SIEMENS

Data Book 1973/74

Optoelectronics Semiconductors

Contents

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SIEMENS AKTIENGESELLSCHAFT

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■ Not for new development.

1.1. Inventory of Types

Germanium-photodiodes

	Type	Reverse voltage V_R(V)	Sensitivity S(nA/Lux)	Dark current at T_{amb}=25 °C I_d(µA)	Maximum power dissipation at T_{amb}=25 °C P_{tot}(mW)	Page
■	APY 12/I	100	100 (>40)	≦8.0	50	44
■	APY 12/II	100	180 (>120)	≦8.0	50	44
■	APY 12/III	100	220 (>200)	≦8.0	50	44
■	APY 13/I	30	100 (>40)	≦8.0	50	44
■	APY 13/II	30	180 (>120)	≦8.0	50	44
■	APY 13/III	30	220 (>200)	≦8.0	50	44

Silicon photo diodes

	Type	Reverse voltage V_R (V)	Sensitivity S (nA/Lux)	Rise time of photo current t_r (ns)	Dark current at T_{amb}=25 °C I_d (µA)	Page
	BPY 12	20	>100	<500	0.5 (<1)	46
▼	BPX 60	32	50 (>35)	1000	7 (<300)	48
▼	BPX 63	7	10	1000	0.15	50
▼	BPX 65	50	6 (>4)	<1	1 (<5)	52
▼	BPX 90	32	40 (>25)	–	5 (<200)	56
▼	BPX 91	32	50 (>35)	1000	7 (<300)	59
▼	BPX 92	32	7 (>4)	800	1 (<100)	62
▼	BPX 93	32	8 (>5)	–	0.5 (<50)	65

Silicon differential photo diode

Type	Reverse voltage V_R(V)	Sensitivity S (nA/Lux)	Rise time of photo current t_r (ns)	Dark current at T_{amb}=25 °C I_d (µA)	Page
BPX 48	10	>15	<150	0.1 (<0.2)	68

▼ New type
■ Not for new development

Silicon photo-voltaic cells

	Type	Open-circuit voltage at E_v= 100 Lux V_L (mV)	10000 Lux V_L (mV)	Sensitivity S (µA/Lux)	Reverse voltage V_R (V)	Dark current at T_{amb}= 25 °C I_d (µA)	Radiation temperature T (K)	Page
	BP 100	≧120	≧200	0.025 (≧0.018)	1.0	3 (≧10)	2856	72
▼	**BPX 79**	≧220	≧310	0.135 (≧0.1)	1.0	0.3 (<50)	2856	75
	BPY 11	≧180	≧260[1])	0.04 (≧0.028)	1.0	1 (≧10)	2856	77
■	**BPY 43**	≧150	≧270[1])	0.02 (≧0.015)	2.0	<5	2856	81
■	**BPY 44**	≧200	≧330[1])	0.027 (≧0.02)	2.0 (<5)	<1	2856	81
	BPY 45	≧150	≧450	1.45 (≧1.0)	1.0	–	2856	84
	BPY 47	≧150	≧450	1.3 (≧0.9)	1.0	–	2856	84
	BPY 48	≧150	≧450	0.43 (≧0.3)	1.0	–	2856	84
	BPY 63	≧150	≧450	0.65 (≧0.45)	1.0	–	2856	89
	BPY 64	≧150	≧450	0.23 (≧0.16)	1.0	–	2856	89
	TP 60	≧160	≧440	1.0 (≧4.1) 0.7	1.0	–	2856	94
	TP 61	≧160	≧440	1.0 (≧4.1) 0.7	1.0	–	2856	94

[1]) E_v = 1000 Lux

Silicon solar cells

	Type	Ambient temperature T_{amb} (°C)	Open-circuit voltage V_L (mV)	Short-circuit current I_K (mA)	Page
■	**BPY 73**	−40 to + 80	535	≧137	97
■	**BPY 74**	−80 to +215	585	≧130	99

Silicon photo transistor arrays

	Type [ ] number of photo transistors per photo array	Collector-emitter reverse voltage V_{CE} (V)	Photo current at V_{CE}=5 V; E_v=1000 Lux I_p (mA)	Collector-emitter cutoff current V_{CE}=25 V E_v=0 Lux I_{CEO} (nA)	Page
▼	**BPX 82** [2]	32	0.63 to 5.0	25 (<200)	125
▼	**BPX 83** [3]				
▼	**BPX 84** [4]				
▼	**BPX 85** [5]				
▼	**BPX 86** [6]				
▼	**BPX 87** [7]				
▼	**BPX 88** [8]				
▼	**BPX 89** [9]				
▼	**BPX 80** [10]				

■ Not for new development ▼ New type

Inventory of Types

Silicon photo transistors

Type	Collector-emitter reverse voltage V_{CE} = (V)	Collector-emitter cutoff current at V_{CE} = 25 V, E_V = 0 lx I_{CEO} (nA)	Photo current at V_{CE} = 5 V, E_V = 1 000 Lux I_p (mA)	Page
BP101/I[2])	32	5 (<100)[3])	0.063 to 0.125	102
BP101/II[2])	32	5 (<100)[3])	0.1 to 0.2	102
BP101/III[2])	32	5 (<100)[3])	0.16 to 0.32	102
BP101/IV[2])	32	5 (<100)[3])	0.25 to 0.5	102
BP102/I[2])	32	5 (<100)[3])	0.16 to 0.32	106
BP102/II[2])	32	5 (<100)[3])	0.25 to 0.5	106
BP102/III[2])	32	5 (<100)[3])	0.4 to 0.8	106
BP102/IV[2])	32	5 (<100)[3])	0.63 to 1.25	106
BPX38/I[2])	25	100 (<500)	0.4 to 0.8	110
BPX38/II[2])	25	100 (<500)	0.63 to 1.25	110
BPX38/III[2])	25	100 (<500)	1.0 to 2.0	110
BPX38/IV[2])	25	100 (<500)	1.6 to 3.2	110
BPX43/I[2])	50	5 (<200)	1.6 to 3.2	114
BPX43/II[2])	50	5 (<200)	2.5 to 5.0	114
BPX43/III[2])	50	5 (<200)	4.8 to 8.0	114
BPX43/IV[2])	50	5 (<200)	6.3 to 12.5	114
▼ BPX62/I[1])	50	10 (<100)	0.4 to 0.8	118
▼ BPX62/II[1])	50	10 (<100)	0.63 to 1.25	118
▼ BPX62/III[1])	50	10 (<100)	1.0 to 2.0	118
▼ BPX62/IV[1])	50	10 (<100)	1.6 to 3.2	118
▼ BPX78[4])	40	100	0.3	120
▼ BPX81/I[1])	32	25 (<200)	0.63 to 1.25	122
▼ BPX81/II[1])	32	25 (<200)	1.0 to 2.0	122
▼ BPX81/III[1])	32	25 (<200)	1.6 to 3.2	122
▼ BPX81/IV[1])	32	25 (<200)	2.5 to 5.0	122
BPY61/I[1])	50	5 (<100)	0.8 to 1.6	128
BPY61/II[1])	50	5 (<100)	1.25 to 2.5	128
BPY61/III[1])	50	5 (<100)	2.0 to 4.0	128
▼ BPY61/IV[1])	50	5 (<100)	3.2 to 3.6	128
BPY62/I[2])	32	5 (<100)	1.25 to 2.5	131
BPY62/II[2])	32	5 (<100)	2.0 to 4.0	131
BPY62/III[2])	32	5 (<100)	3.2 to 6.3	131
▼ BPY62/IV[2])	32	5 (<100)	5.0 to 10.0	131

[1]) Without base connection in glass case
[2]) With base connection in TO-18 case
▼ New type

[3]) at V_{CE} = 30 V
[4]) Without base connection in metal case

GaAs light emitting diodes (infrared emitters)

	Type	Forward current I_F (mA)	Radiant power at $I_F = 100$ mA Φ_e (mW)	Rise time; fall time t_r, t_f (µs)	Page
▼	**CQY17/IV**	100	1.1 to 2.8 [1]	1.0	136
▼	**CQY17/V**	100	1.8 to 4.5 [1]	1.0	136
▼	**CQY17/VI**	100	2.8 to 7.1 [1]	1.0	136
▼	**CQY18/III**	100	0.8 to 2.0 [2]	1.0	140
▼	**CQY18/IV**	100	1.25 to 3.2 [2]	1.0	140
▼	**CQY18/V**	100	2 to 5.0 [2]	1.0	140
▼	**LD261/I**	50	0.28 to 0.71 [2]	1.0	144
▼	**LD261/II**	50	0.45 to 1.112 [3] [2]	1.0	144
▼	**LD261/III**	50	0.71 to 1.8 [3] [2]	1.0	144
▼	**LD261/IV**	50	1.12 to 2.8 [3] [2]	1.0	144

GaAs light-emitting diode arrays (infrared emitters)

	Type (Number of LED's per diodes array)	Forward current I_F (mA)	Radiant power at $I_F = 50$ mA Φ_e (mW) [2]	Rise time; fall time; t_r, t_f (µs)	Page
▼	**LD262** (2)	50	0.32 to 2.50	1.7	147
▼	**LD263** (3)				
▼	**LD264** (4)				
▼	**LD265** (5)				
▼	**LD266** (6)				
▼	**LD267** (7)				
▼	**LD268** (8)				
▼	**LD269** (9)				
▼	**LD260** (10)				

▼ New type
[1] $\varphi = 15°$
[2] $\varphi = 30°$
[3] $I_F = 50$ mA

GaAsP light-emitting diodes (visible light emitters)

	Type	Reverse voltage V_R (V)	Reverse current at $V_R = 3$ V I_R (μA)	Forward current $T_{amb} = 25$ °C I_F (mA)	Luminous intensity at $I_F = 20$ mA I_V (mcd)	Page
▼	**LD 30 B**	3	0.1	50	0.8 (>0.3)	150
▼	**LD 30 C**	3	0.1	50	0.8 (>0.3)	150
▼	**LD 40/I**	3	10	50	0.7 (>0.3)	153
▼	**LD 40/II**	3	10	50	1.2 (>0.8)	153
▼	**LD 50/I**	5	100 [2])	100	2 (>1)[1])	155
▼	**LD 50/II**	5	100 [2])	100	3 (>2)[1])	155
▼	**LD 461**	3	0.01 (<10)	50	1.0 (>0.3)	156

GaAsP light-emitting diode arrays (visible light emitters)

	Type ( ) No. of LED's per diodes array	Reverse voltage V_R (V)	Reverse current at $V_R = 3$ V I_R (μA)	Forward current $T_{amb} = 25$ °C I_F (mA)	Luminous intensity at $I_F = 20$ mA I_V (mcd)	Page
▼	**LD 462** (2)	3	0,01 (<10)	50	1,0 (>0.3)	158
▼	**LD 463** (3)					
▼	**LD 464** (4)					
▼	**LD 465** (5)					
▼	**LD 466** (6)					
▼	**LD 467** (7)					
▼	**LD 468** (8)					
▼	**LD 469** (9)					
▼	**LD 460** (10)					

[1]) $I_F = 10$ mA
[2]) at $V_R = 5$ V
▼ New type

Optoelectronic couplers

	Type	Emitter		Detector		Efficiency ($V_{CE}=5$ V) %	Page
		Forward current I_F (mA)	Reverse voltage V_R (V)	Collector current I_C (mA)	Coll. rev. voltage V_{CEO} (V)		
▼	**CNY 17/I**	60	3	150	32	40 to 80	162
▼	**CNY 17/II**	60	3	150	32	63 to 125	162
▼	**CNY 17/III**	60	3	150	32	100 to 200	162
▼	**CNY 17/IV**	60	3	150	32	160 to 320	162
▼	**CNY 18/I**	60	3	150	32	10 to 20	164
▼	**CNY 18/II**	60	3	150	32	16 to 32	164
▼	**CNY 18/III**	60	3	150	32	25 to 50	164
▼	**CNY 18/IV**	60	3	150	32	40 to 80	164

Photo resistors

Type	Operating voltage V_a (V)	Dark resistance R_0 (Ω)	Light resistance R_{1000} (Ω)	Page
RPY 60	100	$\geqq 1 \cdot 10^8$	300 to 800	168
RPY 61	50	$\geqq 1 \cdot 10^6$	300 to 800	170
RPY 62	100	$\geqq 1 \cdot 10^8$	3500	172
RPY 63	50	$\geqq 1 \cdot 10^6$	300 to 800	174
RPY 64	100	$\geqq 1 \cdot 10^8$	3500	176

▼ New type.

2. Preface

2.1. General Remarks

Optoelectronic components are used in modern electronics to an ever increasing degree. The main fields of application are light barriers for production control and protective devices, light control and regulating devices, e. g. twilight switches, fire detectors and devices for optical heat supervision, scanning of punched cards and perforated tapes, positioning of machine tools (for measuring length, angle and position), checking of optical equipment and ignition processes, signal transmission in case of an electrical separation of input and output, and conversion of light into electrical energy.

Depending upon the application, photo-voltaic cells, solar elements, photo transistors or photodiodes are used. Photodiodes are to be preferred in cases where amplifiers with high input impedances are used.

Photo transistors are primarily employed in conjunction with transistor circuits or to drive integrated circuits, whereas photo-voltaic cells are used to scan large surfaces when a strictly linear relationship between light and useful signal and optimum reliability are required.

Apart from photo-electric receivers, light emitters on a semiconductor basis are used, namely light emitting diodes. Difference is here made between light emitters on the basis of GaAs (gallium arsenide) operating in conjunction with the photo receivers mentioned above and being tuned to them with regard to spectrum and emitters on the basis of GaAsP (gallium arsenide phosphide) or GaP (gallium phosphide) radiating visible light and serving mainly as signal indicators.

Components comprising both emitter and detector are termed optically coupled isolators or optoelectronic couplers. They serve to transmit electrical signals in case of an electrical separation. Furthermore, the elimination of signal feedback to the input may be an inherent advantage.

The following will give further information as to technology, special characteristics and possibilities of application in the various fields. A final chapter is devoted to measuring techniques for optoelectronic components and to the most important tables and performance charts.

2.2. Silicon Photo Diodes

These photo diodes have a PN junction poled by a reversed bias. The capacitance which declines with a growing reverse voltage reduces the switching times. The PN junction is of easy access to the light. Without any illumination, a very small reverse current, the socalled dark current, flows. Light falling onto the area of the PN junction will generate charge carrier pairs there leading to an increase in the reverse current. This photo current is proportional to the illuminance. These photo diodes are therefore particularly suitable for quantitative light measurements. The application of the planar method has two essential advantages: The dark currents are considerably smaller than with comparable photo electric devices of non-planar design. This results in a reduction of current noise and thus to a decisive improvement of the signal/noise ratio.

Moreover, these diodes do not have to be encapsulated in tight cases. The design of high-performance scanning systems with a high packing density thus becomes feasible.

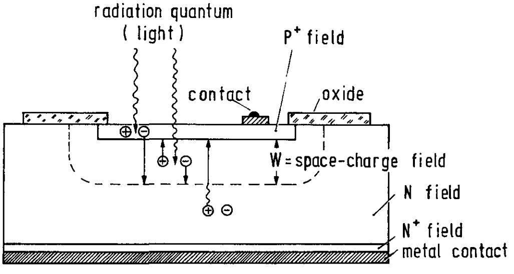


Fig. 1

Fig. 1 shows the basic design of a photo diode. The limit of the space-charge region is indicated by a dashed line.

Without any light, a small dark current I_D flows through the PN junction as a result of thermally generated carriers. In case of illumination the radiation quantums (internal photo effect) will generate additional charge carrier pairs (hole electron pairs) in the P and N region. Carriers caused in the space charge field are immediately sucked off because of the prevalent electrical field, i.e. the holes in the direction of the P side and the electron in the direction of the N side. Carriers from the remaining field must first diffuse into the space-charge region in order to be separated there. In case the holes and electrons will recombine before, they will not contribute to the photo current.

The photo current I_P is thus composed of the drift current of the space-charge region and the diffusion current of the P and N area.

I_P is proportional to the incident radiant intensity. As I_P is very small for diodes it may be neglected in the equation $I_P = I_P' + I_D$. We thus have a linear correlation between I_P and the incident radiant intensity over a very broad range.

Diodes with a small space-charge width are termed PN diodes, diodes with a large space-charge width PIN diodes.

In case of PN diodes, the diffusion current is the dominating part of the photo current and in case of PIN diodes the drift current.

As the capacitance is inversely proportional to the space-charge width W the PIN diode is characterized by a smaller capacitance than a PN diode of identical surface.

The capacitance of (the majority of) the diodes reads:

$$C_D \sim \sqrt{\frac{N}{V}}.$$

The smaller the doping N of the basic material and the higher the applied voltage V, the smaller the capacitance.

Fig. 2 shows the capacitance as a function of voltage for a PIN diode, e.g. BPY 12.

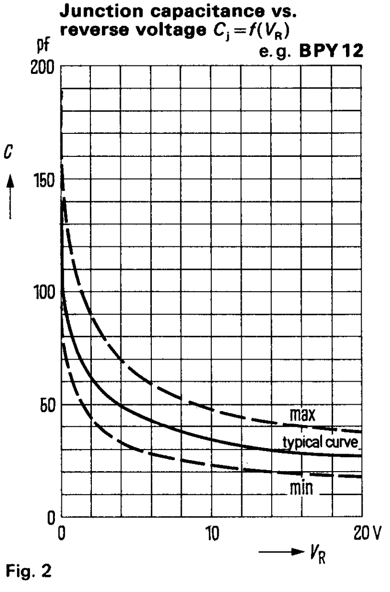


Fig. 2

2.3. Silicon Photo-Voltaic Cells

Silicon photo-voltaic cells are available as large-surface and as small-surface cells. The junction produced by diffusion is close to the surface. The open-circuit voltage increases logarithmically as a function of the illuminance and reaches high values already at low illuminances. It is independent of the size of the photo-voltaic cell.

The short-circuit current increases linearly with the illuminance, when the surface is illuminated entirely, and is proportional to the size of the photo-sensitive surface. To establish the illumination conditions interesting in practice irrespective of the spectral composition of the light, we shall use the magnitude of the short-circuit current of the photo-voltaic cells being employed.

The optimum application of photo-voltaic cells – depending on the respective application – is closely connected with the illumination conditions and the resistance matching conditions. The data sheets state the matching curves applicable to the respective type. The short-circuit current I_K is plotted at the illumination intensity proportional to it as the abscissa and the pertinent photo current I_P and the respective photo voltage V_P on the ordinate. The load resistance R_L is used as a parameter. This mode of plotting will show the user at a first glance whether he is still in the range of operation envisaged (short-circuit operation with an absolute linearity or short-circuit operation with a logarithmic behaviour). Should the illumination sources deviate from the given data the respective curves should first be determined in order to obtain a clear starting point.

The rise-time of the signal voltage delivered to a load resistor by the photo-voltaic cell depends primarily upon the operating conditions. Two broad categories exist.
1) Load resistor smaller than the matching resistor (tendency to short-circuit).
2) Load resistor greater than the matching resistor (tendency to open-circuit).
In case 1, the photo-voltage rise is similar to the charging of a capacitor through a resistor from a constant voltage source. In photo-voltaic cells the junction capacitance C_j must be charged, the charging occurring with time constant $\tau = R_L \, C_j$, R_L being the load resistor. The small photo-voltaic cell resistance is neglected.

In case 2, the photo-voltage rise is similar to the charging of a capacitor from a constant current source. The rise time is then t_r.

$$\text{where } t_r = \frac{V_P \cdot C_j}{I_K}.$$

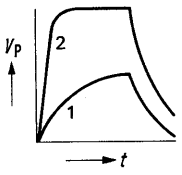
I_K being the short-circuit current under the given lighting conditions.
This relation is valid only for values of V_P less than 80% of the final value of open-circuit voltage.

The diagram below shows the basic rise time relationships of photo-voltaic cells.

Case 1
Rise time according to the equation

$$V_P = I_K \, R_L \cdot \left(1 - e^{-\frac{t}{R_L C_j}}\right)$$

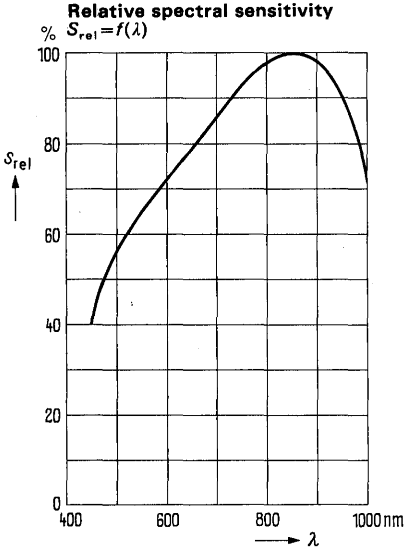
time constant $\tau = R_L \, C_j$.



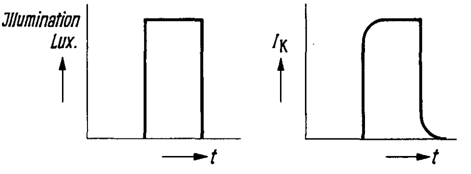
Case 2
Rise time $t_r = \frac{V_P \, C_j}{I_K}$

fall time in both cases $\tau = R_L \, C_j$.

The superposition of other effects can, under certain conditions, lead to a modification of the above conclusions.



E.g.:
With very small time constants (particularly in short-circuit operation) the actual impulse shape of the short-circuit current, which differs from the ideal square wave must be considered.



2.4. Silicon Solar Elements

Solar elements convert sunlight into electrical energy and thus, for instance, ensure the energy requirements of a satellite in space.

The silicon solar elements BPY 73 and BPY 74 have been developed particularly for these extraterrestrial applications. The N to P method ensures a low degradation factor and thus a considerably longer service life even at a highly energetic particle radiation.

The weldable silver-titanium contacts facilitate the connection of single solar elements to form socalled modules and, in case of a greater number of elements, to form panels or even solar batteries.

BPY 74 is particularly provided for use at high temperatures as encountered in satellites operating close to the sun.

2.5. Mounting Instructions for Silicon Photo Diodes and Photo-Voltaic Cells

(open design, without package).

With silicon being inherently brittle material, the photo-electric device must not be subjected to pressure or tension. The contacting positions are especially endangered. When applying tension to the solid wire leads, which for technological reasons are alloyed to a very thin P-type layer, it may only be parallel to the surface, and must not exceed 200 p (pond). Leads may only be bent at least 3 mm from the outer edge of the photo-electric device. Photo-electric devices can be cemented to metallic or plastic supports, but the expansion coefficient of the material must be taken into consideration to avoid mechanical stress between the support and photo-electric device with variations in temperature. An epoxy resin must be employed to cement or encapsulate photo-electric devices, which is colorless and does not darken with time. After curing, the epoxy must not contain any occlusions of gas (filter effect). Particularly suitable for encapsulating photo-electric devices is the epoxy EPICOTE 162[1]) with LAROMIN-C 260[2]) hardener. 100 parts by weight of EPICOTE 162 and 38 parts by weight of LAROMIN-C 260 are to be mixed well. This mixture remains workable for about 30 minutes, after which it becomes viscous. All materials to be encapsulated must be dry and free of dust and grease. If bubbles form after encapsulation, it is advisable to briefly raise the temperature during curing to about 100 °C, so that the bubbles come to the surface and burst. The normal curing temperature is 60 to 80 °C. The curing time is usually one hour, but reduces at higher temperatures. When working with epoxy, care must be taken to prevent it or the hardener from coming into contact with skin: Soap and water should be used to wash off. The quickly binding glue SICOMET 85[3]) is used to cement Si diodes or photo-voltaic cells of open design. The light-sensitive surface of the photocell is coated with a protective lacquer which must not be contaminated during cementing.

2.6. Silicon Photo Transistors

The introduction of planar techniques allows the manufacture of photo transistors of small dimensions and a high photo sensitivity. They are used as photo-electric receivers in control and regulating devices. As the maximum photo sensitivity of these photo transistors lies near the infrared limit of the light wave spectrum they are particularly suitable as receivers for incandescent lamp light.

The mode of operation of a photo transistor corresponds to that of a photo diode with a built-in amplifier. It has 100 to 500 times the photo sensitivity of a comparable photo diode.

The photo transistor is preferably used in a common emitter circuit and there shows a behaviour similar to that of an AF transistor.

Unilluminated, only a small collector-emitter cutoff current is flowing. It amounts to approximately $I_d = h_{FE} \times I_{CBO}$ where h_{FE} is the static forward current transfer ratio and I_{CBO} the reverse current of the base.

With illumination, the reverse current of the base increases by the photo current I_P. The photo current I_P thus reads $\sim h_{FE}(I_{CBO}+I_P)$.

The photo current of a transistor is therefore a function of the photo current I_P of the base and of the static forward current transfer ratio h_{FE}. As h_{FE} may not be raised at will, the photo sensitivity of the base should be as high as possible.

[1]) Registered trade-mark (Shell Chemical),
[2]) Registered trade-mark (BASF),
[3]) Registered trade-mark (Sichel-Werke, Hannover)

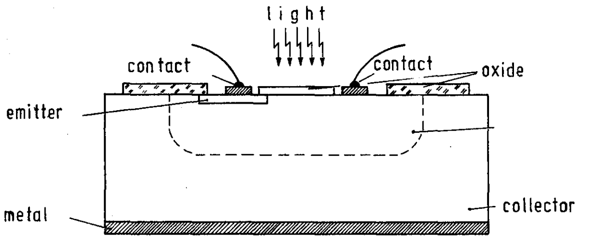


Fig. 3

Fig. 3 shows the design of a photo transistor. The emitter and the base leads are laterally affixed so that the base diode is as readily accessible to radiation as possible. The large collector region ensures that as many radiation quantums are absorbed as possible and will thus contribute to the photo current.

As the static forward current transfer ratio h_{FE} depends on the current there is a linear correlation between the incident radiant intensity and the photo current I_P only over a small range in contrast to a photo diode.

Fig. 4 shows a typical family of characteristics of a photo transistor.

As the reverse current I_{CBO} of the base diode is amplified in the same manner as the photo current I_P, of the base diode the transistor does not exhibit a more favourable signal/noise ratio than the photo diode.

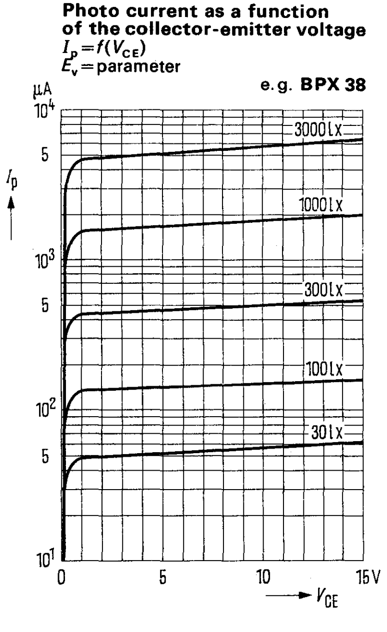


Fig. 4

Special photo transistor types are provided for the various applications. The types BPY 62 and BPX 43 are mainly used for universal applications requiring no lens on the receiver side.

BPY 62 is characterized by a higher cutoff frequency and, in contrast to that, type BPX 43 by a higher photo sensitivity.

In case the field of application requires the use of a lens on the receiver side, this requirement may be met by the type BPX 38. The plane window of this photo transistor enables the focal spot to be reproduced precisely on the photo-sensitive surface of the transistor system. Due to the larger system surface the adjustment and alignment of the transistor case to the light emitter should raise no difficulties.

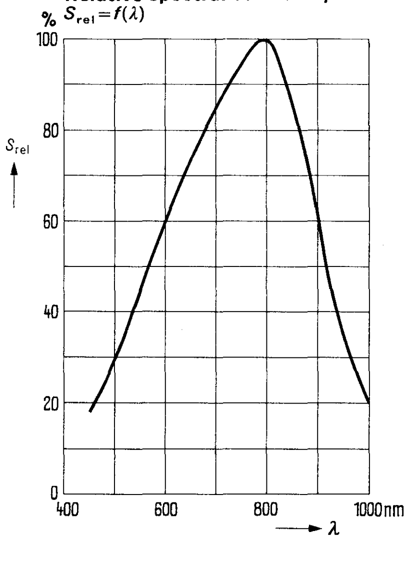
With the types mentioned, a user may preset the operating point of the photo transistor by wiring the base lead. The rapidity of response may thus be increased and the photo sensitivity be reduced. A fixed bias can reverse the photo transistor. When this bias is scanned, coincidence circuits may be realized.

The requirement for a high packing density is met by the photo transistor BPY 61. It is incorporated in a miniature glass package with the dimensions 13 mm × 2.1 mm ∅ and displays a photo sensitivity 500 to 1000 times greater than small-surface silicon photo-voltaic cells. The tolerance range of the light sensitivity is subdivided into three groups of sensitivity. There is no base contact. Light is the control element effecting a correspondingly high collector current via the emitter-base distance of the transistor system multiplied by the factor of static forward current transfer ratio. Rise and fall times depend on the illuminance; they decrease with rising intensity.

Primary applications are scanning of binary coded discs, films and punched cards.

Under difficult mounting conditions, the following amplifier is often connected by relatively long leads. The danger of stray signal disturbances is, however, small as the high photo currents guarantee a sufficiently large signal/noise ratio.

Relative spectral sensitivity



2.7. Photo Resistors

Photo resistors are passive photo-electric elements. They consist of mixed crystals and exhibit a high photo sensitivity for light wavelengths from the ultraviolet to the near infrared region. Electrically, they behave like ohmic resistors and their resistance value is determined by the illumination intensity.

Photo resistors do not have a junction; they are bipolar and may thus be used in AC and DC circuits.

A change in the resistance value as a function of the illuminance is not inertialess. The rise times are of the order of a few milliseconds. The temperature coefficient of photo resistors is low and decreases with a rising illuminance.

2.8. Light Emitting Diodes (LEDs)[1] and Semiconducting Indicators

Definition. Light-emitting diodes are semiconductor diodes emitting electro-magnetic radiation when operated in forward direction. The wavelength of the emitted radiation depends on the semiconductor material used and of its doping. Ga (As, P) LEDs (gallium arsenide phosphide LEDs) emit red light while GaAs diodes (gallium arsenide diodes) radiate in the infrared region of the spectrum. This fact also determines their principal applications: Ga (As, P) diodes are used as signal lamps or indicators while GaAs diodes are applied as source of radiation in light barrier arrangements.

Solid state displays serve to indicate numerical or alpha-numerical symbols. The symbols are produced in one plane which results in a large optic angle.

LEDs and displays are characterized by the following advantages:

- Long life (approx. 10^5 h half-life)
- They are resistant to shock and vibration
- They are circuit-compatible
- The emitted radiation may easily be modulated
- Simple design permitting a high packing density.

[1]) LED – light emitting diode

2.8.1. Design and Mode of Operation

Light emitting diodes are operated in forward direction. When current flows freely movable electrons penetrate into the P region through the PN junction where they recombine with the holes present there. During this operation, energy is released in the form of radiation.

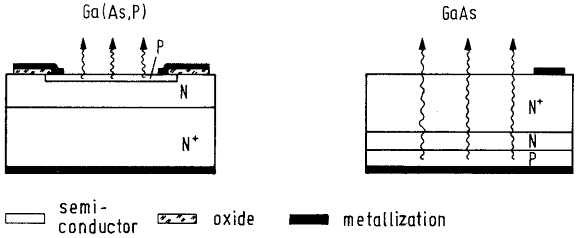


Fig. 5

Fig. 5 shows the schematic views of two types of light-emitting diode systems. In case of epitaxial Ga (As, P) diodes the PN junction is only 2 to 4 µ below the semiconductor surface. The light is produced in the thin P region and leaves the crystal through the near surface. All light propagating into the interior of the crystal is absorbed. GaAs LEDs are epitaxial diodes with an approximately 50 µm P layer where the radiation is being produced. As N-type GaAs absorbs only little infrared radiation the diode may be mounted with its P side on the metal support for better heat dissipation.

The Ga (As, P) diodes emitting red light are supplied in plastic packages. LD 30 and LD 50 are provided for use in front panels. The LD 46 series is suitable for a great many applications. The arrays of 1 to 10 single diodes produced from this type may be arranged in indefinite number. They are also used to build up complex indication systems, such as scales and large displays.

GaAs LEDs are incorporated in plastic packages (array type LD 26) or in hermetically sealed glass-metal cases (CQY 17, CQY 18). The radiation characteristic is important to the user. When the light-emitting diodes are used in arrangements without an optical lens, as for instance in a read-head for punched tape, the cone of apex angle of the radiation should be small. This is the case with LD 26 and CQY 17. In connection with optical lens systems preference is given to those types emitting radiation through a plane window (CQY 18).

In case of 7-segment displays with a digit height of 3.2 mm (CQY 21) 7 LEDs are mounted on a metal support and cast in red resin. The red colouring serves to improve the contrast. Larger displays (up to 60 mm height) may be realized in the form of numerical or alphanumerical displays with the aid of the LD 46 array series. The displays may be triggered both in static operation and in time division multiplex operation ($f > 100$ Hz because of freedom of flicker) by means of BCD seven-segment decoder/driver circuits. In case of displays working with several digits, the time-shared multiplex system usually proves to be less expensive. Only one decoder is used for all digits, which – like the digits – is triggered by a clock circuitry. A latch holds the input signal until new information is received (Fig. 6).

Schematic view of the multiplex triggering of n-figure LED displays

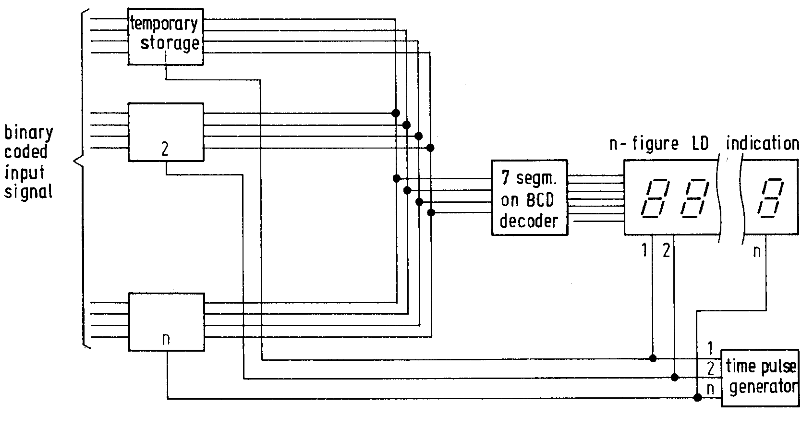


Fig. 6

2.8.2. Electrical-Optical Characteristics

The emitted radiation (or luminous intensity) will change linearly with the forward current in the normal operating region in case of GaAs and Ga (As, P) diodes and displays (Fig. 7). With a very high forward current the curve asymptotically approaches a maximum rating. This is caused by a strong heating of the semiconductor system. The region of linearity may be expanded by switching over from static to pulse operation. Non-linearity also exists in case of small forward currents, where excess currents do not contribute to radiation. These effects cannot be influenced by the customer.

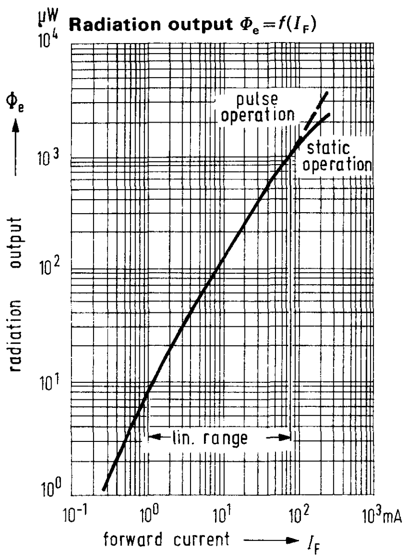


Fig. 7

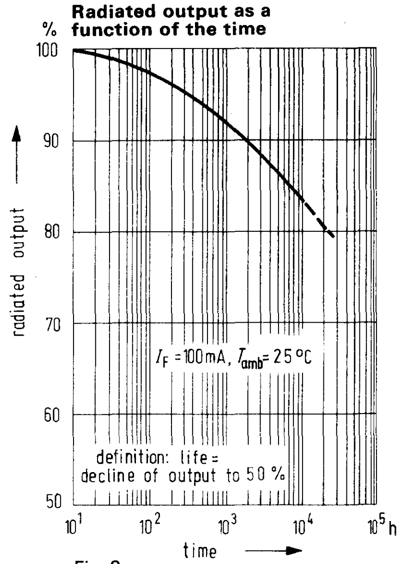


Fig. 8

With rising temperature the radiant intensity and the luminous intensity, respectively, will decline with a constant current. The temperature coefficient for GaAs is −0.7% per degree. This fact may be neglected for many applications. If the temperature dependence proves troublesome it may largely be eliminated by means of compensation circuits. A simple example is shown in Fig. 8.

The radiant power emitted by LEDs declines with a rising time of operation. The term "life" was introduced in order to describe the magnitude of this degradation. It is defined as the time after which the radiant power has fallen to half the value. In case of CW operation, this life amounts to approximately 10^5 hours. This applies to the following conditions: Ambient temperature $T_{amb} = 25$ °C, forward current $I_F =$ 100 mA (CQY 17, CQY 18) and $I_F = 50$ mA (LD 26, LD 46), respectively.

2.9. Optoelectronic Couplers

Definition

Couplers are optoelectronic devices for the transmission of signals in case of an electrical input-output separation. They are also termed optoelectronic isolators.

Design and Mode of Operation

The information is transmitted optically. The electrical signal is converted into an optical one by an emitter in the component. It is then passed on optically and reconverted into an electrical signal by a detector. A gallium arsenide light emitting diode emitting infrared light serves as the emitter and a silicon photo transistor as a detector. With forward current flow the light emitting diode generates radiation of about 950 nm wavelength on the input side of the component. This radiation is fed to the photo transistor by means of a light-conducting medium. The transistor current depends upon the striking radiant power. Potential differences up to a few kV may exist between the input and output, depending upon the type of component.

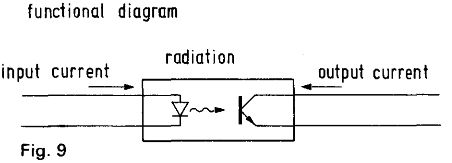


Fig. 9

Basic Circuit

As the above diagram shows, current transmission is effected by simply connecting the output to the emitter and collector of the transistor. Frequently, the base is also connected. More variations in the wiring technique are thus obtained: On the one hand, charge carriers may flow from the base via a resistor to ground whereby the cutoff frequency of the transistor is increased, however, at the expense of the transmission factor. On the other hand, the transistor may be included in the secondary circuit with its normal transistor functions.

The essential characteristics

of optoelectronic couplers are their current transmission ratio and the insulation voltage.

The insulation voltage depends on the design type. For the CNY 18 which is similar to TO-18, it amounts to 500 V because of the short outer insulation paths, in case of the DIL 6-coupler CNY 17 it runs to 2.5 kV.

The transmission ratio is the relation between output current and input current. It is stated in per cent. Practical values lie between 20 and 300%. Its magnitude depends on the radiant power of the light emitting diode, the quality of light transmission and the static forward current transfer ratio of the transistor. The forward current transfer ratio usually runs to a few hundred.
As both the light emitting diode (LED) and the photo transistor are dependent upon temperature the transmission ratio of the couplers is also temperature-dependent, accordingly. At low temperatures, it is determined by the positive temperature coefficient of the transistor and at higher temperatures by the negative coefficient of the LEDs. The transmission ratio of a coupler first increases with temperature, passes through a maximum between 0 and 50 °C and then declines.

Couplers are preferably used to transmit digital and analogue signals. In analogue applications, allowance has to be made for a certain non-linearity between input and output current, which, however, may be neglected in case of small signals.

2.10. Measuring Techniques for Optoelectronic Semiconductor Devices

Optoelectronic semiconductor devices, photo-voltaic cells, photo diodes, photo transistors, etc. are special types of standard semiconductor components, which have been developed for their particular field of application. Their measuring techniques include and are based on the conventional and known measuring techniques for diodes and transistors. These are supplemented by a special optoelectronic measuring technique. Irrespective of the fact whether the objects to be measured are radiation-sensitive (detectors) or radiation-emitting (emitters) components or a combination of the two (e.g. optoelectronic couplers) the measuring system radiator-receiver remains the same, only the object to be measured changes its place. The important difference from the standard measuring method lies in the broadband of the measuring system and the pronounced spectral characteristics of emitters and detectors as well as in the problem of an exact description of these characteristics and their reproducibility in order to obtain consistent results in any place and at any time. Attention has therefore to be paid to the following instructions.

Radiation-Sensitive Components (Detectors)

Radiation-sensitive semiconductor devices serve to convert radiation energy into electric energy. Radiation energy may be supplied to the device in many ways depending on which source of radiation is being used. The measuring purposes are only fulfilled by radiation sources which may easily be covered with respect to their spectral energy distribution and which are reproducible. That are thermal radiation sources, such as the tungsten-filament lamp which comes very close to the black body at least in the wavelength range of interest here, and monochromatic light sources. In other words, light sources should be used emitting radiation of one wavelength only or at least of a very narrow wavelength range, i.e. mainly light-emitting-diodes and a combination of any emitter with narrow-band filters. The tungsten-filament lamp is used because of its high energy, above all for measuring the radiation sensitivity when set to a "colour temperature" of 2856 K corresponding to standard light A according to IEC 306-1 part 1 and DIN 5033 while the light-emitting-diodes are employed primarily for cutoff frequency and switching time measurements because they offer the opportunity of being modulated or pulsed up to high frequencies.

The tungsten-filament lamps used for measuring purposes have to be set to a relative spectral energy distribution which corresponds to that of the black body at a temperature of 2856 K generally. They have to be operated under very constant conditions. The lamp must therefore be operated using constant current and the deviation from the rated value must be kept smaller than $\pm 0.1\%$. This requirement seems to be very high, however, allowance has to be made for the fact that any variation in the lamp current by 0.1% will result in a change of the radiant intensity by 0.7% and a change in the colour temperature of 15 to 20 K. Of course, the lamp may also be operated with constant voltage, however, because of the unavoidable and varying contact resistances in the lamp socket this is hard to realize in practice so that an operation using constant current is to be preferred. If the lamp voltage is checked simultaneously the lamp may be supervised for changes in its characteristics, for instance, by evaporating coiled filament material, and will thus give a clue to when the lamp is no longer suitable for measuring purposes and must be exchanged or newly calibrated. This check is recommended mainly for the "standard lamps" used as a standard for colour temperature and radiant and luminous intensity, respectively.

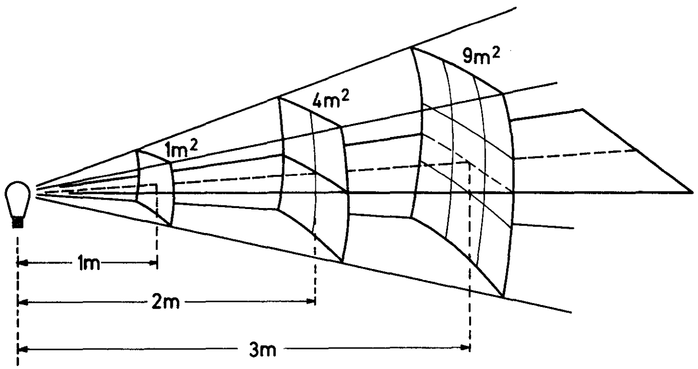
The standard lamps gauged by the PTB or the manufacturers as a rule are not used for general measuring purposes, above all series measurements, because of their costs of calibration. Therefore, the service lamps are set to the given values by comparing them with these standard lamps. The procedure is as follows:

Adjustment of Colour Temperature

The standard lamp is adjusted to the current and/or voltage according to the material test certificate. To obtain accurate and reproducible results, the coil filament of the lamp has to be adjusted to vertical to a tolerance of $\pm 1°$. After a warm-up period of approx. 30 min the photo current of a linear receiver, usually the short-circuit current of a photo-electric device, is measured in each case behind a narrow-band filter with a transmission wavelength of aprox. 500 nm and 900 nm, respectively. Attention has to be paid to the fact that the filters have no other pass band. The relation between these two measuring values characterizes the spectral energy distribution of the black body at the given temperature. The lamp current of the lamp to be calibrated is then varied until the ratio of the photo currents measured behind the two filters corresponds to that measured earlier at the standard lamp. The service lamp has thus the same colour temperature (or to be more precisely, ratio temperature) as the standard lamp. Moreover, it must be mentioned, that the lamp has to be calibrated in the house in which it is to be operated later on because changed heat conditions and reflections in the house could lead to considerable variations in the radiation characteristics of the lamp.

Adjustment of the distance from the incandescent coiled-filament for a given irradiance E_e or illuminance E_v

The material test certificate of the standard lamp usually states the radiation intensity (I_e) or luminous intensity (I_v) for the direction perpendicular to the coiled-filament plane. At a sufficiently large spacing from the coiled filament, at least 10 times



the maximum filament dimension, we have $E=\frac{I}{R^2}$ which may be used to calculate the spacing for the desired value of E according to $R=\sqrt{I/E}$. The photo current of the photo-voltaic cell is now measured at this spacing from the coiled filament of the standard lamp. The photo-voltaic cell is then used to adjust the distance to the service lamp, at which the same photo current is flowing. If a sufficiently precise luxmeter (e.g. Osram-Centra $V(\lambda)$ Si photo-voltaic cell) is available or a power meter of a sufficient bandwidth the adjustment may, of course, also be effected by means of these instruments. With irradiance measuring instruments attention has to be paid to the fact that in general it is impossible to cover the entire range of the spectral energy distribution of the (black) emitter, e.g. because the thermocouple is mounted behind a quartz window. Consequently, the measured irradiance E_e is too low compared to the black body. As a result, the object is measured at too high an irradiance when E_e has been adjusted by means of this instrument (shortened spacing from body) although the object itself is insensitive to the spectral range filtered off in the measuring instrument for radiant intensity. Differences in photo current of up to 20% may thus occur. When the irradiance is stated the measuring instrument used should also be given in order to compare the measuring results (spectral sensitivity curve, window material, etc.). Alternatively, the correction factor referred to the black body should be given for the colour temperature of the body.

At the moment, the PTB and/or lamp manufacturers only gauge standard lamps with respect to colour temperature and ratio temperature in the visible range, respectively. Because of the structure of standard lamps, especially the irregular temperature distribution over the coiled filament (heat is dissipated through the suspension) these gaugeings do not warrant the same shape of the spectral energy distribution in the infrared where the components to be measured usually have their maximum, even for lamps of the same type. This is clearly revealed by differences in photo currents which were measured under the same conditions – $E_v=100$ lx and $T_F=2856$ K – from a few per cent to over 10% depending on lamp type. The new version of the Wi 41 G by Osram with its detached coiled filament is the only exception, showing scatters from one lamp to another of a few per thousand so that they may be recommended as a standard lamp in connection with semiconductor photo-electric devices.

For photo sensitivity measurements (photo current and photo voltage, respectively) the components to be measured are brought to the position determined for each irradiance and held in such a way that the chip surface is perpendicular to the direction of light. Components in TO-18 or TO-5 cases are held in a way that the case axis will coincide with the direction of radiation. This is important especially for components with a highly focusing lens. A holder with a mobile socket for the terminal wires has proved useful in this respect (Fig. 9).

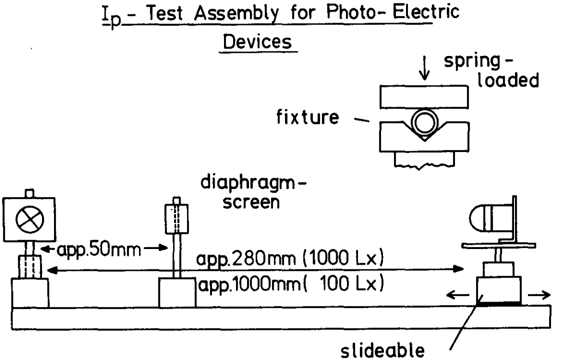


Fig. 9

When measuring the short-circuit current I_K of photo-voltaic cells attention has to be paid to the fact that the internal resistance of the measuring instrument used is small enough compared to the internal resistance of the photo-voltaic cell. The same applies to open-circuit measurements. Here the internal resistance of the measuring instrument has to be large compared to the internal resistance of the photo-voltaic cell. Fig. 10 shows this correlation, for instance, for the photo-voltaic cell BPY 11 for $E_v = 100$ lx.

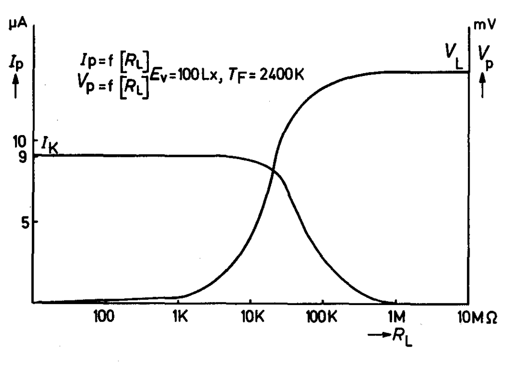


Fig. 10

Radiation-Emitting Components (Emitter)

Radiation in the visible range: In this case the luminous intensity is measured in the direction of the case axes by means of a detector having a $V(\lambda)$ characteristic and being calibrated in Candela (footlambert). It has to be noted, however, that the adjustment to the $V(\lambda)$ curve (Fig. 11) is also sufficiently accurate in the wavelength range of LEDs, for admittedly the majority of the measuring instruments of this type show an integral agreement with $V(\lambda)$ to a few per cent, however, they deviate strongly from the $V(\lambda)$ shape at the slopes, especially around 700 nm.

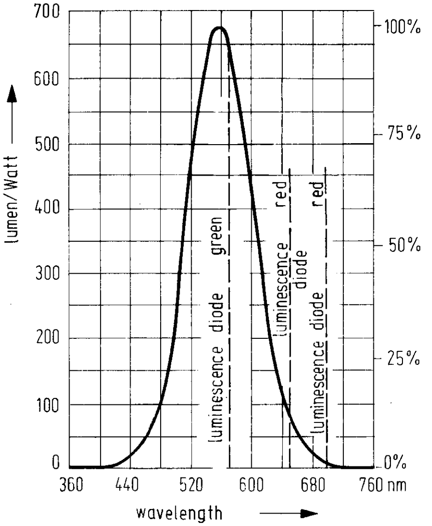


Fig. 11

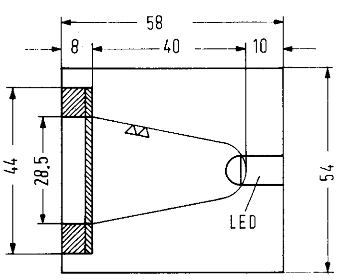


Fig. 12

Radiation in the infrared range: The radiant intensity in the direction of the case axis should be measured by means of a detector (thermocouple) which is independent of wavelength. However, a low sensitivity, inertia and temperature sensitivity will in this case raise difficulties. For this reason, the measurements are generally carried out with a photo-voltaic cell which is calibrated accordingly. In this case, however, the spectral sensitivity curve of the photo-voltaic cell has to be taken into consideration and the measuring result to be corrected with respect to deviations in the emitted wavelength of the radiator to be measured. (E.g. LEDs with a varying technology of manufacture). To measure the total radiation of the component the LED has to be built into a parabolic-type reflector in such a way ensuring that all radiation emitted by the component will reach the photo-voltaic cell which forms the termination of the parabola. Fig. 12 shows the outline of such a measuring parabola. As for the rest, the same requirements apply as for radiant-intensity measurements.

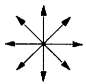
2.10.1. Concepts of Temperature for Optical Radiations

Cons. No.	Denotation	Symbol	Relation to Planckian Radiation	Definition	Application	Notes
Temperature that may be allied to any optical radiation						
1	Radiance temperature	T_s	Equality of the spectral radiance of a selected wavelength	The spectral radiance of any wavelength of a radiation to be denoted may be correlated with that Planckian temperature at which it has the same radiance at the same wavelength. Pyrometry formula (Acc. to Wien): $\frac{1}{T_s}=\frac{1}{T}-\frac{\lambda}{c_2}\ln(\varepsilon\cdot\tau)$.	Pyrometry	Visual pyrometry usually operates with an effective wavelength of about 650 nm. In general, the radiance temperature depends on the wavelength. It is always lower than the real temperature.
Temperatures that may be allied only to optical radiations having certain characteristics						
2	Colour temperature	T_f	Equality of colour	When a radiation has a colour equalling that of a Planckian radiation the temperature of the latter is the colour temperature of the radiation to be denoted.	Colour measurements	In general, T_f may **not** be used to draw any conclusion as to spectral distribution. In case of mere temperature radiations T_f usually equals approx. T_v in the visible region.
3	Correlated colour temperature	T_n	As large a colour similarity as possible	When radiation has a colour not equalling that of a Planckian radiation but—assessed acc. to sensation—comes close to it, the temperature of the closest Planckian radiation is the correlated colour temperature of the radiation to be denoted.	Colour measurements	In general, T_n may **not** be used to draw any conclusion as to spectral distribution. The statement of the correlated colour temperature only makes sense if the colour of the radiation to be denoted is less than about 10...15 thresholds of sensation away from the Planckian curve shape. If the colour difference approaches zero T_n switches to T_f.
4	Distribution temperature	T_v	Equality of the relative spectral radiation distribution between λ_1 and λ_2	If radiation in a wavelength region to be stated has a spectral distribution between λ_1 and λ_2 which is proportional to a Planckian radiation distribution the temperature of the latter is the distribution temperature of the radiation to be denoted.	Spectral measurements	If the range of spectral proportionality covers the visible T_f equals T_v. As there are no radiation sources which strictly meet the spectral proportionality condition over a long wavelength range, in practice deviations of up to a few per cent are allowed so that, for instance, $T_f \approx T_v$ applies to a tungsten radiation in the wavelength range of about 400 to 750 nm.
5	Ratio temperature	T_r	Equality of the radiation quotient of two selected wavelengths	When the quotient Q of the radiation of two (close) wavelengths (ranges) λ_1 and λ_2 of a radiation to be denoted equals the corresponding quotient of a Planckian radiation, the temperature of the latter is the ratio temperature of the radiation to be denoted. Q between 0 ($\Delta T=0$) and $\lambda_2^4 : \lambda_1^4$ ($\Delta T=\infty$) with $\lambda_1<\lambda_2$.	"Blue/Red" measurements	In general T_r may **not** be used to draw any conclusion as to the spectral distribution. In case of mere temperature radiations T_r between λ_1 and λ_2 is usually approximately T_v if the spacing between the two wavelengths is within reasonable bounds.

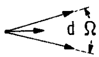
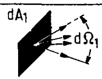
DIN 5496, DIN 5033, DIN 5031
International Dictionary of Light Engineering, 3rd Ed. 1970, publ. by CIE and IEC

In case of a grey body characterized by a total emissivity independent of wavelength $\varepsilon(\lambda)=$ constant, the numerical values of several temperatures will coincide with the real temperature $T=T_w=T_r=T_f=T_n=T_v$ (exception: $T_s<T$).

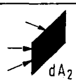
2.10.2. Radiation and Light Measurements

No		Radiometric Terms					Spectr. Radiometric Terms			Photometric Terms		
		Term	Symbol	Unit	Relation	Simplified definition	Term	Symbol	Unit	Term	Symbol	Unit
1		Radiant power	Φ_e, P	W		Radiant power is the total power given in the form of radiation	Spectral radiant power distribution	$\Phi_{e\lambda}$	$\frac{W}{nm}$	Luminous flux	Φ_v	lm Lumen

Emitter

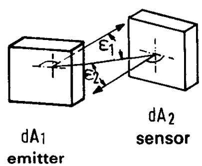
No		Term	Symbol	Unit	Relation	Simplified definition	Term	Symbol	Unit	Term	Symbol	Unit
2		Radiant intensity	I_e	$\frac{W}{sr}$	$I_e = \frac{d\Phi_e}{d\Omega_1}$	Radiant intensity is radiant power per solid angle	Spectral radiant intensity distribution	$I_{e\lambda}$	$\frac{W}{sr\ nm}$	Luminous intensity	I_v	$\frac{lm}{sr} = cd$ Candela
3		Radiance	L_e	$\frac{W}{m^2\ sr}$	$L_e = \frac{d^2\Phi_e}{dA_1 \cdot d\Omega_1}$	Radiance is radiant power per area and solid angle	Spectral radiance distribution	$L_{e\lambda}$	$\frac{W}{cm^2\ sr\ nm}$	Luminance	L_v	$\frac{cd}{cm^2} = sb$ stilb

Sensor

No		Term	Symbol	Unit	Relation	Simplified definition	Term	Symbol	Unit	Term	Symbol	Unit
4		Irradiance	E_e	$\frac{W}{m^2}$	$E_e = \frac{d\Phi_e}{dA_2}$	Irradiance is incident radiant power per (sensor) surface	Spectral irradiance distribution	$E_{e\lambda}$	$\frac{W}{m^2\ nm}$	Illuminance	E_v	$\frac{lm}{m^2} = lx$ lux

Indices "e" (=energetic) and "v" (=visual) may be omitted unless danger of confusion DIN 1301, DIN 1304, DIN 5031, DIN 5496

International Dictionary of Light Engineering, 3rd Ed. publ. by CIE and IEC



Photometric Basic Law

$$d^2\Phi = L\,\frac{dA \times \cos\varepsilon \times dA_2 \times \cos\varepsilon_2}{r^2}\,\Omega_0$$

Inverse Square Law

$E = \frac{I}{r^2}\cos\varepsilon_2\,\Omega_0$ (r should be 10 times the max. spacing of emitter-sensor to keep error below 1%).

dA_1 = element of area of emitter
dA_2 = element of area of sensor
ε_1 = angle of radiation
ε_2 = angle of irradiation
r = spacing emitter-sensor
Ω_0 = 1 sr

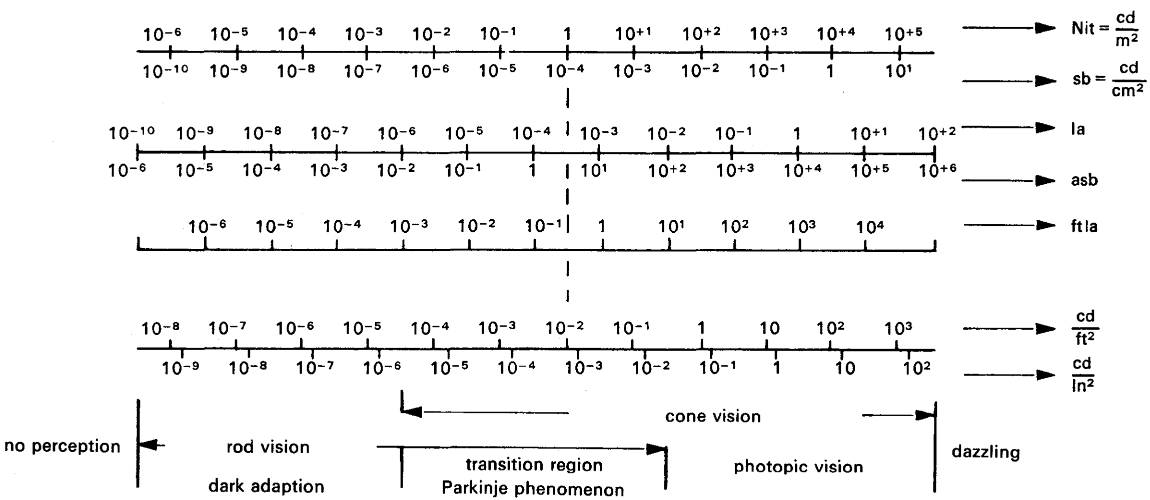
2.11. Tables and Diagrams

Radiometric Parameters

Denotation	Symbol	Meas. quant.	Abbr.	Definition
Quantity of radiation	Q	Joule Wattsecond	J Ws	
Radiant power	Φ	Watt	W	quantity of radiation Q per second through a surface
Point source of radiation (Fig. 2)	–	–	–	... is a source viewed from such a great distance R that all rays seem to emanate from one point. When b max. linear expansion of source: $R \gg b$ (example: sun for observer on earth)
Solid angle (Fig. 2)	Ω	sterad	sr	$\Omega=\frac{A_1}{R_1^2}=\frac{A_2}{R_2^2}=\frac{A_3}{R_3^2}=\frac{A}{R^2}$; the radiant power Φ[W] of a point source is constant in solid angle. (Prerequisite: homogenous, undamping medium.) $\Omega=1$ is $A=R^2$ so that Ω hemisphere$=\Omega_0=2\pi$ sr; Ω full sphere$=\Omega_0=4\pi$ sr
Radiant intensity	I	$\frac{\text{Watt}}{\text{sterad}}$	$\frac{\text{W}}{\text{sr}}$	... is the solid angle density of the radiant power $\left(\frac{d\Phi}{d\Omega}\right)$. I of **one** source generally varies depending upon viewing direction. I only defined when $R \gg b$; comp. $E \rightarrow I = ER^2$
Total radiant power of a source	Φ_{tot}	Watt	W	$\Phi_{tot}=\int_D^{4\pi} I \, d\Omega$
Irradiance	E	$\frac{\text{Watt}}{\text{meter}^2}$	$\frac{\text{W}}{\text{m}^2}$	... is the surface density of the radiant power (**spherical** surface) of a point source. $E=\frac{d\Phi}{dA}$; $dA=R^2\,d\Omega$ $E=\frac{d\Phi}{d\Omega\,R^2}=\frac{I}{R^2}$; $I=ER^2$
Radiance (Fig. 4)	L	$\frac{\text{Watt}}{\text{m}^2\text{ sterad}}$	$\frac{\text{W}}{\text{m}^2\text{ sr}}$	... is the radiant intensity referred to the radiant surface viewed by the observer. (Surface projection $A_p=A\cos\varepsilon$ when ε is the angle by which the radiant surface is rotated against the connecting line to viewer. $L=\frac{I}{A_p}=\frac{I}{A\cos\varepsilon}$.) Important optical quantity. 1) In an undamped beam path L is maintained and cannot be increased by any optical measure. 2) The human eye sees differences in radiance as differences in lightness.
Sensitivity of detector	$S=\frac{i}{E}$	$\frac{\text{ampere}}{\text{irradiance}}$	$\frac{\text{A}}{E}$	electrical quantity (current, voltage or resistance) in relation to irradiance

2.11.1. Luminance Units and Their Interrelationships

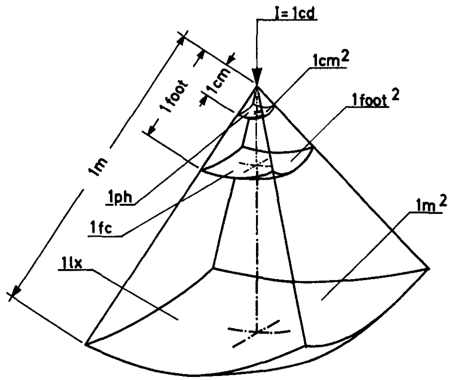
Unit		sb	cd/m²	cd/ft²	cd/in²	asb	L	mL	ftL
1	Stilb = cd/cm² = sb	1	10^4	929	6.45	31400	3.14	3140	2920
1	cd/m² = Nit = nt	10^{-4}	1	9.29×10^{-2}	6.45×10^{-4}	3.14	3.14×10^{-4}	0.314	0.292
1	cd/ft²	1.076×10^{-3}	10.76	1	6.94×10^{-3}	33.8	3.38×10^{-3}	3.38	3.14
1	cd/in²	0.155	1550	144	1	4870	0.487	487	452
1	Apostilb = asb	3.18×10^{-5}	0.318	2.96×10^{-2}	2.05×10^{-4}	1	10^{-4}	0.1	9.29×10^{-2}
1	Lambert = L or la	0.318	3183	296	2.05	10^4	1	10^3	929
1	mL or mla	3.18×10^{-4}	3.18	0.296	2.05×10^{-3}	10	10^{-3}	1	0.929
1 1 1	footlambert = equivalent footcandle = apparent footcandle = ftL or ftla	3.43×10^{-4}	3.43	0.318	2.21×10^{-3}	10.76	1.076×10^{-3}	1.076	1



2.11.2. Illuminance Units and Their Interrelationships

Unit	lx	mlx	ph	fc
Lux = lx	1	10^3	10^{-4}	9.29×10^{-2}
Millilux = mlx	10^{-3}	1	10^{-7}	9.29×10^{-5}
Phot = ph	10^4	10^7	1	929
Footcandle = fc*	10.76	10760	1.076×10^{-3}	1

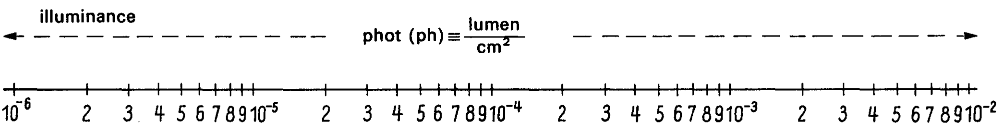
* Note: equivalent footcandle or apparent footcandle equal footlambert (luminance) not footcandle (illuminance)

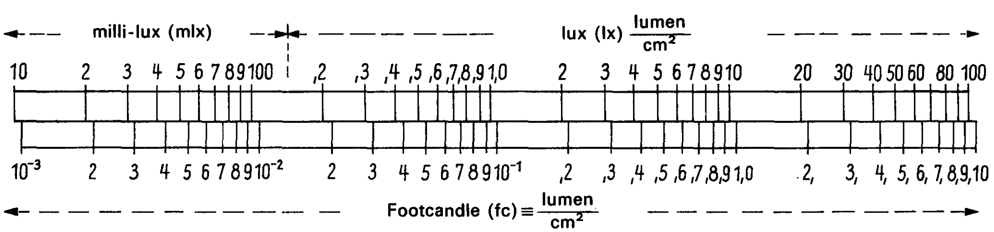


Luminous flux Φ per second per Sterad (sr) 1 Lumen (lm)

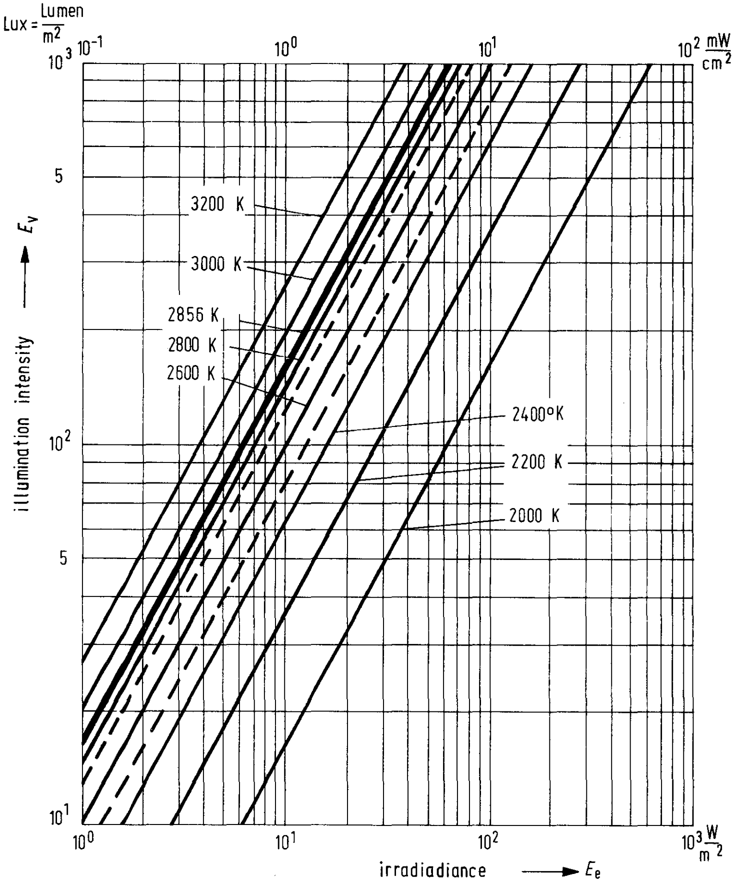
space angle $\Omega = \frac{A}{R^2} = 1$ Sterad = 1 sr

1 foot ≙ 0.305 m



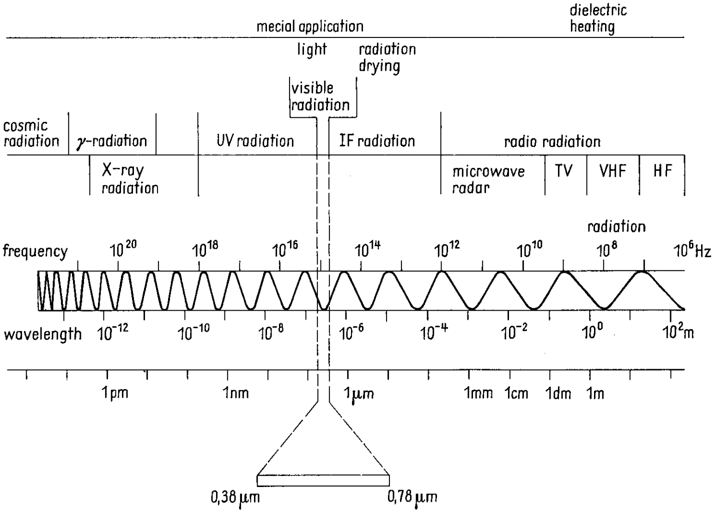


Conversion of E_v(lx) into E_e(W/m^2) or mW/cm^2) referred to the radiation of a black radiator.

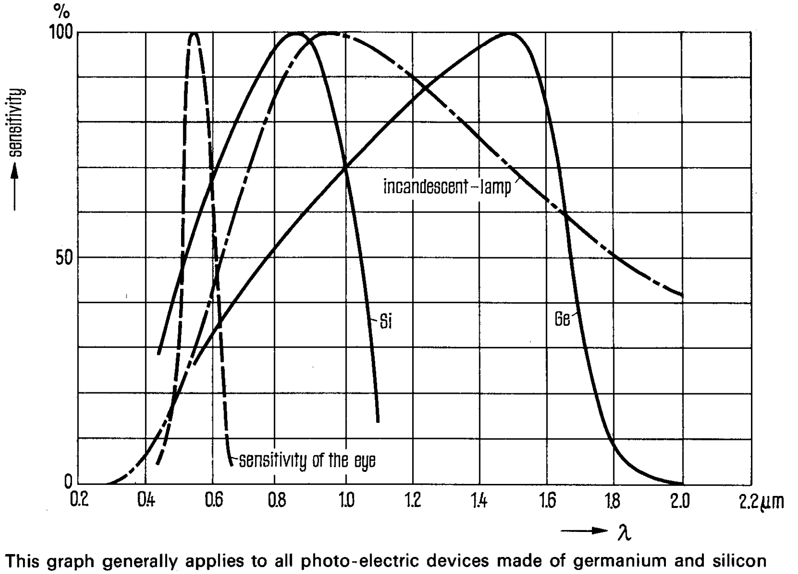


2.11.3. Ranges of Frequency and Wavelength

Ranges of frequency and wavelength of the various types of electromagnetic radiation energy and position of the area of visible radiation plus spectrum of light radiation.

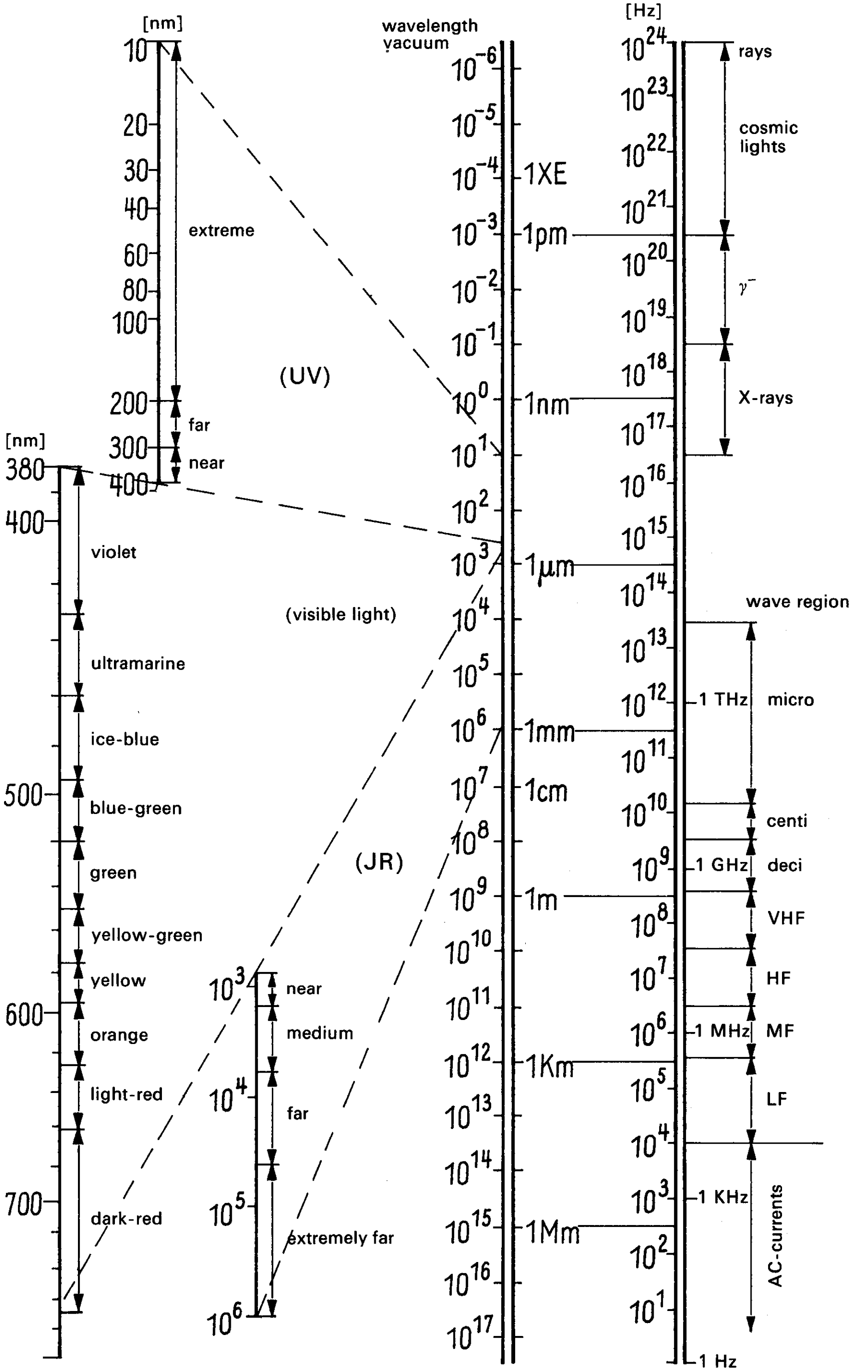


Relative sensitivity of various photo-sensitive receivers in comparison with the spectral emission of an incandescent lamp of 2850 K



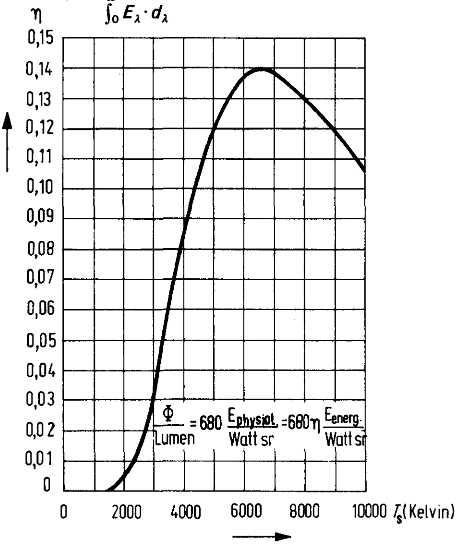
This graph generally applies to all photo-electric devices made of germanium and silicon

2.11.4. Electromagnetic Radiation

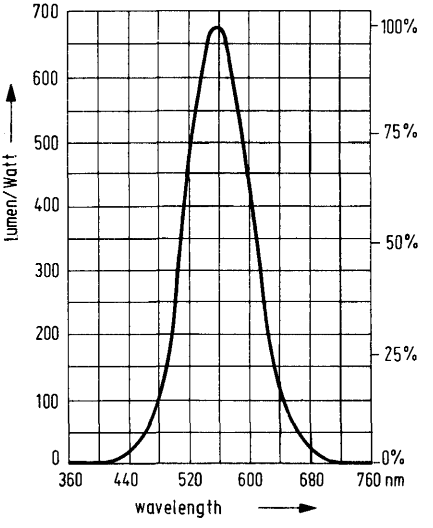


Luminous efficiency η of a blackbody as a function of its absolute temperature T_s

$$\eta = \frac{\int_0^\infty V_\lambda \cdot E_\lambda \cdot d_\lambda}{\int_0^\infty E_\lambda \cdot d_\lambda}$$



Relative spectral response of the average human eye



Luminous efficiency η of a black body as a function of its absolute temperature T_s detail curve

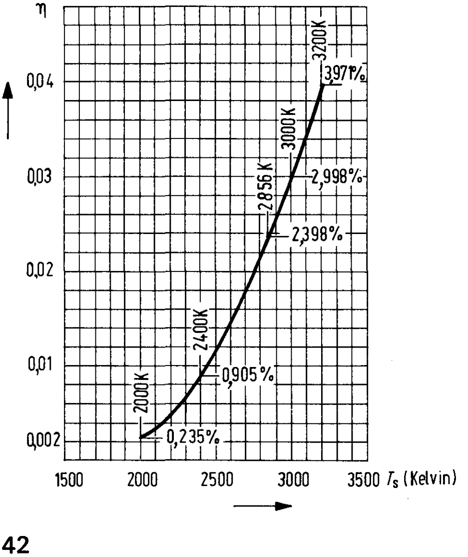


Photo Diodes

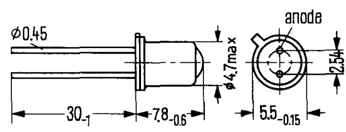
Germanium photodiode for high reverse voltages

Not for new development

Photodiodes APY 12 and APY 13 are suitable for use in photo-electric control and regulating devices. Maximum spectral sensitivity lies in the infrared region. The diodes are suitable for use at higher reverse voltages

They are housed in a metal case 18 B 2 DIN 41876 (similar TO-18); the anode lead is marked by the stud on the rim of the case bottom. This lead is to be connected to the – pole of the voltage supply when using the diode as a photodiode. This lead becomes the + pole when using the diode as a photo-voltaic cell. The case is potential free and insulated from the leads.

Type	Order number
APY 12 I	Q60115-Y12-X1
APY 12 II	Q60115-Y12-X2
APY 12 III	Q60115-Y12-X3
APY 13 I	Q60115-Y13-S1
APY 13 II	Q60115-Y13-S2
APY 13 III	Q60115-Y13-S3



Weight approx. 1 g   Dimensions in mm

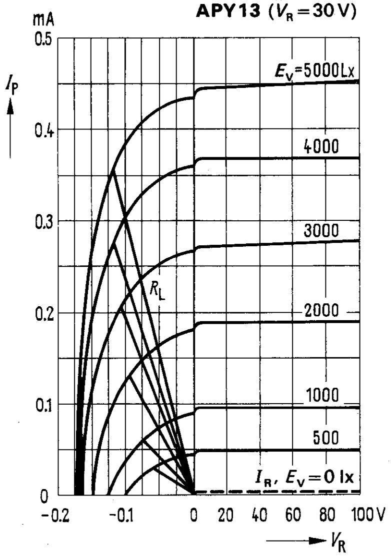
Maximum ratings		**APY 12**		**APY 13**		
for an ambient temperature	T_{amb}	25	50	25	50	°C
Reverse voltage	V_R	100	100	30	30	V
Forward current	I_F	10	10	10	10	mA
Diode photo current (V_R=100 V)	I	0.5	–	–	–	mA
Diode photo current (V_R=30 V)	I	1.5	–	1.5	–	mA
Power dissipation	P_{tot}	50	25	50	25	mW
Ambient temperature	T_{amb}	+50		+50		°C

Characteristics (T_{amb}=25 °C)		**APY 12**	**APY 13**	
Light sensitive area	A	1	1	mm²
Wavelength of max. photo sensitivity	$\lambda_{s\,max}$	1.5	1.5	µm
Sensitivity limit-infrared	λ_g	1.9	1.9	µm
Rise time of the photo current (10 to 90% the final value) measured				
in series with 10 kΩ (λ=900 nm)	t_r	20	20	µs
in series with 50 kΩ (λ=900 nm)	t_r	30	30	µs
Capacitance (V_R=10 V)	C_{10}	5	5	pf
Dark current (V_R=100 V; E_v=0 lx)	I_R	≦8	–	µA
Dark current (V_R=30 V; E_v=0 lx)	I_R	–	≦8	µA

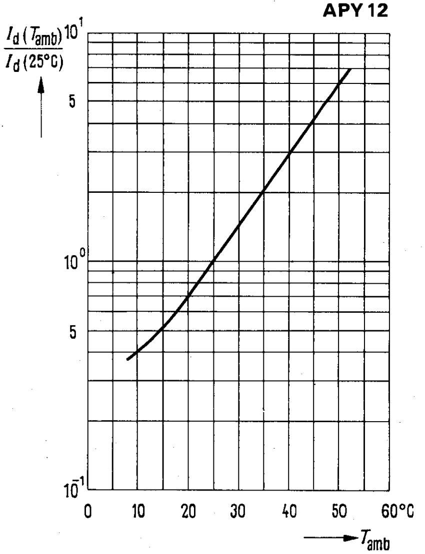
Grouping of photo sensitivity (Radiator colour temperature 2400 °K)

		APY 12, APY 13			
	Group	I	II	III	
Photo sensitivity	S	100 (>40)	180 (>120)	220 (>200)	nA/lx

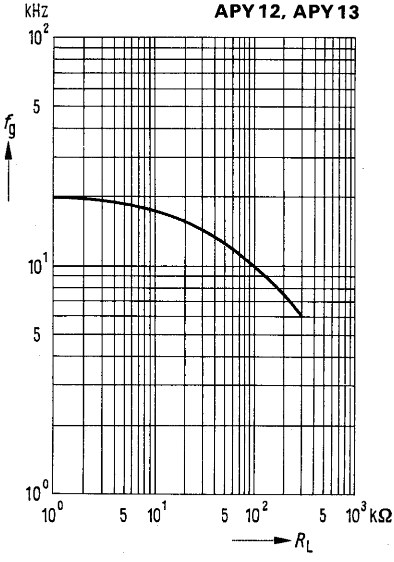
Characteristics $I_P = f(V_R)$; $I_R = f(V_R)$; E_v = parameter
APY 12 (V_R = 100 V)
APY 13 (V_R = 30 V)



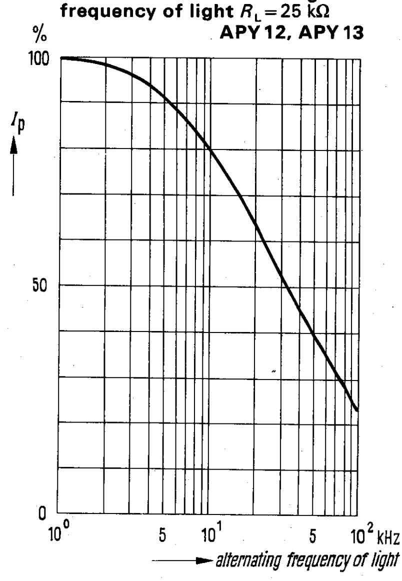
Dark current $I_R = f(T_{amb})$
V_R = 100 V
APY 12



Maximum frequency $f_g = f(R_L)$
typical values
APY 12, APY 13



Mean photo current as a function of the alternating frequency of light R_L = 25 kΩ
APY 12, APY 13

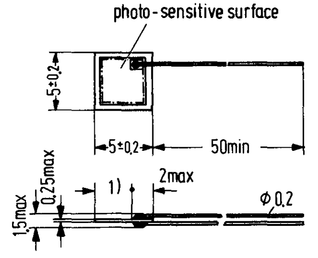


Silicon photo diode

The BPY 12 is a large-surface silicon planar photo diode for universal application, which is also suitable for quantitative light measurements. It is particularly useful in applications requiring a high cutoff frequency at a high-valued operating resistor. The planar technique ensures a low dark current level, low noise and thus very favourable signal conditions.

Mounting instructions: see preface.

Type	Order number
BPY 12	Q62702-P9



(Ag = silver wire) Weight approx. 0.2 g Dimensions in mm

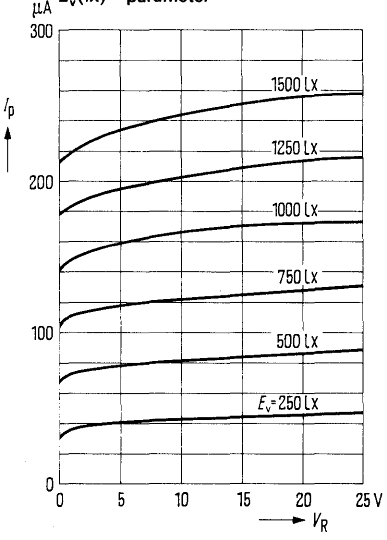
Maximum ratings		BPY 12	
Reverse voltage[1]	V_R	20	V
Storage temperature	T_s	−55 to +100	°C

Characteristics (T_{amb} = 25 °C)			
Photo sensitivity	S	>100	nA/lx
Wavelength of max. photo sensitivity	$\lambda_{s\,max}$	0.85	µm
Rise and fall time of photo current from 10% to 90% and 90% to 10% of final value			
(R_L = 1 kΩ; V_R = 20 V)	t_r; t_f	<150	ns
(R_L = 1 kΩ; V_R = 0 V)	t_r; t_f	2	µs
Cutoff frequency			
(R_L = 1 kΩ; V_R = 20 V)	f_g	1	MHz
Capacitance at			
V_R = 0 V	C_0	140	pf
V_R = 20 V	C_{20}	25	pf
Dark current			
(V_R = 20 V; E_v = 0 lx)	I_R	500 (<1000)	nA
Photo sensitive surface	A	20	mm²

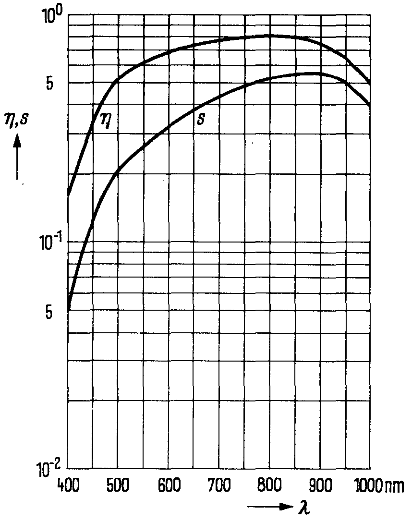
The illuminance stated refers to the unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K.

[1]) The plus pole of the voltage supply is to be connected to the silver coated light-insensitive side of the photo diode.

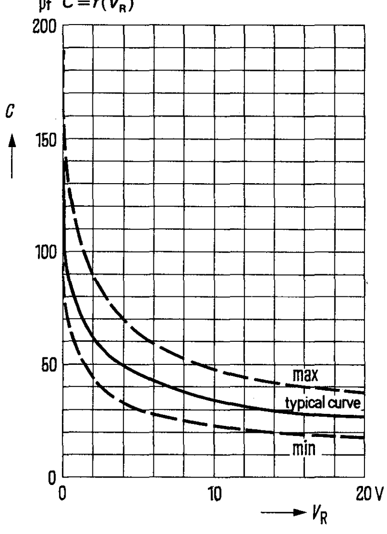
Family of characteristics $I_p = f(V_R)$
E_v(lx) = parameter



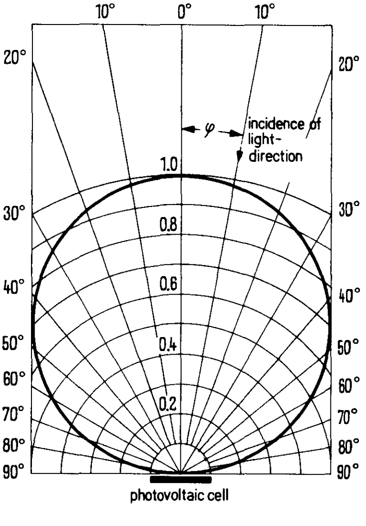
Spectral photo sensitivity $s = f(\lambda)$ in A/W and quantum yield $\eta = f(\lambda)$ in electrons per photon of photo diode



Capacitance vs. reverse voltage
pf $C = f(V_R)$



Directional characteristic
$I_p = f(\varphi)$
($I_p \approx I_{P_0} \cdot \cos \varphi$)

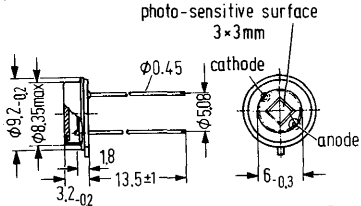


BPX 60

Silicon photo diode

BPX 60 is a silicon planar photo diode. The large-surface photo sensitive system permits its operation both as a photo-voltaic element and as a diode with a minimum reverse current level. The hermetically sealed case – a TO-5 modification with a plane glass window – permits use under extreme operating conditions. Even at low illumination intensities, the noise-signal ratio is particularly favourable. The open-circuit voltage is higher at low illumination intensities than with comparable mesa photo components.

Type	Order number
BPX 60	Q62702-P54

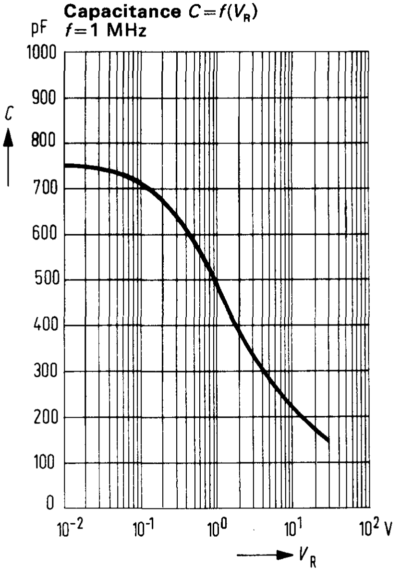


Weight approx. 2 g

Preliminary data

Maximum ratings		**BPX 60**	
Reverse voltage	V_R	32	V
Operating and storage temperature	T_S	−30 to +125	°C
Soldering temperature 2 mm away from case bottom ($t \leqq 3$ s)	T_L	230	°C
Power dissipation	P_{tot}	325	mW
Thermal resistance	R_{thJamb}	300	K/W
	$R_{thJcase}$	80	K/W
Characteristics			
Open-circuit voltage at 100 lx[1])	V_L	360 (>270)	mV
at 1000 lx[1])	V_L	460	mV
Short-circuit current at 100 lx[1])	I_K	5 (>3.5)	µA
Photo sensitivity	S	50 (>35)	nA/lx
Wavelength of max. photo sensitivity	$\lambda_{s\,max}$	850	nm
Rise and fall time of photo current from 10% to 90% and 90% to 10% of final value ($R_L = 1$ kΩ; $V_L = 10$ V)	t_r; t_f	1.0	µs
($R_L = 1$ kΩ; $V_L = 0$ V)	t_r; t_f	2.5	µs
Temperature coefficient f. V_L	TC	−2.6	mV/K
Temperature coefficient f. I_K	TC	0.2	%/K
Capacitance at $V_R = 0$ V, $f = 1$ MHz; $E_v = 0$ lx	C_0	750	pf
at $V_R = 10$ V, $f = 1$ MHz; $E_v = 0$ lx	C_{10}	220	pf
Photo sensitive surface	A	7.6	mm^2
Dark current ($V_R = 10$ V; $T_{amb} = 25$ °C; $E_v = 0$ lx)	I_R	7 (<300)	nA

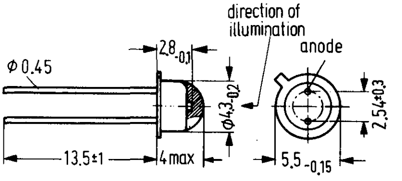
[1]) The illuminance indicated refers to the unfiltered radiation of a tungsten filament lamp with a colour temperature of 2856 K.


Capacitance $C=f(V_R)$
pF $f=1$ MHz
1000
900
800
700
600
500
400
300
200
100
0
C
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2} V
V_R

Silicon photo diode with very small dark current

BPX 63 is a silicon planar photo diode mounted on a TO-18 bottom plate and covered by a transparent plastic material. BPX 38 was developed as a receiver for low illuminances and is intended for use as a sensor for exposure timers and automatic exposure timers. The component is characterized by small dark currents and, used as a voltaic cell, by a high open-circuit voltage at low illuminances. The cathode of the BPX 63 is electrically connected to the case.

Type	Order number
BPX 63	Q62702-P55



Weight approx. 0.5 g

Preliminary data

Maximum ratings		**BPX 63**	
Reverse voltage	V_R	7	V
Storage temperature	T_S	−55 to +90	°C
Forward current	I_F	100	mA
Power dissipation (T_{amb}=25 °C)	P_{tot}	200	mW

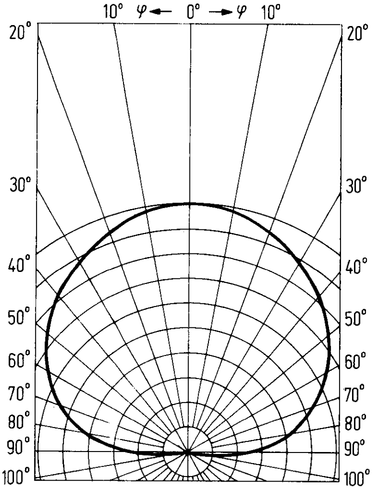
Characteristics (T_{amb}=25 °C)

Photo sensitivity[1])	S	10	nA/lx
Forward voltage[2]) (E_v=0 lx, I_F=pA, T_{amb}=50 °C)	V_F	0.5	mV
Wavelength of max. photo sensitivity	$\lambda_{s\,max}$	800	nm
Rise and fall time of photo current from 10% to 90% and from 90% to 10% of final value			
(R_L=1 kΩ; V_R=5 V)	t_r, t_f	1.0	µs
(R_L=1 kΩ; V_R=0 V)	t_r, t_f	1.3	µs
Capacitance (V_R=0 V)	C_0	120	pf
Capacitance (V_R=3 V)	C_3	50	pf
Dark current (V_R=1 V; E_v=0 lx)	I_R	15	pA
Temperature coefficient of I_K	TC	0.1	%/K
Photo sensitive surface	A	1	mm²

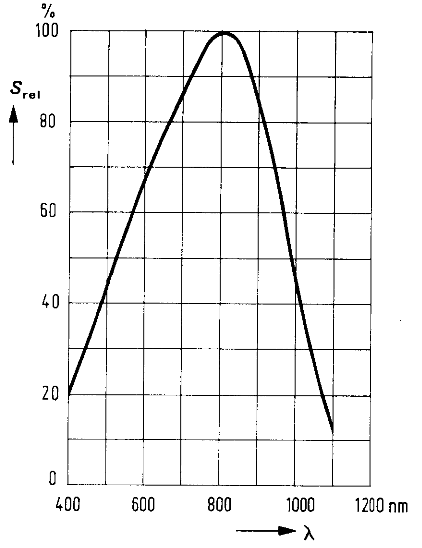
[1]) The illuminance stated refers to the unfiltered radiation of a tungsten filament lamp with a colour temperature of 2856 K

[2]) V_F is a measure of the photo sensitivity minimum, using the photo diode in exposure timers.

Directional characteristic
$I_p = f(\varphi)$



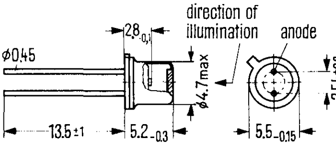
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



High-speed silicon photo diode

BPX 65 is a planar silicon photo diode in a case 18 A 2 DIN 41876 (sim. to TO-18) with a plane light window. The cathode is electrically connected to the case. The plane window has no bearing upon the beam path of optical lens systems. Because of its high cutoff frequency this diode is particularly suitable for use as an optical sensor of a high modulation bandwidth.

Type	Order number
BPX 65	Q 62702-P 27



Weight approx. 0.5 g   Dimensions in mm

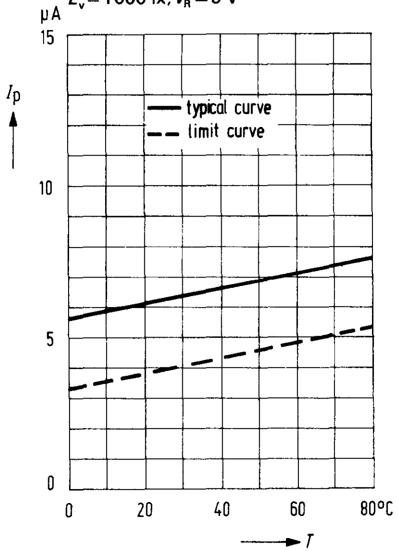
Maximum ratings		BPX 65	
Reverse voltage	V_R	50	V
Junction temperature	T_j	125	°C
Storage temperature	T_S	−55 to +125	°C
Power dissipation	P_{tot}	250	mW

Characteristics ($T_{amb}=25\,°C$)

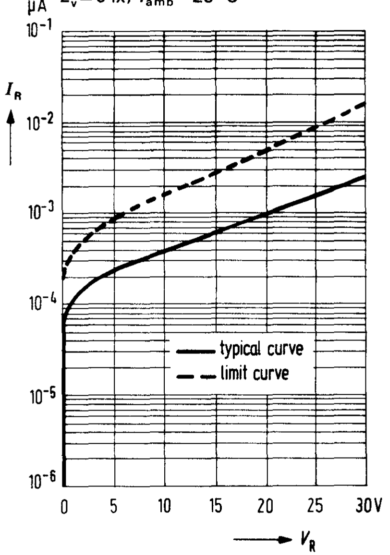
Photo-sensitive surface	A	1	mm²
Wavelength of max. spectral sensitivity	$\lambda_{s\,max}$	0.850	µm
Rise time of photo current (working resistor $R_L=50\,\Omega$; $V_R=20\,V$; $\lambda=900$ nm)	t_r	0.5 (<1)	ns
Capacitance (at $V_R=20\,V$)	C_{20}	3.5	pf
(at $V_R=0\,V$)	C_0	15	pf
Cutoff frequency (working resistor $R_L=50\,\Omega$; $V_R=20\,V$; $\lambda=900$ nm)	f_g	500	MHz
Dark current ($V_R=20\,V$; $E_v=0$ lx)	I_R	1 (<5)	nA
Photo sensitivity[1]	S	6 (>4)	nA/lx

[1]) The illuminance stated refers to the unfiltered radiation of a tungsten filament lamp with a colour temperature of 2856 K.

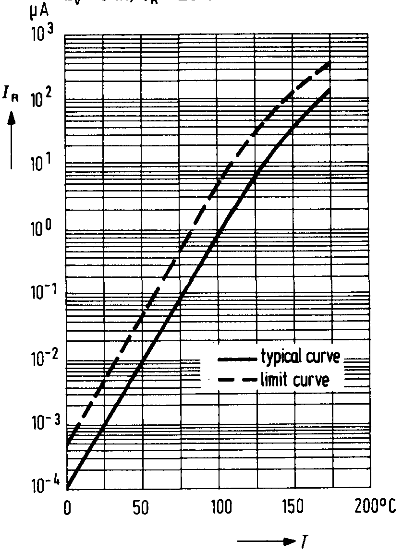
Photo current $I_p = f(T)$
$E_v = 1000$ lx; $V_R = 5$ V



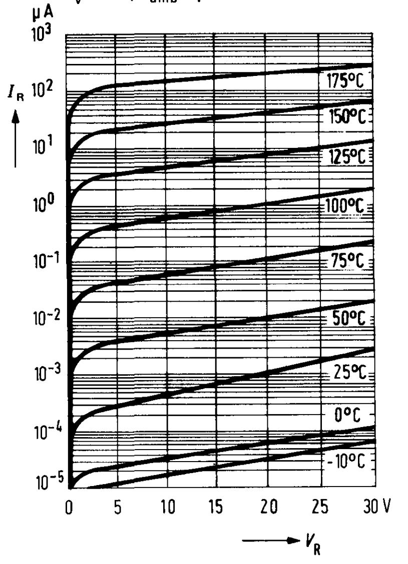
Dark current $I_R = f(V_R)$
$E_v = 0$ lx; $T_{amb} = 25$ °C



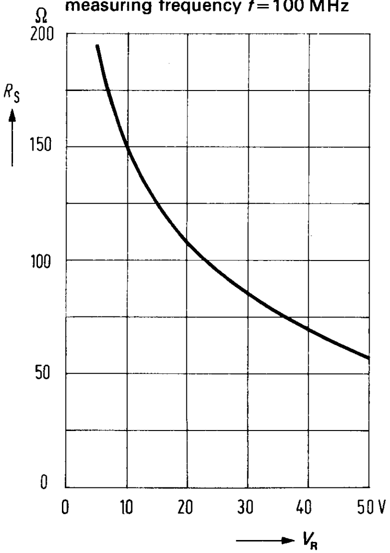
Dark current $I_R = f(T)$
$E_v = 0$ lx; $V_R = 20$ V



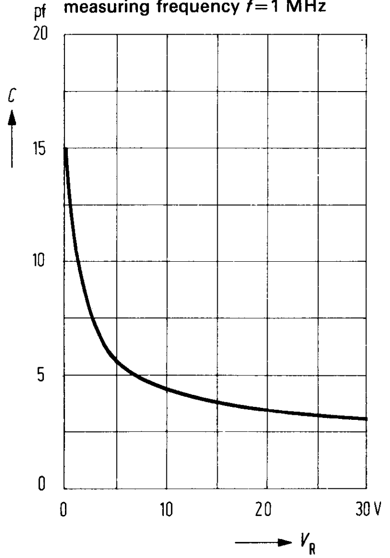
Dark current $I_R = f(V_R)$
$E_v = 0$ lx; T_{amb} = parameter



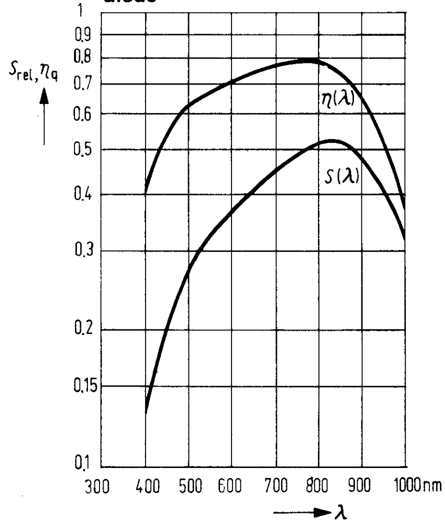
Series resistance $R_S = f(V_R)$; $E_v = 0$ lx measuring frequency $f = 100$ MHz



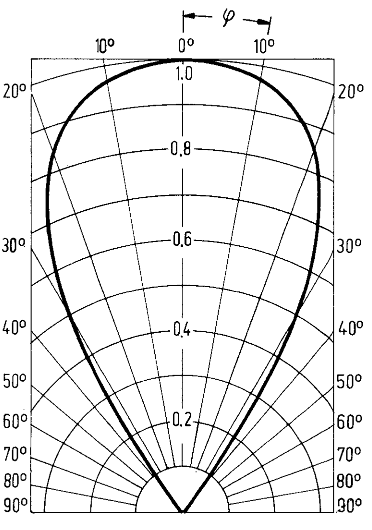
Junction capacitance $C = f(V_R)$; $E_v = 0$ lx measuring frequency $f = 1$ MHz



Spectral sensitivity $s = f(\lambda)$ quantum yield $\eta = f(\lambda)$ in electrons per photon of photo diode



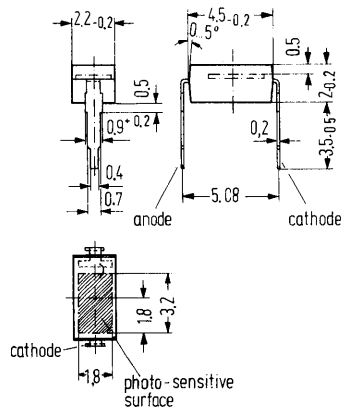
Directional characteristic $I_p = f(\varphi)$



Silicon photo diode in a plastic package

BPX 90 is a silicon planar photo diode which is incorporated in a transparent plastic package. Its terminals consist of soldering tabs in a basic grid system of 2/10″. This design permits very easy assembly of the diodes also on grid boards. The plane back of the epoxy resin case allows a sturdy fixation of the component. Arrays may be realized by multiple arrangements. This universal photo receiver is suitable both for operation as a diode and as a voltaic cell. The noise/signal ratio is particularly favourable, even at low illuminances. The open-circuit voltage is higher with small illuminances than with comparable mesa photo-voltaic cells.

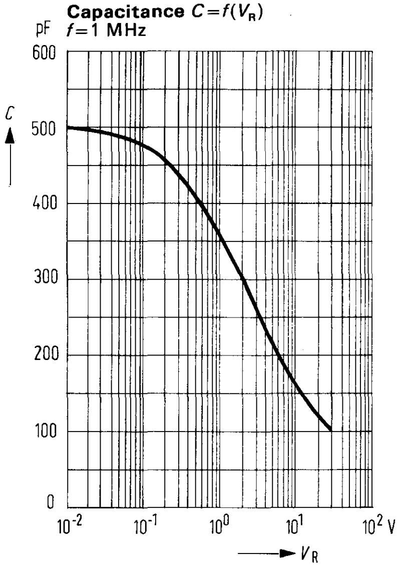
Type	Order number
BPX 90	Q62702-P47

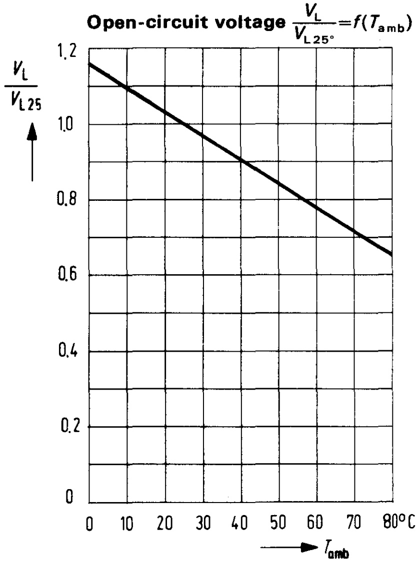


Weight approx. 0.05 g Dimensions in mm

Maximum ratings		**BPX 90**	
Reverse voltage	V_R	32	V
Operating and storage temperature	T_S	−30 to +80	°C
Soldering temperature 2 mm away from case bottom ($t \leqq 3$ s)	T_L	230	°C
Power dissipation	P_{tot}	100	mW

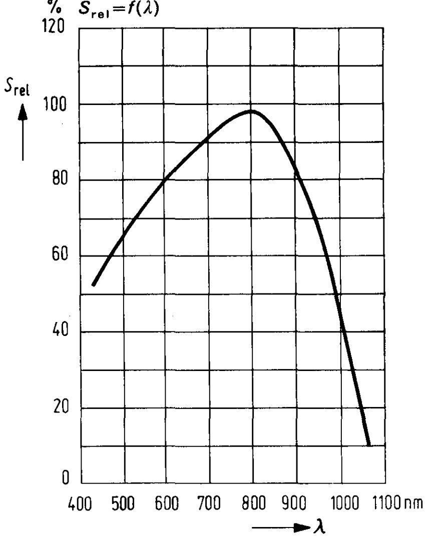
Characteristics (T_{amb} = 25 °C)		BPX 90	
Open-circuit voltage			
at E_v = 100 lx[1])	V_L	360 (>270)	mV
at E_v = 1000 lx[1])	V_L	460	mV
Short-circuit current			
at E_v = 100 lx[1])	I_K	4 (>2.5)	µA
Photo sensitivity[1])	S	40 (>25)	nA/lx
Wavelength of max. photo sensitivity	$\lambda_{s\,max}$	850	nm
Rise and fall time of photo current from 10% to 90% and 90% to 10% of final value			
(R_L = 1 kΩ; V_L = 10 V)	t_r; t_f	0.8	µs
(R_L = 1 kΩ; V_L = 0 V)	t_r; t_f	1.1	µs
Temperature coefficient for V_L	TC	−2.6	mV/K
Temperature coefficient for I_K	TC	0.2	%/K
Capacitance at			
V_R = 0 V; f = 1 MHz; E_v = 0 lx	C_0	500	pf
V_R = 10 V; f = 1 MHz; E_v = 0 lx	C_{10}	170	pf
Photo-sensitive surface	A	5.0	mm²
Dark current (V_R = 10 V; T_{amb} = 25 °C; E_v = 0 lx)	I_R	5 (<200)	nA



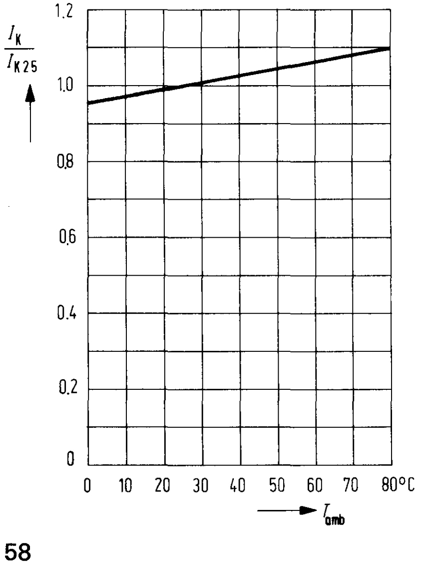


[1]) The illuminance indicated refers to the unfiltered radiation of a tungsten-filament lamp with a colour temperature of 2856 K.

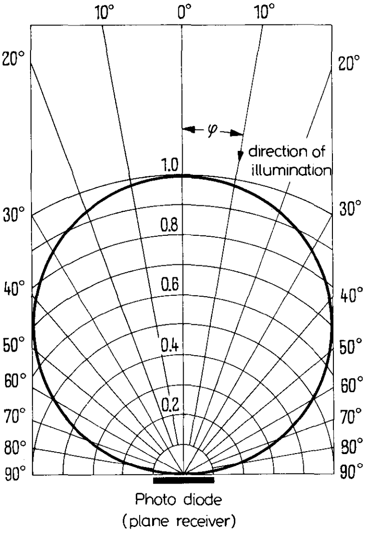
Relative spectral sensitivity
$S_{rel}=f(\lambda)$



Short-circuit current
$\frac{I_K}{I_{K25°}}=f(T_{amb})$



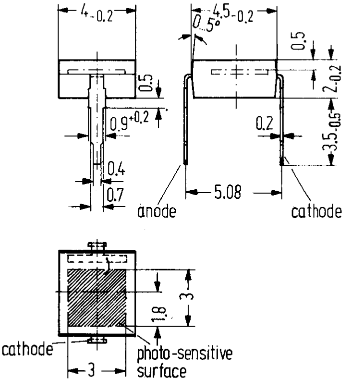
Directional characteristic $I_K=f(\varphi)$



Silicon photo diode in a plastic package

BPX 91 is a silicon planar photo diode which is incorporated in a transparent plastic package. Its terminals are soldering tabs in a basic grid system of 2/10″. This design permits very easy assembly of this component also on grid boards. The plane back of the epoxy resin case allows sturdy fixation of the component. Arrays may be realized by multiple arrangements. This universal photo receiver is suitable both for operation as a diode and as a voltaic cell. The noise/signal ratio is particularly favourable, even at low illuminances. The open-circuit voltage is higher with small illuminances than with comparable mesa photo-voltaic cells.

Type	Order number
BPX 91	Q 62702-P 48

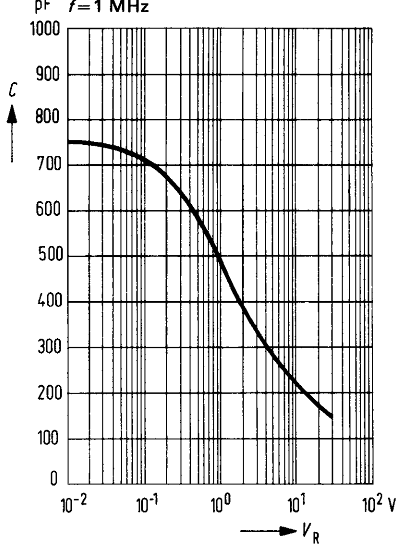


Weight approx. 0.1 g   Dimensions in mm

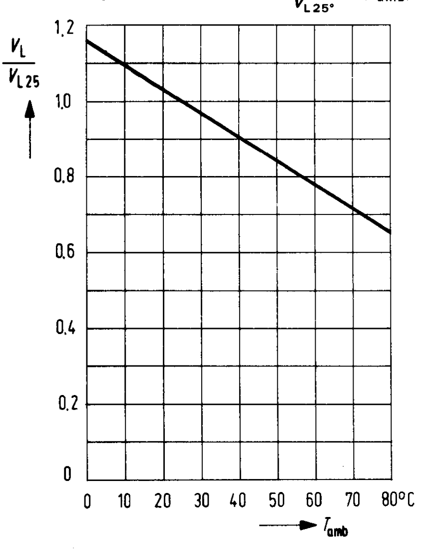
Maximum ratings		BPX 91	
Reverse voltage	V_R	32	V
Operating and storage temperature	T_S	−30 to +80	°C
Soldering temperature 2 mm away from case bottom ($t \leq 3$ s)	T_L	230	°C
Power dissipation ($T_{amb} = 25$ °C)	P_{tot}	150	mW

Characteristics (T_{amb}=25 °C)		**BPX 91**	
Open-circuit voltage			
at E_v=100 lx[1])	V_L	360 (>270)	mV
at E_v=1000 lx[1])	V_L	460	mV
Short-circuit current at E_v= 100 lx[1])	I_K	5 (>3.5)	µA
Photo sensitivity[1])	S	50 (>35)	nA/lx
Wavelength of max. photo sensitivity	$\lambda_{s\,max}$	850	nm
Rise and fall time of photo current from 10% to 90% and 90% to 10% of final value			
(R_L=1 kΩ; V_L=10 V)	t_r; t_f	1.0	µs
(R_L=1 kΩ; V_L=0 V)	t_r; t_f	2.5	µs
Temperature coefficient for V_L	TC	−2.6	mV/K
Temperature coefficient for I_K	TC	0.2	%/K
Capacitance at			
V_R=0 V; f=1 MHz, E_v=0 lx	C_0	750	pf
V_R=10 V; f=1 MHz, E_v=0 lx	C_{10}	220	pf
Photo-sensitive surface	A	7.6	mm²
Dark current (V_R=10 V; T_{amb}=25 °C; E_v=0 lx)	I_R	7 (<300)	nA

Capacitance $C=f(V_R)$
f=1 MHz

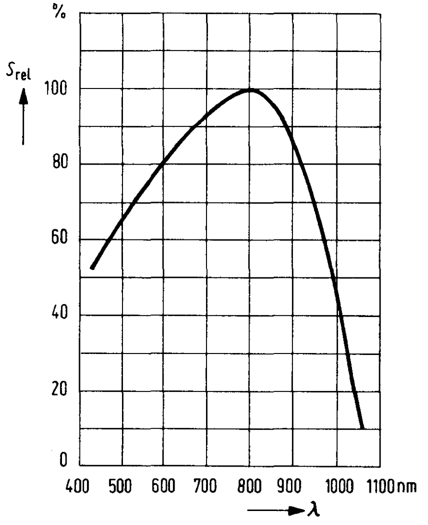


Open-circuit voltage $\frac{V_L}{V_{L25°}}=f(T_{amb})$

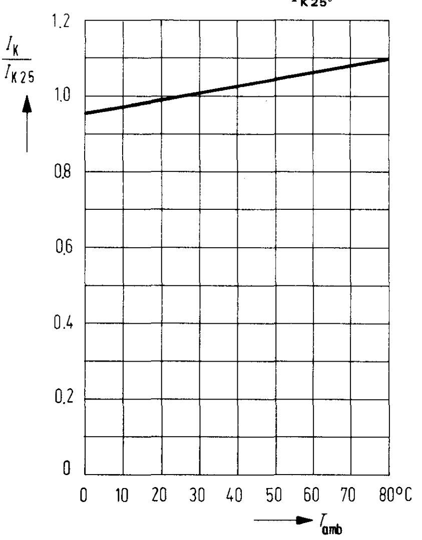


[1]) The illuminances indicated refers to the unfiltered radiation of a tungsten-filament lamp with a colour temperature of 2856 K.

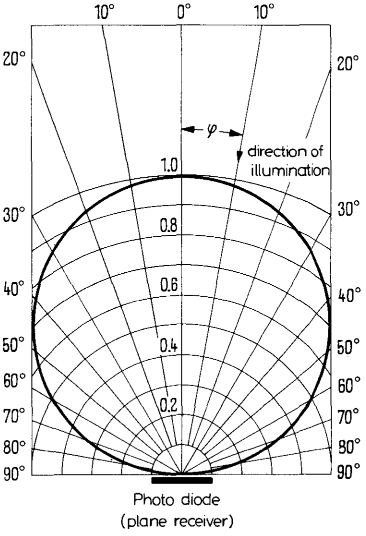
Relative spectral sensitivity $S_{rel} = f(\varphi)$



Short-circuit current $\frac{I_K}{I_{K25°}} = f(T_{amb})$



Directional characteristic $I_K = f(\varphi)$

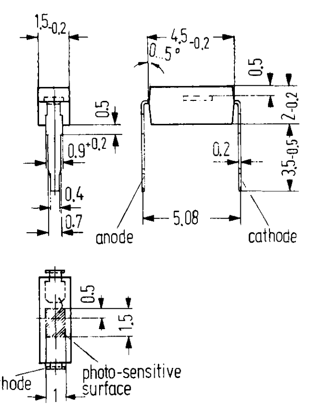


BPX 92

Silicon photo diode in a plastic package

BPX 92 is a silicon planar photo diode which is incorporated in a transparent plastic package. Its terminals are soldering tabs in a basic grid system of 2/10″. This design permits very easy assembly of the component also on grid boards. The plane back of the epoxy resin case allows sturdy fixation of the component. Arrays may be realized by multiple arrangements. This universal photo sensor is suitable both for operation as a diode and as a voltaic cell. The noise/signal ratio is particularly favourable, even at low illuminances. The open-circuit voltage is higher with small illuminances than with comparable mesa photo-voltaic cells.

Type	Order number
BPX 92	Q62702-P49

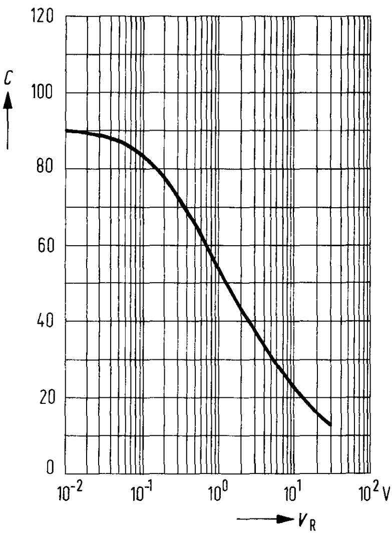


Weight approx. 0.03 g   Dimensions in mm

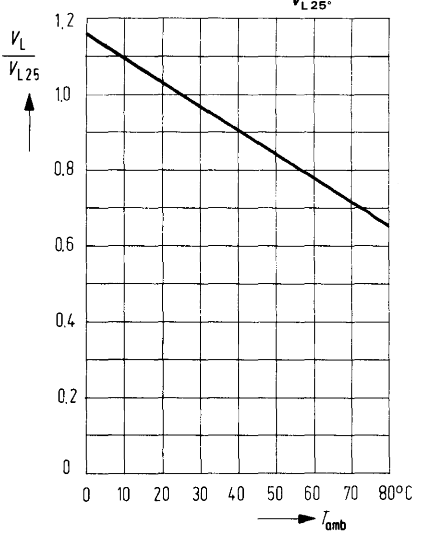
Maximum ratings		BPX 92	
Reverse voltage	V_R	32	V
Operating and storage temperature	T_S	−30 to +80	°C
Soldering temperature 2 mm away from case bottom, ($t \leq 3$ s)	T_L	230	°C
Power dissipation (T_{amb} = 25 °C)	P_{tot}	50	mW

Characteristics ($T_{amb}=25\,°C$)		**BPX 92**	
Open-circuit voltage			
at $E_v=100$ lx[1])	V_L	325 (>240)	mV
at $E_v=1000$ lx[1])	V_L	410	mV
Short-circuit current			
at $E_v=100$ lx[1])	I_K	0.7 (>0.4)	µA
Photo sensitivity[1])	S	7 (>4)	nA/lx
Wavelength of max. photo sensitivity	λ_{smax}	850	nm
Rise and fall time of photo current from 10% to 90% and 90% to 10% of final value			
($R_L=1$ kΩ; $V_R=10$ V)	t_r; t_f	0.8	µs
($R_L=1$ kΩ; $V_R=0$ V)	t_r; t_f	1.1	µs
Temperature coefficient for V_L	TC	−2.6	mV/K
Temperature coefficient for I_K	TC	0.2	%/K
Capacitance at			
$V_R=$ 0 V; $f=1$ MHz; $E_v=0$ lx	C_0	90	pf
$V_R=10$ V; $f=1$ MHz; $E_v=0$ lx	C_{10}	23	pf
Photo-sensitive surface	A	1.0	mm²
Dark current ($V_R=10$ V; $T_{amb}=25\,°C$; $E_v=0$ lx)	I_R	1 (<100)	nA

Capacitance $C=f(V_R)$

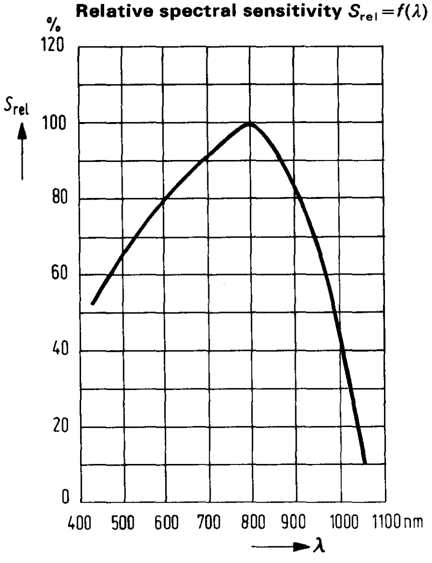


Open-circuit voltage $\frac{V_L}{V_{L25°}}=f(T_{amb})$

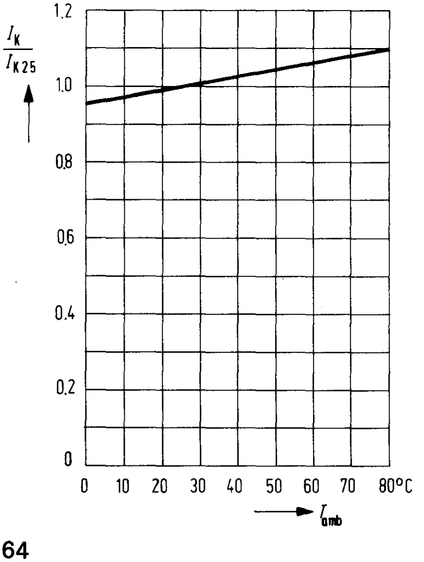


[1]) The illuminances indicated refers to the unfiltered radiation of a tungsten-filament lamp with a colour temperature of 2856 K.

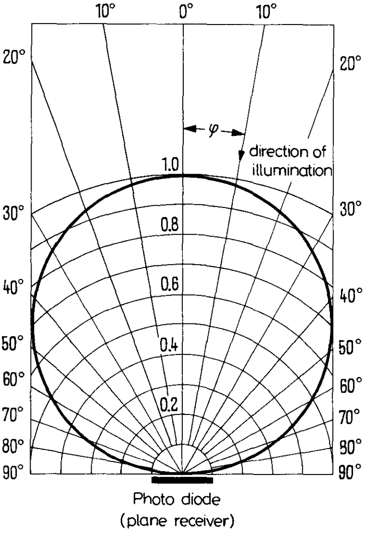
Relative spectral sensitivity $S_{rel} = f(\lambda)$



Short-circuit current $\frac{I_K}{I_{K25°}} = f(T_{amb})$



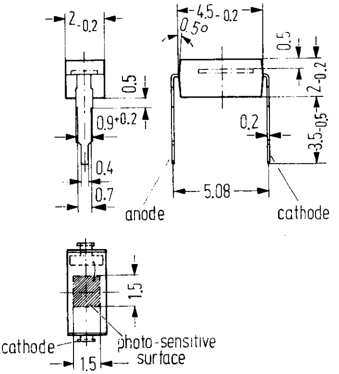
Directional characteristic $I_K = f(\varphi)$



Silicon photo diode in a plastic package

BPX 93 is a silicon planar photo diode which is encapsulated in a transparent plastic package. Its terminals are soldering tabs in a basic grid system of 2/10″. This design permits very easy mounting of the component also on grid boards. The plane back of the epoxy resin case allows sturdy fixation of the component. Arrays may be realized by multiple arrangements. This universal photo sensor is suitable both for operation as a diode and as a voltaic cell. The noise/signal ratio is particularly favourable, even at low illuminances. The open-circuit voltage is higher with small illuminances than with comparable mesa photo voltaic cells.

Type	Order number
BPX 93	Q 62702-P 50

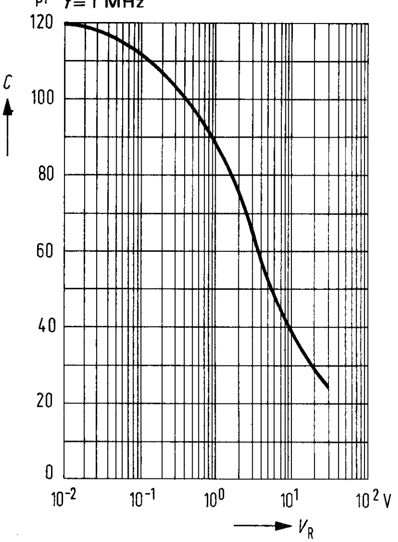


Weight approx. 0.05 g   Dimensions in mm

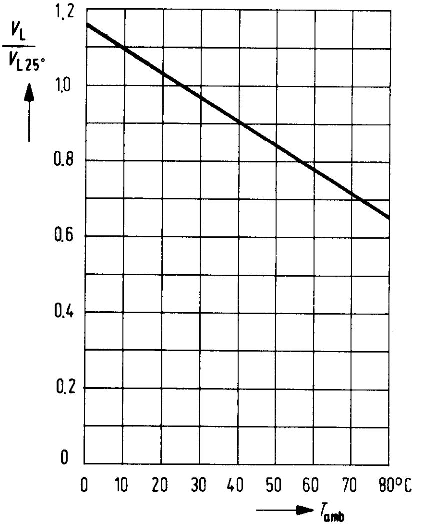
Maximum ratings		BPX 93	
Reverse voltage	V_R	32	V
Operating and storage temperature	T_S	−30 to +80	°C
Soldering temperature 2 mm away from case bottom ($t \leqq 3$ s)	T_L	230	°C
Power dissipation (T_{amb} = 25 °C)	P_{tot}	150	mW

Characteristics ($T_{amb}=25\,°C$)		**BPX 93**	
Open-circuit voltage			
at $E_v=100$ lx[1])	V_L	360 (>270)	mV
at $E_v=1000$ lx[1])	V_L	460	mV
Short-circuit current at $E_v=100$ lx[1])	I_K	0.8 (>0.5)	µA
Photo sensitivity[1])	S	8 (>5)	nA/lx
Wavelength of max. photo sensitivity	λ_{smax}	850	nm
Rise and fall time of photo current from 10% to 90% and 90% to 10% of final value			
($R_L=1\,k\Omega$; $V_L=10\,V$)	t_r; t_f	0.8	µs
($R_L=1\,k\Omega$; $V_L=0\,V$)	t_r; t_f	1.1	µs
Temperature coefficient for V_L	TC	−2	mV/K
Temperature coefficient for I_K	TC	0.1	%/K
Capacitance at			
$V_R=\ 0\,V$; $f=1\,MHz$; $E_v=0$ lx	C_0	120	pf
$V_R=10\,V$; $f=1\,MHz$; $E_v=0$ lx	C_{10}	40	pf
Photo-sensitive surface	A	1	mm^2
Dark current			
($V_R=10\,V$; $T_{amb}=25\,°C$; $E_v=0$ lx)	I_R	0.5 (<50)	nA

Capacitance $C=f(V_R)$

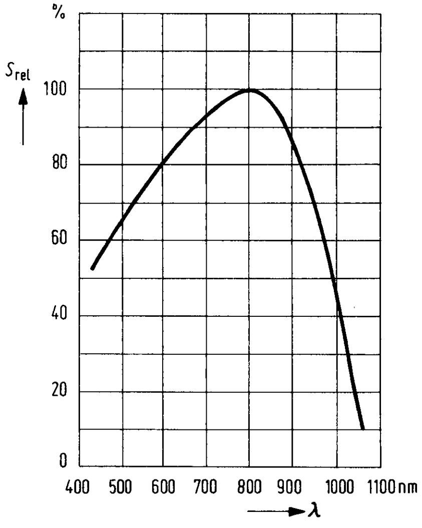


Open-circuit voltage $\frac{V_L}{V_{L25°}}=f(T_{amb})$

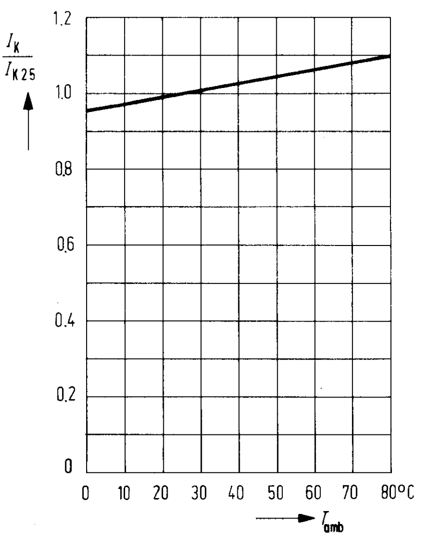


[1]) The illuminance indicated refers to the unfiltered radiation of a tungsten-filament lamp with a colour temperature of 2856 K.

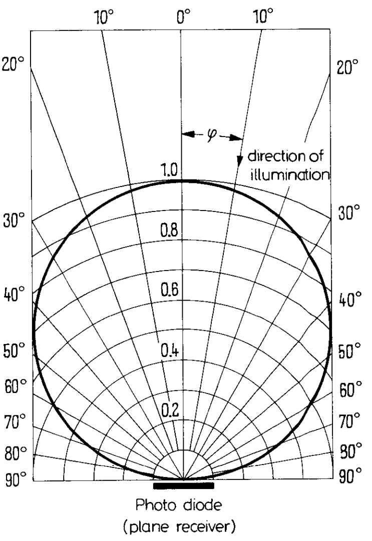
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



Short-circuit current $\frac{I_K}{I_{K25°}} = f(T_{amb})$



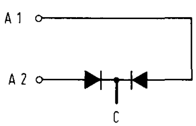
Directional characteristic $I_K = f(\varphi)$



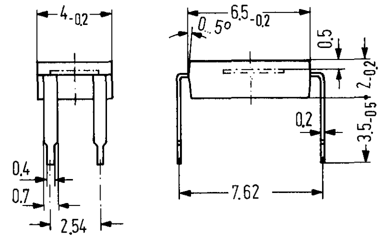
Strip-line differential photo diode in epoxy resin

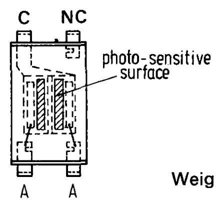
The differential photo diode BPX 48 is designed for special industrial electronic applications, such as follow-up control, edge control, path and angle scanning, respectively. The individual diodes are spaced 50 µm apart. A very accurate determination of position thus becomes feasible. The rise and fall times of the photo current are short so that control systems with small down times may be built up. The silicon planar method ensures a low dark current level, low noise and thus very favourable signal relationships.
Mountings instructions: see preface

Type	Order number
BPX 48	Q 62702-P 17-S 1



System of BPX 48





Weight approx. 0.5 g

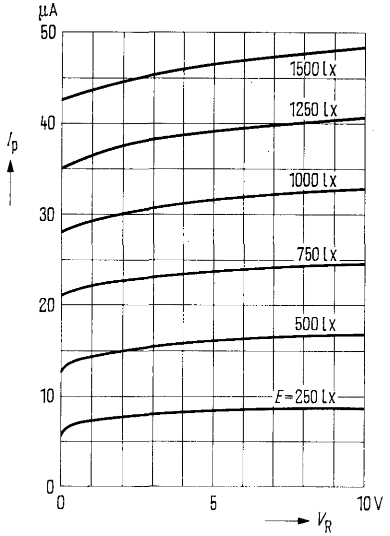
Maximum ratings (for single diode system)

		BPX 48	
Reverse voltage	V_R	10	V
Junction temperature	T_j	125	°C
Storage temperature	T_S	−30 to +80	°C
Power dissipation	P_{tot}	50	mW

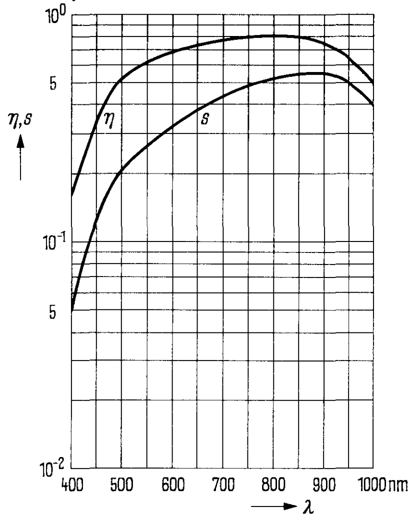
Characteristics (T_{amb} = 25 °C)
(Data refer to one photo diode system)

Photo sensitivity, colour temperature of radiator 2856 K	S	32 (>15)	nA/lx
Wavelength of max. spectral sensitivity	λ_{smax}	0.85	µm
Rise and fall time of photo current from 10% to 90% and 90% to 10% of final value			
(R_L = 1 kΩ; V_R = 10 V)	t_r; t_f	<150	ns
(R_L = 1 kΩ; V_R = 0 V)	t_r; t_f	<500	ns
Cutoff frequency, measured at a working resistor of R_L = 1 kΩ; V_R = 10 V	f_g	3	MHz
Capacitance at V_R = 0 V	C_0	40	pf
at V_R = 10 V	C_{10}	10	pf
Photo-sensitive surface	A	1.9	mm²
Dark current (V_R = 10 V; E_v = 0 lx)	I_R	100 (<200)	nA

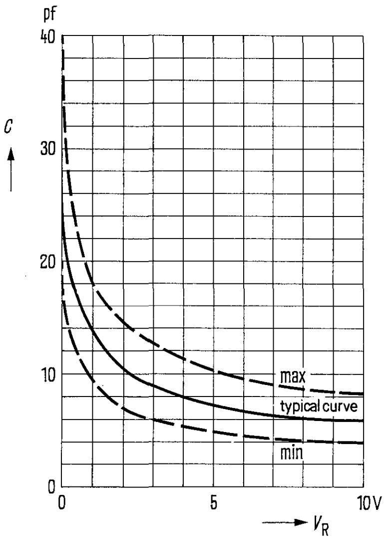
Family of characteristics $I_p = f(V_R)$
E_v(lx) = parameter



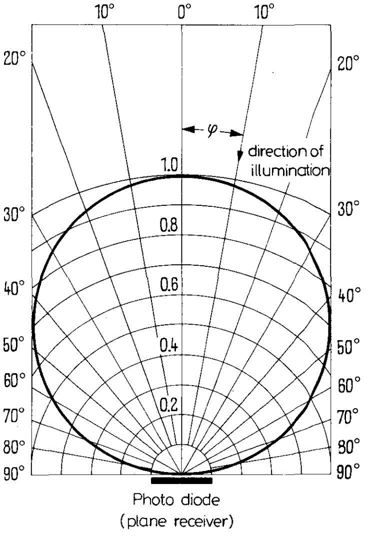
Spectral photo sensitivity $s = f(\lambda)$ in A/W and quantum yield $\eta = f(\lambda)$ in electrons per photon of photo diode



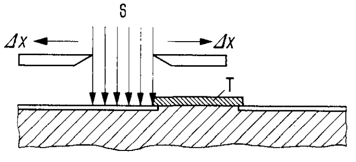
Junction capacitance vs. reverse voltage $C = f(V_R)$



Directional characteristic $I_p = f(\varphi)$
$I_p \approx I_{po} \cdot \cos\varphi$



Scanning a differential photo diode with a 25 µm light beam.

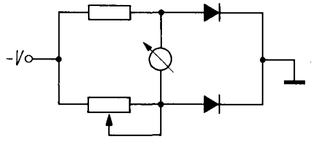


Experimental setup

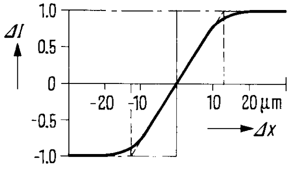
S – gap (25 µm wide)

T – separation of diodes

Δx – displacement of *S*



Measuring circuit



Differential photo signal ΔI (referred to saturation value 1) as a function of the displacement Δx of the air gap *S*

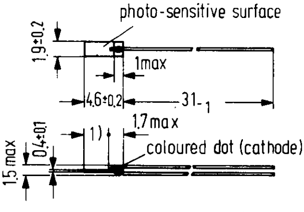
Silicon Photo-Voltaic Cells

Silicon photo-voltaic cell

The silicon photo-voltaic cell BP 100 is suitable for use in control and regulating devices. Its high response sensitivity, its small dimensions, and the high permissible operating temperature favour universal application.
Since a case can be dispensed with, the cell lends itself to the assembly of high-efficiency scanning systems. For this purpose the cells may be glued closely together on suitable supports. The photo-insensitive side of the element is marked by a yellow dot.

Typ	Order number
BP100	Q60215-X100

See mounting instructions



Weight approx. 0.2 g Dimensions in mm

Maximum ratings		BP 100	
Reverse voltage[1]	V_R	1	V
Ambient temperature	T_{amb}	−25 to +100	°C

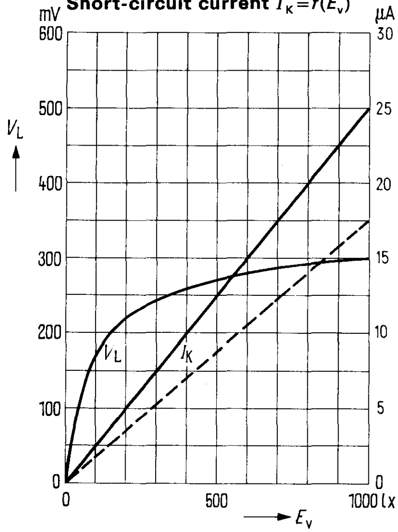
Characteristics (T_{amb}=25 °C)

Open-circuit voltage (E_V= 100 lx)[2]	V_L	≧120	mV
Open-circuit voltage (E_V=1000 lx)[2]	V_L	≧200	mV
Short-circuit current (E_V=1000 lx)[2]	I_K	25	µA
Photo sensitivity (short circuit current I_K)[2]	S	25 (≧15)	nA/lx
Spectral sensitivity maximum	λ_{smax}	0.85	µm
Rise time (for 60% I_K)	t_r	4	µs
Temp. coeffic. of the open-circuit voltage	TC	−2.6	mV/K
Temp. coeffic. of the short-circuit current	TC	0.121	%/K
Capacitance (V_R=0 V)	C_0	1	nf
Light sensitive area	A	7	mm²
Dark current (V_R=1 V; T_{amb}=25 °C; E_v=0 lx)	I_R	3 (≦10)	µA
Dark current (V_R=1 V; T_{amb}=50 °C; E_v=0 lx)	I_R	7	µA

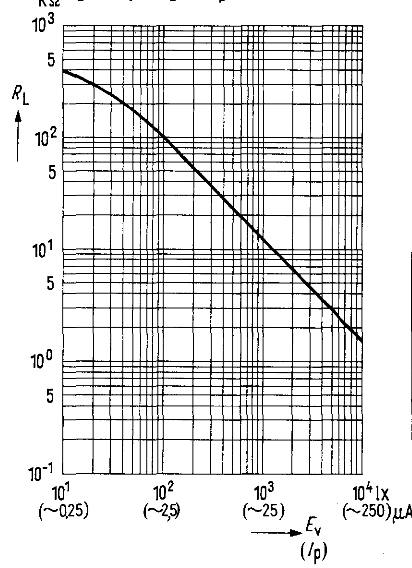
[1]) Plus pole of voltage source connected to lead on the colour dot side.

[2]) The illuminances indicated refers to a radiation source with standard light A acc. to DIN 5033, tungsten filament lamp, colour temperature T_F=2856 K (unfiltered incandescent lamp light).

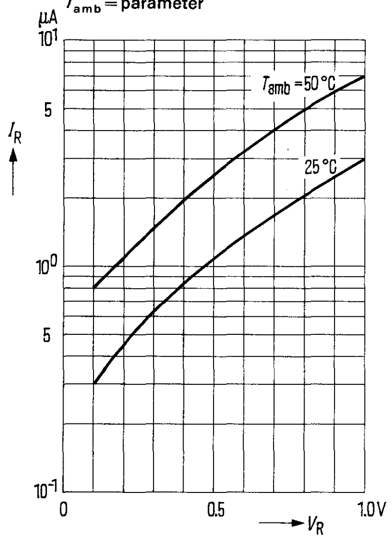
Open-circuit voltage $V_L = f(E_v)$
Short-circuit current $I_K = f(E_v)$



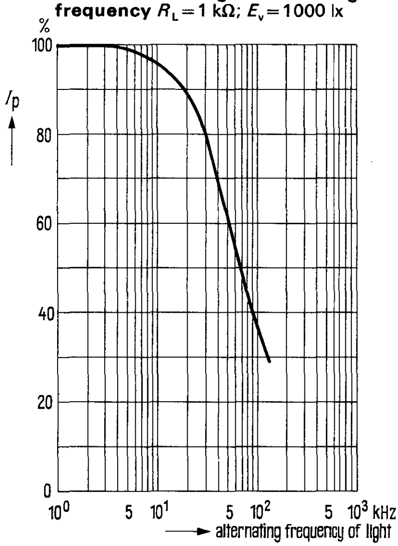
Matching impedance resistor for optimal power output
$R_L = f(E_v)$; $R_L = f(I_p)$



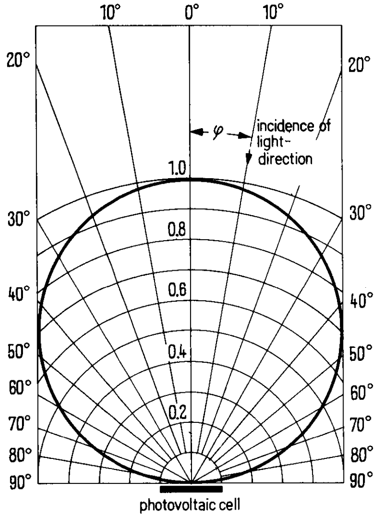
Dark current $I_R = f(V_R)$
T_{amb} = parameter



Mean photo current as a function of the light alternating frequency $R_L = 1$ kΩ; $E_v = 1000$ lx



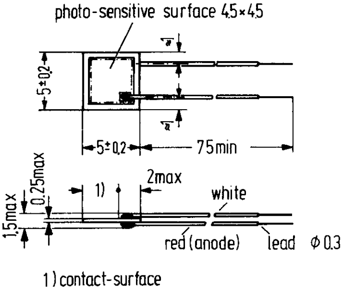
Directional characteristic $I_K = f(\varphi)$



Silicon photo-voltaic cell with increased sensitivity to blue

BPX 79 is a silicon planar photo-voltaic cell. The increased sensitivity with shorter wavelengths makes it particularly suitable for applications with light sources having a high share of blue. The planar method ensures a low reverse current level and low noise. The photo-voltaic cell is nitride-passivated and has an anti-reflection coating for a wavelength of =450 nm.

Type	Order number
BPX 79	Q62702-P51

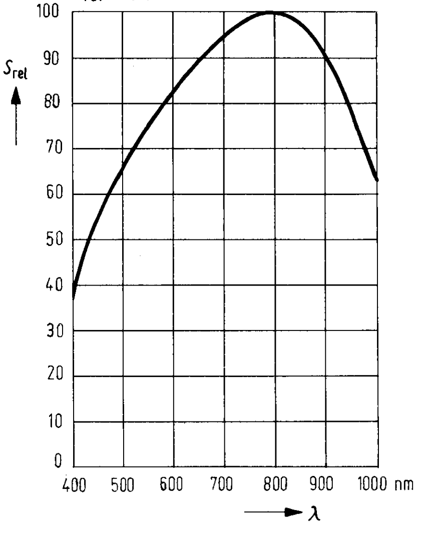


Dimensions in mm

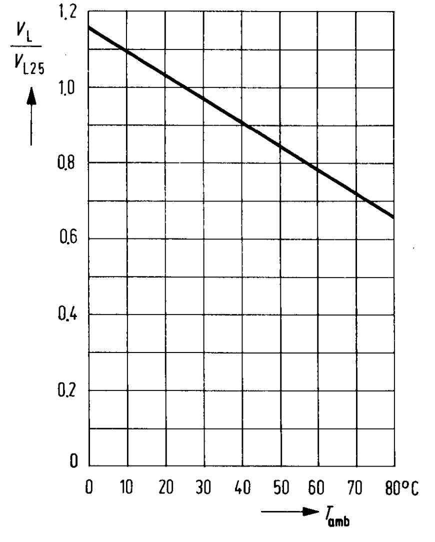
		BPX 79	
Maximum ratings			
Reverse voltage	V_R	1	V
Junction temperature	T_j	125	°C
Storage temperature	T_s	−55 to +100	°C
Power dissipation	P_{tot}	200	mW
Characteristics			
Photo sensitivity[1])	S	135 (>100)	nA/lx
Open-circuit voltage (E_v=100 lx)[1])	V_L	320 (>220)	mV
Open-circuit voltage (E_v=1000 lx)[1])	V_L	410 (>310)	mV
Wavelength of max. photo sensitivity	λ_{smax}	800	nm
Rise and fall time of photo current from 10% to 90% and 90% to 10% of final value			
(R_L=1 kΩ; V_R=1 V)	t_r; t_f	6	µs
(R_L=1 kΩ; V_R=0 V)	t_r; t_f	10	µs
Capacitance			
(V_R=0 V)	C_0	420	pf
(V_R=1 V)	C_1	350	pf
Photo-sensitive surface	A	20	mm²
Dark current (V_R=1 V)	I_R	0.3 (50)	µA
Temperature coefficient f. V_L	TC	−2.6	mV/K
Temperature coefficient f. I_K	TC	0.2	%/K

[1]) The illuminances indicated refers to the unfiltered radiation of a tungsten-filament lamp with a colour temperature of 2856 K.

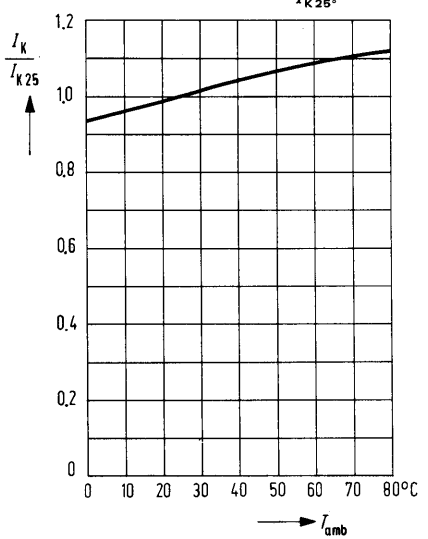
Relative spectral sensitivity $S_{rel} = f(\lambda)$



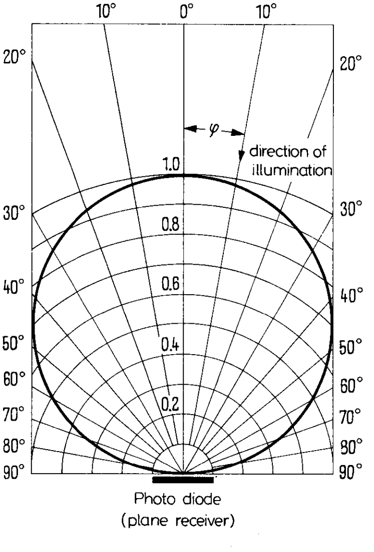
Open-circuit voltage $\frac{V_L}{V_{L25°}} = f(T_{amb})$



Short-circuit current $\frac{I_K}{I_{K25°}} = f(T_{amb})$



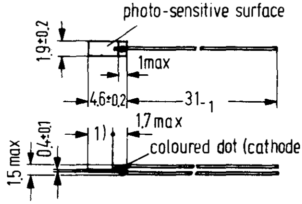
Directional characteristic $I_K = f(\varphi)$



Silicon photo-voltaic cell

The silicon photo-voltaic cell BPY 11 is suitable for use in control and regulating devices, for scanning light pulses, and for quantitative light measurements. Its high response sensitivity, its small dimensions, and the high permissible operating temperature favour universal application.
Since a case can be dispensed with, the cell lends itself to the assembly of high-efficiency scanning systems. For this purpose the cells may be glued closely together on suitable supports. The photo-insensitive side of the element is marked by a coloured dot.
Mounting instructions: see preface

Type	Order number	Code colour
BPY 11	Q 60215-Y 11	red
BPY 11/I	Q 60215-Y 11-X 10	brown
BPY 11/II	Q 60215-Y 11-X 11	orange
BPY 11/III	Q 60215-Y 11-X 12	green



1) contact surface 2.7 min
Weight approx. 0.2 g Dimensions in mm

Maximum ratings		**BPY 11**	
Reverse voltage[1]	V_R	1	V
Ambient temperature	T_{amb}	−50 to +100	°C

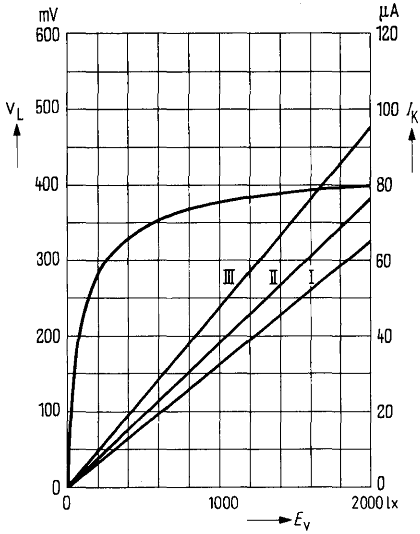
Characteristics (T_{amb}=25 °C)			
Open-circuit voltage (E_V= 100 lx)[2]	V_L	≧180	mV
Open-circuit voltage (E_V=1000 lx)[2]	V_L	≧260	mV
Short-circuit current (E_V=1000 lx)[2]	I_K	40	µA
Photo sensitivity[2]	S	40 (≧28)	nA/lx
Spectral sensitivity maximum	λ_{smax}	0.85	µm
Rise time (for 60% of I_K)	t_r	4	µs
Temp. coeffic. of the open-circuit voltage	TC	−2.6	mV/K
Temp. coeffic. of the short-circuit current	TC	0.121	%/K
Capacitance (V_R=0 V)	C_0	1	nf
Light sensitive area	A	7	mm²
Dark current (V_R=1 V; T_{amb}=25 °C)	I_R	1 (≦10)	µA
Dark current (V_R=1 V; T_{amb}=50 °C)	I_R	2.5	µA
Maximum frequency (R_L=1 kΩ)	f_0	55	kHz

Groups of photo-sensitivity

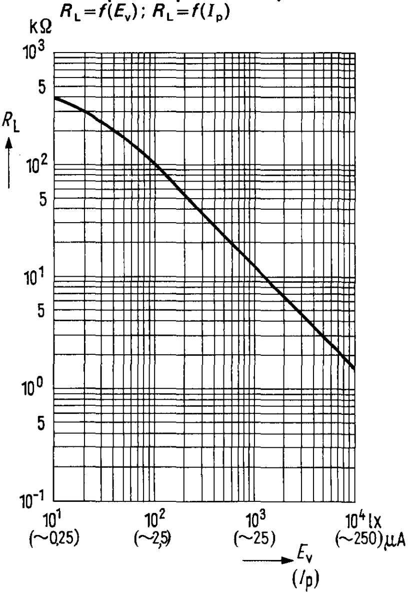
Type	BPY 11	BPY 11/I	BPY 11/II	BPY 11/III	
Code colour	red	brown	orange	green	
Short-circuit current I_K E_v=100 lx	5.5 to 11.0	5.5 to 7.5	6.5 to 9.0	8.0 to 11.0	µA

[1]) Plus pole of voltage source to be connected to lead on coloured dot side.
[2]) The illuminances indicated refers to the unfiltered radiation (standard light A acc. to DIN 5033) of a tungsten filament lamp with a colour temperature of 2856 K.

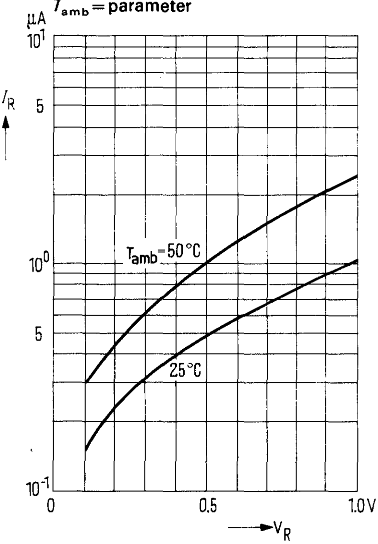
Open circuit voltage $V_L = f(E_v)$
short circuit-current $I_k = f(E_v)$



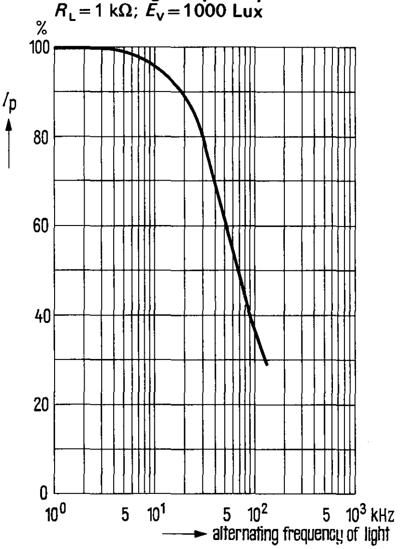
Matching impedance resistor for optimal power output
$R_L = f(E_v)$; $R_L = f(I_p)$



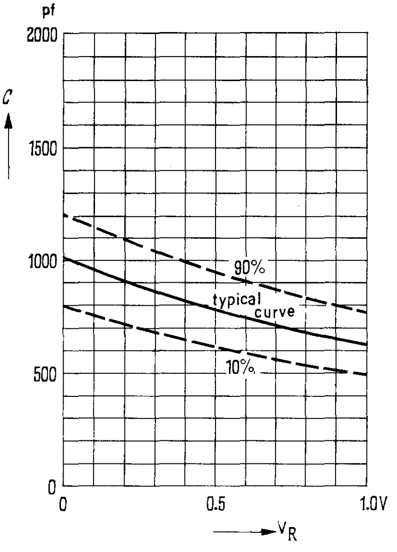
Dark current $I_R = f(V_R)$
T_{amb} = parameter



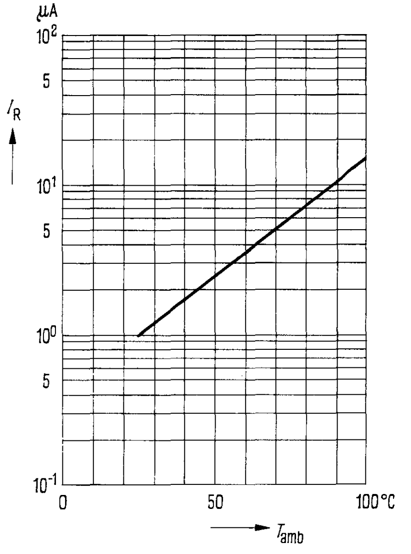
Mean photo current as a function of the light alternating frequency
$R_L = 1$ kΩ; $E_v = 1000$ Lux



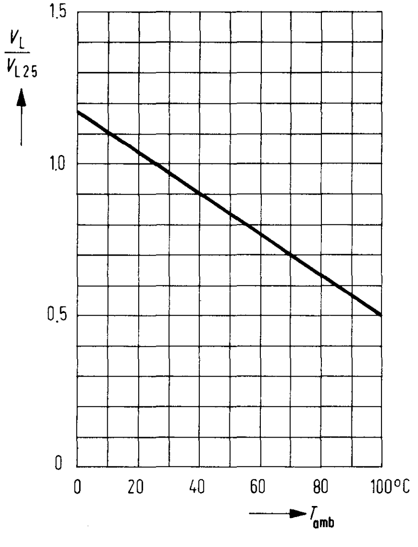
Junction capacitance $C = f(V_R)$
$E_v = 0$ lx



Dark current as a function of temperature $I_R = f(T_{amb})$
$V_R = 1$ V



Temperature dependence of V_L
$\frac{V_L}{V_{L25}} = f(T_{amb})$



Temperature dependence of I_K
$\frac{I_K}{I_{K25}} = f(T_{amb})$

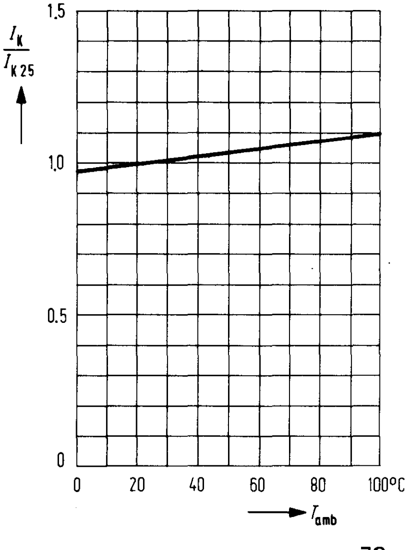


Photo voltage $V_p = f(I_K)$
R_L = parameter

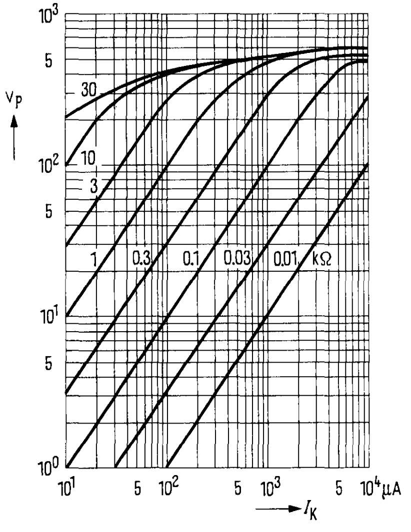
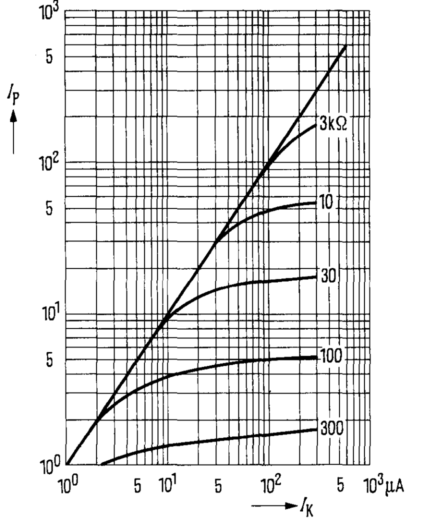
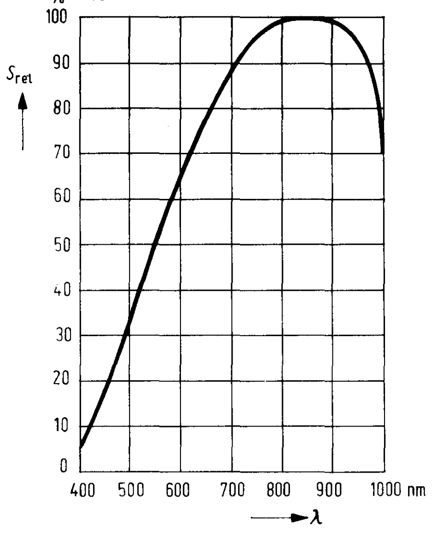


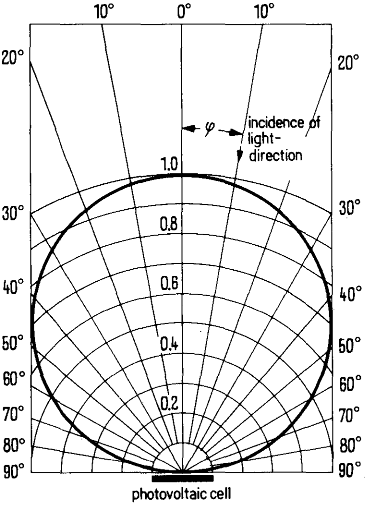
Photo current $I_p = f(I_K)$
R_L = parameter



Relative spectral sensitivity
$S_{rel} = f(\lambda)$



Directional characteristic $I_K = f(\varphi)$

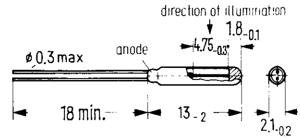


Silicon photo-voltaic cells with reverse characteristics

Not for new development

Silicon photo-voltaic cells BPY 43 and BPY 44 in miniature glass case are suitable for use in control or regulating devices, for scanning light pulses and for quantitative light measurements. Their high response sensitivity, small dimensions and high permissible operating temperature permit universal application.
When mounted in supports with bores having a diameter of 2.2 mm, the cells can be assembled to form special scanning devices. They are designed for radial illumination.

Type	Order number
BPY 43	Q 60215-Y 43
BPY 44	Q 60215-Y 44



Weight approx. 0.2 g Dimensions in mm

Maximum ratings		**BPY 43**	**BPY 44**	
Reverse voltage[1]	V_R	2	5	V
Temperature range	T_{amb}	−55 to +125	−55 to +125	°C

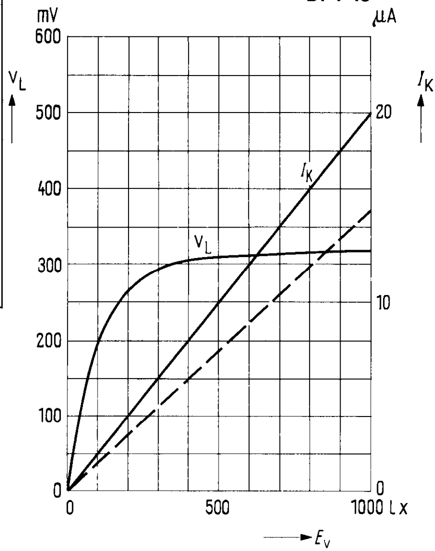
Characteristics (T_{amb} = 25 °C)				
Open-circuit voltage at E_v = 1000 lx[2]	V_L	≧270	≧330	mV
Open-circuit voltage at E_v = 100 lx[2]	V_L	≧150	≧200	mV
Short-circuit current E_v = 1000 lx[2]	I_K	≧15	≧20	µA
Photo sensitivity[2]	S	20 (≧15)	27 (≧20)	nA/lx
Maximum of spectral sensitivity	λ_{smax}	0.85	0.85	µm
Limit of infrared sensitivity	λ_g	1.1	1.1	µm
Size of the photo-sensitive area	A	0.05	0.05	cm^2
Dark current at V_R = 2 V	I_R	–	< 1.0	µA
Dark current at V_R = 1 V	I_R	< 5.0	–	µA
Temperature coefficient of V_L (see diagram)	TC	−2.6	−2.6	mV/K
Temperature coefficient of short-circuit current I_K (see diagram)	TC	0.121	0.121	%/K
Capacitance (V_R = 0 V)	C_0	0.5	0.5	nf

[1]) The negative pole of the voltage supply is to be connected to the lead marked by a red dot.
[2]) The illuminances indicated refers to an unfiltered radiation of a tungsten-filament lamp with a colour temperature of 2856 K.

BPY 43, BPY 44

Not for new development

Open-circuit voltage $V_L = f(E_v)$
short-circuit current $I_k = f(E_v)$
BPY 43



Open-circuit voltage $V_L = f(E_v)$
short-circuit current $I_k = f(E_v)$
BPY 44

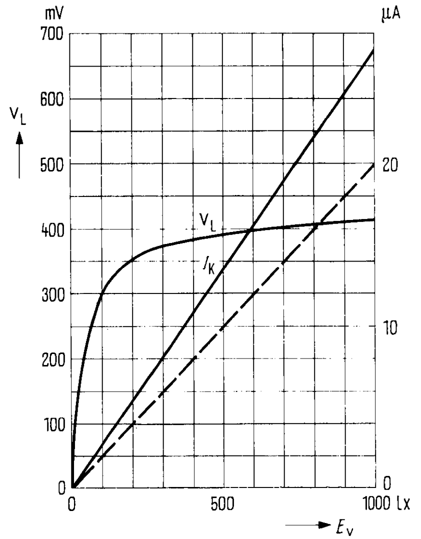


Photo current $I_p = f(I_k)$
R_L = parameter
BPY 43

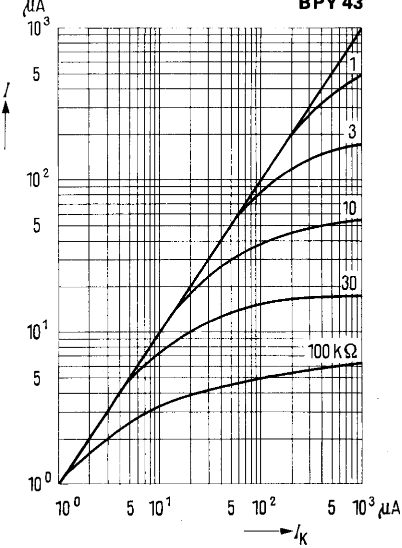
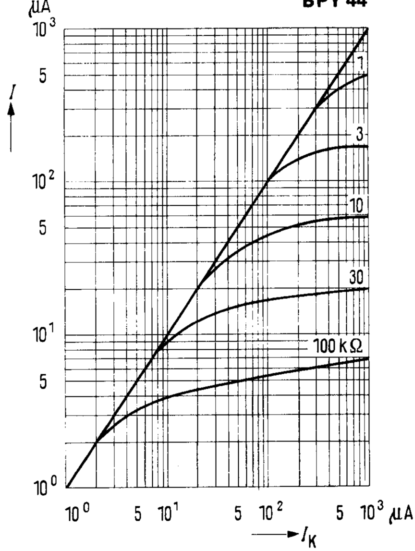


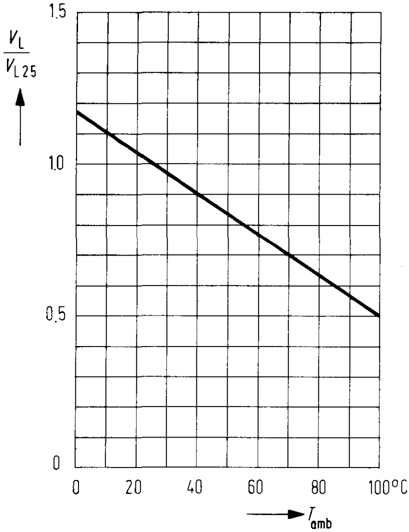
Photo current $I_p = f(I_k)$
R_L = parameter
BPY 44



Not for new development

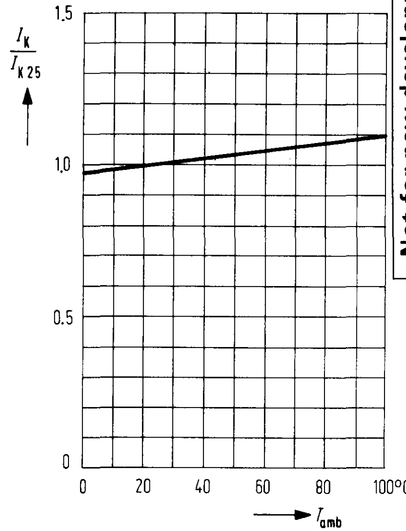
Temperature dependence of V_L

$\frac{V_L}{V_{L25}} = f(T_{amb})$

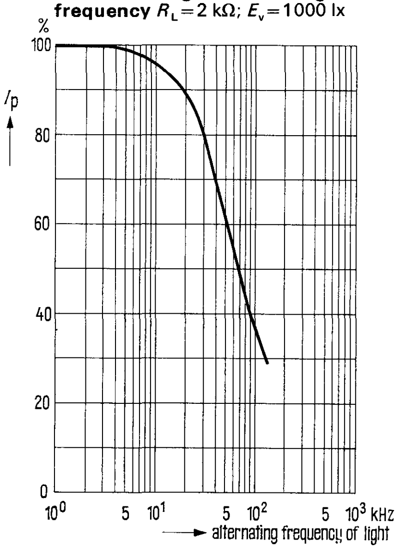


Temperature dependence of I_K

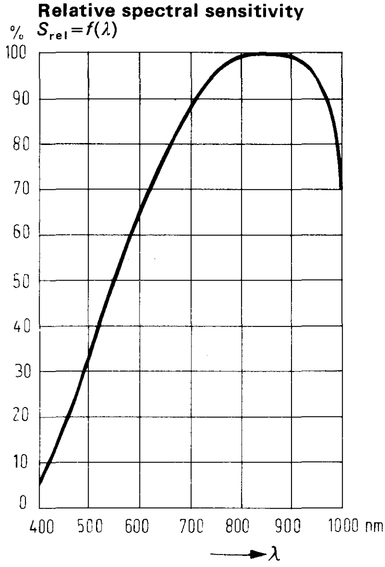
$\frac{I_K}{I_{K25}} = f(T_{amb})$



Mean photo current as a function of light alternating frequency $R_L = 2\ k\Omega$; $E_v = 1000$ lx



Relative spectral sensitivity
$S_{rel} = f(\lambda)$

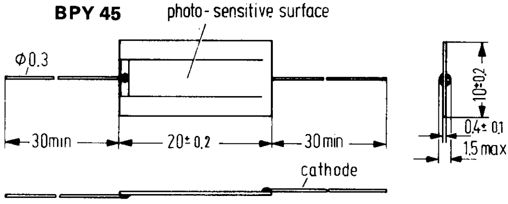


Silicon photo-voltaic cells

Silicon photocells BPY 45, BPY 47 and BPY 48 are suitable for universal application in control and regulating circuits. They may be used as receivers for incandescent lamps or daylight. Mounting instructions: see preface.

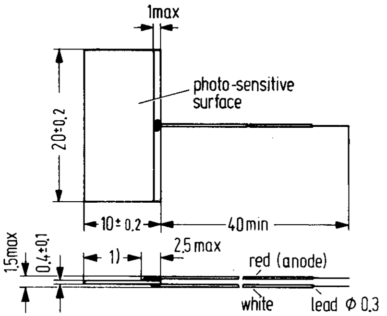
Type	Order number
BPY 45	Q 60215-Y 45
BPY 47	Q 60215-Y 47
BPY 48	Q 60215-Y 48

BPY 45



Weight approx. 1.5 g

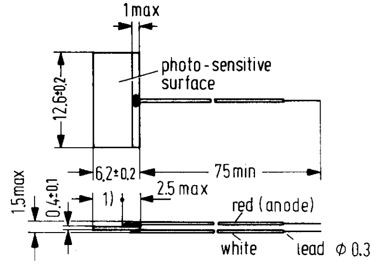
BPY 47



1)contact surface 7.3 min

Weight approx. 1.5 g
Dimensions in mm

BPY 48



1) contact surface 3.5 min

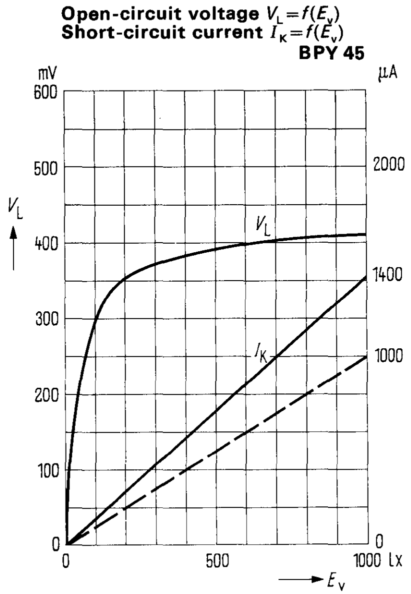
Weight approx. 0.5 g
Dimensions in mm

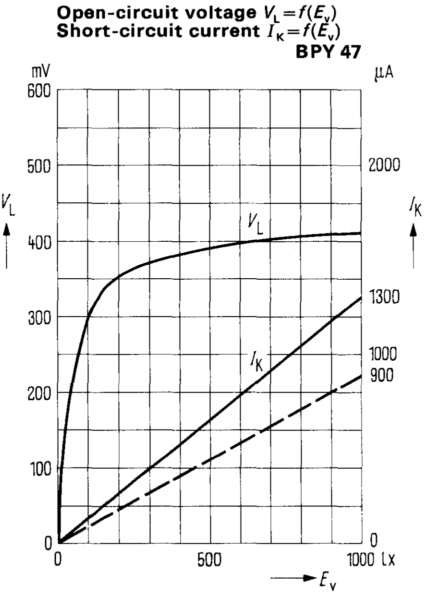
Maximum ratings		BPY 45	BPY 47	BPY 48	
Reverse voltage[1])	V_R	1.0	1.0	1.0	V
Ambient temperature	T_{amb}		−50 to +125		°C

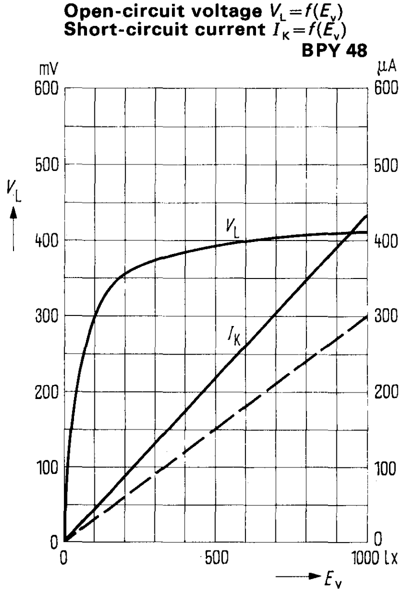
[1]) In case of BPY 45 the positive pole of the voltage source is to be connected to that terminal leading to the fully metallized side of the photo-voltaic cells. In case of BPY 47 and BPY 48 the positive pole of the voltage source is to be connected to the white lead.

Characteristics ($T_{amb}=25\,°C$)		BPY 45	BPY 47	BPY 48	
Open-circuit voltage ($E_v=10000$ lx)[1]	V_L	≧450	≧450	≧450	mV
Open-circuit voltage ($E_v=1000$ lx)[1]	V_L	≧280	≧280	≧280	mV
Open-circuit voltage ($E_v=100$ lx)[1]	V_L	≧150	≧150	≧150	mV
Short circuit current $E_v=10000$ lx[1])	I_K	≧14.5	13	4.3	mA
Photo-sensitivity (short-circuit current I_K)	S	≧1.0	≧0.9	≧0.3	µA/lx
Spectral sensitivity maximum	λ_{smax}	0.85	0.85	0.85	µm
Light-sensitive surface	A	1.8	1.8	0.67	cm²
Temperature coefficient of V_L (see diagram)	TC	−2.6	−2.6	−2.6	mV/K
Temperature coefficient of I_K (see diagram)	TC	0.121	0.121	0.121	%/K
Capacitance	C_0	20	20	8	nf
Conversion of sunlight into electrical energy	η	≧8	–	–	%

[1]) The illuminances indicated refers to an unfiltered radiation of a tungsten-filament lamp with a colour temperature of 2856 K.


Open-circuit voltage $V_L = f(E_v)$
Short-circuit current $I_K = f(E_v)$
BPY 45
mV
µA
600
500
400
300
200
100
0
2000
1400
1000
0
V_L
I_K
0
500
1000 lx
E_v


Open-circuit voltage $V_L = f(E_v)$
Short-circuit current $I_K = f(E_v)$
BPY 47
mV
µA
600
500
400
300
200
100
0
2000
1300
1000
900
0
V_L
I_K
0
500
1000 lx
E_v


Open-circuit voltage $V_L = f(E_v)$
Short-circuit current $I_K = f(E_v)$
BPY 48
mV
µA
600
500
400
300
200
100
0
V_L
I_K
0
500
1000 lx
E_v

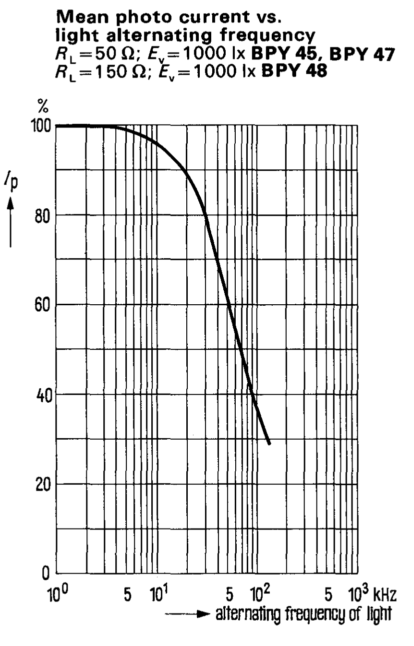

Mean photo current vs.
light alternating frequency
$R_L = 50\ \Omega$; $E_v = 1000$ lx BPY 45, BPY 47
$R_L = 150\ \Omega$; $E_v = 1000$ lx BPY 48
%
100
80
60
40
20
0
I_p
10^0
5
10^1
5
10^2
5
10^3 kHz
alternating frequency of light

Photo voltage versus short-circuit current
$V_p = f(I_K)$; R_L = parameter
BPY 45, BPY 47, BPY 48

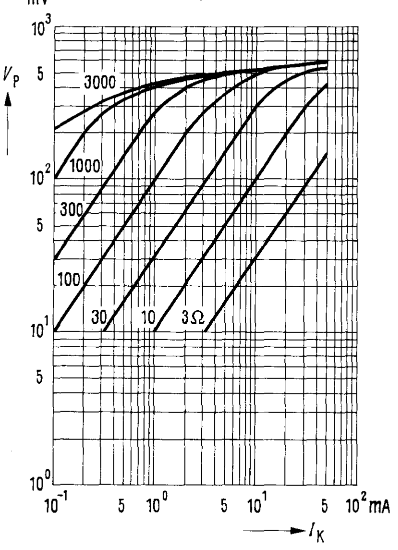
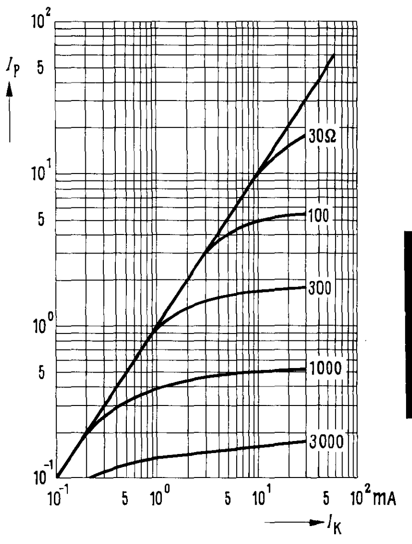
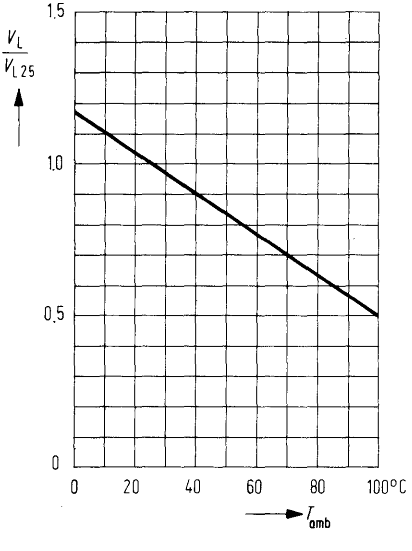


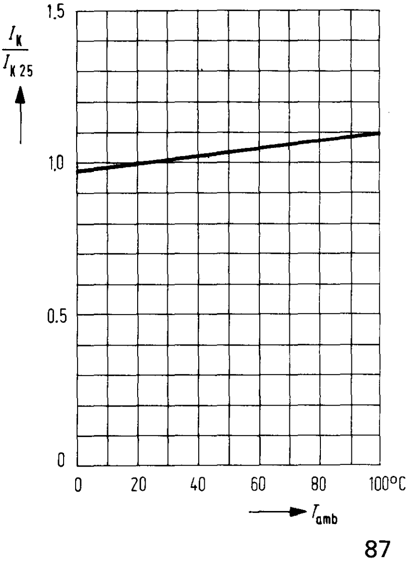
Photo current versus short-circuit current
$I_p = f(I_k)$; R_L = parameter
BPY 45, BPY 47, BPY 48



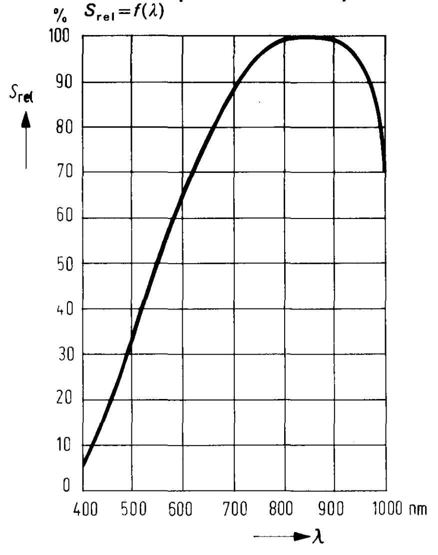
Temperature dependence of V_L
$\frac{V_L}{V_{L25}} = f(T_{amb})$
BPY 45, BPY 47, BPY 48



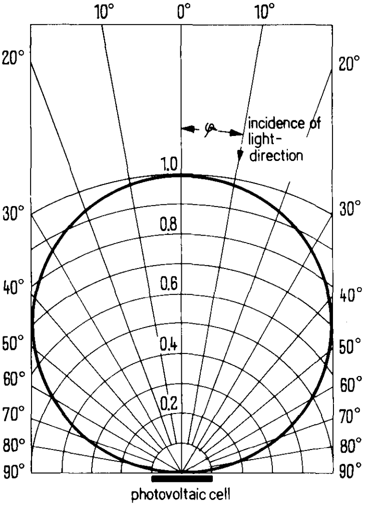
Temperature dependence of I_K
$\frac{I_K}{I_{K25}} = f(T_{amb})$
BPY 45, BPY 47, BPY 48



Relative spectral sensitivity
$S_{rel} = f(\lambda)$



Directional characteristic $I_K = f(\varphi)$

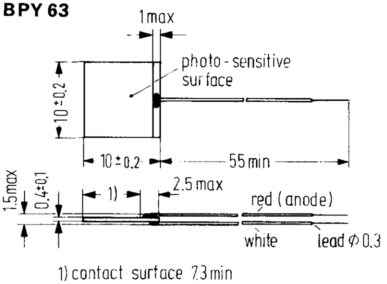


Silicon photo-voltaic cells

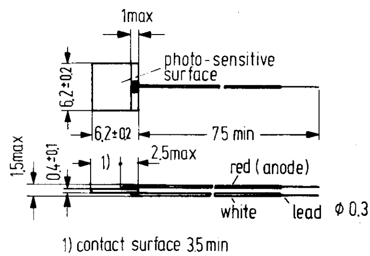
Silicon photo-voltaic cells BPY 63 and BPY 64 are suitable for universal application in control and regulating circuits. As with all silicon photo elements, they are primarily for use with incandescent lamps, but may be used with daylight as well.
Mounting instructions: see preface.

Type	Order number
BPY 63	Q 60215-Y 63
BPY 64	Q 60215-Y 64

BPY 63



BPY 64



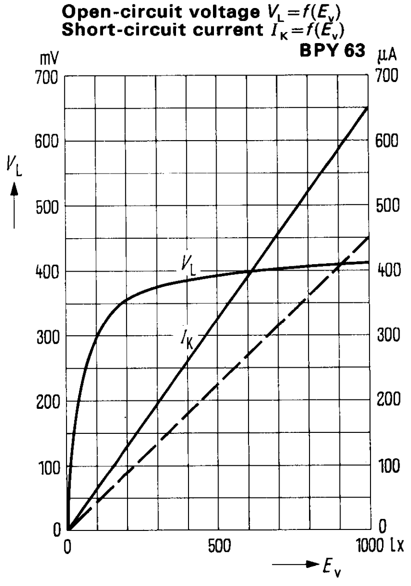
Weight approx. 0.5 g — Dimensions in mm — Weight approx. 0.2 g

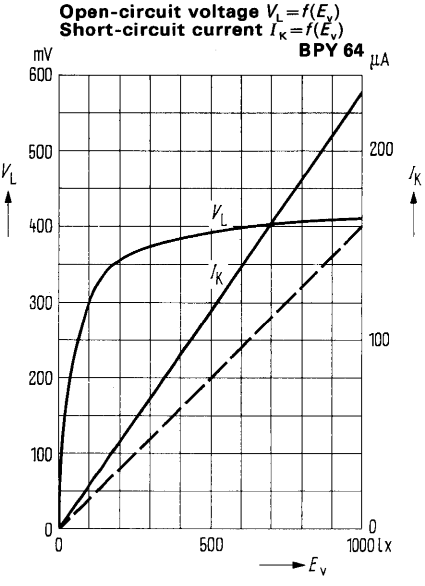
Maximum ratings		BPY 63	BPY 64	
Temperature range	T_{amb}	−55 to +125	−55 to +125	°C
Reverse voltage[1]	V_R	1.0	1.0	V

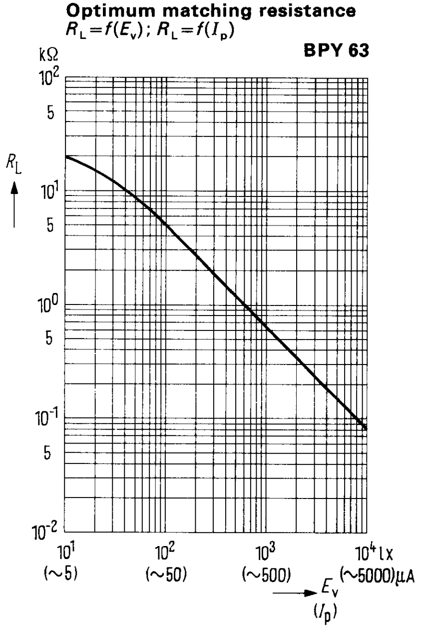
Characteristics (T_{amb} = 25 °C)

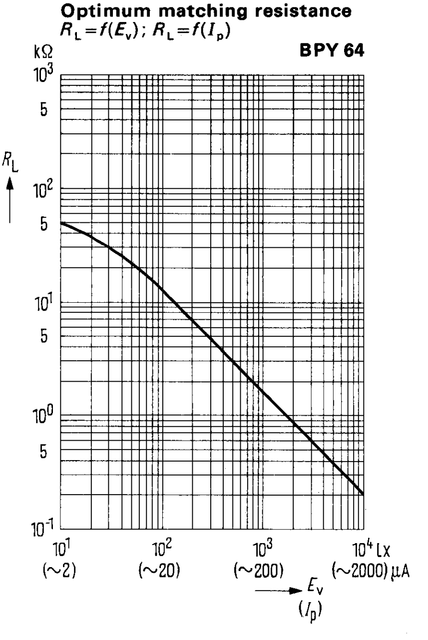
		BPY 63	BPY 64	
Open-circuit voltage (E_v = 10000 lx)[2]	V_L	≧450	≧450	mV
Open-circuit voltage (E_v = 1000 lx)[2]	V_L	≧280	≧280	mV
Open-circuit voltage (E_v = 100 lx)[2]	V_L	≧150	≧150	mV
Photo sensitivity[2] (short-circuit current I_K)	S	0.65 (≧0.45)	0.23 (≧0.16)	µA/lx
Max. photo sensitivity	λ_{smax}	0.85	0.85	µm
Light sensitive area	A	approx. 0.9	approx. 0.32	cm²
Temperature coefficient of V_L (see diagram)	TC	−2.6	−2.6	mV/K
Temperature coefficient of I_K (see diagram)	TC	approx. 0.121	approx. 0.121	%/K
Capacitance (V_R = 0 V)	C_0	10	4	nf

[1]) The plus pole of the voltage source is to be connected to the white lead.
[2]) The illuminances indicated refers to an unfiltered radiation of a tungsten-filament lamp with a colour temperature of 2856 K.

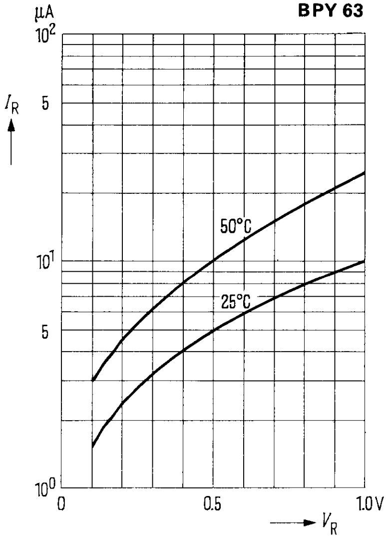

Open-circuit voltage $V_L = f(E_v)$
Short-circuit current $I_K = f(E_v)$
BPY 63
mV
μA
V_L
I_K
0
100
200
300
400
500
600
700
0
500
1000 lx
E_v


Open-circuit voltage $V_L = f(E_v)$
Short-circuit current $I_K = f(E_v)$
BPY 64
mV
μA
V_L
I_K
0
100
200
300
400
500
600
0
100
200
0
500
1000 lx
E_v

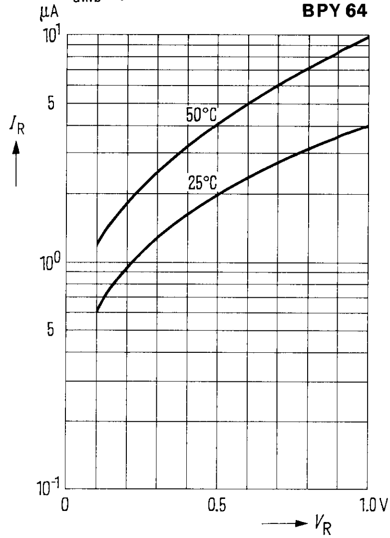

Optimum matching resistance
$R_L = f(E_v)$; $R_L = f(I_p)$
BPY 63
kΩ
R_L
10^{2}
5
10^{1}
5
10^{0}
5
10^{-1}
5
10^{-2}
10^{1}
(~5)
10^{2}
(~50)
10^{3}
(~500)
10^{4} lx
(~5000) μA
E_v
(I_p)


Optimum matching resistance
$R_L = f(E_v)$; $R_L = f(I_p)$
BPY 64
kΩ
R_L
10^{3}
5
10^{2}
5
10^{1}
5
10^{0}
5
10^{-1}
10^{1}
(~2)
10^{2}
(~20)
10^{3}
(~200)
10^{4} lx
(~2000) μA
E_v
(I_p)

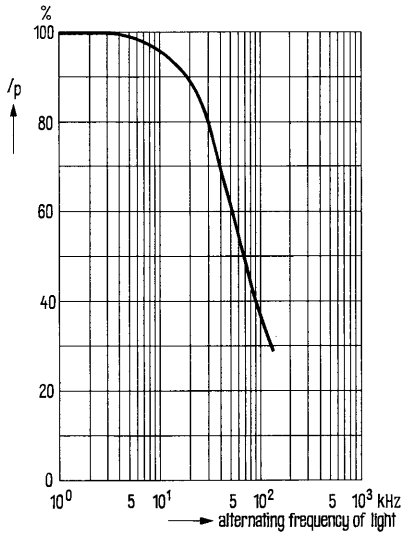
Dark current $I_R = f(V_R)$
T_{amb} = parameter



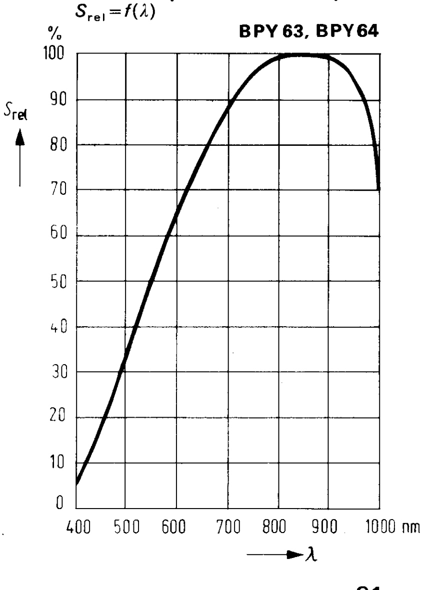
Dark current $I_R = f(V_R)$
T_{amb} = parameter

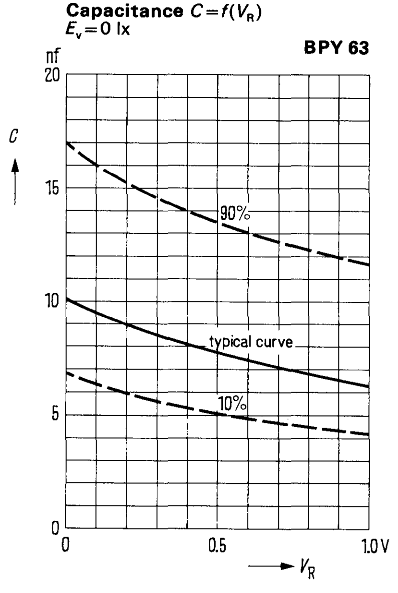


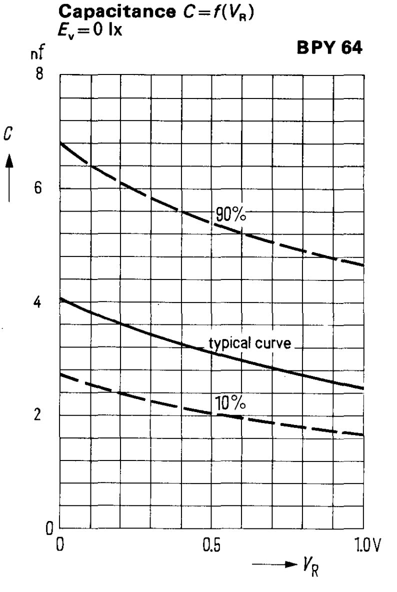
Mean photo current vs. light alternating frequency
$R_L = 100\ \Omega$; $E_v = 1000$ lx **BPY 63**,
$R_L = 250\ \Omega$; $E_v = 1000$ lx **BPY 64**

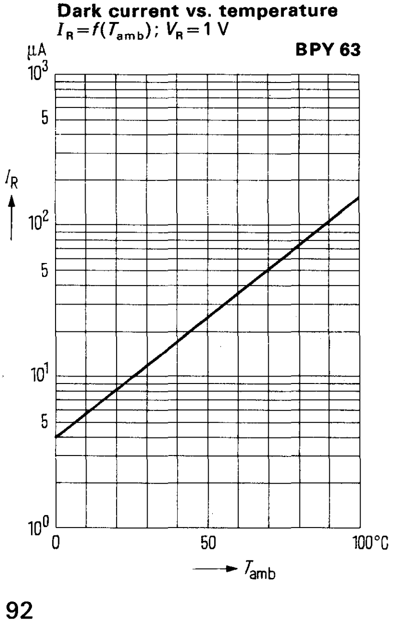


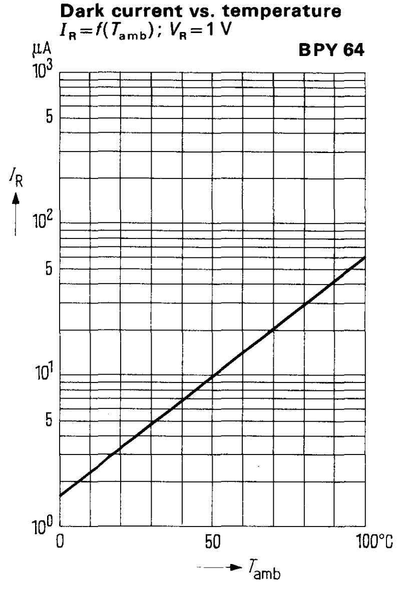
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



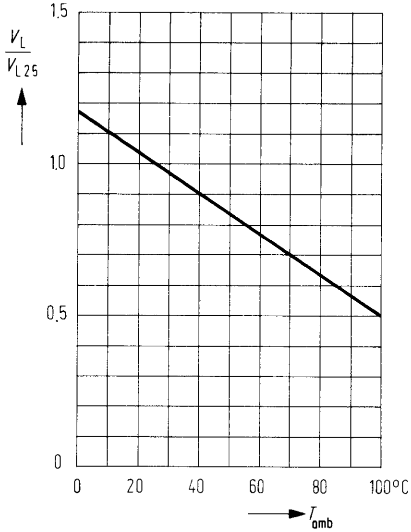

Capacitance $C=f(V_R)$
$E_v=0$ lx
BPY 63
nf
20
15
10
5
0
C
90%
typical curve
10%
0
0.5
1.0 V
V_R


Capacitance $C=f(V_R)$
$E_v=0$ lx
BPY 64
nf
8
6
4
2
0
C
90%
typical curve
10%
0
0.5
1.0 V
V_R

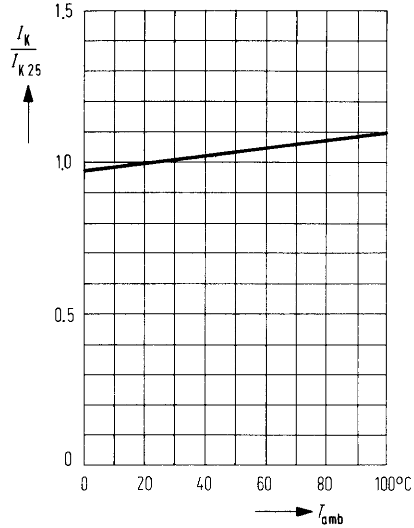

Dark current vs. temperature
$I_R=f(T_{amb})$; $V_R=1$ V
BPY 63
µA
10^3
5
I_R
10^2
5
10^1
5
10^0
0
50
100°C
T_{amb}


Dark current vs. temperature
$I_R=f(T_{amb})$; $V_R=1$ V
BPY 64
µA
10^3
5
I_R
10^2
5
10^1
5
10^0
0
50
100°C
T_{amb}

Temperature dependence of V_L
$\frac{V_L}{V_{L25}} = f(T_{amb})$
BPY 63, BPY 64



Temperature dependence of I_K
$\frac{I_K}{I_{K25}} = f(T_{amb})$
BPY 63, BPY 64

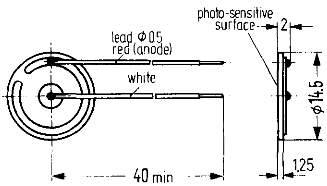


Silicon photo-voltaic cells

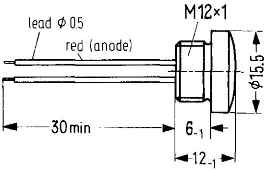
Silicon photo-voltaic cells TP 60 and TP 61 are suitable for use in regulating and control circuits. Displaying uniform electrical characteristics, they differ only in design. The anode (positive pole of the cell) is marked by a red lead.
Mounting instructions: see preface silicon photo voltaic cells.

Type	Order number
TP 60	Q 62607-S 60
TP 61	Q 62607-S 61

TP 61



TP60



Weight approx. 1 g — Dimensions in mm — Weight approx. 20 g

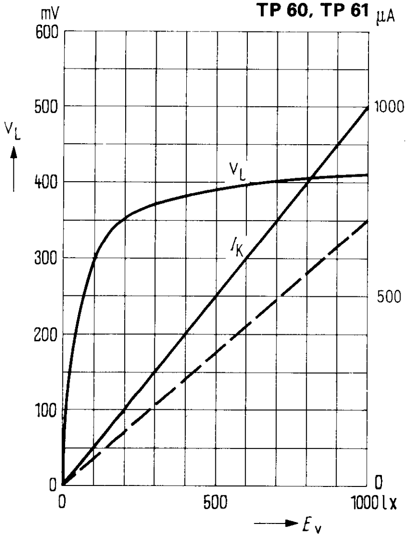
Maximum ratings		**TP 60**	**TP 61**	
Operating and storage temperature	T_{amb}	−25 to +75	−25 to +100	°C
Reverse voltage²)	V_R	1.0	1.0	V

Characteristics (T_{amb} = 25 °C)

Open-circuit voltage at E_v = 10000 lx¹)	V_L	≧440	mV
Open-circuit voltage at E_v = 1000 lx¹)	V_L	≧270	mV
Open-circuit voltage at E_v = 100 lx¹)	V_L	≧140	mV
Short-circuit current at E_v = 10000 lx¹)	I_K	≧7	mA
Short-circuit current at E_v = 1000 lx¹)	I_K	≧0.7	mA
Spectral sensitivity (Short-circuit current)	S	1 (≧0.7)	µA/lx
Wavelength of max. spectral sensitivity E_S	λ_{Smax}	0.85	µm
Limit of infrared sensitivity	λ_g	1.1	µm
Tolerance of photo-sensitive area	A-Tol.	±0.1	cm²
Size of photo-sensitive area	A	1.5	cm²
Temperature coefficient of V_L	TC	−2.6	mV/K
Temperature coefficient of I_K	TC	0.12	%/K
Capacitance (V_R = 0 V)	C_0	20	nf

¹) The illuminances indicated refers to the unfiltered radiation of a tungsten filament lamp with a colour temperature of 2856 K (standard light A acc. to DIN 5033).
²) The positive voltage is to be connected with the white lead.

Open-circuit voltage and short-circuit current versus illumination intensity
$V_L = f(E_v)$; $I_K = f(E_v)$



Typical frequency dependence of photo current of silicon photo-voltaic cells $E_v = 1000$ lx $R_L = 50\ \Omega$

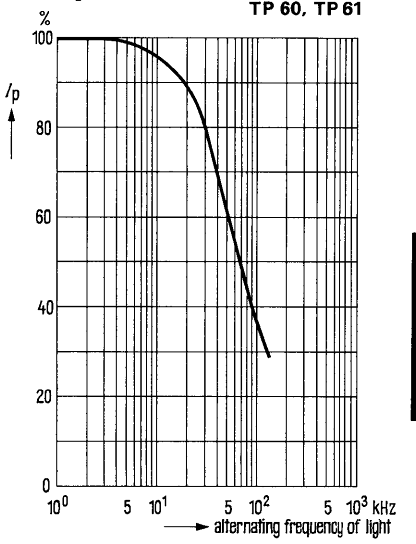


Photo voltage versus short-circuit current $V_p = f(I_K)$; R_L = parameter

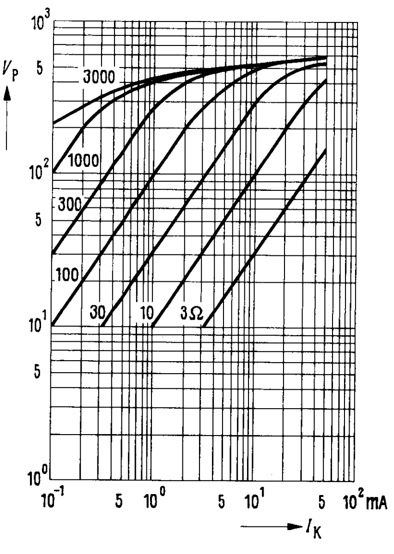
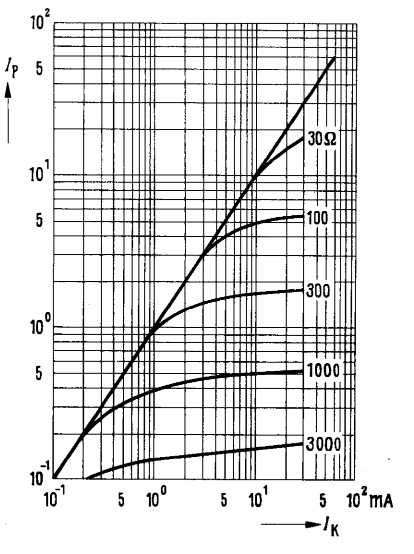
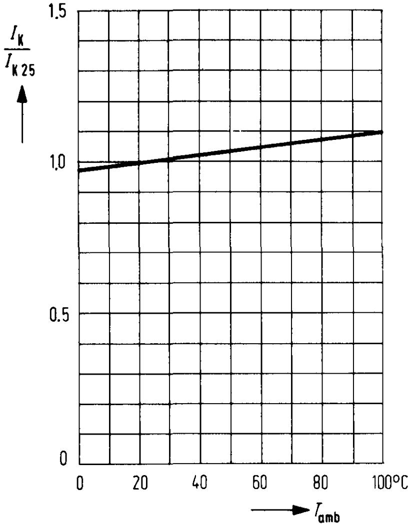


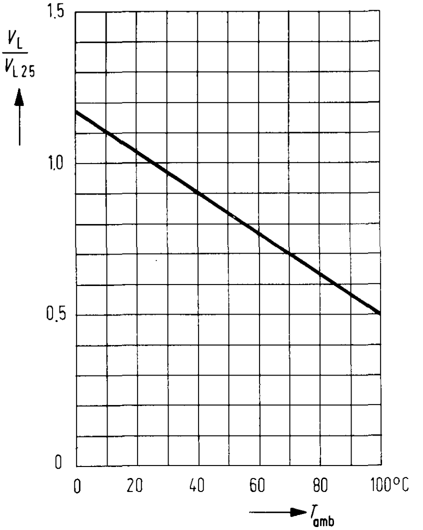
Photo versus short-circuit current $I_p = f(I_K)$; R_L = parameter



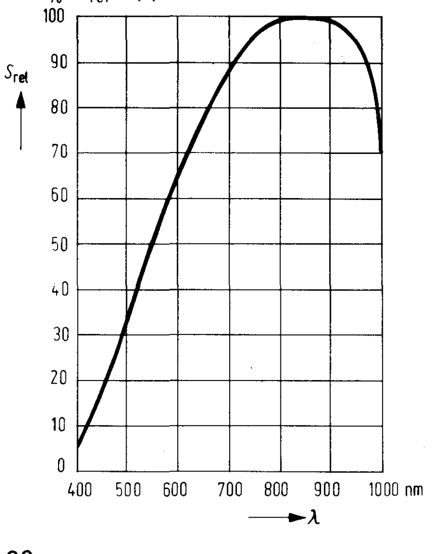
Temperature dependence
$\frac{I_K}{I_{K25}} = f(T_{amb})$



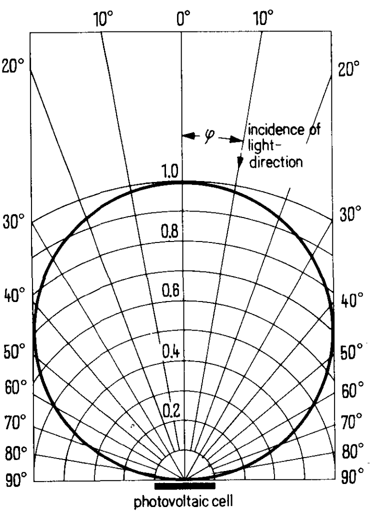
Temperature dependence
$\frac{V_L}{V_{L25}} = f(T_{amb})$



Relative spectral sensitivity
$S_{rel} = f(\lambda)$



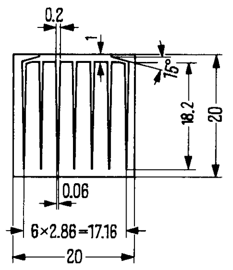
Directional characteristic
$I_K = f(\varphi)$



Silicon solar element

BPY 73 is a silicon solar element and is particularly suited for the assembly of solar batteries permitting the conversion of sunlight into electrical energy. The resistivity is 10 Ω cm. The contacts are made of palladium-titanium silver. Due to the n to p method a high resistivity against highly energetic particles, such as electrons and protons, is achieved. The spectral sensitivity of the solar cell is increased by an anti-reflex coating of the surface.

Type	Order number
BPY 73	Q 62702-P 13

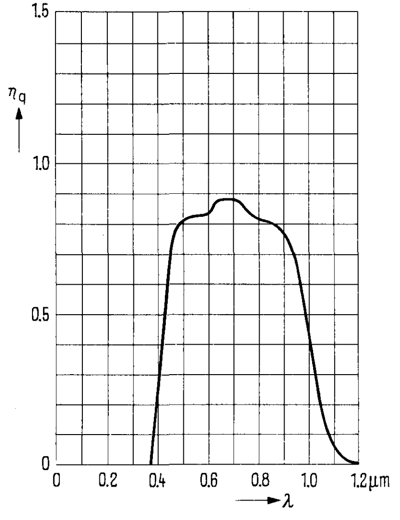


Weight approx. 280 (+20−10) mg
Dimensions in mm

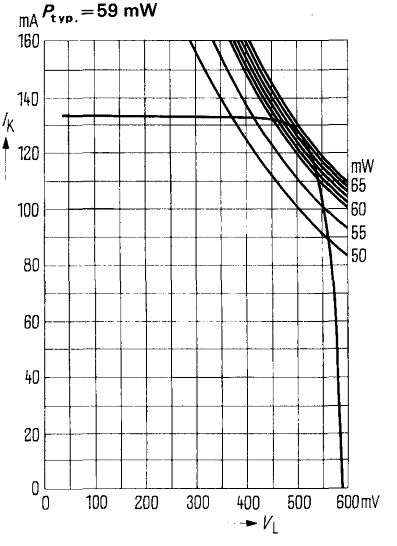
Maximum ratings		**BPY 73**	
Temperature range	T_{amb}	−40 to +80	°C
Characteristics (T_{amb}=28 °C)[1]			
Open-circuit voltage	V_L	≧535	mV
Short-circuit current	I_K	≧137	mA
Wavelength of max. quantum yield	$\lambda_{\eta max}$	approx. 0.7	µm
Light sensitive area	A	3.72±0.04	cm^2
Power output for optimum matching	P	≧57.5	mW
Degradation of power output by radiation of 10^{15} electrons per cm^2		25	%
Specific resistance of the substrate material	ϱ	10±3	Ωcm
Temperature coefficient of V_L	TC	−2.2	mV/K
Temperature coefficient of I_K	TC	+0.07	mA/K

[1]) The electrical characteristics of the solar cells are measured by a lighting equivalent to extraterrestrial sun radiation (AMO). The short-circuit current, which the characteristic measurements are based on, is determined (valid also for different degradation levels) by the quantum yield and the extraterrestrial solar spectrum (Johnson method).

Quantum yield for solar cells
$\eta_q = f(\lambda)$



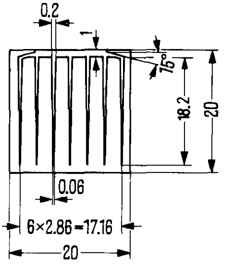
Current and voltage characteristics for solar cells
$P_{typ.} = 59$ mW



Silicon solar element

BPY 74 is a silicon solar element and is particularly suited for the assembly of solar batteries permitting a conversion of sunlight into electrical energy. The resistivity amounts to 1 Ωcm. The contacts consist of palladium-titanium silver. Due to the n to p technique a high resistivity against highly energetic particles, such as electrons and protons, is achieved. The spectral sensitivity of the solar cell is increased by an anti-reflex coating of the surface. BPY 74 was specially developed for missions near to the sun. It may be used up to temperatures of 200 °C.

Type	Order number
BPY 74	Q 62702-P 14

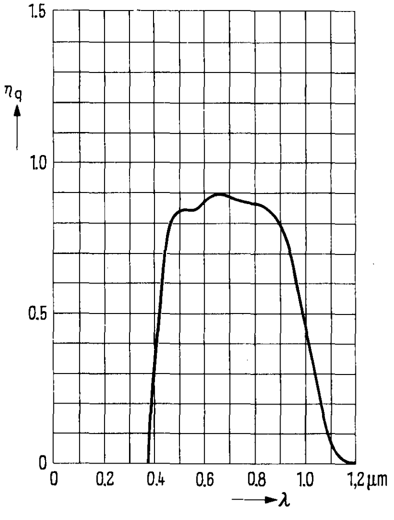


Weight approx. 280 (+20−10) mg
Dimensions in mm

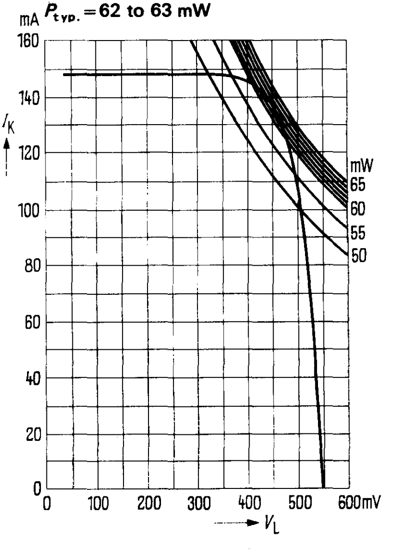
Maximum ratings		**BPY 74**	
Temperature range	T_{amb}	−80 to +215	°C
Characteristics (T_{amb}=28 °C) [1]			
Open-circuit voltage	V_L	≧585	mV
Short-circuit current	I_K	≧130	mA
Wavelength of max. quantum yield	$\lambda_{\eta max}$	approx. 0.7	µm
Light sensitive area	A	3.72±0.04	cm^2
Power output for optimum matching	P	≧61.0	mW
Degradation of power output by radiation of 10^{15} electrons per cm^2		26	%
Specific resistance of the substrate material	ϱ	1±0.3	Ωcm
Temperature coefficient of V_L	TC	−2.15	mV/K
Temperature coefficient of I_K	TC	+0.046	mA/K

[1]) The electrical characteristics of the solar cells are measured by a lighting equivalent to the extraterrestrial sun radiation. The short-circuit current, which the characteristic measurements are based on, is determined (valid also for different degradation levels) by the quantum yield and the extraterrestrial solar spectrum (Johnson method).

Quantum yield for solar cells
$\eta_q = f(\lambda)$



Current and voltage characteristics for solar cells
$P_{typ.} = 62$ to 63 mW



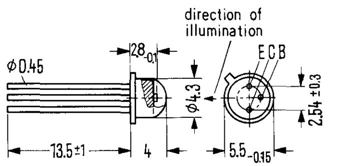
Silicon Photo Transistors

BP 101

NPN silicon planar photo transistor

BP 101 is an epitaxial NPN silicon planar photo-transistor. The epoxy sealed light-window shows a panorama effect. To reduce this effect a diaphragm can be mounted. The emitter lead is marked by a small projection at the case bottom. The collector lead is electrically connected to the metallic parts of the case. The photo-transistor is particularly suitable for automatic electronic flashes and electronic toys. It can be used at incandescent – and daylight.

Type	Order number
BP 101 I	Q 62702-B 28
BP 101 II	Q 62702-B 35
BP 101 III	Q 62702-B 29
BP 101 IV	Q 62702-P 12-S 1



Weight approx. 0.5 g   Dimensions in mm

Maximum ratings		**BP 101**	
Collector-emitter-voltage	V_{CEO}	32	V
Emitter-base-voltage	V_{EBO}	5	V
Collector current	I_C	25	mA
Junction temperature	T_j	125	°C
Storage temperature	T_S	−55 to +80	°C
Max. permissible soldering temperature ($t<5$ s)	T_L	245	°C
Total power Dissipation ($T_{amb}=25$ °C)	P_{tot}	200	mW

Characteristics ($T_{amb}=25$ °C)

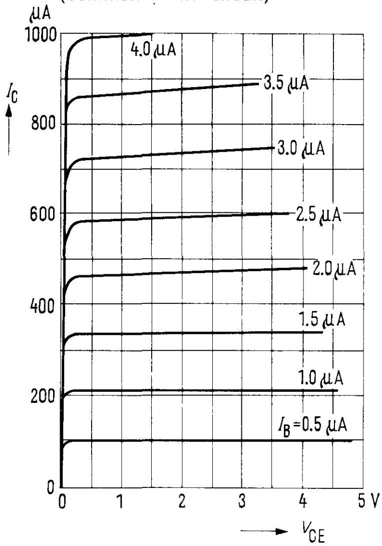
Collector-emitter cutoff current at $V_{CE}=30$ V; $E_V=0$ lx	I_{CEO}	5 (<100)	nA
Collector-emitter saturation voltage ($I_C=500$ µA; $I_B=25$ µA; $E_V=0$ lx)	V_{CEsat}	0.15 (<0.4)	V
Spectral sensitivity of photo-current ($S \geqq 0.1\ S_{max}$)	λ	0.45 to 1.0	µm
Wavelength of max. photosensitivity	$\lambda_{S\,max}$	0.78	µm
Rise time from 10% to 90% of the final value Fall time from 90% to 10% of the initial value ($R_L=1$ kΩ)[2]	t_r, t_f	5 (<10)	µs

Photo transistors are grouped in accordance with their photo sensitivity and characterized by Roman numerals.

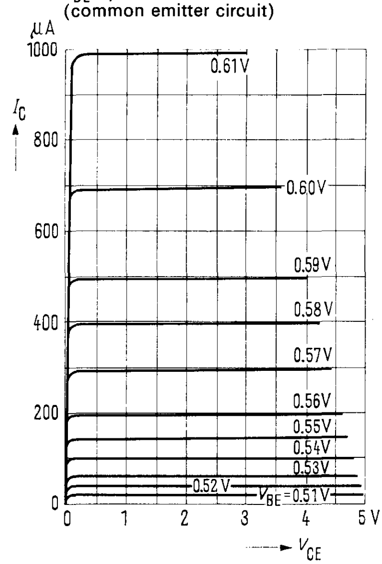
Type		BP 101				
Group		I	II	III	IV	
Photo current ($V_{CE}=5$ V; $E_V=1000$ lx; base open)[1]	I_P	63 to 125	100 to 200	160 to 320	250 to 500	µA

[1]) The illuminances refer to the unfiltered radiation of a tungsten lamp at a colour temperature of 2856 K.
[2]) Measured with LED's $\lambda=930$ nm.

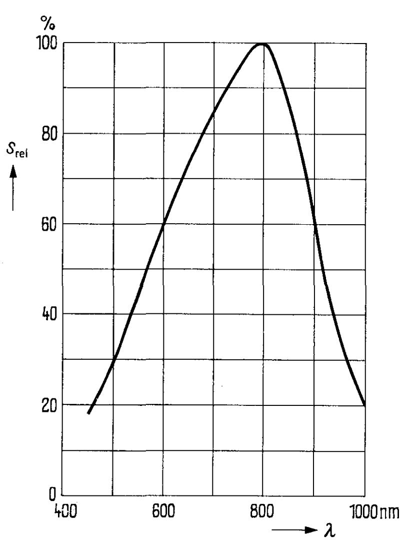
Output characteristics $I_C = f(V_{CE})$
I_B = parameter
(common emitter circuit)



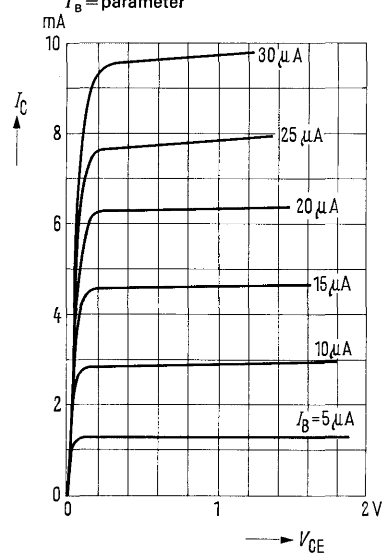
Output characteristics $I_C = f(V_{CE})$
V_{BE} = parameter
(common emitter circuit)



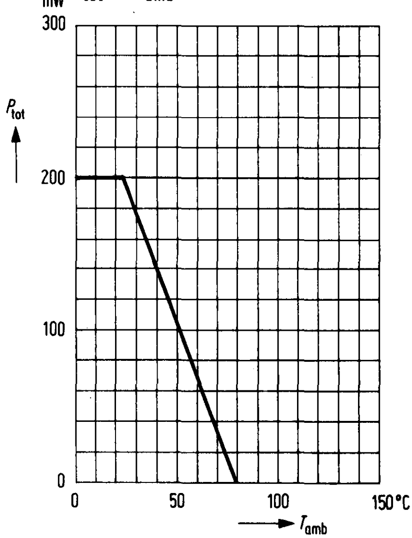
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



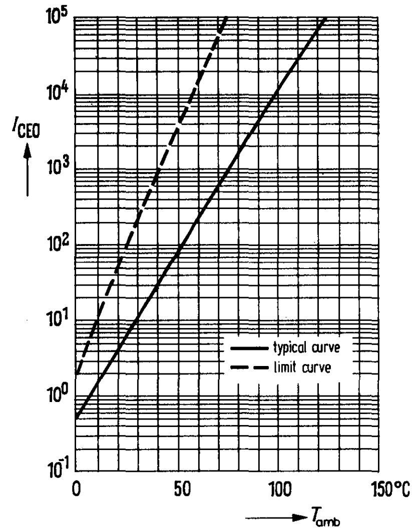
Output characteristics $I_C = f(V_{CE})$
I_B = parameter



Total power dissipation
$P_{tot} = f(T_{amb})$



Collector-emitter cutoff current $I_{CEO} = f(T_{amb})$
$V_{CE} = 25$ V; $E_v = 0$ lx



Collector-emitter cutoff current $I_{CEO} = f(V_{CE})$
T_{amb} = parameter; $E_v = 0$ lx

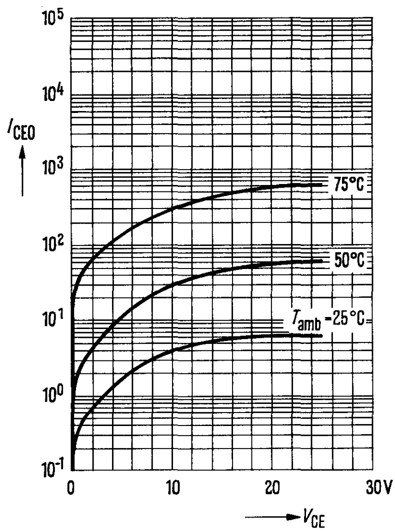
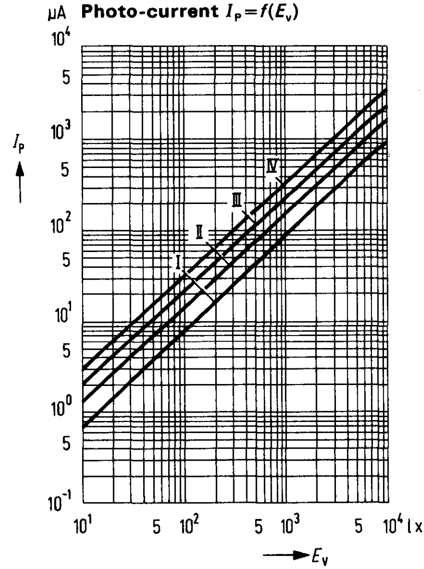
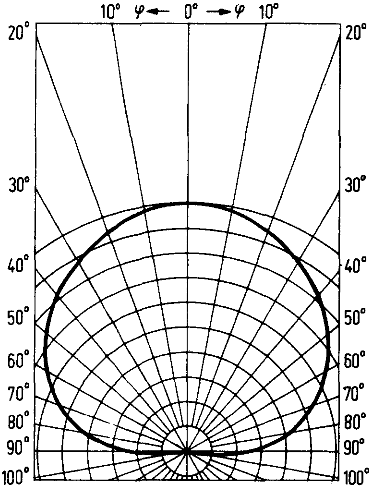


Photo-current $I_P = f(E_v)$



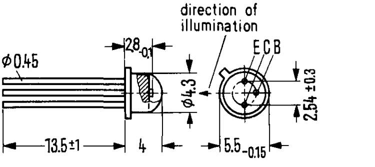
Directional characteristic $I_P = f(\varphi)$



NPN silicon planar photo transistor

BP 102 is an epitaxial NPN silicon planar photo transistor. The epoxy sealed light-window shows a panorama effect which may be reduced at will by mounting a diaphragm. The emitter lead is marked by a stud at the case bottom. The collector is electrically connected to the metallic parts of the case. The photo transistor is particularly suitable for use in computer flashes and high-quality electronic demonstration equipment using incandescent and daylight as well as in combination with GaAs light-emitting diodes in small light barriers.

Type	Order number
BP 102/I	Q 62702-P 23-S 1
BP 102/II	Q 62702-P 23-S 2
BP 102/III	Q 62702-P 23-S 3
BP 102/IV	Q 62702-P 23-S 4



Weight approx. 0.5 g Dimensions in mm

Maximum ratings		BP 102	
Collector-emitter voltage	V_{CEO}	32	V
Emitter-base voltage	V_{EBO}	5	V
Collector current	I_C	25	mA
Junction temperature	T_j	80	°C
Storage temperature	T_S	−55 to +80	°C
Max. permissible soldering temperature ($t<5$ s)	T_L	245	°C
Total power Dissipation ($T_{amb}=25$ °C)	P_{tot}	200	mW

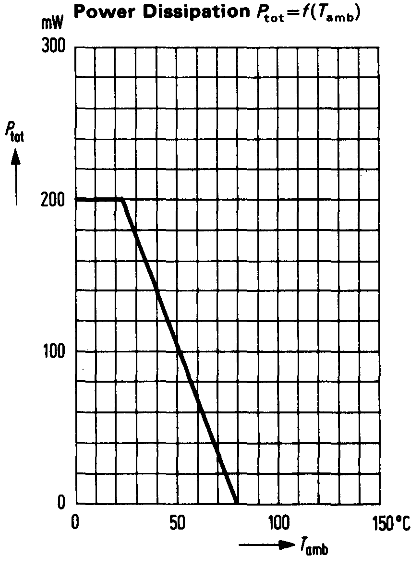
Characteristics ($T_{amb}=25\,°C$)		**BP 102**	
Collector-emitter cutoff current ($V_{CE}=30\,V$; $E_V=0\,lx$)	I_{CEO}	5 (<100)	nA
Collector-emitter saturation voltage ($I_C=500\,\mu A$; $I_B=25\,\mu A$; $E_V=0\,lx$)	V_{CEsat}	0.15 (<0.4)	V
Spectral range of photo sensitivity ($S>0.1\,S_{max}$)	λ	0.45 to 1.0	µm
Wavelength of max. photo sensitivity	λ_{Smax}	0.78	µm
Rise time from 10% to 90% of final value; Fall time from 90% to 10% of initial value ($R_L=1\,k\Omega$;) [2])	t_r; t_f	5 (<10)	µs

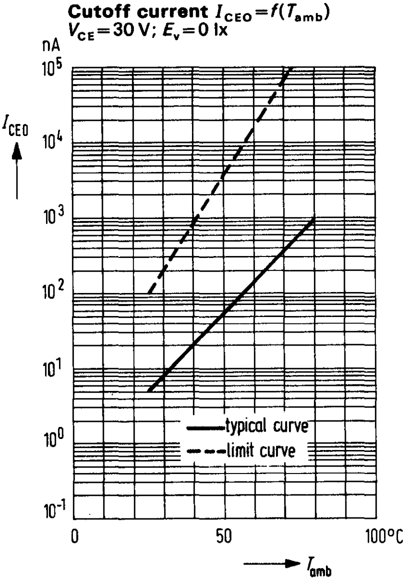
The photo transistors are grouped according to their photo sensitivity and denoted by Roman numerals.

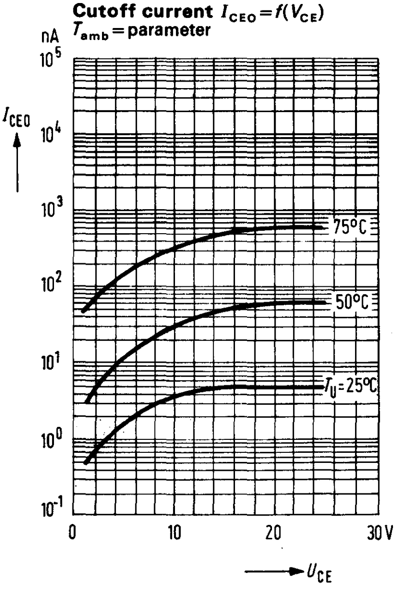
Group	I	II	III	IV	
Photo current I_P($V_{CE}=5\,V$; $E_V=1000\,lx$; base open) [1])	160 to 320	250 to 500	400 to 800	630 to 1250	µA

[1]) The illuminances indicated refers to the unfiltered radiation of a tungsten-filament lamp with a colour temperature of 2856 K

[2]) Measured with LED's $\lambda=930$ nm.


Power Dissipation $P_{tot} = f(T_{amb})$
mW
300
200
100
0
P_{tot}
0
50
100
150 °C
T_{amb}


Cutoff current $I_{CEO} = f(T_{amb})$
$V_{CE} = 30$ V; $E_v = 0$ lx
nA
10^5
10^4
10^3
10^2
10^1
10^0
10^{-1}
I_{CEO}
typical curve
limit curve
0
50
100°C
T_{amb}


Cutoff current $I_{CEO} = f(V_{CE})$
T_{amb} = parameter
nA
10^5
10^4
10^3
10^2
10^1
10^0
10^{-1}
I_{CEO}
75°C
50°C
$T_U = 25$°C
0
10
20
30 V
U_{CE}

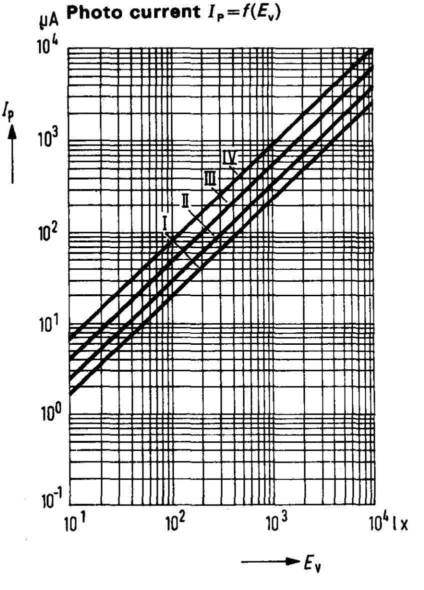
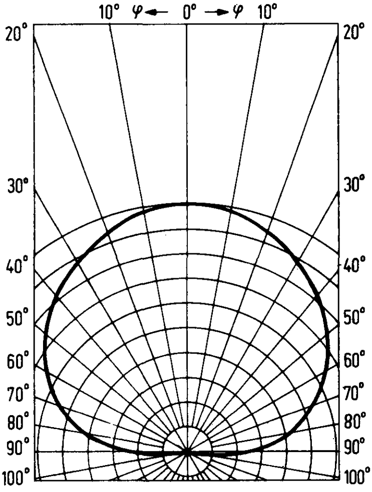
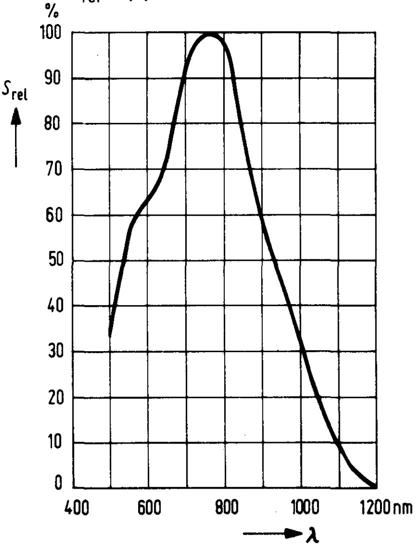


Photo current $I_P = f(E_v)$
μA
10^4
10^3
10^2
10^1
10^0
10^{-1}
I_P
I
II
III
IV
10^1
10^2
10^3
10^4 lx
E_v

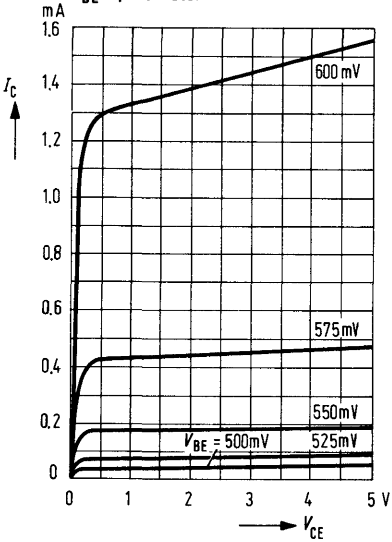
Directional characteristic $I_P = f(\varphi)$



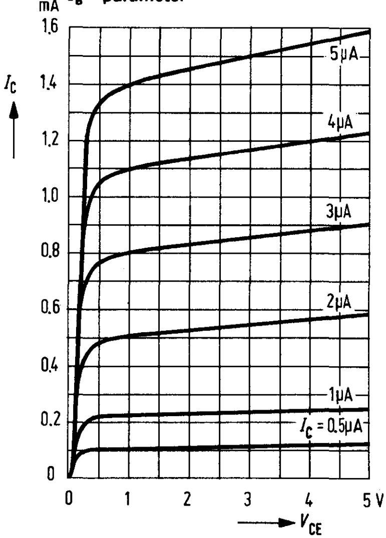
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



Output characteristics $I_C = f(V_{CE})$;
V_{BE} = parameter



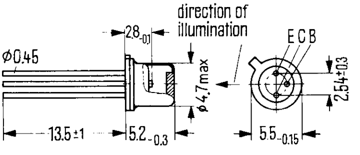
Output characteristics $I_C = f(V_{CE})$;
I_B = parameter



Silicon photo transistor

BPX 38 is an epitaxial NPN silicon planar photo transistor in a case 18 A 3 DIN 41876 (TO-18) with a plane light window and high photo sensitivity for frontal illumination. The plane light window has no bearing upon the beam path. It is therefore particularly suitable for industrial applications using lens systems. The collector lead is electrically connected to the case.

Type	Order number
BPX 38 I	Q62702-P15-S1
BPX 38 II	Q62702-P15-S2
BPX 38 III	Q62702-P15-S3
BPX 38 IV	Q62702-P15-S4



Weight approx. 1.5 g   Dimensions in mm

Maximum ratings		**BPX 38**	
Collector-emitter voltage	V_{CE}	25	V
Junction temperature	T_j	175	°C
Storage temperature	T_S	−55 to +125	°C
Power dissipation (T_{amb}=25 °C)	P_{tot}	300	mW
Thermal resistance			
Junction to air	R_{thJamb}	<450	K/W
Junction to case	$R_{thJcase}$	<150	K/W
Max. permissible soldering temperature (t<5 s)	T_L	245	°C

Characteristics (T_{amb}=25 °C)

Collector-emitter cutoff current (V_{CE}=25 V; E_V=0 lx)	I_{CEO}	100 (<500)	nA
Spectral range of photo sensitivity (S>0.1S_{max})	λ	0.45 to 1.0	µm
Wavelength of max. photo sensitivity	λ_{Smax}	0.8	µm
Collector-emitter saturation voltage (I_C=1 mA; I_B=50 µA; E_V=0 lx)	V_{CEsat}	0.3	V

The photo transistors are classified in groups of photo sensitivity and identified by Roman numerals.

Type	BPX 38				
Group	I	II	III	IV	
Photo current (V_{CE}=5 V; E_v=1 000 lx)[1] I_p	0.4 to 0.8	0.63 to 1.25	1.0 to 2.0	1.6 to 3.2	mA

[1]) The illuminances stated refers to the unfiltered radiation of a tungsten-filament lamp with a colour temperature of 2856 K

Photo current $I_p = f(T)$

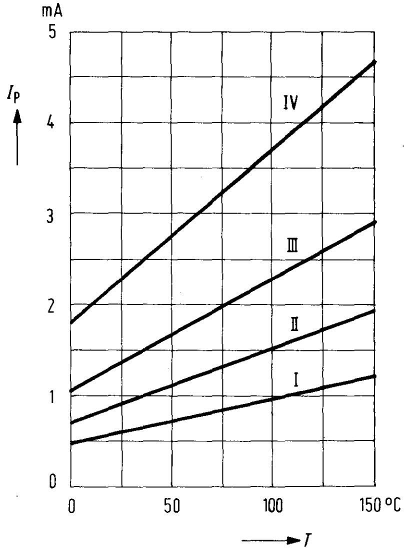
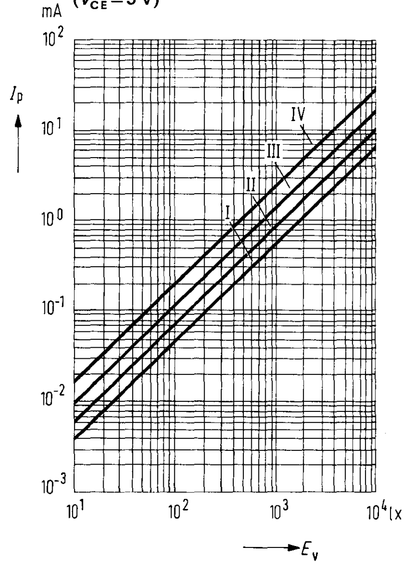
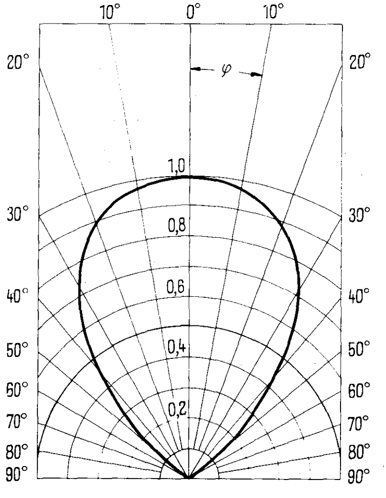


Photo current $I_p = f(E_v)$; ($V_{CE} = 5$ V)



Relative photo sensitivity as a function of the angle of light incidence φ referred to a vertical light incidence $I_p = f(\varphi)$



Relative spectral sensitivity $S_{rel} = f(\lambda)$

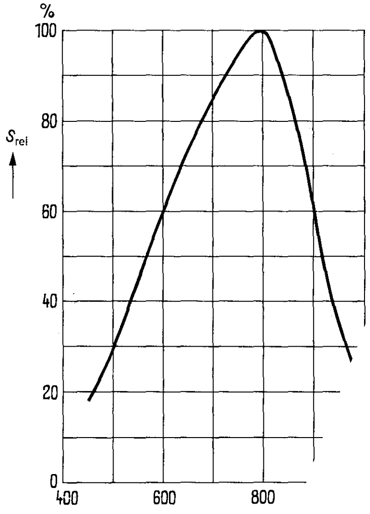
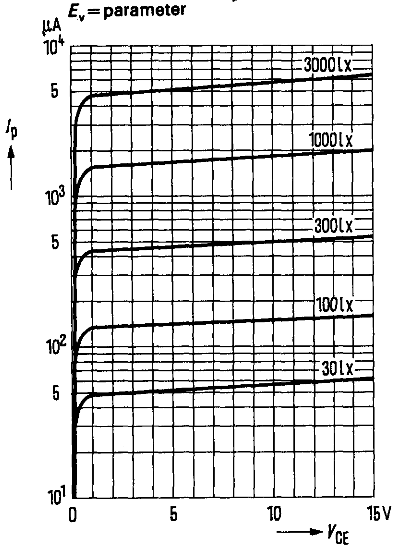
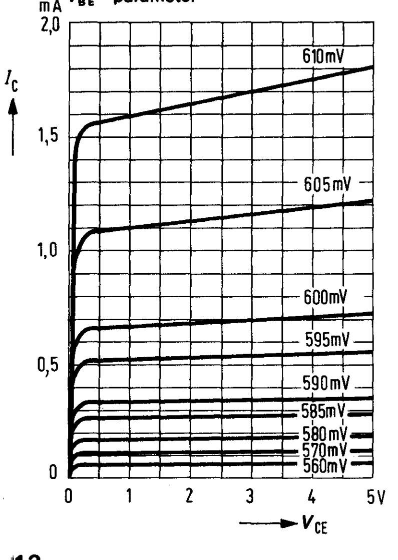


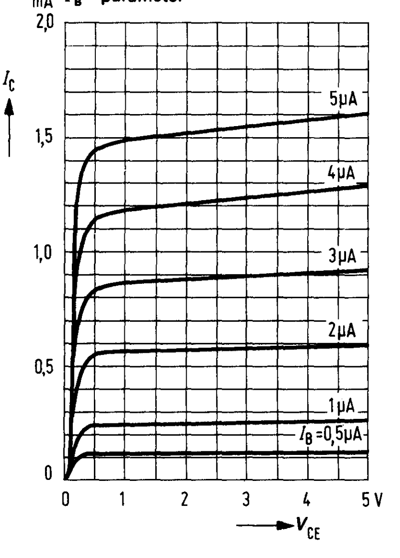
Photo current vs. collector-emitter voltage $I_p = f(V_{CE})$
E_v = parameter



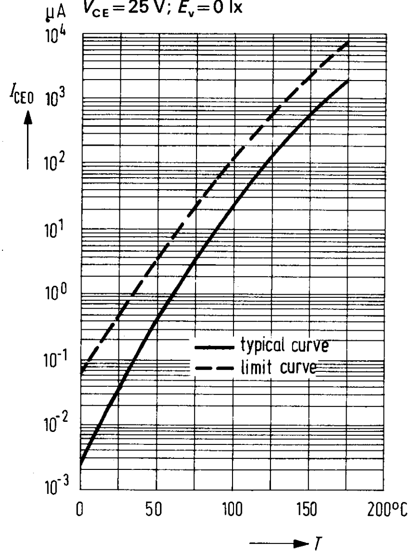
Collector current $I_C = f(V_{CE})$
V_{BE} = parameter



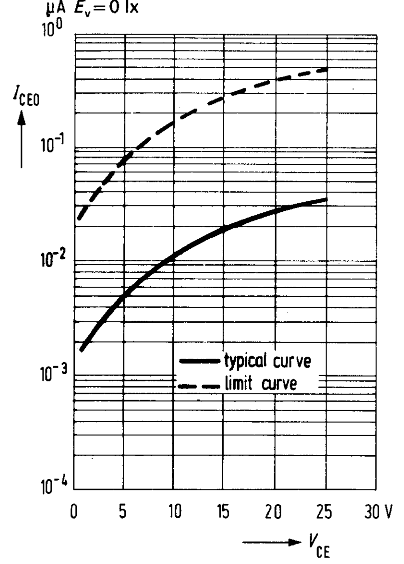
Collector current $I_C = f(V_{CE})$
I_B = parameter



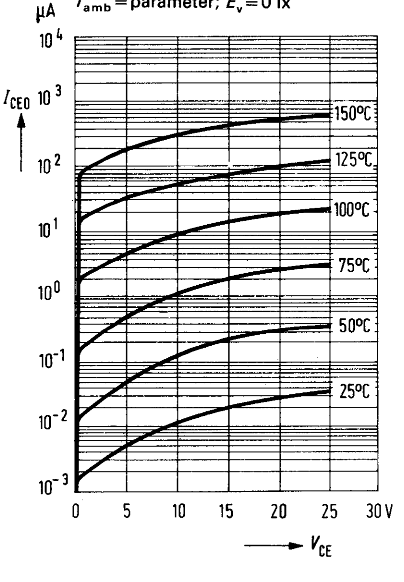
Dark current $I_{CEO} = f(T_{amb})$
$V_{CE} = 25\,V$; $E_v = 0\,lx$



Dark current $I_{CEO} = f(V_{CE})$
$E_v = 0\,lx$



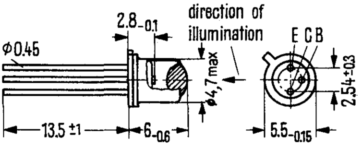
Dark current $I_{CEO} = f(V_{CE})$
T_{amb} = parameter; $E_v = 0\,lx$



Silicon photo transistor

BPX 43 is an epitaxial NPN silicon planar photo transistor in a case 18 A 3 DIN 41876 (TO-18) having a lens-type light window for frontal illumination. The special transistor system together with the lens-type light window ensure a particularly high photo sensitivity. The photo transistor is therefore suitable for industrial applications using low illumination intensities. The collector lead is electrically connected to the case.

Type	Order number
BPX 43 I	Q 62702-P16-S1
BPX 43 II	Q 62702-P16-S2
BPX 43 III	Q 62702-P16-S3
BPX 43 IV	Q 62702-P16-S4



Weight approx. 1.5 g Dimensions in mm

Maximum ratings		BPX 43	
Collector-emitter voltage	V_{CEO}	50	V
Emitter-base voltage	V_{EBO}	5	V
Junction temperature	T_j	175	°C
Storage temperature	T_S	−55 to +125	°C
Power dissipation (T_{amb}=25 °C)	P_{tot}	300	mW
Thermal resistance			
Junction to air	R_{thJamb}	<450	K/W
Junction to case	$R_{thJcase}$	<150	K/W
Max. permissible soldering temperature (t<5 s)	T_L	245	°C

Characteristics (T_{amb}=25 °C)			
Collector-emitter cutoff current (V_{CE}=50 V; E_v=0 lx)	I_{CEO}	5 (<200)	nA
Spectral range of photo sensitivity (S>0.1 S_{max})	λ	0.45 to 1.0	µm
Wavelength of max. photo sensitivity	λ_{Smax}	0.87	µm
Collector-emitter saturation voltage (I_C=1 mA; I_B=50 µA; E_v=0 lx)	V_{CEsat}	0.15	V

Type	BPX 43				
Group	I	II	III	IV	
I_p (E_v=1000 lx)[1], V_{CE}=5 V) I_P	1.6 to 3.2	2.5 to 5.0	4.0 to 8.0	6.3 to 12.5	mA
h_{FE} (2 mA/5 V)	65	100	160	250	
V_{CEsat} (1 mA/50 µA)	175	175	160	140	mV
t_r/t_f (V_{CE}=5 V; I_C=1 mA); R_L=1 kΩ)[2]	5	6	8	12	µs

[1]) The illuminances indicated refers to the unfiltered radiation of a tungsten-filament lamp with a colour temperature of 2856 K

[2]) Measured with LED's λ=930 nm.

Photo current $I_p = f(V_{CE})$
E_v = parameter

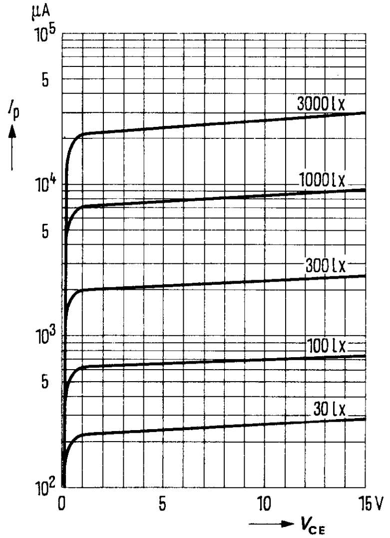
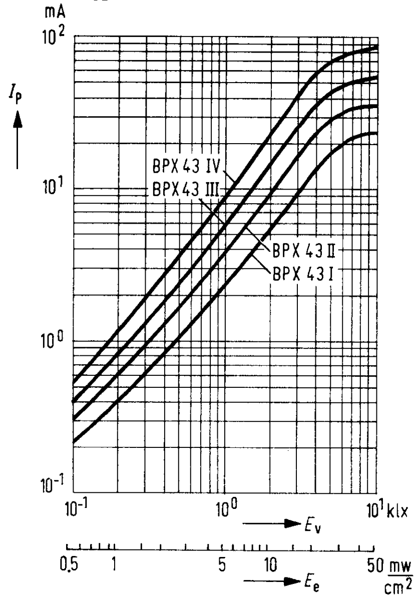
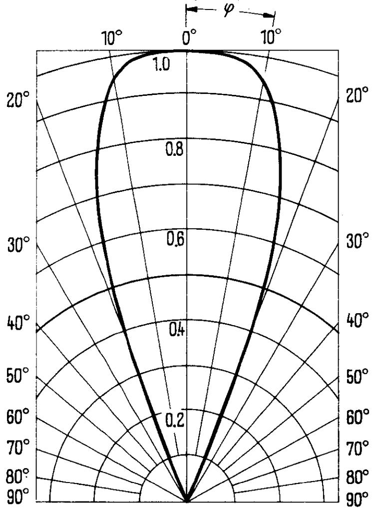


Photo current $I_p = f(E_v)$;
(V_{CE} = 5 V)



Relative photo sensitivity as a function of the angle of light incidence referred to vertical light incidence $I_p = f(\varphi)$



Relative spectral sensitivity
$S_{rel} = f(\lambda)$

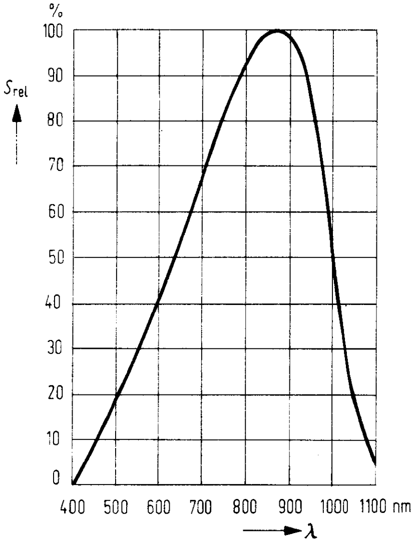
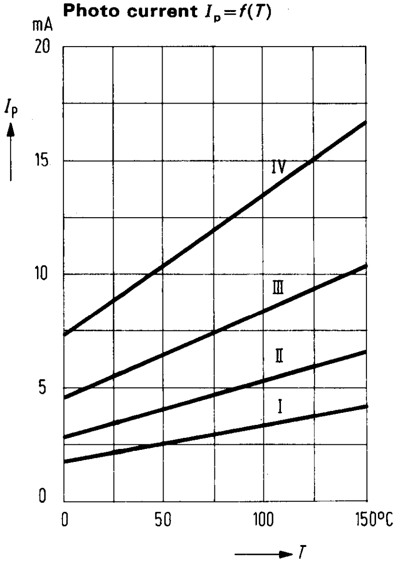
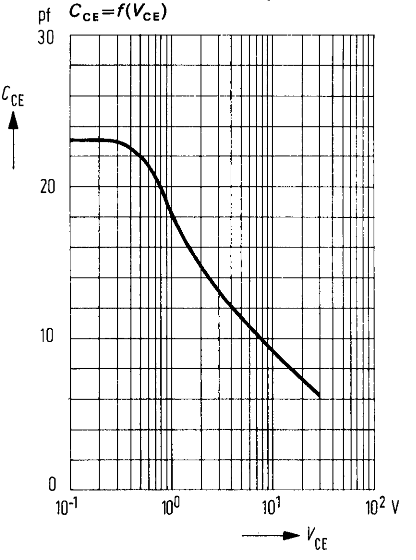


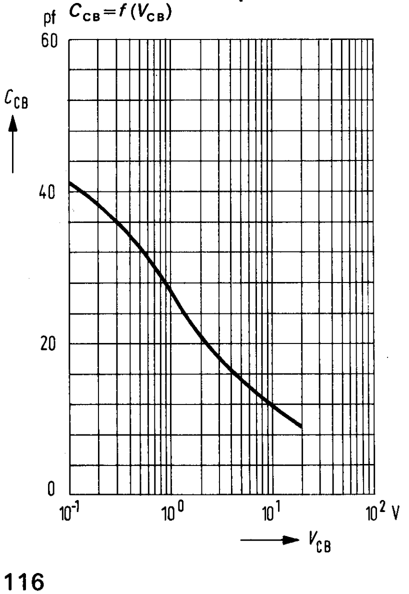
Photo current $I_p = f(T)$



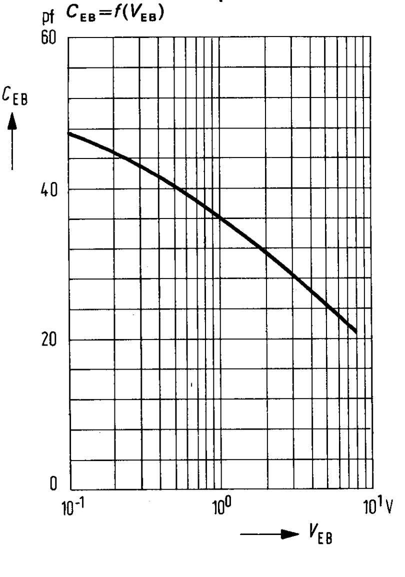
Collector-emitter capacitance
$C_{CE} = f(V_{CE})$

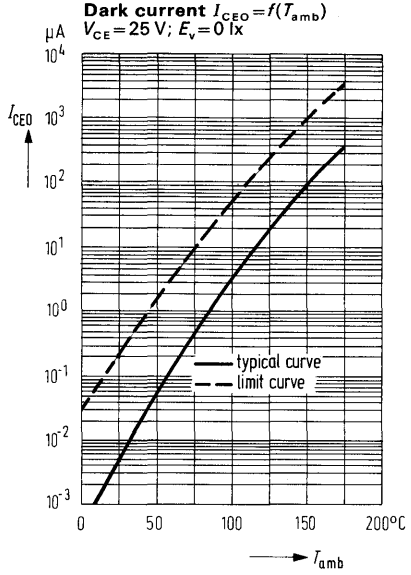


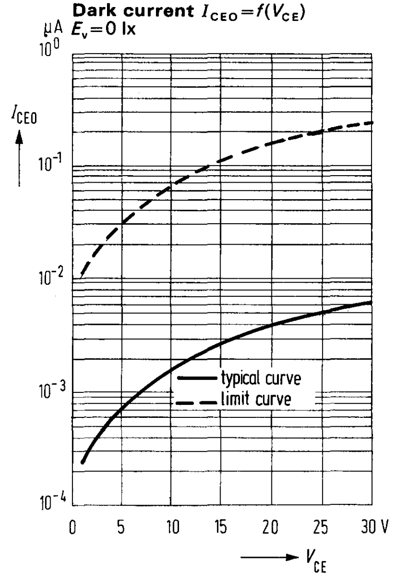
Collector-base capacitance
$C_{CB} = f(V_{CB})$

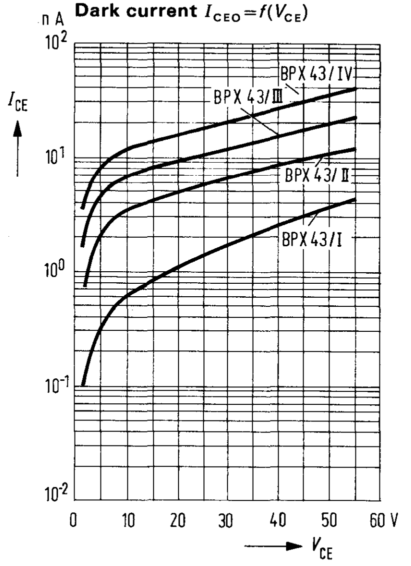


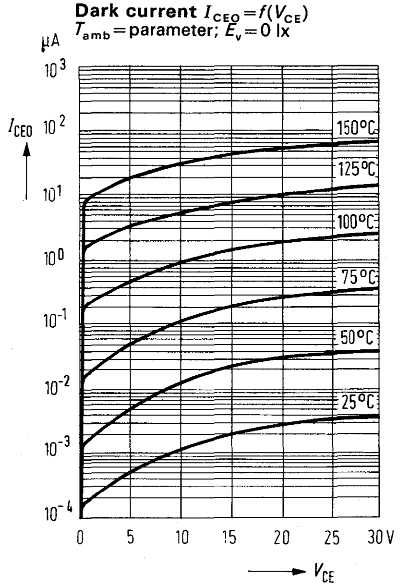
Emitter-base capacitance
$C_{EB} = f(V_{EB})$




Dark current $I_{CEO}=f(T_{amb})$
$V_{CE}=25$ V; $E_v=0$ lx
μA
I_{CEO}
10^4
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
typical curve
limit curve
0
50
100
150
200°C
T_{amb}


Dark current $I_{CEO}=f(V_{CE})$
$E_v=0$ lx
μA
I_{CEO}
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
typical curve
limit curve
0
5
10
15
20
25
30 V
V_{CE}

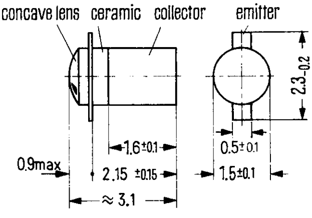

Dark current $I_{CEO}=f(V_{CE})$
nA
I_{CE}
10^2
10^1
10^0
10^{-1}
10^{-2}
BPX 43/IV
BPX 43/III
BPX 43/II
BPX 43/I
0
10
20
30
40
50
60 V
V_{CE}


Dark current $I_{CEO}=f(V_{CE})$
T_{amb}=parameter; $E_v=0$ lx
μA
I_{CEO}
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
150°C
125°C
100°C
75°C
50°C
25°C
0
5
10
15
20
25
30 V
V_{CE}

NPN Silicon photo transistor

BPX 62 is an epitaxial NPN silicon photo transistor of high sensitivity in a micro ceramic package. Because of the small case dimensions and the special lead arrangement this photo transistor is provided for incorporation in printed circuits, in particular, of space-saving one and two-dimensional optical scanning units. It is suitable for universal application with incandescent light and light-emitting diodes also in those cases where miniaturization, small mounting depth and high packing density are at a premium, e.g. for punched tape and card readers, path and angle scanners as well as reading systems for digital applications.

Type	Order number
BPX 62 I	Q 62702-P19-S1
BPX 62 II	Q 62702-P19-S2
BPX 62 III	Q 62702-P19-S3
BPX 62 IV	Q 62702-P19-S4



Weight approx. 1 g   Dimensions in mm

Maximum ratings (T_{amb} = 25 °C)		BPX 62	
Collector-emitter voltage	V_{CEO}	50	V
Emitter-base voltage	V_{EBO}	7	V
Junction temperature	T_j	125	°C
Storage temperature	T_S	−55 to +125	°C
Max. permissible soldering temperature ($t \leqq 3$ s)	T_L	230	°C
Power dissipation	P_{tot}	50	mW

Characteristics (T_{amb} = 25 °C)			
Collector-emitter cutoff current (V_{CE} = 25 V; E_v = 0 lx)	I_{CEO}	10 (≦100)	nA
Spectral sensitivity ($S > 0.1\ S_{max}$)	λ	450 to 1000	nm
Wavelength of max. photo sensitivity	λ_{Smax}	850	nm
Collector-emitter saturation voltage (I_C = 0.25 mA; E_v = 1000 lx) [1]	V_{CEsat}	0.3	V

Photo current A: V_{CE} = 5 V; E_v = 1000 lx [1]; B: V_{CE} = 5 V; E_e = 20 mW/cm2 [2]

Typ		BPX 62				
Group		I	II	III	IV	
A:	I_p	0.4 to 0.8	0.63 to 1.25	1.0 to 2.0	1.6 to 3.2	mA
B:	I_p approx.	2 to 4	3 to 6	4.5 to 9.0	7.5 to 15	mA

[1]) The illuminances indicated refers to the unfiltered radiation of a tungsten-filament lamp with a colour temperature of 2856 K

[2]) Measured by means of a hp Radiant Flux Meter 8334 A with option 013; cf. curve $I_p = f(E)$

Relative spectral sensitivity
$S_{rel}=f(\lambda)$

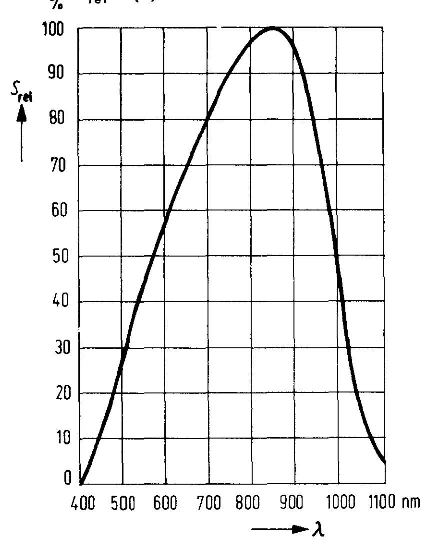
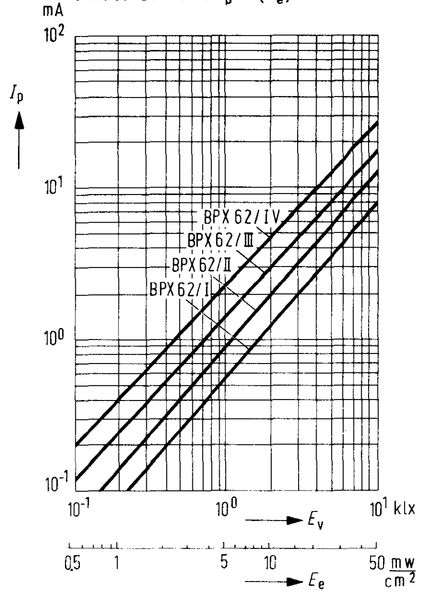
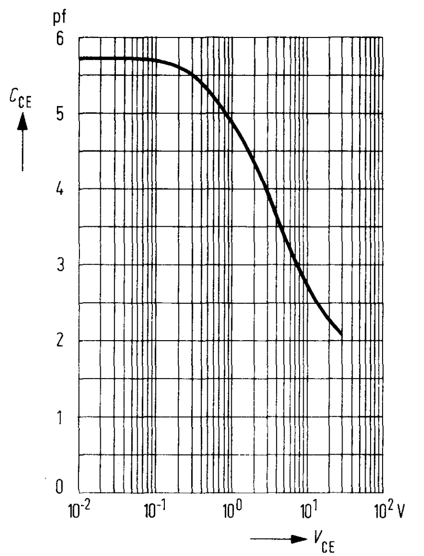


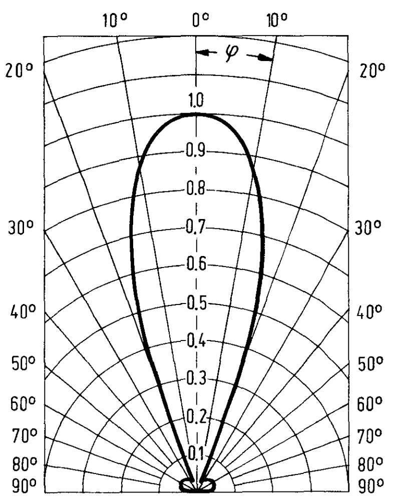
Photo current $I_p=f(E_v)$
Photo current $I_p=f(E_e)$



Collector-emitter capacitance
$C_{CE}=f(V_{CE})$



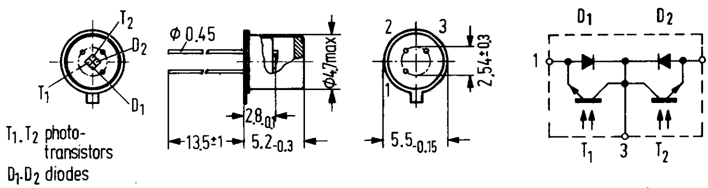
Directional characteristic
$I_p=f(\varphi)$



AC Voltage photo transistor

BPX 78 is a multiple epitaxial NPN silicon planar photo transistor in a case 18 A 3 DIN 41876 (similar to TO-18) with a plane window. The collector leads of the two photo transistors and the cathodes of the parallel diodes are electrically connected to the metal case. Systems 1 and 2 are wired as photo transistors without base connection. The photo transistor BPX 78 is particularly suitable for use in devices and instruments where the only operating voltage available is an AC voltage, e.g. in control circuits for triacs and thyristors. Moreover, the photo receiver may be used as an AC and DC position sensor as well as a detector of motion directions.

Type	Order number
BPX78	Q62702-P62



Weight approx. 0.5 g   Dimensions in mm

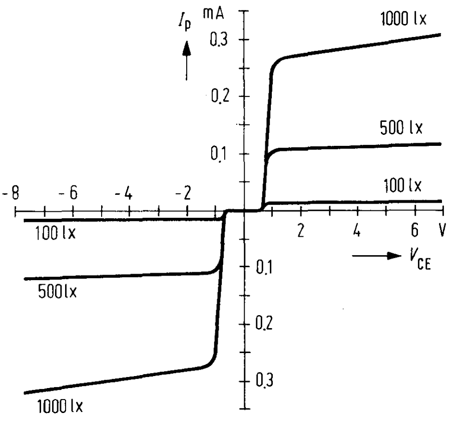
Preliminary data

Maximum ratings		**BPX 78**	
Collector-emitter voltage	V_{CEO}	40	V
Emitter-base voltage	V_{EBO}	7	V
Collector current	I_C	100	mA
Junction temperature	T_j	125	°C
Storage temperature	T_S	−55 to +125	°C
Max. permissible soldering temperature ($t<5$ s)	T_L	245	°C
Power dissipation	P_{tot}	250	mW
Thermal resistance			
Junction to air	R_{thJamb}	<450	K/W
Junction to case	$R_{thJcase}$	<150	K/W

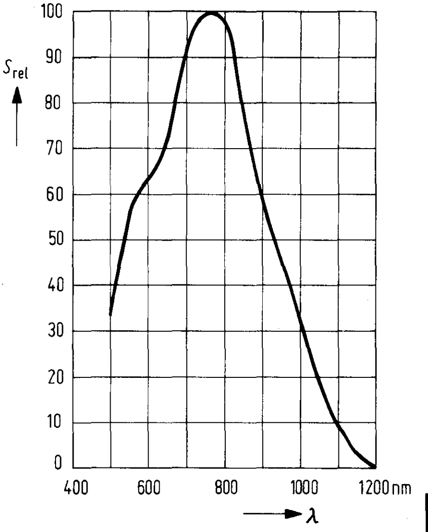
Characteristics ($T_{amb}=25\,°C$)			
Collector-emitter cutoff current ($V_{CE}=25$ V; $E_v=0$ lx)	I_{CEO}	100	nA
Photo current ($E_v=1000$ lx; $V_{CE}=5$ V)	I_p	0.3	mA
Static forward current transfer ratio ($V_{CE}=5$ V; $I_C=2$ mA)	h_{FE}	400 (>300)	–
Wavelength of max. spectral sensitivity	λ_{Smax}	0.8	µm
Rise time, fall time ($R_L=1$ kΩ) [2]	t_r; t_f	8	µs

[1]) Radiation of an unfiltered tungsten-filament lamp with a colour temperature of 2856 K
[2]) Measured with LED ($\lambda=930$ nm) as emitter

Characteristic of the AC voltage photo transistor at various illuminances



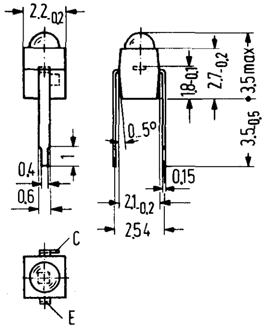
Relative spectral sensitivity
% $S_{rel} = f(\lambda)$



NPN Silicon photo transistor in a plastic package (basic grid system 1/10″)

BPX 81 is an epitaxial NPN silicon transistor in a plastic package with soldering tab leads. The collector lead is marked by a stub on the soldering tab. The photo transistor is suitable for universal application in conjunction with incandescent lamps and infrared light. BPX 81 may be mounted on grid boards and is also provided for as a detector for the light-emitting diode LD 261 (same build-up as BPX81) in miniature light barriers.

Type	Order number
BPX 81 I	Q62702-P43-S1
BPX 81 II	Q62702-P43-S2
BPX 81 III	Q62702-P43-S3
BPX 81 IV	Q62702-P43-S4



Weight approx. 0.02 g Dimensions in mm

Maximum ratings		BPX 81	
Collector-emitter voltage	V_{CE}	32	V
Junction temperature	T_j	90	°C
Storage temperature	T_s	−30 to +90	°C
Soldering temperature 2 mm away from case bottom ($t \leqq 3$ s)	T_L	230	°C
Power dissipation	P_{tot}	85	mW
Thermal resistance	R_{thJamb}	750	K/W

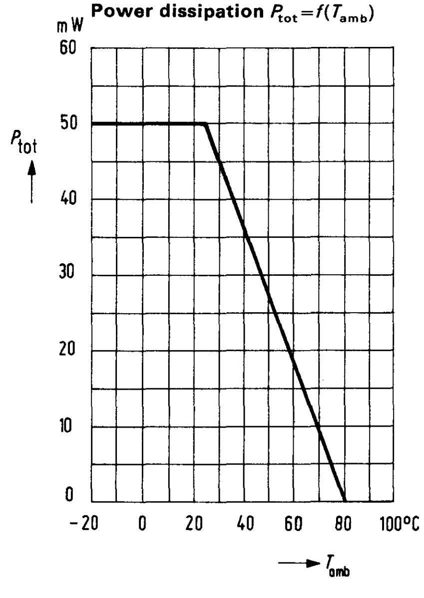
Characteristics			
Collector-emitter cutoff current (V_{CE}=25 V; E_v=0 lx)	I_{CEO}	25 (<200)	nA
Collector-emitter saturation voltage (I_C= 0.25 mA; E_v=1000 lx)	V_{CEsat}	0.3	V
Wavelength of max. photo sensitivity	λ_{Smax}	780	nm
Spectral range of photo sensitivity ($S > 0.1 S_{max}$)	λ	450 to 1000	nm

The photo transistors are classified in groups of photo sensitivity and denoted by Roman numerals.

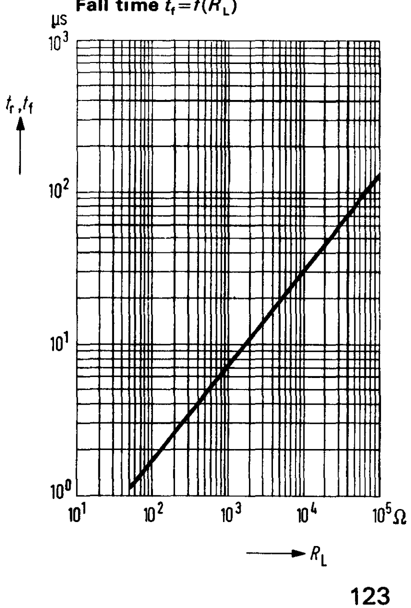
Type	BPX81				
Group	I	II	III	IV	
Photo current I_p (V_{CE}=5 V; E_v=1000 lx[1]))	0.63 to 1.25	1.0 to 2.0	1.6 to 3.2	2.5 to 5.0	mA
Code colour	brown	red	orange	yellow	

[1]) The illuminances indicated refers to the unfiltered radiation of a tungsten-filament lamp with a colour temperature of 2856 K

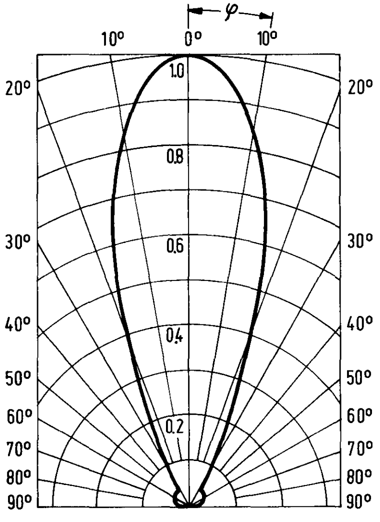
Power dissipation $P_{tot}=f(T_{amb})$



Rise time $t_r=f(R_L)$
Fall time $t_f=f(R_L)$



Directional characteristic $I_p = f(\varphi)$



Relative spectral sensitivity $S_{rel} = f(\lambda)$

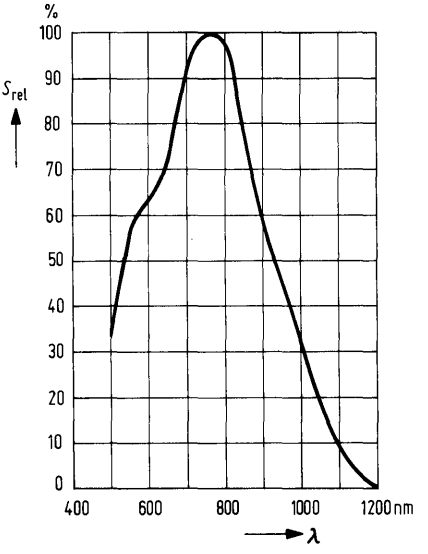
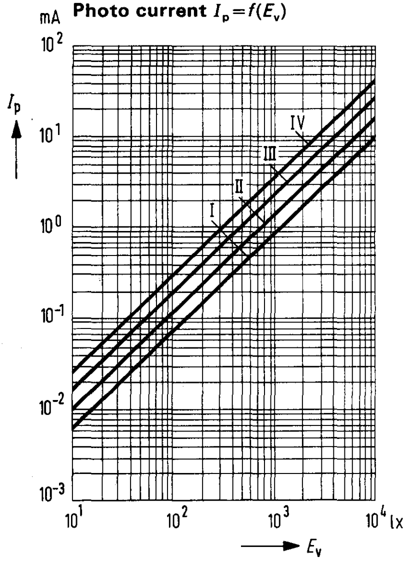
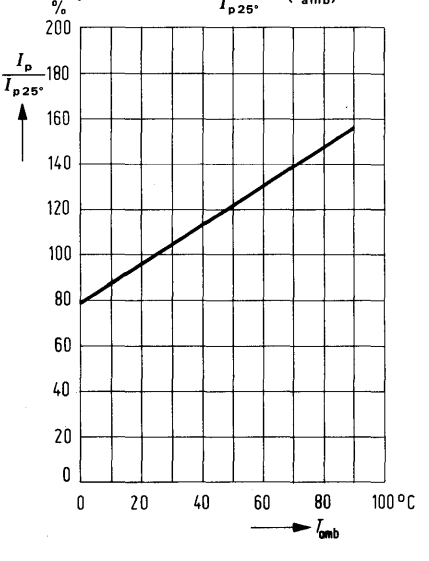


Photo current $I_p = f(E_v)$



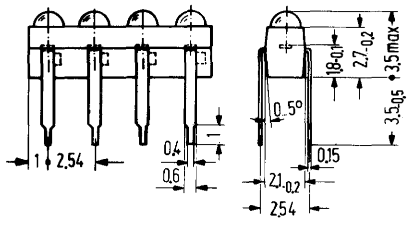
Temperature coefficient of photo current $\frac{I_p}{I_{p25°}} = f(T_{amb})$



NPN Silicon photo transistor arrays (basic grid system 1/10")

Types BPX 80 to BPX 89 are photo transistor arrays in a plastic package consisting of an arrangement of a maximum of 10 epitaxial NPN silicon photo transistors. The spacing of the individual photo-electric detectors corresponds to the standardized basic grid system of 1/10". A small cone of apex angle of the lens-type light window prevents any optical "cross-modulation" from the neighbouring system. The collector leads are marked by lateral stubs on the soldering tabs.
The second digit of the type designation is identical with the number of photo-electric detectors of one array (e.g. BPX 84 constitutes an array with 4 photo transistors). At the moment, primarily arrays with two, three, six and nine photo transistors are being produced, corresponding to the type designations BPX 82, BPX 83, BPX 86 and BPX 89. The remaining photo transistor arrays are not in stock, but are available upon request.

Type	Order number
BPX 82	Q62702-P21
BPX 83	Q62702-P25
BPX 84	Q62702-P30
BPX 85	Q62702-P31
BPX 86	Q62702-P22
BPX 87	Q62702-P32
BPX 88	Q62702-P33
BPX 89	Q62702-P26
BPX 80	Q62702-P28



E.g. sample with 4 photo transistors BPX 84, dimensions in mm

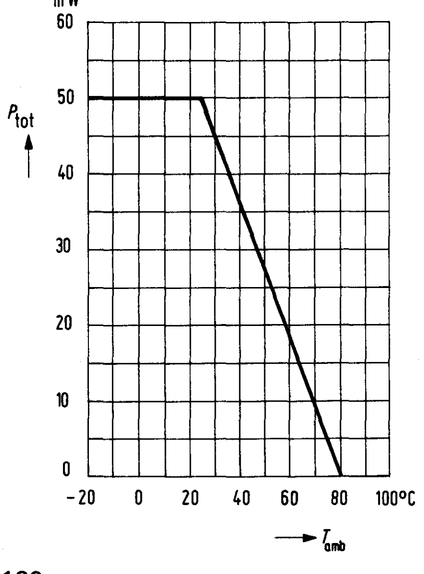
Maximum ratings		BPX 80 to BPX 89	
Collector-emitter voltage	V_{CE}	32	V
Junction temperature	T_j	90	°C
Storage temperature	T_S	−30 to +90	°C
Soldering temperature 2 mm away from case bottom ($t \leq 3$ s)	T_L	230	°C
Power dissipation (T_{amb} = 25 °C)	P_{tot}	85	mW
Thermal resistance	R_{thJamb}	750	K/W

Characteristics ($T_{amb}=25\,°C$)		BPX 80 to BPX 89	
Collector-emitter cutoff current ($V_{CE}=25\,V$; $E_v=0\,lx$)	I_{CEO}	25 (<200)	nA
Wavelength of max. photo sensitivity	λ_{Smax}	780	nm
Spectral range of photo sensitivity ($S>0.1\,S_{max}$)	λ	450 to 1000	nm
Photo sensitivity			
Photo current ($V_{CE}=5\,V$; $E_v=1000\,lx$) [1] [2]	I_p	0.41 to 6.3	mA

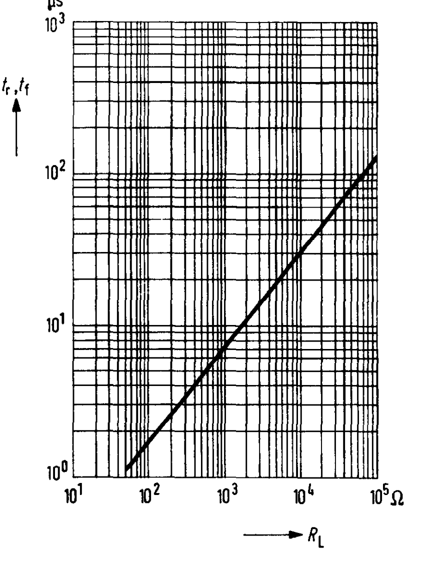
[1]) The illuminances indicated refers to the unfiltered radiation of a tungsten-filament lamp with a colour temperature of 2856 K.

[2]) The scatter of I_p within one array is ≦1:2; arrays with a lower scatter upon request.

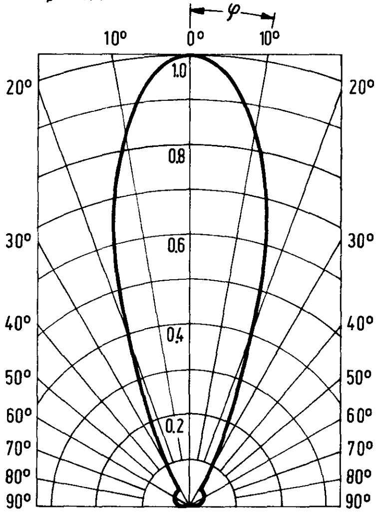
Power dissipation $P_{tot}=f(T_{amb})$



Rise time $t_r=f(R_L)$
Fall time $t_f=f(R_L)$



Directional characteristic
$I_p = f(\varphi)$



Relative spectral sensitivity $S_{rel} = f(\lambda)$

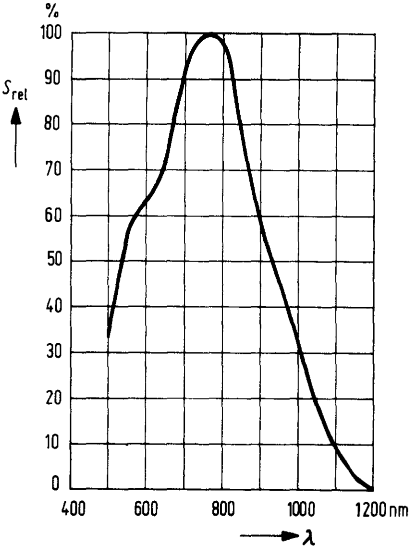
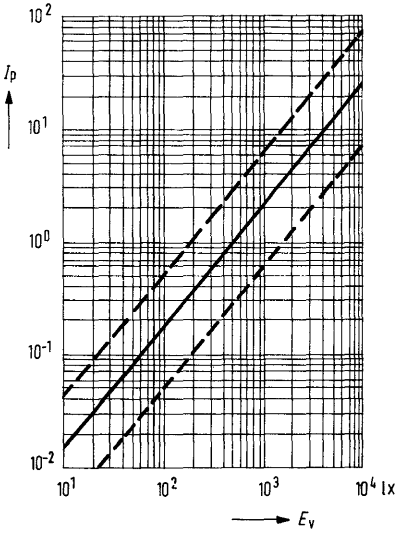
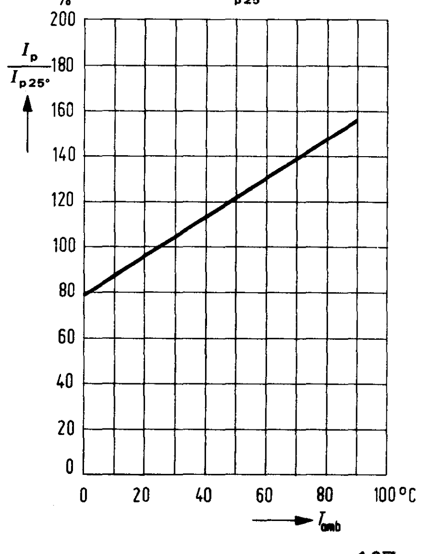


Photo current $I_p = f(E_v)$



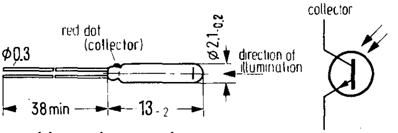
Temperature coefficient of the photo current $\frac{I_p}{I_{p25°}} = f(T_{amb})$



Silicon photo transistor

BPY 61 is an epitaxial NPN silicon planar photo transistor in a miniature glass-case. The base has no connection; control is via light intensity. The collector is marked by a red colour dot on the housing. On account of its high current gain, the transistor is suitable for applications requiring a particularly sensitive detector. The small dimensions favour a high packing density when assembling scanning units.

Type	Order number
BPY 61 I	Q60215-Y61-S1
BPY 61 II	60215-Y61-S2
BPY 61 III	Q60215-Y61-S3
BPY 61 IV	Q60215-Y61-S4



positive voltage to be applied to red dot

Weight approx. 1 g Dimensions in mm

Maximum ratings		**BPY 61**	
Collector-emitter voltage	V_{CEO}	32	V
Emitter-base voltage	V_{EBO}	7	V
Junction temperature	T_j	125	°C
Storage temperature	T_S	−55 to +125	°C
Power dissipation (T_{amb}=25 °C)	P_{tot}	50	mW

Characteristics (T_{amb}=25 °C)

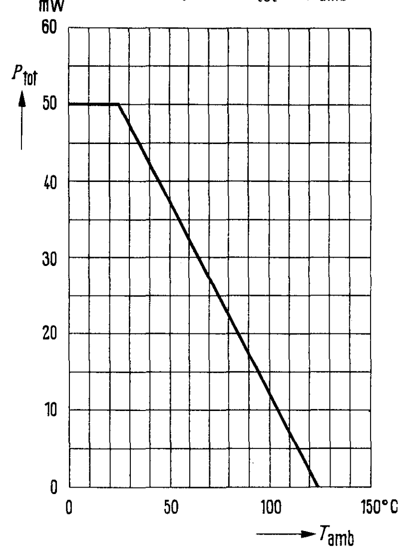
Collector-emitter cutoff current (V_{CE}=25 V; E_v=0 lx)	I_{CEO}	5≦100	nA
Collector-emitter saturation voltage (I_C=0.25 mA; E_v=1000 lx)	V_{CEsat}	0.2	V
Spectral range of photosensitivity ($S>0.1\,S_{max}$)	λ	0.45 to 1.0	µm
Wavelength of max. photosensitivity	λ_{Smax}	0.78	µm
Rise time from 10% to 90% of the final value Fall time from 90% to 10% of the initial value (R_L=1 kΩ) [2]	t_r, t_f	5	µs

The photo-transistors are grouped according to their photo sensitivity, the groups being denoted by Roman numerals.

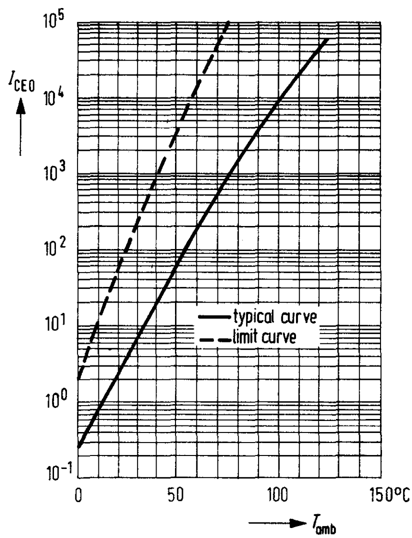
Type		BPY 61				
Group		I	II	III	IV	
Photo-current (V_{CE}=5 V; E_v=1000 lx) [1]	I_p	0.8 to 1.6	1.25 to 2.5	2 to 4	3.2 to 6.3	mA

[1]) The illuminances indicated refers to the unfiltered radiation of a tungsten-filament lamp with a colour temperature of 2856 K
[2]) Measured with LED (λ=930 nm) as emitter.

Power dissipation $P_{tot} = f(T_{amb})$



Cutoff current $I_{CEO} = f(T_{amb})$
$V_{CE} = 25$ V; $E_v = 0$ lx



Cutoff current $I_{CEO} = f(V_{CE})$
T_{amb} = parameter; $E_v = 0$ lx

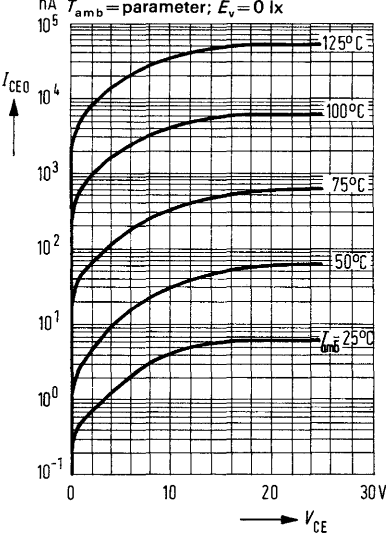
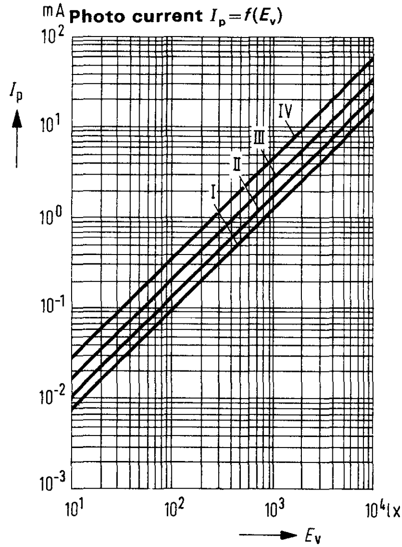
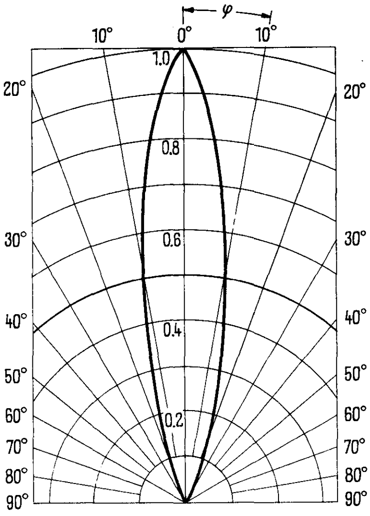


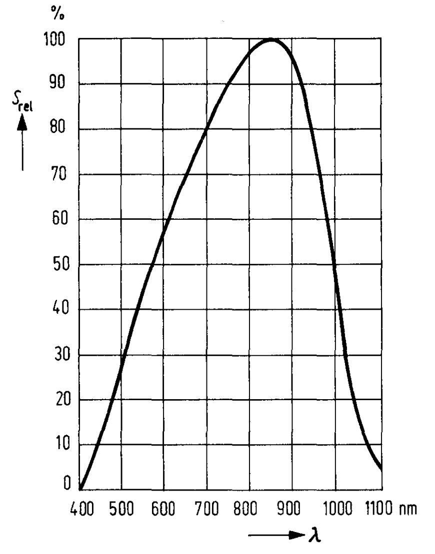
Photo current $I_p = f(E_v)$



Directional characteristic $I_p = f(\varphi)$



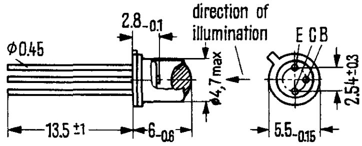
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



Silicon photo transistor

BPY 62 is an epitaxial NPN silicon planar photo transistor in a case 18 A 3 DIN 41876 (TO-18) with a light window for frontal illumination. The base lead has been connected, and the emitter is marked by a stud on the housing bottom. The collector is electrically connected to the case. The transistor is universally suitable for use in conjunction with an incandescent lamp, especially where a particularly sensitive detector is required.

Type	Order number
BPY 62 I	Q60215-Y62-A
BPY 62 II	Q60215-Y62-B
BPY 62 III	Q60215-Y62-C
BPY 62 IV	Q60215-Y62-D



Weight approx. 1.5 g Dimensions in mm

Maximum ratings		BPY 62	
Collector-emitter voltage	V_{CEO}	32	V
Emitter-base voltage	V_{EBO}	5	V
Collector current	I_C	25	mA
Junction temperature	T_j	125	°C
Storage temperature	T_S	−55 to +125	°C
Total power dissipation ($T_{amb}=25\,°C$)	P_{tot}	250	mW

Characteristics ($T_{amb}=25\,°C$)

Collector-emitter cutoff current ($V_{CE}=25$ V; $E_v=0$ lx)	I_{CEO}	5 (<100)	nA
Collector-emitter saturation voltage ($I_C=1$ mA; $E_v=1000$ lx, base open)	V_{CEsat}	0.3	V
Spectral range of photosensitivity ($S>0.1\,S_{max}$)	λ	0.45 to 1.0	µm
Wavelength of max. photosensitivity	λ_{Smax}	0.78	µm
Rise time from 10% to 90% of final value Fall time from 90% to 10% of initial value ($R_L=1\,k\Omega$)[2]	t_r, t_f	5 (<10)	µs

The photo-transistors are grouped according to their photo sensitivity, the groups being denoted by Roman numerals.

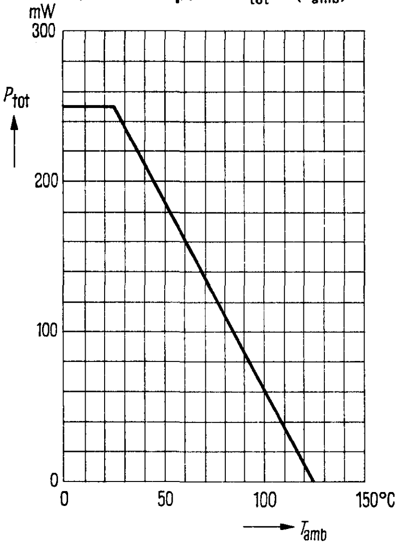
Type	BPY 62				
Group	I	II	III	IV	
Photo-current ($V_{CE}=5$ V; $E_v=1000$ lx[1]); base open) I_p	1.25 to 2.5	2 to 4	3.2 to 6.3	5 to 10	mA

[1]) The illuminances indicated refers to an unfiltered radiation of a tungsten-filament lamp with a colour temperature of 2856 K

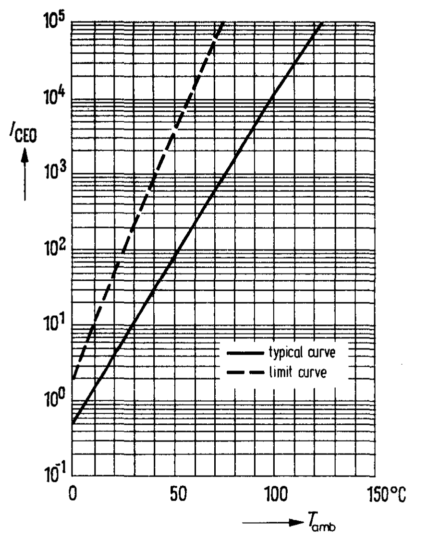
[2]) Measured with LED ($\lambda=930$ nm) as emitter.

BPY 62

Power dissipation $P_{tot} = f(T_{amb})$



Cutoff current $I_{CEO} = f(T_{amb})$
$V_{CE} = 25$ V; $E_v = 0$ lx



Cutoff current $I_{CEO} = f(V_{CE})$
T_{amb} = parameter; $E_v = 0$ lx

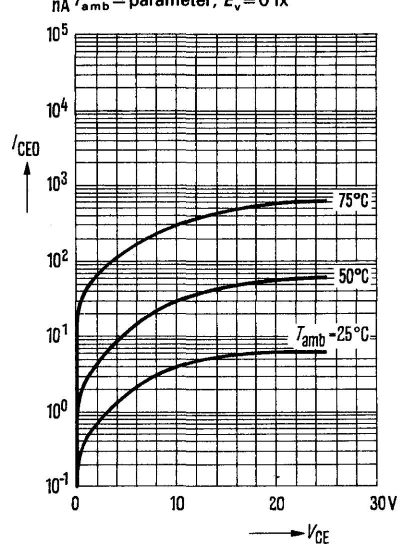
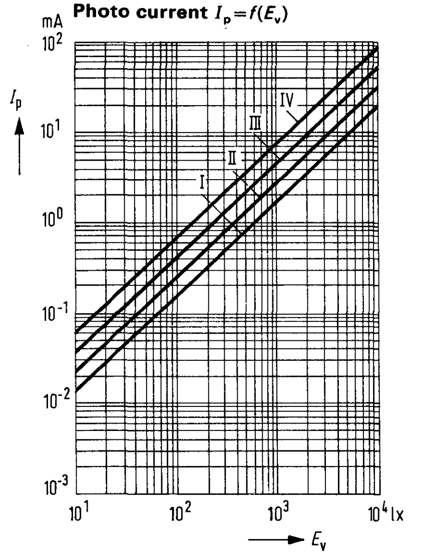
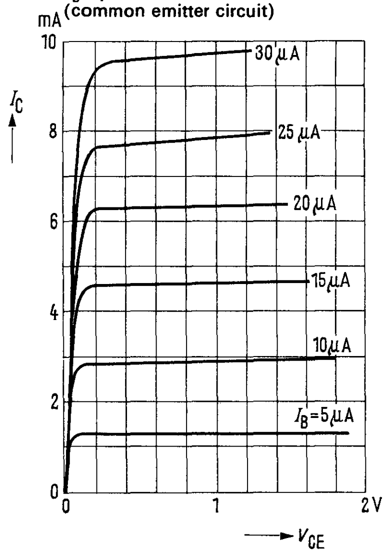


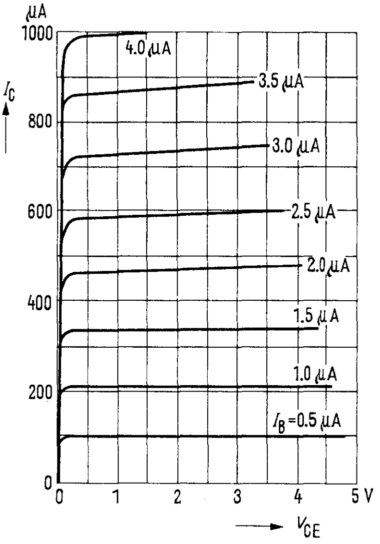
Photo current $I_p = f(E_v)$



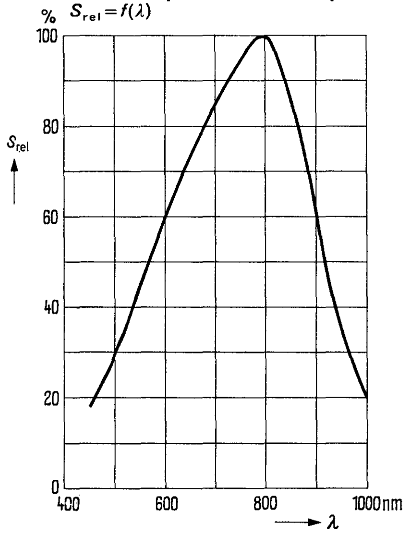
Output characteristics $I_C = f(V_{CE})$, I_B = parameter (common emitter circuit)



Output characteristics $I_C = f(V_{CE})$, I_B = parameter



Relative spectral sensitivity $S_{rel} = f(\lambda)$



Output characteristics $I_C = f(V_{CE})$, V_{BE} = parameter

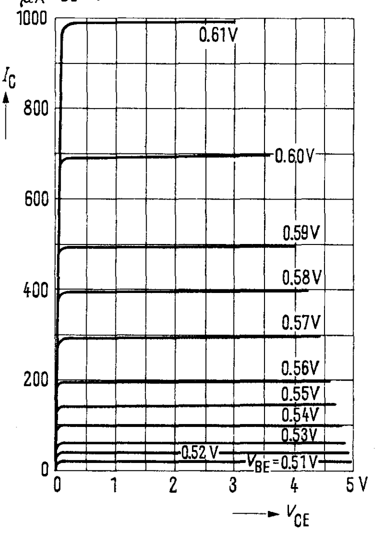
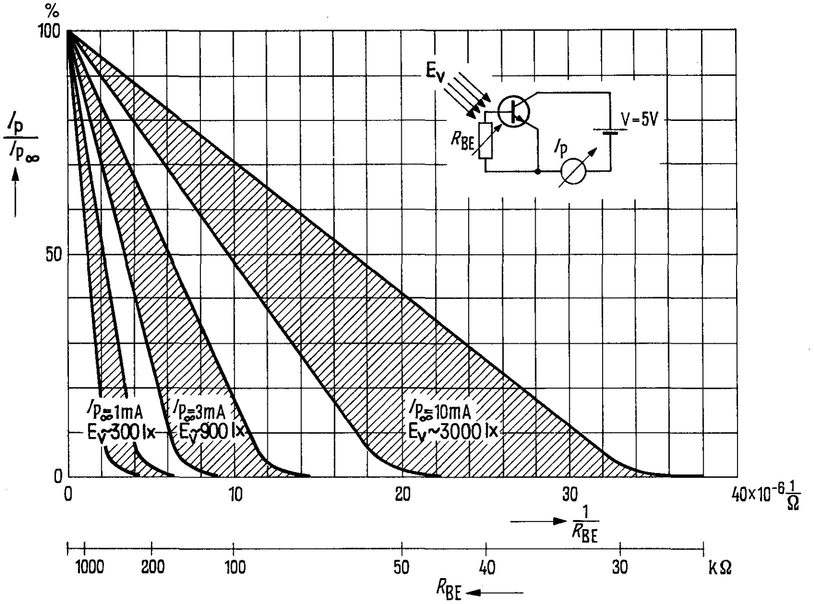
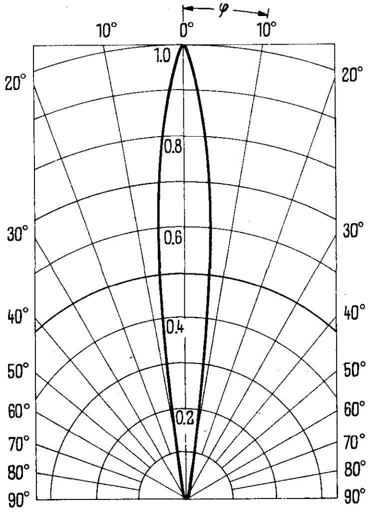


Photo current $I_p = f(R_{BE})$ referred to photo current $I_{p\infty}$ during operation with open base ($R_{BE} = \infty$)
Parameter = illuminance converted into photo currents.



Directional characteristic $I_p = f(\varphi)$



Light-Emitting-Diodes (LED's)

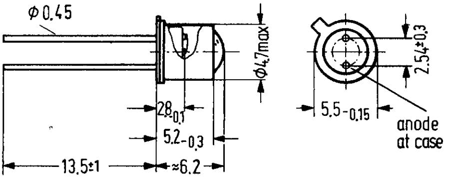
Radiant intensity (I_e) and luminous intensity (I_V) and the electric current I according to NORM, are denoted by the same symbol. To avoid mix-ups, we write I_e and I_V (upright "I") for radiant and luminous intensity, respectively, and I (oblique "I") for the electric current.

GaAs light emitting diode (infrared emitter)

The GaAs light-emitting diode CQY 17 emits radiation with a wavelength lying in the near infrared. The radiation emitted is excited by current flow in forward direction and may be modulated. The case 18 A 2 DIN 41876 (similar to TO-18) is closed by a glass lens. The cathode lead is marked by the neighbouring stub on the case bottom rim. The anode is electrically connected to the case. As of $I_F = 100$ mA heat sinks are to be used.

Type	Order number
CQY 17 IV	Q 62703-Q 89-S 1
CQY 17 V	Q 62703-Q 89-S 2
CQY 17 VI	Q 62703-Q 89-S 3

Preliminary data



Weight approx 0,35 g

Dimensions in mm

Maximum ratings ($T_{amb} = 25$ °C)		CQY 17	
Forward current	I_F	100	mA
Maximum forward current	i_{FM}	300	mA
Surge current ($t \leqq 1$ µs)	i_{FS}	2000	mA
Junction temperature	T_j	100	°C
Storage temperature	T_s	−60 to +100	°C
Power dissipation	P_{tot}	180	mW

Thermal resistance

System to ambient air	R_{thJamb}	500	K/W
System to case	$R_{thJcase}$	180	K/W

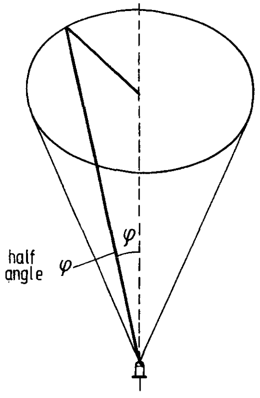
Characteristics (T_{amb} = 25 °C)		CQY 17	
Wavelength of radiation at I_{max}	λ_{Imax}	950	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	±20	nm
Switching times (Φ_e from 10% to 90%; I_F = 100 mA)	t_r; t_f	1	µs
Capacitance at V_R = 0 V	C_0	120	pf
Forward voltage (I_F = 100 mA)	V_F	1.35 (<1.8)	V
Breakdown voltage (I_R = 100 µA)	$V_{(BR)}$	30 (>4)	V
Reverse current (V_R = 3 V)	I_R	0.01 (<10)	µA
Half-life of radiation intensity (typ.) for I_F = 100 mA		10^5	h

Radiant power Φ_e

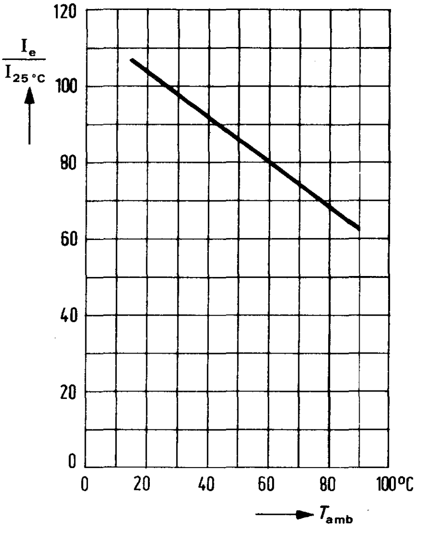
The diodes are grouped according to the radiant power Φ_e emitted in mW in a cone having a half-angle φ of 15°, at I_F = 100 mA.

Type	CQY 17			
Group	**IV**	**V**	**VI**	
Φ_e (15°)	1.1 to 2.8	1.8 to 4.5	2.8 to 7.1	mW
Φ_e (total) typ.	4	6.3	10	mW

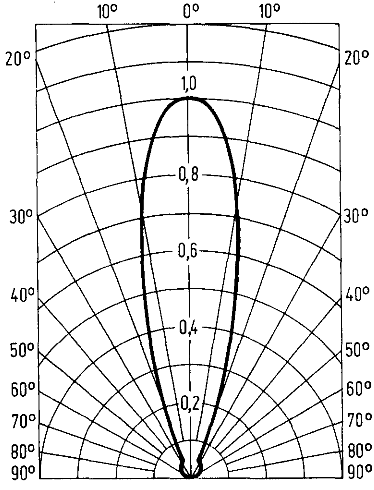
Cone of emission as a function of the half angle φ



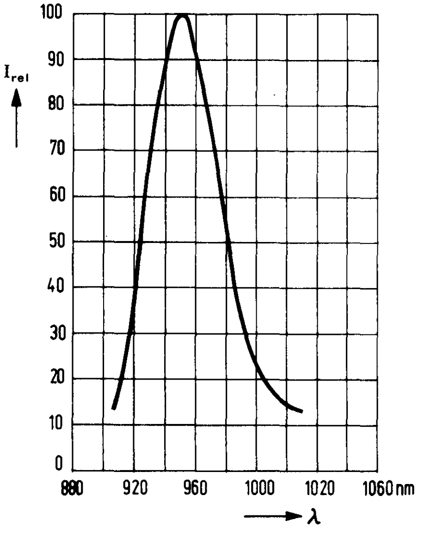
Radiant intensity $\frac{I_e}{I_{e\,25°}} = f(T_{amb})$



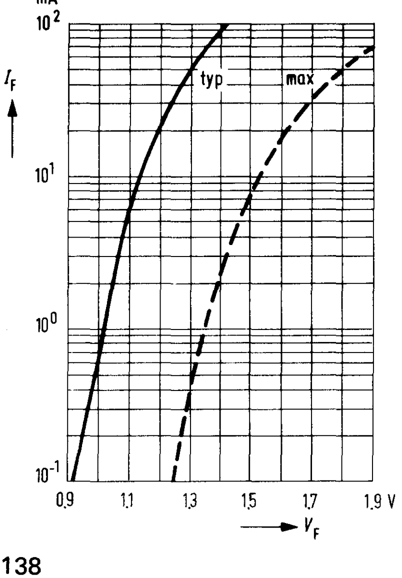
Radiation characteristic $I_{rel}=f(\varphi)$



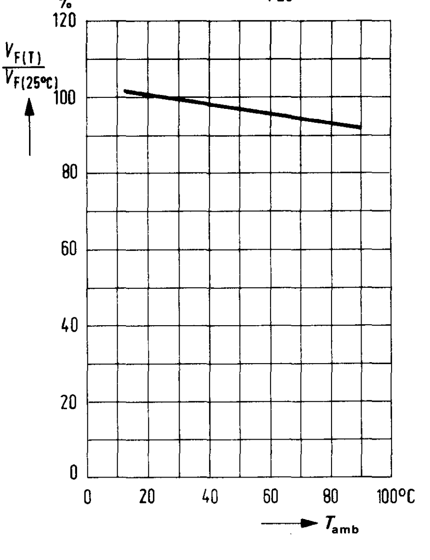
Relative spectral emission $I_{rel}=f(\lambda)$



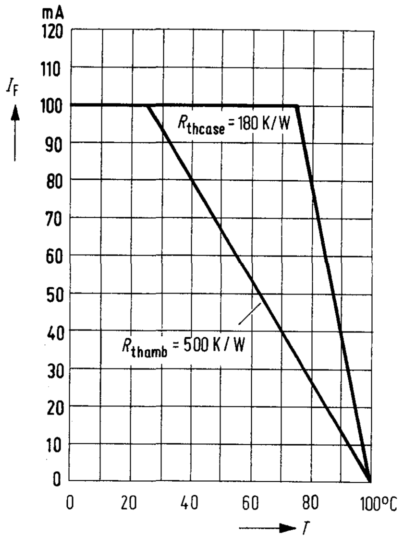
Forward voltage $V_F=f(I_F)$



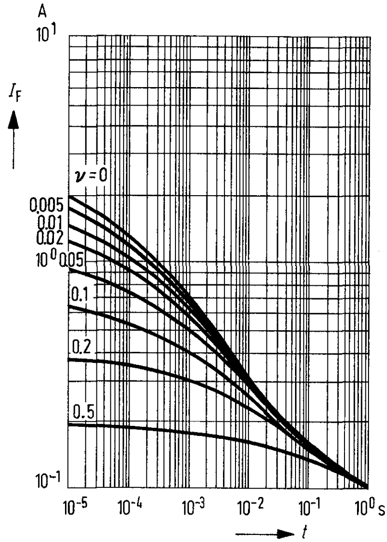
Forward voltage $\frac{V_F}{V_{F25°}}=f(T_{amb})$



Max. forward current $I_F = f(T)$



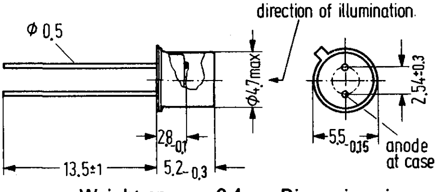
Permissible pulse load $I_F = f(t)$
ν = parameter



GaAs light emitting diode (infrared emitter)

The GaAs light-emitting diode CQY 18 emits radiation with a wavelength lying in the near infrared. The radiation emitted is excited by current flow in forward direction and may be modulated. The case (similar to TO-18) is provided with a plane light window. The cathode is marked by the neighbouring stub at the case bottom rim. The anode is electrically connected to the case.

Type	Order number
CQY 18 III	Q 62703-Q 90-S 1
CQY 18 IV	Q 62703-Q 90-S 2
CQY 18 V	Q 62703-Q 90-S 3



Weight approx. 0.4 g Dimensions in mm

Preliminary data

Maximum ratings (T_{amb} = 25 °C)		**CQY 18**	
Forward current ($t \leqq 1$ µs)	I_F	100	mA
Maximum forward current	i_{FM}	300	mA
Surge current	i_{FS}	2000	mA
Junction temperature	T_j	100	°C
Storage temperature	T_S	−60 to +100	°C
Power dissipation	P_{tot}	180	mW
Thermal resistance			
System to ambient air	R_{thJamb}	500	K/W
System to case	$R_{thJcase}$	180	K/W

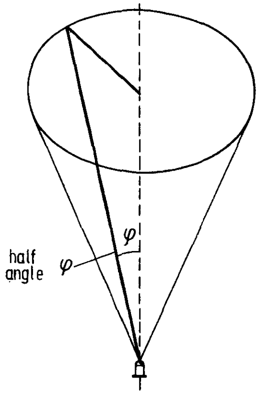
Characteristics ($T_{amb}=25\,°C$)		**CQY 18**	
Wavelength of radiation at I_{max}	λ_{Imax}	950	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	± 20	nm
Switching times (Φ from 10% to 90%; $I_F=100$ mA)	t_r; t_f	1	µs
Capacitance at $V_R=0$ V	C_0	120	pf
Forward voltage ($I_F=100$ mA)	V_F	1.35 (<1.8)	V
Breakdown voltage ($I_R=100$ µA)	$V_{(BR)}$	30 (>4)	V
Reverse current ($V_R=3$ V)	I_R	0.01 (<10)	µA
Half-life of radiation intensity (typ.) for $I_F=100$ mA		10^5	h

Radiant power Φ_e

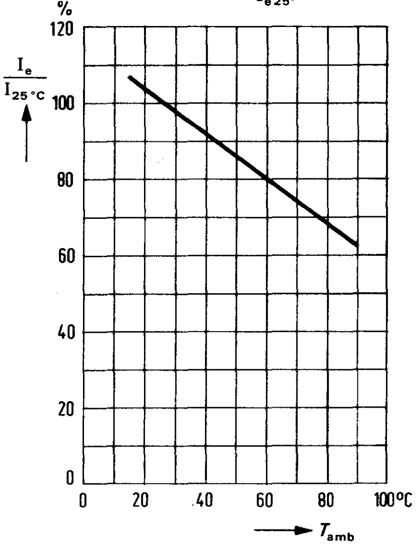
The diodes are grouped according to the radiant power Φ_e emitted in mW in a cone having a half-angle φ of 30°, at $I_F=100$ mA.

Type	**CQY18**			
Group	**III**	**IV**	**V**	
Φ_e at=30°	0.8 to 2.0	1.25 to 3.2	2.0 to 5.0	mW
Φ_e (total) typ.	2.5	4	6.3	mW

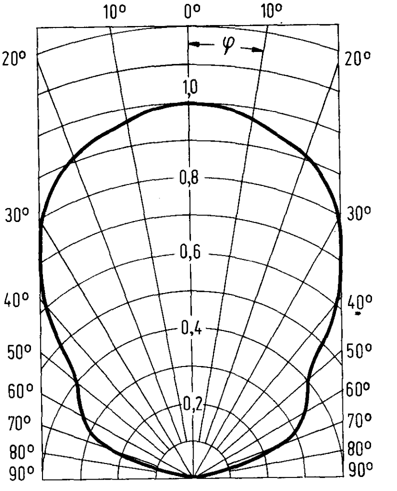
Cone of radiation as a function of the half-angle φ



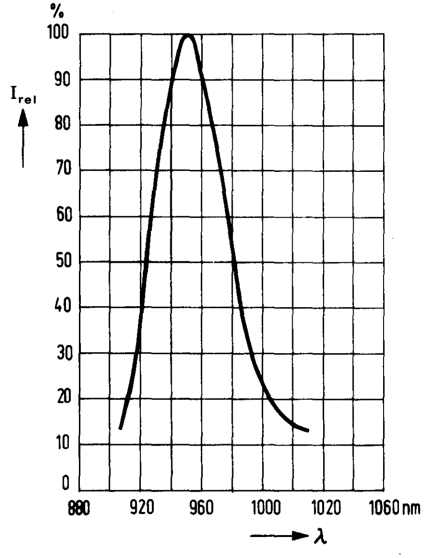
Radiant intensity $\frac{I_e}{I_{e25°}}=f(T_{amb})$



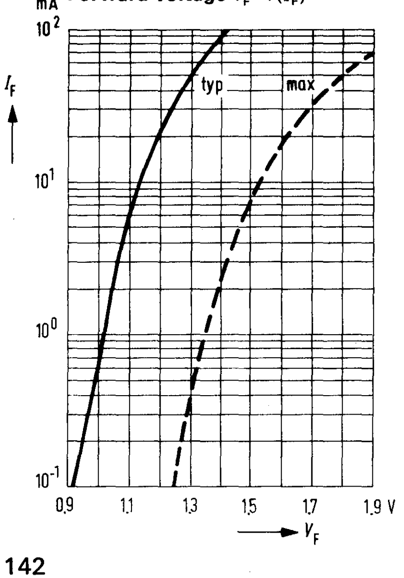
Radiation characteristic $I_{rel} = f(\varphi)$



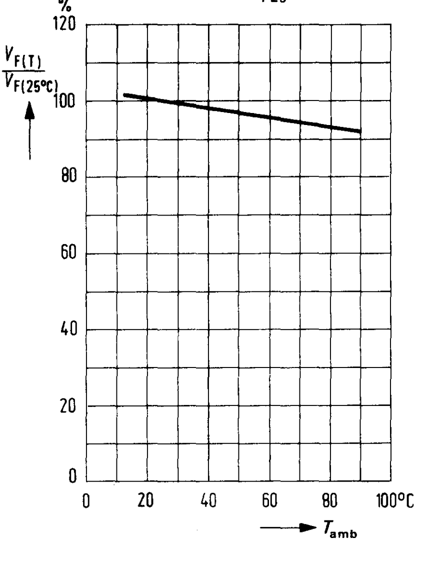
Relative spectral emission
$I_{rel} = f(\lambda)$



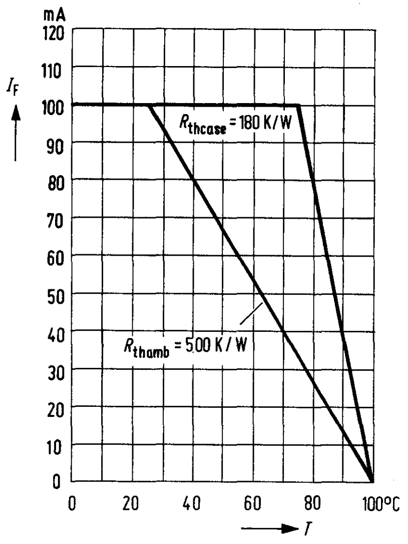
Forward voltage $V_F = f(I_F)$



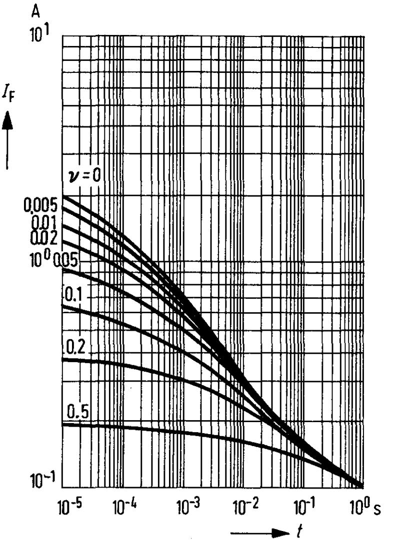
Forward voltage $\frac{V_F}{V_{F25°}} = f(T_{amb})$



Max. forward current $I_F = f(T)$



Permissible pulse load $I_F = f(t)$
v = parameter



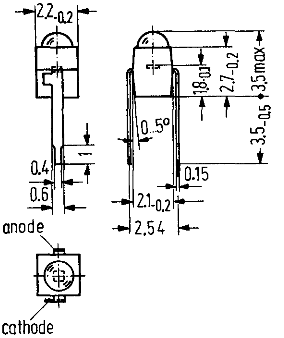
GaAs LED (infrared emitters) in 1/10″ grid system

The GaAs light-emitting diode LD 261 emits radiation having a wavelength lying in the near infrared when current flows in forward direction.

The case consists of orange-coloured transparent plastics with a lens-type light window. The leads are soldering tabs in a basic grid system of 1/10″. The light-emitting diodes are grouped according to radiant intensity. The cathode lead is marked by a colour dot in order to identify the individual groups.

LD 261 may be used in conjunction with the photo transistor of the same design BPX 81 to build up light barriers where emitter and detector are spaced approximately 10 mm apart. The diode may easily be mounted both in printed circuits and in thick film circuits. Complex scanning units are thus realized. Like the photo transistor series BPX 80 to BPX 89, the LD 261 light-emitting diodes are available in arrays up to 10 units as LD 260 to LD 269.

Type	Order number
LD 261 I	Q62703-Q63
LD 261 II	Q62703-Q64
LD 261 III	Q62703-Q65
LD 261 IV	Q62703-Q66



Dimensions in mm Weight approx. 0.02 g

Preliminary data

Maximum ratings ($T_{amb} = 25\,°C$)

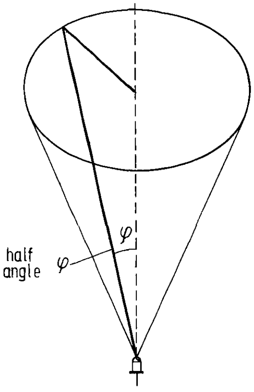
		LD 261	
Forward current	I_F	50	mA
Maximum forward current	i_{FM}	150	mA
Surge current ($t \leq 1\,\mu s$)	i_{FS}	1500	mA
Junction temperature	T_j	80	°C
Storage temperature	T_s	−30 to +80	°C
Soldering temperature 2 mm away from case bottom ($t \leq 3$ s)	T_L	230	°C
Power dissipation	P_{tot}	85	mW
Thermal resistance	R_{thJamb}	750	K/W

Characteristics (T_{amb} = 25 °C)		LD 261	
Wavelength of radiation at I_{max}	λ_{Imax}	950	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	±20	nm
Half-life of radiation intensity (typ.) for I_F = 50 mA		10^5	h
Switching times (Φ_e from 10% to 90%; I_p = 50 mA)	t_r; t_f	1	µs
Capacitance at V_R = 0 V	C_0	120	pf
Forward voltage (I_F = 50 mA)	V_F	1.3 (<2)	V
Breakdown voltage (I_R = 100 µA)	$V_{(BR)}$	30 (>4)	V
Reverse current (V_R = 3 V)	I_R	0.01 (<10)	µA

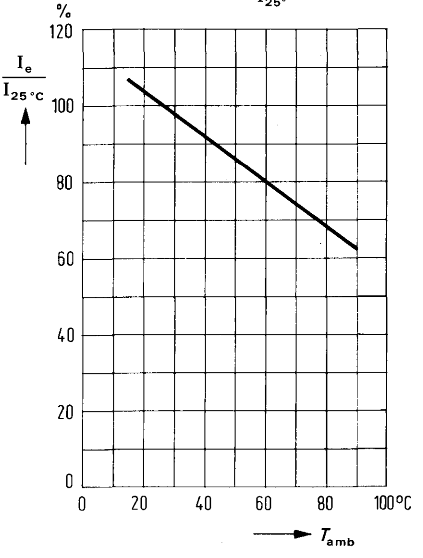
The diodes are grouped according to the radiant power Φ_e emitted in mW in a cone having a half-angle φ of 30°, at I_F = 50 mA.

Type	LD 261				
Group	I	II	III	IV	
Φ_e (30°)	0.28 to 0.71	0.45 to 1.112	0.71 to 1.8	1.12 to 2.8	mW
Φ_e (total) typ.	1.0	1.6	2.5	4.0	mW
Color code (cathode)	brown	red	orange	yellow	

Cone of radiation as a function of the half angle φ

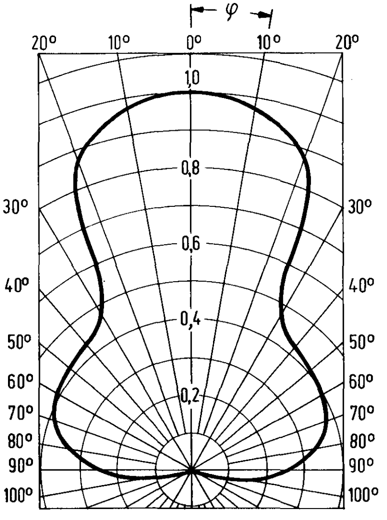


Radiant intensity $\frac{I_e}{I_{25°}} = f(T_{amb})$

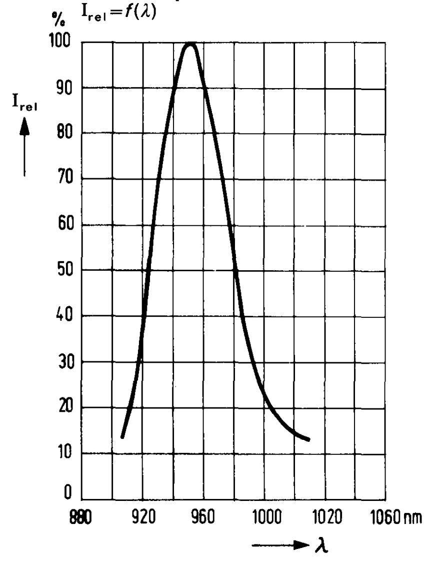


LD 261

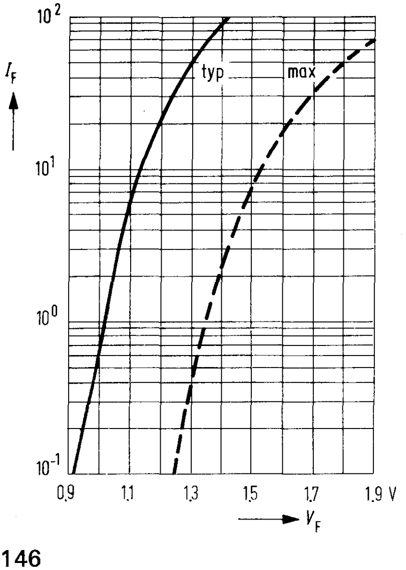
Directional characteristic $I_{rel} = f(\varphi)$



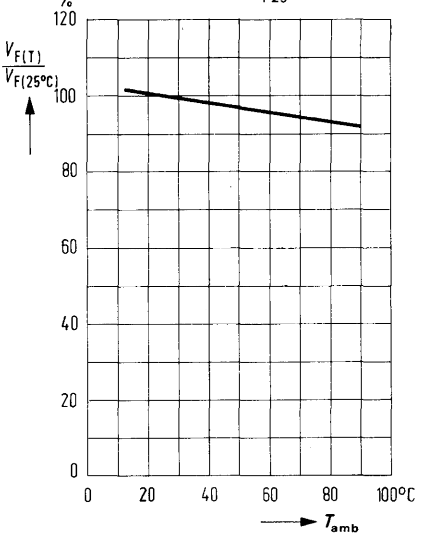
Relative spectral emission
$I_{rel} = f(\lambda)$



Forward voltage $V_F = f(I_F)$



Forward voltage $\frac{V_F}{V_{F25°}} = f(T_{amb})$

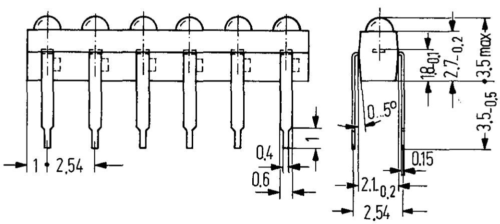


GaAs light-emitting diode arrays (infrared emitter) grid system 1/10″

LD 260 to LD 269 are GaAs light-emitting diode arrays in an orange-coloured plastic package consisting of an arrangement of a maximum of 10 light-emitting diode LD 261 in one row. These diode arrays emit radiation having a wavelength lying in the near infrared when current flows in forward direction. In connection with the photo transistor arrays of the same design BPX 80 to BPX 89 light barriers may be built up where emitter and detector are spaced 10 mm apart. As they are easily mounted in printed circuits complex scanning units may be realized. The spacing of the individual diodes corresponds to the standardized basic grid system of 1/10″. The third digit of the type designation stands for the number of light-emitting diodes contained in the array (e.g. LD 266 = one array with 6 diodes, or LD 260 with 10 diodes).

Type	Order number
LD 262	Q62703-Q70
LD 263	Q62703-Q71
LD 266	Q62703-Q74
LD 269	Q62703-Q77
LD 260	Q62703-Q78

Further number of systems per array upon request



Sample with 6 diodes (e.g. LD 266)
Dimensions in mm

Preliminary data (single diode)

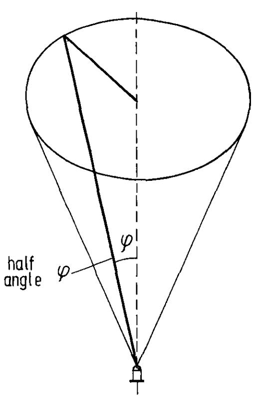
Maximum ratings		**LD 260 to LD 269**	
Forward current	I_F	50	mA
Maximum forward current	i_{FM}	150	mA
Surge current ($t \leqq 1$ µs)	i_{FS}	1500	mA
Junction temperature	T_j	80	°C
Storage temperature	T_S	−30 to +80	°C
Soldering temperature 2 mm away from case bottom ($t \leqq 3$ s)	T_L	230	°C
Power dissipation	P_{tot}	85	mW
Thermal resistance	R_{thJamb}	750	K/W

LD 260 to LD 269

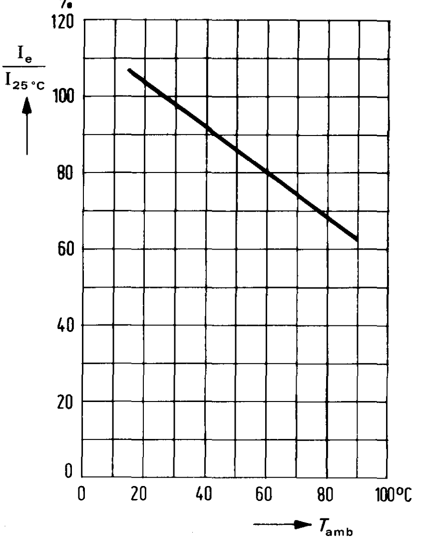
Characteristics		LD 260 to LD 269	
Wavelength of radiation at I_{max}	λ_{Imax}	950	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	± 20	nm
Radiation power output Φ_e			
at $I_F = 50$ mA	Φ_e	0.32 to 2.50	mW
at $\varphi = 30°$			
typ. total value	Φ_e	2.0	mW
Half-life of radiant intensity (typ.) for $I_F = 50$ mA		10^5	h
Switching times			
(Φ_e from 10% to 90%; $I_F = 50$ mA)	t_r; t_f	1.7	µs
Capacitance at $V_R = 0$ V	C_0	120	pf
Forward voltage ($I_F = 50$ mA)	V_F	1.3 (<2)	V
Breakdown voltage ($I_R = 100$ µA)	$V_{(BR)}$	30 (>4)	V
Reverse current ($V_R = 3$ V)	I_R	0.001 (<10)	µA

[1]) Upon request, LED arrays are available with a closer Φ_e (30°) scatter per array

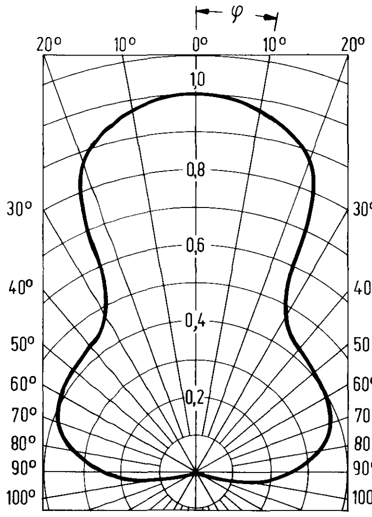
Cone of radiation as a function of half-angle φ



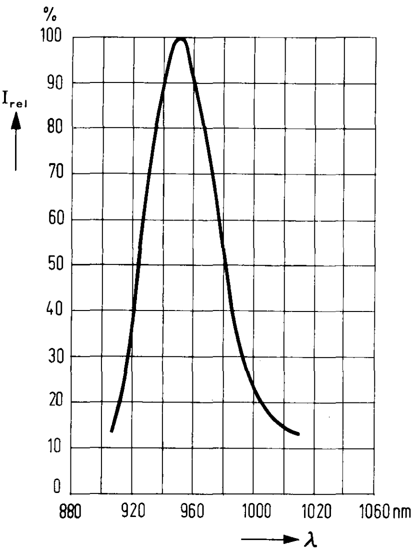
Radiant intensity $\frac{I_e}{I_{e\,25°}} = f(T_{amb})$



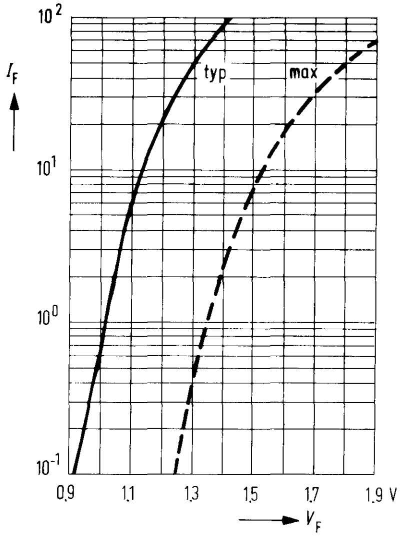
Radiation characteristic $I_{rel} = f(\varphi)$



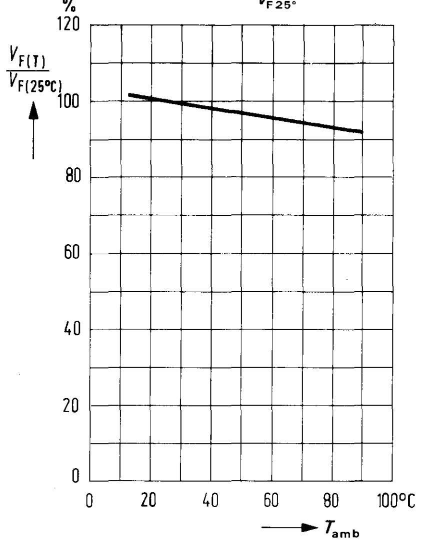
Relative spectral sensitivity $I_{rel} = f(\lambda)$



Forward voltage $V_F = f(I_F)$



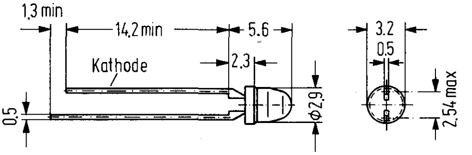
Forward voltage $\frac{V_F}{V_{F25°}} = f(T_{amb})$



GaAsP visible Light-emitting diodes (red light)

LD 30 B and LD 30 C are GaAsP LEDs emitting red light when operated in forward direction. These diodes are primarily suitable for use as optical indicators for the operating control or the indication of operation of instruments using discrete and integrated semiconductor components, respectively. Due to the very low consumption of current, a very low self-heating and a high vibration resistance, these LEDs may be used in fields where signal lamps of conventional design have proved useful only in adequately, if at all. LD 30 B may also be driven by TTL integrated circuits. LD 30 B has a red, diffuse case and LD 30 C a clear case.

Type	Order number
LD 30 B	Q62705-P21-F39
LD 30 C	Q62705-P22-F39

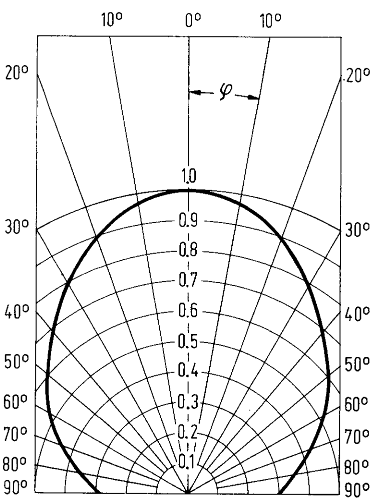


Weight approx. 0.2 g   Dimensions in mm

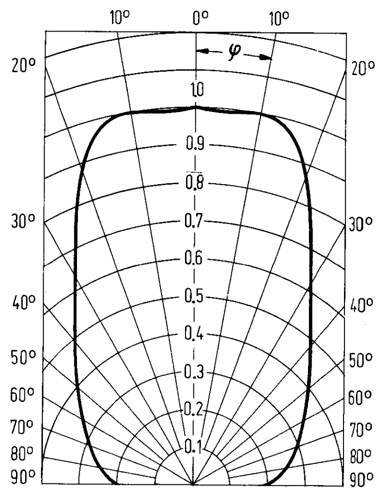
Maximum ratings		LD 30 B	LD 30 C	
Reverse voltage	V_R	3	3	V
Forward current	I_F	50	50	mA
Surge current ($t \leqq 1\ \mu s$)	i_{FS}	1	1	A
Storage temperature	T_S	−55 to +100		°C
Soldering temperature 2 mm away from case bottom ($t \leqq 7$ s)	T_L	230	230	°C
Power dissipation ($T_{amb} = 25$ °C)	P_{tot}	100	100	mW

Characteristics (T_{amb} = 25 °C)		LD 30 B	LD 30 C	
Light intensity (I_F = 20 mA)	I_V	0.8 (>0.3)	0.8 (>0.3)	mcd
Wavelength of emitted light	λ_{Imax}	655±15	655±15	nm
Spectral bandwidth for 50% of I_{max}	$\Delta\lambda$	30	30	nm
Limits for 50% of the light intensity I_V cone of apex angle	φ	60	40	degree
Forward voltage (I_F = 20 mA)	V_F	1.6 (<2)	1.6 (<2)	V
Reverse current at V_R = 3 V	I_R	0.1 (<10)	0.1 (<10)	µA
Capacitance (V_R = 0 V)	C_O	200	200	pf
Switch-on time	t_{on}	10	10	ns
Switch-off time	t_{off}	10	10	ns

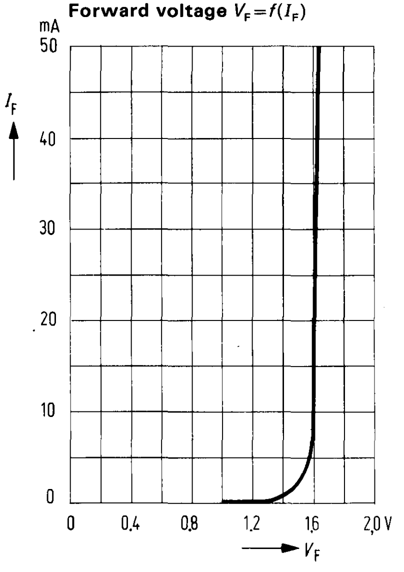
Radiation characteristic $I_{rel} = f(\varphi)$
LD 30 B



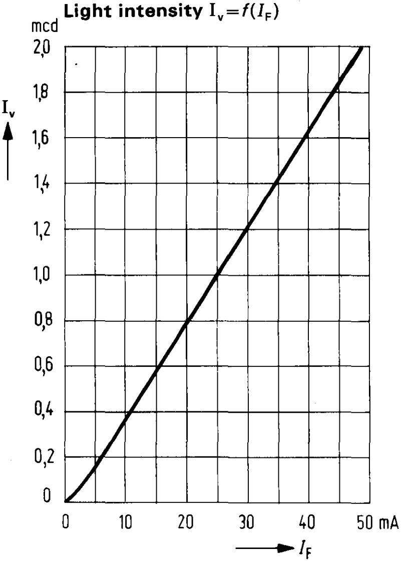
Radiation characteristic $I_{rel} = f(\varphi)$
LD 30 C



Forward voltage $V_F = f(I_F)$

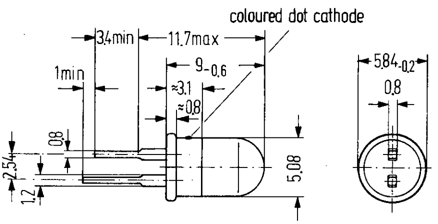


Light intensity $I_v = f(I_F)$

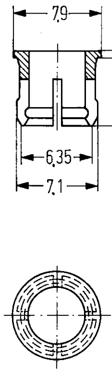


GaAsP visible Light emitting diodes (red light)

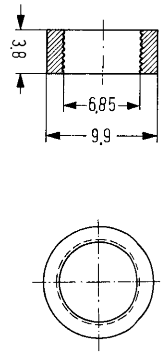
LD 40 I and LD 40 II are GaAsP LEDs emitting red light when operated in forward direction. These diodes are primarily designed for use as optical indicators for the operation control or the indication of operation of instruments using discrete or integrated semiconductor components, respectively. Due to their low current consumption, a low self-heating and a high vibration resistance, these diodes may be used in fields where signal lamps of conventional design have proved useful only inadequately, if at all. The LEDs may also be driven by TTL integrated circuits.



Weight approx. 0.2 g
Dimensions in mm



Mounting sleeve for LD 40



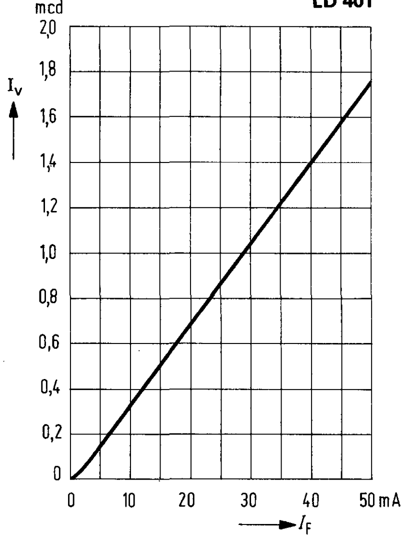
Mounting ring for LD 40

Type	Order number
LD 40/I	Q 62703-P 2-F 39
LD 40/II	Q 62703-P 3-F 39
Mounting sleeve	Q 62902-B 84-F 39 clear
Mounting sleeve	Q 62902-B 85-F 39 black
Mounting ring	Q 62902-B 110-F 39 black

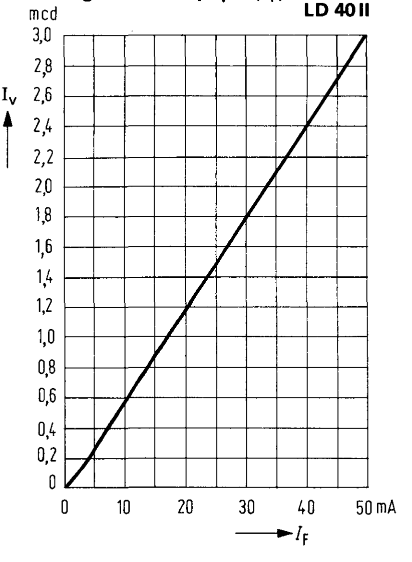
Maximum ratings		LD 40/I	LD 40/II	
Reverse voltage	V_R	3	3	V
Forward current	I_F	50	50	mA
Surge current ($t \leqq 1$ μs)	i_{FS}	1	1	A
Insulation voltage between terminals and sleeve	V	300	300	V
Operation and storage temperature	T_S	−55 to +100		°C
Soldering temperature for ($t \leqq 7$ s)	T_L	230	230	°C
Power dissipation ($T_{amb} = 25$ °C)	P_{tot}	100	100	mW

Characteristics (T_{amb} = 25 °C)		LD 40/I	LD 40/II	
Light intensity (I_F = 20 mA)	I_V	0.7 (0.3)	1.2 (0.8)	mcd
Wavelength of emitted light	λ_{Imax}	655	655	nm
Spectral bandwidth for 50% of I_{max}	$\Delta\lambda$	±15	±15	nm
Switch-on time	t_{on}	10	10	ns
Switch-off time	t_{off}	10	10	ns
Forward voltage (I_F = 20 mA)	V_F	1.6 (<2)	1.6 (<2)	V
Reverse current at V_R = 3 V	I_R	10	10	µA
Code colour		orange	white	

Light intensity $I_V = f(I_F)$ **LD 40 I**

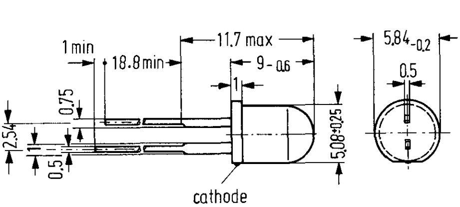


Light intensity $I_V = f(I_F)$ **LD 40 II**



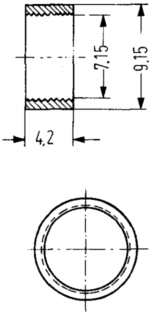
GaAsP visible Light emitting diodes (red light)

LD 50 is a GaAsP LED emitting red light when operated in forward direction. This diode is primarily designed for use as an optical indicator for the operation control or the indication of operation of instruments using discrete and integrated semiconductor components, respectively. Due to its low current consumption, a low self-heating and a high vibration resistance, this LED may be used in fields where signal lamps of conventional design have proved useful only inadequately, if at all. The diode may also be driven by TTL integrated circuits.

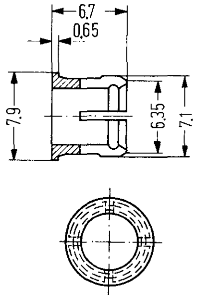


Weight approx. 0.2 g

Dimensions in mm



Mounting ring for LD 50



Mounting sleeve for LD 50

Type	Order number
LD 50/I	Q 62703-Q 53-F 97
LD 50/II	Q 62703-Q 54-F 97
Mounting sleeve	Q 62902-B 104-F 97 clear
Mounting ring	Q 62902-B 105-F 97 clear

Maximum ratings		LD 50/I	LD 50/II	
Reverse voltage	V_R	5	5	V
Forward current	I_F	100	100	mA
Surge current ($t \leq 1$ μs)	i_{FS}	1	1	A
Operation and storage temperature	T_S	−55 to +100		°C
Soldering temperature 2 mm away from case bottom ($t = 5$ s)	T_L	260	260	°C
Power dissipation	P_{tot}	180	180	mW

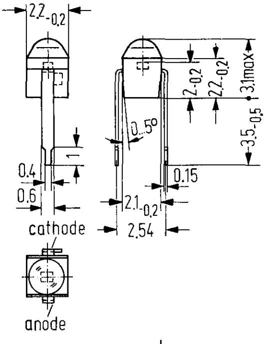
Characteristics				
Light intensity ($I_F = 10$ mA)	I_V	2 (>1)	3 (>2)	mcd
Wavelength of emitted light	λ_{Imax}	650 ± 15	650 ± 15	nm
Spectral bandwidth for 50% of I_{max}	$\Delta\lambda$	30	30	nm
Cone of apex angle (limits for 50% of light intensity I_V)	φ	12	12	degree
Forward voltage ($I_F = 10$ mA)	V_F	1.8(<2.2)	1.8(<2.2)	V
Reverse current at $V_R = 5$ V	I_R	<100	<100	μA
Switch-on time	t_{on}	50	50	ns
Switch-off time	t_{off}	50	50	ns
Code colour		none	white	

GaAsP visible Light emitting diode (red light) in 1/10″ grid system

LD 461 emits visible red light when current flows in forward direction. The diode with its white diffuse plastic package has a lens on the side of light emergence and soldering tab leads in a basic grid system of 1/10″.
The cathode lead is marked by a stub on the soldering tab.

On account of its low current consumption this diode is TTL compatible and is used as an optical indicator for operation control of electronic circuits. In the form of arrays (LD 460 to LD 469) the diodes may be used to build up complete indicator arrangements, as for letters and scales.

Type	Order number
LD 461	Q62703-Q79

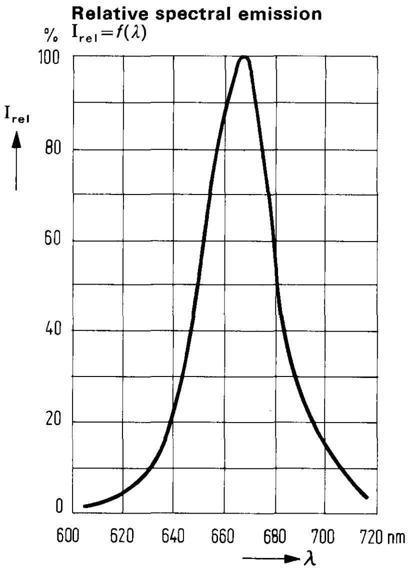


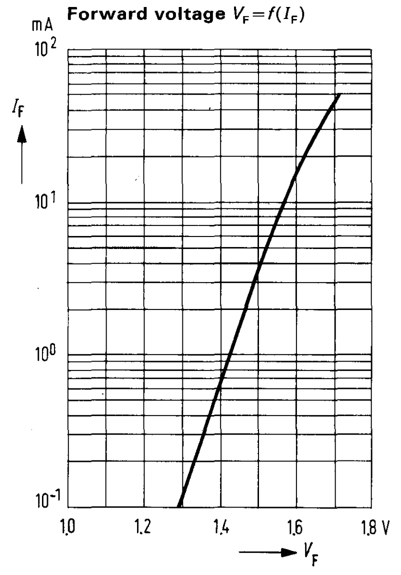
Dimensions in mm

Weight approx. 0.02 g

Maximum ratings		LD 461	
Reverse voltage	V_R	3	V
Forward current	I_F	50	mA
Maximum forward current	I_{FM}	0.2	A
Storage temperature	T_S	−30 to +90	°C
Junction temperature	T_j	90	°C
Soldering temperature 2 mm away from case bottom at ($t \leqq 3$ s)	T_L	230	°C
Power dissipation	P_{tot}	85	mW
Thermal resistance	R_{thJamb}	750	K/W

Characteristics			
Light intensity ($I_F = 20$ mA)	I_V	1 (>0.3)	mcd
Wavelength of emitted light	λ_{Imax}	665±15	nm
Spectral bandwidth for 50% of I_{max}	$\Delta\lambda$	30	nm
Cone of apex angle-limits for 50% of light intensity I_V	φ	35	degree
Forward voltage ($I_F = 20$ mA)	V_F	1.6 (<2.0)	V
Reverse current ($V_R = 3$ V)	I_R	0.01 (<10)	µA
Switch-on time	t_{on}	5	ns
Switch-off time	t_{off}	5	ns
Capacitance at			
($V_R = 0$ V)	C_0	60	pf
($V_R = 3$ V)	C_3	35	pf

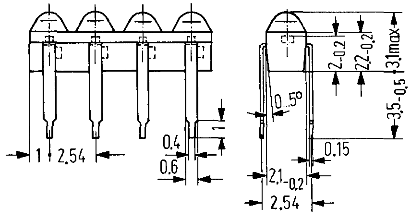

Relative spectral emission
% $I_{rel} = f(\lambda)$
100
I_{rel}
80
60
40
20
0
600
620
640
660
680
700
720 nm
λ


Forward voltage $V_F = f(I_F)$
mA
10^2
I_F
10^1
10^0
10^{-1}
1.0
1.2
1.4
1.6
1.8 V
V_F

GaAsP visible Light emitting diode arrays (red light) in 1/10″ grid system

LD 460 to LD 469 are GaAsP LEDs in a white, diffuse plastic package consisting of an arrangement of a maximum of 10 LEDs LD 461 in one row. The diodes emit red light when current flows in forward direction. The spacing of the individual diodes corresponds to the standard basic grid system of 1/10″. The third digit of the type designation equals the number of LEDs contained per array (e.g. LD 464 is an array of 4 diodes).

Type	Order number
LD 462	Q62703-Q80
LD 463	Q62703-Q81
LD 464	Q62703-Q82
LD 465	Q62703-Q83
LD 466	Q62703-Q84
LD 467	Q62703-Q85
LD 468	Q62703-Q86
LD 469	Q62703-Q87
LD 460	Q62703-Q88

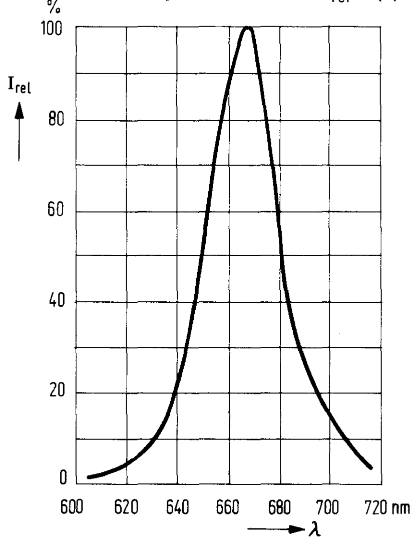


Sample with 4 LED's
(e.g. LD 464)

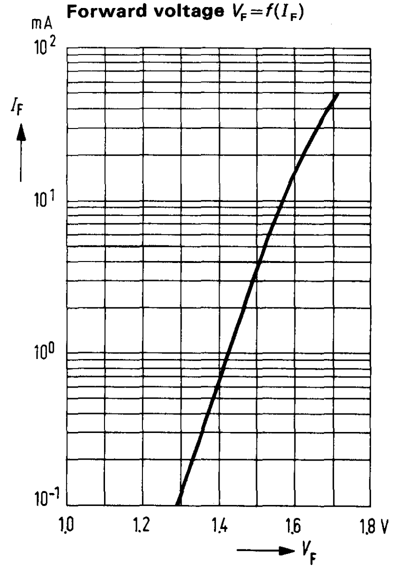
Maximum ratings (single diode)		LD 460 to LD 469	
Reverse voltage	V_R	3	V
Forward current	I_F	50	mA
Maximum forward current	I_{FM}	0.2	A
Storage temperature	T_s	−30 to +80	°C
Junction temperature	T_j	90	°C
Soldering temperature 2 mm away from case bottom ($t \leqq 3$ s)	T_L	230	°C
Power dissipation	P_{tot}	85	mW
Thermal resistance	R_{thJamb}	750	K/W

Characteristics ($T_{amb}=25\,°C$)		LD 460 to LD 469	
Light intensity ($I_F=20$ mA)	I_v	1 (>0.3)	mcd
Wavelength of emitted light	λ_{Imax}	665 ± 15	nm
Spectral bandwidth for 50% of I_{max}	$\Delta\lambda$	30	nm
Cone of apex angle (limits for 50% of the light intensity I_v)	φ	35	degree
Forward voltage ($I_F=20$ mA)	V_F	1.6 (<2.0)	V
Reverse current ($V_R=3$ V)	I_R	0.01 (<10)	µA
Capacitance ($V_R=0$ V)	C_0	60	pf
($V_R=3$ V)	C_3	35	pf
Switch-on time	t_{on}	5	ns
Switch-off time	t_{off}	5	ns

Relative spectral emission $I_{rel}=f(\lambda)$



Forward voltage $V_F=f(I_F)$



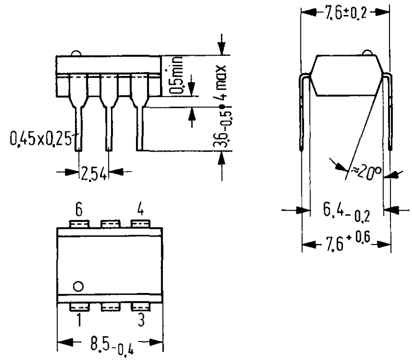
Optoelectronic Couplers

Optoelectronic coupler with a particularly large current transmission ratio

The coupled isolator CNY 17 has a GaAs light-emitting diode as a emitter, which is optically coupled with a silicon planar photo transistor as a detector. The component is incorporated in a plastic plug-type case 20 A 6 DIN 41866.

The optical coupler permits a transmission of signals within two electrically separated circuits. The potential difference between the circuits to be coupled may not exceed the maximum permissible insulating voltage.

Type	Order number
CNY 17 I	Q 62703-N 1-S 1
CNY 17 II	Q 62703-N 1-S 2
CNY 17 III	Q 62703-N 1-S 3
CNY 17 IV	Q 62703-N 1-S 4



Weight approx. 0.7 g Dimensions in mm

Light-emitting diode **emitter**	1 anode 2 cathode 3 not wired
Photo transistor **detector**	4 emitter 5 collector 6 base

Maximum ratings

		CNY 17	
Emitter (GaAs light-emitting diode)			
Reverse voltage	V_R	3	V
Forward current	I_F	60	mA
Maximum forward current	I_{FM}	200	mA
Surge current ($t \leq 1$ µs)	i_{FS}	1.5	A
Power dissipation	P_{tot}	100	mW
Detector (Si photo transistor)			
Collector-emitter reverse voltage	V_{CEO}	32	V
Emitter-base reverse voltage	V_{EBO}	5	V
Collector current	I_C	150	mA
Power dissipation	P_{tot}	150	mW
Coupler			
Storage temperature	T_S	−55 to +125	°C
Operation temperature	T	−55 to +100	°C
Soldering temperature 2 mm away from case bottom ($t \leq 3$ s)	T_L	230	°C
Insulation voltage between Emitter and Detector referred to dry, ambient climate 23/50 DIN 50014	V_{is}	2500	V

Characteristics ($T_{amb}=25\,°C$)

Emitter (GaAs light-emitting diode)

		CNY 17	
Forward voltage ($I_F=60$ mA)	V_F	1.25 (<1.65)	V
Reverse current ($V_R=3$ V)	I_R	0.35 (<10)	µA
Capacitance ($V_R=0$ V; $f=1$ MHz)	C_0	45	pf

Detector (Si photo transistor)

Forward current transfer ratio ($V_{CE}=5$ V; $I_C=100$ µA)	h_{FE}	>100	–
Collector-emitter cutoff current ($V_{CE}=10$ V)	I_{CEO}	2 (<50)	nA
Capacitance ($V_{CE}=0$ V; $f=1$ MHz)	C_{CE}	15	pf

Coupler

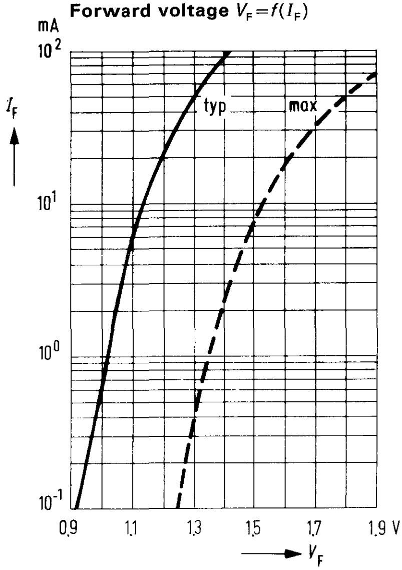
The couplers are grouped according to their current transmission ratio $\frac{I_C}{I_F}$ (at $I_F=10$ mA; $V_{CE}=5$ V) and denoted by Roman numerals.

Type	CNY17					
Group	0[1])	I	II	III	IV	
$\frac{I_C}{I_F}$	<10	40 to 80	63 to 125	100 to 200	160 to 320	%

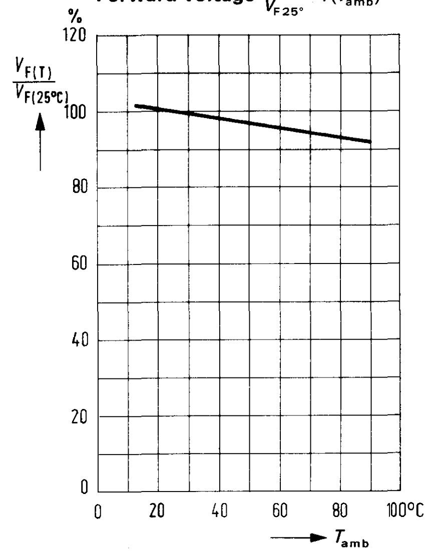
[1]) With reduced static value.

Collector-emitter saturation voltage ($I_F=10$ mA; $I_C=2.5$ mA)	V_{CEsat}	0.3	V
Coupling capacitance	C_C	0.34	pf
Creeping path, minimum		8.2	nm

Forward voltage $V_F=f(I_F)$



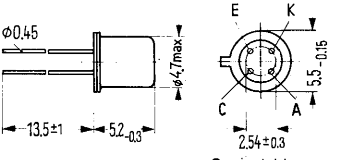
Forward voltage $\frac{V_F}{V_{F25°}}=f(T_{amb})$



Optoelectronic coupler

The coupled isolator CNY 18 has a GaAs light-emitting diode as a emitter, which is optically coupled with a silicon planar photo transistor as a detector. The component is incorporated in a case 18 A 4 DIN 41876 (TO-72). The collector of the photo transistor is electrically connected to the metal case. The coupler permits the transmission of signals within two electrically separate circuits. The potential difference between the circuits to be coupled may not exceed the maximum permissible insulation voltage.

Type	Order number
CNY 18 I	Q 62703-N 2-S 1
CNY 18 II	Q 62703-N 2-S 2
CNY 18 III	Q 62703-N 2-S 3
CNY 18 IV	Q 62703-N 2-S 4



C connected to case

Weight approx. 0.4 g   Dimensions in mm

Maximum ratings

Emitter (GaAs light-emitting diode)

		CNY 18	
Reverse voltage	V_R	3	V
Forward current	I_F	60	mA
Maximum forward current	I_{FM}	200	mA
Surge current ($t \leqq 1$ µs)	i_{FS}	1.5	A
Power dissipation	P_{tot}	100	mW

Detector (Si photo transistor)

Collector-emitter reverse voltage	V_{CEO}	32	V
Emitter-base reverse voltage	V_{EBO}	5	V
Collector current	I_C	150	mA
Power dissipation	P_{tot}	150	mW

Coupler

Storage temperature	T_S	−55 to +125	°C
Operation temperature	T	−55 to +125	°C
Soldering temperature 2 mm away from case bottom (($t \leqq 3$ s)	T_L	230	°C
Insulation voltage between Emitter and Detector referred to dry ambient climate 23/50 DIN 50014	V_{is}	500	V

Characteristics ($T_{amb}=25\,°C$)

Emitter (GaAs light-emitting)		**CNY 18**	
Forward voltage ($I_F=60$ mA)	V_F	1.25 (<1.7)	V
Reverse current ($V_R=3$ V)	I_R	0.35 (<10)	µA
Capacitance ($V_R=0$ V; $f=1$ MHz)	C_0	50	pf

Detector (Si photo transistor)

Forward current transfer ratio ($V_{CE}=5$ V; $I_C=100\,\mu A$)	h_{FE}	>100	
Collector-emitter cutoff current ($V_{CE}=10$ V)	I_{CEO}	2 (<100)	nA
Capacitances			
($V_{CE}=0$ V; $f=1$ MHz)	C_{CE}	7	pf
($V_{CE}=10$ V; $f=1$ MHz)	C_{CE}	3.5	pf
($V_{CE}=30$ V; $f=1$ MHz)	C_{CE}	2.5	pf

Couplers

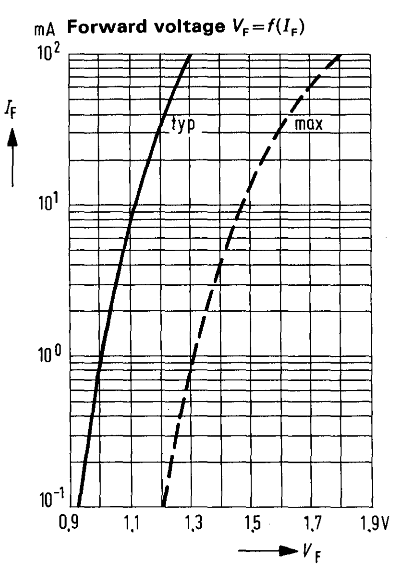
The couplers are grouped according to their current transmission ratio $\frac{I_C}{I_F}$ at ($I_F=$ 10 mA; $V_{CE}=5$ V) and denoted by Roman numerals.

Type	CNY 18				
Group	I	II	III	IV	
$\frac{I_C}{I_F}$	10 to 20	16 to 32	25 to 50	40 to 80	%

Collector-emitter saturation voltage ($I_F=10$ mA; $I_C=1.0$ mA)	V_{CEsat}	0.1 (<0.2)	V

Coupling Capacitances ($f=1$ MHz)

Light-emitting diode		**Photo transistor**			
Anode-cathode short-circuited	→	Emitter-collector short-circuited	C	1.4	pf
Anode-cathode short-circuited	→	Collector (emitter conn. to frame)	C	1.1	pf
Anode-cathode short-circuited	→	Emitter (collector conn. to frame)	C	0.1	pf


mA Forward voltage $V_F = f(I_F)$
10^2
10^1
10^0
10^{-1}
I_F
typ
max
0,9
1,1
1,3
1,5
1,7
1,9 V
V_F

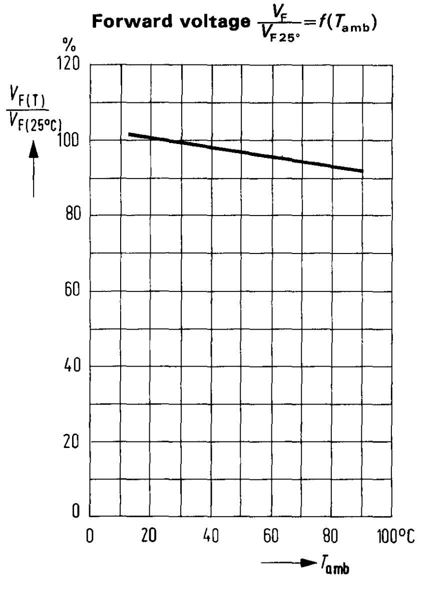
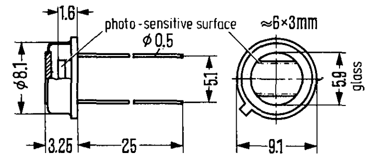

Forward voltage $\frac{V_F}{V_{F25°}} = f(T_{amb})$
%
120
100
80
60
40
20
0
$\frac{V_{F(T)}}{V_{F(25°C)}}$
0
20
40
60
80
100°C
T_{amb}

Photo resistors

Photo resistor

RPY 60 is a cadmium selenide photo resistor in a hermetically closed glass-case similar to TO-5 with a glass window for frontal illumination. The leads are insulated from the case. The photo resistor is characterized by short decay times.

Type	Order number
RPY 60	Q62717-P3



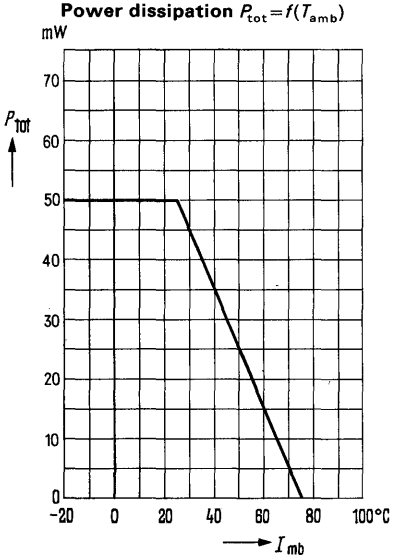
Weight approx. 2 g Dimensions in mm

Maximum ratings		RPY 60	
Power dissipation	P_{tot}	50	mW
Operating voltage	V_a	100	V
Ambient temperature	T_{amb}	−40 to +75	°C

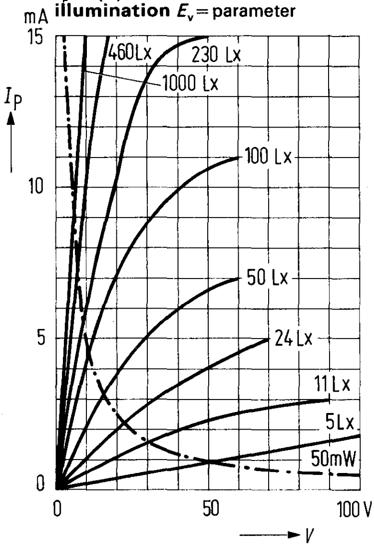
Characteristics (T_{amb}=25 °C)

Dark resistance after 1 min darkness	R_0	$\geqq 1 \cdot 10^8$	Ω
Light resistance (E_v=1000 lx)	R_{1000}	300 to 800	Ω
Wavelength of spectral sensitivity	λ_{Smax}	0.72	µm
Temperature coefficient of I_K (E_v=1000 lx; T_{amb}=−25 to +75 °C)	TC	1	%/K
Rise time for the change of resistance from R_0 to 65% of R_{1000}	t_r	1 to 3	ms

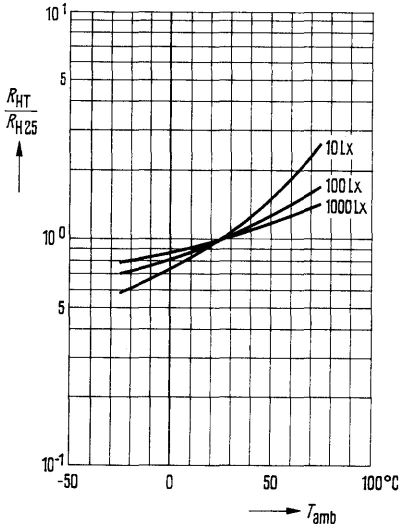
Power dissipation $P_{tot}=f(T_{amb})$



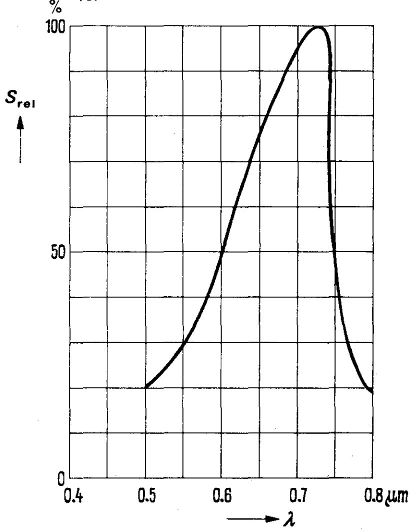
Current-voltage characteristics
$I_p=f(V)$
illumination E_v= parameter



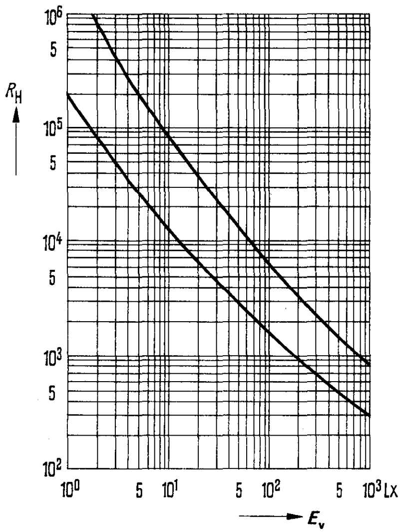
Light resistance as a function of temperature $\frac{R_{HT}}{R_{H25}} = f(T_{amb})$



Relative spectral sensitivity $S_{rel} = f(\lambda)$



Light resistance as a function of illumination $R_H = f(E_v)$
(scatter)



Rise and fall time of the photo-current to 65% of end value as function of illumination $t = f(E_v)$

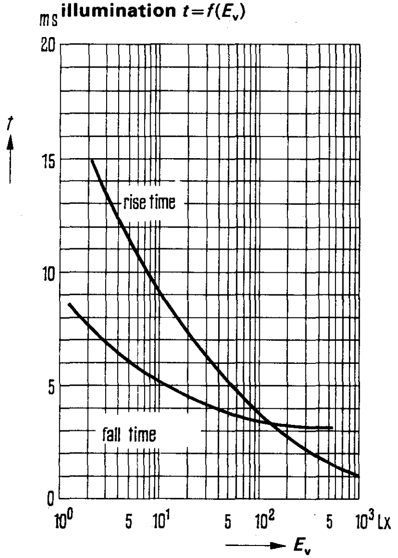
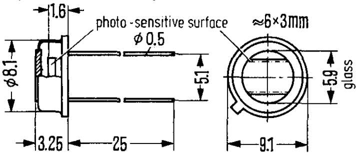


Photo resistor

RPY 61 is a cadmiumsulphoselenide photo resistor in a hermetically closed glass case similar to TO-5 with a glass window for frontal illumination. The leads are insulated from the case. The photo resistor is characterized by short decay times.

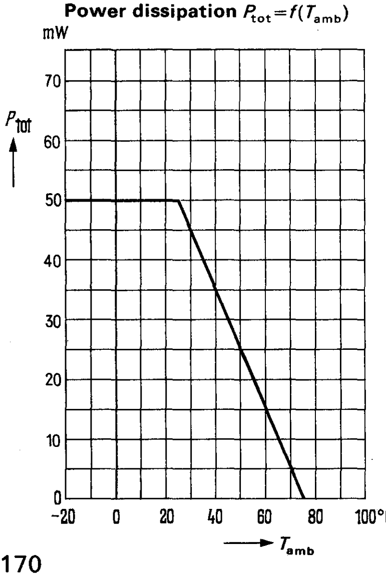
Type	Order number
RPY 61	Q62717-P4



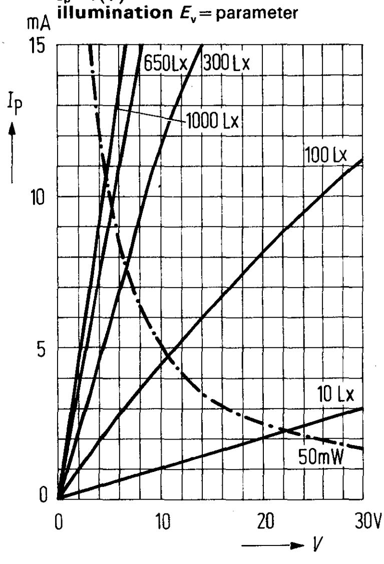
Weight approx. 2 g Dimensions in mm

		RPY 61	
Maximum ratings			
Power dissipation	P_{tot}	50	mW
Operating voltage	V_a	50	V
Ambient temperature	T_{amb}	−40 to +75	°C
Characteristics (T_{amb}=25 °C)			
Dark resistance after 1 min darkness	R_0	$\geqq 1 \cdot 10^6$	Ω
Light resistance (E_v=1000 lx)	R_{1000}	300 to 800	Ω
Wavelength of spectral sensitivity	λ_{Smax}	0.65	µm
Temperature coefficient (E_v=1000 lx; T_{amb}=−25 to +75 °C)	TC	0.8	%/K
Rise time for the change of resistance from R_0 to 65% of R_{1000}	t_r	2 to 6	ms

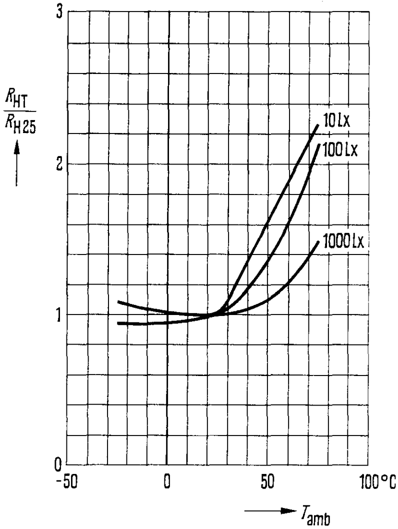
Power dissipation $P_{tot}=f(T_{amb})$



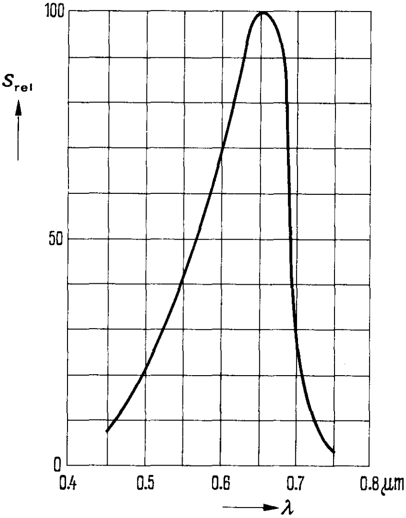
Current-voltage characteristics
$I_p=f(V)$
illumination E_v = parameter



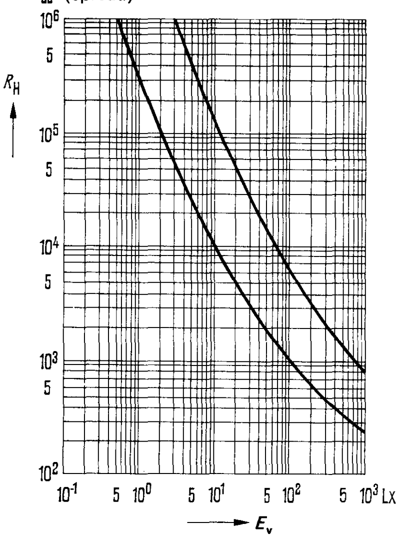
Light resistance as a function of temperature $\frac{R_{HT}}{R_{H25}}=f(T_{amb})$



Relative spectral sensitivity
$\% S_{rel}=f(\lambda)$



Light resistance as a function of illumination $R_H=f(E_v)$
Ω (spread)



Rise and fall time of the photo current to 65% of end value as function of illumination $t=f(E_v)$
ms

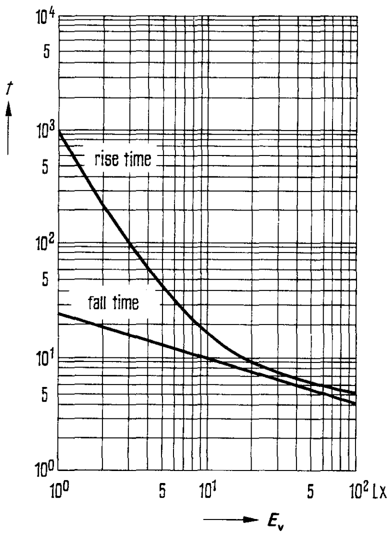
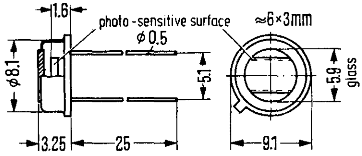


Photo resistor

RPY 62 is a cadmiumsulphoselenide photo resistor in a hermetically closed glass case similar to TO-5 with a glass window for frontal illumination. The leads are insulated from the case. The photo resistor is characterized by short decay times.

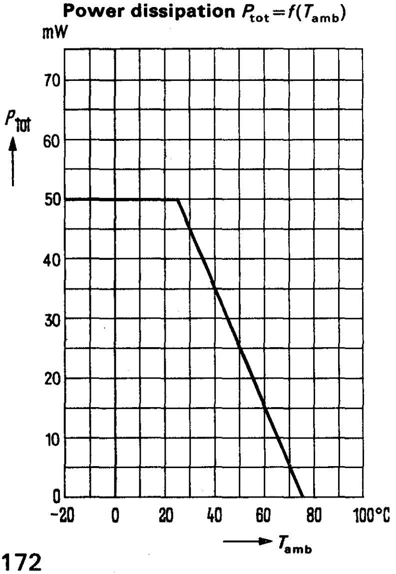
Type	Order number
RPY 62	Q62717-P5



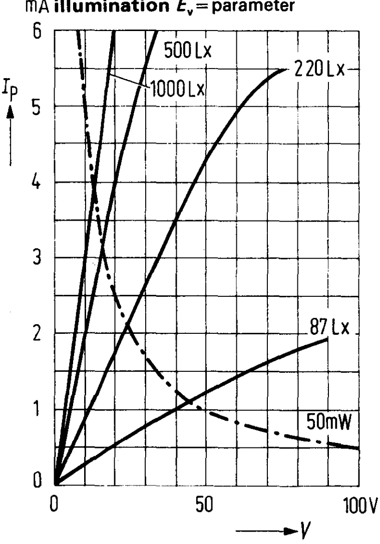
Weight approx. 2 g Dimensions in mm

		RPY 62	
Maximum ratings			
Power dissipation	P_{tot}	50	mW
Operating voltage	V_a	100	V
Ambient temperature	T_{amb}	−40 to +75	°C
Characteristics (T_{amb} = 25 °C)			
Dark resistance after 1 min darkness	R_0	$\geq 1 \cdot 10^8$	Ω
Light resistance (E_v = 1000 lx)	R_{1000}	3500	Ω
Wavelength of spectral sensitivity	λ_{smax}	0.55	µm
Temperature coefficient (E_v = 1000 lx; T_{amb} = −25 to +75 °C)	TC	0.4	%/K
Rise time for the change of resistance from R_0 to 65% of R_{1000}	t_r	10 to 20	ms

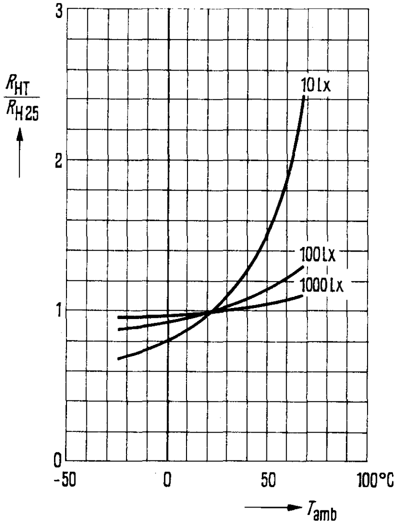
Power dissipation $P_{tot} = f(T_{amb})$



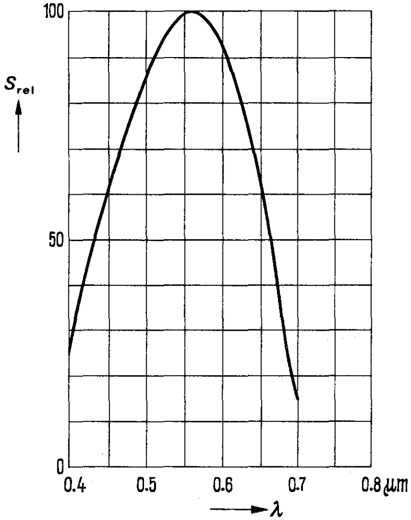
Current-voltage characteristics
$I_p = f(V)$
illumination E_v = parameter



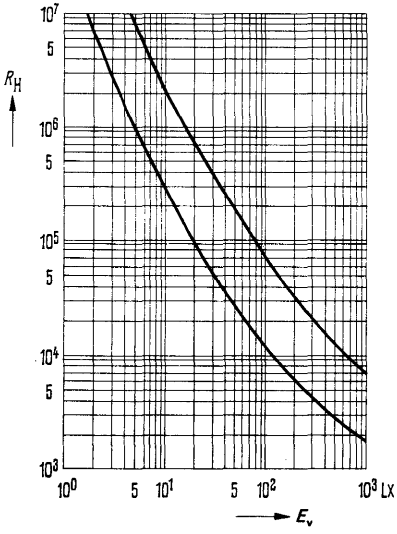
Light resistance as a function of temperature $\frac{R_{HT}}{R_{H25}} = f(T_{amb})$



Relative spectral sensitivity
% $S_{rel} = f(\lambda)$



Light resistance as a function of illumination $R_H = f(E_v)$
Ω (spread)



Rise and fall time of the photo current to 65% of end value as function of illumination $t = f(E_v)$
ms

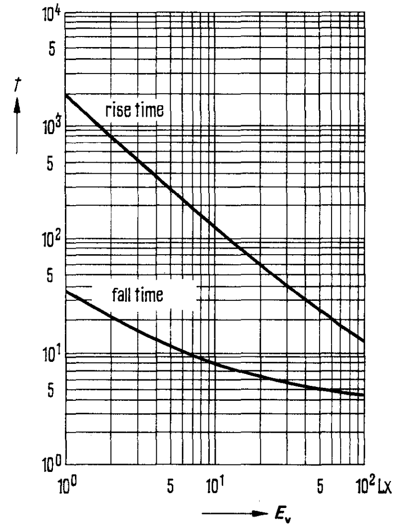
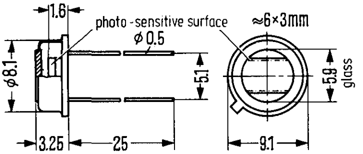


Photo resistor

RPY 63 is a cadmiumsulphoselenide photo resistor in a hermetically closed glass case similar to TO-5 with a glass window for frontal illumination. The leads are insulated from the case. The photo resistor is characterized by short decay times.

Type	Order number
RPY 63	Q62717-P6



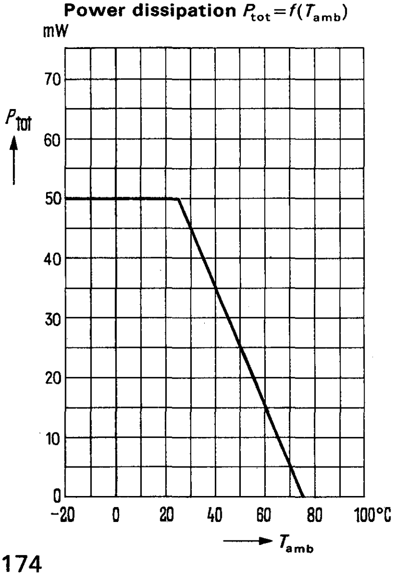
Weight approx. 2 g Dimensions in mm

Maximum ratings		RPY 63	
Power dissipation	P_{tot}	50	mW
Operating voltage	V_a	50	V
Ambient temperature	T_{amb}	−40 to +75	°C

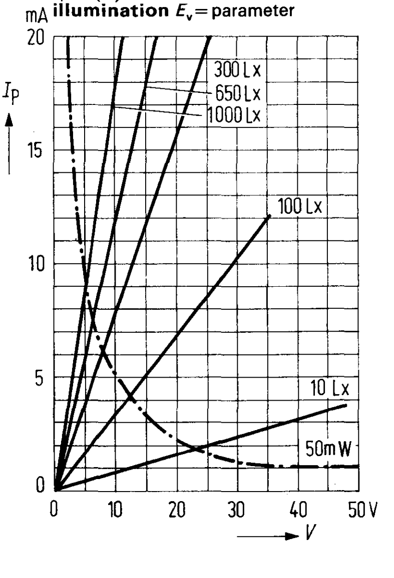
Characteristics (T_{amb}=25 °C)

Dark resistance after 1 min darkness	R_0	$\geqq 1 \cdot 10^6$	Ω
Light resistance (E_v=1000 lx)	R_{1000}	300 to 800	Ω
Wavelength of max. photo sensitivity	λ_{Smax}	0.55	µm
Temperature coefficient (E_v=1000 lx; T_{amb}=−25 to +75 °C)	TC	0.4	%/K
Rise time for the change of resistance from R_0 to 65% of R_{1000}	t_r	10 to 20	ms

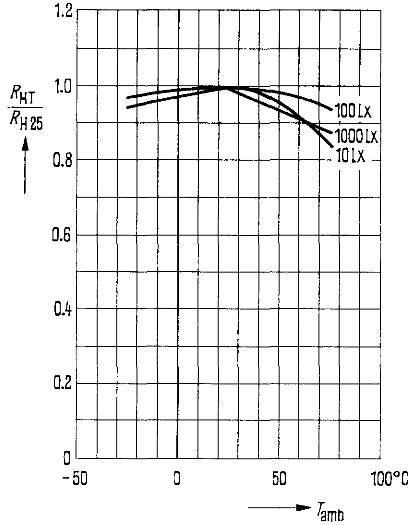
Power dissipation $P_{tot}=f(T_{amb})$



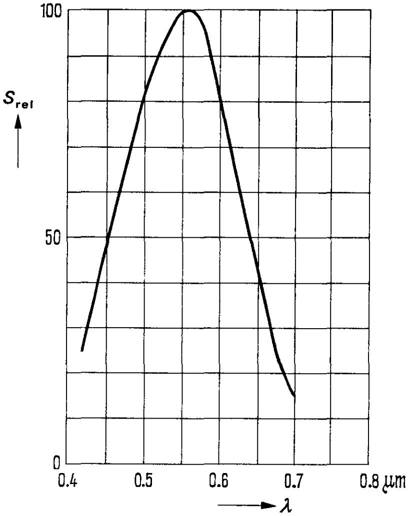
Current-voltage characteristics
$I_p=f(V)$
illumination E_v= parameter



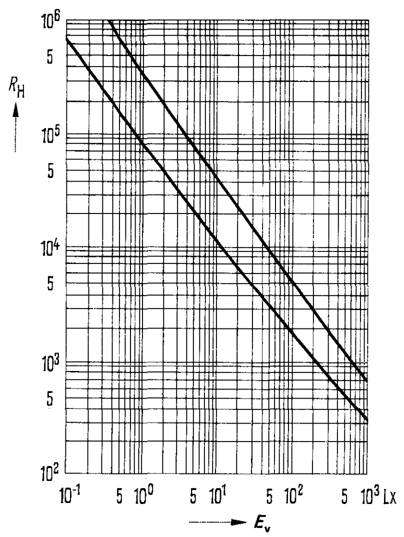
Light resistance as a function of temperature $\frac{R_{HT}}{R_{H25}}=f(T_{amb})$



Relative spectral sensitivity $S_{rel}=f(\lambda)$



Light resistance as a function of illumination $R_H=f(E_v)$



Rise and fall time of the photo current to 65% of end value as function of illumination $t=f(E_v)$

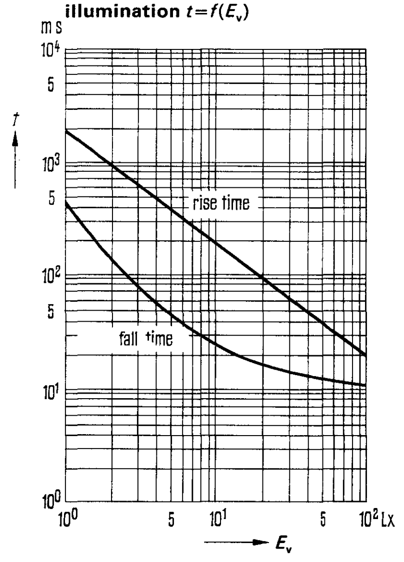
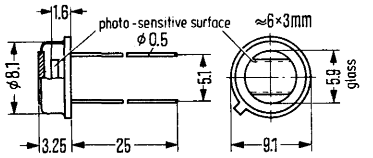


Photo resistor

RPY 64 is a cadmiumsulphide photo resistor in a hermetically closed glass case similar to TO-5 with a glass window for frontal illumination. The leads are insulated from the case. The photo resistor is characterized by short decay times.

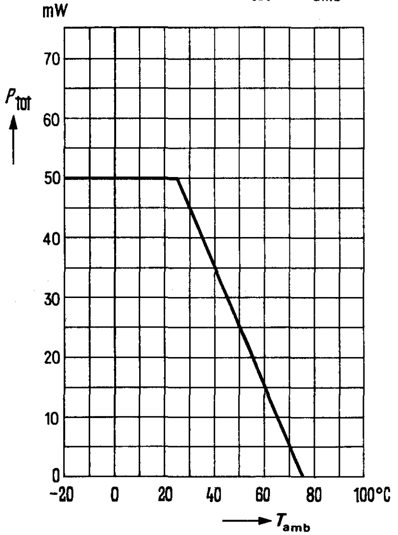
Type	Order number
RPY 64	Q62717-P7



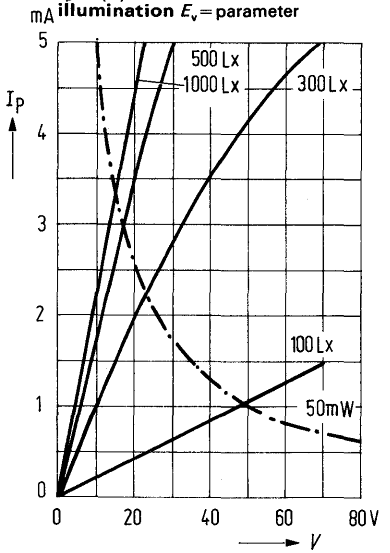
Weight approx. 2 g Dimensions in mm

		RPY 64	
Maximum ratings			
Power dissipation	P_{tot}	50	mW
Operating voltage	V_a	100	V
Ambient temperature	T_{amb}	−40 to +75	°C
Characteristics (T_{amb}=25 °C)			
Dark resistance after 1 min darkness	R_0	$\geqq 1 \cdot 10^8$	Ω
Light resistance (E_v=1000 lx)	R_{1000}	3500	Ω
Wavelength of max. photo sensitivity	λ_{Smax}	0.50	µm
Temperature coefficient (E_v=1000 lx; T_{amb}=−25 to +75 °C)	TC	0.4	%/K
Rise time for the change of resistance from R_0 to 65% of R_{1000}	t_r	30 to 50	ms

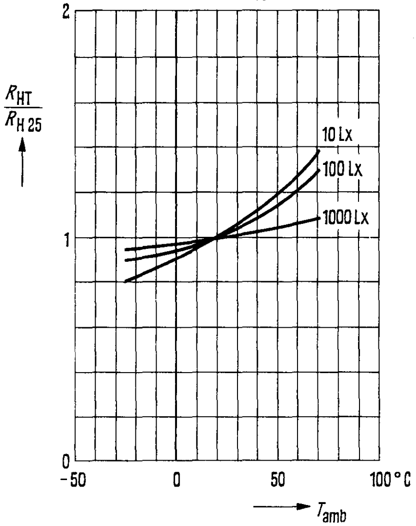
Power dissipation $P_{tot}=f(T_{amb})$



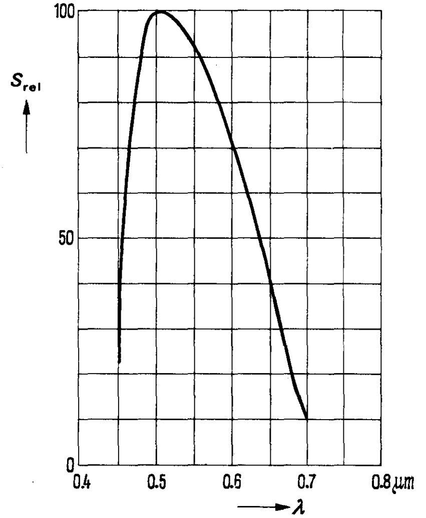
Current-voltage characteristics
$I_p=f(V)$
illumination E_v=parameter



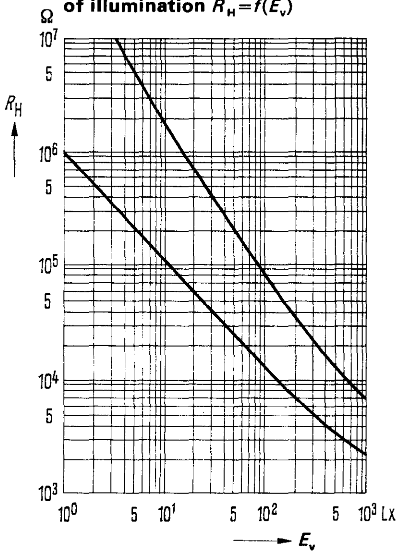
Light resistance as a function of temperature $\frac{R_{HT}}{R_{H25}} = f(T_{amb})$



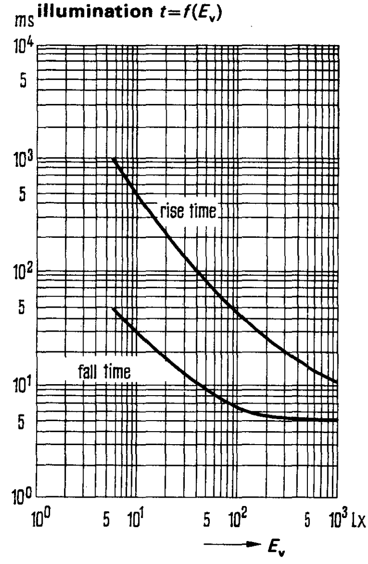
Relative spectral sensitivity
$\% S_{rel} = f(\lambda)$



Light resistance as a function of illumination $R_H = f(E_v)$



Rise and fall time of the photo current to 65% of end value as function of illumination $t = f(E_v)$



New Optoelectronic Components in Preparation

The following new optoelectronic components will shortly additionally be included in our delivery program: (Data sheets upon request)

Ga-As-P-Light emitting diodes (red light emitters)

Red light is emitted. When operated in forward direction. Applications: optical indicator and pilot lamp.

Type	Reverse voltage V_R (V)	Forward current I_F (mA)	Luminous intensity at $I_F = 20$ mA I_v (mcd)	Radiation conc. half angel (degree) φ	Power dissipation P_{tot} (mW)	Wavelength of emitted light λ (nm)	Case plastic	Outline
▼ **LD 30 A**	3	50	>0.5	60	100	655	red-diffuse	**1**
▼ **LD 41**	3	100	1.2 (>0.3)	35	180	655	red-diffuse	**3**

GA-As-P-LED-display (red light emitters)

Type	Reverse voltage V_R (V)	Forward current I_F (mA)	Luminance at $I_F = 5$ mA L_v (cd/m^2)	Luminous intensity at $I_F = 20$ mA I_v (μcd)	Power dissipation P_{tot} (mW)	Wavelength of emitted light λ (nm)	Case plastic	Outline
▼ **CQY 21**	3 [1]	10 [1] 80 [2]	700>350 [1] –	– –	160	660	red clear	**5**
▼ **CQY 22**	6	25 [1] 200 [2]	– –	0.25 (>0.1) [1]	400	655	red diffuse	**2**

Ga-P-Light emitting diodes (green light emitters)

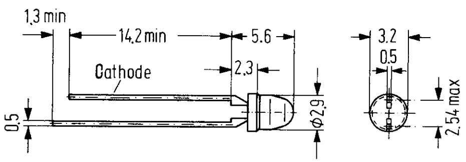
Type	Reverse voltage U_R (V)	Forward current I_F (mA)	Luminous intensity at $I_F = 20$ mA I_v (mcd)	Radiation conc. half angel (degree) φ	Power dissipation P_{tot} (mW)	Wavelength of emitted light λ (nm)	Case plastic	Outline
▼ **LD 37**	3	40	1 (>0.3)	60	100	560	green diffuse	**1**
▼ **LD 57**	3	50	1.5(>0.3)	40	185	560	green diffuse	**3**
▼ **LD 471** [3]	3	30	1 (>0.3)	40	85	560	green diffuse	**4**

Multiple photo transistor (Positions sensor)

Type	Collector Emitter-Reverse voltage V_{CE} (V)	Photo current $V_{CE} = 5$ V $E_v = 1000$ lx I_C (mA)	Collector-Emitter cuttoff current $V_{CE} = 25$ V; $E_v = 0$ lx I_{CEO} (nA)	Outline
▼ **BPX 77**	40	0.3	100	**6**

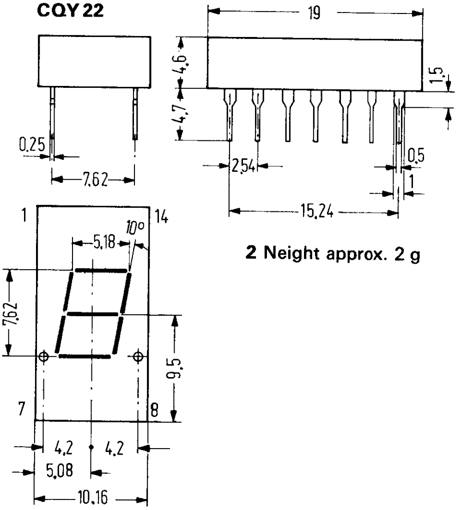
[1] for each segment [2] total value [3] LD 470 to LD 479-Ga-P-LED-Array on request ▼ New Type

LD 30 A, LD 37



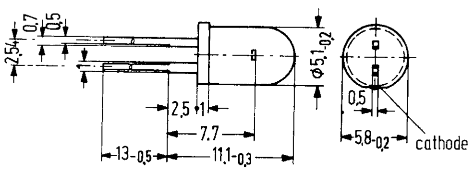
1 Weight approx. 0.2 g

CQY 22

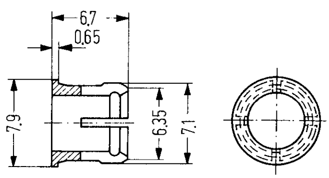


2 Neight approx. 2 g

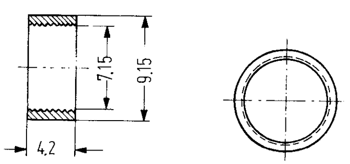
LD 41, LD 57



3 Weight approx. 0.2 g

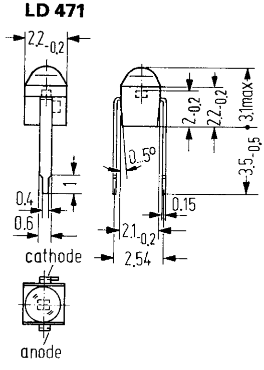


Mounting sleeve for LD 41 and LD 57



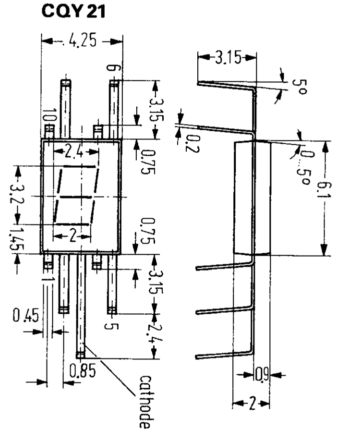
Mounting ring for LD 41 and LD 57

LD 471



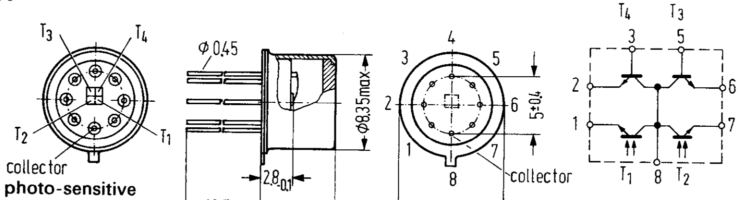
4 Weight approx. 0.02 g

CQY 21



5 Weight approx. 0.5 g

Outline and Circuits for multiple Phototransistor BPX 77



T_1, T_2 photo-sensitive systems

6 Weight approx. 2 g

Offices in the Federal Republik of Germany and West-Berlin

City	Street	Telefon	Telex
1000 Berlin 61	Schöneberger Straße 2–4 Postadress 1000 Berlin 11, P.O.B.	(030) 255-1	**183766**
2800 Bremen 1	Contrescarpe 72, P.O.B. 127	(0421) 364-1	**245451**
4600 Dortmund 1	Märkische Straße 8–14, P.O.B. 658	(0231) 548-1	**822312**
4000 Düsseldorf 1	Lahnweg 10, P.O.B. 1115	(0211) 3030-1	**8581301**
4300 Essen 1	Kruppstraße 16, P.O.B. 22	(02141) 2013-1	**857437**
6000 Frankfurt 1	Gutleutstraße 31, P.O.B. 2513	(0611) 262-1	**414131**
2000 Hamburg 1	Lindenplatz 2	(040) 282-1	**2162721**
3000 Hannover 1	Am Maschpark 1, P.O.B. 5329	(0511) 199-1	**922333**
5000 Köln 30	Franz-Geuer-Straße 10, P.O.B. 101688	(0221) 576-1	**8881006**
6800 Mannheim 1	N 7. 18, P.O.B. 2024	(0621) 296-1	**462261**
8000 München 80	Richard-Strauss-Straße 76 Postadress 8000 München 2, P.O.B. 202109	(089) 9221-1	**529421**
8500 Nürnberg 1	Richard-Wagner-Platz 1	(0911) 2016-1	**622251**
6600 Saarbrücken 3	Martin-Luther-Straße 25, P.O.B. 359	(0681) 3008-1	**4421431**
7000 Stuttgart 1	Geschwister-Scholl-Straße 24, P.O.B. 120	(0711) 2076-1	**723941**

Siemens Companies and Representatives

Europe

Austria
Siemens Aktiengesellschaft
Österreich
A-1030 Wien
Apostelgasse 12
[A-1031 Wien, P.O.B. 326]
Tel. (0222) 72930
Telex 11598, 11866

Belgium
Siemens Société Anonyme
B-1060 Bruxelles
Chaussee de Charleroi 116
Tel. (02) 373100, 380020,
386080, 386180
Telex 21437, 23587

Bulgaria
RUEN
Technisches Beratungsbüro
der Siemens Aktiengesellschaft
Sofia
uliza Zar Boris 1, No. 130
Tel. 873455, 875901,
Telex 22736

Czechoslovakia
EFEKTIM
Technisches Beratungsbüro
Siemens AG
Praha 1
Vaclavské náměsti 1
Tel. 244632, 247234,
Telex 1-2289

Denemark
Siemens Aktieselskab
DK-2100 Kopenhagen ø
Blegdamsvej 124
Tel. (01) 261122, Telex 22313

Finland
Suomen Siemens Osakeyhtiö
SF-00101 Helsinki 10
Mikonkatu 8, [Postilokero 8]
Tel. 10714, 16261
Telex 12465

France
Siemens Société Anonyme
F-93 Saint-Denis
39, Boulevard Ornano
Tel. (16-1) 2433020,
Telex 62835

Great Britain
Siemens Ltd.
London Office
Brentford TW8 9DG,
Middlesex
Great West House,
Great West Road
Tel. (01) 5688281, 5689133
Telex 23176

Greece
Siemens Hellas E.A.E.
Athen 125
Voulis 7, [P.O.B. 601]
Tel. (021) 3243211/19
Telex 216291, 216292

Hungari
Intercooperation AG,
Siemens Kooperationsbüro
Budapest XII
Böszörményi ut 9–11
[P.O.B. 11, Budapest 114]
Tel. 154970, Telex 22-4133

Iceland
Smith & Norland H/F
Reykjavik
Sudurlandsbraut 4, [P.O.B. 519]
Tel. 38320, 38321, Telex 2055

Ireland
Siemens Ltd.
Dublin 4
8, Raglan Road
Tel. 684727, Telex 5341

Italy
Siemens Elettra S.p.A.
I-20124 Milano
Via Fabio Filzi, 29
[Casella Postale 4183]
Tel. (02) 6992,
Telex 31571, 31585

Luxemburg
Siemens Société Anonyme
Luxembourg
17, Rue Glesener, [B.P. 1701]
Tel. *49711-1, Telex 430

Netherlands
Siemens Nederland N.V.
's-Gravenhage
Prinses Beatrixlaan 26,
[Postbus 1068]
Tel. (070) 782782
Telex 31370, 31373

Norway
Siemens Aksjeselskap
N-Oslo 5
Østre Aker Vei 90, Linderud
[Postboks 10, Veitvet]
Tel. (02) 153090, Telex 18477

Poland
PHZ Transactor S.A.
Warszawa 12
Olszewska 8,
[P.O.B. 176, Warszawa 1]
Tel. 452211, 455201,
Telex 81328

Portugal
Siemens S.A.R.L.
Lisboa 1
Avenida Almirante Reis, 65
[Apartado 1380]
Tel. 538805, Telex 1563

Rumania
Siemens birou
de consultatii tehnice
Bucuresti
Str. Jules Michelet Nr. 15–17,
ap. 5.
Tel. 151825, Telex 473

Spain
Siemens S.A.
Madrid 20
Orense 2, [Apartado 155]
Tel. (01) 4582500, 4586500
Telex 27769

Sweden
Siemens Aktiebolag
Stockholm
Norra Stationsgatan 63–65
[Fack, S-10435 Stockholm 23]
Tel. (08) 229680,
Telex 1880, 1881

Switzerland
Siemens-Albis AG
CH-8021 Zürich
Löwenstraße 35
Tel. (01) 230352, 253600
Telex 52131

Turkey
Simko Ticaret ve Sanayi A.S.
Istanbul
Meclisi Mebusan Cad. 55,
Findikli, [P.K. 64 Tophane]
Tel. 452090, Telex 290

U.S.S.R.
Siemens Büro
Moskau
Hotel "Leningradskaja",
Zimmer 301
Tel. 2235257, 2255301
Telex 7-413

Jugoslavia
Generalexport
YU-11000 Beograd
Djure Djakovića 31,
[Poštanski fah 223]
Tel. (011) 664622,
Telex 11287

Afrika

Algeria
Siemens Algérie S.A.R.L.
Alger
3, Viaduc du Duc des Cars,
[B.P. 51]
Tel. 639547/51, Telex 91817

Siemens Companies and Representatives

Egypt
Siemens Resident Engineers
Cairo, Egypt
Immobilia Building, Flat 644,
Chérif Street No. 26b
[P.O.B. 775]
Tel. 54932

Ethiopia
Siemens Ethiopia Ltd.
Addis Ababa
Ras Bitwoded Makonen
Building
[P.O.B. 5505]
Tel. 43447, Telex 21052

Libya
Zeidan & Sons Organisation
Tripoli
8, Sh. Gumhureya,
[P.O.B. 2505]
Tel. 30101, 30102, 31787

Morocco
Siemens Maroc S.A.R.L.
Casablanca
Rue Lafuenta,
Immeuble Siemens
Tel. 613-82, 613-83, 613-84,
689-31, Telex 21914

South African Rupublic
Siemens (Proprietary) Limited
Johannesburg
Siemens House, Corner
Wolmarans and Biccard
Streets, Braamfontein
[P.O.B. 4583]
Tel. 7252500, Telex 543-7721

Sudan
Electric & General
Contracting Co.
Khartoum
Contomichalos Building,
Barlament St. [P.O.B. 1202]
Tel. 80576, 80818

Tunisia
Sitelec S.A., Société
d'Importation
et de Travaux d'Electricité
Tunis
26, Avenue Farhat Hached
Tel. 242860, 243003,
Telex 326

Zaire
Siemens Zaire S.P.R.L.
Kinshasa 1
1222, Avenue Tombalbaye,
Angle Avenue Kasavubu
[B.P. 9897]
Tel. 22608, 23739, Telex 377

America

Argentina
Siemens S.A.
Buenos Aires
Avenida Pte. Julio A. Roca 530
[Casilla Correro Central 1232]
Tel. 300411
Telex 0121812, 0121850

Bolivia
Sociedad Comercial é
Industrial Hansa Ltda.
La Paz
Calle Mercado esq. Yanacocha
[Cajón Postal 1402]
Tel. 54425, Telex BX5261

Brasil
Siemens S.A.
São Paulo 10, SP
Rua Felix Guilhem, 1360
[Caixa Postal 1375,
São Paulo 1, SP]
Tel. 625111,
Telex 021332, 021636

Canada
Siemens Canada Limited
Pointe Claire 730, P.Q.
7300 Trans-Canada Highway
[P.O.B. 7300]
Tel. (514) 695-7300
Telex 05-267300

Chile
Gildemeister S.A.C.
Santiago de Chile
Amunátegui 178, [Casilla 99-D]
Tel. 82523
Telex SGO 392 (Transradio
Chilena), 40588 (Correos y
Telégrafos)

Columbien
Siemens S.A.
Bogota 6
Carrera 65, No.11 – 83
[Apartado Aéreo 6829]
Tel. 603300, Telex 044750

Mexiko
Siemens S.A.
México 15, D.F.
Calle Poniente 116 No. 590;
Col. Industrial Vallejo
[Apartado Postal 15064]
Tel. 5670722,
Telex 1772700, 1773903

Uruguay
Conatel S.A.
Montevideo
Ejido 1690, [Casilla
de Correro 1371]
Tel. 917331, 917332
Telex 398134 UY

U.S.A.
Siemens Corporation
Iselin, New Jersey 08830
186 Wood Avenue South
Tel. (201) 494-1000
Telex WU 84-4491, 84-4492

Venezuela
Siemens Venezolana S.A.
Caracas
Avenida Principal,
Urbanización Los Ruices
[Apartado 3616]
Tel. 348531, Telex 22831

Asien

Afghanistan
Siemens Afghanistan Ltd.
Kabul
Alaudin, Karte 3, [P.O.B. 7]
Tel. 41460, 40446, 40447

Bangla Desh
Siemens Dacca
Dacca
74, Dilkusha Commercial Area
[P.O.B. 33]
Tel. 244381, 245965, 251864,
251865, Telex 824

Burma
Siemens Resident Engineer
Rangoon
185-187, Maha Bandoola Street
[P.O.B. 1427]
Tel. 10522, 10624, Telex 2009

Hong Kong
Jebsen & Co.
Hong Kong
Prince's Building, 23rd floor,
[P.O.B. 97]
Tel. 225111
Telex HX 3221, HX 3769

India
Siemens India Ltd.
Head Office
Bombay 18 WB
134 A, Dr. Annie Besant Road,
Worli, [P.O.B. 6597]
Tel. 379981, Telex 011 2373

Indonesia
Siemens Indonesia
Djakarta
Kebon Sirih 4, [P.O.B. 2469]
Tel. 51051, Telex 011-4111

Iran
Siemens Sherkate Sahami
(Khass)
Teheran
Kh. Takhte Djamshid No. 32,
Siemenshaus
Tel. 6141, Telex 2351, 2647

Israel
Inverko Ltd.
Tel-Aviv
72/76, Harakevet Street,
[P.O.B. 2385]
Tel. 31844, 39640,
Telex 033-513

Japan
Nippon Siemens K.K.
Tokyo 100
Furukawa Sogo Building,
6-1, Marunouchi 2-chome,
Chiyoda-ku
[Central P.O.B. 1144,
Tokyo 100-91]
Tel. (03) 214-0211, 215-3768,
211-1754, Telex J 22808

Korea (Republik)
Siemens Electrical
Engineering Co. Ltd.
Seoul
Daehan Building, Room 806,
75, Susomun-dong,
Sudaemun-ku
[I.P.O.B. 3001]
Tel. 24-1558, Telex 2329 S

Kuwait
Abdul Aziz M.T. Alghanim
Kuwait, Arabia
Abdulla Fahad Al-Mishan
Building, Al-Sour Street
[P.O.B. 3204]
Tel. 420452,
Telex AAA 2131 KT

Lebanon
Ets. F.A. Kettaneh S.A.
(Kettaneh Frères)
Beyrouth
Rue de Port, [P.O.B. 242]
Tel. 221180, Telex 614

Malaysia
Guthrie Waugh (Malaysia)
Sdn. Bhd.
Petaling Jaya
19, Jalan Semangat,
[P.O.B. 30]
Tel. Kuala Lumpur 564523
Telex Kuala Lumpur 346

Pakistan
Siemens Pakistan
Engineering C. Ltd.
Karachi
Ilaco House, Abdullah
Haroon Road, [P.O.B. 7158]
Tel. 516061, Telex 820

Philippines
Engineering Equipment, Inc.
Manila
391 J. Rizal Street, Bo.
Namayan, Mandaluyong, Rizal
[P.O.B. 1386]
Tel. 701851, 707546, 707551
Telex PN 3658

Saudi Arabia
E. A. Juffali & Bros.
Head Office
Jeddah
King Abdul-Aziz-Street
[P.O.B. 1049]
Tel. 2166, 2167, 2168

Singapore
Guthrie Waugh (Singapore)
Pte. Ltd.
Singapore 10
41, Sixth Avenue, Bukit Timah
Road [P.O.B. 495, Singapore 1]
Tel. 662555
Telex Dirgaw RS 21681

Syria
Syrian Import Export &
Distribution Co.,
S.A.S. SIEDCO
Damas
Port Said Street, [P.O.B. 363]
Tel. 13431, 13432, 13433

Taiwan
Delta Engineering Ltd.
Taipei
42, Hsu Chang Street, 8th floor
[P.O.B. 58497]
Tel. 362126, Telex 826

Thailand
B. Grimm & Co. R.O.P.
Bangkok
1643/4, Petchburi Road
(Extension)
[P.O.B. 66]
Tel. 54081, Telex 214

Yemen
Tihama Tractors &
Engineering Co. Ltd. [P.O.B.]
Sana'a

Australien und Ozeanien

Australia
Siemens Industries Limited
Melbourne, Vic. 3121
544 Church Street, Richmond
Tel. 420291, Telex AA 30425

New Zealand
Frederick Barker Ltd.,
Liaison Representative
Wellington
2 Cable Car Lane, [P.O.B. 74]
Tel. 40415

Contents

SIEMENS