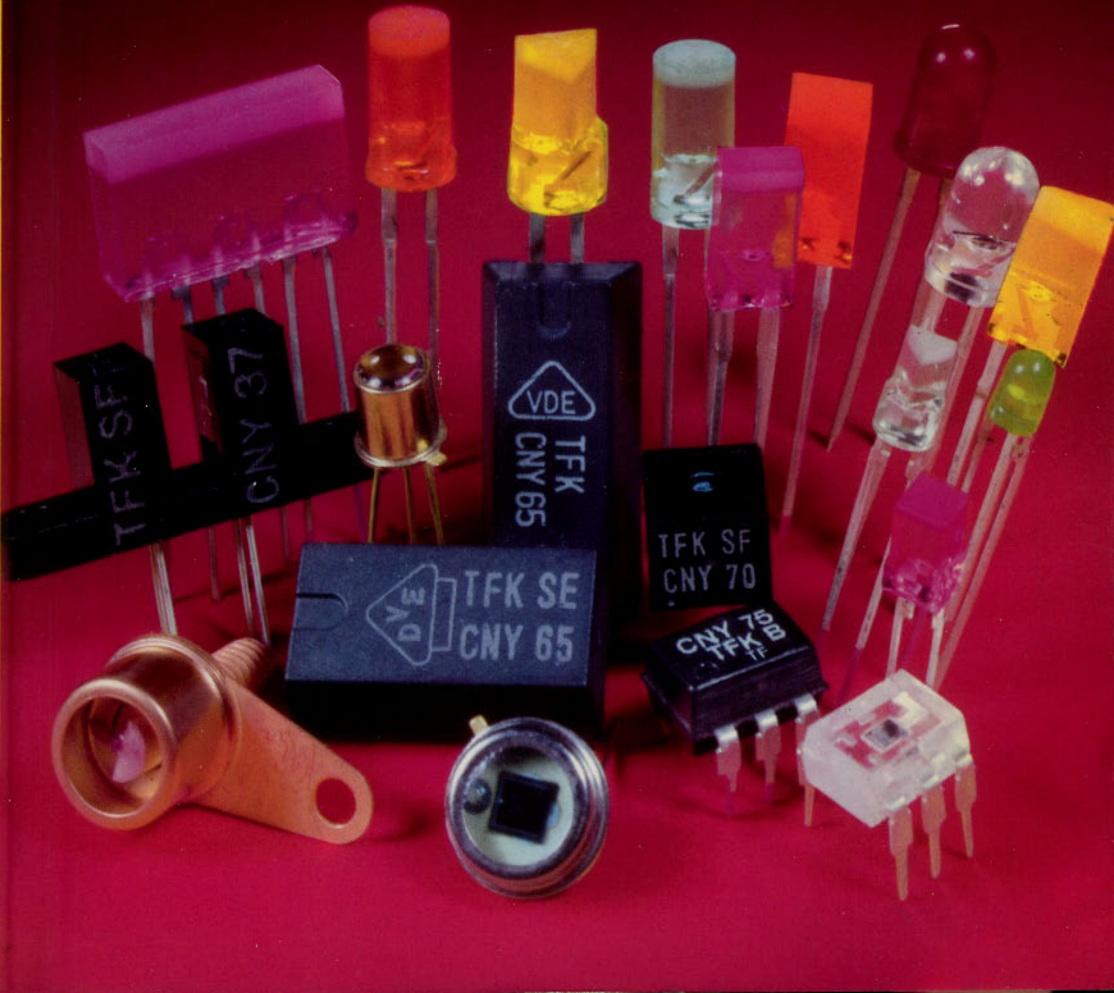
AEG-TELEFUNKEN

Data Book 1981/82

Optoelectronic Devices



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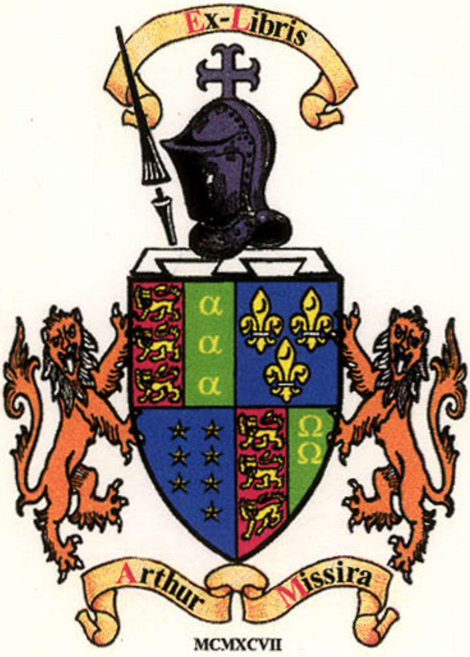
Optoelectronic Devices 1981/82

S1A


Ex-Libris
α α α
Ω Ω
Arthur Missira
MCMXCVII

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Data Book 1981/82

Optoelectronic Devices

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1. Explanation of technical data

2. Physical theory of optoelectronic devices

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3. Measurement technique

4. Quality data

5. Assembly instructions

6. Important notes on device selection

8. Technical data

A. Summary of the types – alpha-numeric

Type	Page	Type	Page
BP 104 ▼	1	CQX 37	267
		CQX 38	289
BPW 13	5	CQX 39	267
BPW 14	5	CQX 40	227
BPW 16 N	13	CQX 41 N	309
BPW 17 N	13	CQX 42	243
BPW 20	21	CQX 42 N	245
BPW 21 ● ●	27	CQX 43 N	299
BPW 24	33	CQX 46	109
BPW 28	37	CQX 47 ▼	113
BPW 34	41	CQX 86 A	399
BPW 35	45	CQX 86 K	399
BPW 39	49	CQX 87 A	407
BPW 40	55	CQX 87 K	407
BPW 41	61	CQX 88 A	399
BPW 42	65	CQX 88 K	399
BPW 43	69	CQX 89 A	407
BPX 99	73	CQX 89 K	407
		CQX 90 A	399
CNY 18 ● ●	159	CQX 90 K	399
CNY 21 ■ VDE	165	CQX 91 A	407
CNY 36	171	CQX 91 K	407
CNY 37	171	CQX 92 A	399
CNY 64 ● ●	177	CQX 92 K	399
CNY 65 ● ● VDE	183	CQX 93 A	407
CNY 66 ● ●	189	CQX 93 K	407
CNY 70	195	CQX 95 ▼	277
CNY 75 ● ●	199	CQX 96 ▼	283
CQW 13 ▼	135	CQY 31	117
CQW 14 ▼	141	CQY 32	117
CQX 10	227	CQY 33 N	123
CQX 11	227	CQY 34 N	123
CQX 12	227	CQY 35 N	123
CQX 18	95	CQY 36 N	129
CQX 19	101	CQY 37 N	129
CQX 20	107	CQY 40	289
CQX 21 ▼	235	CQY 41 ■	297
CQX 22 ▼	239	CQY 41 N	299
CQX 25	243	CQY 72	289
CQX 25 N	245	CQY 73 ■	297
CQX 26	243	CQY 73 N	299
CQX 26 N	245	CQY 74	289
CQX 27	243	CQY 75 ■	297
CQX 27 N	245	CQY 75 N	299
CQX 28	253	CQY 80 N ● ● VDE	205
CQX 29	253	CQY 85 N	309
CQX 30	253	CQY 86 N	309
CQX 31	259	CQY 87 N	309
CQX 32	259	CQY 98	135
CQX 35	267	CQY 99	141
CQX 36	267		

▼ New Typ

■ Not for new developments

● ● Available as qualified semiconductor device

VDE VDE tested device

Type	Page
S 153 P ▼	77
S 168 P ▼	81
S 171 P ▼	83
S 181 P ▼	87
S 191 P ▼	89
U 123 P	221
V 168 P	289
V 169 P	289
V 170 P	289
V 194 P	147
V 213 P ▼	153
V 227 P ▼	415
V 290 P ▼	141
V 292 P ▼	155
V 310 P ▼	319
V 311 P ▼	319
V 312 P ▼	319
V 313 P ▼	319
V 320 P ▼	327
V 321 P ▼	327
V 322 P ▼	327
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V 330 P ▼	335
V 331 P ▼	335
V 332 P ▼	335
V 333 P ▼	335
V 340 P ▼	343
V 341 P ▼	343
V 342 P ▼	343
V 343 P ▼	343
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V 520 P ▼	365
V 521 P ▼	365
V 522 P ▼	365
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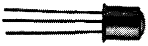
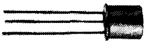
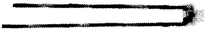
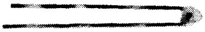
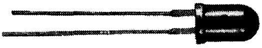
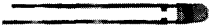
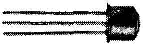
V 531 P ▼	373
V 532 P ▼	373
V 533 P ▼	373
V 540 P ▼	381
V 541 P ▼	381
V 542 P ▼	381
V 543 P ▼	381
V 550 P ▼	389
V 551 P ▼	389
V 552 P ▼	389
V 553 P ▼	389
V 621 P ▼	235
V 622 P ▼	235
V 623 P ▼	235
4 N 25 ▼	211
4 N 26 ▼	211
4 N 27 ▼	211
4 N 35 ▼	215
4 N 36 ▼	215
4 N 37 ▼	215

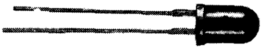
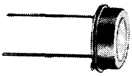
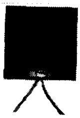
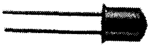
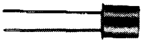
▼ New Typ

Detector devices · Phototransistors

Case	**Angle of half sensitivity α**				**Page**
	25°	40°	80°	130°	
 ≈ JEDEC TO 18	BPW 14				5
 ≈ JEDEC TO 18			BPW 13		5
 Special, plastic ∅ 1.8			BPW 16 N		13
 Special, plastic ∅ 1.8	BPW 17 N				13
 ≈ JEDEC TO 92				BPW 39	49
 Plastic, ∅ 5		BPW 40			55
 Plastic, ∅ 3			BPW 42		65
 ≈ JEDEC TO 52	BPX 99				73

Figures approx 1:1

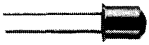
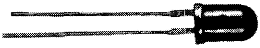
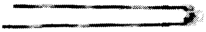
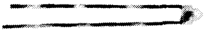
Detector devices · Photo diodes and voltaic cells

Case	Angle of half sensitivity α 40°	50°	70°	90°	100°	≥120°	Page
 Plastic, ∅ 5		BPW 43					69
 ≈ JEDEC TO 56					BPW 20		21
●●					BPW 21		27
▼					S 153 P		77
 ▼				S 171 P			83
Microwave case ▼				S 181 P			87
						BPW 35	45
 Plastic						BPW 41	61
 ≈ JEDEC TO 18	BPW 24						33
 ≈ JEDEC TO 18 ▼			S 191 P				89
 ▼						BP 104	1
Plastic						BPW 34	41
		BPW 28					37
≈ JEDEC TO 18 ▼			S 168 P				81

Figures approx 1:1

▼ New Type ●● Can be delivered as "Qualified semiconductor device"

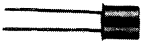
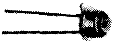
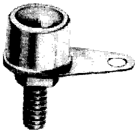
Radiation sources in infrared range

Case	Angle of half intensity α							Page
	10°	25°	35°	50°	55°	80°	100°	
 ≈ JEDEC TO 18	CQY 32							117
	CQY 35 N							123
 ≈ JEDEC TO 18		CQY 34 N						123
 Plastic case ∅ 5 mm ▼ ▼			CQY 98 V 390 P CQW 13					135
▼ ▼				CQY 99 V 290 P CQW 14				141
 Plastic case ∅ 3 mm				CQX 46				109
▼  Plastic case			CQX 47 (a_1)		CQX 47 (a_2)			113
 Plastic case ∅ 1.8 mm						CQY 36 N		129
▼  ≈ JEDEC TO 18							V 292 P	155
 Plastic case ∅ 1.8 mm		CQY 37 N						129
 ≈ JEDEC TO 92							CQX 18	95

Figures approx 1:1

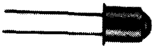
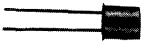
▼ New Type

Radiation sources in infrared range

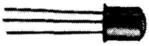
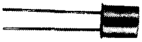
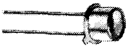
Case	Angle of half sensitivity α				Page
	10°	40°	50°	80°	
 ≈ JEDEC TO 18 ▼				CQY 31	117
				CQY 33 N	123
				V 213 P	153
 Metal base with clear plastic lens covering		CQX 19			101
 Metal base with clear plastic lens covering				V 194 P	147
 Special case	CQX 20 (α_2)		CQX 20 (α_1)		107

Devices to couple with glasfiber

Emitters

Case	Operating frequencies				Page
	600 kHz	3 MHz	10 MHz	300 MHz	
 ≈ JEDEC TO 18		CQY 32			117
	CQY 35 N				123
 ≈ JEDEC TO 18 ▼			V 213 P		153
 ≈ JEDEC TO 18 ▼			V 292 P		155
Special case (Figure see above)				CQX 20	107

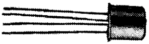
Detectors

Case	Operating frequencies			Page
	200 kHz	300 MHz	> 1 GHz	
≈ JEDEC TO 18 	BPW 14			5
 ≈ JEDEC TO 18 ▼		BPW 28		37
		S 168 P		81
≈ JEDEC TO 18  ▼		S 191 P		89
Microwave case  ▼			S 171 P	83
▼			S 181 P	87

Devices with fiber pigtails are available on special request.

▼ New Type

Photo coupling devices

Case		Isolation voltage										Page
		0,5 kV	1,5 kV	2,5 kV	3,5 kV	4,4 kV	5,3 kV	8,2 kV	10 kV	11,6 kV	15 kV	
 JEDEC TO 72	● ●	CNY 18										159
 VDE	■								CNY 21			165
 ▼							CNY 75					199
VDE	● ●					CQY 80 N						205
▼ ▼ ▼			4N26 4N27	4N25								211
▼ ▼ ▼			4N37	4N36	4N35							215
 ▼	● ●							CNY 64				177
 VDE ▼	● ●									CNY 65		183
 ▼	● ●										CNY 66	189

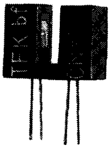
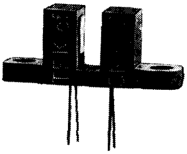
Figures approx 1:1

▼ New Type

● ● Can be delivered as "Qualified semiconductor device"

VDE VDE tested device

Reflective and interrupter optocoupler

Case	Reflective coupler	Interrupter coupler	Page
 ▼	CNY 70		195
		CNY 36	171
		CNY 37	171

Monolithic integrated pulse amplifier

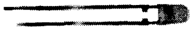
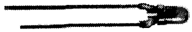
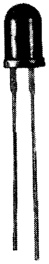
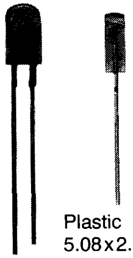
Case		Page
Special 	U 123 P	221

Figures approx 1:1

▼ New Type ● ● Can be delivered as "Qualified semiconductor device"

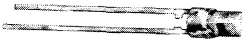
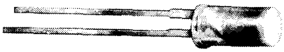
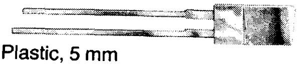
DVE VDE tested device

One colour light emitting diodes

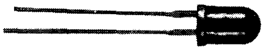
Version / Case	Red		Orange-red		Green		Yellow		Page
	diffuse	white/ clear	diffuse	white/ clear	diffuse	white/ clear	diffuse	white/ clear	
 ■ Plastic ∅ 1.8 mm	CQY 41				CQY 73		CQY 75		297
 Plastic ∅ 1.8 mm	CQY 41 N		CQX 43 N		CQY 73 N		CQY 75 N		299
Plastic ∅ 3 mm 	CQY 85 N		CQX 41 N		CQY 86 N		CQY 87 N		309
		CQX 25 N		CQX 42 N		CQX 26 N		CQX 27 N	245
		CQX 25		CQX 42		CQX 26		CQX 27	243
 Plastic ∅ 5 mm ▼	CQY 40		CQX 38		CQY 72		CQY 74		289
	V 168 P				V 169 P		V 170 P		289
		CQX 35		CQX 39		CQX 36		CQX 37	267
		V 310 P		V 311 P		V 312 P		V 313 P	319
						CQX 96			283
 Plastic 5.08x2.54	CQX 10		CQX 40		CQX 11		CQX 12		227

▼ New Type

One colour light Symbol-LED's

Case	Version	Red diffuse	Orange-red diffuse	Green diffuse	Yellow diffuse	Page
 Plastic, 3 mm	▼ ○	V 320 P	V 321 P	V 322 P	V 323 P	327
	□	V 330 P	V 331 P	V 332 P	V 333 P	335
	△	V 340 P	V 341 P	V 342 P	V 343 P	343
 Plastic, 5 mm	▼ ▯	V 510 P	V 511 P	V 512 P	V 513 P	351
	○	V 520 P	V 521 P	V 522 P	V 523 P	365
	□	V 530 P	V 531 P	V 532 P	V 533 P	373
	△	V 540 P	V 541 P	V 542 P	V 543 P	381
	△	V 550 P	V 551 P	V 552 P	V 553 P	389

Blinking light emitting diodes

Case	Version	Red	Orange-red	Green	Yellow	Page
 Plastic white, diffuse	▼	CQX 21	V 621 P	V 622 P	V 623 P	235
	▼	CQX 22				239

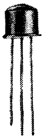
Figures approx 1:1

▼ New Type

One colour light emitting diodes in hermetically sealed case

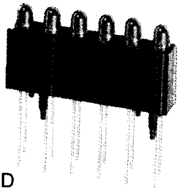
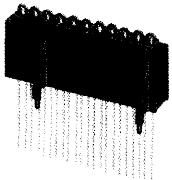
	Red	Green	Yellow	Page
 ≈ JEDEC TO 52 Hermetically sealed case with glass lens white diffuse	CQX 28	CQX 29	CQX 30	253

Bi-colour light emitting diodes

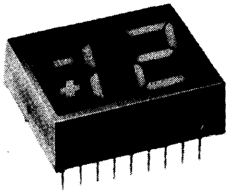
Version Case	Orange-red/ Green	Red/ Green	Red/ Yellow	Page
 Plastic, ∅ 5 mm ▼	CQX 95			277
 Plastic, 5 mm ▼	V 518 P			359
 ≈ JEDEC TO 52 Hermetically sealed case with glass lens white diffuse		CQX 31	CQX 32	259

Figures approx 1:1

Universal LED-bar displays

Type	**Version**	**Construction possibilities**		**Remark**	**Page**
		LED Ø 3 mm	LED Ø 1,8 mm		
V 227 P ▼ i.e. version C LED Ø 3 mm  LED Ø 1,8 mm 	A	3	5	Different combination possibilities are available.	415
	B	10	19		
	C	6	11		
	D	13	25		
	E	19	37		
	F	9	17		
	G	8	15		
	H	16	31		
	J	2	3		
	K	10	20		

1½ digit seven segment displays

Case	**Version**	**Red**	**Orange-red**	**Green**	**Yellow**	**Page**
	Common anode terminals	CQX 86 A	CQX 88 A	CQX 90 A	CQX 92 A	399
	Common cathode terminals	CQX 86 K	CQX 88 K	CQX 90 K	CQX 92 K	399

Figures approx 1:1

▼ New Type

2 digits seven segment displays

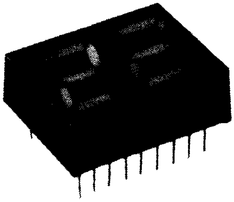
Case	**Version**	**Red**	**Orange-red**	**Green**	**Yellow**	**Page**
	Common anode terminals	CQX 87 A	CQX 89 A	CQX 91 A	CQX 93 A	407
	Common cathode terminals	CQX 87 K	CQX 89 K	CQX 91 K	CQX 93 K	407

Figure approx 1:1

Notice

General

1. Explanation of technical data

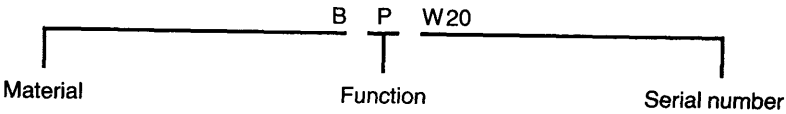
1.1. General information

1.1.1. Type designation code for semiconductor devices according to Pro Electron

The type number of semiconductor devices consists of:

Two letters followed by a serial number

For example:



The **first letter** gives information about the material used for the active part of the devices.

A	GERMANIUM (Materials with a band gap 0.6-1.0 eV)[1]
B	SILICON (Materials with a band gap 1.0-1.3 eV)[1]
C	GALLIUM-ARSENIDE (Materials with a band gap > 1.3 eV)[1]
R	COMPOUND MATERIALS (For instance Cadmium-Sulphide)

The **secound letter** indicates the circuit function:

A	DIODE: Detection, switching, mixer
B	DIODE: Variable capacitance
C	TRANSISTOR: Low power, audio frequency
D	TRANSISTOR: Power, audio frequency
E	DIODE: Tunnel
F	TRANSISTOR: Low power, high frequency
G	DIODE: Oscillator, Miscellaneous
H	DIODE: Magnetic sensitive
K	HALL EFFECT DEVICE: in an open magnetic circuit
L	TRANSISTOR: Power, high frequency
M	HALL EFFECT DEVICE: in a closed magnetic circuit
N	PHOTO COUPLER
P	DIODE: Radiation sensitive
Q	DIODE: Radiation generating
R	THYRISTOR: Low power
S	TRANSISTOR: Low power, switching
T	THYRISTOR: Power
U	TRANSISTOR: Power, switching
X	DIODE: Multiplier, e.g. varactor, step recovery
Y	DIODE: Rectifying, booster
Z	DIODE: Voltage reference or voltage regulator. Transient suppressor diode

The **serial number** consists of:

- Three figures, running from 100 to 999, for devices primarily intended for consumer equipment.
- One letter (Z, Y, X, etc.) and two figures running from 10 to 99, for devices primarily intended for professional equipment.

A version letter can be used to indicate a deviation of a single characteristic, either electrically or mechanically.
The letter never has a fixed meaning, the only exception being the letter R, indicating reversed voltage, i.e. collector to case.

---

[1] The materials mentioned are examples.

1.2. Symbols and terminology – alphabetically

A
Anode, anode terminal

A
Radiant sensitive area
That area which is radiant sensitive for a specified range.

A_v, G_v
Voltage amplification, voltage gain

A_{vo}
Open loop voltage amplification

α
Distance between the emitter (source) and the detector

α
Actinity of a radiation Z: $\alpha(Z)$
The ratio of sensitivity $s(Z)$ of a given radiation to the sensitivity $s(N)$ of a reference radiation N.

$$\alpha(Z) = \frac{s(Z)}{s(N)}$$

Note:
Actinity is always related to a device with a defined spectral sensitivity distribution. In the case of the BPW 21 a radiation with a colour temperature of 4700 K (average daylight) referred to standard illuminant A (2855.6 K) is assumed.

$\alpha_{\mathrm{EV\,amb}}$
Suppression of primary (background) illumination comparing signal

AQL
Acceptable Quality Level, see section 4

B
Base, base terminal

C
Capacitance

C
Collector, collector terminal

°C
Centigrade
Unit of the centigrade scale; can also be used (beside K) to express temperature changes.
Symbols: $T, \Delta t$
$t = (T - 273)$ °C

C_{CEO}
Collector-emitter capacitance
Capacitance between the collector and the emitter with open base.
Measurement is made by applying reverse voltage between collector and emitter terminals.

cd
Candela
SI unit of luminous intensity I_v

C_D
Diode capacitance
Total capacitance effective between the diode terminals due to case, junction and parasitic capacitances.

C_j
Junction capacitance
Capacitance due to a PN-junction of a diode.
It decreases with increasing reverse voltage.

C_k
Coupling capacitance
Capacitance between the emitter and the detector of an opto-isolator.

CTR
Current transfer ratio
Ratio between output and input current in photoelectric (optoelectronic) coupler devices.

i.e.: $k = \frac{I_C}{I_F}$

E
Emitter, emitter terminal

E_A
Illumination at standard illuminant A
According to DIN 5033 and IEC 306-1, illumination emitted from a tungsten filament lamp with a colour temperature $T_f = 2855.6$ K which is equivalent to standard illuminant A.
Unit: lx (Lux) or klx.

$E_{\mathrm{A\,amb}}$
Primary (background) illumination at standard illuminant A

$E_{\mathrm{A(TO)}}$
Switch-on illuminance (standard illuminant A) of a photo threshold switch

$E_{\mathrm{A(TU)}}$
Switch-off illuminance

ΔE_{A}
Difference between switch-on and switch-off illuminance (Hysteresis)

E_{e}
Irradiance, irradiation (at a point of a surface)
Quotient of the radiant power incident on an element of the surface containing the point, by the area of that element.

$$E_{\mathrm{e}} = \frac{\mathrm{d}\,\Phi_{\mathrm{e}}}{\mathrm{d}A}$$

Unit: $\mathrm{W/m^2}$

E_{v}
Illuminance, illumination
(at a point of a surface)
Quotient of the luminous flux incident on an element of the surface containing the point, by the area of that element.

$$E_{\mathrm{v}} = \frac{\mathrm{d}\,\Phi_{\mathrm{v}}}{\mathrm{d}A}$$

Unit: lx (Lux)

f
Frequency
Unit: Hz (Hertz)

f_{g}
Cut-off frequency – detector devices
The frequency at which the incident radiation generates a photocurrent or a photovoltage of the 0.707 times the value of radiation with $f = 1\,\mathrm{kHz}$.

G_{B}
Gain bandwidth product
Gain bandwidth product is defined as the product of M times the frequency of measurement, when the diode is biased for maximum obtainable gain.

G_{v}
Voltage gain

I_{a}
Light current
General: Current which flows through a device due to irradiation/illumination.

I_{B}
Base current

I_{BM}
Base peak current

I_{C}
Collector current

I_{ca}
Collector light current
Collector current which flows for a specified illumination/irradiation.

I_{CEO}
Collector dark current, with open base
By radiant sensitive devices with open base and without illumination/radiation ($E = 0$).

I_{CM}
Repetitive peak collector current

I_{CX}
Cross talk current
For reflex coupled isolators, collector-emitter cut-off current with the IR-emitter activated, but without reflecting medium.

I_{e}
Radiant intensity
(of a source in a given direction)
Quotient of the radiant power leaving the source propagated in an element of solid angle containing the given direction, by the element of solid angle.

$$I_{\mathrm{e}} = \frac{\mathrm{d}\,\Phi_{\mathrm{e}}}{\mathrm{d}\,\Omega}$$

Unit: W/sr.

I_{F}
Forward continuous current
The current flowing through the diode in the direction of lower resistance.

I_{FAV}
Average (mean) forward current

I_{FM}

Peak forward current

I_{FSM}

Surge forward current

I_k

Short circuit current

That value of the current which flows when a photovoltaic cell is short circuited ($R_L \ll R_i$) at its terminals.

I_{ph}

Photocurrent (photoelectric current)

That part of the electric current in a photoelectric detector which is produced by the photoelectric effect.

I_o

DC output current

I_R

Reverse current, leakage current

Current which flows when reverse bias is applied to a semiconductor junction.

I_{ra}

Reverse light current

Reverse light current which flows due to a specified irradiation/illumination in a photoelectric device.

$I_{ra} = I_{ro} + I_{ph}$

I_{ro}

Reverse dark current

Reverse dark current which flows through a photoelectric device without radiation/illumination.

I_{SB}

Quiescent current

$I_{(TO)}$

Threshold current (Laser diode)

I_v

Luminous intensity

(of a source in a given direction)

Quotient of the luminous flux leaving the source propagated in an element of solid angle containing the given direction by the element of solid angle.

$$I_v = \frac{d\,\Phi_v}{d\,\Omega}$$

Unit: cd (candela), lm/sr

$I_{v\,av}$

Luminous intensity, average

K

Cathode, cathode terminal

K

Kelvin

The unit of absolute temperature T (also called the Kelvin temperature); can also be used for temperature changes (formerly °K).

k

Current transfer ratio (CTR; coupling factor)

i.e.: $k = \dfrac{I_C}{I_F}$

L_e

Radiance (in a given direction, at a point on the surface of a source or a detector, or at a point on the part of a beam)

Quotient of the radiant flux leaving, arriving at, or passing through an element of surface at this point and propagated in directions defined by an elementary cone containing the given direction, by the product of the solid angle of the cone and the area of the orthogonal projection of the element of surface on a plane perpendicular to the given direction.

$$L_e = \frac{d^2\,\Phi_e}{d\,\Omega \cdot d\,A \cdot \cos\,\Theta}$$

Unit: $\dfrac{W}{sr \cdot m^2}$ or $\dfrac{kW}{sr \cdot cm^2}$

lm

Lumen

SI-unit of luminous flux, Φ_v

L_v

Luminance (in a given direction, at a point on the surface of a source or a receptor, or at a point on the path of a beam)

Quotient of the luminous flux leaving, arriving at, or passing through an element of surface at this point and propagated in directions defined by an elementary cone containing the given direction, by the product of the solid angle of the cone and the area of the orthogonal projection of the element of source on a plane perpendicular to the given direction.

$$L_v = \frac{d^2\,\Phi_v}{d\Omega \cdot dA \cdot \cos\Theta}$$

Unit: cd/m^2

lx
Lux
SI-unit of illumination, E_v.

M
The voltage dependent photocurrent gain M is defined as the ratio of photocurrent I_{ph} at a certain reverse voltage to the photocurrent at a bias of 10 V.

m
Matching factor
Emitter arrays:
The ratio of the minimum to the maximum radiant flux value measured on the devices constituting an array.
Detector arrays:
The ratio of the minimum to the maximum light current of the devices constituting an array.

M_e
Radiant exitance (at a point of a surface)
Quotient of the radiant power leaving an element of the surface containing the point, by the area of that element.

$$M_e = \frac{d\,\Phi_e}{dA}$$

Unit: W/m^2

M_v
Luminance exitance (at a point of a surface)
Quotient of the luminous flux leaving an element of the surface containing the point, by the area of that element.

$$M_v = \frac{d\,\Phi_v}{dA}$$

Unit: lm/m^2
Numerical Aperture, see page A 18

P_n
Noise Equivalent Power (NEP)

P_{tot}
Total power dissipation

P_V
Power dissipation, general

Q_e
Radiant energy
Energy emitted, transferred or received in the form of radiation.

$$Q_e = \int \Phi_e \cdot dt$$

Unit: J (Joule), Ws

Q_v
Quantity of light
Product of luminous flux and its duration.

$$Q_v = \int \Phi_v \cdot dt$$

Unit: lm s (lumen-second)

R_F
Feedback resistor

r_f
Differential forward resistance
Resistance measured for small signal a.c. voltages or currents at a point, under specified conditions, on forward direction U-I curve.

R_H
Resistor for programming the hysteresis of a photo threshold switch

r_i
Internal resistance

R_{is}
Isolation resistance

R_L
Load resistance

$R_{(TO)}$
Resistor for programming the threshold of a photo threshold switch

R_{thJA}
Thermal resistance, junction-ambient

R_{thJC}
Thermal resistance, junction case

s
Sensitivity, absolute
Quotient between the output value Y of a radiant sensitive device to the input value X of a physical quantity:

$$s = \frac{Y}{X}$$

Unit: A/lx.

s_H
Hysteresis of sensitivity

s_k
Sensitivity, short circuit
Light sensitivity by which the output value of short circuit current, I_k, of a photovoltaic cell has been used.

$s_{(TO)}$
Threshold sensitivity

s_o
Sensitivity, open circuit
Light sensitivity at which the output value of open circuit voltage of a photovoltaic cell has been used.

$s(\lambda)$
Absolute spectral sensitivity, at a wavelength λ
The ratio of the output quantity to the radiant input quantity in the range of wavelengths λ to $(\lambda + d\lambda)$:

$$s(\lambda) = \frac{dY(\lambda)}{dX(\lambda)}$$

e.g. the radiation power $\Phi_{e(\lambda)}$ at a specified wavelength λ is falling on the radiation sensitive area of a detector, which generates a photo current I_{ph}. $s(\lambda)$ is the ratio between the generated photocurrent I_{ph} and the radiation power $\Phi_{e(\lambda)}$ falling on the detector.

$$s(\lambda) = \frac{I_{ph}}{\Phi_{e(\lambda)}}$$

Unit: $\frac{A}{W}$ or $\frac{mA}{mW}$

$s(\lambda)_{rel}$
Spectral sensitivity, relative
Ratio of the radiant sensitivity at any considered wavelengths $s(\lambda)$ to the radiant sensitivity $s(\lambda_o)$ at a certain wavelength λ_o taken as a reference.

$$s(\lambda)_{rel} = \frac{s(\lambda)}{s(\lambda_o)}$$

$s(\lambda_o)$
Spectral sensitivity at a wavelength λ_o

$s(\lambda_p)$
Spectral sensitivity at a wavelength λ_p

sr
Steradian.
SI-unit of a solid angle Ω

T
Period (duration)

T
Absolute Temperature, Kelvin temperature

$0\,K = -273.16°C$

Unit: K (Kelvin)

t
Time

T_{amb}
Ambient temperature
If self-heating is significant:
Temperature of the surrounding air below the device, under conditions of thermal equilibrium.
If self heating is insignificant:
Air temperature in the immediate surroundings of the device.

T_{amb}
Ambient temperature range
As an absolute maximum rating:
The maximum permissible ambient temperature range.

T_{case}
Case temperature
The temperature measured at a specified point on the case of a semiconductor device. Unless otherwise stated, this temperature is given as the temperature of the mounting base for transistors with metal can.

t_d
Delay time,
see section 3.3

T_f
Colour temperature
Temperature of the full radiator which emits radiation of the same chromaticity as the radiation considered.
Unit: K (Kelvin).

t_f
Fall time, see section 3.3

T_j
Junction temperature
It is the spatial mean value of temperature which the junction has acquired during operation. In case of phototransistors, it is mainly the temperature of collector junction because its inherent temperature is maximum.

TK
Temperature coefficient
The ratio of the relative change of an electrical quantity to the change in temperature (Δt) which causes it, under otherwise constant operating conditions.

TK_{Ik}
Temperature coefficient of short circuit current I_k

TK_{Vo}
Temperature coefficient of open circuit voltage V_o

$TK\Phi_e$
Temperature coefficient of radiant power Φ_e

t_{off}
Turn-off time, see section 3.3

t_{on}
Turn-on time, see section 3.3

t_p
Pulse duration

t_r
Rise time, see section 3.3

t_s
Storage time, see section 3.3

T_{sd}
Soldering temperature
Maximum allowable temperature for soldering with specified distance from case and its duration.
Refer to section 5.2.

T_{stg}
Storage temperature range
The temperature range at which the device may be stored or transported without any applied voltage.

V_{BEO}
Base-emitter voltage,
open collector

$V_{(BR)}$
Breakdown voltage
Reverse voltage at which a small increase in voltage results in a sharp rise of reverse current. It is given in technical data sheet for a specified current.

$V_{(BR)CEO}$
Collector-emitter breakdown voltage,
open base

$V_{(BR)EBO}$
Emitter-base breakdown voltage,
open collector

$V_{(BR)ECO}$
Emitter-collector breakdown voltage,
open base

V_{CBO}
Collector-base voltage, open emitter
Generally reverse biasing is the voltage applied to any of two terminals of a transistor in such a way that one of the junction operates in reverse direction, whereas the third terminal (second junction) is specified separately.

V_{CE}
Collector-emitter voltage

V_{CEO}
Collector-emitter voltage, open base ($I_B = 0$)

V_{CEsat}
Collector-emitter saturation voltage
Saturation voltage is the d. c. voltage between collector and emitter for specified (saturation) conditions i. e. I_C and E_V (E_e or I_B) whereas the operating point is within the saturation region.

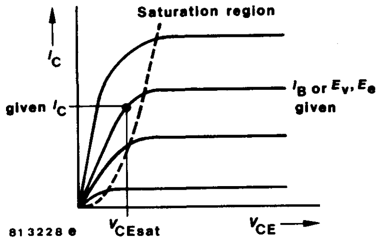


Fig. 1.2.

V_{EBO}
Emitter-base voltage, open collector

V_{ECO}
Emitter-collector voltage, open base

V_F
The voltage across the diode terminals which results from the flow of current in the forward direction.

V_{is}
Isolation voltage – opto isolator
Maximum allowable operating voltage between input and output.

V_o
Open circuit voltage
Voltage measured between the photovoltaic cell terminals by radiation/illumination, if the circuit is open.

V_{ph}
Photo voltage
Voltage measured between the photovoltaic cell terminals due to radiation/illumination.

V_O
DC output voltage

V_{no}
Signal to noise ratio

V_R
Reverse voltage
Voltage drop which results from the flow of reverse current.

V_S
Supply voltage

α
Angle of half sensitivity
The sum of the plane angles through which a detector, illuminated by a point source, can be rotated in both directions away from the optical axis before the electrical output of the device falls to half the maximum value.

α
Angle of half intensity
The sum of the plane angles through which an emitter can be rotated in both directions away from the optical axis before the electrical output of a linear detector facing the emitter falls to half the maximum value.

λ
Wavelength, general
The wavelength of an electromagnetic radiation.

$\lambda_{0.5}$
Range of spectral bandwidth (50 %)
The range of wavelengths within which the spectral sensitivity or spectral emission remains within 50 % of the maximum value.

λ_D
Dominant wavelength

λ_p
Peak wavelength sensitivity or emission

ΔV_o
Output voltage change
(differential output voltage)

$\Delta\lambda$
Spectral half bandwidth
The wavelength interval within which the spectral sensitivity or spectral emission falls to half peak value.

Φ_e

Radiant flux, radiant power

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

$$\Phi_e = \frac{dQ_e}{dt}$$

Unit: W (Watt)

$\Phi_{e\,nutz}$

Effective radiant power

That portion of the radiant power available for practical utilization. If IR-emitters are encapsulated, or combined to form an array (types CQY 36/9 and CQY 37/9, for example), then in practice part of the radiation produced by the semiconductor crystal cannot be utilized because of total reflexion and absorption. The data for IR emitters in "Miniplast" encapsulations or for Miniplast emitter arrays therefore contain a $\Phi_{e\,nutz}$-parameter which gives the radiant power that emanates from the lens or the flat window of the case.

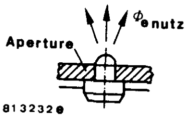


Fig. 1.3.

Φ_v

Luminous flux

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

$$\Phi_v = \frac{d_{Qv}}{dt}$$

Unit: lm (lumen)

Ω

Solid angle

It is the space enclosed by rays which emerge from a single point and lead to all the points of a closed curve. If it is assumed that the apex of the cone formed in this way is the centre of a sphere with radius r and that the cone intersects with the surface of the sphere, then the size of the surface area (A) of the sphere subtending the cone is a measure of the solid angle

$$\Omega = \frac{A}{r^2}$$

There are 4π sr in a complete sphere. A cone with an angle of half sensitivity $\frac{\alpha}{2}$, forms a solid angle of

$$\Omega = 2\pi\,(1 - \cos\tfrac{\alpha}{2}) = 4\pi\,\sin^2\tfrac{\alpha}{4}$$

Unit: sr (Steradian)

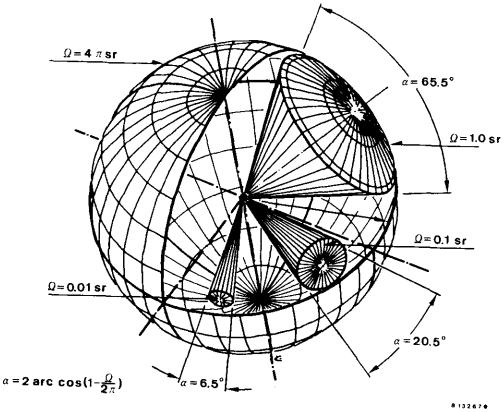
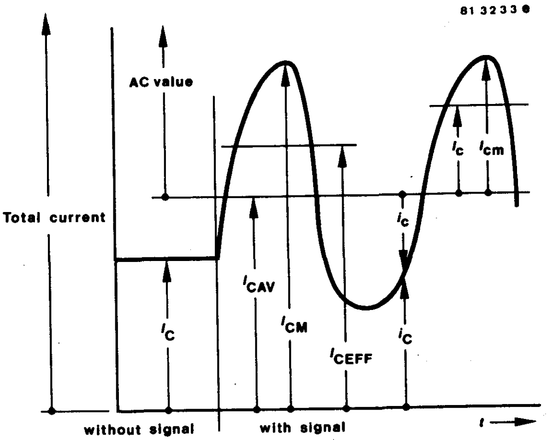


Fig. 1.4.

Examples of the application of the symbols

according to 41785 and IEC 148

a) Transistor



I_C	D.C. value, no signal
I_{CAV}	Average total value
I_{CM}; $\hat{I}_C$	Maximum total value
I_{CEFF}	RMS total value
I_c; I_{ceff}	RMS varying component
I_{cm}; $\hat{I}_c$	Maximum varying component value
i_C	Instantaneous total value
i_c	Instantaneous varying component value

It is valid:

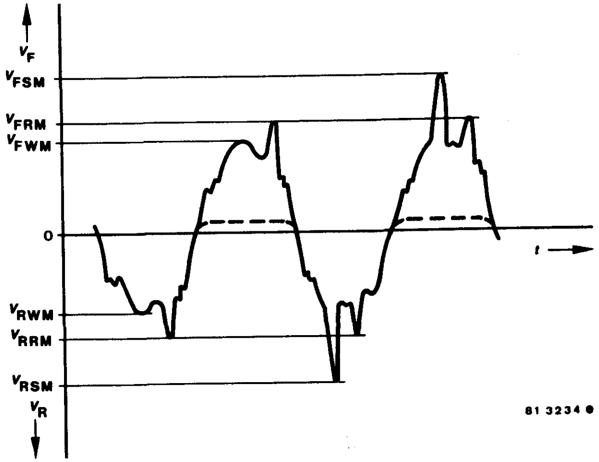
$$I_{CM} = I_{CAV} + I_{cm}$$

$$I_{CEFF} = \sqrt{I^2_{CAV} + I^2_{ceff}}$$

$$i_C = I_{CAV} + i_c$$

Fig. 1.5.

b) Diode



V_F	Forward voltage
V_R	Reverse voltage
V_{FSM}	Surge forward voltage (non-repetitive)
V_{RSM}	Surge reverse voltage (non repetitive)
V_{FRM}	Repetitive peak forward voltage
V_{RRM}	Repetitive peak reverse voltage
V_{FWM}	Crest working forward voltage
V_{RWM}	Crest working reverse voltage

Fig. 1.6.

c) Designation and syymbols of Optoelectronic devices are given so far as possible, according to DIN 44020 sheet 1 and IEC publication 50 (45).

1.3. Data sheet construction

Data sheet information is generally presented in the following sequence:

- Device description
- Dimensions (Mechanical data)
- Absolute maximum ratings
- Thermal data – Thermal resistances
- Optical and electrical characteristics

Additional information on device performance is provided if necessary.

1.3.1. Device description

The following information is provided: Type number, semiconductor materials used, sequence of zones, technology used, device type and, if necessary construction.
Also, short-form information on the typical applications and special features is given.

1.3.2. Dimensions (Mechanical data)

If contains important dimensions, sequence of connection supplemented by a circuit diagram. Case outline drawings carry DIN-, JEDEC or commercial designations. Information on angle of sensitivity or intensity and weight completes the list of mechanical data.

Note especially:
If the dimensional information does not include any tolerances, then the following applies:
Lead length and mounting hole dimensions are minimum values. Radiant sensitive or emitting area respectively being typical, all other dimensions are maximum.
Any device accessories must be ordered separately, quoting the order number.

1.3.3. Absolute maximum ratings

These define maximum permissible operational and environmental conditions. If any one of these conditions is exceeded, then this could result in the destruction of the device. Unless otherwise specified, an ambient temperature of 25 ± 3 °C is assumed for all absolute maximum ratings. Most absolute ratings are static characteristics; if they are measured by a pulse method, then the associated measurement conditions are stated. Maximum ratings are absolute (i. e. not interdependent).
Any equipment incorporating semiconductor devices must be designed so that even under the most unfavourable operating conditions the specified maximum ratings of the devices used are never exceeded. These ratings could be exceeded because of changes in
supply voltage,
the properties of other components used in the equipment,.
control settings,
load conditions,
drive level,
environmental conditions and
the properties of the devices themselves (i. e. ageing).

1.3.4. Thermal data – thermal resistances

Some thermal data (e.g. junction temperature, storage temperature range, total power dissipation), because they impose a limit on the application range of the device, are given under the heading "Absolute maximum ratings".

A special section is provided for thermal resistances. The thermal resistance junction ambient (R_{thJA}) quoted is that which would be measured without artifical cooling, i. e. under the worst conditions.
Temperature coefficients, on the other hand, are listed together with the associated parameters under "Optical and electrical characteristics".

1.3.5. Optical and electrical characteristics, switching characteristics

Under this heading are grouped the most important operational, optical and electrical characteristics (minimum, typical and maximum values) together with associated test conditions supplemented with curves, an AQL-value being quoted for particularly important parameters (refer to section 4.2.).

1.3.6. Additional information

Preliminary specifications
This heading indicates that some information on the device concerned may be subject to slight changes.

Not for new developments
This heading indicates that the device concerned should not be used in equipment under development, it is, however, available for present production.

2. Physical Theory of Optoelectronic Devices

2.1. Introduction

Optoelectronic devices are capable of electromagnetic radiation when a current is passed through them, or alternatively, of absorbing radiation and converting it into a measurable electrical quantity (V, I or R changes).

By electromagnetic radiation is meant here the energy radiated in the visible as well as the adjacent ultraviolet and infrared spectral region (0.3...15 μm). Optoelectronic devices can be divided into two groups. The devices of the first group utilize the external photoelectric effect, and those of the second group the internal photoelectric effect. This publication is concerned only with devices belonging to the second group, such as emitters, detectors and optically coupled isolators (couplers) covering a spectral range extending from visible to near infrared radiation (approx. 0.4...1.2 μm).

2.2. Operating principle of optoelectronic devices

2.2.1. Light emitting diodes (LED)

If a forward current is passed through a semiconductor diode, then electrons and holes are injected into the P and N region respectively. Depending on the magnitude of the current, a recombination of charge carriers (electrons and holes) takes place. According to the energy band concept, so-called radiant recombination requires that electrons jump from the high-energy conduction band to the lower-energy valence band, the surplus energy being converted into electromagnetic radiation.

The ratio of the number of "radiant recombinations" to the total number of recombinations depends on the semiconductor material used. In the III-V-semiconductor compounds GaAs, GaAsP and GaP, the portion of radiant recombinations is several orders of magnitude higher than that occurring in silicon, for example.

Radiation ist produced by direct recombination transitions between the conduction and valence band or by charge carrier transitions between the energy and forbidden band (see Fig. 2.1.). In the first case the energy, and hence the wavelength, of the emitted radiation depends on the energy gap between bands, whilst in the second case the difference in energy level between the forbidden band and the energy bands is the important factor.

Direct band-to-band transition in GaAs, for example, would produce a wavelength of

$$\lambda = \frac{h \cdot c}{\Delta W} = 900 \text{ nm;}$$

where h = Planck's constant = $4.16 \cdot 10^{-15}$ eVs (eV = electron volt),

c = velocity of light = $3 \cdot 10^{8}$ m/s,

ΔW = energy difference = 1.38 eV for GaAs.

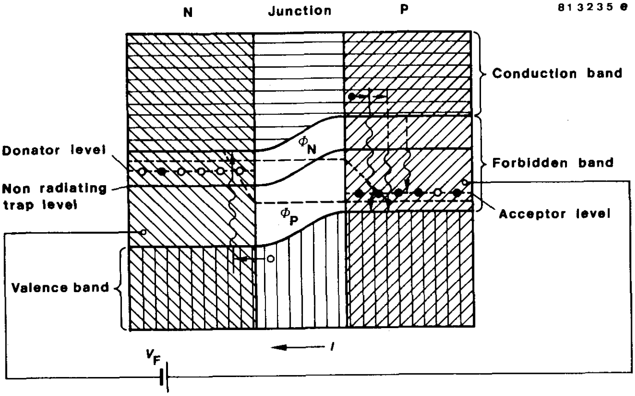


Fig. 2.1.

2.2.2. Laser diode

The semiconductor material that is most frequently employed for use as injection lasers is gallium arsenide. These lasers mostly involve a PN-diode made up of several layers (GaAs, GaAlAs) which, when forward biased at low current densities, act as an LED. To obtain laser action the following prerequisites are to be observed:

1. A sufficiently high number of injected electrons(Inversion) are required to cover the losses and stimulate emission whereby a minimum current (the threshold current $I_{(TO)}$) is neccessary to support the laser action.
2. Further to this an optical resonator is necessary to achieve positive feedback and internal amplification.
   This is made possible in GaAs injection lasers by oppositely cleaved faces (Fabry-Perot-Resonator) with which a part of the radiation is transmitted and the rest is reflected back into the laser cavity.

Because the efficiency under laser operation is higher than under LED operation, a typical characteristics is obtained as shown in Fig. 2.2.

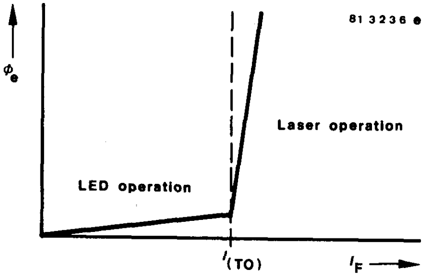


Fig. 2.2.

The substantial differences of a laser to an LED are the directed radiation, the high luminance, the coherence of the radiation and the narrow width of the spectral emission. Further, as a consequence of the stimulated emission, the switching times are very much shorter than LED's.

2.2.3. Detector devices

The operation of the detector devices described in this book is based on the junction photo effect. The main features of this effect are a generation of charge carrier pairs as a result of light absorption by the semiconductor material, and the accumulation of light-generated minority charge carriers at the PN junction, all this producing a photoelectric current in the external circuit (see Fig. 2.3.).

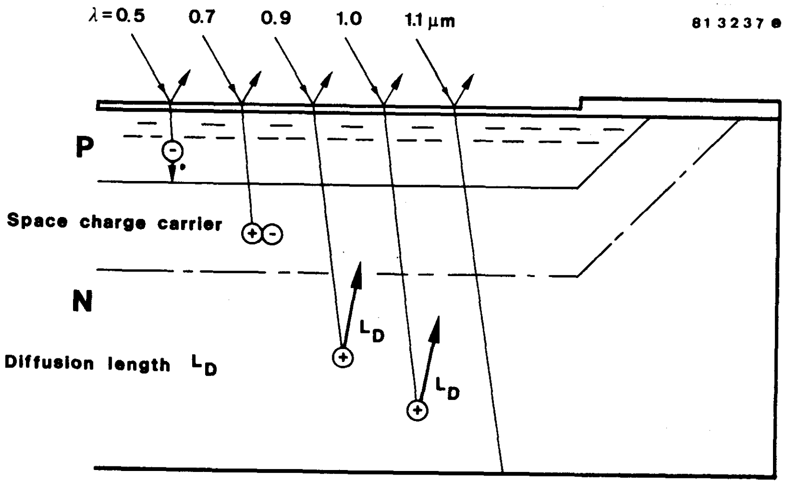


Fig. 2.3.

2.3. Technology and characteristics of optoelectronic devices

The usual division of optoelectronic devices into emitters, detectors and couplers also provides the headings under which the manufacturing processes for these devices can be described. Emitters, in the context of this article, are devices which consist exclusively of III-V-compounds, such as GaAs, GaAsP and GaP, whereas detectors, sensitive to visible light and short-wave IR radiation, employ silicon, and consequently are manufactured using silicon device techniques. Coupler technology is, primarily, encapsulation and assembly technology, to produce, by skilful emitter-detector matching via a suitable coupling medium, as compact a device as possible.

2.3.1. Emitters

The wavelength of the radiation produced by luminescence diodes is governed not only by the semiconductor material used, but also to a certain extent by the way it is doped (Fig. 2.4.).

Materials for light emitters

Material	Wavelength range
GaAs : Zn	Infrared 900 nm
GaAs : Si	Infrared 930 nm
GaAsP	red 660 nm
GaAsP : N	orange 630 nm
GaAsP : N	yellow 590 nm
GaP : N	green 560 nm

Fig. 2.4.

2.3.1.1. GaAs diodes

GaAs diodes emit light in the infrared region at wavelengths between 800 and 1000 nm. There are basically two processes used in the manufacture of IR diodes, the main difference between them being in the production of the PN junction.

a) The PN junction is formed by diffusing zinc into monocrystalline N-doped GaAs wafers. Diffusion is effected either over the whole wafer area so that the PN junction of the devices subsequently produced by wafer division extends right up to the open edge (mesa technique), or it is carried out through windows, formed by a photo-lithographic process in a suitable masking coating (such as $Si_3N_4 + SiO_2$) located on the surface of the GaAs. In the latter case the devices are divided along the "window frames", and the edge of the PN junction does not extend to the edge of the device (planar technique).

b) A liquid phase epitaxy process is used to precipitate from a silicon-doped melt a thin monocrystalline GaAs layer on an N-doped GaAs wafer; because of the different deposition of silicon in the GaAs crystal lattice at the beginning and at the end of the process, a PN junction is formed.

Zn-diffused IR diodes have a short response time (1–100 ns), but produce a relatively low radiant power level (0.5–2 mW); Si-doped IR diodes, on the other hand, have response times of several hundred ns, but can produces radiant power levels up to 20 mW (Fig. 2.5.).

Characteristics of IR diodes $I_F = 100$ mA

Material	GaAlAs : Zn	GaAs : Zn	GaAs : Si
Wavelength range	800...900 nm	ca. 910 nm	ca. 950 nm
Power range	ca. 2 mW	ca. 2 mW	10...20 mW
Switching time range	5...70 ns	5...100 ns	300...500 ns

Fig. 2.5.

2.3.1.2. Laser diode

The GaAlAs – GaAs double heterostructure laser is composed of various layers epitaxially deposited via the liquid phase. The continuous wave (CW) laser consists of, in most cases, 4 to 5 successive layers grown on a GaAs substrate e. g.
N-$GaAl_xAs_{1-x}$, P-GaAs, P-$GaAl_xAs_{1-x}$, P-GaAs. The central P-GaAs region is responsible for the emission. It is in this layer that the properties and thickness ($<1\,\mu$m) must therefore be very accurately controlled.

However it is normal practice to apply the strip-laser structure. Various techniques are incorporated to limit the borders of the few hundred µm long active region e.g. via mesa-etching or proton implantation. The width of the active zone is itself smaller than 20 µm. The laser-chip is mounted on a good heatsink e.g. diamond and because the emitting surface has the dimensions 1 µm x 20 µm. It is possible to obtain very large radiant values. Typical luminescence values are
> 200 kW/sr cm^2.

2.3.1.3. Light emitting diodes (LED's)

Light emitting diodes for the visible spectrum range are manufactured from GaAsP and GaP.

Different colours (Fig. 2.4.) are produced in the advanced planar technology with protected PN junctions, and yields long life time. The material processing knows two different technologies:

a) Red ($GaAs_{.6}P_{4}$)
Red-emitting GaAsP consists of N-doped vapour epitaxial layer on a monochrystal GaAs substrate. The Phosphorous content of the layer is gradually increased up to 40%.

b) Green, Yellow and Orange
These layers are manufactured in the same manner but on a monochrystal GaP substrate. This substrate is transparent for the generated light. The efficiency is doubled due to reflecting backside metallisation, because there is no absorption of the generated light in the substrate.

Three different materials are available for the three colours. All are Nitrogen doped, which enhances the light efficiencies of these materials.

Green:	$GaP : N$	on GaP
Yellow:	$GaAs_{.15}P_{.85} : N$	on GaP
Orange:	$GaAs_{.35}P_{.65} : N$	on GaP

Red emitting diodes have been manufactured formerly with Zn:0 doped GaP. They have lost industrial importance because the efficiency drops down with higher currents and the spectral range of the generated light is unfavourable to the spectral response of the human eye. (Fig. 2.6.)

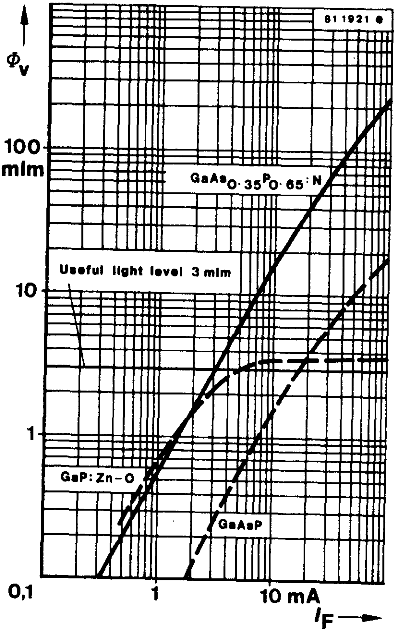


Fig. 2.6.

Luminuous power versus current of different red LED's. GaP (Zn : 0) shows saturation for current greater than 5 mA. The other two materials $GaAs_{.6}P_{4}$ and $GaAs_{.35}P_{.65}$ have a superlinear power-current characteristic.

2.3.2. Detectors

Detectors, such as photodiodes, photovoltaic cells and phototransistors, are primarily manufactured by well-tried silicon semiconductor techniques, augmented by only relatively few processes specific to optoelectronics (Fig. 2.7.).

The PN junctions of Si-detectors are produced in a similar way to those of the emitters by either the mesa or planar process, which in this case, however, affects device performance to a considerably larger extent.

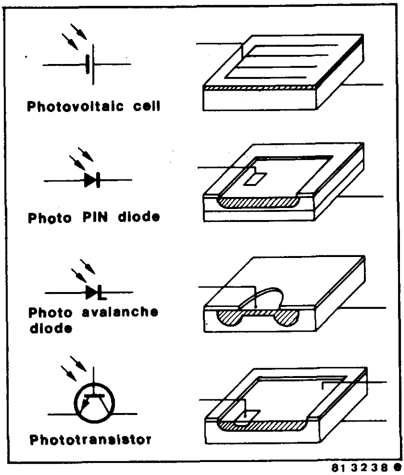


Fig. 2.7.

2.3.2.1. Photovoltaic cells

Because of the open PN junction, photoelectric devices manufactured by the mesa process have relatively high leakage currents, i.e. their internal resistance is low at low illumination levels. Because of their low reverse voltages, they are particularly suitable for photovoltaic applications. High light sensitivity and the facility with which large area structures (> 1 cm^2) can be manufactured are special advantages.

2.3.2.2. Photo diodes

Photo-diodes are manufactured by the planar process. The edges of the PN junctions are protected by and located underneath an $Si\,0_2$ diffusion mask produced by oxidation of the silicon surface. Photodiodes are, therefore, by their very nature, ideal for the detection of weak light signals and capable of operation with high reverse voltage.

A special type of photo-diode is the PIN diode which has an intrinsic low-conductance zone between the P- and N-zones. The main advantages of photo PIN diodes are extremely short switching times, associated with high IR sensitivity. Special technological processes make it possible to keep the reverse voltage, at which this performance can be achieved relatively low.

Diodes with a great width of the depletion layer are called PIN-diodes, irrespective of the initial intrinsic (*I*) crystal which has been doped on its opposite P- and N-surface or by using a very high-ohmic substrate crystal into which a dopant is introduced having a wide space-charge. The generated charge carriers are collected in the drift field of the space charge region very fast (ns-range). Photo PIN-diodes can be used also with advantage in AF-range i.e. infra-red sound carrier, infra-red remote control also where low capacity and high radiation sensitive area is the requirement that means where a low bias voltage and high load resistance (i.e. 100 kΩ) leads to a high output signal voltage.

2.3.2.3. Photo avalanche diodes

Photo avalanche diodes are suitable in optical receivers for modulated radiation at low signal levels, high bandwidth and small radiation sensitive areas. The high internal signal current gain is caused by the multiplication process in the space charge region of a reverse-biased PN junction, being below breakdown voltage. The internal multiplication factor M[1] is determined by the reverse voltage and can be regulated for this type up to values of more than 200. Avalanche diodes can be used for frequencies up to 50 MHz with amplifiers in the current-mode. At micro wave frequencies in the GHz-range photo avalanche detectors are used with low load impedances (50 or 100 Ω) together with voltage amplifiers.

Photo avalanche diodes are given preference mostly as compared to photo-PIN-diodes at frequencies greater than 1 MHz whereas consideration should be given to the complexity of the pre-amplifier, arrangement of optical and mechanical adjustment.

At higher frequencies, the thermal noise of the load resistance or the detection efficiency in pre amplifier limits the use of the photo-PIN-diodes. But in the photo avalanche diodes where there is a possibility of internal amplification, photo signal can be raised above the thermal noise of the load resistance and hence superior to photo PIN-diodes at higher frequencies.

Avalanche photo diodes are, therefore, mostly suitable as a detector for optical communication e.g. glass fiber transmission system and as a detector in range meter equipment.

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¹) The voltage dependent photo current gain M is defined as the ratio of photo current I_{ph} at a certain reverse voltage to the photo current at a lower reverse voltage i.e. 5 V.

2.3.2.4. Phototransistors

In phototransistors, a photoelectric current is generated in the collector-base diode and amplified by the same device. Typical gain values attainable with phototransistors are approximately 100-700, obviating the need for an additional amplifier in many applications. Important phototransistor performance characteristics can be derived from an equivalent circuit showing a large-area collector-base diode which acts as the photodiode, connected to the input of a common emitter transistor stage.

If an output signal of particularly high amplitude is required, then use of a Darlington phototransistor is recommended; this is a device with two internal Darlington amplifier stages.

Optimization of standard processes and the introduction of new ones has resulted in the following photo detector improvements:

a) Improved light sensitivity in defined spectral ranges for photodiodes and phototransistors.

b) Highly linear photocurrent (or log. photo voltage) versus illumination characteristics for photo sensors.

c) Extremely short response times of the order of nanoseconds for photodiodes and microseconds for phototransistors, together with high light sensitivity.

d) Improved stability for phototransistors and photodiodes.

2.3.3. Coupling devices

The aim of the techniques employed in the manufacture of optoelectronic couplers is to produce a device with a

- high coupling factor (CTR)
- high cut off-frequency (i.e. short response time)
- high isolation voltage
- production-orientated design.

Depending on application, additional requirements concerning, for example, linearity, transmission range or stability, may also have to be met. As mentioned previously, coupler technology is, in the main, concerned with design and encapsulation problems. Couplers can be enclosed in either hermatically sealed metal or plastic cases, depending on application requirements. Pin connections, too, are more or less governed by application, the only restriction being that a certain minimum spacing between pins must be maintained to eliminate breakdown when voltages of the order of kilovolt are applied.

A pre-requisite for a high coupling factor is the use of high-power IR emitters and phototransistors of high infrared sensitivity. Furthermore, steps must be taken to ensure that all the light radiated by the emitter is concentrated on the photo transistor. This is achieved by employing light conduction and beam focussing techniques involving lens-shaped encapsulations. In this way it is possible to concentrate almost all the light on the detector even if this is located some distance from the emitter, and thus achieve a high coupling factor combined with high isolation voltage (Fig. 2.8.).

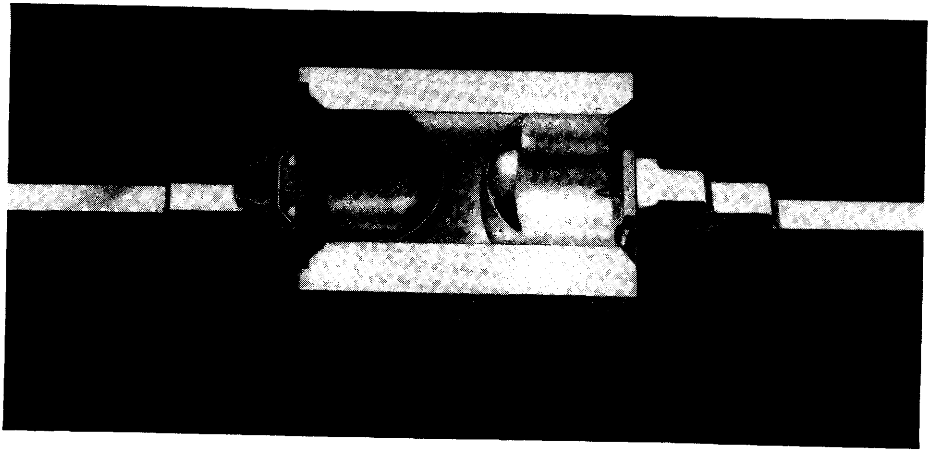


Fig. 2.8.

2.3.4. Glass fiber transmission

2.3.4.1. Introduction

Glass fiber transmission lines can be used like couplers for potential isolation. The main application area is, in fact, signal transmission where broad band transmission over large distances can be realized. This type of line cannot be affected by electromagnetic interference and is safe against interception. With the application of low loss fibers, sensitive receivers and powerful emitters, signals can be transmitted over several kilometers. For the complete characterisation of a transmission line the emitting power of the source, the sensitivity of the receiver, the insertion loss of the glass fiber i.e., coupling and fiber attenuation losses and the bandwidth of all components have to be known.

2.3.4.2. Glass fiber

The following parameters are sufficient for the characterisation of the glass fiber:
refractive index profile, core diameter, attenuation per unit length and material dispersion.

For light propagation by total reflection there needs to be a refractive index difference inside the glass fiber, i.e. between the high refractive core and the less refractive cladding layer. The interface between the cladding layer and the core can be either stepwise such as in the "step index fiber" or graded giving the "graded index fiber". The difference between the refractive indices determines the angular aperture $\frac{\alpha}{2}$ of the fiber which, for the step profile fiber, can be calculated from

N.A. = $\sin\frac{\alpha}{2}(n_1^2 - n_2^2)^{1/2}$.

Using this value one can calculate the amount P_F of the emitted power P_E of a point source that can be coupled into the associated fiber:

$P_F = P_E \cdot \frac{a+1}{2}\,(N.A.)^2$

a is a parameter for the angular distribution of the emitter, given by $I_e = I_{eo} \cos^a \alpha_{/2}$.

In Fig. (2.9.), the coupling losses of a Lambert type and a typical edge emitter (laser) are given.

It is assumed that the point light source is situated at the end of the fiber. Additional losses must be taken into account if the light source is not a point source or if there is a distance between the source and the fiber. The diameter of the radiation source should be as small as possible or equal to the diameter of the core of the fiber. Typical fiber core diameters are 50-60 μm for graded index fibers and 100 or 200 μm for step-index-fibers. The outer diameters are about 125 μm or between 230 μm and 300 μm for the 200 μm step-profile fiber respectively.

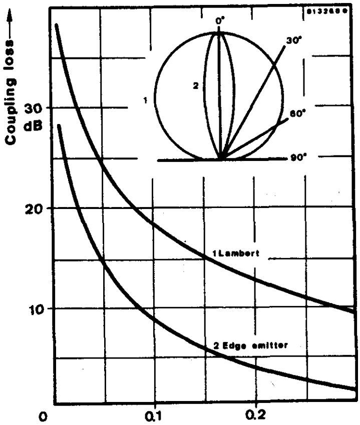


Fig. 2.9.

The attenuation losses are at present typically 5-10 dB/kilometer. The bandwidth of the fibers is (except for the monomode fibers, which are limited by material dispersion) limited by group delay spreading. For this case a δ-impulse has a time dispersion under certain assumption.

$$T_S = \frac{n_1 \cdot L}{c} \cdot (n_1 - n_2) \text{ (step profile) or}$$

$$T_P = \frac{n_0 \cdot L}{c} \cdot \frac{(n_0 - n_2)^2}{2}$$

graded index to fiber, parabolic profile n_o = refractive index in the center of the fiber), where L is the transmission length.

N.A. = Numerical Aperture
N.A. = $n \cdot \sin\frac{\alpha}{2}$, α = angluar aperture, n- refractive index of the surrounding medium. I_{eo} = radiation intensity in the optical axis.
$I_e = I_{eo} \cdot f(\Theta)$
for example
$I_e = I_{eo} \cos^a(\Theta)$, a = o : isotropic distribution
a = 1 : Lambert type radiation, a ≥ 2 = radiative source with a small angular aperture, such as for example a laser.

Emitters for glass fiber transmission

The same principles as for the components described in section 2.3.1. can be applied to the function and construction of these emitters. Small area emitters, with which high radiation densities can be achieved, are used to give efficient coupling to glass fibers. Radiation densities of more than 0.5 W/sr cm^2 over an area with diameter 50-100 μm can be achieved using zinc diffused GaAs diodes. With these diodes a transmission bandwidth of about 10 MHz can be realized. With a coupled power of about 100 μW into a step-profile fiber (N.A. = 0.3) lines of much more than a kilometer can be covered. Using lasers, because of the extremly high radiation density of 200 kW/sr cm^2, higher coupling efficiencies can be achieved. Typical values are for example 1 mW coupled power into a fiber with an aperture of N.A. = 0.2. Lasers are also preferable to IR-Diodes because of their large bandwidth of more than 1 GHz.

Detectors for glass fiber transmission

The technology and function of silicon detectors has been described in section 2.3.1.

For glass fiber applications, the active surface of the chips is matched to the core of the applied glass fiber. The light sensitive surface of a detector should be slightly larger than the fiber core, so that harmful capacitances as well as wasteful adjustements can be minimised.

With hermetically sealed housings the fiber cannot be placed directly onto the chip because of the housing window. Here, the optimum chip size must be derived from the numerical aperture and the distance between the chip and the end of the fiber.

Remarks regarding fiber coupling

Fibers are usually fixed directly onto the receiver and the source. With lasers, the coupled glass fiber is not glued onto the mirror surface but is fixed to the housing. Whenever epoxies are used, it must be ensured that the applied epoxies do not have adverse effects on the lifetime of the components.

2.4. Conversion tables

Corresponding radio metric and photometric definitions, symbols and units

Definition	Radiometry			Photometry		
		Symbol	Unit		Symbol	Unit
Power	Radiant flux (Radiant power)	Φ_e	Watt, W	Luminous flux (Luminous power)	Φ_v	Lumen, lm
Output power per unit area	Radiant emittance/ exitance	M_e	$\frac{W}{m^2}$	Luminous exitance	M_v	$\frac{lm}{m^2}$
Output power per unit solid angle	Radiant intensity	I_e	$\frac{W}{sr}$	Luminous intensity	I_v	candela, cd
Output power per unit solid angle and unit emitting area	Radiance	L_e	$\frac{W}{m^2 \cdot sr}$	Luminance	L_v	$\frac{cd}{m^2}$
Input power per unit area	Irradiance	E_e	$\frac{W}{m^2}$	Illuminance, illumination	E_v	Lux, lx $lx = \frac{lm}{m^2}$
Spectral concentration of radiant energy	Radiant energy	Q_e	Ws	Luminous energy (Quantity of light)	Q_v	$lm \cdot s$
Energy per unit area	Radiant exposure (irradiation)	H_e	$\frac{W \cdot s}{m^2}$	Light exposure (illumination)	H_v	$\frac{lm \cdot s}{m^2}$

Tab. 2.9.

Luminance conversion units

Unit	$cd \cdot m^{-2}$	asb	sb	L	$cd \cdot ft^{-2}$	fL	$cd \cdot in^{-2}$	Notes
1 $cd \cdot m^{-2}$ =	1	π	10^{-4}	$\pi \cdot 10^{-4}$	$9.29 \cdot 10^{-2}$	0.2919	$6.45 \cdot 10^{-4}$	instead of $cd \cdot m^{-2}$ sometimes Nit
1 asb (Apostilb) =	$\frac{1}{\pi}$	1	$\frac{1}{\pi} \cdot 10^{-4}$	10^{-4}	$2.957 \cdot 10^{-2}$	0.0929	$2.054 \cdot 10^{-4}$	
1 sb =	10^4	$\pi \cdot 10^4$	1	π	929	2919	6.452	
1 L (Lambert) =	$\frac{1}{\pi} \cdot 10^4$	10^4	$\frac{1}{\pi}$	1	$2.957 \cdot 10^2$	929	2.054	
1 $cd \cdot ft^{-2}$ =	10.764	33.82	$1.076 \cdot 10^{-3}$	$3.382 \cdot 10^{-3}$	1	π	$6.94 \cdot 10^{-3}$	ft = foot
1 fL (Footlambert) =	3.426	10.764	$3.426 \cdot 10^{-4}$	$1.0764 \cdot 10^{-3}$	$\frac{1}{\pi}$	1	$2.211 \cdot 10^{-3}$	
1 $cd \cdot in^{-2}$ =	1550	4869	0.155	0.4869	144	452.4	1	in = inch

Tab. 2.10.

Illumination conversion units

Unit		lx	lm · cm^{-2}	fc	Notes
1 lx	=	1	10^{-4}	0.0929	
1 lm · cm^{-2}	=	10^{-4}	1	0.0929 · 10^4	instead of lm · cm^{-2} formerly Phot (ph)
1 fc (Footcandle)	=	10.764	10.764 · 10^{-4}	1	

Tab. 2.11.

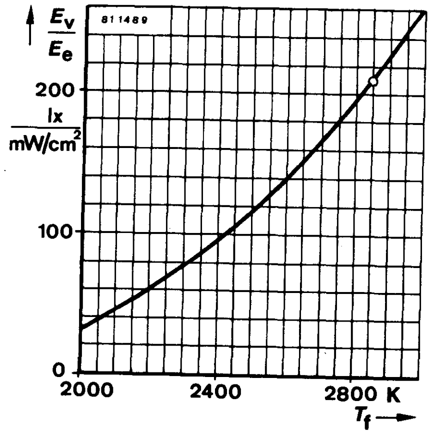


Fig. 2.12

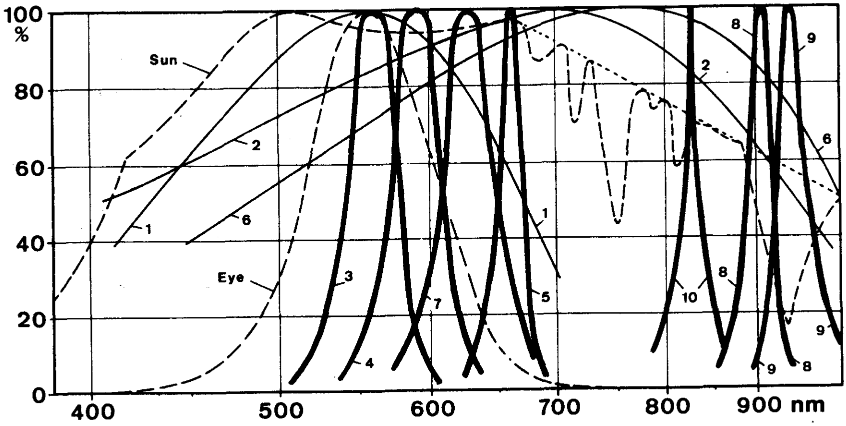
Special notes:

a) At standard illuminant A:
1 klx ≈ 4.75 mW/cm^2
or
1 mW/cm^2 ≈ 210 lx

b) At 550 nm it is valid:
680 lm ≈ 1 W

c) 1 lumen/ft^2 = 1 footcandle
632 im/ft^2 = 1 mW/cm^2 at 550 nm
4π candlepower = 1 lumen (lm)

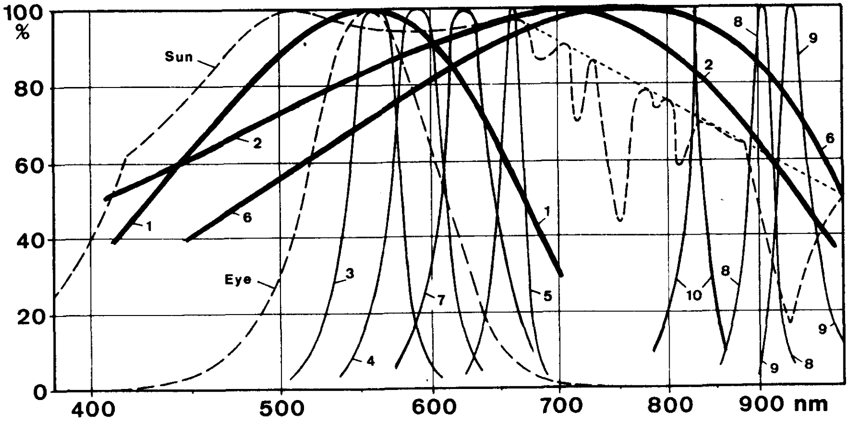
Emitters



GaP / green
GaAsP / yellow
GaAsP / red
GaAs on GaP / orange-red

GaAs: Zn / infrared
GaAs: Si / infrared
GaAlAs / Laserdiode

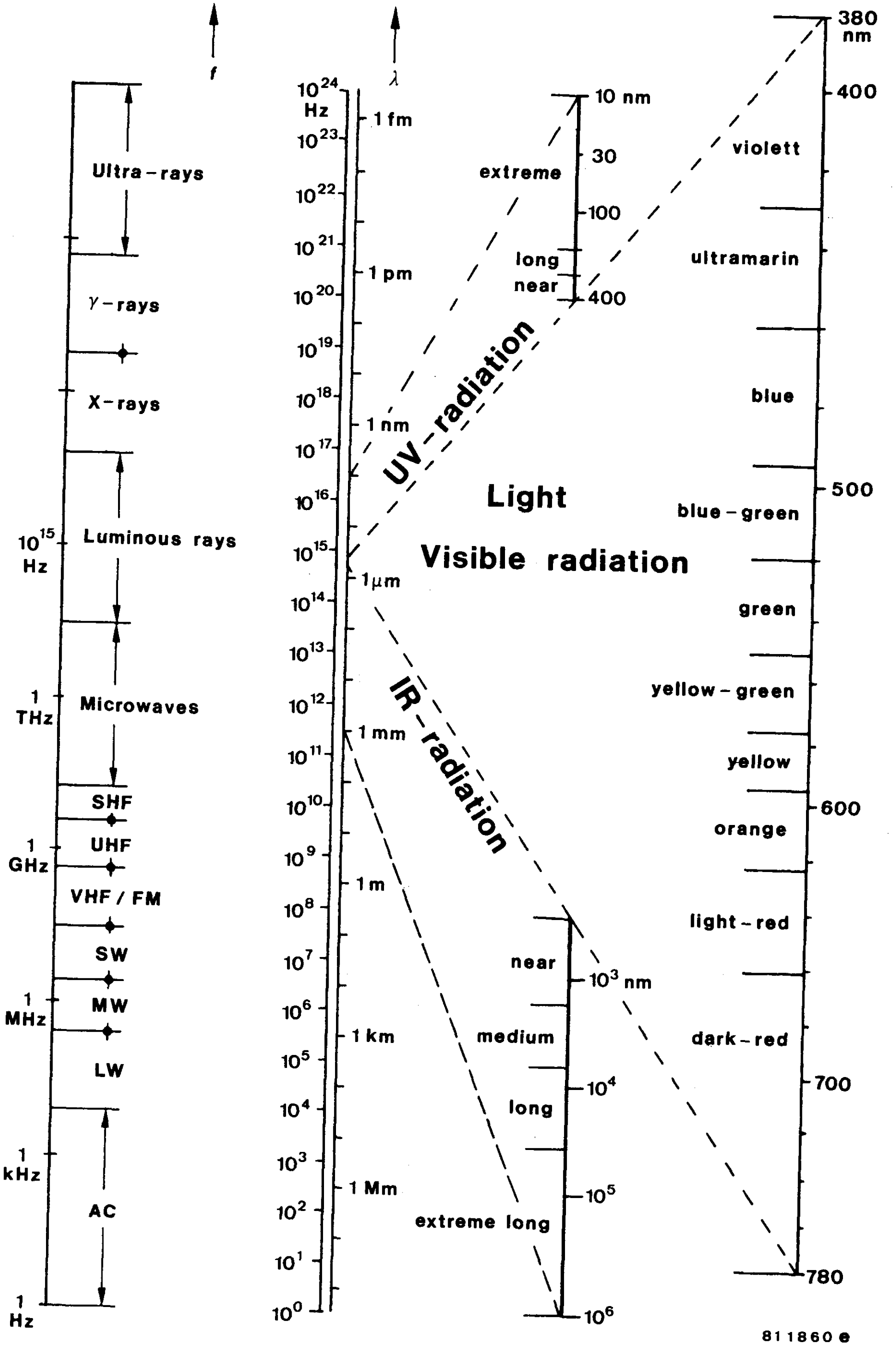
Detectors



1-Sensor cell with filter
2-Sensor cell without filter
6-Solar cell

81 1858 e

Fig. 2.14.


f
λ
Ultra-rays
γ-rays
X-rays
Luminous rays
Microwaves
SHF
UHF
VHF / FM
SW
MW
LW
AC
10^{15} Hz
1 THz
1 GHz
1 MHz
1 kHz
1 Hz
10^{24} Hz
10^{23}
10^{22}
10^{21}
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10^{4}
10^{3}
10^{2}
10^{1}
10^{0}
1 fm
1 pm
1 nm
1 μm
1 mm
1 m
1 km
1 Mm
10 nm
30
100
400
extreme
long
near
UV-radiation
Light
Visible radiation
IR-radiation
near
medium
long
extreme long
10^{3} nm
10^{4}
10^{5}
10^{6}
380 nm
400
violett
ultramarin
blue
500
blue-green
green
yellow-green
yellow
600
orange
light-red
dark-red
700
780
81 1860 e

Fig. 2.15.

3. Measurement Technique

3.1. Introduction

The characteristics given in the data sheets for optoelectronic devices are verified either by 100 % production tests followed by statistic evaluation or by sample tests on typical specimens. These tests can be divided into the following categories:

a) Dark measurements
b) Light measurements
c) Measurement of switching characteristics, cut-off frequency and capacitance
d) Angular light distribution measurements
e) Spectral distribution measurements
f) Thermal measurements.

The dark and light measurements are 100% measurements and are guarantied with AQL-values (see section 4) in data sheets. All other values are typical. The basic circuits used for these measurement are shown in the following sections, although these circuits may be modified slightly to cater for special measurement requirements.

3.2. Dark and light measurements

3.2.1. Emitter devices

3.2.1.1. IR diodes (GaAs)
The forward voltage, V_F, is measured either on a curve tracer or statically using the circuit shown in Fig. 3.1. A specified forward current (from a constant current source) is passed through the device and the voltage developed across it is measured on a high-impedance voltmeter.

To measure the reverse voltage, V_R, a 100 μA reverse current from a constant current source is impressed through the diode (Fig. 3.2.) and the voltage developed across it is measured on a voltmeter of extremely high input impedance ($\geqq 10\ \text{M}\Omega$).

Radiant flux (radiant power), Φ_e: In case of IR GaAs diodes it is usual to measure the total radiant output power, Φ_e, i. e. with a calibrated solar cell BPY 70 fitted in a conical reflector with a bore which accepts the test item – see fig. 3.3. A constant DC or pulsating forward current of specified magnitude is passed through the IR diode. The advantage of pulse current measurements at room temperature (25 °C) is that the results can be reproduced exactly. If, for reasons of measurement economy, only DC measurements (Fig. 3.4.) are to be made, then the energizing time should be kept short (ca. 1 s) and of uniform duration, to minimize any fall-off in light output due to internal heating.
To ensure that the relationship between irradiance and photocurrent is linear, the solar cell should operate near short-circuit configuration. This can be achieved by using a low resistance load ($\leqq 10\ \Omega$) of such a value that the voltage dropped across it is very much lower than the open circuit voltage produced under identical illumination conditions ($R_{\text{meß}} \ll R_j$). The voltage across the load should be measured with a sensitive DVM.

Radiant intensity, I_e: Knowledge of the radiant intensity produced by an IR emitter enables customers to asses the range of IR light barriers. The measurement procedure for this is more or less the same as that used for measuring the radiant power. The only difference ist that in this case the solar cell is

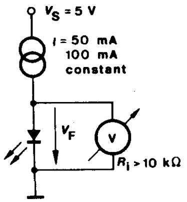


Fig. 3.1.

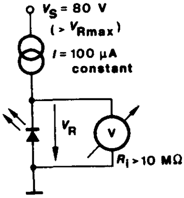


Fig. 3.2.

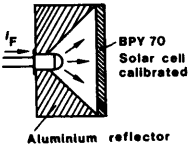


Fig. 3.3

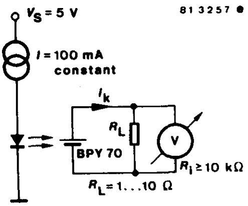


Fig. 3.4.

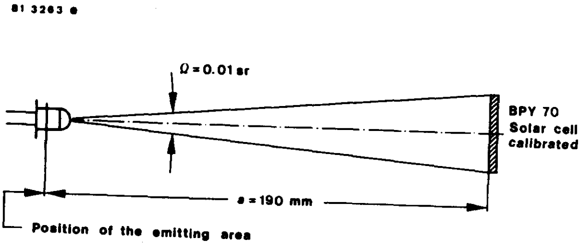


Fig. 3.5.

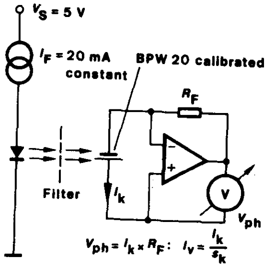


Fig. 3.6.

used without a reflector and is mounted at a specified distance from, and on the optical axis of, the GaAs diode (Fig. 3.5.) so that only radiant power of a narrow axial beam is considered. The radiant power within a solid angle of $\Omega = 0.01$ sr is measured at a distance of 190 mm. The radiant intensity is then obtained by using this measured value for calculating the radiant intensity for a solid angle of $\Omega = 1$ sr.

3.2.1.2. Light emitting diodes (GaAsP and GaP) For forward and reverse voltage measurements (V_F and V_R respectively) refer to the section "IR Diodes", 3.2.1.1.

The luminous intensity, I_v, of a light emitting diode can be calculated by multiplying the radiant intensity, I_e, (see fig. 3.5.) by the absolute eye sensitivity, $K_m \cdot V_\lambda$ (DIN 5031). This assumes, however, that the wavelength of the radiation emitted by the test item is known exactly. In production measurements a calibrated silicon photovoltaic cell is used instead, in conjunction with a special colour filter (e.g. Schott BG 38) which simulates the red-slope of the eye sensitivity curve. BPW 20 is used as a photovoltaic cell, because the short circuit output current characteristics of this cell is strictly linear even when the irradiation is very low. This is because the radiant output power of LEDs is low in comparsion with that of IR diodes, and the colour filter has an attenuating effect causing the cell to produce, at the most, only a few nanoamperes. The cell must operate into an operational amplifier with a high-impedance FET input stage (Fig. 3.6.).

3.2.2. Detector devices

3.2.2.1. Photovoltaic cells, photodiodes

a) Dark measurements

The reverse voltage characteristic V_R is measured either on a curve tracer or statically using the circuit shown in fig. 3.7. A high-impedance voltmeter, which draws only an insignificant fraction of the device reverse current, must be used.

Dark reverse current measurements, I_{ro}, must be carried out in complete darkness; the reverse currents of silicon photo diodes are of the order of nanoamperes only, and an illumination of a few lux is quite sufficient to falsify the test result. If a highsensitive DVM is to be used, then a current sampling resistor of such a value that the voltage dropped across it is small in comparison with the supply voltage must be connected in series with the test item (Fig. 3.8.). Under these conditions any reverse voltage variations of the test samples can be ignored.

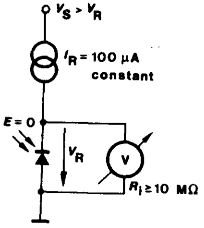


Fig. 3.7.

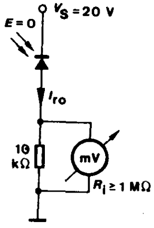


Fig. 3.8.

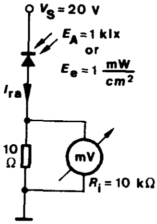


Fig. 3.9.

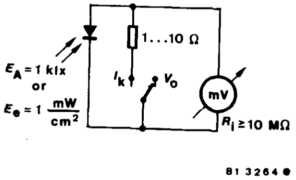


Fig. 3.10.

b) Light measurements

The same as the dark measurement circuit can be used to carry out light reverse current, I_{ra}, measurements on photodiodes, the only difference being that the diode is now irradiated and a current sampling resistor of lower value must be used (Fig. 3.9.), because of the higher currents involved.

The open circuit voltage, V_o, and short circuit current, I_k, of photovoltaic cells and photodiodes are measured by means of the test circuit shown in fig. 3.10. The value of the load resistor used for the I_k measurement should be chosen so that the voltage dropped across it is low in comparison with the open circuit voltage produced under conditions of identical irradiation.

The light source used for light measurements is a calibrated incandescent tungsten lamp without filter. The filament current is adjusted for a colour temperature of 2855.6 K (standard illuminant A to DIN 5033 sheet 7), and the specified illumination, E_v, (usually 100 or 1000 lux) is produced by adjusting the distance, α, between the lamp and the detector on an optical bench. E_v can be measured on a $V(\lambda)$-corrected lux meter, or, if the luminous intensity, I_v, of the lamp is known, can be calculated using the formula.

It should be noted that this inverse square law is only strictly accurate for point light sources, i.e. for sources where the dimensions of the source (the filament) are small ($\leq$ 10%) in comparison with α, the spacing between source and detector.

IR-Diode is used as a radiation source, instead of tungsten incandescent lamp, to measure detector devices being used mainly in IR-transmission system together with IR-emitters e.g. IR-remote control, IR-headphone. Operation is possible both with d.c. or pulsed current.

The adjustment of the irradiance, E_e, is similar to the above mentioned adjustment of the illuminance, E_v. To achieve a high stability similar to the (tungsten incandescent) filament lamps consideration should be given to the following two points:

- The IR-diode should be connected on a good heat sink to provide a sufficient temperature stability.
- The radiant intensity, I_e, of the device is controlled by a calibrated detector.

3.2.2.2. Phototransistors, Photo Darlington

The collector-emitter voltage, V_{CEO}, is measured either on a transistor curve tracer or statically using the circuit shown in fig. 3.11. Normal bench illumination does not change the measuring results.

In contrast, however, the collector dark current, I_{CEO} or I_{co}, must be measured in complete darkness (Fig. 3.12.). Even ordinary daylight illumination of the wire feed-through glass seals would falsify the measurement result.

The same circuit is used for collector light current, I_{ca}, measurements (Fig. 3.13.), the device being positioned so that its optical axis points towards an incandescent tungsten lamp without filter, T_f = 2855.6 K, providing an illumination of 100 or 1000 lux or an IR irradiation of a GaAs diode (refer to the photovoltaic cells and photodiodes section). Note that a lower-value sampling resistor is used, in keeping with the higher current involved.

To measure the collector-emitter saturation voltage, V_{CEsat}, the device is illuminated and a constant collector current passed through it. The magnitude of this current is adjusted so that it is less than the minimum light current, $I_{ca\,min}$, for the same illumination intensity, the value being rounded off to the next lower power of ten (Fig. 3.14.). The saturation

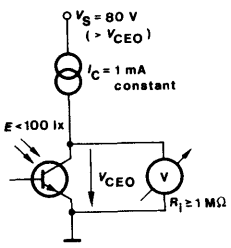


Fig. 3.11.

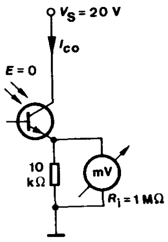


Fig. 3.12.

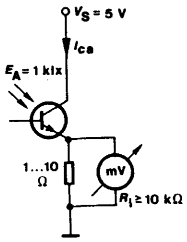


Fig. 3.13.

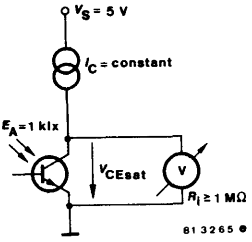


Fig. 3.14.

voltage of the phototransistor or Darlington stage (approx. 100 mV or 600 mV respectively) is then measured on a high-impedance voltmeter.

3.2.3. Coupling devices

a) Dark measurements

Emitters: For forward- and reverse voltage measurements refer to section 3.2.1.1. (IR diodes).

Detectors: For V_{CEO} and I_{co} measurements refer to 3.2.2.2. (Phototransistors)

b) Light measurements

To measure the collector current, I_C (Fig. 3.15.), a specified forward current, I_F, is impressed in the IR diode. Voltage difference is then measured across a low emitter resistance. In case of collector-emitter saturation voltage, V_{CEsat} (Fig. 3.16.), forward current, I_F, in IR diode and a low collector current, I_C, in a phototransistor is impressed. V_{CEsat} is then measured (across collector and emitter terminals) as shown in diagram.

3.3. Switching characteristics

3.3.1. Definition

Every electronic device introduces a certain delay between input and output signals as well as a certain amount of amplitude distortion. The simplified circuit shown in fig. 3.17. shows how the input and output signals of opto-electronic devices can be displayed on a dual-trace oscilloscope.

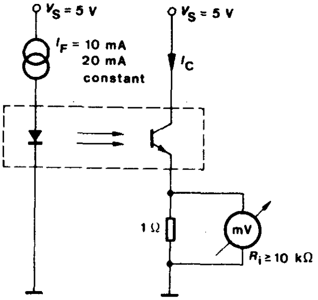


Fig. 3.15.

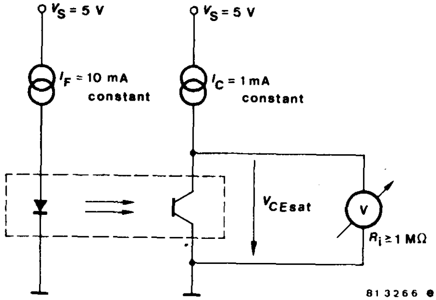


Fig. 3.16.

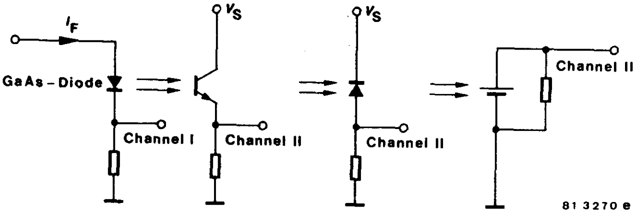


Fig. 3.17.

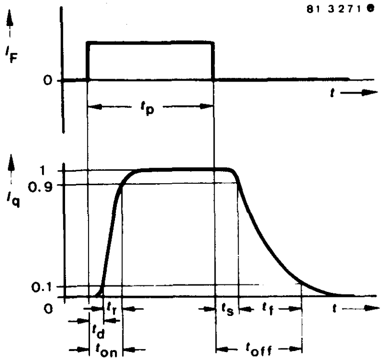


Fig. 3.18.

t_d	delay time
t_r	rise time
t_{on} ($= t_d + t_r$)	turn-on time
t_s	storage time
t_f	fall time
t_{off} ($= t_s + t_f$)	turn-off time

The switching characteristics can be determined by comparing the timing of the output current waveform with that of the input current waveform (Fig. 3.18.).

These time parameters also include the delay that exists in a luminescence diode between the forward current (I_F) and the radiant power Φ_e. Excepting extremely fast detector devices (photo PIN diodes), this delay can, however, be ignored.

3.3.2. Notes concerning the test set-up

The circuits used for testing light-emitting, light sensitive and optically coupled isolator devices are basically the same (Fig. 3.17.), the only difference being the way in which the test item is connected in circuit.

It is assumed that the rise and fall times associated with the signal source (pulse generator) and the dual trace oscilloscope are insignificant, and that the switching characteristics of any light sensitive device used in the set-up are considerably shorter than those of the test item. The switching characteristics of light and IR emitters, for example, ($t_r \approx$ 10...1000 ns) are measured with the aid of a photo PIN diode as a detector ($t_r \approx 1$ ns). Photo and Darlington transistors and photo and solar cells ($t_r \approx 0.5...50\,\mu$s) are, as a rule, measured by use of GaAs: Zn-based fast IR diodes ($t_r \approx 100$ ns) as emitters.

GaAsP red light emitting diodes are used as light sources only for devices which, because of their spectral sensitivity (e.g. BPW 21), cannot be measured with IR diodes. This is because these diodes emit only 1/10 of the radiant power of IR diodes and consequently produce only very low signal levels.

No fast sensors are required for switching speed measurements on optically coupled isolators (couplers) since these incorporate an emitter as well as a detector, and only the overall switching characteristics is of interest.

3.3.3. Switching characteristics improvements on phototransistors and Darlington phototransistors

As in any ordinary transistor, switching characteristics are reduced if the drive signal level and hence the collector current is increased. Another time reduction (especially in fall time t_f) can be achieved by use of a suitable base resistor, assuming there is an external base connection, although this can only be done at the expense of sensitivity.

4. Quality Data

4.1. Delivery quality

To designate the delivery quality, the following specifications are given:

- Maximum and minimum values of the characteristics
- AQL-values (Acceptable Quality Level)

Shipment lots whose defect percentage is equal to or less than the percentage given in AQL-value shall be accepted with greater probability (L ≧ 90%) due to sampling tests (see the single sampling plan in section 4.4.).

4.2. Classification of defects

The possible defects with which a semiconductor device could be subjected are classified according to the probable influence of existing circuits:

- Total (critical) defect

When this defect exists, the functional use of the device is impossible.
Examples are: open contacts, inter-electrode shortcircuits, breakdown in reverse characteristics, wrong type designation, broken leads, critical case defects.

- Major defect

A defect which is usually responsible for the failure of a device to function in its intended purpose.
In technical data sheets certain characteristics are given with foot note*). If the specified limits are exceeded, it is then considered as a major defect. This normally applies to the following characteristics.

Emitters: Φ_e, I_v, $V_{(BR)}$, V_F and m
Detectors: I_{ca}, I_{co}, V_{CEO}, V_{CEsat} and m
Couplers: $V_{(BR)}$, V_F, V_{CEO}, V_{CEsat} and I_C

- Minor defect

A defect which is responsible for the functioning of a device with no or only a slight reduction in its effectiveness.
Failure to meet the specified performance requirements for characteristics not specially marked in the data sheet is considered a minor defect.

Normally these are dynamic characteristics with ambient temperature, T_{amb} = 25°C, provided there is no special meaning for main application. Further, there are static characteristics (T_{amb} = 25°C) whose significance for the main application is restricted.

4.3. AQL-values

According to the classification of defects mentioned in 4.2., the following AQL-values, unless otherwise specified, are valid for technical datas of industrial types. Under it, the inspection follows the single sampling plan for attribute testing AEG 1415 (see 4.4.), which corresponds largely to the ASQ/AWF 1 or ABC-STD 105 D, inspection level II.

Classification of defects	Single-AQL	Cumulative-AQL
Total defect	–	0.25 %
Major defect	0.65 %	–
Minor defect	–	2.50 %

A cumulative-AQL equal to 2.5 % applies to all defective devices considered.
There are additional characteristics given in the data sheets whose measurements are only possible through elaborate and costly tests. These characteristics are given with foot note**) provided they are not of special use for the main application. To check the given limits of these characteristics, a sampling inspection is performed according to single sampling plan AEG 1416 (see 4.4.) which corresponds largely to ABC-STD 105 D, inspection level S 4. In this case an AQL-value of 2.5 % is valid.

4.4. Sampling inspection plans

List of symbols:		
	AQL	Acceptable Quality Level
	N	Lot size
	n	Sample size
	c	Acceptance number
	D_{max}	Average outgoing quality level

Single sampling plan for attribute testing (AEG 1415)

normal inspection	AQL											reduced inspection
	0.06	0.10	0.15	0.25	0.40	0.65	1.0	1.5	2.5	4.0	6.5	
N	n - c (D_{max} in %)											N
2- 15	200-0 *(0.18)*	125-0 *(0.29)*	80-0 *(0.45)*	50-0 *(0.71)*	32-0 *(1.1)*	20-0 *(1.7)*	13-0 *(2.6)*	8-0 *(3.9)*	5-0 *(6.7)*	3-0 *(9.6)*	2-0 *(15.6)*	2- 15
16- 50										13-1 *(4.8)*	8-1 *(9.2)*	16- 150
51- 150								32-1 *(2.3)*	20-1 *(3.6)*	20-2 *(6.0)*	20-3 *(8.4)*	151- 280
151- 280							50-1 *(1.5)*		32-2 *(3.8)*	32-3 *(5.4)*	32-5 *(8.8)*	281- 500
281- 500						80-1 *(1.0)*		50-2 *(2.4)*	50-3 *(3.5)*	50-5 *(5.7)*	50-7 *(8.1)*	501- 1200
501- 1200					125-1 *(0.64)*		80-2 *(1.6)*	80-3 *(2.2)*	80-5 *(3.7)*	80-7 *(5.2)*	80-10 *(7.7)*	1201- 3200
1201- 3200				200-1 *(0.41)*		125-2 *(1.1)*	125-3 *(1.5)*	125-5 *(2.4)*	125-7 *(3.5)*	125-10 *(5.0)*	125-14 *(7.2)*	3201-10000
3201-10000			315-1 *(0.27)*		200-2 *(0.68)*	200-3 *(0.95)*	200-5 *(1.6)*	200-7 *(2.2)*	200-10 *(3.2)*	200-14 *(4.6)*	200-21 *(7.3)*	10001-35000[1]
10001-35000[1]		500-1 *(0.17)*		315-2 *(0.44)*	315-3 *(0.61)*	315-5 *(0.99)*	315-7 *(1.4)*	315-10 *(2.1)*	315-14 *(3.0)*	315-21 *(4.7)*		

Single sampling plan for destructive or very costly test procedurs (AEG 1416, Z-plans).

Z 1 normal inspection	AQL 0.06	0.10	0.15	0.25	0.40	0.65	1.0	1.5	2.5	4.0	6.5	Z 2 reduced inspection
N	n - c (D_{max} in %)											N
2- 25	200-0 *(0.18)*	125-0 *(0.29)*	80-0 *(0.46)*	50-0 *(0.74)*	32-0 *(1.2)*	20-0 *(1.8)*	13-0 *(2.8)*	8-0 *(4.5)*	5-0 *(7.2)*	3-0 *(11.6)*	2-0 *(16.6)*	2- 50
26- 90											8-1 *(10.8)*	51- 150
91- 150										13-1 *(6.3)*		151- 500
151- 500									20-1 *(4.1)*			501- 3200
501- 1200								32-1 *(2.66)*		20-2 *(6.8)*	20.3 *(9.5)*	3201-35000[1]
1201-10000							50-1 *(1.7)*		32-2 *(4.3)*	32-3 *(6.1)*	32-5 *(9.9)*	–
10001-35000[1]						80-1 *(1.1)*		50-2 *(2.7)*	50-3 *(3.9)*	50-5 *(6.3)*	50-7 *(9.0)*	–

[1] Lot size above 35000 must be divided.

5. Assembly Instructions

5.1. General

Optoelectronic semiconductor devices can be mounted in any position.

Connection wires of less than 0.5 mm diameter may be bent, provided the bend is not less than 1.5 mm from the bottom of the case and no mechanical force has an affect on it. Connection wires of larger diameter should not be bent.

If the device is to be mounted near heat generating components, then consideration must be given to the resultant increase in ambient temperature.

5.2. Soldering instructions

Protection against overheating is essential when a device is being soldered. It is recommended, therefore, that connection wires are left as long as possible and are soldered at the tip only, and that any heat generated is quickly conducted away. The time during which the specified maximum permissible device junction temperature is exceeded during the soldering operation should be as short as possible (one minute max.). In the case of plastic encapsulated devices, the maximum permissible soldering temperature is governed by the maximum permissible heat that may be applied to the encapsulant rather than by the maximum permissible junction temperature.

The following maximum soldering iron (or solder bath) temperatures as given in Fig. 5.1. are permissible:

5.3. Heat removal

To keep the thermal equilibrium, the heat generated in the semiconductor junction(s) must be removed to the ambient.

In the case of low-power devices the natural heatconductive path between case and surrounding air is usually adequate for this purpose.

However, in the case of medium-power devices heat radiation may have to be improved by the use of star- or flag-shaped heat dissipators, which increase the heat radiating surface.

Finally, in the case of high-power devices special heat sinks must be provided, the cooling effect of which can be increased further by the use of special coolants or air blowers.

The heat generated in the junction is conveyed to the case or header by conduction rather than convection; a measure of the effectiveness of heat conduction is the inner thermal resistance or thermal resistance junction case, R_{thJC}, the value of which is governed by the construction of the device.

	Iron soldering			Dip or flow soldering		
	Iron temperature	Soldering distance from touching border with intermediate PC-board	Max. allowable soldering time	Soldering temperature	Soldering distance from touching border with intermediate PC-board	Max. allowable soldering time
Metal case	≤ 245 °C	1.5...5 mm	5 s	≤ 245°C	> 1.5 mm	5 s
	≤ 245 °C	> 5 mm	10 s			
	245...350 °C	> 5 mm	5 s	245...300°C	> 5 mm	3 s
Plastic case	≤ 245°C	> 1.5 mm	3 s	≤ 245 °C	> 1.5 mm	3 s
	≤ 245°C	> 5 mm	5 s	245...300 °C	> 5 mm	2 s

Fig. 5.1.

Any heat transfer from the case to the surrounding air involves radiation convection and conduction, the effectiveness of transfer being expressed in terms of an R_{thCA} value, i.e. the external or case-ambient thermal resistance. The total thermal resistance, junction-ambient is consequently:

$$R_{thJA} = R_{thJC} + R_{thCA}$$

The total maximum power dissipation, $P_{tot\,max}$, of a semiconductor device can be expressed as follows:

$$P_{tot\,max} = \frac{T_{jmax} - T_{amb}}{R_{thJA}} = \frac{T_{jmax} - T_{amb}}{R_{thJC} + R_{thCA}}$$

whereas:

T_{jmax}	is the maximum allowable junction temperature
T_{amb}	the highest ambient temperature likely to be reached under the most unfavourable conditions
R_{thJC}	the thermal resistance, junction-case
R_{thJA}	the thermal resistance, junction-ambient
R_{thCA}	the thermal resistance, case-ambient, the value of which depends on cooling conditions. If a heat dissipator or sink is used, then R_{thCA} depends on the thermal contact between case and heat sink, heat propagation conditions in the sink and the rate at which heat is transferred to the surrounding air.

Therefore, the maximum allowable total power dissipation for a given semiconductor device can be influenced only by changing T_{amb} and R_{thCA}. The value of R_{thCA} could be obtained either from the data of heat sink suppliers or through direct measurements.

In case of cooling plates as heat sink without optimum performance, the following approach holds good.

The curves shown in both figures are given for thermal resistance R_{thCA} by using square plates of aluminium with edge length, a, but with different thicknesses. Thereby, the device case should be mounted direct on the cooling plate.

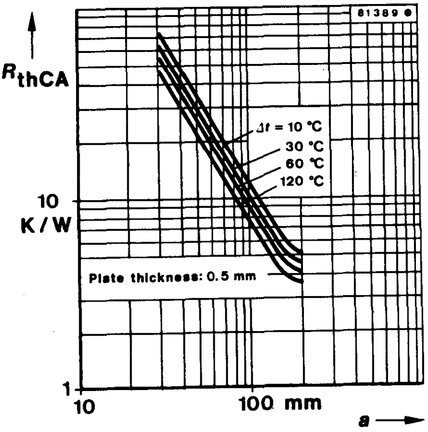


Fig. 5.2.

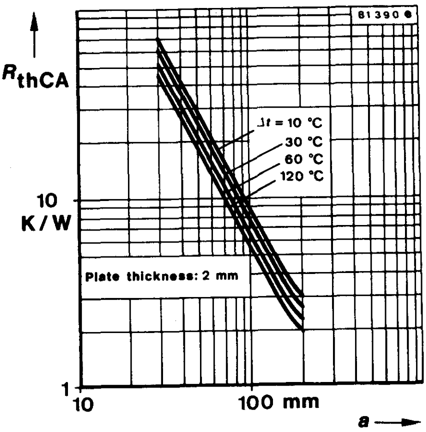


Fig. 5.3.

The edge length, a, derived from Fig. 5.2. and 5.3. for a given R_{thCA} value must be multiplied with α and β:

$$a' = \alpha \cdot \beta \cdot a$$

where α = 1.00 for vertical arrangement
α = 1.15 for horizontal arrangement
β = 1.00 for bright surface
β = 0.85 for dull black surface

Example:
For a GaAs diode with $T_{\mathrm{j\,max}} = 100\ ^\circ\mathrm{C}$ and $R_{\mathrm{thJC}} = 100$ KW, calculate the edge length for a 2 mm thick aluminium square sheet having dull black surface ($\beta = 0.85$) and vertical arrangement ($\alpha = 1$), $T_{\mathrm{amb}} = 70^\circ\mathrm{C}$ and $P_{\mathrm{tot\,max}} = 200$ mW.

$$P_{\mathrm{tot\,max}} = \frac{T_{\mathrm{jmax}} - T_{\mathrm{amb}}}{R_{\mathrm{thJC}} + R_{\mathrm{thCA}}}$$

$$R_{\mathrm{thCA}} = \frac{T_{\mathrm{jmax}} - T_{\mathrm{amb}}}{P_{\mathrm{tot\,max}}} - R_{\mathrm{thJC}}$$

$$R_{\mathrm{thCA}} = \frac{100^\circ\mathrm{C} - 70^\circ\mathrm{C}}{0.2\ \mathrm{W}} - 100\ \mathrm{K/W}$$

$$R_{\mathrm{thCA}} = \left(\frac{30}{0.2} - 100\right)\ \mathrm{K/W}$$

$$R_{\mathrm{thCA}} = 50\ \mathrm{K/W}$$

$\Delta t = T_{\mathrm{case}} - T_{\mathrm{amb}}$ can be calculated from the relationship:

$$P_{\mathrm{tot\,max}} = \frac{T_{\mathrm{jmax}} - T_{\mathrm{amb}}}{R_{\mathrm{thJC}} + R_{\mathrm{thCA}}} = \frac{T_{\mathrm{case}} - T_{\mathrm{amb}}}{R_{\mathrm{thCA}}}$$

$$\Delta t = T_{\mathrm{case}} - T_{\mathrm{amb}} = \frac{R_{\mathrm{thCA}} \cdot (T_{\mathrm{jmax}} - T_{\mathrm{amb}})}{R_{\mathrm{thJC}} + R_{\mathrm{thCA}}}$$

$$\Delta t = \frac{50\ \mathrm{K/W} \cdot (100^\circ\mathrm{C} - 70^\circ\mathrm{C})}{100\ \mathrm{K/W} + 50\ \mathrm{K/W}}$$

$$\Delta t = \frac{50\ \mathrm{K/W} \cdot 30^\circ\mathrm{C}}{150\ \mathrm{K/W}}$$

$$\Delta t = 10^\circ\mathrm{C} = 10\,\mathrm{K}$$

With $R_{\mathrm{thCA}} = 50$ K/W and $\Delta t = 10^\circ\mathrm{C}$ a plate having 2 mm thickness has an edge length $a = 28$ mm (see fig. 5.3.).

This multiplied by the factors α and β gives:
$a' = a \cdot \beta \cdot \alpha$
$a' = 1 \cdot 0.85 \cdot 28$ mm
$a' = 23.8$ mm

This would be the minimum permissible side length of the heat sink, but for the sake of equipment life and reliability one would normally use a larger sink to avoid operating the devices continuously at their maximum permissible junction temperature.

6. Important Notes on Device Selection

Optoelectronic devices are available in a variety of encapsulations enabling the user to select the device best suited to the operational conditions and application envisaged.

6.1. Optical characteristics

Many devices differ only in the magnitude of the angle of half sensitivity/intensity; these differences are explained briefly below.

6.1.1. Devices with flat windows

These exhibit the lowest sensitivity or radiant intensity, but have a large radiation angle ($\alpha > 70^\circ$).
There are no positioning problems and fine adjustment is not necessary to receive an accurate image of the object to be measured, or obtain an accurate projection of the emitting area. When used in conjunction with additional optical systems these devices are ideal for long range light barriers.

6.1.2. Devices with lenses

There are two types of lenses used in optoelectronic devices – medium and sharp focus.

6.1.2.1. Devices with medium focus lenses

These have or produce ten times the sensitivity or radiant intensity respectively of devices with flat windows; they have angles of half sensitivity or intensity between 25 and 40°. More accurate alignment is necessary, although deviations up to approximately ± 5% have hardly any effect.
In these devices the best compromise between focussing and sensitivity/radiant intensity has been achieved; they are therefore the devices best suited for most applications.

6.1.2.2. Devices with sharp focus (high profile) lenses

Because the angle of half sensitivity or intensity of these devices is very narrow ($\alpha \approx 10^\circ$), their sensitivity or radiant intensity is 25 times greater than of flat window devices. However, accurate alignment is essential, since the effect of even the slightest misalignment is considerable.

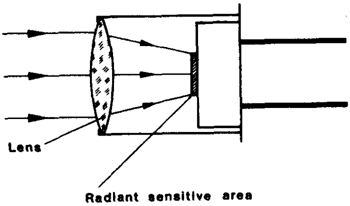
They are ideal for luminance measurements on large surface (in furnace protection systems, for example) or in simple short-distance light barrier systems designed to operate over short distances only (a few cm).

The lenses used in optoelectronic devices are, as a rule, not true lenses in the geometric-optical sense, but simple encapsulated glass drops. Their mechanical axis; therefore, sometimes deviates from the optical axis (squint effect).

This is particularly pronounced on sharp-focus lenses, and, because of this effect elaborate alignment procedures with the necessary equipment are required. Additional optical systems are only of limited use in conjunction with devices incorporating medium-focus lenses and of no use at all with those embodying sharp-focus lenses. An unsuitable arrangement could even diffuse rather than focus the emitted or received radiation (see figs. 6.1. and 6.2.).

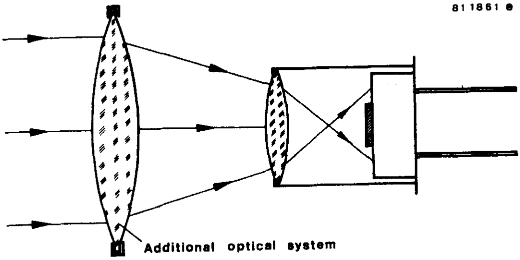
6.2. Environmental conditions

Devices in plastic as well as hermetically sealed glass-metal cases are available. For commercial and special applications where arduous environmental conditions are likely to be encountered, the use of devices in hermetically sealed glassmetal cases is recommended. In an air conditioned environment (class 'F' humidity, for example) devices in either plastic or hermetically sealed glass-metal encapsulations can be employed.



Lens focusses incident collimated light on radiant sensitive area.

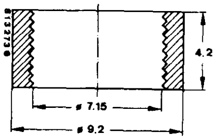
Fig. 6.1.



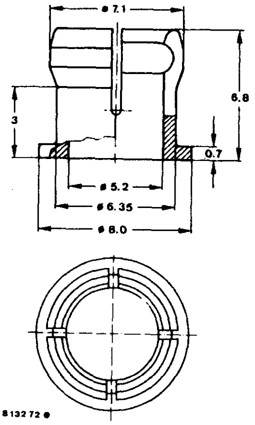
Incorrect positioning of external lens causes collimated light to be dispersed.

Fig. 6.2.

7. Accessoires



Retainer ring Order No. 562135



Mounting clip Order No. 562136

Detectors

BP 104

Silicon Photo PIN Diode

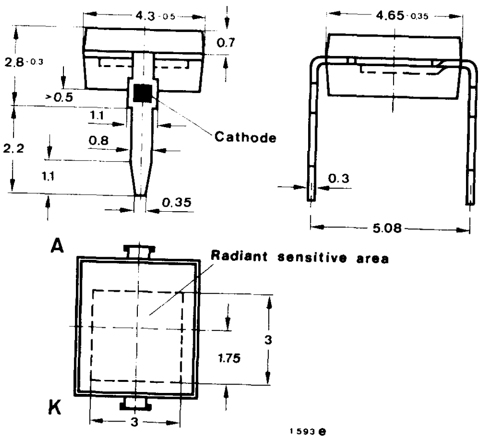
Application: High speed photo detector

Features:

- Fast response times
- Small junction capacitance
- High photo sensitivity
- Large radiant sensitive area $A = 7.5$ mm^2
- Angle of half sensitivity $\alpha = 120°$
- Plastic case with IR-filter

Preliminary specifications

Dimensions in mm



Radiant sensitive area $A = 7.5$ mm^2
Angle of half intensity $\alpha = 120°$
Plastic case
Weight max. 0.4 g

Absolute maximum ratings

Reverse voltage	V_R	32	V
Power dissipation $T_{amb} \leq 25°C$	P_V	150	mW
Junction temperature	T_j	80	°C
Storage temperature range	T_{stg}	−30...+80	°C
Soldering temperature, maximal $t \leq 3$ s	T_{sd}[1]	245	°C

---

[1] Distance from the touching border ≥ 2 mm

BP 104

Thermal resistance		**Min.**	**Typ.**	**Max.**	
Junction ambient	R_{thJA}			350	K/W

Optical and electrical characteristics
$T_{amb} = 25°C$

Photovoltaic cell operation					
Open circuit voltage $E_e = 1$ mW/cm^2	V_o		350		mV
Short circuit current $E_e = 1$ mW/cm^2, $\lambda_p = 950$ nm, $R_L = 100\ \Omega$	I_k		38		μA
Junction capacitance $V_R = 0$, $f = 1$ MHz, $E = 0$	C_j		75		pF

Photodiode operation					
Reverse dark current $V_R = 10$ V, $E = 0$	I_{ro}*)		2	30	nA
Light reverse current $V_R = 5$ V, $E_e = 1$ mW/cm^2, $\lambda_p = 950$ nm	I_{ra}*)	25	40		μA
Breakdown voltage $I_R = 100\ \mu$A, $E = 0$	$V_{(BR)}$*)	32			V
Junction capacitance $V_R = 3$ V, $f = 1$ MHz, $E = 0$	C_j		25	40	pF
Noise equivalent power (NEP)	P_n		10^{-14}		WHz$^{-1/2}$

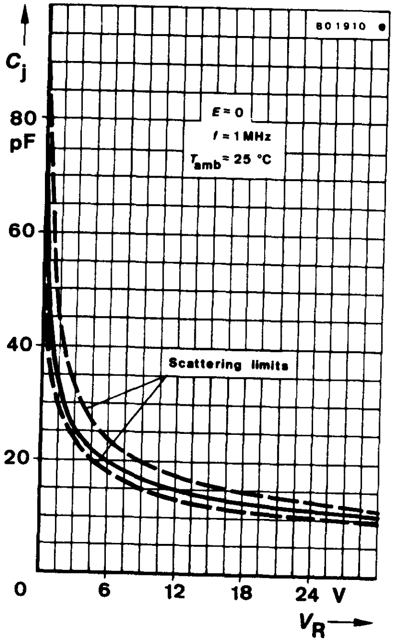
Switching characteristics
$V_R = 10$ V, $R_L = 1$ kΩ, $T_{amb} = 25°C$

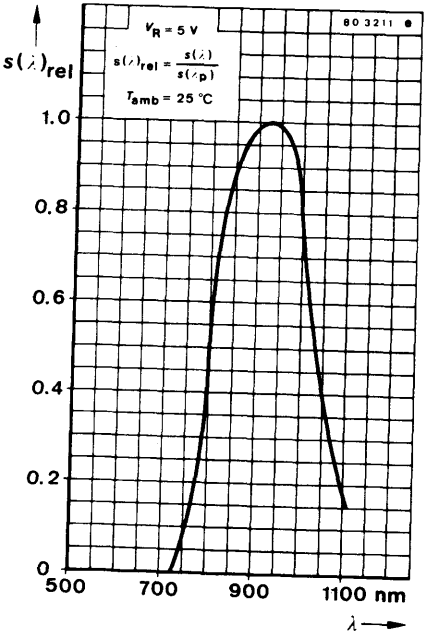
Turn-on time	t_{on}		50		ns
Turn-off time	t_{off}		50		ns

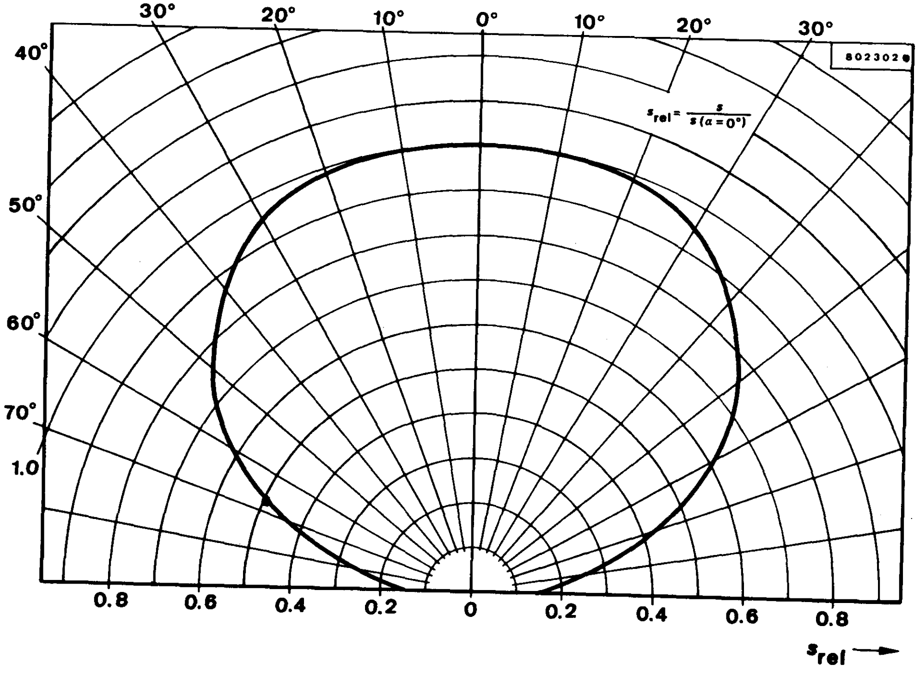
Photovoltaic cell and photodiode operation					
Peak wavelength sensitivity	λ_p		925		nm
Range of spectral bandwidth (50 %)	$\lambda_{0.5}$		800 ... 1000		nm

---

AQL = 0.65 %

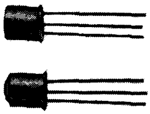

801910
C_j
80 pF
60
40
20
0
6
12
18
24 V
V_R
$E = 0$
$f = 1$ MHz
$T_{amb} = 25$ °C
Scattering limits


803211
$s(\lambda)_{rel}$
1.0
0.8
0.6
0.4
0.2
0
500
700
900
1100 nm
λ
$V_R = 5$ V
$s(\lambda)_{rel} = \frac{s(\lambda)}{s(\lambda p)}$
$T_{amb} = 25$ °C


802302
30°
20°
10°
0°
10°
20°
30°
40°
50°
60°
70°
1.0
0.8
0.6
0.4
0.2
0
0.2
0.4
0.6
0.8
s_{rel}
$s_{rel} = \frac{s}{s(\alpha = 0°)}$

BPW 13 · BPW 14

Silicon NPN Epitaxial Planar Phototransistors

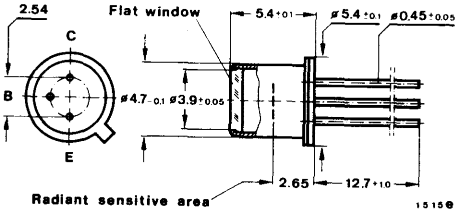


Application: Detector in electronic control and drive circuits

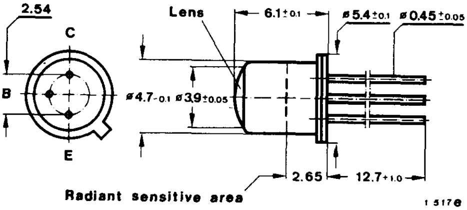
Features:

- Hermetically sealed case
- BPW 13 – flat window, BPW 14 – lens
- Suitable for visible and near infrared radiation
- BPW 13 – Long range light barrier with an additional optics
- Base terminal is available
- *Selected in groups*
- BPW 14-Suitable to couple with glass fibre

Dimensions in mm



BPW 13



BPW 14

Angle of half sensitivity **BPW 13** $\alpha = 80°$
BPW 14 $\alpha = 25°$

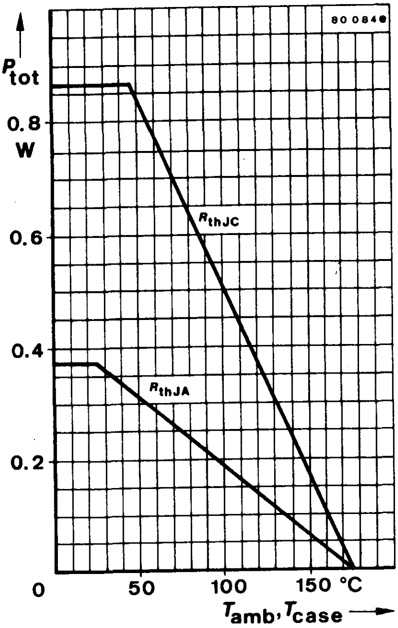
Collector connected with case

≈ JEDEC TO 18
≈ 18 A 3 DIN 41876
≈ JEDEC TO 18
Weight max. 0.5 g

BPW 13 · BPW 14

Absolute maximum ratings

Collector-base voltage	V_{CBO}	32	V
Collector-emitter voltage	V_{CEO}	32	V
Emitter-base voltage	V_{EBO}	5	V
Collector current	I_C	50	mA
Peak collector current $\frac{t_p}{T} = 0.5$, $t_p \leq 10$ ms	I_{CM}	100	mA
Total power dissipation $T_{amb} \leq 25\,°C$	P_{tot}	375	mW
Junction temperature	T_j	175	°C
Storage temperature range	T_{stg}	−55...+175	°C



Thermal resistances		**Min.**	**Typ.**	**Max.**	
Junction ambient	R_{thJA}			400	K/W
Junction case	R_{thJC}			150	K/W

Optical and electrical characteristics

$T_{amb} = 25\,°C$

		Min.	Typ.	Max.	
Collector dark current $V_{CE} = 20$ V, $E = 0$	I_{CEO}		10	100	nA

Type	Group	Collector light current			
		$V_{CE} = 5$ V, $E_A = 1$ klx[1] I_{ca} (mA)	$V_{CE} = 5$ V, $E_e = 1$ mW/cm^2, $\lambda_p = 950$ nm I_{ca}*) (mA)		
		Typ.	Min.	Typ.	Max.
BPW 13	A	0.30	0.07	0.10	0.14
	B	0.45	0.10	0.15	0.20
	C	1.00	0.17	0.30	
BPW 14	A	3.0	0.7	1.0	1.4
	B	4.5	1.0	1.5	2.0
	C	10.0	1.7	3.0	

			Min.	**Typ.**	**Max.**	
Peak wavelength sensitivity		λ_p		780		nm
Range of spectral bandwidth (50 %)		$\lambda_{0.5}$		520…950		nm
Collector-emitter breakdown voltage $I_C = 1$ mA		$V_{(BR)CEO}$*)	32			V
Collector-emitter saturation voltage $I_C = 0.1$ mA, $I_B = 10\,\mu A$	**BPW 13**	V_{CEsat}*)			0.3	V
$I_C = 1.0$ mA, $I_B = 100\,\mu A$	**BPW 14**	V_{CEsat}*)			0.3	V
Cut-off frequency $I_C = 5$ mA, $V_S = 5$ V, $R_L = 100\,\Omega$		f_g		170		kHz
Capacitance, collector-emitter $V_{CE} = 5$ V, $f = 1$ MHz, $E = 0$		C_{CEO}		4.5		pF

---

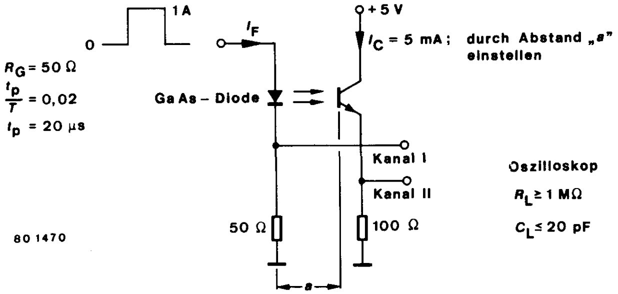
*) AQL = 0.65 %

[1] Standard illuminant A (DIN 5033/IEC 306-1)

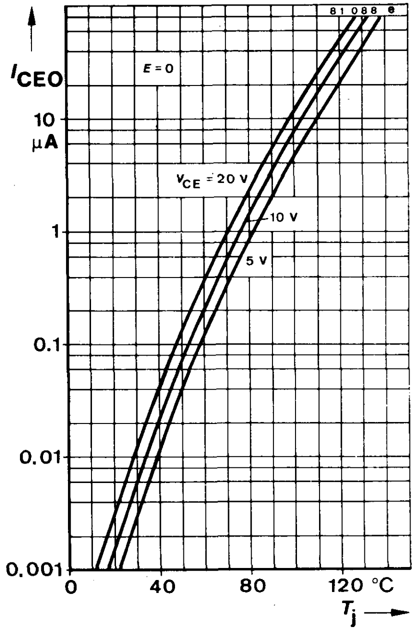
Switching characteristics

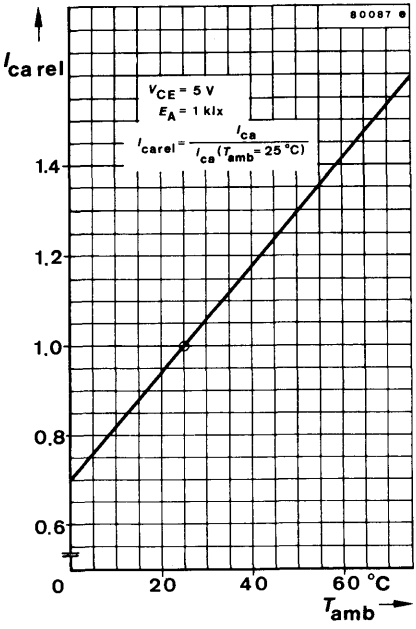
$V_S = 5$ V, $I_C = 5$ mA, $R_L = 100\ \Omega$, see test circuit

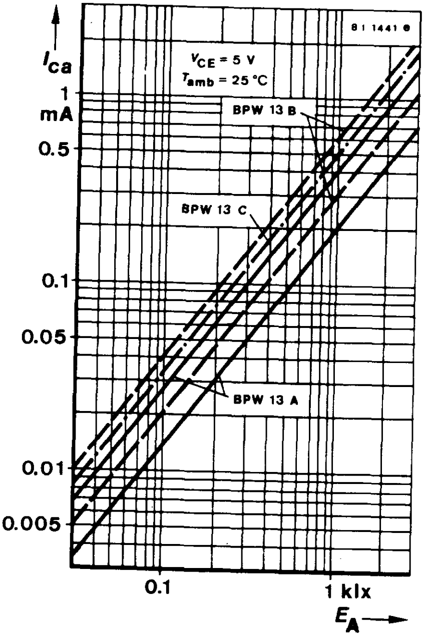
		Min.	Typ.	Max.	
Delay time	t_d		1.8		μs
Rise time	t_r		1.6		μs
Turn-on time	t_{on}		3.4		μs
Storage time	t_s		0.3		μs
Fall time	t_f		1.7		μs
Turn-off time	t_{off}		2.0		μs

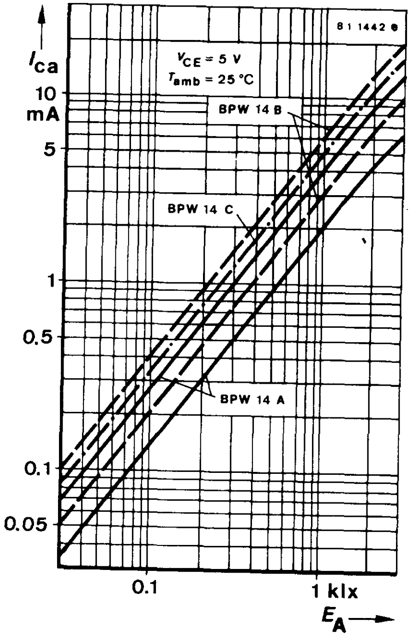


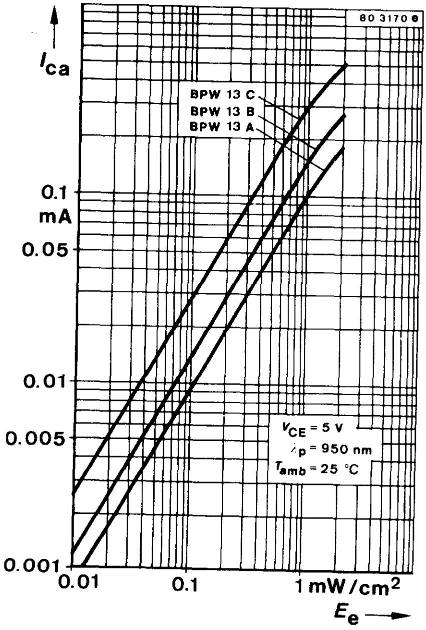
Test circuit

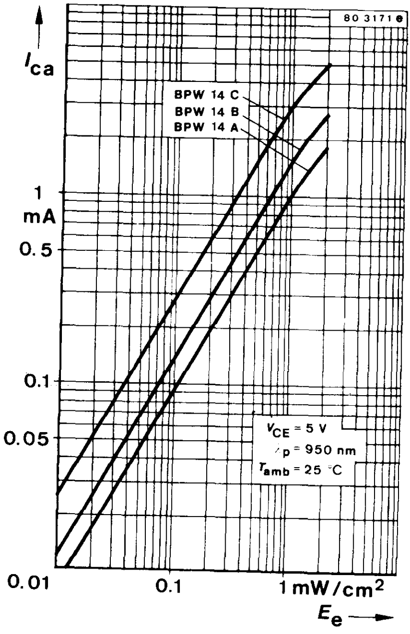




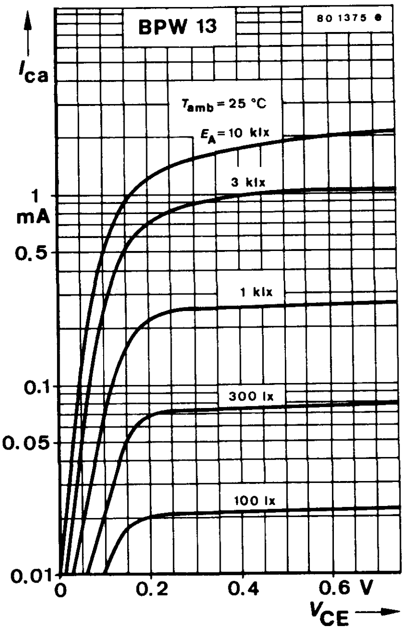

81 1441 e
V_{CE} = 5 V
T_{amb} = 25 °C
I_{ca}
1
mA
0.5
0.1
0.05
0.01
0.005
BPW 13 B
BPW 13 C
BPW 13 A
0.1
1 klx
E_A

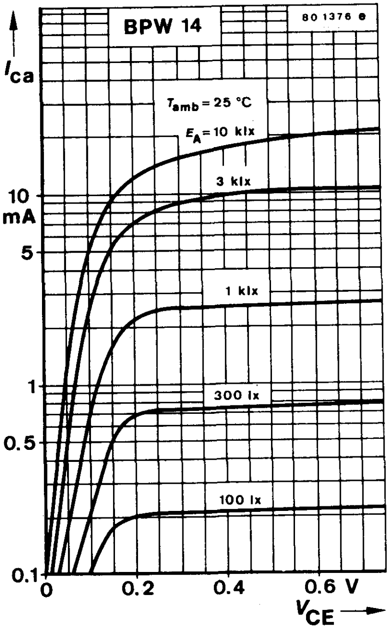

81 1442 e
V_{CE} = 5 V
T_{amb} = 25 °C
I_{ca}
10
mA
5
1
0.5
0.1
0.05
BPW 14 B
BPW 14 C
BPW 14 A
0.1
1 klx
E_A

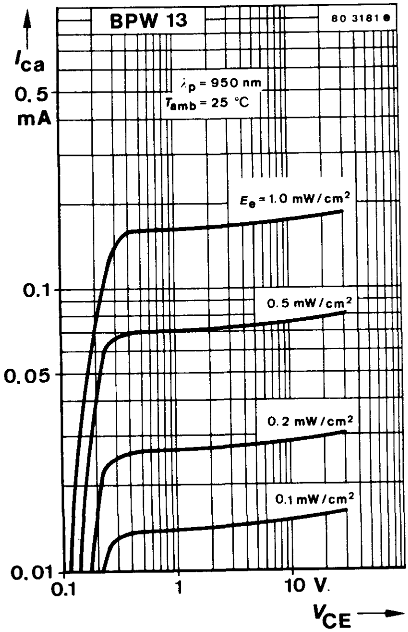

80 3170 e
I_{ca}
BPW 13 C
BPW 13 B
BPW 13 A
0.1
mA
0.05
0.01
0.005
0.001
V_{CE} = 5 V
λ_p = 950 nm
T_{amb} = 25 °C
0.01
0.1
1 mW/cm²
E_e

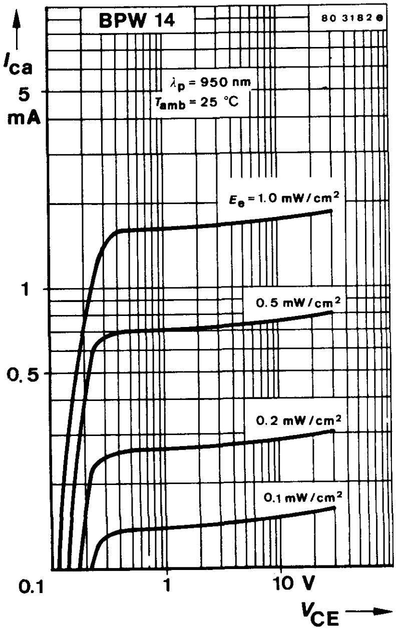

80 3171 e
I_{ca}
BPW 14 C
BPW 14 B
BPW 14 A
1
mA
0.5
0.1
0.05
V_{CE} = 5 V
λ_p = 950 nm
T_{amb} = 25 °C
0.01
0.1
1 mW/cm²
E_e

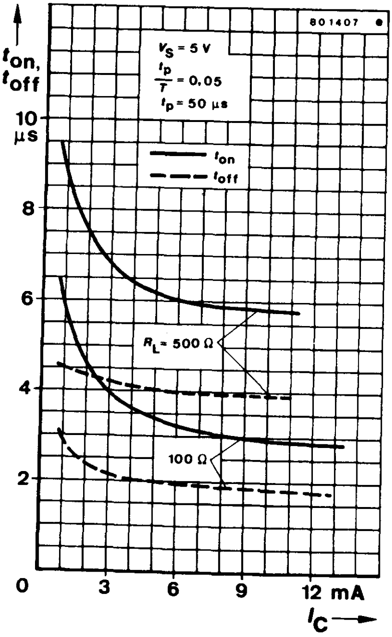
BPW 13 · BPW 14

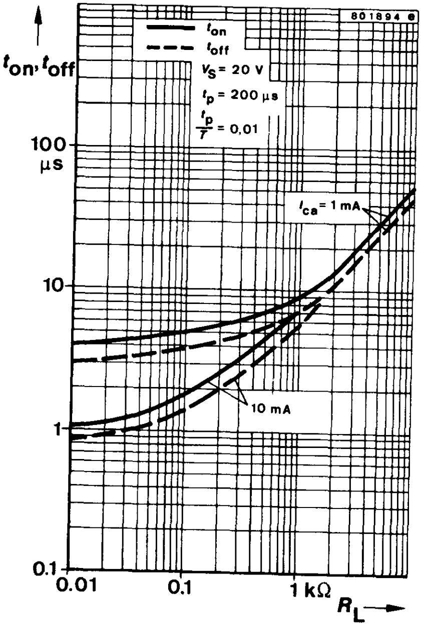

BPW 13
80 1375 e
I_{ca}
T_{amb} = 25 °C
E_A = 10 klx
3 klx
1 klx
300 lx
100 lx
1 mA
0.5
0.1
0.05
0.01
0
0.2
0.4
0.6 V
V_{CE}

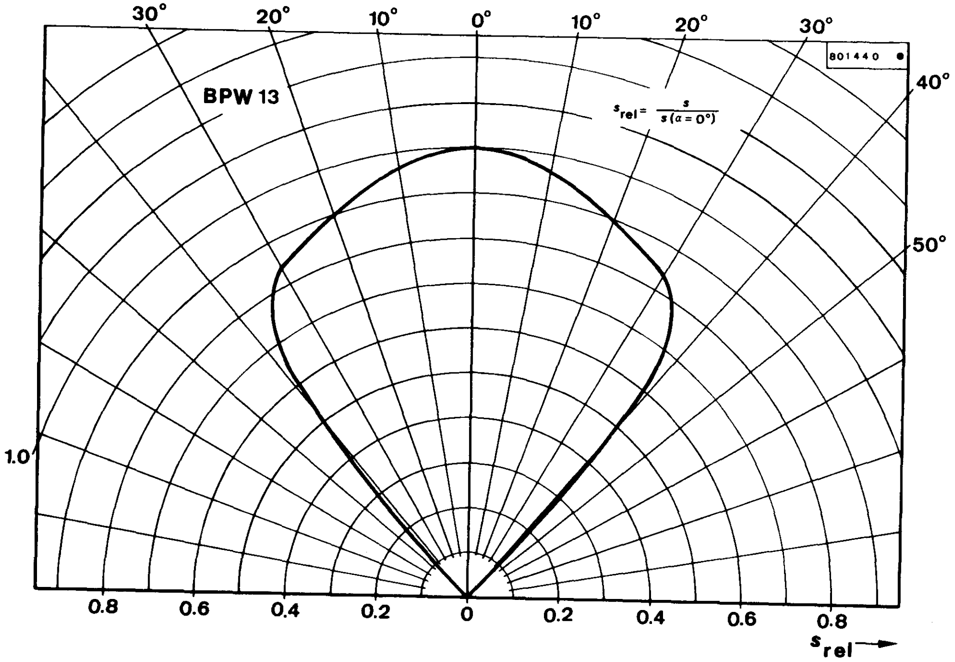

BPW 14
80 1376 e
I_{ca}
T_{amb} = 25 °C
E_A = 10 klx
3 klx
1 klx
300 lx
100 lx
10 mA
5
1
0.5
0.1
0
0.2
0.4
0.6 V
V_{CE}

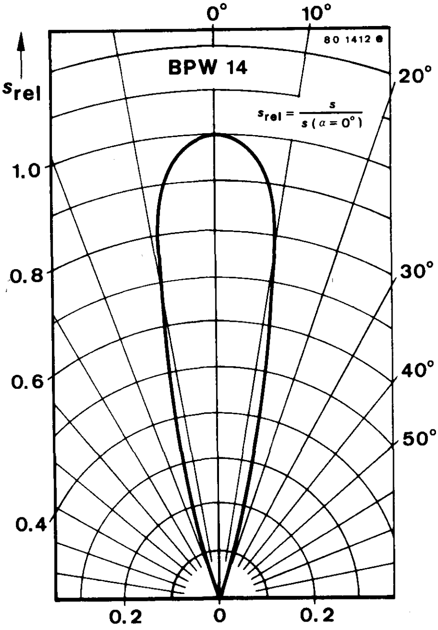

BPW 13
80 3181 e
I_{ca}
λ_p = 950 nm
T_{amb} = 25 °C
E_e = 1.0 mW/cm²
0.5 mW/cm²
0.2 mW/cm²
0.1 mW/cm²
0.5 mA
0.1
0.05
0.01
0.1
1
10 V
V_{CE}

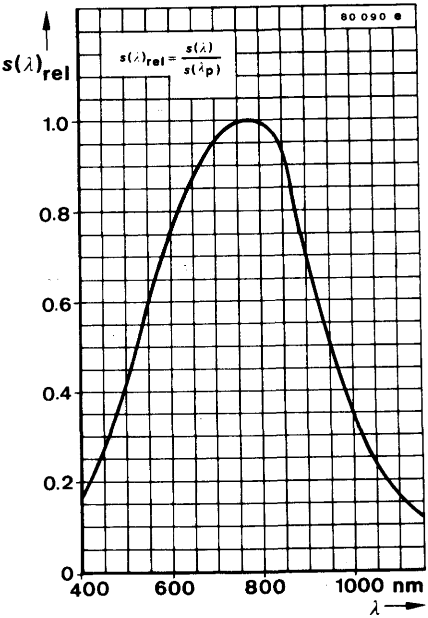

BPW 14
80 3182 e
I_{ca}
λ_p = 950 nm
T_{amb} = 25 °C
E_e = 1.0 mW/cm²
0.5 mW/cm²
0.2 mW/cm²
0.1 mW/cm²
5 mA
1
0.5
0.1
1
10 V
V_{CE}


801407
t_{on}, t_{off}
μs
10
8
6
4
2
0
3
6
9
12 mA
I_C
V_S = 5 V
$\frac{t_p}{T}$ = 0,05
t_p = 50 μs
t_{on}
t_{off}
R_L = 500 Ω
100 Ω


801894
t_{on}, t_{off}
μs
100
10
1
0.1
0.01
0.1
1 kΩ
R_L
t_{on}
t_{off}
V_S = 20 V
t_p = 200 μs
$\frac{t_p}{T}$ = 0,01
I_{ca} = 1 mA
10 mA

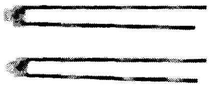

801440
30°
20°
10°
0°
10°
20°
30°
40°
50°
BPW 13
$s_{rel} = \frac{s}{s(\alpha = 0°)}$
1.0
0.8
0.6
0.4
0.2
0
0.2
0.4
0.6
0.8
s_{rel}


0°
10°
20°
30°
40°
50°
80 1412 e
BPW 14
$s_{rel} = \frac{s}{s(\alpha = 0°)}$
s_{rel}
1.0
0.8
0.6
0.4
0.2
0
0.2


80 090 e
$s(\lambda)_{rel} = \frac{s(\lambda)}{s(\lambda_p)}$
$s(\lambda)_{rel}$
1.0
0.8
0.6
0.4
0.2
0
400
600
800
1000 nm
λ

BPW 16 N · BPW 17 N

Silicon NPN Epitaxial Planar Phototransistors



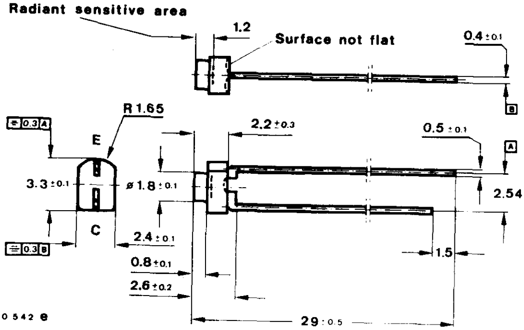
Application: Detector in electronic control and drive circuits

Features:

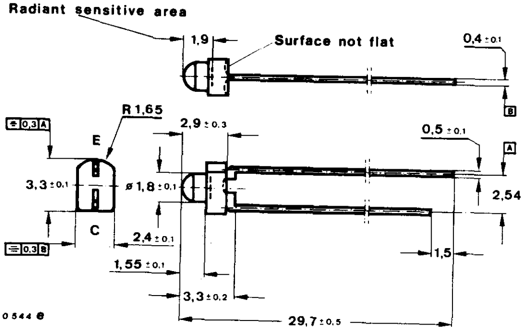
- Miniature plastic case white clear
- Wide radiation angle (80°) – BPW 16 N
- Insensitive against background light due to narrow aperture (25°) – BPW 17 N
- Suitable for visible and near infrared radiation
- Suitable for 0.1" (2.54 mm) center-to-center spacing

Preliminary specifications

Dimensions in mm



BPW 16 N



BPW 17 N

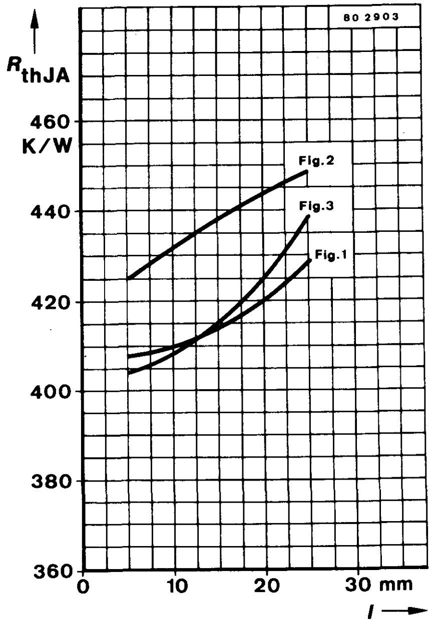
Angle of half sensitivity
BPW 16 N $\alpha = 80°$
BPW 17 N $\alpha = 25°$

Special case
Weight max. 0.04 g

BPW 16 N · BPW 17 N

Absolute maximum ratings

Collector-emitter voltage	V_{CEO}	32	V
Emitter-collector voltage	V_{ECO}	5	V
Collector current	I_C	50	mA
Peak collector current $\frac{t_p}{T} = 0.5$, $t_p \leq 10$ ms	I_{CM}	100	mA
Total power dissipation $T_{amb} \leq 55\,°C$	P_{tot}	100	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−25 ... +100	°C
Soldering temperature, maximal $t \leq 3$ s	T_{sd}[1])	245	°C



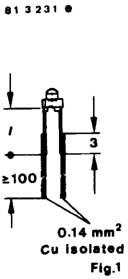


Fig.1

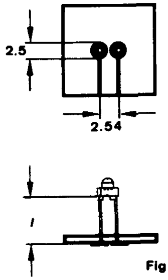


Fig.2

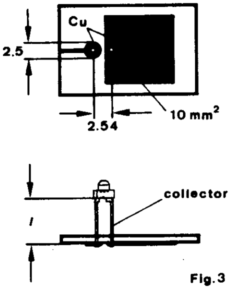


Fig.3

Thermal resistance

		Min.	Typ.	Max.	
Junction ambient	R_{thJA}			450	K/W

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[1]) Distance from the touching border ≥ 2 mm

Optical and electrical characteristics

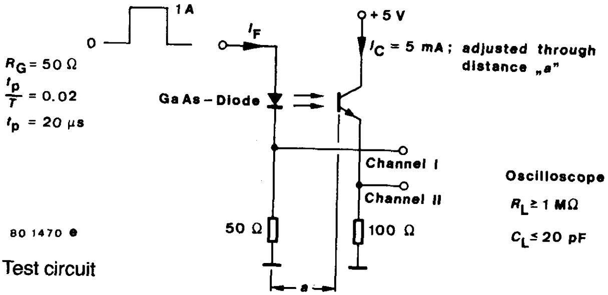
$T_{amb} = 25°C$

Parameter	Type	Symbol	Min.	Typ.	Max.	Unit
Collector dark current $V_{CE} = 20$ V, $E = 0$		I_{CEO}*)		10	200	nA
Collector light current $V_{CE} = 5$ V, $E_A = 1$ klx[1])	BPW 16 N	I_{ca}		0.4		mA
	BPW 17 N	I_{ca}		3		mA
$V_{CE} = 5$ V, $E_e = 1$ mW/cm², $\lambda_p = 950$ nm	BPW 16 N	I_{ca}*)	0.07	0.14		mA
	BPW 17 N	I_{ca}*)	0.5	1.0		mA
Peak wavelength sensitivity		λ_p		780		nm
Range of spectral bandwidth (50 %)		$\lambda_{0.5}$		520...950		nm
Collector-emitter breakdown voltage $I_C = 1$ mA		$V_{(BR)CEO}$*)	32			V
Collector-emitter saturation voltage $I_C = 0.1$ mA, $E_e = 1$ mW/cm², $\lambda_p = 950$ nm		V_{CEsat}*)			0.3	V
Cut-off frequency $I_C = 5$ mA, $V_S = 5$ V, $R_L = 100\ \Omega$		f_g		170		kHz
Capacitance, collector-emitter $V_{CE} = 5$ V, $f = 1$ MHz, $E = 0$		C_{CEO}		4.5		pF

Switching characteristics

$V_S = 5$ V, $I_C = 5$ mA, $R_L = 100\ \Omega$, see test circuit

Parameter	Symbol	Typ.	Unit
Delay time	t_d	1.8	µs
Rise time	t_r	1.6	µs
Turn-on time	t_{on}	3.4	µs
Storage time	t_s	0.3	µs
Fall time	t_f	1.7	µs
Turn-off time	t_{off}	2.0	µs



Test circuit

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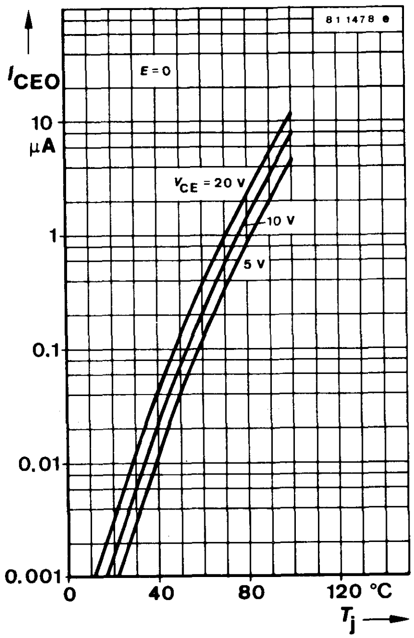
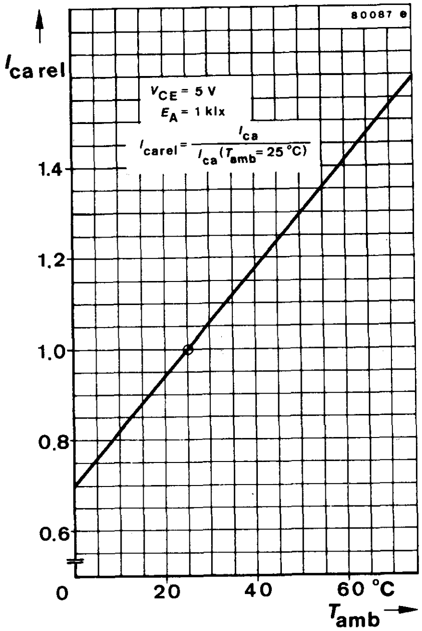
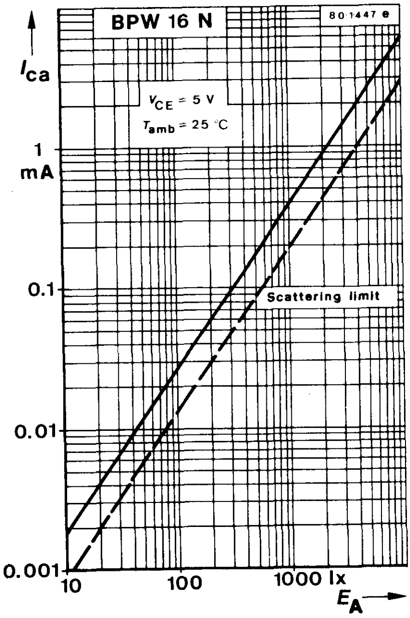
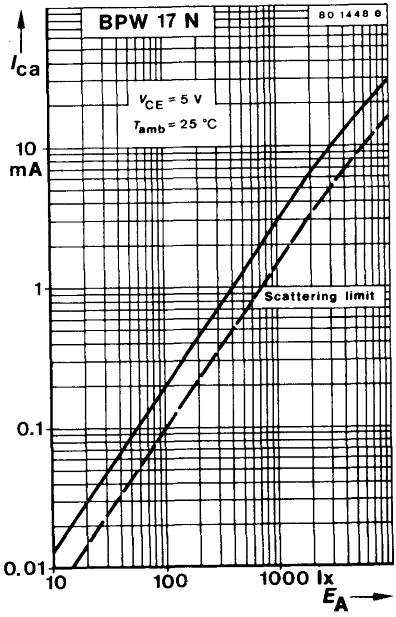
*) AQL = 0.65 %

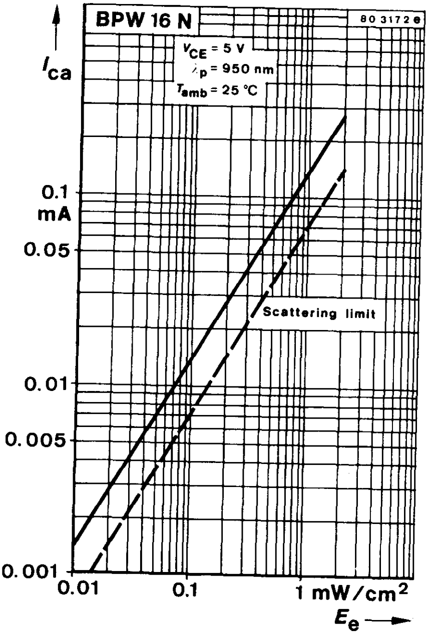
[1]) Standard illuminant A (DIN 5033/IEC 306-1)

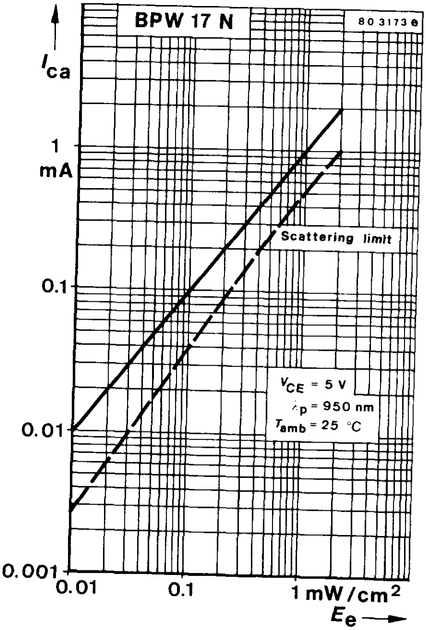

81 1478 e
I_{CEO}
$E = 0$
10 µA
1
0.1
0.01
0.001
$V_{CE} = 20$ V
10 V
5 V
0
40
80
120 °C
T_j

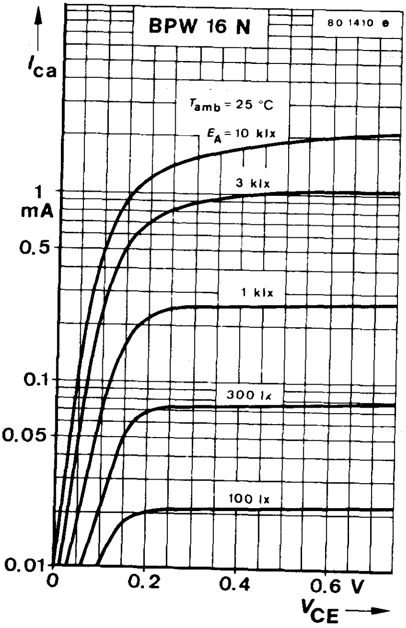

80087 e
$I_{ca\,rel}$
$V_{CE} = 5$ V
$E_A = 1$ klx
$I_{ca\,rel} = \frac{I_{ca}}{I_{ca}(T_{amb} = 25\,°C)}$
1.4
1.2
1.0
0.8
0.6
0
20
40
60 °C
T_{amb}

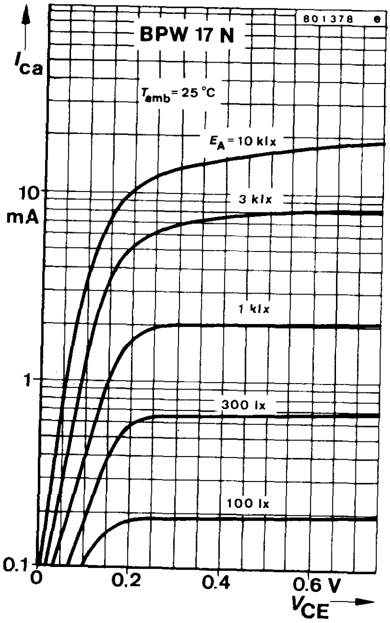

BPW 16 N
80 1447 e
I_{ca}
$V_{CE} = 5$ V
$T_{amb} = 25$ °C
1 mA
0.1
0.01
0.001
Scattering limit
10
100
1000 lx
E_A

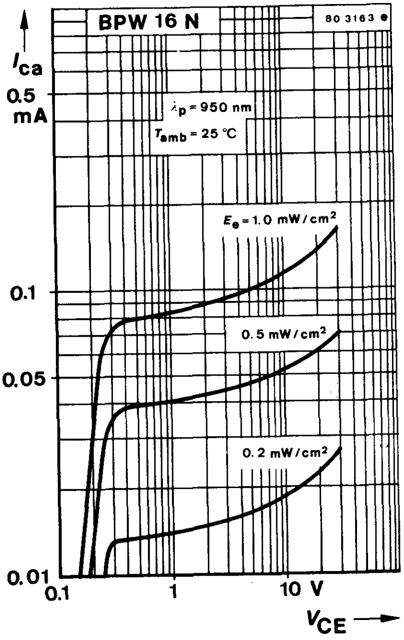

BPW 17 N
80 1448 e
I_{ca}
$V_{CE} = 5$ V
$T_{amb} = 25$ °C
10 mA
1
0.1
0.01
Scattering limit
10
100
1000 lx
E_A

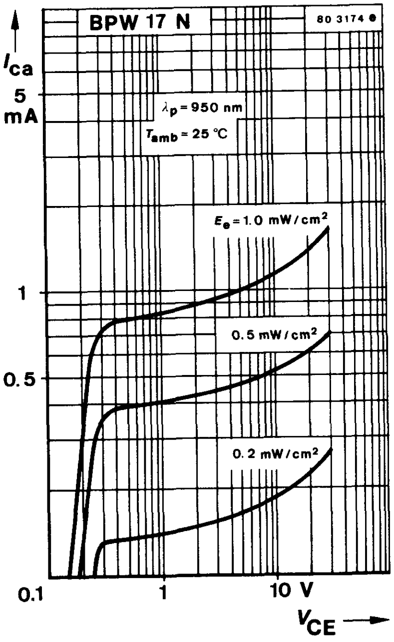

BPW 16 N
80 3172 e
I_{ca}
V_{CE} = 5 V
λ_p = 950 nm
T_{amb} = 25 °C
Scattering limit
0.1 mA
0.05
0.01
0.005
0.001
0.01
0.1
1 mW/cm²
E_e

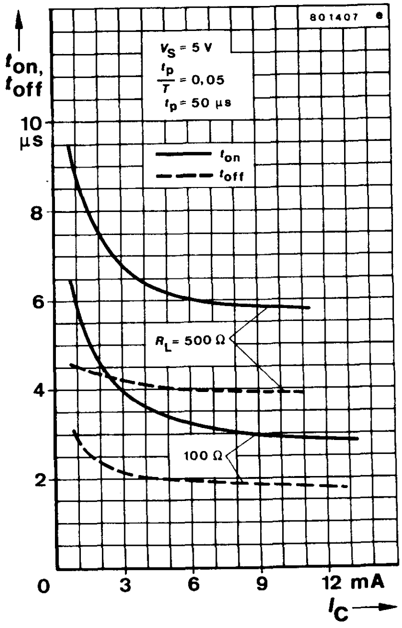

BPW 17 N
80 3173 e
I_{ca}
1 mA
0.1
0.01
0.001
Scattering limit
V_{CE} = 5 V
λ_p = 950 nm
T_{amb} = 25 °C
0.01
0.1
1 mW/cm²
E_e

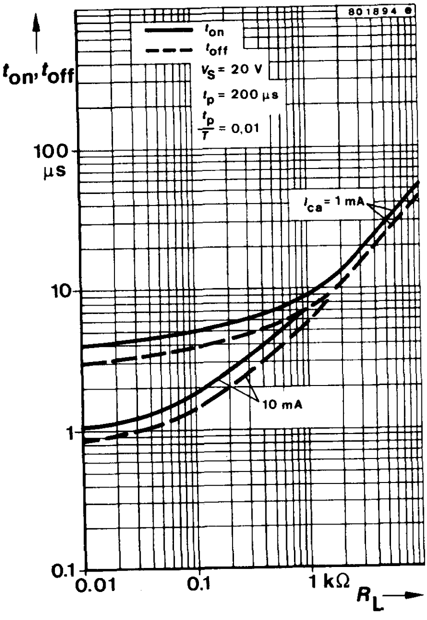

BPW 16 N
80 1410 e
I_{ca}
T_{amb} = 25 °C
E_A = 10 klx
3 klx
1 klx
300 lx
100 lx
1 mA
0.5
0.1
0.05
0.01
0
0.2
0.4
0.6 V
V_{CE}


BPW 17 N
801378 e
I_{ca}
T_{amb} = 25 °C
E_A = 10 klx
3 klx
1 klx
300 lx
100 lx
10 mA
1
0.1
0
0.2
0.4
0.6 V
V_{CE}

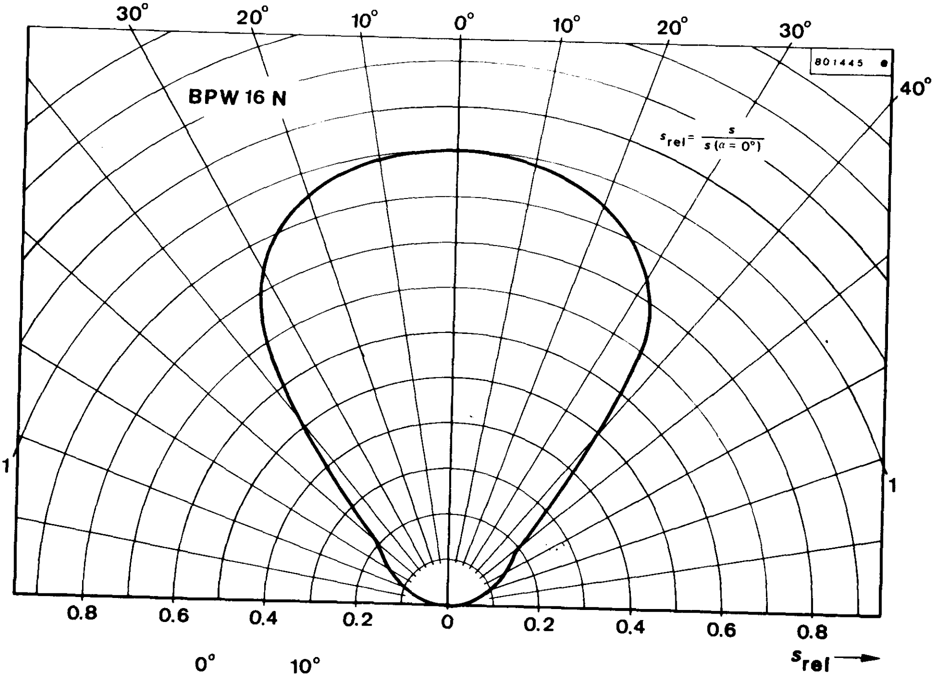

BPW 16 N
80 3163 e
I_{ca}
0.5
mA
0.1
0.05
0.01
λ_p = 950 nm
T_{amb} = 25 °C
E_e = 1.0 mW/cm²
0.5 mW/cm²
0.2 mW/cm²
0.1
1
10 V
V_{CE}

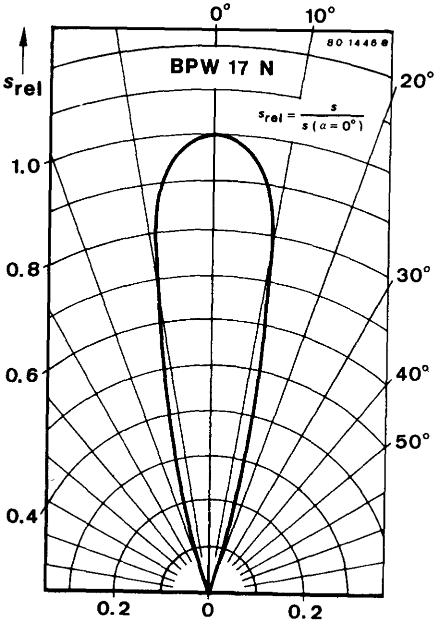

BPW 17 N
80 3174 e
I_{ca}
5
mA
1
0.5
0.1
λ_p = 950 nm
T_{amb} = 25 °C
E_e = 1.0 mW/cm²
0.5 mW/cm²
0.2 mW/cm²
1
10 V
V_{CE}

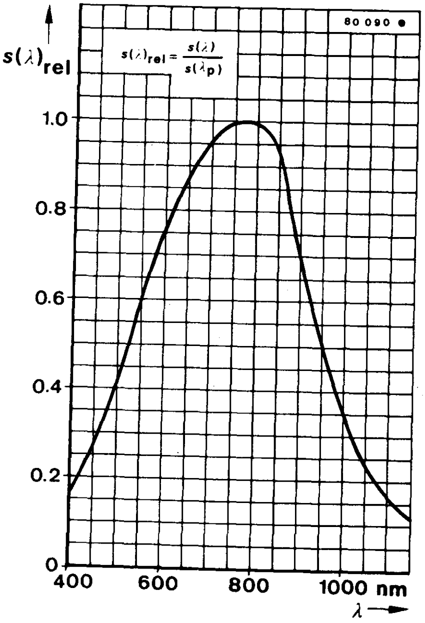

80 1407 e
t_{on}, t_{off}
10
µs
8
6
4
2
0
V_S = 5 V
$\frac{t_p}{T}$ = 0,05
t_p = 50 µs
t_{on}
t_{off}
R_L = 500 Ω
100 Ω
3
6
9
12 mA
I_C


80 1894 e
t_{on}
t_{off}
V_S = 20 V
t_p = 200 µs
$\frac{t_p}{T}$ = 0,01
t_{on}, t_{off}
100
µs
10
1
0.1
I_{ca} = 1 mA
10 mA
0.01
0.1
1 kΩ
R_L

BPW 16 N · BPW 17 N

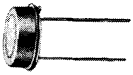






BPW 20

Silicon PN Planar Photovoltaic Cell/Photodiode

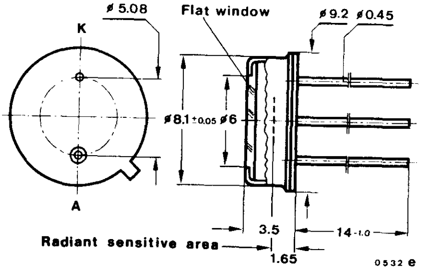


Application: Sensor for light measuring purposes

Features:

- For photodiode and photovoltaic cell operation
- Hermetically sealed case
- Flat window
- Suitable for visible and near infrared radiation
- High blue sensitivity
- Log. correlation between open circuit voltage and illuminance from 10^{-2} till 10^5 lx in photovoltaic cell operation
- Linear correlation between short circuit current and illuminance from 10^{-2} till 10^5 lx in photovoltaic cell operation
- No light memory effect
- No pre-exposure ratio

Dimensions in mm



Radiant sensitive area $A = 7.5\ \text{mm}^2$

Angle of half sensitivity $\alpha = 100°$

Negative terminal/cathode connected with case

≈ JEDEC TO 56
Weight max. 1.0 g

Absolute maximum ratings

Reverse voltage	V_R	10	V
Ambient temperature range	T_{amb}	−25 ... +100	°C

Thermal resistance

		Min.	Typ.	Max.	
Junction ambient	R_{thJA}			250	K/W

BPW 20

Optical and electrical characteristics

$T_{amb} = 25°C$

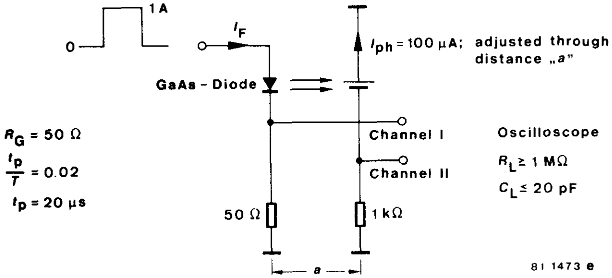
Photovoltaic cell operation

Open circuit voltage $E_A = 1$ klx[1]	V_o*)	330	430	mV
Temperature coefficient of V_o $E_A = 1$ klx[1]	TK_{Vo}		−2	mV/K
Short circuit current $E_A = 1$ klx[1], $R_L = 100\ \Omega$	I_k*)	20	33	µA
Sensitivity, short circuit $E_A = 10^{-2} \ldots 10^5$ lx[1]	s_k		33	nA/lx
Temperature coefficient of I_k $E_A = 1$ klx[1], $R_L = 100\ \Omega$	TK_{Ik}		0.1	%/K
Junction capacitance $V_R = 0, f = 1$ MHz, $E = 0$	C_j		1.2	nF

Switching characteristics

$I_{ph} = 100\ \mu A$, $R_L = 1\ k\Omega$, see test circuit

Rise time	t_r	3.5	µs
Fall time	t_f	3.5	µs



Test circuit

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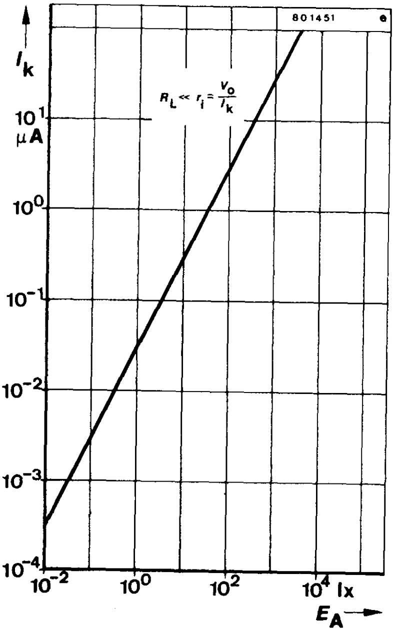
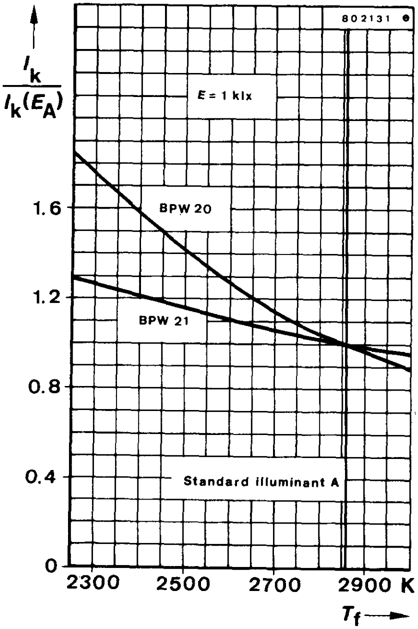
*) AQL = 0.65 %

[1] Standard illuminant A (DIN 5033/IEC 306-1)

		Min.	Typ.	Max.	
Photodiode operation					
Breakdown voltage $I_{ro} = 100\,\mu A$, $E = 0$	$V_{(BR)}$	10			V
Reverse continuous dark current $V_R = 5$ V, $E = 0$	I_{ro}*)		2	30	nA
Light reverse current $V_R = 5$ V, $E_A = 1$ klx[1])	I_{ra}	20	33		μA
Sensitivity $V_R = 5$ V, $E_A = 10^{-2} \ldots 10^5$ lx[1])	s		33		nA/lx
Junction capacitance $V_R = 5$ V, $f = 1$ MHz	C_j		400		pF
Photovoltaic cell and photodiode operation					
Peak wavelength sensitivity	λ_p		700		nm
Range of spectral bandwidth (50 %)	$\lambda_{0.5}$		400 ... 950		nm





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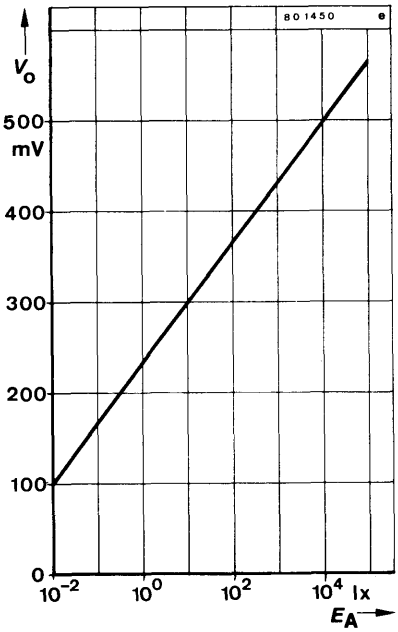
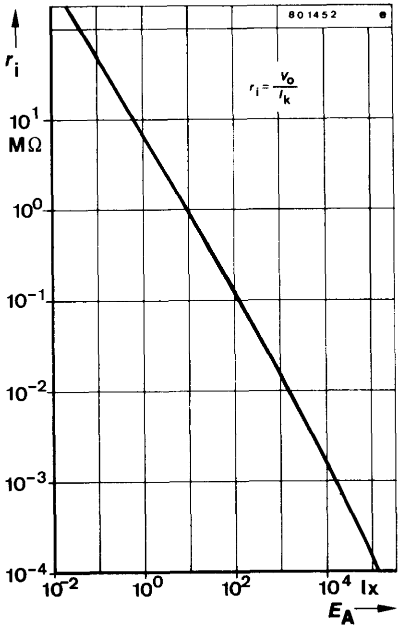
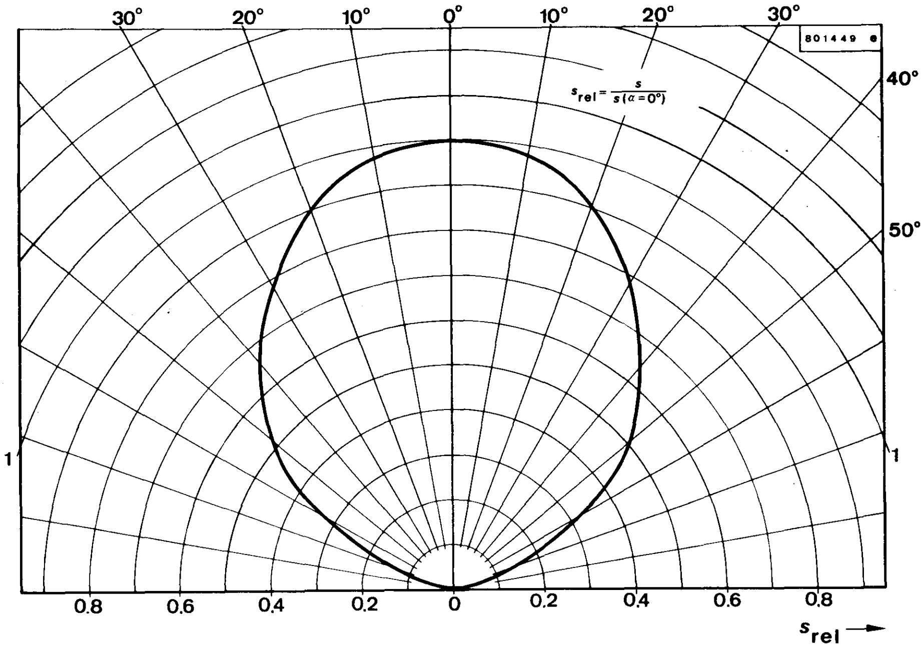
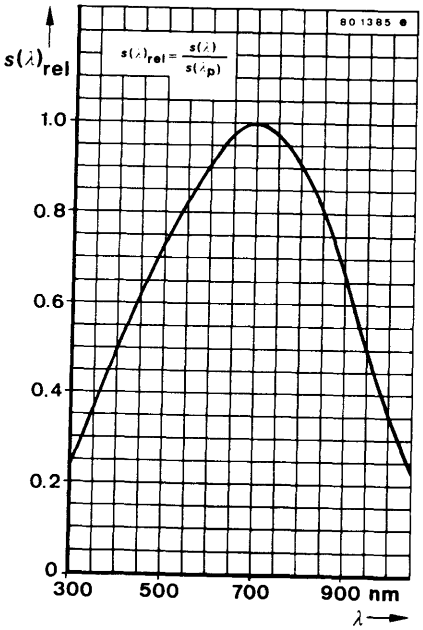
*) AQL = 0.65 %

[1]) Standard illuminant A (DIN 5033/IEC 306-1)


801450 e
V_O
500 mV
400
300
200
100
0
10^{-2}
10^0
10^2
10^4 lx
E_A

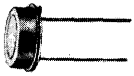

801452 e
r_i
$r_i = \frac{V_O}{I_k}$
10^1 MΩ
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-2}
10^0
10^2
10^4 lx
E_A


801449 e
30°
20°
10°
0°
10°
20°
30°
40°
50°
$s_{rel} = \frac{s}{s(\alpha = 0°)}$
1
1
0.8
0.6
0.4
0.2
0
0.2
0.4
0.6
0.8
s_{rel}


80 1385
$s(\lambda)_{rel}$
$s(\lambda)_{rel} = \frac{s(\lambda)}{s(\lambda_p)}$
1.0
0.8
0.6
0.4
0.2
0
300
500
700
900 nm
λ

BPW 21

Silicon PN Planar Photovoltaic Cell/Photodiode

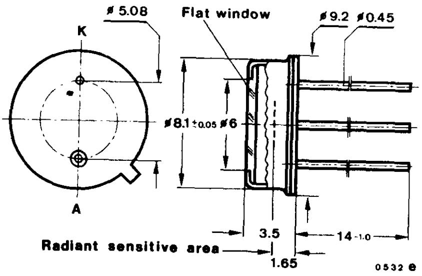


Application: Sensor in exposure and colour measuring purposes

Features:

- For photodiode and photovoltaic cell operation
- Hermetically sealed case
- Flat window with built-in colour correction filter (visible radiation)
- Log. correlation between open circuit voltage and illuminance from 10^{-2} till 10^{5} lx in photovoltaic cell operation
- Linear correlation between short circuit current and illuminance from 10^{-2} till 10^{5} lx in photovoltaic cell operation
- Actinity 0.85 ... 1.15
- No light memory effect
- No pre-exposure ratio
- ● ● Also available as „Qualified semiconductor device" BPW 21 M according to VG 95288

Dimensions in mm



Radiant sensitive area $A = 7.5\ \mathrm{mm}^2$

Angle of half sensitivity $\alpha = 100°$

Negative terminal/cathode connected with case

≈ JEDEC TO 56
Weight max. 1.0 g

Absolute maximum ratings

Reverse voltage		V_R	10	V
Ambient temperature range	**BPW 21**	T_{amb}	−25 ... +100	°C
	BPW 21 M	T_{amb}	−65 ... +100	°C
Storage temperature range	**BPW 21 M**	T_{stg}	−65 ... +100	°C

Thermal resistance

		Min.	Typ.	Max.	
Junction ambient	R_{thJA}			250	K/W

Optical and electrical characteristics

$T_{amb} = 25\,°C$

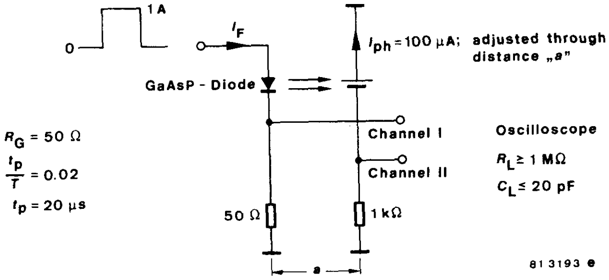
Photovoltaic cell operation

Open circuit voltage $E_A = 1$ klx 1)		V_o*)	280	380		mV
Temperature coefficient of V_o $E_A = 1$ klx 1)		TK_{Vo}		−2		mV/K
Short circuit current $E_A = 1$ klx 1), $R_L = 100\ \Omega$	**BPW 21**	I_k*)	4.5	7.0		μA
	BPW 21 M	I_k*)	5.0	7.0	10	μA
Sensitivity, short circuit $E_A = 10^{-2} \ldots 10^5$ lx 1)	**BPW 21**	s_k		7.0		nA/lx
	BPW 21 M	s_k		7.0		nA/lx
Temperature coefficient of I_k $E_A = 1$ klx 1), $R_L = 100\ \Omega$		TK_{Ik}		−0.05		%/K
Junction capacitance $V_R = 0$, $f = 1$ MHz, $E = 0$		C_j		1.2		nF

Switching characteristics

$I_{ph} = 100\ \mu A$, $R_L = 1\ k\Omega$, see test circuit

Rise time	t_r		3.5	μs
Fall time	t_f		3.5	μs



Test circuit

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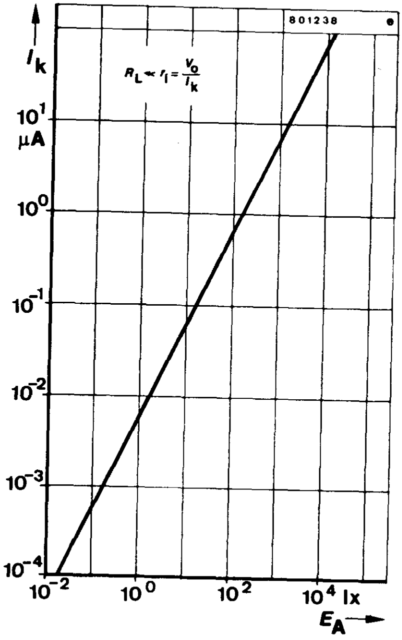
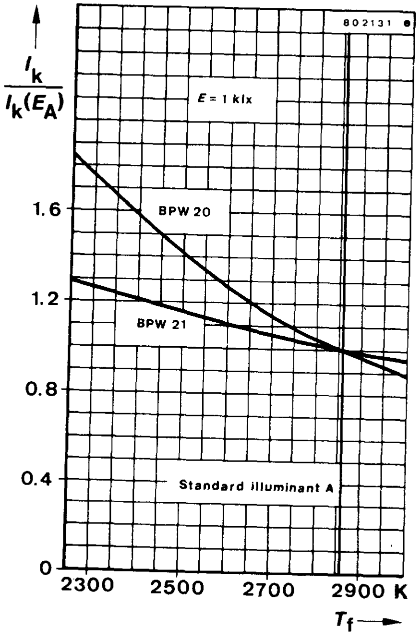
*) AQL = 0.65 %

1) Standard illuminant A (DIN 5033/IEC 306-1)

		Min.	Typ.	Max.	
Photodiode operation					
Breakdown voltage I_{ro} = 100 µA, E = 0	$V_{(BR)}$*)	10			V
Reverse continuous dark current V_R = 5 V, E = 0	I_{ro}*)		2	30	nA
Light reverse current V_R = 5 V, E_A = 1 klx 1)	I_{ra}*)	4.5	7.0		µA
Sensitivity V_R = 5 V, E_A = 10^{-2}...10^5 lx 1)	s		7.0		nA/lx
Junction capacitance V_R = 5 V, f = 1 MHz	C_j		400		pF
Photovoltaic cell and photodiode operation					
Peak wavelength sensitivity	λ_p		565		nm
Range of spectral bandwidth (50 %)	$\lambda_{0.5}$		420...675		nm

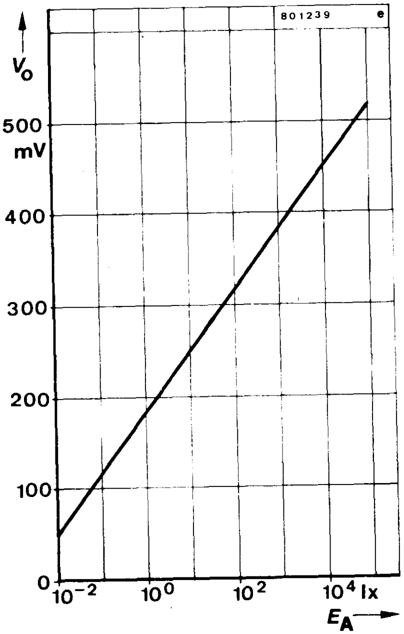


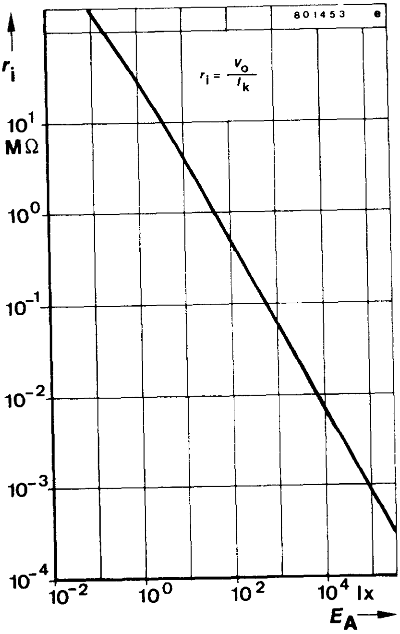


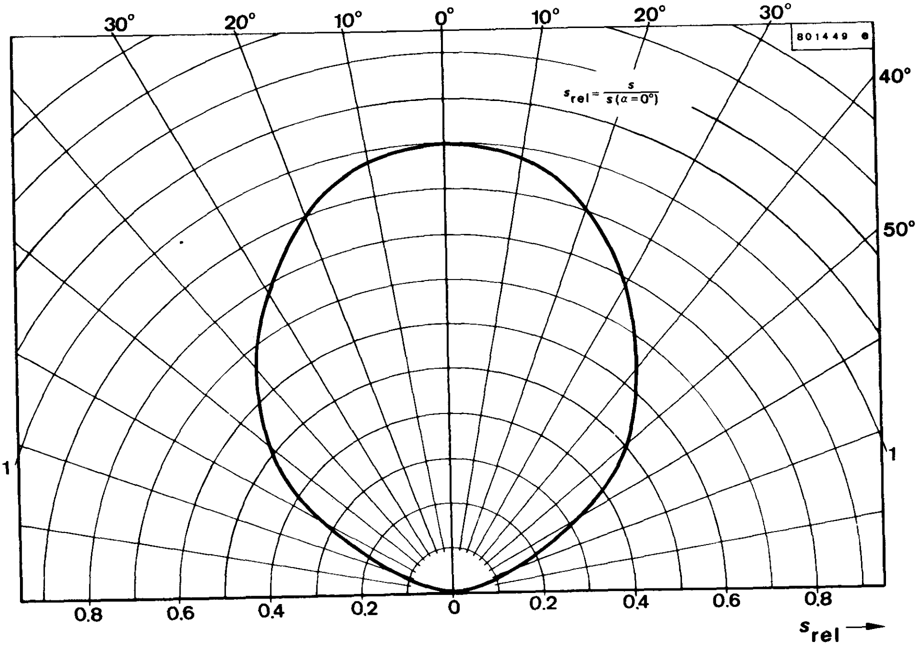
---

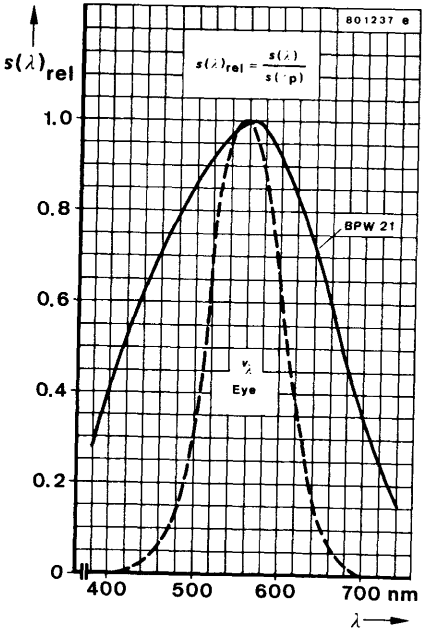
*) AQL = 0.65 %

1) Standard illuminant A (DIN 5033/IEC 306-1)


801239 e
V_O
500 mV
400
300
200
100
0
10^{-2}
10^{0}
10^{2}
10^{4} lx
E_A

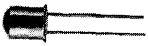

801453 e
r_i
$r_i = \frac{V_o}{I_k}$
10^{1} MΩ
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-2}
10^{0}
10^{2}
10^{4} lx
E_A


801449 e
30°
20°
10°
0°
10°
20°
30°
40°
50°
$s_{rel} = \frac{s}{s(\alpha=0°)}$
1
1
0.8
0.6
0.4
0.2
0
0.2
0.4
0.6
0.8
s_{rel}


801237 e
$s(\lambda)_{rel} = \frac{s(\lambda)}{s(\lambda p)}$
$s(\lambda)_{rel}$
1.0
0.8
0.6
0.4
0.2
0
400
500
600
700 nm
λ
BPW 21
V_λ
Eye

BPW 24

Silicon Photo PIN Diode



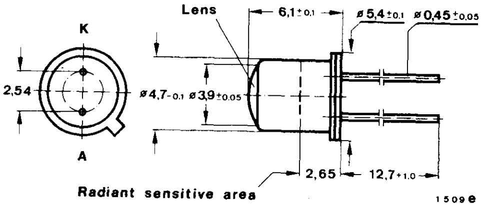
Application: Ultra high-speed photo-detector

Features:

- Fast response times at low operating voltages
- High photo sensitivity
- For photodiode and photovoltaic cell operation
- Hermetically sealed case
- With lens, $\alpha = 40°$
- Suitable for visible and near infrared radiation
- Suitable to couple with glass fiber

Preliminary specifications

Dimensions in mm



Radiant sensitive area $A = 0.64\ \text{mm}^2$
Angle of half sensitivity $\alpha = 40°$
Negative terminal/cathode connected with case

≈ 18 A 2 DIN 41876
≈ JEDEC TO 18
Weight max. 0.5 g

Absolute maximum ratings

Reverse voltage	V_R	50	V
Power dissipation $T_{amb} \leq 25°C$	P_V	180	mW
Junction temperature	T_j	100	°C
Ambient temperature range	T_{amb}	−25 ... +100	°C

Thermal resistance

		Min.	Typ.	Max.	
Junction ambient	R_{thJA}			400	K/W

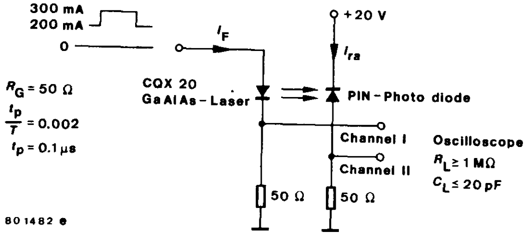
S 1.2. 121/0781 E

Optical and electrical characteristics $T_{amb} = 25\,°C$		**Min.**	**Typ.**	**Max.**	
Photovoltaic cell operation ($V_R = 0$)					
Open circuit voltage $E_A = 1$ klx¹)	V_o		380		mV
Temperature coefficient of V_o $E_A = 1$ klx¹)	TK_{Vo}		−2		mV/K
Short circuit current $E_A = 1$ klx¹), $R_L = 100\,\Omega$	I_k		70		μA
$E_e = 1\,mW/cm^2$, $\lambda_p = 950$ nm, $R_L = 100\,\Omega$	I_k		40		μA
Temperature coefficient of I_k $E_A = 1$ klx¹), $R_L = 100\,\Omega$	TK_{Ik}		0.1		%/K
Junction capacitance $V_R = 0$, $f = 1$ MHz, $E = 0$	C_j		10		pF
Photodiode operation					
Breakdown voltage $I_{ro} = 100\,\mu A$, $E = 0$	$V_{(BR)}$*)	50	80		V
Reverse continuous dark current $V_R = 20$ V, $E = 0$	I_{ro}*)		1	5	nA
Light reverse current $V_R = 20$ V, $E_A = 1$ klx¹), $R_L = 100\,\Omega$	I_{ra}		75		μA
$V_R = 20$ V, $E_e = 1\,mW/cm^2$, $\lambda_p = 950$ nm, $R_L = 100\,\Omega$	I_{ra}*)	25	42		μA
Spectral sensitivity $V_R = 20$ V, $\lambda = 900$ nm	$s(\lambda)$		0.5		A/W
Junction capacitance $f = 1$ MHz, $V_R = 5$ V	C_j		6		pF
$V_R = 20$ V	C_j		4		pF
Switching characteristics $V_R = 20$ V, $R_L = 50\,\Omega$, see test circuit					
Rise time	t_r		7		ns
Fall time	t_f		7		ns
Photovoltaic cell and photodiode operation					
Peak wavelength sensitivity	λ_p		900		nm
Range of spectral bandwidth (50 %)	$\lambda_{0.5}$		550...1000		nm

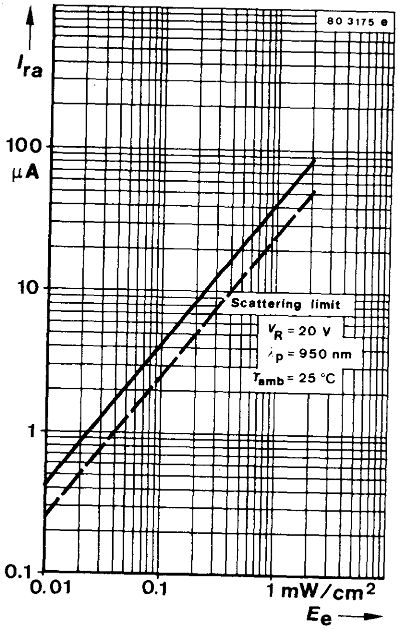
---

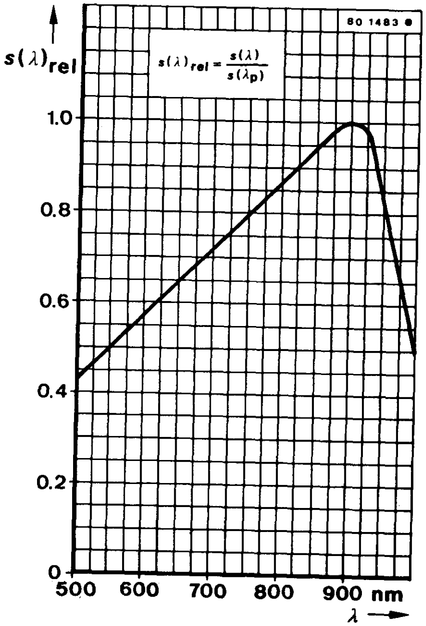
*) AQL = 0.65 %

[1] Standard illuminant A (DIN 5033/IEC 306-1)



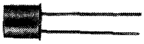
Test circuit





BPW 28

Silicon Avalanche Photodiode



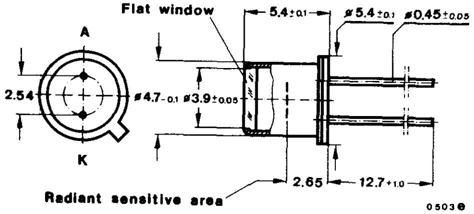
Application: Wide band detector for demodulation of fast signals, e.g. of lasers and GaAs-LED's. Detector for optical communication, e.g. for optical-fiber transmission systems.

Features:

- High sensitive, low-noise photo-detector for demodulation of radiation
- Photocurrent gain higher than 200
- Gain bandwidth product higher than 200 GHz

Preliminary specifications

Dimensions in mm



Diameter of the radiant sensitive area ∅ = 0.2 mm

Angle of half intensity $\alpha = 70°$

≈ 18 A 2 DIN 41876
≈ JEDEC TO 18
Weight max. 0.5 g

Absolute maximum ratings

Power dissipation $T_{amb} = 25°C$	P_V	100	mW
Junction temperature	T_j	125	°C
Ambient temperature range	T_{amb}	−65...+125	°C

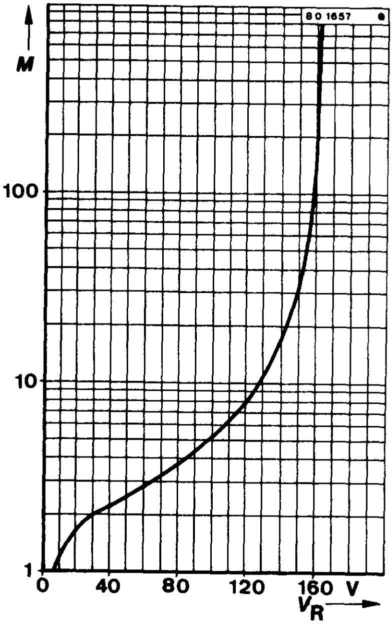
S 1.2.088/0481 E

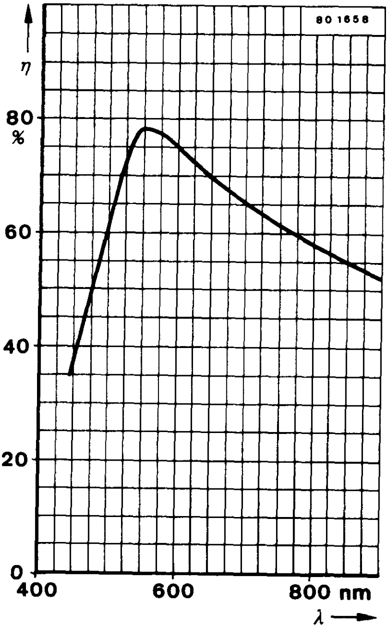
Optical and electrical characteristics $T_{amb} = 25\,°C$		Min.	Typ.	Max.	
Range of spectral bandwidth (50%)	$\lambda_{0.5}$		450...950		nm
Reverse dark current M[1]) = 100, $E = 0$	I_{ro}		1	5	nA
Breakdown voltage $I_R = 10\,\mu A$, $E = 0$	$V_{(BR)}$	140	170	200	V
Temperature coefficient of $V_{(BR)}$	TK_{VBR}		0.35		V/K
Efficiency $\lambda = 910$ nm	η	20			%
Gain bandwidth product	G_B[2])	200			GHz
Capacitance $V_R = 100$ V, $f = 1$ MHz	C_D		1	1.2	pF
Series resistance $f = 1$ MHz	r_s			50	Ω

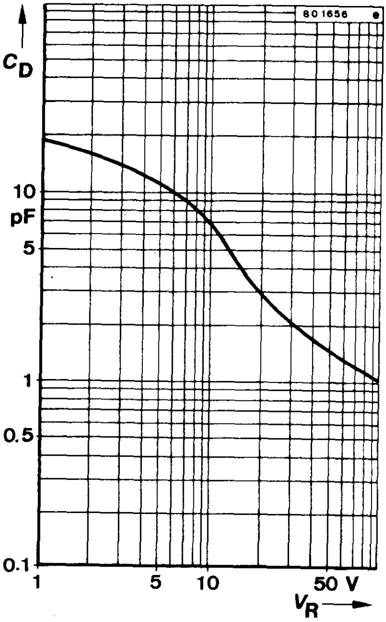
---

[1]) The voltage dependent photocurrent gain M is defined as the ratio of photocurrent I_{ph} at applied reverse voltage V_R to the photocurrent at a bias of 10 V.

[2]) Gain bandwidth product is defined as the product of M times the frequency of measurement, when the diode is biased for maximum obtainable gain.


80 1657
M
100
10
1
0
40
80
120
160 V
V_R


80 1658
η
80
%
60
40
20
0
400
600
800 nm
λ


80 1656
C_D
10
pF
5
1
0.5
0.1
1
5
10
50 V
V_R

BPW 34

Silicon Photo PIN Diode

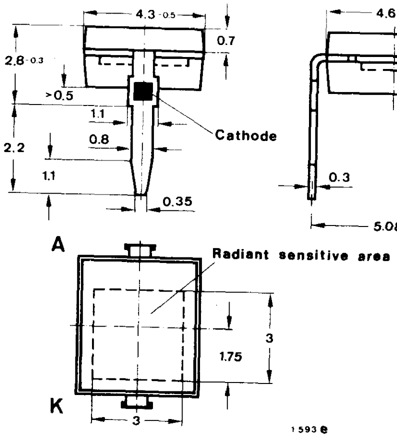
Application: High speed photo detector

Features:

- Fast response times
- Small junction capacitance
- High photo sensitivity
- Large radiant sensitive area $A = 7.5\ \mathrm{mm}^2$
- Angle of half sensitivity $\alpha = 120°$
- Suitable for visible and near infrared radiation

Preliminary specifications

Dimensions in mm



Radiant sensitive area $A = 7.5\ \mathrm{mm}^2$

Angle of half sensitivity $\alpha = 120°$

Plastic case
Weight max 0.4 g

Absolute maximum ratings

Reverse voltage	V_R	32	V
Power dissipation $T_{amb} \leq 25°C$	P_V	150	mW
Junction temperature	T_j	80	°C
Storage temperature range	T_{stg}	−30 ... +80	°C
Soldering temperature, maximal $t \leq 3\ \mathrm{s}$	T_{sd}[1]	245	°C

---

[1] Distance from the touching border ≥ 2 mm

Thermal resistance

		Min.	Typ.	Max.	
Junction ambient	R_{thJA}			350	K/W

Optical and electrical characteristics

$T_{amb} = 25\,°C$

Photovoltaic cell operation

		Min.	Typ.	Max.	
Open circuit voltage					
$E_A = 1\,\text{klx}^{1)}$	V_o		400		mV
Temperature coefficient von V_o					
$E_A = 1\,\text{klx}^{1)}$	TK_{Vo}		−2.6		mV/K
Short circuit current					
$E_e = 1\,\text{mW/cm}^2$, $\lambda_p = 950$ nm, $R_L = 100\,\Omega$	I_k		47		µA
$E_A = 1\,\text{klx}^{1)}$, $R_L = 100\,\Omega$	I_k		80		µA
Temperature coefficient of I_k					
$E_A = 1\,\text{klx}^{1)}$, $R_L = 100\,\Omega$	TK_{Ik}		0.18		%/K
Junction capacitance					
$V_R = 0$, $f = 1$ MHz, $E = 0$	C_j		75		pF

Photodiode operation

		Min.	Typ.	Max.	
Breakdown voltage					
$I_R = 100\,\mu A$, $E = 0$	$V_{(BR)}$*)	32			V
Reverse dark current					
$V_R = 10$ V, $E = 0$	I_{ro}*)		2	30	nA
Light reverse current					
$V_R = 5$ V, $E_A = 1\,\text{klx}^{1)}$	I_{ra}		85		µA
$V_R = 5$ V, $E_e = 1\,\text{mW/cm}^2$, $\lambda_p = 950$ nm	I_{ra}*)	30	50		µA
Junction capacitance					
$V_R = 3$ V, $f = 1$ MHz, $E = 0$	C_j		25	40	pF
Noise equivalent power (NEP)	P_n		10^{-14}		$\text{WHZ}^{-1/2}$

Switching characteristics

$V_R = 10$ V, $R_L = 1\,k\Omega$

		Min.	Typ.	Max.	
Turn-on time	t_{on}		50		ns
Turn-off time	t_{off}		50		ns

Photovoltaic cell and photodiode operation

		Min.	Typ.	Max.	
Peak wavelength sensitivity	λ_p		900		nm
Range of spectral bandwidth (50 %)	$\lambda_{0.5}$		500 ... 1000		nm

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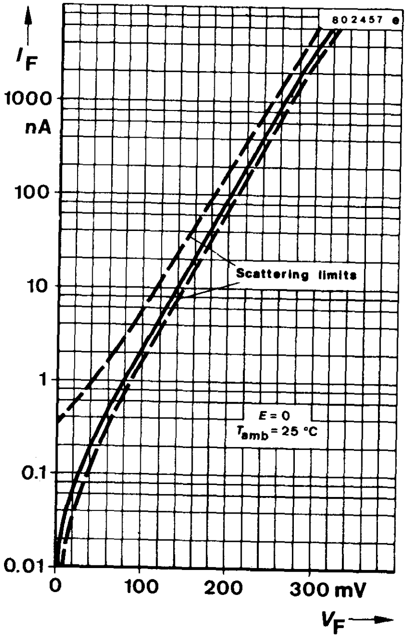
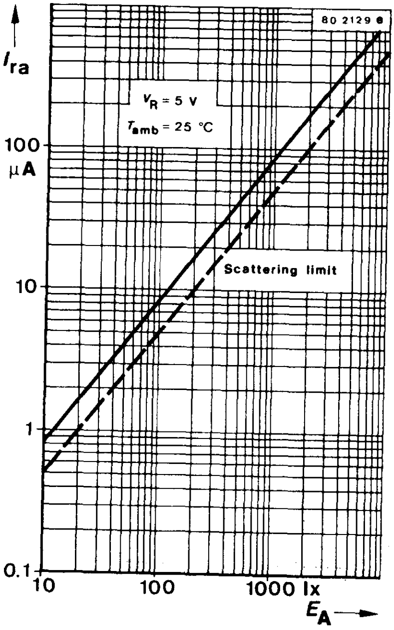
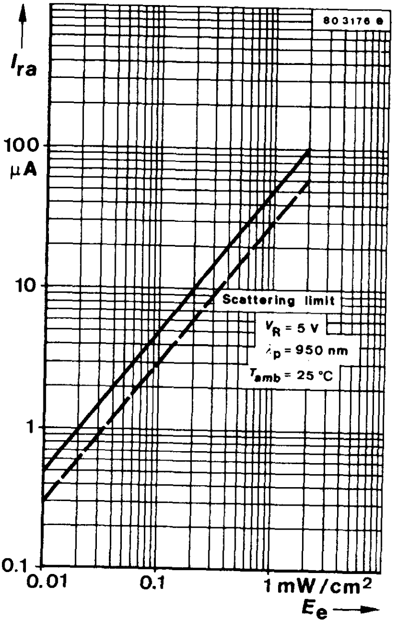
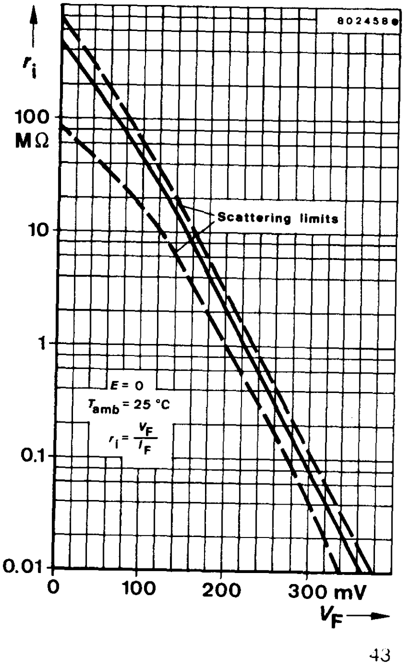
*) AQL = 0.65 %

1) Standard illuminant A (DIN 5033/IEC 306-1)

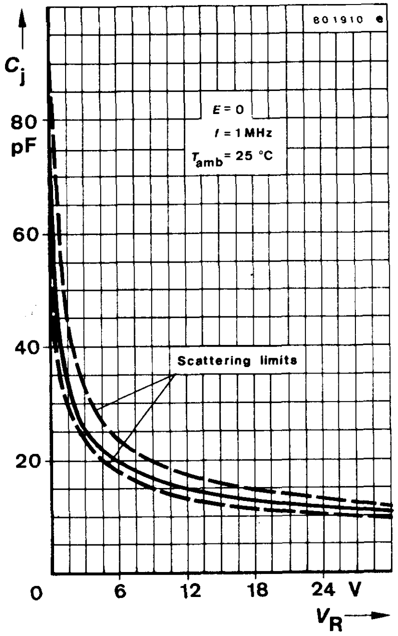

802457
I_F
1000
nA
100
10
1
0.1
0.01
0
100
200
300 mV
V_F
Scattering limits
$E = 0$
$T_{amb} = 25\ °C$

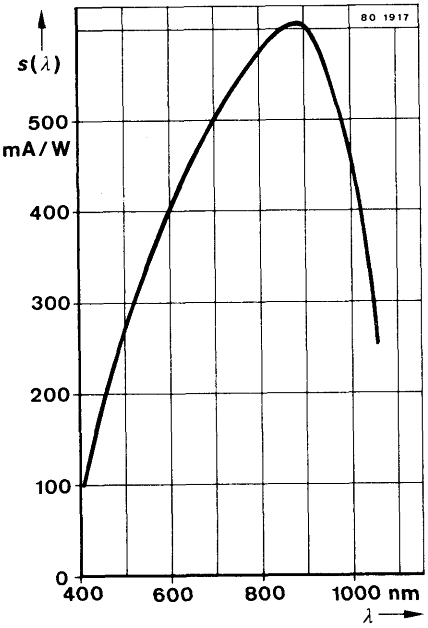

80 2129
I_{ra}
100
μA
10
1
0.1
10
100
1000 lx
E_A
$V_R = 5\ V$
$T_{amb} = 25\ °C$
Scattering limit

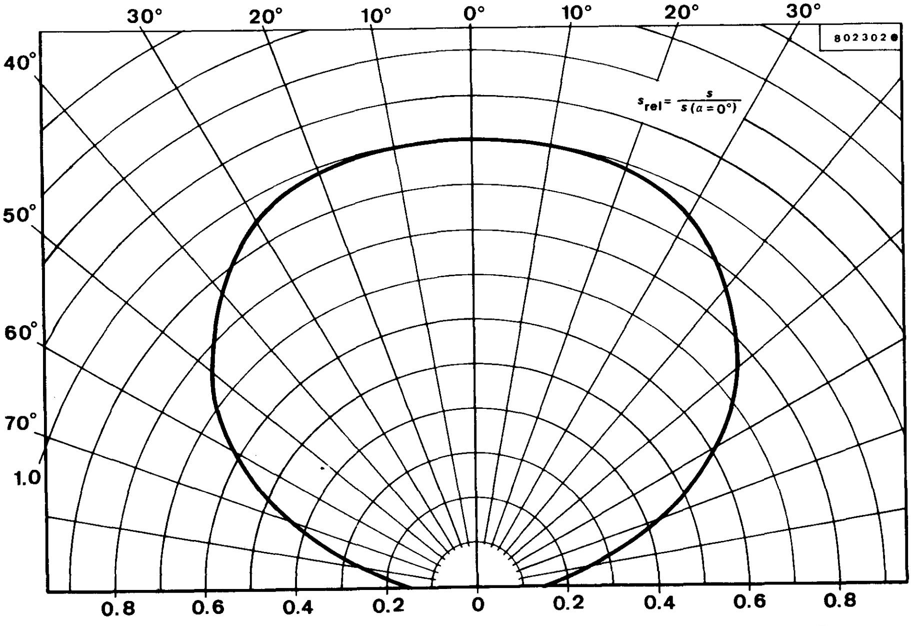

803176
I_{ra}
100
μA
10
1
0.1
0.01
0.1
1 mW/cm²
E_e
Scattering limit
$V_R = 5\ V$
$\lambda_p = 950\ nm$
$T_{amb} = 25\ °C$


802458
r_i
100
MΩ
10
1
0.1
0.01
0
100
200
300 mV
V_F
Scattering limits
$E = 0$
$T_{amb} = 25\ °C$
$r_i = \frac{V_F}{I_F}$

BPW 34

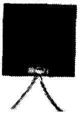

801910 e
C_j
80
pF
60
40
20
0
6
12
18
24 V
V_R
$E = 0$
$f = 1$ MHz
$T_{amb} = 25$ °C
Scattering limits


80 1917
$s(\lambda)$
500
mA/W
400
300
200
100
0
400
600
800
1000 nm
λ


802302 e
30°
20°
10°
0°
10°
20°
30°
40°
50°
60°
70°
1.0
$s_{rel} = \frac{s}{s(\alpha = 0°)}$
0.8
0.6
0.4
0.2
0
0.2
0.4
0.6
0.8
s_{rel}

BPW 35

Silicon Planar PN Photovoltaic Cell



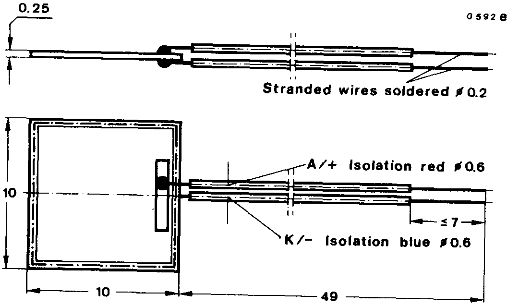
Application: Sensor for light measuring purposes

Features:

- Large radiant sensitive area
- High blue sensitivity up to the UV-range
- Suitable for visible and near infrared radiation
- No light memory effect
- Low temperature coefficient
- High stability and high reliability
- No change by irradiation even in UV-range

Preliminary specifications

Dimensions in mm



Radiant sensitive area $A = 94$ mm^2

Angle of half sensitivity $\alpha = 120°$

Without case
Weight max. 0.2 g

Absolute maximum ratings

Reverse voltage	V_R	1	V
Ambient temperature range	T_{amb}	−40 ... +100	°C
Storage temperature range	T_{stg}	−40 ... +100	°C

Optical and electrical characteristics

$T_{amb} = 25\,°C$

		Min.	Typ.	Max.	
Open circuit voltage $E_A = 1$ klx1)	V_o*)	300	380		mV
Temperature coefficient of V_o	TK_{Vo}		−2		mV/K
Short circuit current $E_A = 1$ klx1), $R_L = 100\ \Omega$	I_k	240	300		µA
$E_C = 1$ klx2), $R_L = 100\ \Omega$	I_k*)	200	220		µA
$E_A = 1$ klx1)3), $R_L = 10\ k\Omega$, $\lambda_p = 425$ nm	I_k	0.8	1.6		µA
Sensitivity, short circuit $E_A = 1$ klx1)	s_k	240	300		nA/lx
Temperature coefficient of I_k	TK_{Ik}		0.1		%/K
Peak wavelength sensitivity	λ_p		750		nm
Range of spectral bandwidth (50 %)	$\lambda_{0.5}$		450...950		nm
Reverse dark current $V_R = 50$ mV, $E = 0$	I_{ro}		10	100	nA
$V_R = 1$ V, $E = 0$	I_{ro}		250		nA
Internal resistance $V_R = 50$ mV, $E = 0$	r_i	0.5	5		MΩ
Junction capacitance $V_R = 1$ V, $f = 100$ kHz, $E = 0$	C_j		10		nF

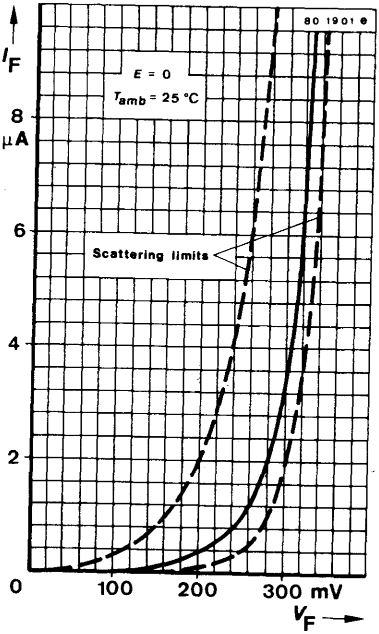
---

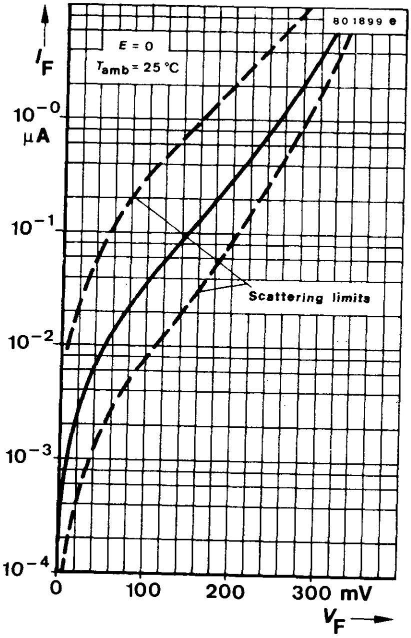
*) AQL = 0.65 %

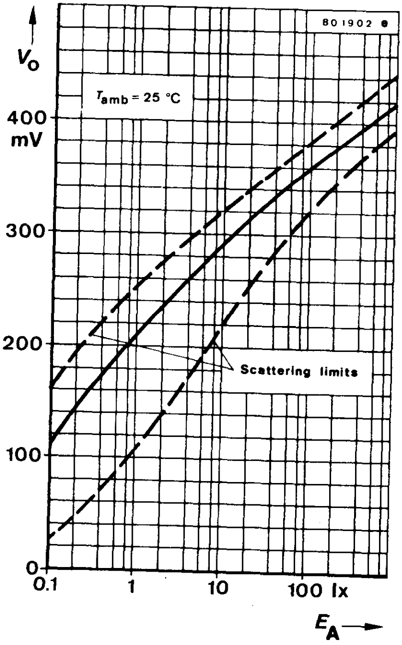
1) Standard illuminant A (DIN 5033/IEC 306-1, $T_f = 2855.6$ K)

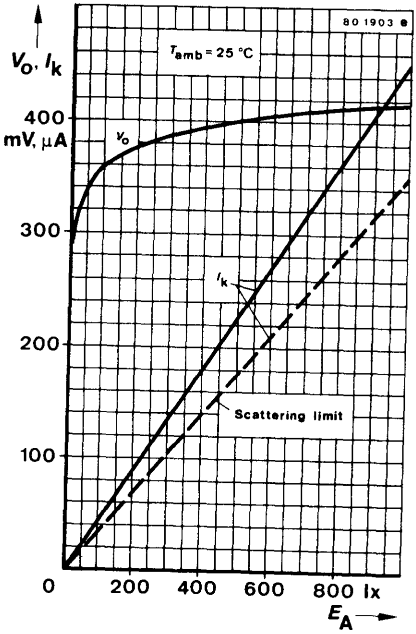
2) Standard illuminant C ($T_f = 4700$ K)

3) with blue filter combination: Schott BG 32 (2 mm) + Kodak Wratten No. 47 B

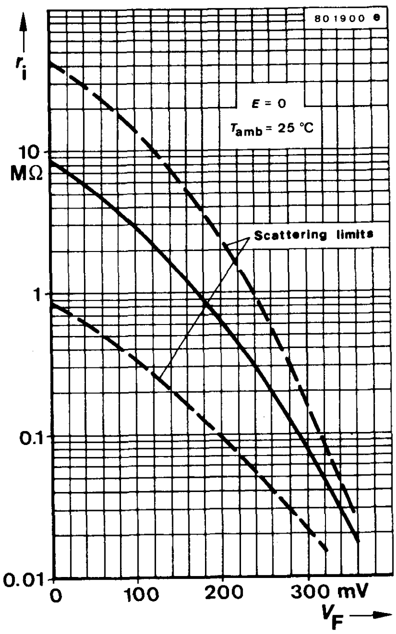

80 1901 e
I_F
8
µA
6
4
2
0
100
200
300 mV
V_F
$E = 0$
$T_{amb} = 25\,°C$
Scattering limits

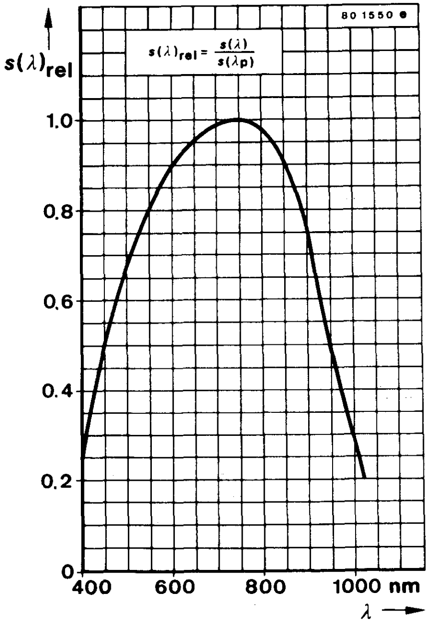

80 1899 e
I_F
10^{-0}
µA
10^{-1}
10^{-2}
10^{-3}
10^{-4}
0
100
200
300 mV
V_F
$E = 0$
$T_{amb} = 25\,°C$
Scattering limits

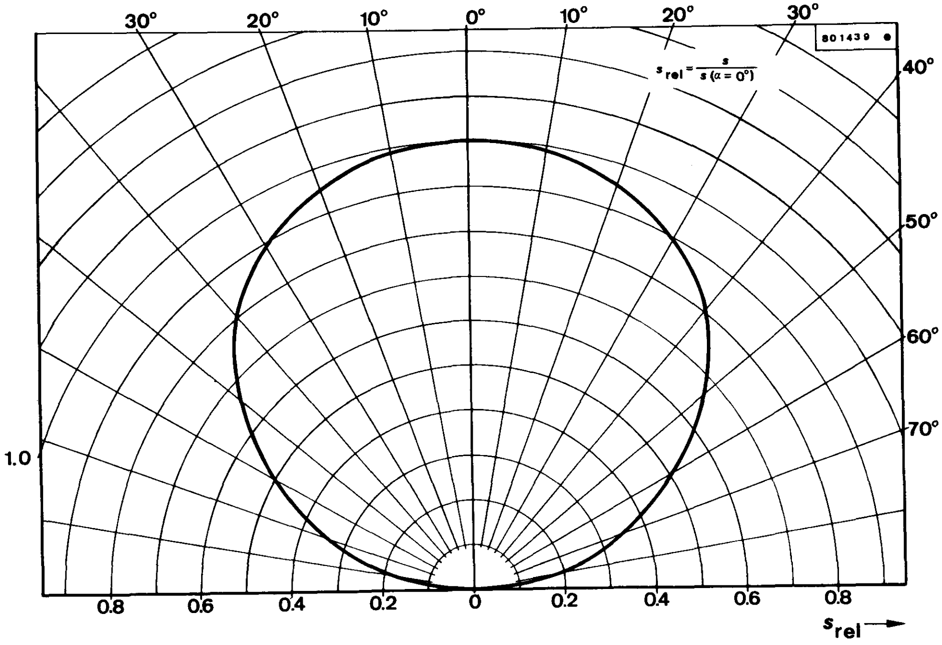

80 1902 e
V_O
400
mV
300
200
100
0
0.1
1
10
100 lx
E_A
$T_{amb} = 25\,°C$
Scattering limits


80 1903 e
V_O, I_k
400
mV, µA
300
200
100
0
200
400
600
800 lx
E_A
$T_{amb} = 25\,°C$
V_O
I_k
Scattering limit

BPW 35

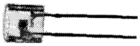

801900
r_i
10 MΩ
1
0.1
0.01
$E = 0$
$T_{amb} = 25$ °C
Scattering limits
0
100
200
300 mV
V_F


801550
$s(\lambda)_{rel}$
$s(\lambda)_{rel} = \frac{s(\lambda)}{s(\lambda p)}$
1.0
0.8
0.6
0.4
0.2
0
400
600
800
1000 nm
λ


801439
30°
20°
10°
0°
10°
20°
30°
40°
50°
60°
70°
$s_{rel} = \frac{s}{s(\alpha = 0°)}$
1.0
0.8
0.6
0.4
0.2
0
0.2
0.4
0.6
0.8
s_{rel}

BPW 39

Silicon NPN Epitaxial Planar Phototransistor



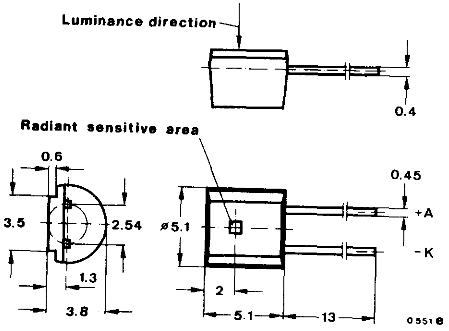
Application: Detector in electronic control and drive circuits

Features:

- Plastic case withe clear
- Suitable for visible and near infrared radiation
- High sensitivity
- Wide angle of half sensitivity
- Flat window
- Irradiation direction vertical to mounting direction
- Compatible with CQX 18
- Selected in groups

Preliminary specifications

Dimensions in mm



Angle of half sensitivity $\alpha = 130°$

Plastic case
≈ 10 B 3 DIN 41868
≈ JEDEC TO 92
Weight max. 0.4 g

Absolute maximum ratings

Collector-emitter voltage	V_{CEO}	32	V
Emitter-collector voltage	V_{ECO}	5	V
Collector current	I_C	100	mA
Peak collector current $\frac{t_p}{T} = 0.5$, $t_p \leq 10$ ms	I_{CM}	200	mA
Total power dissipation $T_{amb} \leq 25\,°C$	P_{tot}	150	mW
Junction temperature	T_j	85	°C
Storage temperature range	T_{stg}	−25 ... +85	°C
Soldering temperature, maximal $t \leq 3$ s	T_{sd}[1]	245	°C

---

[1] Distance from the touching border ≥ 2 mm

S 1.2.124/0781 E

Thermal resistance		Min.	Typ.	Max.	
Junction ambient	R_{thJA}			400	K/W

Optical and electrical characteristics

$T_{amb} = 25°C$

		Min.	Typ.	Max.	
Collector dark current $V_{CE} = 20$ V, $E = 0$	I_{CEO}*)		10	100	nA
Collector light current $V_{CE} = 5$ V, $E_A = 1$ klx^1)					
Group A	I_{ca}		1		mA
Group B	I_{ca}		2		mA
$V_{CE} = 5$ V, $E_e = 1$ mW/cm^2, $\lambda_p = 950$ nm					
Group A	I_{ca}*)	0.15	0.3	0.5	mA
Group B	I_{ca}*)	0.4	0.6		mA
Peak wavelength sensitivity	λ_p		780		nm
Range of spectral bandwidth (50 %)	$\lambda_{0.5}$		520 ... 950		nm
Collector-emitter breakdown voltage $I_C = 1$ mA	$V_{(BR)CEO}$*)	32			V
Collector-emitter saturation voltage $I_C = 0.1$ mA, $E_A = 1$ klx^1)	V_{CEsat}*)			0.3	V
Cut-off frequency $I_C = 5$ mA, $V_S = 5$ V, $R_L = 100\ \Omega$	f_g		170		kHz

Switching characteristics

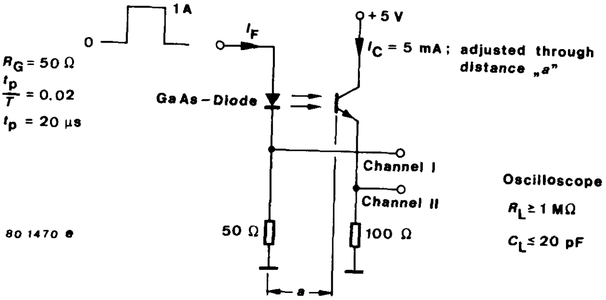
$V_S = 5$ V, $I_C = 5$ mA, $R_L = 100\ \Omega$, see test circuit

		Min.	Typ.	Max.	
Delay time	t_d		1.8		µs
Rise time	t_r		1.6		µs
Turn-on time	t_{on}		3.4		µs
Storage time	t_s		0.3		µs
Fall time	t_f		1.7		µs
Turn-off time	t_{off}		2.0		µs

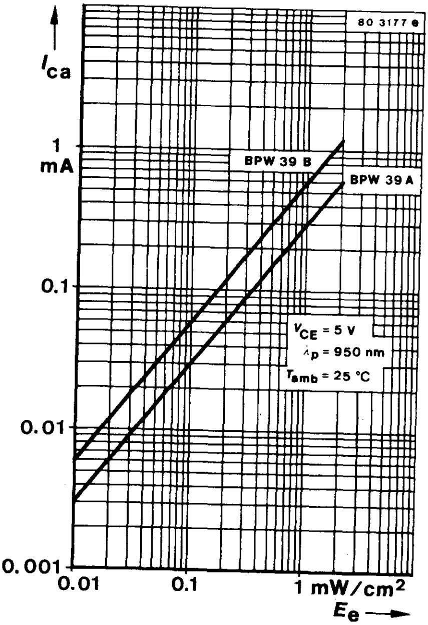
---

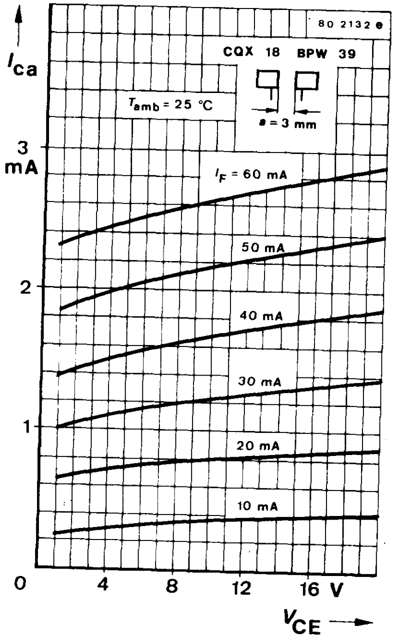
*) AQL = 0.65 %

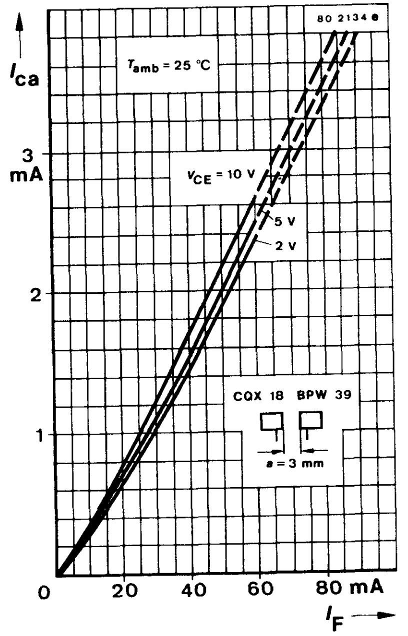
^{1}) Standard illuminant A (DIN 5033/IEC 306-1)

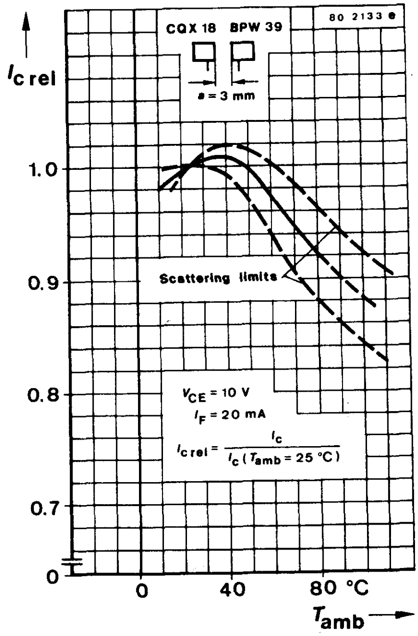


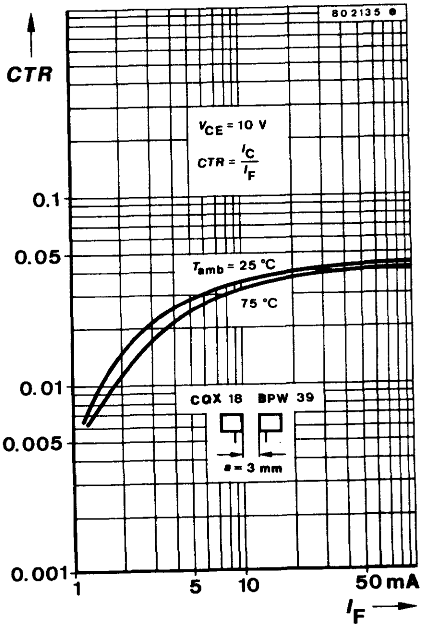
Test circuit

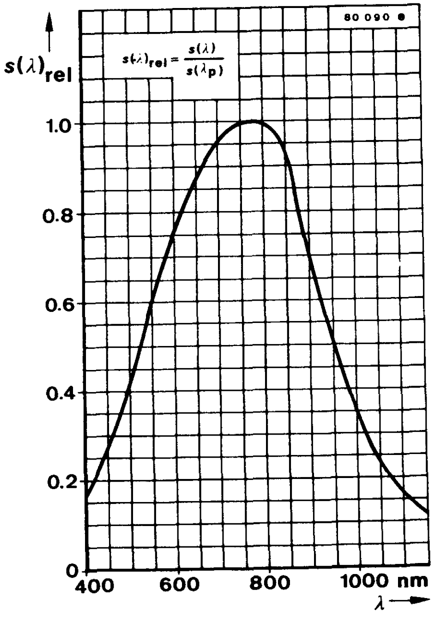


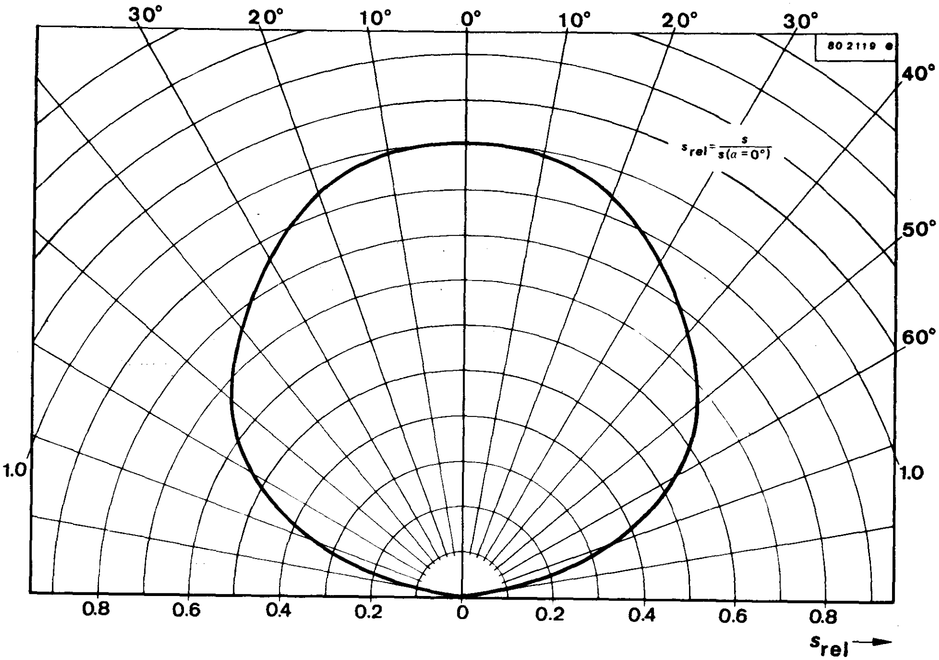



80 2134
I_{ca}
T_{amb} = 25 °C
3 mA
2
1
0
V_{CE} = 10 V
5 V
2 V
CQX 18 BPW 39
a = 3 mm
20
40
60
80 mA
I_F


80 2133
$I_{c\,rel}$
CQX 18 BPW 39
a = 3 mm
1.0
0.9
0.8
0.7
0
Scattering limits
V_{CE} = 10 V
I_F = 20 mA
$I_{c\,rel} = \frac{I_c}{I_c\,(T_{amb} = 25\,°C)}$
0
40
80 °C
T_{amb}


80 2135
CTR
V_{CE} = 10 V
$CTR = \frac{I_C}{I_F}$
0.1
0.05
0.01
0.005
0.001
T_{amb} = 25 °C
75 °C
CQX 18 BPW 39
a = 3 mm
1
5
10
50 mA
I_F


80 090
$s(\lambda)_{rel}$
$s(\lambda)_{rel} = \frac{s(\lambda)}{s(\lambda_p)}$
1.0
0.8
0.6
0.4
0.2
0
400
600
800
1000 nm
λ


30°
20°
10°
0°
10°
20°
30°
40°
50°
60°
80 2119
$s_{rel} = \frac{s}{s(\alpha = 0°)}$
1.0
1.0
0.8
0.6
0.4
0.2
0
0.2
0.4
0.6
0.8
s_{rel}

BPW 40

Silicon NPN Epitaxial Planar Phototransistor

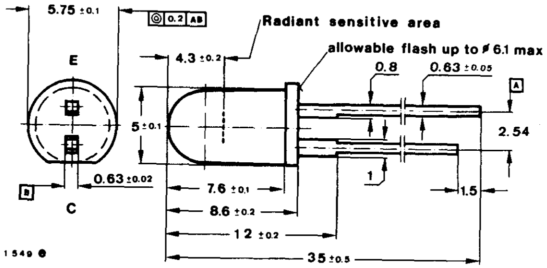
Application: Detector in electronic control and drive circuits

Features:

- Plastic case ∅ 5 mm
- Suitable for visible and near infrared radiation
- High sensitivity
- Wide angle of half sensitivity
- Axial terminals

Preliminary specifications

Dimensions in mm



Angle of half sensitivity $\alpha = 40°$

Special case
Clear plastic
Weight max. 0.4 g

Accessories

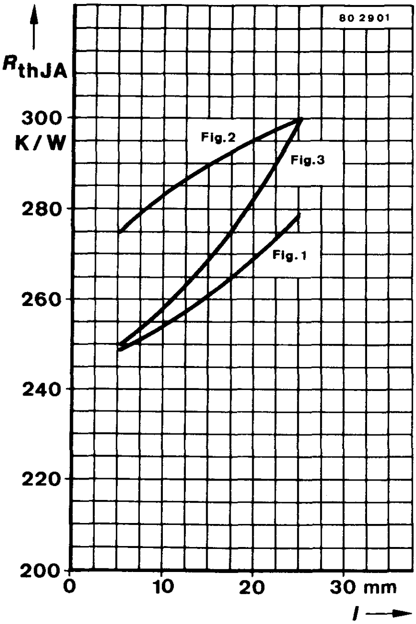
Mounting clip	Best. Nr. 562136
Retainer ring	Best. Nr. 562135

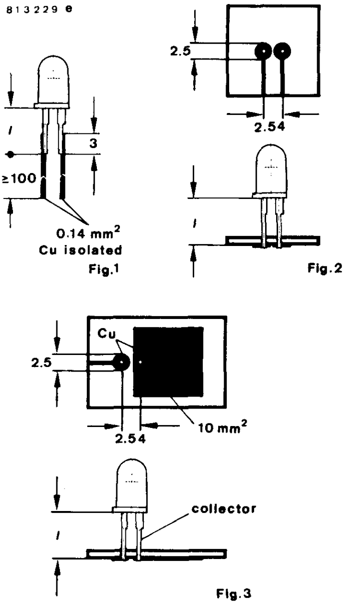
Absolute maximum ratings

Collector-emitter voltage	V_{CEO}	32	V
Emitter-collector voltage	V_{ECO}	5	V
Collector current	I_C	100	mA
Peak collector current $\frac{t_p}{T} = 0.5$, $t_p \leq 10$ ms	I_{CM}	200	mA
Total power dissipation $T_{amb} \leq 45°C$	P_{tot}	100	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−25 ... +100	°C
Soldering temperature, maximal $t \leq 3$ s	T_{sd}[1]	245	°C

---

[1] Distance from the touching border ≥ 1.5 mm with intermediate PC-board





Thermal resistance

		Min.	Typ.	Max.	
Junction ambient	R_{thJA}			350	K/W

Optical and electrical characteristics

$T_{amb} = 25°C$

		Min.	Typ.	Max.	
Collector dark current $V_{CE} = 20$ V, $E = 0$	I_{CEO}*)		10	200	nA
Collector light current $V_{CE} = 5$ V, $E_A = 1$ klx¹)	I_{ca}		6		mA
$V_{CE} = 5$ V, $E_e = 1$ mW/cm², $\lambda_p = 950$ nm	I_{ca}*)	1	2		mA
Peak wavelength sensitivity	λ_p		780		nm
Range of spectral bandwidth (50 %)	$\lambda_{0.5}$		520...950		nm
Collector-emitter breakdown voltage $I_C = 1$ mA	$V_{(BR)CEO}$*)	32			V
Collector-emitter saturation voltage $I_C = 1$ mA, $E_e = 1$ mW/cm², $\lambda_p = 950$ nm	V_{CEsat}*)			0.3	V
Cut-off frequency $V_S = 5$ V, $I_C = 5$ mA, $R_L = 100\ \Omega$	f_g		170		kHz

---

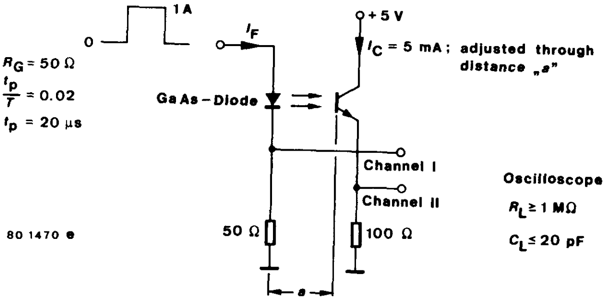
*) AQL = 0.65 %

[1] Standard illuminant A (DIN 5033/IEC 306-1)

Switching characteristics

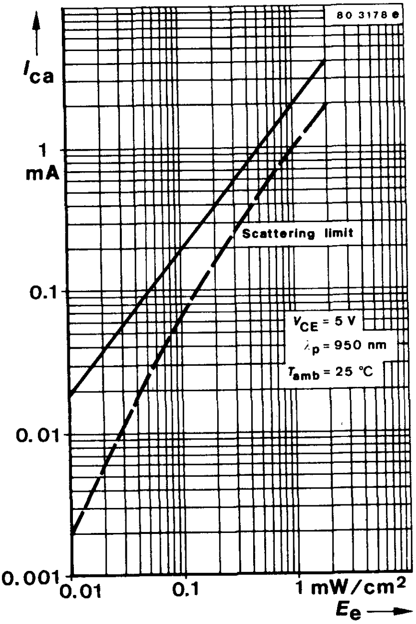
V_S = 5 V, I_C = 5 mA, R_L = 100 Ω, see test circuit

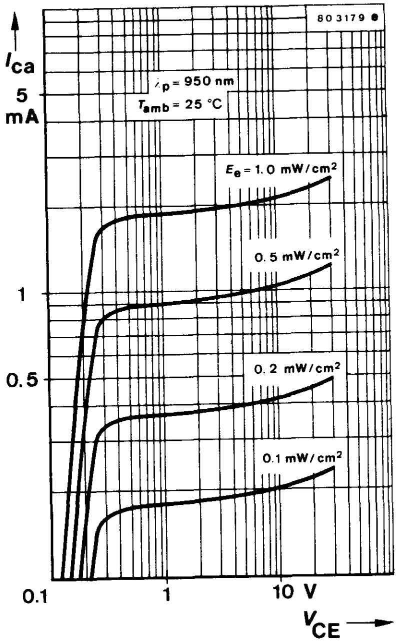
		Min.	Typ.	Max.	
Delay time	t_d		1.8		μs
Rise time	t_r		1.6		μs
Turn-on time	t_{on}		3.4		μs
Storage time	t_s		0.3		μs
Fall time	t_f		1.7		μs
Turn-off time	t_{off}		2.0		μs

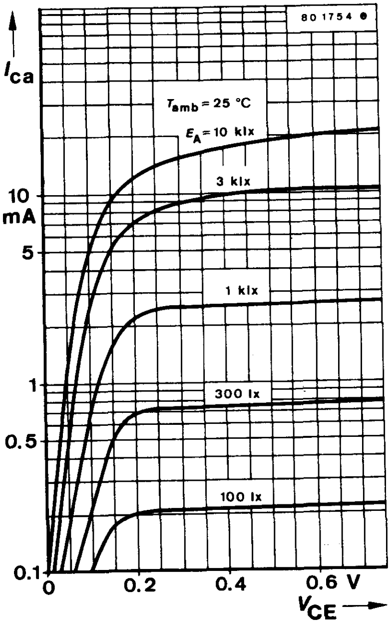


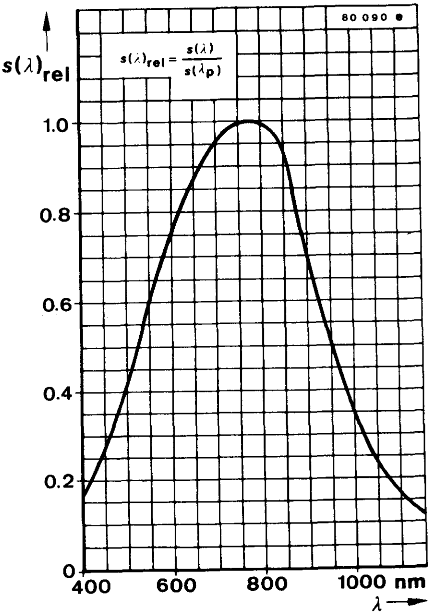
Test circuit

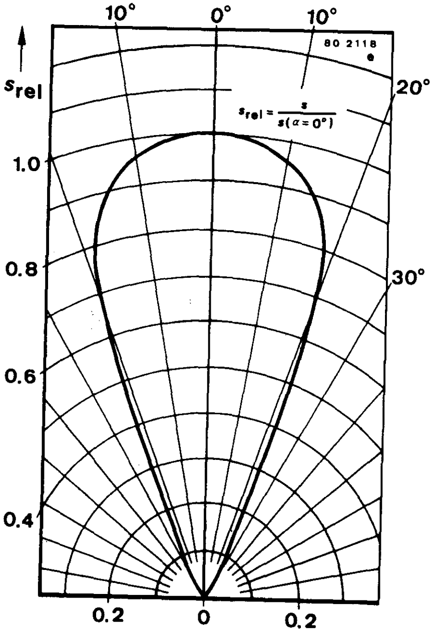
BPW 40


80 3178 ●
I_{ca}
1 mA
0.1
0.01
0.001
0.01
0.1
1 mW/cm²
E_e
Scattering limit
V_{CE} = 5 V
λ_p = 950 nm
T_{amb} = 25 °C


80 3179 ●
I_{ca}
5 mA
1
0.5
0.1
1
10 V
V_{CE}
λ_p = 950 nm
T_{amb} = 25 °C
E_e = 1.0 mW/cm²
0.5 mW/cm²
0.2 mW/cm²
0.1 mW/cm²


80 1754 ●
I_{ca}
10 mA
5
1
0.5
0.1
0
0.2
0.4
0.6 V
V_{CE}
T_{amb} = 25 °C
E_A = 10 klx
3 klx
1 klx
300 lx
100 lx


80 090 ●
$s(\lambda)_{rel}$
$s(\lambda)_{rel} = \frac{s(\lambda)}{s(\lambda_p)}$
1.0
0.8
0.6
0.4
0.2
0
400
600
800
1000 nm
λ


10°
0°
10°
20°
30°
80 2118
e
s_{rel}
$s_{rel} = \frac{s}{s(\alpha = 0°)}$
1.0
0.8
0.6
0.4
0.2
0
0.2

Silicon Photo PIN Diode

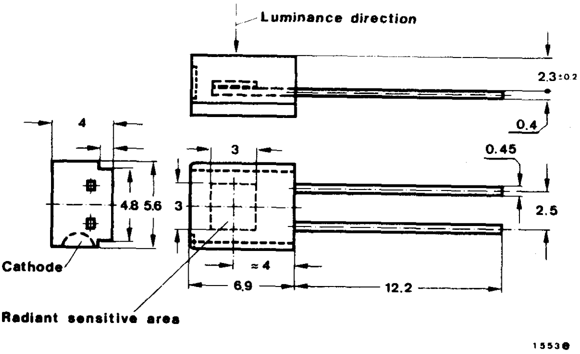
Application: High speed photo detector

Features:

- Fast response times
- Small junction capacitance
- High photo sensitivity
- Large radiant sensitive area
  $A = 7.5\ mm^2$
- Angle of half sensitivity $\alpha = 130°$
- Suitable for near infrared radiation
- Plastic case with IR filter

Preliminary specifications

Dimensions in mm



Radiant sensitive area $A = 7.5\ mm^2$

Angle of half sensitivity $\alpha = 130°$

Plastic case
Weight max 0.4 g

Absolute maximum ratings

Reverse voltage	V_R	32	V
Power dissipation $T_{amb} \leq 25°C$	P_V	150	mW
Junction temperature	T_j	80	°C
Storage temperature range	T_{stg}	−30 ... +80	°C
Soldering temperature, maximal $t \leq 3\ s$	T_{sd}[1]	245	°C

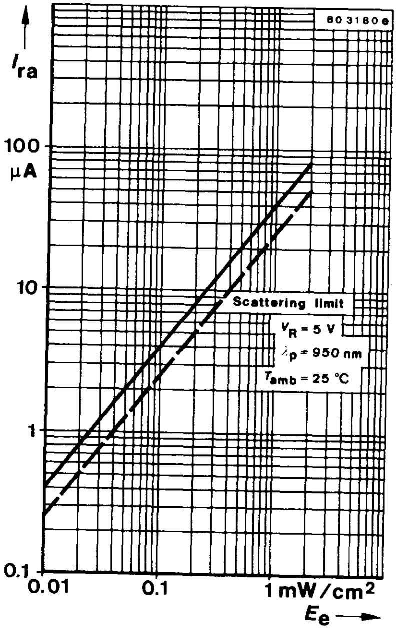
---

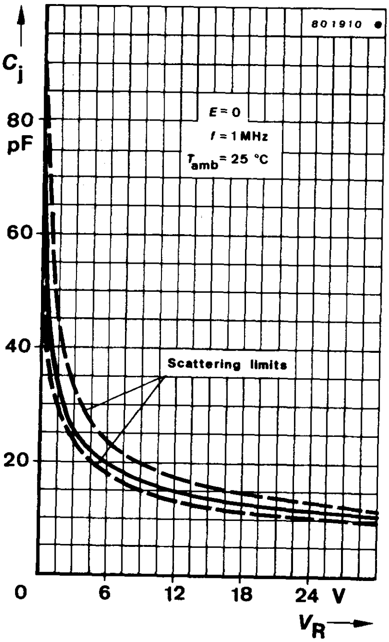
[1] Distance from the touching border ≥ 1.5 mm with intermediate PC-board

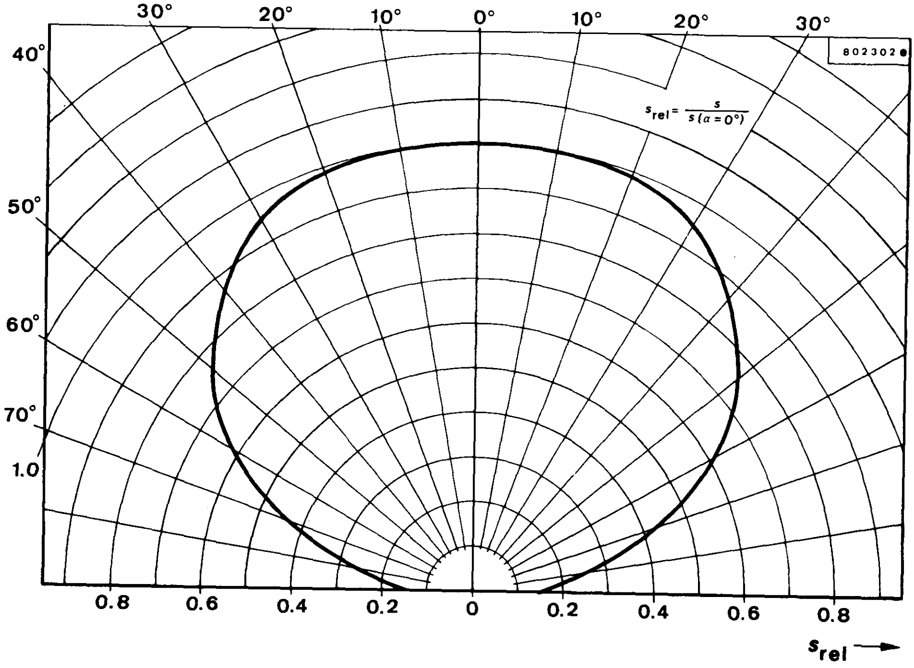
Thermal resistance		**Min.**	**Typ.**	**Max.**	
Junction ambient	R_{thJA}			350	K/W
Optical and electrical characteristics $T_{amb} = 25°C$					
Photovoltaic cell operation					
Open circuit voltage $E_e = 1\ mW/cm^2$, $\lambda_p = 950\ nm$	V_o		350		mV
Short circuit current $E_e = 1\ mW/cm^2$, $\lambda_p = 950\ nm$, $R_L = 100\ \Omega$	I_k		38		µA
Junction capacitance $V_R = 0$, $f = 1\ MHz$, $E = 0$	C_j		75		pF
Photodiode operation					
Breakdown voltage $I_R = 100\ \mu A$, $E = 0$	$V_{(BR)}$*)	32			V
Reverse dark current $V_R = 10\ V$, $E = 0$	I_{ro}*)		2	30	nA
Light reverse current $V_R = 5\ V$, $E_e = 1\ mW/cm^2$, $\lambda_p = 950\ nm$	I_{ra}*)	25	40		µA
Junction capacitance $V_R = 3\ V$, $f = 1\ MHz$, $E = 0$	C_j		25	40	pF
Noise equivalent power (NEP)	P_n		10^{-14}		$WHZ^{-1/2}$
Switching characteristics $V_R = 10\ V$, $R_L = 1\ k\Omega$					
Turn-on time	t_{on}		50		ns
Turn-off time	t_{off}		50		ns
Photovoltaic cell and photodiode operation					
Peak wavelength sensitivity	λ_p		925		nm
Range of spectral bandwidth (50 %)	$\lambda_{0.5}$		730...1040		nm

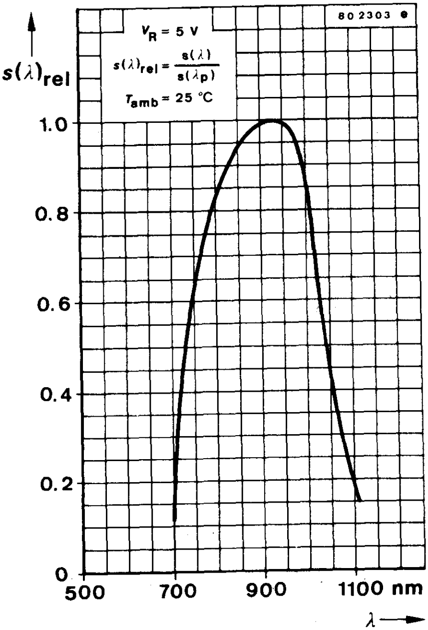
---

*) AQL = 0.65 % (DIN 5033/IEC 306-1)


803180
I_{ra}
100 µA
10
1
0.1
0.01
0.1
1 mW/cm²
E_e
Scattering limit
V_R = 5 V
λ_p = 950 nm
T_{amb} = 25 °C

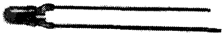

801910
C_j
80 pF
60
40
20
0
6
12
18
24 V
V_R
E = 0
f = 1 MHz
T_{amb} = 25 °C
Scattering limits


802302
30°
20°
10°
0°
10°
20°
30°
40°
50°
60°
70°
1.0
$s_{rel} = \frac{s}{s(\alpha = 0°)}$
0.8
0.6
0.4
0.2
0
0.2
0.4
0.6
0.8
s_{rel}


80 2303
V_R = 5 V
$s(\lambda)_{rel} = \frac{s(\lambda)}{s(\lambda_p)}$
T_{amb} = 25 °C
$s(\lambda)_{rel}$
1.0
0.8
0.6
0.4
0.2
0
500
700
900
1100 nm
λ

BPW 42

Silicon NPN Epitaxial Planar Phototransistor



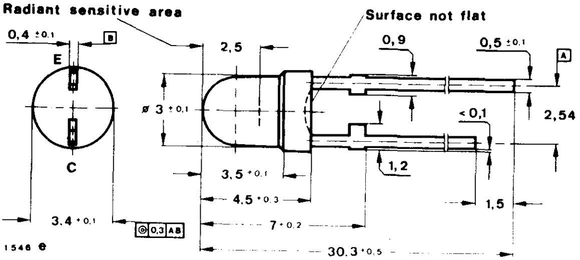
Application: Detector in electronic control and drive circuits

Features:

- Plastic case ∅ 3 mm
- Suitable for visible and near infrared radiation
- High sensitivity
- Wide angle of half sensitivity
- Axial terminals

Preliminary specifications

Dimensions in mm



Angle of half sensitivity $\alpha = 180°$

Special case
Clear plastic
Weight max. 0.35 g

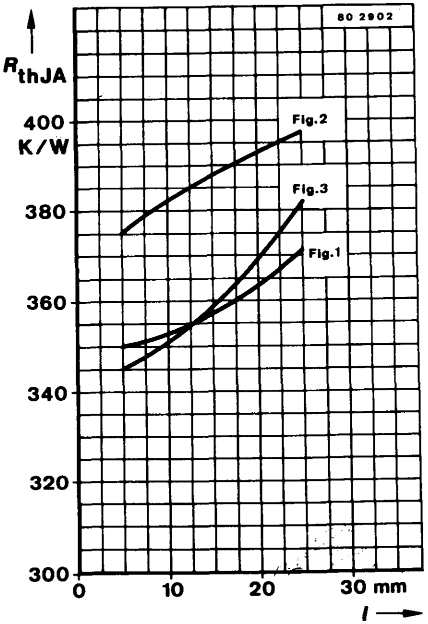
Absolute maximum ratings

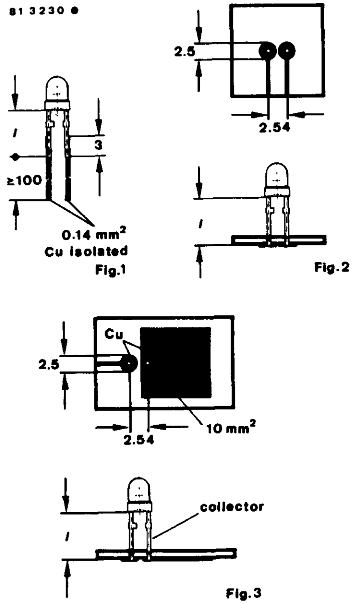
Collector-emitter voltage	V_{CEO}	32	V
Emitter-collector voltage	V_{ECO}	5	V
Collector current	I_C	50	mA
Peak collector current $\frac{t_p}{T} = 0.5$, $t_p \leq 10$ ms	I_{CM}	100	mA
Total power dissipation $T_{amb} \leq 55°C$	P_{tot}	100	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−25 ... +100	°C
Soldering temperature, maximal $t \leq 3$ s	T_{sd} 1)	245	°C

---

1) Distance from the touching border ≥ 1.5 mm with intermediate PC-board

BPW 42



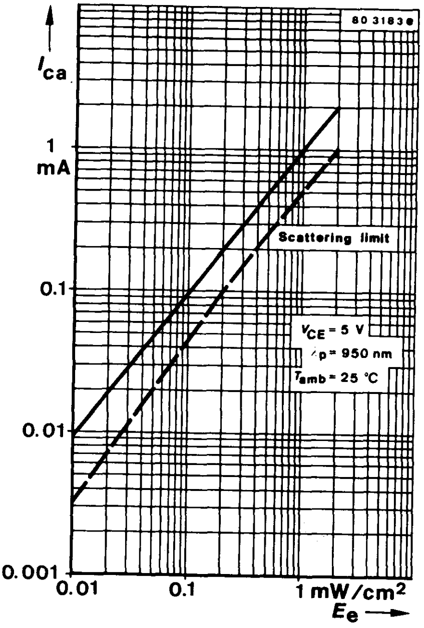


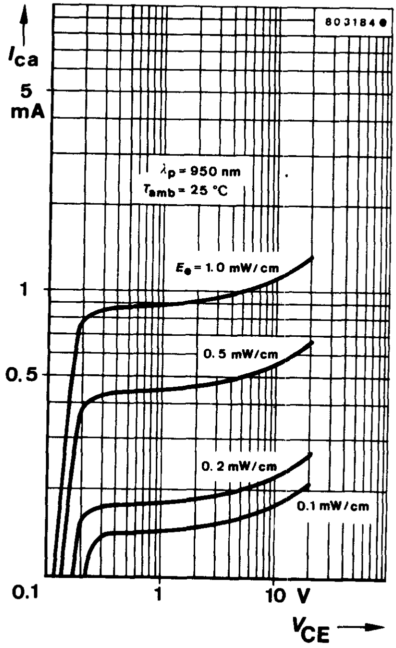
		Min.	Typ.	Max.	
Thermal resistance					
Junction ambient	R_{thJA}			450	K/W
Optical and electrical characteristics $T_{amb} = 25\,°C$					
Collector dark current $V_{CE} = 20\,V, E = 0$	I_{CEO}*)		10	200	nA
Collector light current $V_{CE} = 5\,V, E_A = 1\,klx$¹)	I_{ca}		3		mA
$V_{CE} = 5\,V, E_e = 1\,mW/cm^2, \lambda_p = 950\,nm$	I_{ca}*)	0.5	1.0		mA
Peak wavelength sensitivity	λ_p		830		nm
Range of spectral bandwidth (50 %)	$\lambda_{0.5}$		560 ... 980		nm
Collector-emitter breakdown voltage $I_C = 1\,mA$	$V_{(BR)\,CEO}$*)	32			V
Collector-emitter saturation voltage $I_C = 0.1\,mA, E_e = 1\,mW/cm^2, \lambda_p = 950\,nm$	V_{CEsat}*)			0.3	V

---

*) AQL = 0.65 %

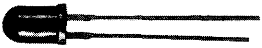
¹) Standard illuminant A (DIN 5033/IEC 306-1)


80 3183●
I_{ca}
1 mA
0.1
0.01
0.001
0.01
0.1
1 mW/cm²
E_e
Scattering limit
V_{CE} = 5 V
λ_p = 950 nm
T_{amb} = 25 °C


803184●
I_{ca}
5 mA
1
0.5
0.1
1
10 V
V_{CE}
λ_p = 950 nm
T_{amb} = 25 °C
E_e = 1.0 mW/cm
0.5 mW/cm
0.2 mW/cm
0.1 mW/cm

BPW 43

Silicon Photo PIN Diode



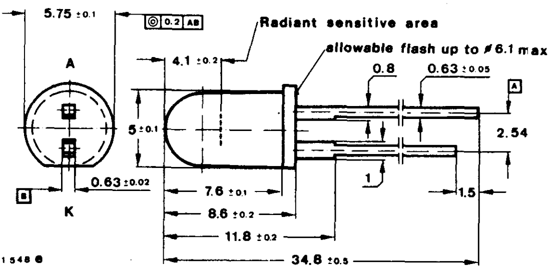
Application: High speed photo detector

Features:

- Plastic case ∅ 5 mm white clear
- Fast response times
- Small junction capacitance
- High photo sensitivity
- Angle of half sensitivity $\alpha = 50°$
- Suitable for near infrared radiation

Preliminary specifications

Dimensions in mm



Radiant sensitive area
$A = 0.25\ \mathrm{mm}^2$

Angle of half sensitivity $\alpha = 50°$

Plastic case
Weight max 0.4 g

Accessories

Mounting clip	Best.-Nr. 562136
Retainer ring	Best.-Nr. 562135

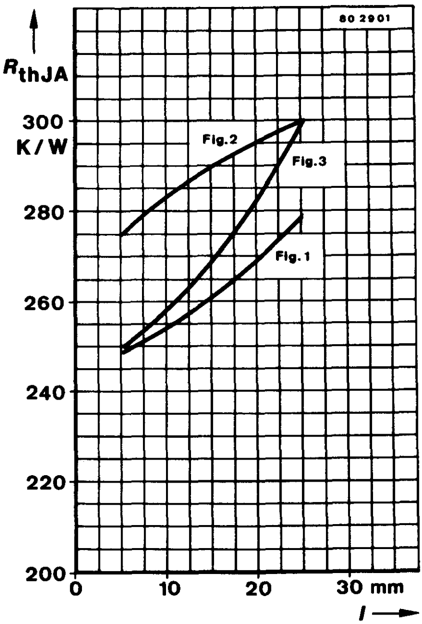
Absolute maximum ratings

Reverse voltage	V_R	32	V
Power dissipation $T_{amb} \leq 25°C$	P_V	150	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−25 ... +100	°C
Soldering temperature, maximal $t \leq 3$ s	T_{sd}[1]	245	°C

---

[1] Distance from the touching border ≥ 1.5 mm with intermediate PC-board

S 1.2. 128/0781 E



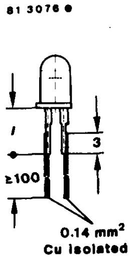


Fig.1

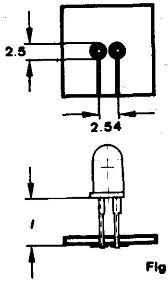


Fig.2

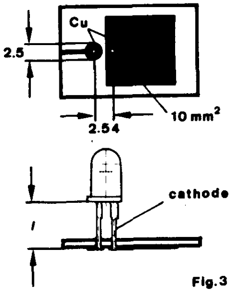


Fig.3

		Min.	Typ.	Max.	
Thermal resistance					
Junction ambient	R_{thJA}			350	K/W

Optical and electrical characteristics
$T_{amb} = 25°C$

Photovoltaic cell operation

		Min.	Typ.	Max.	
Open circuit voltage $E_A = 1$ klx[1])	V_o		320		mV
Short circuit current $E_e = 1$ mW/cm², $\lambda_p = 950$ nm, $R_L = 1$ kΩ	I_k		6		µA
$E_A = 1$ klx[1]), $R_L = 1$ kΩ	I_k		12		µA
Sensitivity, short circuit[1])	s_k		12		nA/lx
Junction capacitance $V_R = 0$, $f = 1$ MHz, $E = 0$	C_j		5		pF

---

[1]) Standard illuminant A (DIN 5033/IEC 306-1)

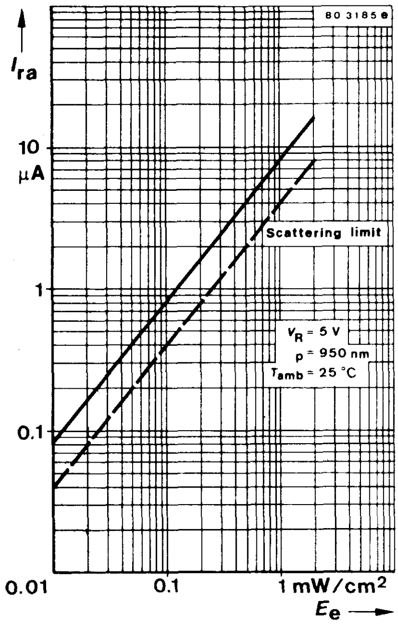
Photodiode operation		Min.	Typ.	Max.	
Reverse dark current $V_R = 10$ V, $E = 0$	I_{ro}*)		1	10	nA
Light reverse current $V_R = 5$ V, $E_A = 1$ klx¹)	I_{ra}		15		µA
$E_e = 1$ mW/cm^2, $\lambda_p = 950$ nm	I_{ra}*)	4	8		µA
Sensitivity $V_R = 5$ V, $E_A = 1$ klx¹)	S		15		nA/lx
Breakdown voltage $I_R = 100$ µA, $E = 0$	$V_{(BR)}$*)	32			V
Junction capacitance $f =$ MHz, $E = 0$, $V_R = 5$ V	C_j		2.5		pF
$V_R = 10$ V	C_j		2		pF
Switching characteristics					
$V_R = 10$ V, $R_L = 50\,\Omega$					
Rise time	t_r		4		ns
Fall time	t_f		4		ns
Photovoltaic cell and photodiode operation					
Peak wavelength sensitivity	λ_p		900		nm
Range of spectral bandwidth (50 %)	$\lambda_{0.5}$		500 ... 1000		nm

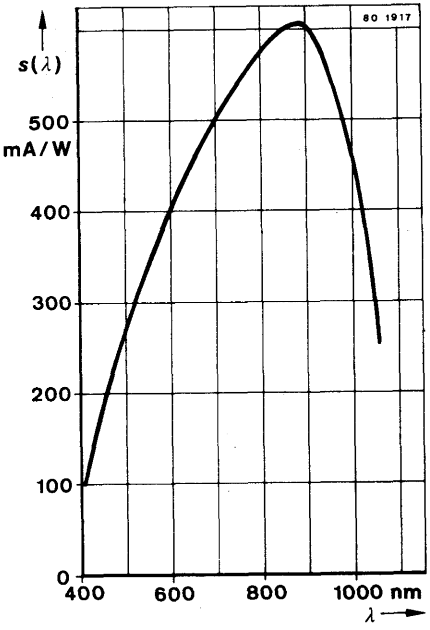
---

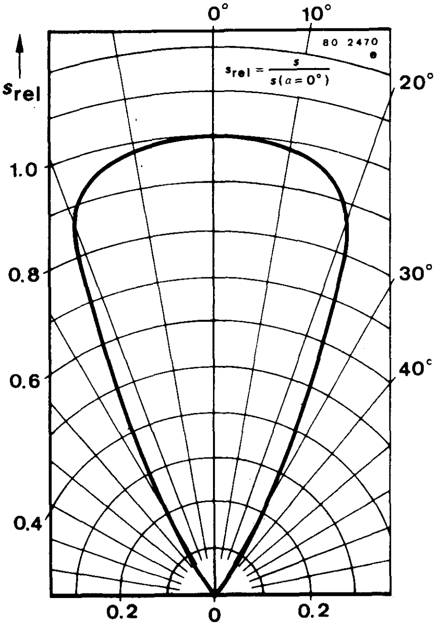
*) AQL = 0.65 %

[1] Standard illuminant A (DIN 5033/IEC 306-1)

BPW 43

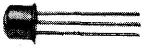

80 3185 e
I_{ra}
10
µA
1
0.1
Scattering limit
V_R = 5 V
p = 950 nm
T_{amb} = 25 °C
0.01
0.1
1 mW/cm2
E_e


80 1917
s(λ)
500
mA/W
400
300
200
100
0
400
600
800
1000 nm
λ


0°
10°
80 2470 e
$s_{rel} = \frac{s}{s(\alpha = 0°)}$
s_{rel}
20°
1.0
0.8
30°
0.6
40°
0.4
0.2
0
0.2

BPX 99

Monolithic Silicon NPN Epitaxial Photo Darlington Transistor



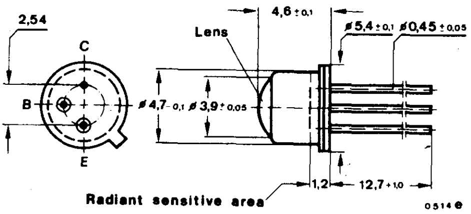
Applications: Direct driving of relays, magnetic valves, small motors etc.

Features:

- Hermetically sealed case
- Suitable for visible and near infrared radiation
- Collector current 0.5 A
- High sensitivity
- Base terminal is available

Preliminary specifications

Dimensions in mm



Collector connected with case

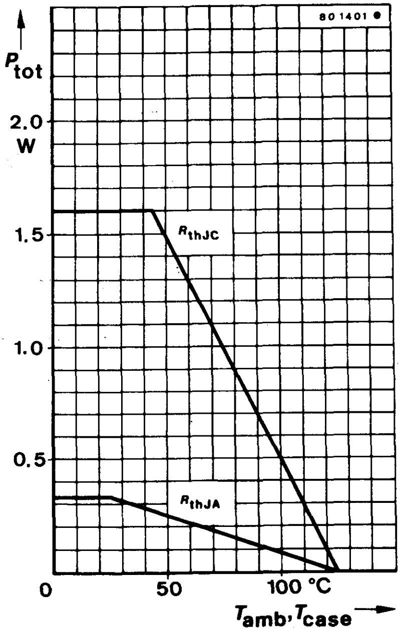
Angle of half sensitivity $\alpha = 25°$

≈ 18 A 3 DIN 41876
~ JEDEC TO 52
Weight max. 0.5 g

Absolute maximum ratings

Collector-emitter voltage	V_{CEO}	32	V
Emitter-base voltage	V_{EBO}	10	V
Collector current	I_C	0.5	A
Peak collector current $\frac{t_p}{T} = 0.05$, $t_p \leq 10$ ms	I_{CM}	1	A
Total power dissipation $T_{amb} \leq 25°C$	P_{tot}	0.33	W
$T_{case} \leq 45°C$	P_{tot}	1.6	W
Ambient temperature range	T_{amb}	−55...+125	°C
Case temperature	T_{case}	125	°C

BPX 99



Thermal resistances		**Min.**	**Typ.**	**Max.**	
Junction ambient	R_{thJA}			300	K/W
Junction case	R_{thJC}			50	K/W

Optical and electrical characteristics
$T_{amb} = 25°C$

Collector dark current $V_{CE} = 20$ V, $E = 0$	I_{CEO}*)		10	200	nA
Collector light current $V_{CE} = 5$ V, $E_A = 100$ lx¹)	I_{ca}*)	3	30		mA
Sensitivity $V_{CE} = 5$ V, $E_A = 100$ lx¹)	s	30	300		µA/lx
Peak wavelength sensitivity	λ_p		800		nm
Range of spectral bandwidth (50 %)	$\lambda_{0.5}$		600...900		nm
Collector-emitter breakdown voltage $I_C = 1$ mA	$V_{(BR)CEO}$*)	32			V
Collector-emitter saturation voltage $I_C = 0.1$ mA, $E_A = 1$ klx¹)	V_{CEsat}*)		0.75	1	V

---

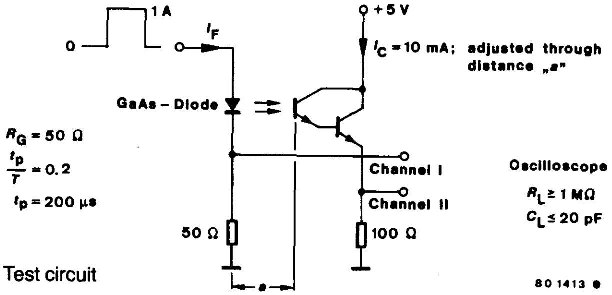
*) AQL = 0.65 %

[1] Standard illuminant A (DIN 5033/IEC 306-1)

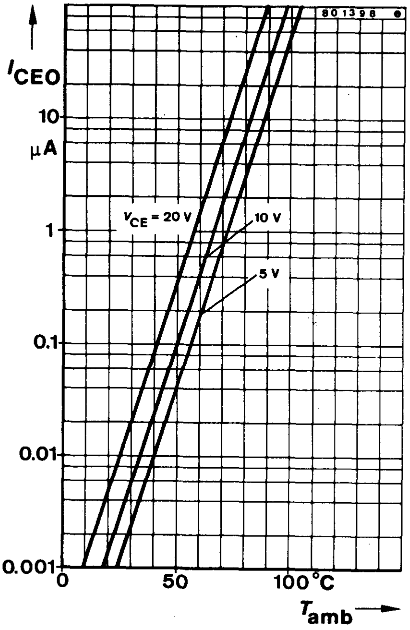
Switching characteristics

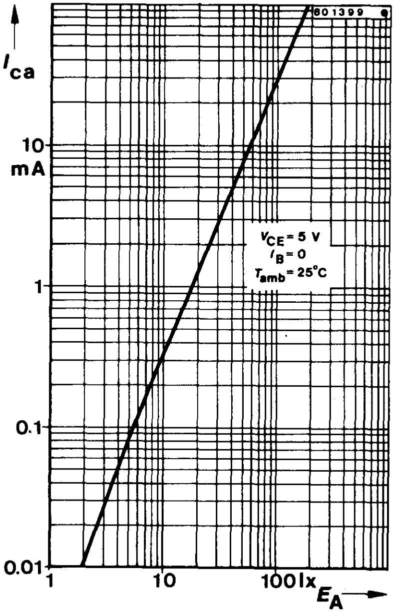
$V_S = 5$ V, $I_C = 10$ mA, $R_L = 100\ \Omega$, see test circuit

		Min.	Typ.	Max.	
Delay time	t_d		10		µs
Rise time	t_r		80		µs
Turn-on time	t_{on}		90		µs
Storage time	t_s		5		µs
Fall time	t_f		60		µs
Turn-off time	t_{off}		65		µs

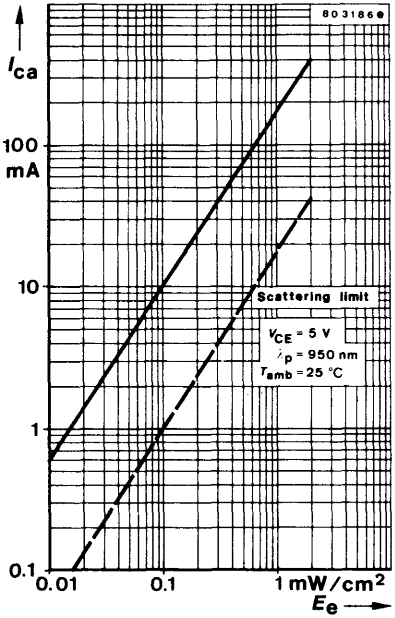


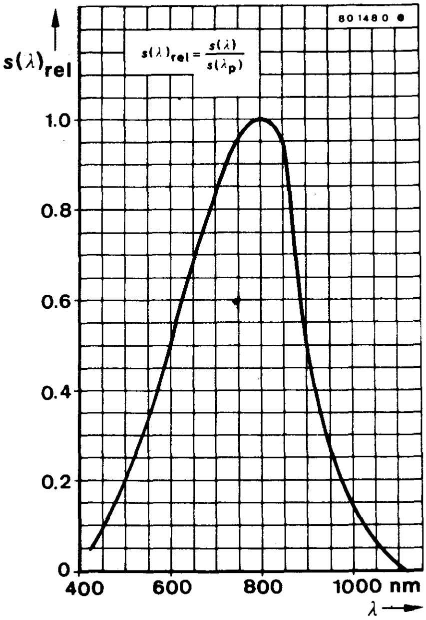
Test circuit

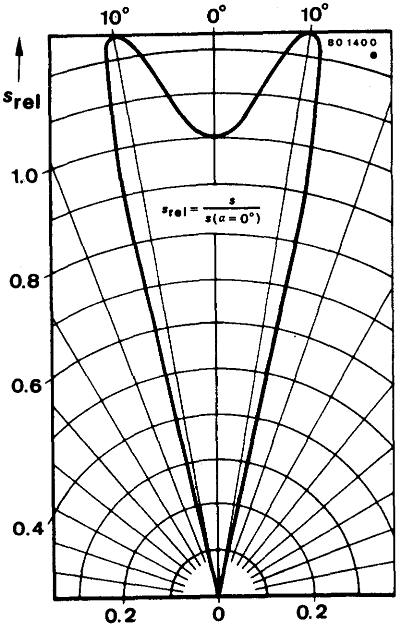




BPX 99

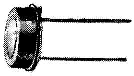

803186
I_{ca}
100 mA
10
1
0.1
0.01
0.1
1 mW/cm²
E_e
Scattering limit
V_{CE} = 5 V
λ_p = 950 nm
T_{amb} = 25 °C


801480
$s(\lambda)_{rel}$
$s(\lambda)_{rel} = \frac{s(\lambda)}{s(\lambda_p)}$
1.0
0.8
0.6
0.4
0.2
0
400
600
800
1000 nm
λ


10°
0°
10°
801400
s_{rel}
$s_{rel} = \frac{s}{s(\alpha = 0°)}$
1.0
0.8
0.6
0.4
0.2
0
0.2

S 153 P

Silicon Photo PIN Diode



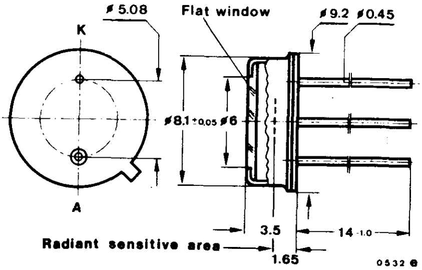
Application: Ultra high-speed photo-detector

Features:

- Fast response times
- Small junction capacitance
- High photo sensitivity
- For photodiode and photovoltaic cell operation
- Hermetically sealed case
- Wide angle of half sensitivity
- Suitable for visible and near infrared radiation
- Suitable to couple with glass fiber

Preliminary specifications

Dimensions in mm



Radiant sensitive area $A = 7.5\ \text{mm}^2$
Angle of half sensitivity $\alpha = 100°$
Negative terminal/cathode connected with case

≈ JEDEC TO 56
Weight max. 1.0 g

Absolute maximum ratings

Reverse voltage	V_R	50	V
Power dissipation $T_{amb} \leqq 25°C$	P_V	300	mW
Junction temperature	T_j	100	°C
Ambient temperature range	T_{amb}	−25...+100	°C

S 1.2.130/0781 E

Thermal resistance		Min.	Typ.	Max.	
Junction ambient	R_{thJA}			250	K/W

Optical and electrical characteristics
$T_{amb} = 25°C$

		Min.	Typ.	Max.	
Photovoltaic cell operation ($V_R = 0$)					
Open circuit voltage $E_A = 1$ klx[1])	V_o*)		350		mV
Temperature coefficient of V_o $E_A = 1$ klx[1])	TK_{Vo}		−2.6		mV/K
Short circuit current $E_A = 1$ klx[1]), $R_L = 100\,\Omega$	I_k		70		μA
Sensitivity, short circuit	s_k		70		nA/lx
Temperature coefficient of I_k $E_A = 1$ klx[1]), $R_L = 100\,\Omega$	TK_{Ik}		0.18		%/K
Junction capacitance $V_R = 0$, $f = 1$ MHz, $E = 0$	C_j		75		pF
Photodiode operation					
Breakdown voltage $I_{ro} = 100\,\mu$A, $E = 0$	$V_{(BR)}$*)	50			V
Reverse continuous dark current $V_R = 10$ V, $E = 0$	I_{ro}*)		2	30	nA
Light reverse current $V_R = 5$ V, $E_A = 1$ klx[1])	I_{ra}*)	50	70		μA
Sensitivity $V_R = 5$ V	s		70		nA/lx
Spectral sensitivity $V_R = 5$ V, $\lambda = 900$ nm	$s(\lambda)$		0.6		A/W
Junction capacitance $V_R = 3$ V, f = 1 MHz, $E = 0$	C_j		25	40	pF
Noise equivalent power (NEP)	P_n		10^{-14}		$WHz^{-1/2}$

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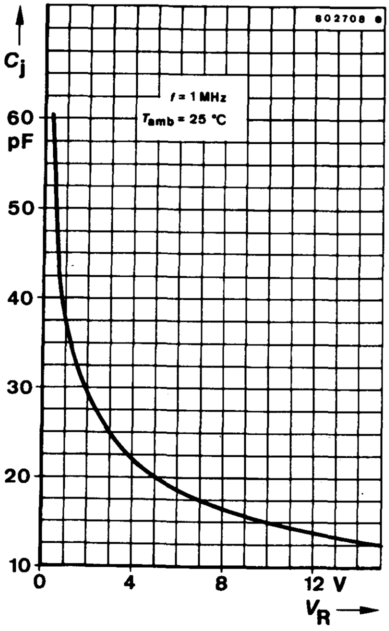
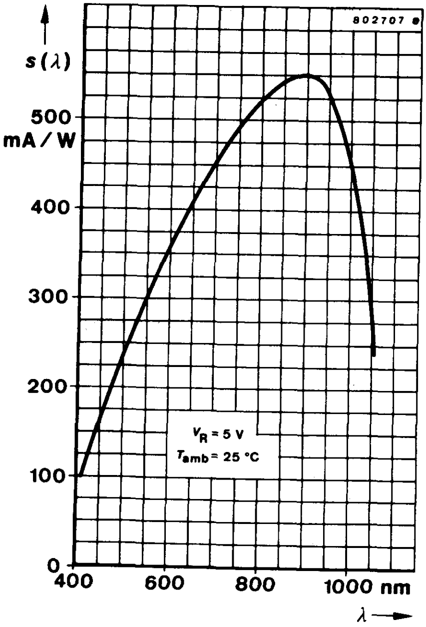
[1]) Standard illuminant A (DIN 5033/IEC 306-1) *) AQL = 0.65 %

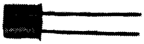
Switching characteristics			
$V_R = 10$ V, $R_L = 1$ kΩ			
Turn-on time	t_{on}	50	ns
Turn-off time	t_{off}	50	ns
Photovoltaic cell and photodiode operation			
Peak wavelength sensitivity	λ_p	900	nm
Range of spectral bandwidth (50%)	$\lambda_{0.5}$	550...1000	nm





S 168 P

Silicon Photo PIN Diode



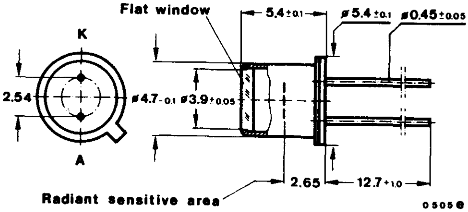
Application: High speed photo detector

Features:

- Fast response times
- Small junction capacitance
- High photo sensitivity
- Suitable for visible and near infrared radiation

Preliminary specifications

Dimensions in mm



Radiant sensitive area $A = 0.25$ mm²
Angle of half sensitivity $\alpha = 70°$
Negative terminal/cathode connected with case

≈ 18 A 2 DIN 41876
≈ JEDEC TO 18
Weight max. 0.5 g

Absolute maximum ratings

Reverse voltage	V_R	32	V
Power dissipation $T_{amb} \leqq 25°C$	P_V	150	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−25...+100	°C
Soldering temperature, maximal $t \leqq 3$ s	T_{sd}[1]	245	°C

Thermal resistance

		Min.	**Typ.**	**Max.**	
Junction ambient	R_{thJA}			350	K/W

---

[1] Distance from the touching border ≧ 2 mm

S 1.2.009/0281 E

S 168 P

Optical and electrical characteristics $T_{amb} = 25\,°C$		**Min.**	**Typ.**	**Max.**	
Photodiode operation					
Breakdown voltage $I_R = 100\,\mu A$, $E = 0$	$V_{(BR)}$	32			V
Reverse dark current $V_R = 5\,V$, $E = 0$	I_{ro}			1	nA
Light reverse current $V_R = 5\,V$, $E_A = 1\,klx$[1])	I_{ra}	2.0			μA
Spectral sensitivity $V_R = 5\,V$, $\lambda = 850\,nm$	$s(\lambda)$	0.5			A/W
Junction capacitance $V_R = 0\,V$, $f = 1\,MHz$	C_j			5	pF
Peak wavelength sensitivity	λ_p		900		nm
Range of spectral bandwidth (50%)	$\lambda_{0.5}$		500...1000		nm

Switching characteristics $V_R = 5\,V$, $R_L = 1\,k\Omega$					
Rise time	t_r			10	ns
Fall time	t_f			10	ns

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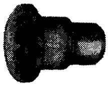
[1]) Standard illuminant A (DIN 5033/IEC 306-1)

S 171 P

Silicon Avalanche Photodiode



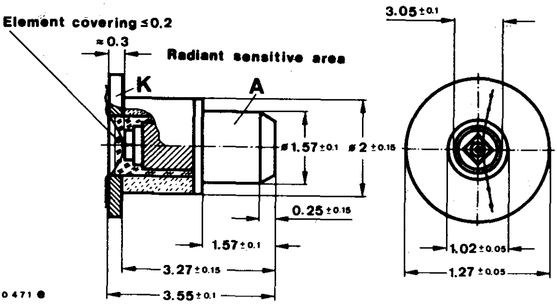
Application: Wide band detector for demodulation of fast signals, e.g. of lasers and GaAs-LED's. Detector for optical communication, e.g. for optical-fiber transmission systems.

Features:

- High sensitive, low-noise photo detector for demodulation of radiation
- Photocurrent gain higher than 200
- Gain bandwidth product higher than 200 GHz
- Microwave case

Preliminary specifications

Dimensions in mm



Diameter of the radiant sensitive area
∅ = 0.2 mm

Angle of half intensity
$\alpha = 90°$

Absolute maximum ratings

Power dissipation $T_{amb} = 25\,°C$	P_V	100	mW
Junction temperature	T_j	125	°C
Ambient temperature range	T_{amb}	−65...+100	°C

S 171 P

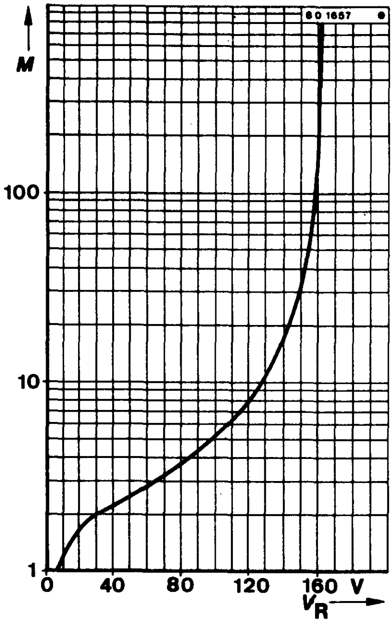
Optical and electrical characteristics

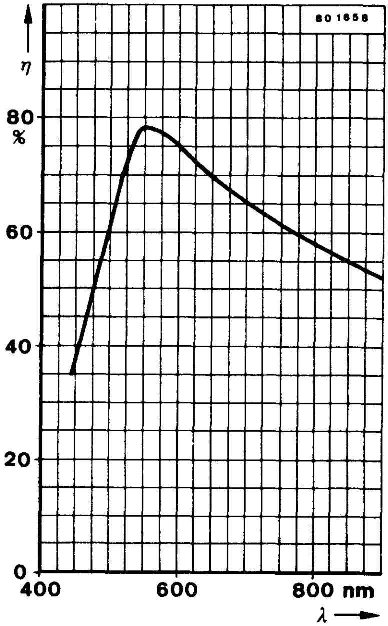
$T_{amb} = 25°C$		Min.	Typ.	Max.	
Range of spectral bandwidth (50%)	$\lambda_{0.5}$		450...950		nm
Reverse dark current M[1]) $= 100, E = 0$	I_{ro}		1	5	nA
Breakdown voltage $I_R = 10\ \mu A, E = 0$	$V_{(BR)}$	140	170	200	V
Temperature coefficient of $V_{(BR)}$	TK_{VBR}		0.20		%/°C
Efficiency $\lambda = 910$ nm	η	20			%
Gain bandwidth product	G_B[2])	200			GHz
Capacitance $V_R = 100$ V, $f = 1$ MHz	C_D		0.85	1.0	pF
Series resistance $f = 1$ MHz	r_s			50	Ω
Rise time $R_L = 50\ \Omega$	t_r		200		ps

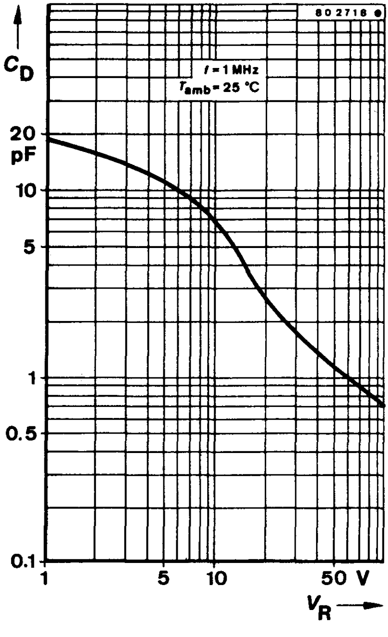
---

[1]) The voltage dependent photocurrent gain M is defined as the ratio of photocurrent I_{ph} at applied reverse voltage V_R to the photocurrent at a bias of 10 V.

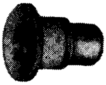
[2]) Gain bandwidth product is defined as the product of M times the frequency of measurement, when the diode is biased for maximum obtainable gain.


80 1657
M
100
10
1
0
40
80
120
160 V
V_R


80 1658
η
80
%
60
40
20
0
400
600
800 nm
λ


80 2718
C_D
f = 1 MHz
T_{amb} = 25 °C
20
pF
10
5
1
0.5
0.1
1
5
10
50 V
V_R

S 181 P



Silicon PIN Photodiode

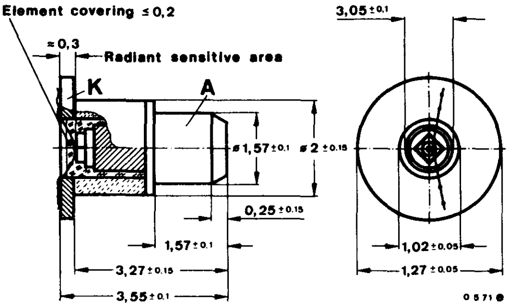
Application: Wide band detector for demodulation of fast signals, e.g. of lasers and GaAs-LED's. Detector for optical communication, e.g. for optical-fiber transmission systems.

Features:

- Low-noise photo-detector for demodulation of radiation
- Microwave case
- Rise time 200 ps
- Suitable for laser diode control

Preliminary specifications

Dimensions in mm



Diameter of the radiant sensitive area ∅ = 0.2 mm

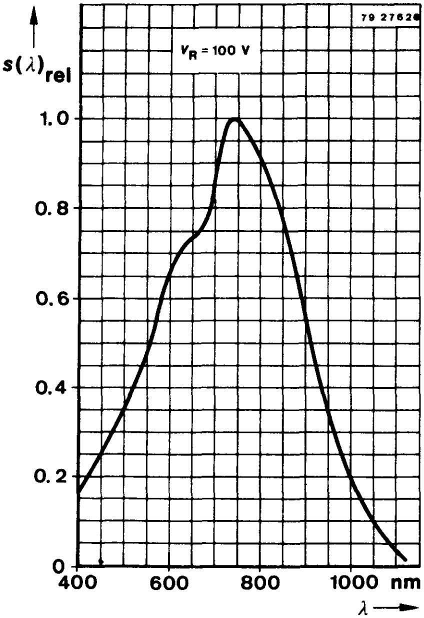
Angle of half intensity $\alpha = 90°$

Absolute maximum ratings

Reverse voltage	V_R	110	V
Power dissipation $T_{amb} = 25°C$	P_V	100	mW
Junction temperature	T_j	125	°C
Ambient temperature range	T_{amb}	−65...+100	°C

S 181 P

Optical and electrical characteristics $T_{amb} = 25\,°C$		**Min.**	**Typ.**	**Max.**	
Breakdown voltage $I_R = 10\,\mu A$, $E = 0$	$V_{(BR)}$	110			V
Reverse dark current $E = 0$, $V_R = 100\,V$	I_{ro}		1	5	nA
Sensitivity $\lambda = 800\,nm$	$s(\lambda)$		0.36		mA/mW
Peak wavenlength sensitivity	λ_p		730		nm
Range of spectral bandwidth (50%)	$\lambda_{0.5}$		550...910		nm
Capacitance $V_R = 100\,V$, $f = 1\,MHz$	C_j		0.85	1.0	pF
Rise time $R_L = 50\,\Omega$	t_r		200		ps



S 191 P

Silicon Photo PIN Diode

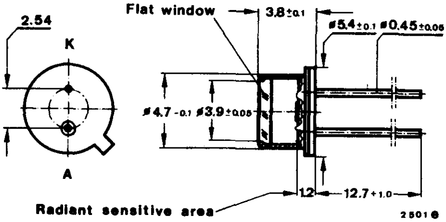
Application: High-speed photo-detector

Features:

- Fast response times at low operating voltages
- High photo sensitivity
- For photodiode and photovoltaic cell operation
- Hermetically sealed package with flat window
- Suitable for visible and near infrared radiation

Preliminary specifications

Abmessungen in mm



Radiant sensitive area $A = 0.64\ \text{mm}^2$
Angle of half sensitivity $\alpha = 70°$
Negative terminal/cathode connected with case

≈ 18 A 2 DIN 41876
≈ JEDEC TO 18
Weight max. 0.5 g

Absolute maximum ratings

Reverse voltage	V_R	50	V
Power dissipation $T_{amb} \leq 25\,°C$	P_V	180	mW
Junction temperature	T_j	100	°C
Ambient temperature range	T_{amb}	−25...+100	°C

Thermal resistance

		Min.	Typ.	Max.	
Junction ambient	R_{thJA}			400	K/W

S 1.2.008/0281 E

S 191 P

Optical and electrical characteristics
$T_{amb} = 25°C$

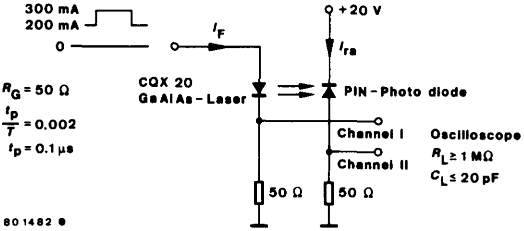
		Min.	Typ.	Max.	
Photovoltaic cell operation ($V_R = 0$)					
Open circuit voltage $E_A = 1$ klx¹)	V_o*)		380		mV
Temperature coefficient of V_o $E_A = 1$ klx¹)	TK_{Vo}		−2		mV/K
Short circuit current $E_A = 1$ klx¹), $R_L = 100\,\Omega$	I_k*)	45	70		μA
Sensitivity, short circuit	s_k	45	70		nA/lx
Temperature coefficient of I_k $E_A = 1$ klx¹), $R_L = 100\,\Omega$	TK_{Ik}		0.1		%/K
Junction capacitance $V_R = 0$, $f = 1$ MHz, $E = 0$	C_j		10		pF
Photodiode operation					
Breakdown voltage $I_{ro} = 100\,\mu A$, $E = 0$	$V_{(BR)}$*)	50	80		V
Reverse continuous dark current $V_R = 20$ V, $E = 0$	I_{ro}*)		1	5	nA
Light reverse current $V_R = 5$ V, $E_e = 1$ mW/cm² $R_L = 100\,\Omega$	I_{ra}*)	3	6		μA
Spectral sensitivity $V_R = 20$ V, $\lambda = 900$ nm	$s(\lambda)$		0.5		A/W
Junction capacitance $f = 1$ MHz, $V_R = 5$ V	C_j		6		pF
$V_R = 20$ V	C_j		4		pF
Switching characteristics $V_R = 20$ V, $R_L = 50\,\Omega$, see test circuit					
Rise time	t_r		7		ns
Fall time	t_f		7		ns

---

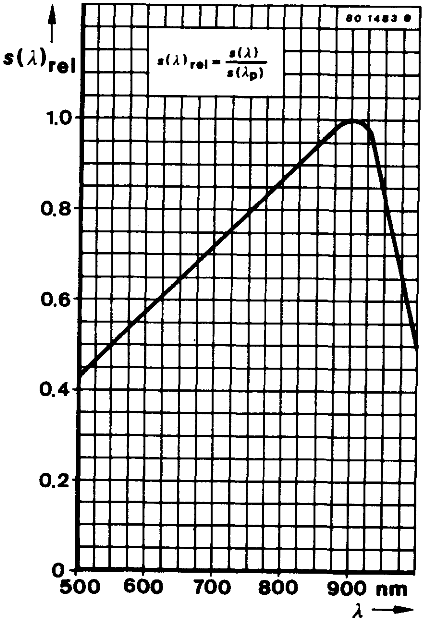
*) AQL = 0.65%

[1] Standard illuminant A (DIN 5033/IEC 306-1)

Photovoltaic cell and photodiode operation		Min.	Typ.	Max.	
Peak wavelength sensitivity	λ_p		900		nm
Range of spectral bandwidth (50%)	$\lambda_{0.5}$		550...1000		nm



Test circuit



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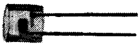
*) AQL = 0.65%

[1] Standard illuminant A (DIN 5033/IEC 306-1)

IR-Emitters

CQX 18

GaAs Infrared Diode in Plastic Case



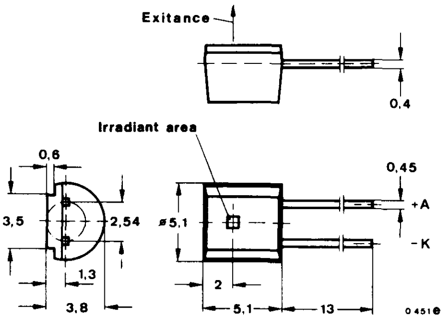
Application: Radiation source in near infrared range

Features:

- Flat window
- Wide radiation angle $\alpha = 150°$
- Radiation direction vertical to mounting direction
- Compatible with BPW 39
- Selected in groups

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 150°$

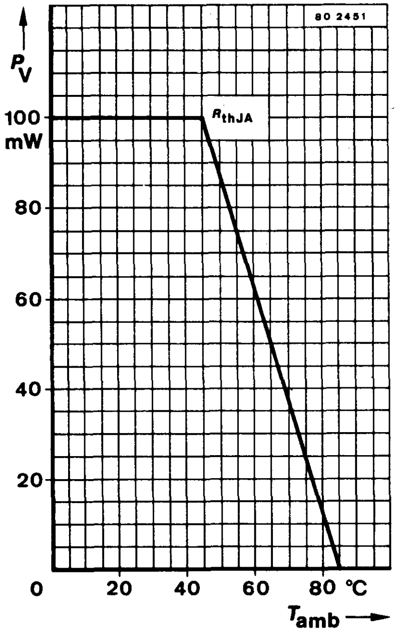
Plastic case
≈ 10 B 3 DIN 41 868
≈ JEDEC TO 92
Weight max. 0.4 g

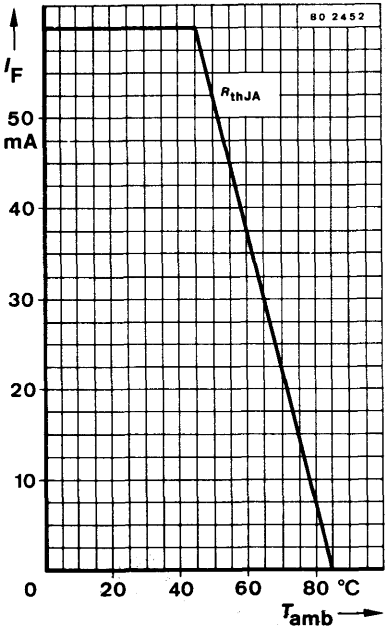
Absolute maximum ratings

Reverse voltage	V_R	5	V
Forward current	I_F	60	mA
Forward surge current $t_p \leq 10\,\mu s$	I_{FM}	1	A
Power dissipation $T_{amb} \leq 45°C$	P_V	100	mW
Junction temperature	T_j	85	°C
Storage temperature range	T_{stg}	−25...+85	°C
Soldering temperature, maximal $t \leq 3$ s	T_{sd}¹)	245	°C

---

¹) Distance from the touching border ≥ 2 mm





Thermal resistance		**Min.**	**Typ.**	**Max.**	
Junction ambient	R_{thJA}			400	K/W

---

*) AQL = 0.65 %

Optical and electrical characteristics

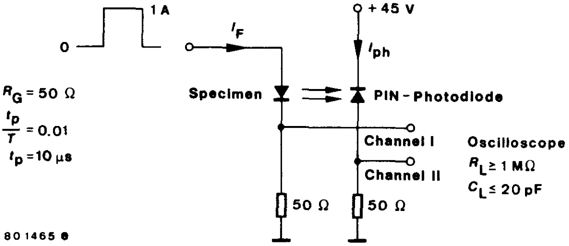
$T_{amb} = 25\,°C$

			Min.	Typ.	Max.	
Radiant power $I_F = 20$ mA		Φ_e		1		mW
Temperature coefficient of Φ_e $I_F = 20$ mA		$TK_{\Phi E}$		−1.0		%/K
Radiant intensity $I_F = 20$ mA	**Group A**	I_e*)	0.15		0.3	mW/sr
	Group B	I_e*)	0.25			mW/sr
Peak wavelength emission $I_F = 50$ mA		λ_p		950		nm
Spectral half bandwidth $I_F = 50$ mA		$\Delta\lambda$		50		nm
Forward voltage $I_F = 20$ mA		V_F*)		1.2	1.5	V
Breakdown voltage $I_R = 100\,\mu$A		$V_{(BR)}$	5			V
Junction capacitance $V_R = 0$, $f = 1$ MHz		C_j		50		pF

Switching characteristics

$I_{FM} = 1$ A, $\frac{t_p}{T} = 0.01$, $t_p = 10\,\mu$s, see test circuit

Rise time	t_r		400	ns
Fall time	t_f		450	ns



Test circuit

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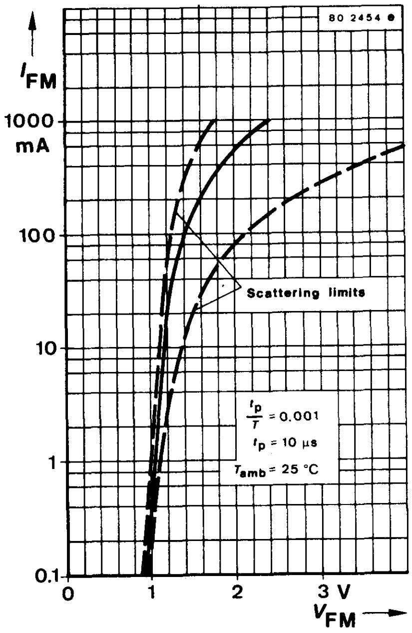
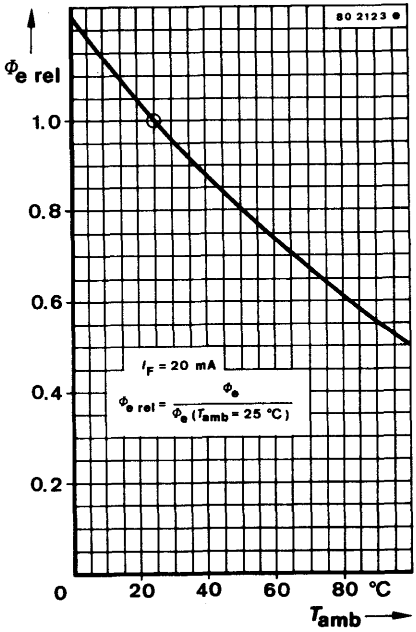
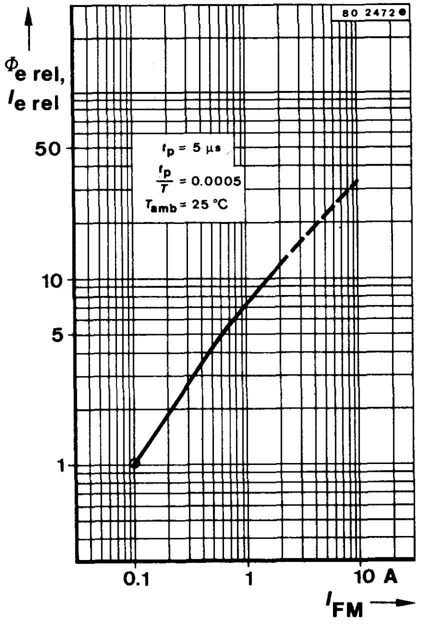
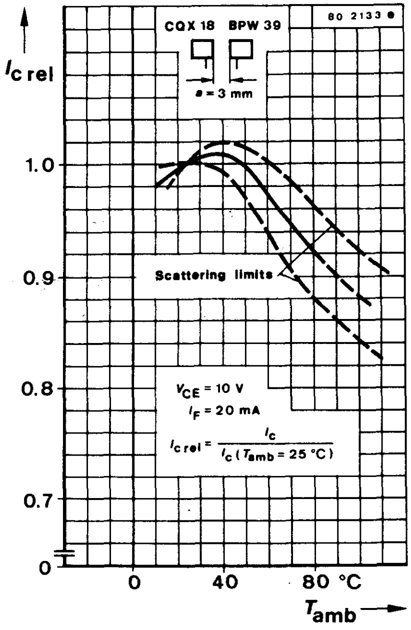
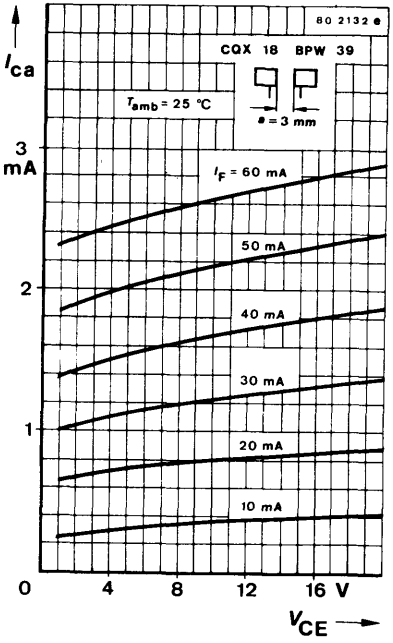
*) AQL = 0.65 %

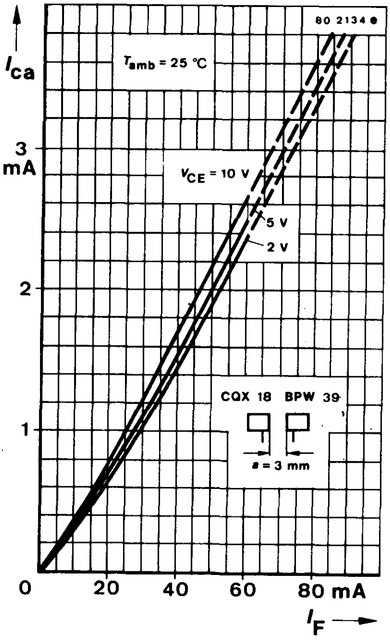

80 2454
I_{FM}
1000 mA
100
10
1
0.1
0
1
2
3 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$

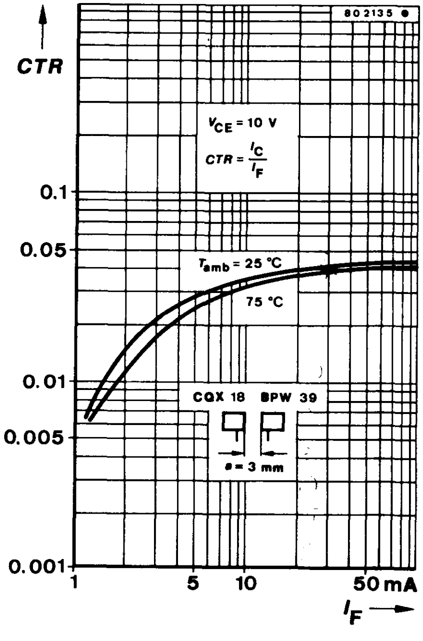

80 2123
$\Phi_{e\ rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_F = 20\ mA$
$\Phi_{e\ rel} = \frac{\Phi_e}{\Phi_e\ (T_{amb} = 25\ °C)}$

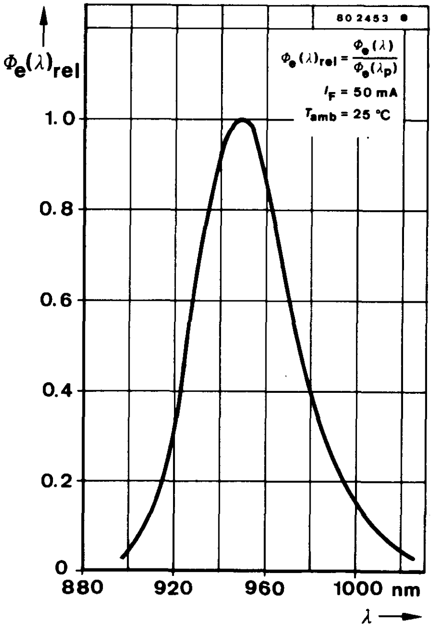

80 2472
$\Phi_{e\ rel}$,
$I_{e\ rel}$
50
10
5
1
0.1
1
10 A
I_{FM}
$t_p = 5\ \mu s$
$\frac{t_p}{T} = 0.0005$
$T_{amb} = 25\ °C$

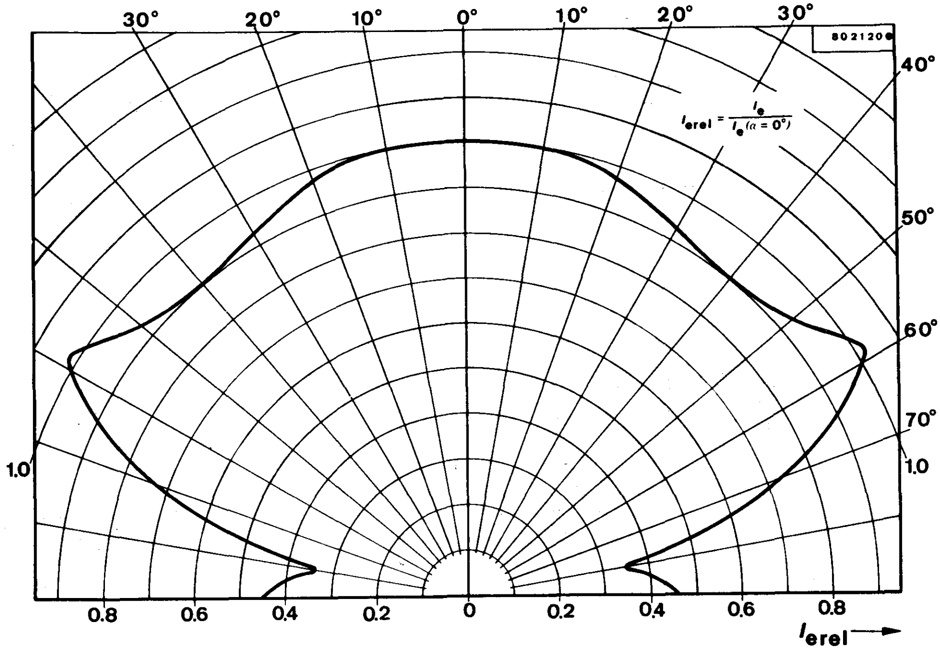

80 2133
CQX 18
BPW 39
a = 3 mm
$I_{c\ rel}$
1.0
0.9
0.8
0.7
0
0
40
80 °C
T_{amb}
Scattering limits
$V_{CE} = 10\ V$
$I_F = 20\ mA$
$I_{c\ rel} = \frac{I_c}{I_c\ (T_{amb} = 25\ °C)}$


80 2132
CQX 18
BPW 39
a = 3 mm
T_{amb} = 25 °C
I_{ca}
3 mA
2
1
0
I_F = 60 mA
50 mA
40 mA
30 mA
20 mA
10 mA
4
8
12
16 V
V_{CE}


80 2134
T_{amb} = 25 °C
I_{ca}
3 mA
2
1
0
V_{CE} = 10 V
5 V
2 V
CQX 18
BPW 39
a = 3 mm
20
40
60
80 mA
I_F


80 2135
CTR
V_{CE} = 10 V
$CTR = \frac{I_C}{I_F}$
0.1
0.05
0.01
0.005
0.001
T_{amb} = 25 °C
75 °C
CQX 18
BPW 39
a = 3 mm
1
5
10
50 mA
I_F


80 2453
$\Phi_e(\lambda)_{rel}$
$\Phi_e(\lambda)_{rel} = \frac{\Phi_e(\lambda)}{\Phi_e(\lambda_p)}$
I_F = 50 mA
T_{amb} = 25 °C
1.0
0.8
0.6
0.4
0.2
0
880
920
960
1000 nm
λ


30°
20°
10°
0°
10°
20°
30°
40°
50°
60°
70°
1.0
1.0
0.8
0.6
0.4
0.2
0
0.2
0.4
0.6
0.8
I_{erel}
$I_{erel} = \frac{I_e}{I_e(\alpha = 0°)}$
8021200

CQX 19

GaAs Infrared Diode

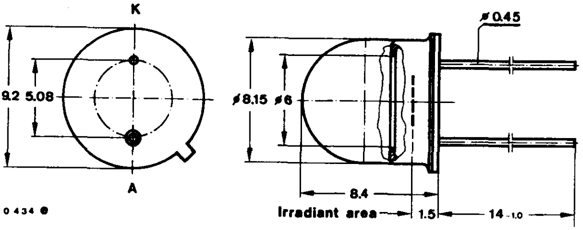
Application: Radiation source in near infrared range, i. e. remote control, light barrier and telecommunication

Features:

- Metal base with plastic lens white clear
- Extremely high radiation power
- Suitable for pulse operation till 10 A
- High loading capability in pulse operation

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 40°$

Cathode connected with case

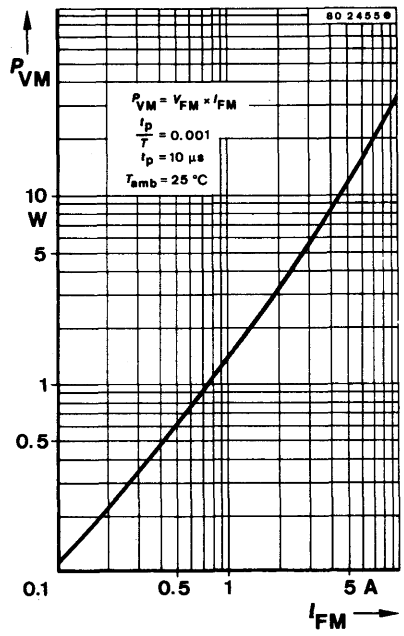
≈ 5 C 2 DIN 41 873
15 ≈ JEDEC TO 39
Weight max. 1.0 g

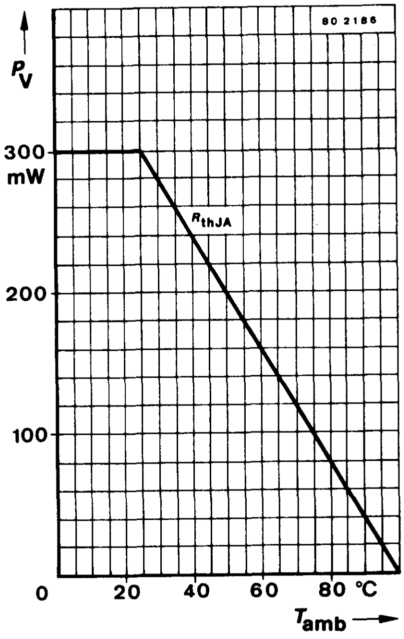
Absolute maximum ratings

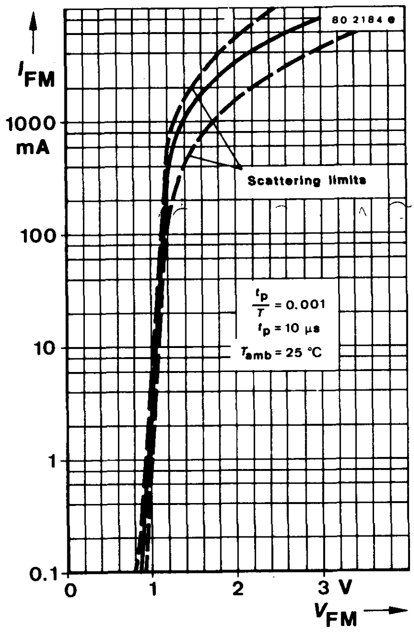
Reverse voltage	V_R	5	V
Forward current $T_{amb} \leq 25°C$	I_F	250	mA
Forward peak current $\frac{t_p}{T} = 0.001$, $t_p \leq 20\,\mu s$	I_{FM}	10	A
Power dissipation $T_{amb} \leq 25°C$	P_V	300	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−25 ... + 85	°C

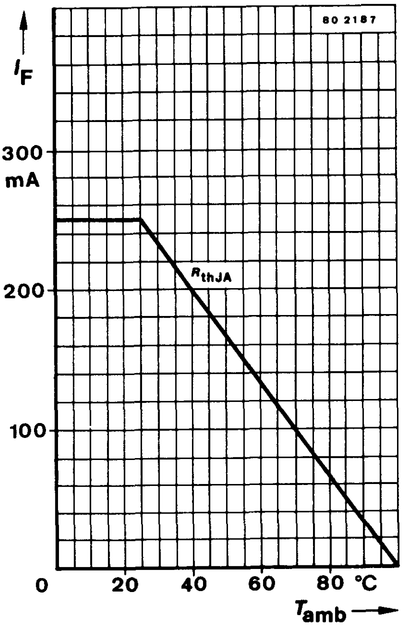
S 1.2. 145/0781 E

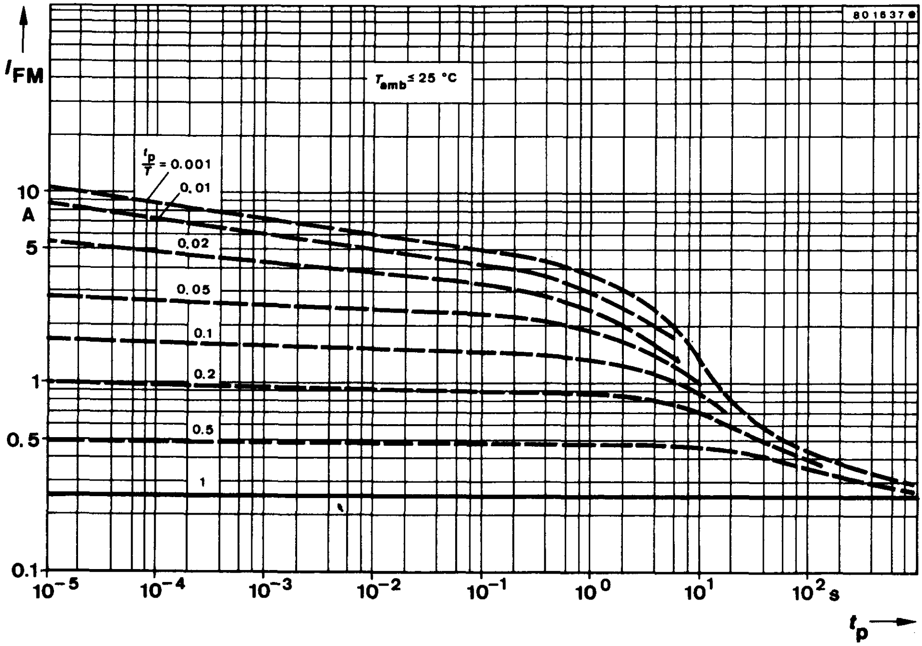
CQX 19


80 2455
P_{VM}
$P_{VM} = V_{FM} \times I_{FM}$
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$
10
W
5
1
0.5
0.1
0.5
1
5 A
I_{FM}


80 2186
P_V
300
mW
200
100
0
20
40
60
80 °C
R_{thJA}
T_{amb}


80 2184
I_{FM}
1000
mA
100
10
1
0.1
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$
0
1
2
3 V
V_{FM}


80 2187
I_F
300
mA
200
100
0
20
40
60
80 °C
R_{thJA}
T_{amb}



Thermal resistances		**Min.**	**Typ.**	**Max.**	
Junction ambient	R_{thJA}			250	K/W
Junction case	R_{thJC}			25	K/W

Optical and electrical characteristics
$T_{amb} = 25\,°C$

		Min.	Typ.	Max.	
Radiant power $I_F = 250$ mA	Φ_e		20		mW
Radiant power at pulse operation $I_{FM} = 10$ A	Φ_{em} 1)		0.5		W
Temperature coefficient of Φ_e	$TK_{\Phi e}$		−1		%/K
Radiant intensity $I_F = 250$ mA	I_e		40		mW/sr
Radiant intensity at pulse operation $I_{FM} = 10$ A	I_{em}*) 1)	0.65	1		W/sr
Peak wavelength emission $I_F = 100$ mA	λ_p		950		nm
Spectral half bandwidth $I_F = 100$ mA	$\Delta\lambda$		50		nm

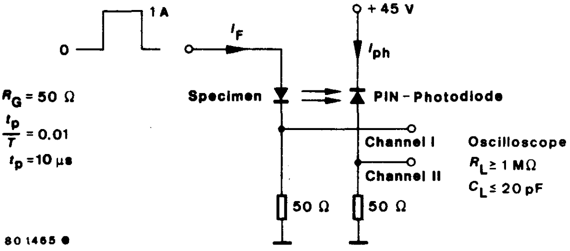
CQX 19

		Min.	Typ.	Max.	
Forward voltage $I_F = 250$ mA	V_F		1.2		V
Forward voltage at pulse operation $I_{FM} = 10$ A	V_{FM}[1])		3.3	4.2	V
Breakdown voltage $I_R = 100\ \mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz	C_j		600		pF

Switching characteristics

$I_{FM} = 1$ A, $\frac{t_p}{T} = 0.01$, $t_p \leq 100\ \mu s$, see test circuit

Rise time	t_r		700	ns
Fall time	t_f		830	ns



Test circuit

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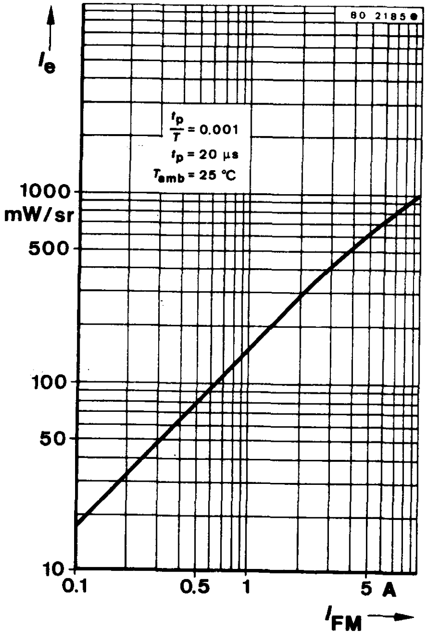
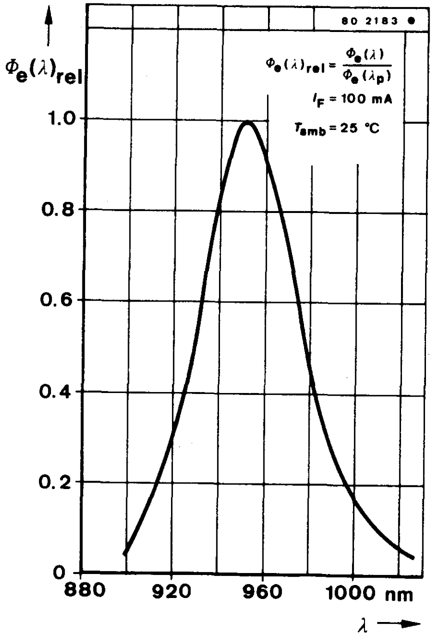
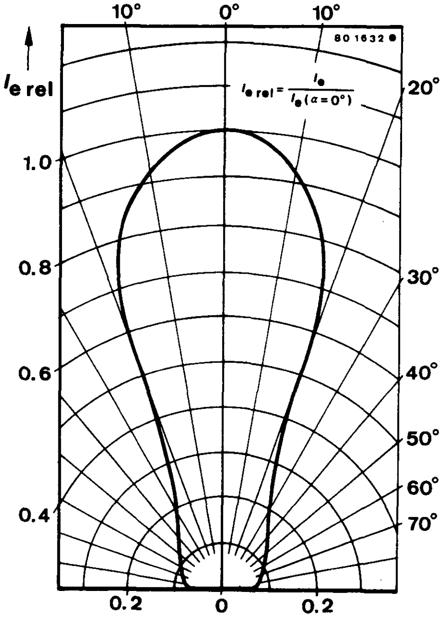
*) AQL = 0.65 %

[1]) $t_p = 20\ \mu s$, $\frac{t_p}{T} = 0.0003$

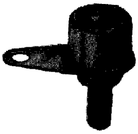

80 2185
I_e
$\frac{t_p}{T} = 0.001$
$t_p = 20\ \mu s$
$T_{amb} = 25\ °C$
1000 mW/sr
500
100
50
10
0.1
0.5
1
5 A
I_{FM}


80 2183
$\Phi_e(\lambda)_{rel}$
$\Phi_e(\lambda)_{rel} = \frac{\Phi_e(\lambda)}{\Phi_e(\lambda_p)}$
$I_F = 100$ mA
$T_{amb} = 25\ °C$
1.0
0.8
0.6
0.4
0.2
0
880
920
960
1000 nm
λ


10°
0°
10°
80 1632
$I_{e\,rel}$
$I_{e\,rel} = \frac{I_e}{I_e(\alpha = 0°)}$
20°
1.0
0.8
30°
0.6
40°
50°
60°
0.4
70°
0.2
0
0.2

CQX 20

GaAlAs CW Laserdiode



Application: Monochromatic radiation source in near infrared range, opto-telecommunication, telemeter.

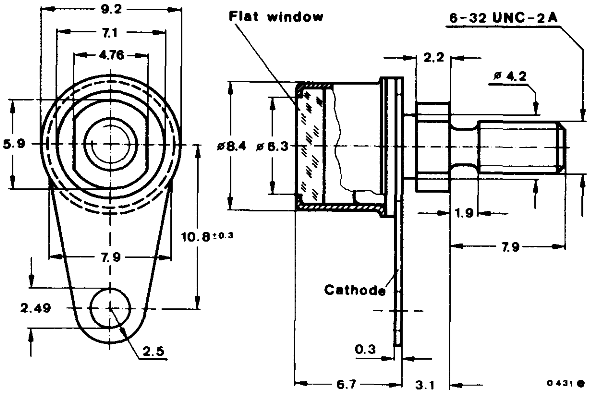
Not for new developments.

Features:

- Radiant power $\Phi_e = 10$ mW
- Small radiation angle
- Good spectral matching with silicon photo-PIN- and avalanche photo diode detectors
- Small spectral half – width
- Diamond heat sink
- Each laser is tested for 300 h at $\Phi_e = 5$ mW

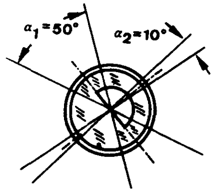
Preliminary specifications

Dimensions in mm



Anode connected with stud

Emitting surface
$A = 20 \times 0.3\ \mu m^2$



Top view:
The drawn angles α_1 and α_2 are the projections of the angles of half intensity into the plane of the emitting area.

Absolute maximum ratings

Total power dissipation	P_{tot} [1]) see diagram		
Case temperature	T_{case}	15...40	°C
Junction temperature	T_j	70	°C
Storage temperature range	T_{stg}	0...70	°C
Soldering temperature, maximal $t \leqslant 5$ s, $t_{heat\ sink} = 20$ °C	T_{sd}	245	°C

---

[1]) See diagram, which is supplied with each laser as test certificate.
The radiant power should not exceed $\Phi_e = 10$ mW. Absolute maximum ratings of forward current I_F and power dissipation P_{tot} are given by this value.
Current surges lead to high radiant power peaks resulting in mirror damage and premature failure. Such current surges can be generated by switching on or off the power supply or by line disturbances. A suitable power supply should be selected with these limits in mind.

Optical and electrical characteristics		Min.	Typ.	Max.	
$T_{amb} = 25\,°C$					
Radiant power $I_F \leqslant 400$ mA	Φ_e	5			mW
Radiance $\Phi_e = 5$ mW	L_e	200			$\frac{kW}{cm^2 \cdot sr}$
Threshold current	$I_{(TO)}$		200	300	mA
Forward voltage					
$I_F = 200$ mA	V_F	1.8	2.0	2.3	V
$I_F = 250$ mA	V_F	1.9	2.1	2.4	V
Peak wavelength emission	λ_p	790	820	840	nm
Spectral half bandwidth	$\Delta\lambda$		2.5		nm

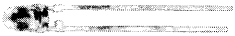
Switching characteristics					
$I_F \geqslant I_{(TO)}$, $\Phi_e \geqslant 2$ mW					
Rise time	t_r		1		ns

Operating precautions

1. Current surges (only for a few nanoseconds) can drastically decrease the lifetime of the laser.
2. Laser goggles are recommended.

CQX 46

GaAs Infrared Diode in 3 mm Plastic Case



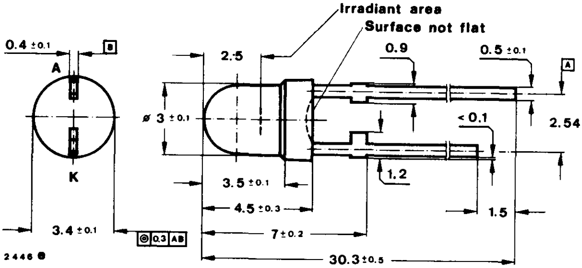
Application: Radiation source in near infrared range

Features:

- High radiant intensity
- High radiant power
- Suitable for pulse operation
- Good spectral matching for silicon photo detectors

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 50°$

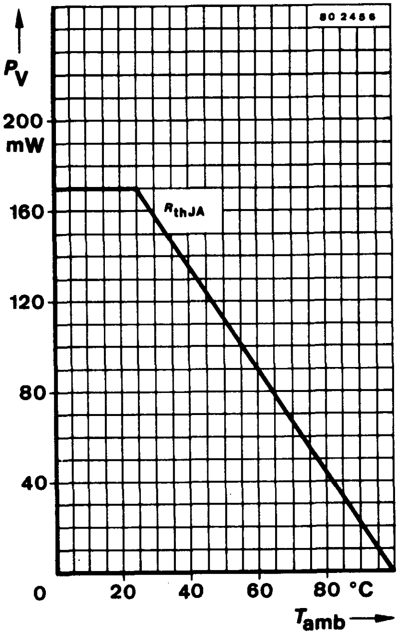
Plastic case
Weight max. 0.4 g

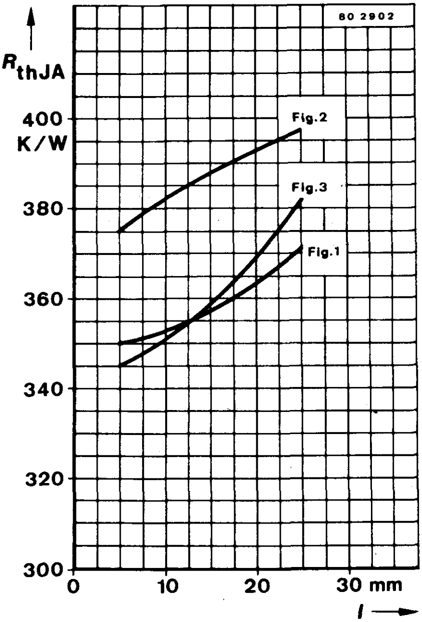
Absolute maximum ratings

Reverse voltage	V_R	5	V
Forward current	I_F	100	mA
Forward peak current $\frac{t_p}{T} = 0.5$, $t_p \leq 10$ ms	I_{FM}	200	mA
Forward surge current $t_p \leq 10\,\mu$s	I_{FSM}	2.5	A
Power dissipation $T_{amb} \leq 25\,°C$	P_v	170	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−25 ... +100	°C
Soldering temperature, maximal $t \leq 3$ s, $l \geq 2$ mm	T_{sd}[1])	245	°C

---

[1]) Distance from the touching border ≥ 2 mm





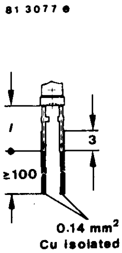


Fig.1

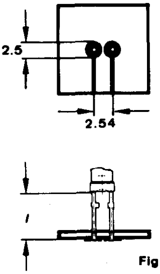


Fig.2

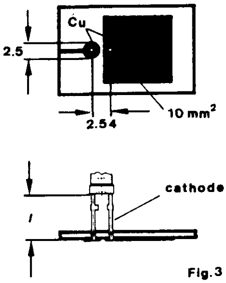


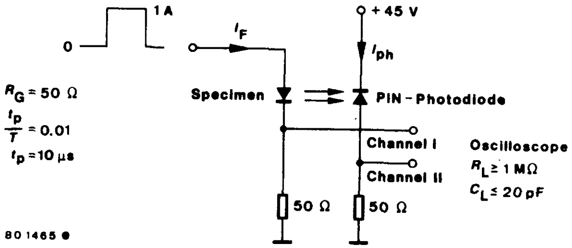
Fig.3

		Min.	Typ.	Max.	
Thermal resistance					
Junction ambient	R_{thJA}			450	K/W
Optical and electrical characteristics T_{amb} = 25°					
Radiant power I_F = 100 mA	Φ_e		10		mW
Temperature coefficient of Φ_e I_F = 100 mA	$TK_{\Phi e}$		−0.8		%/K
Radiant intensity I_F = 100 mA	I_e*)	5	10		mW/sr
Peak wavelength emission I_F = 100 mA	λ_p		950		nm
Spectral half bandwidth I_F = 100 mA	$\Delta\lambda$		50		nm
Forward voltage I_F = 100 mA	V_F*)		1.4	1.7	V
Breakdown voltage I_R = 100 μA	$V_{(BR)}$*)	5			V
Junction capacitance V_R = 0, f = 1 MHz	C_j		50		pF

Switching characteristics

I_{FM} = 1 A, $\frac{t_p}{T}$ = 0.01, $t_p \le 10\ \mu$s, see test circuit

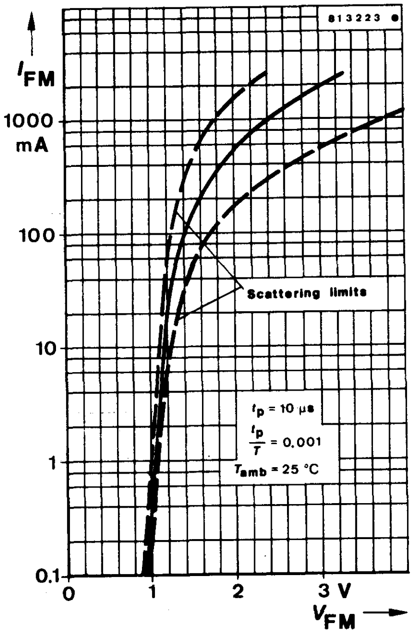
Rise time	t_r		400		ns
Fall time	t_f		450		ns

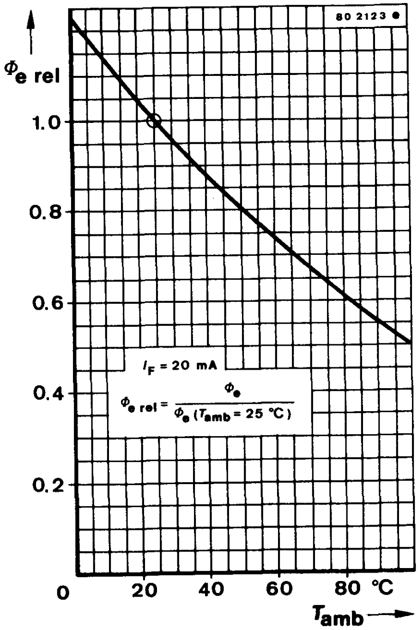


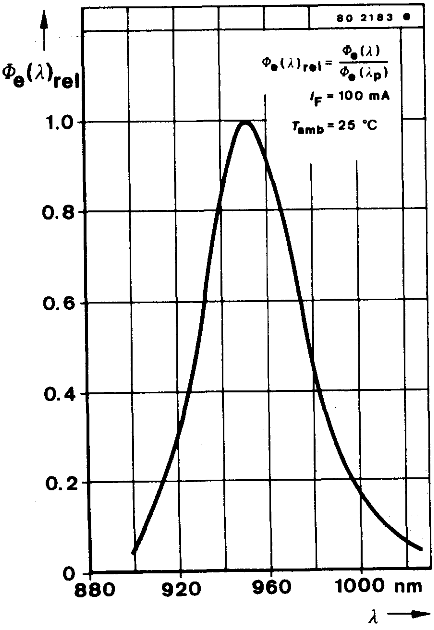
Test circuit

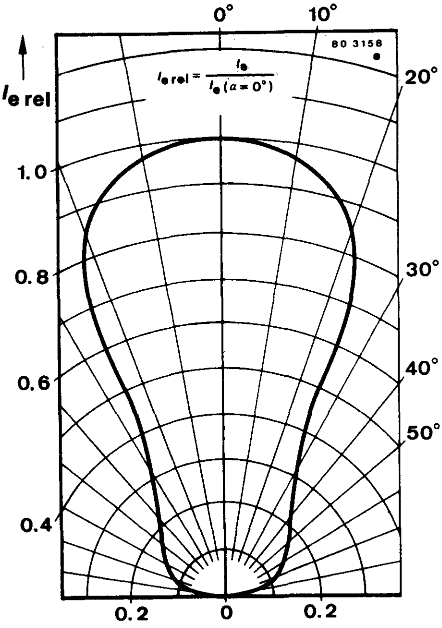
---

*) AQL = 0.65 %


8 1 3 2 2 3
I_{FM}
1000 mA
100
10
1
0.1
0
1
2
3 V
V_{FM}
Scattering limits
t_p = 10 µs
$\frac{t_p}{T}$ = 0.001
T_{amb} = 25 °C

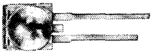

80 2123
$\Phi_{e\ rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
I_F = 20 mA
$\Phi_{e\ rel} = \frac{\Phi_e}{\Phi_e (T_{amb} = 25\ °C)}$


80 2183
$\Phi_e(\lambda)_{rel}$
$\Phi_e(\lambda)_{rel} = \frac{\Phi_e(\lambda)}{\Phi_e(\lambda_p)}$
I_F = 100 mA
T_{amb} = 25 °C
1.0
0.8
0.6
0.4
0.2
0
880
920
960
1000 nm
λ


0°
10°
20°
30°
40°
50°
80 3158
$I_{e\ rel}$
$I_{e\ rel} = \frac{I_e}{I_e(\alpha = 0°)}$
1.0
0.8
0.6
0.4
0.2
0
0.2

CQX 47

GaAs Infrared Diode in Plastic Case



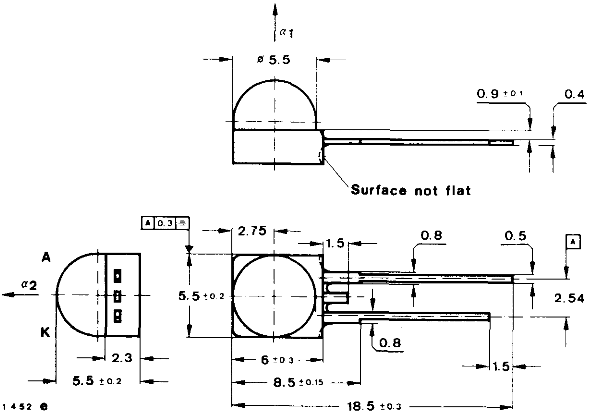
Application: Radiation source in near infrared range, especially for remote control

Features:

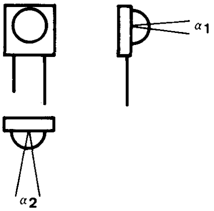
- High radiant intensity
- High radiant power
- Suitable for pulse operation
- Good spectral matching for silicon photo detectors
- Radiation direction vertical to mounting direction
- Serial connection of two pellets

Preliminary specifications

Dimension in mm



Plastic case
Weight max. 0.5 g



Angle of half intensity
$\alpha_1 = 35°$
$\alpha_2 = 55°$

CQX 47

Absolute maximum ratings

Reverse voltage	V_R	10	V
Forward current	I_F	100	mA
Forward peak current $\frac{t_p}{T} = 0.5$, $t_p \leq 10$ ms	I_{FM}	200	mA
Forward surge current $t_p \leq 10\ \mu s$	I_{FSM}	2.5	A
Power dissipation $T_{amb} \leq 25°C$	P_V	280	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−25 ... +100	°C
Soldering temperature, maximal $t \leq 3$ s	T_{sd}[1]	245	°C

Thermal resistance

		Min.	Typ.	Max.	
Junction ambient	R_{thJA}			270	K/W

Optical and electrical characteristics

$T_{amb} = 25°C$

Radiant power $I_F = 100$ mA	Φ_e		25		mW
Temperature coefficient of Φ_e $I_F = 100$ mA	$TK_{\Phi e}$		−0.8		%/K
Radiant intensity $I_F = 100$ mA	I_e		33		mW/sr
$I_F = 1.5$ A	I_e[2] *)	200	300		mW/sr
Peak wavelength emission $I_F = 100$ mA	λ_p		950		nm
Spectral half bandwidth $I_F = 100$ mA	$\Delta\lambda$		50		nm
Forward voltage $I_F = 100$ mA	V_F		2.8		V
$I_F = 1.5$ A	V_F[2] *)		5.0	6.0	V
Breakdown voltage $I_R = 100\ \mu A$	$V_{(BR)}$ *)	10			V
Junction capacitance $V_R = 0$, $f = 1$ MHz	C_j		25		pF

---

*) AQL = 0.65 %

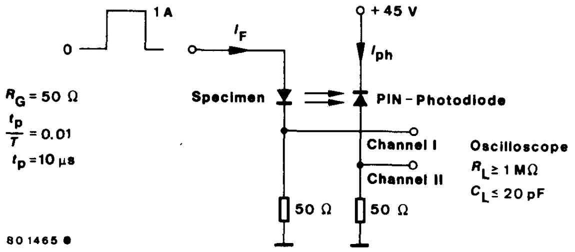
[1] Distance from the touching border ≥ 1.5 mm with intermediate PC-board

[2] $\frac{t_p}{T} = 0.001$, $t_p = 0.1$ ms

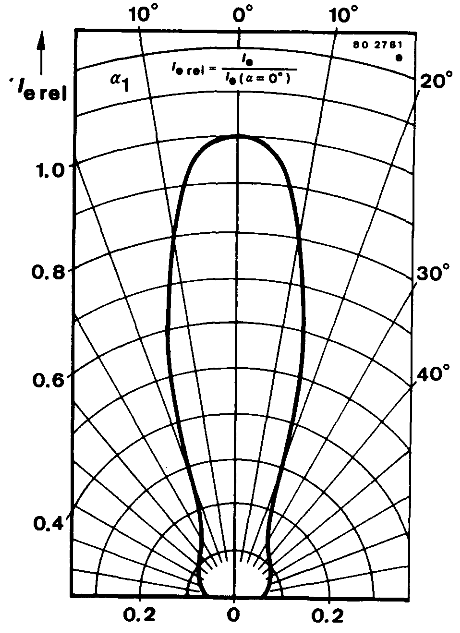
Switching characteristics

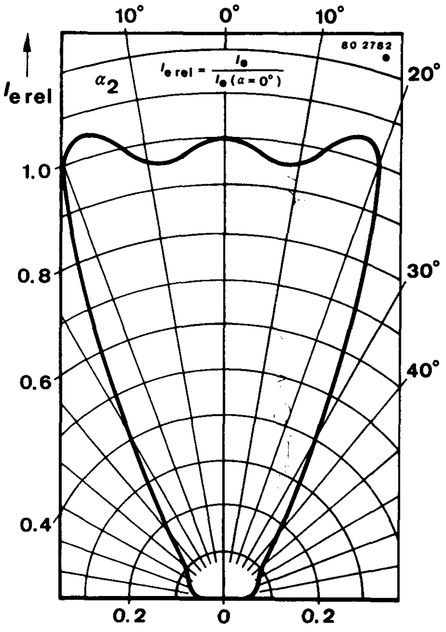
$I_{FM} = 1$ A, $\frac{t_p}{T} = 0.01$, $t_p \leq 10\,\mu$s, see test circuit

Rise time	t_r	400	ns
Fall time	t_f	450	ns



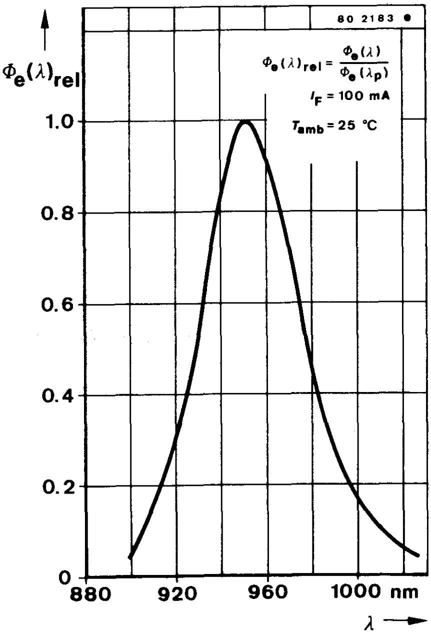
Test circuit





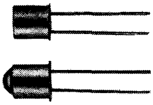
---

*) AQL = 0.65 %


80 2183 ●
$\Phi_e(\lambda)_{rel} = \frac{\Phi_e(\lambda)}{\Phi_e(\lambda_p)}$
I_F = 100 mA
T_{amb} = 25 °C
$\Phi_e(\lambda)_{rel}$
1.0
0.8
0.6
0.4
0.2
0
880
920
960
1000 nm
λ

CQY 31 · CQY 32

GaAs Infrared Diodes in Hermetically Sealed Cases



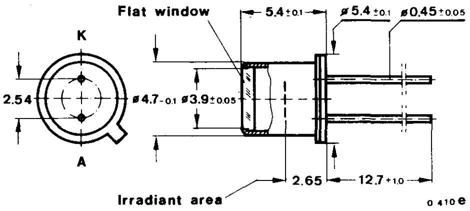
Application: Radiation source in near infrared range

Features:

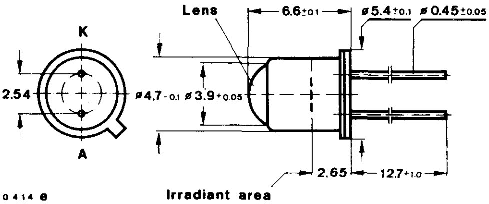
- Flat window – CQY 31, with lens – CQY 32
- High modulation frequencies
- High switching speed
- Suitable for pluse operation
- Good spectral matching for silicon photo detectors
- CQY 32 – *Suitable to couple with for glass fiber*

Preliminary specifications

Dimensions in mm



CQY 31



CQY 32

Angle of half intensity **CQY 31** $\alpha = 80°$
CQY 32 $\alpha = 10°$

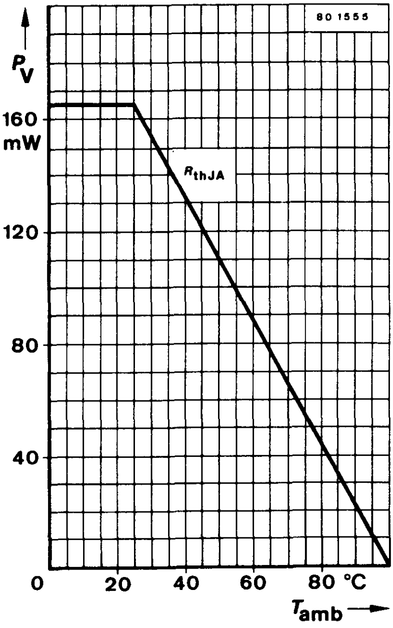
Cathode connected with case

≈ 18 A 2 DIN 41867
≈ JEDEC TO 18
Weight max. 0.5 g

CQY 31 · CQY 32

Absolute maximum ratings

Reverse voltage	V_R	5	V
Forward current	I_F	100	mA
Forward peak current $\frac{t_p}{T} = 0.5$, $t_p \leq 10$ ms	I_{FM}	200	mA
Forward surge current $t_p \leq 10\ \mu s$	I_{FSM}	2.5	A
Power dissipation $T_{amb} \leq 25\,°C$	P_V	165	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−25 ... +100	°C



Thermal resistances		Min.	Typ.	Max.	
Junction ambient	R_{thJA}			450	K/W
Junction case	R_{thJC}			150	K/W

Optical and electrical characteristics

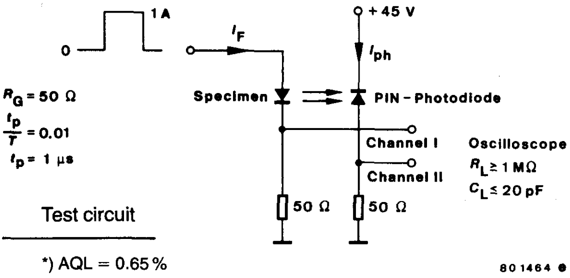
$T_{amb} = 25\,°C$

			Min.	Typ.	Max.	
Radiant power $I_F = 100$ mA		Φ_e		1.5		mW
Temperature coefficient of Φ_e $I_F = 100$ mA		$TK\Phi_e$		−1.0		%/K
Radiant intensity $I_F = 100$ mA	**CQY 31**	I_e*)	0.5	1.0		mW/sr
	CQY 32	I_e*)	3	10		mW/sr
Peak wavelength emission $I_F = 50$ mA		λ_p		900		nm
Spectral half bandwidth $I_F = 50$ mA		$\Delta\lambda$		35		nm
Forward voltage $I_F = 100$ mA		V_F*)		1.25	1.5	V
Differential forward resistance $I_F = 100$ mA		r_f		2		Ω
Breakdown voltage $I_R = 100\,\mu$A		$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz		C_j		130		pF

Switching characteristics

$I_{FM} = 1$ A, $\frac{t_p}{T} = 0.01$, $t_p \leqq 1\,\mu$s, see test circuit

		Min.	Typ.	Max.	
Rise time	t_r		150		ns
Fall time	t_f		120		ns



Test circuit

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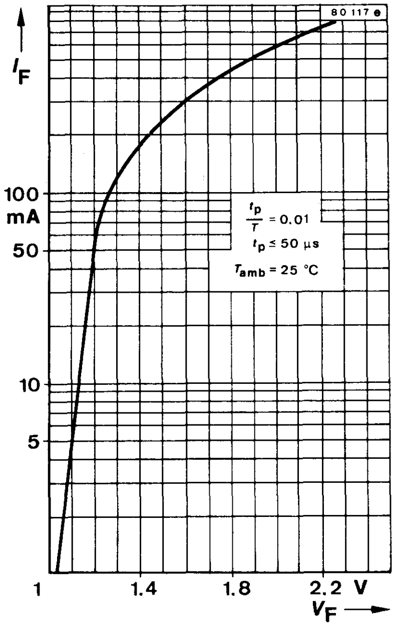
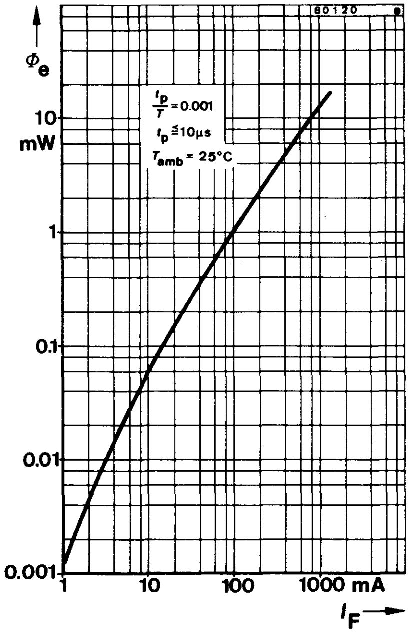
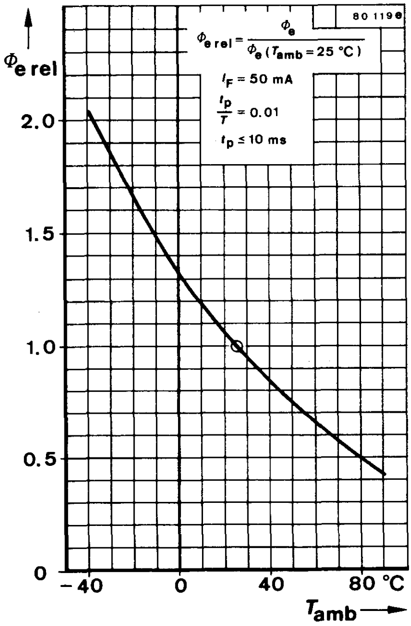
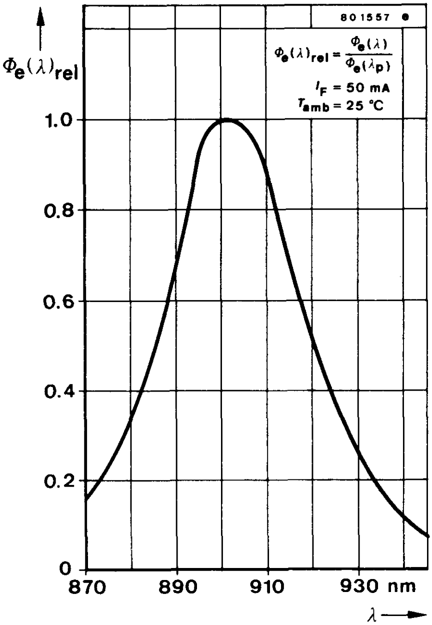
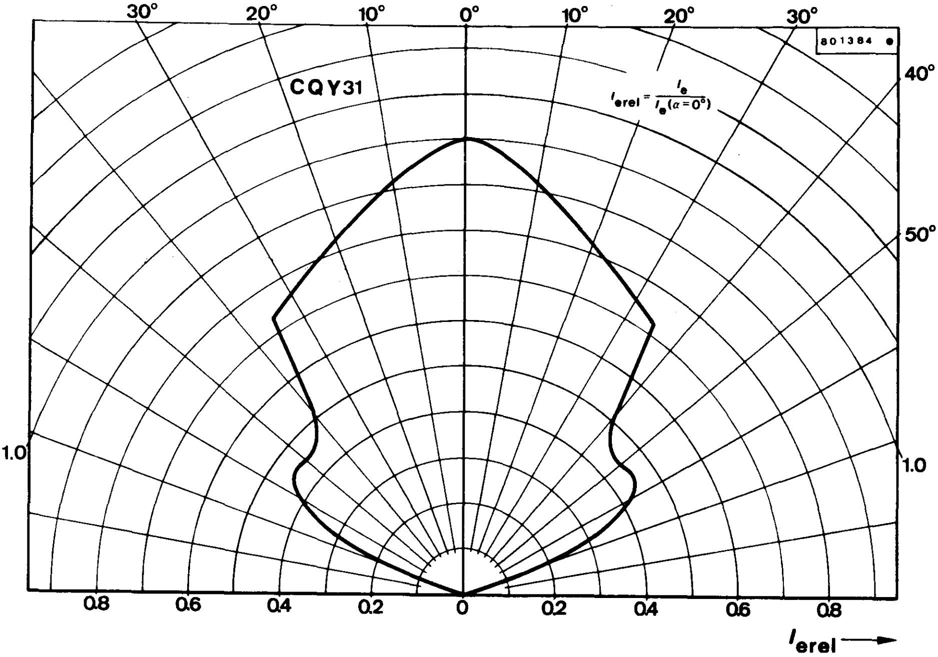
*) AQL = 0.65 %

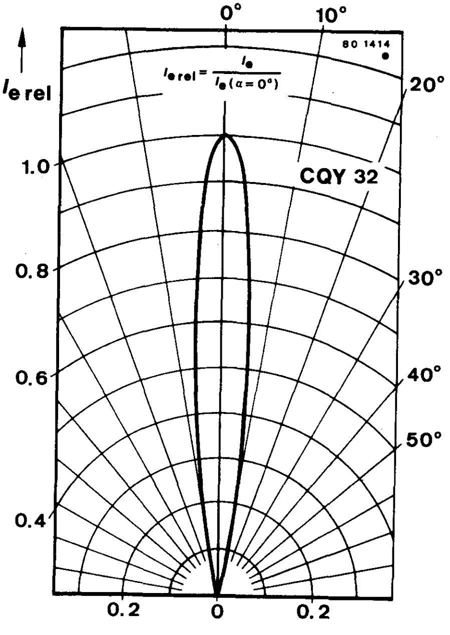

80 117 e
I_F
100 mA
50
10
5
1
1.4
1.8
2.2 V
V_F
$\frac{t_p}{T} = 0.01$
$t_p \leq 50\ \mu s$
$T_{amb} = 25\ °C$


80 120 e
Φ_e
10 mW
1
0.1
0.01
0.001
1
10
100
1000 mA
I_F
$\frac{t_p}{T} = 0.001$
$t_p \leq 10\ \mu s$
$T_{amb} = 25\ °C$


80 119 e
$\Phi_{e\,rel}$
2.0
1.5
1.0
0.5
0
−40
0
40
80 °C
T_{amb}
$\Phi_{e\,rel} = \frac{\Phi_e}{\Phi_e\,(T_{amb} = 25\ °C)}$
$I_F = 50\ mA$
$\frac{t_p}{T} = 0.01$
$t_p \leq 10\ ms$

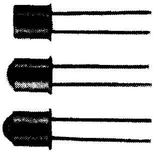

80 1557 e
$\Phi_e(\lambda)_{rel}$
1.0
0.8
0.6
0.4
0.2
0
870
890
910
930 nm
λ
$\Phi_e(\lambda)_{rel} = \frac{\Phi_e(\lambda)}{\Phi_e(\lambda_p)}$
$I_F = 50\ mA$
$T_{amb} = 25\ °C$


30°
20°
10°
0°
10°
20°
30°
40°
50°
801384
CQY31
$I_{erel} = \frac{I_e}{I_e(\alpha=0°)}$
1.0
1.0
0.8
0.6
0.4
0.2
0
0.2
0.4
0.6
0.8
I_{erel} →


0°
10°
80 1414
20°
30°
40°
50°
$I_{e\,rel}$ ↑
$I_{e\,rel} = \frac{I_e}{I_e(\alpha=0°)}$
CQY 32
1.0
0.8
0.6
0.4
0.2
0
0.2

CQY 33 N · CQY 34 N · CQY 35 N

GaAs Infrared Diodes in Hermetically Sealed Cases



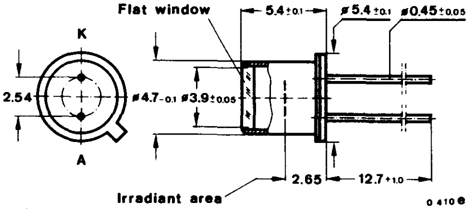
Application: Radiation source in near infrared range

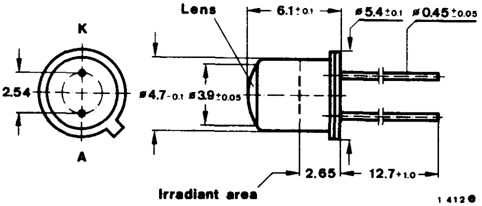
Features:

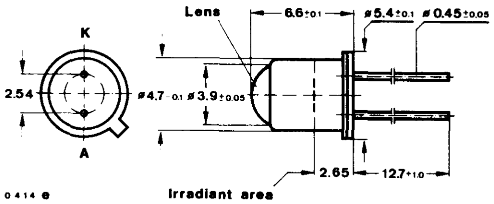
- CQY 33 N Flat window $\alpha = 80°$
- CQY 34 N Lens, $\alpha = 30°$
- CQY 35 N Lens, $\alpha = 10°$
- High radiant intensity – CQY 35 N
- High radiant power
- Suitable for pulse operation
- Good spectral matching for silicon photo detectors
- CQY 35 N – Suitable to couple for glass fiber

Preliminary specifications

Dimensions in mm







Angle of half intensity		
	CQY 33 N	$\alpha = 80°$
	CQY 34 N	$\alpha = 30°$
	CQY 35 N	$\alpha = 10°$

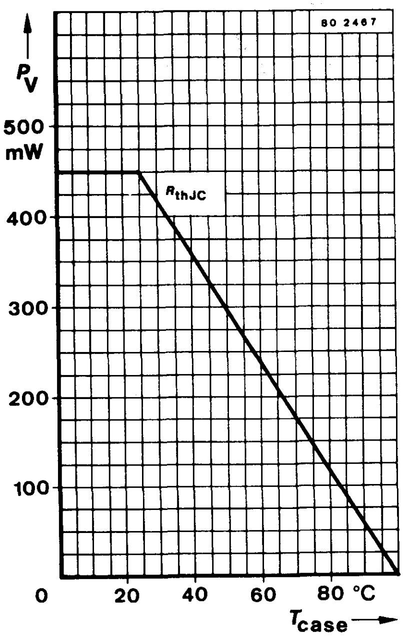
Cathode connected with case

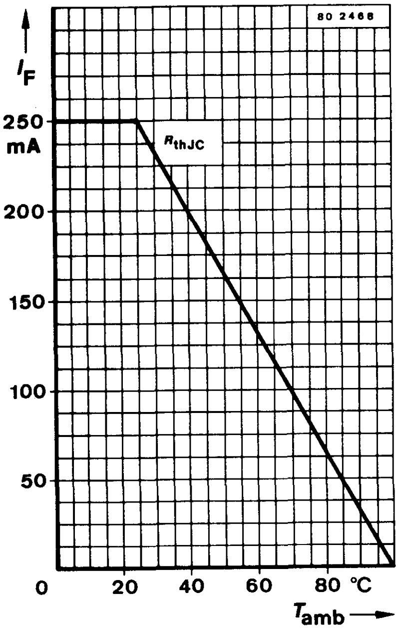
≈ 18 A 2 DIN 41 876
≈ JEDEC TO 18
Weight max. 0.5 g

CQY 33 N · CQY 34 N · CQY 35 N

Absolute maximum ratings

Reverse voltage	V_R	5	V
Forward current	I_F	250	mA
Forward peak current $\frac{t_p}{T} = 0.5$, $t_p \leq 10$ ms	I_{FM}	500	mA
Forward surge current $t_p \leq 10\ \mu s$	I_{FSM}	2.5	A
Power dissipation $T_{case} \leq 25\,°C$	P_V	450	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−55 ... +100	°C





CQY 33 N · CQY 34 N · CQY 35 N

Thermal resistances				**Min.**	**Typ.**	**Max.**	
Junction ambient			R_{thJA}			450	K/W
Junction case			R_{thJC}			150	K/W

Optical and electrical characteristics
$T_{amb} = 25\,°C$

				Min.	Typ.	Max.	
Radiant power $I_F = 100$ mA			Φ_e		8		mW
Temperature coefficient of Φ_e $I_F = 100$ mA			$TK_{\Phi e}$		−0.8		%/K
Radiant intensity $I_F = 100$ mA	**Group E**	**CQY 33 N**	I_e*)	3	4.5	6	mW/sr
		CQY 34 N	I_e*)	8	12	16	mW/sr
		CQY 35 N	I_e*)	16	24	32	mW/sr
	Group F	**CQY 33 N**	I_e*)	4.5	7		mW/sr
		CQY 34 N	I_e*)	12	18		mW/sr
		CQY 35 N	I_e*)	24	36		mW/sr
Peak wavelength emission $I_F = 100$ mA			λ_p		950		nm
Spectral half bandwidth $I_F = 100$ mA			$\Delta\lambda$		50		nm
Forward voltage $I_F = 100$ mA			V_F*)		1.4	1.7	V
Breakdown voltage $I_R = 100\,\mu A$			$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0$, $f = 1$ MHz			C_j		50		pF

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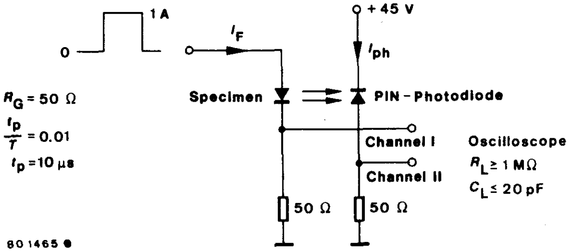
*) AQL = 0.65 %

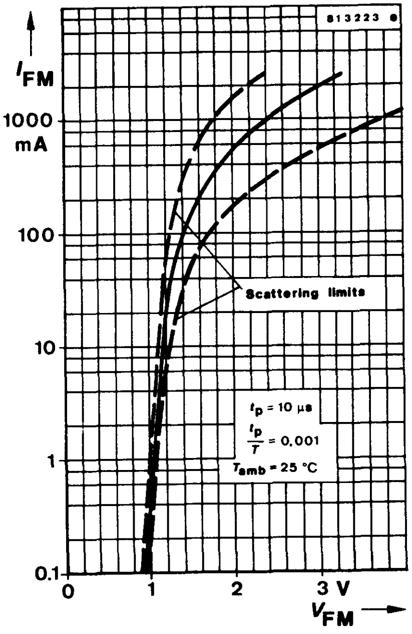
Switching characteristics

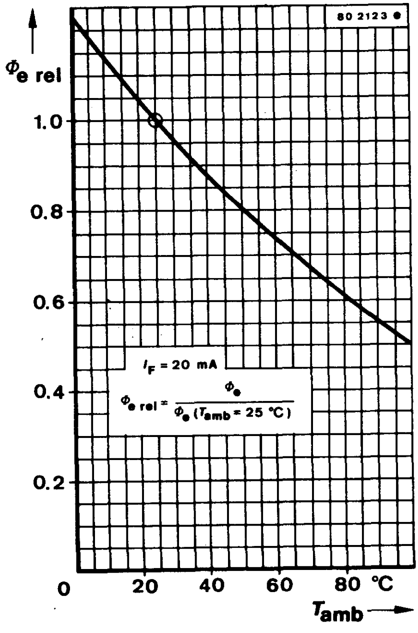
$I_{FM} = 1$ A, $\frac{t_p}{T} = 0.01$, $t_p \leqq 10\,\mu$s, see test circuit

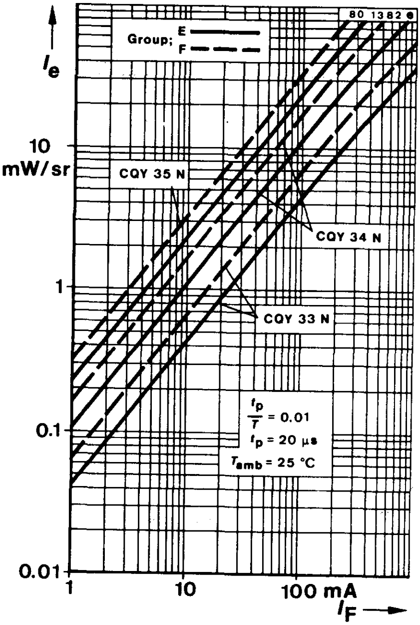
		Min.	Typ.	Max.	
Rise time	t_r		400		ns
Fall time	t_f		450		ns

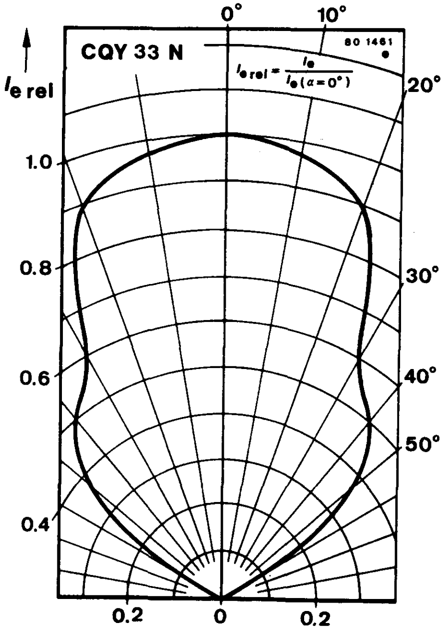


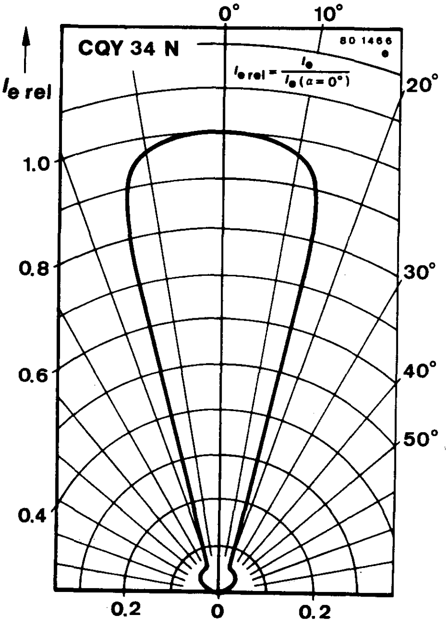
Test circuit

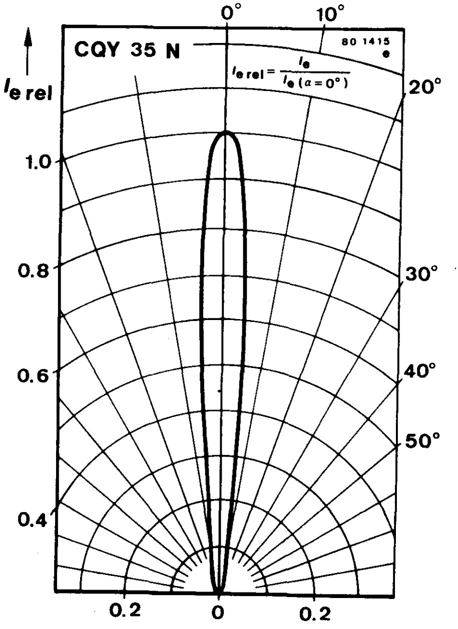


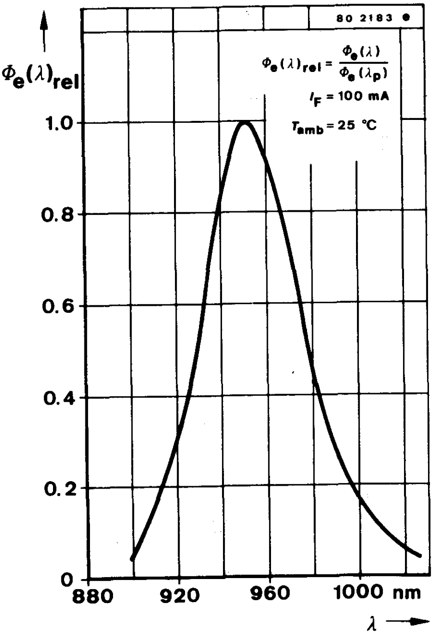



80 1382 e
Group; E
F
I_e
10 mW/sr
1
0.1
0.01
1
10
100 mA
I_F
CQY 35 N
CQY 34 N
CQY 33 N
$\frac{t_p}{T} = 0.01$
$t_p = 20\ \mu s$
$T_{amb} = 25\ °C$


CQY 33 N
80 1461 e
$I_{e\,rel} = \frac{I_e}{I_e(\alpha = 0°)}$
$I_{e\,rel}$
0°
10°
20°
30°
40°
50°
1.0
0.8
0.6
0.4
0.2
0
0.2

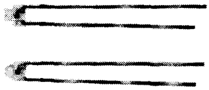

CQY 34 N
80 1466 e
$I_{e\,rel} = \frac{I_e}{I_e(\alpha = 0°)}$
$I_{e\,rel}$
0°
10°
20°
30°
40°
50°
1.0
0.8
0.6
0.4
0.2
0
0.2


CQY 35 N
80 1415 e
$I_{e\,rel} = \frac{I_e}{I_e(\alpha = 0°)}$
$I_{e\,rel}$
0°
10°
20°
30°
40°
50°
1.0
0.8
0.6
0.4
0.2
0
0.2


80 2183 ●
$\Phi_e(\lambda)_{rel} = \frac{\Phi_e(\lambda)}{\Phi_e(\lambda_p)}$
I_F = 100 mA
T_{amb} = 25 °C
$\Phi_e(\lambda)_{rel}$
1.0
0.8
0.6
0.4
0.2
0
880
920
960
1000 nm
λ

CQY 36 N · CQY 37 N

GaAs Infrared Diodes in Miniature Plastic Cases



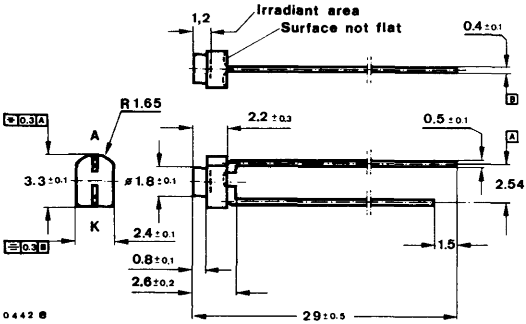
Application: Radiation source in near infrared range

Features:

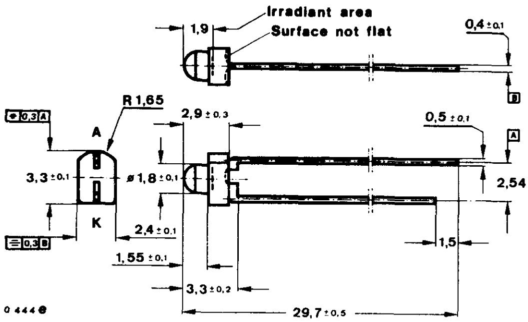
- High package capacity
- High radiant power
- Suitable for pulse operation
- Good spectral matching for silicon photo detectors

Preliminary specifications

Dimensions in mm



CQY 36N



CQY 37N

Angle of half intensity

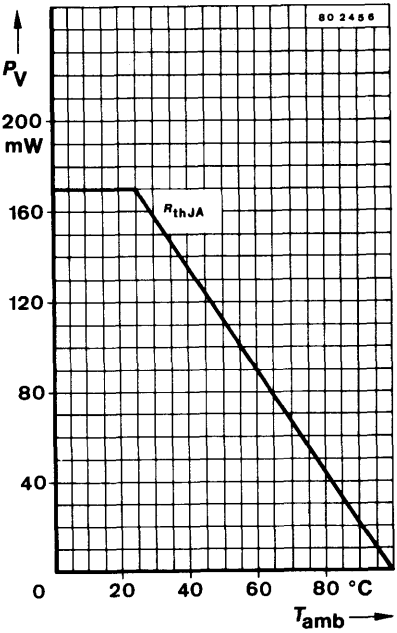
CQY 36 N	$\alpha = 80°$
CQY 37 N	$\alpha = 25°$

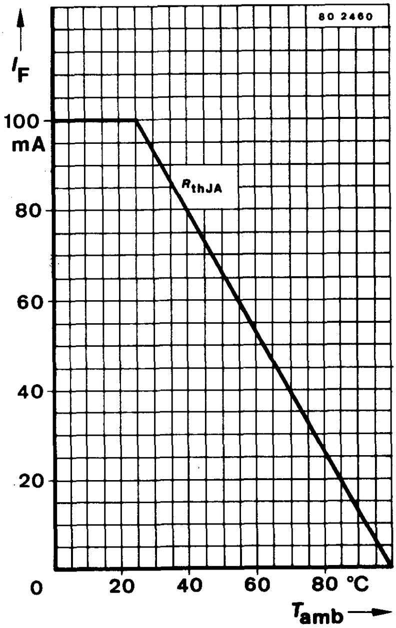
Special case
Weight max. 0.04 g

CQY 36 N · CQY 37 N

Absolute maximum ratings

Reverse voltage	V_R	5	V
Forward current	I_F	100	mA
Forward surge current $t_p \leq 10\,\mu s$	I_{FSM}	2.5	A
Power dissipation $T_{amb} \leq 25\,°C$	P_V	170	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−25 ... + 100	°C
Soldering temperature, maximal $t \leq 3$ s	T_{sd} ¹)	245	°C





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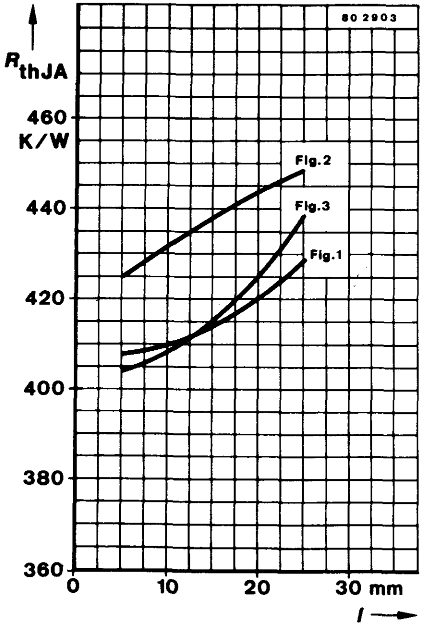
¹) Distance from the touching border ≥ 2 mm



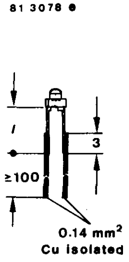


Fig.1

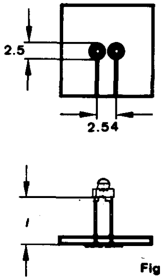


Fig.2

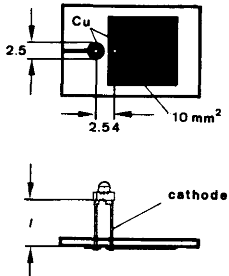


Fig.3

			Min.	Typ.	Max.	
Thermal resistance						
Junction ambient		R_{thJA}			450	K/W
Optical and electrical characteristics $T_{amb} = 25\,°C$						
Radiant power $I_F = 50$ mA		Φ_e		5.0		mW
Temperature coefficient of Φ_e $I_F = 50$ mA		$TK_{\Phi e}$		−0.8		%/K
Radiant intensity $I_F = 50$ mA	**CQY 36 N**	I_e*)	0.7	1.5		mW/sr
	CQY 37 N	I_e*)	2.2	4.5		mW/sr
Peak wavelength emission $I_F = 50$ mA		λ_p		950		nm
Spectral half bandwidth $I_F = 50$ mA		$\Delta\lambda$		50		nm
Forward voltage $I_F = 50$ mA		V_F*)		1.3	1.6	V

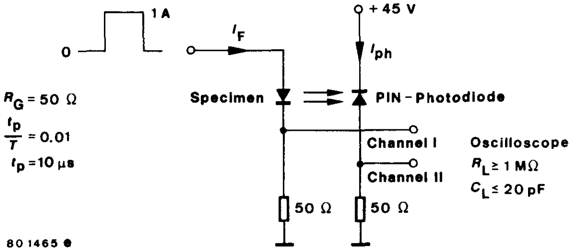
CQY 36 N · CQY 37 N

		Min.	Typ.	Max.	
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz	C_j		50		pF

Switching characteristics

$I_{FM} = 1$ A, $\frac{t_p}{T} = 0.01$, $t_p \leqq 10\,\mu s$, see test circuit

		Min.	Typ.	Max.	
Rise time	t_r		400		ns
Fall time	t_f		450		ns



Test circuit

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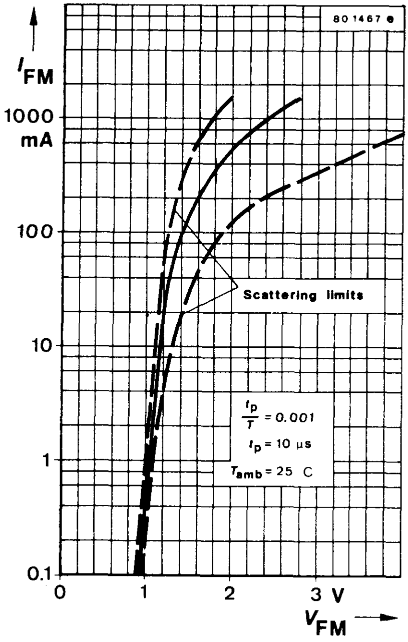
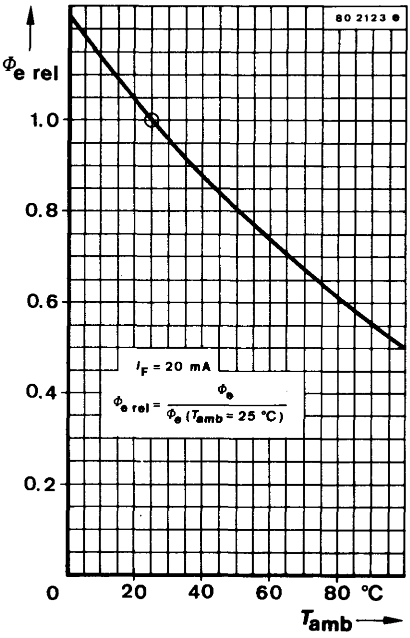
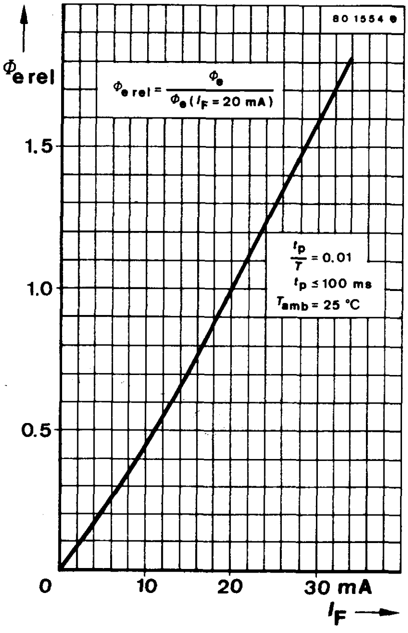
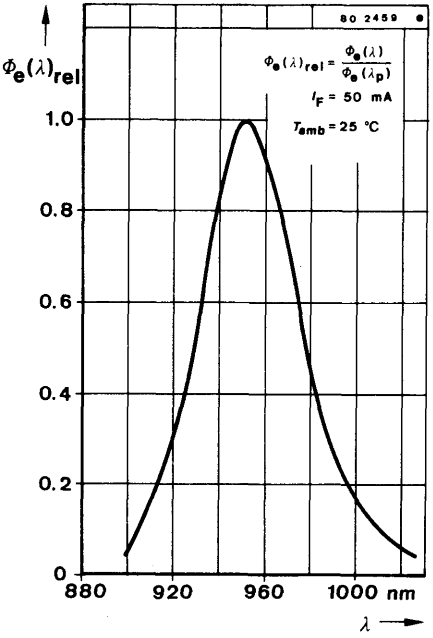
*) AQL = 0.65 %

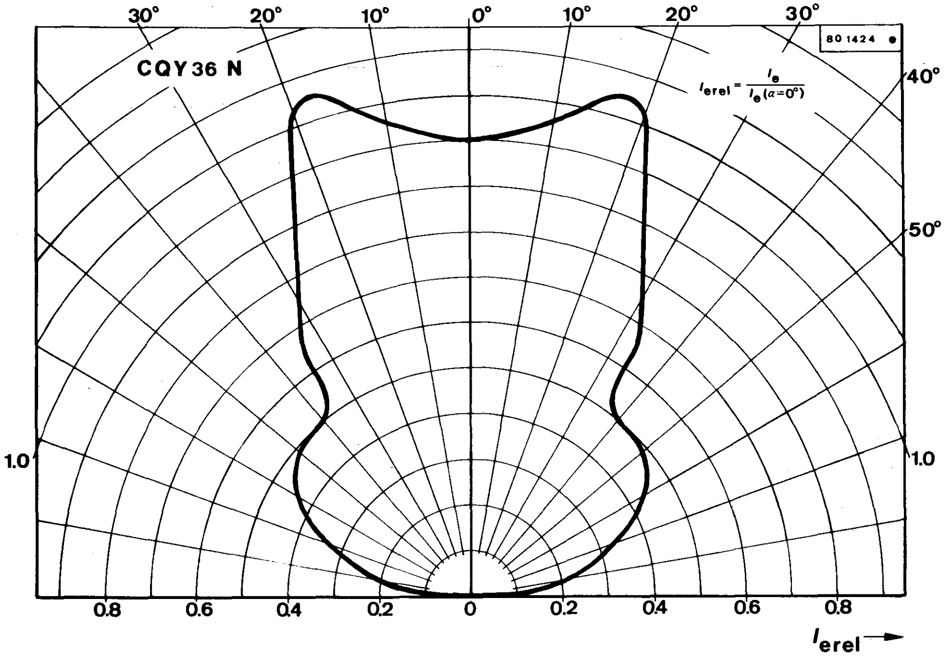

80 1467
I_{FM}
1000 mA
100
10
1
0.1
0
1
2
3 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ C$

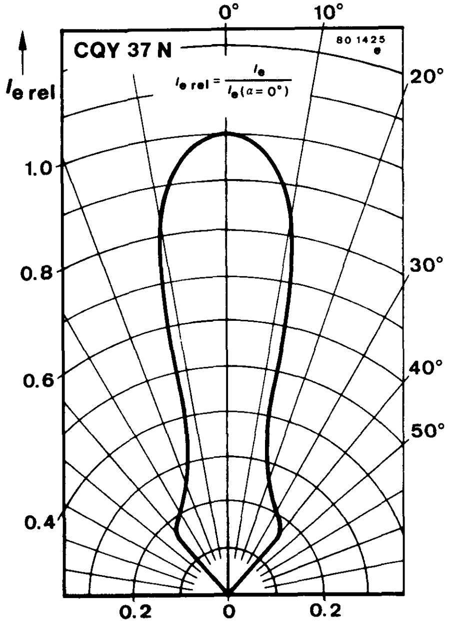

80 2123
$\Phi_{e\ rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_F = 20\ mA$
$\Phi_{e\ rel} = \frac{\Phi_e}{\Phi_e\ (T_{amb} = 25\ °C)}$


80 1554
$\Phi_{e\ rel}$
1.5
1.0
0.5
0
10
20
30 mA
I_F
$\Phi_{e\ rel} = \frac{\Phi_e}{\Phi_e\ (I_F = 20\ mA)}$
$\frac{t_p}{T} = 0.01$
$t_p \leq 100\ ms$
$T_{amb} = 25\ °C$


80 2459
$\Phi_e(\lambda)_{rel}$
1.0
0.8
0.6
0.4
0.2
0
880
920
960
1000 nm
λ
$\Phi_e(\lambda)_{rel} = \frac{\Phi_e(\lambda)}{\Phi_e(\lambda_p)}$
$I_F = 50\ mA$
$T_{amb} = 25\ °C$

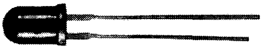
CQY 36 N · CQY 37 N





CQY 98 · V 390 P · CQW 13

GaAs Infrared Diodes in 5 mm Cases



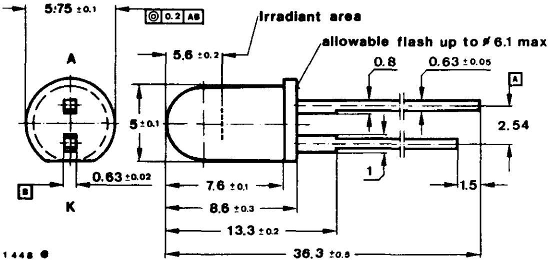
Application: Radiation source in near infrared range

Features:

- Plastic case
- High radiant intensity
- High radiant power
- Suitable for pulse operation
- Angle of half intensity 35°

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 35°$

Plastic case
Weight max. 0.4 g

Accessoires

Mounting clip	Order-Nr. 562136
Retainer ring	Order-Nr. 562135

Absolute maximum ratings

Reverse voltage	V_R	5	V
Forward current	I_F	150	mA
Forward peak current $\frac{t_p}{T} = 0.5$, $t_p \leq 10$ ms	I_{FM}	300	mA
Forward surge current $t_p \leq 10\,\mu s$	I_{FSM}	2.5	A
Power dissipation $T_{amb} \leq °C$	P_V	210	mW
Junction temperature	t_j	100	°C
Storage temperature range	t_{stg}	−25 ... +100	°C
Soldering temperature, maximal $t \leq 3$ s	t_{sd}[1])	245	°C

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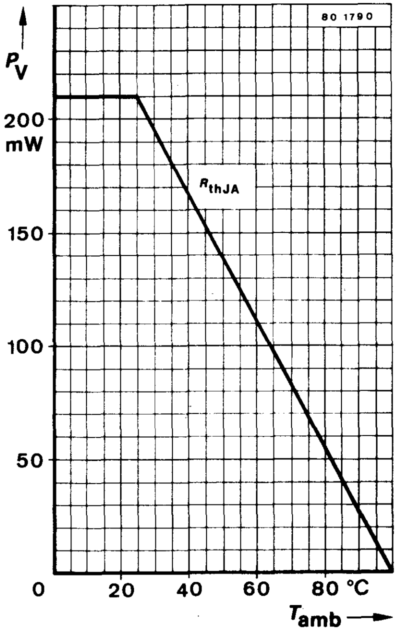
[1]) Distance from the touching border ≥ 1.5 mm with intermediate PC-board

S 1.2. 151/0781 E



Thermal resistance

		Min.	Typ.	Max.	
Junction ambient	R_{thJA}			350	K/W

Optical and electrical characteristics

$T_{amb} = 25°C$

		Min.	Typ.	Max.	
Radiant power $I_F = 100$ mA	Φ_e		15		mW
Temperature coefficient of Φ_e $I_F = 100$ mA	$TK_{\Phi e}$		−0.8		%/K

Type	Radiant intensity I_e (mW/sr)			Forward voltage V_F (V)			
	$I_F = 100$ mA	$I_F = 1.5$ A, $t_p = 100\,\mu s$*)		$I_F = 100$ mA		$I_F = 1.5$ A, $t_p = 100\,\mu s$*)	
	Typ.	Min.	Typ.	Typ.	Max.	Typ.	Max.
CQY 98	20	85	170	1.4	1.7	2.7	—
V 390 P	21	120	180	1.4	1.7	2.7	—
CQW 13	27	170	250	1.3	—	2.4	2.7

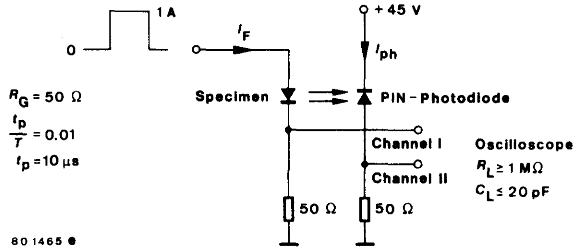
*) AQL = 0.65 %

			Min.	Typ.	Max.	
Peak wavelength emission $I_F = 100$ mA		λ_p		950		nm
Spectral half bandwidth $I_F = 100$ mA		$\Delta\lambda$		50		nm
Forward voltage $I_F = 1.5$ A, $t_p = 100\,\mu s$	**CQY 98, V 390 P**	V_F*)		2.7	2.9	V
	CQW 13	V_F*)		2.4	2.6	V
Breakdown voltage $I_R = 100\,\mu A$		$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0$, $f = 1$ MHz		C_j		50		pF

Switching characteristics

$I_{FM} = 1$ A, $\frac{t_p}{T} = 0.01$, $t_p \leq 10\,\mu s$, see test circuit

			Min.	Typ.	Max.	
Rise time	t_r			400		ns
Fall time	t_f			450		ns



Test circuit

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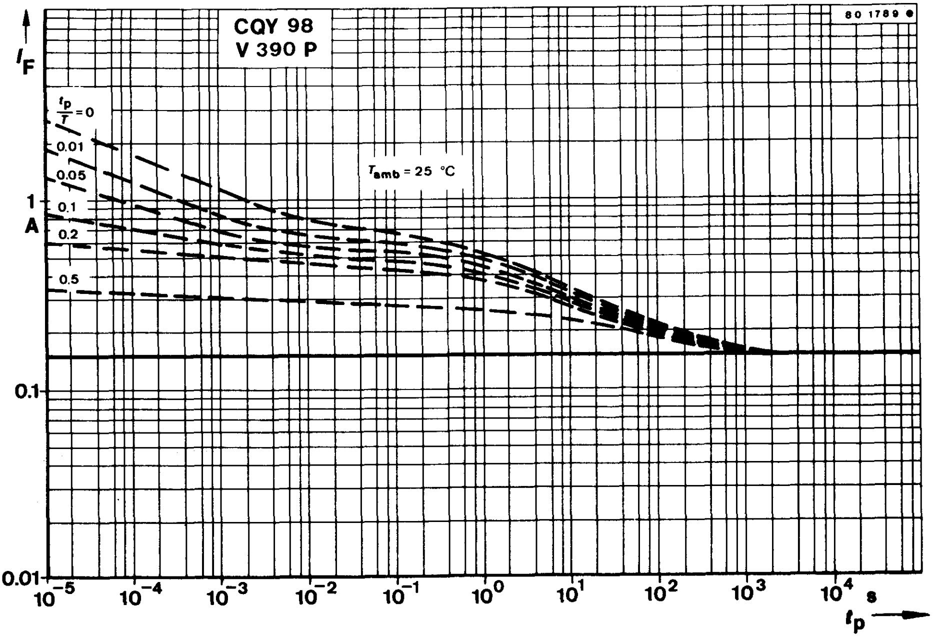
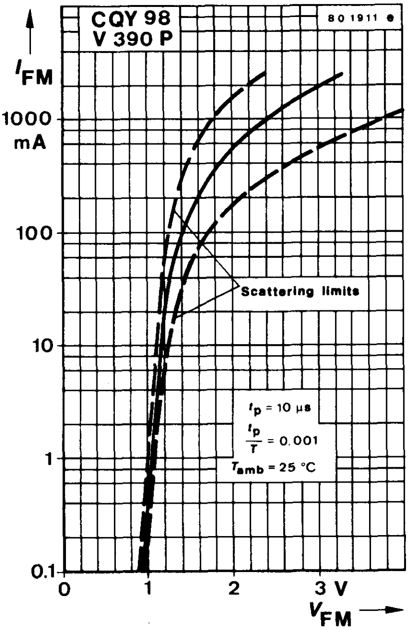
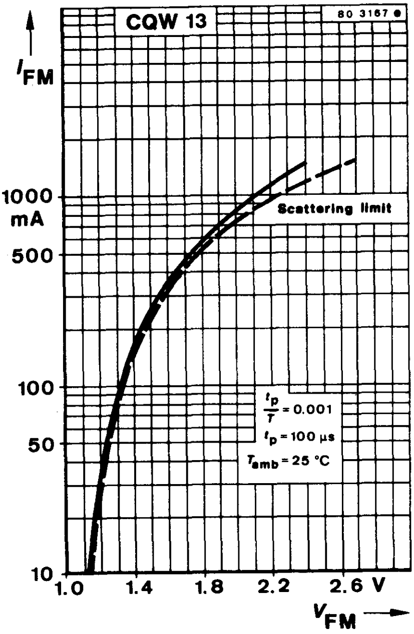
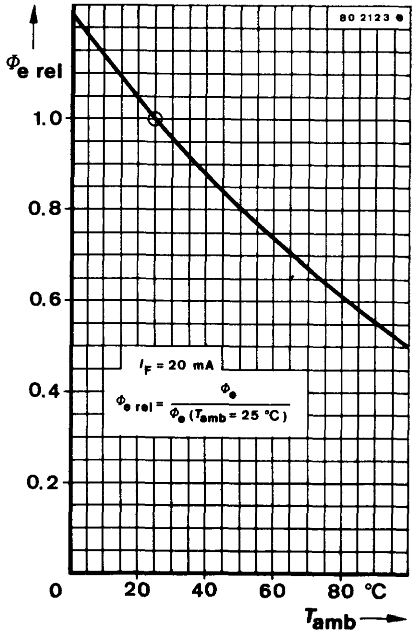
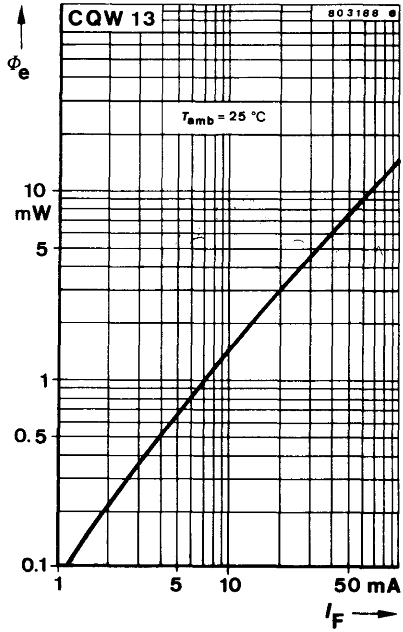
*) AQL = 0.65 %

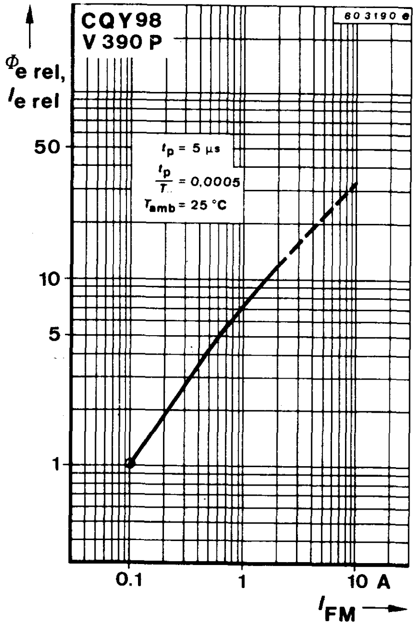

CQY 98
V 390 P
80 1789 e
I_F
$\frac{t_p}{T}$ = 0
0.01
0.05
0.1
0.2
0.5
T_{amb} = 25 °C
1
A
0.1
0.01
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^0
10^1
10^2
10^3
10^4 s
t_p

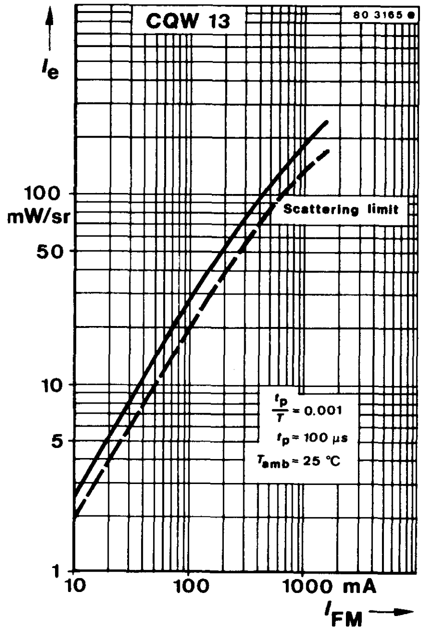

CQY 98
V 390 P
80 1911 e
I_{FM}
1000
mA
100
10
1
0.1
Scattering limits
t_p = 10 µs
$\frac{t_p}{T}$ = 0.001
T_{amb} = 25 °C
0
1
2
3 V
V_{FM}

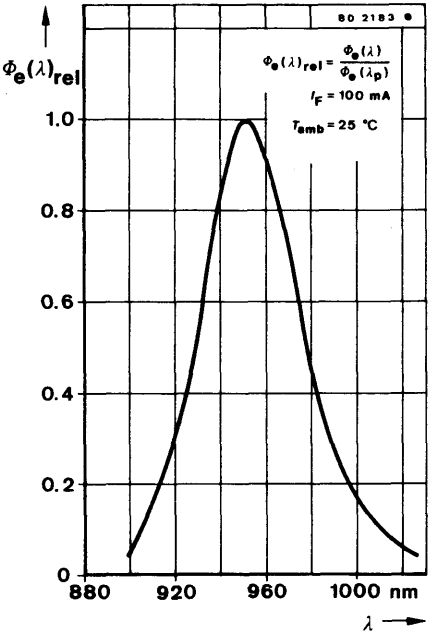

CQW 13
80 3167 e
I_{FM}
1000
mA
500
100
50
10
Scattering limit
$\frac{t_p}{T}$ = 0.001
t_p = 100 µs
T_{amb} = 25 °C
1.0
1.4
1.8
2.2
2.6 V
V_{FM}

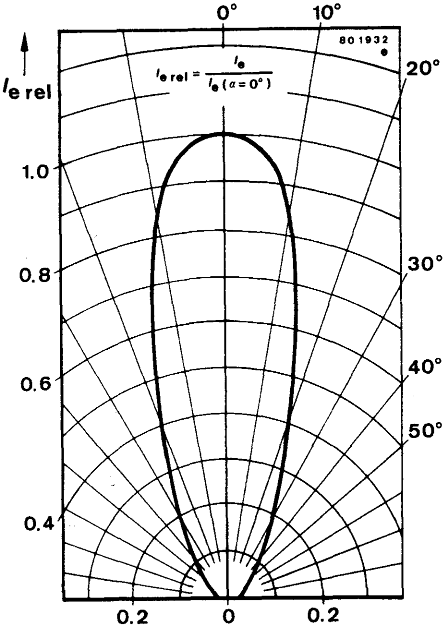

80 2123
$\Phi_{e\ rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
I_F = 20 mA
$\Phi_{e\ rel} = \frac{\Phi_e}{\Phi_e (T_{amb} = 25\ °C)}$


CQW 13
803188
Φ_e
T_{amb} = 25 °C
10 mW
5
1
0.5
0.1
1
5
10
50 mA
I_F


CQY98
V 390 P
80 3190
$\Phi_{e\ rel}$,
$I_{e\ rel}$
t_p = 5 µs
$\frac{t_p}{T}$ = 0,0005
T_{amb} = 25 °C
50
10
5
1
0.1
1
10 A
I_{FM}

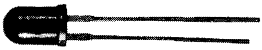

CQW 13
80 3165
I_e
100 mW/sr
50
10
5
1
Scattering limit
$\frac{t_p}{T}$ = 0.001
t_p = 100 µs
T_{amb} = 25 °C
10
100
1000 mA
I_{FM}


80 2183
$\Phi_e(\lambda)_{rel}$
$\Phi_e(\lambda)_{rel} = \frac{\Phi_e(\lambda)}{\Phi_e(\lambda_p)}$
I_F = 100 mA
T_{amb} = 25 °C
1.0
0.8
0.6
0.4
0.2
0
880
920
960
1000 nm
λ


0°
10°
20°
30°
40°
50°
801932
$I_{e\,rel}$
$I_{e\,rel} = \frac{I_e}{I_e(\alpha = 0°)}$
1.0
0.8
0.6
0.4
0.2
0
0.2

CQY 99 · V 290 P · CQW 14

GaAs Infrared Diodes in 5 mm Cases



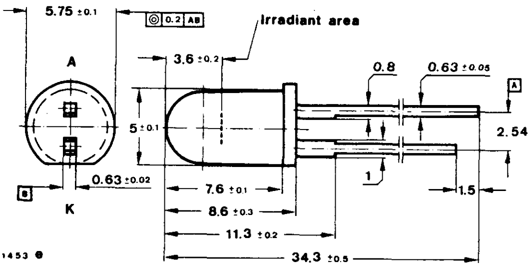
Application: Radiation source in near infrared range

Features:

- Plastic case
- High radiant intensity
- High radiant power
- Suitable for pulse operation
- Angle of half intensity, 50°

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 50°$

Plastic case
Weight max. 0.4 g

Accessoires

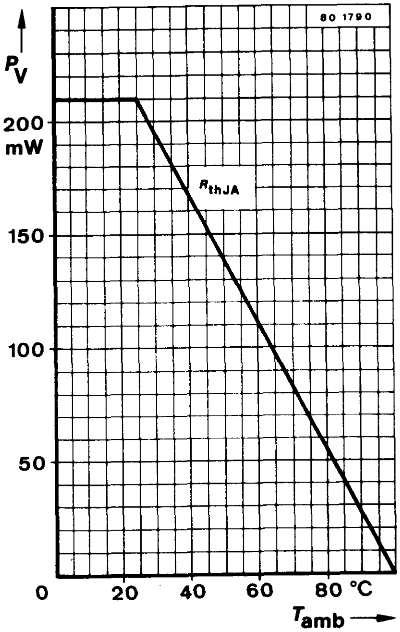
Mounting clip	Order-Nr. 562136
Retainer ring	Order-Nr. 562135

Absolute maximum ratings

Reverse voltage	V_R	5	V
Forward current	I_F	150	mA
Forward peak current $\frac{t_p}{T} = 0.5$, $t_p \leq 10$ ms	I_{FM}	300	mA
Forward surge current $t_p \leq 10\,\mu$s	I_{FSM}	2.5	A
Power dissipation $T_{amb} \leq 25°$C	P_V	210	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−25 ... +100	°C
Soldering temperature, maximal $t \leq 3$ s	T_{sd}[1]	245	°C

---

[1] Distance from the touching border ≥ 1.5 mm with intermediate PC-board



Thermal resistance

		Min.	Typ.	Max.	
Junction ambient	R_{thJA}			350	K/W

Optical and electrical characteristics

$T_{amb} = 25\,°C$

			Min.	Typ.	Max.	
Radiant power $I_F = 100$ mA	**CQY 99, V 290 P**	Φ_e		11		mW
	CQW 14	Φ_e		15		mW
Temperature coefficient of Φ_e $I_F = 100$ mA		$TK_{\Phi e}$		−0.8		%/K

Typ	Radiant intensity I_e (mW/sr)			Forward voltage V_F*) (V)			
	$I_F = 100$ mA	$I_F = 1.5$ A, $t_p = 100\,\mu s$*)		$I_F = 100$ mA		$I_F = 1.5$ A, $t_p = 100\,\mu s$	
	Typ.	Min.	Typ.	Typ.	Max.*)	Typ.	Max.
CQY 99	14	60	120	1.4	1.7	2.7	—
V 290 P	15	85	125	1.4	1.7	2.7	—
CQW 14	19	120	180	1.3	—	2.4	2.7

---

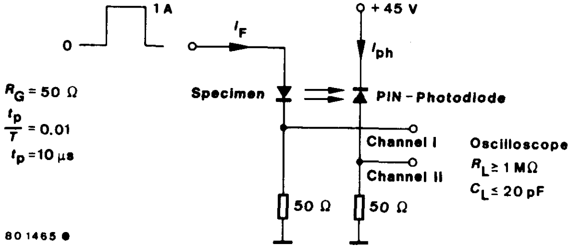
*) AQL = 0.65 %

		Min.	Typ.	Max.	
Peak wavelength emission $I_F = 100$ mA	λ_p		950		nm
Spectral half bandwidth $I_F = 100$ mA	$\Delta\lambda$		50		nm
Breakdown voltage $I_R = 100\ \mu$A	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0$, $f = 1$ MHz	C_j		50		pF

Switching characteristics

$I_{FM} = 1$ A, $\frac{t_p}{T} = 0.01$, $t_p \leq 10\ \mu$s, see test circuit

		Min.	Typ.	Max.	
Rise time	t_r		400		ns
Fall time	t_f		450		ns



Test circuit

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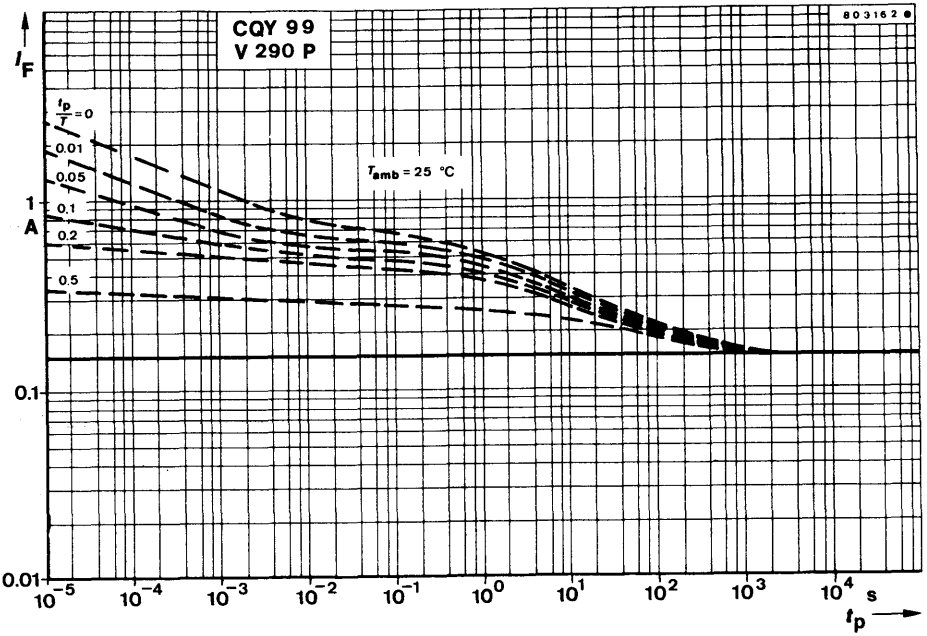
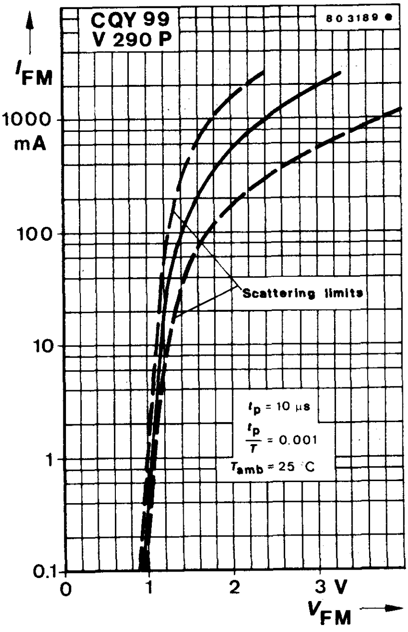
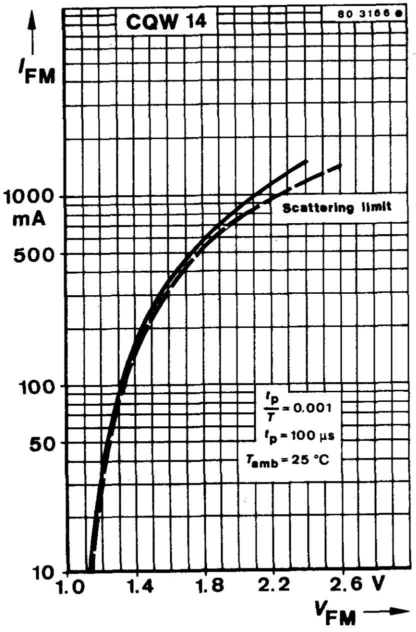
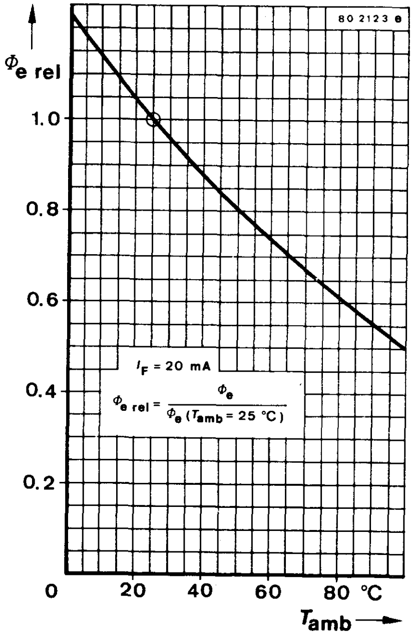
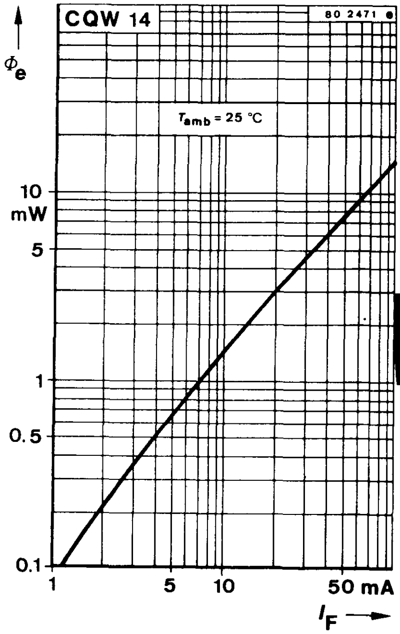
*) AQL = 0.65 %

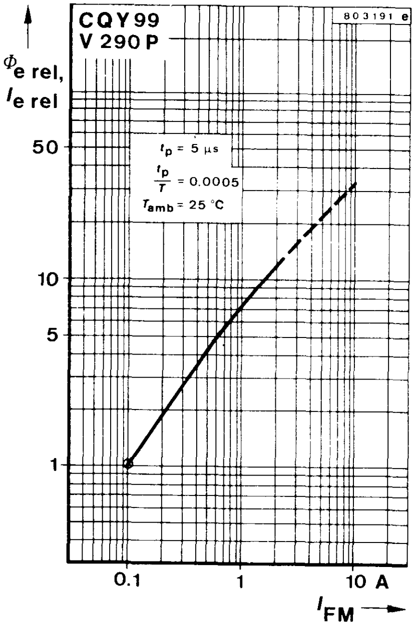

80 3162 ●
CQY 99
V 290 P
I_F
$\frac{t_p}{T} = 0$
0.01
0.05
0.1
0.2
0.5
T_{amb} = 25 °C
1
A
0.1
0.01
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
s
t_p

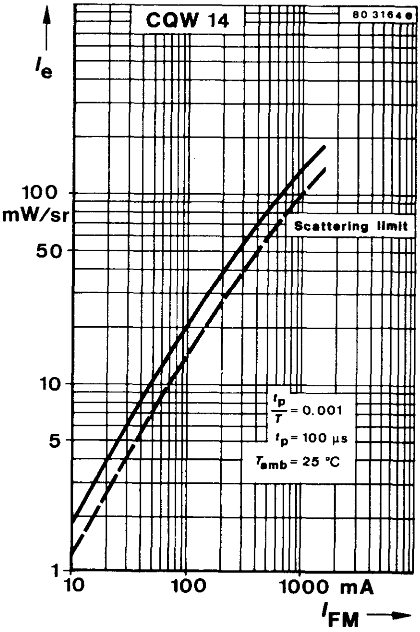

CQY 99
V 290 P
80 3189 ●
I_{FM}
1000
mA
100
10
1
0.1
Scattering limits
t_p = 10 µs
$\frac{t_p}{T}$ = 0.001
T_{amb} = 25 °C
0
1
2
3 V
V_{FM}


CQW 14
80 3166 ●
I_{FM}
1000
mA
500
100
50
10
Scattering limit
$\frac{t_p}{T}$ = 0.001
t_p = 100 µs
T_{amb} = 25 °C
1.0
1.4
1.8
2.2
2.6 V
V_{FM}

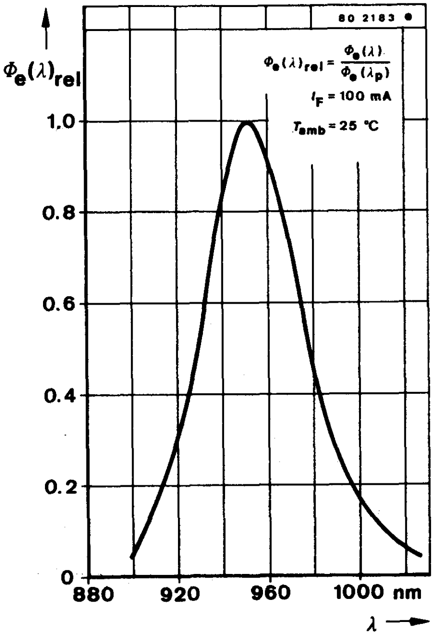

80 2123 e
Φe rel
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
Tamb
IF = 20 mA
Φe rel = Φe / Φe (Tamb = 25 °C)

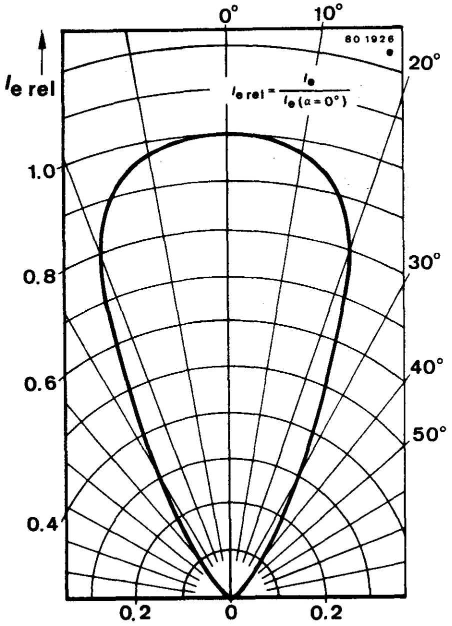

CQW 14
80 2471 e
Φe
Tamb = 25 °C
10 mW
5
1
0.5
0.1
1
5
10
50 mA
IF


CQY99 V 290P
80 3191 e
Φe rel, Ie rel
tp = 5 μs
tp/T = 0.0005
Tamb = 25 °C
50
10
5
1
0.1
1
10 A
IFM


CQW 14
80 3164 e
Ie
100 mW/sr
50
10
5
1
Scattering limit
tp/T = 0.001
tp = 100 μs
Tamb = 25 °C
10
100
1000 mA
IFM

CQY 99 · V 290 P · CQW 14





V 194 P

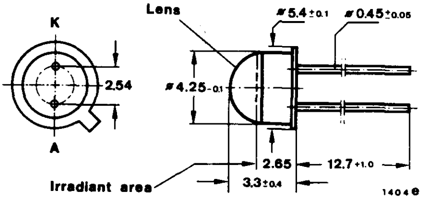
GaAs Infrared Diode with Metal Base

Application: Radiation source in near infrared range

Features:

- Metal base with plastic lens clear
- Wide radiation angle $\alpha = 80°$
- High radiation power
- Good spectral matching for silicon photo detectors

Dimension in mm



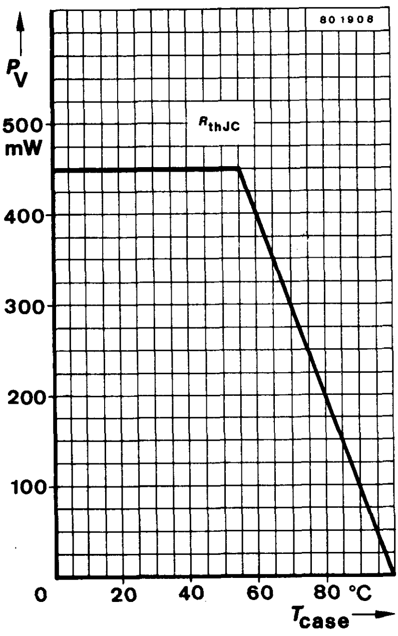
Angle of half intensity $\alpha = 80°$

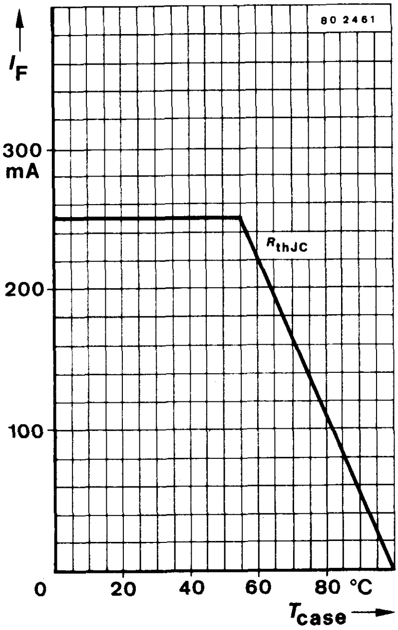
Cathode connected with case

≈ 18 A 2 DIN 41876
≈ JEDEC TO 18
Weight max. 0.5 g

Absolute maximum ratings

Reverse voltage	V_R	5	V
Forward current	I_F	250	mA
Forward peak current $\frac{t_p}{T} = 0.5$, $t_p \leq 10$ ms	I_{FM}	500	mA
Forward surge current $t_p \leq 10\,\mu s$	I_{FSM}	2.5	A
Power dissipation $T_{case} \leq 55\,°C$	P_V	450	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−25 ... +100	°C





Thermal resistances

		Min.	Typ.	Max.	
Junction ambient	R_{thJA}			450	K/W
Junction case	R_{thJC}			100	K/W

Optical and electrical characteristics
$T_{amb} = 25°C$

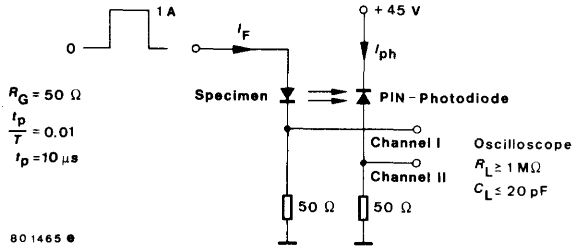
		Min.	Typ.	Max.	
Radiant power $I_F = 100$ mA	Φ_e		10		mW
Temperature coeffizient of Φ_e $I_F = 100$ mA	$TK_{\Phi e}$		−0.8		%/K
Radiant intensity $I_F = 100$ mA	I_e*)	1.5	3.0		mW/sr
Peak wavelength emission $I_F = 100$ mA	λ_p		950		nm
Spectral half bandwidth $I_F = 100$ mA	$\Delta\lambda$		50		nm
Forward voltage $I_F = 100$ mA	V_F*)		1.4	1.7	V

		Min.	Typ.	Max.	
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0$, $f = 1$ MHz	C_j		50		pF

Switching characteristics

$I_{FM} = 1$ A, $\frac{t_p}{T} = 0.01$, $t_p \leq 10\,\mu s$, see test circuit

		Min.	Typ.	Max.	
Rise time	t_r		400		ns
Fall time	t_f		450		ns



Test circuit

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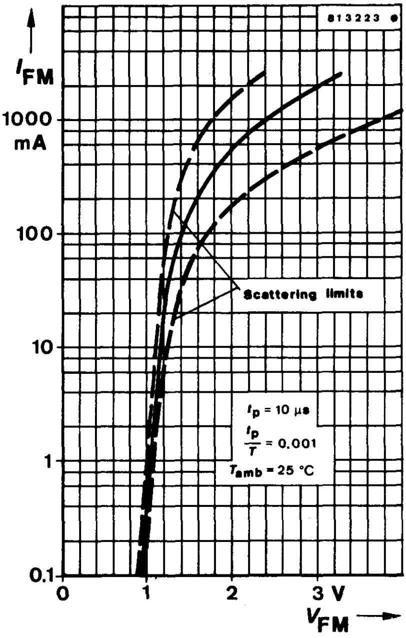
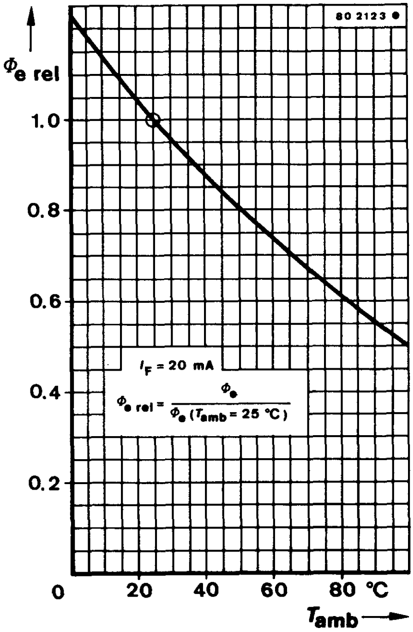
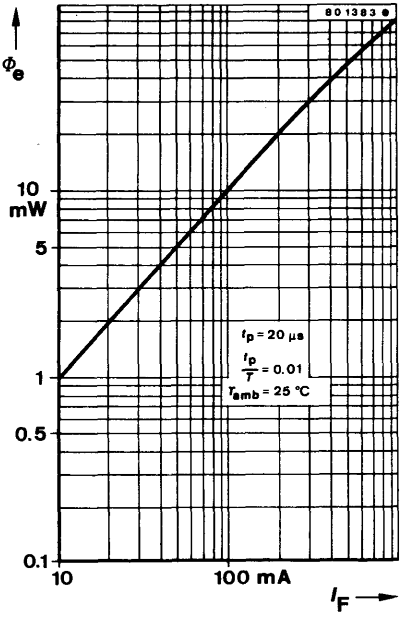
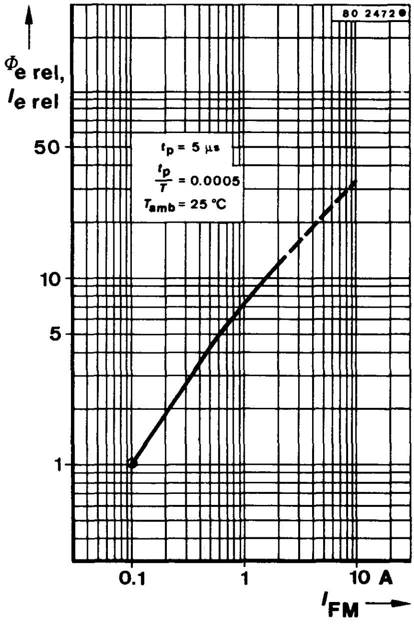
*) AQL = 0.65 %

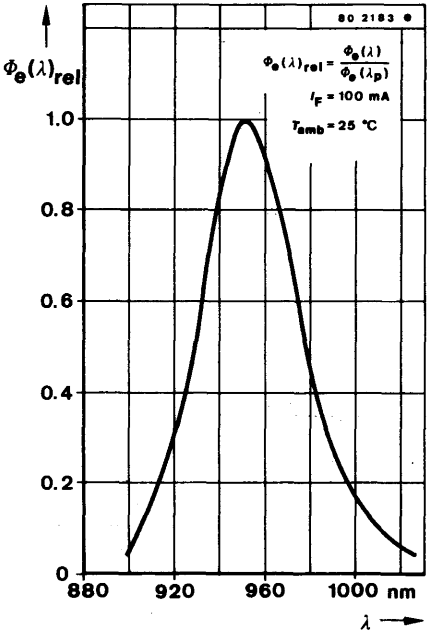
V 194 P

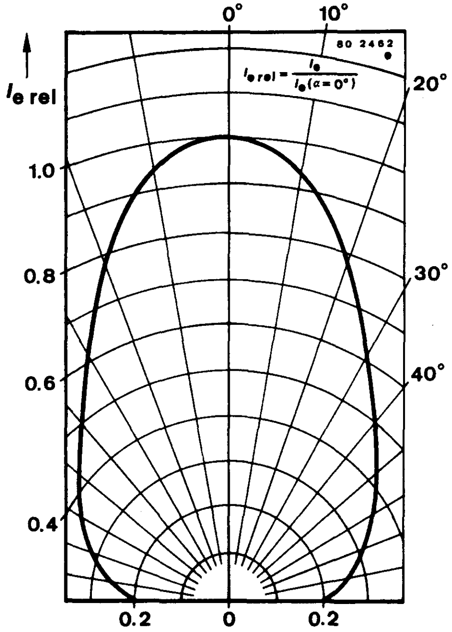

813223
I_{FM}
1000 mA
100
10
1
0.1
0
1
2
3 V
V_{FM}
Scattering limits
t_p = 10 µs
$\frac{t_p}{T}$ = 0.001
T_{amb} = 25 °C


80 2123
$\Phi_{e\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
I_F = 20 mA
$\Phi_{e\,rel} = \frac{\Phi_e}{\Phi_e\,(T_{amb} = 25\,°C)}$


801383
Φ_e
10 mW
5
1
0.5
0.1
10
100 mA
I_F
t_p = 20 µs
$\frac{t_p}{T}$ = 0.01
T_{amb} = 25 °C


80 2472
$\Phi_{e\,rel}$,
$I_{e\,rel}$
50
10
5
1
0.1
1
10 A
I_{FM}
t_p = 5 µs
$\frac{t_p}{T}$ = 0.0005
T_{amb} = 25 °C


80 2183
Φe(λ)rel = Φe(λ) / Φe(λp)
IF = 100 mA
Tamb = 25 °C
Φe(λ)rel
1.0
0.8
0.6
0.4
0.2
0
880
920
960
1000 nm
λ


0°
10°
20°
30°
40°
80 2462
Ie rel = Ie / Ie(α = 0°)
Ie rel
1.0
0.8
0.6
0.4
0.2
0
0.2

V 213 P*)

GaAs Infrared Emitting Diode

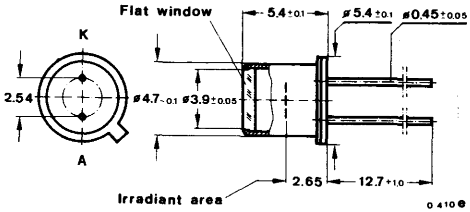
Application: Radiation source in near infrared range for coupling with glass fiber

Features:

- Hermetically sealed case
- High modulation frequencies
- High switching speed
- Good spectral matching for silicon photo detectors

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 80°$
Diameter of the emitting area
$\varnothing = 0.1$ mm
Cathode connected with case

≈ 18 A2 DIN 41876
≈ JEDEC TO 18
Weight max. 0.5 g

Absolute maximum ratings

Reverse voltage	V_R	5	V
Forward current	I_F	100	mA
Forward peak current $\frac{t_p}{T} = 0.5$, $t_p \leqq 10$ ms	I_{FM}	200	mA
Forward surge current $T_p \leqq 100$ ns	I_{FSM}	0.5	A
Power dissipation $T_{amb} \leqq 25°C$	P_V	300	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−25...+100	°C

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*) For effective coupling to graded index fibers with small core diameters (50 µm), the devices V 296 P, V 297 P, V 298 P are available on request. They differ from V 213 P with respect to radiation emitting areas.

Thermal resistances		Min.	Typ.	Max.	
Junction ambient	R_{thJA}			600	K/W
Junction case	R_{thJC}			250	K/W

Optical and electrical characteristics
$T_{amb} = 25\,^\circ C$

		Min.	Typ.	Max.	
Radiant power $I_F = 100$ mA	Φ_e		1.0		mW
Temperature coefficient of Φ_e $I_F = 100$ mA	$TK\,\Phi_e$		–1.0		%/K
Radiant intesity $I_F = 100$ mA	I_e	0.3	0.4		mW/sr
Peak wavelength emission $T_j = 50°$	λ_p	900	910	920	nm
Spectral half bandwidth $T_j = 50°$	$\Delta\lambda$			40	nm
Forward voltage $I_F = 100$ mA	V_F		1.5	1.8	V
Junction capacitance $_R = 0, f = 1$ MHz	C_j		16	20	pF

Switching characteristics
$I_F = 100$ mA

		Min.	Typ.	Max.	
Rise time	t_r			60	ns
Fall time	t_f			60	ns

V 292 P

GaAs Infrared Emitting Diode with Metal Base

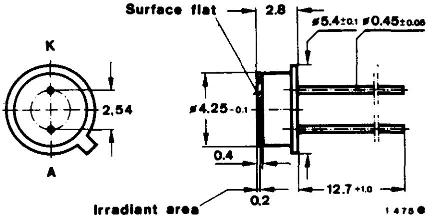
Application: Radiation source in near infrared range for coupling with glass fiber

Features:

- Flat element covering
- High modulation frequencies
- High switching speed
- Good spectral matching for silicon photo detectors

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 140°$
Diameter of the emitting area
$\varnothing = 0.1$ mm
Cathode connected with case

≈ 18 A 2 DIN 41876
≈ JEDEC TO 18
Weight max. 0.5 g

Absolute maximum ratings

Reverse voltage	V_R	5	V
Forward current	I_F	100	mA
Forward peak current $\frac{t_p}{T} = 0.5$, $t_p \leqq 10$ ms	I_{FM}	200	mA
Forward surge current $t_p \leqq 100$ ns	I_{FSM}	0.5	A
Power dissipation $T_{amb} \leqq 25°C$	P_V	300	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	–25...+100	°C

V 292 P

Thermal resistances		Min.	Typ.	Max.	
Junction ambient	R_{thJA}			600	K/W
Junction case	R_{thJC}			250	K/W

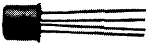
Optical and electrical characteristics					
$T_{amb} = 25\,°C$					
Radiant power $I_F = 100$ mA	Φ_e		2.0		mW
Temperature coefficient of Φ_e $I_F = 100$ mA	$TK\,\Phi_e$		–1.0		%/K
Radiant intensity $I_F = 100$ mA	I_e	0.4	0.5		mW/sr
Peak wavelength emission $T_j = 50°$	λ_p	900	910	920	nm
Spectral half bandwidth $T_j = 50°$	$\Delta\lambda$			40	nm
Forward voltage $I_F = 100$ mA	V_F		1.5	1.8	V
Junction capacitance $V_R = 0, f = 1$ MHz	C_j		16	20	pF

Switching characteristics					
$I_F = 100$ mA					
Rise time	t_r			60	ns
Fall time	t_f			60	ns

Photo coupling devices

CNY 18

Optically Coupled Isolator



Construction Emitter: GaAs-IR-Lumineszenzdiode
Detector: Silizium-NPN-Epitaxial-Planar-Phototransistor

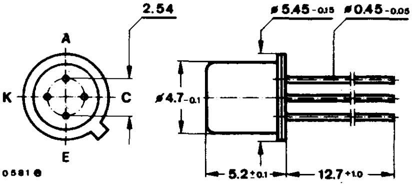
Applications: Galvanically separated circuits, non-interacting switches

Features:

- Hermetically sealed case
- DC isolation voltage 500 V–
- Low coupling capacity
- Current transfer ratio (CTR) typ. 0.5
- Low temperature coefficient of the

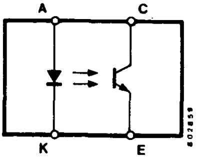
●● Also available as "Qualified semiconductor device" according to: SCC 5000 as COQ Nr. 50, and also according to GfW H 0000 as HIREL-device TB 101

Dimensions in mm



Collector connected with case

DIN 18 A 4
JEDEC TO 72
Weight max. 0.5 g



Absolute maximum ratings

Emitter			
Reverse voltage	V_R	3	V
Forward current	I_F	60	mA
Forward surge current $t_p \leq 10\,\mu s$	I_{FSM}	1.5	A
Power dissipation $T_{amb} \leqq 25\,°C$	P_V	100	mW
Junction temperature	T_j	100	°C
Detector			
Collector-emitter voltage	V_{CEO}	32	V
Emitter-collector voltage	V_{ECO}	5	V
Collector current	I_C	100	mA
Power dissipation $T_{amb} \leqq 25\,°C$	P_V	150	mW
Junction temperature	T_j	125	°C
Coupled device			
DC isolation voltage $t = 1$ min	V_{is}¹)	500	V
Total power dissipation $T_{amb} \leqq 25\,°C$	P_{tot}	250	mW
Storage temperature range	T_{stg}	$-55 \ldots +100$	°C

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¹) related to standard climate 23/50 DIN 50 014

Electrical characteristics

$T_{amb} = 25\,°C$		Min.	Typ.	Max.	
Emitter					
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
Detector					
Collector-emitter breakdown voltage $I_C = 1$ mA	$V_{(BR)\,CEO}$*)	32			V
Collector dark current $V_{CE} = 10$ V, $I_F = 0$, $E = 0$	I_{CEO}*)		2	100	nA
Collector emitter capacitance $V_{CE} = 0$, $f = 1$ MHz	C_{CEO}		7		pF
$V_{CE} = 10$ V, $f = 1$ MHz	C_{CEO}		3.5		pF
$V_{CE} = 30$ V, $f = 1$ MHz	C_{CEO}		2.5		pF

Coupled device

Group	Collector current I_C $V_{CE} = 5$ V, $I_F = 10$ mA	Current transfer ratio CTR $V_{CE} = 5$ V, $I_F = 10$ mA
III	min. 2.5 max. 5.0	min. 0.25 max. 0.5
IV	min. 4.0 max. 8.0	min. 0.4 max. 0.8
V	min. 6.0 max. 12.0	min. 0.6 max. 1.2
VI	min. 10.0 max. 20.0	min. 1.0 max. 2.0

---

*) AQL = 0.65 %

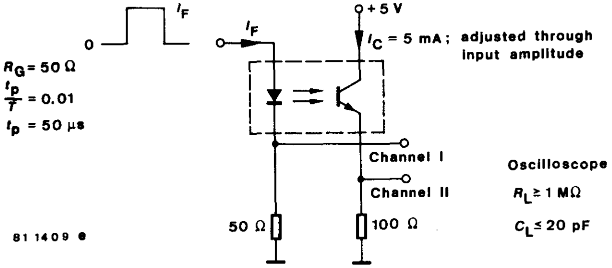
CNY 18

		Min.	Typ.	Max.	
Isolation resistance $V_{is} = 500$ V, 40% relative humidity	R_{is}**) ¹)	10^{10}			Ω
Collector-emitter saturation voltage $I_C = 1$ mA, $I_F = 10$ mA	V_{CEsat}*)			0.2	V
Cut-off frequency $V_{CE} = 5$ V, $I_F = 10$ mA, $R_L = 100\ \Omega$	f_c		170		kHz
Coupling cpacitances $f = 1$ MHz					
A & K short-cctd. → E & C short-cctd.	C_k		1.4		pF
A & K short-cctd. → C (E earthed)	C_k		1.1		pF
A & K short-cctd. → E (C earthed)	C_k		0.1		pF

Switching characteristics

$V_S = 5$ V, $I_C = 5$ mA, $R_L = 100\ \Omega$, see test circuit

		Min.	Typ.	Max.	
Delay time	t_d		1.8		µs
Rise time	t_r		1.6		µs
Turn-on time	t_{on}		3.4		µs
Storage time	t_s		0.3		µs
Fall time	t_f		1.7		µs
Turn-off time	t_{off}		2.0		µs



Test circuit

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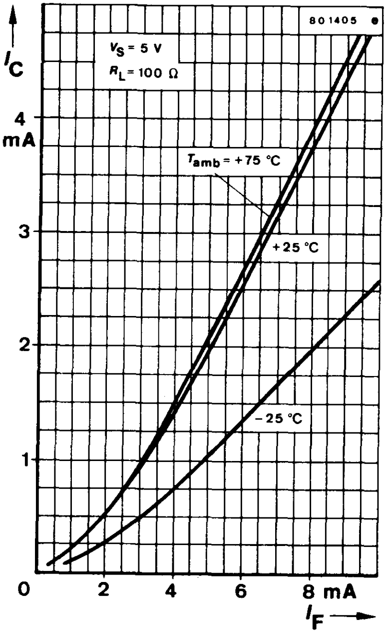
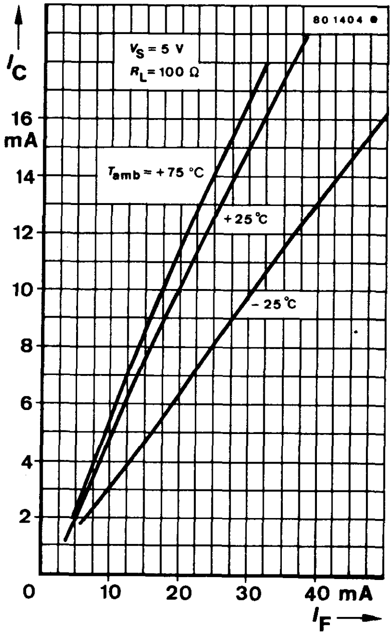
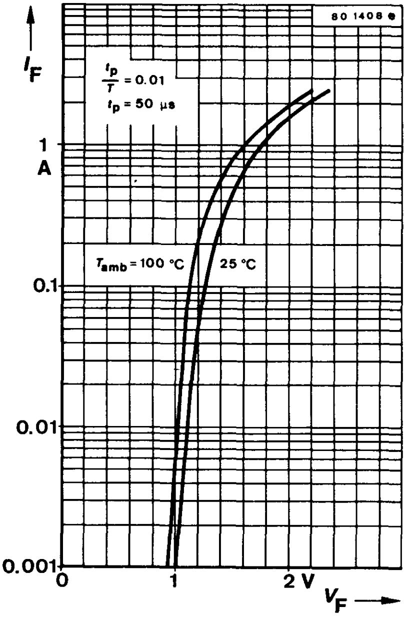
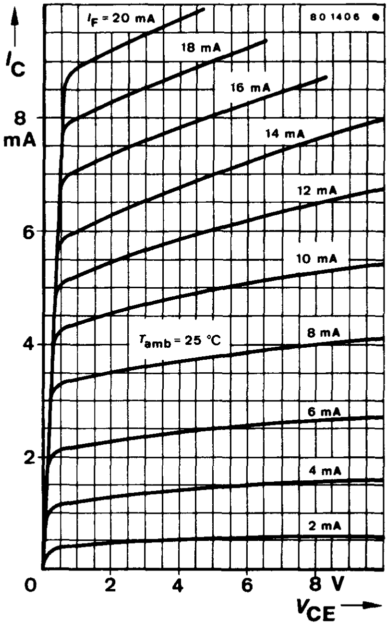
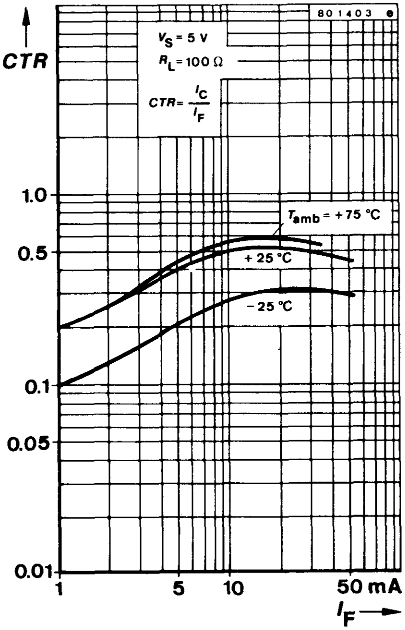
*) AQL = 0.65 %, **) AQL = 2.5 %, ¹) related to standard climate 23/50 DIN 50 014

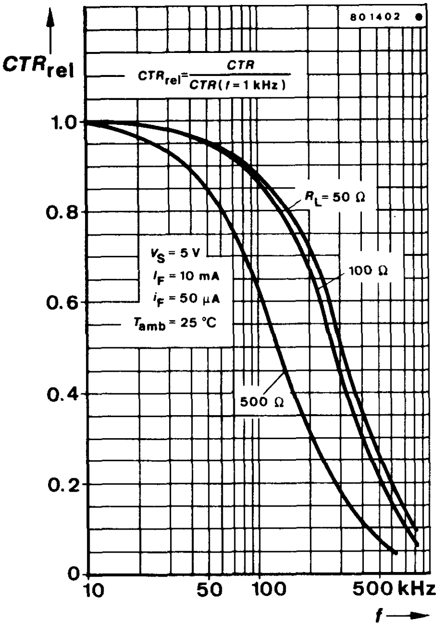

80 1405
V_S = 5 V
R_L = 100 Ω
I_C
4 mA
3
2
1
0
2
4
6
8 mA
I_F
T_{amb} = +75 °C
+25 °C
−25 °C

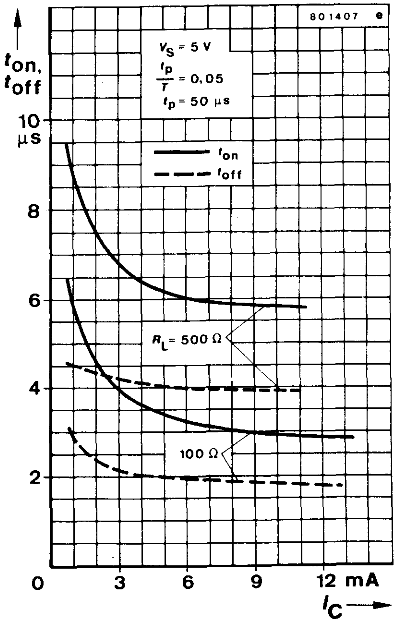

80 1404
V_S = 5 V
R_L = 100 Ω
I_C
16 mA
14
12
10
8
6
4
2
0
10
20
30
40 mA
I_F
T_{amb} = +75 °C
+25 °C
−25 °C


80 1408
$\frac{t_p}{T}$ = 0.01
t_p = 50 µs
I_F
1 A
0.1
0.01
0.001
0
1
2 V
V_F
T_{amb} = 100 °C
25 °C


80 1406
I_F = 20 mA
18 mA
16 mA
14 mA
12 mA
10 mA
8 mA
6 mA
4 mA
2 mA
T_{amb} = 25 °C
I_C
8 mA
6
4
2
0
2
4
6
8 V
V_{CE}


801403
CTR
V_S = 5 V
R_L = 100 Ω
CTR = $\frac{I_C}{I_F}$
T_{amb} = +75 °C
+ 25 °C
− 25 °C
1.0
0.5
0.1
0.05
0.01
1
5
10
50 mA
I_F


801402
CTR_{rel}
$CTR_{rel} = \frac{CTR}{CTR(f = 1\ kHz)}$
R_L = 50 Ω
100 Ω
500 Ω
V_S = 5 V
I_F = 10 mA
i_F = 50 µA
T_{amb} = 25 °C
1.0
0.8
0.6
0.4
0.2
0
10
50
100
500 kHz
f


801407
t_{on}, t_{off}
V_S = 5 V
$\frac{t_p}{T}$ = 0,05
t_p = 50 µs
t_{on}
t_{off}
R_L = 500 Ω
100 Ω
10 µs
8
6
4
2
0
3
6
9
12 mA
I_C

CNY 21

UL Recognised
VDE tested device[1]

Optically Coupled Isolator in TO 116 Case

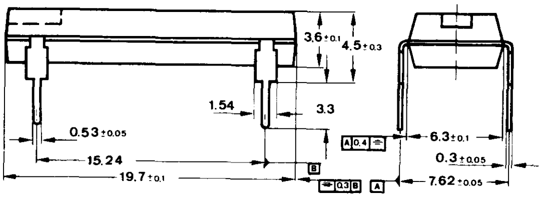
Construction	Emitter:	GaAs Infrared Emitting Diode
	Detector:	Silicon NPN Epitaxial Planar Phototransistor

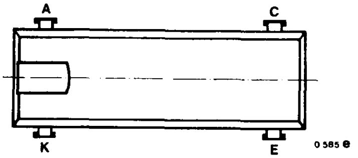
Applications: Galvanically separated circuits,
Non-interacting switches

Features:

- DC isolation voltage 10 kV–
- Nominal isolation operating voltage[1]
  1500 V or 1800 V– for isolation group B
  according to VDE 0110/11.72
- Test class 25/100/21 DIN 40045
- Low coupling capacity typ. 0.3 pF
- Current transfer ratio typ. 0.6
- Suitable in circuits with intrinsic safety (Ex) i G 5[2]

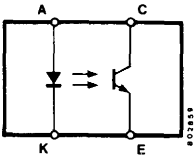
Dimensions in mm





Creeping distance ≥ 12 mm[3]
Air path ≥ 9 mm[3]

Plastic case
≈ JEDEC TO 116
Weight max. 1.5 g



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[1] UL Recognised, File No. E-76222 dated 28. 4. 81, according to VDE test certificate dated 9. 8. 1976 / 2. 7. 1979

[2] According to test certificate Nr. III B/E-26507 U of PTB

[3] Creeping current resistance: Group I according to VDE 0110 § 6 table 3 and DIN 53480 / VDE 0303 part 1

S 1.2. 131/0781 E

CNY 21

Absolute maximum ratings

Emitter			
Reverse voltage	V_R	5	V
Forward current	I_F	50	mA
Forward surge current $t_p \leq 10\ \mu s$	I_{FSM}	1.5	A
Power dissipation $T_{amb} \leqq 25\,°C$	P_V	120	mW
Junction temperature	T_j	100	°C
Detector			
Collector-emitter voltage	V_{CEO}	32	V
Emitter-collector voltage	V_{ECO}	5	V
Collector current	I_C	50	mA
Peak collector current $\frac{t_p}{T} = 0.5,\ t_p \leqq 10$ ms	I_{CM}	100	mA
Power dissipation $T_{amb} \leq 25\,°C$	P_V	130	mW
Junction temperature	T_j	100	°C
Coupled device			
DC isolation voltage $t = 1$ min	V_{is}¹)	10	kV
Total power dissipation $T_{amb} \leqq 25\,°C$	P_{tot}	250	mW
Storage temperature range	T_{stg}	$-55 \ldots +100$	°C

Electrical characteristics

$T_{amb} = 25\,°C$

		Min.	Typ.	Max.	
Emitter					
Forward voltage $I_F = 50$ mA	V_F*)		1.25	1.6	V
Breakdown voltage $I_R = 100\ \mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0,\ f = 1$ MHz	C_j		50		pF

---

*) AQL = 0.65 %

¹) related to standard climate 23/50 DIN 50 014

		Min.	Typ.	Max.	
Detector					
Collector-emitter breakdown voltage $I_C = 1$ mA	$V_{(BR)CEO}$*)	32			V
Collector dark current $V_{CE} = 20$ V, $I_F = 0$, $E = 0$	I_{CEO}*)		10	200	nA
Coupled device					
DC isolation voltage $t = 1$ min	V_{is}*) ¹)	10			kV
Isolation resistance $V_{is} = 1000$ V, 40 % rel. humidity	R_{is}¹)		10^{14}		Ω
Collector current $I_F = 10$ mA, $V_{CE} = 5$ V	I_C*)	2.5	5		mA
$I_F = 20$ mA, $V_{CE} = 5$ V	I_C	5	10		mA
Current transfer ratio $I_F = 10$ mA, $V_{CE} = 5$ V	CTR	0.25	0.6		
Collector-emitter saturation voltage $I_F = 10$ mA, $I_C = 1$ mA	V_{CEsat}*)			0.3	V
Cut-off frequency $I_F = 5$ mA, $V_{CE} = 5$ V, $R_L = 100$ Ω	f_c		170		kHz
Coupling capacitance $f = 1$ MHz	C_k		0.3		pF
Switching characteristics $V_S = 5$ V, $I_C = 5$ mA, $R_L = 100$ Ω, see test circuit					
Delay time	t_d		1.8		μs
Rise time	t_r		1.6		μs
Turn-on time	t_{on}		3.4		μs
Storage time	t_s		0.3		μs
Fall time	t_f		1.7		μs
Turn-off time	t_{off}		2.0		μs

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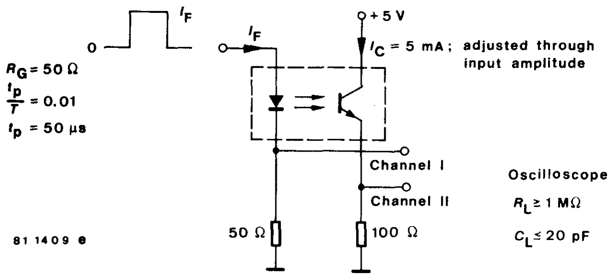
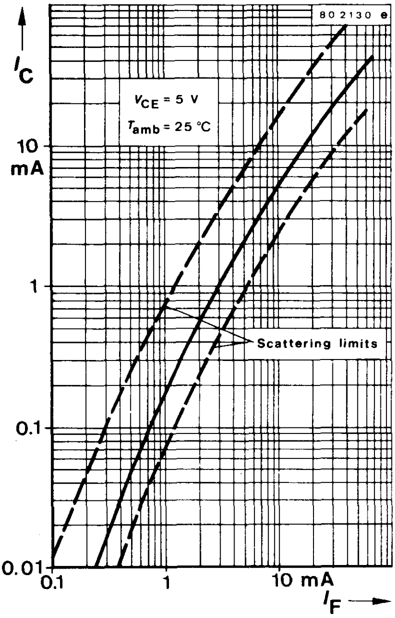
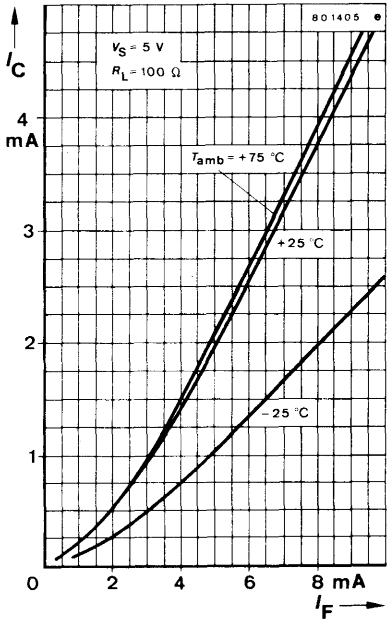
*) AQL = 0.65 %

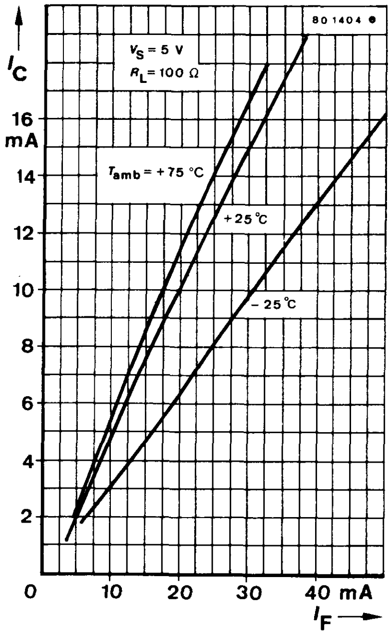
¹) related to standard climate 23/50 DIN 50 014

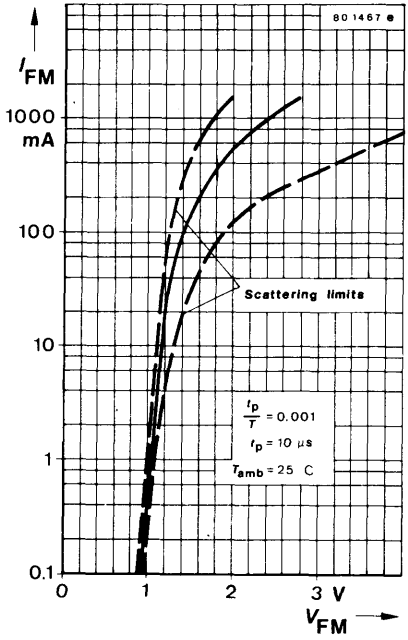


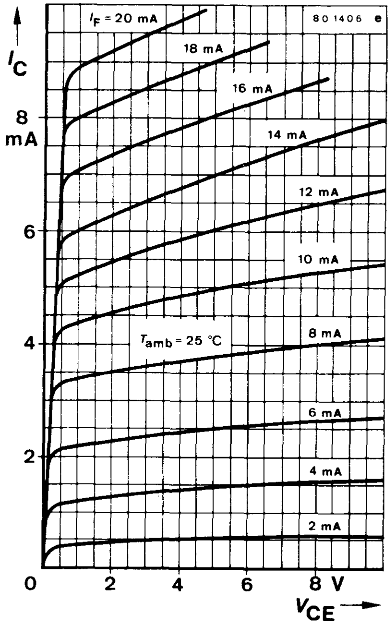
Test circuit

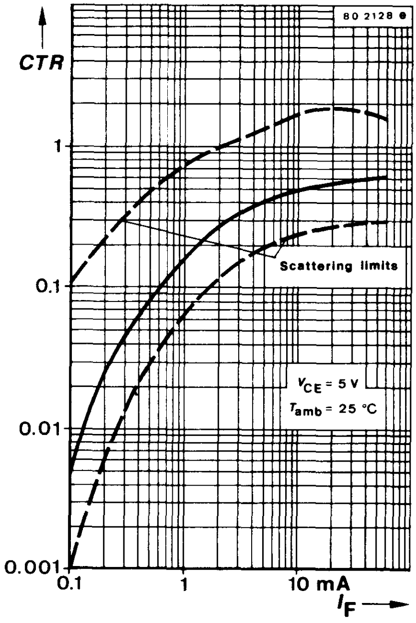




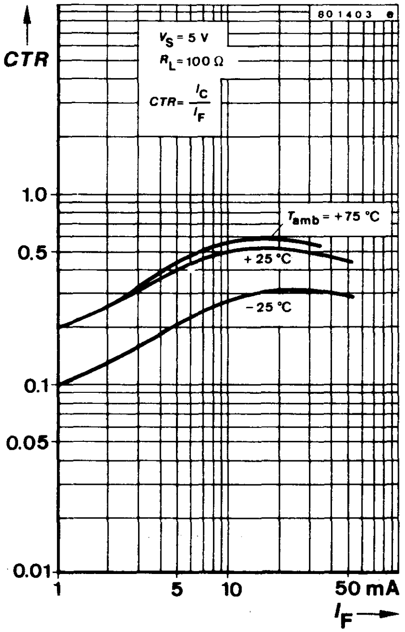

80 1404 e
I_C
16 mA
14
12
10
8
6
4
2
0
10
20
30
40 mA
I_F
V_S = 5 V
R_L = 100 Ω
T_{amb} = + 75 °C
+ 25 °C
– 25 °C

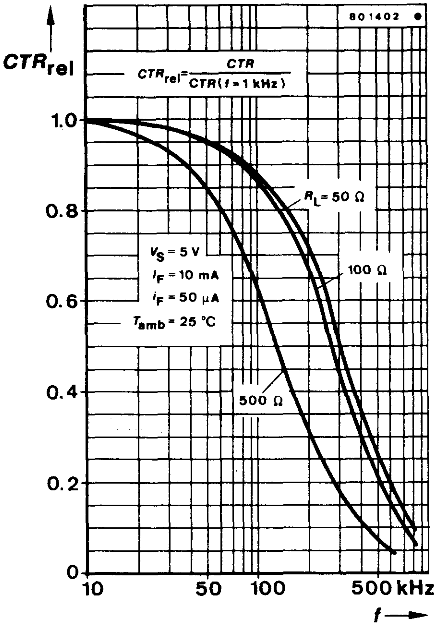

80 1467 e
I_{FM}
1000 mA
100
10
1
0.1
0
1
2
3 V
V_{FM}
Scattering limits
$\frac{t_p}{T}$ = 0.001
t_p = 10 µs
T_{amb} = 25 °C

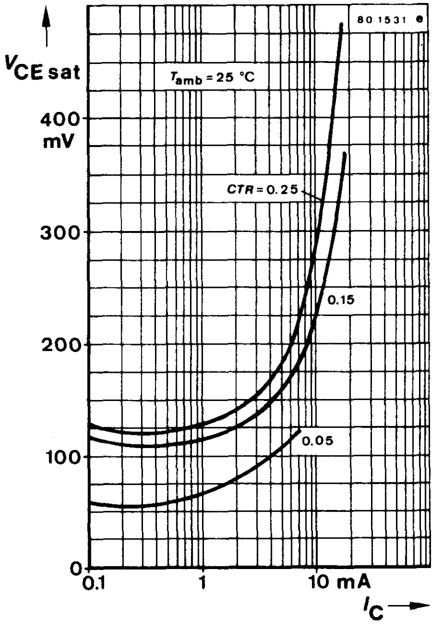

80 1406 e
I_C
8 mA
6
4
2
0
2
4
6
8 V
V_{CE}
I_F = 20 mA
18 mA
16 mA
14 mA
12 mA
10 mA
8 mA
6 mA
4 mA
2 mA
T_{amb} = 25 °C

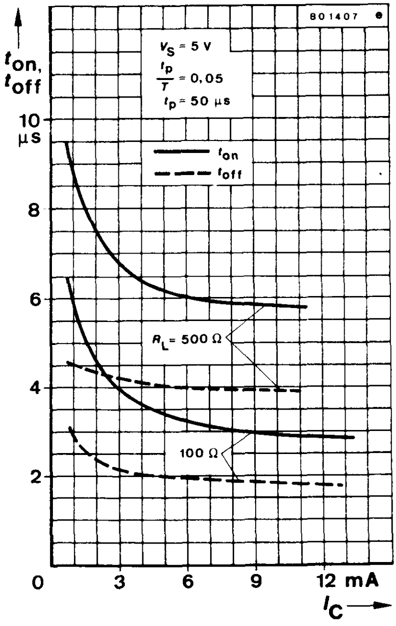

80 2128 e
CTR
1
0.1
0.01
0.001
0.1
1
10 mA
I_F
Scattering limits
V_{CE} = 5 V
T_{amb} = 25 °C

CNY 21


801403
CTR
$V_S = 5$ V
$R_L = 100\ \Omega$
$CTR = \frac{I_C}{I_F}$
1.0
0.5
0.1
0.05
0.01
$T_{amb} = +75$ °C
+25 °C
−25 °C
1
5
10
50 mA
I_F

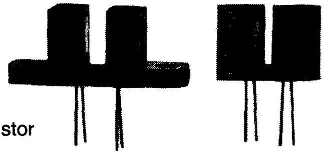

801402
CTR_{rel}
$CTR_{rel} = \frac{CTR}{CTR(f = 1\ kHz)}$
1.0
0.8
0.6
0.4
0.2
0
$R_L = 50\ \Omega$
100 Ω
500 Ω
$V_S = 5$ V
$I_F = 10$ mA
$i_F = 50\ \mu A$
$T_{amb} = 25$ °C
10
50
100
500 kHz
f


801531
$V_{CE\,sat}$
$T_{amb} = 25$ °C
400 mV
300
200
100
0
$CTR = 0.25$
0.15
0.05
0.1
1
10 mA
I_C


801407
t_{on}, t_{off}
$V_S = 5$ V
$\frac{t_p}{T} = 0.05$
$t_p = 50\ \mu s$
t_{on}
t_{off}
10 µs
8
6
4
2
0
$R_L = 500\ \Omega$
100 Ω
3
6
9
12 mA
I_C

CNY 36 · CNY 37

Photon coupled interrupter modules



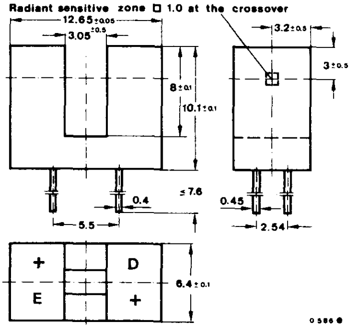
Construction Emitter: GaAs-IR Infrared Emitting Diode
Detector: Silicon NPN Epitaxial Planar Phototransistor

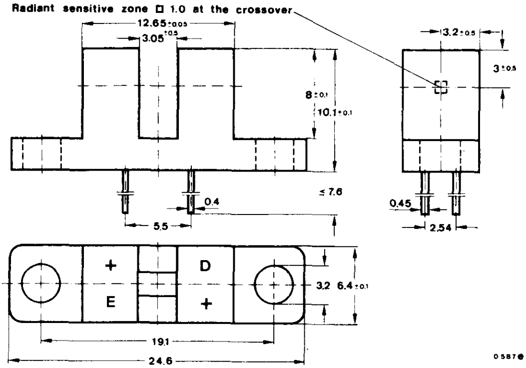
Applications: Opto-electronic scanning and switching devices i. e., index sensing, coded disk scanning etc. (opto-electronic enconder assemblies for transmissive sensing)

Features:

- Compact construction
- CNY 36 for printed circuit board
- CNY 37 with mounting flange
- No setting efforts
- Contact free switching, therefore, high reliability
- Plastic case

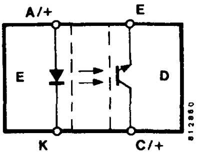
Dimensions in mm





CNY 36

CNY 37



Plastic case

CNY 36 · CNY 37

Absolute maximum ratings

Emitter			
Reverse voltage	V_R	5	V
Forward current	I_F	60	mA
Forward surge current $\frac{t_p}{T} = 0.01$, $t_p \leq 0.1$ ms	I_{FSM}	1	A
Power dissipation $T_{amb} \leq 25\,°C$	P_V	100	mW
Junction temperature	T_j	85	°C
Detector			
Collector-emitter voltage	V_{CEO}	32	V
Emitter-collector voltage	V_{ECO}	5	V
Collector current	I_C	100	mA
Power dissipation $T_{amb} \leq 25\,°C$	P_V	150	mW
Junction temperature	T_j	85	°C
Coupled device			
Total power dissipation $T_{amb} \leq 25\,°C$	P_{tot}	250	mW
Storage temperature range	T_{stg}	−25 ... +85	°C
Soldering temperature, maximal $t \leq 3$ s	T_{sd}[1])	245	°C

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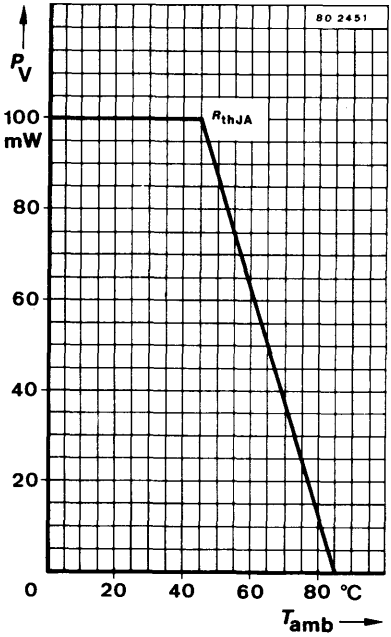
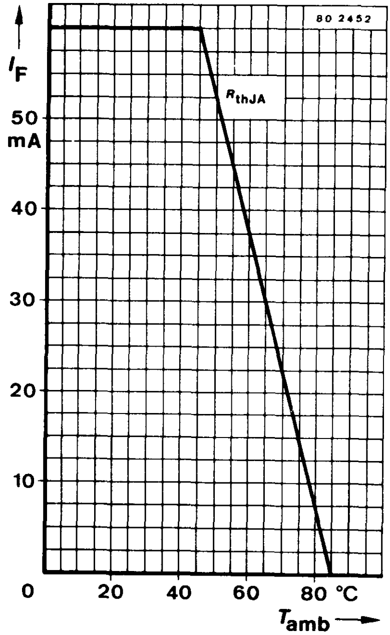
*) AQL = 0.65 %

[1]) Distance from the touching border ≥ 2 mm





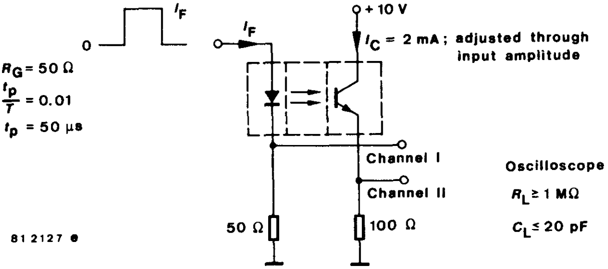
Electrical characteristics
$T_{amb} = 25°C$

		Min.	Typ.	Max.	
Emitter					
Forward voltage $I_F = 20$ mA	V_F*)		1.2	1.5	V
Breakdown voltage $I_R = 100\ \mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz	C_j		50		pF
Detector					
Collector-emitter breakdown voltage $I_C = 1$ mA	$V_{(BR)CEO}$*)	32			V
Collector dark current $V_{CE} = 10$ V, $I_F = 0, E = 0$	I_{CEO}*)			100	nA

---

*) AQL = 0.65 %

		Min.	Typ.	Max.	
Coupled device					
Collector current $V_{CE} = 10$ V, $I_F = 20$ mA	I_C	0.2	0.8		mA
Current transfer ratio $V_{CE} = 10$ V, $I_F = 20$ mA	CTR	0.01	0.04		
Collector dark current $V_{CE} = 10$ V, $I_F = 20$ mA, $E = 0$, closed aperture	I_{CEO}[1])		0.1		μA
Collector-emitter saturation voltage $I_C = 25$ μA, $I_F = 20$ mA	V_{CEsat}*)			0.4	V
Switching characteristics $V_S = 10$ V, $I_C = 2$ mA, $R_L = 100\ \Omega$, see test circuit					
Delay time	t_d		1.8		μs
Rise time	t_r		2.5		μs
Turn-on time	t_{on}		4.3		μs
Storage time	t_s		0.3		μs
Fall time	t_f		3.3		μs
Turn-off time	t_{off}		3.6		μs



Test circuit

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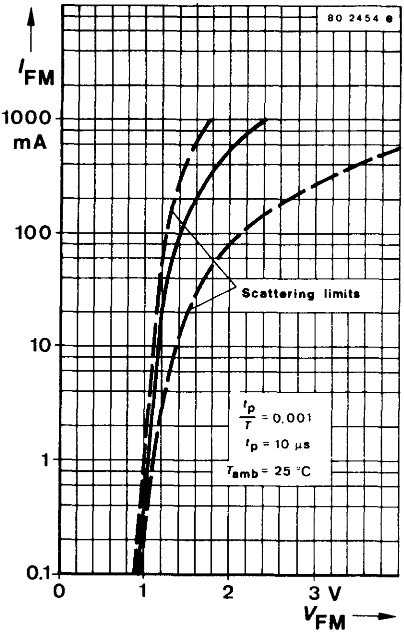
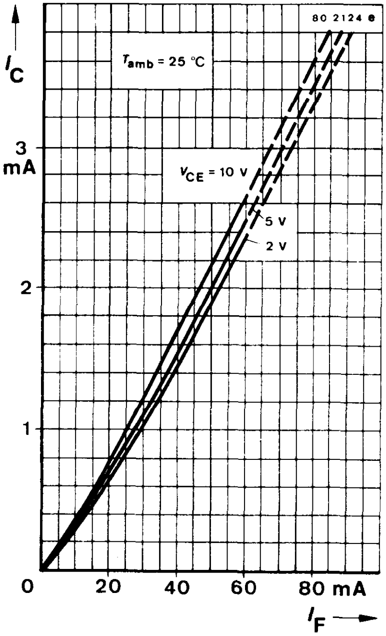
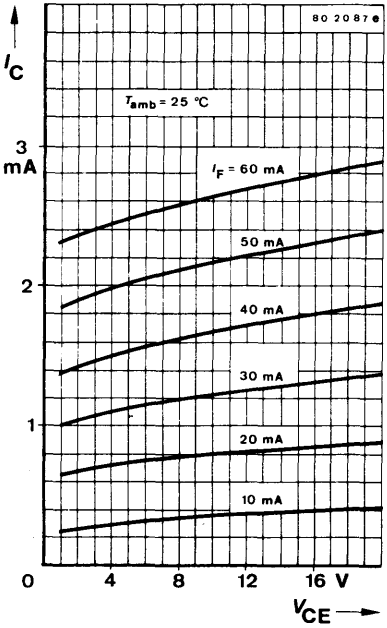
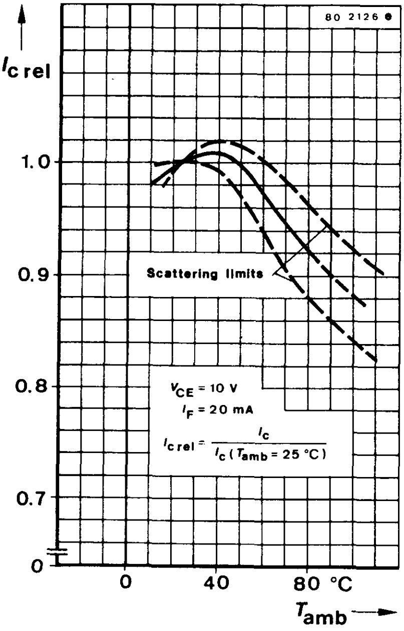
*) AQL = 0.65 %

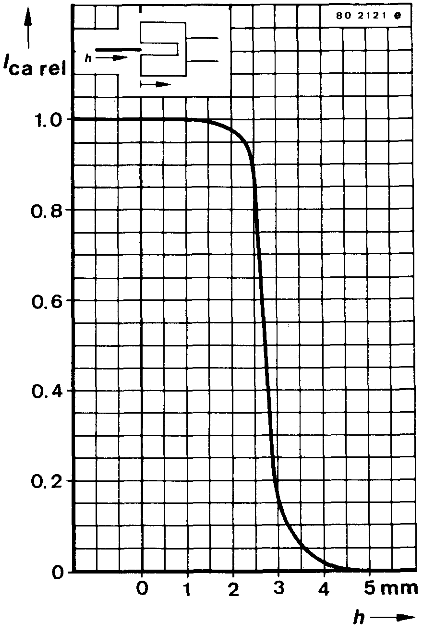
[1]) Scattering limits: 0.03 ... 1 μA

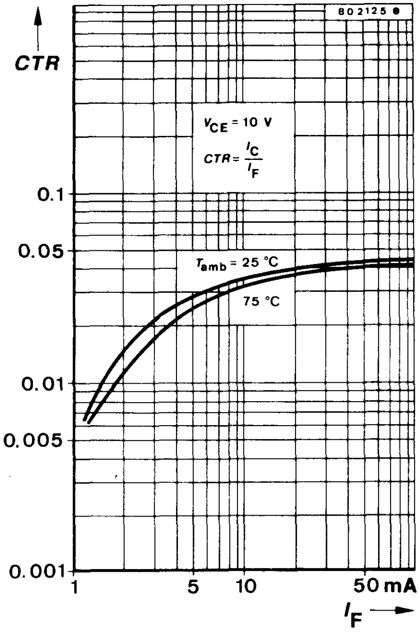

80 2454 e
I_{FM}
1000 mA
100
10
1
0.1
0
1
2
3 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$


80 2124 e
I_C
3 mA
2
1
0
20
40
60
80 mA
I_F
$T_{amb} = 25\ °C$
$V_{CE} = 10\ V$
5 V
2 V


80 2087 e
I_C
3 mA
2
1
0
4
8
12
16 V
V_{CE}
$T_{amb} = 25\ °C$
$I_F = 60\ mA$
50 mA
40 mA
30 mA
20 mA
10 mA


80 2126 e
$I_{C\,rel}$
1.0
0.9
0.8
0.7
0
0
40
80 °C
T_{amb}
Scattering limits
$V_{CE} = 10\ V$
$I_F = 20\ mA$
$I_{C\,rel} = \frac{I_C}{I_C\,(T_{amb} = 25\ °C)}$

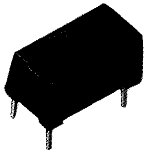

80 2121 e
$I_{ca\ rel}$
1.0
0.8
0.6
0.4
0.2
0
h
0
1
2
3
4
5 mm
h


80 2125 e
CTR
V_{CE} = 10 V
$CTR = \frac{I_C}{I_F}$
0.1
0.05
0.01
0.005
0.001
T_{amb} = 25 °C
75 °C
1
5
10
50 mA
I_F

CNY 64

VDE tested device[1]

Optically Coupled Isolator



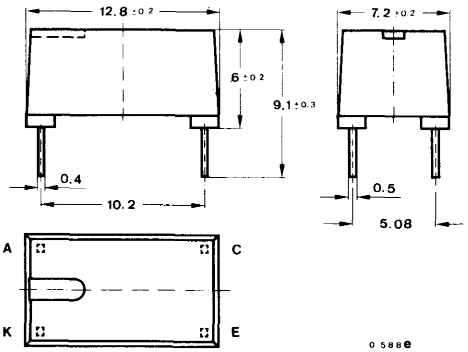
Construction	Emitter:	GaAs Infrared Emitting Diode
	Detector:	Silicon NPN Epitaxial Planar Phototransistor
Applications:		Galvanically separated circuits, Non-interacting switches

Features:

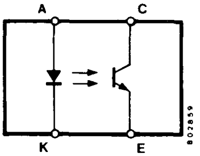
- DC isolation voltage 8.2 kV–
- Nominal isolation operating voltage[1] 1000 V~ or 1200 V– for isolation group B according to VDE 0110 b/2.79
- Test class 25/100/21 DIN 40045
- Low coupling capacity typ. 0.3 pF
- Current transfer ratio typ. 1
- ● Also available as a device for intrinsically safe circuits: CNY 64 Exi[2]

Preliminary specifications

Dimensions in mm



Creeping distance ≥ 9.5 mm[3]
Air path ≥ 9.5 mm[3]
Plastic case
Weight max. 1.5 g



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[1] Certificate according to VDE 0883/6.80 in applied

[2] According to EN 50020 or VDE 0170/0171 from 5. 78. PTB certificate is applied.

[3] Creeping current resistance: Group III (KB > 600 – KC > 600) according to VDE 0110 b/2.79 § 6 table 3 and DIN 53480 / VDE 0303 part 1/10.76

Absolute maximum ratings

Emitter			
Reverse voltage	V_R	5	V
Forward current	I_F	75	mA
Forward surge current $t_p \leq 10\,\mu s$	I_{FSM}	1.5	A
Power dissipation $T_{amb} \leq 25\,°C$	P_V	120	mW
Junction temperature	T_j	100	°C
Detector			
Collector-emitter voltage	V_{CEO}	32	V
Emitter-collector voltage	V_{ECO}	7	V
Collector current	I_C	50	mA
Peak collector current $\frac{t_p}{T} = 0.5$, $t_p \leq 10$ ms	I_{CM}	100	mA
Power dissipation $T_{amb} \leq 25\,°C$	P_V	130	mW
Junction temperature	T_j	100	°C
Coupled device			
DC isolation voltage $t = 1$ min	V_{is}¹)	8.2	kV
Total power dissipation $T_{amb} \leq 25\,°C$	P_{tot}	250	mW
Storage temperature range	T_{stg}	−55 ... +100	°C

---

¹) related to standard climate 23/50 DIN 50 014

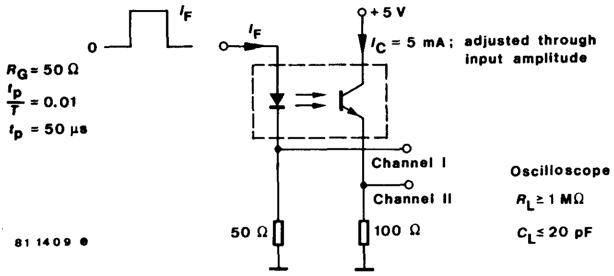
Electrical characteristics $T_{amb} = 25\,°C$		**Min.**	**Typ.**	**Max.**	
Emitter					
Forward voltage $I_F = 50$ mA	V_F*)		1.25	1.6	V
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0$, $f = 1$ MHz	C_j		50		pF
Detector					
Collector-emitter breakdown voltage $I_C = 1$ mA	$V_{(BR)CEO}$*)	32			V
Emitter-collector breakdown voltage $I_E = 100\,\mu A$	$V_{(BR)ECO}$*)	7			V
Collector cut-off current $V_{CE} = 20$ V, $I_F = 0$, $E = 0$	I_{CEO}*)		10	200	nA
Coupled device					
DC isolation voltage $t = 1$ min	V_{is}*) ¹)	8.2			kV
Isolation resistance $V_{is} = 1000$ V, 40 % rel. humidity	R_{is}¹)		10^{12}		Ω
Collector current $I_F = 10$ mA, $V_{CE} = 5$ V	I_C*)	5	10	30	mA
$I_F = 20$ mA, $V_{CE} = 5$ V	I_C*)	12			mA
Current transfer ratio $I_F = 10$ mA, $V_{CE} = 5$ V	CTR	0.5	1.0	3.0	
Collector-emitter saturation voltage $I_F = 10$ mA, $I_C = 1$ mA	V_{CEsat}*)			0.3	V
Cut-off frequency $I_F = 10$ mA, $V_{CE} = 5$ V, $R_L = 100\,\Omega$	f_c		110		kHz
Coupling capacitance $f = 1$ MHz	C_k		0.3		pF

---

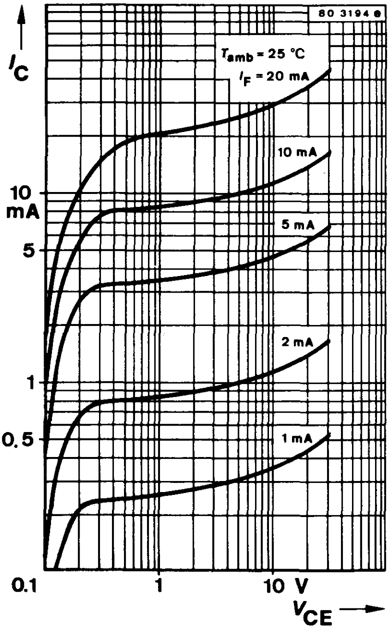
*) AQL = 0.65 %

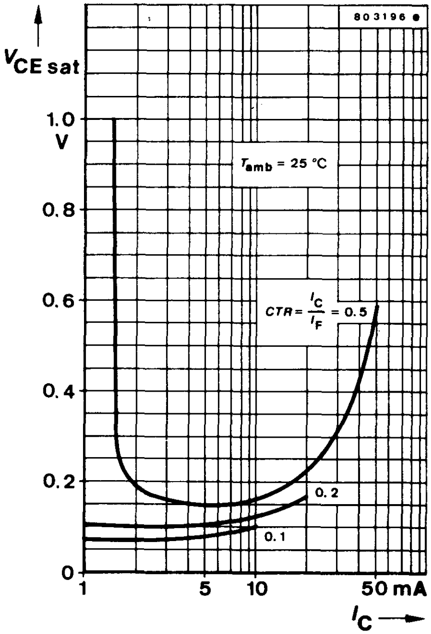
[1] related to standard climate 23/50 DIN 50 014

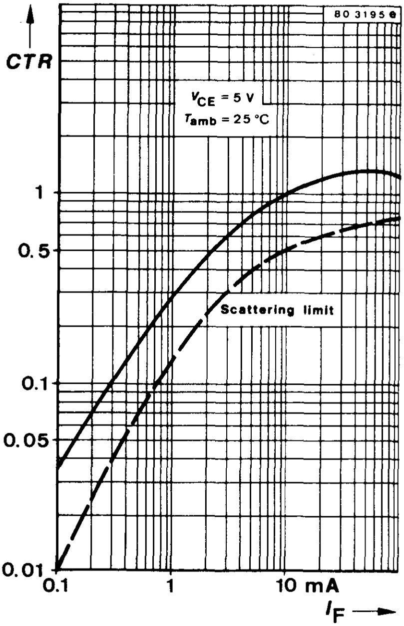
Switching characteristics $V_S = 5$ V, $I_C = 5$ mA, $R_L = 100\ \Omega$, see test circuit		Min.	Typ.	Max.	
Delay time	t_d		2.5		μs
Rise time	t_r		4.5		μs
Turn-on time	t_{on}		7.0		μs
Storage time	t_s		0.3		μs
Fall time	t_f		3.7		μs
Turn-off time	t_{off}		4.0		μs



Test circuit


80 3194
I_C
T_{amb} = 25 °C
I_F = 20 mA
10 mA
5 mA
2 mA
1 mA
10
mA
5
1
0.5
0.1
1
10 V
V_{CE}

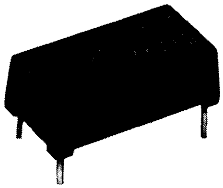

80 3196
$V_{CE\,sat}$
1.0
V
0.8
0.6
0.4
0.2
0
T_{amb} = 25 °C
$CTR = \frac{I_C}{I_F} = 0.5$
0.2
0.1
1
5
10
50 mA
I_C


80 3195
CTR
V_{CE} = 5 V
T_{amb} = 25 °C
1
0.5
0.1
0.05
0.01
Scattering limit
0.1
1
10 mA
I_F

CNY 65

UL Recognised
VDE tested device[1])

Optically Coupled Isolator



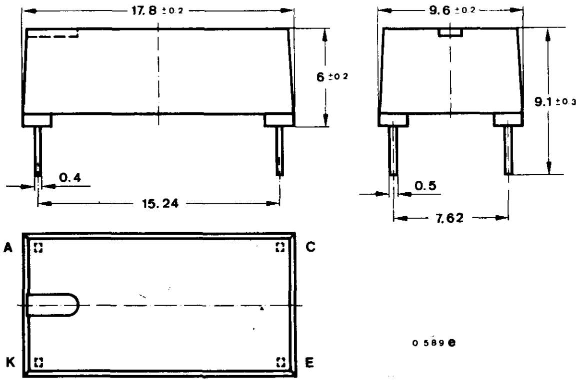
Construction	Emitter:	GaAs Infrared Emitting Diode
	Detector:	Silicon NPN Epitaxial Planar Phototransistor
Applications:		Galvanically separated circuits, Non-interacting switches

Features:

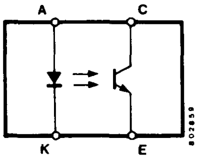
- DC isolation voltage 11.6 kV–
- Nominal isolation operating voltage[1])
  1500 V~ or 1800 V– for isolation group B according to VDE 0110 b/2.79
- Test class 25/100/21 DIN 40045
- Low coupling capacity typ. 0.3 pF
- Current transfer ratio typ. 1
- ● Also available as a device for intrinsically safe circuits: CNY 65 Exi[2])

Preliminary specifications

Dimensions in mm



Creeping distance ≥ 14.5 mm[3])
Air path ≥ 14.5 mm[3])
Plastic case
Weight max. 1.5 g



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[1]) UL Recognised, File No. E-76222, dated 28. 4. 81; Certificate according to VDE 0883/6.80 is applied

[2]) According to EN 50020 or VDE 0170/0171 from 5. 78. PTB certificate is applied.

[3]) Creeping current resistance: Group III (KB > 600– KC > 600) according to VDE 0110 b/2.79 § 6 table 3 and DIN 53480 / VDE 0303 part 1/10.76

CNY 65

Absolute maximum ratings

Emitter

Reverse voltage	V_R	5	V
Forward current	I_F	75	mA
Forward surge current $t_p \leq 10\,\mu s$	I_{FSM}	1.5	A
Power dissipation $T_{amb} \leq 25\,°C$	P_V	120	mW
Junction temperature	T_j	100	°C

Detector

Collector-emitter voltage	V_{CEO}	32	V
Emitter-collector voltage	V_{ECO}	7	V
Collector current	I_C	50	mA
Peak collector current $\frac{t_p}{T} = 0.5,\ t_p \leq 10$ ms	I_{CM}	100	mA
Power dissipation $T_{amb} \leq 25\,°C$	P_V	130	mW
Junction temperature	T_j	100	°C

Coupled device

DC isolation voltage	V_{is}[1])	11.6	kV
Total power dissipation $T_{amb} \leq 25\,°C$	P_{tot}	250	mW
Storage temperature range	T_{stg}	−55 ... +100	°C

---

[1]) related to standard climate 23/50 DIN 50 014

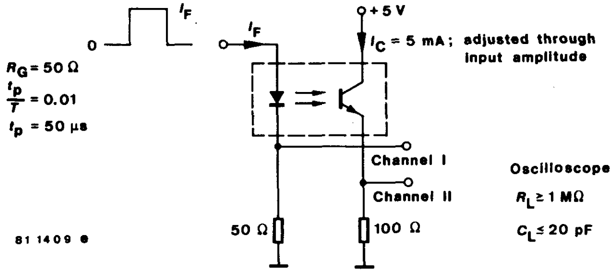
Electrical characteristics $T_{amb} = 25 °C$		**Min.**	**Typ.**	**Max.**	
Emitter					
Forward voltage $I_F = 50$ mA	V_F*)		1.25	1.6	V
Breakdown voltage $I_R = 100\ \mu$A	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz	C_j		50		pF
Detector					
Collector-emitter breakdown voltage $I_C = 1$ mA	$V_{(BR)\,CEO}$*)	32			V
Emitter-collector breakdown voltage $I_E = 100\ \mu$A	$V_{(BR)\,ECO}$*)	7			V
Collector cut-off current $V_{CE} = 20$ V, $I_F = 0$, $E = 0$	I_{CEO}*)		10	200	nA
Coupled device					
DC isolation voltage $t = 1$ min	V_{is}*) [1]	11.6			kV
Isolation resistance $V_{is} = 1000$ V, 40 % rel. humidity	R_{is}[1]		10^{12}		Ω
Collector current $I_F = 10$ mA, $V_{CE} = 5$ V	I_C*)	5	10	30	mA
$I_F = 20$ mA, $V_{CE} = 5$ V	I_C*)	12			mA
Current transfer ratio $I_F = 10$ mA, $V_{CE} = 5$ V	*CTR*	0.5	1.0	3.0	
Collector-emitter saturation voltage $I_F = 10$ mA, $I_C = 1$ mA	V_{CEsat}*)			0.3	V
Cut-off frequency $I_F = 10$ mA, $V_{CE} = 5$ V, $R_L = 100\ \Omega$	f_c		110		kHz
Coupling capacitance $f = 1$ MHz	C_k		0.3		pF

---

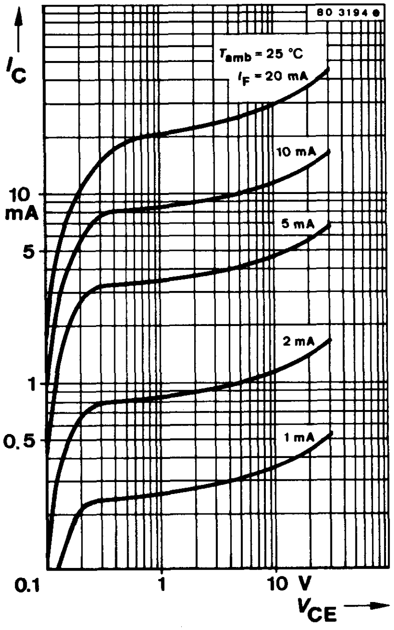
*) AQL = 0.65 %

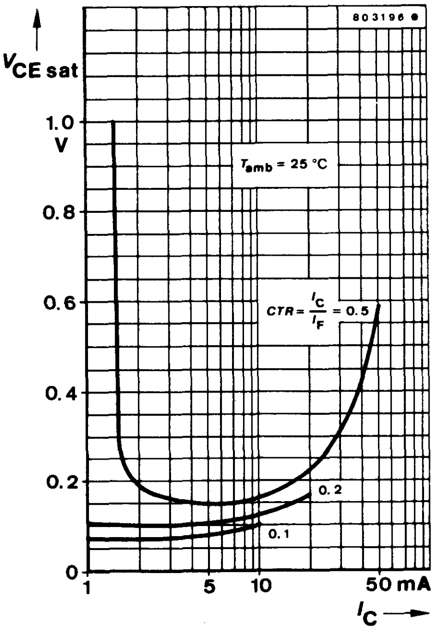
[1] related to standard climate 23/50 DIN 50 014

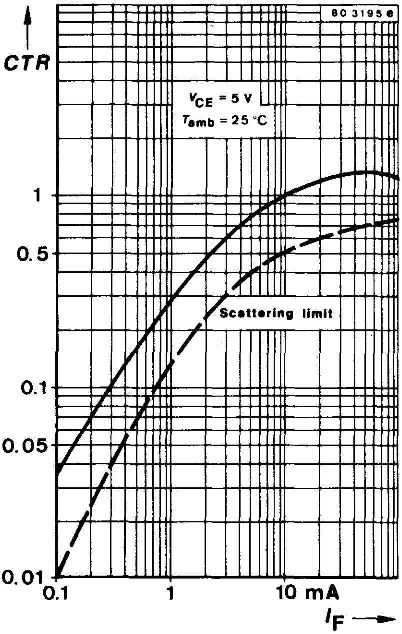
		Min.	Typ.	Max.	
Switching characteristics					
$V_S = 5$ V, $I_C = 5$ mA, $R_L = 100\ \Omega$, see test circuit					
Delay time	t_d		2.5		μs
Rise time	t_r		4.5		μs
Turn-on time	t_{on}		7.0		μs
Storage time	t_s		0.3		μs
Fall time	t_f		3.7		μs
Turn-off time	t_{off}		4.0		μs



Test circuit



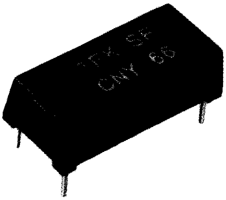



80 3195 e
CTR
V_{CE} = 5 V
T_{amb} = 25 °C
1
0.5
0.1
0.05
0.01
Scattering limit
0.1
1
10 mA
I_F

CNY 66

VDE tested device[1]

Optically Coupled Isolator



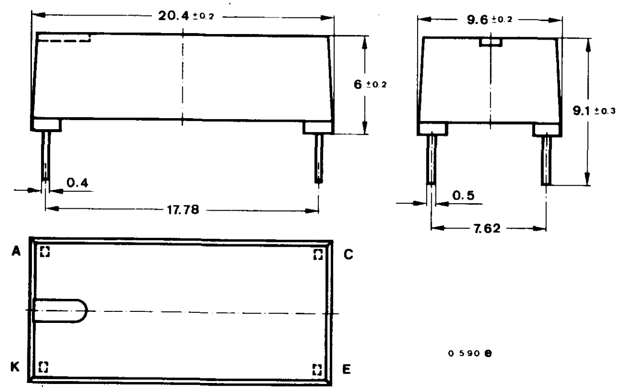
Construction	Emitter:	GaAs Infrared Emitting Diode
	Detector:	Silicon NPN Epitaxial Planar Phototransistor
Applications:		Galvanically separated circuits, Non-interacting switches

Features:

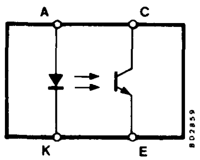
- DC isolation voltage 15 kV–
- Nominal isolation operating voltage[1] 2000 V~ or 2400 V– for isolation group B according to VDE 0110 b/2.79
- Test class 25/100/21 DIN 40 045
- Low coupling capacity typ. 0.3 pF
- Current transfer ratio typ. 1
- ● Also available as a device for intrinsically safe circuits: CNY 66 Exi[2]

Preliminary specifications

Dimensions in mm



Creeping distance ≥ 17 mm[3]
Air path ≥ 17 mm[3]
Plastic case
Weight max. 1.5 g



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[1] Certificate according to VDE 0883/6.80 is applied.

[2] According to EN 50 020 or VDE 0170/0171 from 5. 78. PTB certificate is applied.

[3] Creeping current resistance: Group III (KB > 600– KC > 600) according to VDE 0110 b/2.79 § 6 table 3 and DIN 53 480 / VDE 0303 part 1/10.76

Absolute maximum ratings

Emitter			
Reverse voltage	V_R	5	V
Forward current	I_F	75	mA
Forward surge current $t_p \leq 10\ \mu s$	I_{FSM}	1.5	A
Power dissipation $T_{amb} \leq 25°C$	P_V	120	mW
Junction temperature	T_j	100	°C
Detector			
Collector-emitter voltage	V_{CEO}	32	V
Emitter-collector voltage	V_{ECO}	7	V
Collector current	I_C	50	mA
Peak collector current $\frac{t_p}{T} = 0.5,\ t_p \leq 10$ ms	I_{CM}	100	mA
Power dissipation $T_{amb} \leq 25°C$	P_V	130	mW
Junction temperature	T_j	100	°C
Coupled device			
DC isolation voltage	V_{is} ¹)	15	kV
Total power dissipation $T_{amb} \leq 25°C$	P_{tot}	250	mW
Storage temperature range	T_{stg}	−55 ... +100	°C

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¹) related to standard climate 23/50 DIN 50 014

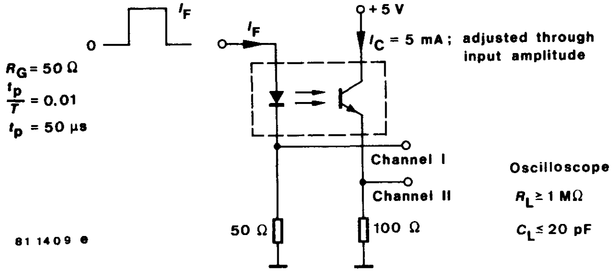
Electrical characteristics $T_{amb} = 25°C$		**Min.**	**Typ.**	**Max.**	
Emitter					
Forward voltage $I_F = 50$ mA	V_F*)		1.25	1.6	V
Breakdown voltage $I_R = 100\,\mu$A	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz	C_j		50		pF
Detector					
Collector-emitter breakdown voltage $I_C = 1$ mA	$V_{(BR)\,CEO}$*)	32			V
Emitter-collector breakdown voltage $I_E = 100\,\mu$A	$V_{(BR)\,ECO}$*)	7			V
Collector cut-off current $V_{CE} = 20$ V, $I_F = 0$, $E = 0$	I_{CEO}*)		10	200	nA
Coupled device					
DC isolation voltage $t = 1$ min	V_{is}*) ¹)	15			kV
Isolation resistance $V_{is} = 1000$ V, 40 % rel. humidity	R_{is}¹)		10^{12}		Ω
Collector current $I_F = 10$ mA, $V_{CE} = 5$ V	I_C*)	5	10	30	mA
$I_F = 20$ mA, $V_{CE} = 5$ V	I_C*)	12			mA
Current transfer ratio $I_F = 10$ mA, $V_{CE} = 5$ V	CTR	0.5	1.0	3.0	
Collector-emitter saturation voltage $I_F = 10$ mA, $I_C = 1$ mA	V_{CEsat}*)			0.3	V
Cut-off frequency $I_F = 10$ mA, $V_{CE} = 5$ V, $R_L = 100\,\Omega$	f_c		110		kHz
Coupling capacitance $f = 1$ MHz	C_k		0.3		pF

---

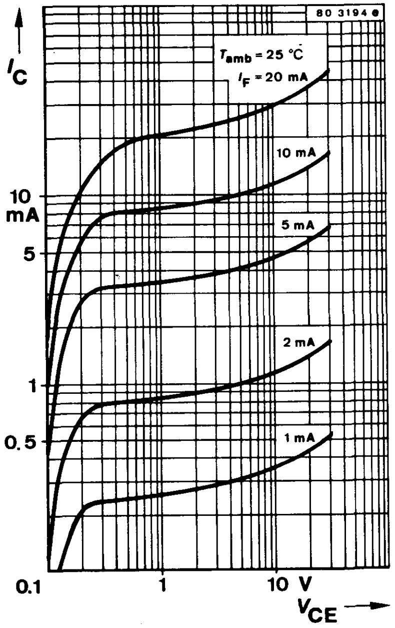
*) AQL = 0.65 %

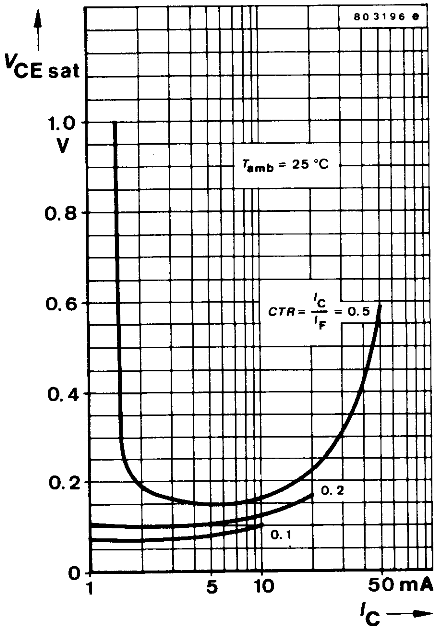
¹) related to standard climate 23/50 DIN 50 014

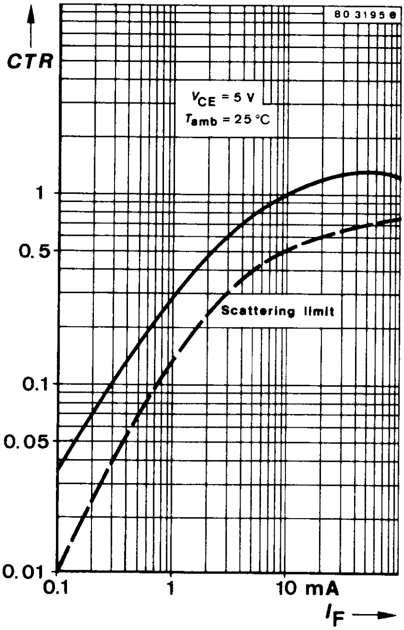
Switching characteristics		Min.	Typ.	Max.	
$V_S = 5$ V, $I_C = 5$ mA, $R_L = 100\ \Omega$, see test circuit					
Delay time	t_d		2.5		μs
Rise time	t_r		4.5		μs
Turn-on time	t_{on}		7.0		μs
Storage time	t_s		0.3		μs
Fall time	t_f		3.7		μs
Turn-off time	t_{off}		4.0		μs



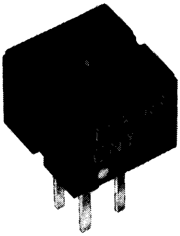
Test circuit






80 3195 e
CTR
V_{CE} = 5 V
T_{amb} = 25 °C
1
0.5
0.1
0.05
0.01
Scattering limit
0.1
1
10 mA
I_F

CNY 70



Reflective Optocoupler

Construction Emitter: GaAs-IR Infrared Emitting Diode
Detector: Silicon NPN Epitaxial Planar Phototransistor

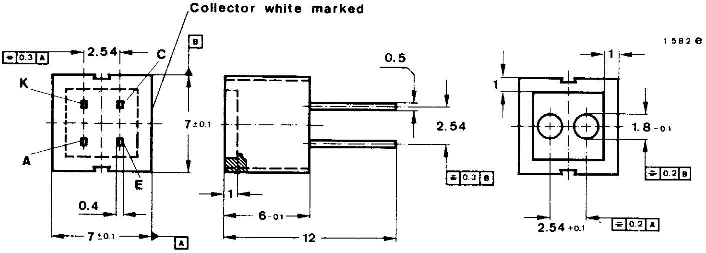
Applications: Opto-electronic scanning and switching devices i. e., index sensing, coded disk scanning etc. (opto-electronic encoder assemblies for transmissive sensing)

Features:

- Compact construction in centre-to-centre spacing of 0.1"
- No setting efforts
- High signal output
- Low temperature coefficient
- Low ambient light sensitivity due to IR-filter

Preliminary specifications

Dimensions in mm



Plastic case
Weight ca. 0.7 g

Absolute maximum ratings

Emitter			
Reverse voltage	V_R	5	V
Forward current	I_F	50	mA
Forward surge current $t_p \leq 10\ \mu s$	I_{FSM}	3	A
Power dissipation $T_{amb} \leq 25°C$	P_V	100	mW
Junction temperature	T_j	100	°C
Detector			
Collector-emitter voltage	V_{CEO}	32	V
Emitter-collector voltage	V_{ECO}	5	V
Collector current	I_C	50	mA
Power dissipation $T_{amb} \leq 25°C$	P_V	100	mW
Junction temperature	T_j	100	°C
Coupled device			
Total power dissipation $T_{amb} \leq 25°C$	P_{tot}	200	mW
Storage temperature range	T_{stg}	−55 ... +100	°C
Soldering temperature, maximal $t \leq 3$ s	T_{sd}[1]	245	°C

---

[1] Distance from the touching border ≥ 2 mm

Electrical characteristics $T_{amb} = 25°C$			**Min.**	**Typ.**	**Max.**	
Emitter						
Forward voltage $I_F = 50$ mA		V_F*)		1.25	1.6	V
Breakdown voltage $I_R = 100\,\mu A$		$V_{(BR)}$*)	5			V
Detector						
Collector-emitter breakdown voltage $I_C = 1$ mA		$V_{(BR)\,CEO}$*)	32			V
Emitter-collector breakdown voltage $I_E = 100\,\mu A$		$V_{(BR)\,ECO}$*)	5			V
Collector cut-off current $V_{CE} = 20$ V, $I_F = 0$, $E = 0$		I_{CEO}*)		10	200	nA
Coupled device						
Collector current $I_F = 20$ mA, $V_{CE} = 5$ V, $\alpha = 0.3$ mm	Fig. 1	I_C*)²)	0.3	0.5		mA
Cross talk current $I_F = 20$ mA, $V_{CE} = 5$ V		$I_{CX}{}^{3}$			200	nA
Collector-emitter saturation voltage $I_F = 20$ mA, $I_C = 0.1$ mA, $\alpha = 0.3$ mm	Fig. 1	V_{CEsat}*)²)			0.3	V

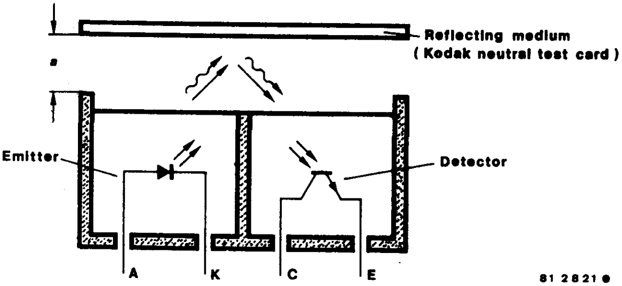


Fig. 1 Test circuit

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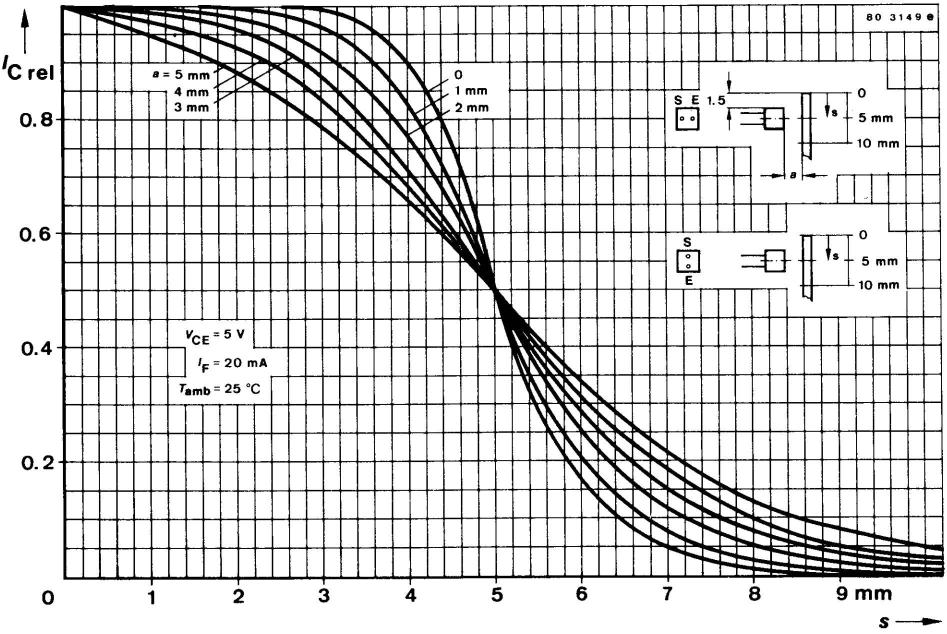
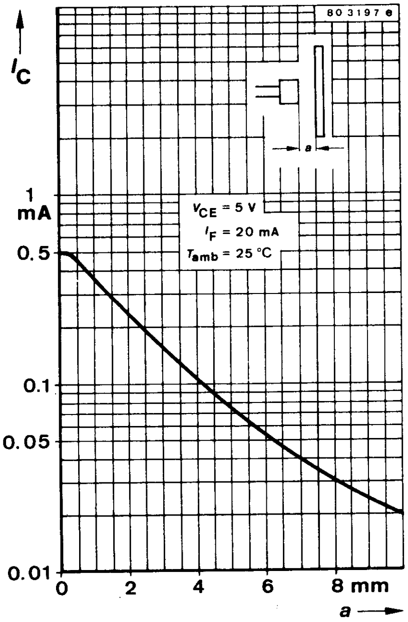
*) AQL = 0.65 %

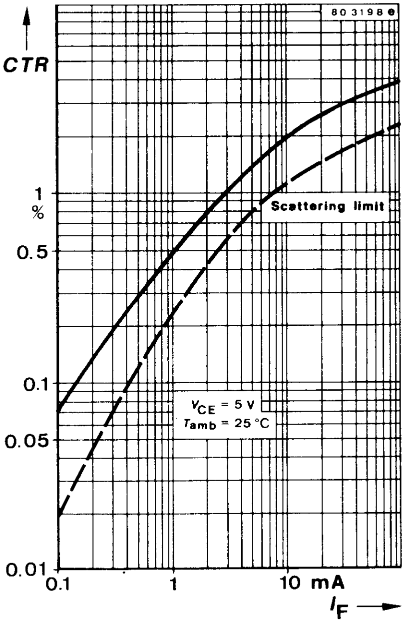
[2] Measured with the "Kodak neutral test card", white side with 90 % diffuse reflectance

[3] Measured without reflecting medium

CNY 70

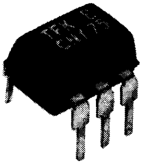

80 3149 e
$I_{C\,rel}$
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
8
9 mm
s
a = 5 mm
4 mm
3 mm
0
1 mm
2 mm
S E 1.5
0
5 mm
10 mm
s
a
S
E
0
5 mm
10 mm
s
V_{CE} = 5 V
I_F = 20 mA
T_{amb} = 25 °C


80 3197 e
I_C
1 mA
0.5
0.1
0.05
0.01
0
2
4
6
8 mm
a
a
V_{CE} = 5 V
I_F = 20 mA
T_{amb} = 25 °C


80 3198 e
CTR
1 %
0.5
0.1
0.05
0.01
0.1
1
10 mA
I_F
Scattering limit
V_{CE} = 5 V
T_{amb} = 25 °C

CNY 75

Optically Coupled Isolator



Construction Emitter: GaAs-IR Infrared Emitting Diode
Detector: Silicon NPN Epitaxial Planar Phototransistor

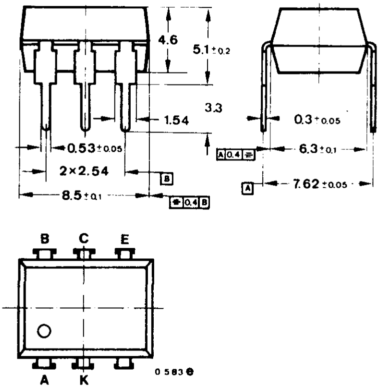
Applications: Galvanically separated circuits non-interacting switches

Features:

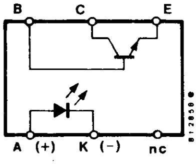
- DC isolation voltage 5.3 kV–[1])
- Nominal isolation operating voltage[1]) 500 V~ or 600 V– for isolation group C according to VDE 0110 b/2.79
- Test class 25/100/21 DIN 40 045
- Low coupling capacity typ. 0.3 pF
- Current transfer ratio *CTR* = 0.63 ... 3.2
- Current transfer ratio selected in groups
- Low temperature coefficient of the CTR

Preliminary specifications

Dimensions in mm



Creeping distance ≥ 8.6 mm[2])
Air path ≥ 7.4 mm[2])
Plastic case
Weight ca. 0.7 g



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[1]) According to VDE 0883/6.80. VDE-certificate is applied.

[2]) Creeping current resistance: Group I according to VDE 0110 § 6 table 3 and DIN 53 480/VDE 0303 part 1

CNY 75

Absolute maximum ratings

Emitter			
Reverse voltage	V_R	5	V
Forward current	I_F	60	mA
Forward surge current $t_p \leq 10\,\mu s$	I_{FSM}	3	A
Power dissipation $T_{amb} \leq 25°C$	P_V	100	mW
Junction temperature	T_j	100	°C
Detector			
Collector-base voltage	V_{CBO}	80	V
Collector-emitter voltage	V_{CEO}	70	V
Emitter-collector voltage	V_{ECO}	7	V
Collector current	I_C	50	mA
Collector peak current $\frac{t_p}{T} = 0.5,\ t_p \leq 10$ ms	I_{CM}	100	mA
Power dissipation $T_{amb} \leq 25°C$	P_V	150	mW
Junction temperature	T_j	100	°C
Coupled device			
DC isolation voltage	V_{is}[1]	5.3	kV
Total power dissipation $T_{amb} \leq 25°C$	P_{tot}	250	mW
Storage temperature range	T_{stg}	−55 ... +100	°C
Soldering temperature, maximal $t \leq 10$ s	T_{sd}[2]	260	°C

---

[1] related to standard climate 23/50 DIN 50 014

[2] Distance from the touching border ≥ 2 mm

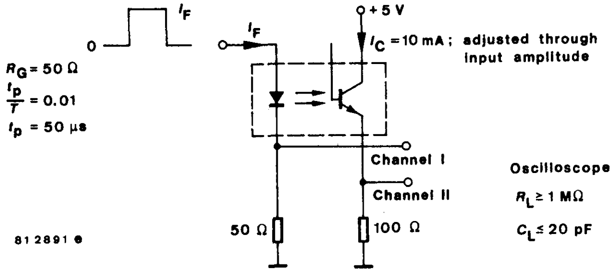
Electrical characteristics $T_{amb} = 25\,°C$			**Min.**	**Typ.**	**Max.**	
Emitter						
Forward voltage $I_F = 50$ mA		V_F*)		1.25	1.6	V
Breakdown voltage $I_R = 100\,\mu A$		$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz		C_j		50		pF
Detector						
Collector-emitter breakdown voltage $I_C = 100\,\mu A$		$V_{(BR)\,CBO}$*)	80			V
Collector-emitter breakdown voltage $I_C = 1$ mA		$V_{(BR)\,CEO}$*)	70			V
Emitter-collector breakdown voltage $I_E = 100\,\mu A$		$V_{(BR)\,ECO}$*)	7			V
Collector cut-off current $V_{CE} = 30$ V, $I_F = 0$, $E = 0$		I_{CEO}*)		30	150	nA
Coupled device						
DC isolation voltage $t = 1$ min		V_{is}**) ¹)	5.3			kV
Isolation resistance $V_{is} = 1$ kV, 40 % relative humidity		R_{is}¹)		10^{12}		Ω
Collector current $V_{CE} = 5$ V, $I_F = 10$ mA,	**Group: A**	I_C*)	6.3		12.5	mA
	B	I_C*)	10		20	mA
	C	I_C*)	16		32	mA
Current transfer ratio $V_{CE} = 5$ V, $I_F = 10$ mA,	**Group: A**	*CTR*	0.63		1.2	
	B	*CTR*	1.0		2.0	
	C	*CTR*	1.6		3.2	
Collector-emitter saturation voltage $I_F = 10$ mA, $I_C = 1$ mA		V_{CEsat}*)			0.3	V
Cut-off frequency $V_{CE} = 5$ V, $I_F = 10$ mA, $R_L = 100\,\Omega$		f_c		110		kHz
Coupling capacitance $f = 1$ MHz		C_k		0.3		pF

---

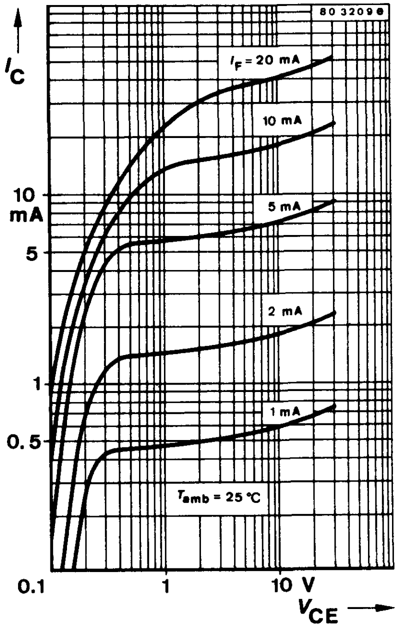
*) AQL = 0.65 % **) AQL = 2.5 % ¹) related to standard climate 23/50 DIN 50 014

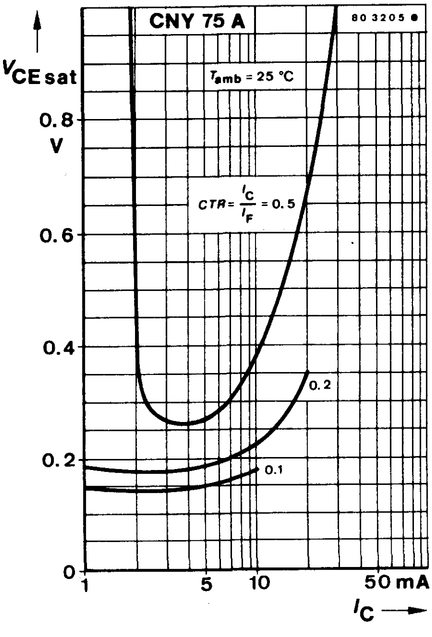
CNY 75

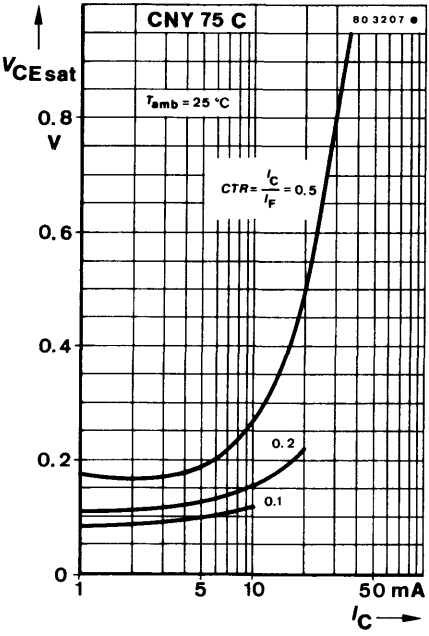
Switching characteristics $V_S = 5$ V, $I_C = 10$ mA, $R_L = 100\ \Omega$, see test circuit		Min.	Typ.	Max.	
Delay time	t_d		2.5		µs
Rise time	t_r		3.5		µs
Turn-on time	t_{on}		6.0		µs
Storage time	t_s		0.3		µs
Fall time	t_f		3.2		µs
Turn-off time	t_{off}		3.5		µs

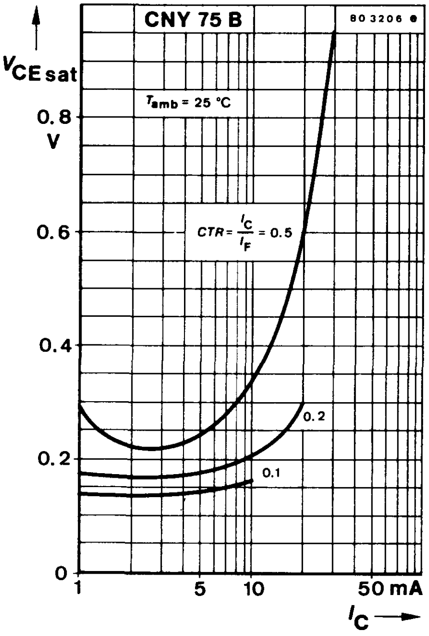


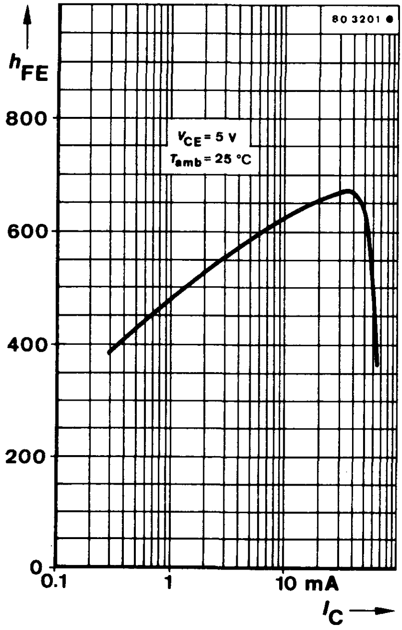
Test circuit

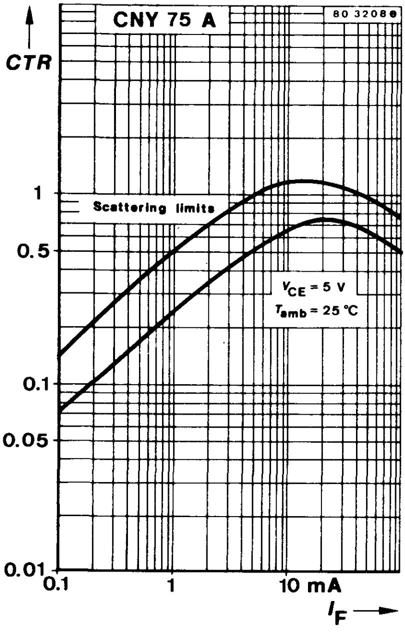


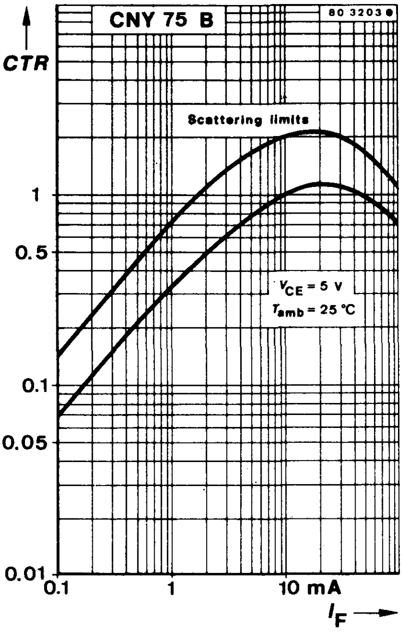


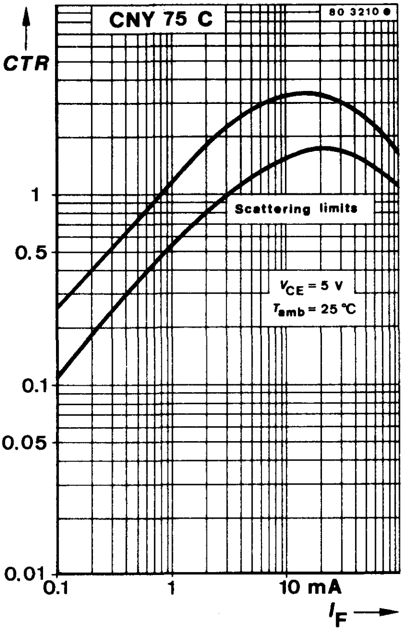

CNY 75 C
80 3207 ●
$V_{CE\,sat}$
T_{amb} = 25 °C
0.8 V
0.6
0.4
0.2
0
CTR = $\frac{I_C}{I_F}$ = 0.5
0.2
0.1
1
5
10
50 mA
I_C

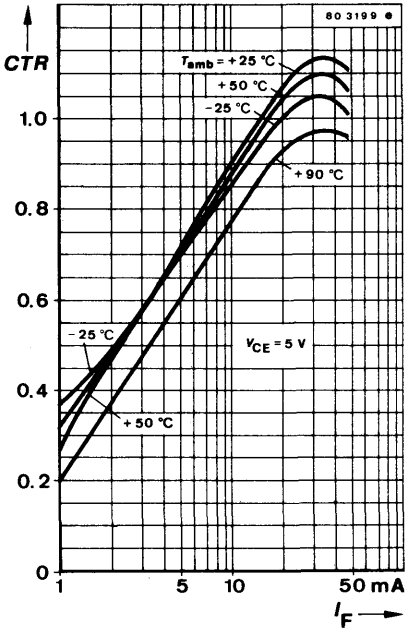

CNY 75 B
80 3206 ●
$V_{CE\,sat}$
T_{amb} = 25 °C
0.8 V
0.6
0.4
0.2
0
CTR = $\frac{I_C}{I_F}$ = 0.5
0.2
0.1
1
5
10
50 mA
I_C

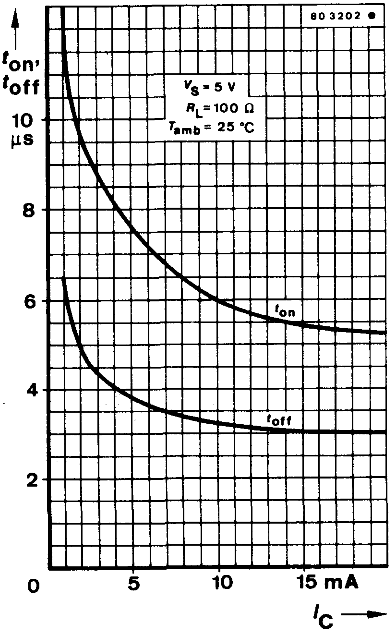

80 3201 ●
h_{FE}
800
600
400
200
0
V_{CE} = 5 V
T_{amb} = 25 °C
0.1
1
10 mA
I_C


CNY 75 A
80 3208 ●
CTR
1
0.5
0.1
0.05
0.01
Scattering limits
V_{CE} = 5 V
T_{amb} = 25 °C
0.1
1
10 mA
I_F


CNY 75 B
80 3203 ●
CTR
Scattering limits
V_{CE} = 5 V
T_{amb} = 25 °C
1
0.5
0.1
0.05
0.01
0.1
1
10 mA
I_F


CNY 75 C
80 3210 ●
CTR
Scattering limits
V_{CE} = 5 V
T_{amb} = 25 °C
1
0.5
0.1
0.05
0.01
0.1
1
10 mA
I_F


80 3199 ●
CTR
T_{amb} = +25 °C
+50 °C
−25 °C
+90 °C
−25 °C
+50 °C
V_{CE} = 5 V
1.0
0.8
0.6
0.4
0.2
0
1
5
10
50 mA
I_F


80 3202 ●
t_{on}, t_{off}
10 µs
V_S = 5 V
R_L = 100 Ω
T_{amb} = 25 °C
8
6
4
2
0
t_{on}
t_{off}
5
10
15 mA
I_C

CQY 80 N
VDE tested device[1]

Optically Coupled Isolator

Construction Emitter: GaAs Infrared Emitting Diode
Detector: Silicon NPN Epitaxial Planar Phototransistor

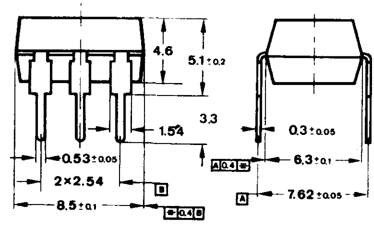
Applications: Galvanically separated circuits, non-interacting switches

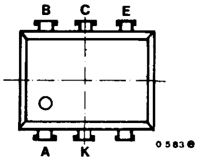
Features:

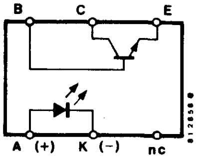
- Isolation voltage 4.4 kV–
- Nominal isolation operating voltage[1] 500 V~ or 600 V– for isolation group C according to VDE 0110/11.72
- Test class 25/100/21 DIN 40045
- Low coupling capacity typ. 0.3 pF
- Current transfer ratio typ. 0.6
- Low temperature coefficient of the CTR

Preliminary specifications

Dimensions in mm







Creeping distance ≥ 8.6 mm[2]
Air path ≥ 7.4 mm[2]
Plastic case
Weight ca. 0.7 g

---

[1] According to VDE test certificate dated 16. 6. 1977/27. 2. 1980. Certificate according to VDE 0883/6.80 is applied.

[2] Creeping current resistance: Group I according to VDE 0110 § 6 table 3 and DIN 53480/VDE 0303 part 1

CQY 80 N

Absolute maximum ratings

Emitter			
Reverse voltage	V_R	5	V
Forward current	I_F	60	mA
Forward surge current $t_p \leq 10\ \mu s$	I_{FSM}	3	A
Power dissipation $T_{amb} \leq 25\,°C$	P_V	100	mW
Junction temperature	T_j	100	°C
Detector			
Collector-emitter voltage	V_{CEO}	32	V
Emitter-collector voltage	V_{ECO}	7	V
Collector current	I_C	50	mA
Collector peak current $\frac{t_p}{T} = 0.5,\ t_p \leq 10$ ms	I_{CM}	100	mA
Power dissipation $T_{amb} \leq 25\,°C$	P_V	150	mW
Junction temperature	T_j	100	°C
Coupled device			
DC isolation voltage	V_{is}¹)	4.4	kV
Total power dissipation $T_{amb} \leq 25\,°C$	P_{tot}	250	mW
Storage temperature range	T_{stg}	−55 ... +100	°C
Soldering temperature, maximal $t \leq 10$ s	T_{sd}²)	260	°C

---

¹) related to standard climate 23/50 DIN 50 014

²) Distance from the touching border ≥ 2 mm

Electrical characteristics
$T_{amb} = 25\,°C$

		Min.	Typ.	Max.	
Emitter					
Forward voltage $I_F = 50\text{ mA}$	V_F*)		1.25	1.6	V
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1\text{ MHz}$	C_j		50		pF
Detector					
Collector-emitter breakdown voltage $I_C = 1\text{ mA}$	$V_{(BR)CEO}$*)	32			V
Emitter-collector breakdown voltage $I_E = 100\,\mu A$	$V_{(BR)ECO}$*)	7			V
Collector cut-off current $V_{CE} = 20\text{ V}, I_F = 0, E = 0$	I_{CEO}*)		10	200	nA
Coupled device					
DC isolation voltage $t = 1\text{ min}$	V_{is}¹)	4.4			kV
Isolation resistance $V_{is} = 1\text{ kV}$, 40 % relative humidity	R_{is}¹)		10^{12}		Ω
Collector current $V_{CE} = 5\text{ V}, I_F = 10\text{ mA}$	I_C*)	5.0	9.0		mA
$I_F = 20\text{ mA}$	I_C*)	12			mA
Current transfer ratio $V_{CE} = 5\text{ V}, I_F = 10\text{ mA}$	*CTR*	0.5	0.9		
Collector-emitter saturation voltage $I_F = 10\text{ mA}, I_C = 1\text{ mA}$	V_{CEsat}*)			0.3	V
Cut-off frequency $V_{CE} = 5\text{ V}, I_F = 10\text{ mA}, R_L = 100\,\Omega$	f_c		110		kHz
Coupling capacitance $f = 1\text{ MHz}$	C_k		0.3		pF

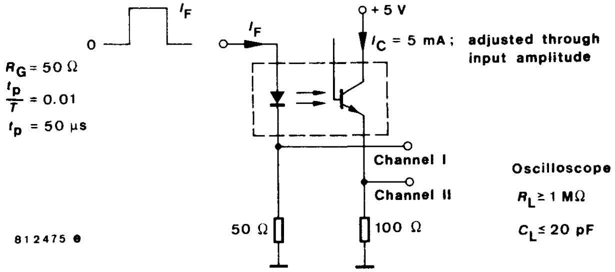
---

*) AQL = 0.65 %

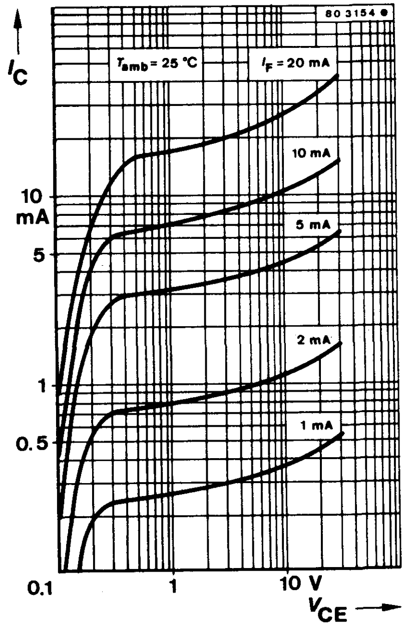
[1] related to standard climate 23/50 DIN 50 014

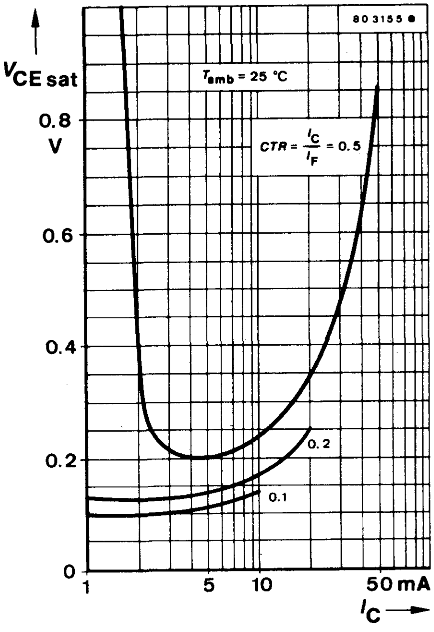
Switching characteristics
$V_S = 5$ V, $I_C = 5$ mA, $R_L = 100\ \Omega$, see test circuit

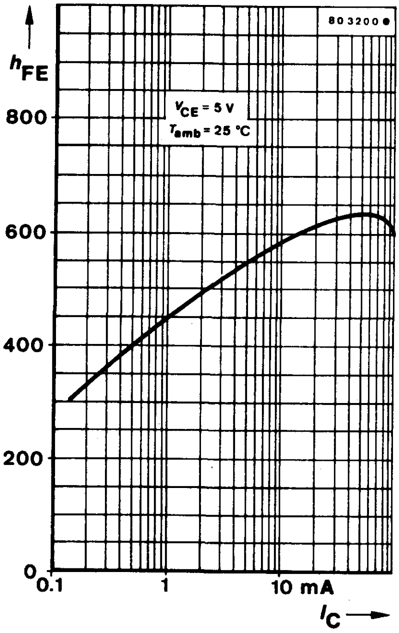
		Min.	Typ.	Max.	
Delay time	t_d		2.5		μs
Rise time	t_r		4.5		μs
Turn-on time	t_{on}		7.0		μs
Storage time	t_s		0.3		μs
Fall time	t_f		3.7		μs
Turn-off time	t_{off}		4.0		μs



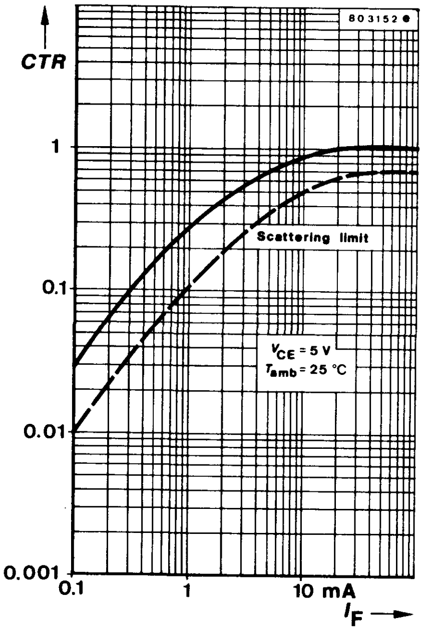
Test circuit



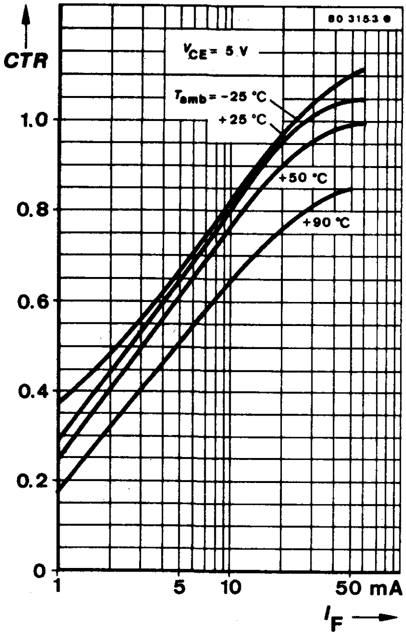




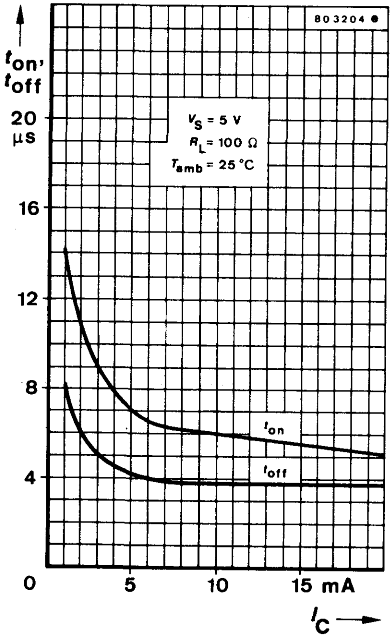
80 3200
h_{FE}
V_{CE} = 5 V
T_{amb} = 25 °C
800
600
400
200
0
0.1
1
10 mA
I_C



80 3152
CTR
1
0.1
0.01
0.001
Scattering limit
V_{CE} = 5 V
T_{amb} = 25 °C
0.1
1
10 mA
I_F



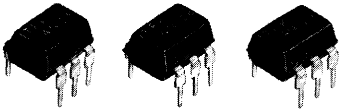
80 3153
CTR
V_{CE} = 5 V
T_{amb} = −25 °C
+25 °C
+50 °C
+90 °C
1.0
0.8
0.6
0.4
0.2
0
1
5
10
50 mA
I_F



80 3204
t_{on}, t_{off}
20 µs
16
12
8
4
0
V_S = 5 V
R_L = 100 Ω
T_{amb} = 25 °C
t_{on}
t_{off}
5
10
15 mA
I_C

4 N 25 · 4 N 26 · 4 N 27

Optically Coupled Isolators



Construction Emitter: GaAs Infrared Emitting Diode
Detector: Silicon NPN Epitaxial Planar Phototransistor

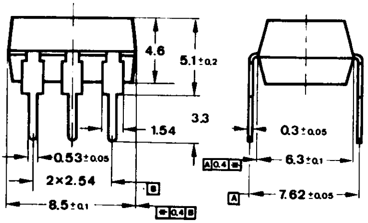
Applications: Galvanically separated circuits, non-interacting switches

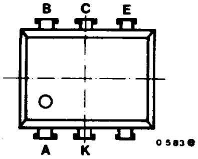
Features:

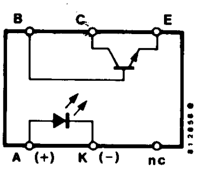
- Isolation voltage
  4 N 25 – V_{is} = 2.5 kV
  4 N 26 – V_{is} = 1.5 kV
  4 N 27 – V_{is} = 1.5 kV
- Low coupling capacity typ. 1 pF
- Current transfer ratio typ. 0.3/0.5
- Low temperature coefficient of the CTR

Preliminary specifications

Dimensions in mm







Plastic case
Weight ca. 0.7 g

4 N 25 · 4 N 26 · 4 N 27

Absolute maximum ratings

Emitter				
Reverse voltage		V_R	5	V
Forward current		I_F	60	mA
Forward surge current $t_p \leq 10\ \mu s$		I_{FSM}	3	A
Power dissipation $T_{amb} \leq 25\,°C$		P_V	100	mW
Junction temperature		T_j	100	°C
Detector				
Collector-base voltage		V_{CBO}	70	V
Collector-emitter voltage		V_{CEO}	30	V
Emitter-collector voltage		V_{ECO}	7	V
Collector current		I_C	50	mA
Peak collector current $\frac{t_p}{T} = 0.5,\ t_p \leq 10$ ms		I_{CM}	100	mA
Power dissipation $T_{amb} \leq 25\,°C$		P_V	150	mW
Junction temperature		T_j	100	°C
Coupled device				
DC isolation voltage	**4 N 25**	V_{is}[1]	2.5	kV
	4 N 26, 4 N 27	V_{is}[1]	1.5	kV
Total power dissipation $T_{amb} \leq 25\,°C$		P_{tot}	250	mW
Storage temperature range		T_{stg}	−55 ... +100	°C
Soldering temperature, maximal $t \leq 10$ s		T_{sd}[2]	260	°C

---

[1] related to standard climate 23/50 DIN 50 014

[2] Distance from the touching border ≥ 2 mm

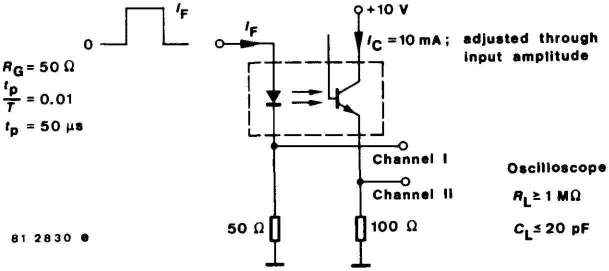
Electrical characteristics			**Min.**	**Typ.**	**Max.**	
Emitter						
Forward voltage $I_F = 50$ mA		V_F*)		1.25	1.5	V
Breakdown voltage $I_R = 100\ \mu$A		$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz		C_j		50		pF
Detector						
Collector-base breakdown voltage $I_C = 100\ \mu$A		$V_{(BR)\,CBO}$*)	70			V
Collector-emitter breakdown voltage $I_C = 1$ mA		$V_{(BR)\,CEO}$*)	30			V
Emitter-collector breakdown voltage $I_E = 100\ \mu$A		$V_{(BR)\,ECO}$*)	7			V
Collector cut-off current $V_{CB} = 10$ V, $I_F = 0, E = 0$		I_{CBO}*)		0.1	20	nA
$V_{CE} = 10$ V, $I_E = 0, E = 0$		I_{CEO}*)		3.5	50	nA
Coupled device						
Isolation voltage $t = 1$ min	**4 N 25**	V_{is}[1])	2.5			kV
	4 N 26, 4 N 27	V_{is}[1])	1.5			kV
Isolation resistance $V_{is} = 1$ kV, 40 % relative humidity		R_{is}[1])		10^{12}		Ω
Collector current $I_F = 10$ mA, $V_{CE} = 10$ V,	**4 N 25, 4 N 26**	I_C*)	2	5		mA
	4 N 27	I_C*)	1	3		mA
Current transfer ratio $I_F = 10$ mA, $V_{CE} = 10$ V	**4 N 25, 4 N 26**	*CTR*	0.2	0.5		
	4 N 27	*CTR*	0.1	0.3		
Collector-emitter saturation voltage $I_F = 50$ mA, $I_C = 2$ mA		V_{CEsat}*)			0.5	V
Cut-off frequency $I_F = 10$ mA, $V_{CE} = 5$ V, $R_L = 100\ \Omega$		f_c		110		kHz
Coupling capacitance $f = 1$ MHz		C_k		1		pF

---

*) AQL = 0.65 %

[1]) related to standard climate 23/50 DIN 50 014

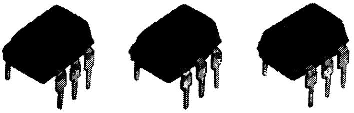
Switching characteristics $V_S = 10$ V, $I_C = 10$ mA, $R_L = 100\ \Omega$, see test circuit		Min.	Typ.	Max.	
Turn-on time	t_{on}		6		μs
Turn-off time	t_{off}		4		μs



Test circuit

4 N 35 · 4 N 36 · 4 N 37

Optically Coupled Isolators



Construction Emitter: GaAs Infrared Emitting Diode
Detector: Silicon NPN Epitaxial Planar Phototransistor

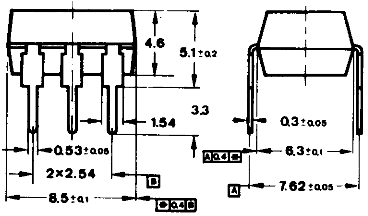
Applications: Galvanically separated circuits, non-interacting switches

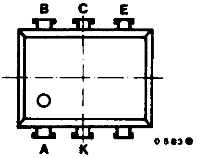
Features:

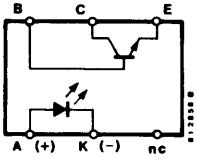
- Isolation voltage
  4 N 35 – V_{is} = 3.55 kV
  4 N 36 – V_{is} = 2.5 kV
  4 N 37 – V_{is} = 1.5 kV
- Low coupling capacity typ. 0.3 pF
- Current transfer ratio > 1
- Low temperature coefficient of the CTR

Preliminary specifications

Dimensions in mm







Plastic case
Weight ca. 0.7 g

4 N 35 · 4 N 36 · 4 N 37

Absolute maximum ratings

Emitter				
Reverse voltage		V_R	6	V
Forward current		I_F	60	mA
Forward surge current $t_p \leq 10\,\mu s$		I_{FSM}	3	A
Power dissipation $T_{amb} \leq 25°C$		P_V	100	mW
Junction temperature		T_j	100	°C
Detector				
Collector-base voltage		V_{CBO}	70	V
Collector-emitter voltage		V_{CEO}	30	V
Emitter-collector voltage		V_{ECO}	7	V
Collector current		I_C	50	mA
Peak collector current $\frac{t_p}{T} = 0.5,\ t_p \leq 10$ ms		I_{CM}	100	mA
Power dissipation $T_{amb} \leq 25°C$		P_V	150	mW
Junction temperature		T_j	100	°C
Coupled device				
Isolation voltage	**4 N 35**	V_{is}¹)	3.55	kV
	4 N 36	V_{is}¹)	2.5	kV
	4 N 37	V_{is}¹)	1.5	kV
Total power dissipation $T_{amb} \leq 25°C$		P_{tot}	250	mW
Storage temperature range		T_{stg}	−55 ... +100	°C
Soldering temperature, maximal $t \leq 10$ s		T_{sd}²)	260	°C

---

¹) related to standard climate 23/50 DIN 50 014

²) Distance from the touching border ≥ 2 mm

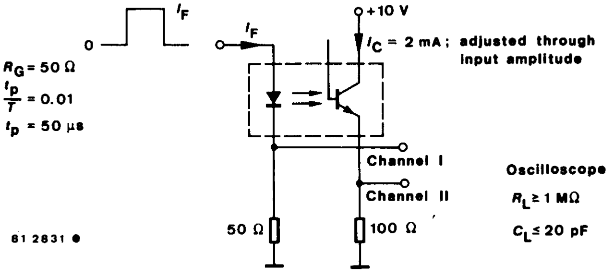
Electrical characteristics			Min.	Typ.	Max.	
Emitter						
Forward voltage						
$I_F = 10$ mA		V_F*)		1.2	1.5	V
$I_F = 10$ mA, $T_{amb} = 100\,°C$		V_F			1.4	V
Breakdown voltage						
$I_R = 10\,\mu A$		$V_{(BR)}$*)	6			V
Junction capacitance						
$V_R = 0$, $f = 1$ MHz		C_j		50		pF
Detector						
Collector-base breakdown voltage						
$I_C = 100\,\mu A$		$V_{(BR)\,CBO}$*)	70			V
Collector-emitter breakdown voltage						
$I_C = 1$ mA		$V_{(BR)\,CEO}$*)	30			V
Emitter-collector breakdown voltage						
$I_E = 100\,\mu A$		$V_{(BR)\,ECO}$*)	7			V
Collector cut-off current						
$V_{CE} = 10$ V, $I_F = 0$, $E = 0$		I_{CEO}*)		5	50	nA
$V_{CE} = 30$ V, $I_F = 0$, $E = 0$, $T_{amb} = 100\,°C$		I_{CEO}*)			500	μA
Coupled device						
Isolation voltage						
$I_{is} = 100\,\mu A$, $t_p = 8$ ms	**4 N 35**	V_{is}[1])	3.55			kV
	4 N 36	V_{is}[1])	2.5			kV
	4 N 37	V_{is}[1])	1.5			kV
Isolation resistance						
$V_{is} = 1$ kV, 40 % relative humidity		R_{is}[1])		10^{12}		Ω
Collector current						
$I_F = 10$ mA, $V_{CE} = 10$ V		I_C*)	10			mA
$I_F = 10$ mA, $V_{CE} = 10$ V, $T_{amb} = 100\,°C$		I_C	4			mA
Current transfer ratio						
$I_F = 10$ mA, $V_{CE} = 10$ V		CTR	1			
$I_F = 10$ mA, $V_{CE} = 10$ V, $T_{amb} = 100\,°C$		CTR	0.4			
Collector-emitter saturation voltage						
$I_F = 10$ mA, $I_C = 0.5$ mA		V_{CEsat}*)			0.3	V
Cut-off frequency						
$I_F = 10$ mA, $V_{CE} = 5$ V, $R_L = 100\,\Omega$		f_c		110		kHz
Coupling capacitance						
$f = 1$ MHz		C_k		0.3		pF

---

*) AQL = 0.65 %

[1]) related to standard climate 23/50 DIN 50 014

Switching characteristics $V_S = 10$ V, $I_C = 2$ mA, $R_L = 100\ \Omega$, see test circuit		Min.	Typ.	Max.	
Turn-on time	t_{on}		10		µs
Turn-off time	t_{off}		10		µs



Test circuit

Photo pulse amplifier

U 123 P

Monolithic Integrated Photo Pulse Amplifier

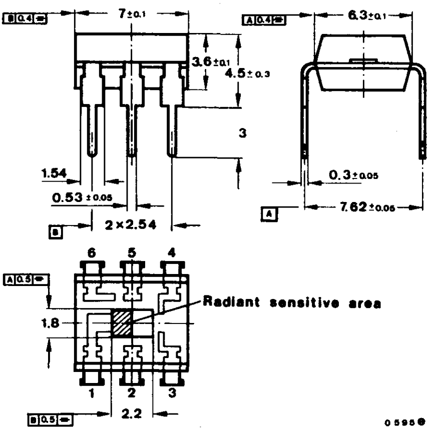
Applications: Pulse light barrier, photo pulse amplifier

Features:

- Integrated operational amplifier and photo detector on one chip
- External controlled photo sensitivity through R_{2-3}
- Quiescent current $I_{SB} = 11$ mA
- For $R_{2-3} \geq 50$ kΩ internal frequency compensation
- No influence on primary illumination up to $E = 15$ klx, $f = 100$ Hz (fluorescent lamps)

Preliminary specifications

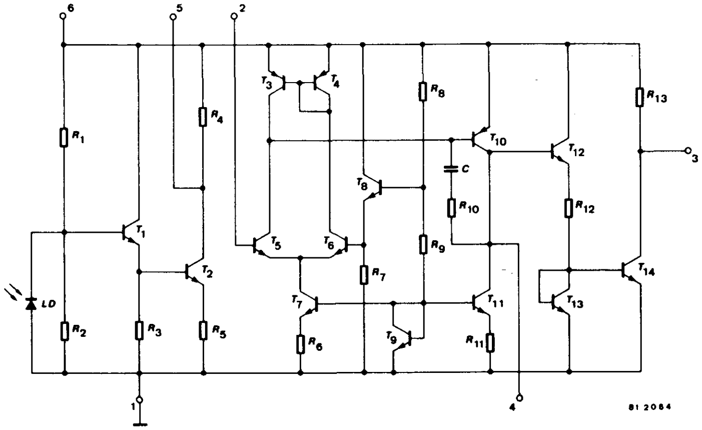
Dimensions in mm



Radiant sensitive area $A = 1$ mm^2

Special case
clear plastic
DIP 6-lead
Weight max. 0.8 g

U 123 P



	Pin
$-V_S$ Reference point	1
Input Operational amplifier	2
Output	3
Frequency compensation	4
Output pre-amplifier	5
$+V_S$ Supply voltage	6

Fig. 1 Diagram and pin connections

Absolute maximum ratings

Supply voltage	Pin 6	V_S	15	V
Output current	Pin 3	I_Q	10	mA
Total power dissipation $T_{amb} \leq 25\,°C$		P_{tot}	210	mW
Junction temperature		T_j	100	°C
Ambient temperature range		T_{amb}	−20 ... +80	°C
Storage temperature range		T_{stg}	−20 ... +100	°C

Thermal resistance		**Min.**	**Typ.**	**Max.**	
Junction ambient	R_{thJA}			350	K/W

Optical and electrical characteristics

V_S = 10 V, reference point Pin 1, T_{amb} = 25 °C, unless otherwise specified

				Min.	Typ.	Max.	
Supply voltage range		Pin 6	V_S	4		12	V
Quiescent current		Pin 6	I_{SB}		11		mA
Output current, operational amplifier		Pin 3	I_Q		5		mA
Open loop voltage gain, operational amplifier $f \leq 1$ kHz, $R_{2-3} = \infty$	Fig. 3	Pin 3	$G_{v\,(open)}$		94		dB
Output voltage change $T_{amb} = -20 \ldots +60$ °C		Pin 3	ΔV_o		15		%
Signal to noise ratio Φ_e = 150 nW		Pin 3	$\frac{V_o}{V_{no}}$		15		dB
Peak wavelength sensitivity	Fig. 6		λ_p		840		nm
Range of spectral bandwidth (50 %)	Fig. 6		$\lambda_{0.5}$		620 ... 970		nm
Rise time Φ_e = 150 nW, R_{2-3} = 1 MΩ, C_K = 10 nF			t_r		4		µs

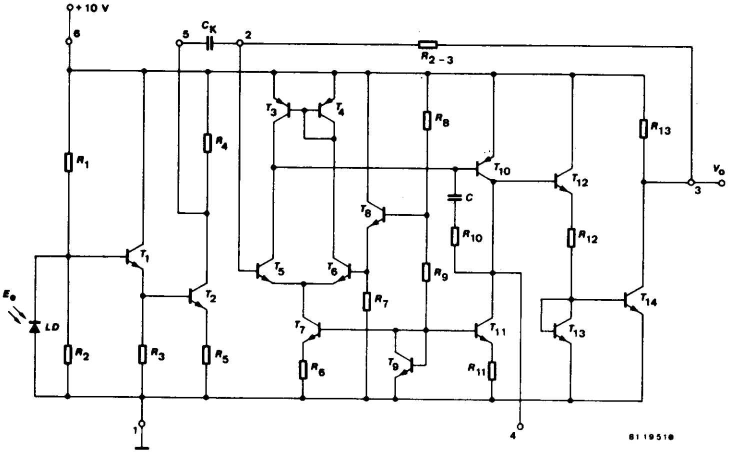


Fig. 2 Test circuit

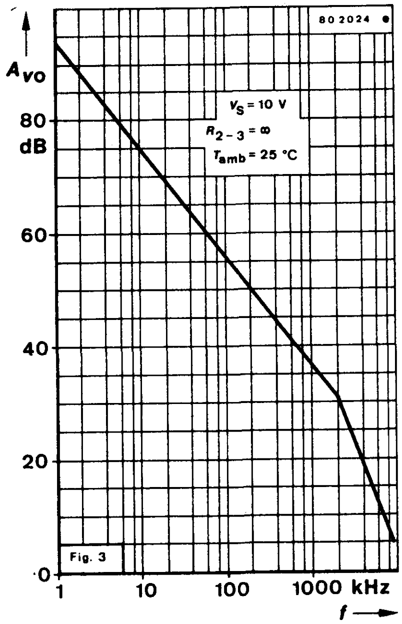


Fig. 3

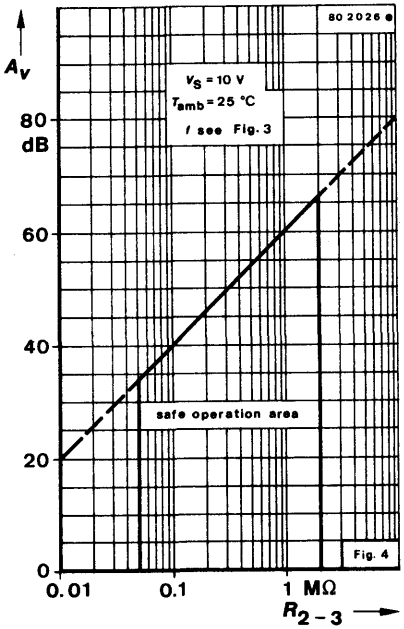


Fig. 4

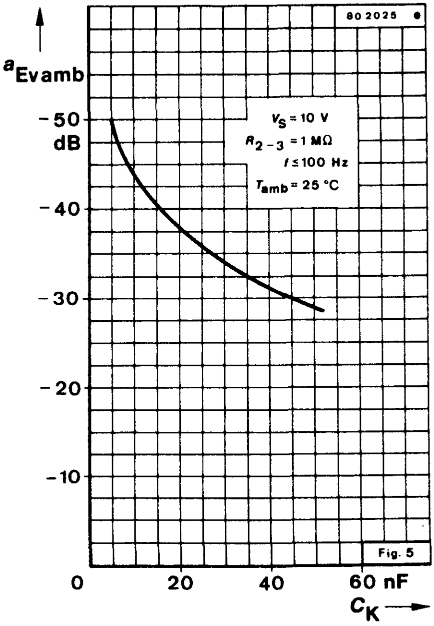


Fig. 5

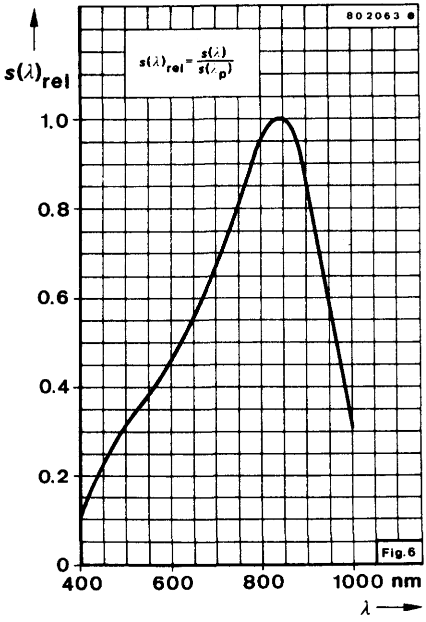
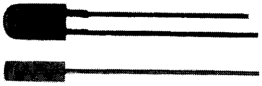


Fig. 6

Light Emitting Diodes

CQX 10 · CQX 40 · CQX 11 · CQX 12



LED in 2.5 x 5 mm Case

Colour	Type	Technology	Angle of half intensity α
Red	**CQX 10**	GaAsP on GaAs	50°
Orange-red	**CQX 40**	GaAsP on GaP	50°
Green	**CQX 11**	GaP on GaP	50°
Yellow	**CQX 12**	GaAsP on GaP	50°

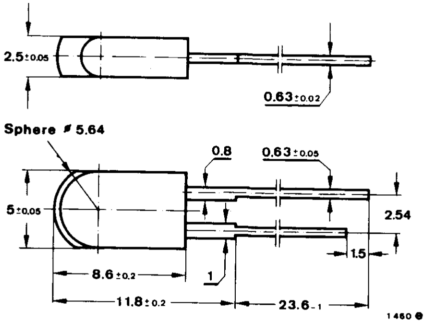
Application: Scales and general indicating purposes

Features:

- Plastic case, diffuse
- End-to-end stackable in centre-to-centre spacing of 0.1” and 0.2” respectively
- Wide viewing angle
- Axial terminals
- Long life compared with filament lamps
- Vibration resistant

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 50°$

Special case
Weight max. 0.35 g

Absolute maximum ratings

Reverse voltage		V_R	5	V
Forward current				
	CQX 10	I_F	50	mA
	CQX 40, CQX 11, CQX 12	I_F	30	mA
Forward surge current $t_p \leq 10\,\mu s$		I_{FSM}	1	A
Power dissipation $T_{amb} \leq 70°$		P_V	100	mW

CQX 10 · CQX 40 · CQX 11 · CQX 12

Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	–55 ... +100	°C
Soldering temperature, maximal $t \leq 5$ s	$T_{sd}{}^1$)	260	°C

Thermal resistances

		Min.	Typ.	Max.	
Junction ambient for a single diode	R_{thJA}			300	K/W
Junction ambient for diodes mounted in groups	R_{thJA}			350	K/W

Optical and electrical characteristics

$T_{amb} = 25\,°C$

Type	Luminous intensity I_V*)²) (mcd)	Peak wavelength emission λ_p (nm) Typ.	Spectral half bandwidth $\Delta\lambda$ (nm) Typ.	Forward voltage V_F*) (V)
	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA
CQX 10	min. 0.8 typ. 2.0	660	20	typ. 1.6 max. 2.0
CQX 40	min. 2.0 typ. 5.0	630	40	typ. 2.2 max. 3.0
CQX 11	min. 0.8 typ. 2.6	560	40	typ. 2.7 max. 3.2
CQX 12	min. 0.8 typ. 4.2	590	40	typ. 2.4 max. 3.2

		Min.	Typ.	Max.	
Breakdown voltage $I_R = 100\,\mu$A	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0$, $f = 1$ MHz	C_j		50		pF

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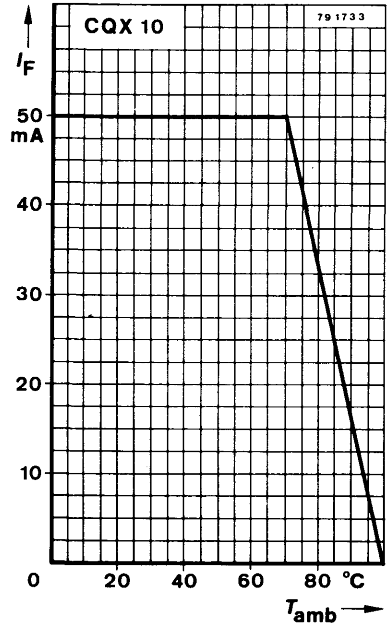
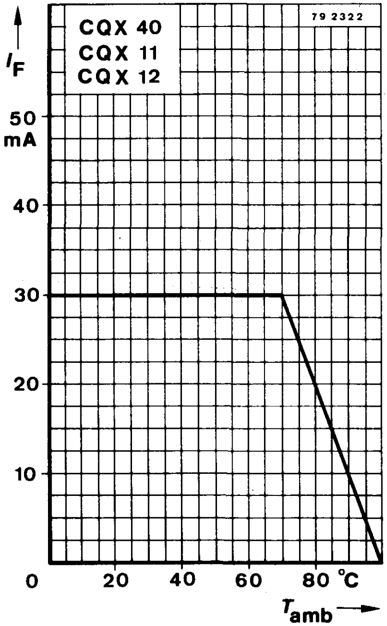
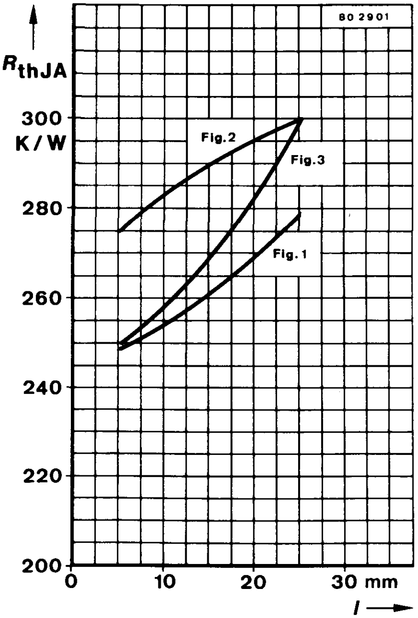
*) AQL = 0.65 %

[1] Distance from the touching border ≥ 1.5 mm with intermediate PC-board

[2] Luminous intensity in packing unit m = 0.5 ... 1







81 3076 e

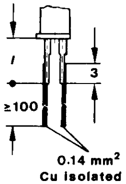


Fig.1

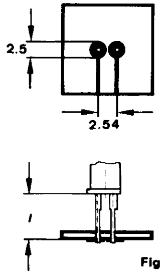


Fig.2

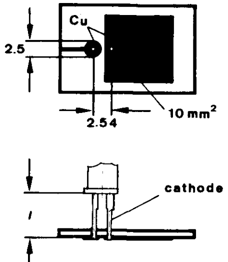
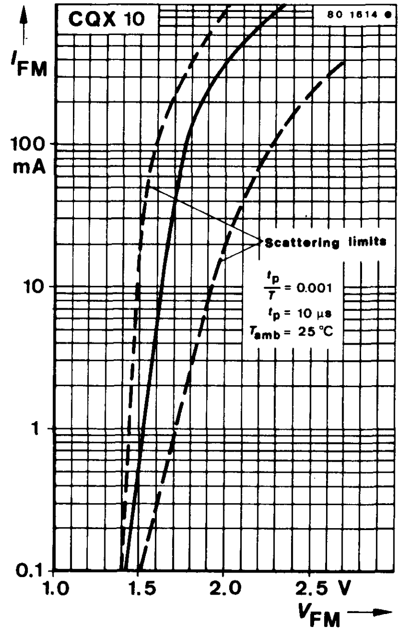
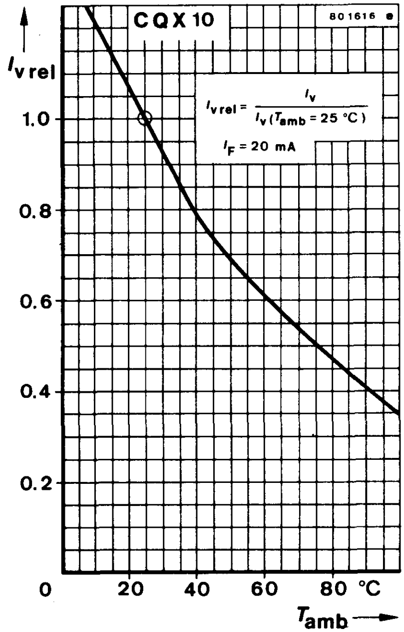
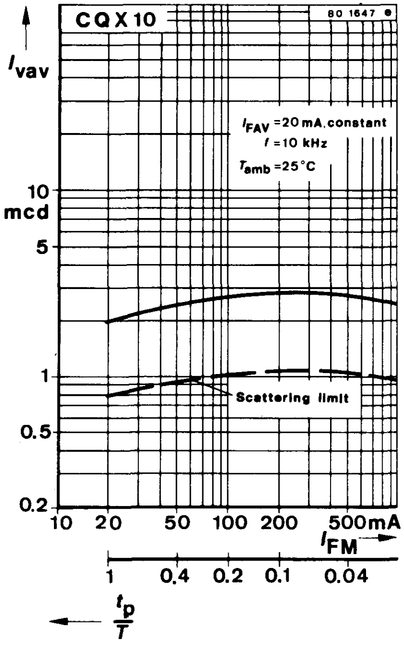


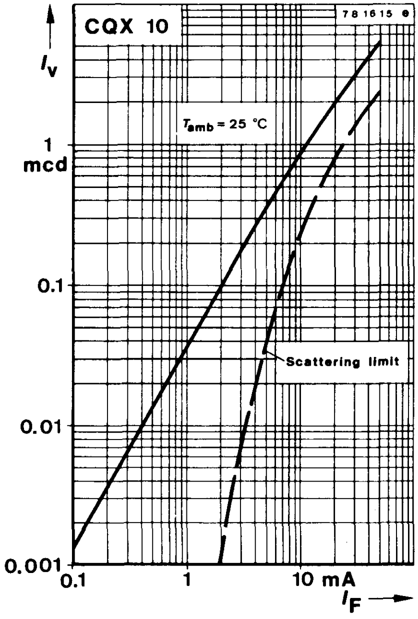
Fig.3

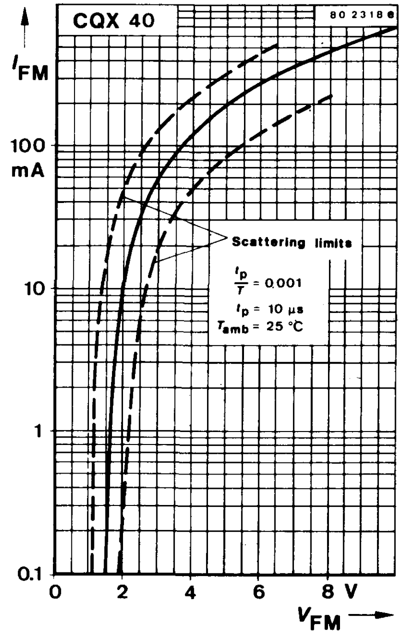
CQX 10 · CQX 40 · CQX 11 · CQX 12

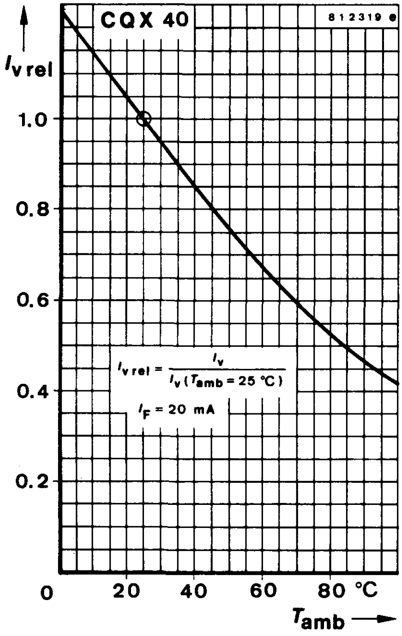


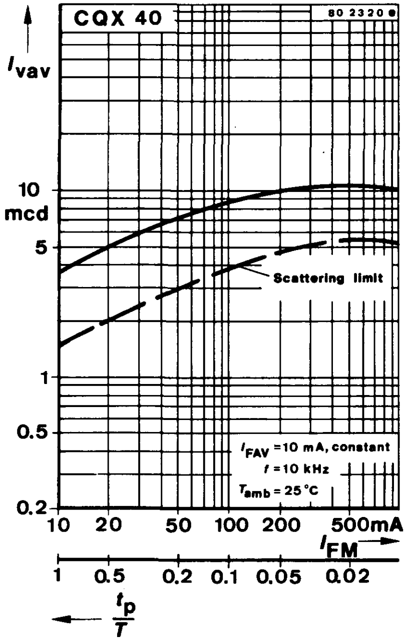


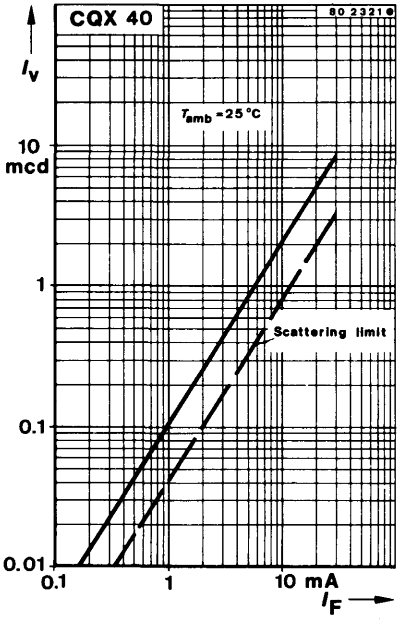




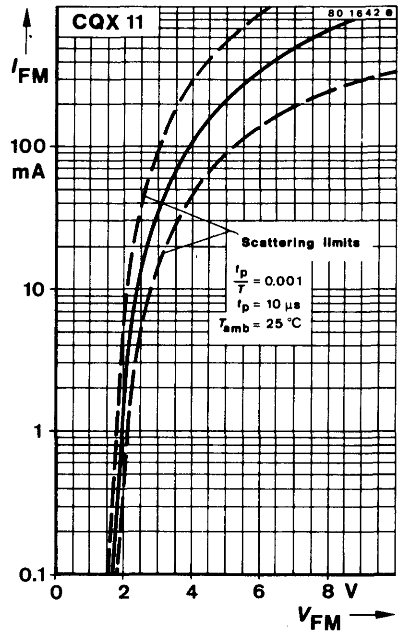

CQX 40
80 2318
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T}$ = 0.001
t_p = 10 µs
T_{amb} = 25 °C

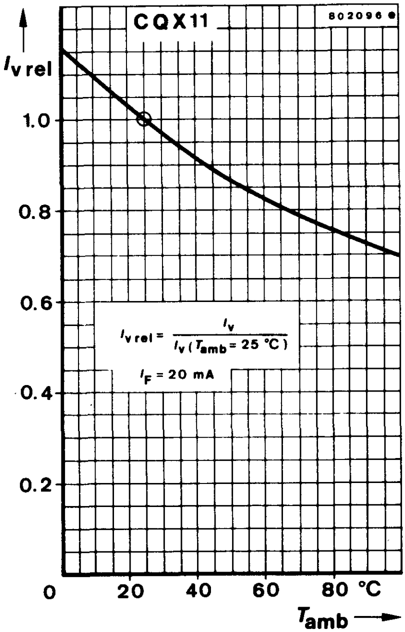

CQX 40
812319
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v\,(T_{amb} = 25\,°C)}$
I_F = 20 mA

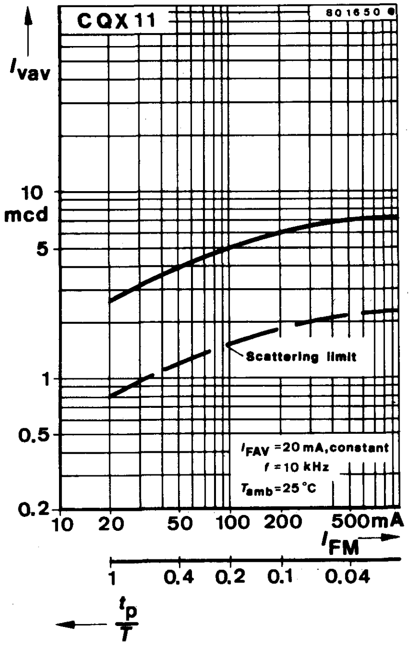

CQX 40
80 2320
I_{vav}
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500mA
I_{FM}
1
0.5
0.2
0.1
0.05
0.02
$\frac{t_p}{T}$
Scattering limit
I_{FAV} =10 mA, constant
f =10 kHz
T_{amb} = 25 °C

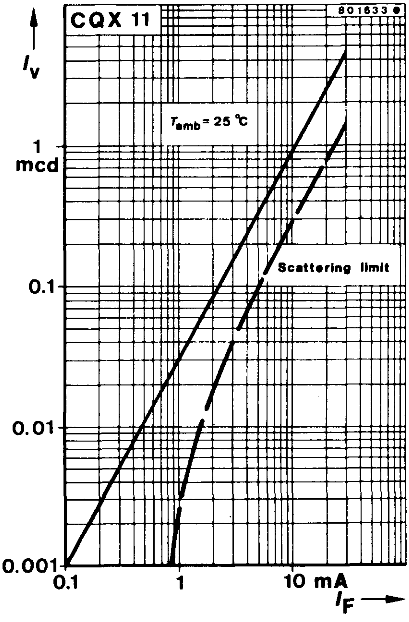

CQX 40
80 2321
I_v
T_{amb} =25 °C
10 mcd
1
0.1
0.01
0.1
1
10 mA
I_F
Scattering limit

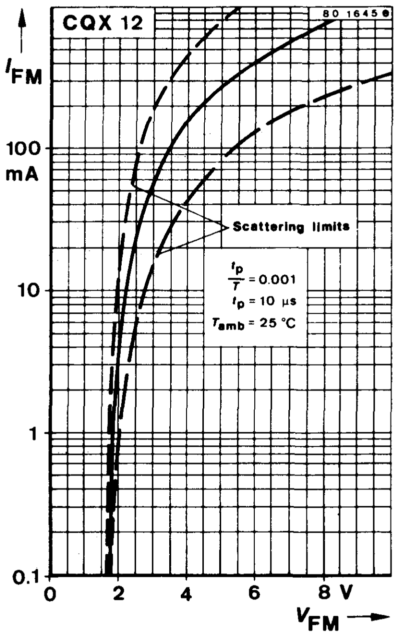
CQX 10 · CQX 40 · CQX 11 · CQX 12

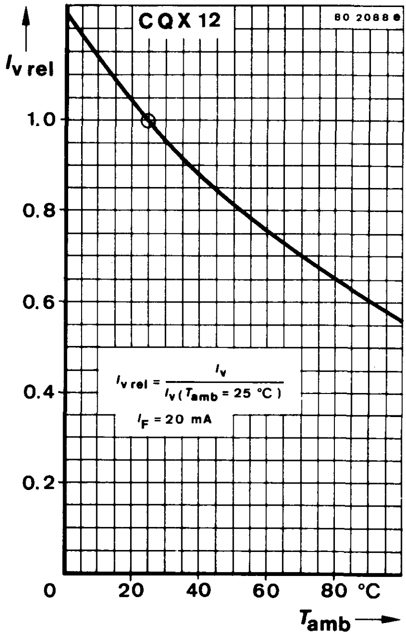


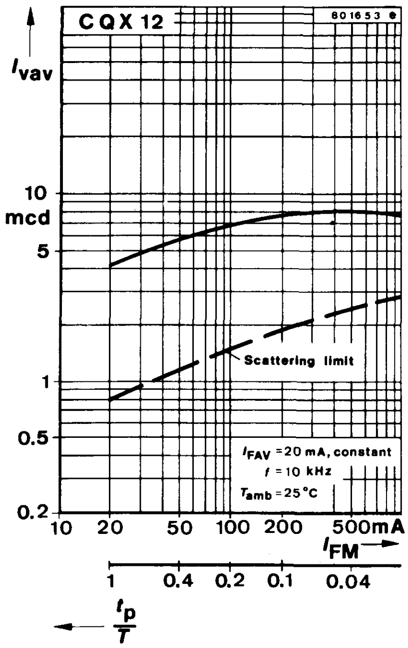


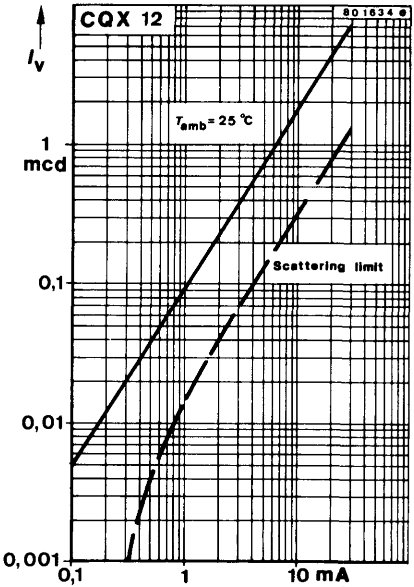


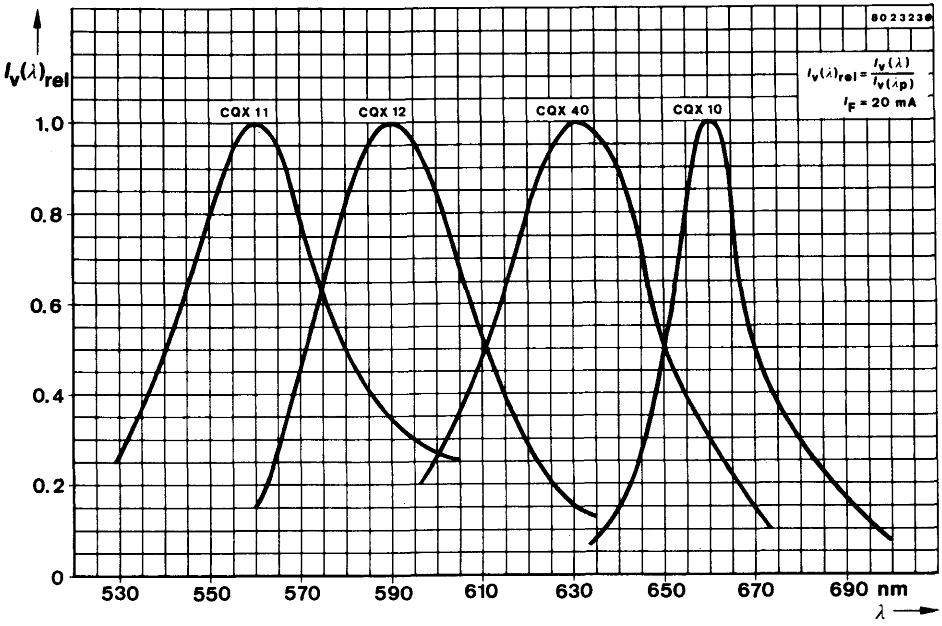


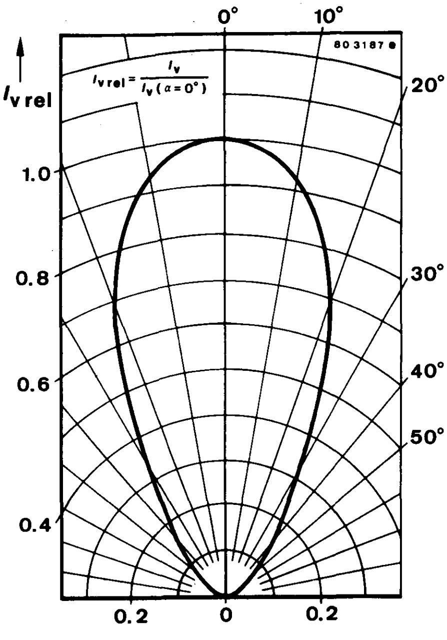

CQX 12
80 1645
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$


CQX 12
80 2088
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v(T_{amb} = 25\ °C)}$
$I_F = 20$ mA


CQX 12
801653
I_{vav}
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$
Scattering limit
I_{FAV} = 20 mA, constant
f = 10 kHz
T_{amb} = 25 °C

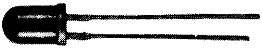

CQX 12
801634
I_v
1 mcd
0,1
0,01
0,001
0,1
1
10 mA
I_F
T_{amb} = 25 °C
Scattering limit


80 2323 ●
$I_V(\lambda)_{rel}$
$I_V(\lambda)_{rel} = \frac{I_V(\lambda)}{I_V(\lambda p)}$
I_F = 20 mA
CQX 11
CQX 12
CQX 40
CQX 10
1.0
0.8
0.6
0.4
0.2
0
530
550
570
590
610
630
650
670
690 nm
λ


0°
10°
20°
30°
40°
50°
80 3187 ●
$I_{V rel}$
$I_{V rel} = \frac{I_V}{I_V(\alpha = 0°)}$
1.0
0.8
0.6
0.4
0.2
0
0.2

CQX 21 · V 621 P · V 622 P · V 623 P

Blinking LED in 5 mm Case



Colour	Type	Technology	Angle of half intensity α
Red	**CQX 21**	GaAsP on GaAs	80°
Orange-red	**V 621 P**	GaAsP on GaP	80°
Green	**V 622 P**	GaP on GaP	80°
Yellow	**V 623 P**	GaAsP on GaP	80°

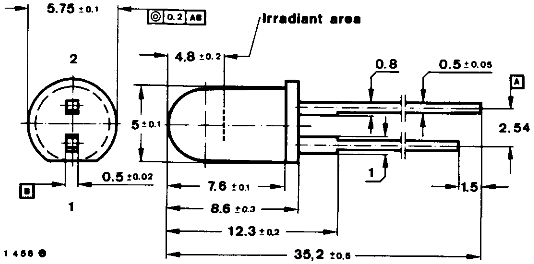
Application: Blink function display

Features:

- Plastic case, diffuse
- Wide viewing angle
- Axial terminals
- Long life compared with filament lamps
- Vibration resistant
- Built-in blinkfunction IC $f = 3$ Hz
- Supply voltage $V_S = 5$ V
- Cycle start in lighted phase

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 80°$

Special case
Weight max. 0.4 g

Accessoires

Mounting clip	Best.-Nr. 562136
Retainer ring	Best.-Nr. 562135

Absolute maximum ratings

Reverse voltage	V_R	0.4	V
Supply voltage	V_S	7	V
Total power dissipation $T_{amb} \leq 65°C$	P_{tot}	200	mW
Junction temperature	T_j	100	°C

CQX 21 · V 621 P · V 622 P · V 623 P

Ambient temperature range	T_{amb}	−40 ... + 70	°C
Storage temperature range	T_{stg}	−55 ... +100	°C
Soldering temperature, maximal $t \leq 5$ s	T_{sd}[1])	260	°C

Optical and electrical characteristics

$V_S = 5$ V, $T_{amb} = 25$ °C, unless otherwise specified

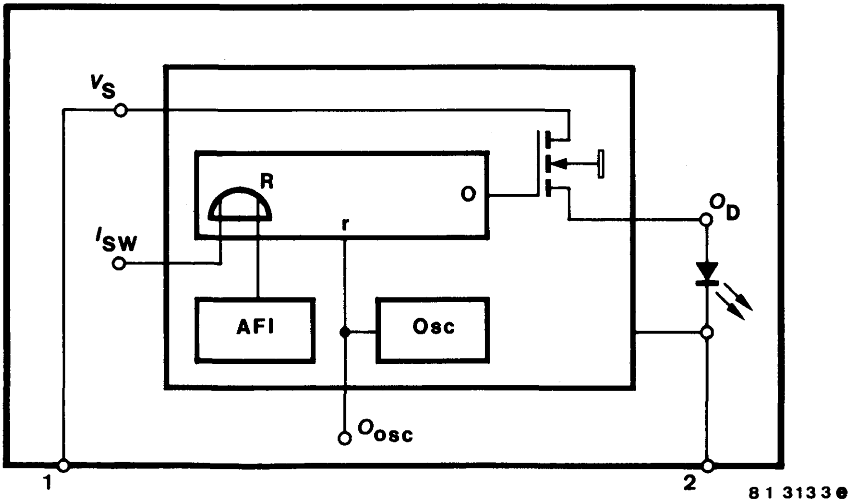
Type	Luminous intensity I_V in mcd	Peak wavelength emission λ_p in nm Typ.	Spectral half bandwidth $\Delta\lambda$ in nm Typ.
CQX 21	min. 0.5 typ. 1.6	660	20
V 621 P	min. 2.0 typ. 5.0	630	40
V 622 P	min. 0.8 typ. 2.0	560	40
V 623 P	min. 0.8 typ. 3.0	590	40

		Min.	**Typ.**	**Max.**	
Supply voltage range	V_S	4.75		7.0	V
Supply current	I_{Son}	10		35	mA
	I_{Soff}			2	mA
Blink frequency					
$T_{amb} = 25$ °C	f	1.3		5.2	Hz
$T_{amb} = -40 ... +70$ °C	f	1.1		7.2	Hz
ON/OFF ratio	$\frac{t_{on}}{t_{off}}$		33 ... 67		%

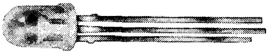
---

*) AQL = 0.65 %

[1]) Distance from the touching border ≥ 1.5 mm with intermediate PC-board


V_S
I_{SW}
R
r
O
AFI
Osc
O_D
O_{osc}
1
2
81 3133e

CQX 22



Blinking LED in 5 mm Case

Red light – GaAsP on GaAs

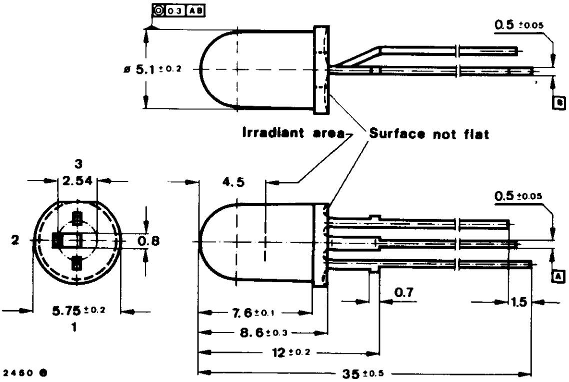
Application: Blink function display

Features:

- Wide viewing angle
- Axial terminals
- Long life compared with filament lamps
- Vibration resistant
- Built-in blinkfunction IC, $f = 3$ Hz
- Supply voltage $V_S = 5$ V
- Cycle start in lighted phase
- Blink function can be switched-off

Preliminary specifications

Dimensions in mm



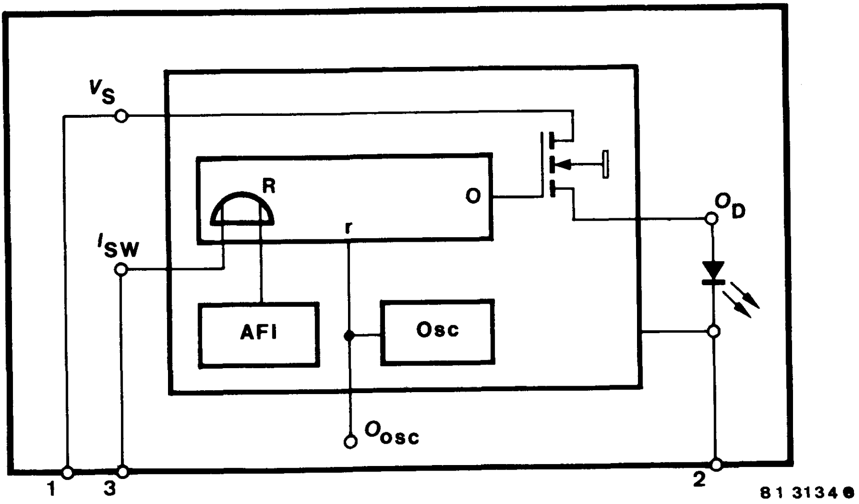
Angle of half intensity $\alpha = 80°$

Special case
Weight max. 0.42 g

Accessoires

Mounting clip	Best.-Nr. 562136
Retainer ring	Best.-Nr. 562135

S 1.2.103/0781 E



Block diagram and pin connections

Absolute maximum ratings

Reverse voltage	Pin 1	V_R	0.4	V
Supply voltage	Pin 1	V_S	7	V
Total power dissipation $T_{amb} \leq 70\,°C$		P_{tot}	200	mW
Junction temperature		T_j	100	°C
Ambient temperature range		T_{amb}	−40 ... + 70	°C
Storage temperature range		T_{stg}	−55 ... +100	°C
Soldering temperature, maximal $t \leq 5$ s		T_{sd}¹)	260	°C

Thermal resistance		**Min.**	**Typ.**	**Max.**	
Junction ambient	R_{thJA}			200	K/W

---

*) AQL = 0.65 %

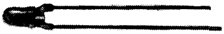
¹) Distance from the touching border ≥ 1.5 with intermediate PC-board

Optical and electrical characteristics $V_S = 5$ V, $T_{amb} = 25$ °C, unless otherwise specified			**Min.**	**Typ.**	**Max.**	
Luminous intensity		I_v	0.5	1.6		mcd
Peak wavelength emission		λ_p		660		nm
Spectral half bandwidth		$\Delta\lambda$		20		nm
Supply voltage range	Pin 1	V_S	4.75		7.0	V
Supply current	Pin 1	I_{Son}	10		35	mA
		I_{Soff}			2	mA
Blink frequency						
$T_{amb} = 25$ °C		f	1.3		5.2	Hz
$T_{amb} = -40 \dots +70$ °C		f	1.1		7.2	Hz
ON/OFF ratio		$\frac{t_{on}}{t_{off}}$		33...67		%
Control current						
$V_{SW} = 5$ V	Pin 3	I_{SW}	10	25	50	μA

CQX 25 · CQX 42 · CQX 26 · CQX 27

Not for new developments, replaced through: CQX 25 N · CQX 42 N · CQX 26 N · CQX 27 N

LED in 3 mm Case



Colour	Type	Technology	Angle of half intensity α
Red	**CQX 25**	GaAsP on GaAs	25°
Orange-red	**CQX 42**	GaAsP on GaP	25°
Green	**CQX 26**	GaP on GaP	25°
Yellow	**CQX 27**	GaAsP on GaP	25°

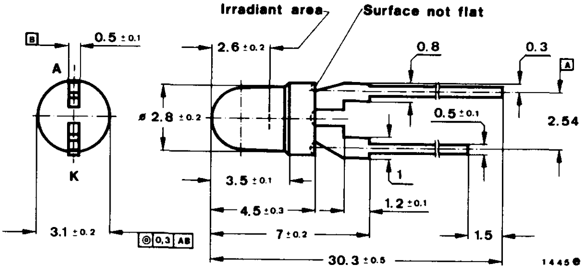
Application: General indicating and illumination purposes

Features:

- Plastic case, white clear
- Axial terminals
- Long life compared with filament lamps
- Vibration resistant

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 25°$

Special case
Weight max. 0.3 g

Absolute maximum ratings

Reverse voltage		V_R	5	V
Forward current	**CQX 25**	I_F	50	mA
	CQX 42, CQX 26, CQX 27	I_F	30	mA
Forward surge current $t_p \leq 10\ \mu s$		I_{FSM}	1	A
Power dissipation $T_{amb} \leq 60°$		P_V	100	mW

CQX 25 · CQX 42 · CQX 26 · CQX 27

Junction temperature	T_j		100		°C
Storage temperature range	T_{stg}		−55 … +100		°C
Soldering temperature, maximal $t \leq 3$ s	T_{sd}[1]		245		°C
Thermal resistance		**Min.**	**Typ.**	**Max.**	
Junction ambient	R_{thJA}			400	K/W

Optical and electrical characteristics

$T_{amb} = 25\,°C$

Type	Group	Luminous intensity I_V*)[2] (mcd)	Peak wavelength emission λ_p (nm) Typ.	Spectral half bandwidth $\Delta\lambda$ (nm) Typ.	Forward voltage V_F*) (V)
		$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA
CQX 25		min. 1.3 typ. 2.6	660	20	typ. 1.6 max. 2.0
CQX 42	A B	min. 3.2 typ. 7.0 min. 8.0 typ. 15.0	630	40	typ. 2.2 max. 3.0
CQX 26		min. 1.3 typ. 4.0	560	40	typ. 2.7 max. 3.2
CQX 27		min. 1.3 typ. 5.0	590	40	typ. 2.4 max. 3.2

		Min.	**Typ.**	**Max.**	
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz	C_j		50		pF

---

*) AQL = 0.65 %

[1]) Distance from the touching border ≥ 1.5 mm with intermediate PC-board

[2]) supplied selected in groups, luminous intensity in packing unit m = 0.5 … 1

CQX 25 N · CQX 42 N · CQX 26 N · CQX 27 N

LED in 3 mm Case

Colour	Type	Technology	Angle of half intensity α
Red	**CQX 25 N**	GaAsP on GaAs	25°
Orange-red	**CQX 42 N**	GaAsP on GaP	25°
Green	**CQX 26 N**	GaP on GaP	25°
Yellow	**CQX 27 N**	GaAsP on GaP	25°

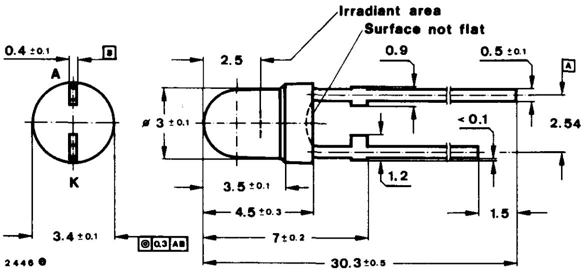
Application: General indicating and illumination purposes

Features:

- Plastic case, white clear
- Axial terminals
- Long life compared with filament lamps
- Vibration resistant

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 25°$

Special case
Weight max. 0.35 g

Absolute maximum ratings

Reverse voltage	V_R	5	V
Forward current			
CQX 25 N	I_F	50	mA
CQX 42 N, CQX 26 N, CQX 27 N	I_F	30	mA
Forward surge current $t_p \leq 10\,\mu s$	I_{FSM}	1	A
Power dissipation $T_{amb} \leq 60°$	P_V	100	mW

CQX 25 N · CQX 42 N · CQX 26 N · CQX 27 N

Junction temperature	T_j		100		°C
Storage temperature range	T_{stg}		−55 ... +100		°C
Soldering temperature, maximal $t \leq 5$ s	T_{sd}[1]		260		°C

Thermal resistance

		Min.	Typ.	Max.	
Junction ambient	R_{thJA}			400	K/W

Optical and electrical characteristics

$T_{amb} = 25°C$

Type	Group	Luminous intensity I_V*)[2] (mcd)	Peak wavelength emission λ_p (nm) Typ.	Spectral half bandwidth $\Delta\lambda$ (nm) Typ.	Forward voltage V_F*) (V)
		$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA
CQX 25 N		min. 1.3 typ. 2.6	660	20	typ. 1.6 max. 2.0
CQX 42 N	A B	min. 3.2 typ. 7.0 min. 8.0 typ. 15.0	630	40	typ. 2.2 max. 3.0
CQX 26 N		min. 1.3 typ. 4.0	560	40	typ. 2.7 max. 3.2
CQX 27 N		min. 1.3 typ. 5.0	590	40	typ. 2.4 max. 3.2

		Min.	Typ.	Max.	
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz	C_j		50		pF

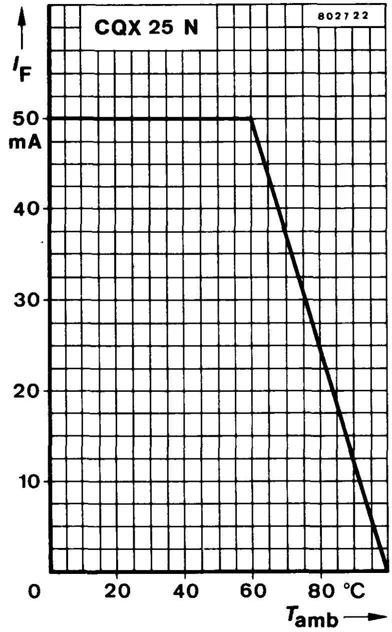
---

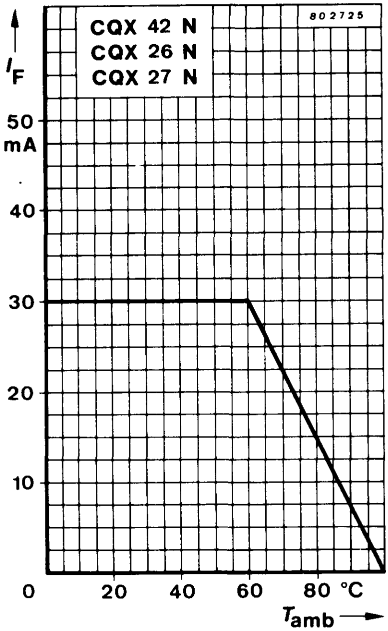
*) AQL = 0.65 %

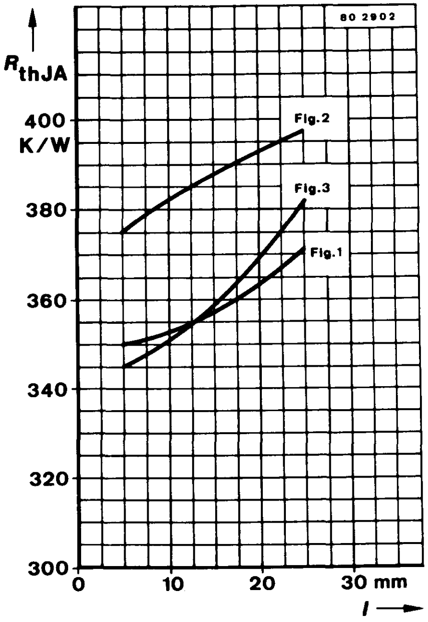
[1] Distance from the touching border ≥ 1.5 mm with intermediate PC-board

[2] supplied selected in groups, luminous intensity in packing unit m = 0.5 ... 1

CQX 25 N · CQX 42 N · CQX 26 N CQX 27 N







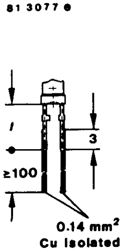


Fig.1

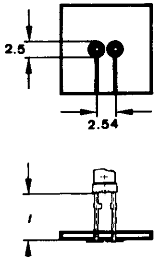


Fig.2

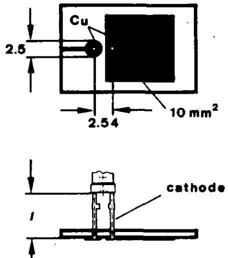
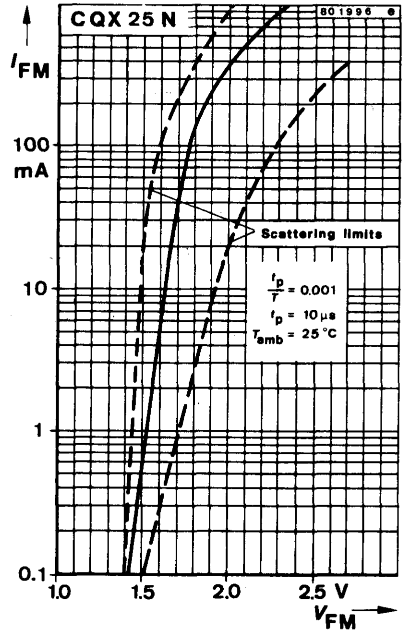
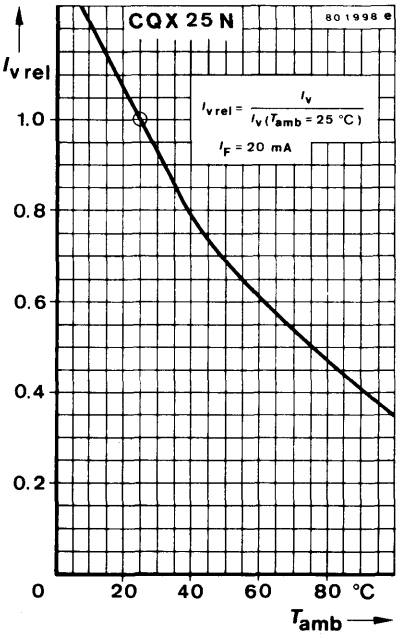
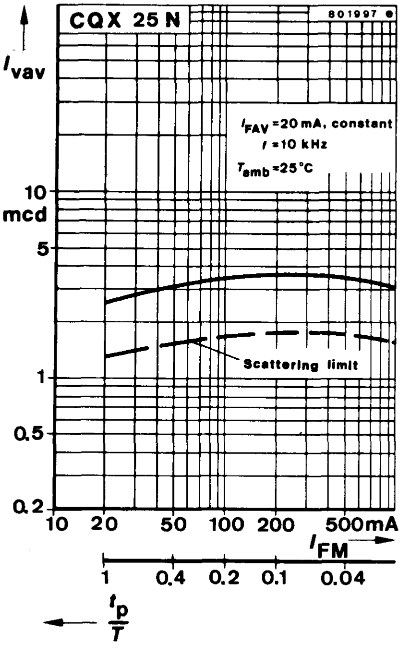


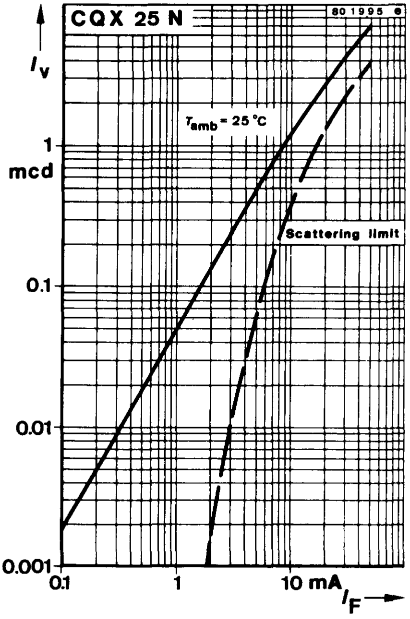
Fig.3

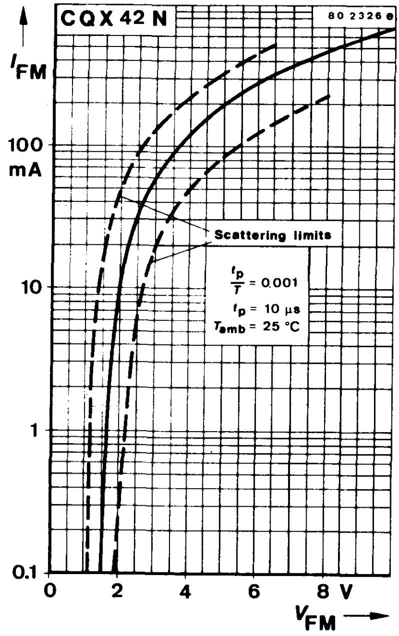
CQX 25 N · CQX 42 N · CQX 26 N · CQX 27 N

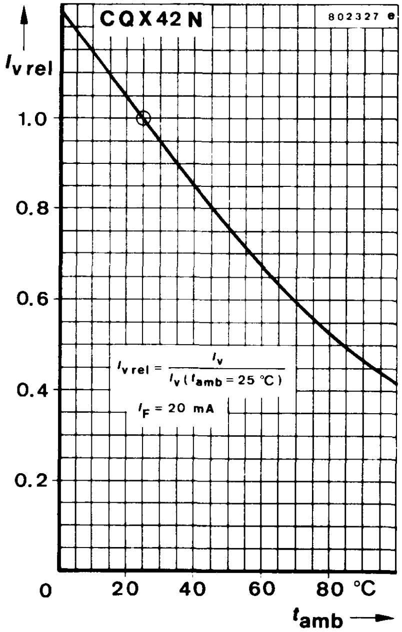


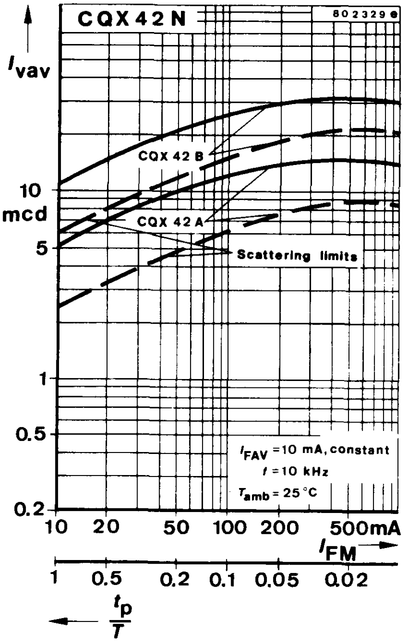


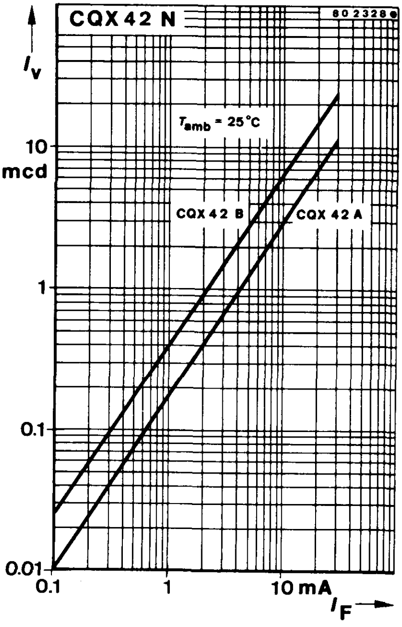




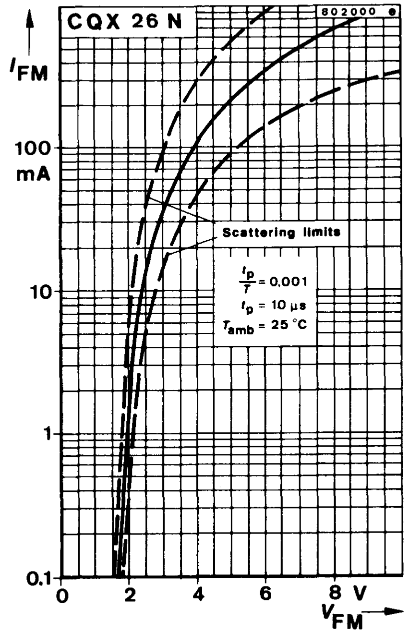

CQX 42 N
80 2326 e
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T}$ = 0.001
t_p = 10 µs
T_{amb} = 25 °C

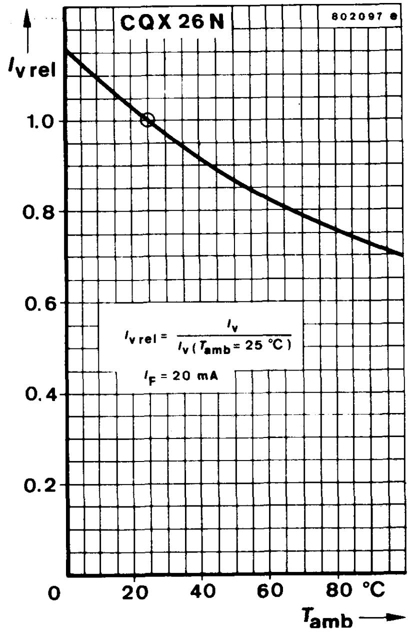

CQX 42 N
802327 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
t_{amb}
$I_{v\,rel} = \frac{I_v}{I_v\,(t_{amb} = 25\,°C)}$
I_F = 20 mA

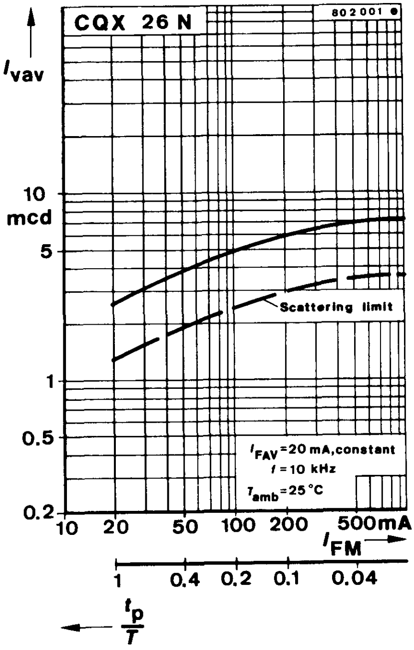

CQX 42 N
802329 e
I_{vav}
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500mA
I_{FM}
1
0.5
0.2
0.1
0.05
0.02
$\frac{t_p}{T}$
CQX 42 B
CQX 42 A
Scattering limits
I_{FAV} = 10 mA, constant
f = 10 kHz
T_{amb} = 25 °C

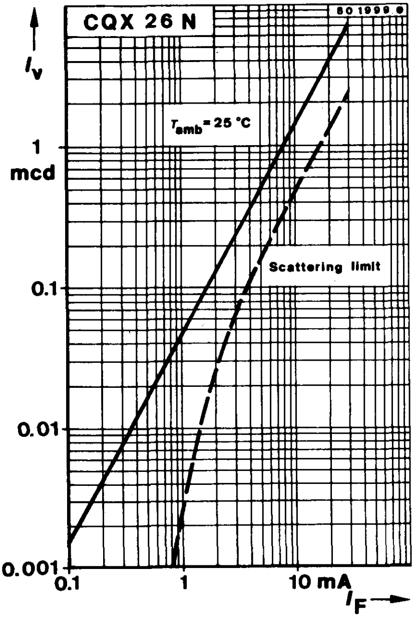

CQX 42 N
802328 e
I_v
10 mcd
1
0.1
0.01
0.1
1
10 mA
I_F
T_{amb} = 25°C
CQX 42 B
CQX 42 A

CQX 25 N · CQX 42 N · CQX 26 N · CQX 27 N

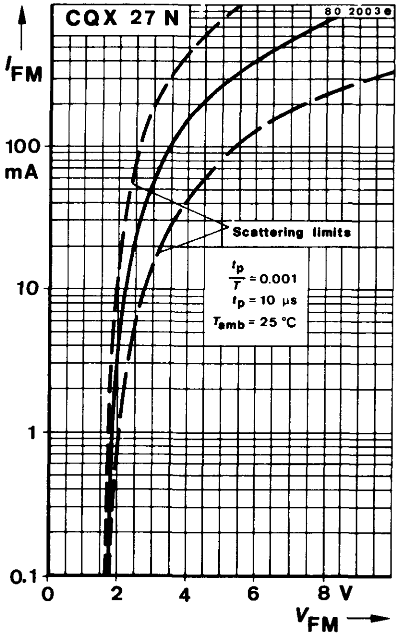


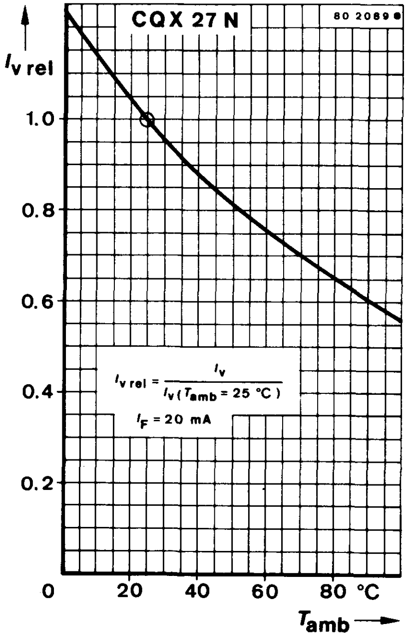


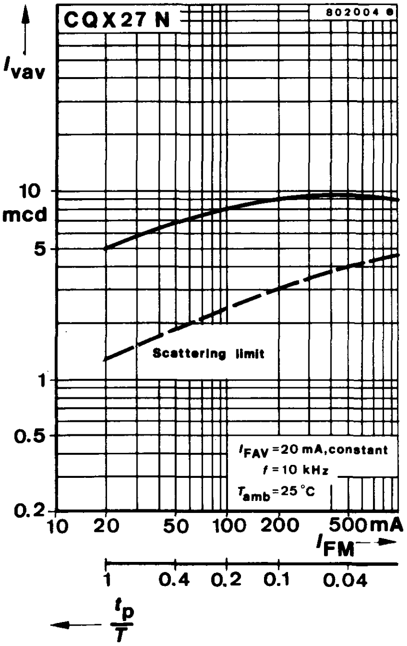


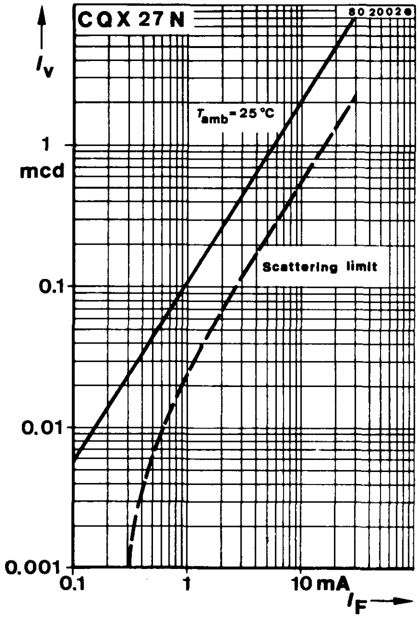


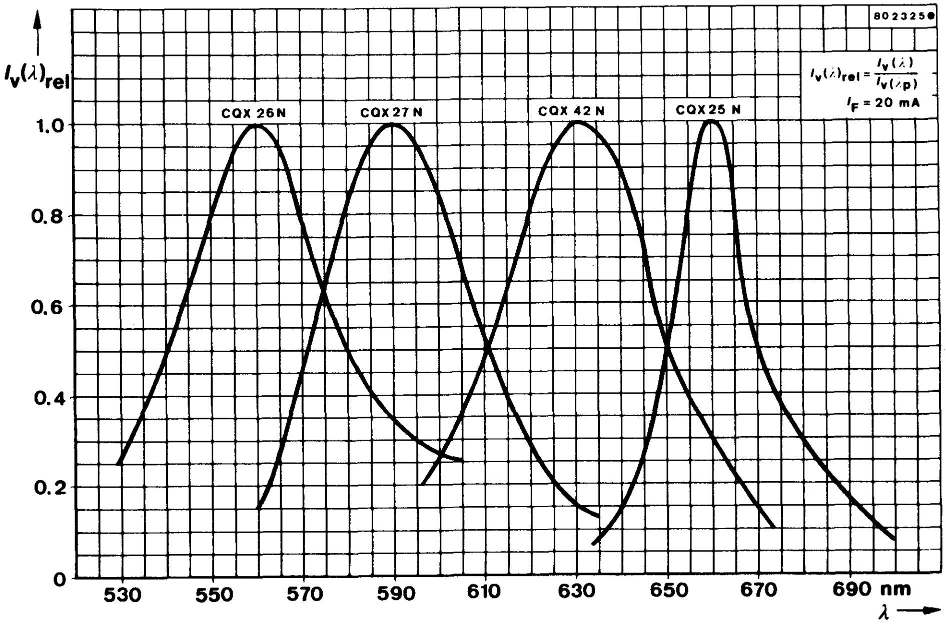
CQX 25 N · CQX 42 N · CQX 26 N · CQX 27 N

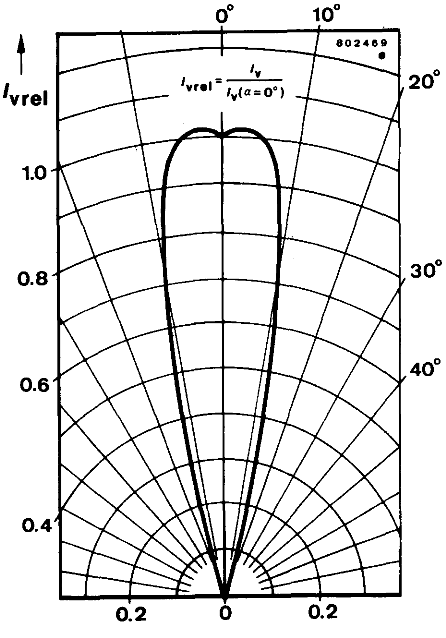






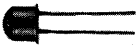



802325
$I_v(\lambda)_{rel} = \frac{I_v(\lambda)}{I_v(\lambda p)}$
I_F = 20 mA
$I_v(\lambda)_{rel}$
CQX 26 N
CQX 27 N
CQX 42 N
CQX 25 N
1.0
0.8
0.6
0.4
0.2
0
530
550
570
590
610
630
650
670
690 nm
λ


0°
10°
20°
30°
40°
802469
$I_{vrel} = \frac{I_v}{I_v(\alpha = 0°)}$
I_{vrel}
1.0
0.8
0.6
0.4
0.2
0
0.2

CQX 28 · CQX 29 · CQX 30

LED in TO 18 Case



Colour	Type	Technology	Angle of half intensity α
Red	**CQX 28**	GaAsP on GaAs	50°
Green	**CQX 29**	GaP on GaP	50°
Yellow	**CQX 30**	GaAsP on GaP	50°

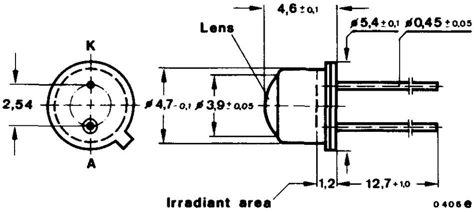
Application: Indications in high commercial equipments

Features:

- Hermetically sealed case with glass lens white diffuse
- Wide viewing angle
- Axial terminals
- Long life compared with filament lamps
- Vibration resistant

Preliminary specifications

Dimensions in mm



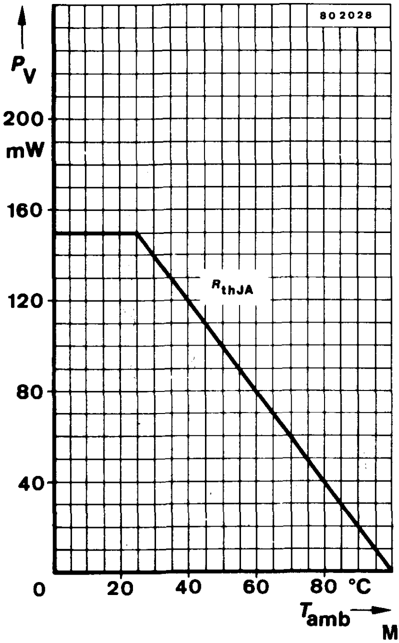
Cathode connected with case

Angle of half intensity $\alpha = 50°$

Special case
≈ 18 A 2 DIN 41876
≈ JEDEC TO 52
Weight max. 0.5 g

Absolute maximum ratings

Reverse voltage	V_R	5	V
Forward current	I_F	50	mA
Forward surge current $t_p \leq 10\,\mu s$	I_{FSM}	1	A
Power dissipation $T_{amb} \leq 25°$	P_V	150	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−55 ... +100	°C



Thermal resistance

		Min.	Typ.	Max.	
Junction ambient	R_{thJA}			500	K/W

Optical and electrical characteristics

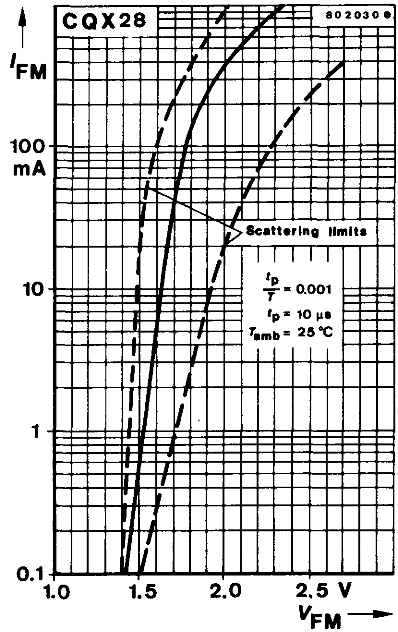
$T_{amb} = 25\,°C$

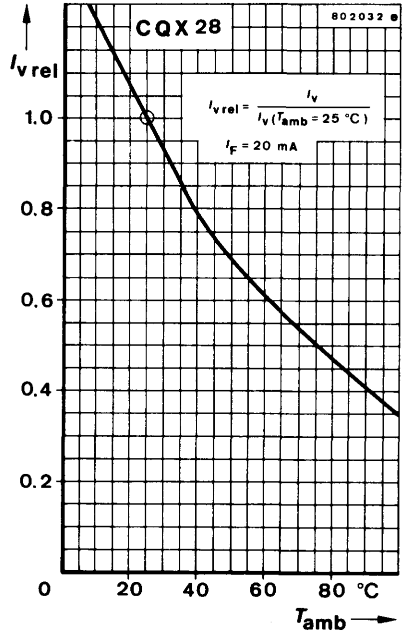
Type	Luminous intensity I_V*) (mcd)	Peak wavelength emission λ_p (nm) Typ.	Spectral half bandwidth $\Delta\lambda$ (nm) Typ.	Forward voltage V_F*) (V)
	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA
CQX 28	min. 0.8 typ. 2.0	660	20	typ. 1.6 max. 2.0
CQX 29	min. 1.0 typ. 2.6	560	40	typ. 2.7 max. 3.2
CQX 30	min. 1.0 typ. 4.2	590	40	typ. 2.4 max. 3.2

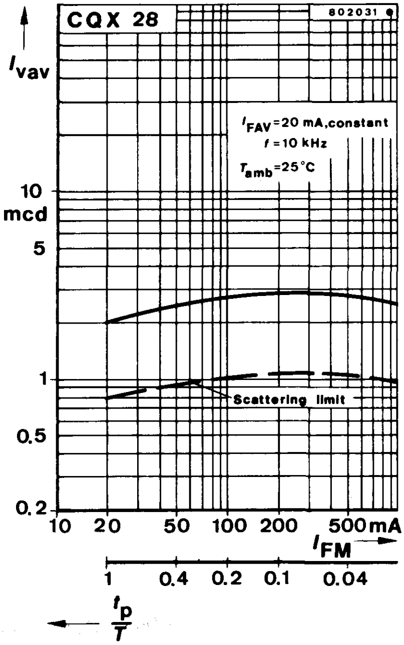
		Min.	Typ.	Max.	
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz	C_j		50		pF

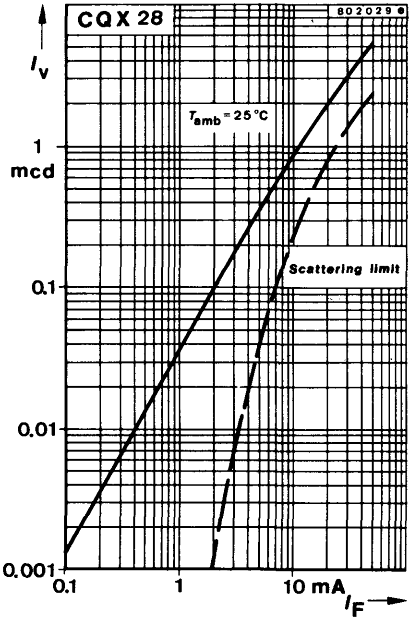
---

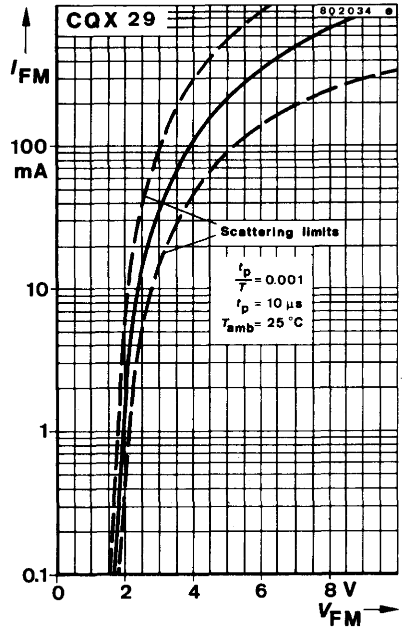
*) AQL = 0.65 %

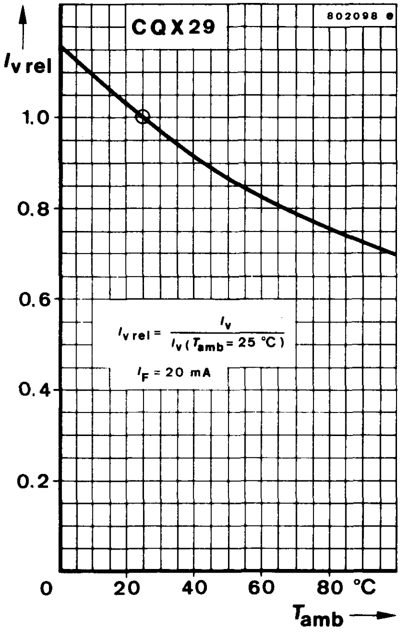

CQX28
802030
I_{FM}
100 mA
10
1
0.1
Scattering limits
$\frac{t_p}{T}$ = 0.001
t_p = 10 µs
T_{amb} = 25 °C
1.0
1.5
2.0
2.5 V
V_{FM}

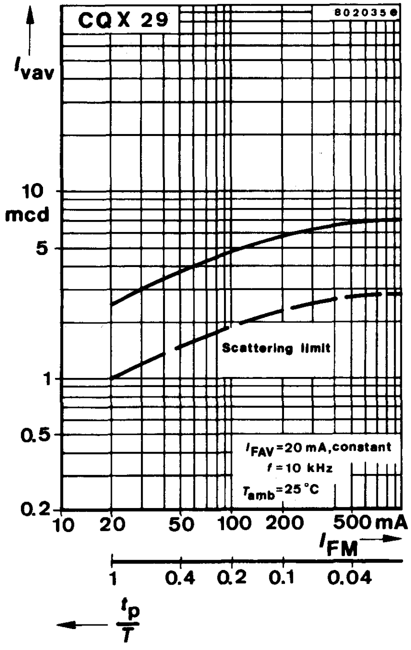

CQX 28
802032
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
$I_{v\,rel} = \frac{I_v}{I_v\,(T_{amb} = 25\ °C)}$
I_F = 20 mA
0
20
40
60
80 °C
T_{amb}

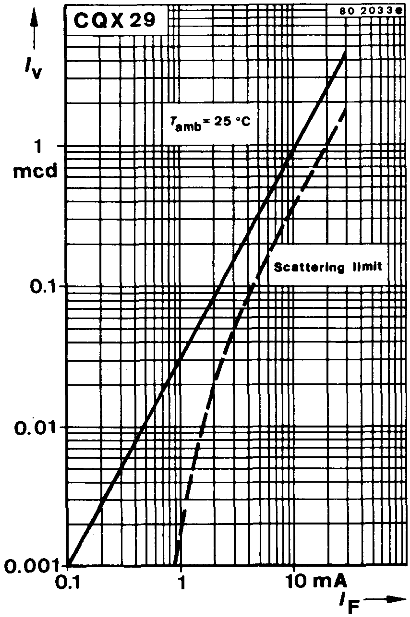

CQX 28
802031
I_{vav}
10 mcd
5
1
0.5
0.2
I_{FAV}=20 mA,constant
f =10 kHz
T_{amb}=25 °C
Scattering limit
10
20
50
100
200
500 mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$

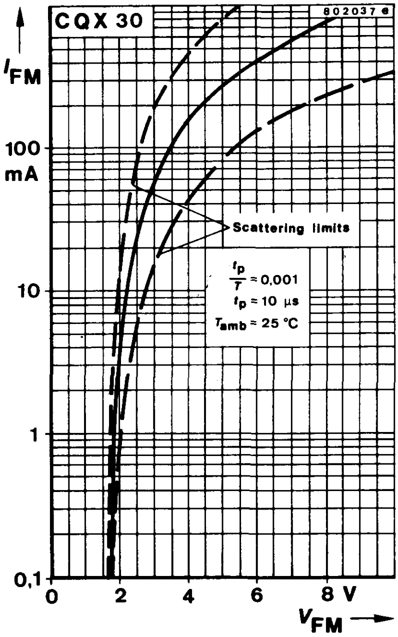

CQX 28
802029
I_v
1 mcd
0.1
0.01
0.001
T_{amb} = 25 °C
Scattering limit
0.1
1
10 mA
I_F

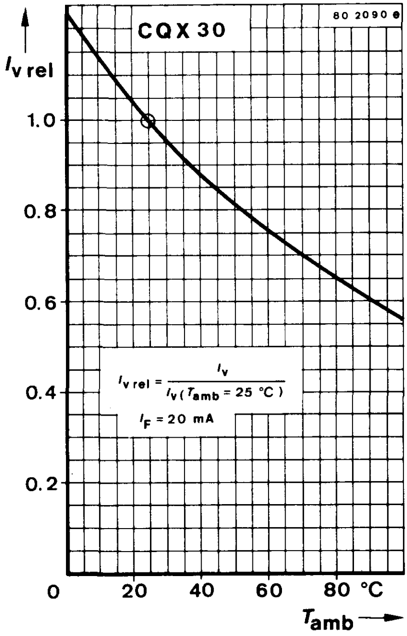

CQX 29
802034
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$

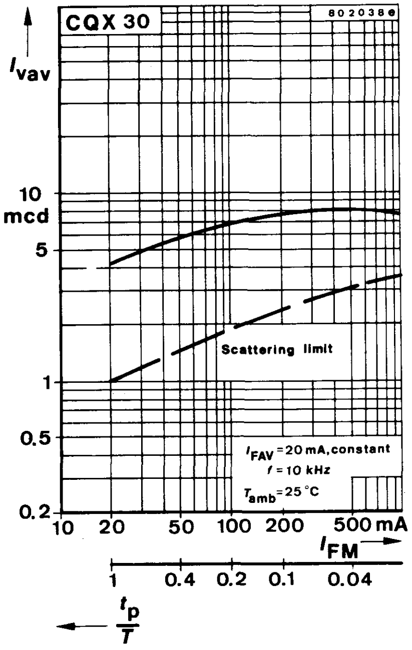

CQX29
802098
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v\,(T_{amb} = 25\ °C)}$
$I_F = 20\ mA$

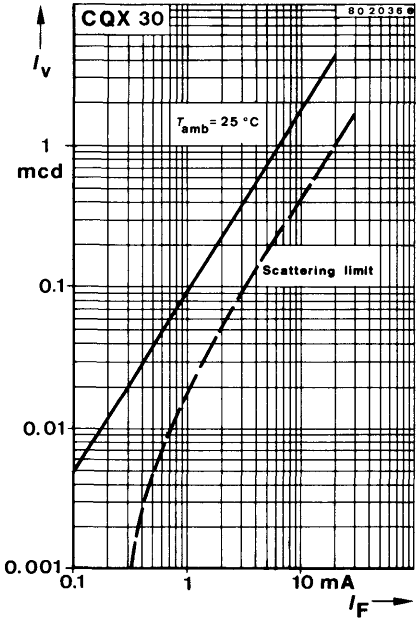

CQX 29
802035
I_{vav}
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500 mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$
Scattering limit
$I_{FAV} = 20$ mA, constant
$f = 10$ kHz
$T_{amb} = 25\ °C$

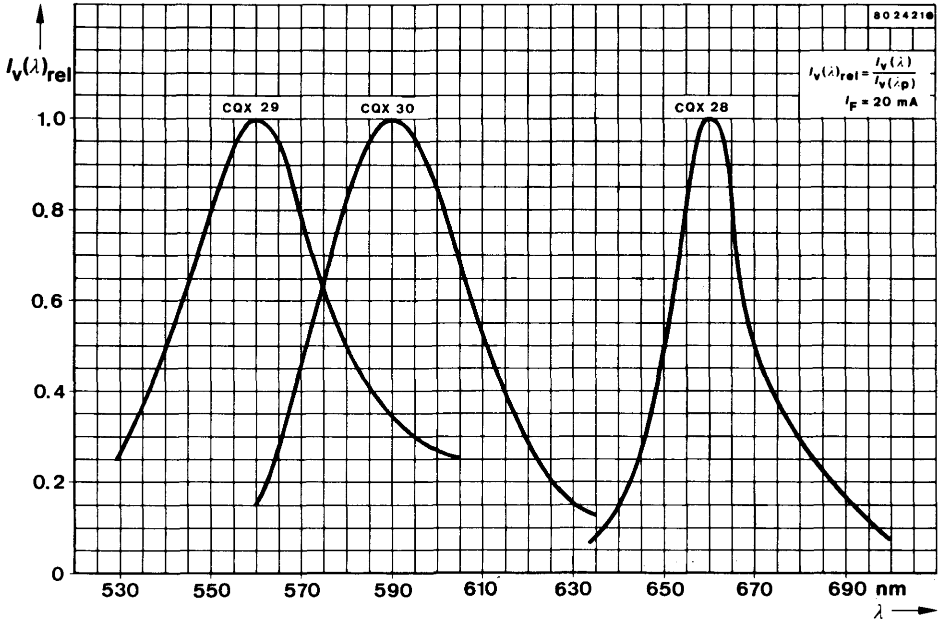

CQX 29
80 2033
I_v
1 mcd
0.1
0.01
0.001
0.1
1
10 mA
I_F
$T_{amb} = 25\ °C$
Scattering limit

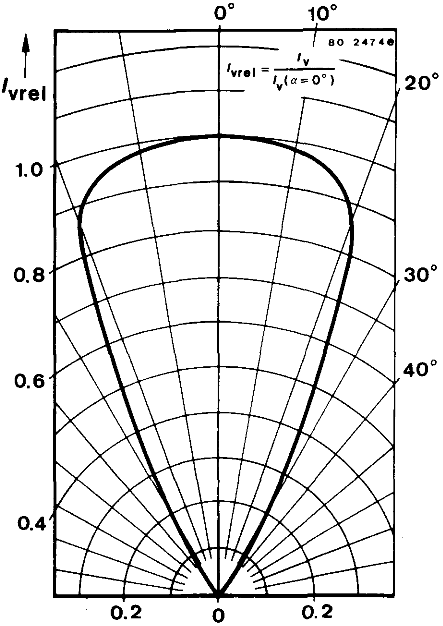

CQX 30
802037 e
I_{FM}
100 mA
10
1
0,1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0{,}001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$


CQX 30
80 2090 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v(T_{amb} = 25\ °C)}$
$I_F = 20\ mA$


CQX 30
802038 e
I_{vav}
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500 mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$
Scattering limit
$I_{FAV} = 20\ mA$, constant
$f = 10\ kHz$
$T_{amb} = 25\ °C$

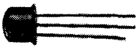

CQX 30
802036 e
I_v
1 mcd
0.1
0.01
0.001
0.1
1
10 mA
I_F
$T_{amb} = 25\ °C$
Scattering limit


8024210
$I_v(\lambda)_{rel}$
$I_v(\lambda)_{rel} = \frac{I_v(\lambda)}{I_v(\lambda p)}$
I_F = 20 mA
CQX 29
CQX 30
CQX 28
1.0
0.8
0.6
0.4
0.2
0
530
550
570
590
610
630
650
670
690 nm
λ


0°
10°
20°
30°
40°
8024740
I_{vrel}
$I_{vrel} = \frac{I_v}{I_v(\alpha = 0°)}$
1.0
0.8
0.6
0.4
0.2
0
0.2

CQX 31 · CQX 32

Bicolour LED in TO 18 Case



Colours	Type	Technology	Angle of half intensity α
Red + Green	**CQX 31**	GaAsP on GaAs GaP on GaP	50°
Red + Yellow	**CQX 32**	GaAsP on GaAs GaAsP on GaP	50°

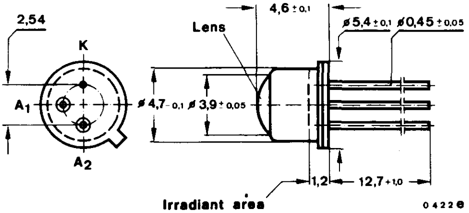
Application: Bicolour indication in high commercial equipments

Features:

- Hermetically sealed case with glass lens white diffuse
- Wide viewing angle
- Axial terminals
- Long life compared with filament lamps
- Vibration resistant

Preliminary specifications

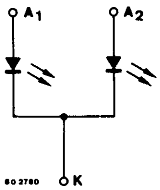
Dimensions in mm



Cathodes connected with case

Angle of half intensity α = 50°

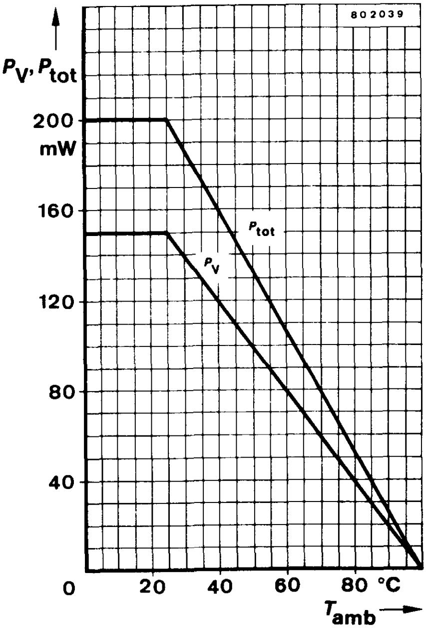
Special case
≈ 18 A 3 DIN 41876
≈ JEDEC TO 52
Weight max. 0.5 g



CQX 31	A_1	red
	A_2	green
CQX 32	A_1	red
	A_2	yellow

Absolute maximum ratings

Reverse voltage	V_R	5	V
Forward current	I_F	50	mA
Forward surge current $t_p \leq 10\,\mu s$	I_{FSM}	1	A
Power dissipation, with a single diode in operation $T_{amb} \leq 25\,°C$	P_V	150	mW
Total power dissipation $T_{amb} \leq 25\,°C$	P_{tot}	200	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−55 ... + 100	°C



Thermal resistances		**Min.**	**Typ.**	**Max.**	
Junction ambient for a single diode	R_{thJA}			500	K/W
Junction ambient, total	$R_{thJAtot}$			375	K/W

Optical and electrical characteristics
$T_{amb} = 25\,°C$

Type	Colour	Luminous intensity I_V*) (mcd)	Peak wavelength emission λ_p (nm) Typ.	Spectral half bandwidth $\Delta\lambda$ (nm) Typ.	Forward voltage V_F*) (V)
		$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA
CQX 31	red	min. 0.8 typ. 2.0	660	20	typ. 1.6 max. 2.0
	green	min. 1.0 typ. 2.6	560	40	typ. 2.7 max. 3.2
CQX 32	red	min. 0.8 typ. 2.0	660	20	typ. 1.6 max. 2.0
	yellow	min. 1.0 typ. 4.2	590	40	typ. 2.4 max. 3.2

		Min.	**Typ.**	**Max.**	
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0$, $f = 1$ MHz	C_j		50		pF

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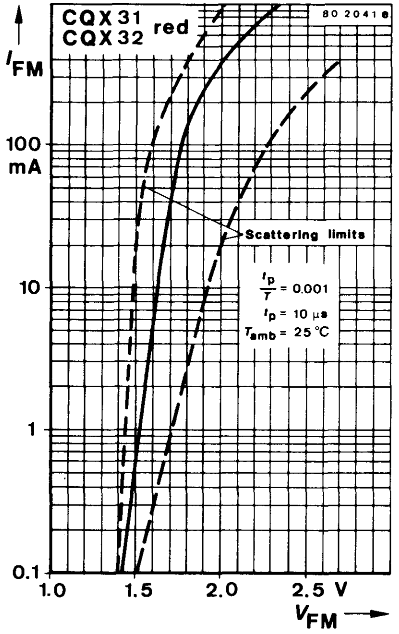
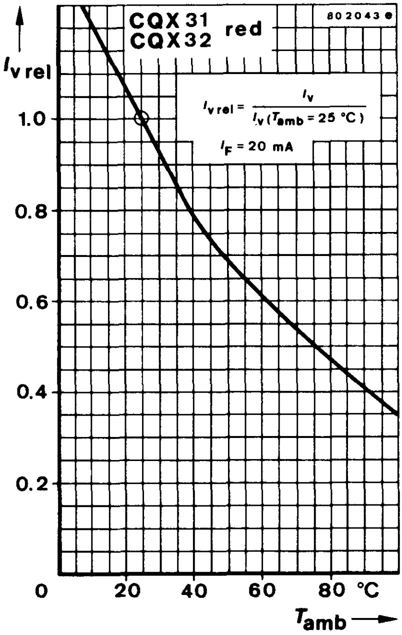
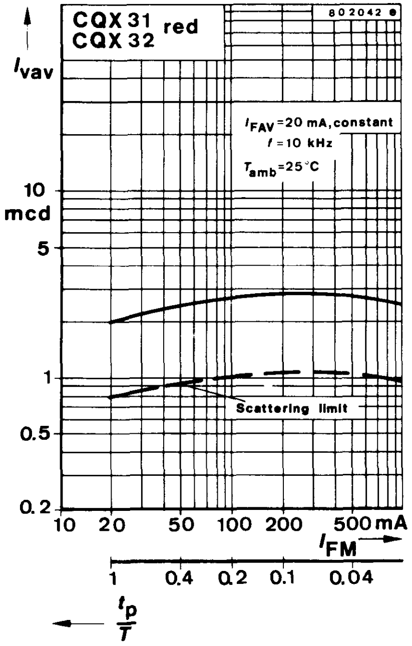
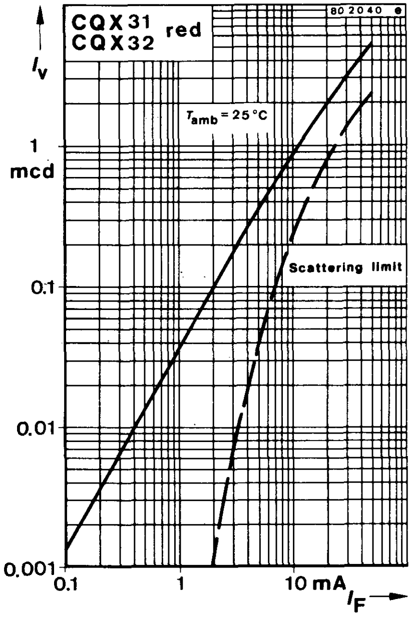
*) AQL = 0.65%

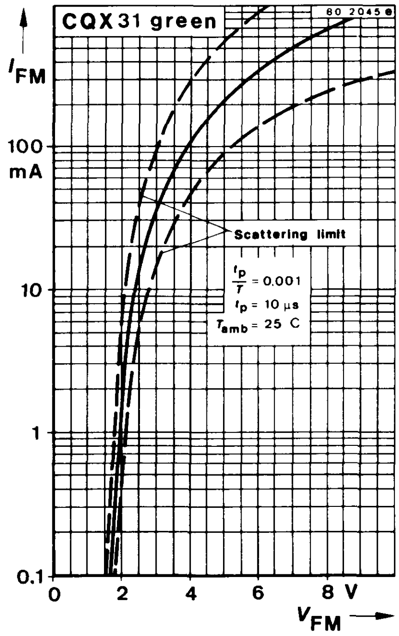
CQX 31 · CQX 32

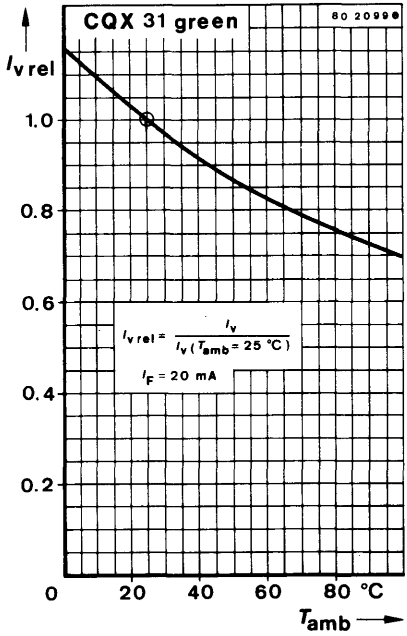

CQX 31
CQX 32
red
80 2041
I_{FM}
100
mA
10
1
0.1
1.0
1.5
2.0
2.5 V
V_{FM}
Scattering limits
$\frac{t_p}{T}$ = 0.001
t_p = 10 μs
T_{amb} = 25 °C

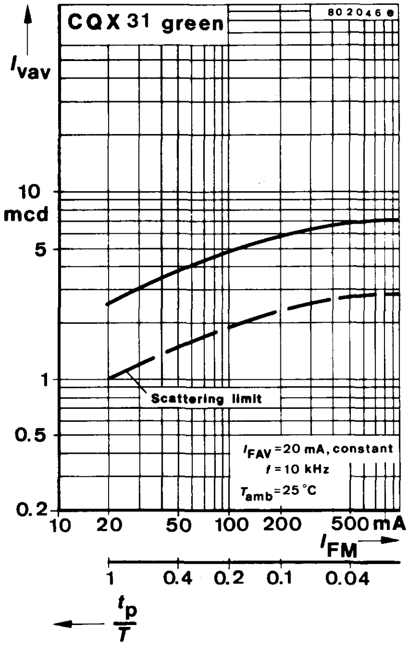

CQX 31
CQX 32
red
80 2043
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v(T_{amb} = 25\ °C)}$
I_F = 20 mA

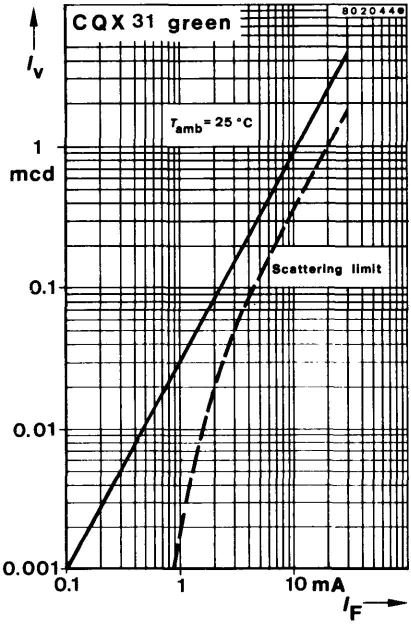

CQX 31
CQX 32
red
80 2042
I_{vav}
10
mcd
5
1
0.5
0.2
10
20
50
100
200
500 mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$
I_{FAV} = 20 mA, constant
f = 10 kHz
T_{amb} = 25 °C
Scattering limit

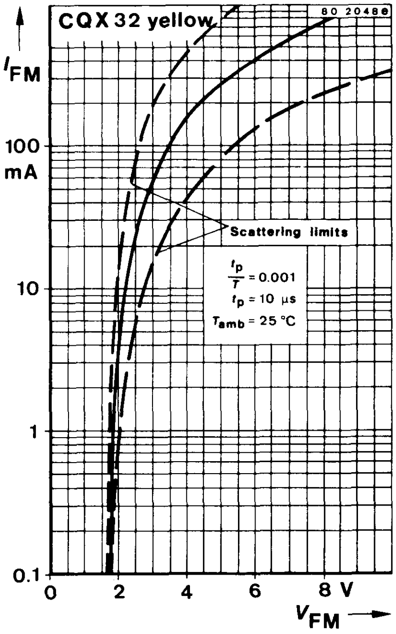

CQX 31
CQX 32
red
80 2040
I_v
1
mcd
0.1
0.01
0.001
0.1
1
10 mA
I_F
T_{amb} = 25 °C
Scattering limit

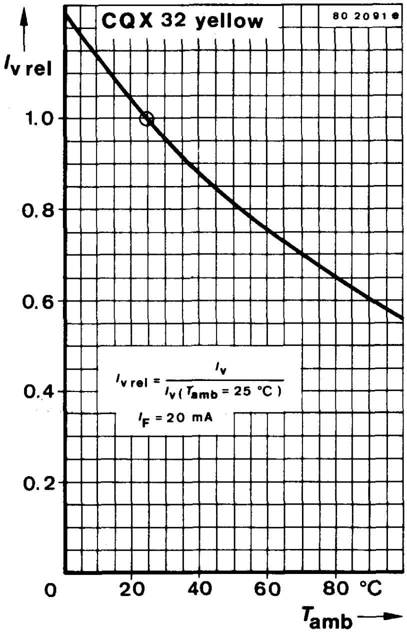

CQX 31 green
80 2045 ●
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limit
$\frac{t_p}{T}$ = 0.001
t_p = 10 µs
T_{amb} = 25 C

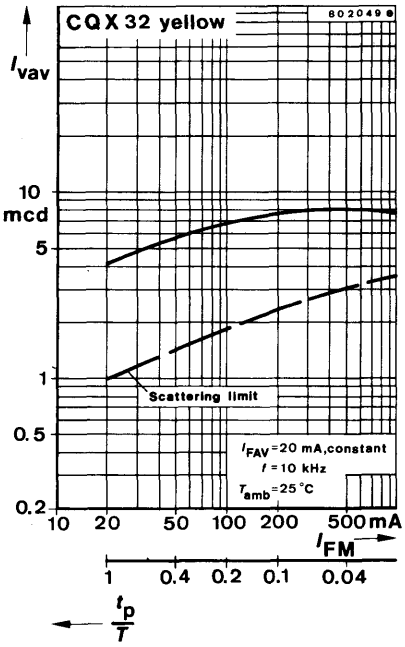

CQX 31 green
80 2099 ●
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v\,(T_{amb} = 25\ °C)}$
I_F = 20 mA

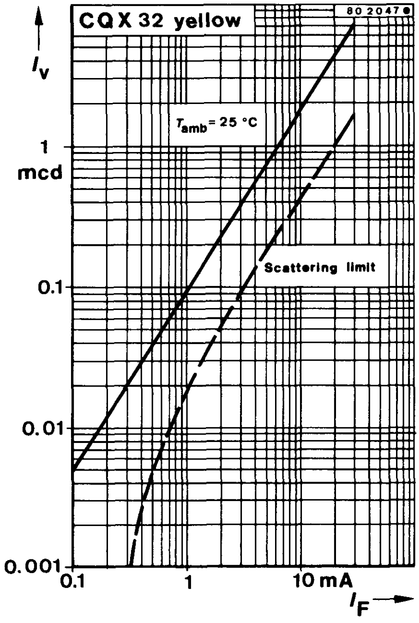

CQX 31 green
80 2046 ●
I_{vav}
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500 mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$
Scattering limit
I_{FAV} = 20 mA, constant
f = 10 kHz
T_{amb} = 25 °C

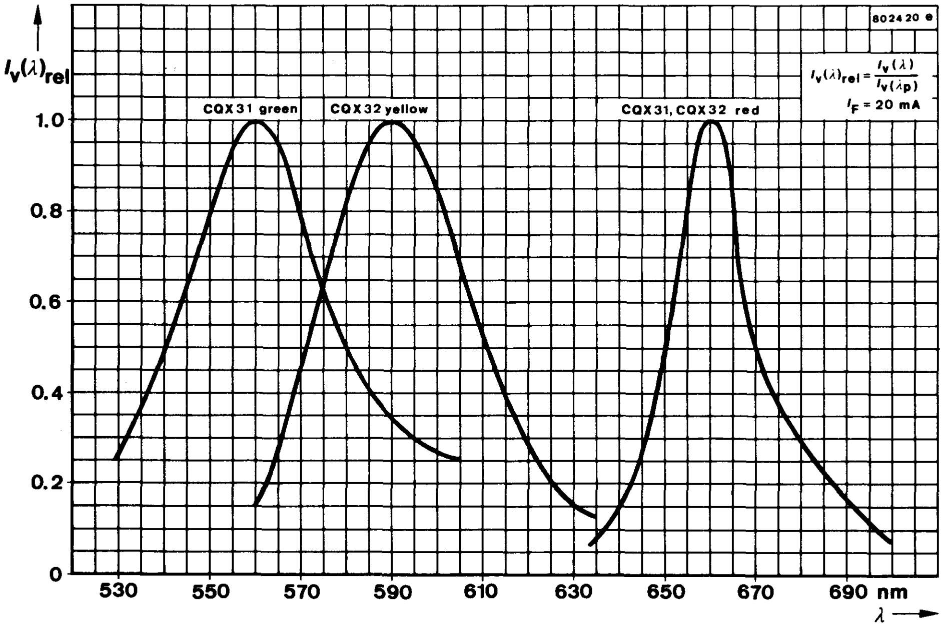

CQX 31 green
80 2044 ●
I_v
1 mcd
0.1
0.01
0.001
0.1
1
10 mA
I_F
T_{amb} = 25 °C
Scattering limit

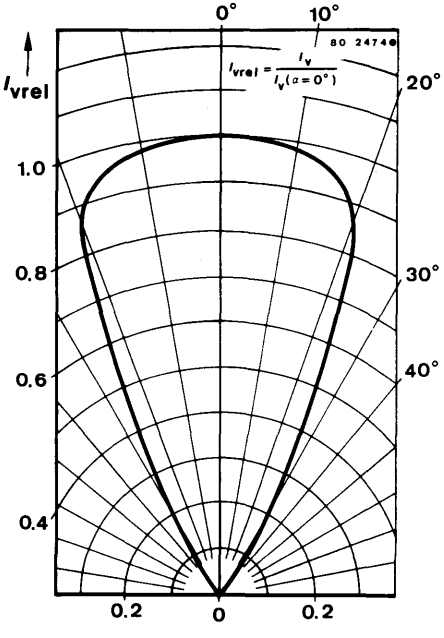

CQX 32 yellow
80 2048 e
I_{FM}
100
mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T}$ = 0.001
t_p = 10 µs
T_{amb} = 25 °C


CQX 32 yellow
80 2091 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v(T_{amb} = 25\ °C)}$
I_F = 20 mA


CQX 32 yellow
80 2049 e
I_{vav}
10
mcd
5
1
0.5
0.2
10
20
50
100
200
500 mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$
Scattering limit
I_{FAV} = 20 mA, constant
f = 10 kHz
T_{amb} = 25 °C


CQX 32 yellow
80 2047 e
I_v
1
mcd
0.1
0.01
0.001
0.1
1
10 mA
I_F
T_{amb} = 25 °C
Scattering limit


802420 e
$I_v(\lambda)_{rel}$
$I_v(\lambda)_{rel} = \frac{I_v(\lambda)}{I_v(\lambda p)}$
I_F = 20 mA
CQX 31 green
CQX 32 yellow
CQX 31, CQX 32 red
1.0
0.8
0.6
0.4
0.2
0
530
550
570
590
610
630
650
670
690 nm
λ


0°
10°
20°
30°
40°
80 2474 e
I_{vrel}
$I_{vrel} = \frac{I_v}{I_v(\alpha = 0°)}$
1.0
0.8
0.6
0.4
0.2
0
0.2

CQX 35 · CQX 39 · CQX 36 · CQX 37

LED in 5 mm Case

Colour	Type	Technology	Angle of half intensity α
Red	**CQX 35**	GaAsP on GaAs	25°
Orange-red	**CQX 39**	GaAsP on GaP	25°
Green	**CQX 36**	GaP on GaP	25°
Yellow	**CQX 37**	GaAsP on GaP	25°

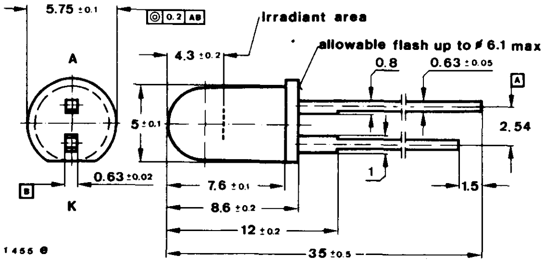
Applications: General indicating and illumination purposes

Features:

- Plastic case, white clear
- High illumination through concentrated radiation
- Axial terminals
- Long life compared with filament lamps
- Vibration resistant

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 25°$
Special case
Weight max. 0.4 g

Accessories

Mounting clip	Best. Nr. 562 136
Retainer ring	Best. Nr. 562 135

Absolute maximum ratings

Reverse voltage		V_R	5	V
Forward current	**CQX 35**	I_F	50	mA
	CQX 39, CQX 36, CQX 37	I_F	30	mA
Forward surge current $t_p \leq 10\ \mu s$		I_{FSM}	1	A

CQX 35 · CQX 39 · CQX 36 · CQX 37

Power dissipation $T_{amb} \leq 70\,°C$	P_V	100	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−55 ... +100	°C
Soldering temperature, maximal $t \leq 5$ s	T_{sd}[1])	260	°C

Thermal resistance

Junction ambient	R_{thJA}	300	K/W

Optical and electrical characteristics

$T_{amb} = 25°$

Type	Group	Luminous intensity I_V*)[2]) (mcd)	Peak wavelength emission λ_p (nm) Typ.	Spectral half bandwidth $\Delta\lambda$ (nm) Typ.	Forward voltage V_F*) (V)
		$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA
CQX 35	A	min. 3.2 typ. 5.0	660	20	typ. 1.6 max. 2.0
	B	min. 5.0 typ. 8.0			
CQX 39	A	min. 8.0 typ. 15.0	630	40	typ. 2.2 max. 3.0
	B	min. 20.0 typ. 40.0			
CQX 36	A	min. 3.2 typ. 5.0	560	40	typ. 2.7 max. 3.2
	B	min. 5.0 typ. 10.0			
CQX 37	A	min. 3.2 typ. 5.0	590	40	typ. 2.4 max. 3.2
	B	min. 5.0 typ. 12.0			

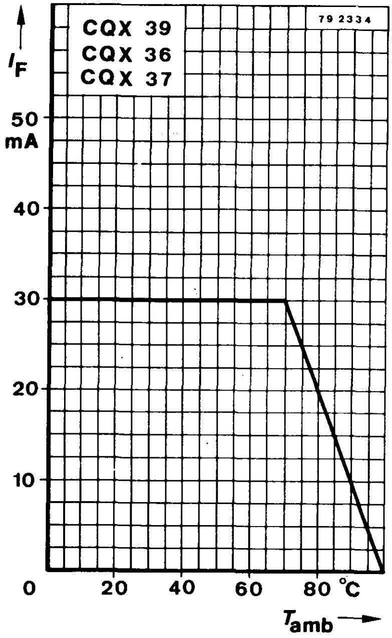
		Min.	**Typ.**	**Max.**	
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz	C_j		50		pF

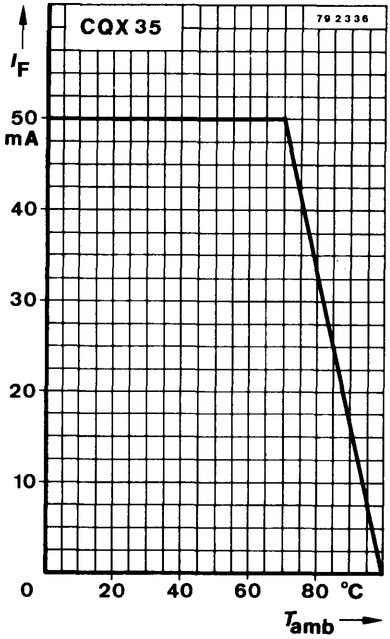
---

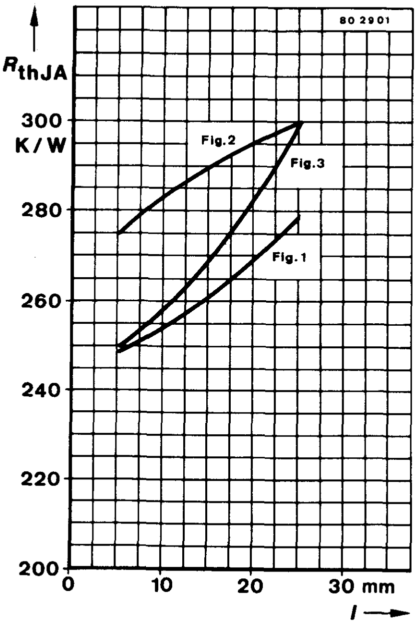
*) AQL = 0.65%

[1]) Distance from the touching border ≥ 1.5 mm with intermediate PC-board

[2]) supplied selected in groups, luminous intensity in packing unit m = 0.5 ...1







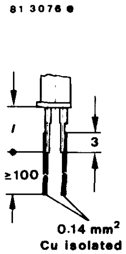


Fig.1

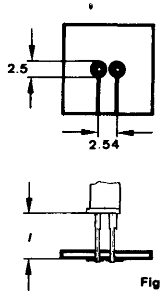


Fig.2

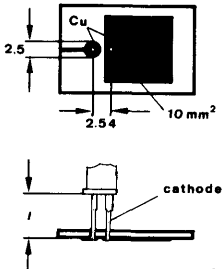
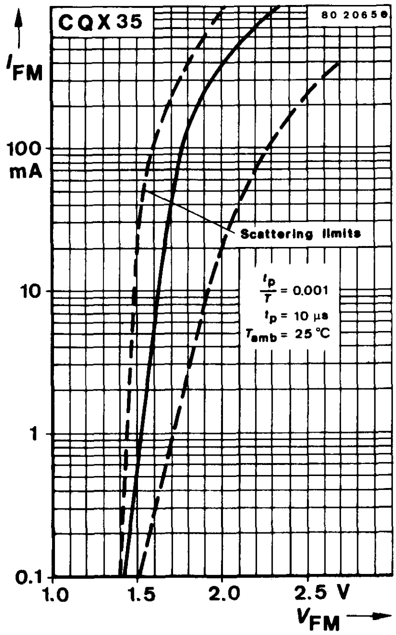
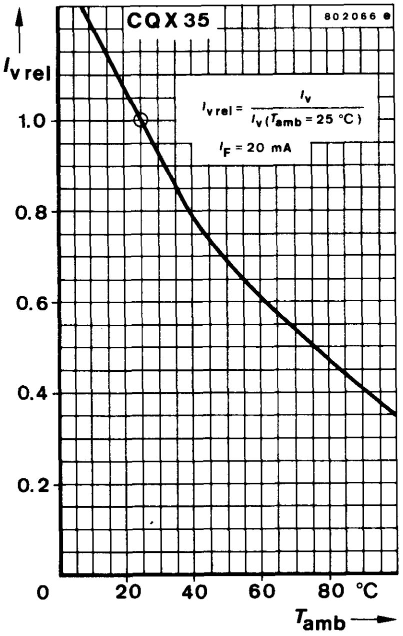
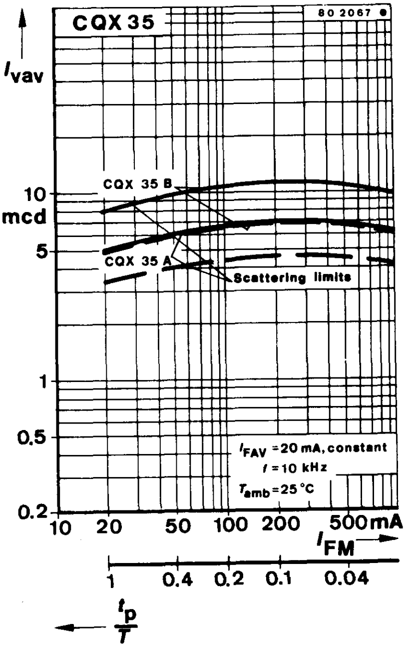


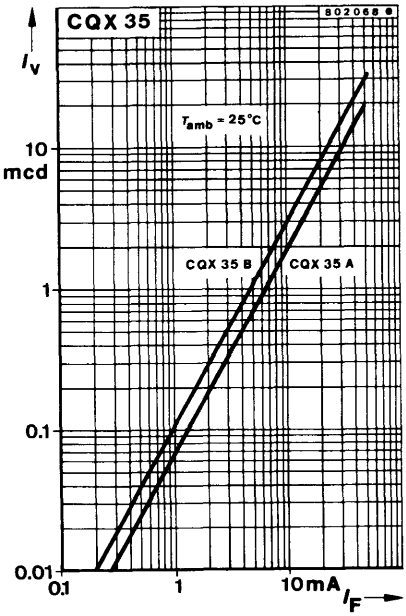
Fig.3

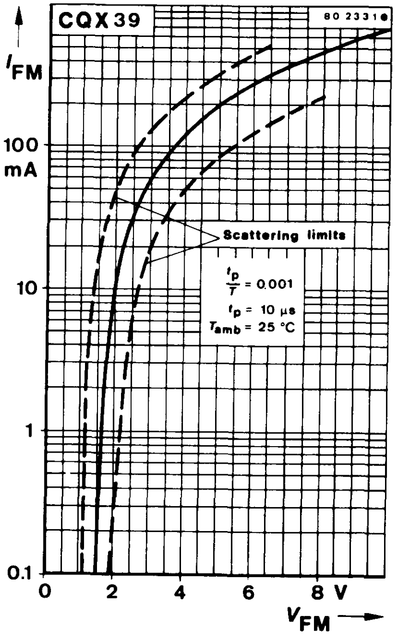
CQX 35 · CQX 39 · CQX 36 · CQX 37

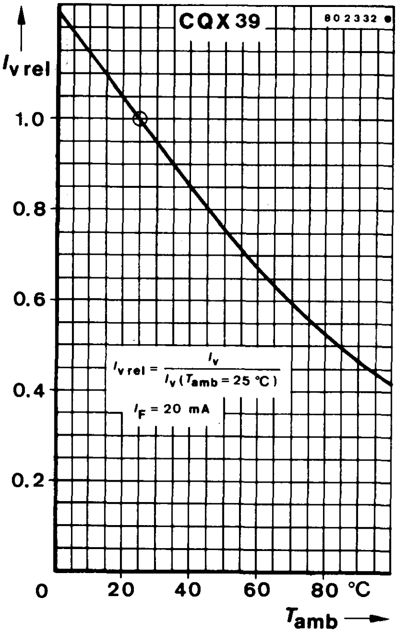


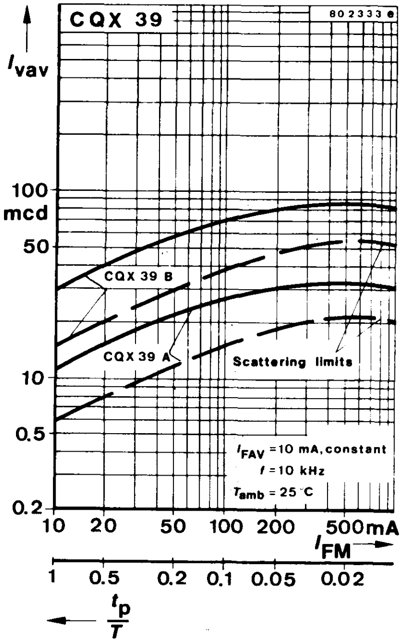


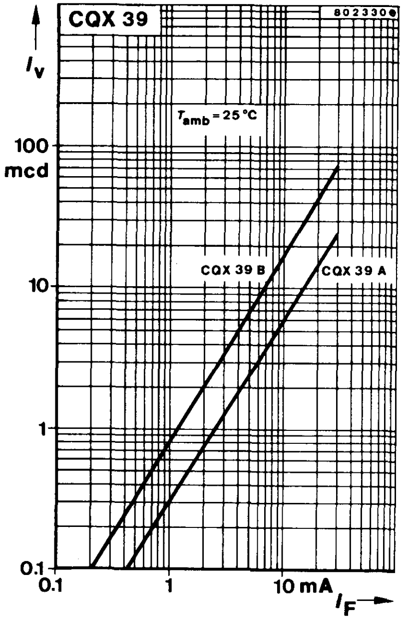




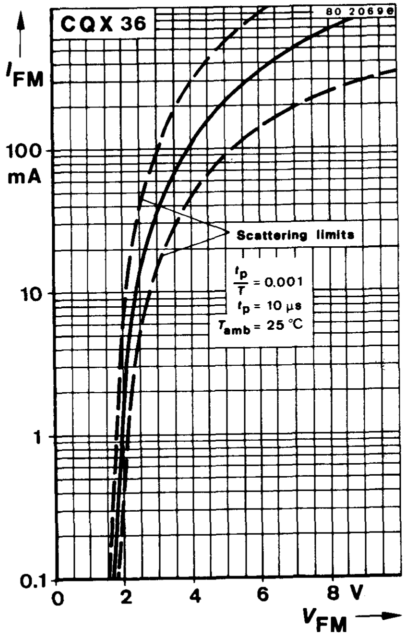

CQX39
80 2331
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T}$ = 0.001
t_p = 10 µs
T_{amb} = 25 °C

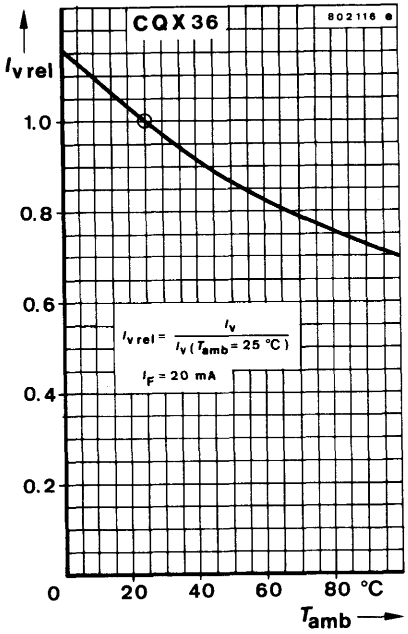

CQX 39
80 2332
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v(T_{amb} = 25\ °C)}$
I_F = 20 mA

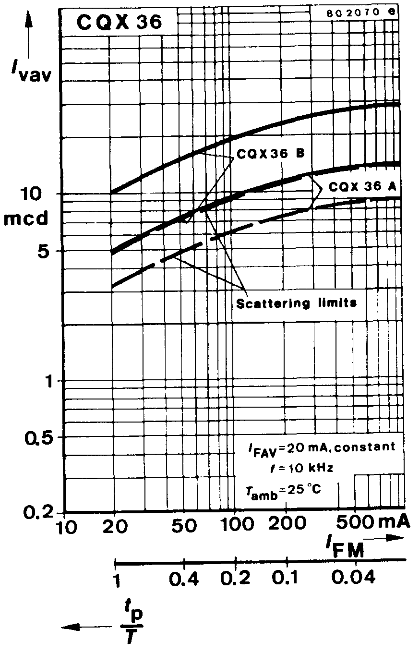

CQX 39
80 2333
I_{vav}
100 mcd
50
10
0.5
0.2
10
20
50
100
200
500mA
I_{FM}
1
0.5
0.2
0.1
0.05
0.02
$\frac{t_p}{T}$
CQX 39 B
CQX 39 A
Scattering limits
I_{FAV} = 10 mA, constant
f = 10 kHz
T_{amb} = 25 °C

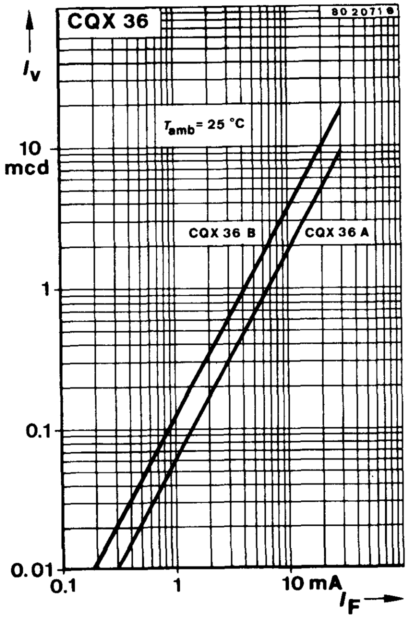

CQX 39
80 2330
I_v
T_{amb} = 25 °C
100 mcd
10
1
0.1
0.1
1
10 mA
I_F
CQX 39 B
CQX 39 A

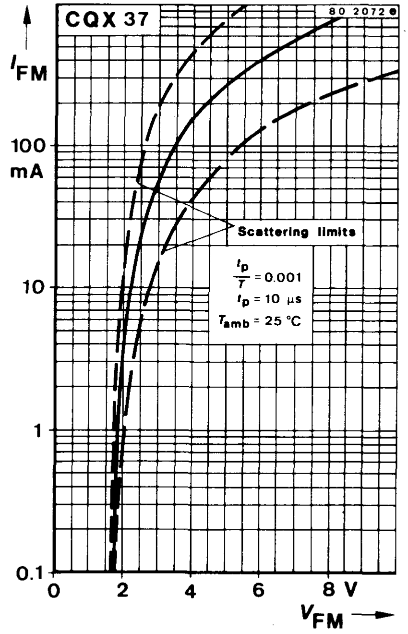
CQX 35 · CQX 39 · CQX 36 · CQX 37

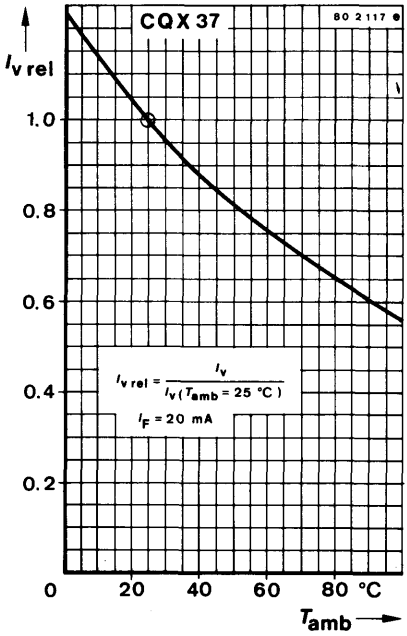


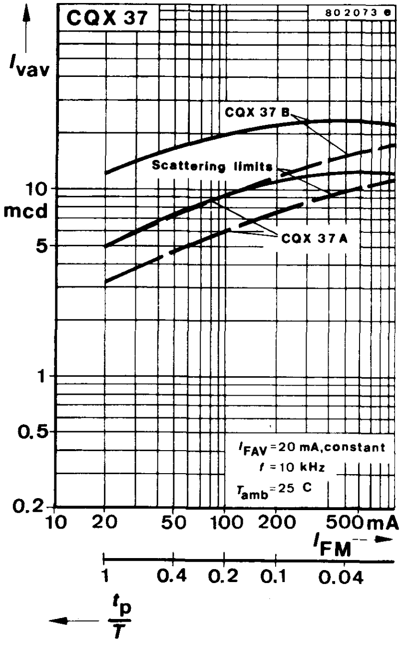


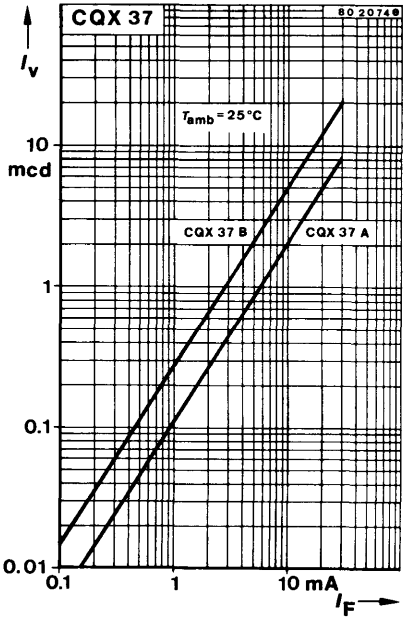




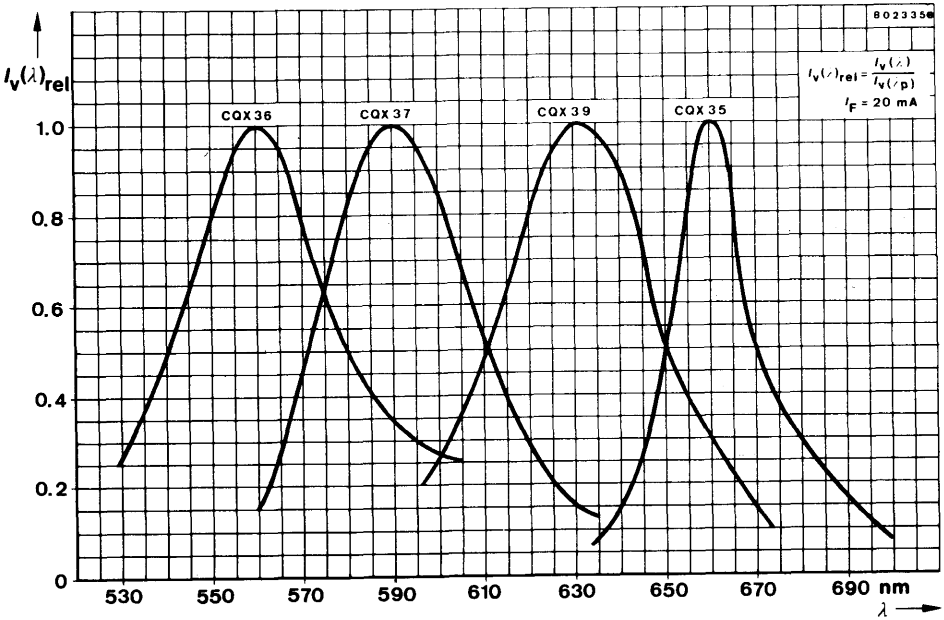

CQX 37
80 2072
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$

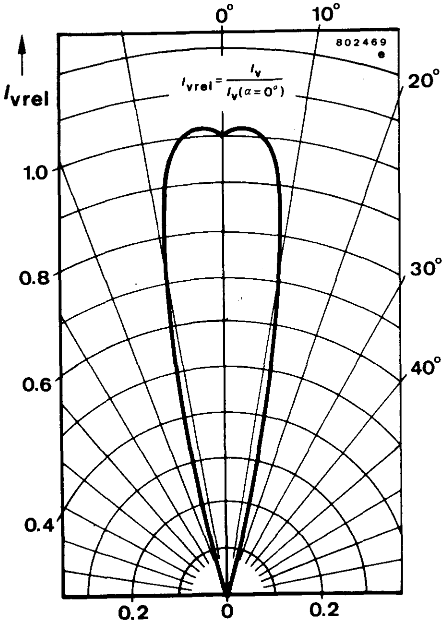

CQX 37
80 2117
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v(T_{amb} = 25\ °C)}$
$I_F = 20$ mA


CQX 37
802073
I_{vav}
CQX 37 B
Scattering limits
CQX 37 A
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500 mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$
$I_{FAV} = 20$ mA, constant
$f = 10$ kHz
$T_{amb} = 25$ C


CQX 37
80 2074
I_v
$T_{amb} = 25\ °C$
10 mcd
1
0.1
0.01
CQX 37 B
CQX 37 A
0.1
1
10 mA
I_F

CQX 35 · CQX 39 · CQX 36 · CQX 37





CQX 38

see page 289

CQX 39

see page 267

CQX 40

see page 227

CQX 41 N

see page 309

CQX 42

see page 243

CQX 42 N

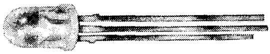
see page 245

CQX 43 N

see page 299

CQX 95

Bicolour LED in 5 mm Case



Orange-red – GaAsP on GaP
Green – GaP on GaP

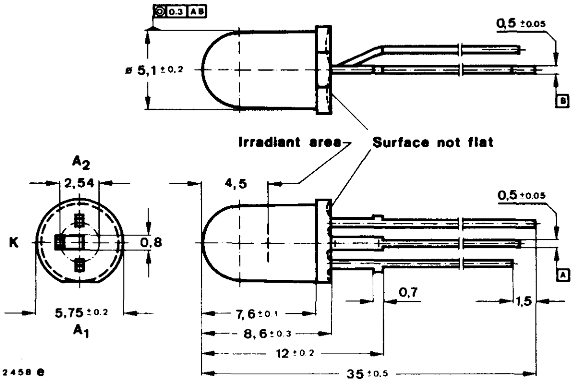
Application: General indicating purposes

Features:

- Plastic case, white diffuse
- Wide viewing angle
- Axial terminals
- Long life compared with filament lamps
- Vibration resistant
- TTL-compatible
- Colour mixing possible due to separate anode terminals

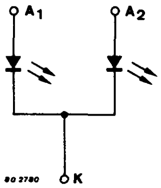
Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 60°$

Weight max. 0.42 g

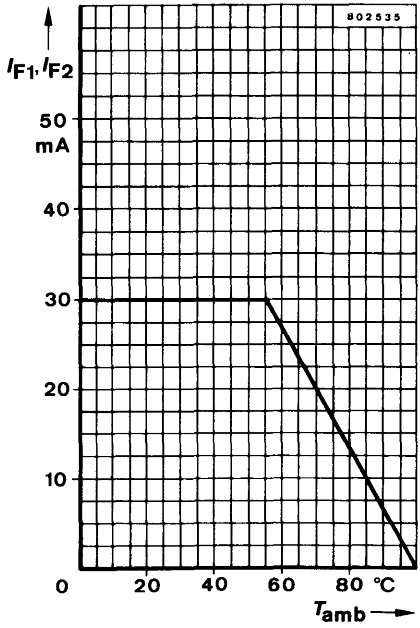


Accessories

Mounting clip	Best. Nr. 562136
Retainer ring	Best. Nr. 562135

Absolute maximum ratings

Reverse voltage	V_R	5	V
Forward current	I_{F1}, I_{F2}	30	mA
Forward surge current $t_p \leqq 10\ \mu s$	I_{FSM}	1	A
Power dissipation, with a single diode in operation $T_{amb} \leqq 55°C$	P_V	100	mW
Total power dissipation $T_{amb} \leqq 55°C$	P_{tot}	150	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−55 ... + 100	°C
Soldering temperature, maximal $t \leqq 5$ s	T_{sd}¹)	260	°C



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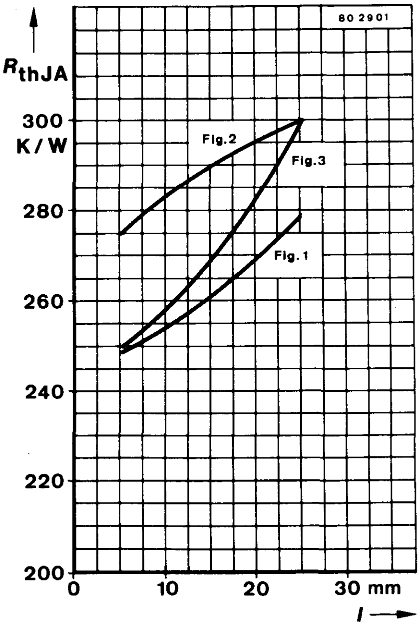
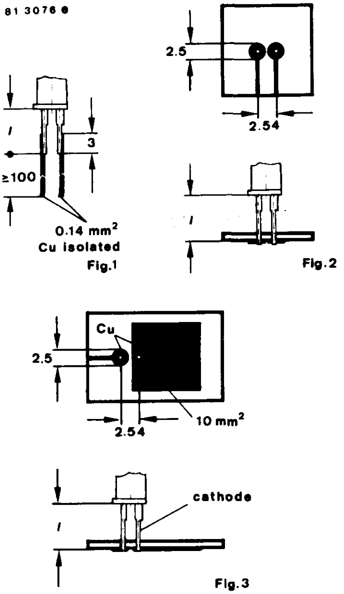
¹) Distance from the touching border ≥ 1.5 mm with intermediate PC-board

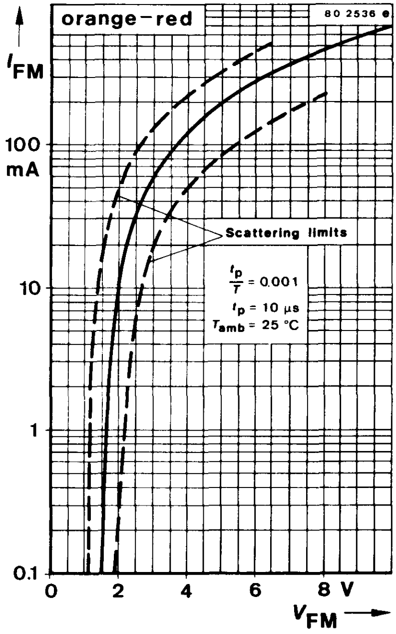


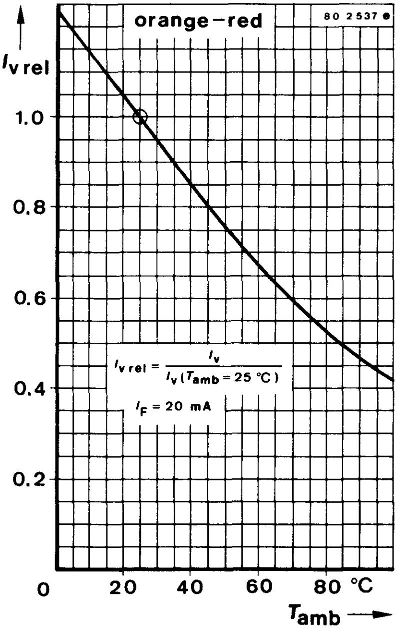


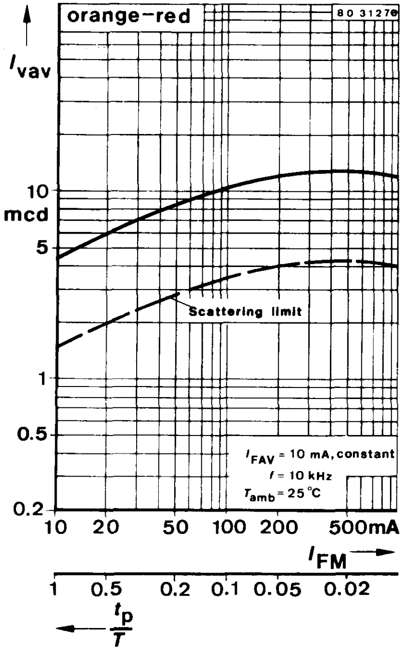
			Min.	Typ.	Max.	
Thermal resistance						
Junction ambient		R_{thJA}			300	K/W
Optical and electrical characteristics						
$T_{amb} = 25°C$						
Luminous intensity $I_F = 20$ mA		I_v*)	2	6		mcd
Matching factor $I_F = 20$ mA		$m = \frac{I_{v\,min}}{I_{v\,max}}$		0.75		
Peak wavelength emission $I_F = 20$ mA	**orange-red**	λ_p		630		nm
	green	λ_p		560		nm
Spectral half bandwidth $I_F = 20$ mA		$\Delta\lambda$		40		nm
Forward voltage $I_F = 20$ mA	**orange-red**	V_F*)		2.2	3.0	V
	green	V_F*)		2.4	3.0	V
Breakdown voltage $I_R = 100\,\mu A$		$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz		C_j		50		pF

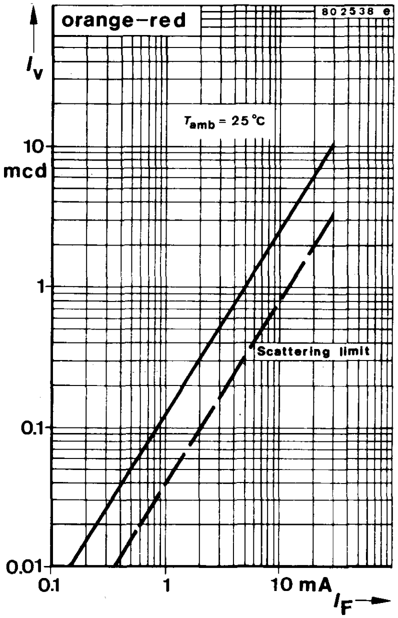
---

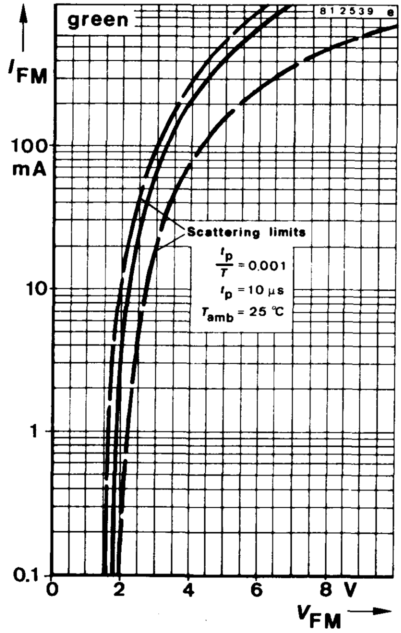
*) AQL = 0.65%

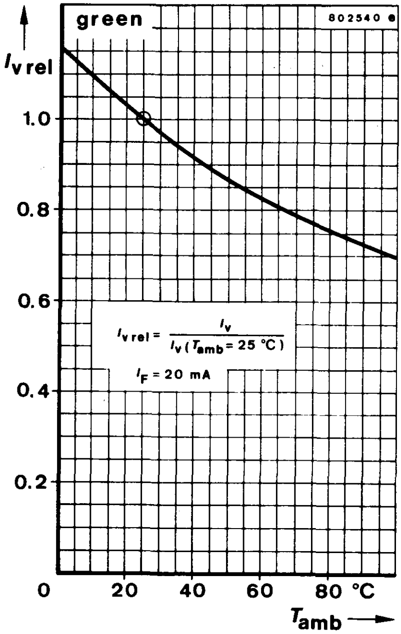

orange−red
80 2536 e
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T}$ = 0.001
t_p = 10 µs
T_{amb} = 25 °C

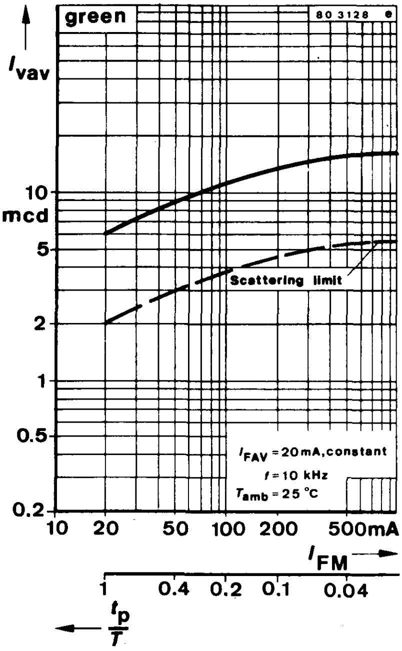

orange−red
80 2537 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v\,(T_{amb} = 25\ °C)}$
I_F = 20 mA

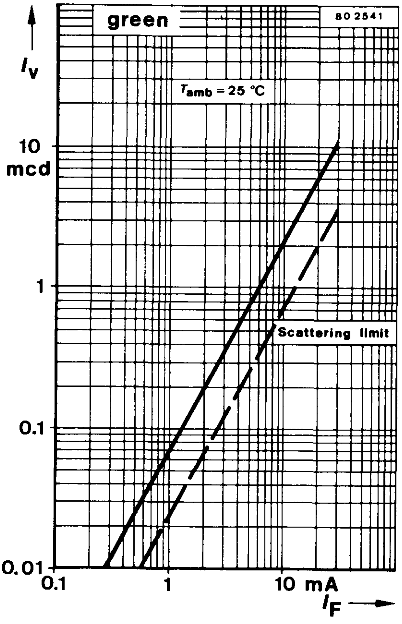

orange−red
80 3127e
I_{vav}
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500mA
I_{FM}
1
0.5
0.2
0.1
0.05
0.02
$\frac{t_p}{T}$
Scattering limit
I_{FAV} = 10 mA, constant
f = 10 kHz
T_{amb} = 25 °C

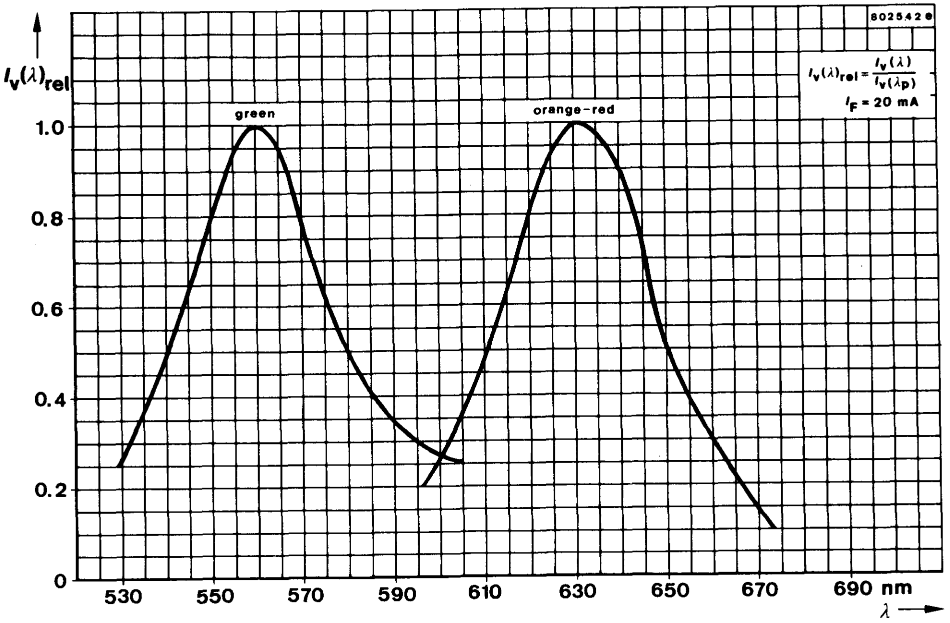

orange−red
802538 e
I_v
10 mcd
1
0.1
0.01
0.1
1
10 mA
I_F
T_{amb} = 25 °C
Scattering limit

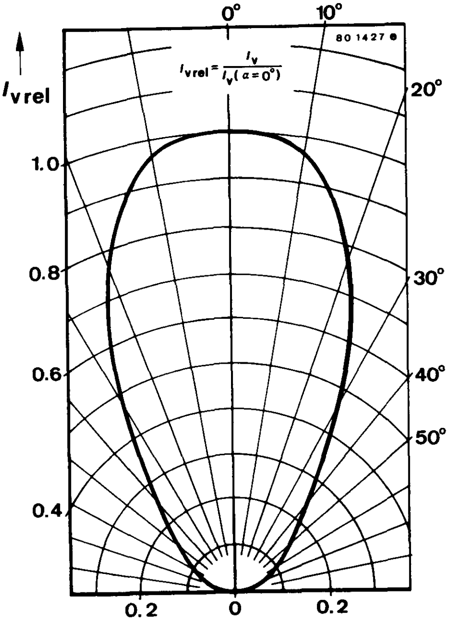

green
812539 e
I_{FM}
100
mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$


green
802540 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v(T_{amb} = 25\ °C)}$
$I_F = 20$ mA


green
80 3128 e
I_{vav}
10
mcd
5
2
1
0.5
0.2
10
20
50
100
200
500mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$
Scattering limit
I_{FAV} = 20 mA, constant
f = 10 kHz
$T_{amb} = 25\ °C$


green
802541
I_v
10
mcd
1
0.1
0.01
0.1
1
10 mA
I_F
$T_{amb} = 25\ °C$
Scattering limit

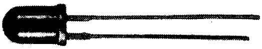

8025420
$I_v(\lambda)_{rel}$
$I_v(\lambda)_{rel} = \frac{I_v(\lambda)}{I_v(\lambda p)}$
$I_F = 20$ mA
green
orange-red
1.0
0.8
0.6
0.4
0.2
0
530
550
570
590
610
630
650
670
690 nm
λ


0°
10°
20°
30°
40°
50°
801427
$I_{vrel} = \frac{I_v}{I_v(\alpha = 0°)}$
I_{vrel}
1.0
0.8
0.6
0.4
0.2
0
0.2

CQX 96

LED in 5 mm Case

Green – GaP on GaP



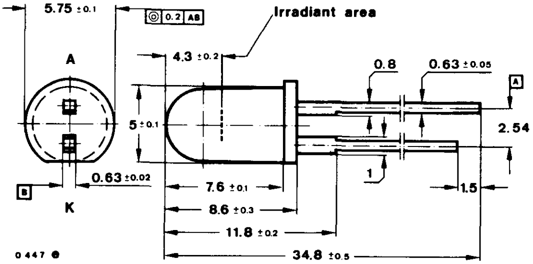
Application: General indicating purposes

Features:

- High illumination
- Axial terminals
- Long life compared with filament lamps
- Vibration resistant
- TTL-compatible

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 24°$

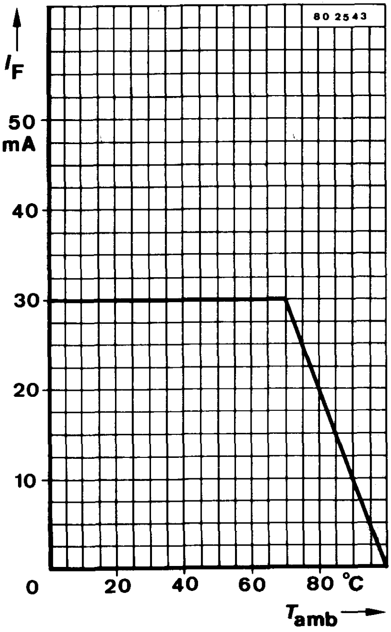
Weight max. 0.42 g

Accessories

Mounting clip	Best. Nr. 562 136
Retainer ring	Best. Nr. 562 135

Absolute maximum ratings

Reverse voltage	V_R	5	V
Forward current	I_F	30	mA
Forward surge current $t_p \leqq 10\ \mu s$	I_{FSM}	1	A
Power dissipation, with a single diode in operation $T_{amb} \leqq 70\ °C$	P_V	100	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−55 ... + 100	°C
Soldering temperature, maximal $t \leqq 5$ s	T_{sd}[1]	260	°C



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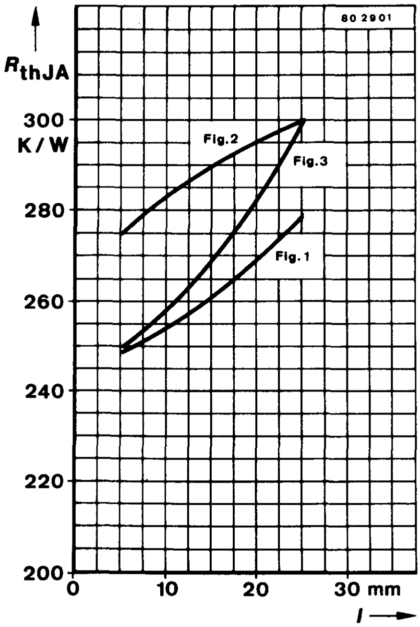
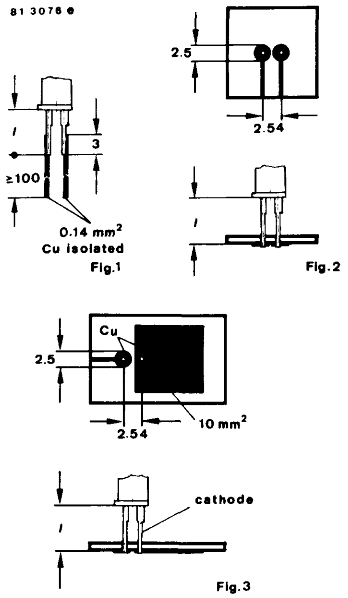
[1] Distance from the touching border ≥ 1.5 mm with intermediate PC-board





Thermal resistance		**Min.**	**Typ.**	**Max.**	
Junction ambient	R_{thJA}			300	K/W

Optical and electrical characteristics

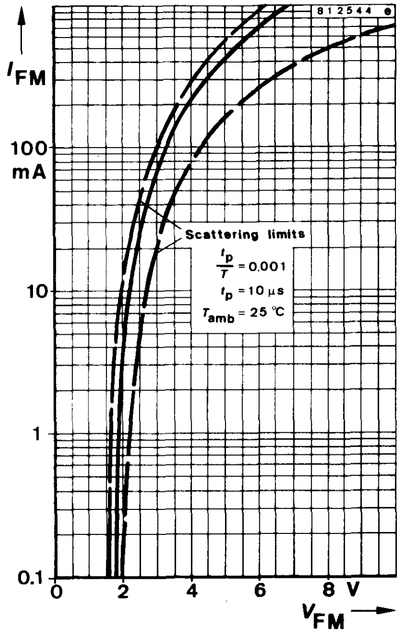
$T_{amb} = 25\,°C$

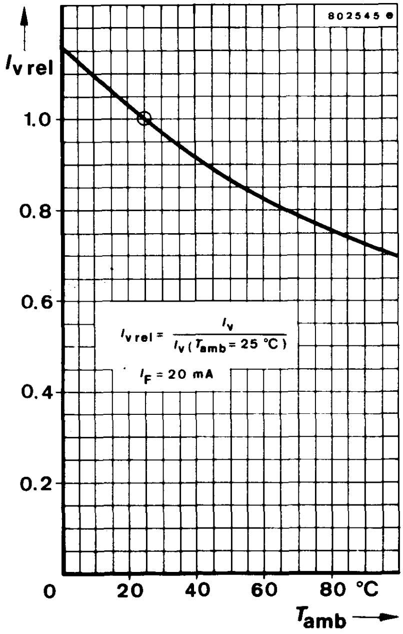
			Min.	Typ.	Max.	
Luminous intensity $I_F = 20$ mA	**Group A**	I_v*) ²)	20	40		mcd
	B	I_v*)	32	70		mcd
Peak wavelength emission $I_F = 20$ mA		λ_p		560		nm
Spectral half bandwidth		$\Delta\lambda$		40		nm
Forward voltage $I_F = 20$ mA		V_F*)		2.4	3.0	V
Breakdown voltage $I_R = 100\,\mu A$		$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0$, $f = 1$ MHz		C_j		50		pF

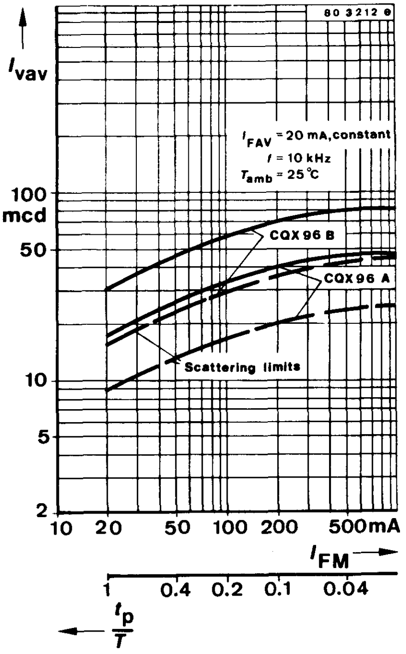
---

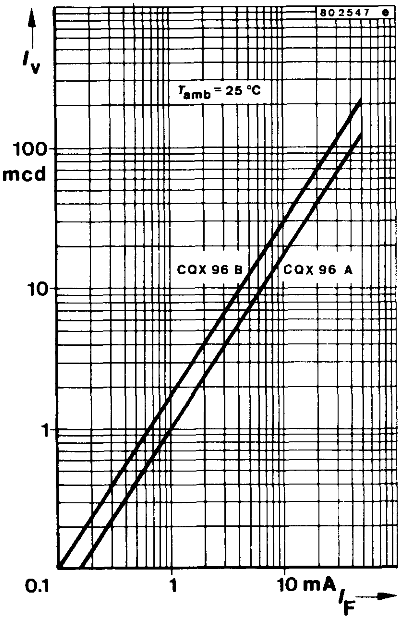
*) AQL = 0.65%   ²) supplied in groups selected, luminous intensity in packing unit m = 0.5...1

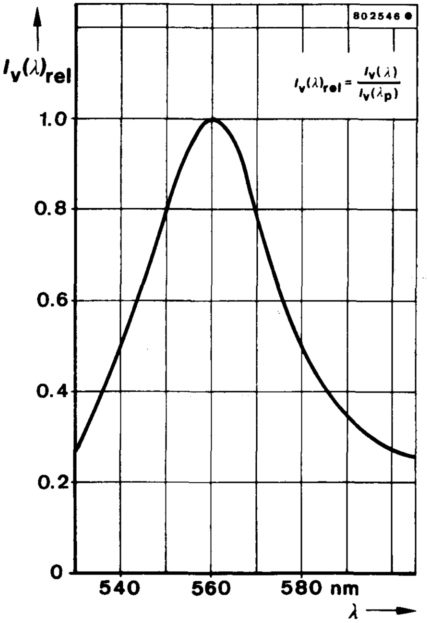
CQX 96

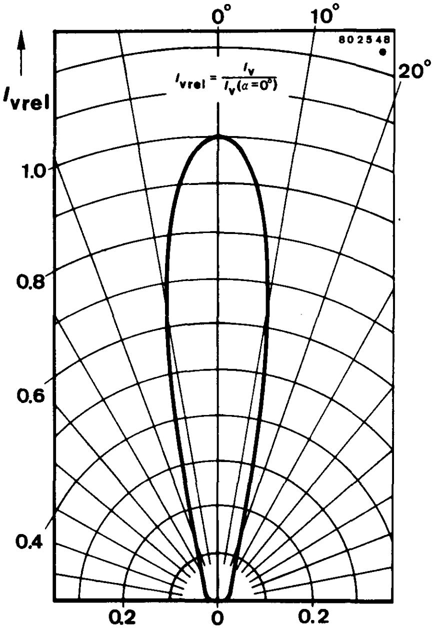

812544
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$


802545
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v\,(T_{amb} = 25\ °C)}$
$I_F = 20\ mA$


803212
I_{vav}
100 mcd
50
10
5
2
10
20
50
100
200
500 mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$
$I_{FAV} = 20\ mA$, constant
$f = 10\ kHz$
$T_{amb} = 25\ °C$
CQX 96 B
CQX 96 A
Scattering limits

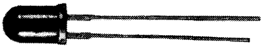

802547
I_v
$T_{amb} = 25\ °C$
100 mcd
10
1
0.1
1
10 mA
I_F
CQX 96 B
CQX 96 A


802546
$I_v(\lambda)_{rel}$
$I_v(\lambda)_{rel} = \frac{I_v(\lambda)}{I_v(\lambda_p)}$
1.0
0.8
0.6
0.4
0.2
0
540
560
580 nm
λ


0°
10°
20°
802548
I_{vrel}
$I_{vrel} = \frac{I_v}{I_v(\alpha = 0°)}$
1.0
0.8
0.6
0.4
0.2
0
0.2

CQY 40 · CQX 38 · CQY 72 · CQY 74
V 168 P V 169 P · V 170 P

LED in 5 mm Case



Colour	Type	Technology	Angle of half intensity α
Red	**CQY 40 · V 168 P**	GaAsP on GaAs	60°
Orange-red	**CQX 38**	GaAsP on GaP	60°
Green	**CQY 72 · V 169 P**	GaP on GaP	60°
Yellow	**CQY 74 · V 170 P**	GaAsP on GaP	60°

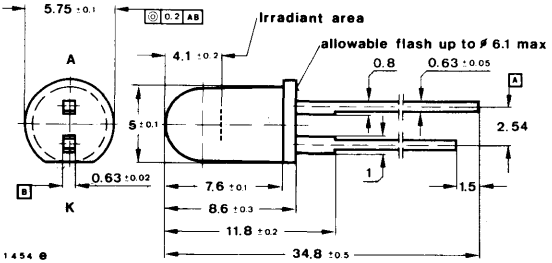
Application: General indicating purposes

Features:

- Plastic case, *diffuse colour*
- Wide viewing angle
- Axial terminals
- *Long life compared with filament lamps*
- Vibration resistant

Preliminary specifications

Dimensions in mm



Angle of half intensity
$\alpha = 60°$

Special case
Weight max. 0.4 g

Accessories

Mounting clip	Best. Nr. 562 136
Retainer ring	Best. Nr. 562 135

Absolute maximum ratings

Reverse voltage		V_R	5	V
Forward current	**CQY 40, V 168 P**	I_F	50	mA
	CQX 38, CQY 72, V 169 P, CQY 74, V 170 P	I_F	30	mA
Forward surge current $t_p \leq 10\,\mu s$		I_{FSM}	1	A

CQY 40 · CQX 38 · CQY 72 · CQY 74
V 168 P V 169 P · V 170 P

Power dissipation $T_{amb} \leq 70\,°C$	P_V	100	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−55 ... + 100	°C
Soldering temperature, maximal $t \leq 5$ s	T_{sd}[1])	260	°C

Thermal resistance		**Min.**	**Typ.**	**Max.**	
Junction ambient	R_{thJA}			300	K/W

Optical and electrical characteristics
$T_{amb} = 25\,°C$

Type	Group	Luminous intensity I_V*)[2]) (mcd)	Peak wavelength emission λ_p (nm) Typ.	Spectral half bandwidth $\Delta\lambda$ (nm) Typ.	Forward voltage V_F*) (V)
		$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA
CQY 40		min. 0.8 typ. 1.6	660	20	typ. 1.6 max. 2.0
CQX 38	A B	min. 2.0 typ. 6.0 min. 5.0 typ.12.0	630	40	typ. 2.2 max. 3.0
CQY 72		min. 0.8 typ. 2.0	560	40	typ. 2.7 max. 3.2
CQY 74		min. 0.8 typ. 3.0	590	40	typ. 2.4 max. 3.2
V 168 P		min. 2.0 typ. 3.0	660	20	typ. 1.6 max. 2.0
V 169 P		min. 2.0 typ. 4.0	560	40	typ. 2.7 max. 3.2
V 170 P		min. 2.0 typ. 5.0	590	40	typ. 2.4 max. 3.2

		Min.	**Typ.**	**Max.**	
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz	C_j		50		pF

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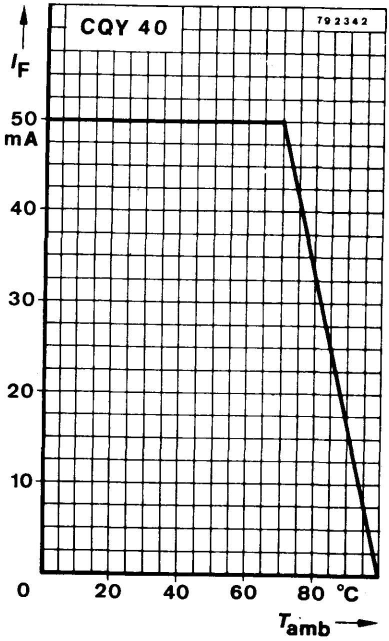
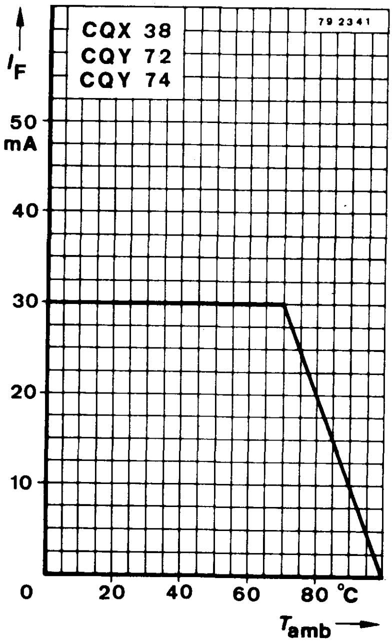
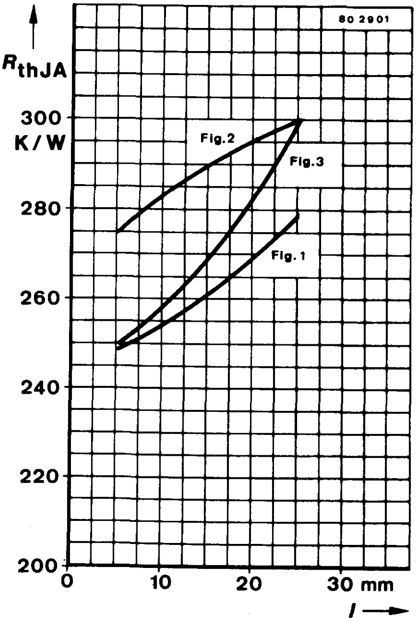
*) AQL = 0.65%

[1]) Distance from the touching border ≥ 1.5 mm with intermediate PC-board

[2]) supplied selected in group, luminous intensity in packing unit m = 0.5 ... 1







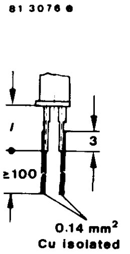


Fig.1

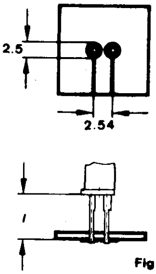


Fig.2

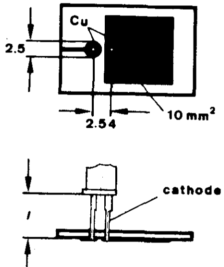
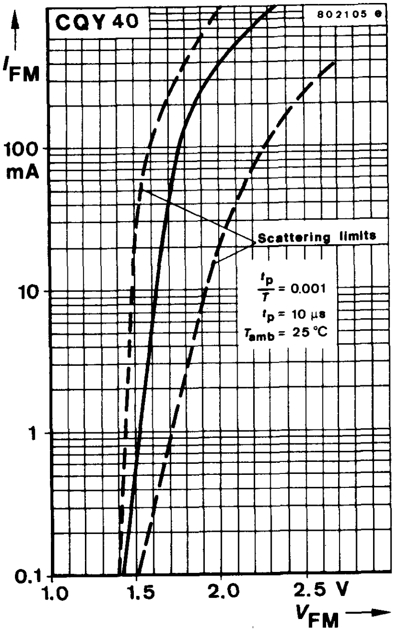
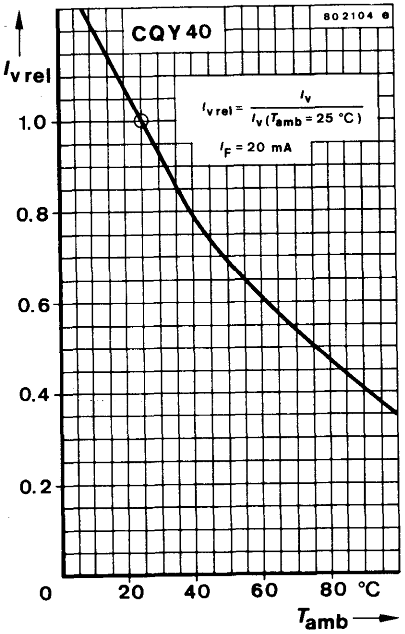
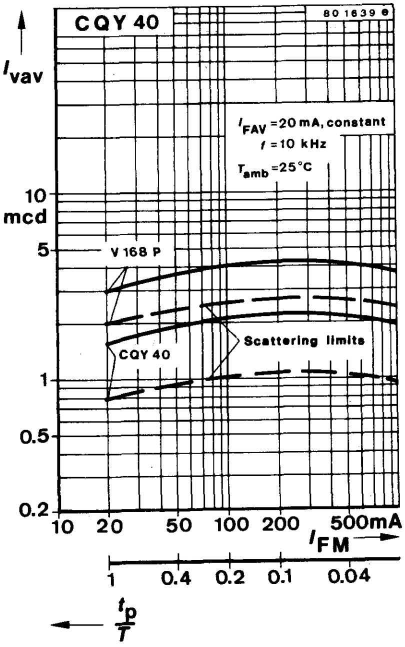
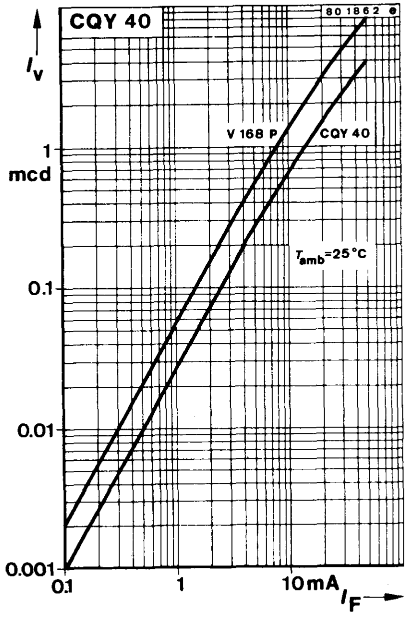


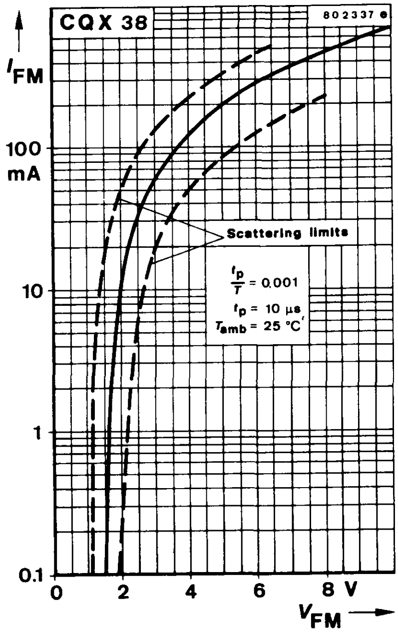
Fig.3

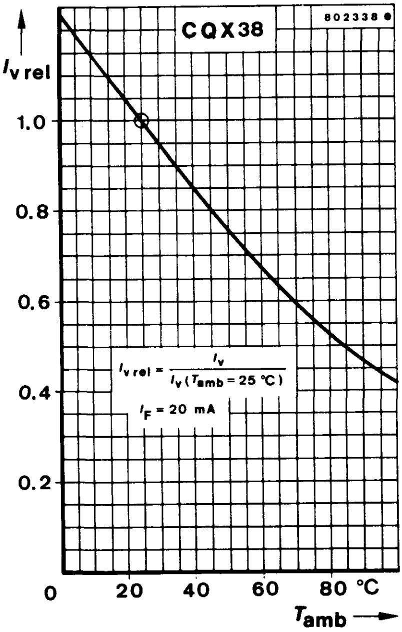

CQY 40
802105 e
I_{FM}
100 mA
10
1
0.1
1.0
1.5
2.0
2.5 V
V_{FM}
Scattering limits
$\frac{t_p}{T}$ = 0.001
t_p = 10 µs
T_{amb} = 25 °C

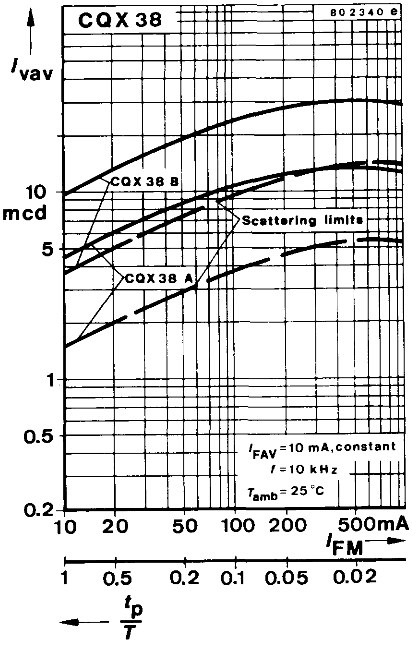

CQY 40
802104 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v(T_{amb} = 25\ °C)}$
I_F = 20 mA

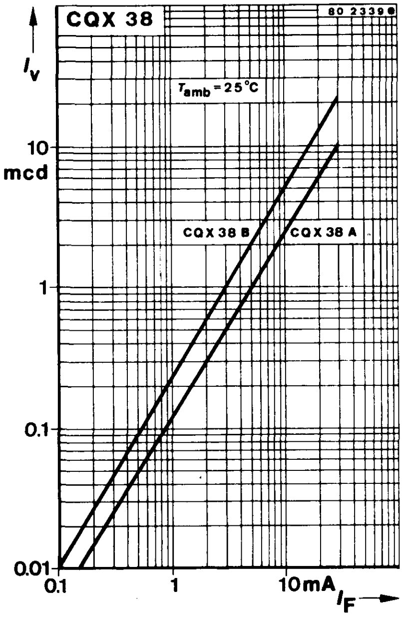

CQY 40
801639 e
I_{vav}
10 mcd
5
1
0.5
0.2
I_{FAV} = 20 mA, constant
f = 10 kHz
T_{amb} = 25 °C
V 168 P
CQY 40
Scattering limits
10
20
50
100
200
500mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$

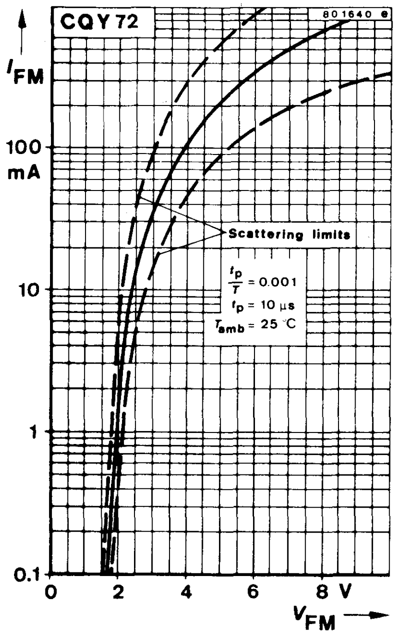

CQY 40
801862 e
I_v
1 mcd
0.1
0.01
0.001
V 168 P
CQY 40
T_{amb} = 25 °C
0.1
1
10mA
I_F

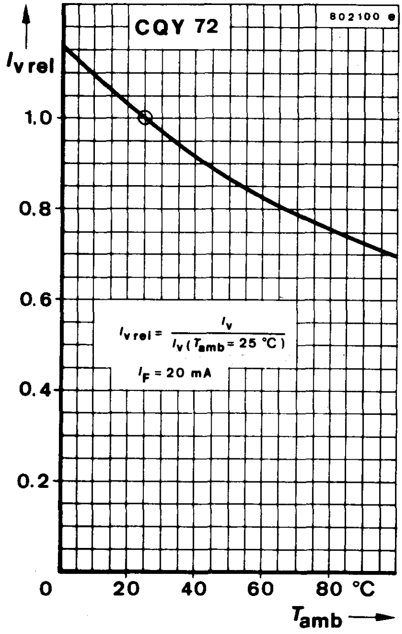

CQX 38
802337 e
I_{FM}
100 mA
10
1
0.1
0 2 4 6 8 V
V_{FM}
Scattering limits
$\frac{t_p}{T}$ = 0.001
t_p = 10 µs
T_{amb} = 25 °C

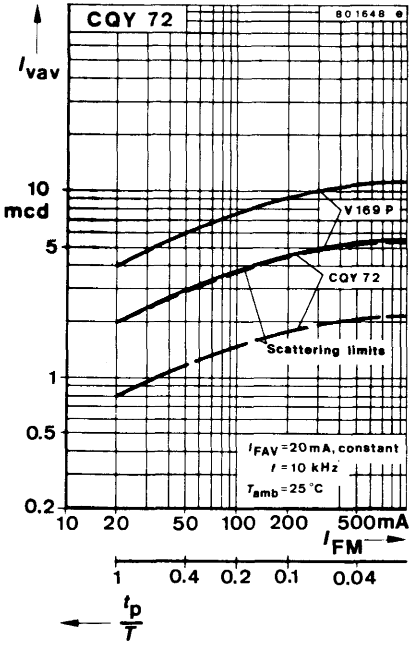

CQX38
802338 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0 20 40 60 80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v(T_{amb} = 25\ °C)}$
I_F = 20 mA

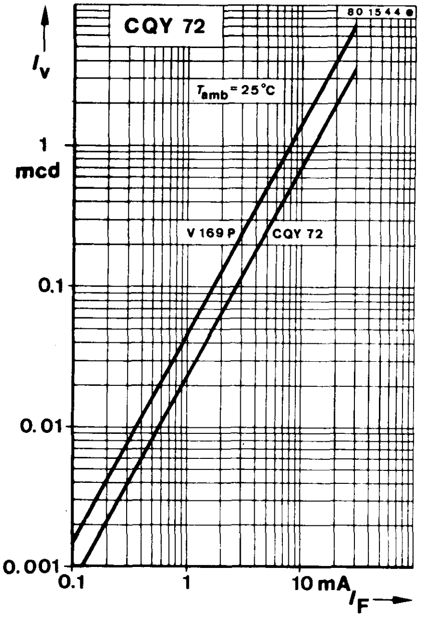

CQX 38
802340 e
I_{vav}
10 mcd
5
1
0.5
0.2
CQX 38 B
CQX 38 A
Scattering limits
I_{FAV} = 10 mA, constant
f = 10 kHz
T_{amb} = 25 °C
10 20 50 100 200 500mA
I_{FM}
1 0.5 0.2 0.1 0.05 0.02
$\frac{t_p}{T}$

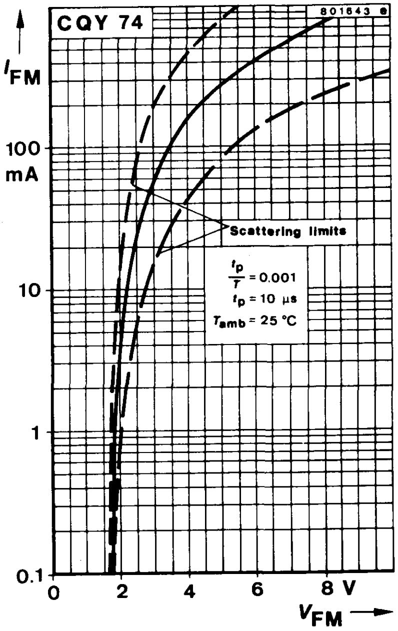

CQX 38
80 2339 e
I_v
T_{amb} = 25 °C
10 mcd
1
0.1
0.01
CQX 38 B
CQX 38 A
0.1 1 10mA
I_F

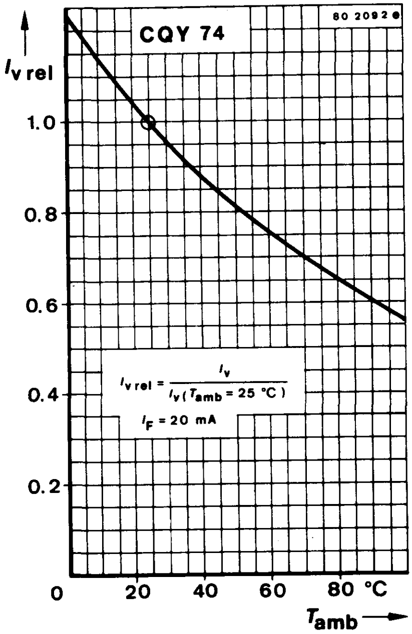

CQY 72
801640 e
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$

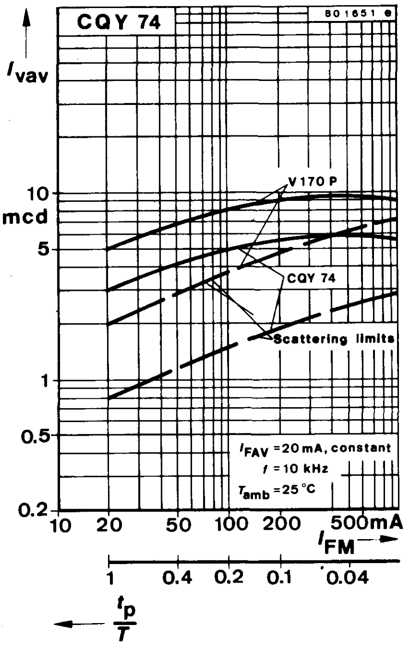

CQY 72
802100 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v\,(T_{amb} = 25\ °C)}$
$I_F = 20$ mA

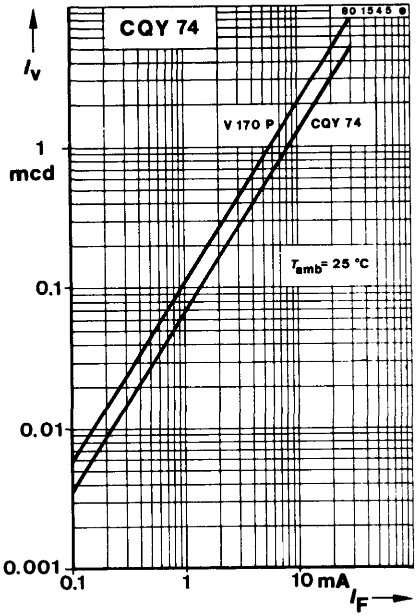

CQY 72
801648 e
I_{vav}
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$
V 169 P
CQY 72
Scattering limits
I_{FAV} = 20 mA, constant
f = 10 kHz
T_{amb} = 25 °C

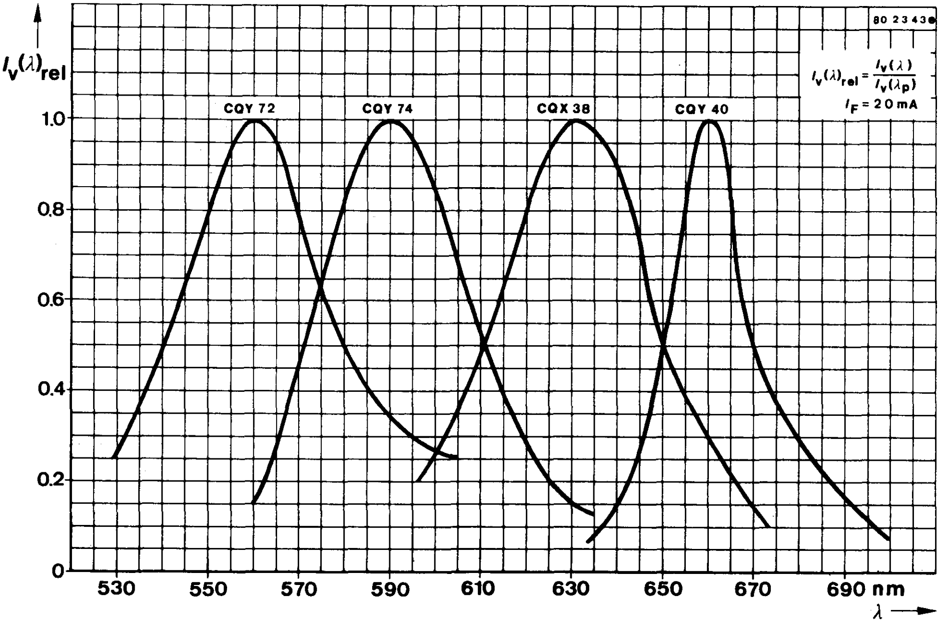

CQY 72
801544 e
I_v
1 mcd
0.1
0.01
0.001
0.1
1
10 mA
I_F
T_{amb} = 25 °C
V 169 P
CQY 72

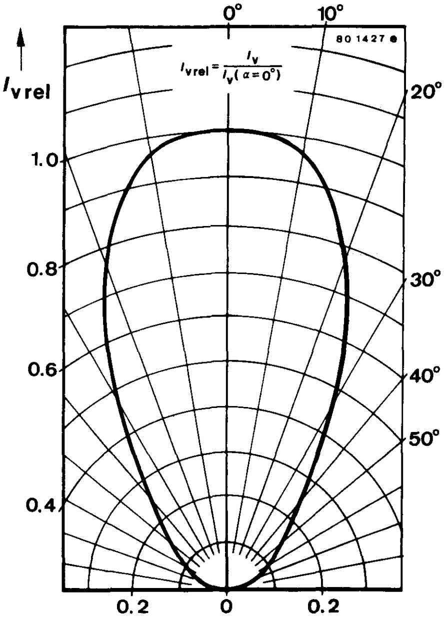

CQY 74
801643 e
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$


CQY 74
80 2092 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v\,(T_{amb} = 25\ °C)}$
$I_F = 20$ mA


CQY 74
801651 e
I_{vav}
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$
V 170 P
CQY 74
Scattering limits
I_{FAV} = 20 mA, constant
f = 10 kHz
T_{amb} = 25 °C


CQY 74
801545 e
I_v
1 mcd
0.1
0.01
0.001
0.1
1
10 mA
I_F
V 170 P
CQY 74
T_{amb} = 25 °C


80 23 43 ●
$I_v(\lambda)_{rel} = \frac{I_v(\lambda)}{I_v(\lambda_p)}$
I_F = 20 mA
$I_v(\lambda)_{rel}$
CQY 72
CQY 74
CQX 38
CQY 40
1.0
0.8
0.6
0.4
0.2
0
530
550
570
590
610
630
650
670
690 nm
λ


0°
10°
20°
30°
40°
50°
80 1427 ●
$I_{v\,rel} = \frac{I_v}{I_v(\alpha = 0°)}$
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
0.2

CQY 41 · CQY 73 · CQY 75

Not for new developments, replaced through: CQY 41 N · CQX 43 N · CQY 73 N · CQY 75 N

LED in 1.8 mm Case

Colour	Type	Technology	Angle of half intensity α
Red	**CQY 41**	GaAsP on GaAs	40°
Green	**CQY 73**	GaP on GaP	40°
Yellow	**CQY 75**	GaAsP on GaP	40°

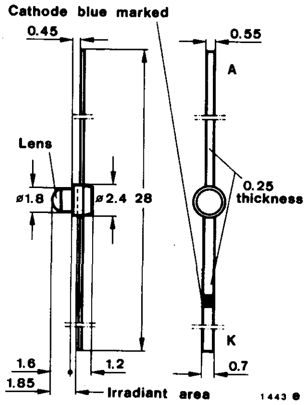
Application: General indicating purposes

Features:

- Plastic case diffuse
- End-to-end stackable in centre to centre spacing of 0.1" (2.54 mm)
- Long life compared with filament lamps
- Vibration resistant

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 40°$

Special case
Weight max. 0.04 g

CQY 41 · CQY 73 · CQY 75

Absolute maximum ratings

Reverse voltage		V_R	5	V
Forward current	**CQY 41**	I_F	50	mA
	CQY 73, CQY 75	I_F	30	mA
Forward surge current $t_p \leq 10\,\mu s$		I_{FSM}	1.0	A
Power dissipation $T_{amb} \leq 25\,°C$		P_V	100	mW
Junction temperature		T_j	100	°C
Storage temperature range		T_{stg}	−25 ... + 100	°C
Soldering temperature $t \leq 3\,s$		T_{sd} ¹)	245	°C

Optical and electrical characteristics

$T_{amb} = 25\,°C$

Type	Luminous intensity I_V*)²) (mcd)	Peak wavelength emission λ_p (nm) Typ.	Spectral half bandwidth $\Delta\lambda$ (nm) Typ.	Forward voltage V_F*) (V)
	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA
CQY 41	min. 0.8 typ. 1.6	660	20	typ. 1.6 max. 2.0
CQY 73	min. 0.8 typ. 2.0	560	40	typ. 2.7 max. 3.2
CQY 75	min. 0.8 typ. 3.0	590	40	typ. 2.4 max. 3.2

		Min.	**Typ.**	**Max.**	
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0$, $f = 1$ MHz	C_j		50		pF

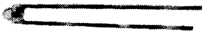
---

*) AQL = 0.65%

[1] Distance from the touching border ≥ 1.5 mm with intermediate PC-board

CQY 41 N · CQX 43 N · CQY 73 N · CQY 75 N

LED in 1.8 mm Case



Colour	Type	Technology	Angle of half intensity α
Red	**CQY 41 N**	GaAsP on GaAs	40°
Orange-red	**CQX 43 N**	GaAsP on GaP	40°
Green	**CQY 73 N**	GaP on GaP	40°
Yellow	**CQY 75 N**	GaAsP on GaP	40°

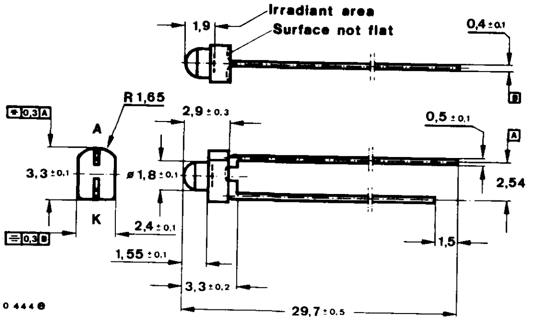
Application: General indicating purposes

Features:

- Plastic case, diffuse colour
- End-to-end stackable in centre-to-centre spacing of 0.1" (2.54 mm)
- Long life compared with filament lamps
- Vibration resistant

Preliminary specifications

Dimensions in mm



Angle of half intensity α = 40°

Special case
Weight max. 0.35 g

Absolute maximum ratings

Reverse voltage		V_R	5	V
Forward current	**CQY 41 N**	I_F	50	mA
	CQX 43 N, CQY 73 N, CQY 75 N	I_F	30	mA
Forward surge current $t_p \leq 10\,\mu s$		I_{FSM}	1	A
Power dissipation $T_{amb} \leq 55\,°C$		P_V	100	mW

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CQY 41 N · CQX 43 N · CQY 73 N · CQY 75 N

Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−55 ... + 100	°C
Soldering temperature, maximal $t \leq 3$ s	T_{sd}[1]	245	°C

Thermal resistance		**Min.**	**Typ.**	**Max.**	
Junction ambient	R_{thJA}			450	K/W

Optical and electrical characteristics

$T_{amb} = 25\,°C$

Type	Luminous intensity I_V*)[2] (mcd)	Peak wavelength emission λ_p (nm) Typ.	Spectral half bandwidth $\Delta\lambda$ (nm) Typ.	Forward voltage V_F*) (V)
	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA
CQY 41 N	min. 0.8 typ. 1.6	660	20	typ. 1.6 max. 2.0
CQX 43 N	min. 2.0 typ. 5.0	630	40	typ. 2.2 max. 3.0
CQY 73 N	min. 0.8 typ. 2.0	560	40	typ. 2.7 max. 3.2
CQY 75 N	min. 0.8 typ. 3.0	590	40	typ. 2.4 max. 3.2

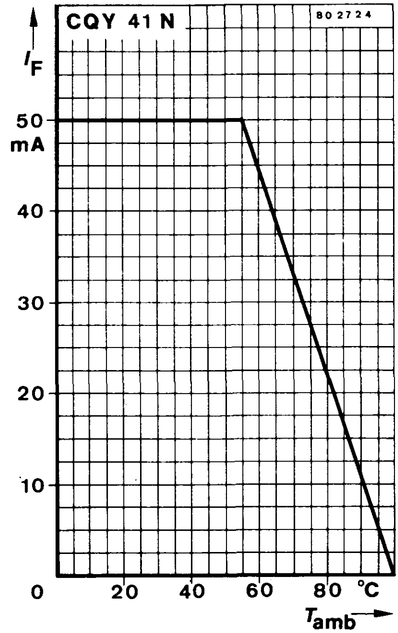
		Min.	**Typ.**	**Max.**	
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz	C_j		50		pF

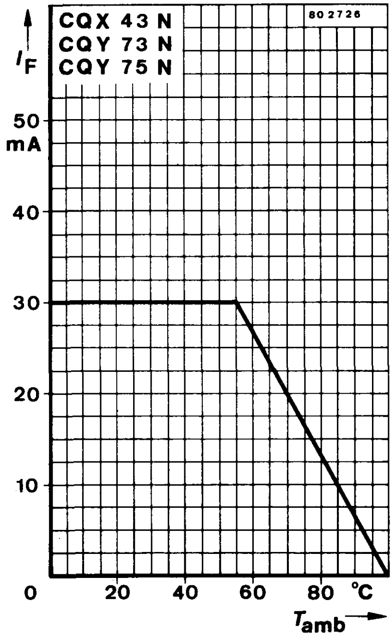
---

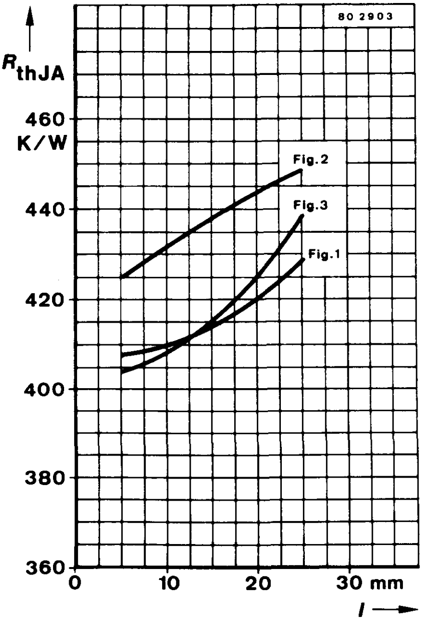
*) AQL = 0.65%

[1]) Distance from the touching border ≥ 1.5 mm; with intermediate PC-board

[2]) supplied selected in groups, luminous intensity in packing unit m = 0.5 ... 1







81 3078 e

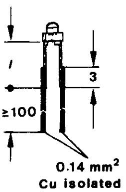


Fig.1

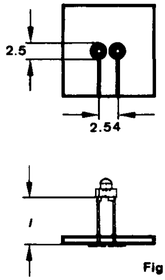


Fig.2

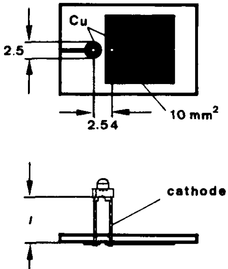
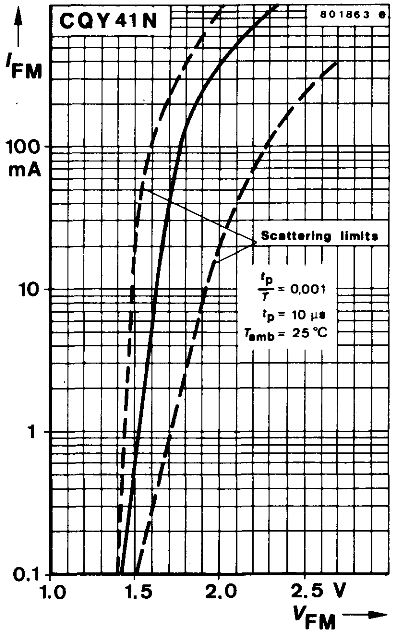
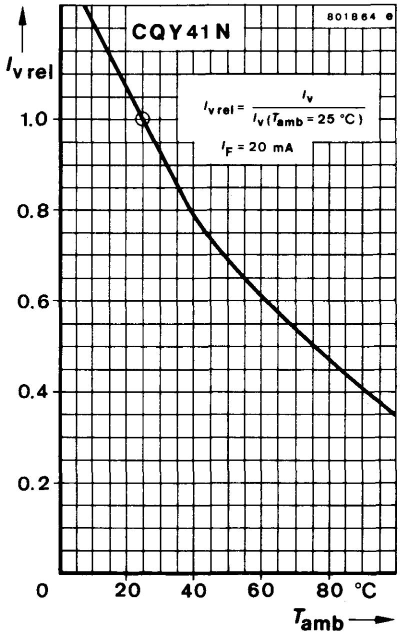
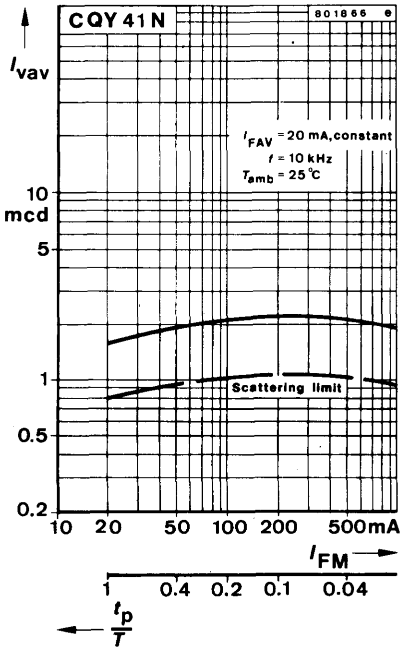
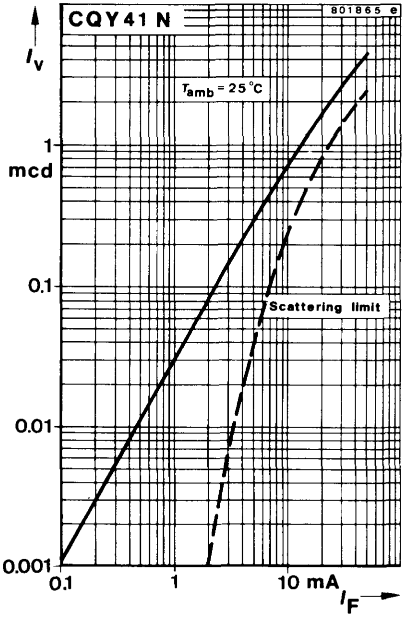


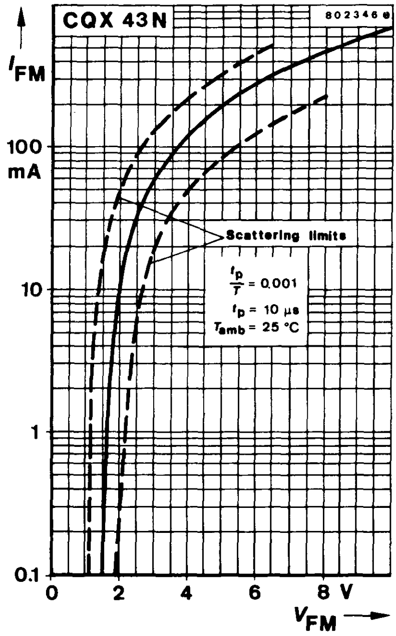
Fig.3

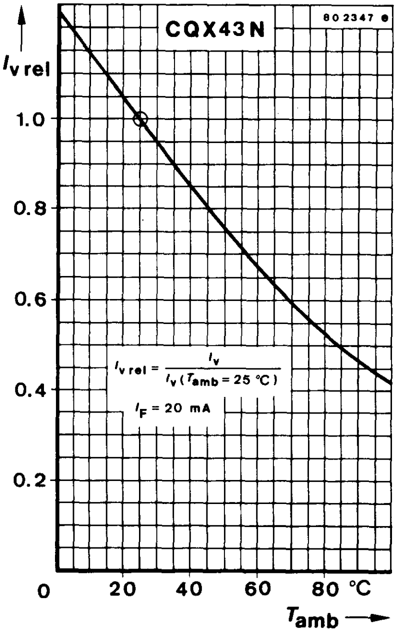

CQY41N
801863 e
I_{FM}
100 mA
10
1
0.1
1.0
1.5
2.0
2.5 V
V_{FM}
Scattering limits
$\frac{t_p}{T}$ = 0,001
t_p = 10 µs
T_{amb} = 25 °C

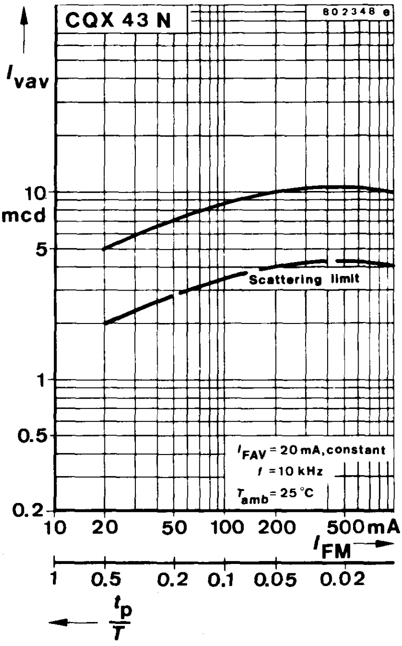

CQY41N
801864 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v(T_{amb} = 25\ °C)}$
I_F = 20 mA

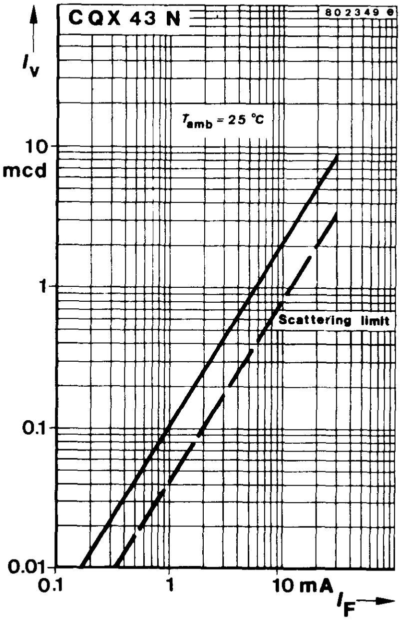

CQY41N
801866 e
I_{vav}
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$
I_{FAV} = 20 mA, constant
f = 10 kHz
T_{amb} = 25 °C
Scattering limit


CQY41N
801865 e
I_v
1 mcd
0.1
0.01
0.001
0.1
1
10 mA
I_F
T_{amb} = 25 °C
Scattering limit

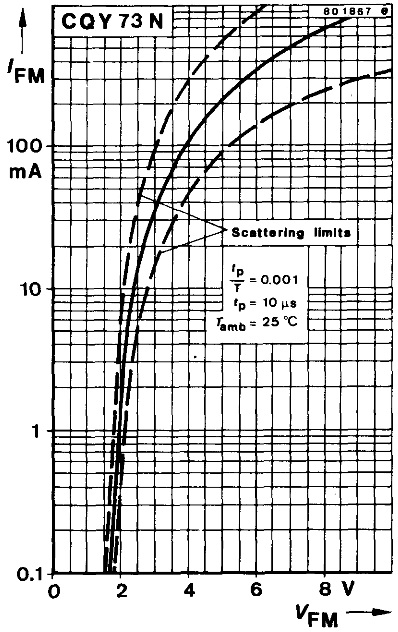

CQX 43 N
802346 e
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T}$ = 0.001
t_p = 10 µs
T_{amb} = 25 °C

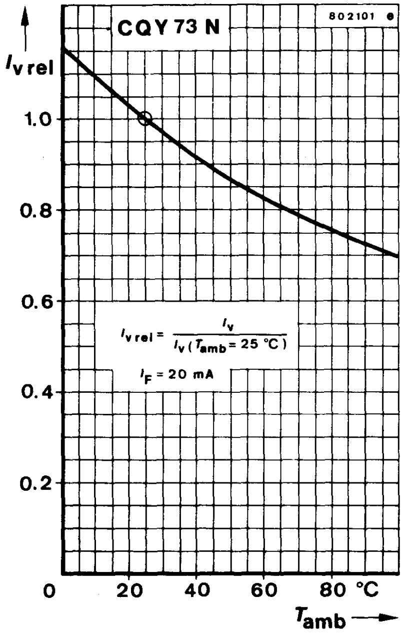

CQX43N
802347 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v\,(T_{amb} = 25\ °C)}$
I_F = 20 mA

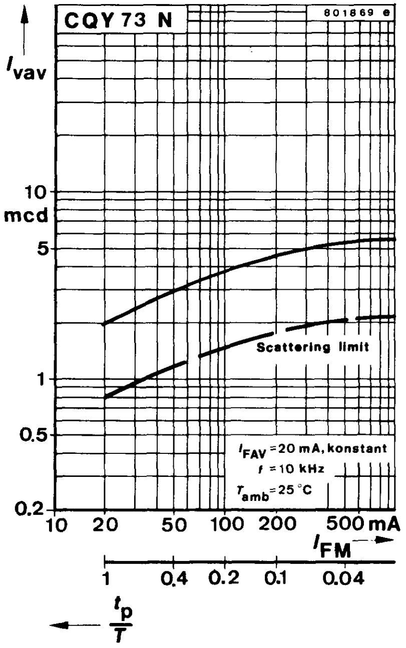

CQX 43 N
802348 e
I_{vav}
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500mA
I_{FM}
1
0.5
0.2
0.1
0.05
0.02
$\frac{t_p}{T}$
Scattering limit
I_{FAV} = 20 mA, constant
f = 10 kHz
T_{amb} = 25 °C

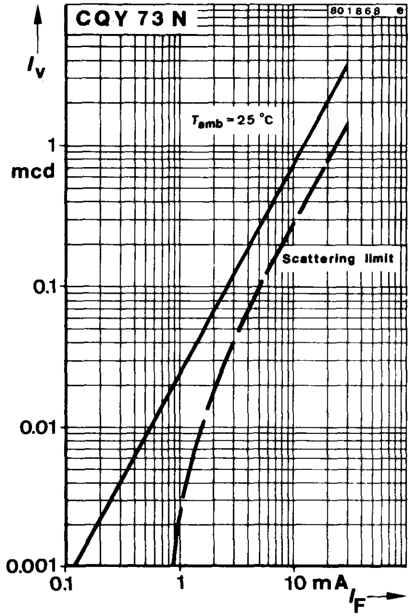

CQX 43 N
802349 e
I_v
10 mcd
1
0.1
0.01
0.1
1
10 mA
I_F
T_{amb} = 25 °C
Scattering limit

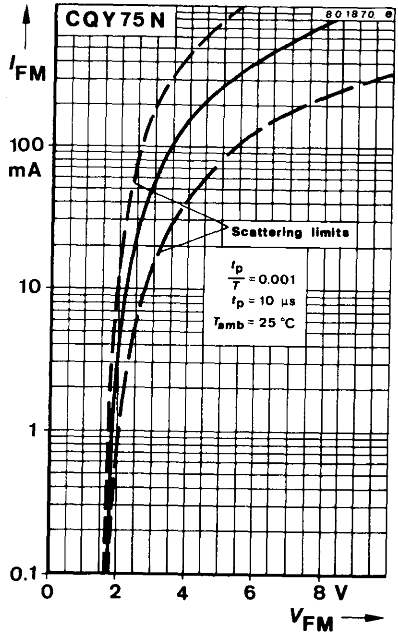
CQY 41 N · CQX 43 N · CQY 73 N · CQY 75 N

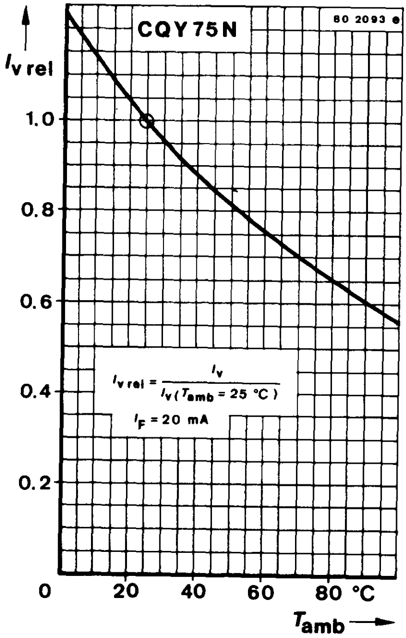


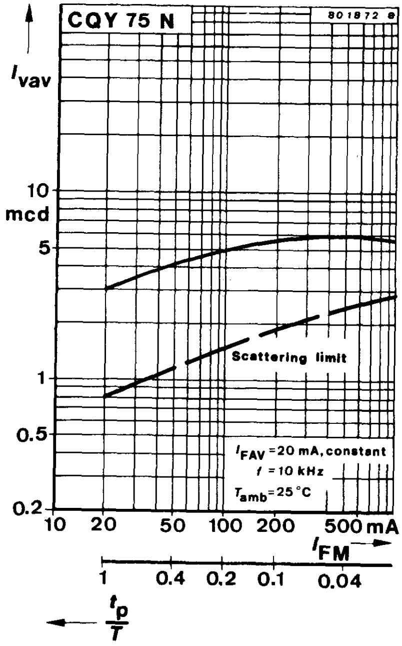


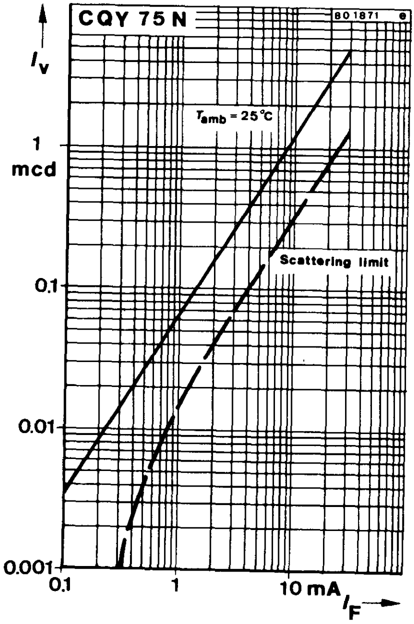


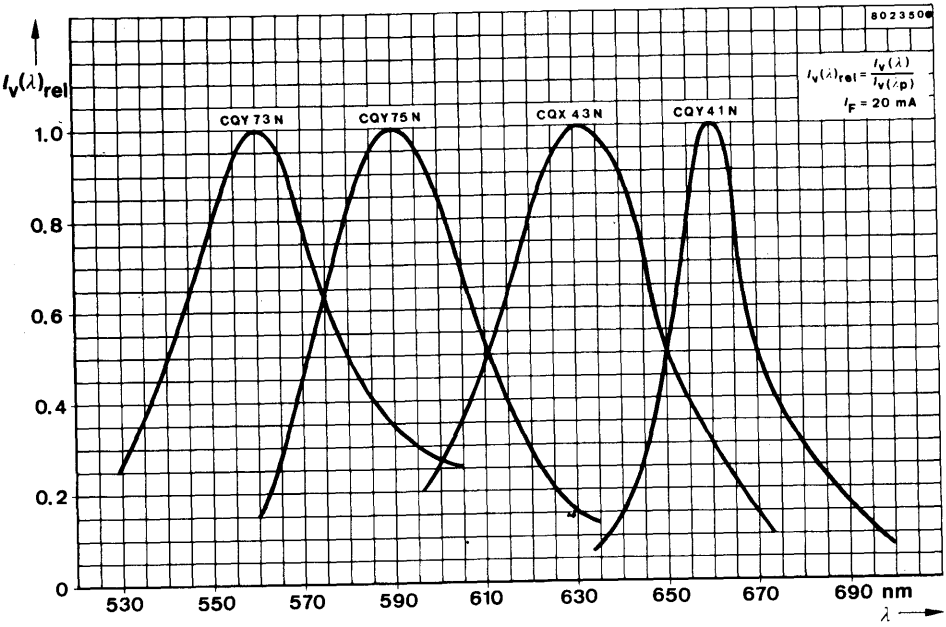


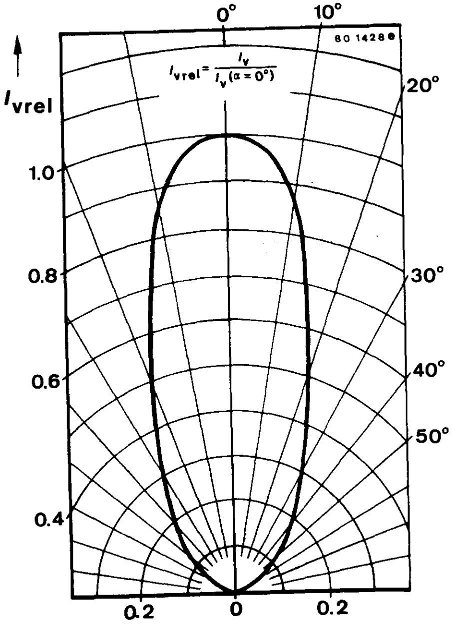

CQY 75 N
801870 e
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T}$ = 0.001
t_p = 10 µs
T_{amb} = 25 °C


CQY 75 N
80 2093 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_{v\,(T_{amb} = 25\,°C)}}$
I_F = 20 mA


CQY 75 N
801872 e
I_{vav}
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500 mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$
Scattering limit
I_{FAV} = 20 mA, constant
f = 10 kHz
T_{amb} = 25 °C


CQY 75 N
801871 e
I_v
1 mcd
0.1
0.01
0.001
0.1
1
10 mA
I_F
T_{amb} = 25 °C
Scattering limit


802350
$I_v(\lambda)_{rel}$
$I_v(\lambda)_{rel} = \frac{I_v(\lambda)}{I_v(\lambda p)}$
I_F = 20 mA
CQY 73 N
CQY 75 N
CQX 43 N
CQY 41 N
1.0
0.8
0.6
0.4
0.2
0
530
550
570
590
610
630
650
670
690 nm
λ


0°
10°
20°
30°
40°
50°
80 1428
$I_{vrel} = \frac{I_v}{I_v(\alpha = 0°)}$
I_{vrel}
1.0
0.8
0.6
0.4
0.2
0
0.2

CQY 72

see page 289

CQY 73

see page 297

CQY 73 N

see page 299

CQY 74

see page 289

CQY 75

see page 297

CQY 75 N

see page 299

CQY 85 N · CQX 41 N · CQY 86 N · CQY 87 N

LED in 3 mm Case

Colour	Type	Technology	Angle of half intensity α
Red	**CQY 85 N**	GaAsP on GaAs	60°
Orange-red	**CQX 41 N**	GaAsP on GaP	60°
Green	**CQY 86 N**	GaP on GaP	60°
Yellow	**CQY 87 N**	GaAsP on GaP	60°

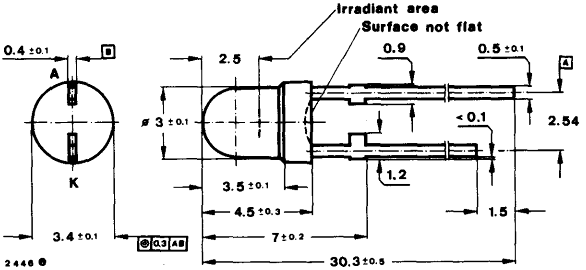
Application: General indicating purposes

Features:

- Plastic case, diffuse colour
- Wide viewing angle
- Axial terminals
- Long life compared with filament lamps
- Vibration resistant

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 60°$

Special case
Weight max. 0.35 g

Absolute maximum ratings

Reverse voltage		V_R	5	V
Forward current	**CQY 85 N**	I_F	50	mA
	CQX 41 N, CQY 86 N, CQY 87 N	I_F	30	mA
Forward surge current $t_p \leq 10\,\mu s$		I_{FSM}	1	A
Power dissipation $T_{amb} \leq 60°C$		P_V	100	mW

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CQY 85 N · CQX 41 N · CQY 86 N · CQY 87 N

Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−55 … + 100	°C
Soldering temperature, maximal $t \leq 5$ s	T_{sd} 1)	260	°C

Thermal resistance

		Min.	Typ.	Max.	
Junction ambient	R_{thJA}			400	K/W

Optical and electrical characteristics

$T_{amb} = 25\,°C$

Type	Group	Luminous intensity I_V*) 2) (mcd)	Peak wavelength emission λ_p (nm) Typ.	Spectral half bandwidth $\Delta\lambda$ (nm) Typ.	Forward voltage V_F*) (V)
		$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA
CQY 85 N	A	min. 0.8 typ. 1.6	660	20	typ. 1.6 max. 2.0
	B	min. 2.0 typ. 3.0			
CQX 41 N	A	min. 2.0 typ. 6.0	630	40	typ. 2.2 max. 3.0
	B	min. 5.0 typ. 12.0			
CQY 86 N	A	min. 0.8 typ. 2.0	560	40	typ. 2.7 max. 3.2
	B	min. 2.0 typ. 4.0			
CQY 87 N	A	min. 0.8 typ. 3.0	590	40	typ. 2.4 max. 3.2
	B	min. 2.0 typ. 5.0			

		Min.	Typ.	Max.	
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0$, $f = 1$ MHz	C_j		50		pF

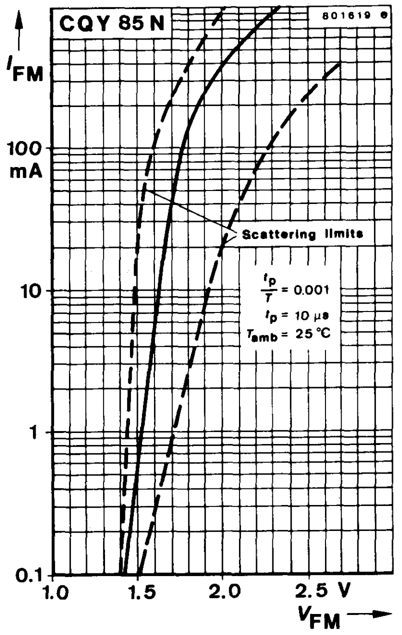
---

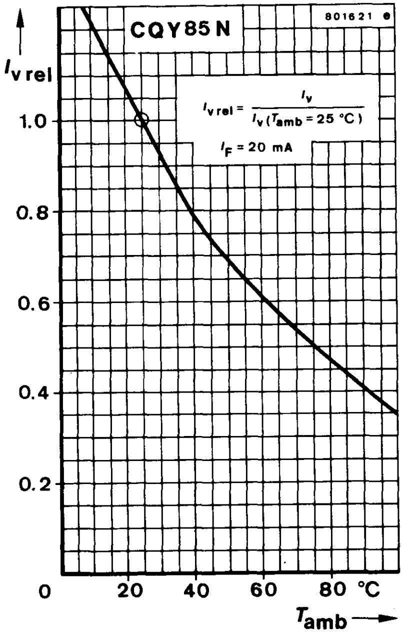
*) AQL = 0.65%

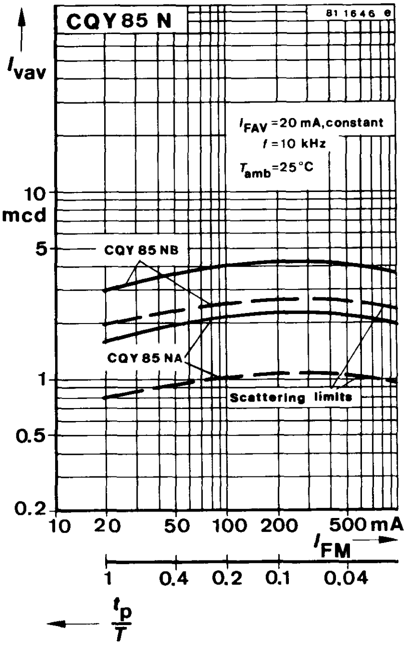
1) Distance from the touching border ≥ 1.5 mm; with intermediate PC-board

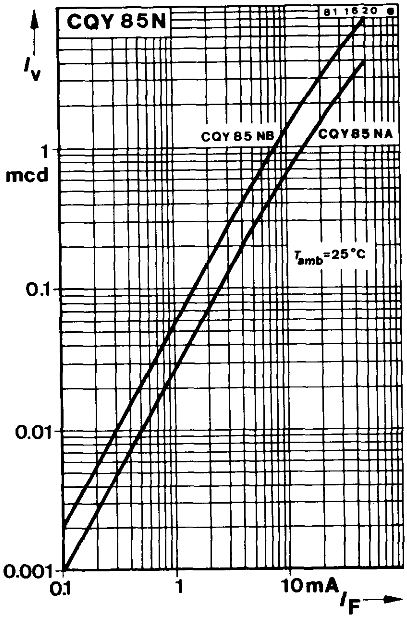
2) supplied selected in groups, luminous intensity in packing unit m = 0.5 … 1

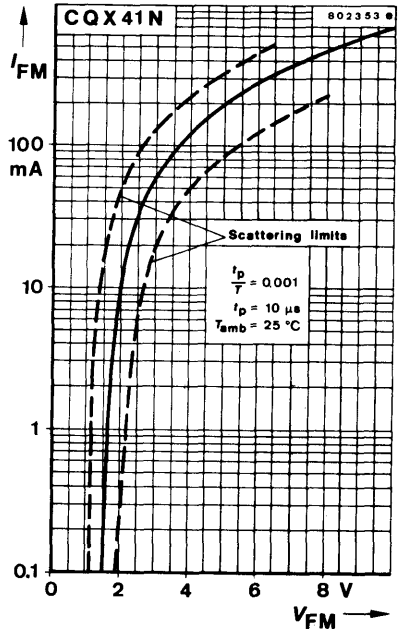
CQY 85 N · CQX 41 N · CQY 86 N · CQY 87 N

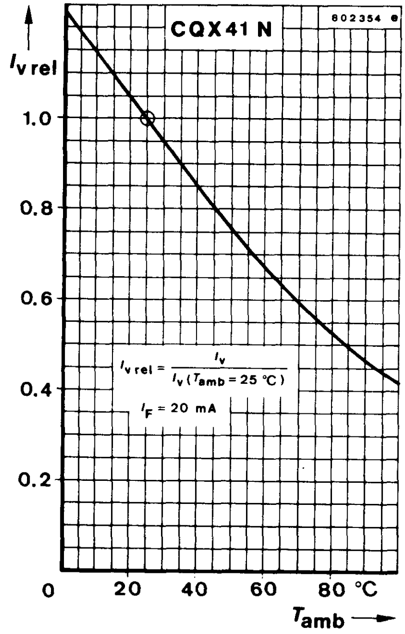


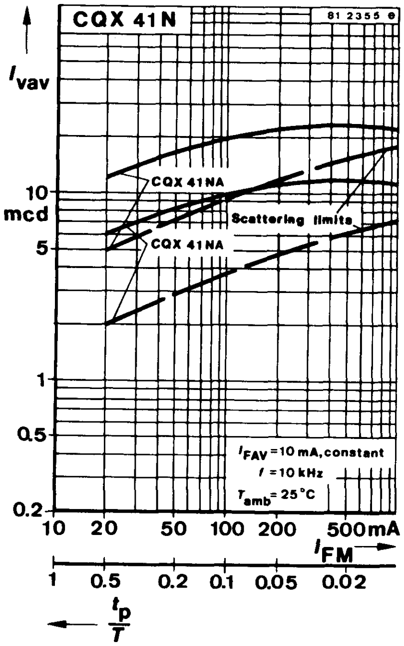


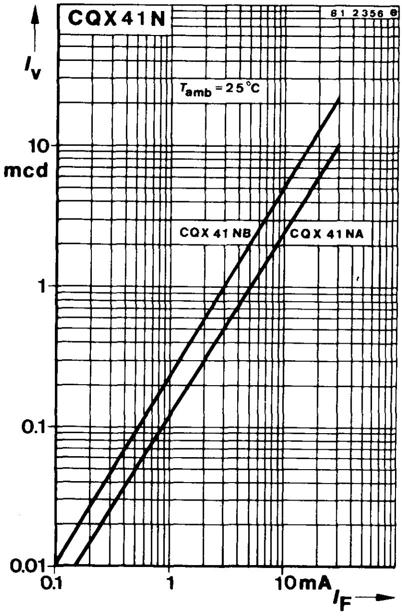


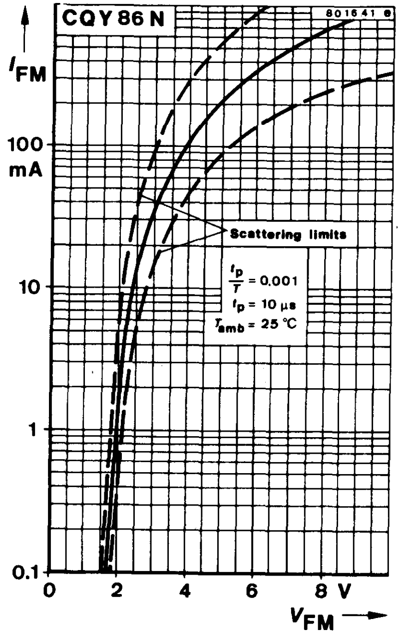


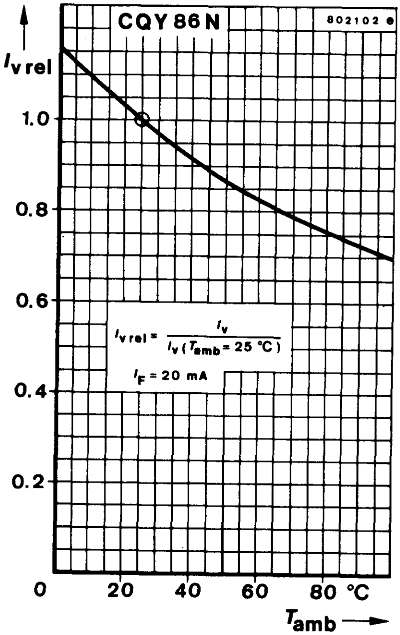

CQX41N
802353 e
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T}$ = 0.001
t_p = 10 µs
T_{amb} = 25 °C

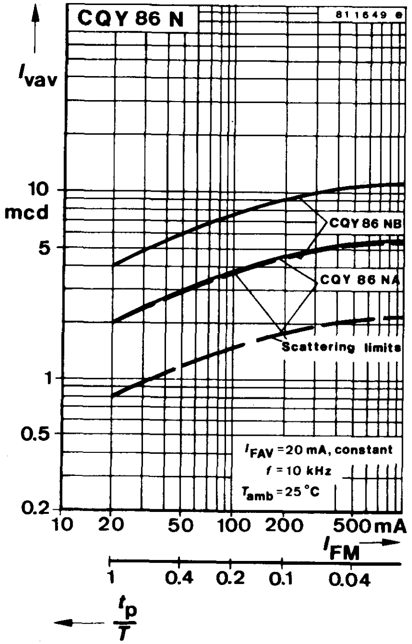

CQX41 N
802354 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v\,(T_{amb} = 25\,°C)}$
I_F = 20 mA

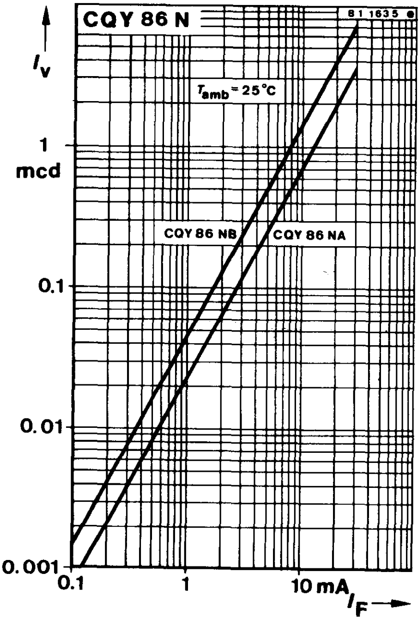

CQX 41N
81 2355 e
I_{vav}
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500mA
I_{FM}
1
0.5
0.2
0.1
0.05
0.02
$\frac{t_p}{T}$
CQX 41NA
Scattering limits
CQX 41NA
I_{FAV}=10 mA, constant
f =10 kHz
T_{amb}= 25°C


CQX41N
81 2356 e
I_v
T_{amb}=25°C
10 mcd
1
0.1
0.01
0.1
1
10mA
I_F
CQX 41 NB
CQX 41 NA

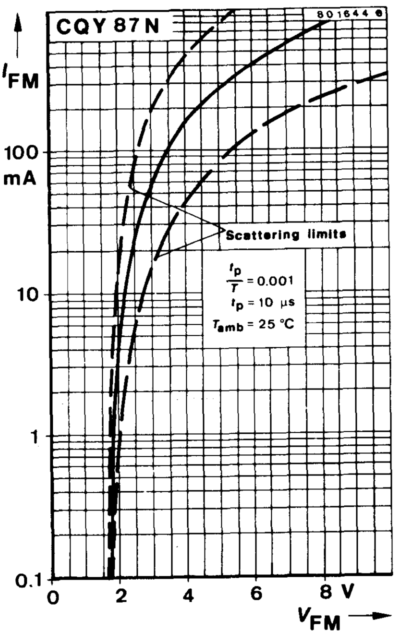

CQY 86 N
801641 e
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$

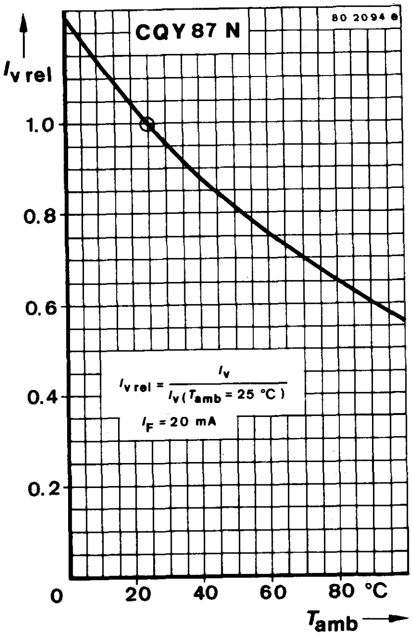

CQY 86 N
802102 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v\,(T_{amb} = 25\ °C)}$
$I_F = 20$ mA

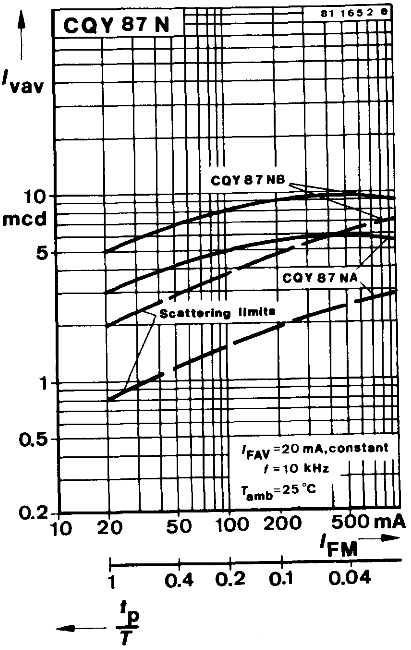

CQY 86 N
811649 e
I_{vav}
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500 mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$
CQY 86 NB
CQY 86 NA
Scattering limits
I_{FAV} = 20 mA, constant
f = 10 kHz
T_{amb} = 25 °C

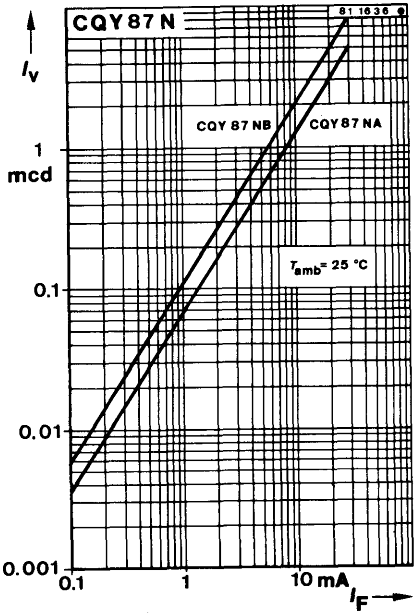

CQY 86 N
811635 e
I_v
1 mcd
0.1
0.01
0.001
0.1
1
10 mA
I_F
T_{amb} = 25 °C
CQY 86 NB
CQY 86 NA

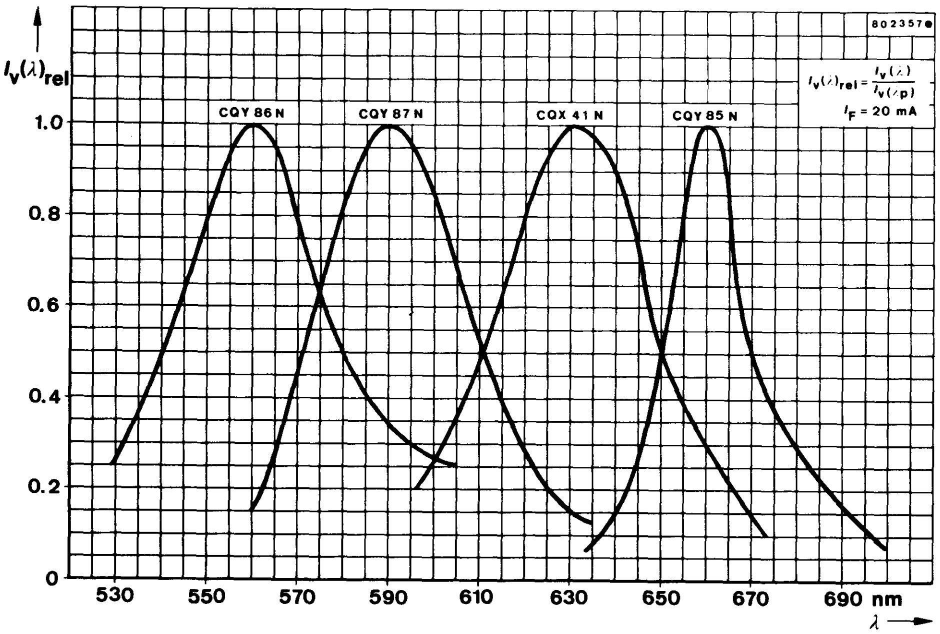
CQY 85 N · CQX 41 N · CQY 86 N · CQY 87 N

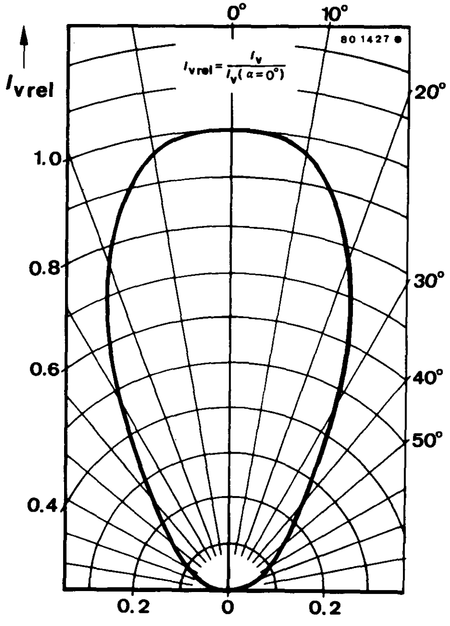









802357●
$I_V(\lambda)_{rel}$
$I_V(\lambda)_{rel} = \frac{I_V(\lambda)}{I_V(\lambda p)}$
I_F = 20 mA
CQY 86 N
CQY 87 N
CQX 41 N
CQY 85 N
1.0
0.8
0.6
0.4
0.2
0
530
550
570
590
610
630
650
670
690 nm
λ

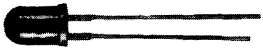

0°
10°
20°
30°
40°
50°
801427●
$I_{V rel}$
$I_{V rel} = \frac{I_V}{I_V(\alpha = 0°)}$
1.0
0.8
0.6
0.4
0.2
0
0.2

V 168 P
V 169 P
V 170 P

see page 289

V 310 P · V 311 P · V 312 P · V 313 P

LED in 5 mm Case



Colour	Type	Technology	Angle of half intensity α
Red	**V 310 P**	GaAsP on GaAs	12°
Orange-red	**V 311 P**	GaAsP on GaP	12°
Green	**V 312 P**	GaP on GaP	12°
Yellow	**V 313 P**	GaAsP on GaP	12°

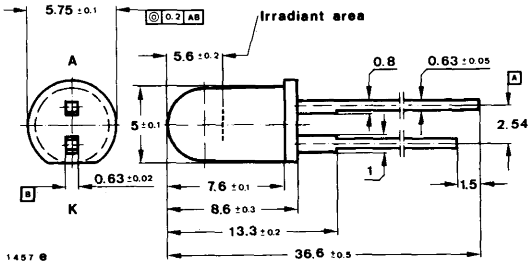
Applications: General indicating and illumination purposes

Features:

- Plastic case white clear
- High illumination through concentrated radiation
- Axial terminals
- Long life compared with filament lamps
- Vibration resistant

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 12°$

Special case
Weight max. 0.4 g

Accessories

Mounting clip	Best. Nr. 562 136
Retainer ring	Best. Nr. 562 135

Absolute maximum ratings

Reverse voltage		V_R	5	V
Forward current	**V 310 P**	I_F	50	mA
	V 311 P, V 312 P, V 313 P	I_F	30	mA

V 310 P · V 311 P · V 312 P · V 313 P

Forward surge current $t_p \leq 10\,\mu s$	I_{FSM}	1	A
Power dissipation $T_{amb} \leq 70\,°C$	P_V	100	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−55 ... + 100	°C
Soldering temperature, maximal $t \leq 5\,s$	T_{sd}[1])	260	°C

Thermal resistance		**Min.**	**Typ.**	**Max.**	
Junction ambient	R_{thJA}			300	K/W

Optical and electrical characteristics

$T_{amb} = 25\,°C$

Type	Luminous intensity I_V*)[2]) (mcd)	Peak wavelength emission λ_p (nm) Typ.	Spectral half bandwidth $\Delta\lambda$ (nm) Typ.	Dominant wave length λ_D (nm) Typ.	Forward voltage V_F*) (V)
	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA
V 310 P	min. 20 typ. 25	660	20	662	typ. 1.6 max. 2.0
V 311 P	min. 32 typ. 70	630	40	625	typ. 2.2 max. 3.0
V 312 P	min. 20 typ. 40	560	40	568	typ. 2.7 max. 3.2
V 313 P	min. 20 typ. 40	590	40	588	typ. 2.4 max. 3.2

		Min.	**Typ.**	**Max.**	
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0$, $f = 1$ MHz	C_j		50		pF

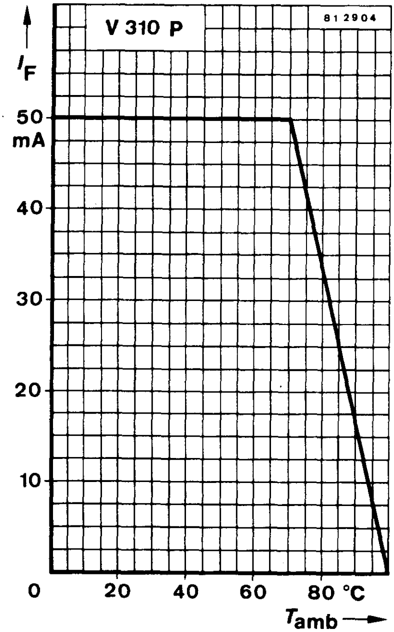
---

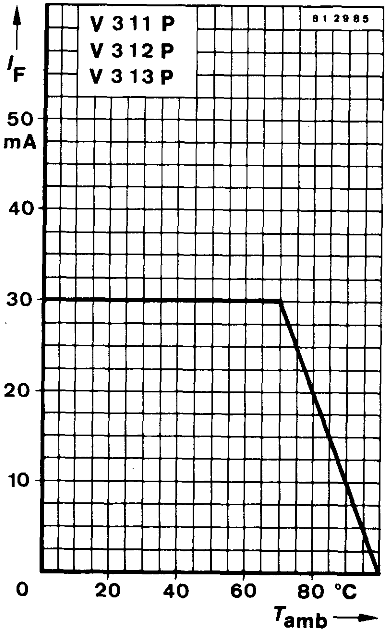
*) AQL = 0.65%

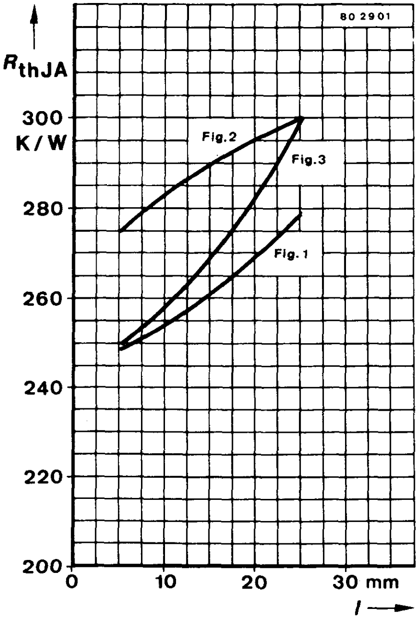
[1]) Distance from the touching border ≥ 1.5 mm with intermediate PC-board

[2]) supplied selected in group, luminous intensity in packing unit m = 0.5 ... 1

V 310 P · V 311 P · V 312 P · V 313 P







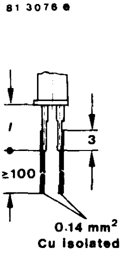


Fig.1

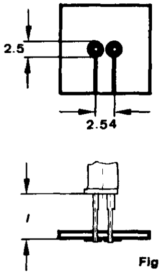


Fig.2

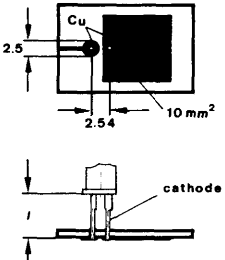
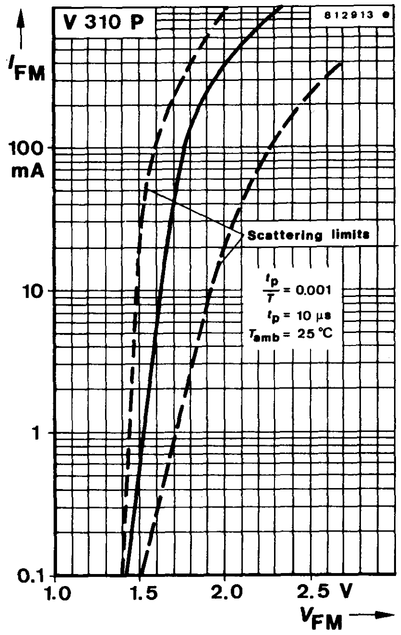
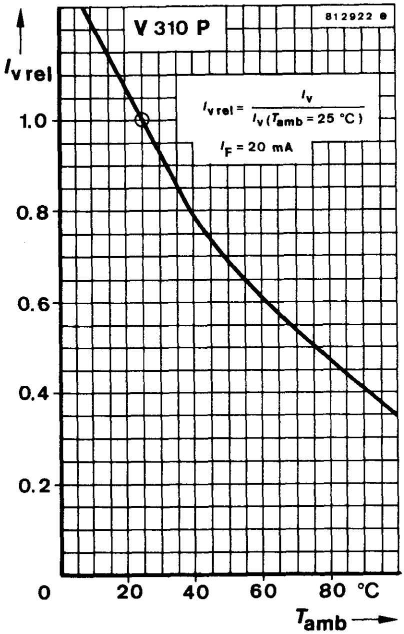
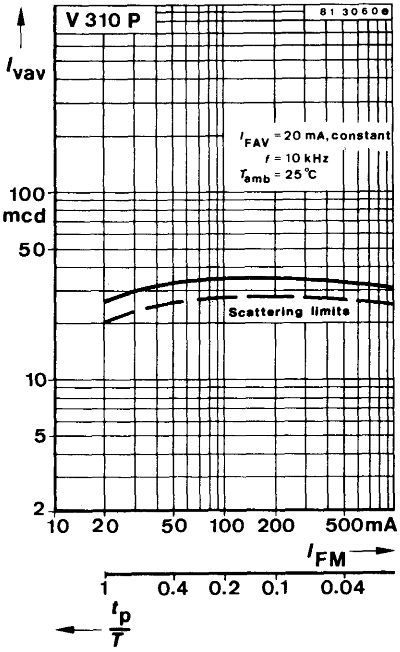


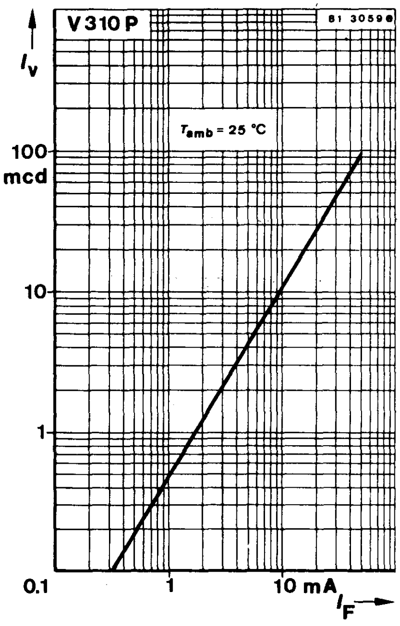
Fig.3

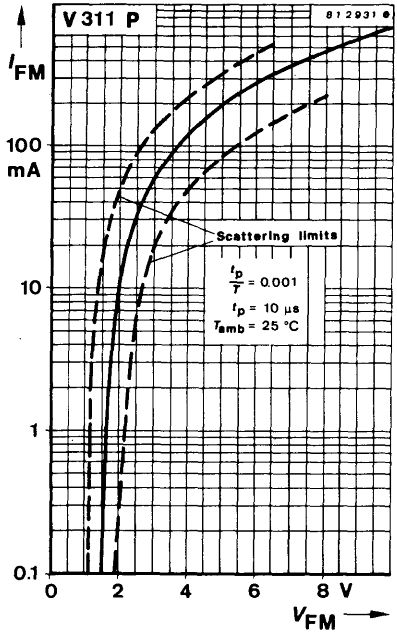
V 310 P · V 311 P · V 312 P · V 313 P

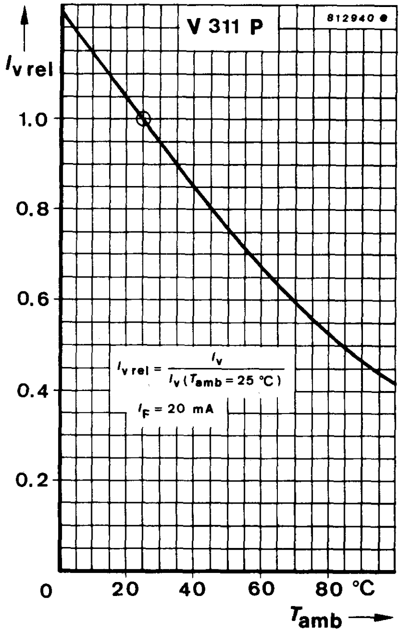


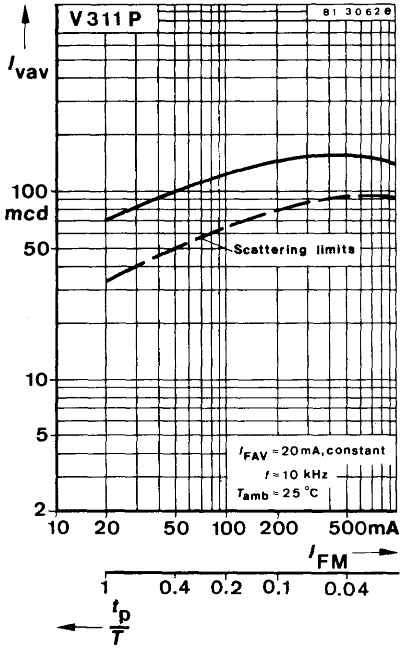


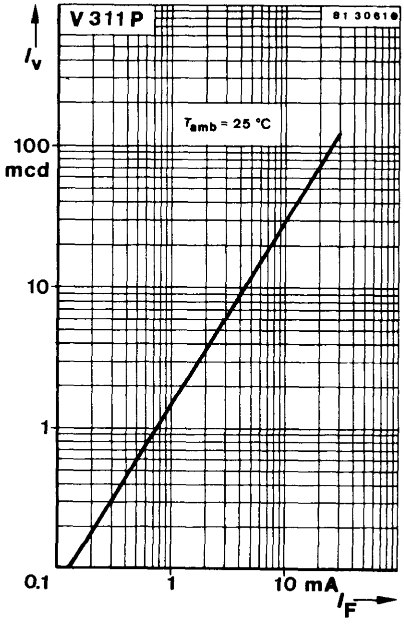




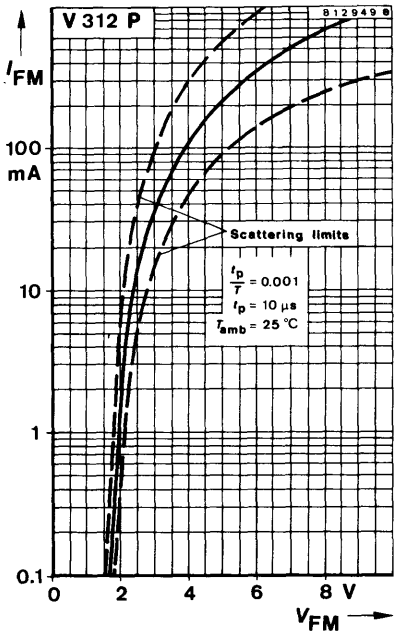

V 311 P
812931
I_FM
100 mA
10
1
0.1
0
2
4
6
8 V
V_FM
Scattering limits
tp/T = 0.001
tp = 10 µs
Tamb = 25 °C

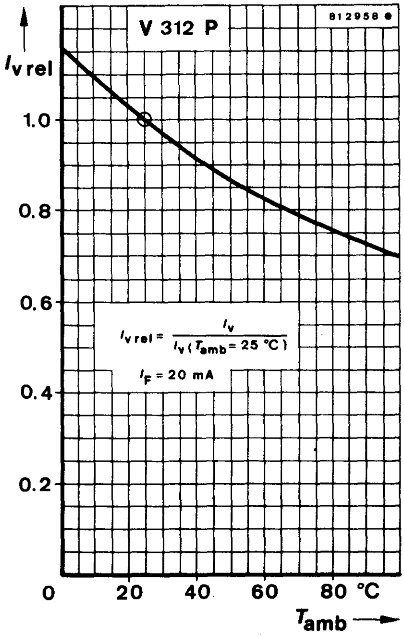

V 311 P
812940
I_v rel
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_amb
I_v rel = I_v / I_v (T_amb = 25 °C)
I_F = 20 mA

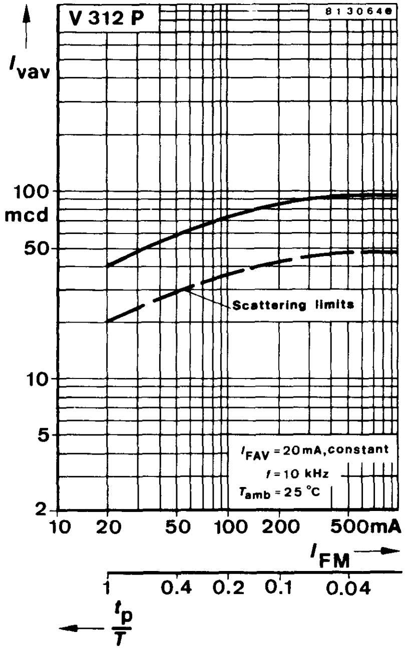

V 311 P
813062
I_vav
100 mcd
50
10
5
2
10
20
50
100
200
500mA
I_FM
1
0.4
0.2
0.1
0.04
tp/T
Scattering limits
I_FAV = 20 mA, constant
f = 10 kHz
T_amb = 25 °C

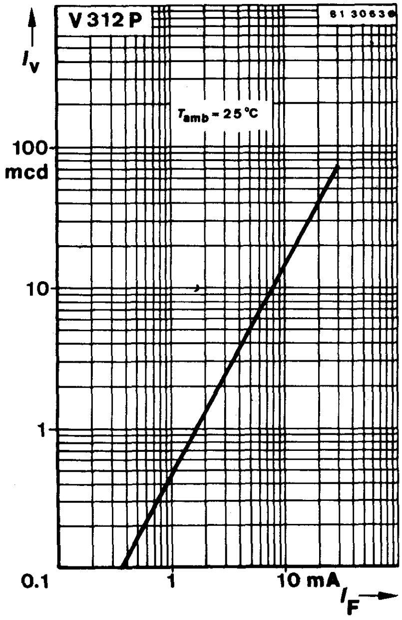

V 311 P
813061
I_v
100 mcd
10
1
0.1
1
10 mA
I_F
T_amb = 25 °C

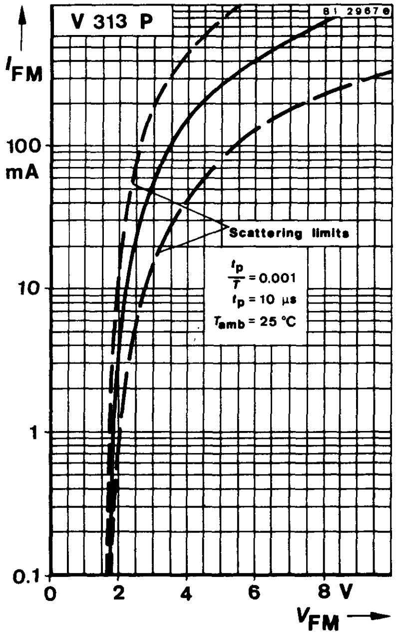
V 310 P · V 311 P · V 312 P · V 313 P

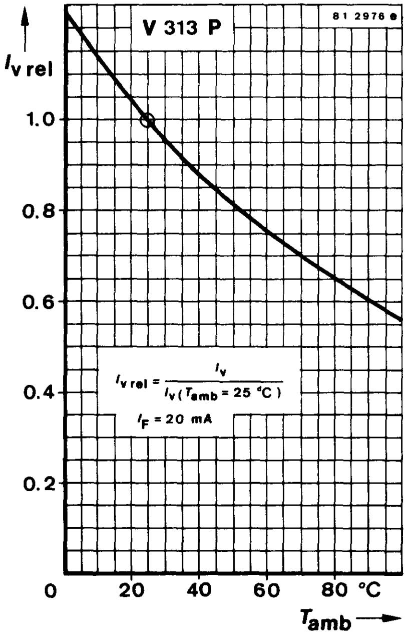


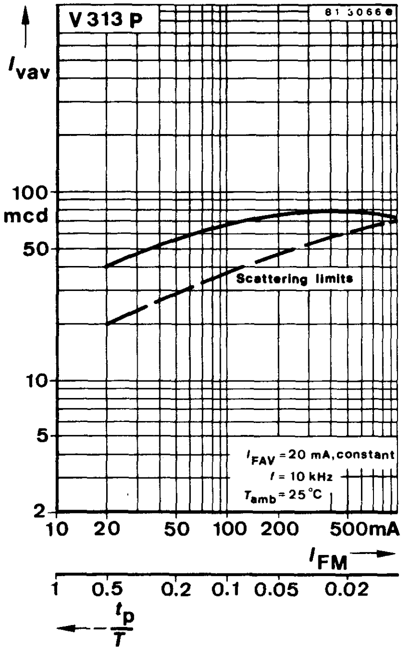


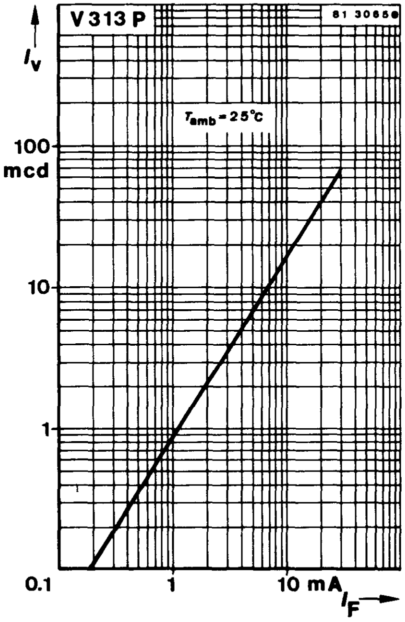




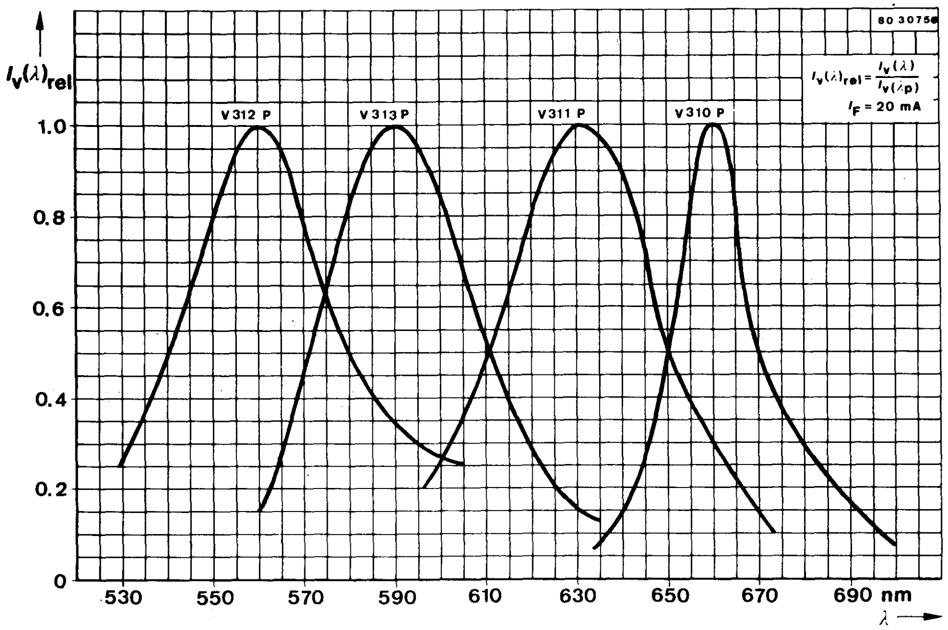

V 313 P
81 2967 e
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T}$ = 0.001
t_p = 10 µs
T_{amb} = 25 °C

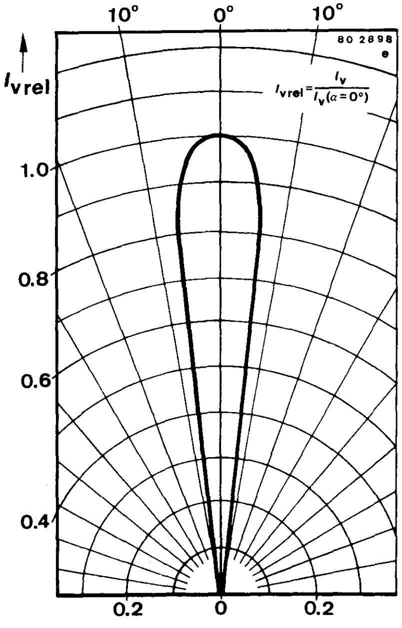

V 313 P
81 2976 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v(T_{amb} = 25\ °C)}$
I_F = 20 mA


V 313 P
81 3066 e
I_{vav}
100 mcd
50
10
5
2
10
20
50
100
200
500mA
I_{FM}
1
0.5
0.2
0.1
0.05
0.02
$\frac{t_p}{T}$
Scattering limits
I_{FAV} = 20 mA, constant
f = 10 kHz
T_{amb} = 25 °C


V 313 P
81 3065 e
I_v
100 mcd
10
1
0.1
1
10 mA
I_F
T_{amb} = 25 °C

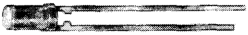
V 310 P · V 311 P · V 312 P · V 313 P





V 320 P · V 321 P · V 322 P · V 323 P

Symbol LED — 3 mm O



Colour	Type	Technology	Angle of half intensity α
Red	**V 320 P**	GaAsP on GaAs	80°
Orange-red	**V 321 P**	GaAsP on GaP	80°
Green	**V 322 P**	GaP on GaP	80°
Yellow	**V 323 P**	GaAsP on GaP	80°

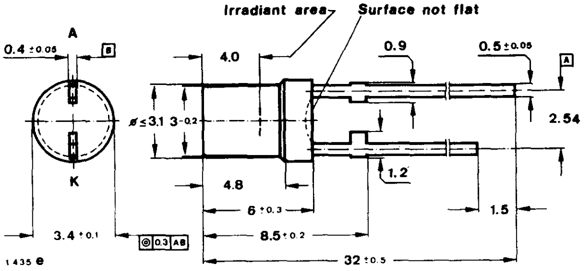
Applications: General indicating and illumination purposes

Features:

- Even luminance of the emitting surface
- Wide viewing angle
- High illuminance through reflector
- Ideal as flush mounted panel indicators
- Axial terminals
- Long life compared with filament lamps
- Vibration resistant

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 80°$

Special case
Weight max. 0.2 g

Absolute maximum ratings

Reverse voltage		V_R	5	V
Forward current	**V 320 P**	I_F	50	mA
	V 321 P, V 322 P, V 323 P	I_F	30	mA
Forward surge current $t_p \leq 10\,\mu s$		I_{FSM}	1	A

V 320 P · V 321 P · V 322 P · V 323 P

Power dissipation $T_{amb} \leq 60°C$	P_V	100	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−55 ... + 100	°C
Soldering temperature, maximal $t \leq 5$ s	T_{sd}[1])	260	°C

Thermal resistance		**Min.**	**Typ.**	**Max.**	
Junction ambient	R_{thJA}			400	K/W

Optical and electrical characteristics

$T_{amb} = 25°C$

Type	Group	Luminous intensity I_V*)[2]) (mcd)	Peak wavelength emission λ_p (nm) Typ.	Spectral half bandwidth $\Delta\lambda$ (nm) Typ.	Dominant wave length λ_D (nm) Typ.	Forward voltage V_F*) (V)
		$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA
V 320 P	A	min. 0.5 typ. 0.7	660	20	662	typ. 1.6 max. 2.0
	B	min. 0.7 typ. 1.0				
V 321 P	A	min. 1.3 typ. 2.0	630	40	625	typ. 2.2 max. 3.0
	B	min. 3.2 typ. 4.0				
V 322 P	A	min. 0.8 typ. 1.0	560	40	568	typ. 2.4 max. 3.0
	B	min. 2.0 typ. 3.0				
V 323 P	A	min. 0.8 typ. 1.0	590	40	588	typ. 2.4 max. 3.0
	B	min. 2.0 typ. 3.0				

		Min.	**Typ.**	**Max.**	
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz	C_j		50		pF

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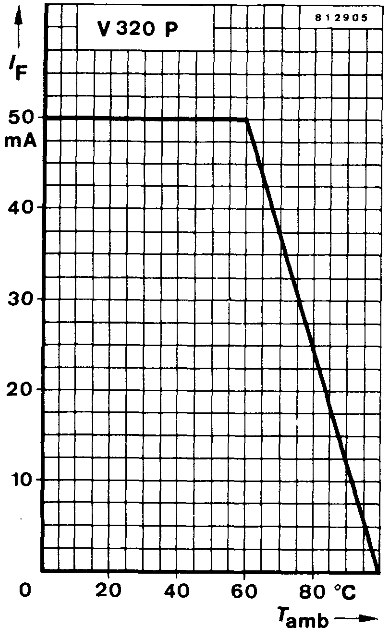
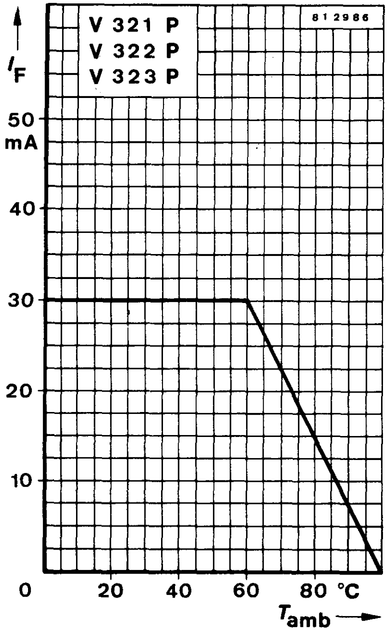
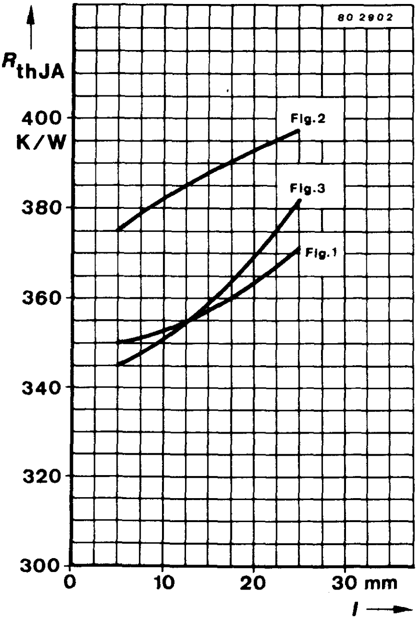
*) AQL = 0.65%

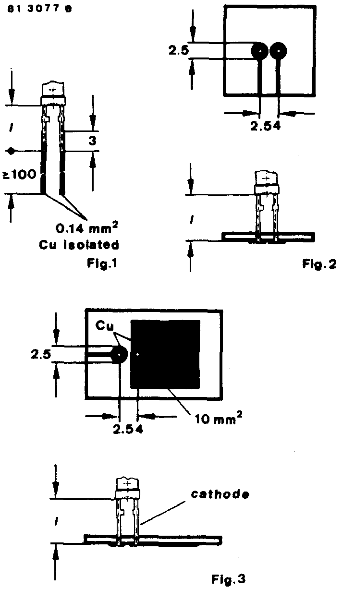
[1]) Distance from the touching border ≥ 1.5 mm, with intermediate PC-board

[2]) supplied selected in groups, luminous intensity in packing unit m = 0.5 ... 1

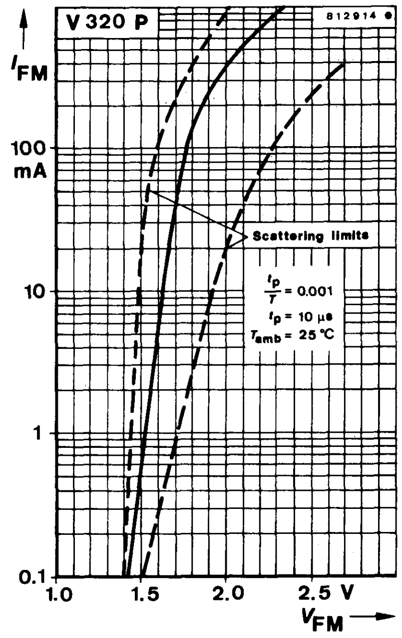

V 320 P
812905
I_F
50
mA
40
30
20
10
0
20
40
60
80 °C
T_{amb}

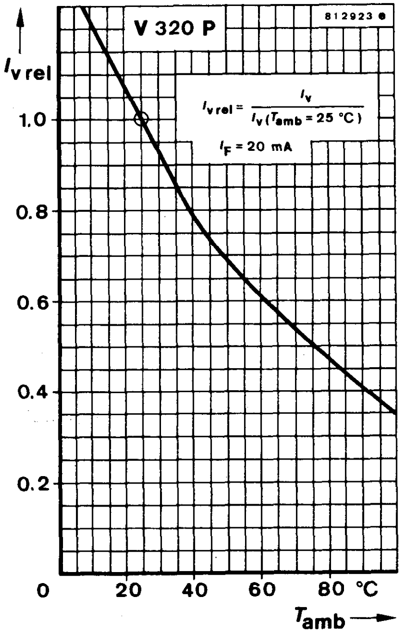

V 321 P
V 322 P
V 323 P
812986
I_F
50
mA
40
30
20
10
0
20
40
60
80 °C
T_{amb}

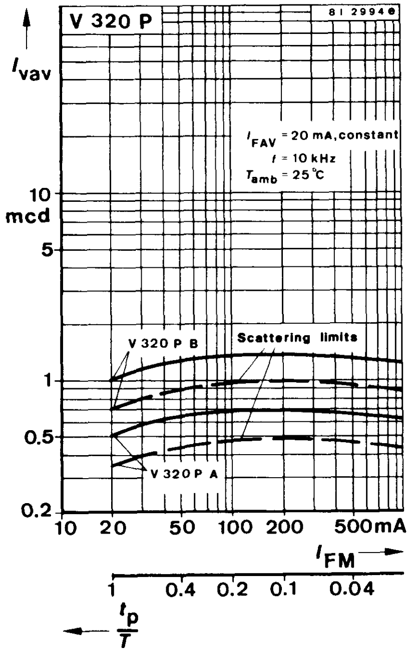

80 2902
R_{thJA}
400
K/W
380
360
340
320
300
0
10
20
30 mm
l
Fig.2
Fig.3
Fig.1

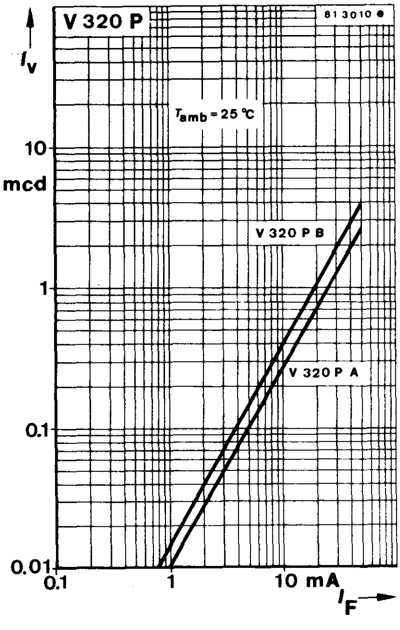

81 3077 e
l
≥100
3
0.14 mm²
Cu isolated
Fig.1
2.5
2.54
l
Fig.2
Cu
2.5
2.54
10 mm²
cathode
l
Fig.3

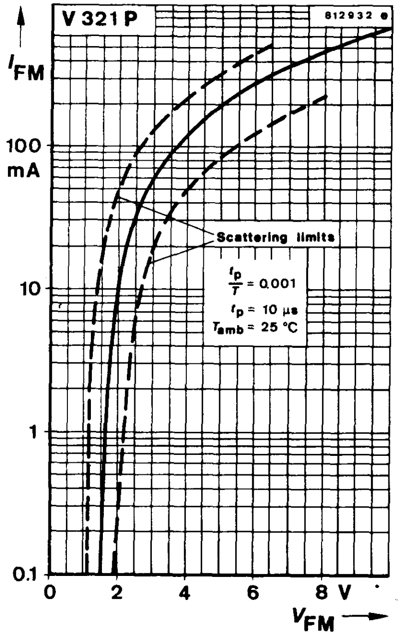
V 320 P · V 321 P · V 322 P · V 323 P

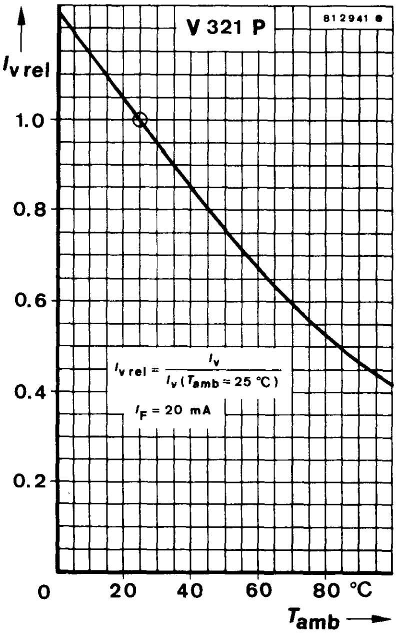


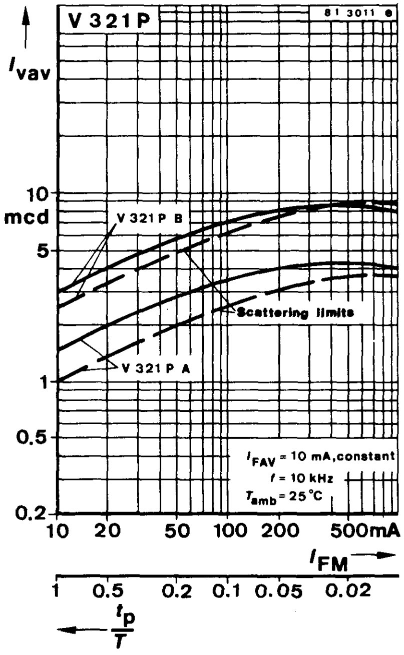


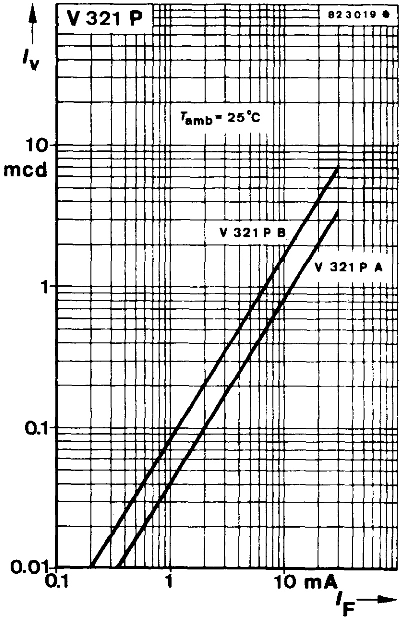




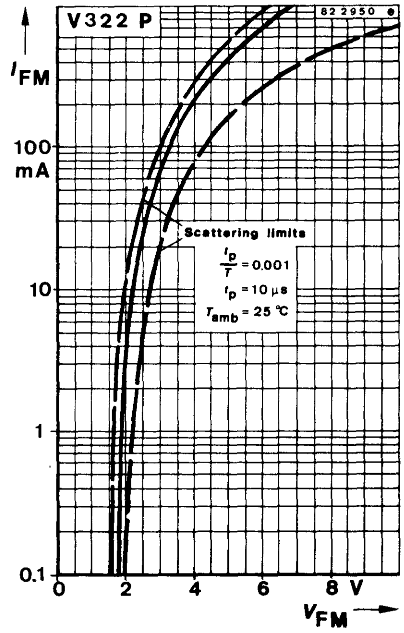

V 321 P
812932
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$

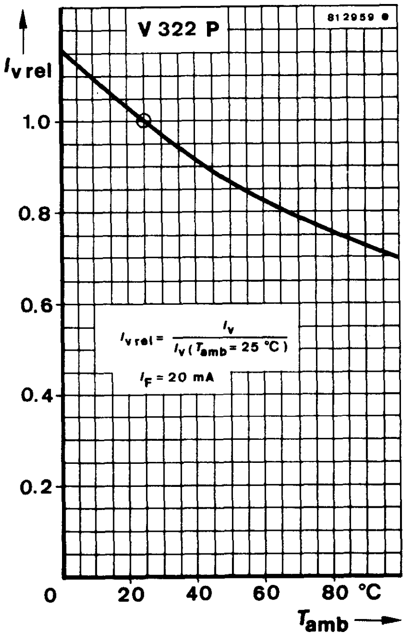

V 321 P
812941
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v\,(T_{amb} = 25\ °C)}$
$I_F = 20\ mA$

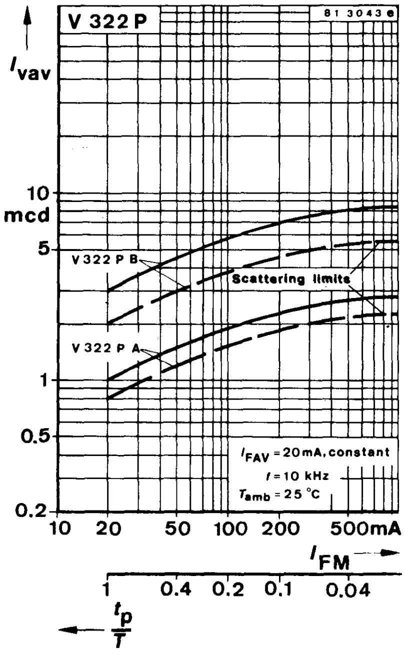

V 321 P
81 3011
I_{vav}
10 mcd
5
1
0.5
0.2
V 321 P B
Scattering limits
V 321 P A
$I_{FAV} = 10\ mA$, constant
$f = 10\ kHz$
$T_{amb} = 25\ °C$
10
20
50
100
200
500mA
I_{FM}
1
0.5
0.2
0.1
0.05
0.02
$\frac{t_p}{T}$

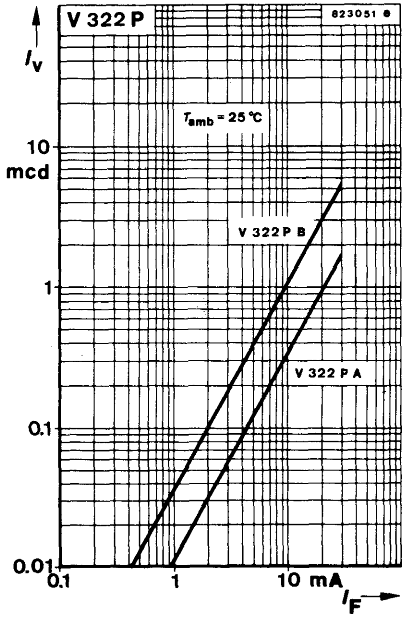

V 321 P
823019
I_v
$T_{amb} = 25°C$
10 mcd
1
0.1
0.01
V 321 P B
V 321 P A
0.1
1
10 mA
I_F

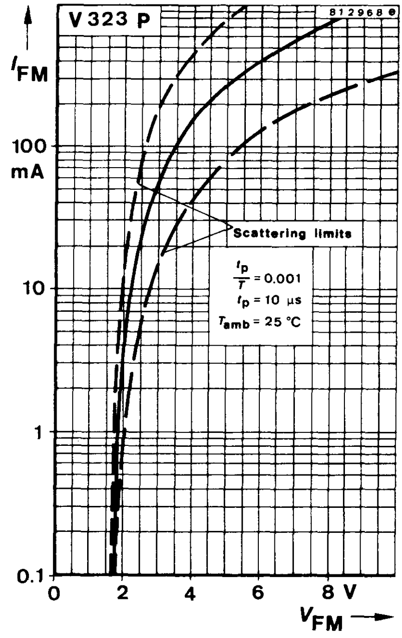
V 320 P · V 321 P · V 322 P · V 323 P

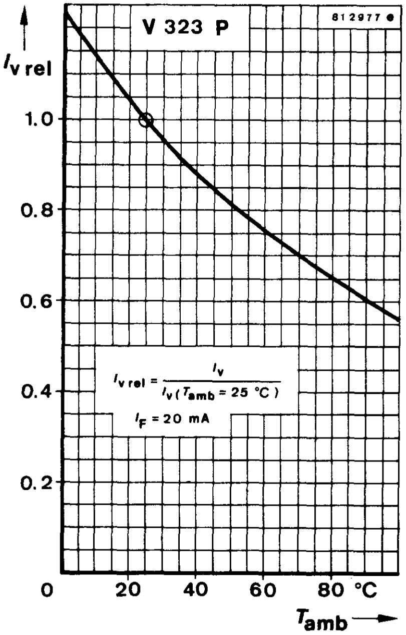


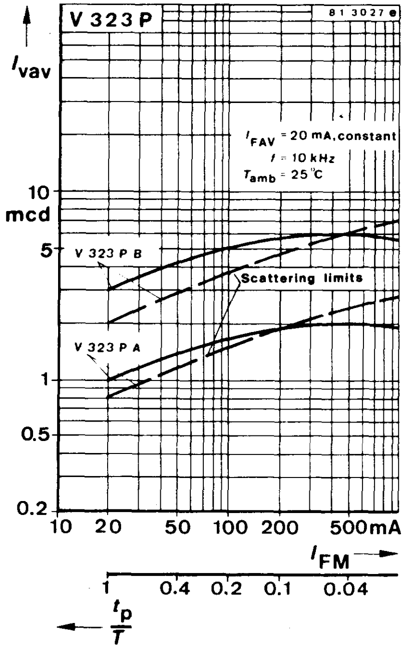


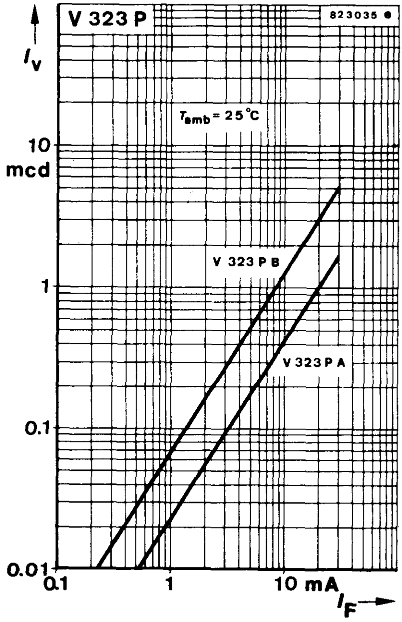




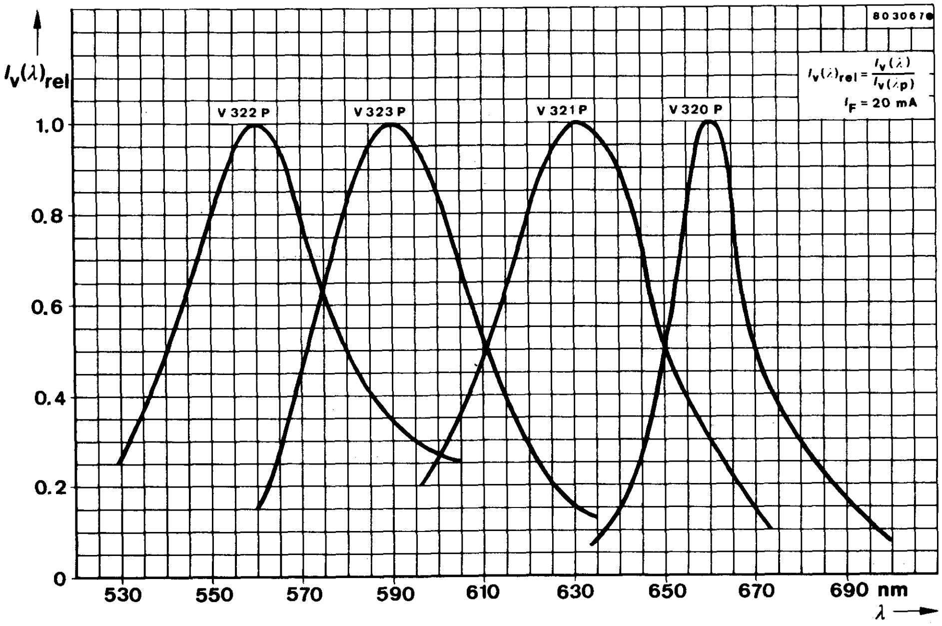

V 323 P
812968 e
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T}$ = 0.001
t_p = 10 µs
T_{amb} = 25 °C

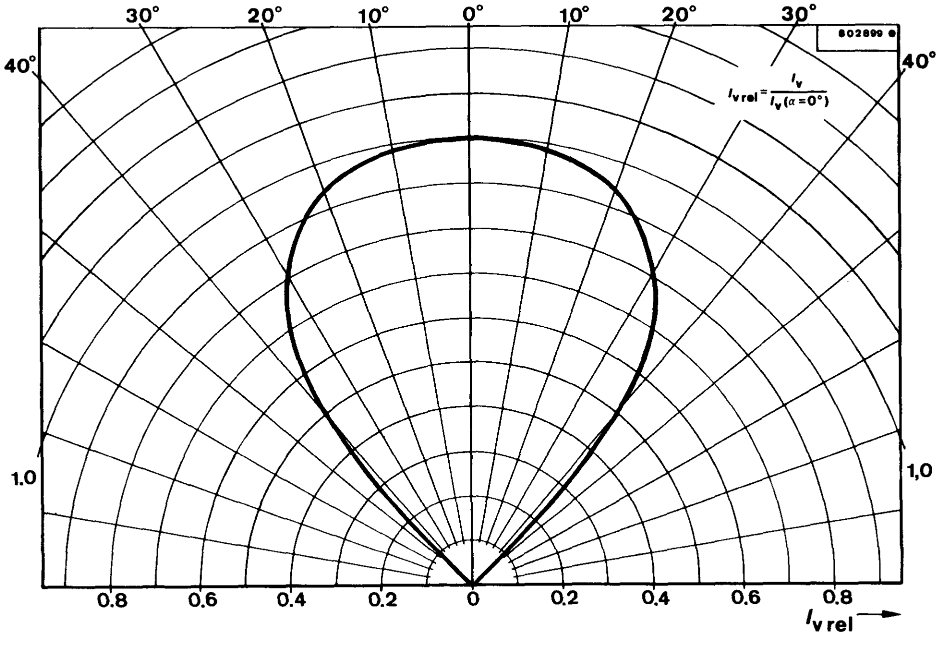

V 323 P
812977 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v(T_{amb} = 25\ °C)}$
I_F = 20 mA


V 323 P
81 3027 e
I_{vav}
I_{FAV} = 20 mA, constant
f = 10 kHz
T_{amb} = 25 °C
10 mcd
5
V 323 P B
Scattering limits
V 323 P A
1
0.5
0.2
10
20
50
100
200
500 mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$


V 323 P
823035 e
I_v
T_{amb} = 25 °C
10 mcd
1
0.1
0.01
V 323 P B
V 323 P A
0.1
1
10 mA
I_F

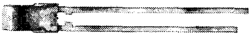
V 320 P · V 321 P · V 322 P · V 323 P





V 330 P · V 331 P · V 332 P · V 333 P

Symbol LED — 3 mm □



Colour	Type	Technology	Angle of half intensity α
Red	**V 330 P**	GaAsP on GaAs	80°
Orange-red	**V 331 P**	GaAsP on GaP	80°
Green	**V 332 P**	GaP on GaP	80°
Yellow	**V 333 P**	GaAsP on GaP	80°

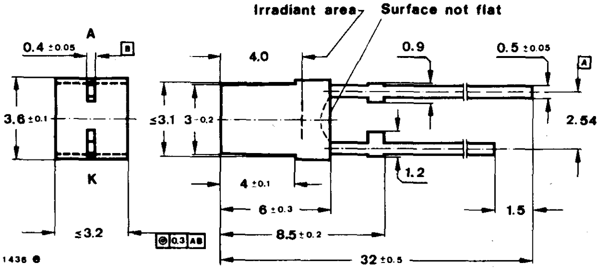
Applications: General indicating and illumination purposes

Features:

- Even luminance of the emitting surface
- Wide viewing angle
- High illuminance through reflector
- Ideal as flush mounted panel indicators
- Axial terminals
- Long life compared with filament lamps
- Vibration resistant

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 80°$

Special case
Weight max. 0.2 g

Absolute maximum ratings

Reverse voltage		V_R	5	V
Forward current	**V 330 P**	I_F	50	mA
	V 331 P, V 332 P, V 333 P	I_F	30	mA
Forward surge current $t_p \leq 10\,\mu s$		I_{FSM}	1	A

V 330 P · V 331 P · V 332 P · V 333 P

Power dissipation $T_{amb} \leq 60°C$	P_V	100	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−55 ... + 100	°C
Soldering temperature, maximal $t \leq 5$ s	T_{sd}[1])	260	°C

Thermal resistance		**Min.**	**Typ.**	**Max.**	
Junction ambient	R_{thJA}			400	K/W

Optical and electrical characteristics
$T_{amb} = 25°C$

Type	Group	Luminous intensity I_V*)[2]) (mcd)	Peak wavelength emission λ_p (nm) Typ.	Spectral half bandwidth $\Delta\lambda$ (nm) Typ.	Dominant wave length λ_D (nm) Typ.	Forward voltage V_F*) (V)
		$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA
V 330 P	A B	min. 0.5 typ. 0.7 min. 0.7 typ. 1.0	660	20	662	typ. 1.6 max. 2.0
V 331 P	A B	min. 1.3 typ. 2.0 min. 3.2 typ. 4.0	630	40	625	typ. 2.2 max. 3.0
V 332 P	A B	min. 0.8 typ. 1.0 min. 2.0 typ. 3.0	560	40	568	typ. 2.4 max. 3.0
V 333 P	A B	min. 0.8 typ. 1.0 min. 2.0 typ. 3.0	590	40	588	typ. 2.4 max. 3.0

		Min.	**Typ.**	**Max.**	
Breakdown voltage $I_R = 100\ \mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz	C_j		50		pF

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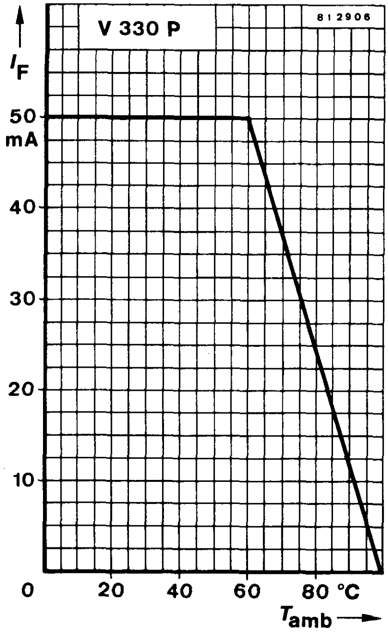
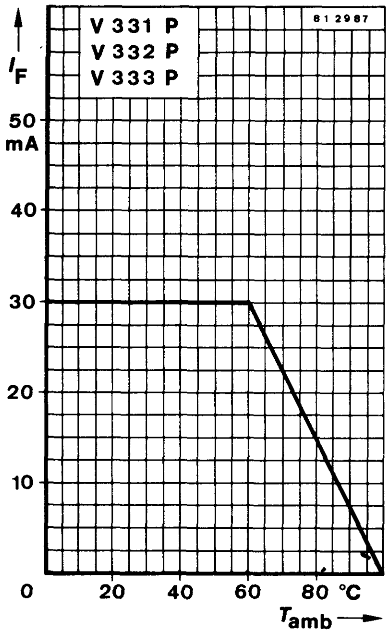
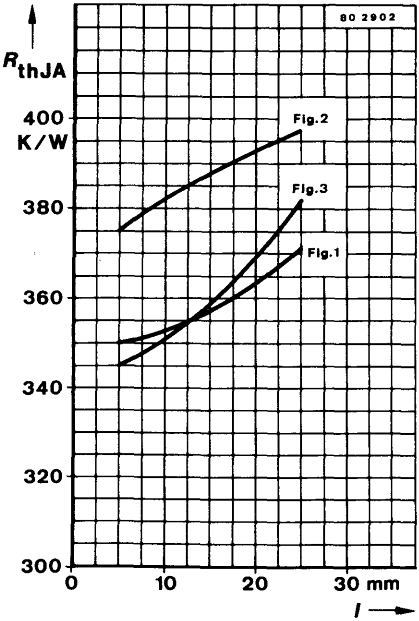
*) AQL = 0.65%

[1]) Distance from the touching border ≥ 1.5 mm, with intermediate PC-board

[2]) supplied selected in groups, luminous intensity in packing unit m = 0.5 ...1







81 3077 e

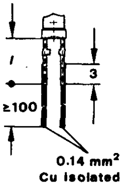


Fig.1

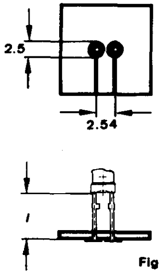


Fig.2

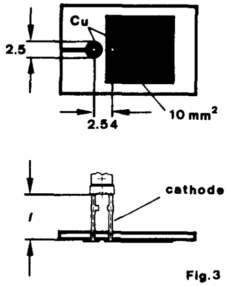
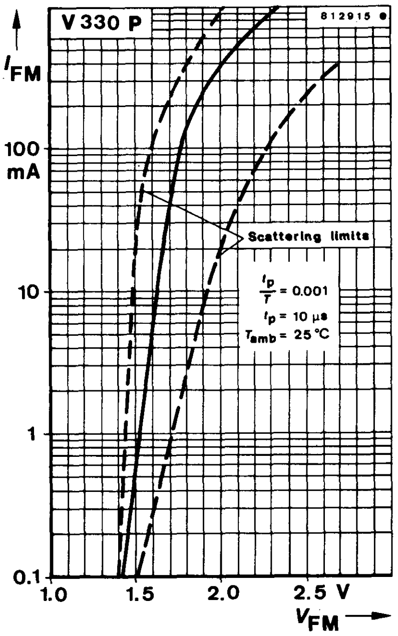
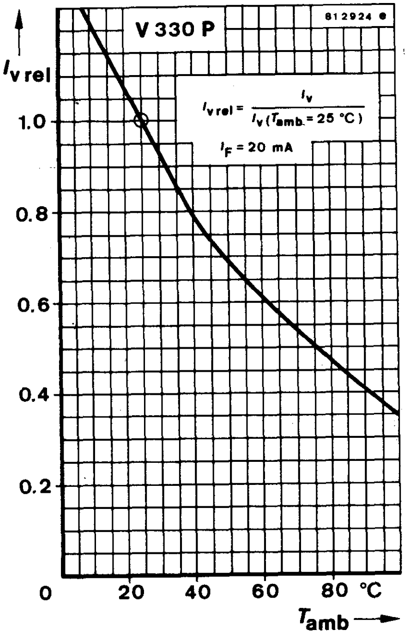
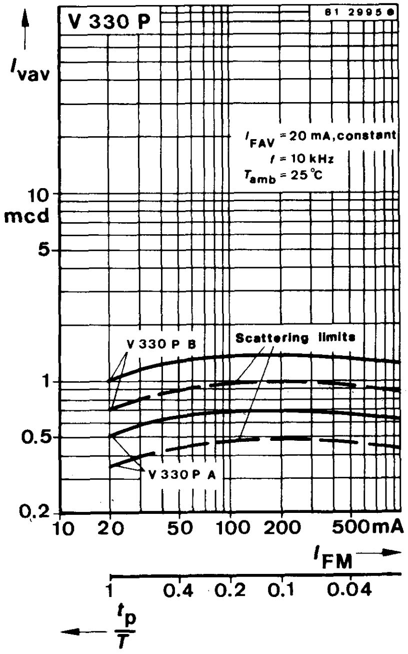


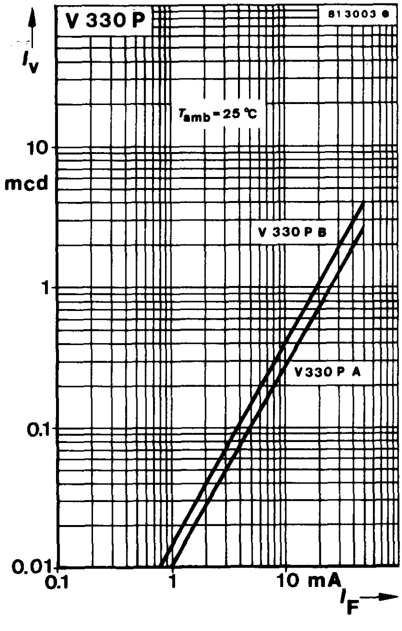
Fig.3

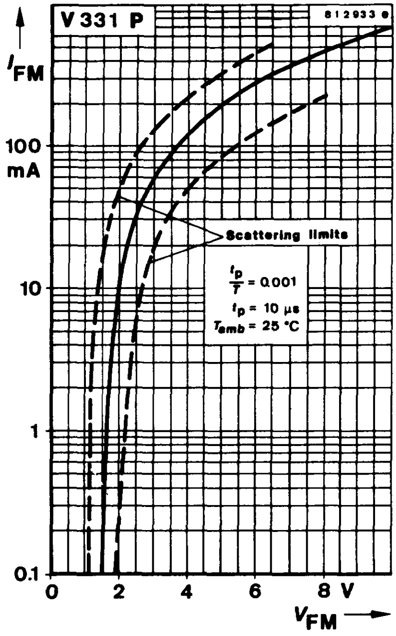
V 330 P · V 331 P · V 332 P · V 333 P

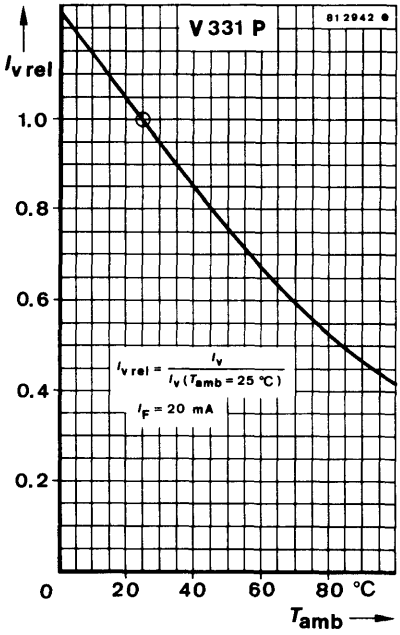


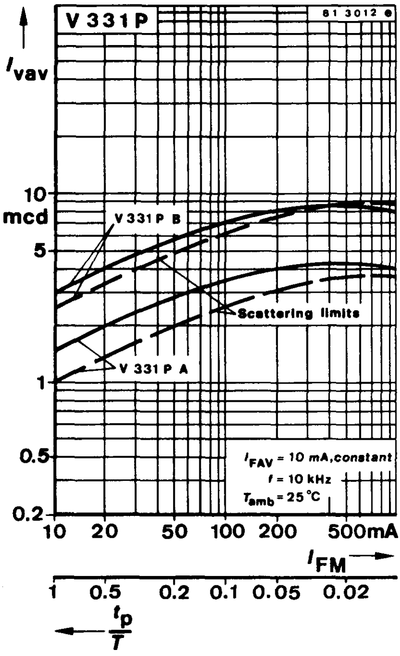


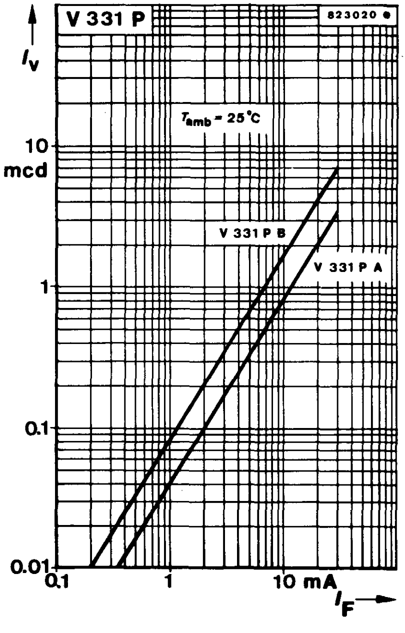




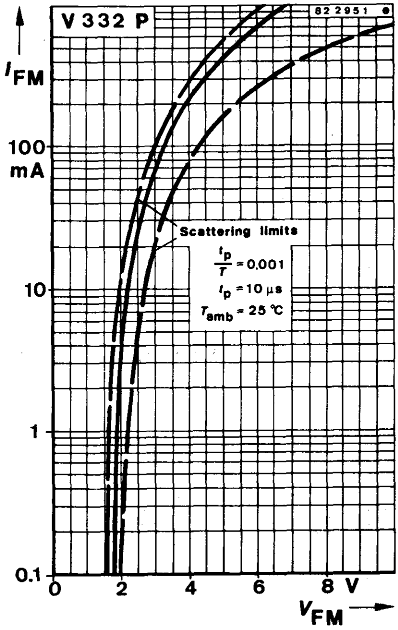

V 331 P
812933
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$

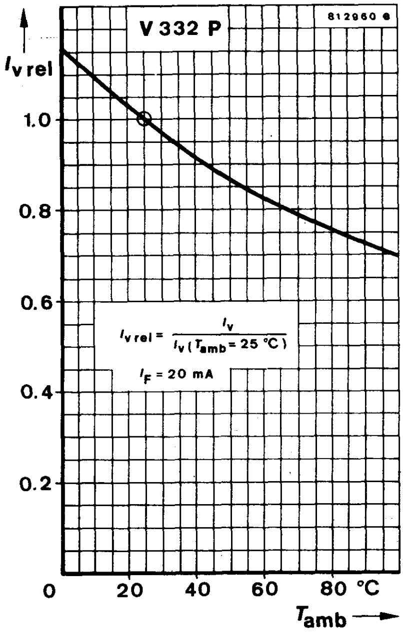

V 331 P
812942
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v\,(T_{amb} = 25\ °C)}$
$I_F = 20\ mA$

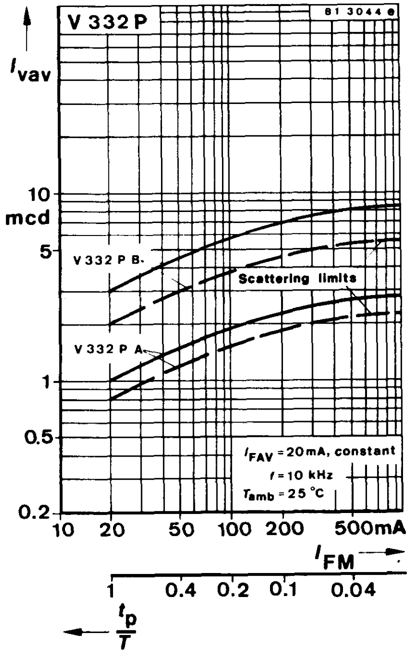

V 331 P
81 3012
I_{vav}
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500mA
I_{FM}
1
0.5
0.2
0.1
0.05
0.02
$\frac{t_p}{T}$
V 331 P B
Scattering limits
V 331 P A
$I_{FAV} = 10\ mA$, constant
$f = 10\ kHz$
$T_{amb} = 25\ °C$

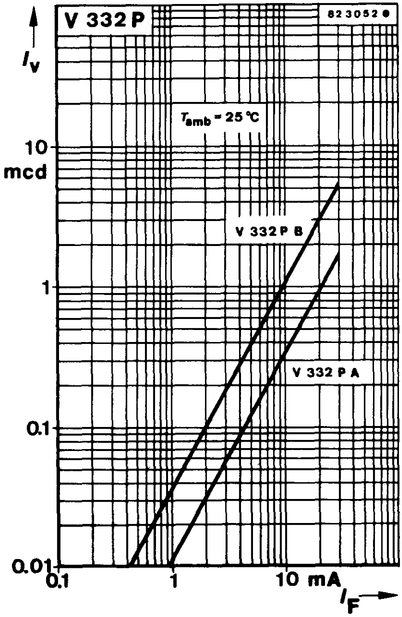

V 331 P
823020
I_v
10 mcd
1
0.1
0.01
0.1
1
10 mA
I_F
$T_{amb} = 25\ °C$
V 331 P B
V 331 P A

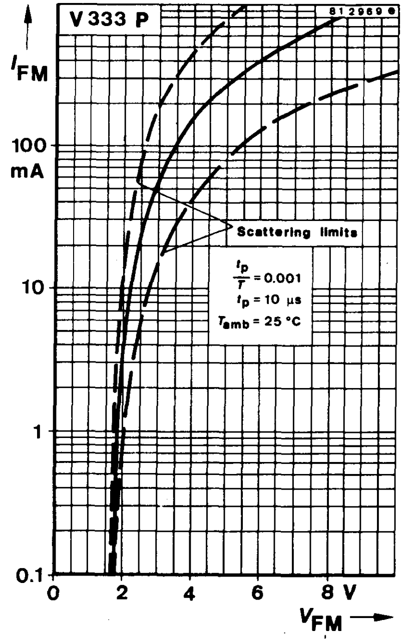
V 330 P · V 331 P · V 332 P · V 333 P

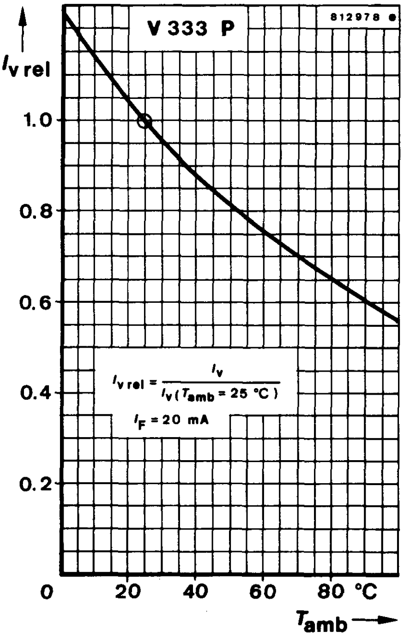


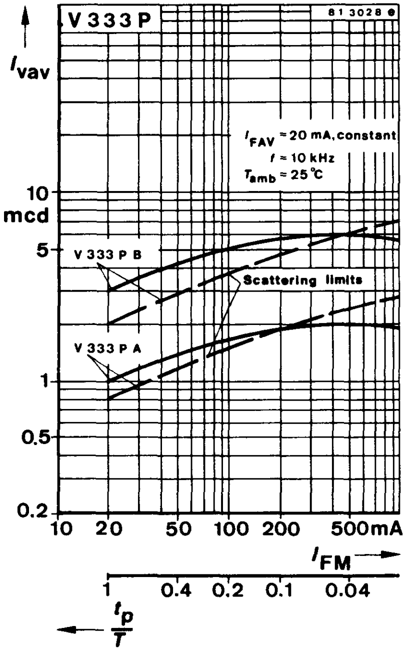


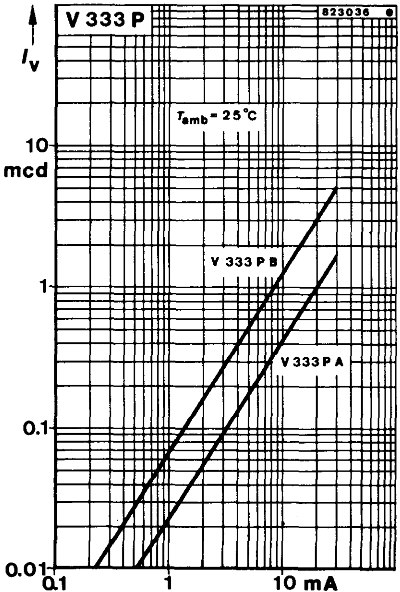




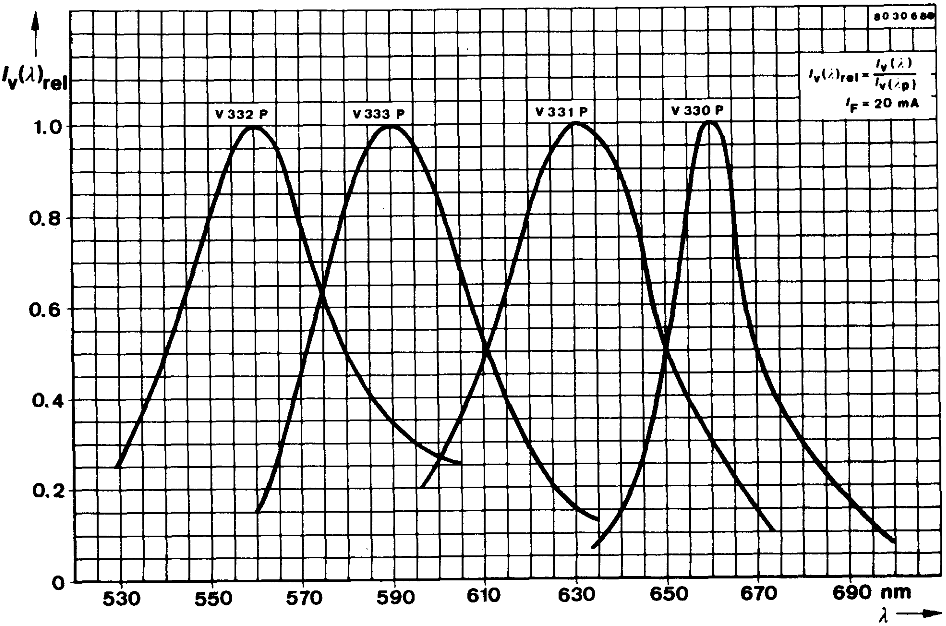

V 333 P
812969
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10$ µs
$T_{amb} = 25$ °C

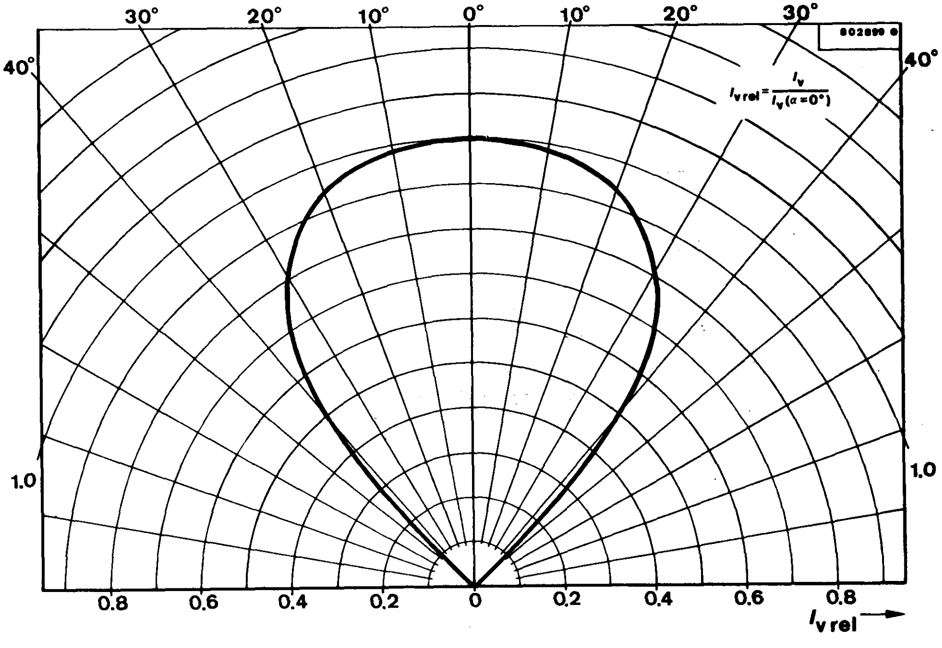

V 333 P
812978
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_{v\,(T_{amb} = 25\,°C)}}$
$I_F = 20$ mA


V 333 P
813028
I_{vav}
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$
$I_{FAV} = 20$ mA, constant
$f = 10$ kHz
$T_{amb} = 25$ °C
V 333 P B
V 333 P A
Scattering limits


V 333 P
823036
I_v
10 mcd
1
0.1
0.01
0.1
1
10 mA
I_F
$T_{amb} = 25$ °C
V 333 P B
V 333 P A

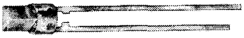
V 330 P · V 331 P · V 332 P · V 333 P





V 340 P · V 341 P · V 342 P · V 343 P

Symbol LED – 3 mm △



Colour	Type	Technology	Angle of half intensity α
Red	**V 340 P**	GaAsP on GaAs	80°
Orange-red	**V 341 P**	GaAsP on GaP	80°
Green	**V 342 P**	GaP on GaP	80°
Yellow	**V 343 P**	GaAsP on GaP	80°

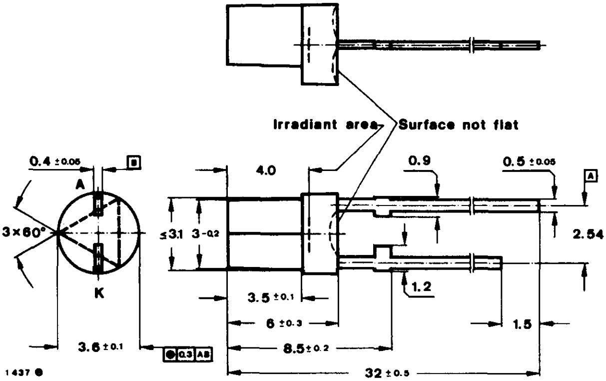
Applications: General indicating and illumination purposes

Features:

- Even luminance of the emitting surface
- Wide viewing angle
- High illuminance through reflector
- Very low cross talk in uninterrupted areas
- Ideal as flush mounted panel indicators
- Axial terminals
- Long life compared with filament lamps
- Vibration resistant

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 80°$

Special case
Weight max. 0.2 g

Absolute maximum ratings

Reverse voltage		V_R	5	V
Forward current	**V 340 P**	I_F	50	mA
	V 341 P, V 342 P, V 343 P	I_F	30	mA
Forward surge current $t_p \leq 10\,\mu s$		I_{FSM}	1	A

V 340 P · V 341 P · V 342 P · V 343 P

Power dissipation $T_{amb} \leq 60°C$	P_V	100	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−55 ... + 100	°C
Soldering temperature, maximal $t \leq 5$ s	T_{sd}¹)	260	°C

Thermal resistance

		Min.	Typ.	Max.	
Junction ambient	R_{thJA}			400	K/W

Optical and electrical characteristics
$T_{amb} = 25°C$

Type	Group	Luminous intensity I_V*)²) (mcd)	Peak wavelength emission λ_p (nm) Typ.	Spectral half bandwidth $\Delta\lambda$ (nm) Typ.	Dominant wave length λ_D (nm) Typ.	Forward voltage V_F*) (V)
		$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA
V 340 P	A	min. 0.5 typ. 0.7	660	20	662	typ. 1.6 max. 2.0
	B	min. 0.7 typ. 1.0				
V 341 P	A	min. 1.3 typ. 2.0	630	40	625	typ. 2.2 max. 3.0
	B	min. 3.2 typ. 4.0				
V 342 P	A	min. 0.8 typ. 1.0	560	40	568	typ. 2.7 max. 3.2
	B	min. 2.0 typ. 3.0				
V 343 P	A	min. 0.8 typ. 1.0	590	40	588	typ. 2.4 max. 3.2
	B	min. 2.0 typ. 3.0				

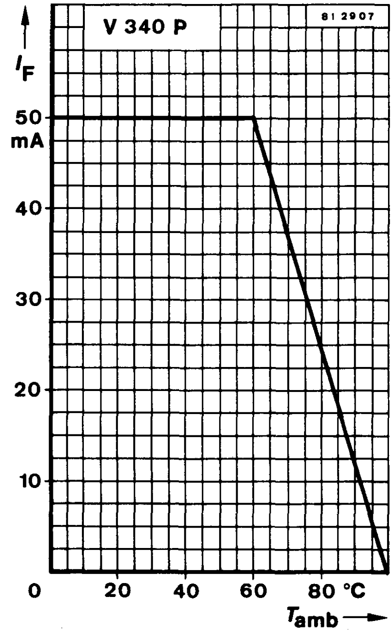
		Min.	Typ.	Max.	
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz	C_j		50		pF

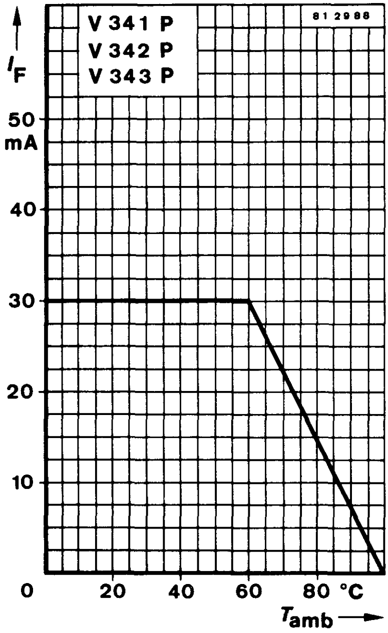
---

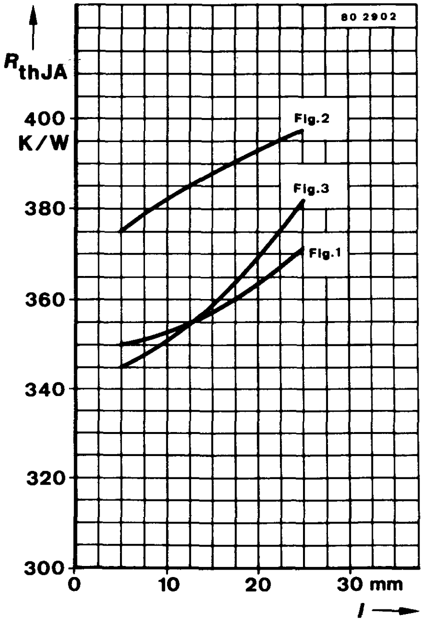
*) AQL = 0.65%

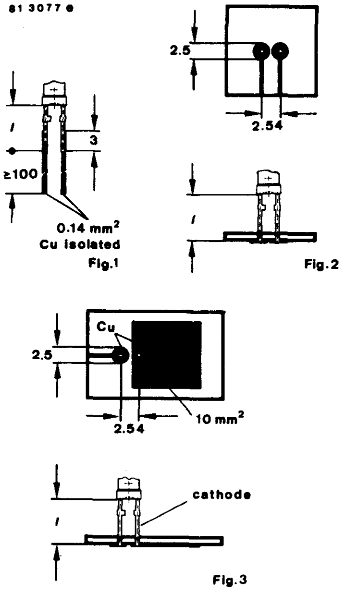
[1] Distance from the touching border ≥ 1.5 mm with intermediate PC-board

[2] supplied selected in groups, luminous intensity in packing unit m = 0.5 ... 1

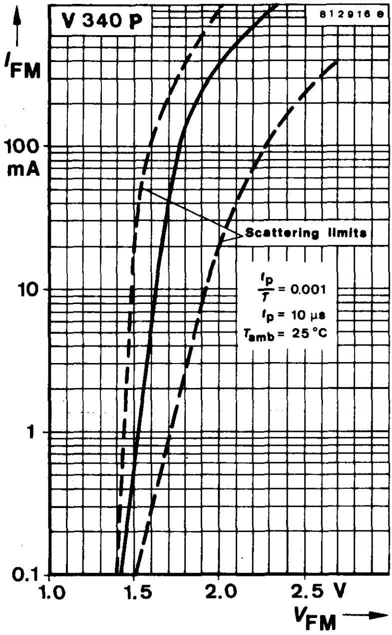

V 340 P
81 2907
I_F
50 mA
40
30
20
10
0
20
40
60
80 °C
T_{amb}

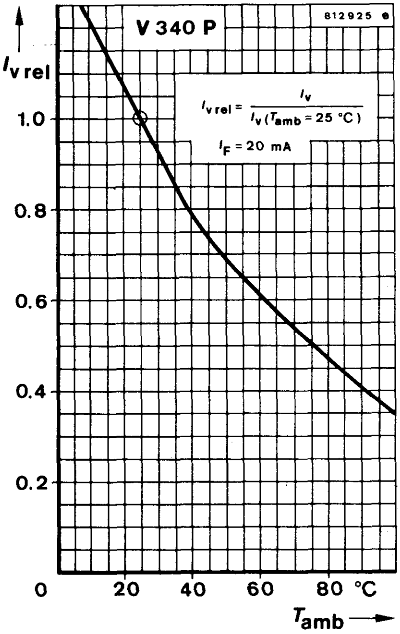

V 341 P
V 342 P
V 343 P
81 2988
I_F
50 mA
40
30
20
10
0
20
40
60
80 °C
T_{amb}

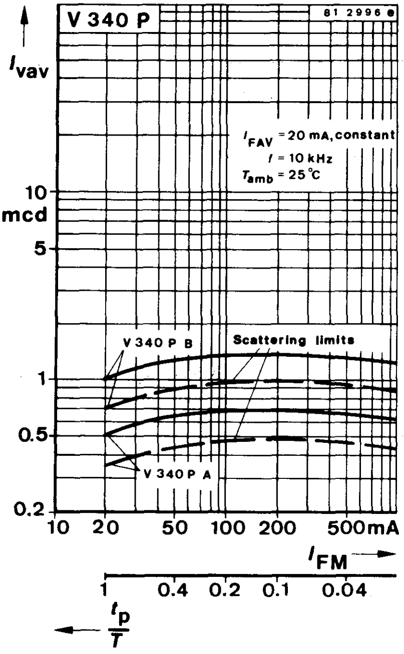

80 2902
R_{thJA}
400 K/W
380
360
340
320
300
0
10
20
30 mm
l
Fig.2
Fig.3
Fig.1

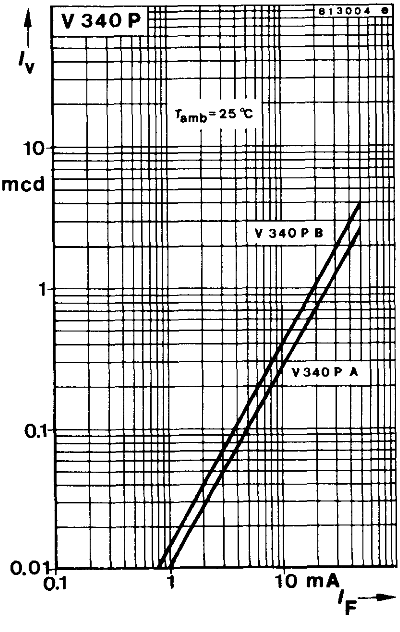

81 3077 e
2.5
2.54
l
3
≥100
0.14 mm²
Cu isolated
Fig.1
l
Fig.2
Cu
2.5
2.54
10 mm²
cathode
l
Fig.3

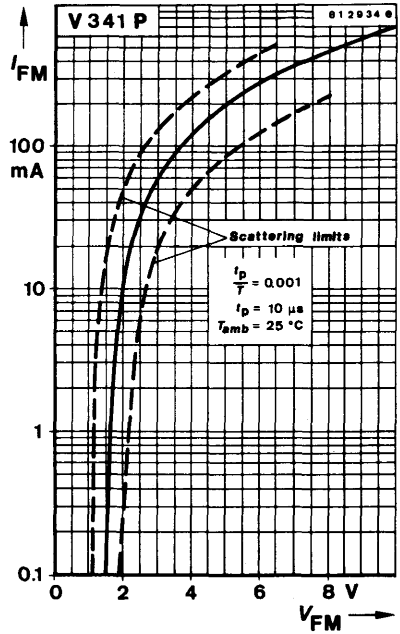
V 340 P · V 341 P · V 342 P · V 343 P

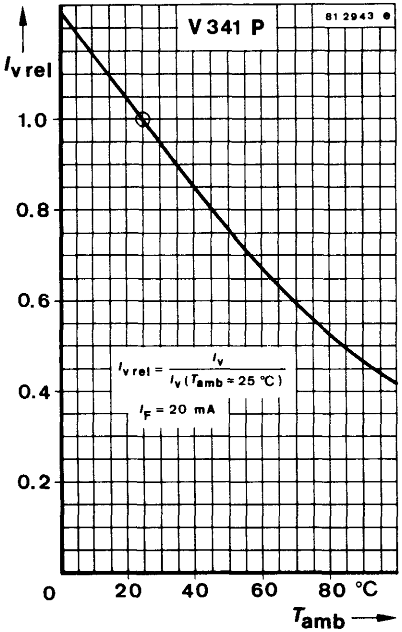


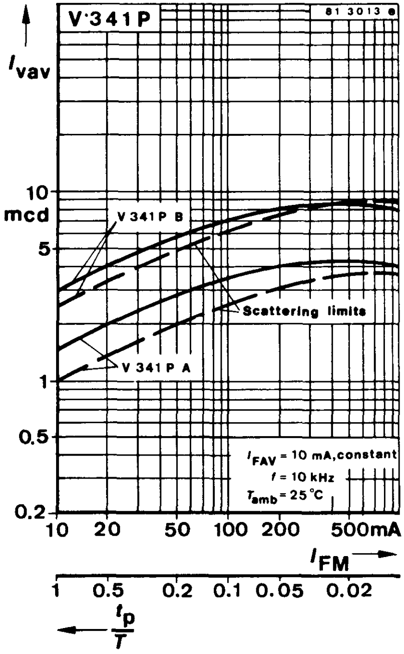


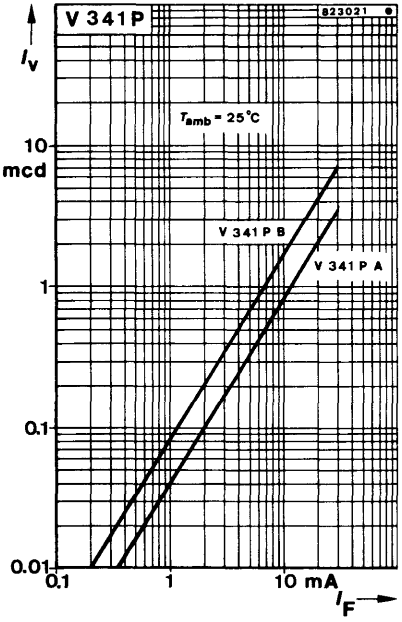


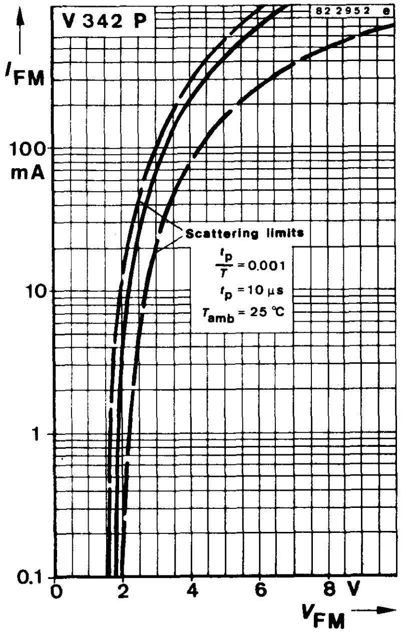


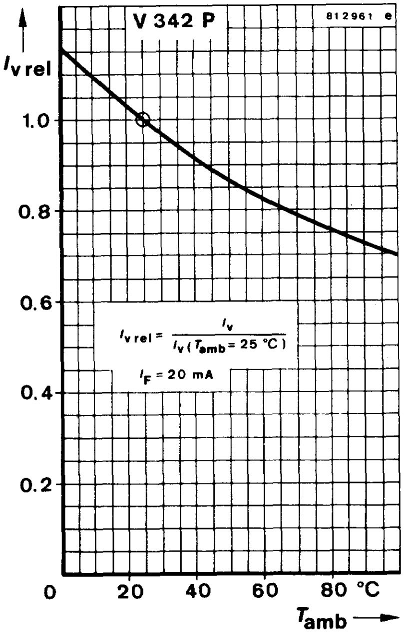

V 341 P
81 2934 e
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$

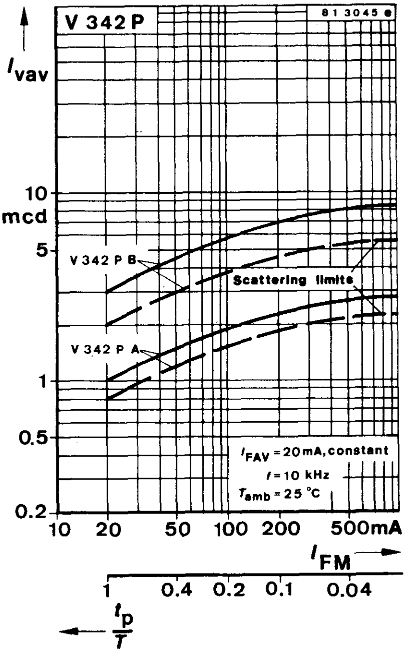

V 341 P
81 2943 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v\,(T_{amb} = 25\ °C)}$
$I_F = 20\ mA$

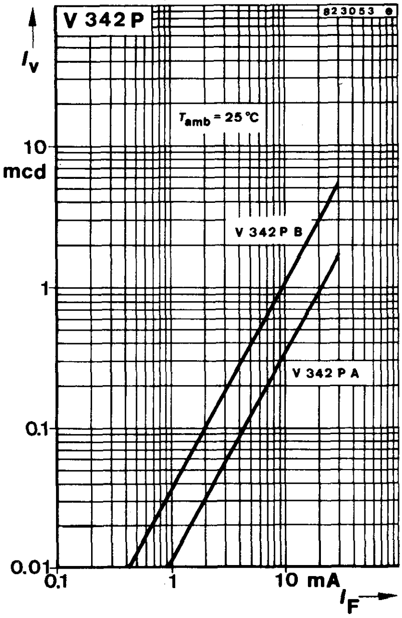

V 341 P
81 3013 e
I_{vav}
10 mcd
5
1
0.5
0.2
V 341 P B
V 341 P A
Scattering limits
$I_{FAV} = 10$ mA, constant
$f = 10$ kHz
$T_{amb} = 25\ °C$
10
20
50
100
200
500mA
I_{FM}
1
0.5
0.2
0.1
0.05
0.02
$\frac{t_p}{T}$

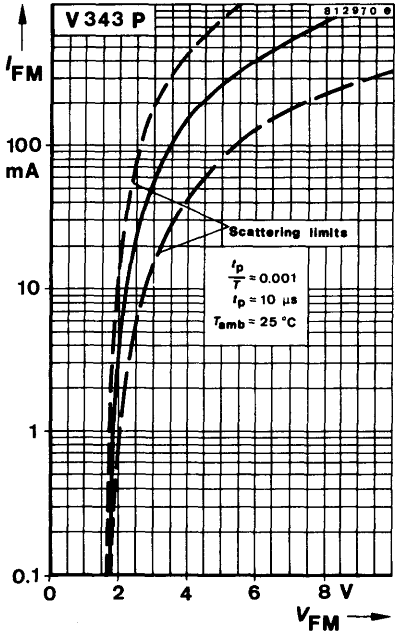

V 341 P
823021 e
I_v
10 mcd
1
0.1
0.01
$T_{amb} = 25\ °C$
V 341 P B
V 341 P A
0.1
1
10 mA
I_F

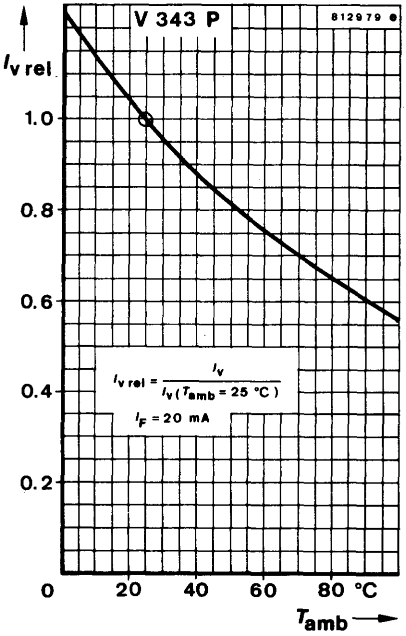

V 342 P
822952 e
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T}$ = 0.001
t_p = 10 µs
T_{amb} = 25 °C

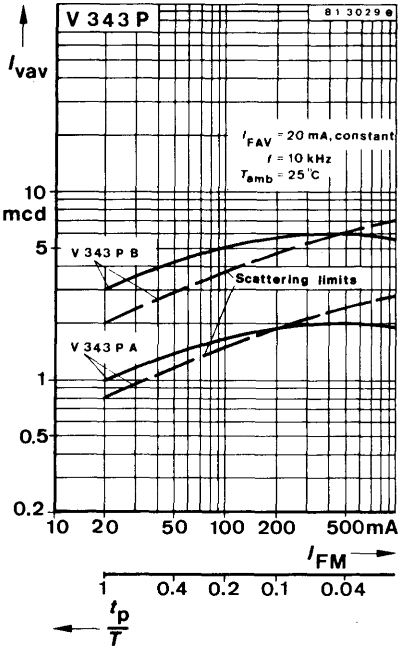

V 342 P
812961 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v(T_{amb} = 25\ °C)}$
I_F = 20 mA

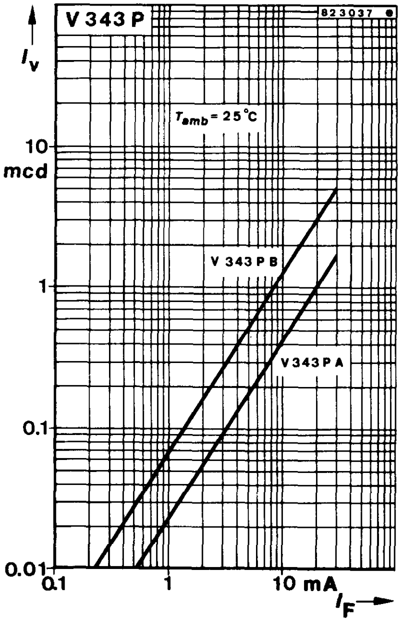

V 342 P
813045 e
I_{vav}
10 mcd
5
1
0.5
0.2
V 342 P B
V 342 P A
Scattering limits
I_{FAV} = 20 mA, constant
f = 10 kHz
T_{amb} = 25 °C
10
20
50
100
200
500 mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$


V 342 P
823053 e
I_v
10 mcd
1
0.1
0.01
T_{amb} = 25 °C
V 342 P B
V 342 P A
0.1
1
10 mA
I_F

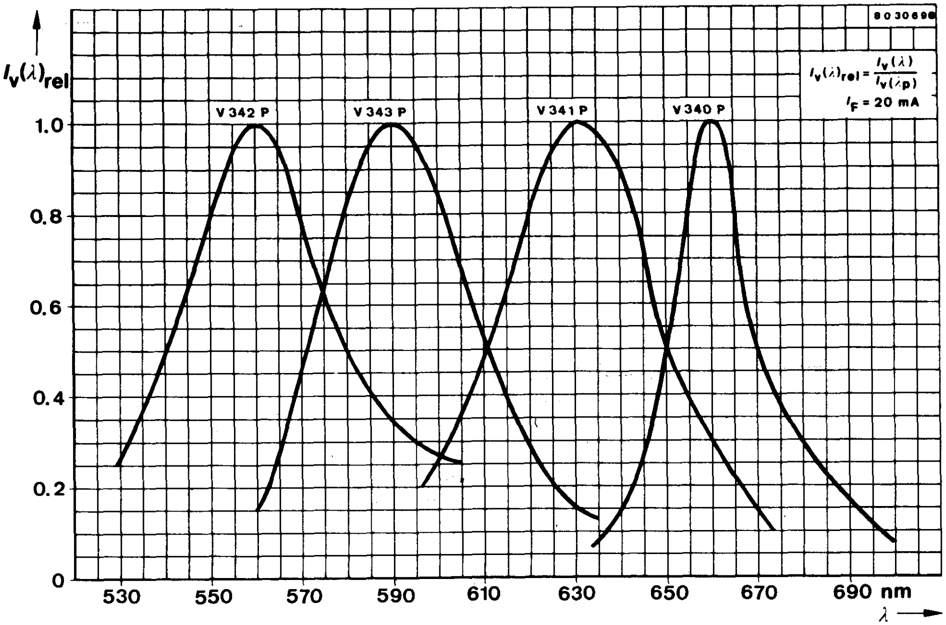

V 343 P
812970
I_{FM}
100 mA
10
1
0.1
0 2 4 6 8 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$

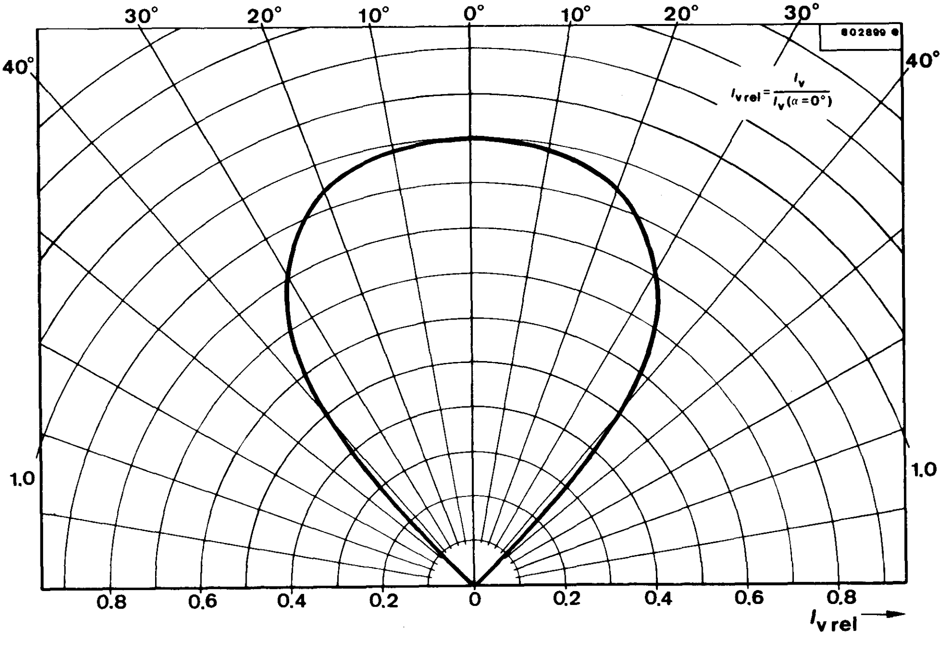

V 343 P
812979
$I_{v\ rel}$
1.0
0.8
0.6
0.4
0.2
0 20 40 60 80 °C
T_{amb}
$I_{v\ rel} = \frac{I_v}{I_v(T_{amb} = 25\ °C)}$
$I_F = 20\ mA$


V 343 P
81 3029
I_{vav}
10 mcd
5
1
0.5
0.2
$I_{FAV} = 20$ mA, constant
$f = 10$ kHz
$T_{amb} = 25\ °C$
V 343 P B
V 343 P A
Scattering limits
10 20 50 100 200 500 mA
I_{FM}
1 0.4 0.2 0.1 0.04
$\frac{t_p}{T}$


V 343 P
823037
I_v
10 mcd
1
0.1
0.01
$T_{amb} = 25\ °C$
V 343 P B
V 343 P A
0.1 1 10 mA
I_F

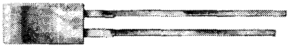
V 340 P · V 341 P · V 342 P · V 343 P





V 510 P · V 511 P · V 512 P · V 513 P

Symbol LED – 2.5 x 5 mm ▯



Colour	Type	Technology	Angle of half intensity α
Red	**V 510 P**	GaAsP on GaAs	80°
Orange-red	**V 511 P**	GaAsP on GaP	80°
Green	**V 512 P**	GaP on GaP	80°
Yellow	**V 513 P**	GaAsP on GaP	80°

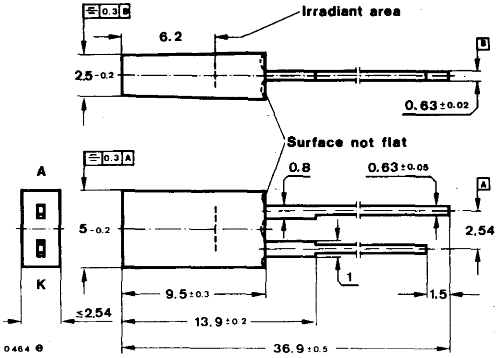
Applications: General indicating and illumination purposes

Features:

- Even luminance of the emitting surface
- Wide viewing angle
- High illuminance through reflector
- Very low cross talk in uninterrupted areas
- Ideal as flush mounted panel indicators
- Axial terminals
- Long life compared with filament lamps
- Vibration resistant

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 80°$

Special case
Weight max. 0.4 g

Absolute maximum ratings

Reverse voltage		V_R	5	V
Forward current	**V 510 P**	I_F	50	mA
	V 511 P, V 512 P, V 513 P	I_F	30	mA
Forward surge current $t_p \leq 10\,\mu s$		I_{FSM}	1	A

V 510 P · V 511 P · V 512 P · V 513 P

Power dissipation $T_{amb} \leq 70°C$	P_V		100		mW
Junction temperature	T_j		100		°C
Storage temperature range	T_{stg}		−55 ... +100		°C
Soldering temperature, maximal $t \leq 5$ s	T_{sd}¹)		260		°C
Thermal resistance		**Min.**	**Typ.**	**Max.**	
Junction ambient	R_{thJA}			300	K/W

Optical and electrical characteristics

$T_{amb} = 25°C$

Type	Group	Luminous intensity I_V*)²) (mcd)	Peak wavelength emission λ_p (nm) Typ.	Spectral half bandwidth $\Delta\lambda$ (nm) Typ.	Dominant wave length λ_D (nm) Typ.	Forward voltage V_F*) (V)
		$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA
V 510 P	A	min. 0.5 typ. 0.7	660	20	662	typ. 1.6 max. 2.0
	B	min. 0.7 typ. 1.0				
V 511 P	A	min. 1.3 typ. 2.0	630	40	625	typ. 2.2 max. 3.0
	B	min. 3.2 typ. 4.0				
V 512 P	A	min. 0.8 typ. 1.0	560	40	568	typ. 2.7 max. 3.2
	B	min. 2.0 typ. 3.0				
V 513 P	A	min. 0.8 typ. 1.0	590	40	588	typ. 2.4 max. 3.2
	B	min. 2.0 typ. 3.0				

		Min.	**Typ.**	**Max.**	
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz	C_j		50		pF

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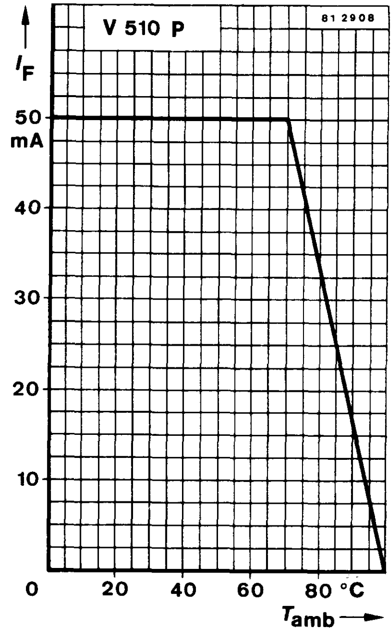
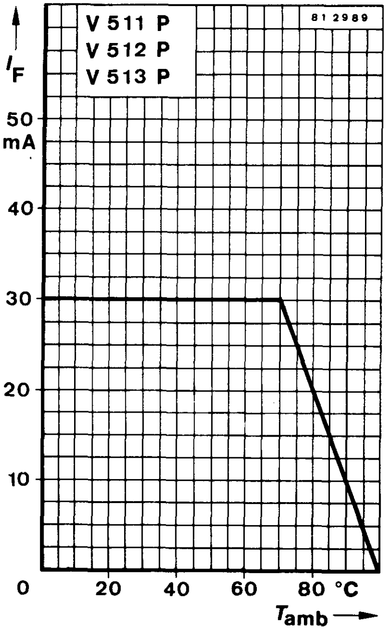
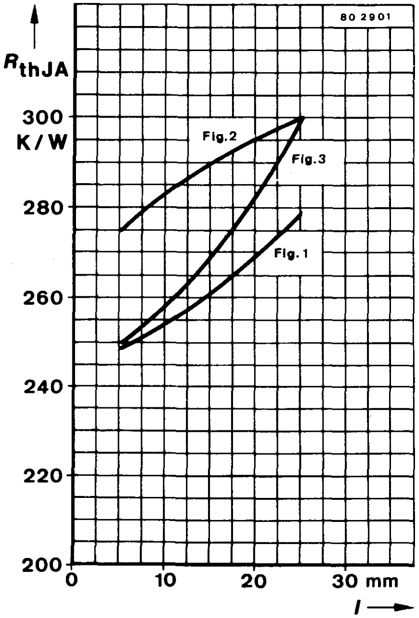
*) AQL = 0.65%

¹) Distance from the touching border ≥ 1.5 mm with intermediate PC-board

²) supplied selected in groups, luminous intensity in packing unit m = 0.5 ...1







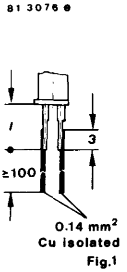


Fig.1

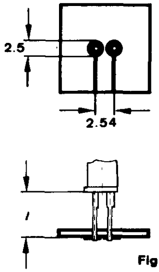


Fig.2

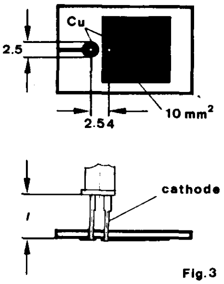
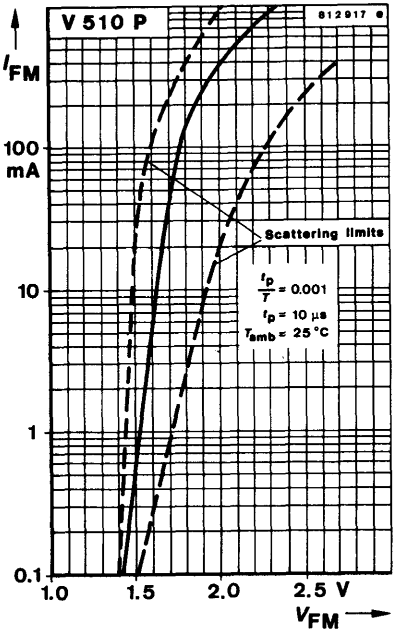
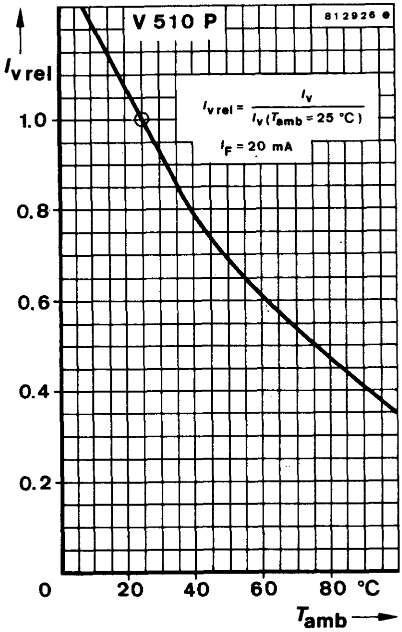
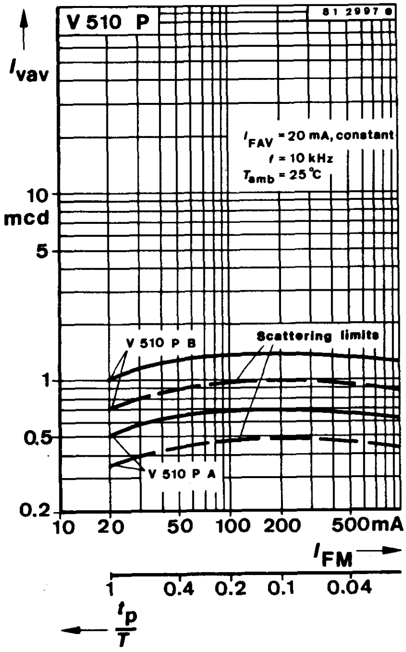


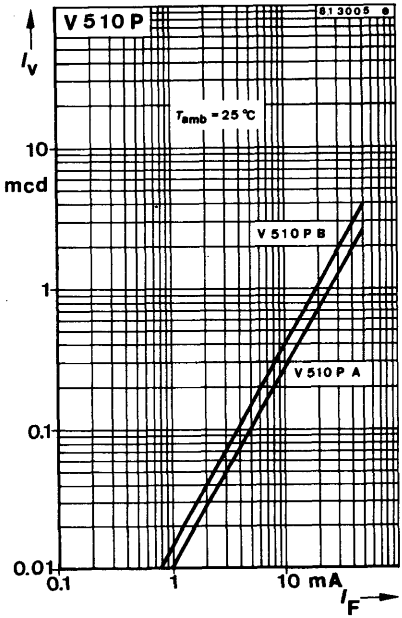
Fig.3

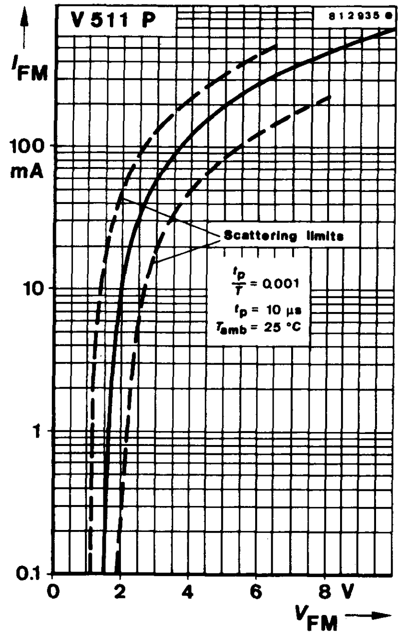
V 510 P · V 511 P · V 512 P · V 513 P

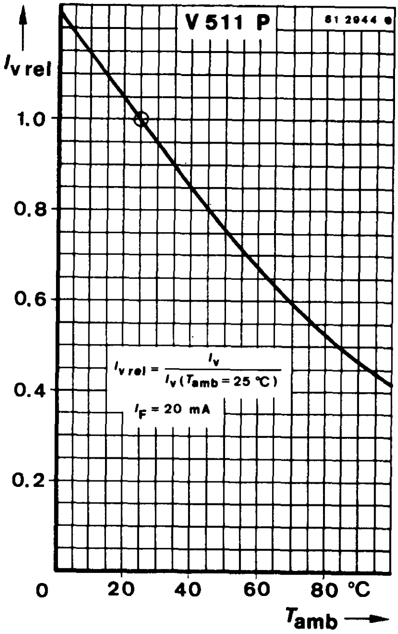


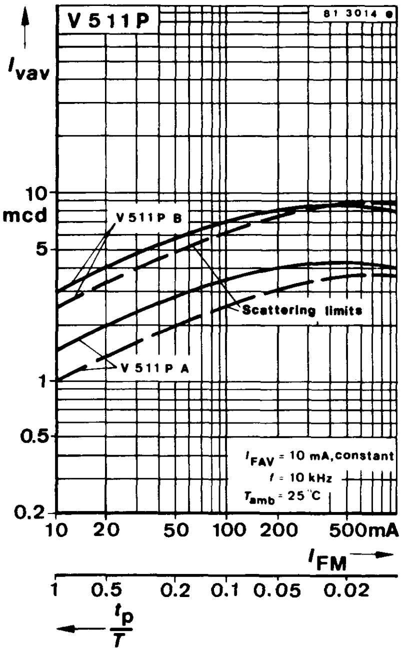


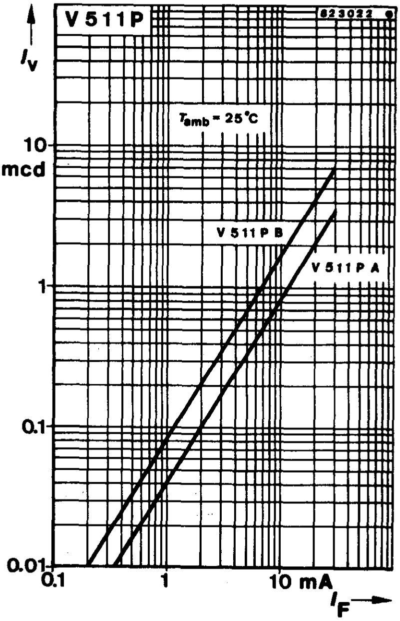




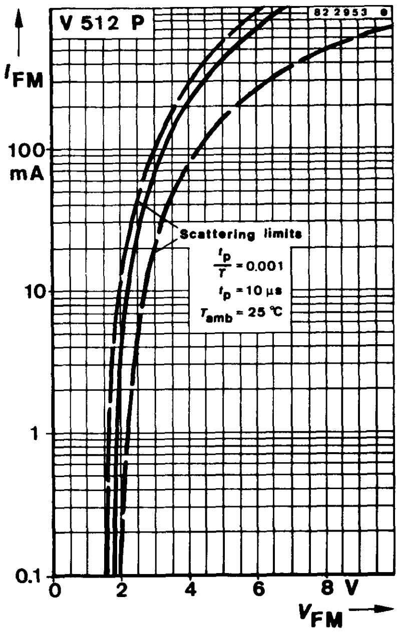

V 511 P
81 2935
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T}$ = 0.001
t_p = 10 µs
T_{amb} = 25 °C

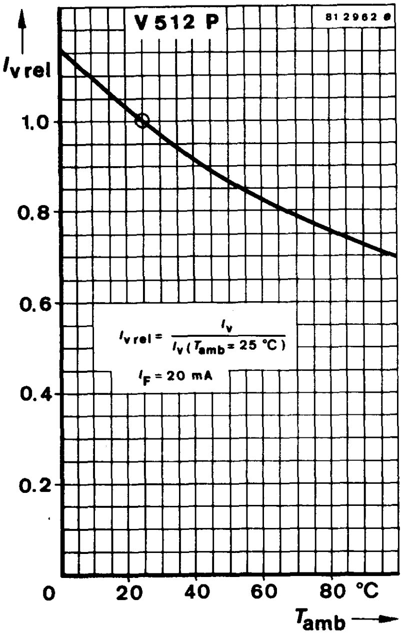

V 511 P
81 2944
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v(T_{amb} = 25\,°C)}$
I_F = 20 mA

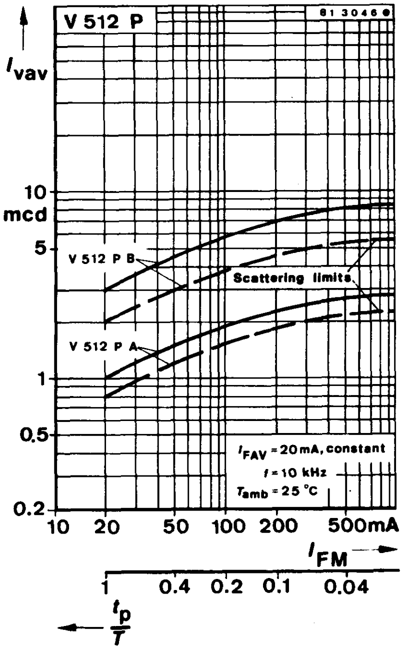

V 511P
81 3014
I_{vav}
10 mcd
5
1
0.5
0.2
V 511P B
Scattering limits
V 511 P A
I_{FAV} = 10 mA, constant
f = 10 kHz
T_{amb} = 25 °C
10
20
50
100
200
500mA
I_{FM}
1
0.5
0.2
0.1
0.05
0.02
$\frac{t_p}{T}$

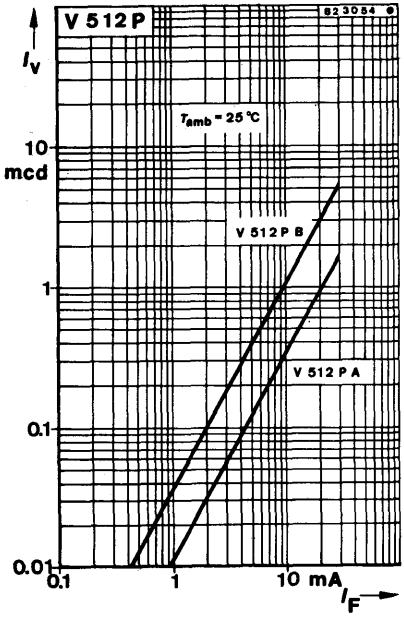

V 511P
823022
I_v
T_{amb} = 25 °C
10 mcd
1
0.1
0.01
V 511 P B
V 511 P A
0.1
1
10 mA
I_F

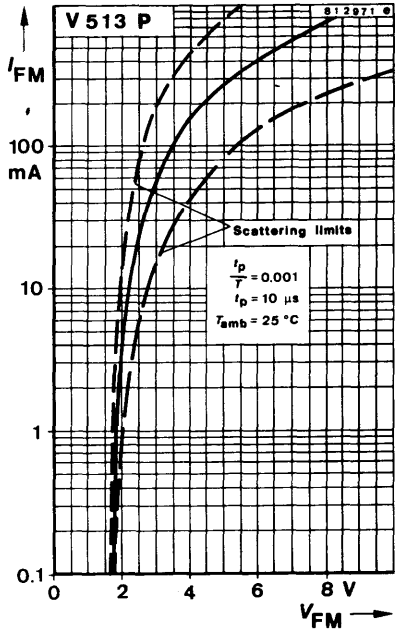
V 510 P · V 511 P · V 512 P · V 513 P

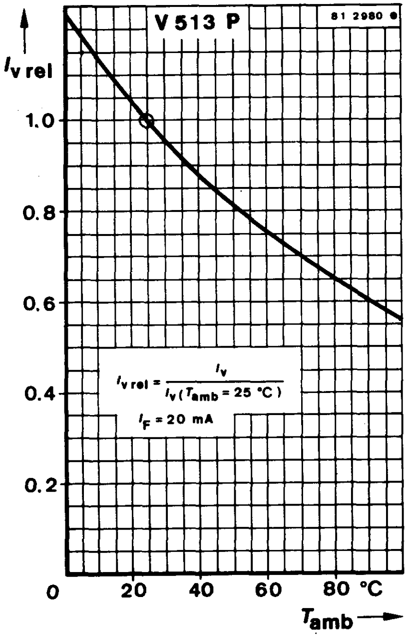


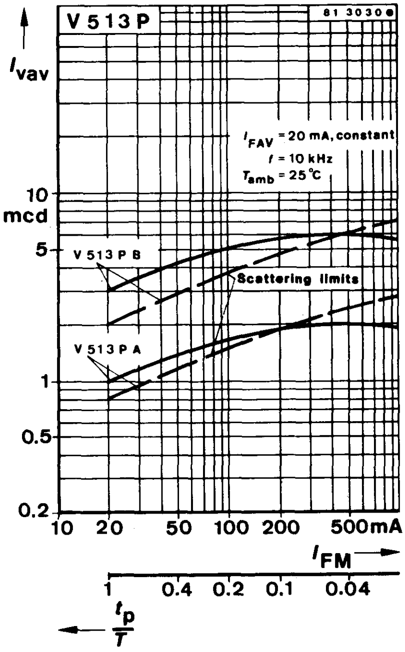


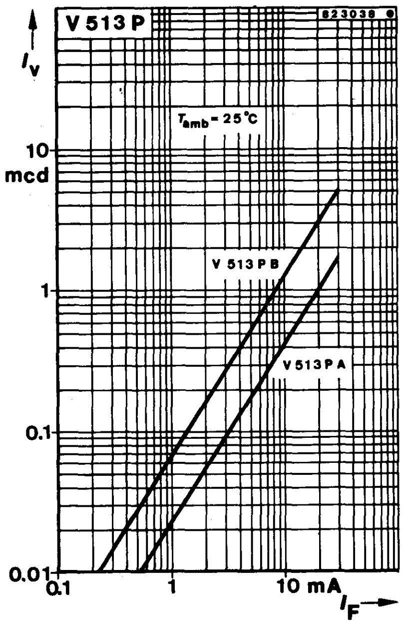




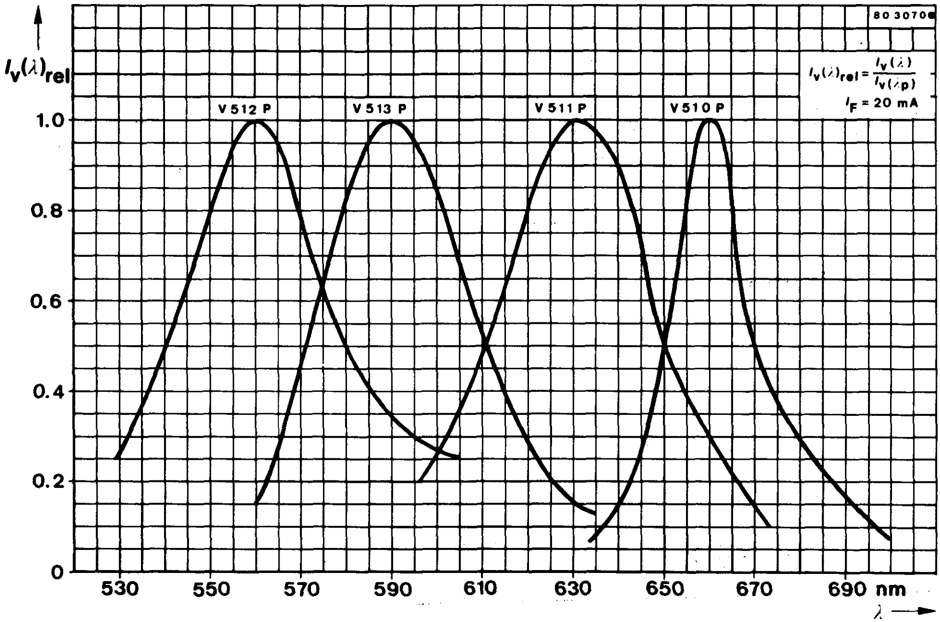

V 513 P
81 2971
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T}$ = 0.001
t_p = 10 µs
T_{amb} = 25 °C

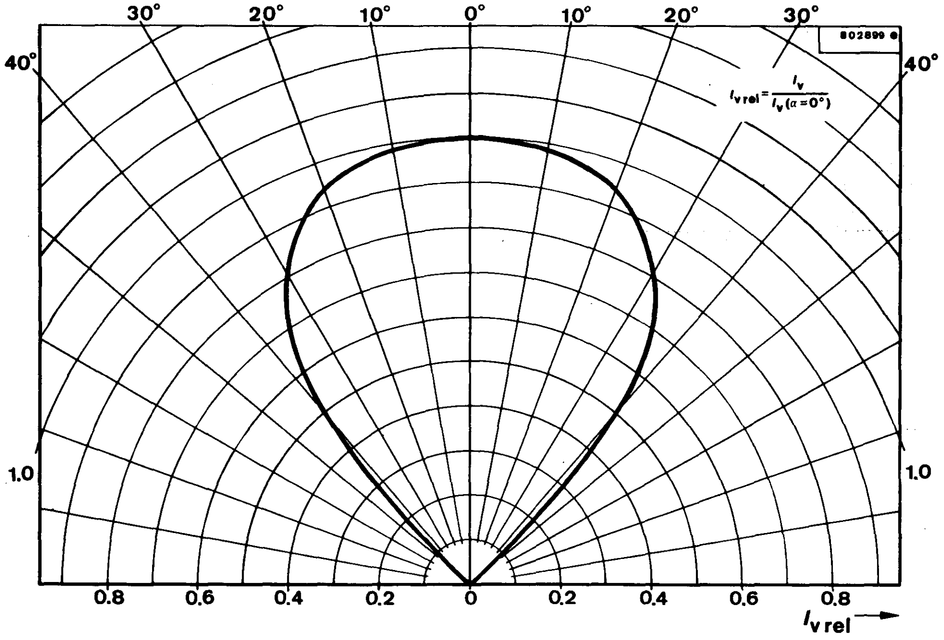

V 513 P
81 2980
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v(T_{amb} = 25\ °C)}$
I_F = 20 mA


V 513 P
81 3030
I_{vav}
10 mcd
5
1
0.5
0.2
I_{FAV} = 20 mA, constant
f = 10 kHz
T_{amb} = 25 °C
V 513 P B
V 513 P A
Scattering limits
10
20
50
100
200
500 mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$


V 513 P
823038
I_v
T_{amb} = 25 °C
10 mcd
1
0.1
0.01
0.1
1
10 mA
I_F
V 513 P B
V 513 P A

V 510 P · V 511 P · V 512 P · V 513 P

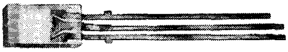




V 518 P

Bicolour symbol LED – 2.5 x 5 mm □

Orange-red – GaAsP on GaP
Green – GaP on GaP



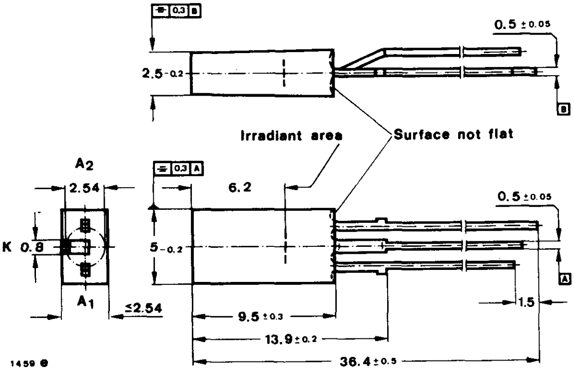
Application: General indicating purposes

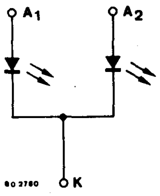
Features:

- Even luminance of the emitting surface
- Wide viewing angle
- High illuminance through reflector
- Very low cross talk in uninterrupted areas
- Ideal as flush mounted panel indicators
- Axial terminals
- Long life compared with filament lamps
- Vibration resistant
- Colour mixing possible due to separate anode terminals

Preliminary specifications

Dimensions in mm





A_1 orange-red
A_2 green

Angle of half intensity $\alpha = 80°$
Special case
Weight max. 0.42 g

Absolute maximum ratings

Reverse voltage	V_R	5	V
Forward current	I_{F1}, I_{F2}	30	mA
Forward surge current $t_p \leqq 10\,\mu s$	I_{FSM}	1	A
Power dissipation, with a single diode in operation $T_{amb} \leqq 55°C$	P_V	100	mW
Total power dissipation $T_{amb} \leqq 55°C$	P_{tot}	150	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−55 ... +100	°C
Soldering temperature, maximal $t \leqq 5$ s	T_{sd}[1]	260	°C

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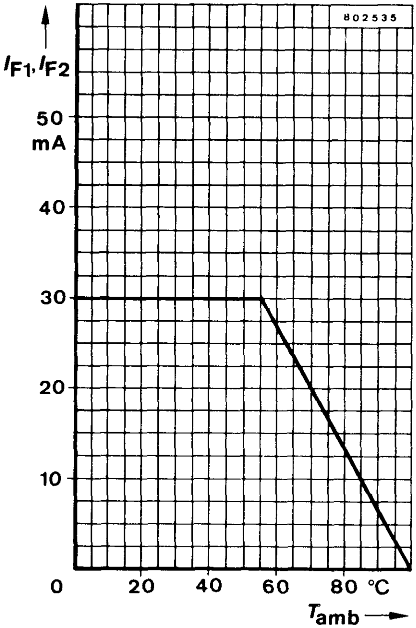
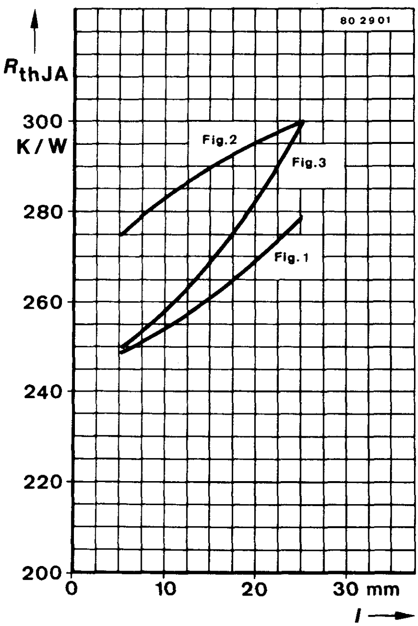
[1] Distance from the touching border ≥ 1.5 mm with intermediate PC-board

S 1.2.175/0781 E

V 518 P





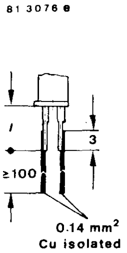


Fig.1

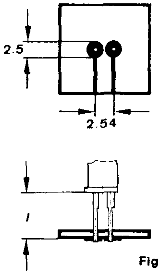


Fig.2

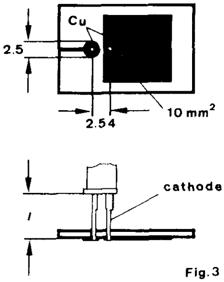
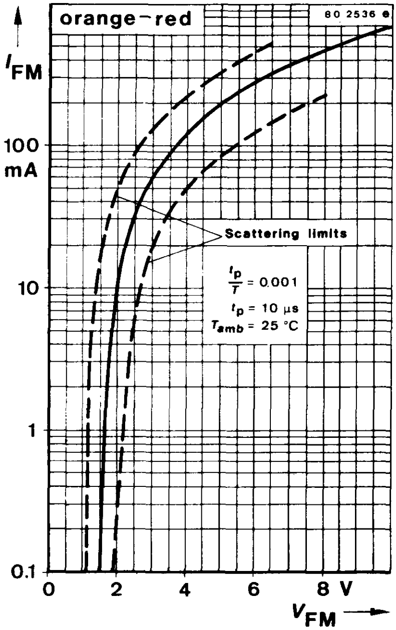
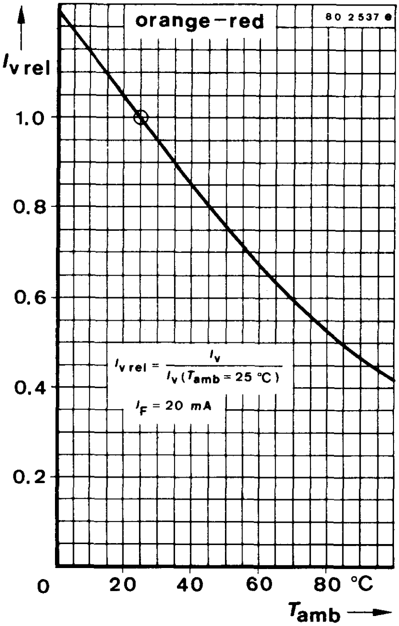


Fig.3

Thermal resistance			Min.	Typ.	Max.	
Junction ambient		R_{thJA}			300	K/W
Optical and electrical characteristics $T_{amb} = 25\,°C$						
Luminous intensity $I_F = 20$ mA		I_v*)	0.8	2		mcd
Matching factor $I_F = 20$ mA		$m = \frac{I_{vmin}}{I_{vmax}}$		0.75		
Peak wavelength emission	**orange-red**	λ_p		630		nm
	green	λ_p		560		nm
Spectral half bandwidth $I_F = 20$ mA		$\Delta\lambda$		40		nm
Forward voltage $I_F = 20$ mA	**orange-red**	V_F*)		2.2	3.0	V
	green	V_F*)		2.4	3.0	V
Breakdown voltage $I_R = 100\,\mu A$		$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0$, $f = 1$ MHz		C_j		50		pF





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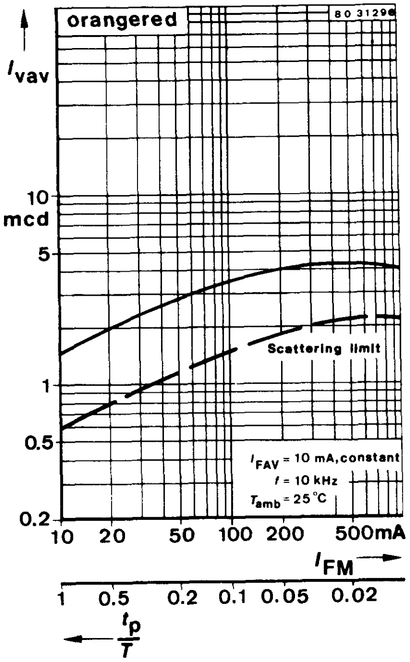
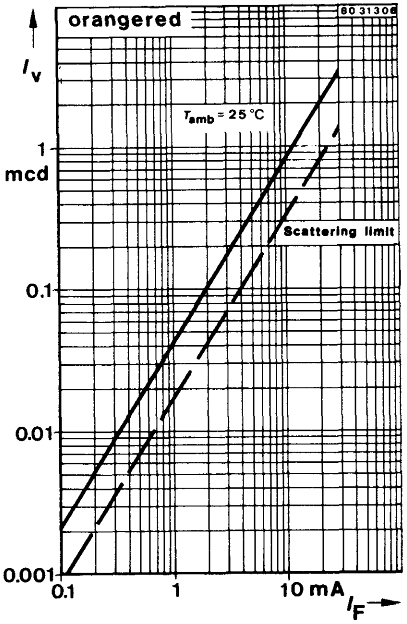
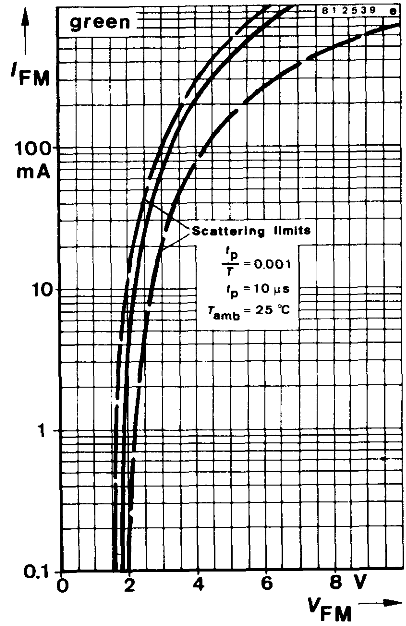
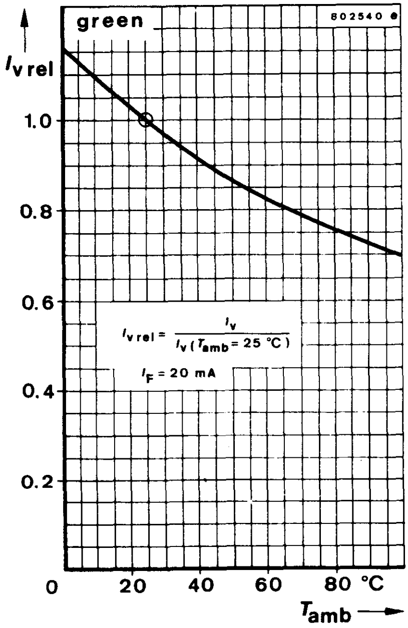
*) AQL = 0.65%

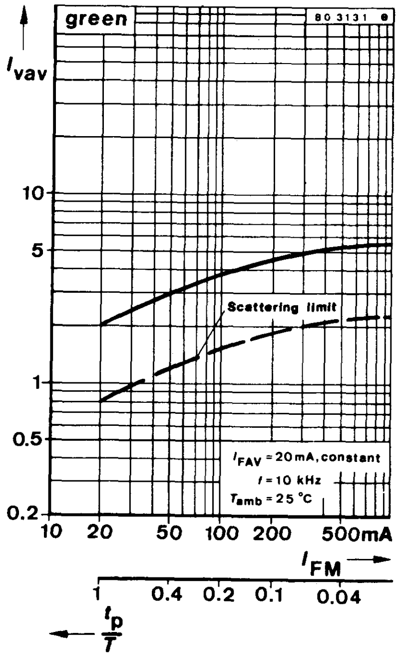
V 518 P

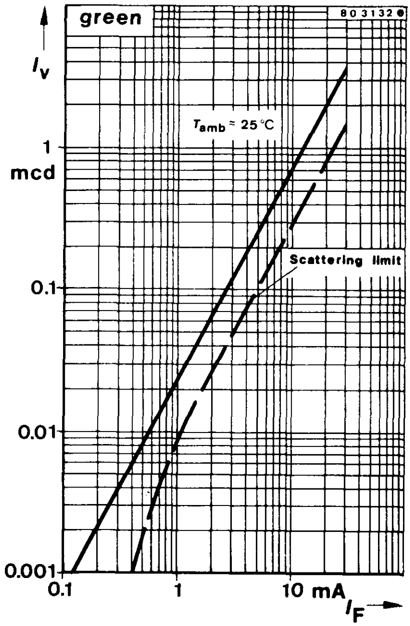

orangered
80 31296
I_{vav}
10 mcd
5
1
0.5
0.2
Scattering limit
I_{FAV} = 10 mA, constant
f = 10 kHz
T_{amb} = 25 °C
10 20 50 100 200 500 mA
I_{FM}
1 0.5 0.2 0.1 0.05 0.02
$\frac{t_p}{T}$

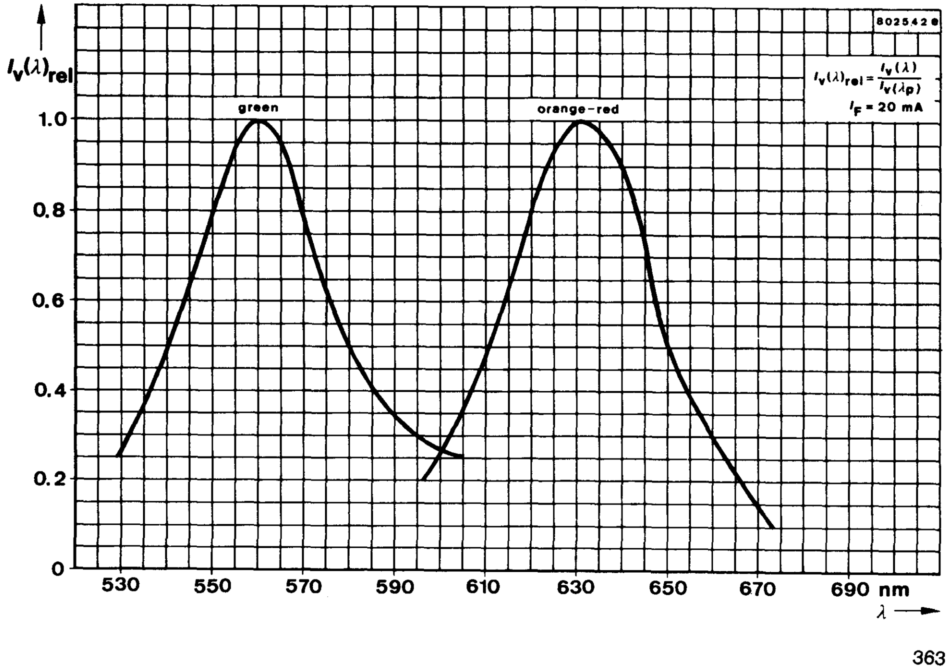

orangered
80 31306
I_v
1 mcd
0.1
0.01
0.001
T_{amb} = 25 °C
Scattering limit
0.1 1 10 mA
I_F


green
812539 e
I_{FM}
100 mA
10
1
0.1
Scattering limits
$\frac{t_p}{T}$ = 0.001
t_p = 10 µs
T_{amb} = 25 °C
0 2 4 6 8 V
V_{FM}

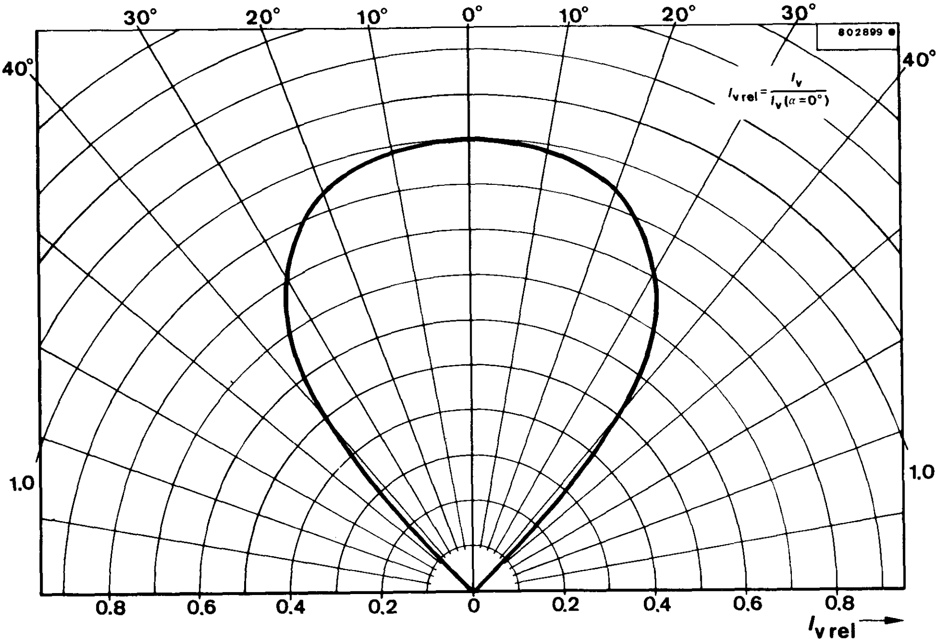

green
802540 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
$I_{v\,rel} = \frac{I_v}{I_v(T_{amb} = 25\ °C)}$
I_F = 20 mA
0 20 40 60 80 °C
T_{amb}


green
80 3131
I_{vav}
10
5
1
0.5
0.2
Scattering limit
I_{FAV} = 20 mA, constant
f = 10 kHz
T_{amb} = 25 °C
10
20
50
100
200
500 mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$


green
80 3132
I_v
1
mcd
0.1
0.01
0.001
T_{amb} = 25 °C
Scattering limit
0.1
1
10 mA
I_F

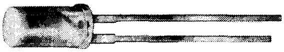

8025420
$I_v(\lambda)_{rel}$
$I_v(\lambda)_{rel} = \frac{I_v(\lambda)}{I_v(\lambda_p)}$
I_F = 20 mA
green
orange-red
1.0
0.8
0.6
0.4
0.2
0
530
550
570
590
610
630
650
670
690 nm
λ

V 518 P


30°
20°
10°
0°
10°
20°
30°
40°
40°
802899
$I_{v\,rel} = \frac{I_v}{I_v(\alpha = 0°)}$
1.0
1.0
0.8
0.6
0.4
0.2
0
0.2
0.4
0.6
0.8
$I_{v\,rel}$

V 520 P · V 521 P · V 522 P · V 523 P

Symbol LED – 5 mm O



Colour	Type	Technology	Angle of half intensity α
Red	**V 520 P**	GaAsP on GaAs	80°
Orange-red	**V 521 P**	GaAsP on GaP	80°
Green	**V 522 P**	GaP on GaP	80°
Yellow	**V 523 P**	GaAsP on GaP	80°

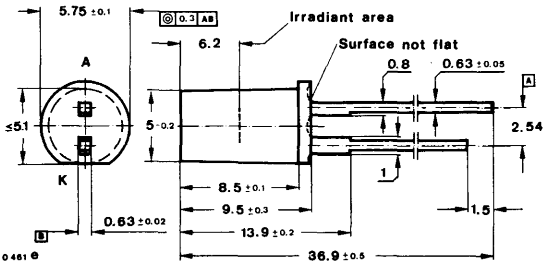
Applications: General indicating and illumination purposes

Features:

- Even luminance of the emitting surface
- Wide viewing angle
- High illuminance through reflector
- Very low cross talk in uninterrupted areas
- Ideal as flush mounted panel indicators
- Axial terminals
- Long life compared with filament lamps
- Vibration resistant

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 80°$

Special case
Weight max. 0.5 g

Absolute maximum ratings

Reverse voltage		V_R	5	V
Forward current	**V 520 P**	I_F	50	mA
	V 521 P, V 522 P, V 523 P	I_F	30	mA
Forward surge current $t_p \leq 10\,\mu s$		I_{FSM}	1	A

V 520 P · V 521 P · V 522 P · V 523 P

Power dissipation $T_{amb} \leq 70°C$	P_V	100	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−55 ... + 100	°C
Soldering temperature, maximal $t \leq 5$ s	T_{sd} [1])	260	°C

Thermal resistance		**Min.**	**Typ.**	**Max.**	
Junction ambient	R_{thJA}			300	K/W

Optical and electrical characteristics
$T_{amb} = 25°C$

Type	Group	Luminous intensity I_V*)²) (mcd)	Peak wavelength emission λ_p (nm) Typ.	Spectral half bandwidth $\Delta\lambda$ (nm) Typ.	Dominant wave length λ_D (nm) Typ.	Forward voltage V_F*) (V)
		$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA
V 520 P	A	min. 0.5 typ. 0.7	660	20	662	typ. 1.6 max. 2.0
	B	min. 0.7 typ. 1.0				
V 521 P	A	min. 1.3 typ. 2.0	630	40	625	typ. 2.2 max. 3.0
	B	min. 3.2 typ. 4.0				
V 522 P	A	min. 0.8 typ. 1.0	560	40	568	typ. 2.7 max. 3.2
	B	min. 2.0 typ. 3.0				
V 523 P	A	min. 0.8 typ. 1.0	590	40	588	typ. 2.4 max. 3.2
	B	min. 2.0 typ. 3.0				

		Min.	**Typ.**	**Max.**	
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz	C_j		50		pF

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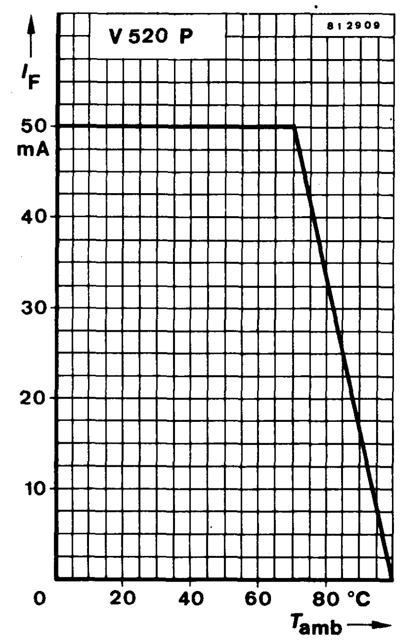
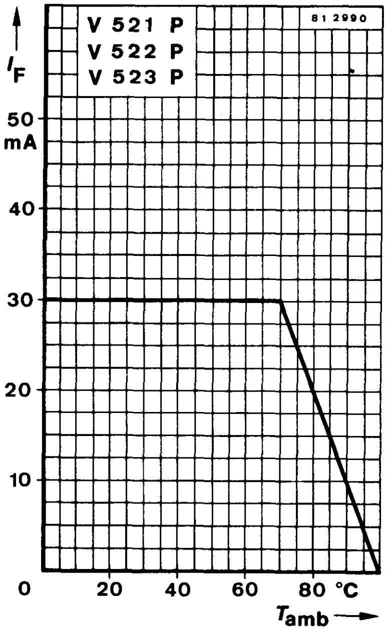
*) AQL = 0.65%

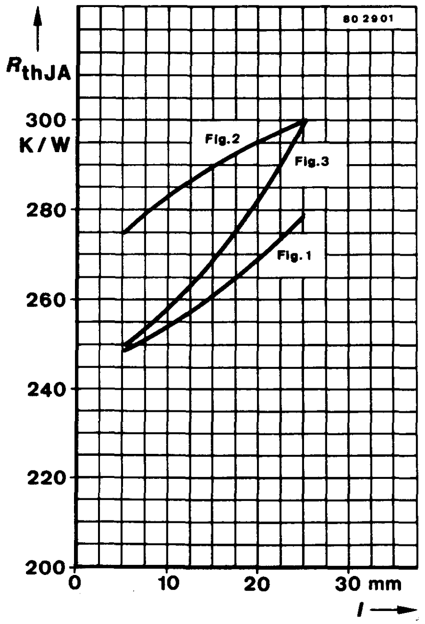
[1]) Distance from the touching border ≥ 1.5 mm with intermediate PC-board

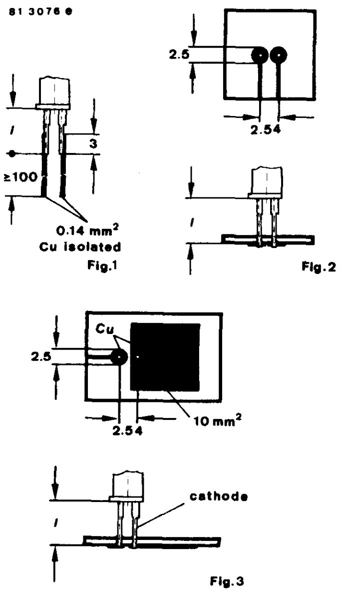
[2]) supplied selected in groups, luminous intensity in packing unit m = 0.5 ...1

V 520 P · V 521 P · V 522 P · V 523 P

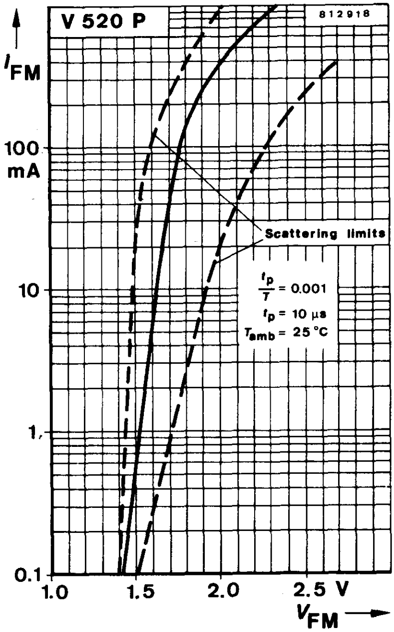


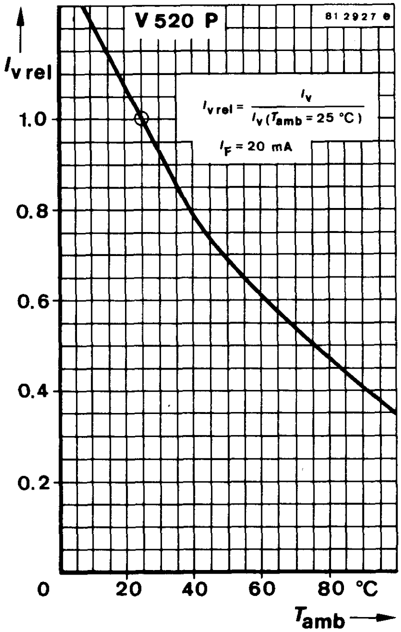


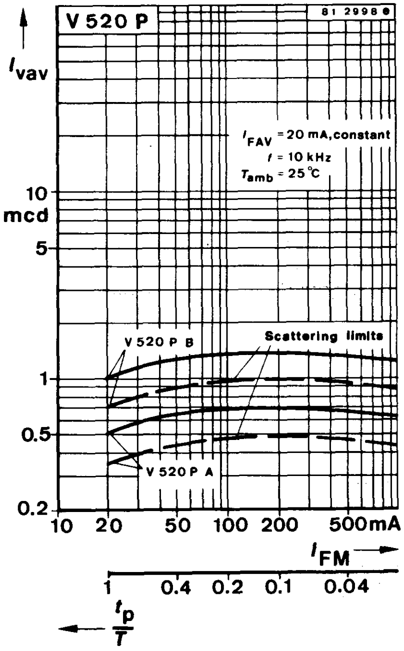


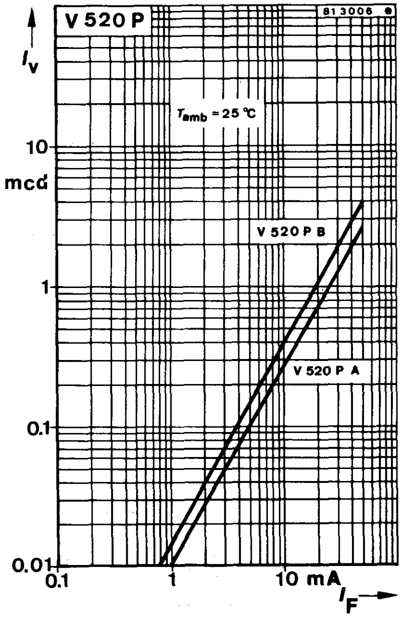


V 520 P · V 521 P · V 522 P · V 523 P

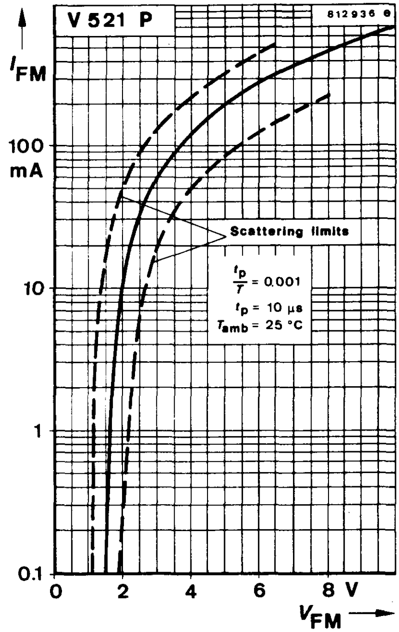


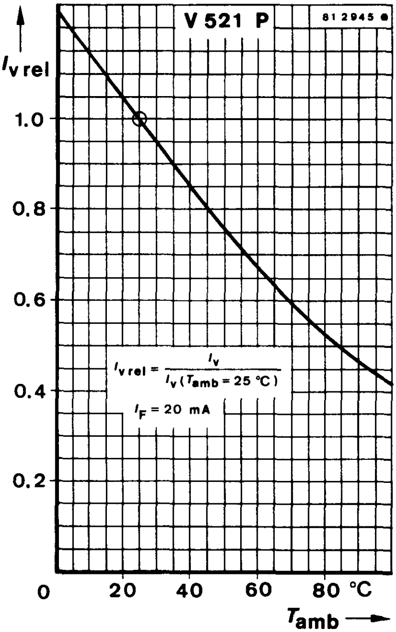


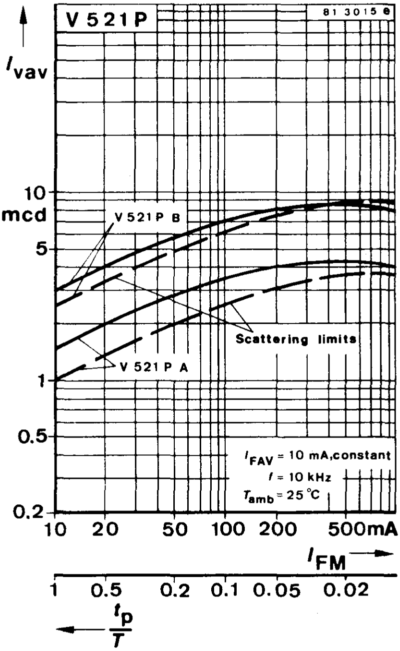


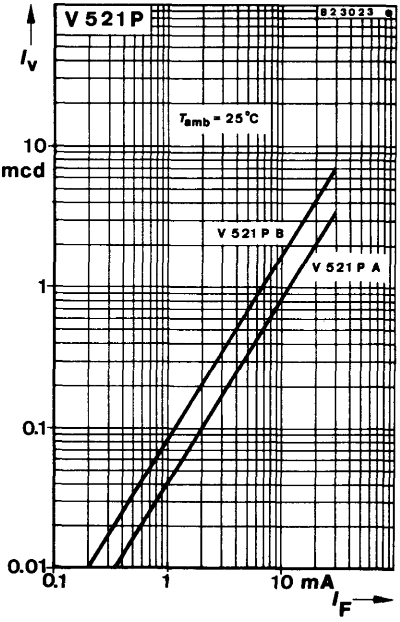


V 520 P · V 521 P · V 522 P · V 523 P

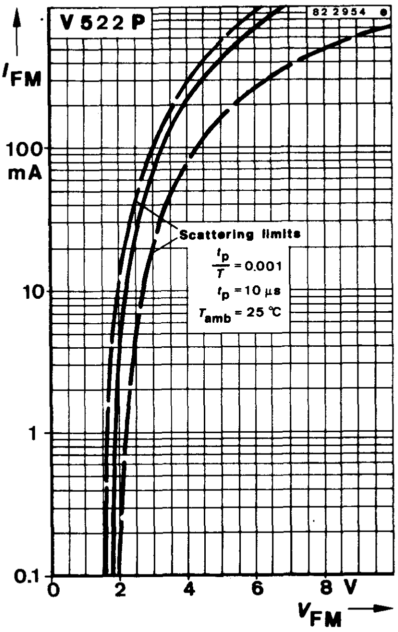


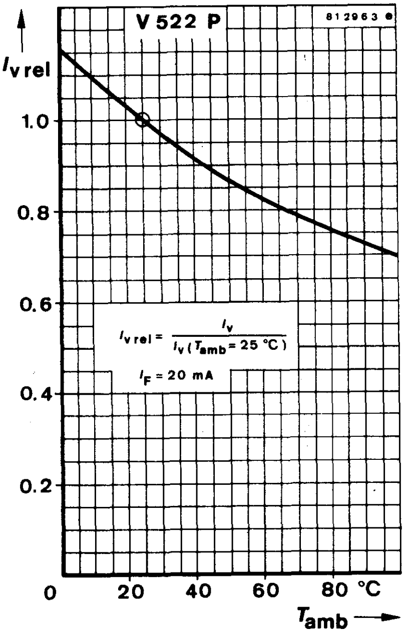


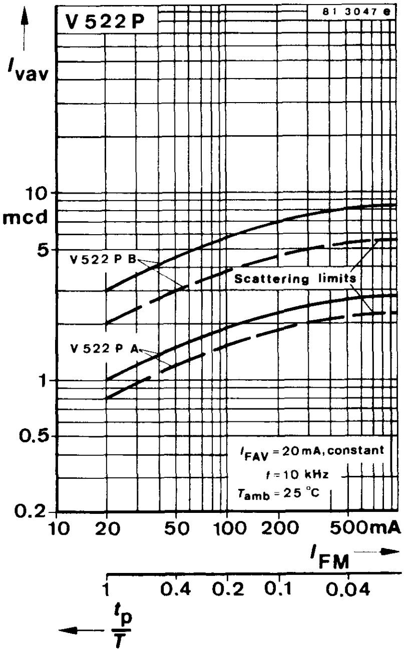


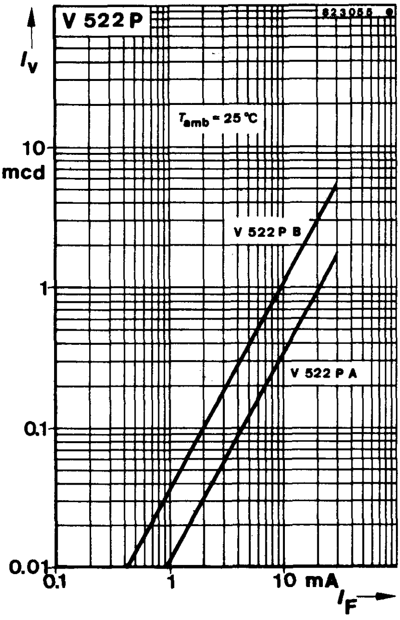


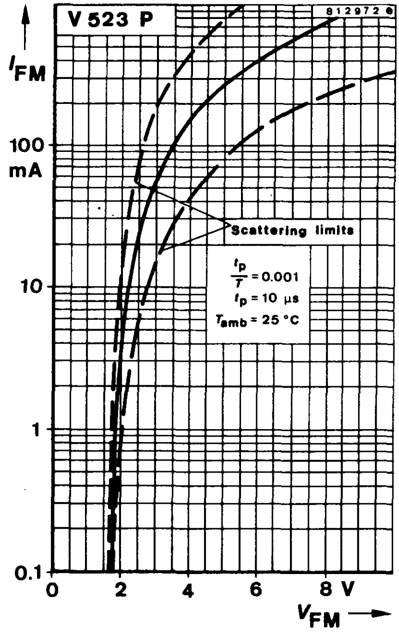
V 520 P · V 521 P · V 522 P · V 523 P

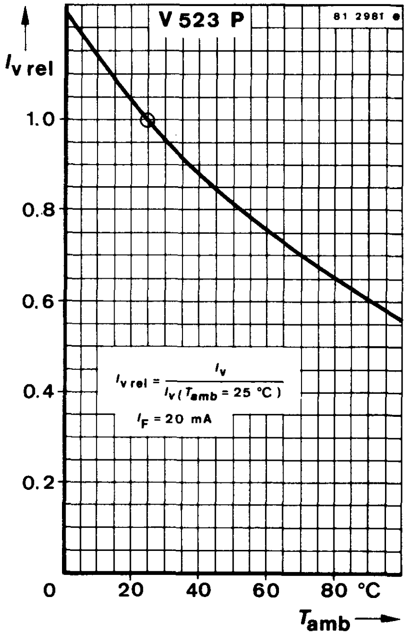


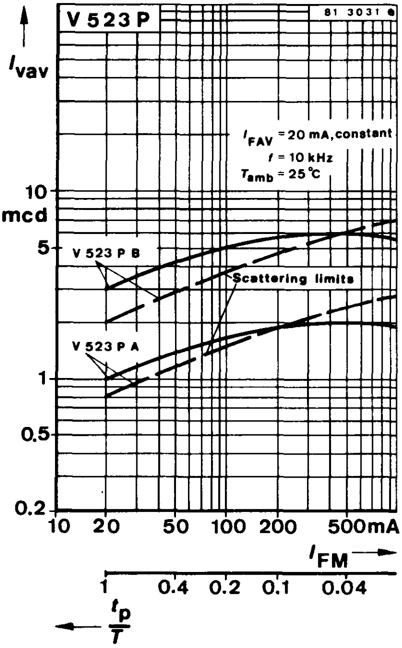


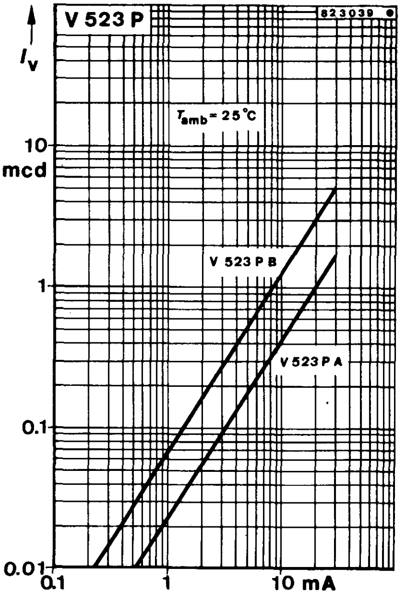




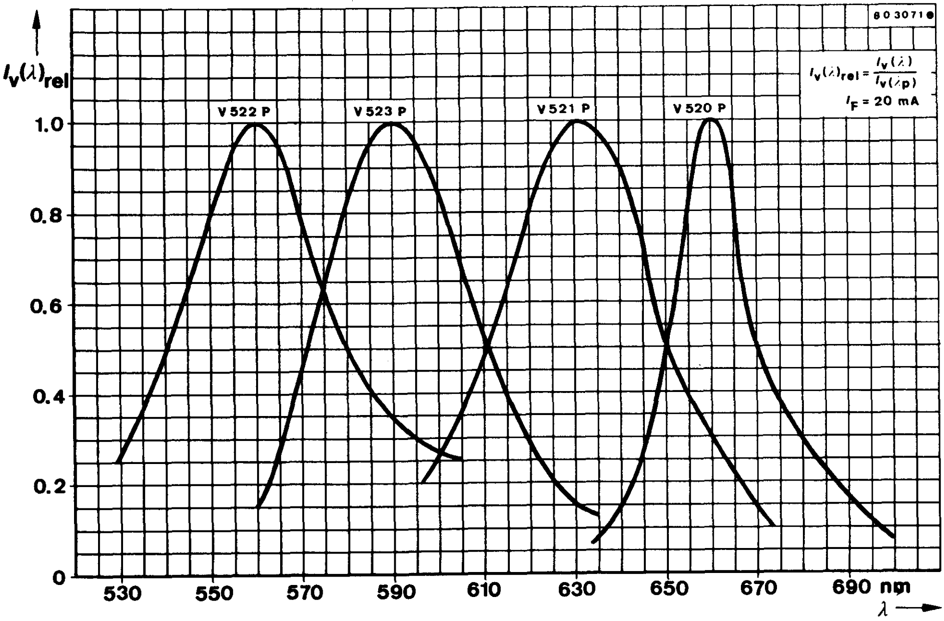

V 523 P
812972
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$

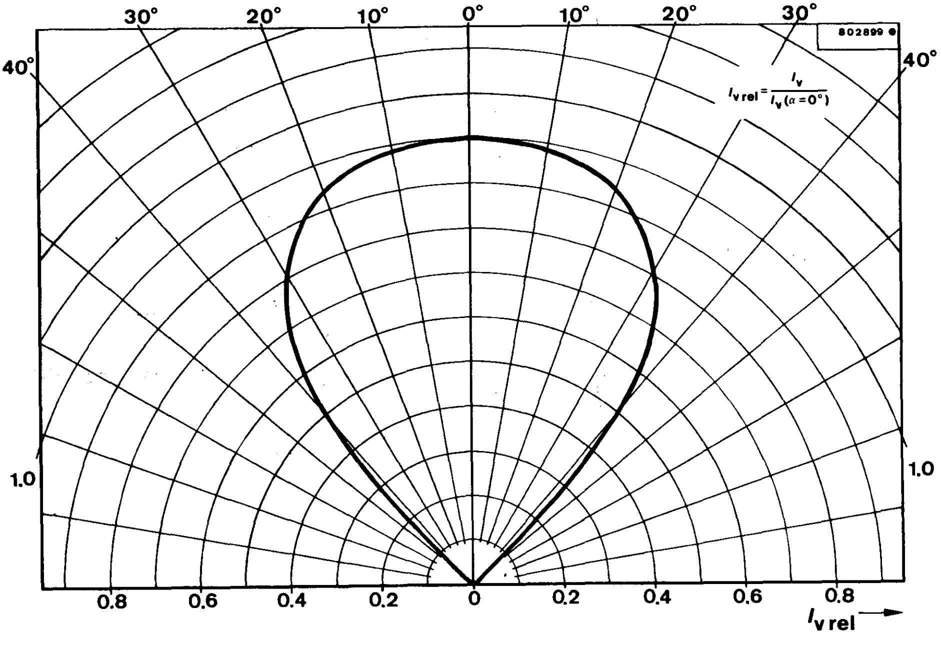

V 523 P
81 2981
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_{v\,(T_{amb} = 25\ °C)}}$
$I_F = 20\ mA$


V 523 P
81 3031
I_{vav}
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$
$I_{FAV} = 20\ mA$, constant
$f = 10\ kHz$
$T_{amb} = 25\ °C$
V 523 P B
V 523 P A
Scattering limits


V 523 P
823039
I_v
10 mcd
1
0.1
0.01
0.1
1
10 mA
I_F
$T_{amb} = 25\ °C$
V 523 P B
V 523 P A

V 520 P · V 521 P · V 522 P · V 523 P





V 530 P · V 531 P · V 532 P · V 533 P

Symbol LED – 5 mm □

Colour	Type	Technology	Angle of half intensity α
Red	**V 530 P**	GaAsP on GaAs	80°
Orange-red	**V 531 P**	GaAsP on GaP	80°
Green	**V 532 P**	GaP on GaP	80°
Yellow	**V 533 P**	GaAsP on GaP	80°

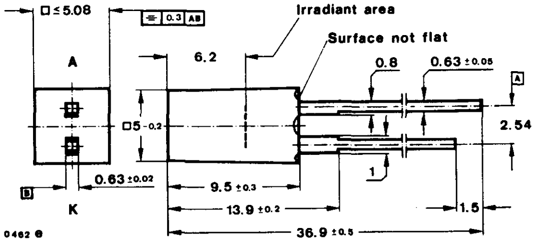
Applications: General indicating and illumination purposes

Features:

- Even luminance of the emitting surface
- Wide viewing angle
- High illuminance through reflector
- Very low cross talk in uninterrupted areas
- Ideal as flush mounted panel indicators
- Axial terminals
- Long life compared with filament lamps
- Vibration resistant

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 80°$

Special case
Weight max. 0.6 g

Absolute maximum ratings

Reverse voltage		V_R	5	V
Forward current	**V 530 P**	I_F	50	mA
	V 531 P, V 532 P, V 533 P	I_F	30	mA
Forward surge current $t_p \leq 10\,\mu s$		I_{FSM}	1	A

V 530 P · V 531 P · V 532 P · V 533 P

Power dissipation $T_{amb} \leq 70\,°C$	P_V	100	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−55 ... + 100	°C
Soldering temperature, maximal $t \leq 5$ s	T_{sd}[1]	260	°C

Thermal resistance		**Min.**	**Typ.**	**Max.**	
Junction ambient	R_{thJA}			300	K/W

Optical and electrical characteristics

$T_{amb} = 25\,°C$

Type	Group	Luminous intensity I_V*)[2] (mcd)	Peak wavelength emission λ_p (nm) Typ.	Spectral half bandwidth $\Delta\lambda$ (nm) Typ.	Dominant wave length λ_D (nm) Typ.	Forward voltage V_F*) (V)
		$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA
V 530 P	A	min. 0.5 typ. 0.7	660	20	662	typ. 1.6 max. 2.0
	B	min. 0.7 typ. 1.0				
V 531 P	A	min. 1.3 typ. 2.0	630	40	625	typ. 2.2 max. 3.0
	B	min. 3.2 typ. 4.0				
V 532 P	A	min. 0.8 typ. 1.0	560	40	568	typ. 2.7 max. 3.2
	B	min. 2.0 typ. 3.0				
V 533 P	A	min. 0.8 typ. 1.0	590	40	588	typ. 2.4 max. 3.2
	B	min. 2.0 typ. 3.0				

		Min.	**Typ.**	**Max.**	
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz	C_j		50		pF

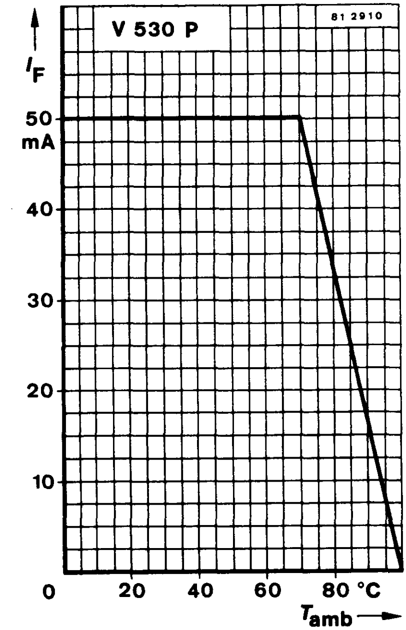
---

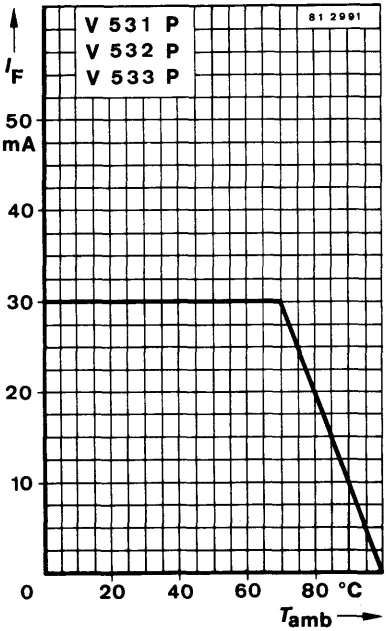
*) AQL = 0.65%

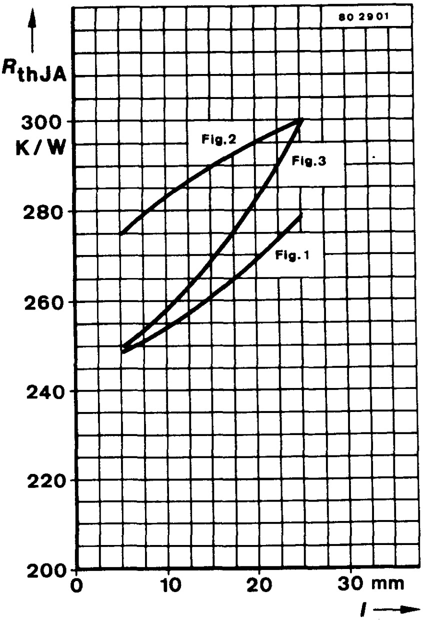
[1] Distance from the touching border ≥ 1.5 mm with intermediate PC-board

[2] supplied selected in groups, luminous intensity in packing unit m = 0.5 ... 1

V 530 P · V 531 P · V 532 P · V 533 P







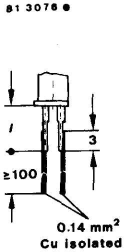


Fig.1

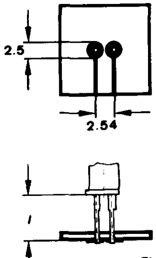


Fig.2

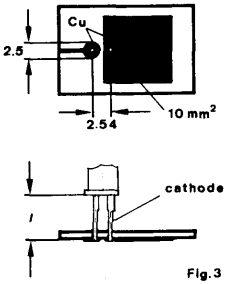
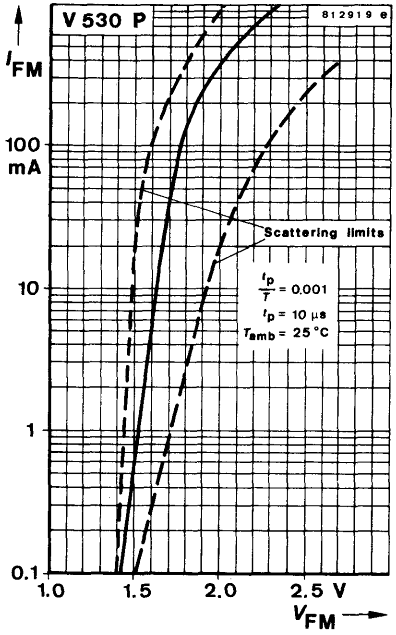
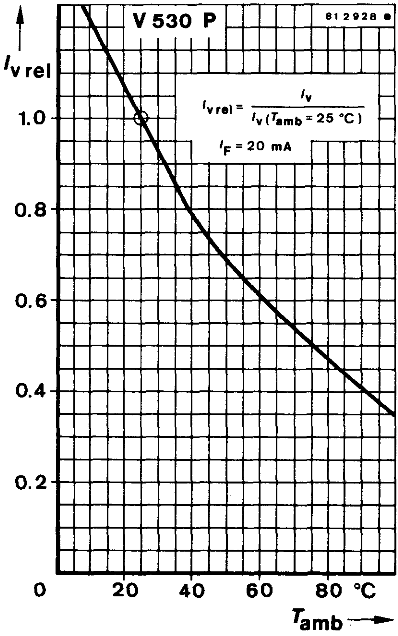
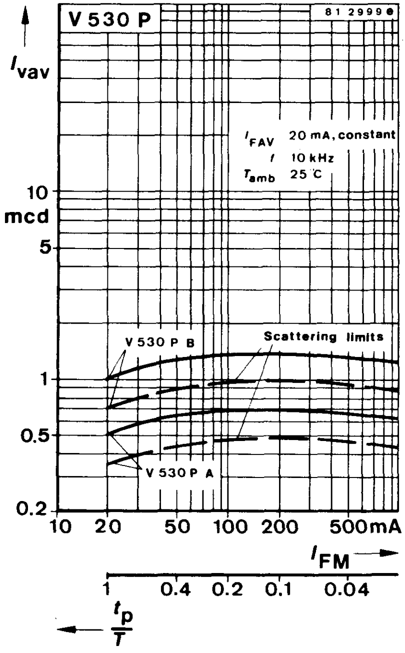


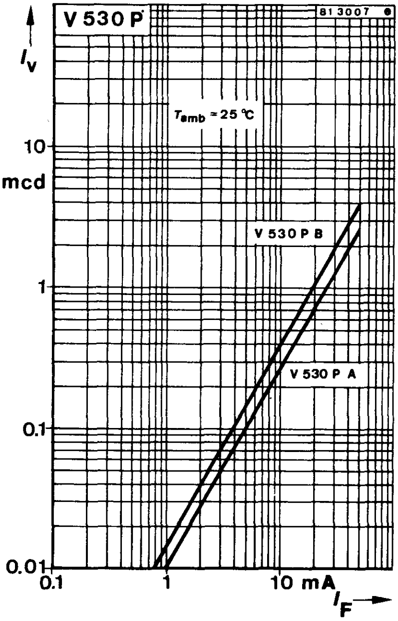
Fig.3

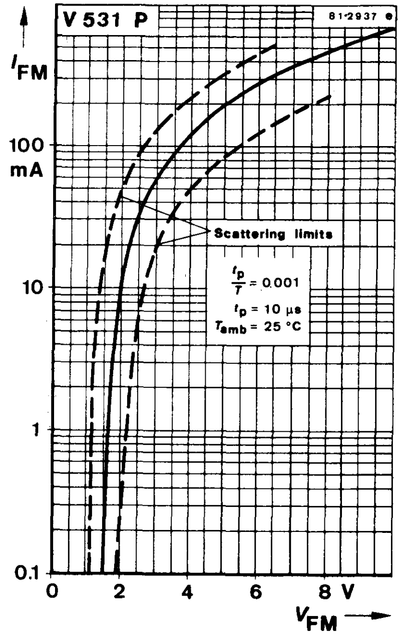
V 530 P · V 531 P · V 532 P · V 533 P

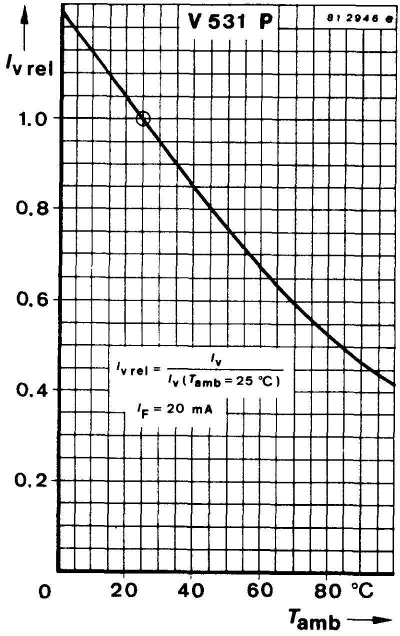


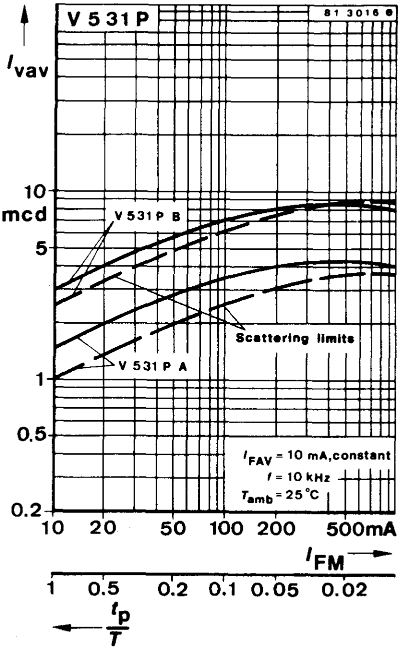


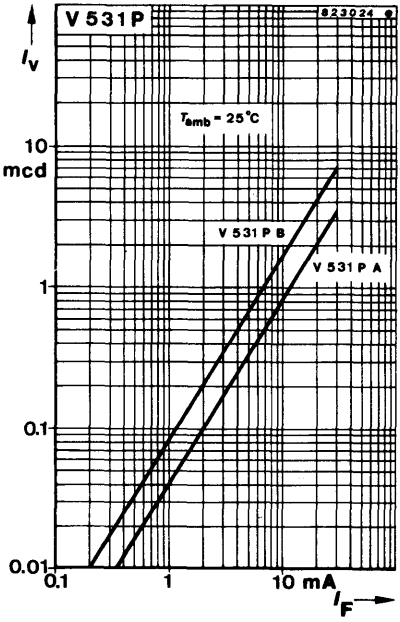




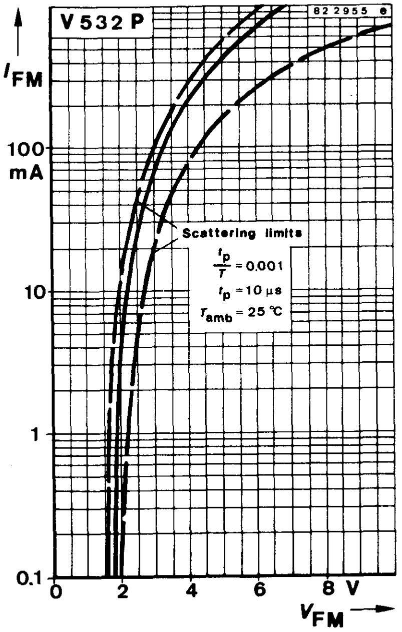

V 531 P
81-2937 e
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T}$ = 0.001
t_p = 10 µs
T_{amb} = 25 °C

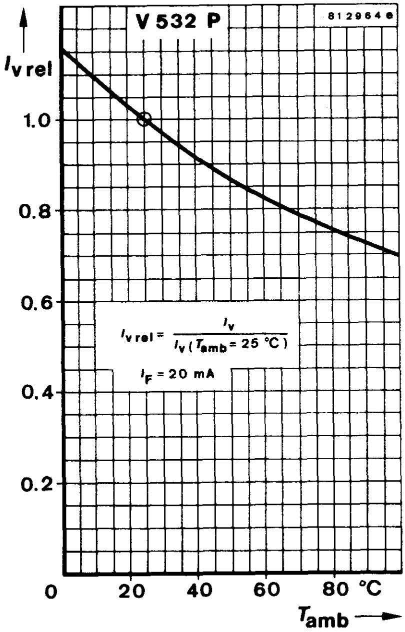

V 531 P
81 2946 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v\,(T_{amb} = 25\,°C)}$
I_F = 20 mA

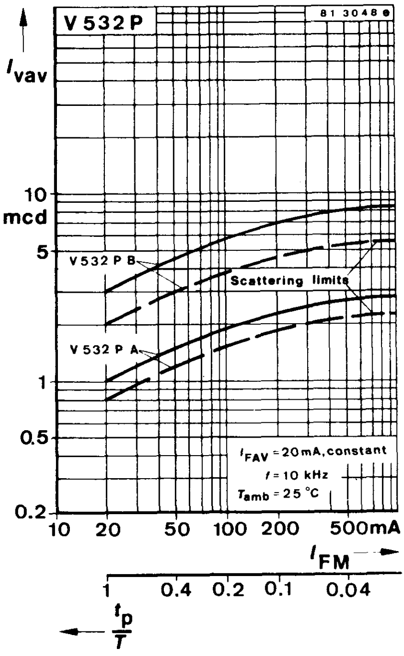

V 531 P
81 3016 e
I_{vav}
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500mA
I_{FM}
1
0.5
0.2
0.1
0.05
0.02
$\frac{t_p}{T}$
V 531 P B
V 531 P A
Scattering limits
I_{FAV} = 10 mA,constant
f = 10 kHz
T_{amb} = 25 °C

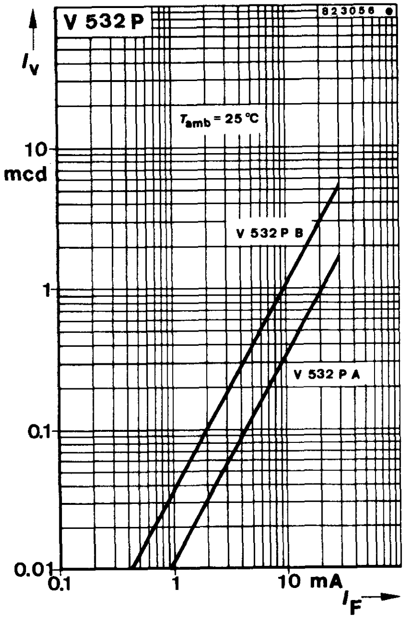

V 531 P
823024 e
I_v
10 mcd
1
0.1
0.01
0.1
1
10 mA
I_F
T_{amb} = 25 °C
V 531 P B
V 531 P A

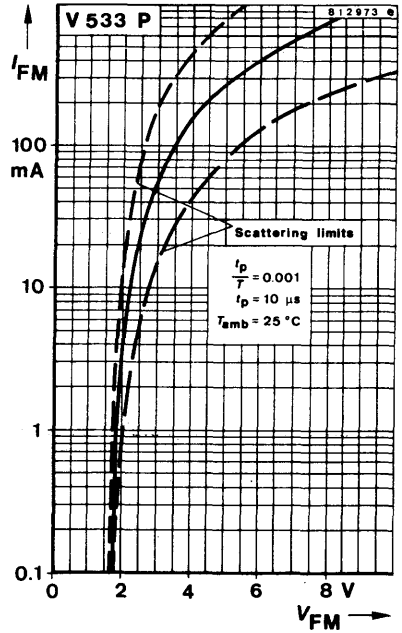
V 530 P · V 531 P · V 532 P · V 533 P

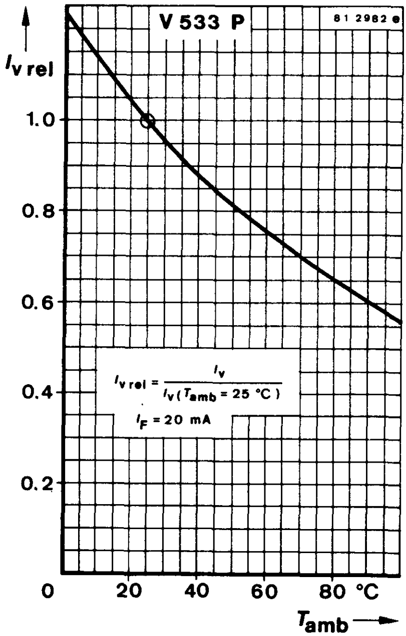


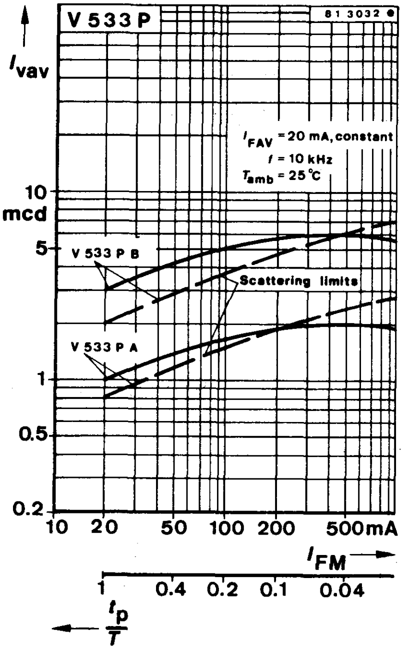


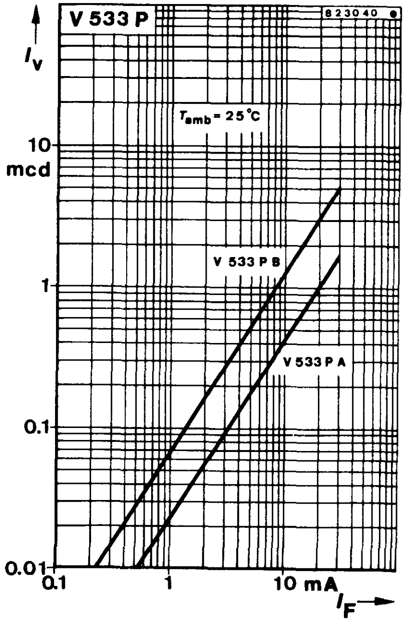




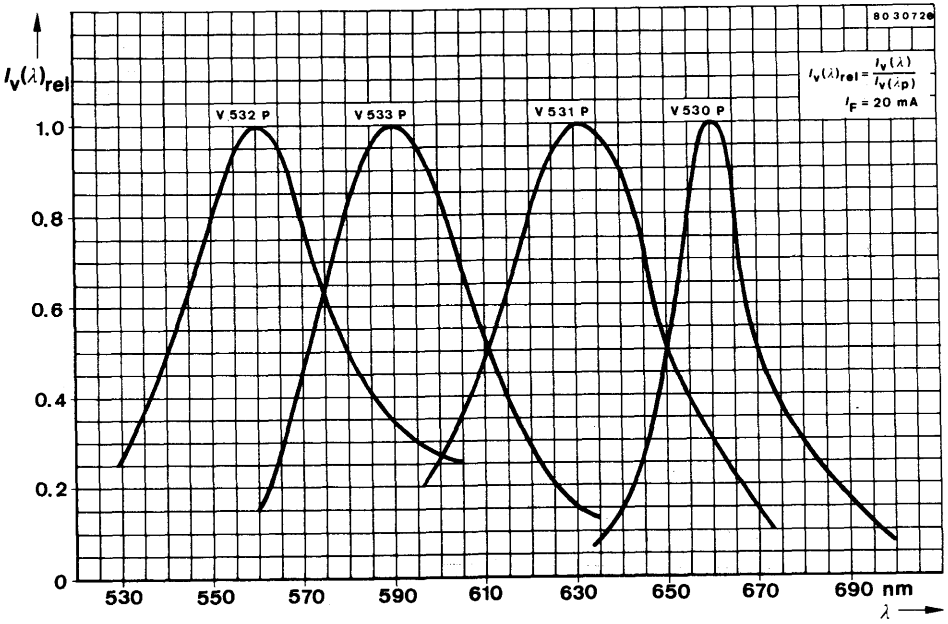

V 533 P
812973
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10$ µs
$T_{amb} = 25$ °C

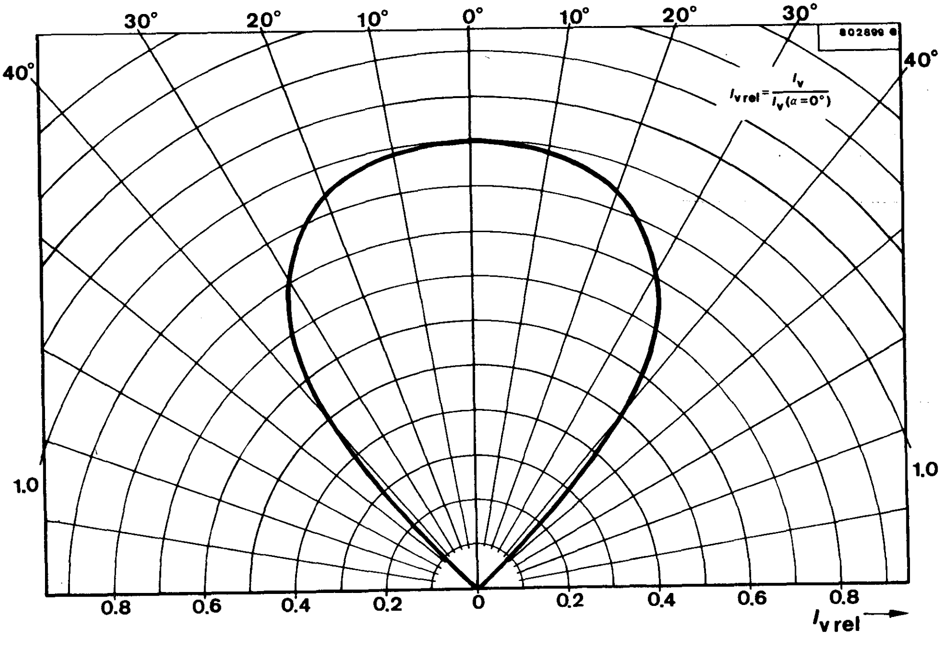

V 533 P
81 2982
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v(T_{amb} = 25\ °C)}$
$I_F = 20$ mA


V 533 P
81 3032
I_{vav}
10 mcd
5
1
0.5
0.2
V 533 P B
V 533 P A
Scattering limits
$I_{FAV} = 20$ mA, constant
$f = 10$ kHz
$T_{amb} = 25$ °C
10
20
50
100
200
500 mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$


V 533 P
823040
I_v
$T_{amb} = 25$ °C
10 mcd
1
0.1
0.01
V 533 P B
V 533 P A
0.1
1
10 mA
I_F

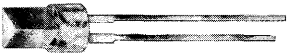
V 530 P · V 531 P · V 532 P · V 533 P





V 540 P · V 541 P · V 542 P · V 543 P

Symbol LED – 5 mm △



Colour	Type	Technology	Angle of half intensity α
Red	**V 540 P**	GaAsP on GaAs	80°
Orange-red	**V 541 P**	GaAsP on GaP	80°
Green	**V 542 P**	GaP on GaP	80°
Yellow	**V 543 P**	GaAsP on GaP	80°

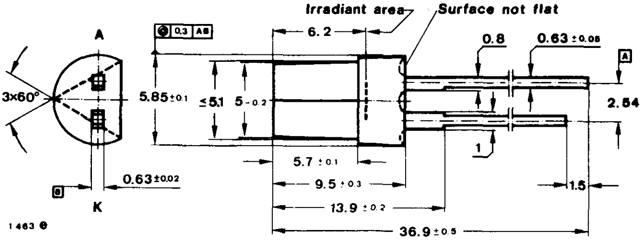
Applications: General indicating and illumination purposes

Features:

- Even luminance of the emitting surface
- Wide viewing angle
- High illuminance through reflector
- Very low cross talk in uninterrupted areas
- Ideal as flush mounted panel indicators
- Axial terminals
- Long life compared with filament lamps
- Vibration resistant

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 80°$

Special case
Weight max. 0.5 g

Absolute maximum ratings

Reverse voltage		V_R	5	V
Forward current	**V 540 P**	I_F	50	mA
	V 541 P, V 542 P, V 543 P	I_F	30	mA
Forward surge current $t_p \leq 10\,\mu s$		I_{FSM}	1	A

V 540 P · V 541 P · V 542 P · V 543 P

Power dissipation $T_{amb} \leq 70\,°C$	P_V	100	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−55 ... + 100	°C
Soldering temperature, maximal $t \leq 5$ s	T_{sd}[1]	260	°C

Thermal resistance		**Min.**	**Typ.**	**Max.**	
Junction ambient	R_{thJA}			300	K/W

Optical and electrical characteristics

$T_{amb} = 25\,°C$

Type	Group	Luminous intensity I_V*)[2] (mcd)	Peak wavelength emission λ_p (nm) Typ.	Spectral half bandwidth $\Delta\lambda$ (nm) Typ.	Dominant wave length λ_D (nm) Typ.	Forward voltage V_F*) (V)
		$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA
V 540 P	A B	min. 0.5 typ. 0.7 min. 0.7 typ. 1.0	660	20	662	typ. 1.6 max. 2.0
V 541 P	A B	min. 1.3 typ. 2.0 min. 3.2 typ. 4.0	630	40	625	typ. 2.2 max. 3.0
V 542 P	A B	min. 0.8 typ. 1.0 min. 2.0 typ. 3.0	560	40	568	typ. 2.7 max. 3.2
V 543 P	A B	min. 0.8 typ. 1.0 min. 2.0 typ. 3.0	590	40	588	typ. 2.4 max. 3.2

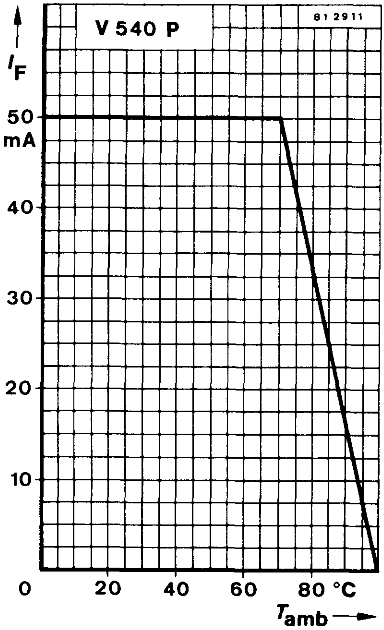
		Min.	**Typ.**	**Max.**	
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1$ MHz	C_j		50		pF

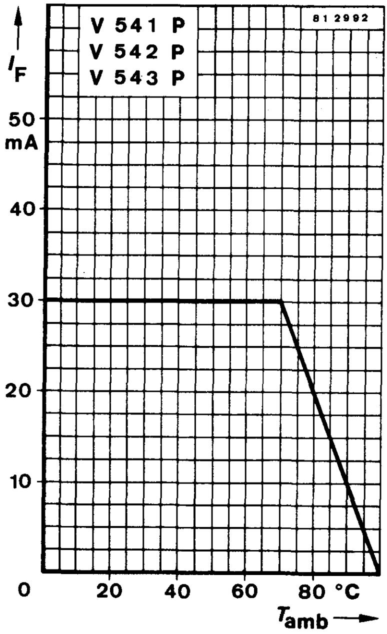
---

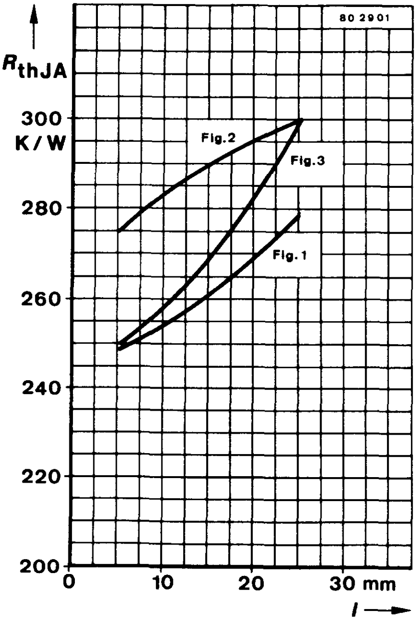
*) AQL = 0.65%

[1] Distance from the touching border ≥ 1.5 mm with intermediate PC-board

[2] supplied selected in groups, luminous intensity in packing unit m = 0.5 ... 1







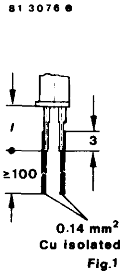


Fig.1

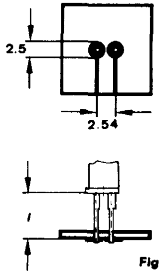


Fig.2

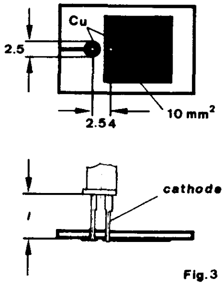
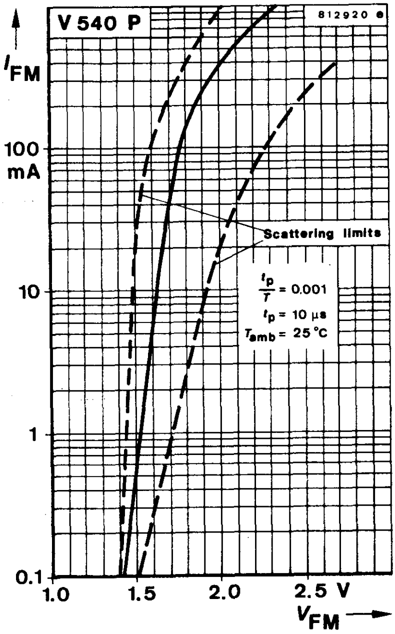
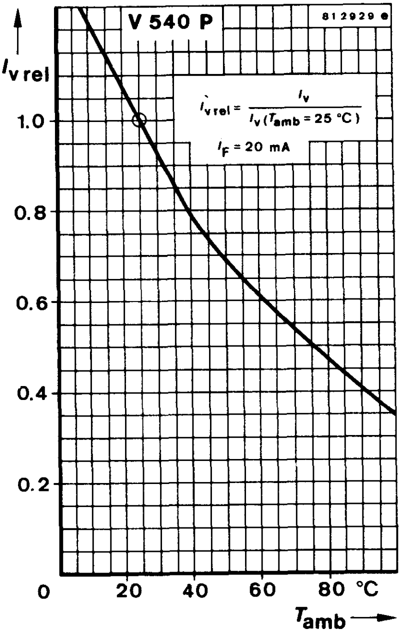
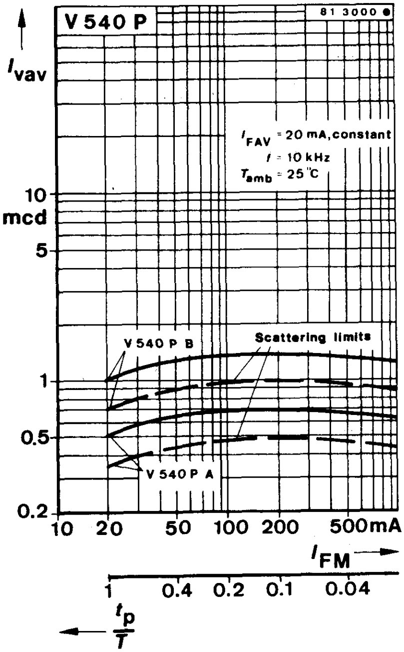


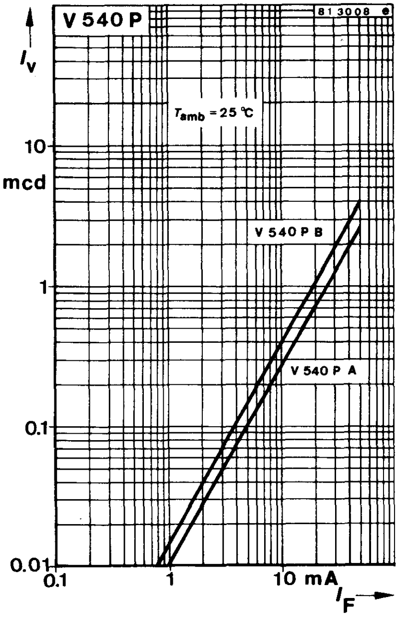
Fig.3

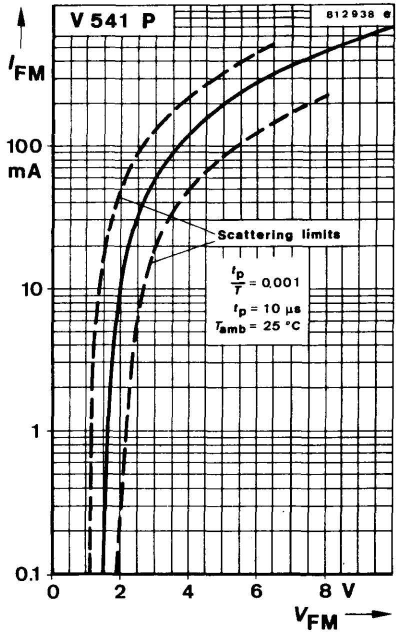
V 540 P · V 541 P · V 542 P · V 543 P

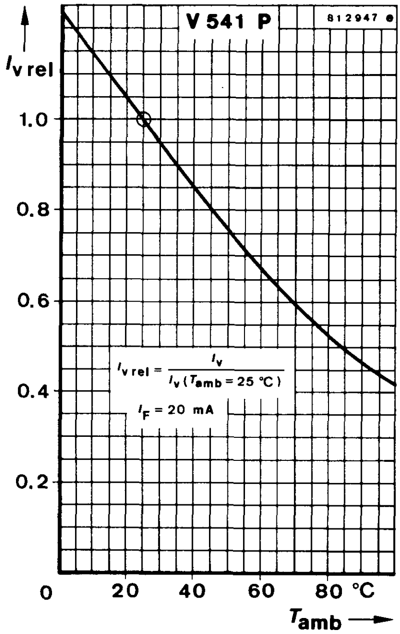


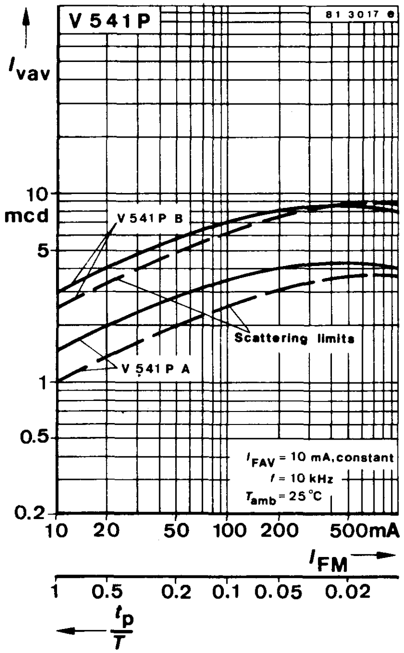


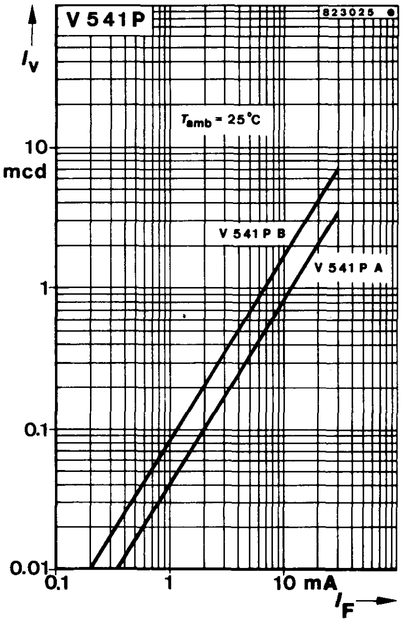




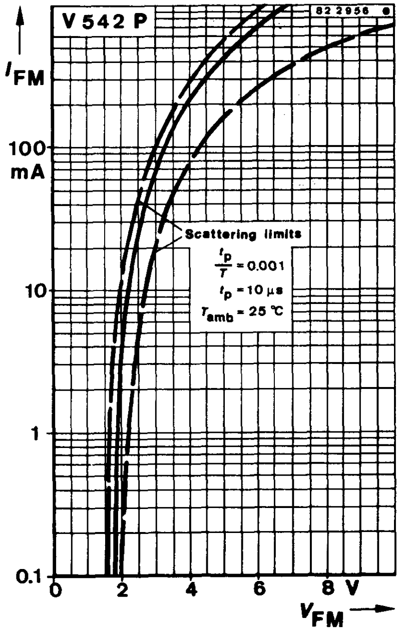

V 541 P
812938 e
I_{FM}
100 mA
10
1
0.1
0 2 4 6 8 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$

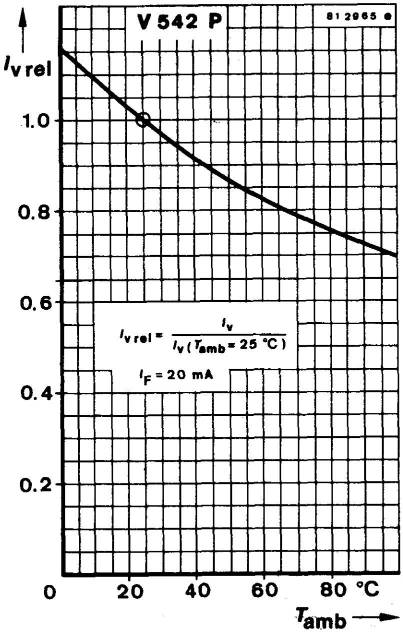

V 541 P
812947 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0 20 40 60 80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v\,(T_{amb} = 25\ °C)}$
$I_F = 20\ mA$

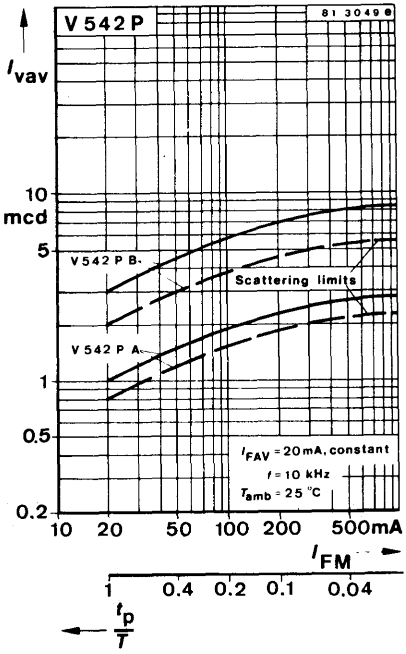

V 541P
81 3017 e
I_{vav}
10 mcd
5
1
0.5
0.2
V 541 P B
Scattering limits
V 541 P A
$I_{FAV} = 10\ mA$, constant
$f = 10\ kHz$
$T_{amb} = 25\ °C$
10 20 50 100 200 500mA
I_{FM}
1 0.5 0.2 0.1 0.05 0.02
$\frac{t_p}{T}$

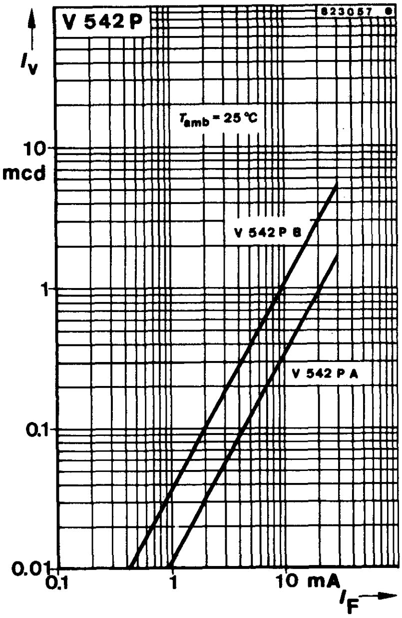

V 541P
823025 e
I_v
$T_{amb} = 25\ °C$
10 mcd
1
0.1
0.01
V 541 P B
V 541 P A
0.1 1 10 mA
I_F

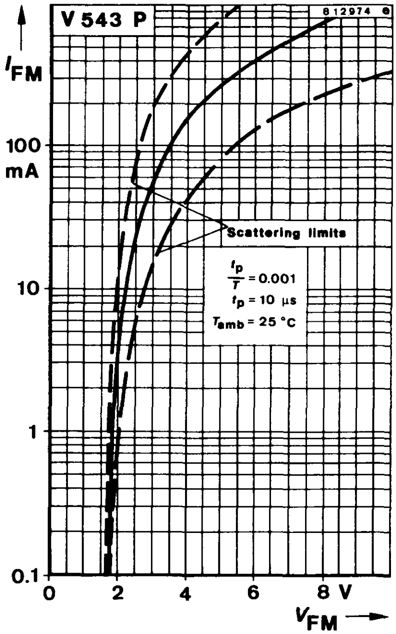
V 540 P · V 541 P · V 542 P · V 543 P

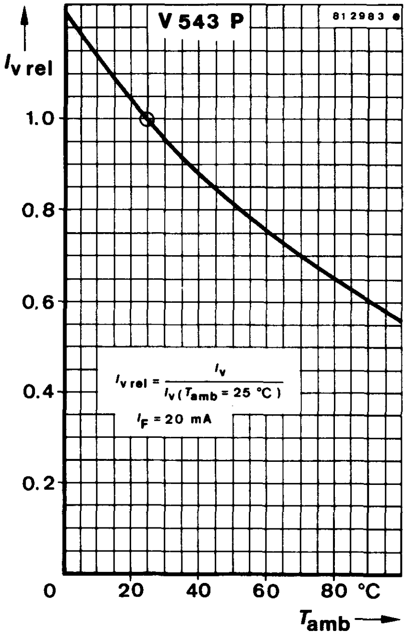


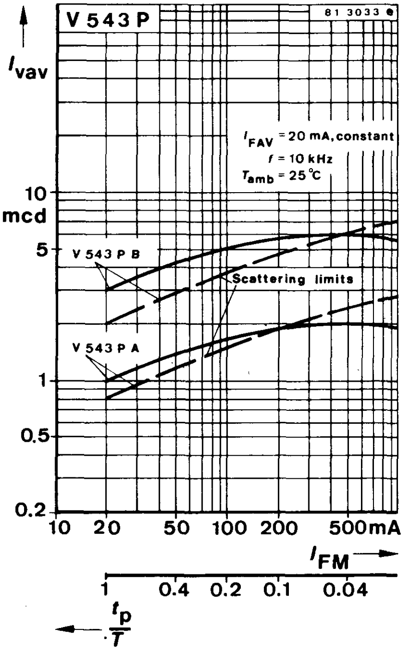


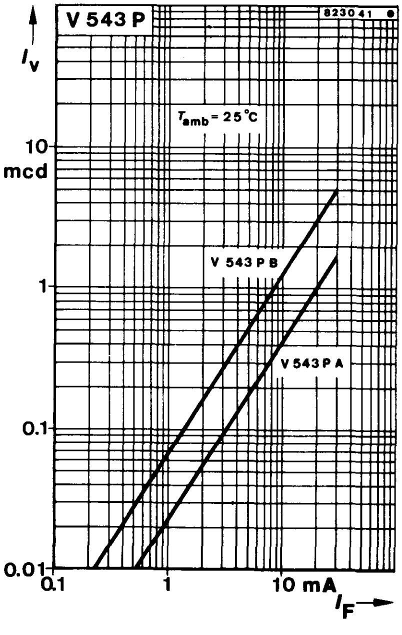




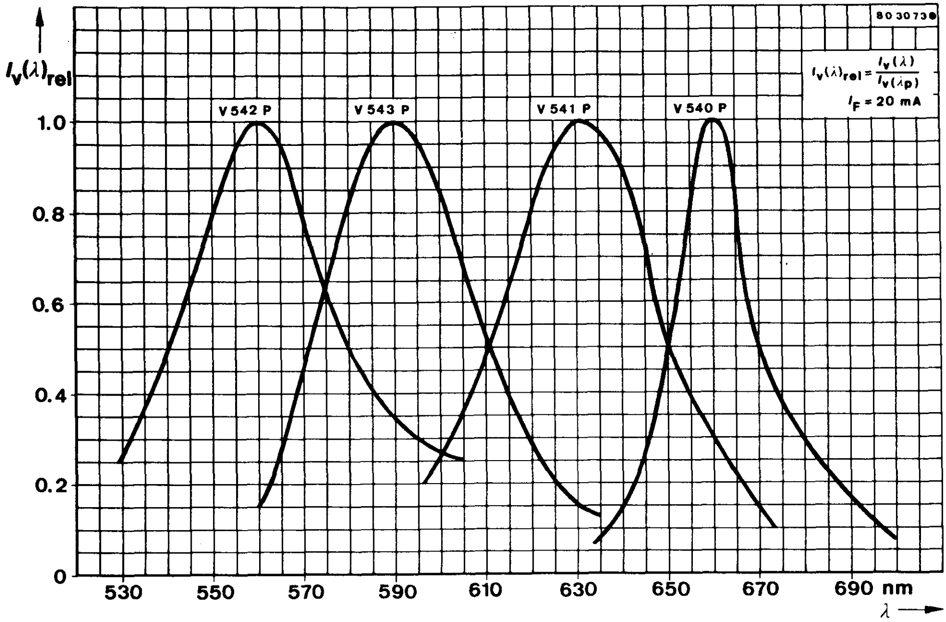

V 543 P
812974
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$

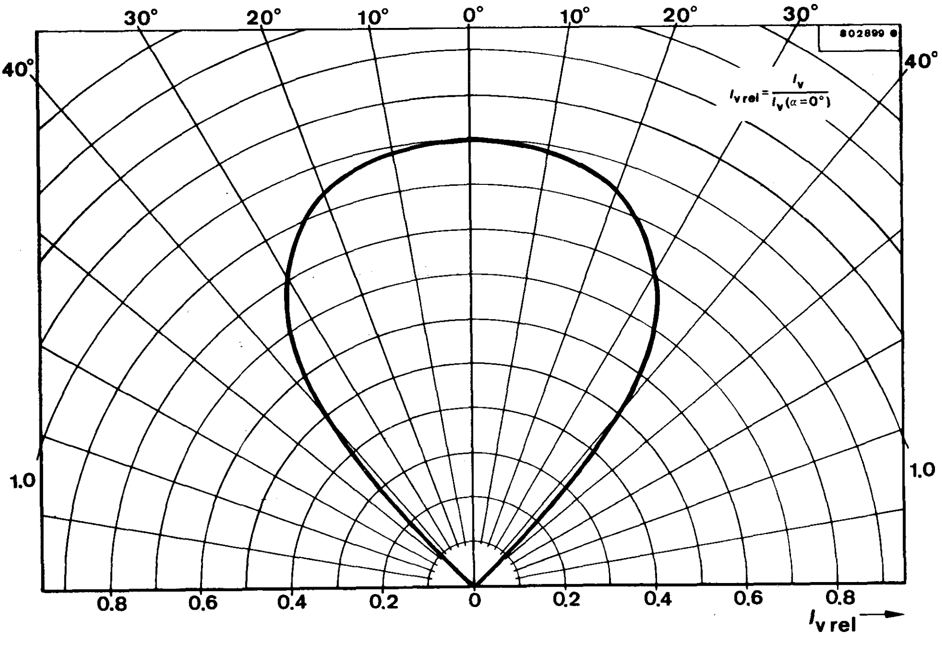

V 543 P
812983
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v(T_{amb} = 25\ °C)}$
$I_F = 20$ mA


V 543 P
81 3033
I_{vav}
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$
$I_{FAV} = 20$ mA, constant
$f = 10$ kHz
$T_{amb} = 25\ °C$
V 543 P B
V 543 P A
Scattering limits


V 543 P
823041
I_v
10 mcd
1
0.1
0.01
0.1
1
10 mA
I_F
$T_{amb} = 25\ °C$
V 543 P B
V 543 P A

V 540 P · V 541 P · V 542 P · V 543 P





V 550 P · V 551 P · V 552 P · V 553 P

Symbol LED – 5 mm Δ

Colour	Type	Technology	Angle of half intensity α
Red	**V 550 P**	GaAsP on GaAs	80°
Orange-red	**V 551 P**	GaAsP on GaP	80°
Green	**V 552 P**	GaP on GaP	80°
Yellow	**V 553 P**	GaAsP on GaP	80°

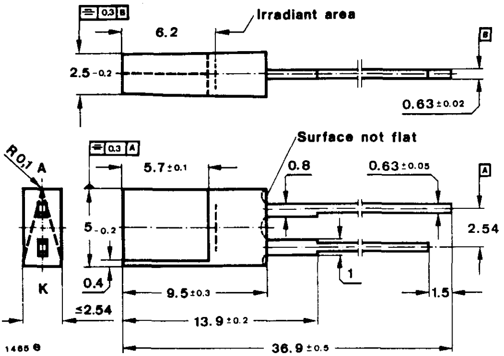
Applications: General indicating and illumination purposes

Features:

- Even luminance of the emitting surface
- Wide viewing angle
- High illuminance through reflector
- Very low cross talk in uninterrupted areas
- Ideal as flush mounted panel indicators
- Axial terminals
- Long life compared with filament lamps
- Vibration resistant

Preliminary specifications

Dimensions in mm



Angle of half intensity $\alpha = 80°$

Special case
Weight max. 0.4 g

Absolute maximum ratings

Reverse voltage		V_R	5	V
Forward current	**V 550 P**	I_F	50	mA
	V 551 P, V 552 P, V 553 P	I_F	30	mA
Forward surge current $t_p \leq 10\,\mu s$		I_{FSM}	1	A

V 550 P · V 551 P · V 552 P · V 553 P

Power dissipation $T_{amb} \leq 70\,°C$	P_V	100	mW
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−55 ... +100	°C
Soldering temperature, maximal $t \leq 5\,s$	T_{sd} 1)	260	°C

Thermal resistance		**Min.**	**Typ.**	**Max.**	
Junction ambient	R_{thJA}			300	K/W

Optical and electrical characteristics
$T_{amb} = 25\,°C$

Type	Group	Luminous intensity I_V*) 2) (mcd)	Peak wavelength emission λ_p (nm) Typ.	Spectral half bandwidth $\Delta\lambda$ (nm) Typ.	Dominant wave length λ_D (nm) Typ.	Forward voltage V_F*) (V)
		$I_F = 20\,mA$	$I_F = 20\,mA$	$I_F = 20\,mA$	$I_F = 20\,mA$	$I_F = 20\,mA$
V 550 P	A	min. 0.5 typ. 0.7	660	20	662	typ. 1.6 max. 2.0
	B	min. 0.7 typ. 1.0				
V 551 P	A	min. 1.3 typ. 2.0	630	40	625	typ. 2.2 max. 3.0
	B	min. 3.2 typ. 4.0				
V 552 P	A	min. 0.8 typ. 1.0	560	40	568	typ. 2.7 max. 3.2
	B	min. 2.0 typ. 3.0				
V 553 P	A	min. 0.8 typ. 1.0	590	40	588	typ. 2.4 max. 3.2
	B	min. 2.0 typ. 3.0				

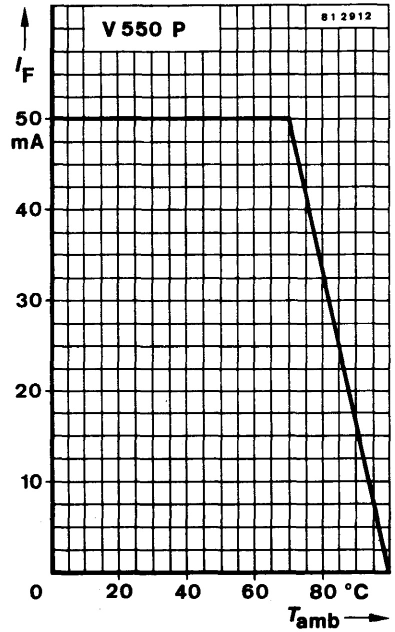
		Min.	**Typ.**	**Max.**	
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V
Junction capacitance $V_R = 0, f = 1\,MHz$	C_j		50		pF

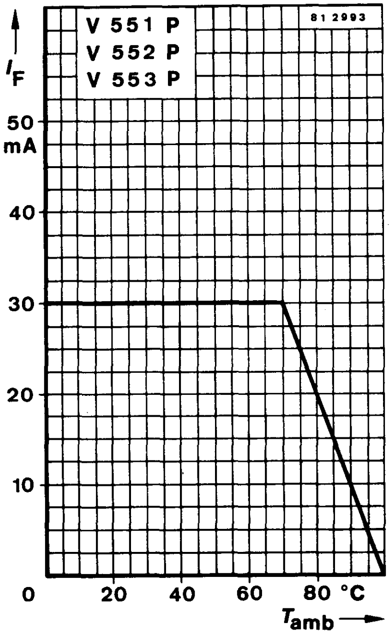
---

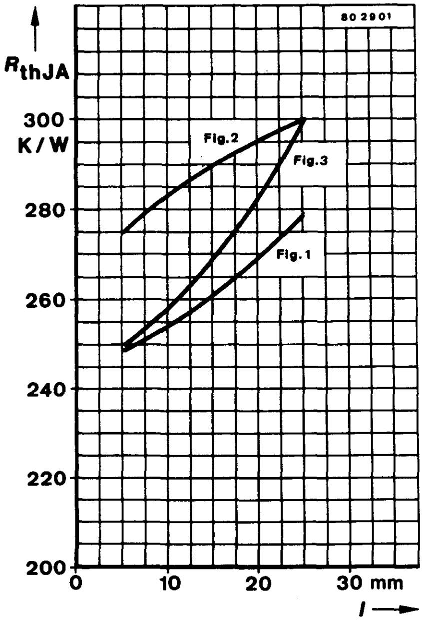
*) AQL = 0.65%

1) Distance from the touching border ≥ 1.5 mm with intermediate PC-board

2) supplied selected in groups, luminous intensity in packing unit m = 0.5 ... 1







81 3076

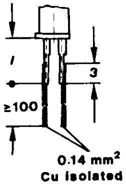


Fig.1

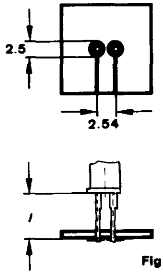


Fig.2

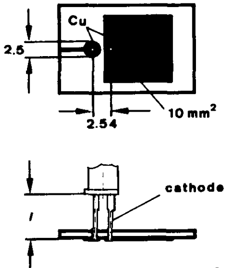
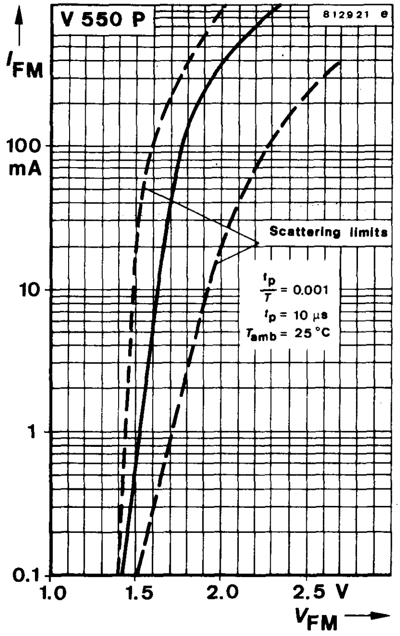
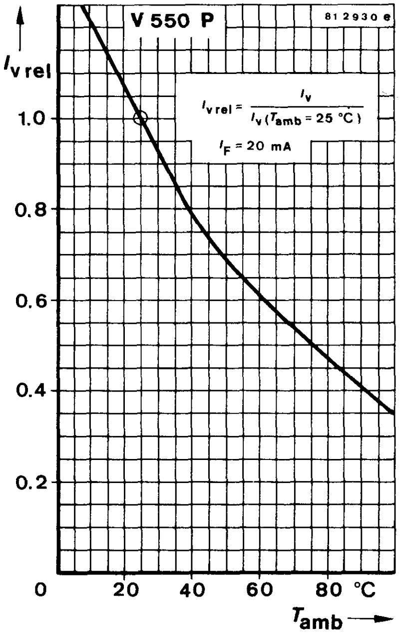
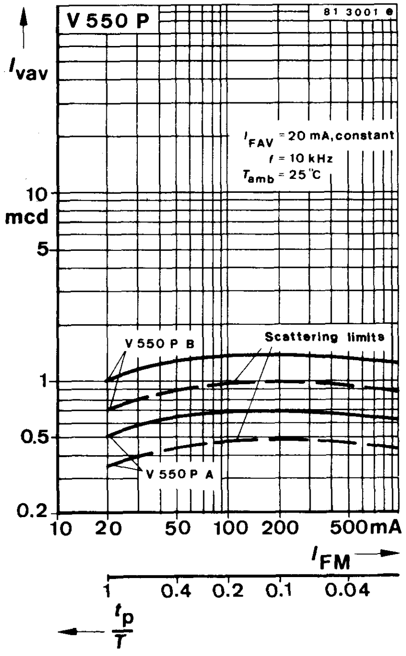


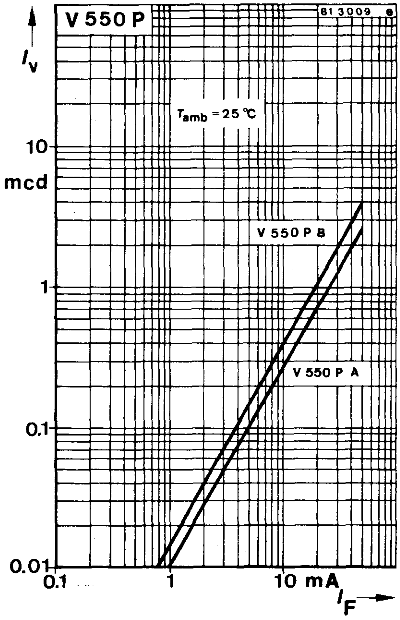
Fig.3

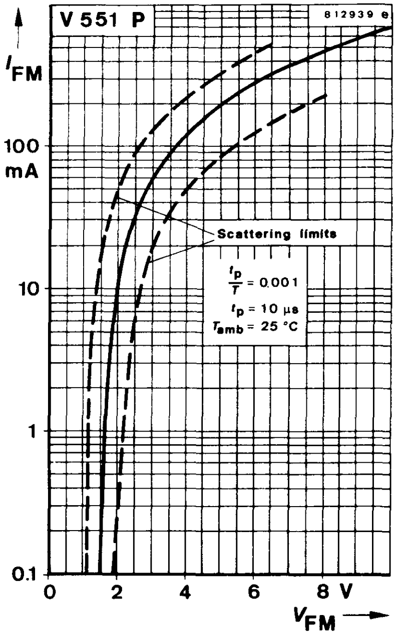
V 550 P · V 551 P · V 552 P · V 553 P

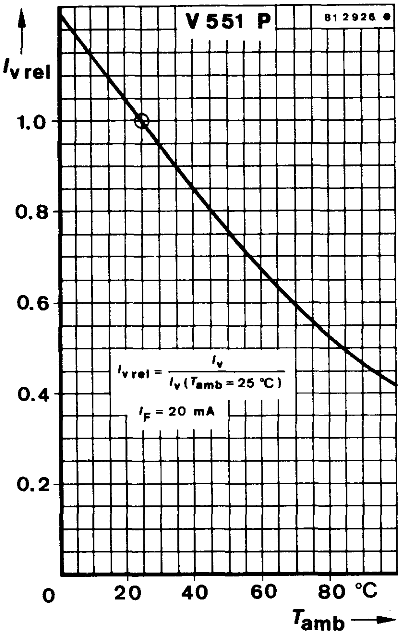


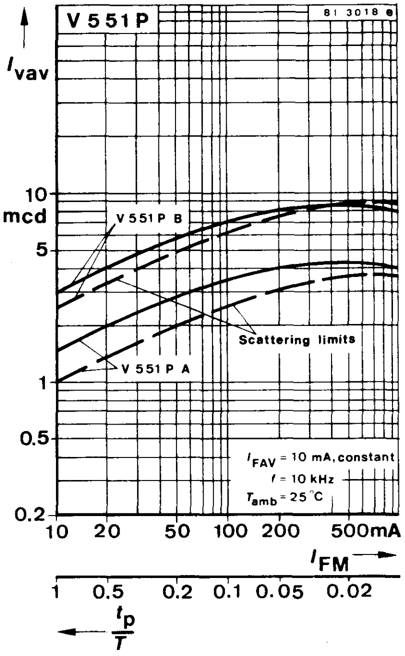


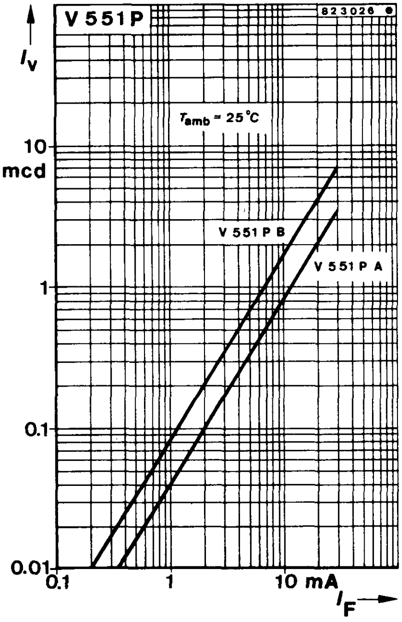




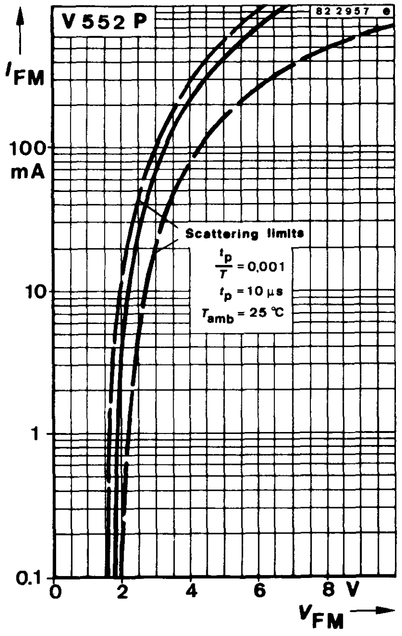

V 551 P
812939 e
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$

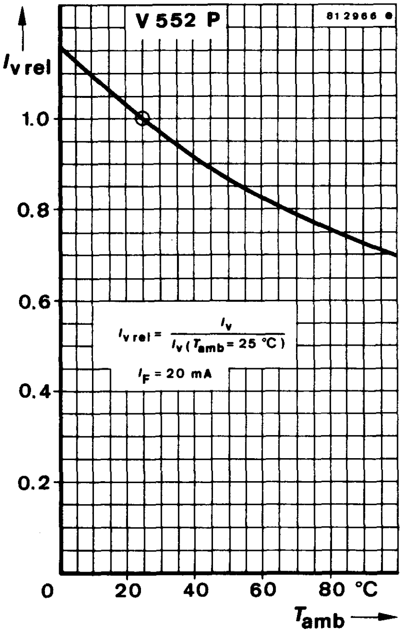

V 551 P
812926 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v\,(T_{amb} = 25\ °C)}$
$I_F = 20\ mA$

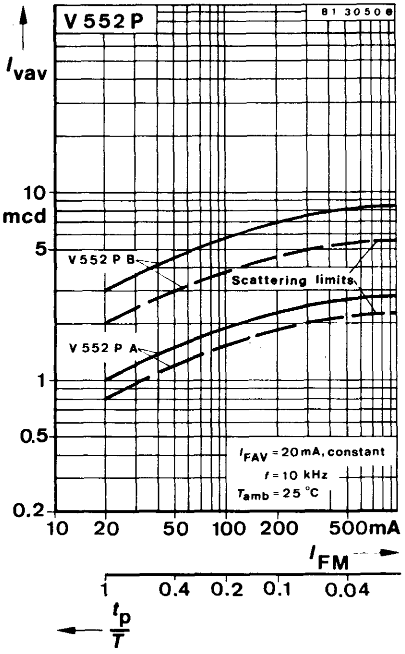

V 551 P
81 3018 e
I_{vav}
10 mcd
5
1
0.5
0.2
V 551 P B
V 551 P A
Scattering limits
$I_{FAV} = 10\ mA$, constant
$f = 10\ kHz$
$T_{amb} = 25\ °C$
10
20
50
100
200
500mA
I_{FM}
1
0.5
0.2
0.1
0.05
0.02
$\frac{t_p}{T}$

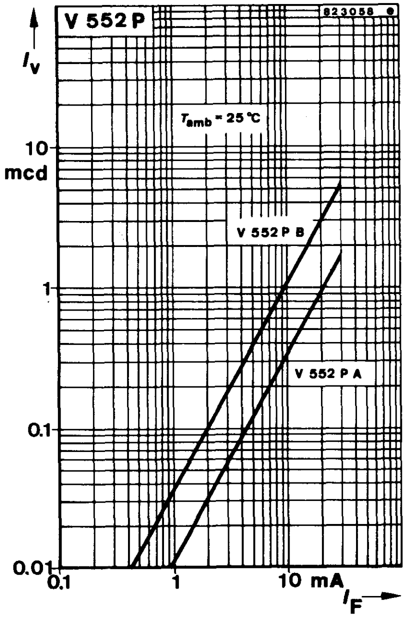

V 551 P
823026 e
I_v
$T_{amb} = 25\ °C$
10 mcd
1
0.1
0.01
0.1
1
10 mA
I_F
V 551 P B
V 551 P A

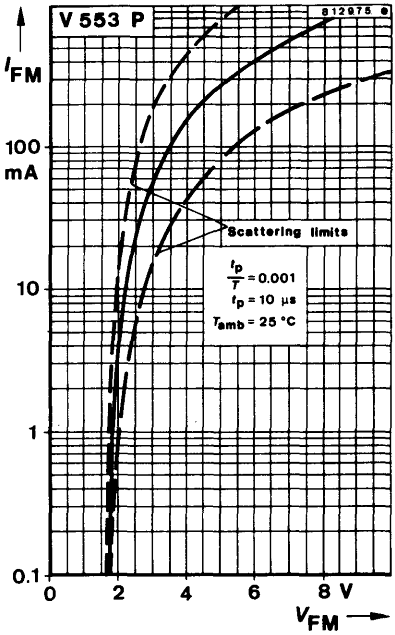
V 550 P · V 551 P · V 552 P · V 553 P

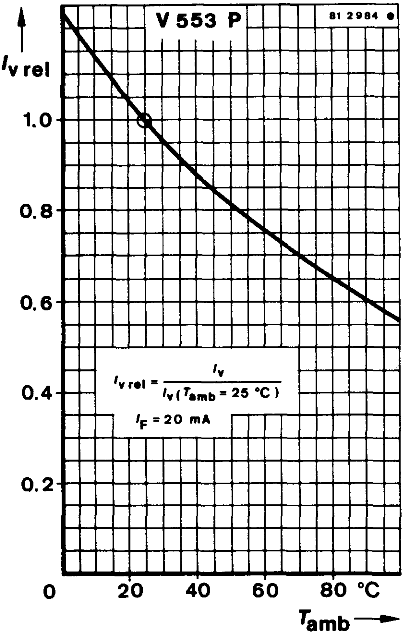


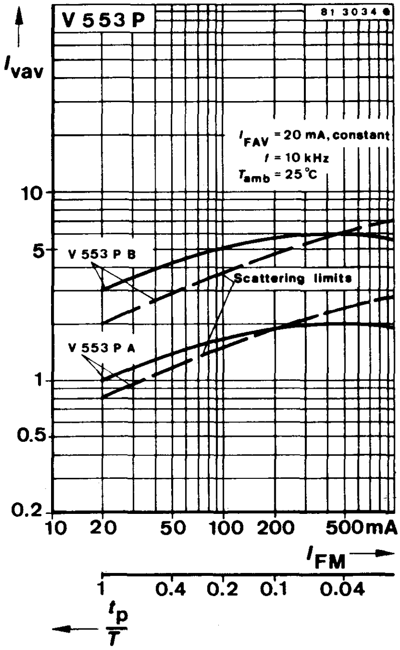


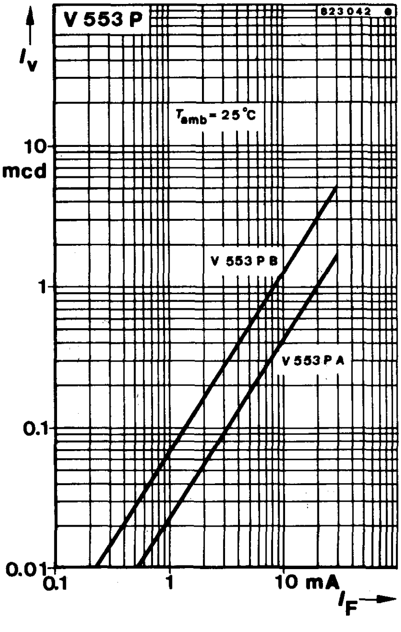




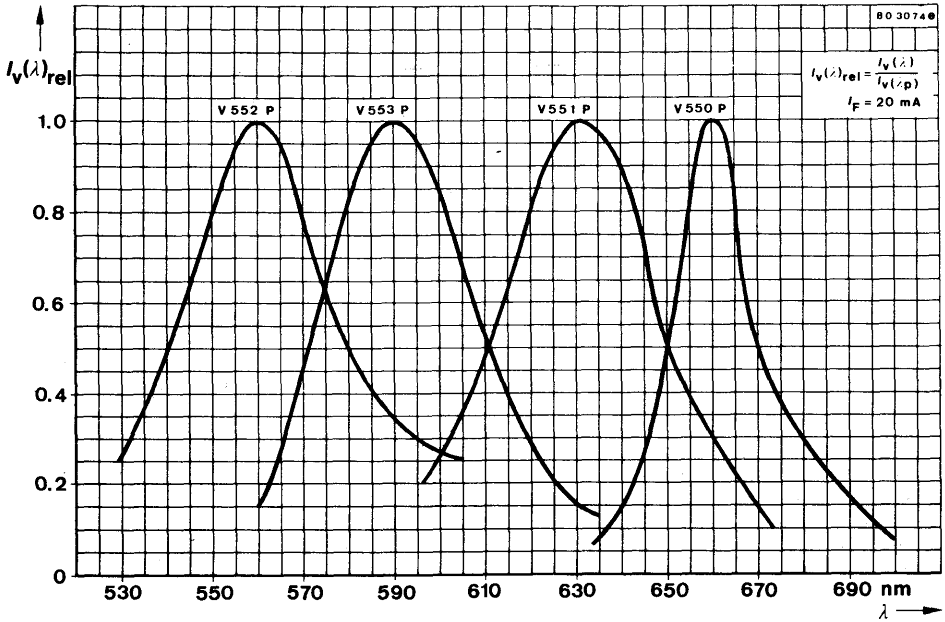

V 553 P
812975
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10\ \mu s$
$T_{amb} = 25\ °C$

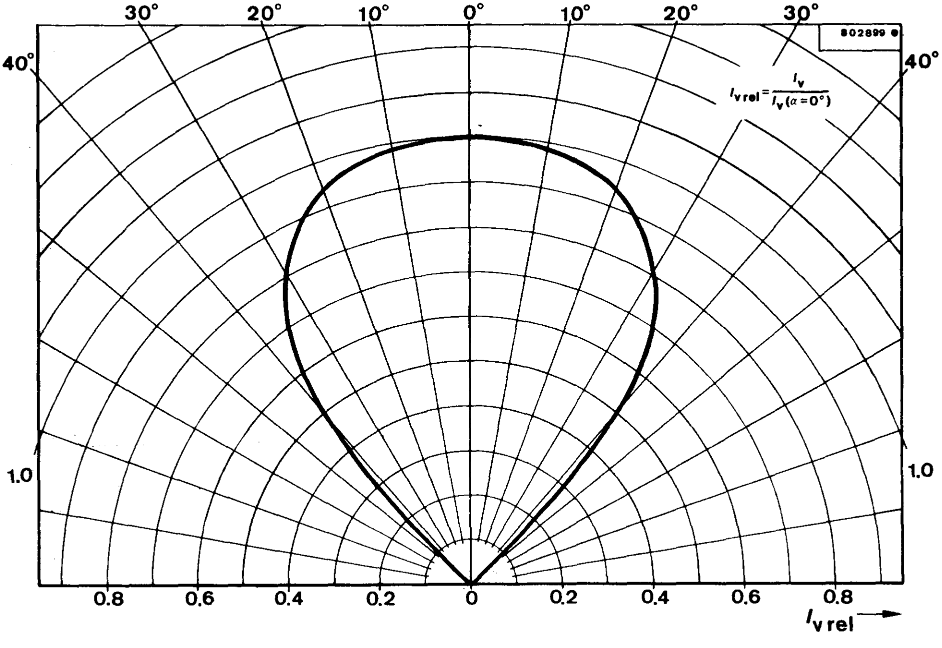

V 553 P
81 2984
$I_{v\ rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\ rel} = \frac{I_v}{I_v(T_{amb} = 25\ °C)}$
$I_F = 20$ mA


V 553 P
81 3034
I_{vav}
$I_{FAV} = 20$ mA, constant
$f = 10$ kHz
$T_{amb} = 25\ °C$
10
5
1
0.5
0.2
V 553 P B
V 553 P A
Scattering limits
10
20
50
100
200
500mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$


V 553 P
823042
I_v
$T_{amb} = 25\ °C$
10 mcd
1
0.1
0.01
V 553 P B
V 553 P A
0.1
1
10 mA
I_F

V 550 P · V 551 P · V 552 P · V 553 P

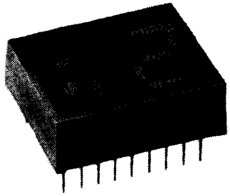




Digits and Displays

CQX 86 A · CQX 88 A · CQX 90 A · CQX 92 A
CQX 86 K · CQX 88 K · CQX 90 K · CQX 92 K

Not for new developments



13 mm – Seven Segment Displays

1½ Digit with + and – sign

Colour	Type	Type	Technology	Angle of half intensity α
Red	**CQX 86 A**	**CQX 86 K**	GaAsP on GaAs	50°
Orange-red	**CQX 88 A**	**CQX 88 K**	GaAsP on GaP	50°
Green	**CQX 90 A**	**CQX 90 K**	GaP on GaP	50°
Yellow	**CQX 92 A**	**CQX 92 K**	GaAsP on GaP	50°

A: common Anode K: common Cathode

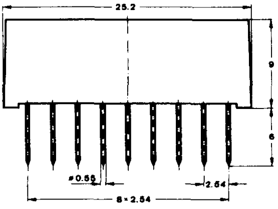
Application: General indicating purposes

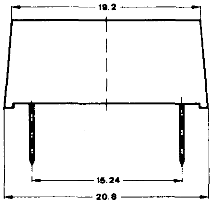
Features:

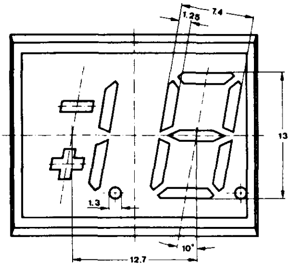
- Decimal point at the right side
- Suitable for d. c. and multiplex operation
- End-to-end stackable
- Wide viewing angle
- Legible with primary illumination

Preliminary specifications

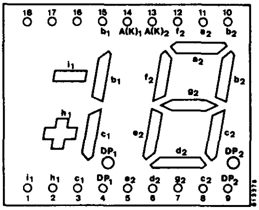
Dimensions in mm







Pin connections:



Angle of half intensity $\alpha = 50°$

S 1.2. 161/0781 E

CQX 86 A · CQX 88 A · CQX 90 A · CQX 92 A
CQX 86 K · CQX 88 K · CQX 90 K · CQX 92 K

Absolute maximum ratings

Reverse voltage	V_R	5	V
Forward current	I_F	25	mA
Forward surge current $t_p \leq 100\ \mu s$	I_{FSM}	200	mA
Power dissipation, with a single element in operation $T_{amb} \leq 25°C$	P_V	80	mW
Total power dissipation $T_{amb} \leq 25°C$	P_{tot}	750	mW
Junction temperature	T_j	85	°C
Storage temperature range	T_{stg}	−25 ... +85	°C
Soldering temperature, maximal $t \leq 3$ s	T_{sd} ^{1})	245	°C

Optical and electrical characteristics

$T_{amb} = 25°C$

Type	Luminous intensity per segment I_V*)^2) (mcd)	Peak wavelength emission λ_p (nm) Typ.	Spectral half bandwidth $\Delta\lambda$ (nm) Typ.	Forward voltage V_F*) (V)
	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA
CQX 86 A **CQX 86 K**	min. 0.3 typ. 0.7	660	20	typ. 1.65 max. 2.00
CQX 88 A **CQX 88 K**	min. 0.6 typ. 1.5	630	40	typ. 2.2 max. 3.0
CQX 90 A **CQX 90 K**	min. 0.3 typ. 0.7	560	40	typ. 2.7 max. 3.2
CQX 92 A **CQX 92 K**	min. 0.4 typ. 1.0	590	40	typ. 2.4 max. 3.2

		Min.	Typ.	Max.	
Breakdown voltage $I_R = 100\ \mu A$	$V_{(BR)}$*)	5			V

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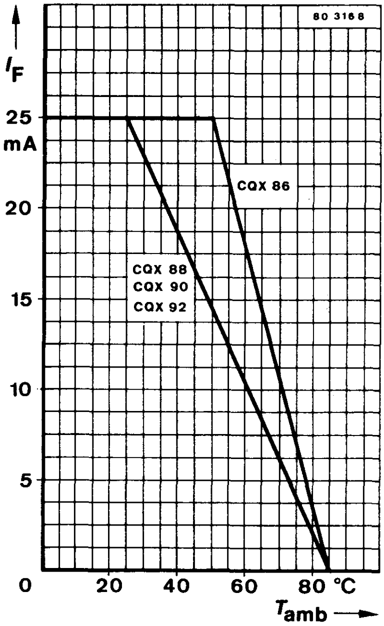
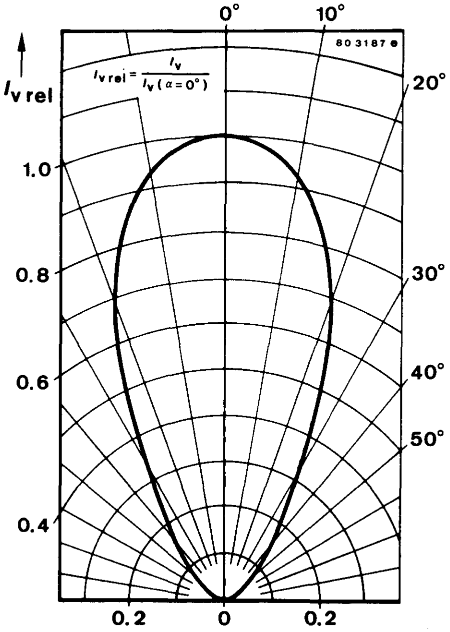
*) AQL = 0.65%

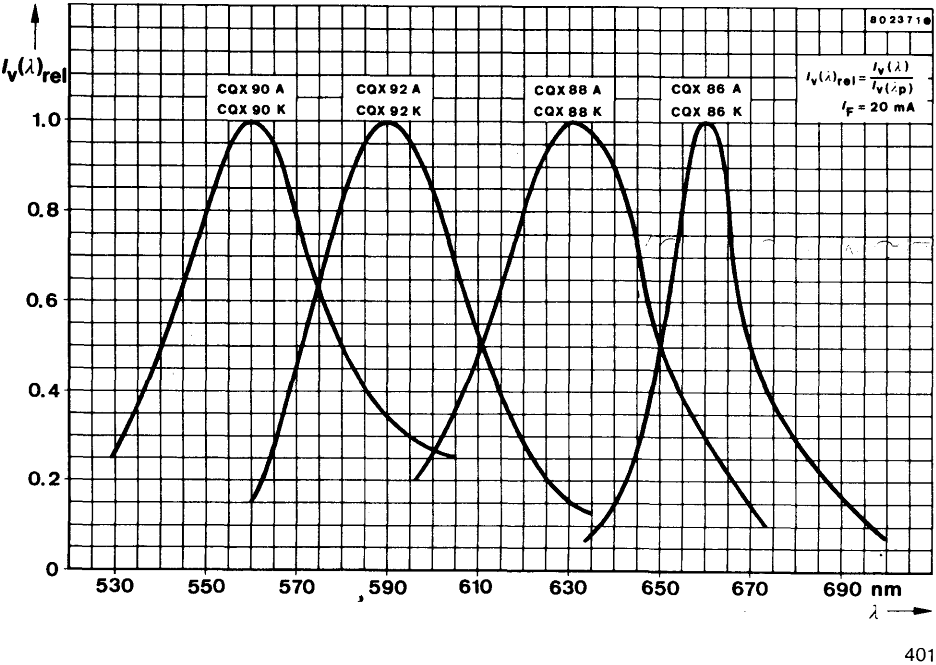
[1]) Distance from the touching border ≥ 1.5 mm with intermediate PC-board

[2]) supplied selected in groups, luminous intensity in packing unit m = 0.5 ... 1

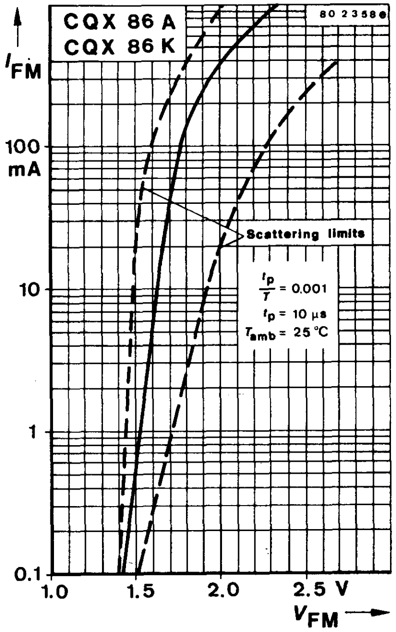
CQX 86 A · CQX 88 A · CQX 90 A · CQX 92 A
CQX 86 K · CQX 88 K · CQX 90 K · CQX 92 K

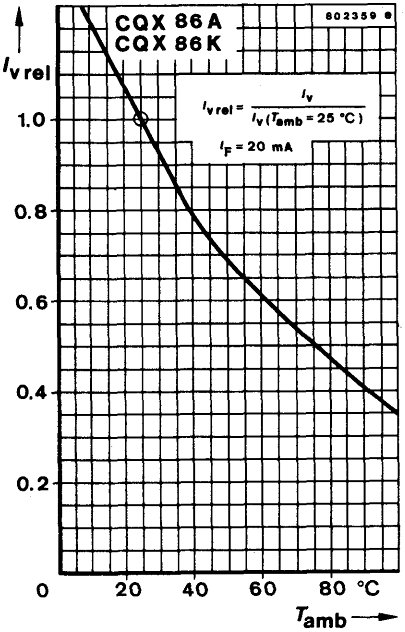


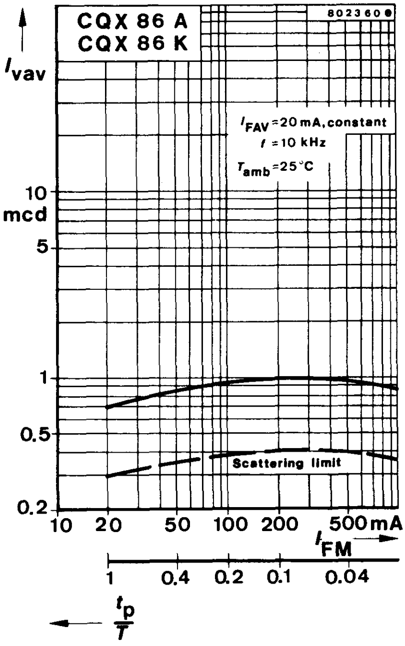


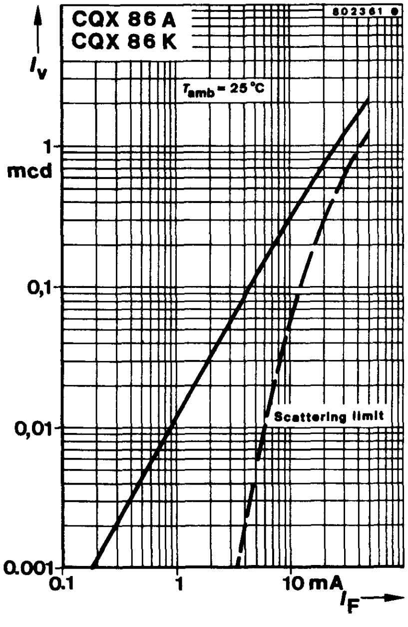


CQX 86 A · CQX 88 A · CQX 90 A · CQX 92 A
CQX 86 K · CQX 88 K · CQX 90 K · CQX 92 K

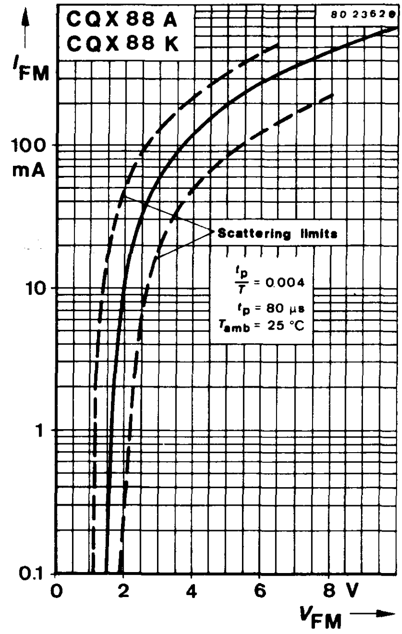


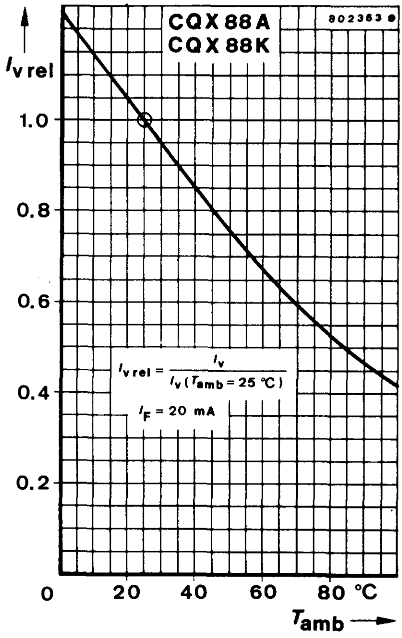


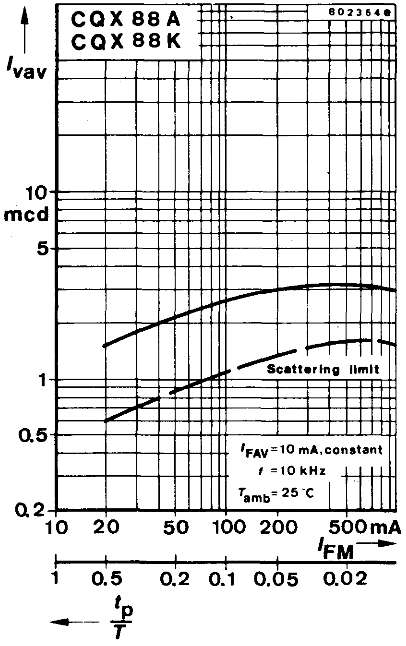


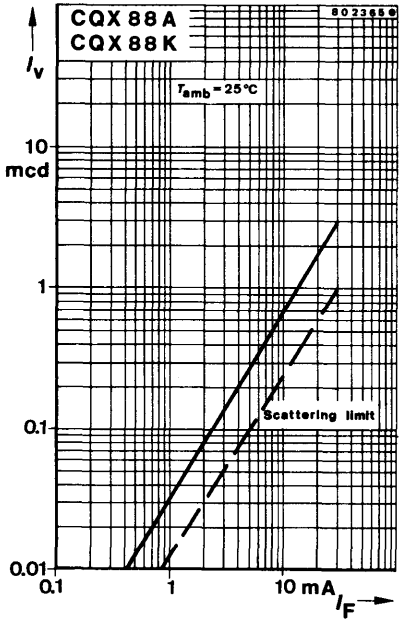


CQX 86 A · CQX 88 A · CQX 90 A · CQX 92 A
CQX 86 K · CQX 88 K · CQX 90 K · CQX 92 K

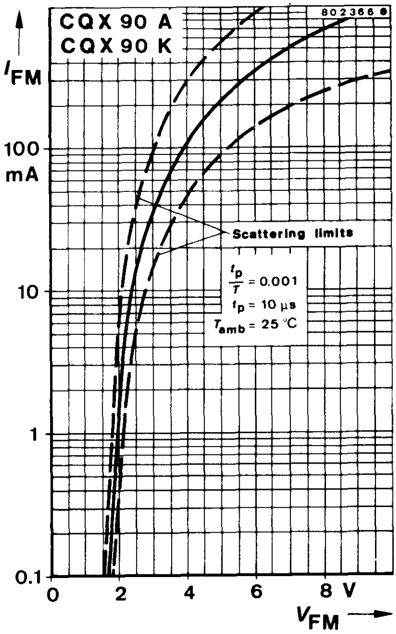


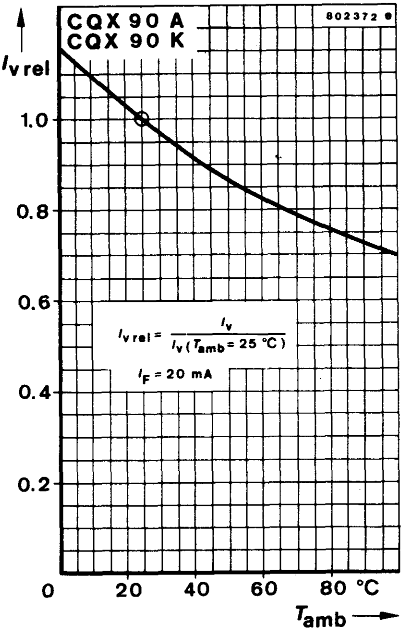


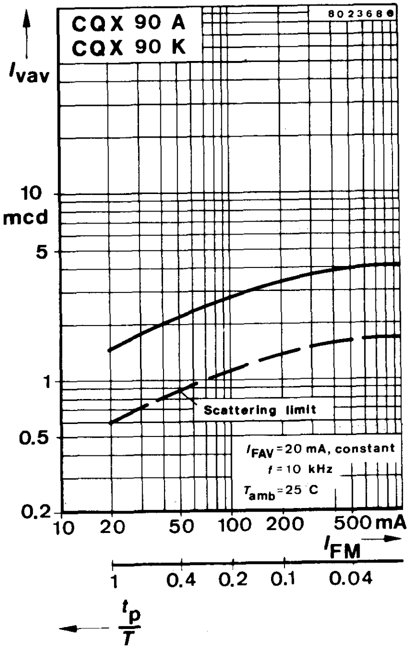


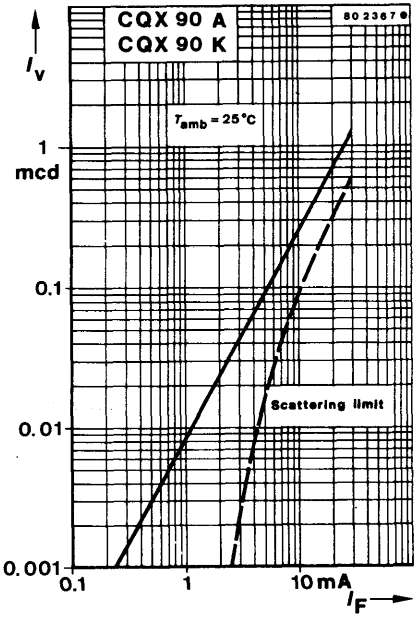


CQX 86 A · CQX 88 A · CQX 90 A · CQX 92 A
CQX 86 K · CQX 88 K · CQX 90 K · CQX 92 K

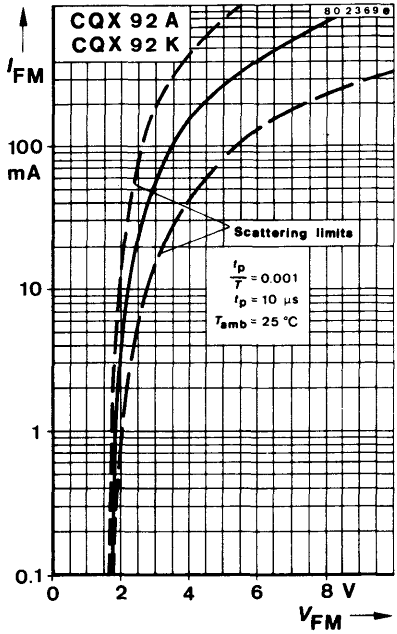


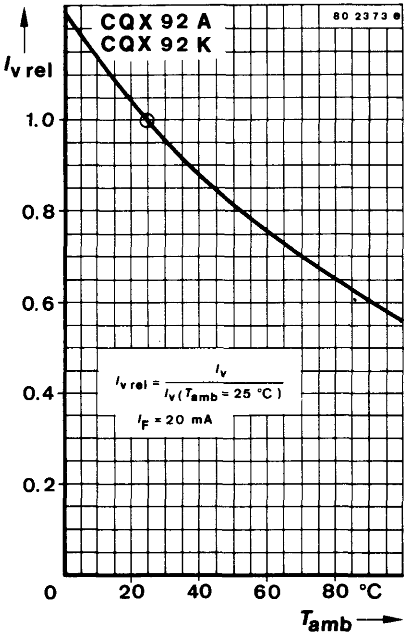


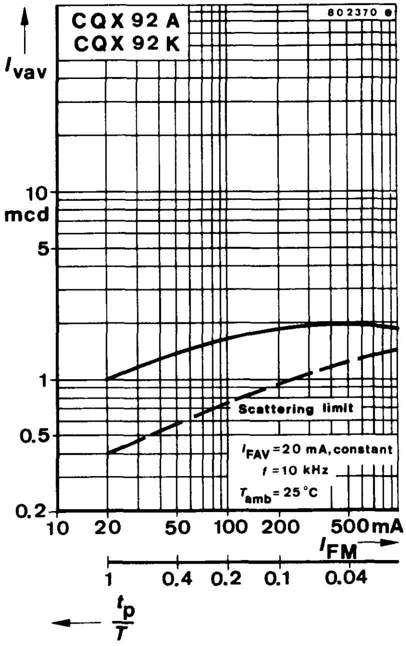


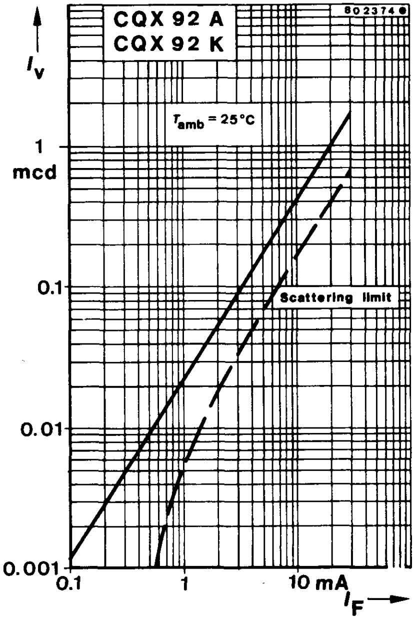


CQX 86 A · CQX 88 A · CQX 90 A · CQX 92 A
CQX 86 K · CQX 88 K · CQX 90 K · CQX 92 K



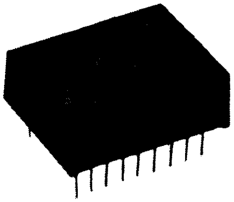






CQX 87 A · CQX 89 A · CQX 91 A · CQX 93 A
CQX 87 K · CQX 89 K · CQX 91 K · CQX 93 K

Not for new developments



13 mm – Seven Segment Displays
2 Digits

Colour	Type	Type	Technology	Angle of half intensity α
Red	**CQX 87 A**	**CQX 87 K**	GaAsP on GaAs	50°
Orange-red	**CQX 89 A**	**CQX 89 K**	GaAsP on GaP	50°
Green	**CQX 91 A**	**CQX 91 K**	GaP on GaP	50°
Yellow	**CQX 93 A**	**CQX 93 K**	GaAsP on GaP	50°

A: common Anode K: common Cathode

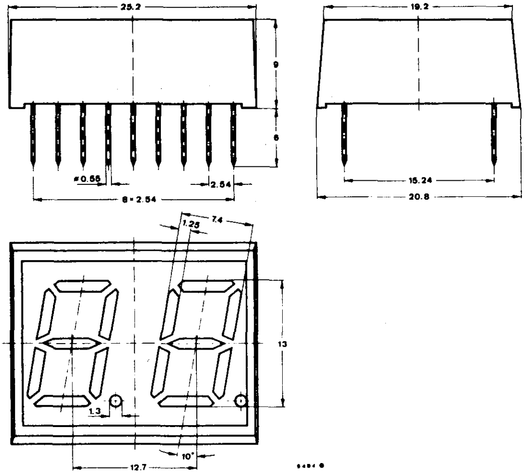
Application: General indicating purposes

Features:

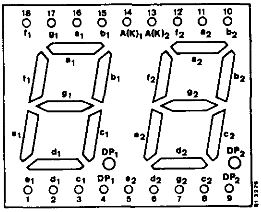
- Decimal point at the right side
- Suitable for d. c. and multiplex operation
- End-to-end stackable
- Wide viewing angle
- Legible with primary illumination

Preliminary specifications

Dimensions in mm



Pin connections:



Angle of half intensity $\alpha = 50°$

S 1.2. 162/0781 E

CQX 87 A · CQX 89 A · CQX 91 A · CQX 93 A
CQX 87 K · CQX 89 K · CQX 91 K · CQX 93 K

Absolute maximum ratings

Reverse voltage	V_R	5	V
Forward current	I_F	25	mA
Forward surge current $t_p \leq 100\,\mu s$	I_{FSM}	200	mA
Power dissipation, with a single element in operation $T_{amb} \leq 25\,°C$	P_V	80	mW
Total power dissipation $T_{amb} \leq 25\,°C$	P_{tot}	900	mW
Junction temperature	T_j	85	°C
Storage temperature range	T_{stg}	−25 ... +85	°C
Soldering temperature, maximal $t \leq 3$ s	T_{sd}[1]	245	°C

Optical and electrical characteristics

$T_{amb} = 25\,°C$

Type	Luminous intensity per segment I_V*)[2] (mcd)	Peak wavelength emission λ_p (nm) Typ.	Spectral half bandwidth $\Delta\lambda$ (nm) Typ.	Forward voltage V_F*) (V)
	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA	$I_F = 20$ mA
CQX 87 A **CQX 87 K**	min. 0.3 typ. 0.7	660	20	typ. 1.65 max. 2.00
CQX 89 A **CQX 89 K**	min. 0.6 typ. 1.5	630	40	typ. 2.2 max. 3.0
CQX 91 A **CQX 91 K**	min. 0.3 typ. 0.7	560	40	typ. 2.7 max. 3.2
CQX 93 A **CQX 93 K**	min. 0.4 typ. 1.0	590	40	typ. 2.4 max. 3.2

		Min.	Typ.	Max.	
Breakdown voltage $I_R = 100\,\mu A$	$V_{(BR)}$*)	5			V

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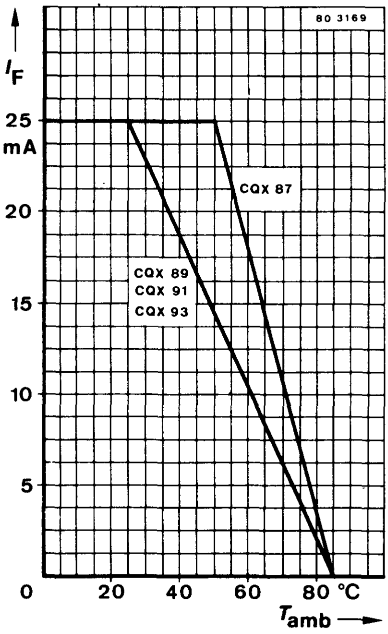
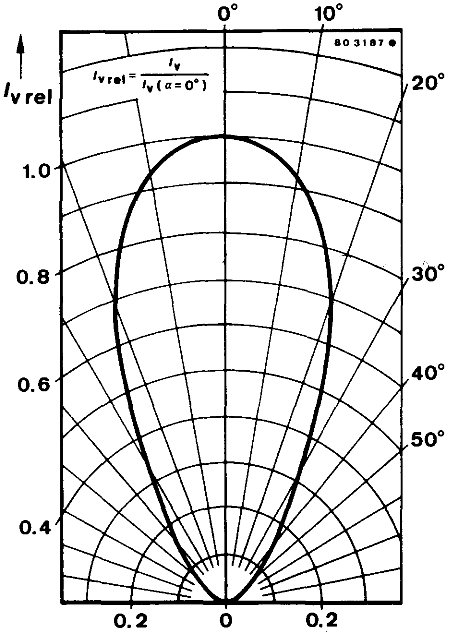
*) AQL = 0.65%

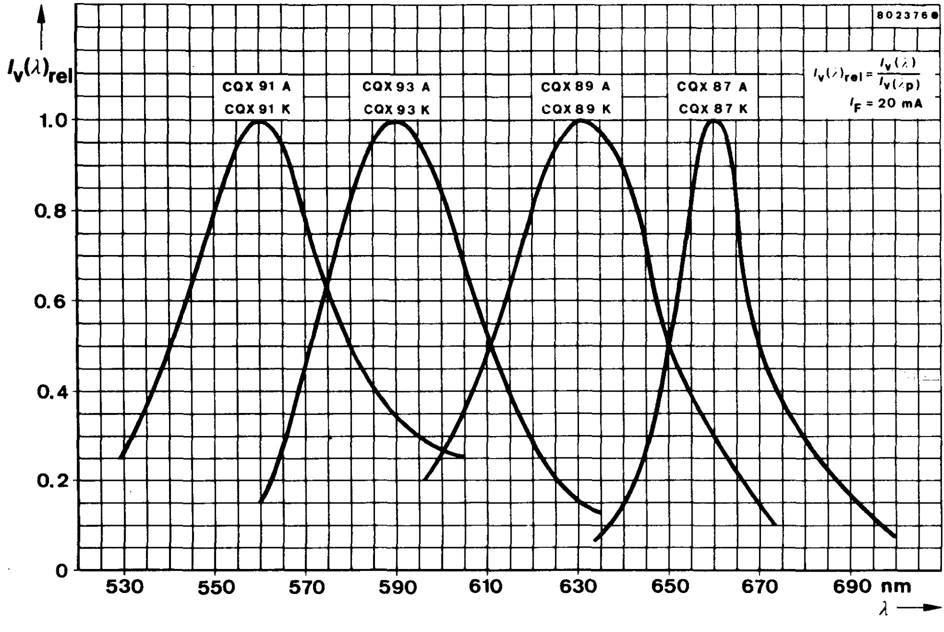
[1] Distance from the touching border ≥ 1.5 mm with intermediate PC-board

[2] supplied selected in groups, luminous intensity in packing unit m = 0.5 ... 1

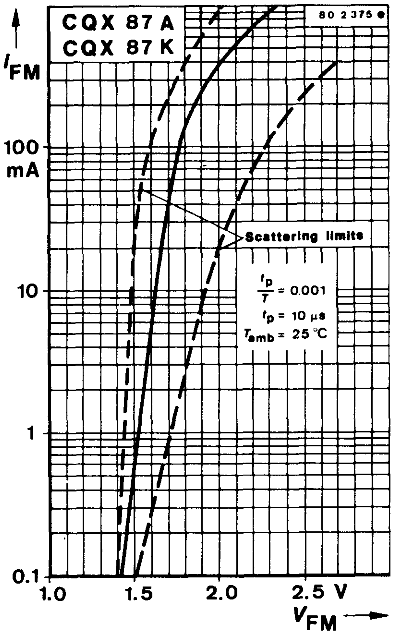
CQX 87 A · CQX 89 A · CQX 91 A · CQX 93 A
CQX 87 K · CQX 89 K · CQX 91 K · CQX 93 K

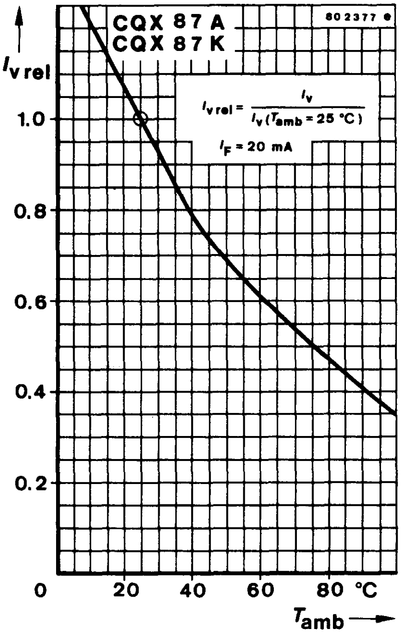


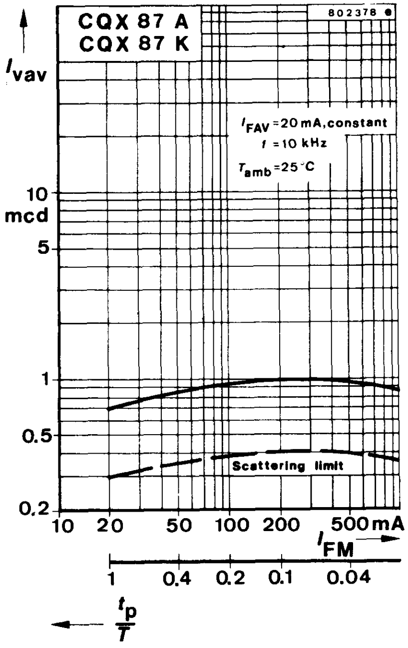


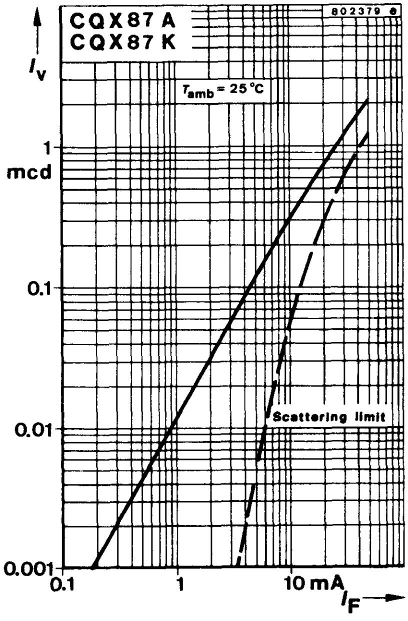


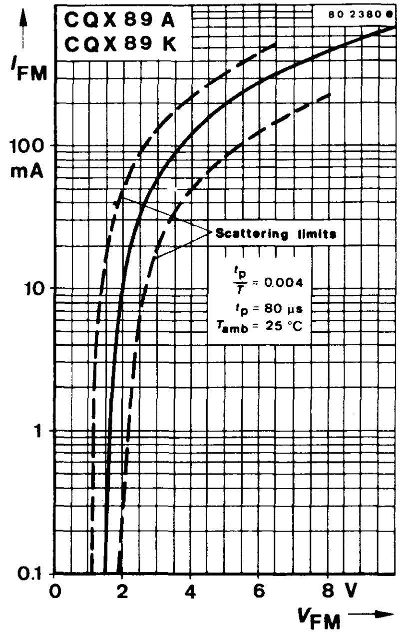
CQX 87 A · CQX 89 A · CQX 91 A · CQX 93 A
CQX 87 K · CQX 89 K · CQX 91 K · CQX 93 K

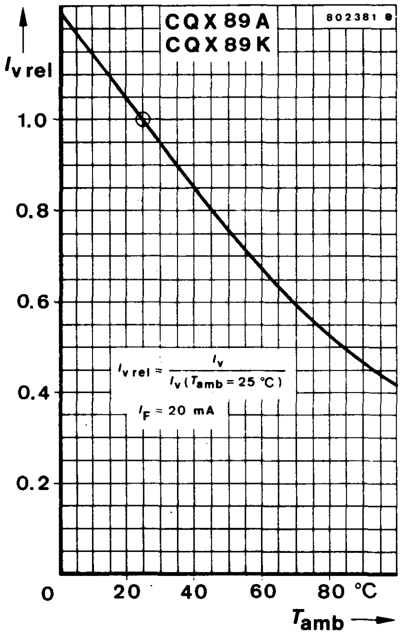


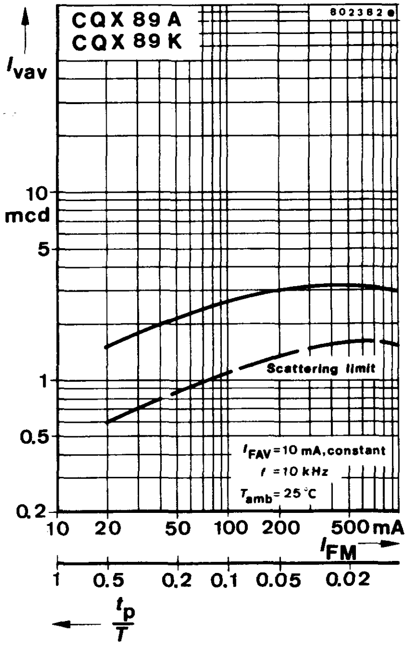


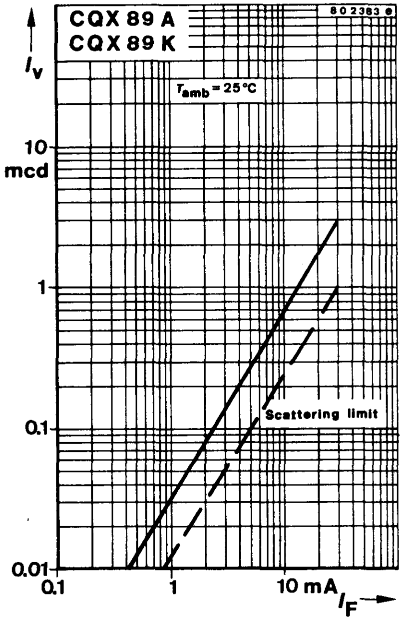




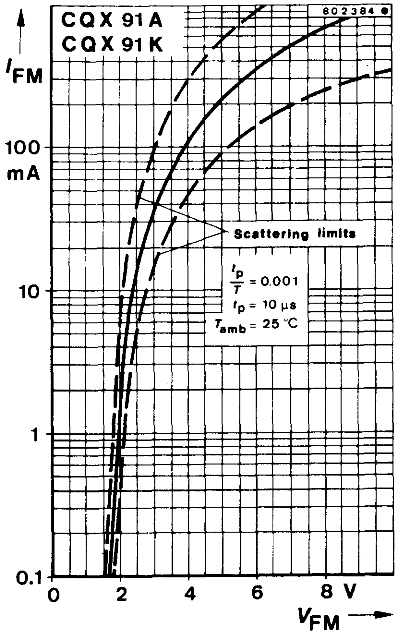

CQX 89 A
CQX 89 K
80 2380
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T}$ = 0.004
t_p = 80 µs
T_{amb} = 25 °C

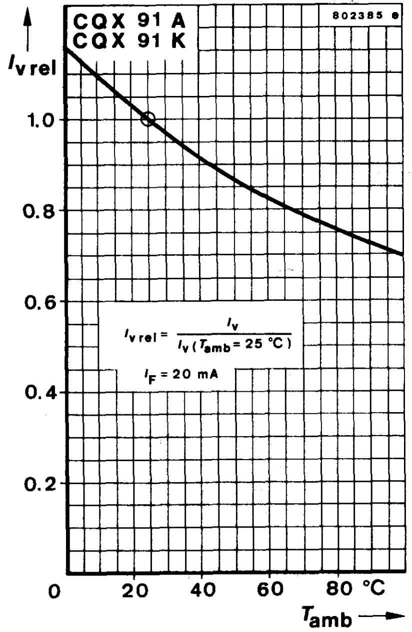

CQX 89 A
CQX 89 K
802381
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v(T_{amb} = 25\ °C)}$
I_F = 20 mA

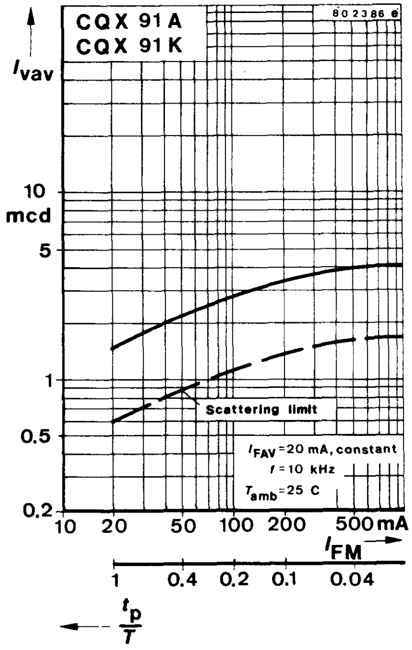

CQX 89 A
CQX 89 K
802382
I_{vav}
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500 mA
I_{FM}
1
0.5
0.2
0.1
0.05
0.02
$\frac{t_p}{T}$
Scattering limit
I_{FAV}=10 mA, constant
f = 10 kHz
T_{amb} = 25 °C

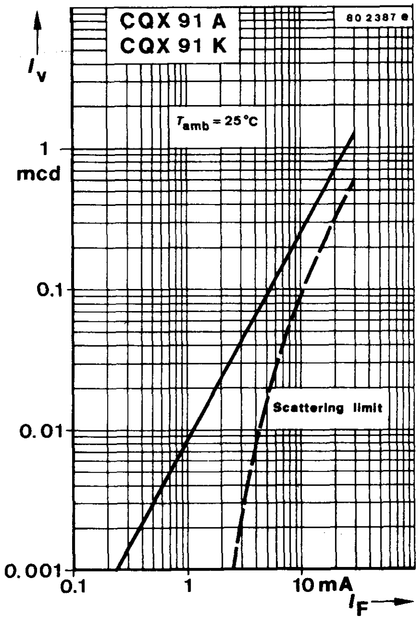

CQX 89 A
CQX 89 K
80 2383
I_v
T_{amb} = 25 °C
10 mcd
1
0.1
0.01
0.1
1
10 mA
I_F
Scattering limit

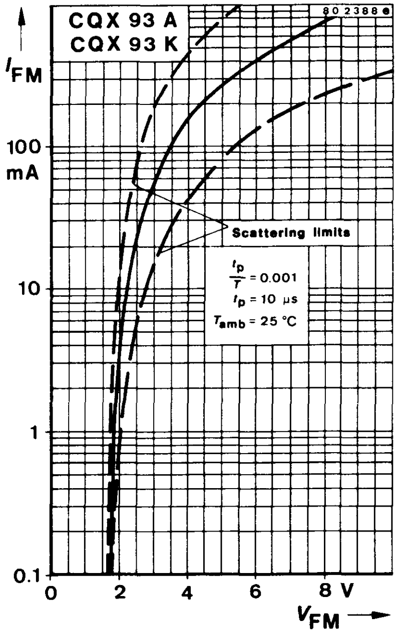
CQX 87 A · CQX 89 A · CQX 91 A · CQX 93 A
CQX 87 K · CQX 89 K · CQX 91 K · CQX 93 K

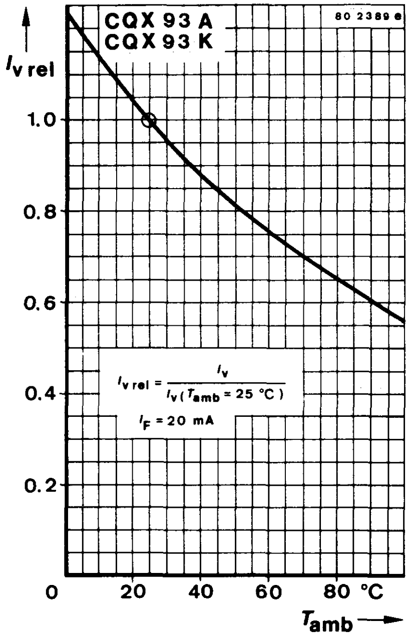


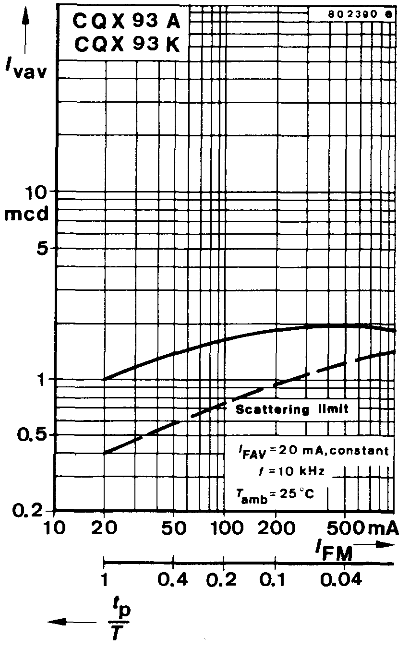


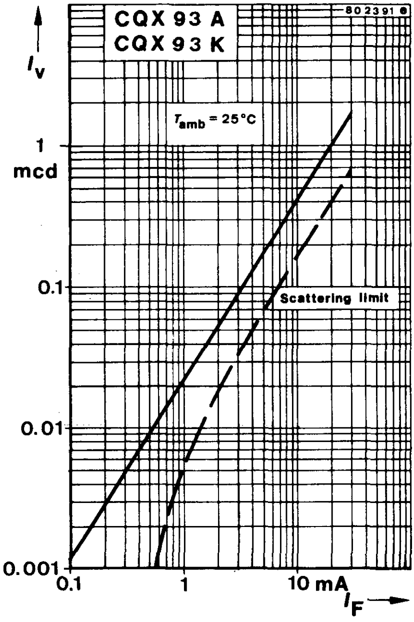




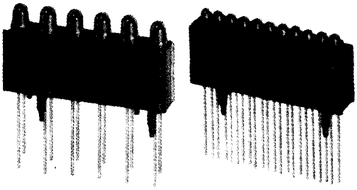

CQX 93 A
CQX 93 K
80 2388 e
I_{FM}
100 mA
10
1
0.1
0
2
4
6
8 V
V_{FM}
Scattering limits
$\frac{t_p}{T} = 0.001$
$t_p = 10$ µs
$T_{amb} = 25$ °C


CQX 93 A
CQX 93 K
80 2389 e
$I_{v\,rel}$
1.0
0.8
0.6
0.4
0.2
0
20
40
60
80 °C
T_{amb}
$I_{v\,rel} = \frac{I_v}{I_v(T_{amb} = 25\ °C)}$
$I_F = 20$ mA


CQX 93 A
CQX 93 K
80 2390 e
I_{vav}
10 mcd
5
1
0.5
0.2
10
20
50
100
200
500 mA
I_{FM}
1
0.4
0.2
0.1
0.04
$\frac{t_p}{T}$
Scattering limit
$I_{FAV} = 20$ mA, constant
$f = 10$ kHz
$T_{amb} = 25$ °C


CQX 93 A
CQX 93 K
80 2391 e
I_v
1 mcd
0.1
0.01
0.001
0.1
1
10 mA
I_F
$T_{amb} = 25$°C
Scattering limit

Universal LED-Bar Display



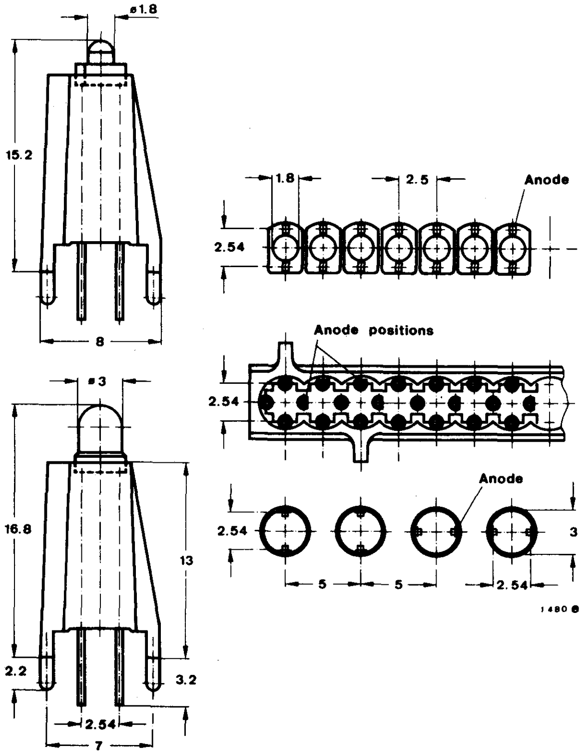
Application: Bar displays with different carrier possibilities

Features:

- Longitudinal and transverse plug-in possible
- Spacing between adjacent ∅ 3 mm LED's = 5 mm
- Spacing between adjacent ∅ 1.8 mm LED's = 2.5 mm
- Different luminous colour combinations possible
- Simple application in p. c. board
- Optimum pins length for soldering

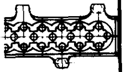
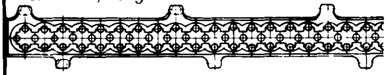
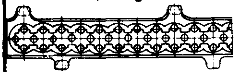
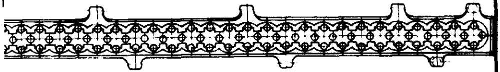
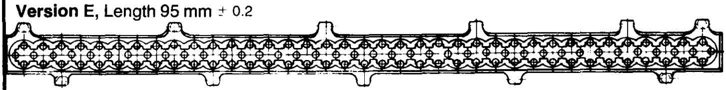
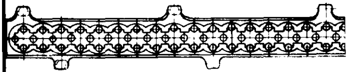
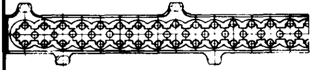
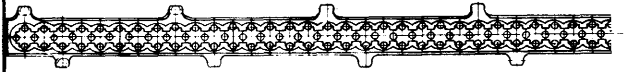
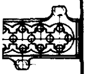
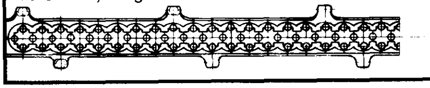
Preliminary specifications

Dimensions in mm



LED carrier:
Polystyrol black

V 227 P

Left fitting edge **Right fitting edge**	Construction possibilities	
	LED Ø 3 mm	LED Ø 1.8 mm
Version A, Length 15 mm – 0.1 	3	5
Version B, Length 50 mm – 0.1 	10	19
Version C, Length 30 mm – 0.1 	6	11
Version D, Length 65 mm – 0.1 	13	25
Version E, Length 95 mm ± 0.2 	19	37
Version F, Length 45 mm – 0.1 	9	17
Version G, Length 40 mm – 0.1 	8	15
Version H, Length 80 mm – 0.1 	16	31
Version J, Length 10 mm – 0.1 	2	3
Version K, Length 52.2 mm – 0.1 	10	20

Different combination possibilities are available

Absolute maximum ratings

For single diode				
Reverse voltage		V_R	5	V
Forward current	red	I_F	50	mA
	orange-red, green, yellow	I_F	30	mA
Forward surge current $t_p \leqq 10\,\mu s$		I_{FM}	1	A
Power dissipation of a single diode $T_{amb} = 25\,°C$		P_V	100	mW
Junction temperature		T_j	100	°C
Storage temperature range		T_{stg}	−20...+85	°C
Soldering temperature, maximal $t = 3\,s$		T_{sd}1)	245	°C

Optical and electrical characteristics

			Min.	Typ.	Max.	
Luminous intensity $I_F = 20\,mA$	red	I_v2)	0.8			mcd
	orange-red	I_v2)	2.0			mcd
	green	I_v2)	1.0			mcd
	yellow	I_v2)	1.0			mcd
Peak wavelength emission $I_F = 20\,mA$	red	λ_p		660		nm
	orange-red	λ_p		630		nm
	green	λ_p		560		nm
	yellow	λ_p		590		nm
Spectral half bandwidth $I_F = 20\,mA$	red	$\Delta\lambda$		20		nm
	orange-red, green, yellow	$\Delta\lambda$		40		nm
Forward voltage $I_F = 20\,mA$	red	V_F		1.6	2.0	V
	orange-red	V_F		2.2	3.0	V
	green	V_F		2.7	3.2	V
	yellow	V_F		2.7	3.2	V
Breakdown voltage $I_R = 100\,\mu A$		$V_{(BR)}$	5			V

---

1) Distance from the touching border ≥ 1.5 mm with intermediate PC-board

2) Luminous intensity for every luminous colour and line m = 0.5 ... 1.0

Subject index

10. Subject Index

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