GENERAL INSTRUMENT

Catalog of Optoelectronic Products 1980

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About General Instrument Optoelectronics

Monsanto Optoelectronics

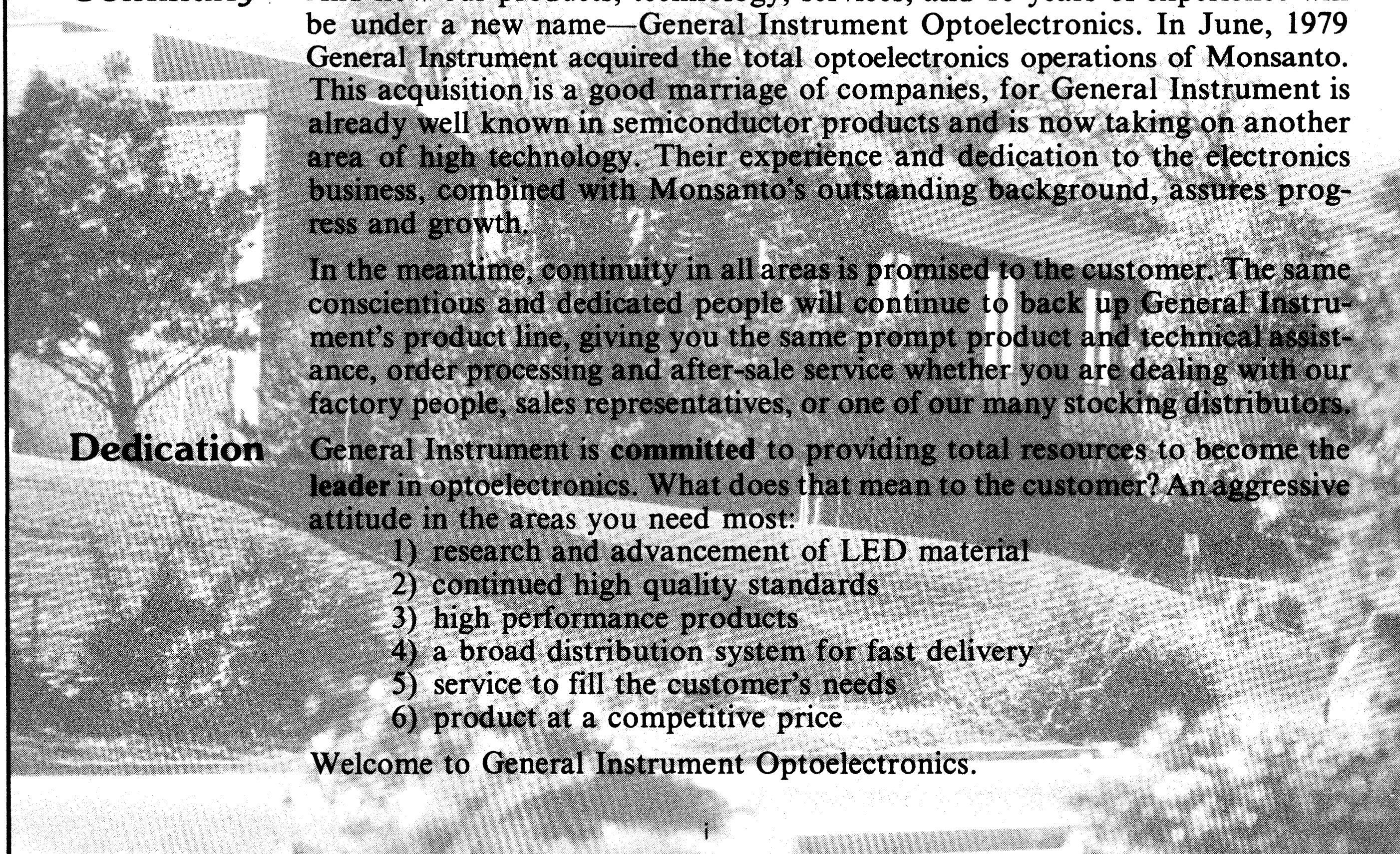
Experience

In 1969, when Monsanto entered into the world of optoelectronics, LED technology was crude, products were few, and experience limited. Since that time, Monsanto has developed into a leader in the marketplace. A leader because Monsanto has constantly sought innovation in product through research, and development.

10 years of effort are reflected in our experience in III-V material technology and development of optoelectronic products. The result—a continuing series of "firsts" in LED lamps, displays, and optoisolators.

Today, you can select from over 150 high performance devices in our product line. And no matter which product you choose, you are assured of high quality—quality that is designed into the product.

General Instrument Optoelectronics, Successor to Monsanto Optoelectronics



Continuity

And now our products, technology, services, and 10 years of experience will be under a new name—General Instrument Optoelectronics. In June, 1979 General Instrument acquired the total optoelectronics operations of Monsanto. This acquisition is a good marriage of companies, for General Instrument is already well known in semiconductor products and is now taking on another area of high technology. Their experience and dedication to the electronics business, combined with Monsanto's outstanding background, assures progress and growth.

In the meantime, continuity in all areas is promised to the customer. The same conscientious and dedicated people will continue to back up General Instrument's product line, giving you the same prompt product and technical assistance, order processing and after-sale service whether you are dealing with our factory people, sales representatives, or one of our many stocking distributors.

Dedication

General Instrument is **committed** to providing total resources to become the **leader** in optoelectronics. What does that mean to the customer? An aggressive attitude in the areas you need most:

1) research and advancement of LED material
2) continued high quality standards
3) high performance products
4) a broad distribution system for fast delivery
5) service to fill the customer's needs
6) product at a competitive price

Welcome to General Instrument Optoelectronics.

Customer Information

General Instrument Optoelectronics offers a complete sales network that is specifically organized to service the customer.

Distributors
(page 253)

Stocking distributors are located throughout the world—

United States, Brazil, Canada, Europe,
Africa, Japan, Australia

to provide the customer with immediate availability of product quantities of most standard products.

Sales Representatives
(page 253)

A large organization of highly qualified technical sales engineers is immediately available in all areas to offer assistance in design, concept, and product selection.

Product Marketing

An internal staff of product marketing personnel is available to provide further factory assistance. Organized by product area, they offer the customer broad experience and knowledge at the factory level.

Applications Engineering

Providing complete backup for applications assistance or discussion of specific problems, General Instrument engineers ensure that the customer has all information sources available to him.

About this Catalog

The General Instrument Optoelectronics catalog describes in detail our complete line of optoelectronic devices.

All of General Instrument's optoelectronic devices have been designed with your needs in mind, and offer you the easiest to use, and most available products on the market today. Using this directory, you should be able to meet virtually any requirement you will have for visible and infrared light emitting diodes; seven segment and alphanumeric displays; optoisolators; and emitters, detectors and sensors.

For your convenience, this catalog is divided into the five major product groups listed above. At the beginning of each product section you will find a selection guide which provides brief basic information on that product line to assist you in selecting the device best suited to your requirements. Full specification sheets are located further within that section.

For fast reference, an alpha-numeric product listing appears on page vii which lists all products individually, with applicable data sheet page numbers.

At the end of this catalog there is a technical section of application notes that will assist you in areas from testing to selecting your devices.

You should be able to find just what you need in this catalog. And we think you'll like what you find.

Thank you for your interest in General Instrument optoelectronic devices.

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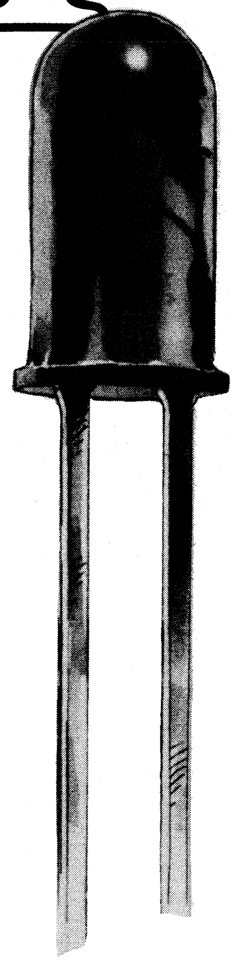
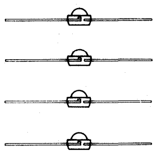
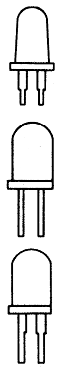
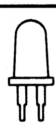
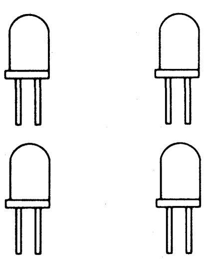
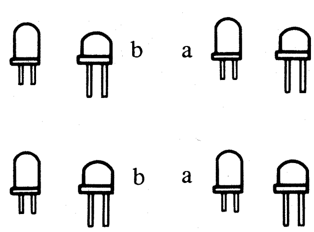
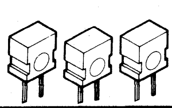
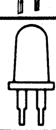
*For applications information in more detail, order a copy of "General Instrument Optoelectronics Applications Guide" (MAG-100) from your local stocking distributor. Price: $4.95.

Alpha-Numeric Product Listings

1 LED Lamps



PACKAGE SIZE (UNITS SHOWN ACTUAL SIZE)	DEVICE NO.	VIEWED COLOR/ LENS COLOR or EFFECT	LUMINOUS INTENSITY @ FORWARD CURRENT	VIEWING ANGLE
TO-18 	MV10B	Red/Clear	0.8 mcd @ 10mA	90°
T-¾ 	MV50 MV52 MV53 MV54	Red/Clear Green/Clear Yellow/Clear Red/Flooded	1.4 mcd @ 20mA 1.5 mcd @ 20mA 1.5 mcd @ 20mA 1.0 mcd @ 20mA	80°
T-¾ 	MV55A	Bright Red	0.5 mcd @ 3mA	40°
T-1¾* 	MV5020 MV5021 MV5022 MV5023 MV5024 MV5025 MV5026	Red/Clear Red/Soft Red/Point Red/Soft Red/Soft Red/Flooded Red/Flooded	2.0 mcd @ 20mA 1.6 mcd @ 20mA 1.6 mcd @ 20mA 1.6 mcd @ 20mA 3.0 mcd @ 20mA 0.4 mcd @ 20mA 0.6 mcd @ 20mA	90° 90° 90° 90° 60° 180° 90°
	MV5050 MV5051 MV5052 MV5053 MV5055 MV5056	Red/Clear Red/Soft Red/Point Red/Flooded Red/Flooded Red/Flooded	2.0 mcd @ 20mA 1.6 mcd @ 20mA 2.0 mcd @ 20mA 1.6 mcd @ 20mA 0.6 mcd @ 20mA 0.8 mcd @ 20mA	50° 72° 72° 80° 150° 110°
	MV5054-1 MV5054-2 MV5054-3	Red	2.0 mcd @ 10mA 3.0 mcd @ 10mA 4.0 mcd @ 10mA	40°
T-1 	MV5074B/C MV5075B/C	Red	2.5 mcd @ 20mA 1.6 mcd @ 20mA	70° 90°
	MV5077B/C		1.7 mcd @ 20mA	110°
T-1¾* 	MV5094	Red	0.8 mcd @ 20mA	50°
T-1¾* 	MV5152 MV5153 MV5154	Orange	40.0 mcd @ 20mA 6.0 mcd @ 20mA 10.0 mcd @ 20mA	28° 65° 24°
	MV5252 MV5253 MV5254	Green	15.0 mcd @ 20mA 3.5 mcd @ 20mA 3.0 mcd @ 20mA	28° 65° 24°
	MV5352 MV5353 MV5354	Yellow	45.0 mcd @ 20mA 8.0 mcd @ 20mA 10.0 mcd @ 20mA	28° 65° 24°
	MV5752 MV5753 MV5754	Bright Red	40.0 mcd @ 20mA 9.0 mcd @ 20mA 10.0 mcd @ 20mA	28° 65° 24°
T-1 	(a) MV5174B/C (b) MV5177B/C	Orange	5.0 mcd @ 20mA 3.0 mcd @ 20mA	90° 180°
	(a) MV5274B/C (b) MV5277B/C	Green	1.8 mcd @ 20mA 0.9 mcd @ 20mA	90° 180°
	(a) MV5374B/C (b) MV5377B/C	Yellow	4.0 mcd @ 20mA 2.0 mcd @ 20mA	90° 180°
	(a) MV5774B/C (b) MV5777B/C	Bright Red	5.0 mcd @ 20mA 3.0 mcd @ 20mA	90° 180°
RECTANGULAR* 	MV52124 MV53124 MV57124	Green Yellow Bright Red	3.0 mcd @ 20mA 4.0 mcd @ 20mA 4.0 mcd @ 20mA	100°
T-1¾* 	MV5491	Green/ Red	0.5 mcd @ 20mA 1.5 mcd @ 20mA	50°

*POP-INS ARE AVAILABLE ON THESE PRODUCTS.

MAX. POWER	MAX. DC CURRENT	FORWARD VOLTAGE		APPLICATIONS
175mW	70mA	1.65V		General purpose indicator lights compatible with Bipolar IC's.
80mW	40mA	1.65V		Indicator lights, diagnostic and panel displays, printed circuit board indicators, miniature low profile package.
105mW	35mA	2.20V		
105mW	35mA	2.10V		
80mW	40mA	1.65V		
6mW	4mA	1.60V		Diagnostic or indicator lights in low-power/low current environments, MOS compatible
180mW	100mA	1.65V		Instruments, printed circuit board indicators, board-mounted panel display, different lens effect and viewing angles. MV5020 series offers leads with standoffs for assembly ease. General purpose indicators.
		1.70V		
		1.80V		
100mW	50mA	1.68V		General purpose indicators, developmental projects, breadboards.
				Miniature indicators, breadboards, test jigs. Low profile.
140mW	70mA	1.60V		High voltage bi-directional AC indicators, power supplies, transformers.
105mW	35mA	2.00V		Computers, general purpose indicators, instruments, test systems, mini- and micro-processors, process controlled industrial systems, sorting machines, assembly equipment, vending machines, telephone equipment, backlight panels. High intensity indicators in four colors.
		2.20V		
		2.10V		
		2.00V		
		2.00V		Portable equipment, general purpose indicators and matrix panel displays, test equipment and systems, sorting machines, vending machines. High intensity indicators in four colors.
		2.20V		
		2.10V		
		2.00V		
105mW	35mA	2.00V		Legend backlight, panel indicator, bar graph, display button. Mounting hardware available.
200mW	35mA 70mA	3.00V 1.65V		Polarity indication tri-state indicator, flow direction display, instruments, tester displays, educational aids.

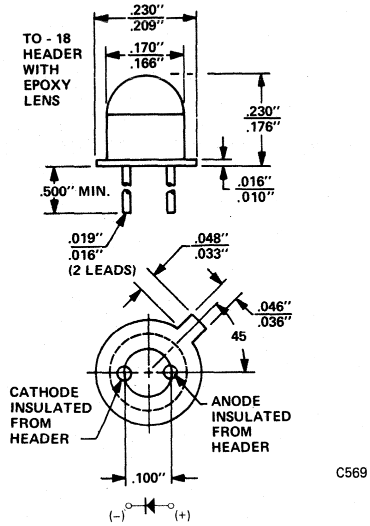
GENERAL INSTRUMENT
Optoelectronics

MV10B
RED LED

PRODUCT DESCRIPTION

The MV10B is a GaAsP light emitting diode mounted on a TO18 header with a clear epoxy lens. On forward bias, it emits a spectrally narrow band of radiation which peaks at 660 nm.

PACKAGE DIMENSIONS



FEATURES

- Ultra High Brightness
- Long Life – Solid State Reliability
- Low Power Requirements
- Compatible with Integrated Circuits – DTL, RTL, T^2L.
- Compact, Rugged, Lightweight.

ABSOLUTE MAXIMUM RATINGS

Power Dissipation @ 25°C Ambient Temperature	175mW
Derate Linearly from 25°C	2.33mW/°C
Storage & Operating Temperature	-55°C to +100°C
Lead Solder Time @ 260°C (See note 2)	7.0 s
Continuous Forward Current	70mA
Peak Forward Current (1 μsec pulse, 0.3% duty cycle)	1.0A
Reverse Voltage	5.0V

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

CHARACTERISTICS	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity (see note 1)	0.8		mcd	I_F = 10 mA
Peak emission wave length	660	700	nm	
Spectral line half width	20		nm	
Forward voltage	1.65	2.0	V	I_F = 50 mA
Forward dynamic resistance	2.0		Ω	I_F = 50 mA
Capacitance	135		pF	V = 0

ELECTRO-OPTICAL CHARACTERISTICS (Continued)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Light rise time and fall time		50		ns	50Ω system, I_F = 50 mA
Reverse current		50		nA	V_R = 3.0 V
Reverse breakdown voltage	3	15		V	I_R = 100 μA
Luminous Flux		3.7		mLumens	I_F = 50 mA
View angle		90		Degrees	Between 50% Points

TYPICAL THERMAL CHARACTERISTICS

Thermal Resistance Junction to Free Air (θ_{JA})	320° C/W
Thermal Resistance Junction to Case (θ_{JA}	155° C/W
Wavelength Temperature Coefficient (case temperature)	0.3 nm/°C
Forward Voltage Temperature Coefficient	−2.0 mV/°C

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS CURVES

(25°C Free Air Temperature)

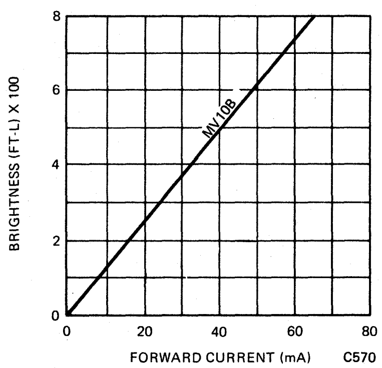


Figure 1 Brightness vs. Forward Current

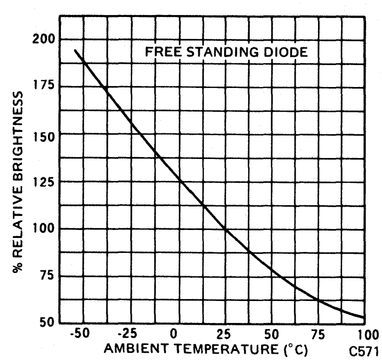


Figure 2 Brightness vs. Temperature

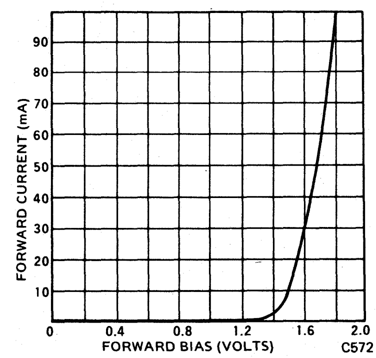


Figure 3 Forward Current vs. Forward Voltage

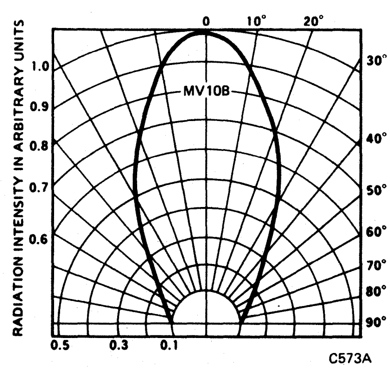


Figure 4 Spatial Distribution (Note 3)

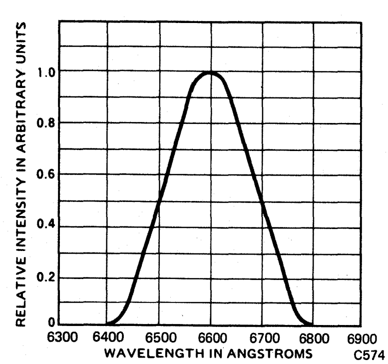


Figure 5 Spectral Distribution

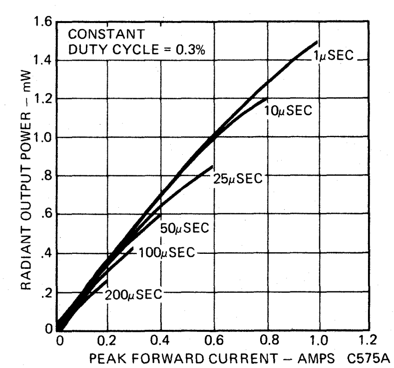


Figure 6 Peak Power Output vs. Pulsed Forward Current

NOTES

1. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The leads of the MV10B were immersed in molten solder, heated to 260°C, to a point 1/16-inch from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*
3. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*

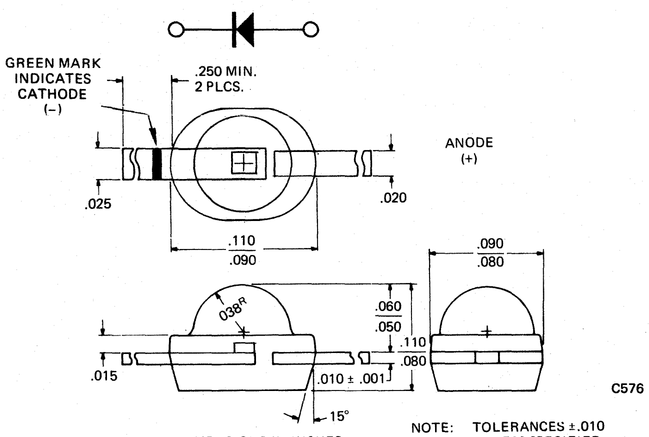
GENERAL INSTRUMENT
Optoelectronics

MV50
MV54
RED LED

PRODUCT DESCRIPTION

The MV50 and MV54 are diffused Gallium Arsenide Phosphide diodes mounted in a two lead epoxy package; the MV50 has a clear lens; the MV54 is red diffused. On forward bias they emit a spectrally narrow band of visible light which peaks at 660 nm. (Also see MV55A.)

PACKAGE DIMENSIONS



NOTE: ALL DIMENSIONS IN INCHES

NOTE: TOLERANCES ±.010 UNLESS SPECIFIED

FEATURES

The MV50 and MV54 are intended for high volume indicator light applications where low cost, high reliability, and top performance are required. Major usage is in applications such as diagnostic lights on printed circuit boards and panel lights. They can be used to displace subminiature lamps as small as T3/4 size.

- Low cost
- Bright
- Compatible with integrated circuits
- Long life, rugged
- Small size – T3/4
- Easily assembled in arrays

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient . . . 80 mW
Derate linearly from 25°C . . . 1.6 mW/°C
Storage and operating temperature . . . –55°C to 100°C
Peak forward current (1 μsec pulse width, 0.3% duty cycle) . . . 1.0A
Lead solder time @ 230° (note 1) . . . 5 sec
Continuous forward current . . . 40 mA
Reverse Voltage . . . 5.0 V

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

CHARACTERISTICS	MINIMUM		TYPICAL		MAXIMUM	UNITS	TEST CONDITIONS
	MV50	MV54	MV50	MV54	MV50/54		
Luminous Intensity (note 2)*	0.5	0.4	1.4	1.0		mcd	I_F = 20 mA
Peak emission wavelength			660	660		nm	I_F = 20 mA
Spectral line halfwidth			20	20		nm	I_F = 20 mA
Forward voltage			1.65	1.65	2.0	V	I_F = 20 mA
Capacitance			80	80		pF	V = 0
Rise and fall time			50	50		ns	50Ω system, I_F = 20 mA
Reverse current			5.0	5.0		nA	V_R = 3.0 V
Reverse breakdown voltage	5		15	15		V	I_R = 100 μA
View angle			80	80		degrees	between 50% points

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

TYPICAL THERMAL CHARACTERISTICS

Wavelength temperature coefficient (case temperature) . . . . 0.3 nm/°C
Forward voltage temperature coefficient . . . . -2.0 mV/°C

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature)

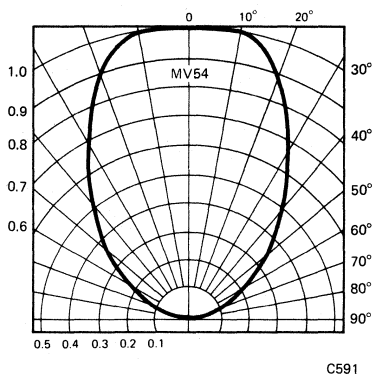


Figure 1 Spatial Distribution (Note 3)

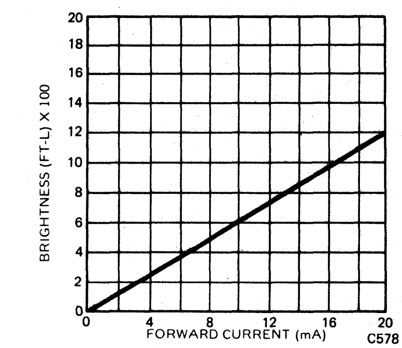


Figure 2 Brightness vs. Forward Current

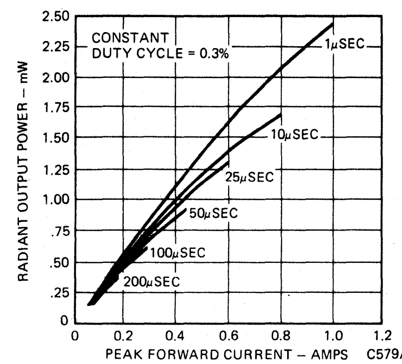


Figure 3 Peak Power Output vs. Pulsed Forward Current

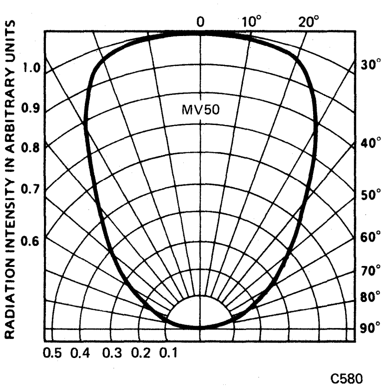


Figure 4 Spatial Distribution (Note 3)

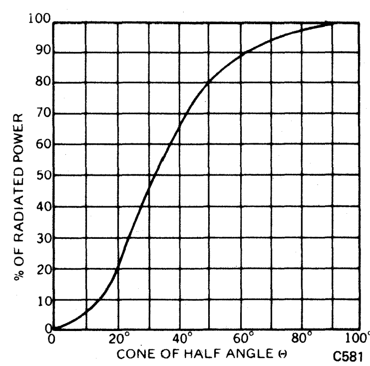


Figure 5 Percent Radiated Power Into Cone of Half Angle

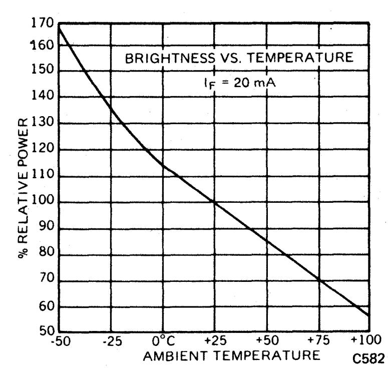


Figure 6 Relative Power vs. Temperature

NOTES

1. *The leads of the device were immersed in molten solder at 230°C to a point 1/16 inch from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*
2. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
3. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*

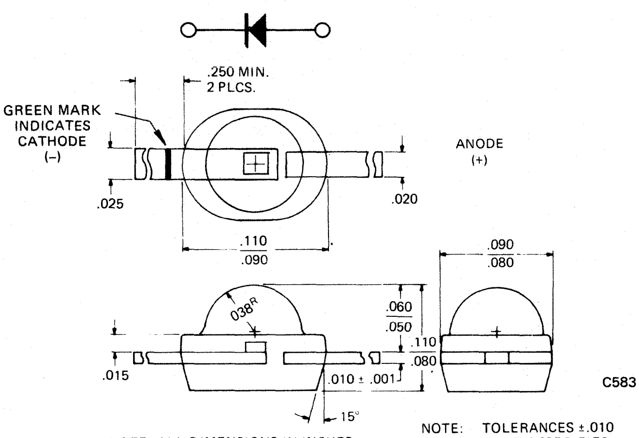
GENERAL INSTRUMENT
Optoelectronics

GREEN MV52
YELLOW MV53
LIGHT EMITTING DIODES

PRODUCT DESCRIPTION

The MV52 is a Gallium Phosphide diode mounted in a two lead green epoxy package. The MV53 is a Gallium Arsenide Phosphide diode mounted in a two lead yellow epoxy package. The identical mechanical configuration is also available in a red lamp, part number MV50 or MV54.

PACKAGE DIMENSIONS



NOTE: ALL DIMENSIONS IN INCHES

NOTE: TOLERANCES ±.010 UNLESS SPECIFIED

FEATURES

The MV52 and MV53 units are intended for high volume indicator light applications where high reliability and top performance are required. Major usage is in applications such as diagnostic lights on printed circuit boards and panel lights. The units can be used to displace subminiature lamps as small as T3/4 size.

- MULTICOLORED VERSIONS OF THE POPULAR MV50 PACKAGE
- Low cost
- Bright
- Compatible with integrated circuits
- Long life, rugged
- Small size — T3/4

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient	105 mW
Derate linearly from 25°C	1.3 mW/°C
Storage and operating temperature	–55°C to 100°C
Lead solder time @ 230°C (See note 3)	5 sec
Continuous forward current	35 mA
Reverse Voltage	5.0 V

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

CHARACTERISTICS	MINIMUM	TYPICAL	MAXIMUM	UNITS	TEST CONDITIONS
Luminous Intensity (Note 1)*	0.2	1.0		mcd	I_F = 20 mA
Peak emission wavelength, MV52		565		nm	I_F = 20 mA
Peak emission wavelength, MV53		589		nm	I_F = 20 mA
Spectral line halfwidth MV52, MV53		35		nm	I_F = 20 mA
Forward voltage MV52		2.2	3.0	V	I_F = 20 mA
MV53		2.1	3.0	V	I_F = 20 mA
Reverse breakdown voltage	5	15		V	I_R = 100 μA
Forward voltage temp. coefficient		–3.0		mV/°C	I_F = 20 mA
Viewing angle		80		degrees	between 50% points

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES
(25°C Free Air Temperature)

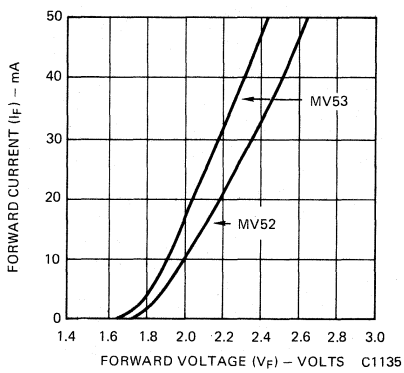


Fig. 1. Forward Current vs. Forward Voltage

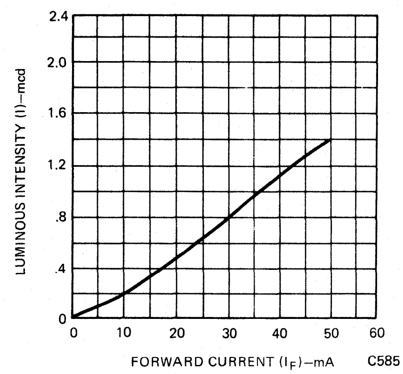


Fig. 2. Luminous Intensity vs. Forward Current

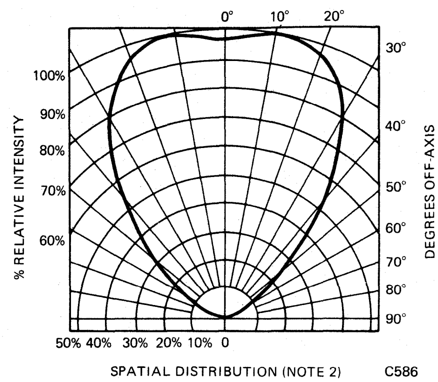


Fig. 3 Spatial Distribution (Note 2)

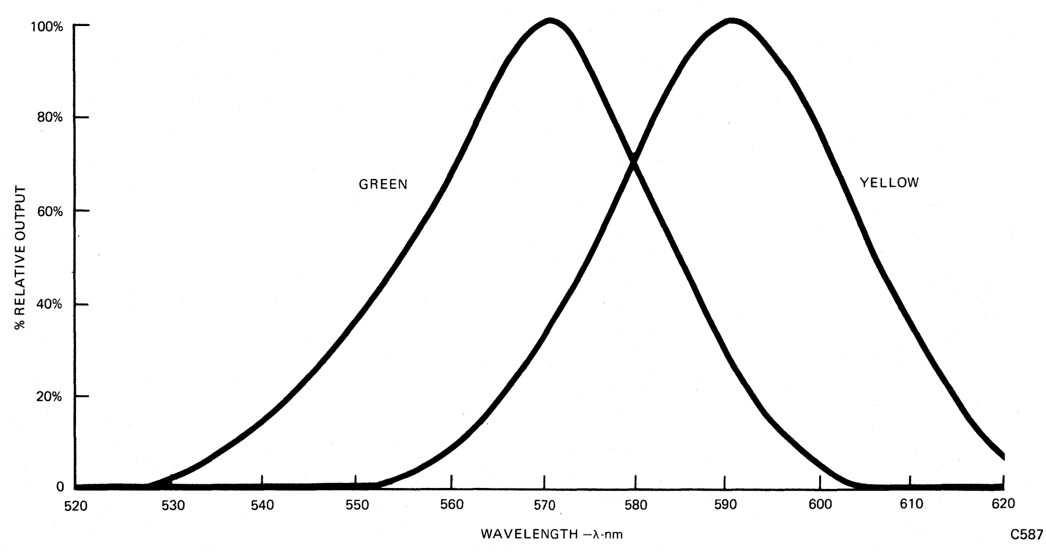


Fig. 4. MV52-MV53 Spectral Response

NOTES

1. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*
3. *The leads of the device were immersed in molten solder at 230°C to a point 1/16 inch from the body of the device per MIL-S-750 with a dwell time of 5 seconds.*

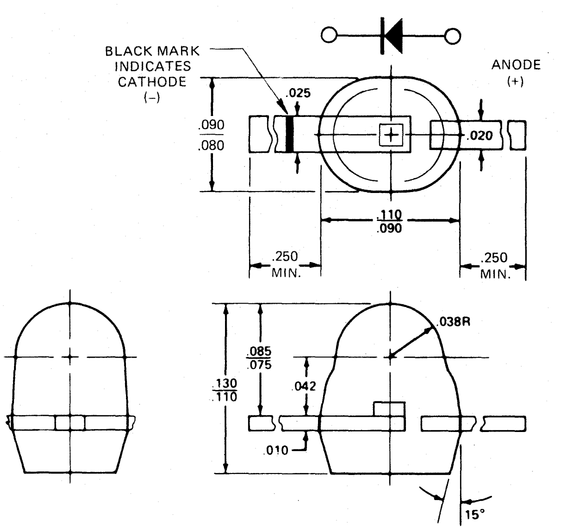
GENERAL INSTRUMENT
Optoelectronics

MV55A
RED LED

PRODUCT DESCRIPTION:

The MV55A is a gallium arsenide phosphide device useful for low current drive (5 mA) applications, such as diagnostic functions or indicators.

PACKAGE DIMENSIONS



NOTE: TOLERANCE ±.010
UNLESS SPECIFIED

C593

FEATURES

MV55A is intended as a low cost, high reliability indicator lamp.

- Low cost
- Compatible with integrated circuits.
- Small size
- High on axis intensity.
- 2 Gate Load Bright Light
- MOS compatible

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient . . . . 105 mW
Derate linearly from 25°C. . . . . 1.3 mW/°C
Storage & operating temperature . . . . –55°C to 100°C
Lead solder time @ 230°C (See Note 1) . . . . 5 sec.
Continuous forward current . . . . 35 mA
Reverse voltage . . . . 5.0 V
Peak forward current (1 μsec pulse, 0.1% duty cycle) . . . . 400 mA

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity (Note 3)*	0.2	0.5		mcd	I_F = 5.0 mA
		2.0		mcd	I_F = 20 mA
Peak emission wave length		635		nm	
Spectral line half-width		45		nm	
Forward voltage		1.6	2.0	V	I_F = 5.0 mA
		2.2		V	I_F = 20 mA
Reverse current		.15	10	μA	V_R = 3.0 volts
Light turn-on and turn-off		1		ns	Z = 1Ω system
Capacitance		20		pF	V = 0
Reverse breakdown voltage	3			V	I_F = 10 μA

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature)

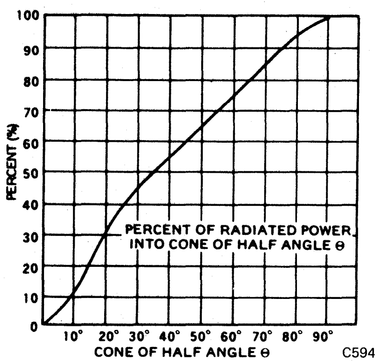


Figure 1

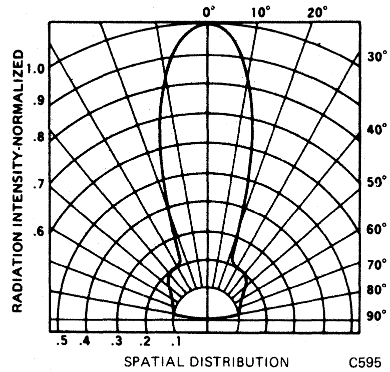


Figure 2 (Note 2)

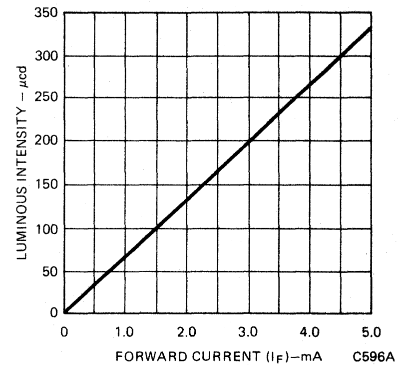


Fig. 3 Luminous Intensity vs. Forward Current

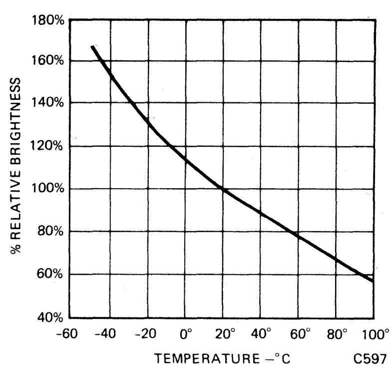


Fig. 4 Relative Output vs. Temperature

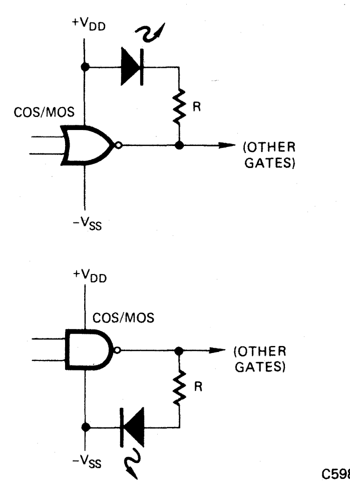


Fig. 5 MV55A Interfaced with COS/MOS

NOTES

1. *The leads of the device were immersed in molten solder, heated to a temperature of 230°C, to a point 1/16 inch from the body of the device per MIL-S-750, with dwell time of 5 sec.*
2. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*
3. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*

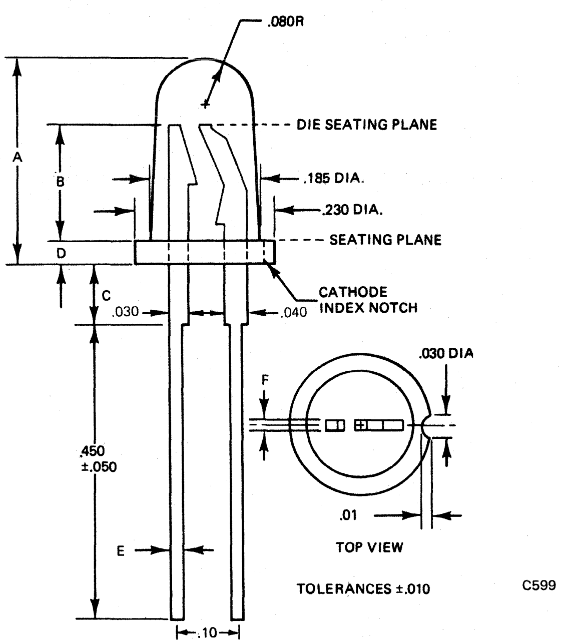
GENERAL INSTRUMENT
Optoelectronics

MV5020 SERIES
RED SOLID STATE LAMPS

PRODUCT DESCRIPTION

The MV5020 series of solid state indicators is made with gallium arsenide phosphide light-emitting diodes. Encapsulation and lens is epoxy. Various lens effects are available for many indicator applications.

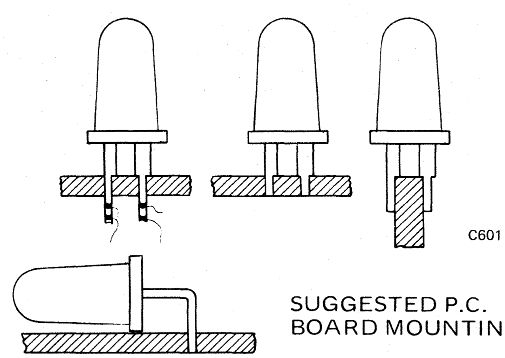
PACKAGE DIMENSIONS



FEATURES

- Low cost
- High intensity red light source with various lens colors and effects
- Versatile mounting on PC board or panel
- Snap in panel mounting clip available (See MP21 and MP22 for clip detail)

BOARD MOUNTING



SUGGESTED P.C.
BOARD MOUNTING

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient	180 mW
Derate linearly from 25°C	2 mW/°C
Storage and operating temperatures	–55°C to 100°C
Lead solder time @ 260°C (Note 2)	5 sec
Continuous forward current @ 25°C	100 mA
Continuous forward current @ 100°C	20 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle)	1.0 A
Reverse voltage	5.0 V

PHYSICAL CHARACTERISTICS

TYPE	A	B	C	D	E & F	SOURCE COLOR	LENS COLOR	LENS EFFECT	POP-IN MOUNTING	CIRCUIT BOARD MOUNTING
MV5020	.340	.190	.100	.040	.025	RED	CLEAR	POINT	X	X
MV5021	.340	.190	.100	.040	.025	RED	CLEAR DIFF.	SOFT	X	X
MV5022	.340	.190	.100	.040	.025	RED	TRANS. RED	POINT	X	X
MV5023	.340	.190	.100	.040	.025	RED	RED DIFF.	SOFT	X	X
MV5024	.340	.160	.130	.040	.025	RED	RED DIFF.	SOFT FLOODED	X	X
MV5025	.340	.160	.130	.040	.025	RED	RED DIFF.	FLOODED	X	X
MV5026	.340	.160	.130	.040	.025	RED	DK. RED DIFF.	FLOODED	X	X

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

PARAMETER		TEST COND.	UNITS	5020	5021	5022	5023	5024	5025	5026
Luminous Intensity—Min. (Note 1)*		20 mA	mcd	0.6	0.5	0.6	0.4	0.9	0.1	0.1
Typ. (Note 1)		20 mA	mcd	2.0	1.6	1.6	1.6	3.0	.4	.6
Peak Wave Length		20 mA	nm	660	660	660	660	660	660	660
Spectral Line Half Width		20 mA	nm	20	20	20	20	20	20	20
Forward Voltage	Typ.	20 mA	V	1.65	1.65	1.65	1.65	1.65	1.65	1.65
VF	Max.	20 mA	V	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Reverse Current IR	Typ.	V_R = 5.0 V	nA	15	15	15	15	15	15	15
	Max.	V_R = 5.0 V	μA	100	100	100	100	100	100	100
Reverse Voltage VR	Min.	I_R = 100μA	V	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	Typ.	I_R = 100μA	V	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Capacitance	Typ.	V = 0	pF	35	35	35	35	35	35	35
View Angle		Between 50% Points	Degrees	90	90	90	90	60	180	90
Rise Time		10%-90% 50Ω system	nsec	50	50	50	50	50	50	50
& Fall Time	Typ.	90%-10% 50Ω system	nsec	50	50	50	50	50	50	50

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS

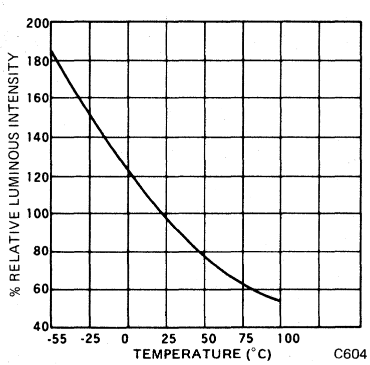


Fig. 1. Luminous Intensity vs. Temperature

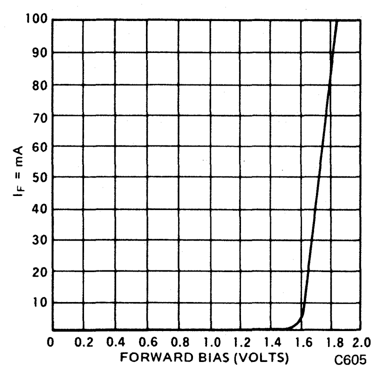


Fig. 2. Forward Current vs. Forward Voltage

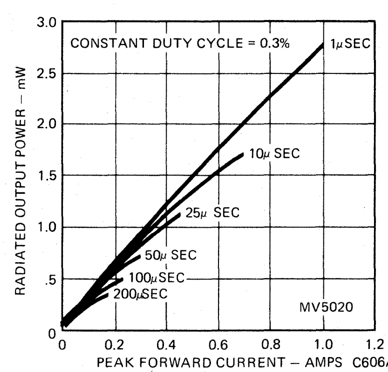


Fig. 3. Radiated Output Power vs. Peak Forward Current

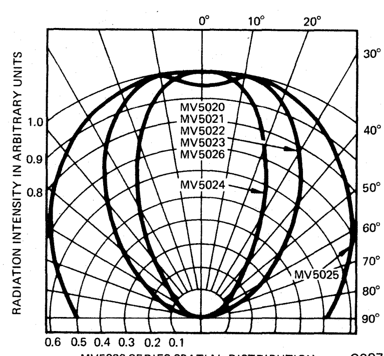


Fig. 4. Spatial Distribution

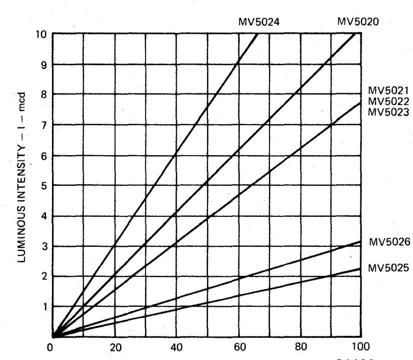


Fig. 5. Luminous Intensity vs. Forward Current

NOTES

1. *As measured with a Photo Research Corp., "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The leads of the device were immersed in molten solder at 260°C to a point 1/16 inch from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

GENERAL INSTRUMENT
Optoelectronics

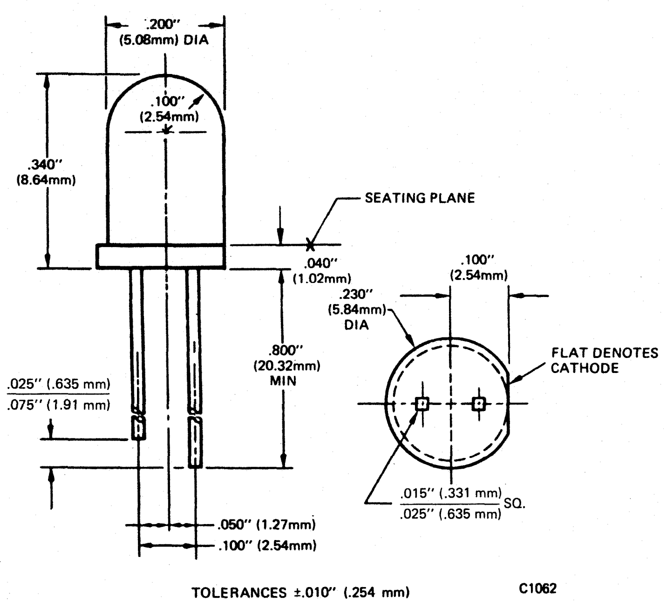
RED SOLID STATE LAMPS

MV5050 MV5053 MV5051 MV5055 MV5052 MV5056

PRODUCT DESCRIPTION

The MV5050 series of solid state indicators is made with Gallium Arsenide Phosphide light emitting diodes encapsulated in epoxy lenses. Various lens effects are pleasing in different design settings.

PACKAGE DIMENSIONS



FEATURES

- High intensity red light source with various lens colors and effects
- Versatile mounting on P.C. board or panel
- Snap in mounting grommet available on request
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight
- Upon request, also available with anode lead trimmed longer than cathode.

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	POP-IN MOUNTING	CIRCUIT BOARD MOUNTING
MV5050	Red	Clear	Point	X	X
MV5051	Red	Diffused	Soft	X	X
MV5052	Red	Trans. Red	Point	X	X
MV5053	Red	Red Diffused	Flooded	X	X
MV5055	Red	Red Diffused	Flooded	X	X
MV5056	Red	Dark Red Diffused	Flooded	X	X

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

PARAMETER	TEST COND.	UNITS	5050	5051	5052	5053	5055	5056
Forward Voltage (V_F)								
Typ.	I_F = 20 mA	V	1.7	1.7	1.7	1.7	1.7	1.7
Max.	I_F = 20 mA	V	2.2	2.2	2.2	2.2	2.2	2.2
Luminous Intensity* (See note 1)								
Typ.	I_F = 20 mA	mcd	2.0	1.6	2.0	1.6	.6	.8
Min.	I_F = 20 mA	mcd	0.5	0.4	0.7	0.5	0.1	0.2
Peak Wave Length	I_F = 20 mA	nm	670	670	670	670	670	670
Spectral Line Half Width	I_F = 20 mA	nm	20	20	20	20	20	20
Capacitance								
Typ.	V = 0	pF	30	30	30	30	30	30
Reverse Voltage (V_R)								
Min.	I_R = 100μA	V	5	5	5	5	5	5
Typ.	I_R = 100μA	V	25	25	25	25	25	25
Reverse Current (I_R)								
Max.	V_R = 5.0V	μA	100	100	100	100	100	100
Typ.	V_R = 5.0V	nA	20	15	5	5	5	5
Rise Time	10%-90% 50Ω system	nsec	50	50	50	50	50	50
Fall Time	90%-10% 50Ω system	nsec	50	50	50	50	50	50
Viewing Angle	See Fig. 5 & 6	degrees	50	72	72	80	150	110

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient . . . . 180 mW
Derate linearly from 25°C . . . . 2.0 mW/°C
Storage and operating temperatures . . . . −55°C to 100°C
Lead solder time @ 260°C (See Note 3) . . . . 5 sec
Continuous forward current @ 25°C . . . . 100 mA
Continuous forward current @ 100°C . . . . 15 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle) . . . . 1.0 A
Reverse voltage . . . . 5.0 V

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

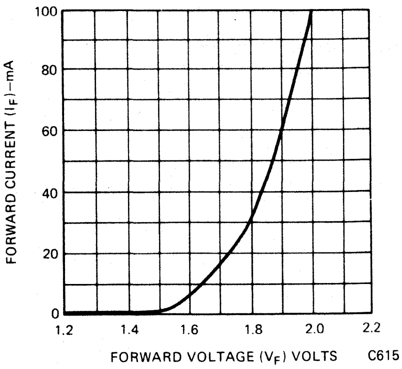


Fig. 1. Forward Current vs. Forward Voltage

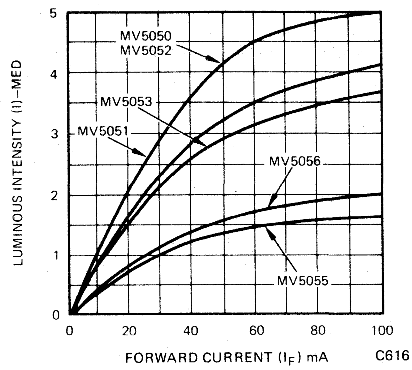


Fig. 2. Luminous Intensity vs. Forward Current

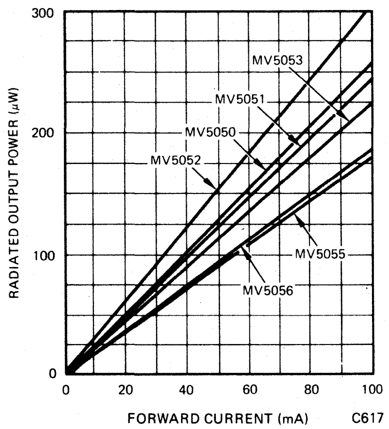


Fig. 3. ROP vs. Forward Current

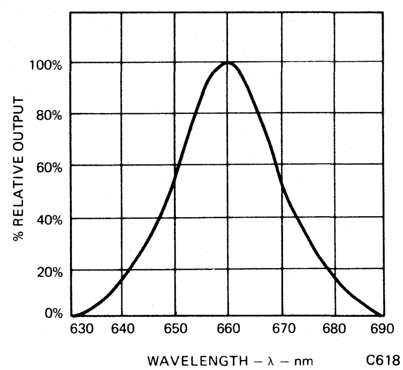


Fig. 4. Spectral Response

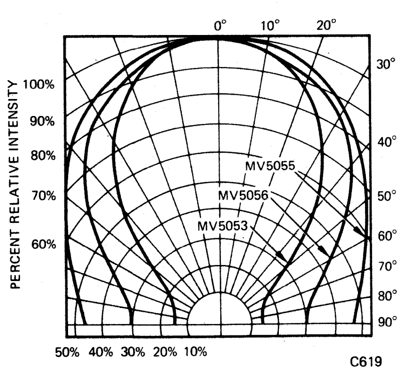


Fig. 5. Spatial Distribution (Note 2)
(MV5053, MV5055, MV5056)

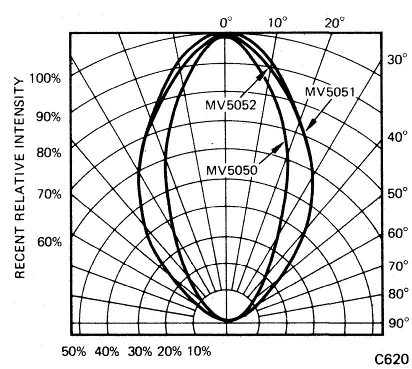


Fig. 6. Spatial Distribution (Note 2)
(MV5050, MV5051, MV5052)

NOTES

1. *As measured with a Photo Research Corp., "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*
3. *The leads of the device were immersed in molten solder at 260°C, to a point 1/16 inch from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

GENERAL INSTRUMENT
Optoelectronics

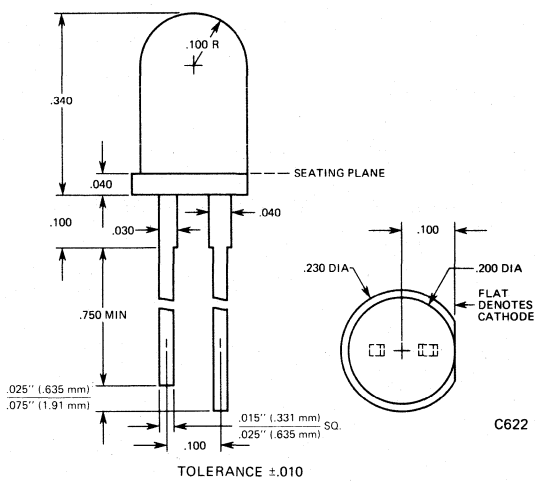
MV5054-1 MV5054-2 MV5054-3

RED SOLID STATE LAMPS

PRODUCT DESCRIPTION

The MV5054 series lamps are made with gallium arsenide phosphide diodes mounted in a red epoxy package.

PACKAGE DIMENSIONS



FEATURES

- Three light intensity categories
- Illuminates a ¼" dia. circle
- High intensity red light source for back lighting a panel
- Versatile mounting on PC board
- Transparent mounting grommet available

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient	180 mW
Derate linearly from 25°C	2.0 mW/°C
Storage and operating temperatures	−55°C to 100°C
Lead solder time @ 230°C (See Note 3)	5 sec
Continuous forward current @ 25°C	100 mA
Continuous forward current @ 100°C	15 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle)	1.0 A
Reverse Voltage	5.0 V
Reverse current	10 μA

ELECTRO-OPTICAL CHARACTERISTICS (25°C Ambient Temperature)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
*Luminous intensity (Note 1)					
MV5054-1	1.0	2.0		mcd	$I_F = 10$ mA
MV5054-2	2.0	3.0		mcd	$I_F = 10$ mA
MV5054-3	3.0	4.0		mcd	$I_F = 10$ mA
Forward voltage		1.8	2.2	V	$I_F = 10$ mA
Capacitance		35		pF	V = 0
Reverse current			100	μA	$V_R = 5.0$ V
Rise and fall time		50		nS	50 Ω System
Viewing angle (total)		40		degrees	Between 50% intensity points

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

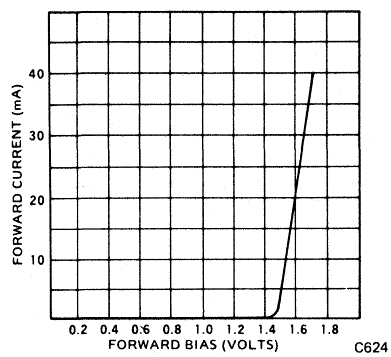


Fig. 2. Forward Current vs. Forward Voltage

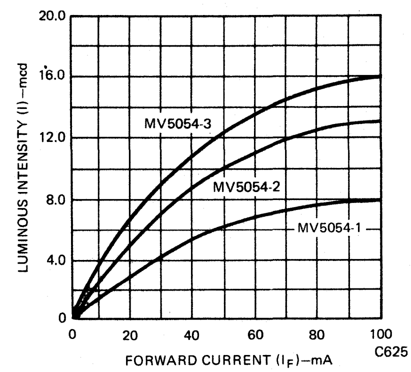


Fig. 3. Luminous Intensity vs. Forward Current

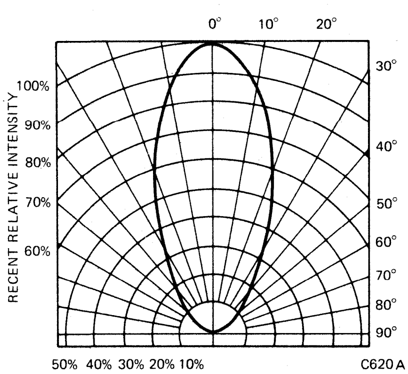


Fig. 4. Spatial Distribution (Note 2)

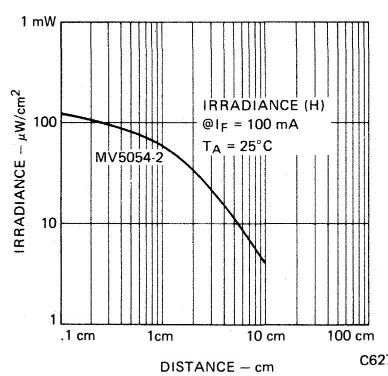


Fig. 5. Irradiance vs. Distance

NOTES

1. *As measured with a Photo Research Corp., "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*
3. *The leads of the deivce were immersed in molten solder at 230°C to a point 1/16 inch from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

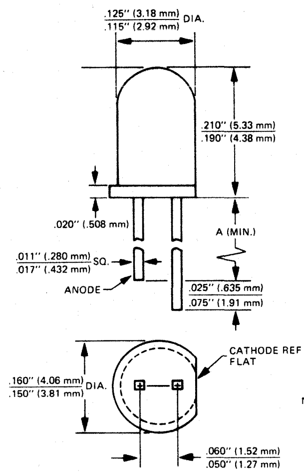
GENERAL INSTRUMENT
Optoelectronics

MV5074B/C
MV5075B/C
RED SOLID STATE LAMP

PRODUCT DESCRIPTION

The MV5074B/C and MV5075B/C are red (GaAsP) light emitting diodes mounted in a red epoxy package. Their small size (approximately T-1 size), good viewing angle, and small square leads contribute to their versatility as all purpose indicators.

PACKAGE DIMENSIONS



LEAD LENGTH (A)	
MV5074B MV5075B	.60" (15.2 mm)
MV5074C MV5075C	1.00" (25.4 mm)

NOTE: TOLERANCE ±.010" UNLESS SPECIFIED

C1128

FEATURES

- Square leads (will fit into .020" (.508 mm) diameter hole)
- Compact size
- Bright (typically 2.0 mcd at 20 mA)
- Long life, rugged
- MV5074B and MV5075B have .6" (15.2 mm) minimum lead length
- MV5074C and MV5075C have 1" (25.4 mm) minimum lead length
- Mount on approximately 3/16" (4.72 mm) centers
- Upon request, also available with anode lead trimmed longer than cathode.

ABSOLUTE MAXIMUM RATINGS

Power Dissipation @ 25°C	100 mW
Derate Linearly from 25°C	−1.27 mW/°C
Storage Temperature	−55°C to +100°C
Operating Temperature	−55°C to +100°C
Continuous Forward Current (25°C)	50 mA
Peak Forward Current (1 μsec Pulse Width, 0.3% Duty Cycle)	1.0 A
Reverse Voltage	5.0 Volts
Lead Solder Time 260°C (See Note 2)	5 sec

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Optical					
Luminous Intensity (I) (Note 1)*					
MV5074B/C	0.7	2.5		mcd	I_F = 20 mA
MV5075B/C	0.6	1.6		mcd	I_F = 20 mA
Wavelength (λpk)		660		nm	
Spectral Half Width		20		nm	
Viewing Angle					
MV5074B/C		70		degrees	Between 50% points
MV5075B/C		90		degrees	Between 50% points
Electrical					
Forward Voltage (V_F)		1.68	2.0	Volts	I_F = 20 mA
Reverse Voltage (V_R)	5.0	15.0		Volts	I_R = 100 μA
Dynamic Resistance (R_D)		7.0		Ω	
Capacitance		23		pF	V = 0

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

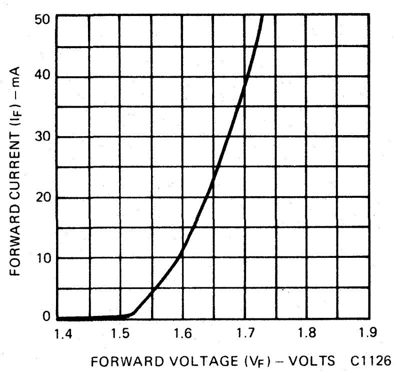


Fig. 1. Forward Current vs. Forward Voltage

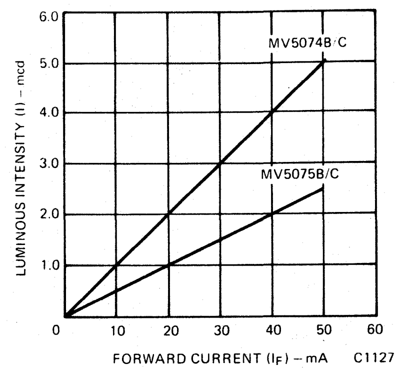


Fig. 2. Luminous Intensity vs. Forward Current

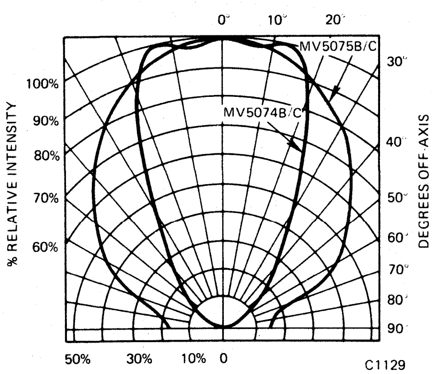


Fig. 3. Spatial Distribution

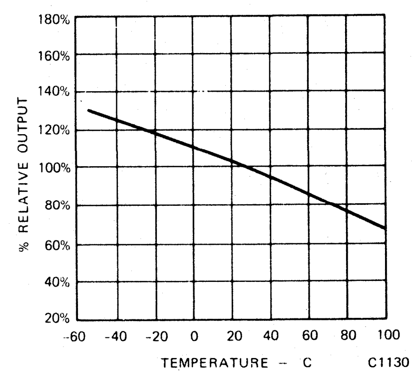


Fig. 4. Percent Relative Response vs. Temperature

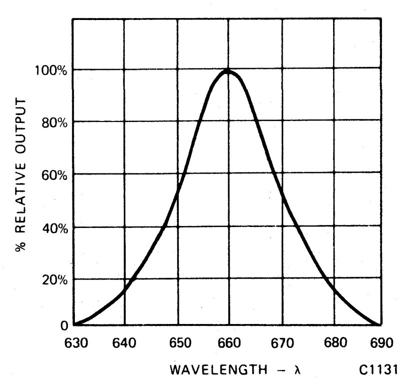


Fig. 5. Spectral Response

NOTES

1. *As measured with a Photo Research Corp., "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The leads of the device were immersed in molten solder at 260°C to a point 1/16 inch from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

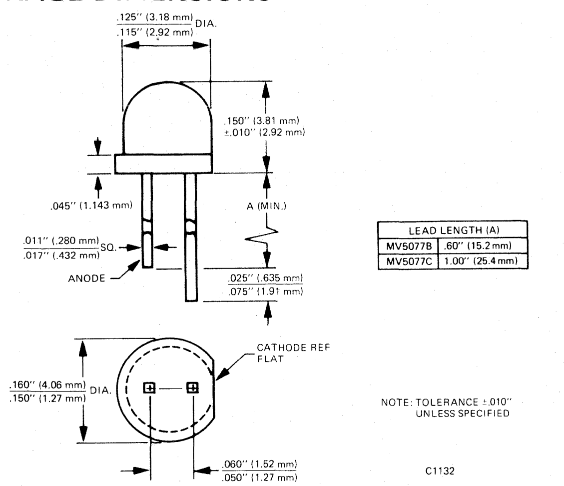
GENERAL INSTRUMENT
Optoelectronics

MV5077B
MV5077C
RED SOLID STATE LAMP

PRODUCT DESCRIPTION

The MV5077B and MV5077C are red (GaAsP) light emitting diodes mounted in a red epoxy package. Their small size (approximately T-1 size), good viewing angle, and small square leads contribute to their versatility as all purpose indicators.

PACKAGE DIMENSIONS



FEATURES

- Square leads (will fit into .020" (.508 mm) diameter hole)
- Compact size
- Bright (typically 1.75 mcd at 20 mA)
- Long life, rugged
- MV5077B have .6" (15.2 mm) minimum lead length
- MV5077C have 1" (25.4 mm) minimum lead length
- Mount on approximately 3/16" (4.72 mm) centers
- Upon request, also available with anode lead trimmed longer than cathode

ABSOLUTE MAXIMUM RATINGS

Power Dissipation @ 25°C . . . . 100 mW
Derate Linearly from 25°C . . . . 1.27 mW/°C
Storage Temperature . . . . −55°C to +100°C
Operating Temperature . . . . −55°C to +100°C
Continuous Forward Current (25°C) . . . . 50 mA
Peak Forward Current (1 μsec Pulse Width, 0.3% Duty Cycle) . . . . 1.0 A
Reverse Voltage . . . . 5.0 Volts
Lead Solder Time 260°C (See Note 2) . . . . 5 sec

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Optical					
Luminous Intensity (I) (Note 1)*	0.3	1.75		mcd	I_F = 20 mA
Wavelength (λpk)		660		nm	I_F = 20 mA
Spectral Half Width		20		nm	I_F = 20 mA
Viewing Angle		110		degrees	Between 50% points
Electrical					
Forward Voltage (V_F)		1.68	2.0	Volts	I_F = 20 mA
Reverse Voltage (V_R)	5.0	15.0		Volts	I_R = 100 μA
Dynamic Resistance (R_D)		7.0		Ω	
Capacitance		23		pF	V = 0

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

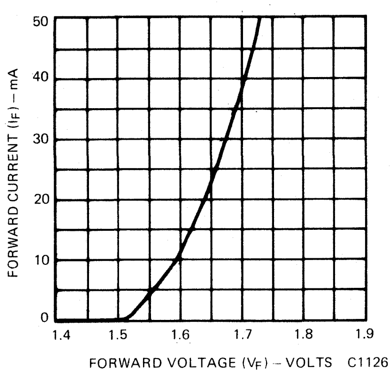


Fig. 1. Forward Current vs. Forward Voltage

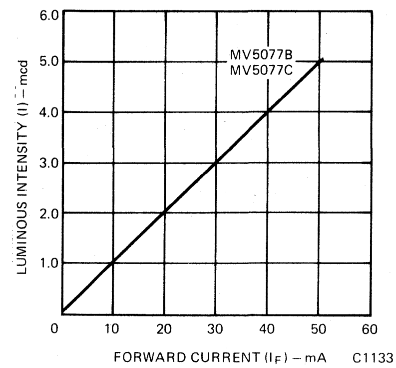


Fig. 2. Luminous Intensity vs. Forward Current

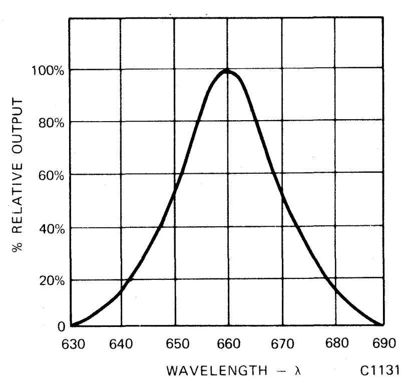


Fig. 3. Spectral Response

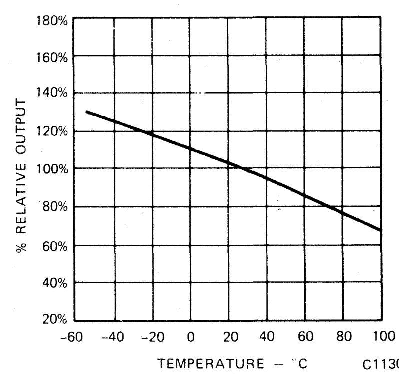


Fig. 4. Percent Relative Response vs. Temperature

NOTES

1. *As measured with a Photo Research Corp., "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The leads of the device were immersed in molten solder at 260°C to a point 1/16 inch from the device per MIL-S-750, with a dwell time of 5 seconds.*

GENERAL INSTRUMENT
Optoelectronics

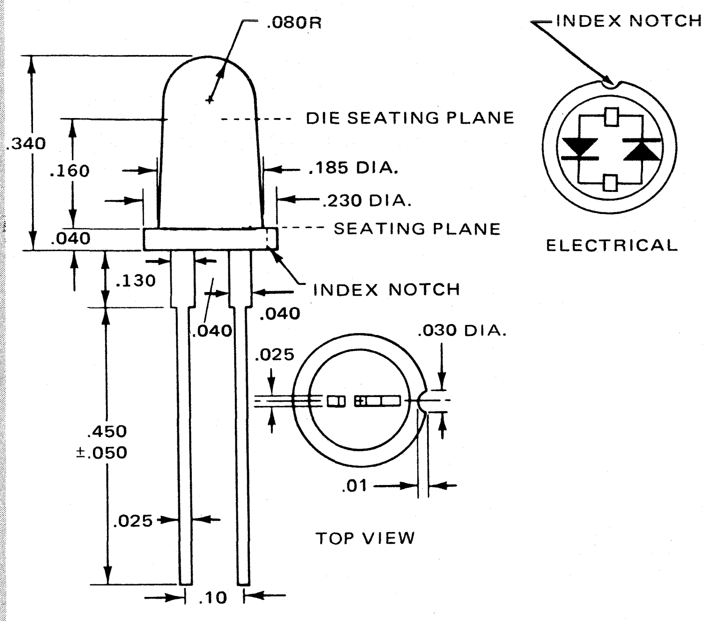
MV5094

RED BIPOLAR SOLID STATE LAMP

PRODUCT DESCRIPTION

The MV5094 is the first commercially available solid state AC-DC lamp. Reliability, long life, plus a convenient panel mounting enable this red lamp to be run from A.C. voltages even as high as 110-115 V.

PACKAGE DIMENSIONS



TOLERANCES ±.010

C647

FEATURES

- Solid state
- A.C. lamp
- 110-115 VAC operation (see chart)
- Versatile mounting on P.C. board or panel
- Convenient mounting grommet available
- Cool operation
- Long life
- This lamp mounts in the MP21 or MP22 grommet.

ABSOLUTE MAXIMUM RATINGS

Power Dissipation @ 25°C (Peak or continuous)	140 mW
Storage and Operating Temperature	–55°C to +100°C
A.C.$_{(RMS)}$/D.C. Forward Current 25°C	70 mA
A.C.$_{(RMS)}$/D.C. Forward Current 100°C	5 mA
I^2T (0.1% Duty Cycle)	2.5×10^{-4} amps^2 sec
I_{peak} (repetitive) (0.3% Duty Cycle, 1.0 μsec pulse width)	1.0A
Lead Solder time 260°C (See Note 3)	5 sec

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (25°C Ambient Temperature Unless Stated Otherwise)

	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Luminous Intensity (1) (Note 1)		.8		mcd	I_F = 20 mA
Forward Voltage (V_F)		1.6	2.0	volts	I_F = 20 mA

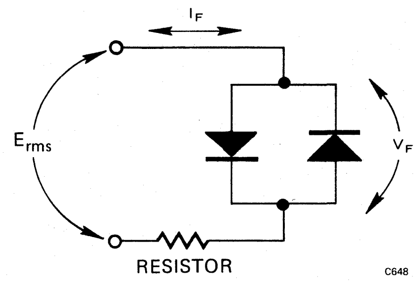
AC OPERATION

E_{RMS}	I_F = 10 mA, V_F = 1.56 RESISTOR	I_F = 25 mA, V_F = 1.62 RESISTOR	I_F = 50 mA, V_F = 1.66 RESISTOR	I_F = 70 mA, V_F = 1.70 RESISTOR
5.0	360 Ω, 1/8 W	130 Ω, 1/8 W	68 Ω, 1/4 W	51 Ω, 1/4 W
6.3	470 Ω, 1/8 W	180 Ω, 1/8 W	100 Ω, 1/4 W	68 Ω, 1/2 W
9.0	750 Ω, 1/8 W	300 Ω, 1/4 W	150 Ω, 1/2 W	110 Ω, 1 W
12.0	1.0 KΩ, 1/8 W	430 Ω, 1/2 W	200 Ω, 1/2 W	150 Ω, 1 W
15.0	1.3 KΩ, 1/4 W	560 Ω, 1/2 W	270 Ω, 1 W	200 Ω, 1 W
18.0	1.6 KΩ, 1/4 W	680 Ω, 1/2 W	330 Ω, 1 W	240 Ω, 2 W
24.0	2.2 KΩ, 1/4 W	910 Ω, 1 W	470 Ω, 2 W	330 Ω, 2 W
28.0	2.7 KΩ, 1/2 W	1.1 KΩ, 1 W	560 Ω, 2 W	390 Ω, 2 W
48.0	4.7 KΩ, 1/2 W	1.8 KΩ, 2 W	---------	---------
110.0	11.0 KΩ, 2 W	----------	---------	---------

Resistor values are nearest commercially available.

$$\text{Resistor Value} = \frac{E_{(RMS)} - V_F}{I_F}$$

where: I_F corresponds to a desired brightness level (from fig. 2).
V_F corresponds to the voltage across the device (from fig. 1).



TYPICAL ELECTRO-OPTICAL CHARACTERISTICS

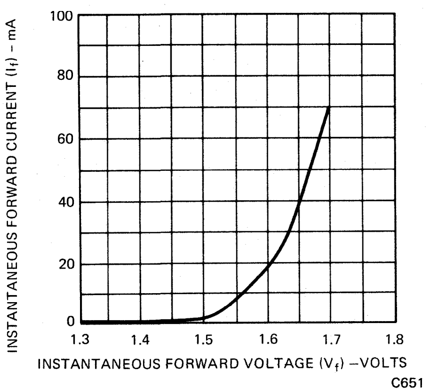


Fig. 1. Forward Current vs. Forward Voltage

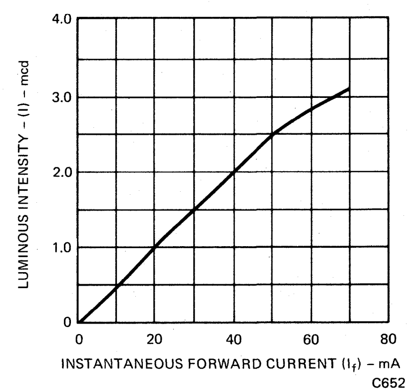


Fig. 2. Luminous Intensity vs. Forward Current

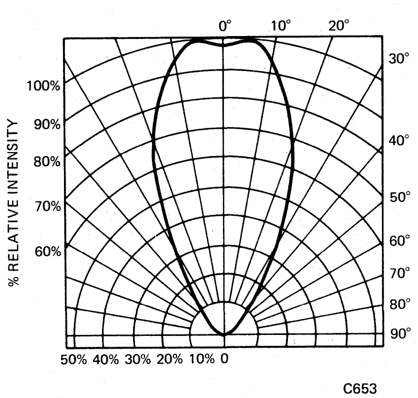


Fig. 3. Spatial Distribution

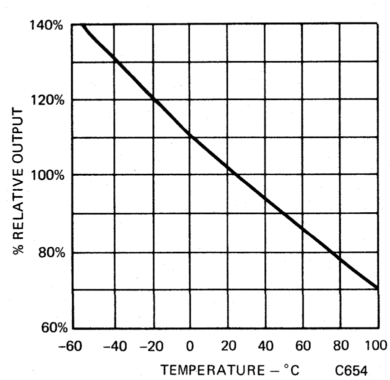


Fig. 4. Output vs. Temperature

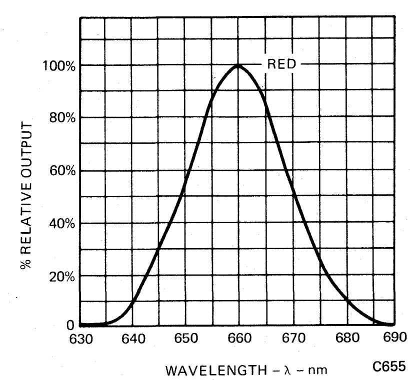


Fig. 5. Spectral Distribution

NOTES

1. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
2. *Values of Luminous Intensity may begin to decrease for operation above 25 KHz.*
3. *The leads of the device were immersed in molten solder at 260°C to a point 1/16 inch from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

GENERAL INSTRUMENT
Optoelectronics

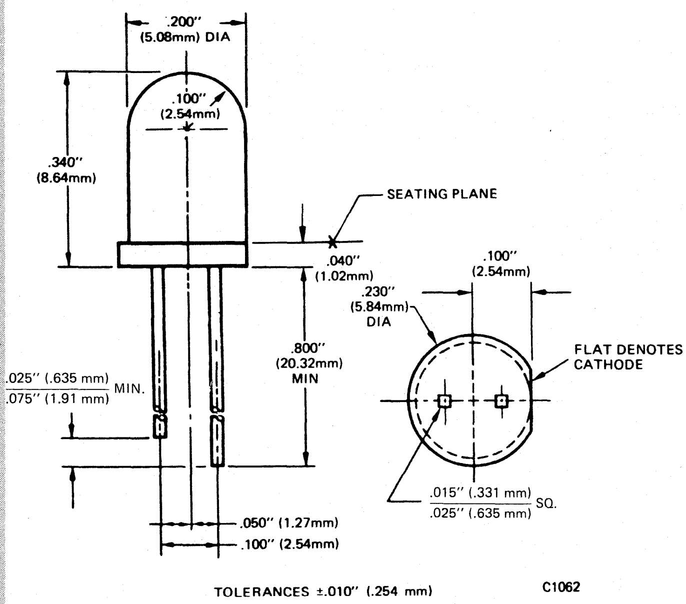
SOLID STATE LAMPS

ORANGE	MV5152
GREEN	MV5252
YELLOW	MV5352
HIGH EFFICIENCY RED	MV5752

PRODUCT DESCRIPTION

These solid state indicators offer high brightness and color availability. The orange and yellow devices are made with gallium arsenide phosphide on gallium phosphide; the green units are made with gallium phosphide on gallium phosphide. The red units are made with gallium arsenide phosphide on gallium arsenide.

PACKAGE DIMENSIONS



FEATURES

- High efficiency GaP light sources
- See MV5050 series for other red sources.
- Versatile mounting on P.C. board or panel
- Snap in grommet available on request
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight
- Upon request, also available with anode lead trimmed longer than cathode.

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient	105 mW
Derate linearly from 25°C	1.14 mW/°C
Storage and operating temperatures	−55°C to 100°C
Lead solder time @ 260°C (See Note 3)	5 sec
Continuous forward current @ 25°C	35 mA
Continuous forward current @ 100°C	10 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle)	1.0 A
Reverse voltage	5.0 V

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	POP-IN MOUNTING	CIRCUIT BOARD MOUNTING
MV5152	Orange	Clear orange	Narrow beam; point source	X	X
MV5252	Green	Clear green	Narrow beam; point source	X	X
MV5352	Yellow	Clear yellow	Narrow beam; point source	X	X
MV5752	Red	Clear red	Narrow beam; point source	X	X

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

PARAMETER	TEST COND.	UNITS	MV5152	MV5252	MV5352	MV5752
Forward voltage (V_F)						
Typ.	I_F = 20 mA	V	2.0	2.2	2.1	2.0
Max.	I_F = 20 mA	V	3.0	3.0	3.0	3.0
Luminous intensity (see Note 1)*						
Min.	I_F = 20 mA	mcd	17.0	2.0	10.0	17.0
Typ.	I_F = 20 mA	mcd	40.0	15.0	45.0	40.0
Peak wave length	20 mA	nm	635	565	585	635
Spectral line Half width	20 mA	nm	45	35	35	45
Capacitance						
Typ.	V = 0	pF	45	45	45	45
Reverse voltage (V_R)						
Min.	I_R = 100 μA	V	5	5	5	5
Typ.	I_R = 100 μA	V	25	25	25	25
Reverse current (I_R)						
Max.	V_R = 5.0 V	μA	100	100	100	100
Typ.	V_R = 5.0 V	nA	20	20	20	20
Viewing angle (total)	See Fig. 3 & 4	degrees	28	28	28	28

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES
(25°C Free Air Temperature Unless Otherwise Specified)

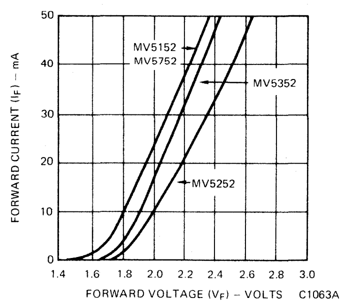


Fig. 1. Forward Current vs. Forward Voltage

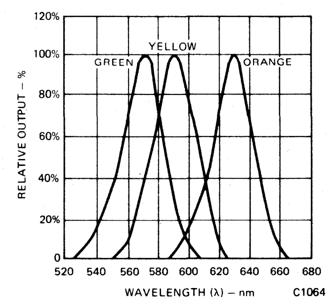


Fig. 2. Spectral Response

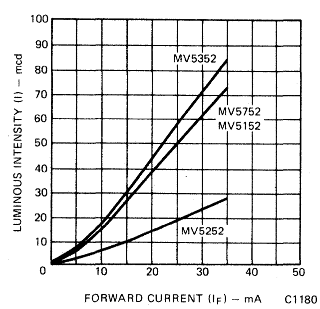


Fig. 3. Luminous Intensity vs. Forward Current

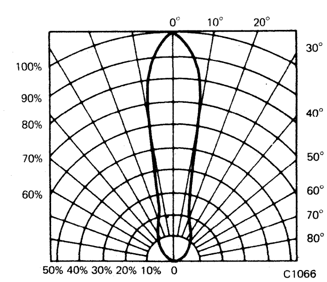


Fig. 4. Spatial Distribution (Note 2) (MV5352, MV5252, MV5152, MV5752)

NOTES

1. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The axes of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*
3. *The leads of the device were immersed in molten solder, at 260°C, to a point 1/16 inch from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

GENERAL INSTRUMENT
Optoelectronics

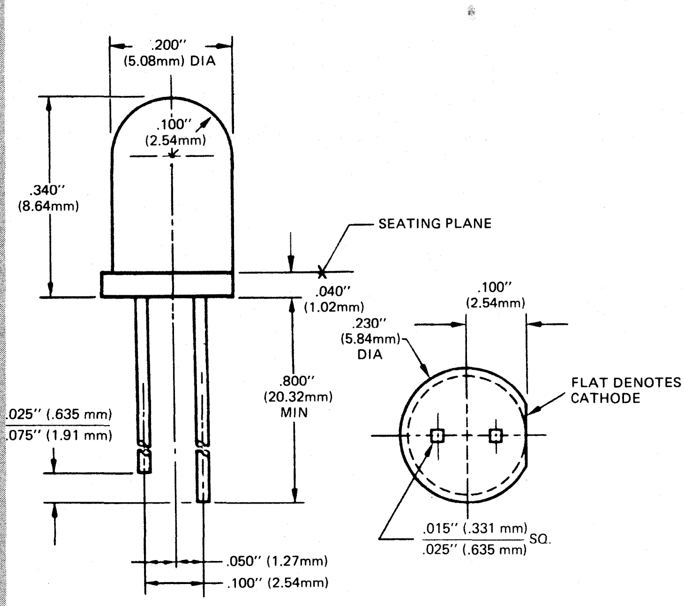
SOLID STATE LAMPS

ORANGE	MV5153	MV5154
GREEN	MV5253	MV5254
YELLOW	MV5353	MV5354
RED	MV5753	MV5754

PRODUCT DESCRIPTION

These solid state indicators offer a variety of lens effects and color availability. The orange and yellow devices are made with gallium arsenide phosphide on gallium phosphide; the green units are made with gallium phosphide on gallium phosphide. The red units are made with gallium arsenide phosphide on gallium arsenide.

PACKAGE DIMENSIONS



TOLERANCES ±.010" (.254 mm)   C1062

FEATURES

- High efficiency GaP light source with various lens effects
- Versatile mounting on P.C. board or panel
- Snap in grommet available on request
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight
- Upon request, also available with anode lead trimmed longer than cathode.

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient	105 mW
Derate linearly from 25°C	1.14 mW/°C
Storage and operating temperatures	–55°C to 100°C
Lead solder time @ 260°C (See Note 3)	5 sec
Continuous forward current @ 25°C	35 mA
Continuous forward current @ 100°C	10 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle)	1.0 A
Reverse voltage	5.0 V

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	POP-IN MOUNTING	CIRCUIT BOARD MOUNTING
MV5153	Orange	Orange diffused	Wide beam	X	X
MV5154	Orange	Orange diffused	Narrow beam	X	X
MV5253	Green	Green diffused	Wide beam	X	X
MV5254	Green	Green diffused	Narrow beam	X	X
MV5353	Yellow	Yellow diffused	Wide beam	X	X
MV5354	Yellow	Yellow diffused	Narrow beam	X	X
MV5753	Red	Red diffused	Wide beam	X	X
MV5754	Red	Red diffused	Narrow beam	X	X

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

PARAMETER	TEST COND.	UNITS	MV5153	MV5154	MV5253	MV5254	MV5353	MV5354	MV5753	MV5754
Forward voltage (V_F)										
Typ.	I_F = 20 mA	V	2.0	2.0	2.2	2.2	2.1	2.1	2.0	2.0
Max.	I_F = 20 mA	V	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Luminous intensity (See Note 1)*										
Min.	I_F = 20 mA	mcd	3.0	3.0	0.8	0.9	2.5	3.0	3.0	3.0
Typ.	I_F = 20 mA	mcd	6.0	8.0	1.5	3.0	6.0	10.0	6.0	8.0
Peak wave length	I_F = 20 mA	nm	635	635	565	565	585	585	635	635
Spectral line Half width	I_F = 20 mA	nm	45	45	35	35	35	35	45	45
Capacitance										
Typ.	V = 0	pF	45	45	45	45	45	45	45	45
Reverse voltage (V_R)										
Min.	I_R = 100 μA	V	5	5	5	5	5	5	5	5
Typ.	I_R = 100 μA	V	25	25	25	25	25	25	25	25
Reverse current (I_R)										
Max.	V_R = 5.0 V	μA	100	100	100	100	100	100	100	100
Typ.	V_R = 5.0 V	nA	20	20	20	20	20	20	20	20
Viewing angle (total)	See Fig. 3 & 4	degrees	65	24	65	24	65	24	65	24

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

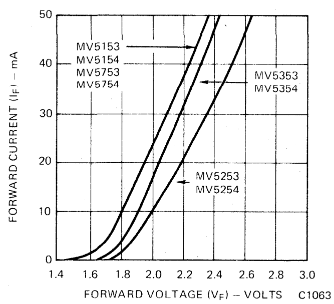


Fig. 1. Forward Current vs. Forward Voltage

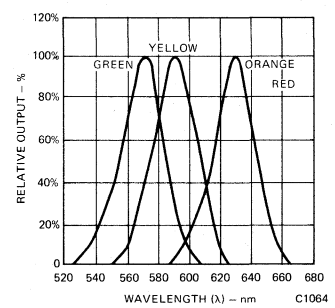


Fig. 2. Spectral Response

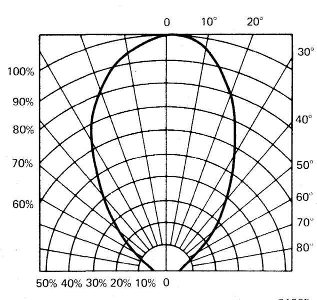


Fig. 3. Spatial Distribution (Note 2)
(MV5353, MV5253, MV5153, MV5753)

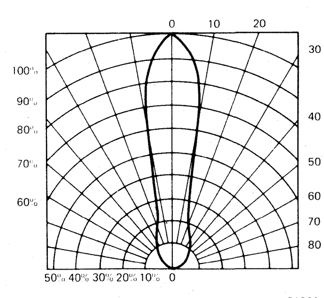


Fig. 4. Spatial Distribution (Note 2)
(MV5354, MV5254, MV5154, MV5754)

NOTES

1. *As measured with Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The axes of spatial distribution are typically with a 10° cone with reference to the central axis of the device.*
3. *The leads of the device were immersed in molten solder, at 260°C, to a point 1/16 inch from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

GENERAL INSTRUMENT
Optoelectronics

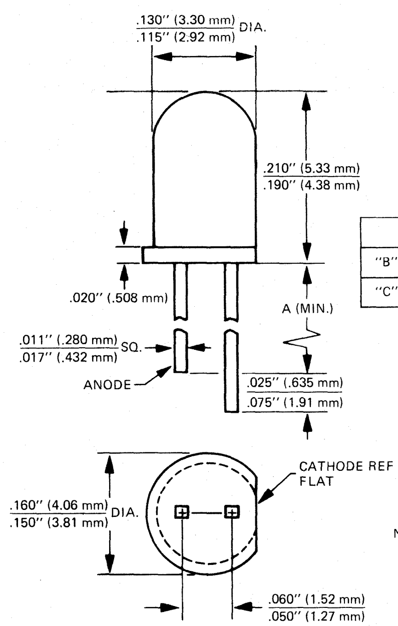
SOLID STATE LAMPS

ORANGE MV5174B/C
GREEN MV5274B/C
YELLOW MV5374B/C
HIGH EFFICIENCY RED MV5774B/C

PRODUCT DESCRIPTION

These solid state indicators offer a variety of color selection. The orange and yellow devices are made with a gallium arsenide phosphide on gallium phosphide; the green units are made with gallium phosphide on gallium phosphide. The red units are made with gallium arsenide phosphide on gallium arsenide. All are encapsulated in epoxy packages. Their small size (approximately T-1 size), good viewing angle, and small square leads contribute to their versatility as all-purpose indicators.

PACKAGE DIMENSIONS



LEAD LENGTH (A)	
"B" Suffix	.60" (15.2 mm)
"C" Suffix	1.00" (25.4 mm)

NOTE: TOLERANCE ±.010" UNLESS SPECIFIED

C1128A

FEATURES

- High efficiency GaP light source with various lens effects
- See MV5074 series for additional red sources
- Versatile mounting on P.C. board or panel
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight
- "B"—designated products have 0.6" (15.2 mm) minimum lead length
- "C"—designated products have 1" (25.4 mm) minimum lead length
- Square leads (will fit into .020" [.508 mm] diameter holes)
- Upon request, also available with anode lead trimmed longer than cathode

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient	105 mW
Derate linearly from 25°C	1.14 mW/°C
Storage and operating temperatures	−55°C to 100°C
Lead solder time @ 260°C (See Note 2)	5 sec
Continuous forward current @ 25°C	35 mA
Continuous forward current @ 100°C	10 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle)	1.0 A
Reverse voltage	5.0 V

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	PACKAGE PROFILE
MV5174B/C	Orange	Orange diffused	Wide beam	High profile
MV5274B/C	Green	Green diffused	Wide beam	High profile
MV5374B/C	Yellow	Yellow diffused	Wide beam	High profile
MV5774B/C	Red	Red diffused	Wide beam	High profile

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

PARAMETER	TEST COND.	UNITS	MV5174B/C	MV5274B/C	MV5374B/C	MV5774B/C
Forward voltage (V_F)						
Typ.	I_F = 20 mA	V	2.0	2.2	2.1	2.0
Max.	I_F = 20 mA	V	3.0	3.0	3.0	3.0
Luminous intensity (see Note 1)*						
Min.	I_F = 20 mA	mcd	1.5	.4	1.5	1.5
Typ.	I_F = 20 mA	mcd	5.0	1.0	4.0	5.0
Peak wave length	I_F = 20 mA	nm	635	565	585	635
Spectral line Half width	I_F = 20 mA	nm	45	35	35	45
Capacitance						
Typ.	V = 0	pF	45	45	45	45
Reverse voltage (V_R)						
Min.	I_R = 100 μA	V	5	5	5	5
Typ.	I_R = 100 μA	V	25	25	25	25
Reverse current (I_R)						
Typ.	V_R = 5.0 V	nA	20	20	20	20
Max.	V_R = 5.0 V	μA	100	100	100	100
Viewing angle (total)	See Fig. 3 & 4	degrees	90	90	90	90

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

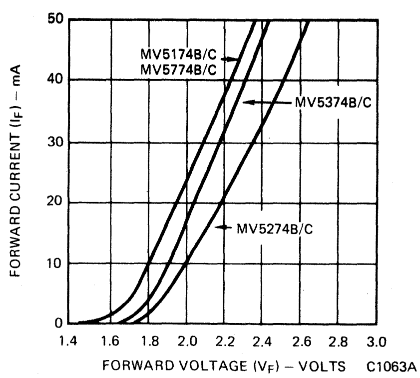


Fig. 1. Forward Current vs. Forward Voltage

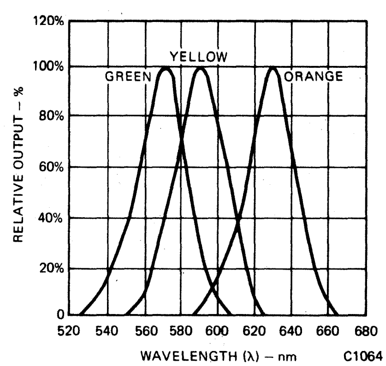


Fig. 2. Spectral Response

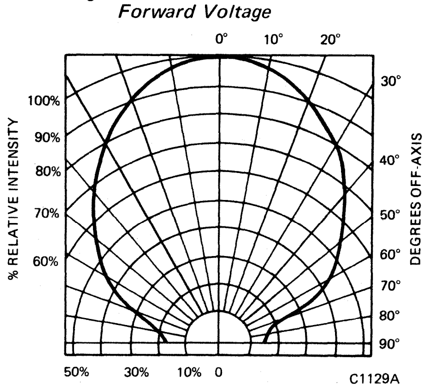


Fig. 3. Spatial Distribution

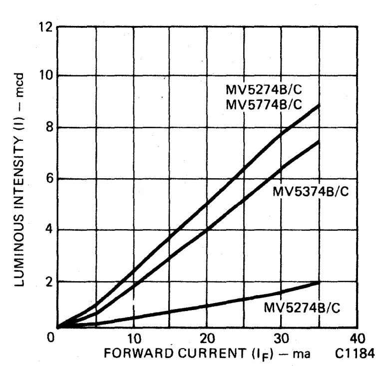


Fig. 4. Luminous Intensity vs. Forward Current

NOTES

1. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The leads of the device were immersed in molten solder, at 260°C, to a point 1/16 inch from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

GENERAL INSTRUMENT
Optoelectronics

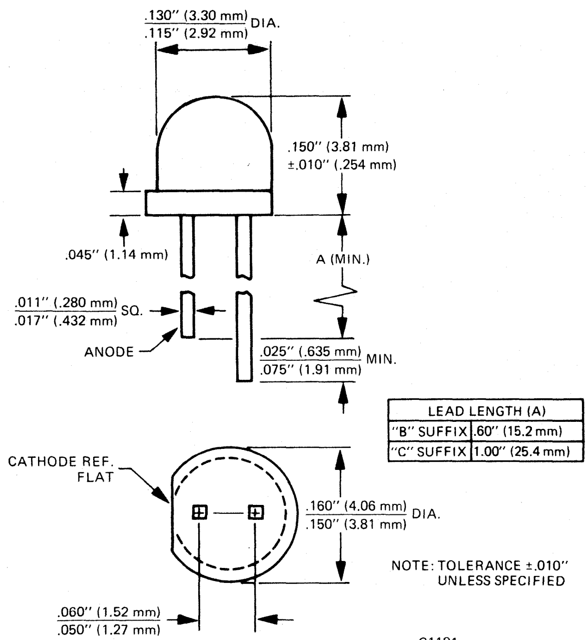
SOLID STATE LAMPS

ORANGE	MV5177B/C
GREEN	MV5277B/C
YELLOW	MV5377B/C
HIGH EFFECIENCY RED	MV5777B/C

PRODUCT DESCRIPTION

These solid state indicators offer a low profile T-1 package. The orange and yellow devices are made with gallium arsenide phosphide on gallium phosphide; the green units are made with gallium phosphide on gallium phosphide. The red units are made with gallium arsenide phosphide on gallium arsenide. All are encapsulated in epoxy packages. Their small size (approximately T-1 size), good viewing angle, and small square leads contribute to their versatility as all purpose indicators.

PACKAGE DIMENSIONS



LEAD LENGTH (A)	
"B" SUFFIX	.60" (15.2 mm)
"C" SUFFIX	1.00" (25.4 mm)

NOTE: TOLERANCE ±.010" UNLESS SPECIFIED

C1181

FEATURES

- Square leads (will fit into .020" [.508 mm] diameter hole)
- Compact size
- Bright (up to 3.0 mcd at 20 mA)
- Long life, rugged
- "B"—designated products have .6" (15.2 mm) minimum lead length
- "C"—designated products have 1" (25.4 mm) minimum lead length
- Mount on approximately 3/16" (4.72 mm) centers
- See MV5077 series for other red sources
- Upon request, also available with anode lead trimmed longer than cathode

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient . . . . 105 mW
Derate linearly from 25°C. . . . . 1.14 mW/°C
Storage and operating temperatures . . . . −55°C to +100°C
Continuous forward current @ 25°C . . . . 35 mA
Peak forward current (1 μsec pulse width, 0.3% duty cycle). . . . . 1.0 A
Reverse voltage . . . . 5.0 V
Lead solder time @ 260°C (See Note 2) . . . . 5 sec

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	PACKAGE PROFILE
MV5177B/C	Orange	Orange diffused	Wide beam	Low profile
MV5277B/C	Green	Green diffused	Wide beam	Low profile
MV5377B/C	Yellow	Yellow diffused	Wide beam	Low profile
MV5777B/C	Red	Red diffused	Wide beam	Low profile

MV5177B/C MV5277B/C MV5377B/C MV5777B/C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

PARAMETER	TEST COND.	UNITS	MV5177B/C	MV5277B/C	MV5377B/C	MV5777B/C
Forward voltage (V_F)						
Typ.	I_F = 20 mA	V	2.0	2.2	2.1	2.0
Max.	I_F = 20 mA	V	3.0	3.0	3.0	3.0
Luminous intensity (see Note 1)*						
Min.	I_F = 20 mA	mcd	1.0	.2	1.0	1.0
Typ.	I_F = 20 mA	mcd	3.0	0.6	2.0	3.0
Peak wave length	I_F = 20 mA	nm	635	565	585	635
Spectral line Half width	I_F = 20 mA	nm	45	35	35	45
Capacitance						
Typ.	V = 0	pF	45	45	45	45
Reverse voltage (V_R)						
Min.	I_R = 100 μA	V	5	5	5	5
Typ.	I_R = 100 μA	V	25	25	25	25
Viewing angle (total) (Fig. 5)		degrees	180	180	180	180
Dynamic resistance (R_D)		Ω	7.0	7.0	7.0	7.0

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

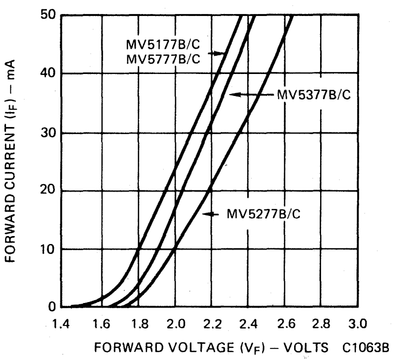


Fig. 1. Forward Current vs. Forward Voltage

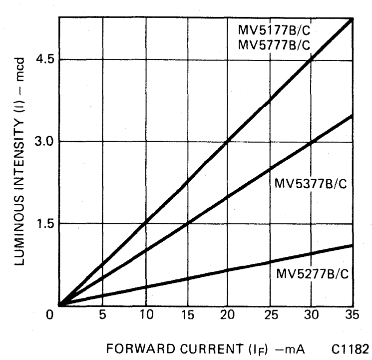


Fig. 2. Luminous Intensity vs. Forward Current

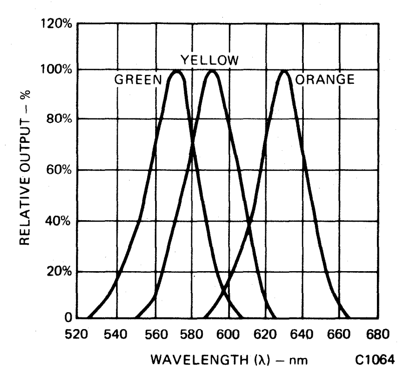


Fig. 3. Spectral Response

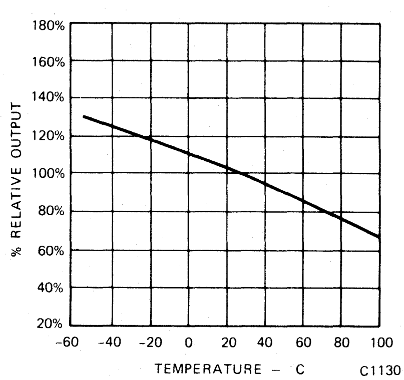


Fig. 4. Percent Relative Response vs. Temperature

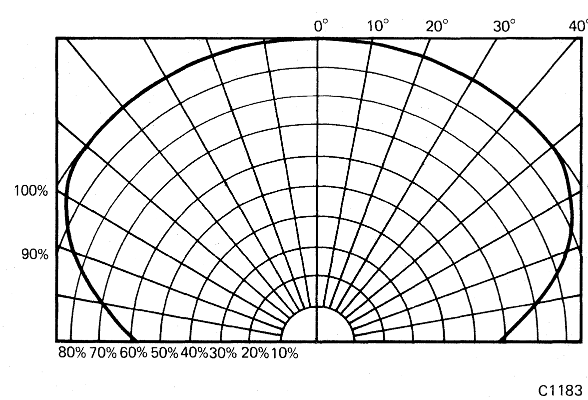


Fig. 5. Spatial Distribution

NOTES

1. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The leads of the device were immersed in molten solder, at 260°C, to a point 1/16 inch from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

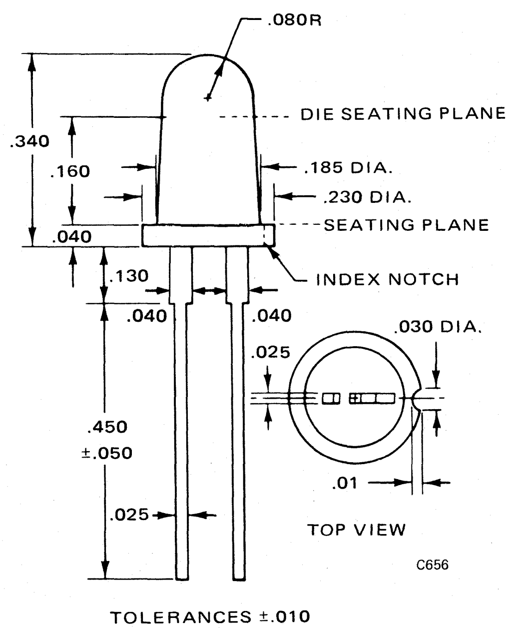
GENERAL INSTRUMENT
Optoelectronics

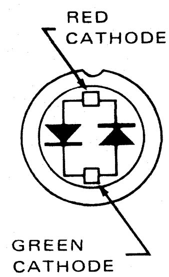
MV5491
RED/GREEN TRI-STATE LAMP

PRODUCT DESCRIPTION

A green and red lamp made of GaAsP (Red) and GaP (Green) offering a changing color dependent on the direction the lamp is biased. These two light emitting diodes are mounted in the same convenient epoxy package.

PACKAGE DIMENSIONS





FEATURES

- Bright
- Long life, rugged
- True polarity indicating
- 3 states: Green, Red, Off
- Solid state
- Integrated circuit compatible
- Convenient mounting clip available
- Versatile mounting on P.C. board or panel

ABSOLUTE MAXIMUM RATINGS

Power Dissipation @ 25°C (Peak or Continuous)	200 mW
Storage & Operating Temp.	−55°C to 100°C
Currents	
Red ON (Peak or Continuous, 25°C)	70 mA
Green ON (Peak or Continuous, 25°C)	35 mA
Derate linearly from 25°C	
Red	−1.66 mW/°C
Green	−2.66 mW/°C
Lead solder time @ 260°C (See Note 3)	5 sec

ELECTRO-OPTICAL CHARACTERISTICS (25°C Ambient Temperature)

OPTICAL

	TYP.	MAX.	UNITS	CONDITIONS
Luminous Intensity (I) (note 2)				
Red	1.5		mcd	I_F = 20 mA
Green	.5		mcd	I_F = 20 mA
Wavelength (λpk)				
Red	660		nm	I_F = 20 mA
Green	560		nm	I_F = 20 mA
Spectral Half Width				
Red	20		nm	I_F = 20 mA
Green	30		nm	I_F = 20 mA

ELECTRICAL

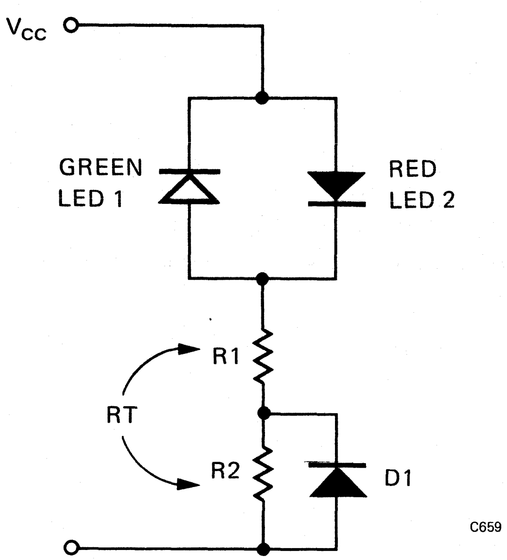
	TYP.	MAX.	UNITS	CONDITIONS
Forward Voltage (V_F)				
Red	1.65	2.0	volts	I_F = 20 mA
Green	2.2	3.0	volts	I_F = 30 mA
Dynamic Resistance (R_D)				
Red	5.5		Ω	
Green	50.0		Ω	

THERMAL CHARACTERISTICS

	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Forward Voltage Temp. Coefficient					
Red		−1.5		mV/°C	I_F = 20 mA
Green		−3.0		mV/°C	I_F = 20 mA

BIASING NETWORK

$V_{CC} = 5V$
D_1 = 1N914 (or equivalent)



$$R_T = \frac{V_{CC} - V_{LED2}}{I_{LED2}} \qquad R_1 = \frac{V_{CC} - (V_{LED1} + V_{D1})}{I_{LED1}}$$

Example: Match Intensities of both red and green units at 20 mA and 35 mA respectively.

FOR RED:

$$R_T = \frac{V_{CC} - V_{LED2}}{I_{LED2}} = \frac{5.0 - 1.63}{.020} = 168\Omega$$

FOR GREEN:

$$R_1 = \frac{V_{CC} - (V_{LED1} + V_{D1})}{I_{LED1}} = \frac{5.0 - (2.5 + 0.7)}{.035} = 51\Omega$$

$R_T - R_1 = R_2$

$168 - 51 = 117\Omega$

SUGGESTED RESISTOR COMBINATIONS:

GREEN →	10 mA			20 mA			30 mA		
RED	R_T	R_1	R_2	R_T	R_1	R_2	R_T	R_1	R_2
10 mA	344	230	114	344	102	242	344	63	281
20 mA	170	230	-60	170	102	68	170	63	107
30 mA	112	230	-118	112	102	10	112	63	49
40 mA	84	230	-146	84	102	-18	84	63	21
50 mA	67	230	-163	67	102	-35	67	63	4
60 mA	55	230	-175	55	102	-47	55	63	-8
70 mA	47	230	-183	47	102	-55	47	63	-16

NOTES: 1) All values are in ohms
2) V_{CC} = 5 volts D.C.
3) Current combinations in shaded area not possible with circuit shown

Note: Values computed are for maximum currents through each diode.

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS

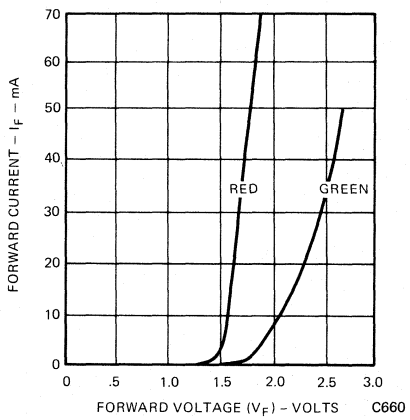


Fig. 1. Forward Current vs Forward Voltage

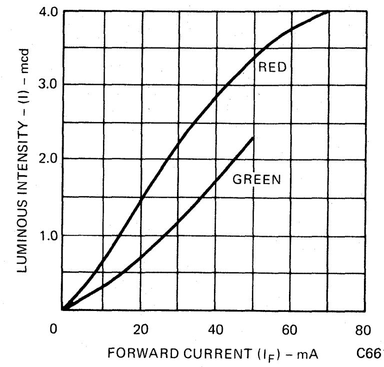


Fig. 2. Luminous Intensity vs Forward Current

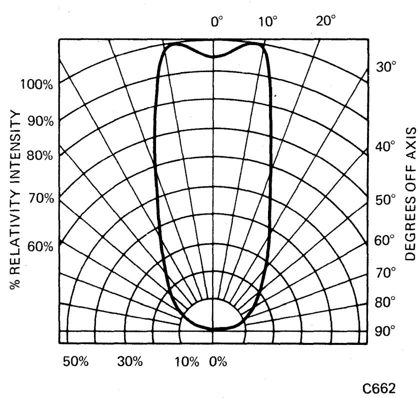


Fig. 3 Spatial Distribution (Note 1)

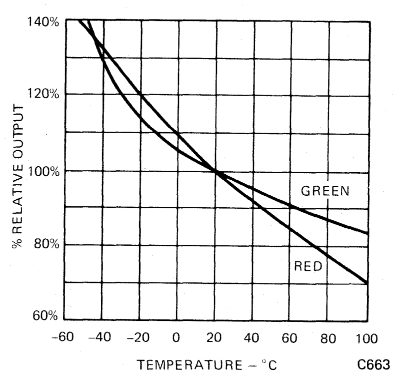


Fig. 4. Relative Output vs Temperature

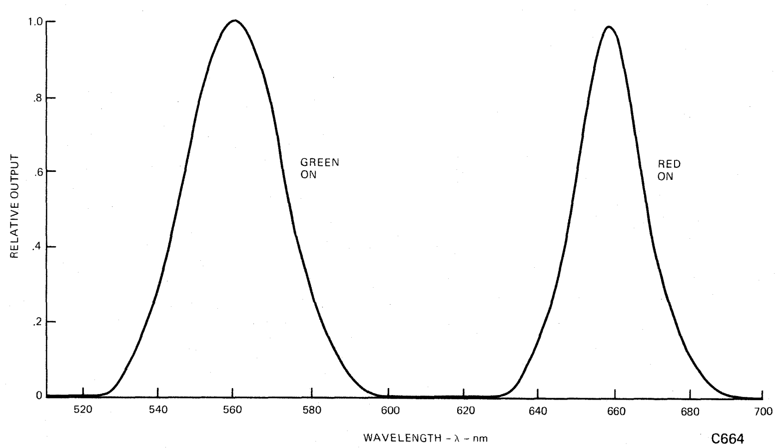


Fig. 5. Spectral Distribution

NOTES

1. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*
2. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
3. *The leads of the device were immersed in molten solder, heated to a temperature of 260°C to a point 1/16 inch from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

GENERAL INSTRUMENT
Optoelectronics

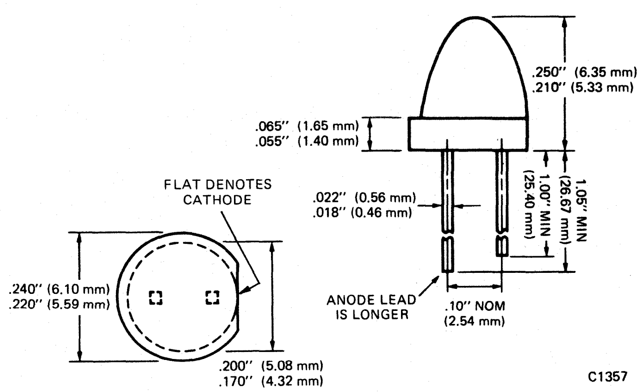
SOLID STATE LAMPS

MV50152 MV53152 MV50154 MV53154 MV52152 MV57152 MV52154 MV57154

PRODUCT DESCRIPTION

These solid state indicators offer a variety of lens effects and color availability in a short barrel T-1-¾ package. The red, orange and yellow devices are made with gallium arsenide phosphide, and the green units are made with gallium phosphide. All are encapsulated in epoxy lenses.

PACKAGE DIMENSIONS



FEATURES

- Low cost
- High intensity light source with two lens effects.
- Red, orange, green and yellow colors available.
- Versatile mounting on P.C. board or panel.
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight
- High efficiency
- Ultra high brightness
- Short T-1 3/4 size

ABSOLUTE MAXIMUM RATINGS

Maximum power dissipation @ 25°C ambient (red) . . . . 180 mW
Maximum power dissipation @ 25°C ambient (Orange, yellow, green) . . . . 105 mW
Derate linearly from 25°C (GYO) . . . . 1.14 mW/°C
Derate linearly from 25°C (Red) . . . . 2.0 mW/°C
Maximum storage and operating temperatures . . . . −55°C to 100°C

Maximum lead solder time @ 260°C (See Note 3) . . . 5 Sec
Maximum currents and voltages
Continuous forward current @ 25°C . . . . Red = 100 mA GYO = 35 mA
Continuous forward current @ 100°C . . . . . . 10 mA
Peak forward current (1 μS pulse, 0.3% duty cycle) . . . . 1.0 A
Reverse voltage . . . . 5.0 V

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT
MV50152	Red	Red clear	Point source
MV50154	Red	Red lightly diffused	Soft point source
MV52152	Green	Green clear	Point source
MV52154	Green	Green lightly diffused	Soft point source
MV53152	Yellow	Yellow clear	Point source
MV53154	Yellow	Yellow lightly diffused	Soft point source
MV57152	Orange	Orange clear	Point source
MV57154	Orange	Orange lightly diffused	Soft point source

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

PARAMETER	TEST COND.	UNITS	MV50152	MV50154	MV52152	MV52154	MV53152	MV53154	MV57152	MV57154
Fwd. Voltage (V_F)	10 mA	V	1.6	1.6	2.2	2.2	2.1	2.1	2.0	2.0
Typ			1.6	1.6	2.2	2.2	2.1	2.1	2.0	2.0
Max			2.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0
*Luminous Intensity										
(see Note 1) Min	10 mA	mcd	.6	.4	.75	.5	3.0	1.5	4.0	2.0
Typ	10 mA	mcd	2.0	1.5	2.0	1.5	5.0	3.0	8.0	4.0
Peak wave length	10 mA	nm	660	660	565	565	585	585	630	630
Spectral line Half width	10 mA	nm	20	20	35	35	35	35	45	45
Capacitance										
Typ	V = 0	pF	30	30	45	45	45	45	45	45
Reverse volt. (V_R)	I_R = 100 μA	V								
Min			5	5	5	5	5	5	5	5
Typ			25	25	25	25	25	25	25	25
Reverse current (I_R)	V_R = 5.0 V	μA								
Max			100	100	100	100	100	100	100	100
Typ			20	20	20	20	20	20	20	20
Viewing angle (see fig. 3)			45	50	45	50	45	50	45	50

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

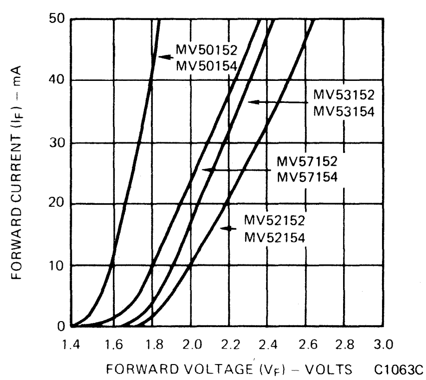


Fig. 1. Forward Current vs. Forward Voltage

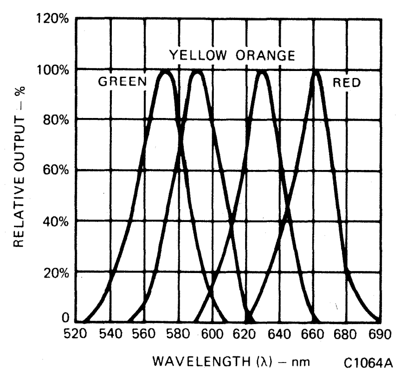


Fig. 2. Spectral Response

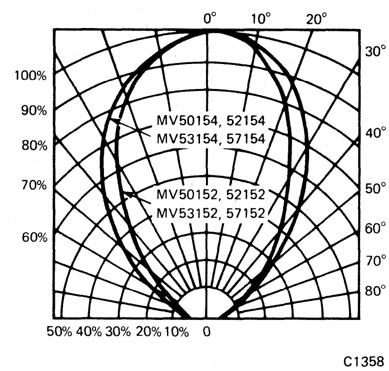


Fig. 3. Spatial Distribution (Note 2)

NOTES

1. *As measured with a Photo Research Corp., "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*
3. *The leads of the device were immersed in molten solder at 260°C, to a point 1/16 inch from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

GENERAL INSTRUMENT
Optoelectronics

.220" RECTANGULAR LEGEND LAMP

GREEN MV52124
YELLOW MV53124
HI. EFF. RED MV57124

FEATURES

- .220" x .125" lighted area
- Stackable in X or Y direction
- High brightness—typically 3 mcd @ 20 mA
- Solid state reliability
- Compact, rugged, lightweight
- No light leakage from unit sides
- Mounting grommet available (see MP65)

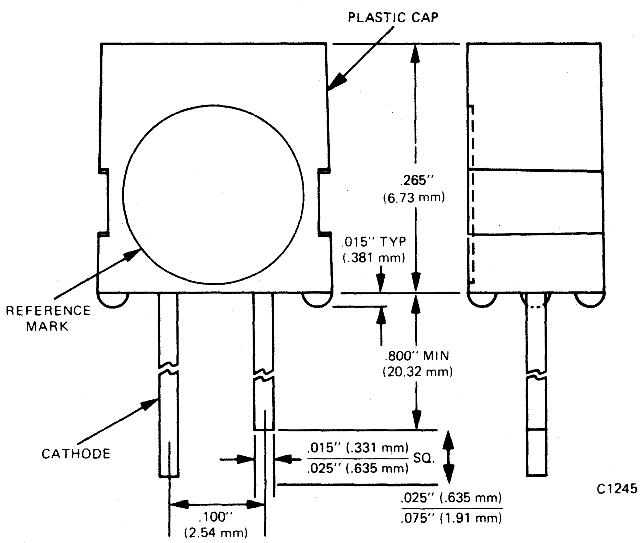
APPLICATIONS

- Legend backlighting
- Illuminated pushbutton
- Panel indicator
- Bargraph meter

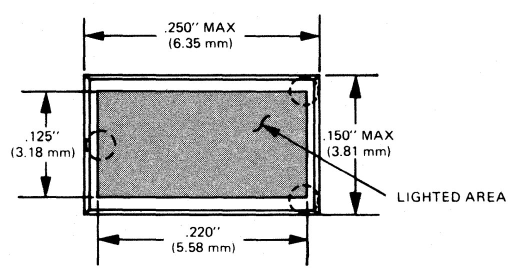
PRODUCT DESCRIPTION

This series of rectangularly shaped solid state indicators is available in green, yellow, and red. The rectangular lighted area is uniformly lit by a high performance LED chip.

PACKAGE DIMENSIONS



C1245



NOTE: TOLERANCE ±.010" UNLESS SPECIFIED

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

PARAMETER	SYM	MV52124	MV53124	MV57124	UNITS	TEST CONDITIONS
Forward voltage, TYP.	V_F	2.0	2.0	2.0	V	$I_F = 20$ mA
MAX.		3.0	3.0	3.0	V	
Luminous intensity, MIN.* (See note 2)		1.0	1.0	1.0	mcd	$I_F = 20$ mA
TYP.		3.0	4.0	4.0	mcd	
Peak wavelength		565	585	635	nm	$I_F = 20$ mA
Spectral line half width		45	45	45	nm	$I_F = 20$ mA
Reverse voltage, MIN.	V_R	5	5	5	V	$I_R = 100\ \mu A$
TYP.		25	25	25	V	
Reverse current, TYP.	I_R	20	20	20	nA	$V_R = 5.0$ V
MAX.		100	100	100	μA	
Capacitance		45	45	45	pF	V = 0

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C . . . . 105 mW
Derate linearly from 25°C. . . . . 1.14 mW/°C
Storage and operating temperature . . –55°C to 100°C
Peak forward current . . . . 1 AMP
(1 μsec pulse width, 300 pps)

Forward current @ 25°C. . . . . 35 mA
Lead solder time @ 260°C (See Note 1) . . . 5 seconds
Reverse voltage . . . . 5.0 volts

MV52124

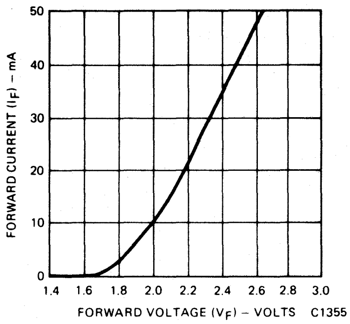


Fig. 1. Forward Current vs. Forward Voltage

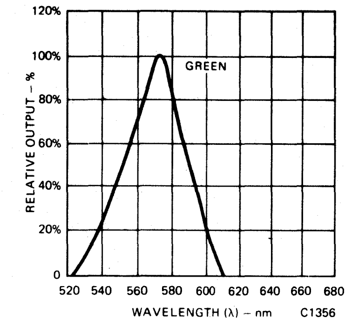


Fig. 2. Spectral Response

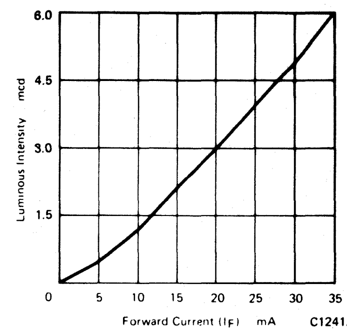


Fig. 3. Luminous Intensity vs. Forward Current

MV53124

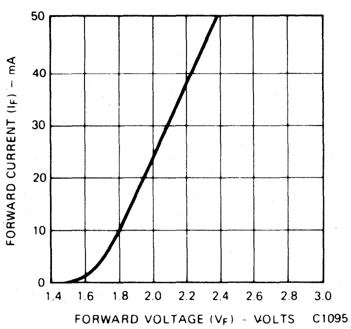


Fig. 4. Forward Current vs. Forward Voltage

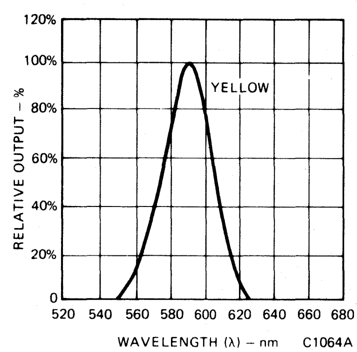


Fig. 5. Spectral Response

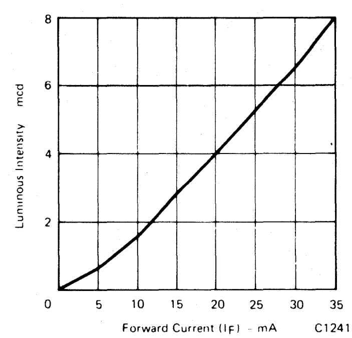


Fig. 6. Luminous Intensity vs. Forward Current

MV57124

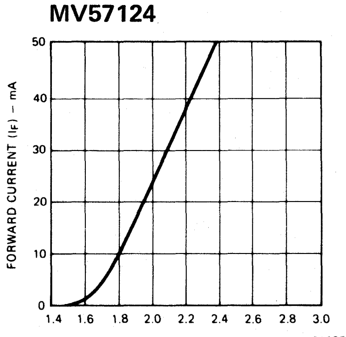


Fig. 7. Forward Current vs. Forward Voltage

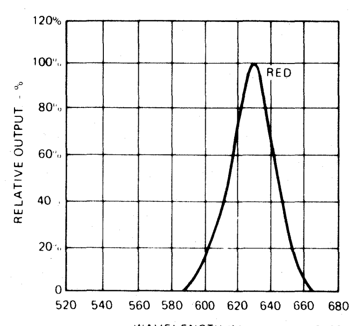


Fig. 8. Spectral Response

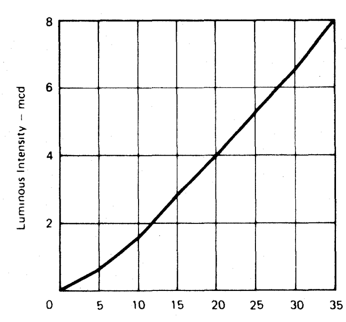


Fig. 9. Luminous Intensity vs. Forward Current

NOTES

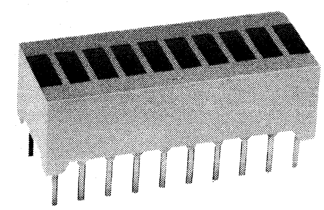
1. *The leads of the device were immersed in molten solder, heated to a temperature of 260°C, to a point 1/16 inch from the body of the device per MIL-S-750, with dwell time of 5 seconds.*
2. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*

GENERAL INSTRUMENT
Optoelectronics

HIGH EFFICIENCY RED MV57164 BAR GRAPH DISPLAY

FEATURES

- Large segments, closely spaced
- End stackable
- Fast switching, excellent for multiplexing
- Low power consumption
- Directly compatible with IC's
- Wide viewing angle
- Standard .3" DIP lead spacing
- Categorized for luminous intensity (see note 4)



DESCRIPTION

The MV57164 is a 10 segment bar graph display with separate anodes and cathodes for each light segment. The packages are end stackable.

ABSOLUTE MAXIMUM RATINGS

Power dissipation @25°C ambient	750 mW
Derate linearly from 50°C	−14.3 mW/°C
Storage and operating temperature	−40°C to 85°C
Continuous forward current	
Total	300 mA
Per segment	30 mA
Reverse voltage	
Per segment	6.0 V
Solder time @260°C (see Note 3)	5 sec.

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Φ_{JA}	160°C/W
Wavelength temperature coefficient (case temp)	1.0 A/°C
Forward voltage temperature coefficient	−2.0 mV/°C

FILTER RECOMMENDATIONS

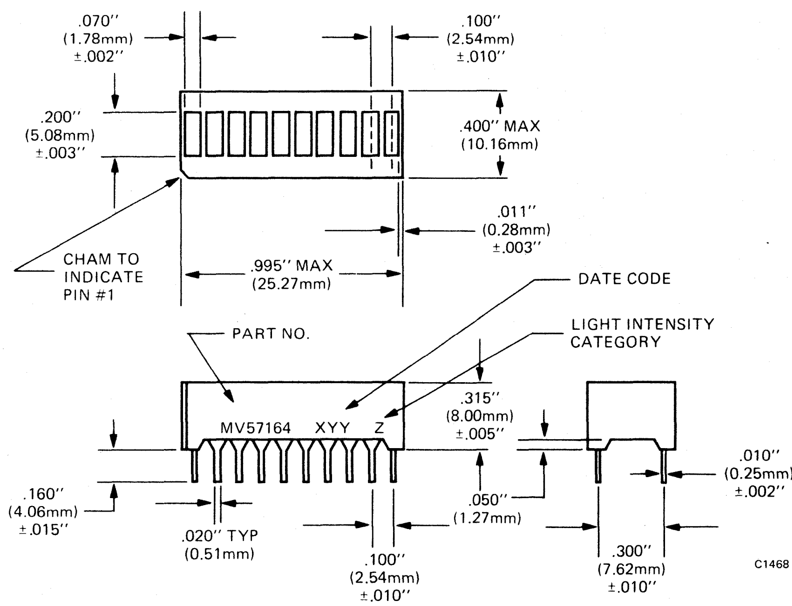
For optimum on and off contrast, one of the following filters or equivalents may be used over the display:

Panelgraphic Red 60
Homalite 100 — 1605

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward Voltage			2.5	V	I_F = 10 mA
Luminous intensity (unit avg.) (see Note 1)	510			μcd	I_F = 10 mA
Peak emission wavelength		630		nm	
Spectral line half width		40		nm	
Dynamic resistance					
Segment		26		Ω	I_F = 20 mA
Capacitance		35		pF	V = 0
Switching Time		400		nS	50 Ω system
Reverse Voltage	6.0			V	I_R = 100 μA

PACKAGE DIMENSIONS



PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS	PIN NO.	ELECTRICAL CONNECTIONS	PIN NO.	ELECTRICAL CONNECTIONS	PIN NO.	ELECTRICAL CONNECTIONS
1	Bar 1 Anode	6	Bar 6 Anode	11	Bar 10 Cathode	16	Bar 5 Cathode
2	Bar 2 Anode	7	Bar 7 Anode	12	Bar 9 Cathode	17	Bar 4 Cathode
3	Bar 3 Anode	8	Bar 8 Anode	13	Bar 8 Cathode	18	Bar 3 Cathode
4	Bar 4 Anode	9	Bar 9 Anode	14	Bar 7 Cathode	19	Bar 2 Cathode
5	Bar 5 Anode	10	Bar 10 Anode	15	Bar 6 Cathode	20	Bar 1 Cathode

TYPICAL CURVES (PER SEGMENT)

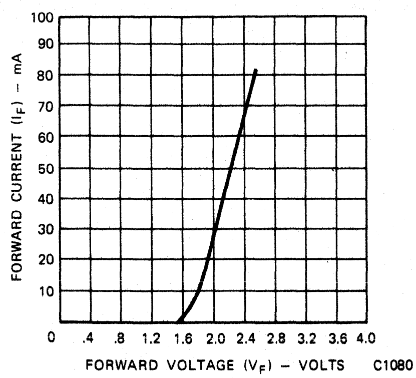


Fig. 1. Forward Current vs. Forward Voltage

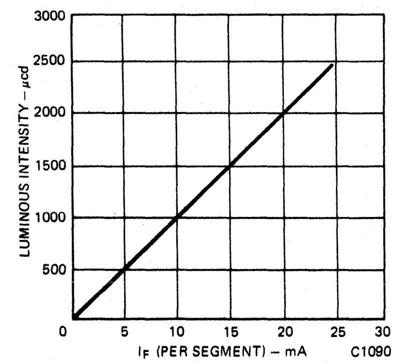


Fig. 2. Luminous Intensity vs. Forward Current

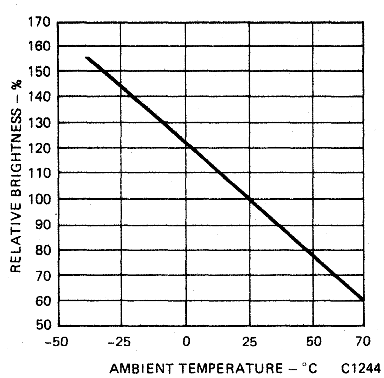


Fig. 3. Luminous Intensity vs. Temperature (See Note 2)

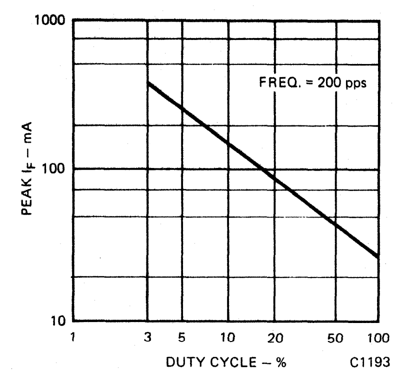


Fig. 4. Max Peak Current vs. Duty Cycle

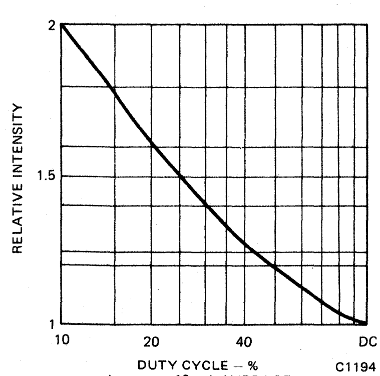
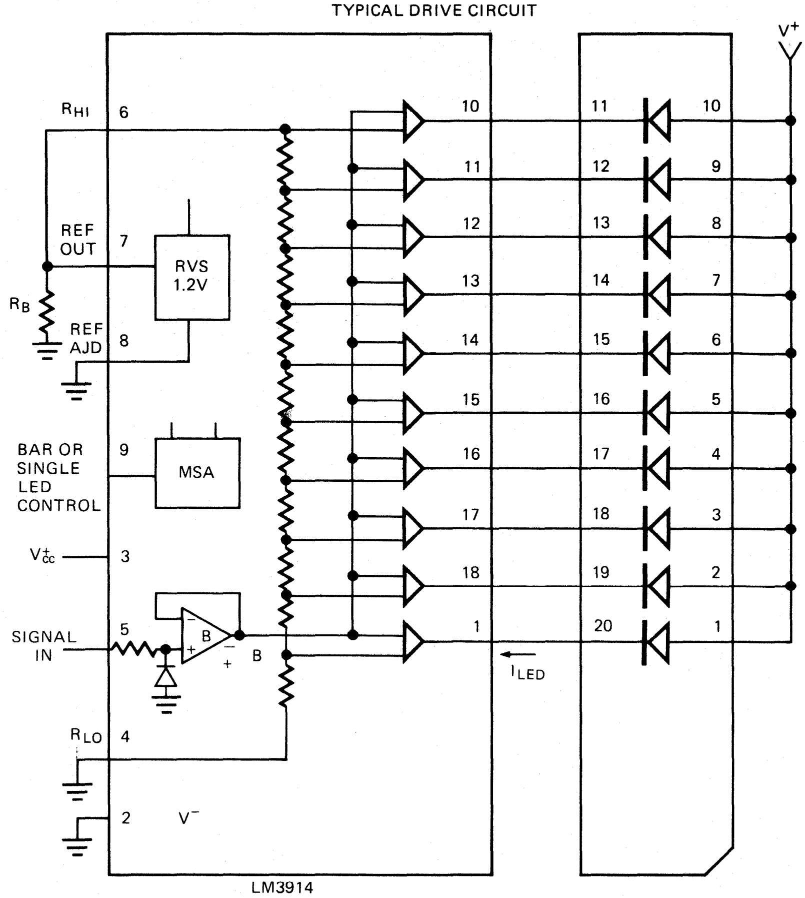


Fig. 5. Luminous Intensity vs. Duty Cycle

TYPICAL DRIVE CIRCUIT



RVS: REFERENCE VOLTAGE SOURCE
MSA: MODE SELECT AMPLIFIER
B: BUFFER
R_B: LED BRIGHTNESS CONTROL

C1471

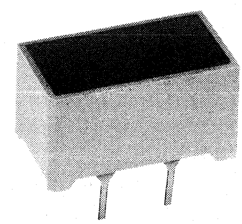
NOTES

1. *The average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. The standard of measurement is the Photo Research Corp. "Spectra" Microcandela Meter (Model IV-D) corrected for wavelength. Intensity will not vary more than ±33.3% between all segments within a unit.*
2. *The curve in Figure 5 is normalized to the brightness at 25°C to indicate the relative efficiency over the operating temperature range.*
3. *Leads immersed to 1/16" from the body of the device. Maximum unit surface temperature is 140°C.*
4. *All units are categorized for luminous intensity. The invensity category is marked on each part as a suffix letter to the part number.*
5. *For flux removal, Freon TF, Freon TE, Isoproponal or water may be used up to their boiling points.*

GENERAL INSTRUMENT
Optoelectronics

HIGH EFFICIENCY RED MV57173
.5″ RECTANGULAR LAMP

FEATURES
- .500″ x .250″ lighted area
- Solid state reliability
- Fast switching — excellent for multiplexing
- Low power consumption
- Directly compatible with IC's
- Wide viewing angle
- .2″ DIP lead spacing
- Mounting hardware available
- Categorized for luminous intensity (See note 1)



APPLICATIONS
- Panel indicators
- Backlight legends
- Light arrays

DESCRIPTION
The MV57173 is a large rectangular lamp which contains two LED chips with separate anodes and cathodes for each light. The illuminated area is 0.500 inches x 0.250 inches (12.7 mm x 6.35 mm).

Separate mounting hardware is available. See MP73.

ABSOLUTE MAXIMUM RATINGS

Power Dissipation at 25°C	200 mw
Derate linearly from 50°C	−4.3 mw/°C
Storage Temperature	−40°C to 100°C
Operating Temperature	−40°C to +85°C
Continuous Forward Current per light (25°C)	35 mA
Peak Forward Current per LED chip (1 μsec pulse width, 300 pps)	1.0A
Solder Time at 260°C (See note 2)	5 sec.

TYPICAL THERMAL CHARACTERISTICS

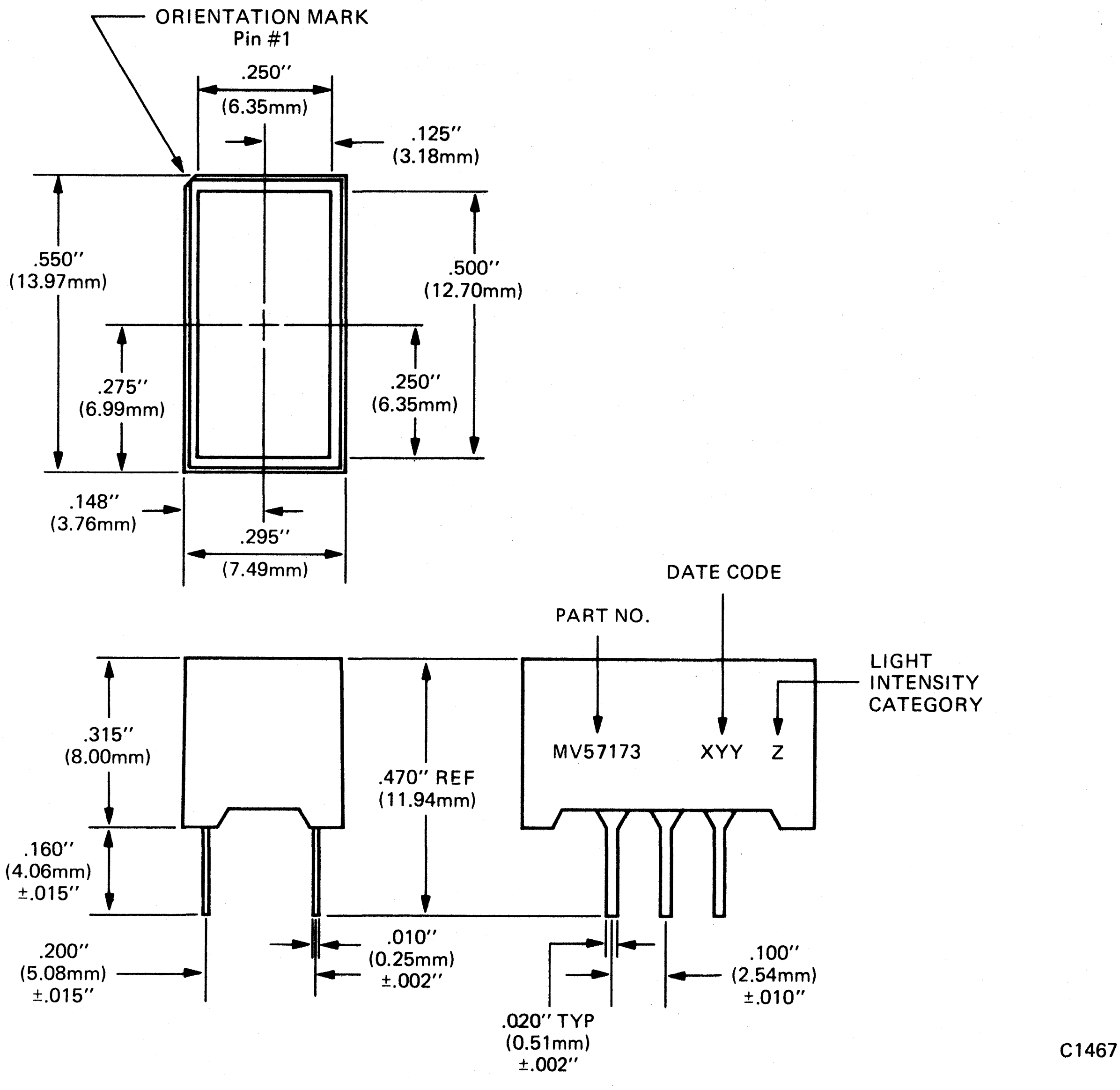
Thermal resistance junction to free air Φ_{JA}	160°C/W
Wavelength temperature coefficient (case temp)	1.0 A/°C
Forward voltage temperature coefficient	−2.0 mV/°C

FILTER RECOMMENDATIONS
For optimum on and off contrast, one of the following filters or equivalents may be used over the lamp:

Panelgraphic Red 60
Homalite 100—1605

MV57173

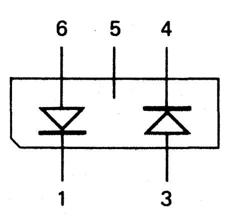
PACKAGE DIMENSIONS



TOLERANCE ±.010″ UNLESS SPECIFIED.

PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS
1	Cathode 1
2	No Pin
3	Anode 2
4	Cathode 2
5	NC
6	Anode 1



SCHEMATIC

ELECTRO-OPTICAL CHARACTERISTICS (Per LED Chip Unless Indicated)

	SYM.	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward Voltage	V_F		2.0	2.5	V	I_F = 20 mA
Luminous Intensity (Total both LED chips on)	I_L	4.5			mcd	I_F = 20 mA (per die)
Peak Wavelength			635		nm	I_F = 20 mA
Spectral Line half width			45		nm	I_F = 20 mA
Reverse Voltage	V_R	6	25		V	I_R = 100 μA
Capacitance			35		pF	V_F = 0
Switching Time			400		nS	50 Ω system

TYPICAL CURVES (Per LED Chip Unless Indicated)

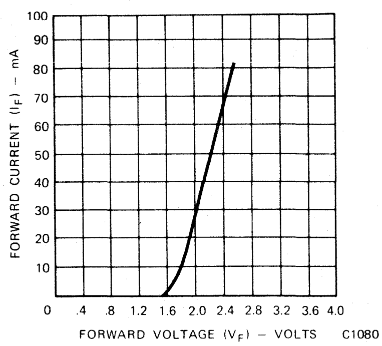


Fig. 1. Forward Current vs. Forward Voltage

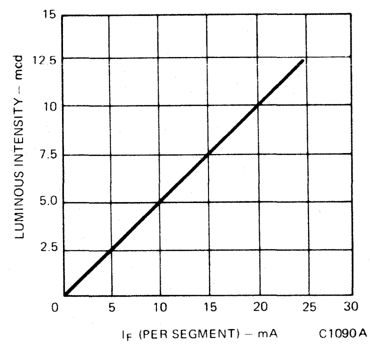


Fig. 2. Luminous Intensity vs. Forward Current (both LED chips on)

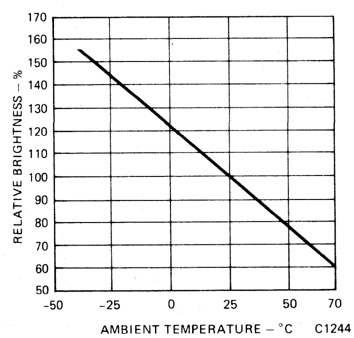


Fig. 3. Luminous Intensity vs. Temperature

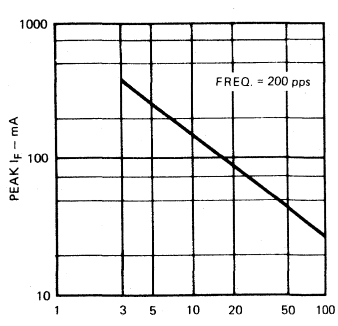


Fig. 4. Max Peak Current vs. Duty Cycle

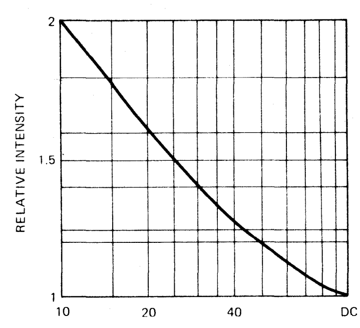


Fig. 5. Luminous Intensity vs. Duty Cycle

NOTES

1. *All units are categorized for luminous intensity. The intensity category is marked on each part as a suffix letter to the part number.*
2. *Leads immersed to 1/16″ from the body of the device. Maximum unit surface temperature is 140°C.*
3. *For flux removal, Freon TF, Freon TE, isoproponal or water may be used up to their boiling points.*

GENERAL INSTRUMENT
Optoelectronics

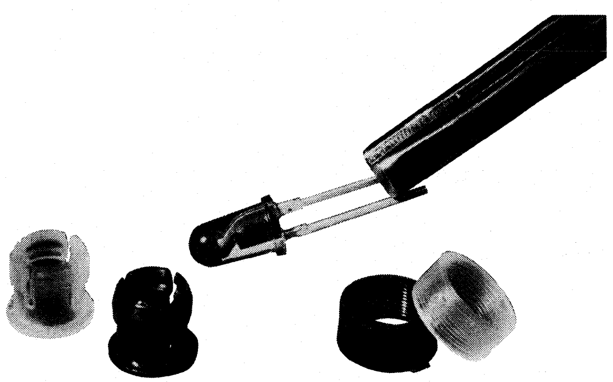
PANEL MOUNTING GROMMETS (FOR LED PANEL INDICATORS)

MP21 MP51 MP22 MP52

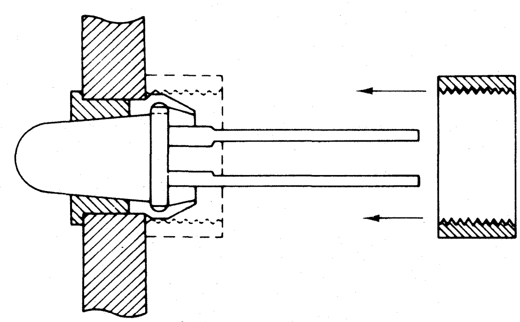
DESCRIPTION

The MP Series of mounting grommets is intended for panel mounting of many standard Monsanto light emitting diode indicators. The grommets are made of plastic and are available in clear and black.

The MP Series will easily mount the applicable lamps on any panel thickness up to .125 inch (3.18mm).

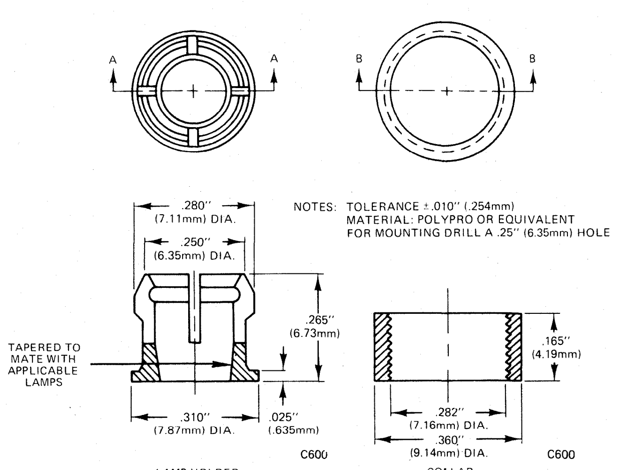


TYPICAL MOUNTING TECHNIQUE

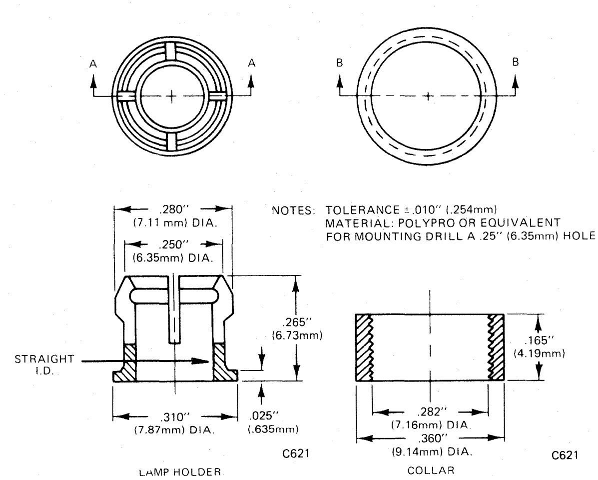


PART NUMBER	COLOR	AVAILABILITY	APPLICABLE LAMPS
MP21	CLEAR	Special order only	ME7021 thru ME7124; MV5020 thru MV5026
MP22	BLACK	Standard	
MP51	CLEAR	Special order only	MV5050 thru MV5056 MV5054-1-2-3 MV5152 thru MV5752 MV5153 thru MV5753 MV5154 thru MV5754
MP52	BLACK	Standard	

DIMENSIONAL DATA



MP21/MP22
TWO-PIECE POP-INS



MP51/MP52
TWO-PIECE POP-INS

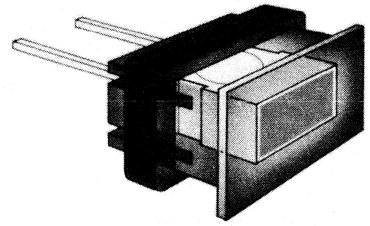
GENERAL INSTRUMENT
Optoelectronics

MP65
PANEL MOUNTING GROMMET FOR .220" RECTANGULAR LAMP

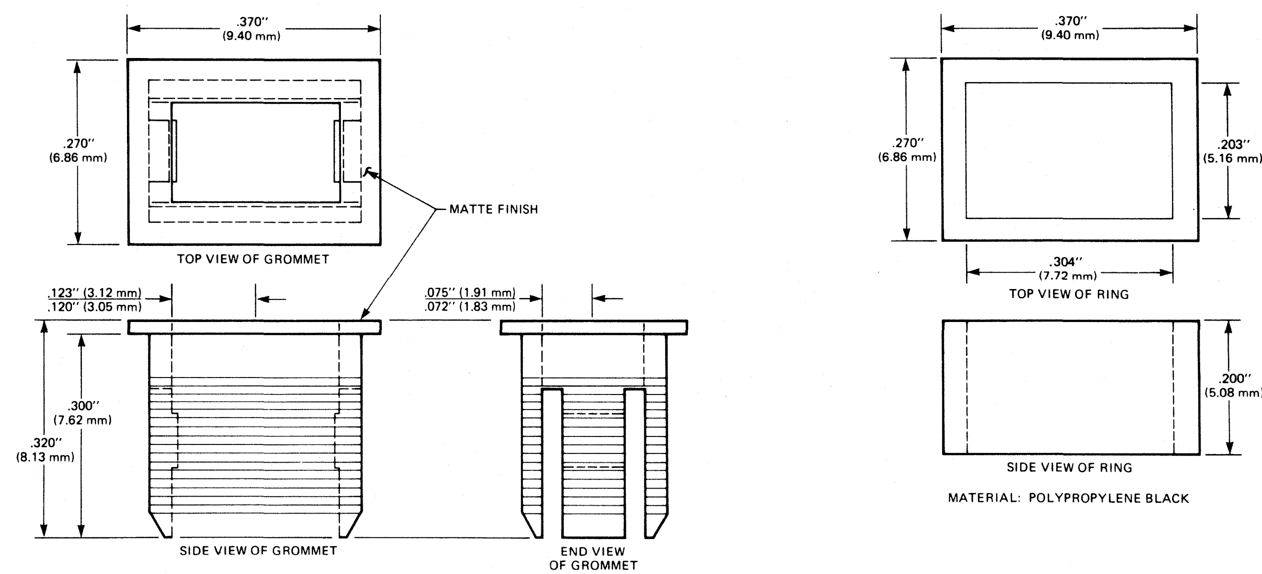
DESCRIPTION:

The MP65 mounting grommet is intended for panel mounting the MV5x124 series of rectangular lamps. The grommets are made of black plastic and provide the user with an easy-to-mount, professional appearance when viewed on a front panel.

The MP65 can be used on any panel thickness up to .125-inch (3.18 mm).



PACKAGE DIMENSIONS:



C1455

PANEL HOLE PUNCHING:

Punches can be ordered from one of the following sources:

W. A. WHITNEY COMPANY 650 Race Street Rockford, IL 61105 (815) 964-6771	(Request a 28xx series punch with dimensions of 5/16" x 7/32")
ROTEX PUNCH COMPANY, INC. 2350 Alvarado Street San Leandro, CA 94577 (415) 357-3600	(Request a 3506 series punch with dimensions of 5/16" x 7/32")

GENERAL INSTRUMENT
Optoelectronics

MP73

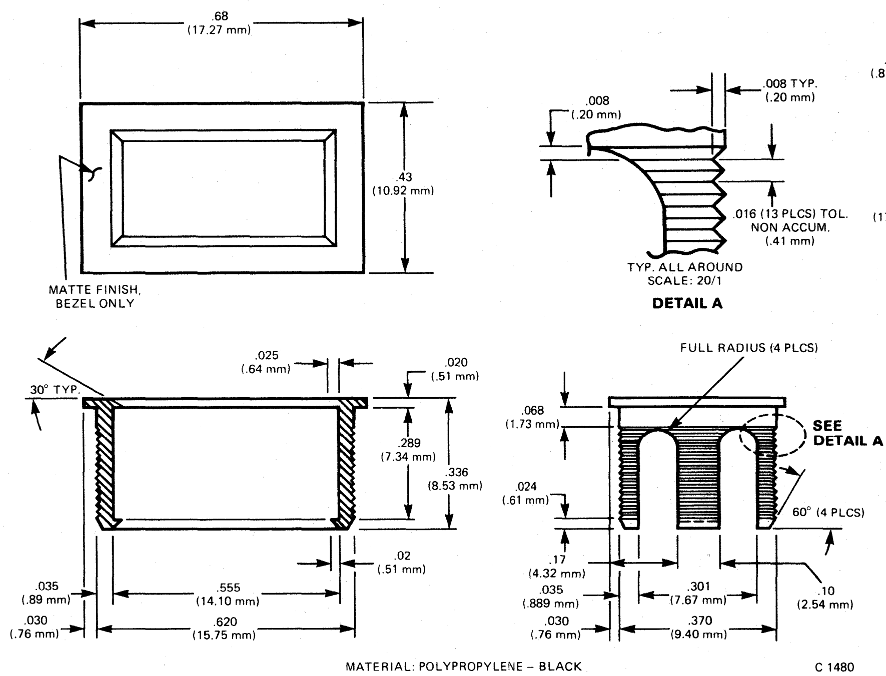
PANEL MOUNTING GROMMET FOR .500" RECTANGULAR LAMP

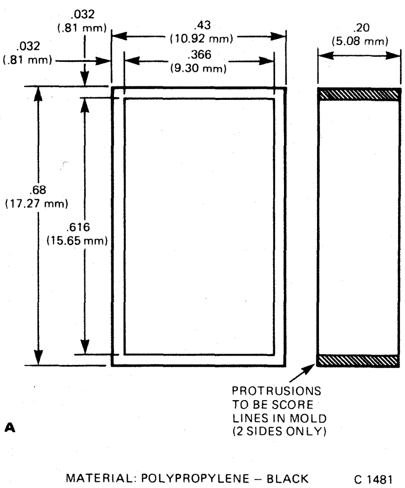
DESCRIPTION:

The MP73 mounting grommet is intended for panel mounting the MV57173 rectangular lamp. The grommets are made of black plastic and provide the user with an easy-to-mount, professional appearance when viewed on a front panel.

The MP73 can be used on any panel thickness up to .125-inch (3.18 mm).

PACKAGE DIMENSIONS:





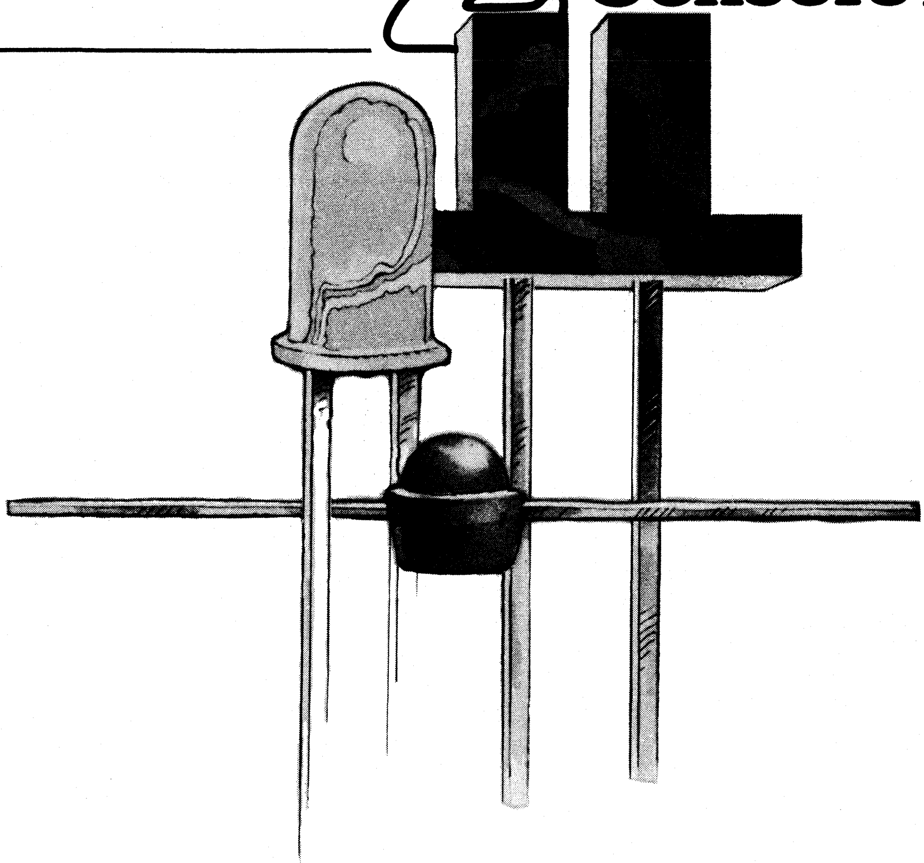
PANEL HOLE PUNCHING:

Punches may be ordered from one of the following sources:

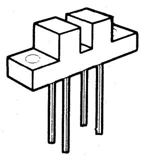
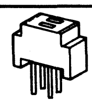
W. A. WHITNEY COMPANY
650 Race Street
Rockford, IL 61105
(815) 964-6771

ROTEX PUNCH COMPANY, INC.
2350 Alvarado Street
San Leandro, CA 94577
(415) 357-3600

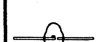
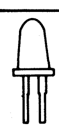
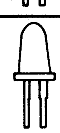
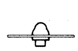
2 IR Emitters, Detectors, Sensors



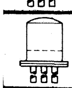
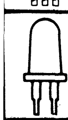
Sensors

ACTUAL SIZE	DEVICE NO.	OUTPUT CONFIGURATION	EMITTER VOLTAGE	DETECTOR MIN. BV_{CEO}	DETECTOR TYPICAL h_{FE}	DETECTOR MAX. $V_{CE(SAT)}$	MIN. CURREN TRANSF RATIO
 (half size)	MCT8	SLOTTED LIMIT SWITCH, TRANSISTOR	1.5V @ 20mA	30V	–	.4V @ 50μA	1%
	MCT81					.4V @ 25mA	0.25%
	MCA8	SLOTTED LIMIT SWITCH, DARLINGTON				1.0V @ 2mA	12.5%
	MCA81					1.0V @ 1.6mA	3.2%
	MCA7	REFLECTIVE SENSOR, DARLINGTON	1.5V @ 20mA	30V	–	–	0.1%

Emitters

ACT. SIZE	DEVICE NO.	RADI-ATED POWER	ON-AXIS IRRADIANCE OR INTENSITY	MAX. FORWARD VOLTAGE	MAX. DC CURRENT	MAX. POWER	ON/OFF DELAY		APPLICATION
	ME60 ME61	550μW	250mW/cm²	1.5V @ 50mA	50mA	75mW	10nsec		Card readers, encoders, alarm and sector systems, le indicator, end-of-tape detection.
	ME7021 ME7024	1.0mW	3.6mW/Str. 81.2mW/Str.	1.5V @ 20mA	100mA	150mW	100nsec		
	ME7121 ME7124	3.0mW	10.8mW/Str. 243.6mW/Str.	1.8V @ 50mA	100mA	150mW	500nsec		
	ME7161	3.0mW		1.8V @ 50mA	50mA	75mW	500nsec		

MIN. DC ISOLATION VOLTAGE	BAND-WIDTH		APPLICATIONS
	150KHz		Tape reader, mark sensor, end-of-tape detector, end-of-film detector, metal processing equipment, length measurement, coded disk detection, edge sensor, textile processing equipment, fluid volume and velocity control, level detector, object sensor, strobing light control, stroboscope.
	200 KHz		
	0.8KHz		
	1.5KHz		
	0.8KHz		Object sensing, end-of-tape detection, length measurement, industrial processing equipment.

ACT. SIZE	DEVICE NO.	SENSITIVITY $\mu A/mW/cm^2$	V_{CE} (SAT)	MAX. DC CURRENT	MIN. BV_{CEO}	DARK CURRENT	BAND-WIDTH		APPLICATIONS
	MT1	560	.5V @ 2mA	40mA	30V	1nA	300KHz		Optical switching, intrusion alarm, process control, tape and card reader, level controls, character recognition.
	MT2	1400							
	MT8020	350	0.2V @ 1.6 mA	40mA	30V	1.5nA	–		

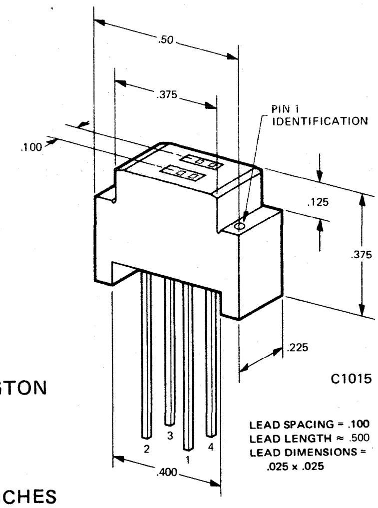
GENERAL INSTRUMENT
Optoelectronics

MCA7
REFLECTIVE OBJECT SENSOR

PRODUCT DESCRIPTION

The MCA7 opto-isolator consists of an infrared emitting diode and a silicon planar photo darlington. The on-axis radiation of the emitter and the on-axis response of the detector are both perpendicular to the face of the MCA7. The photodarlington responds to radiation emitted from the diode only when a reflective object or surface is in the field of view of the detector.

PACKAGE DIMENSIONS



PIN 1 ANODE } LED
2 CATHODE
3 COLLECTOR } PHOTO-DARLINGTON
4 EMITTER

ALL DIMENSIONS ARE IN INCHES

FEATURES

- High sensitivity
- Low Cost
- High reliability

APPLICATIONS

- Object sensing
- End-of-tape sensing

ABSOLUTE MAXIMUM RATINGS

Storage Temperature . . . . −55°C to 100°C
Operating Temperature . . . . −55°C to 100°C
Lead Temperature (Soldering, 5 sec) . . . . 260°C
Total Power Dissipation
(25° Free Air Temp.) . . . . 250 mW
Derate linearly from 25°C . . . . 3.3 mW/°C

INPUT DIODE
Power dissipation at 25°C ambient . . . . . . 90 mW
Derate Linearly from 25°C . . . . 1.2 mW/°C
Forward current . . . . 60 mA
Reverse voltage . . . . 3 V
Peak forward current (1 μs pulse, 300 pps) . . 3.0 A
OUTPUT DARLINGTON
Power dissipation at 25°C Ambient . . . . . 150 mW
Derate linearly from 25°C . . . . 2.0 mW/°C
Collector Current . . . . 25 mA
Collector to emitter voltage . . . . 30 V

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F		1.25	1.50	V	I_F = 20 mA
Reverse Breakdown Voltage	BV_R	3.0	5.5		V	I_R = 10 μA
Junction Capacitance	C_j		50		pF	V_F = 0V
Reverse Leakage Current	I_R		.01	10	μA	V_R = 3.0V
OUTPUT DARLINGTON						
Breakdown Voltage	BV_{CEO}	30	55		V	I_C = 1.0 mA I_F = 0 (NOTE 2)
Reverse Breakdown Voltage	BV_{ECO}	5	7		V	I_C = 100 μA I_F = 0 (NOTE 2)
Leakage current	I_{CEO} (dark)		5	100	nA	V_{CE} = 5V (NOTE 2), I_F=0
Rise Time, Fall Time			0.6		mS	V_{CE} = 5V, R_L = 1KΩ
COUPLED						
DC Current Transfer Ratio	(CTR)	.050	1		mA	I_F = 50 mA V_{CE} = 5.0V (NOTE 1 & 2) d = 1.0 CM

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (25°C Free Air Temperature Unless Otherwise Specified)

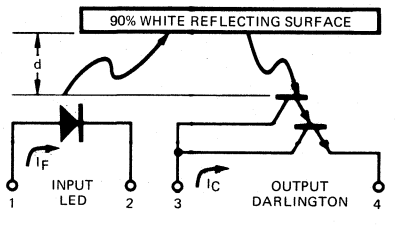


Figure 1 Parameter Symbols

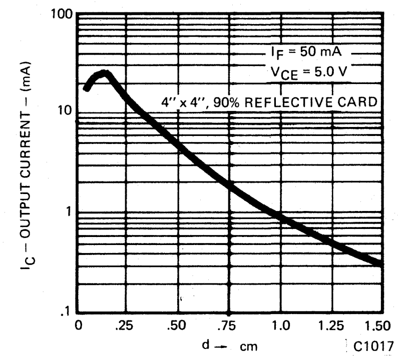


Figure 2 Output Current vs. Distance

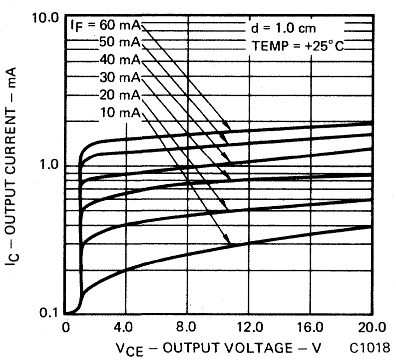


Figure 3 I_C vs. V_{CE}

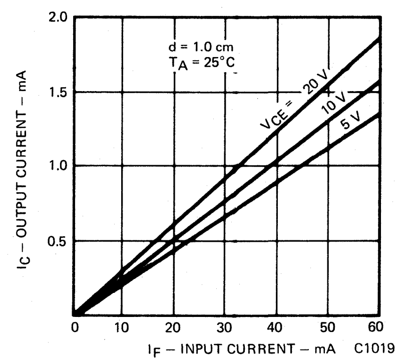


Figure 4 I_C vs. I_F

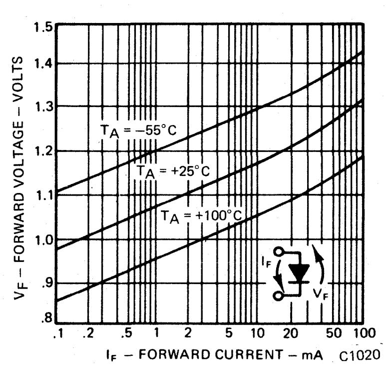


Figure 5 Forward Voltage vs. Forward Current

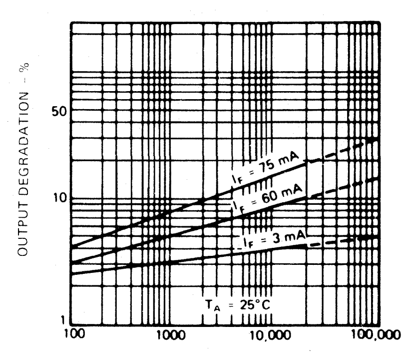


Figure 6 Lifetime vs. Forward Current

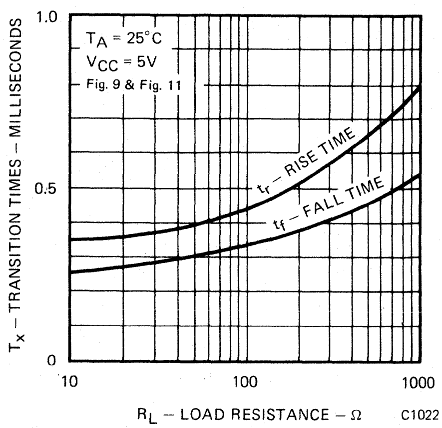


Figure 7. Non-Saturated Rise and Fall Times vs. Load Resistance

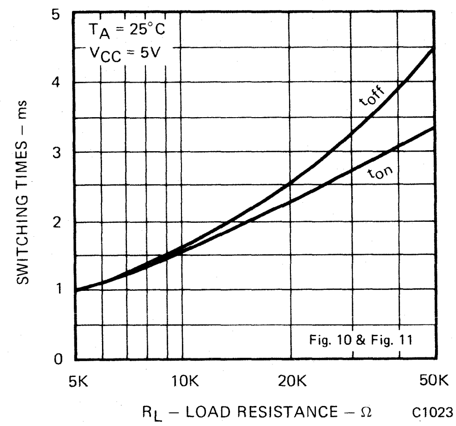


Figure 8. Saturated Switching Times vs. Load Resistance

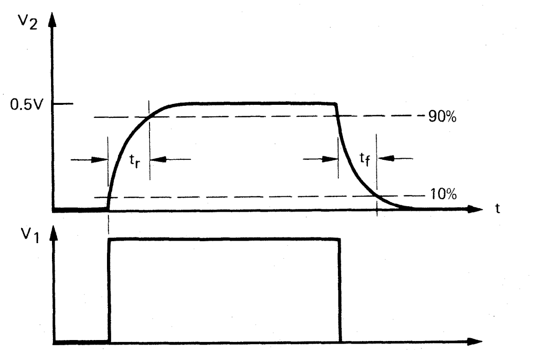


Figure 9. Non-Saturated Switching Waveforms

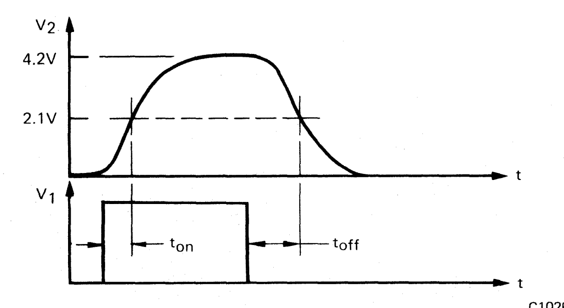


Figure 10. Saturated Switching Waveforms

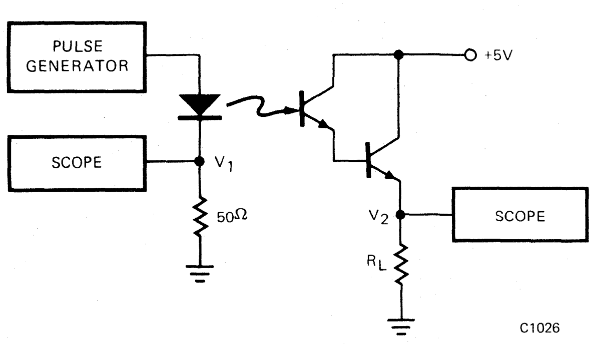


Figure 11. Circuit for Testing Switching Parameters

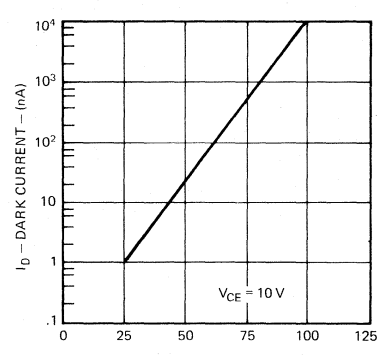
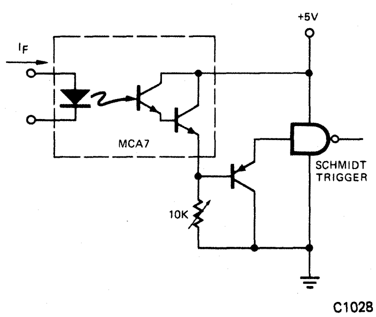


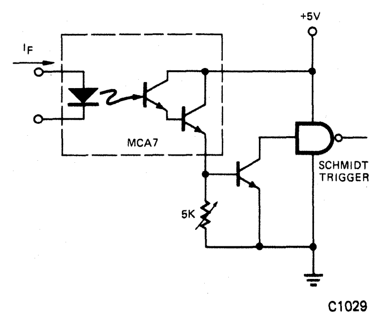
Figure 12. Dark Current vs. Temperature

CIRCUITS TO INTERFACE THE MCA7 WITH 5V LOGIC



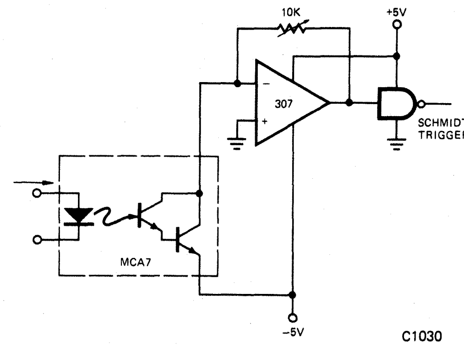
Circuit 1

Normally High Output



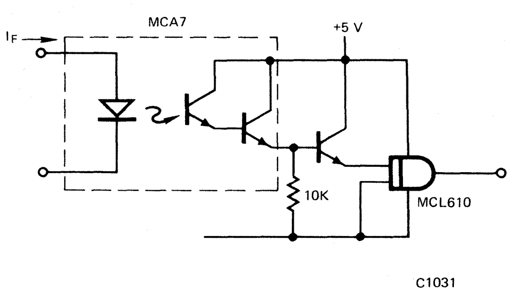
Circuit 2

Normally Low Output



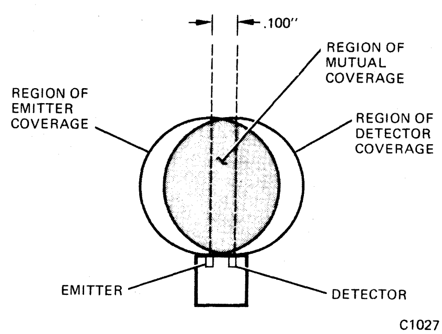
Circuit 3

Comparator Driver



Circuit 4

Booster Drive to Logic Isolator



Spatial Distribution of Maximum Sensitivity

NOTES:

1. *Photo current is obtained from a 4.0" x 4.0", 90% white surface placed at a distance of 1.0 cm from the surface of the MCA7.*
2. *Measured with radiation flux intensity of less than 0.1 μW/cm² (dark condition) over the spectrum from 0.1 micron to 1.5 microns.*
3. *Measured at typical factory ambient of 150 foot-candles (150 lamberts per square foot).*

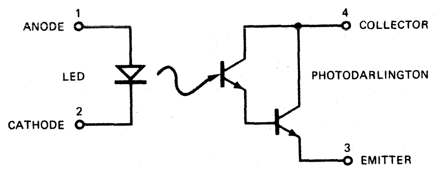
GENERAL INSTRUMENT
Optoelectronics

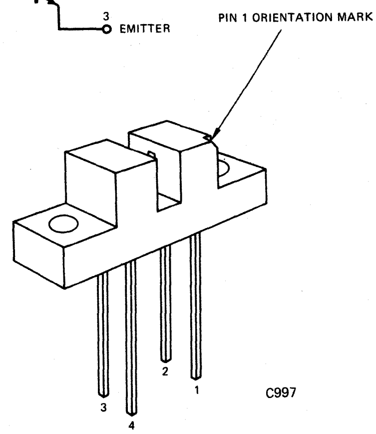
MCA8
MCA81
SLOTTED OPTICAL LIMIT SWITCH

PRODUCT DESCRIPTION

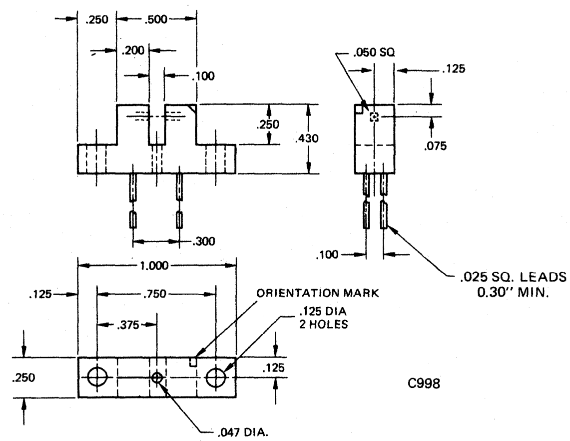
The MCA8 optical limit switch transmits light from a GaAs infrared emitting diode to a silicon photodarlington detector. Both semiconductor chips face each other across an .1-inch air gap. The MCA8 senses an object that interrupts the beam. Output current will directly operate a TTL Schmidt trigger.

PACKAGE DIMENSIONS





C997



C998

All dimensions are in inches.
Active area of LED is .014 x .014
Active area of PhotoDarlington is .010 x .020
Dimensions ± .010 inches

FEATURES

- High Sensitivity permits direct interface with TTL logic.
- Modular construction permits low cost package modification to suit any application.
- Recessed detector provides a high signal to noise ratio in ambient light.
- Plugs into standard DIP socket.
- Multiple flat reference surfaces allow precise mechanical alignment of the optical beam.
- Absence of lensing provides position sensitivity down to 0.020" between full on and full off.
- Solid copper lead-frame provides excellent heat sinking and highest reliability for the LED.
- One piece construction of the emitter and detector components provides excellent moisture resistance, immunity from thermal shocks, high and low temperature stability, and protection from shock and vibration.

APPLICATIONS

- Optical shaft position and velocity monitor using a digitally encoded disk mounted on a shaft.
- Optical sensing of holes in paper, paper tape, IBM card, or magnetic tape.
- Optical sensing of marks on paper, paper tape, or IBM card.
- End of tape sensor using a transparent section of tape, a reflective strip on the tape, or a hole in the tape.
- End of film sensor for films not affected by infra-red light.
- Limit switch for mechanical travel such as cam switches, pressure switches, machine tool limit switches, foot pedal switches, safety interlock switches.
- Edge sensor for sheet materials such as paper, plastic film, fabric, foil, newsprint, belt sanders, reproduction paper.
- Fiber continuity monitor for fibers such as yarn, wire, thread.
- Fluid volume monitor by sensing turbine vanes passing through the slot.
- Liquid level detector of an opaque liquid.

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F		1.25	1.5	V	I_F = 20 mA
Reverse Breakdown Voltage	BV_R	3.0	25		V	I_R = 10 μA
Reverse Leakage Current	I_R		.01	10	μA	V_R = 3 V
Junction Capacitance			50		pF	V_F = 0
OUTPUT DARLINGTON—MCA8						
Saturation Voltage	V_{CE}(SAT)		0.8	1.0	V	I_C = 2 mA, I_F = 16 mA (Note 1)
Collector Breakdown Voltage	BV_{CEO}	30	55		V	I_C = 1 mA, I_F = 0 (Note 1)
Emitter Breakdown Voltage	BV_{ECO}	5	7		V	I_C = 100 μA, I_F = 0
Dark Current—MCA8	I_{CEO}		5	100	nA	V_{CE} = 5.0 V, I_F = 0 (Note 1)
Rise Time	tr		2.3		ms	V_{CE} = 5 V, R_L = 1 KΩ
Fall Time	tf		1.7		ms	V_{CE} = 5 V, R_L = 1 KΩ
Turn-on Time	t_{ON}		.3		ms	I_F = 12 mA, FIG 12
Turn-off Time	t_{OFF}		1.0		ms	I_F = 12 mA, FIG 12
DC Current Transfer Ratio	CTR	15	30		%	I_F = 16 mA, V_{CE} = 5 V
OUTPUT DARLINGTON—MCA81						
Saturation Voltage	V_{CE}(SAT)		0.8	1.0	V	I_C = 1.6 mA, I_F = 50 mA (Note 1)
Collector Breakdown Voltage	BV_{CEO}	30	55		V	I_C = 1 mA, I_F = 0 (Note 1)
Emitter Breakdown Voltage	BV_{ECO}	5	7		V	I_C = 100 μA, I_F = 0
Dark Current	I_{CEO}		5	100	nA	V_{CE} = 5.0 V, I_F = 0 (Note 1)
Ambient Light Leakage Current			2		μA	V_{CE} = 5.0 V, I_F = 0
Rise Time	tr		.36		ms	V_{CE} = 5 V, R_L = 1 KΩ
Fall Time	tf		.3		ms	V_{CE} = 5 V, R_L = 1 KΩ
Turn-on Time	t_{ON}		.15		ms	I_F = 40 mA, FIG 12
Turn-off Time	t_{OFF}		.2		ms	I_F = 40 mA, FIG 12
DC Current Transfer Ratio	CTR	4	8		%	I_F = 16 mA, V_{CE} = 5 V

ABSOLUTE MAXIMUM RATINGS

Storage Temperature Range . . . . . . -65°C to +100°C
Operating Temperature Range . . . . −55°C to +100°C
Lead Temp. (Soldering, 10sec) . . . . 260°C
Total Power Diss. @ 25°C Free
Air Temperature . . . . 275 mW
Derate Linearly to 100°C (θ_{JA}) . . . . 1.65 mW/°C
Input to Output Isolation Voltage . . . . . 1500 VAC

Input Diode
Power Dissipation @25°C Ambient . . . . . . 90 mW
Derate Linearly from 25°C . . . . 1.2 mW/°C
Forward Current . . . . 60 mA
Reverse Voltage . . . . 3 V
Peak Forward Current
(1 μs pulse, 300 pps) . . . . 3.0 A
Output Darlington
Collector-Emitter Voltage (BV_{CEO}) . . . . . . 30 V
Collector Current . . . . 100 mA

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES
(25°C Free Air Temperature Unless Otherwise Specified)

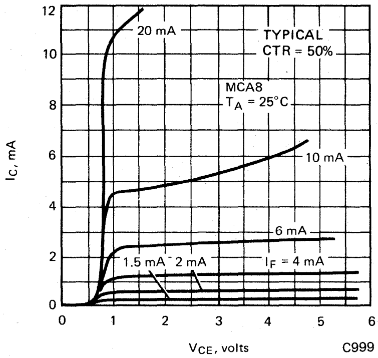


Figure 1 Collector Current vs. Collector Voltage

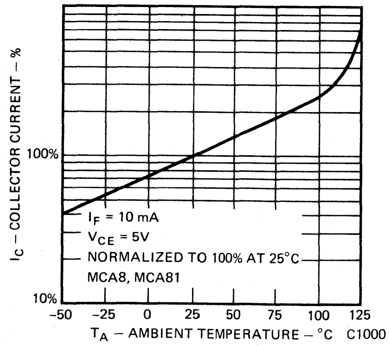


Figure 2 Collector Current vs. Ambient Temperature

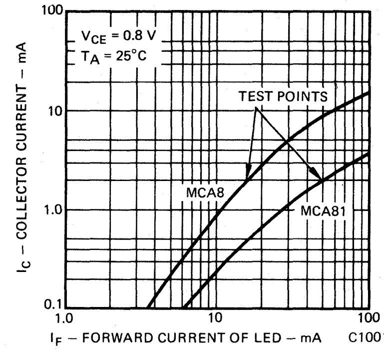


Figure 3 Collector Current vs. LED Current

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (CONT.)

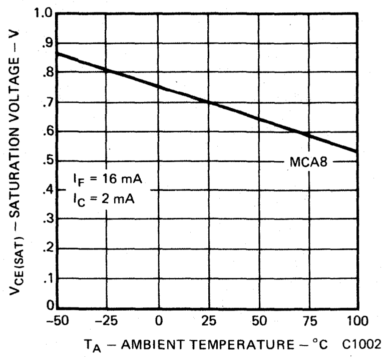


Figure 4 Saturation Voltage vs. Temperature

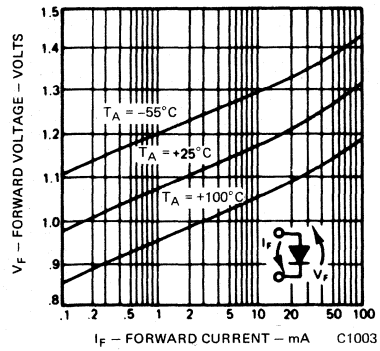


Figure 5 Forward Voltage vs. Forward Current

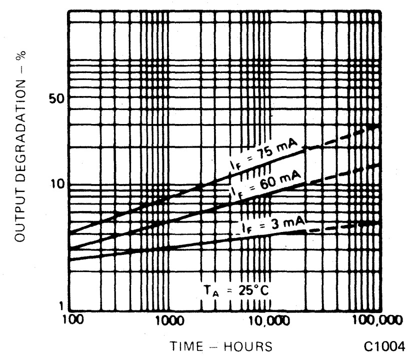


Figure 6 Lifetime vs. Forward Current

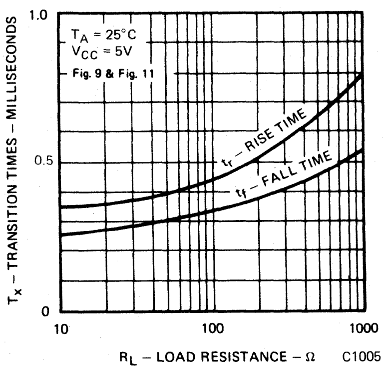


Figure 7 Non-Saturated Rise and Fall Times vs. Load Resistance

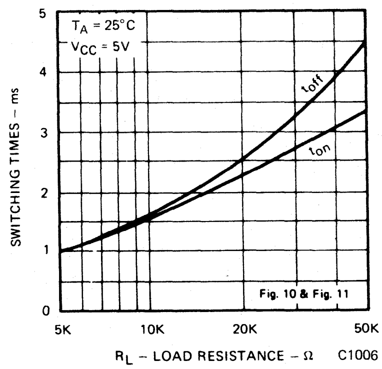


Figure 8 Saturated Switching Times vs. Load Resistance

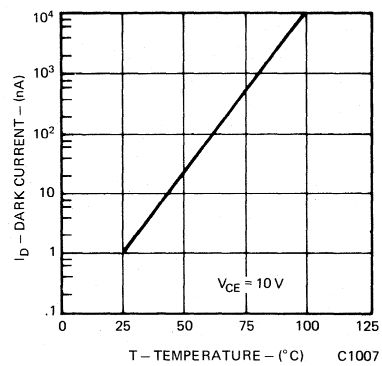


Figure 9. Dark Current vs. Temperature

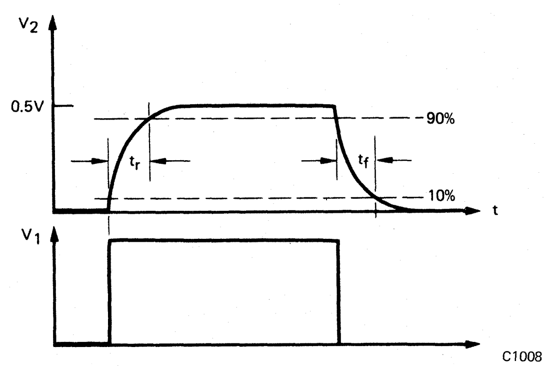


Figure 10 Non-Saturated Switching Waveforms

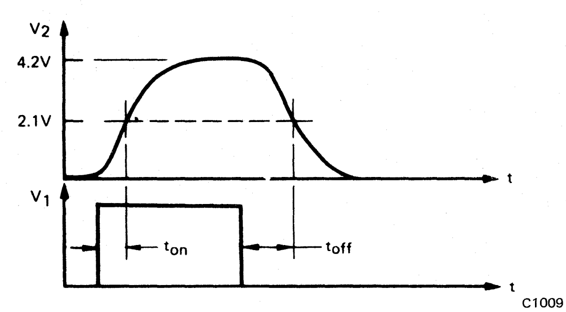


Figure 11 Saturated Switching Waveforms

PW = 10-100 msec
DC = 10%
t_r t_f = ≤10 nsec

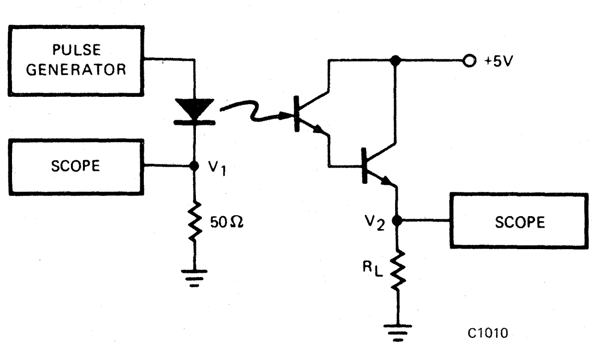


Figure 12 Circuit for Testing Switching Parameters

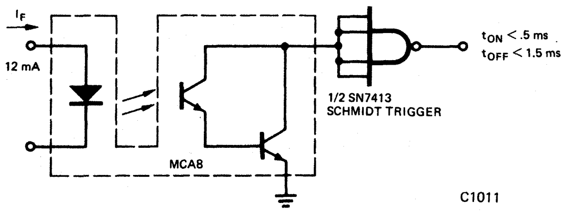


Figure 12 Driving a TTL Schmidt Trigger

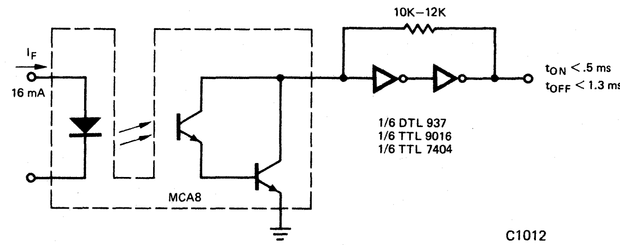


Figure 13 Driving Two Hex Inverters

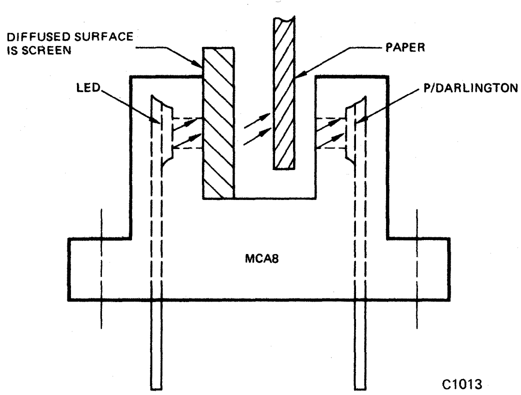


Figure 14 Detecting Paper by using a Lens Screen

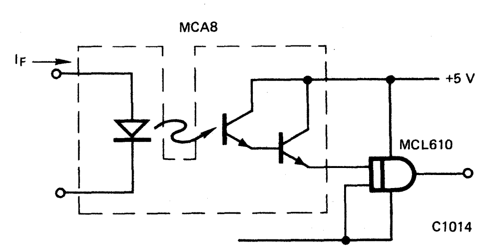


Figure 15 TTL Logic Interface

NOTES:

1. *Measured with radiation flux intensity of less than 0.1 μW/cm² (dark condition) over the spectrum from 0.1 micron to 1.5 microns.*

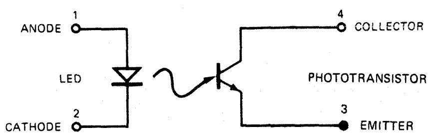
GENERAL INSTRUMENT
Optoelectronics

MCT8
MCT81
SLOTTED OPTICAL LIMIT SWITCH

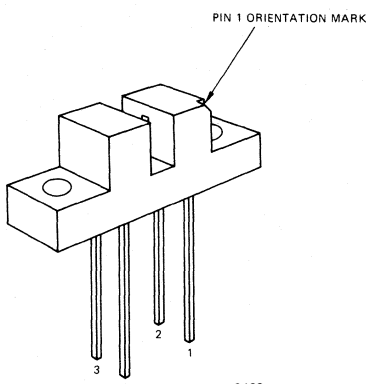
PRODUCT DESCRIPTION

The MCT8 optical limit switch transmits light from a GaAs infrared emitting diode to a silicon phototransistor. Both semiconductor chips face each other across an .1-inch air gap. The MCT8 senses an object in the air gap by the effect on light transmission.

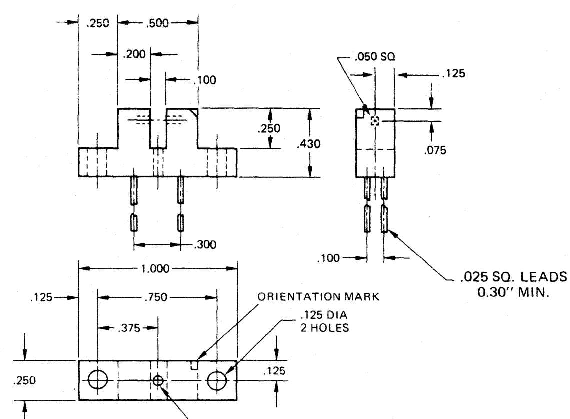
PACKAGE DIMENSIONS



C437



C438



C439

Dimensions ± .010 inches
All dimensions are in inches.

FEATURES

- Transistor detector allows faster switching speeds than darlington detector.
- Modular package design permits low cost package modification to suit any application.
- Recessed detector and use of black plastic provide a high signal to noise ratio in ambient light.
- Plugs into standard DIP socket.
- Solid copper lead-frames provide excellent heat sinking.

APPLICATIONS

- Optical shaft position and velocity monitor using a digitally encoded disc mounted on a shaft.
- Optical sensing of holes in paper, paper tape, IBM card, or magnetic tape.
- Optical sensing of marks on paper, paper tape, or IBM card.
- End of tape sensor using a transparent section of tape, a reflective strip on the tape, or a hole in the tape.
- End of film sensor for films not affected by infra-red light.
- Limit switch for mechanical travel such as cam switches, pressure switches, machine tool limit switches, foot pedal switches, safety interlock switches.
- Edge sensor for sheet materials such as paper, plastic film, fabric, foil, newsprint, belt sanders, reproduction paper.
- Fiber continuity monitor for fibers such as yarn, wire, thread.
- Fluid volume monitor by sensing turbine vanes passing through the slot.
- Liquid level detector of an opaque liquid.

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F		1.30	1.50	V	$I_F = 20$ mA
Reverse Breakdown Voltage	BV_R	3.0	20		V	$I_R = 10\ \mu A$
Reverse Leakage Current	I_R		.01	10	μA	$V_R = 3$ V
OUTPUT TRANSISTOR—MCT8						
DC Current Transfer Ratio	CTR	.200	1.0		mA	$I_F = 20$ mA, $V_{CE} = 10$ V
Saturation Voltage	$V_{CE}(SAT)$		0.2	0.4	V	$I_C = 50\ \mu A$, $I_F = 20$ mA (Note 1)
Collector Breakdown Voltage	BV_{CEO}	30	55		V	$I_C = 1$ mA, $I_F = 0$ (Note 1)
Emitter Breakdown Voltage	BV_{ECO}	5	7		V	$I_C = 100\ \mu A$, $I_F = 0$
Dark Current	I_{CEO}		5	100	nA	$V_{CE} = 10.0$ V, $I_F = 0$ (Note 1)
Rise Time	tr		5		μsec	$V_{CC} = 10$ V, $I_C = 1$ mA $R_L = 100\ \Omega$ CIRCUIT 1
Fall Time	tf		4		μsec	$V_{CC} = 10$ V, $I_C = 1$ mA, $R_L = 100\ \Omega$ CIRCUIT 1
Turn-on Time (from 5 V to 0.8 V)	t_{ON}		6		μsec	$I_F = 40$ mA CIRCUIT 2 $R_B = 1.2k\Omega$, $R_L = 2.4k\Omega$
Turn-off Time (from SAT. to 2 V)	t_{OFF}		4		μsec	$I_F = 40$ mA CIRCUIT 2 $R_B = 1.2k\Omega$, $R_L = 2.4k\Omega$
OUTPUT TRANSISTOR—MCT81						
DC Current Transfer Ratio	CTR	50	100		μA	$I_F = 20$ mA, $V_{CE} = 10$ V
Saturation Voltage	$V_{CE}(SAT)$		0.2	0.4	V	$I_C = 25\ \mu A$, $I_F = 20$ mA (Note 1)
Collector Breakdown Voltage	BV_{CEO}	30	55		V	$I_C = 1$ mA, $I_F = 0$ (Note 1)
Emitter Breakdown Voltage	BV_{ECO}	5	7		V	$I_C = 100\ \mu A$, $I_F = 0$
Dark Current	I_{CEO}		5	100	nA	$V_{CE} = 10.0$ V, $I_F = 0$ (Note 1)
Ambient Light Leakage Current			0.30		μA	$V_{CE} = 10.0$ V, $I_F = 0$
Rise Time	tr		3		μsec	$V_{CC} = 10$ V, $I_C = 1$ mA $R_L = 100\ \Omega$ CIRCUIT 1
Fall Time	tf		4		μsec	$V_{CC} = 10$ V, $I_C = 1$ mA $R_L = 100\ \Omega$ CIRCUIT 1
Turn-on Time (from 5 V to 0.8 V)	t_{ON}		6		μsec	$I_F = 40$ mA CIRCUIT 2 $R_B = 1.2k\Omega$, $R_L = 2.4k\Omega$
Turn-off Time (from SAT to 2 V)	t_{OFF}		3		μsec	$I_F = 40$ mA CIRCUIT 2 $R_B = 1.2k\Omega$, $R_L = 2.4k\Omega$

ABSOLUTE MAXIMUM RATINGS

Storage Temperature Range . . . . −65°C to +100°C
Operating Temperature Range . . . −55°C to +100°C
Lead Temp. (Soldering, 10 sec) . . . . 260°C
Total Power Diss. @ 25°C Free
Air Temperature . . . . 275 mW
Derate Linearly to 100°C (θ_{JA}). . . . . 3.7 mW/°C

Input Diode
Power Dissipation @ 25°C Ambient . . . . 90 mW
Derate Linearly Above 25°C . . . . 1.2 mW/°C
Forward Current . . . . 60 mA
Reverse Voltage . . . . 3 V
Peak Forward Current
(1 μs pulse, 300 pps) . . . . 3.0 A
Output Transistor
Collector-Emitter Voltage . . . . 30 V
Emitter-Collector Voltage . . . . 5 V

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

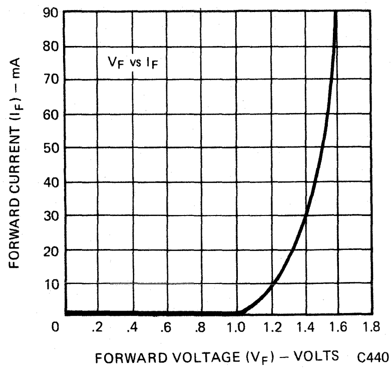


Fig. 1. Forward Voltage vs. Forward Current

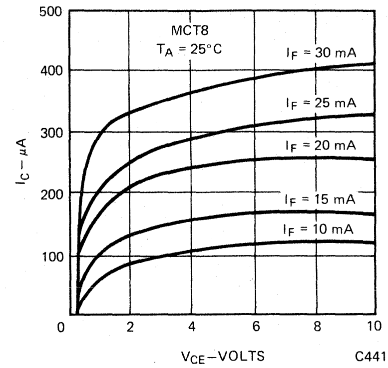


Fig. 2. Collector Current vs. Collector Voltage

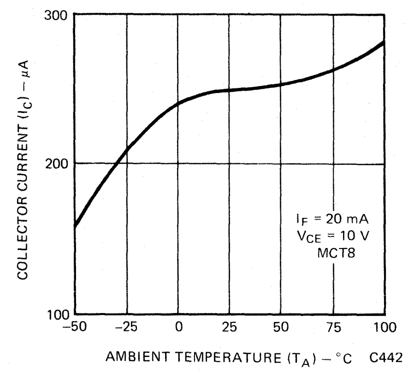


Fig. 3. Collector Current vs. Ambient Temperature

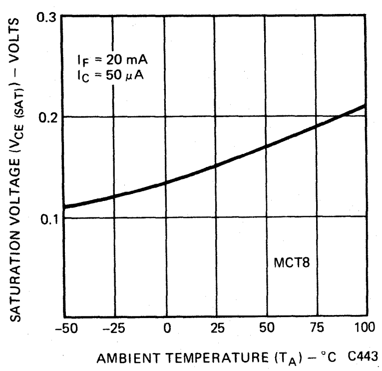


Fig. 4. Saturation Voltage vs. Temperature

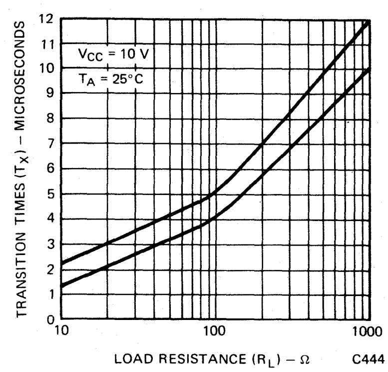


Fig. 5. Non-saturated Rise and Fall Times vs. Load Resistance

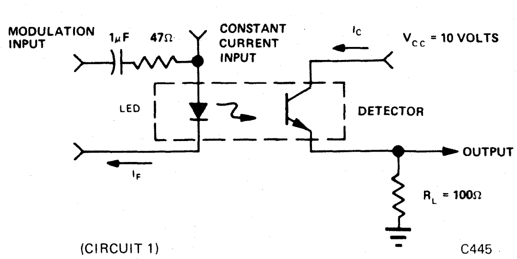


Figure 6.

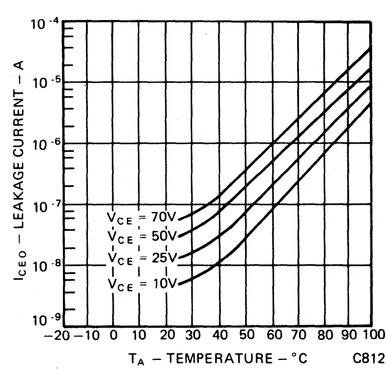


Fig. 7. Dark Current vs. Temperature

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (CONT.)

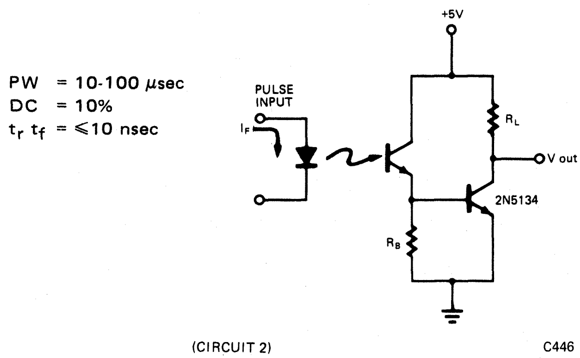


Figure 7.

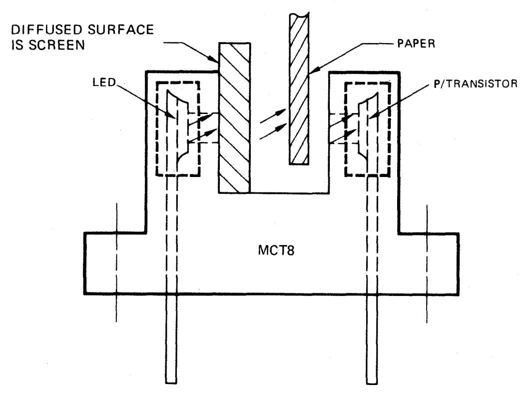


Fig. 8. Detecting Paper by Using a Lens Screen

NOTES:

1. *Measured with radiation flux intensity of less than 0.1 μW/cm^2 (dark condition) over the spectrum from 0.1 micron to 1.5 microns.*

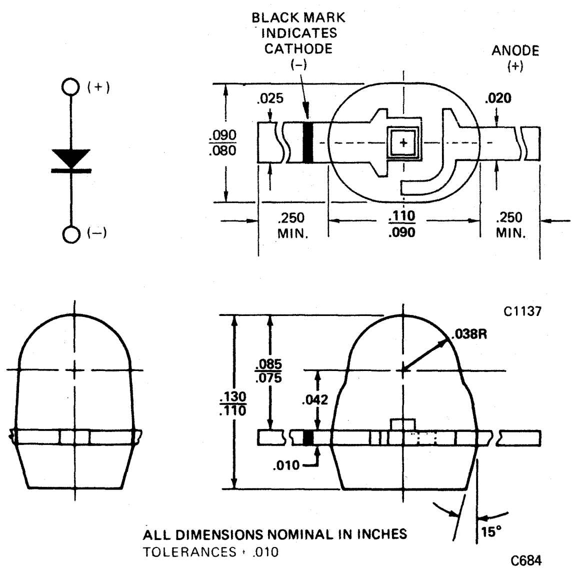
GENERAL INSTRUMENT
Optoelectronics

ME60
INFRARED EMITTER

PRODUCT DESCRIPTION

The ME60 is a diffused planar gallium arsenide infrared diode. The lead-frame construction is encapsulated in an epoxy case and lens.

PACKAGE DIMENSIONS



FEATURES

The ME60 is intended for high volume infrared source application where low cost, high reliability and high density packaging are required.

- Low Cost
- Compatible with integrated circuits
- Long life, rugged
- Small Size
- Easily assembled in linear arrays
- Card & tape reader sources
- High on-axis power

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient . . . . 75 mW
Derate linearly from 25°C . . . . 1.0 mW/°C
Storage and operating temperature . . . . -55°C to 100°C
Lead solder time @ 230°C (See Note 1) . . . . 5 sec
Forward current . . . . 50 mA
Peak forward current (1 μsec pulse width, 0.3% duty cycle) . . . . 1.0 A
Reverse voltage . . . . 3.0 V

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Total external radiated power (see note 2)	400	550		μW	I_F = 50 mA
On-axis irradiance		250		μW/cm2	I_F = 50 mA, d = 1 cm
Peak emission wave length		900		nm	
Spectral line half-width		50		nm	
Forward voltage		1.3	1.5	V	I_F = 50 mA
Reverse current		5		nA	V_R = 3.0 volts
Light turn-on and turn-off		10		ns	
Capacitance		80		pF	V=0
Reverse breakdown voltage	3	5		V	I_R=10μA
Forward voltage temperature coefficient		–1.05		mV/°C	I_F = 10 mA

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

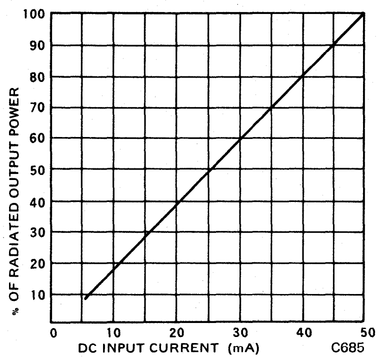


Fig. 1. Input Current vs. Output Power

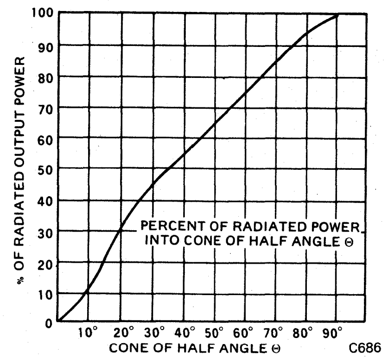


Fig. 2. Percent of Radiated Power into Cone of Half Angle

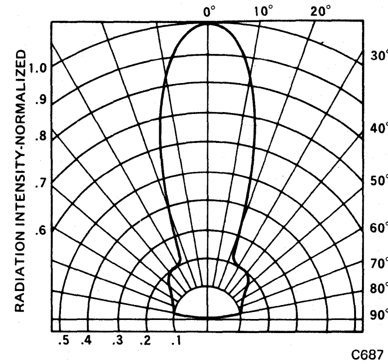


Fig. 3. Spatial Distribution (Note 3)

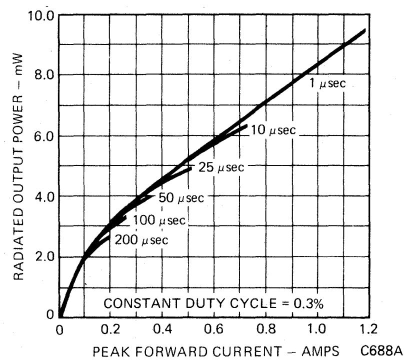


Fig. 4. Radiated Output Power vs. Peak Forward Current

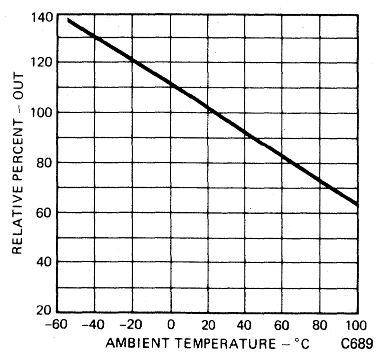


Fig. 5. % Relative Output vs. Temperature

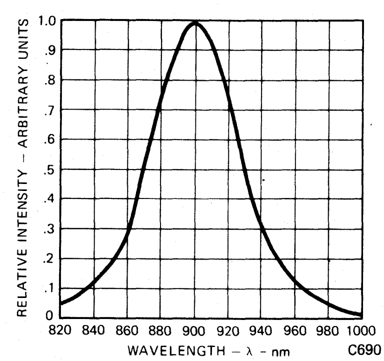


Fig. 6. Spectral Distribution

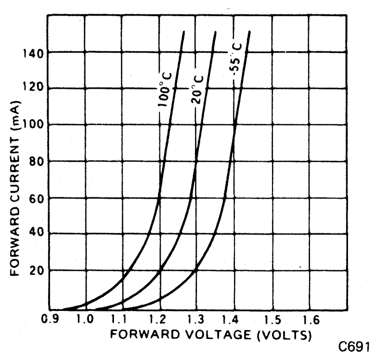


Fig. 7 Forward Current vs. Forward Voltage

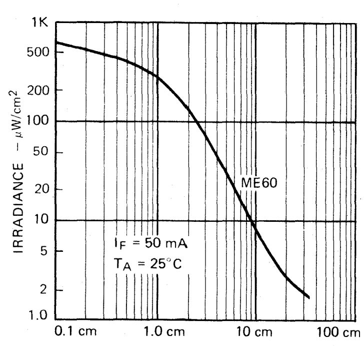


Fig. 8. On-Axis Irradiance vs. Distance (Note 4)

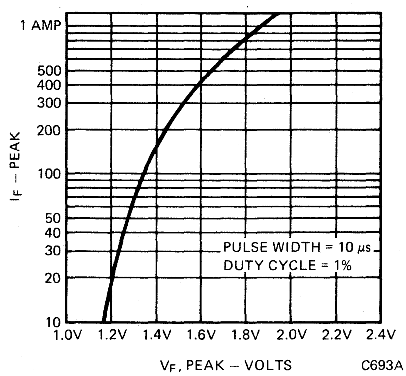


Fig. 9. V_F vs. I_F (to 4 A) Pulsed

NOTES

1. *The leads of the device were immersed in molten solder, heated to a temperature of 230°C, to a point 1/16 inch from the body of the device per MIL-S-750.*
2. *The total external radiated power output measurements are made with a Centralab 110C solar cell terminated into a 100Ω impedance.*
3. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*
4. *Distance measurements taken from top of lens.*

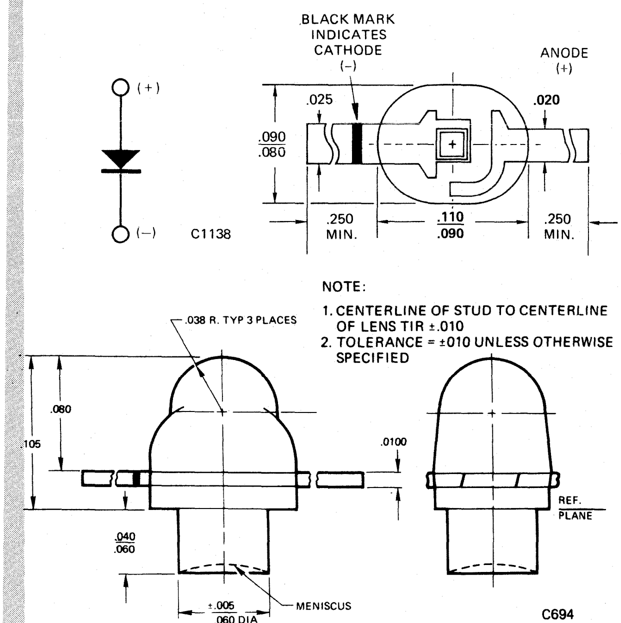
GENERAL INSTRUMENT
Optoelectronics

ME61
INFRARED EMITTER

PRODUCT DESCRIPTION

The ME61 is a diffused planar gallium arsenide infrared diode. The lead-frame construction is encapsulated in an epoxy case and lens and provides an alignment stud as an integral part of the package.

PACKAGE DIMENSIONS



FEATURES

The ME61 is intended for high volume infrared source application where low cost, high reliability and high density packaging are required.

- Stud base for precise alignment
- Low Cost
- Compatible with integrated circuits
- Long life, rugged
- Small Size
- Easily assembled in linear arrays
- Card & tape reader sources
- High on-axis power

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient	75 mW
Derate linearly from 25°C	1.0 mW/°C
Storage and operating temperature	−55°C to 100°C
Lead solder time @ 230°C (See Note 1)	5 sec
Forward current	50 mA
Peak forward current (1 μsec pulse width, 0.3% duty cycle)	1.0 A
Reverse voltage	3.0 V

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CHARACTERISTICS
Total external radiated power (see note 2)	400	550		μW	I_F = 50 mA
On-axis irradiance		250		μW/cm2	I_F = 50 mA, d = 1 cm
Zone 1 power (see Fig. 7)	45			μW	I_F = 50 mA
Peak emission wavelength		900		nm	
Spectral line half-width		50		nm	
Forward voltage		1.3	1.5	V	I_F = 50 mA
Reverse current		5		nA	V_R = 3.0 volts
Light turn-on and turn-off		10		ns	
Capacitance		80		pF	V = 0
Reverse breakdown voltage	3	5		V	I_R = 10 μA
Forward voltage temperature coefficient		−1.05		mV/°C	I_F = 10 mA

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

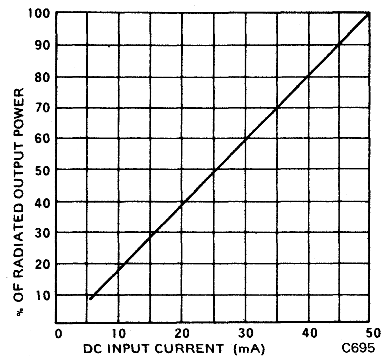


Fig. 1. Input Current vs. Output Power

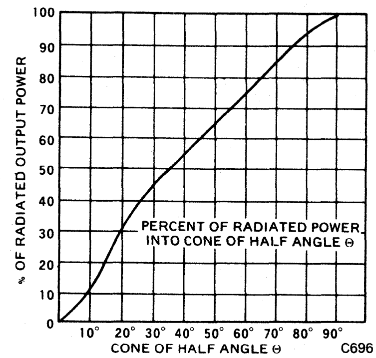


Fig. 2. Percent of Radiated Power into Cone of Half Angle

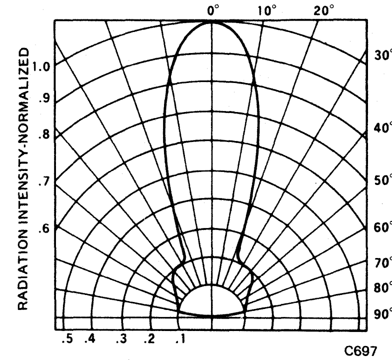


Fig. 3. Spatial Distribution (Note 3)

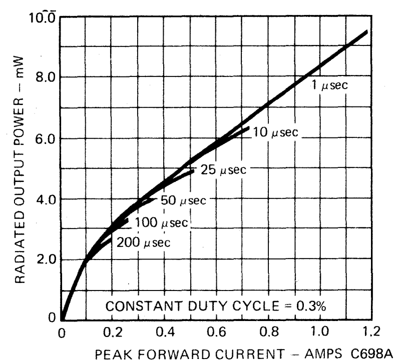


Fig. 4. Radiated Output Power vs. Peak Forward Current

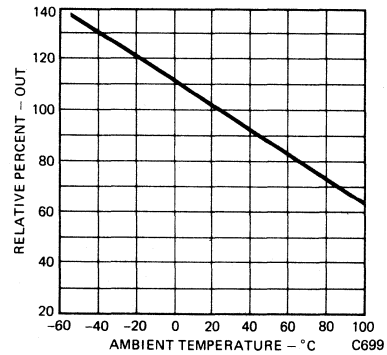


Fig. 5. % Relative Output vs. Temperature

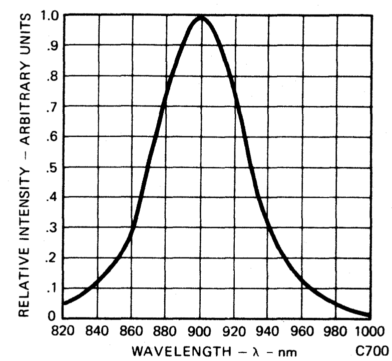


Fig. 6. Spectral Distribution

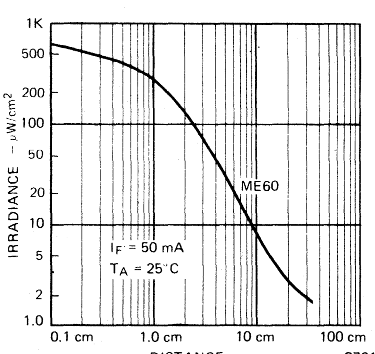


Fig. 7. On-Axis Irradiance vs. Distance

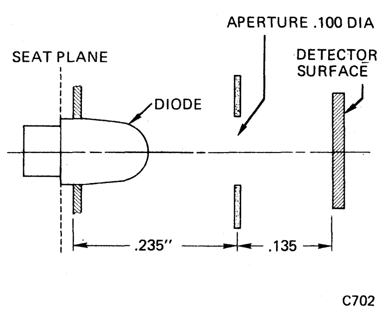


Fig. 8. Zone 1 Measurement

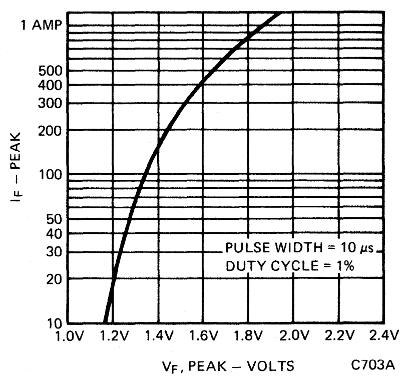


Fig. 9. V_F vs. I_F (to 4A) Pulsed

NOTES

1. *The leads of the device were immersed in molten solder, heated to a temperature of 230°C, to a point 1/16 inch from the body of the device per MIL-S-750.*
2. *The total external radiated power output measurements are made with a Centralab 110C solar cell terminated into a 100Ω impedance.*
3. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*

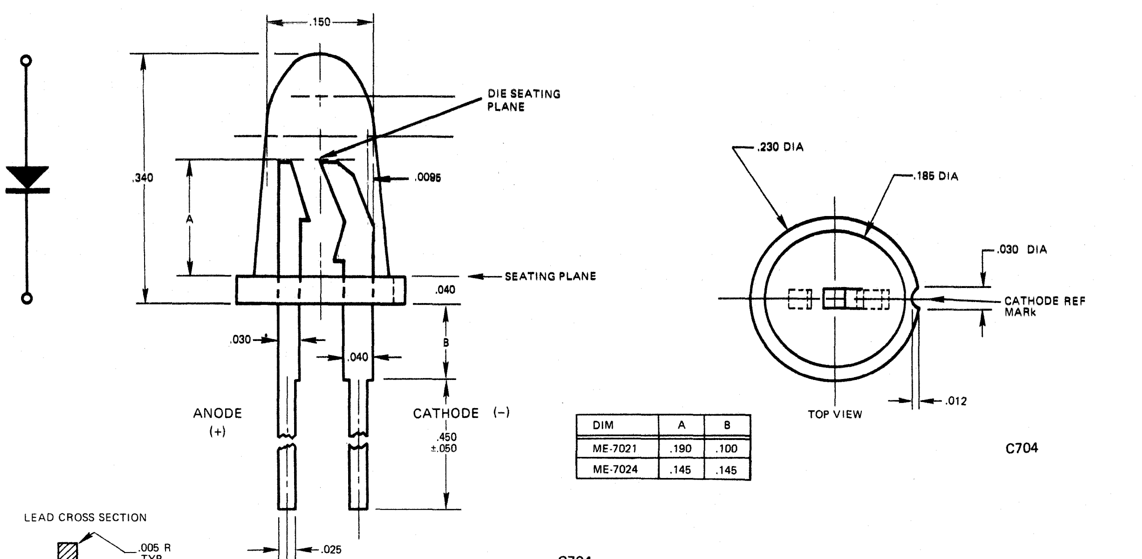
GENERAL INSTRUMENT
Optoelectronics

ME7021
ME7024
INFRARED EMITTERS

PRODUCT DESCRIPTION

This family of IR Emitters is designed to accomodate all needs of the emitter detector relationship. Products range from a wide angle power spread for non-critical detector location to sharp-angle concentration of power for detectors located a significant distance from the emitter. The devices can be mounted with a plastic pop-in, furnished upon request.

PACKAGE DIMENSIONS



DIM	A	B
ME-7021	.190	.100
ME-7024	.145	.145

ALL DIMENSIONS IN INCHES
TOLERANCES = ±.010 UNLESS SPECIFIED

ELECTRO-OPTICAL CHARACTERISTICS

	TYPICAL HALF ANGLE (DEGREES)	TYPICAL ON AXIS INTENSITY (MW/STR.) @ 50 mA
ME7021	15°	3.6
ME7024	4°	81.2

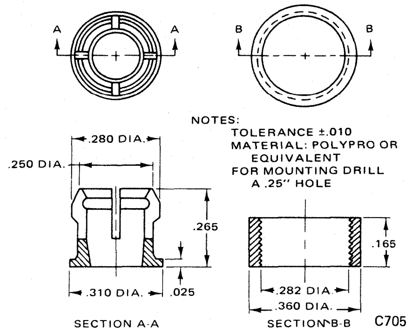
{ into cone @ 1/2 power points
@ I_F = 50 mA
ROP = 1 mW

	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Total External Output Power (Note 2)	.5	1.0		mW	I_F = 50 mA
Peak Emission Wave Length		900		nm	I_F = 50 mA
Spectral Line Half Width		50		nm	I_F = 50 mA
Forward Voltage		1.3	1.5	V	I_F = 50 mA
Reverse Breakdown Voltage	5.0	8.0		V	I_R = 100 μA
Capacitance		105		pF	V=0, f=1 MHz
Light Turn On & Turn Off Time		100		nsec	50 Ω Load
Dynamic Resistance (R_D)		1.6		Ω	T_F = 100 mA

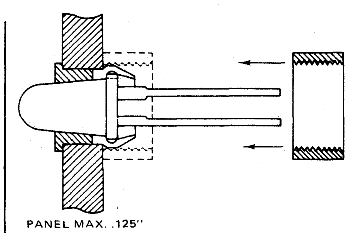
ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient	150 mW
Derate linearly from 50°C	2.8 mW/°C
Storage & operating temperature	–55° to 100°C
Lead solder time @ 230°C (Note 3)	5 sec
Continuous forward current	100 mA
Reverse voltage	5.0 V
Peak forward current (PW - 1.0 μsec, Duty Cycle = 0.3%)	1.0 A

PANEL MOUNTING TECHNIQUES



MOUNTING GROMMET



PANEL MOUNTING

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free air temperature unless otherwise specified)

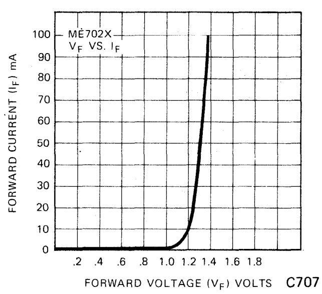


Fig. 1. I_F vs. V_F

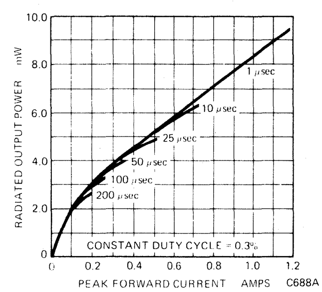


Fig. 2. ROP vs I_F Peak

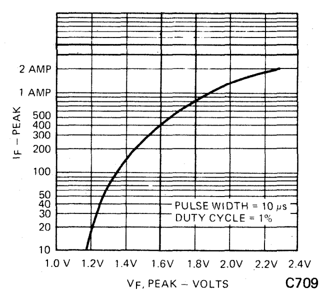


Fig. 3. I_F Peak Pulse Mode Characteristics

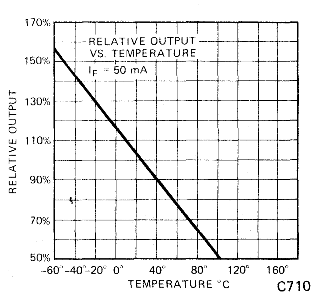


Fig. 4. ROP vs. Temperature (Note 1)

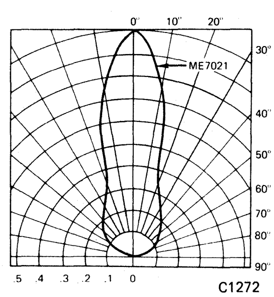


Fig. 5. Spatial Distribution (ME7021)

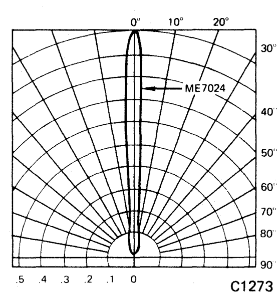


Fig. 6. Spatial Distribution (ME7024)

NOTES

1. *The curves in figure 3 are normalized to the power output at 25°C to indicate the relative efficiency over the operating temperature range.*
2. *The total external radiated power output measurements are made with a Centralab 110C solar cell terminated into a 100Ω impedance.*
3. *The leads of the ME7021 and ME7024 were immersed in molten solder, heated to 230°C, to a point 1/16 inch from the body of the device, per MIL-S-750.*

GENERAL INSTRUMENT
Optoelectronics

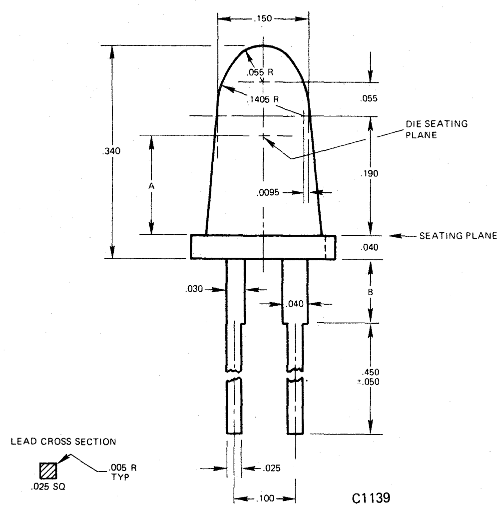
ME7121 ME7124

HIGH POWER INFRARED EMITTERS

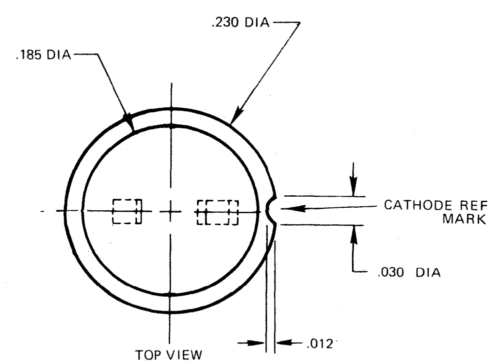
PRODUCT DESCRIPTION

This family of high power liquid phase epitaxial IR Emitters is designed to accommodate all needs of the emitter detector relationship. Products range from a wide angle power spread for non-critical detector location to sharp-angle concentration of power for detectors located a significant distance from the emitter. The devices can be mounted with a plastic pop-in, furnished upon request.

PACKAGE DIMENSIONS



C1139



DIM	A	B
ME7121	.190	.100
ME7124	.145	.145

C1140

ALL DIMENSIONS IN INCHES
TOLERANCES = ±.010 UNLESS SPECIFIED

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient . . . . . 150 mW
Derate linearly from 50°C. . . . . 2.8 mW/°C
Storage & operating temperature . . . . . -55° to 100°C
Lead solder time @ 230°C (Note 3) . . . . . 5 sec
Continuous forward current . . . . . 100 mA
Reverse voltage. . . . . 3.0 V
Peak forward current (PW = 1.0 μsec, Duty Cycle = 0.3%). . . . . 1.0 A

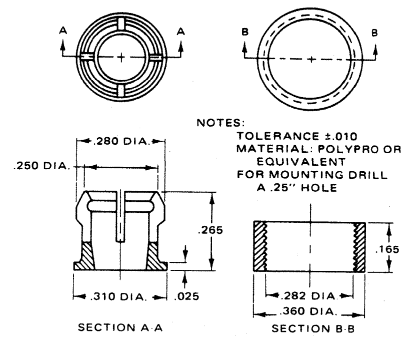
ELECTRO-OPTICAL CHARACTERISTICS

	TYPICAL HALF ANGLE (DEGREES)	TYPICAL ON AXIS INTENSITY (MW/STR.) @ 50 mA
ME7121	17°	10.8
ME7124	6°	243.6

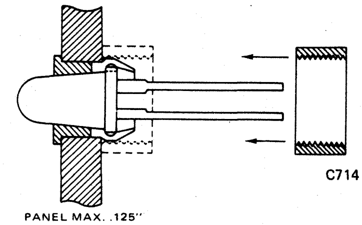
into cone @ 1/2 power points
@ I_F = 50 mA
ROP = 3 mW

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Total External Output Power (Note 2)	1.0	3.0		mW	I_F = 50 mA
Peak Emission Wavelength		940		nm	I_F = 50 mA
Spectral Line Half Width		50		nm	I_F = 50 mA
Forward Voltage		1.4	1.8	V	I_F = 50 mA
Light Turn On & Turn Off Time		500		nsec	50 Ω Load
Reverse Current		10		μA	V_R = 3.0 V

PANEL MOUNTING TECHNIQUES



MOUNTING GROMMET



PANEL MOUNTING

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free air temperature unless otherwise specified.)

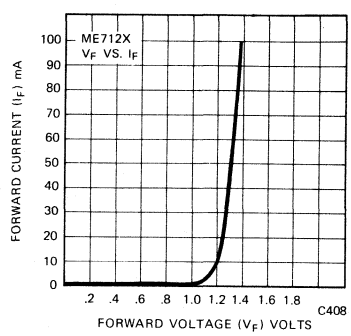


Fig. 1. I_F vs. V_F

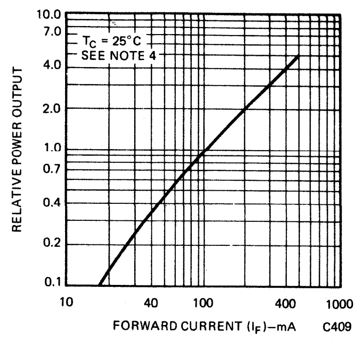


Fig. 2. ROP vs. I_F Peak

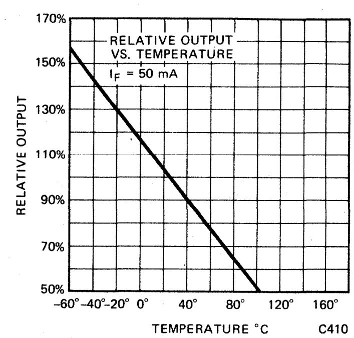


Fig. 3. ROP vs. Temperature (Note 1)

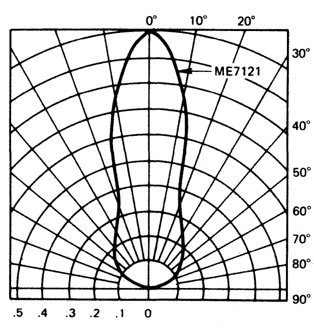


Fig. 4. Spatial Distribution (ME7121)

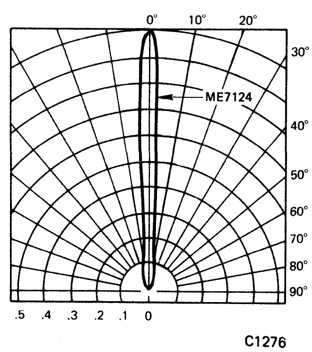


Fig. 5. Spatial Distribution (ME7124)

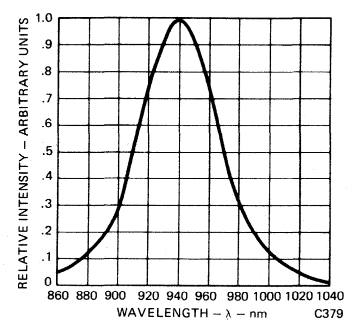


Fig. 6. Spectral Distribution

NOTES

1. *The curves in figure 3 are normalized to the power output at 25°C to indicate the relative efficiency over the operating temperature range.*
2. *The total external radiated power output measurements are made with a Centralab 110C solar cell terminated into a 100Ω impedance.*
3. *The leads of the ME7121 and ME7124 were immersed in molten solder, heated to 230°C, to a point 1/16 inch from the body of the device, per MIL-S-750.*
4. *This parameter is measured using pulse techniques pw = 40 μsec duty cycle ≤10%.*

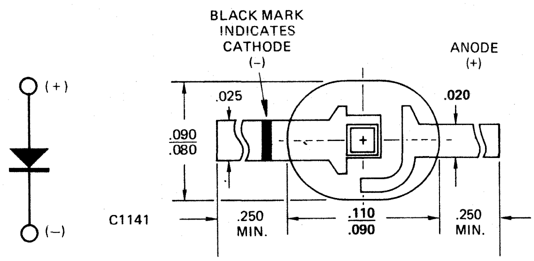
GENERAL INSTRUMENT
Optoelectronics

ME7161
INFRARED EMITTER

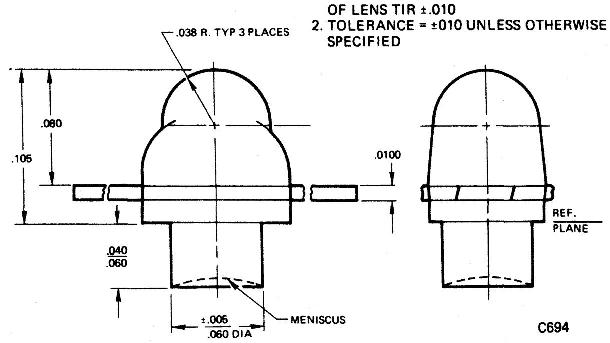
PRODUCT DESCRIPTION

The ME7161 is a liquid phase epitaxial gallium arsenide infrared diode. The lead-frame construction is encapsulated in an epoxy case and lens.

PACKAGE DIMENSIONS



NOTE:
1. CENTERLINE OF STUD TO CENTERLINE OF LENS TIR ±.010
2. TOLERANCE = ±.010 UNLESS OTHERWISE SPECIFIED



FEATURES

The ME7161 is intended for high volume infrared source application where low cost, high reliability and high density packaging are required.

- Low cost
- Compatible with integrated circuits
- Long life, rugged
- Small size
- Easily assembled in linear arrays
- Card & tape reader sources
- High on-axis power

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient . . . . 75 mW
Derate linearly from 25°C . . . . 1.0 mW/°C
Storage & operating temperature . . . . –55°C to 100°C
Lead solder time @ 230°C (See Note 1) . . . . 5 sec
Continuous forward current . . . . 50 mA
Peak forward current (1 μsec pulse width, 0.3% duty cycle) . . . . 1.0 A
Reverse voltage . . . . 3.0 V

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Total external radiated power (see Note 2)	0.8	3.0		mW	I_F = 50 mA
Peak emission wave length		940		nm	I_F = 50 mA
Spectral line half-width		50		nm	I_F = 50 mA
Forward voltage		1.3	1.8	V	I_F = 50 mA
Reverse current		10		μA	V_R = 3.0 V
Light turn-on and turn-off		500		ns	50Ω Load
Capacitance		80		pF	V = 0
Forward voltage temperature coefficient		–1.05		mV/°C	I_F = 10 mA

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

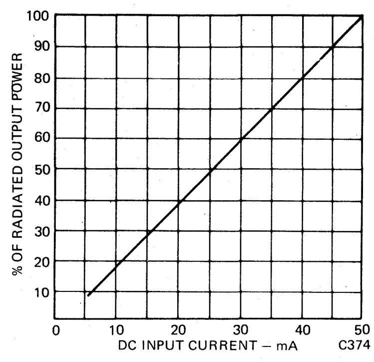


Fig. 1. Input Current vs. Output Power

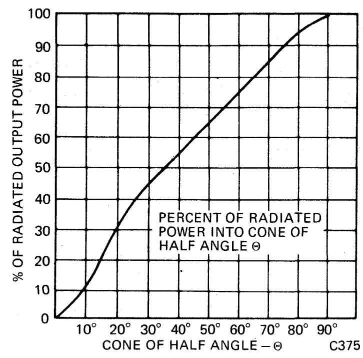


Fig. 2. Percent of Radiated Power Into Cone of Half Angle

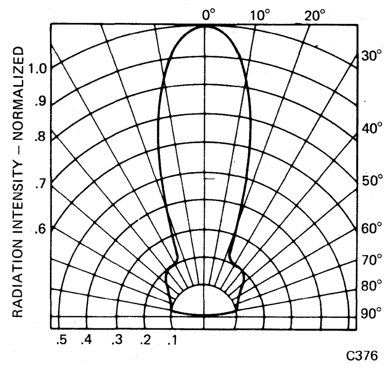


Fig. 3. Spatial Distribution (Note 3)

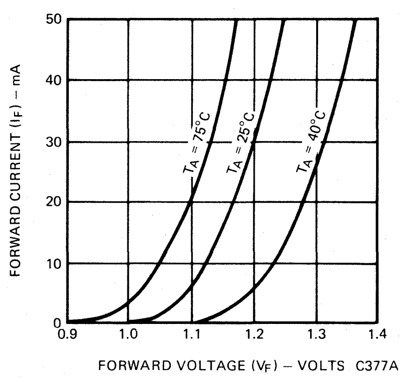


Fig. 4. Forward Current vs. Forward Voltage

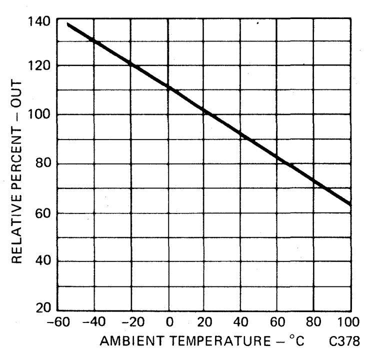


Fig. 5. % Relative Output vs. Temperature

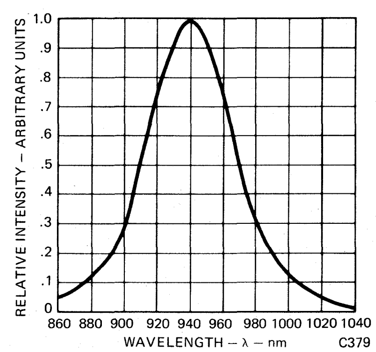


Fig. 6. Spectral Distribution

NOTES

1. *The leads of the device were immersed in molten solder, heated to a temperature of 230°C, to a point 1/16 inch from the body of the device per MIL-S-750.*
2. *The total external radiated power output measurements are made with a Centralab 110C solar cell terminated into a 100Ω impedance.*
3. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*

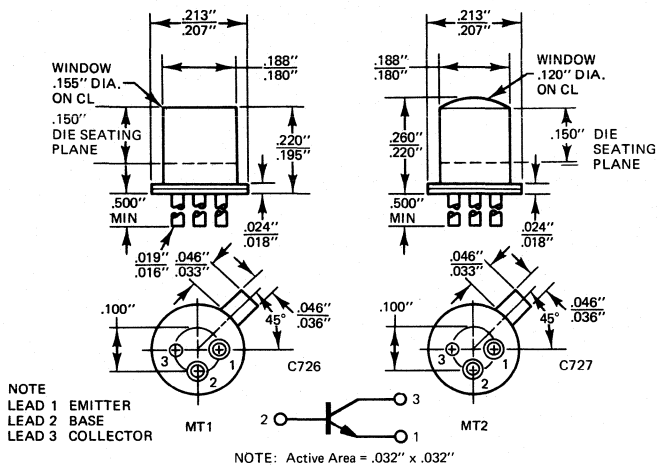
GENERAL INSTRUMENT
Optoelectronics

MT1
MT2
SILICON PHOTOTRANSISTOR

PRODUCT DESCRIPTION

The MT1 and MT2 silicon phototransistors are mounted on a standard TO46 header. The MT1 features a flat window mounted at the top of a protective metal can. The MT2 has a lens in the same position for an optical gain of 4.

PACKAGE DIMENSIONS



FEATURES & APPLICATIONS

- Low leakage current - 1 nA
- Wide Spectral Response
- Responsive to GaAs - 1.40 mA/mW/cm^2
- Optional flat lens (MT1) or built-in optics (MT2)
- Standard Transistor (Hermetic Seal) package for easy handling and mounting

- Optical switching & encoding
- Intrusion Alarm
- Process Control
- Tape and Card Reader
- Level & Industrial Control
- Optical Character Recognition

ABSOLUTE MAXIMUM RATINGS

Storage and Operating Temperature -55°C to 125°C
Maximum Lead Solder Time @ 260°C (See Note 1) - 7.0 sec

Power Dissipation @ 25°C Ambient	200 mW
Derate Linearly from 25°C	2.0 mW/°C
Collector-Emitter Breakdown Voltage (BV_{CEO})	30 V
Emitter-Collector Breakdown Voltage (BV_{ECO})	7.0 V
Collector-Base Breakdown Voltage (BV_{CBO})	80 V
Collector Current (I_C)	40 mA

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTICS & SYMBOLS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Sensitivity MT1 (see note 3) (S_{CEO})	200	560		μA/mW/cm²	λ=0.9 microns, V_{CE}=5.0 V
Sensitivity MT2 (see note 3) (S_{CEO})	500	1400		μA/mW/cm²	λ=0.9 microns, V_{CE}=5.0 V
Sensitivity MT1 (see note 4) (S_{CEO})	80	260		μA/mW/cm²	2875°K, V_{CE}=5.0 V
Sensitivity MT2 (see note 4) (S_{CEO})	200	650		μA/mW/cm²	2875°K, V_{CE}=5.0 V
Sensitivity MT1 (see note 3) (S_{CBO})	1.4	2.5		μA/mW/cm²	λ=0.9 microns, V_{CE}=5.0 V
Sensitivity MT2 (see note 3) (S_{CBO})	3.5	6.2		μA/mW/cm²	λ=0.9 microns, V_{CB}=5.0 V
Sensitivity MT1 (see note 4) (S_{CBO})	0.6	1.0		μA/mW/cm²	2875°K, V_{CB}=5.0 V
Sensitivity MT2 (see note 4) (S_{CBO})	1.5	2.5		μA/mW/cm²	2875°K, V_{CB}=5.0 V
Collector-emitter saturation voltage ($V_{CE(sat)}$)		0.2	0.5	V	I_C=2.0 mA, H=10mW/cm²
Light current rise time (see figure 8) (t_r)		2.0		μs	V_{CC}=5.0 V, I_C=2.0 mA, R_L=100Ω
Light current fall time (see figure 8) (t_r)		2.0		μs	V_{CC}=5.0 V, I_C=2.0 mA, R_L=100Ω
Delay time (see figure 8) (t_d)		1.2		μs	V_{CC}=5.0 V, I_C=2.0 mA, R_L=100Ω
Frequency response		300		kHz	V_{CC}=5.0 V, I_C=2.0 mA, R_L=100Ω

ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTICS	SYMBOLS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Collector dark current (see note 2)	I_{CEO}		1	20	nA	V_{CE}=5.0 V
Collector dark current (see note 2)	I_{CBO}		0.15	10	nA	V_{CB}=5.0 V
Collector base breakdown voltage (see note 2)	BV_{CBO}	80	140		V	I_C=100 μA
Collector emitter breakdown voltage (see note 2)	BV_{CEO}	30	65		V	I_C=100 μA
Emitter collector breakdown voltage (see note 2)	BV_{ECO}	7	12		V	I_E=100 μA

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

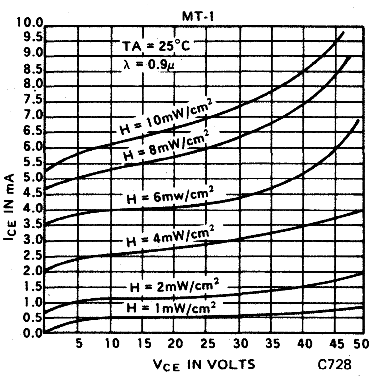


Figure 1 Collector-Emitter Characteristics

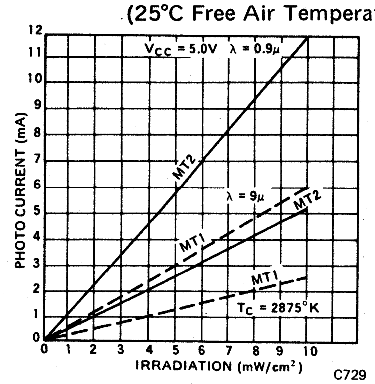


Figure 2 Photo Current vs. Irradiation

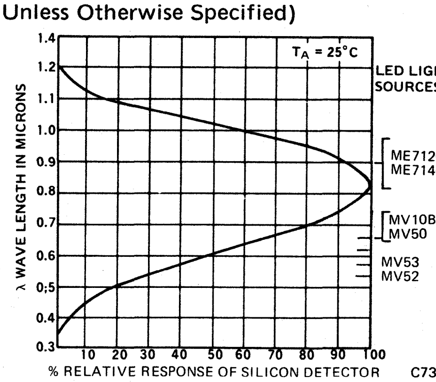


Figure 3 Spectral Response

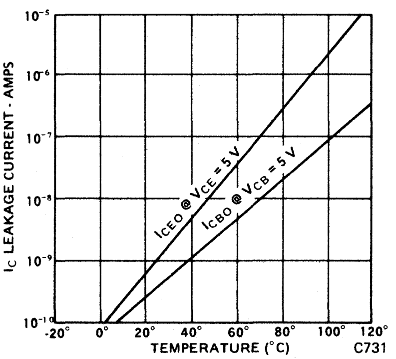


Figure 4 Leakage Current vs. Temperature

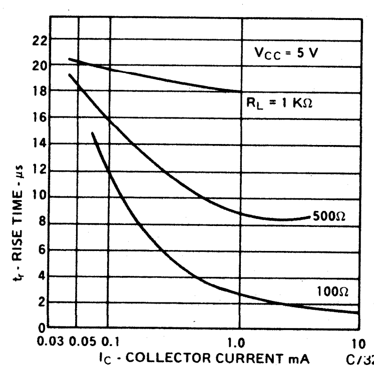


Figure 5 Rise Time vs. Collector Current

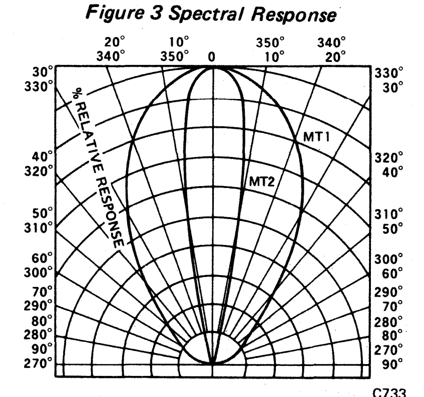


Figure 6 Angular Response

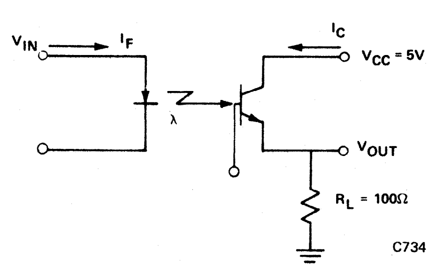


Fig. 7 Circuit Used to Obtain Switching Time vs. Collector Current Plot

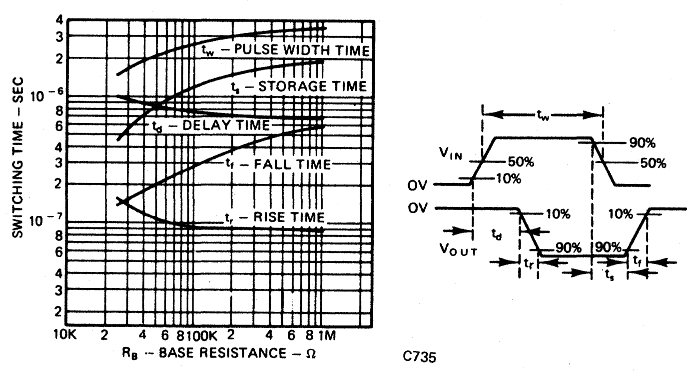


Fig. 8 Switching Time vs. Base Resistance

NOTES

1. *The leads of the device were immersed in molten solder, heated to a temperature of 260°C, to a point 1/16-inch from the body of the device per MIL-S-750.*
2. *Measured under dark conditions H≤1.0μW/cm².*
3. *Measured with a GaAs light source at 0.9 microns with a radiation flux density of 3 mW/cm².*
4. *Measured with a tungsten filament lamp operated at a color temperature of 2875°K with a radiation flux density of 5 mW/cm².*

GENERAL INSTRUMENT
Optoelectronics

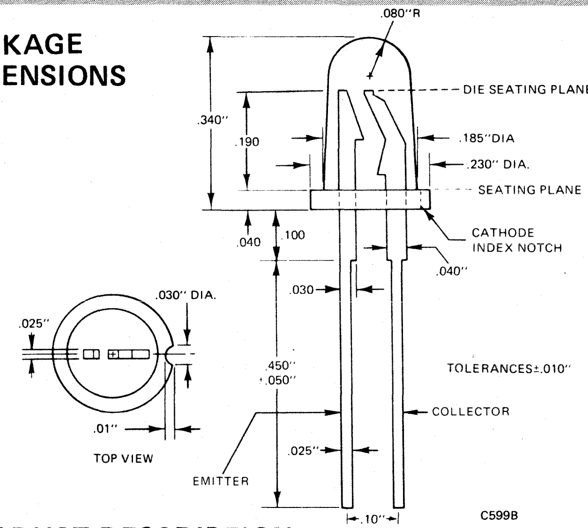
MT8020
SILICON PHOTOTRANSISTOR

APPLICATIONS

When used as an emitter-detector pair the MT8020 and the ME7121 or ME7124 are suitable for the following applications:

- Optical shaft position and velocity monitor using a digitally encoded disc mounted on a shaft.
- Optical sensing of holes in paper, paper tape, IBM card or magnetic tape.
- Optical sensing of marks on paper, paper tape, or IBM card.
- End of tape sensor using a transparent section of tape, a reflective strip on the tape, or a hole in the tape.
- End of film sensor for films not affected by infra-red light.
- Limit switch for mechanical travel such as cam switches, pressure switches, machine tool limit switches, foot pedal switches, safety interlock switches.
- Edge sensor for sheet materials such as paper, plastic film, fabric, foil, newsprint, belt sanders, reproduction paper.
- Fiber continuity monitor for fibers such as yarn, wire, thread.
- Fluid volume monitor by sensing turbine vanes passing through the slot.
- Liquid level detector of an opaque liquid.

PACKAGE DIMENSIONS



PRODUCT DESCRIPTION

The MT8020 is an NPN silicon planar phototransistor in a clear epoxy T-1 3/4 lamp package. The infrared emitter mates for the MT8020 are the ME7121 and the ME7124.

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Sensitivity (light current)	S_{ceo}	125	350	–	μA/mw/cm^2	V_{ce} = 5V source = GaAs (note 4)
Sensitivity (light current)	S_{ceo}	50	140	–	μA/mw/cm^2	V_{ce} = 5V source = tungsten (note 3)
Collector emitter breakdown voltage	BV_{ceo}	30	65	–	Volts	I_c = 100 μA (note 2)
Collector dark current	I_{ceo}	–	1.5	50	nA	V_{ce} = 10 V (note 2)
Emitter Collector breakdown voltage	BV_{eco}	7	12	–	Volts	I_e = 100μA
Collector emitter saturation voltage	V_{ce} (SAT)	–	0.2	0.4	Volts	I_c = 1.6mA H = 10mw/cm^2 source = GaAs (note 4)
Switching Speed	t_{on}	–	2.5	–	μsec	V_{cc} = 5.0 V I_c = 1.6 mA
	t_{off}	–	1.8	--	μsec	R_L = 100Ω (figure 7)
Current transfer ratio –ME7124	CTR	–	2.0	–	%	V_{ce} = 5V, when coupled to ME7124 at I_f = 20mA. MPT8020 to ME7124 distance is .200″
Current transfer ratio –ME7121	CTR	–	0.5	–	%	V_{ce} = 5V, when coupled to ME7121 at I_f = 20mA. MPT8020 to ME7121 distance is .200″

ABSOLUTE MAXIMUM RATINGS

Storage and Operating Temperature −55°C to 100°C

Power Dissipation @ 25°C Ambient . . . . .200 mW
Derate Linearly above 25°C Ambient . . . . . . 2.67 mW/°C
Collector-Emitter Breakdown Voltage (BV_{CEO}) . . . . .30 V

Maximum Lead Solder Time @ 230°C (See Note 1) −5.0 sec

Emitter-Collector Breakdown Voltage (BV_{ECO}) . . . . 7.0 V
Collector Current (I_C) . . . . .40 mA

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

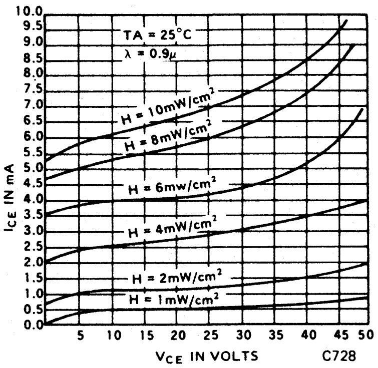


Fig. 1. Collector-Emitter Characteristics

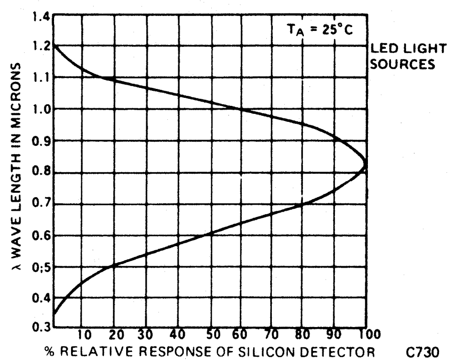


Fig. 2. Spectral Response

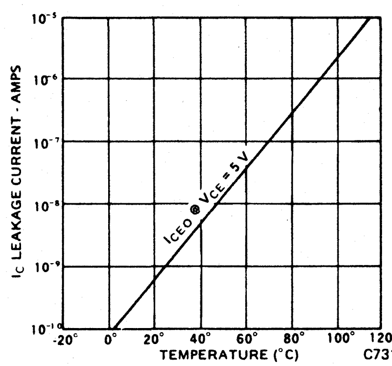


Fig. 3. Leakage Current vs. Temperature

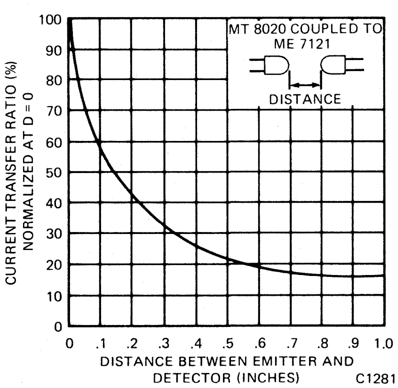


Fig. 4. Normalized Current Transfer Ratio vs. Distance Between Emitter and Detector MT8020 and ME7121.

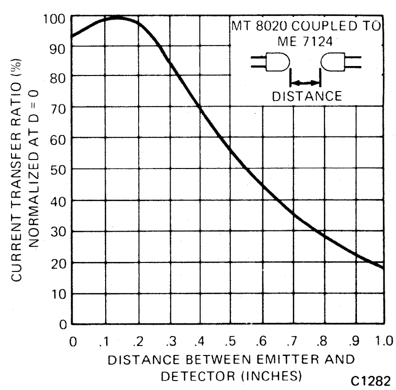


Fig. 5. Normalized Current Transfer Ratio vs. Distance Between Emitter and Detector MT8020 and ME7124.

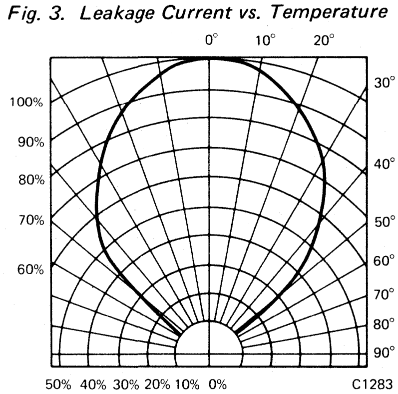


Fig. 6. Angular Response

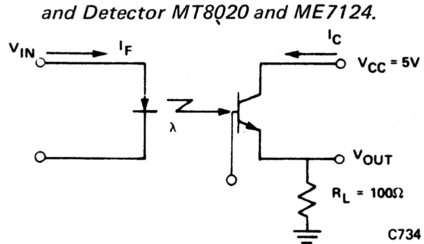
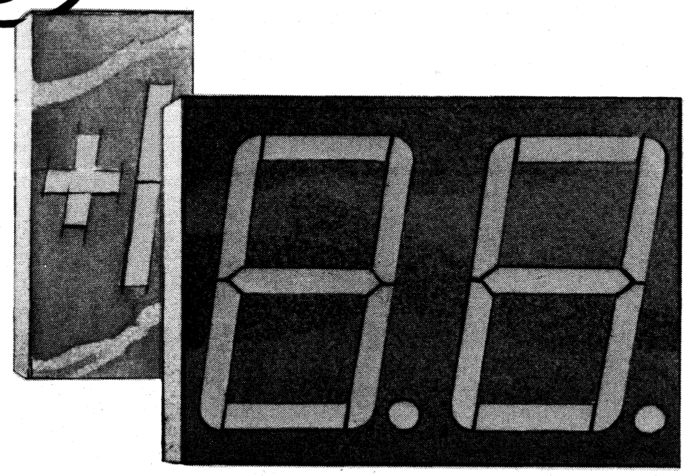


Fig. 7. Circuit Used to Obtain Switching Time Values Light Source is ME7121 or ME7124

NOTES

1. *The leads of the device were immersed in molten solder, heated to a temperature of 230°C, to a point 1/16-inch from the body of the device per MIL-S-750.*
2. *Measured under dark conditions H≤1.0 µw/cm².*
3. *Radiation source is an unfiltered tungsten filament bulb at 2875°K color temperature. H = 5 mW/cm².*
4. *Radiation source is a GaAs infrared emitting diode such as a ME7121 or ME7124 at λ = 0.94 microns. H = 3 mW/cm².*

3 Displays



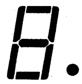
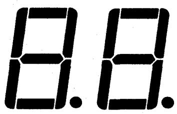
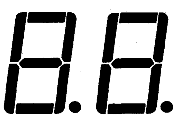
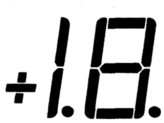
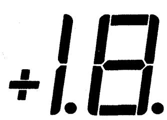
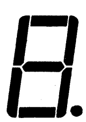
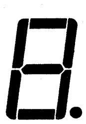
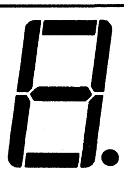
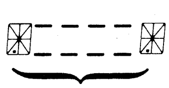
ACTUAL DIGIT SIZE	DEVICE NO.	COLOR	DESCRIPTION	BRIGHTNESS OR LUMINOUS INTENSITY (PER SEG. MIN.)
.8	MAN1A	Red	.270-Inch; Common Anode; LHDP; Direct View	100 ft-L @ 20mA
	MAN10A	Red	.270-Inch; Common Anode; LHDP; Direct View	100 ft-L @ 10mA
+1	MAN1001A	Red	.270-Inch; Common Anode; Polarity/Overflow; Direct View	100 ft-L @ 20mA
	MAN101A	Red	.270-Inch; Common Anode; Polarity/Overflow; Direct View	100 ft-L @ 10mA
	MAN2A	Red	.320-Inch; X-Y 35 Diode, Alphanumeric; Direct View	125μcd @ 10mA
8.	MAN3610A	Orange	.3-Inch; Common Anode; RHDP	510μcd @ 10mA
	MAN51A	Green	.3-Inch; Common Anode; RHDP	320μcd @ 10mA
8.	MAN71A	Red	.3-Inch; Common Anode; RHDP	125μcd @ 10mA
	MAN81A	Yellow	.3-Inch; Common Anode; RHDP	510μcd @ 10mA
8.	MAN3640A	Orange	.3-Inch; Common Cathode; RHDP	510μcd @ 10mA
	MAN54A	Green	.3-Inch; Common Cathode; RHDP	200μcd @ 10mA
8.	MAN74A	Red	.3-Inch; Common Cathode; RHDP	125μcd @ 10mA
	MAN84A	Yellow	.3-Inch; Common Cathode; RHDP	510μcd @ 10mA
.8	MAN3620A	Orange	.3-Inch; Common Anode; LHDP	510μcd @ 10mA
.8	MAN52A	Green	.3-Inch; Common Anode; LHDP	320μcd @ 10mA
.8	MAN72A	Red	.3-Inch; Common Anode; LHDP	125μcd @ 10mA
.8	MAN82A	Yellow	.3-Inch; Common Anode; LHDP	510μcd @ 10mA
+1.	MAN3630A	Orange	.3-Inch; Common Anode; RHDP; Polarity & Overflow	510μcd @ 10mA
+1.	MAN53A	Green	.3-Inch; Common Anode; RHDP; Polarity & Overflow	320μcd @ 10mA
+1.	MAN73A	Red	.3-Inch; Common Anode; RHDP; Polarity & Overflow	125μcd @ 10mA
+1.	MAN83A	Yellow	.3-Inch; Common Anode; RHDP; Polarity & Overflow	510μcd @ 10mA
8.	MAN4610A	Orange	.4-Inch; Common Anode; RHDP	510μcd @ 10mA
+1.	MAN4630A	Orange	.4-Inch; Common Anode; RHDP; Polarity & Overflow	510μcd @ 10mA
8.	MAN4640A	Orange	.4-Inch; Common Cathode; RHDP	510μcd @ 10mA

NOTE: PIN CONNECTION CODES: Ac (e.g.) First letter (capital) is segment, second letter (lower case) is cathode or anode.
E.g. Ac = Segment A cathode
Ac1 (e.g.) Final number refers to digit number in 2-Digit devices.

PIN CONNECTIONS (See note)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	APPLICATIONS
Ac	Fc	ca	NC	NC	DPc	Ec	Dc	ca	Cc	Gc	NC	Bc	ca	Instruments Test Equipment Office Machine Computer
C/D :om- mon	NC	NC	NC	NC	NC	Dc	Cc	NC	Bc	Ac	NC	NC	A/B com- mon	
'ol. 2 (+)	Row 1 (–)	Row 3 (–)	Row 4 (–)	Col. 1 (+)	NC	DP (+)	Col. 3 (+)	Row 7 (–)	Row 6 (–)	Row 5 (–)	Row 2 (–)	Col. 5 (+)	Col. 4 (+)	Business Machines Calculators Computers Indus. Control Equ.
Ac	Fc	ca	NP	NP	NC	Ec	Dc	DPc	Cc	Gc	NP	Bc	ca	
Fa	Ga	NP	cc	NP	Ea	Da	Ca	DPa	NP	NP	cc	Ba	Aa	
Ac	Fc	ca	NP	NP	DPc	Ec	Dc	NC	Cc	Gc	NP	Bc	ca	Instruments Test Equipment Office Machines Computers Automobiles Clocks/Radios Communication Equipment Calculators CB Radios
Ca Da	NP	Ca Da	NP	NP	NP	Dc	Cc	NC	Bc	Ac	NP	NP	Aa Ba	
Ac	Fc	ca	NP	NP	NC	Ec	Dc	DPc	Cc	Gc	NP	Bc	ca	Instruments Test Equipment Office Machines Computers Automobiles Clocks/Radios Communication Equ. Calculators CB Radios
Ca Da	NP	Ca Da	NP	NP	NC	Dc	Cc	DPc	Bc	Ac	NP	NP	Aa Ba DPa	
Fa	Ga	NP	cc	NP	Ea	Da	Ca	DPa	NP	NP	cc	Ba	Aa	

a = common anode
c = common cathode
P = decimal point

NC = no connection
NP = no pin

ACTUAL DIGIT SIZE	DEVICE NO.	COLOR	DESCRIPTION	BRIGHTNESS OR LUMINOUS INTENSITY (PER SEG. MIN.)	
	MAN4710A MAN4740A	Red Red	.4-Inch; Common Anode; RHDP .4-Inch; Common Cathode; RHDP	200μcd @ 10mA	
	MAN4705	Red	.4-Inch; Universal (Common anode or common cathode); Polarity & Overflow	200μcd @ 10mA	
	MAN6610 MAN6640	Orange Orange	.560-Inch; Common Anode; RHDP; 2-Digit .560-Inch; Common Cathode; RHDP; 2-Digit	510μcd @ 10mA	
	MAN6710 MAN6740	Red Red	.560-Inch; Common Anode; RHDP; 2-Digit .560-Inch; Common Cathode; RHDP; 2-Digit	200μcd @ 10mA	
	MAN6630 MAN6650	Orange Orange	.560-Inch; Common Anode; RHDP; 1½-Digit .560-Inch; Common Cathode; RHDP; 1½-Digit	510μcd @ 10mA	
	MAN6730 MAN6750	Red Red	.560-Inch; Common Anode; RHDP; 1½-Digit .560-Inch; Common Cathode; RHDP; 1½-Digit	200μcd @ 10mA	
	MAN6660 MAN6680	Orange Orange	.560-Inch; Common Anode; RHDP .560-Inch; Common Cathode; RHDP	510μcd @ 10mA	
	MAN6760 MAN6780	Red Red	.560-Inch; Common Anode; RHDP .560-Inch; Common Cathode; RHDP	200μcd @ 10mA	
	MAN8610 MAN8630 MAN8640 MAN8650	Orange Orange Orange Orange	.800-Inch; Common Anode; RHDP .800-Inch; Common Anode; RHDP; ±1Overflow .800-Inch; Common Cathode; RHDP .800-Inch; Common Cathode; RHDP; ±1Overflow	600μcd @ 10mA	
 (Total of 8 characters)	MAN2815	Red	.135-Inch; Common Anode; 14 Segment Alphanumeric; 8-Characters	60μcd @ 2.5mA (avge. curr.)	

NOTE: PIN CONNECTION CODES: Ac (e.g.) First letter (capital) is segment, second letter (lower case) is cathode or anode.
E.g. Ac = Segment A cathode
Ac1 (e.g.) Final number refers to digit number in 2-Digit devices.

PIN CONNECTIONS (See note)																		
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	APPLICATIONS
:	Fc	ca	NP	NP	NC	Ec	Dc	DPc	Cc	Gc	NP	Bc	ca	–	–	–	–	Instruments Test Equipment Office Machines Computers Automobiles Clocks/Radios Communication Equipment Calculators CB Radios
.	Ga	NP	cc	NP	Ea	Da	Ca	DPa	NP	NP	cc	Ba	Aa	–	–	–	–	
a	NP	D1c	Cc	D2c	D2a	Ca	DPa	NP	DPc	Bc	Ac	Aa	Ba	–	–	–	–	
1	Dc1	Cc1	DPc1	Ec2	Dc2	Gc2	Cc2	DPc2	Bc2	Ac2	Fc2	ca2	ca1	Bc1	Ac1	Gc1	Fc1	
1	Da1	Ca1	DPa1	Ea2	Da2	Ga2	Ca2	DPa2	Ba2	Aa2	Fa2	cc2	cc1	Ba1	Aa1	Ga1	Fa1	
1	Dc1	Cc1	DPc1	Ec2	Dc2	Gc2	Cc2	DPc2	Bc2	Ac2	Fc2	ca2	ca1	Bc1	Ac1	Gc1	Fc1	
1	Da1	Ca1	DPa1	Ea2	Da2	Ga2	Ca2	DPa2	Ba2	Aa2	Fa2	cc2	cc1	Ba1	Aa1	Ga1	Fa1	
1	Dc1	Bc1	DPc1	Ec2	Dc2	Gc2	Cc2	DPc2	Bc2	Ac2	Fc2	ca2	ca1	Ac1	NC	NC	NC	
1	Da1	Ba1	DPa1	Ea2	Da2	Ga2	Ca2	DPa2	Ba2	Aa2	Fa2	cc2	cc1	Aa1	NC	NC	NC	
1	Dc1	Bc1	DPc1	Ec2	Dc2	Gc2	Cc2	DPc2	Bc2	Ac2	Fc2	ca2	ca1	Ac1	NC	NC	NC	POS Terminals Computers Instruments Test Equipment Clocks/Radios TV Channel Indicators
1	Da1	Ba1	DPa1	Ea2	Da2	Ga2	Ca2	DPa2	Ba2	Aa2	Fa2	cc2	cc1	Aa1	NC	NC	NC	
c	Dc	ca	Ca	DPc	Bc	Ac	ca	Fc	Gc	–	–	–	–	–	–	–	–	
a	Da	cc	Ca	DPa	Ba	Aa	cc	Fa	Ga	–	–	–	–	–	–	–	–	
c	Dc	ca	Cc	DPc	Bc	Ac	ca	Fc	Gc	–	–	–	–	–	–	–	–	
a	Da	cc	Ca	DPa	Ba	Aa	cc	Fa	Ga	–	–	–	–	–	–	–	–	
C	Ac	Fc	ca	Ec	NP	Ec	NP	Dc	DPc	Dc	ca	Cc	Gc	Bc	NP	ca	NP	
C	NC	NC	ca	Cc	NP	Cc	NP	D2c	DPc	D1c	ca	Bc	D2c	Ac	NP	ca	NP	
C	Aa	Fa	cc	Ea	NP	Ea	NP	cc	DPa	Da	cc	Ca	Ga	Ba	NP	cc	NP	
C	NC	NC	cc	Ca	NP	Ca	NP	cc	DPa	D2a	cc	Ba	D1a	Aa	NP	cc	NP	
																		Compact Computers Test Equipment Desk Top Calculators Commun. Equip. Verification Sys.

= common anode
= common cathode
= decimal point

NC = no connection
NP = no pin

GENERAL INSTRUMENT
Optoelectronics

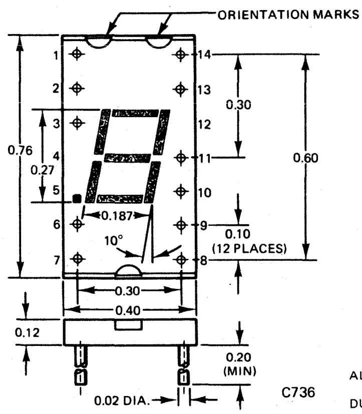
MAN1A
MAN10A

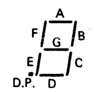
.27″ RED SEVEN SEGMENT DISPLAY

PRODUCT DESCRIPTION

The MAN1A and MAN10A are seven segment diffused planar GaAsP light emitting diode arrays. They are mounted on a dual in-line 14 pin substrate and then encapsulated in red epoxy for protection. They are capable of displaying all digits and nine distinct letters.

PACKAGE DIMENSIONS





PIN 1 CATHODE A
PIN 2 CATHODE F
PIN 3 ANODE-COMMON
PIN 4 NO PIN
PIN 5 NO PIN
PIN 6 DECIMAL POINT CATHODE
PIN 7 CATHODE E
PIN 8 CATHODE D
PIN 9 ANODE-COMMON
PIN 10 CATHODE C
PIN 11 CATHODE G
PIN 12 NO PIN
PIN 13 CATHODE B
PIN 14 ANODE-COMMON
JUMPER PINS 3, 9, AND 14 ON CIRCUIT BOARD

ALL DIMENSIONS NOMINAL IN INCHES

DUAL, IN-LINE CONFIGURATION

FEATURES

- High brightness . . .
- Categorized for luminous intensity (see note 6)
- Single plane, wide angle viewing . . . 150°
- Unobstructed emitting surface
- Standard 14 pin dual-in-line package configuration
- Long operating life . . . solid state reliability
- Shock resistant
- Operates with IC voltage requirements
- Small size; offering unique styling advantages
- All numbers plus 9 distinct letters
- Usable for wide viewing angle requirements
- Usable in vibrating environment, impervious to vibration
- Directly compatible with integrated circuits

The MAN1A/MAN10A is for industrial and military applications such as:

- Digital readout displays
- Cockpit readout displays

ABSOLUTE MAXIMUM RATINGS

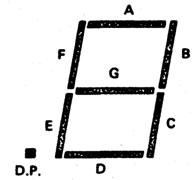
Power dissipation @ 25°C ambient . . . . 750 mW
Derate linearly from 25°C . . . . 10 mW/°C
Storage and operating temp . . . . -55°C to 100°C
Continuous forward current
  Total . . . . 240 mA
  Per segment . . . . 30 mA
  Decimal point . . . . 30 mA
Reverse Voltage
  Per segment . . . . 10.0 volts
  Decimal point . . . . 5.0 volts
Solder time at 260°C (see note 5) . . . . 5 sec

ELECTRO-OPTICAL CHARACTERISTICS

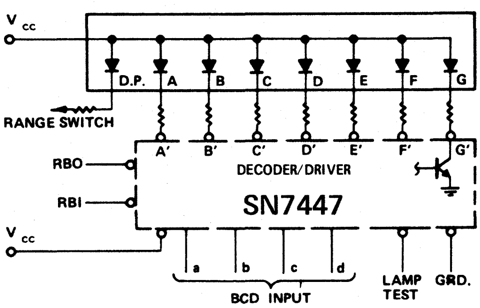
(25°C Ambient Temperature Unless Otherwise Specified)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS MAN1A	TEST CONDITIONS MAN10A
Luminous Intensity (note 1 and 6)						
Segment	74			μcd	I_F=20 mA, λ=660 nm	I_F=10 mA, λ 660 nm
Decimal point	74			μcd	I_F=20 mA, λ=660 nm	I_F=10 mA, λ 660 nm
Peak emission wave length	630		700	nm		
Spectral line half width		20		nm		
Forward voltage						
Segment		3.4	4.0	V	I_F=20 mA	I_F=10 mA
Decimal point		1.6	2.0	V	I_F=20 mA	I_F=10 mA
Dynamic resistance						
Segment		11		Ω	I_F=20 mA	I_F=20 mA
Decimal point		5.5		Ω	I_F=20 mA	I_F=20 mA
Capacitance						
Segment		80		pF	V=0	V=0
Decimal point		135		pF	V=0	V=0
Reverse Current						
Segment			100	μA	V_R=10.0 volts	V_R=10.0 volts
Decimal point			100	μA	V_R= 5.0 volts	V_R= 5.0 volts

Decoder/Driver Functional Diagram



General Instrument MAN1A/MAN10A



C737

Typical Truth Table

INPUT CODE				OUTPUT STATE							DISPLAY
d	c	b	a	A'	B'	C'	D'	E'	F'	G'	
0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	1	1	0	0	1	1	1	1	1
0	0	1	0	0	0	1	0	0	1	0	2
0	0	1	1	0	0	0	0	1	1	0	3
0	1	0	0	1	0	0	1	1	0	0	4
0	1	0	1	0	1	0	0	1	0	0	5
0	1	1	0	1	1	0	0	0	0	0	6
0	1	1	1	0	0	0	1	1	1	1	7
1	0	0	0	0	0	0	0	0	0	0	8
1	0	0	1	0	0	0	1	1	0	0	9

Typical Curves

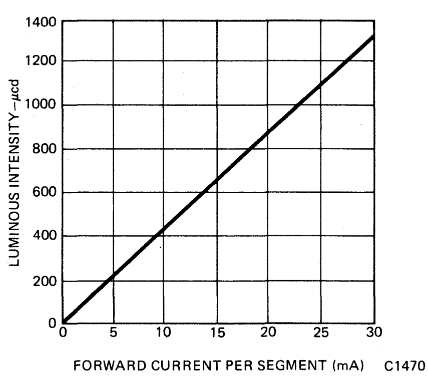


Figure 1 Luminous Intensity vs. Forward Current

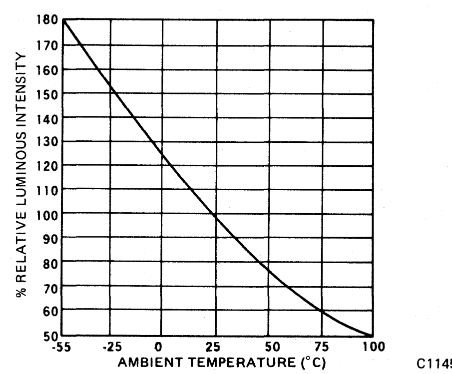


Figure 2 Luminous Intensity vs. Temperature

Typical Thermal Characteristics

Thermal Resistance (note 4) Junction to free air Θ_{JA} . . . . 440°C/W
Wavelength Temperature Coefficient (case temp) . . . . 3.0 Å/°C
Forward Voltage Temperature Coefficient . . . . −3.0 mV/°C

Notes

1. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ± 50% between all segments.*
2. *The curve in Figure 2 is normalized to the brightness at 25°C to indicate the relative efficiency over the operating temperature range.*
3. *For contrast improvement Polaroid HRCP7 circular polarizer filter can be used. Non-glare circular polarizer filter will provide further enhancement in display visibility.*
4. *Thermal resistance (junction to ambient) value of any one segment with all segments in operation.*
5. *Leads of the device immersed to 1/16 inches from the body. Maximum device surface temperature is 140°C.*
6. *All displays are categorized for luminous intensity. The intensity category is marked on each part as a suffix letter to the part number.*

GENERAL INSTRUMENT
Optoelectronics

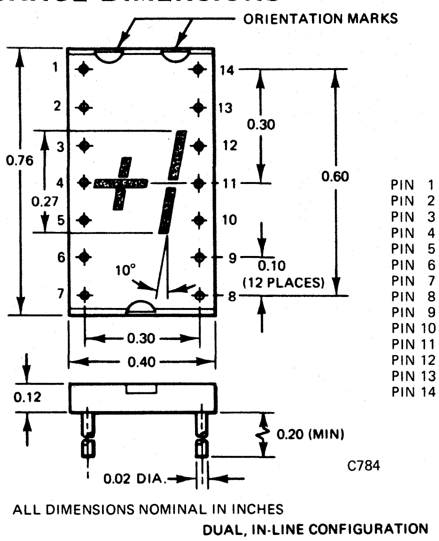
MAN101A
MAN1001A

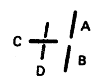
.27" RED POLARITY AND OVERFLOW DISPLAY

PRODUCT DESCRIPTION

The MAN101A and MAN1001A are four segment diffused planar GaAsP LED arrays. They are mounted on a dual in-line 14 pin substrate and then encapsulated in red epoxy for protection. They are designed to present polarity and overflow information when used with the MAN1A/10A seven segment displays.

PACKAGE DIMENSIONS





PIN 1 ANODE COMMON CD
PIN 2 NO PIN
PIN 3 NO PIN
PIN 4 NO PIN
PIN 5 NO PIN
PIN 6 NO PIN
PIN 7 CATHODE D
PIN 8 CATHODE C
PIN 9 NO PIN
PIN 10 CATHODE B
PIN 11 CATHODE A
PIN 12 NO PIN
PIN 13 NO PIN
PIN 14 ANODE COMMON AB

FEATURES

- High brightness . . .
- Categorized for luminous intensity (see note 6)
- Single plane, wide angle viewing . . . 150°
- Unobstructed emitting surface
- Standard 14 pin dual-in-line package configuration
- Long operating life . . . solid state reliability
- Shock resistant
- Operates with IC voltage requirements
- Small size; offering unique styling advantages
- Usable for high ambient applications
- Usable in vibrating environment, impervious to vibration

The MAN101 and MAN1001 are for industrial and military applications such as:

- Digital readout displays
- Cockpit readout displays
- Battery operated equipment

ABSOLUTE MAXIMUM RATINGS

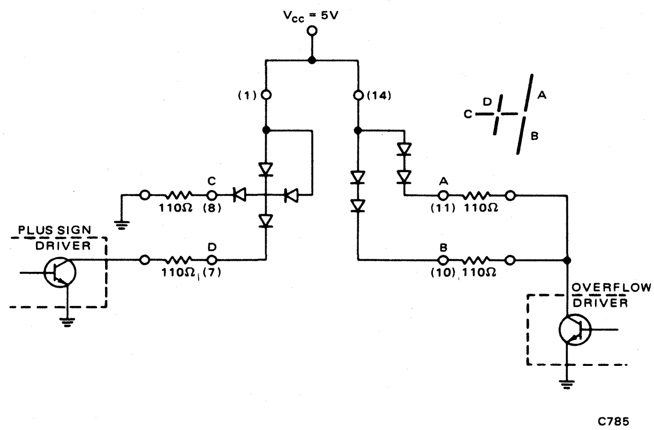
Power dissipation @ 25°C ambient . . . . 480 mW
Derate linearly from 25°C . . . . 6.4 mW/°C
Storage and operating temp . . . . –55°C to 100°C
Continuous forward current
  Total . . . . 120 mA
  Per segment . . . . 30 mA
Reverse Voltage
  Per segment . . . . 10.0 volts
Solder time at 260°C (see note 5) . . . . 5 sec

ELECTRO-OPTICAL CHARACTERISTICS (25°C Ambient Temperature Unless Otherwise Specified)

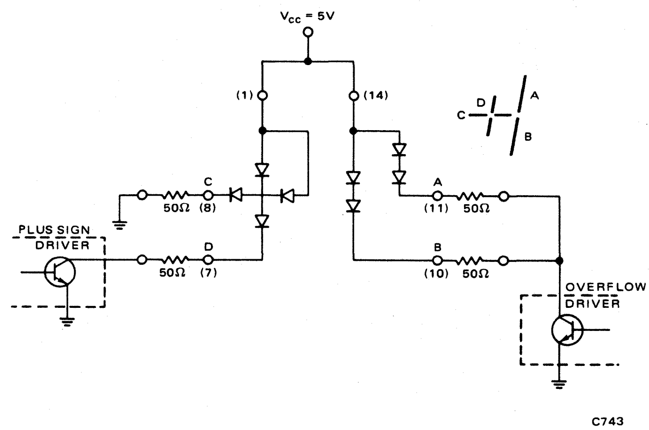
CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS MAN101A	MAN1001A
Luminous intensity (note 1 and 6)						
Segment	74			μcd	I_F = 10 mA, λ = 650 nm	I_F = 20 mA, λ 650 nm
Peak emission wave length	630		700	nm		
Spectral line half width		20		nm		
Forward voltage						
Segment		3.4	4.0	V	I_F = 10 mA	I_F = 20 mA
Dynamic resistance						
Segment		11		Ω	I_F = 20 mA	I_F = 20 mA
Capacitance						
Segment		80		pF	V = 0	V = 0
Reverse Current						
Segment			100	μA	V_R = 10.0 volts	V_R = 10.0 volts

DRIVING CIRCUITRY

MAN101A



MAN1001A



NOTE:
1. *Parenthesis ( ) denote package pin numbers*
2. *Each segment requires 10 mA*

TYPICAL CURVES

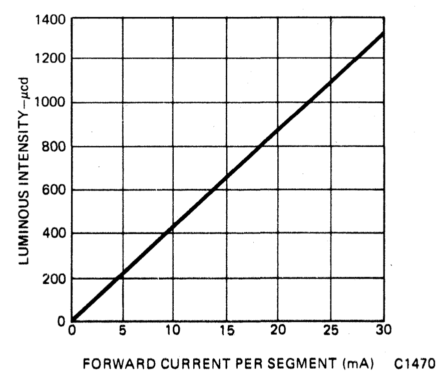


Figure 1 Luminous Intensity vs. Forward Current

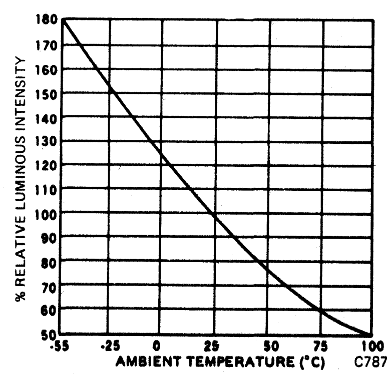


Figure 2 Luminous Intensity vs. Temperature

TYPICAL THERMAL CHARACTERISTICS

Thermal Resistance (note 4) Junction to free air θ_{JA} . . . . 440°C/W
Wavelength Temperature Coefficient (case temp) . . . . 3.0 Å/°C
Forward Voltage Temperature Coefficient . . . . –4.0 mV/°C

NOTES

1. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±50% between all segments.*
2. *The curve in Figure 2 is normalized to the brightness at 25°C to indicate the relative efficiency over the operating temperature range.*
3. *For contrast improvement Polaroid HRCP7 circular polarizer filter can be used. Non-glare circular polarizer filter will provide further enhancement in display visibility.*
4. *Thermal resistance (junction to ambient) value of any one segment with all segments in operation.*
5. *Leads of the device immersed to 1/16 inches from the body. Maximum device surface temperature is 140°C.*
6. *All displays are categorized for luminous intensity. The luminous category is marked on each part as a suffix letter to the part number.*

GENERAL INSTRUMENT
Optoelectronics

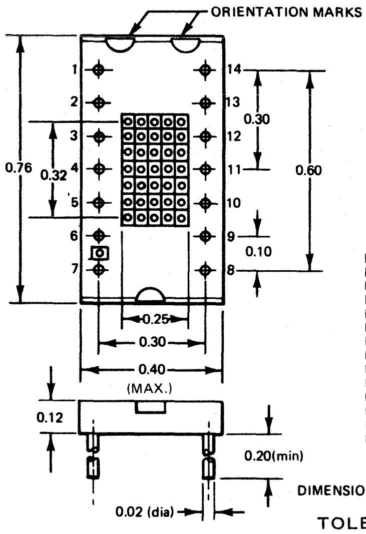
MAN2A

.32" RED ALPHA-NUMERIC DISPLAY

PRODUCT DESCRIPTION

The MAN2A is a 35 diode diffused planar GaAsP LED alpha-numeric array with a decimal point. It is mounted on a dual in-line, 14-pin substrate with a high contrast red epoxy lens. It is capable of displaying the 64 character ASCII code.

PACKAGE DIMENSIONS



PIN 1	COLUMN 2,	+
PIN 2	ROW 1,	−
PIN 3	ROW 3,	−
PIN 4	ROW 4,	−
PIN 5	COLUMN 1,	+
PIN 6	N.C.	
PIN 7	D.P.	+
PIN 8	COLUMN 3,	+
PIN 9	ROW 7,	−
PIN 10	ROW 6,	−
PIN 11	ROW 5,	−
PIN 12	ROW 2,	−
PIN 13	COLUMN 5,	+
PIN 14	COLUMN 4,	+

DIMENSIONS IN INCHES C416

TOLERANCE ±.015"

FEATURES & APPLICATIONS

- X-Y matrix drive
- Visible, bright red, high contrast display
- Categorized for luminous intensity (see note 5)
- 36 light emitting diodes including decimal point
- Capable of displaying 64 ASCII characters
- Single plane, wide angle viewing
- Long life, shock resistant, small size

It is ideal for industrial and military applications such as:

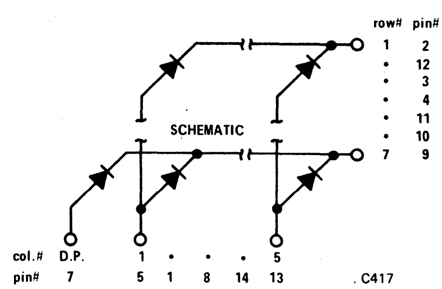
- Keyboard verifier
- Film annotation—2^{36} bits available
- Avionics display
- Computer peripheral displays

ABSOLUTE MAXIMUM RATINGS

Single Diode
- DC forward current .... 20 mA
- Pulsed forward current peak (50 µs, 20% duty cycle) .... 100 mA
- Reverse voltage .... 5 V
- Storage temperature .... −40°C to 85°C
- Operating temperature .... −40°C to 85°C

Diode Array
- Average power dissipation @ 25°C ambient .... 750 mW
- Derate linearly from 25°C .... 12.5 mW/°C
- DC current per diode for worst case A/N .... 20 mA
- DC current per diode for all 35 diodes plus DP .... 11 mA

Solder time at 260°C (notes 3, 4) .... 5 sec



ELECTRO-OPTICAL CHARACTERISTICS (PER DIODE)

(25°C Ambient Temperature Unless Otherwise Specified)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Average Luminous intensity per character (See note 1 and 5)	125			µcd	I_F = 10 mA
Peak emission wavelength		660		nm	
Spectral line half width		20		nm	
Forward voltage			2.0	V	I_F = 20 mA
Capacitance		200		pF	V = 0
Reverse current			100	µA	V_R = 5 V

TYPICAL CURVES

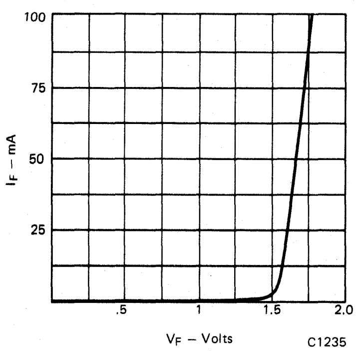


Fig. 1. Forward Current vs. Forward Voltage each LED

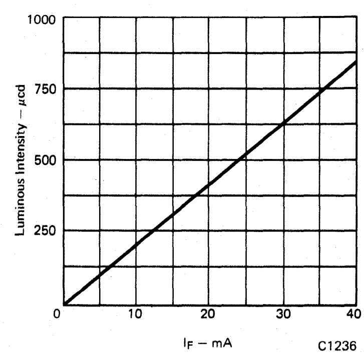


Fig. 2. Light Intensity vs. Forward Current each LED

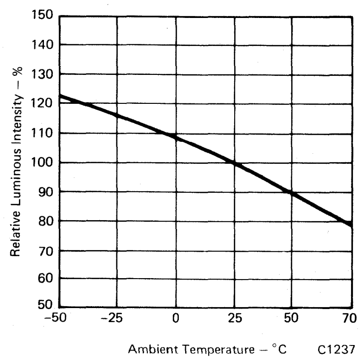


Fig. 3. Relative Luminous Intensity vs. Ambient Temperature

NOTES

1. *The characteristic average luminous intensity is obtained by summing the luminous intensity of each diode and dividing by 35. As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all diodes in a character.*
2. *The curve in Figure 3 is normalized to the brightness of 25°C to indicate the relative luminous intensity over the operating temperature range.*
3. *Leads of the device immersed to 1/16 inches from the body. Maximum device surface temperature is 140°C.*
4. *For flux removal, Freon TF, Freon TE, Isoproponal or water may be used up to their boiling points.*
5. *All displays are categorized for luminous intensity. The luminous intensity category is marked on each part as a suffix letter to the part number.*

RECOMMENDED FILTERS

For optimum on and off contrast, one of the following filters or equivalents should be used over the display:

Panelgraphic Red 60
Homalite 100-1670

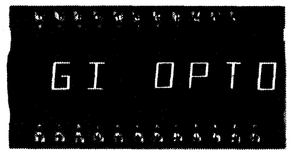
GENERAL INSTRUMENT
Optoelectronics

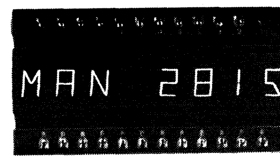
MAN2815

.135" RED 8-CHARACTER 14-SEGMENT ALPHA-NUMERIC DISPLAY

FEATURES

- Low Power Consumption
  (As low as 0.5 mA average current or 1.0 mw per segment.)
- Aesthetically designed characters.
  Sculptured continuous segments.
- Complete Alpha-numerics plus special characters.
- Voltage and current compatibility for interfacing ease with microprocessors and related circuitry.
- 0.135" character height
- 0.175" character spacing allowing as much as 32 characters in 5.6" linear panel space.
- Common Cathode
- Internally wired for multiplexing.





APPLICATIONS

- Computer terminals—lightweight, mobile, compact.
- Test & Measurement Equipment
- Desk Top Calculators
- Automotive Instrumentation
- Communications—message centers.
- Verification Systems

DESCRIPTION

The MAN2815 is an eight-character alpha-numeric display which is end-stackable and capable of displaying all alpha and numeric characters plus symbols. Each character is constructed from a monolithic, red GaAsP chip formated into a 14-segment font with a decimal point.

ABSOLUTE MAXIMUM RATINGS

Average Forward Current per Segment	10 mA
Peak Forward Current per Segment ($\leqslant$200 μs, $\leqslant$4% duty cycle)	250 mA
Reverse Voltage	5.0 volts
Storage & Operating Temperature	–40°C to 85°C
Solder temperature (t $\leqslant$5 sec) (See notes 2 & 3)	260°C
Average Power Dissipation (Total Package) @ T_A = 50°C	1200 mW
Derate Linearly from 50°C:	–17.1 mW/°C

NOTES

1. *The average Luminous Intensity per segment is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments as measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
2. *Leads immersed to 1/16" from the body of the device. Maximum unit surface temperature is 140°C.*
3. *For flux removal, use Freon TE, Isoproponal, or water may be used up to their boiling points.*

ELECTRICAL OPTICAL CHARACTERISTICS (T_A = 25°C)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Average Luminous Intensity per Segment (See Note 1)	60	100		μcd	I_{avg} = 2.5 mA I_{pk} = 20 mA Duty cycle = 1/8
Luminous Intensity Ratio Segment-to-Segment within a character			2.0:1		
Luminous Intensity Ratio, Character-to-Character within a display			2.0:1		
Forward Voltage		1.65	2.0	volts	I_{pk} = 20 mA
Reverse Voltage	5.0			volts	I_R= 100 μA/segment
Peak Emission Wavelength		660		nm	

ELECTRICAL/OPTICAL CONSIDERATIONS

A. DETERMINATION OF MAXIMUM ALLOWABLE STROBING CONDITIONS:

1. From number of characters, determine duty cycle (DC).
   Ex: 32 Characters
   DC = 1/32 = 3.125%
2. Establish refresh frequency (f) and calculate pulse duration (PW).
   Ex: f = 500 HZ
   PW = DC/f = .03125/500 HZ = 62.5 μs
3. The corresponding maximum peak current per segment from Fig. 1 is 250 mA. The intersection of 500 HZ and 62.5 μs pulse duration lies in the <4% duty cycle condition. I_{AVG} = 250 mA X .03125 = 7.8 mA which is the maximum average current for operation at T_A (ambient temperature) = 25°C.
4. If operating temperature is above 50°C, then power dissipation must be derated. Using Derating Factor of –17.1 mW/°C for total package: Or see Fig. 4.
   Ex: T_A = 70°C
   1200 mW – (70°C – 50°C) X (17.1 mW/°C) = 858 mW/package
   OR 107 mW/character
   Assume normal operation where there are no greater than 8 segments on at one time within a character. Then average power (P_{AVG}) (max)/segment = 13.4 mW/seg. At a peak current of 250 mA, maximum V_F = 2.4V; which yields:
   $I_{AVG} = \frac{13.4}{2.4}$ = 5.58 mA which is the max. avg. current for operation up to T_A = 70°C.

B. DETERMINATION OF THE OPERATION WITHIN THE ALLOWABLE CONDITIONS AS ESTABLISHED BY THE AMBIENT SURROUNDING.

1. Ex: Assume ambient light defines the average luminous intensity for each segment to be 120 μcd.
   32 characters; DC = 3.125%
2. Establish I_{AVG} and calculate I_{PK}.
   Referring to Fig. 2, 120 μcd at a duty cycle of 3.125% corresponds to I_{AVG} = 2.5 mA/seg.
   $\therefore I_{PK} = \frac{2.5 \text{ mA}}{.03125}$ = 80 mA/seg.

RECOMMENDED FILTERS

The following filters or equivalent are recommended to provide optimum ON and OFF contrast ratio:

PANELGRAPHIC RED 60
HOMALITE 100–1605
PLEXIGLAS 2423

TYPICAL CURVES (unless otherwise noted)

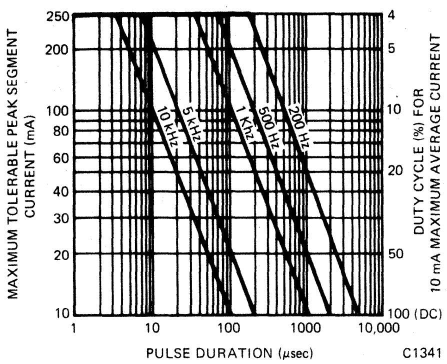


Fig. 1. Maximum Tolerable Peak Segment Current vs. Pulse Duration

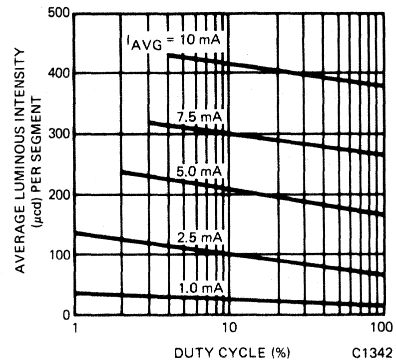


Fig. 2. Average Luminous Intensity/Segment vs. Duty Cycle

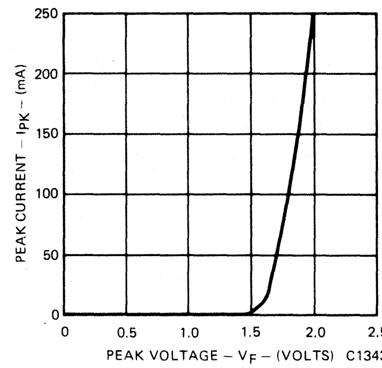


Fig. 3. Peak Current vs. Peak Voltage

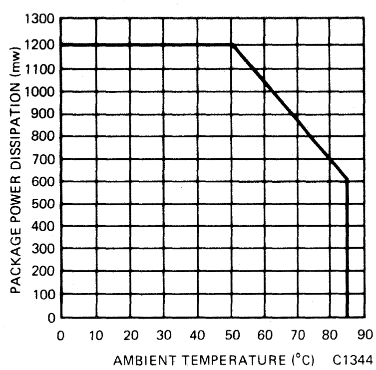


Fig. 4. Max. Tolerable Power Dissipation

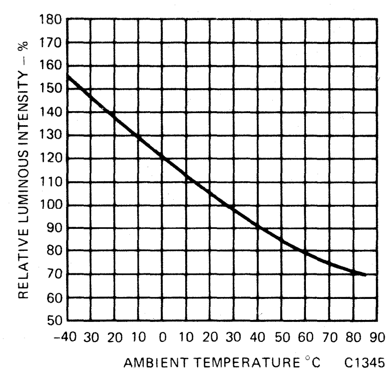


Fig. 5. Luminous Intensity vs. Temperature

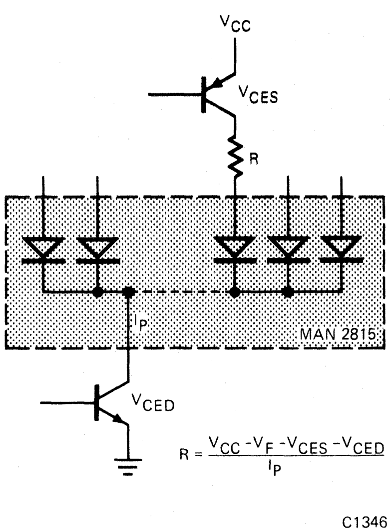


Fig. 6. Display Drive Consideration

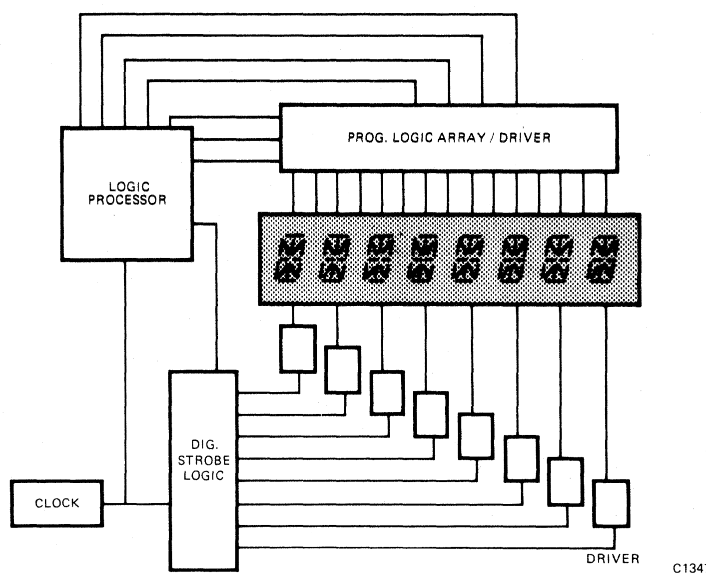
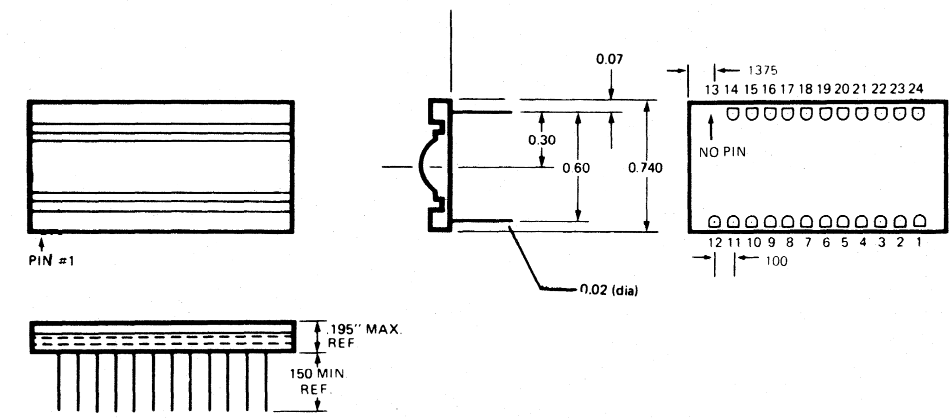


Fig. 7. MAN2815 in a Typical Application

PACKAGE DIMENSIONS

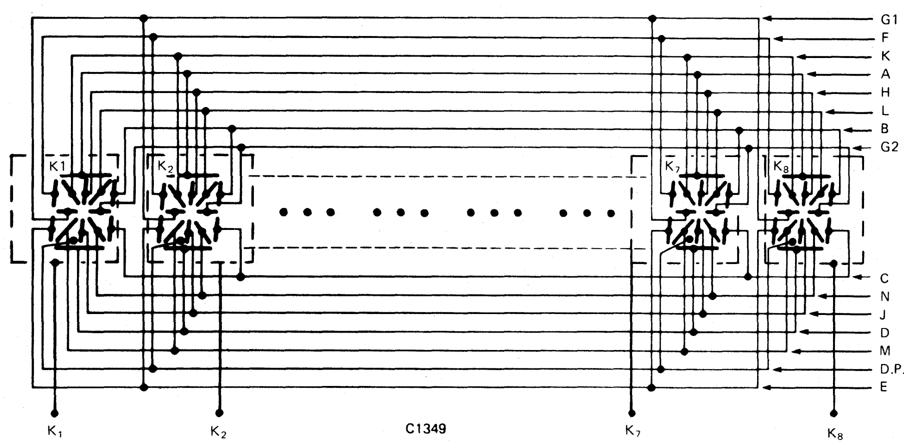


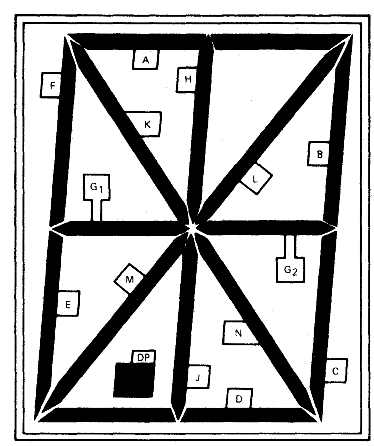
REFERENCE DESIGNATOR		
PIN NO.	DESCRIPTION	
1	K1	CATHODE
2	K2	CATHODE
3	K3	CATHODE
4	(D)	ANODE
5	K4	CATHODE
6	K5	CATHODE
7	(J)	ANODE
8	K6	CATHODE
9	(DP)	ANODE
10	K7	CATHODE
11	(M)	ANODE
12	K8	CATHODE
13		NO PIN
14	(N)	ANODE
15	(C)	ANODE
16	(E)	ANODE
17	(G2)	ANODE
18	(G1)	ANODE
19	(B)	ANODE
20	(L)	ANODE
21	(F)	ANODE
22	(K)	ANODE
23	(H)	ANODE
24	(A)	ANODE

TOLERANCES: ± .015

C1348

ELECTRICAL CONNECTIONS





NOTE: Segments A & D appear as 2 segments each, but both halves are driven together. (See wiring diagram.)

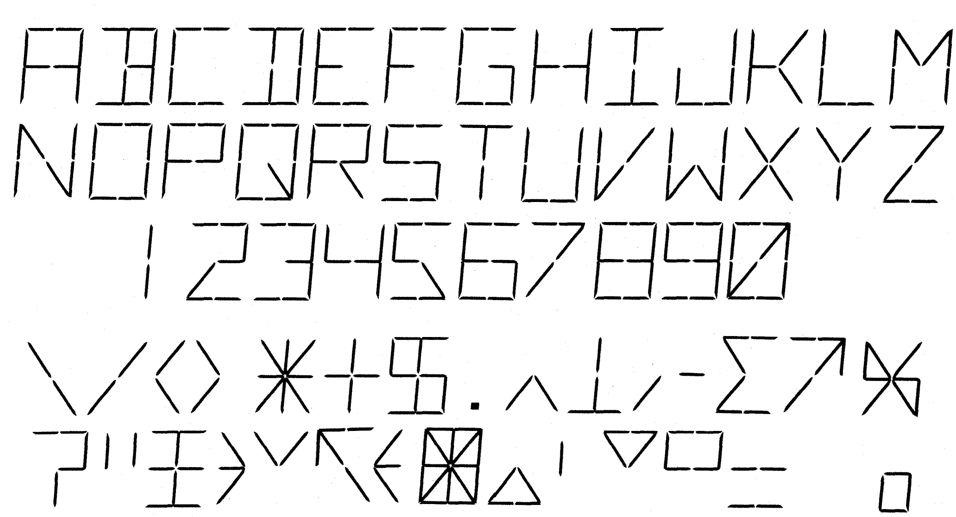
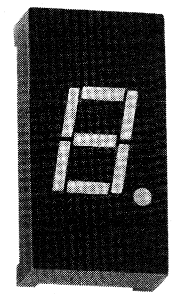


Fig. 8. 14 Segment Character Font

GENERAL INSTRUMENT
Optoelectronics

0.300-INCH SEVEN SEGMENT DISPLAY

GREEN MAN50A
ORANGE MAN3600A
RED MAN70A
YELLOW MAN80A



FEATURES

- Common anode or common cathode models
- Red, yellow, green and orange
- Fast switching—excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability—long operation life
- Impact resistant plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for luminous intensity (see note 6)
- Standard 14 pin dual in-line package configuration
- Wide angle viewing . . . 150°

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Calculators
- Digital clocks

DESCRIPTION

The MAN50A, MAN3600A, MAN70A and MAN80A Series provides a choice of color of LED displays. Standard units are available in red, green, orange and yellow, with common anode right hand decimal, common anode left hand decimal, common cathode right hand decimal, and common anode overflow (±1) with right hand decimal. They can be mounted in arrays with 0.400-inch (10.16 mm) center-to-center spacing.

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION
MAN51A	Green	Common Anode; Right Hand Decimal
MAN52A	Green	Common Anode; Left Hand Decimal
MAN53A	Green	Common Anode; Overflow ±1
MAN54A	Green	Common Cathode; Right Hand Decimal
MAN3610A	Orange	Common Anode; Right Hand Decimal
MAN3620A	Orange	Common Anode; Left Hand Decimal
MAN3630A	Orange	Common Anode; Overflow ±1
MAN3640A	Orange	Common Cathode; Right Hand Decimal
MAN71A	Red	Common Anode; Right Hand Decimal
MAN72A	Red	Common Anode; Left Hand Decimal
MAN73A	Red	Common Anode; Overflow ±1
MAN74A	Red	Common Cathode; Right Hand Decimal
MAN81A	Yellow	Common Anode; Right Hand Decimal
MAN82A	Yellow	Common Anode; Left Hand Decimal
MAN83A	Yellow	Common Anode; Overflow ±1
MAN84A	Yellow	Common Cathode; Right Hand Decimal

MAN50A MAN3600A MAN70A MAN80A SERIES

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

Device	Parameter	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
MAN51A, 52A, 53A, 54A	Luminous intensity, Digit Average (See Note 1)	125			μcd	I_F = 10 mA
	Decimal point (See Note 3)	60			μcd	I_F = 10 mA
	Segment "C" or "D" of MAN53A	60			μcd	I_F = 10 mA
	Peak emission wavelength		565		nm	
	Spectral line half width		40		nm	
	Forward voltage					
	Segment			3.0	V	I_F = 20 mA
	Decimal point			3.0	V	I_F = 20 mA
	Dynamic resistance					
	Segment		17		Ω	I_F = 20 mA
	Decimal point		17		Ω	I_F = 20 mA
	Capacitance					
	Segment		35		pF	V = 0
	Decimal point		35		pF	V = 0
	Reverse current					
	Segment			100	μA	V_R = 5.0 V
	Decimal point			100	μA	V_R = 5.0 V
MAN3610A, 3620A, 3630A, 3640A	Luminous intensity, Digit Average (See Note 1)	510			μcd	I_F = 10 mA
	Decimal point (See Note 3)	265			μcd	I_F = 10 mA
	Segment "C" or "D" of MAN3630A	265			μcd	I_F = 10 mA
	Peak emission wavelength		630		nm	
	Spectral line half width		40		nm	
	Forward voltage					
	Segment			2.5	V	I_F = 20 mA
	Decimal point			2.5	V	I_F = 20 mA
	Dynamic resistance					
	Segment		26		Ω	I_F = 20 mA
	Decimal point		26		Ω	I_F = 20 mA
	Capacitance					
	Segment		35		pF	V = 0
	Decimal point		35		pF	V = 0
	Reverse current					
	Segment			100	μA	V_R = 5.0 V
	Decimal point			100	μA	V_R = 5.0 V
MAN71A, 72A, 73A, 74A	Luminous intensity, Digit Average (See Note 1)	125			μcd	I_F = 10 mA
	Decimal point (See Note 3)	60			μcd	I_F = 10 mA
	Segment "C" or "D" of MAN73A	60			μcd	I_F = 10 mA
	Peak emission wavelength		660		nm	
	Spectral line half width		20		nm	
	Forward voltage					
	Segment			2.0	V	I_F = 20 mA
	Decimal point			2.0	V	I_F = 20 mA
	Dynamic resistance					
	Segment		2		Ω	I_{PK} = 100 mA
	Decimal point		2		Ω	I_{PK} = 100 mA
	Capacitance					
	Segment		35	80		V = 0
	Decimal point		35	80		V = 0
	Reverse current					
	Segment			100	μA	V_R = 5.0 V
	Decimal point			100	μA	V_R = 5.0 V
MAN81A, 82A, 83A, 84A	Luminous intensity, Digit Average (See Note 1)	320			μcd	I_F = 10 mA
	Decimal point (See Note 3)	160			μcd	I_F = 10 mA
	Segment "C" or "D" of MAN83A	160			μcd	I_F = 10 mA
	Peak emission wavelength		585		nm	
	Spectral line half width		40		nm	
	Forward voltage					
	Segment			3.0	V	I_F = 20 mA
	Decimal point			3.0	V	I_F = 20 mA
	Dynamic resistance					
	Segment		26		Ω	I_F = 20 mA
	Decimal point		26		Ω	I_F = 20 mA
	Capacitance					
	Segment		35		pF	V = 0
	Decimal point		35		pF	V = 0
	Reverse current					
	Segment			100	μA	V_R = 5.0 V
	Decimal point			100	μA	V_R = 5.0 V

TYPICAL CURVES

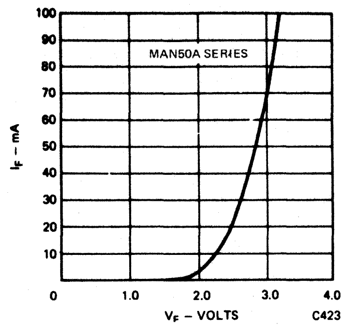


Fig. 1. Forward Current vs. Forward Voltage

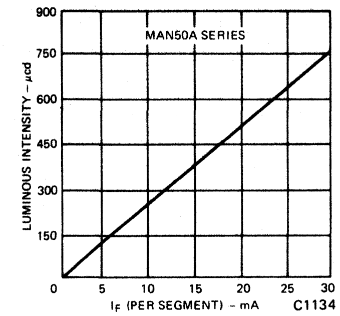


Fig. 2. Luminous Intensity vs. Forward Current

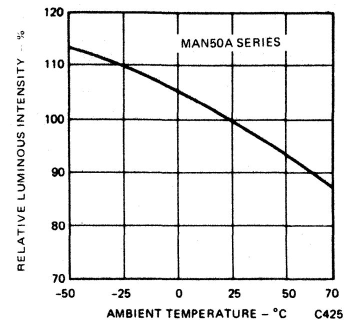


Fig. 3. Luminous Intensity vs. Temperature

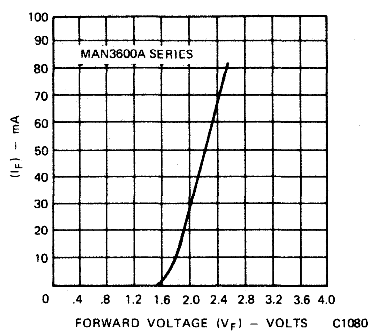


Fig. 4. Forward Current vs. Forward Voltage

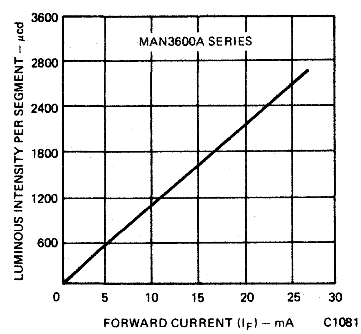


Fig. 5. Luminous Intensity vs. Forward Current

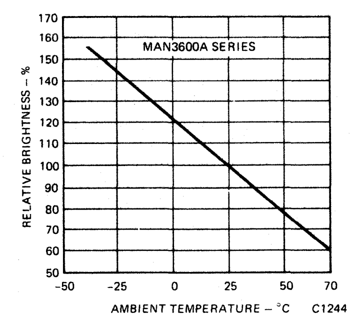


Fig. 6. Luminous Intensity vs. Temperature

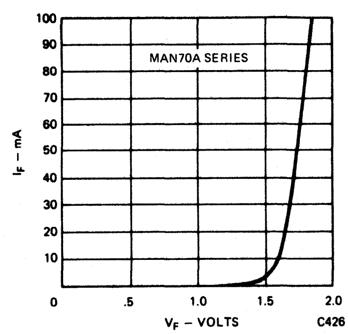


Fig. 7. Forward Current vs. Forward Voltage

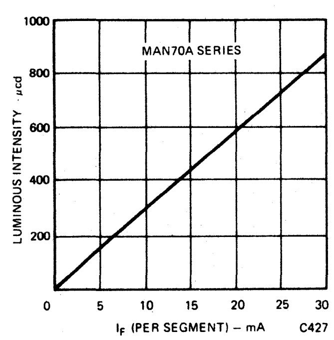


Fig. 8. Luminous Intensity vs. Forward Current

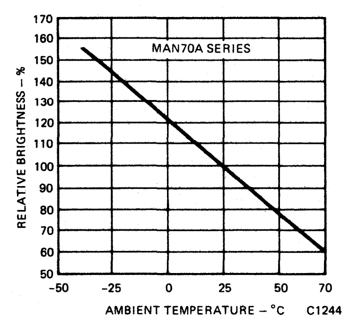


Fig. 9. Luminous Intensity vs. Temperature

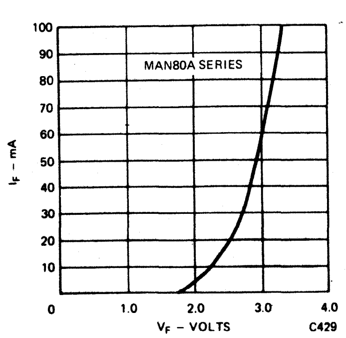


Fig. 10. Forward Current vs. Forward Voltage

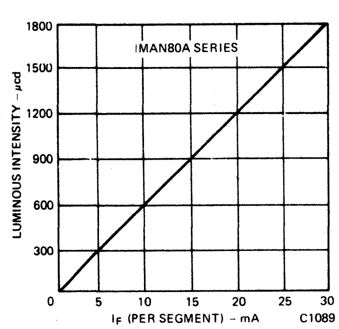


Fig. 11. Luminous Intensity vs. Forward Current

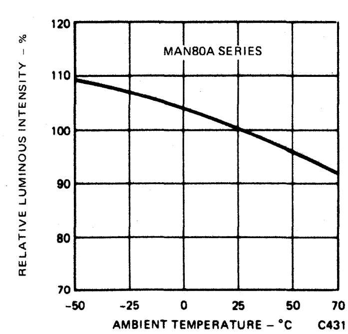


Fig. 12. Luminous Intensity vs. Temperature

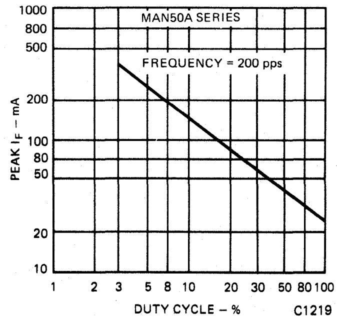


Fig. 13. Max Peak Current vs. Duty Cycle

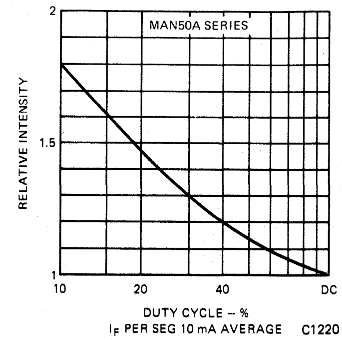


Fig. 14. Luminous Intensity vs. Duty Cycle

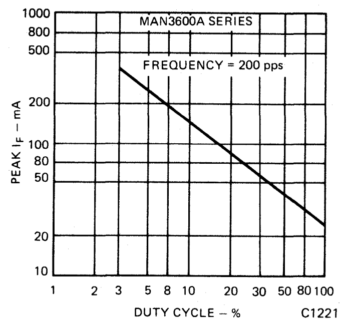


Fig. 15. Max Peak Current vs. Duty Cycle

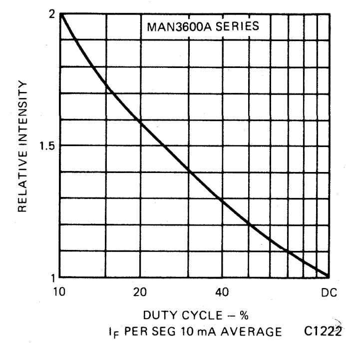


Fig. 16. Luminous Intensity vs. Duty Cycle

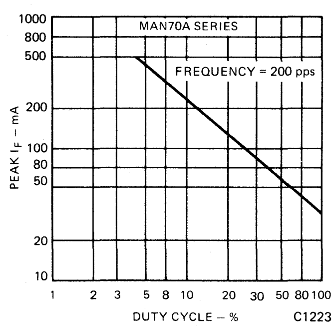


Fig. 17. Max Peak Current vs. Duty Cycle

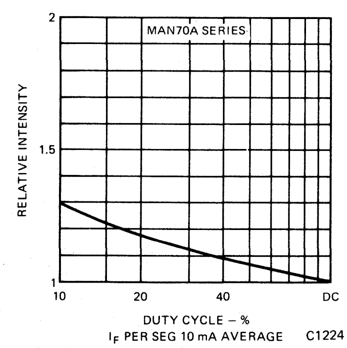


Fig. 18. Luminous Intensity vs. Duty Cycle

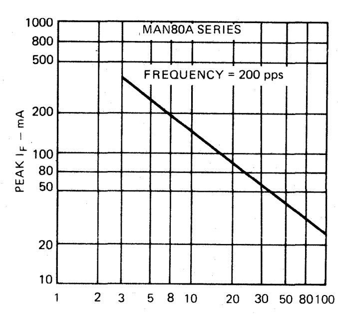


Fig. 19. Max Peak Current vs. Duty Cycle

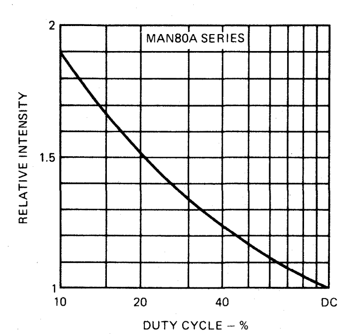
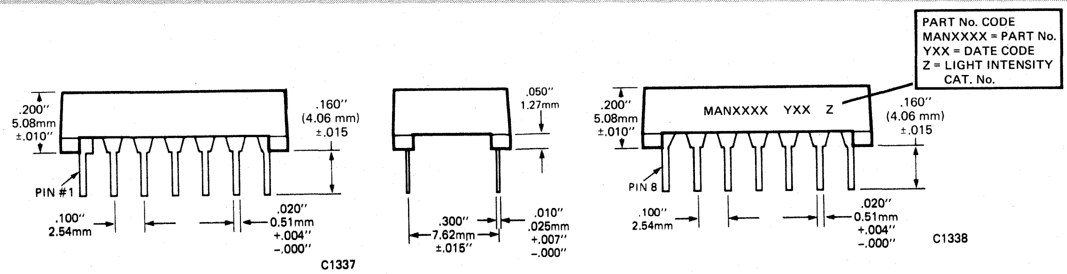
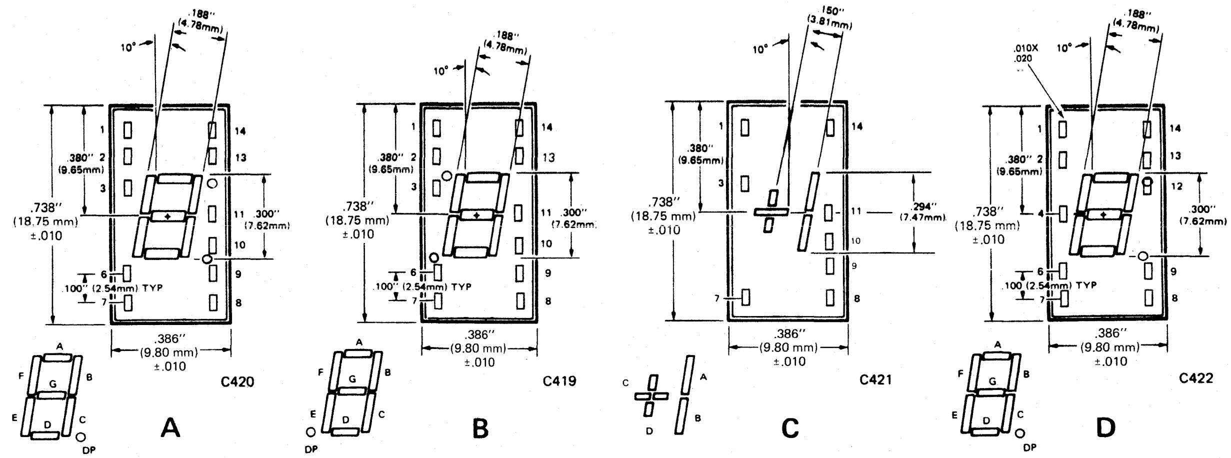


Fig. 20. Luminous Intensity vs. Duty Cycle

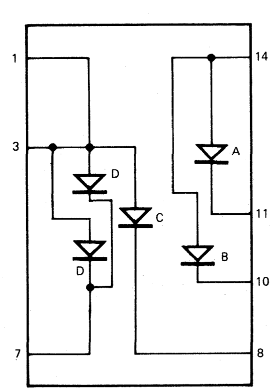




PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS			
	A	B	C	D
	MAN51A, 3610A, 71A, 81A	MAN52A, 72A, 3620A, 82A	MAN53A, 3630A, 73A, 83A	MAN54A, 3640A, 74A, 84A
1	Cathode A	Cathode A	Anode C, D	Anode F
2	Cathode F	Cathode F	No pin	Anode G
3	Common anode	Common anode	Anode C, D	No pin
4	No pin	No pin	No pin	Common cathode
5	No pin	No pin	No pin	No pin
6	N.C.	Cathode D.P.	No pin	Anode E
7	Cathode E	Cathode E	Cathode D	Anode D
8	Cathode D	Cathode D	Cathode C	Anode C
9	Cathode D.P.	N.C.	N.C.	Anode D.P.
10	Cathode C	Cathode C	Cathode B	No pin
11	Cathode G	Cathode G	Cathode A	No pin
12	No pin	No pin	No pin	Common cathode
13	Cathode B	Cathode B	No pin	Anode B
14	Common anode	Common anode	Anode A, B	Anode A

ELECTRICAL SCHEMATIC



MAN53A, 3630A, 73A, 83A

ABSOLUTE MAXIMUM RATINGS

	GREEN		RED	
	MAN51A MAN52A MAN54A	MAN53A	MAN71A MAN72A MAN74A	MAN73A
Power dissipation @ 25°C ambient	480 mW	300 mW	480 mW	300 mW
Derate linearly from 50°C	–9.6 mW/°C	–6.0 mW/°C	–6.9 mW/°C	–4.29 mW/°C
Storage and operating temperature	–40°C to +85°C	–40°C to +85°C	–40°C to +85°C	–40°C to +85°C
Continuous forward current				
Total	160 mA	100 mA	240 mA	150 mA
Per segment	20 mA	20 mA	30 mA	30 mA
Decimal point	20 mA	20 mA	30 mA	30 mA
Reverse voltage				
Per segment	6.0 V	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V	6.0 V
Solder time @ 260°C (Note 4 and 5)	5 sec.	5 sec.	5 sec.	5 sec.

	YELLOW		ORANGE	
	MAN81A MAN82A MAN84A	MAN83A	MAN3610A MAN3620A MAN3640A	MAN3630A
Power dissipation @ 25°C ambient	600 mW	375 mW	600 mW	375 mW
Derate linearly from 25°C	–10.3 mW/°C	–6.43 mW/°C	–8.6 mW/°C	–5.36 mW/°C
Storage and operating temperature	–40°C to +85°C	–40°C to +85°C	–40°C to +85°C	–40°C to +85°C
Continuous forward current				
Total	200 mA	125 mA	240 mA	150 mA
Per segment	25 mA	25 mA	30 mA	30 mA
Decimal point	25 mA	25 mA	30 mA	30 mA
Reverse voltage				
Per segment	6.0 V	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V	6.0 V
Solder time @ 260°C (Note 4 and 5)	5 sec.	5 sec.	5 sec.	5 sec.

RECOMMENDED FILTERS

For optimum on and off contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER	DEVICE TYPE	FILTER
MAN51A, MAN52A, MAN53A, MAN54A	Panelgraphic Green 48	MAN71A, MAN72A, MAN73A, MAN74A	Panelgraphic Red 60 Homalite 100-1605
MAN3610A, MAN3620A, MAN3630A, MAN3640A	Panelgraphic Scarlet 65 Homalite 100-1670	MAN81A, MAN82A, MAN83A, MAN84A	Panelgraphic Yellow 25 or Amber 23 Homalite 100-1720 or 100-1726

TYPICAL THERMAL CHARACTERISTICS

GREEN/YELLOW

Thermal resistance junction to free air Φ_{JA}	160°C/W
Wavelength temperature coefficient (case temp)	1.0 Å/°C
Forward voltage temperature coefficient	–1.5 mV/°C

RED/ORANGE

Thermal resistance junction to free air Φ_{JA}	160°C/W
Wavelength temperature coefficient (case temp)	1.0 Å/°C
Forward voltage temperature coefficient	–2.0 mV/°C

NOTES:

1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments as measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *The curve in Fig. 3, 6, 9, and 12 is normalized to the brightness at 25°C to indicate the relative luminous intensity over the operating temperature range.*
3. *The decimal point is designed to have the same surface brightness as the segments; therefore, the luminous intensity of the decimal point is .3 times the luminous intensity of the segments, since the area of the decimal point is .3 times the area of the average segment.*
4. *Leads of the device immersed to 1/16-inches from the body. Maximum device surface temperature is 140°C.*
5. *For flux removal, Freon TF, Freon TE, Isoproponal or water may be used up to their boiling points.*
6. *All displays are categorized for luminous intensity. The intensity category is marked on each part as a suffix letter to the part number.*

GENERAL INSTRUMENT
Optoelectronics

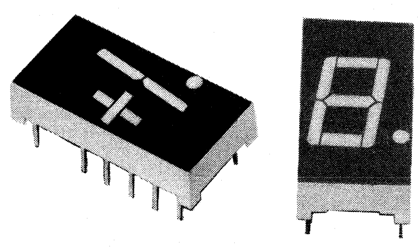
GREEN MAN4500 SERIES
ORANGE MAN4600 SERIES
RED MAN4700 SERIES
YELLOW MAN4800 SERIES
0.400-INCH SEVEN SEGMENT DISPLAY

FEATURES

- Common anode or common cathode models
- Red, yellow, green and orange
- Fast switching—excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability—long operation life
- Impact resistant plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for luminous intensity (see note 6)
- Standard 14 pin dual in-line package configuration
- Wide angle viewing . . . 150°
- Package size and lead configuration is the same as MAN50A/3600A/70A/80A Series

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Calculators
- Digital clocks
- High ambient light conditions



DESCRIPTION

The MAN4500, MAN4600, MAN4700 and MAN4800 Series provides superior brightness in a choice of color LED displays. Standard units are available in red, green, orange and yellow, with common anode right hand decimal, common cathode right hand decimal, and universal (CA or CC) overflow (±1) with right hand decimal. They can be mounted in arrays with 0.400-inch (10.16 mm) center to center spacing. The green and yellow units are standard with a high minimum brightness and high ambient light package design.

MODEL NUMBERS

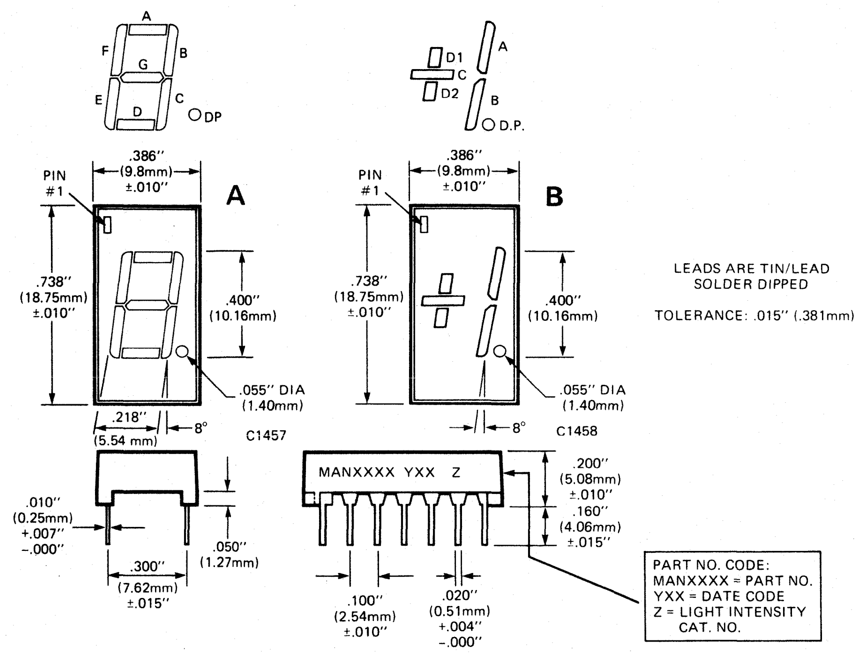
PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN-OUT SPECIFICATION
MAN4505	Green	Universal (CA or CD) Overflow ±1, Rt. Hand Dec.	B	D
MAN4510	Green	Common Anode; Right Hand Decimal	A	A
MAN4540	Green	Common Cathode; Right Hand Decimal	A	C
MAN4605	Orange	Universal (CA or CD) Overflow ±1, Rt. Hand Dec.	B	D
MAN4610	Orange	Common Anode; Right Hand Decimal	A	A
MAN4630	Orange	Common Anode; Overflow ±1, Rt. Hand Dec.	B	B
MAN4640	Orange	Common Cathode; Right Hand Decimal	A	C
MAN4705	Red	Universal (CA or CD) Overflow ±1, Rt. Hand Dec.	B	D
MAN4710	Red	Common Anode; Right Hand Decimal	A	A
MAN4740	Red	Common Cathode; Right Hand Decimal	A	C
MAN4805	Yellow	Universal (CA or CD) Overflow ±1, Rt. Hand Dec.	B	D
MAN4810	Yellow	Common Anode; Right Hand Decimal	A	A
MAN4840	Yellow	Common Cathode; Right Hand Decimal	A	C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

		MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
MAN4505/4510/4540	Luminous intensity, Digit Average (See Note 1)	320			μcd	I_F = 10 mA
	Decimal point (See Note 3)	150			μcd	I_F = 10 mA
	Segment "C" or "D" of MAN4505	150			nm	
	Peak emission wavelength		565			
	Forward voltage					
	Segment		2.5	3.0	V	I_F = 20 mA
	Decimal point		2.5	3.0	V	I_F = 20 mA
	Dynamic resistance					
	Segment		17		Ω	I_F = 20 mA
	Decimal point		17		Ω	I_F = 20 mA
	Capacitance					
	Segment		35		pF	V = 0
	Decimal point		35		pF	V = 0
	Reverse current					
	Segment			100	μA	V_R = 5.0 V
	Decimal point			100	μA	V_R = 5.0 V
MAN4605/4610/4630*/4640	Luminous intensity, Digit Average (See Note 1)	510			μcd	I_F = 10 mA
	Decimal point (See Note 3)	250			μcd	I_F = 10 mA
	Segment "C" or "D" of MAN4630 or 4605	250			μcd	I_F = 10 mA
	Peak emission wavelength		630		nm	
	Forward voltage					
	Segment		2.2	2.5	V	I_F = 20 mA
	Decimal point		2.2	2.5	V	I_F = 20 mA
	Dynamic resistance					
	Segment		26		Ω	I_F = 20 mA
	Decimal point		26		Ω	I_F = 20 mA
	Capacitance					
	Segment		35		pF	V = 0
	Decimal point		35		pF	V = 0
	Reverse current					
	Segment			100	μA	V_R = 5.0 V
	Decimal point			100	μA	V_R = 5.0 V
MAN4705/4710/4740	Luminous intensity, Digit Average (See Note 1)	200			μcd	I_F = 10 mA
	Decimal point (See Note 3)	85			μcd	I_F = 10 mA
	Segment "C" or "D" of MAN4705	85			nm	
	Peak emission wavelength		660			
	Forward voltage					
	Segment		1.6	2.0	V	I_F = 20 mA
	Decimal point		1.6	2.0	V	I_F = 20 mA
	Dynamic resistance					
	Segment		2		Ω	I_{PK} = 100 mA
	Decimal point		2		Ω	I_{PK} = 100 mA
	Capacitance					
	Segment		35	80		V = 0
	Decimal point		35	80		V = 0
	Reverse current					
	Segment			100	μA	V = 5.0 V
	Decimal point			100	μA	V = 5.0 V
MAN4805/4810/4840	Luminous intensity, Digit Average (See Note 1)	510			μcd	I_F = 10 mA
	Decimal point (See Note 3)	250			μcd	I_F = 10 mA
	Segment "C" or "D" of MAN4805	250			nm	
	Peak emission wavelength		585			
	Forward voltage					
	Segment		2.5	3.0	V	I_F = 20 mA
	Decimal point		2.5	3.0	V	I_F = 20 mA
	Dynamic resistance					
	Segment		26		Ω	I_F = 20 mA
	Decimal point		26		Ω	I_F = 20 mA
	Capacitance					
	Segment		35		pF	V = 0
	Decimal point		35		pF	V = 0
	Reverse current					
	Segment			100	μA	V_R = 5.0 V
	Decimal point			100	μA	V_R = 5.0 V

*The MAN4630 should be replaced by the MAN4605 for new design-ins.

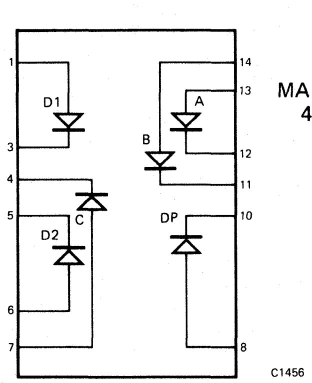
PACKAGE DIMENSIONS



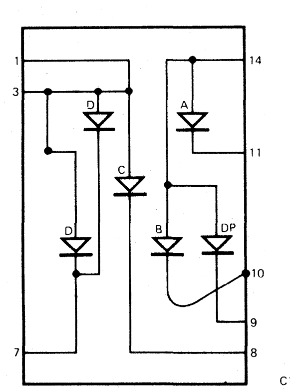
PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS			
	A MAN4510/4610/4710/4810	B MAN4630*	C MAN4540/4640/4740/4840	D MAN4505/4605/4705/4805
1	Cathode A	Anode C, D	Anode F	Anode D1
2	Cathode F	No Pin	Anode G	No Pin
3	Common Anode	Anode C, D	No Pin	Cathode D1
4	No Pin	No Pin	Common Cathode	Cathode C
5	No Pin	No Pin	No Pin	Cathode D2
6	NC	NC	Anode E	Anode D2
7	Cathode E	Cathode D	Anode D	Anode C
8	Cathode D	Cathode C	Anode C	Anode DP
9	Cathode DP	Cathode DP	Anode DP	No Pin
10	Cathode C	Cathode B	No Pin	Cathode DP
11	Cathode G	Cathode A	NC	Cathode B
12	No Pin	No Pin	Common Cathode	Cathode A
13	Cathode B	No Pin	Anode B	Anode A
14	Common Anode	Anode A, B, & DP	Anode A	Anode B

ELECTRICAL SCHEMATIC



MAN4505/4605
4705/4805



MAN4630

*The MAN4630 will be available on an order only basis beginning 6/30/79. New designs should use the MAN4605 instead.

TYPICAL CURVES

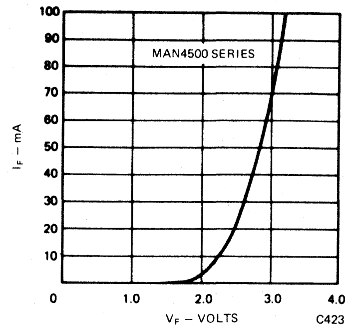


Fig. 1. Forward Current vs. Forward Voltage

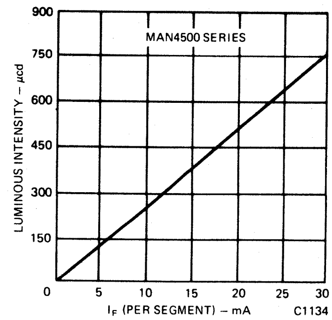


Fig. 2. Luminous Intensity vs. Forward Current

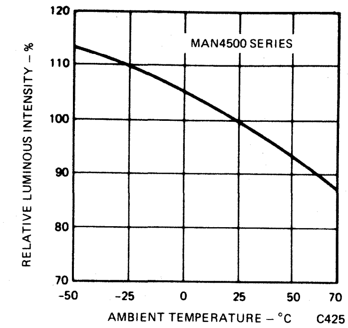


Fig. 3. Luminous Intensity vs. Temperature

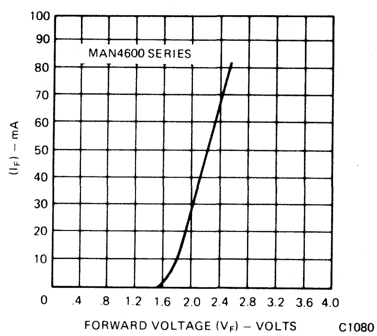


Fig. 4. Forward Current vs. Forward Voltage

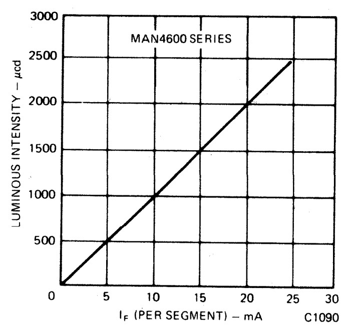


Fig. 5. Luminous Intensity vs. Forward Current

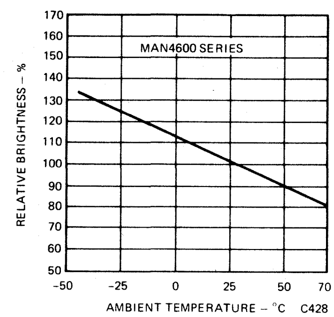


Fig. 6. Luminous Intensity vs. Temperature

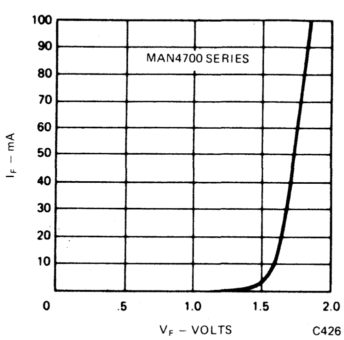


Fig. 7. Forward Current vs. Forward Voltage

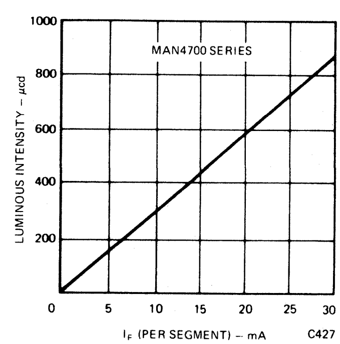


Fig. 8. Luminous Intensity vs. Forward Current

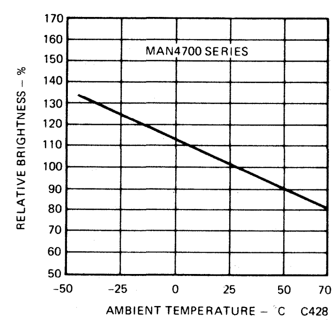


Fig. 9. Luminous Intensity vs. Temperature

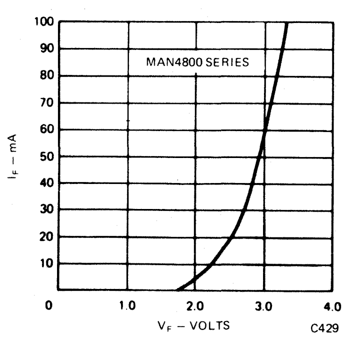


Fig. 10. Forward Current vs. Forward Voltage

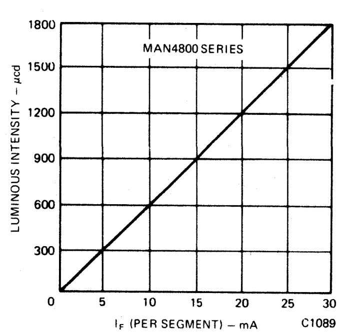


Fig. 11. Luminous Intensity vs. Forward Current

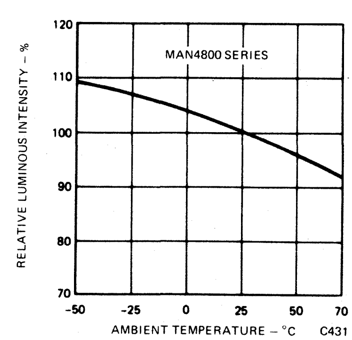


Fig. 12. Luminous Intensity vs. Temperature

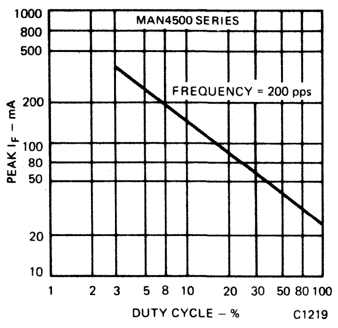


Fig. 13. Max Peak Current vs. Duty Cycle

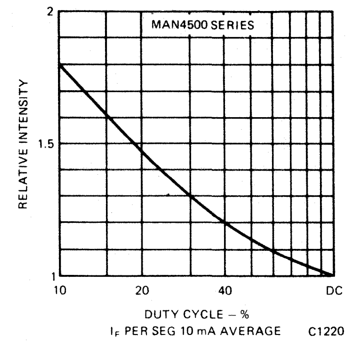


Fig. 14. Luminous Intensity vs. Duty Cycle

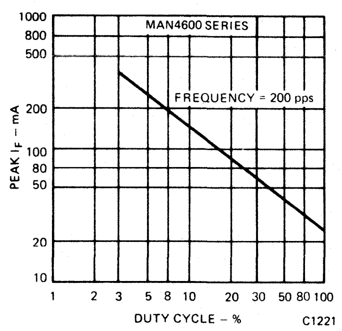


Fig. 15. Max Peak Current vs. Duty Cycle

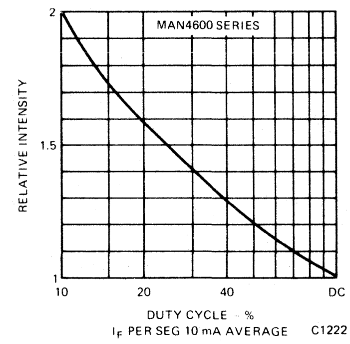


Fig. 16. Luminous Intensity vs. Duty Cycle

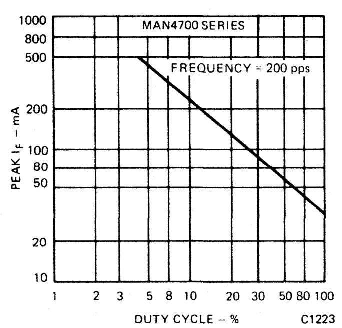


Fig. 17. Max Peak Current vs. Duty Cycle

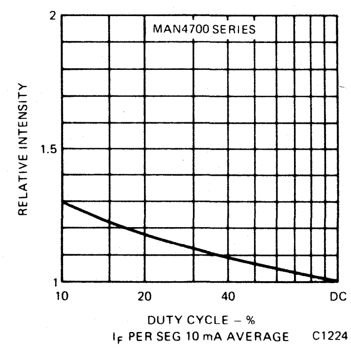


Fig. 18. Luminous Intensity vs. Duty Cycle

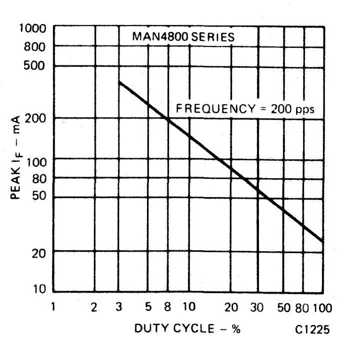


Fig. 19. Max Peak Current vs. Duty Cycle

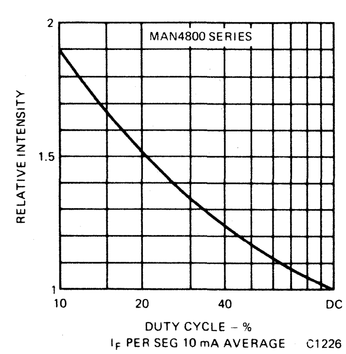


Fig. 20. Luminous Intensity vs. Duty Cycle

ABSOLUTE MAXIMUM RATINGS

	MAN4505	MAN4510 MAN4540	MAN4705	MAN4710 MAN4740
Power dissipation @ 25°C ambient	360 mW	480 mW	360 mW	480 mW
Derate linearly from 50°C	−7.2 mW/°C	−9.6 mW/°C	−5.2 mW/°C	−6.9 mW/°C
Storage and operating temperature	−40°C to +85°C	−40°C to +85°C	−40°C to +85°C	−40°C to +85°C
Continuous forward current				
Total	120 mA	160 mA	180 mA	240 mA
Per segment	20 mA	20 mA	30 mA	30 mA
Decimal point	20 mA	20 mA	30 mA	30 mA
Reverse voltage				
Per segment	6.0 V	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V	6.0 V
Solder time @ 260°C (Note 4 and 5)	5 sec.	5 sec.	5 sec.	5 sec.

	MAN4805	MAN4810 MAN4840	MAN4605 MAN4630	MAN4610 MAN4640
Power dissipation @ 25°C ambient	450 mW	600 mW	450 mW	600 mW
Derate linearly from 25°C	−7.7 mW/°C	−10.3 mW/°C	−6.4 mW/°C	−8.6 mW/°C
Storage and operating temperature	−40° to +85°C	−40°C to +85°C	−40° to +85°C	−40° to +85°C
Continuous forward current				
Total	150 mA	200 mA	180 mA	240 mA
Per segment	25 mA	25 mA	30 mA	30 mA
Decimal point	25 mA	25 mA	30 mA	30 mA
Reverse voltage				
Per segment	6.0 V	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V	6.0 V
Solder time @ 260°C (Note 4 and 5)	5 sec.	5 sec.	5 sec.	5 sec.

RECOMMENDED FILTERS

For optimum on and off contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER	DEVICE TYPE	FILTER
MAN4505, MAN4510, MAN4540	Panelgraphic Green 48	MAN4705, MAN4710, MAN4740	Panelgraphic Red 60 Homalite 100-1605
MAN4605, MAN4610, MAN4630, MAN4640	Panelgraphic Scarlet 65 Homalite 100-1670	MAN4805, MAN4810, MAN4840	Panelgraphic Yellow 25 or Amber 23 Homalite 100-1720 or 100-1726

NOTE: When using the grey face MAN4500 or MAN4800 series in situations of high ambient light, a neutral density filter can be used to achieve a greater contrast. The following or equivalent can be used: Panelgraphic Grey 10.

TYPICAL THERMAL CHARACTERISTICS

GREEN/YELLOW

Thermal resistance junction to free air Φ_{JA} . . . 160°C/W
Wavelength temperature coefficient (case temp) 1.0 Å/°C
Forward voltage temperature coefficient . . . −1.5 mV/°C

RED/ORANGE

Thermal resistance junction to free air Φ_{JA} . . . 160°C/W
Wavelength temperature coefficient (case temp) 1.0 Å/°C
Forward voltage temperature coefficient . . . −2.0 mV/°C

NOTES

1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments as measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *The curve in Fig. 3, 6, 9, and 12 is normalized to the brightness at 25°C to indicate the relative efficiency over the operating temperature range.*
3. *The decimal point is designed to have the same surface brightness as the segments; therefore, the luminous intensity of the decimal point is .3 times the luminous intensity of the segments, since the area of the decimal point is .3 times the area of the average segment.*
4. *Leads of the device immersed to 1/16-inches from the body. Maximum device surface temperature is 140°C.*
5. *For flux removal, Freon TF, Freon TE, Isoproponal or water, may be used up to their boiling points.*
6. *All displays are categorized for luminous intensity. The intensity category is marked on each part as a suffex letter to the part number.*

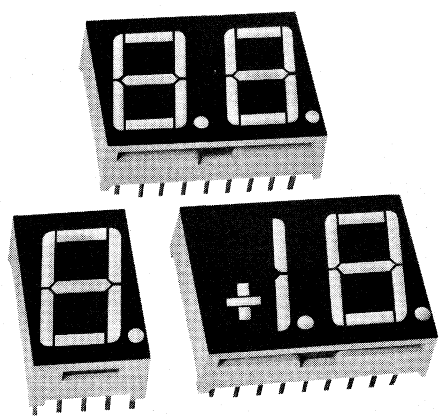
GENERAL INSTRUMENT
Optoelectronics

MAN6600 SERIES

0.560" ORANGE HIGH PERFORMANCE DISPLAY

DESCRIPTION

The MAN6600 Series is a family of large digits which includes double and single digits. The series features the sculptured font which minimizes "gappiness" at the segment intersections. Available models include two-digit, one and one-half digits with polarity sign, and single digits. All models have right hand decimal point and are available in common anode or common cathode configuration.



FEATURES

- High performance nitrogen-doped GaAsP on GaP
- Large, easy to read, digits
- Common anode or common cathode models
- Fast switching—excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability—long operation life
- Rugged plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for luminous intensity (see note 6)
- Wide angle viewing . . . 150°
- Low forward voltage
- Two-digit package simplifies alignment & assembly

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point-of-sale equipment
- Digital clocks
- TV and radios

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN-OUT SPECIFICATION
MAN6610	Orange	2 Digit; Common Anode; Rt. Hand Decimal	A	A
MAN6630	Orange	1½ Digit; Common Anode; Overflow ±1.8. Rt. Hand Decimal	B	B
MAN6640	Orange	2 Digit; Common Cathode; Rt. Hand Decimal	A	C
MAN6650	Orange	1½ Digit; Common Cathode; Overflow ±1.8. Rt. Hand Decimal	B	D
MAN6660	Orange	Single Digit; Common Anode; Rt. Hand Decimal	C	E
MAN6680	Orange	Single Digit; Common Cathode; Rt. Hand Decimal	C	F

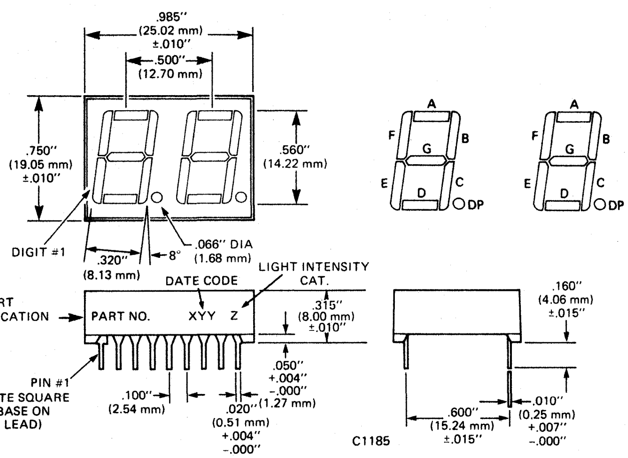
FILTER RECOMMENDATIONS

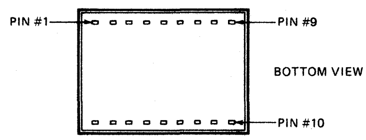
For optimum on and off contrast, one of the following filters or equivalents should be used over the display:

MAN6600 Series	Panelgraphic Scarlet 65 Homalite 100-1670

PACKAGE DIMENSIONS

A





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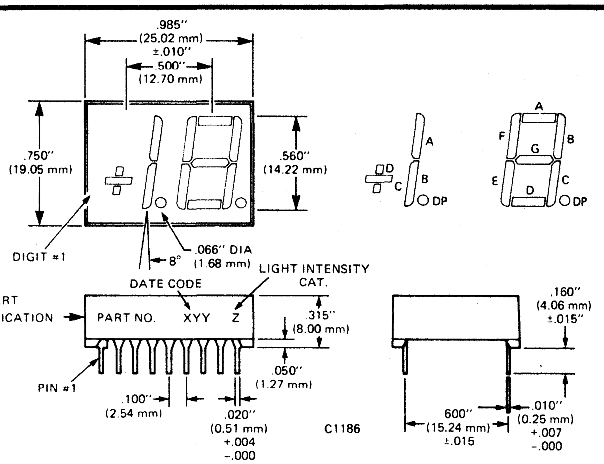
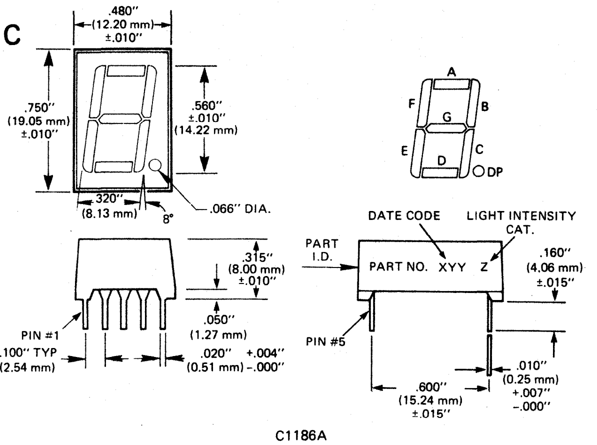
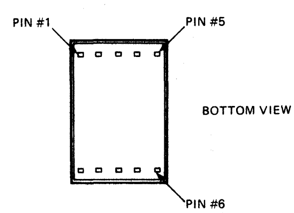


C





NOTE: When placing double digits and single digits together on a board, allowance should be made for .150" spacing between the end leads of the double digit and the end leads of the single digit.

PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS					
	A MAN6610	B MAN6630	C MAN6640	D MAN6650	E MAN6660	F MAN6680
1	E cathode (No. 1)	C cathode (No. 1)	E anode (No. 1)	C anode (No. 1)	E cathode	E anode
2	D cathode (No. 1)	D cathode (No. 1)	D anode (No. 1)	D anode (No. 1)	D cathode	D anode
3	C cathode (No. 1)	B cathode (No. 1)	C anode (No. 1)	B anode (No. 1)	Common anode	Common cathode
4	DP cathode (No. 1)	DP cathode (No. 1)	DP anode (No. 1)	DP anode (No. 1)	C cathode	C anode
5	E cathode (No. 2)	E cathode (No. 2)	E anode (No. 2)	E anode (No. 2)	DP cathode	DP anode
6	D cathode (No. 2)	D cathode (No. 2)	D anode (No. 2)	D anode (No. 2)	B cathode	B anode
7	G cathode (No. 2)	G cathode (No. 2)	G anode (No. 2)	G anode (No. 2)	A cathode	A anode
8	C cathode (No. 2)	C cathode (No. 2)	C anode (No. 2)	C anode (No. 2)	Common anode	Common cathode
9	DP cathode (No. 2)	DP cathode (No. 2)	DP anode (No. 2)	DP anode (No. 2)	F cathode	F anode
10	B cathode (No. 2)	B cathode (No. 2)	B anode (No. 2)	B anode (No. 2)	G cathode	G anode
11	A cathode (No. 2)	A cathode (No. 2)	A anode (No. 2)	A anode (No. 2)		
12	F cathode (No. 2)	F cathode (No. 2)	F anode (No. 2)	F anode (No. 2)		
13	Digit No. 2 anode	Digit No. 2 anode	Digit No. 2 cathode	Digit No. 2 cathode		
14	Digit No. 1 anode	Digit No. 1 anode	Digit No. 1 cathode	Digit No. 1 cathode		
15	B cathode (No. 1)	A cathode (No. 1)	B anode (No. 1)	A anode (No. 1)		
16	A cathode (No. 1)	No connection	A anode (No. 1)	No connection		
17	G cathode (No. 1)	No connection	G anode (No. 1)	No connection		
18	F cathode (No. 1)	No connection	F anode (No. 1)	No connection		

ABSOLUTE MAXIMUM RATINGS

	MAN6610 MAN6640	MAN6630 MAN6650	MAN6660 MAN6680
Power dissipation @ 25°C ambient . . .	1200 mW	1050 mW	600 mW
Derate linearly from 50°C.	−17.1 mW/°C	−15.0 mW/°C	−8.6 mW/°C
Storage and operating temperature . . .	−40°C to +85°C	−40°C to +85°C	−40°C to +85°C
Continuous forward current			
Total.	480 mA	420 mA	240 mA
Per segment	30 mA	30 mA	30 mA
Decimal point.	30 mA	30 mA	30 mA
Reverse voltage			
Per segment	6.0 V	6.0 V	6.0 V
Decimal point.	6.0 V	6.0 V	6.0 V
Solder time @ 260°C (Note 4 and 5)	5 sec.	5 sec.	5 sec.

ELECTRICAL-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity, Digit Average					
(see Note 1)	510			μcd	I_F = 10 mA
Decimal point (see Note 5)	200			μcd	I_F = 10 mA
Segment C or D of "+" (6630/6650)	200			μcd	I_F = 10 mA
Peak emission wavelength		630			
Spectral line half width		40			
Forward voltage					
Segment			2.5	V	I_F = 20 mA
Decimal point			2.5	V	I_F = 20 mA
Dynamic resistance					
Segment		26		Ω	I_F = 20 mA
Decimal point		26		Ω	I_F = 20 mA
Capacitance					
Segment		35		pF	V = 0
Decimal point		35		pF	V = 0
Reverse current					
Segment			100	μA	V_R = 3.0 V
Decimal point			100	μA	V_R = 3.0 V
Ratio I_L			2:1	–	I_F = 10 mA

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Θ_{JA} . . . . 160°C/W
Wavelength temperature coefficient (case temp.) . . . . 1.0 Å/C
Forward voltage temperature coefficient . . . . −2.0 mV/°C

NOTES

1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *The curve in Fig. 3 is normalized to the brightness at 25°C to indicate the relative efficiency over the operating temperature range.*
3. *Leads immersed to 1/16." from the body of the device. Maximum unit surface temperature is 140°C.*
4. *For flux removal, use Freon TF, Freon TE, Isoproponal, or water up to their boiling points.*
5. *Intensity adjusted for smaller areas of the "+" and decimal points.*
6. *All displays are categorized for luminous intensity. The intensity category is marked on each part as a suffix letter to the part number.*

TYPICAL CURVES

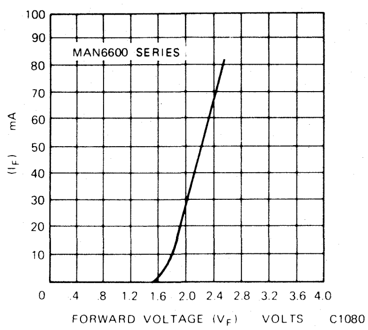


Fig. 1. Forward Current vs. Forward Voltage

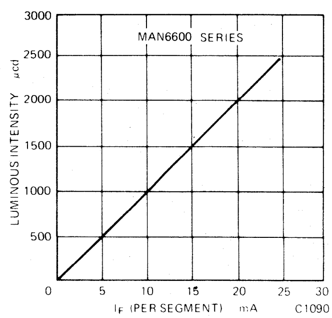


Fig. 2. Luminous Intensity vs. Forward Current

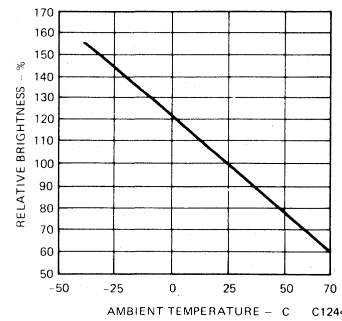


Fig. 3. Luminous Intensity vs. Temperature (see Note 2)

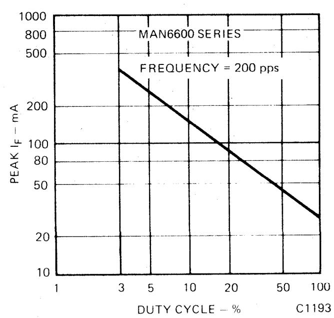


Fig. 4. Max Peak Current vs. Duty Cycle

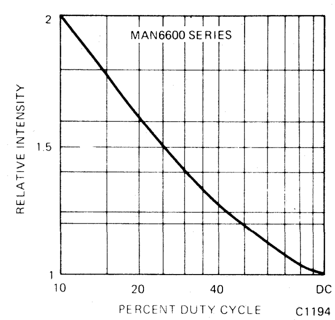
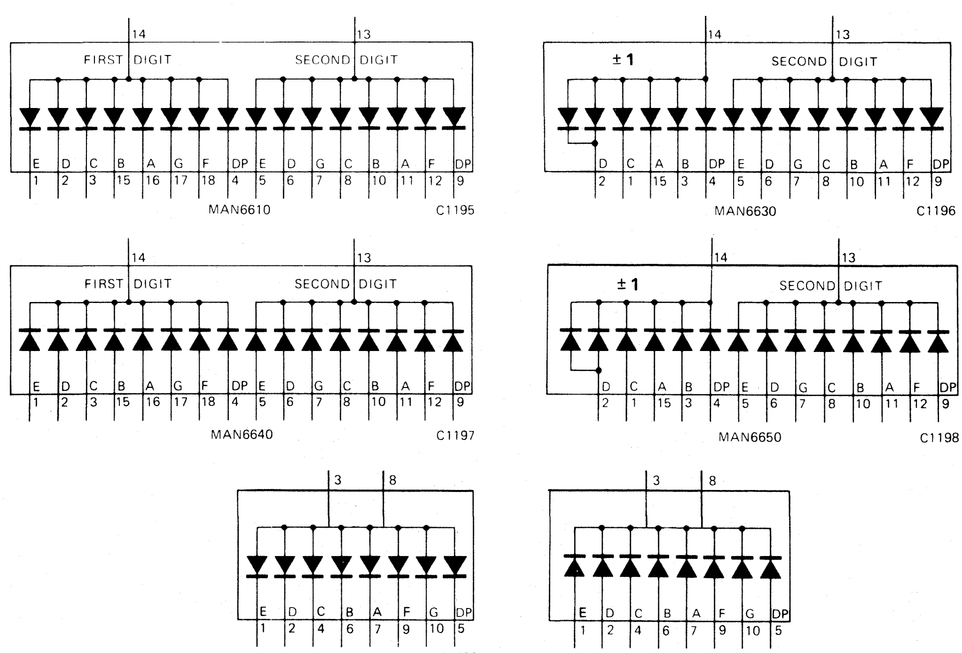


Fig. 5. Luminous Intensity vs. Duty Cycle

INTERNAL CONNECTIONS



GENERAL INSTRUMENT
Optoelectronics

MAN6700 SERIES

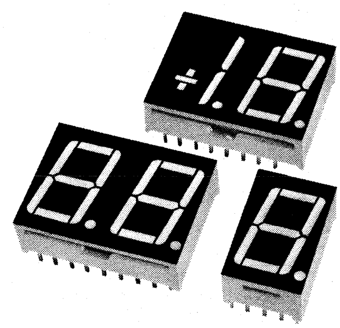
0.560" RED
HIGH PERFORMANCE DISPLAY

FEATURES

- High performance GaAsP
- Large, easy to read digits
- Common anode or common cathode models
- Also available in orange (MAN6600 Series)
- Fast switching—excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability—long operation life
- Rugged plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for luminous intensity (see note 7)
- Wide angle viewing . . . 150°
- Standard double-dip lead configuration
- Low forward voltage
- Two-digit package simplifies alignment & assembly

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point-of-sale equipment
- Digital clocks
- TV and radios



DESCRIPTION

The MAN6700 Series is a family of large digits which includes double and single digits. The series features the sculptured font which minimizes "gappiness" at the segment intersections. Available models include two-digit, one and one-half digits with polarity sign, and single digits. All models have right hand decimal point and are available in common anode or common cathode configuration.

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN-OUT SPECIFICATION
MAN6710	Red	2 Digit; Common Anode; Rt. Hand Decimal	A	A
MAN6730	Red	1½ Digit; Common Anode; Overflow ±1.8 Rt. Hand Decimal	B	B
MAN6740	Red	2 Digit; Common Cathode; Rt. Hand Decimal	A	C
MAN6750	Red	1½ Digit; Common Cathode; Overflow ±1.8 Rt. Hand Decimal	B	D
MAN6760	Red	Single Digit; Common Anode; Rt. Hand Decimal	C	E
MAN6780	Red	Single Digit; Common Cathode; Rt. Hand Decimal	C	F

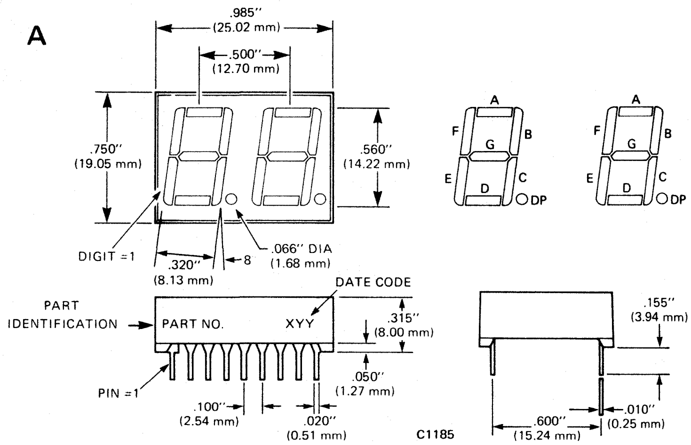
FILTER RECOMMENDATIONS

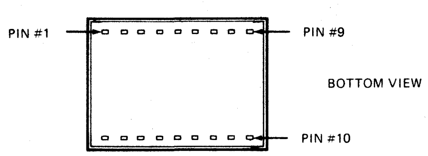
For optimum on and off contrast, one of the following filters or equivalents should be used over the display:

MAN6700 Series	Panelgraphic Red 60 Homalite 100 - 1605

PACKAGE DIMENSIONS

A





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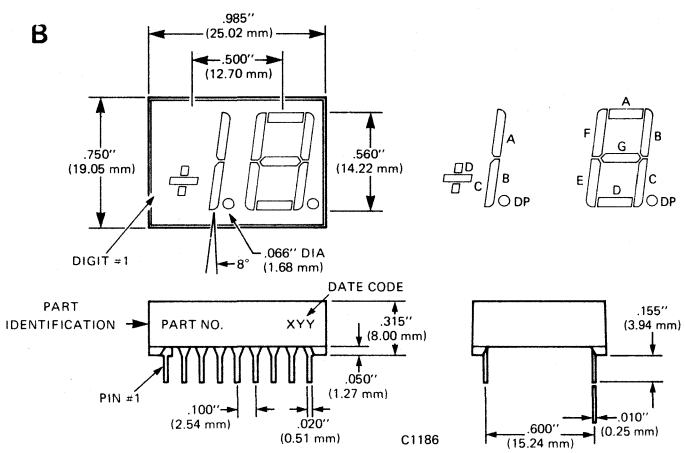
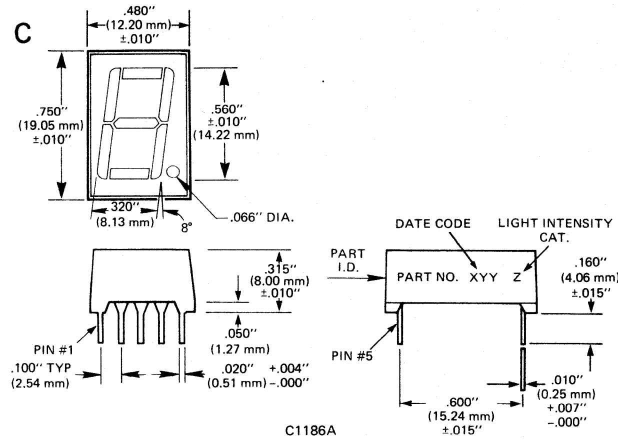
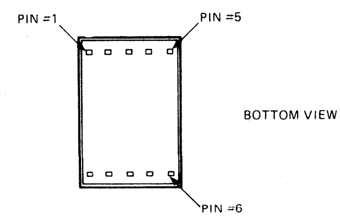


C





Note: When placing double digits and single digits together on a board, allowance should be made for .150" spacing between the end leads of the double digit and the end leads of the single digit.

PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS					
	A MAN6710	B MAN6730	C MAN6740	D MAN6750	E MAN6760	F MAN6780
1	E cathode (No. 1)	C cathode (No. 1)	E anode (No. 1)	C anode (No. 1)	E cathode	E anode
2	D cathode (No. 1)	D cathode (No. 1)	D anode (No. 1)	D anode (No. 1)	D cathode	D anode
3	C cathode (No. 1)	B cathode (No. 1)	C anode (No. 1)	B anode (No. 1)	Common anode	Common cathode
4	DP cathode (No. 1)	DP cathode (No. 1)	DP anode (No. 1)	DP anode (No. 1)	C cathode	C anode
5	E cathode (No. 2)	E cathode (No. 2)	E anode (No. 2)	E anode (No. 2)	DP cathode	DP anode
6	D cathode (No. 2)	D cathode (No. 2)	D anode (No. 2)	D anode (No. 2)	B cathode	B anode
7	G cathode (No. 2)	G cathode (No. 2)	G anode (No. 2)	G anode (No. 2)	A cathode	A anode
8	C cathode (No. 2)	C cathode (No. 2)	C anode (No. 2)	C anode (No. 2)	Common anode	Common cathode
9	DP cathode (No. 2)	DP cathode (No. 2)	DP anode (No. 2)	DP anode (No. 2)	F cathode	F anode
10	B cathode (No. 2)	B cathode (No. 2)	B anode (No. 2)	B anode (No. 2)	G cathode	G anode
11	A cathode (No. 2)	A cathode (No. 2)	A anode (No. 2)	A anode (No. 2)		
12	F cathode (No. 2)	F cathode (No. 2)	F anode (No. 2)	F anode (No. 2)		
13	Digit No. 2 anode	Digit No. 2 anode	Digit No. 2 cathode	Digit No. 2 cathode		
14	Digit No. 1 anode	Digit No. 1 anode	Digit No. 1 cathode	Digit No. 1 cathode		
15	B cathode (No. 1)	A cathode (No. 1)	B anode (No. 1)	A anode (No. 1)		
16	A cathode (No. 1)	No connection	A anode (No. 1)	No connection		
17	G cathode (No. 1)	No connection	G anode (No. 1)	No connection		
18	F cathode (No. 1)	No connection	F anode (No. 1)	No connection		

ABSOLUTE MAXIMUM RATINGS

MAN6700	MAN6710 MAN6740	MAN6730 MAN6750	MAN6760 MAN6780
Power dissipation @ 25°C ambient . . .	960 mW	840 mW	480 mW
Derate linearly from 50°C.	−13.7 mW/°C	−12.0 mW/°C	−6.9 mW/°C
Storage and operating temperature . . .	−40°C to +85°C	−40°C to +85°C	−40°C to +85°C
Continuous forward current			
Total.	480 mA	420 mA	240 mA
Per segment	30 mA	30 mA	30 mA
Decimal point.	30 mA	30 mA	30 mA
Reverse voltage			
Per segment	6.0 V	6.0 V	6.0 V
Decimal point.	6.0 V	6.0 V	6.0 V
Solder time @ 260°C (Note 4 and 5)	5 sec.	5 sec.	5 sec.

ELECTRICAL-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous intensity, Digit Average (see Note 1)	125			μcd	I_F = 10 mA
Decimal point (see Note 5)	55			μcd	I_F = 10 mA
Segment C or D of "+" (6730/6750) (note 5)	35			μcd	I_F = 10 mA
Peak emission wavelength		650		nm	
Spectral line half width		20		nm	
Forward voltage					
Segment			2.0	V	I_F = 20 mA
Decimal point			2.0	V	I_F = 20 mA
Dynamic resistance					
Segment		2		Ω	I_{PK} = 100 mA
Decimal point		2		Ω	I_{PK} = 100 mA
Capacitance					
Segment		35		pF	V = 0
Decimal point		35		pF	V = 0
Reverse current					
Segment			100	μA	V_R = 5.0 V
Decimal point			100	μA	V_R = 5.0 V
Segment C or D of "+" (6730/6750)			100	μA	V_R = 5.0 V

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Θ_{JA} . . . . 160°C/W
Wavelength temperature coefficient (case temp.) . . . . 3.0 Å/°C
Forward voltage temperature coefficient . . . . −2.0 mV/°C

NOTES

1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing the total number of segments as measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *The curve in Fig. 3 is normalized to the brightness at 25°C to indicate the relative efficiency over the operating temperature range.*
3. *Leads immersed to 1/16" from the body of the device. Maximum unit surface temperature is 140°C.*
4. *For flux removal, use Freon TF, Freon TE, Isoproponal, or water up to their boiling points.*
5. *Intensity adjusted for smaller areas of the "+" and decimal points.*
6. *Pins 3 and 8 on MAN6760 and MAN6780 are redundant anodes or cathodes.*
7. *All displays are categorized for luminous intensity. The intensity category is marked on each part as a suffix letter to the part number.*

TYPICAL CURVES

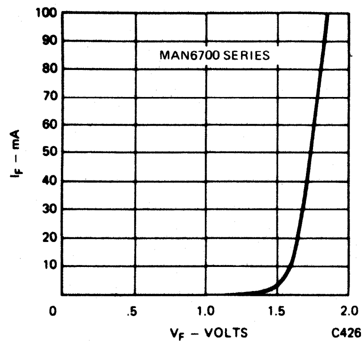


Fig. 1. Forward Current vs. Forward Voltage

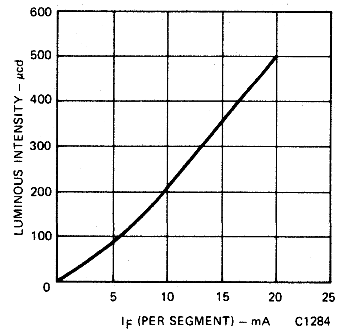


Fig. 2. Luminous Intensity vs. Forward Current

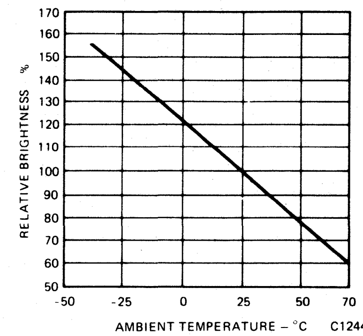


Fig. 3. Luminous Intensity vs. Temperature (See Note 2)

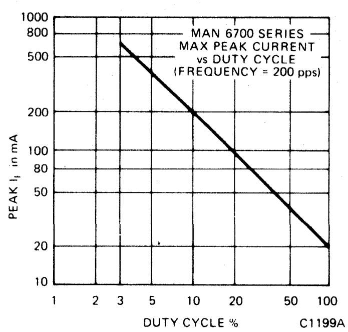


Fig. 4. Max Peak Current vs. Duty Cycle

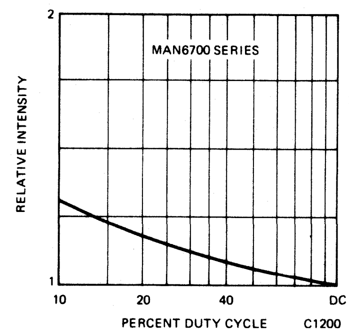
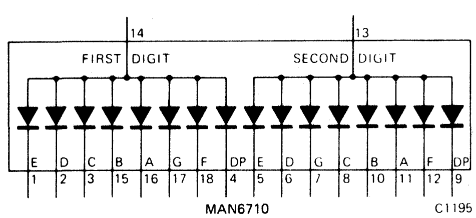
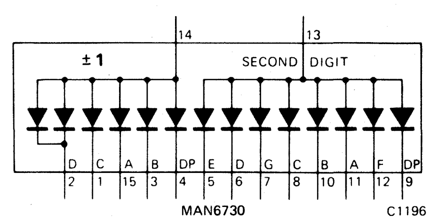
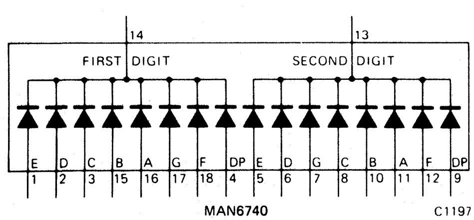


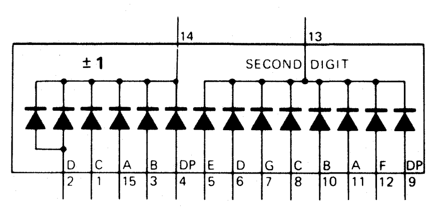
Fig. 5. Luminous Intensity vs. Duty Cycle

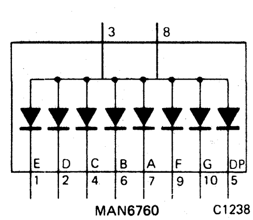
INTERNAL CONNECTIONS

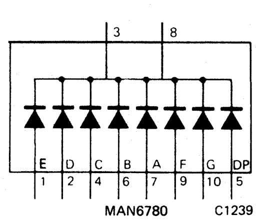












GENERAL INSTRUMENT
Optoelectronics

MAN8600 SERIES

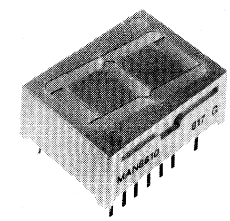
0.800" HIGH EFFICIENCY RED (ORANGE) HIGH PERFORMANCE DISPLAY

FEATURES

- High performance nitrogen-doped GaAsP on GaP
- Large, easy to read, digits
- Common anode or common cathode models
- Fast switching—excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability—long operation life
- Rugged plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for luminous intensity (see note 6)
- Wide angle viewing . . . 150°
- Low forward voltage
- Gray face for use in high ambient light conditions

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point-of-sale equipment
- Digital clocks
- TV and radios



DESCRIPTION

The MAN8600 Series is a family of large digits 0.8 inches in height. This series combines high brightness large size and good aesthetics and is designed to be used where accurate readable displays need to be viewed over a distance. All models use right hand decimal points.

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN-OUT SPECIFICATION
MAN8610	Hi-Efficiency Red (Orange)	Common Anode, Right Hand Decimal Pt.	B	A
MAN8630	Hi-Efficiency Red (Orange)	Common Anode, ± 1 Overflow, Right Hand Decimal Pt.	A	B
MAN8640	Hi-Efficiency Red (Orange)	Common Cathode, Right Hand Decimal Pt.	B	C
MAN8650	Hi-Efficiency Red (Orange)	Common Cathode, ± 1 Overflow, Right Hand Decimal Pt.	A	D

FILTER RECOMMENDATIONS

For optimum on and off contrast, one of the following filters should be used over the display:

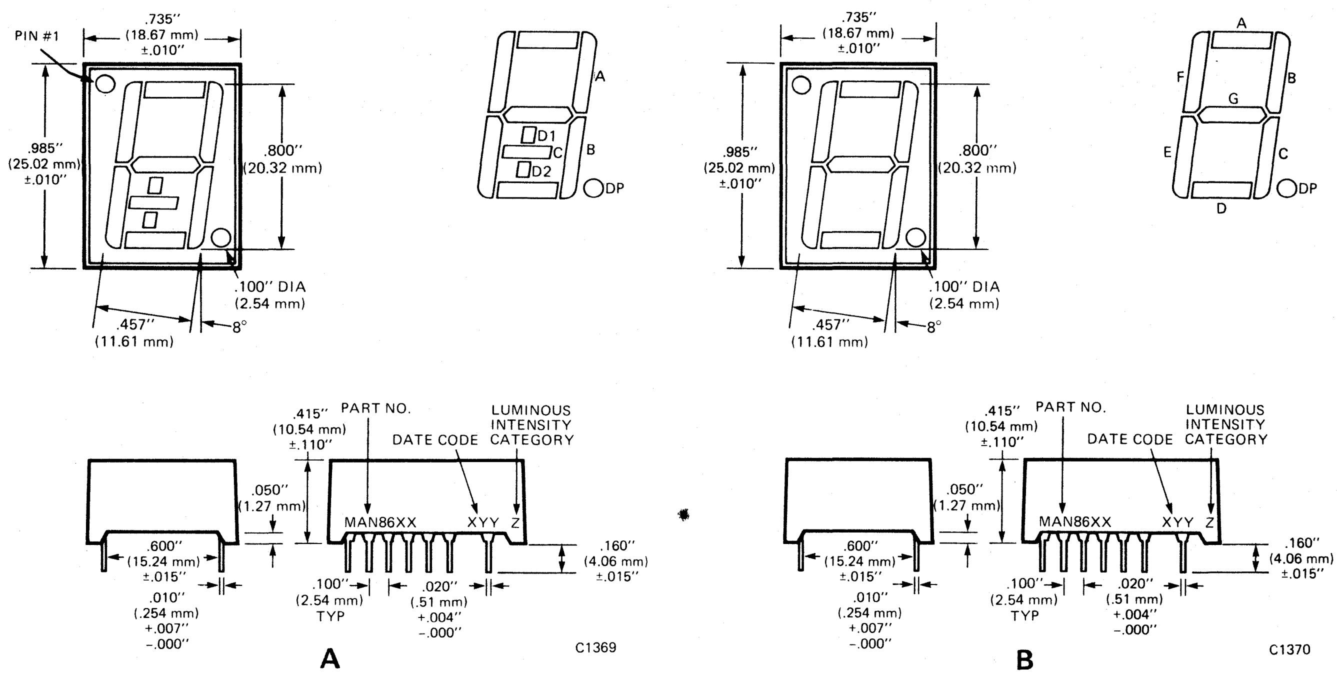
PANELGRAPHIC SCARLET 65
HOMALITE 100-1670

In situations of high ambient light, contrast with the gray face can be enhanced by using a neutral density filter. The following or an equivalent can be used:

PANELGRAPHIC GREY NO. 10

MAN8600 SERIES

PACKAGE DIMENSIONS



PIN CONNECTIONS

	ELECTRICAL CONNECTIONS			
PIN #	A MAN8610	B MAN8630	C MAN8640	D MAN8650
1	No Connection	No Connection	No Connection	No Connection
2	A Cathode	No Connection	A Anode	No Connection
3	F Cathode	No Connection	F Anode	No Connection
4	Common Anode	Common Anode	Common Cathode	Common Cathode
5	E Cathode	C Cathode	E Anode	C Anode
6	–	–	–	–
7	E Cathode	C Cathode	E Anode	C Anode
8	–	–	–	–
9	D Cathode	D2 Cathode	Common Cathode	Common Cathode
10	DP Cathode	DP Cathode	DP Anode	DP Anode
11	D Cathode	D1 Cathode	D Anode	D2 Anode
12	Common Anode	Common Anode	Common Cathode	Common Cathode
13	C Cathode	B Cathode	C Anode	B Anode
14	G Cathode	D2 Cathode	G Anode	D1 Anode
15	B Cathode	A Cathode	B Anode	A Anode
16	–	–	–	–
17	Common Anode	Common Anode	Common Cathode	Common Cathode
18	–	–	–	–

TYPICAL CURVES

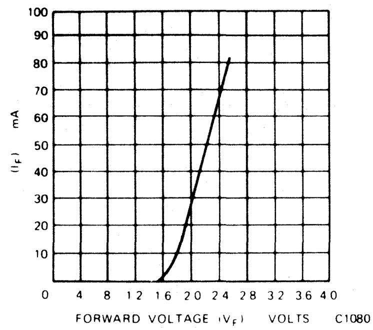


Fig. 1. Forward Current vs. Forward Voltage

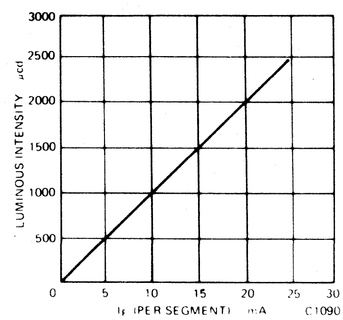


Fig. 2. Luminous Intensity vs. Forward Current

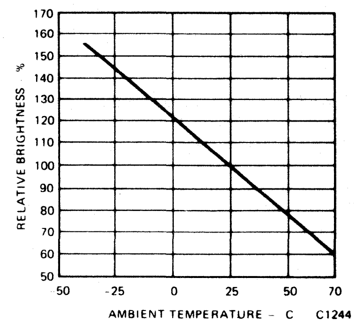


Fig. 3. Luminous Intensity vs. Temperature (see Note 2)

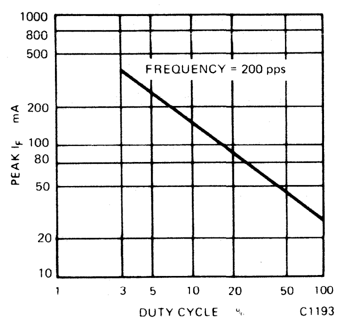


Fig. 4. Max Peak Current vs. Duty Cycle

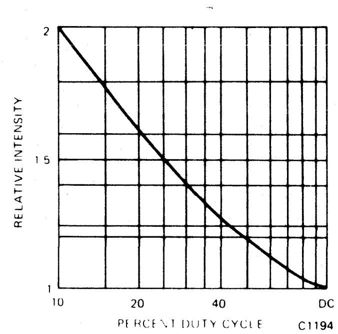


Fig. 5. Luminous Intensity vs. Duty Cycle

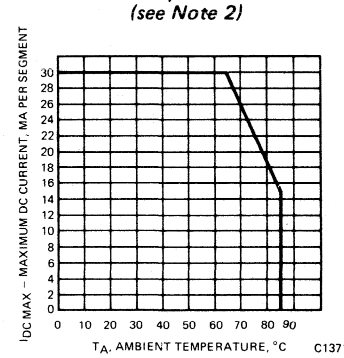
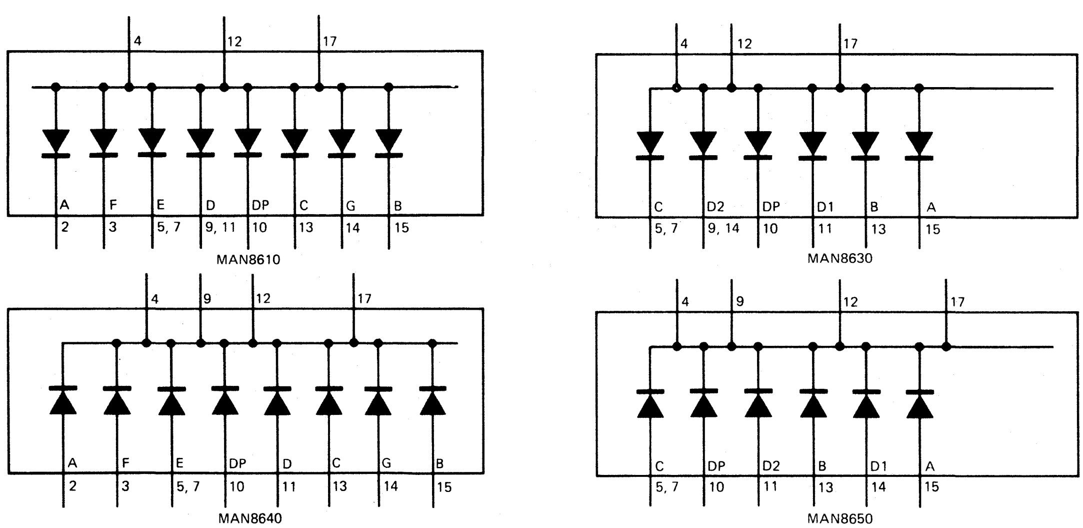


Fig. 6. Maximum DC Current vs. Temperature

INTERNAL CONNECTIONS



ABSOLUTE MAXIMUM RATINGS

MAN8600	MAN8610 MAN8640	MAN8630 MAN8650
Power dissipation @ 25°C ambient	600 mW	450 mW
Derate linearly from 50°C	−8.6 mW/°C	−6.4 mW/°C
Storage and operating temperature	−40°C to +85°C	−40°C to +85°C
Continuous forward current		
Total	240 mA	180 mA
Per segment	30 mA	30 mA
Decimal point	30 mA	30 mA
Reverse voltage		
Per segment	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V
Solder time @ 260°C (Note 4 and 5)	5 sec.	5 sec.

ELECTRICAL-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity, Digit Average					
(see Note 1)	600	1000		μcd	I_F = 10 mA
Decimal point (see Note 5)	240	400		μcd	I_F = 10 mA
Segment C or D of "+" (8630/8650)	240	400		μcd	I_F = 10 mA
Peak emission wavelength		630			
Spectral line half width		40			
Forward voltage					
Segment			2.5	V	I_F = 20 mA
Decimal point			2.5	V	I_F = 20 mA
Dynamic resistance					
Segment		26		Ω	I_F = 20 mA
Decimal point		26		Ω	I_F = 20 mA
Capacitance					
Segment		35		pF	V = 0
Decimal point		35		pF	V = 0
Reverse current					
Segment			100	μA	V_R = 3.0 V
Decimal point			100	μA	V_R = 3.0 V
Ratio I_L			2:1	–	I_F = 10 mA

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Θ_{JA}	160°C/W
Wavelength temperature coefficient (case temp.)	1.0 Å/C
Forward voltage temperature coefficient	−2.0 mV/°C

NOTES

1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments as measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *The curve in Fig. 3 is normalized to the brightness at 25°C to indicate the relative efficiency over the operating temperature range.*
3. *Leads immersed to 1/16" from the body of the device. Maximum unit surface temperature is 140°C.*
4. *For flux removal, use Freon TF, Freon TE, Isoproponal, or water up to their boiling points.*
5. *Intensity adjusted for smaller areas of the "+" and decimal points.*
6. *All displays are categorized for luminous intensity. The intensity category is marked as a suffix letter to the part number.*

4 LED Chips

GENERAL INSTRUMENT
Optoelectronics

MMH SERIES
RED MONOLITHIC LED DISPLAYS

FEATURES/DESCRIPTION

The MMH Series provides a selection of 7 segment, 9 segment, and 16 segment alpha-numeric fonts, with digit slants from 0 degrees to 12 degrees, as well as a bar chip and dot chip. These products offer high performance gallium arsenide phosphide red monolithic numeric, bar, and dot LED's and are particularly suited for watch, clock, toy and game displays. They are specifically designed for hybrid assembly operations with automatic die attach and wire bonding operations in mind.

Monolithic numeric products are available in probed wafer form or mounted on expandable vinyl membranes for ease of handling and maintenance of dice adjacency, giving optimum digit-to-digit luminous intensity matching.

ELECTRICAL/OPTICAL CHARACTERISTICS

DESCRIPTION	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST COND	NOTES
Forward Voltage/Seg.	V_F	1.55	–	1.80	Volts	I_F=10mADC	A
Reverse Voltage/Seg.	V_R	5.0	–	–	Volts	I_R=100μADC	A
Luminous Intensity/Seg.	L.I.	67	–	–	μcd	I_F=5mADC	A,B,F
Luminous Intensity/Seg.	L.I.	160*	–	–	μcd	I_F=10mADC	A,B,F
Luminous Intensity Ratio (Segment to Segment)	R_{LI}–1	–	–	1.5	–	I_F=10mADC	A,B,C,F
Luminous Intensity Ratio (Adjacent Dice)	R_{LI}–2	–	–	1.5	–	I_F=10mADC	A,B,D,F,G
Luminous Intensity Ratio (Five Adjacent Dice)	R_{LI}–3	–	–	1.8	–	I_F=10mADC	A,B,E,F,G
Peak Wave Length	λp	–	655	–	ηm	I_F=10mADC	

*MMH322 = 250 μcd min.

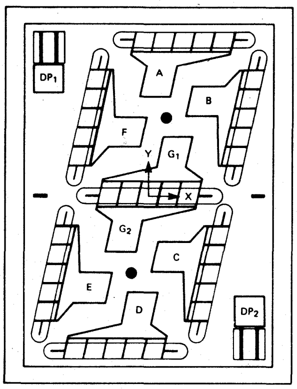
MECHANICAL CHARACTERISTICS

DIE TYPE	FONT	DIE SIZE (INCHES)	CHARACTER SIZE (INCHES)	CHARACTER SLANT	EMITTER WIDTH (IN)	NOMINAL BONDING PAD SIZE (IN)
MMH62M,W	7 seg.	0.048x0.036	0.042x0.022	12°	0.002	0.004x0.004
MMH75M	9 seg.	0.106x0.066	0.100x0.060	0°	0.005	Universal
MMH78M	9 seg.	0.082x0.052	0.075x0.045	0°	0.0055	Universal
MMH83M	9 seg.	0.106x0.066	0.100x0.060	7°	0.005	Universal
MMH66M	16 seg.	0.107x0.090	0.970x0.073	5°	0.0035	0.0065x0.0070
MMH80W	1 seg.	0.040x0.010	0.005x0.035	0°	0.005	0.004x0.0040
MMH321/2W,V	Dot	0.014x0.014	0.010x0.010	–	–	0.003 (DIA)

NOTE: See packaging note 3.

	MIN.	TYP.	MAX.	UNITS	NOTES
Cathode Metallization Au Alloy/Au – Thickness	3000	–	–	Å	
Anode Metallization Aluminum – Thickness	8000	–	–	Å	
Anode Bond Strength	3	–	–	Grams	H
Die Thickness – (Monolithic Digit)	–	0.007	–	Inches	
(Colon Dot)	–	0.0055	–	Inches	

MECHANICAL CRITERIA – (Origin of X-Y coordinate system is located at the geometric center of the chip with the coordinate axes parallel to the edges of the chip.)



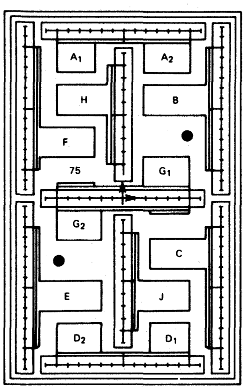
C1360

MMH62

DIE SIZE	0.048″ X 0.036″
CHARACTER SIZE	0.040″, Seg. A-Seg. D, ℄-℄ 0.01956″, Seg. B-Seg. F, ℄-℄
CHARACTER SLANT	12°
EMITTER WIDTH	0.002″
NOMINAL BONDING PAD SIZE	0.004″ X 0.004″

BONDING PAD LOCATIONS

X_A = 0.001″	Y_A = 0.0145″
X_B = 0.007″	Y_B = 0.012″
X_C = 0.0027″	Y_C = −0.008″
X_D = −0.001″	Y_D = −0.0145″
X_E = −0.007″	Y_E = −0.012″
X_F = −0.0027″	Y_F = 0.008″
X_{G_1} = 0.0032″	Y_{G_1} = 0.0055″
X_{G_2} = −0.0032″	Y_{G_2} = −0.0055″
X_{DP_1} = −0.0128″	Y_{DP_1} = 0.015″
X_{DP_2} = 0.0128″	Y_{DP_2} = −0.015″



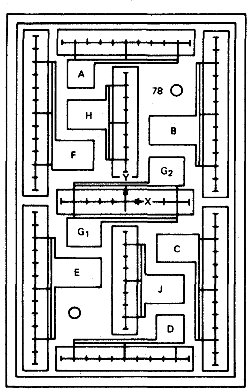
C1363

MMH75

DIE SIZE	0.106″ X 0.066″
CHARACTER SIZE	0.095″, Seg. A-Seg. D, ℄-℄ 0.055″, Seg. F-Seg. B, ℄-℄
CHARACTER SLANT	0°
EMITTER WIDTH	0.005″
EMITTER LENGTH	0.049″, Seg. B, C, E, F 0.046″, Seg. A, D, G 0.038″, Seg. H, J
NOMINAL BONDING PAD SIZE	Universal Chip

BONDING PAD LOCATIONS

X_{A_1} = −0.0132″ ± 0.003″	X_{G_1} = −0.0122″ ± 0.004″	Y_{D_1} = −0.0392″ ± 0.001″
X_{A_2} = 0.0122″ ± 0.004″	X_{G_2} = 0.0122″ ± 0.004″	Y_{D_2} = −0.0392″ ± 0.001″
X_B = 0.0143″ ± 0.006″	X_H = −0.0117″ ± 0.005″	Y_E = −0.0278″ ± 0.002″
X_C = 0.0153″ ± 0.005″	X_J = 0.0117″ ± 0.005″	Y_F = 0.0158″ ± 0.002″
X_{D_1} = −0.0122″ ± 0.003″	Y_{A_1} = 0.0392″ ± 0.001″	Y_{G_1} = −0.0084″ ± 0.001″
X_{D_2} = 0.0132″ ± 0.003″	Y_{A_2} = 0.0392″ ± 0.001″	Y_{G_2} = 0.0084″ ± 0.001″
X_E = −0.0143″ ± 0.006″	Y_B = 0.0278″ ± 0.002″	Y_H = 0.0278″ ± 0.002″
X_F = −0.0153″ ± 0.005″	Y_C = −0.0158″ ± 0.002″	Y_J = −0.0278″ ± 0.002″



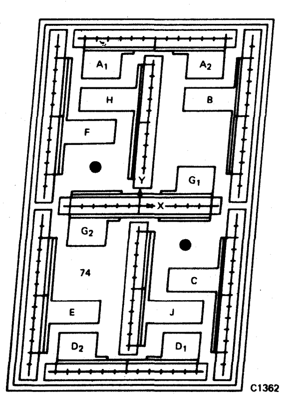
C1364

MMH78

DIE SIZE	0.082″ X 0.052″
CHARACTER SIZE	0.0695″, Seg. A-Seg. D, ℄-℄ 0.0395″, Seg. F-Seg. B, ℄-℄
CHARACTER SLANT	0°
EMITTER WIDTH	0.0055″
EMITTER LENGTH	0.0365″, Seg. B, C, E, F 0.030″, Seg. A, D, G 0.024″, Seg. H, J
NOMINAL BONDING PAD SIZE	Universal Chip

BONDING PAD LOCATIONS

X_A = −0.0099″ ± 0.001″	X_{G_2} = 0.009″ ± 0.002″	Y_D = −0.0275″ ± 0.001″
X_B = 0.0102″ ± 0.003″	X_H = −0.0087″ ± 0.002″	Y_E = −0.0157″ ± 0.001″
X_C = 0.011″ ± 0.002″	X_J = 0.0087″ ± 0.002″	Y_F = 0.0101″ ± 0.001″
X_D = 0.0099″ ± 0.001″	Y_A = 0.0275″ ± 0.001″	Y_{G_1} = −0.0725″ ± 0.001″
X_E = −0.0102″ ± 0.003″	Y_B = 0.0157″ ± 0.001″	Y_{G_2} = 0.0725″ ± 0.001″
X_F = −0.011″ ± 0.002″	Y_C = −0.0101″ ± 0.001″	Y_H = 0.019″ ± 0.001″
X_{G_1} = −0.009″ ± 0.002″		Y_J = −0.019″ ± 0.001″



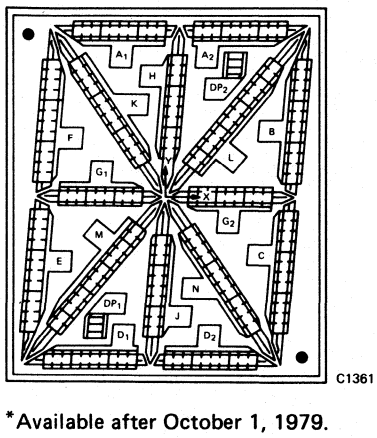
C1362

MMH83

DIE SIZE	0.106″ X 0.066″
CHARACTER SIZE	0.095″, Seg. A-Seg. D, ℄-℄ 0.0548″, Seg. F-Seg. B, ℄-℄
CHARACTER SLANT	7°
EMITTER WIDTH	0.005″
EMITTER LENGTH	0.049″, Seg. B, C, E, F 0.046″, Seg. A, D, G 0.038″, Seg. H, J
NOMINAL BONDING PAD SIZE	

BONDING PAD LOCATIONS

X_{A_1} = −0.0111″ ± 0.003″	X_{G_1} = −0.0153″ ± 0.003″	Y_{D_1} = −0.0395″ ± 0.001″
X_{A_2} = 0.0181″ ± 0.003″	X_{G_2} = 0.0153″ ± 0.003″	Y_{D_2} = −0.0395″ ± 0.001″
X_B = 0.0187″ ± 0.004″	X_H = −0.0097″ ± 0.005″	Y_E = −0.0303″ ± 0.001″
X_C = 0.0142″ ± 0.004″	X_J = 0.0097″ ± 0.005″	Y_F = 0.0211″ ± 0.001″
X_{D_1} = −0.0181″ ± 0.003″	Y_{A_1} = 0.0395″ ± 0.001″	Y_{G_1} = −0.0080″ ± 0.001″
X_{D_2} = 0.0111″ ± 0.003″	Y_{A_2} = 0.0395″ ± 0.001″	Y_{G_2} = 0.0080″ ± 0.001″
X_E = −0.0187″ ± 0.004″	Y_B = 0.0303″ ± 0.001″	Y_H = 0.0303″ ± 0.001″
X_F = −0.0142″ ± 0.004″	Y_C = −0.0211″ ± 0.001″	Y_J = −0.0303″ ± 0.001″



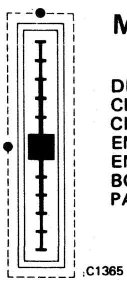
*Available after October 1, 1979.

MMH84* (Preliminary)

DIE SIZE	0.085" X 0.072"
CHARACTER SIZE	0.074", Seg. A-Seg. D, ℄-℄.
	0.0546", Seg. F-Seg. B, ℄-℄.
CHARACTER SLANT	5°
EMITTER WIDTH	0.003"
NOMINAL BONDING PAD SIZE	.0055" X .0055"

BONDING PAD LOCATIONS:

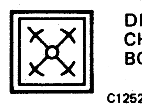
X_{A1} =	−0.0109	X_{G2} =	0.0139	Y_{A1} =	0.305	Y_{G2} =	0.0065
X_{A2} =	0.009	X_{H} =	0.0027	Y_{A2} =	0.0305	Y_{H} =	0.0284
X_{B} =	0.0222	X_{J} =	0.0027	Y_{B} =	0.0127	Y_{J} =	0.0284
X_{C} =	0.0194	X_{K} =	0.0067	Y_{C} =	0.0152	Y_{K} =	0.021
X_{D1} =	0.009	X_{L} =	0.0144	Y_{D1} =	0.0305	Y_{L} =	0.0072
X_{D2} =	0.0109	X_{M} =	0.0144	Y_{D2} =	0.305	Y_{M} =	0.0072
X_{E} =	0.0222	X_{N} =	0.0067	Y_{E} =	0.0127	Y_{N} =	0.021
X_{F} =	0.0194	X_{DP1} =	0.0089	Y_{F} =	0.0152	Y_{DP1} =	0.0219
X_{G1} =	0.0139	X_{DP2} =	0.0089	Y_{G1} =	0.0065	Y_{DP2} =	0.0219



MMH80

DIE SIZE	0.040" X 0.010"
CHARACTER SIZE	0.005" X 0.035"
CHARACTER SLANT	0°
EMITTER WIDTH	0.005"
EMITTER LENGTH	0.035"
BONDING PAD SIZE	0.004" X 0.004"
PAD LOCATION	0.000" X 0.000"

MMH321/2



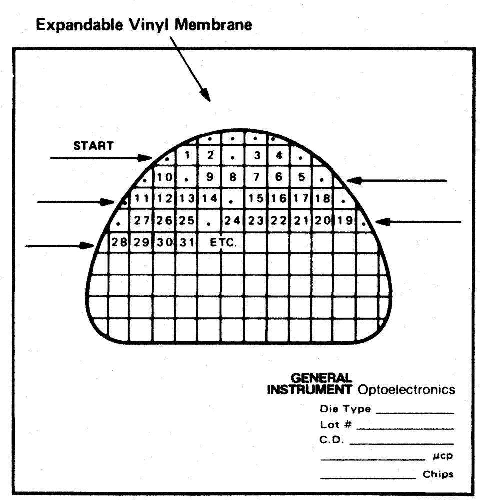
DIE SIZE	0.014" X 0.014"
CHARACTER SIZE	0.010" X 0.010"
BONDING PAD SIZE	0.003" (DIA)

VISUAL CHARACTERISTICS	LIMIT	NOTE
1. Chips	None in active area.	I, J
2. Cracks	None in active area.	K
3. Missing, extraneous, or occluded emitting area	Not detectable to the unaided eye under light-up @ I_F=10mADC.	A
4. Emitter isolation	No emitters electrically shorted.	
5. P-contact metallization defects	No defect producing visual non-uniformity in any emitting area detectable by the unaided eye under light-up @ I_F=10mADC.	A
6. Bonding pad defects	No defect prohibiting normally satisfactory wire bonding.	

NOTE: Supplemental visual characteristic drawings on request.

RECOMMENDED SEQUENCE FOR REMOVING DICE FROM EXPANDED MEMBRANE

In order to optimize digit to digit luminous intensity match, remove dice from expanded vinyl membrane in the sequence relative to wafer orientation on the membrane as shown in the drawing at right.



NOTES:

A. The device under test must be die attached and wire bonded to the display substrate of intended use or on an 8-Pin, TO-5, Au-plated, Kovar header.

B. Luminous intensity will be measured with a Photo-Research Spectra microcandela meter, Model IVD fitted with a 4° probe.

C. R_{LI}—1 is the ratio of brightest emitter divided by dimmest emitter within a die.

D. R_{LI}—2 is the ratio of brightest emitter divided by dimmest emitter between packaged horizontally adjacent dice.

E. R_{LI}—3 is the ratio of brightest emitter divided by the dimmest emitter between five packaged horizontally adjacent dice.

F. All correlation and reject verification must be done by electro-optic means such as monitoring the photo current from a silicon photodetector (C.I.E. corrected) or photomultiplier positioned such that the normal axis of the L.E.D. chip and the photodetector are coincident and that they be separated by at least two inches. The test must be conducted in a zero ambient light environment with device under test configuration as specified in Note A, above.

G. In order to optimize digit to digit luminous intensity matching die should be removed from the vinyl film as shown in figure 1.

H. The pull test shall be performed on a gold ball bond formed from 0.001 inch wire.

I. A chip is defined to be any missing material around the edges of the die when viewed from the emitter side of the die.

J. The active area consists of the areas defined by the emitters and p-contact metallization.

K. A crack is defined to be any mechanical discontinuity of the surface other than etched steps.

PACKAGING/LABELING/SHIPPING CHARACTERISTICS

1) Monolithic Numerics and Colons

Wafers are mounted on 5.75" x 5.75" expandable vinyl membranes. Each wafer is covered by a 0.001" thick mylar overlay and separated from adjacent wafers by anti-static, non-adhesive spacers. Each mounted wafer is marked with the following information:

Die Type
Lot Number
Number of Good Dice
Average Luminous Intensity
Control Date

Mounted wafers are packed in secondary cartons which ensure their integrity during shipment. Each secondary carton is marked with the following information:

Device Type/Part Number	Number of Good Dice
Lot Number	Date Code

2) Watch Set Colons

Standard packaging for discrete colons is a vial marked with the following information:

Die Type
Lot Number
Number of Good Dice
Luminous Intensity Category
Control Date

Colon dice are not visually sorted. The number of good dice supplied in a shipment corresponds to the ratio required for use with the monolithic digits. Colon dice are luminous intensity categorized for optimum match to the monolithic digits and are supplied in two standard categories to be used as follows:

3) Package Code Suffix

W = shipped in unscribed wafer form
M = scribed and mounted on expandable vinyl membrane
V = scribed and packaged in vials

GENERAL INSTRUMENT
Optoelectronics

G-32
Y-32
O-32
GREEN, YELLOW AND ORANGE LED DICE

FEATURES/DESCRIPTION

The G, Y, O-32 Series is a light emitting diode fabricated from state-of-the-art Nitrogen doped $GaAs_xP_{1-x}$ epitaxially grown on a GaP substrate. The device is a full chip emitter whose luminous performance has been optimized by using the current best epitaxial growth and die fabrication procedures currently available. The dice are shipped on expandable vinyl membranes for ease in handling and for maintenance of die adjacency which provides the user the best possible die-to-die hue and luminous intensity matching.

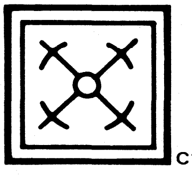
ELECTRICAL/OPTICAL CHARACTERIZATION (See Notes)

PARAMETER	PRODUCT	MIN	MAX	UNITS
Forward Voltage @ I_f = 20mA	G-32		2.6	Volts
	Y-32		2.6	
	O-32		2.5	
Reverse Voltage @ I_r = 100μA	G-32	8	–	Volts
	Y-32	8	–	
	O-32	8	–	
Luminous Intensity at I_f = 20mA (unlensed)	G-32	200	–	μcd
	Y-32	700	–	
	O-32	700	–	
Center Wavelength at I_f = 10mA	G-32	5600	5750	Angstroms
	Y-32	5750	5950	
	O-32	6250	6400	

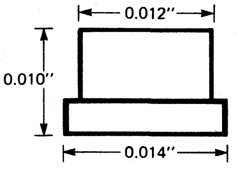
PHYSICAL CHARACTERISTICS

Viewed from the top, the nominal 32 Series die is square measuring 0.0120 inches on a side at the top and 0.0140 inches on a side at the base. The nominal thickness of the die is 0.010 inches. In practice, the die dimensions do not deviate by more than 20% from the nominal values. The bottom of each die is metallized with a gold alloy which can be attached to conventional gold or silver plated substrates or lead frames by using a conductive epoxy.

The top of each die is selectively metallized and the bonding pad material is compatible with conventional gold thermocompression and aluminum wire bonding techniques.



C1252



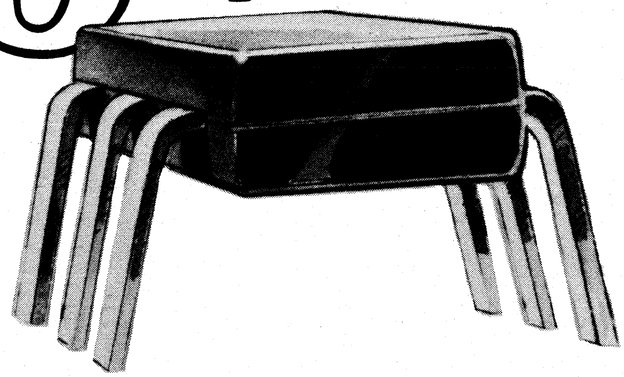
PACKAGING AND LABELING

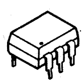
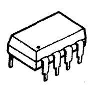
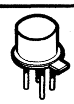
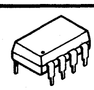
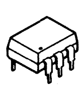
32 Series wafers are mounted on 5.75" x 5.75" expandable vinyl membranes and covered with a thin protective overlay. Each wafer is clearly labeled identifying the die type, lot number, control date, brightness minimum and the number of die which meet the specifications.

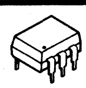
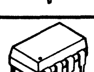
Notes:

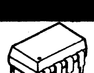
1. Electrical and optical characteristics are determined by die attaching and wire bonding the LED chip to a TO-18, Au plated, Kovar header. No encapsulation is used.
2. Luminous intensity is measured with a Photo-Research Spectra microcandela meter, Model IV-D, fitted with a 4° probe. The center wavelength is determined with a 0.5 meter Jarrell-Ash grating monochromator and is defined as the average of the spectrum half power points.
3. Package code suffix: W = shipped in unscribed wafer form
   M = scribed and mounted on expandable vinyl membrane

5 Optoisolators



ACTUAL SIZE	DEVICE NO.	OUTPUT CONFIGURATION	EMITTER VOLTAGE	DETECTOR			MIN. CURRENT TRANSFER RATIO
				MIN. OUTPUT VOLTAGE (BV_{CEO})	TYPICAL h_{FE}	MAX. V_{CE}(SAT)	
	MCT2 MCT2E MCT26	TRANSISTOR	1.5V @ 20mA	30V	250 250 150	.4V @ 2mA .4V @ 2mA .5V @ 1.6mA	20% 20% 6%
	MCT210	TRANSISTOR	1.5V @ 40mA	30V	400	.4V @ 16mA	150%
	MCT271 MCT272 MCT273 MCT274	TRANSISTOR	1.5V @ 20mA	30V	420 500 280 360	.4V @ 2mA	45-90% 75-150% 125-250% 225-400%
	MCT275	TRANSISTOR	1.5V @ 20mA	80V	170	.4V @ 2mA	70-210%
	MCT276 MCT277	TRANSISTOR	1.5V @ 20mA	30V	90 420	.4V @ 2mA	15-60% 100%-up
	MCC670 MCC671	SPLIT-DARLINGTON	1.7V @ 1.7mA	To 7V To 18V	–	0.4V @ I_f = 1.6mA, I_O = 4.8mA V_{cc} = 4.5V 0.4V @ I_f = 5mA, I_O = 15mA V_{cc} = 4.5V	300% 400%
	MCT4 MCT4R	TRANSISTOR	1.5V @ 40mA	30V	–	.5V @ 2mA	15%
	MCT6 MCT66	TRANSISTOR PAIR	1.5V @ 20mA	30V	–	.4V @ 2mA	20% 6%
	4N25 4N26 4N27 4N28	TRANSISTOR	1.5V @ 50mA	30V	250	.5V @ 2mA	20% 20% 10% 10%
	4N29 4N30 4N31 4N32 4N33	DARLINGTON TRANSISTOR	1.5V @ 50mA	30V	5000	1.0V @ 2mA 1.0V @ 2mA 1.2V @ 2mA 1.0V @ 2mA 1.0V @ 2mA	100% 100% 50% 500% 500%
	4N35 4N36 4N37	TRANSISTOR	1.5V @ 10mA	30V	100	.3V @ .5mA	100%
	MCA230 MCA231 MCA255	DARLINGTON TRANSISTOR	1.5V @ 20mA	30V 30V 55V	25,000 50,000 25,000	1.0V @ 50mA 1.2V @ 50mA 1.0V @ 50mA	100% 200% 100%

ACTUAL SIZE	DEVICE NO.	OUTPUT CONFIGURATION	FORWARD VOLTAGE	DETECTOR			
				V_{GT}	ON-VOLTAGE	HOLDING CURRENT	I_{FT}
	MCS2 MCS2400	SCR	200V 400V	1V	1.3V @ 100mA	.5mA	14mA
	MCS6200 MCS6201	BI-DIRECTIONAL SCR'S	200V	1V	1.3V @ 100mA	2mA	14mA

ACTUAL SIZE	DEVICE NO.	OUTPUT CONFIGURATION	EMITTER VOLTAGE	DETECTOR			
				ΔI_f	I_{OHL}	V_{OL}	I_{CC}
	MCL601 MCL611	OPEN-COLLECTOR LOGIC GATE	1.5V @ 20mA	1mA	200μA	.4V @ 16mA	20mA

MIN. DC SURGE ISOLATION VOLTAGE	OPERATING SPEED OR BANDWIDTH		APPLICATIONS
1500V 3550V 1500V	150KHz 150KHz 300KHz		AC line/digital logic isolator, logic isolator, line receiver, cable receiver, relay monitor, power supply monitor, UL recognized.
2500V	150KHz		Digital logic isolation, line receiver feedback control, monitoring circuits in high isolation environments. UL recognized.
3550V	7μsec 10μsec 20μsec 25μsec		Switching networks, power supply regulators, digital logic inputs, microcircuit inputs, appliance sensor systems, appliance controls. UL recognized.
3550V	7μsec		Telecommunications, high voltage industrial control, relay driver, telephone. UL recognized.
3550V 2500V	2.5μsec 15μsec		Data processing, microprocessor input, high speed digital logic. UL recognized.
3000V	t_{PHL} @ 10μsec t_{PLH} @ 35μsec t_{PHL} @ 1μsec t_{PLH} @ 7μsec		CMOS logic interface, telephone ring detector, low input TTL interface, power supply isolation. UL recognized.
1000V	300KHz		Logic isolation, line or cable receiver for high hermeticity.
1500V	150KHz		Data line isolation, telephone signal coupling, line/cable receiver, mobil equipment.
2500V 1500V 1500V 500V	300KHz		Low cost products for logic isolator, telecommunications, line/cable receiver, high frequency feedback control system, monitoring circuits.
2500V 1500V 1500V 2500V 1500V	30KHz		Low capacitance medium speed products for data isolation, logic conversion, line/cable receiver, monitoring circuits, or mechanical feedback controls.
3550V 2500V 1500V	150KHz		Low current, low power products for industrial control and consumer, monitoring circuits, line receiver. UL recognized.
3550V	10KHz		High current, low capacitance and fast switching products for read relay, pulse transformer, multiple contact control applications. Telecommunication, remote control logic isolation & alarm monitoring circuits, AC line/logic coupling.

EMITTER VOLTAGE	MIN. ISOLATION VOLTAGE		APPLICATIONS
1.5V @ 20mA	2500V 3550V		Lower power IC's to AC line isolation, relay functions, latches for DC circuits, home appliances, consumer and industrial control logic. UL recognized.
1.5V @ 20mA	1500V 2500V		AC power control, triac triggering, AC motor control, power supply polarity control, appliance control, logic interface.

MIN. DC SURGE ISOLATION VOLTAGE	MIN. OPERATING FREQUENCY		APPLICATIONS
2000V	1MHz		Digital logic isolator, DC voltage sensor, pulse shaping, level shifting, logical level conversion.

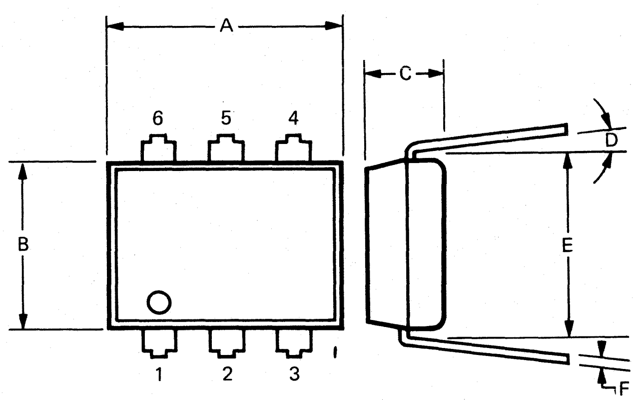
GENERAL INSTRUMENT
Optoelectronics

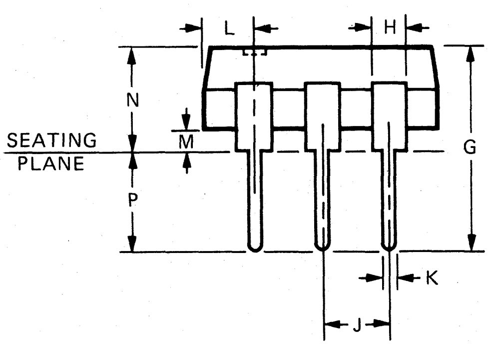
4N25 4N26 4N27 4N28
PHOTOTRANSISTOR OPTOISOLATORS

PRODUCT DESCRIPTION

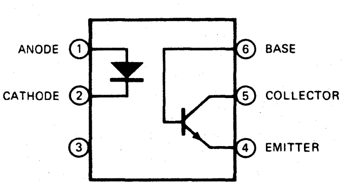
The 4N25, 4N26, 4N27, and 4N28 series of optoisolators have an NPN silicon planar phototransistor optically coupled to a gallium arsenide diode. Each is mounted in a six-lead plastic DIP package.

PACKAGE DIMENSIONS





PACKAGE MATERIALS:
Leads — Tinned with 60/40 tin lead
Body — Silicone plastic



C1339

SYMBOL	INCH MAX.	MM. MAX.	NOTES
A	.365	9.27	
B	.270	6.73	
C	.130	3.18	
D	15°	15°	
E	.300 Ref	7.62 Ref	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			3

NOTES
1. Installed position of lead centers
2. Four places
3. Overall installed position
4. These measurements are made from the seating plane

FEATURES & APPLICATIONS

- AC line/digital logic isolator
- Digital logic/digital logic isolator
- Telephone/telegraph line receiver
- Twisted pair line receiver
- High frequency power supply feedback control
- Relay contact monitor
- Power supply monitor
- Small package size and low cost
- High isolation voltage
- Excellent frequency response

ABSOLUTE MAXIMUM RATINGS

*Storage temperature . . . . –55°C to 150°C
*Operating temperature at junction . . . . –55°C to 100°C
*Lead temperature (soldering, 10 sec) . . . . 260°C
*Total package power dissipation at 25°C ambient (LED plus detector) . . . . 250 mW
*Derate linearly from 25°C . . . . 3.3 mW/°C

Input diode
*Forward DC current continuous . . . . 80 mA
*Reverse voltage . . . . 3.0 V
*Peak forward current
(300 µs, 2% duty cycle) . . . . 3.0 A
*Power dissipation at 25°C ambient . . . . . . 150 mW
*Derate linearly from 25°C . . . . 2.0 mW/°C

Output transistor
*Collector emitter voltage (BV_{CEO}) . . . . 30 V
*Collector base voltage (BV_{CBO}) . . . . 70 V
*Emitter collector voltage (BV_{ECO}) . . . . 7 V
*Power dissipation at 25°C ambient . . . . . . 150 mW
*Derate linearly from 25°C . . . . 2.0 mW/°C

*Indicates JEDEC Registered Data.

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTICS	SYMBOL	MIN.	TYP.	GUAR. MAX.	UNITS	TEST CONDITIONS
Input diode						
*Forward voltage	V_F		1.20	1.50	V	I_F = 50 mA
Capacitance	C		150		pF	V_R = 0 V, f = 1 MHz
*Reverse leakage current			.05	100	μA	V_R = 3.0 V, R_L = 1.0 MΩ
Output transistor						
DC forward current gain	h_{FE}		250			V_{CE} = 5 V, I_C = 500 μA
*Collector to emitter breakdown voltage	BV_{CEO}	30	65		V	I_C = 1.0 mA, I_B = 0
*Collector to base breakdown voltage	BV_{CBO}	70	165		V	I_C = 100 μA, I_E = 0
*Emitter to collector breakdown voltage	BV_{ECO}	7	14		V	I_E = 100 μA, I_B = 0
*Collector to emitter leakage current (4N25, 4N26, 4N27)	I_{CEO}		3.5	50	nA	V_{CE} = 10 V Base Open
*Collector to emitter leakage current (4N28)				100	nA	
*Collector to base leakage current	I_{CBO}		0.1	20	nA	V_{CB} = 10 V Emitter Open
Coupled						
*Collector output current (a)						
(4N25, 4N26)	I_C	2.0	5.0	—	mA	V_{CE} = 10 V, I_F = 10 mA, I_B = 0
(4N27, 4N28)		1.0	3.0	—		
*Isolation voltage (b)						
(4N25)	V_{ISO}	2500	—	—	V	Peak
(4N26, 4N27)		1500	—	—	V	Peak
(4N28)		500	—	—	V	Peak
Isolation resistance (b)			10^{11}		Ω	V = 500 VDC
*Collector-emitter saturation	V_{CE}(SAT)		0.2	0.5	V	I_C = 2.0 mA, I_F = 50 mA
Isolation capacitance (b)			1.3		pF	V = 0, f = 1.0 MHz
Bandwidth (c) (also see note 2)	B_W		300		kHz	I_C = 2.0 mA, R_L = 100 Ω (Figure 12)

*Indicates JEDEC Registered Data.
(a) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2.0%
(b) For this test LED pins 1 and 2 are common and Phototransistor pins 4, 5 and 6 are common.
(c) If adjusted to yield I_C = 2 mA and i_c = 0.7 mA RMS; Bandwidth referenced to 10 kHz.

SWITCHING TIMES		TYP.	UNITS	TEST CONDITIONS
Non-saturated				
Collector				
Delay time	t_d	0.5	μs	R_L = 100 Ω, I_C = 2 mA, V_{CC} = 10 V (Fig. 7 and 13)
Rise time	t_r	2.5	μs	
Fall time	t_f	2.6	μs	
Non-saturated				
Collector				
Delay time	t_d	2.0	μs	R_L = 1kΩ, I_C 2 mA, V_{CC} = 10 V (Fig. 7 and 13)
Rise time	t_r	15	μs	
Fall time	t_f	15	μs	
Saturated				
t_{on} (from 5 V to 0.8 V)	t_{on} (SAT)	5	μs	R_L = 2kΩ, I_F = 15 mA, V_{CC} = 5 V
t_{off} (from SAT to 2.0 V)	t_{off} (SAT)	25	μs	R_B = Open (Circuit No. 1)
Saturated				
t_{on} (from 5 V to 0.8 V)	t_{on} (SAT)	5	μs	R_L = 2kΩ, I_F = 20 mA, V_{CC} = 5 V
t_{off} (from SAT to 2.0 V)	t_{off} (SAT)	18	μs	R_B = 100kΩ (Circuit No. 1)
Non-saturated				
Base — Collector photo diode				
Rise time	t_r	175	ns	R_L = 1kΩ, V_{CB} = 10 V
Fall time	t_f	175	ns	

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES
(25°C Free Air Temperature Unless Otherwise Specified)

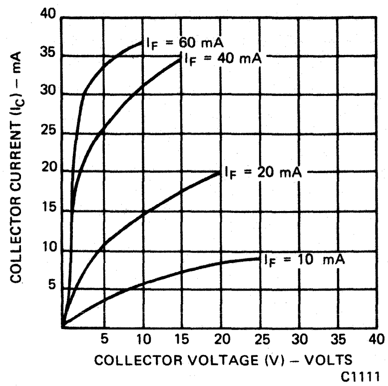


Fig. 1. Collector Current vs. Collector Voltage

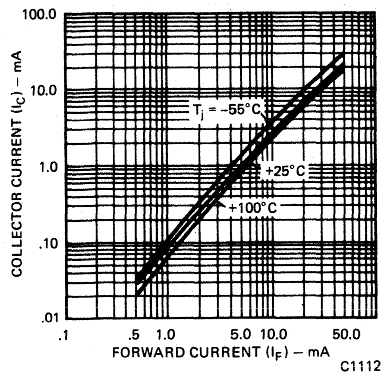


Fig. 2. Collector Current vs. Forward Current

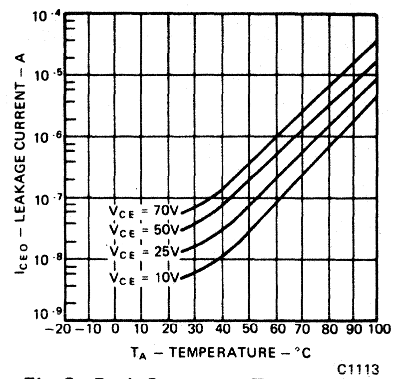


Fig. 3. Dark Current vs. Temperature

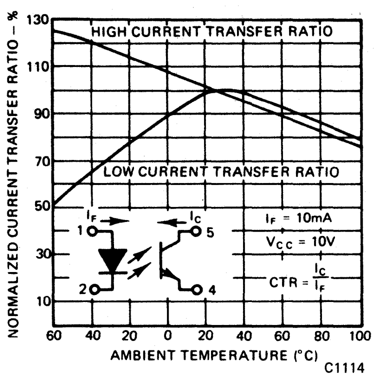


Fig. 4. Current Transfer Ratio vs. Temperature

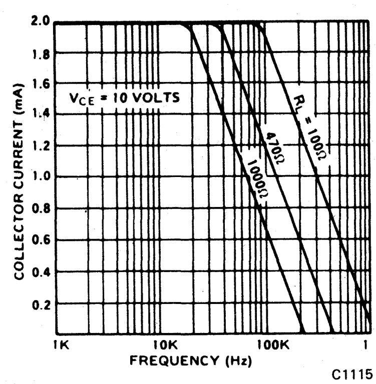


Fig. 5. Collector Current vs. Frequency (see Fig. 12 for circuit)

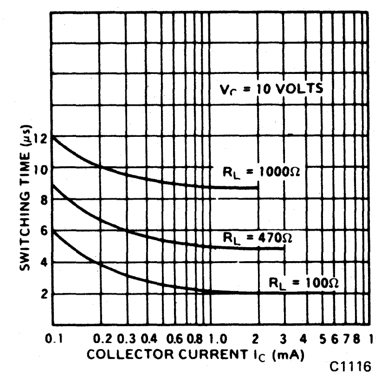
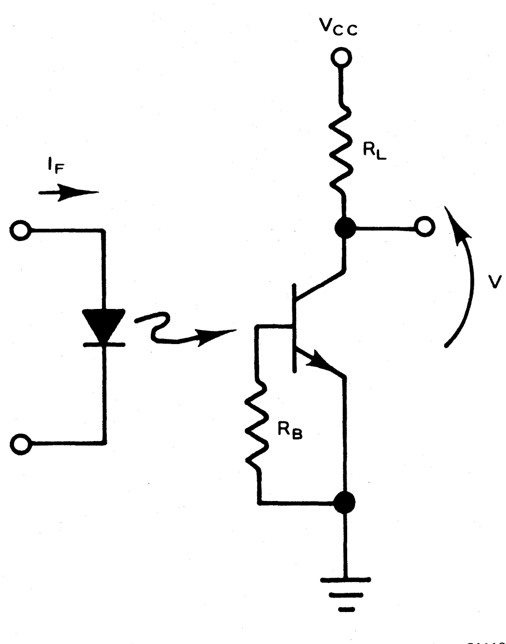


Fig. 6. Switching Time vs. Collector Current (see Fig. 13 for Circuit)



Circuit 1

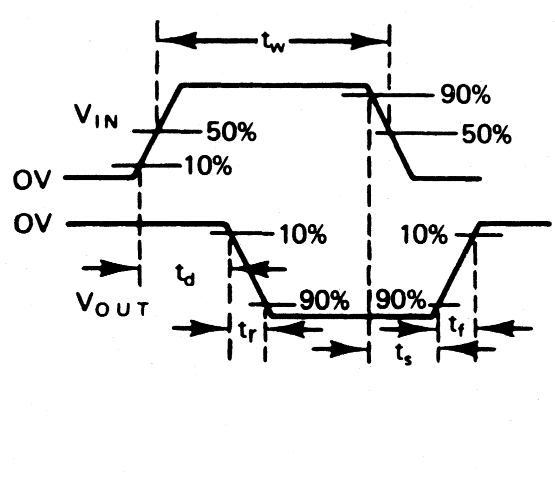


Fig. 7. Pulse Test Definition (Note 3)

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (Cont'd)

(25°C Free Air Temperature Unless Otherwise Specified)

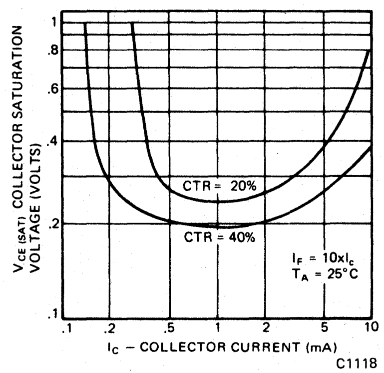


Fig. 8. Saturation Voltage vs. Collector Current

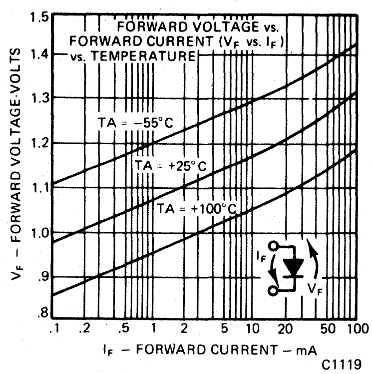


Fig. 9. Forward Voltage vs. Forward Current

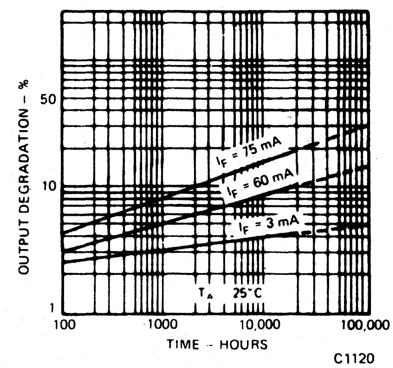


Fig. 10. Lifetime vs. Forward Current

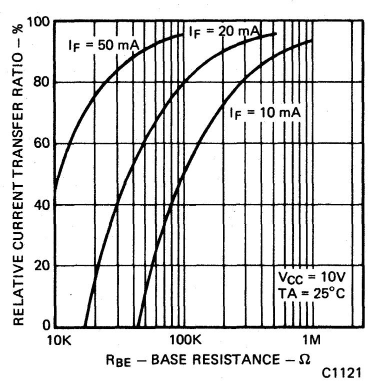


Fig. 11. Sensitivity vs. Base Resistance

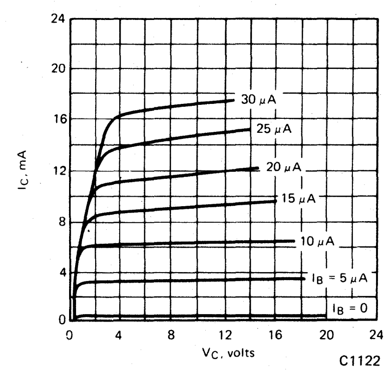


Fig. 12. Detector h_{fe} Curves

OPERATING SCHEMATICS

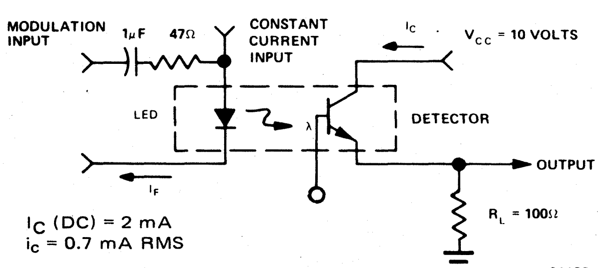


Fig. 13. Modulation Circuit Used to Obtain Output vs. Frequency Plot

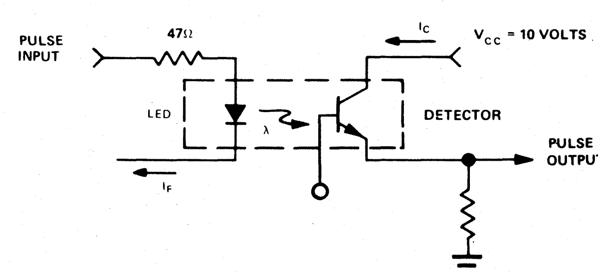


Fig. 14. Circuit Used to Obtain Switching Time vs. Collector Current Plot

NOTES

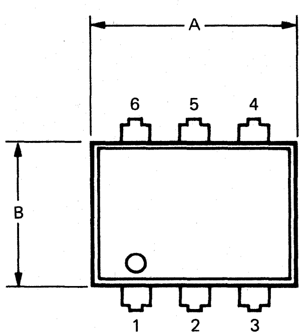
1. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.*
2. *The frequency at which i_c is 3dB down from the 10 kHz value.*
3. *Rise time (t_r) is the time required for the collector current to increase from 10% of its final value to 90%. Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value to 10%.*

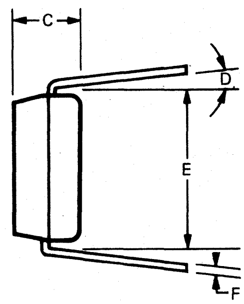
GENERAL INSTRUMENT
Optoelectronics

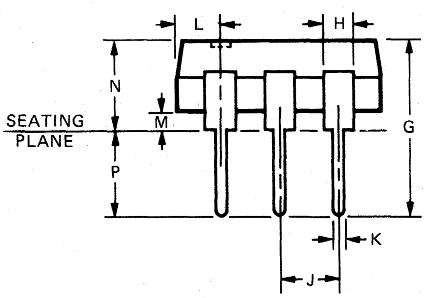
4N29 4N30 4N31 4N32 4N33
PHOTO-DARLINGTON OPTOISOLATOR

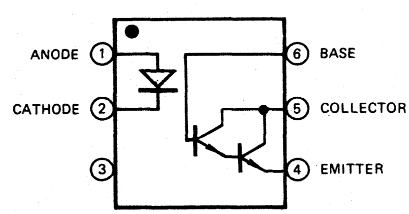
PRODUCT DESCRIPTION
The 4N29, 4N30, 4N31, 4N32 and 4N33 have a gallium arsenide infrared emitter optically coupled to a silicon planar photo-darlington. Each unit is sealed in a 6-lead plastic DIP package.

PACKAGE DIMENSIONS









PACKAGE MATERIALS:
Leads — Tinned with 60/40 tin lead
Body — Silicone plastic

C1339

FEATURES & APPLICATIONS
- Fast operate time — 10 μs
- High isolation resistance — 10^{11} Ω
- High dielectric strength, input to output — 2500 V min. 4N29, 4N32; 1500 V min. 4N30, 4N31, 4N33
- Low coupling capacitance — 1.0 pF
- Convenient package — plastic dual-in-line
- Long lifetime, solid state reliability
- Low weight — 0.4 grams

SYMBOL	INCH MAX.	MM. MAX.	NOTES
A	.365	9.27	
B	.270	6.73	
C	.130	3.18	
D	15°	15°	
E	.300 Ref	7.62 Ref	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			3

NOTES
1. Installed position of lead centers
2. Four places
3. Overall installed position
4. These measurements are made from the seating plane

ABSOLUTE MAXIMUM RATINGS T_A = 25°C (Unless otherwise specified)

*Storage Temperature . . . . –55°C to 150°C
*Operating Temperature at Junction . . . . –55°C to 100°C
*Lead Soldering time @ 260°C . . . . 10 seconds
*Total power dissipation @ 25°C ambient . . . . 250 mW
*Derate linearly from 25°C . . . . 3.3 mW/°C

LED (GaAs Diode)
*Power dissipation @ 25°C ambient . . . . 150 mW
*Derate linearly from 55°C . . . . 2 mW/°C
*Continuous forward current . . . . 80 mA
Reverse current . . . . 10 mA
*Peak forward current (300 μsec, 2% duty cycle) . . 3.0 A

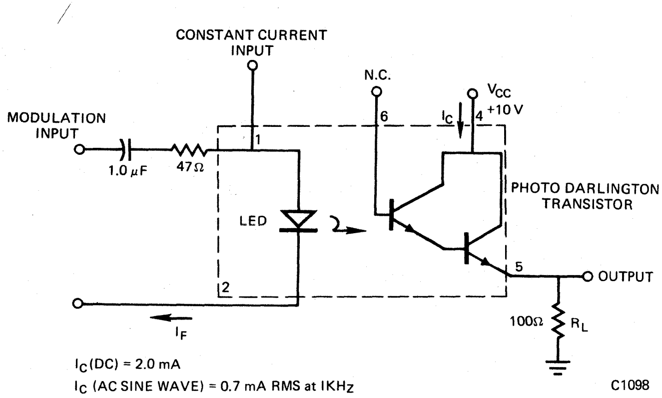
DETECTOR (Silicon Photo Darlington Transistor)
*Power dissipation @ 25°C ambient . . . . 150 mW
*Derate linearly from 25°C . . . . 2.0 mW/°C
*Collector-emitter breakdown voltage (BV_{CEO}) . . . . 30 V
*Collector-base breakdown voltage (BV_{CBO}) . . . . . . 50 V
Emitter-base breakdown voltage (BV_{EBO}) . . . . 8.0 V
*Emitter-collector breakdown voltage (BV_{ECO}) . . . . . 5 V

*Indicated JEDEC Registered data.

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

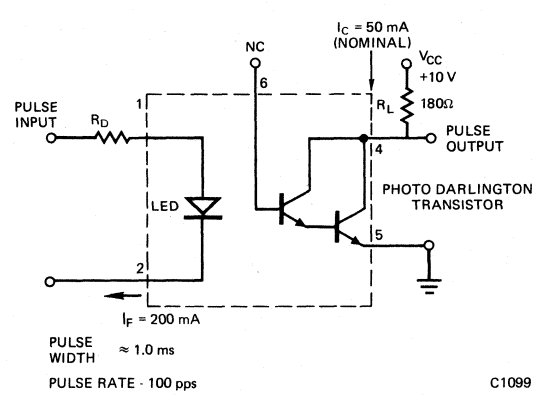
CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION
LED CHARACTERISTICS (T_A = 25°C unless otherwise noted)						
*Reverse leakage current	I_R		0.05	100	μA	V_R = 3.0 V
*Forward voltage	V_F		1.2	1.5	Volts	I_F = 50 mA
Capacitance	C		150		pF	V_R = 0 V, f = 1.0 MHz
PHOTOTRANSISTOR CHARACTERISTICS (T_A = 25°C and I_F = 0 unless otherwise noted)						
*Collector-emitter dark current	I_{CEO}			100	nA	V_{CE} = 10 V, base open
*Collector-base breakdown voltage	BV_{CBO}	30			Volts	I_C = 100 μA, I_E = 0
*Collector-emitter breakdown voltage	BV_{CEO}	30			Volts	I_C = 100 μA, I_B = 0
*Emitter-collector breakdown voltage	BV_{ECO}	5.0			Volts	I_E = 100 μA, I_B = 0
DC current gain	h_{FE}		5000			V_{CE} = 5.0 V, I_C = 500 μA
COUPLED CHARACTERISTICS (T_A = 25°C unless otherwise noted)						
*Collector output current (Note 1)						
4N32, 4N33	I_C	50			mA	V_{CE} = 10 V, I_F = 10 mA, I_B = 0
4N29, 4N30		10			mA	V_{CE} = 10 V, I_F = 10 mA, I_B = 0
4N31		5.0			mA	V_{CE} = 10 V, I_F = 10 mA, I_B = 0
*Isolation voltage (Note 2)						
4N29, 4N32	V_{ISO}	2500			VDC	
4N30, 4N31, 4N33		1500			VDC	
Isolation capacitance (Note 2)	R_{ISO}		10^{11}		Ohms	V = 500 VDC
*Collector-emitter saturation voltage (1)	$V_{CE(SAT)}$					
4N31				1.2	Volts	I_C = 2.0 mA, I_F = 8.0 mA
4N29, 4N30, 4N32, 4N33				1.0	Volts	I_C = 2.0 mA, I_F = 8.0 mA
Isolation capacitance (Note 2)			0.8		pF	V = 0, f = 1.0 MHz
Bandwidth (3) (Test Circuit #1)			30		kHz	
SWITCHING CHARACTERISTICS (Test Circuit #2)						
Turn-on time	t_{ON}		0.6	5.0	μs	I_C = 50 mA, I_F = 200 mA, V_{CC} = 10 V
Turn-off time						
4N29, 4N30, 4N31	t_{OFF}		17	40	μs	I_C = 50 mA, I_F = 200 mA,
4N32, 4N33			45	100		V_{CC} = 10 V

*Indicates JEDEC Registered Data.
(1) Pulse test: pulse width = 300 μs, duty cycle ≤ 2.0%
(2) For this test LED pins 1 and 2 are common and phototransistor pins 4, 5 and 6 are common.
(3) I_F adjusted to I_C = 2.0 mA and ic = 0.7 mA RMS.
(4) t_d and t_r are inversely proportional to the amplitude of I_F; t_s and t_f are not significantly affected by I_F.



Note 2

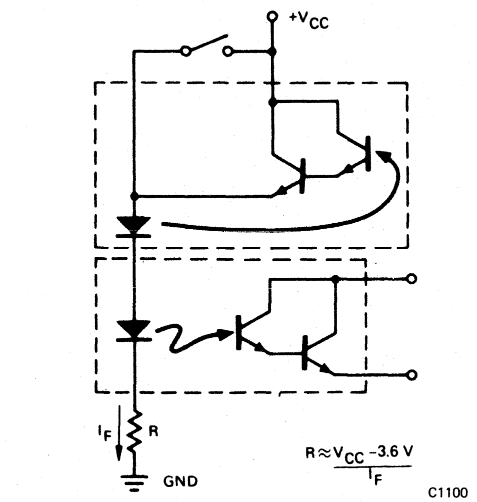
FREQUENCY RESPONSE TEST CIRCUIT #1



SWITCHING TIME TEST CIRCUIT #2

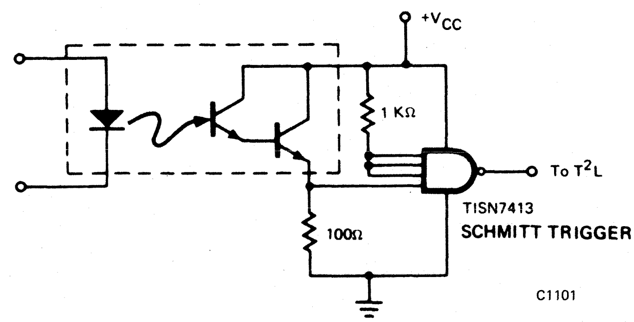
APPLICATION INFORMATION

LATCH

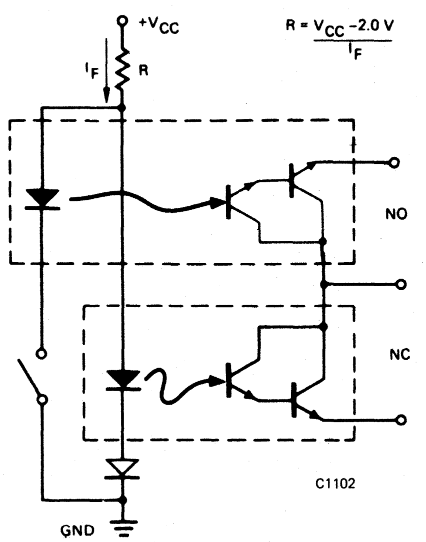


NOT APPLICABLE TO 4N31

T²L LOGIC ISOLATION

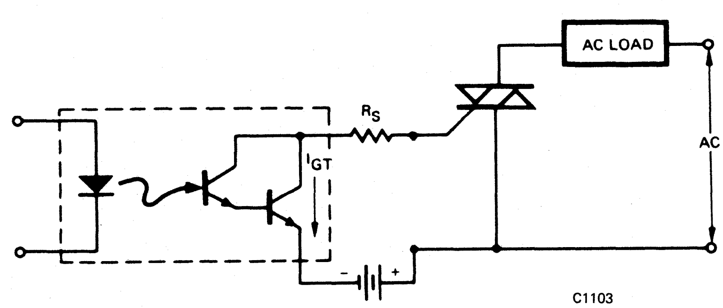


FORM C CONTACT

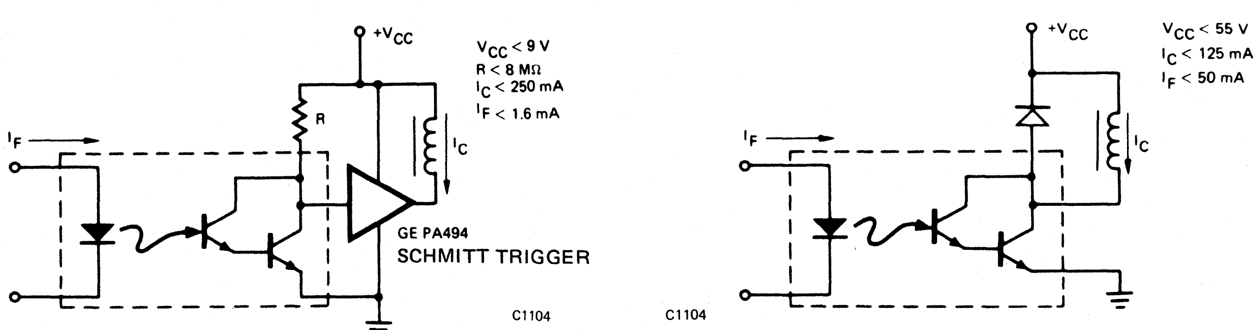


NOT APPLICABLE TO 4N31

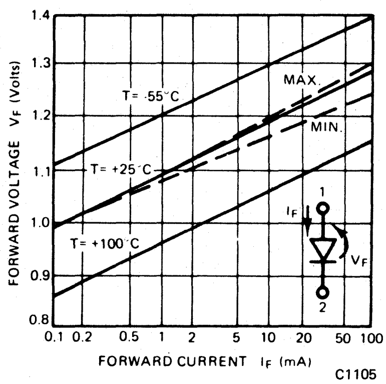
TRIAC TRIGGER



OPERATING A RELAY COIL

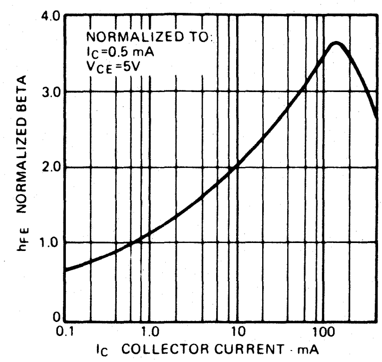


TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES
(25°C Free Air Temperature Unless Otherwise Specified)



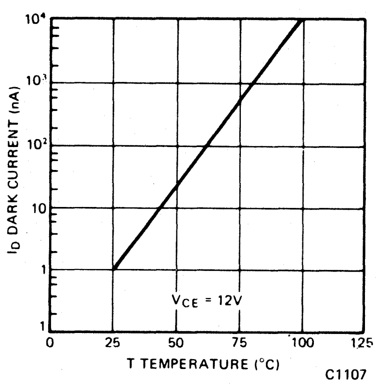
C1105

Fig. 1. Forward Voltage Drop vs. Forward Current



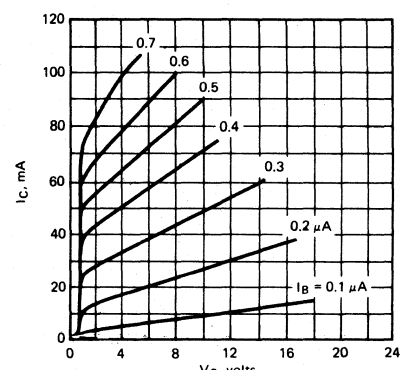
C1106

Fig. 2. Normalized Beta vs. Collector Current



C1107

Fig. 3. Dark Current vs. Temperature



C1108

Fig. 4. Detector Standard Transfer Curves

NOTES

1. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.*
2. *The frequency at which i_C is 3dB down from the $1KH_z$ value.*
3. *t_{ON} is measured from 10% of the leading edge of the input pulse to the 90% point on the leading edge of the output pulse. t_{OFF} is measured from 90% of the trailing edge of the input pulse to the 10% point on the trailing edge of the output pulse.*

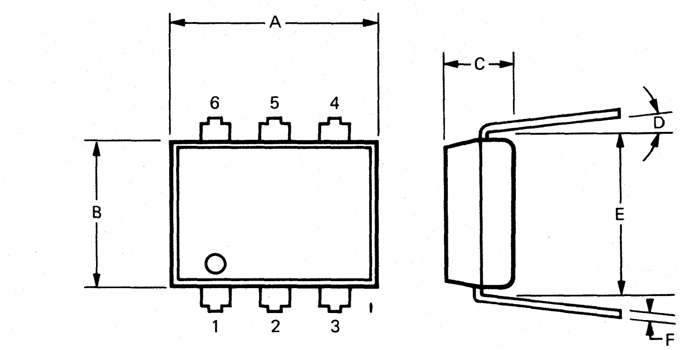
GENERAL INSTRUMENT
Optoelectronics

4N35
4N36 4N37
PHOTOTRANSISTOR OPTOISOLATORS

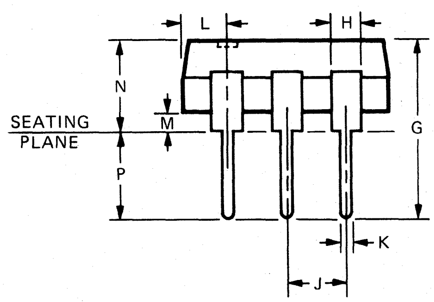
PRODUCT DESCRIPTION

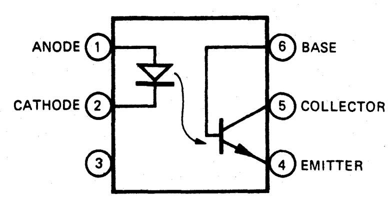
The 4N35, 4N36, and 4N37 series of optoisolators have an NPN silicon planar phototransistor optically coupled to a diffused planar gallium arsenide diode. Each is mounted in a six-lead plastic DIP package.

PACKAGE DIMENSIONS



C1339





PACKAGE MATERIALS:
Leads — Tinned with 60/40 tin lead
Body — Silicone plastic

SYMBOL	INCH MAX.	MM. MAX.	NOTES
A	.365	9.27	
B	.270	6.73	
C	.130	3.18	
D	15°	15°	
E	.300 Ref	7.62 Ref	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			3

NOTES
1. Installed position of lead centers
2. Four places
3. Overall installed position
4. These measurements are made from the seating plane

FEATURES & APPLICATIONS

- AC line/digital logic isolator
- Digital logic/digital logic isolator
- Telephone/telegraph line receiver
- Twisted pair line receiver
- High frequency power supply feedback control
- Relay contact monitor
- Power supply monitor
- Industrial controls
- Covered under UL component recognition program, reference File No. E50151
- High DC current transfer ratio
- High isolation voltage

ABSOLUTE MAXIMUM RATINGS

*Relative humidity 85% @ 85°C
*Storage temperature –55°C to 150°C
*Operating temperature –55°C to 100°C
*Lead temperature (soldering, 10 sec) 260°C

Input Diode
- *Forward DC current (continuous) . . . . . 60 mA
- Reverse voltage . . . . 6 volts
- *Peak forward current (1 μs pulse, 300 pps) . . . . 3.0 A
- *Power dissipation at T_A = 25°C . . . . 100 mW†
- *Power dissipation at T_C = 25°C . . . . 100 mW† (T_C indicates collector lead temp 1/32" from case)

Output Transistor
- *Power dissipation at 25°C ambient . . . . . 300 mW
- Derate linearly above 25°C . . . . 4 mW/°C
- *Power dissipation at T_C = 25°C . . . . . . 500 mW†† (T_C indicates collector lead temp 1/32" from case)
- *V_{CEO} . . . . 30 volts
- *V_{CBO} . . . . 70 volts
- *V_{ECO} . . . . 7 volts
- *Collector current (continuous) . . . . 100 mA

*Indicates JEDEC registered values
†Derate 1.33 mW/°C above 25°C.
††Derate 6.7 mW/°C above 25°C.

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Input Diode						
*Forward voltage	V_F	.8		1.50	V	I_F = 10 mA
*Forward voltage temp. coefficient	V_F	.9		1.7	V	I_F = 10 mA, T_A = –55°C
*Forward voltage	V_F	.7		1.4	V	I_F = 10 mA, T_A = +100°C
*Junction capacitance	C_J			100	pF	V_F = 0 V, f = 1 mHz
*Reverse leakage current			.01	10	μA	V_R = 6.0 V
Output Transistor						
DC forward current gain	h_{FE}		250			V_{CE} = 5 V, I_C = 100 μA
*Collector to emitter breakdown voltage	BV_{CEO}	30	65		V	I_C = 10 mA, I_F = 0
*Collector to base breakdown voltage	BV_{CBO}	70	165		V	I_C = 100 μA
*Emitter to collector breakdown voltage	BV_{ECO}	7	14		V	T_E = 100 μA, I_F = 0
Collector to emitter, leakage current	I_{CEO}		5	50	nA	V_{CE} = 10 V, I_F = 0
*Collector to emitter leakage current (dark)	I_{CEO}			500	μA	V_{CE} = 30 V, I_F = 0, T_A = 100°C
Capacitance collector to emitter			8		pF	V_{CE} = 0
Capacitance collector to base			20		pF	V_{CB} = 10 V
Capacitance base to emitter	C_{BEO}		10		pF	V_{BE} = 0
Coupled						
†*DC current transfer ratio	CTR	100			%	I_F = 10 mA, V_{CE} = 10 V
†*DC current transfer ratio	CTR	40			%	I_F = 10 mA, V_{CE} = 10 V, T_A = – 55°C
†*DC current transfer ratio	CTR	40			%	I_F = 10 mA, V_{CE} = 10 V, T_A = +100°C
*Saturation voltage—collector to emitter	$V_{CE(SAT)}$			.3	volts	I_F = 10 mA, I_C = 0.5 mA
*Input to output isolation current (pulse width = 8 msec) (see Note 1)	$I_{I\text{-}O}$					
Input to output voltage = 3550 V (peak)		4N35		100	μA	
Input to output voltage = 2500 V (peak)		4N36		100	μA	
Input to output voltage = 1500 V (peak)		4N37		100	μA	
*Input to output resistance	$R_{I\text{-}O}$	100			gigaohms	Input to output voltage = 500 V (see Note 1)
*Input to output capacitance	$C_{I\text{-}O}$			2.5	picofarads	Input to output voltage = 0 V, f = 1 MHz (see Note 1)
*Turn on time—t_{on}	t_{ON}		5	10	μsec	V_{CC} = 10 V, I_C = 2 mA, R_L = 100Ω, (see Fig. 15)
*Turn off time—t_{off}	t_{OFF}		5	10	μsec	V_{CC} = 10 V, I_C = 2 mA, R_L = 100Ω, (see Fig. 15)

*Indicates JEDEC registered values

†Pulse test: pulse width = 300μS, duty cycle ≤ 2.0%

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES
(25°C Free Air Temperature Unless Otherwise Specified)

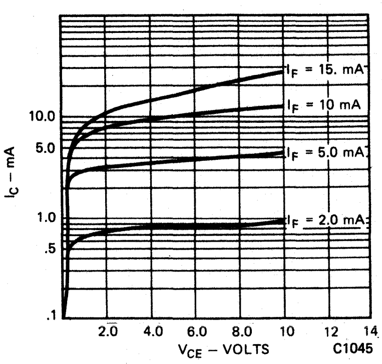


Fig. 1. Collector Current vs. Collector Voltage

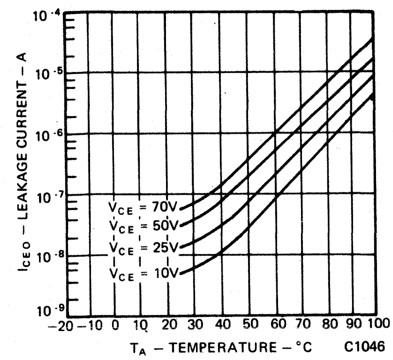


Fig. 2. Dark Current vs. Temperature

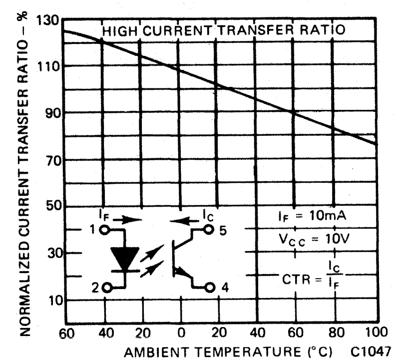


Fig. 3. Current Transfer Ratio vs. Temperature

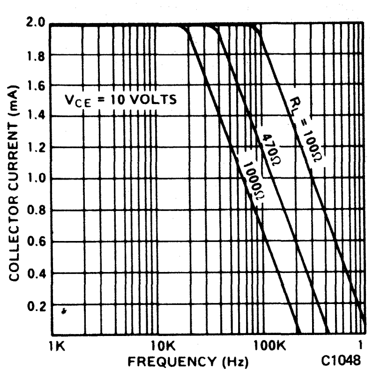


Fig. 4. Collector Current vs. Frequency

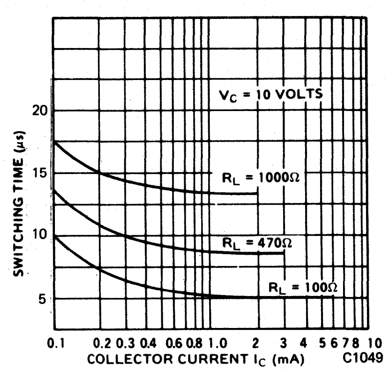


Fig. 5. Switching Time vs. Collector Current

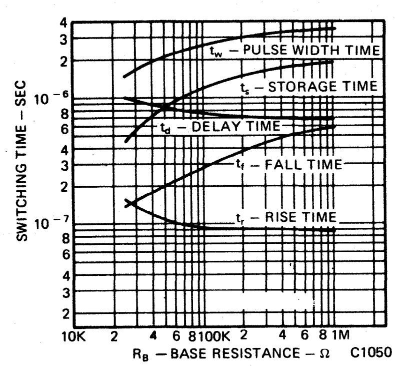


Fig. 6. Switching Time vs. Base Resistance

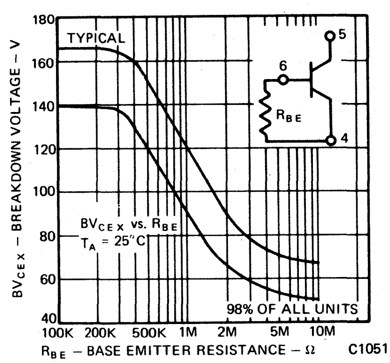


Fig. 7. Collector–Emitter Breakdown Voltage vs. Base Resistance

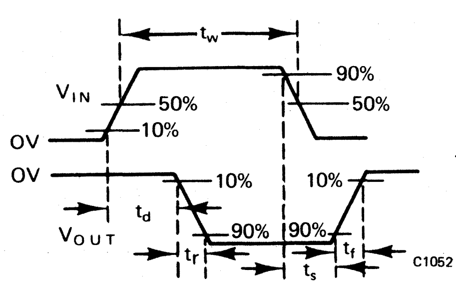


Fig. 8. Test Pulse Definition (Note 3)

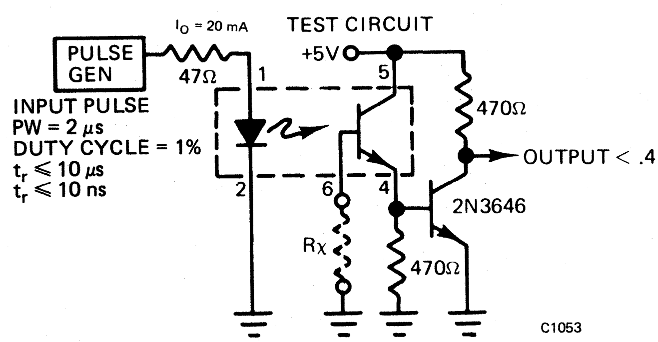


Fig. 9. Pulse Test Circuit for Fig. 7

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

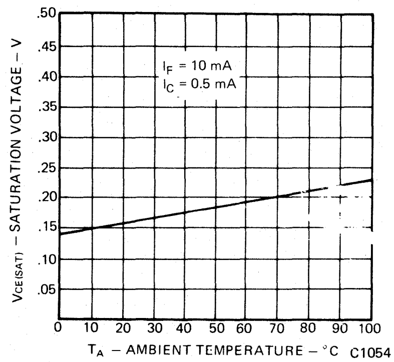


Fig. 10. Saturation Voltage vs. Temperature

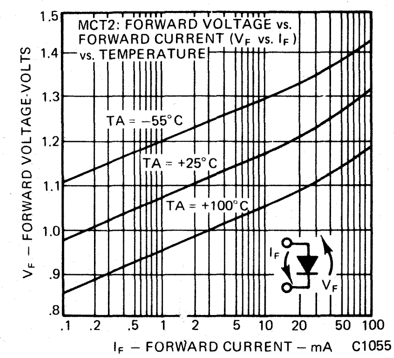


Fig. 11. Forward Voltage vs. Forward Current

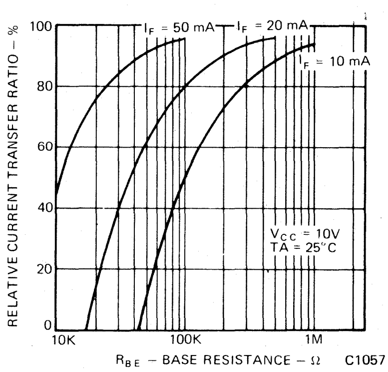


Fig. 12. Sensitivity vs. Base Resistance

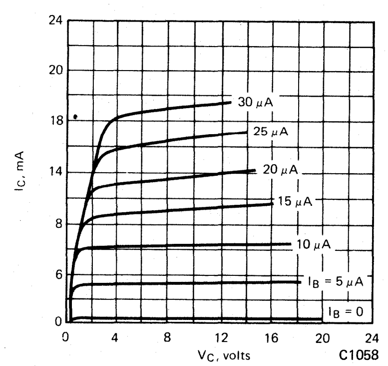


Fig. 13. Detector Standard Transfer Curves

OPERATING SCHEMATICS

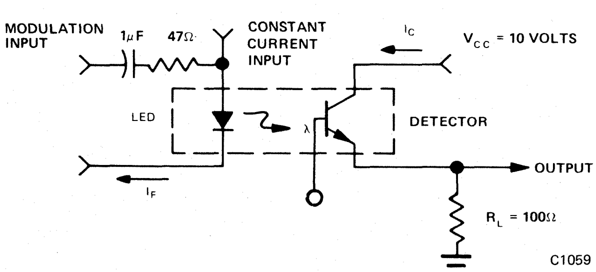


Fig. 14. Modulation Circuit Used to Obtain Output vs. Frequency Plot (Fig. 4)

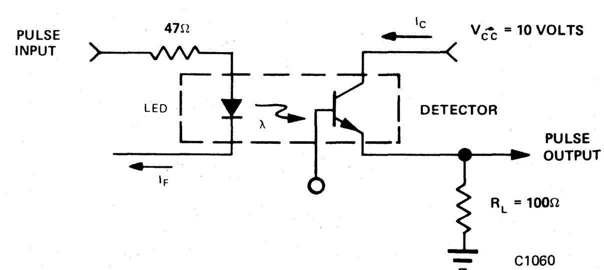


Fig. 15. Circuit Used to Obtain Switching Time vs. Collector Current Plot (Fig. 5)

NOTES

1. *Tests of input to output isolation current resistance and capacitance are performed with the input terminals (diode) shorted together and the output terminals (transistor) shorted together.*
2. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.*
3. *Rise time (t_r) is the time required for the collector current to increase from 10% of its final value, to 90%. Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value to 10%.*

GENERAL INSTRUMENT
Optoelectronics

(MCC670) 6N138
(MCC671) 6N139
HIGH GAIN SPLIT-DARLINGTON OPTOISOLATORS

FEATURES

- High sensitivity to low input currents
  - 6N138 — 300% minimum CTR (I_F = 1.6 mA)
  - 6N139 — 400% minimum CTR (I_F = .5 mA)
- Fast switching capability at logic loads
  - 6N138 — 10 Microseconds (t_{on})
    35 Microseconds (t_{off})
  - 6N139 — 1 Microseconds (t_{on})
    7 Microseconds (t_{off})
- UL Recognized

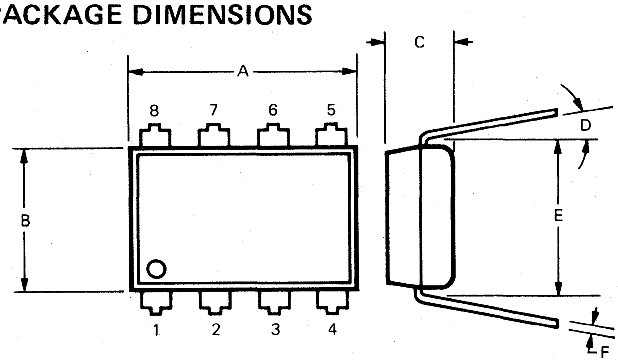
DESCRIPTION

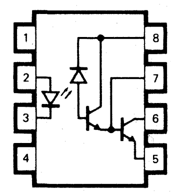
The 6N138 and 6N139 are optically coupled isolators with a split-darlington output configuration. A red visible emitting diode manufactured from specially grown gallium arsenide is coupled to a photo sensitive circuit.

APPLICATIONS

- CMOS logic interface
- Telephone ring detector
- Low input TTL interface
- Power supply isolation

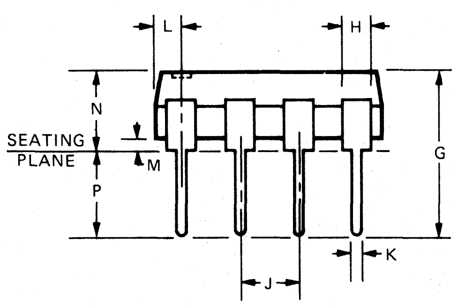
PACKAGE DIMENSIONS





PIN	
1	N/C
2	LED ANODE
3	LED CATHODE
4	N/C
5	GROUND
6	OUTPUT
7	OUTPUT BASE
8	V_{CC}

C1385



SYMBOL	INCH MAX.	MM. MAX.	NOTES
A	.410	10.29	
B	.270	6.86	
C	.130	3.30	
D	15°	15°	
E	.300 Ref	7.62 Ref	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.055	1.40	2
M			3
N	.175	4.45	4
P			3

PACKAGE MATERIALS:
Leads — Tinned with 60/40 tin lead
Body — Silicone plastic

NOTES
1. Installed position of lead centers
2. Four places
3. Overall installed position
4. These measurements are made from the seating plane

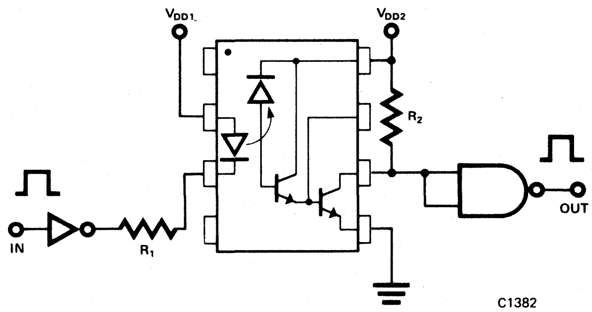
C1340

ABSOLUTE MAXIMUM RATINGS*

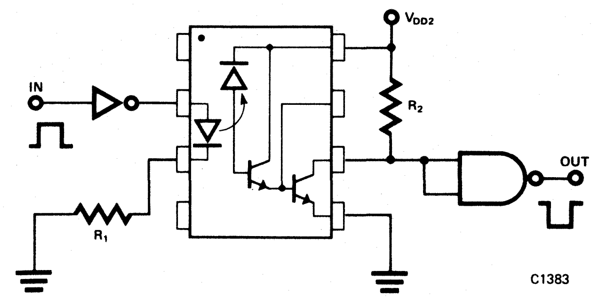
Storage Temperature . . . . -55°C to +125°C
Operating Temperature . . . . 0°C to +70°C
Lead Solder Temperature . . . . 260°C for 10 Sec (1/16" below seating plane)
Average Input Current — I_F . . . . 20 mA (See Note 1)
Peak Input Current — I_F . . . . 40 mA (50% Duty Cycle, 1 ms Pulse Width)
Peak Transient Input Current — I_F . . . . 1.0 A ($\leq$ 1 μsec pulse width, 300 pps)
Reverse Input Voltage — V_R . . . . 5 V

Input Power Dissipation . . . . 35 mW (See Note 2)
Output Current — I_O (Pin 6) . . . . 60 mA (See Note 3)
Emitter-Base Reverse Voltage (Pin 5-7) . . . . .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
Output Power Dissipation . . . . 100 mW (See Note 4)

*JEDEC registered data



NON-INVERTING LOGIC INTERFACE



INVERTING LOGIC INTERFACE

$$R_1\ (\text{NON-INVERT}) = \frac{V_{DD1} - V_{DF} - V_{OL1}}{I_F}$$

$$R_1\ (\text{INVERT}) = \frac{V_{DD1} - V_{OH1} - V_{DF}}{I_F}$$

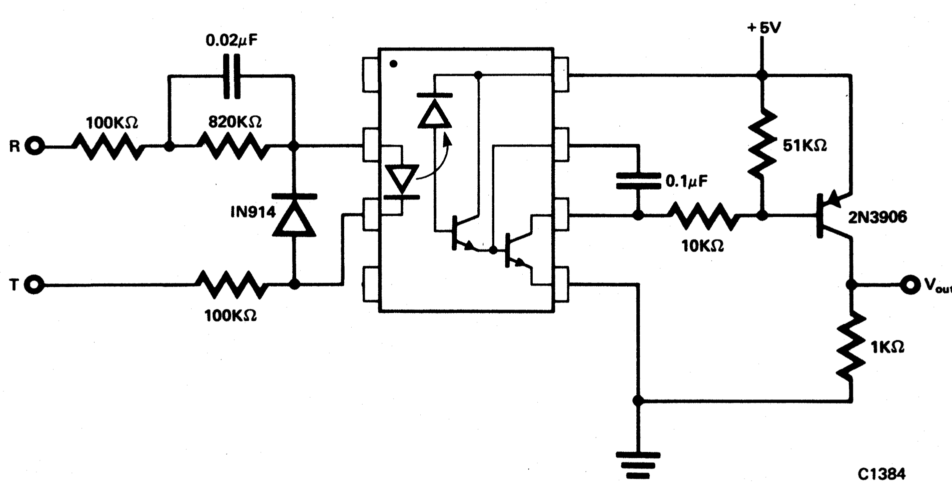
$$R_2 = \frac{V_{DD2} - V_{OLX}(@\ I_L + I_2)}{I_L}$$

WHERE: V_{DD1} : INPUT SUPPLY VOLTAGE
V_{DD2} : OUTPUT SUPPLY VOLTAGE
V_{DF} : DIODE FORWARD VOLTAGE
V_{OL1} : LOGIC "0" VOLTAGE OF DRIVER
V_{OH1} : LOGIC "1" VOLTAGE OF DRIVER
I_F : DIODE FORWARD CURRENT
V_{OLX} : SATURATION VOLTAGE OF MCC670
I_L : LOAD CURRENT THROUGH RESISTOR R_2
I_2 : INPUT CURRENT OF OUTPUT GATE.

CURRENT LIMITING
RESISTOR CALCULATION

			CMOS @ 5V	CMOS @ 10V	74XX	74LXX	74SXX	74LSXX	74HXX
		R_1 (Ω)	R_2 (Ω)	R_2 (Ω)	R_2 (Ω)	R_2 (Ω)	R_2 (Ω)	R_2 (Ω)	R_2 (Ω)
CMOS @ 5V	NON-INV.	2000	1000	2200	750	1000	1000	1000	560
	INV.	510							
CMOS @ 10V	NON-INV.	5100							
	INV.	4700							
74XX	NON-INV.	2200							
	INV.	180							
74LXX	NON-INV.	1800							
	INV.	100							
74SXX	NON-INV.	2000							
	INV.	360							
74LSXX	NON-INV.	2000							
	INV.	180							
74HXX	NON-INV.	2000							
	INV.	180							

RESISTOR VALUES FOR LOGIC INTERFACE



TELEPHONE RINGING DETECTION USING OPTO-ISOLATOR

ELECTRICAL CHARACTERISTIC CURVES (25°C Free air temperature unless specified)

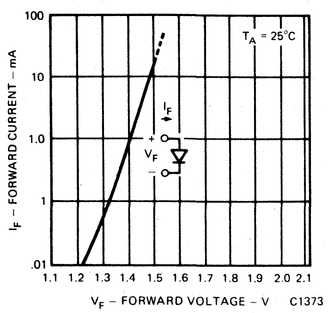


Fig. 1. Input Diode Forward Current vs. Forward Voltage

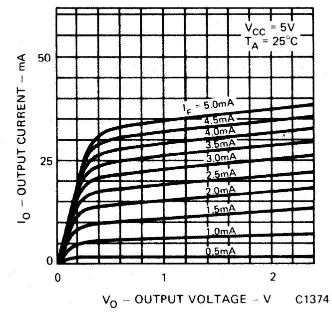


Fig. 2. 6N138 DC Transfer Characteristics

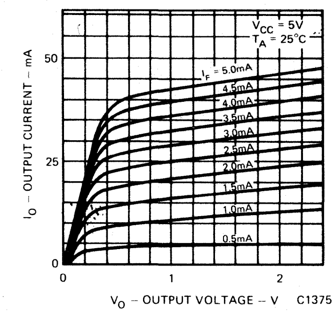


Fig. 3. 6N139 DC Transfer Characteristics

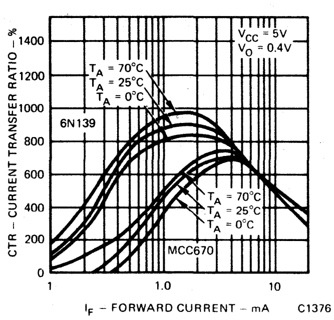


Fig. 4. Current Transfer Ratio vs. Forward Current

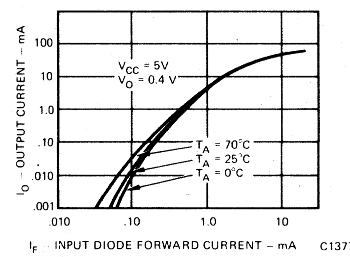


Fig. 5. 6N138 Output Current vs. Input Diode Forward Current

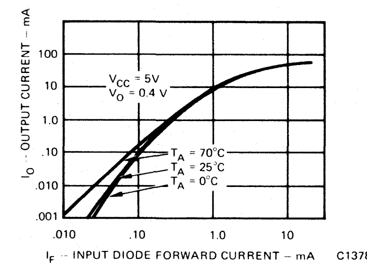


Fig. 6. 6N139 Output Current vs. Input Diode Forward Current

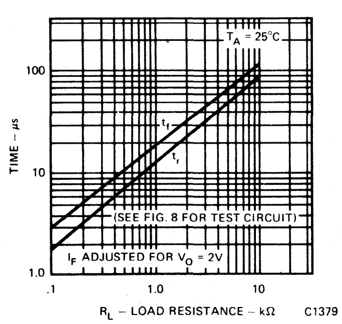


Fig. 7. Non-Saturated Rise and Fall Times vs. Load Resistance

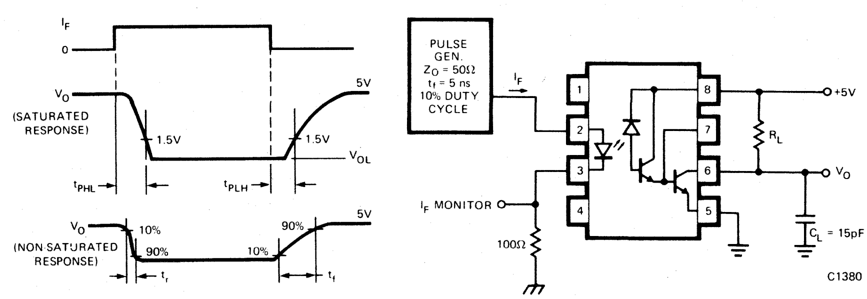


Fig. 8. Switching Test Circuit

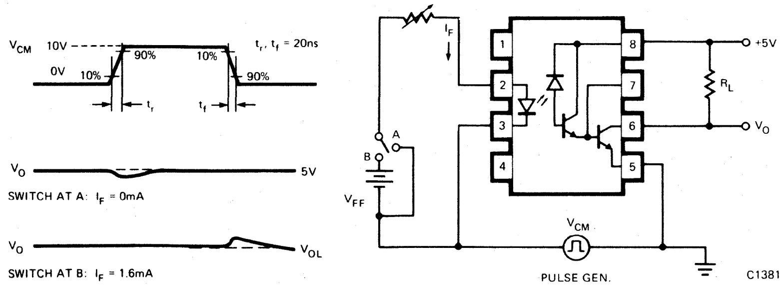


Fig. 9. Test Circuit for Transient Immunity and Typical Waveforms

6N138 6N139 (MCC670 MCC671)

ELECTRICAL SPECIFICATIONS (0° to +70°C Temperature unless otherwise specified)

CHARACTERISTIC	SYMBOL	DEVICE	MIN	TYP*	MAX	UNITS	TEST CONDITIONS
*Current Transfer Ratio (Notes 5, 6)		6N139	400	800		%	I_F = 0.5 mA, V_O = 0.4 V, V_{CC} = 4.5 V
			500	900			I_F = 1.6 mA, V_O = 0.4 V, V_{CC} = 4.5 V
		6N138	300	600		%	I_F = 1.6 mA, V_O = 0.4 V, V_{CC} = 4.5 V
Logic Low Output Voltage (Note 6)	V_{CL}	6N139		0.06	0.4	V	I_F = 1.6 mA, I_O = 6.4 mA, V_{CC} = 4.5 V
				0.08	0.4		I_F = 5 mA, I_O = 15 mA, V_{CC} = 4.5 V
				0.09	0.4		I_F = 12 mA, I_O = 24 mA, V_{CC} = 4.5 V
		6N138		0.06	0.4	V	I_F = 1.6 mA, I_O = 4.8 mA, V_{CC} = 4.5 V
*Logic High Output Current (Note 6)	I_{OH}	6N139		0.1	100	μA	I_F = 0 mA, V_O = V_{CC} = 18 V
		6N138		0.001	250	μA	I_F = 0 mA, V_O = V_{CC} = 7 V
Logic Low Supply Current (Note 6)	I_{CCL}	6N138/6N139		0.20		mA	I_F = 1.6 mA, V_O = Open, V_{CC} = 5 V
Logic High Supply Current (Note 6)	I_{CCH}	6N138/6N139		10.0		nA	I_F = 0 mA, V_O = Open, V_{CC} = 5 V
*Input Forward Voltage	V_F	6N138/6N139		1.45	1.7	V	I_F = 1.6 mA, T_A = 25°C
Reverse Breakdown Voltage	BV_R	6N138/6N139	5			V	I_R = 10 mA, T_A = 25°C
Temperature Coefficient of Forward Voltage	$\frac{\Delta V_F}{\Delta T_A}$	6N138/6N139		−1.8		mV/°C	I_F = 1.6 mA
Input Capacitance	C_O	6N138/6N139		40		pF	f = 1 MHz, V_F = 0
*Isolation Leakage (Input-Output) (Note 7)	I_{I-O}	6N138/6N139			1.0	μA	45% Relative Humidity, T_A = 25°C V_{I-O} = 3000 V, t_d = 5 sec
Resistance (Input-Output) (Note 7)	R_{I-O}	6N138/6N139		10^{12}		Ω	V_{I-O} = 500 Vdc
Capacitance (Input-Output) (Note 7)	C_{I-O}	6N138/6N139		0.6		pF	f = 1 MHz

(All typicals at T_A = 25°C and V_{CC} = 5 V, unless otherwise noted.)

SWITCHING SPECIFICATIONS (T_A = 25°C)

PARAMETER	SYMBOL	DEVICE	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Propagation Delay Time To *Logic Low at Output (See Fig. 8; Notes 6, 8)	t_{PHL}	6N139		5.0	25	μs	I_F = 0.5 mA, R_L = 4.7 kΩ
		6N139		0.2	1	μs	I_F = 12 mA, R_L = 270 Ω
		6N138		1.0	10	μs	I_F = 1.6 mA, R_L = 2.2 kΩ
Propagation Delay Time To *Logic High at Output (See Fig. 8; Notes 6, 8)	t_{PLH}	6N139		1 0	60	μs	I_F = 0.5 mA, R_L = 4.7 kΩ
		6N139		1.0	7	μs	I_F = 12 mA, R_L = 270 Ω
		6N138		4.0	35	μs	I_F = 1.6 mA, R_L = 2.2 kΩ
Common Mode Transient Immunity at Logic High Level Output (See Fig. 9; Note 9)	CM_H			>500		V/μs	I_F = 0 mA, R_L = 2.2 kΩ $\lvert V_{cm}\rvert$ = 10 V_{p-p}
Common Mode Transient Immunity at Logic Low Level Output (See Fig. 9; Note 9)	CM_L			<−500		V/μs	I_F = 1.6 mA, R_L = 2.2 kΩ $\lvert V_{cm}\rvert$ = 10 V_{p-p}

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 output 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. *Use of 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).*

*JEDEC registered data

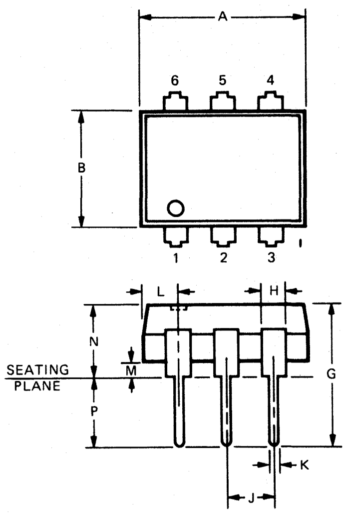
GENERAL INSTRUMENT
Optoelectronics

MCA230
MCA255
PHOTO-DARLINGTON OPTOISOLATOR

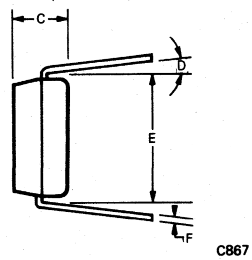
PRODUCT DESCRIPTION

The MCA230 and MCA255 optoisolators contain a gallium arsenide infrared emitting diode optically coupled to a silicon planar photo-darlington transistor. Both units are sealed in a 6-lead plastic DIP package. Electrical isolation compares favorably with that of a relay—without the relay's inherent magnetic field. The MCA230 has a minimum collector-emitter breakdown voltage of 30 volts and the MCA255, 55 volts.

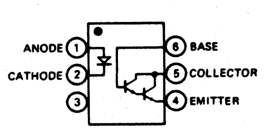
PACKAGE DIMENSIONS



PACKAGE MATERIALS:
Leads – Tinned with 60/40 tin lead
Body – Silicone plastic



SYMBOL	INCH MAX.	MM. MAX.	NOTES
A	.365	9.27	
B	.270	6.73	
C	.130	3.18	
D	15°	15°	
E	.300 Ref	7.62 Ref	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			3



NOTES
1. Installed position of lead centers
2. Four places
3. Overall installed position
4. These measurements are made from the seating plane

FEATURES & APPLICATIONS

- High collector current rating—125 mA
- Fast operate time—10 μs
- Fast release time—35 μs
- High isolation resistance—10^{11} Ω
- High dielectric strength, input to output—3550 VDC
- Low coupling capacitance—0.5 pF
- Convenient package—plastic dual-in-line
- Long lifetime, solid state reliability
- Low weight—0.4 grams
- Replace reed relays for 50 mA, 55 V DC loads.
- Replace pulse transformers.
- Form multiple contact, NO/NC relays.
- Useful for telephone lines, telegraph lines, SCR triggers, hospital monitoring systems, airborne systems, remote data gathering systems and remote control systems.
- Use as a low-current alarm monitor for battery powered supplies.

ABSOLUTE MAXIMUM RATINGS

Storage Temperature . . . . –55°C to 150°C
Operating Temperature . . . . –55°C to 100°C
Lead Soldering time @ 260°C . . . . .7.0 sec
Total power dissipation @ 25°C ambient . . . . 250 mW
Derate linearly from 25°C . . . . 3.3 mW/°C

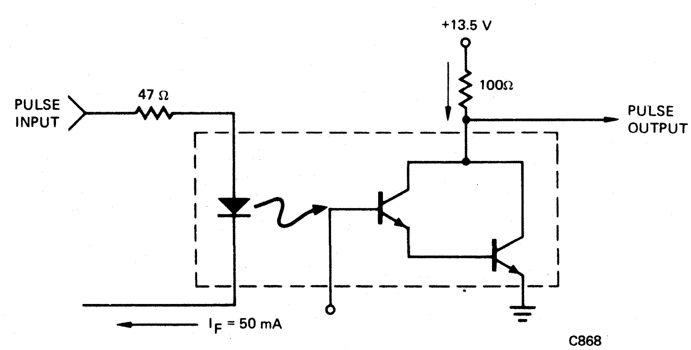
LED (GaAs Diode)
Power dissipation @ 25°C ambient . . . . 90 mW
Derate linearly from 25°C . . . . 1.2 mW/°C
Continuous forward current . . . . 60 mA
Reverse voltage . . . . 3.0 V
Peak forward current (1 μsec pulse, 300 pps) . . 3.0 A

DETECTOR
(Silicon Photo Transistor) **MCA230** **MCA255**
Power dissipation
@ 25°C ambient . . . . .210 mW . . .210 mW
Derate linearly from 25°C . . 2.8 mW/°C .2.8 mW/°C
Collector-emitter breakdown
voltage (BV_{CEO}) . . . . 30 V . . . . . 55 V
Collector-base breakdown
voltage (BV_{CBO}) . . . . 30 V . . . . . 55 V
Emitter-base breakdown
voltage (BV_{EBO}) . . . . 8.0 V . . . . 8.0 V
Collector-emitter
current (I_{CE}) . . . . .125.0 mA 125.0mA

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
EMITTER						
Forward Voltage	V_F		1.25	1.5	V	I_F = 20 mA
Reverse Voltage	V_R	3	25		V	I_R = 10 μA
Capacitance	C_J		50		pF	V = 0
DETECTOR						
Gain	H_{FE}		25,000			V_{CE} = 5 V, I_C = 0.5 mA
Collector Breakdown Voltage	BV_{CEO}	30/55			V	I_C = 100 μA, I_F = 0
Base Breakdown Voltage	BV_{CBO}	30/55			V	I_C = 10 μA, I_F = 0
Emitter Breakdown Voltage	BV_{EBO}	8			V	I_E = 1 μA, I_F = 0
Collector Leakage Current	I_{CEO} (DARK)		1.0	100	nA	V_{CE} = 10 V, I_F = 0
Capacitance						
Collector-Emitter			3.4		pF	V_{CE} = 10 V
Collector-Base			10		pF	V_{CB} = 10 V
Emitter-Base			10		pF	V_{EB} = 0.5 V
COUPLED						
DC Base Current Transfer Ratio			0.1		%	I_F = 50 mA, V_{CB} = 10 V
DC Collector Current Transfer Ratio		100	400		%	I_F = 10 mA, V_{CE} = 5 V, Note 1
Saturation Voltage	V_{CE} (SAT)			1.0	V	I_C = 50 mA, I_F = 50 mA
Bandwidth (50% Δ CTR)			10		kHz	I_C = 10 mA, Note 2, R_L = 100 Ω, V_{CE} = 10 V
Fall time	t_f		35		μsec	See switching time test circuit Note 3
Rise time	t_r		5		μsec	See switching time test circuit Note 3
ISOLATION						
DC Voltage Breakdown	V_{ISO}	3550			V	t = 1 second
Resistance	R_{ISO}	10^{11}	10^{12}		Ω	V = 500 VDC
Leakage Current	I_{ISO}		10		μA	V_{ISO} = 1500 VDC.
Capacitance	C_{ISO}		0.5		pF	
Dielectric Dissipation Limit		50,000			VHz	RMS
AC Voltage Limit @ 60 Hz		2500			V_{RMS}	t = 1 second

SWITCHING TIME TEST CIRCUIT



Pulse Width = 1 ms
Pulse Rep Rate = 100 Hz

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

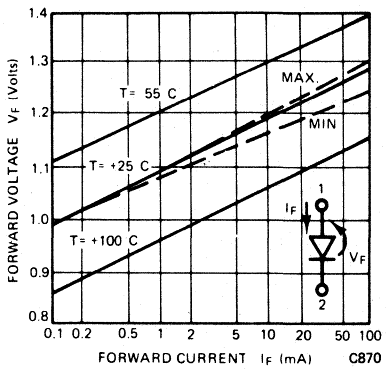


Fig. 1. Forward Voltage Drop vs. Forward Current

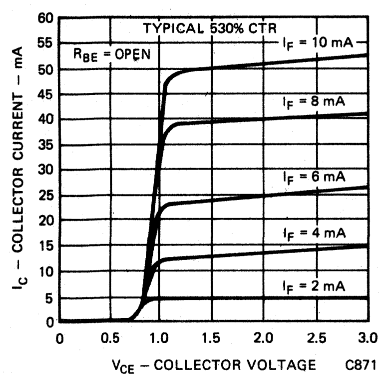


Fig. 2. Collector Current vs. Collector Voltage

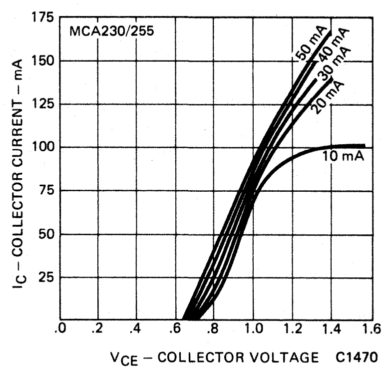


Fig. 3. Collector Current vs. Collector Voltage

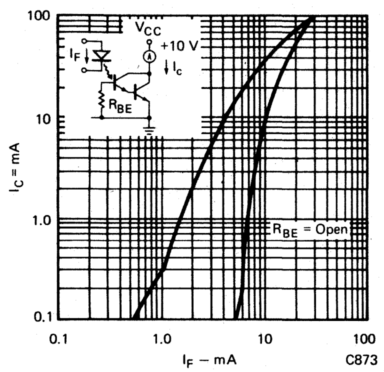


Fig. 4. Current Transfer Characteristic

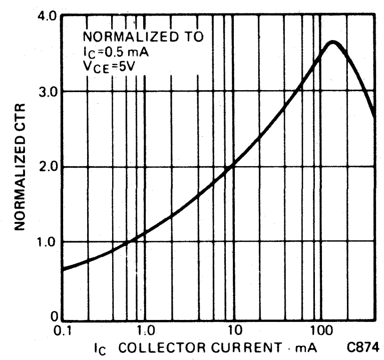


Fig. 5. Normalized CTR vs. Collector Current

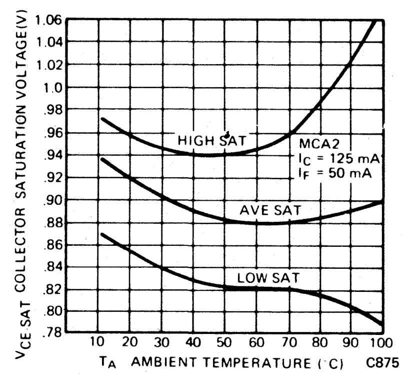


Fig. 6. $V_{CE\text{-}SAT}$ vs. Temperature

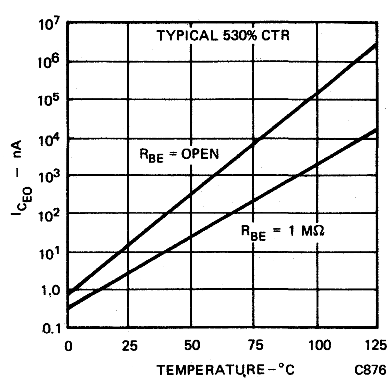


Fig. 7. I_{CEO} vs. Temperature

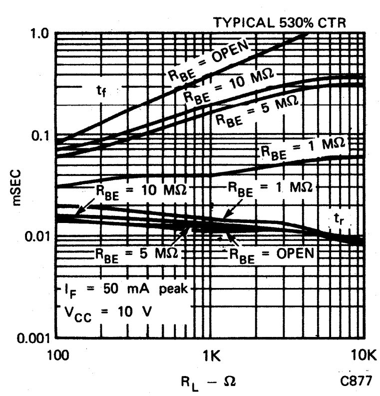


Fig. 8. Switching Times

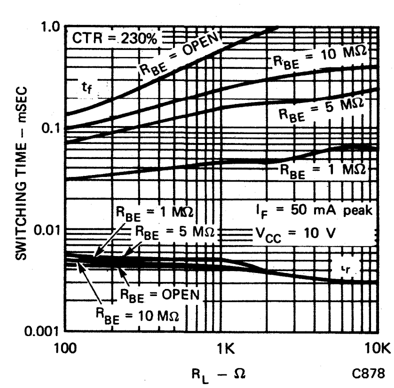


Fig. 9. Switching Times

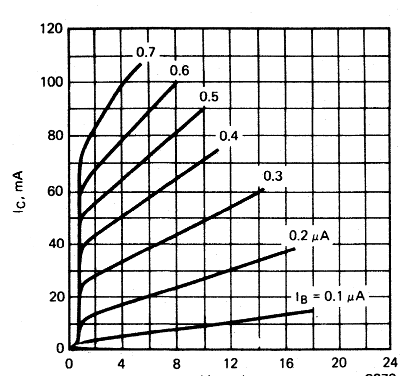


Fig. 10 Detector Standard Transfer Curves

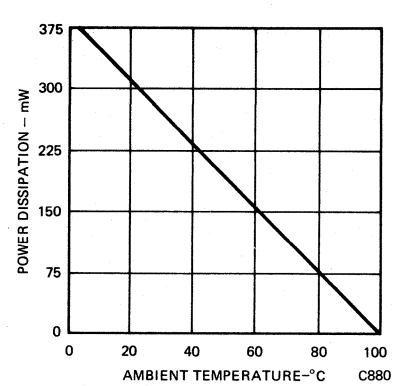


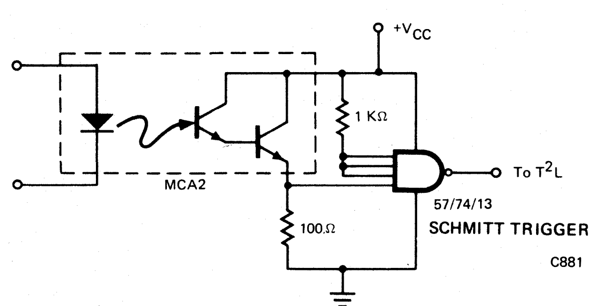
Fig. 11. Package Power Derating

DC RELAY CHARACTERISTICS (TYPICAL)

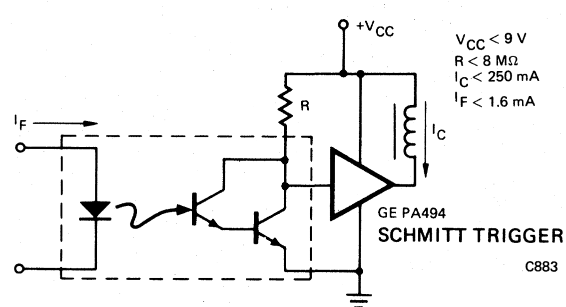
CONTACTS		
Contact configuration		SPST-NO
Contact load rating		50 mA DC
Contact withstand voltage	MCA230	30 V DC
	MCA255	55 V DC
Closed contact voltage		1.0 V
Operate time with 100 Ωload		10 μseconds
Release time with 100 Ωload		35 μseconds
COIL		
Turn on voltage		1.3 V
Turn on current at rated contact load		50 mA
ISOLATION		
Dielectric strength, contacts to coil		3550 VDC minimum
Isolation resistance, contact to coil		10^{11} Ohms
Capacitance, contacts to coil		1.0 pF
WEIGHT		0.4 grams

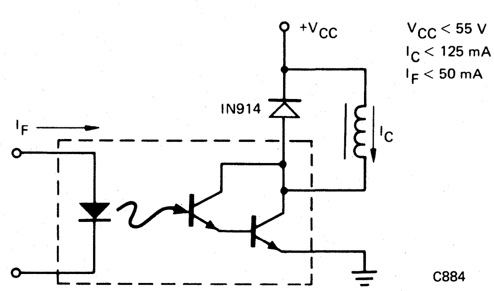
APPLICATION CIRCUITS

ISOLATE T^2L LOGIC WITH MCA2



OPERATING A RELAY COIL WITH MCA2





NOTES

1. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 5 volts.*
2. *The frequency at which i_C is 3 dB down from the 1 kHz value.*
3. *Rise time (t_r) is the time required for the collector current to increase from 10% of its final value, to 90%. Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value to 10%.*

GENERAL INSTRUMENT
Optoelectronics

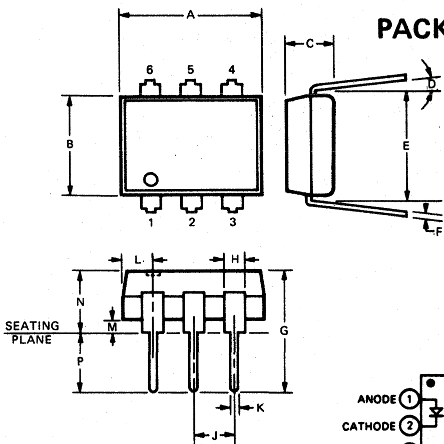
MCA231

PHOTO-DARLINGTON OPTOISOLATOR

PRODUCT DESCRIPTION

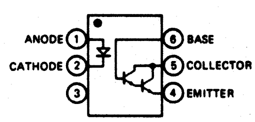
The MCA231 contains a gallium arsenide infrared emitter optically coupled to a silicon planar photo-darlington. Both units are sealed in a 6-lead plastic DIP package.

PACKAGE DIMENSIONS



SYMBOL	INCH MAX.	MM. MAX.	NOTES
A	.365	9.27	
B	.270	6.73	
C	.130	3.18	
D	15°	15°	
E	.300 Ref	7.62 Ref	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			3

NOTES
1. Installed position of lead centers
2. Four places
3. Overall installed position
4. These measurements are made from the seating plane



C1339

PACKAGE MATERIALS:
Leads – Tinned with 60/40 tin lead
Body – Silicone plastic

FEATURES

- High sensitivity—1 mA on the input will sink a TTL gate.
- High isolation—3550 VDC, $10^{12}\ \Omega$, 0.5 pF

TYPICAL APPLICATIONS

- Isolate logic from 110/220 VAC.
- Eliminate troublesome ground loop problems by coupling directly to twisted pair lines in digital systems. Particularly useful for telephone lines, telegraph lines, SCR triggers, hospital monitoring systems, airborne systems, remote data gathering systems, and remote control systems.

ABSOLUTE MAXIMUM RATINGS

Storage Temperature Range . . . . −65°C to +150°C
Operating Temperature Range . . . . −55°C to +100°C
Lead Temp. (Soldering, 10 sec) . . . . 260°C
Total Power Diss. @ 25°C Free
  Air Temperature . . . . 250 mW
  Derate Linearly to 100°C (θ_{JA}) . . . . 3.3 mW/°C
Input to Output Isolation Voltage . . . . 3550 VDC
  (1 second)

Input Diode
  Forward Current . . . . 60 mA
  Reverse Voltage . . . . 3.0 V
  Peak Forward Current (1 μs pulse, 300 pps) . . . . . . 3.0 A
Output Darlington
  Collector-Emitter Voltage . . . . 30 V
  Collector-Base Voltage . . . . 30 V
  Emitter-Base Voltage . . . . 6 V
  Collector Current . . . . 125 mA

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Isolation between emitter and detector						
Capacitance	C_{iso}		0.5		pF	f = 1 MHz
Resistance	R_{iso}	10^{11}	10^{12}		Ω	V = 500 VDC
Voltage Breakdown	V_{iso}	3550			VDC	t = 1 second
Emitter (GaAs LED)						
Forward Voltage	V_F		1.15	1.5	V	I_F = 20 mA
Reverse Voltage	V_R	3.0	25		V	I_R = 10 μA
Junction Capacitance	C_J		50		pF	V_R = 0 V
Detector (Silicon Photo-Darlington)						
Collector Breakdown Voltage	V(BR)CEO	30	60		V	I_C = 1 mA
Base Breakdown Voltage	V(BR)CBO	30	60		V	I_C = 10 μA
Emitter Breakdown Voltage	V(BR)EBO	6	8		V	I_E = 10 μA
Collector Leakage Current	I_{CEO}		1	100	nA	V_{CE} = 10 V
Saturation Voltage	$V_{CE(sat)}$		0.8	1.0	V	I_C = 2 mA, I_F = 1 mA
Saturation Voltage	$V_{CE(sat)}$		0.8	1.0	V	I_C = 10 mA, I_F = 5 mA
Saturation Voltage	$V_{CE(sat)}$		0.9	1.2	V	I_C = 50 mA, I_F = 10 mA
Base photo-current	I_B		2		μA	V_{CB} = 5 V, I_F = 10 mA
Darlington gain	h_{FE}		50 k			I_B = 1 μA, V_{CE} = 1 V
Collector-emitter capacitance	C_{CE}		6		pF	V_{CE} = 10 V
Switching Times, Coupled						
Rise time, fall time	t_r, t_f		80		μs	V_{CC} = 10 V, I_C = 10 mA, R_L = 100Ω
TTL gate turn-on time	t_{ON}		200		μs	I_F = 1 mA, Fig. 10
TTL gate turn-off time	t_{OFF}		400		μs	I_F = 1 mA, Fig. 10
DC Collector Current Transfer Ratio	CTR	200	400		%	I_F = 10 mA, V_{CE} = 5 V

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

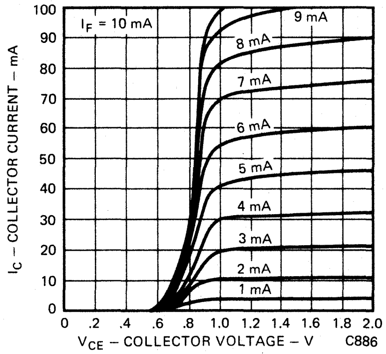


Figure 1. Collector Current vs. Collector Voltage

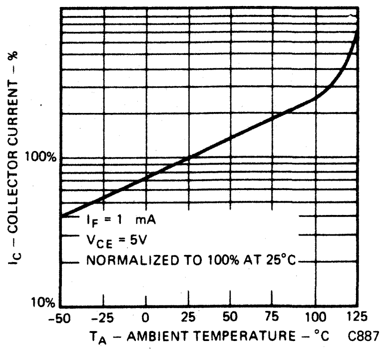


Figure 2. Collector Current vs. Ambient Temperature

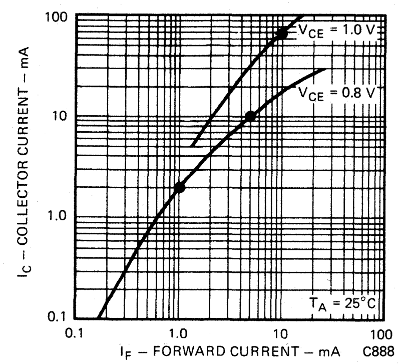


Figure 3. Collector Current vs. LED Current

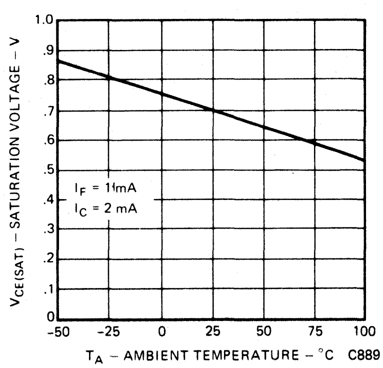


Figure 4. Saturation Voltage vs. Temperature

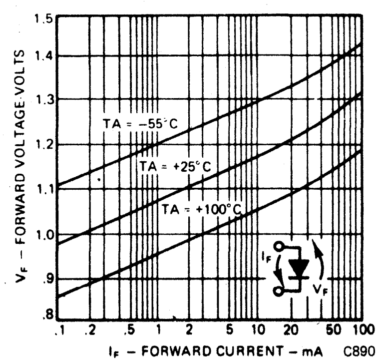


Figure 5. Forward Voltage vs. Forward Current

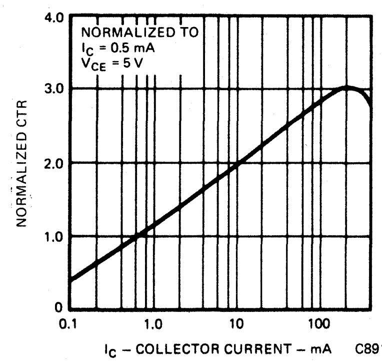


Figure 6. Normalized CTR vs. Collector Current

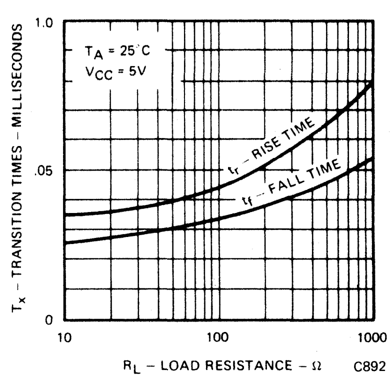


Figure 7. Non-Saturated Rise and Fall Times vs. Load Resistance

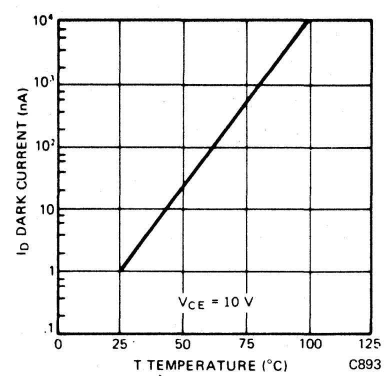


Figure 8. Dark Current vs. Temperature

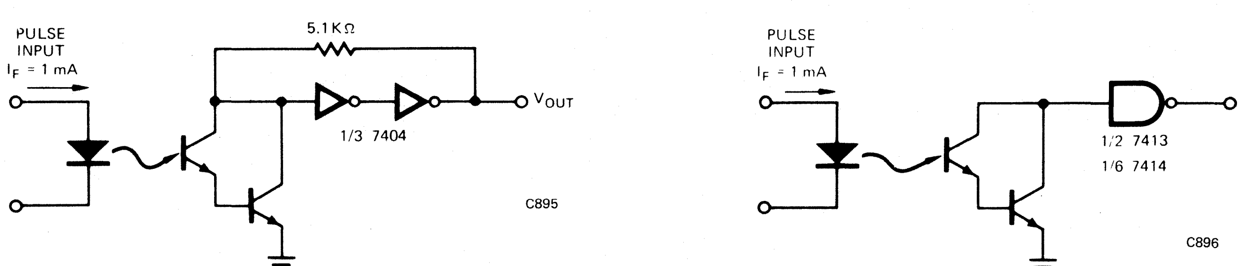


Figure 10. Logic Interface

NOTES

See MCA230 for circuits

GENERAL INSTRUMENT
Optoelectronics

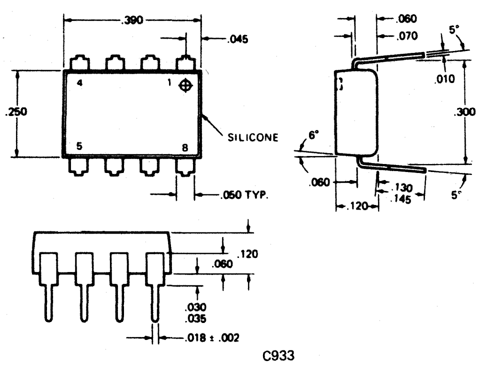
MCL601
MCL611
OPTICALLY ISOLATED LOGIC GATE

PRODUCT DESCRIPTION

The MCL601 and MCL611, are optically isolated logic gates in an 8-lead DIP package. A GaAs LED radiates infrared light onto a high speed photodiode detector, thus providing electrical isolation of ±2000 V between input and output. A differential comparator amplifies the photodiode signal, and a Schmitt trigger improves noise immunity by providing threshold and hysteresis. A standard open collector circuit on the output offers normal current sinking capability. The LED drive current requirement matches either mode of logic loading. The output is compatible to most logic systems. The MCL601 has a 0.1 MHz data rate; the MCL 611 has a 1 MHz data rate.

PACKAGE DIMENSIONS

ALL DIMENSIONS IN INCHES



PIN	
1	LED ANODE
2	LED CATHODE
3	N/C
4	N/C
5	OUT
6	GROUND
7	V_{CC}
8	PHOTO DIODE CATHODE

C933

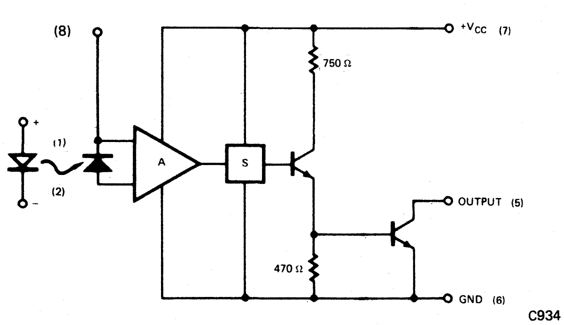
FEATURES

- Compatible TTL input drive load
- Output compatible to TTL, DTL, RTL, CTL, HiNIL
- Single +5 V_{CC} supply required
- High toggle speed, high data rate
- Short transmission delay
- Small 8 pin DIP, two packages fit 16 pin socket
- High isolation between input-output
- High CMRR (Common Mode Rejection Ratio)
- Built-in hysteresis for noise immunity
- Output ORing capability

APPLICATIONS

- Digital logic to digital logic isolator—eliminates spurious grounds
- DC input level sensor—Schmitt trigger toggle
- AC to TTL conversion—square wave shaping
- Line receiver—eliminates CMN and ground loop transients
- Logic level shifter, input-output independent ground systems

SCHEMATIC DIAGRAM

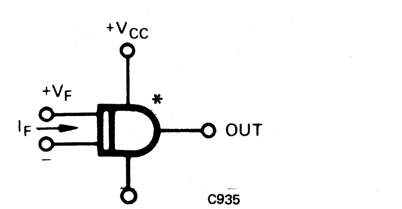


C934

A = Differential amp, comparator
S = Schmitt trigger, threshold hysteresis

Typical Values Shown

SYMBOL



C935

* OPEN COLLECTOR

ABSOLUTE MAXIMUM RATINGS

Storage temperature . . . . –55°C to +150°C
Operating temperature . . . . 0°C to +70°C
Lead temperature (Soldering, 10 sec.) . . . . 260°C

Input Diode
- Forward DC current . . . . 20 mA
- Reverse Voltage 3V
- Peak forward current (1 μs pulse, 300 pps) . . . . 3.0 A
- Power dissipation at 25°C ambient . . . . . . 100 mW
- Derate linearly from 25°C . . . . 1.33 mW/°C

Output Gate
- Power dissipation at 25°C ambient . . . . . . 100 mW
- Derate linearly from 25°C . . . . 1.33 mW/°C
- DC supply current I_{CC} . . . . 30 mA
- Output collector voltage V_{SS} 15V
- V_{CC} 8V
- Output current low—I_{OL} . . . . 16 mA

Input to output voltage . . . . ±2000 V DC

Note: The input is not specified as "HI" or "LOW" as with normal gate units. The input is "ON" or "OFF," set by the current flow through the input LED. Thus the input may be "ON" for logic drive "HI" (pull up load system, Figure 1A) or logic drive "LOW" (pull down load systems, Figure 1B, as in open collector output devices.) See Z plot.

As a convenience of notation, reference will be made to a pull down type load input connected as in Figure 1B. A logical "LOW" is "ON", and a logical "HI" is "OFF".

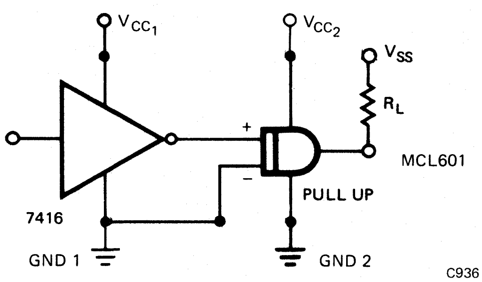


Figure 1A

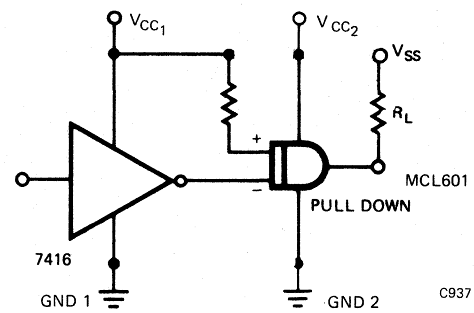


Figure 1B

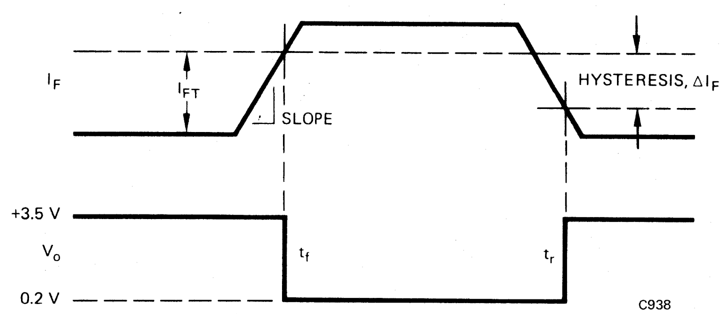


Figure 2A

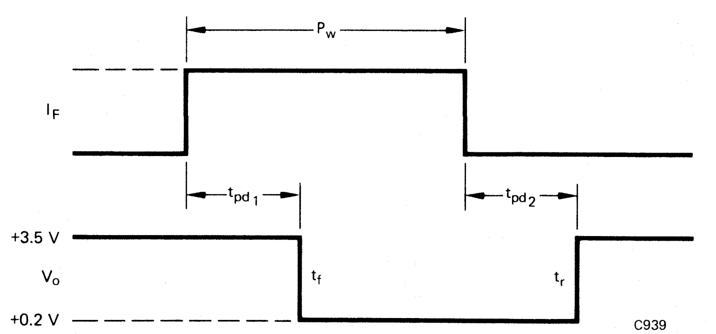


Figure 2B

The MCL input may be driven in series or in parallel with other MCL units, and/or in parallel with other logic units. The input of the MCL has an equivalent unit load (U.L.) rating related to current requirements.

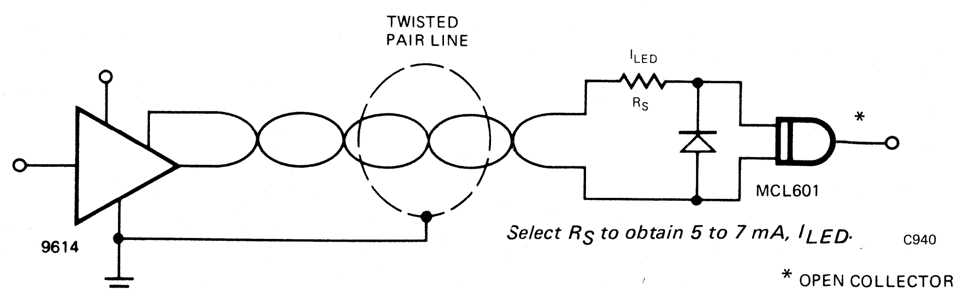


Fig. 3. Line Receiver

RECOMMENDED OPERATING CONDITIONS

PARAMETER		LIMITS MIN.	TYP.	MAX.	UNITS
Supply Voltage V_{CC}		4.5	5.0	5.5	Volts
Operating Free Air Temperature Range		0	25	70	°C
Normalized Fan Out	Logic HIGH			20	U.L.
	Logic LOW			10	U.L.
Maximum Input Rise and Fall Time	Slope		No Restriction		
Minimum Input Rise and Fall Time	Slope		See Fig. 2A		
Minimum Pulse Width			least t_{pd}		

ELECTRICAL CHARACTERISTICS (25°C)

PARAMETER	SYMBOL	LIMITS MIN.	TYP. (Note 2)	MAX.	UNITS	TEST CONDITIONS (Note 1)
Input Diode						
Forward Voltage	V_F		1.25	1.50	V	I_F = 20 mA
Forward Voltage Temp Coefficient			−1.8		mV/°C	
Reverse Breakdown Voltage	BV_R	3.0	5.5		V	I_R = 10 μA
Reverse Leakage Current			.001	10	μA	V_R = 3.0 V
Junction Capacitance	C_J		50		pF	V_F = 0
Rise Time	tr		20		ns	I_F = 50 mA, 50Ω system
Fall Time	tf		20		ns	I_F = 50 mA, 50Ω system
Output						
Output Current HIGH (collector leakage)	I_{OHL}			200	μA	V_{CC} = 4.5 V, I_F = 0 mA, V_{OH} = 15 V
Output Voltage LOW	V_{OL}		0.2	0.4	Volts	V_{CC} = 4.5 V, I_F = (ON)MAX, I_{OL} = 16 mA
Supply Current HIGH	I_{CCH}		6	15	mA	V_{CC} = 5.5V, I_F = 0 mA
Supply Current LOW	I_{CCL}		10	25	mA	V_{CC} = 5.5V, I_F = 20 mA
MCL601, 5 mA DRIVE (V_{CC} = 5 V)						
Switching Characteristics (Fig. 2B)						
t_{pd} (On)			2	4	μs	I_F = 3.0 mA
t_{pd} (Off)			2	4	μs	I_F = 3.0 mA
tr, tf			10		ns	C_L = 25 pF, R_L = 280Ω
Binary data rate		0.1	0.2		MHz	I_F = 3.0 mA, R_L = 280 Ω
Input Diode						
I_F (On)			3.0	5.0	mA	
I_F (Off)		0.5	2.0		mA	
ΔI_F (hysteresis)			1.0		mA	
V_F (On)			1.15		V	I_F = 5.0 mA
V_F (Off)			0.95		V	I_F = 1.0 mA
Input load equivalent			2		U.L.	
MCL611, 15 mA DRIVE (V_{CC} = 5 V)						
Switching Characteristics (Fig. 2B)						
t_{pd} (On) (Fig. 9)			.3	.6	μs	I_F = 10 mA
t_{pd} (Off)					μs	I_F = 10 mA
tr, tf			10		ns	C_L = 25 pF, R_L = 280Ω
Binary data rate		1.0	1.2		MHz	I_F = 3.0 mA, R_L = 280 Ω
Input Diode (Fig. 11)						
I_F (On)			10	15	mA	
I_F (Off)		2.0	5		mA	
ΔI_F (hysteresis)			5		mA	
V_F (On)			1.1	1.30	V	I_F = 10 mA
V_F (Off)		1.00	1.1		V	I_F = 2.5 mA
Input load equivalent			6		U.L.	
ISOLATION						
DC Voltage Breakdown		2000			VDC	t = 1 second
AC Voltage Limit @ 60 Hz		800			VRMS	
Capacitance			1.0		pF	
Resistance			10^{12}		Ω	v = 500 VDC

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

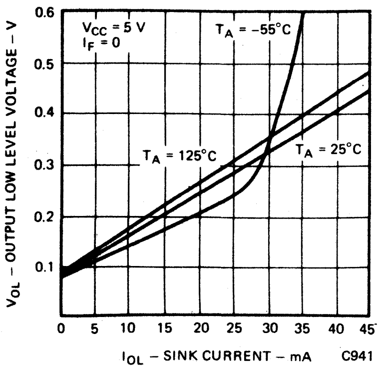


Fig. 4. Low Level Output Voltage vs. Sink Current

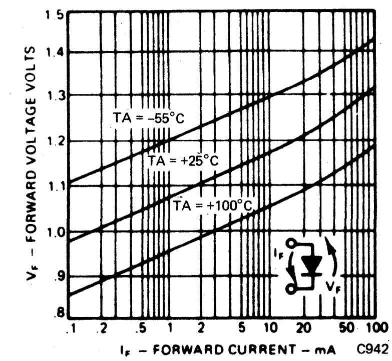


Fig. 5. Forward Voltage vs. Forward Current

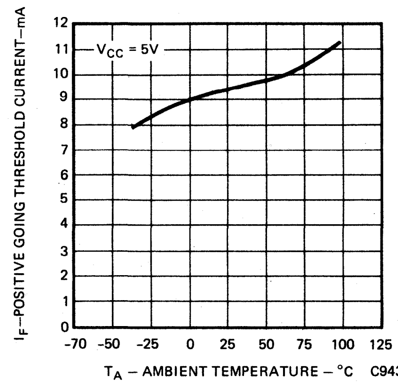


Fig. 6. MCL 611—Positive Going Threshold Current vs. Ambient Temperature

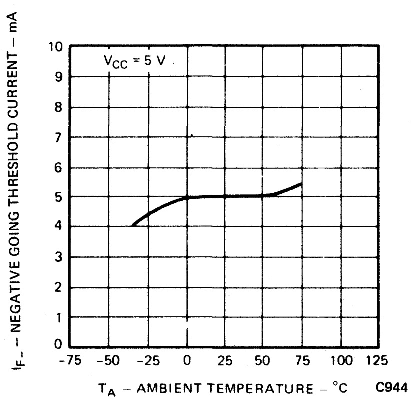


Fig. 7. MCL611—Negative-Going Threshold Current vs. Ambient Temperature

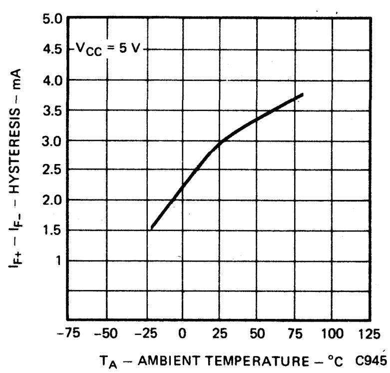


Fig. 8. MCL611—Hysteresis vs. Ambient Temperature

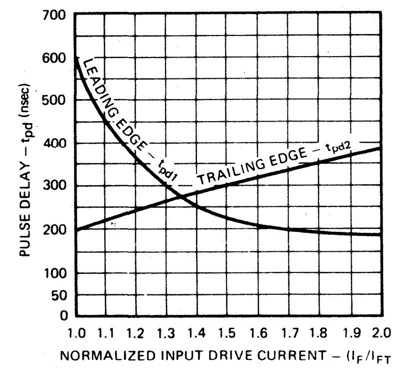


Fig. 9. MCL611—Normalized Input Drive Current vs. Pulse Delay

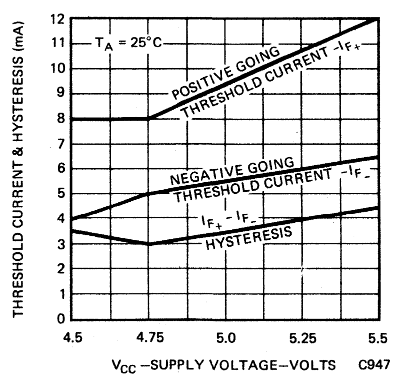


Fig. 10. MCL611—Threshold Current & Hysteresis vs. Supply Voltage

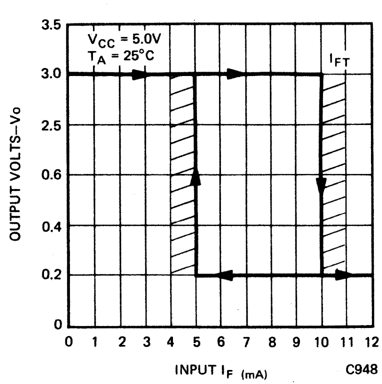


Fig. 11. MCL611—Threshold & Hysteresis of Input/Output

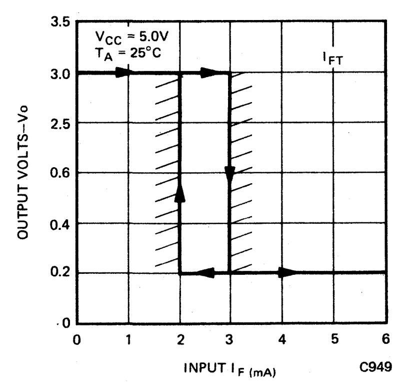


Fig. 12. MCL601—Threshold & Hysteresis of Input/Output

NOTES:

1. *For conditions shown as MIN. or MAX., use the appropriate value specified under recommended operating conditions for the applicable device type.*
2. *Typical limits are at V_{CC} = 5.0 V, 25°C.*

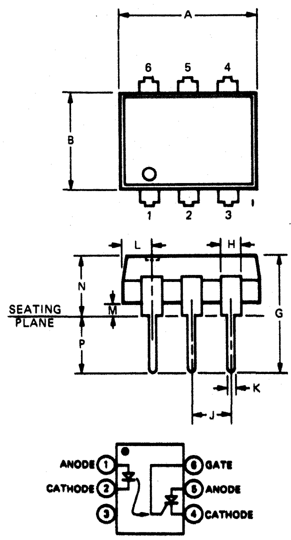
GENERAL INSTRUMENT
Optoelectronics

MCS2
MCS2400
PHOTO SCR OPTOISOLATOR

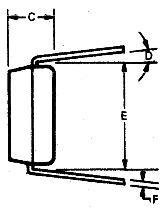
PRODUCT DESCRIPTION

The MCS2 and the MCS2400 devices consist of a photo SCR coupled to a gallium arsenide infrared diode in a six lead plastic DIP package. The MCS2 has a blocking voltage rating of 200 volts while the MCS2400 has a 400 volt rating.

PACKAGE DIMENSIONS



C1339



SYMBOL	INCH MAX.	MM. MAX.	NOTES
A	.365	9.27	
B	.270	6.73	
C	.130	3.18	
D	15°	15°	
E	.300 Ref	7.62 Ref	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			3

NOTES
1. Installed position of lead centers
2. Four places
3. Overall installed position
4. These measurements are made from the seating plane

PACKAGE MATERIALS:
Leads – Tinned with 60/40 tin lead
Body – Silicone plastic

FEATURES & APPLICATIONS

- Built-in memory
- AC switch (SPST)
- High current carrying capability (pulsed condition)
- Plastic dual-in-line package
- High isolation resistance—10^{11} Ω
- Compact, rugged, light-weight
- Low coupling capacitance . . . 1.0 pF typical
- MCS2400, UL recognized (File #E50151)

The Photo SCR coupled pair is intended for applications where complete electrical isolation is required between low power circuitry, such as integrated circuits, and AC line voltages. It provides high speed switching of relay functions. Because of its bistable characteristics, it lends itself for use as a latching relay in direct current circuits.

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Unless Otherwise Specified)

CHARACTERISTICS	MCS2 MIN.	MCS2 TYP.	MCS2 MAX.	MCS2400 MIN.	MCS2400 TYP.	MCS2400 MAX.	UNITS	TEST CONDITIONS
INPUT DIODE								
Forward voltage (V_F)		1.25	1.5		1.25	1.5	V	I_F = 20mA
Reverse voltage (V_R)	3.0	—	—	3.0	—	—	V	I_R = 10 μA
Reverse current (I_R)	—	.001	10	—	.001	10	μA	V_R = 3.0 V
Junction capacitance (C_J)	—	50	—	—	50	—	pF	V = 0
DETECTOR								
Forward leakage current (I_{FX})	—	.02	2.0	—	.02	2.0	μA	V_{FX} = Rated V_{FX}, R_{GK} = 27kΩ
Reverse leakage current (I_{RX})	—	.02	2.0	—	.02	2.0	μA	V_{RX} = Rated V_{RX}, R_{GK} = 27kΩ
Forward blocking voltage (V_{FXM}, V_{DM})	200	—	—	400	—	—	V	R_{GK} = 10kΩ @ 100°C
Reverse blocking voltage (V_{ROM})	200	—	—	400	—	—	V	R_{GK} = 10kΩ @ 100°C
On voltage (V_{TM})	—	.98	1.3	—	.98	1.3	V	I_T = 100 mA
Holding current (I_{HX})	.01	.16	.50	.01	.16	.50	mA	R_{GK} = 27kΩ
Gate trigger voltage (V_{GT})	—	0.5	1.0	—	0.6	1.0	V	V_{FX} = 100 V
Gate trigger current (I_{GT})	—	19	100	—	23	100	μA	V_{FX} = 100 V, R_L = 10kΩ, R_{GK} = 27kΩ
COUPLED								
Turn on current (threshold), (I_{FT})	0.5	5.0	14	0.5	5.0	14	mA	V_{FX} = 100 V, R_{GK} = 27kΩ
$t_r + t_d$ (See note 1) = (t_{on})	—	7	—	—	7	—	μs	I_F = 30 mA, R_{GK} = 27kΩ, V_{CC} = 20 V
Steady state voltage (V_{ISO})	**3150**	—	—	3150	—	—	VDC	t = 1 min.
	2250	—	—	2250	—	—	V_{RMS}	t = 1 min.
Surge isolation rating	**3550**	—	—	3550	—	—	VDC	t = 1 sec.
	2550	—	—	2550	—	—	V_{RMS}	t = 1 sec.
Isolation resistance (R_{ISO})	10^{11}	10^{12}	—	10^{11}	10^{12}	—	Ω	V = 500 VDC
Isolation capacitance (C_{ISO})	—	1.0	2	—	1.0	2	pF	f = 1 MHz

ABSOLUTE MAXIMUM RATINGS

Storage temperature –55°C to 150°C
Operating temperature –55°C to 100°C
Lead soldering time @ 260°C 7.0 seconds

LED (GaAs Diode)
Power dissipation @ 25°C ambient .... 90 mW
Derate linearly from 25°C .... 1.2 mW/°C
Continuous forward current .... 60 mA
Reverse voltage .... 3.0 V
Peak forward current .... 0.5 A
(50 μs pulse, 120 pps)

COUPLED
Isolation voltage .... 3550 VDC
Total package power dissipation .... 250 mW
Derate linearly from 25°C .... 3.3 mW/°C

DETECTOR (Photo SCR)
Power dissipation @ 25°C ambient .... 200 mW
Derate linearly from 25°C .... 2.67 mW/°C
MCS2 DC anode current .... 150 mA
MCS2400 DC anode current .... 100 mA
Peak pulse current (100 μs, 120 pps) .... 1.0 A
Average gate current .... 25 mA
Reverse gate current .... 1.0 mA
MCS2 anode voltage (DC or peak AC) .... 200 V
MCS2400 anode voltage (DC or peak AC) ..... 400 V

ELECTRO-OPTICAL CHARACTERISTIC CURVES (25°C Free Air Unless Otherwise Specified)

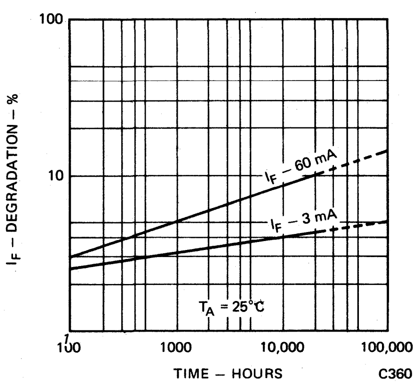


Fig. 1. LED Lifetime vs. Forward Current

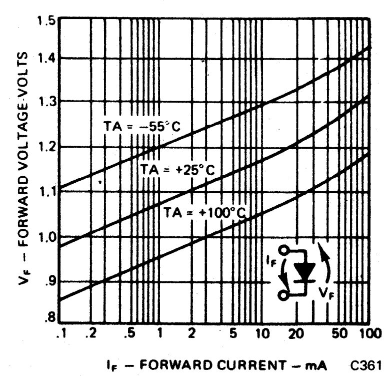


Fig. 2. Forward Voltage vs. Forward Current

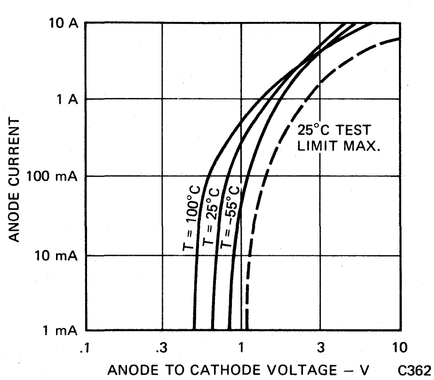


Fig. 3. Anode Current vs. Anode-Cathode Voltage

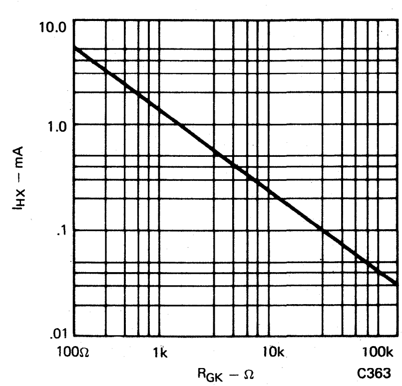


Fig. 4. Holding Current vs. Gate-Cathode Resistance

ELECTRO-OPTICAL CHARACTERISTIC CURVES (Cont'd) (25°C Free Air Unless Otherwise Specified)

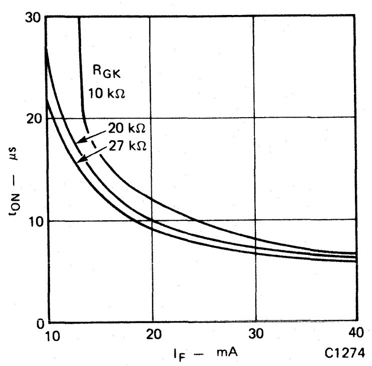


Fig. 5. Trigger Delay Time vs. Forward Current (note 1)

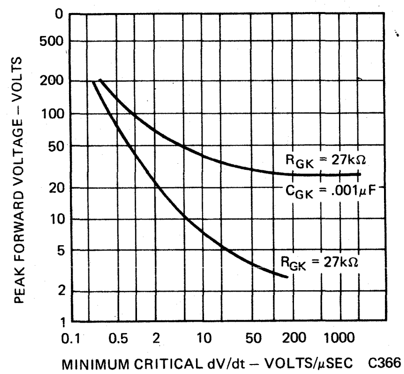


Fig. 6. Forward Blocking Voltage vs. Critical dV/dt

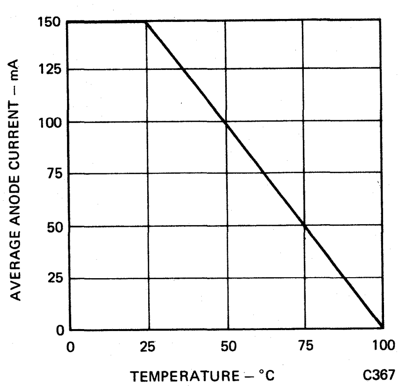


Fig. 7. Continuous Current Rating vs. Ambient Temperature

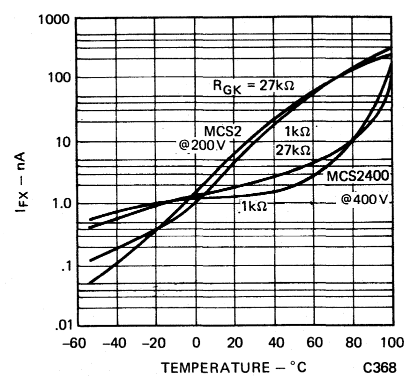


Fig. 8. Forward Leakage Current vs. Temperature

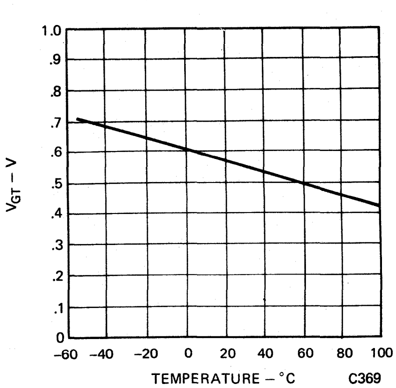


Fig. 9. Gate Trigger Voltage vs. Temperature

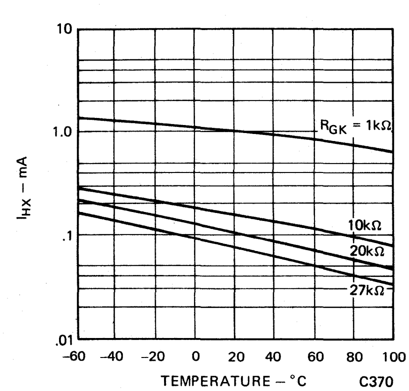
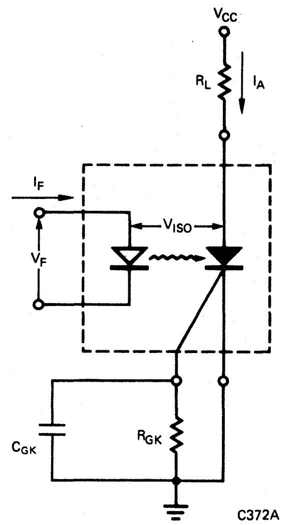
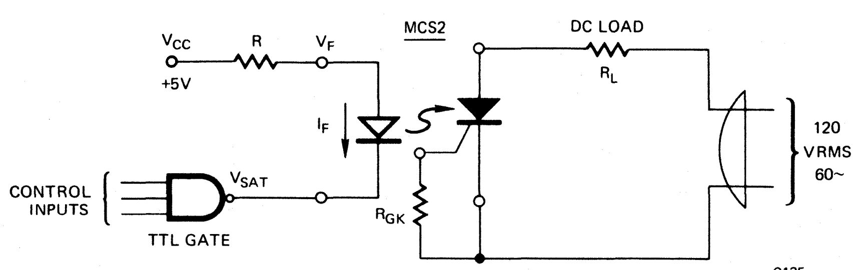


Fig. 10. Holding Current vs. Temperature

TYPICAL CIRCUIT APPLICATIONS



OPERATING SCHEMATICS



RELAY CIRCUIT FOR HALF WAVE A.C. CONDUCTION

NOTES

1. *The rise time of the SCR is typically less than 500 nanoseconds.*

GENERAL INSTRUMENT
Optoelectronics

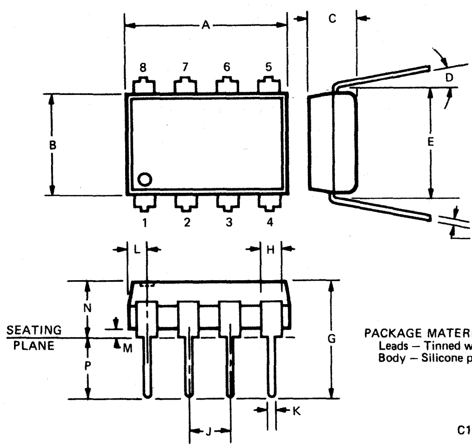
MCS6200
MCS6201

OPTICALLY ISOLATED SOLID STATE AC DIP RELAY

PRODUCT DESCRIPTION

The MCS6200 series are optically-isolated solid state relays with two photo-SCR's connected Anode-to-Cathode (see circuit diagram). Two Light Emitting Diodes, coupled to the photo-SCR's, provide independent SCR control. The MCS6200 features an input to output minimum breakdown voltage of 1500 VDC, while the MCS6201 features 2500 VDC.

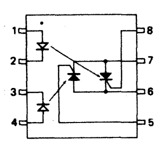
PACKAGE DIMENSIONS



SYMBOL	INCH MAX.	MM. MAX.	NOTES
A	.410	10.29	
B	.270	6.86	
C	.130	3.30	
D	15°	15°	
E	.300 Ref	7.62 Ref	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.055	1.40	2
M			3
N	.175	4.45	4
P			3

NOTES
1. Installed position of lead centers
2. Four places
3. Overall installed position
4. These measurements are made from the seating plane

PACKAGE MATERIALS:
Leads – Tinned with 60/40 tin lead
Body – Silicone plastic



C1340

FEATURES

- Fast switching
- Independent direction control
- Low input control power
- High pulse current capability
- High voltage isolation between input and output
- Compact plastic DIP package

APPLICATIONS

- AC power control
- Triac triggering
- Bi-directional motor control
- DC power supply polarity control

ABSOLUTE MAXIMUM RATINGS

Storage temperature –55° to 150°C
Operating temperature –55°C to 100°C
Lead soldering time @ 260°C 7.0 seconds

LED (GaAs Diode)
- Power dissipation @ 25°C ambient . . . . 90 mW
- Derate linearly from 25°C . . . . 1.2 mW/°C
- Continuous forward current . . . . 60 mA
- Reverse voltage . . . . 3.0 volts
- Peak forward current . . . . 0.5 A
  (50 μs pulse, non-repetitive)

COUPLED
- Total package power dissipation at 25° . . . . 300 mW
- Derate linearly from 25°C 3.1 mW/°C
- Input to output breakdown voltage
  - MCS6200 . . . . 1500 VDC
  - MCS6201 . . . . 2500 VDC

DETECTOR (Photo SCR) each direction
- Power dissipation @ 25°C ambient . . . . . . 200 mW
- Derate linearly from 25°C . . . . 2.67 mW/°C
- Continuous forward current . . . . 150 mA
- Peak pulse current (100 μsec @ 120 pps) . . . . 0.5 A
- Average gate current . . . . 25 mA
- Reverse gate current . . . . 1.0 mA

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
LED (each)						
Forward voltage	V_F		1.25	1.5	V	I_F = 20 mA
Reverse voltage	V_R	3.0	—	—	V	I_R = 10 μA
Reverse current	I_R	—	.001	10	μA	V_R = 3.0 V
Junction capacitance	C_J	—	50	—	pF	V_F = 0 V

ELECTRO-OPTICAL CHARACTERISTICS (Con't)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DETECTOR (each)						
Forward leakage current (Note 2)	I_{FX}	—	.02	2.0	μA	V_{FX} = Rated V_{FXM}, R_{GK} = 27 Ω
Max. forward blocking voltage	V_{FXM}	200	—	—	V	R_{GK} = 27 kΩ
On voltage	V_{TM}	—	1.0	1.3	V	I_T = 100 mA
Holding current	I_{HX}	.01	.15	2.0	mA	R_{GK} = 27 kΩ
Gate trigger voltage	V_{GT}	—	.5	1.0	V	V_{FX} = 100 V
Gate trigger current	I_{GT}	—	15	100	μA	V_{FX} = 100 V, R_L = 10 kΩ, R_{GK} = 27 kΩ
(direct drive)	I_{GT}	—	45	500	μA	V_{FX} = 100 V, R_L = 10 kΩ, R_{GK} = 10 kΩ
	I_{GT}	—	0.5	2.0	mA	V_{FX} = 100 V, R_L = 10 kΩ, R_{GK} = 1 kΩ
COUPLED						
Turn on current	I_{FT}	2	8	14	mA	V_{FX} = 100 V, R_{GK} = 27 kΩ
Trigger time	$t_{on} = t_r + t_d$	—	10.0	—	μsec	R_{GK} = 27 kΩ, I_F = 30 mA, V_{CC} = 20 V
AC turn on current (Note 1)	I_F	20	—	—	mA	V_{CC} = 120 VAC, I_T = 100 mA, R_{GK} = 27 kΩ
ISOLATION						
Isolation breakdown voltage	V_{ISO}					t = 1 second
MCS6200		1500	—	—	VDC	
MCS6201		2500	—	—	VDC	
Isolation resistance	R_{ISO}	—	10^{11}	—	Ω	V = 500 VDC
Capacitance	C_{ISO}	—	1.0	—	pf	f = 1 MHz

Note 1. To ensure conduction in both directions, see "TRIAC CONNECTION" schematic.
Note 2. R_{GK} applied to both channels simultaneously.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES
(25°C Free Air Temperature Unless Otherwise Specified)

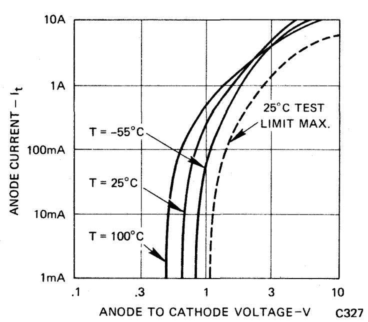


Fig. 1. I_T vs. V_{TM}

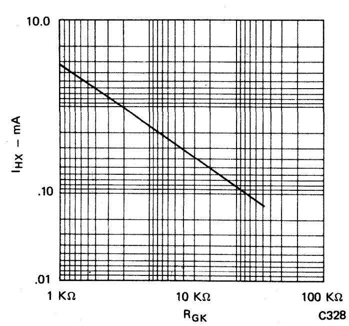


Fig. 2. Holding Current (I_{HX} vs. R_{GK})

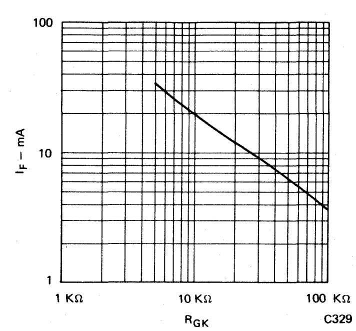


Fig. 3. Turn On vs. R_{GK}

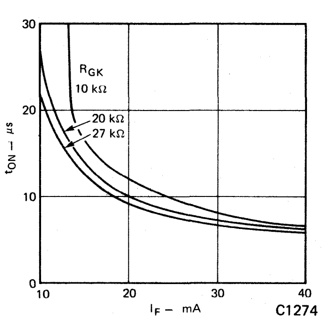


Fig. 4. Trigger Delay Time vs. Forward Current

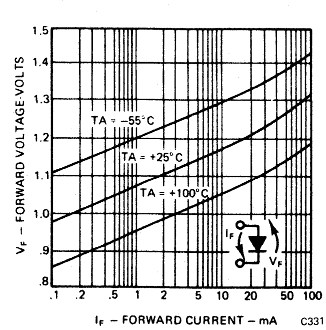


Fig. 5. Forward Voltage vs. Forward Current

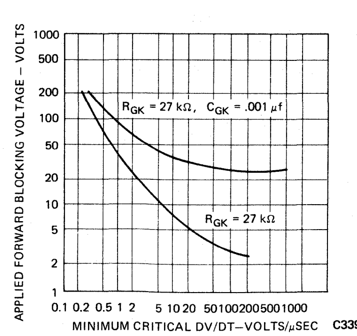


Fig. 6. dV/dt @ 25°C

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (Con't)

(25° Free Air Temperature Unless Otherwise Specified)

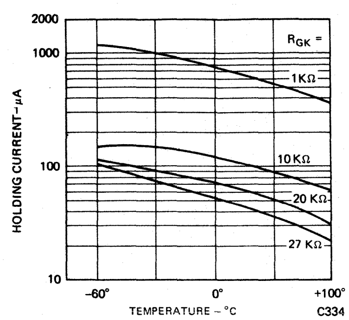


Fig. 7. I_{HX} vs. Temp. °C

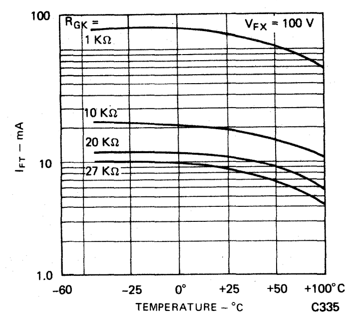


Fig. 8. I_{FT} vs. Temp.

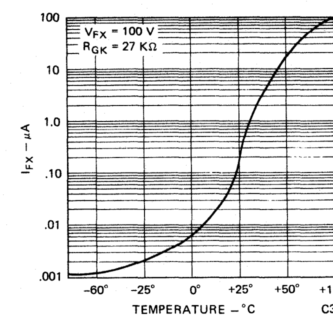


Fig. 9. I_{FX} vs. Temp.

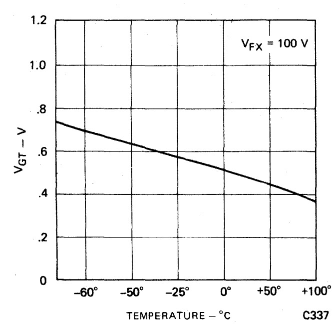


Fig. 10. Gate Trigger Voltage V_{GT} vs. T

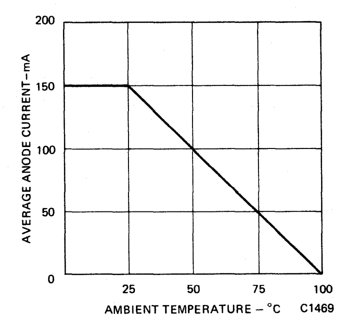
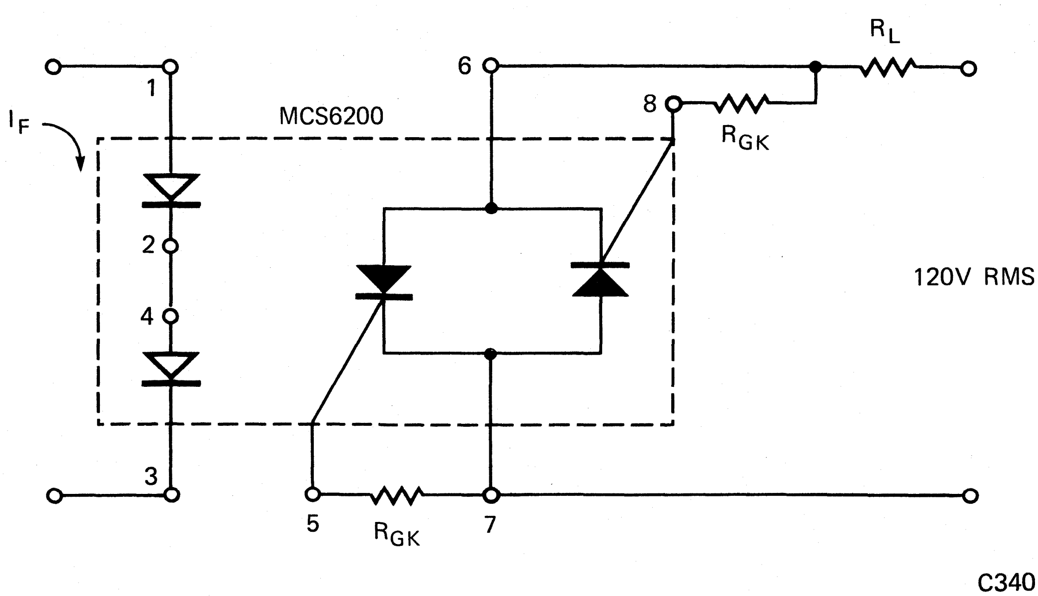


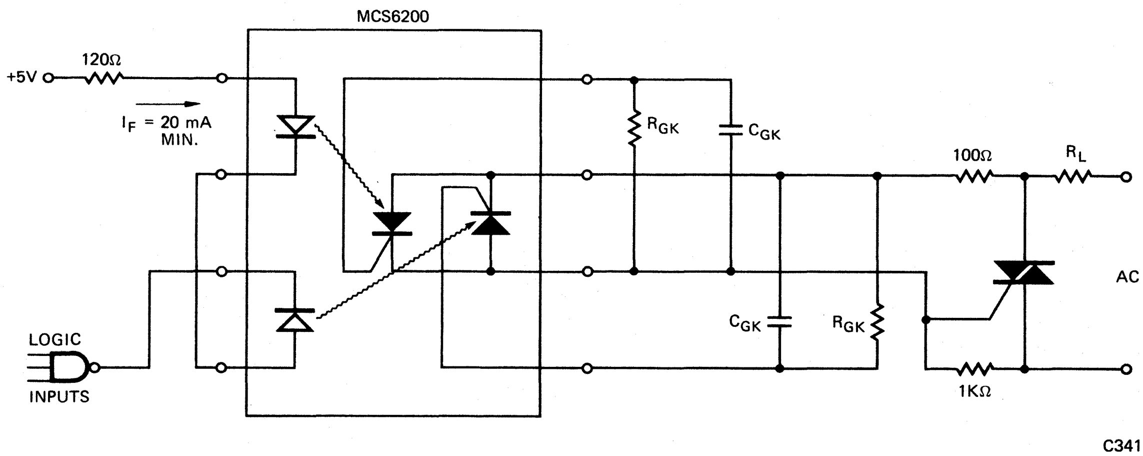
Fig. 11. Anode Current Derating

TYPICAL CIRCUIT APPLICATIONS

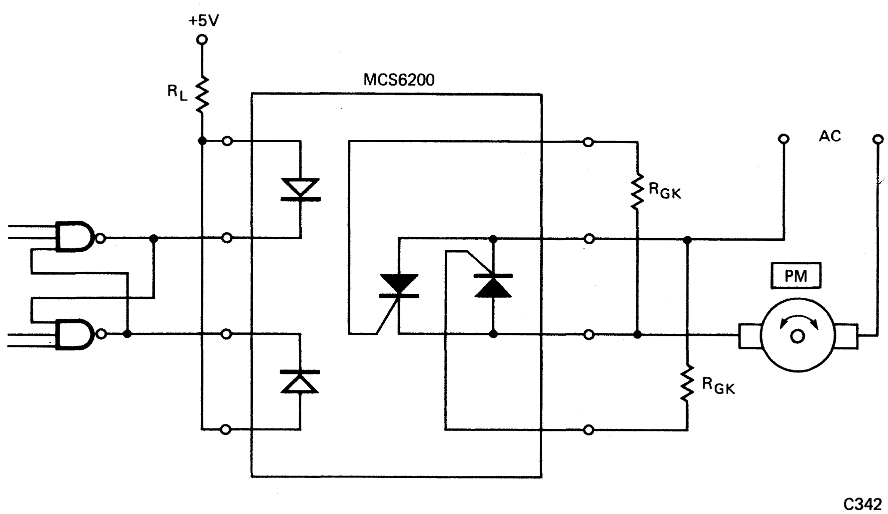


A. TRIAC CONNECTION

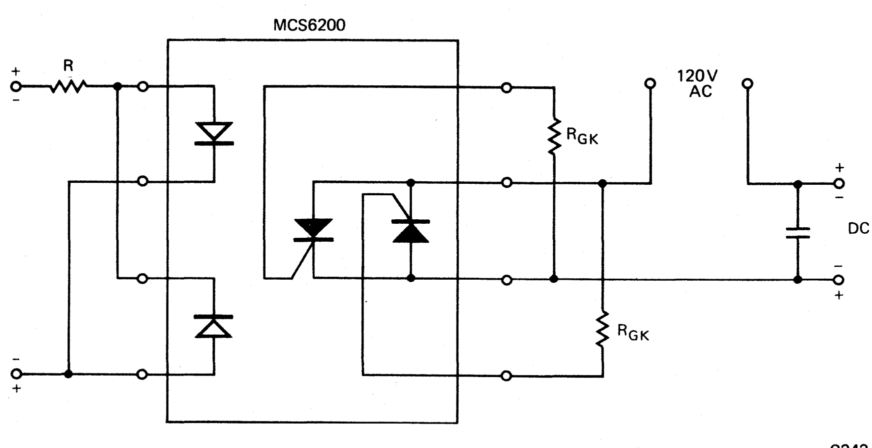
TYPICAL CIRCUIT APPLICATIONS (Cont'd)



B. TRIAC TRIGGER



C. BI-DIRECTIONAL MOTOR CONTROL



D. DC POWER SUPPLY POLARITY CONTROL

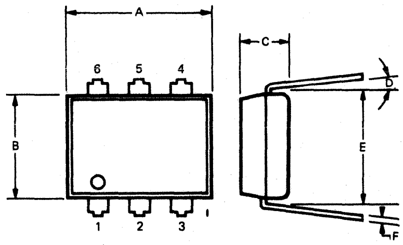
GENERAL INSTRUMENT
Optoelectronics

MCT2
PHOTOTRANSISTOR OPTOISOLATOR

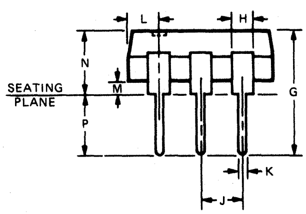
PRODUCT DESCRIPTION

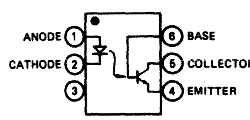
The MCT2 is a NPN silicon planar phototransistor optically coupled to a gallium arsenide diode. It is mounted in a six-lead plastic DIP package.

PACKAGE DIMENSIONS



C1339





SYMBOL	INCH MAX.	MM. MAX.	NOTES
A	.365	9.27	
B	.270	6.73	
C	.130	3.18	
D	15°	15°	
E	.300 Ref	7.62 Ref	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			3

PACKAGE MATERIALS:
Leads – Tinned with 60/40 tin lead
Body – Silicone plastic

NOTES
1. Installed position of lead centers
2. Four places
3. Overall installed position
4. These measurements are made from the seating plane

APPLICATIONS

- AC line/digital logic isolator
- Digital logic/digital logic isolator
- Telephone/telegraph line receiver
- Twisted pair line receiver
- High frequency power supply feedback control
- Relay contact monitor
- Power supply monitor

ABSOLUTE MAXIMUM RATINGS

Storage temperature −55°C to 150°C
Operating temperature −55°C to 100°C
Lead temperature (Soldering, 10 sec) 260°C

Input Diode
- Forward current . . . . 60 mA
- Reverse voltage . . . . 3.0 V
- Peak forward current (1 μs pulse, 300 pps) . . . . 3.0 A
- Power dissipation at 25°C ambient . . . . 200 mW
- Derate linearly from 25°C . . . . 2.6 mW/°C

Output Transistor
- Power dissipation at 25°C ambient . . . . . 200 mW
- Derate linearly from 25°C . . . . 2.6 mW/°C

Input to output voltage isolation . . . . 1500 volts DC
Total package power dissipation at 25°C ambient (LED plus detector) . . . . . 250 mW
Derate linearly from 25°C . . . . 3.3 mW/°C
Collector-Emitter Current (I_{CE}) . . . . 50 mA

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

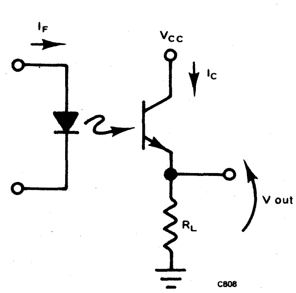
CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Input Diode						
Forward Voltage	V_F		1.25	1.50	V	I_F = 20 mA
Reverse Breakdown Voltage	BV_R	3.0	25		V	I_R=10 μA
Junction Capacitance	C_J		50		pF	V_F=0 V
Reverse Leakage Current	I_R		.01	10	μA	V_R=3.0 V
Output Transistor						
DC Forward Current Gain	h_{FE}		250			V_{CE}=5 V, I_C=100 μA
Collector To Emitter Breakdown Volt.	BV_{CEO}	30	85		V	I_C=1.0 mA, I_F=0
Collector To Base Breakdown Voltage	BV_{CBO}	70	165		V	I_C=10 μA
Emitter to Collector Breakdown Voltage	BV_{ECO}	7	14		V	I_E = 100 μA, I_F = 0
Collector To Emitter, Leakage Current	I_{CEO}		5	50	nA	V_{CE}=10 V, I_F=0
Collector To Base Leakage Current	I_{CBO}		0.1	20	nA	V_{CB}=10 V, I_F=0

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

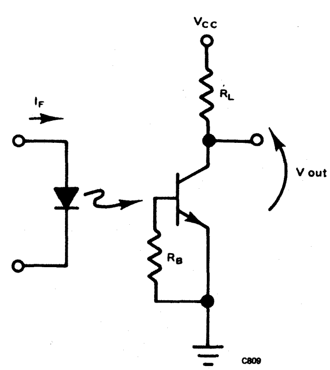
CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Capacitance Collector To Emitter	C_{CEO}		8		pF	V_{CE}=0
Capacitance Collector To Base	C_{CBO}		20		pF	V_{CB}=10 V
Capacitance Emitter To Base	C_{EBO}		10		pF	V_{BE}=0
Coupled						
DC Collector Current Transfer Ratio	I_C/I_F	20	60		%	V_{CE}=10 V, I_F=10 mA, Note 1
DC Base Current Transfer Ratio	I_B/I_F		.35		%	V_{CB}=10 V, I_F-10 mA
Isolation Voltage		1500	2300		VDC	
		800			VRMS	f=60 Hz
Isolation Resistance		10^{11}	10^{12}		Ω	V_{I-O}=500 V
Isolation Capacitance			.5		pF	f=1MHz
Collector-Emitter, Saturation Voltage	V_{CE}(sat)		0.24	0.4	V	I_C = 2.0 mA, I_F = 16 mA
Bandwidth (see note 2)	B_W		150		KHz	I_C=2 mA, V_{CE}=10 V, R_L=100 Ω (Circuit No. 1)

SWITCHING TIMES		TYP.	UNITS	TEST CONDITIONS
Saturated				
t on (from 5 V to 0.8 V)	t_{on} (SAT)	10	μs	R_L=2 KΩ, I_F=15 mA, V_{CC}=5 V
t off (from SAT to 2.0 V)	t_{off} (SAT)	30		R_B=open (Circuit No. 2)
Saturated				
t on (from 5 V to 0.8 V)	t_{on} (SAT)	10	μs	R_L=2 KΩ, I_F=20 mA, V_{CC}=5 V
t off (from SAT to 2.0 V)	t_{off} (SAT)	27		R_B=100 KΩ (Circuit No. 2)
Non-Saturated				
Base Rise Time	t_r	300	ns	R_L=1 KΩ, V_{CB}=10 V
Fall Time	t_f	300	ns	

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES
(25°C Free Air Temperature Unless Otherwise Specified)



Circuit 1



Circuit 2

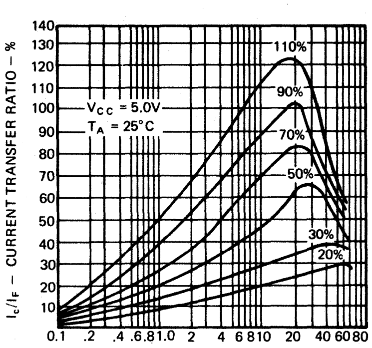


Fig. 1. Current Transfer Ratio vs. Forward Current

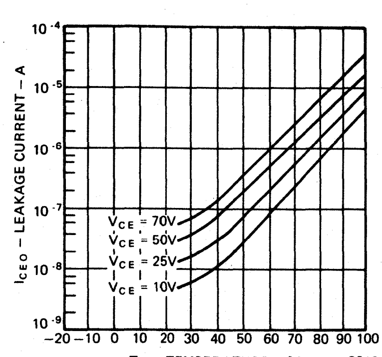


Fig. 2. Dark Current vs. Temperature

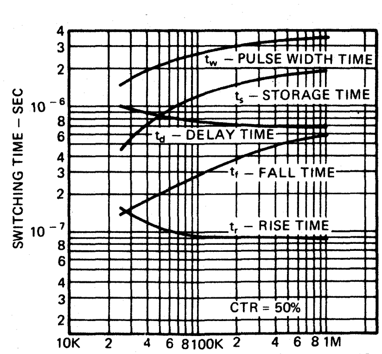


Fig. 3. Switching Time vs. Base Resistance

Typical Electro-Optical Characteristic Curves

(25° C Free Air Temperature Unless Otherwise Specified)

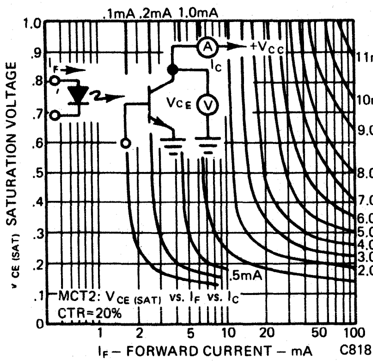


Fig. 4. Saturation Voltage vs. Forward Current

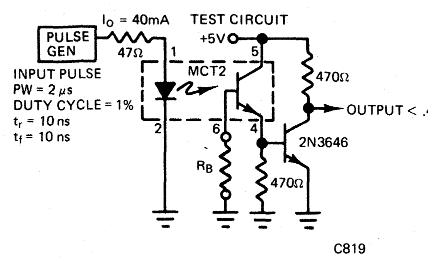


Fig. 5. Circuit for Figure 3

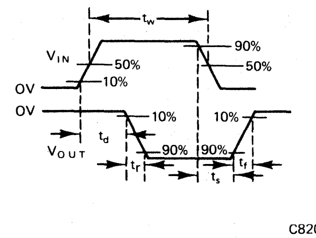


Fig. 6. Waveforms for Figure 3

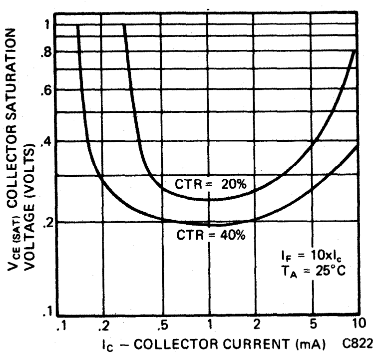


Fig. 7. Saturation Voltage vs. Collector Current

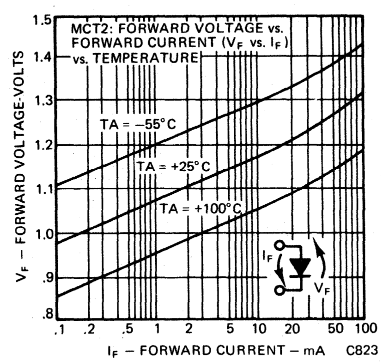


Fig. 8. Forward Voltage vs. Forward Current

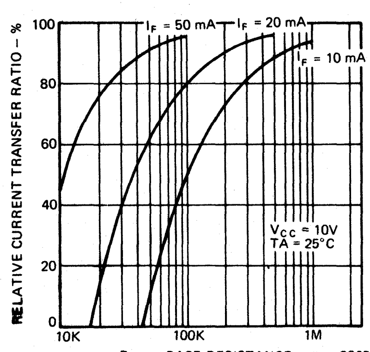


Fig. 9. Sensitivity vs. Base Resistance

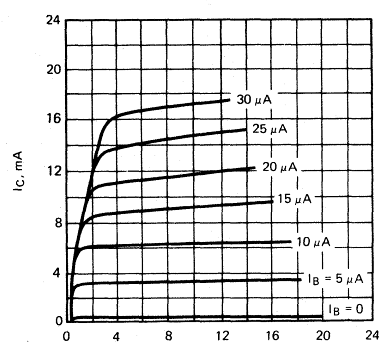


Fig. 10. Detector Typical h_{fe} Curves

Notes

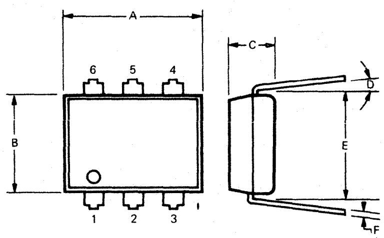
1. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.*
2. *The frequency at which i_c is 3 dB down from the 1 kHz value.*
3. *Rise time (t_r) is the time required for the collector current to increase from 10% of its final value, to 90%.*
   Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value, to 10%.

GENERAL INSTRUMENT
Optoelectronics

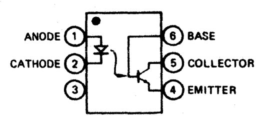
MCT2E
PHOTOTRANSISTOR OPTOISOLATOR

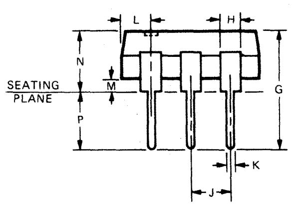
PRODUCT DESCRIPTION
The MCT2E is a NPN silicon planar phototransistor optically coupled to a gallium arsenide diode. It is mounted in a six-lead plastic DIP package.

PACKAGE DIMENSIONS



C1339





SYMBOL	INCH MAX.	MM. MAX.	NOTES
A	.365	9.27	
B	.270	6.73	
C	.130	3.18	
D	15°	15°	
E	.300 Ref	7.62 Ref	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			3

PACKAGE MATERIALS:
Leads – Tinned with 60/40 tin lead
Body – Silicone plastic

NOTES
1. Installed position of lead centers
2. Four places
3. Overall installed position
4. These measurements are made from the seating plane

APPLICATIONS

- Utility/economy isolator
- AC line/digital logic isolator
- Digital logic/digital logic isolator
- Telephone/telegraph line receiver
- Twisted pair line receiver
- High frequency power supply feedback control
- Relay contact monitor
- Power supply monitor
- UL Approved Product File E50151

ABSOLUTE MAXIMUM RATINGS

Storage temperature –55°C to 150°C
Operating temperature –55°C to 100°C
Lead temperature (Soldering, 10 sec) 260°C

Input Diode
- Forward current . . . . 60 mA
- Reverse voltage . . . . 3.0 V
- Peak forward current (1 μs pulse, 300 pps) . . . . 3.0 A
- Power dissipation at 25°C ambient . . . . 200 mW
- Derate linearly from 25°C . . . . 2.6 mW/°C

Output Transistor
- Power dissipation at 25°C ambient . . . . . 200 mW
- Derate linearly from 25°C . . . . 2.6 mW/°C

Isolation rating . . . . 3550 VDC
Total package power dissipation at 25°C ambient (LED plus detector) . . . . . 250 mW
Derate linearly from 25°C . . . . 3.3 mW/°C
Collector-Emitter Current (I_{CE}) . . . . 50 mA

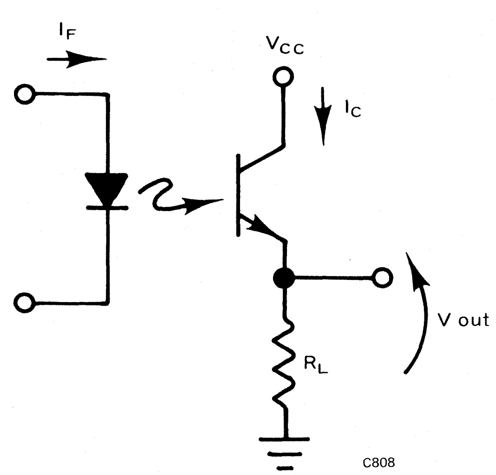
ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Input Diode						
Forward Voltage	V_F		1.25	1.50	V	I_F = 20 mA
Reverse Breakdown Voltage	BV_R	3.0	25		V	I_R=10 μA
Junction Capacitance	C_J		50		pF	V_F=0 V
Reverse Leakage Current	I_R		.01	10	μA	V_R=3.0 V
Output Transistor						
DC Forward Current Gain	h_{FE}	100	250			V_{CE}=5 V, I_C=100 μA
Collector To Emitter Breakdown Volt.	BV_{CEO}	30	85		V	I_C=1.0 mA, I_F=0
Collector To Base Breakdown Voltage	BV_{CBO}	70	165		V	I_C=10 μA
Emitter to Collector Breakdown Voltage	BV_{ECO}	7	14		V	I_E = 100 μA, I_F = 0
Collector To Emitter, Leakage Current	I_{CEO}		5	50	nA	V_{CE}=10 V, I_F=0
Collector To Base Leakage Current	I_{CBO}		0.1	20	nA	V_{CB}=10 V, I_F=0

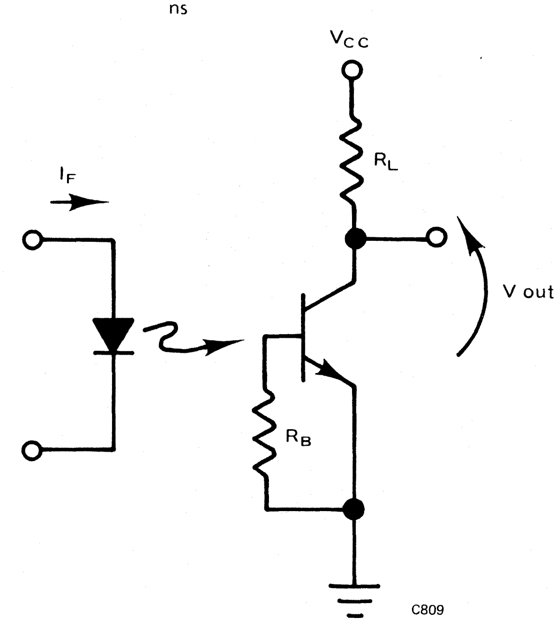
ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	GUAR. MIN.	TYP.	GUAR. MAX.	UNITS	TEST CONDITIONS
Capacitance Collector To Emitter	C_{CEO}		8		pF	$V_{CE}=0$
Capacitance Collector To Base	C_{CBO}		20		pF	$V_{CB}=10$ V
Capacitance Emitter To Base	C_{EBO}		10		pF	$V_{BE}=0$
Coupled						
DC Collector Current Transfer Ratio	I_C/I_F	20	60		%	$V_{CE}=10$ V, $I_F=10$ mA, Note 1
DC Base Current Transfer Ratio	I_B/I_F		.35		%	$V_{CB}=10$ V, I_F-10 mA
Surge isolation	V_{iso}	3550			VDC	Relative humidity $\leq$ 50% T_A = +25°C, $I_{I-O} \leq 10\ \mu A$
		2500			VAC-rms	1 second
Steady state isolation	V_{iso}	3150			VDC	Relative humidity $\leq$ 50%, T_A = +25°C, $I_{I-O} \leq 10\ \mu A$
		2250			VAC-rms	1 minute
Isolation Voltage		2500			V_{RMS}	f = 60 Hz
	B_V (I-O)	3500			VDC	
Isolation Resistance		10^{11}	10^{12}		Ω	$V_{I-O}=500$ V
Isolation Capacitance			.5		pF	f=1MHz
Collector-Emitter, Saturation Voltage	V_{CE}(sat)		0.24	0.4	V	I_C = 2.0 mA, I_F = 16 mA
Bandwidth (see note 2)	B_W		150		KHz	I_C=2 mA, V_{CE}=10 V, R_L=100 Ω (Circuit No. 1)

SWITCHING TIMES			TYP.	UNITS	TEST CONDITIONS
Non-Saturated Collector	Delay Time	t_d	0.5	μs	R_L=100 Ω, I_C=2 mA, V_{CC}=10 V (Circuit No. 1)
	Rise Time	t_r	2.5		
	Storage Time	t_s	0.1		
	Fall Time	t_f	2.6		
Non-Saturated Collector	Delay Time	t_d	2.0	μs	R_L=1 KΩ, I_C=2 mA, V_{CC}=10V (Circuit No. 1)
	Rise Time	t_r	15		
	Storage Time	t_s	0.1		
	Fall Time	t_f	15		
Saturated					
t on (from 5 V to 0.8 V)		t_{on} (SAT)	5	μs	R_L=2 KΩ, I_F=15 mA, V_{CC}=5 V
t off (from SAT to 2.0 V)		t_{off} (SAT)	25		R_B=open (Circuit No. 2)
Saturated					
t on (from 5 V to 0.8 V)		t_{on} (SAT)	5	μs	R_L=2 KΩ, I_F=20 mA, V_{CC}=5 V
t off (from SAT to 2.0 V)		t_{off} (SAT)	18		R_B=100 KΩ (Circuit No. 2)
Non-Saturated Base	Rise Time	t_r	175	ns	R_L=1 KΩ, V_{CB}=10 V
	Fall Time	t_f	175	ns	



Circuit 1



Circuit 2

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

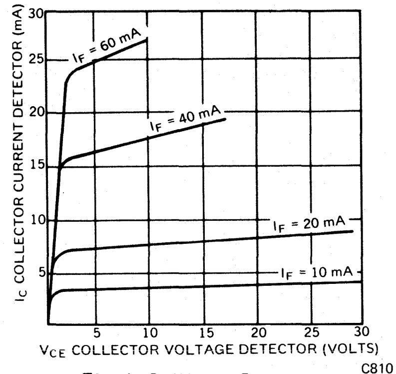


Fig. 1 Collector Current vs. Collector Voltage (for Typical CTR 30%)

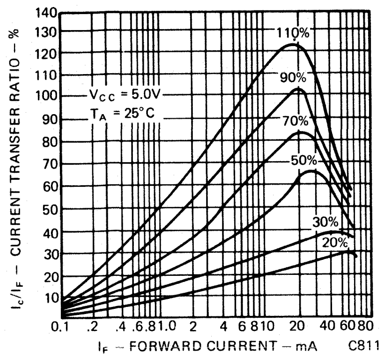


Fig. 2 Current Transfer Ratio vs. Forward Current

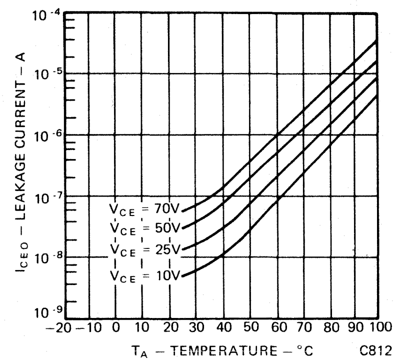


Fig. 3 Dark Current vs. Temperature

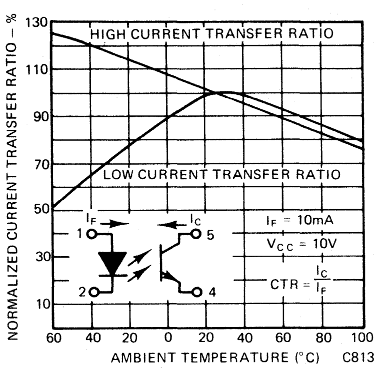


Fig. 4 Current Transfer Ratio vs. Temperature

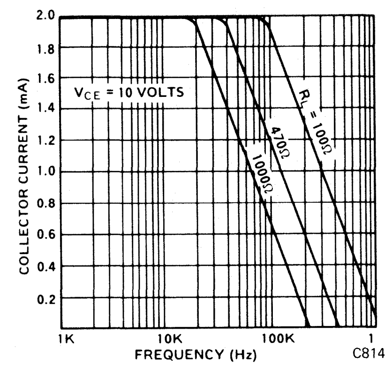


Fig. 5 Collector Current vs. Frequency

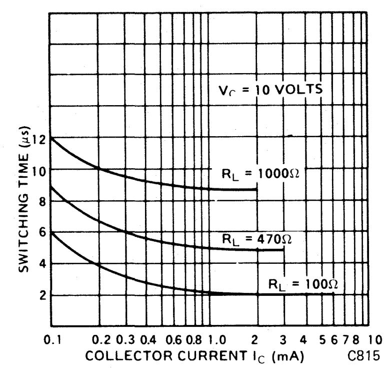


Fig. 6 Switching Time vs. Collector Current

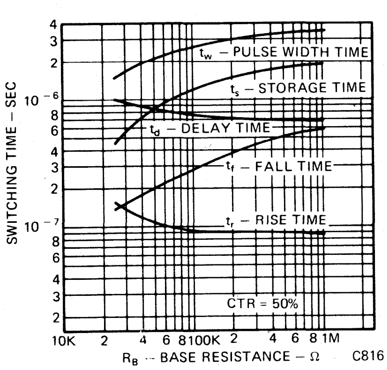


Fig. 7 Switching Time vs. Base Resistance

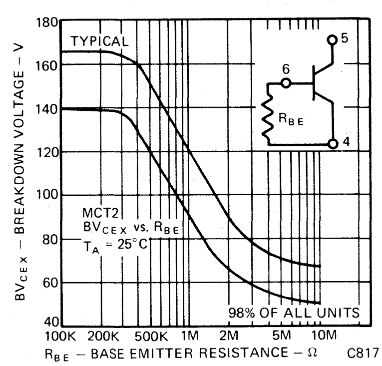


Fig. 8 Collector — Emitter Breakdown Voltage vs. Base Resistance

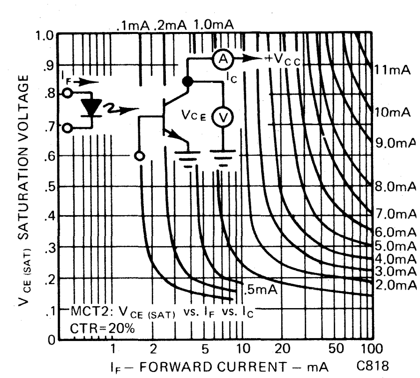


Fig. 9 Saturation Voltage vs. Forward Current

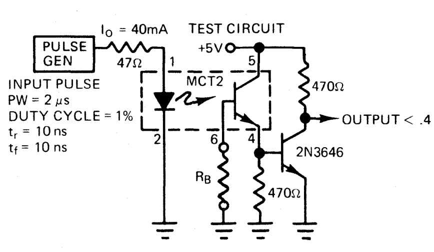


Fig. 10 Circuit for Figure 7

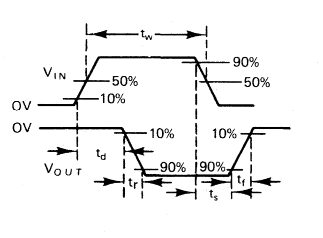


Fig. 11 Waveforms for Figure 7

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25° C Free Air Temperature Unless Otherwise Specified)

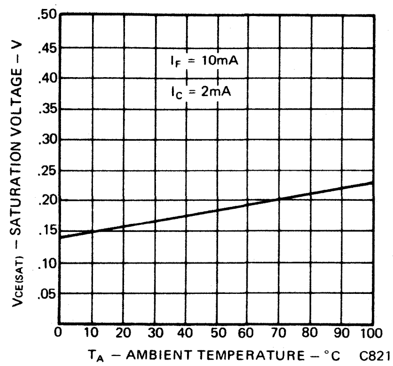


Fig. 12. Saturation Voltage vs. Temperature

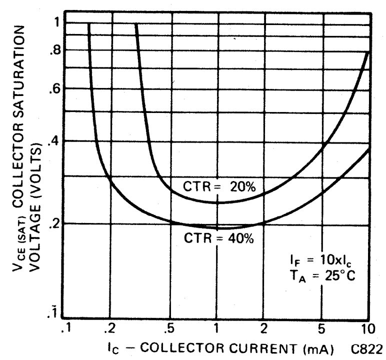


Fig. 13. Saturation Voltage vs. Collector Current

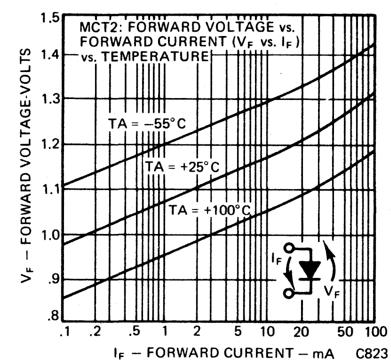


Fig. 14. Forward Voltage vs. Forward Current

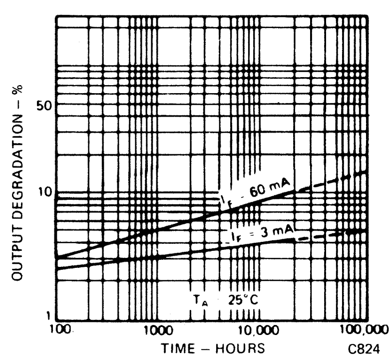


Fig. 15. Lifetime vs. Forward Current (Note 4)

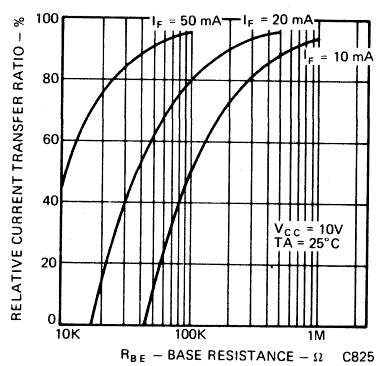


Fig. 16. Sensitivity vs. Base Resistance

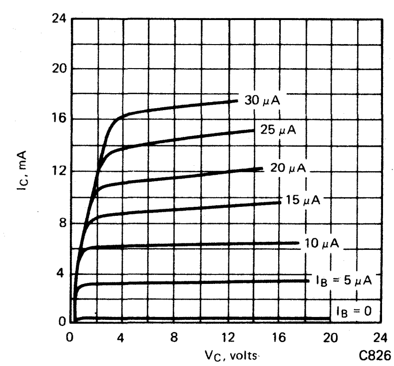
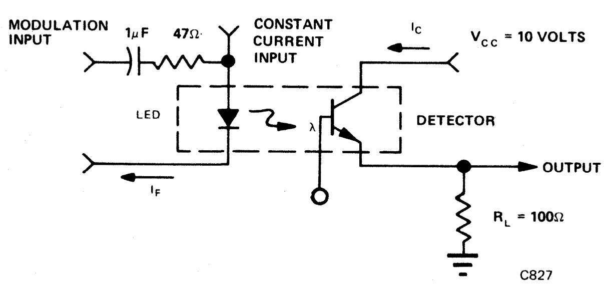
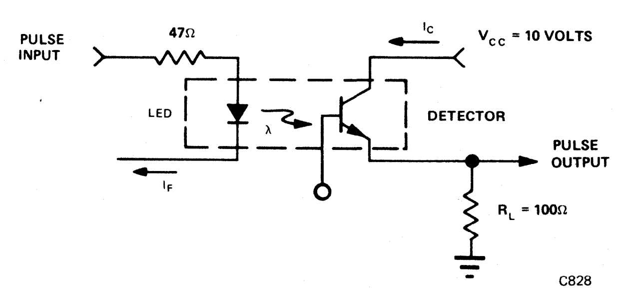


Fig. 17. Detector Typical h_{fe} Curves

OPERATING SCHEMATICS



Modulation Circuit Used to Obtain Output vs Frequency Plot



Circuit Used to Obtain Switching Time vs Collector Current Plot

NOTES

1. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.*
2. *The frequency at which i_c is 3 dB down from the 1 kHz value.*
3. *Rise time (t_r) is the time required for the collector current to increase from 10% of its final value, to 90%.*
   Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value, to 10%.
4. *Normalized CTR degradation* $= \dfrac{CTR_O - CTR}{CTR_O}$

GENERAL INSTRUMENT
Optoelectronics

MCT210

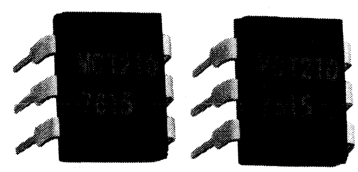
PHOTOTRANSISTOR OPTOISOLATOR

FEATURES

- TTL compatible 1-10 gate loads
- High CTR with transistor output MCT210—150% min.
- Specified CTR over temperature range
- Good logic load characteristics
  V_{OL} = 0.4 V @ 1.6 mA to 16 mA output sinking (I_{OL})
- UL recognized (File #50151)

APPLICATIONS

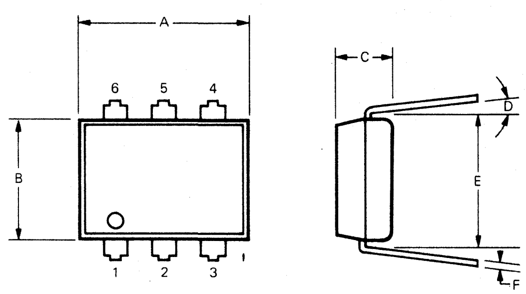
- Digital logic isolation
- Line receivers
- Feedback control circuits
- Monitoring circuits

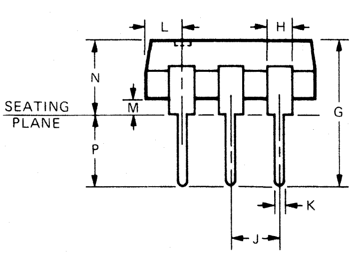


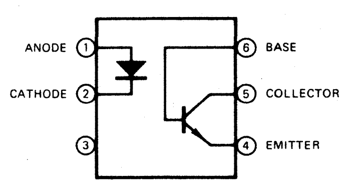
PRODUCT DESCRIPTION

The MCT210 incorporates a NPN silicon planar phototransistor optically coupled to a gallium arsenide diode emitter. The MCT210 has a specified minimum CTR of 50%, saturated, and 150%, unsaturated. This unit is mounted in a six-lead plastic DIP socket.

PACKAGE DIMENSIONS







PACKAGE MATERIALS:
Leads – Tinned with 60/40 tin lead
Body – Silicone plastic

C1339

SYMBOL	INCH MAX.	MM. MAX.	NOTES
A	.365	9.27	
B	.270	6.73	
C	.130	3.18	
D	15°	15°	
E	.300 Ref	7.62 Ref	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			3

NOTES
1. Installed position of lead centers
2. Four places
3. Overall installed position
4. These measurements are made from the seating plane

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature . . . . −55°C to 150°C
Operating temperature . . . . −55°C to 100°C
Lead temperature
(Soldering, 10 sec) . . . . 260°C
Total package power dissipation @ 25°C
(LED plus detector) . . . . 260 mW
Derate linearly from 25°C . . . . 3.4 mW/°C
Surge isolation . . . . 2500 VDC
1500 VRMS
Steady state isolation . . . . 2250 VDC
1250 VRMS

INPUT DIODE

Forward current . . . . 60 mA
Reverse voltage . . . . 3.0 V
Peak forward current
(1 µs pulse, 300 pps). . . . . 3.0 A
Power dissipation 25°C to 70°C ambient . . . 90 mW
Derate linearly from +70°C . . . . .2.0 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C . . . . 200 mW
Derate linearly from 25°C . . . . 2.67 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (0° to +70°C Temperature unless otherwise specified)

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.25	1.50	V	I_F = 40 mA
	Forward voltage temp. coefficient			−1.8		mV/°C	
	Reverse breakdown voltage	BV_R	6.0	15		V	I_R = 10 μA
	Junction capacitance	C_J		50		pF	V_F = 0 V, f = 1 MHz
				65		pF	V_F = 1 V, f = 1 MHz
	Reverse leakage current	I_R		.01	10	μA	V_R = 6.0 V
OUTPUT TRANSISTOR	DC forward current gain	h_{FE}		400			V_{CE} = 5 V, I_C = 10 mA
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	30	45		V	I_C = 1.0 mA, I_F = 0
	Collector to base	BV_{CBO}	70			V	I_C = 10 μA
	Emitter to collector	BV_{ECO}	6	8		V	I_E = 100 μA, I_F = 0
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	V_{CE} = 5 V, I_F = 0, T_A = +25°C
					30	μA	V_{CE} = 5 V, I_F = 0,
	Capacitance						
	Collector to emitter			8		pF	V_{CE} = 0, f = 1 MHz
	Collector to base			20		pF	V_{CB} = 5, f = 1 MHz
	Emitter to base			10		pF	V_{EB} = 0, f = 1 MHz

	COUPLED CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current transfer ratio, collector to emitter	I_{CE}/I_F					
	MCT210 (a)		50	70		%	V_{CE} = 0.4 V, I_F = 3.2 mA to 32 mA
			150	225		%	V_{CE} = 5.0 V, I_F = 10 mA
	Current transfer ratio, collector to base	I_{CB}/I_F		0.6		%	V_{CB} = 5.0 V, I_F = 10 mA
	Saturation voltage collector to emitter	$V_{CE(SAT)}$					
	MCT210			0.2	0.4	V	I_C = 16 mA, I_F = 32 mA
ISOLATION	Surge isolation	V_{iso}	2500			VDC	Relative humidity ≤ 50%, T_A = +25°C, $I_{I\text{-}O}$ ≤ 10 μA
			1500			VAC-rms	1 second
	Steady state isolation	V_{iso}	2250			VDC	Relative humidity ≤ 50%, T_A = +25°C, $I_{I\text{-}O}$ ≤ 10 μA
			1250			VAC-rms	1 minute
	Isolation resistance	R_{iso}	10^{11}	5×10^{12}		ohms	$V_{I\text{-}O}$ = 500 VDC, T_A = +25°C
	Isolation capacitance	C_{iso}		1.0		pF	f = 1 MHz
SWITCHING TIMES	Non-saturated						
	Rise time	t_r		4		μs	R_L = 100 Ω, I_C = 2 mA, V_{CC} = 5 V
	Fall time	t_f		5		μs	See Figures 17 and 18
	Saturated						
	Rise time	t_r		2.5		μs	R_L = 560 Ω, I_F = 16 mA
	Fall time	t_f		25		μs	See Figures 17 and 18
	Propagation delay						
	High to low	$T_{PD(HL)}$		2		μs	R_L = 2.7K, I_F = 16 mA
	Low to high	$T_{PD(LH)}$		10		μs	See Figures 17 and 18

ELECTRICAL CHARACTERISTIC CURVES (25°C Free air temperature unless specified)

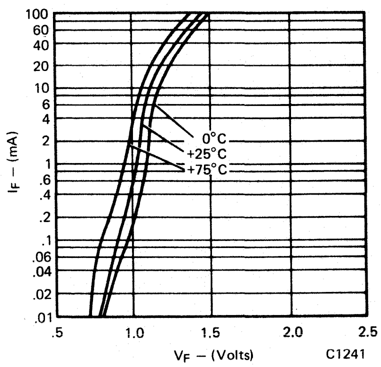


Fig. 1. Forward Voltage vs. Forward Current

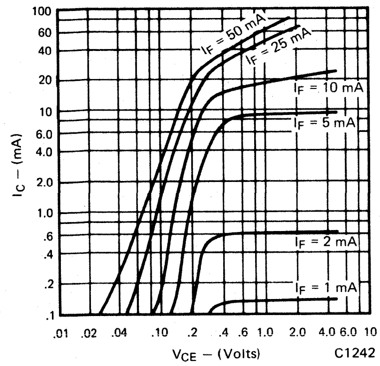


Fig. 2. Collector Current vs. Collector to Emitter Voltage

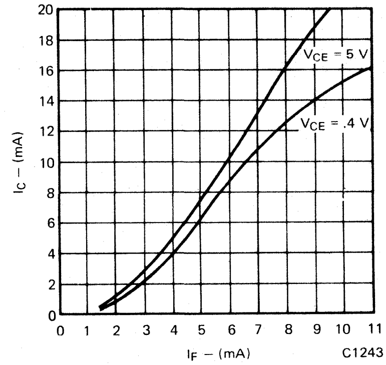


Fig. 3. Collector Current vs. Forward Current

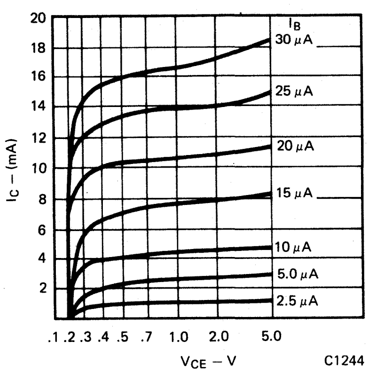


Fig. 4. Collector Current vs. Collector to Emitter Voltage

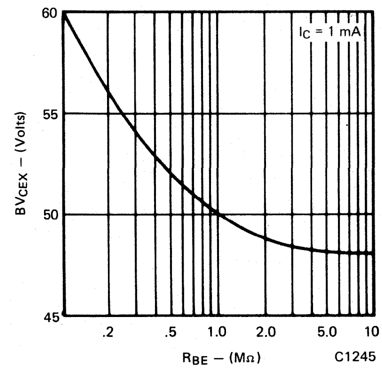


Fig. 5. Collector to Emitter Breakdown Voltage vs. Base to Emitter Resistance

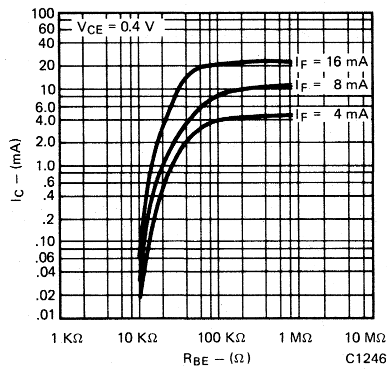


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

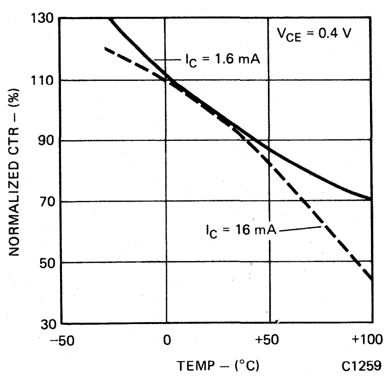


Fig. 7. Current Transfer Ratio (saturated) vs. Temperature

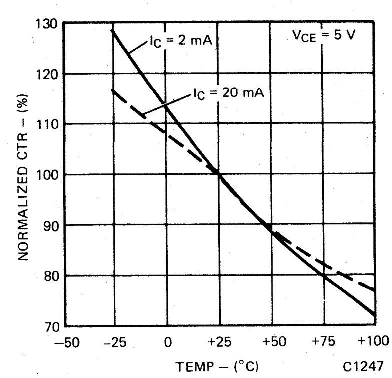


Fig. 8. Current Transfer Ratio (unsaturated) vs. Temperature

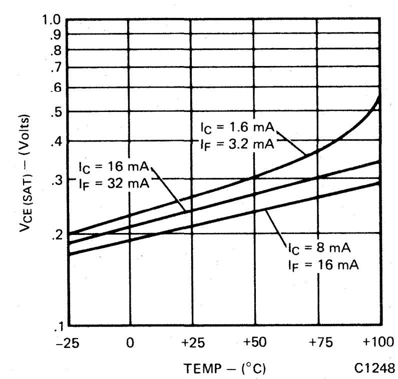


Fig. 9. Collector to Emitter Saturation Voltage vs. Temperature

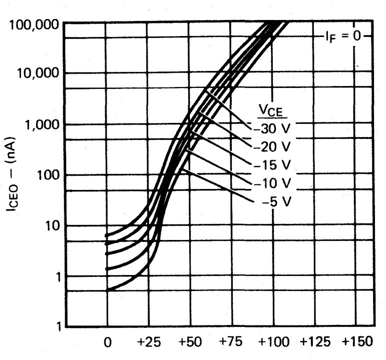


Fig. 10. Collector to Emitter Leakage Current vs. Temperature

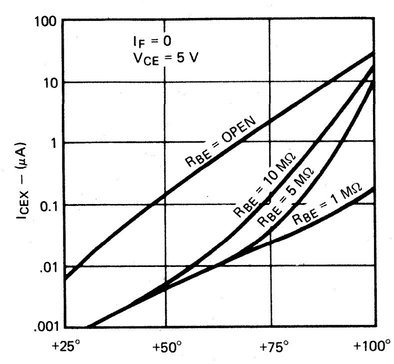


Fig. 11. Collector to Emitter Leakage Current vs. Temperature

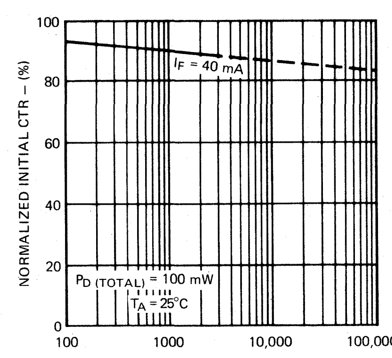


Fig. 12. Current Transfer Ratio vs. Operating Time

SWITCHING CHARACTERISTICS

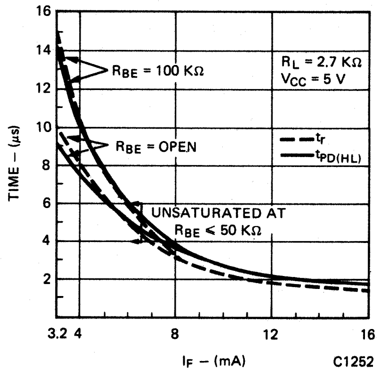


Fig. 13. Switch-on Time vs. I_F Drive (saturated)

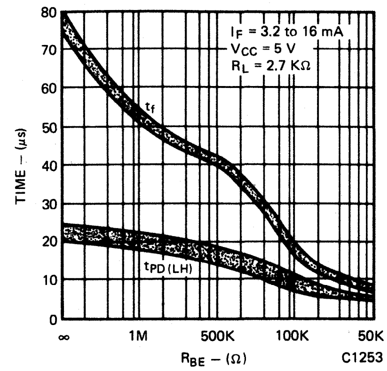


Fig. 14. Switch-off Time vs. Base to Emitter Resistance (saturated)

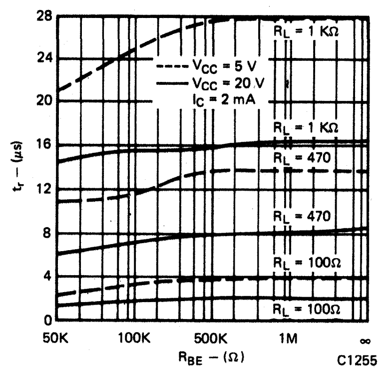


Fig. 15. Rise Time vs. Base to Emitter Resistance (non-saturated)

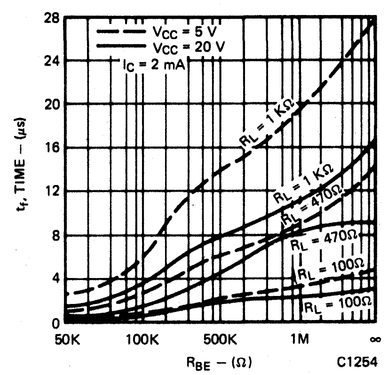


Fig. 16. Fall Time vs. Base to Emitter Resistance (non-saturated)

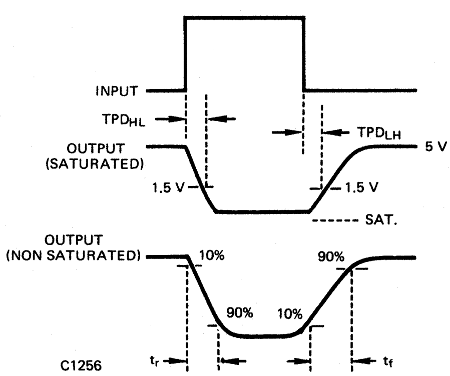


Fig. 17. Switching Time Waveforms

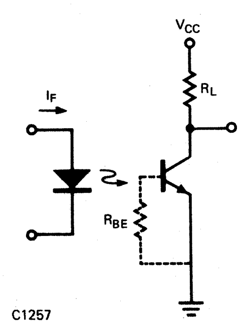


Fig. 18. Switching Time Test Circuits

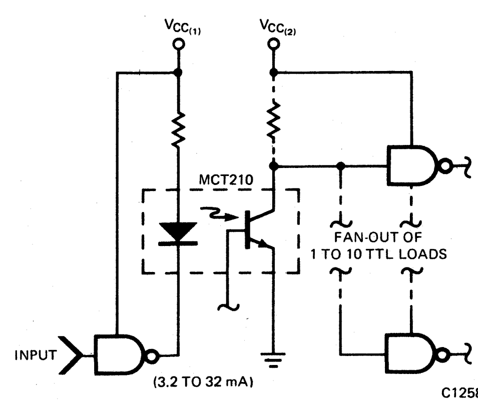


Fig. 19. Typical TTL Interface at Operating Temperatures of 0° to 70° C

GENERAL INSTRUMENT
Optoelectronics

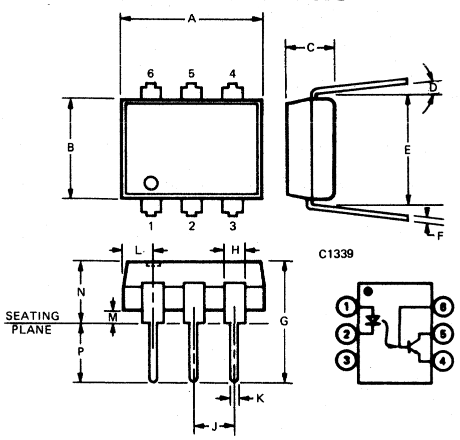
MCT26

PHOTOTRANSISTOR OPTOISOLATOR

PRODUCT DESCRIPTION

The MCT26 is a NPN silicon planar phototransistor optically coupled to a gallium arsenide diode. It is mounted in a six lead plastic DIP.

PACKAGE DIMENSIONS



SYMBOL	INCH MAX.	MM. MAX.	NOTES
A	.365	9.27	
B	.270	6.73	
C	.130	3.18	
D	15°	15°	
E	.300 Ref	7.62 Ref	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			3

NOTES
1. Installed position of lead centers
2. Four places
3. Overall installed position
4. These measurements are made from the seating plane

PACKAGE MATERIALS:
Leads – Tinned with 60/40 tin lead
Body – Silicone plastic

APPLICATIONS

- AC line/digital logic isolator
- Digital logic/digital logic isolator
- Telephone/telegraph line receiver
- Twisted pair line receiver
- High frequency power supply feedback control
- Relay contact monitor
- Power supply monitor

ABSOLUTE MAXIMUM RATINGS

Storage Temperature -55°C to 150°C
Operating temperature -55°C to 100°C
Lead temperature (Soldering, 10 sec) 260°C

Input Diode
- Forward current . . . . 60 mA
- Reverse voltage . . . . 3.0 V
- Peak forward current (1 μs pulse, 300 pps) . . . . 3.0 A
- Power dissipation at 25°C ambient . . . . 200 mW
- Derate linearly from 25°C . . . . 2.6 mW/°C

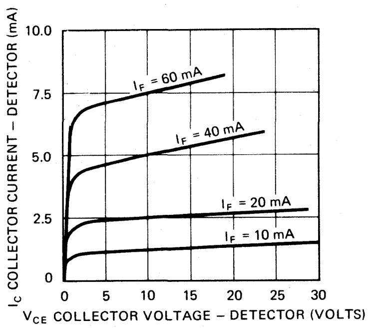
Output Transistor
- Power Dissipation at 25°C ambient . . . . 200 mW
- Derate linearly from 25°C . . . . 2.6 mW/°C

Input to output voltage . . . . 1500 volts
Total package power dissipation at 25°C ambient (LED plus detector) . . . . 250 mW
Derate linearly from 25°C . . . . 3.3 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

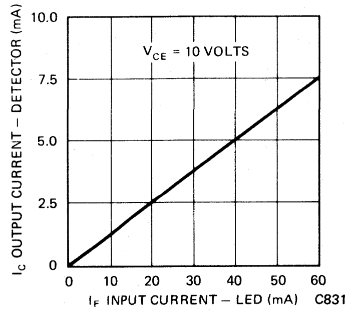
CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Emitter					
Forward voltage V_F	—	1.25	1.5	V	I_F = 20 mA
Reverse current I_R	—	.15	10	μA	V_R = 3.0 V
Capacitance C_J	—	50	—	pF	V = 0
Detector					
h_{FE}	—	150	—		V_{CE} = 5 V, I_C = 100 μA
BV_{CEO}	30	85	—	V	I_C = 1.0 mA, I_F = 0
BV_{ECO}	7	12	—	V	I_E = 100 μA, I_F = 0
I_{CEO}	—	5	100	nA	V_{CE} = 5 V, I_F = 0
Capacitance Collector-emitter C_{CE}	—	8	—	pF	V_{CE} = 0
BV_{CBO}	30	165	—	V	I_C = 10 μA
I_{CBO} (dark)	—	1	100	nA	V_{CB} = 5 V, I_F = 0
Coupled					
DC current transfer ratio CTR	6	14	—	%	I_F = 10 mA, V_{CE} = 10 V, note 1
Breakdown voltage	1500	2500	—	VDC	t = 1 second
	800	—	—		VAC, RMS @ f = 60 Hz
Resistance emitter-detector $R_{I\text{-}O}$	10^{11}	10^{12}		Ω	$V_{E\text{-}D}$ = 500 VDC
V_{CE} (SAT)	—	0.2	0.3	V	I_C = 250 μA, I_F = 20 mA
	—	0.2	0.5	V	I_C = 1.6 mA, I_F = 60 mA
Capacitance LED to detector $C_{I\text{-}O}$	—	0.5	—	pF	f = 1 MHz
Bandwidth (see figure 5) B_W	—	300	—	kHz	I_C = 2 mA, note 2
Rise time + fall time (see oper. schematics) t_r t_f	—	2	—	μs	I_C = 2 mA, V_{CE} = 10 V, note 3

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES
(25°C Free Air Temperature Unless Otherwise Specified)



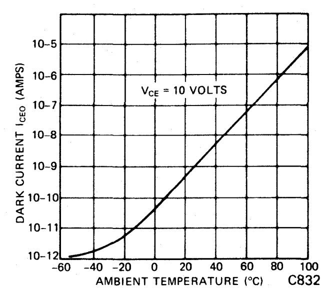
C830

Fig. 1 Detector Output Characteristics



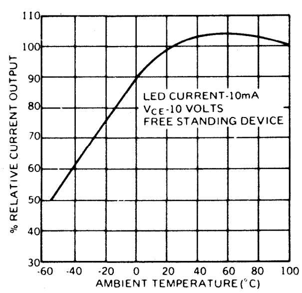
C831

Fig. 2 Input Current vs. Output Current



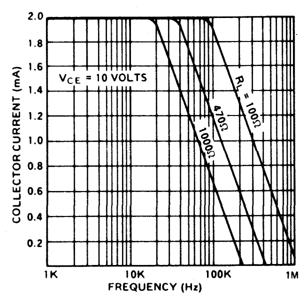
C832

Fig. 3 Dark Current vs. Temperature (°C)



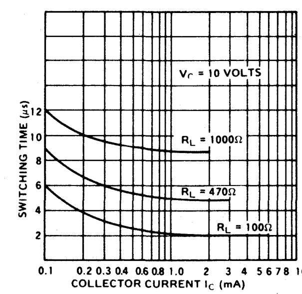
C833

Fig. 4 Current Output vs. Temperature



C834

Fig. 5 Output vs. Frequency

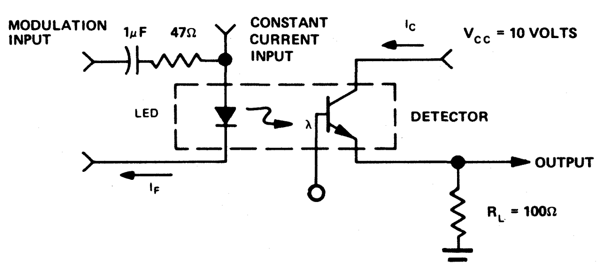


C835

Fig. 6 Switching Time vs. Collector Current

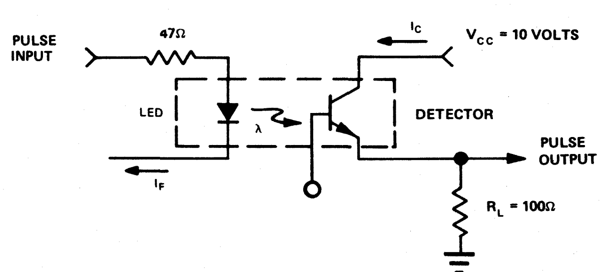
For additional characteristic curves, see figures 2, 3, 5, 6, 8, 11, 12, & 13 on MCT2.

OPERATING SCHEMATICS



C837

Modulation Circuit Used to Obtain Output vs. Frequency Plot



C838

Circuit Used to Obtain Switching Time vs. Collector Current Plot

NOTES

1. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.*
2. *The frequency at which i_C is 3 dB down from the 1 kHz value.*
3. *Rise time (t_r) is the time required for the collector current to increase from 10% of its final value to 90%. Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value to 10%.*

GENERAL INSTRUMENT
Optoelectronics

DESIGNER SERIES

MCT271

PHOTOTRANSISTOR OPTOISOLATORS

FEATURE SPECIFICATIONS

- **Controlled Current Transfer Ratio — 45% to 90% (specified conditions)**
- **Maximum Turn-on time — 7 μseconds (specified condition)**
- **Maximum Turn-off time — 7 μseconds (specified condition)**
- **Surge Isolation Rating — 3550 volts DC 2500 volts AC, rms**
- **Steady-state Isolation Rating — 3150 volts DC 2250 volts AC, rms**
- **Underwriters Laboratory (U.L.) recognized — File E50151**

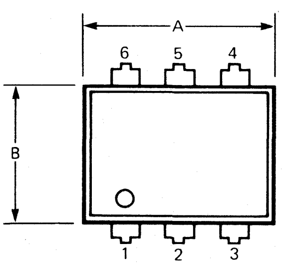
DESCRIPTION

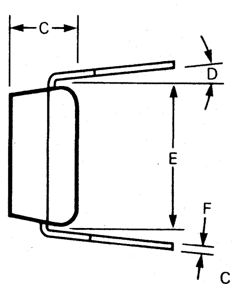
The MCT271 is a phototransistor-type optically coupled isolator. An infrared emitting diode manufactured from specially grown gallium arsenide is selectively coupled with an NPN silicon phototransistor. The device is supplied in a standard plastic six-pin dual-in-line package.

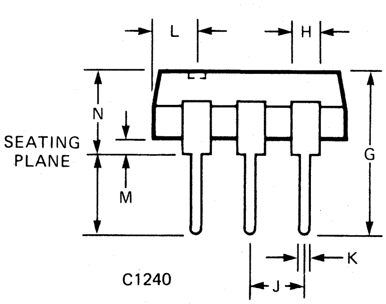
APPLICATIONS

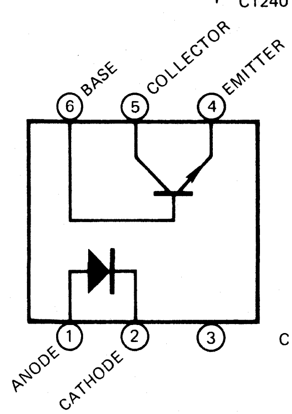
- Switching networks
- Power supply regulators
- Digital logic inputs
- Microprocessor inputs
- Appliance sensor systems

PACKAGE DIMENSIONS









SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.365	9.27	
B	.270	6.73	
C	.130	3.18	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			3

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature unless otherwise specified)

	TRANSFER CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current Transfer Ratio, collector to emitter (a)	I_{CE}/I_F	45	67	90	%	$I_F = 10$ mA; $V_{CE} = 10$ V
			12.5			%	$I_F = 16$ mA; $V_{CE} = 0.4$ V
	Current Transfer Ratio, collector to base	I_{CB}/I_F		.15		%	$I_F = 10$ mA; $V_{CB} = 10$ V
	Saturation voltage	$V_{CE(SAT)}$		.14	.40	V	$I_F = 16$ mA; $I_C = 2$ mA
SWITCHING TIMES	Non-saturated						
	Turn-on time	t_{on}		4.9	7	µs	$R_L = 100\ \Omega$; $I_C = 2$ mA; $V_{CC} = 5$ V
	Turn-off time	t_{off}		4.5	7	µs	See figures 11, 13
	Saturated						
	Turn-on time	t_{on}		5.2		µs	$I_F = 16$ mA; $R_L = 1.9$ KΩ
	Turn-off time	t_{off}		38		µs	See figures 12, 14
	(Approximates a typical TTL interface)						
	Turn-on time	t_{on}		4.9		µs	$I_F = 16$ mA; $R_L = 4.7$ KΩ
	Turn-off time	t_{off}		90		µs	See figures 12, 14
	(Approximates a typical low power TTL interface)						
ISOLATION	Surge isolation	V_{iso}	3550			VDC	Relative humidity ≤ 50%, $I_{I-O} \leq 10\ \mu A$
			2500			VAC-rms	1 second
	Steady state isolation	V_{iso}	3150			VDC	Relative humidity ≤ 50%, $I_{I-O} \leq 10\ \mu A$
			2250			VAC-rms	1 minute
	Isolation resistance	R_{iso}	10^{11}			ohms	$V_{I-O} = 500$ VDC
	Isolation capacitance	C_{iso}		.5		pF	f = 1 MHz

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.20	1.50	V	$I_F = 20$ mA
	Forward voltage temp. coefficient			−1.8		mV/°C	
	Reverse breakdown voltage	BV_R	3.0	25		V	$I_R = 10\ \mu A$
	Junction capacitance	C_J		50		pF	$V_F = 0$ V, f = 1 MHz
				65		pF	$V_F = 1$ V, f = 1 MHz
	Reverse leakage current	I_R		.35	10	µA	$V_R = 3.0$ V
OUTPUT TRANSISTOR	DC forward current gain	h_{FE}	100	420			$V_{CE} = 5$ V, $I_C = 100\ \mu A$
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	30	45		V	$I_C = 1.0$ mA, $I_F = 0$
	Collector to base	BV_{CBO}	70	130		V	$I_C = 10\ \mu A$
	Emitter to collector	BV_{ECO}	7	10		V	$I_E = 100\ \mu A$, $I_F = 0$
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	$V_{CE} = 10$ V, $I_F = 0$
	Capacitance						
	Collector to emitter			8		pF	$V_{CE} = 0$, f = 1 MHz
	Collector to base			20		pF	$V_{CB} = 5$, f = 1 MHz
	Emitter to base			10		pF	$V_{EB} = 0$, f = 1 MHz

ELECTRICAL CHARACTERISTIC CURVES (25°C Free air temperature unless specified)

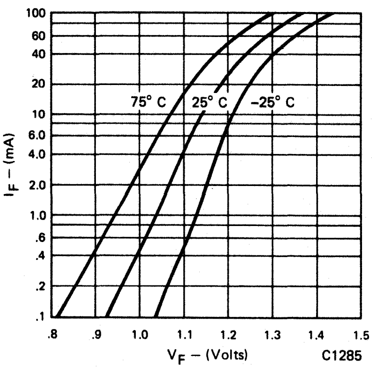


Fig. 1. Forward Voltage vs. Forward Current

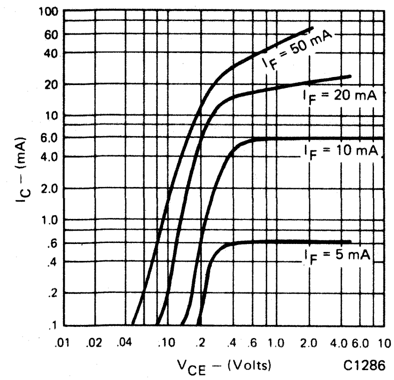


Fig. 2. Collector Current vs. Collector to Emitter Voltage

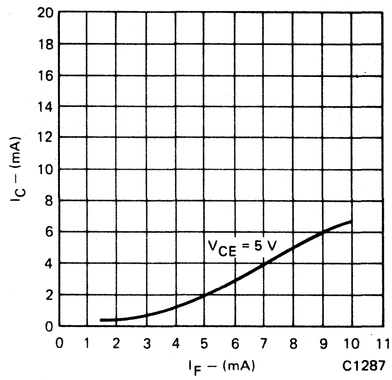


Fig. 3. Collector Current vs. Forward Current

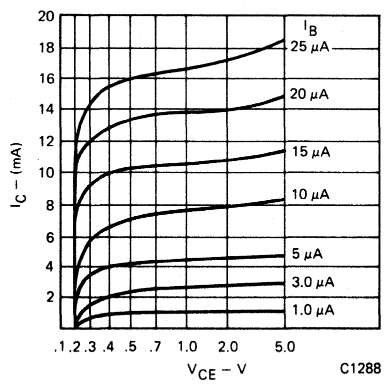


Fig. 4. Collector Current vs. Collector to Emitter Voltage

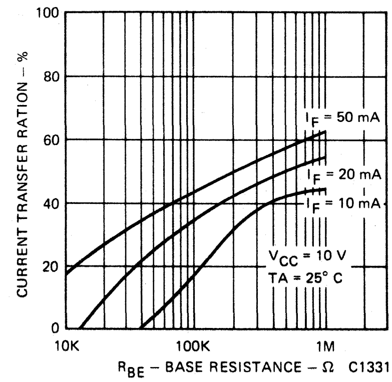


Fig. 5. Sensitivity vs. Base Resistance

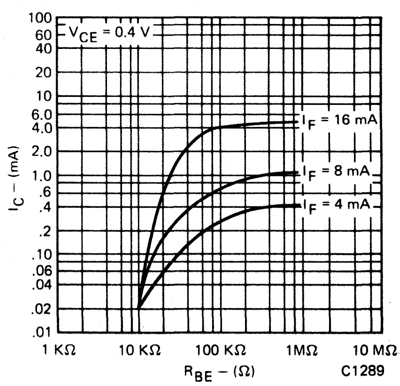


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

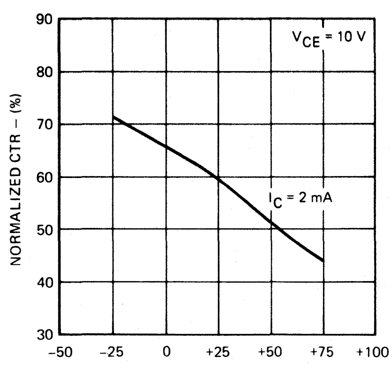


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

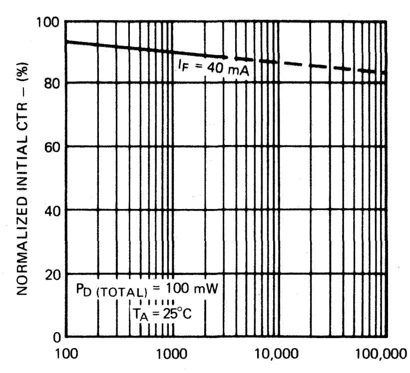


Fig. 8. Current Transfer Ratio vs. Operating Time

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature . . . . -55°C to 150°C
Operating temperature . . . . -55°C to 100°C
Lead temperature
(Soldering, 10 sec) . . . . 260°C
Total package power dissipation @ 25°C
(LED plus detector) . . . . 260 mW
Derate linearly from 25°C . . . . 3.5 mW/°C

INPUT DIODE

Forward DC current . . . . 60 mA
Reverse voltage . . . . 3 V
Peak forward current
(1 μs pulse, 300 pps) . . . . 3.0 A
Power dissipation 25°C ambient . . . . 90 mW
Derate linearly from 25°C . . . . 1.2 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C . . . . 200 mW
Derate linearly from 25°C . . . . 2.67 mW/°C

SWITCHING CHARACTERISTICS

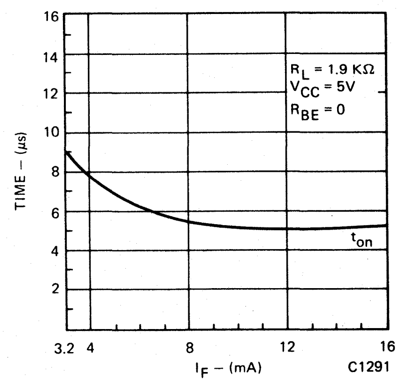


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

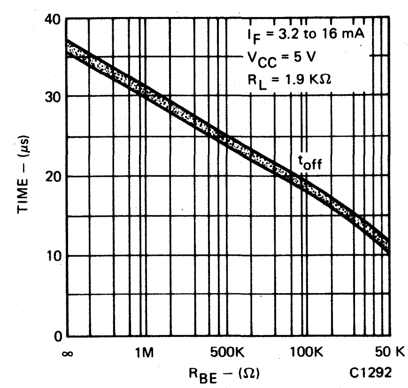


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

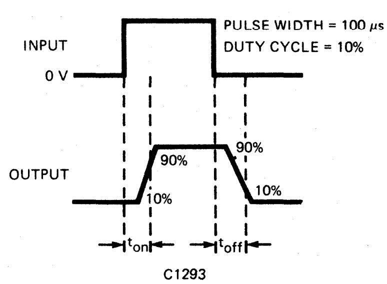


Fig. 11.

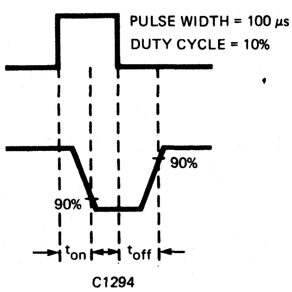


Fig. 12.

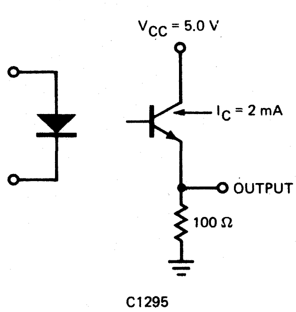


Fig. 13.

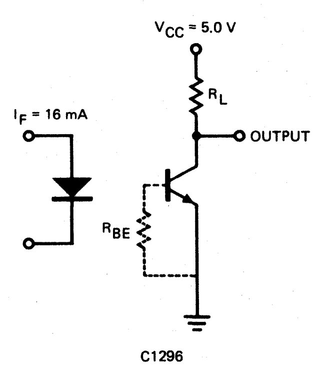


Fig. 14.

GENERAL INSTRUMENT
Optoelectronics

DESIGNER SERIES

MCT272

PHOTOTRANSISTOR OPTOISOLATORS

FEATURE SPECIFICATIONS

- **Controlled Current Transfer Ratio — 75% to 150% (specified conditions)**
- **Maximum Turn-on time — 10 μseconds (specified condition)**
- **Maximum Turn-off time — 10 μseconds (specified condition)**
- **Surge Isolation Rating — 3550 volts DC 2500 volts AC, rms**
- **Steady-state Isolation Rating — 3150 volts DC 2250 volts AC, rms**
- **Underwriters Laboratory (U.L.) recognized — File E50151**

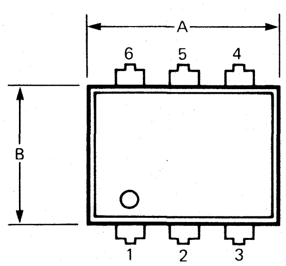
DESCRIPTION

The MCT272 is a phototransistor-type optically coupled isolator. An infrared emitting diode manufactured from specially grown gallium arsenide is selectively coupled with an NPN silicon phototransistor. The device is supplied in a standard plastic six-pin dual-in-line package.

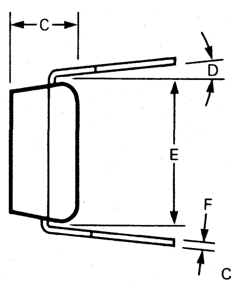
APPLICATIONS

- Power supply regulators
- Digital logic inputs
- Microprocessor inputs
- Appliance sensor systems
- Power supply regulators
- Industrial controls

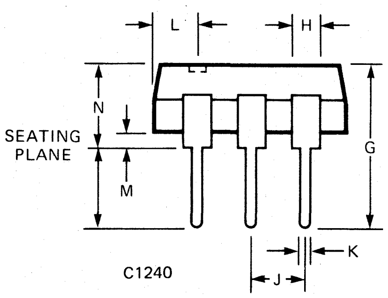
PACKAGE DIMENSIONS



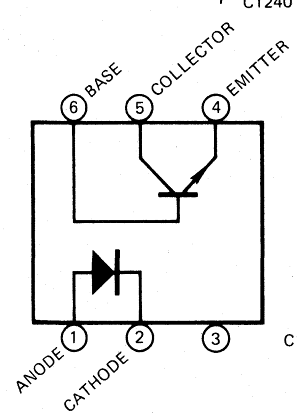
C1240



C1240



C1240



C1109

SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.365	9.27	
B	.270	6.73	
C	.130	3.18	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			3

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature unless otherwise specified)

	TRANSFER CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current Transfer Ratio, collector to emitter (a)	I_{CE}/I_F	75	115	150	%	I_F = 10 mA; V_{CE} = 10 V
			12.5			%	I_F = 16 mA; V_{CE} = 0.4 V
	Current Transfer Ratio, collector to base	I_{CB}/I_F		.15		%	I_F = 10 mA; V_{CB} = 10 V
	Saturation voltage	$V_{CE(SAT)}$		.12	.40	V	I_F = 16 mA; I_C = 2 mA
SWITCHING TIMES	Non-saturated						
	Turn-on time	t_{on}		6.0	10	μs	R_L = 100 Ω; I_C = 2 mA; V_{CC} = 5 V
	Turn-off time	t_{off}		5.5	10	μs	See figures 11, 13
	Saturated						
	Turn-on time	t_{on}		3.9		μs	I_F = 16 mA; R_L = 1.9 KΩ
	Turn-off time	t_{off}		48		μs	See figures 12, 14
	(Approximates a typical TTL interface)						
	Turn-on time	t_{on}		3.9		μs	I_F = 16 mA; R_L = 4.7 KΩ
	Turn-off time	t_{off}		110		μs	See figures 12, 14
	(Approximates a typical low power TTL interface)						
ISOLATION	Surge isolation	V_{iso}	3550			VDC	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA
			2500			VAC-rms	1 second
	Steady state isolation	V_{iso}	3150			VDC	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA
			2250			VAC-rms	1 minute
	Isolation resistance	R_{iso}	10^{11}			ohms	V_{I-O} = 500 VDC
	Isolation capacitance	C_{iso}		.5		pF	f = 1 MHz

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.20	1.50	V	I_F = 20 mA
	Forward voltage temp. coefficient			-1.8		mV/°C	
	Reverse breakdown voltage	BV_R	3.0	25		V	I_R = 10 μA
	Junction capacitance	C_J		50		pF	V_F = 0 V, f = 1 MHz
				65		pF	V_F = 1 V, f = 1 MHz
	Reverse leakage current	I_R		.35	10	μA	V_R = 3.0 V
OUTPUT TRANSISTOR	DC forward current gain	h_{FE}	100	500			V_{CE} = 5 V, I_C = 100 μA
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	30	45		V	I_C = 1.0 mA, I_F = 0
	Collector to base	BV_{CBO}	70	130		V	I_C = 10 μA
	Emitter to collector	BV_{ECO}	7	10		V	I_E = 100 μA, I_F = 0
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	V_{CE} = 10 V, I_F = 0
	Capacitance						
	Collector to emitter			8		pF	V_{CE} = 0, f = 1 MHz
	Collector to base			20		pF	V_{CB} = 5, f = 1 MHz
	Emitter to base			10		pF	V_{EB} = 0, f = 1 MHz

ELECTRICAL CHARACTERISTIC CURVES (25°C Free air temperature unless specified)

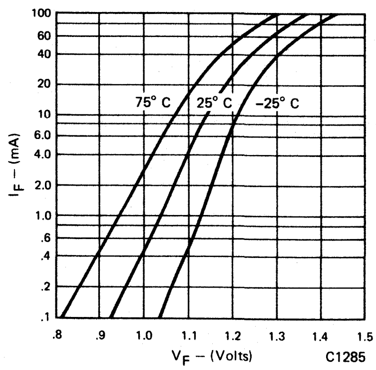


Fig. 1. Forward Voltage vs. Forward Current

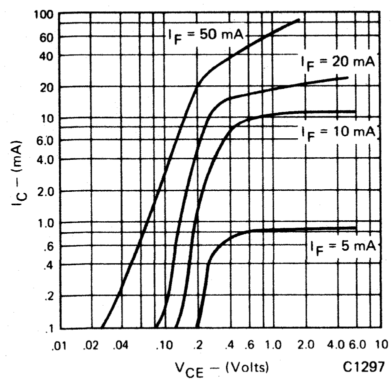


Fig. 2. Collector Current vs. Collector to Emitter Voltage

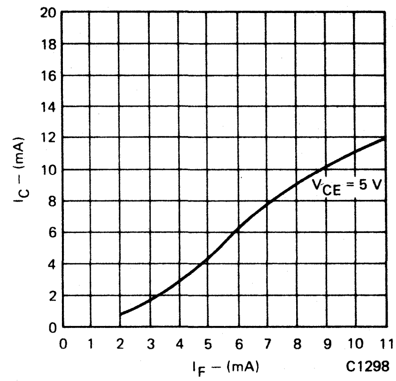


Fig. 3. Collector Current vs. Forward Current

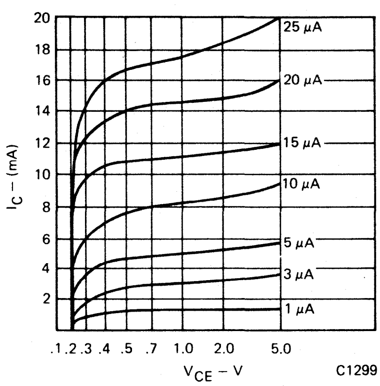


Fig. 4. Collector Current vs. Collector to Emitter Voltage

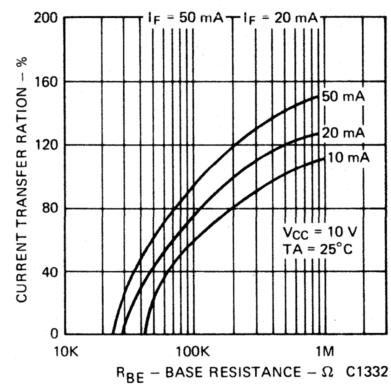


Fig. 5. Sensitivity vs. Base Resistance

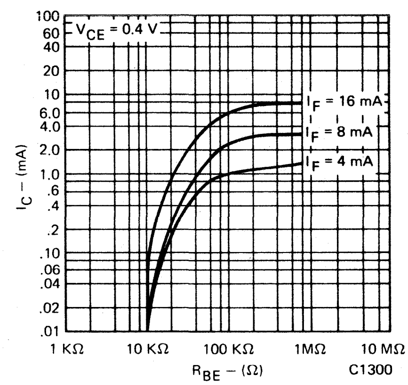


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

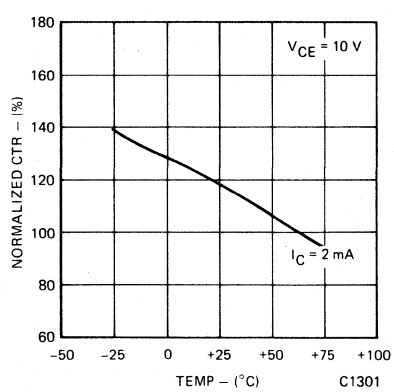


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

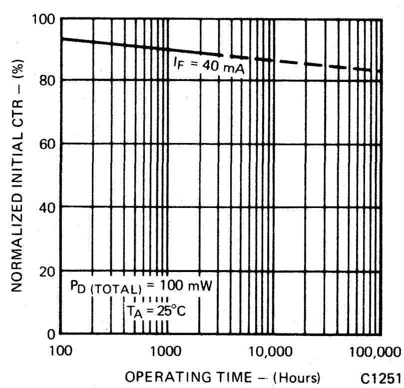


Fig. 8. Current Transfer Ratio vs. Operating Time

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature . . . . -55°C to 150°C
Operating temperature . . . . -55°C to 100°C
Lead temperature
(Soldering, 10 sec) . . . . 260°C
Total package power dissipation @ 25°C
(LED plus detector) . . . . 260 mW
Derate linearly from 25°C . . . . 3.5 mW/°C

INPUT DIODE

Forward DC current . . . . 60 mA
Reverse voltage . . . . 3 V
Peak forward current
(1 μs pulse, 300 pps) . . . . 3.0 A
Power dissipation 25°C ambient . . . . 90 mW
Derate linearly from 25°C . . . . 1.2 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C . . . . 200 mW
Derate linearly from 25°C . . . . 2.67 mW/°C

SWITCHING CHARACTERISTICS

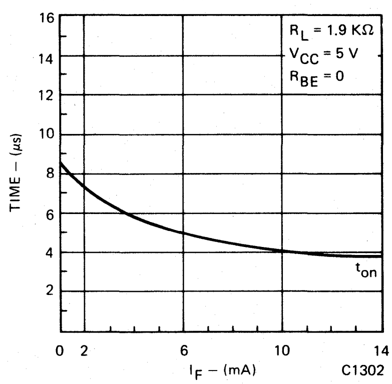


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

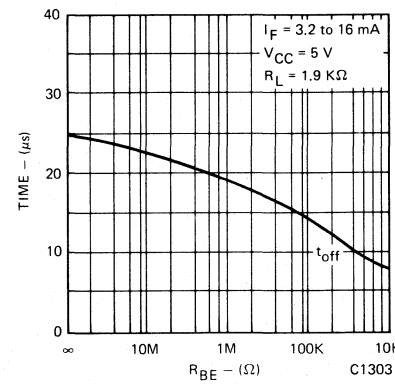


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

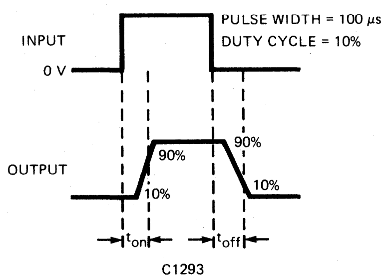


Fig. 11.

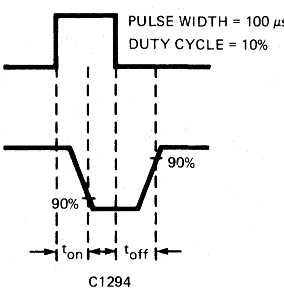


Fig. 12.

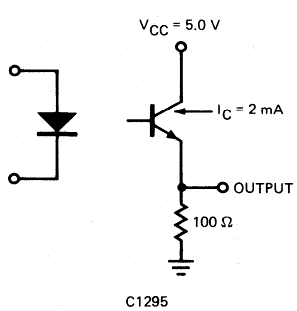


Fig. 13.

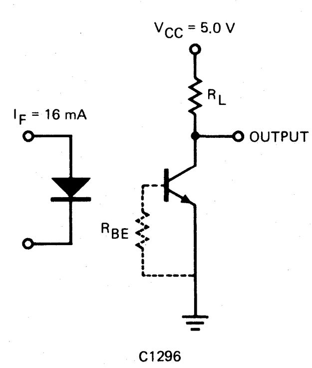


Fig. 14.

GENERAL INSTRUMENT
Optoelectronics

DESIGNER SERIES

MCT273

PHOTOTRANSISTOR OPTOISOLATORS

FEATURE SPECIFICATIONS

- **Controlled Current Transfer Ratio — 125% to 250% (specified conditions)**
- **Maximum Turn-on time — 20 μseconds (specified condition)**
- **Maximum Turn-off time — 20 μseconds (specified condition)**
- **Surge Isolation Rating — 3550 volts DC 2500 volts AC, rms**
- **Steady-state Isolation Rating — 3150 volts DC 2250 volts AC, rms**
- **Underwriters Laboratory (U.L.) recognized — File E50151**

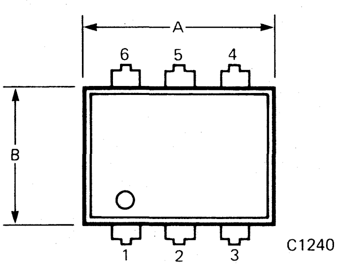
DESCRIPTION

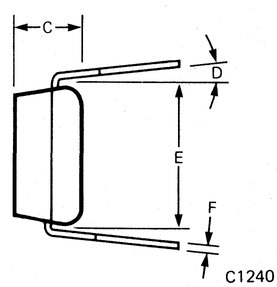
The MCT273 is a phototransistor-type optically coupled isolator. An infrared emitting diode manufactured from specially grown gallium arsenide is selectively coupled with an NPN silicon phototransistor. The device is supplied in a standard plastic six-pin dual-in-line package.

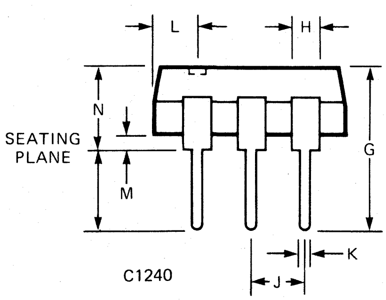
APPLICATIONS

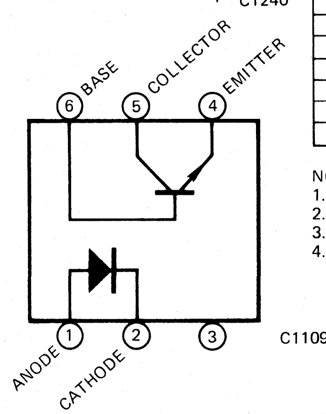
- Microprocessor board, reversible input/output
- Sensors to logic
- Logic to controls
- Appliance controls
- Industrial process control systems

PACKAGE DIMENSIONS









SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.365	9.27	
B	.270	6.73	
C	.130	3.18	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			3

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature unless otherwise specified)

TRANSFER CHARACTERISTICS

	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current Transfer Ratio, collector to emitter (a)	I_{CE}/I_F	125	200	250	%	$I_F = 10$ mA; $V_{CE} = 10$ V
			12.5			%	$I_F = 16$ mA; $V_{CE} = 0.4$ V
	Current Transfer Ratio, collector to base	I_{CB}/I_F		.15		%	$I_F = 10$ mA; $V_{CB} = 10$ V
	Saturation voltage	$V_{CE(SAT)}$		.20	.40	V	$I_F = 16$ mA; $I_C = 2$ mA
SWITCHING TIMES	Non-saturated						
	Turn-on time	t_{on}		7.6	20	μs	$R_L = 100\ \Omega$; $I_C = 2$ mA; $V_{CC} = 5$ V
	Turn-off time	t_{off}		6.6	20	μs	See figures 11, 13
	Saturated						
	Turn-on time	t_{on}		3.6		μs	$I_F = 16$ mA; $R_L = 1.9$ KΩ
	Turn-off time	t_{off}		75		μs	See figures 12, 14
	(Approximates a typical TTL interface)						
	Turn-on time	t_{on}		3.6		μs	$I_F = 16$ mA; $R_L = 4.7$ KΩ
	Turn-off time	t_{off}		155		μs	See figures 12, 14
	(Approximates a typical low power TTL interface)						
ISOLATION	Surge isolation	V_{iso}	3550			VDC	Relative humidity ≤ 50%, $I_{I-O} \leq 10\ \mu A$
			2500			VAC-rms	1 second
	Steady state isolation	V_{iso}	3150			VDC	Relative humidity ≤ 50%, $I_{I-O} \leq 10\ \mu A$
			2250			VAC-rms	1 minute
	Isolation resistance	R_{iso}	10^{11}			ohms	$V_{I-O} = 500$ VDC
	Isolation capacitance	C_{iso}		.5		pF	f = 1 MHz

INDIVIDUAL COMPONENT CHARACTERISTICS

	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.20	1.50	V	$I_F = 20$ mA
	Forward voltage temp. coefficient			−1.8		mV/°C	
	Reverse breakdown voltage	BV_R	3.0	25		V	$I_R = 10\ \mu A$
	Junction capacitance	C_J		50		pF	$V_F = 0$ V, f = 1 MHz
				65		pF	$V_F = 1$ V, f = 1 MHz
	Reverse leakage current	I_R		.35	10	μA	$V_R = 3.0$ V
OUTPUT TRANSISTOR	DC forward current gain	h_{FE}		280			$V_{CE} = 5$ V, $I_C = 100\ \mu A$
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	30	70		V	$I_C = 1.0$ mA, $I_F = 0$
	Collector to base	BV_{CBO}	70	170		V	$I_C = 10\ \mu A$
	Emitter to collector	BV_{ECO}	7	12		V	$I_E = 100\ \mu A$, $I_F = 0$
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	$V_{CE} = 10$ V, $I_F = 0$
	Capacitance						
	Collector to emitter			8		pF	$V_{CE} = 0$, f = 1 MHz
	Collector to base			20		pF	$V_{CB} = 5$, f = 1 MHz
	Emitter to base			10		pF	$V_{EB} = 0$, f = 1 MHz

ELECTRICAL CHARACTERISTIC CURVES (25°C Free air temperature unless specified)

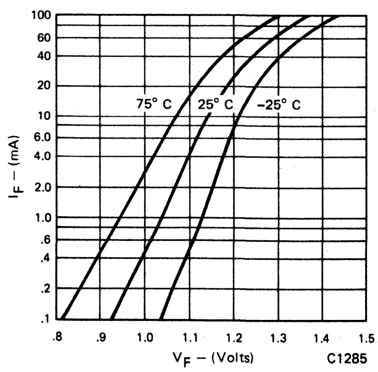


Fig. 1. Forward Voltage vs. Forward Current

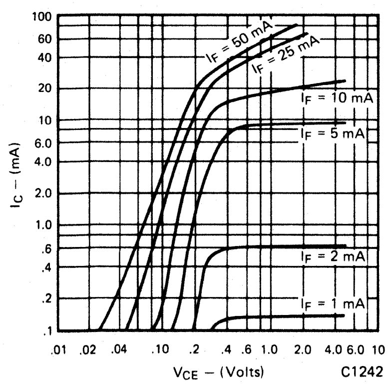


Fig. 2. Collector Current vs. Collector to Emitter Voltage

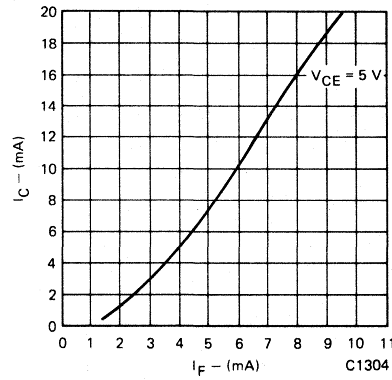


Fig. 3. Collector Current vs. Forward Current

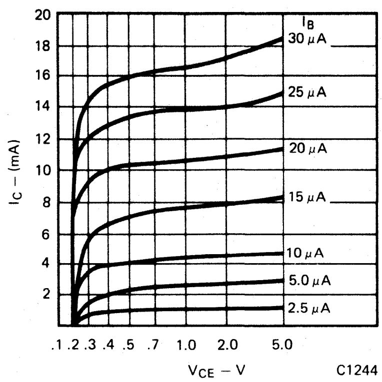


Fig. 4. Collector Current vs. Collector to Emitter Voltage

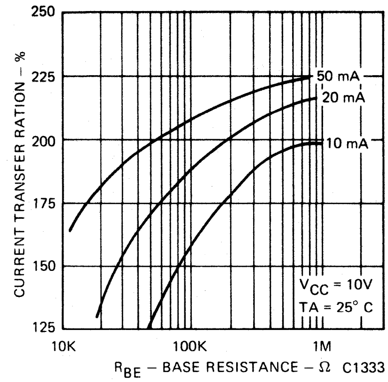


Fig. 5. Sensitivity vs. Base Resistance

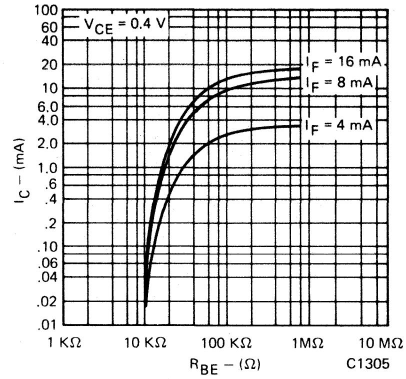


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

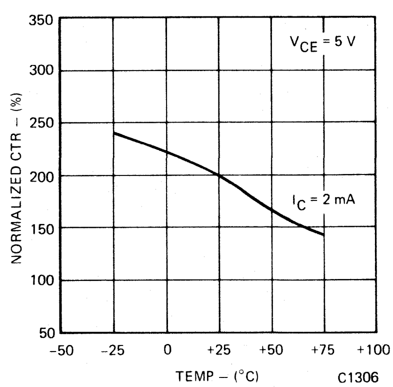


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

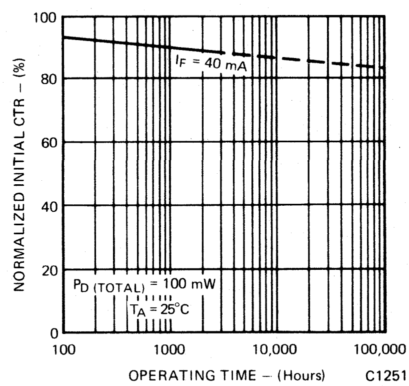


Fig. 8. Current Transfer Ratio vs. Operating Time

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature . . . . -55°C to 150°C
Operating temperature . . . . -55°C to 100°C
Lead temperature
(Soldering, 10 sec) . . . . 260°C
Total package power dissipation @ 25°C
(LED plus detector) . . . . 260 mW
Derate linearly from 25°C . . . . 3.5 mW/°C

INPUT DIODE

Forward DC current . . . . 60 mA
Reverse voltage . . . . 3 V
Peak forward current
(1 μs pulse, 300 pps) . . . . 3.0 A
Power dissipation 25°C ambient . . . . 90 mW
Derate linearly from 25°C . . . . 1.2 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C . . . . 200 mW
Derate linearly from 25°C . . . . 2.67 mW/°C

SWITCHING CHARACTERISTICS

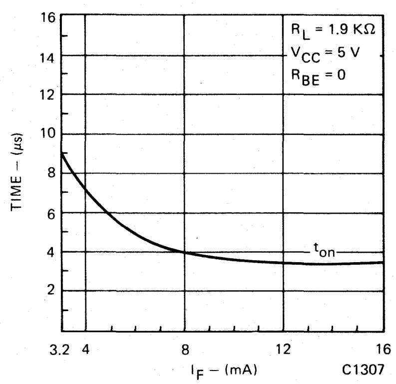


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

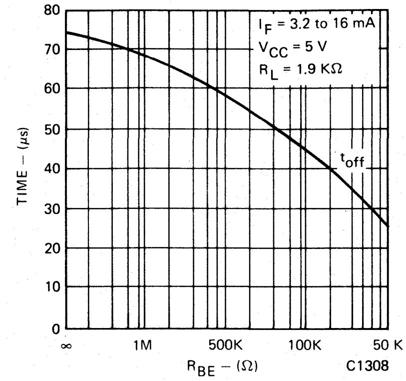


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

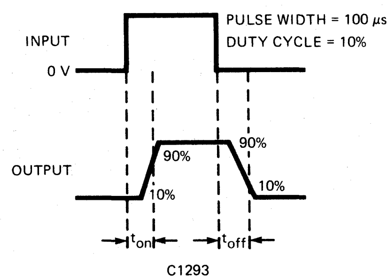


Fig. 11.

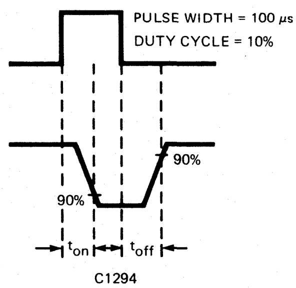


Fig. 12.

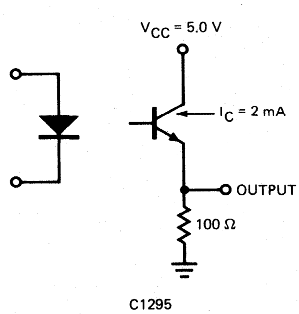


Fig. 13.

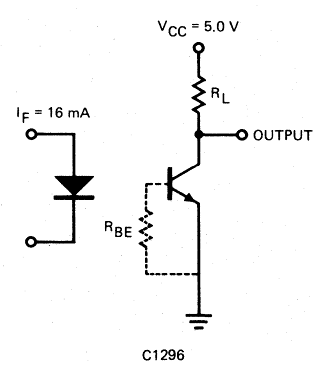


Fig. 14.

GENERAL INSTRUMENT
Optoelectronics

DESIGNER SERIES

MCT274

PHOTOTRANSISTOR OPTOISOLATORS

FEATURE SPECIFICATIONS

- Controlled Current Transfer Ratio — 225% to 400% (specified conditions)
- Maximum Turn-on time — 25 μseconds (specified condition)
- Maximum Turn-off time — 25 μseconds (specified condition)
- Surge Isolation Rating —
  3550 volts DC   2500 volts AC, rms
- Steady-state Isolation Rating —
  3150 volts DC   2250 volts AC, rms
- Underwriters Laboratory (U.L.) recognized — File E50151

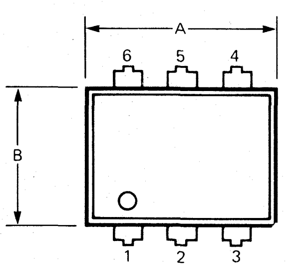
DESCRIPTION

The MCT274 is a phototransistor-type optically coupled isolator. An infrared emitting diode manufactured from specially grown gallium arsenide is selectively coupled with an NPN high-gain silicon phototransistor. The device is supplied in a standard plastic six-pin dual-in-line package.

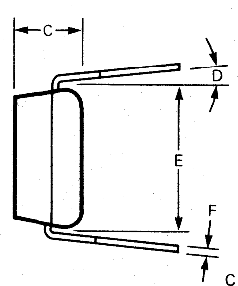
APPLICATIONS

- Control Relays
- Digital controls
- Microprocessor controls
- Replace slow photodarlington types with better switching speeds and equivalent gain devices
- Multiple gate interface

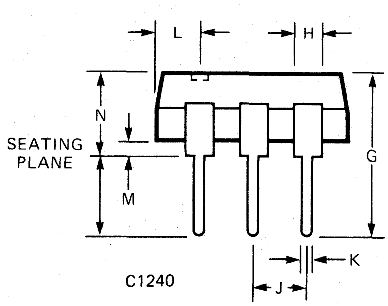
PACKAGE DIMENSIONS



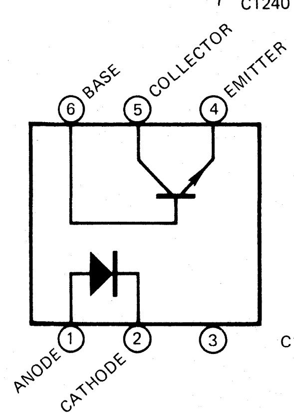
C1240



C1240



C1240



C1109

SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.365	9.27	
B	.270	6.73	
C	.130	3.18	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			3

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature unless otherwise specified)

	TRANSFER CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current Transfer Ratio, collector to emitter (a)	I_{CE}/I_F	225	305	400	%	$I_F = 10$ mA; $V_{CE} = 10$ V
			12.5			%	$I_F = 16$ mA; $V_{CE} = 0.4$ V
	Current Transfer Ratio, collector to base	I_{CB}/I_F		.15		%	$I_F = 10$ mA; $V_{CB} = 10$ V
	Saturation voltage	$V_{CE(SAT)}$		.16	.40	V	$I_F = 16$ mA; $I_C = 2$ mA
SWITCHING TIMES	Non-saturated						
	Turn-on time	t_{on}		9.1	25	μs	$R_L = 100\ \Omega$; $I_C = 2$ mA; $V_{CC} = 5$ V
	Turn-off time	t_{off}		7.9	25	μs	See figures 11, 13
	Saturated						
	Turn-on time	t_{on}		3.0		μs	$I_F = 16$ mA; $R_L = 1.9$ KΩ
	Turn-off time	t_{off}		95		μs	See figures 12, 14
	(Approximates a typical TTL interface)						
	Turn-on time	t_{on}		3.0		μs	$I_F = 16$ mA; $R_L = 4.7$ KΩ
	Turn-off time	t_{off}		185		μs	See figures 12, 14
	(Approximates a typical low power TTL interface)						
ISOLATION	Surge isolation	V_{iso}	3550			VDC	Relative humidity ≤ 50%, $I_{I-O} \leq 10\ \mu A$
			2500			VAC-rms	t = 1 second
	Steady state isolation	V_{iso}	3150			VDC	Relative humidity ≤ 50%, $I_{I-O} \leq 10\ \mu A$
			2250			VAC-rms	t = 1 minute
	Isolation resistance	R_{iso}	10^{11}			ohms	$V_{I-O} = 500$ VDC
	Isolation capacitance	C_{iso}		.5		pF	f = 1 MHz

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.20	1.50	V	$I_F = 20$ mA
	Forward voltage temp. coefficient			−1.8		mV/°C	
	Reverse breakdown voltage	BV_R	3.0	25		V	$I_R = 10\ \mu A$
	Junction capacitance	C_J		50		pF	$V_F = 0$ V, f = 1 MHz
				65		pF	$V_F = 1$ V, f = 1 MHz
	Reverse leakage current	I_R		.35	10	μA	$V_R = 3.0$ V
OUTPUT TRANSISTOR	DC forward current gain	h_{FE}		360			$V_{CE} = 5$ V, $I_C = 100\ \mu A$
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	30	70		V	$I_C = 1.0$ mA, $I_F = 0$
	Collector to base	BV_{CBO}	70	170		V	$I_C = 10\ \mu A$
	Emitter to collector	BV_{ECO}	7	12		V	$I_E = 100\ \mu A$, $I_F = 0$
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	$V_{CE} = 10$ V, $I_F = 0$
	Capacitance						
	Collector to emitter			8		pF	$V_{CE} = 0$, f = 1 MHz
	Collector to base			20		pF	$V_{CB} = 5$, f = 1 MHz
	Emitter to base			10		pF	$V_{EB} = 0$, f = 1 MHz

ELECTRICAL CHARACTERISTIC CURVES (25°C Free air temperature unless specified)

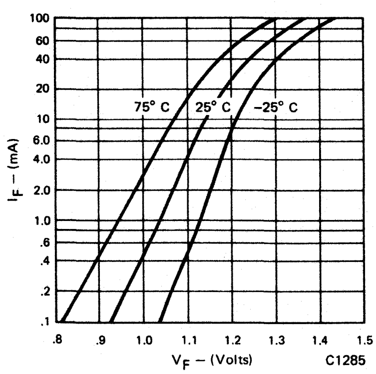


Fig. 1. Forward Voltage vs. Forward Current

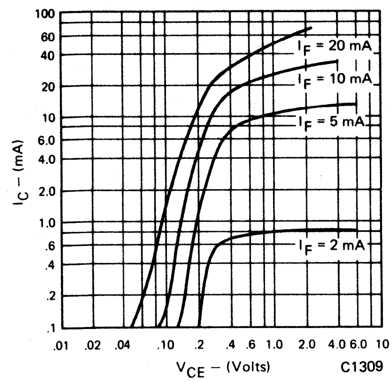


Fig. 2. Collector Current vs. Collector to Emitter Voltage

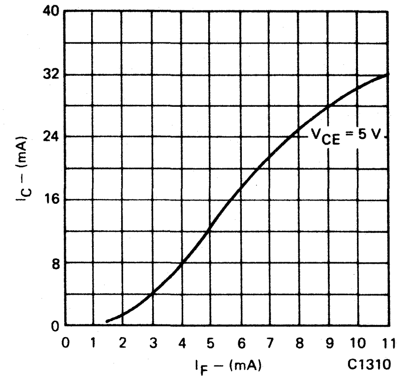


Fig. 3. Collector Current vs. Forward Current

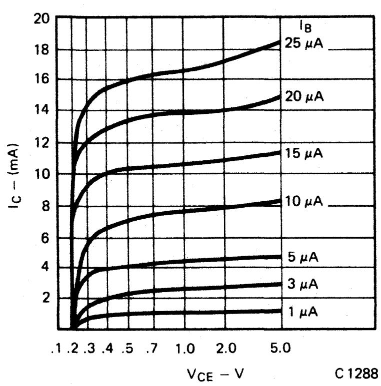


Fig. 4. Collector Current vs. Collector to Emitter Voltage

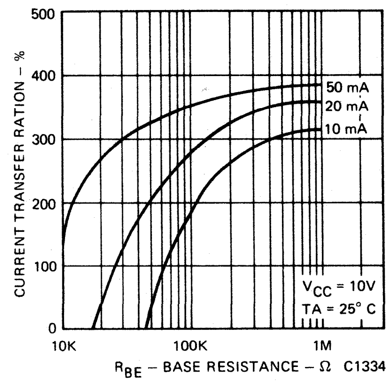


Fig. 5. Sensitivity vs. Base Resistance

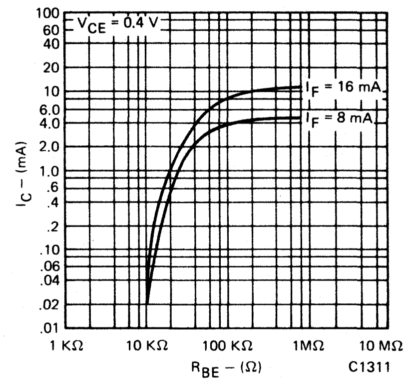


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

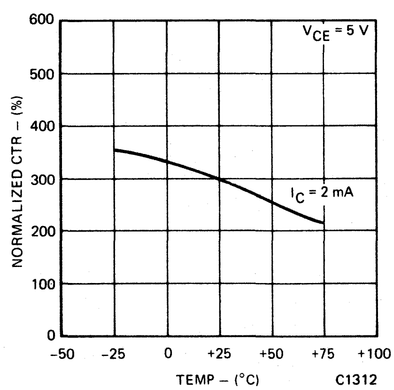


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

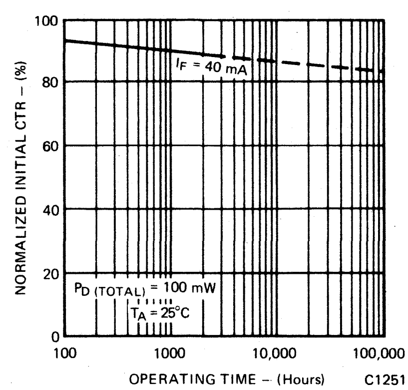


Fig. 8. Current Transfer Ratio vs. Operating Time

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature .... -55°C to 150°C
Operating temperature .... -55°C to 100°C
Lead temperature
(Soldering, 10 sec) .... 260°C
Total package power dissipation @ 25°C
(LED plus detector) .... 260 mW
Derate linearly from 25°C .... 3.5 mW/°C

INPUT DIODE

Forward DC current .... 60 mA
Reverse voltage .... 3 V
Peak forward current
(1 µs pulse, 300 pps) .... 3.0 A
Power dissipation 25°C ambient .... 90 mW
Derate linearly from 25°C .... 1.2 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C .... 200 mW
Derate linearly from 25°C .... 2.67 mW/°C

SWITCHING CHARACTERISTICS

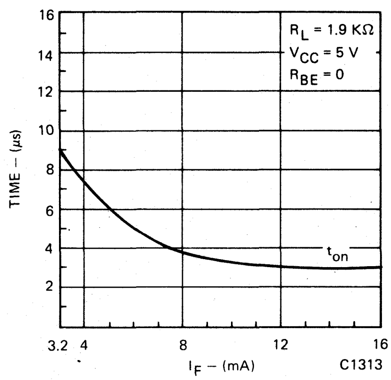


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

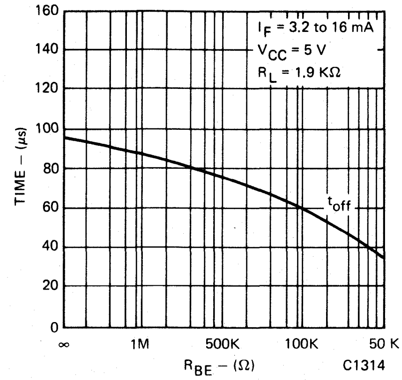


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

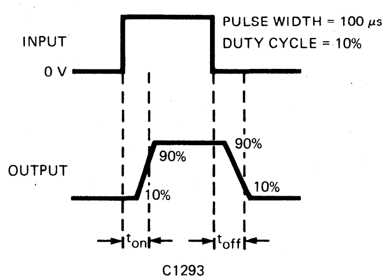


Fig. 11.

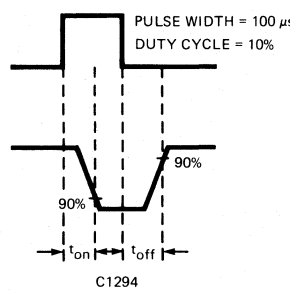


Fig. 12.

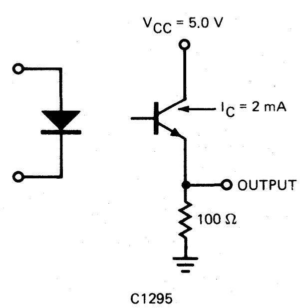


Fig. 13.

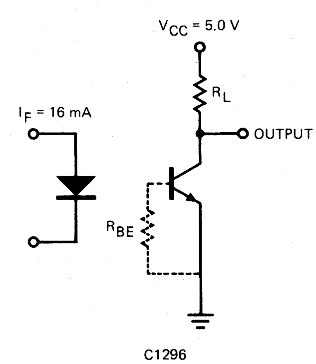


Fig. 14.

GENERAL INSTRUMENT
Optoelectronics

DESIGNER SERIES

MCT275

PHOTOTRANSISTOR OPTOISOLATORS

FEATURE SPECIFICATIONS

- **High voltage output — 80 volts, BV_{CEO}**
- **Controlled Current Transfer Ratio — 70% to 210% (specified conditions)**
- **Maximum Turn-on time — 15 μseconds (specified condition)**
- **Maximum Turn-off time — 15 μseconds (specified condition)**
- **Surge Isolation Rating — 3550 volts DC 2500 volts AC, rms**
- **Steady-state Isolation Rating — 3150 volts DC 2250 volts AC, rms**
- **Underwriters Laboratory (U.L.) recognized — File E50151**

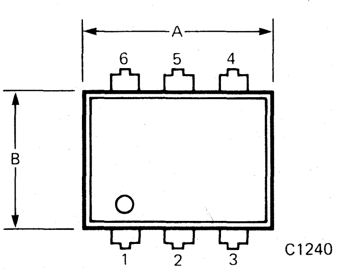
DESCRIPTION

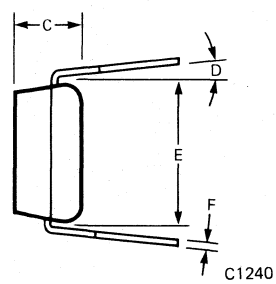
The MCT275 is a phototransistor-type optically coupled isolator. An infrared emitting diode manufactured from specially grown gallium arsenide is selectively coupled with a high voltage NPN silicon phototransistor. The device is supplied in a standard plastic six-pin dual-in-line package.

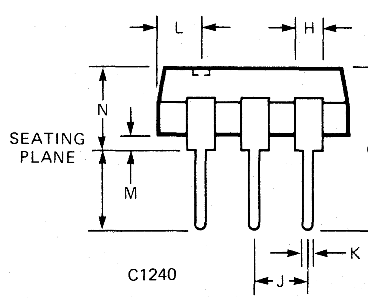
APPLICATIONS

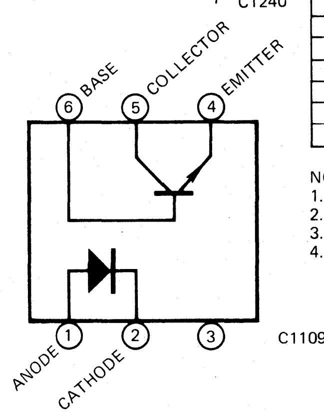
- Telephone circuits
- Digital input to telecommunications
- Industrial control of high DC voltage
- Telephone relay driver

PACKAGE DIMENSIONS









SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.365	9.27	
B	.270	6.73	
C	.130	3.18	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			3

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature unless otherwise specified)

	TRANSFER CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current Transfer Ratio, collector to emitter (a)	I_{CE}/I_F	70	125	210	%	$I_F = 10$ mA; $V_{CE} = 10$ V
			12.5			%	$I_F = 16$ mA; $V_{CE} = 0.4$ V
	Current Transfer Ratio, collector to base	I_{CB}/I_F		.15		%	$I_F = 10$ mA; $V_{CB} = 10$ V
	Saturation voltage	$V_{CE(SAT)}$		.25	.40	V	$I_F = 16$ mA; $I_C = 2$ mA
SWITCHING TIMES	Non-saturated						
	Turn-on time	t_{on}		4.5	15	μs	$R_L = 100\ \Omega$; $I_C = 2$ mA; $V_{CC} = 5$ V
	Turn-off time	t_{off}		3.5	15	μs	See figures 11, 13
	Saturated						
	Turn-on time	t_{on}		3.2		μs	$I_F = 16$ mA; $R_L = 1.9$ KΩ
	Turn-off time	t_{off}		50		μs	See figures 12, 14
	(Approximates a typical TTL interface)						
	Turn-on time	t_{on}		3.1		μs	$I_F = 16$ mA; $R_L = 4.7$ KΩ
	Turn-off time	t_{off}		90		μs	See figures 12, 14
	(Approximates a typical low power TTL interface)						
ISOLATION	Surge isolation	V_{iso}	3550			VDC	Relative humidity ≤ 50%, $I_{I-O} \leq 10\ \mu A$
			2500			VAC-rms	t = 1 second
	Steady state isolation	V_{iso}	3150			VDC	Relative humidity ≤ 50%, $I_{I-O} \leq 10\ \mu A$
			2250			VAC-rms	t = 1 minute
	Isolation resistance	R_{iso}	10^{11}			ohms	$V_{I-O} = 500$ VDC
	Isolation capacitance	C_{iso}		.5		pF	f = 1 MHz

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.20	1.50	V	$I_F = 20$ mA
	Forward voltage temp. coefficient			−1.8		mV/°C	
	Reverse breakdown voltage	BV_R	3.0	25		V	$I_R = 10\ \mu A$
	Junction capacitance	C_J		50		pF	$V_F = 0$ V, f = 1 MHz
				65		pF	$V_F = 1$ V, f = 1 MHz
	Reverse leakage current	I_R		.35	10	μA	$V_R = 3.0$ V
OUTPUT TRANSISTOR	DC forward current gain	h_{FE}		170			$V_{CE} = 5$ V, $I_C = 100\ \mu A$
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	80	85		V	$I_C = 1.0$ mA, $I_F = 0$
	Collector to base	BV_{CBO}	70	180		V	$I_C = 10\ \mu A$
	Emitter to collector	BV_{ECO}	7	11		V	$I_E = 100\ \mu A$, $I_F = 0$
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	$V_{CE} = 10$ V, $I_F = 0$
	Capacitance						
	Collector to emitter			8		pF	$V_{CE} = 0$, f = 1 MHz
	Collector to base			20		pF	$V_{CB} = 5$, f = 1 MHz
	Emitter to base			10		pF	$V_{EB} = 0$, f = 1 MHz

ELECTRICAL CHARACTERISTIC CURVES (25°C Free air temperature unless specified)

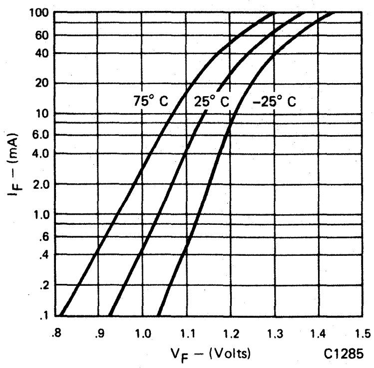


Fig. 1. Forward Voltage vs. Forward Current

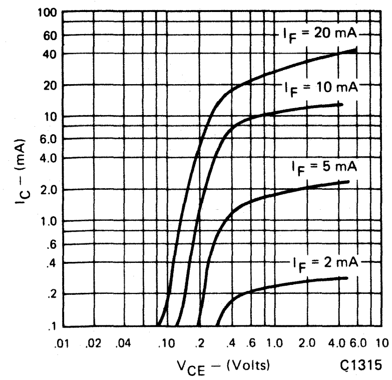


Fig. 2. Collector Current vs. Collector to Emitter Voltage

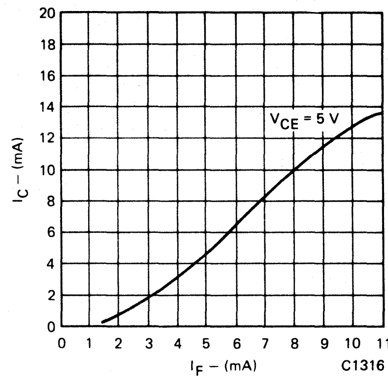


Fig. 3. Collector Current vs. Forward Current

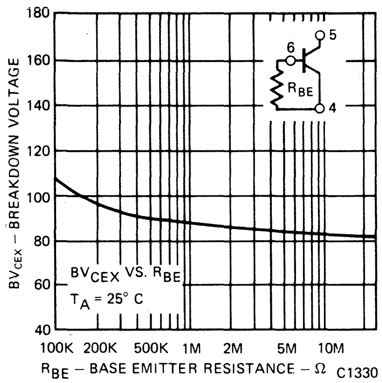


Fig. 4. Collector-Emitter Breakdown Voltage vs. Base Resistance

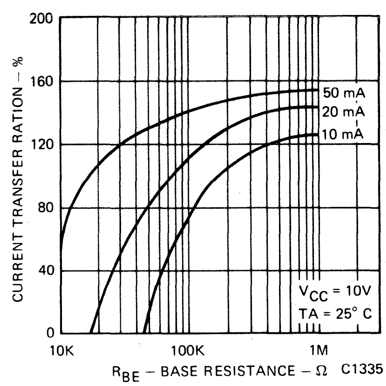


Fig. 5. Sensitivity vs. Base Resistance

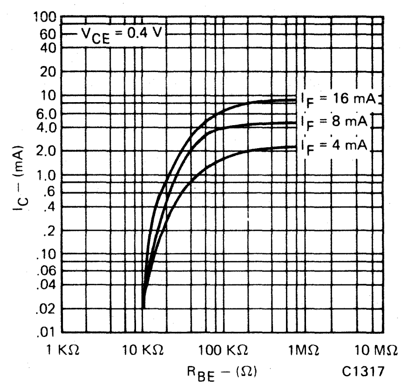


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

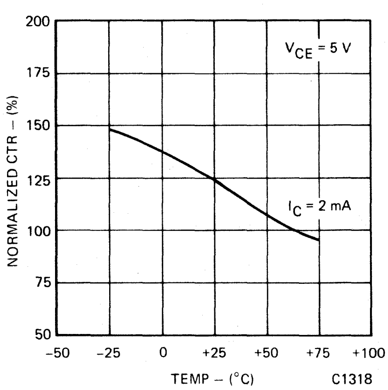


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

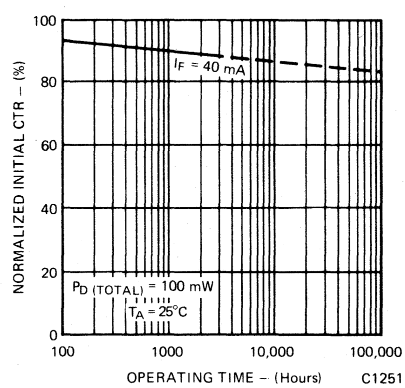


Fig. 8. Current Transfer Ratio vs. Operating Time

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature . . . . -55°C to 150°C
Operating temperature . . . . -55°C to 100°C
Lead temperature
(Soldering, 10 sec) . . . . 260°C
Total package power dissipation @ 25°C
(LED plus detector) . . . . 260 mW
Derate linearly from 25°C . . . . 3.5 mW/°C

INPUT DIODE

Forward current . . . . 60 mA
Reverse voltage . . . . 3 V
Peak forward current
(1 μs pulse, 300 pps) . . . . 3.0 A
Power dissipation 25°C ambient . . . . 90 mW
Derate linearly from 25°C . . . . 1.2 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C . . . . 200 mW
Derate linearly from 25°C . . . . 2.67 mW/°C

SWITCHING CHARACTERISTICS

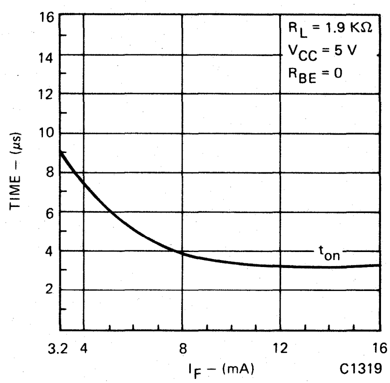


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

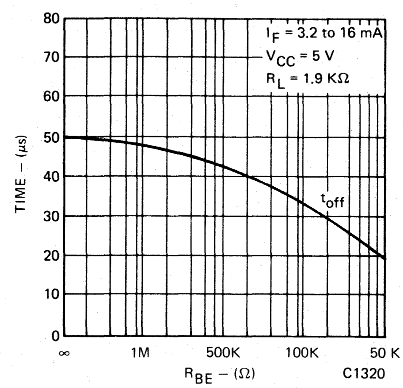


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

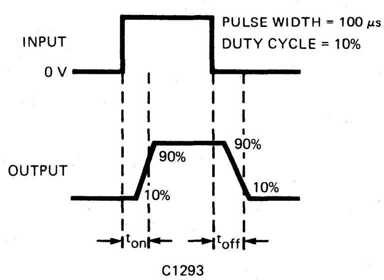


Fig. 11.

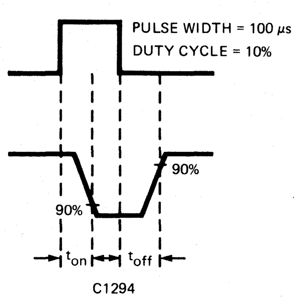


Fig. 12.

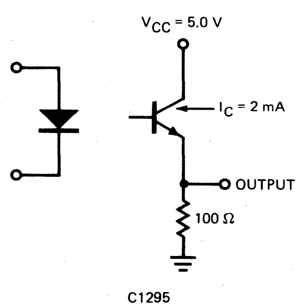


Fig. 13.

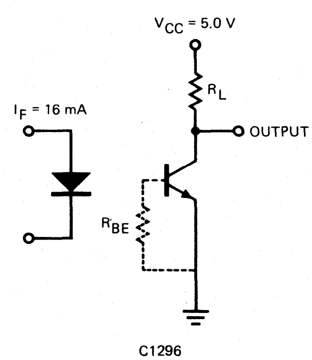


Fig. 14.

GENERAL INSTRUMENT
Optoelectronics

DESIGNER SERIES

MCT276

PHOTOTRANSISTOR OPTOISOLATORS

FEATURE SPECIFICATIONS

- **Highest speed discrete phototransistor optoisolator**
- **Controlled Current Transfer Ratio — 15% to 60% (specified conditions)**
- **Maximum Turn-on time — 2.5 μseconds (specified condition)**
- **Maximum Turn-off time — 2.5 μseconds (specified condition)**
- **Surge Isolation Rating — 3550 volts DC 2500 volts AC, rms**
- **Steady-state Isolation Rating — 3150 volts DC 2250 volts AC, rms**
- **Underwriters Laboratory (U.L.) recognized — File E50151**

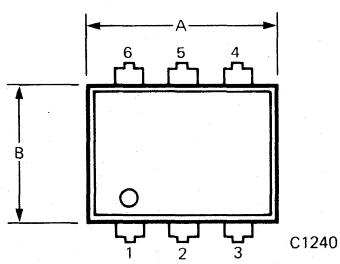
DESCRIPTION

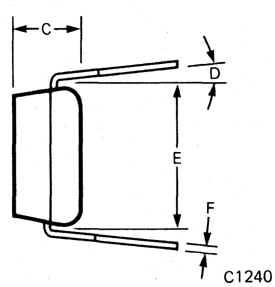
The MCT276 is a phototransistor-type optically coupled isolator. An infrared emitting diode manufactured from specially grown gallium arsenide is selectively coupled with a high speed NPN silicon phototransistor. The device is supplied in a standard plastic six-pin dual-in-line package.

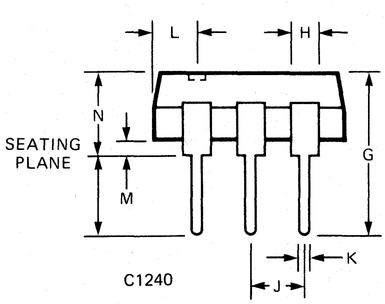
APPLICATIONS

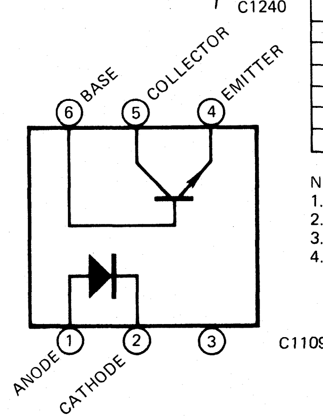
- Data communications
- Digital ground isolation
- Digital logic inputs
- Microprocessor inputs
- Appliance sensor systems

PACKAGE DIMENSIONS









SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.365	9.27	
B	.270	6.73	
C	.130	3.18	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			3

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature unless otherwise specified)

	TRANSFER CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current Transfer Ratio, collector to emitter (a)	I_{CE}/I_F	15	30	60	%	I_F = 10 mA; V_{CE} = 10 V
			12.5			%	I_F = 16 mA; V_{CE} = 0.4 V
	Current Transfer Ratio, collector to base	I_{CB}/I_F		.15		%	I_F = 10 mA; V_{CB} = 10 V
	Saturation voltage	$V_{CE(SAT)}$		.24	.40	V	I_F = 16 mA; I_C = 2 mA
SWITCHING TIMES	Non-saturated						
	Turn-on time	t_{on}		2.4	3.5	μs	R_L = 100 Ω; I_C = 2 mA; V_{CC} = 5 V
	Turn-off time	t_{off}		2.2	3.5	μs	See figures 11, 13
	Saturated						
	Turn-on time	t_{on}		6.8		μs	I_F = 16 mA; R_L = 1.9 KΩ
	Turn-off time	t_{off}		16		μs	See figures 12, 14
	(Approximates a typical TTL interface)						
	Turn-on time	t_{on}		5.4		μs	I_F = 16 mA; R_L = 4.7 KΩ
	Turn-off time	t_{off}		32		μs	See figures 12, 14
	(Approximates a typical low power TTL interface)						
ISOLATION	Surge isolation	V_{iso}	3550			VDC	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA
			2500			VAC-rms	t = 1 second
	Steady state isolation	V_{iso}	3150			VDC	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA
			2250			VAC-rms	t = 1 minute
	Isolation resistance	R_{iso}	10^{11}			ohms	V_{I-O} = 500 VDC
	Isolation capacitance	C_{iso}		.5		pF	f = 1 MHz

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.20	1.50	V	I_F = 20 mA
	Forward voltage temp. coefficient			−1.8		mV/°C	
	Reverse breakdown voltage	BV_R	3.0	25		V	I_R = 10 μA
	Junction capacitance	C_J		50		pF	V_F = 0 V, f = 1 MHz
				65		pF	V_F = 1 V, f = 1 MHz
	Reverse leakage current	I_R		.35	10	μA	V_R = 3.0 V
OUTPUT TRANSISTOR	DC forward current gain	h_{FE}		90			V_{CE} = 5 V, I_C = 100 μA
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	30	45		V	I_C = 1.0 mA, I_F = 0
	Collector to base	BV_{CBO}	70	130		V	I_C = 10 μA
	Emitter to collector	BV_{ECO}	7	10		V	I_E = 100 μA, I_F = 0
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	V_{CE} = 10 V, I_F = 0
	Capacitance						
	Collector to emitter			8		pF	V_{CE} = 0, f = 1 MHz
	Collector to base			20		pF	V_{CB} = 5, f = 1 MHz
	Emitter to base			10		pF	V_{EB} = 0, f = 1 MHz

ELECTRICAL CHARACTERISTIC CURVES (25°C Free air temperature unless specified)

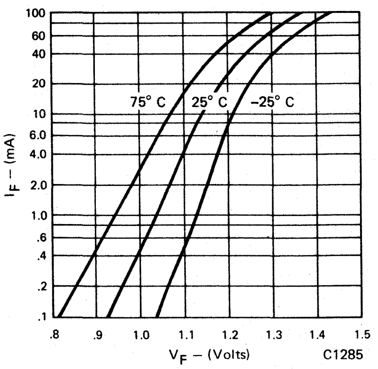


Fig. 1. Forward Voltage vs. Forward Current

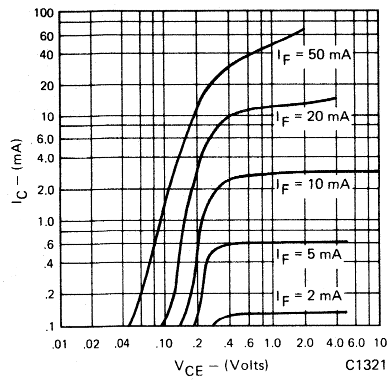


Fig. 2. Collector Current vs. Collector to Emitter Voltage

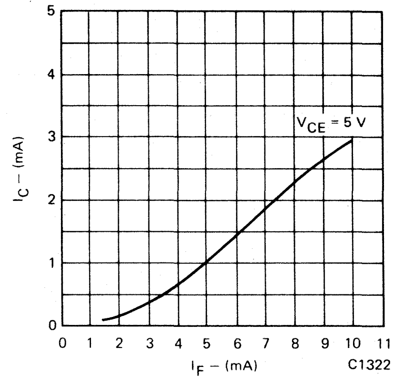


Fig. 3. Collector Current vs. Forward Current

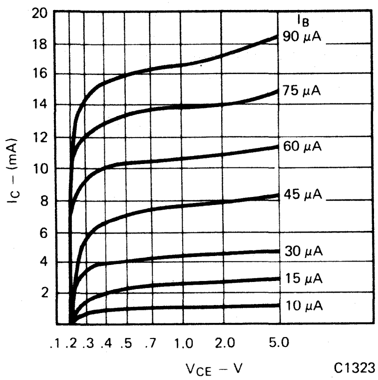


Fig. 4. Collector Current vs. Collector to Emitter Voltage

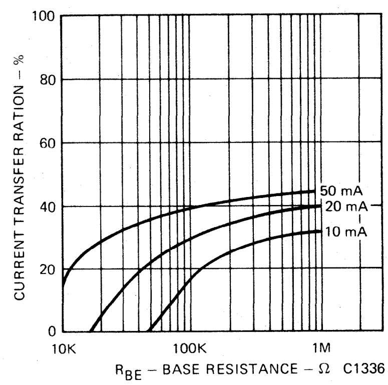


Fig. 5. Sensitivity vs. Base Resistance

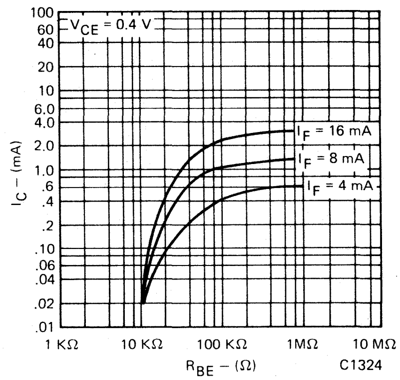


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

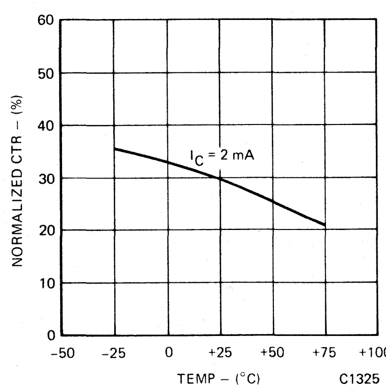


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

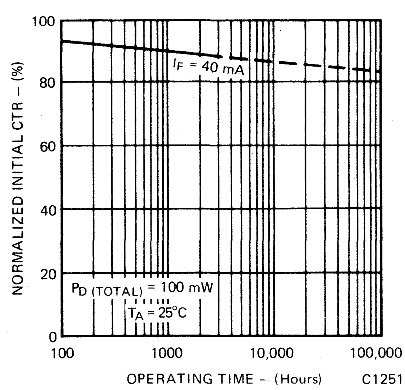


Fig. 8. Current Transfer Ratio vs. Operating Time

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature .... -55°C to 150°C
Operating temperature .... -55°C to 100°C
Lead temperature
(Soldering, 10 sec) .... 260°C
Total package power dissipation @ 25°C
(LED plus detector) .... 260 mW
Derate linearly from 25°C .... 3.5 mW/°C

INPUT DIODE

Forward DC current .... 60 mA
Reverse voltage .... 3 V
Peak forward current
(1 µs pulse, 300 pps) .... 3.0 A
Power dissipation 25°C ambient .... 90 mW
Derate linearly from 25°C .... 1.2 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C .... 200 mW
Derate linearly from 25°C .... 2.67 mW/°C

SWITCHING CHARACTERISTICS

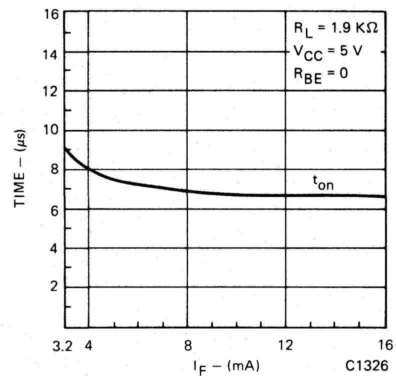


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

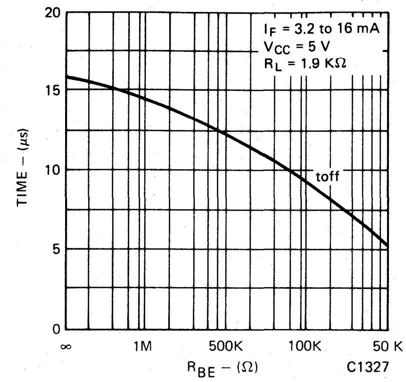


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

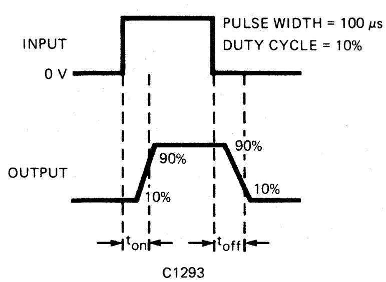


Fig. 11.

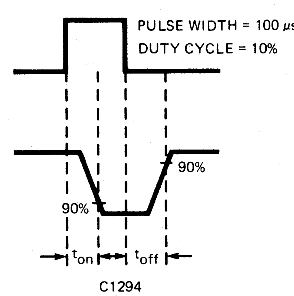


Fig. 12.

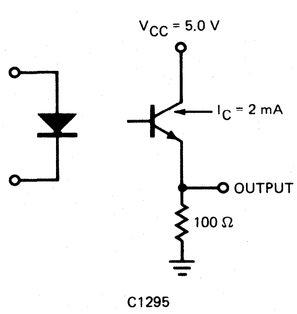


Fig. 13.

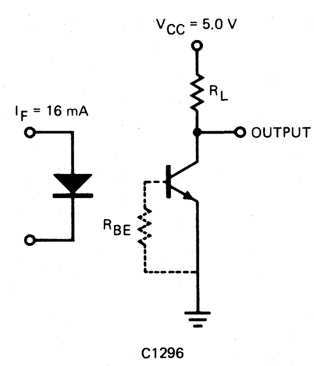


Fig. 14.

GENERAL INSTRUMENT
Optoelectronics

DESIGNER SERIES

MCT277

PHOTOTRANSISTOR OPTOISOLATORS

FEATURE SPECIFICATIONS

- **40% Transfer ratio at $V_{CE(SAT)}$ of 0.4 volts for multiple gate interface**
- **Temperature — stable from 0°C to 25°C**
- **Maximum Turn-on time — 15 µseconds (specified condition)**
- **Maximum Turn-off time — 15 µseconds (specified condition)**
- **Surge Isolation Rating — 2500 volts DC 1500 volts AC, rms**
- **Steady-state Isolation Rating — 1750 volts DC 1250 volts AC, rms**
- **Underwriters Laboratory (U.L.) recognized — File E50151**

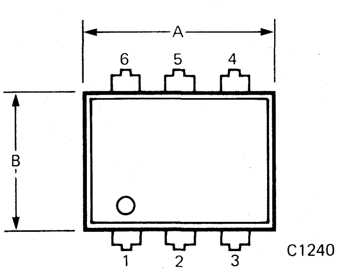
DESCRIPTION

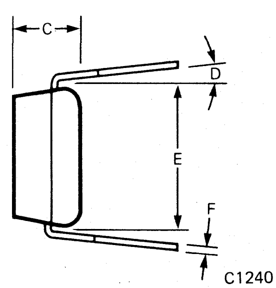
The MCT277 is a phototransistor-type optically coupled isolator. An infrared emitting diode manufactured from specially grown gallium arsenide is selectively coupled with an NPN silicon phototransistor. The device is supplied in a standard plastic six-pin dual-in-line package.

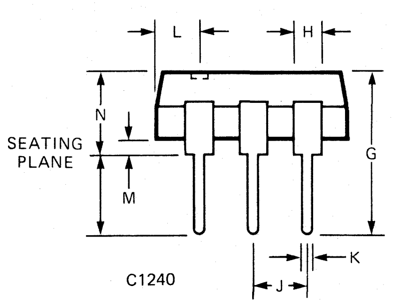
APPLICATIONS

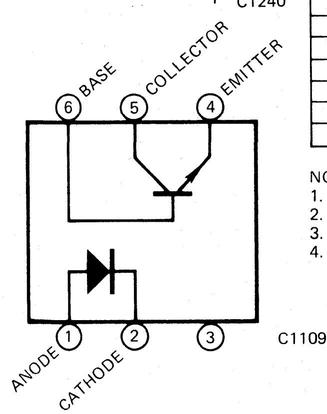
- Digital to digital system interface
- Sensor to many gates
- Ground loop isolation
- Power supply regulation

PACKAGE DIMENSIONS









SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.365	9.27	
B	.270	6.73	
C	.130	3.18	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			3

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature unless otherwise specified)

TRANSFER CHARACTERISTICS

	CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current Transfer Ratio, collector to emitter (a)	I_{CE}/I_F	100			%	I_F = 10 mA; V_{CE} = 10 V
			40			%	I_F = 16 mA; V_{CE} = 0.4 V
	Current Transfer Ratio, collector to base	I_{CB}/I_F		.4		%	I_F = 10 mA; V_{CB} = 10 V
SWITCHING TIMES	Non-saturated						
	Turn-on time	t_{on}			15	μs	R_L = 100 Ω; I_C = 2 mA; V_{CC} = 5 V
	Turn-off time	t_{off}			15	μs	See figures 15, 17
	Saturated						
	Turn-on time	t_{on}		3.8		μs	I_F = 16 mA; R_L = 1.9 KΩ
	Turn-off time	t_{off}		90		μs	See figures 16, 18
	(Approximates a typical TTL interface)						
	Turn-on time	t_{on}		3.7		μs	I_F = 16 mA; R_L = 4.7 KΩ
	Turn-off time	t_{off}		190		μs	See figures 16, 18
	(Approximates a typical low power TTL interface)						
ISOLATION	Surge isolation	V_{iso}	2500			VDC	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA
			1500			VAC-rms	t = 1 second
	Steady state isolation	V_{iso}	1750			VDC	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA
			1250			VAC-rms	t = 1 minute
	Isolation resistance	R_{iso}	10^{11}			ohms	V_{I-O} = 500 VDC
	Isolation capacitance	C_{iso}		1.0		pF	f = 1 MHz

INDIVIDUAL COMPONENT CHARACTERISTICS

	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.20	1.50	V	I_F = 20 mA
	Forward voltage temp. coefficient			−1.8		mV/°C	
	Reverse breakdown voltage	BV_R	3.0	25		V	I_R = 10 μA
	Junction capacitance	C_J		50		pF	V_F = 0 V, f = 1 MHz
				65		pF	V_F = 1 V, f = 1 MHz
	Reverse leakage current	I_R		.35	10	μA	V_R = 3.0 V
OUTPUT TRANSISTOR	DC forward current gain	h_{FE}		420			V_{CE} = 5 V, I_C = 100 μA
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	30	45		V	I_C = 1.0 mA, I_F = 0
	Collector to base	BV_{CBO}	70	130		V	I_C = 10 μA
	Emitter to collector	BV_{ECO}	7	10		V	I_E = 100 μA, I_F = 0
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	V_{CE} = 10 V, I_F = 0
	Capacitance						
	Collector to emitter			8		pF	V_{CE} = 0, f = 1 MHz
	Collector to base			20		pF	V_{CB} = 5, f = 1 MHz
	Emitter to base			10		pF	V_{EB} = 0, f = 1 MHz

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature . . . . –55°C to 150°C
Operating temperature . . . . –55°C to 100°C
Lead temperature
(Soldering, 10 sec) . . . . 260°C
Total package power dissipation @ 25°C
(LED plus detector) . . . . 260 mW
Derate linearly from 25°C . . . . 3.5 mW/°C

INPUT DIODE

Forward DC current . . . . 60 mA
Reverse voltage . . . . 3 V
Peak forward current
(1 μs pulse, 300 pps) . . . . 3.0 A
Power dissipation 25°C . . . . 90 mW
Derate linearly from 25°C . . . . 0.8 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C . . . . 200 mW
Derate linearly from 25°C . . . . 2.67 mW/°C

ELECTRICAL CHARACTERISTIC CURVES (25°C Free air temperature unless specified)

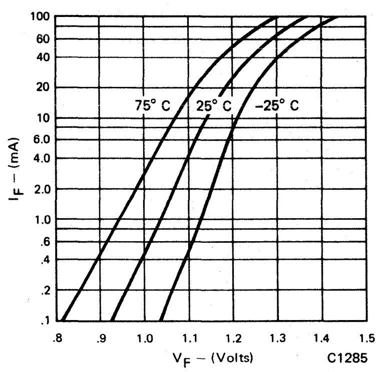


Fig. 1. Forward Voltage vs. Forward Current

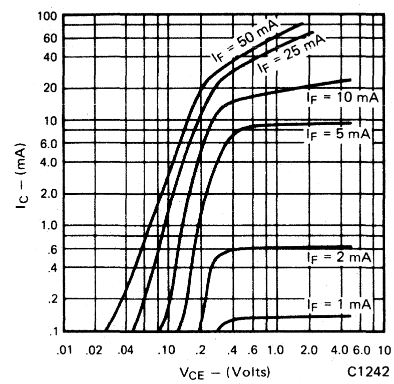


Fig. 2. Collector Current vs. Collector to Emitter Voltage

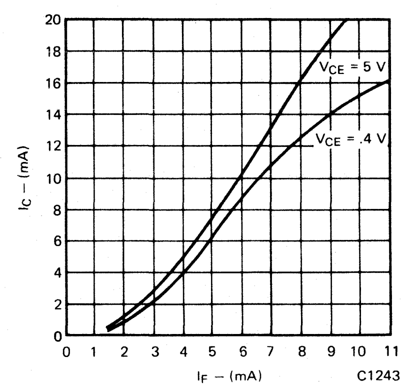


Fig. 3. Collector Current vs. Forward Current

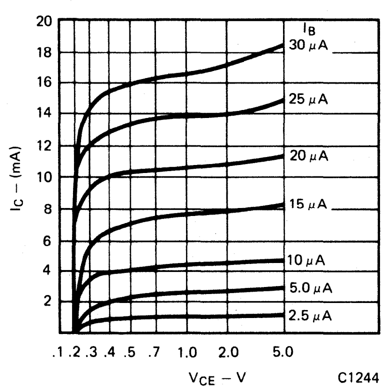


Fig. 4. Collector Current vs. Collector to Emitter Voltage

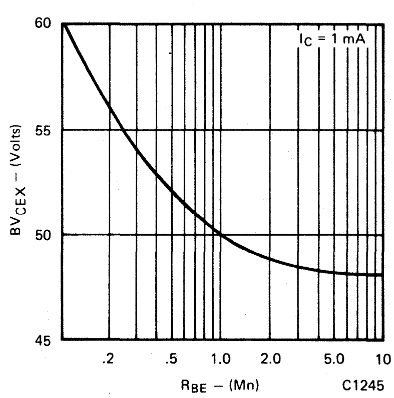


Fig. 5. Collector to Emitter Breakdown Voltage vs. Base to Emitter Resistance

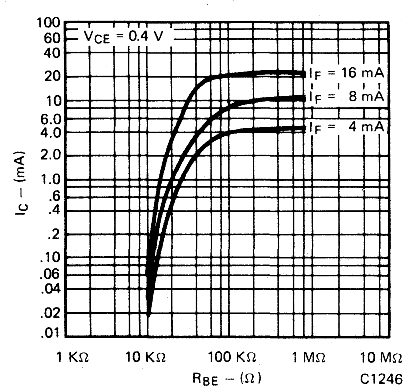


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

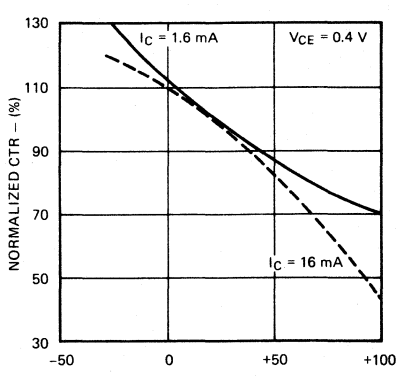


Fig. 7. Current Transfer Ratio (saturated) vs. Temperature

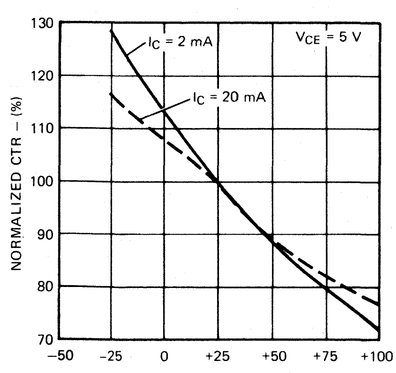


Fig. 8. Current Transfer Ratio (unsaturated) vs. Temperature

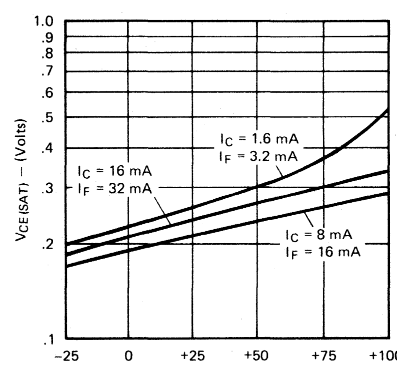


Fig. 9. Collector to Emitter Saturation Voltage vs. Temperature

ELECTRICAL CHARACTERISTIC CURVES (25°C Free air temperature unless specified)

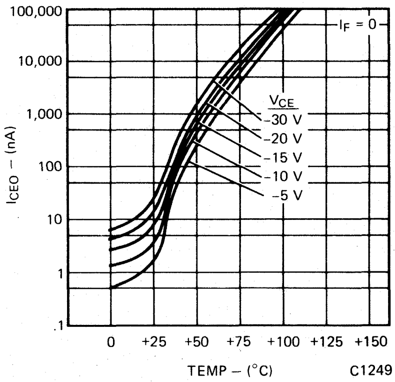


Fig. 10. Collector to Emitter Leakage Current vs. Temperature

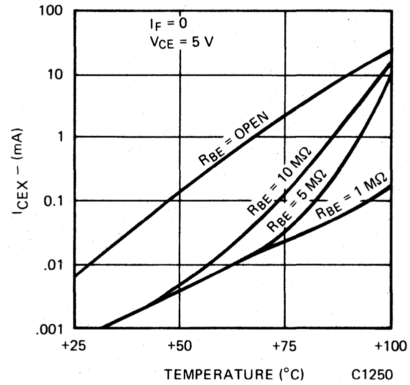


Fig. 11. Collector to Emitter Leakage Current vs. Temperature

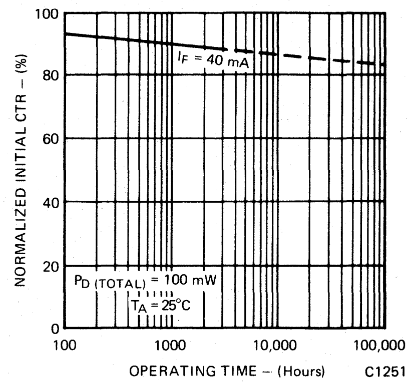


Fig. 12. Current Transfer Ratio vs. Operating Time

SWITCHING CHARACTERISTICS

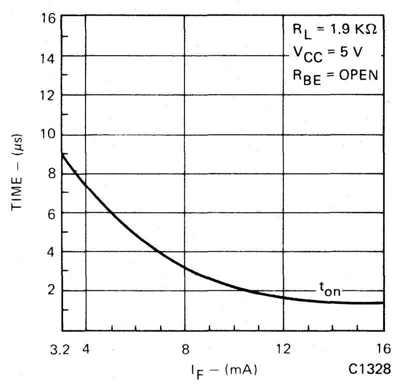


Fig. 13. Switch-on Time vs. I_F Drive (saturated)

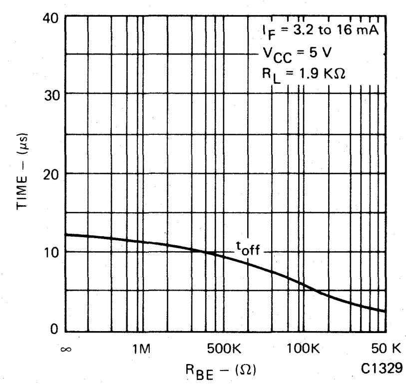


Fig. 14. Switch-off Time vs. Base to Emitter Resistance (saturated)

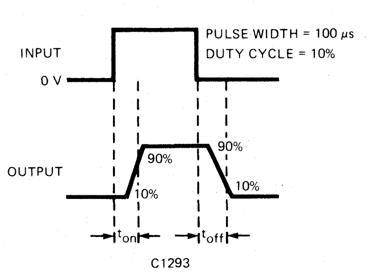


Fig. 15.

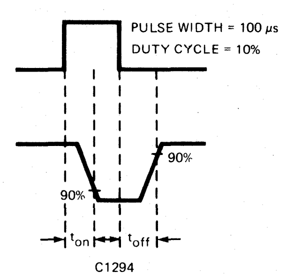


Fig. 16.

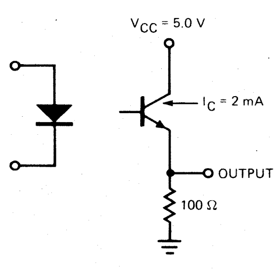


Fig. 17.

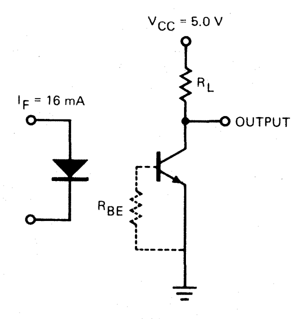


Fig. 18.

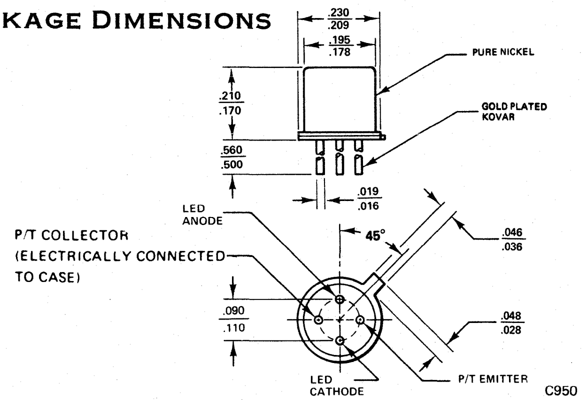
GENERAL INSTRUMENT
Optoelectronics

MCT4
PHOTOTRANSISTOR OPTOISOLATOR

PRODUCT DESCRIPTION

The MCT4 is a standard four-lead, TO-18 package containing a GaAs light emitting diode optically coupled to an NPN silicon planar phototransistor.

PACKAGE DIMENSIONS



FEATURES

- Hermetic package
- High current transfer ratio; typically 35%
- High isolation resistance; 10^{11} ohms at 500 volts
- High voltage isolation emitter to detector

ABSOLUTE MAXIMUM RATINGS

Storage temperature — -65°C to 150°C
Operating temperature — -55°C to 125°C
Lead soldering time @ 260°C - 10.0 seconds

LED(GaAs Diode)	
Power dissipation @ 25°C ambient	90 mW
Derate linearly from 25°C	1.2 mW/°C
Continuous forward current	40 mA
Reverse voltage	3.0 volts
Peak forward current (1 μs pulse, 300 pps)	3.0 A
Total power dissipation	250 mW
Derate linearly from 25°C	3.3 mW/°C

DETECTOR (Silicon phototransistor)	
Power dissipation @ 25°C ambient	200 mW
Derate linearly from 25°C	2.67 mW/°C
Collector-emitter breakdown voltage (BV_{CEO})	30 volts
Emitter-collector breakdown voltage. (BV_{ECO})	7.0 volts
ISOLATION VOLTAGE	1000 VDC

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Emitter					
Forward voltage		1.3	1.5	V	I_F=40 mA
Reverse current		.15	10	μA	V_R=3.0 V
Capacitance		150		pF	V=0
Detector					
BV_{CEO}	30			V	I_C=1.0 mA, I_F=0
BV_{ECO}	7	12		V	I_E = 100 μA, I_F = 0
I_{CEO}(Dark)		5	50	nA	V_{CE}=10 V, I_F=0
Capacitance collector-emitter		2		pF	V_{CE}=0
Coupled					
DC current transfer ratio	15	35		%	I_F=10 mA, V_{CE}=10 V
Breakdown voltage	1000	1500		VDC	t = 1 second
Resistance emitter-detector	10^{11}	10^{12}		ohms	V = 500 VDC
$V_{CE(SAT)}$		0.1		V	I_C=500μA, I_F= 10 mA
		0.2	0.5	V	I_C=2 mA, I_F=50 mA
Capacitance LED to detector		1.8		pF	
Bandwidth (see figure 5)		300		kHz	Note 2
Rise time and fall time (see operating schematic)		2		μs	I_C=2 mA, V_{CE}=10 V Note 3

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

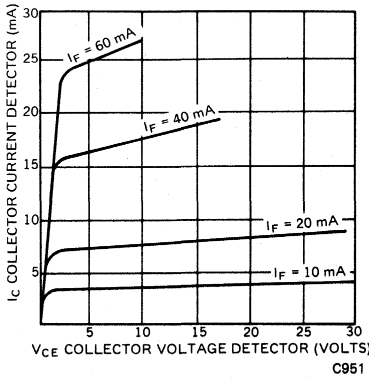


Figure 1 Detector Output Characteristics

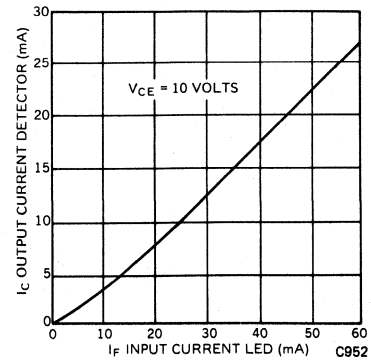


Figure 2 Input Current vs. Output Current

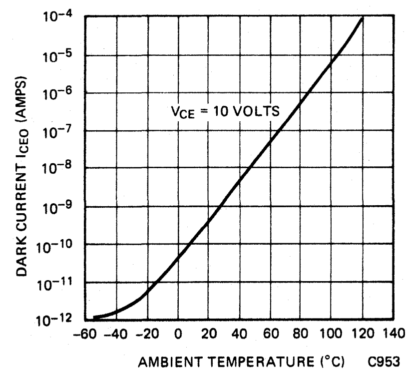


Figure 3 Dark Current vs. Temperature (°C)

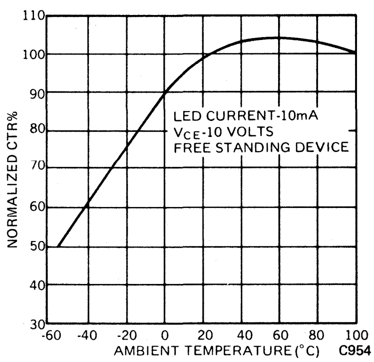


Figure 4 Current Output vs. Temperature

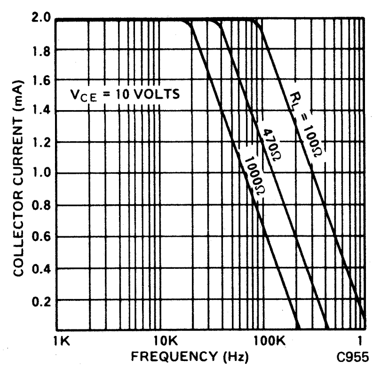


Figure 5 Output vs. Frequency

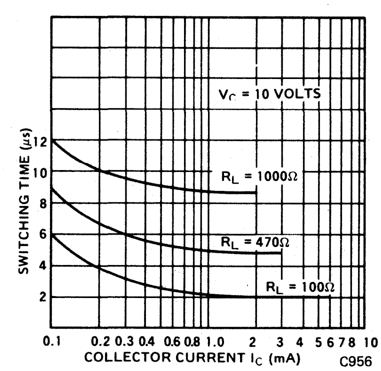
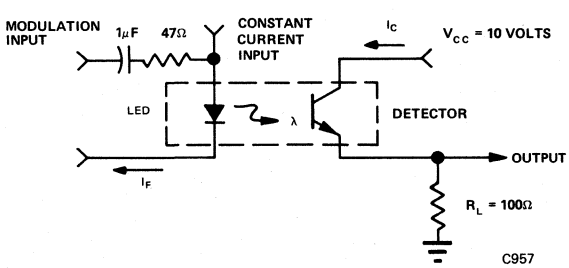


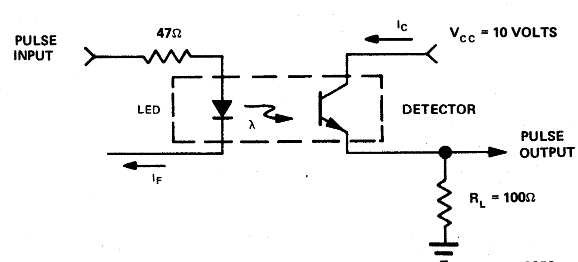
Figure 6 Switching Time vs. Collector Current

For additional characteristic curves, see MCT2

OPERATING SCHEMATICS



Modulation Circuit Used to Obtain Output vs. Frequency Plot



Circuit Used to Obtain Switching Time vs. Collector Current Plot

NOTES

1. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.*
2. *The frequency at which i_C is 3 dB down from the 1 kHz value.*
3. *Rise time (t_r) is the time required for the collector current to increase from 10% of its final value, to 90%. Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value to 10%.*

GENERAL INSTRUMENT
Optoelectronics

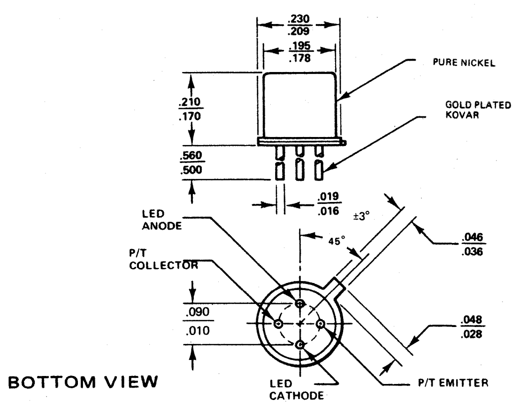
MCT4-R

RELIABILITY CONDITIONED PHOTOTRANSISTOR OPTOISOLATOR

PRODUCT DESCRIPTION

The MCT4 is a standard four-lead, TO-18 package containing a GaAs light emitting diode optically coupled to a silicon planar phototransistor.

PACKAGE DIMENSIONS



FEATURES

- Hermetic package
- High current transfer ratio; typically 35%
- High isolation resistance; 10^{11} ohms at 500 volts
- High voltage isolation emitter to detector

The Monsanto MCT 4R is designed and manufactured to conform to the requirements of military systems. Reliability testing has proven the product capable of conforming to the screening and quality conformance requirements of MIL-STD-883 Class B devices.

SCREEN — 100%

Characteristic	Method
Internal Visual	2010 — Characteristics applicable to device
Stabilization Bake	1008 — 150°C. for 48 hours
Temperature Cycle	1010 — 10 cycles; −55°C., 25°C., 150°., 25°C.
Centrifuge	2001 — Test Condition E
Hermeticity	1014 — Fine and Gross
Critical Electrical	— Data Sheet
Burn In*	1015 — 168 hours @ 125°C.
Final Electrical	— Data Sheet
Group A Sample Inspection	5005 Table I Subgroups
External Visual	2009

LOT QUALIFICATION TESTS

Characteristic	Method	LTPD
Subgroup I		
Visual Mechanical		
Marking Permanency	2008	15%
Physical Dimensions		
Subgroup II		
Solderability	2003	15%
Subgroup III		
Thermal Shock	1011 –15 cycles; 150°C. to –65°C.	
Temperature Cycle	1010 –10 cycles; –55°C., 25°C., 150°C., 25°C.	15%
Moisture Resistance	1004	
Critical Electrical	– Data Sheet	
Subgroup IV		
Mechanical Shock	2002 – Condition B	15%
Vibration Fatigue	2005 – Condition A	
Vibration Variable Frequency	2007 – Condition A	
Constant Acceleration	2001 – Condition E	
Critical Electrical	– Data Sheets	
Subgroup V		
Lead Fatigue	2004 – Condition B_2	15%
Hermeticity	1014 – Fine Condition A Gross Condition C	
Subgroup VI		
Salt Atmosphere	1009 – Condition A	15%

LIFE TESTING 7% LTPD

Subgroup VII		
High Temperature Storage	1008 – 150°C. for 1000 hours	7%
Critical Electrical	– Data Sheet	
Subgroup VIII		
Operating Life	1005 – Condition B	7%
Critical Electrical	– Data Sheets	
Subgroup IX		
Steady State Reverse Bias	1015 – Condition A; 72 hours at 150°C.	7%
Subgroup X		
Bond Strength	2001 –Condition C; 10 devices only	

Reference: MIL-STD-883, Test Methods and Procedures for Microelectronics.

GENERAL INSTRUMENT
Optoelectronics

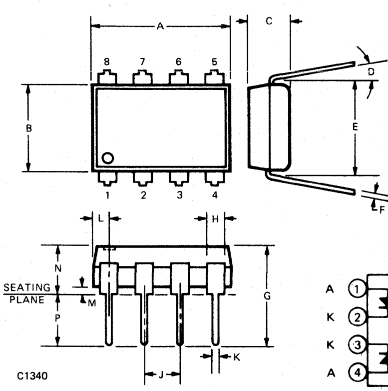
MCT6

DUAL PHOTOTRANSISTOR OPTOISOLATOR

PRODUCT DESCRIPTION

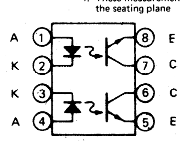
The MCT 6 opto-isolator has two channels for high density applications. For four channel applications, two-packages fit into a standard 16-pin DIP socket. Each channel is an NPN silicon planar phototransistor optically coupled to a gallium arsenide diode.

PACKAGE DIMENSIONS



SYMBOL	INCH MAX.	MM. MAX.	NOTES
A	.410	10.29	
B	.270	6.86	
C	.130	3.30	
D	15°	15°	
E	.300 Ref	7.62 Ref	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.055	1.40	2
M			3
N	.175	4.45	4
P			3

NOTES
1. Installed position of lead centers
2. Four places
3. Overall installed position
4. These measurements are made from the seating plane



FEATURES

- Two isolated channels per package
- Two packages fit into a 16 lead DIP socket
- Same basic electrical characteristics as MCT2
- 1500 volt isolation
- 50% typical current transfer ratio

APPLICATIONS

- AC Line/Digital Logic . . . . Isolate high voltage transients
- Digital Logic/Digital Logic . . . . . . Eliminate spurious grounds
- Digital Logic/AC Triac Control . . . Isolate high voltage transients
- Twisted pair line receiver . . . . Eliminate ground loop feedthrough
- Telephone/Telegraph line receiver. . Isolate high voltage transients
- High Frequency Power Supply Feedback Control . . . . Maintain floating ground
- Relay contact monitor . . . . Isolate floating grounds and transients
- Power Supply Monitor . . . . Isolate transients

ABSOLUTE MAXIMUM RATINGS

Storage Temperature -55°C to 150°C
Operating Temperature -55°C to 100°C
Lead Temperature (soldering, 10 sec.) 250°C

INPUT DIODE (each channel)
Forward current. . . . . 60 mA
Reverse voltage . . . . 3.0 V
Peak forward current (1μs pulse, 300 pps) . . . . 3 A

TOTAL INPUT
Power dissipation at 25°C ambient . . . . 100 mW
Derate linearly from 25°C . . . . 1.3 mW/°C

OUTPUT TRANSISTOR (each channel)
Power dissipation @ 25°C ambient . . . . 150 mW
Derate linearly from 25°C . . . . 2 mW/°C
Collector Current . . . . 30 mA

COUPLED
Input to output breakdown voltage . . . . . . 1500 volts DC
Total package power dissipation @ 25°C ambient . . 400 mW
Derate linearly from 25°C . . . . 5.33 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE					
Rated forward voltage V_F		1.25	1.50	V	I_F = 20 mA
Reverse voltage V_R	3.0	25		V	I_R = 10 μA
Reverse current I_R		.01	10	μA	V_R = 3.0 V
Junction capacitance C_J		50		pF	V_F = 0 V
OUTPUT TRANSISTOR (I_F = 0)					
Breakdown voltage, collector to emitter BV_{CEO}	30	85		V	I_C = 1.0 mA
Breakdown voltage, emitter to collector BV_{ECO}	6	13		V	I_E = 100 μA
Leakage current, collector to emitter I_{CEO}		5	100	nA	V_{CE} = 10 V
Capacitance collector to emitter C_{CE}		8		pF	V_{CE} = 0 V
COUPLED					
DC current transfer ratio (I_C/I_F) CTR	20	50		%	V_{CE} = 10 V, I_F = 10 mA
Isolation voltage $BV_{(I-O)}$	1500	2500		VDC	t = 1 second
Isolation resistance $R_{(IU)}$	10^{11}	10^{12}		Ω	V_{I-O} = 500 VDC
Isolation capacitance $C_{(I-O)}$		0.5		pF	f = 1 MHz
Breakdown voltage — channel-to-channel		500		V	Relative humidity = 40%
Capacitance between channels		0.4		pF	f = 1 MHz
Saturation voltage — collector to emitter $V_{CE(SAT)}$		.20	.40	V	I_C = 2 mA, I_F = 16 mA
Bandwidth B_W		150		kHz	I_C = 2 mA, V_{CC} = 10 V, R_L = 100 Ω

ELECTRO-OPTICAL CHARACTERISTICS (Con't)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SWITCHING TIMES, OUTPUT TRANSISTOR					
Non-saturated rise time, fall time		2.4		μs	I_C = 2 mA, V_{CE} = 10 V, R_L = 100Ω
Non-saturated rise time, fall time		15		μs	I_C = 2 mA, V_{CE} = 10 V, R_L = 1 KΩ
Saturated turn-on time (from 5.0 V to 0.8 V)		5		μs	R_L = 2 KΩ, I_F = 15 mA
Saturated turn-off time (from saturation to 2.0 V)		25		μs	R_L = 2 KΩ, I_F = 15 mA

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (25°C Free Air Temperature Unless Otherwise Specified)

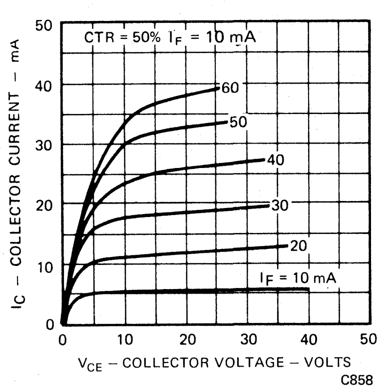


Figure 1 I-V Curve of Phototransistor

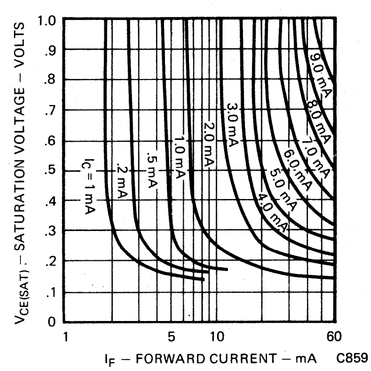


Figure 2 I-V Curve in Saturation

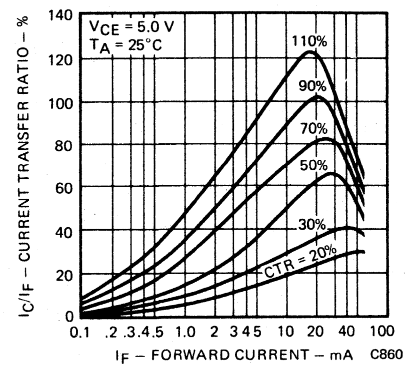


Figure 3 CTR vs. Forward Current

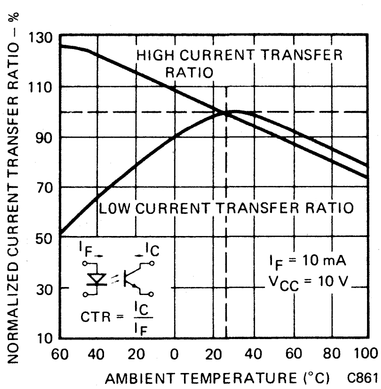


Figure 4 Current Transfer Ratio vs. Temperature

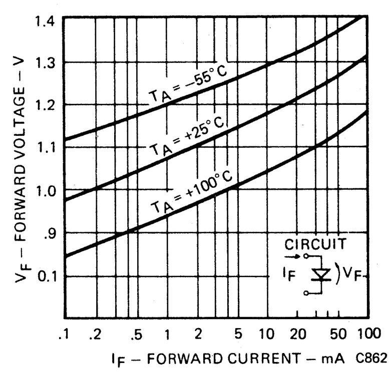


Figure 5 I-V Curve of LED vs. Temperature

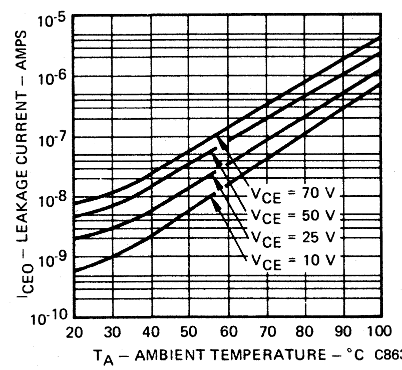


Figure 6 Leakage Current vs. Temperature vs. Collector Voltage

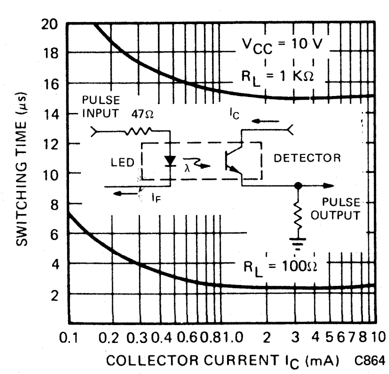


Figure 7 Switching Time vs. Collector Current

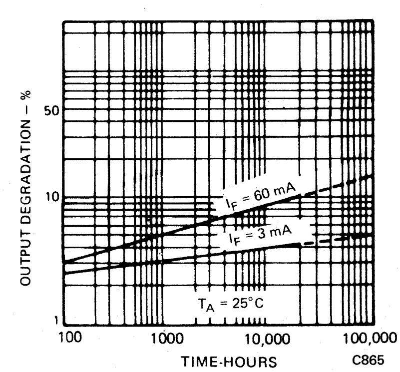


Figure 8 Lifetime vs. Forward Current (Note 1)

NOTES

1. Normalized CTR degradation = $\frac{CTR_o - CTR}{CTR_o}$

GENERAL INSTRUMENT
Optoelectronics

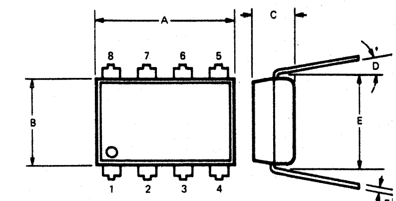
MCT66

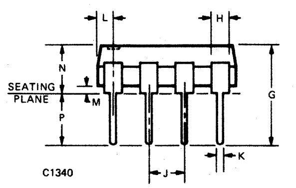
DUAL PHOTOTRANSISTOR OPTOISOLATOR

PRODUCT DESCRIPTION

The MCT 66 opto-isolator has two channels for high density applications. For four channel applications, two-packages fit into a standard 16-pin DIP socket. Each channel is an NPN silicon planar phototransistor optically coupled to a gallium arsenide diode.

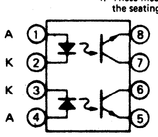
PACKAGE DIMENSIONS





SYMBOL	INCH MAX.	MM. MAX.	NOTES
A	.410	10.29	
B	.270	6.86	
C	.130	3.30	
D	15°	15°	
E	.300 Ref	7.62 Ref	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.055	1.40	2
M			3
N	.175	4.45	4
P			3

NOTES
1. Installed position of lead centers
2. Four places
3. Overall installed position
4. These measurements are made from the seating plane



FEATURES

- Two isolated channels per package
- Two packages fit into a 16 lead DIP socket
- Same basic electrical characteristics as MCT26
- 1500 volt isolation from non-repetitive surges
- 15% typical current transfer ratio

APPLICATIONS

- AC Line/Digital Logic . . . . Isolate high voltage transients
- Digital Logic/Digital Logic . . . . . . Eliminate spurious ground loops
- Digital Logic/AC Triac Control . . . Isolate high voltage transients
- Twisted pair line receiver . . . . Eliminate ground loop pick-up
- Telephone/Telegraph line receiver. . Isolate high voltage transients
- High Frequency Power Supply Feedback Control . . . . Maintain floating ground
- Relay contact monitor . . . . Isolate floating grounds and transients
- Power Supply Monitor . . . . Isolate transients and ground systems

ABSOLUTE MAXIMUM RATINGS

Storage Temperature -55°C to 150°C
Operating Temperature -55°C to 100°C
Lead Temperature (soldering, 10 sec.) 250°C

INPUT DIODE (each channel)

Forward current	60 mA
Reverse voltage	3.0 V
Peak forward current (1 μs pulse, 300 pps)	3 A
Power dissipation at 25° C ambient	100 mW
Derate linearly from 25°C	1.3 mW/°C

OUTPUT TRANSISTOR (each channel)

Power dissipation @ 25°C ambient	150 mW
Derate linearly from 25°C	2 mW/°C
Collector Current	30 mA

COUPLED

Input to output breakdown voltage	1500 volts DC
Total package power dissipation @ 25°C ambient	400 mW
Derate linearly from 25°C	5.33 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE					
Rated forward voltage V_F	—	1.25	1.50	V	I_F = 20 mA
Reverse voltage V_R	3.0	25	—	V	I_R = 10 μA
Reverse current I_R	—	.001	10	μA	V_R = 3.0 V
Junction capacitance C_J	—	50	—	pF	V_F = 0 V
OUTPUT TRANSISTOR (I_F = 0)					
Breakdown voltage, collector to emitter BV_{CEO}	30	85	—	V	I_C = 1.0 mA
Breakdown voltage, emitter to collector BV_{ECO}	6	13	—	V	I_E = 100 μA
Leakage current, collector to emitter I_{CEO}	—	5	100	nA	V_{CE} = 10 V
Capacitance collector to emitter C_{CE}		8		pF	V_{CE} = 0 V
COUPLED					
DC current transfer ratio (I_C/I_F) = CTR	6	15	—	%	V_{CE} = 10 V, I_F = 10 mA
Isolation voltage $BV_{(I-O)}$	1500	2500	—	VDC	t = 1 second
Isolation resistance $R_{(I-O)}$	10^{11}	10^{12}	—	Ω	V_{I-O} = 500 VDC
Isolation capacitance $C_{(I-O)}$	—	0.5	—	pF	f = 1 MHz
Breakdown voltage — channel-to-channel	—	500	—	VDC	Relative humidity = 40%
Capacitance between channels	—	0.4	—	pF	f = 1 MHz
Saturation voltage — collector to emitter V_{CE} (SAT)	—	0.2	0.4	V	I_C = 2 mA, I_F = 40 mA
Bandwidth B_W	—	150	—	kHz	I_C = 2 mA, V_{CC} = 10 V, R_L = 100 Ω

ELECTRO-OPTICAL CHARACTERISTICS (Con't)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SWITCHING TIMES, OUTPUT TRANSISTOR					
Non-saturated rise time, fall time (Note 3)		2.4		μs	I_C = 2 mA, V_{CE} = 10 V, R_L = 100 Ω
Non-saturated rise time, fall time (Note 3)		15		μs	I_C = 2 mA, V_{CE} = 10 V, R_L = 1 kΩ
Saturated turn-on time (from 5.0 V to 0.8 V)		5		μs	R_L = 2 KΩ, I_F = 40 mA
Saturated turn-off time (from saturation to 2.0 V)		25		μs	R_L = 2 KΩ, I_F = 40 mA

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (25°C Free Air Temperature Unless Otherwise Specified)

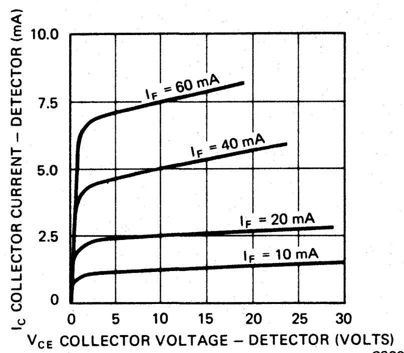


Fig. 1. Detector Output Characteristics

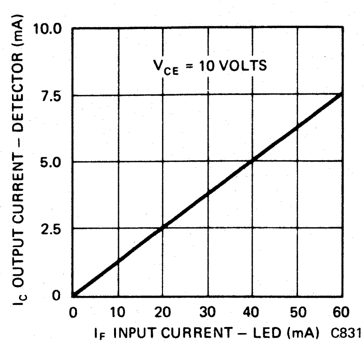


Fig. 2. Input Current vs. Output Current

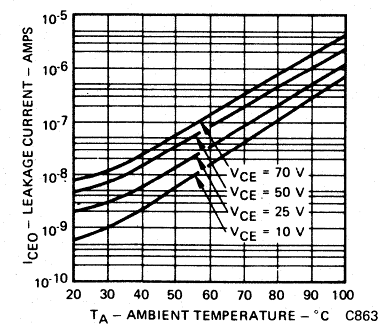


Fig. 3. Leakage Current vs. Temperature vs. Collector Voltage

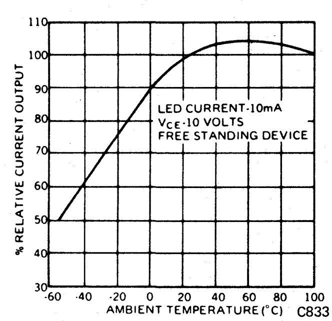


Fig. 4. Current Output vs. Temperature

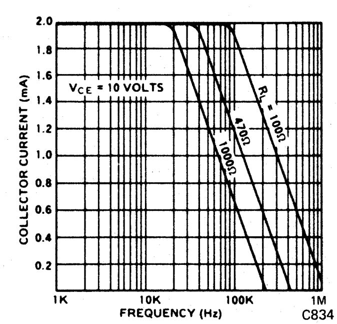


Fig. 5. Output vs. Frequency

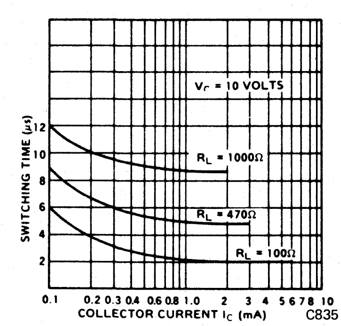


Fig. 6. Switching Time vs. Collector Current

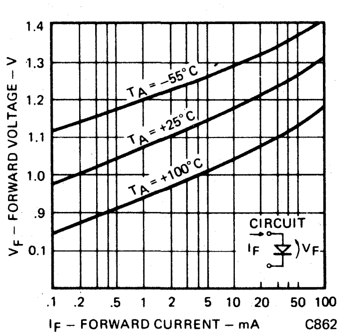


Fig. 7. I-V Curve of LED vs. Temperature

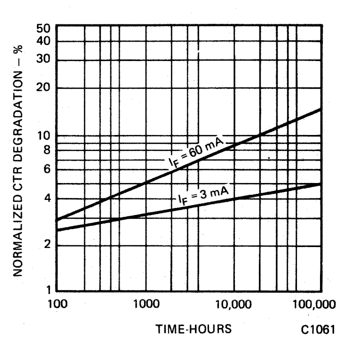
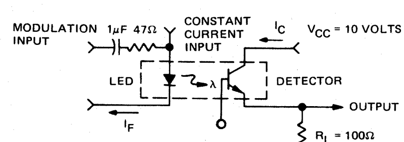
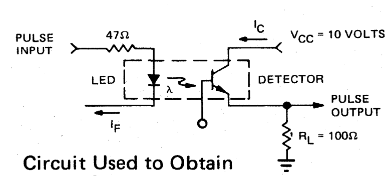


Fig. 8. Lifetime vs. Forward Current



Modulation Circuit Used to Obtain Figure 5

C837



Circuit Used to Obtain Figure 6

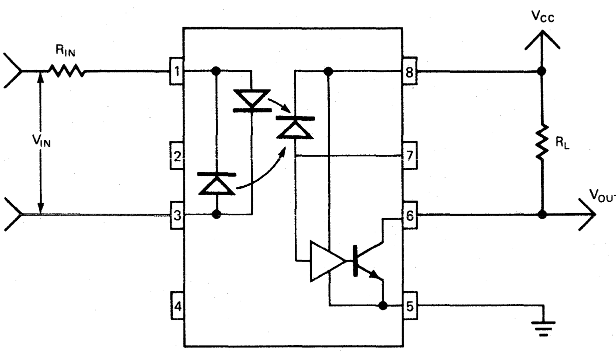
C838

NOTES

1. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.*
2. *The frequency at which i_c is 3 dB down from the 1 kHz value.*
3. *Rise time (t_r) is the time required for the collector current to increase from 10% of its final value to 90%.*
   Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value to 10%.

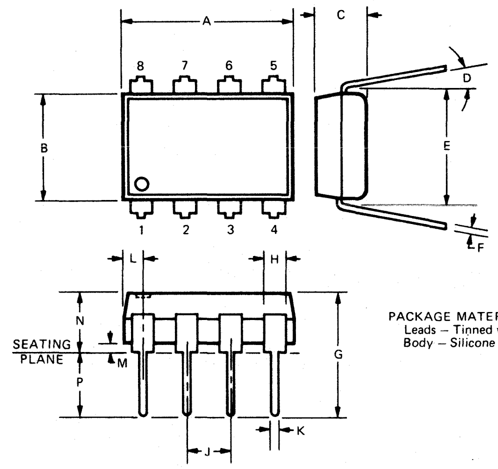
GENERAL INSTRUMENT
Optoelectronics

MID400
AC LINE MONITOR
OPTICALLY ISOLATED INTERFACE DEVICE



C1472

Fig. 1. MID400 Interfacing Circuit



PACKAGE MATERIALS:
Leads – Tinned with 60/40 tin lead
Body – Silicone plastic

SYMBOL	INCH MAX.	MM. MAX.	NOTES
A	.410	10.29	
B	.270	6.86	
C	.130	3.30	
D	15°	15°	
E	.300 Ref	7.62 Ref	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.055	1.40	2
M			3
N	.175	4.45	4
P			3

PIN	
1	V_{IN}
2	N/C
3	V_{IN}
4	N/C
5	GROUND
6	V_O
7	AUX.
8	V_{CC}

NOTES
1. Installed position of lead centers
2. Four places
3. Overall installed position
4. These measurements are made from the seating plane

C1340

FEATURES

- Direct operation from 120 VAC line with the use of an external resistor
- Externally adjustable time delay
- Externally adjustable AC voltage sensing level
- High voltage isolation between input and output
- Compact plastic DIP package
- Logic level compatibility
- UL recognized (File #E50151)

APPLICATIONS

- Monitoring of the AC "line-down" condition
- "Closed-loop" interface between electromechanical elements such as solenoids, relay contacts, small motors, and microprocessors
- Time delay isolation switch

DESCRIPTION

The MID400 is an optically isolated AC line-to-logic interface device. It is packaged in an 8-lead plastic DIP. The AC line voltage is monitored by two back-to-back GaAs LED diodes in series with an external resistor. A high gain detector circuit senses the LED current and drives the output gate to a logic low condition.

The MID400 has been designed primarily for use as an AC line monitor. It is recommended for use in any AC-to-DC control application where excellent optical isolation, solid state reliability, TTL compatibility, small size, low power, and low frequency operation are required.

ABSOLUTE MAXIMUM RATINGS

INPUT – LED CIRCUIT

RMS Current . . . . 25 mA
DC Current . . . . ±30 mA
Power Dissipation at 25°C Ambient . . . . 45 mW
Derate Linearly from 70°C . . . . 2.0 mW/°C

OUTPUT – DETECTOR CIRCUIT

Low Level Output Current (I_{OL}) . . . . 20 mA
High Level Output Voltage (V_{OH}) . . . . 7.0 V
Supply Voltage (V_{CC}) . . . . 7.0 V
Power Dissipation at 25°C Ambient . . . . 70 mW
Derate Linearly from 70°C . . . . 2.0 mW/°C

TOTAL PACKAGE

Storage Temperature . . . . –55°C to +125°C
Operating Temperature . . . . 0°C to +85°C
Lead Soldering Temperature, 10 Sec. . . . . 260°C
Power Dissipation at 25°C Ambient . . . . 115 mW
Derate Linearly from 70°C . . . . 4.0 mW/°C
Surge Isolation . . . . 3550 VDC
2500 V RMS
Steady State Isolation . . . . 3200 VDC
2250 V RMS

ELECTRICAL CHARACTERISTICS

(0°C to 70°C Free Air Temperature Unless Otherwise Specified—All Typical Values Are At 25°C)
Device Operation Input Voltage Range: 24 VAC to 240 VAC.

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS
LED Forward Voltage	V_F			1.5	V	$I_F = \pm 30$ mA DC
On-state RMS Input Voltage	$V_{I(ON)}$ RMS	90			V	$V_O = 0.4$ V, $I_O = 16$ mA $V_{CC} = 4.5$ V, $R_{IN} = 22$ KΩ
Off-state RMS Input Voltage	$V_{I(OFF)}$ RMS			5.5	V	$V_O = V_{CC} = 5.5$ V, $I_O \leq 100\mu A$, $R_{IN} = 22$ KΩ
On-state RMS Input Current	$I_{I(ON)}$ RMS	4.0			mA	$V_O = 0.4$ V, $I_O = 16$ mA $V_{CC} = 4.5$ V 24 V $\leq V_{I(ON)}$ RMS $\leq$ 240 V
Off-state RMS Input Current	$I_{I(OFF)}$ RMS			.15	mA	$V_O = V_{CC} = 5.5$ V, $I_O \leq 100\mu A$, $V_{I(OFF)}$ RMS $\geq$ 5.5 V
Logic Low Output Voltage	V_{OL}		.18	0.40	V	$I_{IN} = I_{I(ON)}$ RMS $I_O = 16$ mA, $V_{CC} = 4.5$ V 24 V $\leq V_{I(ON)}$ RMS $\leq$ 240 V
Logic High Output Current	I_{OH}		.02	100	μA	$I_{IN} = 0.15$ mA RMS $V_O = V_{CC} = 5.5$ V $V_{I(OFF)}$ RMS $\geq$ 5.5 V
Logic Low Output Supply Current	I_{CCL}			3.0	mA	$I_{IN} = 4.0$ mA RMS V_O = Open, $V_{CC} = 5.5$ V 24 V $\leq V_{I(ON)}$ RMS $\leq$ 240 V
Logic High Output Supply Current	I_{CCH}			0.80	mA	$I_{IN} = 0.15$ mA RMS $V_{CC} = 5.5$ V $V_{I(OFF)}$ RMS $\geq$ 5.5 V
SWITCHING TIMES ($T_A = +25°C$)						
Turn-On Time	t_{ON}		1.0		mS	$I_{IN} = 4.0$ mA RMS $I_O = 16$ mA, $V_{CC} = 4.5$ V $R_{IN} = 22$ KΩ (See Test Circuit 2)
Turn-Off Time	t_{OFF}		1.0		mS	I_{IN} 4.0 mA RMS $I_O = 16$ mA, $V_{CC} = 4.5$ V $R_{IN} = 22$ KΩ (See Test Circuit 2)
ISOLATION ($T_A = +25°C$)						
Surge Isolation Voltage	V_{ISO}	3550			VDC	Relative Humidity $\leq$ 50%, $I_{I\text{-}O} \leq 10\mu A$
		2500			VACRMS	1 Second, 60 Hz
Steady State Isolation Voltage	V_{ISO}	3200			VDC	Relative Humidity $\leq$ 50%, $I_{I\text{-}O} \leq 10\mu A$
		2250			VACRMS	1 Minute, 60 Hz
Isolation Resistance	R_{ISO}	10^{11}			Ω	$V_{I\text{-}O} = 500$ VDC
Isolation Capacitance	C_{ISO}		2		pF	f = IMHZ

(RMS = True RMS Voltage at 60 Hz, THD $\leqslant$ 1%.)

DESCRIPTION/APPLICATIONS

The input of the MID400 consists of two back-to-back LED diodes which will accept and convert alternating currents into light energy. An integrated photo diode-detector amplifier forms the output network. Optical coupling between input and output provides 3550 V DC voltage isolation. A very high current transfer ratio, (defined as the ratio of the DC output current and the DC input current) is achieved through the use of a high gain amplifier. The detector amplifier circuitry operates from a 5 V DC supply and drives an open collector transistor output. The switching times are intentionally designed to be slow in order to enable the MID400, when used as an AC line monitor, to respond only to changes of input voltage exceeding several milliseconds. The short period of time during zero crossing which occurs once every half cycle of the power line is completely ignored. To operate the MID400, always add a resistor, R_{IN}, in series with the input (as shown in Fig. 1) to limit the current to the required value. The value of the resistor can be determined by the following equation:

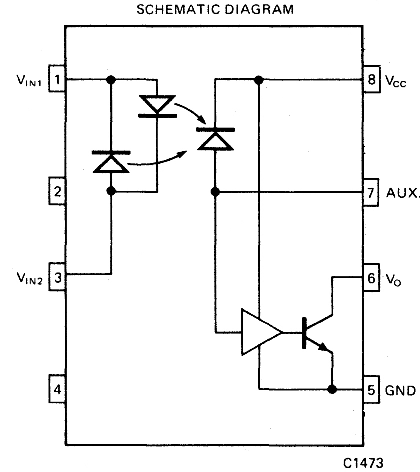
$$R_{IN} = \frac{V_{IN} - V_F}{I_{IN}}$$

Where V_{IN} (RMS) is the input voltage.
V_F is the forward voltage drop across the LED.
I_{IN} (RMS) is the desired input current required to sustain a logic "O" on the output.

PIN DESCRIPTION

DESIGNATION	PIN #	FUNCTION
V_{IN1}, V_{IN2}	1, 3	Input terminals.
V_{CC}	8	Supply voltage, output circuit.
AUX.	7	Auxiliary terminal. Programmable capacitor input to adjust AC voltage sensing level and time delay.
V_O	6	Output terminal; open collector.
GND	5	Circuit ground potential.

SCHEMATIC DIAGRAM



NOTE: DO NOT CONNECT PIN 2 AND 4

GLOSSARY

VOLTAGES

$V_{I(ON)}$ RMS — On-state RMS input voltage
The RMS voltage at an input terminal for a sqecified input current with output conditions applied that according to the product specification will cause the output switching element to be sustained in the on-state within one full cycle.

$V_{I(OFF)}$ RMS — Off-state RMS input voltage
The RMS voltage at an input terminal for a specified input current with output conditions applied that according to the product specification will cause the output switching element to be sustained in the off-state within one fill cycle.

V_{OL} — Low-level output voltage
The voltage at an output terminal for a specific output current I_{OL} with input conditions applied that according to the product specification will establish a low-level at the output.

V_{OH} — High-level output voltage
The voltage at an output terminal for a specified output current I_{OH} with input conditions applied that according to the product specification will establish a high-level at the output.

V_F — LED forward voltage
The voltage developed across the LED when input current I_F is applied to the anode of the LED.

CURRENTS

$I_{I(ON)}$ RMS — On-state RMS input current
The RMS current flowing into an input with output conditions applied that according to the product specification will cause the output switching element to be sustained in the on-state within one full cycle.

$I_{I(OFF)}$ RMS — Off-state RMS input current
The RMS current flowing into an input with output conditions applied that according to the product specification will cause the output switching element to be sustained in the off-state within one full cycle.

I_{OH} — High-level output current
The current flowing into * an output with input conditions applied that according to the product specification will establish a high-level at the output.

I_{OL} — Low-level output current
The current flowing into * an output with input conditions applied that according to the product specification will establish a low-level at the output.

I_{CCL} — Supply current, output low
The current flowing into * the V_{CC} supply terminal of a circuit when the output is at a low-level voltage.

I_{CCH} — Supply current, output high
The current flowing into * the V_{CC} supply terminal of a circuit when the output is at a high-level voltage.

DYNAMIC CHARACTERISTICS

t_{ON} — Turn-on time
The time between the specified reference points on the input and the output voltage waveforms with the output changing from the defined high-level to the defined low-level.

t_{OFF} — Turn-off time
The time between the specified reference points on the input and output voltage waveforms with the output changing from the defined low-level to the defined high-level.

*Current flowing out of a terminal is a negative value.

TYPICAL CURVES

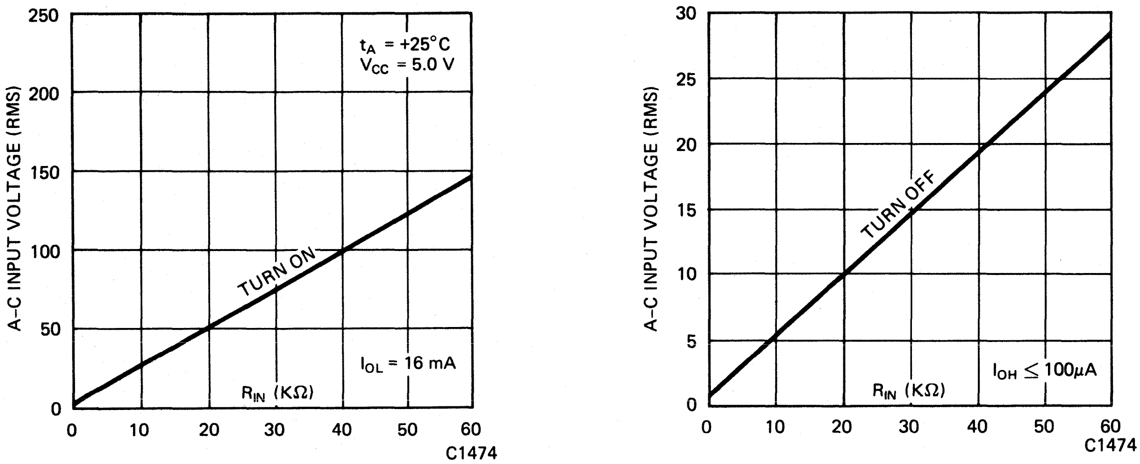


Fig. 2. Input Voltage vs. Input Resistance

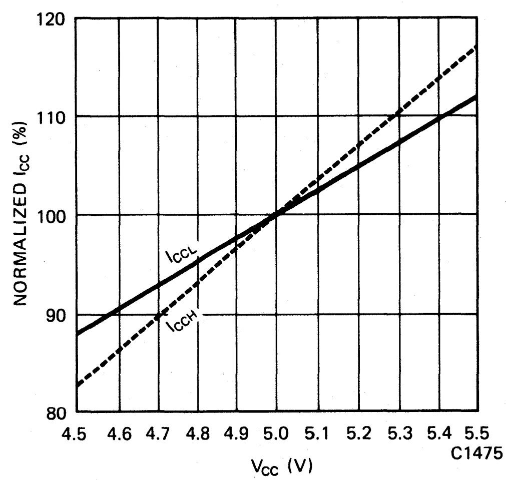


Fig. 3. Supply Current vs. Supply Voltage

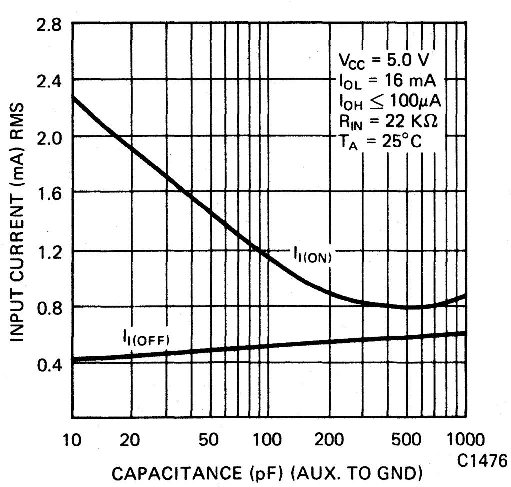


Fig. 4. Input Current vs. Capacitance (See test circuit 1)

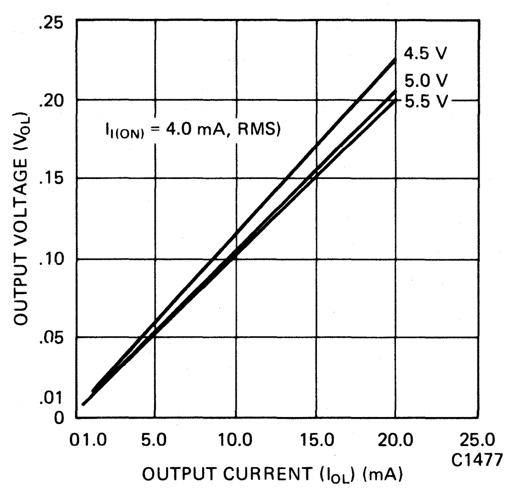
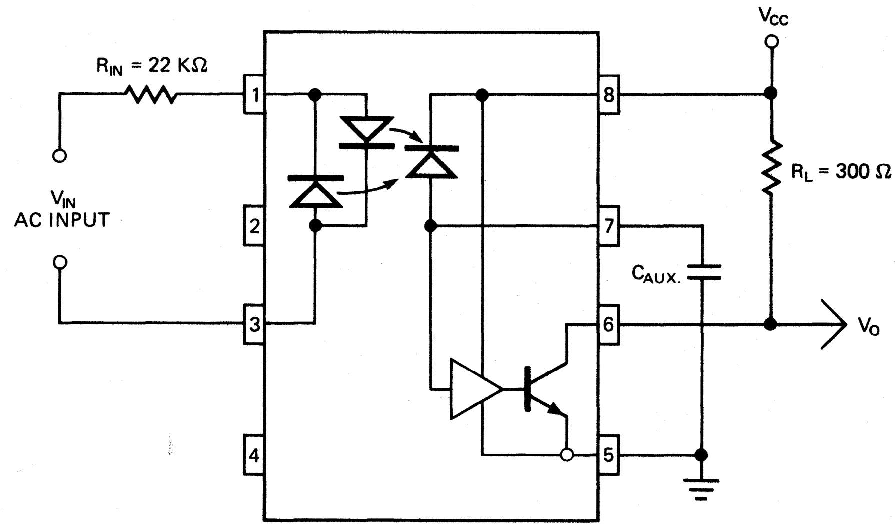


Fig. 5. Output Voltage vs. Output Current

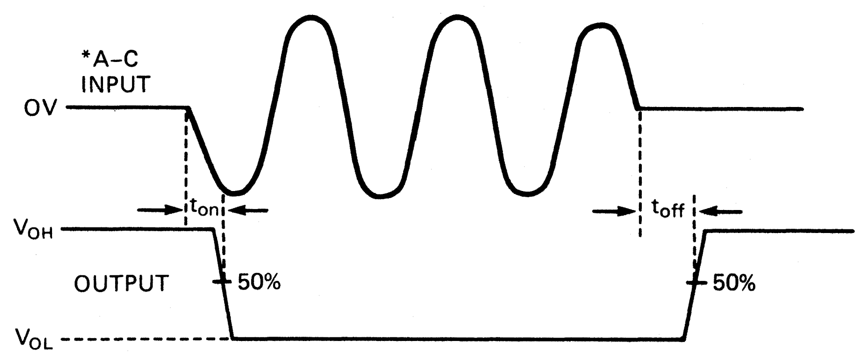
OPERATING SCHEMATICS



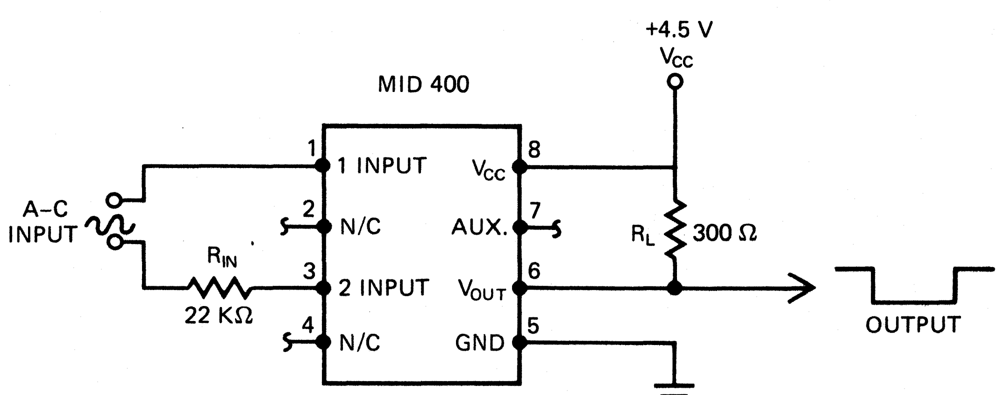
TEST CIRCUIT 1

Input Current vs. Capacitance, $C_{AUX.}$ Circuit

C1478



*INPUT TURNS ON AND OFF AT ZERO CROSSING.



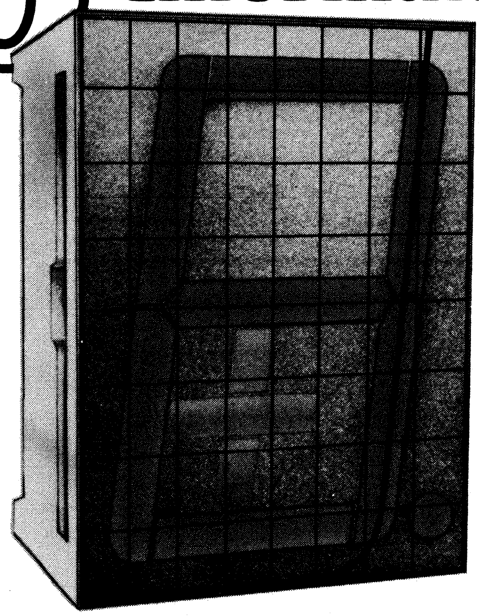
TEST CIRCUIT

TEST CIRCUIT 2

MID400 Switching Time

C1479

6 Technical Information



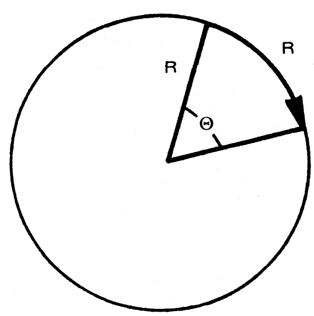
AN601
the photometry of LED's
a primer in photometry

REVIEW OF GEOMETRIC PRINCIPLES

Any short discourse on the subject of photometry requires a brief review of geometric principles utilized.

RADIAN

In plane geometry the angle whose arc is equal to the radius generating it is called a radian. Therefore, if $C = 2\pi R$ (Circumference of a circle) $2\pi R = 360°$. Radian $= 180°/\pi = 57.27°$ (approx.)

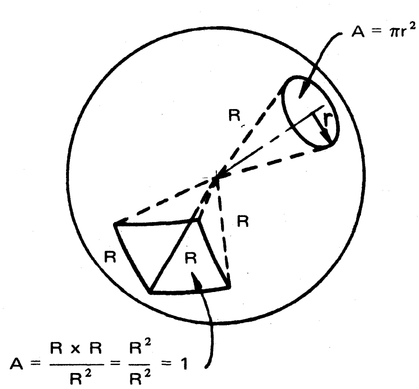


TWO DIMENSIONAL FIGURE

FIGURE 1

STERADIAN

In solid geometry one steradian is the solid angle subtended at the center of a sphere by a portion of the surface area equal to the square of the radius of the sphere. Therefore, if $AREA/R^2 = 1 = 1$ steradian and the area on the surface of a sphere equals $4\pi R^2$, then $4\pi R^2/R^2$ or 4π steradians of solid angle ω about the center of a sphere. The steradian is usually abbreviated as STER.



THREE DIMENSIONAL FIGURE

FIGURE 2

Other abbreviations of immediate concern are:

Ae = Area of emitting (or reflecting) surface.
Ap = Apparent area of an emitting source whose image is protected in space and viewed at some angle, Θ.
Ad = Detection area. Whether a physical target or merely a defined spatial area, it is the area of interest.

PHOTOMETRIC TERMINOLOGY

FLUX (Symbol F)

Any radiation, whether visible or otherwise, can be expressed by a number of FLUX LINES about the source, the number being proportional to the intensity of that source. This LUMINOUS flux is expressed in LUMENS for visible radiation.

LUMINOUS EMITTANCE (Symbol L)

A source measurement parameter. It is defined as the ratio of the luminous flux emitted from a source to the area of that source, or L = F/Ae. Typically expressed in units of:

lumens/cm^2 or one PHOT,
lumens/m^2 or one LUX (or one METER CANDLE),
lumens/ft^2 or one FOOT CANDLE.
The foot candle is the more common term used in this country.

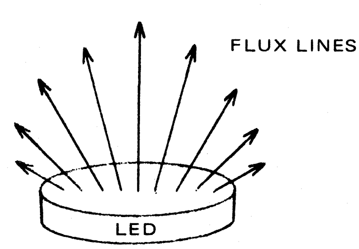


FIGURE 3

ILLUMINANCE (Symbol E)

This is a target or detector area measurement parameter. It is the ratio of flux lines incident on a surface to the area of that surface or E = L/Ad. Typical measurement units are the same for LUMINOUS EMITTANCE (above) i.e. lumen/cm^2 = one phot, lumen/m^2 = one lux, and lumen/ft^2 = one ft. candle.

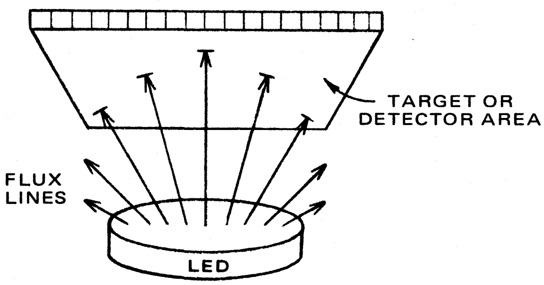


FIGURE 4

LUMINOUS INTENSITY (Symbol I)

A spatial flux density concept. It is the ratio of luminous flux of a source to the solid angle subtended by the detected area and that source. The LUMINOUS INTENSITY of a source assumes that source to be point rather than an area dimension. The LUMINOUS INTENSITY (or CANDLE POWER) of a source is measured in LUMENS/STERADIAN which is equal to one CANDELA (or loosely, one CANDLE).

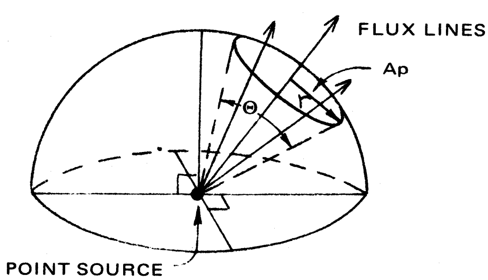


FIGURE 5

LUMINANCE (Symbol B)

Sometimes called photometric brightness (although the term brightness should not be used alone as it encompasses other physiological factors such as color, sparkle, texture, etc.) it is applied to sources of appreciable area size. Mathematically, if the area of an emitter (circular for example) has a diameter or diagonal dimension greater than 0.1 the distance to the detector, it can be considered as an area source. If less than this 10% figure, the source can be treated as point in nature. This one to ten ratio of source diameter to distance is offered as it MATHEMATICALLY very closely approximates results obtained when comparing an area source to its point equivalent. LUMINANCE presents itself as an extremely useful parameter as it applies a figure of merit to:

1. Apparent or protected area of the source (Ap).
2. Amount of luminous flux contained within the projected area of the source (Ap).
3. Solid angle the projected area generates with respect to the center of the source.

NOTE: The projected area Ap varies directly as the cosine of Θ i.e. max. at 0° or normal to the surface and minimum at 90°

$$Ap = Ae \cos \Theta$$

LUMINANCE is defined as the ratio of LUMINOUS INTENSITY to the projected area of the source Ap.

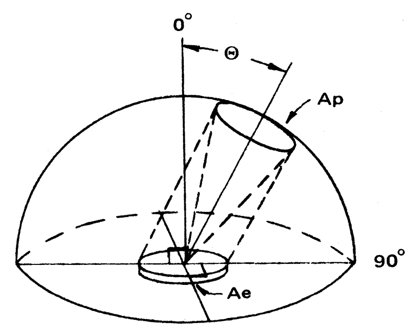


FIGURE 6

$$\frac{\text{LUMINOUS INTENSITY}}{\text{Ap}} = \frac{\dfrac{\text{LUMENS}}{\text{STERADIAN}}}{\text{Ae} \cos \Theta} = \frac{\text{CANDELAS}}{\text{(Sq. Unit)}}$$

And depending on the units used for area:

1 CANDELA/cm^2 = 1 STILB
1 CANDELA/m^2 = 1 NIT
1 CANDELA/in^2 =)
1 CANDELA/ft^2 =) no designator available.

Also:

$1/\pi$ candela/cm^2 = LAMBERT
$1/\pi$ candela/m^2 = APOSTILB (or BLONDEL)
$1/\pi$ candela/in^2 = no designator available
$1/\pi$ candela/ft^2 = FOOT LAMBERT

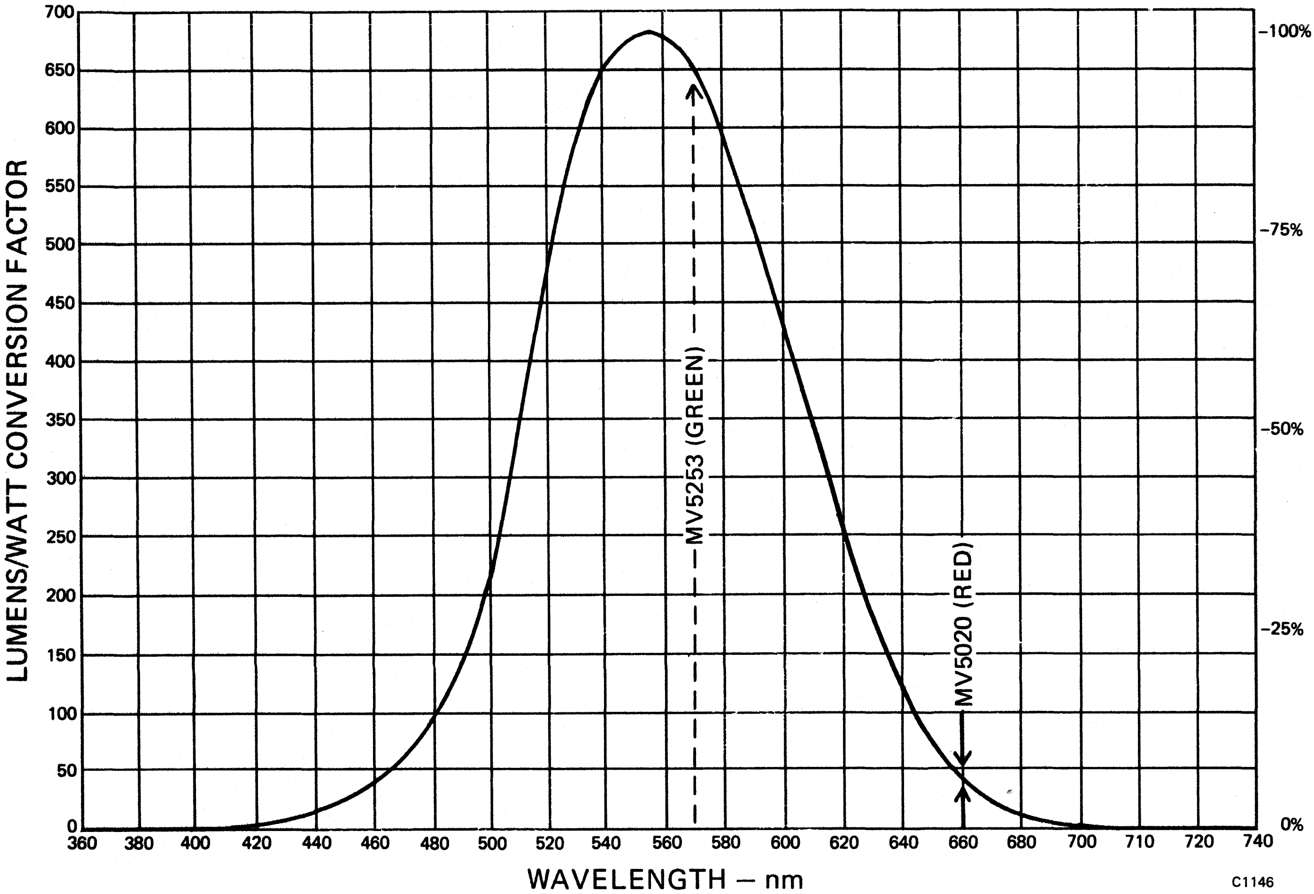
CIE CURVE

Following is the standard observer curve or "standard eyeball" established by the Commission Internationale de l'Eclair (commonly called the CIE curve). Whereas one watt of radiated energy at any frequency corresponds to one watt of radiated energy at any other frequency, this relationship fails to hold true for photometric measurement. The CIE curve is essential therefore, not only in determining the eye's efficiency at any particular wavelength, but also the corresponding lumens per watt conversion of that particular wavelength.

For example, the MV5020 which emits 180 μW of radiant energy at 6600Å (typical) or 41.4 lumens per watt has

$$180 \times 10^{-6} \text{ watts} \times \frac{41.4 \text{ lumens}}{\text{watt}} = 7.45 \text{ mLumens}$$

of flux emitted from it.



Similarly, a green emitter such as the MV5253 operating at an identical input power as the red will emit 10 μwatts of radiant energy or

$$10 \times 10^{-6} \text{ watts} \times \frac{649 \text{ lumens}}{\text{watt}} = 6.49 \text{ mLumens}$$

of flux emitted from it. In short although there exists at least an order of magnitude difference in radiant power the eyes' compensating effect "magnifies" the green to appear equally bright.

LUMINOUS INTENSITY versus LUMINANCE

The successful application of either measurement parameter as a yardstick to duplicate mathematically the visual stimulation experienced by an observer is a controversy which will probably rage for some time. As the entire electromagnetic spectrum is bounded only by the capabilities of a detector to discern it, so for within the visual spectrum the eye is the limiting factor. SUBJECTIVELY speaking, the eye can discern finer increments of arc (computed from target to eye) than a 1 to 10 relationship, or approximately 5° 43 min. In fact, it can be shown that for view angles of much less than 2 minutes, the eye translates the source into a point and thus the photometric measurement of LUMINOUS INTENSITY (in candelas) most directly correlates with subjective brightness. For view angles of much greater than approximately 2 minutes, the eye sees the source as an area source, and thus the photometric measurement of LUMINANCE most directly correlates with subjective brightness. A two minute view angle computes to a 1/1666 ratio of source diameter to distance ratio. For the MV5025 this computes to approximately 22 feet (1666 x .16″ diameter, approximately 22 feet) well within the expected normal viewing distance of an observer.

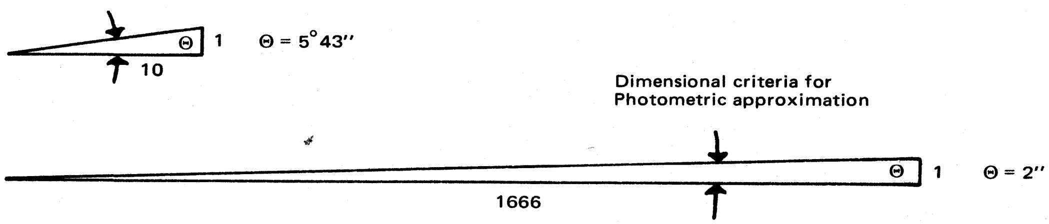


FIGURE 7

Considering that the usage of the discrete MV5025 LED is as an indicator and as such is utilized arms length or approximately 30″ away, it can be seen that the LUMINANCE parameter and its basic unit, the FOOT LAMBERT, most closely correlates with subjective brightness.

Below are the products, their respective chip dimension, either diameter or diagonal, apparent size due to optical magnification and luminance/luminous intensity crossover distance. It should be stressed that this distance is not finite but represents a gradual threshold distance at which either parameter might be definitive.

Product	Active Chip Area	Optical Lens Factor	Apparent Size	Crossover Distance Feet
MV10B	.015″	x1.9	.028″	3.96
MV50	.017″ diag.	x1.75	.030″	3.0
MV5020	.017″ diag.	x1.5	.025″	2.5
MV5025	(.160″)*	(x15.2)	.160″	22.2

*Entire lens is considered the apparent emitting area.

RADIOMETRY

While photometric units are concerned with only the visible spectrum of wavelength, all frequencies of emission, including the visible are expressable in RADIOMETRIC terms. Radiometric terms and their photometric equivalents are as follows:

RADIOMETRIC	PHOTOMETRIC
Radiant flux (Symbol P) expressed in watts	**Luminous flux** (F) expressed in lumens
Irradiance (Symbol H) expressed in watts/sq. unit	**Illuminance** (E) expressed in lumens/sq. unit
Radiant Emittance (Symbol W) expressed in watts/sq. unit	**Luminous Emittance** (L) expressed in lumens/sq. unit
Radiant Intensity (Symbol J) expressed in watts/steradian	**Luminous Intensity** (Symbol I) expressed in lumens/steradian
Radiance (Symbol N) expressed in watts/ster/sq. unit	**Luminance** (B) expressed in lumens/ster/sq. unit

AN603
improper testing methods for LED devices

In any manufacturing operation it is essential that the materials used in the fabrication process meet the minimum quality specifications of the device under production. To that end, prudent manufacturers establish some sort of incoming quality assurance system to make sure that defective materials are culled at the door. It is equally important, however, that the screening system used in the Q.A. inspection does not reject materials which are acceptable, and that the testing procedures utilized in the system do not inadvertently damage materials which are otherwise acceptable. Unfortunately, this latter aspect of quality assurance procedures is often neglected, and whenever a device is rejected because of inappropriate testing methods, both the manufacturer and the vendor are subject to a great deal of unnecessary expense and inconvenience. Because many manufacturers who buy LED components are relatively inexperienced with the features and limitations of III-V devices, problems involving improper testing methods and unnecessary materials rejection are of particular concern to LED vendors. This note is intended to familiarize the user with the basic electrical and opto-electrical properties of LED devices and to clear up some of the problems involved in testing them.

THE MATERIAL

Historically, silicon and germanium were the first semiconductor materials to have been used for p-n junction devices such as transistors, diodes, and solar cells. However, following closely upon the invention of the germanium transistor in 1948, work was begun on predicting the semiconductivity of a material from its chemical compound. Based on energy band-gap experimentation, it was discovered that III-V materials have semiconductor properties.[1]

Gallium semiconducting materials, Gallium Arsenide (GaAs), Gallium Arsenide Phosphide (GaAsP), and Gallium Phosphide (GaP) are the materials from which LED's are fabricated. These materials have the ability to emit a narrow band of monochromatic light in either the visible or infrared spectrum, depending on the constituent and ratio of ingredients. The mechanism for this emission of radiant energy is best described in terms of semiconductor Energy-Band Theory. When an external, forward-biasing voltage is applied to a p-n junction, the conduction mechanism is such that electrons are excited by the electric field, gaining enough energy to cross the energy gap from the valence band to the conduction band, and then to relax back from the conduction band into the valence band. During the transition from the valence band to the conduction band, the electrons take energy from the field. As they pass back into the valence band, the electrons release this energy in the form of light photons. The amount of energy released is determined by the width of the energy gap. (The wavelength, or color, or the light is a function of the energy gap.) The light is emitted directly from the electrons within the depletion region formed between the two sides of the junction.

The electrical characteristics of LED's are also related to the energy gap. For example, the conduction threshold, or "knee" point on the I_f/V_f curve in the forward-biased direction occurs at approximately 1.0 volts for infrared LED's, at approximately 1.3 volts for visible red LED's, and from 1.8 to 2 volts for yellow and green LED's. The brightness of the light is directly proportional to the operating current flowing in the forward direction.

GALLIUM VS. SILICON

As a semiconductor, III-V compounds using Gallium have several advantages over silicon and germanium—reverse leakage current is several orders of magnitude lower; forward current is lower below the "knee" point; inherent thermal noise is lower; and carrier mobility is high. Perhaps the greatest advantage, certainly where LED's are concerned, is the ability to produce light directly from electron flow.

Figure 1 shows a comparison between the forward conduction characteristics of diodes formed from III-V materials and silicon. Notice that the "knee" of the conduction curve for the Gallium diodes occurs at higher voltages, and is harder than the "knee" of silicon diodes. Notice also that as the wavelength progresses from the infrared toward the blue end of the spectrum, the GaAsP "knee" points get progressively higher and the slope of the I_f/V_f curve tends to decrease. Excluding exotic devices such as Schottky or Esaki diodes, silicon diode de-

[1] E.G. Bylander, *Materials for Semiconductor Functions* (New York, 1971), p. 17.

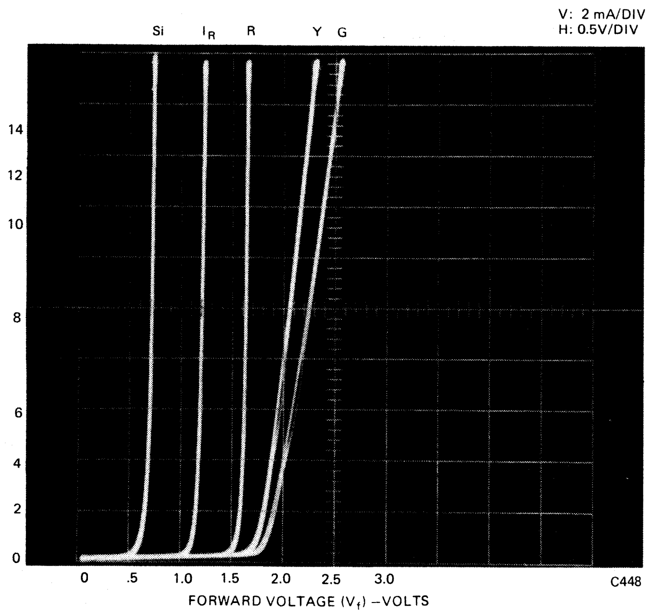


Fig. 1. Typical I_f/V_f Curves of Silicon, GaAs, and GaAsP, GaP (Silicon-IN914, IR-ME7024, Red-MV5053, Yellow-MV5353, Green-MV5253)

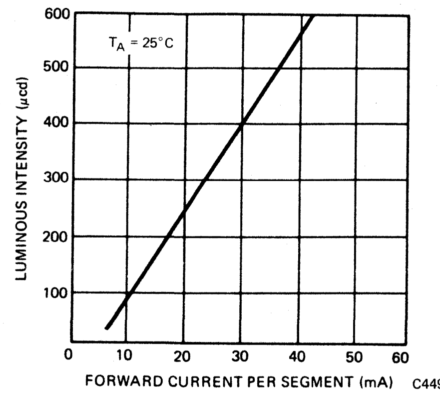


Fig. 2. Typical LED Curve Luminous Intensity vs. Forward Current for Constant Temperature

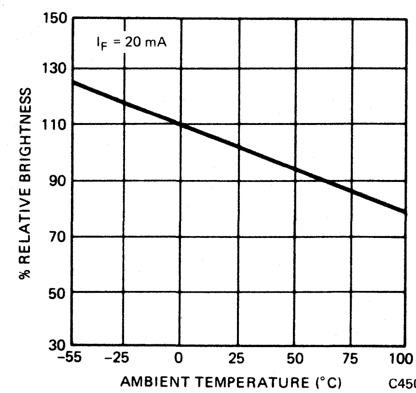


Fig. 3. Typical LED Curve Brightness vs. Temperature for Constant Current

vices normally show little difference in the forward conduction curve.

The reverse characteristics of III-V materials are similar to those of silicon except that silicon's thermal leakage current is higher at very low reverse voltages. The reverse breakdown voltages of silicon are typically higher, and the characteristics of silicon devices are usually controlled for reverse breakdown at particular voltages. The reverse breakdown characteristics of diodes used in LED devices are not particularly controlled, since the quality of light emission is the first priority. The MANX and MANXX series displays use LED's which have a typical reverse-mode breakdown voltage range of from 5 to 20 volts. However for guard-band purposes, the reverse voltage is specified on the data sheets at 5 volts minimum.

If a silicon device is subject to junction damage, it will often continue to perform adequately because of silicon's inherent annealing capability. When damage occurs to the junction of an LED device, however, the result is usually a softening of the "knee" or a flattening of the I_f/V_f curve. Although the device may continue to operate, performance will be less than satisfactory, and early failure may result.

DAMAGE MECHANISMS

The discussion which follows will treat, in some detail, the most common errors in LED test set-ups and will suggest either alternative testing methods or means by which improper testing methods can be corrected to produce more reliably accurate results.

Testing for Fabrication Defects

Thermal Shock—is a passive mode test involving a rapid refrigerate/heat cycle in which no current is applied to the device. This test is a good method for detecting weak bonds and, therefore, locating defective devices, but it should be used cautiously, especially with LED's. In LED's a 1-mil gold wire is bonded from the top of the die over to the side contact, whether it is lead frame or substrate. The wire is surrounded by the epoxy which encloses the die and forms the package. When heat is applied, the epoxy, the gold, and the lead frame all expand at different rates. Thus, when the device is heated up too rapidly, the effects on the bond are similar to giving the wire a hard jerk. This action constitutes thermal shock and tends to weaken even good bonding and, consequently, shorten life expectancy.

Burn-In—consists of operating the device at elevated temperatures, thus accelerating the effects of operationally imposed heating. This method is frequently used in testing semiconductors, but its use is **not** advised with LED's, especially if the testing involves operating with excess current or current which exceeds the device ratings for several hours. LED's exhibit a gradual degradation of brightness as a function of current, time, and

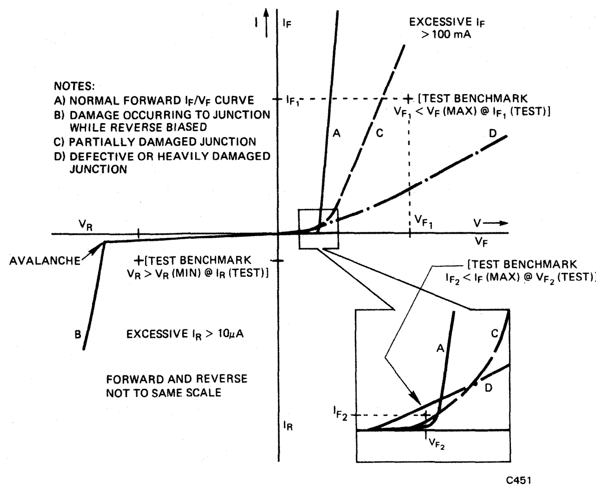


Fig. 4. Effects of Improper Testing Procedure

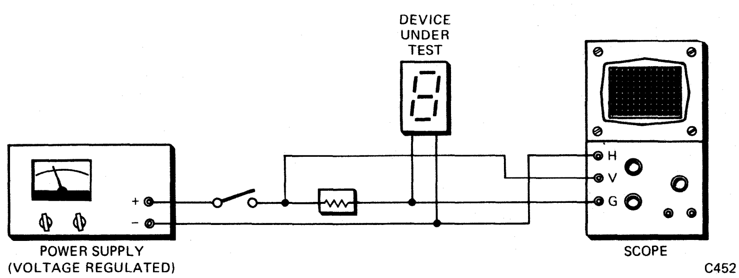


Fig. 5. Potentially Damaging Forward-Mode Test Setup

temperature, and the higher the current, the faster the degradation. The graphs in Figures 2 and 3 illustrate typical LED responses to forward current and temperature. Exceeding the rated parameters in test can result in rapid degradation beyond an acceptable level. For the same reasons, burn-in is particularly inadvisable with LED's if the test set-up involves slow on-off cycles of overcurrent (cyclic room temperature to high temperature and then cooling).

Thermal Cycling—is an on-off cycling method which simulates operational heating effects. The device is allowed to heat up from room temperature with rated current, and is then cooled down. Thermal cycling is an excellent method for finding defective devices (poor bonds, fractures in the metalization, voids in the die-attach, etc.), and its use is recommended for testing LED's. Too often, such thermal cycling occurs in actual use, and defects are detected too late. However, to insure against exceeding the rated capabilities of a particular device, a thermal cycling test program (or operational program) should not be established without factory guidance.

Reverse Conduction Mode Problems

Reverse voltage testing can be hazardous since it may involve a system capable of delivering voltages and currents which considerably exceed the reverse voltage and power ratings of the device under test. Too much current at the avalanche voltage will dissipate excessive power, resulting in heat which will degrade the junction rapidly. The importance of adequate current limiting cannot be over-emphasized. Without it, damage to the junction can result from testing into the avalanche region and/or from the sudden application of voltage which exceeds the rated avalanche breakdown voltage of the device. Damage in the avalanche region is usually the result of an improperly set testing apparatus. As Figure 4 indicates, damage may not be immediately apparent, but it could result in poor performance during other test situations and possible rejection of the device due to excessive voltage or current values.

Forward Conduction Mode Problems

Forward mode testing is used to check such performance criteria as the forward V/I curve of the diode, brightness, ROP, and luminescence. The potential danger in examining the forward curve is damage to the diode junction, since the test circuitry can sometimes deliver very high energy bursts. For example, if a 50-volt regulated power supply is set for 5 volts to supply the test fixture, and if power is supplied through a switch as shown in Figure 5, it is possible to deliver current pulses of a high enough amplitude to result in junction damage. This problem is easily avoided by supplying low voltage power with current limiting to the test fixture. Another acceptable method, and the one which is used by General Instrument quality assurance engineers, is to use a power supply which is both full voltage regulated and current limited.

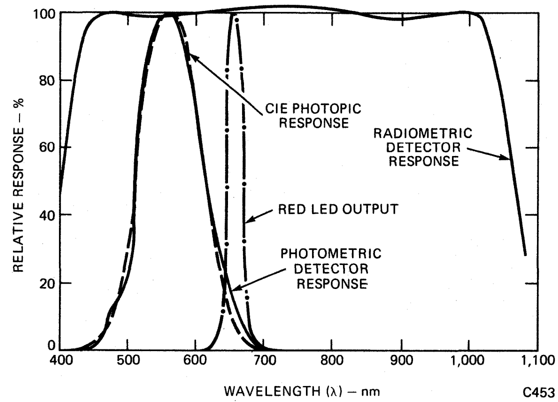


Fig. 6. Responses of Two Detectors to the Output of a Visible Red LED

Brightness Tests

Optical measurements are typically, and in most instances, unavoidably, of very low accuracy. Optical measurements with errors of less than 1% are rare, and accuracy within 5% is difficult to obtain. With an experienced technician using good equipment it is possible to secure accuracy within 10% to 20% on a routine basis, but even here a slight difference in technique can result in errors in excess of 50%.

Detectors—A good detector approximates the CIE curve area with 2%. However, it is important to note that even when the detector is within 2% of perfect, it is still possible to produce mismatches at specific wavelengths which can cause the percentage of error to increase considerably. Therefore, in order to determine the margin of possible error, it is imperative that one know the detector's spectral response within the wavelength range of the device to be measured. To illustrate the problem of spectral mismatch, the reader is referred to Figure 6 where we show the responses of two detectors, a radiometric detector and a photometric detector, to the output of a visible red LED. The response of the radiometric detector is about 3% high. Notice, however, that the photometric detector, which provides a very close match to the CIE curve, produces a +25% error.[2]

Additional factors which must be considered are detector aging and filter deterioration, nonlinear detector responses, circuitry which is not temperature-compensated, and stray light. Periodic calibration is essential if a reasonable degree of accuracy is to be maintained.

Correlation Samples—Unless the testing apparatus is reciprocally related to a vendor-supplied correlation sample, test results may erroneously indicate that many devices in a shipment do not meet the minimum brightness that was specified on the order, and could result in the rejection of devices which do meet minimum standards. Correlation samples are also essential for the correction of instrumentation drift.

Subjectivity Problems—In some instances a visual comparison may be the best method for brightness testing. However, the manner by which the human eye "sees" is affected by various factors such as the nature of the light source, viewing distance, color, texture, the observer's visual acuity, and even the viewer's emotional state. Therefore, because of these highly subjective factors involved in human visual perception, such tests alone are usually inadequate and should be used only as a supplement to or in correlation with instrumentation. It has been our experience that manufacturers who rely solely on visual testing return many devices, a fair percentage of which can be reshipped and accepted.

Testing to Parameters Other Than Those Specified—This is a particularly important consideration when a manufacturer specifies his own parameters distinct from those normally specified. To avoid unnecessary rejection of devices, it is imperative that a device is **always tested to the parameters under which it will be expected to operate.**

SUGGESTIONS FOR PROPER TESTING

That which follows is a quick check list of "do's" which enable manufacturers to avoid many of the problems associated with running incoming quality assurance tests on LED's.

- In cooperation with the vendor, establish specifications which are economically feasible and ensure that devices are screened at their point of origin.
- Always obtain a correlation sample from the vendor before setting up the test procedure.
- Establish a reliable test procedure.
- Measure relevant parameters at relevant points.
- Make sure that the test circuitry will not erroneously indicate defects and that it will not generate failures later in the manufacturing cycle.
- Work closely with the vendor in establishing the test system.

[2]Michael A. Zaha, "Shedding Some Needed Light on Optical Measurements," *Electronics*, November 6, 1972, pp. 94-96.

AN301
discrete LED selecting made easier

Light Emitting Diodes, LED's, have come into widespread use on the electronics scene. This application note is intended to aid the designer in selecting a particular device from the many LED's offered today. The more important parameters as well as some little-known pitfalls are discussed.

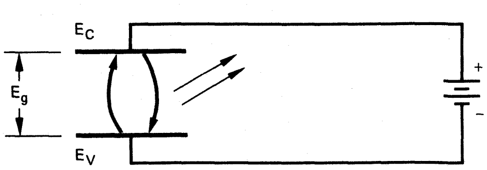
THEORY

Although light emission from a semiconductor junction had long been speculated, the first commercial devices did not become available until about 1963. This light emission phenomenon can be explained in terms of Semiconductor Energy-Band Theory. An external voltage applied to forward-bias a PN junction excites the majority carriers (electrons), causing them to move from the N-side Conduction Band to the P-side Valence Band. In making this transition the electrons cross the Energy Gap, E_g, that separates the two Bands, and so have to give up energy in the form of heat (phonons) and light (photons).

Each semiconductor material type has an E_g characteristic, and the wavelength (λ) of emitted light depends upon the magnitude of E_g, (see Figure 1). For example, Gallium Arsenide material, GaAs, has an E_g = 1.35 eV and a λ_{peak} = 9000 Å. The wavelength (i.e., color) emitted by some other materials made from Gallium compounds are listed in Table 1.

Material	Wavelength	Color
GaAs:Zn	9000Å	infrared
$GaAsP_{.4}$	6600Å	red
$GaAsP_{.5}$	6100Å	amber
$GaAsP_{.85}$:N	5900Å	yellow
GaP:N	5600Å	green

Table 1. Some Wavelentghs and Colors Emitted by Gallium Compounds



$$\text{Wavelength of Emission } (\lambda_{peak}) \cong \frac{12380}{E_g} \text{ (in Angstrom units)}$$

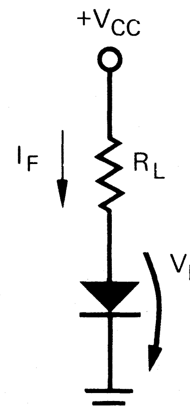
[Equation 1]

Fig. 1. Relationship Between Band-Gap Energy and Wavelength

ELECTRICAL CONSIDERATIONS

Most incandescents are rated in terms of voltage; LED's, on the other hand, are current-dependent devices since they are basically diodes. When operating from constant-voltage sources, protection should be provided by incorporating a current-limiting resistor with each LED.

Basic DC Circuit. For the simple circuit shown in Figure 2 the resistor value can be calculated from



$$R_L = \frac{V_{CC} - V_F}{I_F}$$

[Equation 2]

C1147

Figure 2.

where V_F and I_F are taken from an LED Data Sheet. The power rating required for the resistor should also be kept in mind.

Design Example #1: Suppose that a MV50 is to be used with Figure 2's circuit and a V_{CC} of +5 volts. Figure 3a shows the MV50's Brightness versus I_F curve, and Figure 3b shows I_F vs. V_F. (Note that Brightness varies directly with I_F). Further suppose that a Brightness of 800 foot-Lamberts is decided upon. From Figure 3a we see that I_F must be set at 13 mA, from Figure 3b we see that V_F will be 1.5 volts when I_F is 13 mA. Substituting these values in Equation 2, we obtain

$$R_L = \frac{V_{CC} - V_F}{I_F},\ R_L = \frac{5 - 1.5}{0.013},\ R_L = 269 \text{ ohm.}$$

From the expression, Power = $(I_F)^2 R_L$, we see that R_L's power rating can be 1/8 watt.

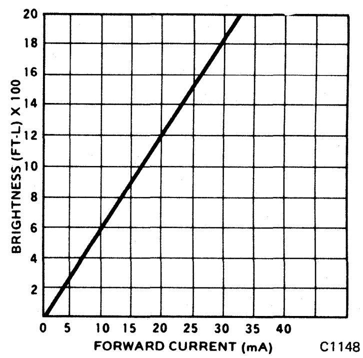


Figure 3a.

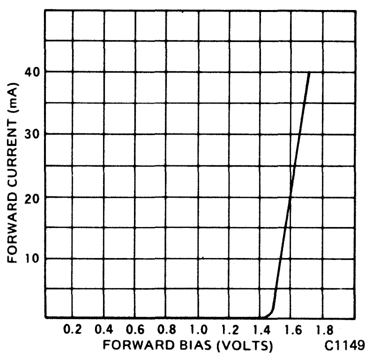


Figure 3b.

Active-Low Drive Circuit. Figure 4 shows a single-transistor drive circuit that lights the LED when the transistor is "low," i.e., conducting. The value for R_L can be calculated from

$$R_L = \frac{V_{CC} - V_F - V_{CE(sat)}}{I_F}$$

[Equation 3]

Active-High Drive Circuit. Figure 5 shows a single-transistor drive circuit that lights the LED when the transistor is "high," i.e., not conducting. Equation 2 can be used for calculating the value of R_L. The transistor should have a V_{CE} of approximately 0.4 volts when conducting.

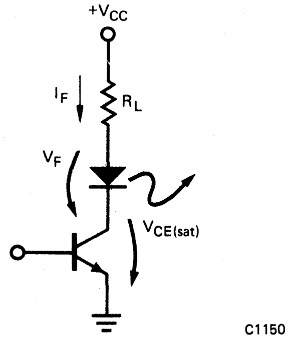


Figure 4.

Figure 6 shows a circuit that has an MOS IC output driving both an LED and a TTL logic input.

Design Example #2: Suppose that a given MOS ROM, operated with V_{SS} = +12 volts, V_{GG} = −12 volts, and V_{DD} = ground, is to drive an LED and a TTL logic input. Further suppose that the LED's brightness is to be adequate for use as a trouble-shooting indicator lamp.

From the data sheet for a MV55 we see that this low-cost, low-current LED typically delivers a usable 125 foot-Lamberts when I_F is 1 mA, and has an I_F maximum rating of 3 mA. A value of 6.8 Kohm should be used for R_L.

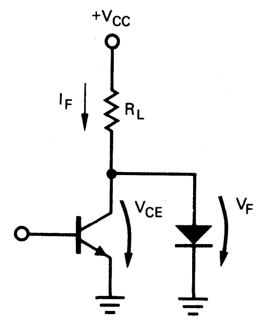


Figure 5.

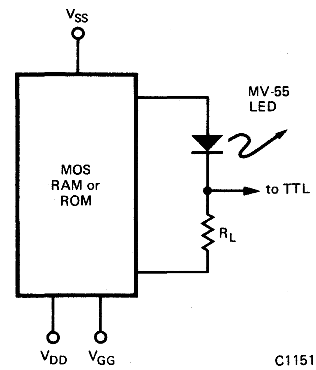


Figure 6.

AC Operation. LED's should be operated in the forward direction only. Therefore, the LED circuit must provide reverse-voltage protection if applied voltage is expected to exceed the V_R maximum rating of the LED. Figure 7a shows a circuit having an ordinary silicon diode (e.g., 1N914) placed "back-to-back" with the LED. Figure 7b shows an alternate and more novel approach that utilizes two LED's in parallel. If no current flows, neither LED lights. But as long as current does flow (in either direction), one of the LED's lights and one does not (because one LED will be conducting

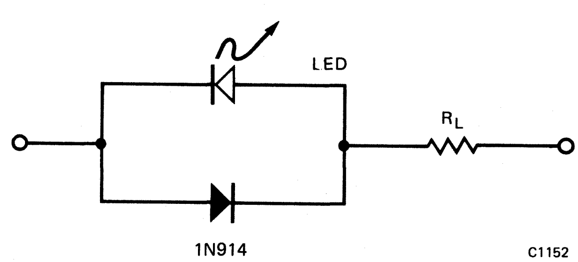


Fig. 7a. Bipolar Operation

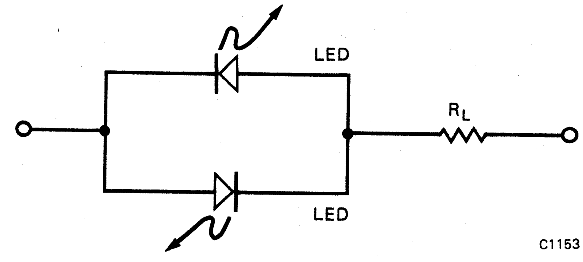


Fig. 7b. Bipolar Operation

and the other not conducting.) An extension of this back-to-back thinking led to the development of the bipolar devices, i.e., the MV5094 (Red/Red) and the MV5491 (Red/Green). These are actually two diodes in each package allowing either AC/DC or tri-state status indication.

If reverse operation (below breakdown) is expected for any length of time, then the designer should be aware of the fact that reverse leakage over temperature of LED materials (GaAs, GaAsP, etc.) is significantly less than that of silicon diode materials.

Pulsed Operation. Significantly higher peak LED light output can be obtained from ampere-level drive current pulses (of narrow width and at low duty cycle) than from steady-state driving. For example, total radiated power (expressed in milliwatts) from a ME7021, infra-red-emitting LED, operated steady-state (typically with I_F = 100 mA) is 2 mW. But this output increases to 50 mW when driven by a 6 amp, one microsecond-wide pulse at 0.1% Duty Cycle. It should be pointed out that this factor of 25 increase comes at the expense of a somewhat lower internal (quantum) efficiency.

Besides the increase in average power just described, pulsed operation of visible-emitting LED's also gives rise to a human perception phenomenon commonly known as Light Enhancement. This phenomenon is due in part to the eye's retention of high brightness levels (such as those produced by camera flash bulbs). A numerical Light Enhancement Factor (always greater than 1) can be defined by the following ratio:

$$\text{Light Enhancement Factor} = \frac{I_{DC\ (\text{steady-state operation})} \text{ to produce Brightness "B"}}{I_{\text{average (pulsed operation)}} \text{ to produce Brightness "B"}}$$

[Equation 6]

This Light Enhancement phenomenon is available only from GaAsP because this LED material will not saturate under high-current conditions.

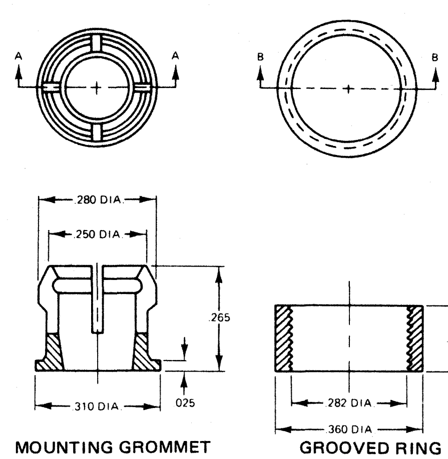
When the human eye is the detector of visible energy, lower average power is consumed by pulsed operation than by steady-state operation. This advantage of pulsed operation is especially important for battery-powered applications and for applications in which large LED arrays are being driven.

MOUNTING CONSIDERATIONS

Panel Mounting. In the "Pop-In" panel mounting method, (see Figure 8a), a black plastic mounting grommet is placed over the top of the lens and the LED is inserted—leads first—into the panel mounting hole until the grommet's flange butts against the panel. Next a grooved ring is placed against the inside-panel end of the grommet, and the ring is pushed on until the LED is securely held in place. The grommet's black color provides contrast improvement. This mounting method allows mounting of the MV5020-Series (T1¾ size) lamps in ¼ in. diameter holes on panels having thicknesses from 0.62 in. to 0.125 in.

A method for mounting LED types without using mounting hardware is to drill the panel holes and either epoxy the LED's into place or solder them to a back-panel printed circuit board, (see Figure 8b).

Printed Circuit Board Mounting. The most common techniques for mounting LED's on P.C. Boards are illustrated in Figure 9. The lead bending can be performed by the user, or arrangements can be made to have it done prior to shipment from the Factory.



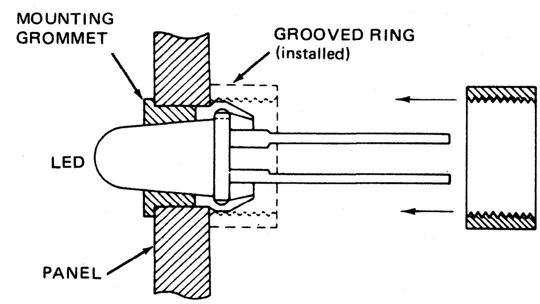


Figure 8a.

OPTICAL CONSIDERATIONS

Lens Effects. Lenses of the earliest LED's were designed to pass maximum light in the forward direction, i.e., perpendicular to the mounting surface, (see Figure 10). Later LED's produced more light and their lenses were designed to spread light over a wider area, thus permitting broader observer viewing angles. Still later, as higher light output LED's became available, a variety of red-colored, epoxy lenses came into use. These lenses act to diffuse light into a broader apparent emitting area. LED lenses that produce a broad, evenly-diffused light

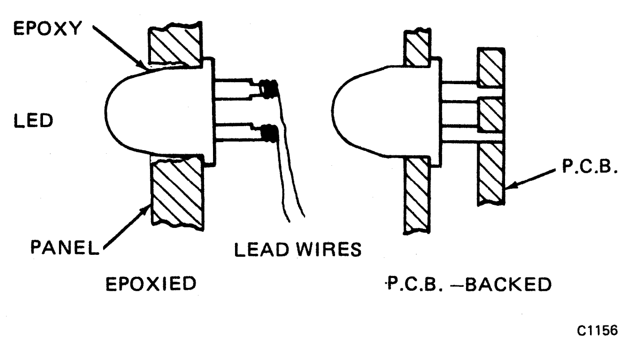
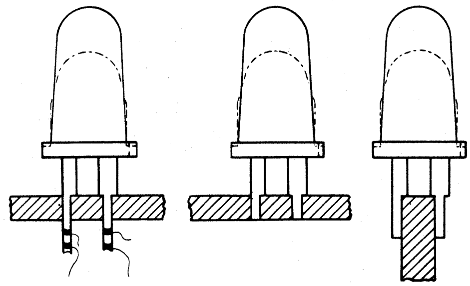
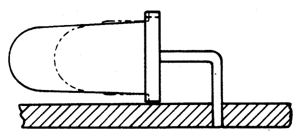


Fig. 8b. LED's Mounted Without Hardware



(a) LED's mounted
without leads being bent



(b) LED mounted
with leads bent

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Fig. 9. Techniques for Mounting LED's on P.C. Boards

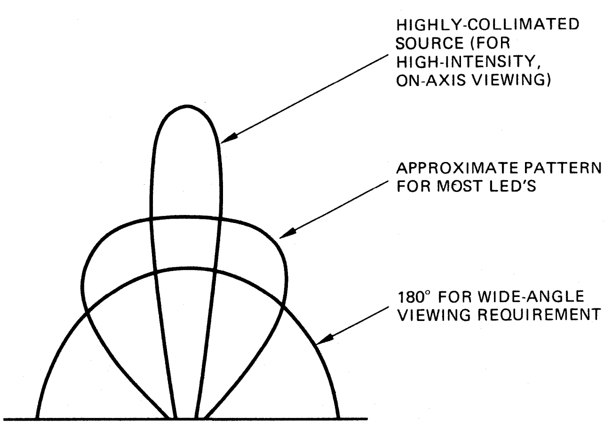
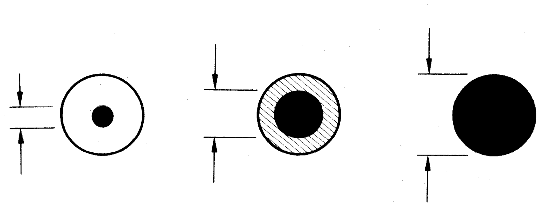


Fig. 10. Different Lens Effects (Used on the Same LED)

are generally assumed to be more pleasing to the eye than lenses that produce a highly-intense point of light. Figure 11 illustrates the effects of adding varying amounts of red diffusants to the epoxy lens material.



(a) Clear Lens (Point Source) (b) Partially Diffused (c) Fully Flooded (Area Source)

Fig. 11. Epoxy Lenses With Varying Amounts of Diffusants

Light Measurement. The manner by which the human eye "sees" is highly subjective and is affected by various factors such as "nature" of the light source (i.e., "point" or "area" source), viewing distance, color, and the observer's visual acuity. For example, it has been found that a "standard" observer with 20/20 vision can discern objects having dimensions that transcribe angles as small as two minutes. To such an observer a source having a 0.16-inch diameter and positioned farther away than 22 feet seems more "point" than "area" in nature.

Two photometric parameters which designers find useful for evaluating LED light output are Luminous Intensity, I, and Luminance (Brightness), B, (see Table 2). While an infinitely-small light source exists in theory only, the following expression can provide a means for determining the distance at which the eye loses its ability to discern an "area" and begins to see a "point."

$$\text{THRESHOLD DISTANCE} = \frac{\text{Diameter of Light Source}}{\text{TAN } 0^\circ\, 2'}$$

(At which sources "lose" their area)

[Equation 7]

From this determination the designer can decide whether to use the I or B parameter for his evaluation of LED light output. The "diameter of the light source" in Equation 7 is the apparent emitting area of the LED. For a "clear" lens LED, (Figure 11a), multiply diode emitting area by the lens magnifying factor. (Unless stated otherwise, most clear lenses magnify by about 2X.) For a "flooded" lens LED, (Figure 11c), use the outside package diameter. For a partially-diffused lens LED, (Figure 11b), a good rule of thumb is one-half the outside package diameter.

Nature of Source	Photometric Parameter	Symbol	Units	Measurement of
Point	Luminous Intensity	I	candela	Luminous Flux/steradian
Area	Luminance (Brightness)	B	foot-Lambert	$\frac{\text{Luminous Flux/steradian}}{(\pi)(\text{Area of source in ft}^2)}$
			stilb	$\frac{\text{Luminous Flux/steradian}}{\text{Area of source in cm}^2}$

Table 2. I and B Photometric Parameters

Contrast Ratio. The degree by which an observer distinguishes an object or source is a function both of time spent looking and of Contrast Ratio. Contrast Ratio is defined as "the difference in Luminance between an object and its background," or

$$\text{CONTRAST RATIO} = \frac{L_s - L_b}{L_b}$$

where "L_s" is a Source Luminance and "L_b" is Background Luminance

[Equation 8]

After an observer has focused on an object for longer than about one second, the time factor becomes negligible and Contrast Ratio remains as the important factor.

Human Factors Studies have shown that a Contrast Ratio of 10 is the minimum design value. Knowing this, and knowing the background Luminance of some common materials under normal illumination levels, we can easily determine the minimum acceptable Luminance levels required from our LED light sources.

Design Example #3: Suppose that the illumination level produced by normal laboratory lighting is approximately 25 foot-candles, and that the reflection from a light-gray panel under this lighting produces a Background Luminance, L_b, of approximatley 10 foot-Lamberts. What is the minimum acceptable Luminance which must be produced by an LED mounted on this panel?

Substituting the above values into Equation 8, we have

$$10 = \frac{L_s - 10}{10}, \text{ or } L_s = 110.$$

Therefore, for an LED installed on a light-gray panel and used in this lighting environment, we see that the minimum acceptable level of Luminance is 110 foot-Lamberts.

Colors. LED's are now available in various colors. In some applications the designer may be called upon to develop circuits in which LED's of different colors are to produce equal Brightness. Since light output from an LED is basically a function of current flow through the PN junction, equal Brightness can be achieved by adjustments of current flow.

Design Example #4: Suppose that three LED's, one each of red, yellow, and green, are to each produce a luminous intensity of 2 mcd when installed in the circuit shown in Figure 12. Further suppose that V_{CC} is set at +5 volts and the LED types chosen are MV5053 (red), MV5353 (yellow), and MV5253 (green).

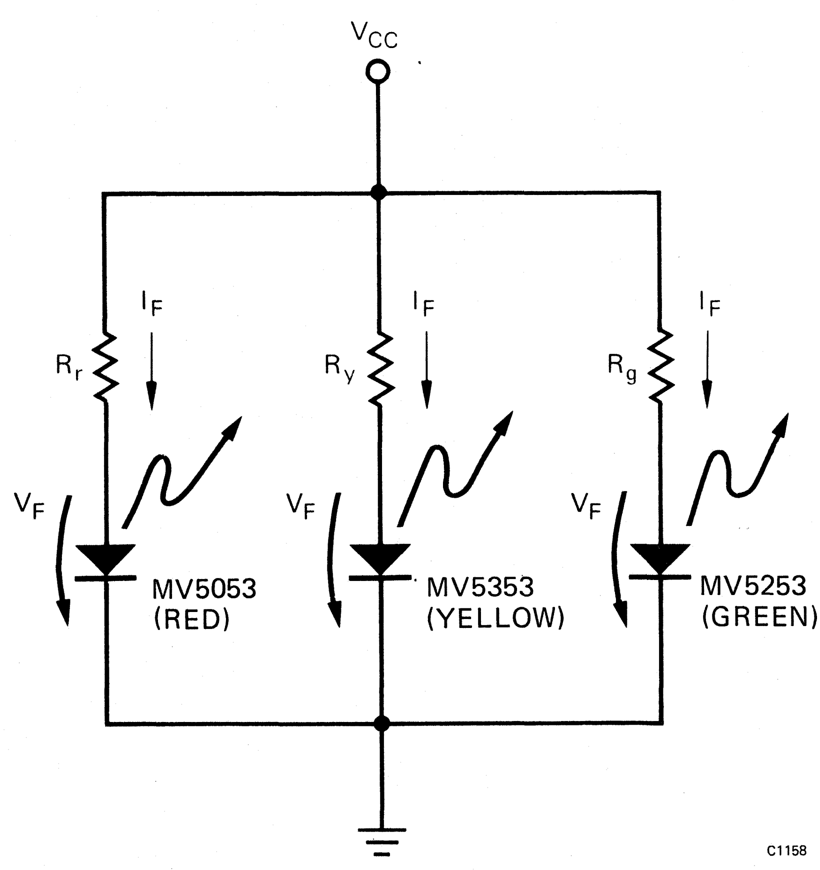


Fig. 12. Brightness Matching Different Colors

First the values of I_F needed to produce 2 mcd in each LED must be determined. From the data sheets we are given that the MV5053 typically produces 1.6 mcd when I_F is 20 mA; the MV5253 produces 1.5 mcd when I_F is 20 mA; and MV5353 produces 6.0 mcd when I_F is 20 mA. The brightness—I_F relationship for LED's can be assumed to be linear for I_F values within the maximum ratings. Therefore, knowing these points and that the luminous intensity is zero when I_F is zero, we can plot the straight-line relationship for each LED type (see Figure 13). From these plots we see that the MV5053 produces 2.0 mcd when I_F is 25 mA; the MV5253 when I_F is 26 mA; and the MV5353 when I_F is 7 mA.

Now the resistor values for R_r, R_y, and R_g can be calculated using Equation 2.

$$R_L = \frac{V_{CC} - V_F}{I_F}$$

with V_F taken as the "typical" values given on the data sheets. We then have:

$$R_r = \frac{5 - 1.65}{.025} \qquad R_y = \frac{5 - 2.1}{.007} \qquad R_g = \frac{5 - 2.2}{.026}$$

$$R_r = 134 \text{ ohms} \qquad R_y = 414 \text{ ohms} \qquad R_g = 108 \text{ ohms}$$

It should be noted that the foregoing analysis holds true only as long as spatial distribution (beam pattern) and apparent image size are very nearly the same for all LED's, regardless of color.

Infrared LED Sources. Visible-emitting LED's, the vital link in the man-machine interface, are characterized in terms of Photometric quantities. On the other hand, infrared-emitting LED's (whose invisible light is of wavelengths longer than 750 nanometers) are characterized in terms of Radiometric quantities. Also, applications requirements for infrared LED sources are different from those for visible-emitting LED's. Whereas for visible-emitting LED's a wide viewing angle is normally important, for infrared sources a narrow beam width and high on-axis intensity are normally important. Light output produced by infrared sources is defined by one or more of the following Radiometric parameters (see Table 3):

Radiated Output Power (P) or (ROP)—Total output of the device in all directions (measured in Watts).

Radiant Intensity (J)—Radiant flux per unit solid angle in a given direction (measured in Watts/steradian).

Irradiance (H)—The density of radiant flux incident on a surface (measured in Watts/area).

Irradiance is a particularly useful parameter because it describes how much output power is available at a given

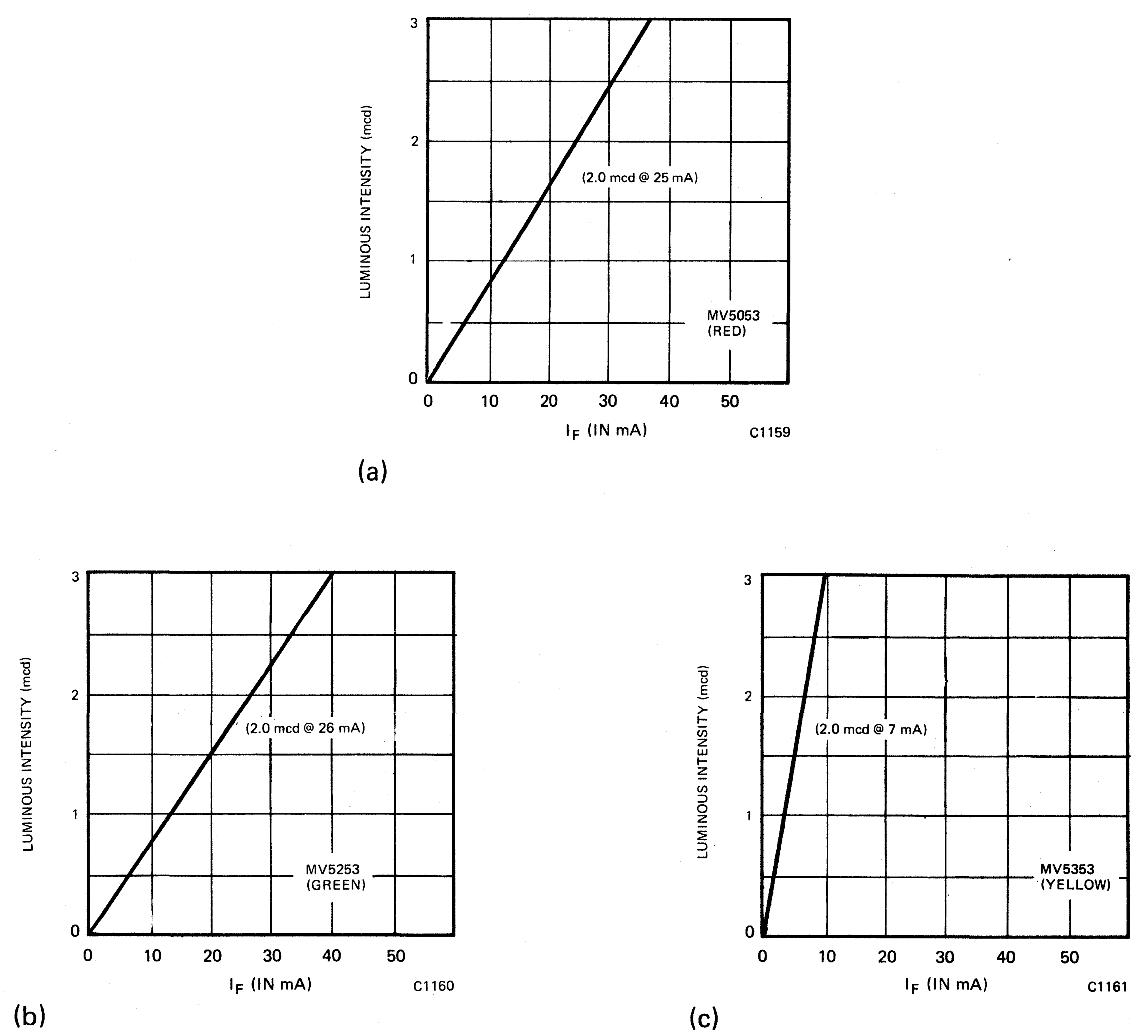


Figure 13.

Table 3.

	Parameter and Symbol		Definition	Units	Abbrev.
RADIOMETRIC	Radiant Energy	Q_e		erg joule calorie kilowatt-hour	 J cal kWh
RADIOMETRIC	Radiant Flux	P	$P = \frac{dQ_e}{dt}$	erg per second watt	erg s^{-1} W
RADIOMETRIC	Radiant Emittance (see Note 2)	W	$W = \frac{dP}{dA}$	watt per sq. cm, watt per sq. m, etc.	W cm^{-2} W m^{-2}
RADIOMETRIC	Irradiance	H	$H = \frac{dP}{dA}$	watt per sq. cm, watt per sq. m, etc.	W cm^{-2} W m^{-2}
RADIOMETRIC	Radiant Intensity (see Note 1)	J	$J = \frac{dP}{d\omega}$	watt per steradian	W sr^{-1}
RADIOMETRIC	Radiance (see Note 1)	N	$N = \frac{d^2P}{d\omega(dA \cos \Theta)}$ $N = \frac{dJ}{(dA \cos \Theta)}$	watt per steradian and sq. cm watt per steradian and sq. m	W sr^{-1} cm^{-2} W sr^{-1} m^{-2}
PHOTOMETRIC	Luminous Efficacy	K	$K = \frac{F}{W}$	lumen per watt	lm W^{-1}
PHOTOMETRIC	Luminous Efficiency	V	$V = \frac{K}{K_{maximum}}$		
PHOTOMETRIC	Luminous Energy (quantity of light)	Q_v	$Q_v = \int_{380}^{760} K(\lambda) Q_e \lambda d\lambda$	lumen-hour lumen-second (talbot)	lm h lm s
PHOTOMETRIC	Luminous Flux	F	$F = \frac{dQ_v}{dt}$	lumen	lm
PHOTOMETRIC	Luminous Emittance (see Note 2)	L	$L = \frac{dF}{dA}$	lumen per sq. ft	lm ft^{-2}
PHOTOMETRIC	Illumination (illuminance)	E	$E = \frac{dF}{dA}$	footcandle (lumen per sq. ft.) lux (lumen per sq. m) phot (lumen per sq. cm)	fc lx ph
PHOTOMETRIC	Luminous Intensity (candlepower)	I	$I = \frac{dF}{d\omega}$	candela (lumen per steradian)	cd
PHOTOMETRIC	Luminance (brightness)	B	$B = \frac{d^2F}{d\omega(dA \cos \Theta)}$ $B = \frac{dI}{(dA \cos \Theta)}$	candela per unit area stilb (candela per sq. cm) nit (candela per sq. m) foot-Lambert (cd per πft^2) apostilb (cd per πm^2) Lambert (cd per πcm^2)	cd in^{-2}, etc. sb nt ft-L asb L

NOTES:

1. ω is a solid angle through which flux from point source is radiated

   Θ is angle between line of sight and normal to surface considered

   λ is wavelength

2. W and L refer to "emitted from" and H and E refer to "incident on"

distance away from the LED. Designers often make use of this parameter when choosing their infrared detectors. Silicon "solar cell" or "photovoltaic cell" detectors are the best detector choices because they generally have large active areas, good long-term stability, and near-perfect match in spectral response compared with infrared LED sources, (see Figure 14).

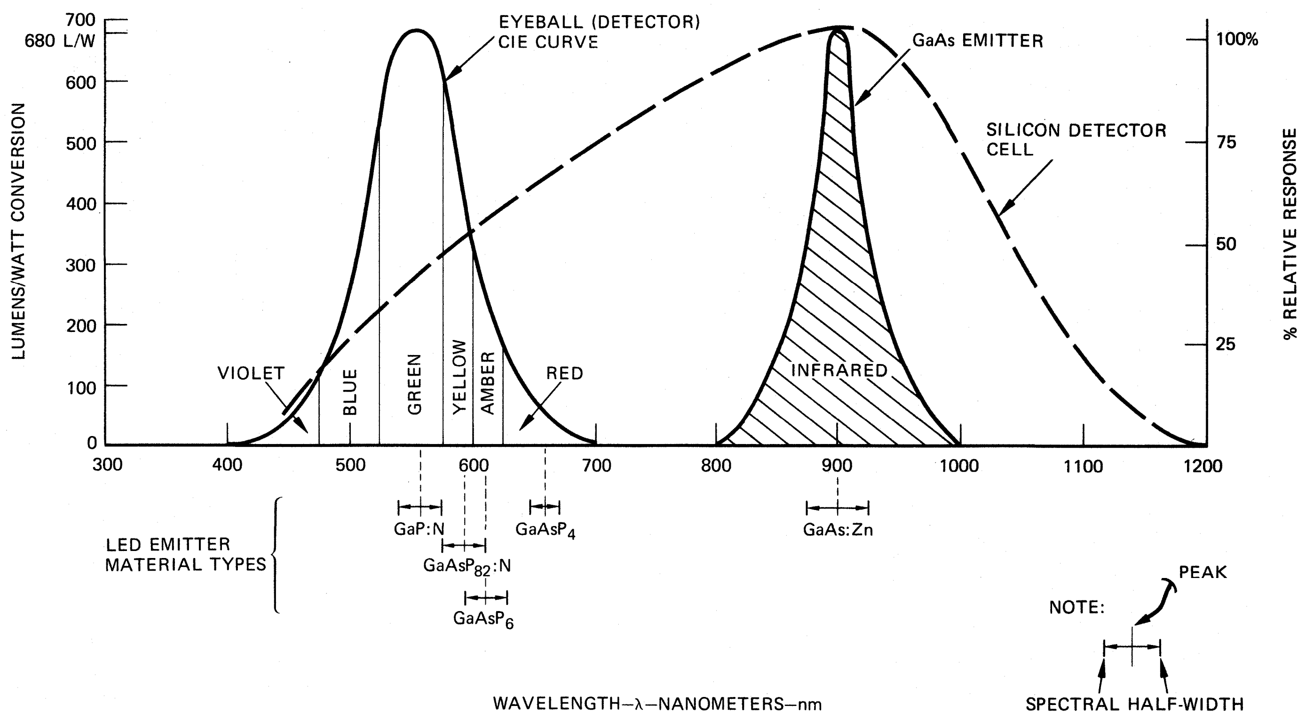


Fig. 14. Relationship Between LED and Detector Spectrums

AN302
using LED's
to replace incandescent lamps

High-density configurations of high-intensity incandescent lamps can generate considerable heat. For example, a 10-by-10 bank of miniature 50-volt lamps can dissipate 200 watts. The resulting heat can cause catastrophic damage to mounting sockets, shorten life of insulation material, weaken structural material, and make lamp replacement almost hazardous. LED's, on the other hand, not only run cooler but also use less power and have longer life. This Application Note points out some important electrical design considerations when using LED's as indicator lamps. Circuits that assure low power dissipation and protection for the LED's will be shown.

Note from the Editor: The author of this Note wrote from a point of view which subscribed to socketing off-the-shelf LED's. He realizes that various methods can be used to prohibit the inverse insertion of a polarized device into a symmetric socket, but chose to ignore these means for exemplification.

DEVICE MAXIMUM RATINGS

As in any circuit design, care must be taken not to exceed the maximum ratings of the components. In the case of LED's used as indicator lamps, the main absolute maximum parameters to be considered are Continuous Forward Current, I_F, and Reverse Voltage, V_R. Well-engineered circuit designs should protect the LED's from the consequences of being plugged into a socket in the reverse polarity, damage arising from voltage transients on the power supply, and inductive kicks of solenoids or relay coils. Table I lists some of the absolute maximum ratings for a typical LED solid-state indicator lamp, the MV5054-2.

MV5054-2

Absolute Maximum Ratings at 100°C		Units
Reverse Voltage, V_R	5.0	V
Continuous Forward Current, I_F	15.0	mA
Peak Forward Current, I_P	6.0	A

Table I. Absolute Maximum Ratings of a Typical LED

SUPPLY VOLTAGE LESS THAN LED'S V_R MAX. RATING

The simple circuit shown in Figure 1 can be used in applications that have a DC supply voltage equal to or less than the V_R maximum rating of the LED. The resistance value of R1 can be calculated from the expression $R = 100\ (V_{CC} - 2)$ when the I_F of the LED is to be 10mA. If the LED is plugged in so as to effect reverse polarity, no prohibitively high current flows since V_{CC} does not exceed the V_R max. of the LED.

Now consider what happens in Figure 1 if transient voltage spikes appear on the power supply line. Positive-going spikes cause I_F to increase, but cause no device problems since LED's can withstand very large positive-going spikes of short duration as they have extremely high Peak Forward Current, I_P, ratings. As long as the amplitude is less than V_{CC}, negative-going spikes merely reduce I_F; if greater than $V_{CC} + V_R$), LED Reverse Current, I_R, can become very large and device damage can result. Those applications in which negative-going spikes of amplitude greater than $(V_R + V_{CC})$ can occur should have a silicon diode added, either in series (Figure 2) or in parallel (Figure 3) with the LED.

The "$+V_{CC}$" of Figures 1, 2, and 3 just described can, of course, be half-wave or full-wave rectification as well as DC (provided that the peak does not exceed +5 volts).

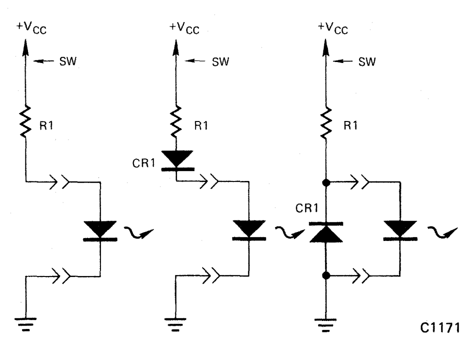


Figure 1 *Figure 2* *Figure 3*

NOTES:

R1 is 1/4w., ±5%, composition resistor

CR1 is 1N914 or equivalent silicon diode

"SW" idicates recommended location of series switch or relay contact

"⏚" indicates ground return of $+V_{CC}$ or output of NAND/NOR logic gate

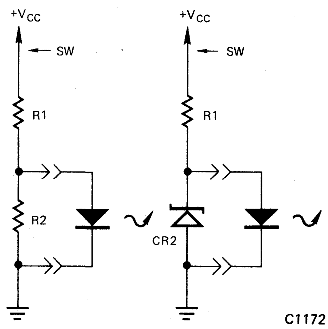


Figure 4 *Figure 5*

NOTES:
R1 is 1/4 to 1 w., ±5%, composition resistor
R2 is 1/4 w., ±5%, composition resistor
CR2 is 5 volt, ±20%, 250 mw., low-cost zener

"SW" indicates recommended location of series switch or relay contact
"⏚" indicates ground return of $+V_{CC}$ or output of NAND/NOR logic gate

SUPPLY VOLTAGE GREATER THAN LED'S V_R MAX. RATING

An LED plugged in the inverse polarity in Figure 1, 2, or 3 can be damaged by high I_R if the supply voltage is greater than the V_R maximum rating of the LED. To protect against possible damage, an additional component must be added. Figure 4 shows a circuit having an additional resistor, R2, whose function is to limit the voltage drop to the V_R max. of the LED when no LED is plugged in.

DESIGN EXAMPLE: Suppose that an MV5054-2 LED is to be used in an application having a V_{CC} of 50 volts and an I_F of 10mA. When no LED is plugged in, R2's voltage drop is to be less than 5 volts (the V_R maximum rating listed in Table I for a MV5054-2).

Standard values of 3300 ohms for R1 and 360 ohms for R2 are obtained from a simple Thevenin's Theorem equivalent circuit, as:

$$\frac{V_{R\ max.} - V_{F\ (typ.)}}{I_F} = \frac{R1\ R2}{R1 + R2}, \text{ where } R1 = 9\ R2$$

$$\frac{5 - 1.8}{.01} = \frac{R1\ R2}{R1 + R2} = \frac{9\ R2}{10}, \text{ etc.}$$

Note that Figure 4's circuit also provides protection against damage from negative-going voltage spikes of amplitudes greater than $V_R + V_{CC}$).

The circuit shown in Figure 5 can protect the LED against incorrect socketing as well as against voltage spikes of virtually any amplitude. The value of the zener diode's breakdown voltage is chosen to be less than the V_R maximum but greater than V_F maximum of the LED. When no LED is plugged in, the zener conducts with a breakdown voltage less than V_R. An LED plugged in with the wrong polarity is not stressed because the voltage applied across its terminals is less than its V_R maximum rating. Figure 5's circuit provides protection against negative-going voltage spikes since a spike of amplitude greater than V_{CC} put the zener into forward conduction, holding the reverse voltage across the terminals of the LED to no more than one volt.

Notice that the "$+V_{CC}$" of Figures 4 and 5 can be half-wave or full-wave rectification (or for that matter just plain AC) so long as the peak voltage does not exceed 50 volts. Figure 4, if driven by AC, gives an effect that the LED is non-polarized and will operate no matter how inserted in the socket.

HIGH-DENSITY LAMP CONFIGURATIONS

At the beginning of this application note it was pointed out that a 10-by-10 bank of miniature 50-volt incandescent lamps can dissipate 200 watts. Besides running cooler than incandescents, LED indicator lamps can be used in circuit designs that reduce power dissipated at the socket. Consider the circuit shown in Figure 6 for a 20-lamp bank operating from a 50-volt, ±5% power source. Here the Q1, CR3 portion of the circuit acts as an equivalent 40-volt zener, and can be located easily on a heat sink remote from the lamp sockets. The amount of power dissipated at each socket—LED plus resistors—is less than one-fifth watt, rather than the incandescent lamp's two watts.

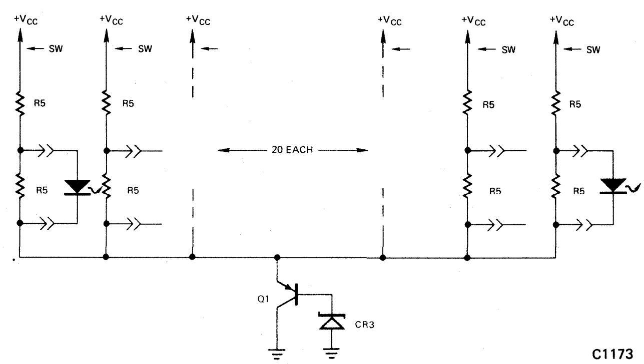


Figure 6

NOTES:
R5 is 680 ohm, 1/2 w., ±5%, composition resistor
Q1 is 10 w., PNP transistor

CR3 is 39 volt, ±5%, 1 w. zener
"SW" indicates recommended location location of series switch or relay contact

Although an MV5054-2 LED has been used in all circuits shown in this application note, the same design considerations apply to other LED types as well.

AN303
MOS logic level indicator

A very low current LED has been developed that is capable of being driven directly from MOS and COS integrated circuits. Designated the MV55, this visible red LED incorporates a new chip, specially designed for operation at low current levels. The MV55 typically produces a Brightness of more than 100 ft-Lamberts from a Forward Current of only 1 mA. This Brightness is adequate for indicating binary logic level, especially in the subdued ambient lighting environment commonly found within cabinet- or chassis-mounted equipment.

ELECTRICAL CHARACTERISTICS

The Brightness versus Continuous Forward Current relationship for a typical MV55 is shown in Figure 1. In steady-state operation the MV55 has an absolute maximum Continuous Forward Current rating of 4 mA, and in pulsed operation (with one microsecond pulse width and 0.1% duty cycle) an absolute maximum Peak Forward Current rating of 400 mA. For Reverse Voltage the MV55 has a 3.0 volt absolute maximum rating, and "turn-on" and "turn-off" times (with a one-ohm load impedance) are typically one nanosecond, (10^{-9} seconds).

MECHANICAL CHARACTERISTICS

The MV55's package has an axial-lead form factor (see Figure 2). Its very small size minimizes space requirements, permitting high-density P.C. Board layouts. The MV55 is simple to install, since mounting sockets or other hardware are not required. The ribbon-type leads can be either soldered or welded. The low profile of the package enables edge-board or flat-board mounting. (Arrangements can be made to have leads custom prebent prior to shipment from the factory.)

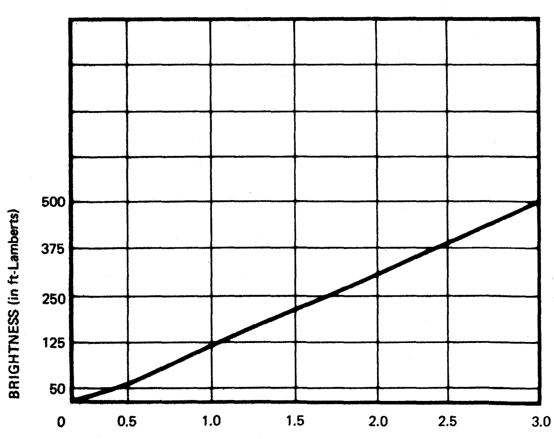


Fig. 1. Brightness versus Continuous Forward Current for typical MV55

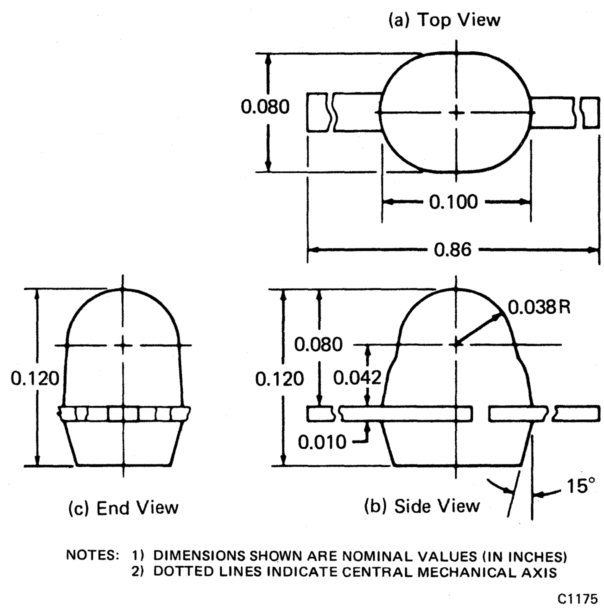


Fig. 2. MV55 Package

LENS CHARACTERISTICS

The MV55 has a red, fully-diffused plastic lens which collects the LED output into a narrow spatial distribution pattern (see Figure 3). For MV55 devices the axis of spatial distribution is typically within a 10° cone with reference to the central mechanical axis of the package. This lens assures high Luminous Intensity along the axis of spatial distribution.

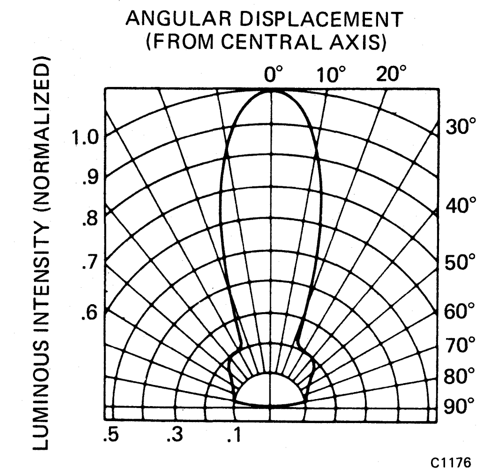


Fig. 3. Spatial Distribution Pattern for MV55

BASIC CIRCUITS

Some basic circuits for the MV55 are shown in Figure 4. Note that this LED does not require buffering or interface stages, but merely connects directly to the IC output. The choice between the circuits shown in Figure 4a and 4b is made according to whether the LED is to light when the IC output state is at logical "1," or at logical "0." In Figure 4c's circuit the MV55 not only performs as an indicator, but also presents a high impedance to the TTL gate when the MOS output is at logical "0."

CONCLUSION

This application note has briefly pointed out the main features of the MV55 and has shown circuits in which it can be used. The MV55 not only offers the high reliability and long lifetime inherent in solid state devices, but also has low unit cost.

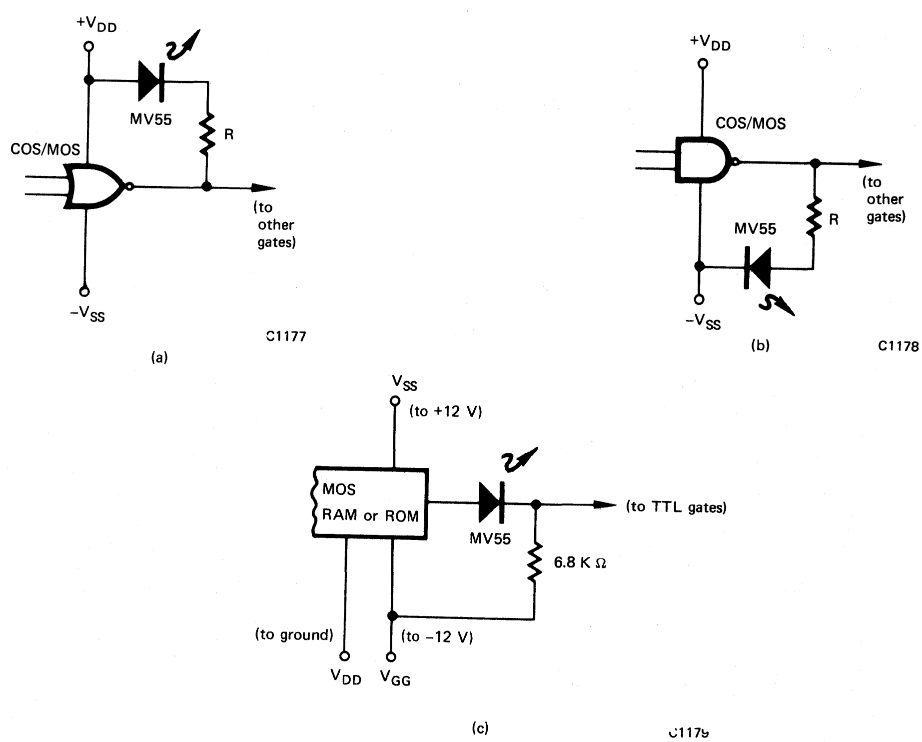


Fig. 4. Basic Circuits for MV55

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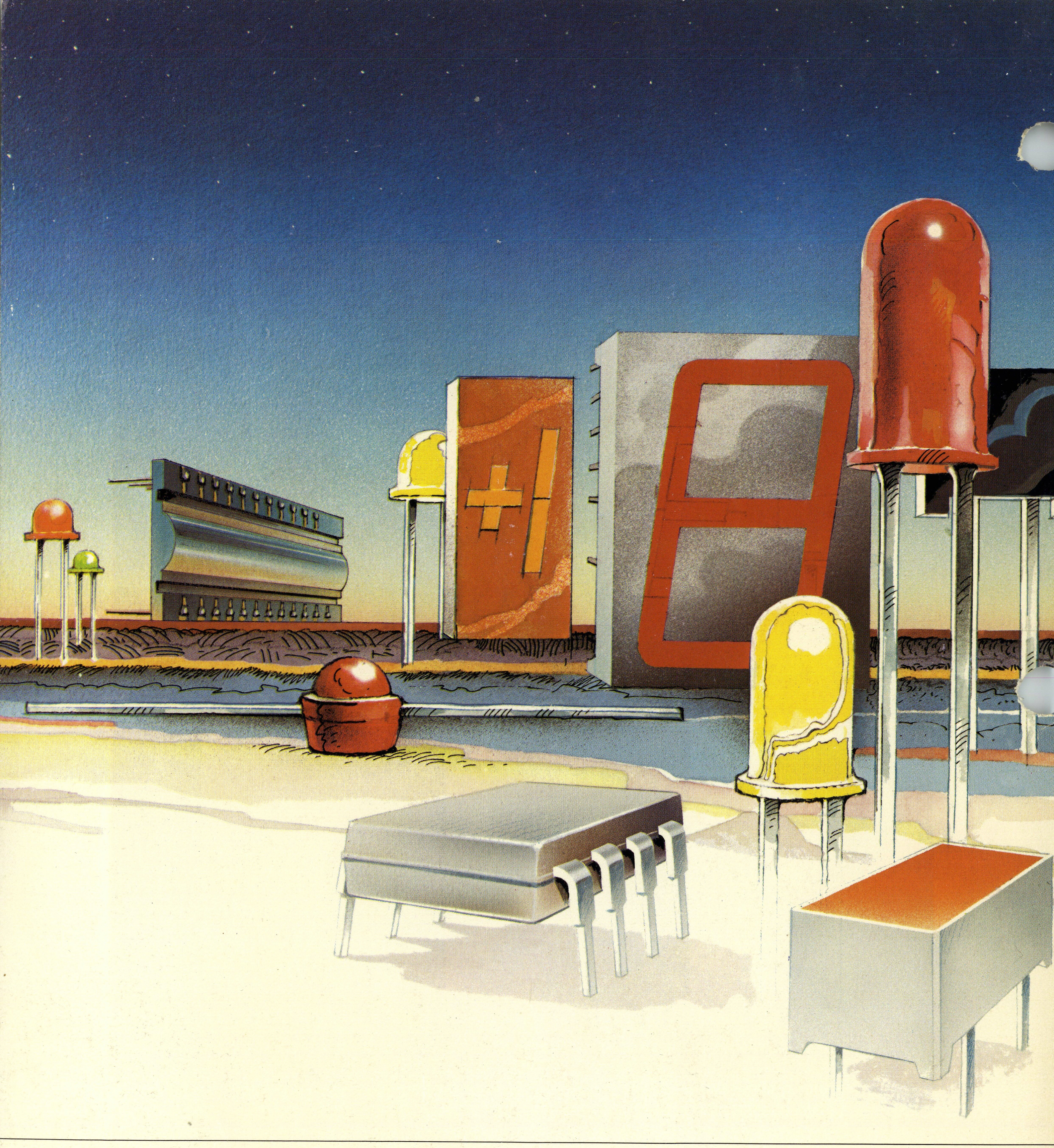

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