PHILIPS

Data handbook

Electronic components and materials

Semiconductors and integrated circuits

Part 4b March 1973

Photosensitive diodes and transistors

Light emitting diodes

Infra-red sensitive devices

Photoconductive devices

SEMICONDUCTORS AND INTEGRATED CIRCUITS

Part 4 b **March 1973**

General

Photosensitive diodes and transistors

Light emitting diodes

Infra-red sensitive devices

Photoconductive devices

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November 1972

DATA HANDBOOK SYSTEM

Our Data Handbook System is a comprehensive source of information on electronic components, subassemblies and materials; it is made up of three series of handbooks each comprising several parts.

ELECTRON TUBES	**BLUE**
SEMICONDUCTORS AND INTEGRATED CIRCUITS	**RED**
COMPONENTS AND MATERIALS	**GREEN**

The several parts contain all pertinent data available at the time of publication, and each is revised and reissued periodically.

Where ratings or specifications differ from those published in the preceding edition they are pointed out by arrows. Where application information is given it is advisory and does not form part of the product specification.

If you need confirmation that the published data about any of our products are the latest available, please contact our representative. He is at your service and will be glad to answer your inquiries.

December 1972

ELECTRON TUBES (BLUE SERIES)

This series consists of the following parts, issued on the dates indicated.

Part 1	**Transmitting tubes (Tetrodes, Pentodes); Amplifier circuit assemblies**	**January 1972**
Part 2	**Tubes for microwave equipment**	**February 1972**
Part 3	**Special Quality tubes; Miscellaneous devices**	**March 1972**
Part 4	**Receiving tubes**	**June 1972**
Part 5	**Cathode-ray tubes; Photo tubes; Camera tubes**	**July 1972**
Part 6	**Devices for nuclear equipment**	**September 1972**
Part 7	**Gas-filled tubes**	**October 1972**
Part 8	**T.V.Picture tubes**	**November 1972**
Part 9	**Transmitting tubes (Triodes) ; Tubes for r.f. heating (Triodes)**	**December 1971**

Part 6 — Devices for nuclear equipment:

Photomultiplier tubes
Channel electron multipliers
Scintillators
Photoscintillators
Radiation counter tubes
Semicinductor radiation detectors
Neutron generator tubes
Photo diodes

Part 7 — Gas-filled tubes:

Voltage stabilizing and reference tubes
Counter, selector, and indicator tubes
Trigger tubes
Switching diodes
Thyratrons
Ignitrons
Industrial rectifying tubes
High-voltage rectifying tubes

SEMICONDUCTORS AND INTEGRATED CIRCUITS (RED SERIES)

This series consists of the following parts, issued on the dates indicated.

Part 1a Rectifier diodes and thyristors — **December 1972**

Rectifier diodes
Voltage regulator diodes
Transient suppressor diodes
Thyristors, diacs, triacs
Ignistors
Rectifier stacks

Part 1b Diodes — **December 1972**

Small signal germanium diodes
Small signal silicon diodes
Special diodes
Voltage regulator diodes
Voltage reference diodes
Tuner diodes

Part 2 Low frequency and deflection transistors — **January 1973**

Part 3 High frequency and switching transistors — **February 1973**

Part 4a Special semiconductors — **March 1973**

Transmitting transistors
Microwave devices
Field effect transistors
Dual transistors
Microminiature devices for thick- and thin-film circuits

Part 4b Devices for opto-electronics — **March 1973**

Photosensitive diodes and transistors
Light emitting diodes
Infra-red sensitive devices
Photoconductive devices

Part 5 Linear integrated circuits — **February 1972**

Part 6 Digital integrated circuits — **March 1972**

DTL (FC family)
DTL/HNIL (FZ family)
TTL (FJ family)
TTL (GJ family)
CML (GH family)
MOS (FD family)

COMPONENTS AND MATERIALS (GREEN SERIES)

This series consists of the following parts, issued on the dates indicated.

Part 1 Circuit Blocks, Input/Output Devices, Electro-mechanical Components, Peripheral Devices — **January 1973**

Circuit blocks 40-Series and CSA70
Counter modules 50-Series
Norbits 60-Series, 61- Series
Circuit blocks 90-Series
Input/output devices
Electro-mechanical components
Peripheral devices

Part 2 Resistors, Capacitors — **April 1973**

Electrolytic capacitors
Paper capacitors and film capacitors
Ceramic capacitors
Variable capacitors
Fixed resistors
Variable resistors
Non-linear resistors
(VDR, LDR, NTC, PTC)

Part 3 Radio, Audio, Television — **February 1972**

FM tuners
Coil assemblies
Piezoelectric ceramic resonators and filters
Loudspeakers
Audio and mains transformers
Television tuners, aerial input assemblies
Components for black and white television
Components for colour television
Deflection assemblies for camera tubes

Part 4 Magnetic Materials, Piezoelectric Ceramics, Ni Cd cells — **May 1972**

Ferrites for radio, audio and television
Small coils and assembling parts
Ferroxcube potcores and square cores
Ferroxcube transformer cores
Piezoelectric ceramics
Permanent magnet materials
Cylindrical nickel cadmium cells *)

Part 5 Memory Products, Magnetic Heads, Quartz Crystals, Microwave Devices, Variable Transformers — **August 1972**

Ferrite memory cores
Matrix planes, matrix stacks
Complete memories
Magnetic heads
Quartz crystal units, crystal filters
Isolators, circulators
Variable mains transformers

Part 6 Electric Motors and Accessories, Timing and Control Devices — **October 1972**

Small synchronous motors
Stepper motors
D.C. motors
D.C. tachogenerators
Asynchronous motors
Indicators for built-in test equipment
Time indicators, timers, timing motors
Aircraft electronic clock system

Part 7 Circuit Blocks — **September 1971**

Circuit blocks 100 kHz Series
Circuit blocks 1-Series
Circuit blocks 10-Series
Circuit blocks for ferrite core memory drive

*) These items have been discontinued

General

Type designation

Rating systems

Letter symbols

Definitions applying to photosensitive devices

PRO ELECTRON TYPE DESIGNATION CODE

FOR SEMICONDUCTOR DEVICES

This type designation code applies to discrete devices and to multiple devices [1])

The type designation consists of:

TWO LETTERS FOLLOWED BY A SERIAL NUMBER

The first letter gives an indication of the material

A Material with a band gap of 0.6 to 1.0 eV, such as germanium

B Material with a band gap of 1.0 to 1.3 eV, such as silicon

C Material with a band gap of 1.3 eV and more, such as gallium arsenide

D Material with a band gap of less than 0.6 eV, such as indium antimonide

R Compound material as employed in Hall generators and photoconductive cells

[1]) A multiple device is defined as a combination of similar or dissimilar active devices, contained in a common encapsulation that cannot be dismantled, and of which all electrodes of the individual devices are accessible from the outside.

Multiples of similar devices as well as multiples consisting of a main device and an auxiliary device are designated according to the code for discrete devices described above.
Multiples of dissimilar devices of other nature are designated by the second letter G.

The second letter indicates primarily the main application respectively main application and construction if a further differentiation is essential

- A Detection diode, switching diode, mixer diode
- B Variable capacitance diode
- C Transistor for a.f. applications ($R_{th\ j\text{-}mb} > 15\ ^oC/W$)
- D Power transistor for a.f. applications ($R_{th\ j\text{-}mb} \leq 15\ ^oC/W$)
- E Tunnel diode
- F Transistor for h.f. applications ($R_{th\ j\text{-}mb} > 15\ ^oC/W$)
- G Multiple of dissimilar devices (see note on page 1); Miscellaneous
- H Magnetic sensitive diode; Field probe
- K Hall generator in an open magnetic circuit, e.g. magnetogram or signal probe
- L Power transistor for h.f. applications ($R_{th\ j\text{-}mb} \leq 15\ ^oC/W$)
- M Hall generator in a closed electrically energised magnetic circuit, e.g. Hall modulator or multiplier
- → N Photocoupler
- P Radiation sensitive device [1)]
- Q Radiation generating device
- R Electrically triggered controlling and switching device having a breakdown characteristic ($R_{th\ j\text{-}mb} > 15\ ^oC/W$)
- S Transistor for switching applications ($R_{th\ j\text{-}mb} > 15\ ^oC/W$)
- T Electrically, or by means of light, triggered controlling and switching power device having a breakdown characteristic ($R_{th\ j\text{-}mb} \leq 15\ ^oC/W$)[1)]
- U Power transistor for switching applications ($R_{th\ j\text{-}mb} \leq 15\ ^oC/W$)
- X Multiplier diode, e.g. varactor, step recovery diode
- Y Rectifying diode, booster diode, efficiency diode [1)]
- Z Voltage reference or voltage regulator diode [1)]

1) For the type designation of a range see page 4.

The serial number consists of:

Three figures for semiconductor devices designed primarily for use in domestic equipment

One letter and two figures for semiconductor devices designed primarily for use in professional equipment

VERSION LETTER

A version letter can be used, for instance, for a diode with up-rated voltage, for a sub-division of a transistor type in different gain ranges, a low noise version of an existing transistor and for a diode, transistor, or thyristor with minor mechanical differences, such as finish of the leads, length of the leads etc. The letters never have a fixed meaning, the only exception being the letter R.

TYPE DESIGNATION FOR A RANGE OF SEMICONDUCTOR DEVICES

The type designation of a range of variants of:

a) voltage reference or voltage regulator diodes (second letter Z)

b) rectifying diodes (second letter Y)

c) thyristors (second letter T)

d) radiation detectors

distinctly belonging to one basic type may be qualified by a suffix part which is clearly separated from the basic part by a dash (-)
The basic part being the same for the whole range, is in accordance with the designation code for discrete devices.

The suffix part consists of:

a) for voltage reference or voltage regulator diodes

one letter followed by the typical zener voltage and where appropriate the letter R [1])
The first letter indicates the nominal tolerance of the zener voltage in %

A	1%
B	2%
C	5%
D	10%
E	15%

The typical zener voltage is related to the nominal current rating for the whole range. The letter V is used to denote the decimal point when this occurs.

b) for rectifying diodes

a number and where appropriate the letter R [1])
The number generally indicates the maximum repetitive peak reverse voltage
For controlled avalanche types it indicates the maximum crest working reverse voltage

c) for thyristors

a number and where appropriate the letter R [1])
The number generally indicates either the maximum repetitive peak reverse voltage or the maximum repetitive peak off-state voltage, whichever is lower
For controlled avalanche types it indicates the maximum crest working reverse voltage

d) for radiation detectors

a figure giving the depth of the depletion layer in μm and where appropriate a version letter if there are differences in resolution.

[1]) The letter R indicates reverse polarity (anode to stud). The normal polarity (cathode to stud) and symmetrical executions are not specially indicated.

RATING SYSTEMS

ACCORDING TO I.E.C. PUBLICATION 134

1. DEFINITIONS OF TERMS USED

1.1 Electronic device. An electronic tube or valve, transistor or other semiconductor device.

Note: This definition excludes inductors, capacitors, resistors and similar components.

1.2 Characteristic. A characteristic is an inherent and measurable property of a device. Such a property may be electrical, mechanical, thermal, hydraulic, electro-magnetic, or nuclear, and can be expressed as a value for stated or recognized conditions. A characteristic may also be a set of related values, usually shown in graphical form.

1.3 Bogey electronic device. An electronic device whose characteristics have the published nominal values for the type. A bogey electronic device for any particular application can be obtained by considering only those characteristics which are directly related to the application.

1.4 Rating. A value which establishes either a limiting capability or a limiting condition for an electronic device. It is determined for specified values of environment and operation, and may be stated in any suitable terms.

Note: Limiting conditions may be either maxima or minima.

1.5 Rating system. The set of principles upon which ratings are established and which determine their interpretation.

Note: The rating system indicates the division of responsibility between the device manufacturer and the circuit designer, with the object of ensuring that the working conditions do not exceed the ratings.

2. ABSOLUTE MAXIMUM RATING SYSTEM

Absolute maximum ratings are limiting values of operating and environmental conditions applicable to any electronic device of a specified type as defined by its published data, which should not be exceeded under the worst probable conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the device under consideration and of all other electronic devices in the equipment.

p.t.o.

The equipment manufacturer should design so that, initially and throughout life, no absolute maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, equipment control adjustment, load variations, signal variation, environmental conditions, and variations in characteristics of the device under consideration and of all other electronic devices in the equipment.

3. DESIGN MAXIMUM RATING SYSTEM

Design maximum ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking responsibility for the effects of changes in operating conditions due to variations in the characteristics of the electronic device under consideration.

The equipment manufacturer should design so that, initially and throughout life, no design maximum value for the intended service is exceeded with a bogey device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, variation in characteristics of all other devices in the equipment, equipment control adjustment, load variation, signal variation and environmental conditions.

4. DESIGN CENTRE RATING SYSTEM

Design centre ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device of a specified type as defined by its published data, and should not be exceeded under normal conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device in average applications, taking responsibility for normal changes in operating conditions due to rated supply voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of all electronic devices.

The equipment manufacturer should design so that, initially, no design centre value for the intended service is exceeded with a bogey electronic device in equipment operating at the stated normal supply voltage.

NOTE

It is common use to apply the Absolute Maximum System in semiconductor published data.

Letter symbols

LETTER SYMBOLS FOR SEMICONDUCTOR DEVICES
excluding rectifier diodes, thyristors and integrated circuits

This system is based on the Recommendations of the INTERNATIONAL ELECTROTECHNICAL COMMISSION as published in I.E.C. Publication 148.

QUANTITY SYMBOLS

1. Instantaneous values of current, voltage and power, which vary with time are represented by the appropriate lower case letter.

   Examples: i, v, p

2. Maximum (peak), average, d.c. and root-mean-square values are represented by the appropriate upper case letter.

   Examples: I, V, P

SUBSCRIPTS FOR QUANTITY SYMBOLS

1. Total values are indicated by upper case subscripts.

   Examples: I_C, I_{CM}, $I_{C(AV)}$, i_C, V_{EB}

2. Values of varying components are indicated by lower case subscripts.

   Examples: i_c, I_c, v_{eb}, V_{eb}

3. To distinguish between maximum (peak), average, d.c. and root-mean-square values, the following subscripts are added:

   For maximum (peak) values : M or m

   For average values : (AV) or (av) (only if it is necessary to distinguish between d.c. and average)

   For d.c. values : no additional subscript

   For root-mean-square values : (RMS) or (rms)

   Examples: I_C, I_{cm}, $I_{C(AV)}$, $I_{c(rms)}$, $I_{C(RMS)}$

4. List of subscripts (examples, see figure 1)

A, a	=	Anode terminal
K, k	=	Cathode terminal
E, e	=	Emitter terminal
B, b	=	Base terminal or Substrate for MOS devices
C, c	=	Collector terminal
D, d	=	Drain terminal
(BR)	=	Break-down
X, x	=	Specified circuit
M, m	=	Maximum (peak) value
(AV), (av)	=	Average value
(RMS), (rms)	=	R.M.S. value
F, f	=	Forward
G, g	=	Gate terminal
R, r	=	As first subscript: Reverse. As second subscript: Repetitive
O, o	=	As third subscript: The terminal not mentioned is open circuited
S, s	=	As first or second subscript: Source terminal (for FETS only) As second subscript: Non-repetitive (not for FETS) As third subscript : Short circuit between the terminal not mentioned and the reference terminal
Z, z	=	Zener. (Replaces R to indicate the actual zener voltage, current or power of voltage reference or voltage regulator diodes)

5. Examples of the application of the rules:
Figure 1 represents a transistor collector current, consisting of a direct current and a signal, as a function of time.

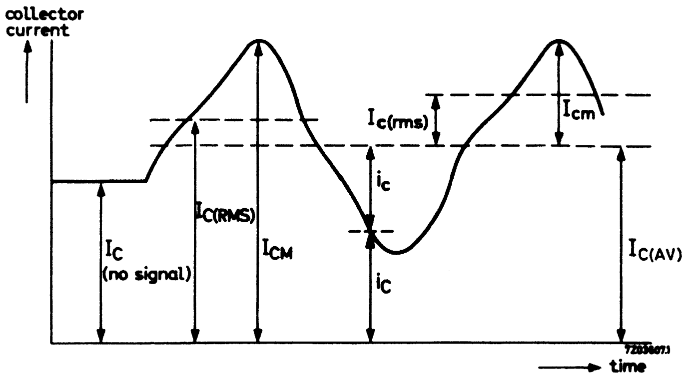


Fig.1

CONVENTIONS FOR SUBSCRIPT SEQUENCE

1. Currents

For transistors the first subscript indicates the terminal carrying the current (conventional current flow from the external circuit into the terminal is positive)

For diodes a forward current (conventional current flow into the anode terminal) is represented by the subscript F or f; a reverse current (conventional current flow out of the anode terminal) is represented by the subscript R or r.

2. Voltages

For transistors normally, two subscripts are used to indicate the points between which the voltage is measured. The first subscript indicates one terminal point and the second the reference terminal.
Where there is no possibility of confusion, the second subscript may be omitted.

For diodes a forward voltage (anode positive with respect to cathode) is represented by the subscript F or f and a reverse voltage (anode negative with respect to cathode) by the subscript R or r.

3. Supply voltages

Supply voltages may be indicated by repeating the terminal subscript.

Examples: V_{EE}, V_{CC}, V_{BB}

The reference terminal may then be indicated by a third subscript.

Examples: V_{EEB}, V_{CCB}, V_{BBC}

4. In devices having more than one terminal of the same type, the terminal subscripts are modified by adding a number following the subscript and on the same line.

Example: V_{B2-E} voltage between second base and emitter

In multiple unit devices, the terminal subscripts are modified by a number preceding the terminal subscripts:

Example: V_{1B-2B} voltage between the base of the first unit and that of the second one.

ELECTRICAL PARAMETER SYMBOLS

1. The values of four pole matrix parameters or other resistances, impedances admittances, etc... inherent in the device, are represented by the lower case symbol with the appropriate subscripts.

Examples: h_{ib}, z_{fb}, y_{oc}, h_{FE}

2. The four pole matrix parameters of external circuits and of circuits in which the device forms only a part are represented by the upper case symbols with the appropriate subscripts.

Examples: H_i, Z_o, H_F, Y_R

SUBSCRIPTS FOR PARAMETER SYMBOLS

1. The static values of parameters are indicated by upper case subscripts.

Examples: h_{IB}, h_{FE}

Note The static value is the slope of the line from the origin to the operating point on the appropriate characteristic curve, i.e. the quotient of the appropriate electrical quantities at the operating point.

2. The small-signal values of parameters are indicated by lower case subscripts.

Examples: h_{ib}, z_{ob}

3. The first subscript, in matrix notation identifies the element of the four pole matrix.

i (for 11) = input
o (for 22) = output
f (for 21) = forward transfer
r (for 12) = reverse transfer

Examples:
$$V_1 = h_i I_1 + h_r V_2$$
$$I_2 = h_f I_1 + h_o V_2$$

Notes 1) The voltage and current symbols in matrix notation are indicated by a single digit subscript.
The subscript 1 = input; the subscript 2 = output

2) The voltages and currents in these equations may be complex quantities.

4. The second subscript identifies the circuit configuration.

e = common emitter
b = common base
c = common collector
j = common terminal, general

Examples: (common base)

$$I_1 = y_{ib} V_{1b} + y_{rb} V_{2b}$$
$$I_2 = y_{fb} V_{1b} + y_{ob} V_{2b}$$

When the common terminal is understood, the second subscript may be omitted.

5. If it is necessary to distinguish between real and imaginary parts of the four pole parameters, the following notations may be used.

$Re(h_{ib})$ etc.. for the real part

$Im(h_{ib})$ etc.. for the imaginary part

LIST OF LETTER SYMBOLS IN ALPHABETICAL ORDER

Letter symbol	Definition
B	Bandwidth
b_{ib}, b_{ie}, b_{is}, b_{fb}, b_{fe}, b_{fs}, b_{ob}, b_{oe}, b_{os}, b_{rb}, b_{re}, b_{rs}	See y parameters
C_c [1]	Collector capacitance (emitter open-circuited to a.c. and d.c.)
C_d [1]	Diode capacitance
C_e [1]	Emitter capacitance (collector open-circuited to a.c. and d.c.)
C_{ib}, C_{ie}, C_{is}, C_{fb}, C_{fe}, C_{fs}, C_{ob}, C_{oe}, C_{os}, C_{rb}, C_{re}, C_{rs}	See y parameters
d	Distortion
F	Noise figure
f	Frequency
f_{hfb}, f_{hfe}, f_{yfe}	Cut-off frequency (frequency at which the parameter indicated by the subscript is 0.7 of its low frequency value)
f_T	Transition frequency (Gain-bandwidth product)
g_{ie}, g_{ib}, g_{oe}, g_{ob}	See y parameters
G_p	Power gain
G_S	Source conductance
G_{tr}	Transducer gain
G_{UM}	Maximum unilateralised power gain
G_v	Voltage gain

[1] As an exception to the general rule for electrical parameters capacitances are represented by the upper-case letter.

Letter symbol	Definition
h_{FB}, h_{FC}, h_{FE}	D.C. current gain (static value of the forward current transfer ratio; output voltage held constant)
h_{fb}, h_{fc}, h_{fe}	Small-signal current gain (small-signal value of the forward current transfer ratio; output short-circuited to a.c.)
h_{IB}, h_{IC}, h_{IE}	Static value of the input resistance (output voltage held constant)
h_{ib}, h_{ic}, h_{ie}	Small-signal value of the input impedance (output short-circuited to a.c.)
h_{OB}, h_{OC}, h_{OE}	Static value of the output conductance (input current held constant)
h_{ob}, h_{oc}, h_{oe}	Small-signal value of the output admittance (input open-circuited to a.c.)
h_{RB}, h_{RC}, h_{RE}	Static value of the reverse voltage transfer ratio (input current held constant)
h_{rb}, h_{rc}, h_{re}	Small-signal value of the reverse voltage transfer ratio (input open-circuited to a.c.)
I_B, I_C, I_D, I_E, I_G, I_S	Total d.c. (or average) current
I_b, I_c, I_d, I_e, I_g, I_s	Varying component of the current
i_B, i_C, i_D, i_E, i_G, i_S	Instantaneous total value of the current
i_b, i_c, i_d, i_e, i_g, i_s	Instantaneous value of the varying component of the current
$I_{B(AV)}$, $I_{C(AV)}$, $I_{E(AV)}$	Total average current (to distinguish between average and d.c. if necessary)
I_{BEX}, I_{CEX}	Total base, respectively collector current under specified conditions. These symbols are commonly used in case of a reverse biased emitter junction
I_{BM}, I_{CM}, I_{EM}	Maximum (peak) value of the total current
I_{bm}, I_{cm}, I_{em}	Maximum (peak) value of the varying component of the current
I_{CBO}	Collector cut-off current (open emitter)
I_{CEO}	Collector cut-off current (open base)
I_{CBS} or I_{CES}	Collector cut-off current (emitter short-circuited to base)

Letter symbol	Definition
I_{DSS}	Drain current (source short-circuited to gate)
I_{EBO}	Emitter cut-off current (open collector)
I_F	Total forward current of a diode (d.c. or average)
i_F	Instantaneous total value of the forward current of a diode
$I_{F(AV)}$	Total average forward current of a diode (to distinguish between average and d.c. if necessary)
I_{FM}	Peak forward current of a diode
I_{GSS}	Gate cut-off current (source short-circuited to drain)
I_i, I_o	Input, respectively output current of a specified circuit
I_R	Total reverse (cut-off) current of a diode
i_R	Instantaneous total value of the reverse current of a diode
I_{RRM}	Repetitive peak reverse current of a diode
I_{RSM}	Non-repetitive peak reverse current of a diode
I_{SDS}	Source cut-off current (drain short-circuited to gate)
I_Z	Zener current (d.c. or average)
I_{ZM}	Peak zener current
I_{ZS}	Non-repetitive zener current
P_i, P_o	Input, respectively output power of a specified circuit
P_{tot}	Total power dissipation in the device
P_Z	Zener power dissipation
P_{ZM}	Peak zener power dissipation
P_{ZSM}	Non-repetitive peak zener power dissipation
Q_s	Reverse recovery charge

Letter symbol	Definition
r_D	Diode (internal) series resistance
r_{DS}	Drain-source resistance
r_{GS}	Gate-source resistance
R_L	Load resistance
R_S	Source resistance
R_{th}	Thermal resistance
$R_{th\ j\text{-}a}$	Thermal resistance from junction to ambient
$R_{th\ j\text{-}mb}$	Thermal resistance from junction to mounting base
$R_{th\ j\text{-}c}$	Thermal resistance from junction to case
$R_{th\ mb\text{-}h}$	Thermal resistance from mounting base to heatsink (contact thermal resistance)
r_z	Dynamic-slope resistance of a zener diode
S_z	Temperature coefficient of the operating voltage of a zener diode
T_{amb}	Ambient temperature
T_{case}	Case temperature
t_d ; t_f	Delay time; fall time
t_{fr}	Forward recovery time of a diode
T_j	Junction temperature
t_{off}	**Turn-off** time ($t_{off} = t_s + t_f$)
t_{on}	**Turn-on** time ($t_{on} = t_d + t_r$)
t_r	Rise time
t_{rr}	Reverse recovery time of a diode
t_s	Storage time
T_{stg}	Storage temperature
V_{BB}, V_{CC}, V_{EE}	Supply voltage
V_{BE}, V_{CB}, V_{CE}, V_{EB}	Total value of the voltage (d.c. or average)
V_{be}, V_{cb}, V_{ce}, V_{eb}	Varying component of the voltage
v_{BE}, v_{CB}, v_{CE}, v_{EB}	Instantaneous value of the total voltage
v_{be}, v_{cb}, v_{ce}, v_{eb}	Instantaneous value of the varying component of the voltage

Letter symbols	Definition
V_{BEfl}	Base-emitter floating voltage (open base)
V_{BEsat}	Saturation voltage at specified bottoming conditions
$V_{(BR)}$	Breakdown voltage
$V_{(BR)CBO}$, $V_{(BR)CEO}$, $V_{(BR)EBO}$	Breakdown voltage between the terminal indicated by the first subscript and the reference terminal (second subscript) when the third terminal is open circuited
$V_{(BR)CER}$	Collector-emitter breakdown voltage with a specified resistance between emitter and base
$V_{(BR)CES}$	Collector-emitter breakdown voltage with the emitter short circuited to the base
V_{CBO}, V_{CEO}, V_{DGO}, V_{EBO}, V_{GSO}	Voltage of the terminal indicated by the first subscript w.r.t. the reference terminal (second subscript) with the third terminal open circuited
V_{CBOM}, V_{CEOM}	Peak value of V_{CBO}, V_{CEO}
V_{CEK}	Knee voltage at specified conditions
V_{CER}	Collector-emitter voltage with a specified resistance between emitter and base
V_{CERM}	Peak value of V_{CER}
V_{CES}	Collector-emitter voltage with the emitter short circuited to the base
V_{CEsat}	Saturation voltage at specified bottoming conditions
$V_{CE.sust}$	Collector-emitter sustaining voltage under the condition, indicated by the third subscript
V_{CEX}	Collector-emitter voltage in a specified circuit. This symbol is commonly used to indicate a reverse biased emitter junction
V_{DSS}	Drain-source voltage with the source short-circuited to the gate
V_{EBfl}	Emitter-base floating voltage (open emitter)
V_F	Continuous forward voltage of a diode
V_{FM}	Peak forward voltage of a diode

Letter symbol	Definition	
V_i, V_o	Input, respectively output voltage of a specified circuit	
$V_{(P)GS}$	Gate-source cut-off voltage	
V_R	Continuous reverse voltage of a diode	
V_{RM}	Peak reverse voltage of a diode	
V_{RSM}	Non-repetitive peak reverse voltage of a diode	
V_Z	Operating voltage (zener voltage) of a zener diode	
y_{ib}, y_{ie}, y_{is}	Input admittance	Output short circuited to a.c.
b_{ib}, b_{ie}, b_{is}	Input susceptance	
g_{ib}, g_{ie}, g_{is}	Input conductance	
C_{ib}, C_{ie}, C_{is}	Input capacitance	
φ_{ib}, φ_{ie}, φ_{is}	Phase angle of input admittance	
y_{fb}, y_{fe}, y_{fs}	Transfer admittance	Output short circuited to a.c.
b_{fb}, b_{fe}, b_{fs}	Transfer susceptance	
g_{fb}, g_{fe}, g_{fs}	Transfer conductance	
C_{fb}, C_{fe}, C_{fs}	Transfer capacitance	
φ_{fb}, φ_{fe}, φ_{fs}	Phase angle of transfer admittance	
y_{ob}, y_{oe}, y_{os}	Output admittance	Input short circuited to a.c.
b_{ob}, b_{oe}, b_{os}	Output susceptance	
g_{ob}, g_{oe}, g_{os}	Output conductance	
C_{ob}, C_{oe}, C_{os}	Output capacitance	
φ_{ob}, φ_{oe}, φ_{os}	Phase angle of output admittance	
y_{rb}, y_{re}, y_{rs}	Feedback admittance	Input short circuited to a.c.
b_{rb}, b_{re}, b_{rs}	Feedback susceptance	
g_{rb}, g_{re}, g_{rs}	Feedback conductance	
C_{rb}, C_{re}, C_{rs}	Feedback capacitance	
φ_{rb}, φ_{re}, φ_{rs}	Phase angle of feedback admittance	
Z_{th}	Transient thermal impedance	

DEFINITIONS APPLYING TO PHOTOSENSITIVE DEVICES to IEC 306

DEFINITIONS AND UNITS OF RADIATION AND LIGHT QUANTITIES

Radiant flux; radiant power

Power emitted, transferred or received in the form of radiation.

Symbols: ϕ_e, ϕ, P $\qquad \phi_e = \frac{dQ_e}{dt}$; unit: watt, W.

Radant intensity

The radiant intensity of a source in a given direction is the quotient of (1) the radiant flux leaving the source propagated in an element of solid angle containing the given direction, by (2) the element of solid angle.

Symbols: I_e, I $\qquad I_e = \frac{d\phi_e}{d\Omega}$; unit: watt per steradian, W/sr.

Irradiance

The irradiance at a point of a surface is the quotient of (1) the radiant flux incident on an element of the surface containing the point, by (2) the area of that element.

Symbols: E_e, E $\qquad E_e = \frac{d\phi_e}{dA}$; unit: watt per square metre, W/m^2.

Light

Radiation capable of stimulating the organ of vision.

Luminous flux

Quantity derived from radiant flux by evaluating the radiation according to its action upon a selective receptor, the spectral sensitivity of which is defined by the standard spectral luminous efficiency.

Symbols: ϕ_v, ϕ; unit: lumen, lm.

Lumen

SI unit of luminous flux: luminous flux emitted within unit solid angle (one steradian) by a point source having a uniform intensity of 1 candela.

Symbol: lm.

Note: – SI stands for "Systême International".

Luminous intensity

The luminous intensity of a source in a given direction is the quotient of (1) the luminous flux leaving the source propagated in an element of solid angle containing the given direction, by (2) the element of solid angle.

Symbols: I_V, I $\qquad I_V = \frac{d\phi_V}{d\Omega}$; unit: candela, cd.

Candela

SI unit of luminous intensity: Luminous intensity, in the perpendicular direction, of a surface of 1/600 000 square metre of a black body at the temperature of freezing platinum under a pressure of 101 235 newtons per square metre.

Symbols: cd; 1 cd = 1 lm/sr.

Illuminance

At a point of a surface, the quotient of (1) the luminous flux incident on an element of the surface containing the point, by (2) the area of that element.

Symbols: E_V, E $\qquad E_V = \frac{d\phi_V}{dA}$; unit: lux, lx.

Lux; lumen per square metre

SI unit of illuminance: illuminance produced by a luminous flux of 1 lumen uniformly distributed over a surface of area 1 square metre.

Symbol: lx ; 1 lx = 1 lm/m^2.

Distribution temperature

Temperature of the full radiator for which the ordinates of the spectral distribution curve of its radiance are proportional, in the visible region, to those of the distribution curve of the radiation cosidered.

The unit of measurement is degree Kelvin (K).

Colour temperature

For the purpose of this Recommendation, colour temperature is the distribution temperature of the radiation source.

The unit of measurement is degree Kelvin.

DEFINITIONS OF ELECTRICAL QUANTITIES

Photocurrent

The change in output current from the photocathode caused by incident radiation.

Frequency response characteristic

Relation, usually shown by a graph, between the radiant (or luminous) dynamic sensitivity and the modulation frequency of the incident radiation.

Dark current

The current flowing in a photoelectric device in the absence of irradiation.

Equivalent dark-current irradiation

The incident radiation required to give a d.c. signal output current equal to the dark current.

Equivalent noise irradiation

The value of incident radiation which, when modulated in a stated manner, produces a signal output power equal to the noise power, both in a stated bandwidth.

Quantum efficiency

The ratio of (1) the number of emitted photoelectrons to (2) the number of incident photons.

Quantum efficiency (Q.E.) at a given wavelength of incident radiation may be computed from:

$$Q.E. = \frac{\text{const. x } s_k}{\lambda}$$

where:

s_k	= spectral sensitivity (amperes per watt) at wavelength λ
λ	= wavelength of incident radiation (nanometres)
const. = hc_0/e	= 1.24×10^3 W.nm/A
h	= Planck constant
c_0	= speed of propagation of electromagnetic waves in vacuo
e	= elementary charge

Saturation voltage

The lowest operating voltage which causes no change, or only a slight change, of the photocurrent when this voltage is increased under conditions of given constant radiation.

Saturation current

The output current of a photosensitive device which is not changed, or only insignificantly changed, by an increase of either:
a) the irradiance under constant operating conditions; or
b) the operating voltage under constant irradiance.

Note. – The context should make clear which definition is applicable.

DEFINITIONS OF SENSITIVITY

These definitions apply more directly to photocathode sensitivity. For devices in which it is necessary to define the anode (over-all) sensitivity, signal output current should be considered instead of photocurrent.

Radiant sensitivity

a) The quotient of (1) the photocurrent of the device by (2) the incident radiant power, expressed in amperes per watt.

b) The quotient of (1) the photocurrent of the device by (2) the incident irradiance, expressed in amperes per watt/m^2.

Absolute spectral sensitivity

The radiant sensitivity for monochromatic radiation of a stated wavelength.

Relative spectral sensitivity

The ratio of (1) the radiant sensitivity at any considered wavelength to (2) the radiant sensitivity at a certain wavelength taken as reference, usually the wavelength of maximum response.

Note. — For non-linear detectors, it is neccessary to refer to constant photocurrent at all wavelengths.

Luminous sensitivity

a) The quotient of (1) the photocurrent of the device by (2) the incident luminous flux, expressed in amperes per lumen.

b) The quotient of (1) the photocurrent of the device by (2) the incident illuminance, expressed in amperes per lux.

Dynamic sensitivity

Under stated conditions of operation, the quotient of (1) the variation of the photocurrent of the device by (2) the initiating small variation of the incident radiant power (or luminous)

Note. — Distinction is made between "luminous dynamic sensitivity" and "radiant sensitivity."

Spectral sensitivity characteristic

The relation, usually shown by a graph, between wavelength and absolute or relative spectral sensitivity.

Absolute spectral sensitivity characteristic

The relation, usually shown by a graph, between wavelength and absolute spectral sensitivity.

Relative spectral sensitivity characteristic

The relation between wavelength and relative spectral sensitivity.

Quantum efficiency characteristic

The relation, usually shown by a graph, between wavelength and quantum efficiency.

DEFINITIONS OF TIME QUANTITIES

Rise time

The time required for the photocurrent to rise from a stated low percentage to a stated higher percentage of the maximum value when a steady state of radiation is instantaneously applied.

It is usual to consider the 10 % and 90 % levels.

Fall time

The time required for the photocurrent to fall from a stated high percentage to a stated lower percentage of the maximum value when the steady state of radiation is instantaneously removed.

It is usual to consider the 90 % and 10 % levels.

Photosensitive diodes and transistors

SILICON PLANAR EPITAXIAL PHOTO-TRANSISTORS

General purpose n-p-n silicon photo-transistors in TO-18.
The window of the BPX25 is a lens, that of the BPX29 is plane.

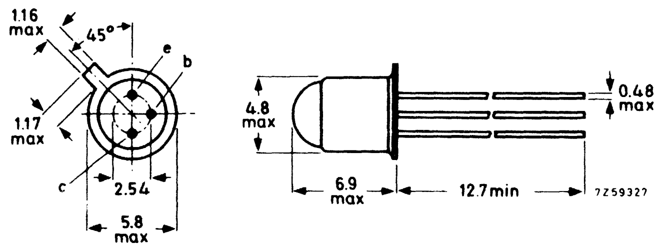
QUICK REFERENCE DATA				
Collector-emitter voltage (open base)	V_{CEO}	max.	32	V
Collector current (peak value)	I_{CM}	max.	200	mA
Junction temperature	T_j	max.	150	^oC
Collector-emitter dark cut-off current $I_B = 0$; $V_{CE} = 24$ V	$I_{CEO(D)}$	<	1.0	μA
Collector-emitter light cut-off current $I_B = 0$; $V_{CE} = 24$ V; at 1000 lx	$I_{CEO(L)}$	typ.	BPX25: 8.0 / BPX29: 0.8	mA
Peak spectral response	λ_m	typ.	800	nm

MECHANICAL DATA

Dimensions in mm

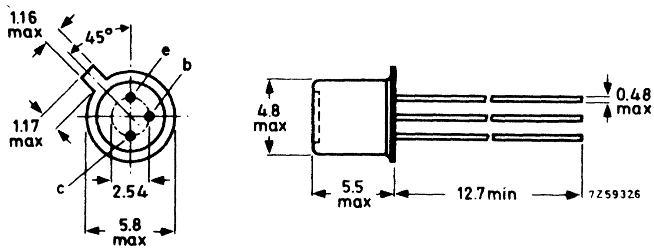
BPX25

TO-18, except for lens
Collector connected to case



BPX29

TO-18, except for window
Collector connected to case



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	32	V
Collector-emitter voltage (open base)	V_{CEO}	max.	32	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Current

Collector current (d.c.)	I_C	max.	100	mA
Collector current (peak value)	I_{CM}	max.	200	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25^oC$	P_{tot}	max.	300	mW

Temperatures

Storage temperature	T_{stg}		−65 to +150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	0.4	^oC/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.15	^oC/mW

CHARACTERISTICS $T_{amb} = 25\,^oC$ unless otherwise specified

Collector-emitter dark cut-off current

$I_B = 0$; $V_{CE} = 24$ V	$I_{CEO(D)}$	typ.	0.2	μA
		<	1.0	μA
$I_B = 0$; $V_{CE} = 24$ V; $T_{amb} = 100\,^oC$	$I_{CEO(D)}$	typ.	30	μA
		<	200	μA

Collector-emitter light cut-off current

			BPX25	BPX29	
$I_B = 0$; $V_{CE} = 24$ V; illumination: 1000 lx tungsten filament lamp source with colour temperature 2700 K (7.7 mW/cm^2)	$I_{CEO(L)}$	>	2.5	0.25	mA
		typ.	8.0	0.8	mA
GaAs source; 15 mW/cm^2	$I_{CEO(L)}$	typ.	13	1.3	mA

D.C. current gain

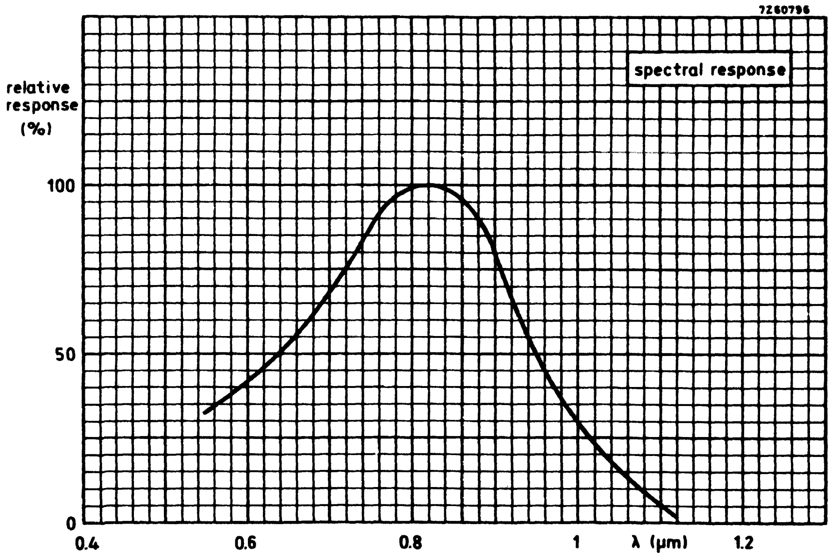
			BPX25	BPX29	
$I_C = 2$ mA; $V_{CE} = 5$ V	h_{FE}	typ.	250	250	

Cut-off frequency

			BPX25	BPX29	
Source: modulated GaAs; 0.4 mW/cm^2 Load : optimum (50 Ω); $V_{CE} = 24$ V	f_{co}	typ.	200	150	kHz

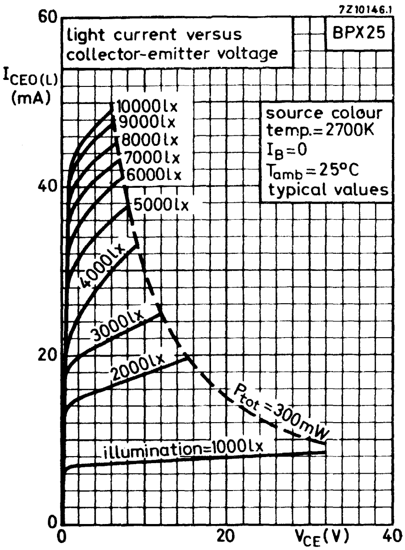
CHARACTERISTICS (continued)

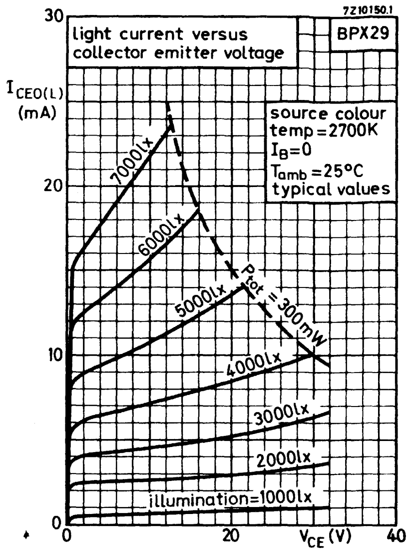
			BPX25	BPX29	
Switching times [1]					
Delay time	t_d	typ.	1.0	2.5	μs
		<	3.0	5.0	μs
Rise time	t_r	typ.	1.5	2.5	μs
		<	3.0	5.0	μs
Storage time	t_s	typ.	0.2	0.2	μs
		<	0.4	0.4	μs
Fall time	t_f	typ.	1.5	3.5	μs
		<	4.0	8.0	μs
Peak spectral response	λ_m	typ.	800	800	nm
Equivalent noise illumination at f = 800 Hz [2]					
V_{CE} = 5 V; illumination: 1000 lx		typ.	0.5	1.5	$\frac{mlx}{\sqrt{Hz}}$

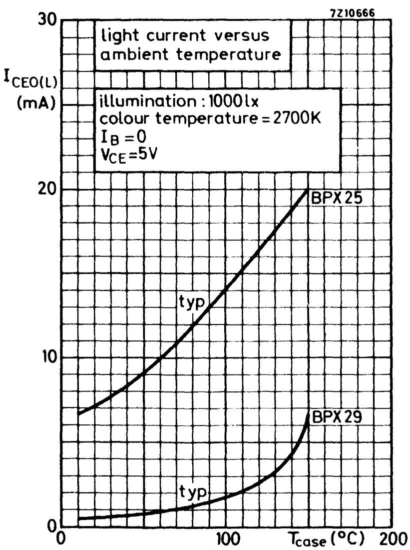


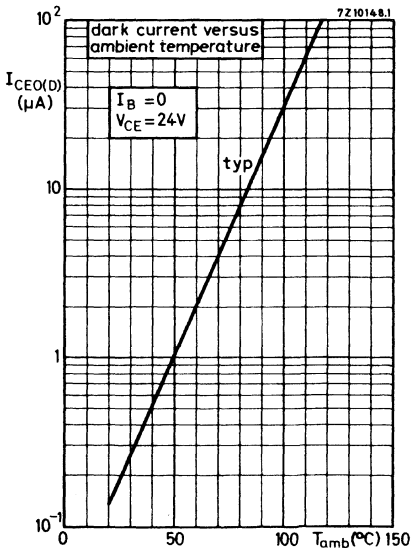
[1]) Source: modulated GaAs: 0.4 mW/cm^2
Load: optimum (50 Ω)
V_{CE} = 24 V
Improved switching times can be obtained by a quiescent bias current.
I.e. I_B = 2 μA: t_d < 0.2 μs.

[2]) At this and lower frequencies, $\frac{1}{f}$ noise predominates.

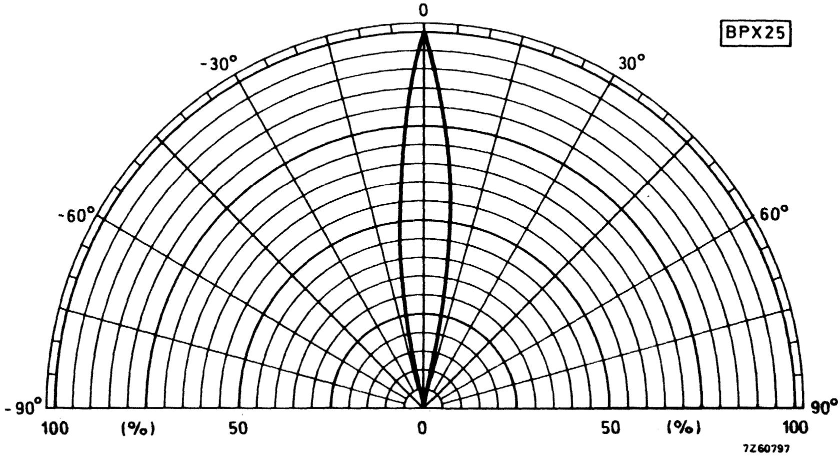

7Z10146.1
light current versus collector-emitter voltage
BPX25
$I_{CEO(L)}$ (mA)
source colour temp.=2700K
I_B=0
T_{amb}=25°C
typical values
10000 lx
9000 lx
8000 lx
7000 lx
6000 lx
5000 lx
4000 lx
3000 lx
2000 lx
illumination=1000 lx
P_{tot}=300mW
V_{CE} (V)
0
20
40
60


7Z10150.1
light current versus collector emitter voltage
BPX29
$I_{CEO(L)}$ (mA)
source colour temp=2700K
I_B=0
T_{amb}=25°C
typical values
7000 lx
6000 lx
5000 lx
4000 lx
3000 lx
2000 lx
illumination=1000 lx
P_{tot}=300mW
V_{CE} (V)
0
10
20
30
40

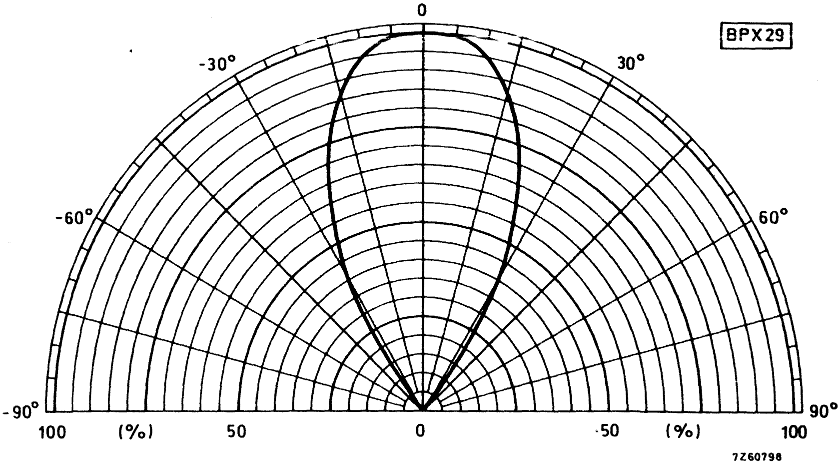

7Z10666
light current versus ambient temperature
$I_{CEO(L)}$ (mA)
illumination: 1000 lx
colour temperature=2700K
I_B=0
V_{CE}=5V
BPX25
typ
BPX29
typ
T_{case} (°C)
0
10
20
30
100
200


7Z10148.1
dark current versus ambient temperature
$I_{CEO(D)}$ (μA)
I_B=0
V_{CE}=24V
typ
10^2
10
1
10^{-1}
0
50
100
T_{amb} (°C)
150

polar response of relative sensitivity



polar response of relative sensitivity

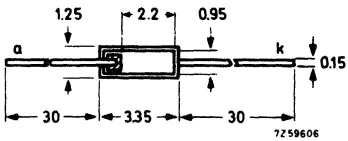


SILICON PLANAR PHOTO-DIODE

Unencapsulated photo-diode for general purpose applications.

QUICK REFERENCE DATA				
Reverse voltage	V_R	max.	18	V
Light sensitivity V_R = 15 V; E = 1000 lx	N	typ.	14	nA/lx
Dark reverse current at V_R = 15 V	I_d	<	0.5	μA
Peak spectral response	λ_m	typ.	800	nm

MECHANICAL DATA Dimensions in mm



Slice thickness 0.27 mm

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage

Reverse voltage	V_R	max.	18 V

Currents

Forward current	I_F	max.	5 mA
Dark reverse current	I_R	max.	2 mA

Temperatures

Storage temperature	T_{stg}	−65 to +125	°C
Junction temperature	T_j	max.	125 °C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.5 °C/mW

CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

Dark reverse current

V_R = 15 V	I_d	typ. <	0.01 μA 0.5 μA
V_R = 15 V; T_{amb} = 100 °C	I_d	typ. <	0.6 μA 4.0 μA

→ Photovoltaic mode

E = 1000 lx; colour temperature = 2700 K [2])

Light reverse current; V = 0	I_l	> typ.	10 μA 13 μA
Forward voltage; I = 0	V_F	> typ.	330 mV 350 mV

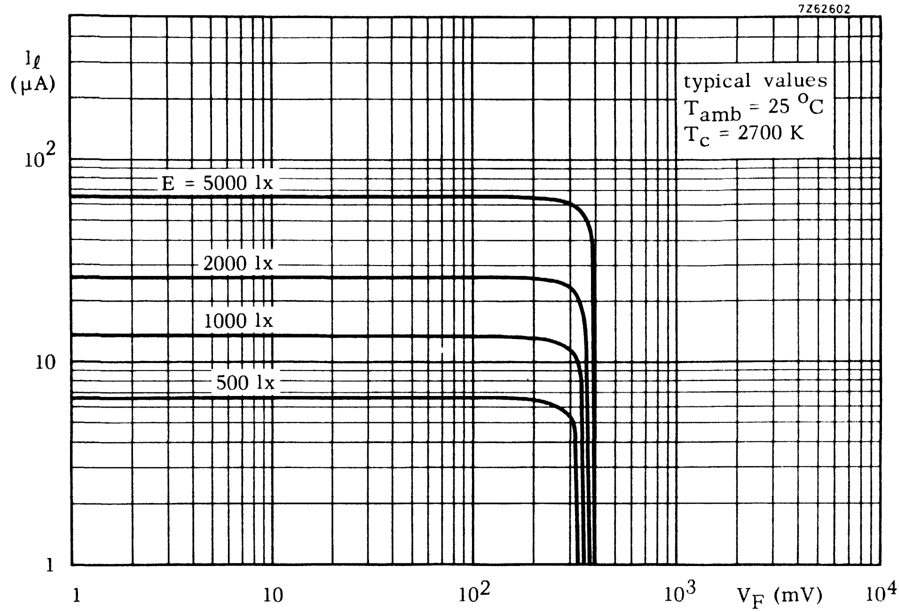
→ Light sensitivity with external voltage [1])

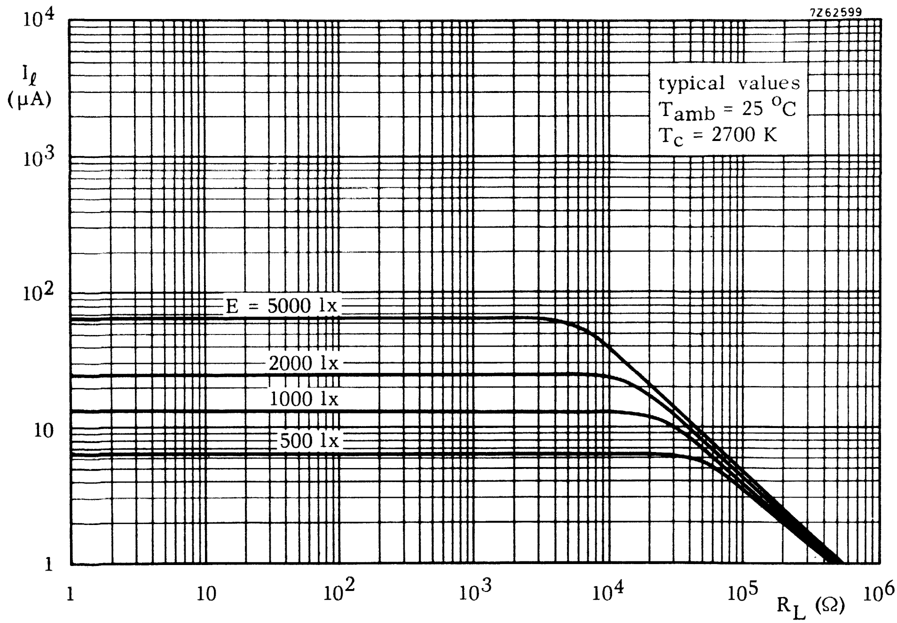
V_R = 15 V; E = 1000 lx colour temperature = 2700 K [2])	N	> typ.	10.5 nA/lx 14 nA/lx
Peak spectral response	λ_m	typ.	800 nm

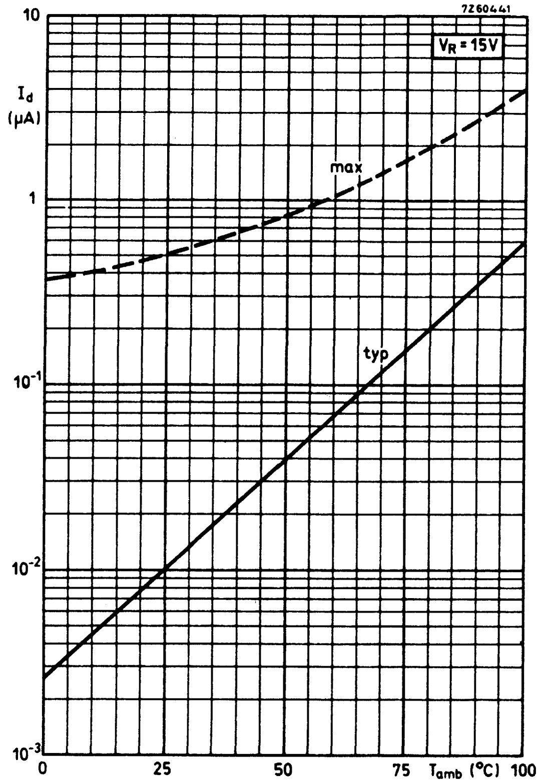
Diode capacitance; f = 500 kHz

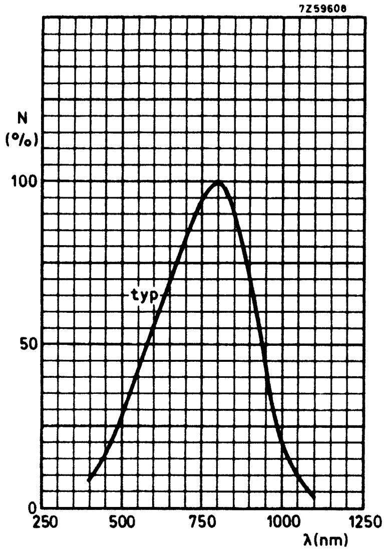
V_R = 15 V	C_d	typ.	90 pF
V_R = 0	C_d	typ.	300 pF

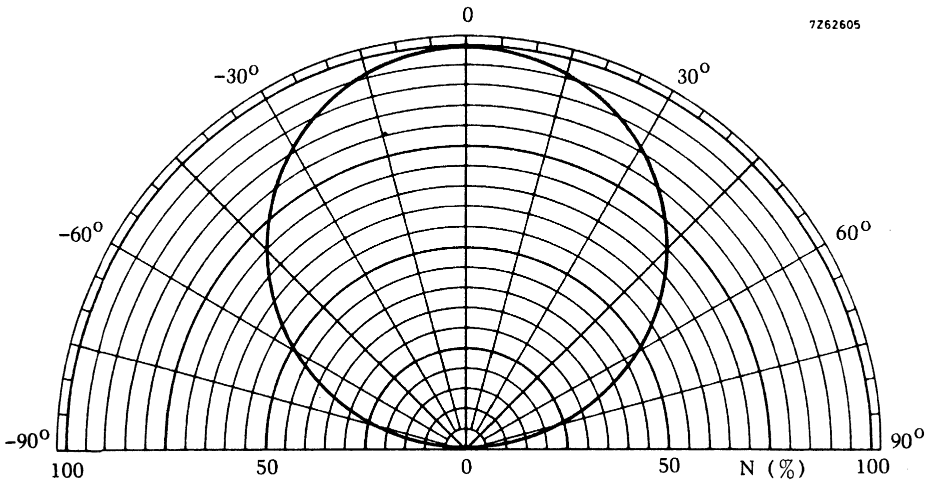
1) The value of light current increases with temperature by an amount approximately equal to the increase in dark current.
2) Equivalent to 7.7 mW/cm^2


7Z62602
I_ℓ (µA)
typical values
T_{amb} = 25 °C
T_c = 2700 K
E = 5000 lx
2000 lx
1000 lx
500 lx
10^2
10
1
1
10
10^2
10^3
V_F (mV)
10^4


7Z62599
I_ℓ (µA)
typical values
T_{amb} = 25 °C
T_c = 2700 K
E = 5000 lx
2000 lx
1000 lx
500 lx
10^4
10^3
10^2
10
1
1
10
10^2
10^3
10^4
10^5
R_L (Ω)
10^6


7Z60441
$V_R = 15V$
I_d (μA)
10
1
10^{-1}
10^{-2}
10^{-3}
max
typ
0
25
50
75
T_{amb} (°C)
100


7Z59608
N
(%)
100
50
0
250
500
750
1000
1250
λ(nm)
typ


7Z62605
0
-30°
30°
-60°
60°
-90°
90°
100
50
0
50
N (%)
100

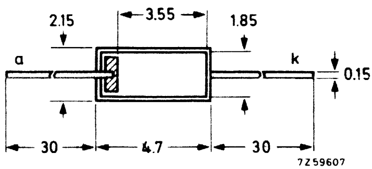
SILICON PLANAR PHOTO-DIODE

Unencapsulated photo-diode for general purpose applications.

QUICK REFERENCE DATA				
Reverse voltage	V_R	max.	18	V
Light sensitivity V_R = 15 V; E = 1000 lx	N	typ.	40	nA/lx
Dark reverse current at V_R = 15 V	I_d	<	1.0	µA
Peak spectral response	λ_m	typ.	800	nm

MECHANICAL DATA

Dimensions in mm



Slice thickness 0.27 mm

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage			
Reverse voltage	V_R	max.	18 V
Currents			
Forward current	I_F	max.	10 mA
Dark reverse current	I_R	max.	5 mA
Temperatures			
Storage temperature	T_{stg}	-65 to +125	°C
Junction temperature	T_j	max.	125 °C

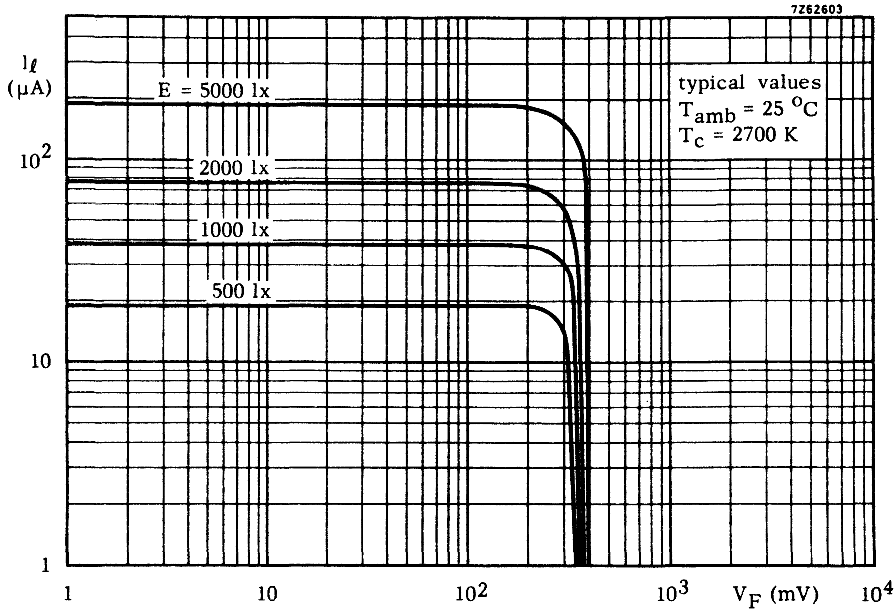
THERMAL RESISTANCE

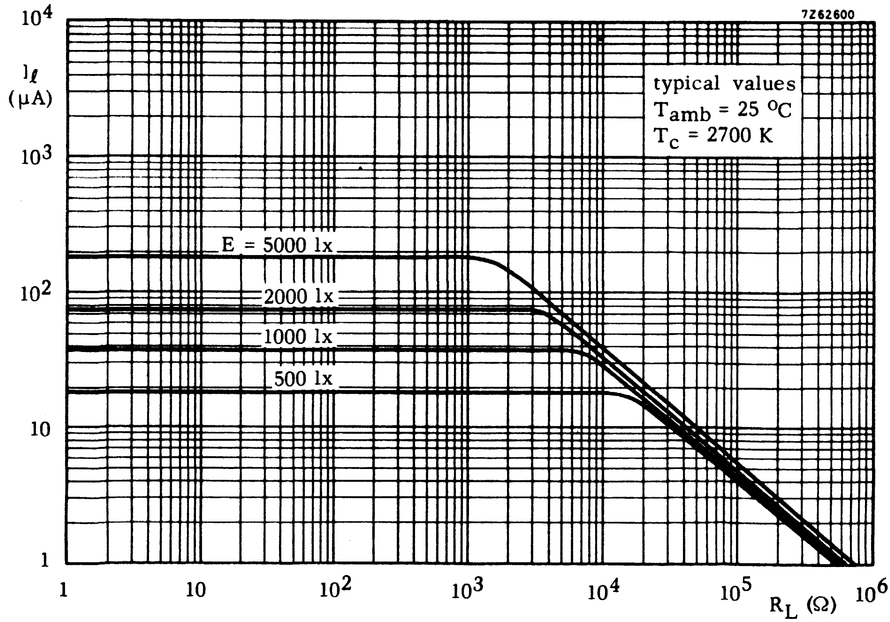
From junction to ambient in free air	$R_{th\ j-a}$	=	0.5 °C/mW

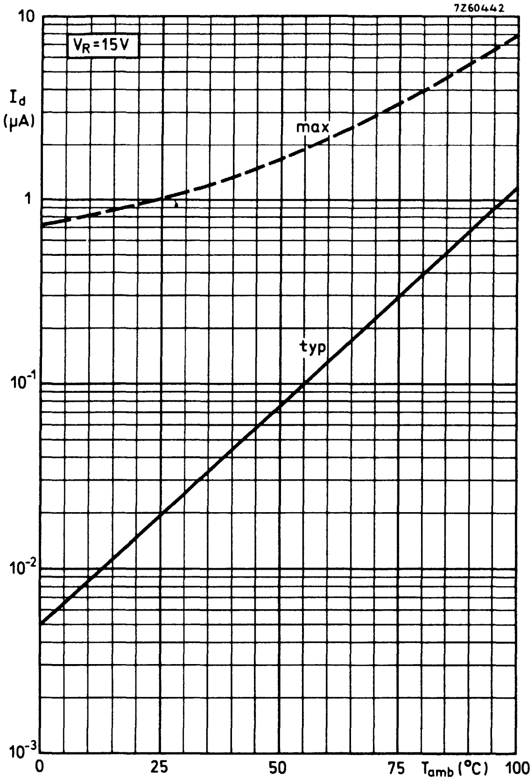
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

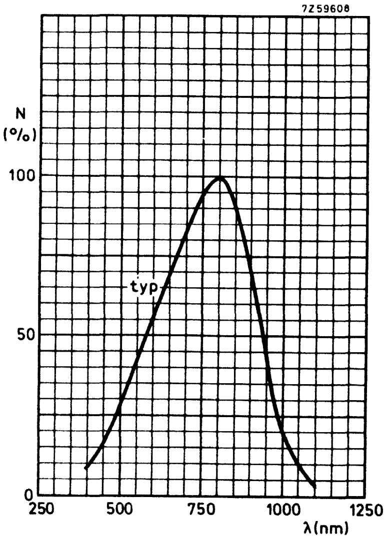
Dark reverse current			
V_R = 15 V	I_d	typ. <	0.02 µA 1.0 µA
V_R = 15 V; T_{amb} = 100 °C	I_d	typ. <	1.2 µA 8.0 µA
→ Photovoltaic mode			
E = 1000 lx; colour temperature = 2700 K [2]			
Light reverse current; V = 0	I_l	> typ.	30 µA 38 µA
Forward voltage; I = 0	V_F	> typ.	330 mV 350 mV
→ Light sensitivity with external voltage [1]			
V_R = 15 V; E = 1000 lx colour temperature = 2700 K [2]	N	> typ.	31 nA/lx 40 nA/lx
Peak spectral response	λ_m	typ.	800 nm
Diode capacitance; f = 500 kHz			
V_R = 15 V	C_d	typ.	250 pF
V_R = 0	C_d	typ.	800 pF

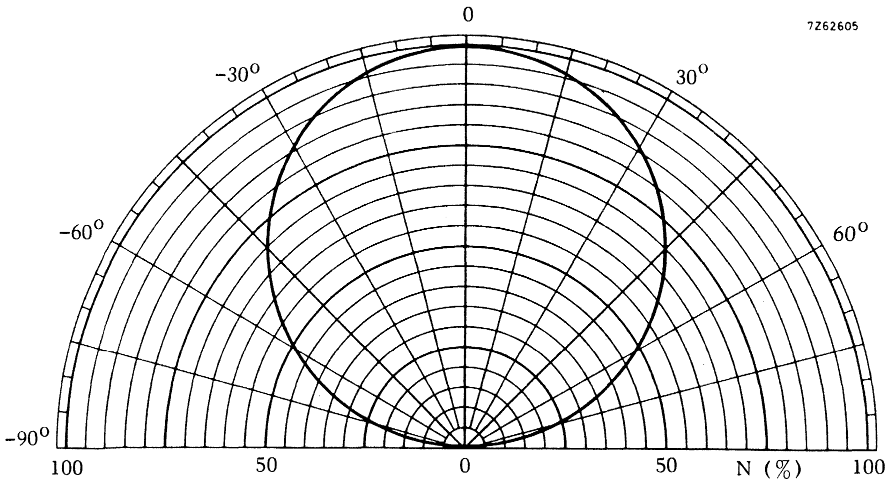
1) The value of light current increases with temperature by an amount approximately equal to the increase in dark current.
2) Equivalent to 7.7 mW/cm^2


7Z62603
I_ℓ (μA)
E = 5000 lx
2000 lx
1000 lx
500 lx
typical values
T_{amb} = 25 °C
T_c = 2700 K
1
10
10^2
1
10
10^2
10^3
V_F (mV)
10^4


7Z62600
I_ℓ (μA)
E = 5000 lx
2000 lx
1000 lx
500 lx
typical values
T_{amb} = 25 °C
T_c = 2700 K
1
10
10^2
10^3
10^4
1
10
10^2
10^3
10^4
10^5
R_L (Ω)
10^6


7Z60442
$V_R = 15 V$
I_d (μA)
10
1
10^{-1}
10^{-2}
10^{-3}
max
typ
0
25
50
75
T_{amb} (°C)
100


7Z59608
N
(%)
100
50
0
typ
250
500
750
1000
1250
λ(nm)


0
7Z62605
-30°
30°
-60°
60°
-90°
90°
100
50
0
50
N (%)
100

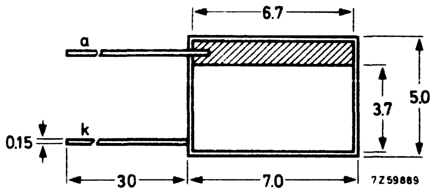
SILICON PLANAR PHOTO-DIODE

Unencapsulated photo-diode for general purpose applications.

QUICK REFERENCE DATA				
Reverse voltage	V_R	max.	12	V
Light sensitivity V_R = 10 V; E = 1000 lx	N	typ.	150	nA/lx
Dark reverse current at V_R = 10 V	I_d	<	5	μA
Peak spectral response	λ_m	typ.	800	nm

MECHANICAL DATA

Dimensions in mm



Slice thickness 0.27 mm

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage				
Reverse voltage	V_R	max.	12	V
Currents				
Forward current	I_F	max.	50	mA
Dark reverse current	I_R	max.	20	mA
Temperatures				
Storage temperature	T_{stg}	-65 to +125		^oC
Junction temperature	T_j	max.	125	^oC

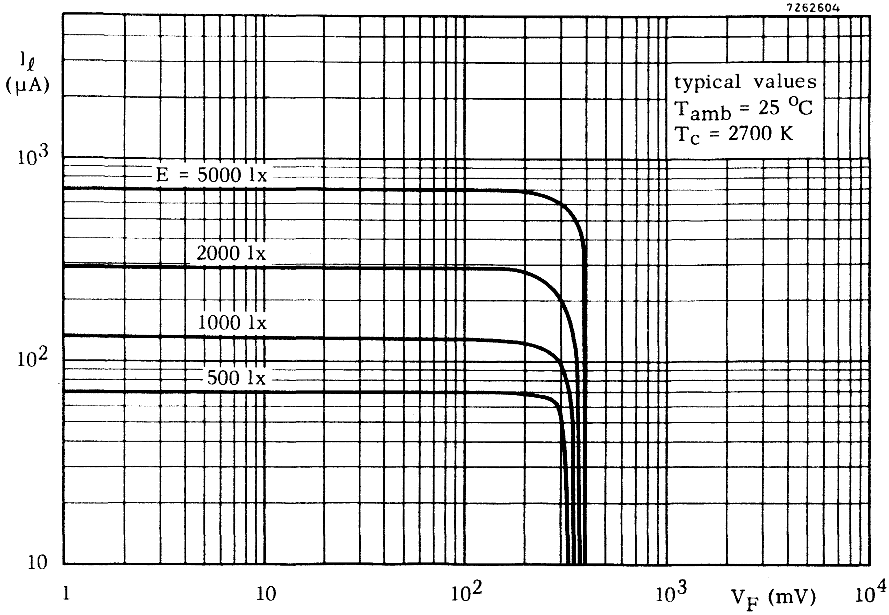
THERMAL RESISTANCE

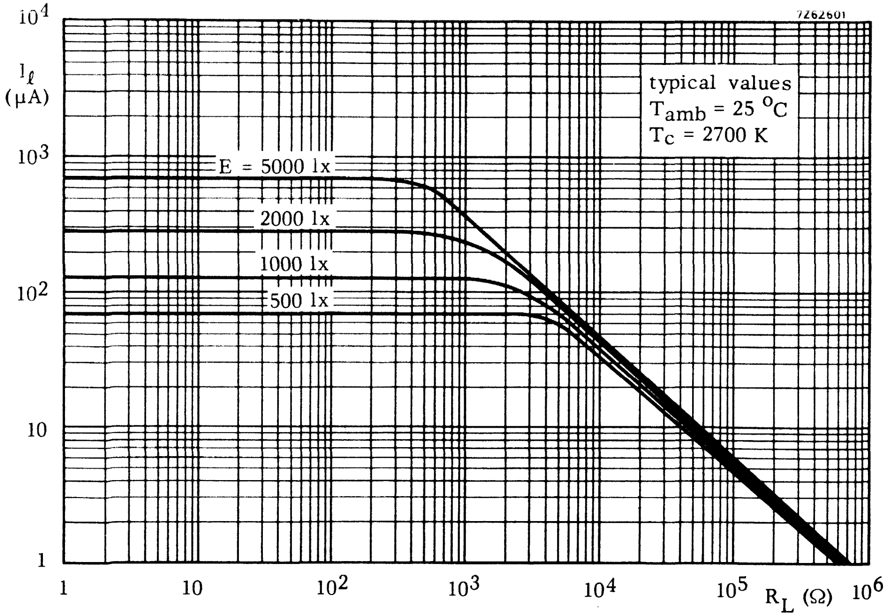
From junction to ambient in free air	$R_{th\ j-a}$	=	0.3	$^oC/mW$

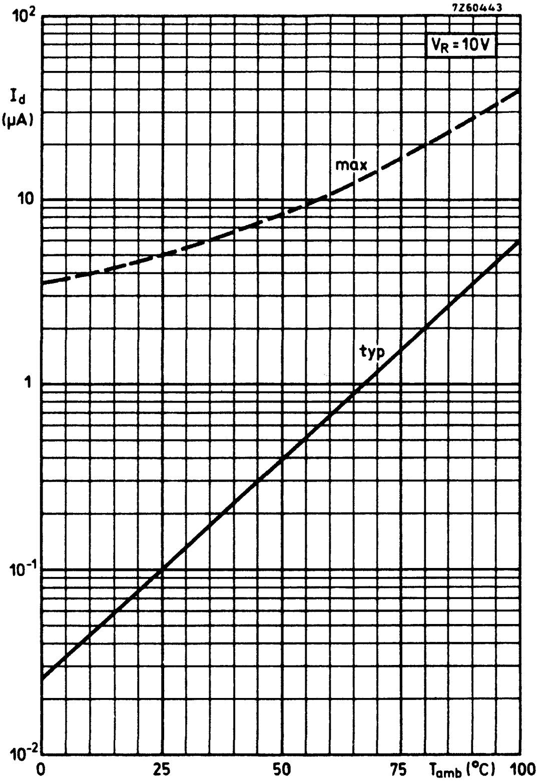
CHARACTERISTICS T_{amb} = 25 ^oC unless otherwise specified

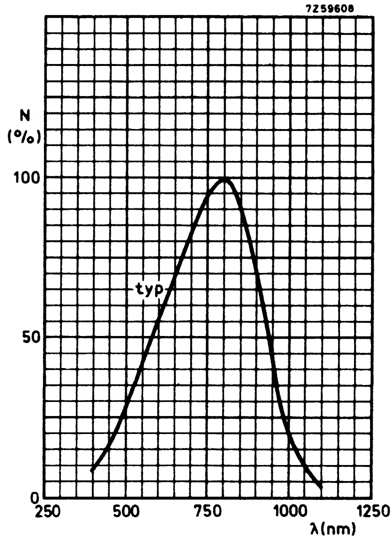
Dark reverse current				
V_R = 10 V	I_d	typ.	0.1	μA
		<	5.0	μA
V_R = 10 V; T_{amb} = 100 ^oC	I_d	typ.	6.0	μA
		<	40	μA
→ Photovoltaic mode				
E = 1000 lx; colour temperature = 2700 K 2)				
Light reverse current; V = 0	I_l	>	110	μA
		typ.	140	μA
Forward voltage; I = 0		>	330	mV
		typ.	350	mV
→ Light sensitivity with external voltage 1)				
V_R = 10 V; E = 1000 lx colour temperature = 2700 K 2)	N	>	120	nA/lx
		typ.	150	nA/lx
Peak spectral response	λ_m	typ.	800	nm
Diode capacitance; f = 500 kHz				
V_R = 10 V	C_d	typ.	1000	pF
V_R = 0	C_d	typ.	3000	pF

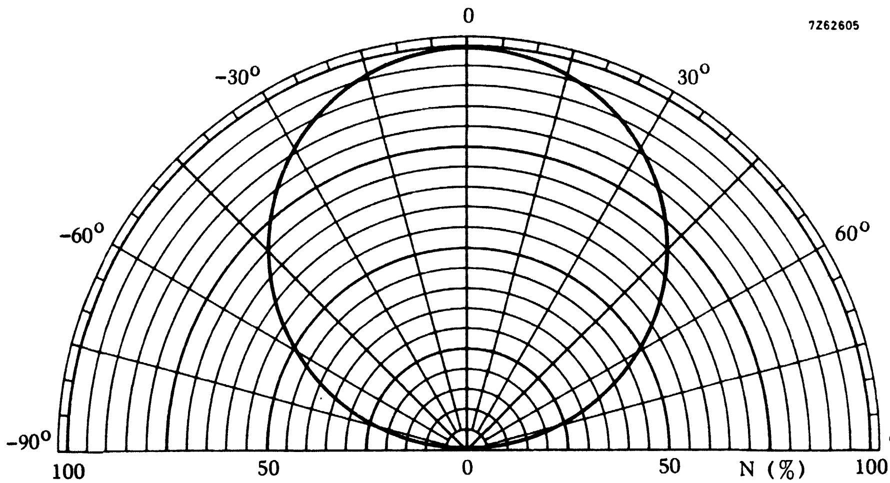
1) The value of light current increases with temperature by an amount approximately equal to the increase in dark current.
2) Equivalent to 7.7 mW/cm^2


7Z62604
I_ℓ (μA)
typical values
T_{amb} = 25 °C
T_c = 2700 K
E = 5000 lx
2000 lx
1000 lx
500 lx
10^3
10^2
10
1
10
10^2
10^3
V_F (mV)
10^4


7Z62601
I_ℓ (μA)
typical values
T_{amb} = 25 °C
T_c = 2700 K
E = 5000 lx
2000 lx
1000 lx
500 lx
10^4
10^3
10^2
10
1
1
10
10^2
10^3
10^4
10^5
R_L (Ω)
10^6


7Z60443
$V_R = 10V$
I_d (μA)
10^2
10
1
10^{-1}
10^{-2}
max
typ
0
25
50
75
T_{amb} (°C)
100


7Z59608
N
(%)
100
50
0
typ
250
500
750
1000
1250
λ(nm)


0
7Z62605
-30°
30°
-60°
60°
-90°
90°
100
50
0
50
N (%)
100

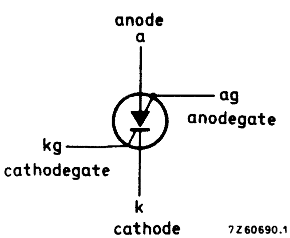
LIGHT ACTIVATED SCS

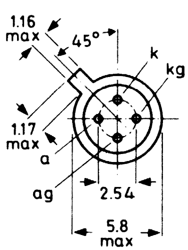
Planar p-n-p-n light activated SCS in a hermetically sealed metal envelope corresponding to TO-72 but with flat glass window. It is capable of switching currents up to 10 A.
With this component it is possible to build relatively simple circuits which will trigger at a light intensity of 100 lux.
The device is an integrated pnp-npn transistor of which all electrodes are accessible.

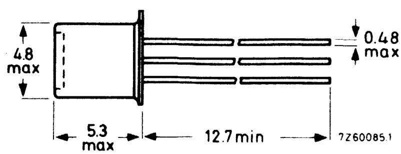
QUICK REFERENCE DATA				
Anode-cathode voltage (forward and reverse)	$V_D = V_R$	max.	70	V
D.C. on-state current	I_T	max.	150	mA
Repetitive peak on-state cathode current $t_p = 1\ \mu s$; $\delta = 10^{-6}$	I_{TRM}	max.	10	A
Spread: The ratio of minimum light level at which any specimen is ON to maximum light level at which any specimen is OFF			3	
Irradation level to trigger all devices $V_D = 70$ V; $I_{AG} = 0$; $T_j = 25\ ^oC$; $R_{KG\text{-}K} = 1\ M\Omega$; $\lambda = 800$ nm	E_e	>	1.5	mW/cm^2
Irradiation level not to trigger any device $V_D = 70$ V; $I_{AG} = 0$; $T_j = 25\ ^oC$; $R_{KG\text{-}K} = 1\ M\Omega$; $\lambda = 800$ nm	E_e	<	0.5	mW/cm^2
Peak spectral response	λ_m	typ.	800	nm

MECHANICAL DATA

Dimensions in mm







The anodegate is connected to the case.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage				
Anode-cathode voltage (forward and reverse)	$V_D = V_R$	max.	70	V
Reverse cathodegate-cathode voltage (peak value)	V_{RGKM}	max.	5	V
Reverse anode-anodegate voltage (peak value)	V_{RAGM}	max.	70	V
Currents				
D.C. on-state current	I_T	max.	150	mA
Repetitive peak on-state current				
$t \leq 10\ \mu s$, $\delta = 0.01$	I_{TRM}	max.	2.5	A
$t \leq 1\ \mu s$, $\delta = 10^{-6}$	I_{TRM}	max.	10	A [1]
Anodegate current (peak value)	I_{FGAM}	max.	100	mA
Power dissipation				
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	250	mW
Temperatures				
Storage temperature	T_{stg}		-65 to +100	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

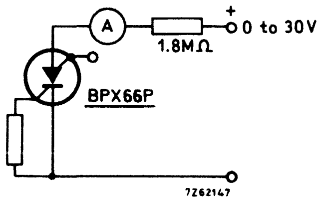
From junction to ambient	$R_{th\ j-a}$	=	0.5	$^oC/mW$

[1] This value holds for the use of the device in circuit 1b on page 9

CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

Forward on-state voltage				
I_T = 100 mA; R_{KG-K} = 1 MΩ; I_{AG} = 0	V_T	<	1.5	V
Dark current (cathodegate current)				
V_D = 70 V; I_{AG} = 0; $V_{KG-K} \leq$ 25 mV; T_j = 25 °C	$I_{KG(d)}$	<	1	nA
V_D = 15 V; I_{AG} = 0; $V_{KG-K} \leq$ 25 mV; T_j = 25 °C	$I_{KG(d)}$	<	0.3	nA
V_D = 70 V; I_{AG} = 0; $V_{KG-K} \leq$ 25 mV; T_j = 100 °C	$I_{KG(d)}$	<	100	nA
Cathodegate trigger voltage				
V_D = 70 V; I_{AG} = 0; R_{KG-K} = 1 MΩ; T_j = 25 °C	V_{GKT}		200 to 500	mV
Holding current (anode current)				
I_{AG} = 0; R_{KG-K} = 1 MΩ	I_H	<	10	μA

Test circuit:



Light current (cathodegate current)				
V_D = 70 V; I_{AG} = 0; T_j = 25 °C				
E_e = 1.5 mW/cm²; λ = 800 nm	$I_{KG(\ell)}$		400 to 1200	nA
Irradiation level to trigger all devices				
V_D = 70 V; I_{AG} = 0; T_j = 25 °C				
R_{KG-K} = 1 MΩ; λ = 800 nm	E_e	>	1.5	mW/cm²
Irradation level not to trigger any device				
V_D = 70 V; I_{AG} = 0; T_j = 25 °C				
R_{KG-K} = 1 MΩ; λ = 800 nm	E_e	<	0.5	mW/cm²

CHARACTERISTICS (continued)

Turn-on time

V_D = 70 V, I_{AG} = 0; R_{KG-K} = 1 MΩ

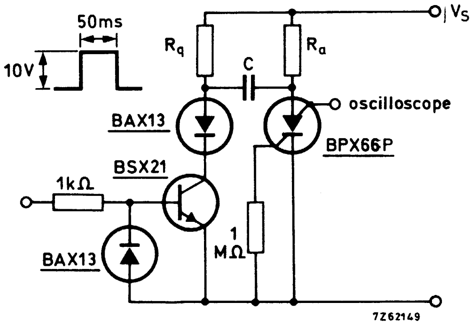
The irradiation level is switched from E_e = 0 to E_e = 1.5 mW/cm^2; λ = 800 nm	t_{on}	typ.	30	μs
E_e = 0 to E_e = 2.5 mW/cm^2; λ = 800 nm	t_{on}	typ.	20	μs
		<	50	μs

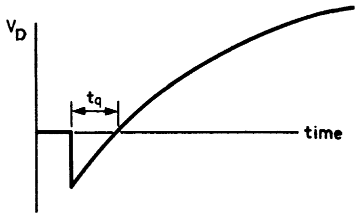
Turn-off time

I_{AG} = 0; R_{KG-K} = 1 MΩ; E_e = 0

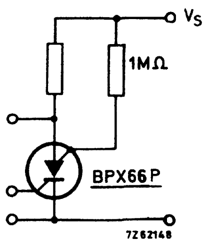
V_S = 70 V; R_a = 50 kΩ; R_q = 3.9 kΩ	t_q	typ.	450	μs
V_S = 12 V; R_a = 10 kΩ; R_q = 2.7 kΩ	t_q	typ.	100	μs

Test circuit:





The turn-off time decreases a factor 10 by connecting the anodegate to the supply voltage via 1 MΩ. See adjacent figure



Peak spectral response	λ_m	typ.	800	nm

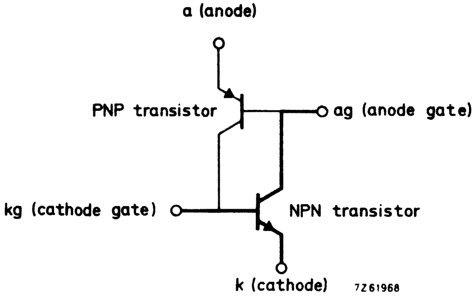
Conversion of lux into mW/cm^2

Each 1000 lux may be substituted by 1.2 mW/cm^2 with 800 nm

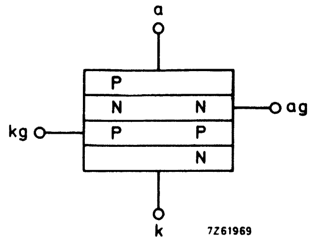
OPERATING PRINCIPLE

The BPX66P can be thought of as two transistors connected as shown below. It will trigger when the forward cathodegate-cathode voltage has a sufficient high value (approx. 0.3 V)

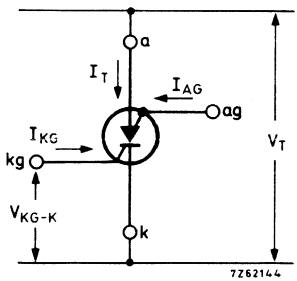
2 transistors equivalent circuit



p-n-p-n SCS equivalent circuit



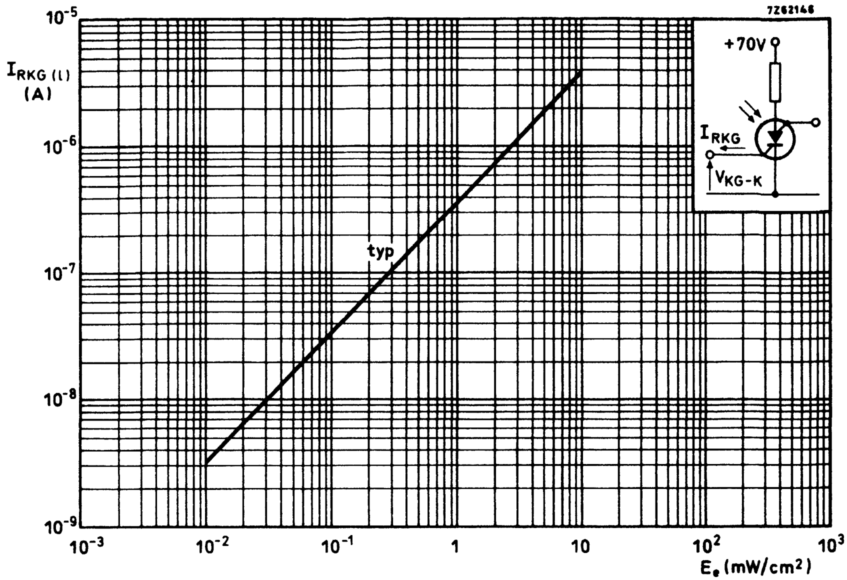
Symbol



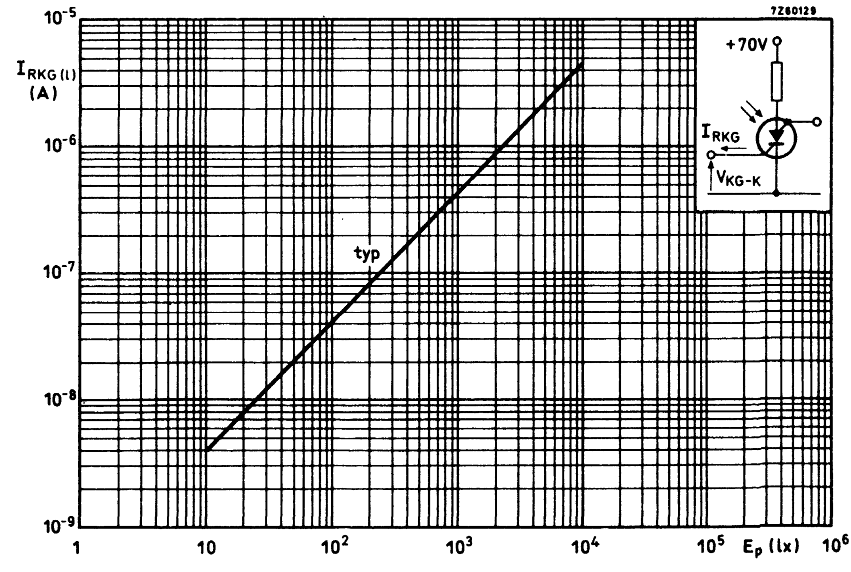
Consider the situation in which the anodegate is left floating. Illumination gives rise to a photocurrent in the p-n-p transistor which will trigger the device into conduction unless there is a bypass (e.g. a resistor) between cathodegate and cathode. If there is such a bypass, triggering will occur when the photocurrent is sufficient to cause a voltage drop across it corresponding to the triggering voltage of 0.3 to 0.4 V. The irradiation value at which the device will trigger varies inversely as the impedance of the bypass.

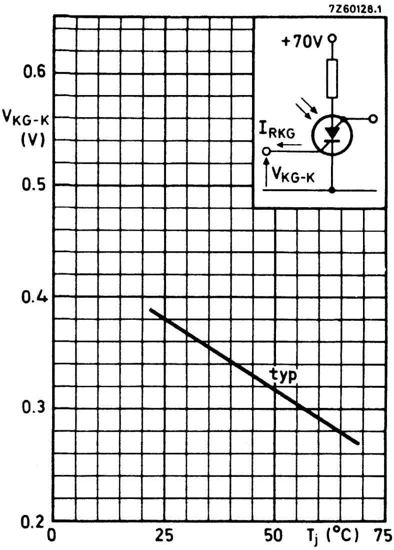
Two factors set a practical limit to the minimum triggering irradiation threshold:
- the leakage current across the base-collector junction of the p-n-p transistor;
- the maximum practical bypass impedance (the higher the impedance, the more vulnerable it is to moisture contamination, and the more sensitive the circuit is to switching transients).

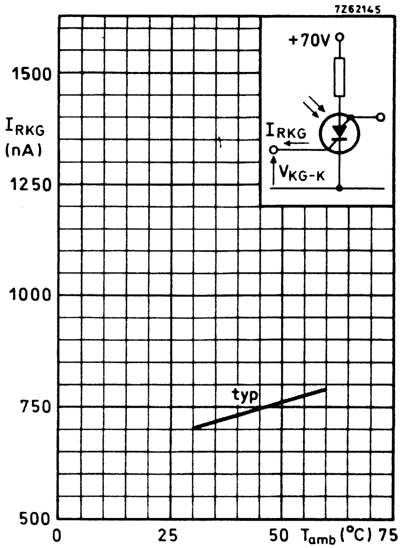
Once triggered into conduction, the device can be returned to the non-conducting state by switching-off the supply voltage, an a.c. voltage reversal, or a negative voltage pulse on the anode.



Light current as a function of illumination level measured with an incandescent lamp at a colour temperature of 2854 K.

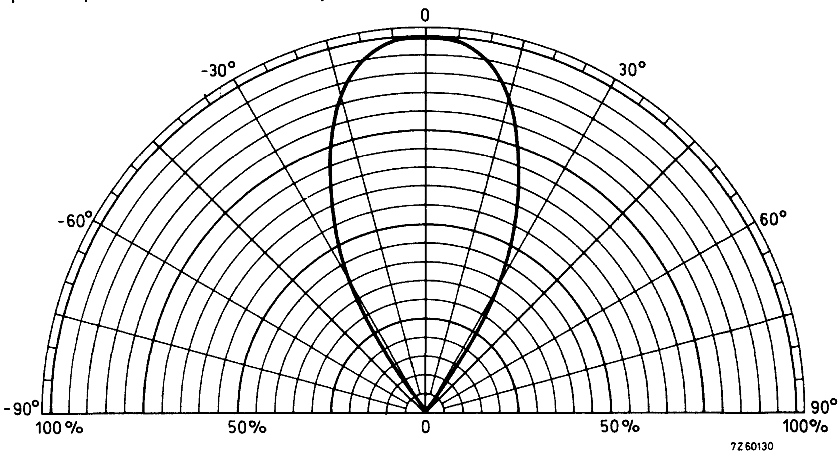


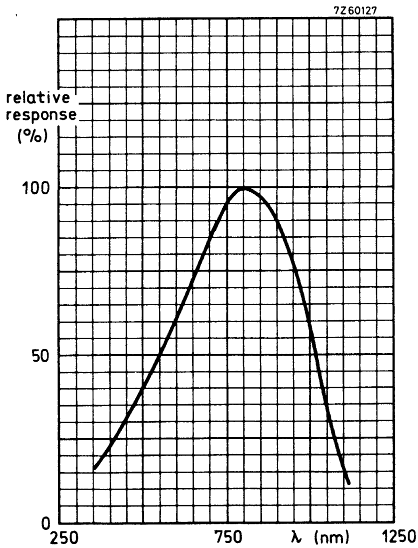




Trigger voltage as a function
of junction temperature

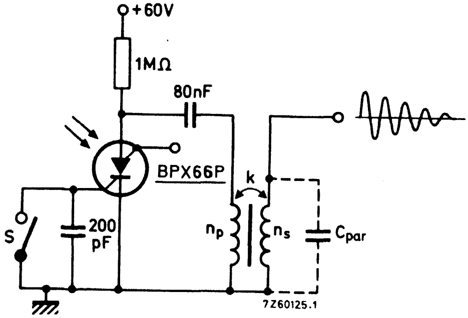
polar response of relative sensitivity





APPLICATION INFORMATION

1. D.C. supply-Circuit for igniting a quench tube in photoflash equipment

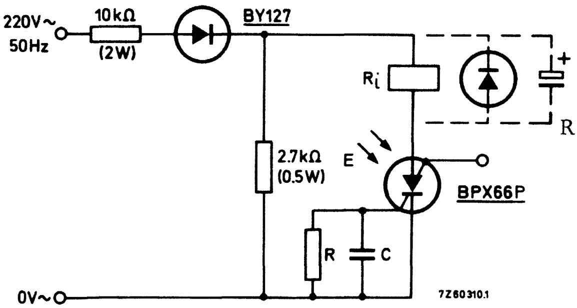


Transformer data:
n_p = 15 turns (2 μH)
n_s = 1215 turns (13.1 mH)
k = 0.68
C_{par} = 10.6 pF
Performance:
repetition frequency 1 Hz
number of discharges > 10^4

Switch S should open when the photoflash is fired. As soon as it opens, the BPX66P starts to register the incident illumination E. When $\int E\,dt$ reaches a predetermined value, the BPX66P is triggered and feeds a 1 μs pulse of 10 A through the primary of the transformer; the resulting high voltage across the secondary triggers the quench tube, extinguishing the photoflash tube.

2. A.C. supply - light activated relay circuits

a. 220 V



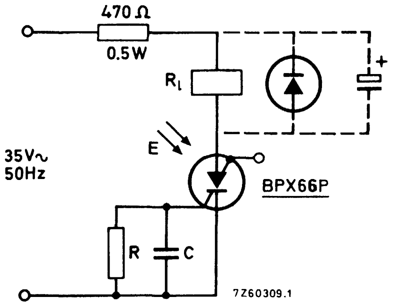
R_ℓ = d.c. relay

Coil resistance		12 kΩ
I_{on}	<	3 mA
I_{off}		1 mA

R and C must be chosen to meet requirements as to illumination levels E_{in} and E_{out}. The values are practically the same as in the table below.
For gradually changing light levels the relay should be shunted by a capacitor (e.g. 10 μF, 64 V) to prevent chatter; for suddenly changing light levels (on-off) it may be shunted by a diode.

APPLICATION INFORMATION (continued)

b. 35 V



R_ℓ = d.c. relay

Coil resistance	2 kΩ
I_{on}	8.5 mA
I_{off}	2.2 mA

R and C must be choosen to meet requirements as to illumination levels E_{in} and E_{out}; see table below.
For gradually changing light levels the relay should be shunted by a capacitor (e.g. 100 μF, 40 V); for suddenly changing light levels (on-off) it may be shunted by a diode.

R (MΩ)	C(nF)	E_{in}(lx)	E_{out}(lx)
3.3	10	1150	750
3.3	1	450	400
1	0.5	820	800

The values are average values that can be expected at a colour temperature of 2854 K; at other colour temperatures large deviations from these values may be observed.

Caution:

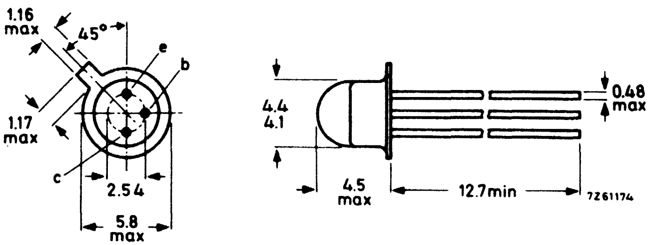
To avoid difficulties with temperature dependence it is generally advantageous to design a circuit for higher values of E_{in} and E_{out}, for then R can be given a lower value.

PHOTO-TRANSISTOR

General purpose n-p-n silicon photo-transistor with a plastic lens

QUICK REFERENCE DATA				
Collector-emitter voltage (open base)	V_{CEO}	max.	30	V
Collector current (peak value) $t_p \leq 50\ \mu s$; $\delta \leq 0.1$	I_{CM}	max.	50	mA
Junction temperature	T_j	max.	125	^oC
Collector-emitter dark current $V_{CE} = 20$ V	I_d	<	100	nA
Collector-emitter light current $V_{CE} = 5$ V; $E = 1000$ lx	I_l		100 to 700	μA
Peak spectral response	λ_m	typ.	800	nm

MECHANICAL DATA Dimensions in mm



Max. lead diameter is guaranteed only for 12.7 mm

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages				
Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	V
Emitter-collector voltage (open base)	V_{ECO}	max.	6	V
Current				
Collector current (d.c.)	I_C	max.	25	mA
Collector current (peak value) $t_p \leq 50\ \mu s$; $\delta \leq 0.1$	I_{CM}	max.	50	mA
Power dissipation				
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	180	mW
Temperatures				
Storage temperature	T_{stg}		−40 to +125	^oC
Junction temperature	T_j	max.	125	^oC

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	0.55	^oC/mW

CHARACTERISTICS $T_{amb} = 25\ ^oC$ unless otherwise specified

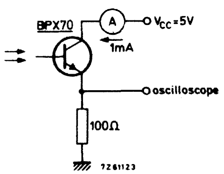
Collector-emitter dark current				
$V_{CE} = 20$ V	I_d	typ.	10	nA
		<	100	nA
$V_{CE} = 20$ V; $T_j = 100\ ^oC$	I_d	typ.	10	μA
		<	100	μA
Collector-emitter light current				
$V_{CE} = 5$ V; tungsten filament lamp source with colour temperature 2854 K; illumination: 1000 lx	I_l		100 to 700	μA
2500 lx	I_l	>	300	μA
irradiance: 4.75 mW/cm^2	I_l		100 to 700	μA
12 mW/cm^2	I_l	>	300	μA

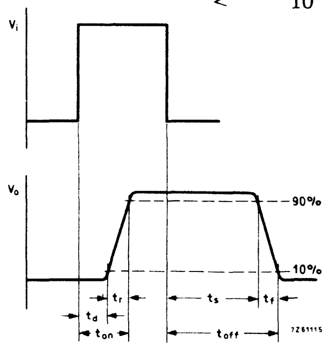
CHARACTERISTICS (continued)

Breakdown voltages				
Collector-base voltage				
$E = 0$; $I_C = 0.1$ mA	$V_{(BR)CBO}$	>	40	V
Collector-emitter voltage				
$E = 0$; $I_C = 1$ mA	$V_{(BR)CEO}$	>	30	V
Emitter-collector voltage				
$E = 0$; $I_C = 0.1$ mA	$V_{(BR)ECO}$	>	6	V
Collector capacitance				
$I_E = I_e = 0$; $V_{CB} = 20$ V	C_c	typ.	3.5	pF
Switching times				
$I_C = 1.0$ mA; $V_{CC} = 5$ V; $R_L = 100\ \Omega$				
Delay time	t_d	typ.	1.5	µs
		<	3.0	µs
Rise time	t_r	typ.	3.0	µs
		<	10	µs
Storage time	t_s	typ.	1.5	µs
		<	3.0	µs
Fall time	t_f	typ.	2.0	µs
		<	10	µs

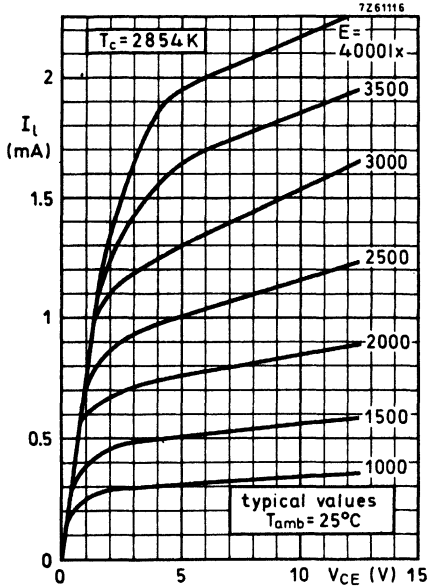
Light input pulse:

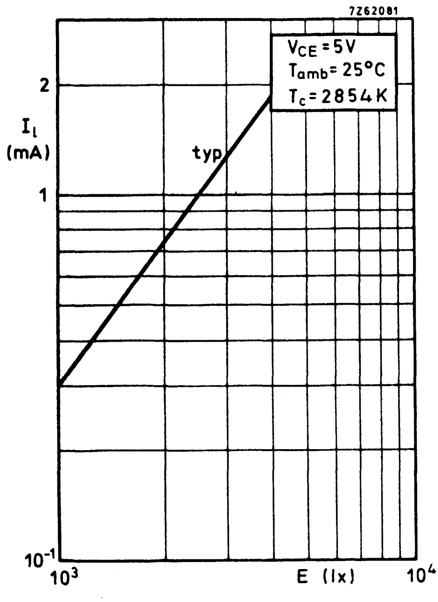
$t_r = t_f = 20$ ns
$t_p = 20$ µs
$f = 500$ Hz
$\lambda = 800$ nm

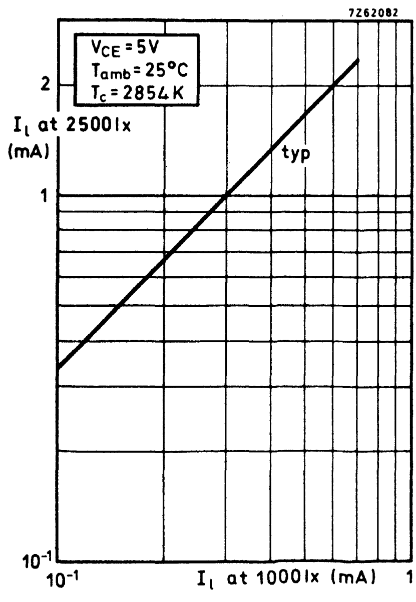


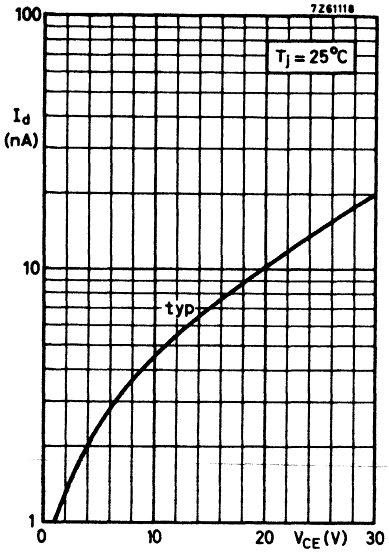


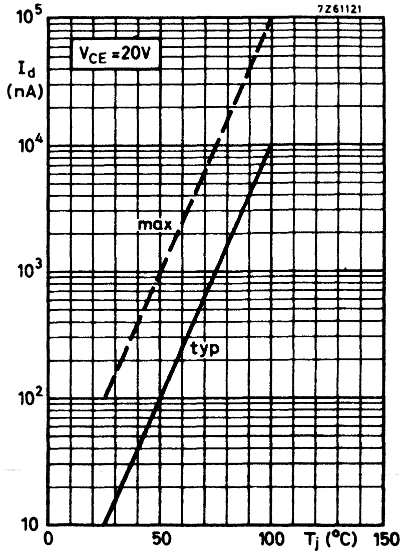
Peak spectral response	λ_m	typ.	800	nm
Bandwidth at half height	$\Delta\lambda$	typ.	300	nm

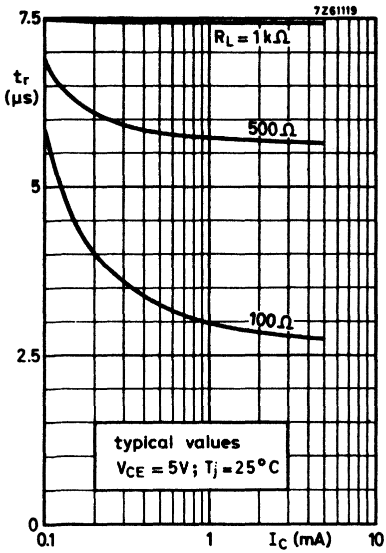

7Z61116
T_c = 2854 K
E = 4000 lx
3500
3000
2500
2000
1500
1000
typical values
T_{amb} = 25°C
I_l (mA)
2
1.5
1
0.5
0
0
5
10
V_{CE} (V) 15

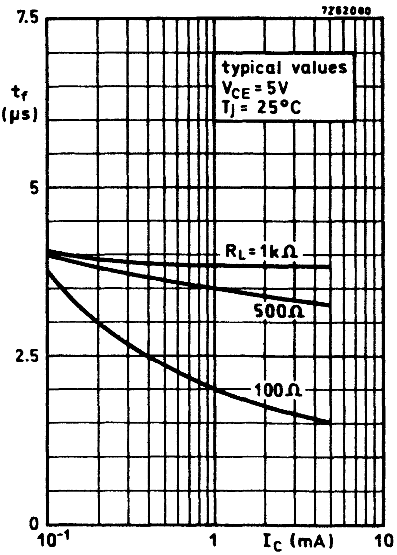

7Z62081
V_{CE} = 5 V
T_{amb} = 25°C
T_c = 2854 K
typ
I_l (mA)
2
1
10^{-1}
10^3
E (lx)
10^4

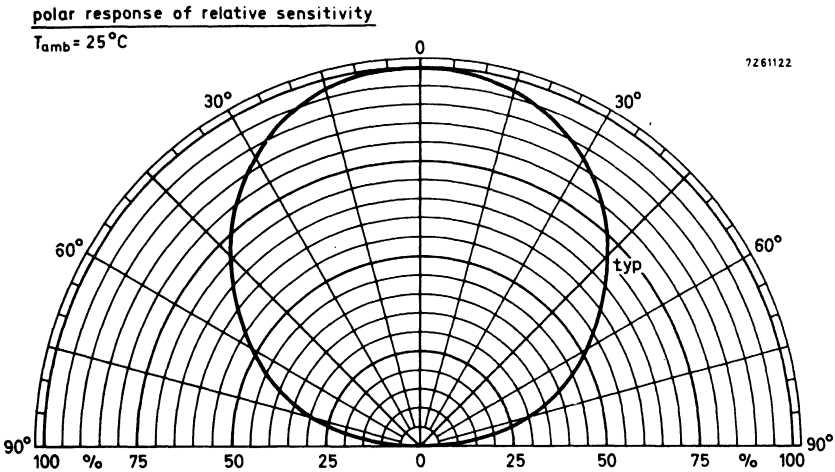

7Z62082
V_{CE} = 5 V
T_{amb} = 25°C
T_c = 2854 K
I_l at 2500 lx (mA)
typ
2
1
10^{-1}
10^{-1}
I_l at 1000 lx (mA)
1

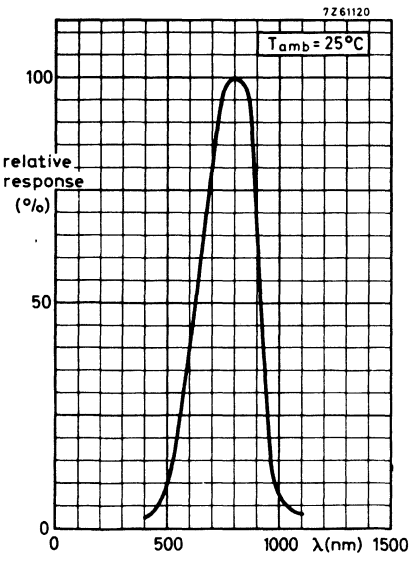

7Z61118
100
I_d
(nA)
10
1
$T_j = 25°C$
typ
0
10
20
V_{CE} (V)
30


7Z61121
10^5
I_d
(nA)
10^4
10^3
10^2
10
$V_{CE} = 20V$
max
typ
0
50
100
T_j (°C)
150


7Z61119
7.5
t_r
(μs)
5
2.5
0
$R_L = 1k\Omega$
500Ω
100Ω
typical values
$V_{CE} = 5V$; $T_j = 25°C$
0.1
1
I_C (mA)
10


7Z62080
7.5
t_f
(μs)
5
2.5
0
typical values
$V_{CE} = 5V$
$T_j = 25°C$
$R_L = 1k\Omega$
500Ω
100Ω
10^{-1}
1
I_C (mA)
10


polar response of relative sensitivity
Tamb = 25°C
7Z61122
0
30°
30°
60°
60°
typ
90°
90°
100 % 75 50 25 0 25 50 75 % 100


7Z61120
Tamb = 25°C
100
relative response (%)
50
0
0 500 1000 λ(nm) 1500

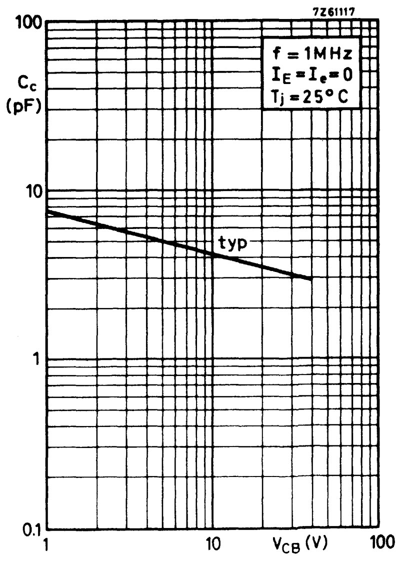

7Z61117
100
Cc (pF)
f = 1MHz
IE = Ie = 0
Tj = 25°C
10
typ
1
0.1
1 10 VCB (V) 100

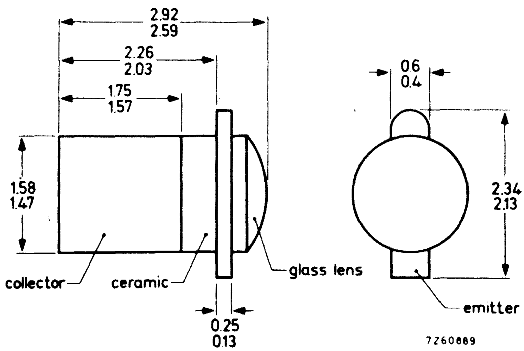
PHOTO-TRANSISTOR

General purpose n-p-n silicon photo-transistor with a glass lens.

QUICK REFERENCE DATA				
Collector-emitter voltage (open base)	V_{CEO}	max.	50	V
Collector current (peak value) $t_p < 50\ \mu s;\ \delta < 0.1$	I_{CM}	max.	50	mA
Junction temperature	T_j	max.	150	^oC
Collector-emitter dark current $V_{CE} = 30$ V	I_d	<	25	nA
Collector-emitter light current $V_{CE} = 5$ V; $E = 20$ mW/cm^2	I_ℓ	0.75 to 15		mA
Peak spectral response	λ_m	typ.	800	nm

MECHANICAL DATA

Dimensions in mm



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages				
Collector-emitter voltage (open base)	V_{CEO}	max.	50	V
Emitter-collector voltage (open base)	V_{ECO}	max.	7	V
Current				
Collector current (d.c.)	I_C	max.	20	mA
Collector current (peak value) $t_p < 50\ \mu s$; $\delta < 0.1$	I_{CM}	max.	50	mA
Power dissipation				
Total power dissipation up to T_{amb} = 50 °C	P_{tot}	max.	50	mW
up to T_{mb} = 55 °C	P_{tot}	max.	100	mW
Temperatures				
Storage temperature	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	2	°C/mW
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.95	°C/mW

CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

Collector-emitter dark current				
V_{CE} = 30 V	I_d	<	25	nA
V_{CE} = 30 V; T_{amb} = 100 °C	I_d	<	100	μA
Collector-emitter light current				
V_{CE} = 5 V; tungsten filament lamp source with colour temperature 2854K				
irradiation: 4.75 mW/cm²	I_ℓ	typ.	1	mA
20 mW/cm²	I_ℓ	typ.	5	mA
			0.75 to 15	mA
Breakdown voltages				
Collector-emitter voltage E = 0; I_C = 0.5 mA	$V_{(BR)CEO}$	>	50	V
Emitter-collector voltage E = 0; I_C = 0.1 mA	$V_{(BR)ECO}$	>	7	V
Collector-emitter saturation voltage				
I_C = 0.4 mA; E = 20 mW/cm² colour temperature: 2854 K	V_{CEsat}	typ.	150	mV
		<	400	mV

CHARACTERISTICS (continued)

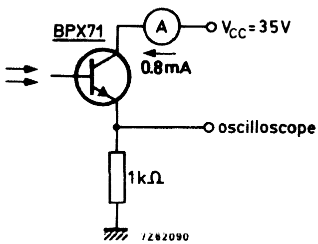
Switching times

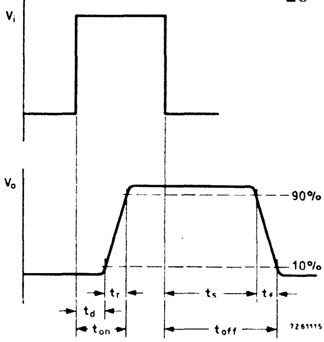
I_C = 0.8 mA; V_{CC} = 35 V; R_L = 1 kΩ

Delay time	t_d	typ.	2.0	µs
		<	20	µs
Rise time	t_r	typ.	3.0	µs
		<	30	µs
Storage time	t_s	typ.	0.1	µs
		<	2.0	µs
Fall time	t_f	typ.	2.5	µs
		<	20	µs

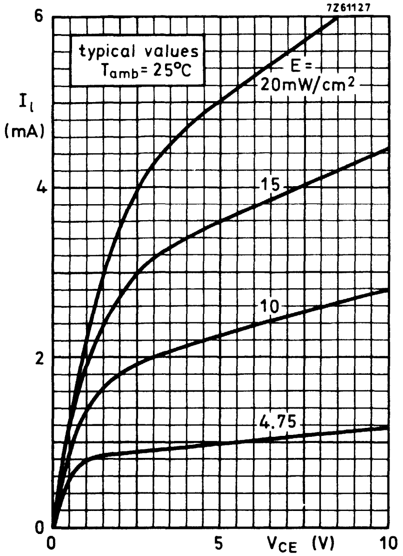
Light input pulse:

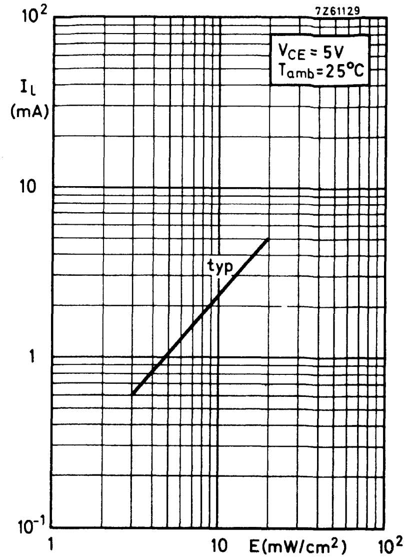
t_r = t_f = 20 ns
t_p = 20 µs
f = 500 Hz
λ = 800 nm

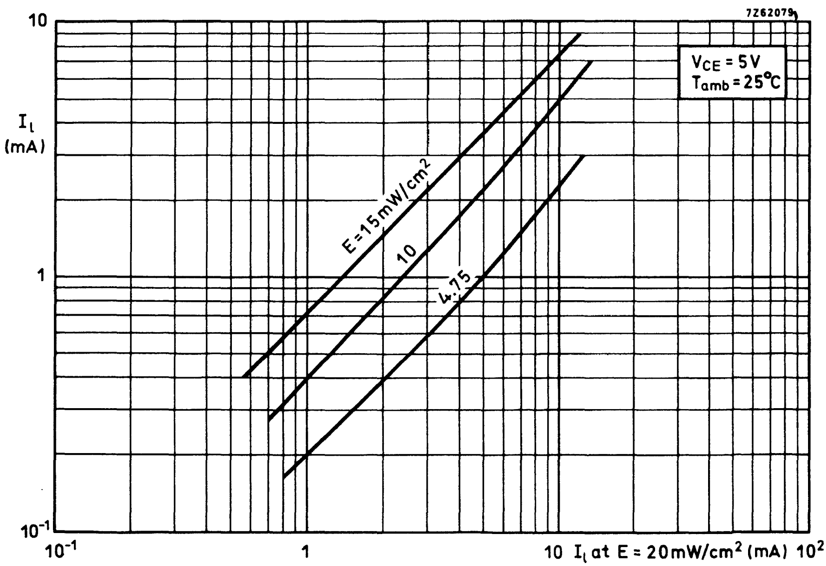


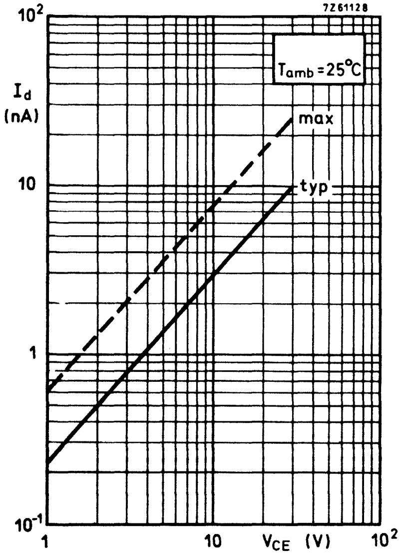


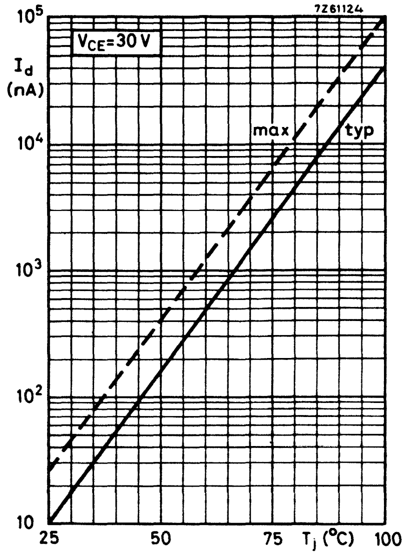
Peak spectral response	λ_m	typ.	800	nm
Bandwidth at half height	$\Delta\lambda_m$	typ.	400	nm

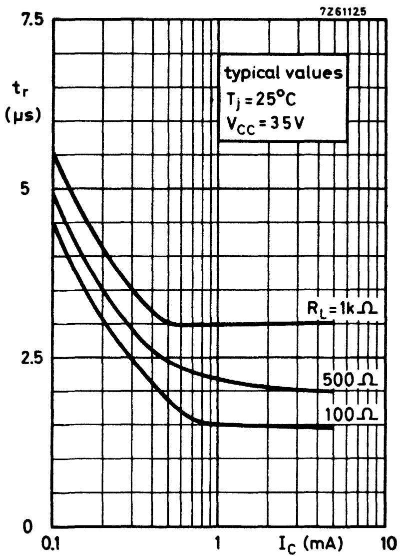

7Z61127
typical values
T_{amb} = 25°C
E = 20mW/cm²
15
10
4.75
I_l (mA)
V_{CE} (V)
0
2
4
6
5
10

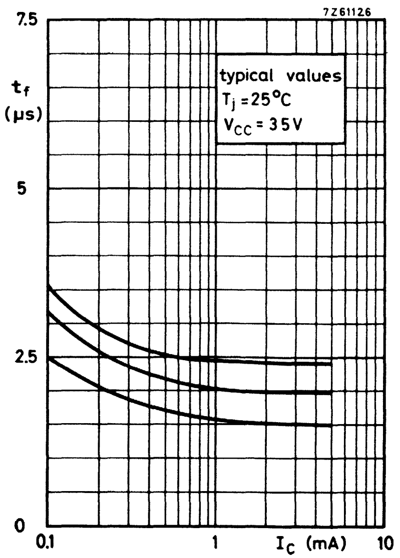

7Z61129
V_{CE} = 5V
T_{amb} = 25°C
typ
I_l (mA)
E(mW/cm²)
10^{-1}
1
10
10^2


7Z62079
V_{CE} = 5V
T_{amb} = 25°C
E = 15mW/cm²
10
4.75
I_l (mA)
I_l at E = 20mW/cm² (mA)
10^{-1}
1
10
10^2


7Z61128
T_{amb} = 25°C
I_d (nA)
max
typ
V_{CE} (V)


7Z61124
V_{CE} = 30 V
I_d (nA)
max
typ
T_j (°C)


7Z61125
typical values
T_j = 25°C
V_{CC} = 35 V
t_r (μs)
R_L = 1k Ω
500 Ω
100 Ω
I_C (mA)


7Z61126
typical values
T_j = 25°C
V_{CC} = 35 V
t_f (μs)
I_C (mA)

polar response of relative sensitivity

$T_{amb} = 25\,^{\circ}C$

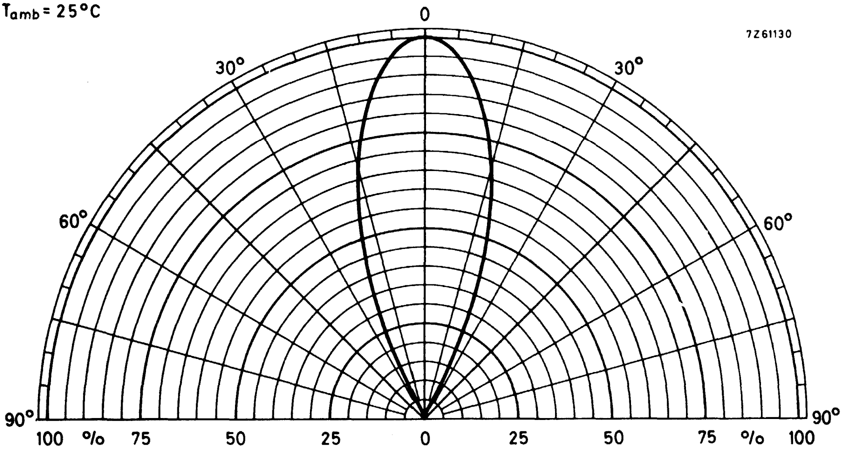
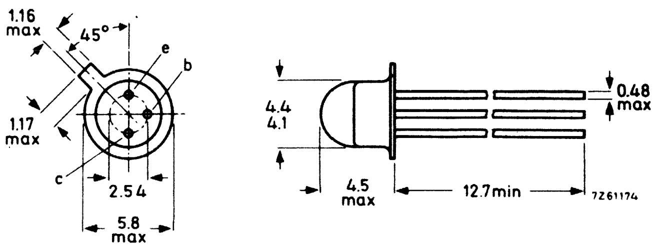


PHOTO-TRANSISTOR

General purpose n-p-n silicon photo-transistor with a plastic lens

QUICK REFERENCE DATA				
Collector-emitter voltage (open base)	V_{CEO}	max.	30	V
Collector current (peak value) $t_p \leq 50\ \mu s$; $\delta \leq 0.1$	I_{CM}	max.	50	mA
Junction temperature	T_j	max.	125	^oC
Collector-emitter dark current $V_{CE} = 20$ V	I_d	<	100	nA
Collector-emitter light current $V_{CE} = 5$ V; E = 1000 lx	I_l	500 to 3000		μA
Peak spectral response	λ_m	typ.	800	nm

MECHANICAL DATA Dimensions in mm



Max. lead diameter is guaranteed only for 12.7 mm

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	V
Emitter-collector voltage (open base)	V_{ECO}	max.	6	V

Current

Collector current (d.c.)	I_C	max.	25	mA
Collector current (peak value) $t_p \leq 50\ \mu s$; $\delta \leq 0.1$	I_{CM}	max.	50	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	180	mW

Temperatures

Storage temperature	T_{stg}		−40 to +125	^oC
Junction temperature	T_j	max.	125	^oC

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j-a}$	=	0.55	^oC/mW

CHARACTERISTICS $T_{amb} = 25\ ^oC$ unless otherwise specified

Collector-emitter dark current

$V_{CE} = 20$ V	I_d	typ.	10	nA
		<	100	nA
$V_{CE} = 20$ V; $T_j = 100\ ^oC$	I_d	typ.	10	μA
		<	100	μA

Collector-emitter light current

$V_{CE} = 5$ V; tungsten filament lamp source with colour temperature 2854 K

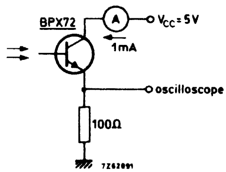
illumination: 1000 lx	I_l		500 to 3000	μA
2500 lx	I_l	typ.	3000	μA
irradiance: 4.75 mW/cm^2	I_l		500 to 3000	μA
12 mW/cm^2	I_l	typ.	3000	μA

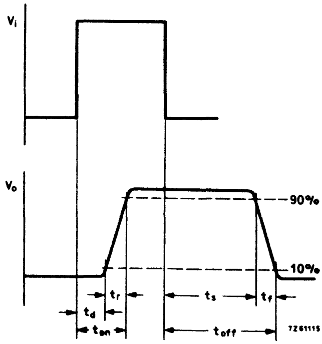
CHARACTERISTICS (continued)

Breakdown voltages				
Collector-base voltage $E = 0$; $I_C = 0.1$ mA	$V_{(BR)CBO}$	>	40	V
Collector-emitter voltage $E = 0$; $I_C = 1$ mA	$V_{(BR)CEO}$	>	30	V
Emitter-collector voltage $E = 0$; $I_C = 0.1$ mA	$V_{(BR)ECO}$	>	6	V
Collector capacitance				
$I_E = I_e = 0$; $V_{CB} = 20$ V	C_c	typ.	3.5	pF
Switching times				
$I_C = 1.0$ mA; $V_{CC} = 5$ V; $R_L = 100\ \Omega$				
Delay time	t_d	typ. <	3.0 6.0	µs µs
Rise time	t_r	typ. <	6.0 20	µs µs
Storage time	t_s	typ. <	1.5 3.0	µs µs
Fall time	t_f	typ. <	4.0 20	µs µs

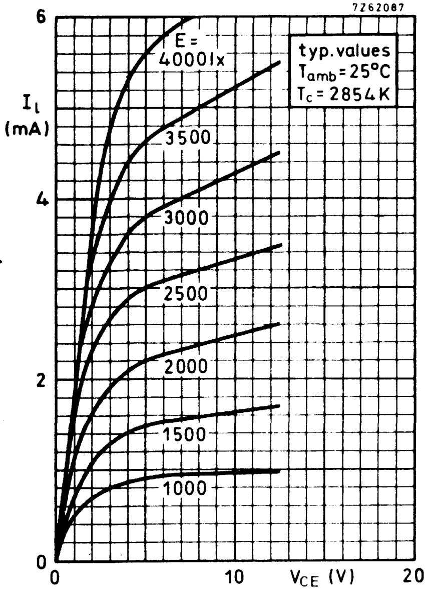
Light input pulse:

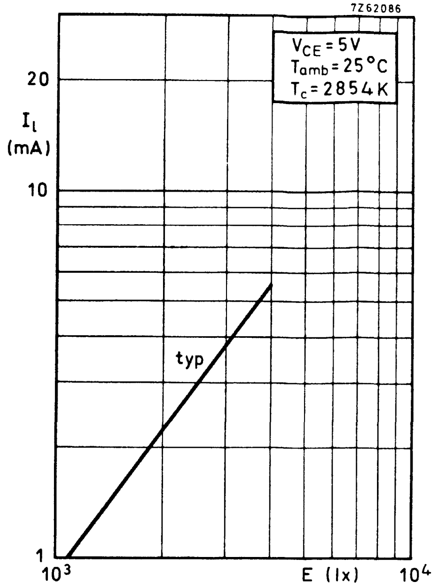
$t_r = t_f =$ 20 ns
t_p = 20 µs
f = 500 Hz
λ = 800 nm

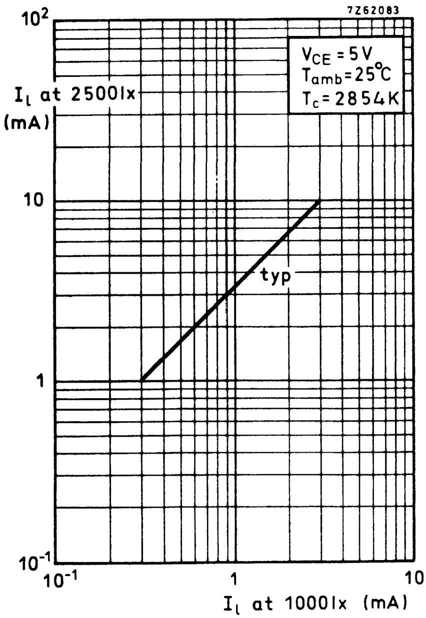


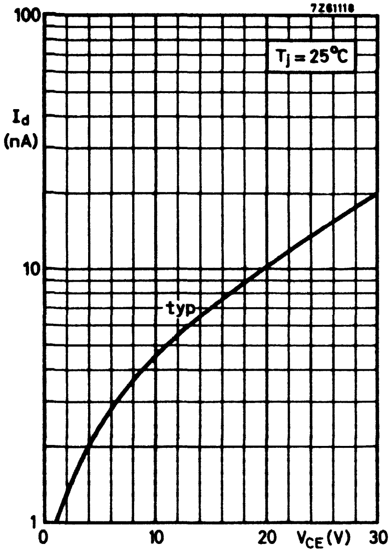


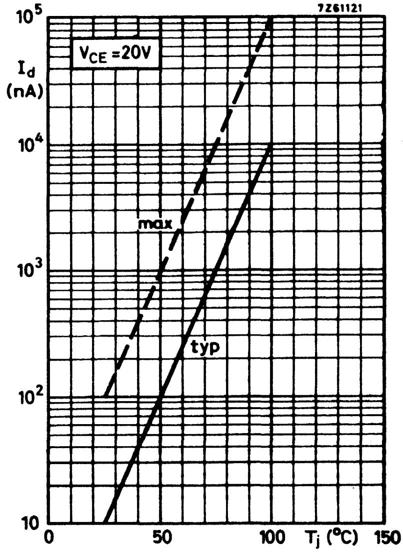
Peak spectral response	λ_m	typ.	800	nm
Bandwidth at half height	$\Delta\lambda$	typ.	300	nm

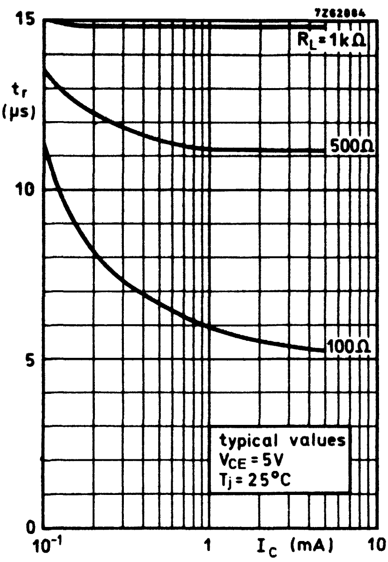

7Z62087
typ. values
T_{amb} = 25 °C
T_c = 2854 K
E = 4000 lx
3500
3000
2500
2000
1500
1000
I_l (mA)
V_{CE} (V)
0
2
4
6
10
20

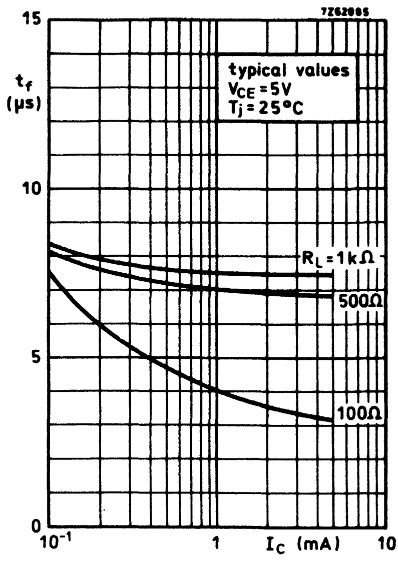

7Z62086
V_{CE} = 5 V
T_{amb} = 25 °C
T_c = 2854 K
typ
I_l (mA)
E (lx)
1
10
20
10^3
10^4


7Z62083
V_{CE} = 5 V
T_{amb} = 25 °C
T_c = 2854 K
typ
I_l at 2500 lx (mA)
I_l at 1000 lx (mA)
10^{-1}
1
10
10^2

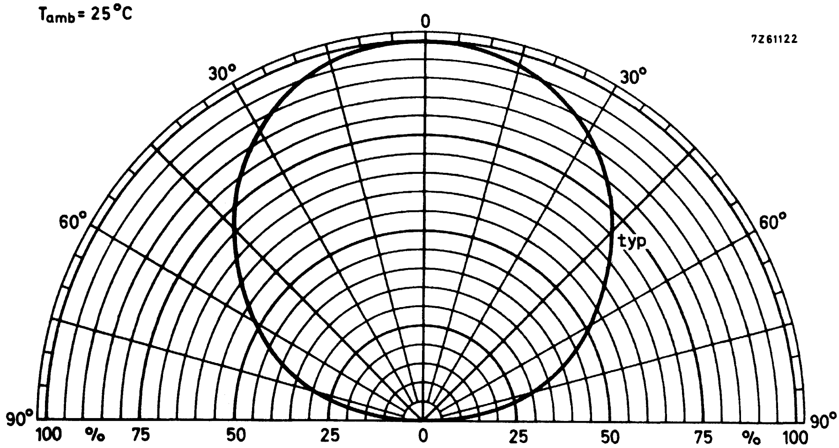

7Z61118
100
10
1
Id
(nA)
Tj = 25°C
typ
0
10
20
VCE (V)
30

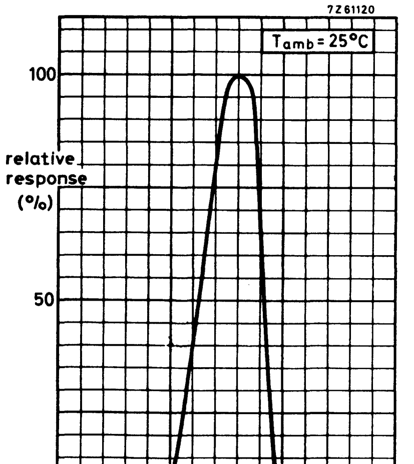

7Z61121
10^5
10^4
10^3
10^2
10
Id
(nA)
VCE = 20V
max
typ
0
50
100
Tj (°C)
150

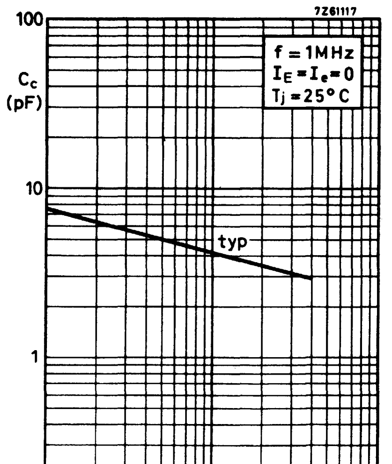

7Z62084
15
10
5
0
tr
(μs)
RL = 1 kΩ
500Ω
100Ω
typical values
VCE = 5V
Tj = 25°C
10^-1
1
IC (mA)
10


7Z62085
15
10
5
0
tf
(μs)
typical values
VCE = 5V
Tj = 25°C
RL = 1 kΩ
500Ω
100Ω
10^-1
1
IC (mA)
10

polar response of relative sensitivity







Light emitting diodes

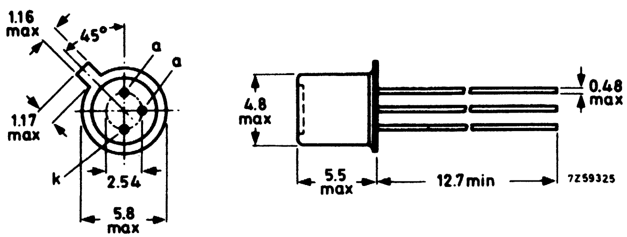
GALLIUM ARSENIDE LIGHT EMITTING DIODE

GaAs light emitting diode intended for optical coupling and encoding. It emits radiation in the near infrared when forward biased. The diode is provided with a flat glass window.

QUICK REFERENCE DATA				
Continuous reverse voltage	V_R	max.	2	V
Forward current (d.c.)	I_F	max.	30	mA
Forward current (peak value) t_p = 100 μs; δ = 0,1	I_{FM}	max.	200	mA
Total power dissipation up to T_{amb} = 95 °C	P_{tot}	max.	50	mW
Radiant output power at I_F = 20 mA	ϕ_e	> typ.	60 100	μW μW
Radiant intensity (on-axis) at I_F = 20 mA	I_e	typ.	64	μW/sr
Radiant power rise time at I_F = 20 mA	t_r	<	100	ns
Radiant power fall time at I_F = 20 mA	t_f	<	100	ns
Wavelength at peak emission	λ_{peak}	typ.	880	nm
Thermal resistance from junction to ambient	$R_{th\ j-a}$	=	0,6	°C/mW

MECHANICAL DATA Dimensions in mm

TO-18, except for window



Max. lead diameter is guaranteed only for 12,7 mm

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltage

Continuous reverse voltage	V_F	max.	2	V

Current

Forward current (d.c.)	I_F	max.	30	mA
Forward current (peak value) t_p = 100 µs; δ = 0,1	I_{FM}	max.	200	mA

Power dissipation

Total power dissipation up to T_{amb} = 95 °C	P_{tot}	max.	50	mW

Temperature

Storage temperature	T_{stg}		-55 to +150	°C
Operating junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j-a}$	=	0,6	°C/mW
From junction to case	$R_{th\ j-c}$	=	0,22	°C/mW

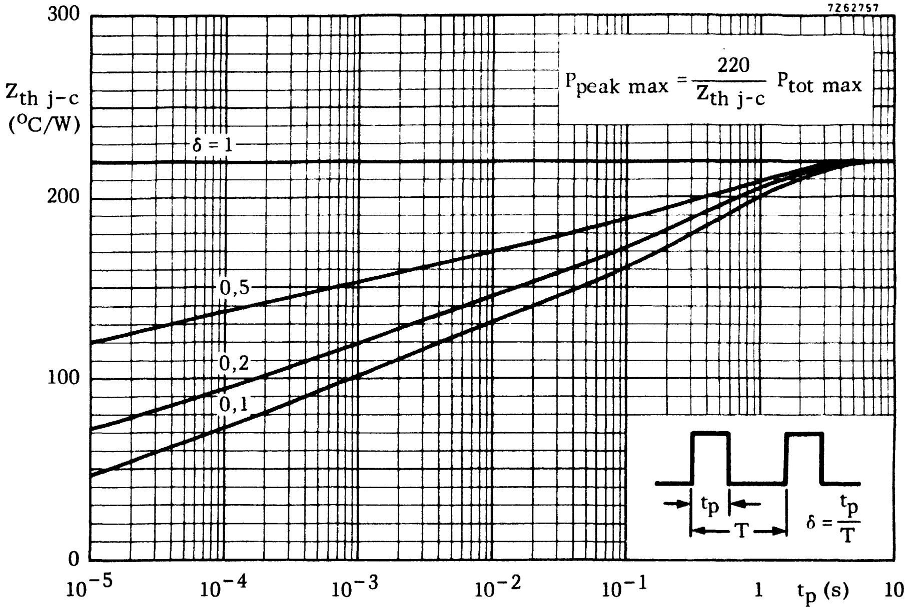
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

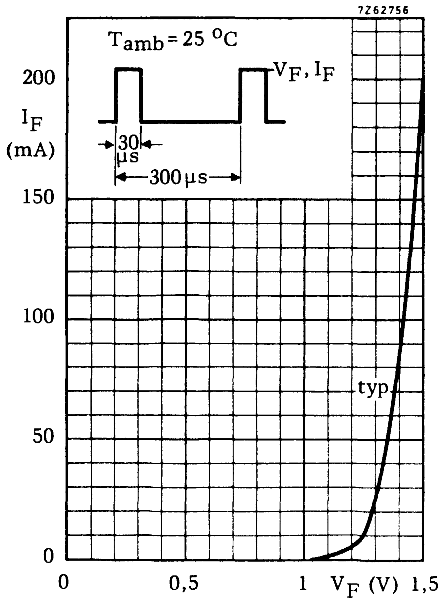
Forward voltage at I_F = 30 mA	V_F	typ.	1,3	V
		<	1,6	V
I_F = 0,2 A	V_F	typ.	1,5	V
Reverse current at V_R = 2 V	I_R	<	0,5	mA
Diode capacitance at f = 1 MHz; V_R = 0	C_d	typ.	65	pF

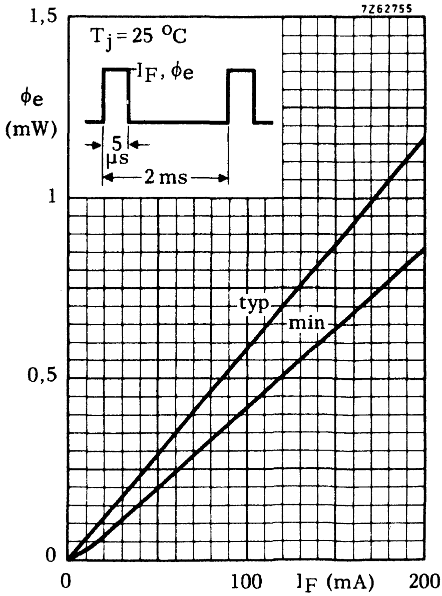
CHARACTERISTICS (continued) T_{amb} = 25 °C unless otherwise specified

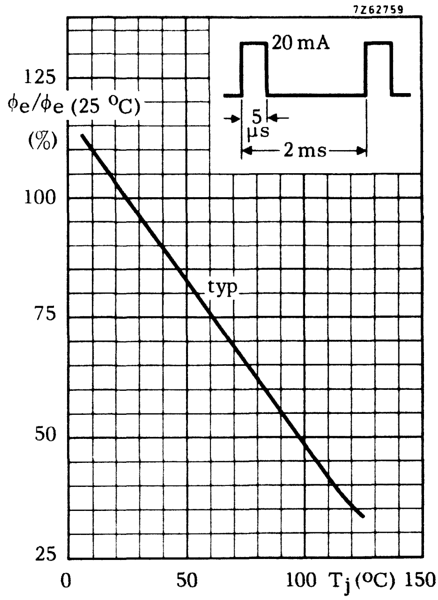
Radiant output power at I_F = 20 mA	ϕ_e	>	60	μW
		typ.	100	μW
I_F = 20 mA; T_j = 100 °C	ϕ_e	typ.	50	μW
I_F = 200 mA [1]	ϕ_e	typ.	1,16	mW
Radiant intensity (on-axis) at I_F = 20 mA	I_e	typ.	64	μW/sr
Radiance at I_F = 20 mA	L_e	typ.	1,6	mW/mm^2sr
I_F = 200 mA [1]	L_e	typ.	15	mW/mm^2sr
Emissive area	A_e	typ.	0,04	mm^2
Wavelength at peak emission	λ_{peak}	typ.	880	nm
Bandwidth at half height	$\Delta\lambda$	typ.	40	nm
Radiant power rise time at I_F = 20 mA	t_r	typ.	30	ns
		<	100	ns
Radiant power fall time at I_F = 20 mA	t_f	typ.	30	ns
		<	100	ns

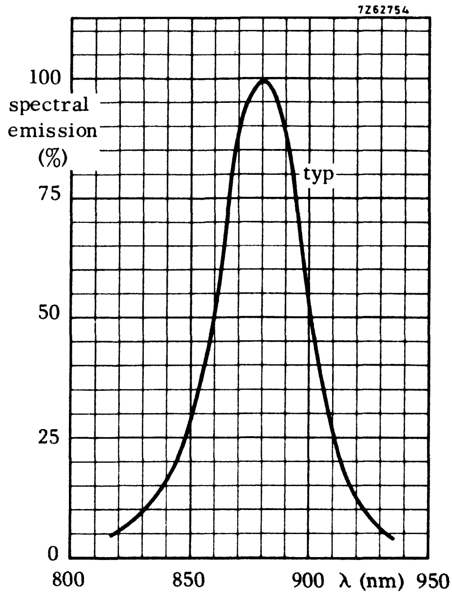
1) t_p = 100 μs; δ = 0,1.

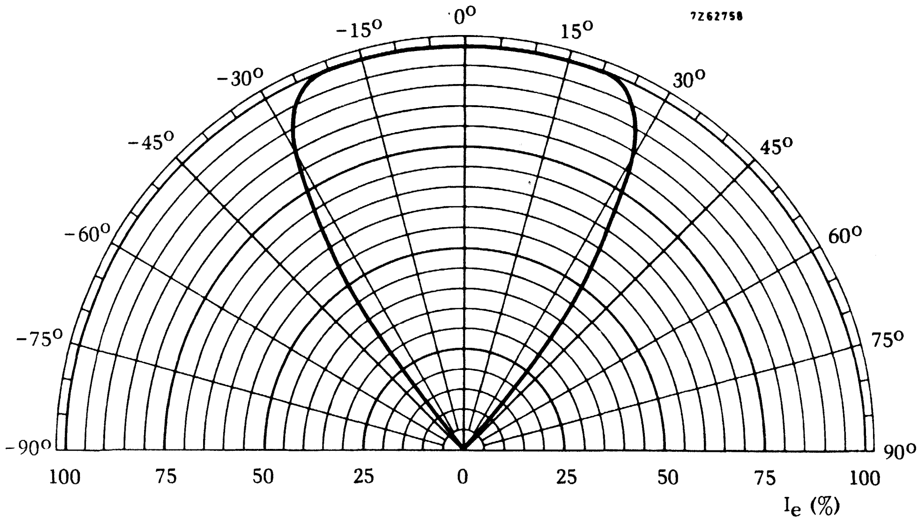

7Z62757
$Z_{th\ j-c}$ (°C/W)
300
200
100
0
$P_{peak\ max} = \frac{220}{Z_{th\ j-c}} P_{tot\ max}$
δ = 1
0,5
0,2
0,1
t_p
T
$\delta = \frac{t_p}{T}$
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
t_p (s)
10


7Z62756
T_{amb} = 25 °C
V_F, I_F
30 µs
300 µs
I_F (mA)
200
150
100
50
0
typ
0
0,5
1
V_F (V)
1,5


7Z62755
T_j = 25 °C
I_F, ϕe
5 µs
2 ms
ϕe (mW)
1,5
1
0,5
0
typ
min
0
100
I_F (mA)
200


7Z62759
20 mA
5 μs
2 ms
125
ϕ_e/ϕ_e (25 °C)
(%)
100
typ
75
50
25
0
50
100
T_j (°C)
150


7Z62754
100
spectral emission (%)
typ
75
50
25
0
800
850
900
λ (nm)
950


7Z62758
0°
-15°
15°
-30°
30°
-45°
45°
-60°
60°
-75°
75°
-90°
90°
100
75
50
25
0
25
50
75
100
I_e (%)

Infra-red sensitive devices

PHOTOCONDUCTIVE CELL

Indium antimonide photoconductive element mounted on a copper heatsink, recommended for operation at a temperature of 20 °C.
Sensitive to infra-red radiation extending to 7.5 μm and intended for use with mod-modulated or pulsed radiation.

RATINGS (Limiting values) [1])

Bias current at T_{amb} = 20 °C	I	max.	100	mA
Temperatures				
Operating ambient temperature	T_{amb}	max.	70	°C
Storage temperature	T_{stg}		- 50 to + 70	°C

CHARACTERISTICS T_{amb} = 20 °C unless otherwise specified

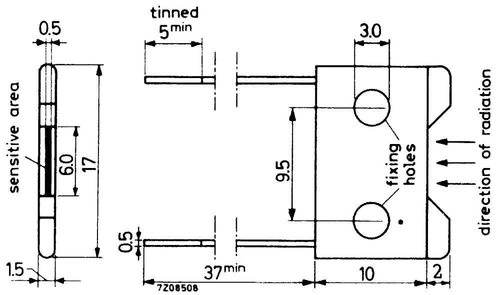
Peak spectral response	λ		6.0 to 6.3	μm
Spectral response range	from visible to		7.5	μm
Cell resistance	r_1		30 to 120	Ω
Time constant			0.1	μs
Sensitive area			6.0 x 0.5	mm^2
Sensitivity (6.0 μm radiation)		>	0.4	μV/μW
		typ.	1.0	μV/μW
(500 °K radiation)		typ.	0.3	μV/μW
D* (6.0 μm, 800 Hz, 1 Hz)	see notes 1 and 2	>	8.5×10^7	$cm\sqrt{Hz}/W$
		typ.	2.0×10^8	$cm\sqrt{Hz}/W$
(500 °K, 800 Hz, 1 Hz)	see notes 1 and 2	typ.	6.0×10^7	$cm\sqrt{Hz}/W$
Noise equivalent power (N.E.P.)				
(6.0 μm, 800 Hz, 1 Hz)	see notes 1 and 2	typ.	8.6×10^{-10}	W
		<	2.0×10^{-9}	W
(500 °K, 800 Hz, 1 Hz)	see notes 1 and 2	typ.	2.5×10^{-9}	W

MECHANICAL DATA (see page 2)

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

MECHANICAL DATA

Dimensions in mm



NOTES

1. Measuring conditions.

The detector is attached to a heatsink which is maintained at a temperature of 20 °C and a bias current of 50 mA is applied. A parallel beam of monochromatic radiation of wavelength 4.4 μm, which would produce a steady irradiance of 68 $\mu W/cm^2$ at the sensitive element, is chopped at 800 Hz, giving an actual r.m.s. power at the element which amounts to

$$\frac{68}{2.2} = 31\ \mu W/cm^2$$

Measurements of the detector output are made with an amplifier tuned to 800 Hz and with a bandwidth of 50 Hz, and are referred to open circuit conditions i.e. correction is made for the shunting effects of the bias supply impedance and the amplifier input impedance. Under these test conditions, the ORP10 will exhibit a minimum signal-to-noise ratio of 45 and typical of 105. The sensitivities quoted at the wavelength of peak response and under black body conditions are calculated from these measurements, assuming the detector to have a typical response curve.

2. D* and N.E.P.

These are figures of merit for the materials of detectors.
D* is defined in the expression:

$$D^* = \frac{\frac{V_s}{V_n} \times \sqrt{A\,(\Delta f)}}{W}$$

where: V_s = signal voltage across detector terminals
V_n = noise voltage across detector terminals
A = detector area
(Δf) = bandwidth of measuring amplifier
W = radiation power incident on detector sensitive element in watts.

NOTES (continued)

The figures in brackets which follow D* refer to the measuring conditions e.g. D* (5.3 μm, 800 Hz, 1 Hz) denotes monochromatic radiation incident on the detector of wavelength 5.3 μm, chopping frequency 800 Hz, bandwidth 1 Hz.

The Noise Equivalent Power (N.E.P.) is related to D* by the expression:

$$N.E.P. = \frac{\sqrt{A}}{D^*}.$$

3. Variation of performance with bias current.

Both signal and noise vary with bias current. Typical curves are shown on page 5. At high currents the noise increases more rapidly than the signal, and therefore the signal-to-noise ratio has a peak value at some optimum current, which will vary slightly from cell to cell. A typical value is 50 mA. In addition the ohmic heating caused by bias currents above 60 mA causes the temperature of the element to become significantly greater than the substrate so that the signal decreases as described in note 4.

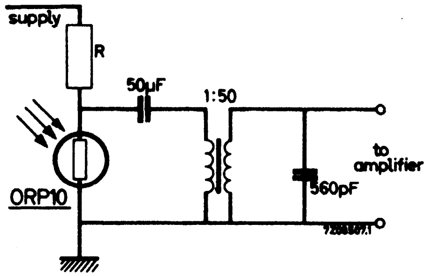
4. Variation of performance with element temperature.

As with all semiconductor photocells, the performance depends on the temperature of the sensitive element. In the case of the ORP10 this is influenced by the ambient temperature and ohmic heating caused by the d.c. bias current. To minimise fluctuations, the element is mounted on a copper base from which it is insulated by a layer of aluminium oxide, and can readily be attached to a large heatsink.
A typical variation of performance with temperature is given on page 5. The curve on page 5 shows the decrease in signal caused by the high current raising the temperature of the element.
On cooling, indium antimonide exhibits improved sensitivity and increased resistance. Below 15 °C this is impractical with the ORP10 unless special precautions are taken to prevent condensation and icing on the exposed element.

5. Warning.

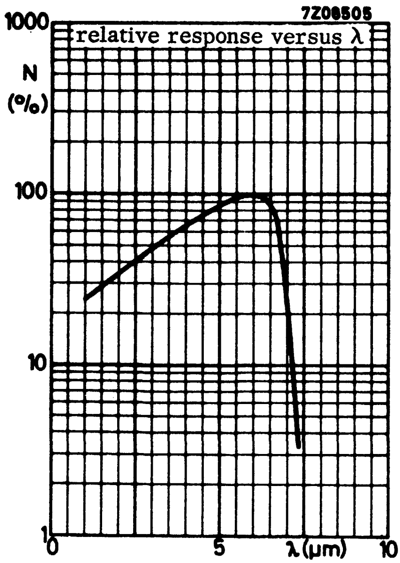
The sensitive surface is unprotected and should not be touched. It is stable in normal atmospheres but should not be exposed to high concentrations of the vapours of organic solvents. Care should be taken to avoid strain when attaching cells to heatsinks.

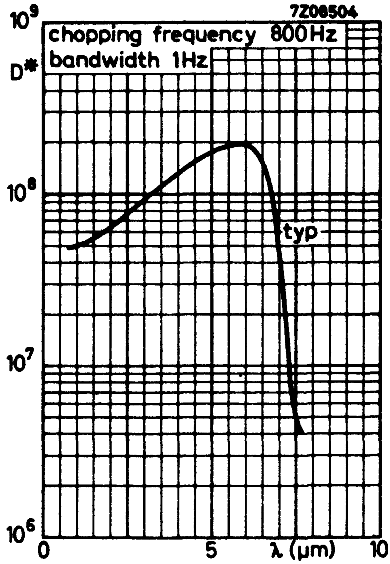
Recommended circuit for use with radiation chopped at 800 Hz.

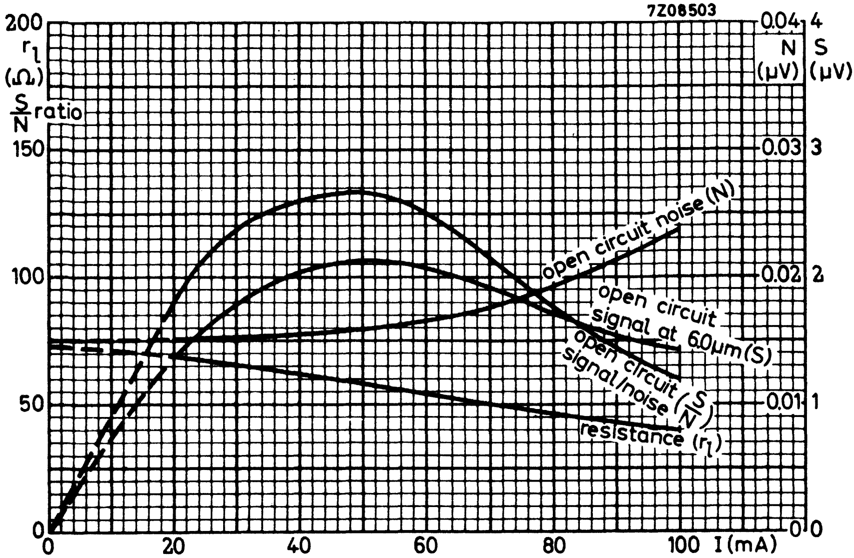


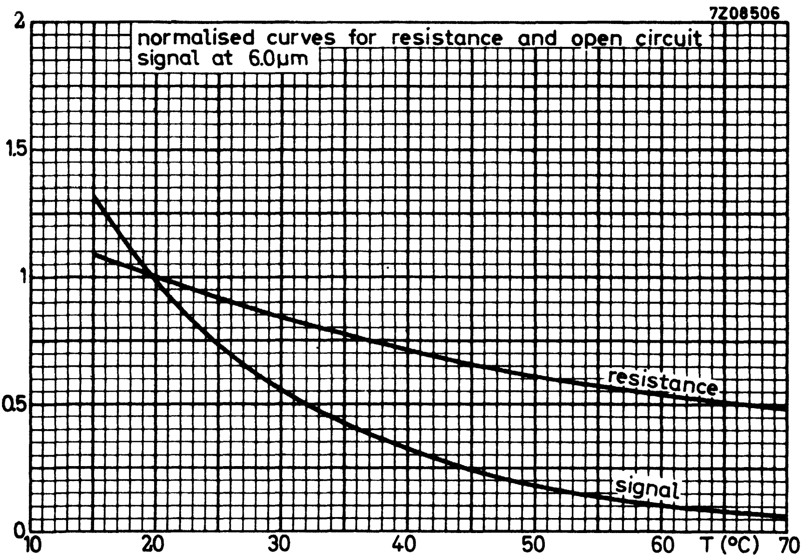
CIRCUIT NOTES

The transformer should be adequately screened to prevent stray pick-up.
The resistor R should be wire wound to minimise noise. It must be substantially larger than the cell resistance and its actual value will depend upon the supply voltage and the cell currents required. The 560 pF capacitor tunes the secondary to 800 Hz.






7Z08503
200
r_l
(Ω)
$\frac{S}{N}$ ratio
150
100
50
0
0
20
40
60
80
100 I (mA)
0.04
N
(μV)
0.03
0.02
0.01
0
4
S
(μV)
3
2
1
0
open circuit noise (N)
open circuit signal at 6.0μm (S)
open circuit signal/noise ($\frac{S}{N}$)
resistance (r_l)


7Z08506
normalised curves for resistance and open circuit signal at 6.0μm
2
1.5
1
0.5
0
10
20
30
40
50
60
T (°C)
70
resistance
signal

PHOTOCONDUCTIVE CELL

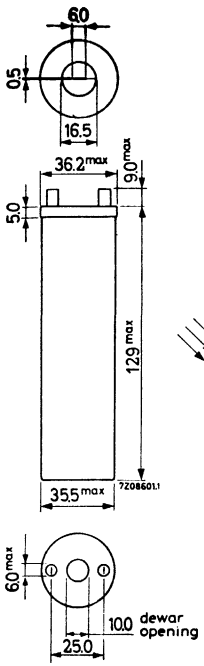
Indium antimonide photoconductive element mounted in a glass dewar vessel and cooled by liquid nitrogen or liquid air. Sensitive to infrared radiation extending to 5.6μm an intended for use with modulated or pulsed radiation.

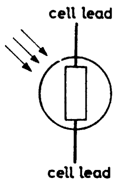
QUICK REFERENCE DATA				
Peak spectral response	λ_m		5.3	μm
Operating temperature	T		77	K
Responsivity (5.3 μm, 800 Hz)		typ.	35	mV/μW
D^* (5.3 μm, 800 Hz, 1 Hz)		typ.	5.5×10^{10}	cm $\sqrt{Hz}$/W
Time constant		typ.	5	μs
Sensitive area			6.0 x 0.5	mm^2

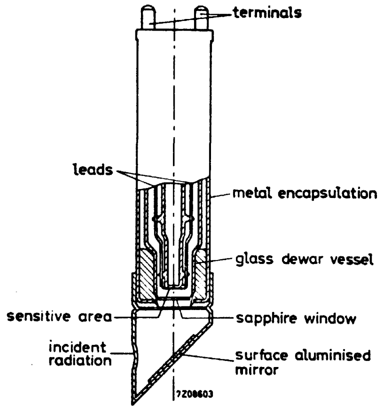
MECHANICAL DATA see page 2

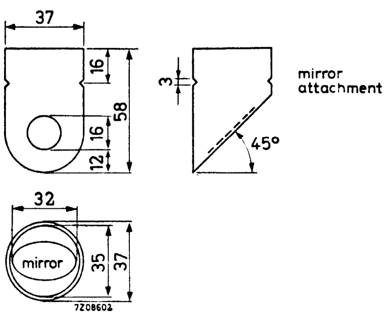
MECHANICAL DATA

Dimensions in mm









RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Bias current at T_{amb} = 77 K	I	max.	30	mA
Temperatures				
Storage temperature	T_{stg}		−55 to +55	°C

CHARACTERISTICS (see note 1 on page 4)

Peak spectral response	λ_m		5.3	μm
Spectral response range	from visible to		5.6	μm
Cell resistance	r_ℓ	20 to	60	kΩ
Time constant		typ.	5	μs
Boil-off time of bulk liquid nitrogen		>	90	min
		typ.	120	min

Performance

1. Black body source measurement
   colour temperature : 500 K
   chopping frequency : 800 Hz
   bandwidth : 1 Hz

Responsivity	>	4	mV/μW
	typ.	7	mV/μW
D*	>	5×10^9	cm$\sqrt{Hz}$/W
	typ.	7.5×10^9	cm$\sqrt{Hz}$/W
N.E.P.	typ.	16	pW
	<	35	pW

2. Monochromatic source measurement
   radiation : 5.3 μm
   chopping frequency : 800 Hz
   bandwidth : 1 Hz

Responsivity	typ.	35	mV/μW
D*	typ.	55×10^9	cm$\sqrt{Hz}$/W
N.E.P.	typ.	3.2	pW

NOTES

1. Test conditions

The detector is cooled to 77K by filling the dewar vessel with liquid nitrogen, or by use of a liquid transfer system. An optimum bias of 250 to 500μA is applied. The sensitive element is situated at a distance of 264mm from a black body source limited by an aperture of 3mm diameter.

The radiation path is interrupted at 800Hz by a chopper blade at ambient temperature. Under these conditions the r.m.s. power at the element (chopping factor 2.2) is 4.5μW/cm^2.

Measurements of the detector output are made with an amplifier tuned to 800Hz with a bandwidth of 50Hz, and referred to open-circuit conditions, i.e., correction is made for the shunting effects of the bias supply impedance and the amplifier impedance.

2. D* and N.E.P.

These are figures of merit for the materials of detectors.

The detectivity D* is defined in the expression:

$$D^* = \frac{\frac{V_s}{V_n}\sqrt{A(\Delta f)}}{W}$$

where: V_s = signal voltage across detector terminals
V_n = noise voltage across detector terminals
A = detector area
(Δf) = bandwidth of measuring amplifier
W = radiation power incident on detector sensitive element in r.m.s. watts.

The Noise Equivalent Power (N.E.P.) is related to D* by the expression:

$$\text{N.E.P.} = \frac{\sqrt{A}}{D^*}$$

3. Time constant

Detector time constant figures are based on the response to a step function in the incident radiation. Quoted times indicate the interval between the moment the radiation is cut off and the output falling to 63% of its peak value.

4. Variation of performance with bias current

Both signal and noise vary with current in this type of cell. At high currents the noise increases more rapidly than the signal, and therefore the signal-to-noise ratio has a peak value at some optimum current, which will vary slightly from cell to cell.

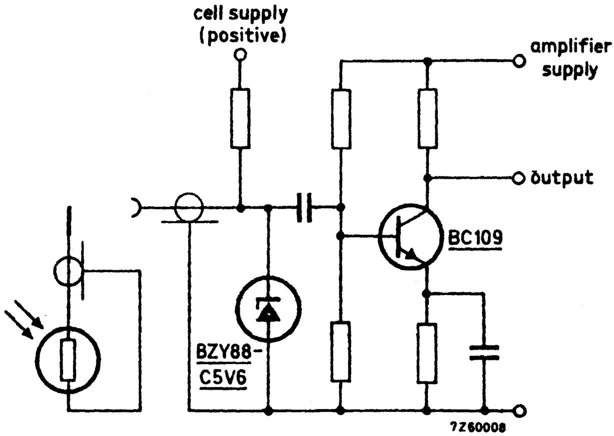
NOTES (continued)

5. Warnings

a. The resistance of the cell at room temperature is three orders of magnitude less than at the operating temperature (77K). Care should therefore be taken to ensure that the device is not allowed to reach room temperature while still biased, if any form of low impedance biasing is employed.

b. If provision is made for cells to be plugged into the bias current and amplifier, steps must be taken to limit the current available from the amplifier input capacitor. This current can be excessive at the instant of plugging in the cell.

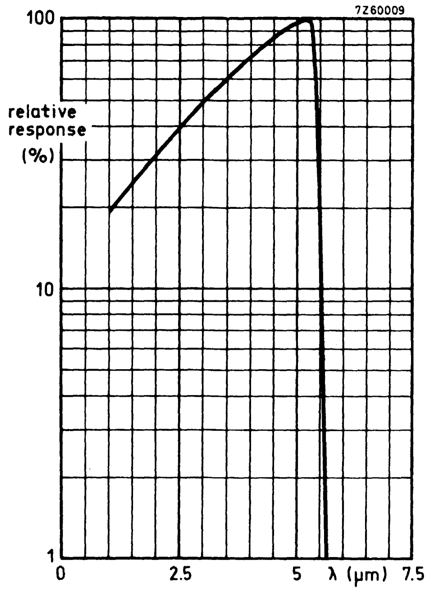
A zener diode can be used to limit the voltage developed across the input capacitor as shown in the diagram.

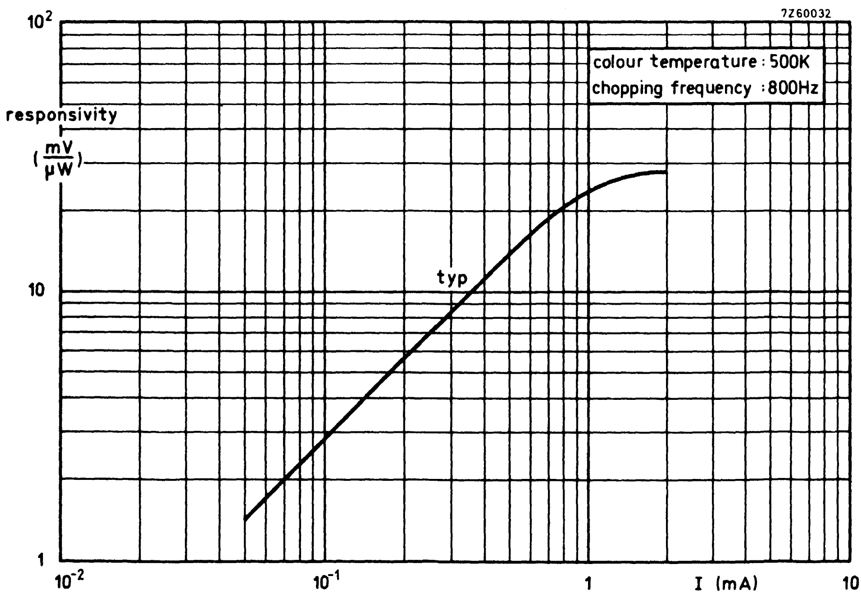


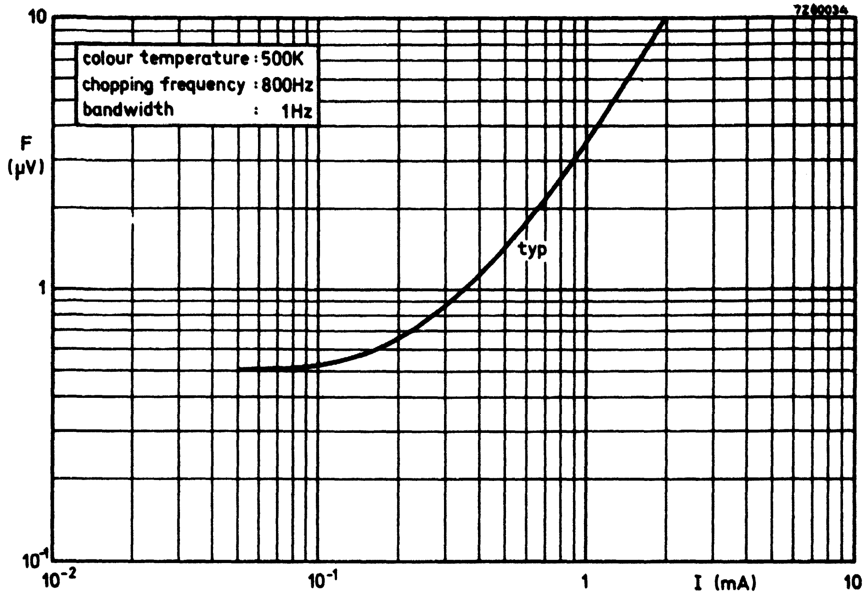
c. The dewar vessel must always be completely dry before being refilled with liquid nitrogen. In humid conditions, water vapour may condense at the top of the dewar. Should this occur, the remaining liquid nitrogen should be allowed to boil off, the ice should be removed carefully and precautions taken to avoid a recurrence. In very humid conditions the window should be purged with a claen dry gas.

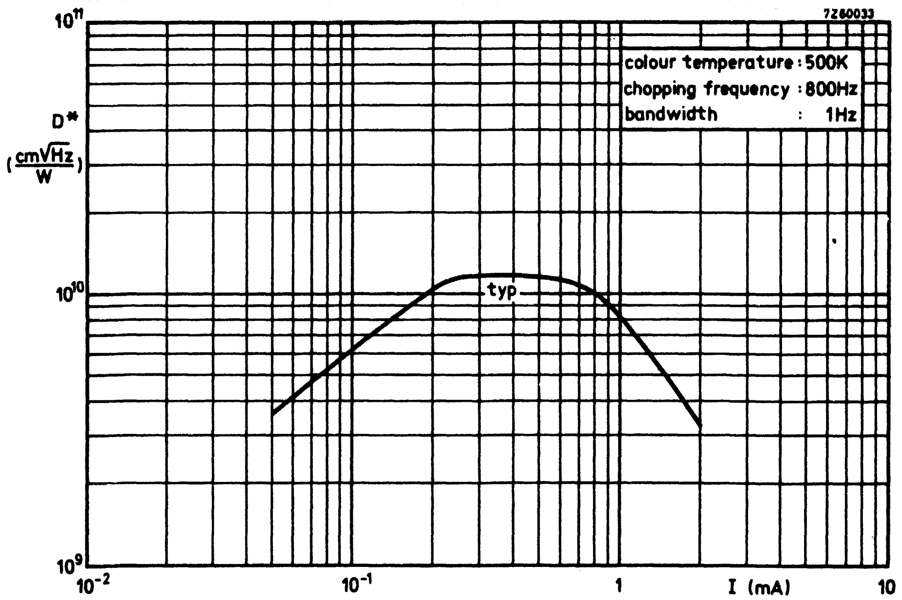
6. Low frequency noise

This will be minimised by use of non-absorbent cotton wool placed in the bottom of the dewar. The recommended quantity is 40mg.


7Z60009
100
relative
response
(%)
10
1
0
2.5
5
λ (μm)
7.5


7Z60032
10^2
responsivity
$(\frac{mV}{\mu W})$
colour temperature : 500K
chopping frequency : 800Hz
typ
10
1
10^{-2}
10^{-1}
1
I (mA)
10


7Z60034
colour temperature : 500K
chopping frequency : 800Hz
bandwidth : 1Hz
F (μV)
typ
10
1
10^-1
10^-2
10^-1
1
I (mA)
10

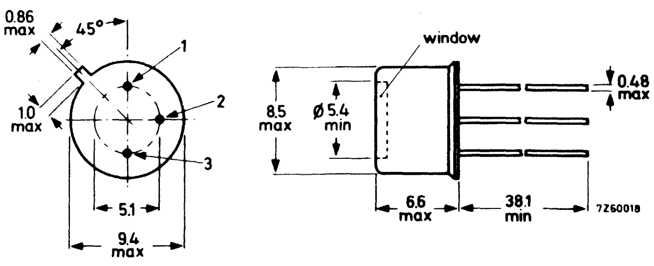

7Z60033
colour temperature : 500K
chopping frequency : 800Hz
bandwidth : 1Hz
D* (cm√Hz / W)
typ
10^11
10^10
10^9
10^-2
10^-1
1
I (mA)
10

PHOTOCONDUCTIVE CELL

Lead sulphide, chemically deposited, photoconductive cell recommended for room temperature operation.
It is encapsulated in a hermetically sealed TO-5 envelope with an end viewing window.
It has a germanium filter to cut off radiation below 1.5 μm and therefore it may be exposed continuously to visible radiation.

QUICK REFERENCE DATA				
Peak spectral response	λ_m	typ.	1.9	μm
Spectral response range	$\Delta\lambda$		1.5 to 3.0	μm
Responsivity (2.0μm, 800 Hz)		>	200	mA/W
Responsivity (500K, 800 Hz)		>	2.0	mA/W
D^* (500K, 800 Hz, 1 Hz)			$>1.0 \times 10^8$	$\text{cm}\sqrt{\text{Hz}}/\text{W}$
Time constant		typ.	250	μs
Sensitive area			1.0 x 1.0	mm^2

MECHANICAL DATA



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Power dissipation	P	max.	20	mW

Temperatures

Storage temperature	T_{stg}		−20 to +50	°C
Operating ambient temperature	T_{amb}	max.	50	°C

CHARACTERISTICS at T_{amb} = 20 °C (see notes on pages 3 and 4)

Peak spectral response	λ_m	typ.	1.9	μm
Spectral response range	$\Delta\lambda$		1.5 to 3.0	μm
Cell resistance	r_ℓ	>	200	kΩ
		typ.	600	kΩ
Time constant		typ.	250	μs
		<	400	μs

Performance

1. Black body source measurement
   colour temperature : 500 K
   chopping frequency : 800 Hz
   bandwidth : 1 Hz

Responsivity	>	2.0	mA/W
D*	>	1.0×10^8	cm $\sqrt{Hz}$/W
N.E.P.	<	1.0	nW

2. Monochromatic source measurement
   radiation : 2.0 μm
   chopping frequency : 800 Hz
   bandwidth : 1 Hz

Responsivity	>	200	mA/W
D*	>	1.0×10^{10}	cm $\sqrt{Hz}$/W
N.E.P.	<	10	pW

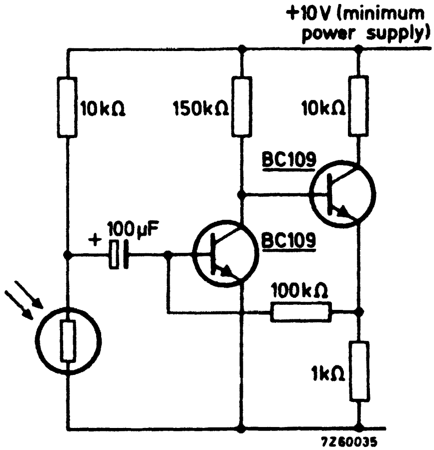
NOTES

1. Test conditions

The cell is operated at a temperature of 20 °C. The sensitive element is situated at a distance of 264 mm from a black body source limited by an aperture of 3 mm diameter.

The radiation path is interrupted at 800 Hz by a chopper blade at ambient temperature. Under these conditions the r. m. s. power at the element (chopping factor 2.2) is 4.5 μW/cm².

A bias voltage of 24 V is applied to the cell. Measurements of the detector output are made using a low value resistive load, followed by a current pre-amplifier, as shown below. The output is fed into an amplifier tuned to 800 Hz with a bandwidth of 50 Hz.



2. D* and N.E.P.

These are figures of merit for the materials of detectors.
The detectivity D* is defined in the expression:

$$D^* = \frac{\frac{V_s}{V_n}\sqrt{A(\Delta f)}}{W}$$

where: V_s = signal voltage across detector terminals
V_n = noise voltage across detector terminals
A = detector area
(Δf) = bandwidth of measuring amplifier
W = radiation power incident on detector sensitive element in r. m. s. watts.

The Noise Equivalent Power (N.E.P.) is related to D* by the expression:

$$N.E.P. = \frac{\sqrt{A}}{D^*}$$

NOTES (continued)

3. Time constant

Detector time constant figures are based on the response to a step function in the incident radiation. Quoted times indicate the interval between the moment the radiation is cut off and the output falling to 63% of its peak value.

4. a. Variation of performance with bias

Both signal and noise vary with bias in this type of cell. At bias levels at which the cell dissipation is less than 2.5 mW the maximum level of D^* is maintained. At higher levels the noise increases more rapidly than the signal so that although the responsivity increases, D^* falls. The maximum responsivity typically occurs at a dissipation level of 10 mW, beyond which heating occurs with a consequent reduction in responsivity.

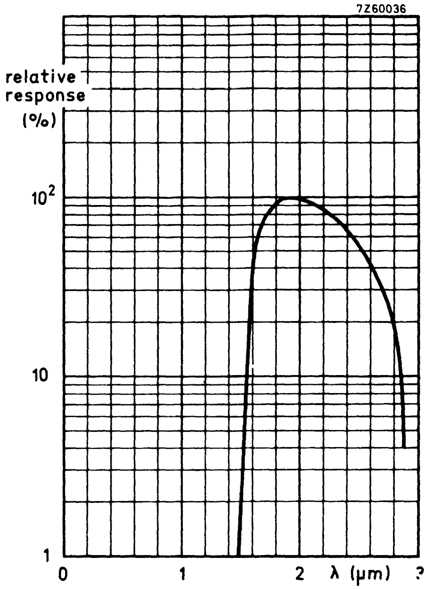
b. Variation of performance with temperature/life

Resistance, responsivity and D^* are dependent on the previous temperature/life history of the cell. The quoted values are the minimum which may be expected after storage or operation up to 35 °C. These values may decrease by 50% after storage or operation at temperatures up to the absolute maximum temperature of 50 °C.

5. Recommended operating conditions

In order to minimise the effects of parameter variations with temperature and life it is recommended that a constant voltage bias is used. A suitable circuit is shown on page 3. With this mode of operation the signal is the short-circuit current, which is related to the open-circuit cell voltage by the expression:

$$V_{oc} = I_{sc} \times r_{\ell}$$


7Z60036
relative
response
(%)
10^2
10
1
0
1
2
λ (μm)
3

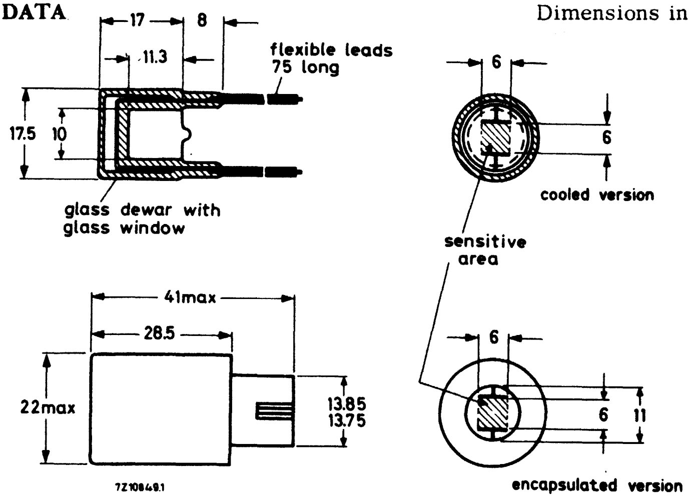
PHOTOCONDUCTIVE CELL

Evaporated lead sulphide photoconductive cells with sensitive element mounted in a glass dewar, encapsulated in an envelope for room temperature operation.
Also available without envelope for cooled operation.
The cells are intended for use with pulsed or modulated radiation.

QUICK REFERENCE DATA				
Peak spectral response	λ_m		2.2	μm
Spectral response range	$\Delta\lambda$		0.3 to 3.5	μm
Internal resistance	r_i	typ.	1.5	MΩ
Responsivity (radiation 2.0 μm)		typ.	80	mV/μW
D^* (2.0 μm, 800 Hz, 1 Hz)		typ.	4×10^{10}	cm $\sqrt{Hz}$/W
Time constant		typ.	100	μs
Sensitive area			6.0 x 6.0	mm^2

MECHANICAL DATA

Dimensions in mm



Accessory: socket for encapsulated version: Belling-Lee type 789/CS.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage (bidirectional)		V	max.	250	V
Current (bidirectional)		I	max.	0.5	mA
Temperatures					
Storage temperature	encapsulated version	T_{stg}		−55 to +60	°C
	cooled version	T_{stg}		−80 to +60	°C
Operating ambient temperature		T_{amb}	max.	60	°C

CHARACTERISTICS at T_{amb} = 20 °C (see note 1 on page 3)

Peak spectral response	λ_m		2.2	μm
Spectral response range	$\Delta\lambda$		0.3 to 3.5	μm
Internal resistance	r_i	typ.	1.5	MΩ
			1.0 to 4.0	MΩ
Time constant		typ.	100	μs
Noise voltage		typ.	8.5	μV

Performance

1. Black body source
   - colour temperature : 500 K
   - chopping frequency : 800 Hz
   - bandwidth : 1 Hz

→ Responsivity	>	**0.2**	mV/μW
	typ.	1.3	mV/μW
→ D*	>	**2.0 x 10^8**	cm $\sqrt{Hz}$/W
	typ.	6.5 x 10^8	cm $\sqrt{Hz}$/W
→ N.E.P.	typ.	0.92	nW
	<	**3.0**	nW

2. Monochromatic source
   - radiation : 2.0 μm
   - chopping frequency: 800 Hz
   - bandwidth : 1 Hz

Responsivity	typ.	80	mV/μW
D*	typ.	4 x 10^{10}	cm $\sqrt{Hz}$/W
N.E.P.	typ.	15	pW

NOTES

1. Test conditions

The characteristics are measured with the cell biased from a 200 V d.c. supply in series with a 1.0 MΩ load resistor. No correction is made for the loading effect of the 1.0 MΩ resistor, i.e. open circuit characteristics are not given.

The sensitive element is situated at a distance of 264 mm a black body source limited by an aperture of 3 mm. The radiation path is interrupted at 800 Hz by a chopper blade at ambient temperature. Under these conditions the r.m.s. power at the element (chopping factor 2.2) is 4.5 $\mu W/cm^2$.

Measurements of the detector output are made with an amplifier tuned to 800 Hz with a bandwidth of 50 Hz.

2. D^* and N.E.P.

These are figures of merit for the materials of detectors.

The detectivity D^* is defined in the expression:

$$D^* = \frac{\frac{V_s}{V_n}\sqrt{A(\Delta f)}}{W}$$

where: V_s = signal voltage across detector terminals
V_n = noise voltage across detector terminals
A = detector area
(Δf) = bandwidth of measuring amplifier
W = radiation power incident on detector sensitive element in r.m.s. watts.

The Noise Equivalent Power (N.E.P.) is related to D^* by the expression:

$$\text{N.E.P.} = \frac{\sqrt{A}}{D^*}$$

3. Time constant

Detector time constant figures are based on the response to a step function in the incident radiation. Quoted times indicate the interval between the moment the radiation is cut off and the output falling to 63% of its peak value.

4. Variation of performance with bias current.

Both signal and noise vary with current in this type of cell. At high currents the noise increases more rapidly than the signal, and therefore the signal-to-noise ratio has a peak value at some optimum current, which will vary slightly from cell to cell.

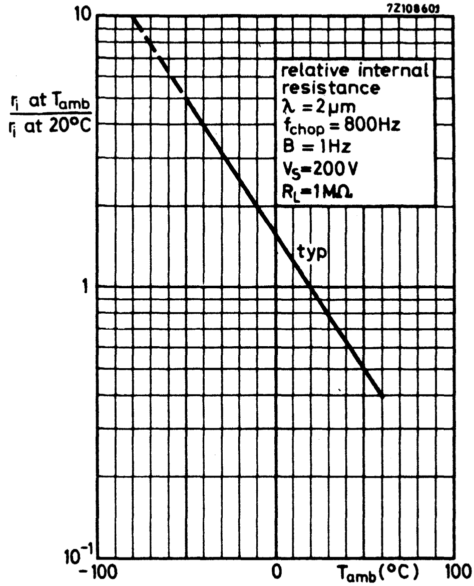
NOTES (continued)

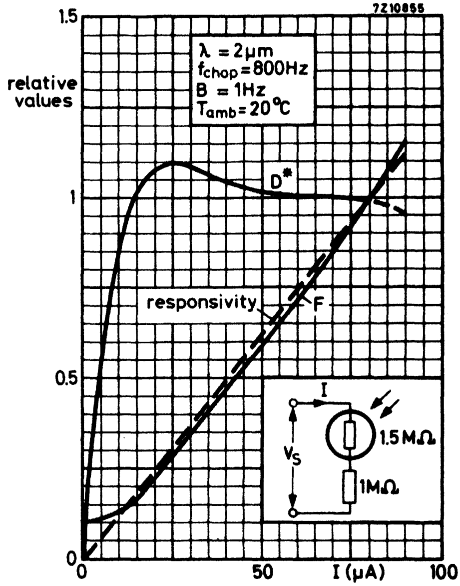
5. Effect of ambient radiation

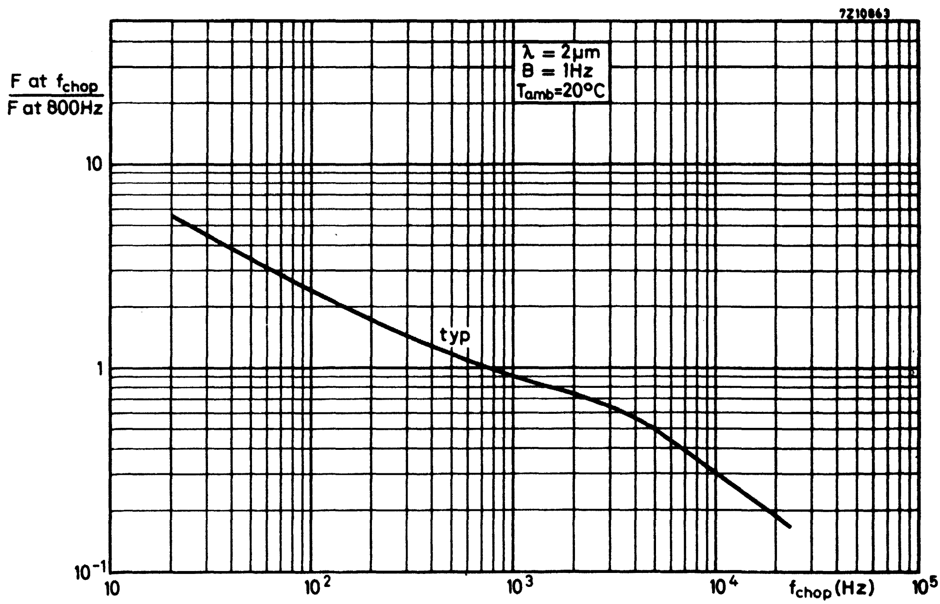
Care should be taken to avoid the incidence on the cell of appreciable radiation in the visible range. Such radiation will cause a decrease in the cell resistance and signal as long as the cell is kept cool. Normal daylight can cause this effect if seen for more than a few minutes. Precautions should be taken to prevent visible light reaching the sensitive element via the liquid nitrogen compartment.

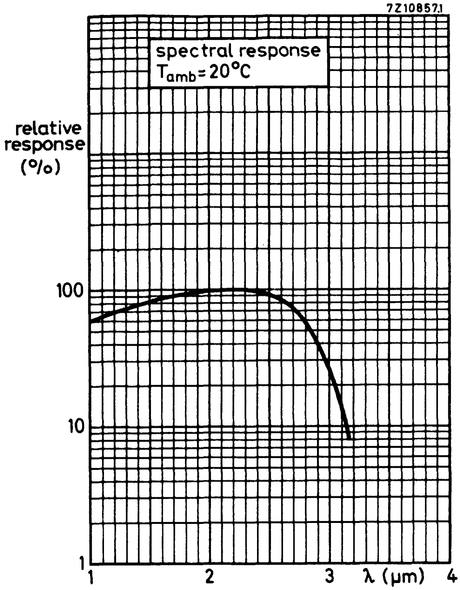
6. Warning

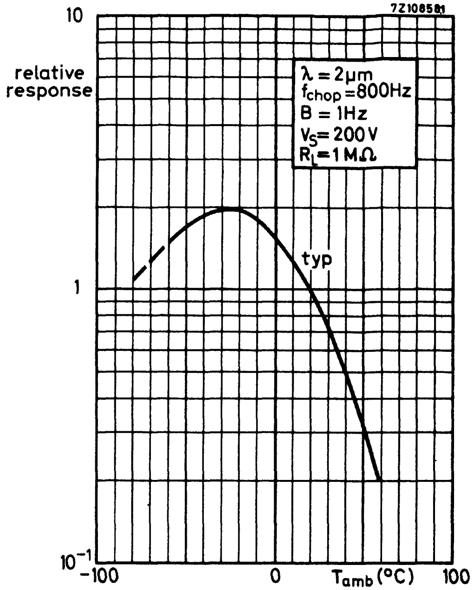
Care should be taken to ensure that the device is not allowed to reach room temperature while still biased.
The dewar vessel must always be completely dry before being refilled with liquid nitrogen. In very humid conditions, water vapour may condense at the top of the dewar vessel. Should this occur, the remaining liquid nitrogen should be allowed to boil off, the ice should be removed and precautions taken to avoid a recurrence.

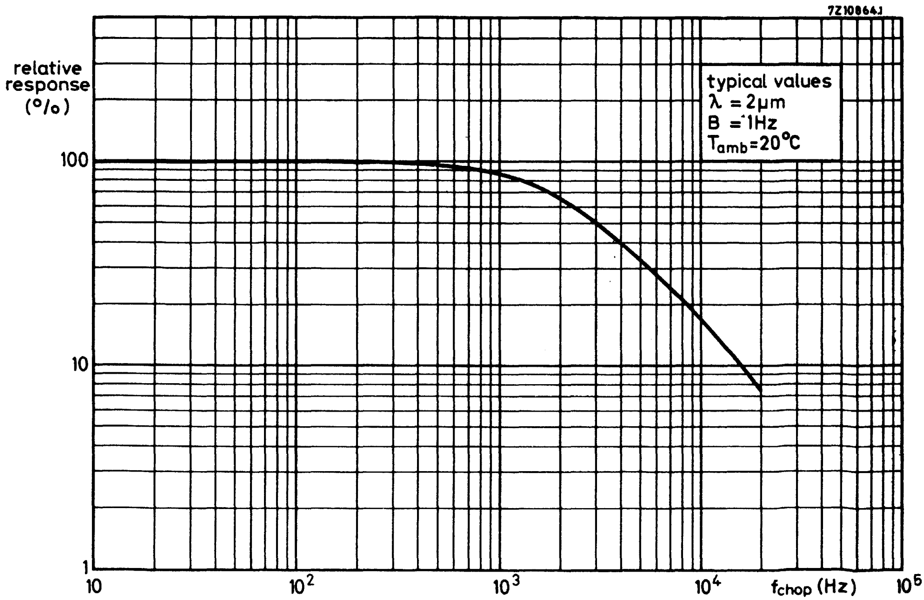

7Z108601
relative internal resistance
λ = 2 μm
fchop = 800Hz
B = 1Hz
VS=200V
RL=1MΩ
typ
ri at Tamb / ri at 20°C
10
1
10⁻¹
-100
0
Tamb (°C)
100

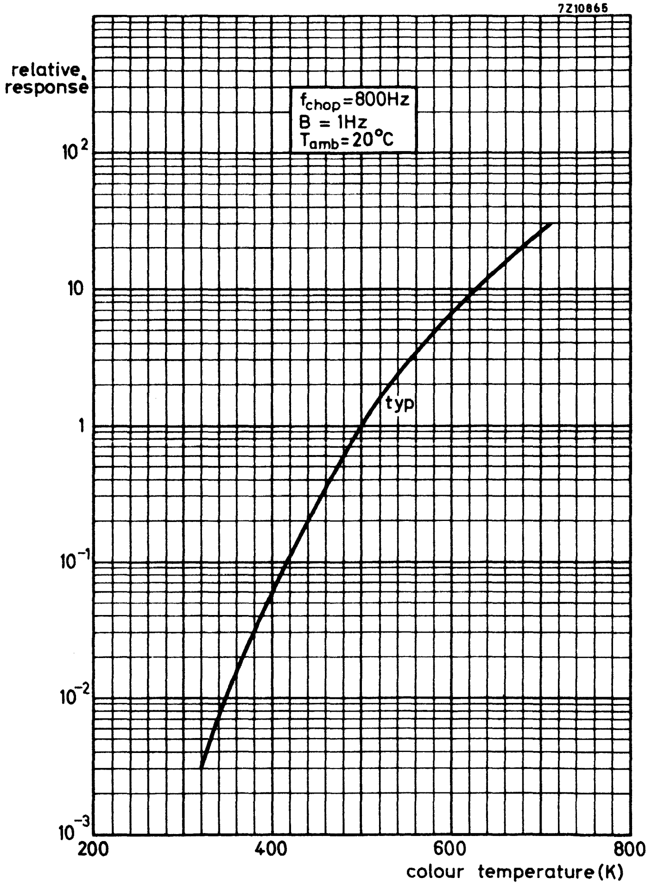

7Z10855
λ = 2 μm
fchop = 800Hz
B = 1Hz
Tamb = 20°C
relative values
D*
responsivity
F
I
VS
1.5 MΩ
1MΩ
1.5
1
0.5
0
50
I (μA)
100

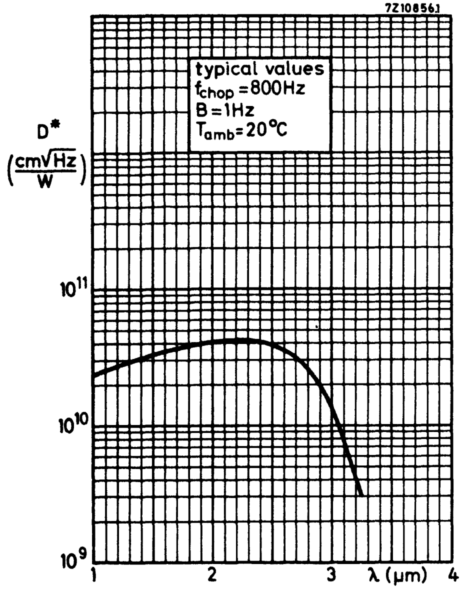

7Z10863
λ = 2μm
B = 1Hz
Tamb=20°C
F at fchop / F at 800Hz
typ
10
1
10⁻¹
10
10²
10³
10⁴
fchop (Hz)
10⁵

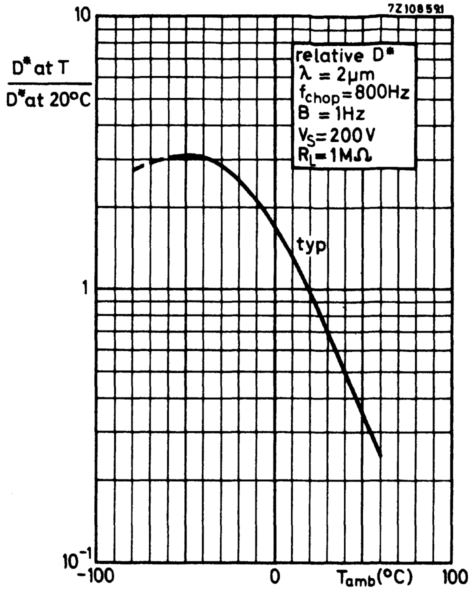

7Z10857.1
spectral response
T_{amb} = 20°C
relative response (%)
100
10
1
1
2
3
λ (μm)
4

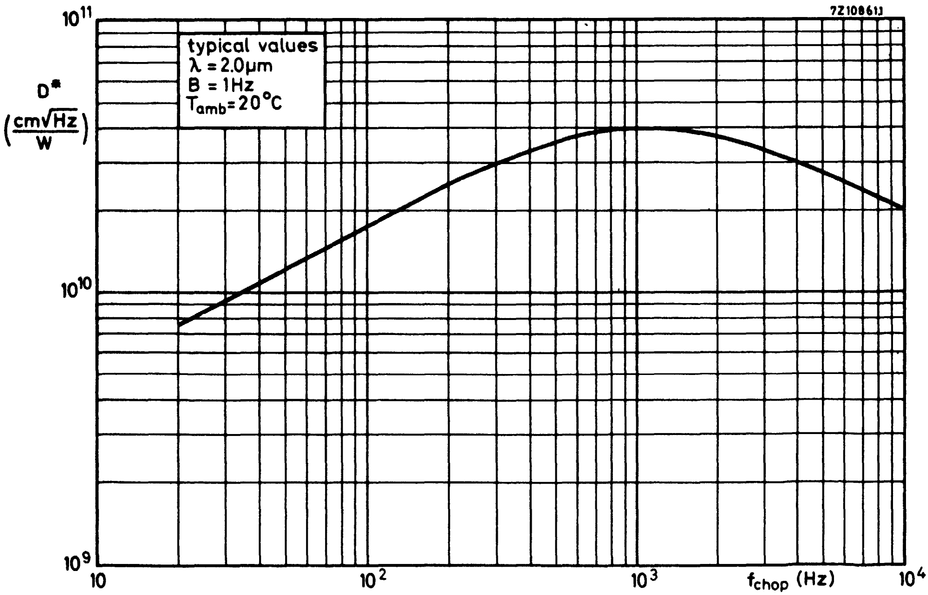

7Z10858.1
10
relative response
λ = 2μm
f_{chop} = 800Hz
B = 1Hz
V_S = 200 V
R_L = 1 MΩ
typ
1
10^{-1}
−100
0
T_{amb} (°C)
100

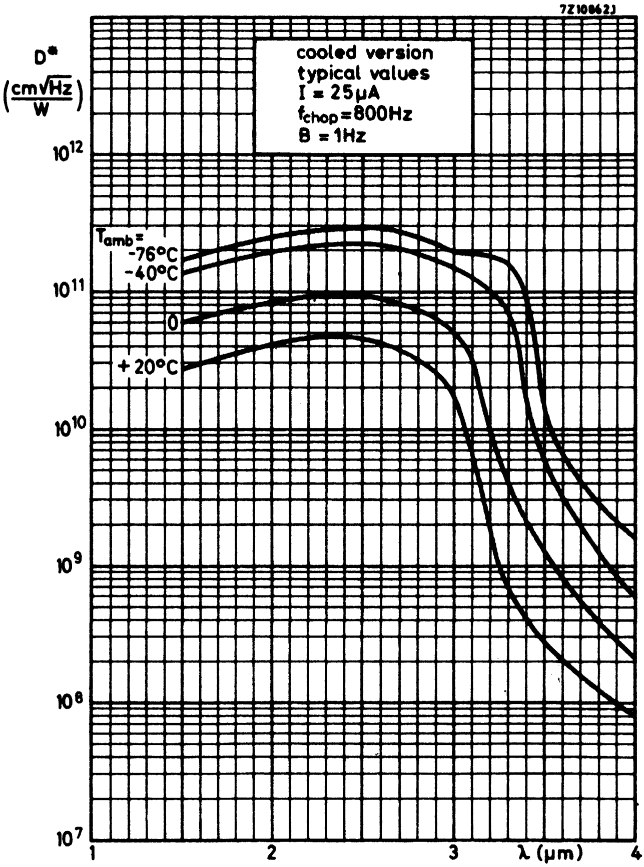

7Z10864.1
relative response (%)
typical values
λ = 2μm
B = 1Hz
T_{amb} = 20°C
100
10
1
10
10^2
10^3
10^4
f_{chop} (Hz)
10^5


7Z10865
relative response
f_{chop}=800Hz
B = 1Hz
T_{amb}=20°C
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
typ
200
400
600
800
colour temperature (K)


7Z10856.1
typical values
f_{chop} = 800Hz
B = 1Hz
T_{amb} = 20°C
D*
(cm√Hz / W)
10^{11}
10^{10}
10^{9}
1
2
3
λ (μm)
4


7Z10859.1
D* at T / D* at 20°C
10
1
10^{-1}
relative D*
λ = 2μm
f_{chop} = 800Hz
B = 1Hz
V_S = 200 V
R_L = 1MΩ
typ
−100
0
T_{amb} (°C)
100


7Z10861.1
typical values
λ = 2.0μm
B = 1Hz
T_{amb} = 20°C
D*
(cm√Hz / W)
10^{11}
10^{10}
10^{9}
10
10^{2}
10^{3}
f_{chop} (Hz)
10^{4}


7Z10862J
cooled version
typical values
I = 25μA
fchop = 800Hz
B = 1Hz
D*
(cm√Hz / W)
10^12
10^11
10^10
10^9
10^8
10^7
Tamb =
-76°C
-40°C
0
+20°C
1
2
3
λ (μm)
4

Photoconductive devices

TYPE SELECTION CHART

	$P_{tot\ max}$ at T_{amb} = 25 °C (mW)	on-off services	measuring purposes
hermetically sealed	10		RPY33
	50		RPY71
	70	ORP60, ORP61, ORP66	
	100	ORP62, ORP68, ORP69	
	225	RPY17, RPY41	
	400	ORP50, ORP52	
	500	RPY18, RPY19	
	1000	ORP23, ORP90, RPY20, RPY27, RPY55	
plastic	100	RPY58A	
lacquered	300	RPY82	
	500	RPY85	
	750	RPY84	

GENERAL OPERATIONAL RECOMMENDATIONS PHOTOCONDUCTIVE DEVICES

1. GENERAL

1.1 These application directions are valid for all types of photoconductive cells, unless otherwise stated on the individual technical data sheets.

1.2 A photoconductive device is a light-sensitive device whose resistance varies with the illumination on the device.

1.3 Where the term illumination is used in the following sections it shall be taken to mean the radiant energy which is normally used to excite the device.

1.4 Also in the following sections, history is taken to mean the duration of the specified conditions plus a sufficient description of previous conditions.

2. OPERATING CHARACTERISTICS

2.1 The data given on the individual technical data sheets are based on the devices being uniformly illuminated.

2.2 The illumination resistance is the ratio of the voltage across the device to the current through the device when illumination is applied to the device.

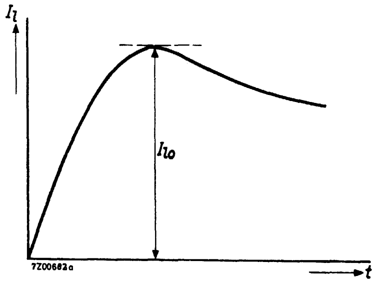
2.2.1 For a particular set of conditions the equilibrium illumination resistance is the illumination resistance after such a time under these conditions that the rate of change of the illumination resistance is less than 1% per 5 minutes.

2.2.2 For a particular set of conditions the initial illumination resistance is the first virtually constant value of the illumination resistance after a period of storage or other operating conditions.
The initial-illumination resistance usually occurs after a few seconds under the specified conditions.

2.3 The illumination current is the current which passes when a voltage and illumination are applied to the device.

2.3.1 For a particular set of conditions the equilibrium illumination current is the illumination current after such a time under these conditions that the rate of change of the illumination current is less than 1% per 5 minutes.

2.3.2 For a particular set of conditions the initial illumination current is the first virtually constant value of the illumination current after a period of storage or other operating conditions.
The initial illumination current usually occurs after a few seconds under the specified conditions.



2.4 The dark resistance is the resistance of the device in the absence of illumination.

2.4.1 For a particular set of conditions the equilibrium dark resistance is the dark resistance after such a time under these conditions that the rate of change of the dark resistance is less than 2% per 5 minutes.

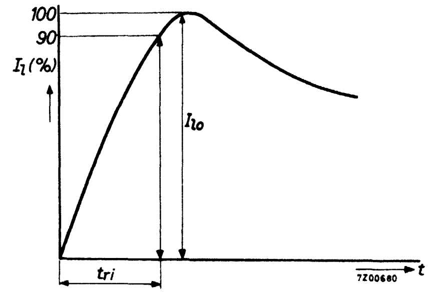
2.4.2 For a particular set of conditions the initial dark resistance is the dark resistance after a specified time under these conditions following a specified history.

2.5 The dark current is the current which passes when a voltage is applied to the device in the absence of illumination.

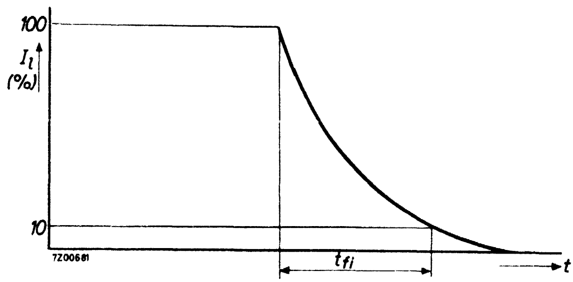
2.5.1 For a particular set of conditions the equilibrium dark current is the dark current after such a time under these conditions that the rate of change of the dark current is less than 2% per 5 minutes.

2.5.2 For a particular set of conditions the initial dark current is the dark current after a specified time under these conditions immediately following a specified history.

2.6.1 For a particular set of conditions and history the current rise time is the time taken for the current through the device to rise to 90% to its initial illumination current measured from the instant of starting the illumination.



2.6.2 For a particular set of conditions and history the current decay time is the time taken for the current through the device to fall to 10% of its value at the instant of stopping the illumination, measured from that instant.



2.7 The illumination sensitivity is the quotient of illumination current by the incident illumination.

2.8 The illumination resistance (current) temperature response is the relationship between the illumination resistance (current) and the ambient temperature of the device under constant illumination and voltage conditions.

2.9 For a particular set of conditions the initial drift is the difference between the equilibrium and initial illumination current, expressed as a percentage of the initial illumination current.

2.10 The illumination response is the relationship between the initial illumination resistance and the illumination, defined as $\frac{\Delta \log r_{lo}}{\Delta \log E}$

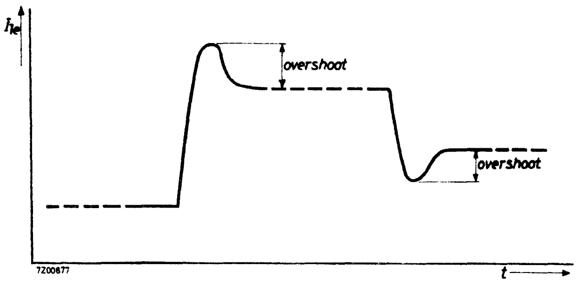
3. THERMAL DATA

3.1 Ambient temperature. The ambient temperature of a device is the temperature of the surrounding air of that device in its practical situation, which means that other elements in the same space or apparatus must have their normal maximum dissipation and that the same apparatus envelope must be used. This ambient temperature can normally be measured by using a mercury thermometer the mercury container of which has been blackened, placed at a distance of 5 mm from the envelope in the horizontal plane through the centre of the effective area of the CdS tablet.
It shall be exposed to substantially the same radiant energy as that incident on the CdS tablet.

3.2 The thermal resistance of a device is defined as the temperature difference between the hottest point of the device and the dissipating medium, divided by the power dissipated in the device.

4. OPERATIONAL NOTES

4.1 When a photoconductive device is subjected to a change of operating conditions there may be a transient change of current in excess of that due to the difference between the equilibrium illumination currents. This transient change is called overshoot.



4.2 Direct sunlight irradiation should be avoided.

5. MOUNTING

5.1 If no restrictions are made on the individual published data sheets, the device may be mounted in any position.

5.2 Most of the photoconductive devices may be soldered directly into the circuit, which is indicated on the individual published data sheets. However, the heat conducted to the seal of the device should be kept to a minimum by the use of a thermal shunt. If not otherwise indicated, the device may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 seconds up to a point 5 mm from the seals.

6. **STORAGE**

It is recommended that the devices be stored in the dark. At any rate direct sunlight irradiation should be avoided.

7. **LIMITING VALUES**

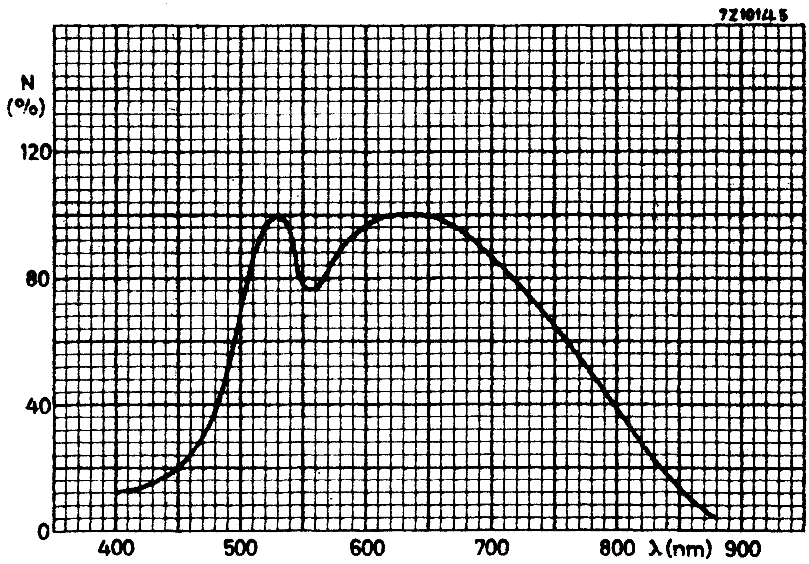
The limiting values of photoconductive devices are given in the absolute maximum rating system.

8. **OUTLINE DIMENSIONS**

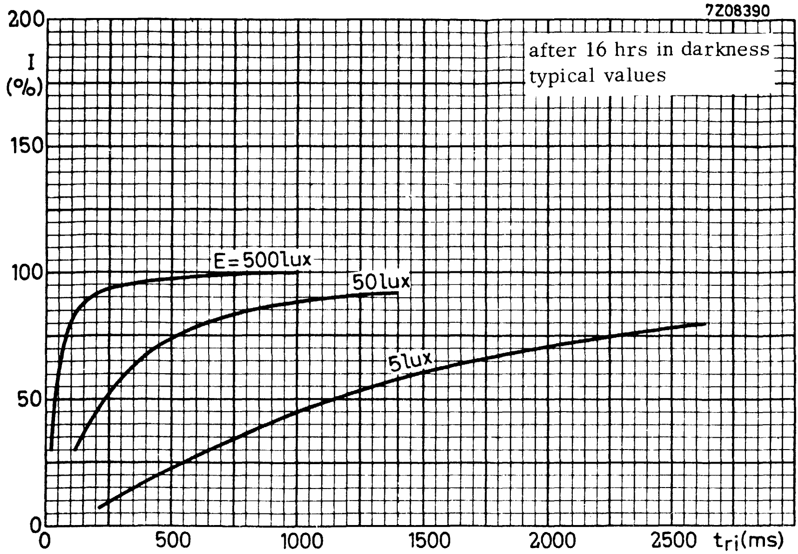
The outline dimensions are given in mm.

9. **MECHANICAL ROBUSTNESS**

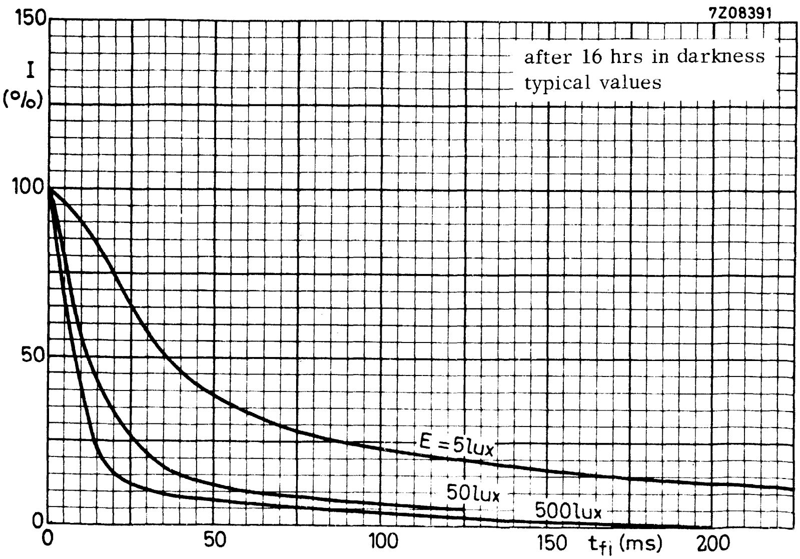
The conditions for shock and vibration given on the individual data sheets are intended only to give an indication of the mechanical quality of the device. It is not advisable to subject the device to such conditions.



Type D response curve



Current rise curves for cells with type D response curve



Current decay curves for cells with type D response curve

LIST OF SYMBOLS

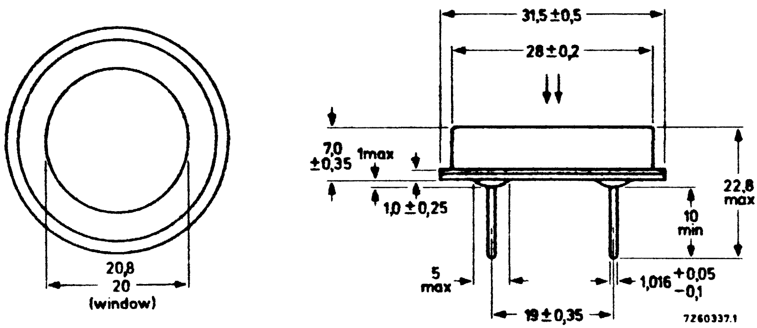
Cell voltage	V
Cell current	I
Illumination current	I_l
Initial illumination current	I_{lo}
Equilibrium illumination current	I_{le}
Dark current	I_d
Initial dark current	I_{do}
Equilibrium dark current	I_{de}
Illumination resistance	r_l
Initial illumination resistance	r_{lo}
Equilibrium illumination resistance	r_{le}
Dark resistance	r_d
Initial dark resistance	r_{do}
Equilibrium dark resistance	r_{de}
Current rise time	t_{ri}
Current decay time	t_{fi}
Pulse duration	t_p (t_{imp})
Averaging time	t_{av}
Pulse repetition rate	prr
Illumination sensitivity	N
Illumination response	γ
Voltage response	α
Ambient temperature	T_{amb}
Thermal resistance	R_{th} (K)
Temperature of CdS tablet	T_{tablet}
Colour temperature	T_c (T_K)
Dissipation	P
Illumination	E
Initial drift	D_o
Peak value (subscript)	M

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Top sensitive cadmium sulphide photoconductive cell in hermetically sealed metal envelope with glass window intended for use in general control circuits such as twilight switches and flame failure circuits.
The cell is shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	1	W
Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell resistance at 50 lx, 2700 K colour temperature	r_{lo}	typ.	3.3	kΩ
Spectral response, current rise and decay curves			type D	
Outline dimensions		max.	32 dia. x 7,6	mm

MECHANICAL DATA Dimensions in mm



ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and the time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only check points of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic charactersitics at T_{amb} = 25 °C, illumination with colour temperature of 2700 K and at delivery

Initial dark resistance measured with 400 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	>	10	MΩ	1)
Equilibrium dark resistance measured with 400 V d.c. applied via 1 MΩ, 30 min after switching off the illumination	r_{de}	>	80	MΩ	1)
Initial illumination resistance measured with 10 V d.c., illumination = 50 lx, after 16 h in darkness 2)	r_{lo}	 typ.	2 to 8,9 3,3	kΩ kΩ	
Equilibrium illumination resistance measured with 10 V d.c., illumination = 50 lx, after 15 min under the measuring conditions	r_{le}	 typ.	2 to 12,2 4,2	kΩ kΩ	
Negative temperature response of illumination resistance		typ. <	0,2 0,5	%/°C %/°C	
Voltage response $\frac{r \text{ at } 0.5 \text{ V d.c.}}{r \text{ at } 10 \text{ V d.c.}}$		typ.	1,05		
Insulation resistance between cell and envelope, measured with 400 V d.c. via 1 MΩ	r_{ins}	>	200	MΩ	

1) The spread of the dark resistance is large and values higher than 100 MΩ and 1000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

2) After 16 hours in darkness changes in the CdS material are still ocurring but have only insignificant effect on the illumination resistance.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell voltage, pulse, $t_p \leq 5$ ms $p_{rr} \leq$ once per minute	V_M	max.	1500	V
Insulation voltage, d.c. and repetitive peak	V_{ins}	max.	400	V
Insulation voltage, pulse, between cell and envelope, $t_p \leq 5$ ms, $p_{rr} \leq$ once per min	V_{ins}	max.	1500	V
Power dissipation (t_{av} = 2 s) see graph P_{max}				
Power dissipation, pulse	P_M	max.	5 x P_{max}	
Cell current, d.c. and repetitive peak	I	max.	150	mA
Illumination	E	max.	50 000	lx
Temperature CdS tablet, operating	T_{tablet}	max.	85	°C
Ambient temperature, storage and operating	T_{amb}	min.	-40	°C
storage	T_{stg}	max.	50	°C [1])
operating	T_{amb}	max.	70	°C

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in illumination resistance of the cells during life under rated load from -30 % to +70 % (typ. +40 %) do not impair the circuit performance. Direct irradiation by sunlight should be avoided.

MECHANICAL ROBUSTNESS

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95 % of the devices pass these tests without perceptible damage.

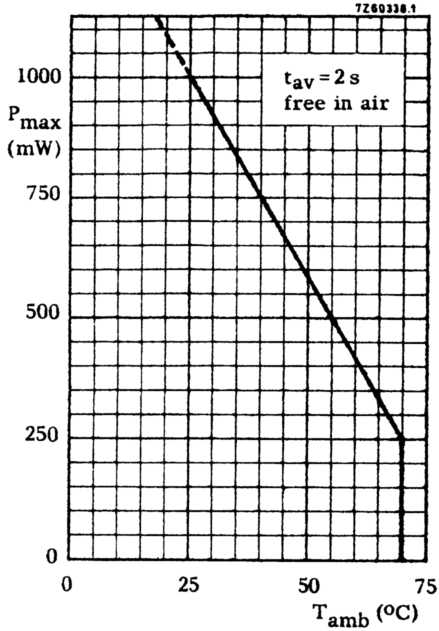
Shock

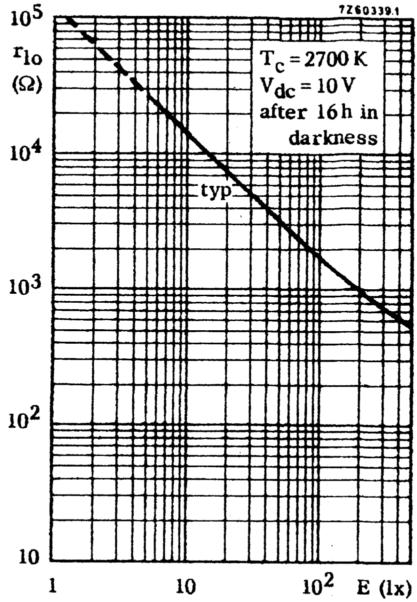
25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

Vibration

2,5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

[1]) Operating of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z60338.1
1000
P max (mW)
750
500
250
0
0
25
50
75
T amb (°C)
t av = 2 s
free in air


7Z60339.1
10^5
r lo (Ω)
10^4
10^3
10^2
10
1
10
10^2
E (lx)
T c = 2700 K
V dc = 10 V
after 16 h in darkness
typ

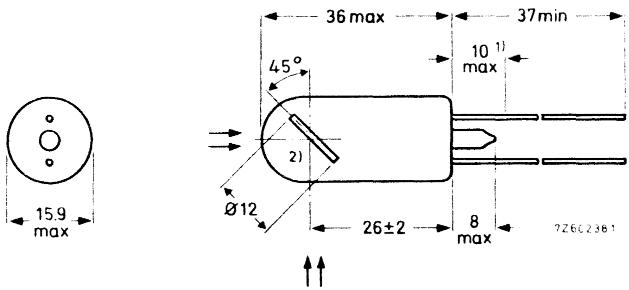
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Top and side sensitive cadmium sulphide photoconductive cell in hermetically sealed all-glass envelope intended for on-off applications such as flame failure circuits.
The cell is shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	0, 36	W
Cell voltage, d.c. and repetitive peak	V	max.	300	V
Cell resistance at 50 lx, 2700 K colour temperature	r_{lo}	typ.	2700	Ω
Spectral response, current rise and decay curves			type D	
Outline dimensions		max.	15, 9 dia. x 44	mm

MECHANICAL DATA

Dimensions in mm



Soldering

The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dipsoldered at a solder temperature of 240 °C for maximum 10 s up to a point 5 mm from the seals.

1) Not tinned.
2) Centre of sensitive area.

→ ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and the time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 K and at delivery

Initial dark resistance measured with 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	>	5	MΩ [1]
Equilibrium dark resistance measured with 300 V d.c. applied via 1 MΩ, 30 min after switching off the illumination	r_{de}	>	100	MΩ [1]
Initial illumination resistance measured with 20 V d.c., illumination = 50 lx, after 16 h in darkness [2] [3]	r_{lo}		1300 to 6200	Ω
		typ.	2700	Ω
Equilibrium illumination resistance measured with 20 V d.c., illumination = 50 lx, after 15 min under the measuring conditions [3]	r_{le}	typ.	3400	Ω
Negative temperature response of illumination resistance		typ.	0,2	%/°C
		<	0,5	%/°C
Voltage response $\frac{\text{r at 0,5 V d.c.}}{\text{r at 20 V d.c.}}$		typ.	1,1	

[1] The spread of the dark resistance is large and values higher than 10 MΩ and 100 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

[2] After 16 hours in darkness changes in the CdS material are still occurring but have only insignificant effect on the illumination resistance.

[3] Measured at top sensitivity.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Cell voltage, d.c. and repetitive peak	V	max.	300	V
Cell voltage, pulse, $t_p \leq 5$ ms $p_{rr} \leq$ once per minute	V_M	max.	500	V
Power dissipation (t_{av} = 2 s) see graph P_{max}				
Power dissipation, pulse	P_M	max.	5 x P_{max}	
Cell current, d.c. and repetitive peak	I	max.	100	mA
Illumination	E	max.	50 000	lx
Temperature CdS tablet, operating	T_{tablet}	max.	85	^oC
Ambient temperature, storage and operating	T_{amb}	min.	-40	^oC
storage	T_{stg}	max.	50	^oC [1]
operating	T_{amb}	max.	70	^oC

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in illumination resistance of the cells during life under rated load from −30 % to +70 % (typ. +40 %) do not impair the circuit performance. Direct irradiation by sunlight should be avoided.

MECHANICAL ROBUSTNESS

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95 % of the devices pass these tests without perceptible damage.

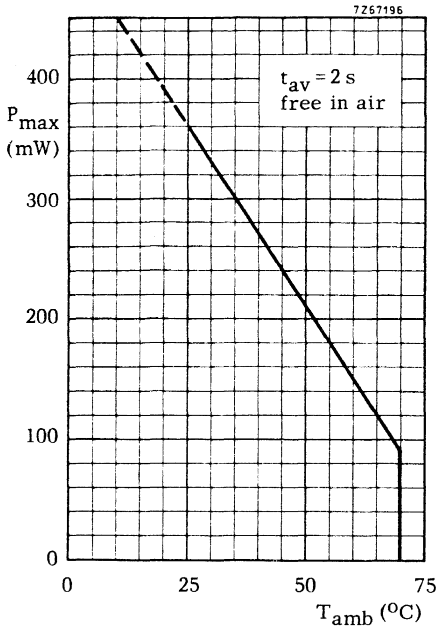
Shock

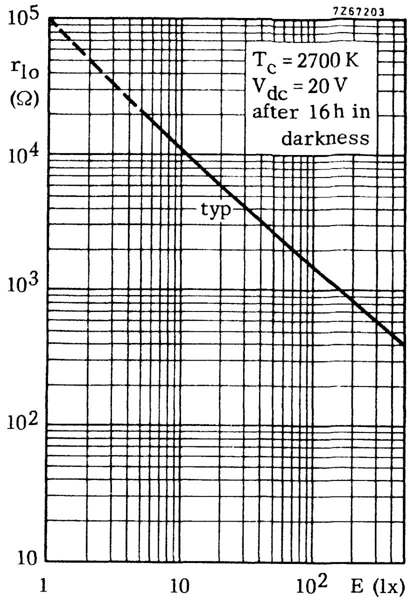
25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

Vibration

2,5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

[1]) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z67196
400
300
200
100
0
Pmax
(mW)
0
25
50
75
Tamb (°C)
tav = 2 s
free in air


7Z67203
10^5
10^4
10^3
10^2
10
rlo
(Ω)
1
10
10^2
E (lx)
Tc = 2700 K
Vdc = 20 V
after 16 h in
darkness
typ

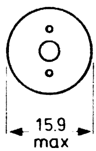
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

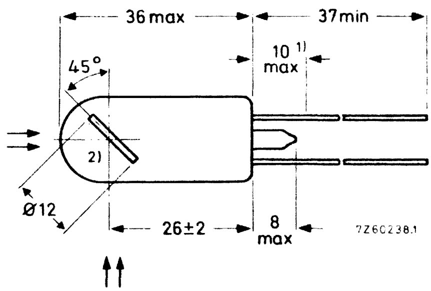
Top and side sensitive cadmium sulphide photoconductive cell in hermetically sealed all-glass envelope intended for on-off applications such as flame failure circuits.
The cell is shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	0,4	W
Cell voltage, d.c. and repetitive peak	V	max.	200	V
Cell resistance at 50 lx, 2700 K colour temperature	r_{lo}	typ.	1200	Ω
Spectral response, current rise and decay curves			type D	
Outline dimensions		max.	15,9 dia. x 44	mm

MECHANICAL DATA

Dimensions in mm





Soldering

The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dipsoldered at a solder temperature of 240 °C for maximum 10 s up to a point 5 mm from the seals.

---

1) Not tinned.
2) Centre of sensitive area.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only check points of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 K and at delivery

Initial dark resistance measured with 200 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	>	4	MΩ [1]
Equilibrium dark resistance measured with 200 V d.c. applied via 1 MΩ, 30 min after switching off the illumination	r_{de}	>	100	MΩ [1]
Initial illumination resistance measured with 10 V d.c., illumination = 50 lx, after 16 h in darkness [2] [3]	r_{lo}		750 to 3000	Ω
		typ.	1200	Ω
Equilibrium illumination resistance measured with 10 V d.c., illumination = 50 lx, after 15 min under the measuring conditions	r_{le}		750 to 4100	Ω
		typ.	1500	Ω
Negative temperature response of illumination resistance		typ.	0,2	%/°C
		<	0,5	%/°C
Voltage response $\frac{r \text{ at } 0{,}5 \text{ V d.c.}}{r \text{ at } 10 \text{ V d.c.}}$		typ.	1,05	

[1]) The spread of the dark resistance is large and values higher than 100 MΩ and 1000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

[2]) After 16 hours in darkness changes in the CdS material are still occurring but have only insignificant effect on the illumination resistance.

[3]) Measured at top sensitivity.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Cell voltage, d.c. and repetitive peak	V	max.	200	V
Cell voltage, pulse, $t_p \leq 5$ ms $p_{rr} \leq$ once per minute	V_M	max.	500	V
Power dissipation (t_{av} = 2 s) see graph P_{max}				
Power dissipation, pulse	P_M	max.	5 x P_{max}	
Cell current, d.c. and repetitive peak	I	max.	100	mA
Illumination	E	max.	50 000	lx
Temperature CdS tablet, operating	T_{tablet}	max.	85	°C
Ambient temperature, storage and operating	T_{amb}	min.	−40	°C
storage	T_{stg}	max.	50	°C [1]
operating	T_{amb}	max.	70	°C

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in illumination resistance of the cells during life under rated load from −30 % to +70 % (typ. +40 %) do not impair the circuit performance. Direct irradiation by sunlight should be avoided.

MECHANICAL ROBUSTNESS

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95 % of the devices pass these tests without perceptible damage.

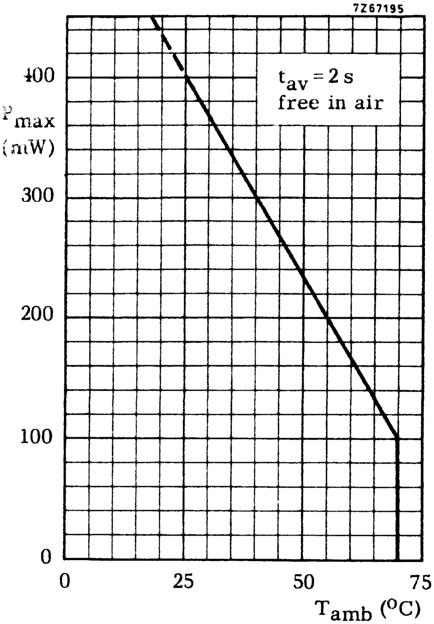
Shock

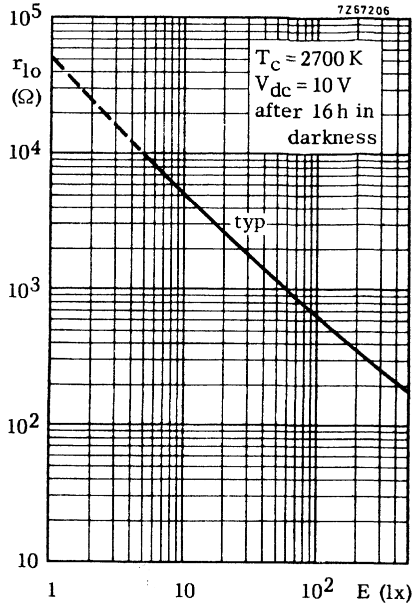
25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

Vibration

2,5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

[1]) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z67195
P_{max} (mW)
400
300
200
100
0
0
25
50
75
T_{amb} (°C)
t_{av} = 2 s
free in air


7Z67206
r_{lo} (Ω)
10^5
10^4
10^3
10^2
10
1
10
10^2
E (lx)
T_c = 2700 K
V_{dc} = 10 V
after 16 h in
darkness
typ

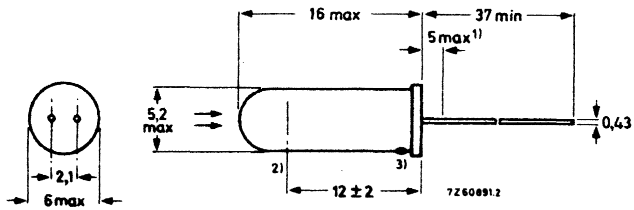
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

Top sensitive cadmium sulphide photoconductive cells in hermetically sealed all-glass envelope intended for on-off applications such as flame failure circuits, and for automatic brightness and contrast control in television receivers.
The cells are shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	70	mW
Cell voltage, d.c. and repetitive peak	V	max.	350	V
Cell resistance at 50 lx, 2700 K colour temperature, ORP60	r_{lo}	typ.	60	kΩ
ORP66	r_{lo}	<	55	kΩ
Spectral response, current rise and decay curves			type D	
Outline dimensions		max.	6 dia. x 16	mm

MECHANICAL DATA

Dimensions in mm



Soldering

The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dipsoldered at a solder temperature of 240 °C for maximum 10 s up to a point 5 mm from the seals.

[1]) Not tinned.
[2]) Sensitive surface.
[3]) Blue dot on ORP66.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only check points of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 K and at delivery

			ORP60	ORP66	
Initial dark resistance measured at 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	>	200	200	MΩ [1]
Initial illumination resistance measured at 30 V d.c., illumination = 50 lx, after 16 hrs in darkness [2]		>	37,5	-	kΩ
	r_{lo}	typ.	60	-	kΩ
		<	150	55	kΩ
Equilibrium illumination resistance measured at 30 V d.c., illumination = 50 lx, after 15 min under the measuring conditions		>	37,5	-	kΩ
	r_{le}	typ.	75	-	kΩ
		<	190	90	kΩ
Negative temperature response of illumination resistance		typ.	0,2		%/°C
		<	0,5		%/°C
Voltage response $\frac{\text{r at 0,5 V d.c.}}{\text{r at 30 V d.c.}}$	α	typ.	1,5		

[1] The spread of the dark resistance is large and values higher than 1000 MΩ are possible for the initial dark resistance.

[2] After 16 hours in darkness changes in the CdS material are still occurring but have only insignificant effect on the illumination resistance.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Cell voltage d.c. and repetitive peak	V	max.	350	V	
Cell voltage, pulse, $t_p \leq 5$ ms, $p_{rr} \leq$ once per minute	V_M	max.	500	V	
Power dissipation (t_{av} = 2 s) see graph P_{max}					
Power dissipation, pulse	P_M	max.	5 x P_{max}		
Illumination	E	max.	50 000	lx	
Temperature CdS tablet, operating	T_{tablet}	max.	85	°C	
Ambient temperature, storage and operation	T_{amb}	min.	-40	°C	
storage	T_{stg}	max.	50	°C	1)
operating	T_{amb}	max.	70	°C	

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in illumination resistance of the cells during life under rated load from -50 % to +100 % (typ. +50 % do not impair the circuit performance. Direct irradiation by sunlight should be avoided.

MECHANICAL ROBUSTNESS

An indication for the ruggedness of the device is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95 % of the devices pass these tests without perceptible damage.

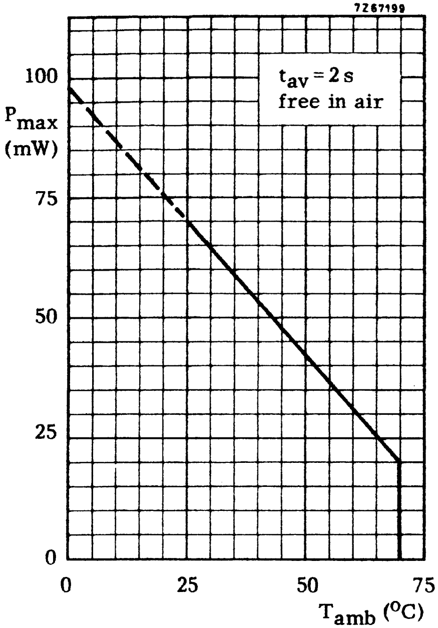
Shock

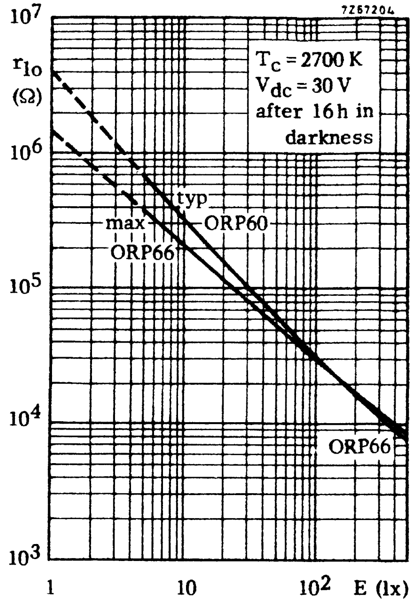
25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

Vibration

2,5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

1) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z67199
t_{av} = 2 s
free in air
P_{max} (mW)
100
75
50
25
0
0
25
50
75
T_{amb} (°C)

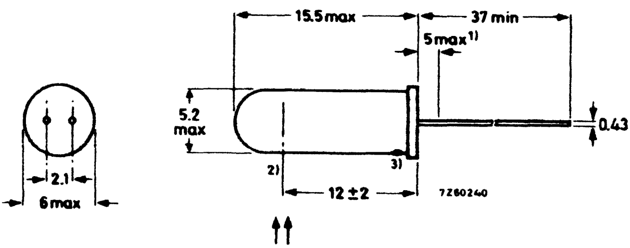

7Z67204
r_{lo} (Ω)
10^7
10^6
10^5
10^4
10^3
T_c = 2700 K
V_{dc} = 30 V
after 16 h in darkness
typ
max
ORP60
ORP66
ORP66
1
10
10^2
E (lx)

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

Side sensitive cadmium sulphide photoconductive cells in hermetically sealed all-glass envelope intended for on-off applications such as flame failure circuits, and for automatic brightness and contrast control in television receivers.
The cells are shock and vibration resistant.

QUICK REFERENCE DATA				
			ORP61	ORP62
Power dissipation at T_{amb} = 25 °C	P	max.	70	100 mW
Cell voltage, d.c. and repetitive peak	V	max.	350	350 V
Cell resistance at 50 lx, 2700 K colour temperature	r_{lo}	typ.	60	45 kΩ
Spectral response, current rise and decay curves			type D	
Outline dimensions		max.	6 dia. x 15,5 mm	

MECHANICAL DATA Dimensions in mm



Soldering

The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dipsoldered at a solder temperature of 240 °C for maximum 10 s up to a point 5 mm from the seals.

1) Not tinned
2) Centre of sensitive area
3) ORP61 brown dot; ORP62 red dot.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only check points of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 K and at delivery.

			ORP61	ORP62	
Initial dark resistance measured at 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	>	200	150	MΩ [1]
Initial illumination resistance		>	37,5	30	kΩ
measured at 30 V d.c., illumination = 50 lx,	r_{lo}	typ.	60	45	kΩ
after 16 hrs in darkness [2]		<	150	100	kΩ
Equilibrium illumination resistance		>	37,5	30	kΩ
measured at 30 V d.c., illumination = 50 lx,	r_{le}	typ.	75	60	kΩ
after 15 min under the measuring conditions		<	190	170	kΩ
Negative temperature response of illumination resistance		typ.	0,2	0,2	%/°C
		<	0,5	0,5	%/°C
Voltage response $\frac{r \text{ at } 0,5 \text{ V d.c.}}{r \text{ at } 30 \text{ V d.c.}}$	α	typ.	1,5	1,4	

1) The spread of the dark resistance is large and values higher than 1000 MΩ are possible for the initial dark resistance.

2) After 16 hours in darkness changes in the CdS material are still occurring but have only insignificant effect on the illumination resistance.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Cell voltage, d.c. and repetitive peak	V	max.	350	V	
Cell voltage, pulse, $t_p \leq 5$ ms, $p_{rr} \leq$ once per minute – ORP61	V_M	max.	500	V	
ORP62	V_M	max.	1000	V	
Power dissipation (t_{av} =2 s) see graph P_{max}					
Power dissipation, pulse	P_M	max.	5 x P_{max}		
Illumination	E	max.	50 000	lx	
Temperature CdS tablet, operating	T_{tablet}	max.	85	°C	
Ambient temperature, storage and operation	T_{amb}	min.	−40	°C	
storage	T_{stg}	max.	50	°C	1)
operating	T_{amb}	max.	70	°C	

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that under rated load, during life, changes in illumination resistance - for ORP61 from −50 % to +100 % (typ. +50 %) and for ORP62 from −30 % to +70 % (typ. +40 %) - do not impair the circuit performance.
Direct irradiation by sunlight should be avoided.

MECHANICAL ROBUSTNESS

An indication for the ruggedness of the device is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95 % of the devices pass these tests without perceptible damage.

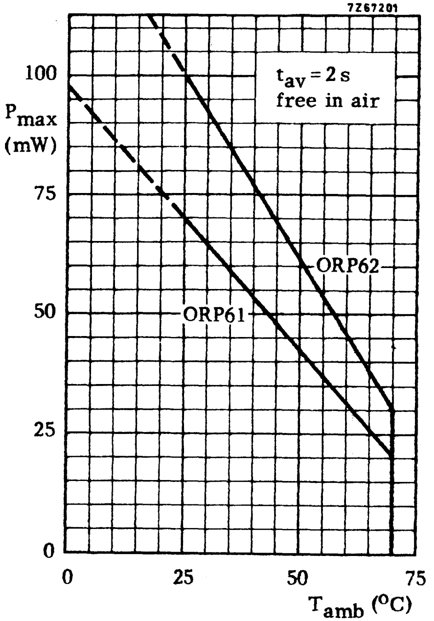
Shock

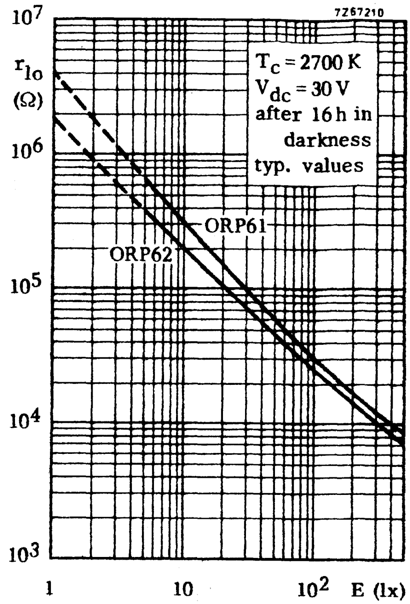
25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

Vibration

2,5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

1) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z67201
t_{av} = 2 s
free in air
P_{max}
(mW)
100
75
50
25
0
0
25
50
75
T_{amb} (°C)
ORP62
ORP61


7Z67210
T_c = 2700 K
V_{dc} = 30 V
after 16 h in
darkness
typ. values
r_{lo}
(Ω)
10^7
10^6
10^5
10^4
10^3
1
10
10^2
E (lx)
ORP61
ORP62

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

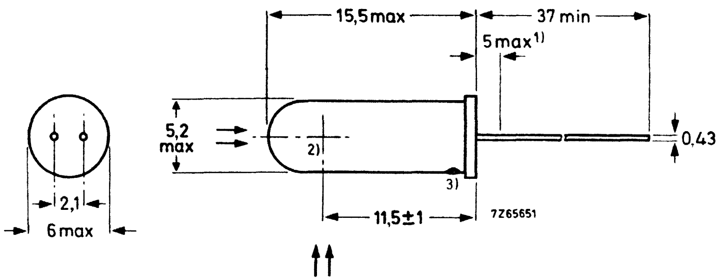
See data ORP60; ORP66

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

Top and side sensitive cadmium sulphide photoconductive cells in hermetically sealed all-glass envelope intended for on-off applications such as flame failure circuits, and for automatic brightness and contrast control in television receivers.
The cells are shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	100	mW
Cell voltage, d.c. and repetitive peak	V	max.	350	V
Cell resistance at 50 lx, 2700 K colour temperature, ORP68	r_{10}	typ.	64	kΩ
ORP69	r_{10}	typ.	30	kΩ
Spectral response, current rise and decay curves			type D	
Outline dimensions		max.	6 dia. x 15,5	mm

MECHANICAL DATA Dimensions in mm



Soldering

The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dipsoldered at a solder temperature of 240 °C for maximum 10 s up to a point 5 mm from the seals.

1) Not tinned.
2) Centre of sensitive area.
3) ORP68: gray dot; ORP69: white dot.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and the time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only check points of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 K and at delivery

			ORP68	ORP69	
Initial dark resistance measured with 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	>	150	100	MΩ [1]
Initial illumination resistance		>	30	20	kΩ
measured at 30 V d.c., illumination = 50 lx,	r_{lo}	typ.	46	30	kΩ
after 16 h in darkness [2] [3]		<	100	60	kΩ
Equilibrium illumination resistance		>	30	27	kΩ
measured at 30 V d.c., illumination = 50 lx,	r_{le}	typ.	60	46	kΩ
after 15 min under the measuring conditions		<	170	115	kΩ
Negative temperature response of		typ.	0,2		%/°C
illumination resistance		<	0,5		%/°C
Voltage response $\frac{\text{r at 0,5 V d.c.}}{\text{r at 30 V d.c.}}$		typ.	1,4		

[1] The spread of the dark resistance is large and values higher than 1000 MΩ are possible for the initial dark resistance.

[2] After 16 hours in darkness changes in the CdS material are still occurring but have only insignificant effect on the illumination resistance.

[3] Measured at top sensitivity.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Cell voltage, d.c. and repetitive peak	V	max.	350	V
Cell voltage, pulse, $t_p \leq 5$ ms, $p_{rr} \leq$ once per minute - ORP68	V_M	max.	1000	V
ORP69	V_M	max.	700	V
Power dissipation (t_{av} = 2 s) see graph P_{max}				
Power dissipation, pulse	P_M	max.	5 x P_{max}	
Illumination	E	max.	50 000	lx
Temperature of CdS tablet, operating	T_{tablet}	max.	+85	°C
Ambient temperature, storage and operating	T_{amb}	min.	−40	°C
storage	T_{stg}	max.	+50	°C [1]
operating	T_{amb}	max.	+70	°C

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be so designed that changes in illumination resistance of the cells during life under rated load from −30 % to +70 % (typ. +40 %) do not impair the circuit performance. Direct irradiation by sunlight should be avoided.

MECHANICAL ROBUSTNESS

An indication of the ruggedness of the device is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95 % of the devices pass these tests without perceptible damage.

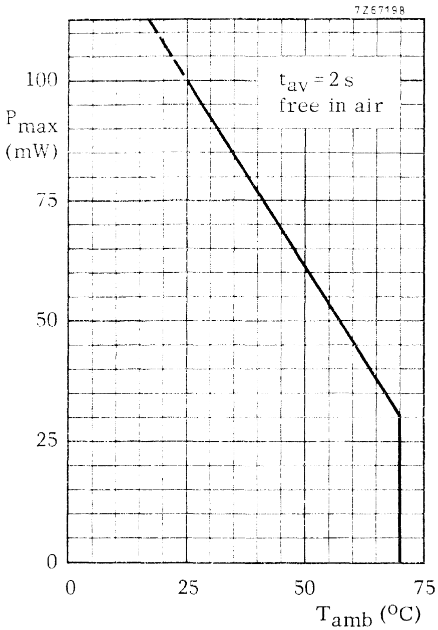
Shock

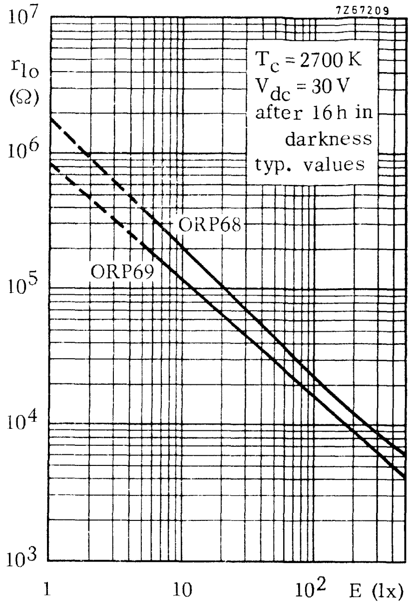
25 g_{peak}, 10 000 shocks in one of the three positions of the cell

Vibration

2,5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

[1]) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z67198
100
P_{max}
(mW)
75
50
25
0
t_{av} = 2 s
free in air
0
25
50
75
T_{amb} (°C)


7Z67209
10^7
r_{lo}
(Ω)
10^6
10^5
10^4
10^3
T_c = 2700 K
V_{dc} = 30 V
after 16 h in
darkness
typ. values
ORP68
ORP69
1
10
10^2
E (lx)

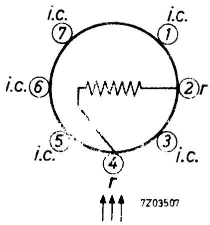
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

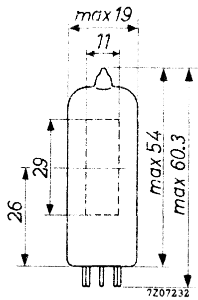
Side sensitive cadmium sulphide photoconductive cell in hermetically sealed all-glass envelope intended for use in flame control, smoke detector or industrial on-off switching applications.
The cell is shock and vibration resistant.

QUICK REFERENCE DATA

Power dissipation at T_{amb} = 25 ^{o}C	P	max.	1	W
Cell voltage, d.c. and repetitive peak	V	max.	350	V
Cell resistance at 50 lx, 2700 K colour temperature,	r_{lo}	typ.	1500	Ω
Spectral response, current rise and decay curves			type D	
Outline dimensions		max.	19 dia.x 60,3	mm

MECHANICAL DATA Dimensions in mm





Base : 7 p. miniature

Total area to be illuminated 1,1 x 2,9 cm^2

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only check points of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 K and at delivery.

Initial dark resistance measured with 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	>	42	MΩ [1]
Equilibrium dark resistance measured with 300 V d.c. applied via 1 MΩ, 30 min after switching off the illumination	r_{de}	>	120	MΩ [1]
Initial illumination resistance measured at 10 V d.c., illumination = 50 lx, after 16 hrs in darkness [2]	r_{lo}		700 to 3300	Ω
		typ.	1500	Ω
Equilibrium illumination resistance measured at 10 V d.c., illumination = 50 lx, after 15 min under the measuring conditions	r_{le}		700 to 4100	Ω
		typ.	1900	Ω
Negative temperature response of illumination resistance		typ.	0,2	%/°C
		<	0,5	%/°C
Voltage response $\frac{\text{r at 0,5 V d.c.}}{\text{r at 10 V d.c.}}$	α	typ.	1,05	
Initial illumination resistance measured at 10 V d.c., illumination = 50 lx, T_C = 1500 K, after 16 hrs in darkness [2]	r_{lo}		325 to 1650	Ω
		typ.	500	Ω

1) The spread of the dark resistance is large and values higher than 100 MΩ and 1000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

2) After 16 hours in darkness changes in the CdS material are still occurring but have only insignificant effect on the illumination resistance.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Cell voltage, d.c. and repetitive peak	V	max.	350	V
Cell voltage, pulse, $t_p \leq 5$ ms, $p_{rr} \leq$ once per minute	V_M	max.	500	V
Power dissipation (t_{av} = 2 s) see graph P_{max}				
Power dissipation, pulse	P_M	max.	5 x P_{max}	
Cell current, d.c. and repetitive peak	I	max.	500	mA
Illumination	E	max.	50 000	lx
Temperature CdS tablet, operating	T_{tablet}	max.	85	^oC
Ambient temperature, storage and operating	T_{amb}	min.	-40	^oC
storage	T_{stg}	max.	50	^oC [1]
operating	T_{amb}	max.	70	^oC

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in illumination resistance of the cells during life under rated load from -30% to +70% (typ. +40%) do not impair the circuit performance. Direct sunlight irradiation should be avoided.

MECHANICAL ROBUSTNESS

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

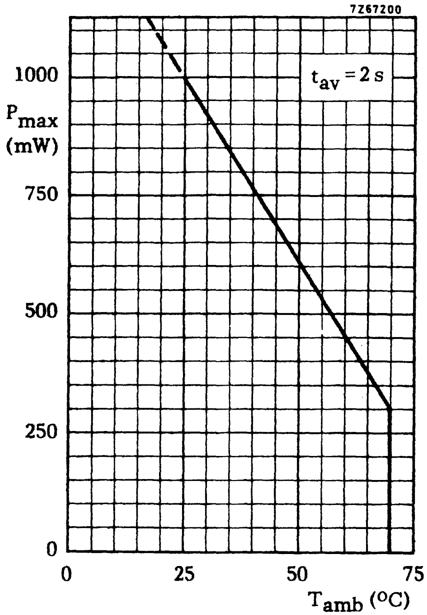
Shock

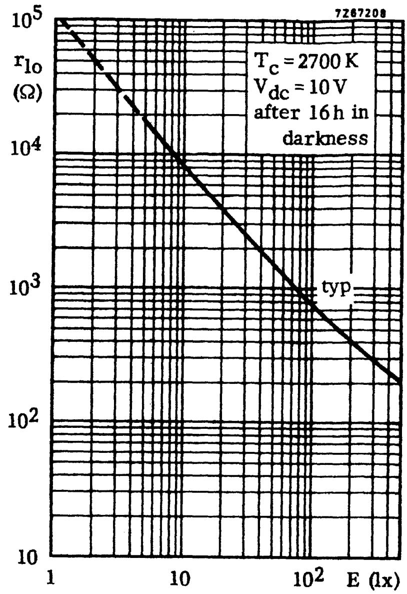
25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

Vibration

2,5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

[1] Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z67200
t_{av} = 2 s
1000
P_{max}
(mW)
750
500
250
0
0
25
50
75
T_{amb} (°C)


7Z67208
10^5
r_{lo}
(Ω)
T_c = 2700 K
V_{dc} = 10 V
after 16 h in
darkness
10^4
10^3
typ
10^2
10
1
10
10^2
E (lx)

LAMP CdS CELLS-COMBINATION

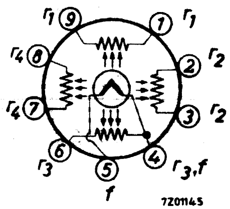
Combination of four cadmium sulphide photoconductive cells and a small incandescent lamp in a Noval envelope for use in relais circuits with low output resistance, control circuits and logic circuits.

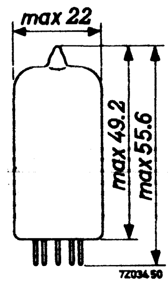
QUICK REFERENCE DATA				
Power dissipation, each cell, at T_{amb} = 25 °C	P	max.	150	mW
Cell voltage, d.c. and repetitive peak	V	max.	200	V
Cell resistance	r		15	Ω
Outline dimensions		max. 22 dia. x 55.6		mm

MECHANICAL DATA

Dimensions in mm

Base: Noval





ELECTRICAL DATA

Basic characteristics at T_{amb} = 25 °C, and at delivery

	symbol	min.	typical	max.	unit
Lamp filament voltage	V_f		24		V 2)
Lamp filament current at V_f = 24 V	I_f	54	60	66	mA
Initial dark current measured in the circuit of fig.1	I_{do}			15	μA

Basic characteristics at T_{amb} = 25 °C, and at delivery (continued)

	symbol	min.	typical	max.	unit
Initial illumination resistance measured in the circuit of fig.1 after 16 hrs in darkness [1]	r_{lo}		15	25	Ω
Resistance decay time Time to reach 400 Ω in circuit of fig.2, measured from the instant of starting the illumination after 16 hrs in darkness	t_{fr}		20		ms
Resistance rise time Time to reach 300 kΩ in circuit of fig.2, measured from the instant of stopping the illumination after 5 minutes or longer illumination	t_{rr}			1.7	s
Insulation resistance between two cells or between cell and filament measured at 300 V d.c.	r_{ins}	200			MΩ

CAPACITANCES measured at filament voltage V_f = 0 V

Between the terminals of each cell	C_r		9.5	pF
Between any cell terminal and the filament (except pins 4 and 6)	C_{rf}	max.	1	pF

REMARK

Shock and vibration should be avoided.

LIMITING VALUES (Absolute max. rating system)

Filament voltage (d.c. or r.m.s.)	V_f	max.	25.2	V	[2]
Cell voltage, d.c. and repetitive peak	V	max.	200	V	
Power dissipation of each cell at T_{amb} = 25 °C	P	max.	150	mW	[3]
Power dissipation of each cell at T_{amb} = 55 °C	P	max.	85	mW	[3]
Voltage between any pair of cells	V_{ri}-V_{rj}	max.	350	V	
Ambient temperature, operating	T_{amb}	min.	-40	°C	
		max.	+55	°C	[3]

Measuring circuit for r_{lo} and I_{do}

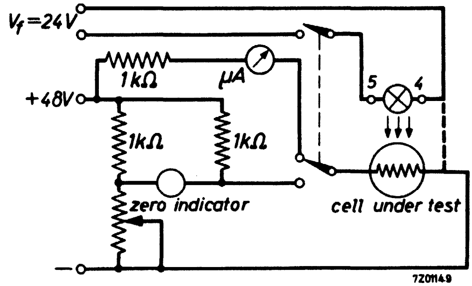


Fig.1

Measuring circuit t_{fr} and t_{rr}

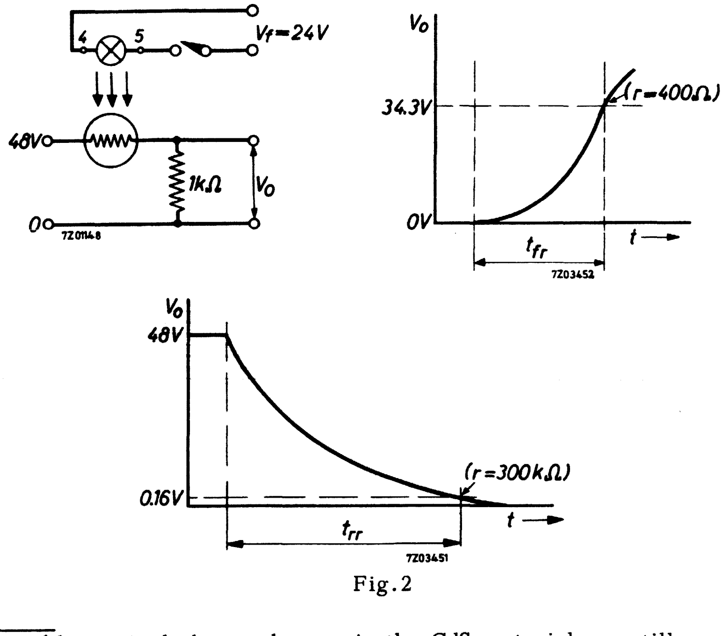
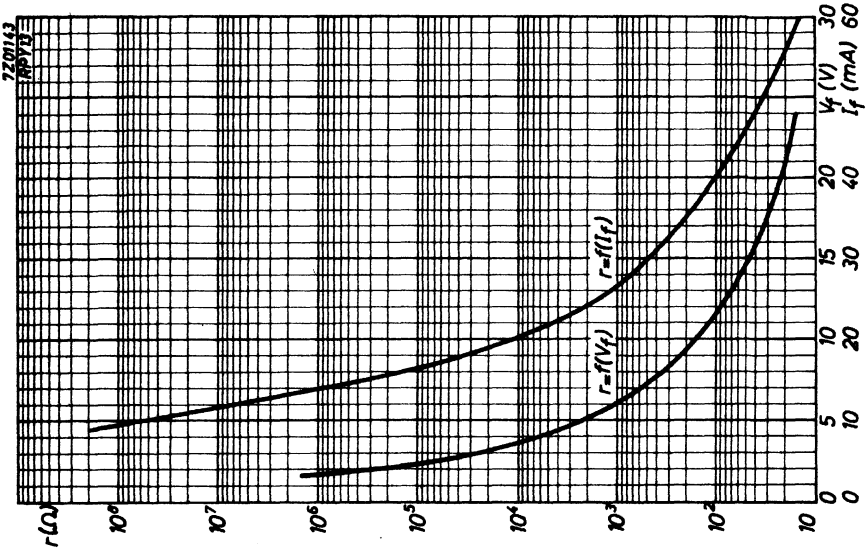


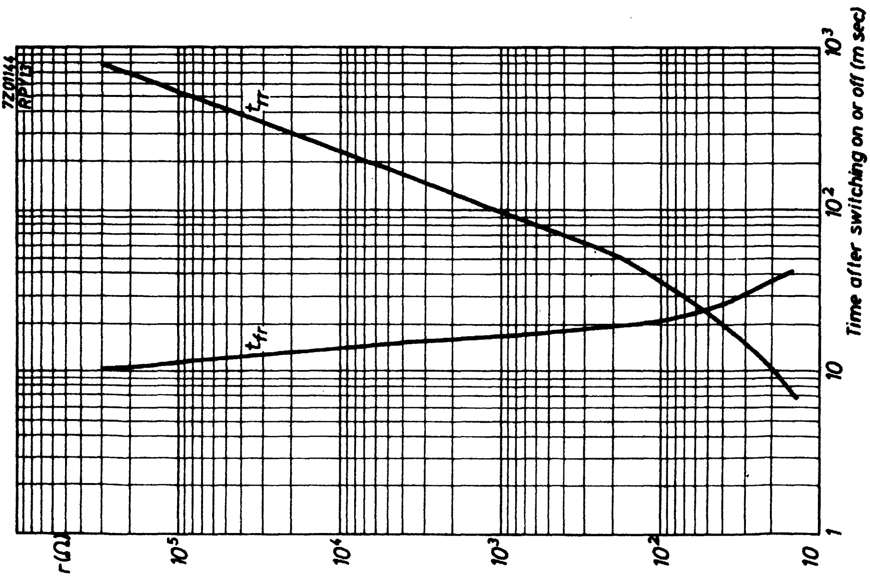
Fig.2

1) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

2) The life expectancy is considerably longer with lower values of V_f. In this respect it is recommended to apply a voltage not higher than 20 V.

3) For V_f = 24 V.


7Z01143
RPY13
r(Ω)
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10
r=f(I_f)
r=f(V_f)
0 5 10 15 20 30 V_f (V)
0 10 20 30 40 60 I_f (mA)


7Z01144
RPY13
r(Ω)
10^5
10^4
10^3
10^2
10
t_{rr}
t_{fr}
1 10 10^2 10^3
Time after switching on or off (m sec)

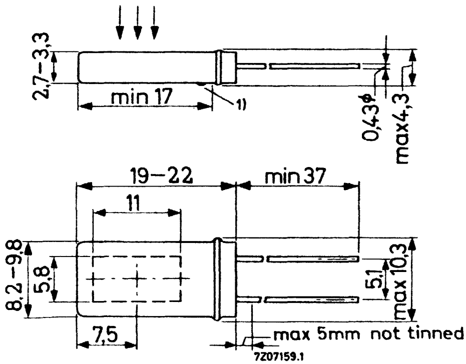
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

Side sensitive cadmium sulphide photoconductive cells in hermetically sealed all-glass envelope intended for general control circuits such as twilight switches and flame failure circuits. The high voltage type can be connected direct to the mains.
The cells are shock and vibration resistant.

QUICK REFERENCE DATA

			RPY41	RPY17	
Power dissipation at T_{amb} = 25 °C	P	max.	225	225	mW
Cell voltage, d.c. and repetitive peak	V	max.	100	400	V
Cell resistance at 50 lx, 2700 K colour temperature	r_{lo}	typ.	1,6	7	kΩ
Spectral response, current rise and decay curves			type D		
Outline dimensions		max.	22 x 10,3 x 4,3		mm

MECHANICAL DATA Dimensions in mm



Soldering

The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dipsoldered at a solder temperature of 240 °C for maximum 10 s up to a point 5 mm from the seals.

1) Violet dot indicating the type RPY17: the type RPY41 has no dot.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only check points of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 K and at delivery

			RPY41	RPY17		
Initial dark resistance V_{dc} = 100 V (RPY41) or 300 V (RPY17) applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	>	9	30	MΩ	1)
Equilibrium dark resistance V_{dc} = 100 V (RPY41) or 300 V (RPY17) applied via 1 MΩ, 30 min after switching off the illumination	r_{de}	>	100	200	MΩ	1)
Initial illumination resistance		>	0,95	4,1	kΩ	
measured at 10 V d.c., illumination = 50 lx,	r_{lo}	typ.	1,6	7	kΩ	
after 16 hrs in darkness 2)		<	4,8	21	kΩ	
Equilibrium illumination resistance		>	0,95	4,1	kΩ	
measured at 10 V d.c., illumination = 50 lx,	r_{le}	typ.	1,9	9	kΩ	
after 15 min under the measuring conditions		<	6,2	29	kΩ	
Negative temperature response of		typ.	0,2	0,2	%/°C	
illumination resistance		<	0,5	0,5	%/°C	
Voltage response $\frac{r \text{ at } 0,5 \text{ V d.c.}}{r \text{ at } 10 \text{ V d.c.}}$	α	typ.	1,1	1,05		

1) The spread of the dark resistance is large and values higher than 100 MΩ and 1000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

2) After 16 hours in darkness changes in the CdS material are still occurring but have only insignificant effect on the illumination resistance.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Cell voltage, d.c. and repetitive peak	RPY41	V	max.	100	V
	RPY17	V	max.	400	V
Cell voltage, pulse, $t_p \leq 5$ ms, $p_{rr} \leq$ once per minute	RPY41	V_M	max.	250	V
	RPY17	V_M	max.	1000	V
Power dissipation (t_{av} = 2 s) see graph P_{max}					
Power dissipation, pulse		P_M	max.	5 x P_{max}	
Cell current, d.c. and repetitive peak		I	max.	100	mA
Illumination		E	max.	50 000	lx
Temperature CdS tablet, operating		T_{tablet}	max.	85	°C
Ambient temperature, storage and operating		T_{amb}	min.	−40	°C
storage		T_{stg}	max.	50	°C 1)
operating		T_{amb}	max.	70	°C

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in illumination resistance of the cells during life under rated load from −30% to +70% (typ. +40%) do not impair the circuit performance. Direct sunlight irradiation should be avoided.

MECHANICAL ROBUSTNESS

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95 % of the devices pass these tests without perceptible damage.

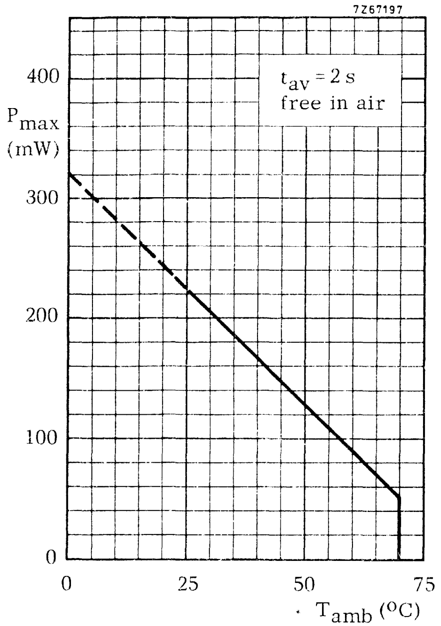
Shock

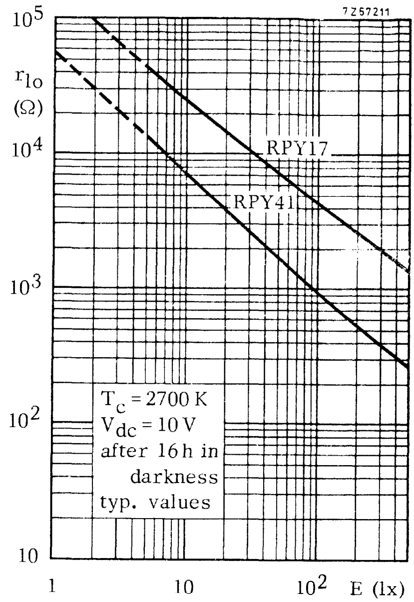
25 g_{peak}, 10 000 shocks in one of three positions of the cell.

Vibration

2,5 g_{peak}, 50 Hz, during 32 hours in each of the three positions in the cell.

1) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z67197
400
P_{max}
(mW)
300
200
100
0
0
25
50
75
T_{amb} (°C)
t_{av} = 2 s
free in air


7Z57211
10^5
r_{lo}
(Ω)
10^4
10^3
10^2
10
1
10
10^2
E (lx)
RPY17
RPY41
T_c = 2700 K
V_{dc} = 10 V
after 16 h in
darkness
typ. values

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

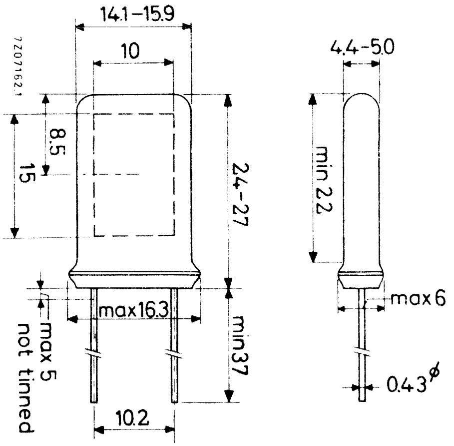
Side sensitive cadmium sulphide photoconductive cells in hermetically sealed all-glass envelope intended for general control circuits such as twilight switches and flame failure circuits. The high voltage type can be connected direct to the mains.
The cells are shock and vibration resistant.

QUICK REFERENCE DATA

			RPY18	RPY19	
Power dissipation at T_{amb} = 25 °C	P	max.	0,5	0,5	W
Cell voltage, d.c. and repetitive peak	V	max.	100	400	V
Cell resistance at 50 lx, 2700 K colour temperature	r_{10}	typ.	400	3000	Ω
Spectral response, current rise and decay curves			type D		
Outline dimensions		max.	27 x 16,3 x 6 mm		

MECHANICAL DATA

Dimensions in mm



Soldering

The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dipsoldered at a solder temperature of 240 °C for maximum 10 s up to a point 5 mm from the seals.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only check points of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 K and at delivery

			RPY18	RPY19		
Initial dark resistance V_{dc} = 100 V (RPY 18) or 300 V (RPY 19) applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	>	5,6	10	MΩ	1)
Equilibrium dark resistance V_{dc} = 100 V (RPY 18) or 300 V (RPY 19) applied via 1 MΩ, 30 min after switching off the illumination	r_{de}	>	50	200	MΩ	1)
Initial illumination resistance measured at 10 V d.c., illumination = 50 lx, after 16 hrs in darkness 2)		>	235	1400	Ω	
	r_{lo}	typ.	400	3000	Ω	
		<	1200	6600	Ω	
measured at 1 V d.c., illumination = 5000 lx, after 16 hrs in darkness 2)	r_{lo}	typ.	25	-	Ω	
		<	35 3)	-	Ω	
Equilibrium illumination resistance measured at 10 V d.c., illumination = 50 lx, after 15 min under the measuring conditions		>	235	1400	Ω	
	r_{le}	typ.	480	3800	Ω	
		<	1560	9000	Ω	
measured at 1 V d.c., illumination = 5000 lx, after 15 min under the measuring conditions	r_{le}	<	35 3)	-	Ω	
Negative temperature response of illumination resistance		typ.	0,2	0,2	%/°C	
		<	0,5	0,5	%/°C	
Voltage response $\frac{\text{r at 0,5 V d.c.}}{\text{r at 10 V d.c.}}$	α	typ.	1,1	1,05		

1) The spread of the dark resistance is large and values higher than 100 MΩ and 1000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively .

2) After 16 hours in darkness changes in the CdS material are still occurring but have only insignificant effect on the illumination resistance.

3) During life < 40 Ω.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Cell voltage, d.c. and repetitive peak	RPY18	V	max.	100	V
	RPY19	V	max.	400	V
Cell voltage, pulse, $t_p \leq 5$ ms, $p_{rr} \leq$ once per minute	RPY18	V_M	max.	250	V
	RPY19	V_M	max.	1000	V
Power dissipation (t_{av} = 2 s) see graph P_{max}					
Power dissipation, pulse		P_M	max.	5 x P_{max}	
Cell current, d.c. and repetitive peak		I	max.	250	mA
Illumination		E	max.	50 000	lx
Temperature CdS tablet, operating		T_{tablet}	max.	85	°C
Ambient temperature, storage and operating		T_{amb}	min.	−40	°C
storage		T_{stg}	max.	50	°C 1)
operating		T_{amb}	max.	70	°C

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in illumination resistance of the cells during life under rated load from −30% to +70% (typ. +40%) do not impair the circuit performance. Direct sunlight irradiation should be avoided.

MECHANICAL ROBUSTNESS

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95 % of the devices pass these tests without perceptible damage.

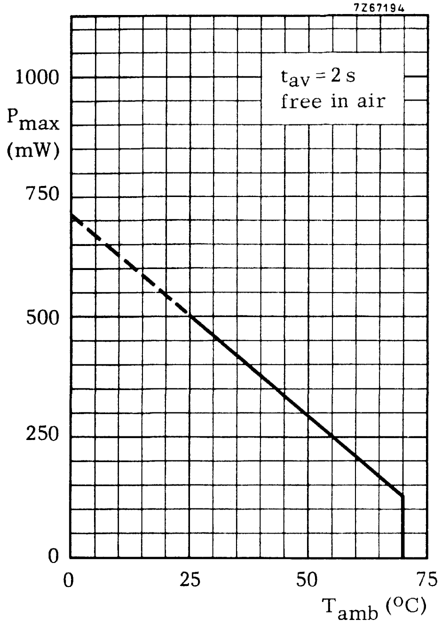
Shock

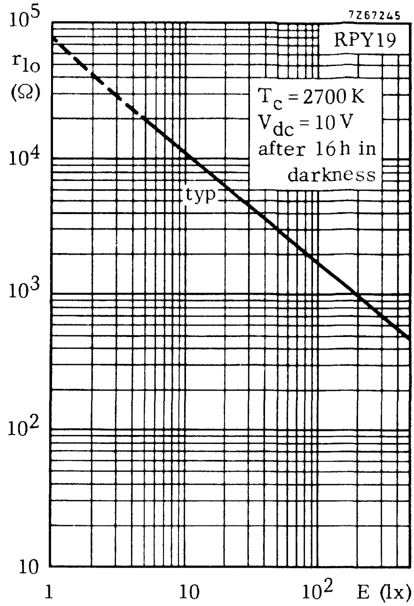
25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

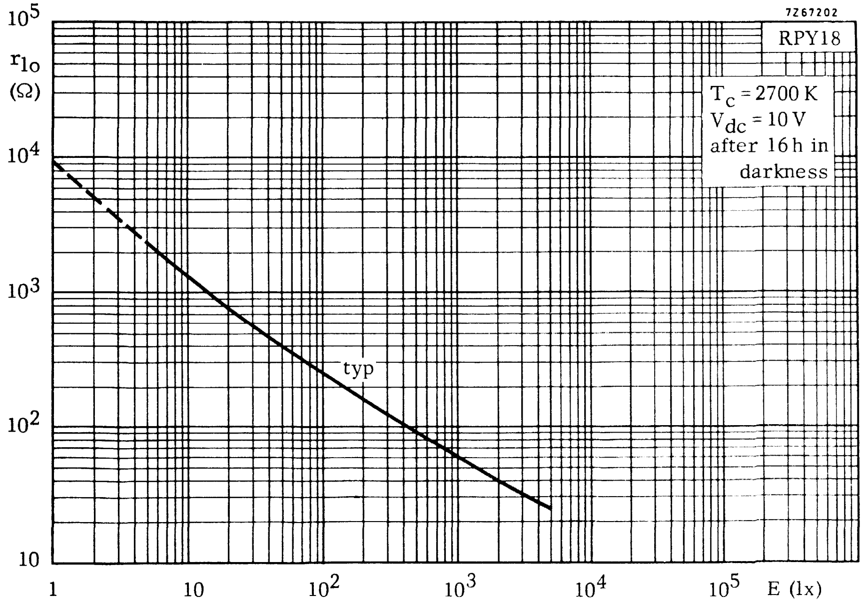
Vibration

2,5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

1) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z67194
1000
Pmax
(mW)
750
500
250
0
tav = 2 s
free in air
0
25
50
75
Tamb (°C)


7Z67245
RPY19
10^5
r1o
(Ω)
10^4
10^3
10^2
10
Tc = 2700 K
Vdc = 10 V
after 16 h in
darkness
typ
1
10
10^2
E (lx)


7Z67202
RPY18
10^5
r1o
(Ω)
10^4
10^3
10^2
10
Tc = 2700 K
Vdc = 10 V
after 16 h in
darkness
typ
1
10
10^2
10^3
10^4
10^5
E (lx)

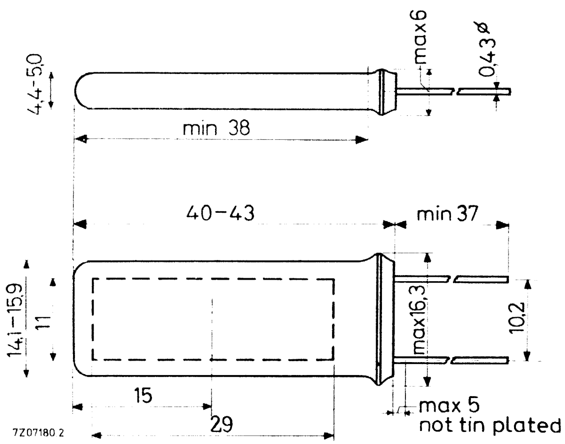
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Side sensitive cadmium sulphide photoconductive cell in hermetically sealed all-glass envelope intended for general control circuits such as twilight switches and flame failure circuits. This high voltage type can be connected direct to the mains.
The cell is shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	1	W
Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell resistance at 50 lx, 2700 K colour temperature	r_{lo}	typ.	1500	Ω
Spectral response, current rise and decay curves			type D	
Outline dimensions		max.	43 x 16,3 x 6	mm

MECHANICAL DATA

Dimensions in mm



Soldering

The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dipsoldered at a solder temperature of 240 °C for maximum 10 s to a point 5 mm from the seals.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characterictics are therefore only check points of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 K and at delivery

Initial dark resistance measured with 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	>	6,5	MΩ [1]
Equilibrium dark resistance measured with 300 V d.c. applied via 1 MΩ, 30 min after switching off the illumination	r_{de}	>	120	MΩ [1]
Initial illumination resistance measured at 10 V d.c., illumination = 50 lx, after 16 hours in darkness [2]	r_{lo}		700 to 3300	Ω
		typ.	1500	Ω
Equilibrium illumination resistance measured at 10 V d.c., illumination= 50 lx, after 15 min under the measuring conditions	r_{le}		700 to 4500	Ω
		typ.	1900	Ω
Negative temperature response of illumination resistance		typ.	0,2	%/°C
		<	0,5	%/°C
Voltage response $\frac{r \text{ at } 0,5 \text{ V d.c.}}{r \text{ at } 10 \text{ V d.c.}}$	α	typ.	1,05	

---

1) The spread of the dark resistance is large and values higher than 100 MΩ and 1000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

2) After 16 hours in darkness changes in the CdS material are still occurring but have only insignificant effect on the illumination resistance.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell voltage, pulse, $t_p \leq 5$ ms, $p_{rr} \leq$ once per minute	V_M	max.	1000	V
Power dissipation (t_{av} = 2 s) see graph P_{max}				
Power dissipation, pulse	P_M	max.	5 x P_{max}	
Cell current d.c. and repetitive peak	I	max.	500	mA
Illumination	E	max.	50000	lx
Temperature CdS tablet operating	T_{tablet}	max.	85	^oC
Ambient temperature, storage and operating	T_{amb}	min.	-40	^oC
storage	T_{stg}	max.	50	^oC 1)
operating	T_{amb}	max.	70	^oC

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in illumination resistance of the cells during life under rated load from −30% to +70% (typ.+40%) do not impair the circuit performance. Direct sunlight irradiation should be avoided.

MECHANICAL ROBUSTNESS

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95 % of the devices pass these tests without perceptible damage.

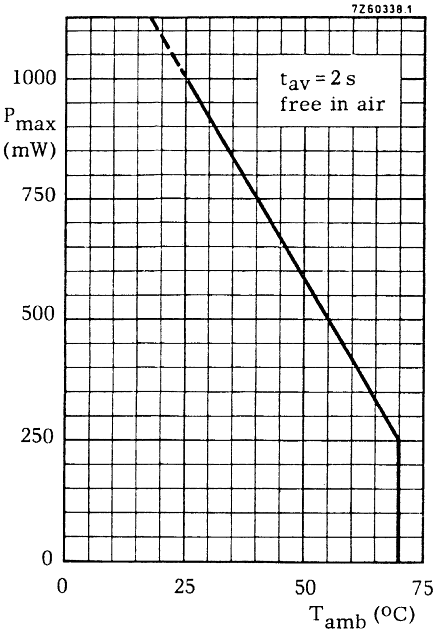
Shock

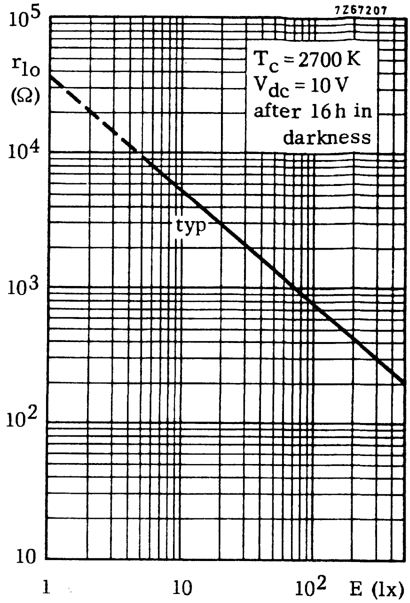
25 g_{peak}, 10000 shocks in one of the three positions of the cell.

Vibration

2,5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

1) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z60338.1
1000
750
500
250
0
P_{max}
(mW)
t_{av} = 2 s
free in air
0
25
50
75
T_{amb} (°C)


7Z67207
10^5
r_{lo}
(Ω)
10^4
10^3
10^2
10
T_c = 2700 K
V_{dc} = 10 V
after 16 h in
darkness
typ
1
10
10^2
E (lx)

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

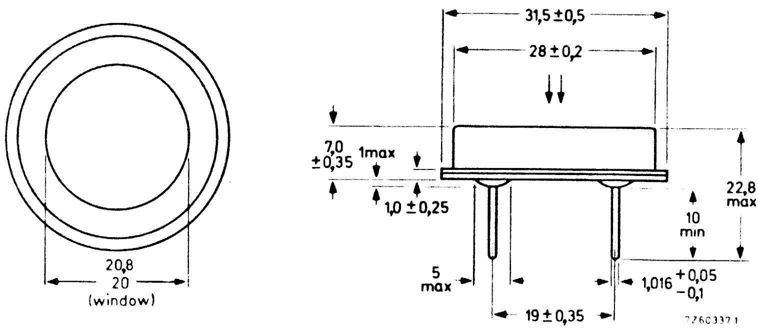
Top sensitive cadmium sulphide photoconductive cells in hermetically sealed metal envelope with a glass window intended for general control circuits such as twilight switches and flame failure circuits. The high voltage type can be connected direct to the mains. The cells are shock and vibration resistant.

QUICK REFERENCE DATA

			RPY27	RPY55	
Power dissipation at T_{amb} = 25 °C	P	max.	1	1	W
Cell voltage, d.c. and repetitive peak	V	max.	400	200	V
Cell resistance at 50 lx, 2700 K colour temperature	r_{lo}	typ.	650	420	Ω
Spectral response, current rise and decay curves			type D		
Outline dimensions		max.	32 dia. x 7,6		mm

MECHANICAL DATA

Dimensions in mm



ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only check points of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 K and at delivery.

			RPY27	RPY55		
Initial dark resistance V_{dc} = 400 V (RPY27) or 200 V (RPY55) applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	>	6	3	MΩ	1)
Equilibrium dark resistance V_{dc} = 400 V (RPY27) or 200 V (RPY55) applied via 1 MΩ, 30 min after switching off the illumination	r_{de}	>	100	50	MΩ	1)
Initial illumination resistance		>	380	250	Ω	
measured at 10 V d.c., illumination = 50 lx,	r_{lo}	typ.	650	420	Ω	
after 16 hrs in darkness 2)		<	1900	1250	Ω	
Equilibrium illumination resistance		>	380	250	Ω	
measured at 10 V d.c., illumination = 50 lx,	r_{le}	typ.	820	530	Ω	
after 15 min under the measuring conditions		<	2600	1700	Ω	

Negative temperature response of illumination resistance: typ. 0,2 %/°C; < 0,5 %/°C

Voltage response $\frac{\text{r at 0,5 V d.c.}}{\text{r at 10 V d.c.}}$ α typ. 1,05

1) The spread of the dark resistance is large and values higher than 100 MΩ and 1000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively .

2) After 16 hours in darkness changes in the CdS material are still occuring but have only insignificant effect on the illumination resistance.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Cell voltage, d.c. and repetitive peak,	RPY 27	V	max.	400	V
	RPY 55	V	max.	200	V
Cell voltage, pulse, $t_p \leq 5$ ms, $p_{rr} \leq$ once per minute	RPY27	V_M	max.	1000	V
	RPY55	V_M	max.	500	V
Power dissipation (t_{av} = 2 s) see graph P_{max}					
Power dissipation, pulse		P_M	max.	5 x P_{max}	
Cell current, d.c. and repetitive peak		I	max.	250	mA
Illumination		E	max.	50 000	lx
Temperature CdS tablet, operating		T_{tablet}	max.	85	^oC
Ambient temperature, storage and operating		T_{amb}	min.	−40	^oC
storage		T_{stg}	max.	50	^oC 1)
operating		T_{amb}	max.	70	^oC

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in illumination resistance of the cells during life under rated load from −30% to +70% (typ. +40%) do not impair the circuit performance. Direct sunlight irradiation should be avoided.

MECHANICAL ROBUSTNESS

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95 % of the devices pass these tests without perceptible damage.

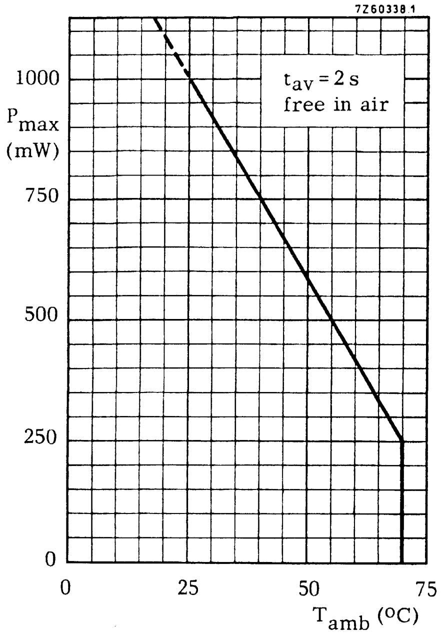
Shock

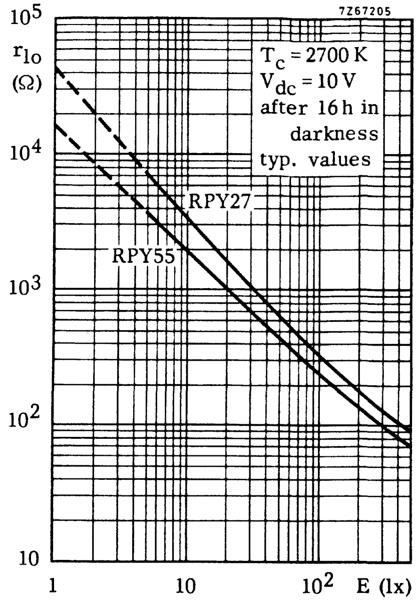
25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

Vibration

2,5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

1) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z60338.1
1000
750
500
250
0
P_{max}
(mW)
t_{av} = 2 s
free in air
0
25
50
75
T_{amb} (°C)


7Z67205
10^5
10^4
10^3
10^2
10
r_{lo}
(Ω)
T_c = 2700 K
V_{dc} = 10 V
after 16 h in
darkness
typ. values
RPY27
RPY55
1
10
10^2
E (lx)

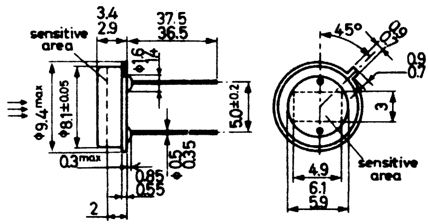
CADMIUM SULPHO-SELENIDE PHOTOCONDUCTIVE CELL

Cadmium sulpho-selenide photoconductive device with top sensitivity intended for use in exposure meters, light-control equipment and for general industrial use. The device is tropic proof, shock and vibration resistant. The envelope is hermetically sealed and has a plane glass window.

QUICK REFERENCE DATA				
Power dissipation, as measuring device	P	max.	10	mW
for general use	P	max.	75	mW
Cell voltage, d.c. and repetitive peak	V	max.	50	V
Outline dimensions	max. 3.4 xdia 9.4			mm
Light sensitive area	4.9 mm x 3 mm			

MECHANICAL DATA

Dimensions in mm



Soldering

The device may be soldered direct into the circuit but heat conducted to the seals should be kept at a minimum by the use of a thermal shunt. Dipsoldering at a solder temperature of 245 °C may be employed for a maximum of 10 s up to a point 5 mm from the seals of for maximum 3 s up to a point 1.5 mm from the seals. At a solder temperature between 245 °C and 400 °C the soldering time is maximum 5 s up to a point 5 mm from the seals.
The leads should not be bent less than 1.5 mm from the seals.

ELECTRICAL DATA

Basic characteristics at T_{amb} = 25 °C

Pre-conditioning > 1 h illumination with 300 lx (fluorescent light)

	symbol	min.	typical	max.	unit
Initial dark resistance measured at 50 $V_{d.c.}$, 20 s after stopping the illumination of 25.6 lx	r_{do}	100			kΩ
Initial illumination resistance measured at 1 $V_{d.c.}$, illumination 25.6 lx, colour temperature 4700 °K	r_{lo}	**1.65**		**5.1**	kΩ
Current decay time: time to reach 10% of the current at the instant of stopping the illumination of 5 lx	t_{fi}		3		s
Gamma between E_1 = 0.4 lx and E_2 = 25.6 lx 1)	γ	**0.60**	0.75	**0.84**	
Shift in illumination current, measured with E = 50 lx, t = 10 min				10	
Pre-conditioning factor 2)		0.9		1.2	
Actinism $\frac{\text{Illumination at 2700 °K}}{\text{Illumination at 4700 °K}}$ (referred to the same cell current)			0.9		

1) $\gamma = \dfrac{\log r1 - \log r2}{\log E_2 - \log E_1}$

2) Pre-conditioning factor = $\dfrac{\text{Cell current at 0.4 lx, after 3 days in darkness}}{\text{Cell current at 0.4 lx after 1 h pre-conditioning at 300 lx (fluorescent light)}}$

SHOCK AND VIBRATION

An indication of the ruggedness of the device is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

Shock

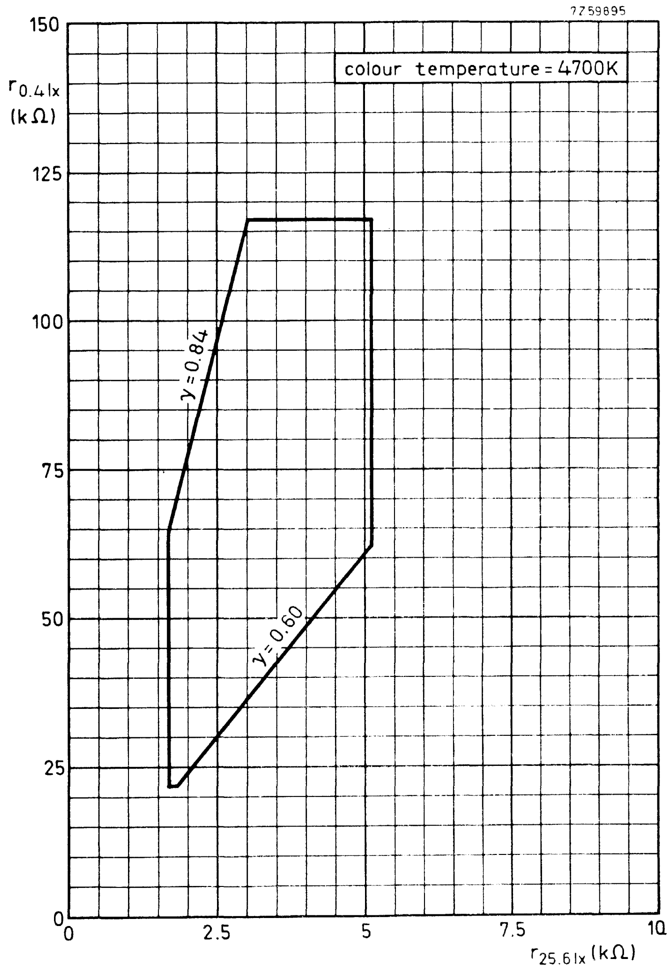
50 g_{peak}, 5 shocks in each of the four positions of the device.

Vibration

2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the device.

LIMITING VALUES (Absolute max. rating system)

Cell voltage, d.c. and repetitive peak	V	max.	50	V
Power dissipation, for use as measuring device	P	max.	10	mW
for general use	P	max.	75	mW
Ambient temperature	T_{amb}	max.	+60	^{o}C
	T_{amb}	min.	-40	^{o}C



Area of illumination resistance ratio

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

For RPY41 see data RPY17; RPY41.

For RPY55 see data RPY27; RPY55.

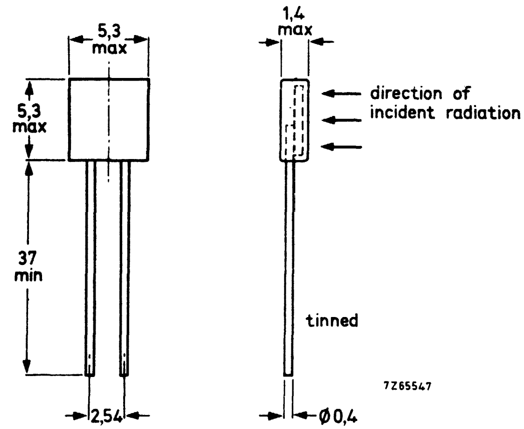
CADMIUM SULPHIDE PHOTOCONDUCTIVE DEVICE

Cadmium sulphide photoconductive device with side sensitivity in plastic encapsulation. The device consists of two cells connected in series and is intended for general applications.

QUICK REFERENCE DATA				
Power dissipation at $T_{amb} \le 25$ °C	P		100	mW
Voltage, d.c. and repetitive peak	V	max.	50	V
Resistance at 50 lux, T_c = 2700 °K	r_{lo}		600	Ω
Wavelengths at 50% sensitivity	λ		500 and 675	nm
Outline dimensions		max.	5,3 x 5,3 x 1,4	mm

MECHANICAL DATA

Dimensions in mm



Soldering

The device may be soldered direct into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt.
It may be dip-soldered at a solder temperature of 270 °C for a maximum of 2 s up to a point 6 mm from the envelope.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Cell voltage, d.c. and repetitive peak	V	max.	50	V
Cell voltage, P_{rr} ≤ once per minute, t_p ≤ 5 ms	V_M	max.	100	V
Power dissipation, t_{av} = 0,5 s, T_{amb} ≤ 25 °C	P	max.	100	mW
Cell current, d.c. and repetitive peak	I	max.	25	mA
Ambient temperature, storage and operating	T_{amb}	min.	-40	°C
storage	T_{stg}	max.	+50	°C
Temperature of CdS tablet	T_{tablet}	max.	+70	°C

THERMAL RESISTANCE

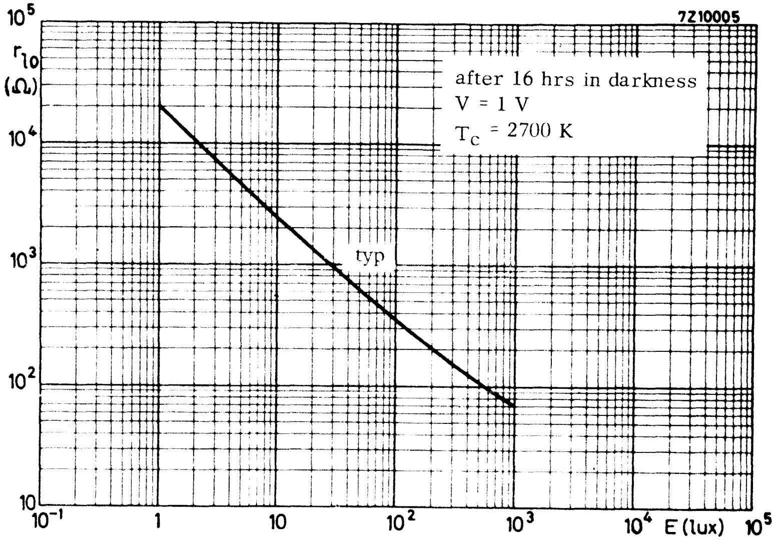
Thermal resistance from CdS tablet to ambient	$R_{th\ t-a}$	=	0,45	°C/mW

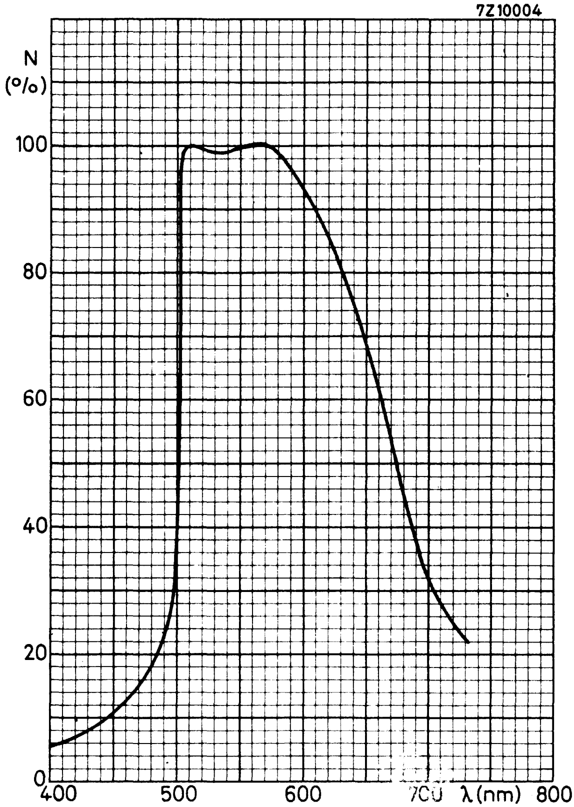
CHARACTERISTICS

Initial dark resistance, measured with 50 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	>	200	kΩ
Initial ilumination resistance measured at 1 V d.c., illumination 50 lx, T_c = 2700 K	r_{lo}	typ.	0,6	kΩ
			0,35-1,4	kΩ
Initial drift	D_o	typ.	0	%
F_{4700} (= $\frac{r_l \text{ at } 4700\text{ K}}{r_l \text{ at } 2856\text{ K}}$ at constant illumination and using a Davis-Gibson filter)		typ.	1,2	

OPERATING NOTES

1. The device consits of two photoconductive cells connected in series. The resistance of the device is mainly governed by the resistance of that cell receiving the lowest luminous flux.
   If it is essential for the application that the device is partly shaded off, the shadow line should be perpendicular to the axis of the device.
2. For optimum heat dissipation use the shortest permissible lead length.


7Z10005
r_{10} (Ω)
10^5
10^4
10^3
10^2
10
after 16 hrs in darkness
V = 1 V
T_c = 2700 K
typ
10^{-1}
1
10
10^2
10^3
10^4
E (lux)
10^5


7Z10004
N
(%)
100
80
60
40
20
0
400
500
600
700
λ (nm)
800

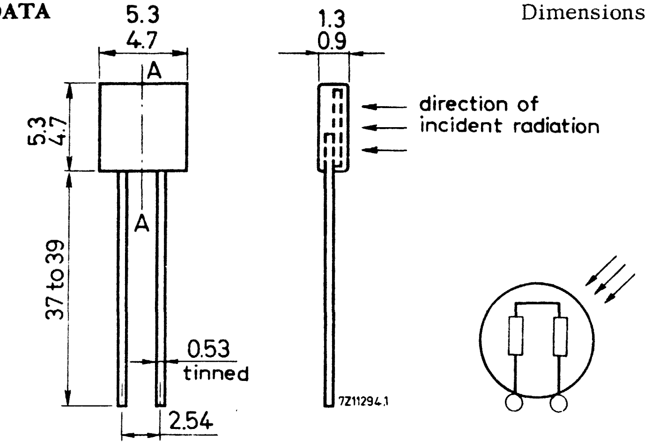
CADMIUM SULPHIDE PHOTOCONDUCTIVE DEVICE

Cadmium sulphide photoconductive cell with side sensitivity in a plastic encapsulation. The device consists of two cells in series and is intended for use in cameras, exposure meters, light control equipment and for general industrial use.

QUICK REFERENCE DATA				
Power dissipation	P	max.	50	mW
Cell voltage, d.c. and repetitive peak	V	max.	50	V
Cell resistance at 10 lux, 2700 °K	r_{10}		3 to 6	kΩ
Outline dimensions			5 mm x 5 mm x 1	mm

MECHANICAL DATA

Dimensions in mm



Soldering

The device may be soldered direct into the circuit but heat conducted to the seals should be kept at a minimum by the use of a thermal shunt. Dip soldering at a solder temperature of 270 °C may be employed for a maximum of 2 s up to a point 6 mm from the seals.

ELECTRICAL DATA

Basic characteristics at T_{amb} = 25 °C, illumination with 2700 K c.t.

Pre-conditioning 1 h illumination with 300 lx (fluorescent light)

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 50 $V_{d.c.}$ applied via 1 MΩ, 20 s after stopping the illumination of 10 lx	r_{do}	0.6			MΩ
Initial illumination resistance measured at V = 1 $V_{d.c.}$, illumination 10 lx	r_{lo}	2.4		6.0	kΩ
Illumination response [1] measured at 1 $V_{d.c.}$ between 0.1 lx and 10 lx	$\gamma_{0.1-10}$	0.94		1.12	
Negative temperature response of illumination resistance between −10 °C and +40 °C at 1 lx, V = 1 V	$r_l/\Delta T$			0.5	%/°C
Pre-conditioning factor [2]		0.9		1.1	
Actinism $\frac{\text{Illumination at 2700 K}}{\text{Illumination at 4700 K}}$ (referred to the same cell current)		0.9		1.1	

[1]) $\gamma = \frac{\log r1 - \log r2}{\log E2 - \log E1}$ where E1 = 0.1 lx and E2 = 10 lx

[2]) Pre-conditioning factor = $\frac{\text{Cell current at 1 lx, after 3 days in darkness}}{\text{Cell current at 1 lx, after 1 h pre-conditioning at 300 lx (fluorescent light)}}$

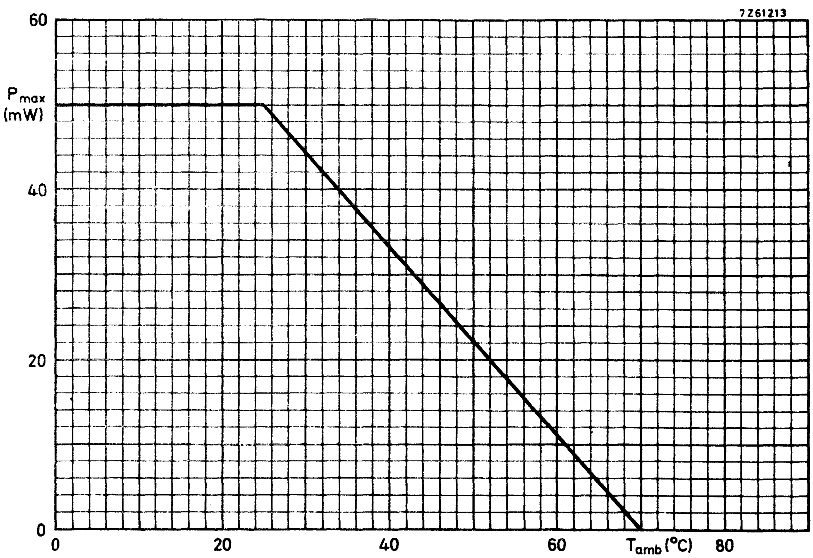
measured when a stable current is reached

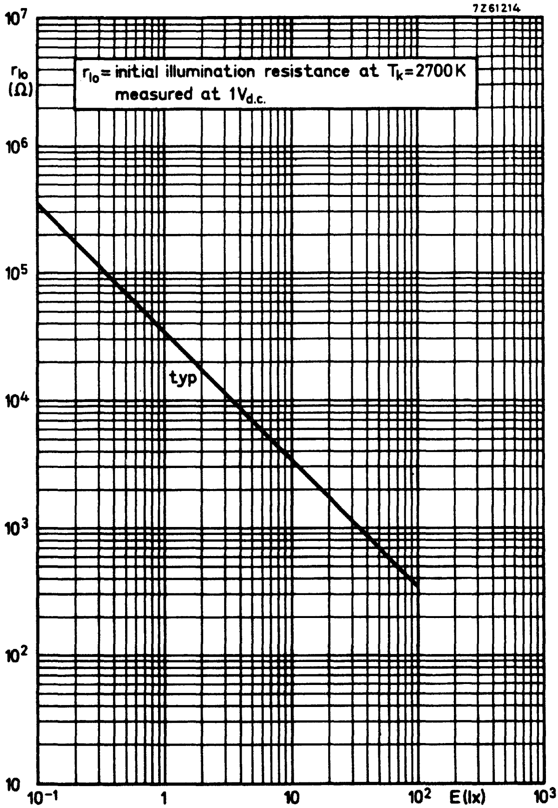
LIMITING VALUES (Absolute max. rating system)

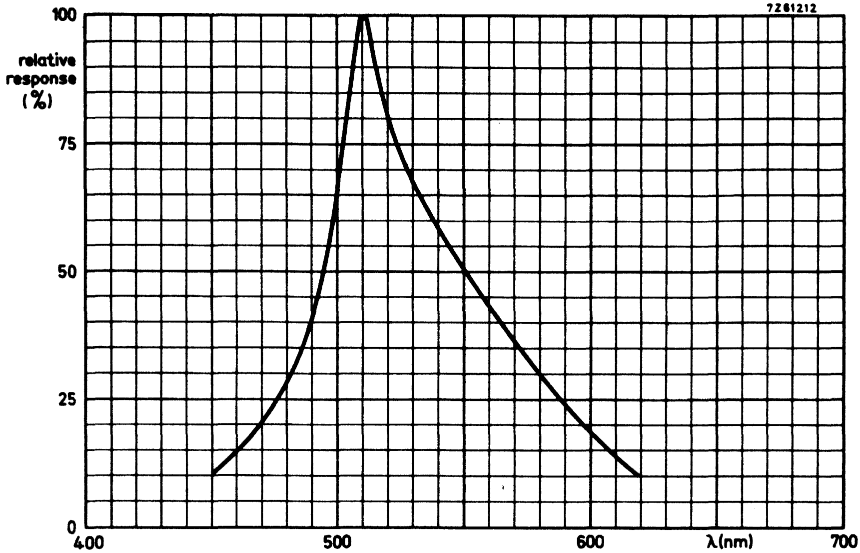
Cell voltage, d.c. and repetitive peak	V	max. 50	V
Power dissipation	P	max. 50	mW
Cell current, d.c. and repetitive peak	I	max. 20	mA
Operating ambient temperature	T_{amb}	−40 to +70	°C
Storage temperature	T_{stg}	−40 to +70	°C

OPERATING NOTE

The device consists of two photoconductive cells connected in series.
The resistance of the device is mainly governed by the resistance of that cell receiving the lowest luminous flux.
If it is essential for the application that the device is partly shaded off, the shadow line should be perpendicular to the axis A-A of the device.




7Z61214
r_{lo} = initial illumination resistance at T_k = 2700 K
measured at 1 $V_{d.c.}$
r_{lo} (Ω)
typ
E (lx)
10
10^2
10^3
10^4
10^5
10^6
10^7
10^{-1}
1
10
10^2
10^3


7Z61212
100
relative
response
(%)
75
50
25
0
400
500
600
λ(nm)
700

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

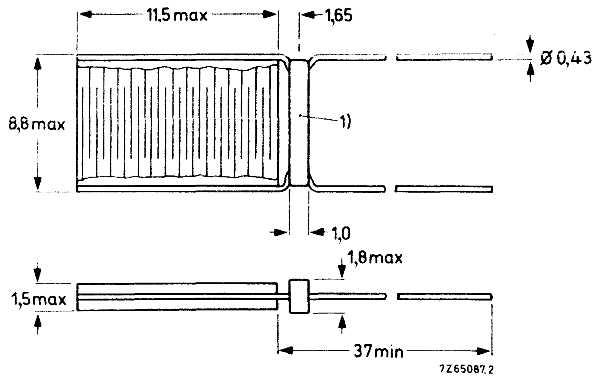
Data based on pilot production

Side sensitive cadmium sulphide photoconductive cell protected by a lacquer coating. The device withstands the steady state damp heat test of IEC Publication 68-2-3 (test Ca: severity 56 days).

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	0,30	W
Cell voltage, d.c. and repetitive peak	V	max.	100	V
Cell resistance at 50 lx, 2700 K colour temperature	r_{lo}		950	Ω
Spectral response, current rise and decay curves		type D		
Outline dimensions		max.	11,5 x 8,8 x 1,5	mm

MECHANICAL DATA

Dimensions in mm



Soldering

The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dipsoldered at a solder temperature of 240 °C for maximum 10 s up to a point 5 mm from the stress relief band.

Mounting

The cell is not insulated electrically and should be mounted accordingly.

Notice

If the cell is to be encapsulated, request manufacturer's instructions.

1) Stress relief band.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only check points of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 K and at delivery

Initial dark resistance measured with 100 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	>	6	MΩ 1)
Equilibrium dark resistance measured with 100 V d.c. applied via 1 MΩ, 30 minutes after switching off the illumination	r_{de}	>	50	MΩ 1)
Initial illumination resistance measured at 10 V d.c., illumination = 50 lx, after 16 hrs in darkness 2)	r_{lo}		560 to 2800	Ω
		typ.	950	Ω
Equilibrium illumination resistance measured at 10 V d.c., illumination = 50 lx, after 15 min under the measuring conditions	r_{le}		560 to 3800	Ω
		typ.	1200	Ω
Negative temperature response of illumination resistance		<	0,5	%/°C
		typ.	0,2	%/°C
Voltage response $\frac{\text{r at 0,5 V d.c.}}{\text{r at 10 V d.c.}}$	α	typ.	1,05	

1) The spread of the dark resistance is large and values higher than 100 MΩ and 1000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respecitively.

2) After 16 hours in darkness changes in the CdS material are still occurring but have only insignificant effect on the illumination resistance.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Cell voltage, d.c. and repetitive peak	V	max.	100	V
Cell voltage, pulse, $t_p \leq 5$ ms, $p_{rr} \leq$ once per minute	V_M	max.	250	V
Power dissipation (t_{av} = 2 s) see graph P_{max}				
Power dissipation, pulse	P_M	max.	$5xP_{max}$	
Cell current, d.c. and repetitive peak	I	max.	100	mA
Illumination	E	max.	50 000	lx
Temperature CdS tablet, operating	T_{tablet}	max.	+85	°C
Ambient temperature, storage and operation	T_{amb}	min.	−40	°C
storage	T_{stg}	max.	+50	°C [1]
operating	T_{amb}	max.	+70	°C

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in illumination resistance of the cells during life under rated load from −30 % to +70 % (typ. +40 %) do not impair the circuit performance. Direct sunlight irradiation should be avoided.

CLIMATIC DATA

The device withstands the damp heat test Ca (steady state) of IEC Publication 68-2-3: severity 56 days, under no-load conditions or under continuous load conditions such that the tablet temperature is ≥ 5 °C above ambient temperature.

MECHANICAL ROBUSTNESS

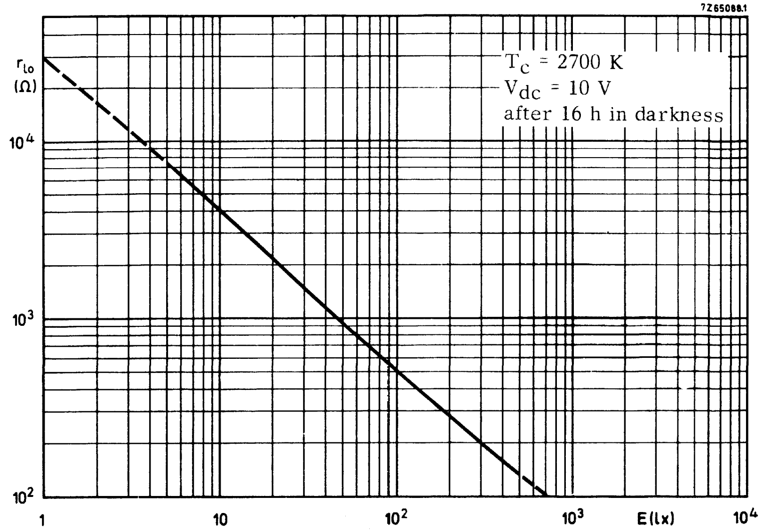
Tensile test

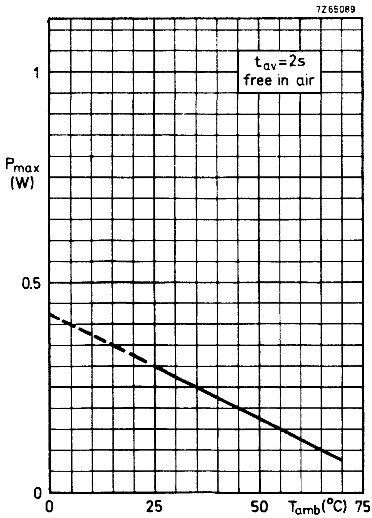
The device withstands the tensile test of IEC Publication 68-2-21, Test Ua: loading weight 500 g.

Pull test

The device withstands the following test: The leads are bent outwards over an angle of 90° at 2 mm from the stress relief band; a pulling force of 500 g is then applied at the end of the leads.

1) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z65088.1
T_c = 2700 K
V_{dc} = 10 V
after 16 h in darkness
r_{lo}
(Ω)
10^4
10^3
10^2
1
10
10^2
10^3
E (lx)
10^4


7Z65089
t_{av}=2s
free in air
P_{max}
(W)
1
0.5
0
0
25
50
T_{amb}(°C)
75

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

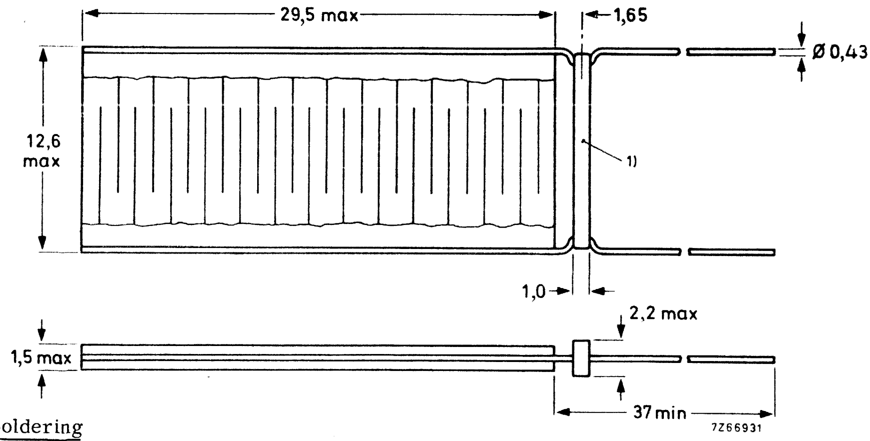
Data based on pilot production

Side sensitive cadmium sulphide photoconductive cell protected by a lacquer coating. The device withstands the steady state damp heat test of IEC publication 68-2-3 (test Ca: severity 56 days).

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	0,75	W
Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell resistance at 50 lx, 2700 K colour temperature	r_{lo}	typ.	1150	Ω
Spectral response, current rise and decay curves		type D		
Outline dimensions		max.	29,5 x 12,6 x 1,5	mm

MECHANICAL DATA

Dimensions in mm



Soldering

The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dipsoldered at a solder temperature of 240 °C for maximum 10 s up to a point 5 mm from the stress relief band.

Mounting

The cell is not insulated electrically and should be mounted accordingly.

Notice

If the cell is to be encapsulated, request manufacturer's instructions.

1) Stress relief band.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only check points of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 K and at delivery

Initial dark resistance measured with 400 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	>	9	MΩ [1]
Equilibrium dark resistance measured with 400 V d.c. applied via 1 MΩ, 30 minutes after switching off the illumination	r_{de}	>	200	MΩ [1]
Initial illumination resistance measured at 10 V d.c., illumination = 50 lx, after 16 hrs in darkness [2]	r_{lo}		700 to 3300	Ω
		typ.	1150	Ω
Equilibrium illumination resistance measured at 10 V d.c., illumination = 50 lx, after 15 min under the measuring conditions	r_{le}		700 to 4100	Ω
		typ.	1450	Ω
Negative temperature response of illumination resistance		typ.	0,2	%/°C
		<	0,5	%/°C
Voltage response $\frac{\text{r at 0,5 V d.c.}}{\text{r at 10 V d.c.}}$	α	typ.	1,05	

[1]) The spread of the dark resistance is large and values higher than 100 MΩ and 1000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respecitively.

[2]) After 16 hours in darkness changes in the CdS material are still occurring but have only insignificant effect on the illumination resistance.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell voltage, pulse, $t_p \leq 5$ ms, prr ≤ once per minute	V_M	max.	1000	V
Power dissipation (t_{av} = 2 s) see graph P_{max}				
Power dissipation, pulse	P_M	max.	$5 \times P_{max}$	
Cell current, d.c. and repetitive peak	I	max.	500	mA
Illumination	E	max.	50 000	lx
Temperature CdS tablet, operating	T_{tablet}	max.	+85	°C
Ambient temperature, storage and operating	T_{amb}	min.	−40	°C
storage	T_{stg}	max.	+50	°C 1)
operating	T_{amb}	max.	+70	°C

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in illumination resistance of the cells during life under rated load from −30 % to +70 % (typ. +40 %) do not impair the circuit performance. Direct sunlight irradiation should be avoided.

CLIMATIC DATA

The device withstands the damp heat test Ca (steady state) of IEC Publication 68-2-3: severity 56 days, under no-load conditions or under continuous load conditions such that the tablet temperature is ≥ 5 °C above ambient temperature.

MECHANICAL ROBUSTNESS

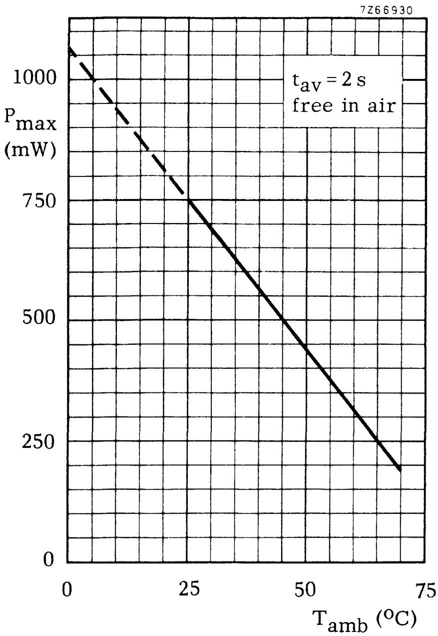
Tensile test

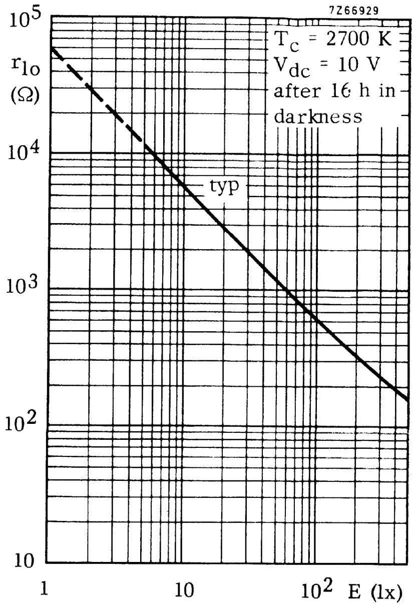
The device withstands the tensile test of IEC Publication 68-2-21, Test Ua: loading weight 500 g.

Pull test

The device withstands the following test: The leads are bent outwards over an angle of 90° at 2 mm from the stress relief band; a pulling force of 500 g is then applied at the end of the leads.

1) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z66930
1000
750
500
250
0
Pmax
(mW)
0
25
50
75
Tamb (°C)
tav = 2 s
free in air


7Z66929
10^5
10^4
10^3
10^2
10
rlo
(Ω)
1
10
10^2
E (lx)
Tc = 2700 K
Vdc = 10 V
after 16 h in
darkness
typ

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

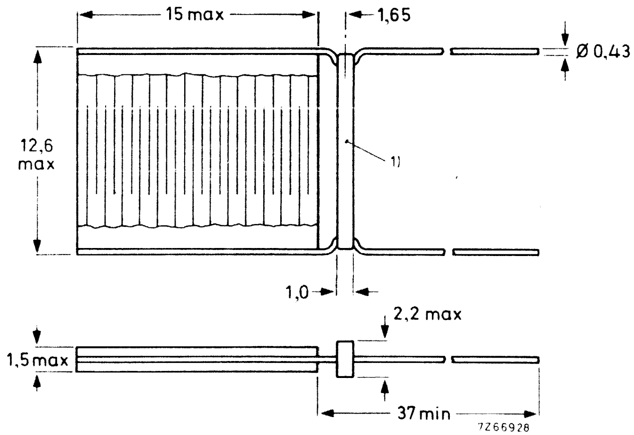
Data based on pilot production

Side sensitive cadmium sulphide photoconductive cell protected by a lacquer coating. The device withstands the steady state damp heat test of IEC publication 68-2-3 (test Ca: severity 56 days).

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	0,500	W
Cell voltage, d.c. and repetitive peak	V	max.	200	V
Cell resistance at 50 lx, 2700 K colour temperature	r_{lo}	typ.	1150	Ω
Spectral response, current rise and decay curves		type D		
Outline dimensions		max.	15 x 12,6 x 1,5	mm

MECHANICAL DATA

Dimensions in mm



Soldering

The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dipsoldered at a solder temperature of 240 °C for maximum 10 s up to a point 5 mm from the stress relief band.

Mounting

The cell is not insulated electrically and should be mounted accordingly.

Notice

If the cell is to be encapsulated, request manufacturer's instructions.

1) Stress relief band.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only check points of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 K and at delivery

Initial dark resistance measured with 200 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	>	9	MΩ [1])
Equilibrium dark resistance measured with 200 V d.c. applied via 1 MΩ, 30 minutes after switching off the illumination	r_{de}	>	100	MΩ [1])
Initial illumination resistance measured at 10 V d.c., illumination = 50 lx, after 16 hrs in darkness [2])	r_{lo}	700 to typ.	3300 1150	Ω Ω
Equilibrium illumination resistance measured at 10 V d.c., illumination = 50 lx, after 15 min under the measuring conditions	r_{le}	700 to typ.	4100 1450	Ω Ω
Negative temperature response of illumination resistance		< typ.	0,5 0,2	%/°C %/°C
Voltage response $\frac{\text{r at 0,5 V d.c.}}{\text{r at 10 V d.c.}}$	α	typ.	1,05	

[1]) The spread of the dark resistance is large and values higher than 100 MΩ and 1000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respecitively.

[2]) After 16 hours in darkness changes in the CdS material are still occurring but have only insignificant effect on the illumination resistance.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Cell voltage, d.c. and repetitive peak	V	max.	200	V
Cell voltage, pulse, $t_p \leq 5$ ms, $p_{rr} \leq$ once per minute	V_M	max.	500	V
Power dissipation (t_{av} = 2 s) see graph P_{max}				
Power dissipation, pulse	P_M	max.	$5 \times P_{max}$	
Cell current, d.c. and repetitive peak	I	max.	250	mA
Illumination	E	max.	50 000	lx
Temperature CdS tablet, operating	T_{tablet}	max.	+85	^oC
Ambient temperature, storage and operation	T_{amb}	max.	−40	^oC
storage	T_{stg}	max.	+50	^oC 1)
operating	T_{amb}	max.	+70	^oC

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in illumination resistance of the cells during life under rated load from −30 % to +70 % (typ. +40 %) do not impair the circuit performance. Direct sunlight irradiation should be avoided.

CLIMATIC DATA

The device withstands the damp heat test Ca (steady state) of IEC Publication 68-2-3: severity 56 days, under no-load conditions or under continuous load conditions such that the tablet temperature is ≥ 5 ^oC above ambient temperature.

MECHANICAL ROBUSTNESS

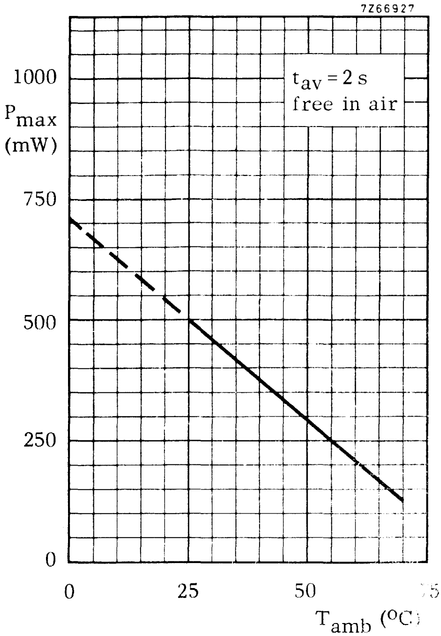
Tensile test

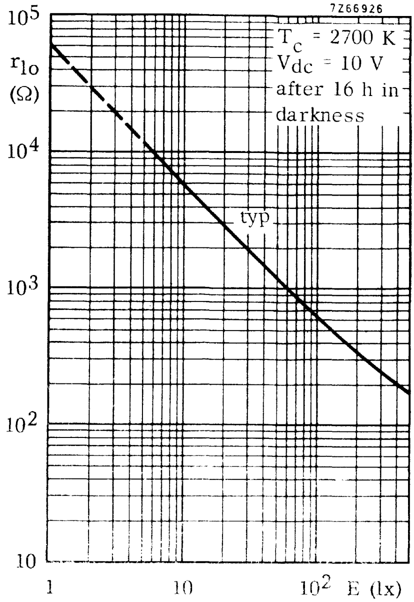
The device withstands the tensile test of IEC Publication 68-2-21, Test Ua: loading weight 500 g.

Pull test

The device withstands the following test: The leads are bent outwards over an angle of 90^o at 2 mm from the stress relief band; a pulling force of 500 g is then applied at the end of the leads.

1) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z66927
1000
Pmax
(mW)
750
500
250
0
tav = 2 s
free in air
0
25
50
75
Tamb (°C)


7Z66926
10^5
rlo
(Ω)
10^4
10^3
10^2
10
Tc = 2700 K
Vdc = 10 V
after 16 h in
darkness
typ
1
10
10^2
E (lx)

INDEX OF TYPE NUMBERS

The inclusion of a type number in this publication does not necessarily imply its availability.

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
AA119	1b	GePC	AEY29R	4a	Mw	BA148	1a	R
AAY21	1b	GePC	AEY31	4a	Mw	BA182	1b	T
AAY30	1b	GeGB	AEY31A	4a	Mw	BA216	1b	SiW
AAY32	1b	GeGB	AF124	3	HF	BA217	1b	SiW
AAY39	4a	Mw	AF125	3	HF	BA218	1b	SiW
AAY39A	4a	Mw	AF126	3	HF	BA219	1b	SiW
AAY51	4a	Mw	AF127	3	HF	BA220	1b	SiW
AAY51R	4a	Mw	AF139	3	HF	BA221	1b	SiW
AAY52	4a	Mw	AF239	3	HF	BA222	1b	SiW
AAY52R	4a	Mw	AF239S	3	HF	BA314	1b	SiW
AAY59	4a	Mw	AF267	3	HF	BA315	1b	SiW
AAZ13	1b	GeGB	ASY26	3	Sw	BA316	1b	SiW
AAZ15	1b	GeGB	ASY27	3	Sw	BA317	1b	SiW
AAZ17	1b	GeGB	ASY28	3	Sw	BA318	1b	SiW
AAZ18	1b	GeGB	ASY29	3	Sw	BAV10	1b	SiW
AC125	2	LF	ASY73	3	Sw	BAV18	1b	SiW
AC126	2	LF	ASY74	3	Sw	BAV19	1b	SiW
AC127	2	LF	ASY75	3	Sw	BAV20	1b	SiW
AC127/01	2	LF	ASY76	3	Sw	BAV21	1b	SiW
AC128	2	LF	ASY77	3	Sw	BAV40	1b	Sp
AC128/01	2	LF	ASY80	3	Sw	BAV41	1b	Sp
AC132	2	LF	ASZ15	2	P	BAV42	1b	Sp
AC132/01	2	LF	ASZ16	2	P	BAV43	1b	Sp
AC187	2	LF	ASZ17	2	P	BAV45	1b	Sp
AC187/01	2	LF	ASZ18	2	P	BAV46	4a	Mw
AC188	2	LF	ASZ21	3	Sw	BAV70	4a	Mm
AC188/01	2	LF	BA100	1b	SiA	BAV96A	4a	Mw
AD161	2	P	BA102	1b	T	BAV96B	4a	Mw
AD162	2	P	BA114	1b	SiA	BAV96C	4a	Mw
AEY29	4a	Mw	BA145	1a	R	BAV96D	4a	Mw

GeGB = Germanium gold bonded diodes
GePC = Germanium point contact diodes
HF = High frequency transistors
LF = Low frequency transistors
Mm = Microminiature devices for thick-and thin-film circuits
Mw = Microwave devices
P = Low frequency power transistors
R = Rectifier diodes
SiA = Silicon alloyed diodes
SiW = Silicon whiskerless diodes
Sp = Special diodes
Sw = Switching transistors
T = Tuner diodes

INDEX

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
BAV97	4a	Mw	BC157	2	LF	BCW49	2	LF
BAV99	4a	Mm	BC158	2	LF	BCW56	2	LF
BAW56	4a	Mm	BC159	2	LF	BCW57	2	LF
BAW62	1b	SiW	BC177	2	LF	BCW58	2	LF
BAW95D	4a	Mw	BC178	2	LF	BCW59	2	LF
BAW95E	4a	Mw	BC179	2	LF	BCW69	4a	Mm
BAW95F	4a	Mw	BC200	2	LF	BCW70	4a	Mm
BAW95G	4a	Mw	BC237	2	LF	BCW71	4a	Mm
BAX12	1b	SiW	BC238	2	LF	BCW72	4a	Mm
BAX13	1b	SiW	BC239	2	LF	BCX17	4a	Mm
BAX14	1b	SiW	BC264A	4a	FET	BCX18	4a	Mm
BAX15	1b	SiW	BC264B	4a	FET	BCX19	4a	Mm
BAX16	1b	SiW	BC264C	4a	FET	BCX20	4a	Mm
BAX17	1b	SiW	BC264D	4a	FET	BCY10	2	LF
BAX18	1b	SiW	BC307	2	LF	BCY11	2	LF
BAY96	4a	Mw	BC308	2	LF	BCY12	2	LF
BB104B	1b	T	BC309	2	LF	BCY30	2	LF
BB104G	1b	T	BC327	2	LF	BCY31	2	LF
12-BB105A	1b	T	BC328	2	LF	BCY32	2	LF
12-BB105B	1b	T	BC337	2	LF	BCY33	2	LF
12-BB105G	1b	T	BC338	2	LF	BCY34	2	LF
3-BB106	1b	T	BC547	2	LF	BCY38	2	LF
4-BB106	1b	T	BC548	2	LF	BCY39	2	LF
BB110B	1b	T	BC549	2	LF	BCY40	2	LF
BB110G	1b	T	BC557	2	LF	BCY54	2	LF
BB113	1b	T	BC558	2	LF	BCY55	4a	Dual
BB117	1b	T	BC559	2	LF	BCY56	2	LF
BBY31	4a	Mm	BCW29	4a	Mm	BCY57	2	LF
BC107	2	LF	BCW30	4a	Mm	BCY58	2	LF
BC108	2	LF	BCW31	4a	Mm	BCY59	2	LF
BC109	2	LF	BCW32	4a	Mm	BCY70	2	LF
BC146	2	LF	BCW33	4a	Mm	BCY71	2	LF
BC147	2	LF	BCW46	2	LF	BCY72	2	LF
BC148	2	LF	BCW47	2	LF	BCY87	4a	Dual
BC149	2	LF	BCW48	2	LF	BCY88	4a	Dual

Dual = Dual transistors
FET = Field-effect transistors
LF = Low frequency transistors
Mm = Microminiature devices for thick- and thin-film circuits
Mw = Microwave devices
SiW = Silicon whiskerless diodes
T = Tuner diodes

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
BCY89	4a	Dual	BD435	2	P	BF200	3	HF
BCZ10	2	LF	BD436	2	P	BF240	3	HF
BCZ11	2	LF	BD437	2	P	BF241	3	HF
BCZ12	2	LF	BD438	2	P	BF244A	4a	FET
BD115	2	P	BDY20	2	P	BF244B	4a	FET
BD131	2	P	BDY38	2	P	BF244C	4a	FET
BD132	2	P	BDY60	2	P	BF245A	4a	FET
BD133	2	P	BDY61	2	P	BF245B	4a	FET
BD135	2	P	BDY90	2	P	BF245C	4a	FET
BD136	2	P	BDY91	2	P	BF254	3	HF
BD137	2	P	BDY92	2	P	BF255	3	HF
BD138	2	P	BDY93	2	P	BF256A	4a	FET
BD139	2	P	BDY94	2	P	BF256B	4a	FET
BD140	2	P	BDY95	2	P	BF256C	4a	FET
BD181	2	P	BDY96	2	P	BF257	3	HF
BD182	2	P	BDY97	2	P	BF258	3	HF
BD183	2	P	BDY98	2	P	BF259	3	HF
BD201	2	P	BF115	3	HF	BF324	3	HF
BD202	2	P	BF167	3	HF	BF336	3	HF
BD203	2	P	BF173	3	HF	BF337	3	HF
BD204	2	P	BF177	3	HF	BF338	3	HF
BD226	2	P	BF178	3	HF	BF450	3	HF
BD227	2	P	BF179	3	HF	BF451	3	HF
BD228	2	P	BF180	3	HF	BF457	3	HF
BD229	2	P	BF181	3	HF	BF458	3	HF
BD230	2	P	BF182	3	HF	BF459	3	HF
BD231	2	P	BF183	3	HF	BF494	3	HF
BD232	2	P	BF184	3	HF	BF495	3	HF
BF234	2	P	BF185	3	HF	BFQ10	4a	FET
BD235	2	P	BF194	3	HF	BFQ11	4a	FET
BD236	2	P	BF195	3	HF	BFQ12	4a	FET
BD237	2	P	BF196	3	HF	BFQ13	4a	FET
BD238	2	P	BF197	3	HF	BFQ14	4a	FET
BD433	2	P	BF198	3	HF	BFQ15	4a	FET
BD434	2	P	BF199	3	HF	BFQ16	4a	FET

Dual = Dual transistors
FET = Field-effect transistors
HF = High frequency transistors
LF = Low frequency transistors
P = Low frequency power transistors

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
BFR29	4a	FET	BFX34	3	Sw	BPX42	4b	PhDT
BFR30	4a	Mm	BFX44	3	HF	BPX66P	4b	PhDT
BFR31	4a	Mm	BFX89	3	HF	BPX70	4b	PhDT
BFR53	4a	Mm	BFY44	4a	Tr	BPX71	4b	PhDT
BFR63	3	HF	BFY50	3	HF	BPX72	4b	PhDT
BFR64	3	HF	BFY51	3	HF	BR100	1a	Thyr
BFR65	3	HF	BFY52	3	HF	BR101	3	Sw
BFR90	3	HF	BFY55	3	HF	BRY39	1a	Thyr
BFR91	3	HF	BFY70	4a	Tr	BRY39(SCS)	3	Sw
BFR92	4a	Mm	BFY90	3	HF	BRY39(PUT)	3	Sw
BFR93	4a	Mm	BLX13	4a	Tr	BSS27	3	Sw
BFS17	4a	Mm	BLX14	4a	Tr	BSS28	3	Sw
BFS18	4a	Mm	BLX65	4a	Tr	BSS29	3	Sw
BFS19	4a	Mm	BLX66	4a	Tr	BSS40	3	Sw
BFS20	4a	Mm	BLX67	4a	Tr	BSS41	3	Sw
BFS21	4a	FET	BLX68	4a	Tr	BSV15	3	Sw
BFS21A	4a	FET	BLX69	4a	Tr	BSV16	3	Sw
BFS22A	4a	Tr	BLX91	4a	Tr	BSV17	3	Sw
BFS23A	4a	Tr	BLX92	4a	Tr	BSV52	4a	Mm
BFS28	4a	FET	BLX93	4a	Tr	BSV64	3	Sw
BFS92	3	HF	BLX94	4a	Tr	BSV68	3	Sw
BFS93	3	HF	BLY83	4a	Tr	BSV78	4a	FET
BFS94	3	HF	BLY84	4a	Tr	BSV79	4a	FET
BFS95	3	HF	BLY87A	4a	Tr	BSV80	4a	FET
BFW10	4a	FET	BLY88A	4a	Tr	BSV81	4a	FET
BFW11	4a	FET	BLY89A	4a	Tr	BSV86	3	Sw
BFW12	4a	FET	BLY90	4a	Tr	BSV87	3	Sw
BFW13	4a	FET	BLY91A	4a	Tr	BSV88	3	Sw
BFW16A	3	HF	BLY92A	4a	Tr	BSV96	3	Sw
BFW71A	3	HF	BLY93A	4a	Tr	BSV97	3	Sw
BFW30	3	HF	BLY94	4	Tr	BSV98	3	Sw
BFW45	2	Defl	BPX25	4b	PhDT	BSW41	3	Sw
BFW61	4a	FET	BPX29	4b	PhDT	BSW66	3	Sw
BFW92	3	HF	BPX40	4b	PhDT	BSW67	3	Sw
BFW93	3	HF	BPX41	4b	PhDT	BSW68	3	Sw

Defl = Deflection transistors
FET = Field-effect transistors
HF = High frequency transistors
Mm = Microminiature devices for thick- and thin-film circuits

PhDT = Photodiodes and transistors
Sw = Switching transistors
Thyr = Thyristors, diacs, triacs
Tr = Transmitting transistors

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
BSW69	3	Sw	BU206	2	Defl	BYX55series	1a	R
BSX12	3	Sw	BU207	2	Defl	BYX56series	1a	R
BSX12A	3	Sw	BU208	2	Defl	BYX59series	1a	R
BSX19	3	Sw	BU209	2	Defl	BYX71series	1a	R
BSX20	3	Sw	BXY27	4a	Mw	BZW86series	1a	TS
BSX21	3	Sw	BXY28	4a	Mw	BZW91series	1a	TS
BSX59	3	Sw	BXY29	4a	Mw	BZW93series	1a	TS
BSX60	3	Sw	BYX32	4a	Mw	BZX48	1b	Vref
BSX61	3	Sw	BY126	1a	R	BZX49	1b	Vref
BSY38	3	Sw	BY127	1a	R	BZX50	1b	Vref
BSY39	3	Sw	BY164	1a	R	BZX61series	1b	Vreg
BT100Aseries	1a	Thyr	BY176	1a	R	BZX70series	1a	Vreg
BT101series	1a	Thyr	BY179	1a	R	BZX75series	1b	Vreg
BT102series	1a	Thyr	BY184	1a	R	BZX79series	1b	Vreg
BTW23series	1a	Thyr	BY185	1a	R	BZX84series	4a	Mm
BTW24series	1a	Thyr	BY187	1a	R	BZX90	1b	Vref
BTW30series	1a	Thyr	BY188	1a	R	BZX91	1b	Vref
BTW31series	1a	Thyr	BY206	1a	R	BZX92	1b	Vref
BTW32series	1a	Thyr	BYX10	1a	R	BZX93	1b	Vref
BTW33series	1a	Thyr	BYX13series	1a	R	BZY78	1b	Vref
BTW34series	1a	Thyr	BYX22series	1a	R	BZY88series	1b	Vref
BTW47series	1a	Thyr	BYX25series	1a	R	BZY91series	1a	Vreg
BTW92series	1a	Thyr	BYX29series	1a	R	BZY93series	1a	Vreg
BTX18series	1a	Thyr	BYX30series	1a	R	BZY95series	1a	Vreg
BTX41series	1a	Thyr	BYX32series	1a	R	BZY96series	1a	Vreg
BTX94series	1a	Thyr	BYX35	1a	R	BZZ14	1a	Vreg
BTX95series	1a	Thyr	BYX36series	1a	R	BZZ15	1a	Vreg
BTY79series	1a	Thyr	BYX38series	1a	R	BZZ16	1a	Vreg
BTY87series	1a	Thyr	BYX39series	1a	R	BZZ17	1a	Vreg
BTY91series	1a	Thyr	BYX40series	1a	R	BZZ18	1a	Vreg
BU105	2	Defl	BYX42series	1a	R	BZZ19	1a	Vreg
BU108	2	Defl	BYX45series	1a	R	BZZ20	1a	Vreg
BU126	2	Defl	BYX46series	1a	R	BZZ21	1a	Vreg
BU132	2	Defl	BYX48series	1a	R	BZZ22	1a	Vreg
BU133	2	P	BYX49series	1a	R	BZZ23	1a	Vreg
BU204	2	Defl	BYX50series	1a	R	BZZ24	1a	Vreg
BU205	2	Defl	BYX52series	1a	R	BZZ25	1a	Vreg

Defl = Deflection transistors
Mm = Microminiature devices for thick- and thin-film circuits
Mw = Microwave devices
P = Low frequency power transistors
R = Rectifier diodes
Sw = Switching transistors
Thyr = Thyristors, diacs, triacs
TS = Transient suppressor diodes
Vref = Voltage reference diodes
Vreg = Voltage regulator diodes

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
BZZ26	1a	Vreg	OSM9110	1a	St	1N759A	1b	Vreg
BZZ27	1a	Vreg	OSM9210	1a	St	1N821	1b	Vref
BZZ28	1a	Vreg	OSM9310	1a	St	1N823	1b	Vref
BZZ29	1a	Vreg	OSM9410	1a	St	1N825	1b	Vref
CAY10	4a	Mw	OSS9110	1a	St	1N827	1b	Vref
CQY11B	4b	L	OSS9210	1a	St	1N829	1b	Vref
CXY10	4a	Mw	OSS9310	1a	St	1N914	1b	SiW
CXY11A	4a	Mw	OSS9410	1a	St	1N914A	1b	SiW
CXY11B	4a	Mw	OTH1200	1a	Ign	1N916	1b	SiW
CXY11C	4a	Mw	RPY13	4b	PhC	1N916A	1b	SiW
CXY12	4a	Mw	RPY17	4b	PhC	1N916B	1b	SiW
OA47	1b	GeGB	RPY18	4b	PhC	1N4009	1b	SiW
OA90	1b	GePC	RPY19	4b	PhC	1N4148	1b	SiW
OA91	1b	GePC	RPY20	4b	PhC	1N4150	1b	SiW
OA95	1b	GePC	RPY27	4b	PhC	1N4151	1b	SiW
OA200	1b	SiA	RPY33	4b	PhC	1N4154	1b	SiW
OA202	1b	SiA	RPY41	4b	PhC	1N4446	1b	SiW
OC122	3	Sw	RPY55	4b	PhC	1N4448	1b	SiW
OC123	3	Sw	RPY58A	4b	PhC	1N5152	4a	Mw
ORP10	4b	I	RPY71	4b	PhC	1N5153	4a	Mw
ORP13	4b	I	RPY76A	4b	I	1N5155	4a	Mw
ORP23	4b	PhC	RPY82	4b	PhC	1N5157	4a	Mw
ORP50	4b	PhC	RPY84	4b	PhC	1N5729B	1b	Vreg
ORP52	4b	PhC	RPY85	4b	PhC	1N5730B	1b	Vreg
ORP60	4b	PhC	1N748A	1b	Vreg	1N5731B	1b	Vreg
ORP61	4b	PhC	1N749A	1b	Vreg	1N5732B	1b	Vreg
ORP62	4b	PhC	1N750A	1b	Vreg	1N5733B	1b	Vreg
ORP66	4b	PhC	1N751A	1b	Vreg	1N5734B	1b	Vreg
ORP68	4b	PhC	1N752A	1b	Vreg	1N5735B	1b	Vreg
ORP69	4b	PhC	1N753A	1b	Vreg	1N5736B	1b	Vreg
ORP90	4b	PhC	1N754A	1b	Vreg	1N5737B	1b	Vreg
OSB9110	1a	St	1N755A	1b	Vreg	1N5738B	1b	Vreg
OSB9210	1a	St	1N756A	1b	Vreg	1N5739B	1b	Vreg
OSB9310	1a	St	1N757A	1b	Vreg	1N5740B	1b	Vreg
OSB9410	1a	St	1N758A	1b	Vreg	1N5741B	1b	Vreg

GeGB = Germanium gold bonded diodes
GePC = Germanium point contact diodes
I = Infrared devices
Ign = Ignistors
L = Light emitting devices
Mw = Microwave devices
PhC = Photoconductive devices
SiA = Silicon alloyed diodes
SiW = Silicon whiskerless diodes
St = Rectifier stacks
Sw = Switching transistors
Vref = Voltage reference diodes
Vreg = Voltage regulator diodes

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
1N5742B	1b	Vreg	2N1893	3	HF	2N3771	2	P
1N5743B	1b	Vreg	2N2218	3	Sw	2N3772	2	P
1N5744B	1b	Vreg	2N2218A	3	Sw	2N3819	4a	FET
1N5745B	1b	Vreg	2N2219	3	Sw	2N3823	4a	FET
1N5746B	1b	Vreg	2N2219A	3	Sw	2N3866	4a	Tr
1N5747B	1b	Vreg	2N2221	3	Sw	2N3924	4a	Tr
1N5748B	1b	Vreg	2N2221A	3	Sw	2N3926	4a	Tr
1N5749B	1b	Vreg	2N2222	3	Sw	2N3927	4a	Tr
1N5750B	1b	Vreg	2N2222A	3	Sw	2N3966	4a	FET
1N5751B	1b	Vreg	2N2297	3	HF	2N4036	3	Sw
1N5752B	1b	Vreg	2N2368	3	Sw	2N4091	4a	FET
1N5753B	1b	Vreg	2N2369	3	Sw	2N4092	4a	FET
1N5754B	1b	Vreg	2N2369A	3	Sw	2N4093	4a	FET
1N5755B	1b	Vreg	2N2483	3	HF	2N4347	2	P
1N5756B	1b	Vreg	2N2484	3	HF	2N4391	4a	FET
1N5757B	1b	Vreg	2N2894	3	Sw	2N4392	4a	FET
2N706A	3	Sw	2N2894A	3	Sw	2N4393	4a	FET
2N708	3	Sw	2N2904	3	Sw	2N4427	4a	Tr
2N743	3	Sw	2N2904A	3	Sw	2N4856	4a	FET
2N744	3	Sw	2N2905	3	Sw	2N4857	4a	FET
2N753	3	Sw	2N2905A	3	Sw	2N4858	4a	FET
2N914	3	Sw	2N2906	3	Sw	2N4859	4a	FET
2N918	3	HF	2N2906A	3	Sw	2N4860	4a	FET
2N929	2	LF	2N2907	3	Sw	2N4861	4a	FET
2N930	2	LF	2N2907A	3	Sw	61SV	4b	I
2N1302	3	Sw	2N3055	2	P	40809	2	LF
2N1303	3	Sw	2N3303	3	Sw	40819	2	LF
2N1304	3	Sw	2N3375	4a	Tr	40820	3	HF
2N1305	3	Sw	2N3426	3	Sw	40829	3	HF
2N1306	3	Sw	2N3442	2	P	40835	3	HF
2N1307	3	Sw	2N3553	4a	Tr	56200	2, 3, 4a	A
2N1308	3	Sw	2N3570	3	HF	56201	2	A
2N1309	3	Sw	2N3571	3	HF	56201a	2	A
2N1613	3	HF	2N3572	3	HF	56201b	2	A
2N1711	3	HF	2N3632	4a	Tr	56201c	2	A

A = Accessories
FET = Field-effect transistors
HF = High frequency transistors
I = Infrared devices
LF = Low frequency transistors
P = Low frequency power transistors
Sw = Switching transistors
Tr = Transmitting transistors
Vreg = Voltage regulator diodes

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
56201d	2	A	56262A	1a	A	56314	1a	DH
56201e	2	A	56263	1a to 4a	A	56315	1a	DH
56203	2	A	56264A	1a	A	56316	1a	A
56207	3, 4a	A	56265	2, 3, 4a	A	56318	1a	DH
56208	2, 3, 4a	A	56268	1a	DH	56319	1a	DH
56209	2, 3, 4a	A	56271	1a	DH	56324	2	A
56210	2, 3, 4a	A	56278	1a	DH	56325	2	A
56218	2, 3, 4a	A	56280	1a	DH	56326	2, 3	A
56226	2, 3, 4a	A	56284	1a	DH	56333	2, 3	A
56227	2, 3, 4a	A	56290	1a	HE	56334	1a	DH
56230	1a	HE	56293	1a	HE			
56231	1a	HE	56295	1a	A			
56233	1a	A	56299	1a	A			
56234	1a	A	56302	2	A			
56239	2	A	56303	2	A			
56245	2, 3, 4a	A	56309B	1a	A			
56246	1a to 4a	A	56309R	1a	A			
56253	1a	DH	56311	1a	WH			
56256	1a	DH	56312	1a	DH			
56261	2	A	56313	1a	DH			

A = Accessories
DH = Diecast heatsinks
HE = Heatsink extrusions
WH = Water cooled heatsinks

MAINTENANCE TYPE LIST

The type numbers listed below are not included in this handbook.

Detailed information will be supplied on request.

BPY10	OAP12
BPY68	OCP70
BPY69	ORP31N
BPY76	ORP63
BPY77	RPY43

General

Photosensitive diodes and transistors

Light emitting diodes

Infra-red sensitive devices

Photoconductive devices