that is to say the range between the maximum and minimum optical power for which the performance of the component is guaranteed.

In order to be able to define this range, it is necessary to consider the behavior of the detector at the limits.

Minimum Optical Power

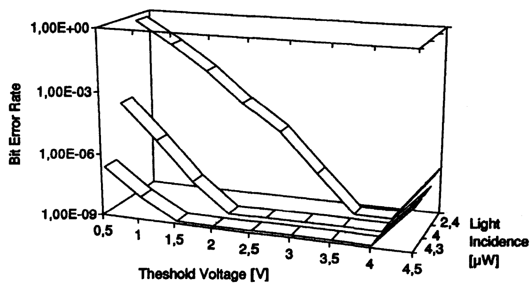
As has been described, noise impulses can appear at the output of the detector, when the input optical power lies near or below the limit 4 μW (as specified in the data sheet).

Due to their random nature, the noise impulses are difficult to measure. An oscilloscope with an adjustable trigger threshold may be used to verify which noise level is reached.

In the final analysis it is important whether the noise is sufficient to bring about incorrect switching events. This can best be determined from measurements of the Bit Error Rate (BER).

Figure 2.1 shows such a BER measurement for three different optical power levels for a range of threshold voltages from 0.5 V to 4.5 V. A BER of 1.0 x 10^{-9} signifies that 1 bit error occurred in 1 billion transmitted bits. Indeed the BER reduces even further, though this is in practice no longer measurable within the test period.

Figure 2.1. Bit Error Rate Measurements for Different Optical Power and Threshold Voltage at the Output of the SFH551



The measurements show that the detector switches at around 2 μW optical power, though the noise robust region is small and lies above 3.5 V. Since the thresholds of most gates usually lie much lower, optical power should not fall below 4 μW as specified in the data sheet for error free operation.

Maximum Optical Power

At high data rates the upper limit of the usable optical power is reached by an overshoot in the electrical output signal (about 50 ns after the transition from L to H). It appears above 50 μW and grows with increased optical power. At 100 μW, with a load resistor of 330 Ω, it can lead to an erroneous impulse. For this reason the data sheet specifies 50 μW as the maximum power.

At lower data rates (for example 1 Mbit/s) the overshoot is less of a problem. When the output of the SFH551 is slowed, for instance using a large load resistance, a jitter may still be observed at 100 µW, but this will not lead to erroneous impulses. Indeed in this case it may be possible to operate up to 300 µW. Only when higher power levels are reached does the noise become a limiting factor in performance.

Combining the SFH551 and TTL/CMOS Gates

When combining the PFC detector SFH551 with gates of different logic technologies, it is necessary to determine how logic at the output reacts to noise impulses. The circuits shown in table 2.2 are recommended for combination with SFH551 due to their relatively high switching thresholds. CMOS gates are particularly suitable for this purpose as table 2.2 demonstrates.

By using logic with a Schmitt trigger at the output, the safety can be increased further. In this case the optical power required for error-free operation can be reduced to 3 µW.

Table 2.2. Parameters Relating to Different Logic Families (V_{CC} 5 V)

Logic Gate	Ui (low) max. [V]	Ui (high) min. [V]	Signal propagation time [ns]
74132	0.9	1.7	15
74HC00	1.0	3.6	8
74ALS00	0.8	2.0	4
HEF4011	1.5	3.5	35
CD4011	1.5	3.5	60
CD4093	1.4	3.6	200
74C08	1.5	3.5	80
7408	0.8	2.0	10
74AC08	1.5	3.6	5.5

Further Application Hints for the SFH551

Protection against scattered light:

The connector housing provides sufficient protection against scattered light; no further protection is required.

Clamping of the Supply Voltage:

The supply voltage must be clamped by a capacitor of at least 100 nF (between V_{CC} and GND) placed no further than 5 cm from the component. Should the clamping of the component be insufficient, the overshoot observable at the output may reach high levels for certain inputs.

Output Resistance:

At the highest bit rates it is recommended not to exceed the maximum output current of 13 mA. This means that when a load resistance is connected to the supply voltage, it should at least have a value of 350 Ohm. With this configuration the shortest switching times are attainable in the output stage. When slower switching times are admissible larger resistances should be used in order to reduce the power loss.

Output low pass filter:

At lower bit rates it is possible to reduce the required input power somewhat and extend the dynamic operating range by reducing the noise signal using a low pass filter. For this purpose it is recommended to make the load resistance large and/or connect a capacitor to the output of a size corresponding to the required switching time and bit rate.

3. Systems with PFC Diodes

3.1. Plastic Optical Fiber (POF)

The most common type of fiber consists of a polymethylmethacrylate (PMMA) core approximately 970 µm thick with 30 µm thick cladding made of fluoride-containing carbon polymer. Given that the refractive indices of the core and cladding are 1.492 and 1.417 respectively, the numerical aperture is 0.47 and the fiber acceptance angle 56°. With a PVC or PE protecting sheath the POF has a total diameter of 2.2 mm.

These fibers are obtainable from many manufacturers. The CUPOFLEX fibers, are typical of the POFs available.

The appendix also gives the typical attenuation as a function of wavelength. Of the two attenuation minima in the visible spectrum, the one in the red region with λ=650 nm is suitable for distances up to 100 m. Due to the low quantum efficiency of the green emitter, the attenuation minimum at λ=570 nm is unsuitable for communications applications. Moreover the switching times of the red emitters are significantly lower and the degradation is less than green emitters. In spite of the high attenuation of POF in the IR-spectrum (4 dB/m) infrared emitters (SFH450) can still produce sufficient power levels at the fiber end over a few meters to be of practical use.

Plastic optical fiber made of PMMA can be used in ambient temperatures of –20 up to 85°C. For lower temperatures (down to –50°C) the constraint of mechanical flexibility has to be taken into account. Fibers for higher temperatures up to 125°C, such as those necessary for automotive applications, are in development.

When using POF, the bend radius should not be less than 20 mm, otherwise the fiber attenuation increases. Smaller radii are possible using fibers with higher numerical aperture.

Treatment of Fiber Ends

Due to the thick diameter of POF it is easier to handle than glass fiber. Thus for very short distances, where plenty of allowance has been made for attenuation, it is possible to cleave the fiber using a sharp edged blade. For greater distances, wet polishing the fiber end with 600 grain sandpaper yields greatly improved results. To achieve very flat surfaces at the fiber ends, the fiber should be cut with a blade heated to 160–180°C or the clean cut fiber end may be pressed for 2–4 seconds on a plate heated to 100–140°C. Alternatively it is suggested to refer to the manufacturer's recommendations.

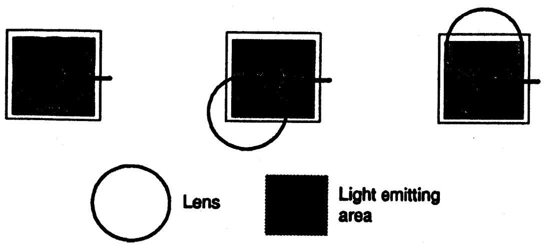
3.2. Connecting the PFCs to the Fiber Emitter

When current flows in the forward direction the emitter diode emits optical radiation. The task of the housing is to bundle the output radiation so that the greater portion of it is coupled into the fiber. The components are intended for use with plastic fibers and thus the data regarding optical coupling into and out of the fiber refers to standard plastic fiber with a core diameter of 1 mm and a numerical aperture (NA) of

0.47. So that as much as possible of the radiation emitted within this angle falls upon the fiber, the radiation is concentrated on the fiber using a built-in reflector and a lens.

The chip in the SFH756 is a large area radiating chip with the bonding ball in the center. Consequently there are several alternatives for optimal postioning of the fiber core over the chip (indicated by the lens) (see figure 3.1).

Figure 3.1. Lens Position for Maximum Coupling in the Transmitter



In section 2.1 it was already pointed out that the optical power which can be coupled into the fiber is measured using a standard plastic fiber with a numerical aperture of 0.47 and alength of approximately 30 cm. The power defined in this way is not transmitted along large lengths (>3 m) of fiber. For long stretches of fiber the first meters exhibit a higher level of attenuation. This can be taken into account by adding 2 dB to the attenuation incurred due to the length of the fiber itself.

Detector

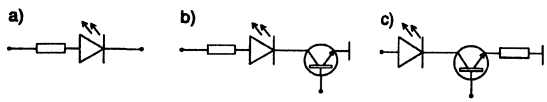
Due to the lens of the detector's housing, virtually all the input radiation is focused on the chip.

3.3. Dimensioning the Emitter Driver and the Detector

3.3.1. The Emitter Driver

The emitter is stimulated into emission by current flowing in the forward direction. There are several possibilities for the design of the driver circuit, which has the task of adjusting and stabilizing the current flow. In figure 3.2 the basic types of driver circuits are given.

Figure 3.2. Types of Emitter Diode Driver Circuits



In the simplest example (figure 3.2 a) the emitter diode is connected in series with a resistance R_S to the supply voltage V_S. The current I_F is dependent on the forward voltage V_F of the diode: $I_F=(V_S-V_F)/R_S$

The diode may also be driven using the output transistor of a TTL gate or a separate driver transistor (figure 3.2 b), in which case the collector-emitter voltage should be taken into account. In this configuration the current let through by the transistor is given as: $I_F=(V_S-V_F-V_{CE})/R_S$

In order to keep the current and thus the optical power constant, it is preferable to control the current flow (figure 3.2 c). For this example as with the others, it is necessary to ensure that sufficient voltage is provided.

One of the diagrams in the emitter data sheet shows the dependency of the forward voltage V_F on the current. Since V_F may reach 3 V for currents of 300 mA for example, the maximum duty cycle may be limited by the supply voltage.

Another important parameter when dimensioning the driver is the permissible pulse load. It is clear from the relevant diagram in the data sheet, that in regard to power loss, peak currents of up to 1 A are possible for short duty cycles. Whether this peak current can be used, depends on the available supply voltage.

3.3.2. Detector

When dimensioning the detector it is necessary to establish the dynamic range, ie., the relation between the minimum current required and the maximum permissible current.

3.4. System Planning

In order to demonstrate the process of system planning, an example of the design of an optical transmission system over a long distance using the SFH551 detector will be discussed.

According to the data sheet, the SFH detector has a dynamic range of around 11 dB. This range must be attributed to the various levels of attenuation along the fiber and the tolerance of the emitter power.

Attenuation in plastic fiber over long distances for light of wavelength 660 nm is of the order 0.3 dB/m. However, the first section of fiber exhibits higher attenuation (around 2 dB in the first five meters). Since the emitter power is measured and specified using a short length of fiber, the effect needs to be taken into account. (cf. section 3.2).

The example, Table 3.1. demonstrates how a fiber length of 50 m should be driven:

Thus the configuration in this example requires an emitter with between 560 µW and 1400 µW output power.

Emitter and Current Selection

For additional security (design tolerance) the emitter power should be chosen to lie between the minimum necessary and the maximum tolerable values (ie., 1000 W for example Table 3.1). At 10 kbit/s, for instance, the pulse should last a maximum of 0.5 µs in order to make use of the maximum duty cycle current of 1 A. As the data sheet shows, the increase is a factor of 60 (17.8 dB) relative to 10 mA.

4. Recommendations for Mounting

When soldering it should be ensured that the component is not overheated. Given a distance of 2 mm between the component and the soldering point, when using a soldering iron the maximum permissible temperature is 300°C for a maximum of 3 s. In flow and dip soldering the maximum temperature should be 260°C up to a period of 5 s.

Particular care should be taken so that the component is not subject to any mechanical stress. When bending the connection pins, the packaging should not be loaded in any way.

The soldered components may be cleaned using organic solvents, with an alcohol base, a base of certain fluorohydro-

Table 3.1. Planning of a Transmission Line

	Min.	Max.	
Detector power	–24.0	–13.0	**dBm**
50 m distance at 0.3 dB/m	15.0	15.0	dB
Additional attenuation of first few meters	2.0	2.0	dB
Emitter power without tolerances	–7.0	4.0	**dBm**
Further effects which contribute to the reduction of the operating range:			
Temperature (–20 to 45°C)	1.0	–1.0	dB
Aging	2.0	–	dB
Range of emitter power distribution	1.5	–1.5	dB
Emitter power	–2.5	1.5	**dBm**

carbons or a mix of the two. Never use solvents or solvent mixtures which contain chorohydrocarbons or ketones, these can attack or dissolve the housing.

5. Reliability

5.1. Degradation

For optoelectronic emitters, the emitted radiation power reduces over the component's lifetime. This effect is known as aging. It is dependent on the technology of the diode system, the load current I_F and the ambient temperature TA.

If one defines the failure criterium as a 50% (–3 dB) fall in output power relative to the start value, the lifetime of all PFC emitter is more than 10^5 hours.

5.2. Emitter Diode Permissible Current Load

When the emitter diode is in operation, most of the electrical input power ($U_F \times I_F$) is converted into heat. The temperature of the semiconductor chip and the packaging rises as a consequence. To ensure reliability, the chip should not be heated above the maximum permitted for the depletion layer. This in turn yields a maximum power loss, dependent on the ambient temperature, which cannot be exceeded (cf. relevant data sheets). These values are valid for dc operation.

Significantly better operation conditions are possible using the emitter diodes in pulse operation, as the average power decreases inversely proportional to the duty cycle. However this means that the maximum forward current I_F can be increased for shorter pulse widths and/or longer duty cycles, as shown in the Permissible Pulse Load plot in the data sheets. These plots give the maximum permissible forward current dependent on the pulse width for an ambient temperature TA of 25°C. The duty cycle parameter D (ratio of pulse width τ to cycle period T) given as $D=\tau/T$. For very short pulse widths (10 µs) and small duty factor (1:200) a current up to 20 times greater than the maximum direct current is permissible for PFC emitter diodes. Even in the range of 100 milliseconds and a duty cycle of 1:5 a doubling of the forward current may be reached, thereby raising the power coupled into the fiber by a factor of 2 with the SFH450 and a factor of 2.5 with the SFH750 in comparison with dc operation.

5.3. Permissible Mechanical Load

The fiber optic components SFH250, SFH350, SFH450, SFH750, SFH756 and SFH551 are designed in such a way, that they can cope with a heavy mechanical load, as required for instance in automotive applications. The following tests have been successfully conducted on all the above components:

- Oscillation test (according to DIN IEC Teil 2–6, Test Fc)
- Shock test (according to IEC 68-2-27, Test Ea)

In these tests diodes were employed with a fiber length of approximately 5 cm attached. The diodes were soldered to a board and subjected to oscillations and shocks (single impulses) in the three orthogonal axes. The oscillation frequency varied10 to 500 Hz with an acceleration of 49 ms^{-2} (ie. five times the acceleration due to gravity).

Part 2 – Plastic Fiber, Light-Link Optocouplers are Faster

Application Example

by Günther Hirschmann

Derived from optoelectronic mass-produced components, light-link devices are special types which permit the simple construction of signal transmission paths using plastic fibers.

Optical signal transmission has the following advantages relative to conventional wire links:

- Handling of high frequencies because of short switching times and negligible capacitive coupling
- Maximum transmission distance is several yards
- The low power transmitter allows operation in areas subject to explosion hazards because there is no risk of ignition
- Interference-free transmission even in the presence of strong, varying electromagnetic fields
- No crosstalk because of negligible capacitive coupling between emitter and detector
- Unlimited isolation voltage ratings

Every Device has Particular Features

The three optical emitter diodes available are distinguished by emission colors and radiation wavelengths:
SFH450 – infrared, 950 nm and SFH750/756 – red, 660 nm.

In addition they have features which either recommend or exclude their use in particular applications. The SFH450 IR-diode provides the highest efficiency in converting electrical power into radiation. It allows the strongest signals to be obtained in the detector circuit.

Attenuation in the plastic fiber at 950 mm is so high, however, that this combination is only suitable for short-distance transmission.

Moreover, the switching times of about 1 µs do not satisfy the more stringent frequency response requirements. With ten times shorter switching times [2] but reduced radiation power, the SFH750 and SFH756 red diodes are better suited to handling high-frequency pulse trains.

Detector devices can be distinguished in a similar way. The SFH350 device benefits from on-chip power gain and so has a high sensitivity. With a given fiber output power, its signal is 250 times greater than that of the SFH250 diode. Transistor switching times in the order of 15 µs permit applications of only 10 kHz when the switching edges of pulse trains have to be detected with almost no delay. If there is no such requirement the phototransistor is capable of handling frequencies of 50 to 100 kHz.

The SFH250 silicon PIN-diode is ideal when switching speed and frequency response requirements are more stringent. Its signal rise and fall times are around 10 ns. When the PIN-diode is used in conjunction with the SFH750 diode, however, the latter is the frequency-determining component with rise times of about 120 ns and fall times of 50 ns.

Coupler Circuits Using Light-link Components

The mechanical construction of transmission paths is simple:

The plastic fiber is inserted in the cylindrical holes on top of the components and is firmly connected by a shrink sleeve. With long transmission distances, it is a good idea to polish the fiber ends to avoid attenuation losses. Figure 1 gives an example of an optocoupler setup. In the circuits described here the SFH750 red emitting diode is used as the transmitter and the SFH250 PIN-diode as the detector The resistor connected in series with the transmitter diode serves for current limiting.

When the diode is measured its forward current may reach values (independent of switch-on time and duty factor) as listed in Figure 2. In the following examples, the diode's rms current is limited to about 27 mA.

Figure 1. Basic Circuit to Operate Light-link Optocouplers

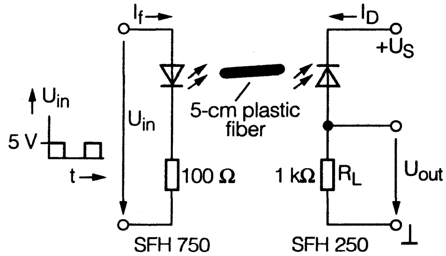
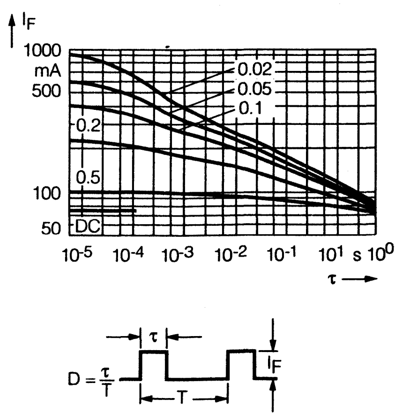


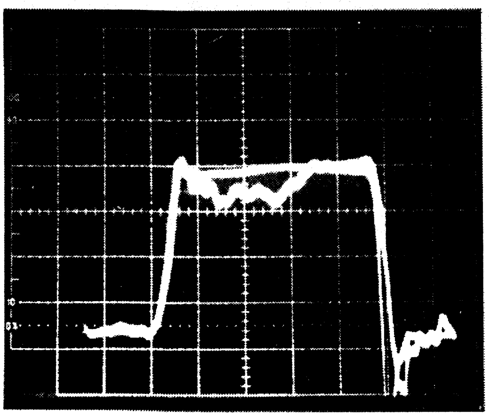
Figure 2. Pulse Handling Capability of the SFH750 Emitter Diode



The receiver diode is operated in the reverse condition. Its load resistor R_L across which the output signal is developed, not only influences the output amplitude U_{OUT} but also the rate of change of the output pulses. High resistance results in higher signal voltages and longer rise and fall times. Characteristics of the input signal U_{IN} and the output signal U_{OUT} for the Figure 1 circuit with a 1 MHz switching frequency are shown in Figure 3.

The current transfer ratio is a crucial factor with opto-electronic coupling distance s.

Figure 3. Drive Signal (5 V) and Output Voltage (70 mV) with 1 MHz Frequency in the Figure 1 Circuit



This is the ratio of current through the detector to current through the emitting diode. In the described setup of SFH750, 5 cm long plastic fiber and SFH250 the current transfer ratio is 0.13%. Under these conditions the detector signal has to be further amplified. Figure 4 is a simple amplifier circuit suitable for frequencies up to 50 kHz.

The detected signal is amplified by a common emmiter stage. The unit is characterized by high current gain and low upper limit frequency. To phase match the input and output signals, a phase reversal stage is provided by transistor T2.

The anti-saturation diode D1 improves the switching characteristics. Rise and fall times of the output signals are about 200ns. The output signal delay relative to the input signal is 0.7 µs.

Figure 5 is a circuit suitable for transmitting analog signals up to 200 kHz:

The TAE 1453 A op-amp has a pnp input differential stage and an open-collector output. The incoming signal is applied to the non-inverting op-amp input and is amplified by the ratio of R_1/R_2. A high speed CMOS logic driver converts the output signal to TTL level. Delay times with this circuit are only about 250 ns, while rise and fall times can be neglected. To handle higher frequencies (up to 1 MHz) the Figure 6 circuit is

Figure 4. Amplifier with Common- emitter Circuit Suitable for Analog Signals up to 50 kHZ

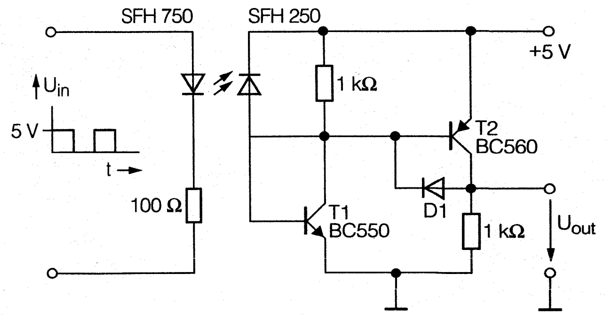


Figure 5. Optocoupler Circuit to Transmit Analog Signals up to 200 kHZ

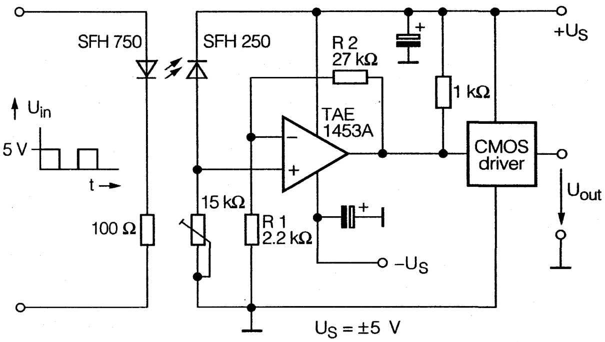
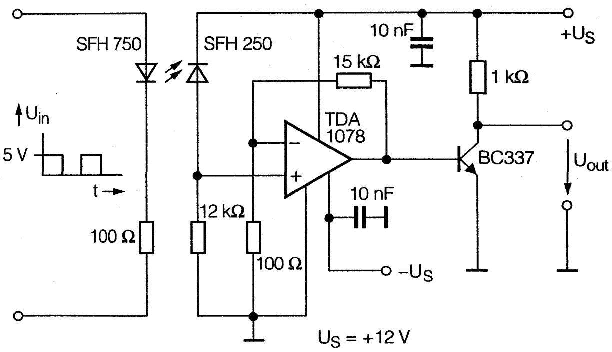
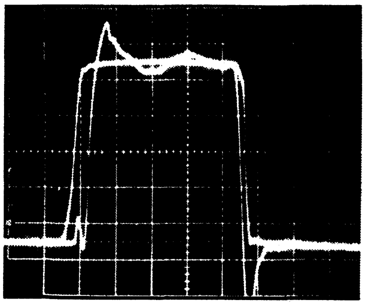


Figure 6. Optocoupler Circuit to Transmit Analog Signals up to 1 MHz



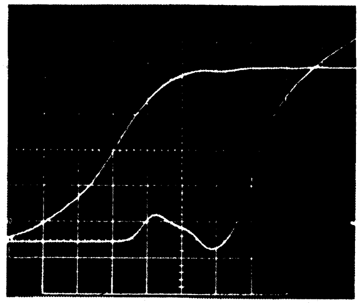
the most suitable. It uses the fast TDA 1078 op-amp. The device is operated as a non-inverting amplifier with a gain of about 150.

Figure 7. Switching Performance of Figure 6 Circuit, Input Pulse (left) and Output Pulse (right)



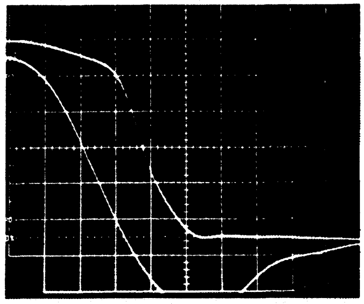
U=1 V/Div
t=100 ns/Div
f=1 MHz

Figure 8. Rising Edges of Input and Output Pulses in Figure 6



t=10 ns/Div
f=1 MHz
35 ns delay time of the output signal
25 ns rise time of the output signal

Figure 9. Falling Edges of Input and the Output Pulses in Figure 6



t=10 ns/Div
f=1 MHz
16 ns delay time of the output signal
18 ns fall time of the output signal

Transistor T1 brings the output voltage U_{OUT} to 5 V. Figure 7 shows the appropriate switching characteristic. Figure 8 and 9 illustrate in more detail the rising and falling edges of the input pulses on the left, and the waveforms of the output pulses on the right. It is obvious that the amplifier circuit introduces short delays of 35 and 10 ns but does not further extend the remaining switching times.

Photo Interrupter Circuit

In Figure 10 a photo interrupter arrangement is shown. The ends of the optical fiber are polished. As shown in Figure 11 the distance from the optical fiber end must not exceed 5 mm to avoid an excessive voltage drop in signal voltage level. Thanks to the optical fiber the optical detection area can be remote from the electronic circuit. The optical detector is ideal for use in atmospheres subject to explosion hazards.

Figure 10. Photo Interrupter Arrangement Using Light-link Components

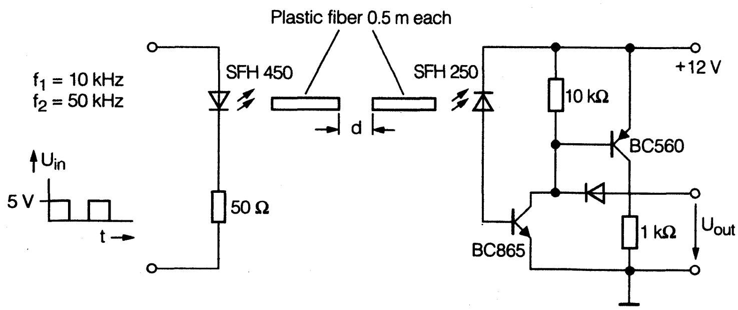
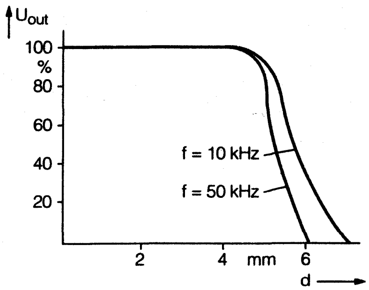


Figure 11. Output Signal of the Photo Interrupter Circuit Dependent on the Distance of the End of the Plastic Fiber



SIEMENS

Light-Link Components Control High-Frequency Switched-Mode Power Supplies
Appnote 41

by Reinhard Blöckl

Operating frequencies of 100 kHz are common practice in modern switched-mode power supplies. And the trend continues towards even higher frequencies. The reason for this is that they allow the development of power supplies of smaller size and improved dynamic control characteristics. The necessary feedback is done by Siemens light-link components which permit reliable control of SMPS with working frequencies in the MHz range.

Feedback of control information in switched-mode power supplies is mainly handled by integrated analog optocouplers (e.g. CNY 17 and SFH 600). The limited bandwidth of these couplers allows SMPS to be controlled at working frequencies below 100 kHz.

Use of the new light-link components, SFH 450 and SFH 750 (emitters) and SFH 250 (detector), greatly extends the range of optical signal transmission.

The circuits described here for analog signal transmission are characterized by:

- suitability for SMPS with high and very high working frequencies,
- minimizing parasitic coupling capacitance between emitter and detector,
- no electromagnetic interference in the transmission line (plastic fiber).

Using the new light-link components in SMPS results in a higher efficiency and a reduction of screening. The savings achieved largely compensate for the extra costs of light-link components and mounting them relative to integrated optocouplers.

Low-cost optoelectronic coupling elements can be used in SMPS with higher working frequencies (above 100 kHz). This has so far been the domain of sophisticated transformer techniques.

Electrical isolation of the SMPS is provided by a power transformer with primary and secondary windings isolated from each other. **Figure 1** is a block diagram of such an arrangement. With the control and monitoring circuit on the primary side of the

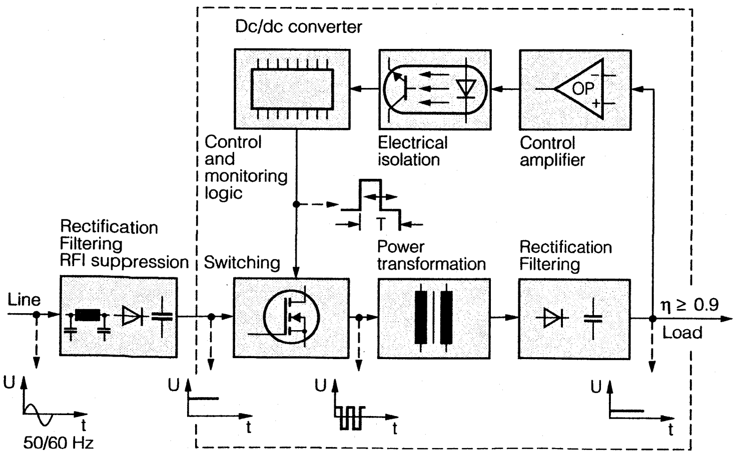


Figure 1. Block diagram of a pulsewidth-modulation controlled switched-mode power supply

Application Notes 11

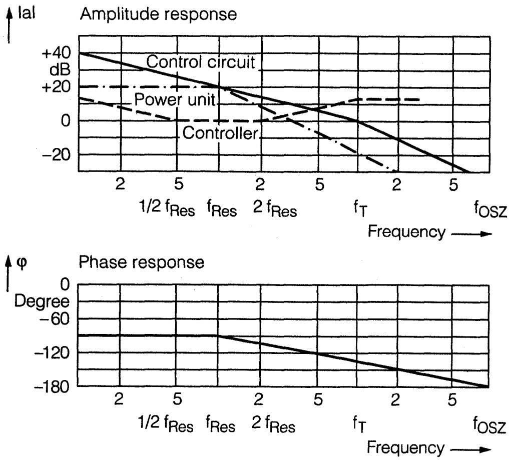


Figure 2. Typical frequency characteristics in the control of switched-mode power supplies

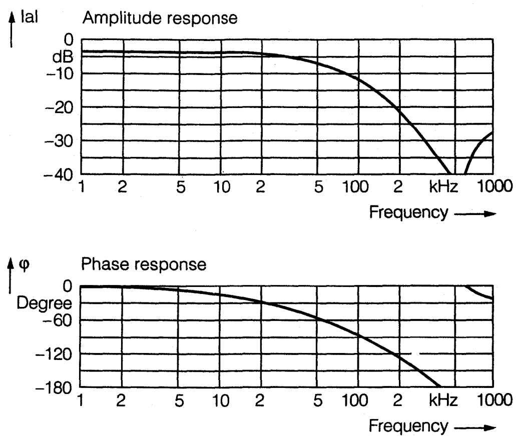


Figure 3. Frequency characteristics of CNY 17-1 coupler

SMPS, as shown in **Figure 1**, the closed-loop voltage control therefore bridges the isolation between the primary and secondary sides.

To maintain electrical isolation, the control feedback path must include an isolated linear transmission device.
This device is governed by the same VDE regulations as the power transformer in terms of isolation voltage, air and creepage paths.
Two methods are currently employed in isolated signal transmission:

- transformer signal transmission,
- optical signal transmission.

Relative to the technically valuable but expensive transformer solution, optocouplers are less costly. But this method does have some engineering restrictions.

Design of SMPS Control Circuits

Forward-converter SMPS operating in the »voltage mode«, normally use a controller with PIDT1-characteristic (proportional – integral – derivative 1st order action) whereas SMPS in the »current mode« use controllers with a PIT1 characteristic. Frequency response is compensated to maintain the widest possible bandwidth with sufficient stability.
The SFH 600, and CNY 17 optocouplers have a limited achievable bandwidth.

The new broadband light-link components are linear transmission elements which allow for a control bandwidth depending only on the chosen working frequency of the SMPS. Hence an improved SMPS dynamic control characteristic (the most important reason for increasing the working frequency) can be implemented in practice. **Figure 2** shows the Bode diagram of a »voltage mode« forward converter power unit (chain line).
The LC output filter has a transfer function with two poles at the resonance point. This implies a –180° phase shift at higher frequencies. The circuitry for frequency response compensation is designed so that the control amplifier has the desired PIDT1 type frequency response, as shown in **Figure 2** (broken lines). From this the frequency response (solid line) of the complete control circuit is obtained.

Time constant T1 has been chosen so that the associated corner frequency corresponds to the transition frequency f_T of the system

$f_T = 1/(2 \cdot \pi \cdot T1)$

This serves for the bandwidth limiting necessary to suppress the switching frequency.

Sufficient attenuation is guaranteed by making the transition frequency one decade below the switching frequency.

A parameter of control stability is the phase shift of the separated control circuit at the transition frequency (gain at transit frequency is 0 dB). A maximum phase angle of –150° (this means a –30° phase margin) is still considered sufficiently stable.

So far we have neglected the optocoupler's frequency response. We started from the assumption that the control op-amp would not cause any significant phase shift of the given transition frequency.

A phase shift of –135° results from **Figure 2** for the transition frequency.
Consequently, the additional phase shift of the optocoupler at transition frequency may be a maximum of –15° to maintain a minimum phase margin of 30°.

As a rule of thumb the working frequency of a switched-mode power supply should exceed the frequency at which the optocoupler produces a –15° phase shift by a factor of ten.

Although a higher switching frequency is possible, it will not improve the dynamic control characteristics as the transition frequency cannot be raised appropriately for reasons of stability.

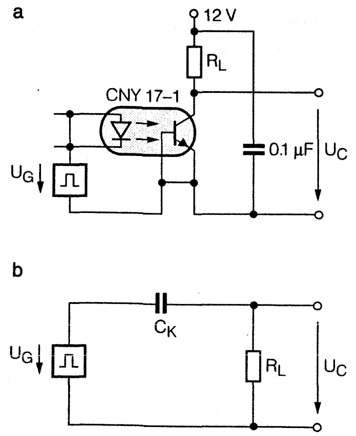


Figure 4. Common-mode transmission through coupling capacitance C_K
a. measuring circuit to determine the coupling capacitance
b. equivalent circuit footman-mode transmission

Properties of Integrated Optocouplers in Linear Operation

Obvious benefits of optocouplers are their compact size and low price.
Against these, however, are some drawbacks:

- low cut-off frequency
- coupling capacitance between emitter and detector.
- air and creepage paths between external connections are likely to fall short of requirements after pc board mounting.

Frequency Response of Integrated Optocouplers

When a high cut-off frequency is required, the optocoupler should be used in a low impedance circuit. For example, the data sheet specifications for the limit frequency for the SFH 600 optocoupler is 250 kHz with a load resistance of $R_L = 7\ \Omega$. The permissible component current limits the reduction of resistance values. To assess the possibilities of using optocouplers as part of a control circuit, the frequency response. characteristic method (Bode diagram) is very useful. **Figure 3** shows the measured frequency response characteristics of the CNY 17 standard optocoupler for a load resistance R_L=1 kΩ. The amplitude characteristic lal here has a logarithmic current transfer ratio.

$|a| = 20 \cdot \log (I_C/I_F)$

The phase response shows the phase angle between the light emitting diode current I_F and the detector transistor current I_C. From the frequency response characteristic it can be seen that

- the phase angle of –15° lies at about 10 kHz
- a zero occurs at about 550 kHz in the amplitude response

From the first, it can be concluded that the integrated optocoupler is suitable for working at frequencies up to 100 kHz. The second observation points to the effect of the parasitic coupling capacitance. By superimposing both signal transfer paths, optoelectrical and capacitive, which produce phase displacements with opposite signs, the output signal may be partially erased. This gives the observed non-uniformity of the frequency response.

Common-mode Suppression with Integrated Optocoupler

The undesired transmission of common-mode signals through optocouplers is caused by the parasitic coupling capacitance C_K between the input and the output of the optocoupler. **Figure 4** shows a measurement circuit to find the coupling capacitance and obtain the high-frequency equivalent circuit. As can be seen from the equivalent circuit the transmission of common-mode signals corresponds to an RC first-order high pass filter consisting of parasitic coupling capacitance C_K and the external load resistance R_L. The common-mode signal transmission produces spiked interference waveforms in the output voltage U_C from the square-wave input voltage U_G.
The appropriate signal characteristics are shown in **Figure 5**. The measured load resistance R_L was 10 kΩ.

With the switched-mode power supply described common-mode transfer action is most disturbing as capacitively coupled in (e.g. transformer winding capacitance) common-mode signals of high amplitude are likely to occur at regular intervals because of the clock-pulse mode of operation.

Insufficient common-mode suppression may cause these interference waveforms to be transmitted through the optocoupler to the pulsewidth-modulation control circuit.

This often leads to incorrect operation of the PWM. Here an additional interference suppression in the form of a screen inside the power transformer is required.

Useful Features of Light-link Components

Unlike integrated optocouplers, light-link components consist of separate emitter and detector units optically coupled through an optical fiber (for example plastic fiber) over any desired distance.

This technology brings some major benefits with it:

- The coupling capacitance is negligible because of the spacing between emitter and detector,
- the required air and creepage paths and isolation voltages are easily provided because of the spacing between emitter and detector,
- optical fiber links can neither emit nor receive electromagnetic interference in the radio frequency band,
- using a PIN photodiode as the detector provides very broad bandwidths.

A technical description of available emitter and detector devices and amplifier circuits is given in [1].

This article deals with applications in linear transmission, especially in the control feedback paths of SMPS. Suitable circuits are discussed.
To determine the limit values of the individual circuits, their frequency response characteristics were measured and plotted as Bode diagrams.

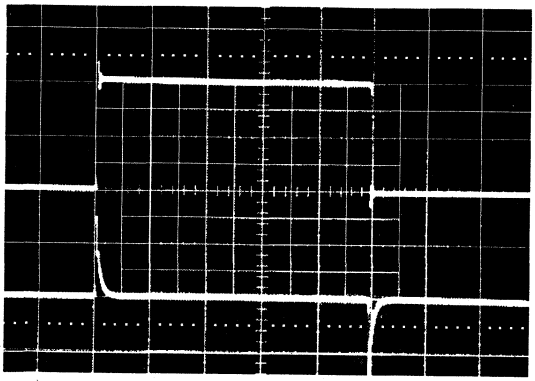


Figure 5. Common-mode interference at the output of Figure 4 circuit with R_L=10 kΩ

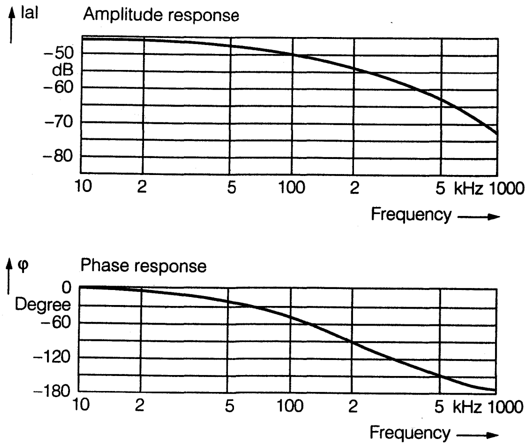


Figure 7. Frequency characteristics of the Figure 6 circuit

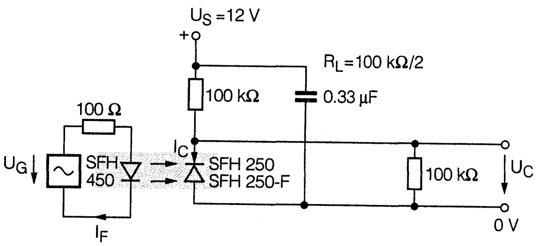


Figure 6. Optical signal transmission circuit with single-stage amplifier

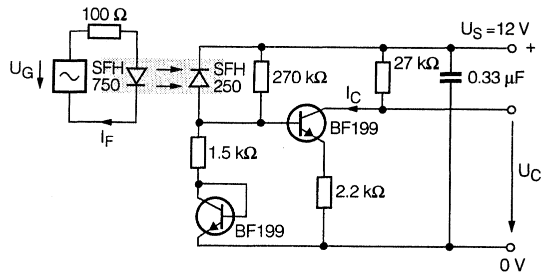


Figure 8. Optical signal transmission circuit with single-stage amplifier

Circuits for Linear Optical Signal Transmission

Interface Requirements

The design of optical signal transmission circuits is based on the following assumptions:

- for driving the photodiode (emitter) a current I_F between 0 and 50 mA is available,
- a voltage U_C of about 5 V is provided at the detector circuit output,
- with LED control current I_F = 0 A, the output voltage is $U_C \geq 5$ V,
- the complete circuit is inverted – in other words – the output voltage U_C drops with rising control current I_F.

These interface conditions are so chosen that the optoelectronic circuits can be driven by standard amplifiers and there is compatibility with the TDA 47xx and TDA 49xx SMPS control IC series. The optical signal transmission circuit can be incorporated into the SMPS concept of **Figure 1**.
Three optical transmission circuits are described which meet the increasing demands for transmissible frequencies.

Optical Signal Transmission Circuits without Amplifiers for Frequencies up to 450 kHz

The circuit shown in **Figure 6** is built from just a few components. As the current transfer ratio I_C/I_F of the combination SFH 450 (IR emitter diode) and SFH 250 (photodiode) is sufficient, the output signal can be obtained at the load resistor R_L without any additional amplification after the photodiode. As the 1-µs switching time of the SFH 450 is rather long, a wide bandwidth cannot be achieved with this simple circuit. The SFH 250-F infra-red light-transmitting filter detector diode can be used with the same results as protection against daylight in the **Figure 6** circuit. The associated Bode diagram is given in **Figure 7**.
From this it can be seen that at about 45 kHz a phase shift of –15° occurs. With these parameters the circuit is suitable for switched-mode power supplies operating at frequencies up to 450 kHz. Technical data are summarized in the **Table**.

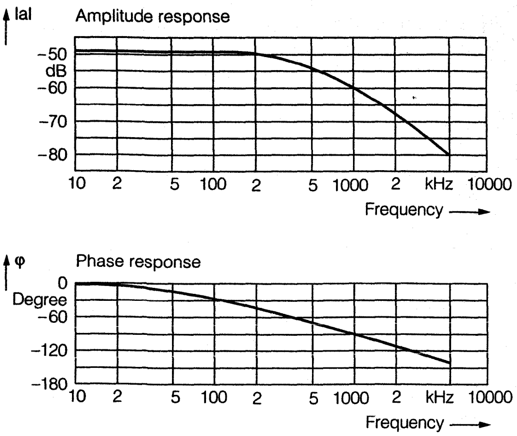


Figure 9. Frequency characteristics of Figure 8 circuit

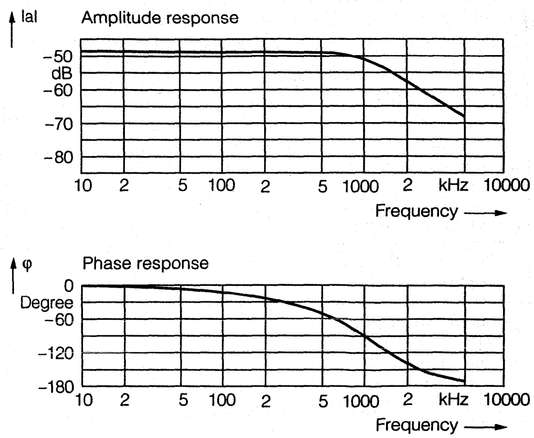


Figure 11. Frequency characteristics of Figure 10 circuit

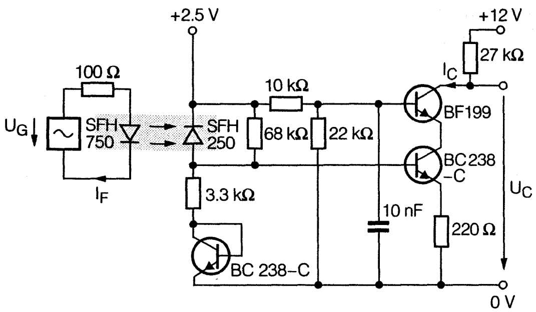


Figure 10. Optical signal transmission circuit with amplifier in cascade arrangement

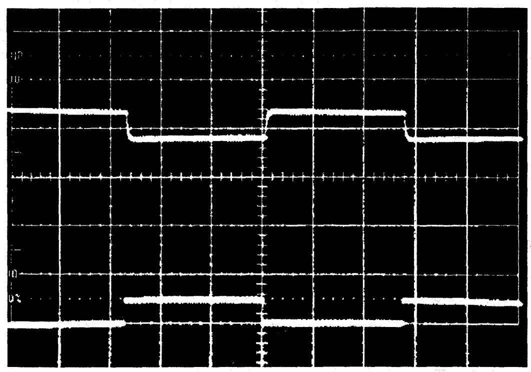


Figure 12. Optical signal transmission circuit with amplifier in cascade arrangement

Circuits with Single-stage Amplifier for Frequencies up to 650 kHz

The limit frequency can be increased when the SFH 450 IR LED is replaced by the SFH 750 emitter diode operating in the red spectral range. Switching times are reduced by a factor of 10. The radiant power coupled into the optical fiber from this LED is, however, much smaller. An amplifier stage is required to produce the necessary output voltage. **Figure 8** is the block diagram.
The BF 199 transistor is used as common-emitter amplifier. The base-emitter diode of another transistor provides temperature compensation.

To allow for the manufacturing tolerances of the transistor, it may become necessary to trim the 270-kΩ resistor. The Bode diagram of this arrangement is shown in **Figure 9**.

The frequency at which the phase is shifted by -15° lies at 65 kHz. The transmission circuit is suitable for SMPS with working frequencies up to 10 times higher than this. The **Table** gives the technical data on this circuit.

Circuits Using Cascade Amplifier for Frequencies up to 1600 kHz

The cascode circuit is characterized by an excellent high-frequency performance. The **Figure 10** arrangement requires a stabilized 2.5-V source and 12-V supply voltage, which are already provided when TDA 47xx or TDA 49xx SMPS control IC_S are used.

The cascode circuit uses one BC238-C and one BF 199 transistor.

The operating point of the BF I99 transistor is set by a voltage divider supplied from the 2.5-V source. The base-emitter diode of the third transistor provides temperature compensation. To allow for the transistor manufacturing tolerances, it may be necessary to trim the 68-kΩ resistor. The Bode diagram of this arrangement is shown in **Figure 11**. The frequency at which the phase is shifted by –15° lies at 160 kHz. Consequently, the highest possible working frequency for a SMPS using this circuit is about 1.6 MHz. **Figure 12** shows the behavior of the circuit with time. The

Description	Symbol	Circuit to Fig. 6	Fig. 8	Fig. 10 typical values	Unit
Operating point (U_S =12 V)	I_F	10	10	12	mA
	U_C	4.2	5.5	5	V
DC transmission performance	$\frac{\Delta U_C}{\Delta I_F}$	0.24	0.1	0.1	$\frac{V}{mA}$
3-dB limit frequency	f_{3dB}	100	250	700	kHz
Dependency of output voltage on U_S	$\frac{\Delta U_C}{\Delta U_S}$	0.5	–0.53	–	–
Dependency of output voltage on 2.5-V supply voltage	$\frac{\Delta U_C}{\Delta 2.5\ V}$	–	–	9.5	–
Temperature coefficient of output voltage (in the range 0°C ≤ ϑ ≤ 60°C) I_F =15mA	$\frac{\Delta U_C}{\Delta \vartheta}$	9	2	~0	$\frac{mV}{K}$

Table: Technical data on three transmission circuits using light-link components to control switched-mode power supplies with different working frequencies

emitter diode is driven with a square-wave current I_F of 5-mA amplitude. The amplitude of the output signal U_C is 0.6 V. Technical data are given in the **Table**.

Conclusion

Switched-mode power supplies using light-link components in the control feedback path provide broadband control characteristics which depend on the chosen switching frequency. Stability and excellent dynamic control characteristics are obtained. The small coupling capacitance between emitter and detector in the optical transmission path (large spacing) eliminates the need for a screen in the power transformer.

The possibility of obtaining higher working frequencies with simpler and thus lower-cost configurations of SMPS will be an impetus towards further increases of frequency in power supply design.

FREDFET Power Half-Bridge: Short-Circuit Proof through Light-Link Components Appnote 43

by Walter Schumbrutzki

With higher clock frequencies in power switches inverse-capable MOS power transistors (FREDFET) are going to replace bipolar devices. In the low power range (≤ 2 kW) MOS half-bridges are already being designed which are far superior to those using bipolar transistors.

The most important requirements to be met by bridge circuits are:
minimum forward and switching losses,
duty factor of 0 to 100%,
current limiting (if necessary, short-circuit and leakage protection),
low control power,
separate drive of individual transistors,
electrical isolation of control and output circuits.
Driving of »high side« transistors is made somewhat difficult because of the switched source potential (floating). Apart from providing a solution to this problem, the circuit described in this article fulfills all the above requirements.

Transformer Coupled SIPMOS Halfbridge (Figure 1)

Pulse Transmission of Input Signal Using a Ring Core

Though transformer coupling permits fast switching times, the effects of magnetic saturation generally confine the duty factor to about 50%. Magnetic saturation also limits the time a transformer can hold a MOSFET in the on-state. To overcome this problem the transformer in the circuit described is fed with a high-frequency pulse train (burst of 1 MHz) for the duration of the input pulse.

The FET is operated as long as the burst is present. Thus turn-on times are freely selectable. An auxiliary power supply on the secondary side is not necessary. Driving the half-bridge entails two opposed square-wave signals with some delay of the positive edge (around 500 ns) and a 2-MHz clock signal. These signals can be derived from a pulse-width modulation circuit. The 2-MHz clock can be obtained from the drive circuit via the ALE line of a microcomputer. The drive signal (active high) goes to a turn-off logic circuit which blocks the input signal when the current threshold is reached. Then, with active low on pins R and S of the data flipflop 4013, complementary 1-MHz bursts are delivered to the push-pull stage and the ring core transformer (R 10/N 30) is energized. Both windings are put on face to face to minimize their capacitance. The primary has 10 turns, the secondary 12.

As the carrier current flowing through the capacitance between primary and secondary circuits is rectified and may cause spurious turn-on of the FREDFET, special attention has to be given to the design of the transformer. Common-mode rejection of more than 100 V/µs is achieved by simply using a thin coaxial cable for the secondary winding. One end of the outer shield (not both) has to be connected to the appropriate FREDFET source.
On the secondary side the burst is rectified via a diode bridge and a positive gate signal is produced which simultaneously switches on the load and the current measuring MOSFETs.
Figure 2 shows the transmission of an input pulse of 1.5 µs duration. When switched on the MOSFET gates are discharged via the BC 327/25 pnp transistor. Discharge time is determined by the time constant of the base resistance (1 kΩ) and smoothing capacitance (220 pF). The FREDFET is operated as long as the 1-MHz carrier is available, that is, when the control input (R, S) is low.

Low-loss Use of the Signal for Current Measurement (Figure 3)

Current measurement resistance in the load circuit means high additional losses. For current measurement the drain-source voltage of the load transistor in the on-state is taken out via a small-signal transistor (BSS 125). In the on-state it can be measured by the BSS 125 source resistance as the gates and drains of the two transistors are connected. This drain voltage is a direct measure for the flowing current ($U_{DS} = I_{DS} \cdot R_{DS\,(on)}$) and can be used to turn off the transistor via a threshold switch.

Transmission of Current Measurement Signals via Light-link Components

The main problem in transmitting the turn-off pulse is the $\frac{du}{dt}$ sensitivity of commercially available fast optocouplers. Their high coupling capacitance prevents the transmission of steep signal edges. For this reason, a diode coupler is used here as a transfer device. It is made up from one special light-link transmitting diode and one receiving diode and

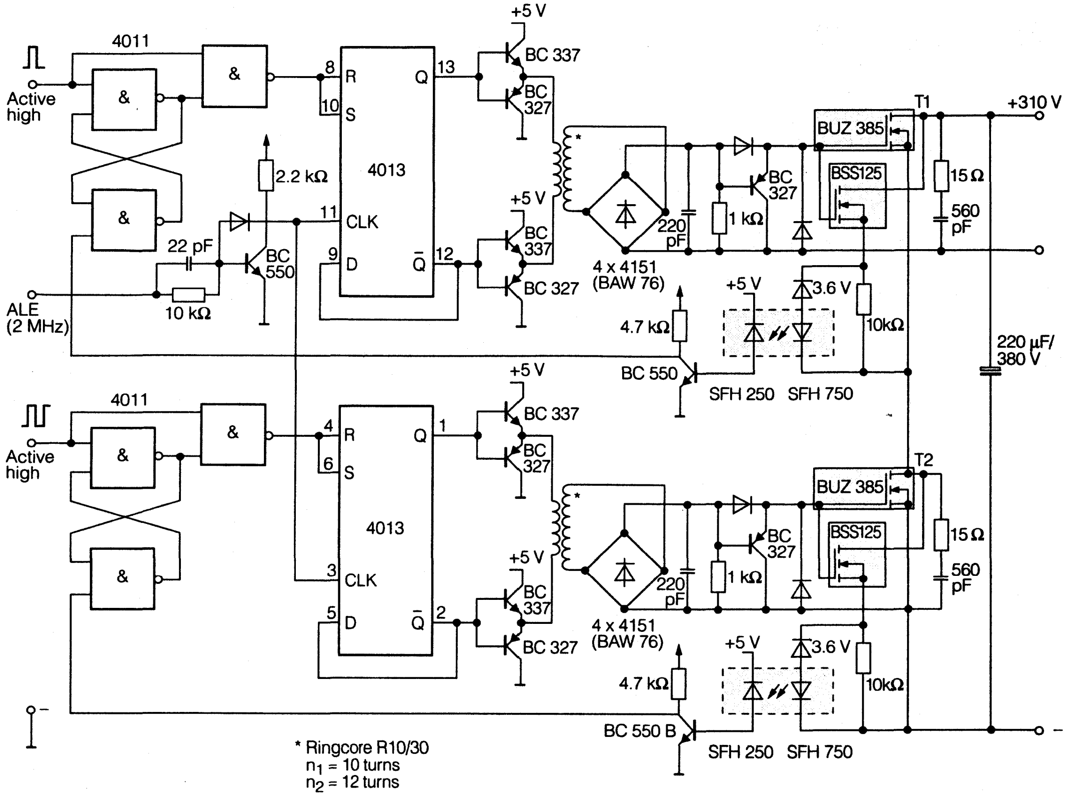


Figure 1. Circuit diagram of SIPMOS half-bridge

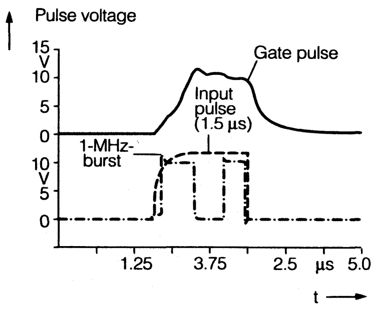


Figure 2. Waveform in the driver stage

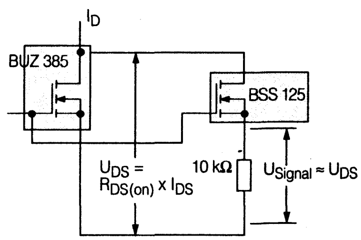


Figure 3. Circuit (extract) for low-loss capture of the signal for current measurement

a plastic fiber about 4-cm long. A shrink sleeve supports the function between the diodes and the fiber and protects the assembly against extraneous light (**Figure 5**).

Coupling capacitance can be neglected in this case, which, in turn leads to excellent $\frac{du}{dt}$ immunity. Here the signal voltage is taken from the source circuit of the small signal transistor. The transmitting diode of the light-link device is connected in series with the Z-diode.

With a certain signal voltage (limit current drop) sufficient current flows through the transmitting diode to cause information to be sent through the plastic fiber to the detecting diode in the drive circuit. An amplifier transistor then actuates the flipflop which turns off the output stage.

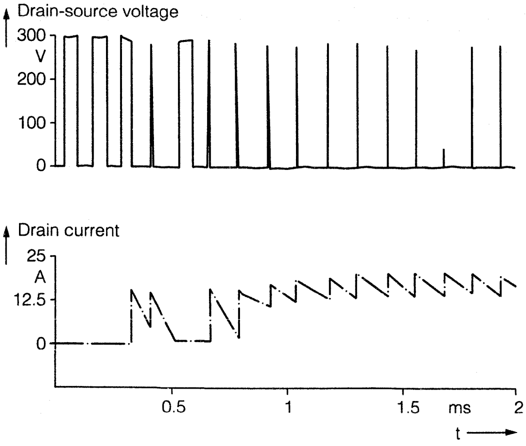


Figure 4. Overcurrent behavior of the Figure 1 circuit with a load switched in abruptly via T2 (77 µH, 186 mΩ)

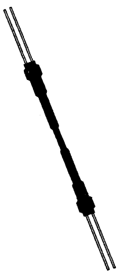


Figure 5. Diode coupler built from light-link diodes and plastic fiber

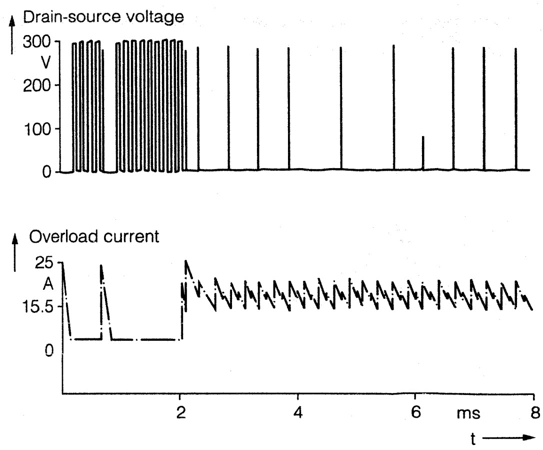


Figure 6. Current and voltage waveforms in the FREDFET with overload

The turn-off circuit is incorporated on the low-voltage side because any short-circuit would seriously load the transformer and the risk of coupling in capacitive interference currents in the turn-of circuit would occur.
The current transfer ratio of the diode coupler is very low with this system configuration.
Unambiguous pulse transmission requires a diode current of 50 to 60 mA. The on-resistance of the BSS 125 transistor is a crucial factor in this current, so that thc Z-diode voltage should be fairly small for a trigger current of 10 A. The actual turn-off current (after 2 µs) is about 18 A with a test overload of 77 µH and 186 mΩ, see **Figure 4**.

The circuit is so designed as to reset the flipflop immediately after the overload current has been turned off. If the overload is not eliminated the remaining input control pulses will initiate another turn-off operation. This constant repetition results in load current limiting, as can be seen in **Figure 6**.

Refer to Appnote 40 "Low Cost, Fiber Optic Systems Using Siemens Light-Link Emitters and Detectors."

SIEMENS

Designing with the Small AlphaNumeric Display Appnote 44

By Bob Krause and Dave Takagishi

Introduction

The Siemens Small AlphaNumeric (SAN) Display family is one of the most versatile and flexible LED readout systems available today. Its four 5x7 characters are dot addressable permitting alphanumeric, graphics, and special symbols to be easily programmed in four colors (red, high efficiency red, yellow, green). SANs are available in 0.15″ or 0.20″ character heights, which are efficiently assembled in row and column stackable plastic or ceramic DIP packages. These packages allow environmental operation from commercial to the most demanding industrial and military requirements. Table 1 lists the SAN model numbers and their principle characteristics.

The internal CMOS row drivers and memory reduce power consumption and support electronics. Blanking Control makes night vision to sunlight ambient intensity control easy.

This appnote covers the SAN family capabilities which include: display operation, intensity control, thermal and optical management, and an 8051 MPU interface.

Display Operation

As compared to Siemens Intelligent and Programmable Displays, SANs require dot decoded serial data rather than parallel ASCII to operate. Figure 1 block diagram shows that the display with its four 5x7 LED characters and two CMOS 14 bit serial-in, parallel-out (SIPO) shift registers. Each LED matrix is a 5x7 diode array organized with the anode of each column tied in common and the cathodes of each character tied in common. The seven row cathode commons of each character are connected to the constant current sinking outputs of the seven successive stages of the shift register. The like columns of the four characters are tied together and brought to a single column pin (i.e., column one of all four digits is connected to pin one, etc.). So that any diode of any character may be addressed by shifting data to the appropriate shift register location and supplying current to the appropriate column.

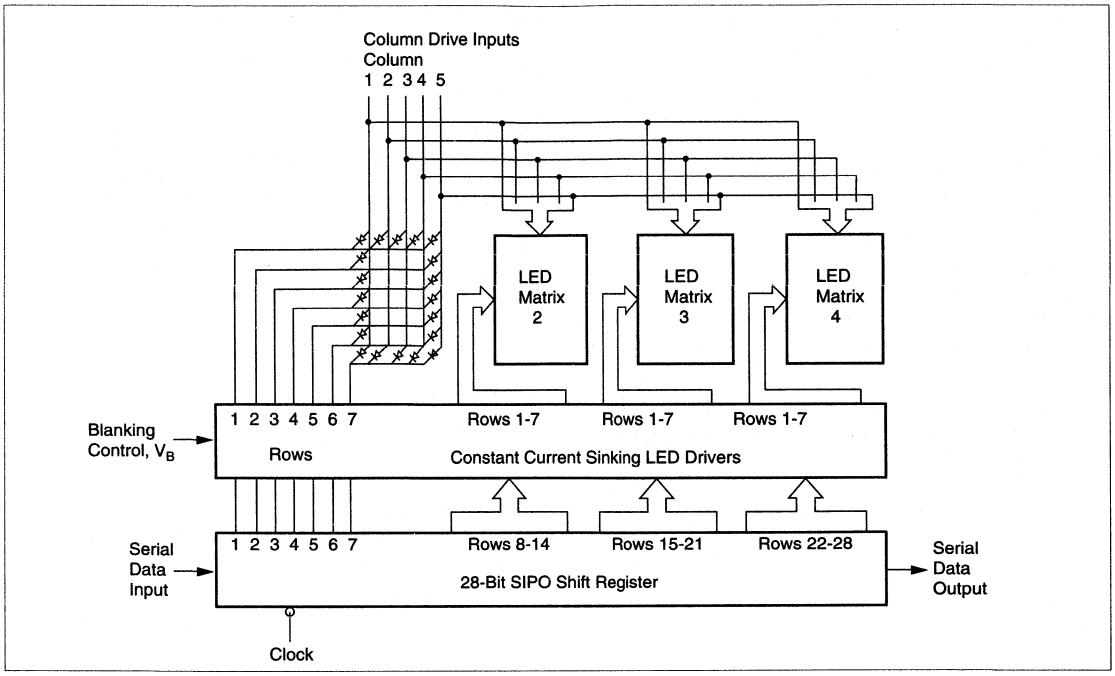
The SIPO shift register has constant current sinking outputs associated with each shift register stage. A FET current mirror supplies a reference signal to all of the 28 constant

Table 1. SAN Display Principal Characteristics

Part No.	Color	Character Height	Power Dissipation*	Temperature Range	Package Type
HDSP2000LP HDSP2001LP HDSP2002LP HDSP2003LP	Red Yellow HER Green	0.15 in.	0.40 W	-40°C to +85°C	Plastic
ISD/MSD2010 ISD/MSD2011 ISD/MSD2012 ISD/MSD2013	Red Yellow HER Green	0.15 in.	0.40 W	-55°C to +100°C	Ceramic
ISD/MSD2310 ISD/MSD2311 ISD/MSD2312 ISD/MSD2313	Red Yellow HER Green	0.20 in.	0.52 W	-55°C to +100°C	Ceramic
ISD/MSD2351 ISD/MSD2352 ISD/MSD2353	Yellow HER Green	0.20 in.	0.74 W	-55°C to +100°C	Ceramic

* 15 LEDs ON per character/4 characters per package.

Figure 1. Block Diagram



current shift register out (logic 1) and is ANDed with this reference source to turn on the output drivers. Data is loaded serially into the shift register when the clock goes from HIGH to LOW and the data is stable for a minimum hold time and will be latched on the LOW to HIGH signal of the clock.

The Data Output (pin 7) is a TTL buffer interface from the 28th bit of the shift register (i.e., the 7th row of character four in each package). The Data Output directly interconnects to the Data Input (pin 12) on a succeeding SAN display. The data, clock and Vb inputs are all buffered to allow direct interface to any TTL logic family.

Theory of Operation

Dot matrix alphanumeric display systems generally are organized logically so that any character can be generated either as a combination of five subsets of seven bits each or seven subsets of five bits each. This technique reduces from 35 to five or seven the number of outputs required from the character generator. To display a complete character, these subsets of data appear sequentially in the appropriate locations of the display matrix. Repeating this process a minimum of 100 times per second insures that each of the appropriate matrix locations is re-energized, the eye will perceive a continuous image of the entire character. The apparent intensity of each of the display elements will be equal to the intensity of that element during the "ON" period multiplied by the ratio of the "ON" time to refresh period. This ratio is referred to as the display duty factor and the technique, "strobing."

Each character of SANs is made up of five subsets of seven bits. For a four character display, 28 bits representing the first subset of each of the four characters are loaded serially into the on-board SIPO shift register. The first column is energized for a period of time, T. This process is repeated for columns two through five. If the time required to load the 28 bits into the SIPO shift register is t, the duty factor is: $DF = t/5\,(t+T)$, and the term $5(t+T)$, the refresh period. For a satisfactory display, the refresh frequency should be ≥100Hz, which means:

$$5(t+T) = 10\text{ms}$$

$$(t+T) = 2\text{ms}$$

Therefore, two milliseconds is the maximum time period which should be allowed for loading and displaying of each column.

Application Notes 11

Interfacing

A display system using the SAN display requires interfacing with a character generator and refresh memory electronics. The system in Figure 2 is a single four digit display, therefore the 1/N counter becomes a 1/4 counter where N equals the number of characters in the string. The refresh memory stores the information to be displayed. Information can be coded in any one of several different standard data codes, such as ASCII or EBDIC; or a customized code and display font using a custom coded ROM. The only requirement being that the output data be generated as five subsets of seven bits each.

The character generator receives data from the refresh memory and outputs seven displaying data bits that correspond to the character and the column select data input. This data is converted to serial format in the parallel to serial shift register. In a typical system the right most character to be displayed is selected first, and the data corresponding to the ON and OFF display elements in the first column is clocked into the first seven shift register locations of the SAN.

In a similar manner, column one data for characters three, two and one is selected by the 1/N counter, decoded and shifted into the display shift register. After 28 clock counts, data for each character is located in the SAN shift register locations which are associated with the seven rows of the appropriate LED matrix. The 1/N counter overflows, triggering the display time counter enabling the output of the 1/5 column select decoder, and disabling the clock input to the display. The information now in the shift registers will be displayed for a period, T. The divide by five counter which provides column select data for both the SAN and the character generator is incremented one count and column data is loaded and displayed in the same manner as column one.

This process is repeated for each of the five columns which comprise the five subsets of data necessary to display the desired characters. After the fifth count, the 1/5 decoder automatically resets to one and the sequence is repeated. The only changes required to extend this interface to character strings of more than four digits are to increase the size of the refresh memory and to change the divide one by four counter to a module equal to the number of digits in the desired string.

Since data is loaded for all of the like columns in the display string and these columns are enabled simultaneously, only five columns are enabled simultaneously. Only five column transistors are required regardless of the number of characters in the string. The column switch transistors should be selected to handle approximately 110 mA per character in the display string. The collector voltage saturation voltage characteristics and column voltage supply should be chosen to provide a $2.6V \leq V_{col} > V_{cc}$. To save power supply costs and improve efficiency, this supply may be a full rectified unregulated DC voltage as long as the PEAK value doesn't exceed the Vcc and the minimum value doesn't drop below 2.6 volts. Since large current transients can occur if a column line is enabled during data shifting operations, the most satisfactory operations will be achieved if the columns current is switched off before clocking begins.

Interface Design

A logical "1" in the display shift register turns a corresponding LED "ON." Clocking occurs on the high to low transition of the clock input. A character generator which produces seven bit "column" data can be used. The internal shift register is 28 bits in length. The right hand digit is loaded first. Each column should be refreshed at a minimum rate of 100 Hz.

The following program uses a single chip microprocessor to control a SAN display (i.e., the 8051 microprocessor and a Sprague UCN5890A driver). See Figure 3.

The processing speed of a microprocessor is so high that the refresh rate of 1/5 can't be comprehended, therefore this program repeats itself 255 times before continuing to another line of data (similar to the scanning technique of a television screen).

Figure 2. Block Diagram

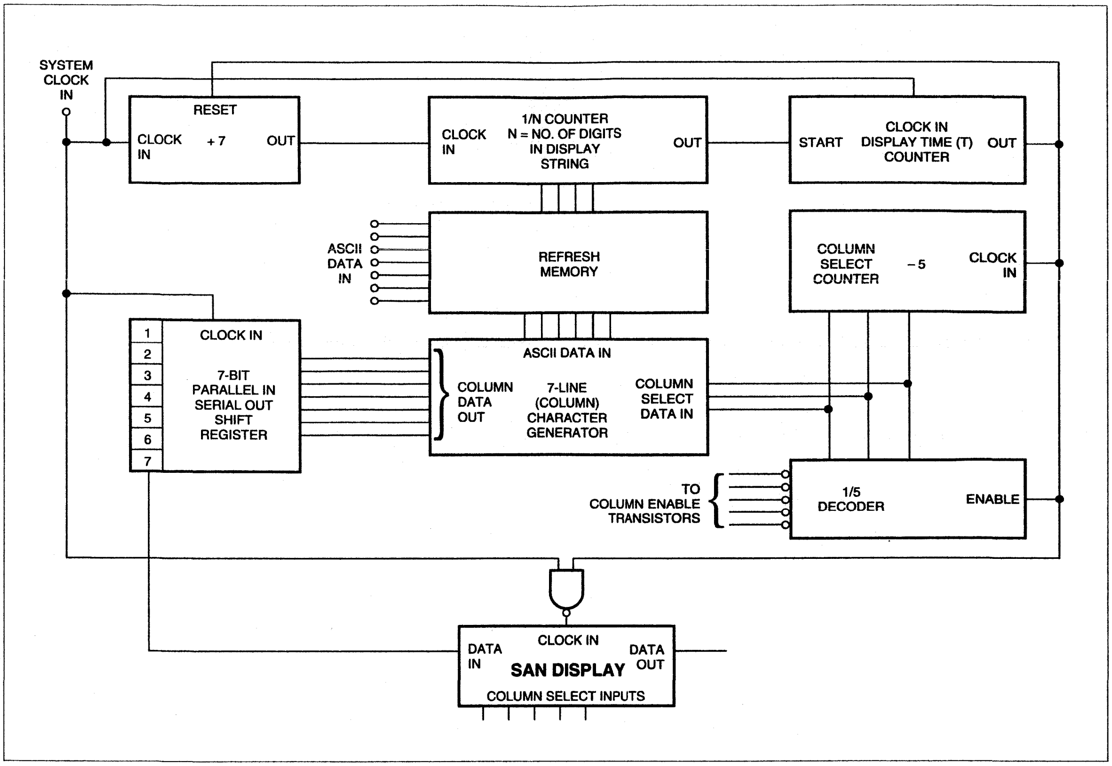
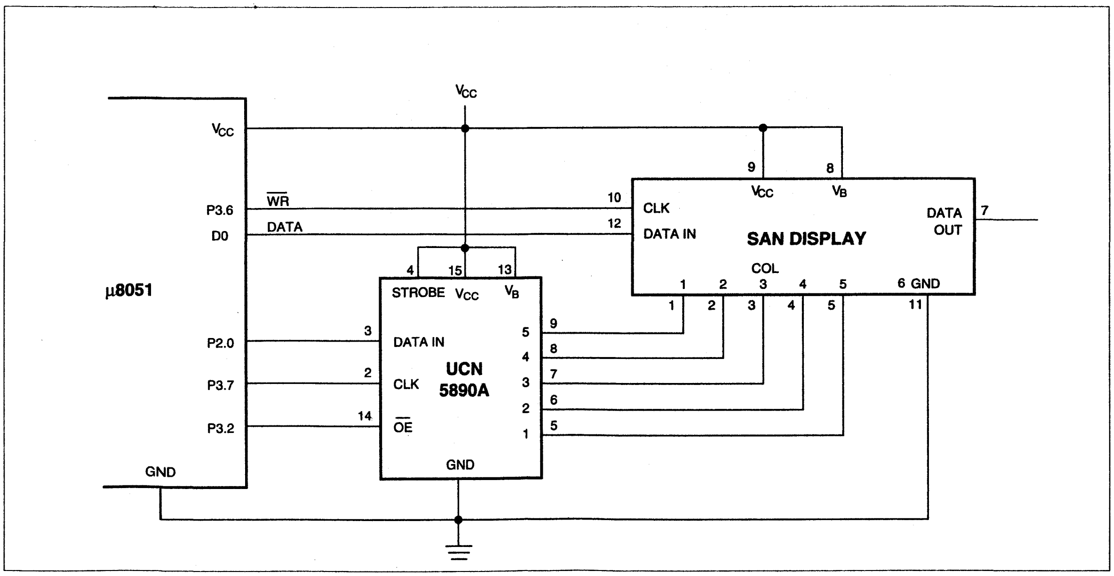


Figure 3. Schematic for SAN Display & UCN5890A



Program to Drive One SAN Display with the 8051 and the UCN5890A as the Column Driver

This program assumes that the data memory address is loaded into DPTR prior to entering this subroutine:

```
                              ;R0 = # REPEATS
                              ;R1 = DISPLAY ADDRESS
                              ;R2 = WAIT
                              ;R3 = # COL
                              ;R4 = ROW COUNTER
                              ;R5 = BIT/COL
                              ;R6 = DIGIT COUNTER
                              ;R7 = UNUSED

REG  30H   EQU DPTRL                ;DPTR MEM LOW REGISTER
REG  31H   EQU DPTRH                ;DPTR MEM HIGH REGISTER

HDSP:      MOV   R0, #0FFH          ;# OF REPEAT CYCLES
BEGIN:     MOV   DPTRL, DPL         ;SAVE DPTR LOW
           MOV   DPTRH, DPH         ;SAVE DPTR HIGH
           SETB  P3.2               ;TURN OFF COLUMN
           SETB  P2.0               ;DATA 1st COLUMN
           MOV   R3, #5H            ;# OF COL
START:     CLR   P3.7               ;COL CLK
           SETB  P3.7               ;COL CLK
           MOV   R4, #7H            ;# ROWS
NXCOL:     MOV   R6, #4H            ;4 DIGITS
NWBYT:     MOV   R5, #7H            ;7 BIT/COL
           CLR   A
           MOVC  A, @A+DPTR         ;GET DATA
           INC   DPTR               ;INC DATA ADDRESS
NXBT:      MOVX  @R1, A             ;OUTPUT D0 & CLK
           RR    A                  ;SHIFT TO NEXT BIT
           DJNZ  R5, NXBT           ;DO 7 TIMES
           DJNZ  R6, NWBYT          ;DO 4 CHARS
           CLR   P3.2               ;TURN ON COL
           MOV   R2, #77H           ;WAIT TIME
           DJNZ  R2, $              ;WAIT
           MOV   R2, #77H
           DJNZ  R2, $              ;WAIT
           SETB  P3.2               ;TURN OFF COL
           MOV   P2, #00H           ;SET COL DRVR DATA
           DJNZ  R3, START          ;NEXT COL
           MOV   DPH, DPTRH         ;RESTORE DPTR HIGH
           MOV   DPL, DPTRL         ;RESTORE DPTR LOW
           DJNZ  R0, BEGIN          ;REPEATS?
           RET                      ;RETURN FOR ANOTHER LINE
```

Table 2. SAN Display Optical Characterics

Part No.	LED PK I_V	Average LED I_V	Character* I_V	Peak I_F	Average I_F	η_V	Average Sterance L_V LED	
	µcd	µcd	mcd	mA	mA	µcd/mA	cd/m²	ft candle
HDSP2000LP	200	40	0.60	12.0	2.4	17	717	67
HDSP2001LP	750	150	2.25	12.0	2.4	63	1923	179
HDSP2002LP	1430	286	4.30	12.0	2.4	119	3667	340
HDSP2003LP	1550	310	4.65	12.0	2.4	129	3974	369
ISD/MSD2010	200	40	0.60	12.0	2.4	17	717	67
ISD/MSD2011	750	150	2.25	12.0	2.4	63	1923	179
ISD/MSD2012	1430	286	4.30	12.0	2.4	119	3667	341
ISD/MSD2013	1550	310	4.65	12.0	2.4	129	3974	369
ISD/MSD2310	300	60	0.90	13.6	2.7	22	1075	100
ISD/MSD2311	1140	228	3.42	13.6	2.7	84	2923	271
ISD/MSD2312	1632	326	4.89	13.6	2.7	120	4179	388
ISD/MSD2313	2410	482	7.23	13.6	2.7	177	6179	573
ISD/MSD2351	3400	680	10.20	16.0	3.2	212	8718	810
ISD/MSD2352	2850	570	8.55	16.0	3.2	178	7308	679
ISD/MSD2353	3000	600	9.00	16.0	3.2	187	7692	714

* 15 LEDs ON per character, DF=20%.

Optical Considerations

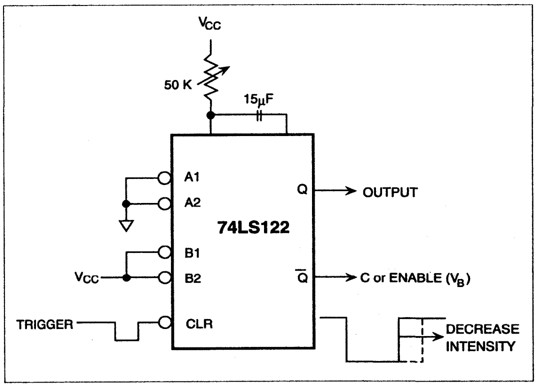
Luminous Intensity Control

The luminous intensity of the Small Alphanumeric display can be easily adjusted from sunlight viewability through night vision requirements (ISD/MSD 235X only).

The light output of the SAN display depends on a number of variables. These include the absolute efficiency of the LED material, the average current through the LED, and the LED's junction temperature. The readability of the display's light output depends upon the luminous and chrominous contrast of the LED diode to the package and ambient lighting environment.

Table 2 lists the lūminous intensity per LED for the SAN family. The average character brightness is based on 15 LEDs per character with a 20% duty factor. The time averaged LED current for the SAN is in the range of 2.4 – 3.2 mA/LED (DF = 20%). The Blanking Control (VB) can be used to change the duty factor ON time, resulting in a lower LED intensity. Figure 4 shows a 74LS122 timer whose pulse width can be manually adjusted for a 1000:1 intensity control.

Figure 4. Brightness Control Using a One Shot Multivibrator



Optical Filtering

Having a bright display does not guarantee readability in a given lighting ambient. The readability of the SAN depends on the contrast of the LED to the ambient light. The human eye measures contrast in both brightness (luminance) and color (chrominance) perception.

There are three contrast ratios that describe the optimum readability for the display. The first is ratio between the ON LED to an OFF LED and should be much greater than one. The second ratio deals with the ON LED to the color and brightness of the surrounding package and also is much greater than one. The third ratio is equal to OFF LED to the brightness and color of the surrounding package. This ratio should be equal to one, meaning no color or brightness difference between the OFF LED and the package.

Using proper package design and optical filter selection insures high constrast ratios. In dim ambients high optical transmission long wave and bandpass filters are the best choice. However, in high light ambients low transmission neutral density (grey) filters give the best contrast ratios of the OFF LED and ON LED to the package background, improving the true readability of the display. For sunlight readability, the SAN's glass window permits the use of

Table 3. Contrast Enhancement Filters

<table>
<tr><th rowspan="2">Display Color[2]
Part No.</th><th colspan="3">Ambient Light</th></tr>
<tr><th>Dim</th><th>Moderate</th><th>Bright</th></tr>
<tr><td>Red
HDSP2000LP</td><td>Panelgraphic Dark Red 63
Panelgraphic Ruby Red 60
Chequers Red 118
Plexiglass 2423</td><td rowspan="4">Polaroid HNCP37
3M Light Control Film
Panelgraphic Gray 10
Chequers Gray 105</td><td></td></tr>
<tr><td>Yellow
HDSP2001LP</td><td>Panelgraphic Yellow 27</td><td>Polaroid HNCP10-Glass
Marks Polarized MPC 30-25C</td></tr>
<tr><td>HER
HDSP2002LP</td><td>Panelgraphic Ruby Red 60
Chequers Red 112</td><td>Note 1
Polaroid HNCP10-Glass
Marks Polarized MPC 20-15C</td></tr>
<tr><td>Bright Green
HDSP2003LP</td><td>Panelgraphic Green 48
Chequers Green 107</td><td>Polaroid HNCP10-Glass
Marks Polarized MPC 50-12C</td></tr>
</table>

<table>
<tr><th>Display Color
Part No.</th><th>Filter Color</th><th>Marks Polarized Corp.
Filter Series</th><th colspan="2">Optical Characteristics of Filter</th></tr>
<tr><td>Red, HER
MSD 2010, 2012, 2310, 2312, 2352</td><td>Red</td><td>MPC 20-15C</td><td>25% @ 635 nm</td><td rowspan="5">Circular Polarizer</td></tr>
<tr><td>Yellow
MSD 2011, 2311, 2351</td><td>Amber</td><td>MPC 30-25C</td><td>25% @ 583 nm</td></tr>
<tr><td>Green
MSD 2013, 2313, 2353</td><td>Yellow/Green</td><td>MPC 50-22C</td><td>22% @ 568 nm</td></tr>
<tr><td>Multiple Colors
High Ambient Light</td><td>Neutral Gray</td><td>MPC 80-10C</td><td>10% Neutral</td></tr>
<tr><td>Multiple Colors</td><td>Neutral Gray</td><td>MPC 80-37C</td><td>37% Neutral</td></tr>
</table>

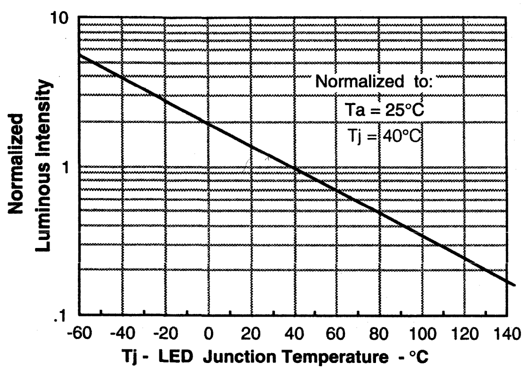
Note:
1. Optically coated circular polarized filters, such as Polaroid HNCP10.
2. For multiple colors use Marks Polarized Corporation filters, MPC 80-10C or MPC 80-37C.

Polaroid Corporation
1 Upland Road, Bldg. #2
Norwood, MA 02062
☎ (800) 225-2770

Marks Polarized Corporation
25-B Jefryn Blvd. W.
Deer Park, NY 11729
☎ (516) 242-1300
FAX (516) 242-1347

Marks Polarized Corp. manufactures to MIL-I-45208 inspection system.

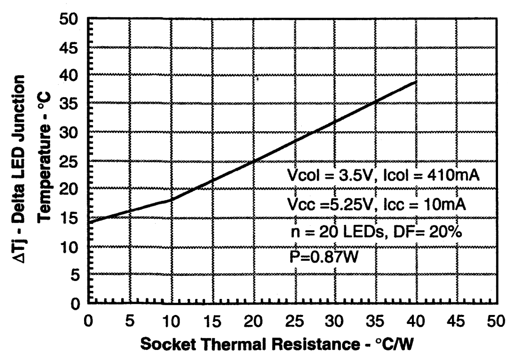
Figure 5. Normalized Luminous Intensity vs. Junction Temperature



The light output of the LEDs is inversely related to the LED diodes junction temperature as shown in Figure 5. For optimum light output, keep thermal resistance of the socket of PC board as low as possible.

For example, when the HDSP200XLP is mounted in a 10°C/W socket and operated at Absolute Maximum Electrical conditions, the LED junction will rise 17°C above ambient. If T_A = 40°C, then the LED's T_J will be 57°C. Under these conditions Figure 5 shows that the I_V will be 75% of its 25°C value.

Figure 6. Maximum LED Junction Temperature vs. Socket Thermal Resistance



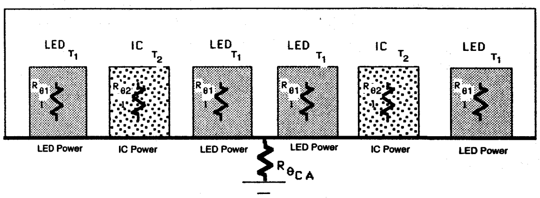
Thermal Consideration

Optimum reliability and optical performance will result when the junction temperature of the LEDs and CMOS ICs are kept as low as possible. The plastic HDSP200XLP should operate to a maximum ambient temperature of 85°C, while maintaining a maximum junction temperature of ≤100°C. The ceramic and glass SANs (ISD/MSD2XXX) may operate up to 100°C as long as the junction temperature of the IC is maintained at less then 125°C.

Table 4.

Model Number	V_F		
	Min.	**Typ.**	**Max.**
HDSP2000LP	1.6	1.7	2.0
HDSP2001/2/3LP	1.9	2.2	3.0

Figure 7. Thermal Model



Thermal Modeling

For a thermal model of the display, see Figure 7 which shows junction self heating + the case temperature rise + ambient temperature = junction temperature of the semi-conductor. Equation 1 shows this relationship.

Application Notes 11

Equation 1.

$$T_{J(LED)} = P_{LED} Z_{\theta JC} + P_{CASE} (R_{\theta JC} + R_{\theta CA}) + T_A$$

$$T_{J(LED)} = [(I_{COL}/28) V_{F(LED)} Z_{\theta JC}] + [(n/35) I_{COL} DF (5 V_{COL}) + V_{CC} I_{CC}] \bullet [R_{\theta JC} + R_{\theta CA}] + T_A$$

The junction rise within the LED equals the thermal impedance of an individual LED (37°C/W, DF = 20%, F = 200 Hz) times the forward voltage, $V_{F(LED)}$, and forward current, $I_{F(LED)}$, of 13–14.5 mA. This rise averages $T_{J(LED)}$ = 1°C. Table 4 shows the $V_{F(LED)}$ for respective displays.

The junction rise within the LED driver IC is the combination of the power dissipated by the IC quiescent current and the 28 row driver current sinks. The IC junction rise is given in Equation 2. A thermal resistance of 28°C/W results in a typical junction rise of 6°C.

Equation 2.

$$T_{J(IC)} = P_{COL} (R_{\theta JC} + R_{\theta CA}) + T_A$$

$$T_{J(IC)} = [5 (V_{COL} - V_{F(LED)}) \bullet (I_{COL}/2) \bullet (n/35) DF + V_{CC} \bullet I_{CC}] \bullet [R_{\theta JC} + R_{\theta CA}] + T_A$$

For easier calculations, the maximum allowable electrical operating condition is dependant on the the aggregate thermal resistance of the LED matrixes and the two driver ICs. The parallel combination of these two networks is 15°C/W. All of the thermal management calculations are based on this number. The maximum allowable power dissipation is given in Equation 3.

Equation 3.

$$P_{DISPLAY} = \frac{T_{J(MAX)} - T_A}{R_{\theta JC} + R_{\theta CA}}$$

$$P_{DISPLAY} = 5 V_{COL} I_{COL} (n/35) DF + V_{CC} I_{CC}$$

KEY TO EQUATION SYMBOLS

DF	Duty factor
I_{CC}	Quiescent IC current
I_{COL}	Column current
n	Number of LEDs on in a 5 × 7 array
P_{CASE}	Package power dissipation excluding LED under consideration
P_{COL}	Power dissipation of a column
$P_{DISPLAY}$	Power dissipation of the display
P_{LED}	Power dissipation of a LED
$R_{\theta CA}$	Thermal resistance case to ambient
$R_{\theta JC}$	Thermal resistance junction to case
T_A	Ambient temperature
$T_{J(IC)}$	Junction temperature of an IC
$T_{J(LED)}$	Junction temperature of a LED
$T_{J(MAX)}$	Maximum junction temperature
V_{CC}	IC voltage
V_{COL}	Column voltage
$V_{F(LED)}$	Forward voltage of LED
$Z_{\theta JC}$	Thermal impedance junction to case

SIEMENS

How to Use Optocoupler Normalized Curves Appnote 45

by Bob Krause

An optocoupler provides insulation safety, electrical noise isolation, and signal transfer between its input and output. The insulation and noise rejection characteristics of the optocoupler are provided by the mechanical package design and insulating materials.

A phototransistor optocoupler provides signal transfer between an isolated input and output via an infrared LED and a silicon NPN phototransistor.

When current is forced through the LED diode, infrared light is generated that irradiates the photosensistive base-collector junction of the phototransistor. The base-collector junction converts the optical energy into a photocurrent which is amplified by the current gain (HFE) of the transistor.

The gain of the optocoupler is expressed as a Current Transfer Ratio (CTR), which is the ratio of the photoransistor collector current to the LED forward current. The current gain (HFE) of the transistor is dependent upon the voltage between its collector and emitter. Two separate CTRs are often needed to complete the interface design. The first CTR, the non-saturated or linear operation of the transistor, is the most common specification of a phototransistor optocoupler and has a Vce of 10 volts. The second is the saturated or switching CTR of the coupler with a Vce of 0.4 volts. Figure 1 and 2 illustrate the Normalized CTR_{CE} for the linear and switching operation of the phototransistor. Figure 1 shows the Normalized Non-Saturated CTR_{CE} operation of the coupler as a function of LED current and ambient temperature when the transistor is operated in the linear mode. Normalized $CTR_{CE(SAT)}$ is illustrated in Figure 2. The saturated gain is lower with LED drive greater than 10 mA.

Figure 1. Normalized CTR versus I_F and T_{amb}

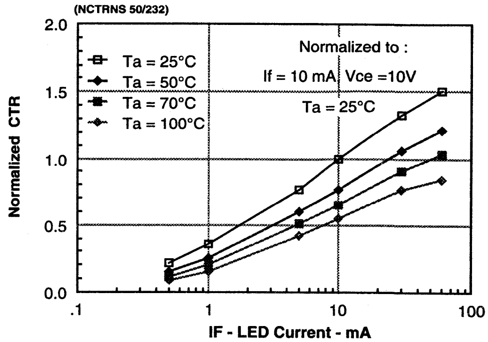
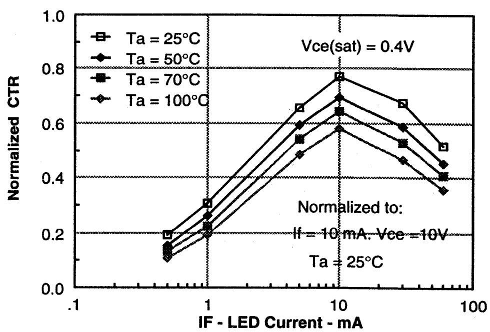


Figure 2. Normalized Saturated CTR

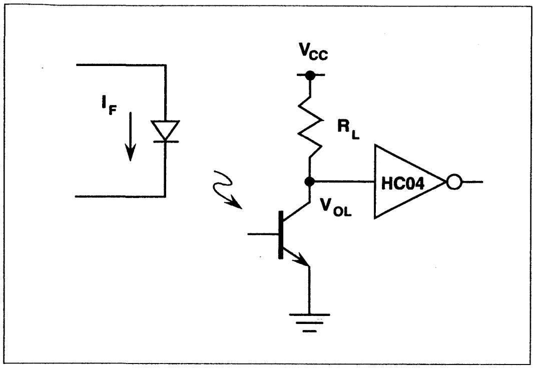


The following design example illustrates how normalized curves can be used to calculate the appropriate load resistors.

Problem 1.

Using an IL1 optocoupler in a common emitter amplifier (Figure 3) determine the worst case load resistor under the following operation conditions:

Figure 3. IL1 to 74HC04 Interface



T_{amb}=70°C, I_F =2 mA, V_{OL}=0.4 V, Logic load=74HC04

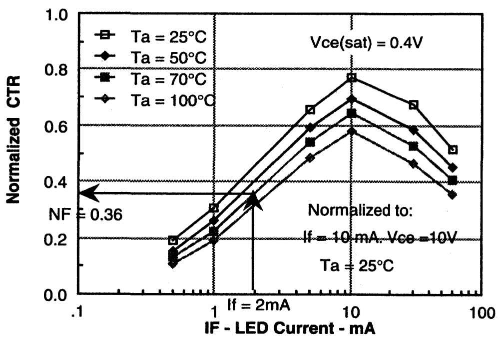
IL1 Characteristics:

$CTR_{CE(NON\ SAT)}$=20% Min. @ (T_{amb}=25°C, I_F=10 mA, V_{CE}=10 V)

Solution

Step 1. Determine $CTR_{CE(SAT)}$ using the normalization factor ($NF_{CE(SAT)}$) found in Figure 2.

Figure 4. Normalized Saturated CTR



(1) $CTR_{CE(SAT)}=CTR_{CE(NON\ SAT)}\ NF_{CE(SAT)}$

$CTR_{CE(SAT)}$=20% * 0.36

$CTR_{CE(SAT)}$=7.2%

Step 2. Select the minimum load resistor using the following equation

(2)
$$R_{L(MIN)} = \frac{V_{CC} - V_{OL}}{\frac{CTR_{CE(SAT)}\ I_F}{100\%} - I_{IL}}$$

$$R_{L(MIN)} = \frac{5V - 0.4V}{\frac{7.2\%\ 2mA}{100\%} - 50\mu A}$$

$R_{L(MIN)}$=48.94 KΩ, select 51 KΩ ±5%

The switching speed of the optocoupler can be greatly improved through the use of a resistor between the base and emitter of the output transistor. This is shown in Figure 5. This resistor assists in discharging the charge stored in the base to emitter and collector to base junction capacitances. When such a speed-up technique is used the selection of the collector load resistor and the base-emitter resistor requires the determination of the photo-current and the HFE of the optocoupler.

The photocurrent generated by the LED is decribed by the CTR_{CB} of the coupler. This relationship is shown in equations 3 and 4. Equation 5 shows that CTR_{CE} is the product of the CTR_{CB} and the HFE. The HFE of the transistor is easily determined by evaluating equation 4, once the $CTR_{CE(SAT)}$ and CTR_{CB} are known. The Normalized CTR_{CB} is shown in Figure 6. Equations 5, 6, and 7 describe the solution for determing the R_{BE} that will permit reliable operation.

Figure 5. Optocoupler/Logic Interface with R_{BE} Resistor

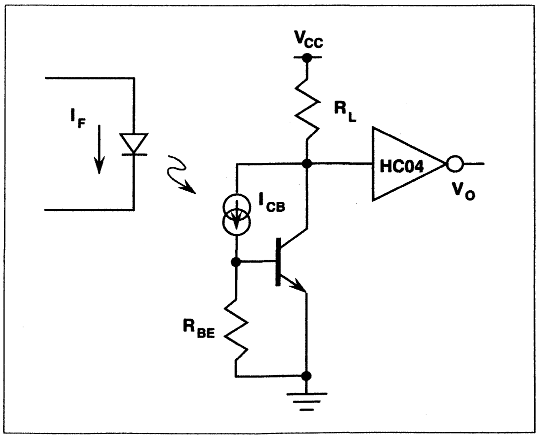
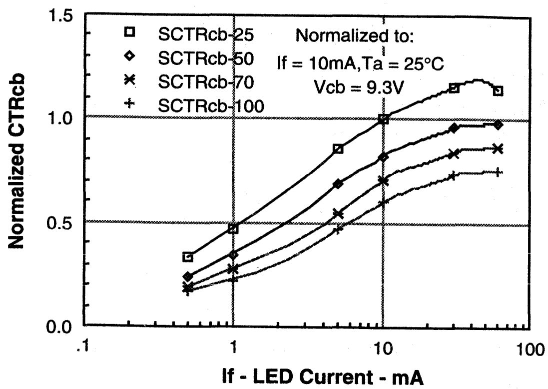


Figure 6. Normalized CTR_{CB} versus LED Current



(3) $$CTR_{CB} = \frac{I_{CB}}{I_F} \times 100\%$$

(4) $$I_{CB} = I_F \frac{CTR_{CB}}{100\%}$$

(5) $$CTR_{CE(SAT)} = CTR_{CB}\ HFE_{(SAT)}$$

(6) $$HFE_{(SAT)} = \frac{CTR_{CE(SAT)}}{CTR_{CB}}$$

(7) $$R_{BE} = \frac{V_{be}}{I_{CB} - I_{BE}}$$

(8) $$R_{BE} = \frac{V_{BE}\ HFE_{(SAT)}\ R_L}{I_{CB}\ HFE_{(SAT)}\ R_L - [V_{CC} - V_{CE(SAT)}]}$$

(9) $$R_{BE} = \frac{V_{BE} \frac{CTR_{CE}\ NF_{CE(SAT)}}{CTR_{CB}\ NF_{CB}} R_L}{\frac{I_F\ CTR_{CE}\ NF_{CE(SAT)}\ R_L}{100\%} - [V_{CC} - V_{CE(SAT)}]}$$

Problem 2

Using an IL2 optocoupler in the circuit shown in Figure 6, determine the value of the collector load and base-emitter resistor, given the following operational conditions:

T_{amb}=70°C, I_F=5 mA, V_{OL}=0.4 V, Logic load =74HC04

IL2 Characteristics:

CTR_{CE}=100% @ T_{amb}=25°C, V_{CE}=10 V, I_F=10 mA

CTR_{CB}= 0.24% @ T_{amb}=25°C, V_{CB}=9.3 V, I_F=10 mA

Solution

Step 1. Determine $CTR_{CE(SAT)}$, and CTR_{CB}.

From Figure 2 the $CTR_{CE(SAT)}$=55%, [$NF_{CE(SAT)}$=0.55]

From Figure 6 the CTR_{CB}=0.132%, [NF_{CB}=0.55]

Step 2. Determine R_L

From Equation 2 R_L=1.7 KΩ

Select R_L= 3.3 KΩ

Step 3. Determine R_{BE}, using Equation 9

(10) $$R_{BE} = \frac{0.65V \frac{100\%\ 0.55}{0.24\%\ 0.55} 3.3K\Omega}{\frac{5mA\ 100\%\ 0.55\ 3.3K\Omega}{100\%} - [5V - 0.4V]}$$

R_{BE}= 199KΩ , select 220KΩ

Using a 3.3 kΩ collector and a 220 KΩ base-emitter resistor greatly minimize the turn-off propagation delay time and pulse distortion. The following table illustrates the effect the R_{BE} has on the circuit performance.

	I_F = 5 mA, V_{CC}=5 V	
	R_L=3.3 KΩ R_{BE}=∞ Ω	**R_L=3.3 KΩ R_{BE}=220 kΩ**
t_{delay}	1 µs	2 µs
t_{rise}	4 µs	5 µs
$t_{storage}$	17 µs	10 µs
t_{fall}	5 µs	12 µs
t_{PHL}	3.5 µs	7 µs
t_{PLH}	22 µs	12 µs
Pulse Distortion 50 µs pulse	37%	10%

Not only does this circuit offer less pulse distortion, but it also improves high temperature switching and lower static DC power dissipation and improved common mode transient rejection.

SIEMENS

Sunlight Readability Contrast Measurements for the MSD2351 and MSD2353 Serial Input Small Alphanumeric Military Display Appnote 47

by Bob Krause

Introduction

Light emitting diode alphanumeric displays have had a long and successful relationship with military and avionic equipment. Applications with very high light ambients now are possible because of advances in the efficiency of LEDs. Polarized filters enhance the readability of LEDs by eliminating much of the ambient reflection from the LED die and the surrounding package.

Readability Criteria

An observer's ability to perceive the information from an alphanumeric display depends on two factors. These include font and size of the message in relationship to the viewing position and the optical contrast of the message to the surrounding environment.

Optical contrast is the comparison of the brightness or sterance (L) of the On/OffLED to the brightness of the surrounding environment. High readability results by optimizing the following contrast ratios. The first ratio, C_1, involves the OnLED stearance, L_{LEDon}, and the background stearance, L_B, is optimized when the OnLED is brighter than the surrounding area. Thus C_1 will be much greater than unity (1).

The next ratio, C_2, involves the sterance ratio of the On, L_{LEDon}, and Off, L_{LEDoff}, LED. C_2 is optimized when the L_{LEDon} is much greater than the L_{LEDoff}, resulting in being much greater than unity (1).

The optimal ratio of C_3, involving OffLED to the background, is achieved when the ratio is near zero. The OffLED should have minimal contrast with the background.

The equations for these three ratios are given below.

The U.S. military has established contrast ratios limits to satisfy sunlight readability criteria. These criteria are published in, *"Night Vision Goggle Lighting Specification."* The specifications are shown below:

C_1—OnLED to Background	≥ 2.0 :1 Minimum
C_2—OnLED to OffLED	≥ 2.0 :1 Minimum
C_3—OffLED to Background	≤ 0.25 :1 Maximum

Optical Filtering

An LED, regardless of its brightness, has a difficult time competing with the sterance of the sun. An LED display's readability can be greatly improved by using contrast enhancement filters. The filter of choice is one that eliminates the interference of the sun with the background of the display. A number of filter vendors offer anti-reflection coated, circular polarized (AR/CP), optically tinted bandpass and neutral density filters which have proven very helpful in satisfying the sunlight readability contrast requirements.

The display front surface and the areas surrounding the LEDs have specular reflector characteristics. This reflective property allows optimum contrast when used with a circular polarized filter with anti-reflective coating. See Table 1 for Filter Selection Guide.

Ratio Equations

1) *C_1—OnLED to Background*

$$C_1 = \frac{L_{LEDon} - L_B}{L_B}$$

2) *C_2—OnLED to OffLED*

$$C_2 = \frac{L_{LEDon} - L_{LEDoff}}{L_{LEDoff}}$$

3) *C_3—OffLED to Background*

$$C_3 = \frac{\left| L_{LEDoff} - L_B \right|}{L_B}$$

Table 1. Contrast Enhancement Filter Selection Guide

Display P/N or Condition	Display Color	Transmission	Filter Color	Filter Model No. Filter Manufacturer
MSD2010 MSD2012 MSD2352* MSD2310 MSD2312	Red/ Hi Eff. Red	25% @ 635nm	Red	MPC 20-15C Marks
MSD2011 MSD2351* MSD2311	Yellow	25% @ 585nm	Amber	MPC 30-25C Marks
MSD2013 MSD2353* MSD2313	Hi Eff. Green	22% @ 565nm	Yellow/Green	MPC 50-22C Marks
High Ambient Light	All Colors	10% Neutral	Neutral Gray	MPC 80-10C Marks
High Ambient Light	All Colors	37% Neutral	Neutral Gray	MPC 80-37C Marks
MSD2010 MSD2012 MSD2352* MSD2310 MSD2312	Red/ Hi Eff. Red	14%	Reddish Orange	HLF-608-5R Hoya
MSD2011 MSD2351* MSD2311	Yellow	14%	Yellowish Orange	HLF-608-3Y Hoya
MSD2013 MSD2353* MSD2313	Hi Eff. Green	14%	Yellow/Green	HLF-608-1G Hoya
High Ambient Light	All Colors	10% Neutral	Neutral Gray	HNCP10 Polaroid

* Sunlight viewable displays. All other part numbers represent *all* the standard Military Small Alphanumeric Displays.

Manufacturers

Marks Polarized Corporation
25B Jefryn Blvd. West
Deer Park, NY 11729-5715
(516) 242-1300

HOYA Optics, Inc.
3400 Edison Way
Fremont, CA 94538-6138
(415) 490-1880

Polaroid Corp.
Polarizer Divison
1 Upland Road
Norwood, MA 02062
(617) 577-2000

CONTRAST MEASUREMENTS

The ability to read a display in direct sunlight used to be determined by using a series of standard observers and irradiating the display with one sun. Recent technical studies have established contrast criteria permitting laboratory measurements that verify sunlight readability.

A yellow MSD2351 and a high efficiency green MSD2353 Small Alphanumeric Display were evaluated for sunlight readablility under a simulated sun with an incident of 4200fc. These two displays were tested with both pass-band and neutral density AR/CP filters. The measurement technique and results follow.

Contrast Measurement Setup

Contrast measurements require the use of a spot photometer, which measures the luminance of the surface within a specific spot size. A Photo Research Spectra Pritchard spot photometer Model 1980B with a Macro Spectar MS-80 Lens was calibrated and set to read out in foot Lamberts, fL. The display and filter were mounted on a micro adjustable X/Y/Z stage. This stage, the spot photometer, and a 500W Unimat LX80 light source were mounted on a optical bench. The light source was oriented 30° from the normal of the display. See Figure 1.

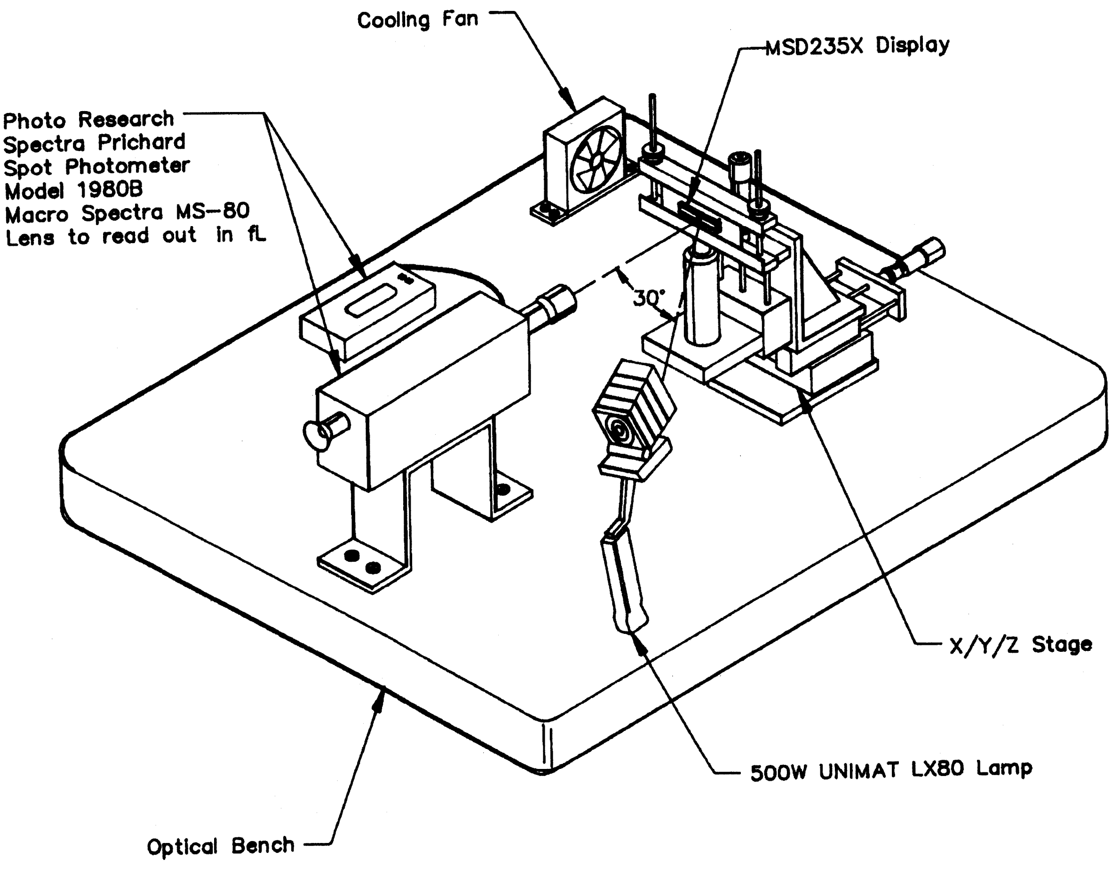


Figure 1. Sunlight Readability Contrast Measurement Setup

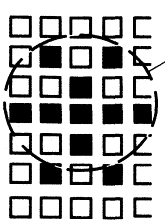


Figure 2. LEDs Selected for Measurement

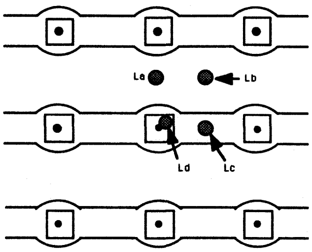


Figure 3. Points for Luminous Stearance Measurement

The sterance measurments were made using the photometer with an angle setting of 2 minutes resulting in a spot size of .004 in. The incidence flux was determined by using a Kodak 6080 standard lambertian reflector painted slide.

The X/Y/Z stage supported the display, the AR/CP filter, and the display drive electronics. Figure 2 shows the asterisk (*) programmed on the display. Each LED had a duty factor of ON 17.6%. The center of the asterisk was used as the measurement LED. The stage was used to position the display at the four contrast measurements points as shown in Figure 3.

Contrast Calculations

The data derived from the spot photometer was used to calculate the three contrast ratios, C_1, C_2, C_3. For best accuracy, L_B was the average of three spot locations. Figure 2 shows these as L_a, L_b, L_c. L_a is the substrate sterance between two LED die, L_b is the substrate sterance of the area between four LED die; and L_c is the sterance of a gold trace connecting the LEDs.

Measurements were made using a yellow MSD2351 and a Marks MPC80-10C neutral density gray filter. This display had a typical intensity of 2450µcd/LED with an average wavelength of 585nm.

Measurements were also made using a green MSD2353 with a Marks MPC50-22C yellow/green bandpass filter and a Marks MPC80-10C neutral density gray filter. This display had a typical intensity of 3470µcd/LED with an average wavelength of 572nm.

The data and results of the experiment are shown in Table 2.

Conclusion

From the data, the most readable combination is the green MSD2353 display and a green bandpass AR/CP filter, followed by the green display and the 10% transmissive neutral density gray AR/CP filter. In both cases these combinations exceeded the military limit by almost 2.5 times. The yellow display has optimum contrast with a neutral density AR/CP gray filter.

Table 2. Luminous Contrast @ 4200fC

Display Color Filter Model #	Status	Footlamberts							
		L_a	L_b	L_c	L_d	L_B	C_1	C_2	C_3
Green MPC50-22C	LED-On	12.00	10.20	27.10	101.60	16.43	5.18	7.06	0.08
	LED-Off	11.00	9.40	20.60	12.60	13.67			
Green MPC80-10C	LED-On	9.70	8.60	17.80	69.80	12.03	4.80	5.91	0.05
	LED-Off	8.80	8.60	11.40	10.10	9.60			
Green MPC50-22C	LED-On	12.60	11.30	37.30	111.00	15.30	6.25	6.71	0.12
	LED-Off	11.10	9.80	17.70	14.40	12.87			
Yellow MPC80-10C	LED-On	9.30	8.20	19.40	46.50	12.30	2.78	5.04	0.09
	LED-Off	7.80	7.20	10.30	7.70	8.43			
Yellow No Filter	LED-On	208.00	198.00	650.00	480.00	352.00	0.36	1.81	0.58
	LED-Off	198.00	171.00	853.00	171.00	407.33			

SIEMENS

Optocouplers for Safe Electrical Isolation to VDE 0884 Appnote 48

by Gerhard Kaiser

Because of their high reliability and long life, optocouplers are used in applications requiring safe electrical isolation of two circuits, such as in switched-mode power supplies (SMPS). Optocouplers have to comply with the relevant VDE standards and/or international standards like IEC when used for protecting systems against electrical damage.

Currently the tendency is to incorporate international standards (e.g. IEC) into the German VDE regulations. On the other hand, the goal is to make a national VDE standard (such as one that has proved to increase safety) into an internationally recognized IEC standard. For example, a new VDE standard, VDE 0884, has just been introduced in Germany and also is being reviewed in various international standardization committees.
German VDE standards are divided into three main groups:

- Basic VDE standards, such as VDE 0110 which describes air and creepage path requirements in general
- VDE standards governing components, such as the recently expired VDE 0883 standard for optocouplers
- VDE standards governing systems and equipment, such as VDE 0805/0806 for office machines and EDP systems

Optocouplers used in a switched mode power supply of a computer have to satisfy the requirements of VDE 0883 *and* VDE 0805/0806.

Thickness of solid insulation between conducting parts, the *isolation test voltage* and the *air and creepage paths* are crucial in applications requiring reliable electrical isolation. Depending on the sensitivity of the application, different values are given in the VDE standards.

For example, an electrical control cabinet will probably be opened and operated infrequently and only by skilled staff. However, it's not unusual for a cup of coffee to be spilled accidentally over the keyboard of an electric typewriter. Thus the requirements to be met in the two cases are very different.

The latest findings in high-voltage technology have questioned two parameters *thickness of solid insulation* and *isolation test voltage*. Dielectric strength does increase with the thickness of the insulating material, but *only* when the insulating material is homogeneous and free of impurities or air-pockets. A high-quality thin insulation can be better than a thick layer with impurities or air-bubbles. The trend is clearly towards reducing insulation thickness (about 0.3 to 0.5 mm) for more economical manufacturing and technologically advanced optocoupler functions

To test the breakdown strength, isolation test voltage normally lasts 60 seconds in qualification tests and up to one second in 100% inspection (depending on the particular VDE standard). However, no determination is made whether any partial discharge occurs in the insulation material during testing. This requires measurement equipment of extreme sensitivity and has been introduced on the market only recently.

Studies in high-voltage technology have shown that a single partial discharge will probably not be extinguished at low voltages and that permanent partial discharge may degrade and damage the insulating material. So that even under normal operating conditions partial discharge may occur when operating voltage is applied. A high-voltage breakdown is likely to occur after a certain time of operation.

The new standard for optocouplers, VDE 0884, used for safe electrical isolation addresses the two drawbacks mentioned earlier. Suitable dielectric strength is now determined by the presence of partial discharges at a defined test voltage. Partial discharges occur with impurities or air-bubbles in the insulating material or insufficient thickness of solid insulation.

The conventional breakdown test (isolation test voltage) may risk causing initial damage to the optocoupler which is not detectable. This test has been replaced in VDE 0884 by the partial discharge test which detects any partial discharge. The absence of partial discharge during the test reliably proves the isolation capability without any undesirable initial damage to the insulation material.

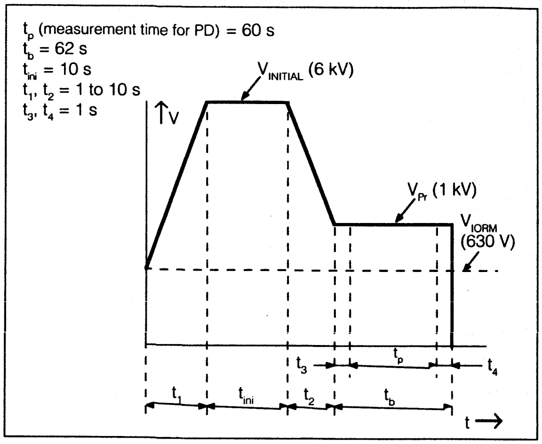


Figure 1. Measurement Method A of VDE 0884: A destructive test for the qualification of optocouplers and sample testing in manufacture. This time-test voltage diagram can be used with SFH601 and CNY17 couplers

Partial discharge measurement method per VDE 0884

Two measurement methods, as described in VDE 0884, have proved to be reliable and suitable for optocouplers.

- Measurement method A—a destructive test to qualify optocouplers and for sample testing in manufacture.
- Measurement method B—a non-destructive test of every component (100% inspection).

Figures I and 2 show two typical voltage time curves (AC voltage peak-to-peak values) for Siemens optocoupler testing per VDE 0884.

More VDE 0884 test criteria for safe electrical isolation by optocouplers

In addition to the partial discharge test, VDE 0884 has further requirements to improve optocoupler reliability. For example, data on reliability limits such as limit current, temperature, and/or power dissipation must be given for every approved and qualified component. Figure 3 shows the reliability limit values for SFH601 and CNY17 optocouplers

Limit values are generally higher than the maximum ratings. They indicate whether and if additional components are required in the circuit to ensure safe electrical isolation in case of failure in the surrounding circuitry.

In the qualification test (destructive test) the optocoupler is exposed to numerous tests in rough environments such as humidity cycles or temperature shocks. The optocouplers are then stressed to the limit values for 72 hours. Finally, they are tested partial discharge. Absence of partial discharge (PD) currently means a value below 5 picocoulombs.

Importance of VDE 0884 standard for the future

Optocouplers used in applications for safe electrical isolation are tested for freedom from partial discharge to give improved reliability and useful information on the long term stability of insulating materials. VDE 0884 is only a first step in this direction. Partial discharge measurements probably will become applicable to transformers, capacitors, and other components. VDE 0883 is no longer the standard since December 1988. However, until the end of 1991 approvals to VDE 0883 were accepted in the marketplace.

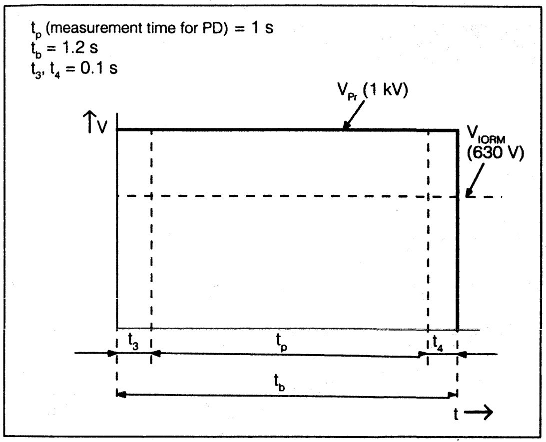


Figure 2. Measurement Method B: A non-destructive test of every component (100% inspection)

From 1992 optocouplers must have VDE 0884 approval. New designs of PC boards or systems using optocouplers which have to fulfil the requirements of safe electrical isolation, must use only optocouplers with VDE 0884 approval.

Siemens already offers the SFH601 and CNY17 optocouplers with VDE 0884 approval under option I. Other types, especially DIP-4 series, have been approved and are available.

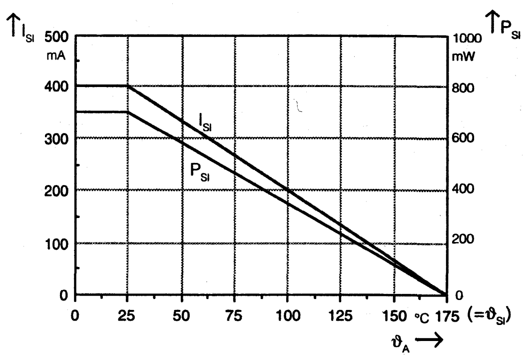


Figure 3. Dependency of reliability maximum ratings on ambient temperatnre for SFH601, CNY17 . For every optocoupler type approved to VDE 0884, reliability limit values such as limit temperature, current and power dissipation must be given

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SIEMENS

Interfacing the PD243X Alphanumeric Programmable Display™ with the SAB80515/SAB80535 Microcontroller

To Produce a Bidirectional, Speed Regulated Moving Message Display by Using the SAB80515/SAB80535's Timer 2 & 8-Bit Converter

Appnote 49

by Ashutosh Ahluwalia

This application note introduces the user to one of the features of Timer 2 and A/D converter of the SAB 80515/535. Included in this application note is a description of both the software and hardware implementations of the SAS 80515/535 to use its Timer 2 and 8-bit A/D converter for the bidirectional, speed regulated moving message display. The program listing demonstrates how the Timer 2 and the 8-bit A/D converter of the SAB 80515/535 can be combined to generate time delays controlled by analog levels. The hardware circuitry shows an interface of the SAP 80515/535 with a simulated analog input, a 2 kbyte EPROM, and intelligent display chips of Siemens used in memory mapped 1/0 scheme.

The SAB 80515/535 microcontroller with on-chip A/D converter and a 16-bit Timer (Timer 2) with reload capability offers a solution which can be applied to a wide range of industrial applications. These applications vary from analog controlled digital delays to controlled frequency converters for pulse width modulation.

In the present application example, the above features of the SAB 80515/535 are used in conjunction to generate the software delays. The software delay results in varying the voltage level of the analog signal applied to the A/D converter of the SAB 80515/535.

A/D Converter

The SAB 80515/535 provides an 8-bit A/D converter with eight multiplexed analog input channels on-chip. In addition, the A/D converter has a sample and hold circuit and offers the feature of software programmable reference voltages. For the conversion, the method of successive approximation with a capacitor network is used.

Figure 1 shows a block diagram of the A/D converter. There are three user-accessible special function registers:

—ADCON (A/D converter control register)

—ADDAT (A/D converter data register)

—DAPR (D/A converter program register) for the programmable reference voltages.

Special function register ADCON is used to select one of the eight analog input channels to be converted, to specify a single or continuous conversion, and to check the status bit BSY which signals whether a conversion is in progress or not.

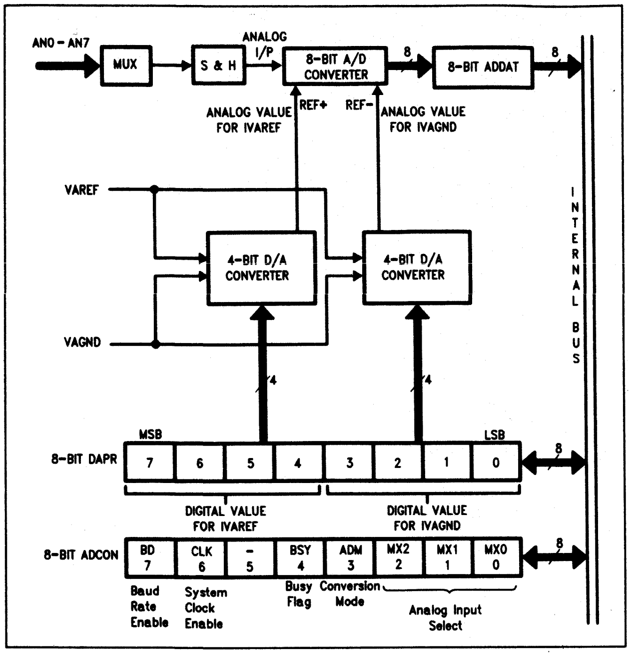
The special function register ADDAT holds the converted digital 8-bit data result. The data remains in ADDAT until it is overwritten by the next converted data. The new converted value will appear in ADDAT in the 15th machine cycle after a conversion has been started. ADDAT can be read and written to under software control. If the A/D converter of the SAB 80515/535 is not used, register ADDAT can be used as an additional general-purpose register.

The special function register DAPR is provided for programming the internal reference voltages IVAREF and IVAGND. In the present application DAPR holds a value of 00H. For this value of DAPR, IVAREF and IVAGND are the same as VAREF and VAGND respectively.

A/D Conversion

A conversion is started by writing to the special function register DAPR. A "Write-to-DAPR" will start a new conversion even if a conversion is currently in progress. The conversion begins with the next machine cycle. The busy flag BSY will be set in the same machine cycle as the "write-to-DAPR" operation occurs. If the value written to DAPR is 00H, meaning that no adjustment of the internal reference voltages is desired, the conversion needs 15 machine cycles to be completed. Thus, the conversion time is 15 µs for 12 MHz oscillator frequency.

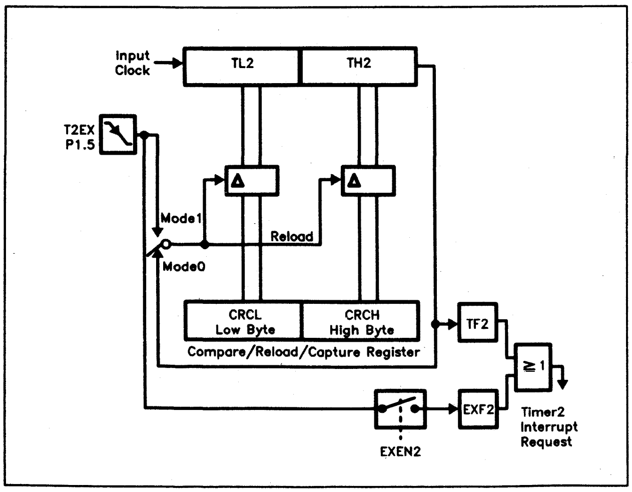
Figure 1. Block Diagram of A/D Converter



After a conversion has been started by writing into the special function register DAPR, the analog voltage at the selected input channel is sampled for 5 machine cycles (5 µs at 12 MHz oscillator frequency), which will then be held at the sampled level for the rest of the conversion time. The external analog source must be strong enough to source the current in order to load the sample & hold capacitance, being 25 pF, within those 5 machine cycles.

Conversion of the sampled analog voltage takes place between the 6th and 15th machine cycle after sampling has been completed. In the 15th machine cycle the converted result is moved to ADDAT.

Figure 2. Functional Diagram of Timer 2 in Reload Mode



Timer 2

The SAB 80515 has three 16-bit Timer/Counters: Timer 0, Timer 1 and Timer 2. These Timers can be configured to operate either as timers or event counters. Timer 2 is the time base of the programmable Timer/Counter Register Array (PTRA) unit. In addition to the operational modes "Timer" or "counter", Timer 2, being the time base for the PTRA unit, provides the features of:

—16-bit reload

—16-bit compare

—16-bit capture

The reload mode of Timer 2 is used in this application to generate software delays. For explanation of the other modes please refer to the users' manual.

Reload

The reload mode for Timer 2 is selected by bits T2R0 and T2R1 in special function register T2CON as illustrated in Table 1. In mode 0, when Timer 2 rolls over from all 1s to all 0s, it not only sets TF2 but also causes the Timer 2 registers to be loaded with the 16-bit value in the CRC (compare/reload/cap ture) register which is preset by software. The reload will happen in the same machine cycle in which TF2 is set, thus overwriting the count value 0000H.

Table 1. Timer 2 Reload Mode Selection

T2RI	T2R0	Mode
0	X	Reload Disabled
1	0	Mode 0: Auto-Reload upon Timer 2 Overflow (TF2)
1	1	Mode 1: Reload upon Falling Edge at Pin T2EX/P1.5

PD2435

The PD2435 is a CMOS 4-character 5 x 7 dot matrix alphanumeric programmable display with ROM to decode 128 ASCII alphanumeric characters and enough RAM to store the display's complete four digit ASCII message with software programmable attributes. The CMOS IC incorporates special interface control circuitry to allow the user to control the module as a fully supported microprocessor peripheral.

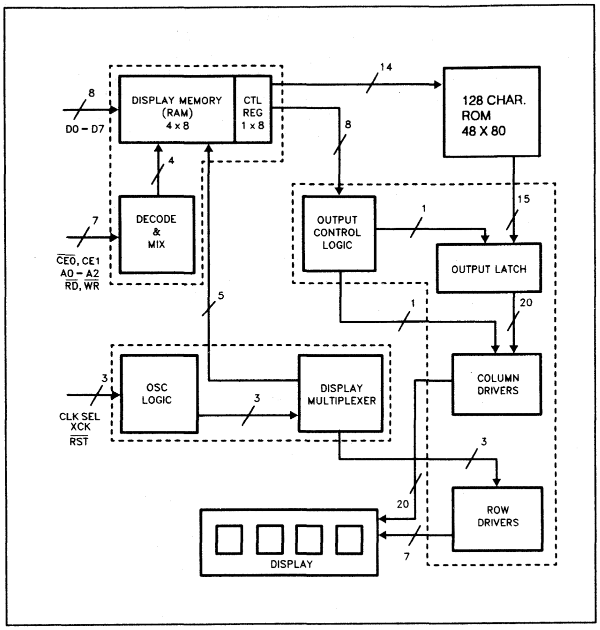
Microprocessor Interface

The interface to the microprocessor is through the address lines (A0-A2), the data bus (D0-D7), two chip select lines ($\overline{CE0}$, CE1), and ($\overline{RD}$) and ($\overline{WR}$) lines. The $\overline{CE0}$ should be held low and CE1 held high when executing a read or write to a specific PD243X device. The read and write lines are both active low. A valid write will enable the data as input lines.

Programming the PD2435

There are five registers within the PD2435. Four of the registers are used to hold the ASCII code of the four display characters. The fifth register is the Control Word, which is used to blink, blank, clear or dim the entire display to change the presentation (attributes) of individual characters.

Figure 3. PD2435 Block Diagram Showing the Major Blocks and Internal Registers



Application

The speed regulated moving message display is an example where a digitized value of the controlling analog signal is used to compute a reload value for the Timer 2. The Timer 2 is operated in mode 0 where this reload value becomes a starting point for the Timer to count up. On overflow the Timer automatically takes the restart value for counting from reload register CRC. While the Timer is counting up, a new reload value is computed using the present A/D value.

Hardware

The circuit used in this application has the advantage of requiring a minimum of components. The single chip microcomputer SAB 80535 operates in conjunction with four alphanumeric programmable display chips PD 2435 to form a 16-digit long display.

The ASCII-coded data is transferred from the SAB 80535 to the display ICs via the data port P0 and using the control signal WR (P3.6) of the SAB 80535. The address pins from the ports P0 and P2 of the SAB 80535 are used to address the EPROM as well as the display chips in a memory-mapped 1/O scheme. The display chips are addressed as memory locations with the following addresses.

Display Chip	Control Register Address	Digits Address
1	1000H	1004H-1007H
2	2000H	2004H -2007H
3	4000H	4004H -4007H
4	8000H	8004H -8007H

A push button is interfaced to port P3.2 of the SAB 80535 to provide an external interrupt to the microcontroller.

Firmware Description

Besides controlling speed of the moving message, there is a provision to interrupt the moving message and roll it backwards to the beginning of the message. The microcontroller reads the code and the message to display from an EPROM 2716A interfaced to the ports P0 and P2 of the SAB 80535. A virtual image of the message is created in the internal RAM of the SAB 80535. Four display chips PD2435 are interfaced to the SAB 80535 in a memory-mapped scheme and can be addressed as external memory to the SAB 80535. The virtual image of the message in internal RAM of the SAB 80535 is used to manipulate data to be displayed on the display chips. The internal RAM used for the display can be viewed as an area divided into two portions:

1. For active display
2. As a data buffer

The active display area is the replica of the data being displayed on the display chips. In this case the 16-digit display would need 16 RAM locations which correspond to 16 digits currently being displayed. The data buffer contains the rest of the message which is not being displayed. The message is shifted character by character in the RAM area. When the message on the display moves from right to left, the RAM buffer acts in "First In First Out" mode, and when the message on the display moves from left to right, the data to the display from the microcontroller RAM buffer is supplied in the "Last In First Out" scheme.

Between display of every character there is a software delay which depends upon the level of the analog signal supplied to the ANO pin of the SAB 80535. The external interrupt 0 (at port P3.2) is used to interrupt the microcontroller to inform it that the message needs to be scrolled backwards. On getting this interrupt the software sets the flag bit 0 which remains set until the message is scrolled back to the beginning of the message.

List of Components

Name	Number
SAB 80535	1
271 6A	1
PD2435	4
12 MHz Crystal	1
74LS373	1
22 pF Capacitors	2
100 nF Capacitor	1
4.7 µf Capacitor	1
1 k Resistor	1
10 k Pot	1

Reference Material for ICs

1. SAB 80515/80535 User's Manual.
2. PD2435 Data-Sheet or Optoelectronic Data Book (1990).

Figure 4. Interface Circuit

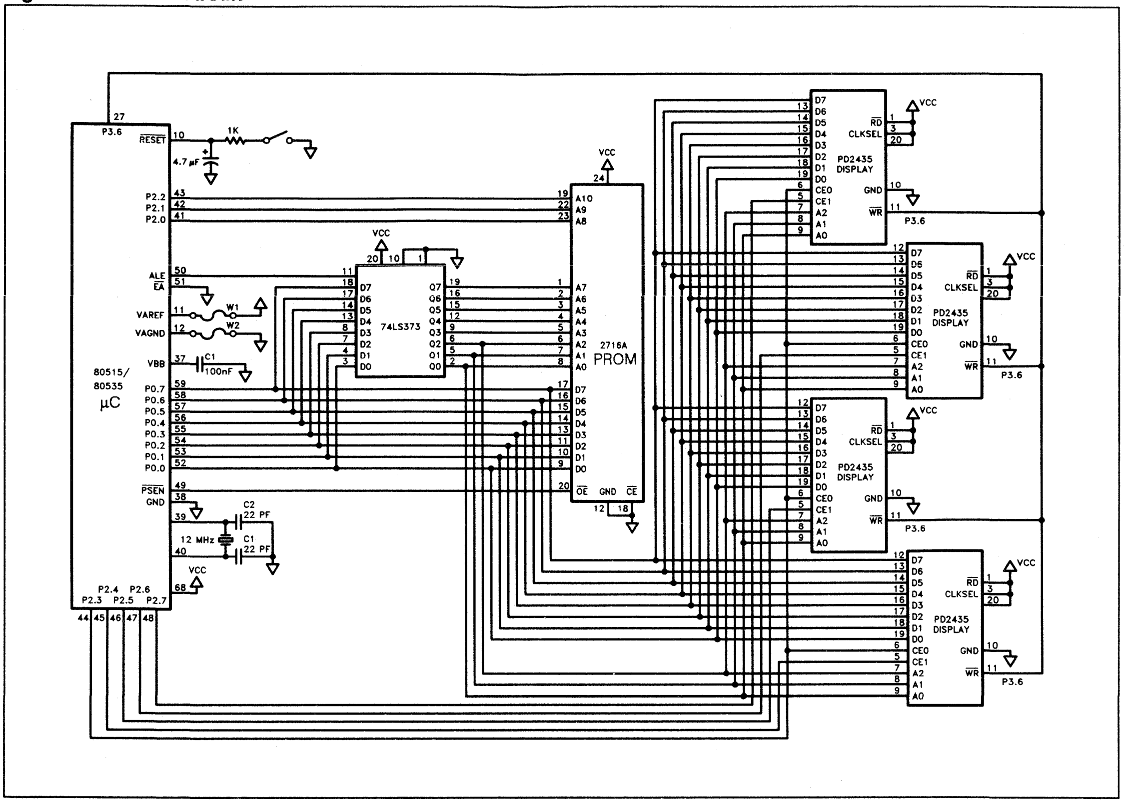
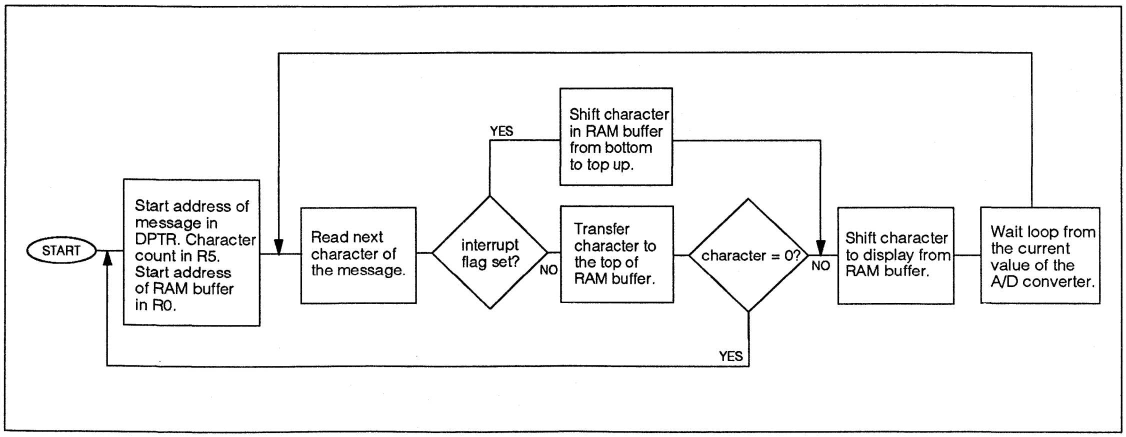


Figure 5. Program Flow Chart



Program Listing

```
UDISP                'PD 2435 DISPLAY PROGRAM'

                     $TITLE ('PD 2435 DISPLAY PROGRAM')
                     $MOD515
                     $NOSYMBOLS
. . . .              CSEG
                     $DEBUG
0000                          ORG     00H
0000 02000C                   LJMP    BEGIN          ;Jump on reset
                              ;
                              ; ___________________________________________________________
                              ; This is the interrupt subroutine for INT0. This is used to set a flag
                              ; which then indicates that the message needs to be rolled back.
                              ; ___________________________________________________________
                              ;
0003                          ORG     03H
0003 C0E0                     PUSH    ACC
0005 D2D5                     SETB    F0             ;Set flag for external interrupt
0007 D0E0                     POP     ACC
0009 C289                     CLR     IE0
000B 32                       RETI
                              ; ___________________________________________________________
                              ; MAIN PROGRAM
                              ; ___________________________________________________________
000C D282            BEGIN:   SETB    P3.2           ;Set bit for INT0
000E 758110                   MOV     SP,#10H
0011 75D800                   MOV     ADCON, #00H    ;Select analog channel 0
0014 C2D5            OPTS:    CLR     F0             ;Clear flag 0
0016 7800                     MOV     R3,#00H        ;Character pointer in the message
0018 79FF                     MOV     R1,#0FFH       ;R1 used as a flag
001A 90F000                   MOV     DPTR,#0F000H   ;Control register of all displays
001D 7403                     MOV     A,#03H         ;Control word for display
001F F0                       MOVX    @DPTR,A
0020 9000C2                   MOV     DPTR,#(TEXT-1) ;Beginning of the text
0023 7820                     MOV     R0,#20H        ;Internal RAM location
0025 7D65                     MOV     R5,#101        ;A count for 101 characters
0027 7420                     MOV     A,#20H         ;ASCII for space
0029 F6              BLANK:   MOV     @R0,A          ;Fill all locations with blank
002A 08                       INC     R0
002B DDFC                     DJNZ    R5, BLANK
002D 12006C          SHIF:    CALL    NEXTC          ;Read the next character
0030 20D501                   JB      F0, TEMP       ;Check if the interrupt was raised
0033 0B                       INC     R3             ;If no interrupt
0034 7D65            TEMP:    MOV     R5,#101        ;Character count in message
0036 7820                     MOV     R0,#20H        ;RAM location 20H
0038 20D506                   JB      F0, REV0
003B C6              SHFT:    XCH     A,@R0          ;If no interrupt
003C 08                       INC     R0             ;Add the character
003D DDFC                     DJNZ    R5,SHFT        ;To the top of the RAM buffer
003F 0158                     AJMP    CONT0
```

```
0041 7421            REV0:   MOV     A,#21H          ;If there is an interrupt
0043 2B                      ADD     A,R3            ;Offset for the RAM buffer
0044 F8                      MOV     R0,A            ;Pointer in the RAM buffer
0045 7600                    MOV     @R0,#00H        ;Displayed so far
0047 7820                    MOV     R0,#20H         ;Beginning of the RAM buffer
0049 E6                      MOV     A,@R0           ;Read the character
004A C0E0                    PUSH    ACC             ;Save it
004C 08              AGAIN:  INC     R0              ;Next location in RAM buffer
004D E6                      MOV     A,@R0           ;Read the next character
004E 18                      DEC     R0              ;Back to first character
004F F6                      MOV     @R0,A           ;Replace with second character
0050 08                      INC     R0              ;Process repeats
0051 DDF9                    DJNZ    R5, AGAIN       ;Moving character backwards
0053 08                      INC     R0
0054 7600                    MOV     @R0,#00H        ;End of character buffer
0056 D0E0                    POP     ACC             ;Restore character
0058 7820            CONT0:  MOV     R0,#20H         ;Beginning of character buffer
005A E9                      MOV     A,R1            ;Check if end of character buffer
005B 6087                    JZ      OPTS
005D 120071                  CALL    OUTC
0060 C2AF                    CLR     IEN0.7          ;Disable interrupt
0062 1200A4                  CALL    WAITA           ;Before delay
0065 75A881                  MOV     IEN0,#81H       ;Enable interrupt
0068 D288                    SETB    IT0             ;INT0 control bit
006A 012D                    AJMP    SHIF

                             ; ________________________________________________
                             ; The routine moves a character of the message to ACC.
                             ; ________________________________________________

006C A3              NEXTC:  INC     DPTR
006D 7400                    MOV     A,#0
006F 93                      MOVC    A,@A+DPTR       ;Move the character to Acc.
0070 22                      RET

                             ; ________________________________________________
                             ; This routine displays and moves a character over the four digits of
                             ; the PD2435 and then repeats for the next display chip and so on.
                             ; ________________________________________________
                             ;

0071 C0E0            OUTC:   PUSH    ACC
0073 C082                    PUSH    DPL
0075 C083                    PUSH    DPH
0077 7A04                    MOV     R2,#4           ;For four digits (0 to 3) in a chip
0079 901004                  MOV     DPTR,#1004H     ;Digit 0 in first display chip
007C 120098                  CALL    OUTC0
007F 902004                  MOV     DPTR,#2004H     ;Digit 0 in second display chip
0082 120098                  CALL    OUTC0
0085 904004                  MOV     DPTR,#4004H     ;Digit 0 in third display chip
0088 120098                  CALL    OUTC0
008B 908004                  MOV     DPTR,#8004H     ;Digit 0 in fourth display chip
008E 120098                  CALL    OUTCO
0091 D083                    POP     DPH
0093 0082                    POP     DPL
0095 D0E0                    POP     ACC
0097 22                      RET

                             ; ________________________________________________
                             ; This is a nested subroutine. It moves a nonzero hex value (ASCII)
                             ; from left to right of the four digit display.
                             ; ________________________________________________
                             ;
```

```
0098 E6                OUTCO:   MOV     A,@R0
0099 6007                       JZ      FIN
0098 F0                         MOVX    @DPTR,A
009C 08                         INC     R0
009D A3                         INC     DPTR
009E DAF8                       DJNZ    R2,OUTCO
00A0 7A04                       MOV     R2,#4
00A2 F9                FIN:     MOV     R1,A
00A3 22                         RET

                                ;
                                ; ____________________________________________________
                                ; This subroutine generates the software delay. The delay is
                                ; generated by the timer 2. The start count of the timer 2 is
                                ; computed from the present value of the A/D converter.
                                ; ____________________________________________________
                                ;

00A4 7E03              WAITA:   MOV     R6,#03H
00A6 7D10              WAITB:   MOV     R5,#10H
00A8 75DA00            WAITC:   MOV     DAPR,#00H
00AB E5D9                       MOV     A,ADDAT
00AD 75F0FF                     MOV     B,#255        ;For computing reload value
00B0 A4                         MUL     AB            ;Reload value is computed
00B1 F5CA                       MOV     CRCL,A        ;Load the reload value low
00B3 85F0C8                     MOV     CRCH,B        ;Load the reload value high
00B6 75C811                     MOV     T2CON,#11H
00B9 10C602            WAITD:   JBC     TF2,WAITE
00BC 01B9                       AJMP    WAITD
00BE DDE8              WAITE:   DJNZ    R5,WAITC
00C0 DEE4                       DJNZ    R6,WAITB
00C2 22                         RET

                                ; ____________________________________________________
                                ; MESSAGE
                                ; ____________________________________________________

00C3 20202020          TEXT:    DB
00C7 20202020
00CB 20202020
00CF 20202020
00D3 5349454D                   DB      'SIEMENS MICROCONTROLLER SAB 80515/535'
00D7 454E5320
00D8 4D494352
00DF 4F434F4E
00E3 54524F4C
00E7 4C455220
00EB 53414220
00EF 38303531
00F3 352F3533
00F7 35
00F8 20202020                   DB           SAB 80515/535        0
00FC 20202020
0100 20202020
0104 53414220
0108 38303531
010C 352F3533
0110 35202020
0114 20202020
0118 20202020
011C 20202020
0120 00
                                END

ASSEMBLY COMPLETE, 0 ERRORS FOUND
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SIEMENS

Designing Linear Amplifiers Using the IL300 Optocoupler Appnote 50

by Bob Krause

Siemens IL410 and IL420 optically coupled TRIACs can be used to solve many of the

Introduction

This application note presents isolation amplifier circuit designs useful in industrial, instrumentation, medical, and communications systems. It covers the IL300's coupling specifications, and circuit topologies for photovoltaic and photoconductive amplifier design. Specific designs include unipolar and bipolar responding amplifiers. Both single ended and differential amplifier configurations are discussed. Also included is a brief tutorial on the operation of photodetectors and their characteristics .

Galvanic isolation is desirable and often essential in many measurement systems. Applications requiring galvanic isolation include: industrial sensors, medical transducers, and mains powered switch mode power supplies. Operator safety and signal quality are insured with isolated interconnections. These isolated interconnections commonly use isolation amplifiers.

Industrial sensors include thermocouples, strain gauges, and pressure transducers. They provide monitoring signals to a process control system. Their low level DC and AC signal must be accurately measured in the presence of high common mode noise. The IL300's 130 dB common mode rejection (CMR), ±50 ppm/°C stability and ±0.01% linearity provide a quality link from the sensor to the controller input.

Safety is an important factor in instrumentation for medical patient monitoring. EEG, ECG, and similar systems demand high insulation safety for the patient under evaluation. The IL300's 7500 V Withstand Test Voltage (WTV) insulation, DC response, and high CMR are features which assure safety for the patient and accuracy of the transducer signals.

The aforementioned applications require isolated signal processing. Current designs rely on A to D or V to F converters to provide input/output insulation and noise isolation. Such designs use transformers or high speed optocouplers which often result in complicated and costly solutions. The IL300 eliminates the complexity of these isolated amplifier designs without sacrificing accuracy or stability.

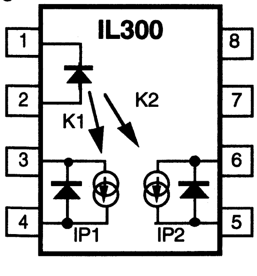
The IL300's 200 KHz bandwidth and gain stability make it an excellent candidate for subscriber and data phone interfaces. Present OEM switch mode power supplies are approaching 1 MHz switching frequencies. Such supplies need output monitoring feedback networks with wide bandwidth and flat phase response. The IL300 satisfies these needs with simple support circuits.

Operation of the IL300

The IL300 consists of a high efficiency AlGaAs LED emitter coupled to two independent PIN photodiodes. The servo (pins 3, 4) photodiode provides a feedback signal which controls the current to the LED emitter (pins 1, 2). This photodiode provides a photocurrent, IP1, that is directly proportional to the LED's incident flux. This servo operation linearizes the LED's output flux and eliminates the LED's time and temperature. The galvanic isolation between the input and the output is provided by a second PIN photodiode (pins 5, 6) located on the output side of the coupler. The output current, IP2, from this photodiode accurately tracks the photocurrent generated by the servo photodiode.

Figure 1 shows the package footprint and electrical schematic of the IL300. The following sections discuss the key operating characteristics of the IL300. The IL300 performance characteristics are specified with the photodiodes operating in the photoconductive mode.

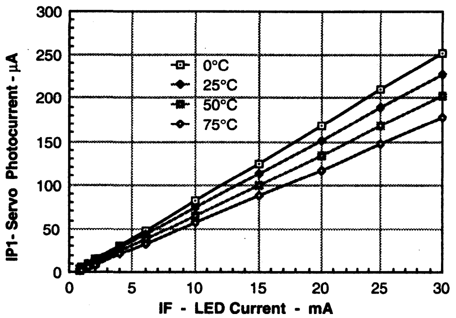
Figure 1. IL300 Schematic



Servo Gain—K1

The typical servo photocurrent, IP1, as a function of LED current, is shown in Figure 2. This graph shows the typical nonservo LED-photodiode linearity is ±1% over an LED drive current range of 1 to 30 mA. This curve also shows that the nonservo photocurrent is affected by ambient temperature. The photocurrent typically decreases by -0.5% per °C. The LED's nonlinearity and temperature characteristics are minimized when the IL300 is used as a servo linear amplifier.

Figure 2. Servo Photocurrent vs. LED current

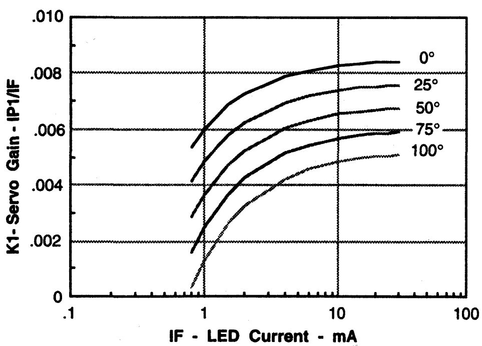


The servo gain is defined as the ratio of the servo photocurrent, IP1, to the LED drive current, IF. It is called K1, and is described in Equation 1.

Equation 1: K1 =IP1/ IF

The IL300 is specified with an IF=10mA, Ta=25°C, and Vd=−15V. This condition generates a typical servo photocurrent of IP1=70 µA. This results in a typical K1=0.007. The relationship of K1 and LED drive current is shown in Figure 3.

Figure 3. Servo Gain vs. LED Current



The servo gain, K1, is guaranteed to be between 0.005 minimum to 0.011 maximum of an IF=10 mA, TA=25°C, and VD=−15V.

Figure 4. Normalized Servo Gain vs. LED Current

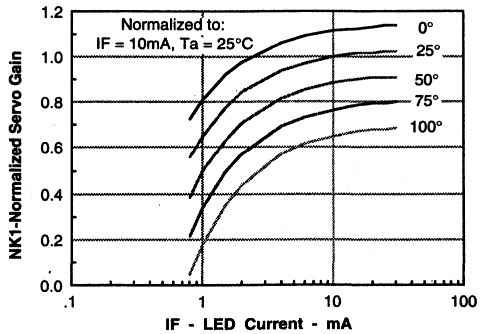


Figure 4 presents the Normalized servo gain, NK1(IF, Ta), as a function of LED current and temperature. It can be used to determine the minimum or maximum servo photocurrent, IP1, given LED current and ambient temperature. The actual servo gain can be determined from equation 2.

Equation 2: K1(IF,Ta)=K1(data sheet limit) • NK1(IF, Ta)

The minimum servo photocurrent under specific use conditions can be determined by using the minimum value for K1 (0.005) and the normalization factor from Figure 4. The example is to determine IP1 (min) for the condition of K1 at Ta=75°C, and IF=6mA.

Equation 3: NK1(IF=6mA,Ta=75°C)=0.72 • NK1(IF, Ta)

Equation 4: K1 MIN(IF,Ta)=K1 MIN(0.005) • NK1(0.72)

Equation 5: K1MIN(IF,Ta)=0.0036

Using K1(IF, Ta)=0.0036 in Equation 1 the minimum IP1 can be determined.

Equation 6: IP1 MIN=K1 MIN(IF,Ta) • IF

Equation 7: IP1 MIN=0.0036 • 6mA

Equation 8: IP1 MIN (IF=6mA, Ta=75°C)=21.6µA

The minimum value IP1 is useful for determining the maximum required LED current needed to servo the input stage of the isolation amplifier.

Output Forward Gain—K2

Figure 1 shows that the LED's optical flux is also received by a PIN photodiode located on the output side (pins 5, 6) of the coupler package. This detector is surrounded by an optically transparent high voltage insulation material. The coupler construction spaces the LED 0.4 mm from the output PIN photodiode. The package construction and the insulation material guarantee the coupler to have a Withstand Test Voltage of 7500V peak.

K2, the output (forward) gain is defined as the ratio of the output photodiode current, IP2, to the LED current, IF. K2 is shown in Equation 9.

Equation 9: K2=IP2/ IF

The forward gain, K2, has the same characteristics of the servo gain, K1. The normalized current and temperature performance of each detector is identical. This results from using matched PIN photodiodes in the IL300's construction.

Transfer Gain – K3

The current gain, or CTR, of the standard phototransistor optocoupler is set by the LED efficiency, transistor gain, and optical coupling. Variation in ambient temperature alters the LED efficiency and phototransistor gain and result in CTR drift. Isolation amplifiers constructed with standard phototransistor optocouplers suffer from gain drift due to changing CTR.

Isolation amplifiers using the IL300 are not plagued with the drift problems associated with standard phototransistors. The following analysis will show how the servo operation of the IL300 eliminates the influence of LED efficiency on the amplifier gain.

The input-output gain of the IL300 is termed transfer gain, K3. Transfer gain is defined as the output (forward) gain, K2, divided by servo gain, K1, as shown in Equation 10.

Equation 10: $K3 = K2/K1$

The first step in the analysis is to review the simple optical servo feedback amplifier shown in Figure 5.

The circuit consists of an operational amplifier, U1, a feedback resistor R1, and the input section of the IL300. The servo photodiode is operating in the photoconductive mode. The initial conditions are: Va = Vb = 0 V. Initially, a positive voltage is applied to the noninverting input (Va) of the opamp. At that time the output of the opamp will swing toward the positive Vcc rail, and forward bias the LED. As the LED current, IF, starts to flow, an optical flux will be generated. The optical flux will irradiate the servo photodiode causing it to generate a photocurrent, IP1. This photocurrent will flow through R1 and develop a positive voltage at the inverting input (Vb) of the operational amplifier. The amplifier output will start to swing toward the negative supply rail, - Vcc. When the magnitude of the Vb is equal to that of Va, the LED drive current will cease to increase. This condition forces the circuit into a stable closed loop condition.

When Vin is modulated, Vb will track Vin. For this to happen the photocurrent through R1 must also track the change in Va. Recall that the photocurrent results from the change in LED current times the servo gain, K1. The following equations can be written to describe this activity.

Equation 11: $Va = Vb = Vin = 0$

Equation 12: $IP1 = IF \bullet K1$

Equation 13: $Vb = IP1 \bullet R1$

The relationship of LED drive to input voltage is shown by combining Equations 11, 12, and 13 .

Equation 14: $Va = IP1 \bullet R1$

Equation 15: $Vin = IF \bullet K1 \bullet R1$

Equation 16: $IF = Vin/(K1 \bullet R1)$

Equation 16 shows that the LED current is related to the input voltage Vin. A changing Va causes a modulation in the LED flux. The LED flux will change to a level that generates the necessary servo photocurrent to stabilize the optical feedback loop. The LED flux will be a linear representation of the input voltage, Va. The servo photodiode's linearity controls the linearity of the isolation amplifier.

The next step in the analysis is to evaluate the output transresistance amplifier. The common inverting transresistance amplifier is shown in Figure 6. The output photodiode is operated in the photoconductive mode. The photocurrent, IP2, is derived from the same LED that irradiates the servo photodetector. The output signal, Vout, is proportional to the output photocurrent , IP2, times the transresistance, R2.

Equation 17: $Vout = - IP2 \bullet R2$

Equation 18: $IP2 = K2 \bullet IF$

Combining Equations 17 and 18 and solving for IF is shown in Equation 19.

Equation 19: $IF = - Vout / (K2 \bullet R2)$

Figure 5. Optial Servo Amplifiert

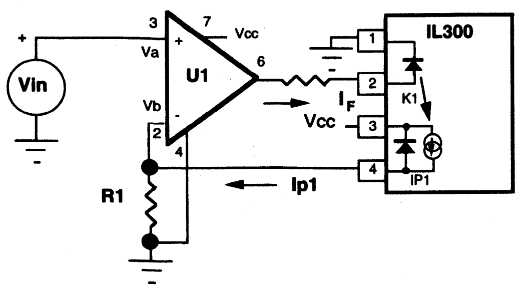
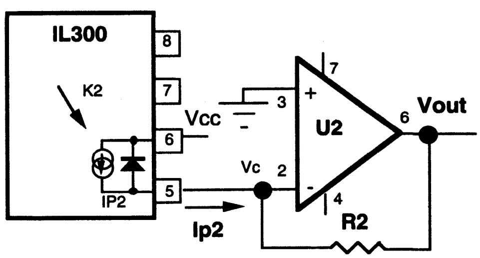


Figure 6. Output Transresistance Amplifier



Application Notes
11

The input-output gain of the isolation amplifier is determined by combining Equations 16 and 19.

Equation 16: IF = Vin/(K1 • R1)

Equation 19: IF = - Vout/(K2 • R2)

Equation 20: Vin/(K1 R1) = - Vout/(K2 • R2)

Equation 21 gives the solution for the input-output gain.

Equation 21: Vout/Vin = - (K2 • R2)/(K1 • R1)

Note that the LED current, IF, is factored out of Equation 21. This is possible because the servo and output photodiode currents are generated by the same LED source. This equation can be simplified further by replacing the K2/K1 ratio with IL300's transfer gain, K3.

Equation 22: Vout/Vin = - K3 • (R2/R1)

Figure 7 shows the composite isolation amplifier including the input servo amplifier and the output transresistance amplifier. This circuit offers the insulation of an optocoupler and the gain stability of a feedback amplifier.

The IL300 isolation amplifier gain stability and offset drift depends on the transfer gain characteristics. Figure 8 shows the consistency of the normalized K3 as a function of LED current and ambient temperature. The transfer gain drift as a function of temperature is ±0.005%/°C over a 0°C to 75°C range.

Figure 8. Normalized Servo Transfer Gain

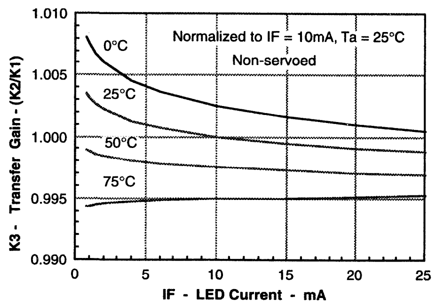
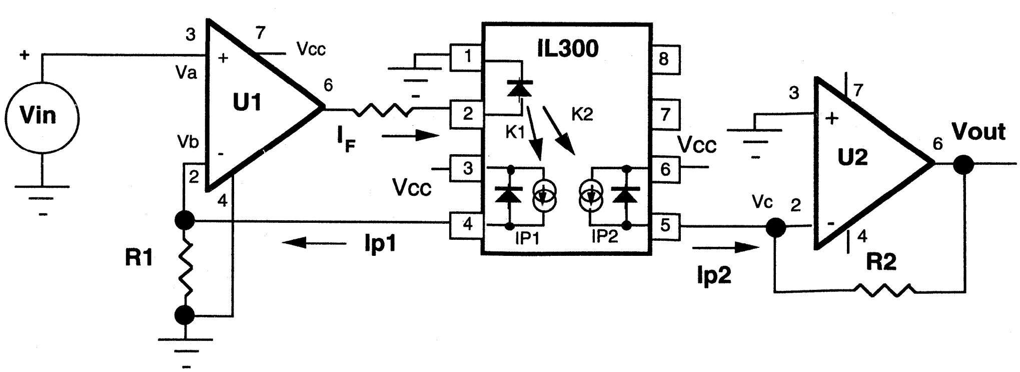


Figure 7. Composite Amplifier



An instrumentation engineer often seeks to design an isolation amplifier with unity gain: Vout / Vin = 1.0. The IL300's transfer gain is targeted for unity gain: K3 = 1.0. Package assembly variations result in a range of K3. Because of the importance of K3, Siemens offers the transfer gain sorted into ±5% bins. The bin designator is listed on the IL300 package. The K3 bin limits are shown in Table 1.

This table is useful when selecting the specific resistor values needed to set the isolation amplifier transfer gain.

Table 1: K3 Transfer Gain Bins

Bin	Typ.	Min.	Max.
A	0.59	0.56	0.623
B	0.66	0.623	0.693
C	0.73	0.693	0.769
D	0.81	0.769	0.855
E	0.93	0.855	0.95
F	1.0	0.95	1.056
G	1.11	1.056	1.175
H	1.24	1.175	1.304
I	1.37	1.304	1.449
J	1.53	1.449	1.61

Isolation Amplifier Design Techniques

The previous section discussed the operation of an isolation amplifier using the optical servo technique. The following section will describe the design philosophy used in developing isolation amplifiers optimized for input voltage range, linearity, and noise rejection.

The IL300 can be configured as either a photovoltaic or photoconductive isolation amplifier. The photovoltaic topology offers the best linearity, lowest noise, and drift performance. Isolation amplifiers using these circuit configurations meet or exceed 12 bit AD performance. Photoconductive photodiode operation provides the largest coupled frequency bandwidth. The photoconductive configuration has linearity and drift characteristics comparable to a 8-9 bit AD converter.

Photovoltaic Isolation Amplifier

When low offset drift and greater than 12 bit linearity is desired, photovoltaic amplifier designs should be considered. The schematic of a typical positive unipolar photovoltaic isolation amplifier is shown in Figure 9.

The transfer characteristics of this amplifier are shown in Figure 10.

The input stage consists of a servo amplifier, U1, which controls the LED drive current. The servo photodiode is operated with zero voltage bias. This is accomplished by connecting the photodiodes anode and cathode directly to U1's inverting and non-inverting inputs. The characteristics of the servo amplifier operation are presented in Figure 10a and 10b. The servo photocurrent is linearly proportional to the input voltage, IP1 = VIN/R1. Figure 10b shows the LED current is inversely proportional to the servo transfer gain, IF = IP1/K1. The servo photocurrent, resulting from the LED emission, keeps the voltage at the inverting input of U1 equal to zero. The output photocurrent, IP2, results from the incident flux supplied by the LED. Figure 10c shows that the magnitude of the output current is determined by the output transfer gain, K2. The output voltage, as shown in Figure 10d, is proportional to the output photocurrent IP2. The output voltage equals the product of the output photocurrent times the output amplifier's transresistance, R2.

The composite amplifier transfer gain (Vo/Vin) is the ratio of two products. The first is the output transfer gain, K2 • R2.

Figure 10. Positive Unipolar Photovoltaic Amplifier Transfer Characteristics

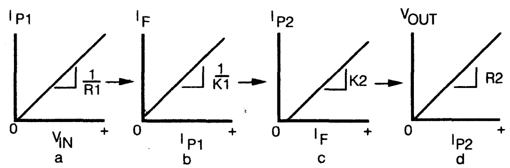
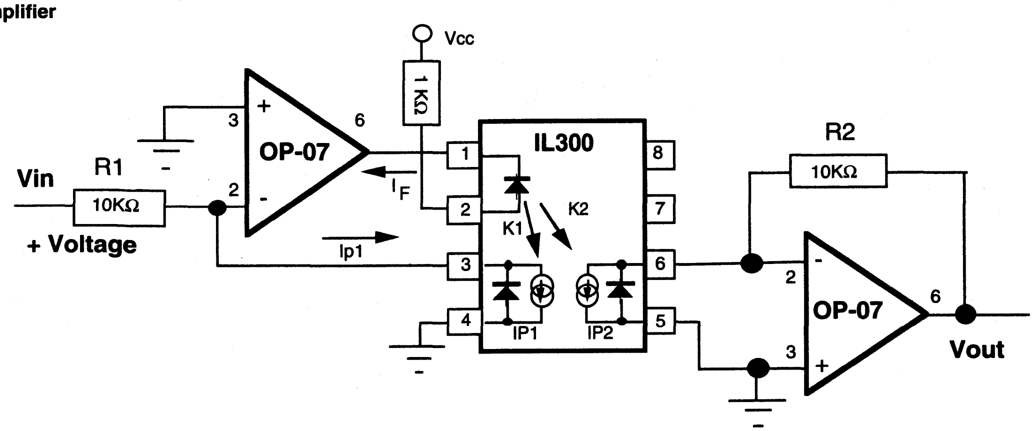


Figure 9. Positive Unipolar Photovoltaic Isolation Amplifier



The second is the servo transfer gain, K1 • R1. The amplifier gain is the first divided by the second. See Equation 23.

Equation 23: $\frac{Vo}{Vin} = \frac{K2 \bullet R2}{K1 \bullet R1}$.

Equation 23 shows that the composite amplifier transfer gain is independent of the LED forward current. The K2/K1 ratio reduces to IL300 transfer gain, K3. This relationship is included in Equation 24. This equation shows that the composite amplifier gain is equal to the product of the IL300 gain, K3, times the ratio of the output to input resistors.

Equation 24: $\frac{Vo}{Vin} = \frac{K3 \bullet R2}{R1}$.

Designing this amplifier is a three step process. First, given the input signal span and U1's output current handling capability, the input resistor R1 can be determined by using the circuit found in Figure 9 and the following typical characteristics:

OP-07	Iout = ± 15mA
IL300	K1 = 0.007
	K2 = 0.007
	K3 = 1.0
Vin	0 ≥ + 1.0 V

The second step is to determine servo photocurrent, IP1, resulting from the peak input signal swing. This current is the product of the LED drive current, IF, times the servo transfer gain, K1. For this example the $Iout_{max}$ is equal to the largest LED current signal swing, i.e., $IF = Iout_{max}$.

$IP1 = K1 \bullet Iout_{max}$

$IP1 = 0.007 \bullet 15\ mA$

$IP1 = 105\ \mu A$

The input resistor, R1, is set by the input voltage range and the peak servo photocurrent, IP1. Thus R1 is equal to:

R1 = Vin / IP1

R1 = 1.0 / 105 μA

R1 = 9.524 KΩ

R1 is rounded to 10 KΩ.

The third step in this design is determining the value of the transresistance, R2, of the output amplifier. R2 is set by the composite voltage gain desired, and the IL300's transfer gain, K3. Given K3 = 1.0 and a required Vout/Vin = G = 1.0, the value of R2 can be determined.

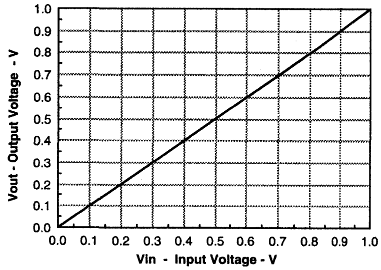
R2 = (R1 • G)/ K3

R2 = (10 KΩ • 1.0)/1.0

R2 = 10 KΩ

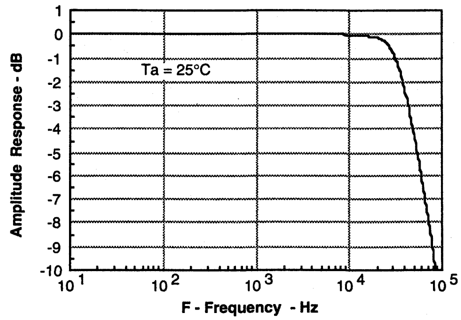
When the amplifier in Figure 9 is constructed with OP-07 operational amplifiers it will have the characteristics shown in Figures 11 and 12.

Figure 11. Photovoltaic Amplifier Transfer Gain



The frequency response is shown in Figure 12. This amplifier has a small signal bandwidth of 45 KHz.

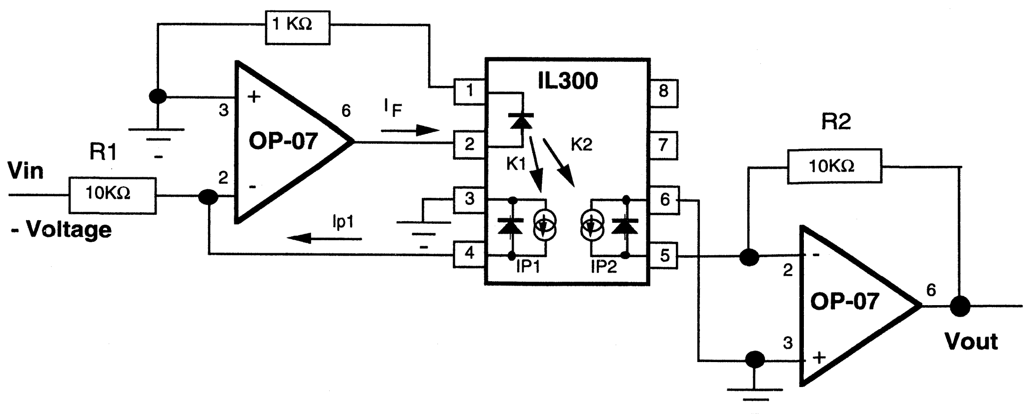
Figure 12. Photovoltaic Amplifier Frequency Response



The amplifier in Figure 9 responds to positive polarity input signals. This circuit can be modified to respond to negative polarity signals. The modifications of the input amplifier include reversing the polarity of the servo photodiode at U1's input and connecting the LED so that it sinks current from U1's output. The noninverting isolation amplifier response is maintained by reversing the IL300's output photodiodes connection to the input of the transresistance amplifier. The modified circuit is shown in Figure 13.

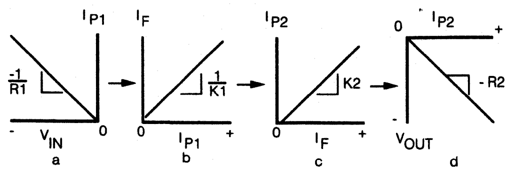
The negative unipolar photovoltaic isolation amplifier transfer characteristics are shown in Figure 14. This amplifier, as shown in Figure 13, responds to signals in only one quadrant. If a positive signal is applied to the input of this amplifier, it will forward bias the photodiode , causing U1 to reverse bias the LED. No damage will occur, and the amplifier will be cut-off under this condition. This operation is verified by the transfer characteristics shown in Figure 14.

Figure 13. Negative Unipolar Photovoltaic Isolation Amplifier



Appnote 50

Figure 14. Negative Unipolar Photovoltaic Isolation Amplifier Transfer Characteristics



A bipolar responding photovoltaic amplifier can be constructed by combining a positive and negative unipolar amplifier into one circuit. This is shown in Figure 15. This amplifier uses two IL300s with each detector and LED connected in antiparallel. The IL300a responds to positive signals while the IL300b is active for the negative signals. The operation of the IL300s and the U1 and U2 is shown in the transfer characteristics given in Figure 16.

Figure 15. Bipolar Input Photovoltaic Isolation Amplifier

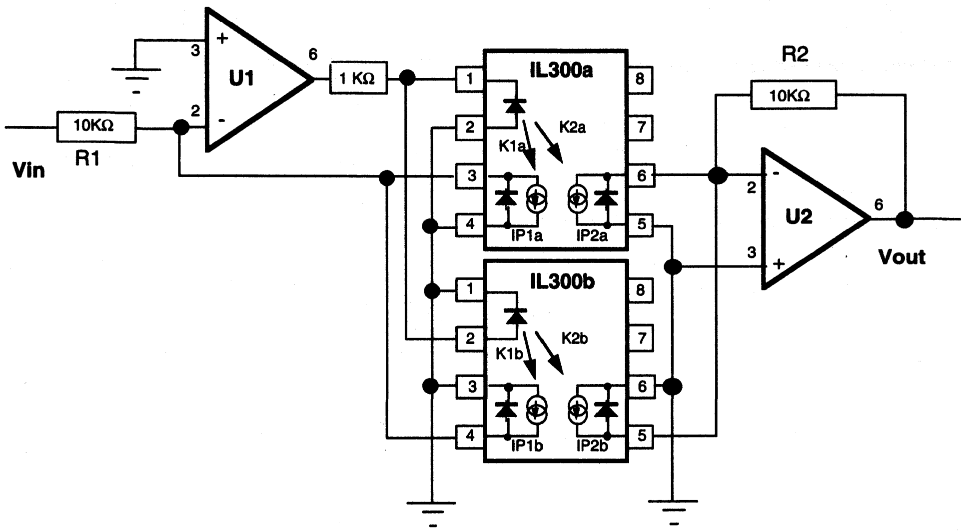
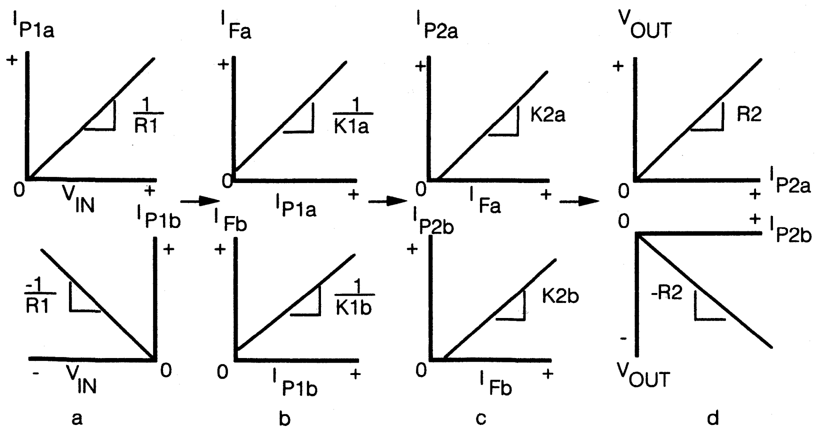


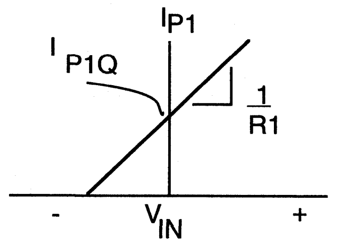
Figure 16. Bipolar Input Photovoltaic Isolation Amplifier Transfer Characteristics



The operational analysis of this amplifier is similar to the positive and negative unipolar isolation amplifier. This simple circuit provides a very low offset drift and exceedingly good linearity. The circuit's useful bandwidth is limited by cross-over distortion resulting from the photodiode stored charge. With a bipolar signal referenced to ground and using a 5% distortion limit, the typical bandwidth is under 1KHz. Using matched K3s, the composite amplifier gain for positive and negative voltage will be equal.

Whenever the need to couple bipolar signals arises a prebiased photovoltaic isolation amplifier is a good solution. By prebiasing the input amplifier the LED and photodetector will operate from a selected quiescent operating point. The relationship between the servo photocurrent and the input voltage is shown in Figure 17.

Figure 17. Transfer Characteristic Prebiased Photovoltaic Bipolar Amplifier



The quiescent operation point, I_{P1Q}, is determined by the dynamic range of the input signal . This establishes maximum LED current requirements. The output current capability of the OP-07 is extended by including a buffer transistor between the output of U1 and the LED. The buffer transistor minimizes thermal drift by reducing the OP-07 internal power dissipation if it were to drive the LED directly. This is shown in Figure 18.

The bias is introduced into the inverting input of the servoamplifier, U1. The bias forces the LED to provide photocurrent, IP1, to servo the input back to a zero volt equilibrium. The bias source can be as simple as a series resistor connected to Vcc. Best stability and minimum offset drift is achieved when a good quality current source is used. Figure 20 shows the amplifier found in Figure 18 including two modified Howland current sources. The first source prebiases the servo amplifier, and the second source is connected to U2's inverting input which matches the input prebias.

Figure 19. Prebiased Photovoltaic Isolation Amplifier Transfer Characteristics

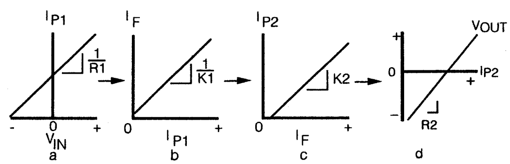


Figure 18. Prebiased Photovoltaic Isolation Amplifier

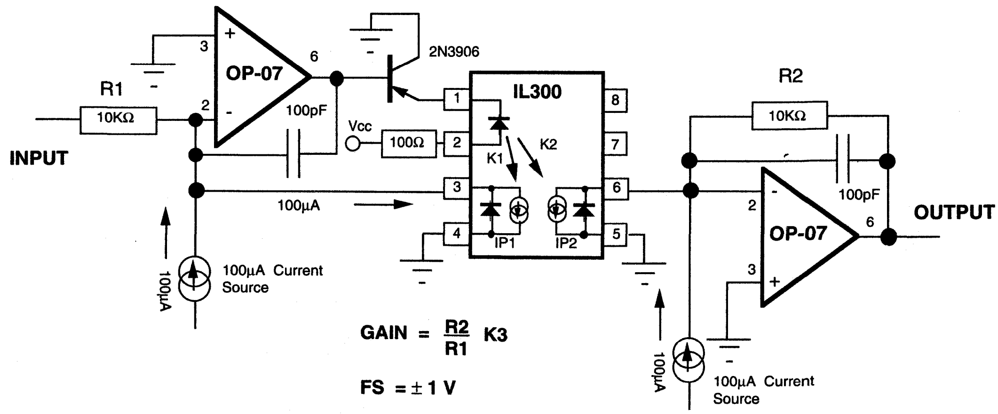


Figure 20. Prebiased Photovoltaic Isolation Amplifier

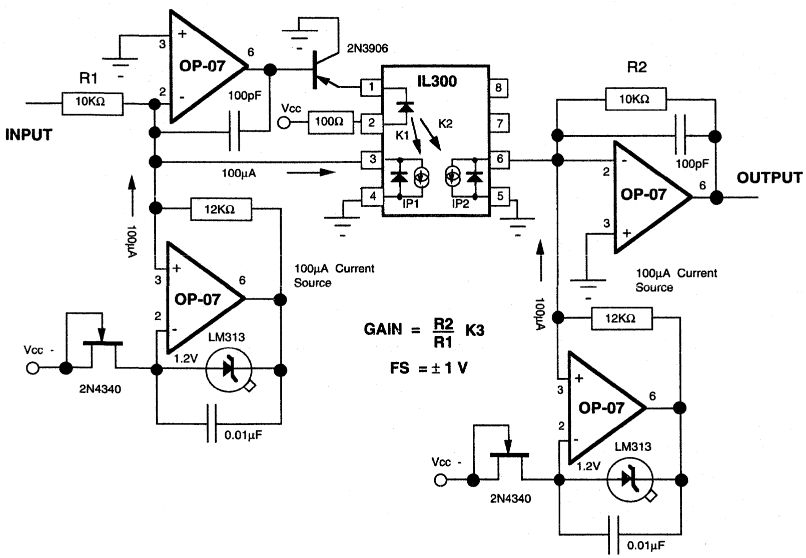
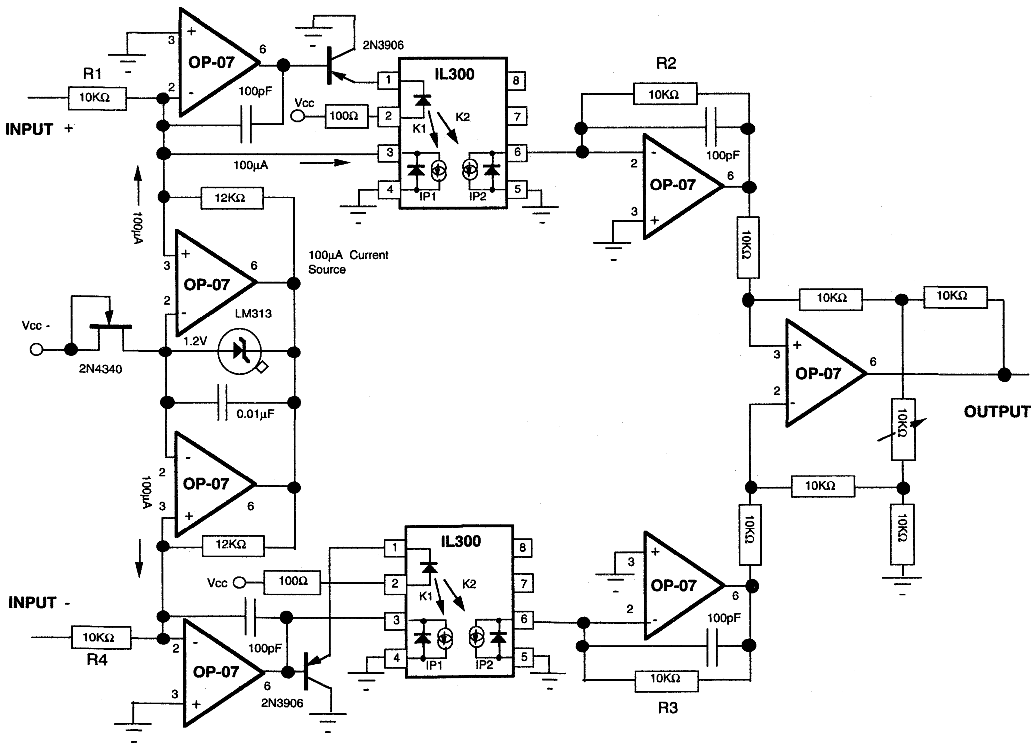


Figure 21. Differential Prebiased Photovoltaic Isolation Amplifier



The previous circuit offers a DC/AC coupled bipolar isolation amplifier. The output will be zero volts for an input of zero volts. This circuit exhibits exceptional stability and linearity. This circuit has demonstrated compatibility with 12 bit A/D converter systems. The circuit's common mode rejection is determined by CMR of the IL300. When higher common mode rejection is desired one can consider the differential amplifier shown in Figure 21.

This amplifier is more complex than the circuit shown in Figure 20. The complexity adds a number of advantages. First the CMR of this isolation amplifier is the product of the IL300 and that of the summing differential amplifier found in the output section. Note also that the need for an offsetting bias source at the output is no longer needed. This is due to differential configuration of the two IL300 couplers. This amplifier is also compatible with instrumentation amplifier designs. It offers a bandwidth of 50KHz, and an extremely good CMR of 140dB at 10KHz.

Photoconductive Isolation Amplifier
The photoconductive isolation amplifier operates the photodiodes with a reverse bias. The operation of the input network is covered in the discussion of K3 and as such will not be repeated here. The photoconductive isolation amplifier is recommended when maximum signal bandwidth is desired.

Unipolar Isolation Amplifier
The circuit shown in Figure 22 is a unipolar photoconductive amplifier and responds to positive input signals. The gain of this amplifier follows the familiar form of Vo/Vin = G = K3 • (R2 / R1). R1 sets the input signal range in conjunction with the servo gain and the maximum output current ,Io, which U1 can source. Given this, $Io_{max} = IF_{max}$. R1 can be determined from Equation 28.

Equation 28: $R1 = Vin_{max} / (K1 \bullet Io_{max})$

The output section of the amplifier is a voltage follower. The output voltage is equal to the voltage created by the output photocurrent times the photodiode load resistor, R2. This resistor is used to set the composite gain of the amplifier as shown in Equation 29.

Equation 29: $R2 = (R1 \bullet G)/K3$

This amplifier is conditionally stable for given values of R1. As R1 is increased beyond 10KΩ, it may become necessary to frequency compensate U1. This is done by placing a small capacitor from U1's output to its inverting input. This circuit uses 741 op-amps and will easily provide 100 KHz or greater bandwidth.

Figure 22. Unipolar Photoconductive Isolation Amplifier

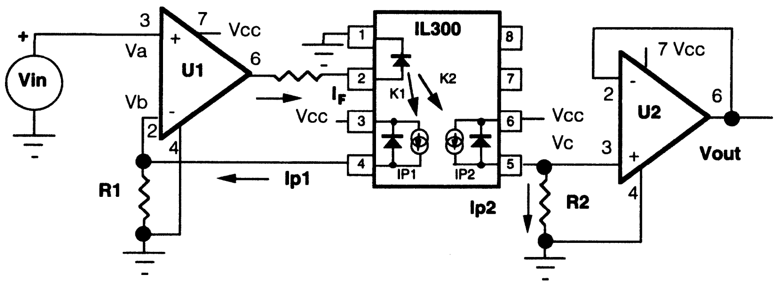
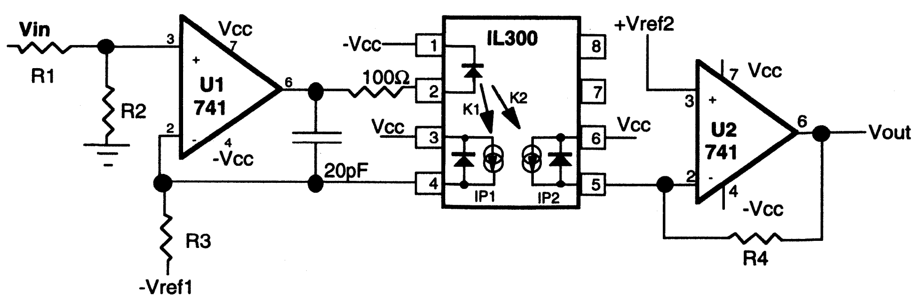


Figure 23. Bipolar Photoconductive Isolation Amplifier



Bipolar Isolation Amplifier

Many applications require the isolation amplifier to respond to bipolar signals. The generic inverting isolation amplifier shown in Figure 23 will satisfy this requirement. Bipolar signal operation is realized by prebiasing the servo loop. The prebias signal, Vref1, is applied to the inverting input through R3. U1 forces sufficient LED current to generate a voltage across R3 which satisfies U1's differential input requirements. The output amplifier, U2, is biased as a transresistance amplifier. The bias or offset, Vref2, is provided to compensate for bias introduced in the servo amplifier.

Much like the unipolar amplifier, selecting R3 is the first step in the design. The specific resistor value is set by the input voltage range, reference voltage, and the maximum output current, Io, of the op-amp. This resistor value also affects the bandwidth and stability of the servo amplifier.

The input network of R1 and R2 form a voltage divider. U2 is configured as a inverting amplifier. This bipolar photoconductive isolation amplifier has a transfer gain given in Equation 30.

Equation 30: $\frac{Vout}{Vin} = -\frac{K3 \bullet R4 \bullet R2}{R3\,(R1 + R2)}$

Equation 31 shows the relationship of the Vref1 to Vref2.

Equation 31: $Vref2 = (Vref1 \bullet R4)/R3$

Another bipolar photoconductive isolation amplifier is shown in Figure 24. It is designed to accept an input signal of ±1 V and uses inexpensive signal diodes as reference sources. The input signal is attenuated by a 50% by a voltage divider formed with R1 and R2. The solution for R3 is given in Equation 30.

Equation 30: $R3 = (0.5 \bullet Vin_{max} + Vref1)/(IF \bullet K1)$

For this design R3 equals 30KΩ.

The output transresistance, is selected to satisfy the gain requirement of the composite isolation amplifier. With K3 = 1, and a goal of unity transfer gain, the value of R4 is determined by Equation 33.

Equation 33: $R4 = (R3 \bullet G \bullet (R1 + R2)) / (K3 \bullet R2)$
$R4 = 60\ K\Omega$

From Equation 31, Vref2 is shown to be twice Vref1. Vref2 is easily generated by using two 1N914 diodes in series.

This amplifier is simple and relatively stable. When better output voltage temperature stability is desired, consider the isolation amplifier configuration shown in Figure 25. This amplifier is very similar in circuit configuration except that the bias is provided by a high quality LM313 band gap reference source.

This circuit forms a unity gain non-inverting photoconductive isolation amplifier. Along with the LM113 references and low offset OP-07 amplifiers the circuit replaces the 741 opamps. A 2N2222 buffer transistor is used to increase the OP-07's LED drive capability. The gain stability is set by K3, and the output offset is set by the stability of OP-07s and the reference sources.

Figure 26 shows a novel circuit that minimizes much of the offset drift introduced by using two separate reference sources. This is accomplished by using a optically coupled tracking reference technique. The amplifier consists of two optically coupled signal paths. One IL300 couples the input to the output. The second IL300 couples a reference voltage generated on the output side to the input servo amplifier. This isolation amplifier uses dual opamps to minimize parts count. Figure 26 shows the output reference being supplied by a voltage divider connected to Vcc. The offset drift can be reduced by using a band gap reference source to replace the voltage divider.

Figure 24. Bipolar Photoconductive Isolation Amplifier

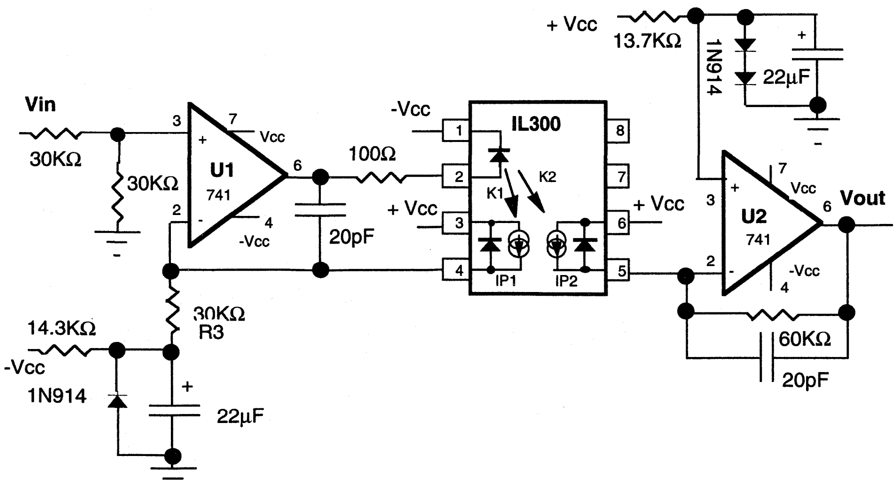


Figure 25. High Stability Bipolar Photoconductive Isolation Amplifier

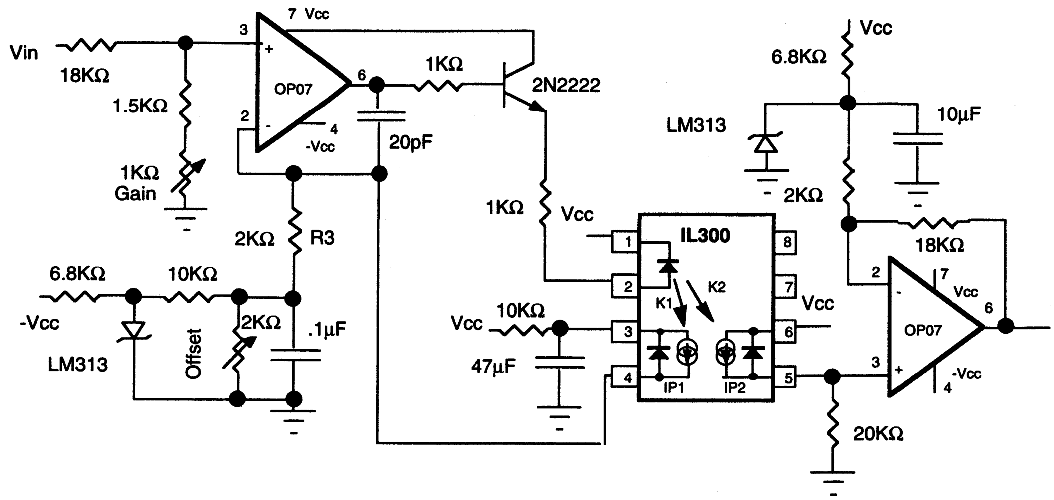
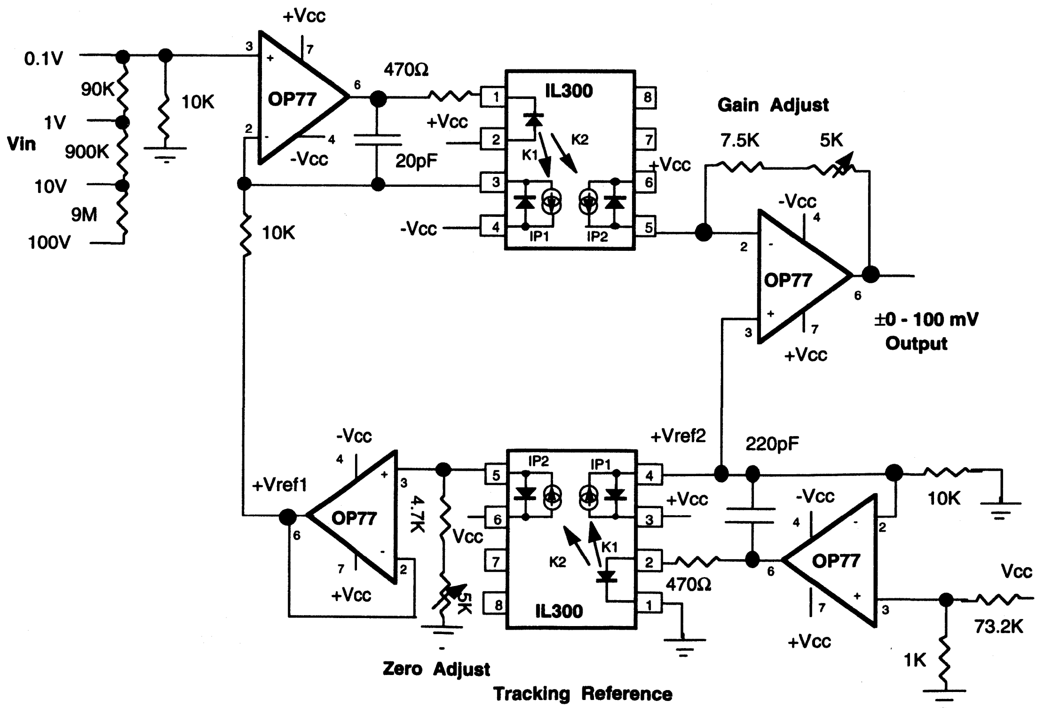


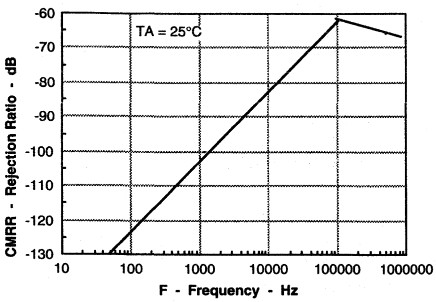
Figure 26. Bipolar Photoconductive Isolation Amplifier with Tracking Reference



Differential Photoconductive Isolation Amplifier

One of the principal reasons to use an isolation amplifier, is to reject electrical noise. The circuits presented thus far are of a single ended design. The common mode rejection, CMRR, of these circuits is set by the CMRR of the coupler and the bandwidth of the output amplifier. The typical common mode rejection for the IL300 is shown in Figure 27.

Figure 27. Common Mode Rejection



The CMRR of the isolation amplifier can be greatly enhanced by using the CMRR of the output stage to its fullest extent. This is accomplished by using a differential amplifier at the output that combines optically coupled differential signals. The circuit shown in Figure 28 illustrates the circuit.

Opamps U1 and U5 form a differential input network. U4 creates a 100 μA, I_S, current sink which is shared by each of the servo amplifiers. This bias current is divided evenly between these two servo amplifiers when the input voltage is equal to zero. This division of current creates a differential signal at the output photodiodes of U2 and U6. The transfer gain, Vout/ Vin, for this amplifier is given in Equation 34.

Equation 34:

$$\frac{Vout}{Vin} = \frac{R4 \bullet R2 \bullet K3(U5) + R3 \bullet R1 \bullet K3(U2)}{2 \bullet R1 \bullet R2}$$

The offset independent of the operational amplifiers is given in Equation 35.

Equation 35:

$$Voffset = \frac{Is \bullet [R1 \bullet R3 \bullet K3(U2) - R2 \bullet R4 \bullet K3(U5)]}{R1 + R2}$$

Equation 35 shows that the resistors, when selected to produce equal differential gain, will minimize the offset voltage, Voffset. Figure 29 illustrates the voltage transfer characteristics of the prototype amplifier. The data indicates the offset at the output is -500 μV when using 1 KΩ 1% resistors.

Figure 28. Differential Photoconductive Isolation Amplifier

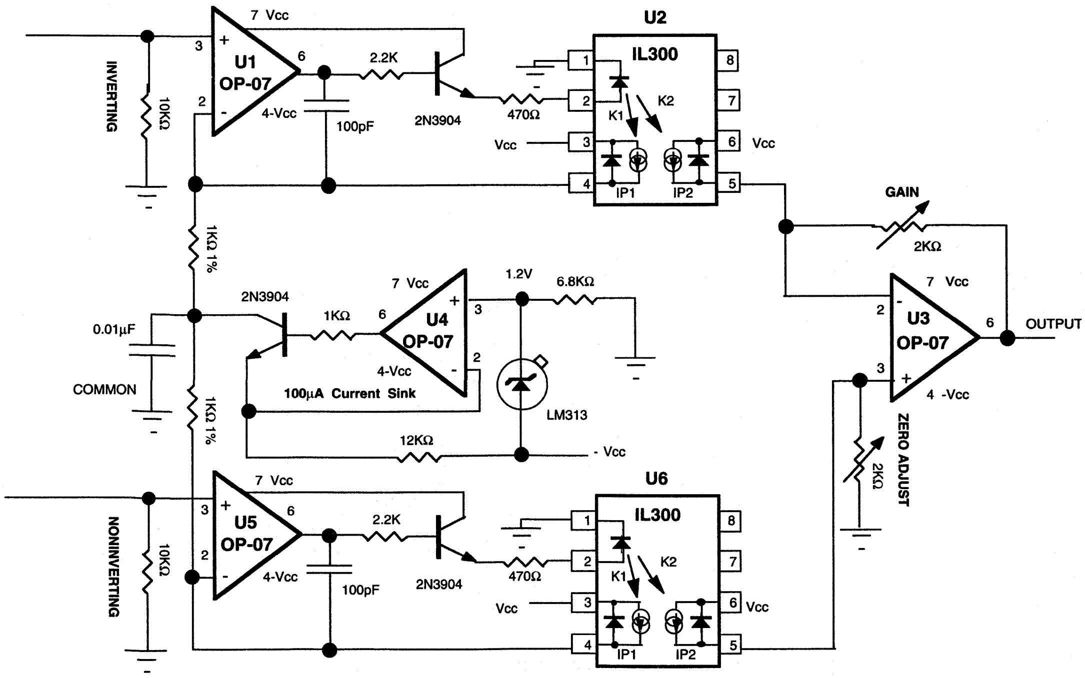
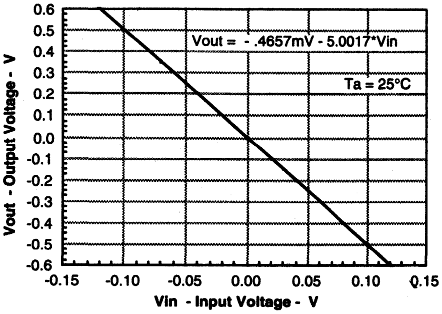


Figure 29. Differential Photoconductive Isolation Amplifier Transfer Characteristics



Discrete Isolation Amplifier

A unipolar photoconductive isolation amplifier can be constructed using two discrete transistors. Figure 30 shows such a circuit. The servo node, Va, sums the current from the photodiode and the input signal source. This control loop keeps Va constant. This amplifier was designed as a feedback control element for a DC power supply. The DC and AC transfer characteristics of this amplifier are shown in Figures 31 and 32.

Figure 31. Transistor Unipolar Photoconductive Isolation Amplifier Transfer Characteristics

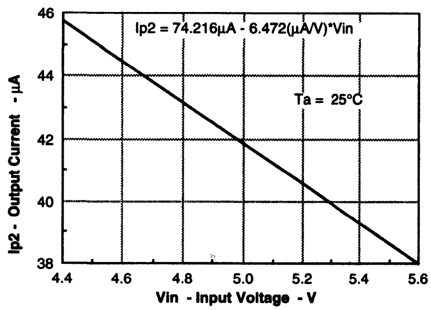
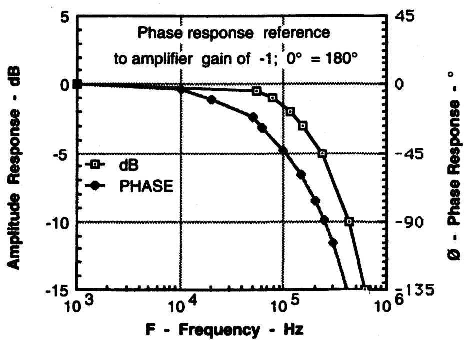


Figure 32. Transistor Unipolar Photoconductive Isolation Amplifier Frequency and Phase Response

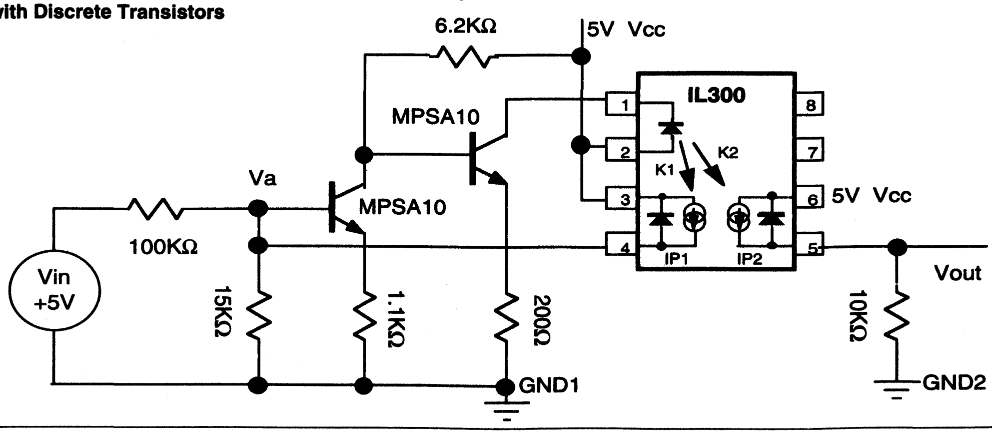


CONCLUSION

The analog design engineer now has a new circuit element that will make the design of isolation amplifiers easier. The preceding circuits and analysis illustrate the variety of isolation amplifiers that can be designed. As a guide, when highest stability of gain and offset is needed, consider the photovoltaic amplifier. Widest bandwidth is achieved with the photoconductive amplifier. Lastly, the overall performance of the isolation amplifier is greatly influenced by the operational amplifier selected. Noise and drift are directly dependent on the servo amplifier.

The IL300 also can be used in the digital environment. The pulse response of the IL300 is constant over time and temperature. In digital designs where LED degradation and pulse distortion can cause system failure, the IL300 will eliminate this failure mode.

Figure 30. Unipolar Photoconductive Isolation Amplifier with Discrete Transistors



SUPPLEMENTAL INFORMATION

PHOTODETECTOR OPERATION TUTORIAL

Photodiode Operation and Characteristics

The photodiodes in the IL300 are PIN (**P**-material - **I**ntrinsic material - **N**-material) diodes. These photodiodes convert the LED's incident optical flux into a photocurrent. The magnitude of the photocurrent is linearly proportional to the incident flux. The photocurrent is the product of the diode's responsivity ,S_I , (A/W), the incident flux,E_e (W/mm^2), and the detector area A_D, (mm^2). This relationship is shown below:

Equation 1a: $I_P = S_I \bullet E_e \bullet A_D$

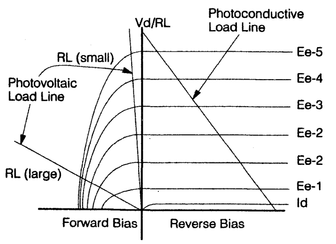
Photodiode I/V Characteristics

Reviewing the photodiode's current /voltage characteristics aids in understanding the operation of the photodiode,when connected to an external load. The I-V characteristics are shown in Figure 1a. The graph shows that the photodiode will generate photocurrent in either forward biased (photovoltaic), or reversed biased (photoconductive) mode.

In the forward biased mode the device functions as a photovoltaic, voltage generator. If the device is connected to a small resistance, corresponding to the vertical load line, the current output is linear with increases in incident flux. As R_L increases, operation becomes nonlinear until the open circuit (load line horizontal) condition is obtained. At this point the open circuit voltage is proportional to the logarithm of the incident flux.

In the reverse biased (photoconductive mode), the photodiode generates a current that is linearly proportional to the incident flux. Figure 1a illustrates this point with the equally spaced current lines resulting from linear increase of E_e. The photocurrent is converted to a voltage by the load resistor R_L. Figure 1a also shows that when the incident flux is zero (E_e =0), a small leakage current, or dark current (I_D) will flow.

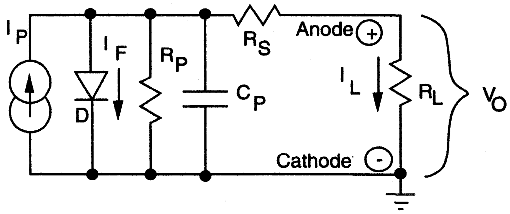
Figure 1a. Photodiode I/V Characteristics



Photovoltaic Operation

Photodiodes, operated in the photovoltaic mode, generate a load voltage determined by the load resistor,R_L, and the photocurrent, I_P. The equivalent circuit for the photovoltaic operation is shown in Figure 2a. The photodiode includes a current source (I_P), a shunt diode (D), a shunt resistor (R_P), a series resistor (R_S), and a parallel capacitor (C_P). The intrinsic region of the PIN diode offers a high shunt resistance resulting in a low dark current, and reverse leakage current.

Figure 2a. Equivalent Circuit—Photovoltaic Mode

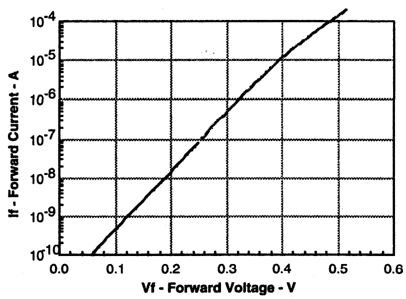


The output voltage,Vo, can be determined through nodal analysis. The circuit contains two nodes. The first node ,V_F, includes the photocurrent generator, I_P, the shunt diode, D, shunt resistor (R_P), and parallel capacitance, C_P. The second node, V_O, includes: the series resistor, R_S, and the load resistor, R_L. The diode, D, in the VF node is responsible for the circuit's nonlinearity. The diode's current voltage relationship is given in Equation 2a.

Equation 2a: $I_F = I_S \bullet [EXP(V_F / K) - 1]$

This graphical solution of 2a for the IL300 is shown in Figure 3a.

Figure 3a. Photodiode Forward Voltage vs. Forward Current



Inserting the diode Equation 2a, into the two nodal equations gives the following DC solution for the photovoltaic operation (Equation 3a):

Equation 3a

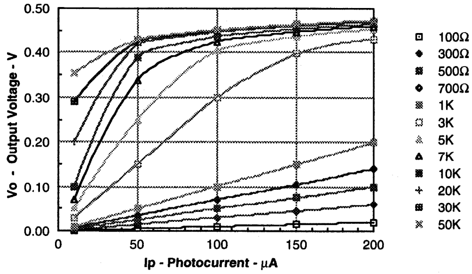
$0 = I_P - I_S \bullet \{ EXP[V_O \bullet (R_S+R_L)/K \bullet R_L] -1\} - V_O \bullet [(R_S+R_L+R_P)/R_P \bullet R_L]$

Typical IL300 values:

I_S = 13.94 •10^-12
R_S = 50Ω
R_P = 15GΩ
K = 0.0288

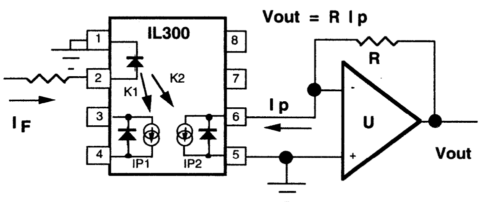
By inspection, as R_L approaches zero ohms the diode voltage,VF, also drops. This indicates a small diode current. All of the photocurrent will flow through the diode series resistor and the external load resistor. Equation 3a was solved with a computer program designed to deal with nonlinear transcendental equations. Figure 4a illustrates the solution.

Figure 4a. Photovoltaic Output vs. Load Resistance and Photocurrent



This curve shows a series of load lines, and the output voltage,Vo, caused by the photocurrent. Optimum linearity is obtained when the load is zero ohms. Reasonable linearity is obtained with load resistors up to 1000 ohms. For load resistances greater than 1000Ω, the output voltage will responed logarithmically to the photocurrent. This response is due to the nonlinear characteristics of the intrinsic diode, D. Photovoltaic operation with a zero ohm load resistor offers the best linearity and the lowest dark current, I_D. This operating mode also results in the lowest circuit noise. A zero load resistance can be created by connecting the photodiode between the inverting and non-inverting input of a transresistance operational amplifier, as shown in Figure 5A.

Figure 5a. Photovoltaic Amplifier Configuration



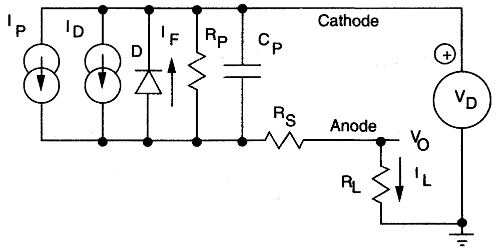
Photoconductive Operation Mode

Isolation amplifier circuit architectures often load the photodiode with resistance greater than zero ohms. With non-zero loads, the best linearity is obtained by using the photodiode in the photoconductive or reverse bias mode. Figure 6a shows the photodiode operating in the photoconductive mode. The output voltage, Vo, is the product of the photocurrent times the load resistor.

The reverse bias voltage causes a small leakage or dark current, ID, to flow through the diode. The output photocurrent and the dark current, sum the load resistor. This shown in Equation 4a.

Equation 4a: $V_L = R_L \bullet (I_P + I_D)$

Figure 6a. Photoconductive Photodiode Model



The dark current depends on the diode construction, reverse bias voltage and junction temperature. The dark current can double every 10°C. The IL300 uses matched PIN photodiodes that offer extremely small dark currents, typically a few picoamps. The dark current will usually track one another, and their effect will cancel each other when a servo amplifier architecture is used. The typical dark current as a function of temperature and reverse voltage is shown in Figure 7a.

The responsivity, S, of the photodiode is influenced by the potential of the reverse bias voltage. Figure 8a shows the responsivity percentage change versus bias voltage. This graph is normalized to the performance at a reverse bias of 15 volts. The responsivity is reduced by 4% when the bias is reduced to 5 volts.

Figure 7a. Dark Current vs. Reverse Bias

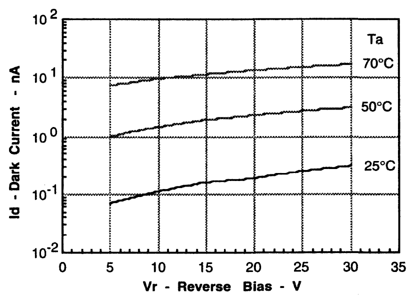
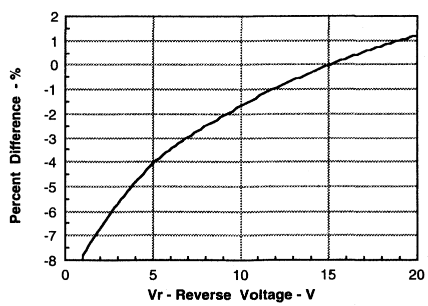


Figure 8a. Photoconductive Responsivity vs. Bias Voltage



The photodiode operated in the photoconductive mode is easily connected to an operational amplifier. Figure 9a shows the diode connected to a transresistance amplifier. The transfer function of this circuit is given in Equation 5a.

Equation 5a: $V_{out} = R \bullet (I_P + I_d)$

Bandwidth Considerations

PIN photodiodes can respond very quickly to changes in incident flux. The IL300 detectors respond in tens of nanoseconds. The slew rate of the output current is related to the diodes junction capacitance, Cj, and the load resistor, R. The product of these two elements set the photo-response time constant.

Equation 6a: $\tau = R \bullet Cj$

This time constant can be minimized by reducing the load resistor, R, or the photodiode capacitance. This capacitance is reduced by depleting the photodiode's intrinsic region, **I**, by applying a reverse bias. Figure 10a illustrates the effect of photodiode reverse bias on junction capacitance.

Figure 9a. Photoconductive Amplifier

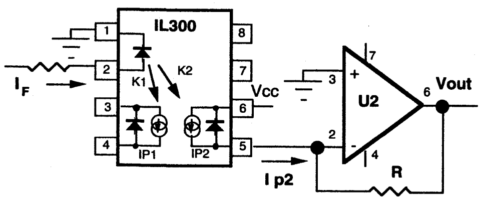
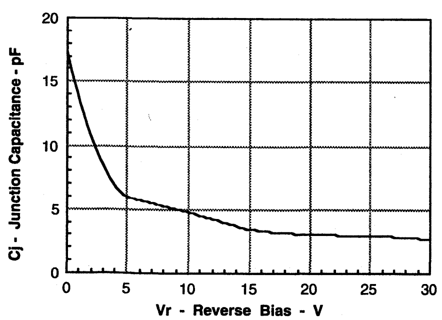
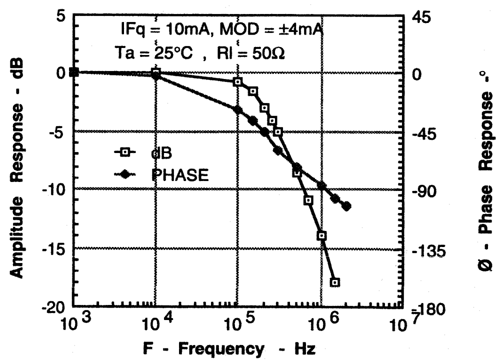


Figure 10a. Photodiode Junction Capacitance vs. Reverse Voltage



The zero biased photovoltaic amplifier offers a 50 KHz-60 KHz usable bandwidth. When the detector is reverse biased to -15 V, the typical isolation amplifier response increases to 100-150 KHz. The phase and frequency response for the IL300 is presented in figure 11a. When maximum system bandwidth is desired, the reverse biased photoconductive amplifier configuration should be considered.

Figure 11a. Phase and Frequency Response



Application Notes 11

SIEMENS

Applications of Surface Mount LEDs
Appnote 51

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Frank Möllmer, Günther Waitl
Siemens AG, Semiconductor Group, Munich, Germany

SMT Replaces Through Hole Technology

The use of SMT-TOPLED™ varies greatly from the use of traditional through hole LEDs. Historically through hole LEDs have been incorporated directly into front panels using the leads as a stand off (Figure 1).

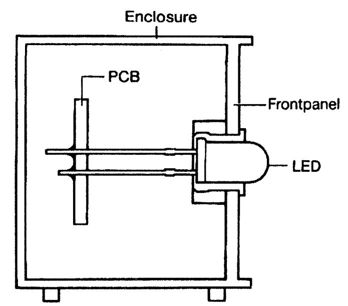

Figure 1. Typical through hole LED mounting.

Due to the automated nature of SMT assembly, and the size constraints of SMT component and assemblies, SMT-TOPLED™ applications are different from through hole applications. For SMT applications the LED is often 1 0 mm or more from the front panel (Figure 2). Employing light pipes can create the optimum display to the final viewer. Because of the size and radiation pattern of the Siemens/Hewlett-Packard SMT-TOPLED™ the final light emitting surfaces can be created in almost any shape. Lenses can also be combined with SMT-TOPLED™ . Because of the uniform repeatable radiation pattern, the lens design can be matched to the exact customer requirements. Additional applications include backlighting of symbols and liquid crystal displays.

Applications

Of course the simplest way of using the new SMT-TOPLED™ is in a direct view application. Efficient optical design ensures that further optics are not required. Direct view applications include simple displays and moving message boards. Figures 3 and 4 show these examples.

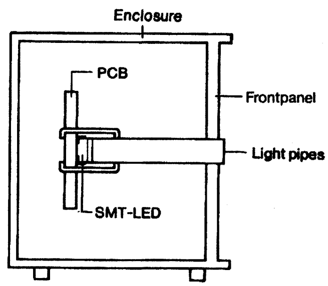

Figure 2. SMT TOPLED™ with light pipe to front panel

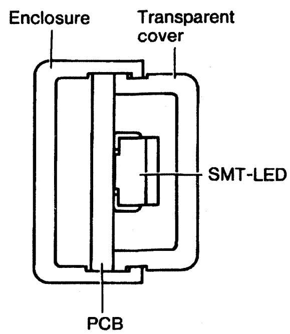

Figure 3. Direct view application of SMT-TOPLED™.

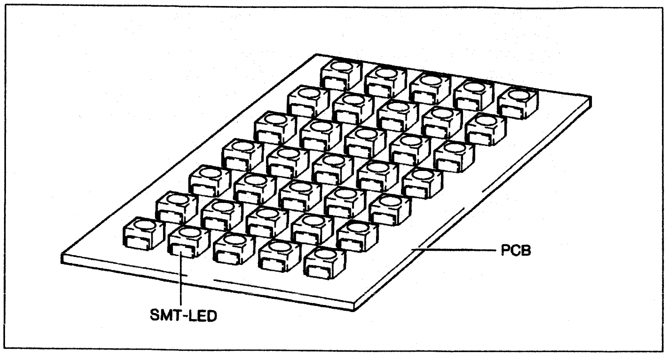

Figure 4. Moving message board with SMT-TOPLED™

In direct view applications, the following features are of particular advantage:

- Defined, rounded light emitting area
- Uniform illumination
- Large, uniform radiation pattern
- Due to the optical and package design, the performance of the package is very robust.
- Misplacement and tilting will not adversely affect the optical performance.

All these applications are addressed with the same SMT-TOPLED™ design. For the user this means simplified design and standardized assembly. This improved optical design freedom is an additional benefit of the new SMT-TOPLED™.

Light Pipes
A major application of the new SMT-TOPLED™ will be with light pipes. Figure 5 shows some possible designs.

By using light pipes, the distances between boards and front panels can be bridged and almost any luminous area or picture can be produced. The light emitted from a light pipe does not need to be directly above the SMT-TOPLED™. By making use of the critical angle of an optical system, (based on total internal reflection), or with mirrored reflectors, the light can be deflected to any angle with only minimal losses. Figure 6 illustrates one example

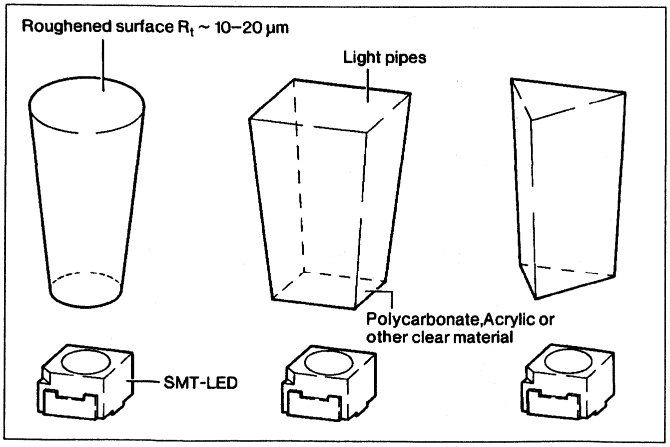

Figure 5. Light pipes used in conjunction with SMT-TOPLED™

Multi Color Light Pipes
By coupling LEDs of different wavelengths (colors) into the same light pipe it is possible to have either multicolor capability, or new colors formed by the combination of the existing colors (Figure 7).

Bridging the distance between PC boards and front panels by an electrically non conducting light pipe automatically produces protection for electronics against ESD or for users against high voltage.

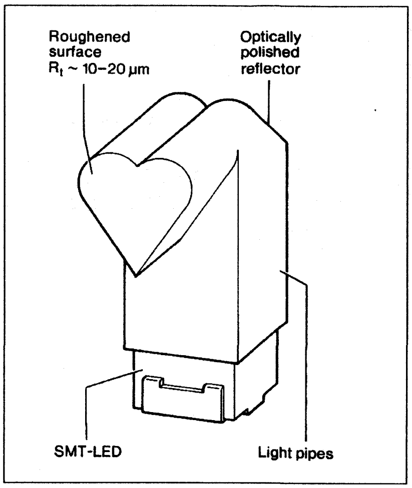

Figure 6. Right angle light pipe.

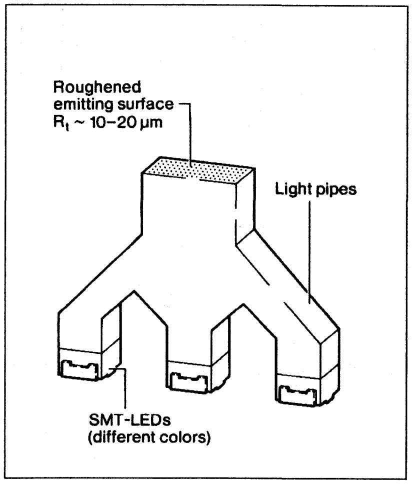

Figure 7. Light pipe used to form a multicolor indicator

Backlighting

Backlighting of legends and LCDs is a major application possibility for this new SMT-TOPLED™ design. There are three ways of getting the light from the LED to the backlighting area.

- Direct use of SMT-TOPLED™
- Incorporating reflectors
- Incorporating large area light pipes

Direct use is appropriate for low total height applications such as membrane keyboards. Because of the uniform, wide emission angel, surfaces with heights of 2 to 3 mm can be illuminated uniformly without any additional measures (Figure 8).

If more height is available or required and larger surfaces are to be illuminated, such as car dashboards, the SMT-TOPLED™ can be combined with external reflectors. In this way both single legends (Figure 9) and surfaces of any size can be backlit brightly and uniformly (Figure 10). A reflector/SMT-TOPLED™ combination is advantageous for backlighting positive and negative LCDs as sufficient brightness is produced with only a few LEDs.

If the assembly does not leave space for an external reflector, legends and LCDs can be backlit with flat light pipes. In this way it is possible to produce backlighted units of only a few mm height. Figure 11 illustrates backlighting for a LCD display where the LCD is at a right angle to the LED board.

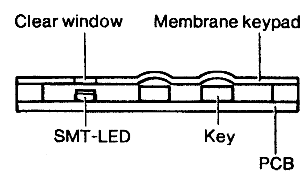

Figure 8. LED behind membrane keypad.

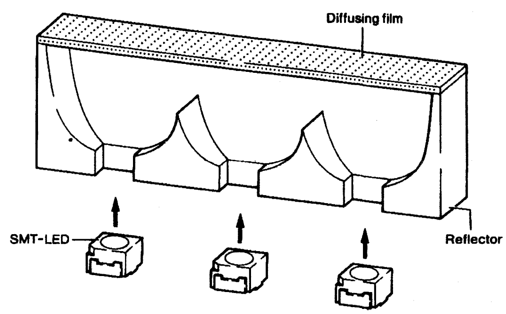

Figure 10. SMT- TOPLED™ illuminating a large area.

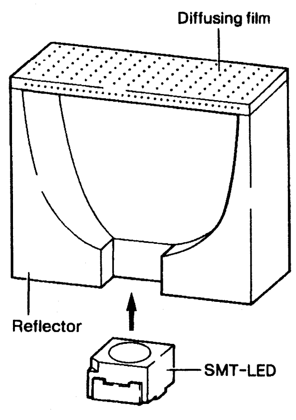

Figure 9. SMT-TOPLED™ illuminating a reflecting cavity.

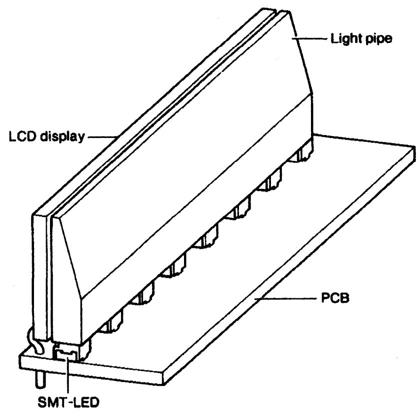

Figure 11. LEDs backlighting an LCD display with a right angle light pipe.

Figure 12 and 13 outline locations in which the LCD is parallel to the LEDs. In Figure 13 the light couples into the light pipe on both sides to increase brightness or illuminate a large area.

Lenses

The common through hole LED standards of 3 mm and 5 mm diameter emit light through a lens integrated into the package. Different radiation patterns are produced depending on the die and lens spacing and the shape of the lens. With straight forward design lenses can be produced to couple with the SMT-TOPLED™ to emit light at any required angle or pattern (Figure 14).

Using an external lens can change both the on axis intensity and the viewing angle. For example it is possible to change the typical light output from an Iv of 6 mcd and a viewing angle to 120 degrees to an Iv of 1 8 mcd and a viewing angle of 60 degrees, or even to an Iv of 40 mcd with a viewing angle of 30 degrees (Figures 15 & 16).

Exercise proper care in the design of the light pipes for optimum coupling of the light emitted by the SMT-TOPLED™ to the final viewer. Tests have shown that with proper design and care more than 90% of the light can be transmitted by the light pipe. The design guidelines for light pipes are effectively covered by existing application notes, common literature associated with fiber optics as well as most texts covering optics. Both Hewlett-Packard and Siemens have advanced ray tracing programs and services.

HP and Siemens will give application support for design and manufacturing of boards incorporating SMT-TOPLED™ . Clarification of the optical and electrical needs for each application are the first step in the support process.

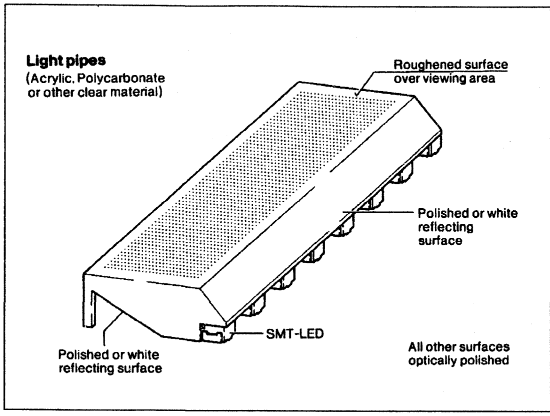

Figure 12. LCD backlighting configuration.

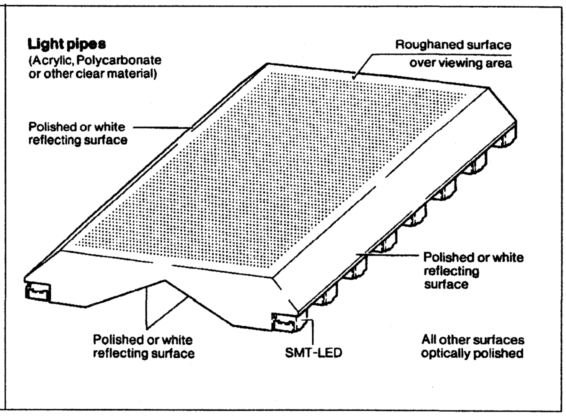

Figure 13. Improved brightness for LCD backlighting.

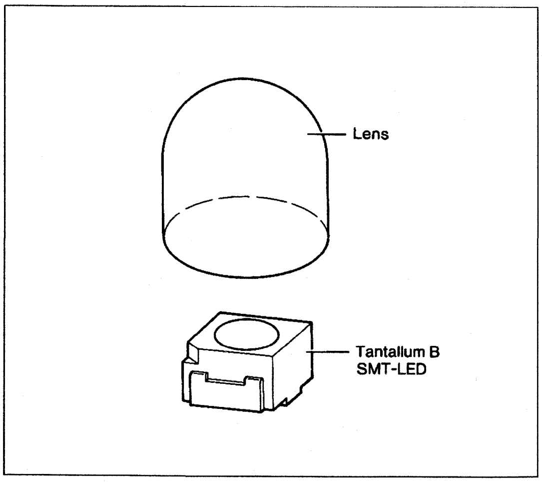

Figure 14. LED with lens.

Application Notes 11

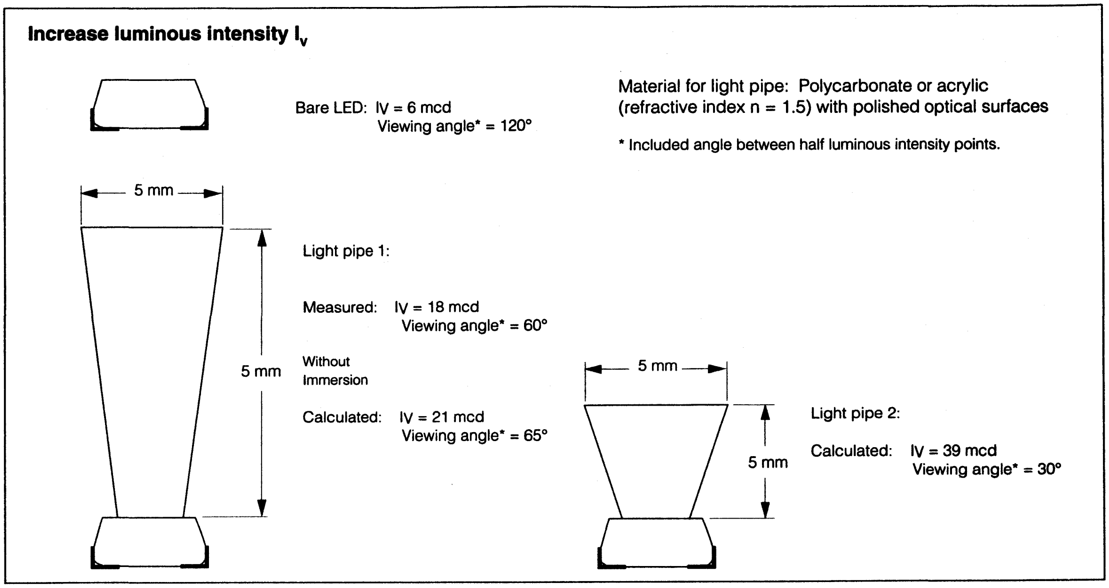

Figure 15. Different light pipe configurations.

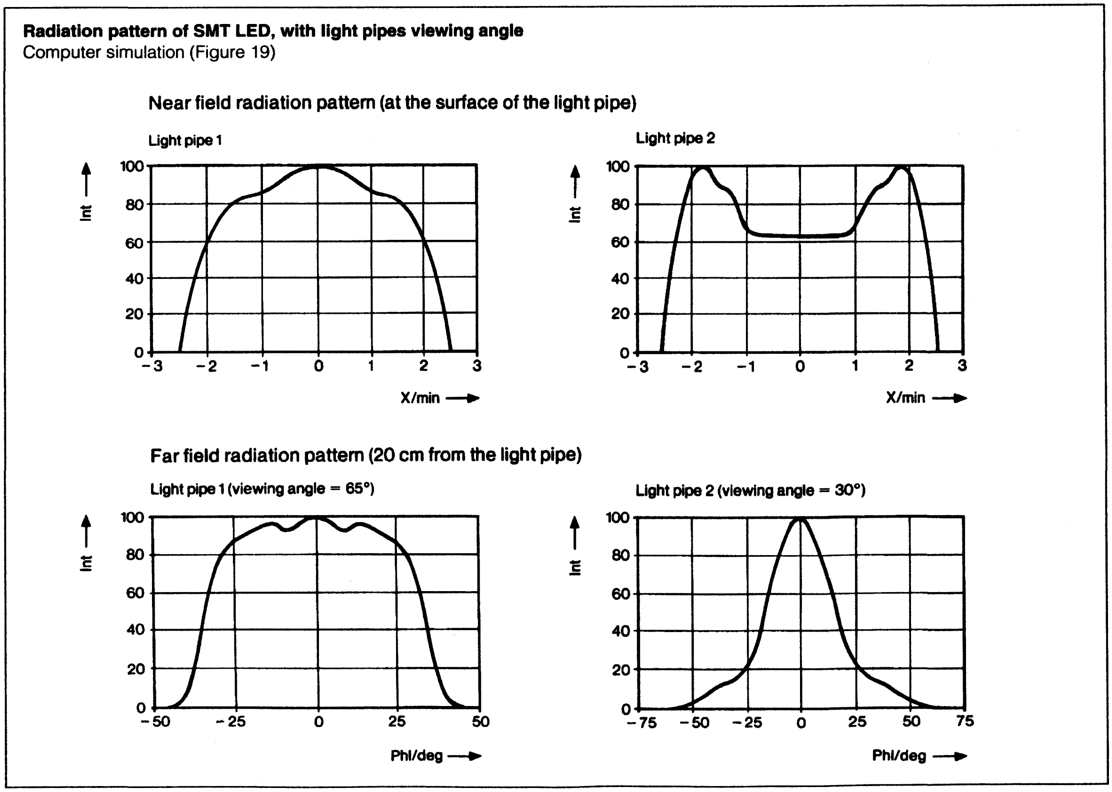

Figure 16. Computer simulation of radiation patterns of SMT-TOPLED™ with light pipes.

Designing with Surface Mount LEDs

The evolution from through hole technology to SMT demands surface mount optoelectronic components. HP and Siemens have addressed this need by creating a SMT standard for LEDs. The advantages to the user of using SMT-TOPLED™ are many:

- Lower PC board costs: reduced area, less drilling, fewer plated through holes
- Quality, time and cost improvement through automatic placement
- Components packaged in standard tape and reel
- Standard package allows for ease of landing pad design
- Low component height compared to through hole
- Uniformly placed components
- Uniform soldering techniques
- Improvement in reliability
- More flexibility during assembly
- Assembly processes compatible with active and passive components

SMT LED Design

Figure 17 shows a cross sectional view of the SMT-TOPLED™. High temperature thermoplastic is insert molded around a continuously stamped lead frame. Selection criteria for the plastic material included mechanical and thermal characteristics, and its high value of diffuse reflectance (90% efficient). Optical characteristics were achieved by reflector cavity geometry and the material features. The light output intensity is a factor of 2 greater than the SOT-23 LED with a more usable radiation pattern. A semiconductor die is placed in the prefabricated leadframe/molding assembly. An epoxy resin is used to improve the light output coupling, and seals the reflector cavity for environmental protection. The resin and the package materials were carefully matched to minimize mechanical and thermal stresses during soldering.

SMT Compatibility

Due to the specific and standardized assembly techniques that evolved in SMT, the following list of requirements are essential for a true SMT-TOPLED™.

Pick and Place

- Flat surfaces on LED package
- Tight package tolerances
- Standard dimensions for automation
- Standard tape and reel sizes
- Standard lead bends and finishes

Traditional through hole LEDs lack many if not all of these features. Careful engineering and cooperation with standards setting organizations assures that all of these requirements are met.

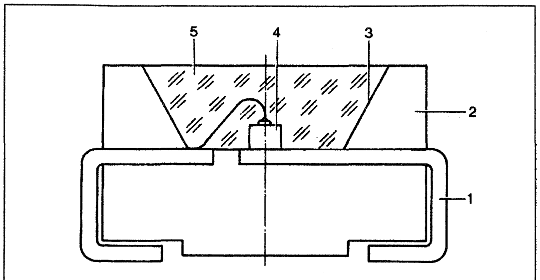

Figure 17. SMT-TOPLED™ cross section.

Soldering

- Infrared Reflow (IR)
- Vapor Phase Reflow (VP)
- Through the Wave Soldering
- (TTW) Solder finished leads for soldering processes
- Standard Landing Pads

Characterization of these processes insured an LED designed to withstand the specific mechanical, thermal, and chemical extremes of each.

Cleaning

- Ethyl Alcohol
- Isopropyl Alcohol
- Aqueous Cleaning solutions
- Solvent Cleaning solutions

Aqueous and organic solvents containing alcohol are suitable for cleaning soldered components to remove the remaining soldering flux. Due to environmental concerns and possible negative effects on the LED package do not use chlorinated hydrocarbons, fluorated hydrocarbons, and ketones.

Optics

- Rounded emitting area
- High on axis intensity
- Wide viewing angle
- Compatible with external optical systems
- Compatible with light pipes
- Suitable for backlighting: legends or LCDs

Siemens has produced LEDs in a SOT-23 package for a number or years. Similarly HP has produced gull wing and yoke lead LEDs for SMT. Experience with these designs formed the foundation for developing a new SMT-TOPLED™. A major objective was improvement of the optical performance with respect to intended SMT applications.

Reliability

Incoming inspection of SMT-TOPLED™ supplied in tape and reel format is difficult for the user. This means that high quality must be assured at incoming inspection in the low parts per million (PPM) defective range. To ensure this the quality departments of the user and the supplier must have effective communication to monitor quality levels and concerns. Working together it is possible to achieve incoming quality levels of better than 10 PPM.

HP and Siemens SMT-TOPLED™ Solution

Figure 18 shows the design of the new SMT-TOPLED™ in a form that matches the Tantalum B molded capacitor. This is from the IEC publication 286 part 3, and from EIA standard IS28. Refer to Table 1 of the last page of this appnote for optical characteristics .

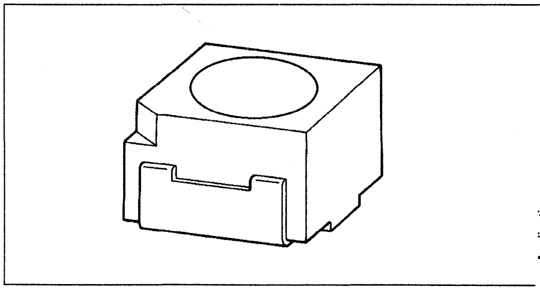

Figure 18. Package drawing of SMT-TOPLED™ .

Features
- EIA and IEC Standard Package
- Standard Lead Bend and Footprint
- Cathode Identification
- Flat top and sides for Pick and Place Compatibility
- High Temperature Thermoplastic Housing for SMT Soldering
- Nonimaging Optical Design for High Intensity Light Output

Close cooperation between Siemens and Hewlett-Packard's Optoelectronic Divisions carried out the development of the SMT-TOPLED™. These two worldwide leaders in optoelectronic components have agreed upon this package standard.

SMT-TOPLED™ Manufacturing
A stable, controlled manufacturing line helps to assure quality (Figure 19). The SMT-TOPLED™ manufacturing line incorporates the latest semiconductor assembly equipment in a "hands off" environment for process quality and repeatability. Decisions which affect quality are made based on statistical data and process capability data. The use of extensive automation eliminates the possibility of random uncontrolled failures in the process. From leadframe manufacturing to final bagging, the SMT-TOPLED™ is never handled by human hands.

Quality and Reliability
With SMT comes a heightened need for

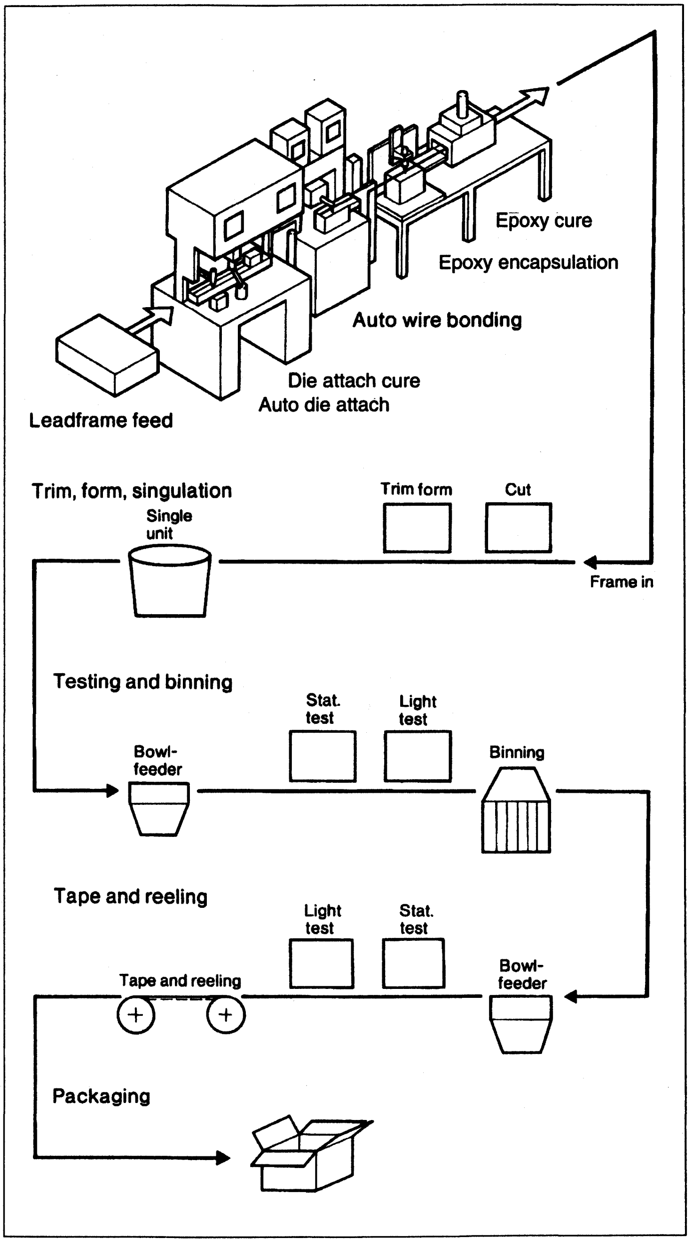

Figure 19. Manufacturing process flow.

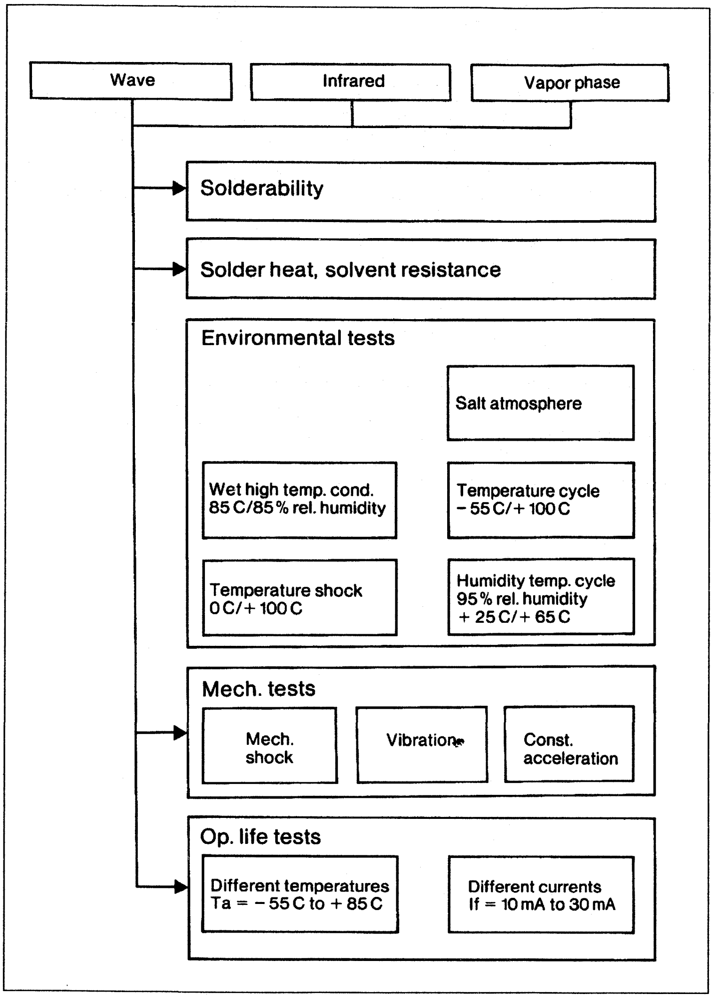

Figure 20. SMT-TOPLED™ qualification tests.

quality and reliability. Cost and complexity of boards demand high yields in SMT assembly. To meet these yields effectively, the components must exhibit outstanding initial quality and long term reliability. Performing stringent qualification testing by the component manufacturer ensures adherence to customers' strict requirements.

Reliability qualification of the SMT-TOPLED™ includes preconditioning of the LEDs before testing. This consists of screen printing adhesive to the test boards, pick and placing the LEDs, and soldering the board through the intended soldering process. On completing preconditioning, the boards' reliability testing may begin. Figure 20 illustrates the qualification tests done on the SMT-TOPLED™.

These tests simulate and accelerate actual user environments. Demanding qualification criteria used in testing assures LED users a guarantee for a product that will function after soldering and long into the future in the field.

SMT-TOPLED™ Performance

Table 1 highlights the important optical and electrical data for the new SMT design. Of special note is the combination of the high on axis intensity (Iv), and the large, uniform radiation pattern characterized by 2 Θ ½ (Figure 21). The uniformity and repeatability of the radiation pattern assure uniform viewing of multiple LEDs in both direct view or through secondary optics.

Conclusion

Through joint design efforts Hewlett-Packard and Siemens have assured true second sourcing of a high quality SMT-TOPLED™ that meets the manufacturabilty and illumination needs of the industry. Work is already under way on IR and detector implementations. It can be expected that further optoelectronic devices such as seven segment displays, light bars, multicolor emitters and sideways emitting LEDs will be standardized in this or a similar technology.

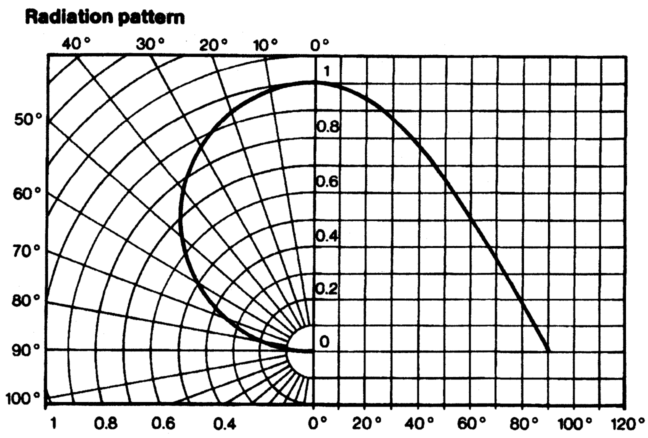

Figure 21. SMT-TOPLED™ radiation patterns.

Table 1: SMT LED Typical Data

Parameter	Symbol	AlGaAs	Red	Orange	Yellow	Green	Unit
Luminous Intensity (If = 10 mA)	Iv	14	6	5	5	8	mcd
Dominant Wavelength (If = 10 mA)	Idom	641	627	605	588	570	nm
Forward Voltage (If = 10 mA)	Vf	1.8	1.9	1.9	1.9	2.0	V
Viewing Angle 2 Θ ½	2 Θ ½	120	120	120	120	120	Degrees
HP Part No.		HSMA T400	HSMS-T400	HSMD-T400	HSMY-T400	HSMG-T400	
Siemens Part No.		LH T674	LS T670	LO T670	LY T670	LG T670	

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Visible and IR LEDs in SMT-TOPLED™ Package— Tape and Reel Packaging Data Appnote 52

Applicable Part Numbers—A Sampling

Visible LEDs

LS T670	High Efficiency Red
LY T670	Yellow
LG T670	Green
LO T670	Orange

IR Emitters/Detectors

SFH320	Phototransistor
SFH320F	Phototransistor with daylight filter
SFH420	GaAs 950 nm IRED

For Automatic Placement

These parts come packaged on 18 cm diameter spools with 1500 pieces/spool. 33 cm spools (7500 pieces) are also available. The tape is compartmentalized and sealed with a foil cover.

Spool/Tape Characteristics

Maximum Storage Temperature .... 40° +5°
C/R-H = 95%/240 hrs.
Tape Tear Resistance (max.) .... ≥10 N
(at right angle to direction of unreeling)
Cover Foil Pull Force .... 0.2 to 1.0 N
(pull speed = 300 mm/min.)

Polarity and Orientation

- Mounting surface (bottom) on bottom of tape compart ment
- All devices are oriented in one direction

Reel Marking

All reels are marked with manufacturer's name, part number, date code, and order number.

Parameter	Symbol	Dimensions (mm)	Notes
Tape Width	W	8 ±0.3	
Carrier Tape Thickness	t	0.3 max.	
Sprocket Hole Pitch	P_0	4 ±0.1	Cumulative pitch error, ±0.5 mm pitches
Sprocket Hole Diameter	D_0	1.5 +0.1	
Sprocket Hole Distance	E	1.75 ±0.1	
Component Position	F P_2	3.5 ±0.05 2 ±0.05	Center hole to center compartment
Component to Component Position	P3	4	
Compartment Dimensions	K	3 max.	See individual component for exact dimensions
	OL	15° max.	
	R_1, R_2	0.5 max.	
	H_0	0.3 +0.1/-0.05	Between inner side or the compartment bottom and the reference level for measur ing A_0, B_0
	A_0 B_0		Tolerances chosen so that the components can change their orientation, but can easily be removed from the tape.
Hole in Compartment	D_1	1 +0.2	Tolerance to the center or sprocket hole: ±0.1 mm
Fixing Tape Width Device Tilt in Compartment	W_1 d	5.5 typ. 0.1 max. 15° max.	Fixing tape not to cover srocket holes, nor protrude beyond carrier tape so not to exceed max. tape width
Bending Radius	R	25 min.	

SIEMENS

Optocouplers Isolate Modem Data Access Arrangement Appnote 53

by Bob Krause

Lap Top, Palm Top, and Pen Based computer modem manufactures are seeking ways to accommodate the small form factor of the PCMCIA peripheral cards. They are looking for devices to replace the bulky magnetic and electromechanical components normally found in the modem's telco line interconnection. Modem supplier have found that optocouplers satisfy both the space and performance needs of a PCMCIA format Fax/Modem product.

This application note describes various DAA circuit architectures*. It shows how the Linear Optocoupler, IL350, is used to isolate the modem signal, provide ring detection, and OFF/Hook operation. The IL350 offers the PCMCIA modem designer a small package with wide signal bandwidth and high insulation and isolation.

Data Access Arrangement–DAA

Figure 1 shows the block diagram of the Data-Access Arrangement (DAA) direct connect modem. The line interconnect section consists of the OFF/Hook relay, Ring Detector, Signal Isolation, Line Current Sink, and Surge Protection. An optically coupled FET switch, such as the LH1056, is commonly used for OFF/Hook switching. Ringer signal sensing is done by phototransistor optocouplers such as 4N35 or ILD255.

Optical 2-4 Wire Hybrid

Replacing the 600 Ω transformer is the most obvious application of the IL350. When a single baud rate modem is being designed, the IL350 can provide line isolation and also can function as the 2-4 wire hybrid.

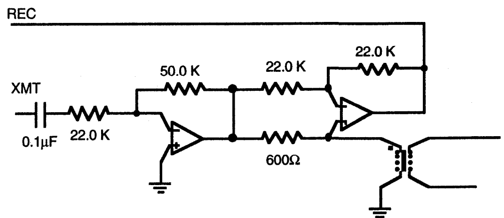

Figure 2. 2-4 Wire Electronic Hybrid

A typical transformer coupled 2-4 wire electronic hybrid is shown in Figure 2. This circuit provides transmitted tone cancellation, while supplying a –3dBm transmit level, and receiver sensitivity for a –42 dBm signal. It offers a 600 Ω termination impedance to the telco transformer in both transmit and receive function. The hybrid function is provided by U2. When a telco signal is being received the transformer sees a 600 Ω load, R3,

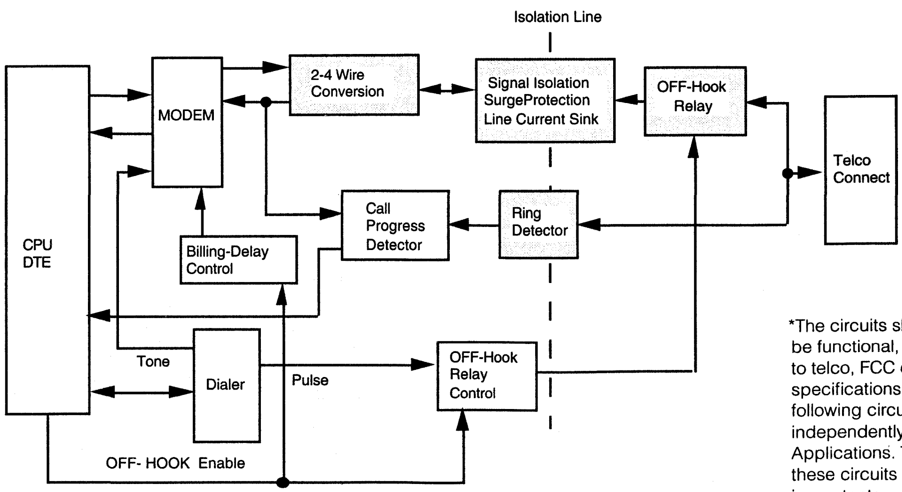

Figure 1. DAA–Direct Connect Modem

*The circuits shown are believed to be functional, however compliance to telco, FCC or other government specifications is not guaranteed. The following circuits were developed independently by Siemens OED Applications. The interconnection of these circuits may infringe on existing patents.

terminated to virtual ground. U2 amplifies the receive signal across R3 with a gain specified by the values of R1 and R4. The modem's transmit signal is canceled by U2's differential amplifier action. The amplifier inverting gain is set so that the feedback signal is equal and 180° out of phase to the transmit signal level arriving at U2's non-inverting input. R1 is selected to set U2's gain. The magnitude of transmit tone cancellation is described in Equation 1. Optimum tone cancellation is achieved when R3=R2 and R1=R4.

$$\text{Transmit suppression}(\text{dB}) = 20\,\text{Log}\left(\text{Abs}\left[\frac{R1+R4}{R1}\left(\left(\frac{R3}{R1+R3}\right)-\left(\frac{R4}{R1+R4}\right)\right)\right]\right)$$

Equation 1.

Figure 3 is a block diagram of an optical transformer connected between the output U1 and the non-inverting input U2. By introducing two unity gain isolation amplifiers in this path, it is possible to isolate the 600 Ω line termination resistor while preserving the hybrid's tone cancellation feature. Figure 4 is a detail of Figure 3.

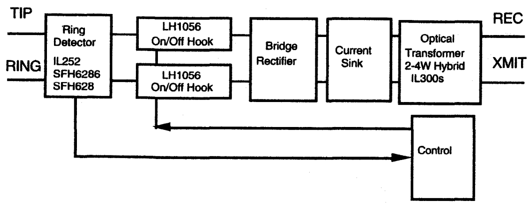

Figure 3. DDA/2

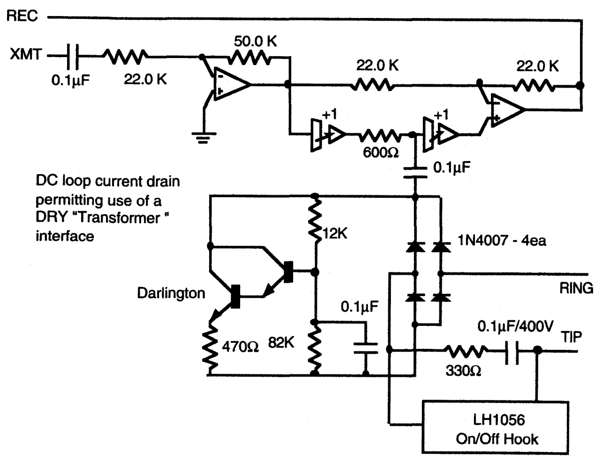

Figure 4. 2-4 Wire Hybrid Optically Isolated Transformer

Application of the optical transformer results in a "Dry Transformer" type line termination. A dry transformer requires a separate central office battery current return path, which is usually a current sink constructed with discrete components. This example shows a Darlington transistor current sink providing this path.

Various optical transformer 2-4 hybrid circuits were investigated. One circuit used single supply Thevenin style differential operational amplifiers in the isolated section of the interface. The results were less than acceptable. These circuits had difficulty driving reactive low impedance (600 Ω) loads.

Figure 5 shows a better performing design that uses Norton or current input operation amplifiers (LM3900) in the isolated telco line and standard Thevenin Dual supply operational amplifiers (LM324) within the subscriber unit. The LM3900, U6, easily drives the IL350's LED, and a non-inverting photodiode amplifier requires a minimum of components, U5. Note that U3, LM324, requires a buffer transistor (2N3906) to adequately drive the LED. U4 is used as a transresistance amplifier, converting the receive IL350's photocurrent into a voltage that is compatible with the cancellation requirements of U2. The R3, R4,C1 forms the lag compensation network to compensate for the delay in the isolated path between U1's output and U2's input.

A lower component count circuit is shown in Figure 5. This interface uses Norton amplifiers exclusively for both the telco line and subscriber instrument sections. The transmit and receive sections are identical to those in Figure 4. The transmit suppression is accomplished in the current differential amplifier, U2. R4,R5,C2 form the lag network to compensate for the delay introduced by U3,U4,U5,U6, and U7.

A 1 KHz transmit signal suppression of –36 dB was measured on the bench. Both of these optical hybrids derive their power from the telco line through a voltage dropping network connected after the OFF/Hook switch. The circuits were evaluated with 5-9 V supply voltages.

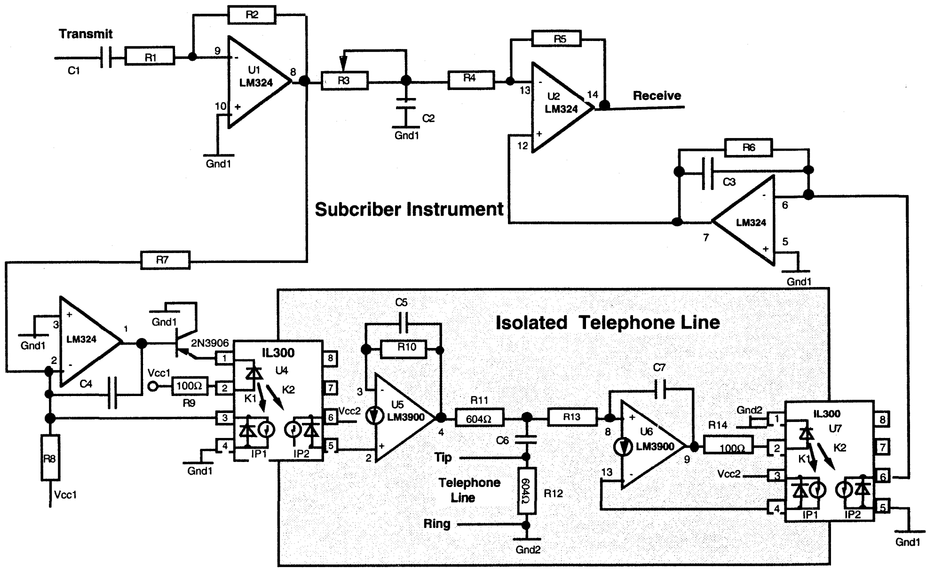

Figure 5. 2-4 Wire Optically Coupled Hybrid Norton/hevenin Amplifier Configuration

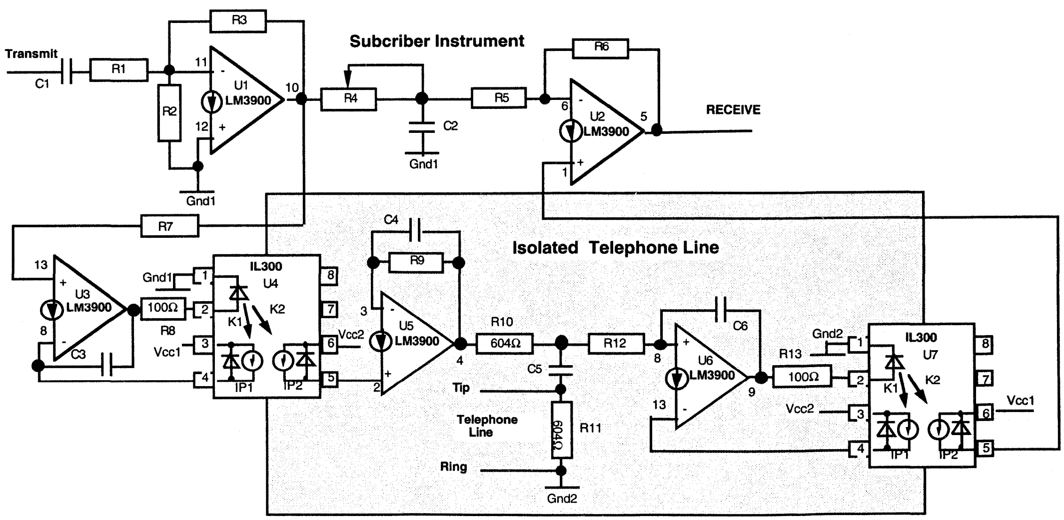

Figure 6. 2-4 Wire Optically Coupled Hybrid Norton Amplifier Configuration

Non Hybrid DAA Architectures

The previous circuits may not be suitable for multiple baud rate applications. This results from the frequency dependency of the lag network found in the hybrid. This situation leads to a series of architectures that use digital transmit suppression techniques. When such techniques are possible then standard IL350 interface circuits can be used.

Figure 7 shows a design with a phototransistor coupler as the ring detector and one or more LH1056 FET switches for OFF/Hook control.

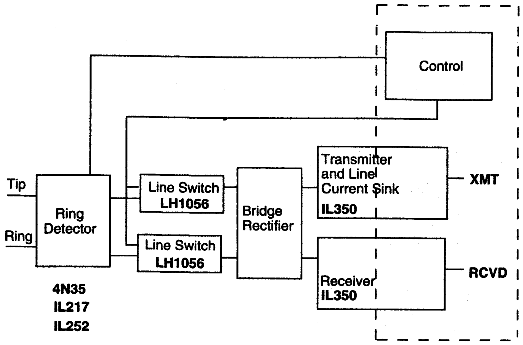

Figure 7.

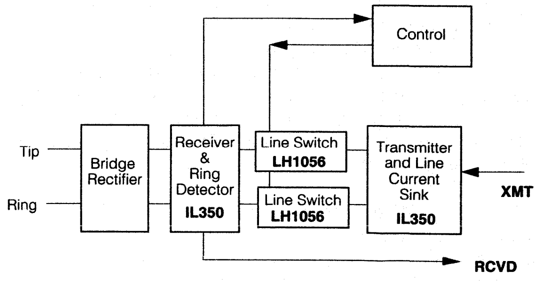

Figure 8.

This design can be simplified by having ring detection performed by the IL350 receiver, using one LH1056 OFF/Hook switch and combining the transmitter and line current into one circuit function. The block diagram for this approach is shown in Figure 8, the schematic in Figure 9.

The circuit operation is as follows. Line OFF/Hook control is performed by one LH1056 FET switch. Ring detection is accomplished by the signal path of C1, R1 and the LED of the IL350 coupler. These values are selected to provide a 1-2 mA LED ringing current.

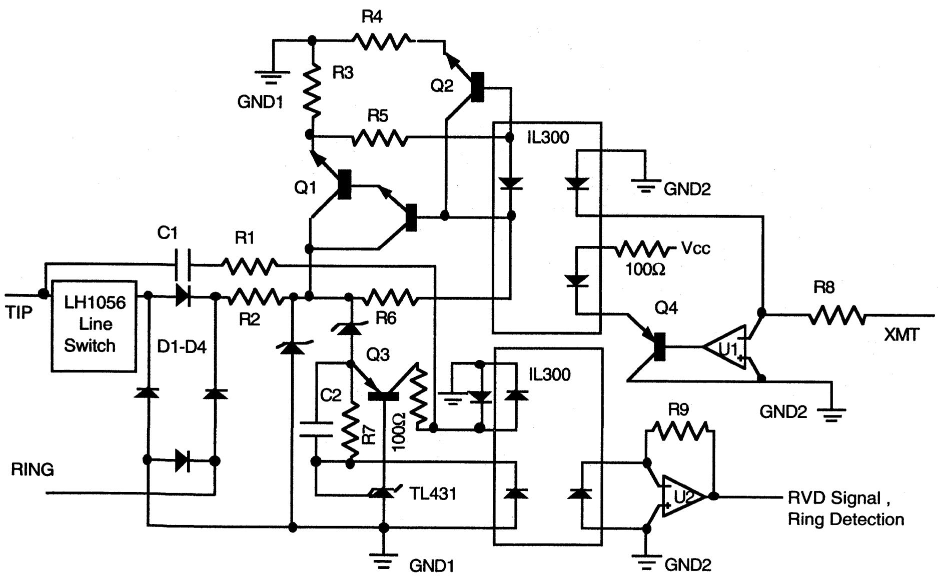

Figure 9.

Once the ringing signal is detected the OFF/Hook control closes the LH1056, and the IL350 receiver amplifier is energized from power supplied by the central office battery via the bridge rectifier D1-D4. The zener diode ZD2 is used to supply +15 V. The IL350 servo amplifier is constructed with Q3 and a shunt regulator, TL431. R7 is used to set a prebias current for the servo operation. The optical servo current can range from 50 µA to 100 µA depending on the K1 servo gain of the IL350. This photo bias current will result in a LED current of 5 mA to 10 mA. C2 provides a low impedance received signal path into the input of the TL431. The received signal is converted to an output photocurrent based upon the transfer gain, K3, of the IL350. This output photocurrent is then amplified by the transresistance amplifier, U2.

The transmit function and central office battery current sink is provided by the transmit amplifier. This circuit consists of Q1,Q2, R2, R4, R5, and R6. Under transmit operation the transmit signal XMT consists of a DC and AC component. The DC component prebiases the transmit amplifier. This prebias sets the supplemental line current to be sunk. Recall that the receiver amplifier will require a 5–10 mA operating current, therefore the transmit current sink will handle any additional current required by the central office switch. The central office line current is typically 20-30 mA. The AC component of the transmit signal is set to a level that satisfies the –3 dBm line transmit level. This circuit was designed to use the smallest and the fewest number of components as possible.

See Figure 10 for a circuit design that further minimizes board space by eliminating the OFF/Hook optocouplers. The schematic of this design is shown in Figure 11.

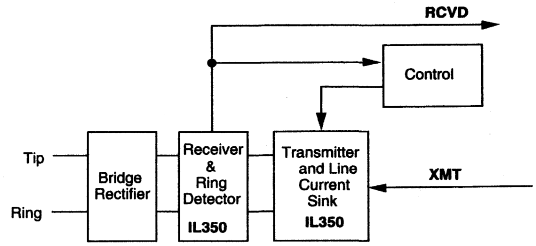

Figure 10. Switchless DAA Interconnection

The circuit operation for this design is as follows. Ring detec-

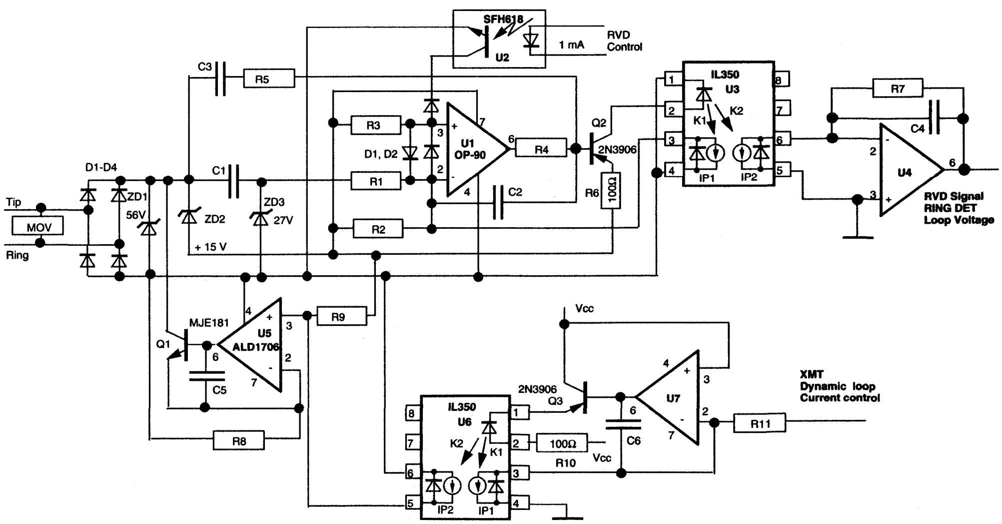

Figure 11. Switchless DAA Interconnection

tion is performed by a network consisting of C3, R5, Q2, and the LED of the IL350. This ringer offers a higher impedance than previous designs. This was done to reduce the value and physical size of C3. During ringing, Q2 functions as a ringer amplifier for the LED. Once the ringing signal has been recognized by the modem, the receiver amplifier is activated by turning ON the SFH618 optocoupler, U2. When U2 is OFF, it disables a bias network which also disables the micro-power opamp, U1. Under this condition this amplifier requires only a 20 µA supply current, equivalent to an OFF/Hook resistance of 2.5 MΩ. When the U2 is ON, it provides a current return for the photo bias current supplied by R2 and R3. This bias network is selected to set an LED quiescent current of 5-10 mA.

The received signal is supplied to U1 via C1 and R1. These values are selected to satisfy the bandwidth and signal to noise requirement of the modem. The received signal generates a modulated LED current that is optically coupled through U3 to the modem receive transresistance amplifier consisting of U4, C4, and R4.

The transmit and central office battery current sink is provided by the transmit amplifier. The transmit amplifier and current sink are connected across the telco line. The transmit signal consists of a DC and AC component. When not transmitting, the transmit signal will have a DC level that forces the LED current of transmit IL350,U6, to zero. Under this condition the output photocurrent, IP2, of U6 will also be zero, disabling the transmit amplifier U5 and Q1. When disabled, the transmit amplifier requires a supply current of less that 10 µA, giving the line an OFF/Hook resistance of 5 MΩ.

When the modem is transmitting, the transmit signal, XMT, will have a DC component sufficient to force Q1 to sink any additional central office line current not required by the activated receive amplifier. U5 and Q1 function as a current to current amplifier. The transconductance of the amplifier is set by R8, and R11. The transmit AC signal level at U7 is set to provide a –3 dBm signal to the telco line. R9 provides the output photodiode bias return path. The bandwidth of the transmit circuit is set by amplifier selection, with the values of R11, R8, and C6. Signal bandwidths in excess of 20KHz are possible with proper component selection.

Conclusion

The circuit designs shown in this application note are provided as a starting point for the design of PCMCIA compatible modem. By using the special lead formed IL350, SOT23, SOT223 transistors, surface mount ICs and passive components, a DAA interface that will fit the 5 mm height form factor of the PCMCIA standard can be constructed.

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Isolated Industrial Current Loop Using the IL300 Linear Optocoupler Appnote 54

by Bob Krause

Introduction

Programmable Logic Controllers (PLC) were once only found in large manufacturing firms but now are used in small to medium manufacturing firms. PLCs are being retrofitted into manufacturing environments where temperature, pressure, and level sensor control signals are exposed to harsh electrical noise. The connection between these sensors and the controller requires the use of high noise immunity communication technology.

One solution to this communication problem is the analog current loop. A current loop is an interface technique that converts a process sensor's output to a DC current signal. When compared to voltage control techniques, a current loop receiver's low input resistance offers higher noise immunity. Current loops have the added advantage of better accuracy, because they eliminate sensor signal errors introduced by communication line resistance.

Electrical noise can be reduced further by providing isolation between the current loop receiver or transmitter and the process controller. An isolated receiver and transmitter can be constructed using the IL300, linear optocoupler. This application note will describe how to design a line powered isolated current loop receiver and transmitter. It will discuss the design process and show circuit variations compatible with common current loop pseudo-standards.

Current Loop Elements

A current loop typically consists of a transmitter, a receiver, and a DC power supply. The highest insulation and noise immunity is achieved when an isolated transmitter and an isolated receiver are used as shown in Figure 1. However there are many situations where only one end of the loop can be isolated. Figures 2 and 3 illustrate combinations of isolated and non-isolated current loop elements.

Isolated current loop transmitters and receivers commonly require separate isolated power supplies in addition to the standard loop voltage supply. The designs in this application note derive their power from the DC supply found in the loop. Commonly the loop power supply is an isolated voltage supply whose output voltage will range from 10 to 24 volts. Thus only a single isolated power supply is needed to power the loop.

Current Loop Conventions

The 4–20 mA current loop is the most common pseudo-standard. This convention defines a 4 mA loop current as the sensor's zero reference. The full scale of the sensor output corresponds to a 20 mA loop current, representing a minimum to maximum current ratio of 1:5. The sensor's signal output commonly has a zero reference of +1 volt and a full scale of +5 volts which also corresponds to a 1:5 signal ratio and a

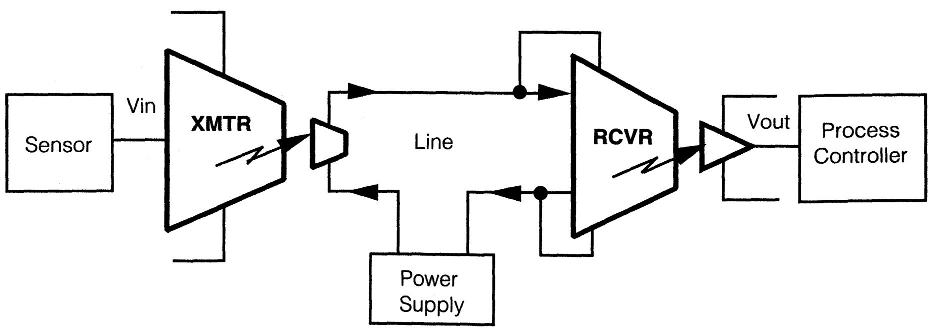


Figure 1. Isolate transmitter and receiver current loop

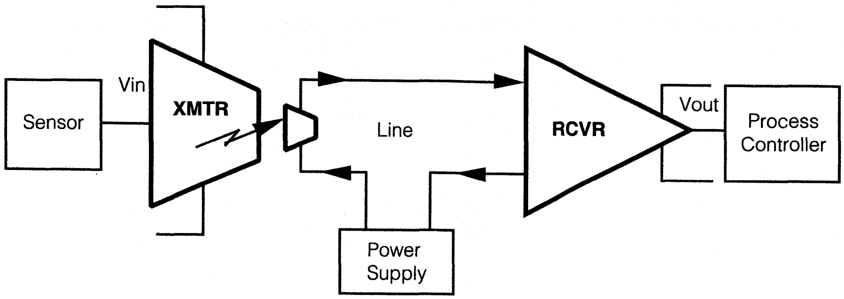


Figure 2. Isolate transmitter and non-isolated receiver current loop

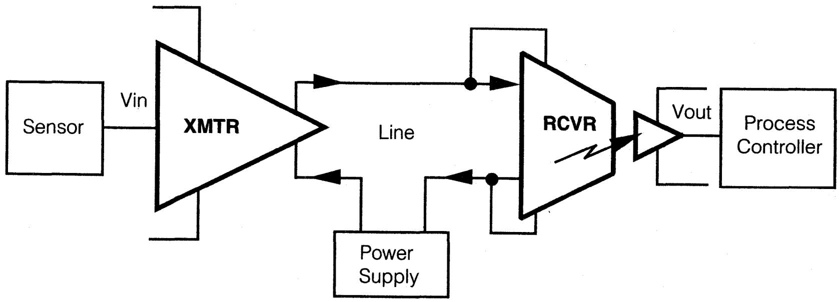


Figure 3. Non-isolated transmitter and isolated receiver

+4 volt span. Figure 4 shows the transmitter's output loop current as a function of input sensor voltage. Other conventions include sensor signal spans of 5 volts, where the sensor's zero reference is 0 V, and full scale is +5 volts (Figure 5).

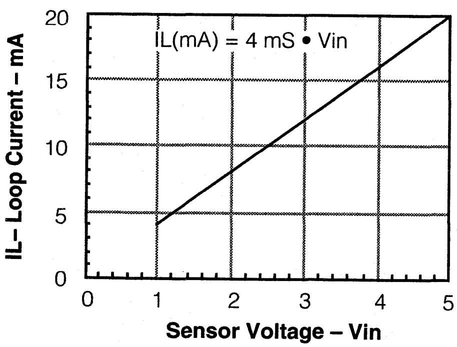


Figure 4. 1–5 V to 4–20 mA current loop transfer

Figures 4 and 5 show the transmitter transfer function. The loop current (IL) is the product of the sensor voltage (Vin) times the transmitter transconductance, milli-Siemens. The receiver in Figure 4 has a transresistance of 250 Ω, while for Figure 5 it is 312.5 Ω.

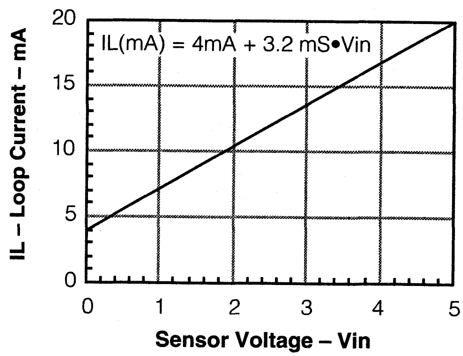


Figure 5. 0–5 V to 4–20 mA current loop transfer

Current Loop Transmitter

Figure 6 shows an isolated current loop transmitter with a 1–5 V input and a 4–20 mA output. The sensor section consists of an optical feedback amplifier (U1, IL300) that converts the sensor voltage (Vin) to an output photocurrent (IP2). The output amplifier, U2, operates as a current controlled current sink. The equation for the line current (IL) as a function of the output photocurrent (IP2) is given below:

$$Io = \frac{IP2 \bullet R3}{R4} \qquad (1)$$

The equation for the output photocurrent, IP2, as a function of the sensor voltage is given below:

$$IP2 = \frac{Vin \bullet K3}{R1} \qquad (2)$$

Combining Equations 1 and 2 results in the complete transmitter DC transfer relationship with K3 the IL300's transfer gain.

$$\frac{Io}{Vin} = \frac{K3 \bullet R3}{R1 \bullet R4} \qquad (3)$$

1–5 V to 4–20 mA Transmitter Design

The design of the 1–5 V input, 4–20 mA output isolated current loop transmitter starts with analyzing the isolated current to current converter. This amplifier (U2), a National Semiconductor LM10 operational amplifier, was chosen for its high output current and ability to operate from a single supply. The input sensor amplifier controls the output photocurrent (IP2). IP2 develops a voltage across R3 at the inverting input of U2, forcing a loop current to flow through R4. Thus Io times R4 is equal to the voltage developed across R3 times IP2 (Equation 4). Equation 5 shows that resistors R3 and R4 set U2's current gain.

$$IP2 \bullet R3 = Io \bullet R4 \qquad (4)$$

$$\text{Current Gain} = \frac{R3}{R4} \qquad (5)$$

A current gain of 400 is selected, with R4 equal to 50 Ω. From Equation 5, R3 is 20 KΩ. Equation 1 shows that a loop current of 4-2 mA requires an output photocurrent (IP2) of 10–50 µA.

The last design step is to determine the input resistor (R1) by rearranging Equation 3. The transconductance, Io/Vin of Figure 6, is 4 milli-Siemens (mS). The remaining variable is the IL300's transfer gain, K3. The part to part variation of the transfer gain offers a range of 0.56 to 1.53. With K3 = 1, R1 is calculated to be 100 KΩ from Equation 6. See Figure 7 for the spread of R1 versus the guaranteed range of K3. Thus a 200 KΩ, 10 turn potentiometer will compensate for the full distribution of K3.

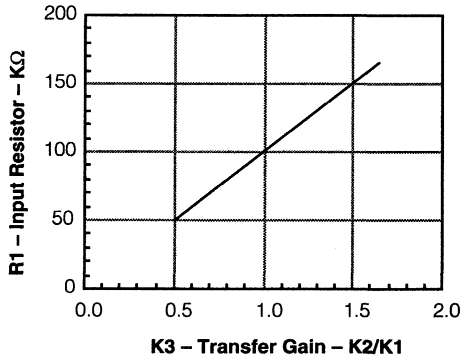


Figure 7. R1 versus K3 for isolated 1-5 V, 4-20 mA transmitter

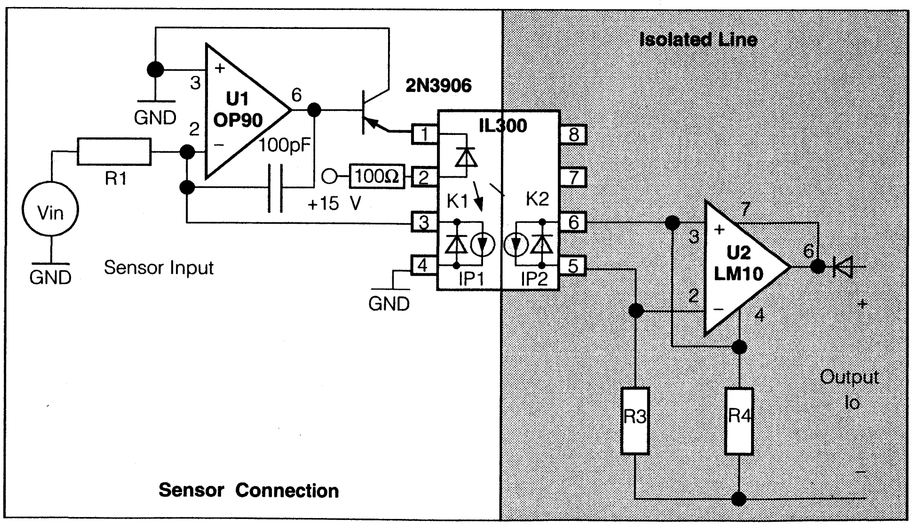


Figure 6. Isolated 1-5 V, 4-20 mA transmitter

$$R1 = \frac{K3 \bullet 20\ K\Omega}{6\ mS \bullet 50\ K\Omega}$$

R1= 100 KΩ for K3 = 1.0

0-5 V to 4–20 mA Transmitter Design

A current loop transmitter conforming to the pseudo-standard of 0-5 V input to 4–20 mA output can be designed using the general circuit topology in Figure 6. With the addition of a bias source (Vref) 4 mA of line current will flow when Vin=0 V. The LM10 offers an integrated 200 mV band gap reference source with voltage follower buffer amplifier. The LM10's voltage reference and differential amplifier make it uniquely qualified as the output current amplifier. Figure 8 shows the schematic of a current transmitter including a bias source, U3.

By inspection and using Equation 4, the transmitter current transfer function can be determined. The transfer function for Figure 8 is given in Equation 7.

$$Io = \frac{Vin \bullet K3 \bullet R3}{R1 \bullet R4} + \frac{Vref \bullet R3}{R2 \bullet R4} \quad (7)$$

This equation shows that the loop current is the sum of the sensor controlled signal (Vin) and current provided by the bias source (Vref). The bias source consists of a voltage follower (U3) that buffers a 200 mV band gap reference. This voltage reference is converted to a current source by the R2 resistor. The value of R2 can be calculated from Equation 8, when Vin=0 V, and Io=4 mA.

$$Iref = \frac{Vref}{R2}$$

$$Io = \frac{Vref}{R2} \bullet \frac{R3}{R4};\ \text{when } Vin = 0\ V$$

$$R2 = \frac{Vref \bullet R3}{Io \bullet R4} \quad (8)$$

Given the current gain, R3/R4=400, Vin=0 V, and Io=4 mA, R2 is calculated to be 20 KΩ.

The input resistor (R1) sets the transconductance (ΔIP2/ΔVin) of the input amplifier. The current transmitter's transconductance equals the transconductance of the input amplifier times the current gain of the output amplifier. The transmitter incremental transconductance is calculated given a ΔVin of 5 V, (0 V–5 V), and ΔIo of 16 mA (4 mA–20 mA). A transmitter transconductance 3.2 milli-Siemens results.

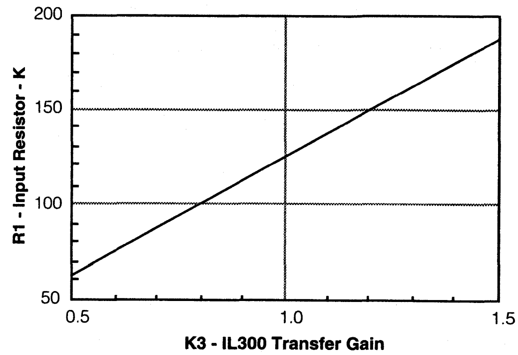


Figure 9. R1 versus K3 for Isolated 0–5V, 4—20 mA transmitter

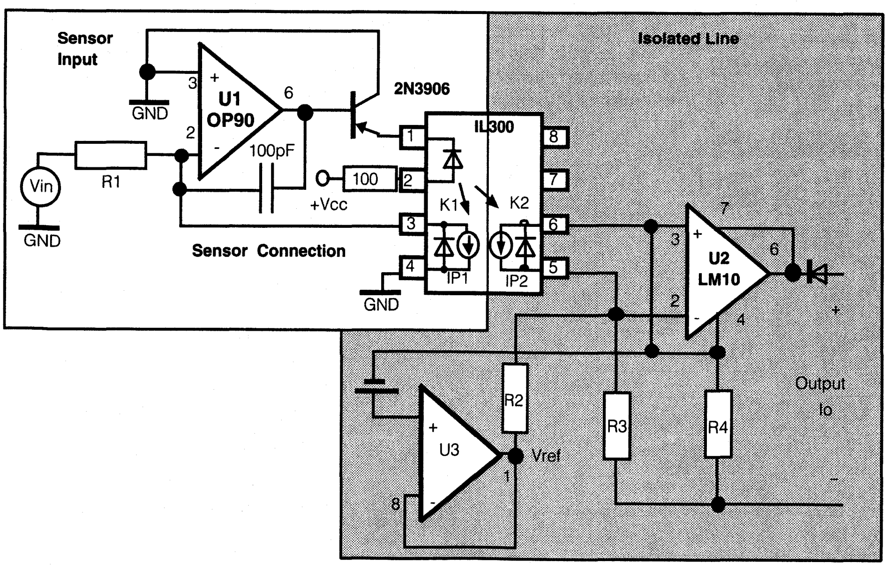


Figure 8. Isolated 0–5 V, 4–20 mA transmitter

$$\frac{\Delta IP2}{\Delta Vin} = \frac{K3}{R1}$$

$$\frac{\Delta Io}{\Delta Vin} = \frac{K3}{R1} \bullet \frac{R3}{R4} \quad (9)$$

$$R1 = \frac{\Delta Vin}{\Delta Io} \bullet K3 \bullet \frac{R3}{R4} \quad (10)$$

Given a output amplifier current gain of 400 (R3=20KΩ, R4=50Ω), a typical K3=1, and a transmitter transconductance of 3.2 mS. Substituting R3, R4, and K3 into Equation 10, R1 can be determined.

$$R1 = \frac{1.0 \bullet 20K\Omega}{3.2\ mS \bullet 50\ \Omega} \quad (11)$$

R1 = 125 KΩ

Figure 11 shows the relationship of R1 as a function K3 .

See Table 1 for the component values for each design.

Table 1. Isolated Transmitter Resistor Values, K3 =1

	0–5 V to 4–20 mA	1–5 V to 4–20 mA
R1	125 KΩ	100 KΩ
R2	20 KΩ	INF
R3	20 KΩ	20 KΩ
R4	50 Ω	50 Ω

1–5 V to 4–20 mA Transmitter Performance

The transmitter described in Figure 6 was constructed and evaluated for accuracy and linearity as a function of input sensor voltage and ambient temperature. The transmitter was calibrated by adjusting R1 for 12.000 mA loop current with an input voltage of 3.000 V at T_A=23°C. Figure 10 shows the percent error deviation from the expected loop current. This circuit offers a typical accuracy of ±0.2 % over a temperature range of 0°C to 75°C. Note that the temperature performance appears to follow a parabolic contour.

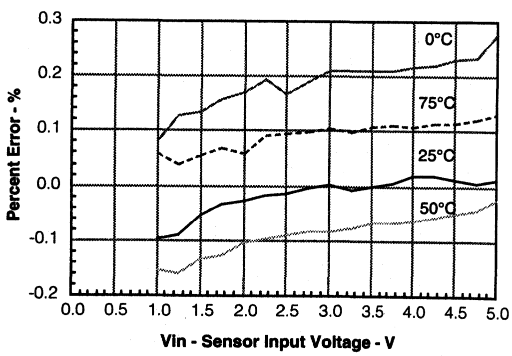


Figure 10. Percent error versus input sensor voltage 1–5 V to 4–20 mA transmitter

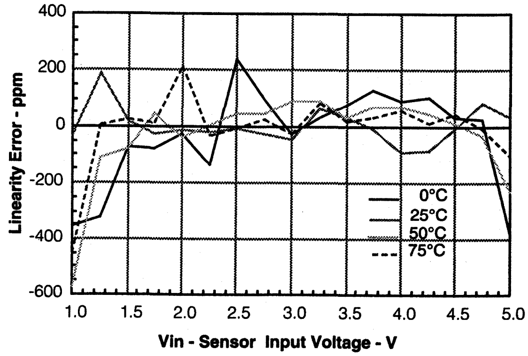


Figure 11. Linearity error versus input sensor voltage 1–5 V to 4–20 mA transmitter

Many industrial controllers have calibration techniques that can compensate for temperature imposed accuracy errors. These techniques are only valid if the transmitter exhibits a high degree of linearity. Figure 11 shows the linearity error for the transmitter. The linearity error is expressed as a deviation in parts per million (ppm) from a best fit linear regression at each temperature. Figure 11 shows a typical linearity of +200 ppm to –600 ppm over a 0°C to 75 °C temperature range.

0–5 V to 4–20 mA Transmitter Performance

The transmitter in Figure 8 was constructed and evaluated for accuracy and linearity as a function of input sensor voltage and ambient temperature. The transmitter was calibrated by adjusting R2 for 4.000 mA loop current with an input voltage of zero volts (0.000 V). The R1 resistor is then adjusted for 12.000 mA loop current with an input voltage of 2.5 V at T_A=23°C. Figure 12 shows the percent error deviation from the expected loop current. This circuit offers a typical accuracy of +0.4% over a temperature range of 0°C to 75°C. Note that the temperature performance appears to follow a parabolic contour.

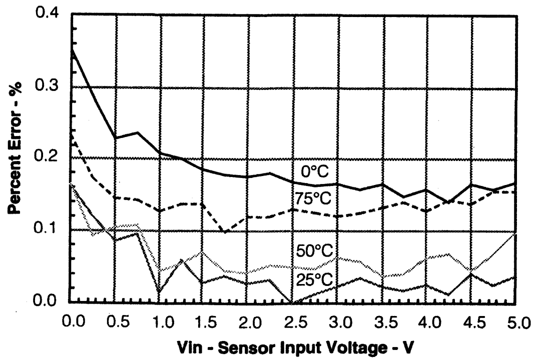


Figure 12. Percent error versus input sensor voltage 0–5 V to 4–20 mA transmitter

Figure 13 shows the linearity error for the transmitter. The linearity error is expressed as a deviation in parts per million (ppm) from a best fit linear regression at each temperature. Figure 13 shows a typical linearity of +600 ppm to –1000 ppm over a 0°C to 75 °C temperature range.

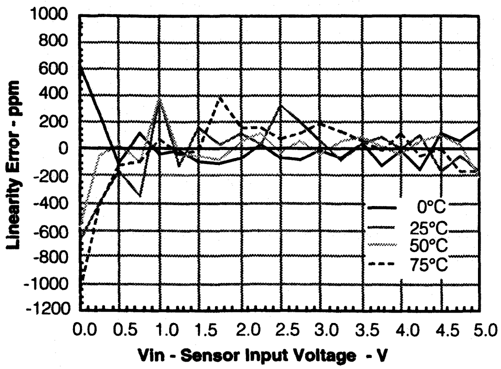


Figure 13. Percent error versus input sensor voltage 0–5 V to 4–20 mA transmitter

Current Loop Receiver

The sensor controlled, current loop signal is converted to a voltage by the current loop receiver. The receiver's conversion gain and output voltage span is determined by the adopted current loop standard. A 4–20 mA loop current is commonly converted to a 1 to 5 V output signal. The receiver design in this section conforms to this standard. Signal conversion and isolation are provided by an IL300, linear optocoupler. The circuit is loop current powered. The isolation feature and the receiver's low operating voltage drop permits multiple receivers within the loop.

Receiver Operation

The isolated current loop receiver consists of two sections. They include a loop current to photocurrent current amplifier, U1, and an output transresistance amplifier, U2. Figure 14 shows a simplified schematic. The receiver's linearity and stability are insured by using optical feedback within the loop current to photocurrent amplifier.

The optical feedback amplifier provides precise control of the LED's output flux. A bifurcated optical signal path within the IL300 provides an equally well controlled photocurrent for the output transresistance amplifier.

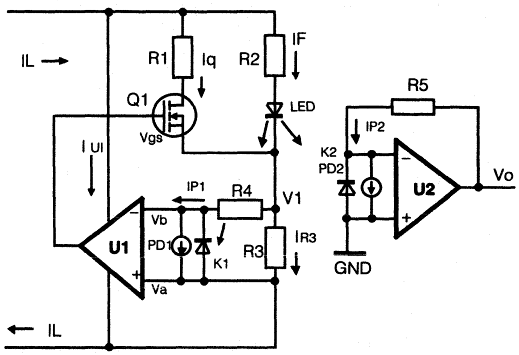


Figure 14. Isolated current loop receiver

The loop current to photocurrent current amplifier consists of a single supply micro-powered differential control amplifier, U1, and an LED current shunt regulator, Q1. Shunt control of the LED current was chosen to accommodate the receiver's need for a low supply voltage operation.

The current loop receiver circuit functions as follows. The loop current (IL) flows into the junction of U1's Vcc (R1 and R2). U1's supply current (IU1) is substantially smaller than the loop current and will be ommitted in the analysis. The loop current is divided at the juncture of R1 and R2. The sum of the currents flowing in each leg is equal to the loop current. The individual currents (Iq and IF) are determined by the required LED current to generate the needed photocurrent (IP1) connected to the control network at U1. Figure 15 shows the Iq and IF relationships for the receiver.

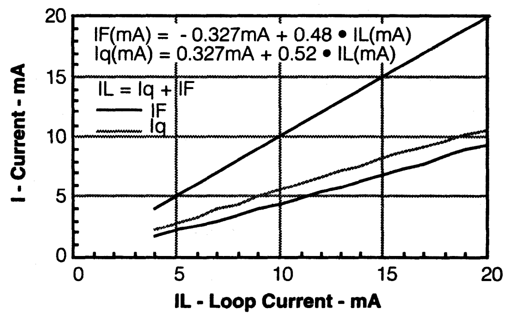


Figure 15. LED current shunt control

The total loop current flows into the junction, V1. This current, IR3, develops a voltage across R3. Under initial conditions, this positive voltage appearing at the inverting input of U1 will force U1's output towards the negative rail. This Vgs forces Q1 into cut-off. Under this condition the LED current (IF) equals the loop current (IL). This rise in LED current generates an optical flux which falls on the feedback photodiode (PD1) and generates a photocurrent (IP1). This photocurrent will rise to a value where voltage developed across R4 equals the voltage across R3. This satisfies the differential amplifier requirement of Va=Vb. U1's output provides the control signal for Q1's gate, forcing it into conduction and shunting excess loop current away from the LED current path. The feedback control relationship is shown in Equation 12.

$IP1 \bullet R4 = IR3 \bullet R3$;$IR3 \sim IL$

$IP1 \bullet R4\ IL \bullet R3$ (12)

The control relation shown in equation can be used to develop the current to current gain ratio. Recall the following IL300 gain equations.

$IP1 = K1 \bullet IF$ (13)

$IP2 = K2 \bullet IF$ (14)

$IP2 = IP1 \bullet K3$ (15)

Where: IP1= feedback photocurrent
K1 = feedback gain
IP2 = output photocurrent
K2 = output gain
K3 = transfer gain (K2/K1)

With Equations 12, and 15, solve for IP2.

$$IP2 = \frac{R3}{R4} \bullet IL \bullet K3 \quad (16)$$

The transfer gain can be written from Equation 16.

$$\frac{IP2}{IL} = \frac{R3}{R4} \bullet K3 \quad (17)$$

The output current, IP2, is converted to a voltage by the transresistance amplifier U2. The output voltage gain equation is shown below.

$Vo = IP2 \bullet R5$ (18)

Combining Equations 18 and 17 results in the current loop transfer gain solution, Vo/IL (Equation 19).

$$\frac{Vo}{IL} = \frac{R3}{R4} \bullet R5 \bullet K3 \quad (19)$$

LED Current Shunt Operation

The differential amplifier, U1, provides the control signal to the LED current shunt regulator. U1's output is connected to the gate of an N-Channel FET, Q1. This transistor is the control element of the LED current shunt regulator. The regulator consists of a network made up of the series connection of the FET and R1, in parallel with the series connection of the IL300's LED and R2.

The amplifier's output signal controls the FET's drain to source resistance, Rq. As the gate voltage is increased, the FET resistance will decrease causing a larger percentage of the loop current to be diverted away from the LED signal path. Thus a rising control voltage,Vgs, causes the LED current to decrease. A Siliconix TN0201L low enhancement voltage FET was selected as the control device for two reasons. First, with Iq ≤ 20 mA, the FET's gate voltage should be less than 3 volts. The TN0201L control characteristics as a function of loop current are shown in Figure 16. Second, the FET's dynamic resistance should be in the same order of magnitude as the IL300's LED dynamic resistance. The dynamic resistance of both the LED and FET are shown in Figure 17

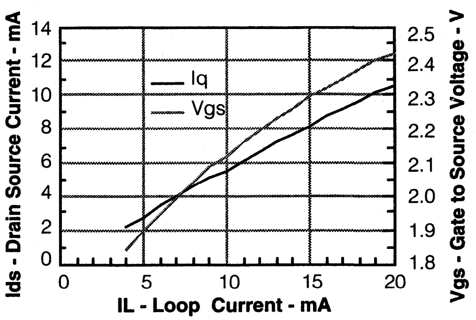


Figure 16. TN0201L gate voltage versus drain current.

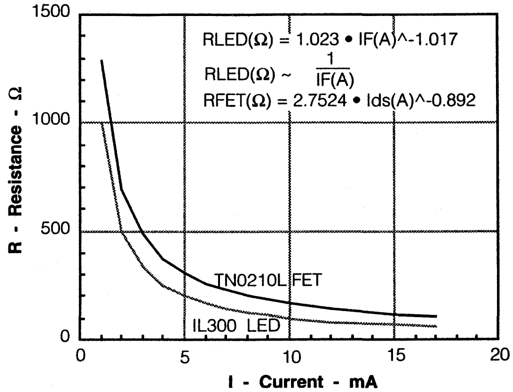


Figure 17. Dynamic resistance versus current

The shunt regulator includes a series resistor in each leg of the network. These resistors are included in the design for two reasons. First, to provide a measure of current overload protection for the LED and FET, and second to set the initial control conditions for the network.

The design equations are given below:

$IL = Iq + IF$ (20)

$Vn = Iq\,(R_{FET} + R1)$ (21)

$Vn = IF\,(R_{LED} + R2)$ (22)

Where: IL = loop current
Iq = Q1 drain current
IF = LED forward current
R_{FET} = Q1 dynamic resistance
R_{LED} = LED dynamic resistance
Vn = Voltage across the control network

Combining Equations 20, 21, and 22:

$$Iq (R_{FET} + R1) = IF (R_{LED} + R2) \quad (23)$$

Replacing Iq in terms of IF and setting to zero gives Equation 24

$$0 = R_{FET} - R_{LED} + R1 - R2 \quad (24)$$

The LED and FET dynamic resistance equations are substituted into EQ 24.

$$0 = (2.7524 \bullet (IL - IF)^{\wedge} - 0.892) - (1 / IF) + R1 - R2 \quad (25)$$

This transcendental equation is best solved by iterative techniques.

Current Loop Receiver Design

The current loop receiver design is divided into two sections. The first is the shunt regulator and second, is control the amplifier. The shunt regulator design relies on Equation 25 and intuitive selection of an LED operating point. The LED forward current is bounded by the loop current range which is 4 mA to 20 mA. The selection of R1 and R2 is determined by solving Equation 25 when the LED current, IF=10 mA, for a loop current equal to 20 mA. This point is selected to provide sufficient FET current control range given the initial value range of K1 and its temperature dependence. Under the IF and IL conditions selected, Equation 25 will provide the resistance range for R1 and R2.

$$R2 - R1 = 67\,\Omega \quad (26)$$

Equation 26 shows that R2 is greater than R1, and the recommended difference is 67 Ω. Given this guidance, a 100 Ω resistor is selected for R2. A larger value than the recommended 33 Ω is selected for R1. A 47 Ω resistor is used providing for greater LED current limiting. Given R1=47 Ω and R2=100 Ω, the LED current is calculated equation 25 at loop current extremes. At IL=4 mA, the LED current (IF) is equal to 1.735 mA, while for a loop current of 20 mA, IF=9.42 mA.

The next part of the design selecting the resistors, R3 and R4, surrounding the feedback control amplifier. Recall that R3 is the loop current sense resistor and should be valued less than 100 Ω. For this design example, R3=20 Ω. Equation 27 shows the relationship of R4 in terms of circuit variables.

$$R4 = \frac{R3 \bullet IL}{IF \bullet K1} \quad (27)$$

Figure 18 shows the nonlinear nature of the feedback gain, K1, for the IL300. The worst case condition occurs when the loop current is at its minimum, IL=4 mA. Under this condition IF=1.75 mA. Figure 14 can be used to determine K1 under these conditions. The figure shows that at IF=1.75 mA, K1 equals 0.00475.

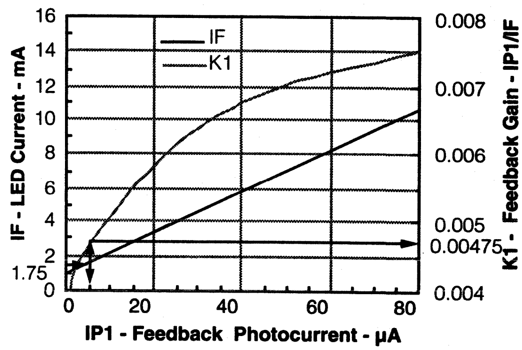


Figure 18. LED current and feedback gain versus feedback photocurrent

Substituting these values into Equation 27, R4 can be determined.

$$R4 = \frac{20\Omega \bullet 4\text{ mA}}{1.75\text{ mA} \bullet 0.00475} \quad (28)$$

R4 = 9.62 kΩ, a 10 KΩ resistor is selected.

The final section of the design centers on the selection of the transresistance of the output amplifier shown in Figure 19. The feedback resistor (R5) combined with the operation of the output amplifier (U2) converts the IL300's output photocurren (IP2) into the output voltage (Vo). The output voltage span (ΔVo) will be 1 V to 5 V, given a loop current span (ΔIL) of 16 mA. This relationship substituted into Equation 19 can be used to solve for R5.

$$R5 = \frac{\Delta Vo \bullet R4}{\Delta IL \bullet K3 \bullet R3} \quad (29)$$

$$\Delta Vo = (Vo_{MAX} - Vo_{MIN}) \quad (30)$$

$$\Delta IL = IL_{MAX} - IL_{MIN}$$

$$R5 = \frac{(Vo_{MAX} - Vo_{MIN}) \bullet R4}{(IL_{MAX} - IL_{MIN}) \bullet K3 \bullet R3} \quad (31)$$

$$R5 = \frac{(5V - 1V) \bullet 10\text{ K}\Omega}{(20\text{ mA} - 4\text{ mA}) \bullet 1.0 \bullet 20\Omega} \quad (32)$$

R5 = 125 KΩ

The final circuit of the isolated current loop receiver is shown in Figure 19.

The circuit is completed by adding two diodes placed in series with the loop. The diode, D2, is a protection device which will block current flow if the receiver's loop voltage source is improperly connected. The diode, D1, performs two functions: (1) a visual indicator of loop current flow, (2) functions as a 2 V drop in the loop. This voltage drop is needed to provide supply head room for the control of the shunt regulator FET.

Receiver Performance 4–20 mA Loop Current, 1–5 Volt Output

The receiver in Figure 19 was constructed and evaluated for accuracy and linearity as a function of input loop current and ambient temperature. The receiver was calibrated by adjusting R6 for 3.00 V output with a loop current of 12.00 mA at T_A=23°C. Figure 20 shows the percent error deviation from the expected output voltage. This circuit offers a typical accuracy of +0.8% to –0.5% over a temperature range of 0°C to 75°C. Note that the temperature performance appears to follow a linear temperature characteristic. Figure 18 shows a typical temperature coefficient of 175 ppm/°C.

Many industrial controllers have calibration techniques that can compensate for temperature imposed accuracy errors. These techniques are only valid if the receiver exhibits a high degree of linearity. Figure 21 shows the receiver's linearity error as a deviation in parts per million (ppm) from a best fit linear regression at each temperature. Figure 21 shows a typical linearity of +300 ppm to –1000 ppm over a 0°C to 75°C temperature range.

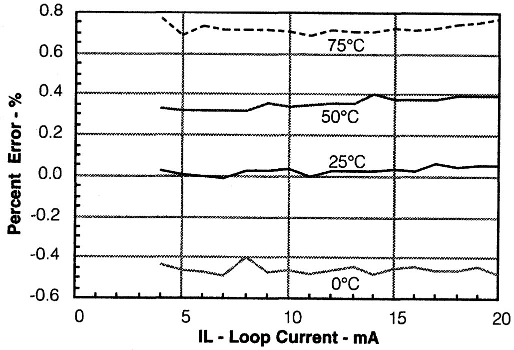


Figure 20. Percent error versus loop current 4–20 mA receiver

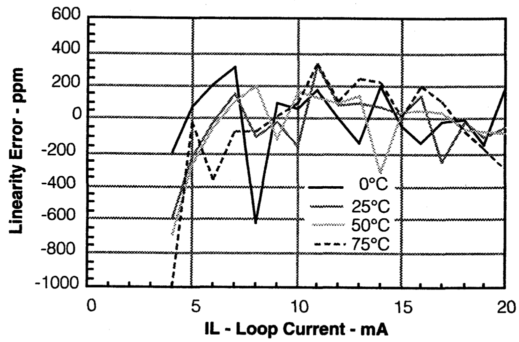


Figure 21. Linearity error versus loop current 4–20 mA receiver

Conclusion

Isolated current loops offer the industrial control designer the peace of mind that electrical noise and grounding problems will not influence the sensor signal. This application note has shown the design technique and results to construct a line powered 4–20 mA current loop receiver. It also presented two isolated current loop transmitters, one conforming to the 1–5 V input and a second to the 0–5 V input standard.

The performance data in this application note shows that the receiver and transmitter easily conform to a 8-bit operation over a 0–75°C operating range.

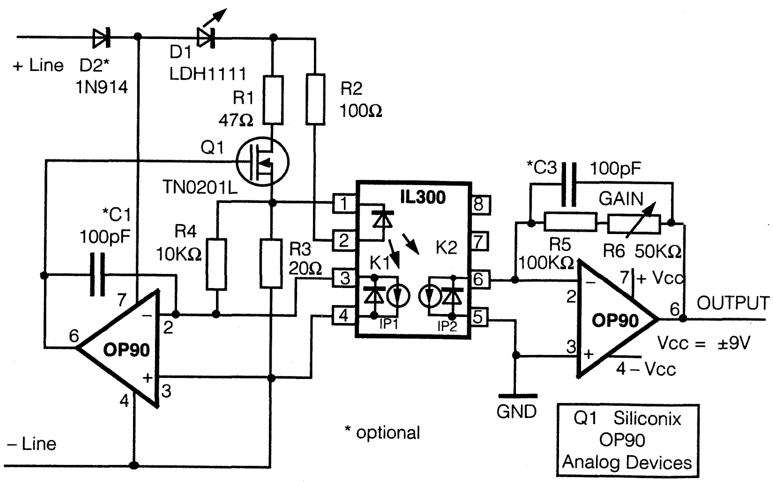


Figure 19. Isolated current loop receiver

SIEMENS

Optoelectronic Feedback Control Techniques for Linear and Switch Mode Power Supplies Appnote 55

by Bob Krause
Applications Engineering Manager

Introduction

The power supply designer is continually being pressured to provide units which have higher efficiency, better regulation, less EMI & RFI, smaller size and weight, all at a lower cost. The solution to this problem is a combination of circuit topology, layout, and supply control. This appnote will address output control techniques for linear and Switch Mode Power Supplies (SMPS). Specifically it will cover control techniques using standard phototransistors and a new family of linear optocouplers.

Isolated Regulation

National and international safety agencies require a supply's output to be isolated and insulated from the AC mains. Many supply manufacturers have elected to offer power supplies that satisfy all national and international safety insulation criteria by selecting power transformers and feedback devices that meet a 3750 Vac withstand tests voltage. Feedback systems that use optocouplers easily comply with this insulation criteria. Optocouplers also offer a high degree of noise rejection or isolation combined with its insulation characteristics.

Linear Power Supply Feedback

Linear power supplies comply with the main insulation and isolation safety requirements by virtue of the primary/secondary insulation of the power transformer. There are numerous circumstances where isolated feedback in a linear power supply is needed. Requirements such as monitoring high voltage power supplies, current measurement in the high side of the supply, or monitoring multiple isolated outputs. Figure 1 shows a typical block diagram.

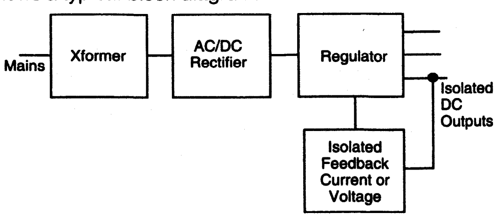
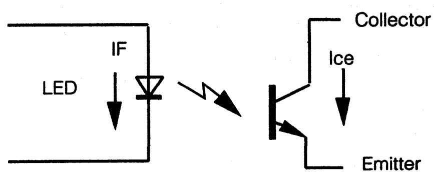


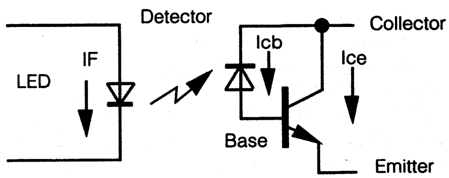
Figure 1. Linear Power Supply Phototransistor Model

Originally presented at the PCIM®/Power Quality®, 1993 Conference, Irvine, CA, U.S.A.

The feedback system for a linear power supply should be DC transparent and continuous. A standard phototransistor coupler when properly specified can perform the feedback function. To properly specify the phototransistor it is important to review the elements that contribute to a coupler's operation. Figure 2 shows the phototransistor optocoupler schematic.



A. Simple Phototransistor



B. Expanded Simple Phototransistor

Figure 2. Phototransistor Coupler Schematic

Phototransistor optocouplers are current amplifiers. These couplers include an infrared light emitting diode, LED, and an NPN silicon phototransistor. Figure 2A shows the common schematic of a standard phototransistor optocoupler. Figure 2B is an expanded schematic that includes a collector-base photodetector. An input LED current, IF, creates an optical flux, which is detected by the photodiode. The photodiode develops a photocurrent, Icb, which is amplified by the phototransistor. The phototransistor supplies a collector-emitter current, Ice. The current gain of the device is defined as a Current Transfer Ratio (CTR) and expressed as a percentage. The CTR relationship is given in Equation 1.

$$CTR = \frac{Ice}{IF \times 100}\ \% \qquad (1)$$

The relationship of the LED forward current flux creation and the generation of photocurrent is called Current Transfer Ratio Collector-Base (CTRcb). See Equation 2.

$$CTRcb = \frac{Icb}{IF \times 100}\ \% \qquad (2)$$

Combining Equation 2 with the transistor current gain, Hfe, provides a more complete optocoupler gain equation.

$$CTR = \frac{Icb}{IF \times Hfe \times 100}\ \% \qquad (3)$$

The relationship given in Equation 3 can be shown in a block diagram of the four elements that make up the DC transfer function of the phototransistor coupler. These elements are shown in Figure 3.

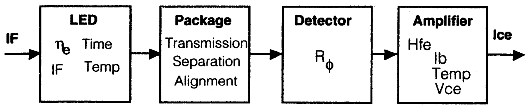


Figure 3. Phototransistor Block Diagram

The LED, package, detector, and transistor components have independent variables contributing to the optocoupler transfer function. The performance of the LED is influenced by four variables. These include the LED's external quantum efficiency, η_e, the forward current, I_F, junction temperature, T_J, and the total operation time.

The LED's external quantum efficiency, η_e, specifies the electrical to optical conversion factor. The optimum efficiency is determined by LED construction, for example, a GaAs LED has an η_e of approximately 10%, while the η_e for a AlGaAs LED may be as high as 30%. The operational LED efficiency is determined by the three remaining variable. The two most important are junction temperature and LED current. The LED's, η_e has a negative temperature coefficient, typically –1%/°C. Figure 4 shows the temperature dependence. This figure shows that when the LED junction experiences a 50°C temperature change, for example, from 25°C to 75°C. The output of the LED may be reduced by as much as 50%. The temperature characteristic is more pronounced at a lower LED drive current. As the LED current is increased this coefficient may fall to –0.5%/°C.

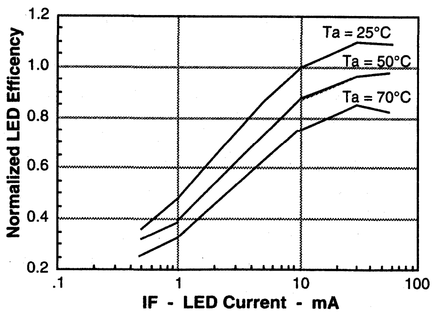


Figure 4. Normalized LED Efficiency

The influence of forward current on LED efficiency is also shown in Figure 4. Note that a standard GaAs LED efficiency will be reduced by 50% when the LED current is changed from 10 mA to 2 mA. One can conclude that in DC circuit design the LED introduces large variations as a function of forward current and junction temperature.

Today's LED processing techniques have all but eliminated efficiency reduction as function of time. LED efficiency reduction is commonly called CTR degradation. Typical degradation is less than 10% at 10 K hour and increases at a logarithmic rate.

The second element is the optical coupling (K_ϕ) within the package. Numerous assembly techniques exist for creating the LED-photodiode coupling path. However manufacturing variations introduce coupling deviations, such as, optical transmission media, emitter-detector separation distance, and alignment. K_ϕ is set at the time of manufacturing and is constant as a function of time and temperature.

The third element is the phototransistor's collector-base photodetector responsivity. This factor is the most consistent and linear element of the coupler. Process variations introduce worst case responsivity, R_ϕ, variations of less than 25%. The nonlinearity of the detector, over the designed photocurrent range, is less than ±0.1%.

The fourth element is the phototransistor current gain, HFE. The typical DC current gain showing the temperature, collector current, and V_{CE} influence on DC current gain is illustrated in Figure 5. Note that Siemens phototransistors do not exhibit the typical beta peak found at low (<1 mA) collector currents. It shows a typical HFE temperature coefficient of +0.5%/°C. The most noticeable is the influence that V_{CE} has on current gain. Figure 5 shows that the saturated gain (V_{CE} < 0.4V) is reduced by 30% for an LED current of 10 mA.

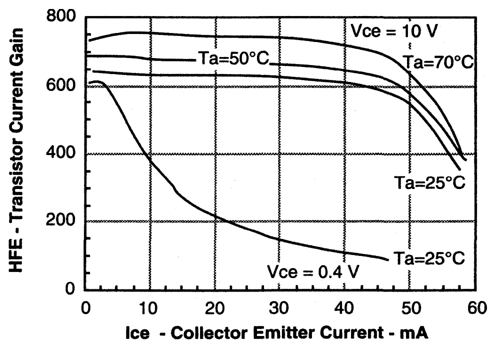


Figure 5. Phototransistor HFE versus Ice and Temperature

These four elements optocoupler elements create a linear DC transfer function, implying that a change in any one of these elements creates a factored change at the output. Functionally the relationship is shown in Equation 4.

$$I_{CE}=I_F \bullet (\eta_e (I_F, T_J, \text{time}) \bullet K_\phi (T,A,S) \bullet R_\phi \bullet HFE (Ib,T_J,V_{CE}) \qquad (4)$$

This section has presented the basic DC model and resulting transfer equation of the standard phototransistor. The goal was to illustrate factors that effect the DC current gain. The designer is encouraged to review the characteristics of the optocoupler being considered and be aware of the temperature and LED current influences on the current transfer ratio of a simple phototransistor.

Most designers compensate for these variations by selecting narrow binned CTR optocouplers. Designer often compensate for gain variations by introducing negative feedback within a control loop. Equation 4 illustrates that typical voltage or current feedback techniques are not possible if insulation or noise isolation is to be maintained.

Optical Feedback Control Technique

The factors that influence the DC current gain of the optocoupler can be compensated by introducing optical feedback within the LED or input side of the coupler. This technique consists of including an optical detector or photodiode on the input that monitors the LED's output flux which is possible now with the introduction of Siemens family of linear optocouplers.

A DC coupler optical isolation amplifier using the new IL300 linear optocoupler is shown in Figure 6.

This optical isolation amplifier uses an operational amplifier (U1) as an electro-optical servo amplifier that controls the LED current. The servo photodiode is operated in the photovoltaic mode and is zero biased from its connection to U1's inverting and non-inverting inputs.

This circuit responds to positive unipolar voltages, as found at the voltage output of the power supply. Initially when the power supply is energized, Vin=0 V, IF and IP1 are also zero. As the input voltage rises, U1 forces a voltage across the LED causing it to emit light. The LED's optical flux generates a servo photocurrent (IP1) which is proportional to the input voltage, IP1=Vin/R1. The LED's current increases until sufficient servo photocurrent is generated to keep the difference between U1's inverting-noninverting inputs equal to zero volts.

The servo photocurrent is proportional to the LED's current. This relationship is defined as servo gain, K1=IP1/IF. Combining the two equations describes the LED's current dependence on input voltage,

$$IF = \frac{Vin}{K1 \times R1} \qquad (6)$$

The isolated output circuit consists of a zero biased photodiode transresistance amplifier. This output amplifier is configured to generate an output voltage proportional to IP2 and the transresistance R2. The output photocurrent, IP2, is determined by the output transfer gain, K2=IP2/IF. The output gain equation is Vo=IP2•R2. Solving for LED current by combing the preceding equations results in:

$$IF = \frac{Vo}{K2 \times R2} \qquad (7)$$

The composite DC transfer function of the input and output amplifiers can be determined when the equations 6 and 7 are combined resulting in the voltage gain equation.

$$\frac{Vo}{Vin} = \left(\frac{K2}{K1}\right) \times \frac{R2}{R1} \qquad (8)$$

For simplicity the ratio of K2/K1 is defined as the transfer gain, K3. The transfer gain can rewritten as:

$$\frac{Vo}{Vin} = K3 \times \frac{R2}{R1} \qquad (9)$$

The coupler's transfer gain (K3) is determined by the bifurcation of the LED's optical path within the coupler package. The time, temperature, and LED current have little effect on the transfer gain (Figure 7).

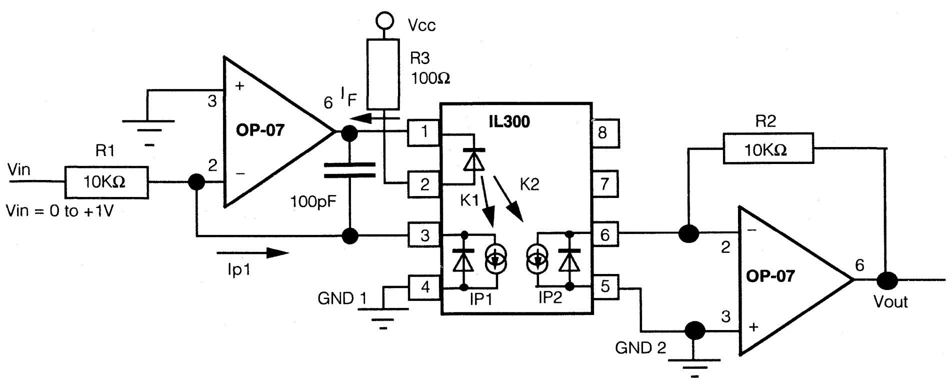


Figure 6. Optical Feedback Amplifier

Application Notes 11

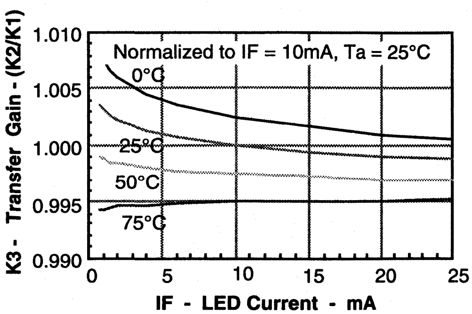


Figure 7. IL300 Transfer Gain, K3

Figure 7 shows that the IL300's gain typically varies by only ±0.2% over an LED current range of 5 to 20 mA and has a temperature stability of ±50 ppm/°C.

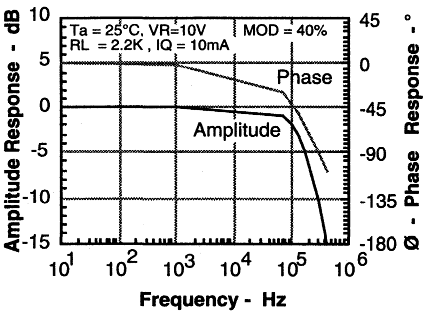


Figure 8. IL300 Frequency and Phase Response

Figure 8 shows the frequency and phase response curve that shows the –3 dB point and a phase shift of 45° occurs at a frequency in excess of 100 KHz.

The optical feedback technique greatly improves the main characteristic needed for a feedback amplifier used in a linear power supply.

Mains Isolated Switching Power Supply

Today's mains connected switch mode power supplies require an insulated and isolated output voltage control method. Standard phototransistor optocoupler are one of the various techniques used to effect this regulation. With the goal of high switching frequencies the use phototransistor is being pushed to its frequency response limits. Most power supply designers have found that gain and phase flatness can only be assured to operating frequencies of ≤10 KHz. Given these limitations designers are considering the optical feedback optocoupler.

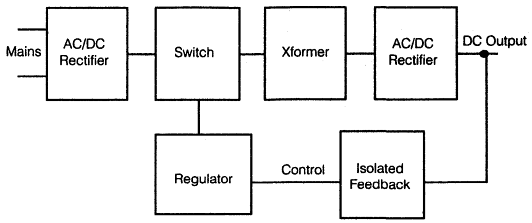


Figure 9. SMPS Block Diagram

Figure 9 shows a block diagram of a typical SMPS. The isolated feedback section can be viewed as an isolated piece of wire connecting the DC output to the control pin of the switch mode regulator. A simple design using a LM201 low cost differential op-amp is shown in Figure 10. R1 and R2 function as a voltage divider, dividing the +5 V supply output to 3 V. The servo/feedback photodiode sources a feedback current (IP1) to R1 (30 KΩ). This resistor will develop 3 V when 100 μA flows through it. With K3=1 a similar value of 100 μA will flow through R5 (30 KΩ). Thus IP2 of 100 μA will develop the 3 V DC signal needed by the control pin of the regulator. Figure 11 shows the DC response of this amplifier. Figure 12 shows the phase and frequency response.

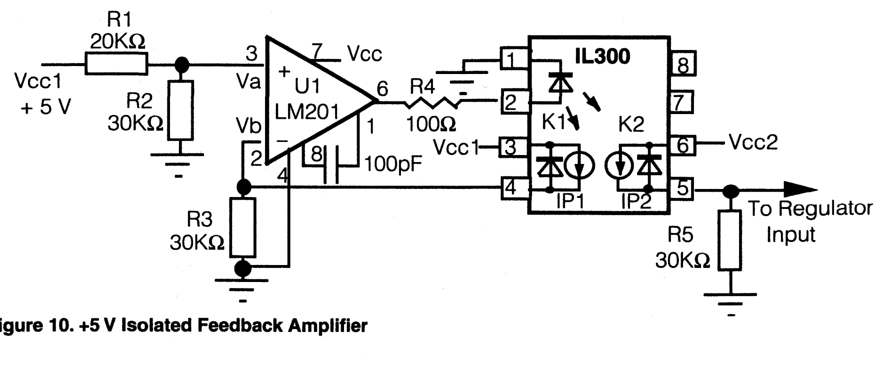


Figure 10. +5 V Isolated Feedback Amplifier

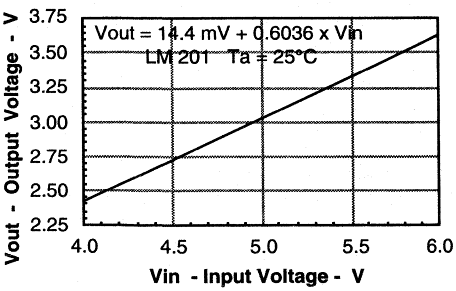


Figure 11. LM201 DC Transfer Gain

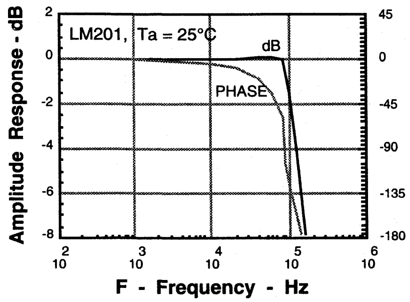


Figure 12. LM201 Phase and Frequency Response

This feedback circuit offers linearity and gain accuracy of ±0.02% over a 4.0 V to 6.0 V input, Figure 13.

The previous examples used differential amplifiers as the summing device. It is possible to configure a single input DC amplifier that will perform the sample optical servo control. One such design is shown in Figure 14.

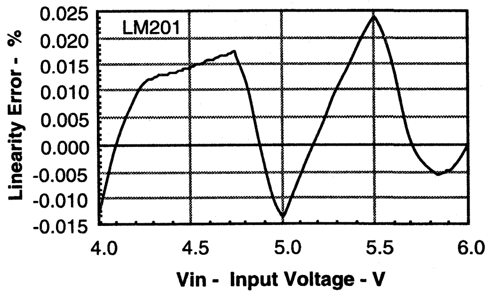


Figure 13. LM201 Linearity Error

Figure 14 shows a DC coupled current feedback amplifier. Q1 and Q2 form the gain stages. The feedback photocurrent, IP, is supplied to the summing network at Va. By inspection the nodal equation indicates that the photocurrent will be that necessary to create a 2 Vbe drop across R1. The input resistor is also sourcing current to this node. Thus as the input voltage rises the photocurrent will drop, for this reason this amplifier functions as an inverting amplifier. The frequency response and phase response for Figure 14 is shown in Figure 15.

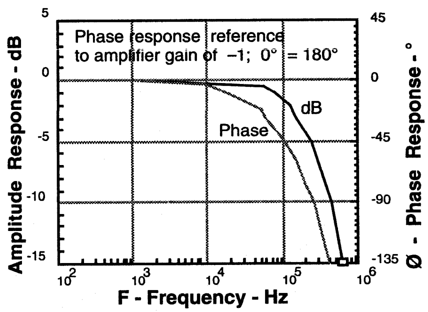


Figure 15. Discrete Isolation Phase and Frequency Response

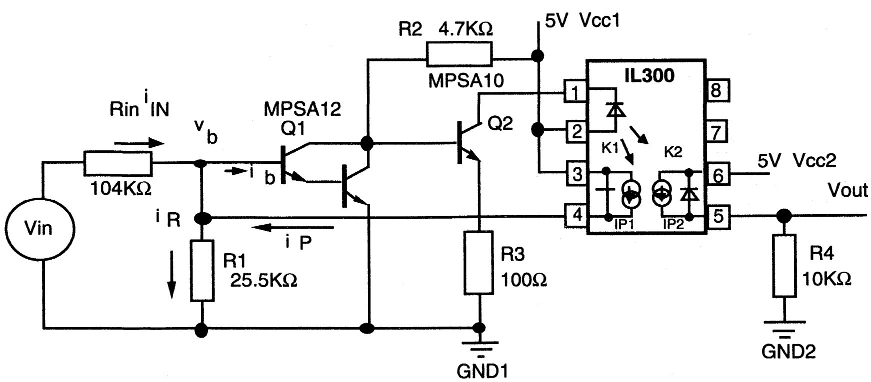


Figure 14. Discrete Isolation Amplifier

Application Notes 11

Given this circuit's simplicity, gain accuracy and linearity are not compromised. The linearity error for this amplifier is ±0.015% as shown in Figure 16.

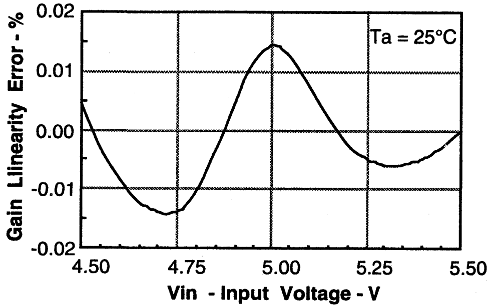


Figure 16. Discrete Isolation Linearity Error

Most power supply designers are familiar with TL431 and LM4041 precision adjustable zener diode. When you look more closely at the internal operation of this device you will find that it too can function as a optical feedback amplifier for the IL300, Figure 17.

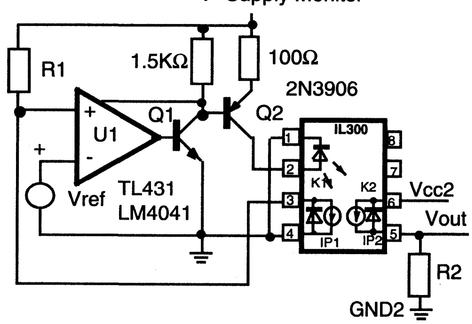


Figure 17. Shunt Voltage Regulator

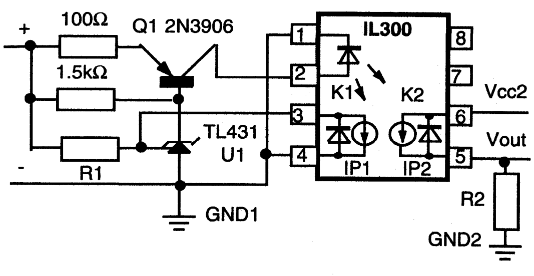


Figure 18. Shunt Voltage Regulator Isolation Amplifier

The three terminal regulators includes U1, Q1, and the precision reference, Vref. The linear coupler will supply sufficient photocurrent to develop a difference voltage across R1. The transfer equation for this amplifier is given in equation 10.

$$\frac{Vo}{Vmon - Vref} = \frac{R2}{R1} \times K3 \qquad (10)$$

The precision voltage reference (Vref) is 2.5 volts for the TL43. When lower voltage supplies, i.e., 3.3 volts are to be regulated, the new LM4041 with a reference of 1.225 volts can be used.

The designer may be more familiar with the circuit schematic shown in Figure 18.

Conclusion

This appnote was a generic presentation of the DC model of the standard phototransistor. Most designers have overcome many of standard phototransistor's temperature and initial gain variations by selecting well specified couplers such as the CNY17-X family.

When wider bandwidth and greater gain stability is required power supply designers are using the new optical feedback linear optocouplers. The circuits provided and their performance characteristic will satisfy even the most demanding high frequency SMPS applications.

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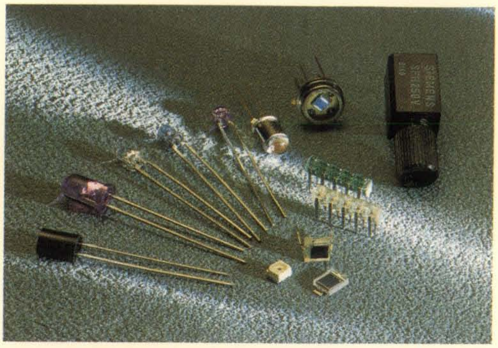

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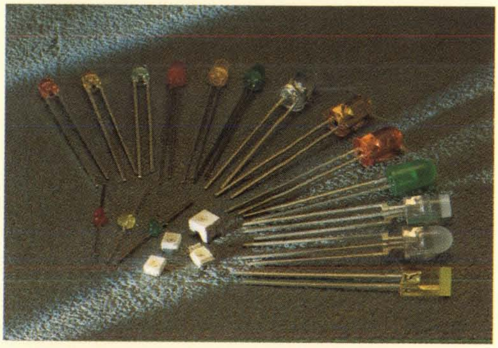

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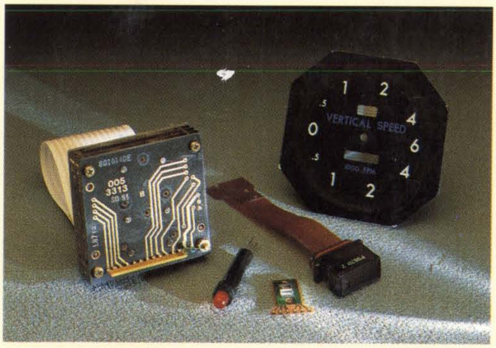

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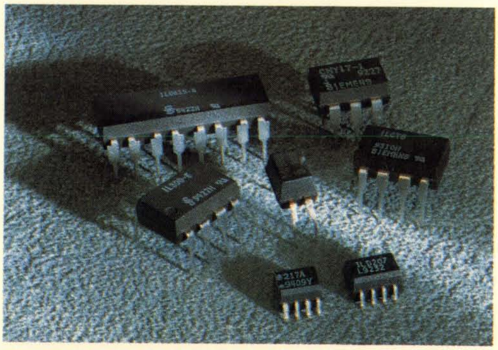

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