SIEMENS

Data Book 1975/76

Optoelectronics
Semiconductors

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Optoelectronics · Semiconductors 1975/76

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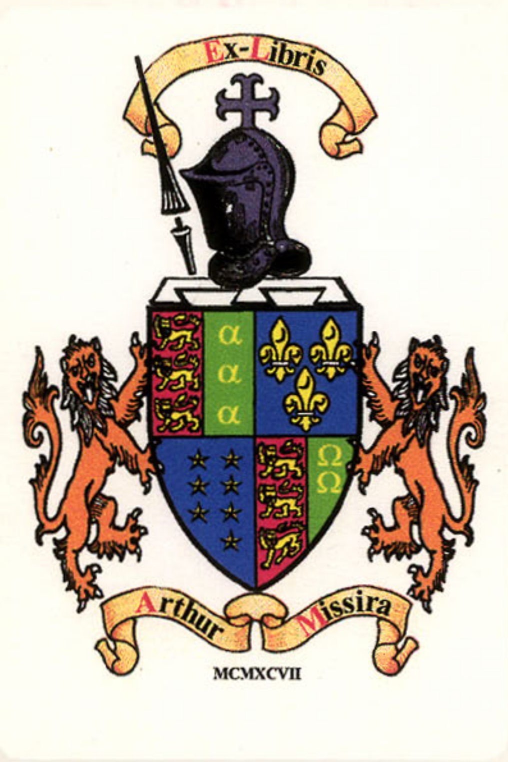
Optoelectronics Semiconductors Data Book 1975/76

The second English Edition of the Data Book "Optoelectronics, Semiconductors" is available now, offering an extended volume and an increased number of types.

Virtually the whole range of electronic activities is covered by the versatile application possibilities of optoelectronic components: from tape readers to automatic exposure time control in cameras, from HF modulated transmitters of far-reaching light barriers to channel indication in colour TV sets.

Further increasing applications, such as IR sound transmission from TV radio sets to cableless head phone receivers and remote handling of the TV equipment by means of IR radiation are putting considerable impetus on optoelectronics. Also in this field the proper components were pioneered by Siemens at an early time, thus providing a good initial position for these new applications.

If you don't find in this data book just what you want, please contact Siemens – our development activities are continuously marching forward. With your aid and to meet your requirements we make available new components which will help solving your problems.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Contents
Summary of types
General

Photovoltaic Cells

Photodiodes

Phototransistors

Light Emitting Diodes

Optoelectronic Coupling Devices

Photoresistors

Threshold Switches for Optoelectronic Applications

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Optoelectronics
Semiconductors

1975/76

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Contents · Summary of types · General

Contents

1.1. Summary of types . . . 9
1.2. Symbols, alphabetically . . . 16

2. General

2.1. Introduction . . . 19
2.2. Silicon photovoltaic cells . . . 20
2.3. Silicon photodiodes . . . 22
2.4. Mounting instructions for silicon voltaic cells and photodiodes . . . 24
2.5. Silicon phototransistors . . . 25
2.6. Photoresistors . . . 28
2.7. Light emitting diodes (IRED/LED)[1] and semiconducting indicators . . . 29
2.7.1. Design and mode of operation . . . 30
2.7.2. Electrical-optical characteristics . . . 32
2.8. Optoelectronic couplers . . . 34
2.9. Measuring technique of optoelectronic semiconductor devices . . . 35
2.9.1. Terms of temperature for optical radiation . . . 45
2.9.2. Radiation and light measurements . . . 46
2.9.3. Radiation characteristics . . . 47
2.9.4. Luminance – units and conversion factors . . . 48
2.9.5. Illuminance – units and conversion factors . . . 49
2.9.6. Electromagnetic radiation – ranges of frequency and wavelength . . . 52
2.10. Quality definition . . . 55
2.11. Mounting and soldering instructions . . . 57

Photovoltaic cells

Silicon photovoltaic cells . . . 61

Photodiodes

Silicon differential photodiodes . . . 97
Silicon photodiodes . . . 103

Phototransistors

Silicon phototransistors . . . 171/208
Silicon phototransistor arrays . . . 204

Light emitting diodes (LEDs)

GaAs infrared emitting diodes . . . 221
GaAs infrared emitter diode arrays . . . 246
GaAsP LEDs, red emitter . . . 363
GaAsP LED arrays, red emitter . . . 294
GaP LEDs, green emitter . . . 299
GaP LED arrays, green emitter . . . 319
GaP LEDs, yellow emitter . . . 324
GaP LED arrays, yellow emitter . . . 344

Optoelectronic coupling devices . . . 351

Photoresistors . . . 363

Threshold switches for optoelectronic applications . . . 383

[1] LED = light emitting diode
IRED = infrared emitting diode

1.1. Summary of Types
Optoelectronic semiconductor devices

Types so far available		**New types**
Photovoltaic cells		
Silicon photovoltaic cells	BP 100, BPX 79, BPY 11, BPY 47, BPY 48, BPY 64, TP 60, TP 61,	
Photodiodes		
Silicon differential photodiodes	BPX 48	
Silicon photodiodes	BPX 60, BPX 63, BPX 65, BPX 90, BPX 91, BPX 92, BPX 93, ■ BPY 12	**BPW 32, BPW 33, BPW 34, BPX 61, BPX 66**
Phototransistors		
Silicon phototransistors	BP 101, BP 102, BPX 38, BPX 43, BPX 62, BPX 81, BPY 61, BPY 62	**BP 103**
Silicon phototransistor arrays	BPX 80 to BPX 89	
Light emitting diodes (LEDs)		
GaAs infrared emitting diodes	CQY 17, ■ CQY 18, LD 261	**CQY 57, CQY 77, CQY 78, LD 241**
GaAs infrared emitting diode arrays	LD 260 to LD 269	
GaAsP light emitting diodes (red light)	■ LD 40, LD 461, LD 50	**CQY 26 A, LD 30 A, C, LD 41 A, LD 461 A**
GaAsP light emitting diode arrays (red light)	LD 460 to LD 469	
GaP light emitting diodes (green light)	LD 471	**CQY 28 A, LD 37 A, LD 57 A, LD 471 A**
GaP light emitting diode arrays (green light)	LD 470 to LD 479	
GaP light emitting diodes (yellow light)		**CQY 29 A, LD 35 A, LD 55 A, LD 481 A**
GaP light emitting diode arrays (yellow light)		**LD 480 to LD 489**
Optoelectronic couplers	CNY 17, CNY 18	
Photoconductive cells	RPY 60, RPY 61, RPY 62, RPY 63, RPY 64	**FW 9801, FW 9802**
Threshold switch for optoelectronic applications		**TPV 63**

■ Not for new equipment

Summary of Types

Silicon photovoltaic cells

Type	Sensitivity S (μA/lux)	Open circuit voltage at E_v = 100 lux V_L (mV)	 10 000 lux V_L (mV)	Dark current I_R at T_{amb} = 25°C I_R (μA)	Page
BP 100	0.025 (≧ 0.019)	170 (≧ 120)	≧ 200[1])	3 (≦ 10)	61
BPX 79	0.135 (≧ 0.1)	320 (≧ 220)	≧ 310[1])	0.3 (≦ 50)	66
BPY 11	0.04 (≧ 0.028)	220 (≧ 180)	≧ 260[1])	1 (≦ 10)	70
BPY 11/I	0.04 (≧ 0.028)	220 (≧ 180)	≧ 260[1])	1 (≦ 10)	70
BPY 11/II	0.04 (≧ 0.028)	220 (≧ 180)	≧ 260[1])	1 (≦ 10)	70
BPY 11/III	0.04 (≧ 0.028)	220 (≧ 180)	≧ 260[1])	1 (≦ 10)	70
BPY 47	1.3 (≧ 0.9)	300 (≧ 150)	≧ 450	–	75
BPY 48	0.43 (≧ 0.3)	300 (≧ 150)	≧ 450	–	80
BPY 64	0.23 (≧ 0.16)	300 (≧ 150)	≧ 450	–	85
TP 60	1.0 (≧ 0.7)	300 (≧ 140)	≧ 440	–	90
TP 61	1.0 (≧ 0.7)	300 (≧ 140)	≧ 440	–	90

1) E_v = 1000 lux

Silicon differential photodiodes

Type	Sensitivity S (nA/lux)	Reverse voltage V_R (V)	Dark current I_R at T_{amb} = 25°C (μA)	Page
BPX 48	32 (≧ 15)	10	0.1 (≦ 0.2)	48

Silicon photodiodes

Type	Sensitivity S (nA/lux)	Reverse voltage V_R (V)	Dark current I_R at T_{amb} = 25°C (nA) [pA]	Page
▼ **BPW 32**	10	7	[15]	103
▼ **BPW 33**	50 (≧ 35)	7	[20 (≦ 100)]	108
▼ **BPW 34**	70 (≧ 50)	32	[2 (≦ 30)]	113
BPX 60	50 (≧ 35)	32	7 (≦ 300)	118
▼ **BPX 61**	70 (≧ 50)	32	2 (≦ 30)	123
BPX 63	10	7	[0.15]	128
BPX 65	10 (≧ 7)	50	1 (≦ 5)	133
▼ **BPX 66**	9 (≧ 5)	50	0.15 (≦ 0.3)	138
BPX 90	40 (≧ 25)	32	5 (≦ 200)	143
BPX 91	50 (≧ 35)	32	7 (≦ 300)	148
BPX 92	7 (≧ 4)	32	1 (≦ 100)	153
BPX 93	8 (≧ 5)	32	0.5 (≦ 50)	158
■ **BPY 12**	≧100	20	100 (≦ 1000)	162

The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

▼New type ■ Not for new rquipment

1.1. Summary of Types

Silicon phototransistors

Type	Photocurrent I_P at V_{CE} = 5 V, E_V = 1000 lux I_P (mA)	Collector-emitter reverse voltage V_{CE} (V)	Collector-emitter leakage current at V_{CE}= 25 V, [30 V] E = 0; I_{CEO} (nA)	Page
BP 101/I	0.063 to 0.125	32	[5 (≦ 100)]	171
BP 101/II	0.1 to 0.2	32	[5 (≦ 100)]	171
BP 101/III	0.16 to 0.32	32	[5 (≦ 100)]	171
BP 101/IV	0.25 to 0.5	32	[5 (≦ 100)]	171
BP 102/I	0.16 to 0.32	32	[5 (≦ 100)]	176
BP 102/II	0.25 to 0.5	32	[5 (≦ 100)]	176
BP 102/III	0.4 to 0.8	32	[5 (≦ 100)]	176
BP 102/IV	0.63 to 1.25	32	[5 (≦ 100)]	176
▼ **BP 103/I**	0.16 to 0.32	100	[5 (≦ 100)]	181
▼ **BP 103/II**	0.25 to 0.5	100	[5 (≦ 100)]	181
▼ **BP 103/III**	0.4 to 0.8	100	[5 (≦ 100)]	181
▼ **BP 103/IV**	0.63 to 1.25	100	[5 (≦ 100)]	181
BPX 38/I	0.4 to 0.8	50	5 (≦ 200)	186
BPX 38/II	0.63 to 1.25	50	8 (≦ 200)	186
BPX 38/III	1.0 to 2.0	50	12 (≦ 500)	186
BPX 38/IV	1.6 to 3.2	50	20 (≦ 500)	186
BPX 43/I	1.6 to 3.2	50	5 (≦ 200)	191
BPX 43/II	2.5 to 5.0	50	8 (≦ 200)	191
BPX 43/III	4.0 to 5.0	50	12 (≦ 500)	191
BPX 43/IV	6.3 to 12.5	50	20 (≦ 500)	191
BPX 62/I	0.4 to 0.8	50	10 (≦ 100)	196
BPX 62/II	0.63 to 1.25	50	10 (≦ 100)	196
BPX 62/III	1.0 to 2.0	50	10 (≦ 100)	196
BPX 62/IV	1.6 to 3.2	50	10 (≦ 100)	196
BPX 81/I	0.63 to 1.25	32	25 (≦ 200)	200
BPX 81/II	1.0 to 2.0	32	25 (≦ 200)	200
BPX 81/III	1.6 to 3.2	32	25 (≦ 200)	200
BPX 81/IV	2.5 to 5.0	32	25 (≦ 200)	200
BPY 61/I	0.8 to 1.6	32	5 (≦ 100)	208
BPY 61/II	1.25 to 2.5	32	5 (≦ 100)	208
BPY 61/III	2.0 to 4.0	32	5 (≦ 100)	208
BPY 61/IV	3.2 to 6.3	32	5 (≦ 100)	208
BPY 62/I	1.25 to 2.5	32	5 (≦ 100)	212
BPY 62/II	2.0 to 4.0	32	5 (≦ 100)	212
BPY 62/III	3.2 to 6.3	32	5 (≦ 100)	212

The illuminance indicated refers to unifiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

▼ New type

1.1. Summary of Types

Silicon phototransistor arrays

Type (number of phototransistors per array)	Photocurrent I_P at V_{CE} = 5 V, E_v = 1000 lx I_P (mA)	Collector-emitter reverse voltage V_{CE} (V)	Collector-emitter leakage current at V_{CE} = 25 V, E = 0, I_{CEO} (nA)	Page
BPX 81 (1)[1]	0.41 to 6.3	32	25 (≦ 200)	204
BPX 82 (2)		32		204
BPX 83 (3)		32		204
BPX 84 (4)		32		204
BPX 85 (5)		32		204
BPX 86 (6)		32		204
BPX 87 (7)		32		204
BPX 88 (8)		32		204
BPX 89 (9)		32		204
BPX 80 (10)		32		204

The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

GaAs infrared emitting diodes

Type	Radiant intensity I_e[2] I_F = 100 mA [50 mA] (mW/sr) I_e	Radiant flux I_F = 100 mA [50 mA] Φ_e (mW) Φ_e at	φ	Φ_e total	Half angle φ (for 50% $I_{v\,max}$) (degree)	Max. perm. forward current I_F (mA)	Page
CQY 17/IV		1.1 to 2.8	15°	4	13	100	221
CQY 17/V		1.8 to 4.5	15°	6.3	13	100	221
■ **CQY 18/III**		0.8 to 2.0	30°	2.5	45	100	226
■ **CQY 18/IV**		1.25 to 3.2	30°	4	45	100	226
■ **CQY 18/V**		2 to 5.0	30°	6.3	45	100	226
▼ **CQY 57/I**	[0.5 to 1.0]			[1.0]	12	100	231
▼ **CQY 57/II**	[0.8 to 1.6]			[1.6]	12	100	231
▼ **CQY 57/III**	[1.25 to 2.5]			[2.5]	12	100	231
▼ **CQY 57/IV**	[2.0 to 4.0]			[4.0]	12	100	231
▼ **CQY 77/I**	8 to 16			2.5	6	230	236
▼ **CQY 77/II**	12.5 to 25			4.0	6	230	236
▼ **CQY 77/III**	20 to 40			6.3	6	230	236
▼ **CQY 78/I**	1.0 to 2.0			2.5	40	230	241
▼ **CQY 78/II**	1.6 to 3.2			4.0	40	230	241
▼ **CQY 78/III**	2.5 to 5.0			6.3	40	230	241
▼ **LD 241/I**	1.0 to 2.0			4.0	60	230	246
▼ **LD 241/II**	1.6 to 3.2			6.3	60	230	246
▼ **LD 241/III**	2.5 to 5.0			10	60	230	246
LD 261/I		[0.28 to 0.71]	30°	[1.0]	30	60	251
LD 261/II		[0.45 to 1.112]	30°	[1.6]	30	60	251
LD 261/III		[0.71 to 1.8]	30°	[2.5]	30	60	251
LD 261/IV		[1.12 to 2.8]	30°	[4.0]	30	60	251

1) I_p spread within one array ≦ 1 : 2 (matching factor 0.5) closer spread values upon request
2) Measured with HP radiant flux meter 8334A (option 013) measuring distance ≧ 70 mm.

▼ New type ■ Not for new equipment

1.1. Summary of types

GaAs Infrared emitting diode arrays

Type (Number of diodes per array)	Radiant flux I_F = 50 mA Φ_e (mW)			Half angle φ (for 50% $I_{v\,max}$)	Max. perm. forward current	Page
	Φ_e at	φ	Φ_e total	degree	I_F (mA)	
LD 261 (1)[1]	0.32 to 2.50	30°	2.0	30	50	256
LD 262 (2)						256
LD 263 (3)						256
LD 264 (4)						256
LD 265 (5)						256
LD 266 (6)						256
LD 267 (7)						256
LD 268 (8)						256
LD 269 (9)						256
LD 260 (10)						256

[1] I_e spread within one array ≦1 : 2 (matching factor 0.5) closer spread values upon request

GaAsP light emitting diodes (red light)

Type	Luminous intensity at I_F = 20 mA I_v (mcd)	Half angle φ (for 50% $I_{v\,max}$) degree	Case colour	Reverse current at V_R = 3 V I_R (μA)	Page
▼ CQY 26 A	0.8	30	red diffuse	0.01 (≦ 10)	265
▼ CQY 26/I	1.5 (≧ 1.0)	30	red diffuse	0.01 (≦10)	265
▼ CQY 26/II	2.5 (≧ 2.0)	30	red diffuse	0.01 (≦ 10)	265
▼ LD 30 A	0.8	35	red diffuse	0.01 (≦ 10)	271
▼ LD 30/I	1.5 (≧ 1.0)	35	red diffuse	0.01 (≦ 10)	271
▼ LD 30/II	2.5 (≧ 2.0)	35	red diffuse	0.01 (≦ 10)	271
▼ LD 30 C	2.5 (≧ 1.0)	25	glass clear	0.01 (≦ 10)	271
■ LD 40/I	0.7 (≧ 0.3)	40	red diffuse	0.01 (≦ 10)	275
■ LD 40/II	1.2 (≧ 0.8)	40	red diffuse	0.01 (≦ 10)	275
▼ LD 41 A	0.8	30	red diffuse	0.01 (≦ 10)	279
▼ LD 41/I	1.5 (≧1.0)	30	red diffuse	0.01 (≦ 10)	279
▼ LD 41/II	2.5 (≧ 2.0)	30	red diffuse	0.01 (≦ 10)	279
LD 50/I	3.0 (≧ 2.0)	12	red diffuse	0.01 (≦ 10)	284
LD 50/II	6.0 (≧ 4.0)	12	red diffuse	0.01 (≦ 10)	284
LD 461	1 (≧ 0.6)	50	white diffuse	0.01 (≦ 10)	289
▼ LD 461 A	≧ 0.4	50	white diffuse	0.01 (≦ 10)	289

GaAsP light emitting diode arrays (red light)

Type (Number of LEDs per array)	Luminous intensity at I_F = 20 mA I_v (mcd)	Half angle φ (for 50% $I_{v\,max}$) degree	Case colour	Reverse current at V_R = 3 V I_R (μA)	Page
LD 462 (2)	0.6 to 1.2	50	white diffuse	0.01 (≦ 10)	295
LD 463 (3)					295
LD 464 (4)					295
LD 465 (5)					295
LD 466 (6)					295
LD 467 (7)					295
LD 468 (8)					295
LD 469 (9)					295
LD 460 (10)					295

▼ New type; ■ Not for new equipment

1.1. Summary of Types

GaP light emitting diodes (green light)

Type	Luminous intensity at I_F = 20 mA I_v (mcd)	Half angle φ (for 50% $I_{v\,max}$) (degree)	Case colour	Reverse current at V_R = 3 V I_R (μA)	Page
▼ **CQY 28 A**	1.2	25	green diffuse	0.01 (≦ 10)	299
▼ **CQY 28/I**	3.0 (≧ 2.5)	25	green diffuse	0.01 (≦ 10)	299
▼ **CQY 28/II**	5.5 (≧ 4.0)	25	green diffuse	0.01 (≦ 10)	299
▼ **LD 37 A**	1.0	35	green diffuse	0.01 (≦ 10)	304
▼ **LD 37/I**	2.5 (≧ 2.0)	35	green diffuse	0.01 (≦ 10)	304
▼ **LD 37/II**	5.0 (≧ 3.0)	35	green diffuse	0.01 (≦ 10)	304
▼ **LD 57 A**	1.2	25	green diffuse	0.01 (≦ 10)	309
▼ **LD 57/I**	3.0 (≧ 2.5)	25	green diffuse	0.01 (≦ 10)	309
▼ **LD 57/II**	5.5 (≧ 4.0)	25	green diffuse	0.01 (≦ 10)	309
LD 471	4.5 (≧ 3.2)	50	green diffuse	0.1 (≦ 10)	314
▼ **LD 471 A**	≧ 1.25	50	green diffuse	0.1 (≦ 10)	314

GaP light emitting diode arrays (green light)

Type (Number of LEDs per array)	Luminous intensity at I_F = 20 mA I_v (mcd)	Half angle φ (for 50% $I_{v\,max}$) (degree)	Case colour	Reverse current at V_R = 3 V I_R (μA)	Page
LD 472 (2)	3.2 to 6.3	50	green diffuse	0.1 (≦ 10)	319
LD 473 (3)					319
LD 474 (4)					319
LD 475 (5)					319
LD 476 (6)					319
LD 477 (7)					319
LD 478 (8)					319
LD 479 (9)					319
LD 470 (10)					319

GaP light emitting diodes (yellow light)

Type	Luminous intensity at I_F = 20 mA I_v (mcd)	Half angle φ (for 50% $I_{v\,max}$) (degree)	Case colour	Reverse current at V_R = 3 V I_R (μA)	Page
▼ **CQY 29 A**	1.5	25	yellow diffuse	0.01 (≦ 10)	324
▼ **CQY 29/I**	4.0 (≧ 3.0)	25	yellow diffuse	0.01 (≦ 10)	324
▼ **CQY 29/II**	7.0 (≧ 5.0)	25	yellow diffuse	0.01 (≦ 10)	324
▼ **LD 35 A**	1.5	35	yellow diffuse	0.01 (≦ 10)	329
▼ **LD 35/I**	3.5 (≧ 2.5)	35	yellow diffuse	0.01 (≦ 10)	329
▼ **LD 35/II**	6.0 (≧ 4.0)	35	yellow diffuse	0.01 (≦ 10)	329
▼ **LD 55 A**	1.5	25	yellow diffuse	0.01 (≦ 10)	334
▼ **LD 55/I**	4.0 (≧ 3.0)	25	yellow diffuse	0.01 (≦ 10)	334
▼ **LD 55/II**	7.0 (≧ 5.0)	25	yellow diffuse	0.01 (≦ 10)	334
▼ **LD 481**	7 (≧ 4)	50	yellow diffuse	0.1 (≦ 10)	339

▼ New type

1.1. Summary of Types

GaP light emitting diode arrays (yellow light)

Type (Number of diodes per array)	Luminous intensity at I_F = 20 mA I_v (mcd)	Half angle φ (for 50% $I_{v\,max}$) degree	Case colour	Page
▼ LD 482 (2)	4 to 8	50	yellow diffuse	344
▼ LD 483 (3)				344
▼ LD 484 (4)				344
▼ LD 485 (5)				344
▼ LD 486 (6)				344
▼ LD 487 (7)				344
▼ LD 488 (8)				344
▼ LD 489 (9)				344
▼ LD 480 (10)				344

Optoelectronic couplers

Type	Current transfer ratio in % I_C/I_F (10 mA)	Insulation test voltage V_{is} (V)	GaAs LED		Phototransistor		Page
			Forward current I_F (mA)	Reverse voltage V_R (V)	Collector current I_C (mA)	Collector voltage V_{CEO} (V)	
CNY 17/I	40–80	4000 =	60	3	100	70	351
CNY 17/II	63–125	4000 =	60	3	100	70	351
CNY 17/III	100–200	4000 =	60	3	100	70	351
CNY 17/IV	160–320	4000 =	60	3	100	70	351
CNY 18/I	10–20	800 =	60	3	100	32	357
CNY 18/II	16–32	800 =	60	3	100	32	357
CNY 18/III	25–50	800 =	60	3	100	32	357
CNY 18/IV	40–80	800 =	60	3	100	32	357

Photoresistors

Type	Operating voltage V_a (V)	Dark resistance R_0 (Ω)	Light resistance R_{1000} (Ω) [R_{20}]	Wavelength of the max. sensitivity $\lambda_{S\,max}$ (nm)	Page
▼ **FW 9801**	100	$\geqq 8 \cdot 10^5$	[600]	575	363
▼ **FW 9802**	200	$\geqq 8 \cdot 10^5$	[1800]	575	363
RPY 60	100	$\geqq 1 \cdot 10^8$	300 to 800	720	365
RPY 61	50	$\geqq 1 \cdot 10^6$	300 to 800	650	368
RPY 62	100	$\geqq 1 \cdot 10^8$	3500	550	371
RPY 63	50	$\geqq 1 \cdot 10^6$	300 to 800	550	374
RPY 64	100	$\geqq 1 \cdot 10^8$	3500	550	377

Threshold switch for optoelectronic applications

Type	Max. operating voltage V_{batt}	Input current I_E (pA)	Switching threshold V_{ES} (V)	Rise time $\frac{dV_A}{dt}$ $\frac{(V)}{\mu s}$	Temperature coefficient TC (%/K)	Page
▼ **TPV 63**	± 10	20	0.8	3	– 0.6	383

▼ New type

1.2. Symbols, alphabetically

A	Anode
A	Radiant sensitive area
B	Base terminal
B	Static current gain, emitter circuit
C	Collector terminal
C	Capacitance
C_0	Capacitance at $V_R = 0$ V
C_{10}	Capacitance at $V_R = 10$ V
C_D	Diode capacitance
C_{CB}	Collector-base capacitance
C_{CE}	Collector-emitter capacitance
C_{EB}	Emitter-base capacitance
C_j	Junction capacitance
C_E	Input capacitance
C_K	Coupling capacitance
cd	Candela (unit of luminous intensity I_v)
D^*	Detection limit
E	Emitter terminal
E_e	Irradiance (unit: W/m^2)
E_v	Illuminance (unit: lx)
η	Quantum yield
η	Efficiency (%)
f	Frequency
f_g	Cut-off frequency
I_B	Base current
I_C	Collector current
I_{CEO}	Collector-emitter leakage current (open base, $I_B = 0$)
I_{EAV}	Emitter current at a given integrated time t_{av}
I_{EBO}	Emitter base leakage current (open collector, $I_e = 0$)
i_{FS}	Surge current
I_F	Forward current
I_E	Emitter current
I_e	Radiant intensity (unit: W/sr)
I_K	Short circuit current
I_{K25}	Short circuit current at $T_{amb} = 25°C$
I_v	Luminous intensity (unit: cd or mcd)

I_P	Photocurrent
I_R	Reverse current
K	Cathode
L_v	Luminance (cd/m²)
λ	Wavelength (nm)
$\lambda_{S\,max}$	Wavelength of the max. sensitivity
λ_{peak}	Wavelength at peak emission
ν	Duty cycle
NC	Not connected contact
NEP	Noise equivalent power $\left(\frac{W}{\sqrt{Hz}}\right)$
P_{tot}	Power dissipation
φ	Half angle
Φ_e	Radiant flux (radiant power) (W)
R_H	Light resistance Luminous flux (lm) Lumen
R_{HT}	Light resistance at temperature T
$R_{H\,25^\circ}$	Light resistance at temperature T = 25°C
R_{1000}	Light resistance at E_v = 1000 lx
R_L	Load resistance
R_O	Dark resistance 1 min after darking
R_s	Series resistance
R_{th}	Thermal resistance junction (heat source) – case at unlimited good heat dissipation from case ($T_{case} = T_{amb}$)
R_{thL}	Thermal resistance, junction (heat source) – static ambient air when using a cooling plate of definite size
R_{thJamb}	Thermal resistance, junction (heat source) – ambient static air
$R_{thJcase}$	Thermal resistance, junction – case
R_{thJL}	Thermal resistance, junction – solder pin connection
S	Spectral sensitivity
S_{rel}	Relative spectral sensitivity
t	Time
t_{on}	Turn-on time
t_{off}	Turn-off time
t_f	Fall time
t_r	Rise time
t_d	Delay time
t_s	Storage time
T	Temperature

T_{case}	Case temperature
T_j	Junction temperature
TC	Temperature coefficient
T_s	Soldering temperature
T_{stor}	Storage temperature
T_{amb}	Ambient temperature
T_F	Colour temperature
ΔT	Temperature deviation
V_{batt}	Voltage
V_{op}	Operating voltage
V	Battery voltage
V_{out}	Output voltage
V_{BR}	Breakdown voltage
V_{CE}	Collector-emitter voltage
V_{CEO}	Collector-emitter junction voltage, open base (I_B = 0)
V_{CEsat}	Collector-emitter saturation voltage
V_{EBO}	Emitter-base junction voltage, open emitter (I_E = 0)
V_{ES}	Switching threshold
V_F	Forward voltage
V_{IS}	Insulation voltage
V_L	Open circuit voltage
V_{L25}	Open circuit voltage at T_{amb} = 25°C
V_P	Photovoltage
V_R	Reverse voltage
V_{leak}	Leakage voltage
ϱ	Resistivity of base material (Ω/cm)

2. General

2.1. Introduction

Optoelectronic components are increasingly used in modern electronics. Main fields of application are light barriers for production control and safety devices, light control and regulating equipment like twilight switches, fire detectors and facilities for optical heat supervision, scanning of punched cards and perforated tapes, positioning of machine tools (for measuring length, angle and position), of optical apparatus and ignition processes, for signal transmission at electrically separated input and output, as well as conversion of light into electrical energy.

Lately, new fields of application opened up for optoelectronic components in the photo industry in form of exposure and aperture control and for automatic electronic flashes. IR sound transmission and IR remote control are new modes in the radio industry. Computer diagnosis and LED displays in instrument panels are possible applications in the automotive industry.

In data processing couplers electrically separate computer and peripherals. Ultimately LED and numerical indicator tubes won wide application in the measuring and control technique.

Depending upon the application either photovoltaic cells, photodiodes or
are used. Wherever amplifiers with high input impedance are required, photodiodes are to be preferred.

Phototransistors are predominantly used in connection with transistor circuits or to drive integrated circuits, whereas photovoltaic cells are preferred to scan large surfaces, if a strictly linear relation between light and signal level or optimum reliability is required.

Apart from photoelectric detectors also light emitters on a semiconductor basis find application, the light emitting diodes. One differentiates between light emitters on the basis of GaAs (gallium arsenide) which operate in conjunction with the photo detectors described and are spectrally attuned to them and those based on GaAsP (gallium arsenide phosphide) or GaP (gallium phosphide) which emit visible light and mainly serve as signal indicators.

Light emitting diodes and alphanumerical displays in red, green, and yellow replace the conventional indication by lamps in an ever increasing scale.

Components comprising both emitter and sensor are termed optically coupled isolators or optoelectronic couplers. They are used to transmit electrical signals at electrical isolation.

In the following the various topics will be handled in detail as to technology, special characteristics and application possibilities. Thereafter comes a chapter devoted to the measuring technique of optoelectronic components togehter with the most essential tables and performance charts, finally quality specifications, mounting and soldering instructions.

2.2 Silicon photovoltaic cells

Photovoltaic cells are active two-poles with a comparably low internal resistance that has its cause in the voltage of the voltaic cell, which may only be some tenth of a volt. For practical application, this characteristic requires special attention.

The open circuit voltage V_L rises almost logarithmically as a function of the illuminance and, particularly in case of planar photovoltaic cells, reaches high values already at very low illuminances. It is independent of the size of the photovoltaic cell.

The short circuit current I_K increases linearly with the illuminance. It is proportional to the size of the exposed photosensitive area at uniform illuminance.

The maximum energy of the photovoltaic cell is yielded in a load resistance R_L of approx $\frac{V_L}{I_K}$.

Practical short circuit operation and thus proportionality between optical and electrical signal is given at load resistance up to $\frac{V_L}{2\,I_K}$. This relation can be applied to an open circuit voltage of $\geqq$ 100 mV.

In any type of application the highest value of I_K has to be used. A simple procedure to gain information on the load resistance required is to measure V_L and I_K at given illumination conditions, irrespective of the radiation source.

In case the voltage yielded by the photovoltaic cell is insufficient it can also be used in diode operation at reverse voltages up to 1 V. In such case the flowing dark current has to be taken into consideration.

The rise time of a signal voltage delivered to a load resistor by the voltaic cell primarily depends on the operating conditions. There are two distinctive borderline cases:

1. Load resistor smaller than the matching resistor (tendency toward short circuit operation)
2. Load resistor larger than the matching resistor (tendency to open circuit operation).

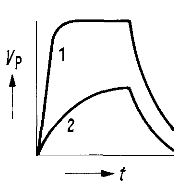
In case 1) the photovoltage rise is analogous to the charging of a capacitor via a resistor from a constant voltage source. In photovoltaic cells the junction capacitance C_j must be charged. The rise occurs by the time constant $\tau = R_L \cdot C_j$, R_L being the load resistor (the low ohmic resistance of the photovoltaic cell is considered negligible).

In case 2) the photovoltage rise is similar to the charging of a capacitor by a constant current mode. The rise time t_r of the photovoltage follows the equation

$$t_r = \frac{V_P \cdot C_j}{I_K}$$

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

The principal characteristic of the rise time of photovoltaic cells is shown in the following diagram:



Case 1) Rise time according to the equation

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

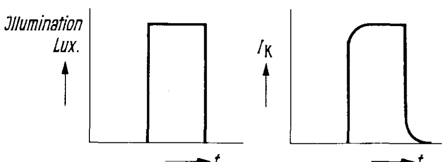
Time constant $\tau = R_L \cdot C_j$.

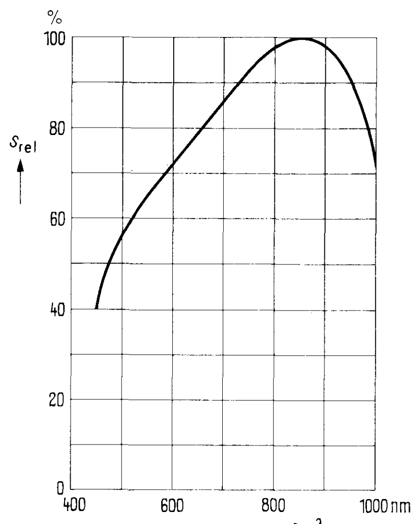
Case 2) Rise time $t_r = \frac{V_P \cdot C_j}{I_K}$

fall time in both cases $\tau = R_L \cdot C_j$

Modulation transients can, under certain conditions, lead to a modification of the above diagram.

E.g. At very low time constants (particularly in short circuit operation) the actual pulse shape of the short circuit current that deviates from an ideal square pulse has to be noted. See diagram.





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

2.3. Silicon photodiodes

These photodiodes have a PN junction poled by a reversed bias. The capacitance which decreases with a growing reverse voltage reduces the switching times. The PN junction is of easy access to the light. Without illumination a very small reverse current flows, the so-called dark current. Light falling onto the surrounding of the PN junction generates charge carrier pairs there that lead to an increase of the reverse current. This photocurrent is proportional to the illuminance. Therefore, photodiodes are particularly well suited for quantitative light measurements. The planar technique has 2 essential advantages: The dark currents are considerably smaller than for comparable photo electric components in non-planar technique. This leads to a reduction of the current noise and thus to a decisive improvement of the signal/noise ratio.

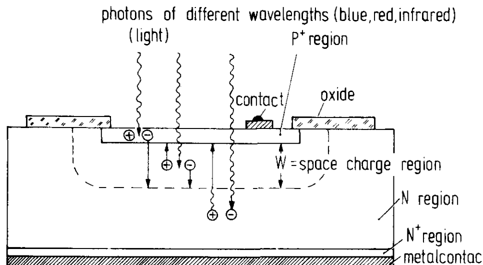


Figure 1

Figure 1 shows the basic design of a photodiode. The limit of the space charge region is indicated by a dashed line.

Without illumination only a small dark current I_D flows through the PN junction as a result of thermally generated carriers.

With light, additional charge carrier pairs (hole electron pairs) are generated in the P and N region by the radiation quantum (internal photo effect). Carriers originating in the space charge region are immediately extracted because of the electrical field present there, i.e. the holes in the P and the electrons in the N direction. Carriers from the remaining field must first diffuse into the space charge region in order to be separated there. If holes and electrons recombine before, they do not contribute to the photocurrent.

Thus, the photocurrent I_P is a combination of the drift current of the space charge region and the diffusion current of the P and N area.

I_P is proportional to the incident radiation intensity. Since I_D is very small for diodes, it can be neglected in the equation $I_P = I_P + I_D$. Subsequently one gets a linear correlation between I_P and the incident radiation intensity over a very wide range.

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

PN diodes have the diffusion current as dominating part of the photocurrent whereas it is the drift current in the case of PIN diodes.

As the capacitance of the space charge width W is inversely proportional, the PIN diode is characterized by a smaller capacitance than a PN diode of identical surface. The capacitance of (most of) the diodes reads:

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

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

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

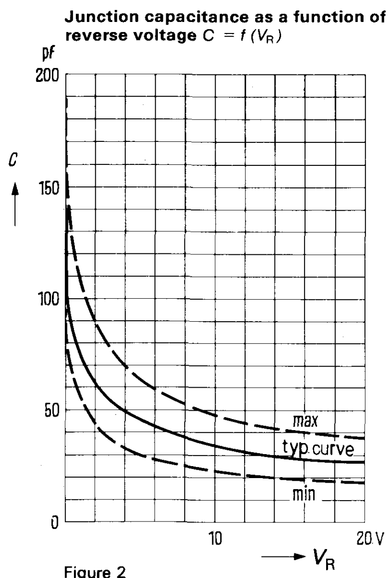


Figure 2

2.4. Mounting instructions for silicon voltaic cells and photodiodes,
open design without casing

As silicon is an inherently brittle material, the photoelectronic component should be shielded from pressure or tension. Contact points are particularly endangered. Should tension come to bear on the solid wire leads which, for technological reasons, are alloyed to a very thin P layer it should only be parallel to the surface and must not exceed 200 p (pond). Leads may only be bent 3 mm off the outer edge of the photoelectric component. Photoelectric components can be cemented onto metallic or plastic supports but the expansion coefficient of the material has to be taken into consideration to prevent mechanical strain between support and photoelectric component at change of temperature. An epoxy resin is to be used to cement or encapsulate the photoelectric component. It has to be colourless and should not grow darker with time. After curing, the epoxy resin must not have any gas occlusions (filter effect). The epoxy resin EPICOTE 162[1] together with the hardener LAROMIN-C 260[2] are particularly suited for the encapsulation of photoelectric components. 100 weight parts EPICOTE 162, 38 weight parts LAROMIN-C 260 are to be mixed well and remain workable for about 30 minutes. After that period of time the epoxy becomes viscid. All material to be encapsulated has to be dry, dust- and grease-free. Should bubbles form after the encapsulation it is advisable to raise the curing process temperature to 100°C for a short time. It makes the bubbles come to the surface and burst. The normal curing temperature lies between 60 and 80°C. The curing time is 1 hour, it lessens with higher temperature. When working with epoxy great care should be taken that neither the resin nor the hardener touches the skin. The quickly binding glue SICOMET 85[3] proves adequate to cement open-design Si diodes or photovoltaic cells. The light sensitive surface of the photovoltaic cell is coated with a protective lacquer and should not be contaminated while cementing.

1) Registered trademark (Shell Chemical)
2) Registered trademark (BASF)
3) Registered trademark (Sichel-Werke, Hannover)

2.5. Silicon phototransistors

The introduction of the planar technique allows to produce phototransistors of small dimensions. They are used as photoelectric detectors in control and regulating devices. The photoelectric transistors are excellently suited as receivers for incandescent lamp light, as their maximal photosensitivity lies near the infrared limit of the light wave spectrum.

In its mode of operation a photoelectric transistor corresponds to that of a photodiode with built-in amplifier. It has a 100 to 500 times higher photosensitivity than a comparable photoelectric diode.

The photoelectric transistor is preferably operated in an emitter circuit and acts similar to an AF transistor.

Unilluminated only a small collector-emitter leakage current flows. It amounts to approximately $I_d = B \cdot I_{CBO}$, B standing for the current amplification and I_{CBO} for the reverse current of the base diode.

At illumination the reverse current of the base diode I_{CBO} increases by the photocurrent I_P'. Thus, one receives for the photocurrent $I_P \sim B\ (I_{CBO} + I_P')$.

Consequently, the photocurrent of a transistor is a function of the photocurrent I_P' of the base diode and the current amplification B. As B cannot be increased indefinitely, an as high as possible photosensitivity of the base diode is aimed at.

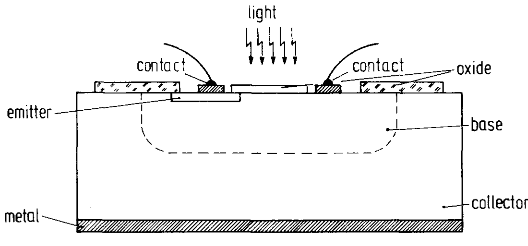


Figure 3

Figure 3 shows the design of a phototransistor. The emitter and base leads are affixed laterally to make the base diode most easily accessible to light. The large collector zone ensures that the most possible radiation quanta are absorbed there and will contribute to the photocurrent.

Contrary to a photodiode, a linear interconnection between the incident radiation intensity and the photocurrent I_P exists only in a small region, since the current gain B depends on the current. Figure 4 shows typical current voltage characteristics of a phototransistor.

Since the reverse current I_{CBO} of the base diode is amplified in the same way as the photocurrent I_P, the signal/noise ratio of the phototransistor is the same as that of the photodiode.

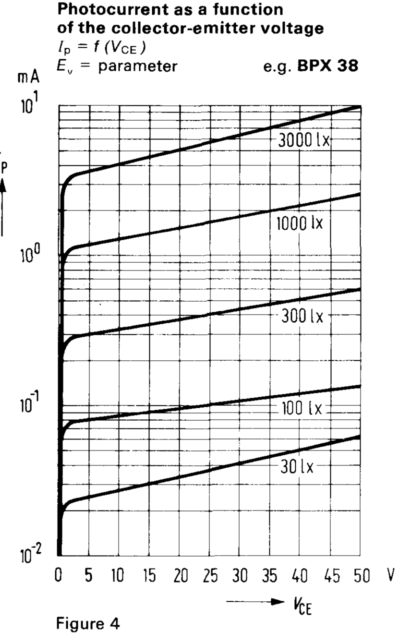


Figure 4

For the versatile applications, special type phototransistors are available. BPY 62, BPX 43, BP 101 and BP 102 requiring no lens on the receiver side are suitable for general applications.

BPY 62 is outstanding for a higher cut off frequency, BPX 43 for a higher photo-sensitivity.

In case the application demands a lens on the detector side, this requirement is met by BPX 38. The flat window of this phototransistor makes a precise reproduction of the focal spot on the photosensitive surface of the transmitter system possible. On account of the larger system surface, the adjustment and alignment of the transistor case to the light emitter causes less difficulties.

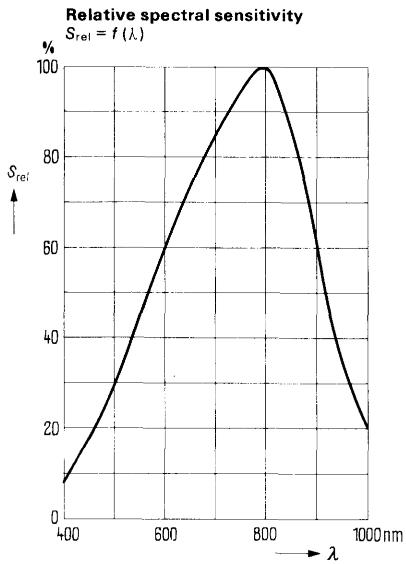
At the types mentioned, the user may preset the operating point of the phototransistor by wiring the base leads. The rapidity of response may thus be increased and the photo-sensitivity reduced. A fixed bias can reverse the phototransistor. Coincidence circuits can be realized by scanning this bias.

The phototransistor BPY 61 meets the requirement for high packing density. It is enclosed in a miniature glass case of 13 mm x 2.1 mm Ø and its photosensitivity is by the factor 500 to 1000 higher than small-surface silicon photovoltaic cells. Also the BPX 62 in micro ceramic case is provided for use on PC boards at minimum space requirements. The tolerance range of the light sensitivity is subdivided into four sensitivity groups. There is no base contact. Light is the controlling element which produces a correspondingly high collector current via the emitter-base path of the transmitter system, multiplied by the factor of the current gain. The rise and fall times depend on the illuminance and decrease with rising intensity.

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

Under limited mounting conditions the following amplifier must often be connected by relatively long leads. There is only little danger of interference pick-up since a sufficiently large signal to noise ratio is ensured by high photoelectric currents.

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



2.6. Photoresistors

Photoresistors are passive photoelectric components. They consist of cadmium sulphide or cadmium selenide or a mixture of these two materials and have a high spectral sensitivity for light wavelengths from ultraviolet to the near infrared. Electrically they are ohmic resistors, their resistance degree being determined by the illuminance.

Photoresistors are bipolar and can therefore be used in dc and ac circuits.

A change in the resistance degree as a function of the illuminance causes a moment of inertia. The response times are some milliseconds. The temperature coefficient of a photoresistor is low and decreases with rising illuminance.

2.7. Light emitting diodes (IRED/LED)[1] and semiconducting indicators

Definition

Light emitting diodes are semiconductor diodes emitting electromagnetic radiation when operated in forward direction. The wavelength of the emitted radiation depends on the semiconductor material used and its doping. GaAsP LEDs (gallium arsenide phosphide LEDs) emit red light, GaP LEDs (gallium phosphide-LEDs) emit green, yellow light, respectively, and GaAs diodes (gallium arsenide IRED) emit in the infrared region of the spectrum.

The main applications result from these facts. Diodes emitting in the visible spectral region are used as signal lamps or indicators whereas GaAs diodes are employed as a radiation source in light barrier arrangements.

Displays are used to represent numerical or alpha-numerical symbols. The symbols are produced in one level which results in a wide viewing angle. Special data sheets are available on LED semiconductor displays.

IRED, LED and displays have the following advantages:

- long life (appr. 10^5 hrs half life)
- they are shock and vibration resistant
- they are circuit compatible
- the emitted light can easily be modulated
- their designs permit a high packing density.

[1] LED = Light emitting diode
IRED = Infrared emitting diode

2.7.1. Design and mode of operation

Light emitting diodes are operated in forward direction. At flow of current freely moving electrons penetrate through the PN junction into the P-space where they recombine with the holes present there. At this process, energy is released in form of radiation.

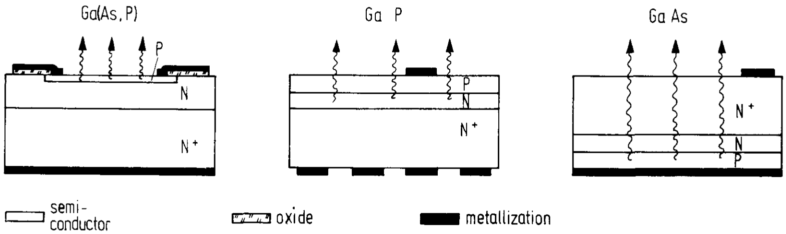


Figure 5

Figure 5 shows as diagram three types of light emitting diode systems. GaAsP diodes manufactured in planar-technology have their PN junction 2–4 μ under the semiconductor surface. The light is produced in the thin P region and leaves the crystal through the near surface. All light propagating into the interior of the crystal is absorbed. The GaP and GaAs LEDs are epitaxial diodes with an approximately 20–50 μm P layer, where the radiation is produced.

The absorption of these materials is very low. Therefore, the GaAs IRED LEDs are mounted with the P side to the metal support for better heat dissipation.

LEDs emitting in the visible range are offered as full-plastic versions. The single diodes (such as LD 41, LD 30, LD 57, LD 37 etc.) are intended for installation in front panels. The arrays LD 46, LD 47, LD 48 are suitable for versatile applications. The arrays of these types, consisting of 1 to 10 individual diodes, can be arranged indefinitely. They are suitable for use in complex indication systems such as scales and large displays.

GaAs IREDs are enclosed in plastic cases (array series LD 26) or in hermetically sealed glass-metal ones (CQY 17, CQY 18, CQY 77, CQY 78). The radiation characteristics are essential for the user. When using the light emitting diodes in arrangements without an optical lens as for instance in a reading-head for punched tapes, the apex angle of the radiation should be small. This is the case with LD 26 and CQY 77. In connection with optical lens systems those types are preferred where radiation leaves through a flat window (CQY 18, CQY 78).

In a 7-segment display 7 LEDs are mounted on a metal support and are red plastic encapsulated. The red colouring is meant to improve the contrast. Larger ones (up to 60 mm height) can be realized with the LD 46 array series as numerical or alpha-numerical display. The displays can be triggered as well in static as in time division multiplex-operation ($f > 100$ Hz because then free of flickering) by a BCD seven segment decoder/driver circuit. For displays with several digits the time division multiplex process usually proves more economic. Only one decoder is used for all figures which, like the digits, are driven by a clock generator. A latch holds the input signal until new information is received (Fig. 6).

Block diagram of the multiplex driving of n-digit LED displays

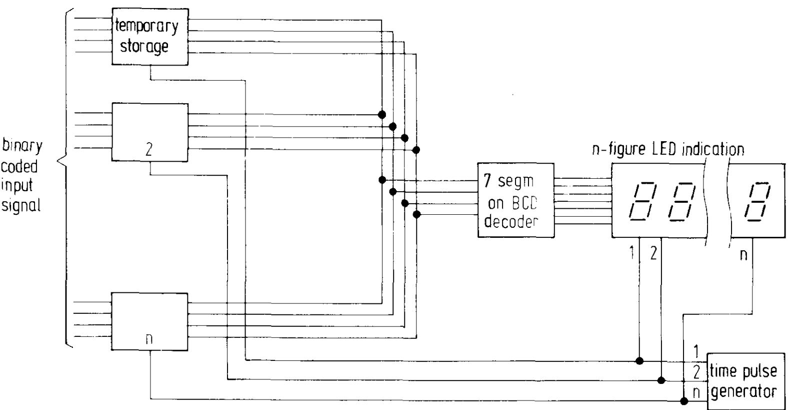


Figure 6

2.7.2. Electrical-optical characteristics

The emitted radiation (luminous intensity respectively) changes lineary with the forward current in the normal operation range as far as diodes and displays are concerned. If the forward current is very high, the curve asymptotically approaches a threshold value. This is caused by a strong heating of the semiconductor system. The linearity range can be widened by switching from static to pulse operation. Non-linearity also turns-up at small forward currents. It is caused by excess current not contributing to the radiation and cannot be influenced by the customer.

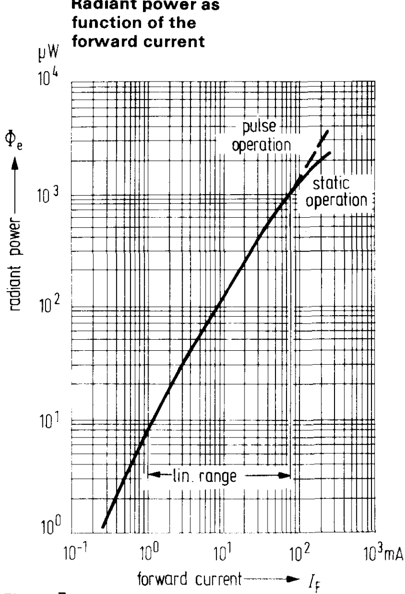


Figure 7

At constant current, the radiant intensity, luminous intensity respectively, decreases with rising temperature. The temperature coefficient is −0.7% per degree for GaAs, −0.8% per degree for GaAsP, and −0.3% per degree for GaP. This is negligible for many applications. If the temperature dependence proves disturbing it can widely be eliminated by compensation circuits.

The radiant power emitted by LEDs declines with increasing length of operation ("aging"). A "life" of components was introduced to describe the degree of degradation. It is defined as the time after which the radiant power has fallen to half the value. In case of CW operation the life is approximately 10^5 hours. This applies to an ambient temperature T_{amb} = 25°C and a forward current I_F = 100 mA (CQY 17, CQY 18, CQY 77, CQY 78) respectively I_F = 50 mA (LD 26 series and visible LED).

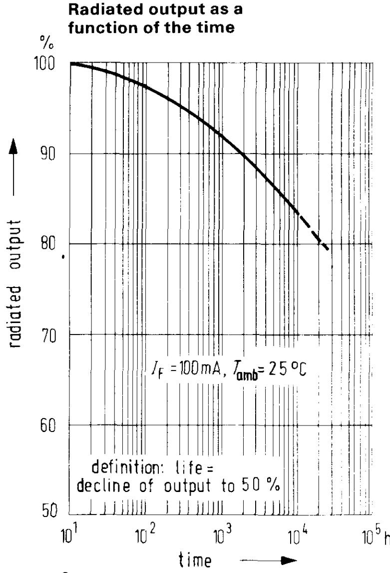


Figure 8

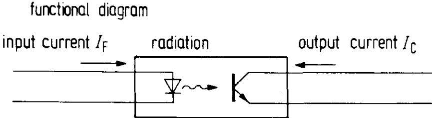
2.8 Optoelectronic couplers

Definition

Couplers are optoelectronic components for the transmission of signals at electrical input-output separation. They are also termed optoelectronic isolators.

Design and mode of application

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



Basic circuit

As shown in the above diagram the current transmission is effected by connecting the output to the emitter and collector of the transistor. Often also the base is connected. This permits more variations in the wiring technique. On the one hand, charge carriers can be shunt off from the base via a resistor by which the cut-off frequency of the transistor is increased, though at the expense of the transmission factor. On the other side, the transistor with its normal transistor functions can be incorporated in the secondary circuit.

The essential characteristics

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

The insulation voltage depends on the type. At the TO 18 like CNY 18 it amounts to 500 V, at the DIL 6 coupler CNY 17 to 2.5 kV.

The transmission ratio is the relation between output and input current and is stated in percents. Practical values lie between 20 and 300%. Its rating depends on the radiant power of the light emitting diode, the quality of light transmission and the static current transfer ratio of the transistor. Latter usually amounts to a few hundred.

Since both, the light emitting diode and the phototransistor are temperature dependent, the transmission ratio of the coupler is so too. At low temperatures, it is determined by the positive temperature coefficient of the transmitter, at higher temperatures the negative coefficient of the LED prevails. At first, the transmission ratio of the coupler increases with the temperature, then passes through a maximum between 0 and 50°C and declines afterwards.

Couplers are well suited for transmission of both digital and analog signals. In analog operation a certain non-linearity between input and output current has to be taken into consideration which, however, is negligible in case of small signals.

2.9. Measuring technique of optoelectronic semiconductor devices

Optoelectronic semiconductor devices, photovoltaic cells, photodiodes, phototransistors etc. are special versions of standard semiconductor devices which were developed in view of their particular field of application. Their measuring technique includes and is based on the conventional and well-known one of diodes and transistors. It is supplemented by a special optoelectronic measuring technique. Irrespective of the fact whether the objects to be measured are radiation sensitive (detectors) or radiation emitting (emitters) components or a combination of both (e.g. optoelectronic couplers), the measuring system radiator/receiver remains the same, only the object to be measured changes its place. The essential difference to the standard measuring method lies in the broadband of the measuring system and the pronounced spectral characteristics of emitters and detectors as well as in the problem of an exact description of these characteristics and their reproducibility in order to achieve coinciding results at any time and in any place. This requires the observation of the following instructions.

Radiation sensitive components (detectors)

Radiation-sensitive semiconductor devices serve to convert radiation energy into electrical one. Radiation energy can be offered to the component in manifold forms, depending on the source of radiation. For measuring purposes only such radiation sources can be taken into consideration which, in their spectral energy distribution, can easily be covered and are reproducible, i.e. thermic radiation sources like the tungsten filament lamp, which at least in the wavelength range here of interest comes very close to the black body and monochromatic light sources that means those emitting radiation of only one wavelength or at least of a very narrow wavelength range, above all light emitting diodes and a combination of whatever emitters with narrow band filters. Because of its high energy, the tungsten filament lamp is mainly used for measuring the radiation sensitivity when set to a "colour temperature" of 2856 K, corresponding to standard light A as per IEC 306-1 part 1 and DIN 5033 while light emitting diodes are primarily employed for cut-off frequency and switching time measurements as they can be modulated or pulsed up to high frequencies. At this instance, we want to draw your attention to the following. The definition "colour temperature" (see table 2.9.1) shows that basically, this statement is only very limited useful for the optoelectronic measuring technique, quasi only as auxiliary. But unfortunately the term has come to stay. In practice the lamps are not calibrated to colour temperature but to "relative temperature in the visible range", mostly to a green-red relation. An extension to a red-green-infrared relation and thus an approach to the, for our measuring technique solely correct, "distribution temperature" in the wavelength range 350 nm to 1200 nm, or even better 300 nm to 1800 nm, is worth aspiring after. This still meets with objections on the part of lamp manufacturers to extend their calibration equipment and the relative small quantity of lamps required.

The tungsten filament lamps used for measuring purposes have to be set to a relative spectral energy distribution that corresponds to that of the black body at a temperature of normally 2856 K at least in the wavelength range 350 nm to 1200 nm, and have to be operated under very stable conditions. It is necessary to have the lamp operated with constant current, the deviation from the rated value must be kept less than ±0.1%. This requirement seems to be very high, but one has to consider that a deviation of the lamp current by 0.1% brings about a change of the radiant intensity by 0.7% and, of the colour temperature, by 2 K. Naturally, the lamp can also be operated with constant voltage but this is hard to realize in practice because of the inevitable and varying contact resistances in the lamp socket, therefore an operation with constant current is to be preferred.

A lamp voltage check at the same time permits a control of the lamp with regard to a change in its characteristics for example by evaporating of coiled filament material which would point to the fact that the lamp is no longer suitable for measuring purposes and has

either to be replaced or calibrated anew. This check is mainly recommended for the "standard lamps" which are standard for colour temperature, radiant and/or luminous intensityy.

For general measuring purposes, serial measurements in particular, the standard lamps gauged by the PTB or the manufacturer are usually not used because of the calibration costs. Therefore, the service lamps are set to the given ratings by a comparison with these standard lamps. The procedure is as follows:

Setting of colour temperature

The standard lamp is set to current and/or voltage according to the material test certificate. So as to obtain exact and reproducible values, the coil filament of the lamp has to be adjusted precisely to vertical with a tolerance of $\pm 1°$. After a heating period of approximately 30 minutes the photocurrent of a linear receiver, usually the short-circuit current of a photoelectric device, is measured behind a narrow-band filter with a transmission wavelength of approximately 500 nm, 900 nm respectively. Care should be taken that the filters have no further pass band. The relation of these 2 measured values characterizes the spectral energy distribution of the black body at the given temperature. Now, the lamp current of the lamp to be calibrated is changed until the ratio of the photocurrent measured behind the 2 filters coincides with that measured before at the standard lamp. Thus the service lamp has the same colour temperature (or to be more precise, ratio temperature) as the standard lamp. It should be mentioned here that the lamp has to be calibrated in the case in which it will be operated later on since different heat conditions and reflexions in the case may lead to considerable changes in the radiation characteristics of the lamp.

Adjustment of the distance from the incandescent coiled filament for a given irradiance E_e, illuminance E_v, respectively

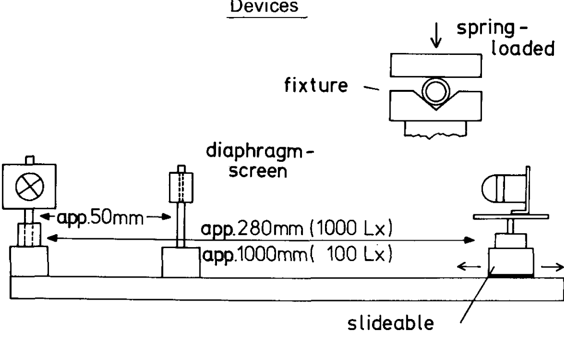
The material test certificate of the standard lamp usually states the radiant intensity (I_e) the luminous intensity (I_v), respectively, for the direction vertical to the coiled filament. At a sufficiently large spacing from the coiled filament, at least ten times the maximal filament dimension, we have $E = I/R^2$ from which one can calculate the spacing for the desired value of E according to $R = \sqrt{I/E}$. Now, the photocurrent of the photovoltaic cell is measured at this distance from the coiled filament of the standard lamp and then, by means of the voltaic cell, the distance to the service lamp at which the same photocurrent flows is set. In case a sufficiently precise luxmeter (e.g. Osram Centra-V (λ) Si photovoltaic cell) or a power meter of an adequate bandwidth is available the adjustment can, of course, be done by them. When irradiance measuring instruments are used one has to take into consideration that, in general, it is impossible to cover the entire range of the spectral energy distribution of the (black) emitter because, for example, of the installation of the thermocoupler behind a quartz-window. Consequently the measured irradiance E_e is too low compared to the black body. As a result the object is measured at too high an irradiance when E_e has been adjusted by this instrument (shortened spacing from body) although the object itself is insensitive to the spectral range filtered off in the radiant intensity meter. This can lead to differences in the photo current up to 20%. When stating the irradiance it is necessary to indicate the measuring instrument used in order to compare the measuring results (spectral sensitivity curve, window material, etc) and, for the colour temperature of the emitter, the correction factor related to the black body.

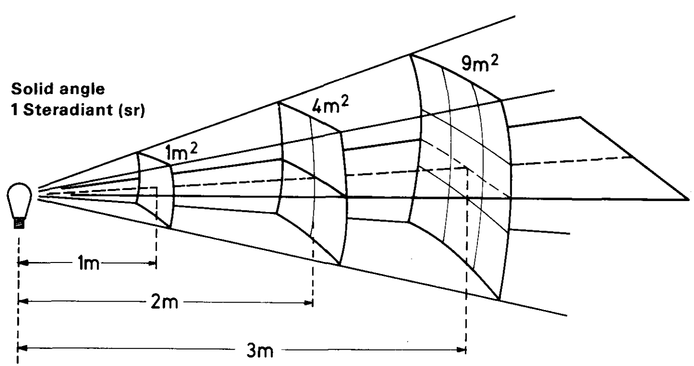
The radiant intensities given in this book were measured with the Hewlett-Packard Radiant Flux Meter hp 8334A with option 013.

At the moment the PTB and/or lamp manufacturers gauge standard lamps only at colour and/or ratio temperature in the visible range. Caused by the structure of standard lamp, in particular by uneven temperature distribution over the coiled filament (heat dissipation

by suspension), these gaugings do not even for lamps of the same type guarantee the same shape of spectral energy distribution in the infrared where the components to be measured usually have their maximum. Depending on type of lamp this is expressed in differences of the photocurrent of some % up to more than 10% under same measuring conditions, i.e. E_v = 100 lx and T_F = 2856 K. Lamps with filament or double filament show this particularly strong. Merely the new version Wi 41G of Osram with its detached coiled filament is an exception. The scattering from lamp to lamp is only some per mills as measurements of a large quantity of lamps proved and it can therefore be recommended as standard lamp in connection with semiconductor photoelectric components.

For photosensitivity measurements (photocurrent or photovoltage) the components to be measured are placed at the position predetermined for the specific irradiance and there they are held in such way that the radiant sensitive surface of the semiconductor chip is vertical to the direction of light. Cylindric components such as in TO 18, TO 5 or similar plastic cases are put up so that the case axis will coincide with the direction of radiation. This is of prime importance for components with a highly focusing lens. A holder with a sliding socket for the terminal wires proved useful (see figure 9).





$$E = \frac{I}{R^2} = \frac{\Phi}{F}$$

F = **Space penetrated by light flux Φ**

Figure 9

When measuring the short-circuit current I_K of a voltaic cell care has to be taken that the internal resistance of the measuring instrument used is small enough compared to the internal resistance of the photovoltaic cell. The same applies to measuring the open circuit, the internal resistance of the measuring instrument is large compared to the internal resistance of the photovoltaic cell. Fig. 10 shows this connection for the photovoltaic cell BPY 11 for E_v = 100 lx.

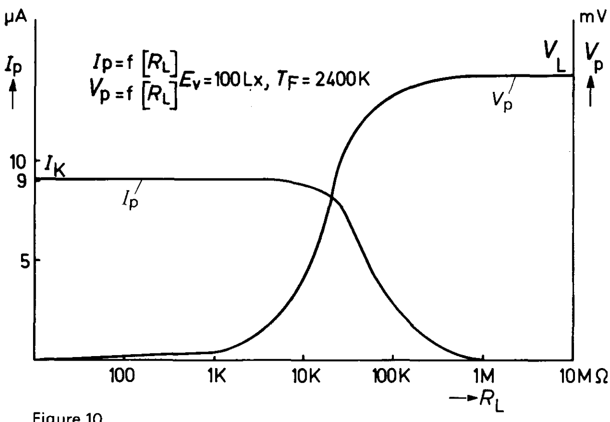


Figure 10

Measuring of switching times

The switching times are measured oscillographically by a set-up as shown in the below circuit diagram (fig. 11) by means of a pulsed infrared emitting GaAs diode as measuring source and a double-beam oscillograph. The switching times of the GaAs must, of course, be small compared to the switching times of the component to be measured.

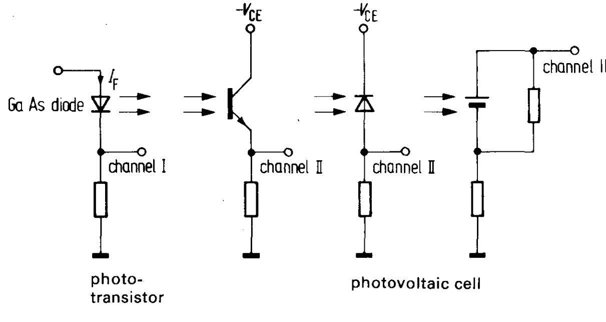
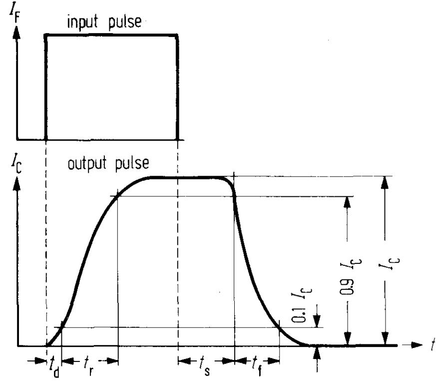


Figure 11

Switching times

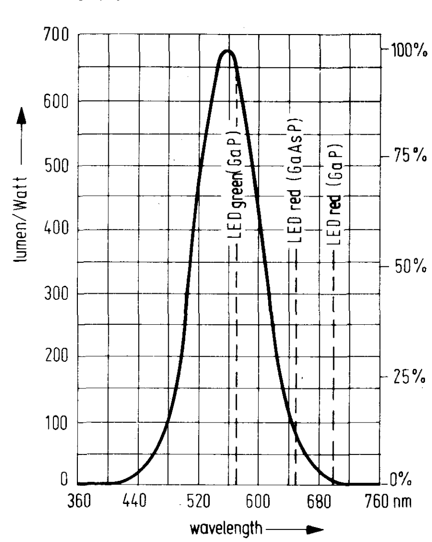
Delay time	t_d
Rise time	t_r
Turn-on time	t_{on} $(= t_d + t_r)$
Storage time	t_s
Fall time	t_f
Turn-off time	t_{off} $(= t_s + t_f)$



Radiation emitting components (emitters)
Radiation in the visible range – LED – (light emitting diodes)

The luminous intensity is measured in the direction of the case axes by a detector with $V(\lambda)$ characteristics and a calibration in candela (foot-lambert). Attention has to be paid that the adjustment to the $V(\lambda)$-curve (fig. 12) is also sufficiently exact in the wavelength range of the LED. Though most meters of this kind have an integral coincidence with $V(\lambda)$ up to a few percents, but at the slopes, particularly around 700 nm, deviate strongly from the $V(\lambda)$ shape.

Sensitivity curve of the human eye
$[V(\lambda)]$



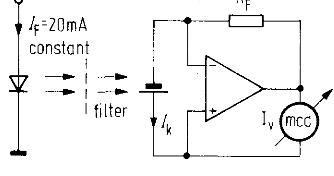
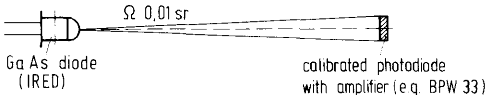


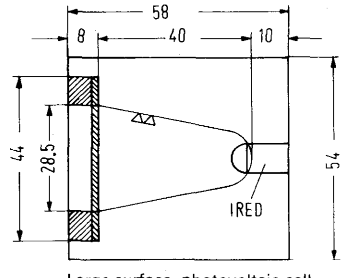
Figure 12

Radiation in the infrared range – IRED – (infrared emitting diodes)

The radiant intensity I_e in the direction of the case axis should be measured by a wavelength independent detector (thermocouple element) but low sensitivity, inertia and temperature sensitivity cause difficulties. For this reason, one usually measures with a correspondingly calibrated photovoltaic cell. In such case, the spectral sensitivity curve of the photovoltaic cell has to be considered and the measuring result corrected with regard to the deviations in the emitted wavelength of the radiator to be measured (for example IRED with different production technology). If the total radiation of the component shall be measured, the IRED has to be fitted in a parabolic like reflector to ensure that all radiation emitted by the component reaches the photovoltaic cell that forms the end of the parabola. Figure 13 shows the outline of such a measuring parabola. As for the rest, the same requirements apply as for radiant intensity measurements.



Calibrated photodiode with amplifier (for example BPW 33)



I=100 mA constant

I_K

R_L

mW

Φ_e

$R_i \geq 10\,k\Omega$

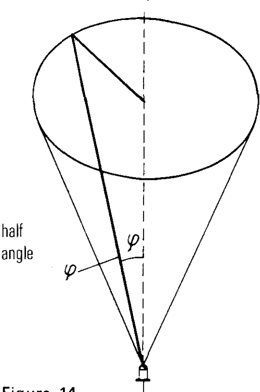
$R_L = 1 \ldots 10\,\Omega$

Large surface photovoltaic cell

Figure 13

In cases where IRED emitting diodes are used in connection with mirrors or lenses, for example in light barriers it can proof useful to state the radiant power (radiation capacity) Φ_e defined in a cone with the half viewing angle φ, respectively the curve $\Phi_e = f(\varphi)$ – (Fig. 14)

Radiation cone as a fuction of the half angle φ



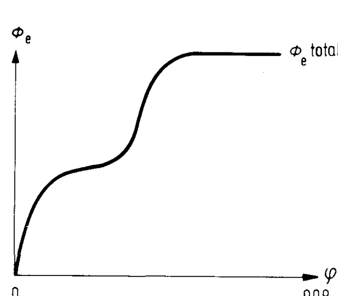
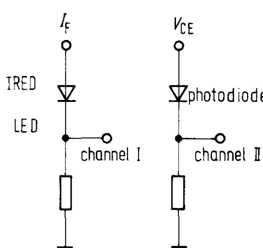


Figure 14

Measuring of switching times

For measuring of switching times the same applies as for the radiant sensitive components except that now a photodiode serves as detector and its switching time must be small compared to that of the IRED or LED to be measured.



Optoelectronic couplers

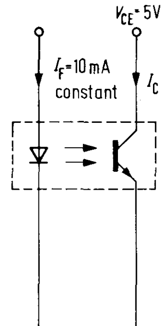
Optoelectronic couplers isolate electrically the input and output of two circuits with different voltage potentials. The potential differences that can safely be separated in the sense of VDE regulations depend not only on the characteristics of the coupler but also on the type of circuit and the environmental conditions at the time of operation.

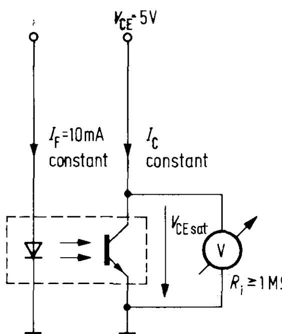
Up to now no definite DIN standards or VDE regulations have been established for couplers but the Deutsche Elektrotechnische Kommission (DKE/VK 631.6) is working at it. As basis for the use of couplers the regulations VDE 0110 and VDE 0160 as well as VDE 0303/ DIN 53480 can be consulted besides the decision VDE-69 [ETZ-b, volume 26 (1974) H 22] on which in all probability the DIN standards now being worked on will rest.

To determine the permissible nominal insulation test voltage for a specific application, the component manufacturer can state the ratings of the insulation test voltage, the air gap and leakage path, latter in respect of the insulation characteristics of the packaging material used (KC value according to VDE 6303/DIN 53480) from which parameter the nominal insulation test voltage can be derived on hand of the tables VDE 0110/0160.

Measuring optoelectronic couplers

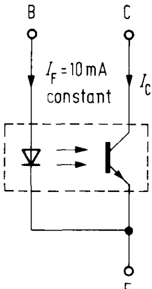
Apart from measuring the static parameter of GaAs IR and Si phototransistors (or Si photodiodes) the coupling factor is of prime importance. Its gauging corresponds to that of the current amplification at the transistor only that in this case I_F (analogous I_B) and V_{CE} are operated under constant current source while I_C is gauged.





The analogy with the transistor goes so far that, except of course for the isolation characteristics, one can gauge couplers at the plotter oscilloscope like transistors with extreme low current amplification.

In this case the anode of the GaAs IRED is the base ($I_F \triangleq I_B$), cathode and emitter of the phototransistor are commonly connected with the emitter terminal, whereas the collector of the phototransistor is connected with the collector terminal of the plotter oscilloscope.



Switching times

For optocouplers the same applies as for radiation sensitive components with the modification that the IRED emitting diode is fixed in the component (see figure 11).

2.9.1. Terms of temperature for optical radiations

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

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

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

2.9.2. Radiation and light measurements

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

Emitter

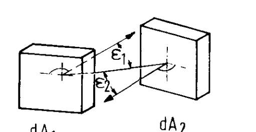
No		Radiometric terms: Term	Symbol	Unit	Relation	Simplified definition	Spectr. radiometric terms: Term	Symbol	Unit	Photometric terms: Term	Symbol	Unit
2		Radiant intensity	I_e	$\frac{W}{sr}$	$I_e = \frac{d\Phi_e}{d\Omega_1}$	Radiant intensity is radiant power per solid angle	Spectral radiant intensity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

Sensor

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

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

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



Photometric Basic Law

$$d^2\Phi = L \frac{dA_1 \cdot \cos \varepsilon_1 \cdot dA_2 \cdot \cos \varepsilon_2}{r^2} \Omega_0$$

Inverse Square Law

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

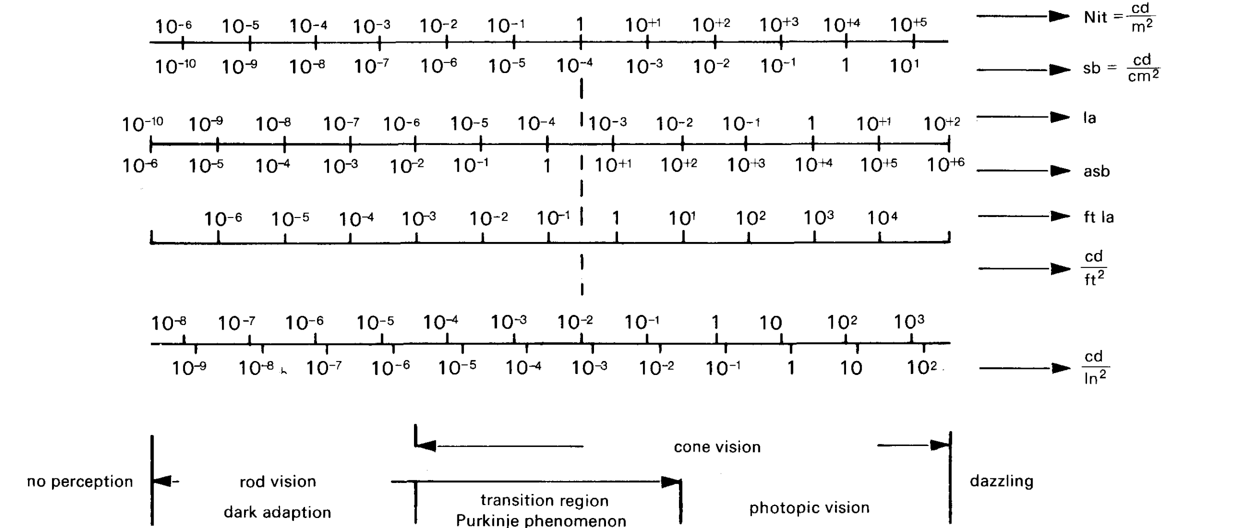
dA_1 = element of area of emitter
dA_2 = element of area of sensor
ε_1 = angle of radiation
ε_2 = angle of irradiation
= spacing emitter-sensor
Ω_0 = 1 sr

2.9.3. Radiation characteristics

Denotation	Symbol	Meas. quant.	Abbr.	Definition
Quantity of radiation	Q	Joule Wattsecond	J Ws	quantity of radiation through a surface
Radiant power	Φ	Watt	W	quantity of radiation Q per second through a surface
Point source of radiation	–	–	–	. . . is a source viewed from such a great distance R that all rays seem to emanate from one point. When b max. linear expansion of source: $R \geqq b$ (example: sun for observer on earth).
Solid angle (For figure see "General")	Ω	sterad	sr	$\Omega = \frac{A_1}{R_1^2} = \frac{A_2}{R_2^2} = \frac{A_3}{R_3^2} = \frac{A}{R^2}$; the radiant power Φ [W] of a point source is constant in solid angle. (Prerequisite: homogenous, undamping medium.) $\Omega = 1$ is $A = R^2$ so that Ω hemisphere $= \Omega_0 = 2\pi$ sr; Ω full sphere $= \Omega_0 = 4\pi$ sr
Radiant intensity	I	$\frac{\text{Watt}}{\text{sterad}}$	$\frac{\text{W}}{\text{sr}}$	is the solid angle density of the radiant power $\left(\frac{d\Phi}{d\Omega}\right)$. I of one source generally varies depending upon viewing direction. I only defined when $R \geqq b$;
Total radiant power of a source	Φ_{tot}	Watt	W	$\Phi_{tot} = \int_0^{4\pi} I \, d\Omega$
Irradiance (For figure see "General")	E–	$\frac{\text{Watt}}{\text{meter}^2}$	$\frac{\text{W}}{\text{m}^2}$	. . . is the surface density of the radiant power (spherical surface) for a point source. $E = \frac{d\Phi}{dA}$; $dA = R^2 \, d\Omega$ $E = \frac{d\Phi}{d\Omega \, R^2} = \frac{I}{R^2}$; $I = ER^2$
Radiance (For figure see "General")	L	$\frac{\text{Watt}}{\text{m}^2 \text{ sterad}}$	$\frac{\text{W}}{\text{m}^2 \text{ sr}}$	. . . is the radiant intensity referred to the radiant surface viewed by the observer. (Surface projection $A_p = A \cos \varepsilon$ when ε is the angle by which the radiant surface is rotated against the connecting line to viewer. $L = \frac{I}{A_p} = \frac{I}{A \cos \varepsilon}$). Important optical quantity. 1) In an undamped beam path L is maintained and cannot be increased by any optical measure. 2) The human eye sees differences in radiance as differences in brightness.
Sensitivity of detector	$S = \frac{i}{E}$	$\frac{\text{ampere}}{\text{irradiance}}$	$\frac{\text{A}}{E}$	electrical quantity (current, voltage or resistance) in relation to irradiance

2.9.4. Luminance conversion factors units

Unit		sb	cd/m2	cd/ft2	cd/in2	asb	L	mL	ftL
1	Stilb = cd/cm2 = sb	1	10^4	929	6.45	31400	3.14	3140	2920
1	cd/m2 = Nit = nt	10^{-4}	1	9.29×10^{-2}	6.45×10^{-4}	3.14	3.14×10^{-4}	0.314	0.292
1	cd/ft2	1.076×10^{-3}	10.76	1	6.94×10^{-3}	33.8	3.38×10^{-3}	3.38	3.14
1	cd/in2	0.155	1550	144	1	4870	0.487	487	452
1	Apostilb = asb	3.18×10^{-5}	0.318	2.96×10^{-2}	2.05×10^{-4}	1	10^{-4}	0.1	0.29×10^{-2}
1	Lambert = L or la	0.318	3183	296	2.05	10^4	1	10^3	929
1	mL or mla	3.18×10^{-4}	3.18	0.296	2.05×10^{-3}	10	10^{-3}	1	0.929
1 1 1 1	footlambert = equivalent footcandle = apparent footcandle = ftL or ftla	3.43×10^{-4}	3.43	0.318	2.21×10^{-3}	10.76	1.076×10^{-3}	1.076	1



2.9.5. Illuminance units and conversion factors

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

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

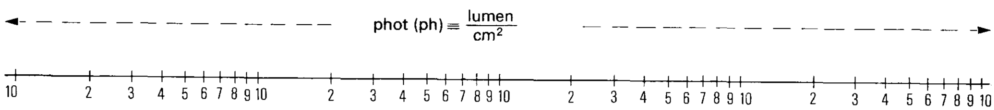
I = 1cd
1cm²
1foot²
1m²
1foot
1cm
1m
1ph
1fc
1lx

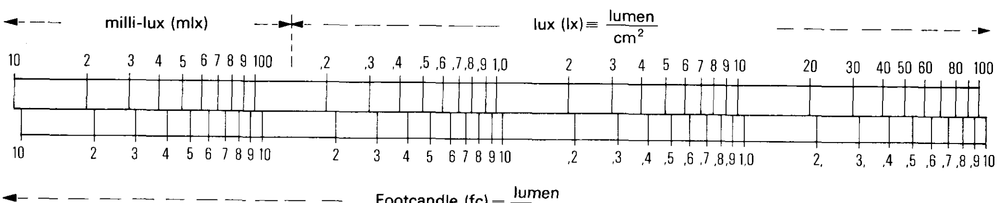
Luminous flux Φ per second per sterad (sr) 1 lumen (lm)

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

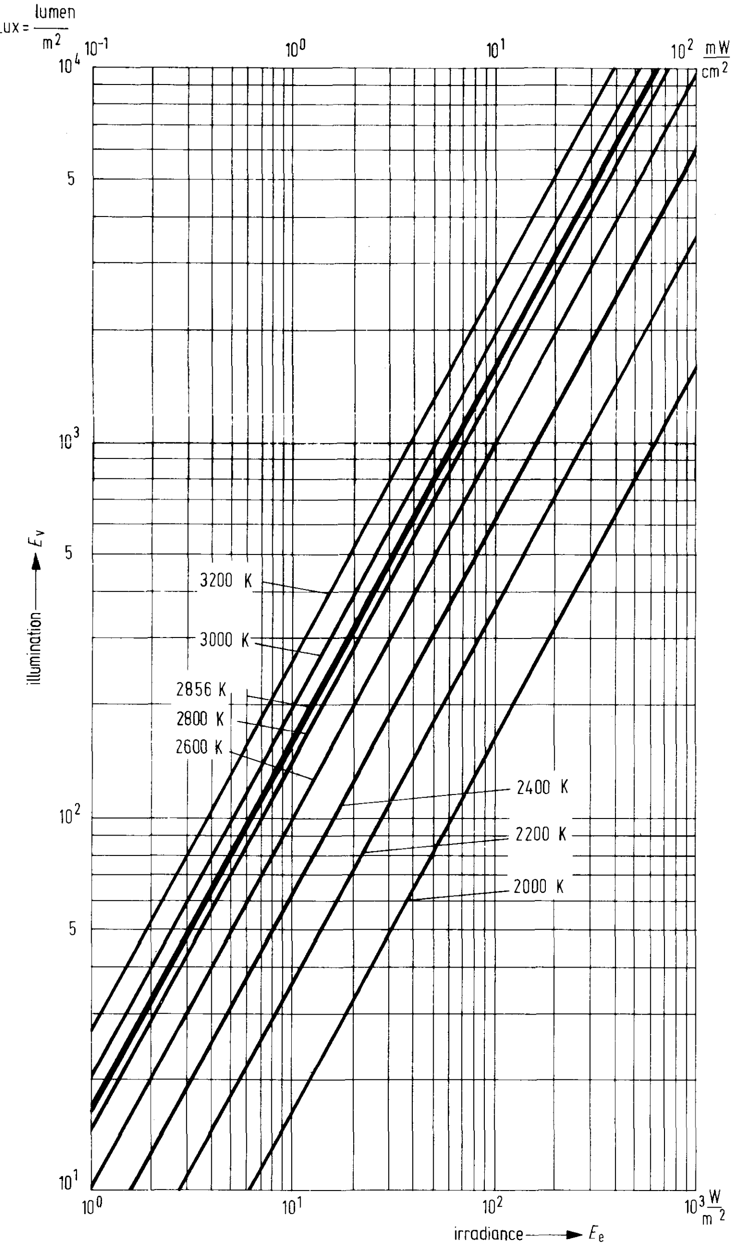
1 foot ≙ 0.305 m
1 full sphere ⦵ = $4\pi \cdot$ sr

illuminance

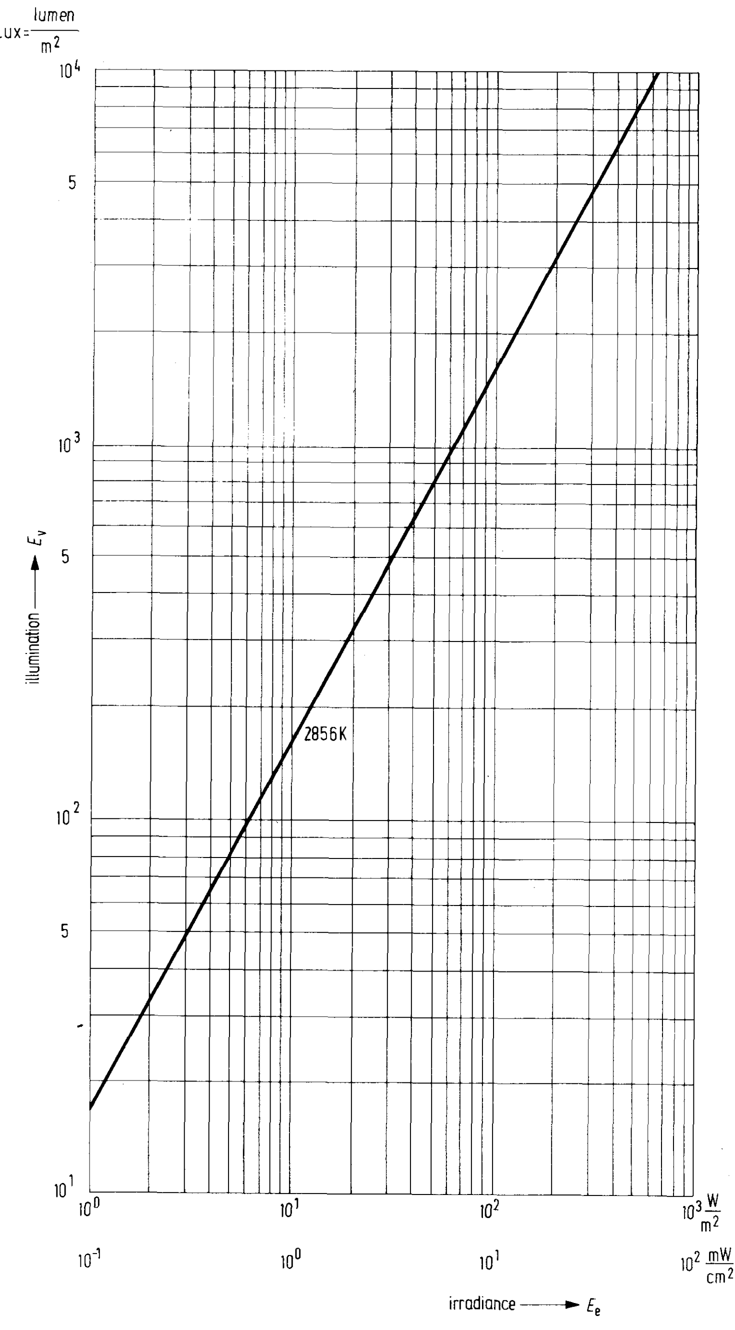




Conversion of E_v (lx) into E_e (W/m^2 or mW/cm^2) referred to the radiation of a black radiator

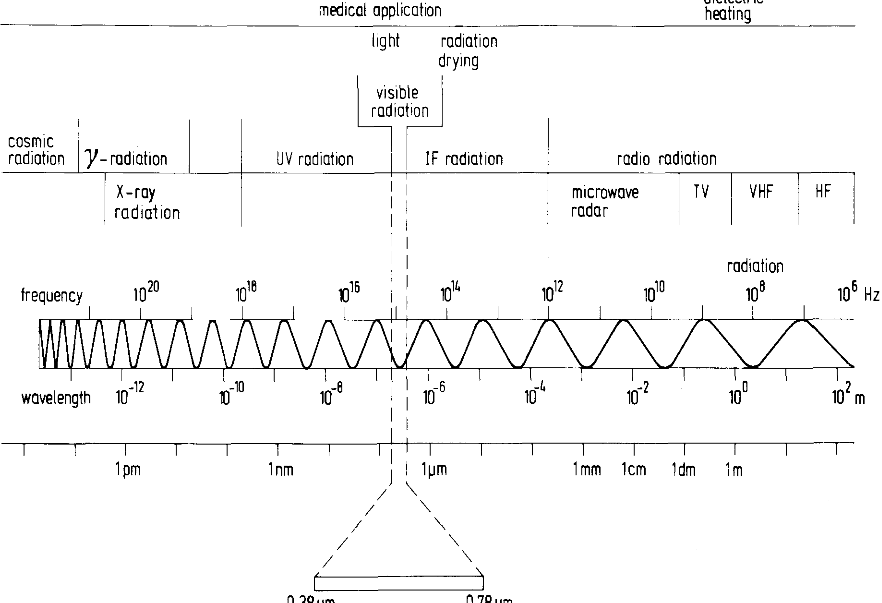


Conversion of E_v (lx) into E_e (W/m² or mW/cm²) referred to the radiation of a black radiator

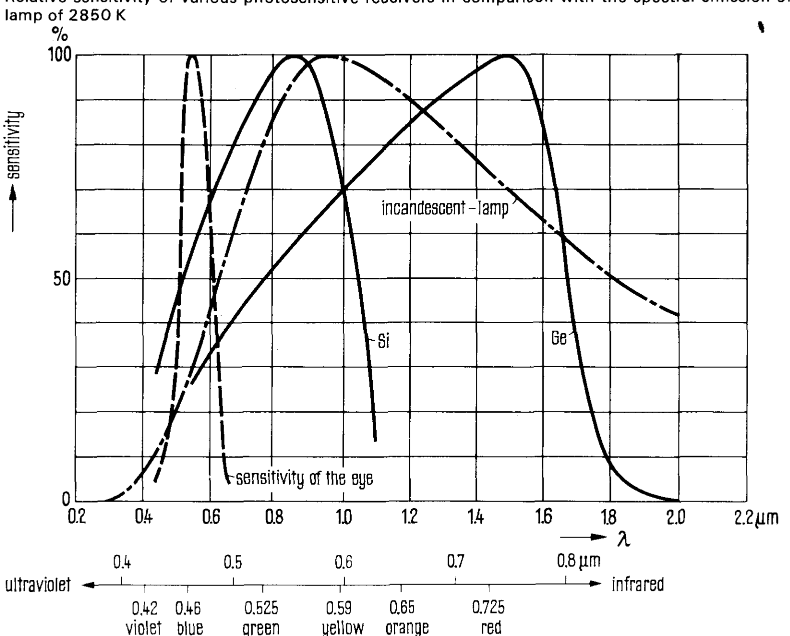


2.9.6 Electromagnetic radiation – ranges of frequency and wavelength

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

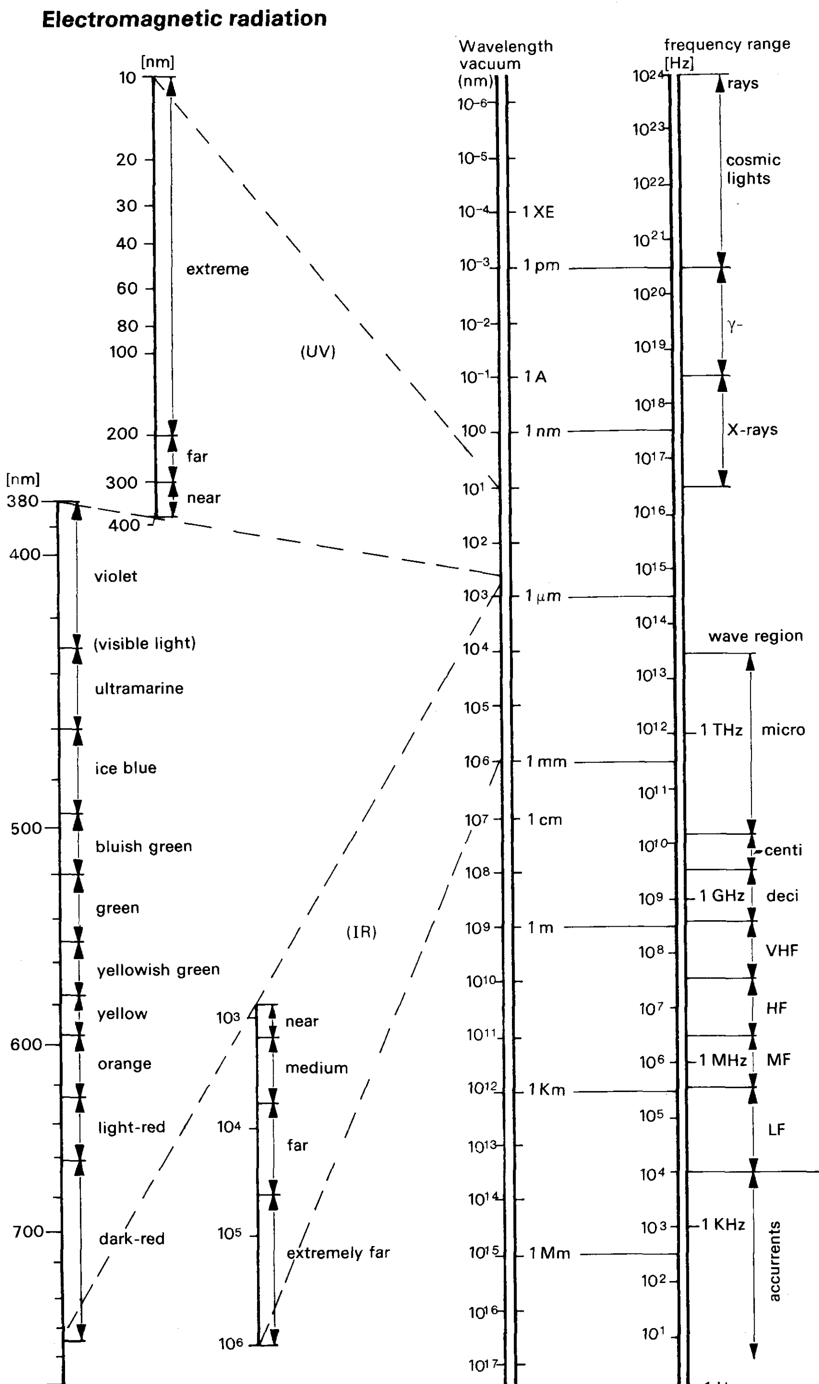


Relative sensitivity of various photosensitive receivers in comparison with the spectral emission of an incandescent lamp of 2850 K



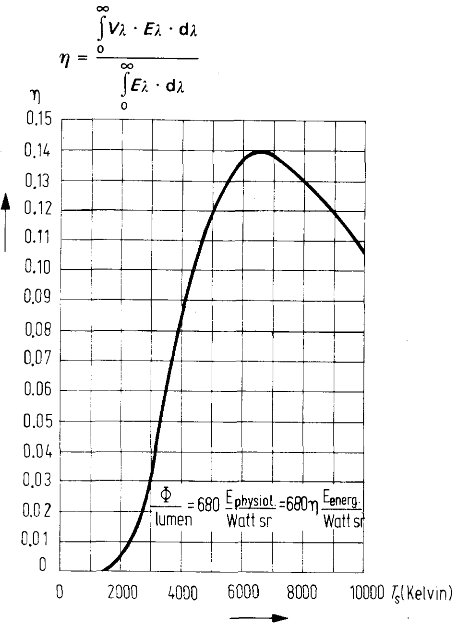
This graph generally applies to all photoelectric devices made of germanium and silicon

Electromagnetic radiation

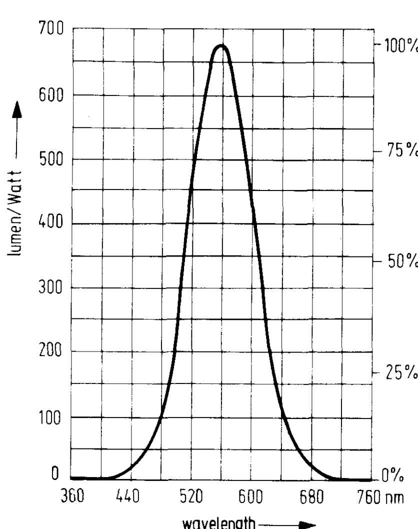


Visual efficiency of the total radiation of the black body as a function of temperature

$$\eta = \frac{\int_0^\infty V\lambda \cdot E\lambda \cdot d\lambda}{\int_0^\infty E\lambda \cdot d\lambda}$$

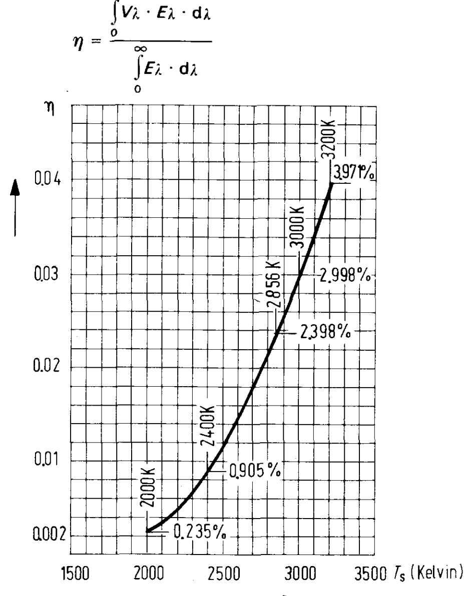


Sensitivity curve of the human eye ($V\lambda$ = luminosity factor for photopic vision)



Section of above curve

$$\eta = \frac{\int_0^\infty V\lambda \cdot E\lambda \cdot d\lambda}{\int_0^\infty E\lambda \cdot d\lambda}$$



2. 10. Quality definition

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

1. Maximum and minimum values of the characteristics

2. AQL value (Acceptable Quality Level)

A delivered lot, the defect percentage of which is equal to or less than the percentage given in AQL-value shall be accepted with greater probability (usually 90%) due to sampling tests.

For the various defects (for definitions see para. 3) the AQL values listed in the table apply, unless otherwise specified. The identical sampling inspection plans DIN 40 080 or ABC-STD 105 serve as basis for the attribute test.

3. Definition of defects (the tentative norm DIN 40 080 was considered)

For each group of defects covered by an AQL value, only the number of defective devices (with one or several defective characteristics in this group) is considered.

Total (critical) defect

In case of such a defect the functional use of the device is considerably impaired or impossible.

Examples:

Broken leads or case, wrong or missing type designation, rough cracks and porous spots, open contacts or short circuits as well as essential deviation from characteristics.

Major defect

Such defect noticeably affects the usability of the device. If the specified limits of the characteristics with * are exceeded, it is considered as a major defect.

Minor defect

Such defects impair only slightly the usability of the device

Examples:

Deviation from dynamic and optic characteristics provided there is no particular importance for main application; insignificant excess of temperature, slight case damage, poorly legible type designation.

Classification of defects	Single AQL	Summary AQL
1. Defective case or connection		
a) total defect	0.25	0.25
b) major defect	0.25	
2. Defective electrical or optical characteristics		
a) total defect	0.25	0.25
b) major defect	0.65	2.50
c) minor defect	2.50	–

2.11. Mounting and soldering instructions

1. Mounting

The component can be mounted in any position. Bending of the leads is allowed up to a distance of 1.5 mm from the case provided the diameter of the leads does not exceed 0.5 mm. While bending the leads no mechanical forces must be applied to the case. Leads with a diameter larger than 0.55 mm should not be bent.

If the device is to be mounted near heat generating components, the increased ambient temperature has to be considered in the calculation of the junction temperature.

2. Soldering

Care has to be taken that the component is not overloaded thermically when soldered in. The maximum junction temperature may only be exceeded for a very short time (max. 1 minute).

The following maximum soldering temperatures and times are permissible:

(Compare DIN 40 046, Sheet 18)

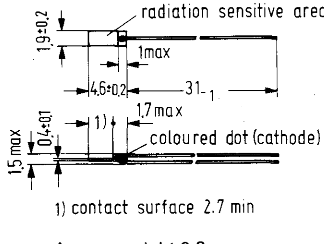
	Iron soldering (with 3 mm nozzle)			Dip soldering		
	Iron temperature	Soldering distance from the case	Maximum soldering time	Soldering temperature	Soldering distance from the case	
Metal or glass case	300°C	≧ 1.5 mm	5 s	235°C 260°C	≧ 1.5 mm ≧ 1.5 mm	5 s 3 s
Plastic case	300°C	≧ 2 mm	3 s	235°C 260°C	≧ 2 mm ≧ 2 mm	3 s 3 s

Photovoltaic Cells

Silicon Photovoltaic Cell **BP 100**

The silicon photovoltaic cell BP 100 is suitable for use in control and drive circuits. Its rapid response, small dimensions and high permissible operating temperature make versatile application feasible. Since this cell is not encased, the assembly of highly efficient scanning systems could be realized. For this purpose the cells may be cemented closely together on suitable mounting assemblies. The photo-insensitive side of the element is marked by a yellow dot.

Type	Ordering code
BP 100	Q 60 215-X 100



Approx. weight 0.2 g
Dimensions in mm

For mounting instructions see para. 2.4 on page 24.

Maximum ratings

Ambient temperature	T_{amb}	– 55 to + 100	°C
Reverse voltage [1]	V_R	1	V

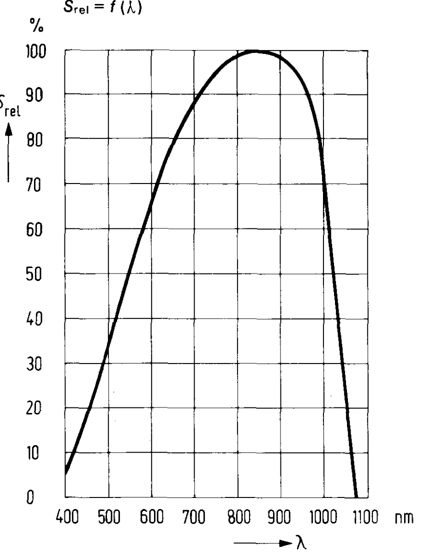
1) The positive pole of the voltage source has to be connected to the side of the photovoltaic cell, which is marked by a coloured dot.

Characteristics (T_{amb} = 25°C)

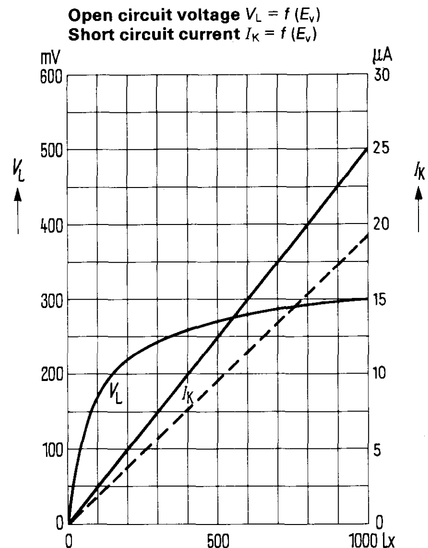
Spectral sensitivity (short circuit current I_K) [1]	S	25 (≧ 19)	nA/lx
Wavelength of the max. sensitivity	$\lambda_{S\ max}$	850	nm
Quantum yield (Electrons per photon) (= 850 nm)	η	0.80	Electrons / Photon
Spectral sensitivity (λ = 850 mm)	S	0.55	A/W
Open circuit voltage (E_v = 100 lx) [1]	V_L	170 (≧ 120)	mV
Open circuit voltage (E_v = 1000 lx) [1]	V_L	300 (≧ 200)	mV
Short circuit current (E_v = 1000 lx) [1]	I_K	25	µA
Rise time (for 60% of I_K)	t_r	4	µs
Temperature coefficient of V_L (see diagram)	TC	− 2.6	mV/K
Temperature coefficient of I_K (see diagram)	TC	0.12	%/K
Capacitance (V_R = 0 V; E = 0)	C_0	1000	pF
Radiant sensitive area	A	7	mm²
Dark current (V_R = 1 V; E = 0)	I_R	3 (≦ 10)	µA
Dark current (V_R = 1 V; T_{amb} = 50°C; E = 0)	I_R	7	µA

1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

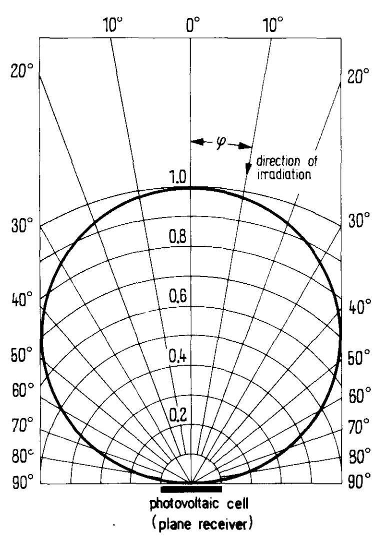
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



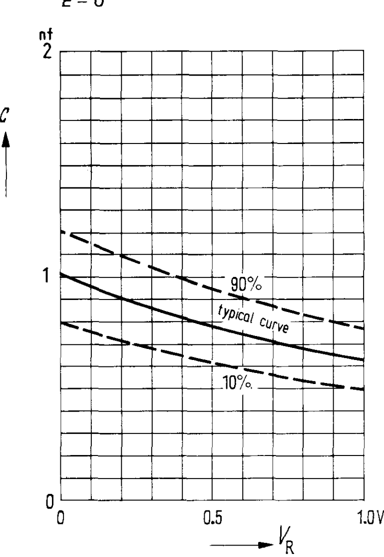
Open circuit voltage $V_L = f(E_v)$
Short circuit current $I_K = f(E_v)$

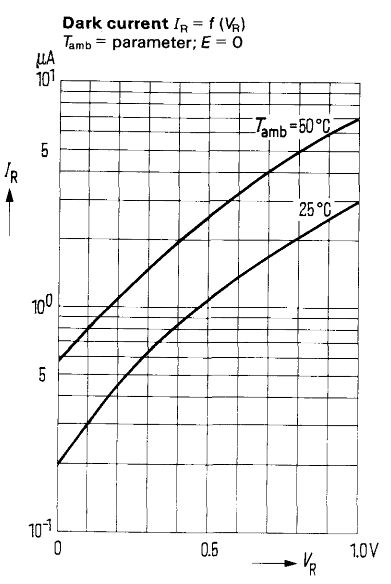


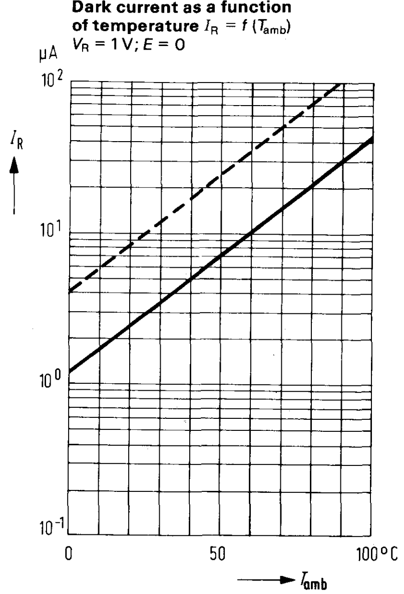
Directional characteristic $I_K = f(\varphi)$

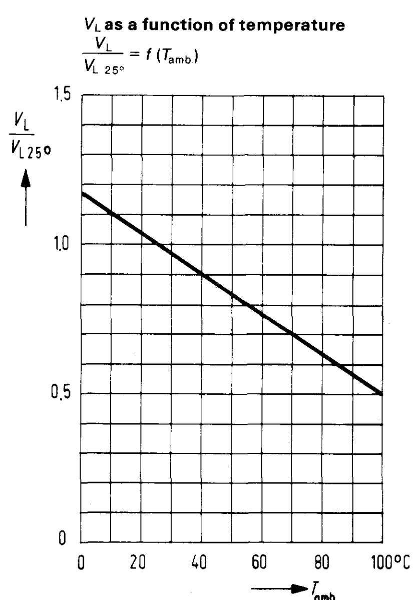


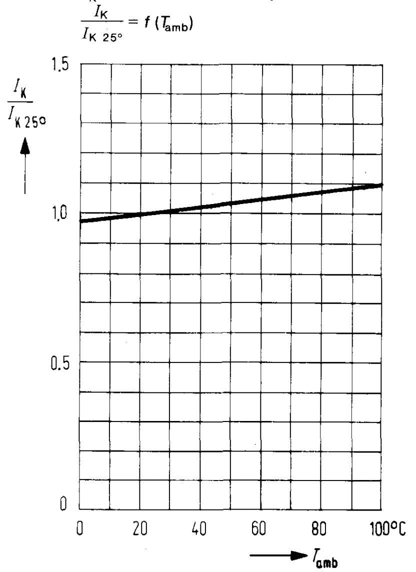
Junction capacitance $C = f(V_R)$;
$E = 0$



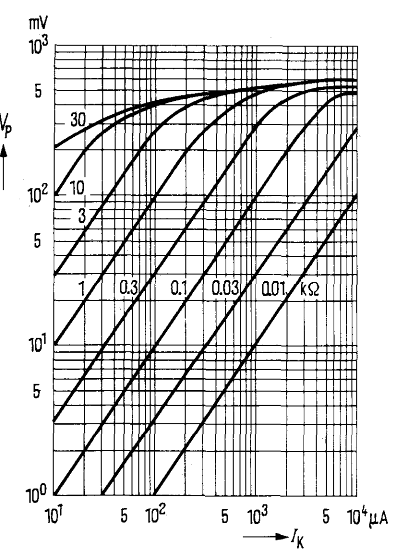

Dark current $I_R = f(V_R)$
T_{amb} = parameter; $E = 0$
µA
10^1
5
I_R
10^0
5
10^{-1}
T_{amb} = 50 °C
25 °C
0
0.5
1.0 V
V_R


Dark current as a function of temperature $I_R = f(T_{amb})$
V_R = 1 V; $E = 0$
µA
10^2
I_R
10^1
10^0
10^{-1}
0
50
100 °C
T_{amb}

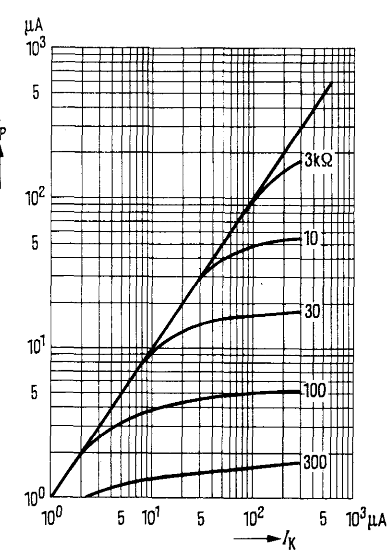

V_L as a function of temperature
$\frac{V_L}{V_{L\,25°}} = f(T_{amb})$
1.5
$\frac{V_L}{V_{L\,25°}}$
1.0
0.5
0
0
20
40
60
80
100°C
T_{amb}


I_K as a function of temperature
$\frac{I_K}{I_{K\,25°}} = f(T_{amb})$
1.5
$\frac{I_K}{I_{K\,25°}}$
1.0
0.5
0
0
20
40
60
80
100°C
T_{amb}

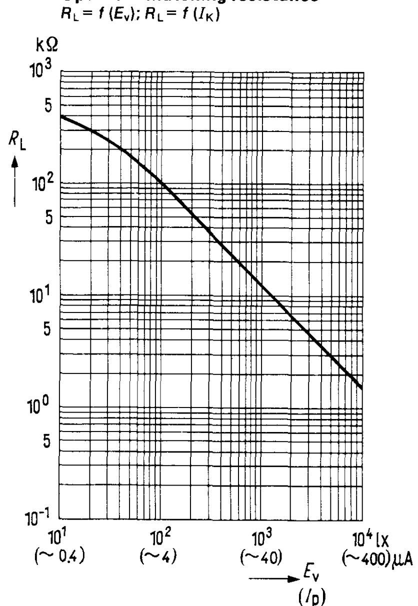
Photovoltage $V_P = f(I_K)$; R_L = parameter



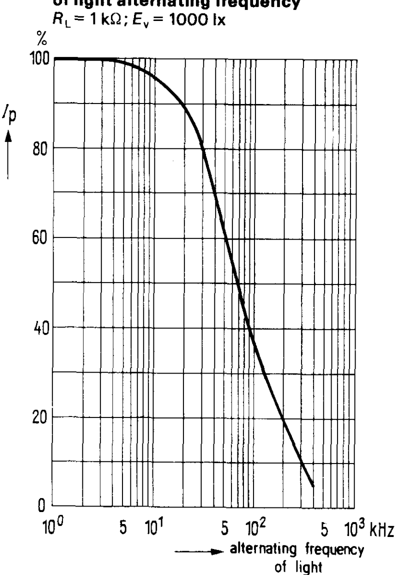
Photocurrent $I_P = f(I_K)$; R_L = parameter



Optimum matching resistance
$R_L = f(E_v)$; $R_L = f(I_K)$



Average photocurrent as a function of light alternating frequency
$R_L = 1\ k\Omega$; $E_v = 1000\ lx$

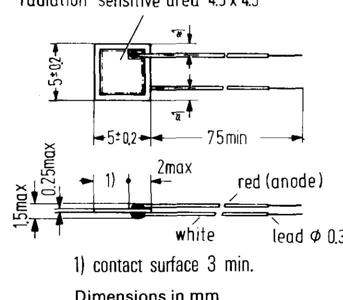


Silicon Photovoltaic Cell with High Blue Sensitivity

BPX 79

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

Type	Ordering code
BPX 79	Q 62 702-P 51



Dimensions in mm

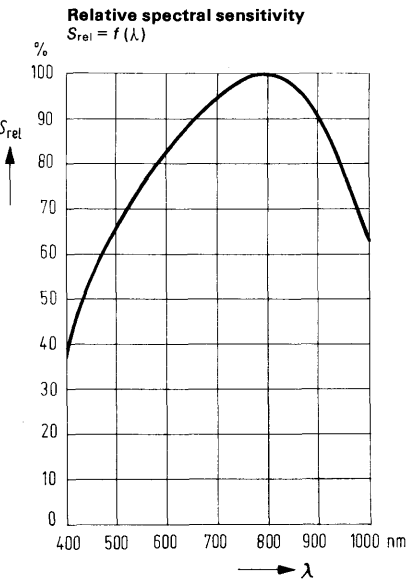
Maximum ratings

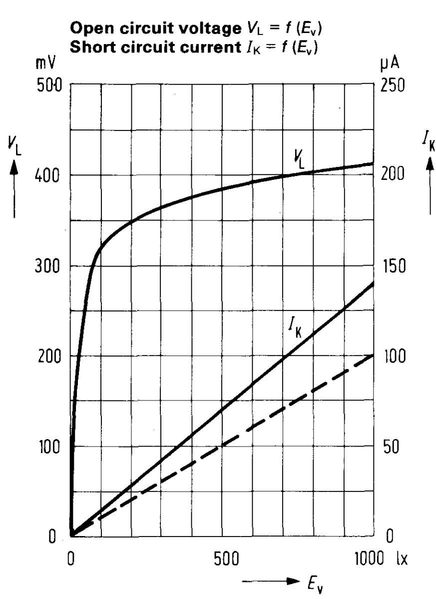
Reverse voltage	V_R	1	V
Storage temperature and operating temperature	T_{amb}	– 55 to + 100	°C

Characteristics

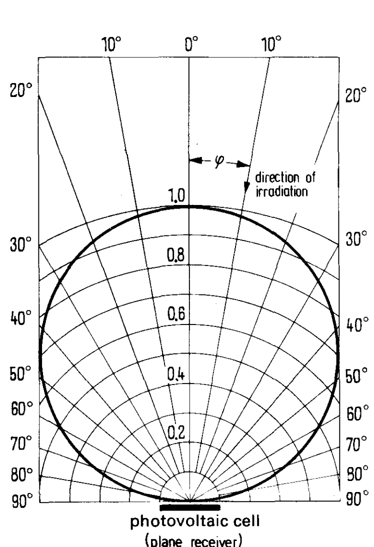
Spectral sensitivity [1]	S	135 (≧ 100)	nA/lx
Open circuit voltage (E_v = 100 lx) [1]	V_L	320 (≧ 220)	mV
Open circuit voltage (E_v = 1000 lx) [1]	V_L	410 (≧ 310)	mV
Wavelength of the max. sensitivity	$\lambda_{S\ max}$	800	nm
Quantum yield (Electrons per photon) (λ = 800 nm)	η	0.73	Electrons/Photon
Spectral sensitivity (λ = 800 nm)	S	0.47	A/W
Rise and fall time of the photocurrent from 10% to 90% and from 90% to 10% of the final value			
(R_L = 1 kΩ; V_R = 1 V; λ = 950 nm)	t_r; t_f	6	µs
(R_L = 1kΩ; V_R = 0 V; λ = 950 nm)	t_r; t_f	10	µs
Capacitances			
(V_R = 0 V)	C_0	2500	pF
(V_R = 1 V)	C_1	1800	pF
Radiant sensitive area	A	20	mm²
Dark current (V_R = 1 V; E = 0)	I_R	0.3 (≦ 50)	µA
Temperature coefficient of V_L	TC	− 2.6	mV/K
Temperature coefficient of I_K	TC	0.2	%/K

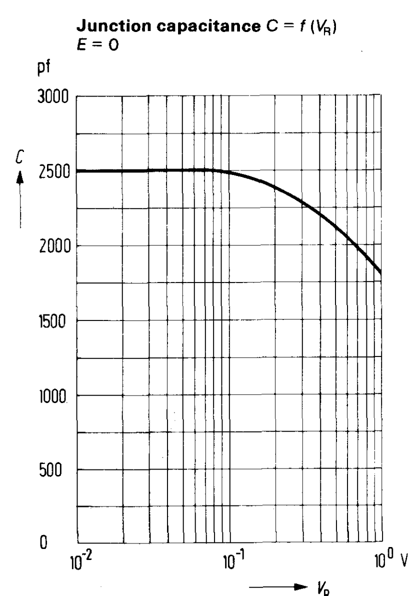
1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).


Relative spectral sensitivity
$S_{rel} = f(\lambda)$
%
S_{rel}
100
90
80
70
60
50
40
30
20
10
0
400 500 600 700 800 900 1000 nm
λ

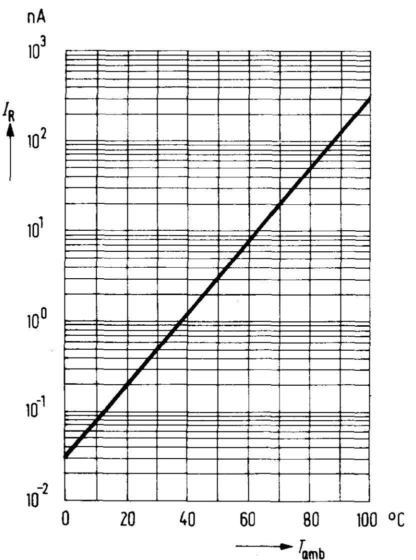

Open circuit voltage $V_L = f(E_v)$
Short circuit current $I_K = f(E_v)$
mV
μA
V_L
I_K
500 400 300 200 100 0
250 200 150 100 50 0
0 500 1000 lx
E_v

Directional characteristic $I_K = f(\varphi)$

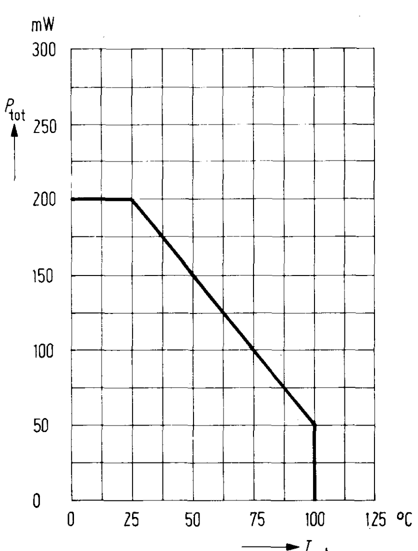

10° 0° 10°
20° 30° 40° 50° 60° 70° 80° 90°
φ
direction of irradiation
1.0
0.8
0.6
0.4
0.2
photovoltaic cell
(plane receiver)


Junction capacitance $C = f(V_R)$
$E = 0$
pf
C
3000 2500 2000 1500 1000 500 0
10^{-2} 10^{-1} 10^{0} V
V_R

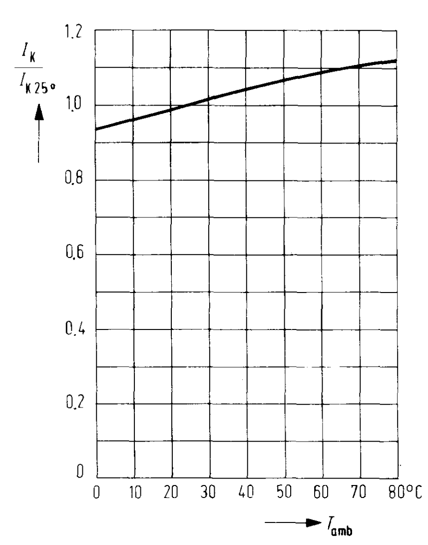
Dark current $I_R = f\,(T_{amb})$



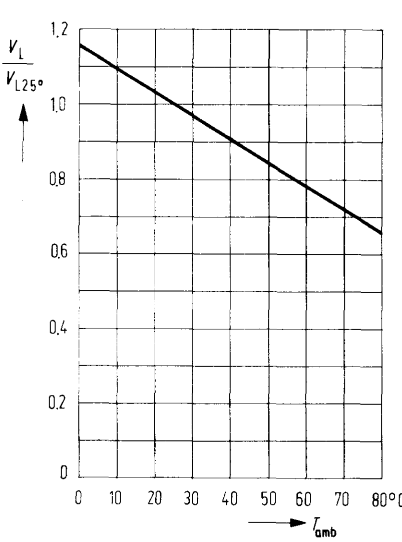
Power dissipation $P_{tot} = f\,(T_{amb})$



Short circuit current $\frac{I_K}{I_{K\,25°}} = f\,(T_{amb})$



Open circuit voltage $\frac{V_L}{V_{L\,25°}} = f\,(T_{amb})$

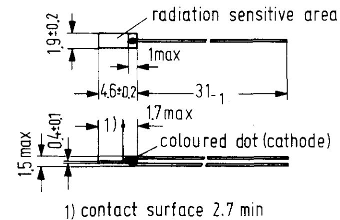


The silicon photovoltaic cell BPY 11 is suitable for use in control and drive circuits, for light pulse scanning, and for quantitative light measurements. Its rapid response, small dimensions, and high permissible operating temperature make versatile application feasible.

Since this cell is not encased, the assembly of highly efficient scanning systems can be realized. For this purpose the cells may be cemented closely together on suitable mounting assemblies. The photo-insensitive side of the element is marked by a coloured dot.

For mounting instructions see introduction, para. 2.4, page 24.

Type	Ordering code	Colour code
BPY 11	Q 60215-Y 11	red
BPY 11/I	Q 60215-Y 11-X 10	brown
BPY 11/II	Q 60215-Y 11-X 11	orange
BPY 11/III	Q 60215-Y 11-X 12	green



Approx. weight 0.2 g
Dimensions in mm

Maximum ratings

Ambient temperature	T_{amb}	– 55 to + 100	°C
Reverse voltage (positive pole to cathode)	V_R	1	V

Characteristics (T_{amb} = 25°C)

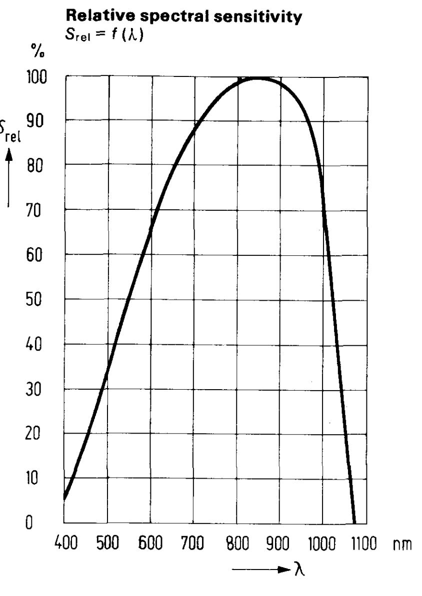
Spectral sensitivity [1]	S	40 (≧ 28)	nA/lx
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	850	nm
Quantum yield (Electrons per photon) (λ = 850 nm)	η	0.80	Electrons / Photon
Spectral sensitivity (λ = 850 nm)	S	0.55	A/W
Open circuit voltage (E_v = 100 lx) [1]	V_L	220 (≧ 180)	mV
Open circuit voltage (E_v = 1000 lx) [1]	V_L	375 (≧ 260)	mV
Short circuit current (E_v = 1000 lx) [1]	I_K	40	μA
Rise time (for 60% of I_K)	t_r	4	μs
Cut-off frequency (Load resistance R_L = 1 kΩ)	f_g	55	kHz
Temperature coefficient of V_L (see diagram)	TC	− 2.6	mV/K
Temperature coefficient of I_K (see diagram)	TC	0.12	%/K
Capacitance (V_R = 0 V; E = 0)	C_0	1000	pF
Radiant sensitive area	A	7	nm²
Dark current (V_R = 1 V; E = 0)	I_R	1 (≦ 10)	μA
Dark current (V_R = 1 V; T_{amb} = 50°C; E = 0)	I_R	2.5	μA

Spectral sensitivity groups

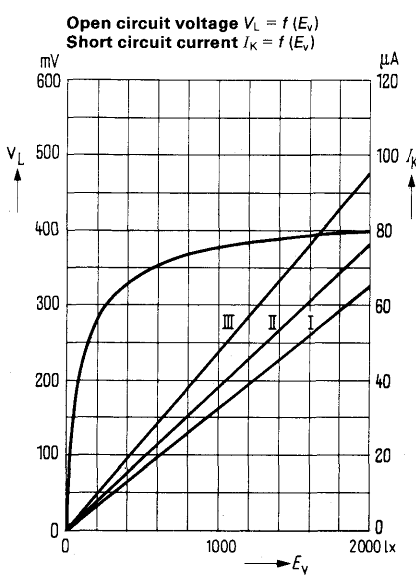
Type	**BPY 11**	**BPY 11/I**	**BPY 11/II**	**BPY 11/III**	
Short circuit current I_K E_v = 100 lx [1]	2.8 to 5.5	2.8 to 3.8	3.3 to 4.5	4.0 to 5.5	μA
Colour code	red	brown	orange	green	

1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

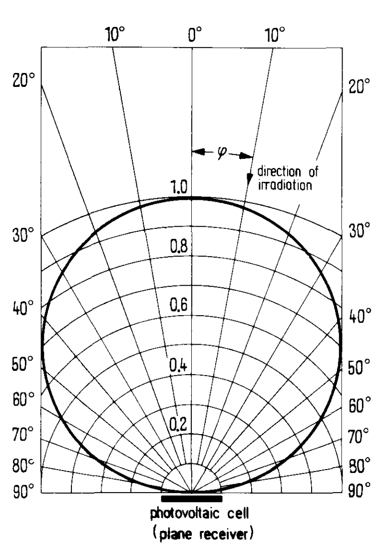
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



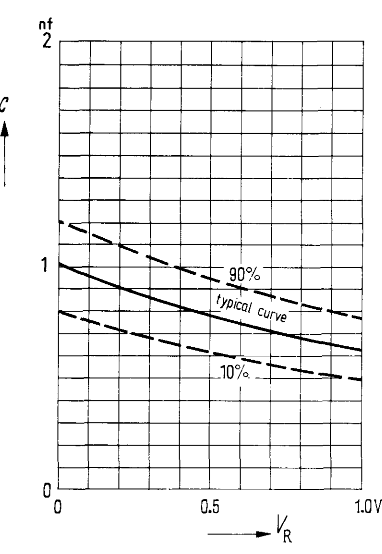
Open circuit voltage $V_L = f(E_v)$
Short circuit current $I_K = f(E_v)$

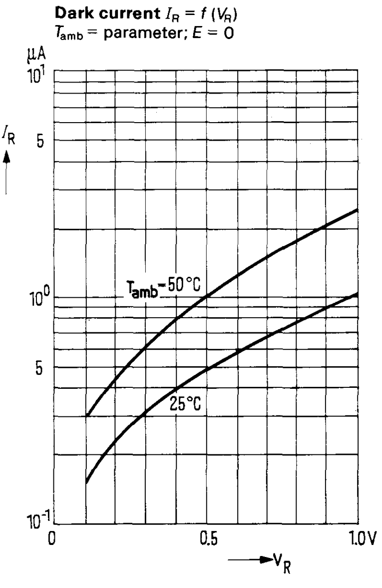


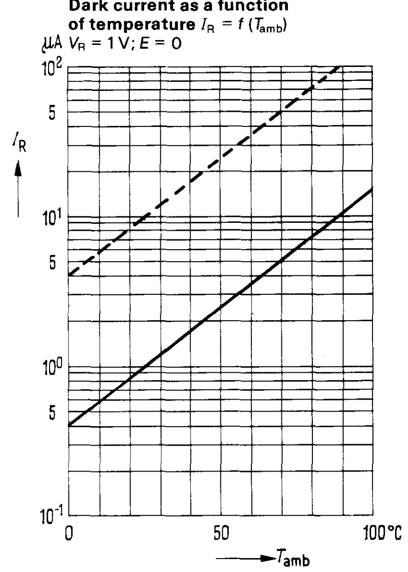
Directional characteristic $I_K = f(\varphi)$

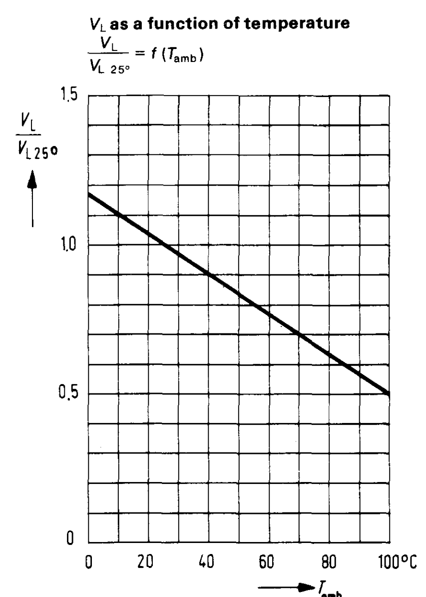


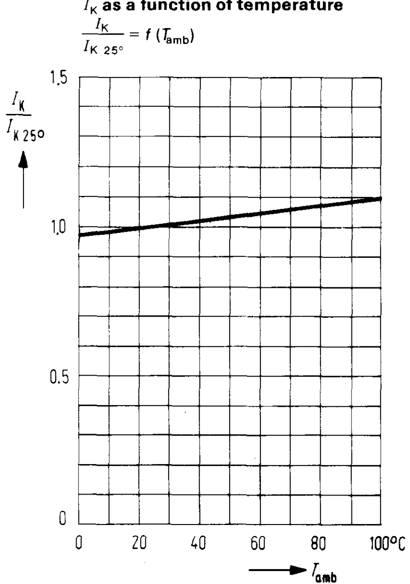
Junction capacitance $C = f(V_R)$
$E = 0$



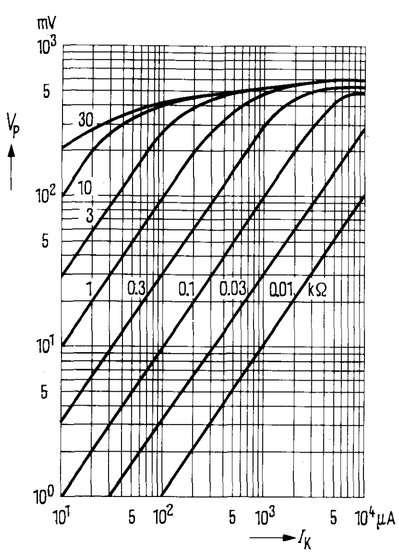

Dark current $I_R = f(V_R)$
T_{amb} = parameter; E = 0
µA
10^1
I_R
5
T_{amb}=50 °C
10^0
5
25°C
10^{-1}
0
0.5
1.0V
V_R


Dark current as a function
of temperature $I_R = f(T_{amb})$
µA V_R = 1 V; E = 0
10^2
5
I_R
10^1
5
10^0
5
10^{-1}
0
50
100°C
T_{amb}

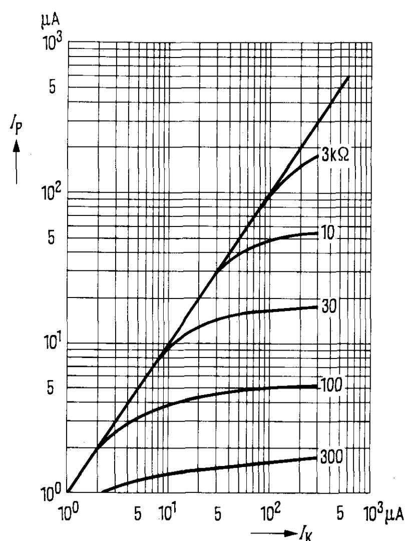

V_L as a function of temperature
$\frac{V_L}{V_{L\ 25°}} = f(T_{amb})$
1.5
1.0
0.5
0
0
20
40
60
80
100°C
T_{amb}


I_K as a function of temperature
$\frac{I_K}{I_{K\ 25°}} = f(T_{amb})$
1.5
1.0
0.5
0
0
20
40
60
80
100°C
T_{amb}

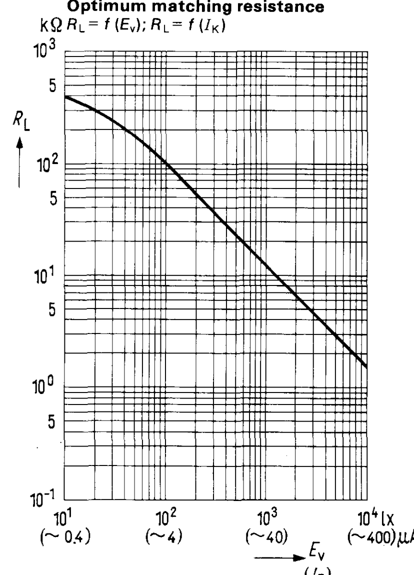
Photovoltage $V_P = f(I_K)$; R_L = parameter



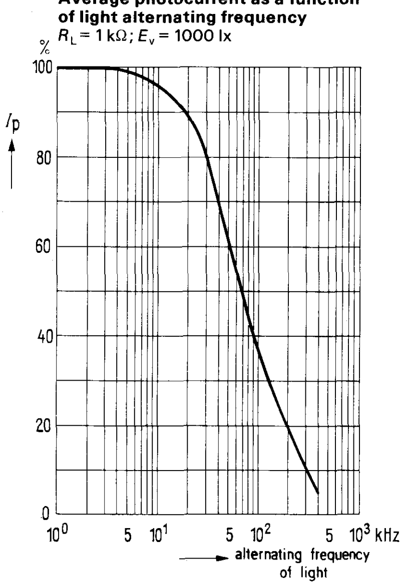
Photocurrent $I_P = f(I_K)$; R_L = parameter



Optimum matching resistance
kΩ $R_L = f(E_v)$; $R_L = f(I_K)$



Average photocurrent as a function of light alternating frequency
$R_L = 1\ k\Omega$; $E_v = 1000$ lx

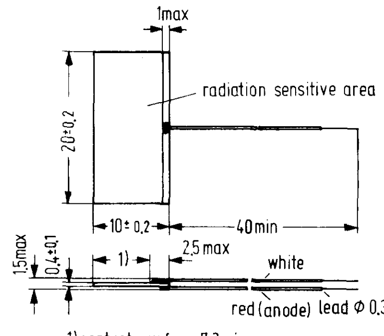


Silicon Photovoltaic Cell

The photovoltaic cell BPY 47 is suitable for general applications in control and drive circuits. It can be used as detector for filament lamps or daylight.

For mounting instructions see introduction, para. 2.4, page 24.

Type	Ordering code
BPY 47	Q 60 215-Y 47



Approx. weight 1.5 g
Dimensions in mm

Maximum ratings

Reverse voltage	V_R	1	V
Temperature range	T_{amb}	−55 to +100	°C

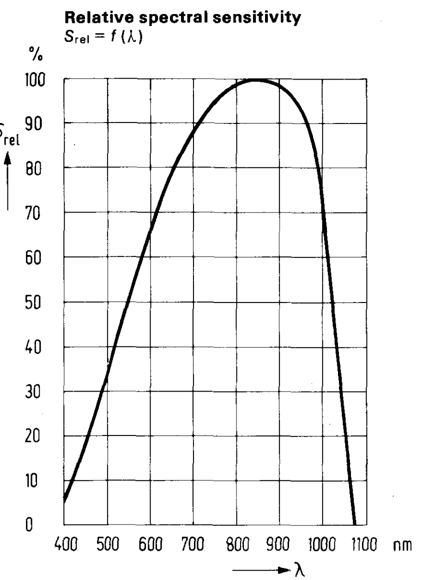
For BPY 47 the positive pole of the voltage source has to be connected with the white lead.

Characteristics (T_{amb} = 25°C)

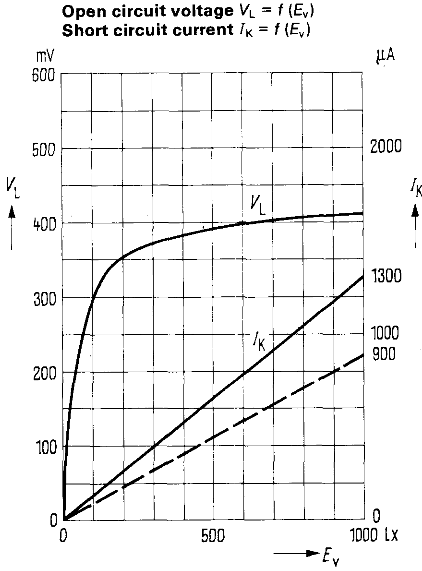
Spectral sensitivity [1] (Short circuit current I_K)	S	1.3 (≧ 0.9)	μA/lx
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	850	nm
Quantum yield (Electrons per photon) (λ = 850 nm)	η	0.80	Electrons/Photon
Spectral sensitivity (λ = 850 nm)	S	0.55	A/W
Open circuit voltage (E_v = 10 000 lx) [1]	V_L	≧ 450	mV
Open circuit voltage (E_v = 1000 lx) [1]	V_L	410 (≧ 280)	mV
Open circuit voltage (E_v = 100 lx) [1]	V_L	300 (≧ 150)	mV
Short circuit current (E_v = 10 000 lx) [1]	I_K	13	mA
Radiant sensitive area	A	1.8	cm²
Temperature coefficient of V_L (see diagram)	TC	− 2.6	mV/K
Temperature coefficient of I_K (see diagram)	TC	0.12	%/K
Capacitance (V_R = 0 V; E = 0)	C_0	20	nF
Dark current (V_R = 1 V; E = 0)	I_R	25	μA
Dark current (V_R = 1 V; T_{amb} = 50°C; E = 0)	I_R	70	μA

1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

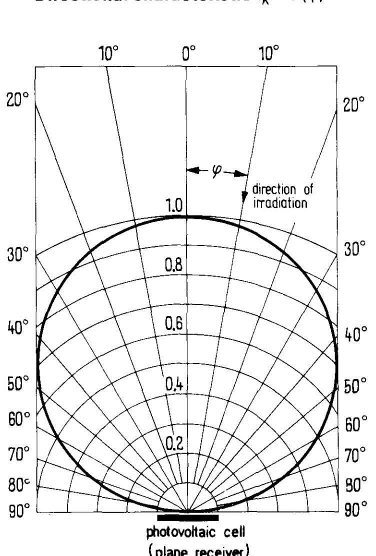
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



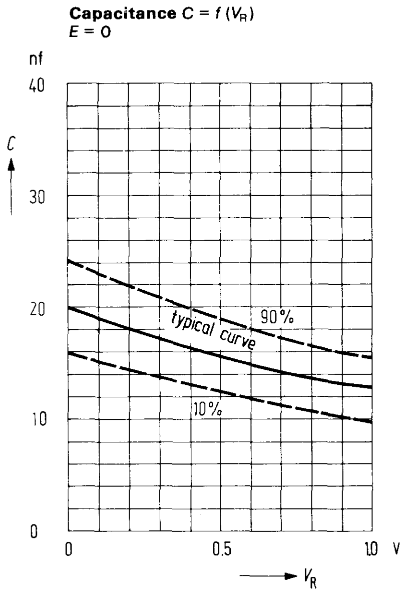
Open circuit voltage $V_L = f(E_v)$
Short circuit current $I_K = f(E_v)$

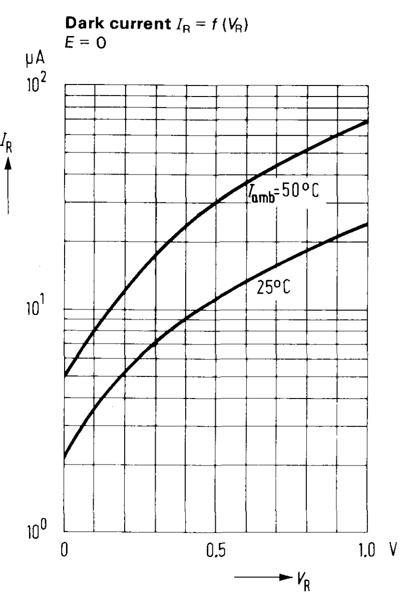


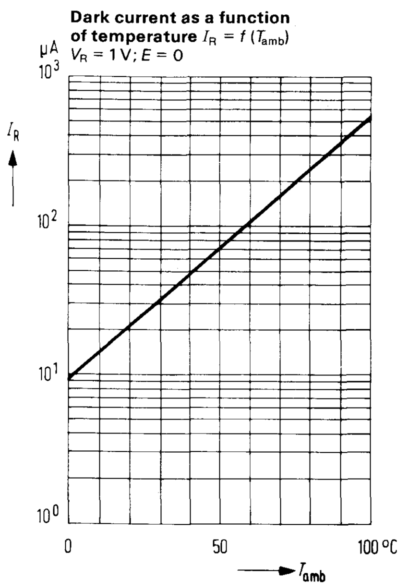
Directional characteristic $I_K = f(\varphi)$

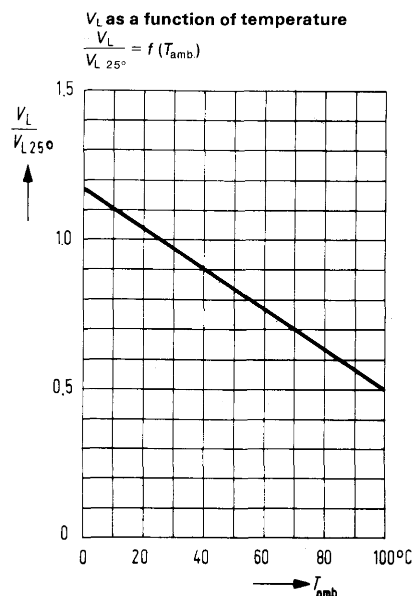


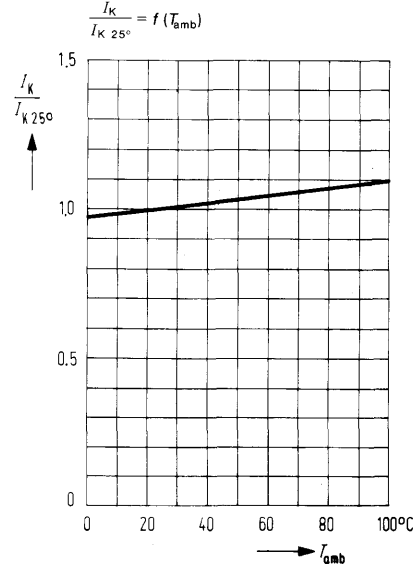
Capacitance $C = f(V_R)$
$E = 0$



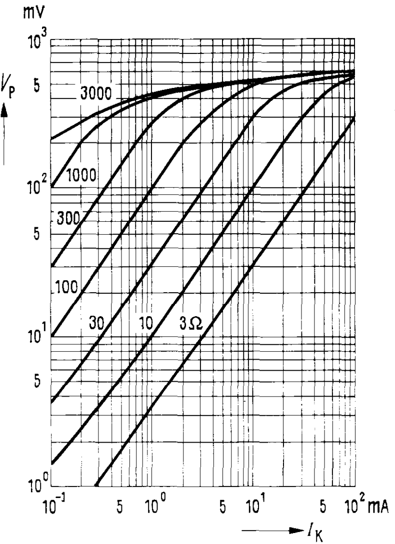

Dark current $I_R = f(V_R)$
$E = 0$
μA
10^2
I_R
T_{amb}=50°C
25°C
10^1
10^0
0
0.5
1.0 V
V_R


Dark current as a function of temperature $I_R = f(T_{amb})$
$V_R = 1\,V$; $E = 0$
μA
10^3
I_R
10^2
10^1
10^0
0
50
100 °C
T_{amb}

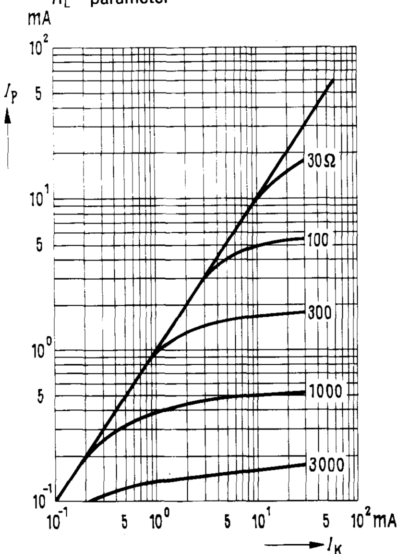

V_L as a function of temperature
$\frac{V_L}{V_{L\,25°}} = f(T_{amb})$
1.5
$\frac{V_L}{V_{L\,25°}}$
1.0
0.5
0
0
20
40
60
80
100°C
T_{amb}


I_K as a function of temperature
$\frac{I_K}{I_{K\,25°}} = f(T_{amb})$
1.5
$\frac{I_K}{I_{K\,25°}}$
1.0
0.5
0
0
20
40
60
80
100°C
T_{amb}

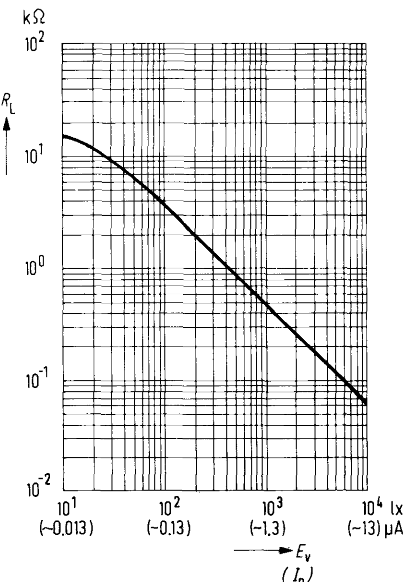
Photovoltage as a function of short circuit current $V_P = f(I_K)$
R_L = parameter



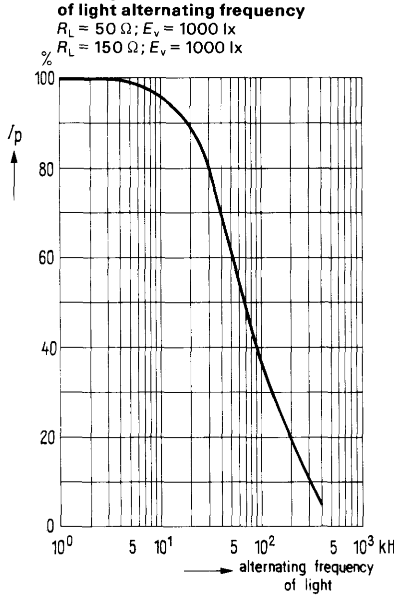
Photocurrent as a function of short circuit current $I_P = f(I_K)$
R_L = parameter



Optimum matching resistance
$R_L = f(E_v)$; $R_L = f(I_K)$



Average photocurrent as a function of light alternating frequency
$R_L = 50\,\Omega$; $E_v = 1000$ lx
$R_L = 150\,\Omega$; $E_v = 1000$ lx



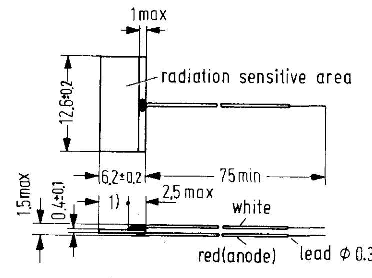
Silicon Photovoltaic Cell

BPY 48

The photovoltaic cell BPY 48 is suitable for general applications in control and drive circuits. It can be used as detector for filament lamps or daylight.

For mounting instructions see introduction, para. 2.4, page 24.

Type	Ordering code
BPY 48	Q 60 215-Y 48



Approx. weight 0.5 g
Dimensions in mm

Maximum ratings

Reverse voltage	V_R	1	V
Temperature range	T_{amb}	– 55 to + 100	°C

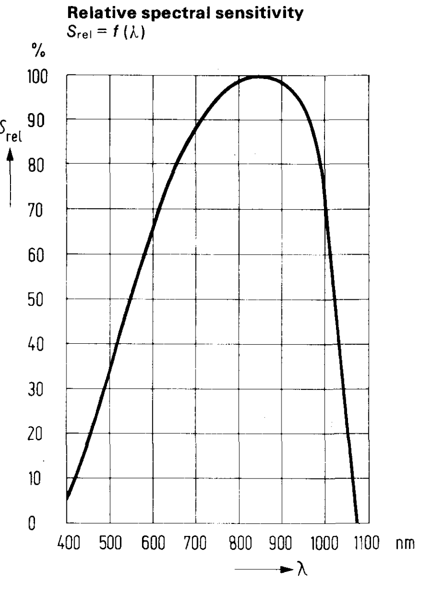
For BPY 48 the positive pole of the voltage source has to be connected with the white lead.

Characteristics (T_{amb} = 25°C)

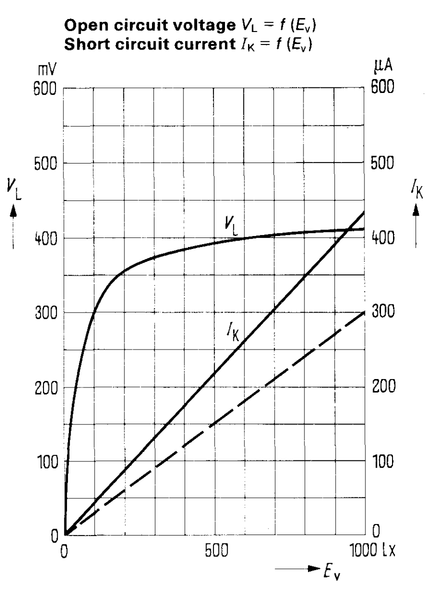
Spectral sensitivity [1)] (Short circuit current I_K)	S	0.43 (≧ 0.3)	µA/lx
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	850	nm
Quantum yield (Electrons per photon) (λ = 850 nm)	η	0.80	$\frac{\text{Electrons}}{\text{Photon}}$
Spectral sensitivity (λ = 850 nm)	S	0.55	A/W
Open circuit voltage (E_v = 10 000 lx) [1)]	V_L	≧ 450	mV
(E_v = 1000 lx) [1)]	V_L	410 (≧ 280)	mV
(E_v = 100 lx) [1)]	V_L	300 (≧ 150)	mV
Short circuit current (E_v = 10 000 lx) [1)]	I_K	4.3	mA
Radiant sensitive area	A	0.67	cm^2
Temperature coefficient of V_L (see diagram)	TC	−2.6	mV/K
Temperature coefficient of I_K (see diagram)	TC	0.12	%/K
Capacitance (V_R = 0 V; E = 0)	C_0	8	nF
Dark current (V_R = 1 V; E = 0)	I_R	10	µA
Dark current (V_R = 1 V; T_{amb} = 50°C; E = 0)	I_R	25	µA

1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

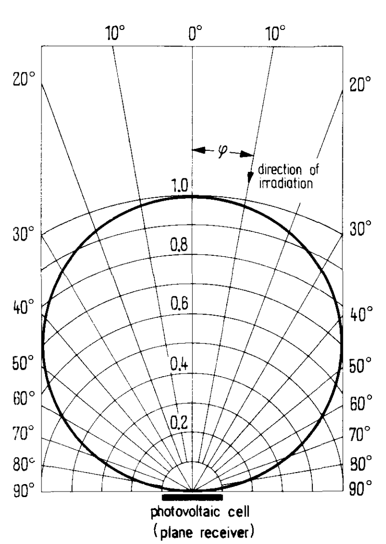
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



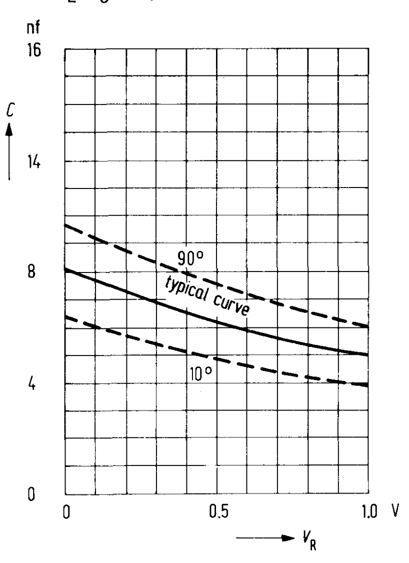
Open circuit voltage $V_L = f(E_v)$
Short circuit current $I_K = f(E_v)$

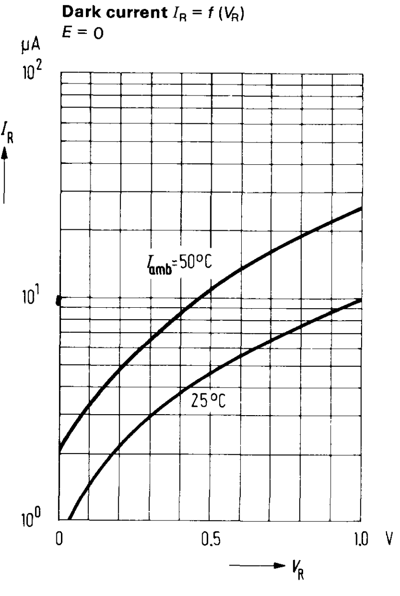


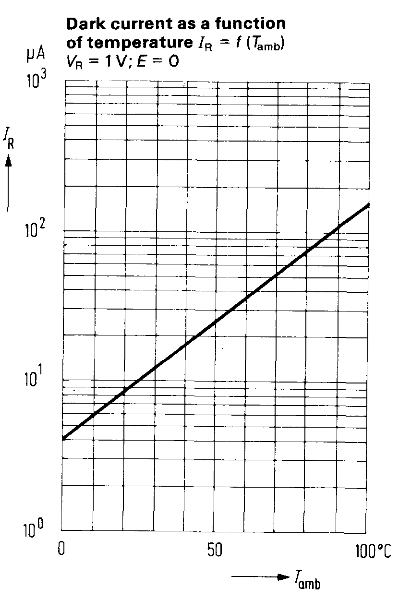
Directional characteristic $I_K = f(\varphi)$

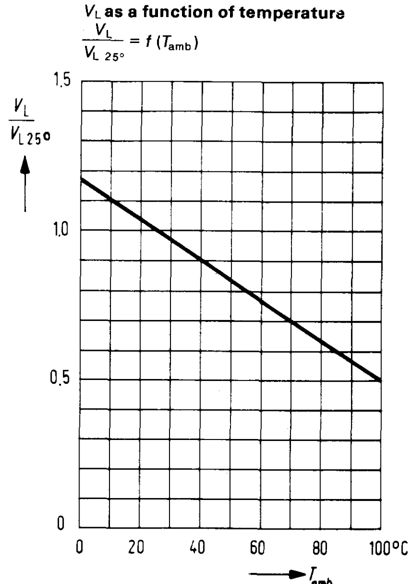


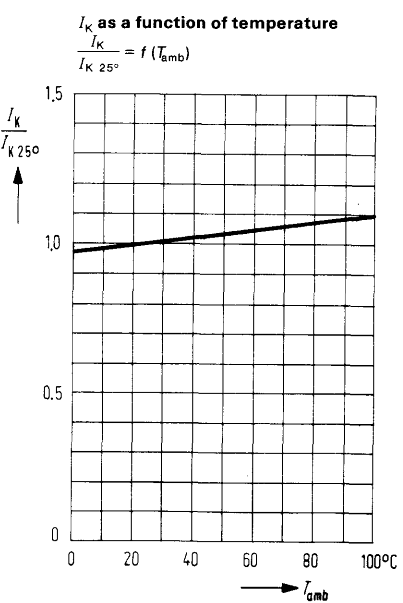
Capacitance $C = f(V_R)$
$E = 0$



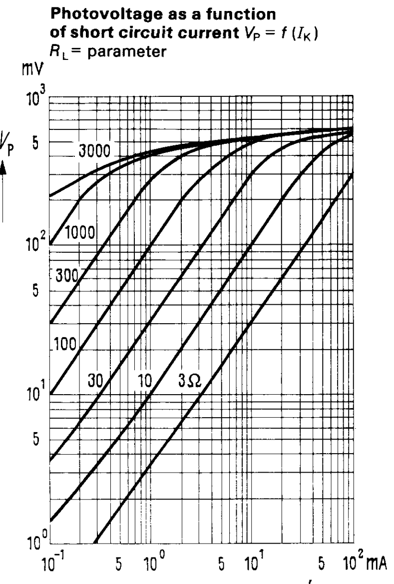

Dark current $I_R = f(V_R)$
$E = 0$
μA
10^2
I_R
10^1
10^0
T_{amb}=50°C
25°C
0
0.5
1.0 V
V_R


Dark current as a function of temperature $I_R = f(T_{amb})$
$V_R = 1\,V; E = 0$
μA
10^3
I_R
10^2
10^1
10^0
0
50
100°C
T_{amb}

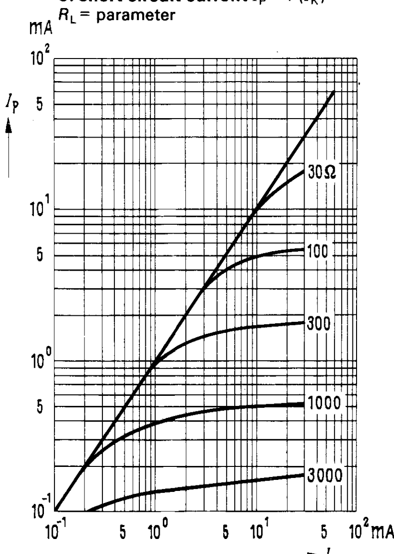

V_L as a function of temperature
$\frac{V_L}{V_{L\,25°}} = f(T_{amb})$
1.5
1.0
0.5
0
0
20
40
60
80
100°C
T_{amb}


I_K as a function of temperature
$\frac{I_K}{I_{K\,25°}} = f(T_{amb})$
1.5
1.0
0.5
0
0
20
40
60
80
100°C
T_{amb}

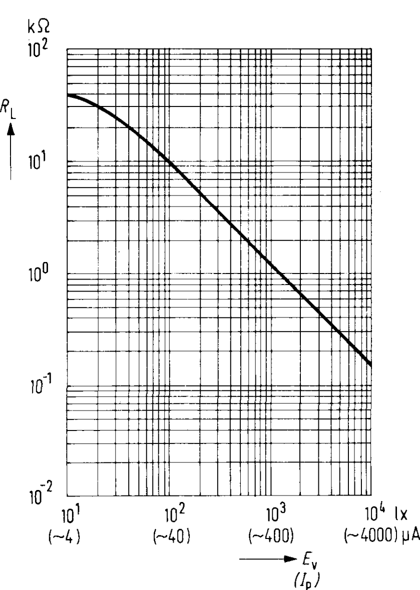
Photovoltage as a function of short circuit current $V_P = f(I_K)$
R_L = parameter



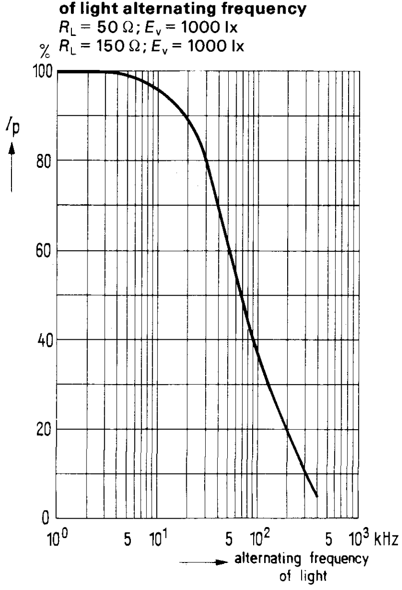
Photocurrent as a function of short circuit current $I_P = f(I_K)$
R_L = parameter



Optimum matching resistance
$R_L = f(E_v)$; $R_L = f(I_K)$



Average photocurrent as a function of light alternating frequency
$R_L = 50\ \Omega$; $E_v = 1000$ lx
$R_L = 150\ \Omega$; $E_v = 1000$ lx



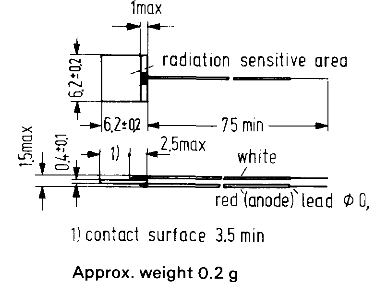
Silicon Photovoltaic Cell

BPY 64

The BPY 64 is suitable for versatile applications in control and drive circuits. It can be used – like all silicon photovoltaic cells – as detector for light of filament lamps or daylight.

For mounting instructions see introduction, para. 2.4, page 24.

Type	Ordering code
BPY 64	Q 60 215-Y 64



1) contact surface 3.5 min

Approx. weight 0.2 g
Dimensions in mm

Maximum ratings

Reverse voltage [1]	V_R	1	V
Temperature range	T_{amb}	– 55 to + 100	°C

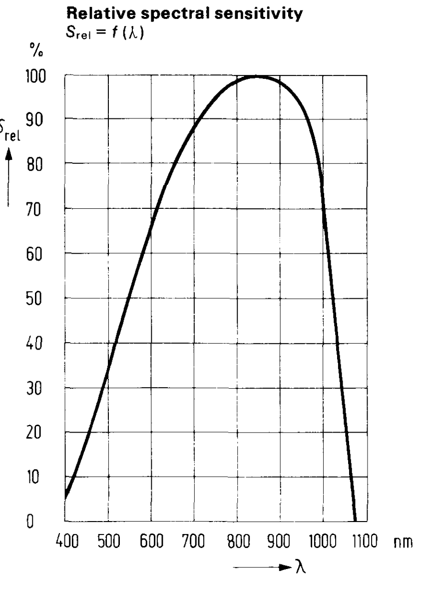
1) The positive pole of the voltage source shall be connected to the white lead.

Characteristics (T_{amb} = 25°C)

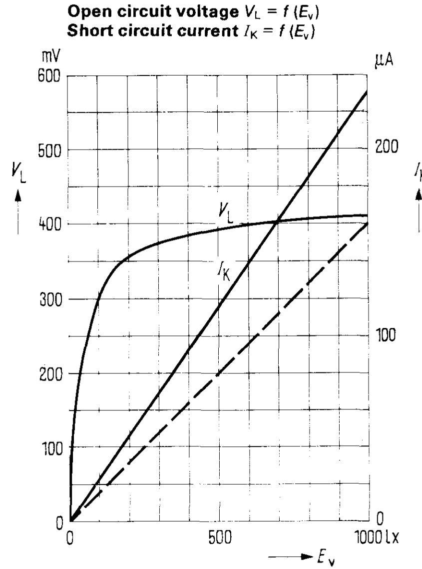
Spectral sensitivity [1] (Short circuit current I_K)	S	0.23 (≧ 0.16)	µA/lx
Wavelength of the max. sensitivity	$\lambda_{S\ max}$	850	nm
Quantum yield (Electrons per photon) (λ = 850 nm)	η	0.80	$\frac{\text{Electrons}}{\text{Photon}}$
Spectral sensitivity (λ = 850 nm)	S	0.55	A/W
Open circuit voltage (E_v = 10 000 lx) [1]	V_L	≧ 450	mV
(E_v = 1000 lx) [1]	V_L	410 (≧ 280)	mV
(E_v = 100 lx) [1]	V_L	300 (≧ 150)	mV
Radiant sensitive area	A	approx. 0.32	cm^2
Temperature coefficient of V_L (see diagram)	TC	– 2.6	mV/K
Temperature coefficient of I_K (see diagram)	TC	0.12	%/K
Capacitance (V_R = 0 V; E = 0)	C_0	4	nF
Dark current (V_R = 1 V; E = 0)	I_R	4	µA
Dark current (V_R = 1 V; T_{amb} = 50°C; E = 0)	I_R	10	µA

1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

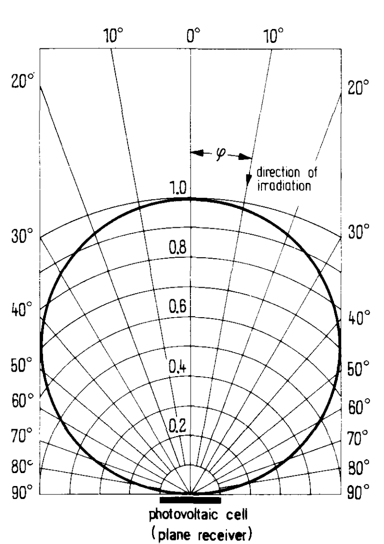
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



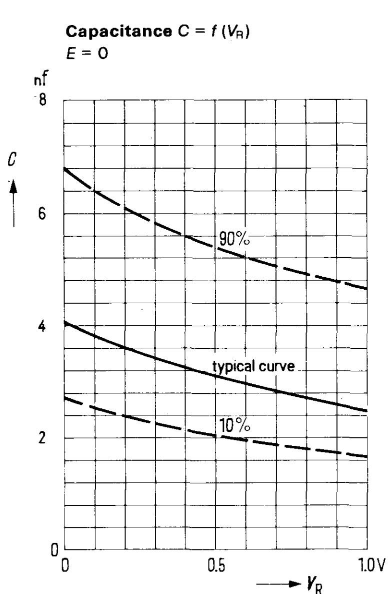
Open circuit voltage $V_L = f(E_v)$
Short circuit current $I_K = f(E_v)$

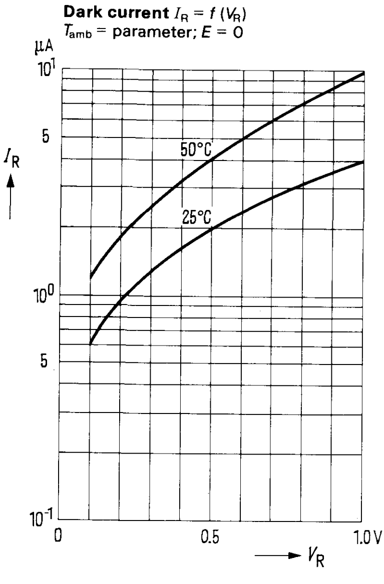


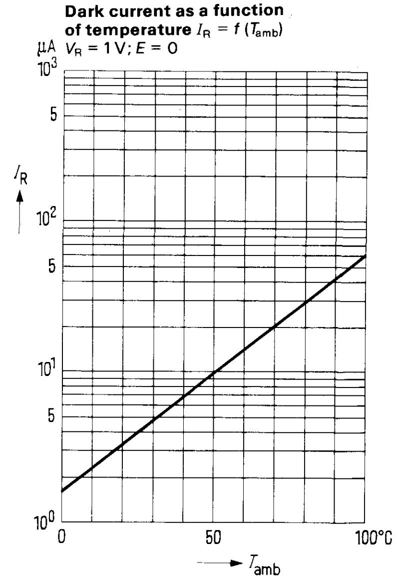
Directional characteristic $I_K = f(\varphi)$

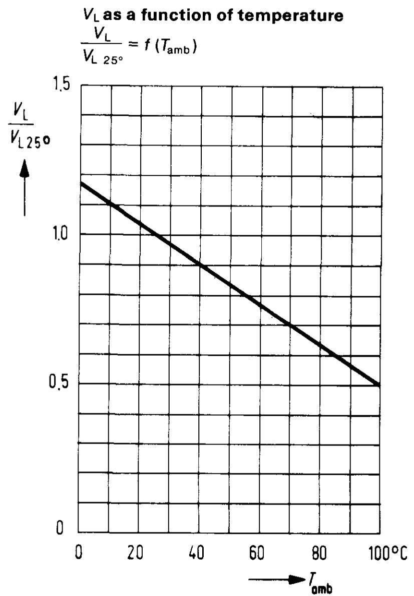


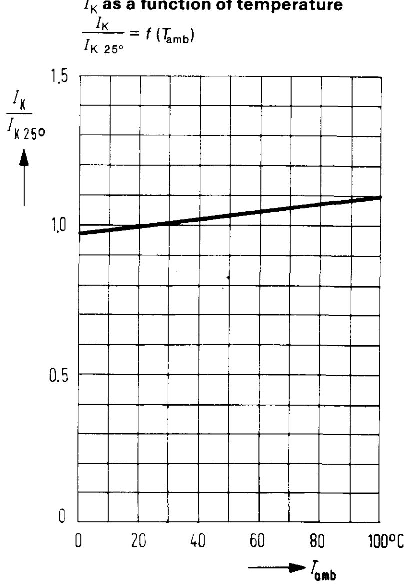
Capacitance $C = f(V_R)$
$E = 0$

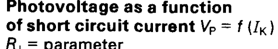



Dark current $I_R = f(V_R)$
T_{amb} = parameter; $E = 0$
µA
10^1
5
I_R
50°C
25°C
10^0
5
10^{-1}
0
0.5
1.0 V
V_R

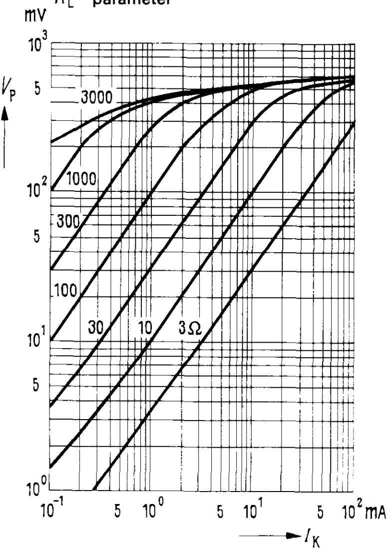

Dark current as a function of temperature $I_R = f(T_{amb})$
µA $V_R = 1\,V$; $E = 0$
10^3
5
I_R
10^2
5
10^1
5
10^0
0
50
100°C
T_{amb}


V_L as a function of temperature
$\frac{V_L}{V_{L\,25°}} = f(T_{amb})$
1.5
$\frac{V_L}{V_{L\,25°}}$
1.0
0.5
0
0
20
40
60
80
100°C
T_{amb}

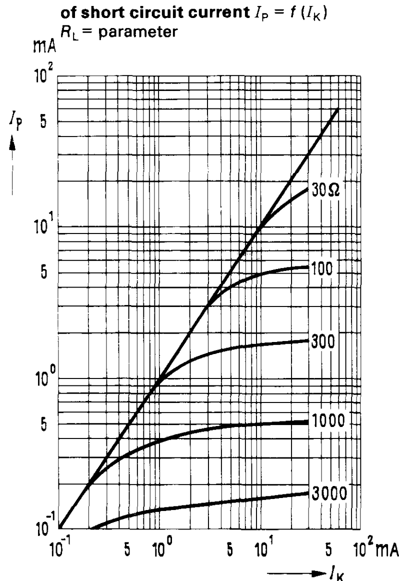

I_K as a function of temperature
$\frac{I_K}{I_{K\,25°}} = f(T_{amb})$
1.5
$\frac{I_K}{I_{K\,25°}}$
1.0
0.5
0
0
20
40
60
80
100°C
T_{amb}



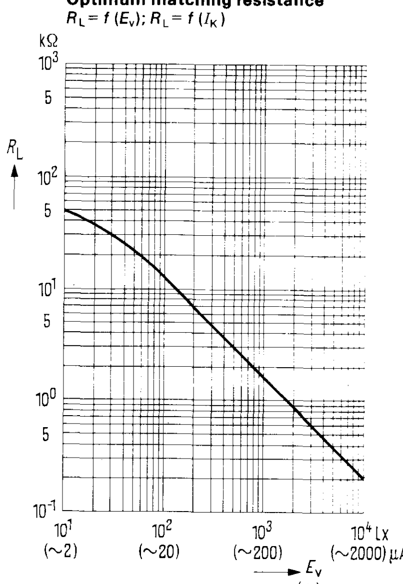
Photovoltage as a function of short circuit current $V_P = f\,(I_K)$
R_L = parameter



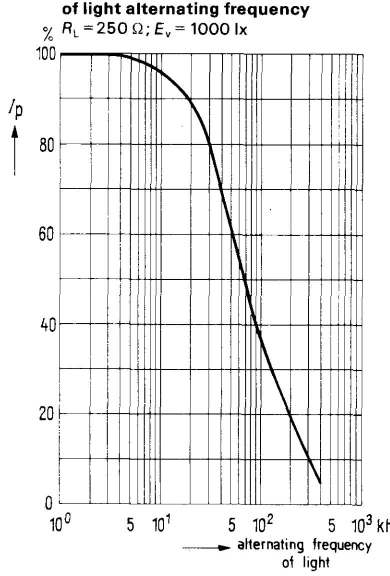
Photocurrent as a function of short circuit current $I_P = f\,(I_K)$
R_L = parameter



Optimum matching resistance
$R_L = f\,(E_v)$; $R_L = f\,(I_K)$



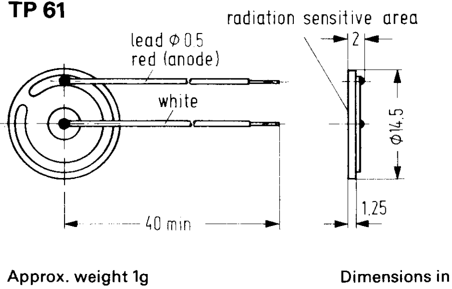
Average photocurrent as a function of light alternating frequency
R_L = 250 Ω; E_v = 1000 lx



The silicon photovoltaic cells TP 60 and TP 61 are suitable for use in drive and control circuits. Featuring the same electrical characteristics, they differ only in design. The anode (positive pole of the cell) is marked by a red lead. For mounting instructions see introduction, para. 2.4, page 24.

Type	Ordering code
TP 60	Q 62607-S 60
TP 61	Q 62607-S 61

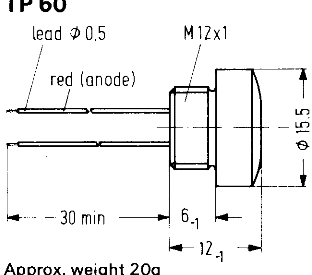
TP 61



Approx. weight 1g

Dimensions in mm

TP 60



Approx. weight 20g

Maximum ratings		TP 60	TP 61	
Operating and storage temperature range	T_{amb}	− 25 to + 75	− 55 to + 100	°C
Reverse voltage [1]	V_R	1.0	1.0	V

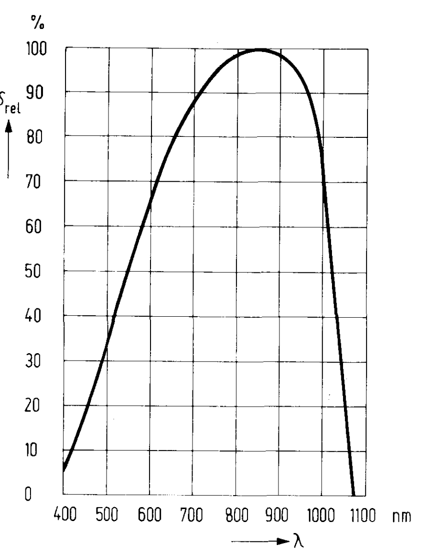
1) The positive pole of the voltage source shall be connected to the white lead.

Characteristics (T_{amb} = 25°C)

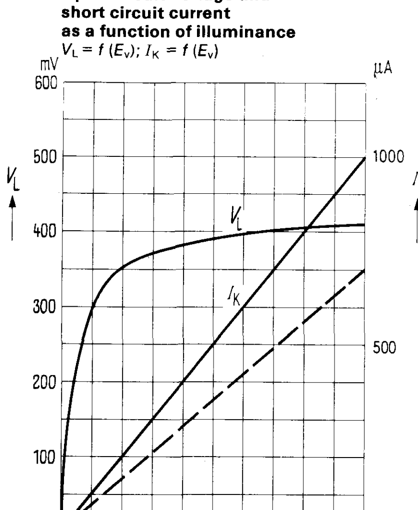
Spectral sensitivity [1] (Short circuit current I_K)	S	1 (≧ 0.7)	µA/lx
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	850	nm
Quantum yield (Electrons per photon) (λ = 850 nm)	η	0.80	Electrons / Photon
Spectral sensitivity (λ = 850 nm)	S	0.55	A/W
Open circuit voltage (E_v = 10 000 lx) [1]	V_L	≧ 440	mV
(E_v = 1000 lx) [1]	V_L	410 (≧ 270)	mV
(E_v = 100 lx) [1]	V_L	300 (≧ 140)	mV
Short circuit current (E_v = 10 000 lx) [1]	I_K	≧ 7	mA
(E_v = 1000 lx) [1]	I_K	≧ 0.7	mA
Infrared response limit	λ_g	1.100	nm
Radiant sensitive area	A	1.5	cm^2
Tolerance of the radiant sensitive area	A tol	± 0.1	cm^2
Temperature coefficient of V_L (see diagram)	TC	– 2.6	mV/K
Temperature coefficient of I_K (see diagram)	TC	0.12	%/K
Capacitance (V_R = 0 V; E = 0)	C_0	16	nF
Dark current (V_R = 1 V; E = 0)	I_R	25	µA
Dark current (V_R = 1 V; T_{amb} = 50°C; E = 0)	I_R	65	µA

1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

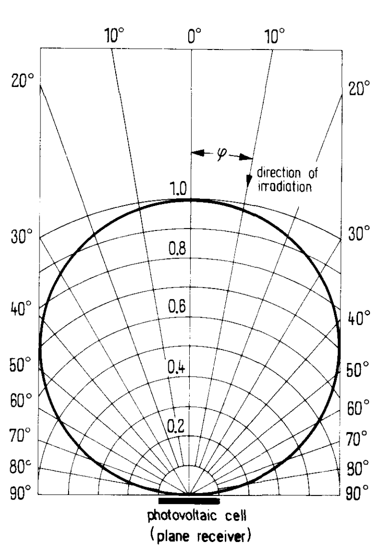
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



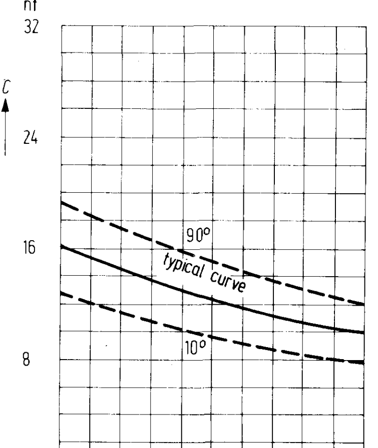
Open circuit voltage and short circuit current as a function of illuminance
$V_L = f(E_v)$; $I_K = f(E_v)$



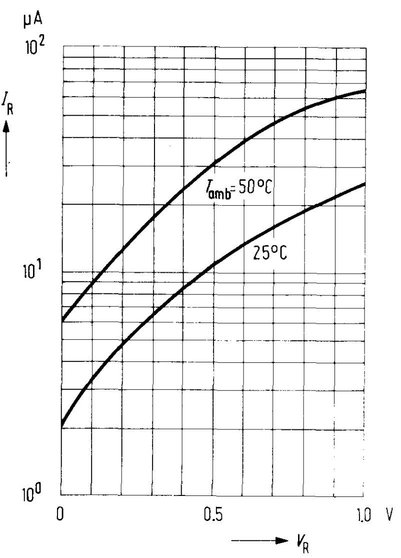
Directional characteristic $I_K = f(\varphi)$



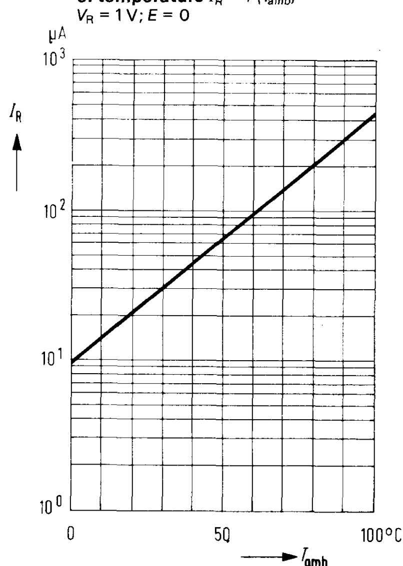
Capacitance $C = f(V_R)$
$E = 0$



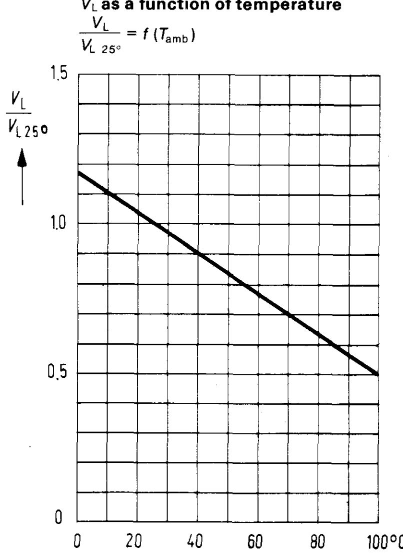
Dark current $I_R = f(V_R)$
T_{amb} = parameter; $E = 0$



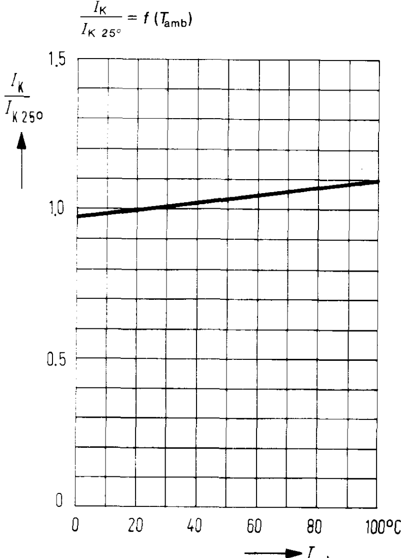
Dark current as a function of temperature $I_R = f(T_{amb})$
$V_R = 1\,V$; $E = 0$



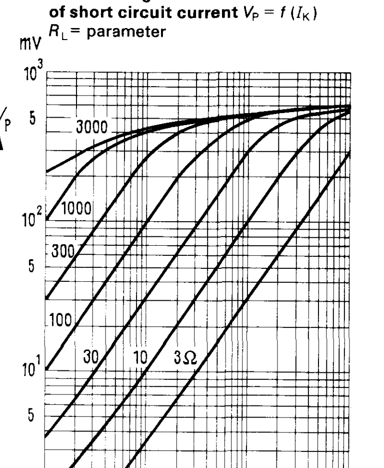
V_L **as a function of temperature**
$\frac{V_L}{V_{L\ 25°}} = f(T_{amb})$



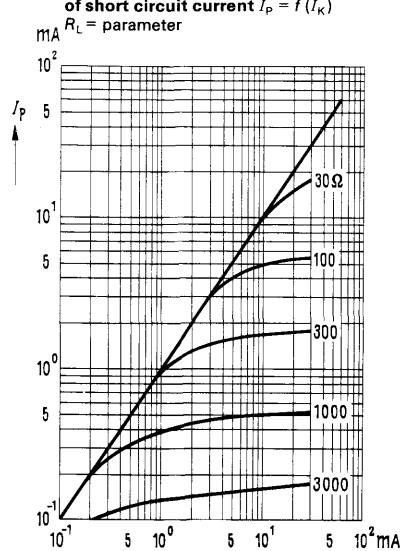
I_K **as a function of temperature**
$\frac{I_K}{I_{K\ 25°}} = f(T_{amb})$



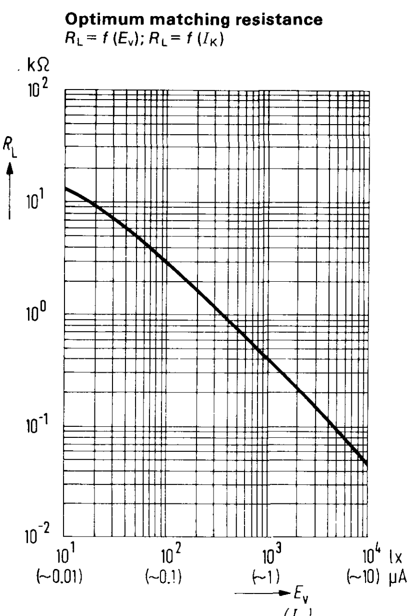
Photovoltage as a function of short circuit current $V_P = f(I_K)$
R_L = parameter



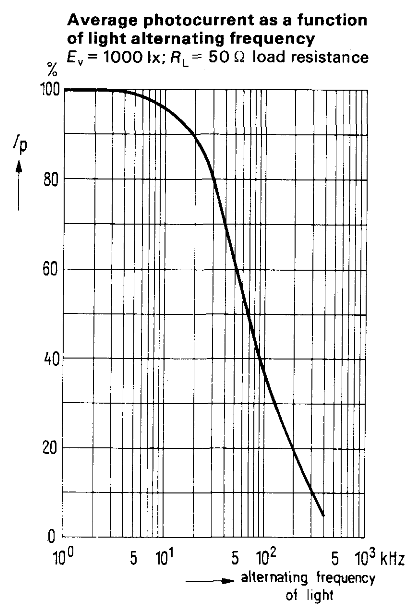
Photocurrent as a function of short circuit current $I_P = f(I_K)$
R_L = parameter

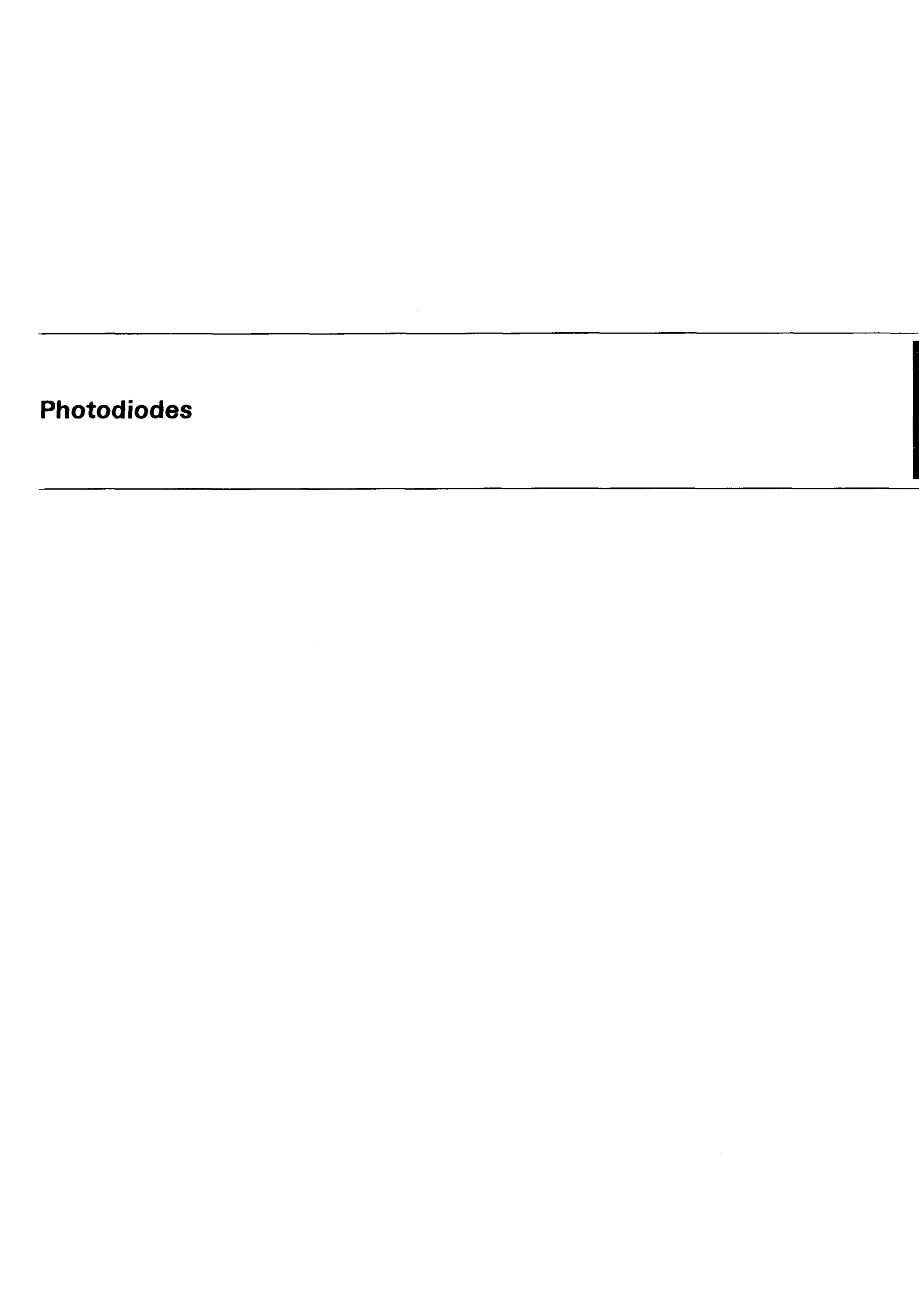


Optimum matching resistance
$R_L = f(E_v)$; $R_L = f(I_K)$



Average photocurrent as a function of light alternating frequency
E_v = 1000 lx; R_L = 50 Ω load resistance





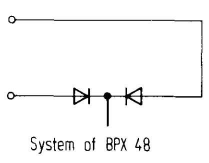
Photodiodes

Plastic Encapsulated, Differential Photodiode in Strip Line Technique

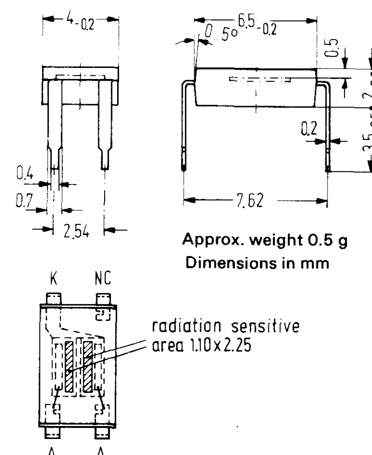
BPX 48

The differential photodiode BPX 48 is designed for special industrial electronic applications, such as follow-up control, edge control, path and angle scanning, respectively. The individual diodes are spaced 50 μm apart, thus resulting in a highly precise positional indication. The rise and fall times of the photocurrent are so short that control systems with small down times can be built up. The silicon planar method ensures a low dark current level, low noise and thus very favourable signal relationships.

Type	Ordering code
BPX 48	Q 62 702-P 17-S 1



System of BPX 48



Approx. weight 0.5 g
Dimensions in mm

Maximum ratings (for individual diode system)

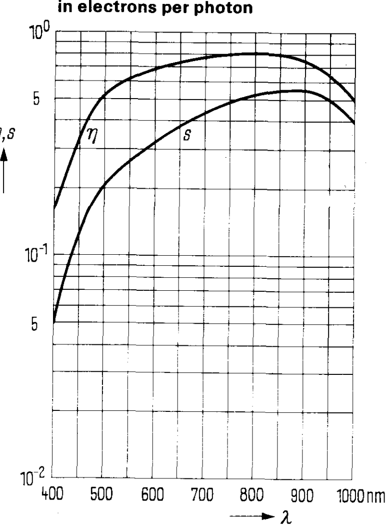
Reverse voltage	V_R	10	V
Junction temperature	T_j	125	°C
Storage temperature range	T_{stor}	– 40 to + 80	°C
Power dissipation	P_{tot}	50	mW

Characteristics (T_{amb} = 25°C)
(the data refers to a photodiode system)

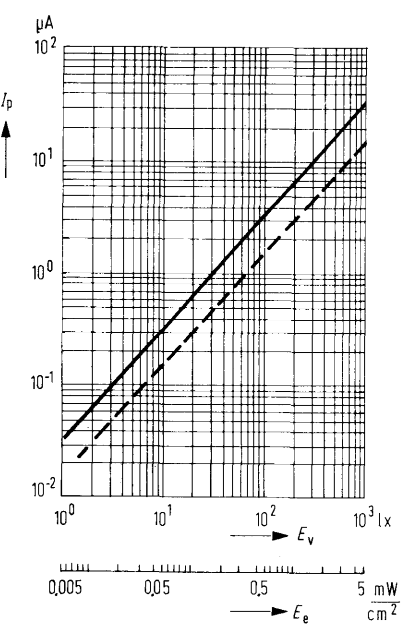
Spectral sensitivity [1]	S	32 (≧ 15)	nA/lx
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	850	nm
Quantum yield (Electrons per photon) (λ = 850 nm)	η	0.80	Electrons / Photon
Spectral sensitivity (λ = 850 nm)	S	0.55	A/W
Rise and fall time of the photo current from 10% to 90% and from 90% to 10% of the final value			
(R_L = 1 kΩ; V_R = 0 V)	t_r; t_f	≦ 500	ns
(R_L = 1 kΩ; V_R = 10 V)	t_r; t_f	≦ 150	ns
Cut-off frequency measured with a load resistance (R_L = 1 kΩ; V_R = 10 V)	f_g	3	MHZ
Capacitance			
(V_R = 0 V)	C_0	40	pF
(V_R = 10 V)	C_{10}	10	pF
Radiant sensitive area	A	1.9	mm^2
Dark current (V_R = 10 V; E = 0)	I_R	100 (≦ 200)	nA

1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

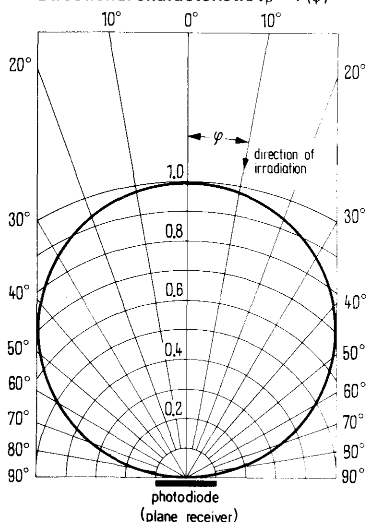
Spectral sensitivity $S = f(\lambda)$ in A/W and quantum yield $\eta = f(\lambda)$ in electrons per photon



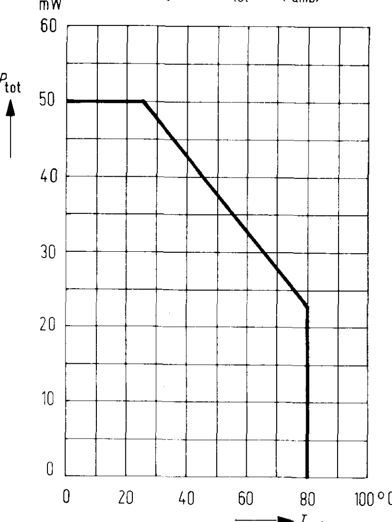
Photocurrent $I_P = f(E_v)$

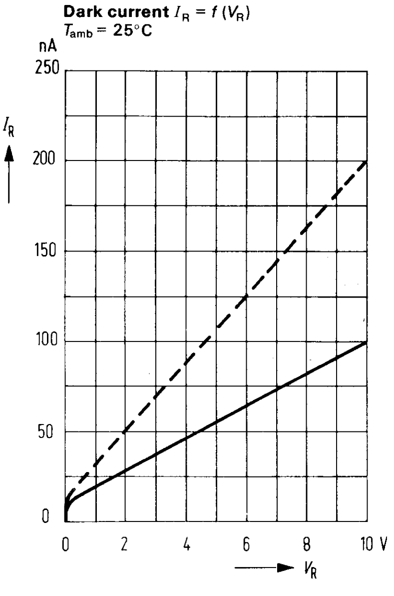


Directional characteristic $I_P = f(\varphi)$

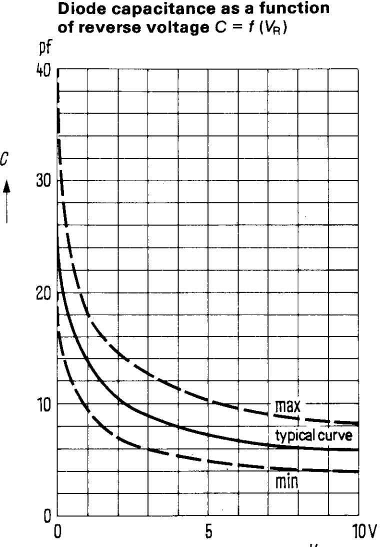


Power dissipation $P_{tot} = f(T_{amb})$

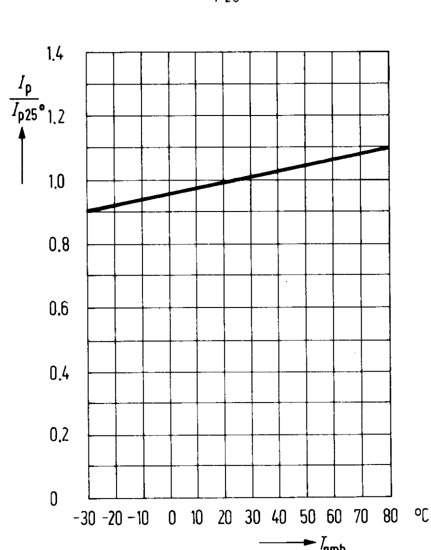




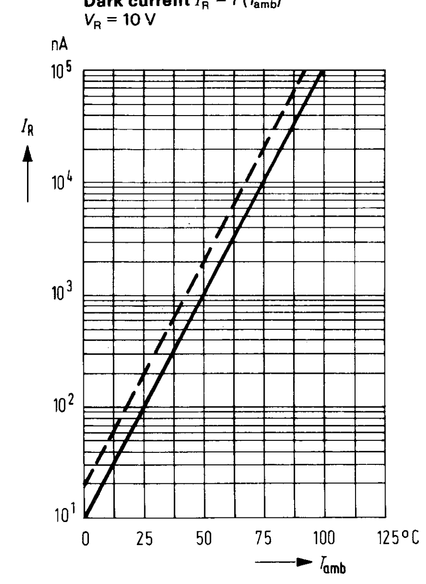
Dark current $I_R = f(V_R)$
$T_{amb} = 25°C$
nA
250
200
150
100
50
0
I_R
0
2
4
6
8
10 V
V_R



Diode capacitance as a function of reverse voltage $C = f(V_R)$
pf
40
30
20
10
0
C
max
typical curve
min
0
5
10V
V_R

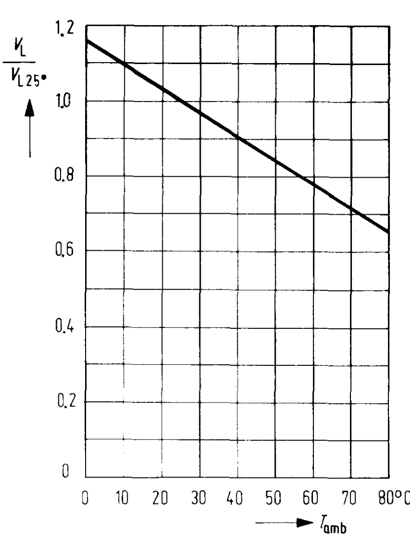


Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
$\frac{I_p}{I_{p25°}}$
-30 -20 -10 0 10 20 30 40 50 60 70 80 °C
T_{amb}

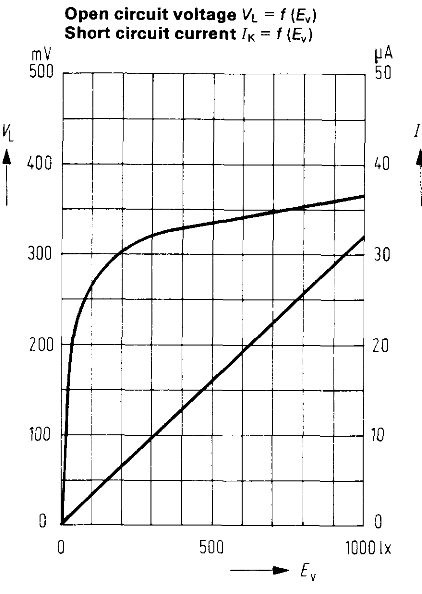


Dark current $I_R = f(T_{amb})$
$V_R = 10$ V
nA
10^5
10^4
10^3
10^2
10^1
I_R
0
25
50
75
100
125°C
T_{amb}

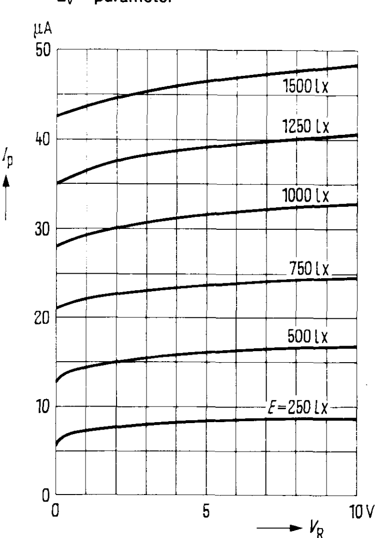
Open circuit voltage $V_L = f(T_{amb})$



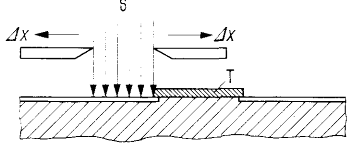
Open circuit voltage $V_L = f(E_v)$
Short circuit current $I_K = f(E_v)$



Family of characteristics $I_P = f(V_R)$
E_v = parameter



Scanning a differential photodiode with a 25 μm light beam.

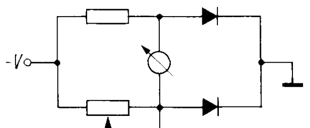


Test setup

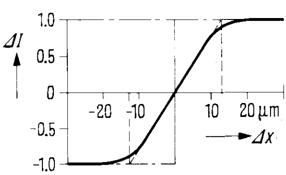
S – slit (25 μm wide)

T – separation of diodes

Δx – displacement of S



Measuring circuit



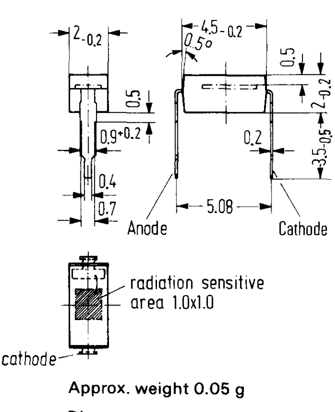
Differential photo signal ΔI (referred to saturation value 1) as a function of the displacement Δx of the slit of light S

Silicon Photodiode with Very Low Dark Current — BPW 32

The BPW 32 is a silicon planar photodiode, which is incorporated in a transparent plastic package. Its terminals are soldering tabs, arranged in 5.08 mm (2/10") lead spacing. Because of this design, the diodes can also very easily be assembled on PC boards. The flat back of the epoxy resin case makes rigid fixing of the component feasible.

The BPW 32 has been developed as a detector for low illuminances and is intended for use as a sensor in exposure meters and automatic exposure timers. The component is outstanding for low dark currents and – when used as a voltaic cell – for a high open circuit voltage at low illuminances. The cathode is marked by an orange dot.

Type	Ordering code
BPW 32	Q 62 702-P 74



Approx. weight 0.05 g

Dimensions in mm

Maximum ratings

Reverse voltage	V_R	7	V
Storage temperature range	T_{stor}	– 55 to + 80	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leq 3$ s)	T_s	230	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	100	mW

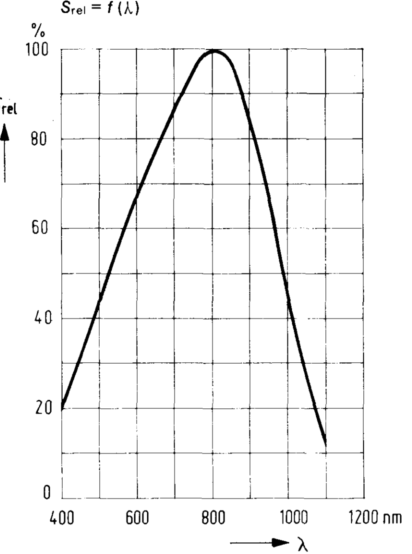
Characteristics (T_{amb} = 25°C)

Parameter	Symbol	Value	Unit
Spectral sensitivity [1]	S	10 (≧ 7)	nA/lx
Zero cross over [2] (E_e = 0 lx; T = 50°C)	S_0	≧ 0.5	mV/pA
Radiant sensitive area	A	1	mm^2
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	800	nm
Quantum yield (Electrons per photon) (λ = 800 nm)	η	0.73	$\frac{Electrons}{Photon}$
Spectral sensitivity (λ = 800 nm)	S	0.47	A/W
Rise and fall time of the photocurrent from 10% to 90% and from 90% to 10% of the final value (R_L = 1 kΩ; V_R = 0 V; λ = 950 nm)	t_r; t_f	1.3	µs
(R_L = 1 kΩ; V_R = 5 V; λ = 950 nm)	t_r; t_f	1.0	µs
Capacitance (V_R = 0 V; E = 0)	C_0	120	pF
(V_R = 3 V; E = 0)	C_3	50	pF
Dark current (V_R = 1 V; E = 0)	I_R	5 (≦ 20)	pA
Temperature coefficient of I_K	TC	0.2	%/K
Noise equivalent power (V_R = 1 V)	NEP	2.1×10^{-15}	$\frac{W}{\sqrt{Hz}}$
Detection limit	D^*	4.8×10^{13}	$\frac{cm\sqrt{Hz}}{W}$

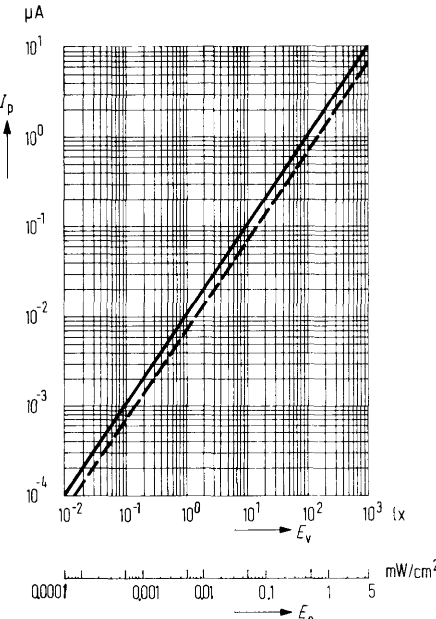
1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

2) S_0 is a measure for the lower spectral sensitivity when the photodiode is used in exposure meters. The zero cross over S_0 is defined in the diagram on page 107.

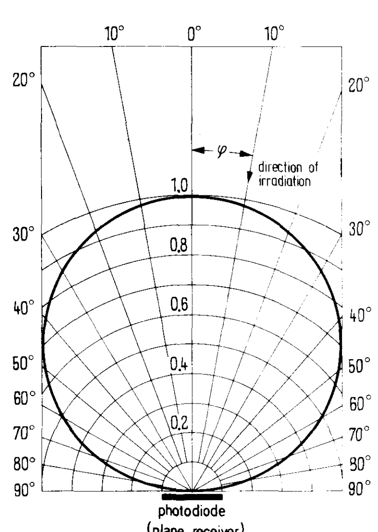
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



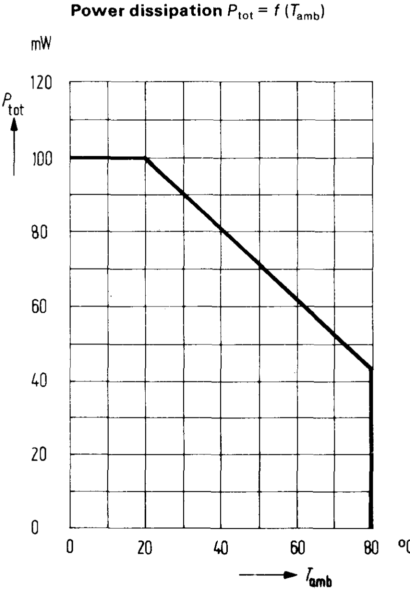
Photocurrent $I_P = f(E_v)$

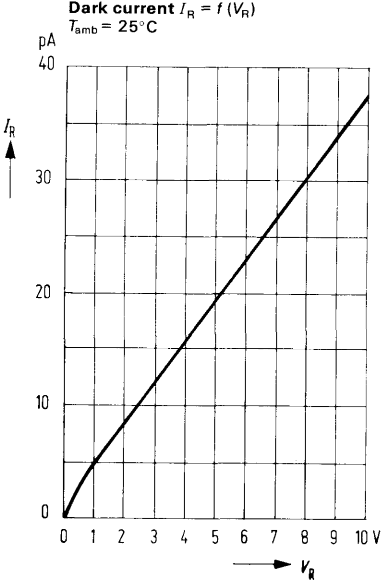


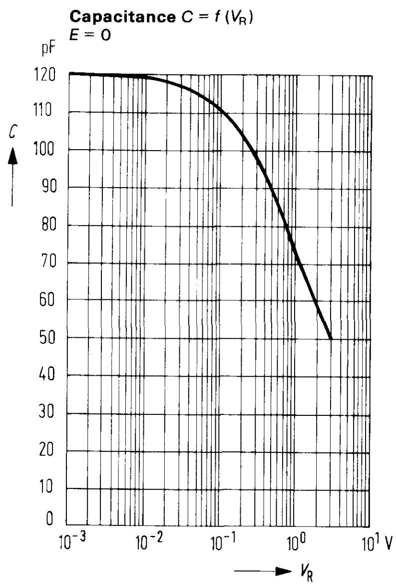
Directional characteristic $I_K = f(\varphi)$

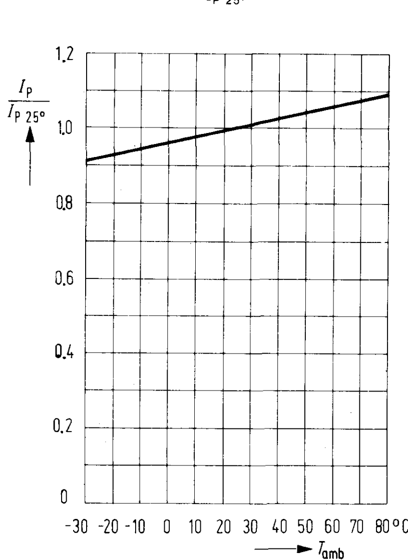


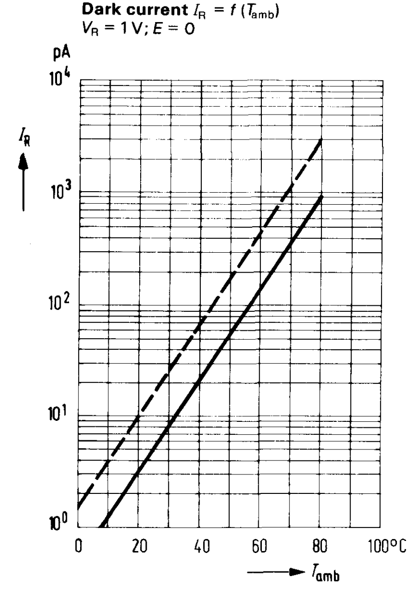
Power dissipation $P_{tot} = f(T_{amb})$



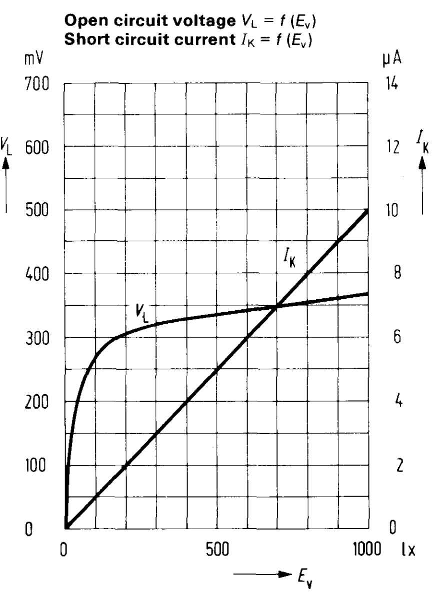

Dark current $I_R = f(V_R)$
$T_{amb} = 25°C$
pA
40
30
20
10
0
I_R
0 1 2 3 4 5 6 7 8 9 10 V
V_R


Capacitance $C = f(V_R)$
$E = 0$
pF
120
110
100
90
80
70
60
50
40
30
20
10
0
C
10^{-3} 10^{-2} 10^{-1} 10^{0} 10^{1} V
V_R


Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$
$\frac{I_P}{I_{P\,25°}}$
1.2
1.0
0.8
0.6
0.4
0.2
0
-30 -20 -10 0 10 20 30 40 50 60 70 80°C
T_{amb}


Dark current $I_R = f(T_{amb})$
$V_R = 1\,V$; $E = 0$
pA
10^4
10^3
10^2
10^1
10^0
I_R
0 20 40 60 80 100°C
T_{amb}

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



Open circuit voltage $\frac{V_L}{V_{L\,25°}} = f(T_{amb})$

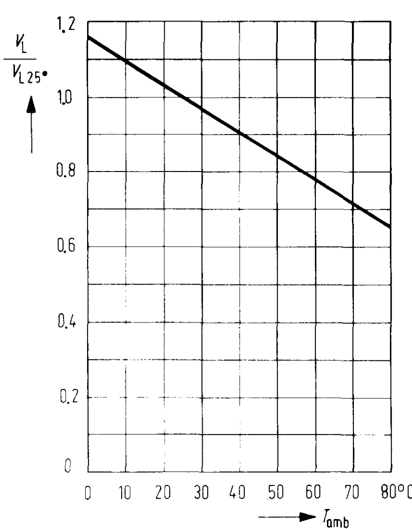
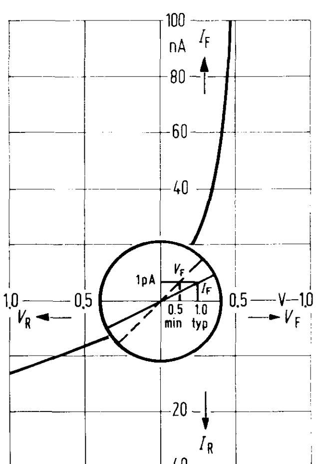


Diagram of the zero cross over S_0

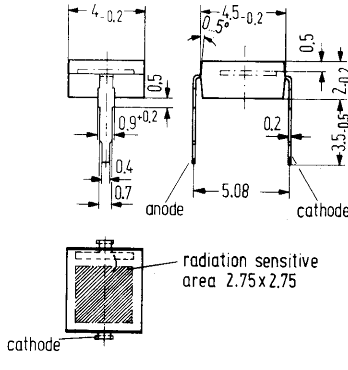


Large Area Silicon Photodiode with Very Low Dark Current

The BPW 33 is a large area silicon planar photodiode, which is incorporated in a transparent plastic package. Its terminals are soldering tabs, arranged in 5.08 mm (2/10") lead spacing. Because of its design the diodes can also very easily be assembled on PC boards. The flat back of the epoxy resin case makes rigid fixing of the component feasible.

The BPW 33 has been developed as a detector for low illuminances and is intended for use as a sensor in exposure meters and automatic exposure timers. The component is outstanding for high open circuit voltage at low illuminances. The cathode is marked by an orange dot.

Type	Ordering code
BPW 33	Q 62 702-P 76



Dimensions in mm

Maximum ratings

Reverse voltage	V_R	7	V
Storage temperature range	T_{stor}	– 40 to + 80	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leqq 3$ s)	T_s	230	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	150	mW

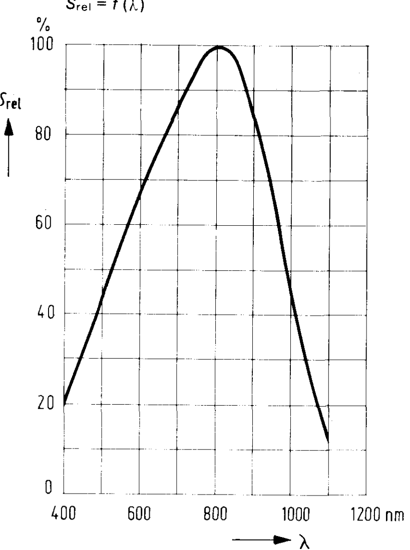
Characteristics (T_{amb} = 25°C)

Spectral sensitivity [1]	S	50 (≧ 35)	nA/lx
Zero cross over [2] ($E_v = 0$; T_{amb} = 50°C)	S_O	≧ 0.05	mV/pA
Radiant sensitive area	A	7.6	mm^2
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	800	nm
Quantum yield (Electrons per photon) (λ = 800 nm)	η	0.73	$\frac{Electrons}{Photon}$
Spectral sensitivity (λ = 800 nm)	S	0.47	A/W
Rise and fall time of the photocurrent from 10% to 90% and from 90% to 10% of the final value			
(R_L = 1 kΩ; V_R = 0 V; λ = 950 nm)	t_r; t_f	2.5	µs
(R_L = 1 kΩ; V_R = 5 V; λ = 950 nm)	t_r; t_f	1.0	µs
Capacitance (V_R = 0 V; $E = 0$)	C_0	750	pF
(V_R = 3 V; $E = 0$)	C_3	330	pF
Dark current (V_R = 1 V; $E = 0$)	I_R	20 (≦ 100)	pA
Temperature coefficient of I_K	TC	0.2	%/K
Noise equivalent power (V_R = 1 V)	NEP	5.3×10^{-15}	$\frac{W}{\sqrt{Hz}}$
Detection limit	D^*	5.2×10^{13}	$\frac{cm\sqrt{Hz}}{W}$

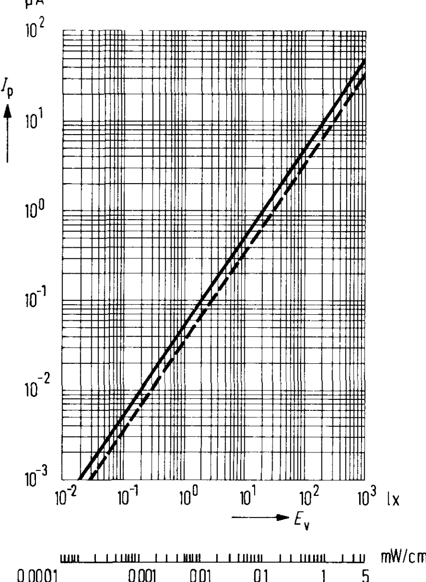
1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5040 and IEC publ. 306-1).

2) S_O is a measure for the lower spectral sensitivity when the photodiode is used in exposure meters. The zero cross over S_O is defined in the diagram on page 112.

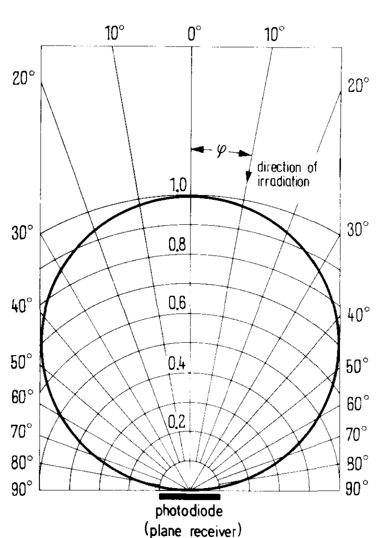
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



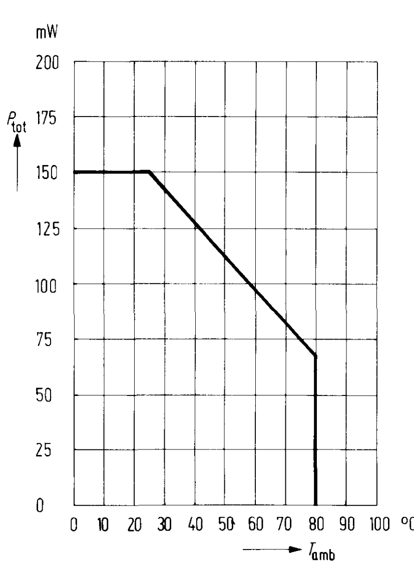
Photocurrent $I_P = f(E_v)$

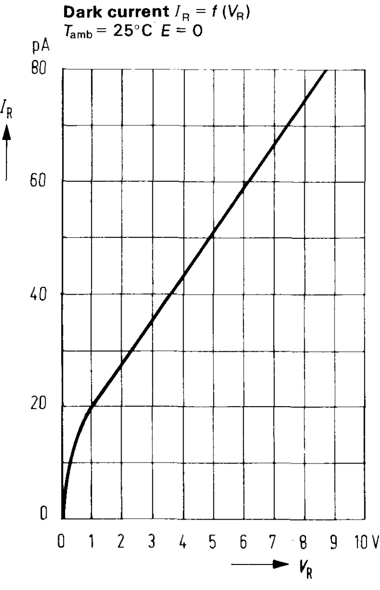


Directional characteristic $I_K = f(\varphi)$

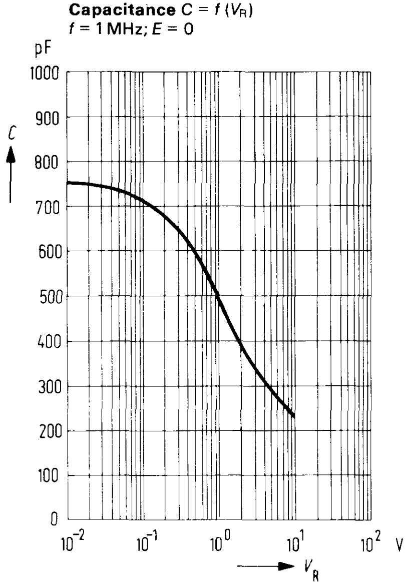


Power dissipation $P_{tot} = f(T_{amb})$

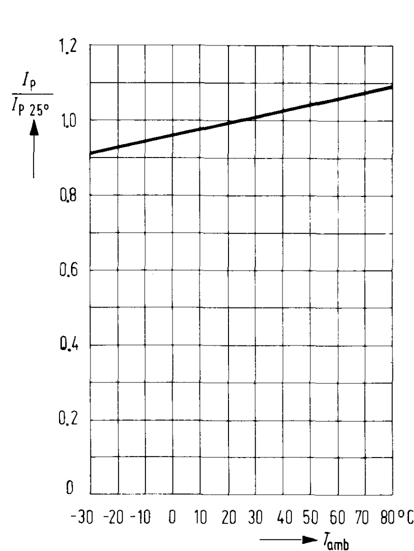




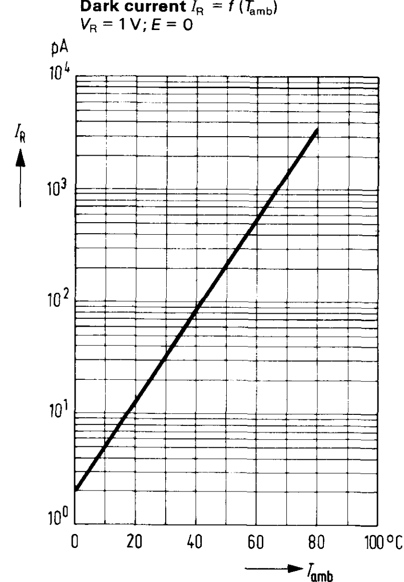
Dark current $I_R = f(V_R)$
$T_{amb} = 25°C$ $E = 0$
pA
I_R
0
20
40
60
80
0 1 2 3 4 5 6 7 8 9 10 V
V_R



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

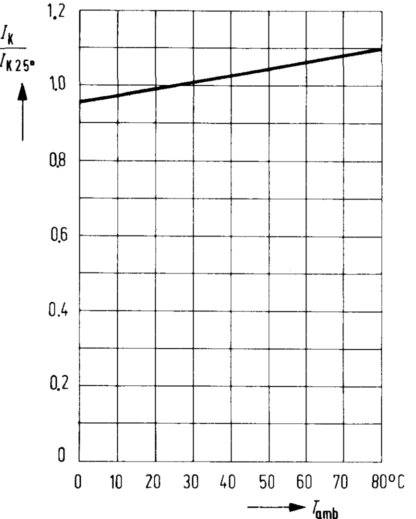


Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$
$\frac{I_P}{I_{P\,25°}}$
0
0,2
0,4
0,6
0,8
1,0
1,2
-30 -20 -10 0 10 20 30 40 50 60 70 80 °C
T_{amb}



Dark current $I_R = f(T_{amb})$
$V_R = 1\,V$; $E = 0$
pA
I_R
10^0
10^1
10^2
10^3
10^4
0 20 40 60 80 100 °C
T_{amb}

Short circuit current $I_K = f(T_{amb})$



Open circuit voltage $V_L = f(T_{amb})$

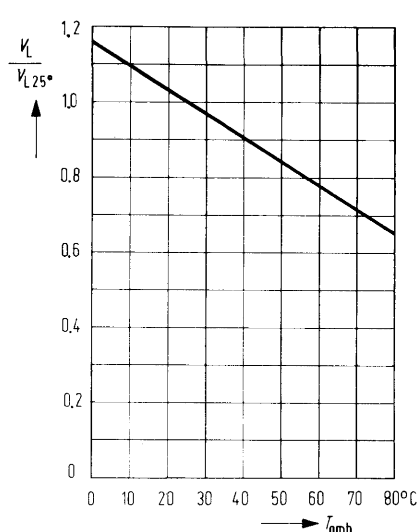
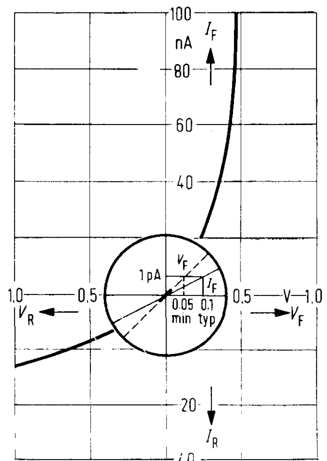


Diagram of the zero cross over S_0

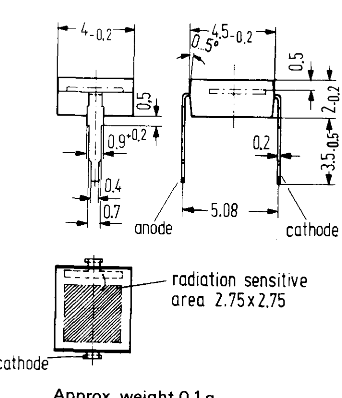


Plastic Encapsulated Silicon PIN Photodiode **BPW 34**

The BPW 34 is a silicon planar PIN photodiode, which is incorporated in a transparent plastic package. Its terminals are soldering tabs arranged in 5.08 mm (2/10") lead spacing. Due to its design the diode can also very easily be assembled on PC boards. The flat back of the epoxy resin case makes rigid fixing of the component feasible.

Arrays can be realized by multiple arrangements. This versatile photodetector can be used as a diode as well as a voltaic cell. The signal/noise ratio is particularly favourable, even at low illuminances. The open circuit voltage at low illuminances is higher than with comparable mesa photovoltaic cells. The PIN photodiode is outstanding for low junction capacitance, high cut-off frequency and short switching times. The photodiode is particularly suitable for IR sound transmission. The cathode is marked by a blue dot.

Type	Ordering code
BPW 34	Q 62 702-P 73



Approx. weight 0.1 g
Dimensions in mm

Maximum ratings

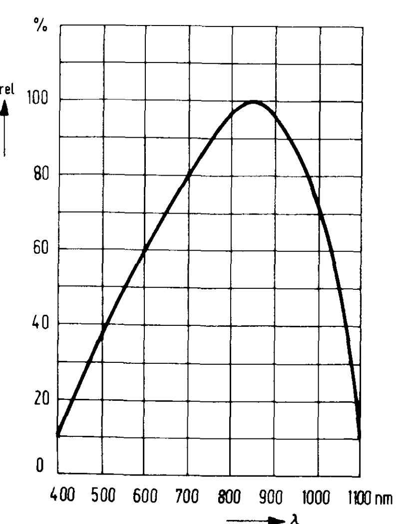
Reverse voltage	V_R	32	V
Operating and storage temperature range	T_{stor}	− 40 to + 80	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leqq 3$ s)	T_s	230	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	150	mW

Characteristics (T_{amb} = 25°C)

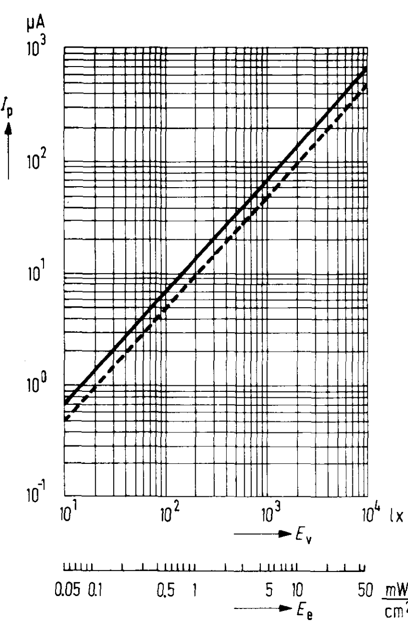
Spectral sensitivity [1] (V_R = 5 V)	S	70 (≧ 50)	nA/lx
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	850	nm
Quantum yield (Electrons per photon) (λ = 850 nm)	η	0.88	Electrons/Photon
Spectral sensitivity (λ = 850 nm)	S	0.60	A/W
Open circuit voltage (E_v = 100 lx) [1]	V_L	285	mV
Open circuit voltage (E_v = 1000 lx) [1]	V_L	365	mV
Short circuit current (E_v = 100 lx) [1]	I_K	6.5	μA
Rise and fall time of the photocurrent from 10% to 90% and from 90% to 10% of the final value			
(R_L = 1 kΩ; V_R = 0 V; λ = 950 nm)	t_r; t_f	125	ns
(R_L = 1 kΩ; V_R = 10 V; λ = 950 nm)	t_r; t_f	50	ns
Temperature coefficient of V_L	TC	− 2.6	mV/K
Temperature coefficient of I_K or I_P	TC	0.18	%/K
Capacitance			
(V_R = 0 V; f = 1 MHz; E = 0)	C_0	72	pF
(V_R = 3 V; f = 1 MHz; E = 0)	C_3	25 (≦ 40)	pF
Radiant sensitive area	A	7.6	mm^2
Dark current (V_R = 10 V)	I_R	2 (≦ 30)	nA
Noise equivalent power (V_R = 10 V)	NEP	4.2×10^{-14}	$\frac{W}{\sqrt{Hz}}$
Detection limit	D^*	6.6×10^{12}	$\frac{cm\sqrt{Hz}}{W}$

1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5030 and IEC publ. 306-1).

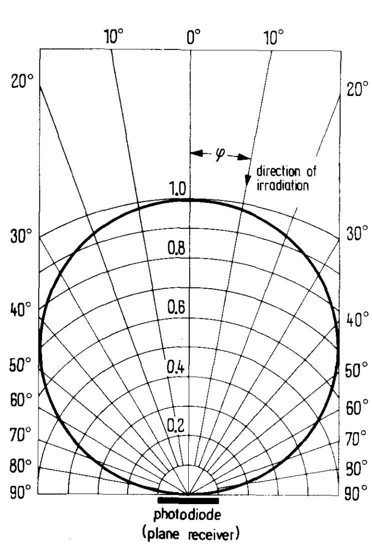
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



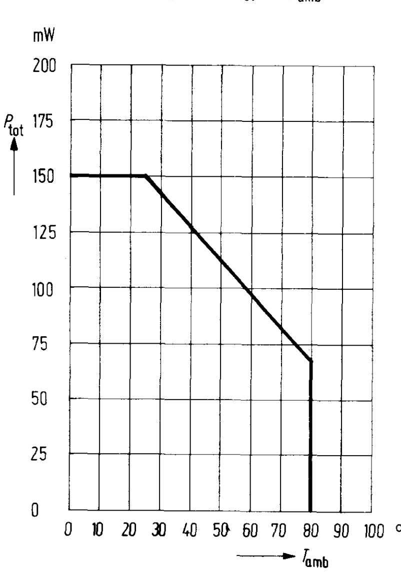
Photocurrent $I_P = f(E_v)$

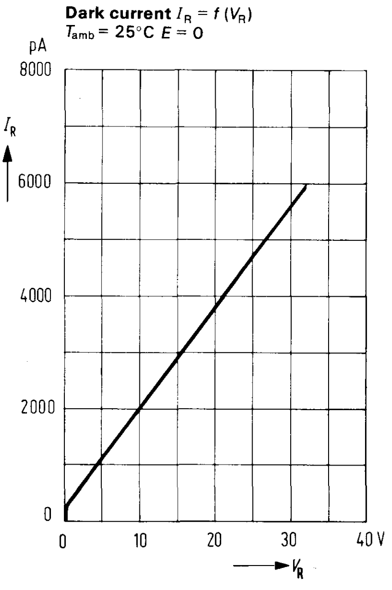


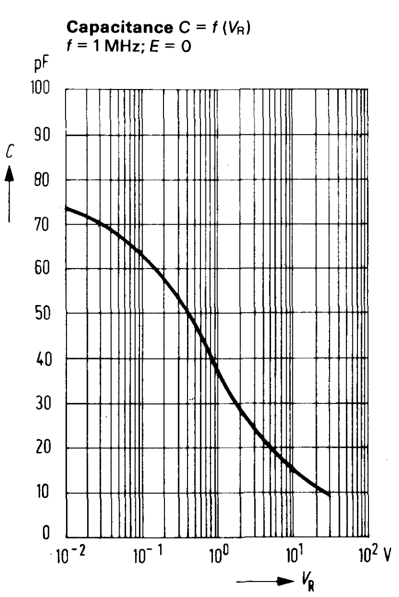
Directional characteristic $S_{rel} = f(\varphi)$

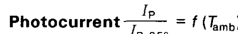


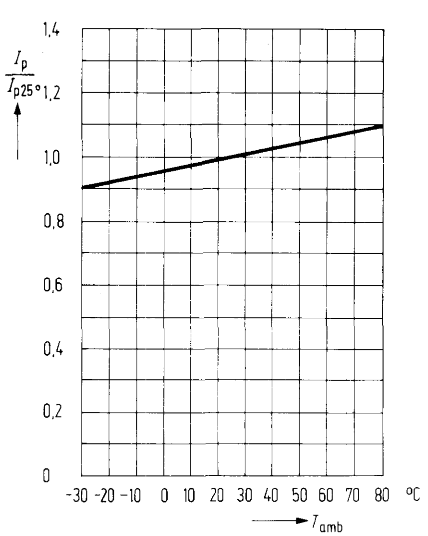
Power dissipation $P_{tot} = f(T_{amb})$

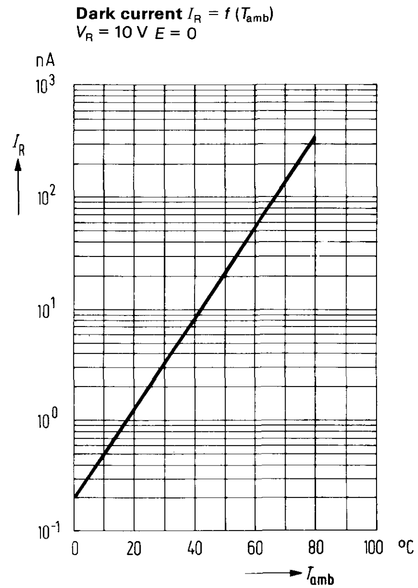



Dark current $I_R = f(V_R)$
T_{amb} = 25°C E = 0
pA
8000
6000
4000
2000
0
I_R
0
10
20
30
40 V
V_R

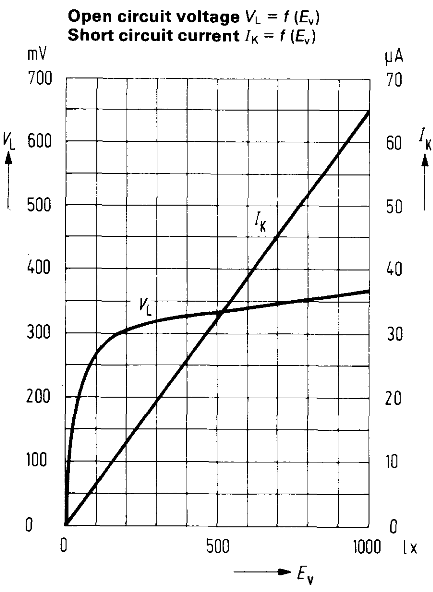

Capacitance $C = f(V_R)$
f = 1 MHz; E = 0
pF
100
90
80
70
60
50
40
30
20
10
0
C
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2} V
V_R


Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$

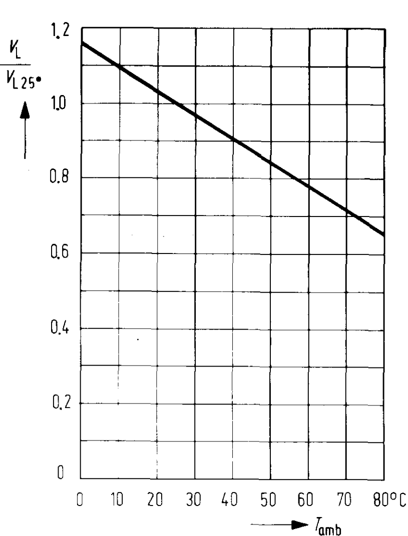

$\frac{I_p}{I_{p25°}}$
1,4
1,2
1,0
0,8
0,6
0,4
0,2
0
-30 -20 -10 0 10 20 30 40 50 60 70 80 °C
T_{amb}


Dark current $I_R = f(T_{amb})$
V_R = 10 V E = 0
nA
10^3
10^2
10^1
10^0
10^{-1}
I_R
0
20
40
60
80
100 °C
T_{amb}

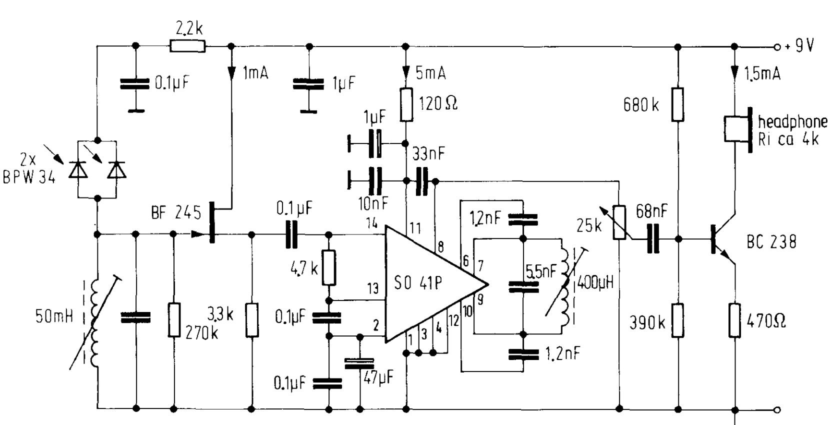
Open circuit voltage $V_L = f(E_v)$
Short circuit current $I_K = f(E_v)$



Open circuit voltage $\frac{V_L}{V_{L\,25°}} = f(T_{amb})$



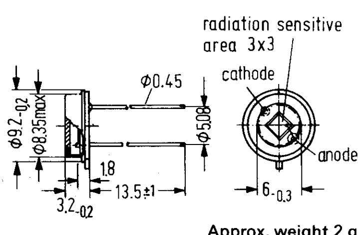
Detector for infrared sound transmission
Application example



Centre frequency 100 kHz
Frequency deviation approx. 5 kHz
Power consumption 9 V/7.5 mA

The BPX 60 is a planar silicon photodiode. The large area photosensitive system is suitable for cell as well as diode operation at a very low reverse current level. The hermetically sealed case – a TO 5 modification with flat glass window – allows application at extreme operating conditions. The signal/noise ratio is particularly favourable even at low illuminances. The open circuit voltage at low illuminances is higher than with comparable mesa photovoltaic cells.

Type	Ordering code
BPX 60	Q 62 702-P 54



Approx. weight 2 g
Dimensions in mm

Maximum ratings

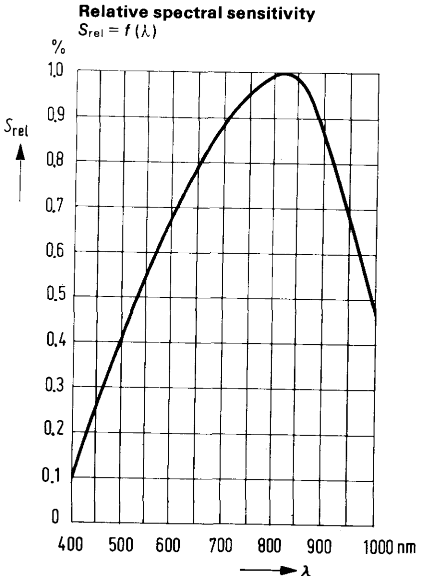
Reverse voltage	V_R	32	V
Operating and storage temperature range	T_{stor}	– 40 to + 125	°C
Junction temperature	T_j	125	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leq 3$ s)	T_s	230	°C
Power dissipation	P_{tot}	325	mW
Thermal resistance	$R_{th\ Jamb}$	300	K/W
	$R_{th\ Jcase}$	80	K/W

Characteristics (T_{amb} = 25°C)

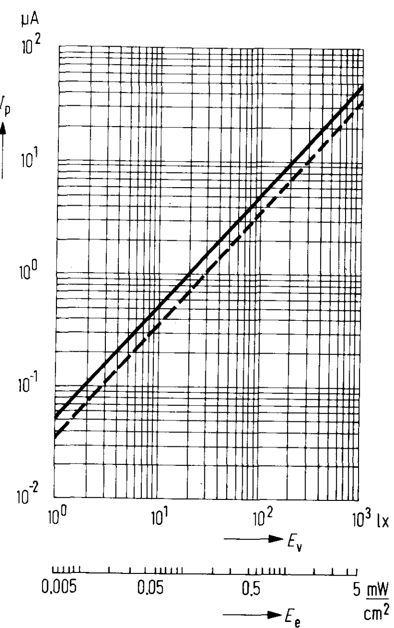
Parameter	Symbol	Value	Unit
Spectral sensitivity [1]	S	50 (≧ 3.5)	nA/lx
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	850	nm
Quantum yield (Electrons per photon) (λ = 850 nm)	η	0.73	Electrons / Photon
Spectral sensitivity (λ = 850 nm)	S	0.50	A/W
Open circuit voltage (E_v = 100 lx) [1]	V_L	360 (≧270)	mV
(E_v = 1000 lx) [1]	V_L	460	mV
Short circuit current (E_v = 100 lx) [1]	I_K	5 (≧ 3.5)	μA
Rise and fall time of the photocurrent from 10% to 90% and from 90% to 10% of the final value			
(R_L = 1 kΩ; V_R = 0 V; λ = 950 nm)	t_r; t_f	2.5	μs
(R_L = 1 kΩ; V_R = 10 V; λ = 950 nm)	t_r; t_f	1.0	μs
Temperature coefficient of V_L	TC	− 2.6	mV/K
Temperature coefficient of I_K	TC	0.2	%/K
Junction capacitance			
(V_R = 0 V; f = 1 MHz; E = 0)	C_0	750	pF
(V_R = 10 V; f = 1 MHz; E = 0)	C_{10}	220	pF
Radiant sensitive area	A	7.6	mm2
Dark current (V_R = 10 V; T_{amb} = 25°C; E = 0)	I_R	7 (≦ 300)	nA

1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

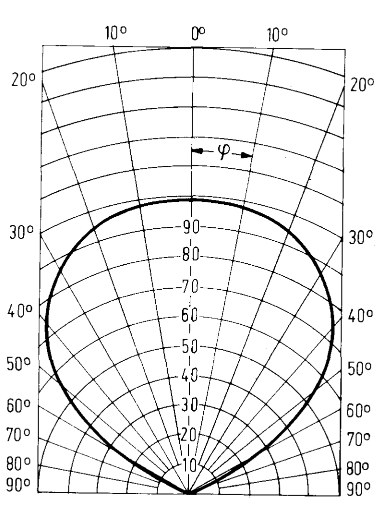
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



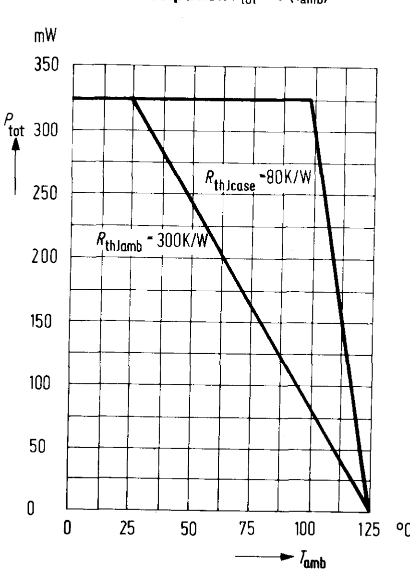
Photocurrent $I_P = f(E_v)$



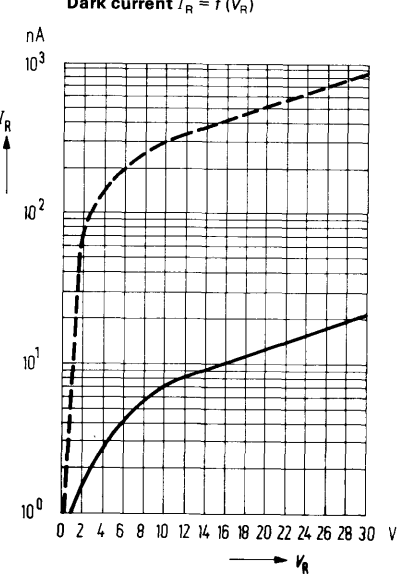
Directional characteristic $I_K = f(\varphi)$



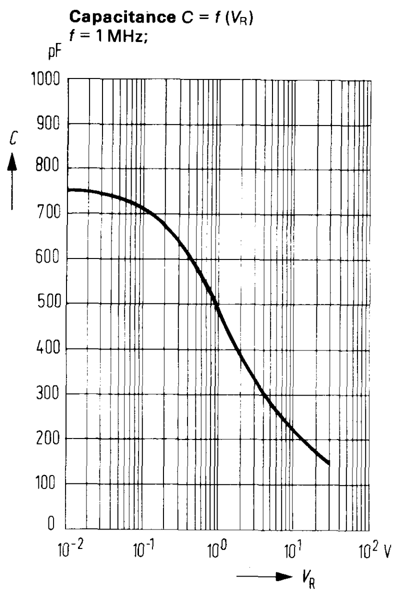
Power dissipation $P_{tot} = f(T_{amb})$



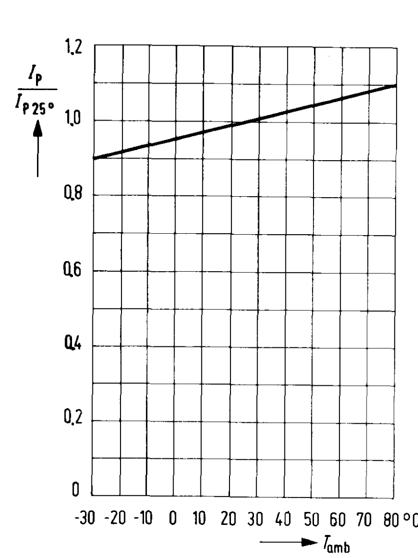
Dark current $I_R = f(V_R)$



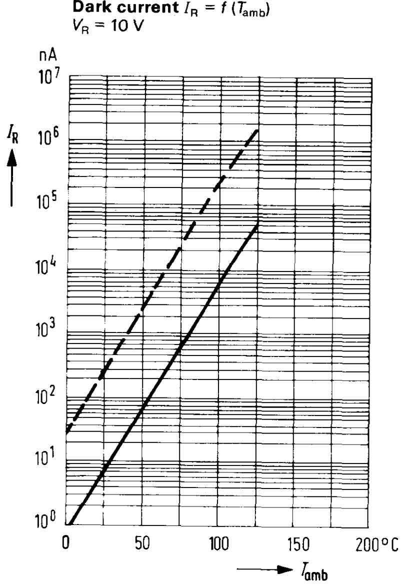
Capacitance $C = f(V_R)$
f = 1 MHz;

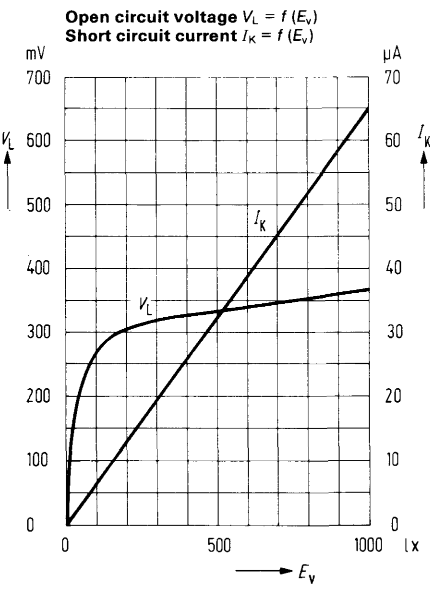


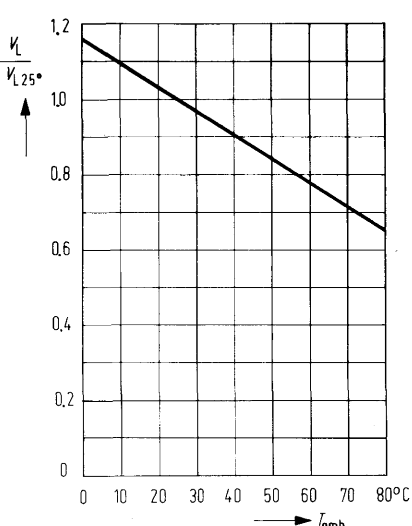
Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$



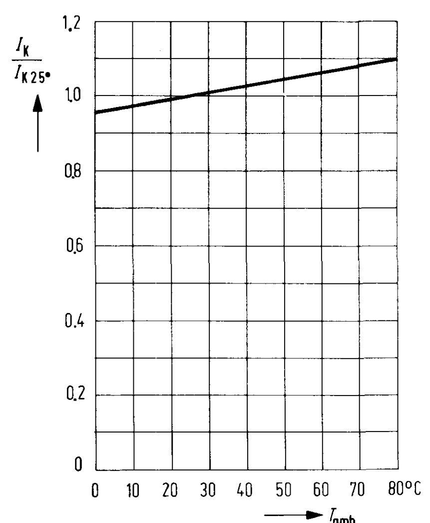
Dark current $I_R = f(T_{amb})$
V_R = 10 V







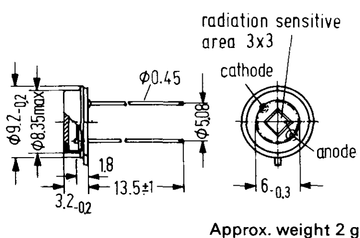
Short circuit current $\frac{I_K}{I_{K\,25°}} = f(T_{amb})$



Silicon PIN Photodiode with Low Reverse Current — BPX 61

The BPX 61 is a planar silicon photodiode with low reverse current. Its low capacitance permits use up to 10 MHz. The large area photosensitive system is suitable for cell as well as diode operation at a very low reverse current level. The hermetically sealed case – a TO 5 modification with flat glass window – allows application at extreme operating conditions. The signal/noise ratio is particularly favourable even at low illuminances. The open circuit voltage at low illuminances is higher than with comparable mesa photovoltaic cells. The PIN photodiode is outstanding for low junction capacitance, high cut-off frequency and short switching times.

Type	Ordering code
BPX 61	Q 62 705-P 25



Approx. weight 2 g
Dimensions in mm

Maximum ratings

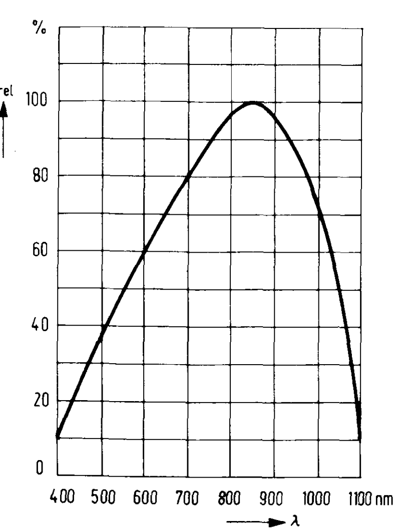
Parameter	Symbol	Value	Unit
Reverse voltage	V_R	32	V
Operating and storage temperature range	T_{stor}	– 40 to + 125	°C
Junction temperature	T_j	125	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leqq 3$ s)	T_s	230	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	325	mW
Thermal resistance	$R_{th\ Jamb}$	300	K/W
	$R_{th\ Jcase}$	80	K/W

Characteristics (T_{amb} = 25°C)

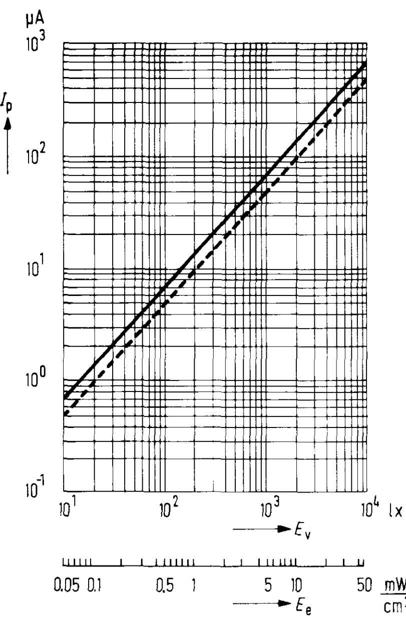
Spectral sensitivity [1] (V_R = 5 V)	S	70 (≧ 50)	nA/lx
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	850	nm
Quantum yield (Electrons per photon) (λ = 850 nm)	η	0.88	$\frac{\text{Electrons}}{\text{Photon}}$
Spectral sensitivity (λ = 850 nm)	S	0.60	A/W
Open circuit voltage (E_v = 100 lx) [1]	V_L	285	mV
(E_v = 1000 lx) [1]	V_L	365	mV
Short circuit current (E_v = 100 lx) [1]	I_K	6.5	µA
Rise and fall time of the photocurrent from 10% to 90% and from 90% to 10% of the final value			
(R_L = 1 kΩ; V_R = 0 V; λ = 950 nm)	t_r; t_f	125	ns
(R_L = 1 kΩ; V_R = 10 V; λ = 950 nm)	t_r; t_f	50	ns
Temperature coefficient of V_L	TC	– 2.6	mV/K
Temperature coefficient of I_K	TC	0.2	%/K
Capacitance			
(V_R = 0 V; f = 1 MHz; E = 0)	C_0	72	pF
(V_R = 3 V; f = 1 MHz; E = 0)	C_3	25 (≦ 40)	pF
Radiant sensitive area	A	7.6	mm^2
Dark current (V_R = 10 V; T_{amb} = 25°C; E = 0)	I_R	2 (≦ 30)	nA
Noise equivalent power (V_R = 10 V)	NEP	4.2×10^{-14}	$\frac{W}{\sqrt{Hz}}$
Detection limit (V_R = 10 V)	D^*	6.6×10^{12}	$\frac{cm\sqrt{Hz}}{W}$

1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

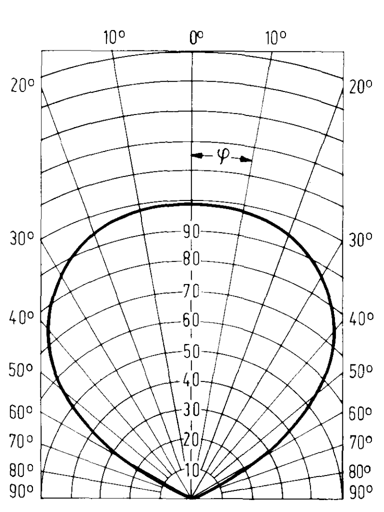
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



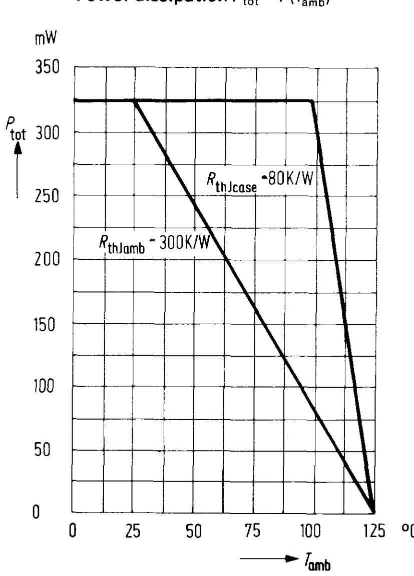
Photocurrent $I_P = f(E_v)$

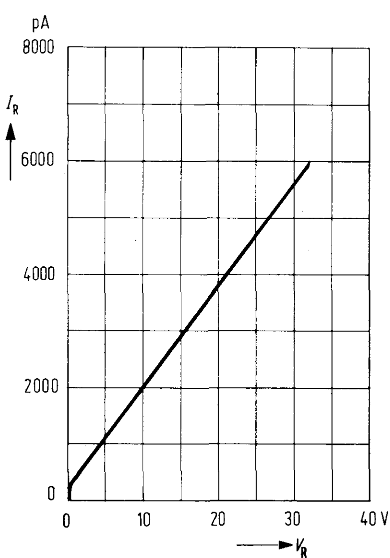


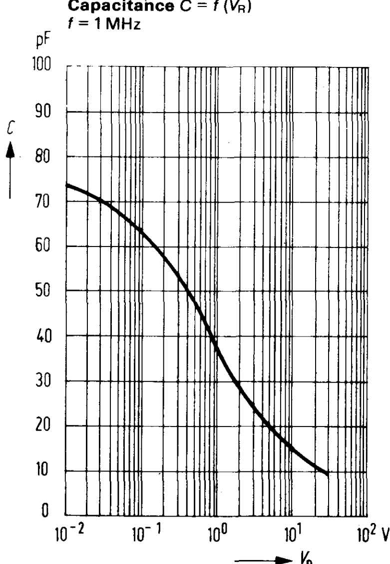
Directional characteristic $I_K = f(\varphi)$



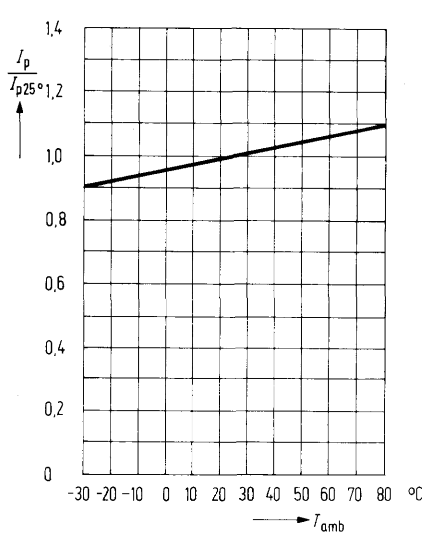
Power dissipation $P_{tot} = f(T_{amb})$



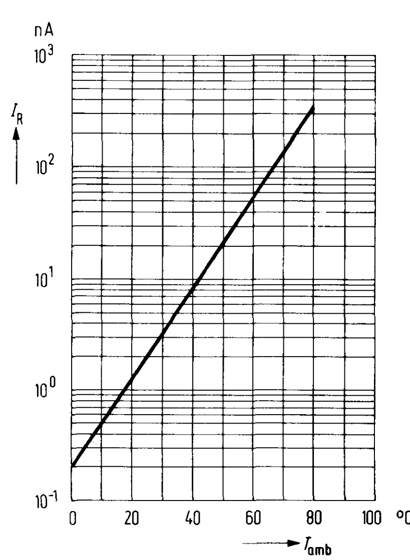




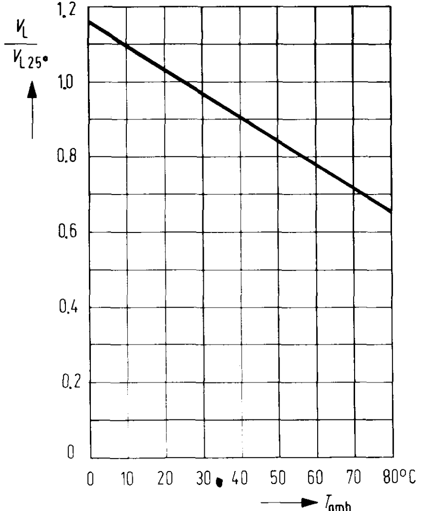
Photocurrent $\frac{I_P}{I_{P\ 25°}} = f(T_{amb})$



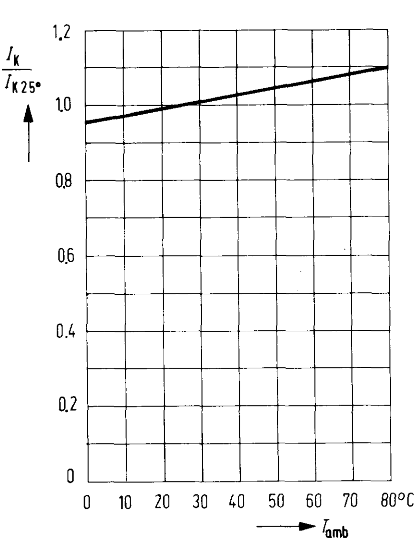
Dark current $I_R = f(T_{amb})$



Open circuit voltage $\frac{V_L}{V_{L\,25°}} = f\,(T_{amb})$



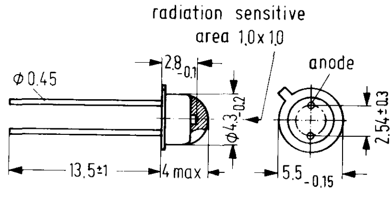
Short circuit current $\frac{I_K}{I_{K\,25°}} = f\,(T_{amb})$



Silicon Photodiode with Very Low Dark Current — BPX 63

The BPX 63 is a planar silicon photodiode, mounted on a TO 18 base plate and covered with transparent plastic material. The BPX 63 has been developed as a detector for low illuminances and is intended for use as a sensor for exposure meters and automatic exposure meters. The component is outstanding for low dark currents and – when used as a voltaic cell – for a high open circuit voltage at low illuminances. The cathode of the BPX 63 is electrically connected to the case.

Type	Ordering code
BPX 63	Q 62 702-P 55



Approx. weight 0.5 g
Dimensions in mm

Maximum ratings

Reverse voltage	V_R	7	V
Storage temperature range	T_{stor}	– 55 to + 90	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	200	mW

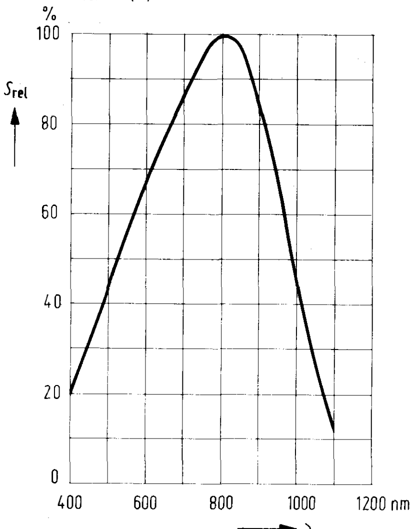
Characteristics (T_{amb} = 25°C)

Spectral sensitivity [1]	S	10 (≧ 0.8)	nA/lx
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	800	nm
Quantum yield (Electrons per photon) (λ = 800 nm)	η	0.73	$\frac{\text{Electrons}}{\text{Photon}}$
Spectral sensitivity (λ = 800 nm)	S	0.47	A/W
Forward voltage [2] (E = 0; I_F = 1 pA; T_{amb} = 50°C)	V_F	1 (≧ 0.5)	mV
Rise and fall time of the photocurrent from 10% to 90% and from 90% to 10% of the final value (R_L = 1 kΩ; V_R = 0 V; λ = 950 nm)	t_r; t_f	1.3	µs
(R_L = 1 kΩ; V_R = 5 V; λ = 950 nm)	t_r; t_f	1.0	µs
Capacitance (V_R = 0 V)	C_0	120	pF
(V_R = 3 V)	C_3	50	pF
Dark current (V_R = 1 V; E = 0)	I_R	5 (≦ 20)	pA
Temperature coefficient of I_K	TC	0.1	%/K
Radiant sensitive area	A	1	mm²
Noise equivalent power (V_R = 1 V)	NEP	2.7×10^{-15}	$\frac{W}{\sqrt{Hz}}$
Detection limit (V_R = 1 V)	D^*	3.7×10^{13}	$\frac{cm\sqrt{Hz}}{W}$

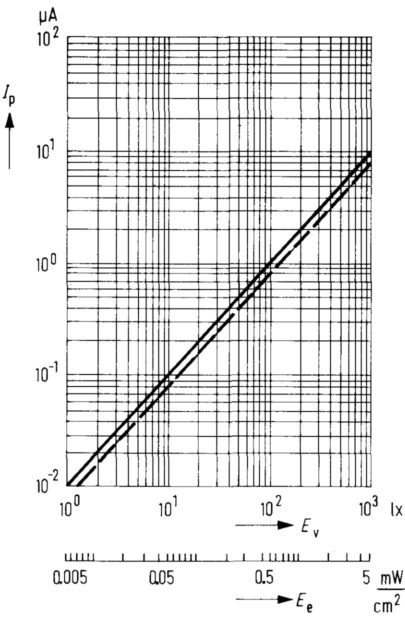
1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

2) V_F is a measure for the lower spectral sensitivity when the photodiode is used in exposure meters.

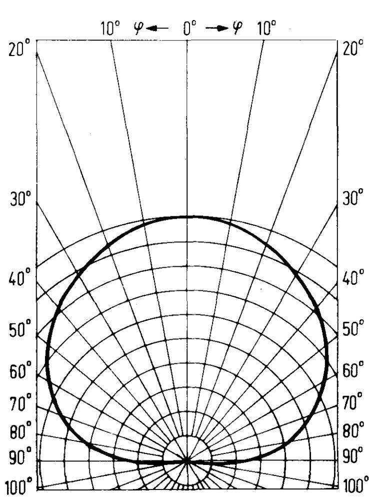
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



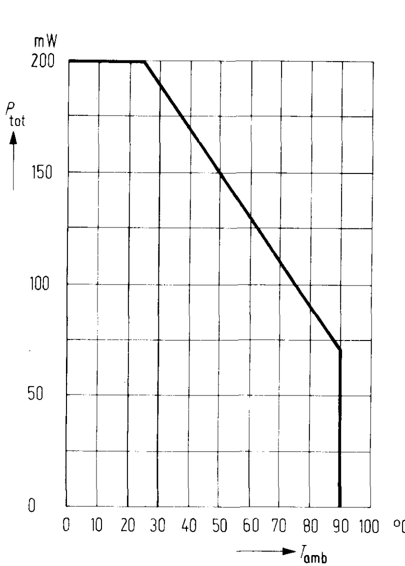
Photocurrent $I_P = f(E_v)$

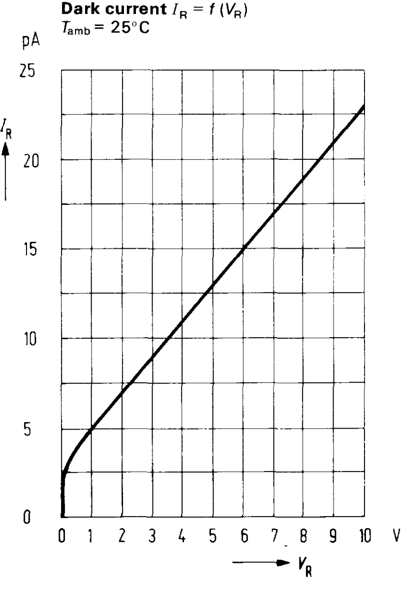


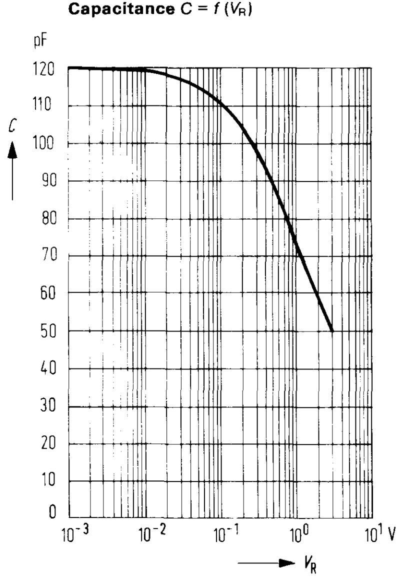
Directional characteristic $I_P = f(\varphi)$

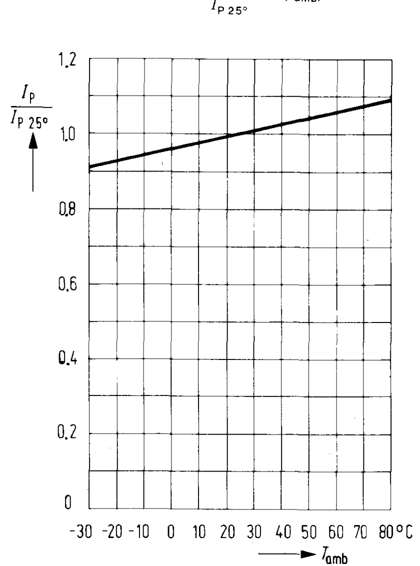


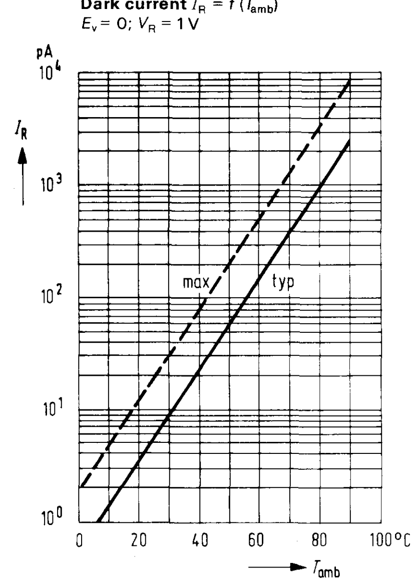
Power dissipation $P_{tot} = f(T_{amb})$



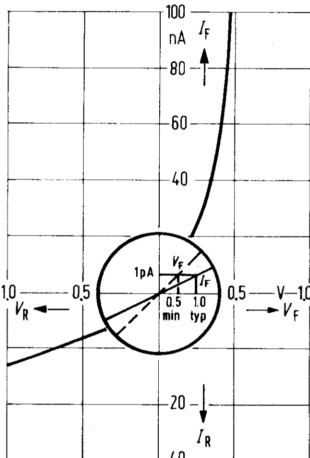

Dark current $I_R = f(V_R)$
$T_{amb} = 25°C$
pA
25
I_R
20
15
10
5
0
0 1 2 3 4 5 6 7 8 9 10 V
V_R


Capacitance $C = f(V_R)$
pF
120
110
C
100
90
80
70
60
50
40
30
20
10
0
10^{-3} 10^{-2} 10^{-1} 10^{0} 10^{1} V
V_R


Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$
1,2
$\frac{I_P}{I_{P\,25°}}$
1,0
0,8
0,6
0,4
0,2
0
-30 -20 -10 0 10 20 30 40 50 60 70 80 °C
T_{amb}


Dark current $I_R = f(T_{amb})$
$E_v = 0$; $V_R = 1$ V
pA
10^4
I_R
10^3
max
typ
10^2
10^1
10^0
0 20 40 60 80 100 °C
T_{amb}

Zero cross over $S_0 = \frac{V_F}{I_F}$

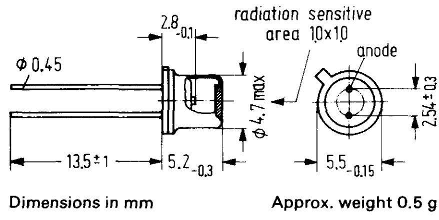


High-speed Silicon PIN Photodiode **BPX 65**

The BPX 65 is a planar silicon PIN photodiode in a case 18 A 2 DIN 41876 (sim. to TO-18) with a flat window. The cathode is electrically connected to the case. The flat window has no influence on the beam path of optical lens systems. Because of its high cut-off frequency this diode is particularly suitable for use as optical sensor of high modulation bandwidth.

The PIN photodiode is outstanding for low junction capacitance and short switching times.

Type	Ordering code
BPX 65	Q 62 702-P 27



Dimensions in mm Approx. weight 0.5 g

Maximum ratings

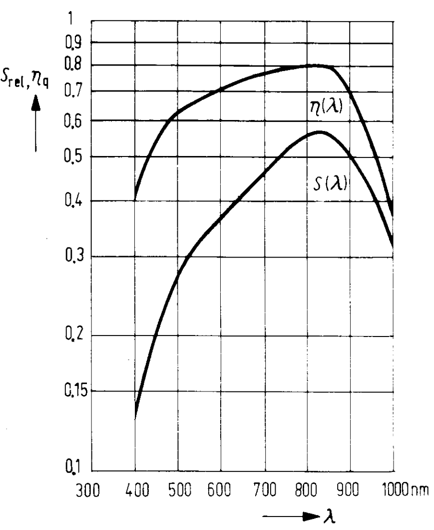
Reverse voltage	V_R	50	V
Junction temperature	T_j	125	°C
Storage temperature range	T_{stor}	– 55 to + 125	°C
Power dissipation	P_{tot}	250	mW

Characteristics (T_{amb} = 25°C)

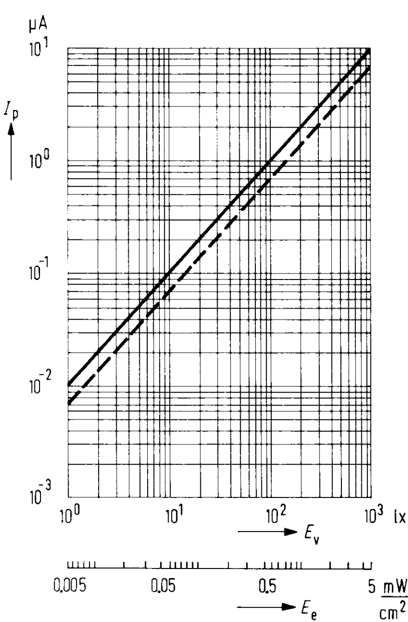
Parameter	Symbol	Value	Unit
Radiant sensitive area	A	1	mm^2
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	850	nm
Quantum yield (Electrons per photon) (λ = 850 nm)		0.80	$\frac{\text{Electrons}}{\text{Photon}}$
Spectral sensitivity (λ = 850 nm)	S	0.55	A/W
Rise time of the photo current (load resistance R_L= 50 Ω; V_R = 20 V; λ = 900 nm)	t_r	0.5 (≦ 1)	ns
Capacitance (V_R = 0 V)	C_0	15	pF
(V_R = 1 V)	C_1	12	pF
(V_R = 20 V)	C_{20}	3.5	pF
Cut-off-frequency (load resistance R_L= 50 Ω; V_R = 20 V; λ= 900 nm)	f_g	500	MHz
Dark current (V_R = 20 V; E = 0)	I_R	1 (≦ 5)	nA
Spectral sensitivity [1] V_R = 20 V	S	10 (≧ 7)	nA/lx
Noise equivalent power (V_R = 20 V)	NEP	3.3 x 10^{-14}	$\frac{W}{\sqrt{Hz}}$
Detection limit (V_R = 20 V)	D^*	3.1 x 10^{12}	$\frac{cm\sqrt{Hz}}{W}$
Temperature coefficient for I_P	TC	0.2	%/K

1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

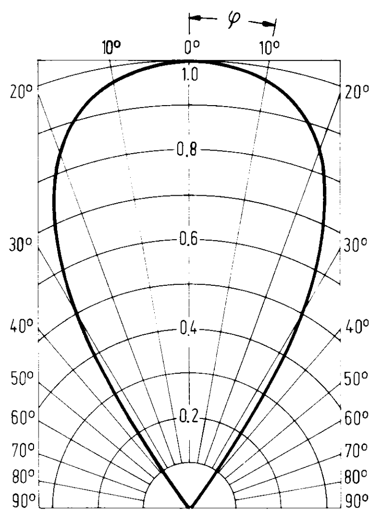
Spectral sensitivity $S_{rel} = f(\lambda)$ in A/W and quantum yield $\eta = f(\lambda)$ in electrons per photon



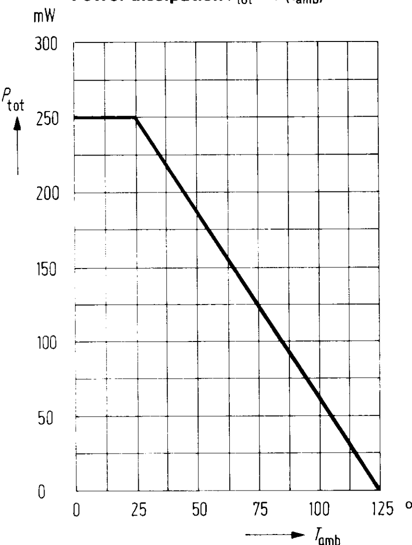
Photocurrent $I_P = f(E_v)$

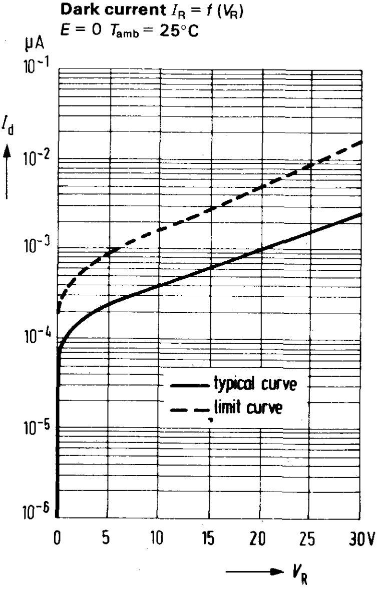


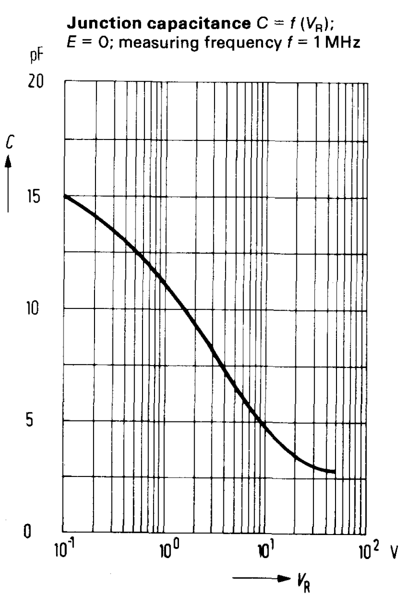
Directional characteristic $I_P = f(\varphi)$

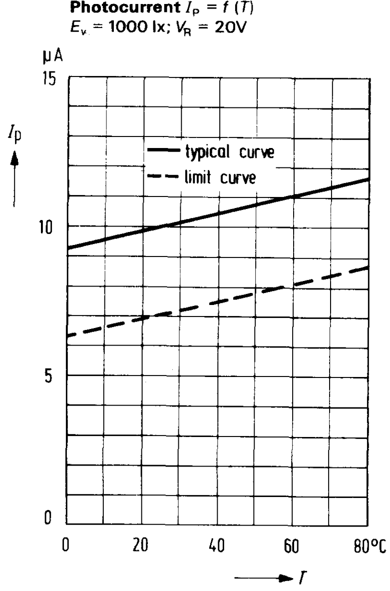


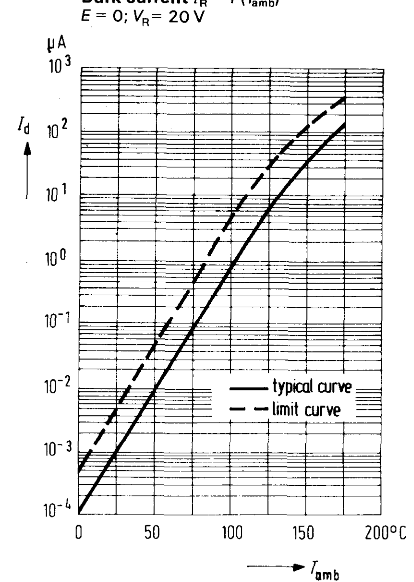
Power dissipation $P_{tot} = f(T_{amb})$



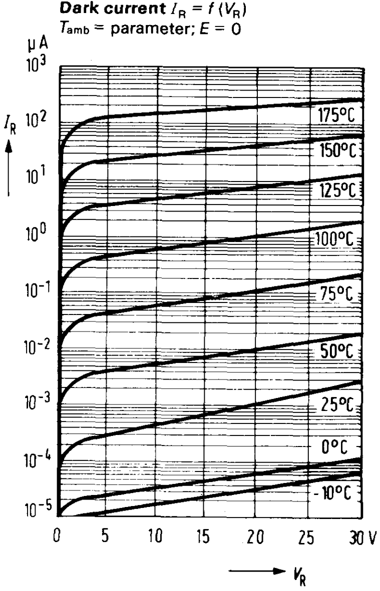

Dark current $I_R = f(V_R)$
$E = 0$ $T_{amb} = 25°C$
μA
I_d
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
typical curve
limit curve
0 5 10 15 20 25 30V
V_R


Junction capacitance $C = f(V_R)$;
$E = 0$; measuring frequency $f = 1$ MHz
pF
C
20
15
10
5
0
10^{-1} 10^{0} 10^{1} 10^{2} V
V_R

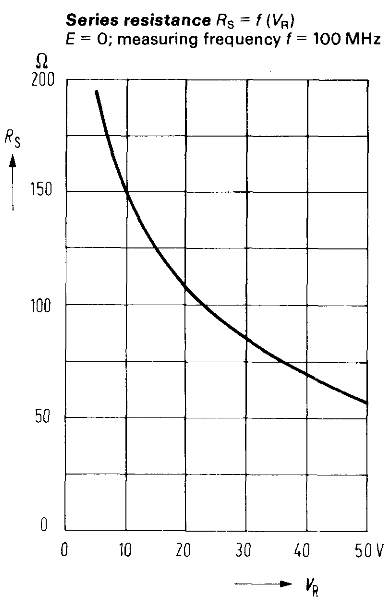

Photocurrent $I_P = f(T)$
$E_v = 1000$ lx; $V_R = 20V$
μA
I_P
15
10
5
0
typical curve
limit curve
0 20 40 60 80°C
T


Dark current $I_R = f(T_{amb})$
$E = 0$; $V_R = 20$ V
μA
I_d
10^{3}
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
typical curve
limit curve
0 50 100 150 200°C
T_{amb}

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



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

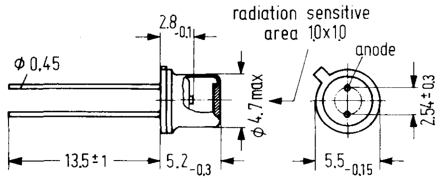


High-speed Silicon PIN Photodiode **BPX 66**

The BPX 66 is a planar silicon PIN photodiode in a case 18 A 2 DIN 41876 (sim. to TO-18) with a flat window and extremely low dark current. The cathode is electrically connected to the case. The flat window has no influence on the beam path of optical lens systems. Because of its high cut-off frequency, this diode is particularly suitable for use as optical sensor of high modulation bandwidth.

The PIN photodiode is outstanding for low junction capacitance and short switching times.

Type	Ordering code
BPX 66	Q 62 702-P 80



Approx. weight 0.5 g
Dimensions in mm

Maximum ratings

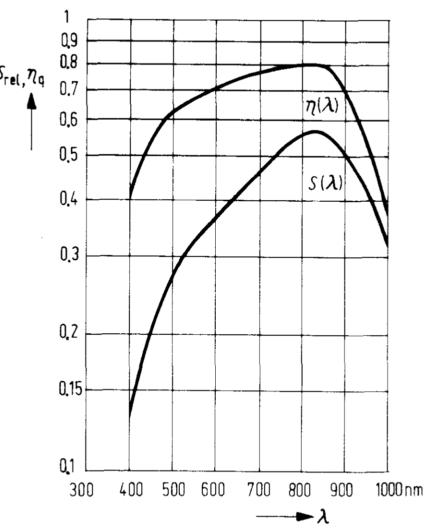
Reverse voltage	V_R	50	V
Junction temperature	T_j	125	°C
Storage temperature range	T_{stor}	– 55 to + 125	°C
Power dissipation	P_{tot}	250	mW

Characteristics (T_{amb} = 25°C

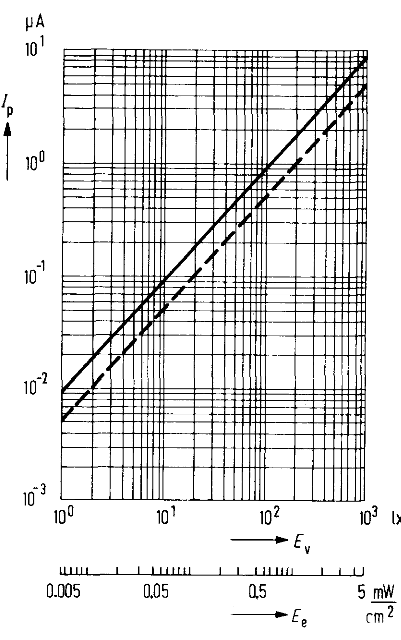
Parameter	Symbol	Value	Unit
Radiant sensitive area	A	1	mm^2
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	850	nm
Quantum yield (Electrons per photon) (λ = 850 nm)	η	0.80	$\frac{\text{Electrons}}{\text{Photon}}$
Spectral sensitivity (λ = 850 nm)	S	0.55	A/W
Rise time of the photocurrent (load resistance R_L = 50 Ω; V_R = 20 V; λ = 900 nm)	t_r	0.5 (≦ 1)	ns
Capacitance (V_R = 0 V)	C_0	15	pF
(V_R = 1 V)	C_1	12	pF
(V_R = 20 V)	C_{20}	3.5	pF
Cut-off-frequency (load resistance R_L = 50 Ω; V_R = 20 V; λ = 900 nm)	f_g	500	MHz
Dark current (V_R = 1 V; E = 0)	I_R	0.15 (≦ 0.3)	nA
Spectral sensitivity [1] (V_R = 1 V)	S	9 (≧ 5)	nA/lx
Noise equivalent power (V_R = 1 V)	NEP	1.3×10^{-14}	$\frac{W}{\sqrt{Hz}}$
Detection limit (V_R = 1 V)	D^*	6.4×10^{12}	$\frac{cm\sqrt{Hz}}{W}$
Temperature coefficient for I_P	TC	0.2	%/K

1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

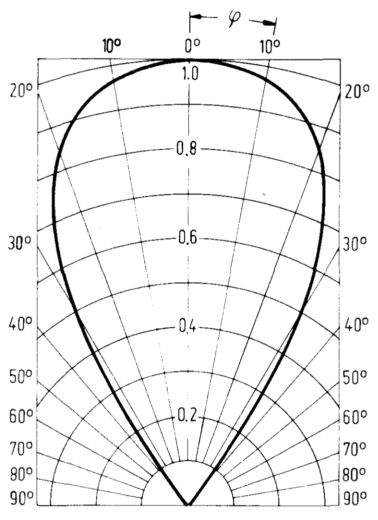
Spectral sensitivity $S_{rel} = f(\lambda)$ in A/W and quantum yield $\eta = f(\lambda)$ in electrons per photon



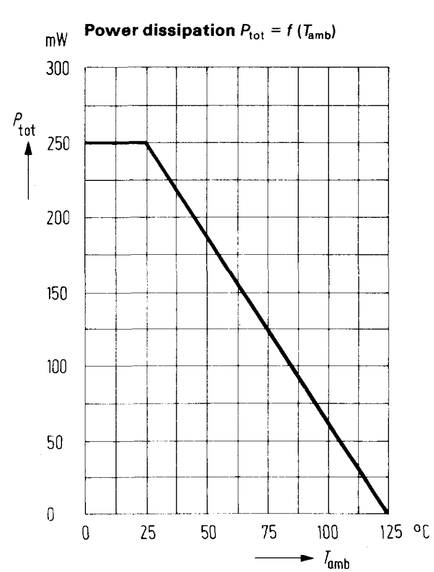
Photocurrent $I_P = f(E_v)$



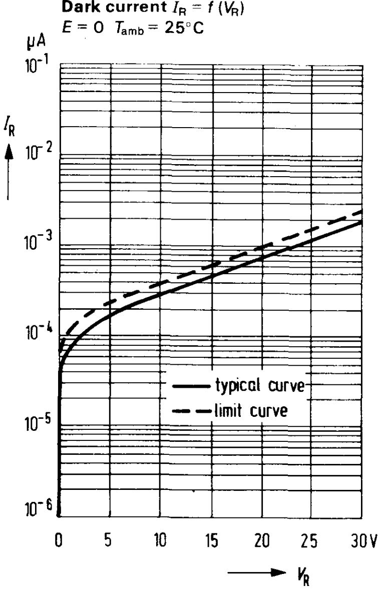
Directional characteristic $I_P = f(\varphi)$



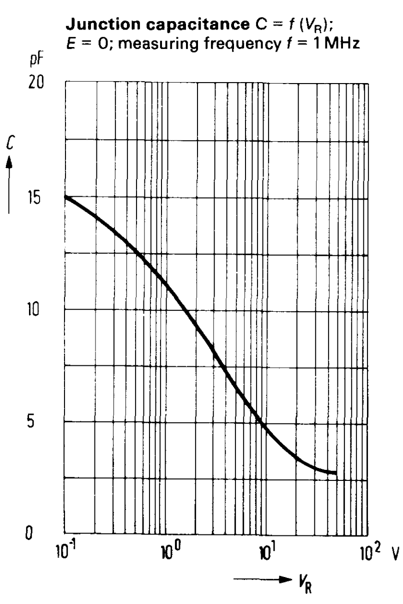
Power dissipation $P_{tot} = f(T_{amb})$



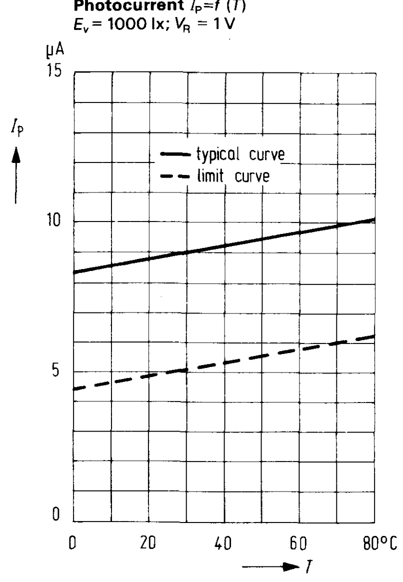
Dark current $I_R = f(V_R)$
$E = 0$ $T_{amb} = 25°C$



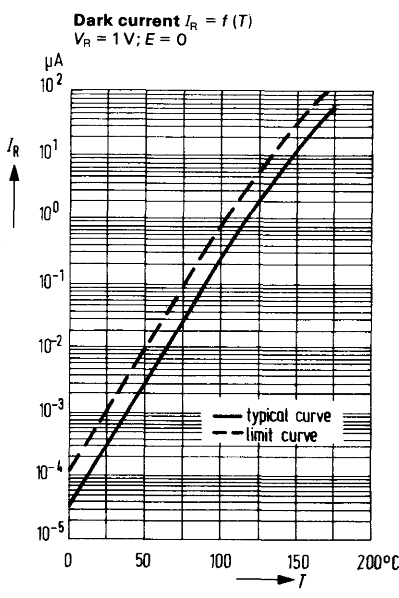
Junction capacitance $C = f(V_R)$;
$E = 0$; measuring frequency $f = 1$ MHz



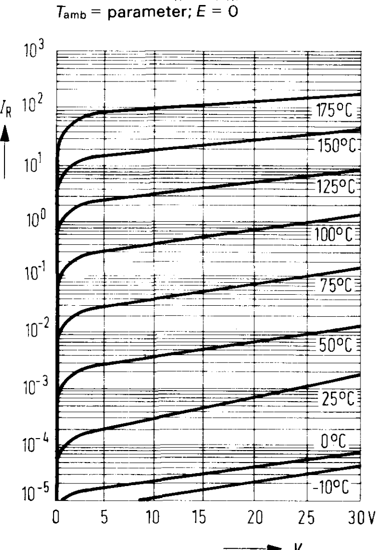
Photocurrent $I_P = f(T)$
$E_v = 1000$ lx; $V_R = 1$ V



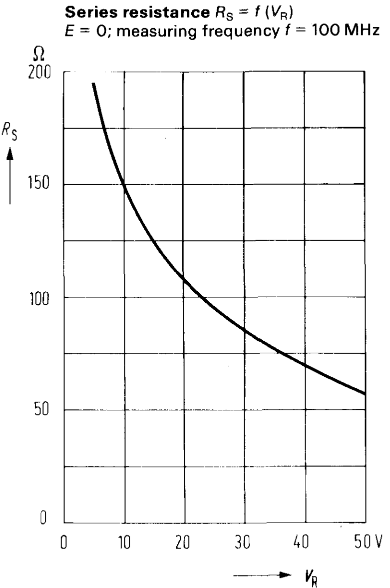
Dark current $I_R = f(T)$
$V_R = 1$ V; $E = 0$



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



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

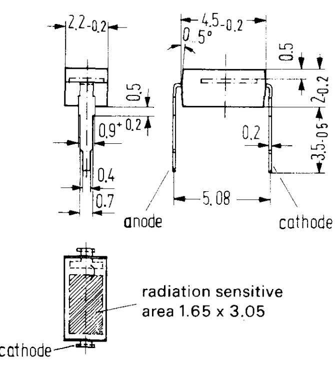


Plastic Encapsulated Silicon Photodiode — BPX 90

The BPX 90 is a planar silicon photodiode, which is incorporated in a transparent plastic package. Its terminals are soldering tabs arranged in 5.08 mm (2/10") lead spacing. Due to its design the diode can also very easily be assembled on PC boards. The flat back of the epoxy resin case makes rigid fixing of the component feasible. Arrays can be realized by multiple arrangements.

This versatile photodetector is suitable for diode as well as voltaic cell operation. The signal/noise ratio is particularly favourable, even at low illuminances. The open circuit voltage at low illuminances is higher than with comparable mesa photovoltaic cells.

Type	Ordering code
BPX 90	Q 62 702-P 47



Dimensions in mm

Maximum ratings

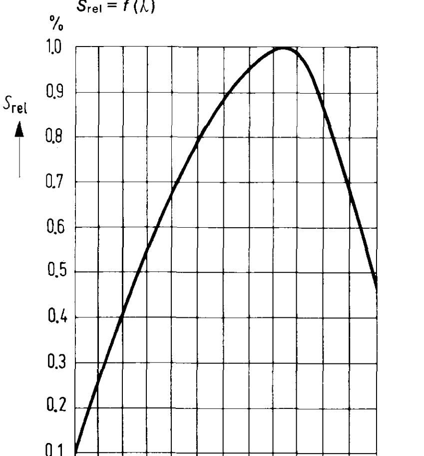
Reverse voltage	V_R	32	V
Operating and storage temperature range	T_{stor}	– 40 to + 80	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leq 3$ s)	T_s	230	°C
Power dissipation	P_{tot}	100	mW

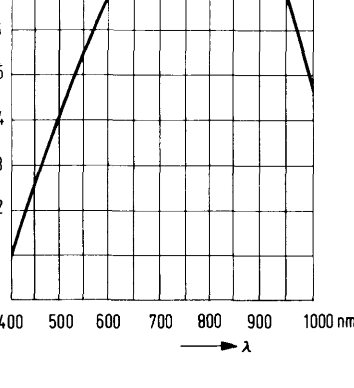
Characteristics (T_{amb} = 25°C)

Spectral sensitivity [1]	S	40 (≧ 25)	nA/lx
Wavelength of max. spectral sensitivity	$\lambda_{S\,max}$	850	nm
Quantum yield (Electrons per photon) (λ = 850 nm)	η	0.73	Electrons / Photon
Spectral sensitivity (λ = 850 nm)	S	0.50	A/W
Open circuit voltage (E_v = 100 lx) [1]	V_L	360 (≧ 270)	mV
(E_v = 1000 lx) [1]	V_L	460	mV
Short circuit current (E_v = 100 lx) [1]	I_K	4 (≧ 2.5)	µA
Rise and fall time of the photocurrent from 10% to 90% and from 90% to 10% of the final value			
(R_L = 1 kΩ; V_R = 0 V; λ = 950 nm)	t_r; t_f	1.1	µs
(R_L = 1 kΩ; V_R = 10 V; λ = 950 nm)	t_r; t_f	0.8	µs
Temperature coefficient for V_L	TC	– 2.6	mV/K
Temperature coefficient for I_K	TC	0.2	%/K
Capacitance			
(V_R = 0 V; f = 1 MHz; E = 0)	C_0	500	pF
(V_R = 10 V; f = 1 MHz; E = 0)	C_{10}	170	pF
Radiant sensitive area	A	5.0	mm^2
Dark current (V_R = 10 V; E = 0)	I_R	5 (≦ 200)	nA

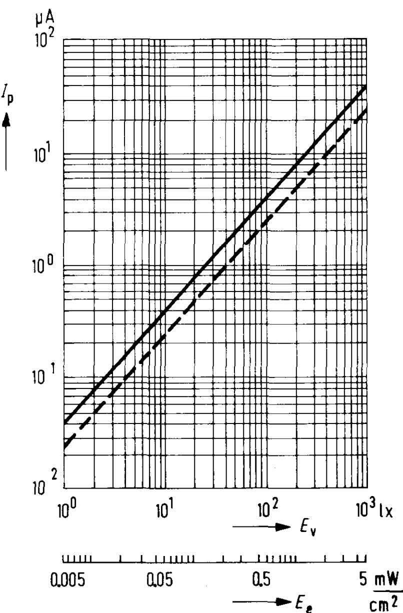
1) The illuminance indicated refers to unfiltered radiation of a tungsten-filament lamp at a colour temperature of 2856 K. (Standard light A in accordance with DIN 5033 and IEC publ. 306-1.)

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

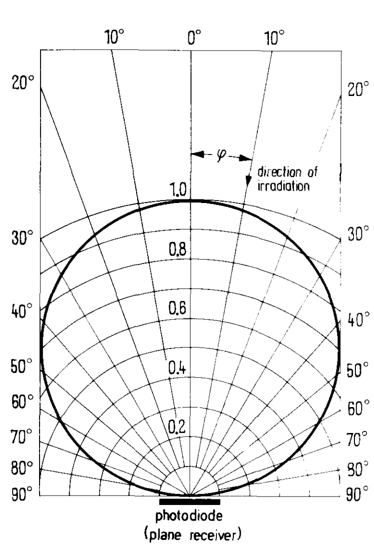




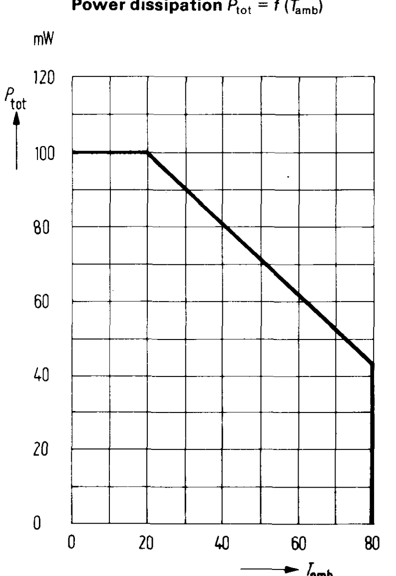
Photocurrent $I_P = f(E_v)$

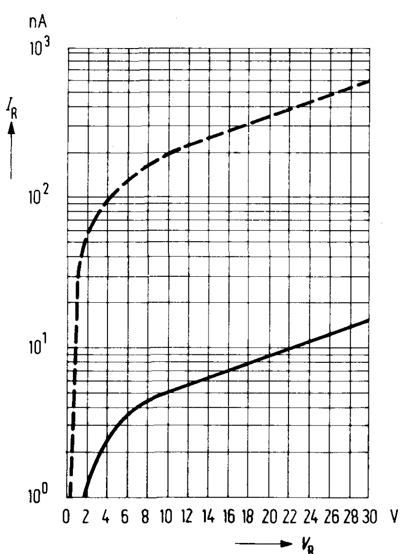


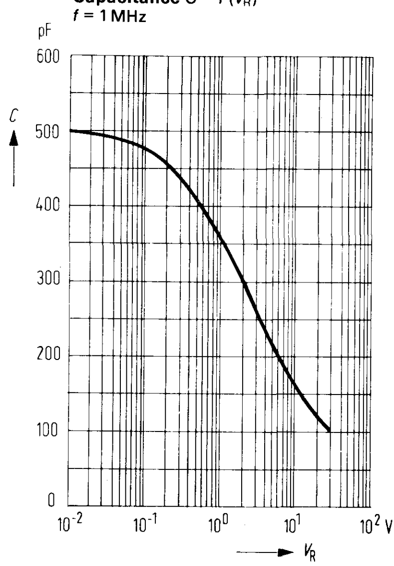
Directional characteristic $I_K = f(\varphi)$



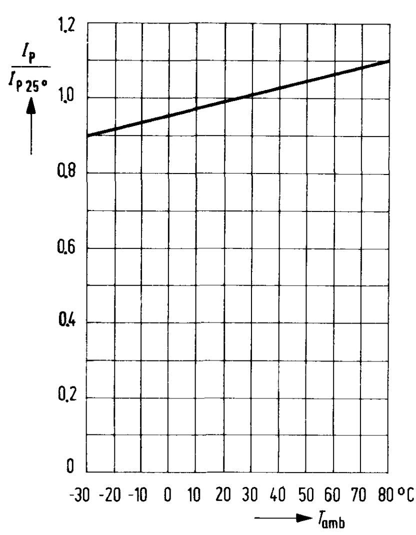
Power dissipation $P_{tot} = f(T_{amb})$



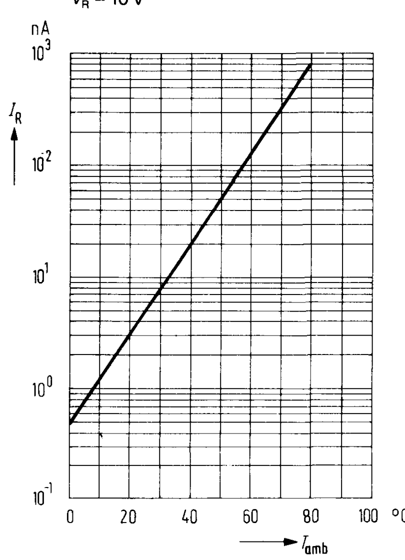


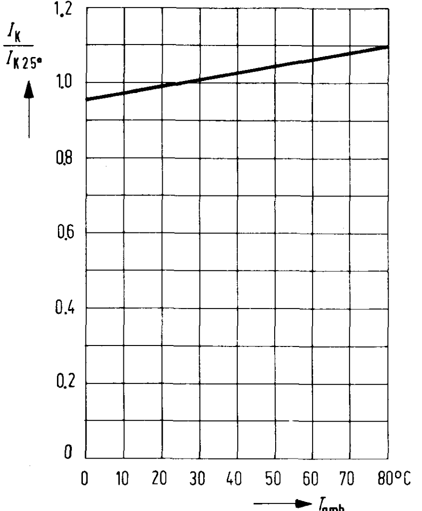


Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$

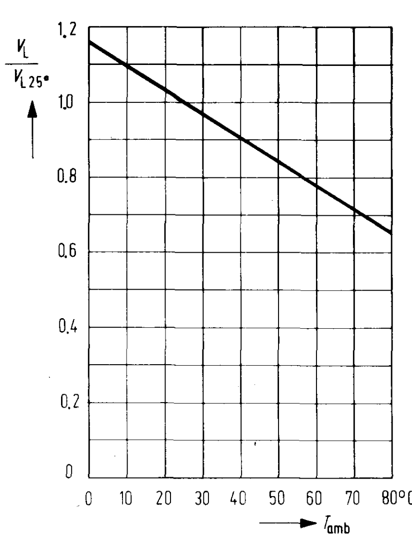


Dark current $I_R = f(T_{amb})$
V_R = 10 V





Open circuit voltage $\frac{V_L}{V_{L\,25°}} = f\,(T_{amb})$

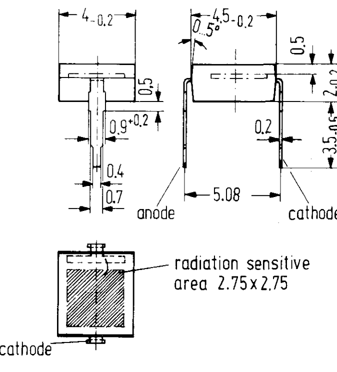


Plastic Encapsulated Silicon Photodiode **BPX 91**

The BPX 91 is a planar silicon photodiode, which is incorporated in a transparent plastic package. Its terminals are soldering tabs arranged in 5.08 mm (2/10") lead spacing. Due to its design the diode can also very easily be assembled on PC boards. The flat back of the epoxy resin case makes rigid fixing of the component feasible. Arrays can be realized by multiple arrangements.

This versatile photodetector is suitable for diode as well as voltaic cell operation. The signal/noise ratio is particularly favourable, even at low illuminances. The open circuit voltage at low illuminances is higher than with comparable mesa photovoltaic cells. The cathode is marked by a white dot.

Type	Ordering code
BPX 91	Q 62 702-P 48



Dimensions in mm

Maximum ratings

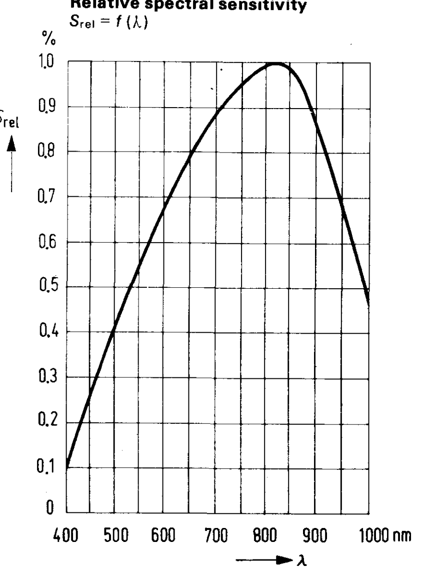
Reverse voltage	V_R	32	V
Operating and storage temperature range	T_{stor}	− 40 to + 80	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leq 3$ s)	T_s	230	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	150	mW

Characterictics (T_{amb} = 25°C)

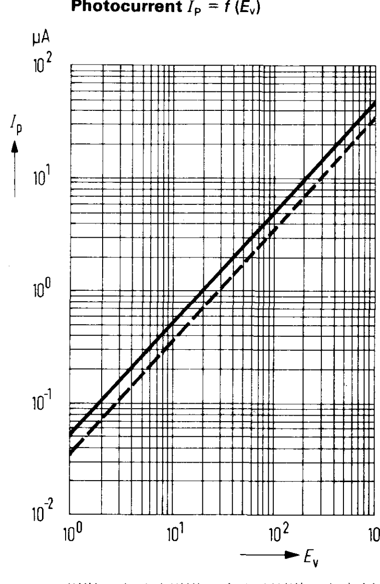
Parameter	Symbol	Value	Unit
Spectral sensitivity [1]	S	50 (≧ 35)	nA/lx
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	850	nm
Quantum yield (Electrons per photon) (λ = 850 nm)	η	0.73	Electrons / Photon
Spectral sensitivity (λ = 850 nm)	S	0.50	A/W
Open circuit voltage			
(E_v = 100 lx) [1]	V_L	360 (≧ 270)	mV
(E_v = 1000 lx) [1]	V_L	460	mV
Short circuit current (E_v = 100 lx) [1]	I_K	5 (≧ 3.5)	μA
Rise and fall time of the photocurrent from 10% to 90% and from 90% to 10% of the final value			
(R_L = 1 kΩ; V_R = 0 V; λ = 950 nm)	t_r; t_f	2.5	μs
(R_L = 1 kΩ; V_R = 10 V; λ = 950 nm)	t_r; t_f	1.0	μs
Temperature coefficient of V_L	TC	− 2.6	mV/K
Temperature coefficient of I_K	TC	0.2	%/K
Capacitance			
(V_R = 0 V; f = 1 MHz; E = 0)	C_0	750	pF
(V_R = 10 V; f = 1 MHz; E = 0)	C_{10}	220	pF
Radiant sensitive area	A	7.6	mm^2
Dark current (V_R = 10 V; E = 0)	I_R	7 (≦ 300)	nA

1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

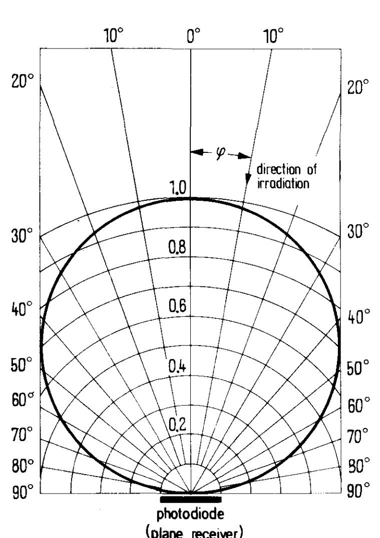
Relative spectral sensitivity $S_{rel} = f(\lambda)$



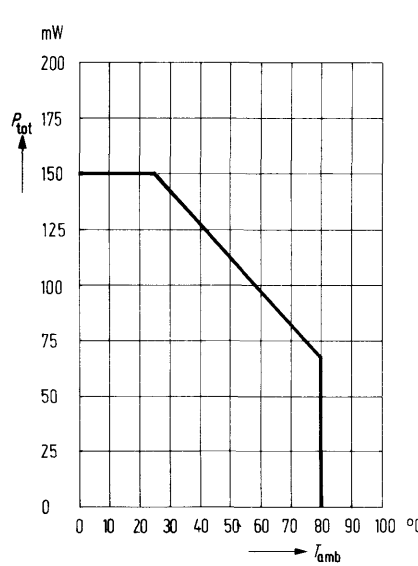
Photocurrent $I_P = f(E_v)$

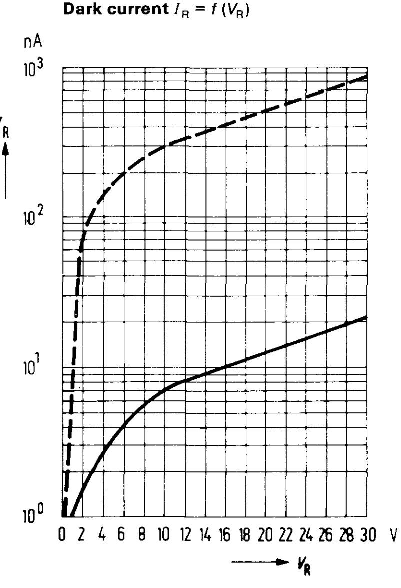


Directional characteristic $I_K = f(\varphi)$

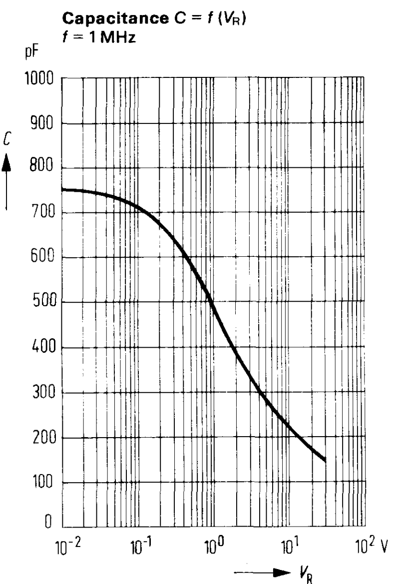


Power dissipation $P_{tot} = f(T_{amb})$

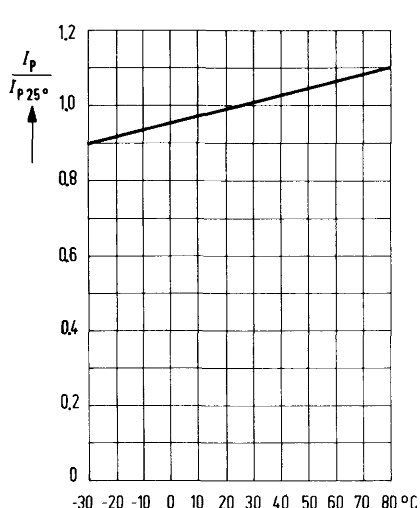




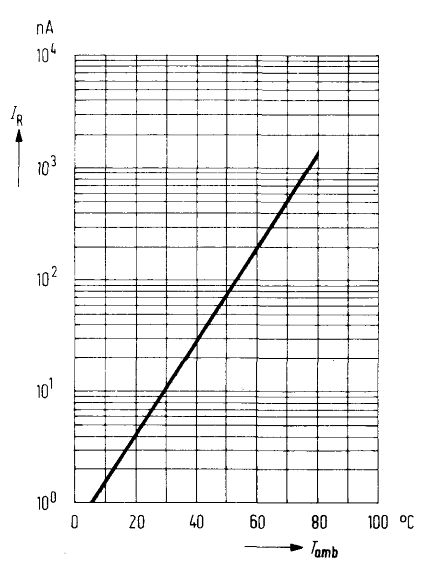
Dark current $I_R = f(V_R)$



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

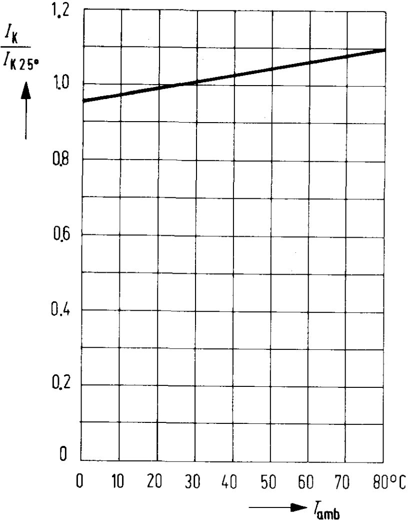


Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$

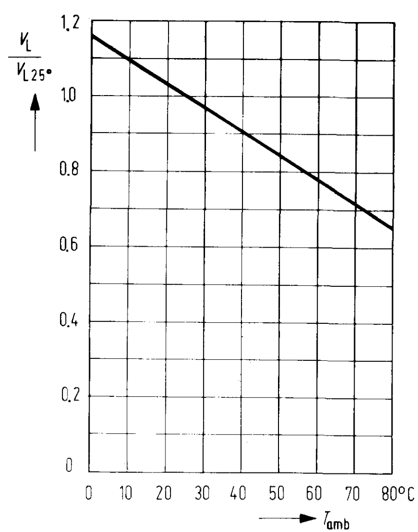


Dark current $I_R = f(T_{amb})$

Short circuit current $\frac{I_K}{I_{K\,25°}} = f\,(T_{amb})$



Open circuit voltage $\frac{V_L}{V_{L\,25°}} = f\,(T_{amb})$

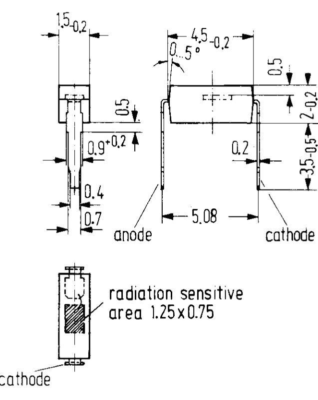


Plastic Encapsulated Silicon Photodiode BPX 92

The BPX 92 is a planar silicon photodiode, which is incorporated in a transparent plastic package. Its terminals are soldering tabs arranged in 5.08 mm (2/10") lead spacing. Due to its design the diode can also very easily be assembled on PC boards. The flat back of the epoxy resin case makes rigid fixing of the component feasible. Arrays can be realized by multiple arrangements.

This versatile photodetector is suitable for diode as well as voltaic cell operation. The signal/noise ratio is particularly favourable, even at low illuminances. The open circuit voltage at low illuminances is higher than with comparable mesa photovoltaic cells.

Type	Ordering code
BPX 92	Q 62 702-P 49



Dimensions in mm

Maximum ratings

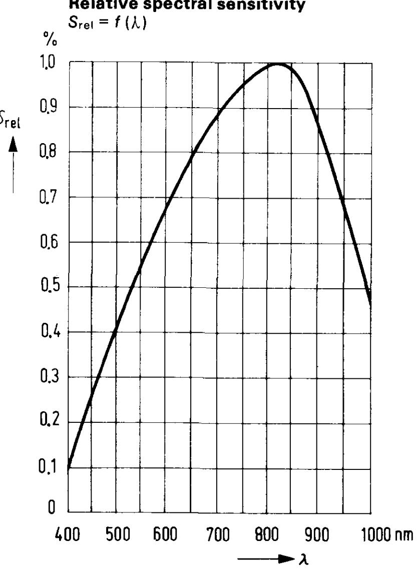
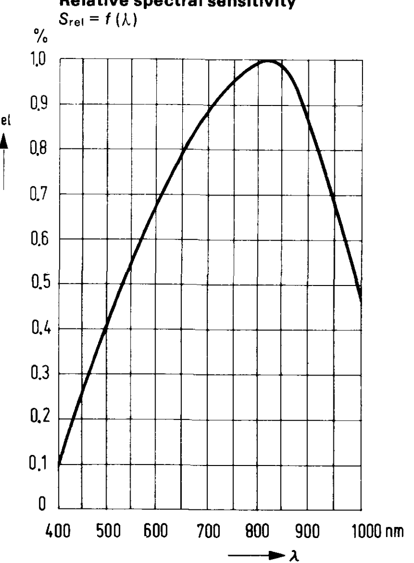
Reverse voltage	V_R	32	V
Operating and storage temperature	T_{stor}	– 55 to + 80	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leqq 3$ s)	T_s	230	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	50	mW

Characteristics (T_{amb} = 25°C)

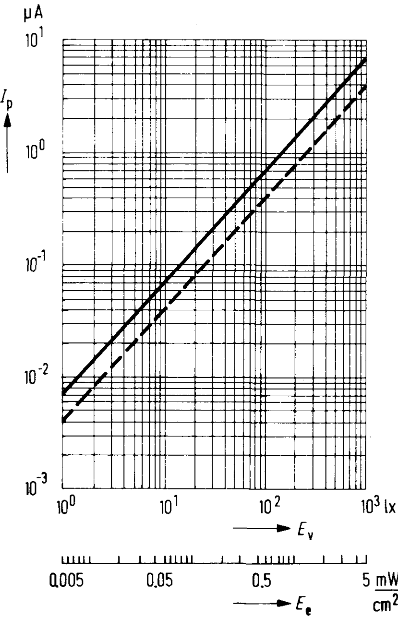
Spectral sensitivity [1]	S	7 (≧ 4)	nA/lx
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	850	nm
Quantum yield (Electrons per photon) (λ = 850 nm)	η	0.73	$\frac{Electrons}{Photon}$
Spectral sensitivity (λ = 850 nm)	S	0.50	A/W
Short circuit current			
(E_v = 100 lx) [1]	V_L	325 (≧ 240)	mV
(E_v = 1000 lx) [1]	V_L	410	mV
Open circuit voltage (E_v = 100 lx) [1]	I_K	0.7 (≧ 0.4)	µA
Rise and fall time of the photocurrent from 10% to 90% and from 90% to 10% of the final value			
(R_L = 1Ω; V_R = 0 V; λ = 950 nm)	t_r; t_f	1.1	µs
(R_L = 1Ω; V_R = 10 V; λ = 950 nm)	t_r; t_f	0.8	µs
Temperature coefficient of V_L	TC	– 2.6	mV/K
Temperature coefficient of I_K	TC	0.2	%/K
Capacitance			
(V_R = 0 V; f = 1 MHz; E = 0)	C_0	90	pF
(V_R = 10 V; f = 1 MHz; E = 0)	C_{10}	23	pF
Radiant sensitive area	A	1.0	mm²
Dark current (V_R = 10 V; E = 0)	I_R	1 (≦ 100)	nA

1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

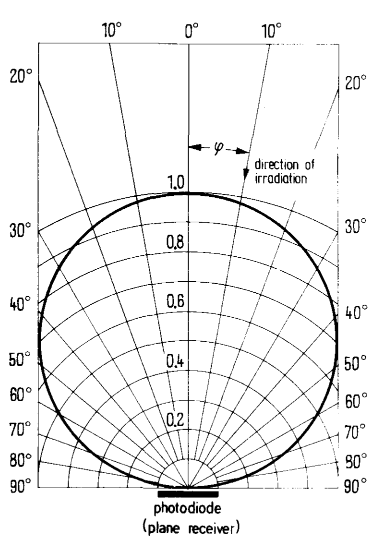
Relative spectral sensitivity
$S_{rel} = f(\lambda)$

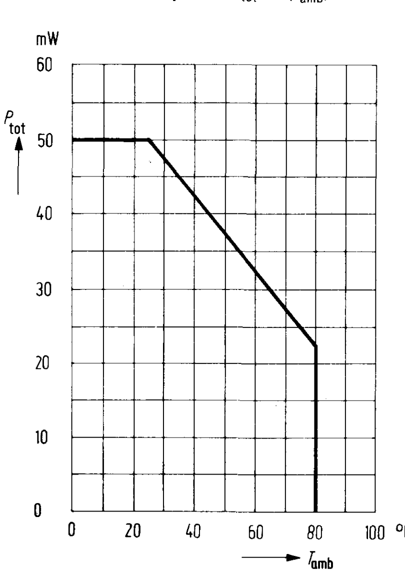
Photocurrent $I_P = f(E_v)$



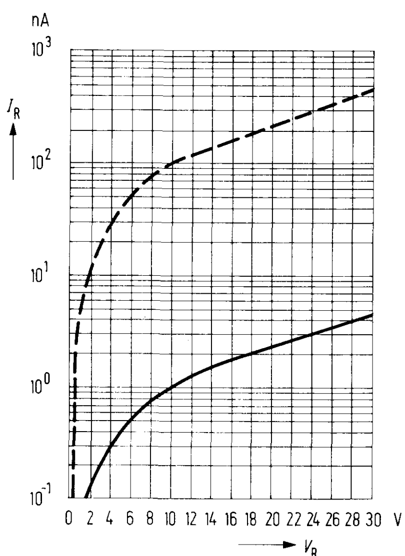
Directional characteristic $I_K = f(\varphi)$



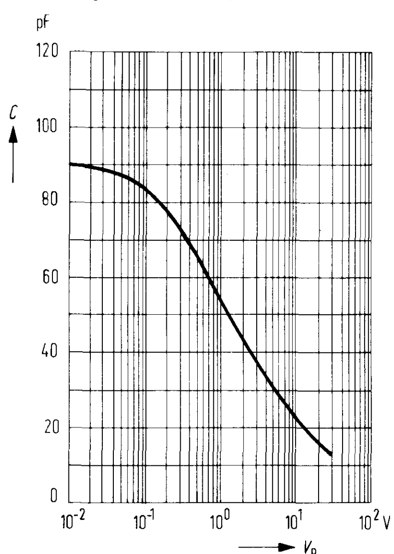
Power dissipation $P_{tot} = f(T_{amb})$



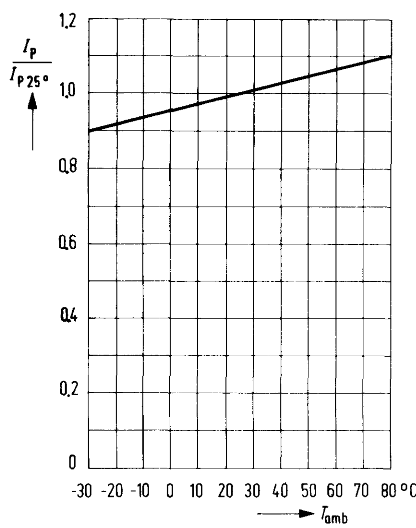
Dark current $I_R = f(V_R)$



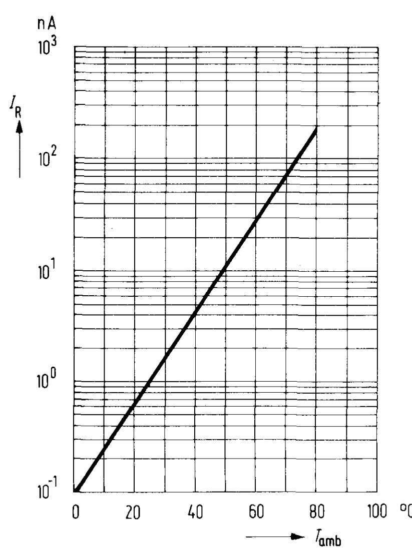
Capacitance $C = f(V_R)$

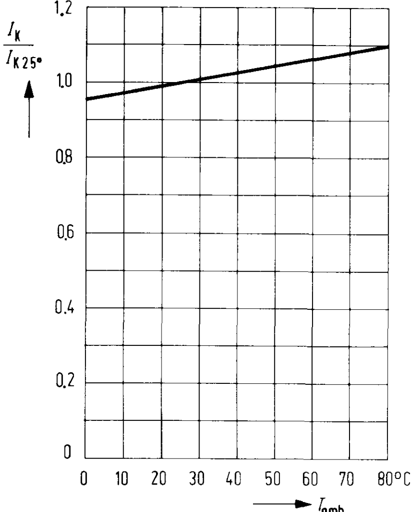


Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$

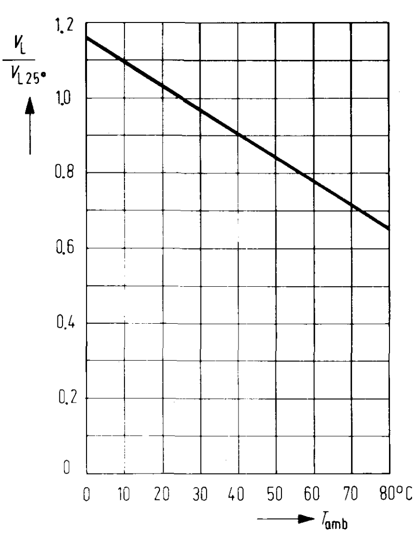


Dark current $I_R = f(T_{amb})$





Open circuit voltage $\frac{V_L}{V_{L\,25°}} = f\,(T_{amb})$



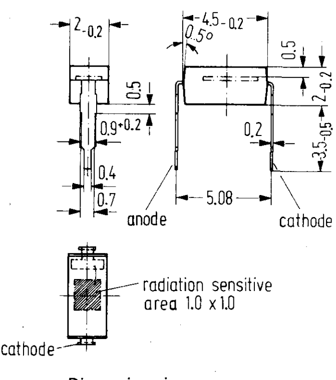
Plastic Encapsulated Silicon Photodiode

BPX 93

The BPX 93 is a planar silicon photodiode, which is incorporated in a transparent plastic package. Its terminals are soldering tabs arranged in 5.08 mm (2/10") lead spacing. Due to its design the diode can also very easily be assembled on PC boards. The flat back of the epoxy resin case makes rigid fixing of the component feasible. Arrays can be realized by multiple arrangements.

This versatile photodetector is suitable for diode as well as voltaic cell operation. The signal/noise ratio is particularly favourable, even at low illuminances. The open circuit voltage at low illuminances is higher than with comparable mesa photovoltaic cells. The cathode is marked by a white dot.

Type	Ordering code
BPX 93	Q 62 702-P 50



Dimensions in mm

Maximum ratings

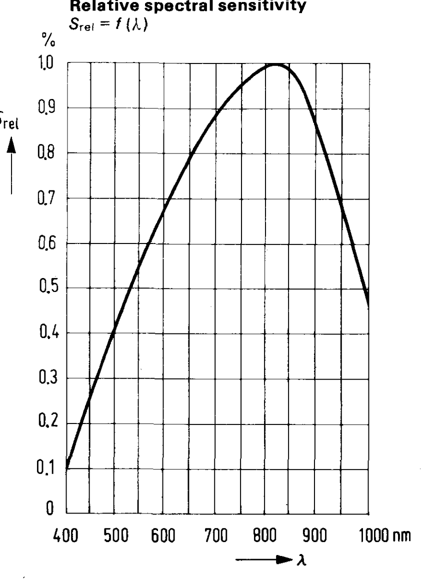
Reverse voltage	V_R	32	V
Operating and storage temperature	T_{stor}	– 55 to + 88	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leq 3$ s)	T_s	230	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	75	mW

Characteristics (T_{amb} = 25°C)

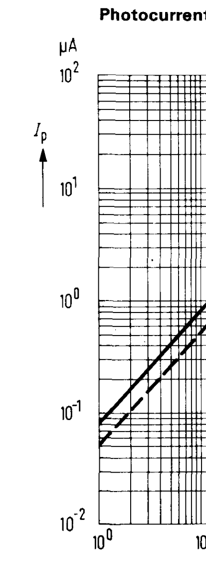
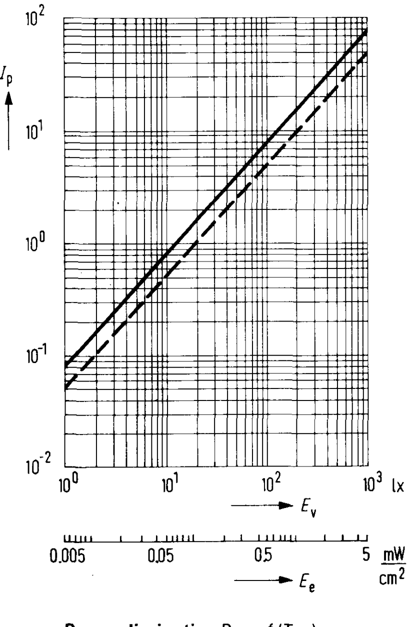
Spectral sensitivity [1]	S	8 (≧ 5)	nA/lx
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	850	nm
Quantum yield (Electrons per photon) (λ = 850 nm)	η	0.73	Electrons / Photon
Spectral sensitivity (λ = 850 nm)	S	0.50	A/W
Open circuit voltage			
(E_v = 100 lx) [1]	V_L	360 (≧ 270)	mV
(E_v = 1000 lx) [1]	V_L	460	mV
Short circuit current (E_v = 100 lx) [1]	I_K	0.8 (≧ 0.5)	µA
Rise and fall time of the photocurrent from 10% to 90% and from 90% to 10% of the final value			
(R_L = 1 kΩ; V_R = 0 V)	t_r; t_f	1.1	µs
(R_L = 1 kΩ; V_R = 10 V)	t_r; t_f	0.8	µs
Temperature coefficient of V_L	TC	– 2	mV/K
Temperature coefficient of I_K	TC	0.1	%/K
Capacitance			
(V_R = 0 V; f = 1 MHz; E = 0)	C_0	120	pF
(V_R = 10 V; f = 1 MHz; E = 0)	C_{10}	40	pF
Radiant sensitive area	A	1	mm^2
Dark current (V_R = 10 V; E = 0)	I_R	0.5 (≦ 50)	nA

1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

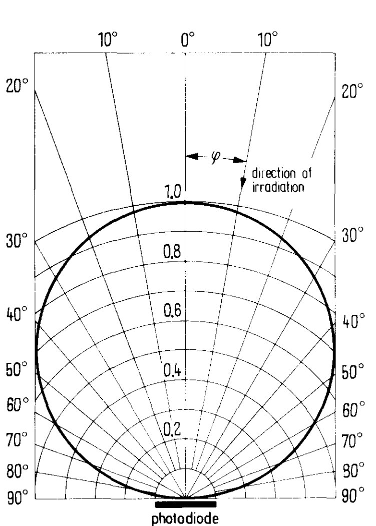
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



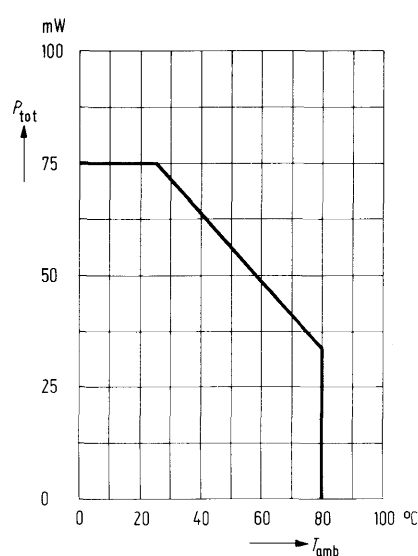
Photocurrent $I_P = f(E_v)$

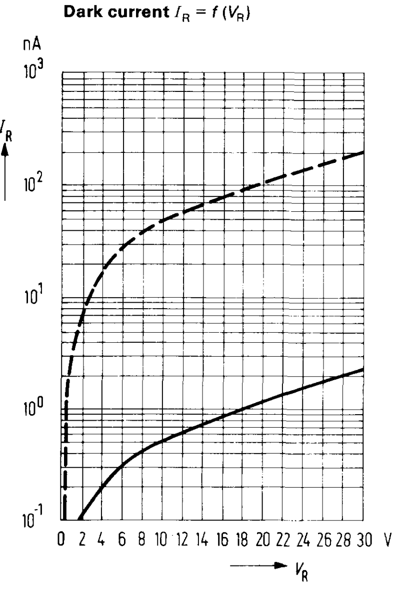



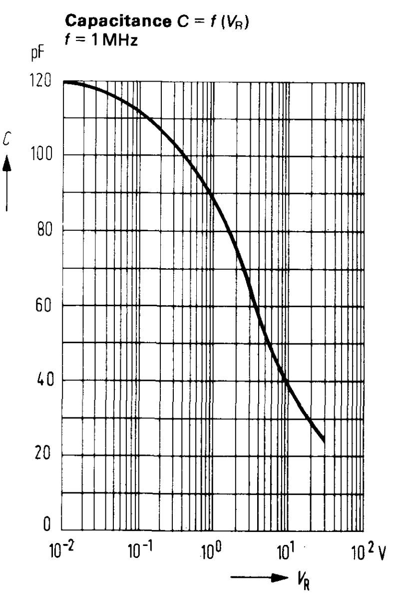
Directional characteristic $I_K = f(\varphi)$

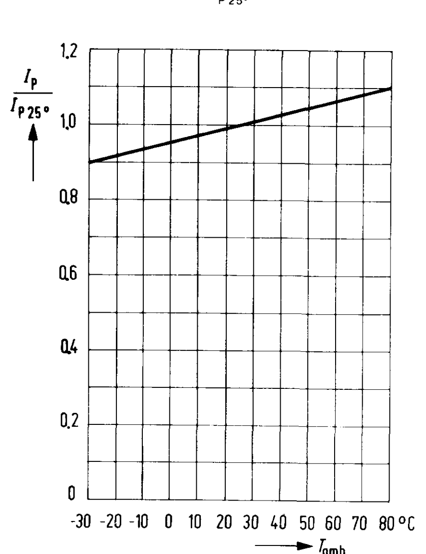


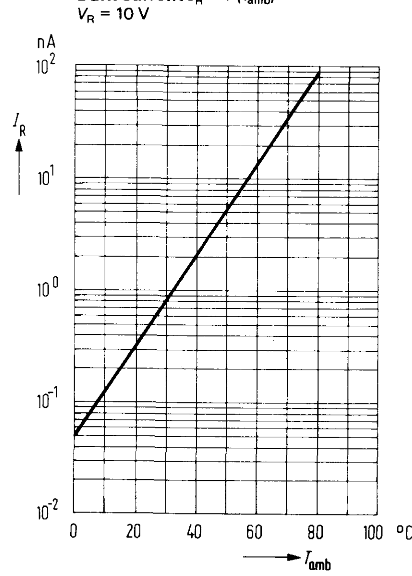
Power dissipation $P_{tot} = f(T_{amb})$



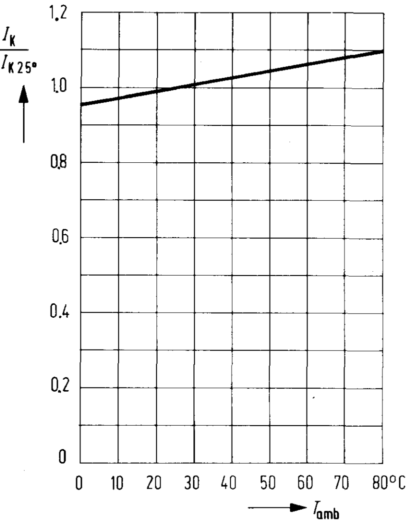

Dark current $I_R = f(V_R)$
nA
10^3
10^2
10^1
10^0
10^{-1}
I_R
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 V
V_R


Capacitance $C = f(V_R)$
f = 1 MHz
pF
120
100
80
60
40
20
0
C
10^{-2} 10^{-1} 10^0 10^1 10^2 V
V_R

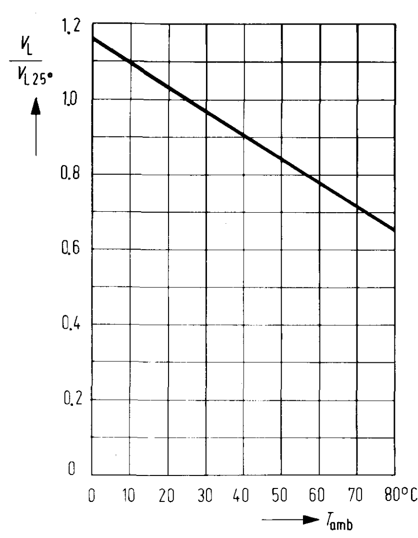

Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$
1,2
1,0
0,8
0,6
0,4
0,2
0
$\frac{I_P}{I_{P\,25°}}$
-30 -20 -10 0 10 20 30 40 50 60 70 80 °C
T_{amb}


Dark current $I_R = f(T_{amb})$
V_R = 10 V
nA
10^2
10^1
10^0
10^{-1}
10^{-2}
I_R
0 20 40 60 80 100 °C
T_{amb}

Short circuit current $\frac{I_K}{I_{K\ 25°}} = f\ (T_{amb})$



Open circuit voltage $\frac{V_L}{V_{L\ 25°}} = f\ (T_{amb})$



Silicon Photodiode

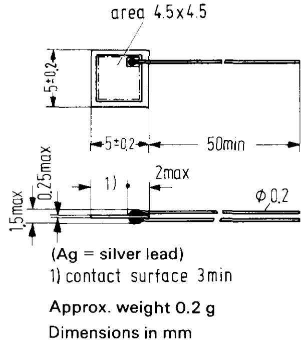
BPY 12

Not for new equipment

The BPY 12 is a large-area planar silicon photodiode for versatile applications, which is also suitable for quantitative light measurements. It is particularly useful, where a high cut-off frequency of a high ohmic load resistor is required. The planar technique ensures a low dark current level, low noise and thus very favourable signal conditions.

For mounting instructions see introduction, para. 2.4, page 24.

Type	Ordering code
BPY 12	Q 62 702-P 9



(Ag = silver lead)
1) contact surface 3min

Approx. weight 0.2 g
Dimensions in mm

Maximum ratings

Reverse voltage [2]	V_R	20	V
Storage temperature	T_{stor}	– 55 to + 100	°C
Power dissipation	P_{tot}	150	mW

2) The positive pole of the voltage source shall be connected to the silver coated, light-insensitive side of the photodiode.

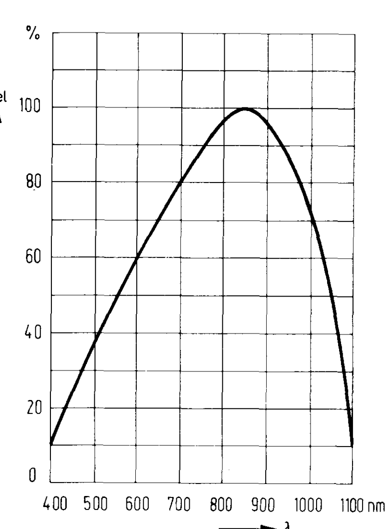
Characteristics (T_{amb} = 25°C)

Spectral sensitivity [1]	S	≧ 100	nA/lx
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	850	nm
Quantum yield (Electrons per photon) (λ = 850 nm)	η	0.88	$\frac{\text{Electrons}}{\text{Photon}}$
Spectral sensitivity (λ = 850 nm)	S	0.60	A/W
Rise and fall time of the photocurrent from 10% to 90% and from 90% to 10% of the final value			
(R_L = 1 kΩ; V_R = 0 V; λ = 950 nm)	t_r; t_f	2	µs
(R_L = 1 kΩ; V_R = 20 V; λ = 950 nm)	t_r; t_f	≦ 150	µs
Cut-off frequency (R_L = 1 kΩ; V_R = 20 V)	f_g	1	MHz
Capacitance			
(V_R = 0 V; E = 0)	C_0	140	pF
(V_R = 20 V; E = 0)	C_{20}	25	pF
Dark current (V_R = 20 V; E = 0)	I_R	100 (≦1000)	nA
Radiant sensitive area	A	20	mm^2
Noise equivalent power (V_R = 20 V)	NEP	6.7×10^{-13}	$\frac{W}{\sqrt{Hz}}$
Detection limit (V_R = 20 V)	D^*	6.7×10^{11}	$\frac{cm\sqrt{Hz}}{W}$
Temperature coefficient of I_P	TC	0.15	%/K

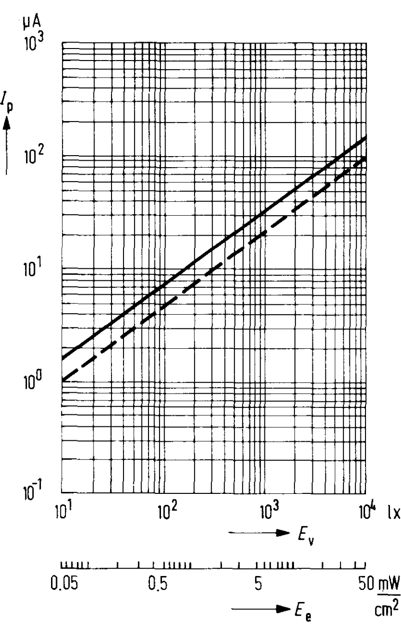
Not for new equipment

1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

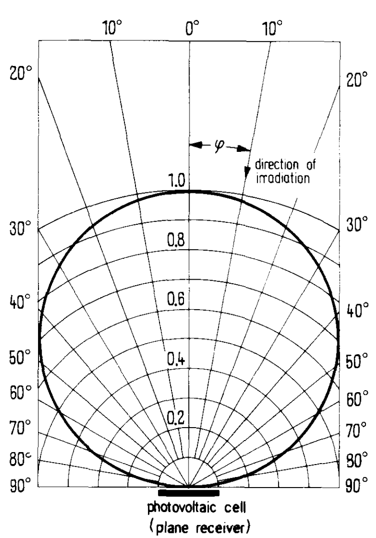
Spectral sensitivity $S = f(\lambda)$ **in A/W and quantum yield** $\eta = f(\lambda)$ **in electrons per photon**



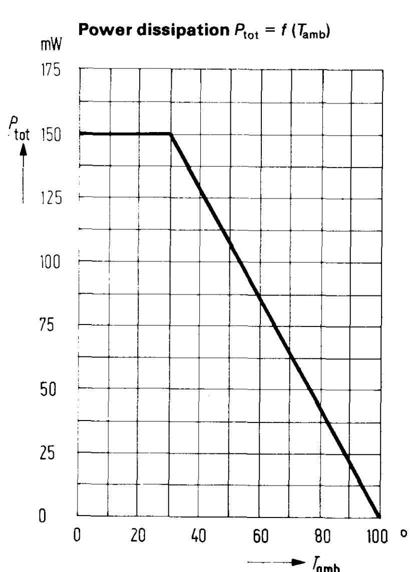
Photocurrent $I_P = f(E_v)$
$V_R = 20$ V



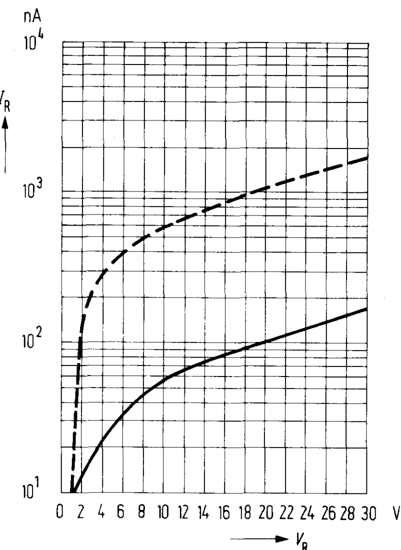
Directional characteristic $I_P = f(\varphi)$



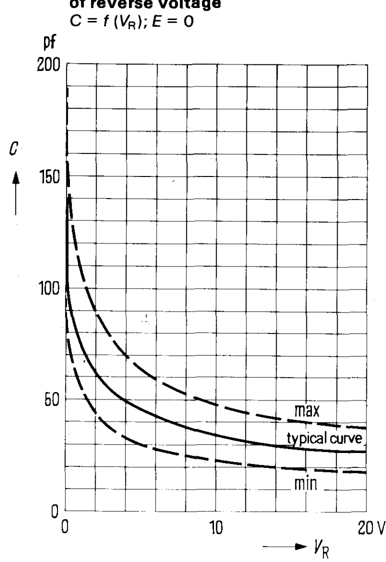
Power dissipation $P_{tot} = f(T_{amb})$



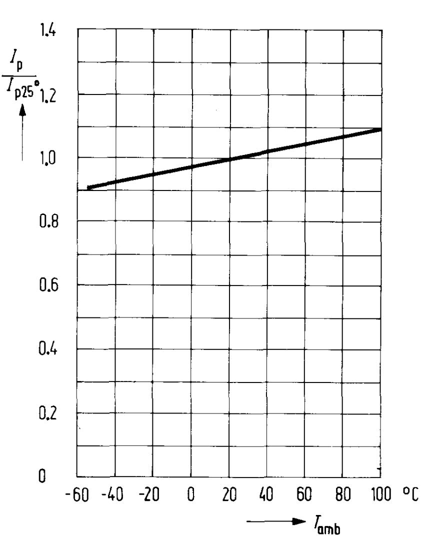
Dark current $I_R = f(V_R)$
$T_{amb} = 25°C$ $E = 0$



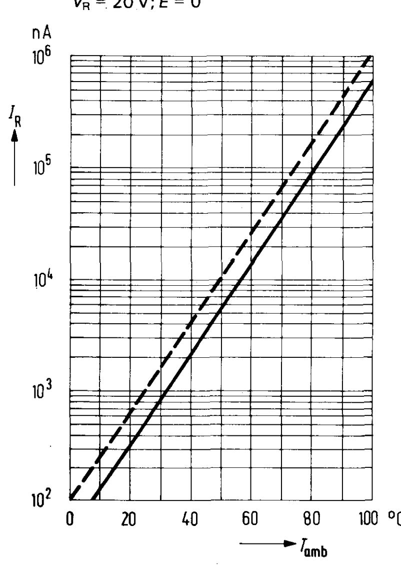
Capacitance as a function of reverse voltage
$C = f(V_R)$; $E = 0$



Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$
$E = 0$

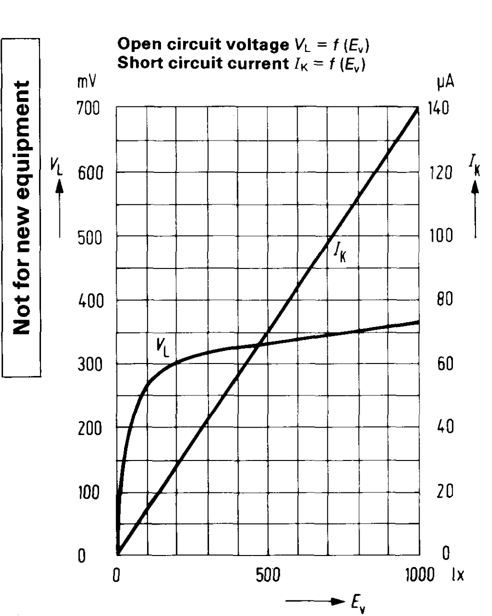


Dark current $I_R = f(T_{amb})$
$V_R = 20$ V; $E = 0$

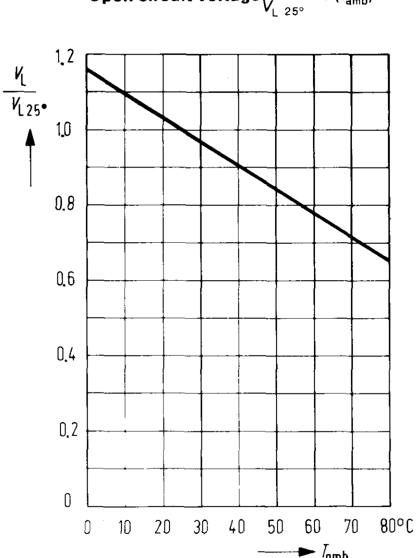


Not for new equipment

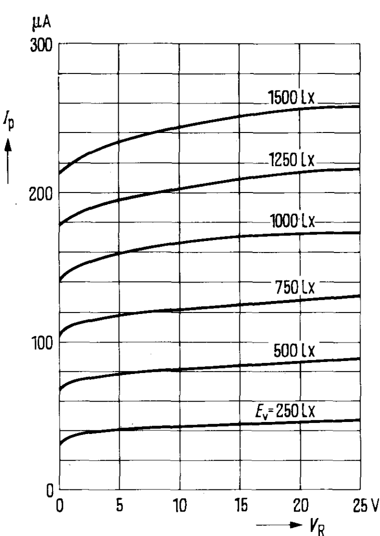
Open circuit voltage $V_L = f(E_v)$
Short circuit current $I_K = f(E_v)$



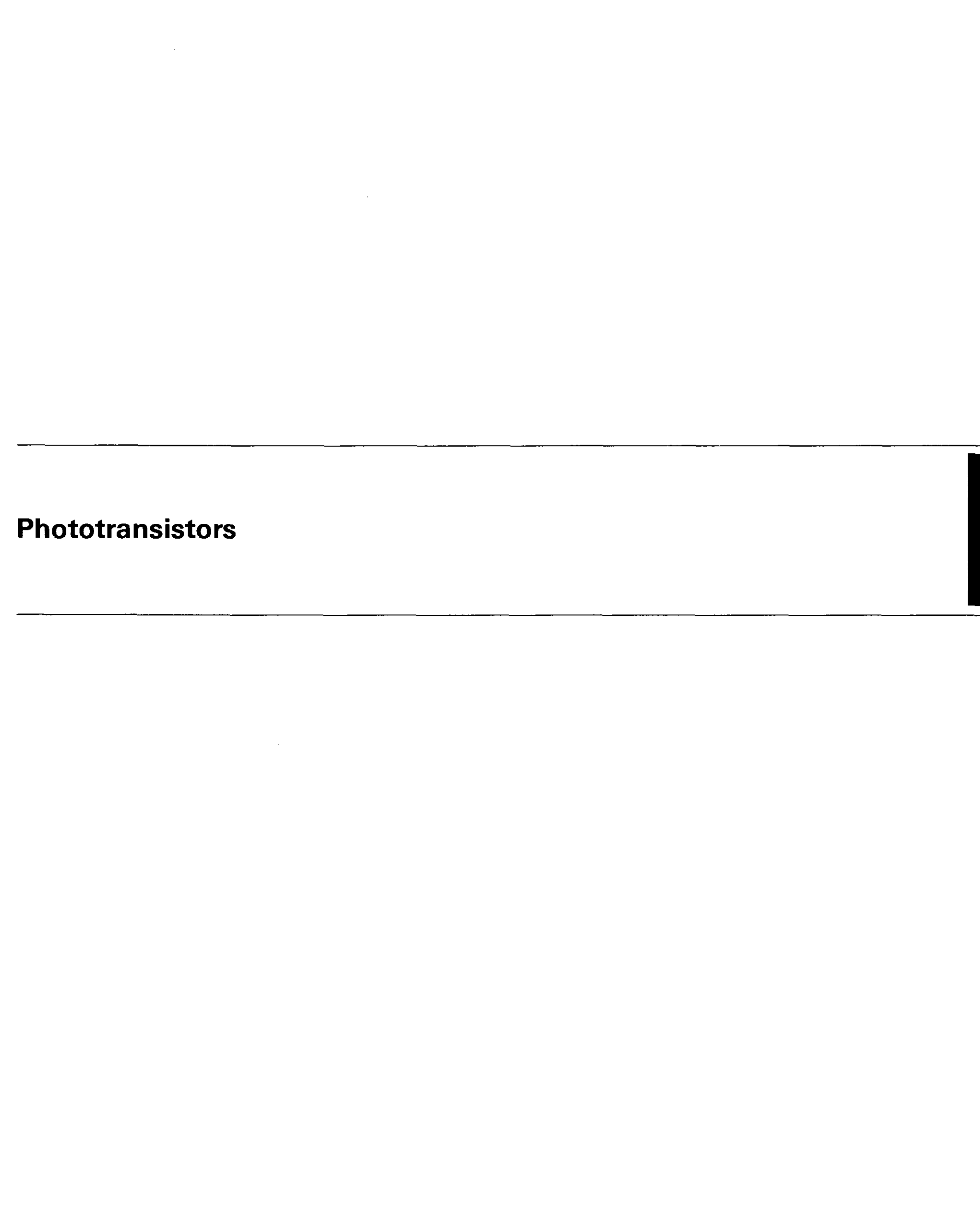
Open circuit voltage $\frac{V_L}{V_{L\,25°}} = f(T_{amb})$



Family of characteristics $I_P = f(V_R)$
E_v = parameter



Phototransistors

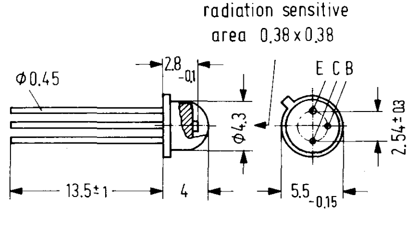


NPN Silicon Planar Phototransistor

BP 101

The BP 101 is an epitaxial NPN silicon planar phototransistor, mounted on a base plate similar to 18 A 3 DIN 41876 (TO 18) with glass-clear plastic encapsulation. The plastic cover provides a wide angle for the incident light. This angle can be reduced by mounting a diaphragm. The emitter terminal is marked by a small projection on the case bottom. The collector is electrically connected to the metallic case parts. The phototransistor is particularly suitable for use in automatic electronic flashes as well as in high Q electronic instructional toys, used at filament lamp light and daylight.

Type	Ordering code
BP 101 I	Q 62 702-B 28
BP 101 II	Q 62 702-B 35
BP 101 III	Q 62 702-B 29
BP 101 IV	Q 62 702-P 12-S 1



Dimensions in mm

Approx. weight 0.5 g

Maximum ratings

Collector-emitter voltage	V_{CEO}	32	V
Emitter-base voltage	V_{EBO}	5	V
Collector current	I_C	100	mA
Collector peak current ($t \leq 10$ µs)	I_{CM}	200	mA
Junction temperature	T_j	125	°C
Storage temperature	T_{stor}	−55 to +80	°C
Max. soldering temperature ($t \leq 5$ s)	T_s	260	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	300	mW
Thermal resistance			
Collector junction to air	R_{thJamb}	500	K/W
Collector junction to case	$R_{thJcase}$	200	K/W

Characteristics (T_{amb} = 25°C)

Parameter	Symbol	Value	Unit
Collector-emitter leakage current (V_{CE} = 30 V; E = 0)	I_{CEO}	5 (≦ 100)	nA
Collector-emitter saturation voltage (I_C = 500 μA; I_B = 25 μA; E = 0)	V_{CEsat}	0.15 (≦ 0.4)	V
Range of spectral sensitivity (S = 0.1 S_{max})	λ	430 to 1060	nm
Wavelength of the max. sensitivity	$\lambda_{S\ max}$	800	nm
Typ. spectral sensitivity of the collector base photodiode	S	0.35	nA/lx
Radiant sensitive area	A	0.14	mm²
Rise time to 90% of the final value Fall time to 10% of the initial value (R_L = 1 kΩ)[1]	t_r; t_f	5 (≦ 10)	μs
Capacitance (V_{CE} = 0 V; f = 1 MHz; E = 0)	C_{CE}	6	pF
(V_{CB} = 0 V; f = 1 MHz; E = 0)	C_{CB}	10	pF
(V_{EB} = 0 V; f = 1 MHz; E = 0)	C_{EB}	12	pF

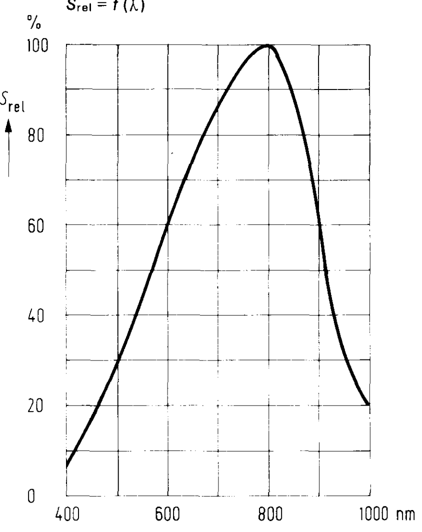
The phototransistors are grouped according to their spectral sensitivity and marked by Roman numerals. Grouping is done at E_V = 1000 lx.

Group	I	II	III	IV	
Photocurrent (V_{CE} = 5 V; E_v = 1000 lx) I_P	63 to 125	100 to 200	160 to 320	250 to 500	μA
Photocurrent at 20 mW/cm² approx. I_P	0.25 to 0.56	0.45 to 0.90	0.70 to 1.40	1.0 to 2.0	mA
Power gain $\frac{I_{P\ (CE)}}{I_{P\ (CB)}}$[2] ($E_v$ = 1000 lx; V_{CE} = 5 V)	260	400	640	1000	

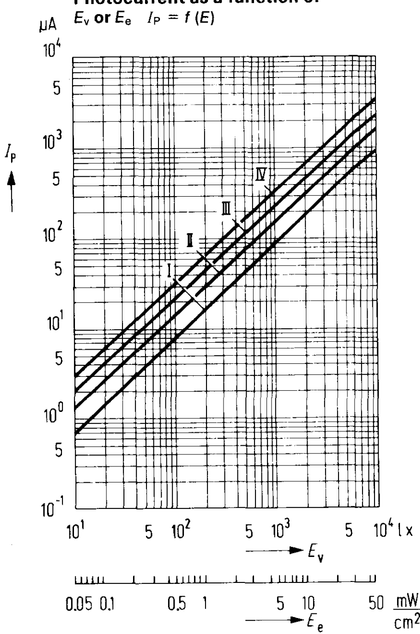
The illuminances refer to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K. (standard light A in accordance with DIN 5033 and IEC 306-1). Irradiance E_e measured with HP radiant flux meter 8334A with option 013.

[1]) measured with LED λ = 950 nm

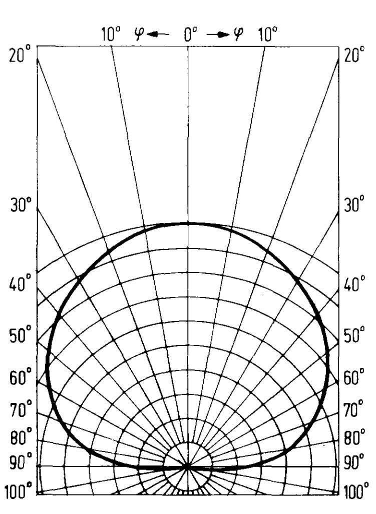
[2]) $I_{p\ (CE)}$ = Photocurrent of the phototransistor
$I_{p\ (CB)}$ = Photocurrent of the collector-base photodiode



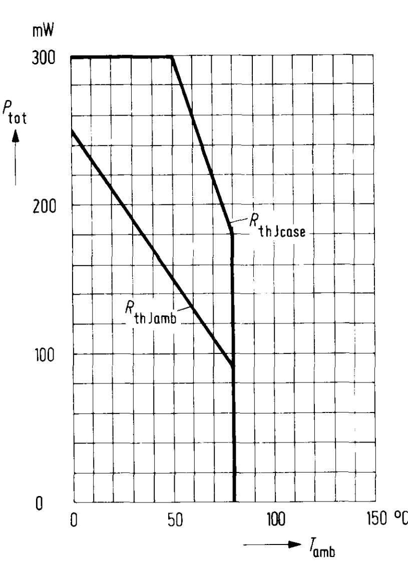
Photocurrent as a function of E_v or E_e $I_P = f(E)$

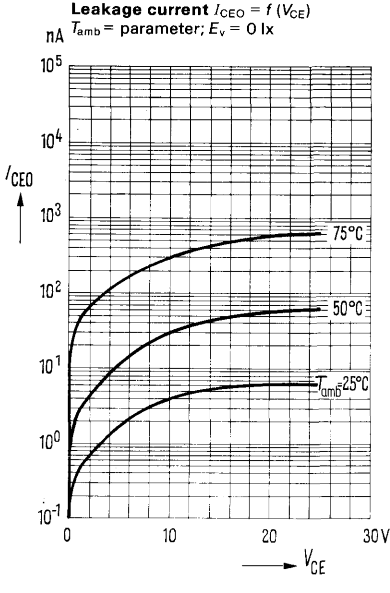


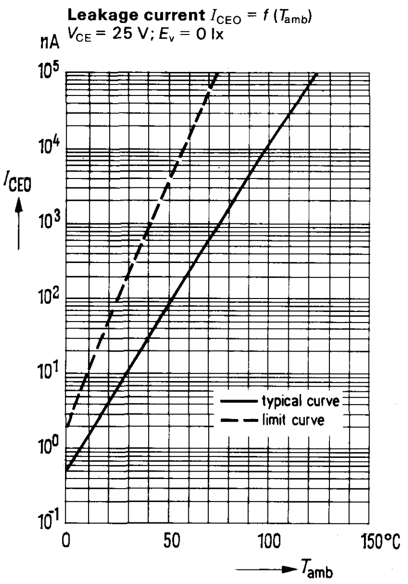
Directional characteristic $I_P = f(\varphi)$

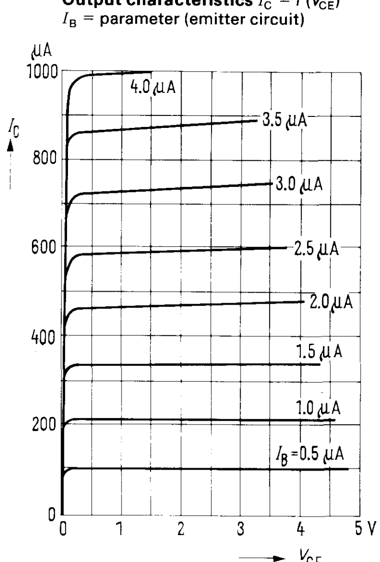


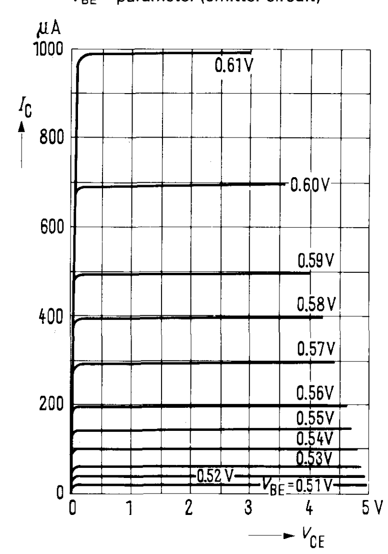
Power dissipation $P_{tot} = f(T_{amb})$

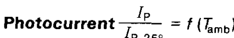


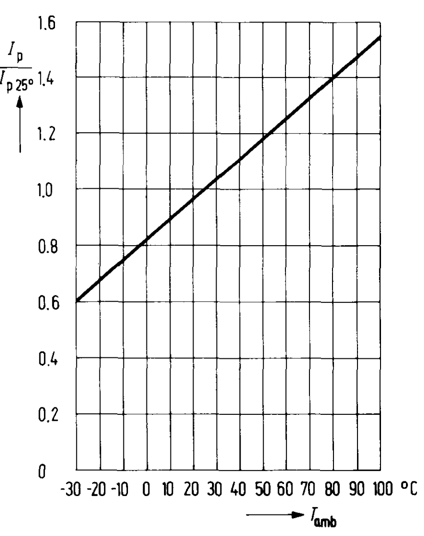

Leakage current $I_{CEO} = f(V_{CE})$
T_{amb} = parameter; E_v = 0 lx
nA
10^5
10^4
10^3
10^2
10^1
10^0
10^{-1}
I_{CEO}
75°C
50°C
T_{amb}=25°C
0
10
20
30 V
V_{CE}


Leakage current $I_{CEO} = f(T_{amb})$
V_{CE} = 25 V; E_v = 0 lx
nA
10^5
10^4
10^3
10^2
10^1
10^0
10^{-1}
I_{CEO}
typical curve
limit curve
0
50
100
150°C
T_{amb}

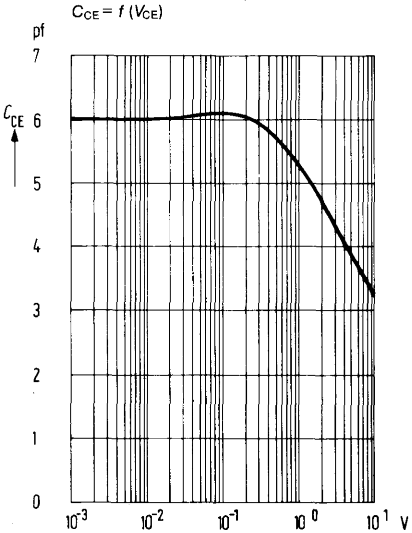

Output characteristics $I_C = f(V_{CE})$
I_B = parameter (emitter circuit)
µA
1000
800
600
400
200
0
I_C
4.0 µA
3.5 µA
3.0 µA
2.5 µA
2.0 µA
1.5 µA
1.0 µA
I_B = 0.5 µA
0
1
2
3
4
5 V
V_{CE}


Output characteristics $I_C = f(V_{CE})$
V_{BE} = parameter (emitter circuit)
µA
1000
800
600
400
200
0
I_C
0.61 V
0.60 V
0.59 V
0.58 V
0.57 V
0.56 V
0.55 V
0.54 V
0.53 V
0.52 V
V_{BE} = 0.51 V
0
1
2
3
4
5 V
V_{CE}

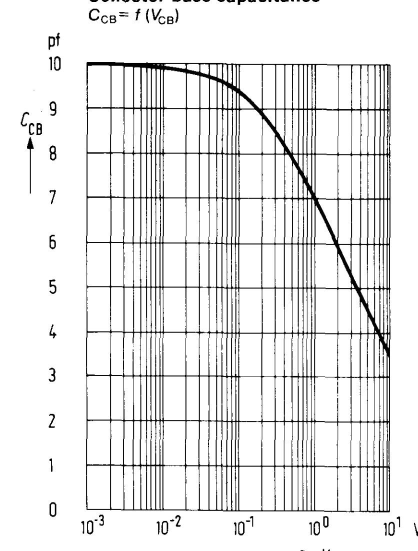
Photocurrent 



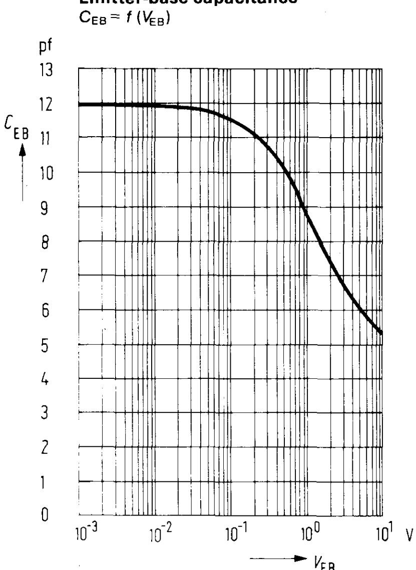
Collector-emitter capacitance
$C_{CE} = f\ (V_{CE})$



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



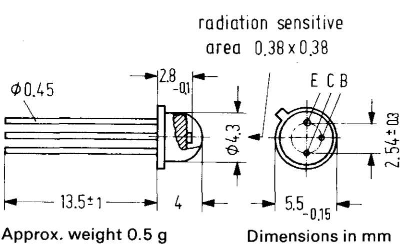
Emitter-base capacitance
$C_{EB} = f\ (V_{EB})$



NPN Silicon Planar Phototransistor BP 102

The BP 102 is an epitaxial NPN silicon planar phototransistor, mounted on a base plate similar to 18 A 3 DIN 41876 (TO 18) with glass-clear plastic encapsulation. The plastic cover provides a wide angle for the incident light. This angle can also be reduced by mounting a diaphragm. The emitter terminal is marked by a small projection on the case bottom. The collector is electrically connected to the metallic case parts. The phototransistor is particularly suitable for use in automatic electronic flashes as well as in high Q electronic instructional toys, used at filament lamp light and daylight as well as in combination with GaAs infrared emitting diodes in small light barriers.

Type	Ordering code
BP 102 I	Q 62 702-P 23-51
BP 102 II	Q 62 702-P 23-52
BP 102 III	Q 62 702-P 23-53
BP 102 IV	Q 62 702-P 23-54



Approx. weight 0.5 g Dimensions in mm

Maximum ratings

Collector-emitter voltage	V_{CEO}	32	V
Emitter-base voltage	V_{EBO}	5	V
Collector current	I_C	100	mA
Collector peak voltage	I_{CM}	200	mA
Junction temperature	T_j	125	°C
Storage temperature	T_{stor}	−55 to +80	°C
Max. permissible soldering temperature	T_s	260	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	300	mW
Thermal resistance			
Collector junction to air	R_{thJamb}	500	K/W
Collector junction to case	$R_{thJ\,case}$	200	K/W

Characteristics (T_{amb} = 25°C)

Parameter	Symbol	Value	Unit
Collector-emitter leakage current (V_{CE} = 30 V; E = 0)	I_{CEO}	5 (≦ 100)	nA
Collector-emitter saturation voltage (I_C = 500 µA; I_B = 25 µA; E = 0)	V_{CEsat}	0.15 (≦ 0.4)	V
Range of spectral sensitivity (S = 0.1 S_{max})	λ	450 to 1100	nm
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	760	nm
Typ. spectral sensitivity of the collector-base photodiode	S	1.1	nA/lx
Radiant sensitive area	A	0.17	mm^2
Rise time to 90% of the final value Fall time to 10% of the initial value (R_L = 1 kΩ)[1]	t_r; t_f	5 (≦ 10)	µs
Capacitance (V_{CE} = 0 V; f = 1 MHz; E = 0)	C_{CE}	6	pF
(V_{CB} = 0 V; f = 1 MHz; E = 0)	C_{CB}	20	pF
(V_{EB} = 0 V; f = 1 MHz; E = 0)	C_{EB}	8	pF

The phototransistors are grouped according to their spectral sensitivity and marked by Roman numerals. Grouping is done at E_v = 1000 lx.

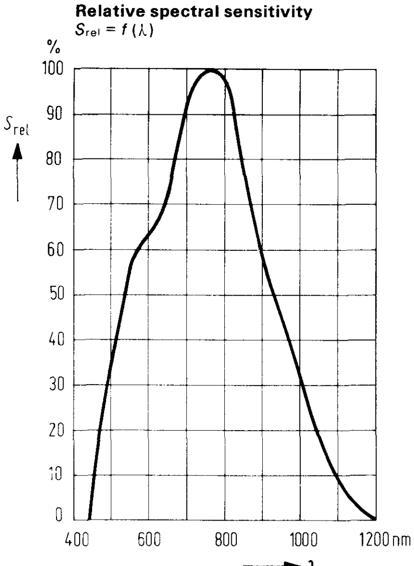
Group	I	II	III	IV	
Photocurrent I_P (V_{CE} = 5 V; E_V = 1000 lx)	160 to 320	250 to 500	400 to 800	630 to 1250	µA
Photocurrent approx. I_P (V_{CE} = 5 V; E_e = 20 mW/cm²)	0.7 to 1.4	1.1 to 2.2	1.8 to 3.6	2.8 to 5.6	mA
Power gain $\frac{I_{P(CE)}}{I_{P(CB)}}$[2] ($E_v$ = 1000 lx; V_{CE} = 5 V)	200	320	500	800	

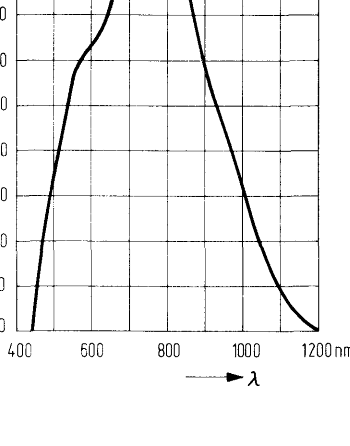
The illuminances refer to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC 306-1). Irradiance E_e measured with HP radiant flux meter 8334A with option 013.

[1] measured with LED λ = 950 nm

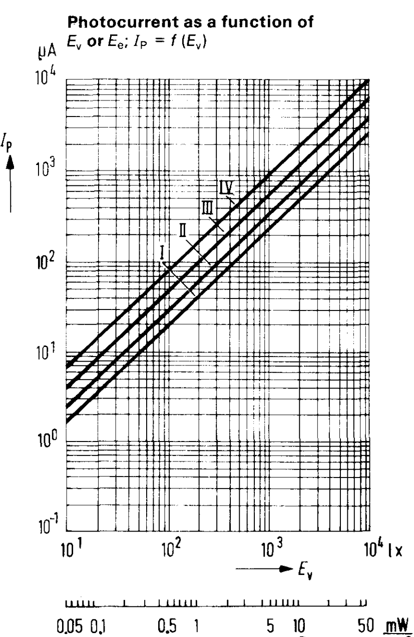
[2] $I_{p\,(CE)}$ = Photocurrent of the phototransistor
$I_{p\,(CB)}$ = Photocurrent of the collector-base photodiode

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

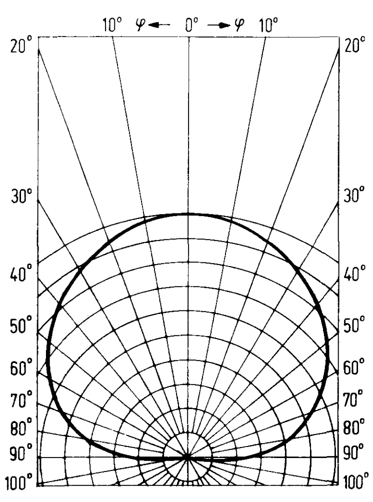




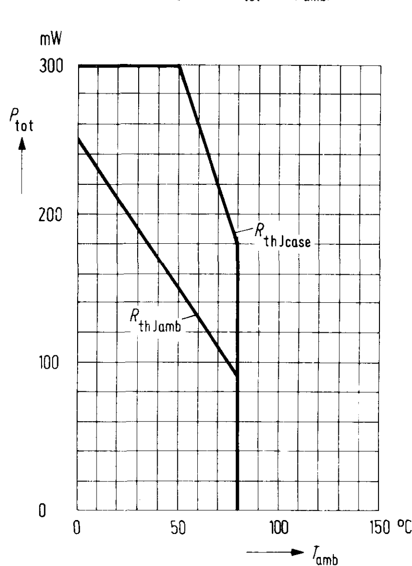
Photocurrent as a function of
E_v **or** E_e; $I_P = f(E_v)$



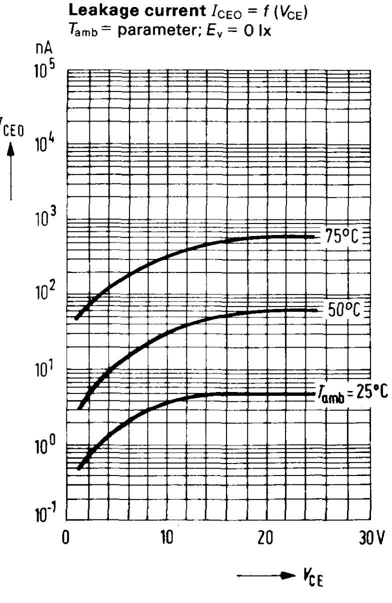
Directional characteristic $I_P = f(\varphi)$



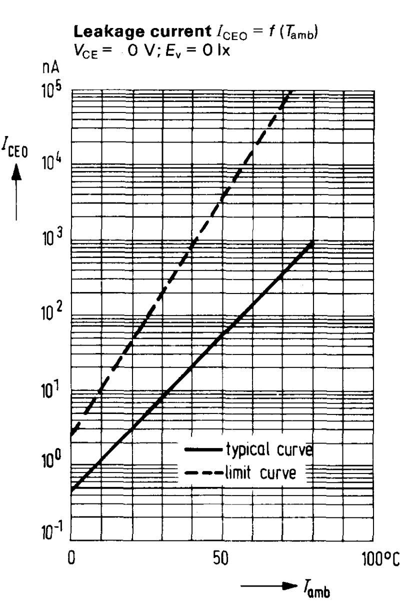
Power dissipation $P_{tot} = f(T_{amb})$



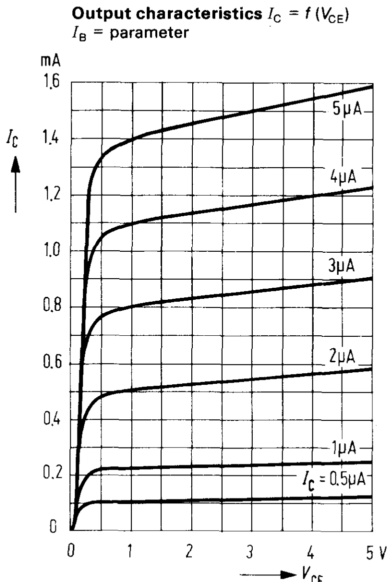
Leakage current $I_{CEO} = f(V_{CE})$
T_{amb} = parameter; E_v = 0 lx



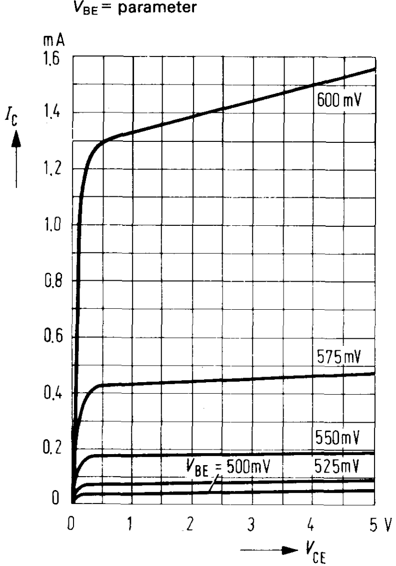
Leakage current $I_{CEO} = f(T_{amb})$
V_{CE} = 0 V; E_v = 0 lx

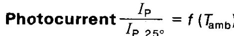


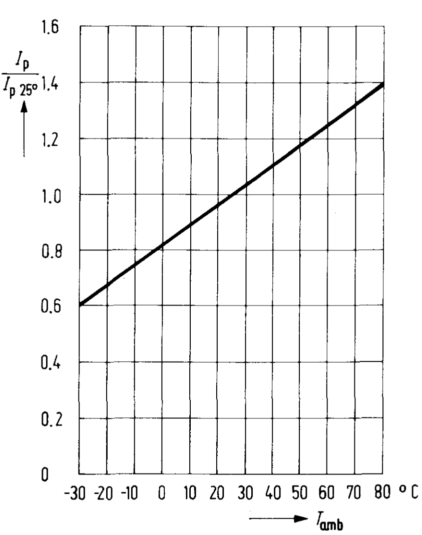
Output characteristics $I_C = f(V_{CE})$
I_B = parameter



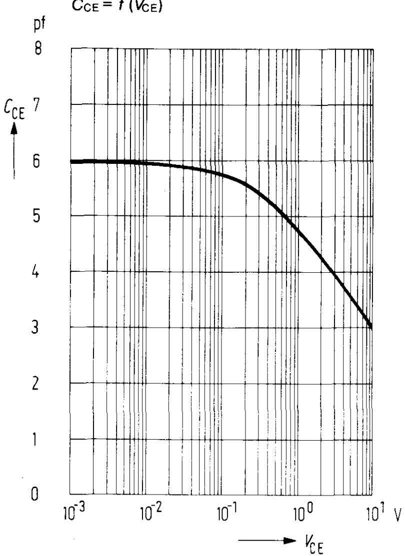
Output characteristics $I_C = f(V_{CE})$
V_{BE} = parameter



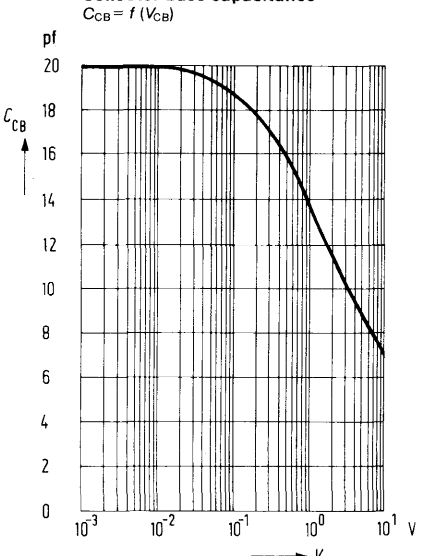
Photocurrent  $\frac{I_P}{I_{P\,25°}} = f\,(T_{amb})$



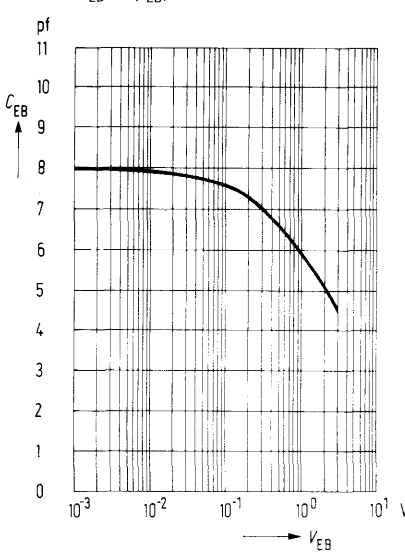
Collector-emitter capacitance
$C_{CE} = f\,(V_{CE})$



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



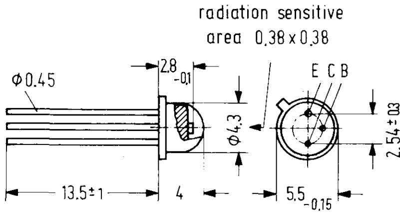
Emitter-base capacitance
$C_{EB} = f\,(V_{EB})$



NPN Silicon Planar Phototransistor **BP 103**

The BP 102 is an epitaxial NPN silicon planar phototransistor, mounted on a base plate similar to 18 A 3 DIN 41876 (TO 18) with glass-clear plastic encapsulation. The plastic cover provides a wide angle for the incident light. This angle can also be reduced by mounting a diaphragm. The emitter terminal is marked by a small projection on the case bottom. The collector is electrically connected to the metallic case parts. The phototransistor ist particularly suitable for use in automatic electronic flashes with base integrating circuit and self-excited (high-frequency) breakdown voltage generators (see circuit diagram) and in high Q electronic instructional toys used at filament lamp light and daylight, as well as in combination with GaAs infrared emitting diodes in small light barriers.

Type	Ordering code
BP 103 I	Q 62 702-P 79-S3
BP 103 II	Q 62 702-P 79-S1
BP 103 III	Q 62 702-P 79-S2
BP 103 IV	Q 62 702-P 79-S4



Approx. weight 0.5 g
Dimensions in mm

Maximum ratings

Collector-emitter voltage	V_{CEO}	100	V
Emitter-base voltage	V_{EBO}	7	V
Collector current	I_C	100	mA
Collector peak voltage ($t \leq 10$ µs)	I_{CM}	200	mA
Junction temperature	T_j	125	°C
Storage temperature	T_{stor}	−55 to +80	°C
Max. permissible soldering temperature ($t \leq 5$ s)	T_s	260	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	300	mW
Thermal resistance			
Collector junction to air	R_{thJamb}	500	K/W
Collector junction to case	$R_{thJcase}$	200	K/W

Characteristics (T_{amb} = 25°C)

Collector-emitter leakage current (V_{CE} = 30 V; E = 0)	I_{CEO}	5 (≦ 100)	nA
Range of spectral sensitivity ($S = 0.1\ S_{max}$)	λ	440 to 1070	nm
Wavelength of the max. sensitivity	$\lambda_{S\ max}$	850	nm
Typ. spectral sensitivity of the collector base photodiode	S	1.2	nA/lx
Radiant sensitive area	A	0.12	mm^2
Rise time to 90% of the final value Fall time to 10% of the initial value (R_L = 1 kΩ)[1]	t_r; t_f	5 (≦ 10)	µs
Capacitance (V_{CE} = 0 V; f = 1 MHz; E = 0)	C_{CE}	9	pF
(V_{CB} = 0 V; f = 1 MHz; E = 0)	C_{CB}	13	pF
(V_{EB} = 0 V; f = 1 MHz; E = 0)	C_{EB}	21	pF

The phototransistors are grouped according to their spectral sensitivity and marked by Roman numerals. Grouping is done at E_v = 1000 lx.

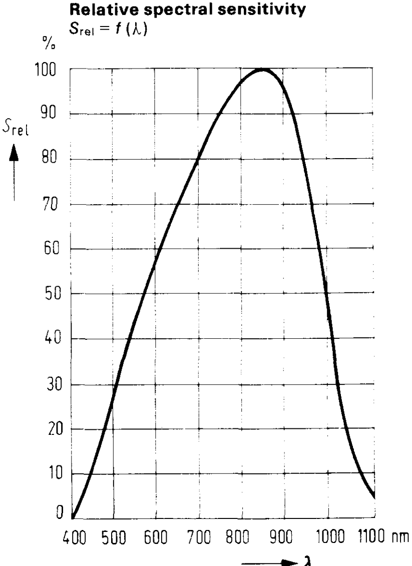
Group	I	II	III	IV	
Photocurrent I_P (V_{CE} = 5 V; E_v = 1000 lx)	160 to 320	250 to 500	400 to 800	630 to 1250	µA
Photocurrent approx. I_P (V_{CE} = 5 V; E_e = 20 mW/cm²)	0.7 to 1.4	1.1 to 2.2	1.8 to 3.6	2.8 to 5.6	mA
Power gain $\frac{I_{P(CE)}}{I_{P(CB)}}$[2] ($E_v$ = 1000 lx; V_{CE} = 5 V)	180	280	450	710	
Collector-emitter saturation voltage (I_C = 0.1 mA; I_B = 1 µA; E = 0) V_{CEsat}	200	170	160	160	mV
(I_C = 2.5 mA; I_B = 25 µA; E = 0) V_{CEsat}	190	160	150	150	mV

The illuminances refer to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K. (standard light A in accordance with DIN 5033 and IEC 306-1). Irradiance E_e measured with HP radiant flux meter 8334A with option 013.

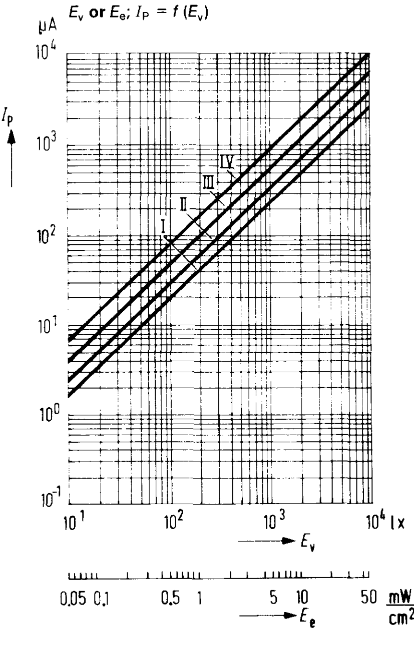
[1]) measured with LED λ = 950 nm

[2]) $I_{p\ (CE)}$ = Photocurrent of the phototransistor
$I_{p\ (CB)}$ = Photocurrent of the collector-base photodiode

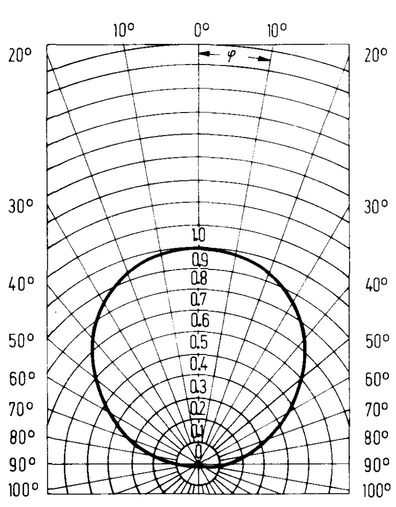
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



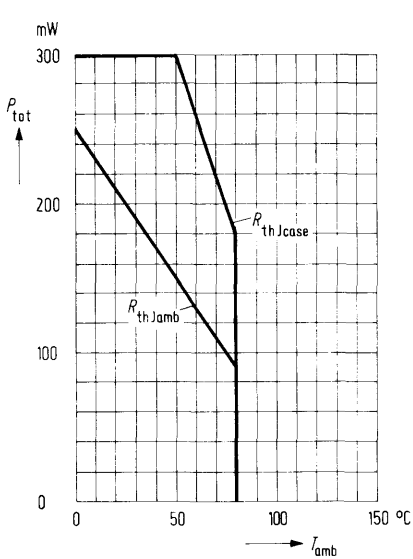
Photocurrent as a function of
E_v **or** E_e; $I_P = f(E_v)$



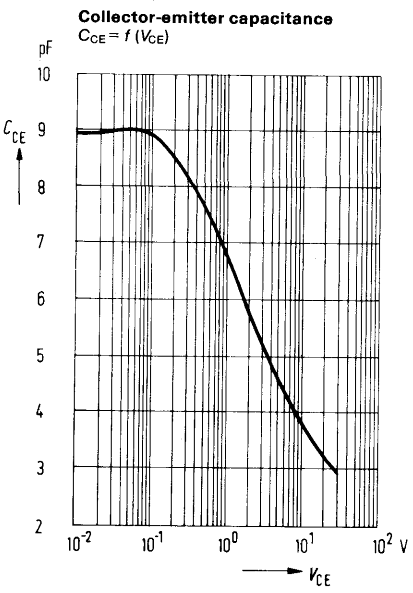
Directional characteristic $I_P = f(\varphi)$



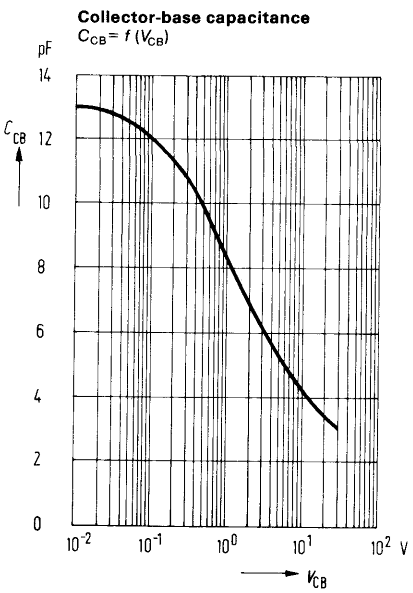
Power dissipation $P_{tot} = f(T_{amb})$



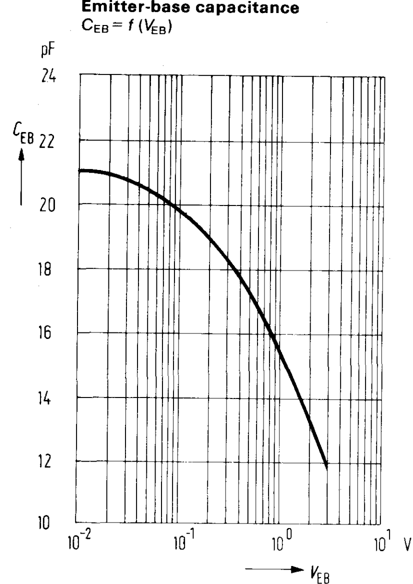
Collector-emitter capacitance
$C_{CE} = f(V_{CE})$



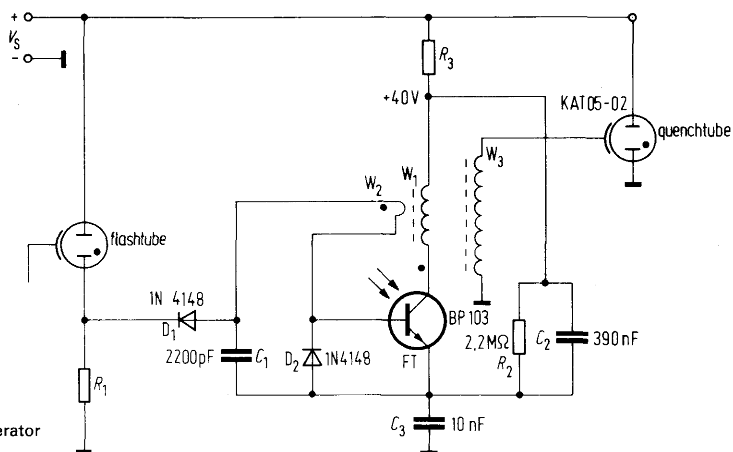
Collector-base capacitance
$C_{CB} = f(V_{CB})$



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



Application example



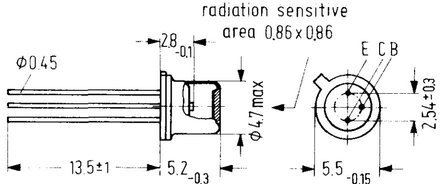
Breakdown voltage generator
for measuring circuit
W_1 : 4 turns 0.15 Ø CuLS
W_2 : 1 turns 0.25 Ø CuL
W_3 : 140 turn 0.15 Ø CuLS

Interior space of the coil
with SIFERRIT cylindrical core,
material M 25,
inner coil diameter: 11 mm

NPN Silicon Planar Phototransistor BPX 38

The BPX 38 is a silicon NPN epitaxial planar phototransistor in an 18 A 3 DIN 41876 (TO 18) case with flat window and high radiant sensitivity for front irradiation. The flat window has no influence on the light paths. It is, therefore, particularly suitable for industrial applications, where lens systems are used. The collector terminal is electrically connected to the case.

Type	Ordering code
BPX 38 I	Q 62 702-P 15-S 1
BPX 38 II	Q 62 702-P 15-S 2
BPX 38 III	Q 62 702-P 15-S 3
BPX 38 IV	Q 62 702-P 15-S 4



Dimensions in mm

Maximum ratings

Collector-emitter voltage	V_{CEO}	50	V
Emitter-base voltage	V_{EBO}	7	V
Collector current	I_C	50	mA
Junction temperature	T_j	175	°C
Storage temperature	T_{stor}	−55 to +125	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	330	mW
Max. permissible soldering temperature ($t \leq 5$ s)	T_s	260	°C
Thermal resistance			
Collector junction to air	R_{thJamb}	≦ 450	K/W
Collector junction to case	$R_{thJcase}$	≦ 150	K/W

Characteristics (T_{amb} = 25°C)

Parameter	Symbol	Value	Unit
Range of spectral sensitivity ($S = 0.1\,S_{max}$)	λ	450 to 1080	nm
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	870	nm
Spectral sensitivity of the collector base photodiode	S	5.5	nA/lx
Radiant sensitive area	A	0.60	mm²
Capacitance (V_{CE} = 0 V; f = 1 MHz; E = 0)	C_{CE}	23	pF
(V_{CB} = 0 V; f = 1 MHz; E = 0)	C_{CB}	41	pF
(V_{EB} = 0 V; f = 1 MHz; E = 0)	C_{EB}	47	pF

The phototransistors are grouped according to their spectral sensitivity and marked by Roman numerals. Grouping is done at E_v = 1000 lx.

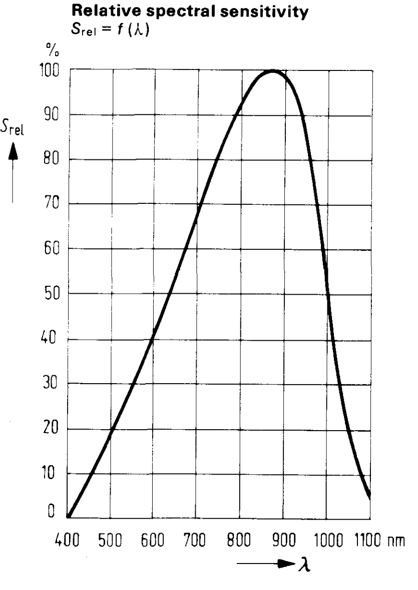
Group	I	II	III	IV	
Photocurrent I_P (V_{CE} = 5 V; E_v = 1000 lx)	0.4 to 0.8	0.63 to 1.25	1.0 to 2.0	1.6 to 3.2	mA
Photocurrent approx. I_P (V_{CE} = 5 V; E_e = 20 mW/cm²)	1.6 to 3.2	2.5 to 5.0	4.5 to 9.0	7.0 to 14.0	mA
Rise time from 10% to 90% of the final value; Fall time from 90% to 10% of the initial value (I_C = 1 mA; V_{CE} = 5 V; R_L = 1 kΩ)[1] t_r; t_f	5	6	8	12	µs
Collector-emitter saturation voltage (I_C = 2 mA; I_B = 50 µA; E = 0) V_{CEsat}	175	175	160	140	mV
Power gain $\frac{I_{P(CE)}}{I_{P(CB)}}$[2] ($E_v$ = 1000 lx; V_{CE} = 5 V)	100	160	250	400	
Collector-emitter leakage current (V_{CEO} = 25 V; E = 0) I_{CEO}	5 (≦ 200)	8 (≦ 200)	12 (≦ 500)	20 (≦ 500)	nA

The illuminances refer to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K. (standard light A in accordance with DIN 5033 and IEC 306-1). Irradiance E_e measured with HP radiant flux meter 8334A with option 013.

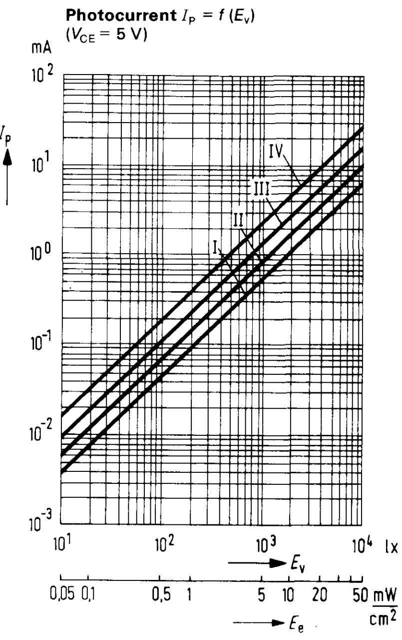
[1] measured with LED λ = 950 nm

[2] $I_{p\,(CE)}$ = Photocurrent of the phototransistor
$I_{p\,(CB)}$ = Photocurrent of the collector-base photodiode

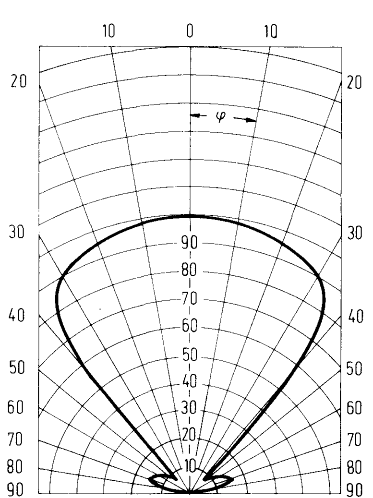
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



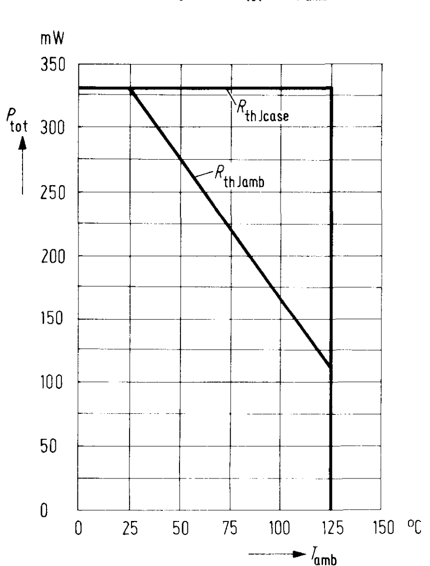
Photocurrent $I_P = f(E_v)$
(V_{CE} = 5 V)



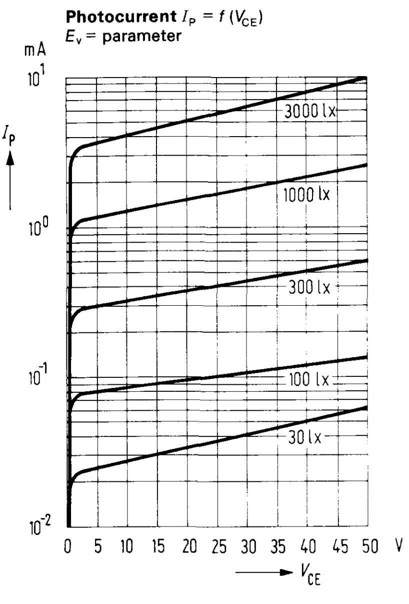
Directional characteristic $I_P = f(\varphi)$



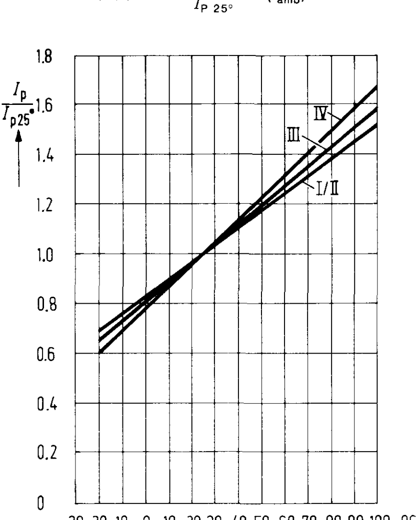
Power dissipation $P_{tot} = f(T_{amb})$



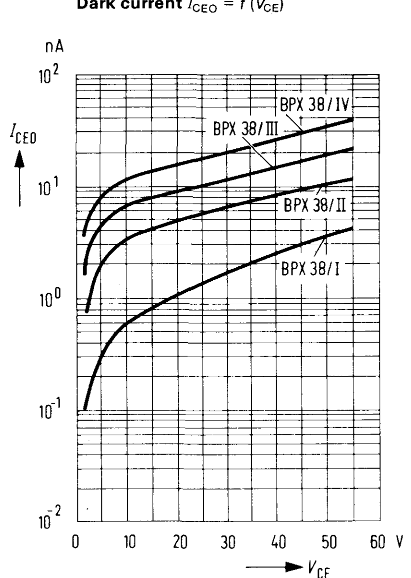
Photocurrent $I_P = f(V_{CE})$
E_v = parameter



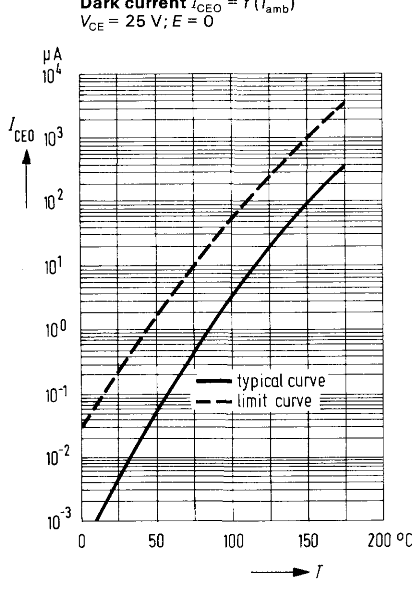
Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$



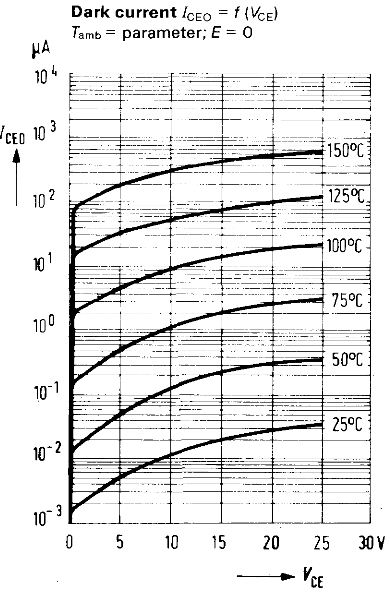
Dark current $I_{CEO} = f(V_{CE})$



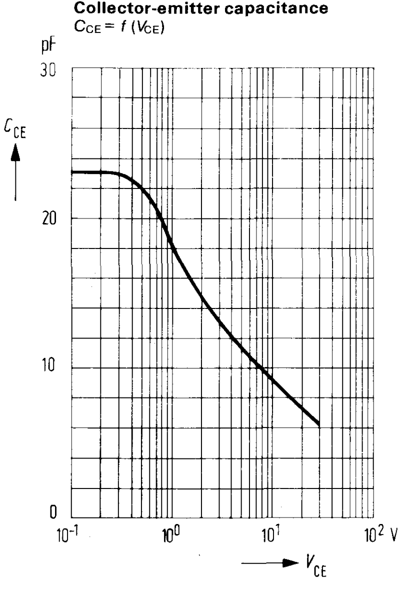
Dark current $I_{CEO} = f(T_{amb})$
V_{CE} = 25 V; E = 0



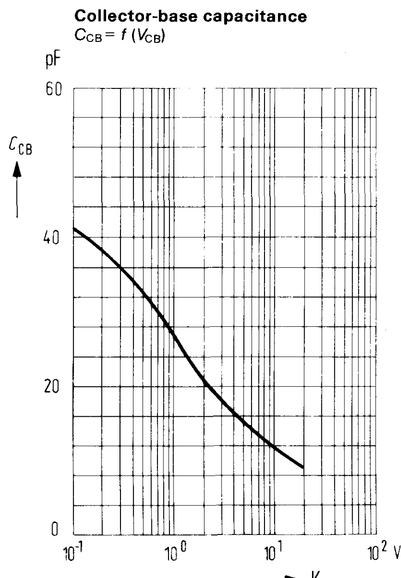
Dark current $I_{CEO} = f(V_{CE})$
T_{amb} = parameter; $E = 0$



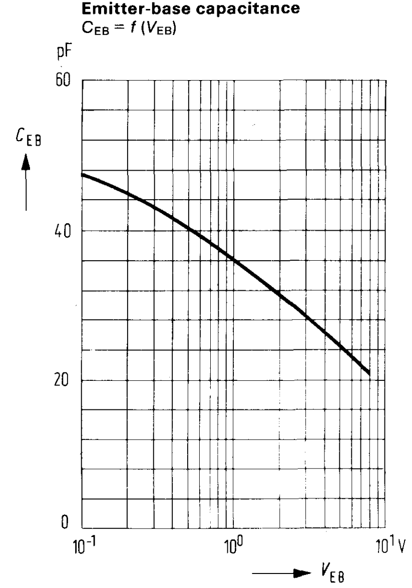
Collector-emitter capacitance
$C_{CE} = f(V_{CE})$



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



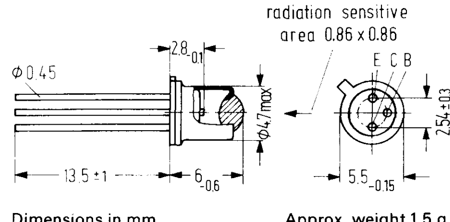
Emitter-base capacitance
$C_{EB} = f(V_{EB})$



NPN Silicon Planar Phototransistor **BPX 43**

The BPX 43 is a silicon NPN epitaxial planar phototransistor in an 18 A 3 DIN 41876 (TO 18) case with lens-shaped window for front irradiation. The special transistor system in connection with the lens shaped window provides the transistor with a particularly high spectral sensitivity. It is therefore suitable for industrial applications at low illuminances. The collector terminal is electrically connected to the case.

Type	Ordering code
BPX 43 I	Q 62 702-P 16-S 1
BPX 43 II	Q 62 702-P 16-S 2
BPX 43 III	Q 62 702-P 16-S 3
BPX 43 IV	Q 62 702-P 16-S 4



Dimensions in mm

Approx. weight 1.5 g

Maximum ratings

Collector-emitter voltage	V_{CEO}	50	V
Emitter-base voltage	V_{EBO}	7	V
Collector current	I_C	100	mA
Junction temperature	T_j	175	°C
Storage temperature	T_{stor}	− 55 to + 125	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	330	mW
Max. permissible soldering temperature ($t \leqq 5$ s)	T_s	260	°C
Thermal resistance			
Collector junction to air	$R_{thJ\,amb}$	≦ 450	K/W
Collector junction to case	$R_{thJ\,case}$	≦ 150	K/W

Characteristics (T_{amb} = 25°C)

Range of spectral sensitivity ($S = 0.1\,S_{max}$)	λ	450 to 1080	nm
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	870	nm
Spectral sensitivity of the collector base photodiode	S	26	nA/lx
Radiant sensitive area	A	0.65	mm^2
Capacitance			
(V_{CE} = 0 V; f = 1 MHz; E = 0)	C_{CE}	23	pF
(V_{CB} = 0 V; f = 1 MHz; E = 0)	C_{CB}	41	pF
(V_{EB} = 0 V; f = 1 MHz; E = 0)	C_{EB}	47	pF

The phototransistors are grouped according to their spectral sensitivity and marked by Roman numerals. Grouping is done at E_v = 1000 lx.

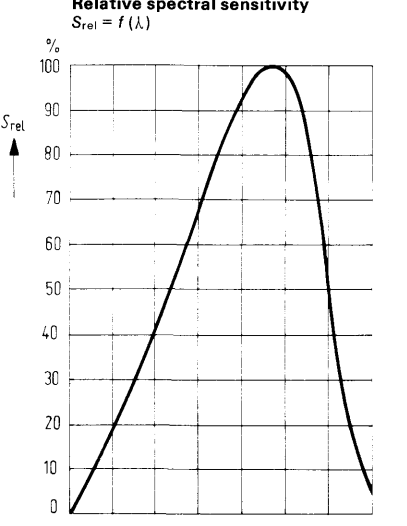
Group		I	II	III	IV	
Photocurrent (V_{CE} = 5 V; E_v = 1000 lx)	I_P	1.6 to 3.2	2.5 to 5.0	4.0 to 8.0	6.3 to 12.5	mA
Photocurrent approx. (V_{CE} = 5 V; E_e = 20 mW/cm^2)	I_P	9 to 18	14 to 28	22 to 45	35 to 70	mA
Rise time from 10% to 90% of the final value; Fall time from 90% to 10% of the initial value (I_C = 1 mA; V_{CE} = 5 V; R_L = 1 kΩ[1])	t_r; t_f	5	6	8	12	µs
Collector-emitter saturation voltage (I_C = 2 mA; I_B = 50 µA; E = 0)	V_{CEsat}	175	175	160	140	mV
Power gain $\frac{I_{P(CE)}}{I_{P(CB)}}$[2] ($E_v$ = 1000 lx; V_{CE} = 5 V)		85	135	215	345	
Collector-emitter leakage current (V_{CEO} = 25 V; E = 0)	I_{CEO}	5 (≦ 200)	8 (≦ 200)	12 (≦ 500)	20 (≦ 500)	nA

The illuminances refer to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K. (standard light A in accordance with DIN 5033 and IEC 306-1). Irradiance E_e measured with HP radiant flux meter 8334A with option 013.

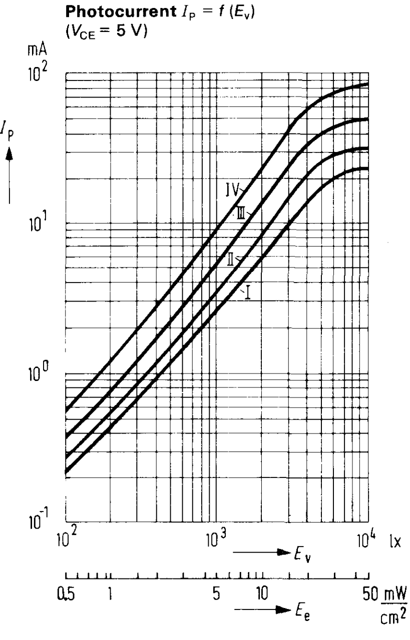
[1]) measured with LED λ = 950 nm

[2]) $I_{p\,(CE)}$ = Photocurrent of the phototransistor
$I_{p\,(CB)}$ = Photocurrent of the collector-base photodiode

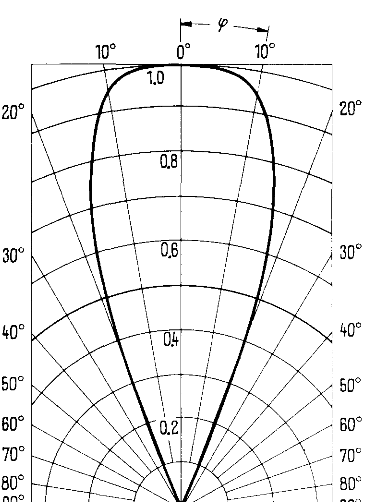
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



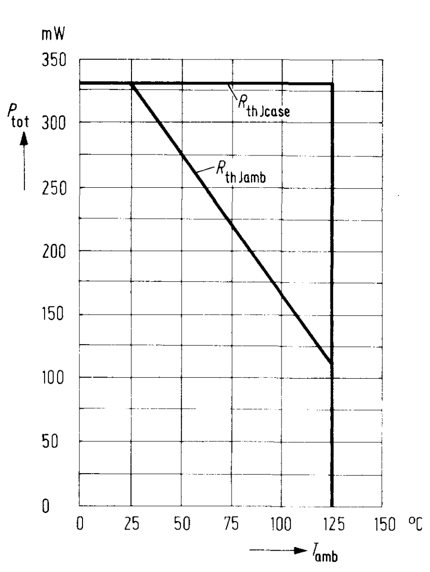
Photocurrent $I_P = f(E_v)$
(V_{CE} = 5 V)

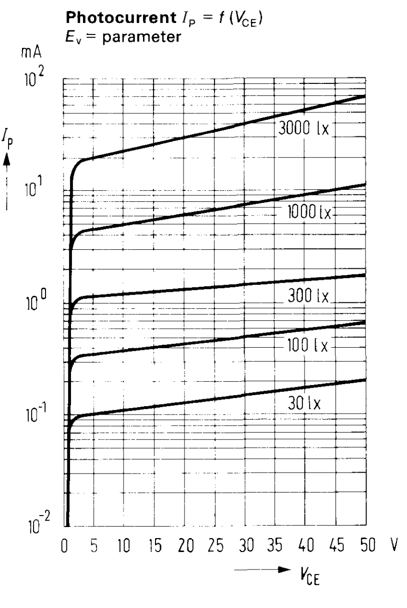


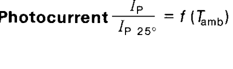
Directional characteristic $I_P = f(\varphi)$

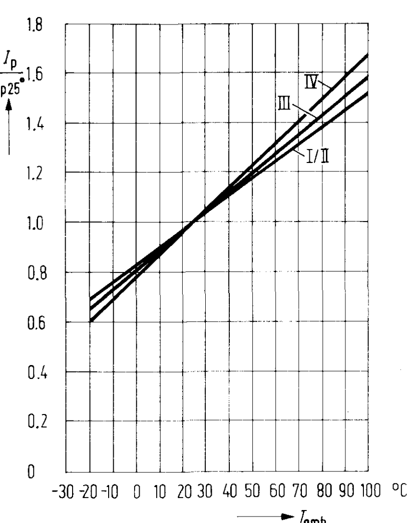


Power dissipation $P_{tot} = f(T_{amb})$

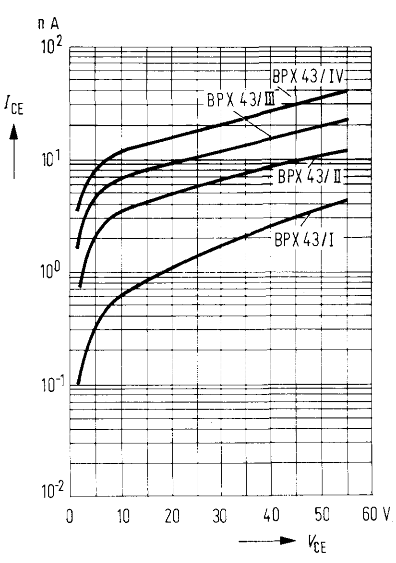


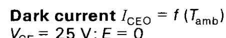

Photocurrent $I_P = f(V_{CE})$
E_v = parameter
mA
10^2
I_P
10^1
10^0
10^{-1}
10^{-2}
3000 lx
1000 lx
300 lx
100 lx
30 lx
0 5 10 15 20 25 30 35 40 45 50 V
V_{CE}

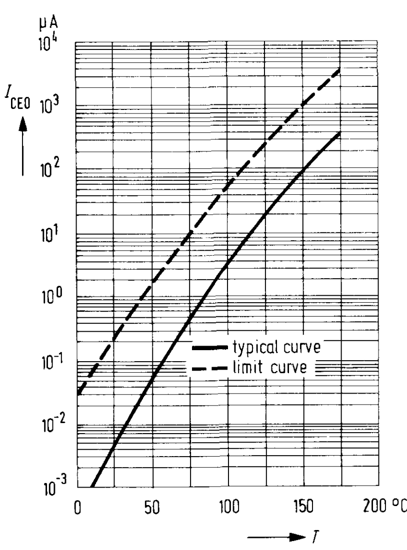

Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$


$\frac{I_P}{I_{P25°}}$
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
IV
III
I/II
-30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 °C
T_{amb}

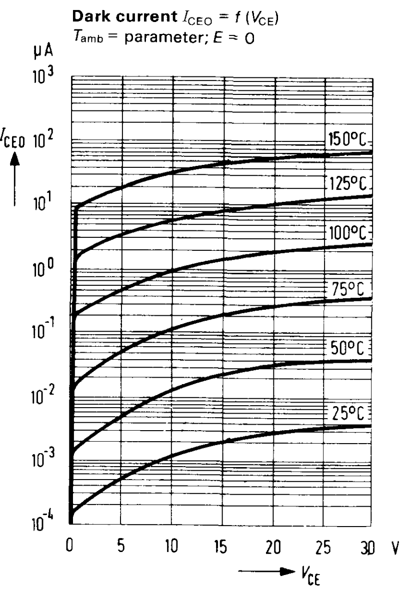
Dark current $I_{CEO} = f(V_{CE})$


nA
10^2
I_{CE}
10^1
10^0
10^{-1}
10^{-2}
BPX 43/IV
BPX 43/III
BPX 43/II
BPX 43/I
0 10 20 30 40 50 60 V
V_{CE}

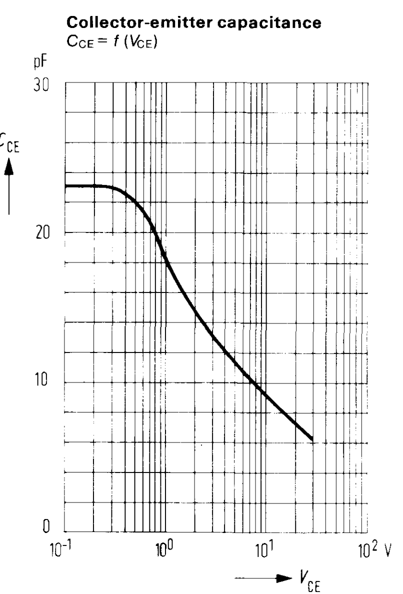

Dark current $I_{CEO} = f(T_{amb})$
V_{CE} = 25 V; E = 0


µA
10^4
I_{CEO}
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
typical curve
limit curve
0 50 100 150 200 °C
T

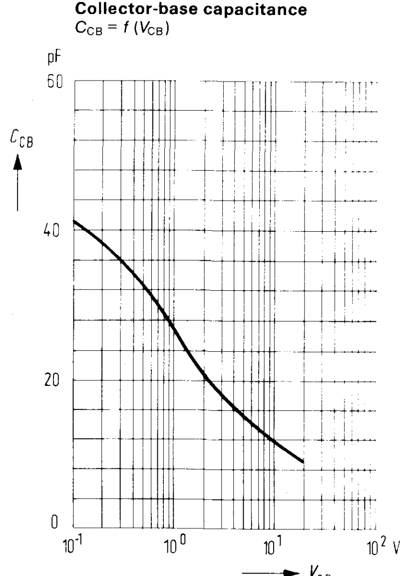
Dark current $I_{CEO} = f(V_{CE})$
T_{amb} = parameter; $E = 0$



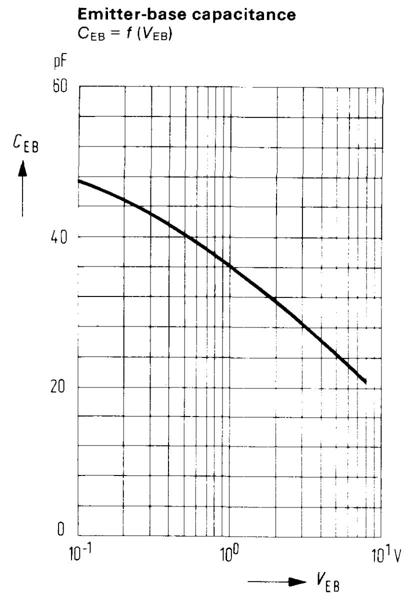
Collector-emitter capacitance
$C_{CE} = f(V_{CE})$



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



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

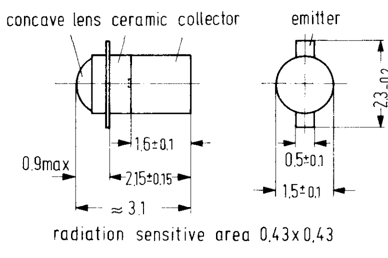


NPN Silicon Planar Phototransistor

BPX 62

The BPX 62 is a highly sensitive, silicon NPN epitaxial planar phototransistor, encased in a micro ceramic package. Because of its small case dimensions and the special lead arrangement this phototransistor is provided for PC board mounting in particularly space-saving uni- and two-dimensional optical scanning systems. It is suitable for versatile applications at filament lamp light and light emitting diodes, also where miniaturization, low built-in depth and high packing density are of main interest, e.g. for tape and card readers, for path and angle scanners as well as reading systems for digital applications.

Type	Ordering code
BPX 62 I	Q 62 702-P 19-S 1
BPX 62 II	Q 62 702-P 19-S 2
BPX 62 III	Q 62 702-P 19-S 3
BPX 62 IV	Q 62 702-P 19-S 4



Approx. weight 1 g Dimensions in mm

Maximum ratings (T_{amb} = 25°C)

Collector emitter voltage	V_{CEO}	50	V
Emitter-base voltage	V_{EBO}	7	V
Collector current	I_C	50	mA
Junction temperature	T_j	125	°C
Storage temperature	T_{stor}	– 55 to + 125	°C
Soldering temperature ($t \leq 3$ s)	T_s	230	°C
Power dissipation	P_{tot}	100	mW
Thermal resistance			
Collector junction to air	R_{thJamb}	1000	K/W
Collector junction to case	$R_{thJcase}$	300	K/W

Characteristics (T_{amb} = 25°C)

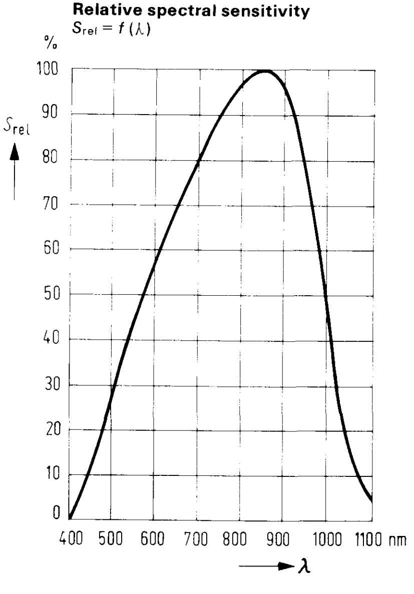
Parameter	Symbol	Value	Unit
Collector-emitter leakage current (V_{CE} = 25 V; E = 0)	I_{CEO}	5 (≦ 100)	nA
Collector-emitter saturation voltage (I_C = 0.25 mA; E_v = 1000 lx)	V_{CEsat}	0.2	V
Range of spectral sensitivity ($S \geqq 0.1\, S_{max}$)	λ	440 to 1070	nm
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	850	nm
Rise time from 10% to 90% of the final value Fall time from 90% to 10% of the initial value (R_L = 1 kΩ)[1]	t_r; t_f	5 (≦ 10)	µs
Radiant sensitive area	A	0.17	mm^2
Capacitance (V_{CE} = 0 V; f = 1 MHz; E = 0)	C_{CE}	6	pF

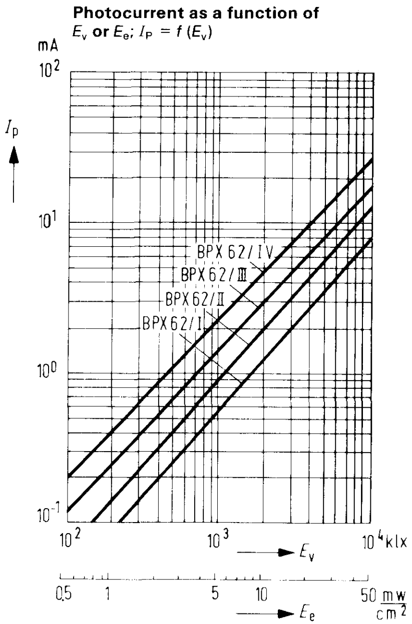
The phototransistors are grouped according to their spectral sensitivity and marked by Roman numerals. Grouping is done at E_v = 1000 lx.

Group	I	II	III	IV	
Photocurrent (V_{CE} = 5 V; E_v = 1000 lx) I_P	0.4 to 0.8	0.63 to 1.25	1.0 to 2.0	1.6 to 3.2	mA
Photocurrent (V_{CE} = 5 V; E_e=20 mW/cm^2) approx. I_P	2 to 4	3 to 6	4.5 to 9.0	7.5 to 15.0	mA

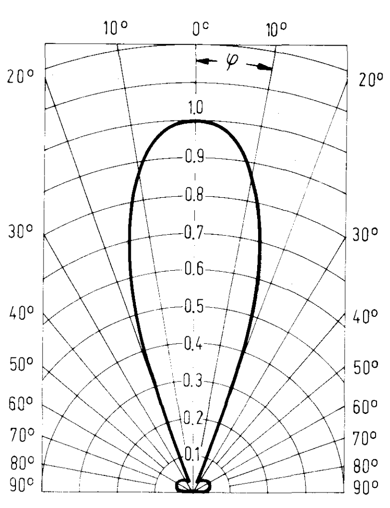
The illuminances refer to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K. (standard light A in accordance with DIN 5033 and IEC 306-1). Irradiance E_e measured with HP radiant flux meter 8334A with option 013.

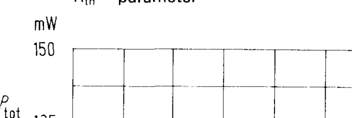
[1]) measured with LED λ = 950 nm

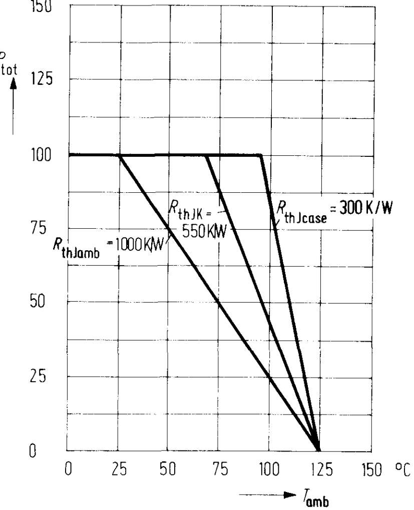

Relative spectral sensitivity
$S_{rel} = f(\lambda)$
%
S_{rel}
100
90
80
70
60
50
40
30
20
10
0
400 500 600 700 800 900 1000 1100 nm
λ

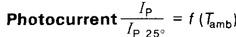

Photocurrent as a function of
E_v or E_e; $I_P = f(E_v)$
mA
I_p
10^2
10^1
10^0
10^{-1}
BPX 62/IV
BPX 62/III
BPX 62/II
BPX 62/I
10^2
10^3
10^4 klx
E_v
0,5 1 5 10 50 mW/cm²
E_e

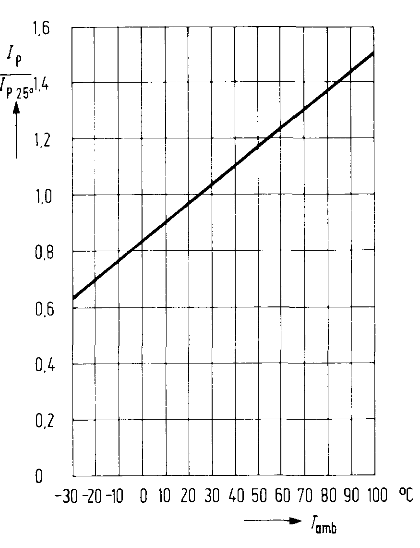
Directional characteristic $I_p = f(\varphi)$


10° 0° 10°
φ
20° 20°
30° 30°
40° 40°
50° 50°
60° 60°
70° 70°
80° 80°
90° 90°
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1

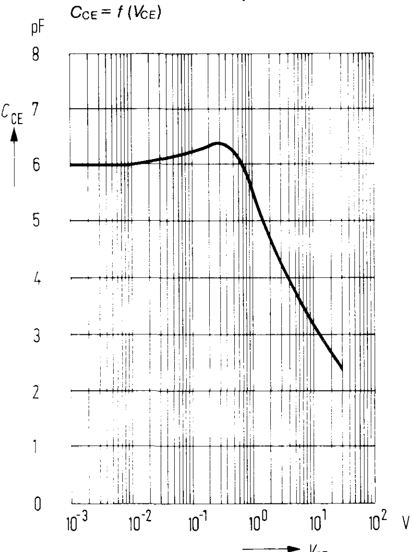

Power dissipation $P_{tot} = f(T_{amb})$
R_{th} = parameter

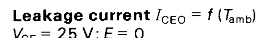

mW
P_{tot}
150
125
100
75
50
25
0
R_{thJamb} = 1000 K/W
R_{thJK} = 550 K/W
$R_{thJcase}$ = 300 K/W
0 25 50 75 100 125 150 °C
T_{amb}

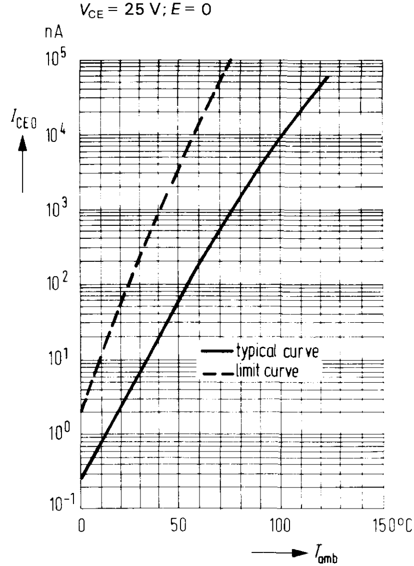




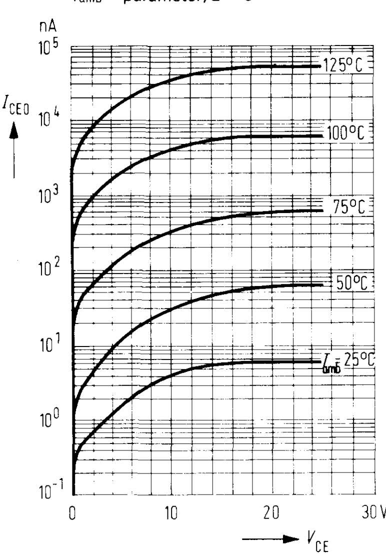
Collector-emitter capacitance
$C_{CE} = f\,(V_{CE})$




$V_{CE} = 25$ V; $E = 0$



Leakage current $I_{CEO} = f\,(V_{CE})$
T_{amb} = parameter; $E = 0$

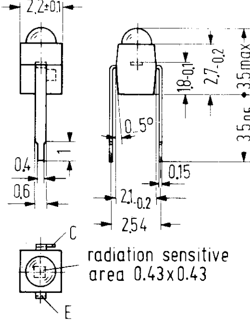


NPN Silicon Phototransistor in Plastic Encapsulation Lead Spacing 2.54 mm

BPX 81

The BPX 81 is a silicon NPN planar transistor in plastic encapsulation with solder pin terminals. The collector terminal is marked by a small projection on the pin. The phototransistor is suitable for versatile applications in conjunction with filament lamps and infrared light. The BPX 81 can be mounted on PC boards and is also provided for use as detector of the light emitting diode LD 261 (same type as BPX 81) in miniature light barriers.

Type	Ordering code
BPX 81/I	Q 62 702-P 43-S 1
BPX 81/II	Q 62 702-P 43-S 2
BPX 81/III	Q 62 702-P 43-S 3
BPX 81/IV	Q 62 702-P 43-S 4



Approx. weight 0.02 g
Dimensions in mm

Maximum ratings

Collector-emitter voltage	V_{CE}	32	V
Junction temperature	T_j	90	°C
Collector current	I_C	50	mA
Storage temperature	T_{stor}	– 40 to + 80	°C
Power dissipation	P_{tot}	100	mW
Soldering temperature in a 2 mm distance from the case bottom ($t \leq 3$ s)	T_s	230	°C
Thermal resistance			
Collector junction to air	R_{thJamb}	750	K/W
Collector junction to solder pin	R_{thJL}	650	K/W

Characteristics (T_{amb} = 25°C)

Collector-emitter leakage current (V_{CE} = 25 V; E = 0)	I_{CEO}	25 (≦ 200)	nA
Collector emitter saturation voltage (I_C = 0.25 mA; E_v = 1000 lx)	V_{CEsat}	0.2	V
Range of spectral sensitivity ($S \geqq 0.1\, S_{max}$)	λ	440 to 1070	nm
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	850	nm
Rise time from 10% up to 90% of the final value Fall time from 90% up to 10% of the initial value (R_L = 1 kΩ)[1]	t_r; t_f	5 (≦ 10)	µs
Radiant sensitive area	A	0.17	mm^2
Capacitance (V_{CE} = 0 V; f = 1 MHz; E = 0)	C_{CE}	6	pF

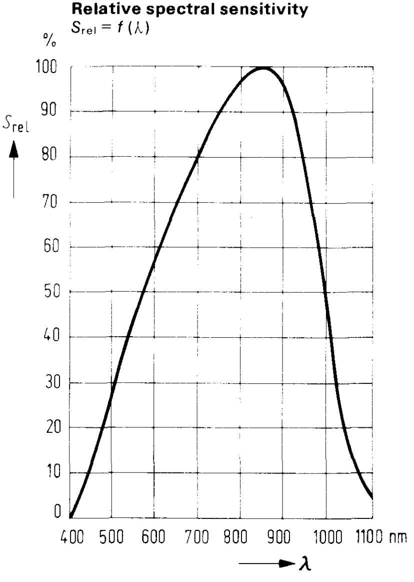
The phototransistors are grouped according to their spectral sensitivity and marked by Roman numerals. Grouping is done at E_v = 1000 lx.

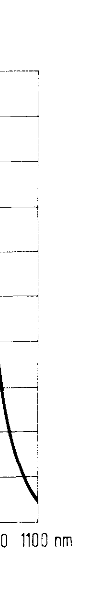
Group	I	II	III	IV	
Photocurrent I_P (V_{CE} = 5 V; E_v = 1000 lx)	0.63 to 1.25	1.0 to 2.0	1.6 to 3.2	2.5 to 5.0	mA
Photocurrent approx. I_P (V_{CE} = 5 V; E_e = 20 mW/cm^2)	2.5 to 5.0	4.0 to 8.0	7.0 to 14.0	11.0 to 22,0	mA
Colour code	brown	red	orange	yellow	

The illuminances refer to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K. (standard light A in accordance with DIN 5033 and IEC 306-1). Irradiance E_e measured with HP radiant flux meter 8334A with option 013.

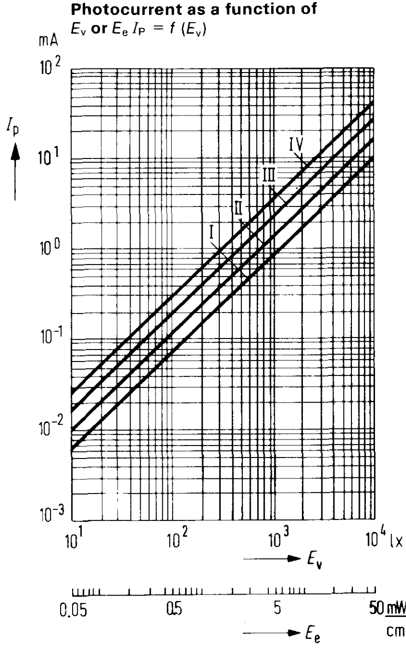
[1]) measured with LED λ = 950 nm

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

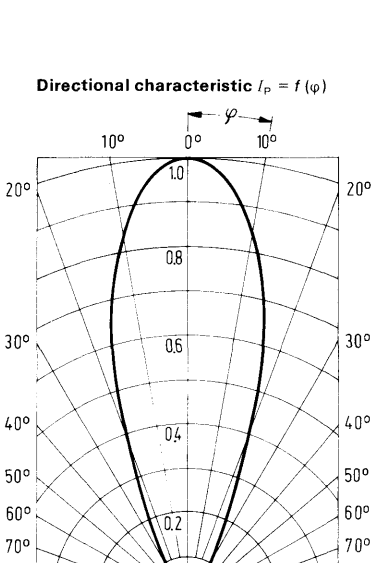




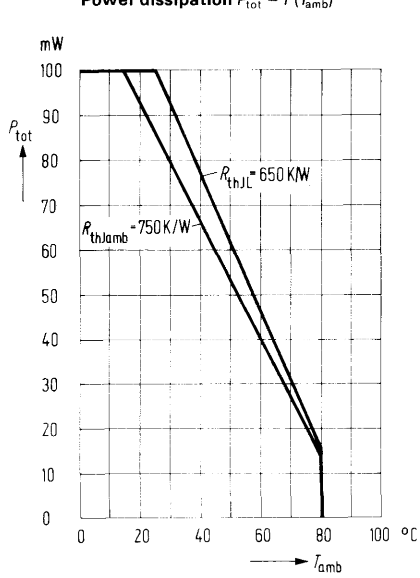
Photocurrent as a function of
E_v or E_e $I_P = f(E_v)$

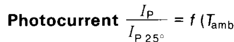


Directional characteristic $I_P = f(\varphi)$

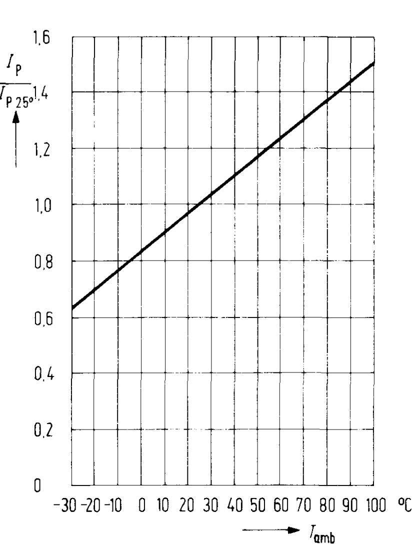


Power dissipation $P_{tot} = f(T_{amb})$

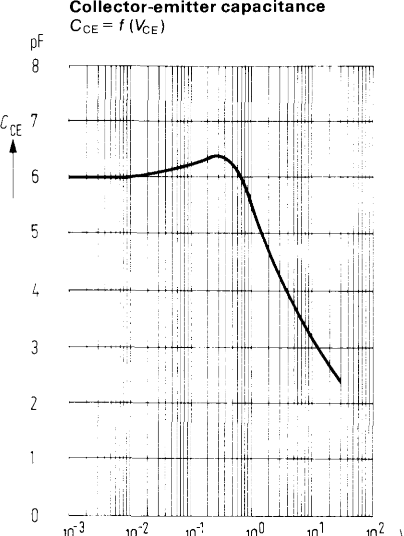


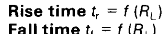


Photocurrent $\frac{I_P}{I_{P\,25°}} = f\,(T_{amb})$

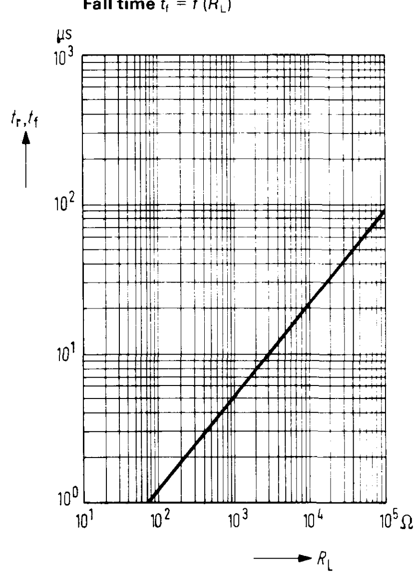


Collector-emitter capacitance
$C_{CE} = f\,(V_{CE})$





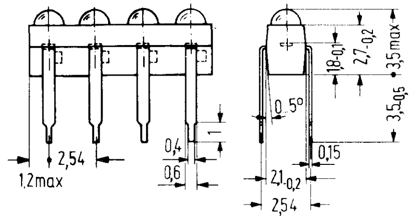
Rise time $t_r = f\,(R_L)$
Fall time $t_f = f\,(R_L)$



The types BPX 80 to BPX 89 are plastic encapsulated phototransistor arrays consisting of an arrangement of max. 10 silicon NPN epitaxial planar phototransistors. The individual photoelectric detectors are spaced apart according to the standard lead spacing of 2.54 mm (1/10"). A small angle of the lens-shaped light window avoids optical "cross modulation" from the adjacent system. The collector terminals are marked by small projections arranged at the sides of the solder pins.

The second digit of the type designation is identical with the number of photoelectric detectors of one array; (BPX 84 e.g. comprises an array with 4 phototransistors; BPX 80 one with 10 phototransistors). At present, arrays with two, three, six and nine phototransistors are primarily produced corresponding to the type designations BPX 82, BPX 83, BPX 86 and BPX 89. The remaining phototransistor arrays are not kept in stock, they are, however, available upon request.

Type	Ordering code
BPX 82	Q 62 702-P 21
BPX 83	Q 62 702-P 25
BPX 84	Q 62 702-P 30
BPX 85	Q 62 702-P 31
BPX 86	Q 62 702-P 22
BPX 87	Q 62 702-P 32
BPX 88	Q 62 702-P 33
BPX 89	Q 62 702-P 26
BPX 80	Q 62 702-P 28



Sample with 4 phototransistors (e.g. BPX 84)
Dimensions in mm

Maximum ratings

Collector-emitter voltage	V_{CE}	32	V
Junction temperature	T_j	90	°C
Collector current	I_C	50	mA
Storage temperature	T_{stor}	−40 to +80	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	100	mW
Soldering temperature in a 2 mm distance from the case bottom ($t \leq 3$ s)	T_s	230	°C
Thermal resistance			
Collector junction to air	R_{thJamb}	750	K/W
Collector junction to solder pin	R_{thJL}	650	K/W

Characteristics (T_{amb} = 25°C)

Collector emitter leakage current (V_{CE} = 25 V; E = 0)	I_{CEO}	25 (≦ 200)	nA
Range of spectral sensitivity (S = 0.1 S_{max})	λ	440 to 1070	nm
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	850	nm
Photocurrent (V_{CE} = 5 V; E = 1000 lx) [1; 4]	I_P	0.63 to 5.0	mA
Photocurrent (V_{CE} = 5 V; E_e = 20 mW/cm [2]) [2]	approx. I_P	2.5 to 22.0	mA
Rise time from 10% up to 90% of the final value Fall time from 90% up to 10% of the initial value (R_L = 1 kΩ) [3]	t_r; t_f	5 (≦ 10)	µs
Radiant sensitive area	A	0.17	mm^2
Capacitance (V_{CE} = 0 V; f = 1 MHz; E = 0)	C_{CE}	6	pF

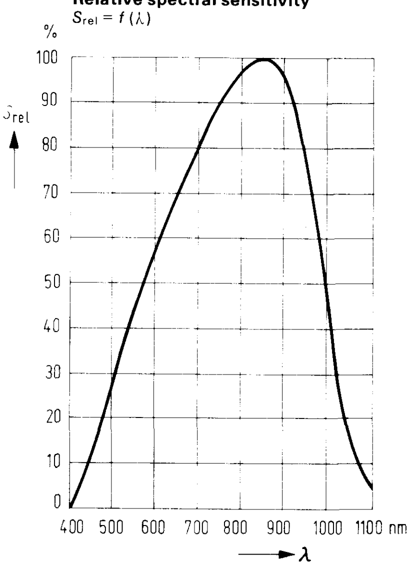
1) The illuminances refer to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K. (Standard light A in accordance with DIN 5033 and IEC 306-1.)

2) Measured with HP radiant flux meter 8334 A with option 013, see curve $I_p = f(E)$.

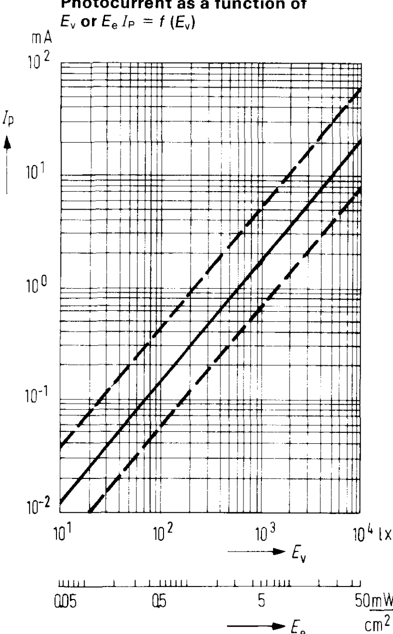
3) Measured with LED (λ = 950 nm) as emitter.

4) The deviation of I_p within one array is ≦ 1 : 2. Arrays with closer deviations or closer I_p range similar to BPX 81, gr. II/III upon request.

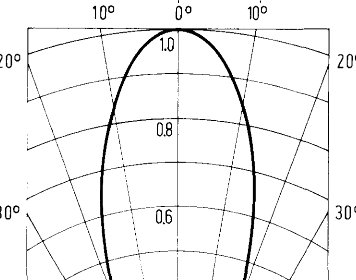
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



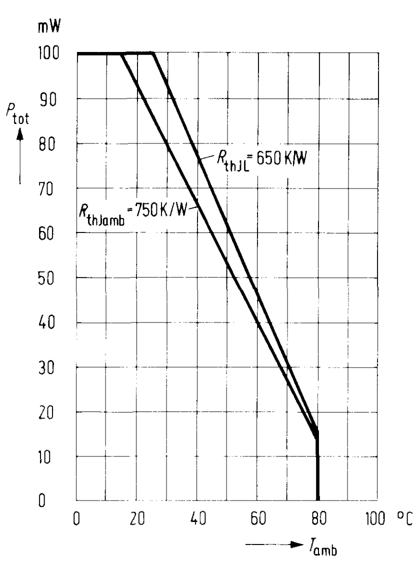
Photocurrent as a function of
E_v **or** E_e $I_P = f(E_v)$

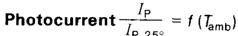


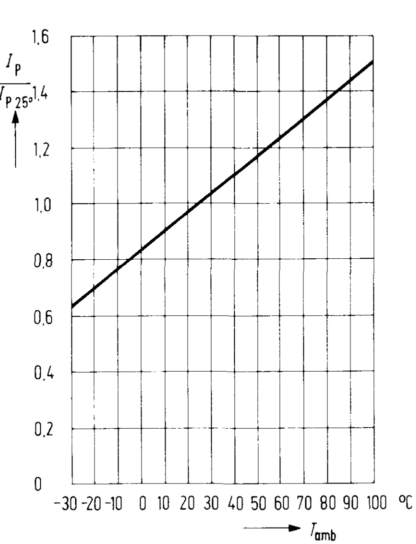
Directional characteristic $I_P = f(\varphi)$

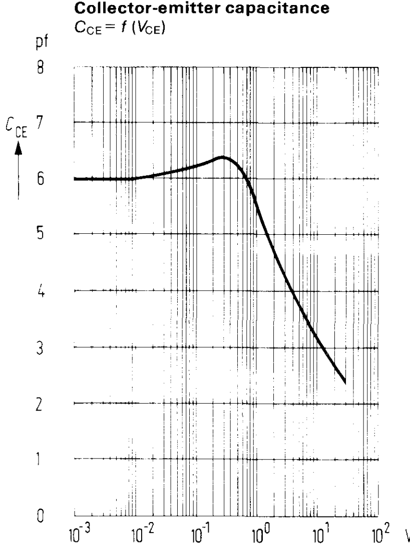


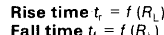
Power dissipation $P_{tot} = f(T_{amb})$

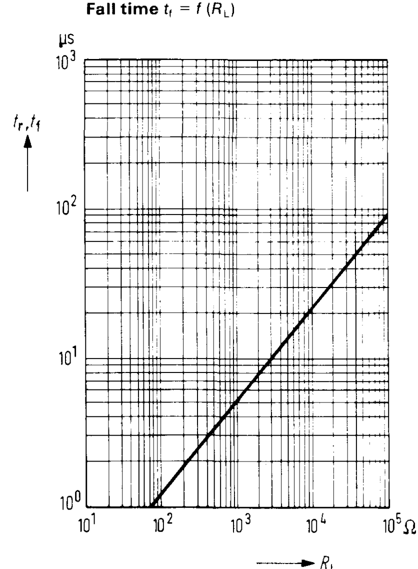



Photocurrent $\frac{I_P}{I_{P\,25°}} = f\,(T_{amb})$


$\frac{I_P}{I_{P\,25°}}$
1,6
1,4
1,2
1,0
0,8
0,6
0,4
0,2
0
-30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 °C
T_{amb}

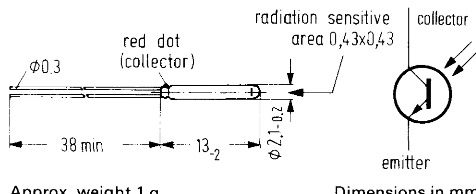

Collector-emitter capacitance
$C_{CE} = f\,(V_{CE})$
pf
C_{CE}
8
7
6
5
4
3
2
1
0
10^{-3} 10^{-2} 10^{-1} 10^{0} 10^{1} 10^{2} V
V_{CE}


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


µs
t_r, t_f
10^3
10^2
10^1
10^0
10^1 10^2 10^3 10^4 10^5 Ω
R_L

The BPY 61 is a silicon NPN epitaxial planar phototransistor in a miniature glass case without base connection. The transistor is controlled by the incident light. The collector is marked by a red dot on the case. Because of high current gain of the transistor system this transistor is suitable for applications where particularly sensitive photoelectric detectors for filament lamp light are required. When scanning facilities are to be assembled high packing density can be obtained as a result of the small dimensions.

Type	Ordering code
BPY 61 I	Q 60215-Y 61-S 1
BPY 61 II	Q 60215-Y 61-S 2
BPY 61 III	Q 60215-Y 61-S 3
BPY 61 III	Q 60215-Y 61-S 4



Approx. weight 1 g

Dimensions in mm

Maximum ratings

Collector emitter voltage	V_{CEO}	50	V
Emitter-base voltage	V_{EBO}	7	V
Collector current	I_C	60	mA
Junction temperature	T_j	125	°C
Storage temperature	T_s	– 55 to + 125	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	70	mW
Thermal resistance			
Collector junction to air	R_{thJamb}	1400	K/W

Characteristics (T_{amb} = 25°C)

Parameter	Symbol	Value	Unit
Collector-emitter leakage current (V_{CE} = 25 V; E = 0)	I_{CEO}	5 (≦ 100)	nA
Collector-emitter saturation voltage (I_C = 0.25 mA; E_v = 1000 lx)	V_{CEsat}	0.2	V
Range of spectral sensitivity ($S > 0.1\,S_{max}$)	λ	440 to 1070	nm
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	850	nm
Rise time from 10% up to 90% of I_P Fall time from 90% up to 10% of I_P (R_L = 1 kΩ)[1]	t_r; t_f	5 (≦ 10)	µs
Radiant sensitive area	A	0.17	mm²
Capacitance (V_{CE} = 0 V; f = 1 MHz; E = 0)	C_{CE}	6	pF

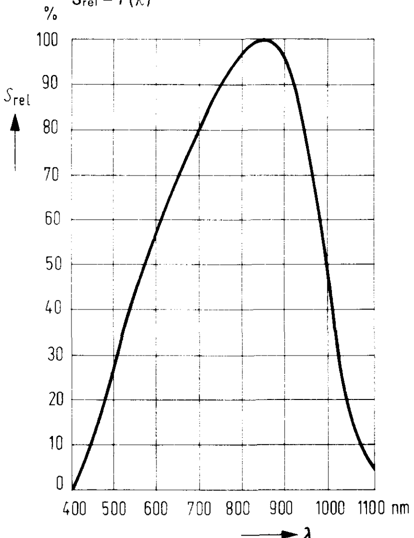
The phototransistors are grouped according to their spectral sensitivity and marked by Roman numerals. Grouping is done at E_v = 1000 lx.

Group	I	II	III	IV	
Photocurrent (V_{CE} = 5 V; E_v = 1000 lx)[1] I_P	0.8 to 1.6	1.25 to 2.5	2 to 4	3.2 to 6.3	mA
(V_{CE} = 5 V; E_e= 20 mW/cm²) approx. I_P	3.2 to 6.3	5.0 to 10.0	9.0 to 18.0	14.0 to 28.0	mA

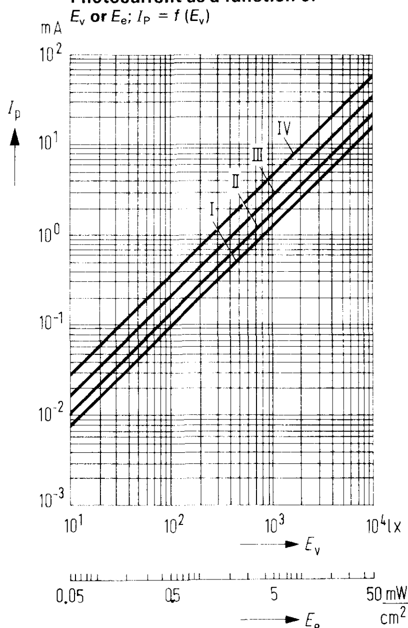
The illuminances refer to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K. (standard light A in accordance with DIN 5033 and IEC 306-1). Irradiance E_e measured with HP radiant flux meter 8334A with option 013.

[1]) measured with LED λ = 950 nm

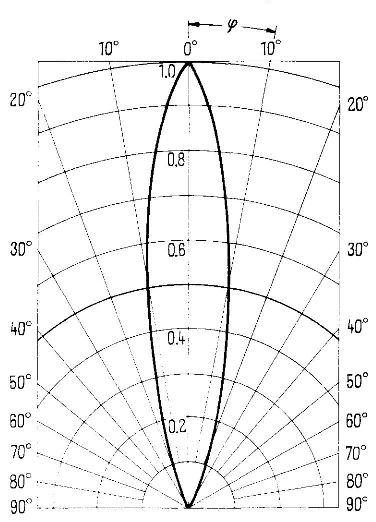
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



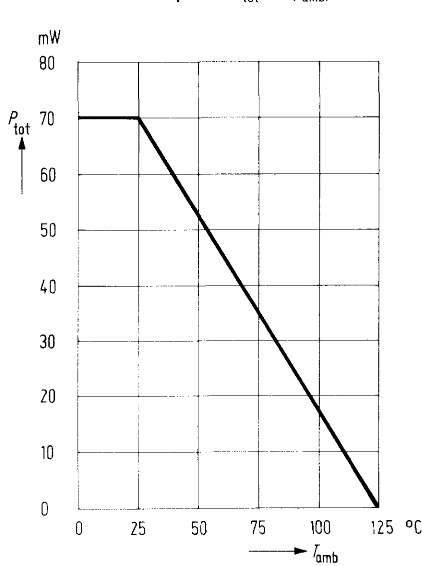
Photocurrent as a function of
E_v **or** E_e; $I_P = f(E_v)$



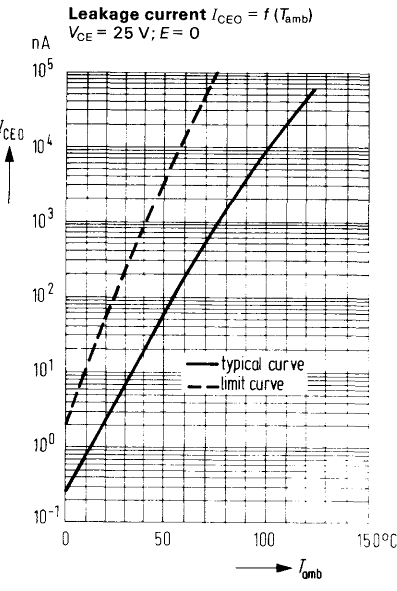
Directional characteristic $I_P = f(\varphi)$



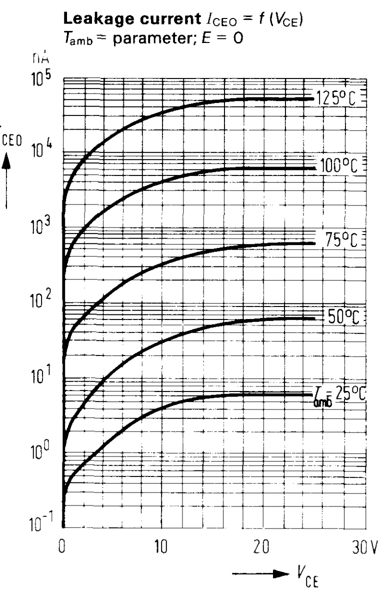
Power dissipation $P_{tot} = f(T_{amb})$



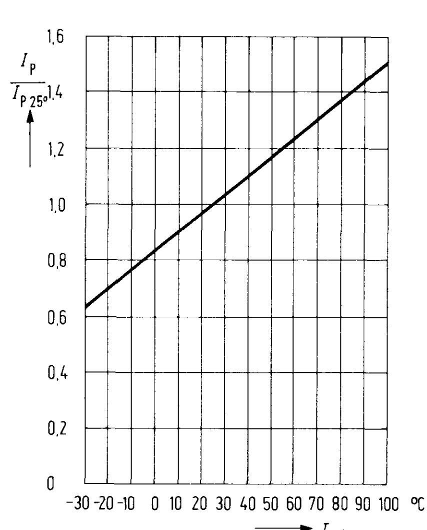
Leakage current $I_{CEO} = f(T_{amb})$
$V_{CE} = 25$ V; $E = 0$



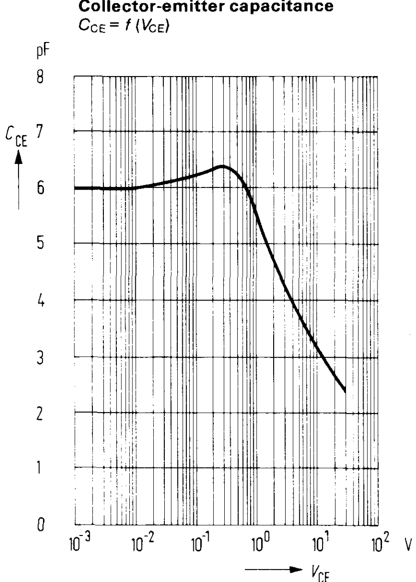
Leakage current $I_{CEO} = f(V_{CE})$
T_{amb} = parameter; $E = 0$



Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$



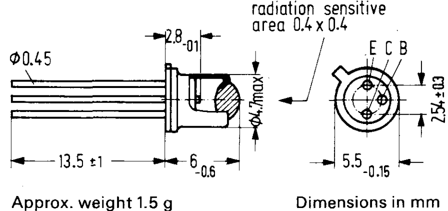
Collector-emitter capacitance
$C_{CE} = f(V_{CE})$



NPN Silicon Planar Phototransistor

The BPY 62 is a silicon NPN epitaxial planar phototransistor in an 18 A 3 DIN 41876 (TO 18) case with a light window for front irradiation. The base connection is brought out and the emitter is marked by a small projection on the case bottom. The collector is electrically connected to the case.
The phototransistor BPY 62 is suitable for versatile applications in connection with filament lamp light mainly where particularly sensitive photoelectric detectors are required.

Type	Ordering code
BPY 62 I	Q 60 215-Y 62-A
BPY 62 II	Q 60 215-Y 62-B
BPY 62 III	Q 60 215-Y 62-C



Approx. weight 1.5 g

Dimensions in mm

Maximum ratings

Collector-emitter voltage	V_{CEO}	32	V
Emitter-base voltage	V_{EBO}	5	V
Collector current	I_C	100	mA
Junction temperature	T_j	125	°C
Storage temperature	T_{stor}	−55 to +125	°C
Power dissipation (T_{amb} = 75°C)	P_{tot}	300	mW
Thermal resistance			
Collector junction to air	R_{thJamb}	500	K/W
Collector junction to case	$R_{thJcase}$	200	K/W

Characteristics (T_{amb} = 25°C)

Parameter	Symbol	Value	Unit
Collector-emitter leakage current (V_{CE} = 25 V; E = 0)	I_{CEO}	5 (≦ 100)	nA
Collector-emitter saturation voltage (I_C = 1 mA; E_v = 1000 lx)	V_{CEsat}	0.3	V
Range of spectral sensitivity ($S > 0.1\, S_{max}$)	λ	430 to 1060	nm
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	800	nm
Rise time from 10% up to 90% of I_P Fall time from 90% up to 10% of I_P (R_L = 1 kΩ)[1]	t_r; t_f	5	µs
Spectral sensitivity of the collector base photodiode	S	5	nA/lx
Radiant sensitive area	A	0.14	mm^2
Capacitance (V_{CE} = 0 V; f = 1 MHz; E = 0)	C_{CE}	6	pF
(V_{CB} = 0 V; f = 1 MHz; E = 0)	C_{CB}	10	pF
(V_{EB} = 0 V; f = 1 MHz; E = 0)	C_{EB}	12	pF

The phototransistors are grouped according to their spectral sensitivity and marked by Roman numerals. Grouping is done at E_v = 1000 lx.

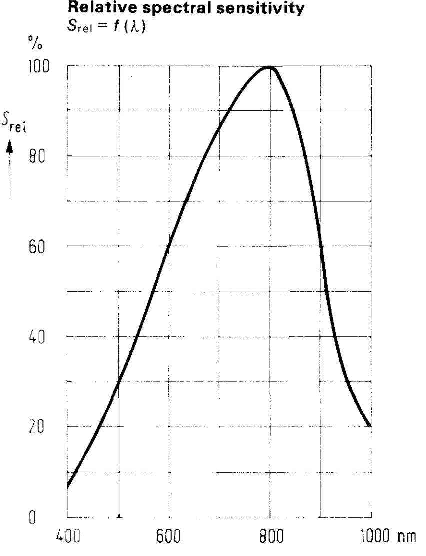
Group		I	II	III	
Photocurrent (V_{CE} = 5 V; E_v = 1000 lx;)[1]	I_P	1.25 to 2.5	2.0 to 4.0	3.2 to 6.3	mA
(V_{CE} = 5 V; E_e = 20 mW/cm^2	approx. I_P	5.0 to 10.0	9.0 to 18.0	14.0 to 28.0	mA
Power gain (E_v = 1000 lx; V_{CE} = 5 V)	$\frac{I_{P(CE)}}{I_{P(CB)}}$[2]	355	560	900	

The illuminances refer to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K. (standard light A in accordance with DIN 5033 and IEC 306-1). Irradiance E_e measured with HP radiant flux meter 8334A with option 013.

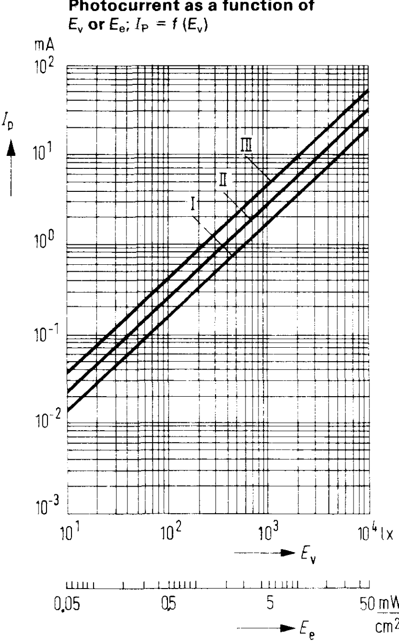
[1] measured with LED λ = 950 nm

[2] $I_{p\,(CE)}$ = Photocurrent of the phototransistor
$I_{p\,(CB)}$ = Photocurrent of the collector-base photodiode

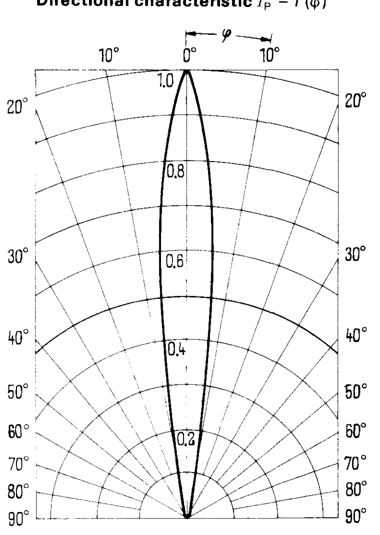
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



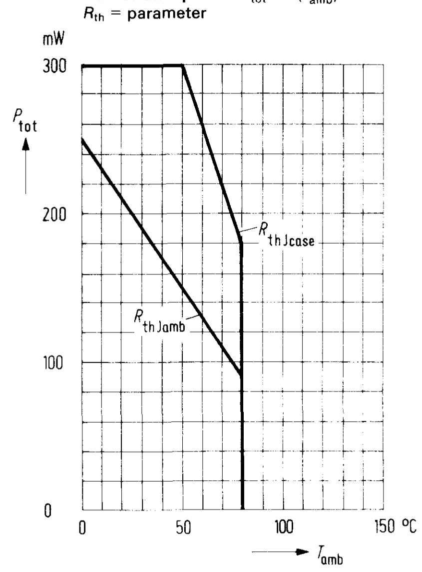
Photocurrent as a function of
E_v **or** E_e; $I_P = f(E_v)$



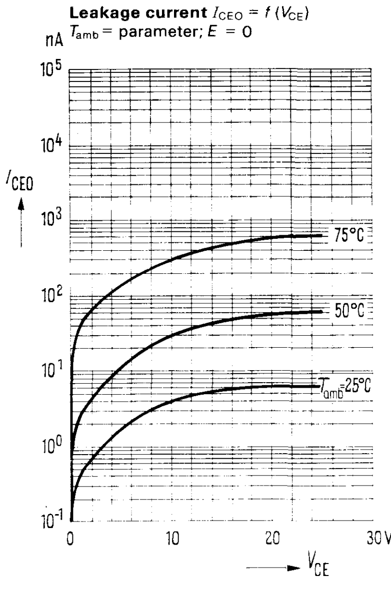
Directional characteristic $I_P = f(\varphi)$



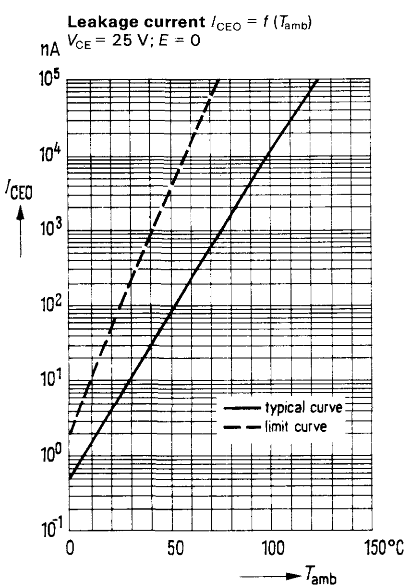
Power dissipation $P_{tot} = f(T_{amb})$
R_{th} = parameter



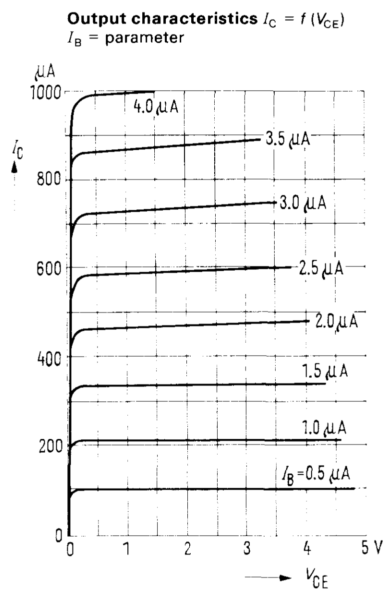
Leakage current $I_{CEO} = f(V_{CE})$
T_{amb} = parameter; $E = 0$



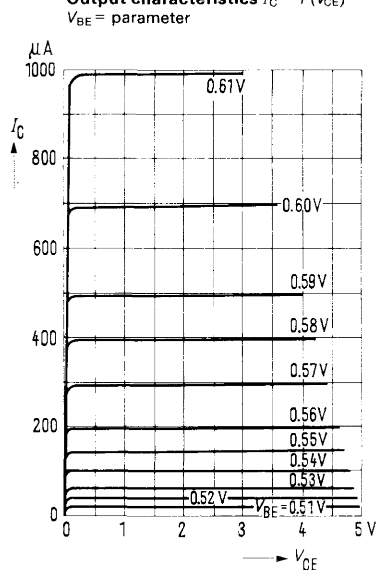
Leakage current $I_{CEO} = f(T_{amb})$
$V_{CE} = 25$ V; $E = 0$



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



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



Photocurrent $I_P = f(R_{BE})$ referred to photocurrent $I_{P\infty}$ during operation with open base ($R_{BE} = \infty$)
Parameter is the illuminance E_v converted into the photocurrents $I_{P\infty}$

%
100
$I_P/I_{P\infty}$
50
0

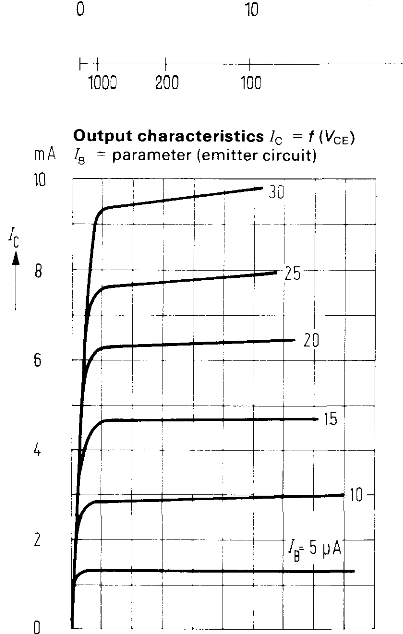
$I_{P\infty}$=1mA E_v~ 300 lx
$I_{P\infty}$=3mA E_v~ 900 lx
$I_{P\infty}$=10mA E_v~ 3000 lx

E_v
R_{BE}
V=5V
I_P

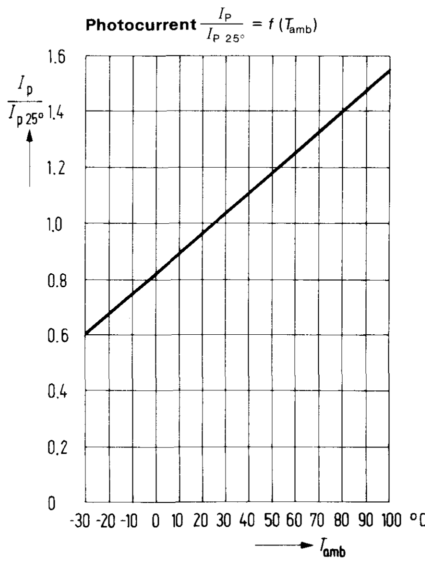
0 10 20 30 $40 \times 10^{-6} \frac{1}{\Omega}$
$\frac{1}{R_{BE}}$

1000 200 100 50 40 30 kΩ
R_{BE}

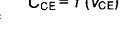
Output characteristics $I_C = f(V_{CE})$
I_B = parameter (emitter circuit)



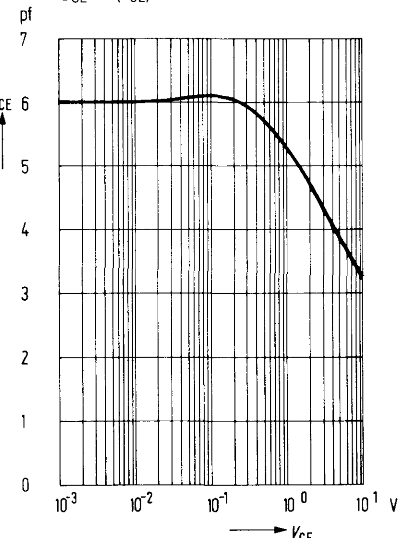
Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$



Collector-emitter capacitance

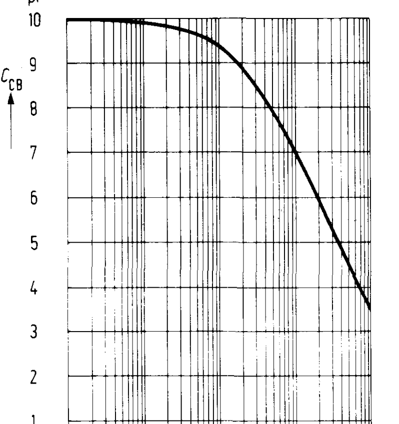


$C_{CE} = f\,(V_{CE})$



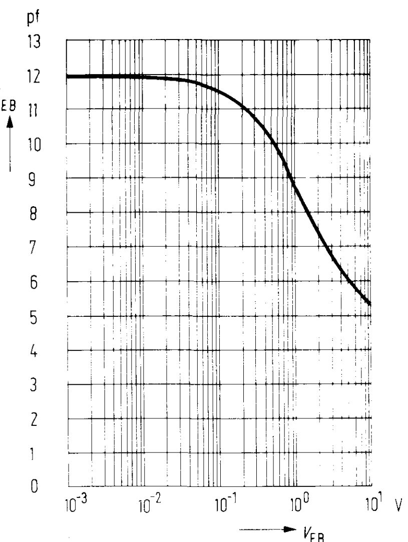
Collector-base capacitance

$C_{CB} = f\,(V_{CB})$



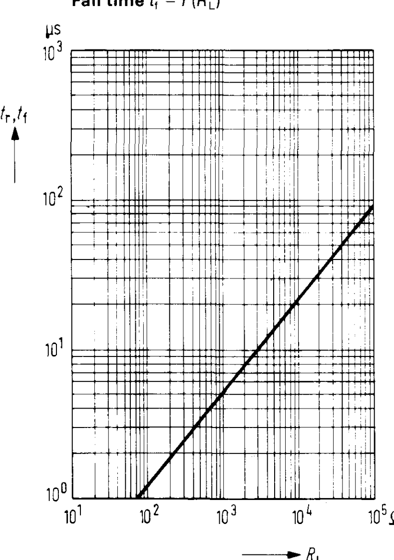
Emitter-base capacitance

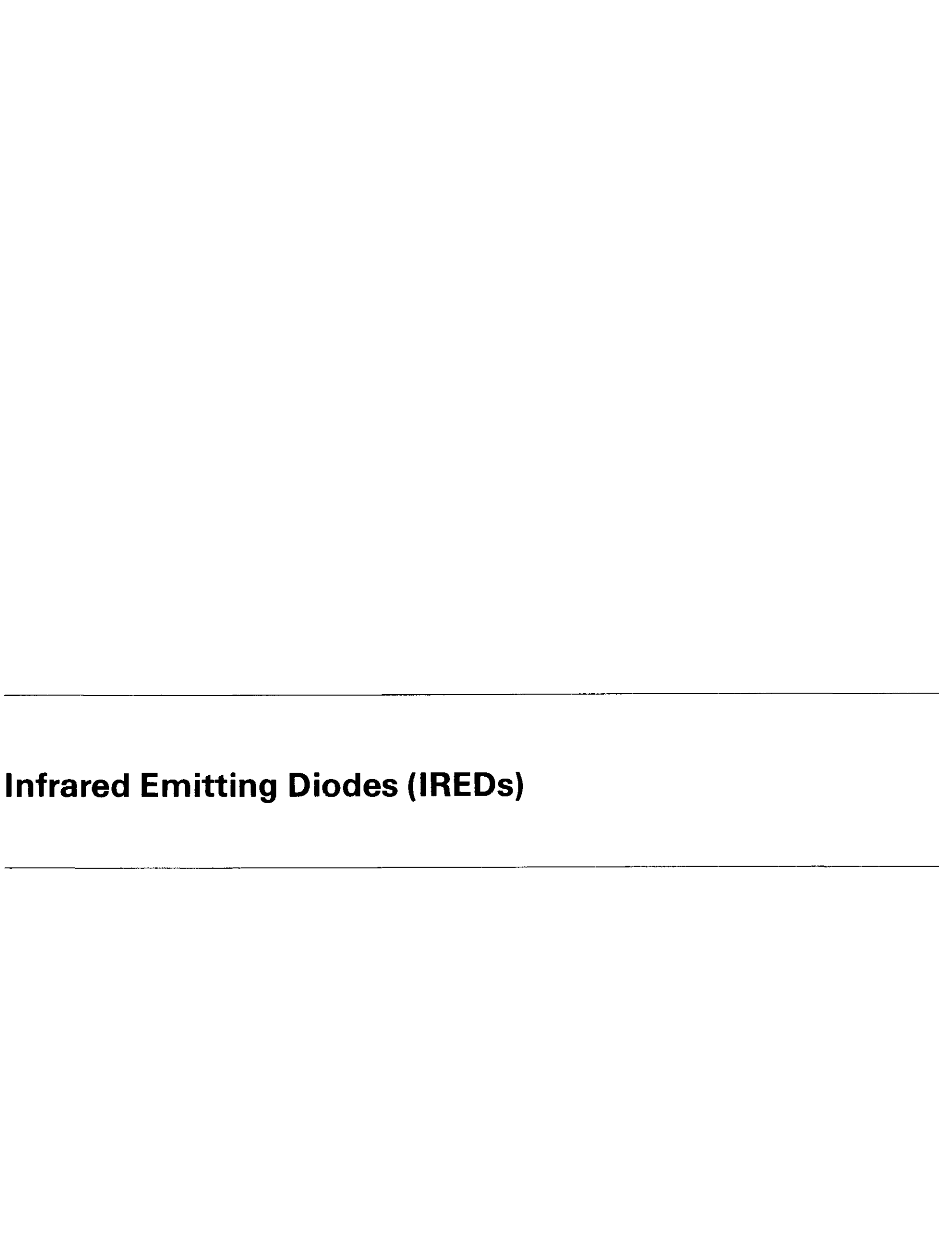
$C_{EB} = f\,(V_{EB})$



Rise time $t_r = f\,(R_L)$

Fall time $t_f = f\,(R_L)$





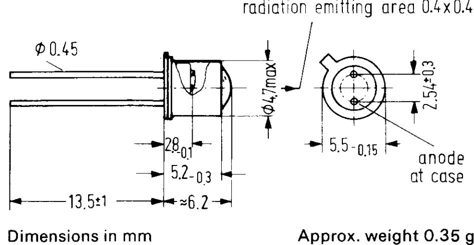
Infrared Emitting Diodes (IREDs)

Radiant intensity (I_e) and luminous intensity (I_V) and electrical current I have in the standard specification the same symbols. In order to avoid mix-up we use for the above terms I_e or I_V respectively (straight letters) for radiant or luminous intensity respectively and I (italic letter) for the electric current.

GaAs Infrared Emitting Diode

The GaAs infrared emitting diode CQY 17 is designed to emit radiation at a wavelength in the near infrared. The radiation emitted is excited by current flowing in forward direction and can be modulated. The case 18A 2 DIN 41876 (similar to TO 18) is closed by a glass lens. The cathode terminal is marked by the adjacent projection on the rim of the case bottom. The anode is electrically connected to the case. From I_F = 100 mA heat sinks have to be used.

Type	Ordering code
CQY 17/IV	Q 62 703-Q 89-S 1
CQY 17/V	Q 62 703-Q 89-S 2



Dimensions in mm

Approx. weight 0.35 g

Maximum ratings

Reverse voltage	V_R	4	V
Forward current	I_F	100	mA
Surge current ($t \leqq 10\ \mu s$)	i_{FS}	2000	mA
Junction temperature	T_j	100	°C
Storage temperature	T_{stor}	−55 to +100	°C
Power dissipation (T_{case} = 65°C)	P_{tot}	180	mW
Thermal resistance			
Junction to air	R_{thJamb}	500	K/W
Junction to case	$R_{thJcase}$	180	K/W

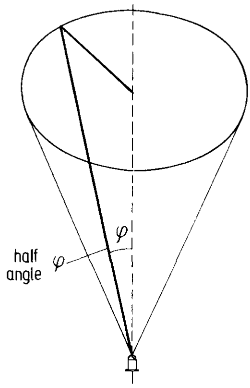
Characteristics (T_{amb} = 25°C)

Wavelength at peak emission at I_{max}	λ_{peak}	950	nm
Spectral bandwidth at 50% from I_{max}	$\Delta\lambda$	±20	nm
Switching times (I_e from 10% to 90%; I_F = 100 mA)	t_r; t_f	1	μs
Capacitance at V_R = 0 V	C_0	50	pF
Forward voltage (I_F = 100 mA)	V_F	1.35 (≦ 1.7)	V
Breakdown voltage (I_R = 100 μA)	V_{BR}	30 (≧ 4)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦ 10)	μA
Half-life of radiant intensity (typ) for I_F = 100 mA		10^5	h
Temperature coefficient of I_e or Φ_e	TC	−0.55	%/K
Temperature coefficient of V_F	TC	−1.5	mV/K
Temperature coefficient of λ_{peak}	TC	0.3	nm/K

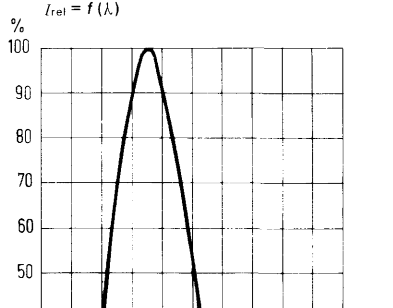
The diodes are grouped according to the radiant flux (radiant power) Φ_e in mW, at I_F = 100 mA, emitted in a cone with a half angle φ of 15°.

Group	IV	V	
Φ_e at φ = 15°	1.1 to 2.8	1.8 to 4.5	mW
Φ_e (total) typ.	4	6.3	mW

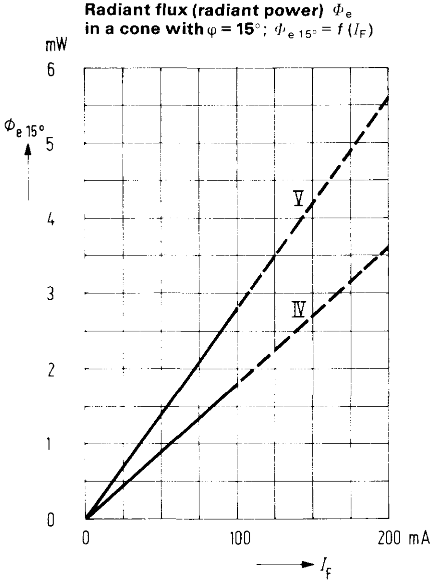
radiation cone as a function of the half angle φ



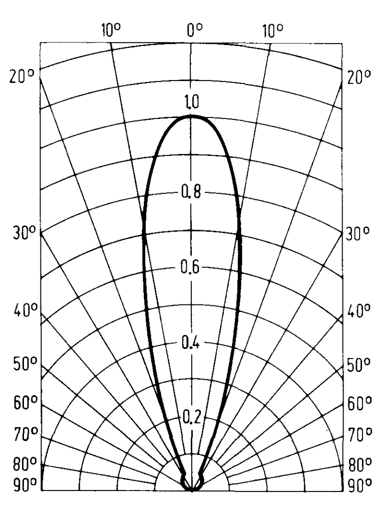
Relative spectral emission
$I_{rel} = f(\lambda)$



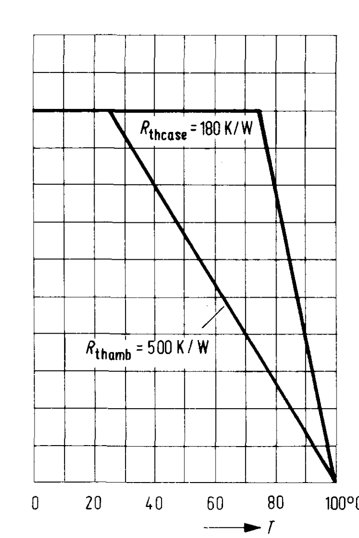
Radiant flux (radiant power) Φ_e
in a cone with $\varphi = 15°$; $\Phi_{e\,15°} = f(I_F)$

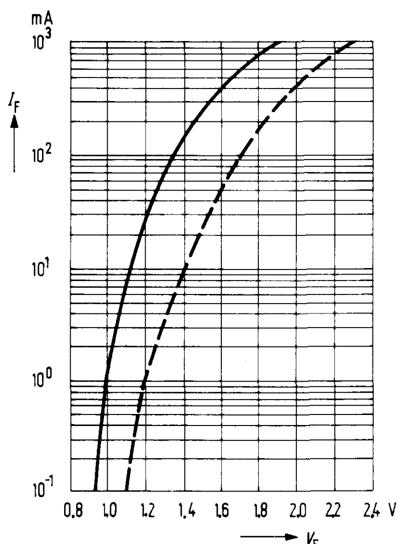


Radiation characteristic $I_{rel} = f(\varphi)$

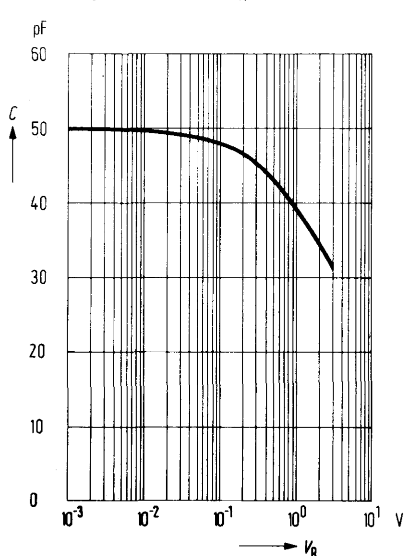


Max. permissible forward current
$I_F = f(T)$

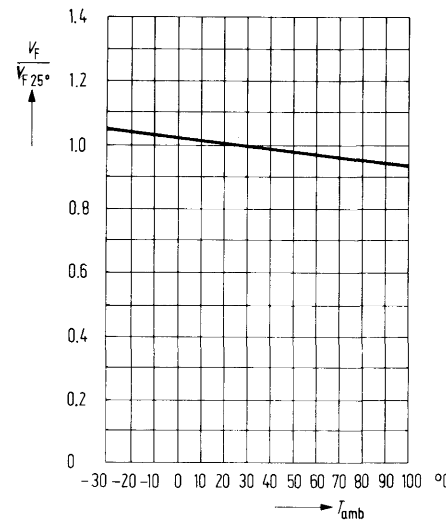




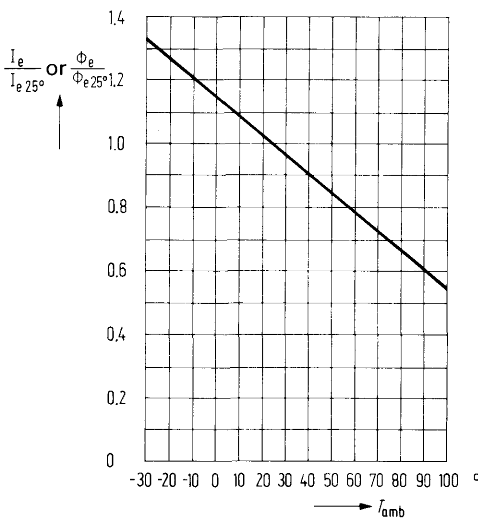
Capacitance $C = f(V_R)$



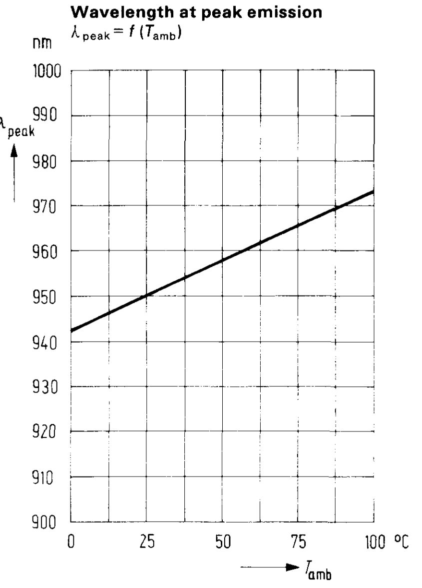
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



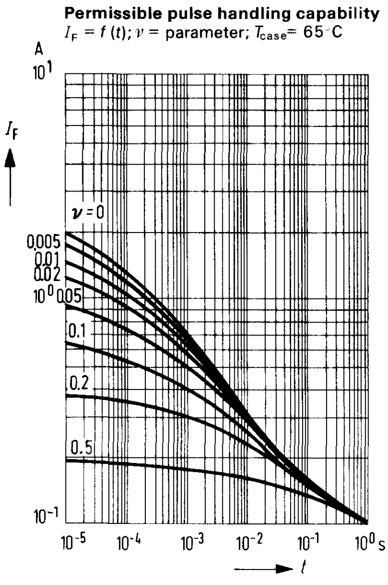
Radiant intensity $\frac{I_e}{I_{e\,25°}} = f(T_{amb})$



Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$



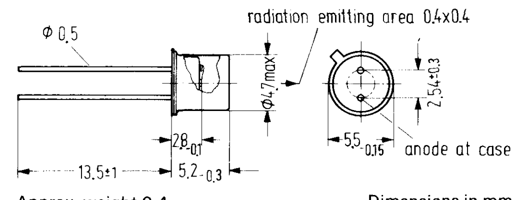
Permissible pulse handling capability
$I_F = f(t)$; ν = parameter; T_{case} = 65 °C



Not for new equipment

The GaAs infrared emitting diode CQY 18 is designed to emit radiation at a wavelength in the near infrared range. The radiation emitted is excited by current flowing in forward direction, and can be modulated. The case, similar to TO-18, is provided with a flat light window. The cathode is marked by an adjacent small projection on the rim of the case bottom. The anode is electrically connected to the case.

Type	Ordering code
CQY 18/III	Q 62 703-Q 90-S 1
CQY 18/IV	Q 62 703-Q 90-S 2
CQY 18/V	Q 62 703-Q 90-S 3



Approx. weight 0.4 g

Dimensions in mm

Maximum ratings

Reverse voltage	V_R	4	V
Forward current	I_F	100	mA
Surge current ($t \leq 10\ \mu s$)	i_{FS}	2000	mA
Junction temperature	T_j	100	°C
Storage temperature	T_{stor}	−55 to +100	°C
Power dissipation (T_{case} = 65°C)	P_{tot}	180	mW
Thermal resistance			
Junction to air	R_{thJamb}	500	K/W
Junction to case	$R_{thJcase}$	180	K/W

Not for new equipment

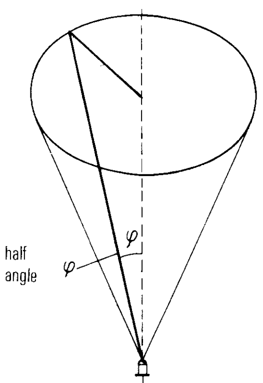
Characteristics (T_{amb} = 25°C)

Wavelength at peak emission at I_{max}	λ_{peak}	950	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	±20	nm
Switching times (I_e from 10% to 90%; I_F = 100 mA)	t_r; t_f	1	μs
Capacitance at V_R = 0 V	C_O	50	pF
Forward voltage (I_F = 100 mA)	V_F	1.35 (≦ 1.7)	V
Breakdown voltage (I_R = 100 μA)	V_{BR}	30 (≧ 4)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦ 10)	μA
Half-life of radiant intensity (typ) for I_F = 100 mA		10^5	h
Temperature coefficient of I_e or Φ_e	TC	−0.55	%/K
Temperature coefficient of V_F	TC	−1.5	mV/K
Temperature coefficient of λ_{peak}	TC	0.3	nm/K

The diodes are grouped according to the radiant flux (radiant power) Φ_e in mW, at I_F = 100 mA emitted in a cone with a half angle φ = 30°.

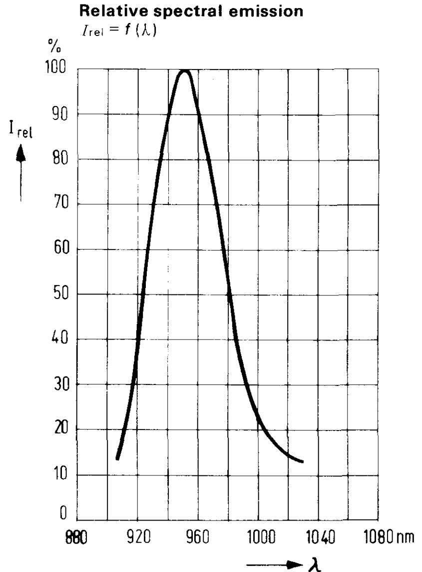
Group	III	IV	V	
Φ_e at φ = 30°	0.8 to 2.0	1.25 to 3.2	2.0 to 5.0	mW
Φ_e (total) typ.	2.5	4	6.3	mW

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

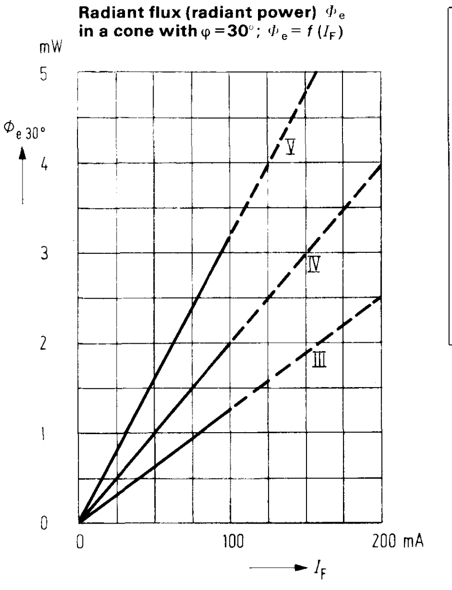


Not for new equipment

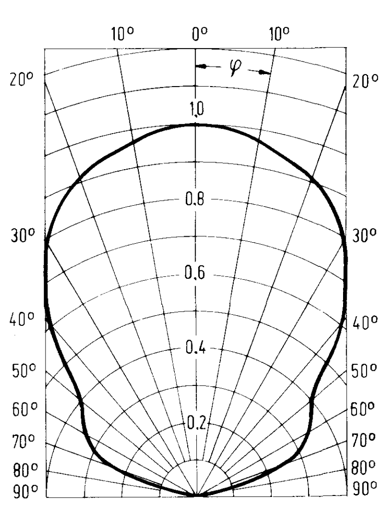
Relative spectral emission
$I_{rel} = f(\lambda)$



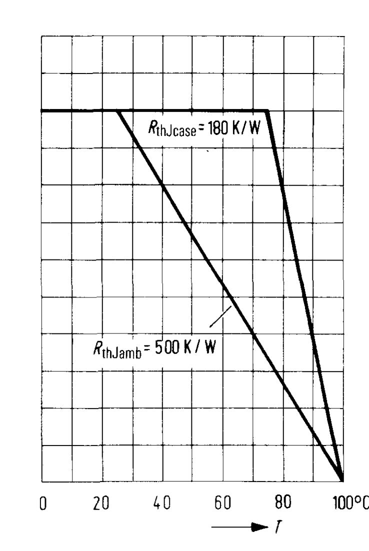
Radiant flux (radiant power) Φ_e in a cone with $\varphi = 30°$; $\Phi_e = f(I_F)$



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

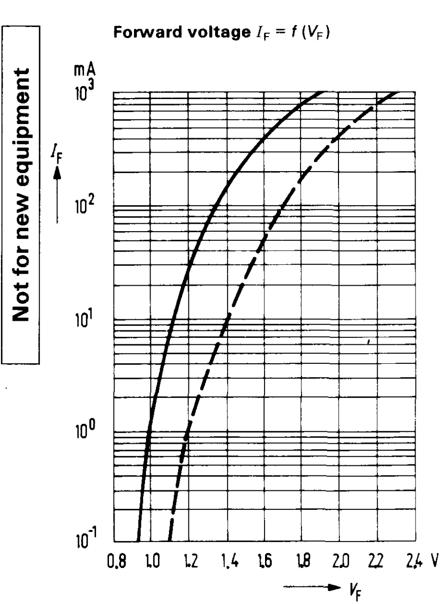


Max. permissible forward current
$I_F = f(T)$

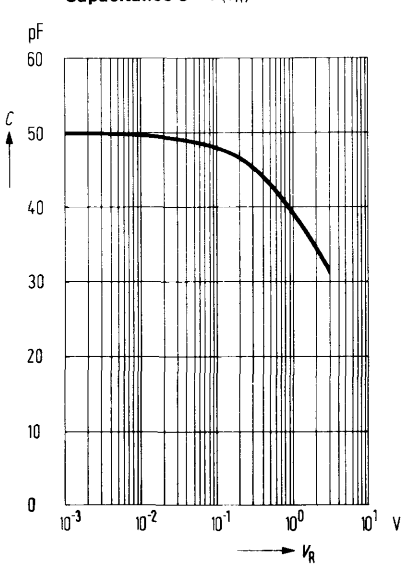


Not for new equipment

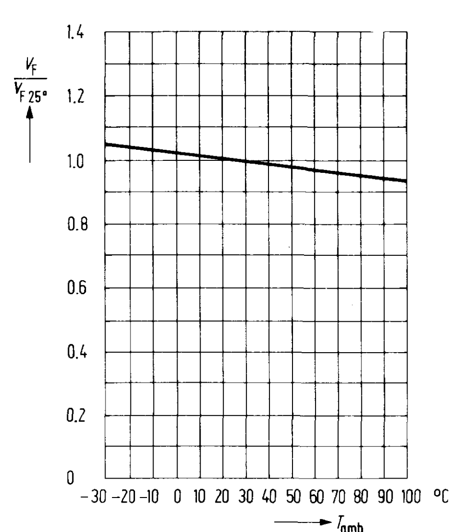
Forward voltage $I_F = f(V_F)$



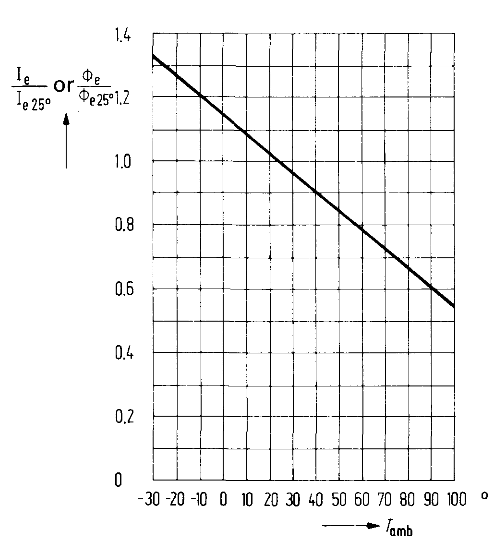
Capacitance $C = f(V_R)$



Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$

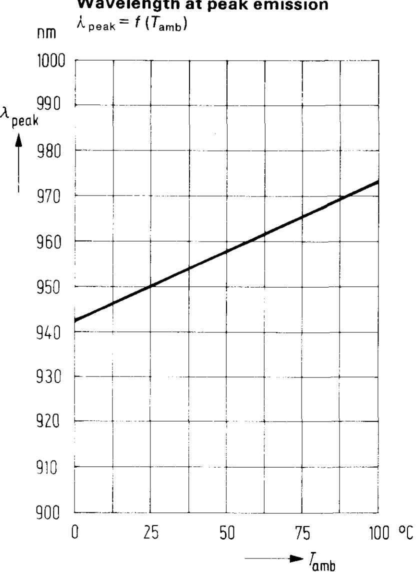


Radiant intensity $\frac{I_e}{I_{e\,25°}} = f(T_{amb})$

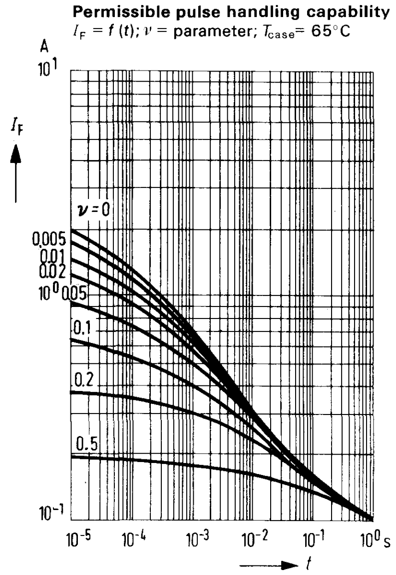


Not for new equipment

Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$



Permissible pulse handling capability
$I_F = f(t)$; ν = parameter; T_{case} = 65°C

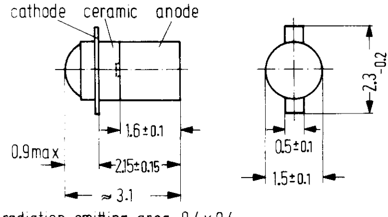


GaAs Infrared Emitting Diode

CQY 57

The GaAs infrared emitting diode CQY 57 emits radiation at a wavelength in the near infrared range, when current flows in forward direction. The CQY 57 is hermetically sealed in a microceramic case with a lens. Because of its small size the CQY 57 is suitable for versatile applications with the phototransistors BPX 62 and where miniaturization, small built-in depth and high packing density are of prime interest, e.g. for tape and punched-card readers, for motion and angle scanning as well as reading devices for digital grid systems. The type allows high flexibility in producing complex, areal, optical emitter units. The anode is electrically connected to the solid metal cylinder to provide improved heat dissipation.

Type	Ordering code
CQY 57/I	Q 62 703-Q 111
CQY 57/II	Q 62 703-Q 112
CQY 57/III	Q 62 703-Q 113
CQY 57/IV	Q 62 703-Q 114



Approx. weight 1 g

Dimensions in mm

Maximum ratings

Reverse voltage	V_R	4	V
Forward current	I_F	100	mA
Surge current ($t \leq 10\ \mu s$)	i_{FS}	2	A
Junction temperature	T_j	125	°C
Storage temperature	T_{stor}	−55 to +150	°C
Soldering temperature ($t \leq 3$ s)	T_s	240	°C
Power dissipation (T_{case} = 70°C)	P_{tot}	180	mW
Thermal resistance[1]			
Junction to air	R_{thJamb}	1000	K/W
Junction to case	$R_{thJcase}$	300	K/W

[1] In accordance with the mounting method the junction temperature must be controlled by the heating. When mounted in double-clad epoxy resin PC boards (copper thickness 40 µm; area 80 mm^2), a thermal resistance in air of R_{thJK} = 550 K/W must be expected.

Characteristics (T_{amb} = 25°C)

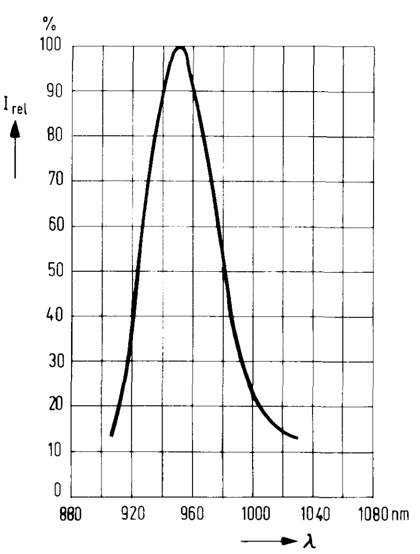
Wavelength at peak emission at I_{max}	λ_{peak}	950	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	±20	nm
Half angle (limits for 50% of radiant intensity I_e)	φ	12	degree
Switching times (I_e from 10% to 90%; I_F = 50 mA)	t_r; t_f	1	μs
Capacitance at V_R = 0 V	C_0	40	pF
Forward voltage (I_F = 50 mA)	V_F	1.25 (≦ 1.6)	V
Breakdown voltage (I_R = 100 μA)	V_{BR}	30 (≧ 4)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦ 10)	μA
Temperature coefficient of I_e or Φ_e	TC	−0.55	%/K
Temperature coefficient of V_F	TC	−1.5	mV/K
Temperature coefficient of λ_{peak}	TC	0.3	nm/K
Half-life of radiant intensity (typ) for I_F = 50 mA		10^5	h

The diodes are grouped in accordance with the radiant intensity I_e in the axial direction at I_F = 50 mA in mW/sr.

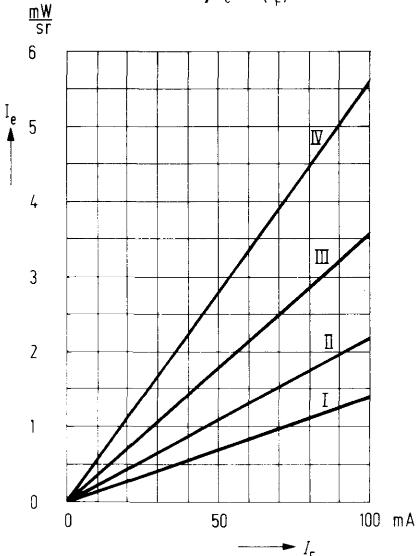
Group	I	II	III	IV	
I_e[1]	0.5–1.0	0.8–1.6	1.25–2.5	2.0–4.0	mW/sr
Φ_e (total)	1.0	1.6	2.5	4.0	mW

[1]) Measured with HP radiant flux meter 8334A (option 013) measuring distance ≧ 70 mm.

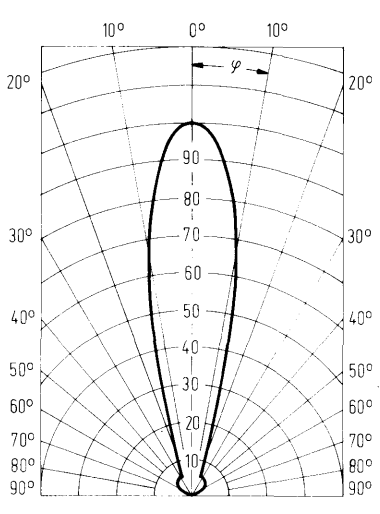
Relative spectral emission $I_{rel} = f(\lambda)$



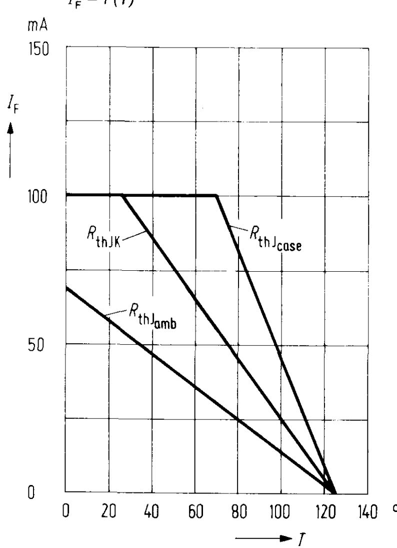
Radiant intensity $I_e = f(I_F)$



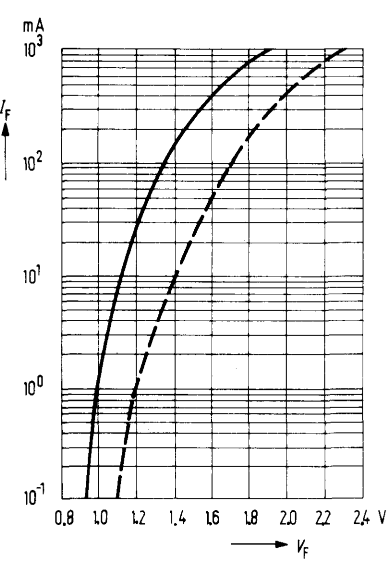
Radiation characteristic $I_{rel} = f(\varphi)$



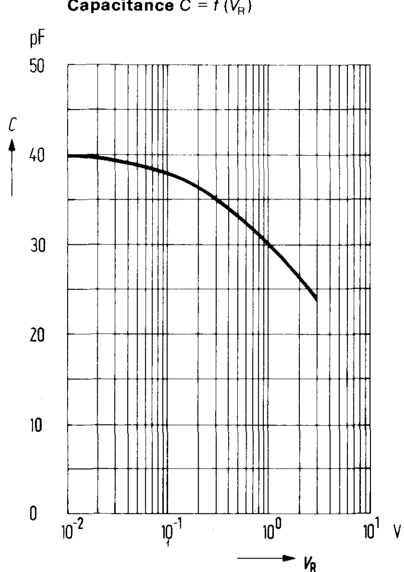
Max. permissible forward current
$I_F = f(T)$



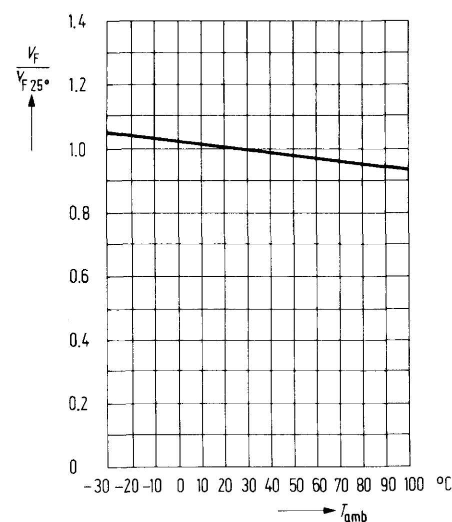
Forward voltage $I_F = f(V_F)$



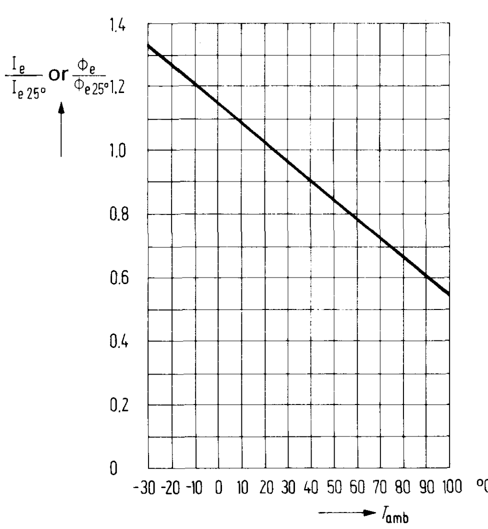
Capacitance $C = f(V_R)$



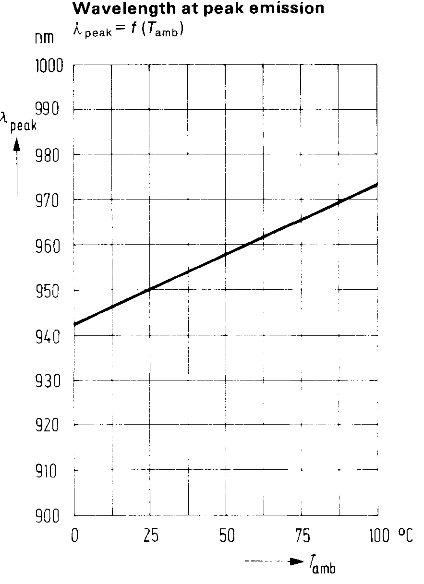
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



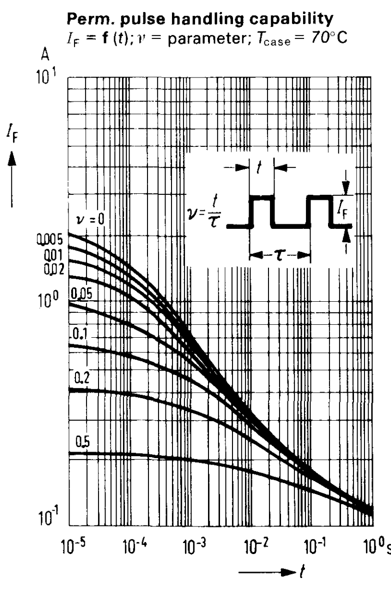
Radiant intensity $\frac{I_e}{I_{e\,25°}} = f(T_{amb})$



Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$



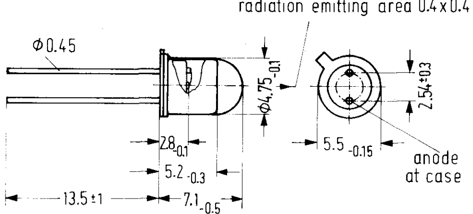
Perm. pulse handling capability
$I_F = f(t)$; ν = parameter; $T_{case} = 70°C$



GaAs Infrared Emitting Diode CQY 77

The GaAs infrared emitting diode CQY 77 emits radiation at a wavelength in the near infrared range. The radiation emitted is excited by current flowing in forward direction and can be modulated. The case 18 A 2 DIN 41876 (similar to TO 18) is closed by a glass lens. The cathode terminal is marked by the adjacent projection on the rim of the case bottom. The anode is electrically connected to the case. From I_F = 100 mA heat sinks have to be used.

Type	Ordering code
CQY 77/I	Q 62 703-Q 121-S 1
CQY 77/II	Q 62 703-Q 121-S 2
CQY 77/III	Q 62 703-Q 121-S 3



Approx. weight 0.35 g
Dimensions in mm

Maximum ratings

Reverse voltage	V_R	4	V
Forward current	I_F	230	mA
Surge current ($t \leq 10\ \mu s$)	i_{FS}	4	A
Junction temperature	T_j	100	°C
Storage temperature	T_{stor}	−55 to +100	°C
Power dissipation (T_{case} = 40°C)	P_{tot}	350	mW
Thermal resistance			
Junction to air	R_{thJamb}	500	K/W
Junction to case	$R_{thJcase}$	180	K/W

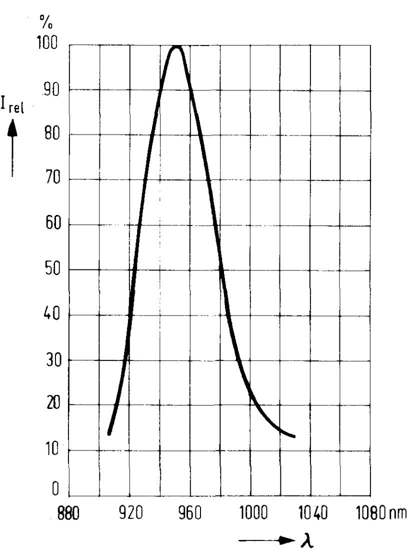
Characteristics (T_{amb} = 25°C)

Wavelength at peak emission at I_{max}	λ_{peak}	950	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	±20	nm
Half angle (limits for 50% of radiant intensity I_e)	φ	6	degree
Switching times (I_e from 10% to 90%; I_F = 1000 mA)	t_r; t_f	1	µs
Capacitance (V_R = 0 V)	C_0	40	pF
Forward voltage (I_F = 100 mA)	V_F	1.35 (≦ 1.7)	V
Breakdown voltage (I_R = 100 µA)	V_{BR}	30 (≧ 4)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦ 10)	µA
Half-life of radiant intensity (typ) for I_F = 100 mA		10^5	h
Temperature coefficient of I_e or Φ_e	TC	−0.55	%/K
Temperature coefficient of V_F	TC	−1.5	mV/K
Temperature coefficient of λ_{peak}	TC	0.3	nm/K

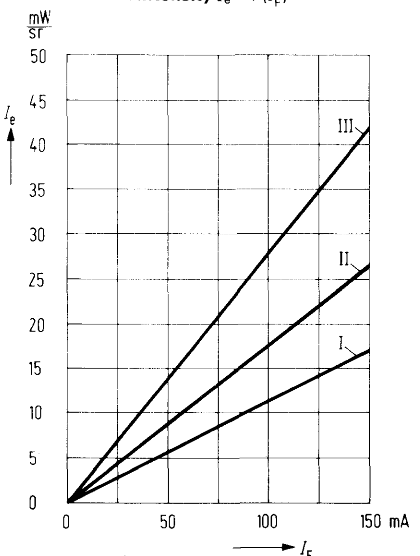
The diodes are grouped according to their radiant intensity I_e at I_F = 100 mA in axial direction and marked by Roman numerals.

Group	I	II	III	
Radiant intensity I_e	8 to 16	12.5 to 25	20 to 40	mW/sr
Φ_e typ (total)	2.5	4.0	6.3	mW

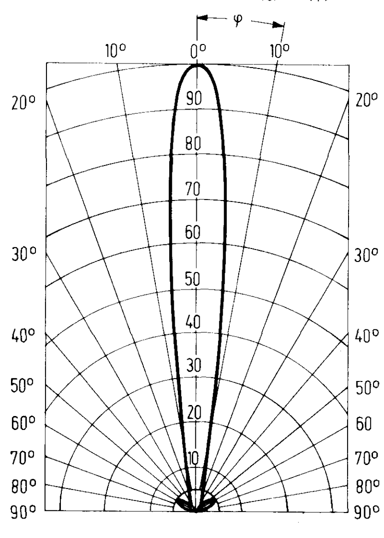
Relative spectral emission $I_{rel} = f(\lambda)$



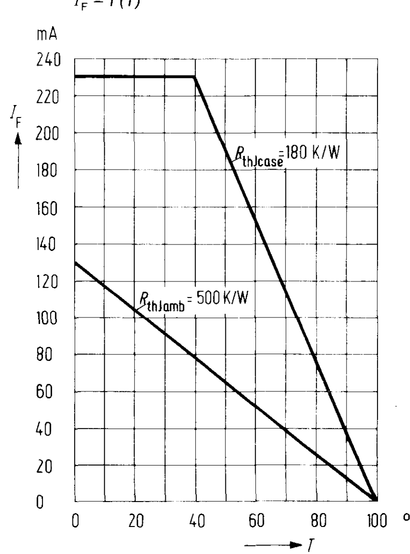
Radiant intensity $I_e = f(I_F)$



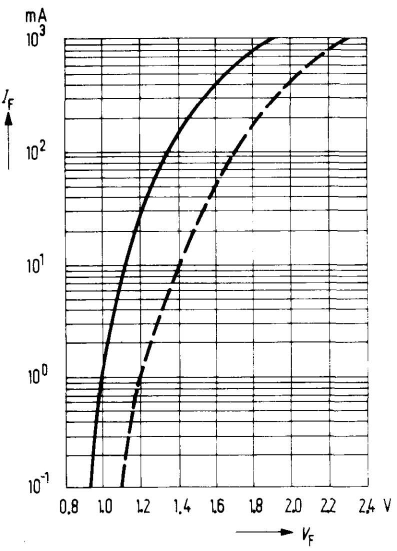
Radiation characteristic $I_{rel} = f(\varphi)$



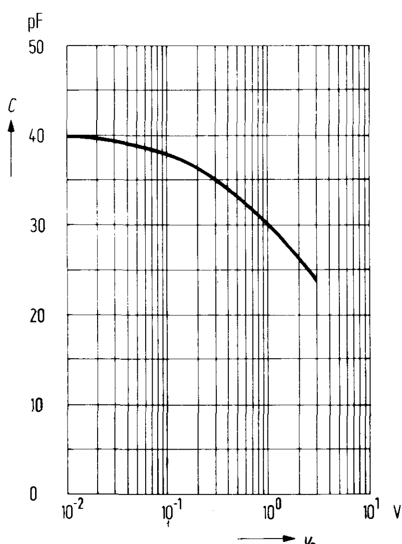
Max. permissible forward current
$I_F = f(T)$



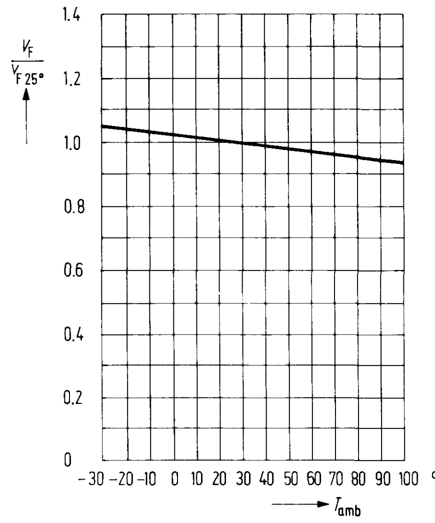
Forward voltage $I_F = f(V_F)$



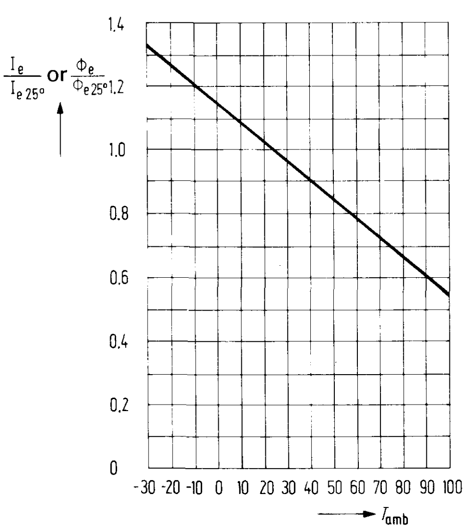
Capacitance $C = f(V_R)$



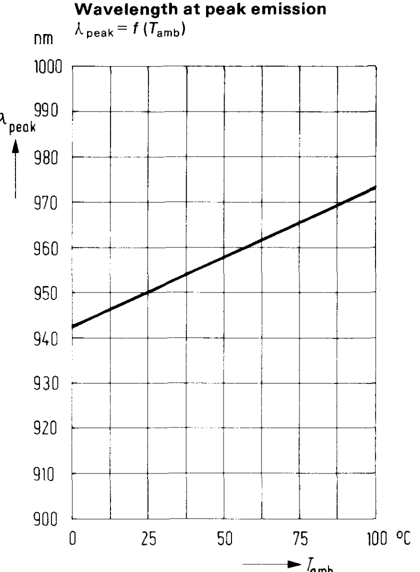
Forward voltage $\frac{V_F}{V_{F\,25^\circ}} = f(T_{amb})$



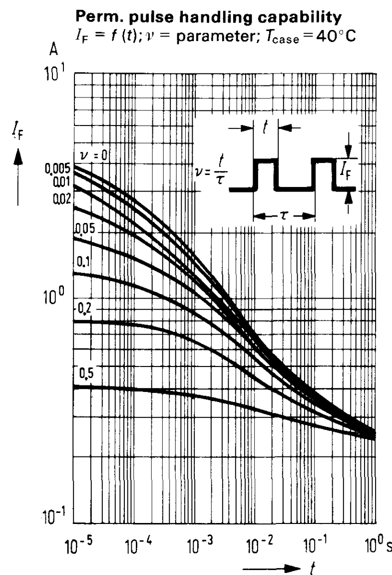
Radiant intensity $\frac{I_e}{I_{e\,25^\circ}} = f(T_{amb})$



Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$



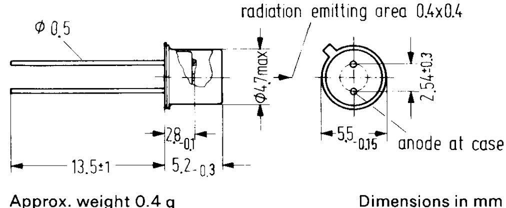
Perm. pulse handling capability
$I_F = f(t)$; ν = parameter; $T_{case} = 40°C$



GaAs Infrared Emitting Diode CQY 78

The GaAs infrared emitting diode CQY 78 is designed to emit radiation at a wavelength in the near infrared range. The radiation emitted is excited by current flowing in forward direction and can be modulated. The case similar to TO 18, is equipped with a flat light window. The cathode is marked by the adjacent projection on the rim of the case bottom. The anode is electrically connected to the case. From I_F = 100 mA heat sinks have to be used.

Type	Ordering code
CQY 78/I	Q 62 703-Q 132-S 1
CQY 78/II	Q 62 703-Q 132-S 2
CQY 78/III	Q 62 703-Q 132-S 3



Approx. weight 0.4 g

Dimensions in mm

Maximum ratings

Reverse voltage	V_R	4	V
Forward current	I_F	230	mA
Surge current ($t \leq 10\,\mu s$)	i_{FS}	4	A
Junction temperature	T_j	100	°C
Storage temperature	T_{stor}	−55 to +100	°C
Power dissipation (T_{case} = 40 °C)	P_{tot}	350	mW
Thermal resistance			
Junction to air	R_{thJamb}	500	K/W
Junction to case	$R_{thJcase}$	180	K/W

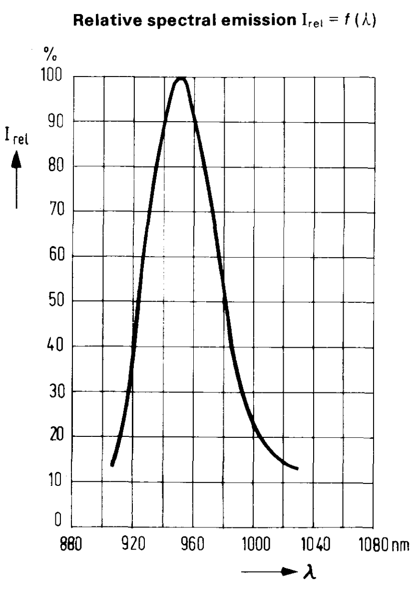
Characteristics (T_{amb} = 25 °C)

Wavelength at peak emission at I_{max}	λ_{peak}	950	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	±20	nm
Half angle (limits for 50% of radiant intensity I_e)	φ	40	degree
Switching times (I_e from 10% to 90%; I_F = 100 mA)	t_r; t_f	1	µs
Capacitance (V_R = 0 V)	C_0	40	pF
Forward voltage (I_F = 100 mA)	V_F	1.35 (≦ 1.7)	V
Breakdown voltage (I_R = 100 µA)	V_{BR}	30 (≧ 4)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦ 10)	µA
Half-life of radiant intensity (typ) for I_F = 100 mA		10^5	h
Temperature coefficient of I_e or Φ_e	TC	−0.55	%/K
Temperature coefficient of V_F	TC	−1.5	mV/K
Temperature coefficient of λ_{peak}	TC	0.3	nm/K

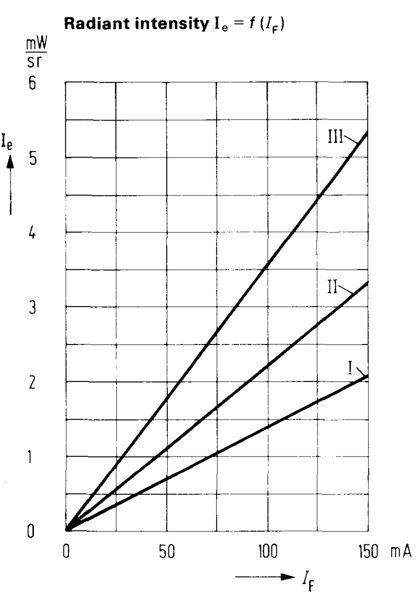
The diodes are grouped according to their radiant intensity I_e at I_F = 100 mA in axial direction and marked by Roman numerals.

Group	I	II	III	
Radiant intensity I_e	1 to 2	1.6 to 3.2	2.5 to 5	mW/sr
Φ_e typ (total)	2.5	4.0	6.3	mW

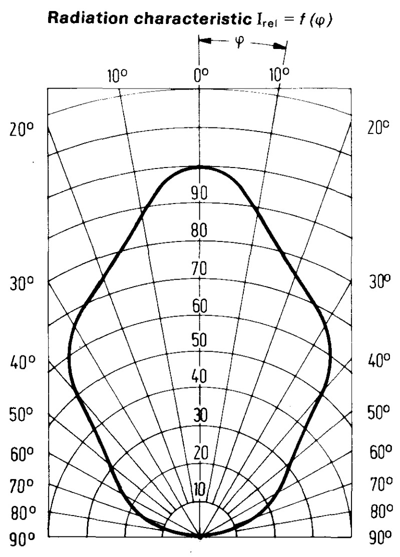
Relative spectral emission $I_{rel} = f(\lambda)$



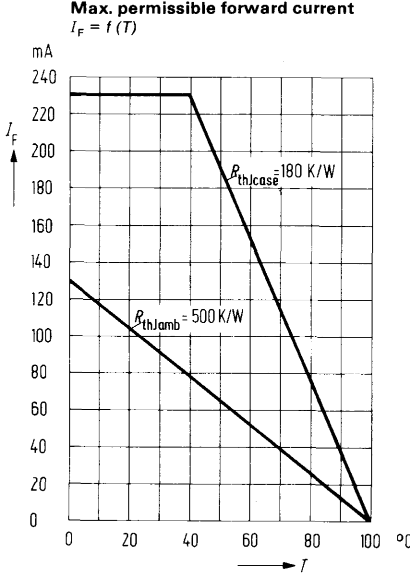
Radiant intensity $I_e = f(I_F)$



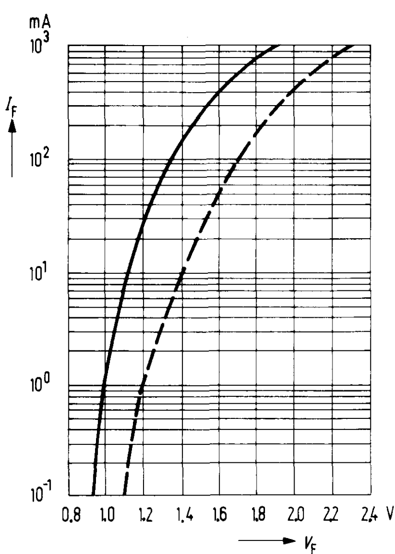
Radiation characteristic $I_{rel} = f(\varphi)$



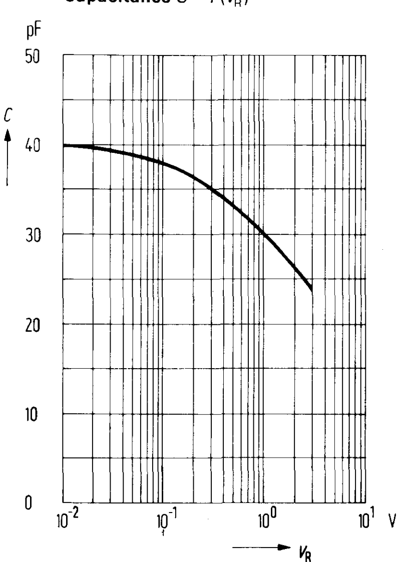
Max. permissible forward current
$I_F = f(T)$



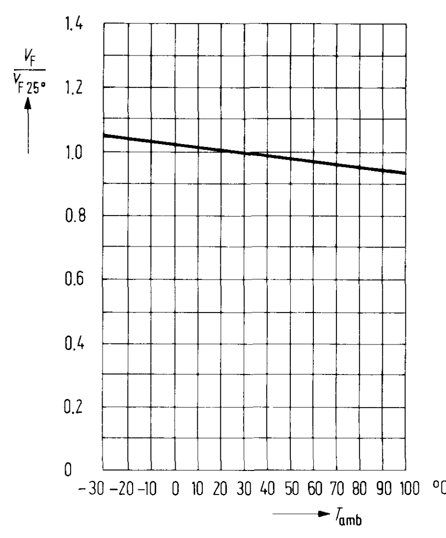
Forward voltage $I_F = f(V_F)$



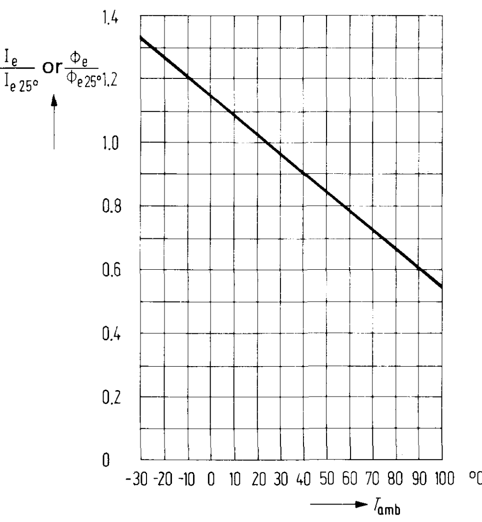
Capacitance $C = f(V_R)$



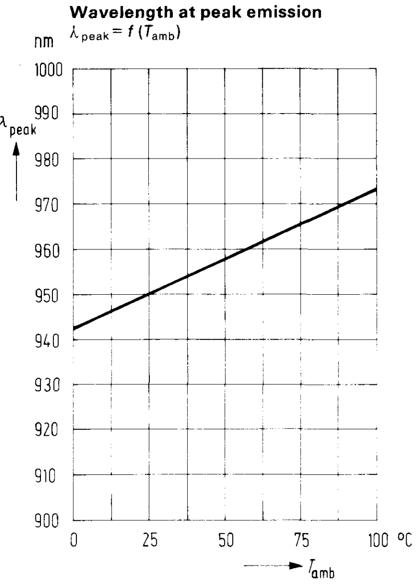
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



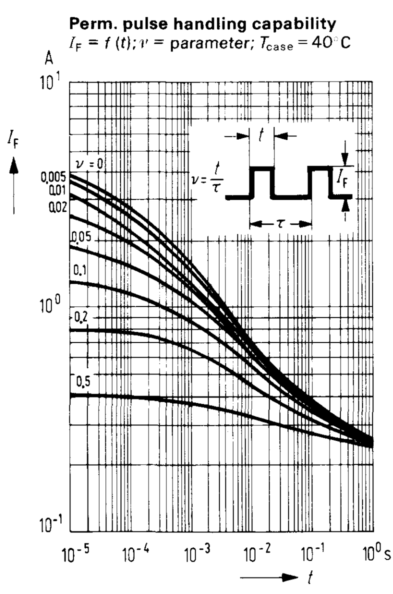
Radiant intensity $\frac{I_e}{I_{e\,25°}} = f(T_{amb})$



Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$



Perm. pulse handling capability
$I_F = f(t)$; ν = parameter; $T_{case} = 40\,°C$

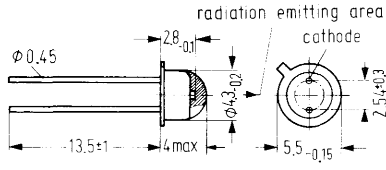


GaAs Infrared Emitting Diodes

LD 241

The GaAs infrared emitting diode LD 241 is designed to emit radiation at a wavelength in the near infrared range. The radiation emitted is excited by current flowing in forward direction and can be modulated. The plastic cover permits wide-angle radiation. The cathode terminal is marked by the adjacent projection on the rim of the case bottom. The anode is electrically connected to the case.

Type	Ordering code
LD 241/I	Q 62 703-Q 95
LD 241/II	Q 62 703-Q 97
LD 241/III	Q 62 703-Q 98



Approx. weight 0.5 g

Dimensions in mm

Maximum ratings

Reverse voltage	V_R	4	V
Forward current	I_F	230	mA
Surge current ($t \leqq 10\ \mu s$)	i_{FS}	5	A
Junction temperature	T_j	100	°C
Storage temperature	T_{stor}	−55 to +100	°C
Power dissipation ($T_{case} = 40°C$)	P_{tot}	350	mW
Thermal resistance			
Junction to air	R_{thJamb}	500	K/W
Junction to case	$R_{thJcase}$	180	K/W

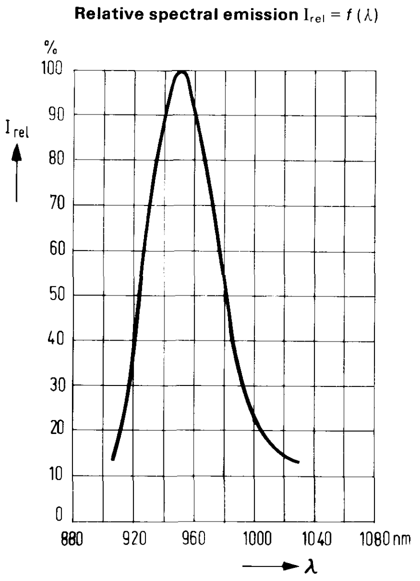
Characteristics (T_{amb} = 25°C)

Wavelength at peak emission at I_{max}	λ_{peak}	950	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	±20	nm
Half angle (limits for 50% of radiant intensity I_e)	φ	60	degree
Switching times (I_e from 10% to 90%; I_F = 100 mA)	t_r; t_f	1	μs
Capacitance at V_R = 0 V	C_O	40	pF
Forward voltage (I_F = 100 mA)	V_F	1.35 (≦ 1.7)	V
Breakdown voltage (I_R = 100 μA)	V_{BR}	30 (≧ 4)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦ 10)	μA
Temperature coefficient of I_e or Φ_e	TC	−0.55	%/K
Temperature coefficient of V_F	TC	−1.5	mV/K
Temperature coefficient of λ_{peak}	TC	0.3	nm/K
Half-life of radiant intensity (typ) for I_F = 100 mA		10^5	h

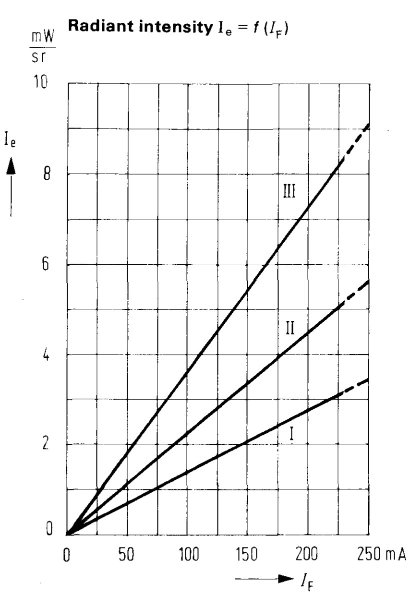
The diodes are grouped according to their radiant intensity I_e at I_F = 100 mA in axial direction and marked by Roman numerals.

Group	I	II	III	
Radiant intensity I_e	1.0 to 2.0	1.6 to 3.2	2.5 to 5.0	mW/sr
Φ_e typ (total)	4	6	10	mW

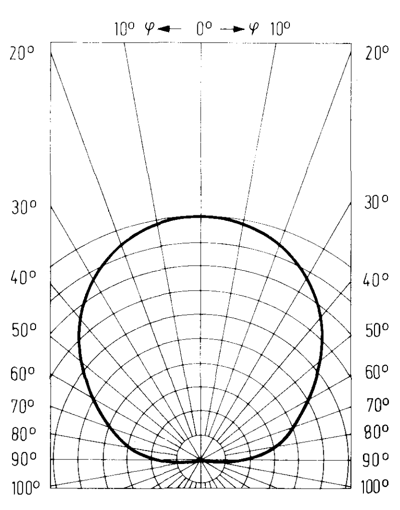
Relative spectral emission $I_{rel} = f(\lambda)$



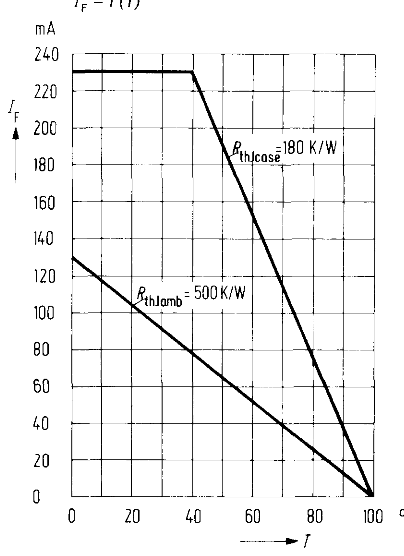
Radiant intensity $I_e = f(I_F)$



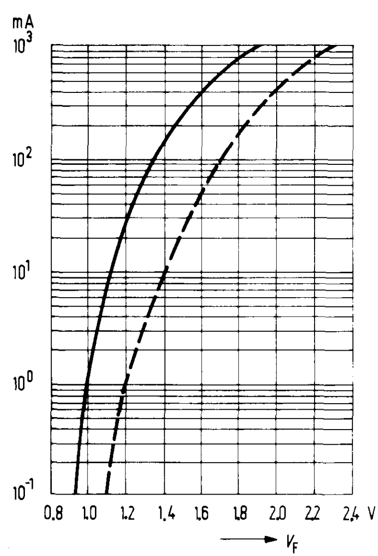
Radiation characteristic $I_{rel} = f(\varphi)$



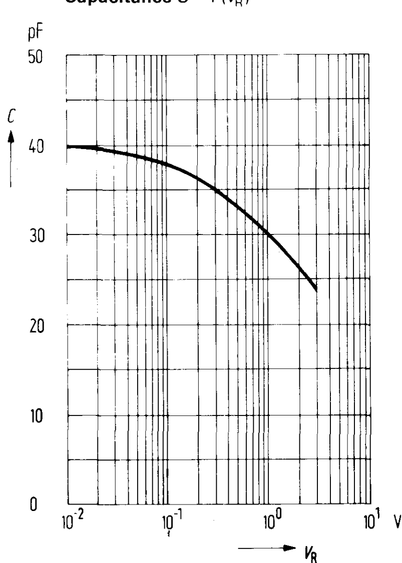
Max. permissible forward current
$I_F = f(T)$



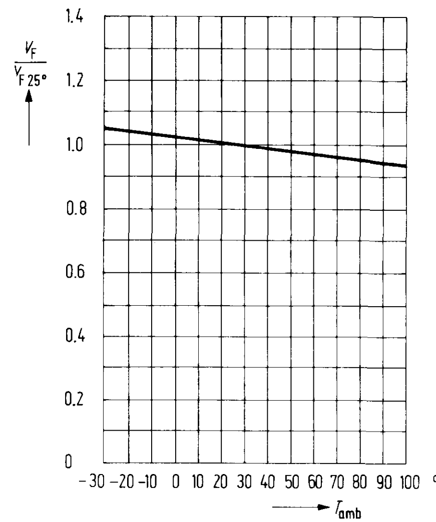
Forward voltage $I_F = f(V_F)$



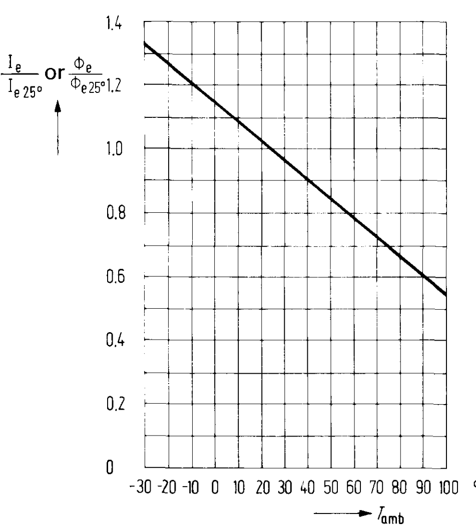
Capacitance $C = f(V_R)$



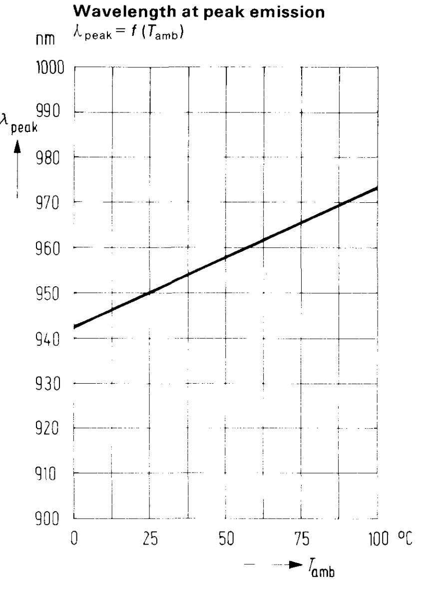
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



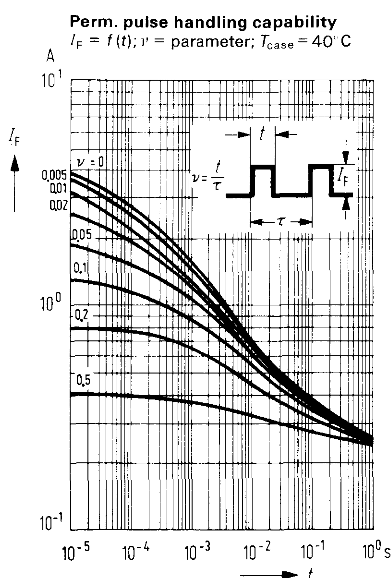
Radiant intensity $\frac{I_v}{I_{v\,25°}} = f(T_{amb})$



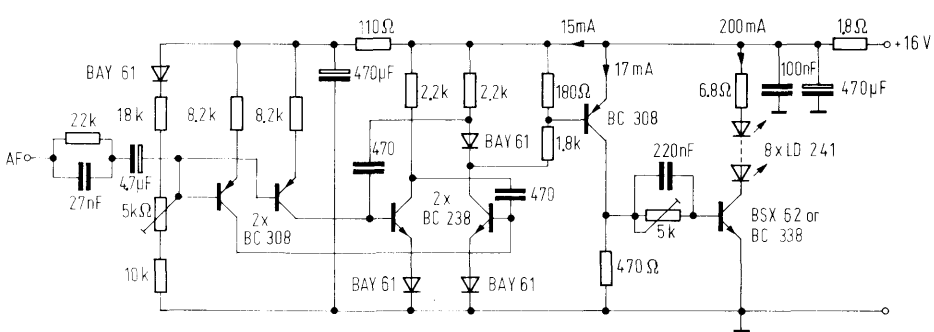
Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$



Perm. pulse handling capability
$I_F = f(t)$; ν = parameter; $T_{case} = 40\,°C$



Infrared emitter
Application example



Centre frequency 100 kHz
Power consumption 16 V / 230 mA
Radiated IR performance mean time value > 100 mW

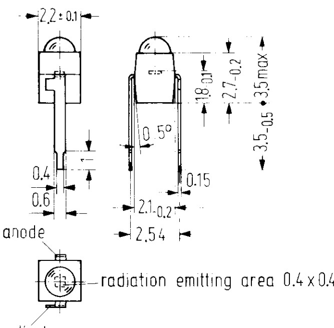
GaAs Infrared Emitting Diode Lead Spacing 2.54 mm

The GaAs infrared emitting diode LD 261 is designed to emit radiation at a wavelength in the near infrared range. The radiation emitted is excited by current flowing in the forward direction.

The case out of glass-clear plastic material provides lens-shaped light output. The plastic is slightly orange coloured in order to make the diodes different from the same type phototransistors (BPX 81). The terminals are solder pins in 2.54 mm (1/10") lead spacing. The infrared emitting diodes are grouped according to their radiant intensity. To identify the group the cathode terminal is marked by a coloured dot.

The LD 261 in conjunction with the BPX 81 phototransistor is suitable for use in light barriers when emitter and detector are spaced approx 10 mm apart. Mounting on PC boards as well as incorporation in thickfilm circuits can easily be performed. Thus, even complex scanning systems can be realized. Like the phototransistor series BPX 80 to BPX 89, the LD 261 infrared emitting diodes are also available in arrays up to 10 units comprising LD 260 to LD 269.

Type	Ordering code
LD 261/I	Q 62 703-Q 63
LD 261/II	Q 62 703-Q 64
LD 261/III	Q 62 703-Q 65
LD 261/IV	Q 62 703-Q 66



Dimensions in mm
Approx. weight 0.02 g

Maximum ratings

Reverse voltage	V_R	4	V
Forward current	I_F	50	mA
Surge current ($t \leq 10\ \mu s$)	i_{FS}	1.5	A
Junction temperature	T_j	80	°C
Storage temperature	T_{stor}	−40 to +80	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leq 3$ s)	T_S	230	°C
Power dissipation (T_L = 25°C)	P_{tot}	85	mW
Thermal resistance			
Junction to air	R_{thJamb}	750	K/W
Junction to solder pin	R_{thJL}	650	K/W

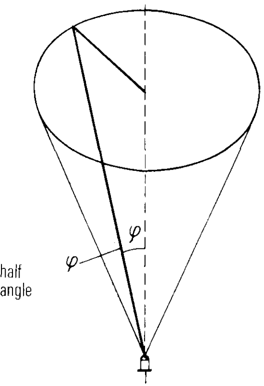
Characteristics (T_{amb} = 25°C)

Wavelength at peak emission at I_{max}	λ_{peak}	950	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	±20	nm
Switching times (I_e from 10% to 90%; I_F = 50 mA)	t_r; t_f	1	µs
Capacitance at V_R = 0 V	C_0	60	pF
Forward voltage (I_F = 50 mA)	V_F	1.25 (≦ 1.6)	V
Breakdown voltage (I_R = 100 µA)	V_{BR}	30 (≧ 4)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦ 10)	µA
Temperature coefficient of I_e or Φ_e	TC	−0.55	%/K
Temperature coefficient of V_F	TC	−1.5	mV/K
Temperature coefficient of λ_{peak}	TC	0.3	nm/K
Half-life of radiant intensity (typ) for I_F = 50 mA		10^5	h

The diodes are grouped according to their radiant intensity I_e at I_f = 50 mA in axial direction.

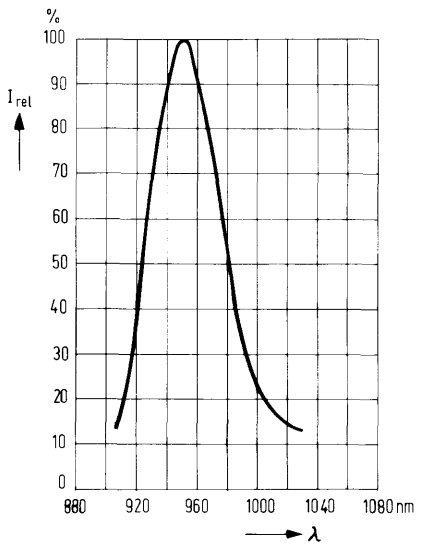
Group	I	II	III	IV	
Radiant intensity I_e[1] Φ_e at φ = 30°approx. Φ_e (total) typ.	0.5 to 1.0 0.28 to 0.71 1.0	0.8 to 1.6 0.45 to 1.112 1.6	1.25 to 2.5 0.71 to 1.8 2.5	2.0 to 4.0 1.12 to 2.8 4.0	mW/sr mW mW
Colour code: ((cathode)	brown	red	orange	yellow	

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

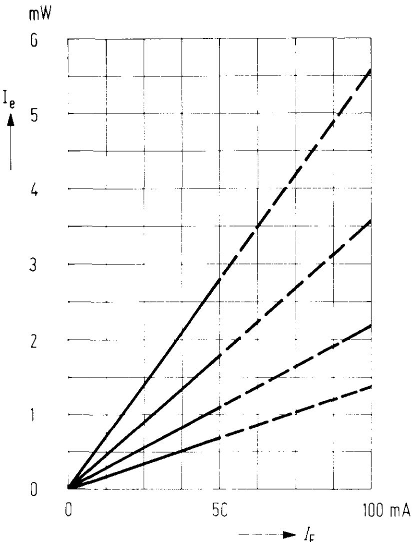


[1]) Radiant flux (radiant power) Φ_e in a cone with a half angle φ of 30°

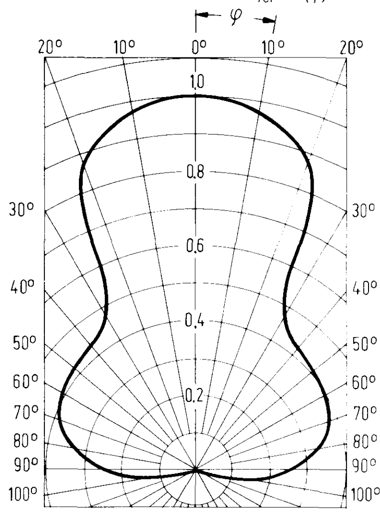
Relative spectral emission $I_{rel} = f(\lambda)$



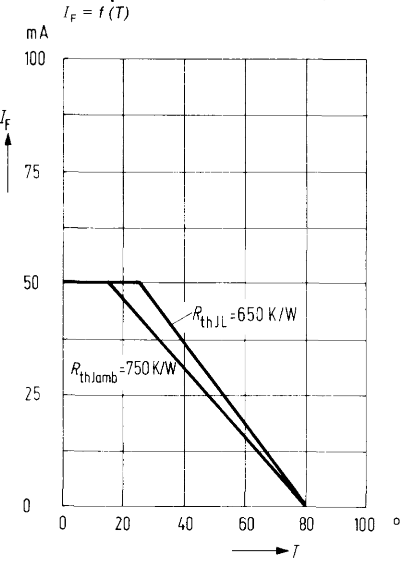
Radiant intensity $I_e = f(I_F)$



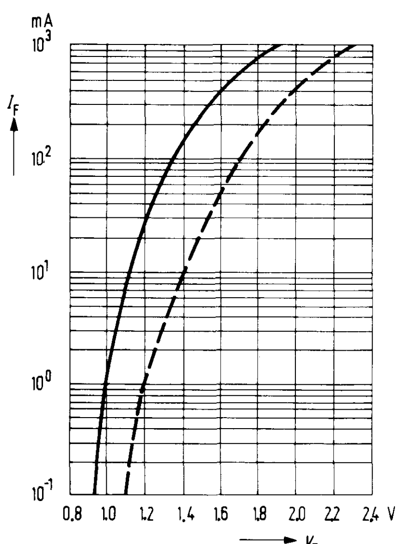
Radiation characteristic $I_{rel} = f(\varphi)$

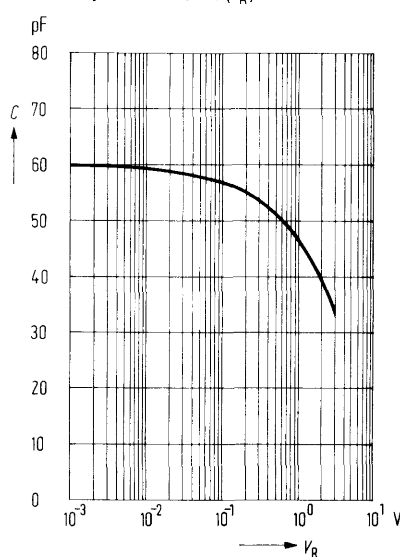


Max. permissible forward current
$I_F = f(T)$



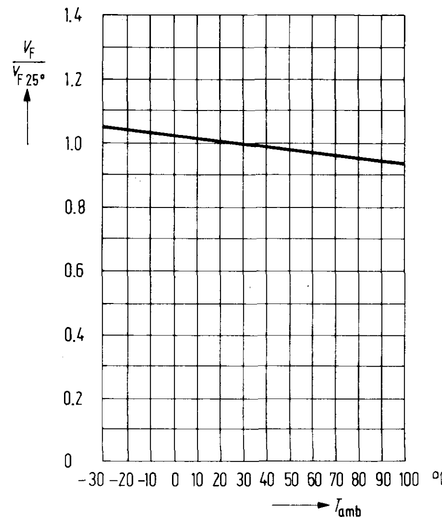
Capacitance $C = f(V_R)$

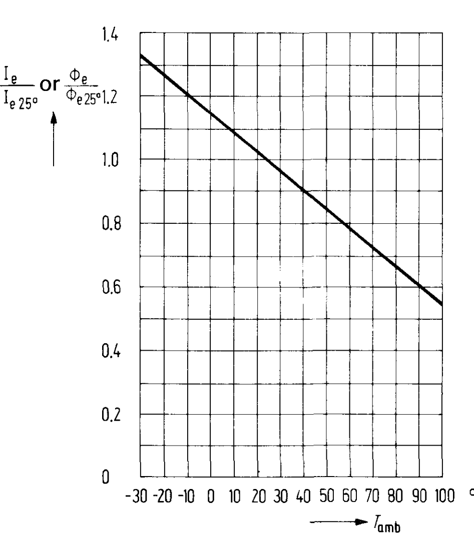




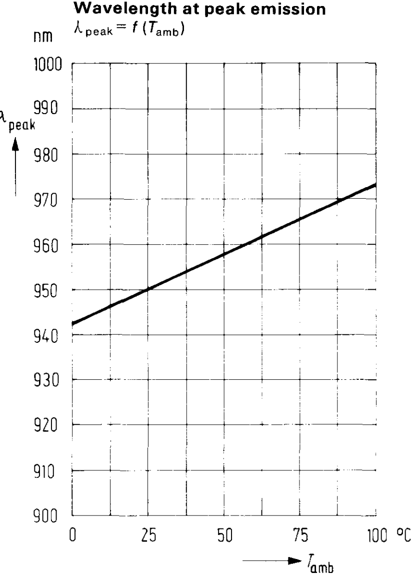
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$

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

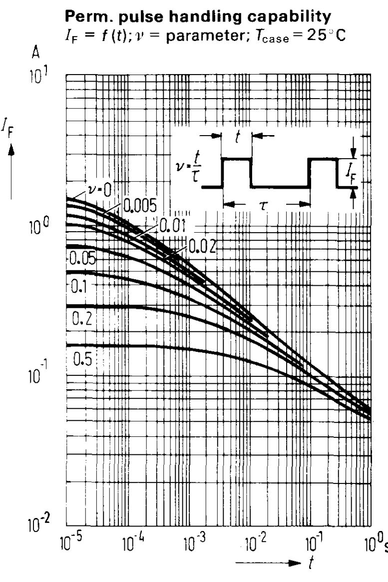




Wavelength at peak emission
$\lambda_{peak} = f\,(T_{amb})$



Perm. pulse handling capability
$I_F = f\,(t)$; ν = parameter; $T_{case} = 25\,°C$



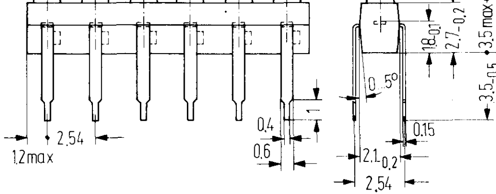
GaAs Infrared Emitting Diode Arrays Lead Spacing 2.54 mm

LD 260 to LD 269

The types LD 260 to LD 269 are GaAs infrared emitting diode arrays in an orange-coloured plastic encapsulation. The arrays consist of an arrangement of max. 10 infrared emitting diodes, similar to the type LD 261, in one row. These arrays emit radiation at a wavelength in the near infrared range, when current flows in forward direction. In conjunction with the BPX 80 to BPX 89 phototransistor arrays of the same design light barriers may be built up when emitter and detector are spaced 10 mm apart. Since they can easily be mounted on PC boards as well as incorporated in thickfilm circuits, even complex scanning systems can be realized. The individual diodes are spaced apart according to the standard lead spacing of. 2.54 mm (1/10").
The 3rd digit of the type designation is identical with the number of LEDs of the relevant array (e.g. LD 266 = an array with 6 diodes, LD 260 an array with 10 diodes).

Type	Ordering code
LD 262	Q 62 703-Q 70
LD 263	Q 62 703-Q 71
LD 266	Q 62 703-Q 74
LD 269	Q 62 703-Q 77
LD 260	Q 62 703-Q 78

Deviating system numbers per array upon request



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

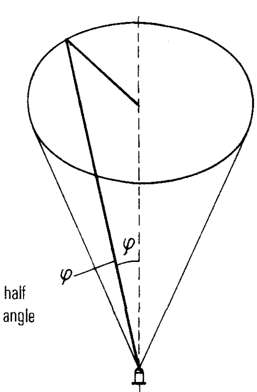
Maximum ratings (Individual diode)

Reverse voltage	V_R	4	V
Forward current	I_F	50	mA
Surge current ($t \leq 10\ \mu s$)	i_{FS}	1.5	A
Junction temperature	T_j	80	°C
Storage temperature	T_{stor}	−40 to +80	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leq 3$ s)	T_s	230	°C
Power dissipation (T_L = 25°C)	P_{tot}	85	mW
Thermal resistance			
Junction to air	R_{thJamb}	750	K/W
Junction to solder pin	R_{thJL}	650	K/W

Characteristics

Wavelength of radiation at I_{max}	λ_{peak}	950	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	±20	nm
Radiant intensity in axial direction[1] (I_F = 50 mA)	I_e	0.5 to 4.0	mW/sr
Emitted radiant flux Φ_e[2] in a cone φ = 30° (I_F = 50 mA)	approx. Φ_e	0.32 to 2.5	mW
Radiant flux (radiant power) Φ_e total (typ.) (I_F = 50 mA)	Φ_e	2.0	mW
Switching times (I_e from 10% to 90%; I_F = 50 mA)	t_r; t_f	1.7	µs
Capacitance at V_R = 0 V	C_O	60	pF
Forward voltage (I_F = 50 mA)	V_F	1.25 (≦ 1.6)	V
Breakdown voltage (I_R = 100 µA)	V_{BR}	30 (≧ 4)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦ 10)	µA
Temperature coefficient of I_e or Φ_e	TC	−0.55	%/K
Temperature coefficient of V_F	TC	−1.5	mV/K
Temperature coefficient of λ_{peak}	TC	0.3	nm/K
Half-life of radiant intensity (typ) for I_F = 50 mA		10^5	h

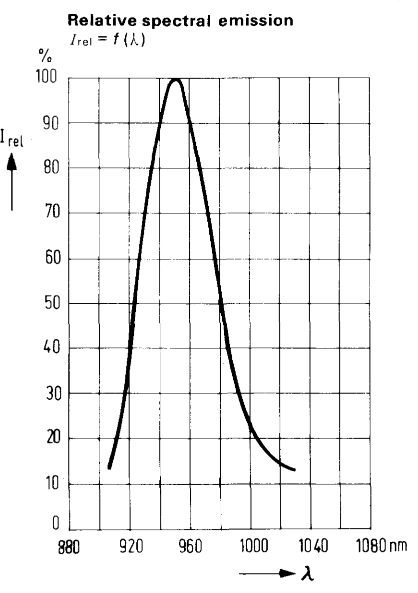
Cone of radiation as a function of half-angle φ



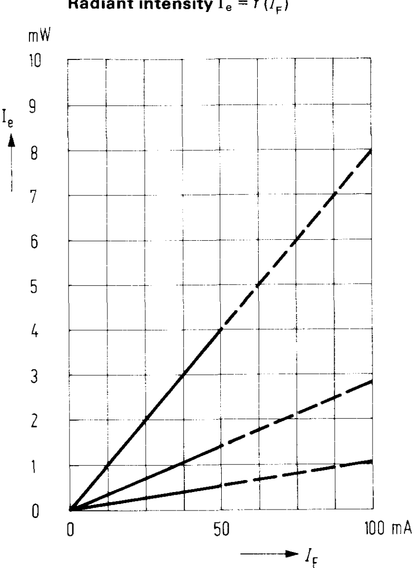
[1] Radiant flux (radiant power) Φ_e in a cone with a half angle φ of 30°

[2] The deviation of I_e within one array is ≦ 1 : 2. Arrays with closer deviations or closer I_e range similar to LD 261, gr. II/III upon request.

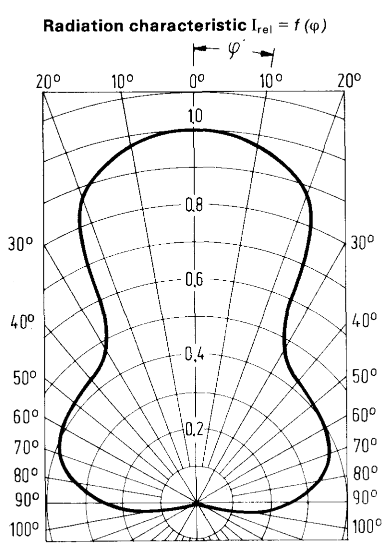
Relative spectral emission $I_{rel} = f(\lambda)$



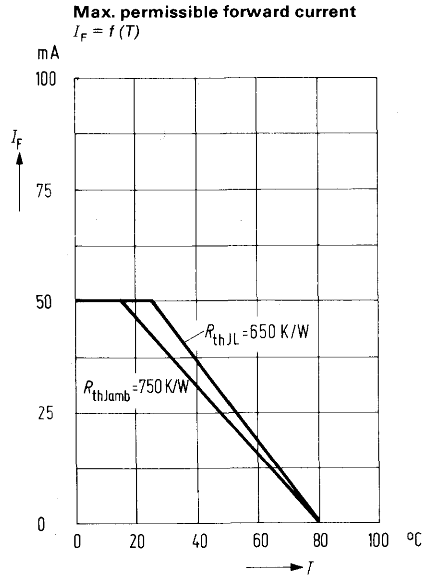
Radiant intensity $I_e = f(I_F)$



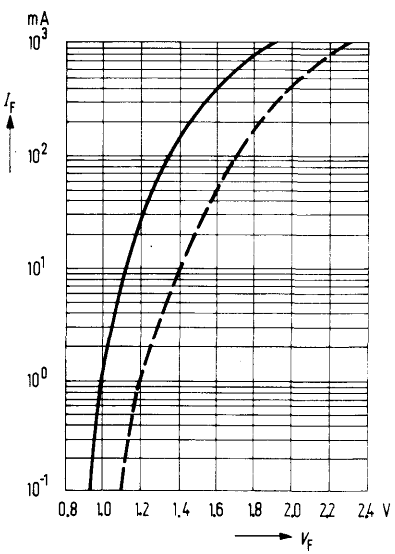
Radiation characteristic $I_{rel} = f(\varphi)$



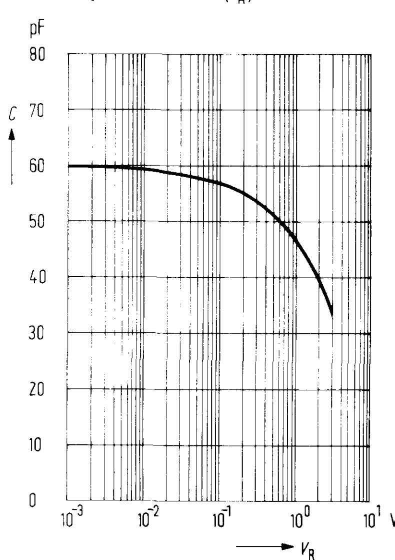
Max. permissible forward current $I_F = f(T)$



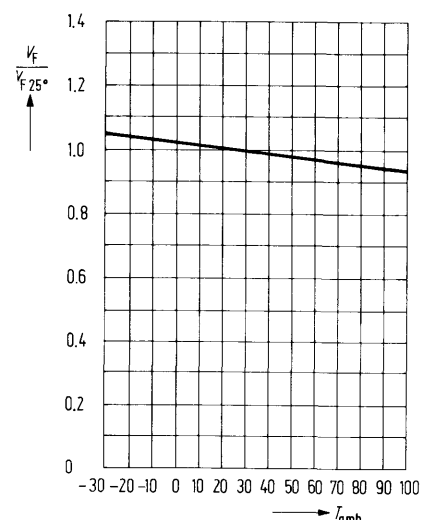
Forward voltage $I_F = f(V_F)$



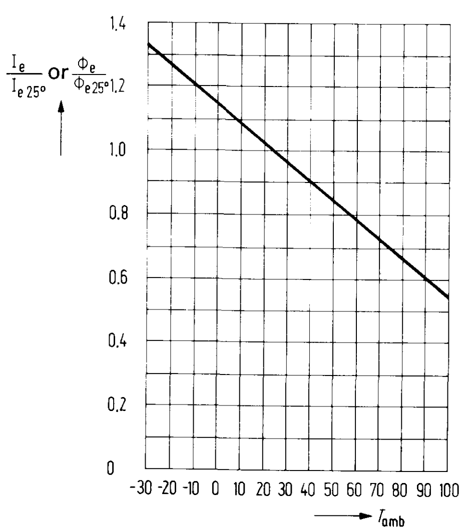
Capacitance $C = f(V_R)$



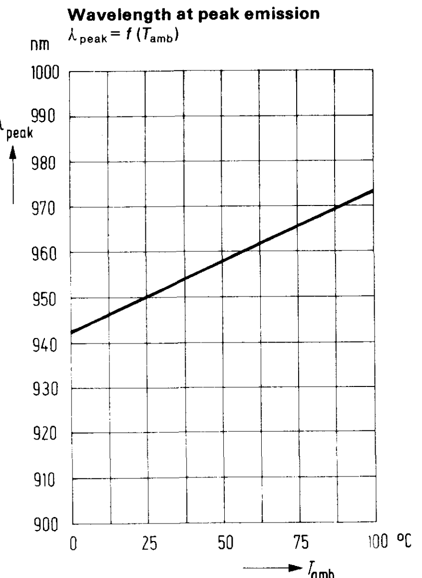
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



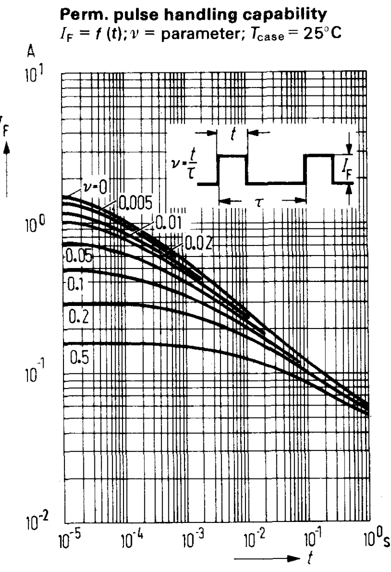
Radiant intensity $\frac{I_e}{I_{e\,25°}} = f(T_{amb})$



Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$



Perm. pulse handling capability
$I_F = f(t); \nu$ = parameter; $T_{case} = 25°C$



Light Emitting Diodes (LEDs)
(Red Emitter)
(Green Emitter)
(Yellow Emitter)

Summary of LEDs with red, green and yellow light

Type	
CQY 26 A	red
CQY 26/I	red
CQY 26/II	red
CQY 28 A	green
CQY 28/I	green
CQY 28/II	green
CQY 29 A	yellow
CQY 29/I	yellow
CQY 29/II	yellow
LD 30 A	red
LD 30/I	red
LD 30/II	red
LD 30 C	red
LD 37 A	green
LD 37/I	green
LD 37/II	green
LD 35 A	yellow
LD 35/I	yellow
LD 35/II	yellow
LD 40/I	red
LD 40/II	red
LD 50/I	red
LD 50/II	red
From Sept. 1975 types rearranged like LD 41 . . .	
LD 41/A	red
LD 41/I	red
LD 41/II	red
LD 57/A	green
LD 57/I	green
LD 57/II	green
LD 55 A	yellow
LD 55/I	yellow
LD 55/II	yellow

Dimensions in mm

Summary of LEDs with red, green and yellow light

Type	
LD 461	red
LD 461 A	red
LD 471	green
LD 471 A	green
LD 481	yellow
LD 481 A	yellow
LD 460 to LD 469	red
LD 470 to LD 479	green
LD 480 to LD 489	yellow

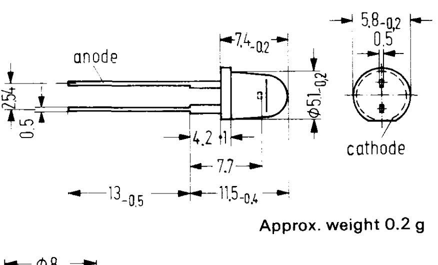
(Sample with 4 LEDs)

Dimensions in mm

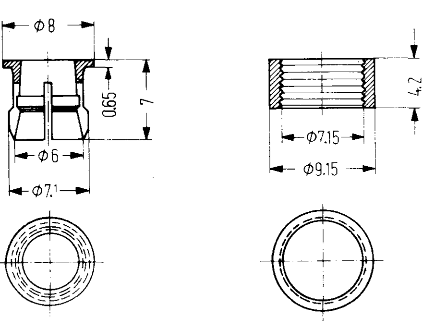
GaAsP Light Emitting Diode (Red Emitter) CQY 26

The CQY 26 is a GaAsP light emitting diode which emits red light when operated in forward direction. This diode is mainly intended as optical indicator for process control functions or for the indication of operations in devices with discrete or integrated semiconductor components. Owing to their very low current consumption in addition to low self heating and high resistance to vibration these LEDs are suitable for applications where signal lamps of conventional design are not or only inadequately useful. The CQY 26 can also be driven by TTL integrated circuits.

Type	Ordering code
CQY 26 A	Q 62 703-Q 52-S 1
CQY 26 I	Q 62 703-Q 52-S 2
CQY 26 II	Q 62 703-Q 52-S 3
Mounting sleeve with ring, black	Q 62 901-B 66



Approx. weight 0.2 g



Mounting sleeve

Mounting ring

Dimensions in mm

Maximum ratings

Reverse voltage	V_R	3	V
Forward current	I_F	100	mA
Surge current ($t \leq 10\ \mu s$)	i_{FS}	2.0	A
Storage temperature	T_{stor}	−55 to +100	°C
Junction temperature	T_j	100	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	210	mW
Thermal resistance			
Junction to air	R_{thJamb}	350	K/W

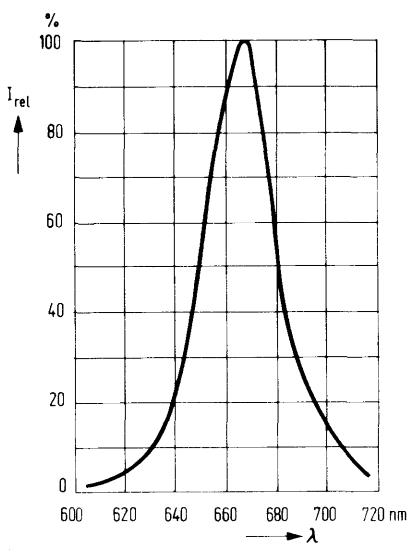
Characteristics (T_{amb}= 25°C)

Wavelength at peak emission	λ_{peak}	665 ±15	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	30	nm
Half angle (limits for 50% of luminous intensity I_v)	φ	25	degree
Forward voltage (I_F = 20 mA)	V_F	1.6 (≦ 2.0)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦ 10)	µA
Rise time	t_r	5	ns
Fall time	t_f	5	ns
Capacitance (V_R = 0 V)	C_0	60	pF
Temperature coefficient of I_v	TC	−0.8	%/K
Temperature coefficient of V_F	TC	−1.6	mV/K
Temperature coefficient of λ_{peak}	TC	0.3	nm/K

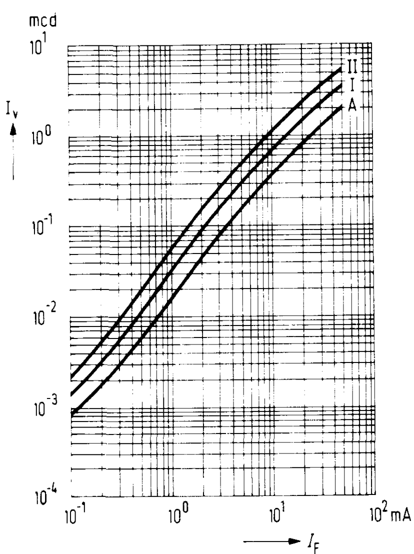
Luminous intensity (I_F = 20 mA)

Type	CQY 26 A	CQY 26 I	CQY 26 II	
I_v	0.8 (≧ 0.3)	1.5 (≧ 1.0)	2.5 (≧ 2.0)	mcd

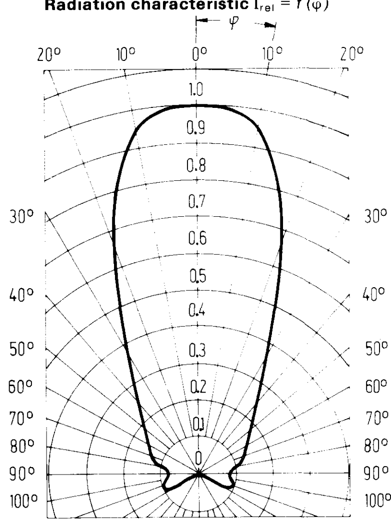
Relative spectral emission $I_{rel} = f(\lambda)$



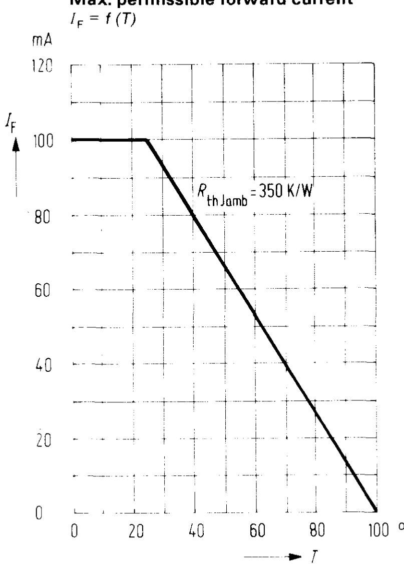
Luminous intensity $I_v = f(I_F)$



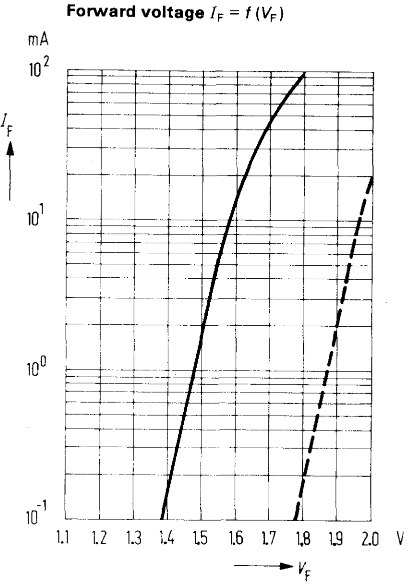
Radiation characteristic $I_{rel} = f(\varphi)$



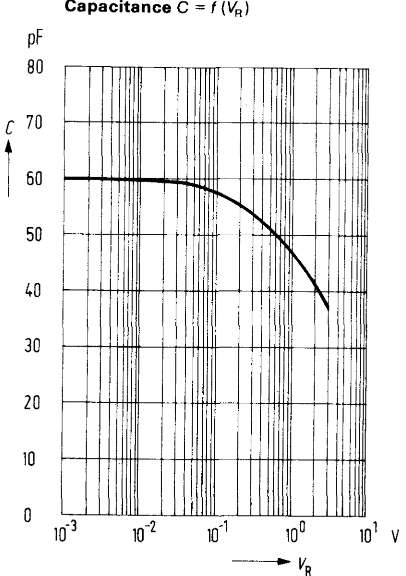
Max. permissible forward current
$I_F = f(T)$



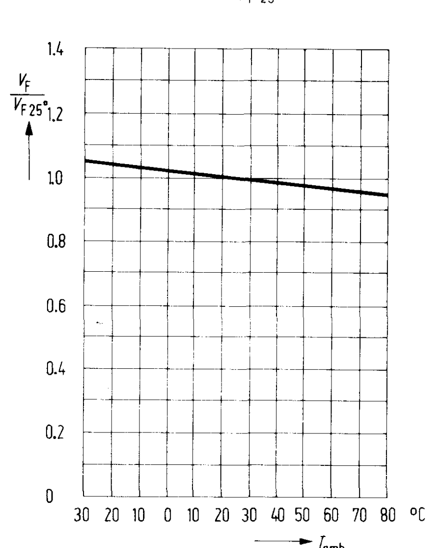
Forward voltage $I_F = f(V_F)$



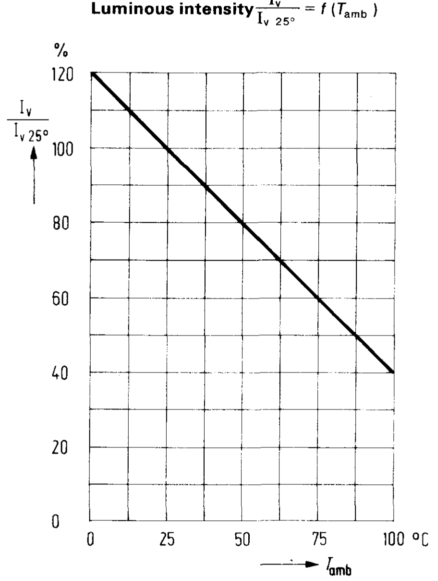
Capacitance $C = f(V_R)$



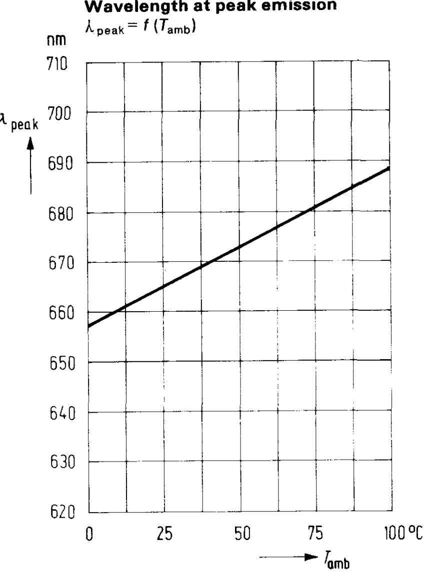
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



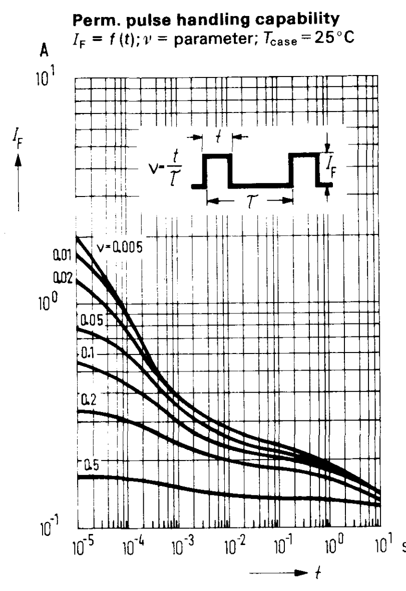
Luminous intensity $\frac{I_v}{I_{v\,25°}} = f(T_{amb})$



Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$



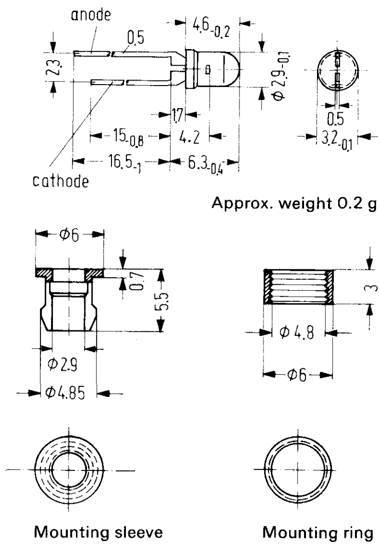
Perm. pulse handling capability
$I_F = f(t)$; ν = parameter; $T_{case} = 25\,°C$



GaAsP Light Emitting Diode (Red Emitter) LD 30 . . .

The types LD 30... are GaAsP light emitting diodes which emit red light when operated in forward direction. These diodes are mainly intended as optical indicators for process control functions or for the indication of operations in devices with discrete of integrated semiconductor components. Owing to their very low current consumption in addition to low self heating and high resistance to vibration, these LEDs are suitable for applications where signal lamps of conventional design are not or only inadequately useful. The LD 30... can also be driven by TTL integrated circuits. LD 30 A, I, II have a red diffuse, LD 30 C a glass-clear case.

Type	Ordering code
LD 30 A	Q 62 705-P 23-F 39
LD 30/I	Q 62 705-P 17-S 1
LD 30/II	Q 62 705-P 17-S 2
LD 30 C	Q 62 705-P 22-F 39
Mounting sleeve with ring, glass-clear	Q 62 901-B 61
Mounting sleeve with ring, black	Q 62 901-B 62



Mounting sleeve

Mounting ring

Dimensions in mm

Maximum ratings

Reverse voltage	V_R	3	V
Forward current	I_F	100	mA
Surge current ($t \leq 1\ \mu s$)	i_{FS}	2.0	A
Storage temperature	T_{stor}	−55 to +100	°C
Junction temperature	T_j	100	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	210	mW
Thermal resistance			
Junction to air	R_{thJamb}	350	K/W

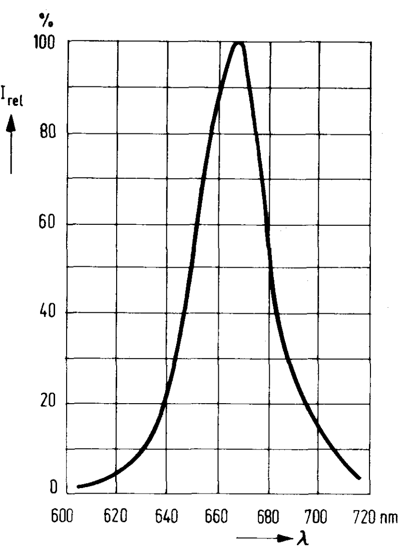
Characteristics (T_{amb} = 25°C)

Wavelength at peak emission	λ_{peak}	665 ±15	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	30	nm
Half angle			
(limits for 50% of luminous intensity I_V)			
LD 30 A, I, II	φ	35	degree
LD 30 C	φ	25	degree
Forward voltage (I_F = 20 mA)	V_F	1.6 (≦ 2.0)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦ 10)	µA
Rise time	t_r	5	ns
Fall time	t_f	5	ns
Capacitance (V_R = 0 V)	C_0	60	pF
Temperature coefficient of I_V	TC	−0.8	%/K
Temperature coefficient of V_F	TC	−1.6	mV/K
Temperature coefficient of λ_{peak}	TC	0.3	nm/K

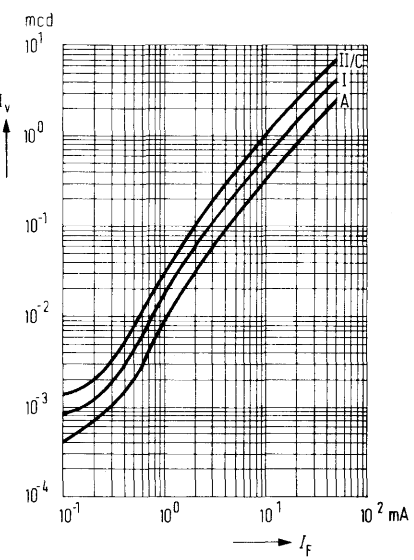
Luminous intensity (I_F = 20 mA)

Type	LD 30 A	LD 30/I	LD 30/II	LD 30 C	
I_V	0.8 (≧ 0.3)	1.5 (≧ 1.0)	2.5 (≧ 2.0)	2.5 (≧ 0.3)	mcd

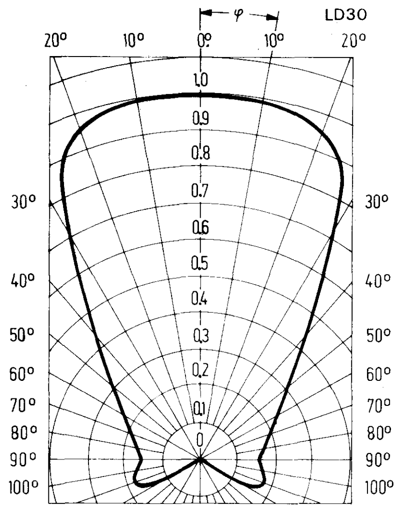
Relative spectral emission $I_{rel} = f(\lambda)$



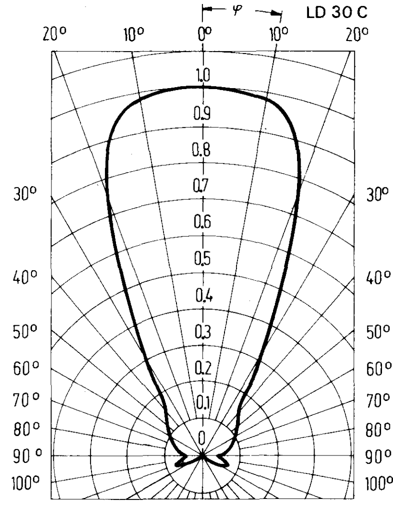
Luminous intensity $I_v = f(I_F)$

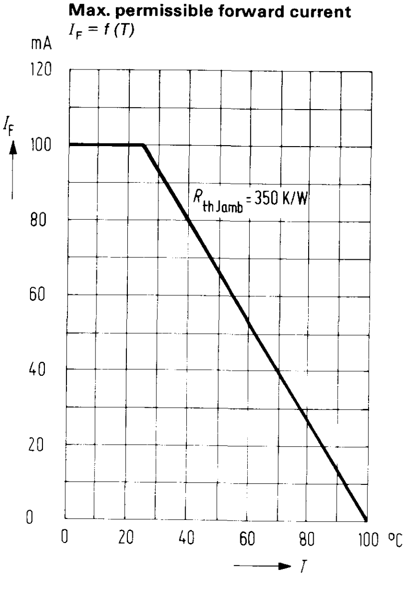


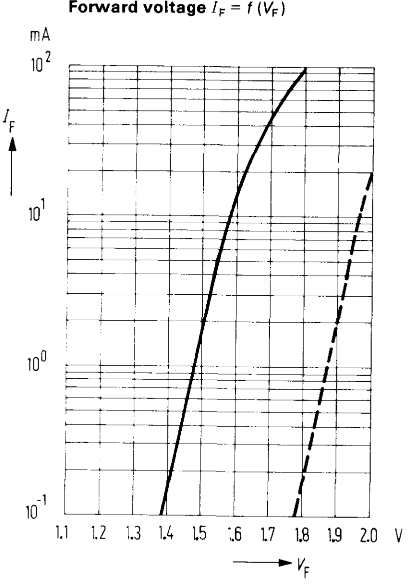
Radiation characteristic $I_{rel} = f(\varphi)$

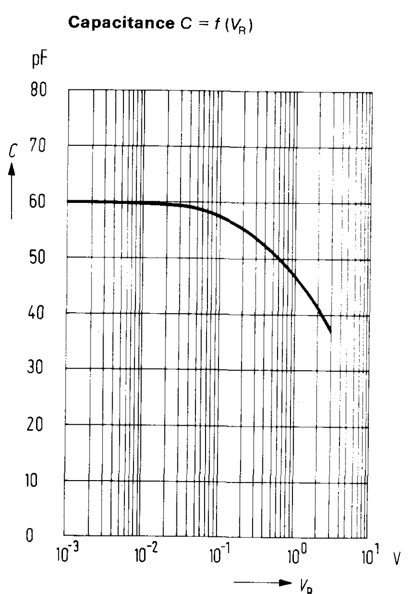


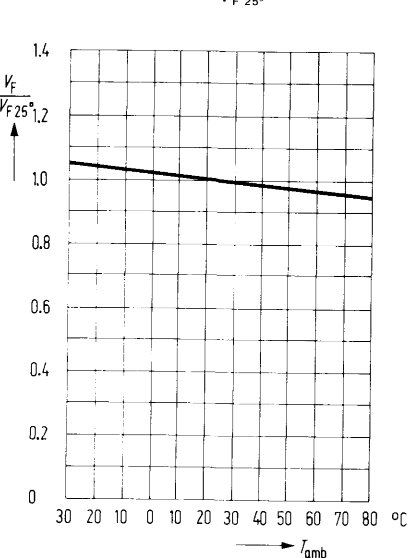
Radiation characteristic $I_{rel} = f(\varphi)$



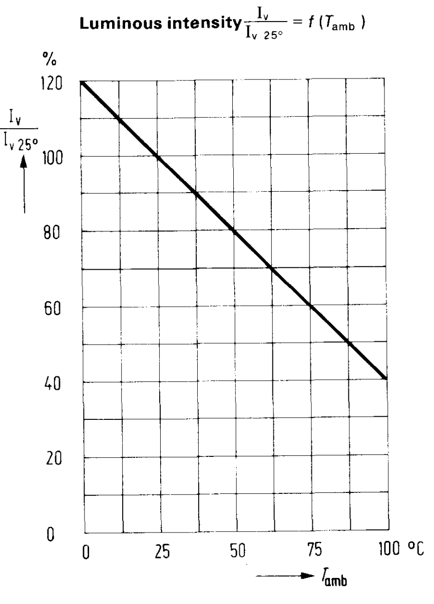

Max. permissible forward current
$I_F = f(T)$
mA
120
100
80
60
40
20
0
I_F
R_{thJamb} = 350 K/W
0
20
40
60
80
100 °C
T


Forward voltage $I_F = f(V_F)$
mA
10^2
10^1
10^0
10^{-1}
I_F
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0 V
V_F

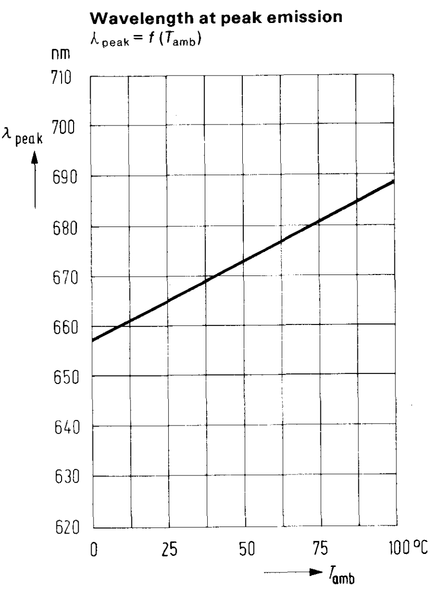

Capacitance $C = f(V_R)$
pF
80
70
60
50
40
30
20
10
0
C
10^{-3}
10^{-2}
10^{-1}
10^0
10^1 V
V_R


Forward voltage $\frac{V_F}{V_{F\ 25°}} = f(T_{amb})$
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
$\frac{V_F}{V_{F25°}}$
30
20
10
0
10
20
30
40
50
60
70
80 °C
T_{amb}

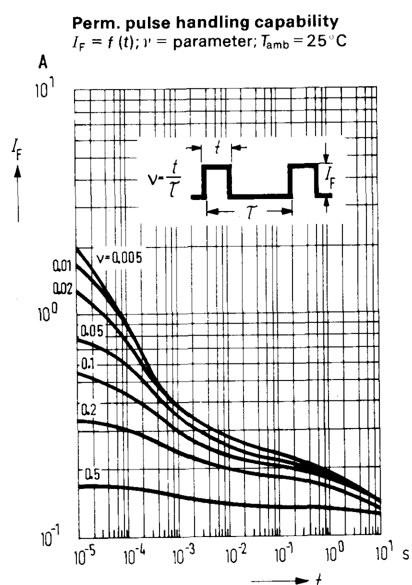
Luminous intensity $\frac{I_v}{I_{v\,25°}} = f\,(T_{amb})$



Wavelength at peak emission
$\lambda_{peak} = f\,(T_{amb})$



Perm. pulse handling capability
$I_F = f\,(t)$; ν = parameter; $T_{amb} = 25\,°C$

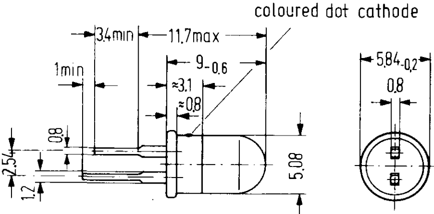


GaAsP Light Emitting Diode (Red Emitter) — LD 40

Not for new equipment

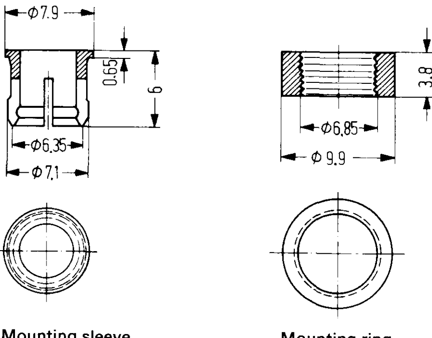
The types LD 40 I and LD 40 II are GaAsP light emitting diodes which emit red light when operated in forward direction. These diodes are mainly intended as optical indicator for process control functions or for the indication of operations in devices with discrete or integrated semiconductor components. Owing to their very low current consumption in addition to low self heating and high resistance to vibration, these LEDs are suitable for applications where signal lamps of conventional design are not or only inadequately useful. These LEDs can also be driven by TTL integrated circuits.

Type	Ordering code
LD 40 I	Q 62 703-P 2-F 39
LD 40 II	Q 62 703-P 3-F 39
Mounting sleeve with ring, black	Q 62 902-B 110-F 39



Approx. weight 0.2 g

Dimensions in mm



Mounting sleeve

Mounting ring

Maximum ratings

Reverse voltage	V_R	3	V
Forward current	I_F	50	mA
Surge current ($t \leq 1\,\mu s$)	i_{FS}	1	A
Insulation voltage between terminals and sleeve	V	300	V
Operating and storage temperature	T_{stor}	−55 to +100	°C
Soldering temperature ($t \leq 7$ s)	T_s	230	°C
Power dissipation (T_{amb} = 25°C) (from T_{amb} = 50°C reduced by 1.6 mW/K)	P_{tot}	100	mW

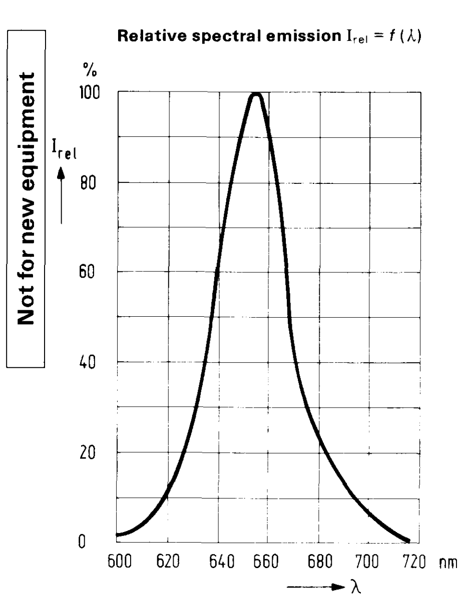
Characteristics (T_{amb} = 25°C)

		LD 40/I	LD 40/II	
Luminous intensity (I_F = 20 mA)	I_v	0.7 (≧ 0.3)	1.2 (≧ 0.8)	mcd
Wavelength at peak emission	λ_{lmax}	655 ±15	655 ±15	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	30	30	nm
Turn-on time	t_{on}	10	10	ns
Turn-off time	t_{off}	10	10	ns
Forward voltage (I_F = 20 mA)	V_F	1.6 (≦ 2)	1.6 (≦ 2)	V
Reverse current at V_R = 3 V	I_R	10	10	μA
Colour code		orange	white	

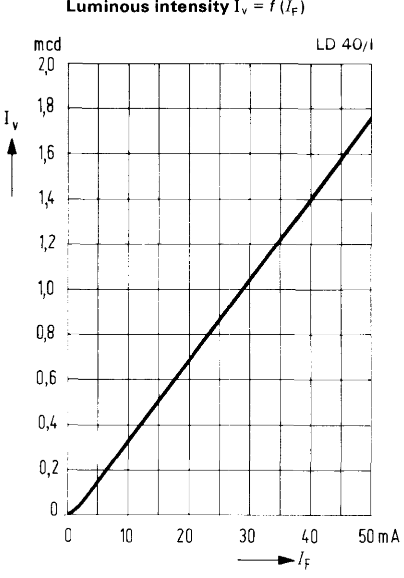
Not for new equipment

Not for new equipment

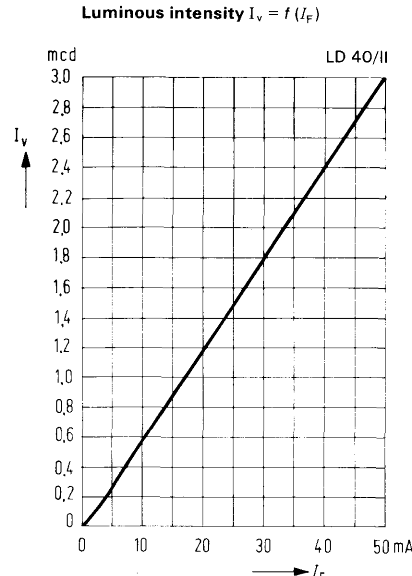
Relative spectral emission $I_{rel} = f(\lambda)$



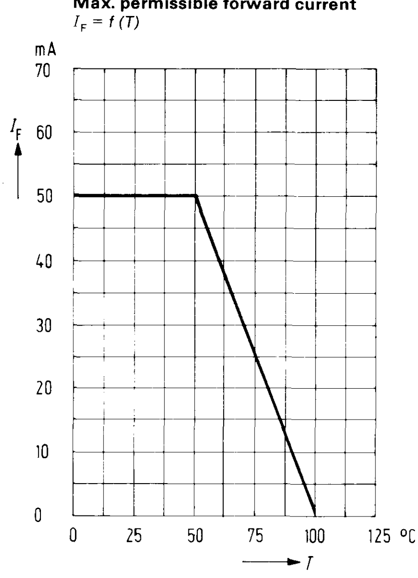
Luminous intensity $I_v = f(I_F)$



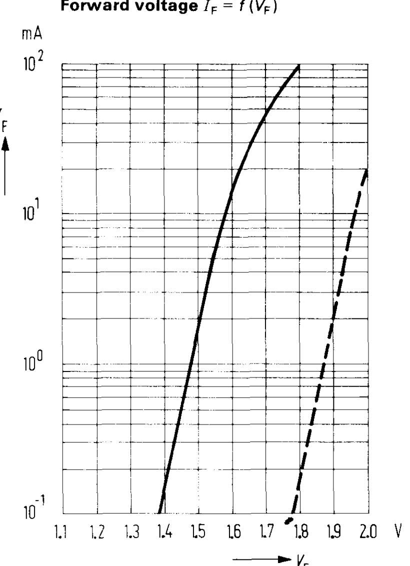
Luminous intensity $I_v = f(I_F)$



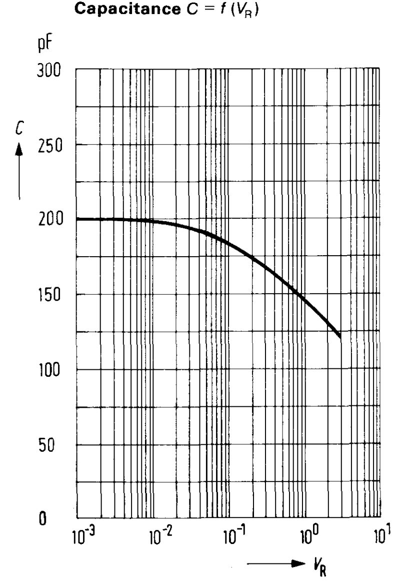
Max. permissible forward current
$I_F = f(T)$



Forward voltage $I_F = f(V_F)$



Capacitance $C = f(V_R)$



Not for new equipment

GaAsP Light Emitting Diode (Red Emitter) — LD 41

The LD 41 is a GaAsP light emitting diode which emits red light when operated in forward direction. This diode is mainly intended as optical indicator for process control functions or for the indication of operations in devices with discrete or integrated semiconductor components. Owing to their very low current consumption in addition to low self heating and high resistance to vibration these LEDs are suitable for applications where signal lamps of conventional design are not or only inadequately useful. The LD 41 can also be driven by TTL integrated circuits.

Type	Ordering code
LD 41/A	Q 62 703-Q 115-S 1
LD 41/I	Q 62 703-Q 115-S 2
LD 41/II	Q 62 703-Q 115-S 3
Mounting sleeve with ring, glass-clear	Q 62 901-B 64
Mounting sleeve with ring, black	Q 62 901-B 65

Approx. weight 0.2 g

Dimensions in mm

Mounting sleeve

Mounting ring

Maximum ratings

Reverse voltage	V_R	3	V
Forward current	I_F	100	mA
Surge current ($t \leq 1\,\mu s$)	i_{FS}	2.0	A
Storage temperature	T_{stor}	−55 to +100	°C
Junction temperature	T_j	100	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	210	mW
Thermal resistance Junction to air	R_{thJamb}	350	K/W

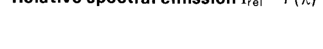
Characteristics (T_{amb} = 25°C)

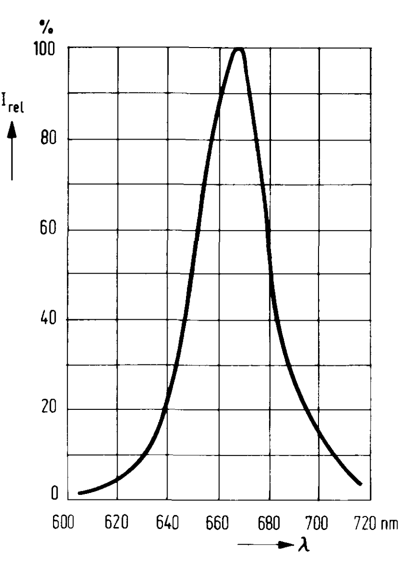
Wavelength at peak emission	λ_{peak}	665 ±15	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	30	nm
Half angle			
(limits for 50% of luminous intensity I_v)	φ	25	degree
Forward voltage (I_F = 20 mA)	V_F	1.6 (≦2.0)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦10)	µA
Rise time	t_r	5	ns
Fall time	t_f	5	ns
Capacitance (V_R = 0 V)	C_0	60	pF
Temperature coefficient of I_v	TC	−0.8	%/K
Temperature coefficient of V_F	TC	−1.6	mV/K
Temperature coefficient of λ_{peak}	TC	0.3	nm/K

Luminous intensity (I_F = 20 mA)

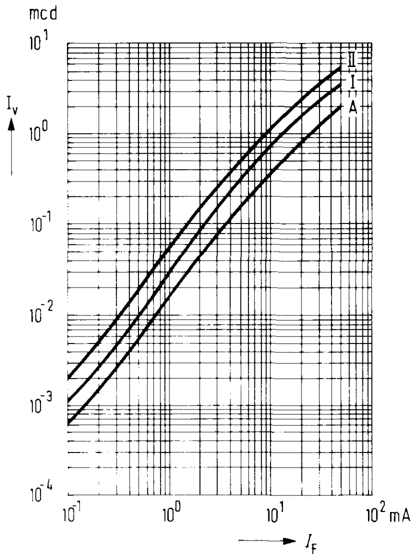
Type	LD 41 A	LD 41/I	LD 41/II	
I_v	0.8 (≧0.3)	1.5 (≧1.0)	2.5 (≧2.0)	mcd

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

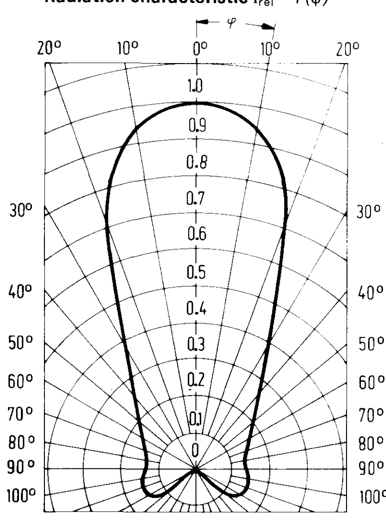




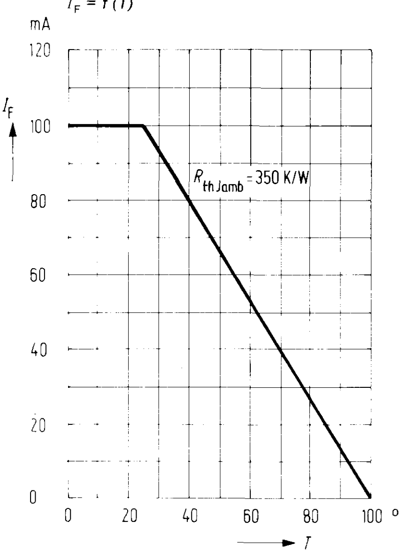
Luminous intensity $I_v = f(I_F)$



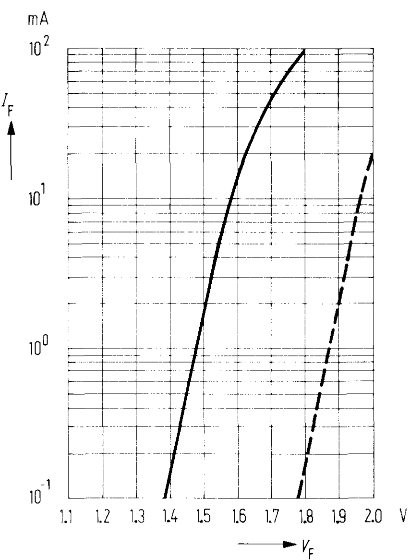
Radiation characteristic $I_{rel} = f(\varphi)$



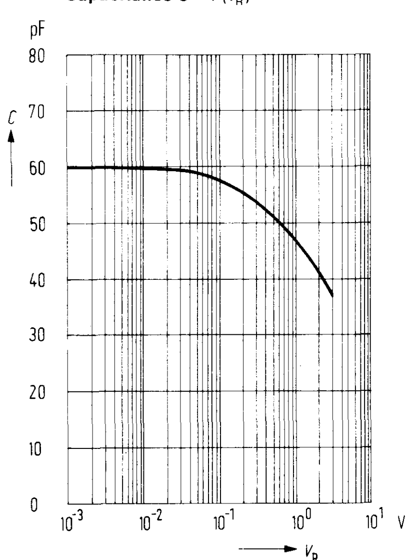
Max. permissible forward current
$I_F = f(T)$



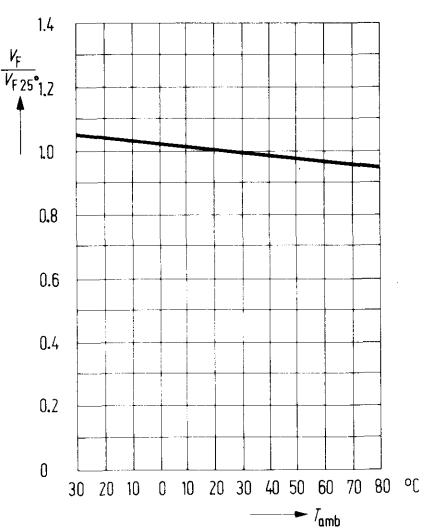
Forward voltage $I_F = f(V_F)$



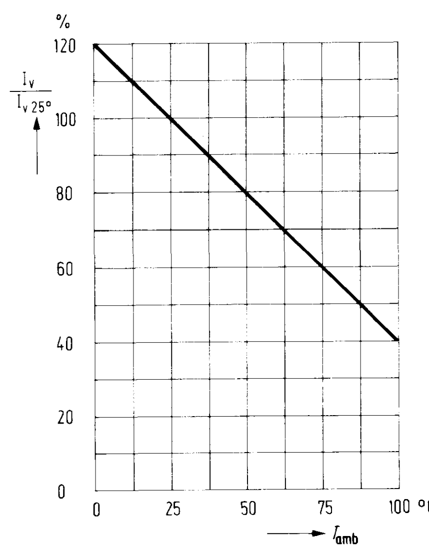
Capacitance $C = f(V_R)$



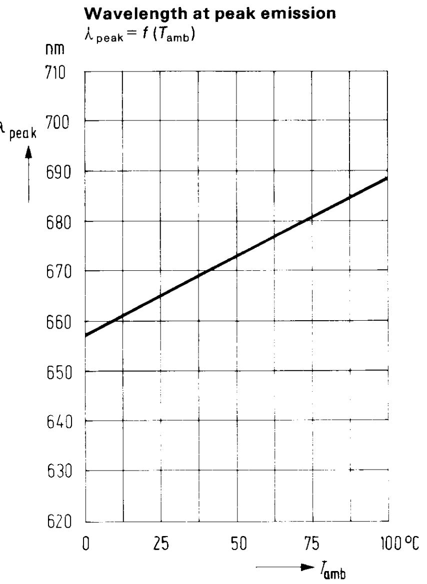
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



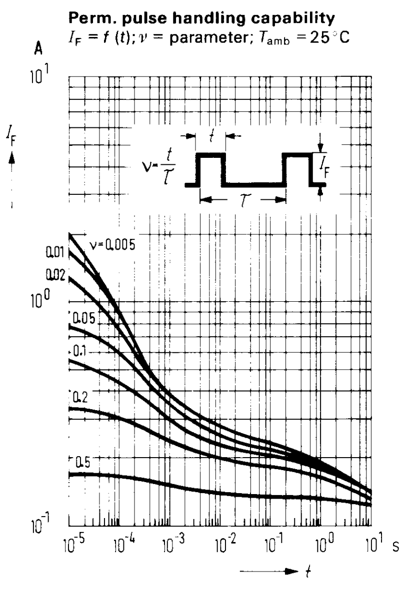
Luminous intensity $\frac{I_v}{I_{v\,25°}} = f(T_{amb})$



Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$

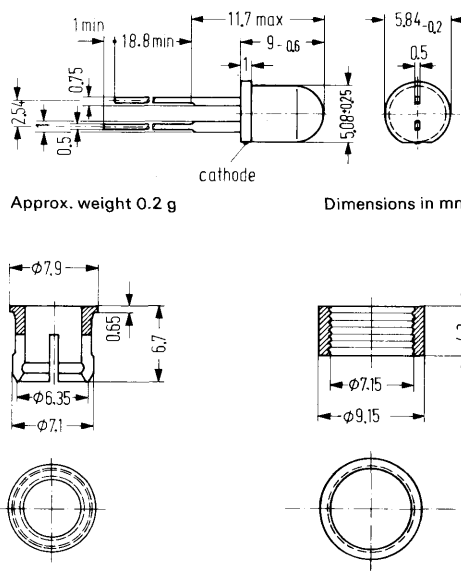


Perm. pulse handling capability
$I_F = f(t)$; ν = parameter; $T_{amb} = 25\,°C$



The LD 50 is a GaAsP light emitting diode which emits red light when operated in forward direction. This diode is mainly intended as optical indicator for process control functions or for the indication of operations in devices with discrete or integrated semiconductor components. Owing to their very low current consumption in addition to low self heating and high resistance to vibration these LEDs are suitable for applications where signal lamps of conventional design are not or only inadequately useful. The LD 50 can also be driven by TTL integrated circuits.

Type	Ordering code
LD 50/I	Q 62 703-Q 53
LD 50/II	Q 62 703-Q 54
Mounting sleeve with ring, glass-clear	Q 62 901-B 64
Mounting sleeve with ring, black	Q 62 901-B 65



Approx. weight 0.2 g

Dimensions in mm

Mounting sleeve

Mounting ring

From Sept. 1975 types rearranged like LD 41 . . .

Maximum ratings

Reverse voltage	V_R	3	V
Forward current	I_F	100	mA
Surge current ($t \leq 1\,\mu s$)	i_{FS}	2.0	A
Storage temperature	T_{stor}	−55 to +100	°C
Junction temperature	T_j	100	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	210	mW
Thermal resistance			
Junction to air	R_{thJamb}	350	K/W

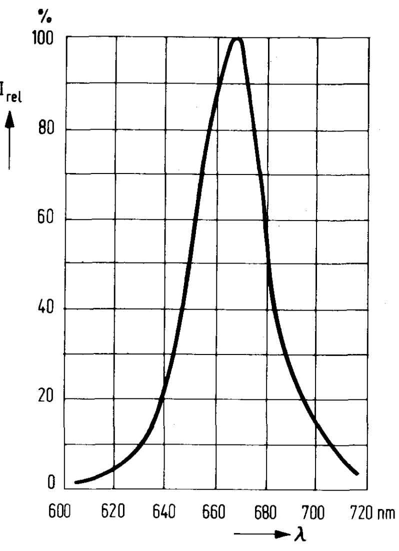
Characteristics (T_{amb} = 25°C)

Wavelength at peak emission	λ_{peak}	665 ±15	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	30	nm
Half angle (limits for 50% of luminous intensity I_v)	φ	12	degree
Forward voltage (I_F = 20 mA)	V_F	1.6 (≦ 2.0)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦ 10)	µA
Rise time	t_r	5	ns
Fall time	t_f	5	ns
Capacitance (V_R = 0 V)	C_0	60	pF
Temperature coefficient of I_v	TC	−0.8	%/K
Temperature coefficient of V_F	TC	−1.6	mV/K
Temperature coefficient of λ_{peak}	TC	0.3	nm/K

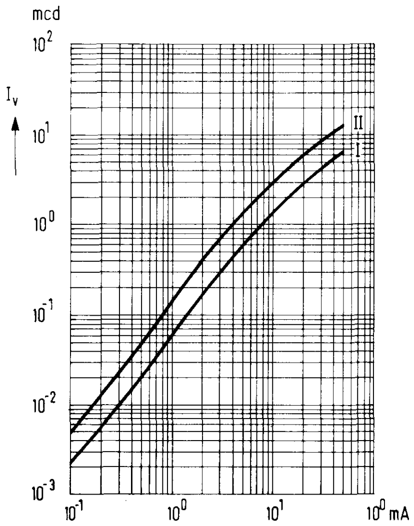
Luminous intensity (I_F = 20 mA)

Type	LD 50/I	LD 50/II	
I_v	3.0 (≧ 2.0)	6.0 (≧ 4.0)	mcd

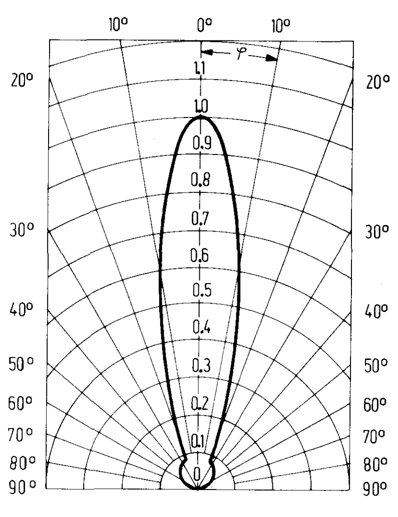
Relative spectral emission $I_{rel} = f(\lambda)$



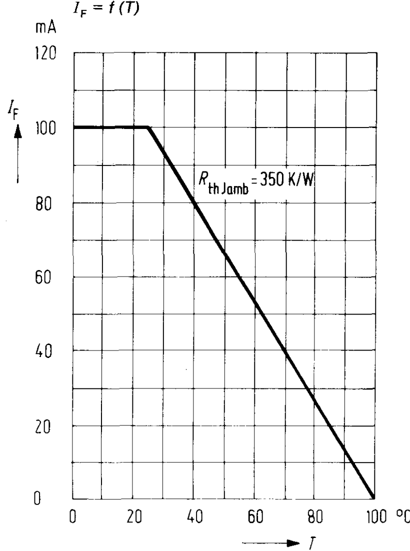
Luminous intensity $I_v = f(I_F)$



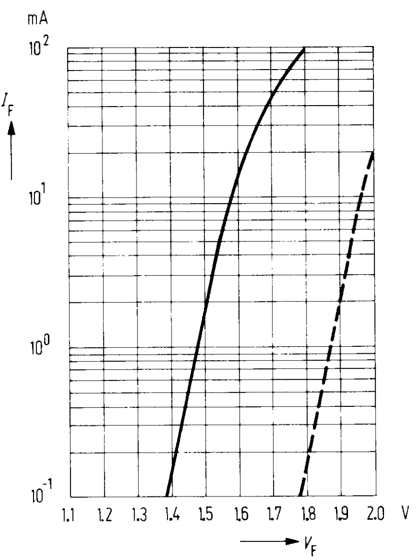
Radiation characteristic $I_{rel} = f(\varphi)$



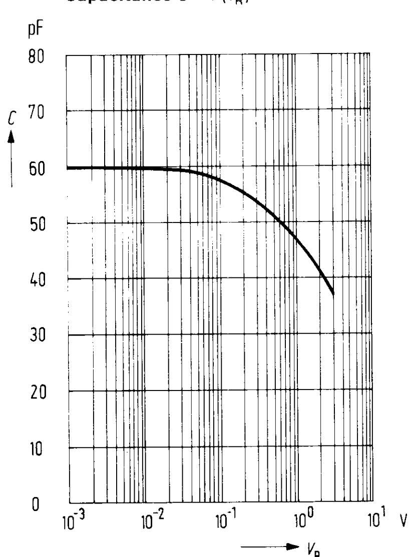
Max. permissible forward current
$I_F = f(T)$



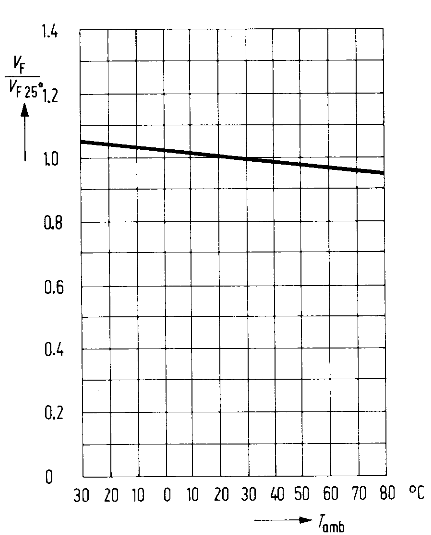
Forward voltage $I_F = f(V_F)$



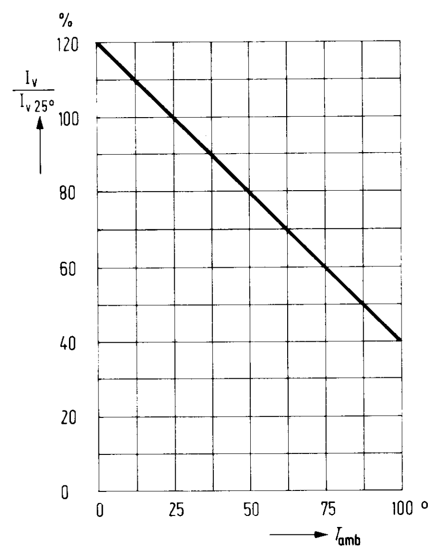
Capacitance $C = f(V_R)$



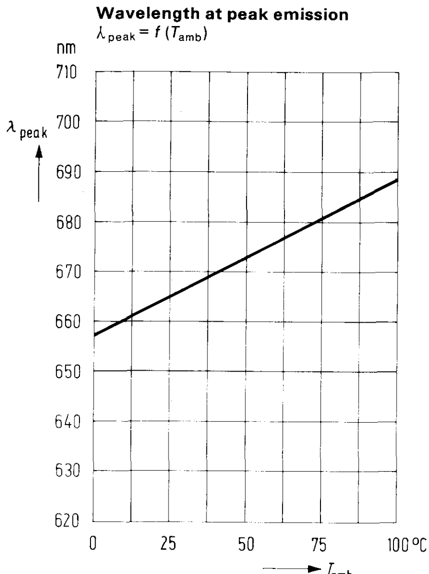
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



Luminous intensity $\frac{I_v}{I_{v\,25°}} = f(T_{amb})$



Wavelength at peak emission
$\lambda_{peak} = f\ (T_{amb})$



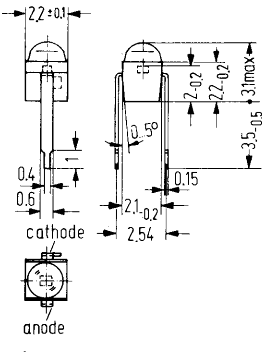
GaAsP Light Emitting Diode (Red Emitter) 2.54 mm Lead Spacing

LD 461

The LD 461 emits red light when current flows in forward direction. Features of the diode are: a white diffuse plastic encapsulation, the form of a lens on the side where light is emittted, and solder pin connections in the 2.54 mm (1/10") lead spacing. The cathode is marked by a small projection on the connecting leg.

This diode is TTL compatible as a result of its low current consumption. It is used as optical indicator for process control functions in electronic equipment. As light emitting diode arrays (LD 460 to LD 469) the diodes are suitable for the assembly of complete indicator arrangements, such as characters and scales.

Type	Ordering code
LD 461	Q 62 703-Q 79
LD 461 A	Q 62 703-Q 79-S 1



Approx. weight 0.2 g

Dimensions in mm

Maximum ratings

Reverse voltage	V_R	3	V
Forward current	I_F	35	mA
Surge current ($t \leq 10\ \mu s$)	i_{FS}	1.0	A
Storage temperature	T_{stor}	−40 to +100	°C
Junction temperature	T_j	80	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leq 3$ s)	T_s	230	°C
Power dissipation (T_L = 25°C)	P_{tot}	85	mW
Thermal resistance			
Junction to air	R_{thJamb}	750	K/W
Junction to solder pin	R_{thJL}	650	K/W

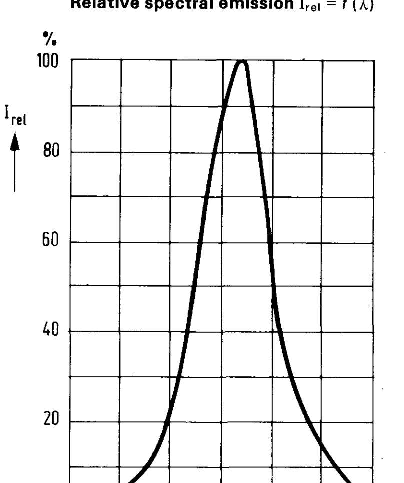
Characteristics (T_{amb} = 25°C)

Wavelength at peak emission	λ_{peak}	665 ± 15	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	30	nm
Half angle (limits for 50% of luminous intensity I_v)	φ	50	degree
Forward voltage (I_F = 20 mA)	V_R	1.6 (≦ 2.0)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦ 10)	µA
Rise time	t_r	5	ns
Fall time	t_f	5	ns
Capacitance (V_R = 0 V)	C_0	65	pF
Temperature coefficient of I_v	TC	−0.8	%/K
Temperature coefficient of V_F	TC	−1.6	mV/K
Temperature coefficient of λ_{peak}	TC	0.3	nm/K

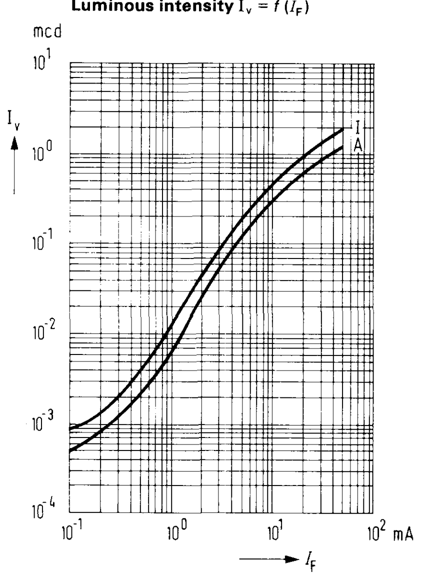
Luminous intensity (I_F = 20 mA)

Type	LD 461	LD 461 A	
I_v	1 (≧ 0.6)	≧ 0.4	mcd

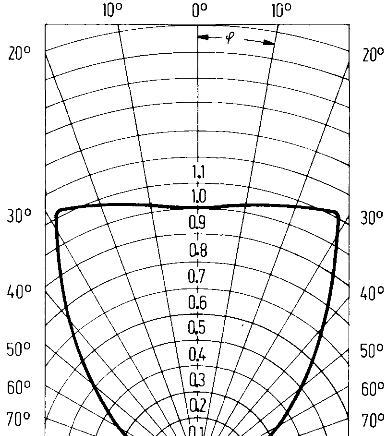
Relative spectral emission $I_{rel} = f(\lambda)$



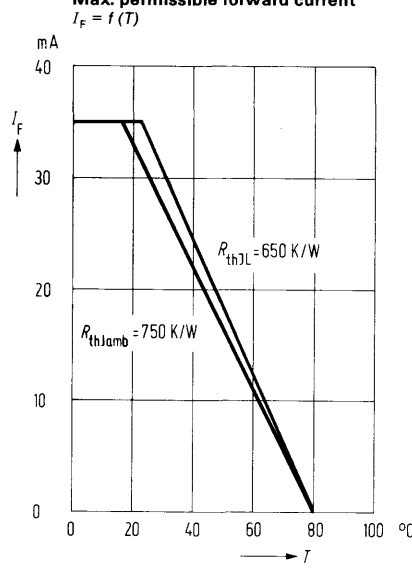
Luminous intensity $I_v = f(I_F)$



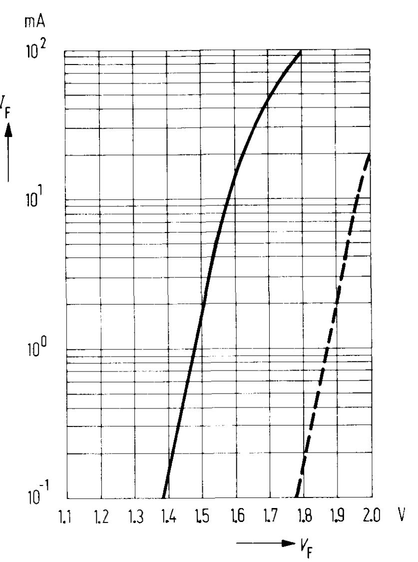
Radiation characteristic $I_{rel} = f(\varphi)$



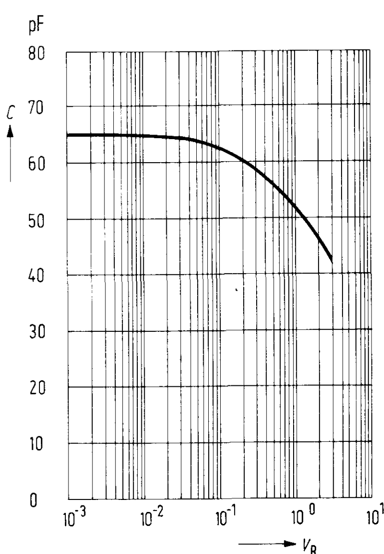
Max. permissible forward current
$I_F = f(T)$



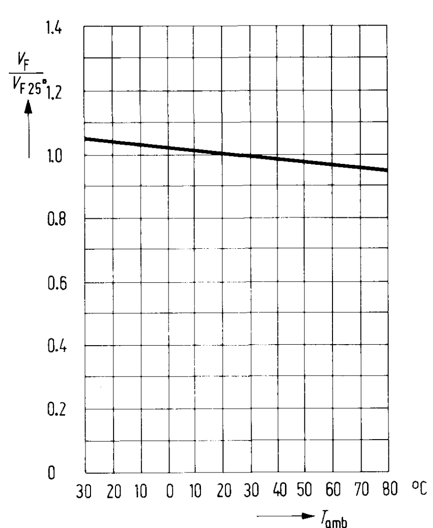
Forward voltage $I_F = f(V_F)$



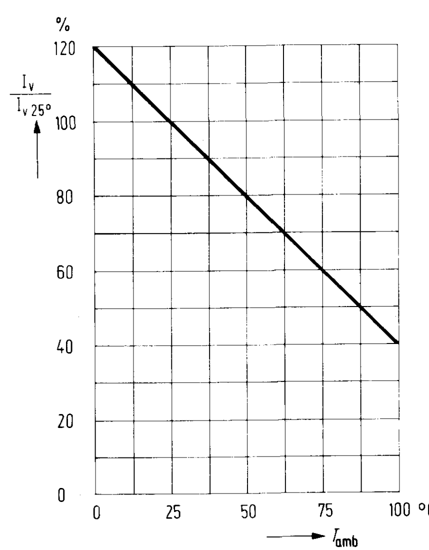
Capacitance $C = f(V_R)$



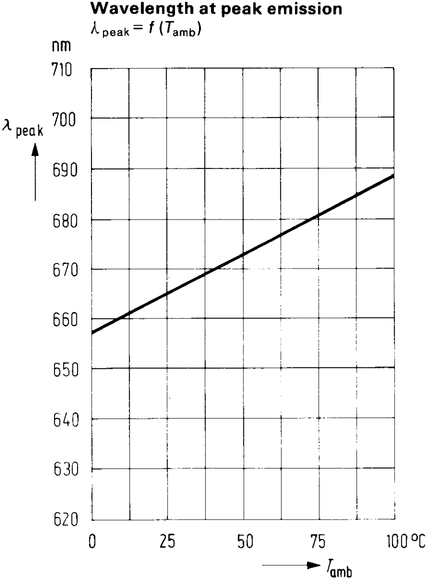
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



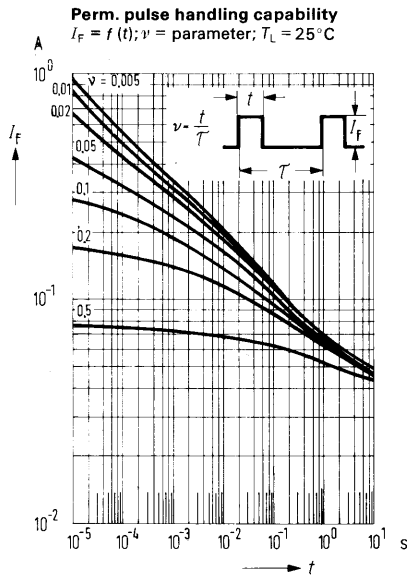
Luminous intensity $\frac{I_v}{I_{v\,25°}} = f(T_{amb})$



Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$



Perm. pulse handling capability
$I_F = f(t)$; ν = parameter; $T_L = 25°C$

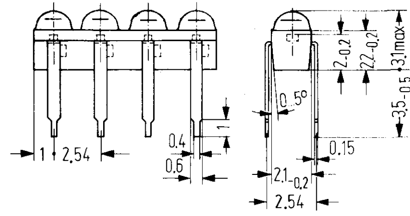


GaAsP Light Emitting Diode Arrays (Red Emitter) 2.54 mm Lead Spacing

LD 460 to LD 469

The types LD 460 to LD 469 are GaAsP light emitting diode arrays in white diffuse plastic encapsulation. The arrays consist of an arrangement of max. 10 light emitting diodes in one row. The diodes emit red light when current flows in forward direction. The spaces between the individual diodes are in accordance with the standard lead spacing of 2.54 mm (1/10"). The 3rd digit of the type designation is identical with the number of LEDs in one row (e.g. LD 464 is an array with 4 LEDs; LD 460 one with 10 LEDs).

Type	Number of LEDs per array	Ordering code
LD 462	2	Q 62 703-Q 80
LD 463	3	Q 62 703-Q 81
LD 464	4	Q 62 703-Q 82
LD 465	5	Q 62 703-Q 83
LD 466	6	Q 62 703-Q 84
LD 467	7	Q 62 703-Q 85
LD 468	8	Q 62 703-Q 86
LD 469	9	Q 62 703-Q 87
LD 460	10	Q 62 703-Q 88



Sample with 4 diodes (e.g. LD 464)
Dimensions in mm

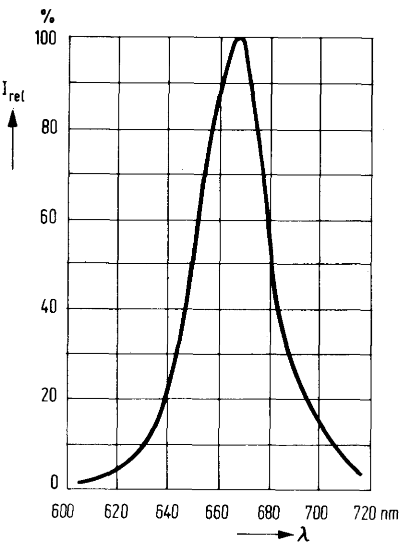
Maximum ratings (Individual diode)

Reverse voltage	V_R	3	V
Forward current	I_F	35	mA
Surge current ($t \leqq 10$ µs)	i_{FS}	1.0	A
Storage temperature	T_{stor}	−40 to +80	°C
Junction temperature	T_j	80	°C
Soldering temperature in a 2 mm distance from the case bottom at ($t \leqq 3$ s)	T_s	230	°C
Power dissipation (T_L = 25°C)	P_{tot}	85	mW
Thermal resistance			
Junction to air	R_{thJamb}	750	K/W
Junction to solder pin	R_{thJL}	650	K/W

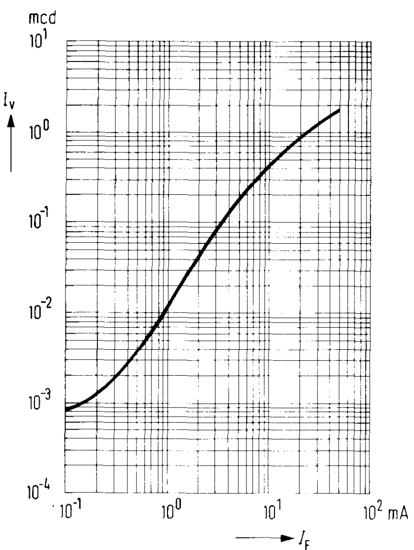
Characteristics (T_{amb} = 25°C)

Luminous intensity (I_F = 20 mA)	I_v	0.6 to 1.2	mcd
Wavelength at peak emission	λ_{peak}	665 ± 15	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	30	nm
Half angle (limits for 50% of luminous intensity I_v)	φ	50	degree
Forward voltage (I_F = 20 mA)	V_F	1.6 (≦ 2.0)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦ 10)	μA
Capacitance (V_R = 0 V)	C_0	65	pF
Rise time	t_r	5	ns
Fall time	t_f	5	ns
Temperature coefficient of I_v	TC	−0.8	%/K
Temperature coefficient of V_F	TC	−1.6	mV/K
Temperature coefficient of λ_{peak}	TC	0.3	nm/K

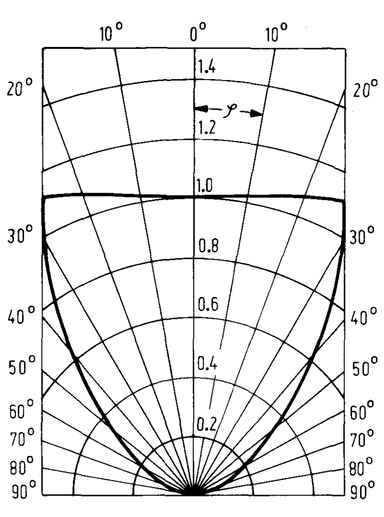
Relative spectral emission $I_{rel} = f(\lambda)$



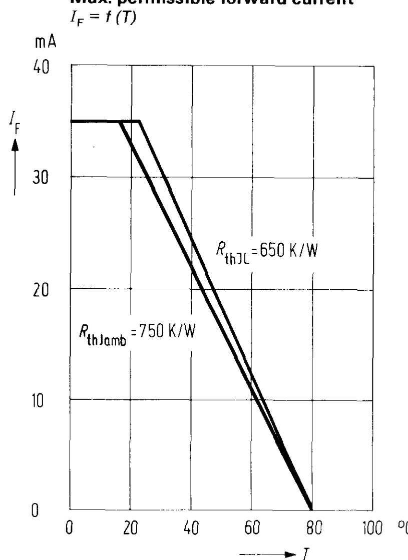
Luminous intensity $I_v = f(I_F)$



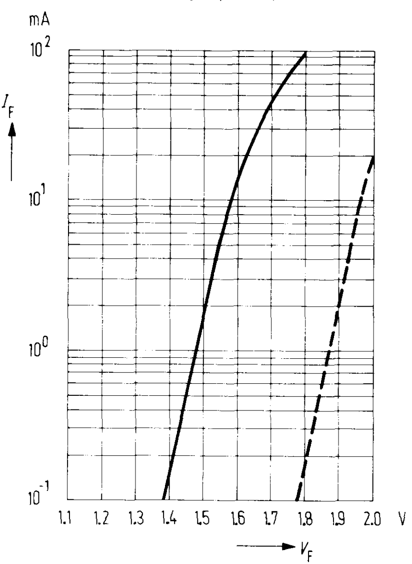
Radiation characteristic $I_{rel} = f(\varphi)$



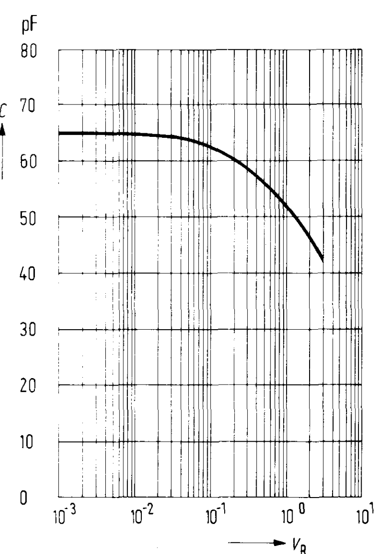
Max. permissible forward current
$I_F = f(T)$



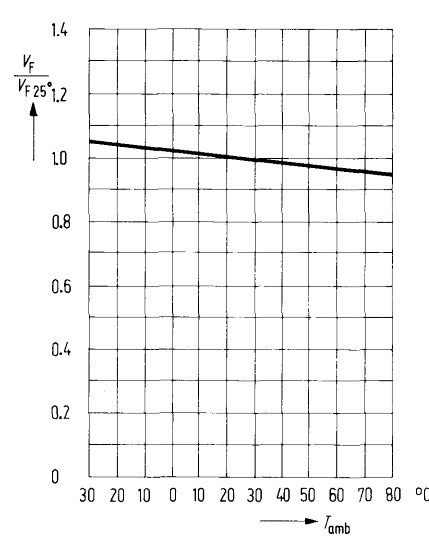
Forward voltage $I_F = f(V_F)$



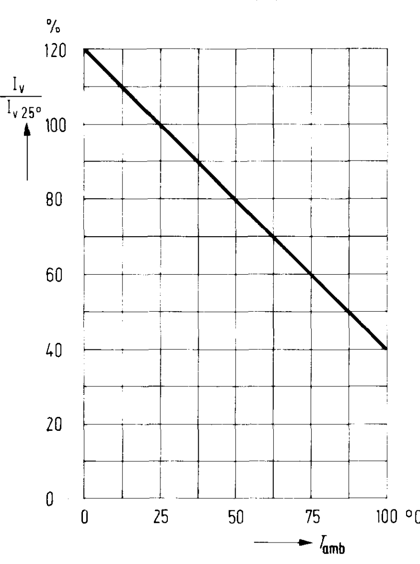
Capacitance $C = f(V_R)$



Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$

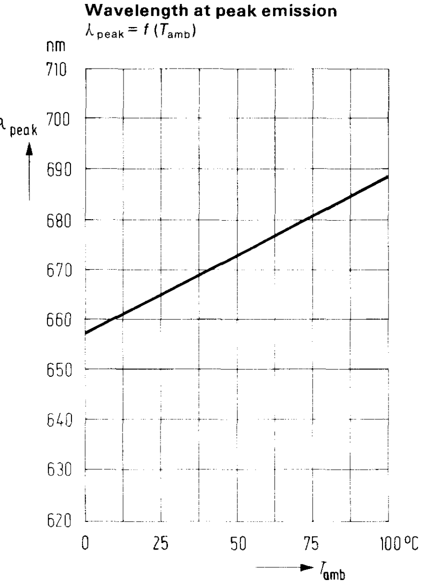


Luminous intensity $\frac{I_v}{I_{v\,25°}} = f(T_{amb})$



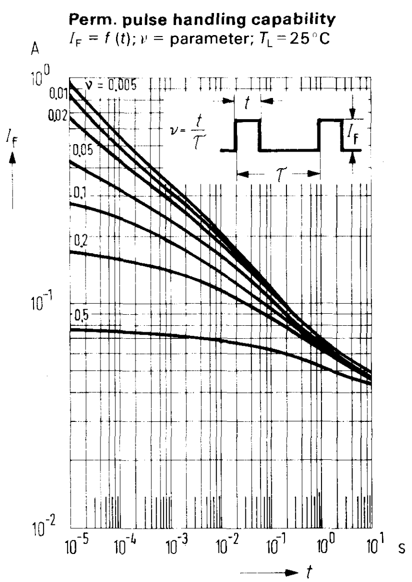
Wavelength at peak emission

$\lambda_{peak} = f(T_{amb})$



Perm. pulse handling capability

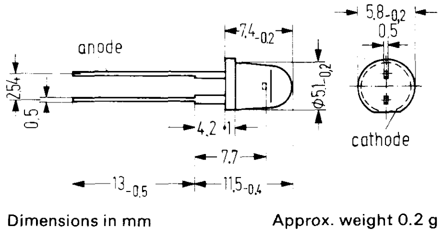
$I_F = f(t)$; ν = parameter; $T_L = 25\,°C$



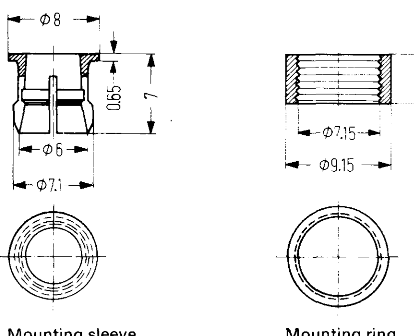
GaP Light Emitting Diode (Green Emitter) **CQY 28**

The CQY 28 is a GaP light emitting diode which emits green light when operated in forward direction. This diode is mainly intended as optical indicator for process control functions or for the indication of operations in devices with discrete or integrated semiconductor components. Owing to their very low current consumption in addition to low self heating and high resistance to vibration these LEDs are suitable for applications where signal lamps of conventional design are not or only inadequately useful. The CQY 28 can also be driven by TTL integrated circuits. CQY 28 has a green diffuse case.

Type	Ordering code
CQY 28 A	Q 68 000-A 766-S 1
CQY 28/I	Q 68 000-A 766-S 2
CQY 28/II	Q 68 000-A 766-S 3
Mounting sleeve with ring, black	Q 62 901-B 66



Dimensions in mm Approx. weight 0.2 g



Mounting sleeve Mounting ring

Maximum ratings

Reverse voltage	V_R	3	V
Forward current	I_F	60	mA
Surge current ($t \leq 1\ \mu s$)	i_{FS}	1	A
Storage temperature	T_{stor}	−55 to +100	°C
Junction temperature	T_j	100	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	210	mW
Thermal resistance Junction to air	R_{thJamb}	350	K/W

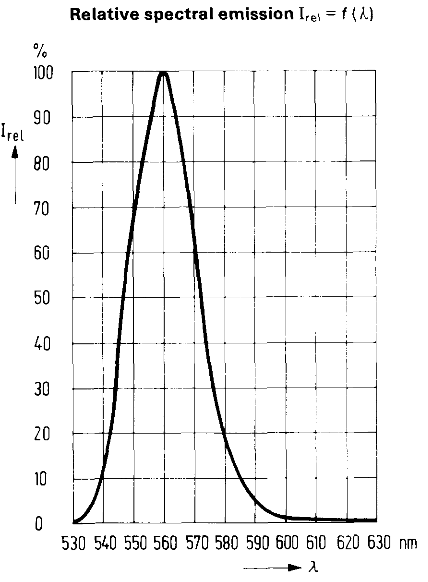
Characteristics (T_{amb} = 25°C)

Wavelength at peak emission	λ_{peak}	560 ± 15	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	25	nm
Half angle (limits for 50% of luminous intensity I_v)	φ	25	degree
Forward voltage (I_F = 20 mA)	V_F	2.4 (≦ 3.0)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦ 10)	μA
Rise time	t_r	50	ns
Fall time	t_f	50	ns
Capacitance (V_R = 0 V)	C_0	45	pF
Temperature coefficient of I_v	TC	−0.55	%/K
Temperature coefficient of V_F	TC	−1.6	mV/K
Temperature coefficient of λ_{peak}	TC	0.15	nm/K

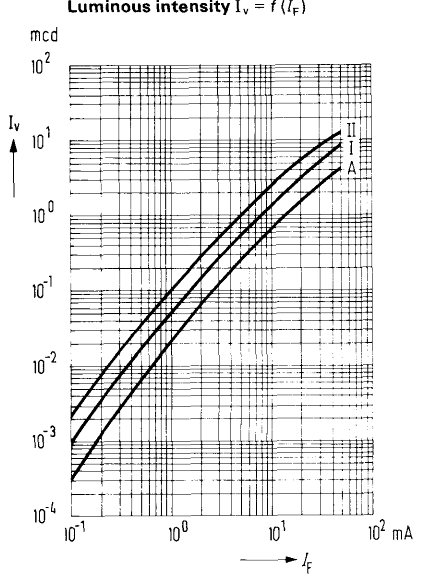
Luminous intensity (I_F = 20 mA)

Type	CQY 28 A	CQY 28/I	CQY 28/II	
I_v	1.2 (≧ 0.6)	3.0 (≧ 2.0)	5.5 (≧ 4.0)	mcd

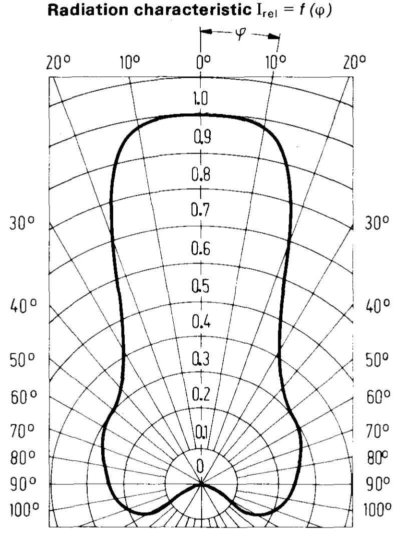
Relative spectral emission $I_{rel} = f(\lambda)$



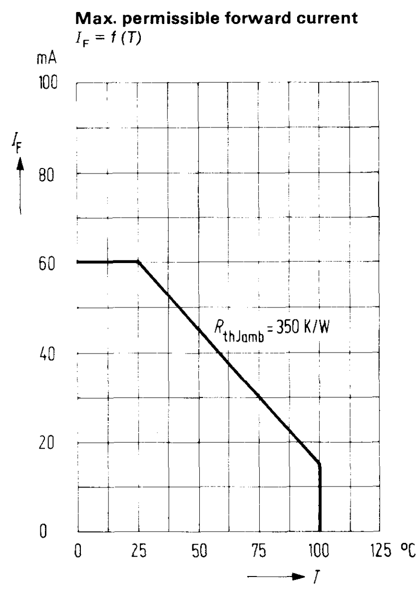
Luminous intensity $I_v = f(I_F)$



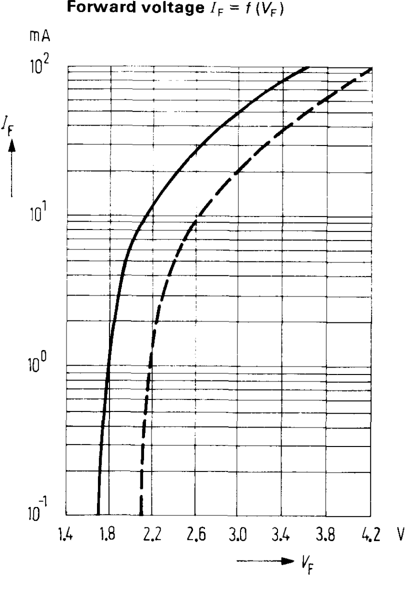
Radiation characteristic $I_{rel} = f(\varphi)$



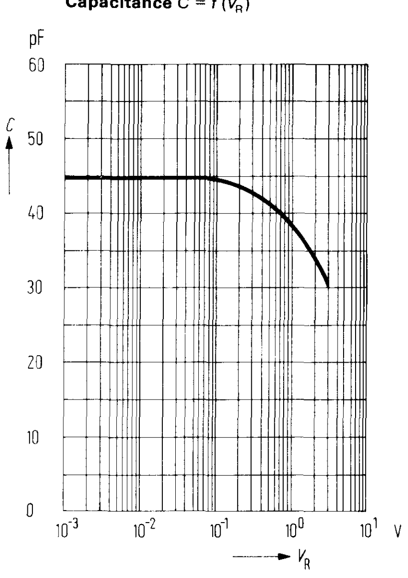
Max. permissible forward current
$I_F = f(T)$



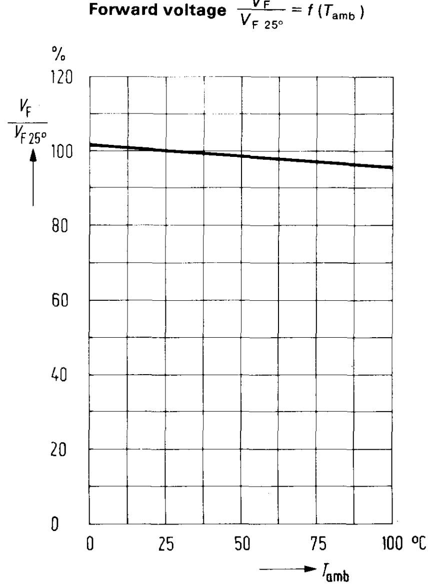
Forward voltage $I_F = f(V_F)$



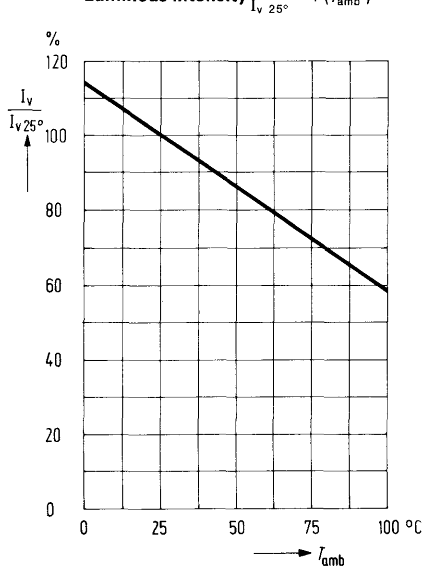
Capacitance $C = f(V_R)$



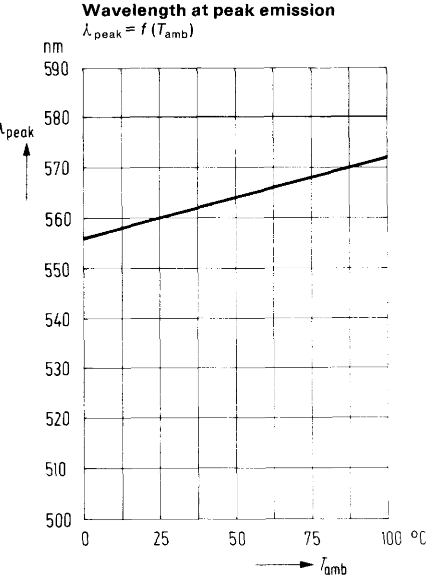
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



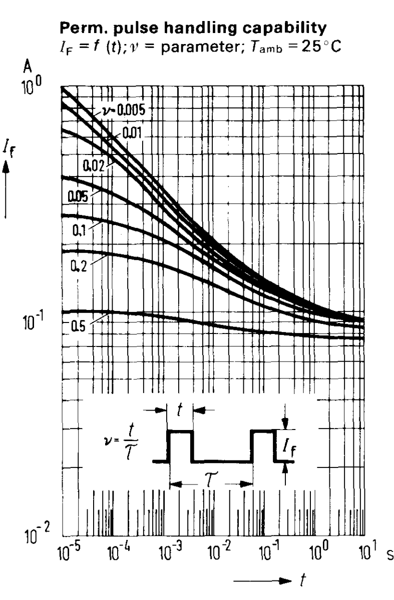
Luminous intensity $\frac{I_v}{I_{v\,25°}} = f(T_{amb})$



Wavelength at peak emission
$\lambda_{peak} = f\,(T_{amb})$



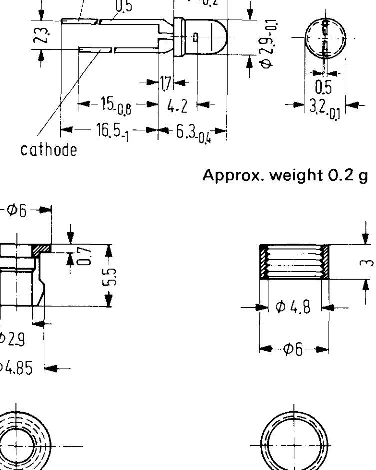
Perm. pulse handling capability
$I_F = f\,(t); \nu$ = parameter; $T_{amb} = 25\,°C$



GaP Light Emitting Diode (Green Emitter) — LD 37

The LD 37 is a GaP light emitting diode which emits green light when operated in forward direction. This diode is mainly intended as optical indicator for process control functions in thick- and thin-film circuits or for the indication of operations in devices with discrete or integrated semiconductor components. Owing to their very low current consumption in addition to low self heating and high resistance to vibration these LEDs are suitable for applications where signal lamps of conventional design are not or only inadequately useful. The LD 37 can also be driven by TTL integrated circuits. The LD 37 has a green diffuse case.

Type	Ordering code
LD 37 A	Q 62 703-Q 99-S 1
LD 37/I	Q 62 703-Q 99-S 2
LD 37/II	Q 62 703-Q 99-S 3
Mounting sleeve with ring, glass-clear	Q 62 901-B 61
Mounting sleeve with ring, black	Q 62 901-B 62



Approx. weight 0.2 g

Mounting sleeve

Mounting ring

Dimensions in mm

Maximum ratings

Reverse voltage	V_R	3	V
Forward current	I_F	60	mA
Surge current ($t \leq 1\ \mu s$)	i_{FS}	1	A
Storage temperature	T_{stor}	−55 to +100	°C
Junction temperature	T_j	100	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	210	mW
Thermal resistance Junction to air	R_{thJamb}	350	K/W

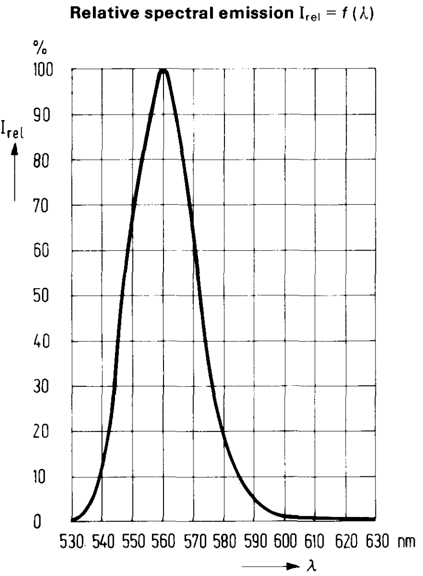
Characteristics (T_{amb} = 25°C)

Wavelength at peak emission	λ_{peak}	560 ± 15	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	25	nm
Half angle (limits for 50% of luminous intensity I_v)	φ	35	degree
Forward voltage (I_F = 20 mA)	V_F	2.4 (≦ 3.0)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦ 10)	µA
Rise time	t_r	50	ns
Fall time	t_f	50	ns
Capacitance (V_R = 0 V)	C_0	45	pF
Temperature coefficient of I_v	TC	−0.55	%/K
Temperature coefficient of V_F	TC	−1.6	mV/K
Temperature coefficient of λ_{peak}	TC	0.15	nm/K

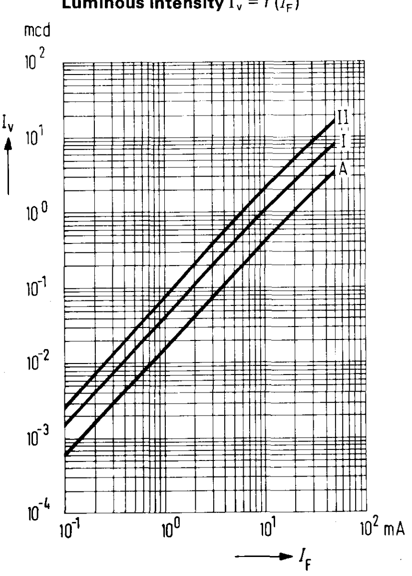
Luminous intensity (I_F = 20 mA)

Type	LD 37 A	LD 37/I	LD 37/II	
I_v	1.0 (≧ 0.5)	2.5 (≧ 2.0)	5.0 (≧ 3.0)	mcd

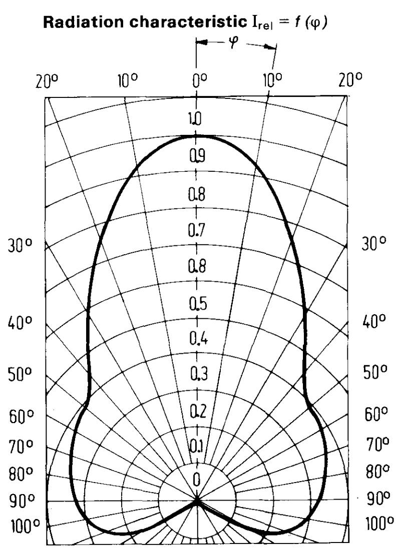
Relative spectral emission $I_{rel} = f(\lambda)$



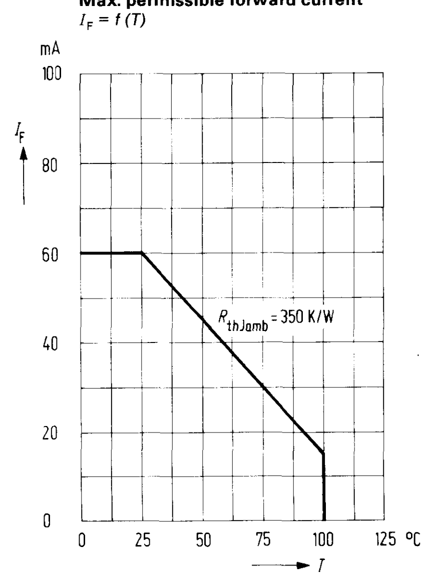
Luminous intensity $I_v = f(I_F)$



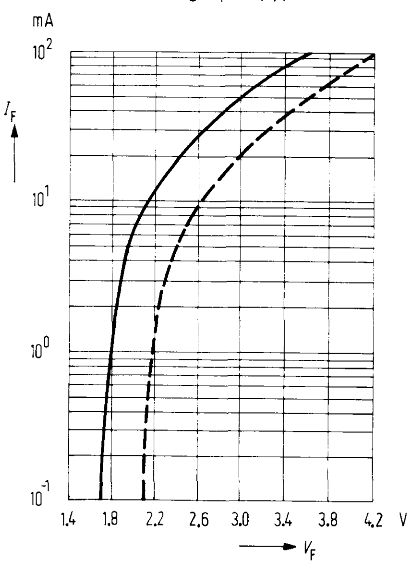
Radiation characteristic $I_{rel} = f(\varphi)$



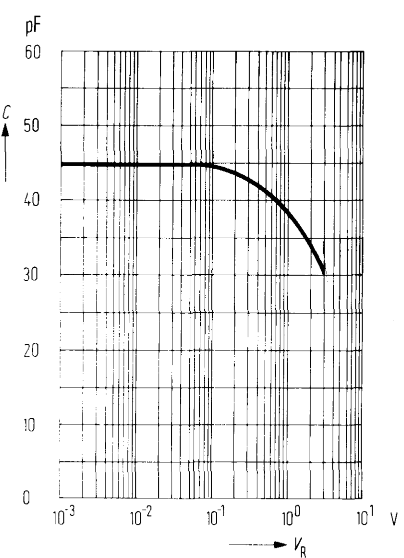
Max. permissible forward current
$I_F = f(T)$



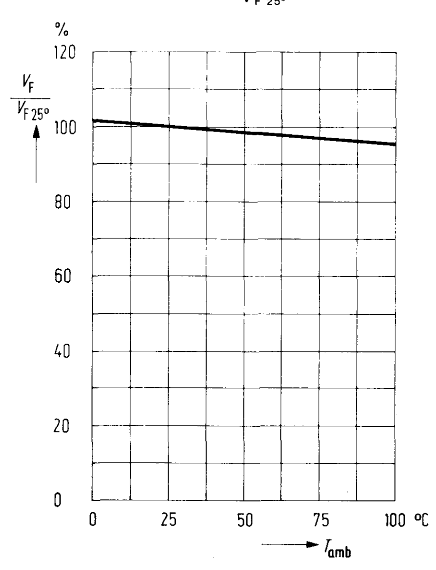
Forward voltage $I_F = f(V_F)$



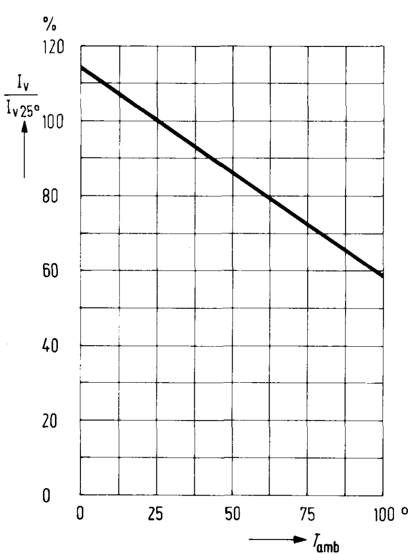
Capacitance $C = f(V_R)$



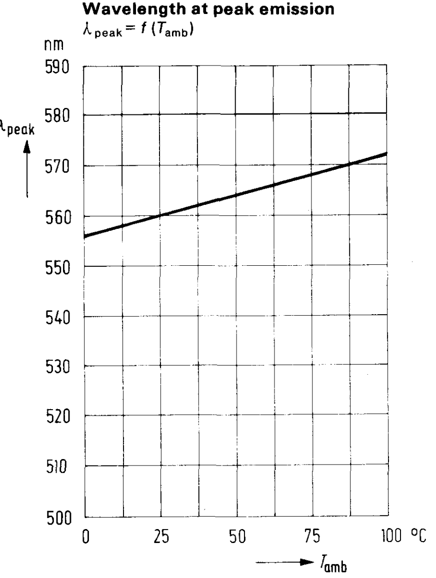
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



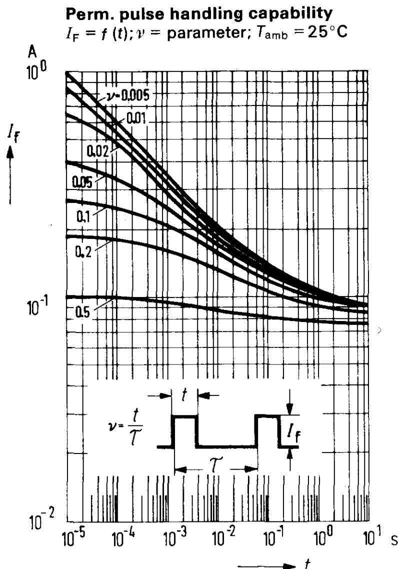
Luminous intensity $\frac{I_v}{I_{v\,25°}} = f(T_{amb})$



Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$



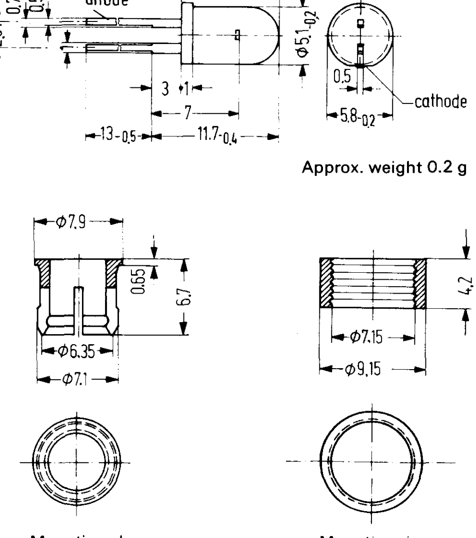
Perm. pulse handling capability
$I_F = f(t)$; ν = parameter; $T_{amb} = 25°C$



GaP Light Emitting Diode (Green Emitter) LD 57

The LD 57 is a GaP light emitting diode which emits green light when operated in forward direction. This diode is mainly intended as optical indicator for process control functions or for the indication of operations in devices with discrete or integrated semiconductor components. Owing to their very low current consumption in addition to low self heating and high resistance to vibration these LEDs are suitable for applications where signal lamps of conventional design are not or only inadequately useful. The LD 57 can also be driven by TTL integrated circuits. The LD 57 has a green diffuse case.

Type	Ordering code
LD 57 A	Q 62 703-Q 100-S 1
LD 57/I	Q 62 703-Q 100-S 2
LD 57/II	Q 62 703-Q 100-S 3
Mounting sleeve with ring, glass-clear	Q 62 901-B 64
Mounting sleeve with ring, black	Q 62 901-B 65



Approx. weight 0.2 g

Mounting sleeve

Mounting ring

Dimensions in mm

Maximum ratings

Reverse voltage	V_R	3	V
Forward current	I_F	60	mA
Surge current ($t \leq 10\ \mu s$)	i_{FS}	1	A
Storage temperature	T_{stor}	−55 to +100	°C
Junction temperature	T_j	100	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	210	mW
Thermal resistance			
Junction to air	R_{thJamb}	350	K/W

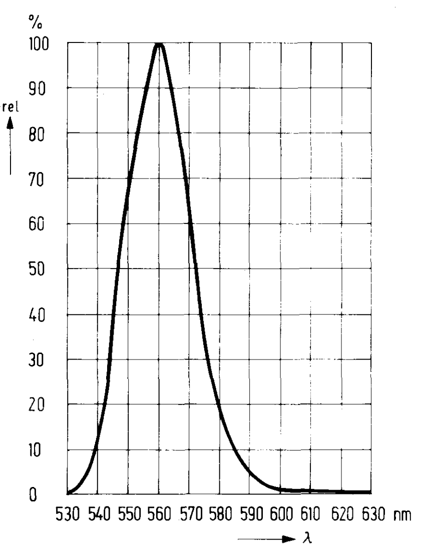
Characteristics (T_{amb} = 25°C)

Wavelength at peak emission	λ_{peak}	560 ± 15	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	25	nm
Half angle (limits for 50% of luminous intensity I_v)	φ	25	degree
Forward voltage (I_F = 20 mA)	V_F	2.4 (≦ 3.0)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦ 10)	μA
Rise time	t_r	50	ns
Fall time	t_f	50	ns
Capacitance (V_R = 0 V)	C_0	45	pF
Temperature coefficient of I_v	TC	−0.55	%/K
Temperature coefficient of V_F	TC	−1.6	mV/K
Temperature coefficient of λ_{peak}	TC	0.15	nm/K

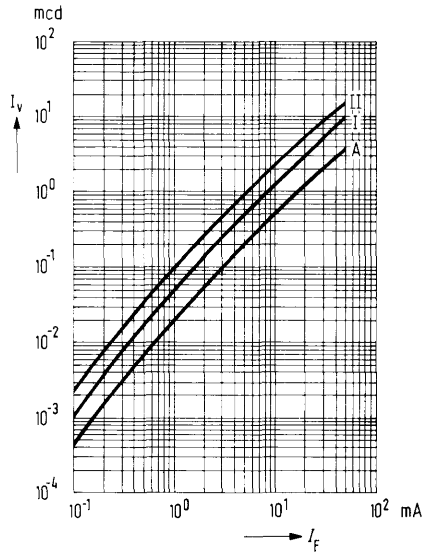
Luminous intensity (I_F = 20 mA)

Type	LD 57 A	LD 57/I	LD 57/II	
I_v	1.2 (≧ 0.6)	3.0 (≧ 2.0)	5.5 (≧ 4.0)	mcd

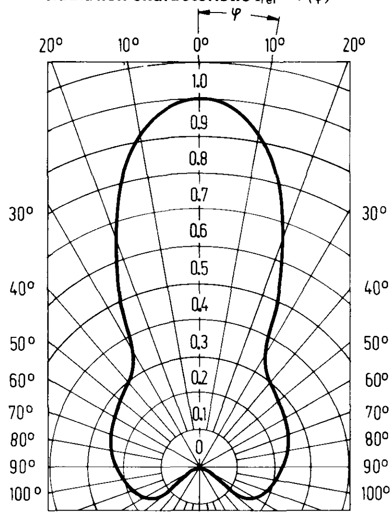
Relative spectral emission $I_{rel} = f(\lambda)$



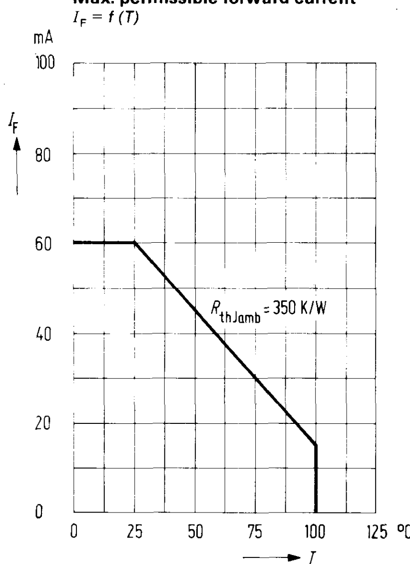
Luminous intensity $I_v = f(I_F)$



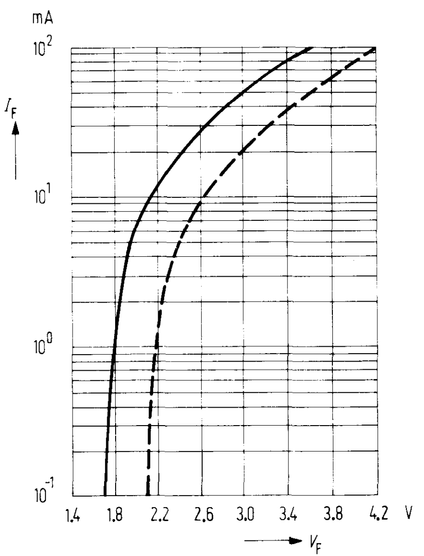
Radiation characteristic $I_{rel} = f(\varphi)$



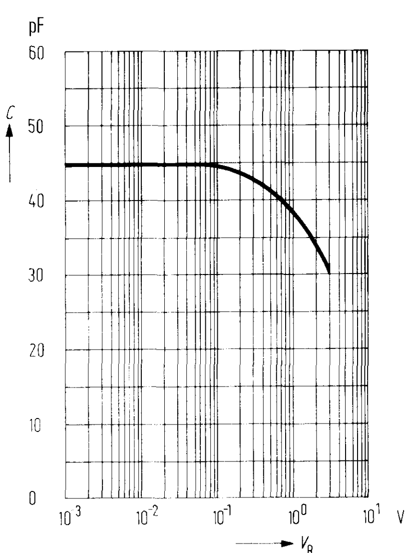
Max. permissible forward current
$I_F = f(T)$



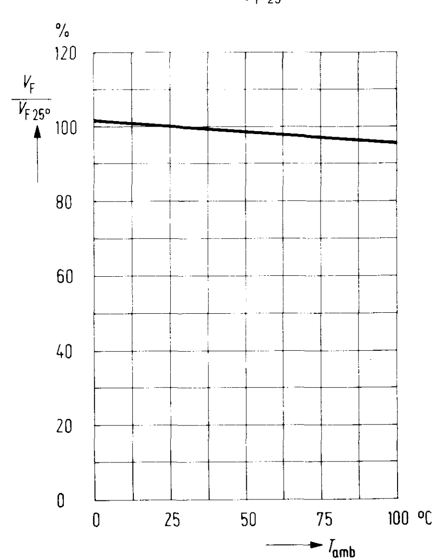
Forward voltage $I_F = f(V_F)$



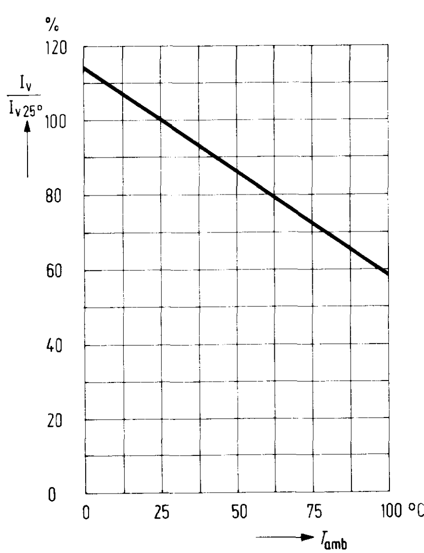
Capacitance $C = f(V_R)$



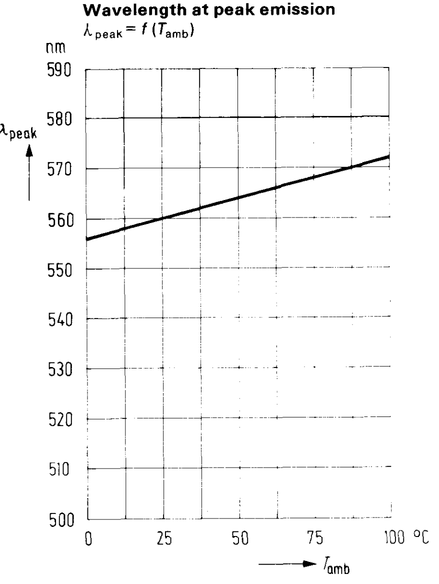
Forward voltage $\frac{V_F}{V_{F\ 25°}} = f(T_{amb})$



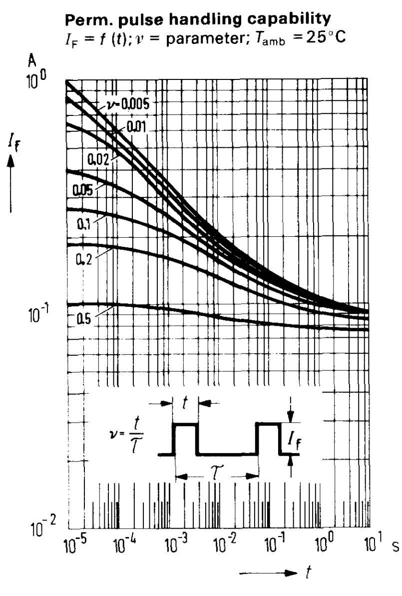
Luminous intensity $\frac{I_v}{I_{v\ 25°}} = f(T_{amb})$



Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$



Perm. pulse handling capability
$I_F = f(t)$; ν = parameter; T_{amb} = 25 °C



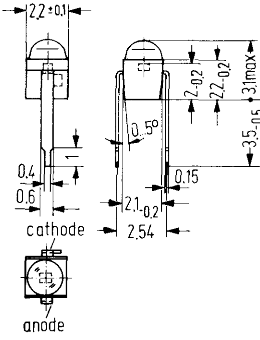
GaP Light Emitting Diode (Green Emitter) 2.54 mm Lead Spacing

LD 471

The LD 471 emits green light when current flows in forward direction. The diode with its green plastic encapsulation has the form of a lens on the side where light is emitted, and on the opposite side solder pin connections in the 2.54 mm (1/10") lead spacing. The cathode is marked by a small projection on the connecting leg.

The diode is TTL compatible as a result of its low current consumption. It is used as optical indicator for process control functions in electronic equipment. As light emitting diode arrays (LD 470 to LD 479) the diodes are suitable for the assembly of complete indicator arrangements, such as characters and scales.

Type	Ordering code
LD 471	Q 62 703-Q 102
LD 471 A	Q 62 703-Q 102-51



Approx. weight 0.2 g
Dimensions in mm

Maximum ratings

Reverse voltage	V_R	3	V
Forward current	I_F	25	mA
Surge current ($t \leq 10\ \mu s$)	i_{FS}	0.5	A
Storage temperature	T_{stor}	−40 to +80	°C
Junction temperature	T_j	80	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leq 3$ s)	T_s	230	°C
Power dissipation (T_L = 25°C)	P_{tot}	85	mW
Thermal resistance			
Junction to air	R_{thJamb}	750	K/W
Junction to solder pin	R_{thJL}	650	K/W

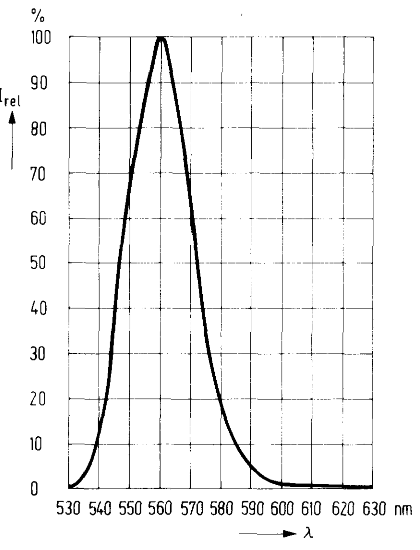
Characteristics (T_{amb} = 25°C)

Parameter	Symbol	Value	Unit
Wavelength at peak emission	λ_{peak}	560 ± 15	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	25	nm
Half angle (limits for 50% of luminous intensity I_v)	φ	50	degree
Forward voltage (I_F = 20 mA)	V_F	2.4 (≦ 3.0)	V
Reverse current (V_R = 3 V)	I_R	0.1 (≦ 10)	μA
Capacitance (V_R = 0 V)	C_0	50	pF
Rise time	t_r	50	ns
Fall time	t_f	50	ns
Temperature coefficient of I_v	TC	−0.55	%/K
Temperature coefficient of V_F	TC	−1.6	mV/K
Temperature coefficient of λ_{peak}	TC	0.15	nm/K

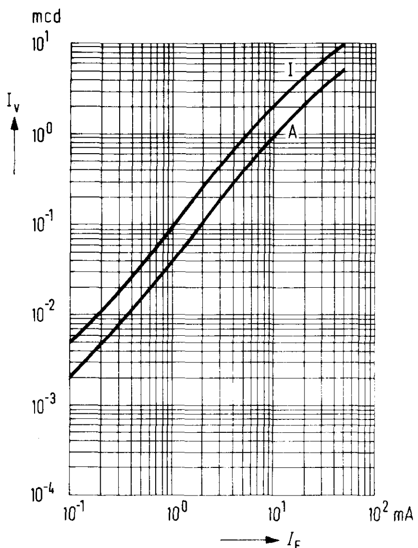
Luminous intensity (I_F = 20 mA)

Type	LD 471	LD 471 A	
I_v	4.5 (≧ 3.2)	≧ 1.25	mcd

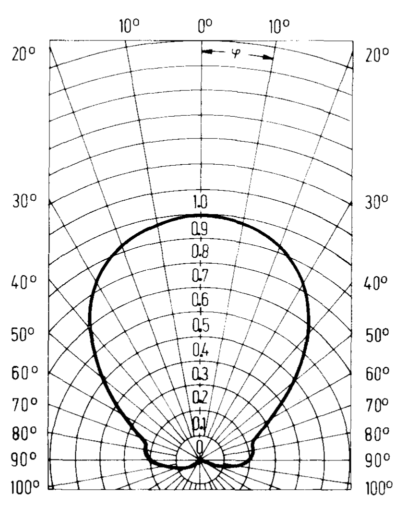
Relative spectral emission $I_{rel} = f(\lambda)$



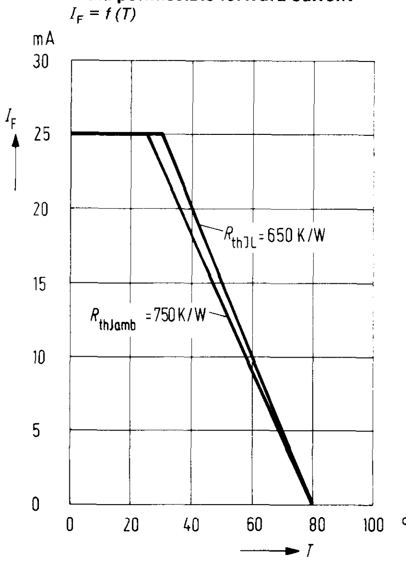
Luminous intensity $I_v = f(I_F)$



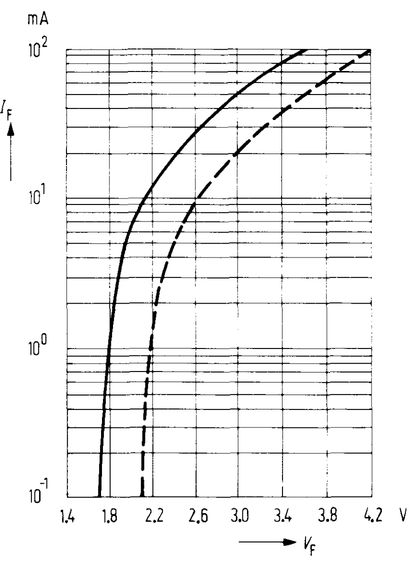
Radiation characteristic $I_{rel} = f(\varphi)$



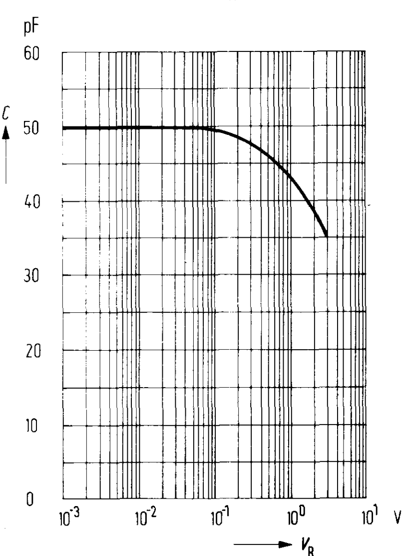
Max. permissible forward current
$I_F = f(T)$



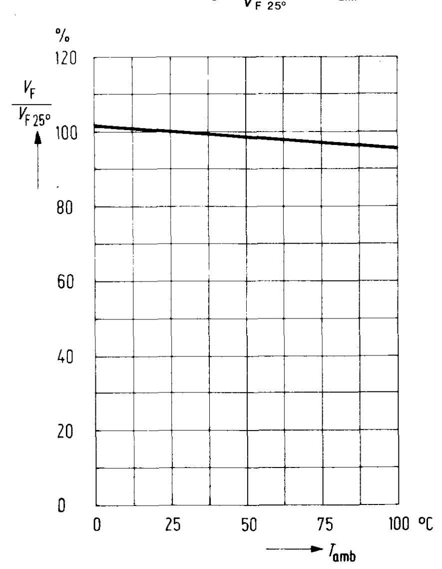
Forward voltage $I_F = f(V_F)$



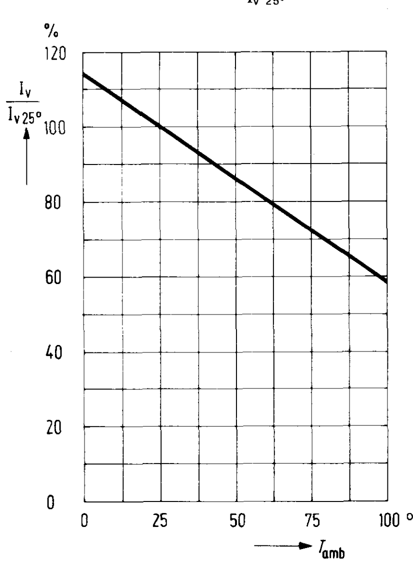
Capacitance $C = f(V_R)$



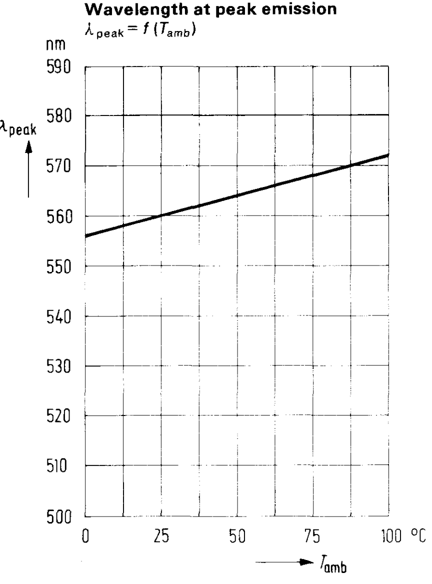
Forward voltage $\frac{V_F}{V_{F\ 25°}} = f(T_{amb})$



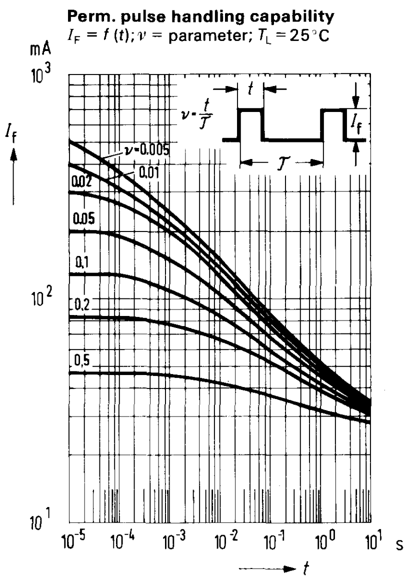
Luminous intensity $\frac{I_v}{I_{v\ 25°}} = f(T_{amb})$



Wavelength at peak emission
$\lambda_{peak} = f\,(T_{amb})$



Perm. pulse handling capability
$I_F = f\,(t); \nu$ = parameter; $T_L = 25\,°C$

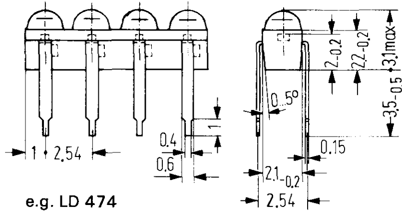


GaP Light Emitting Diode (Green Emitter) Lead Spacing 2.54 mm

LD 470 to LD 479

The types LD 470 to LD 479 are GaP light emitting diode arrays in green plastic encapsulation. The arrays consist of an arrangement of max. 10 light emitting diodes in one row. The diodes emit green light when current flows in forward direction. The individual diodes are spaced apart in accordance with the standard lead spacing of 2.54 mm (1/10"). The 3rd digit of the type designation is identical with the number of LEDs in one row (e.g. LD 474 = an array with 4 LEDs).

Type	Ordering code
LD 472	Q 62 703-Q 103 (2 diodes per array)
LD 473	Q 62 703-Q 104 (3 diodes per array)
LD 474	Q 62 703-Q 105 (4 diodes per array)
LD 475	Q 62 703-Q 106 (5 diodes per array)
LD 476	Q 62 703-Q 107 (6 diodes per array)
LD 477	Q 62 703-Q 108 (7 diodes per array)
LD 478	Q 62 703-Q 109 (8 diodes per array)
LD 479	Q 62 703-Q 110 (9 diodes per array)
LD 470	Q 62 703-Q 101 (10 diodes per array)



Dimensions in mm

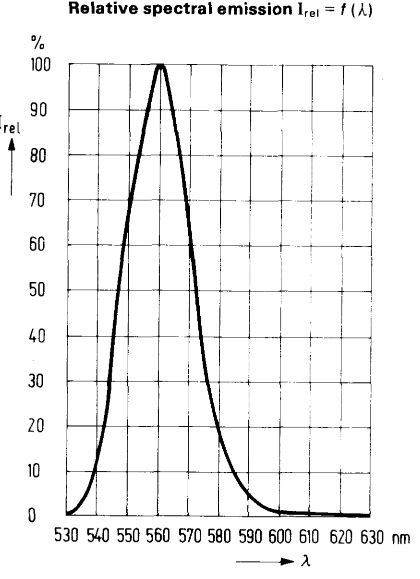
Maximum ratings (Individual diode)

Reverse voltage	V_R	3	V
Forward current	I_F	25	mA
Surge current ($t \leq 10\ \mu s$)	i_{FS}	0.5	A
Storage temperature	T_{stor}	−40 to +80	°C
Junction temperature	T_j	80	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leq 3$ s)	T_s	230	°C
Power dissipation (T_L = 25°C)	P_{tot}	85	mW
Thermal resistance			
Junction to air	$R_{thJcamb}$	750	K/W
Junction to solder pin	R_{thJL}	650	K/W

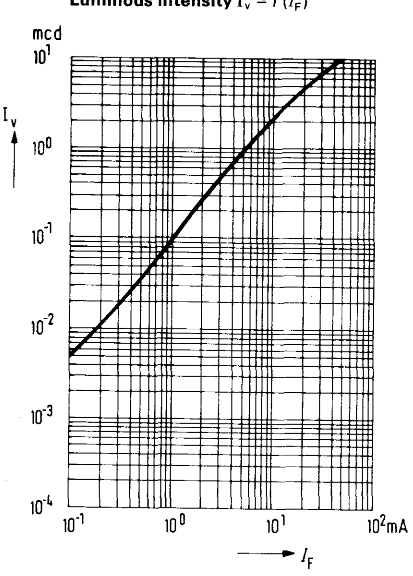
Characteristics (T_{amb} = 25°C)

Luminous intensity (I_F = 20 mA)	I_v	3.2 to 6.3	mcd
Wavelength at peak emission	λ_{peak}	560 ± 15	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	25	nm
Half angle (limits for 50% of luminous intensity I_v)	φ	50	degree
Forward voltage (I_F = 20 mA)	V_F	2.4 (< 3.0)	V
Reverse current (V_R = 3 V)	I_R	0.1 (< 10)	μA
Capacitance (V_R = 0 V)	C_0	50	pF
Rise time	t_r	50	ns
Fall time	t_f	50	ns
Temperature coefficient of I_v	TC	−0.55	%/K
Temperature coefficient of V_F	TC	−1.6	mV/K
Temperature coefficient of λ_{peak}	TC	0.15	nm/K

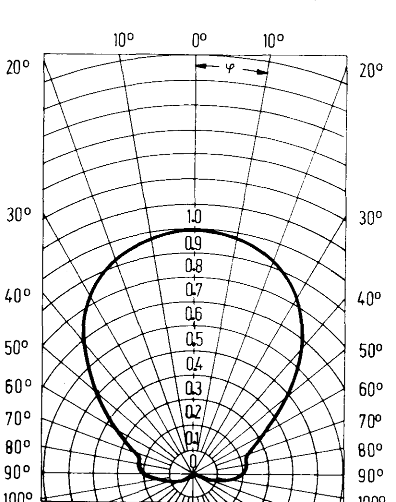
Relative spectral emission $I_{rel} = f(\lambda)$



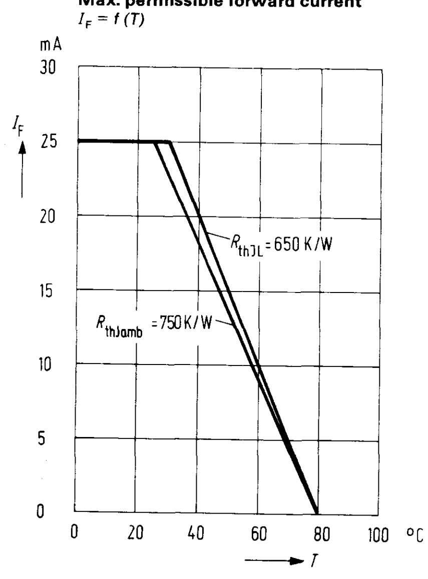
Luminous intensity $I_v = f(I_F)$



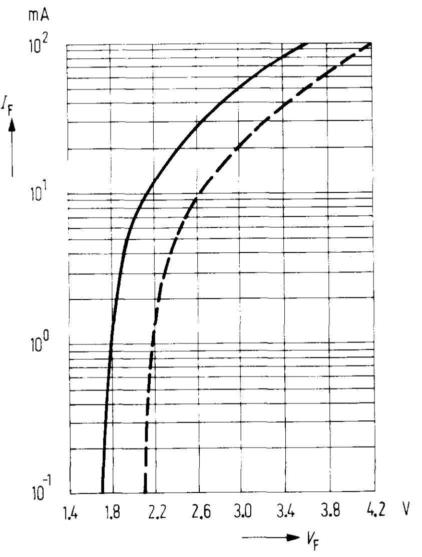
Radiation characteristic $I_{rel} = f(\varphi)$



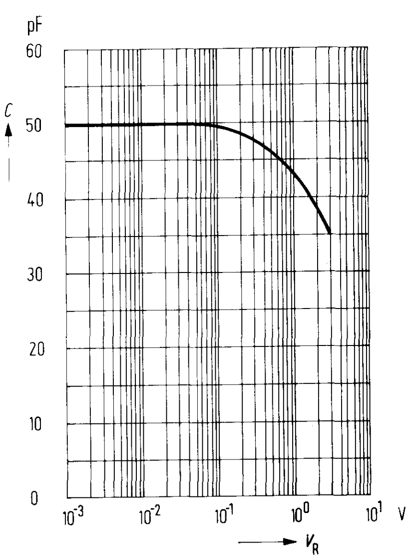
Max. permissible forward current
$I_F = f(T)$



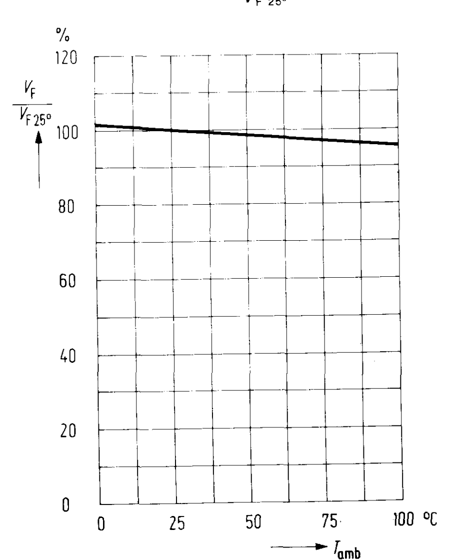
Forward voltage $I_F = f(V_F)$



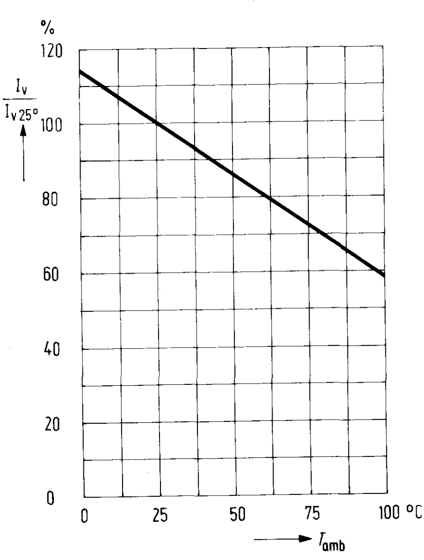
Capacitance $C = f(V_R)$



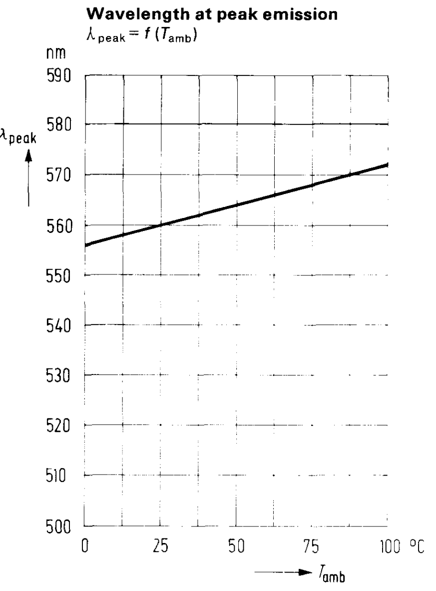
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



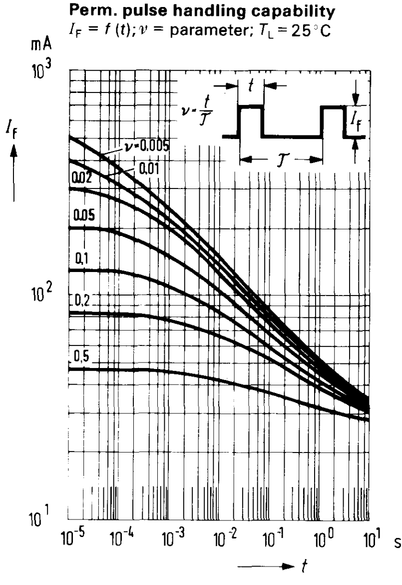
Luminous intensity $\frac{I_v}{I_{v\,25°}} = f(T_{amb})$



Wavelength at peak emission
$\lambda_{peak} = f\,(T_{amb})$



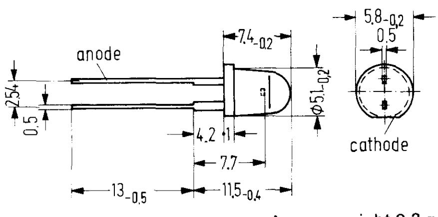
Perm. pulse handling capability
$I_F = f\,(t);\nu$ = parameter; $T_L = 25\,°C$



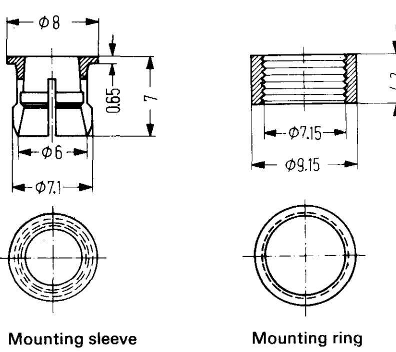
GaP Light Emitting Diode (Yellow Emitter) — CQY 29

The CQY 29 is a GaP light emitting diode which emits yellow light when operated in forward direction. This diode is mainly intended as optical indicator for process control functions or for the indication of operations in devices with discrete or integrated semiconductor components. Owing to their very low current consumption in addition to low self heating and high resistance to vibration these LEDs are suitable for applications where signal lamps of conventional design are not or only inadequately useful. The CQY 29 can also be driven by TTL integrated circuits.

Type	Ordering code
CQY 29 A	Q 68 000-A 1121-S 1
CQY 29/I	Q 68 000-A 1121-S 2
CQY 29/II	Q 68 000-A 1121-S 3
Mounting sleeve with ring, black	Q 62 901-B 66



Approx. weight 0.2 g



Mounting sleeve

Mounting ring

Dimensions in mm

Maximum ratings

Reverse voltage	V_R	3	V
Forward current	I_F	60	mA
Surge current ($t \leq 1\,\mu s$)	i_{FS}	1	A
Storage temperature	T_{stor}	−55 to +100	°C
Junction temperature	T_j	100	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	210	mW
Thermal resistance Junction to air	R_{thJamb}	350	K/W

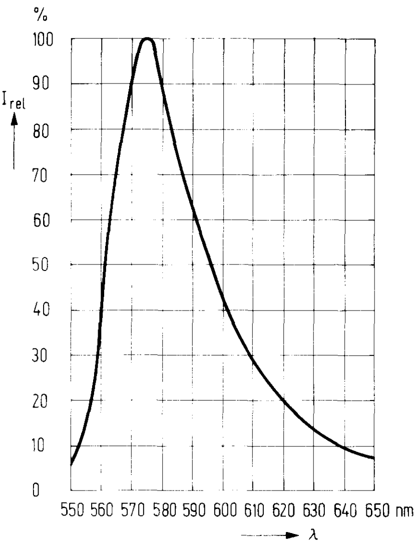
Characteristics (T_{amb} = 25°C)

Wavelength at peak emission	λ_{peak}	575 ±15	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	25	nm
Half angle (limits for 50% of luminous intensity I_v)	φ	25	degree
Forward voltage (I_F = 20 mA)	V_F	2.4 (≦3.0)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦10)	µA
Rise time	t_r	50	ns
Fall time	t_f	50	ns
Capacitance (V_R = 0 V)	C_0	45	pF
Temperature coefficient of I_v	TC	−0.55	%/K
Temperature coefficient of V_F	TC	−1.6	mV/K
Temperature coefficient of λ_{peak}	TC	0.15	nm/K

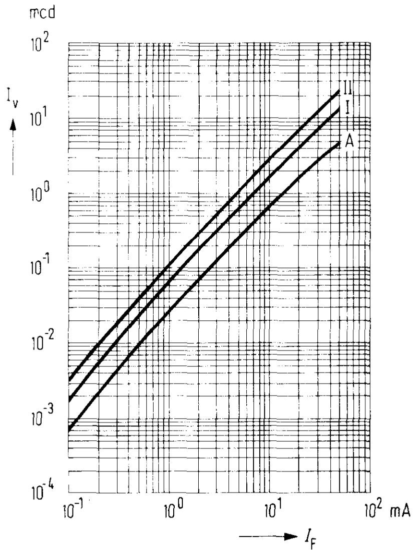
Luminous intensity (I_F = 20 mA)

Type	CQY 29 A	CQY 29/I	CQY 29/II	
I_v	1.5 (≧0.8)	4.0 (≧3.0)	7.0 (≧5.0)	mcd

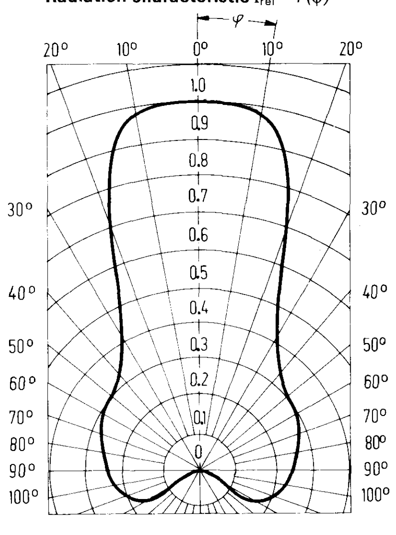
Relative spectral emission $I_{rel} = f(\lambda)$



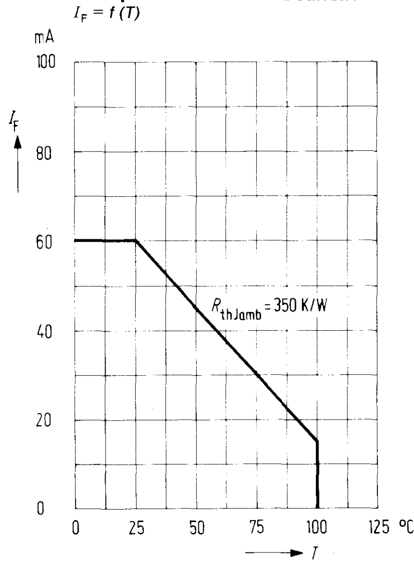
Luminous intensity $I_v = f(I_F)$



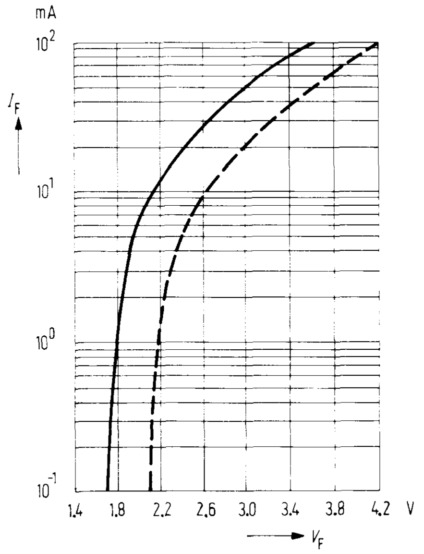
Radiation characteristic $I_{rel} = f(\varphi)$



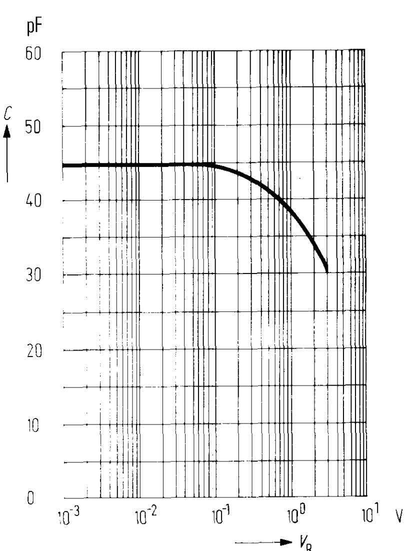
Max. permissible forward current
$I_F = f(T)$



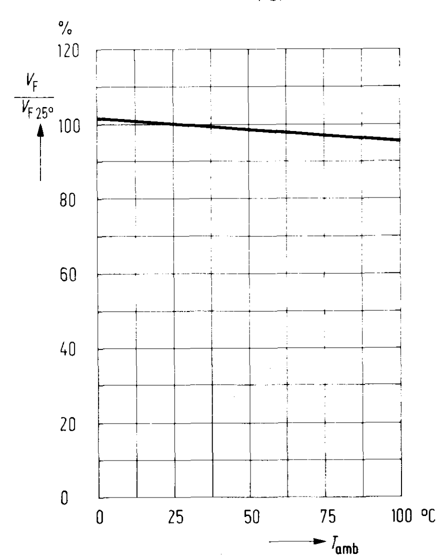
Forward voltage $I_F = f(V_F)$



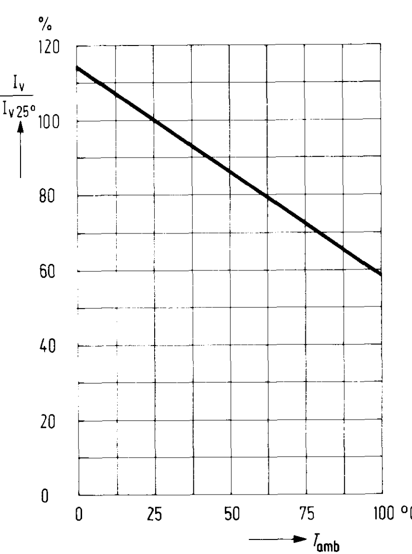
Capacitance $C = f(V_R)$



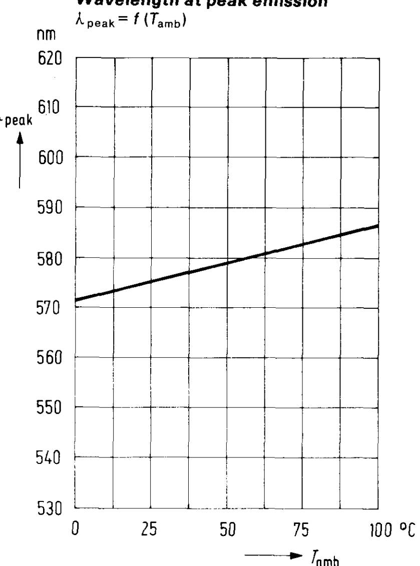
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



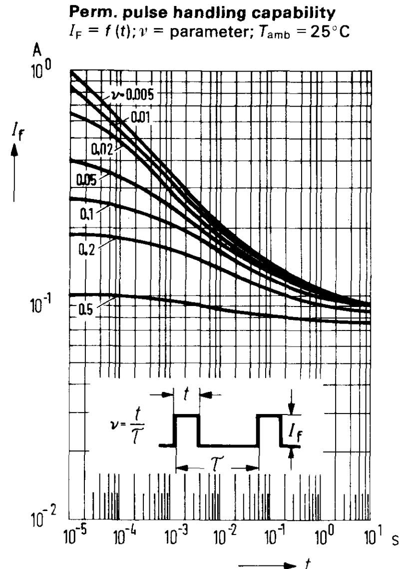
Luminous intensity $\frac{I_V}{I_{V\,25°}} = f(T_{amb})$



Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$

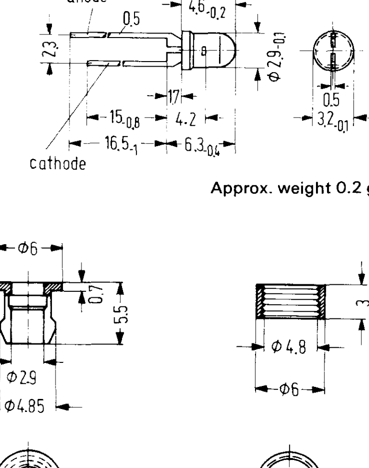


Perm. pulse handling capability
$I_F = f(t)$; ν = parameter; $T_{amb} = 25°C$

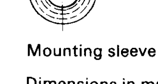


The LD 35 is a GaP light emitting diode which emits yellow light when operated in forward direction. This diode is mainly intended as optical indicator for process control functions in thick- and thin-film circuits or for the indication of operations in devices with discrete or integrated semiconductor components. Owing to their very low current consumption in addition to low self heating and high resistance to vibration these LEDs are suitable for applications where signal lamps of conventional design are not or only inadequately useful. The LD 35 can also be driven by TTL integrated circuits. The LD 35 has a yellow diffuse case.

Type	Ordering code
LD 35 A	Q 62 703-Q 118-S 1
LD 35/I	Q 62 703-Q 118-S 2
LD 35/II	Q 62 703-Q 118-S 3
Mounting sleeve with ring, glass-clear	Q 62 901-B 61
Mounting sleeve with ring, black	Q 62 901-B 62



Approx. weight 0.2 g



Mounting sleeve

Mounting ring

Dimensions in mm

Maximum ratings

Reverse voltage	V_R	3	V
Forward current	I_F	60	mA
Surge current ($t \leq 1\ \mu s$)	i_{FS}	1	A
Storage temperature	T_{stor}	−55 to +100	°C
Junction temperature	T_j	100	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	210	mW
Thermal resistance Junction to air	R_{thJamb}	350	K/W

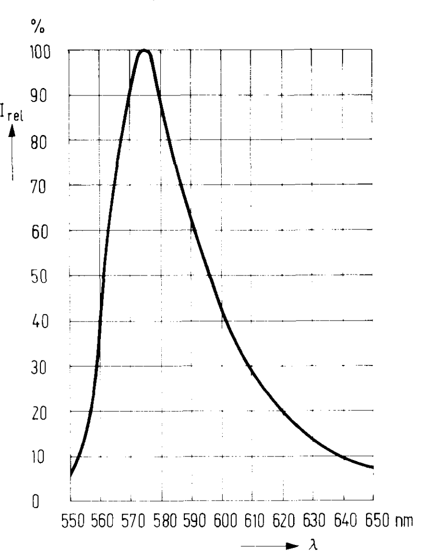
Characteristics (T_{amb} = 25°C)

Wavelength at peak emission	λ_{peak}	575 ± 15	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	25	nm
Half angle (limits for 50% of luminous intensity I_v)	φ	35	degree
Forward voltage (I_F = 20 mA)	V_F	2.4 (≦ 3.0)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦ 10)	μA
Rise time	t_r	50	ns
Fall time	t_f	50	ns
Capacitance (V_R = 0 V)	C_0	45	pF
Temperature coefficient of I_v	TC	−0.55	%/K
Temperature coefficient of V_F	TC	−1.6	mV/K
Temperature coefficient of λ_{peak}	TC	0.15	nm/K

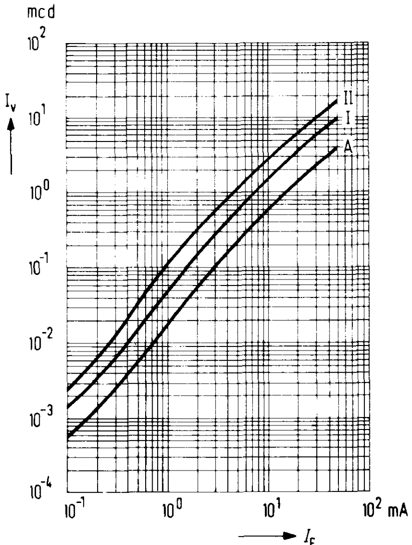
Luminous intensity (I_F = 20 mA)

Type	LD 35 A	LD 35/I	LD 35/II	
I_v	1.5 (≧ 0.6)	3.5 (≧ 2.5)	6.0 (≧ 4.0)	mcd

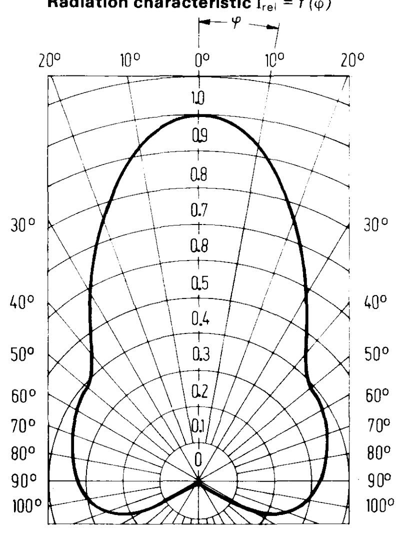
Relative spectral emission $I_{rel} = f(\lambda)$



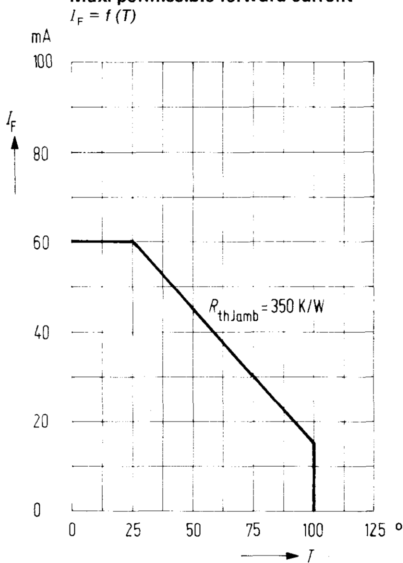
Luminous intensity $I_v = f(I_F)$

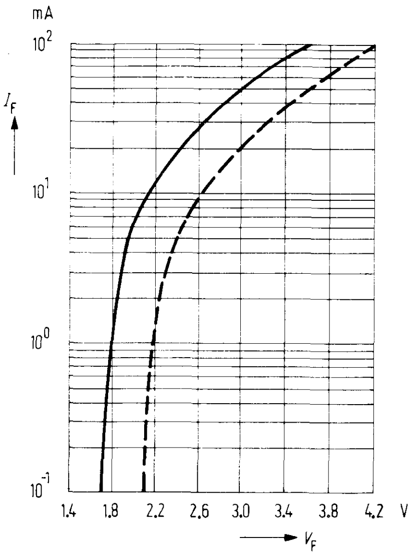


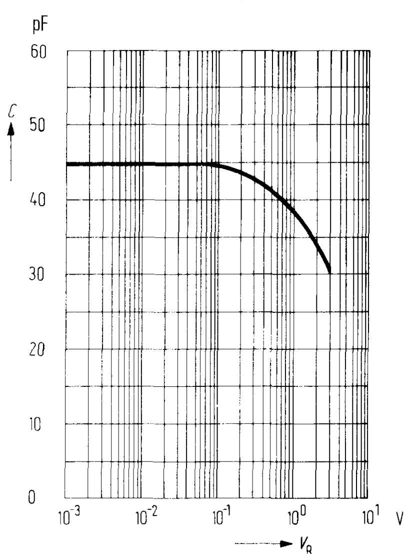
Radiation characteristic $I_{rel} = f(\varphi)$

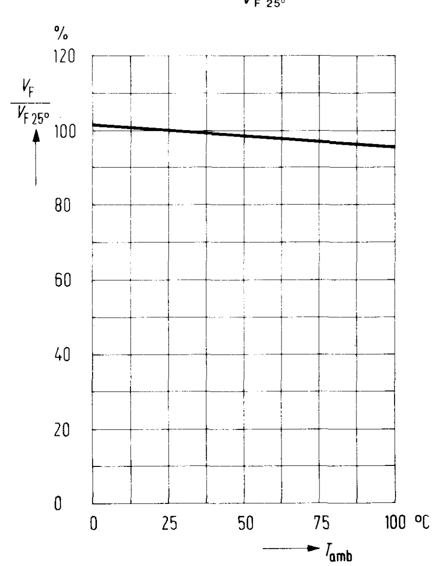


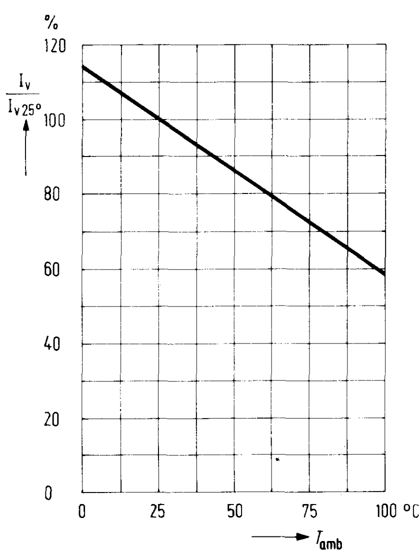
Max. permissible forward current
$I_F = f(T)$



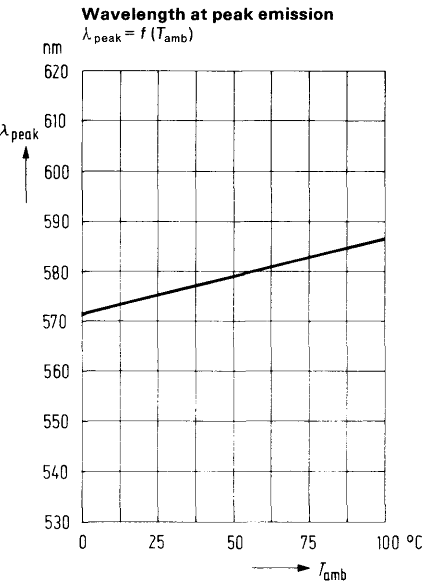

Forward voltage $I_F = f(V_F)$
mA
10^2
I_F
10^1
10^0
10^{-1}
1.4
1.8
2.2
2.6
3.0
3.4
3.8
4.2
V
V_F


Capacitance $C = f(V_R)$
pF
60
50
40
30
20
10
0
C
10^{-3}
10^{-2}
10^{-1}
10^0
10^1
V
V_R

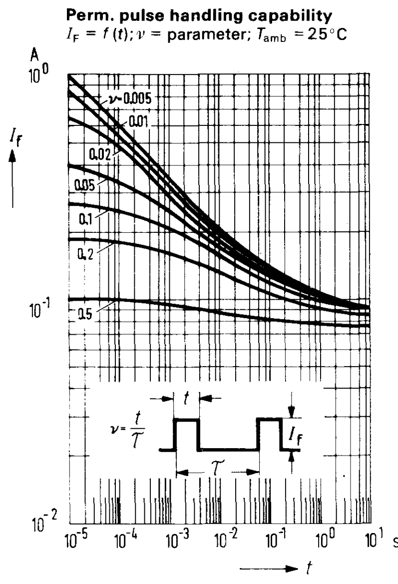

Forward voltage $\frac{V_F}{V_{F\ 25°}} = f(T_{amb})$
%
120
100
80
60
40
20
0
$\frac{V_F}{V_{F\ 25°}}$
0
25
50
75
100
°C
T_{amb}


Luminous intensity $\frac{I_v}{I_{v\ 25°}} = f(T_{amb})$
%
120
100
80
60
40
20
0
$\frac{I_v}{I_{v\ 25°}}$
0
25
50
75
100
°C
T_{amb}

Wavelength at peak emission
$\lambda_{peak} = f\,(T_{amb})$



Perm. pulse handling capability
$I_F = f\,(t); \nu$ = parameter; T_{amb} = 25 °C



GaP Light Emitting Diode (Yellow Emitter)

The LD 55 is a GaP light emitting diode which emits yellow light when operated in forward direction. This diode is mainly intended as optical indicator for process control functions or for the indication of operations in devices with discrete or integrated semiconductor components. Owing to their very low current consumption in addition to low self heating and high resistance to vibration these LEDs are suitable for applications where signal lamps of conventional design are not or only inadequately useful. The LD 55 can also be driven by TTL integrated circuits.

Type	Ordering code
LD 55 A	Q 62 703-Q 120-S 1
LD 55/I	Q 62 703-Q 120-S 2
LD 55/II	Q 62 703-Q 120-S 3
Mounting sleeve with ring, glass-clear	Q 62 901-B 64
Mounting sleeve with ring, black	Q 62 901-B 65

Approx. weight 0.2 g

Mounting ring

Mounting sleeve

Dimensions in mm

Maximum ratings

Reverse voltage	V_R	3	V
Forward current	I_F	60	mA
Surge current ($t \leqq 1\ \mu s$)	i_{FS}	1	A
Storage temperature	T_{stor}	−55 to +100	°C
Junction temperature	T_j	100	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	210	mW
Thermal resistance Junction to air	R_{thJamb}	350	K/W

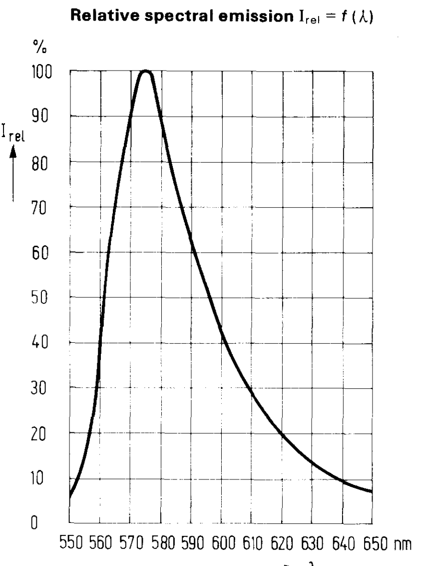
Characteristics (T_{amb} = 25°C)

Wavelength at peak emission	λ_{peak}	575 ±15	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	25	nm
Half angle (limits for 50% of luminous intensity I_V)	φ	25	degree
Forward voltage (I_F = 20 mA)	V_F	2.4 (≦3.0)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦10)	μA
Rise time	t_r	50	ns
Fall time	t_f	50	ns
Capacitance (V_R = 0 V)	C_0	45	pF
Temperature coefficient of I_V	TC	−0.55	%/K
Temperature coefficient of V_F	TC	−1.6	mV/K
Temperature coefficient of λ_{peak}	TC	0.15	nm/K

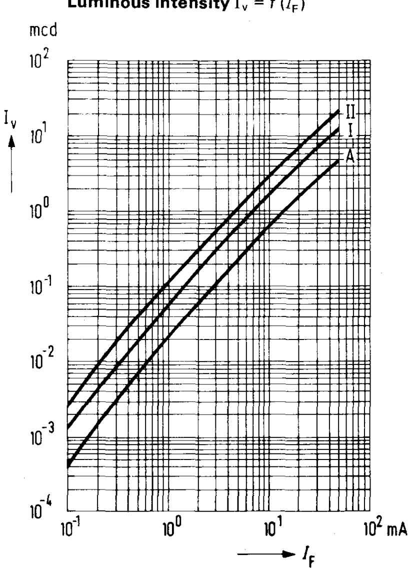
Luminous intensity (I_F = 20 mA)

Type	LD 55 A	LD 55/I	LD 55/II	
I_V	1.5 (≧0.8)	4.0 (≧3.0)	7.0 (≧5.0)	mcd

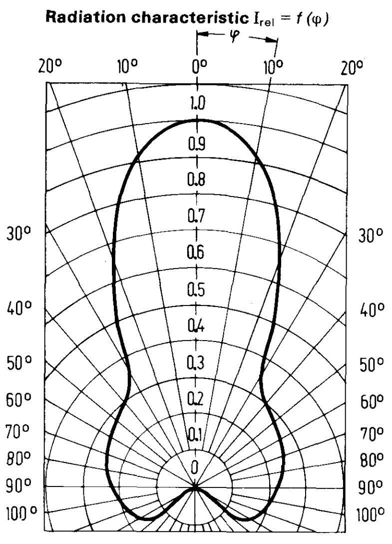
Relative spectral emission $I_{rel} = f(\lambda)$



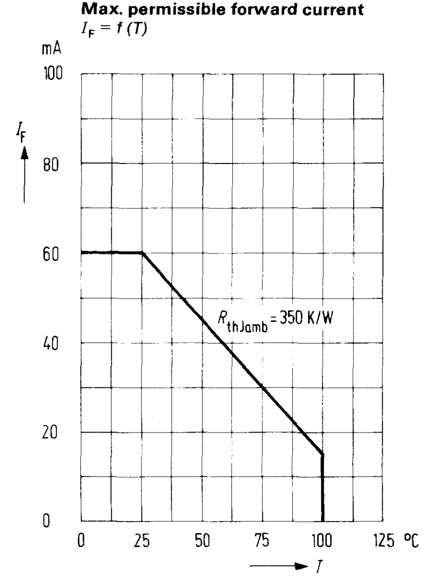
Luminous intensity $I_v = f(I_F)$



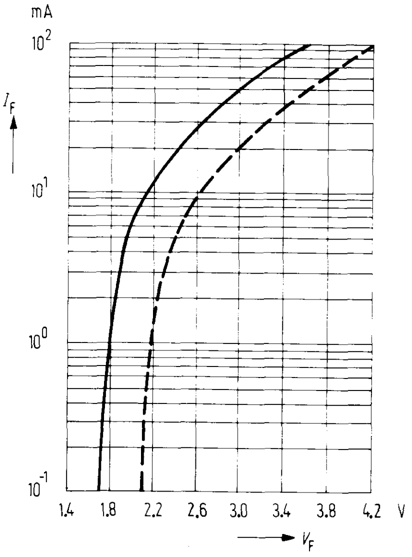
Radiation characteristic $I_{rel} = f(\varphi)$



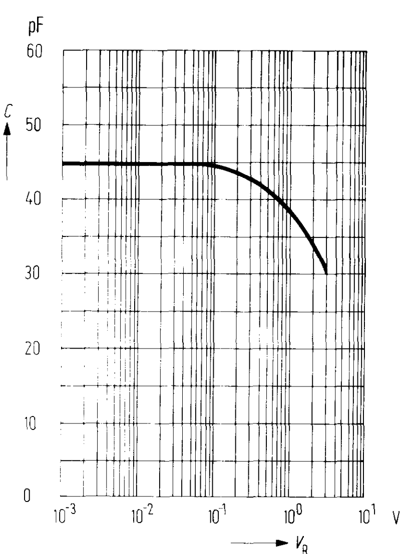
Max. permissible forward current
$I_F = f(T)$



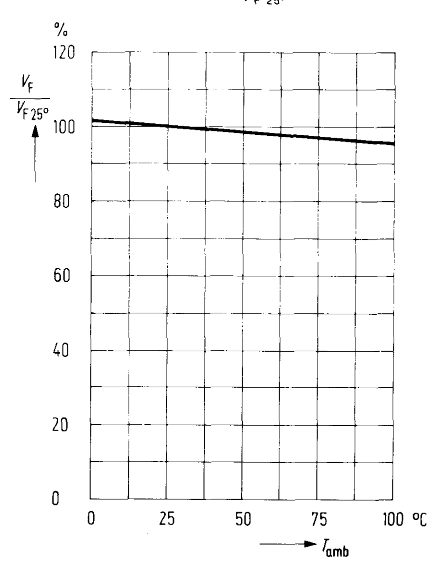
Forward voltage $I_F = f(V_F)$



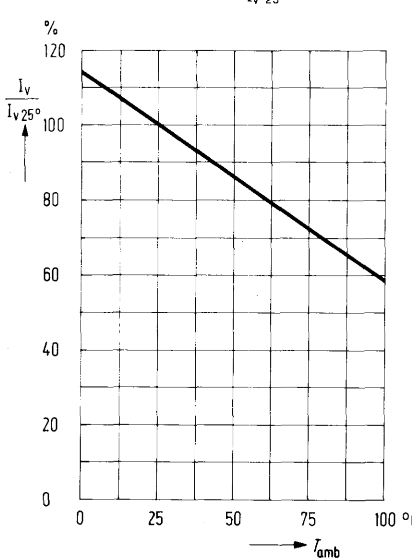
Capacitance $C = f(V_R)$



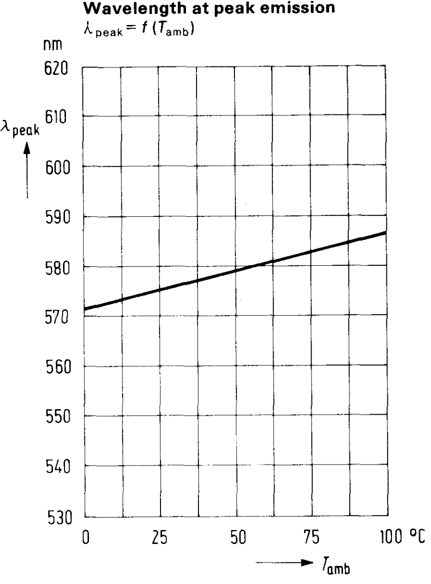
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



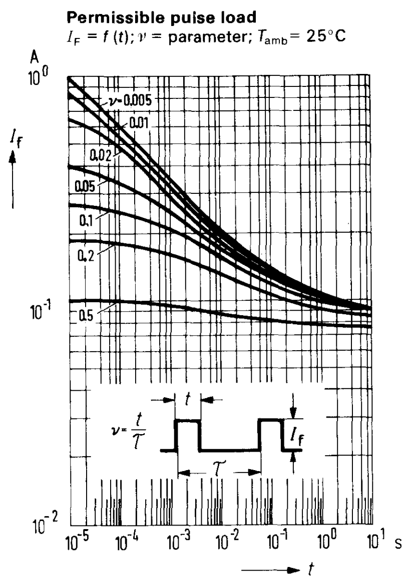
Luminous intensity $\frac{I_v}{I_{v\,25°}} = f(T_{amb})$



Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$



Permissible pulse load
$I_F = f(t)$; ν = parameter; T_{amb} = 25°C



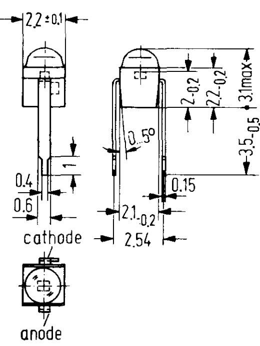
GaP Light Emitting Diode (Yellow Emitter) 2.54 mm Lead Spacing

LD 481

The LD 481 emits yellow light when current flows in forward direction. The diode with its yellow plastic encapsulation has the form of a lens on the side where light is emitted, and on the opposite side solder pin connections in the 2.54 mm (1/10") lead spacing. The cathode is marked by a small projection on the connecting pin.

The diode is TTL compatible as a result of its low current comsumption. It is used as optical indicator for process control functions in electronic equipment. As light emitting diode arrays (LD 480 to LD 489) the diodes are suitable for the assembly of complete indicator arrangements, such as characters and scales.

Type	Ordering code
LD 481	Q 62 703-Q 123
LD 481 A	Q 62 703-Q 123-S 1



Dimensions in mm

Approx. weight 0.02 g

Maximum ratings

Reverse voltage	V_R	3	V
Forward current	I_F	25	mA
Surge current ($t \leq 10\ \mu s$)	i_{FS}	0.5	A
Storage temperature	T_{stor}	−30 to +80	°C
Junction temperature	T_j	80	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leq 3$ s)	T_s	230	°C
Power dissipation (T_L = 25°C)	P_{tot}	85	mW
Thermal resistance			
Junction to air	R_{thJamb}	750	K/W
Junction to solder pin	R_{thJL}	650	K/W

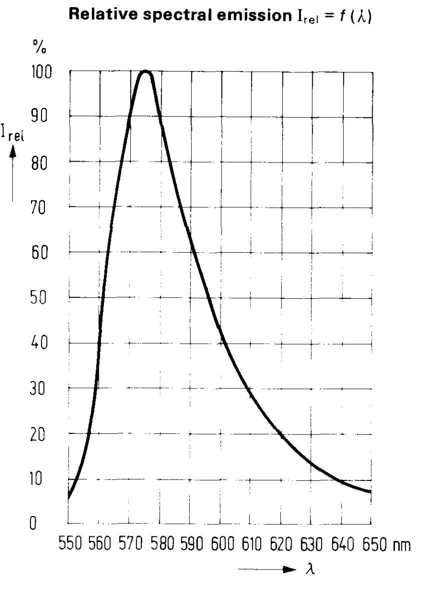
Characteristics (T_{amb} = 25°C)

Parameter	Symbol	Value	Unit
Wavelength at peak emission	λ_{peak}	575 ±15	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	25	nm
Half angle (limits for 50% of luminous intensity I_v)	φ	50	degree
Forward voltage (I_F = 20 mA)	V_F	2.4 (≦3.0)	V
Reverse current (V_R = 3 V)	I_R	0.1 (≦10)	µA
Capacitance (V_R = 0 V)	C_0	50	pF
Rise time	t_r	50	ns
Fall time	t_f	50	ns
Temperature coefficient of I_v	TC	−0.55	%/K
Temperature coefficient of V_F	TC	−1.6	mV/K
Temperature coefficient of λ_{peak}	TC	0.15	nm/K

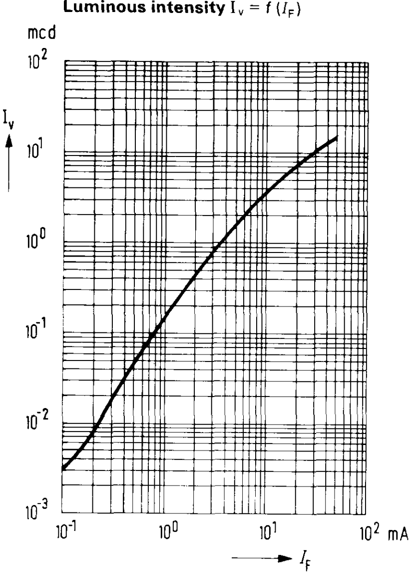
Luminous intensity (I_F = 20 mA)

Type	LD 481	LD 481 A	
I_v	7 (≧4)	≧1.6	mcd

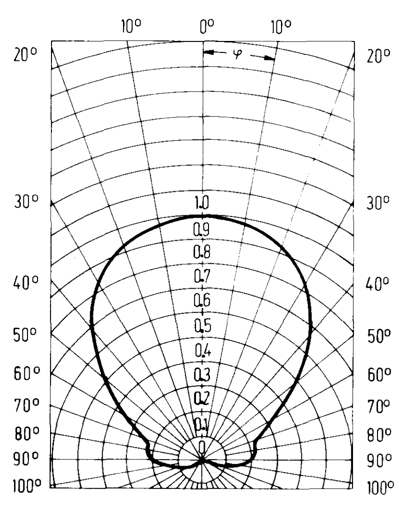
Relative spectral emission $I_{rel} = f(\lambda)$



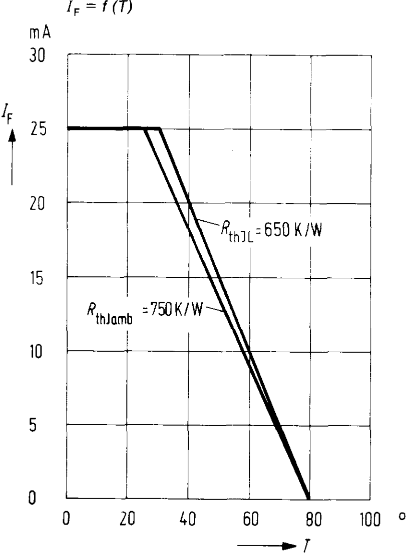
Luminous intensity $I_v = f(I_F)$



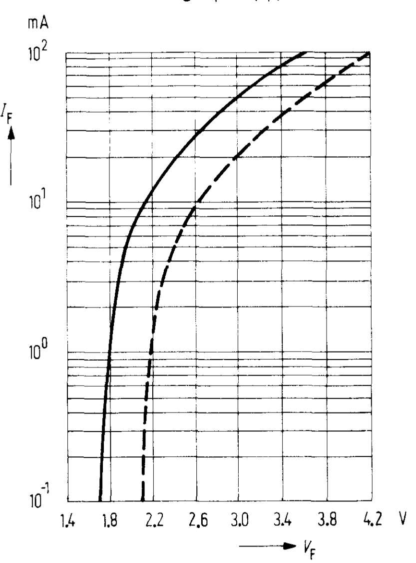
Radiation characteristic $I_{rel} = f(\varphi)$



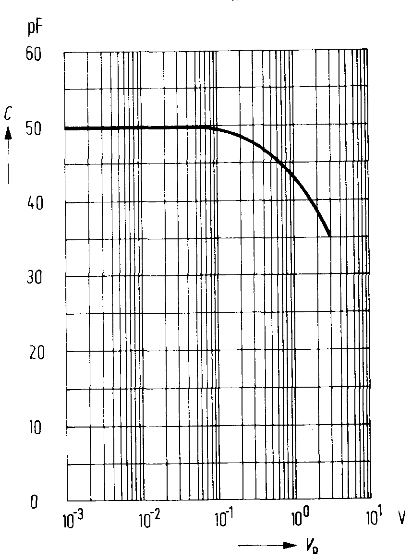
Max. permissible forward current
$I_F = f(T)$



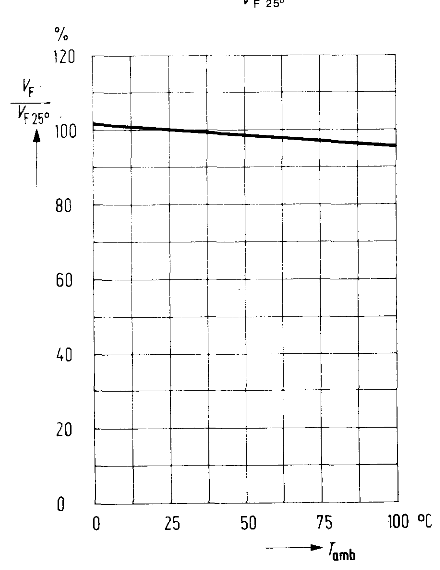
Forward voltage $I_F = f(V_F)$



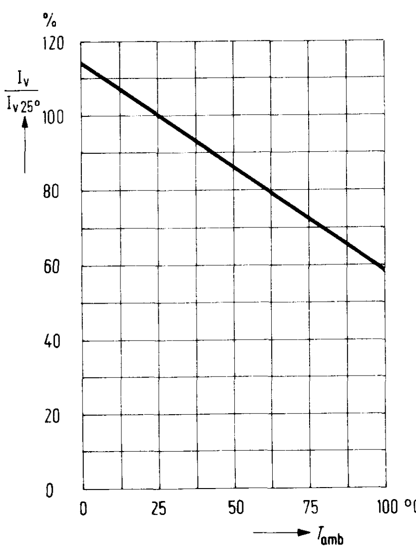
Capacitance $C = f(V_R)$



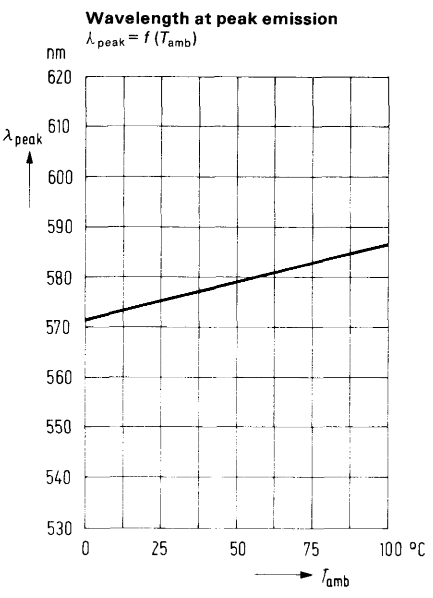
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



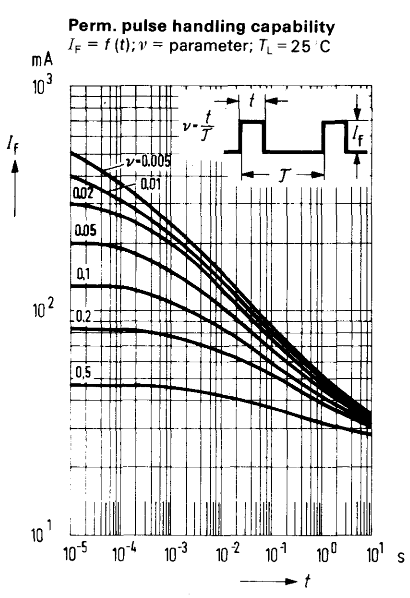
Luminous intensity $\frac{I_v}{I_{v\,25°}} = f(T_{amb})$



Wavelength at peak emission
$\lambda_{peak} = f\,(T_{amb})$



Perm. pulse handling capability
$I_F = f\,(t)$; ν = parameter; $T_L = 25\,°C$



GaP Light Emitting Diode Arrays (Yellow Emitter) Lead Spacing 2.54 mm

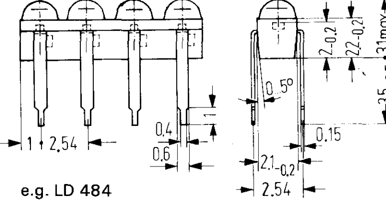
LD 480 to LD 489

The types LD 480 to LD 489 are GaP light emitting diode arrays in yellow plastic encapsulation. The arrays consist of an arrangement of max. 10 light emitting diodes in one row. These arrays emit yellow light when current flows in forward direction. The individual diodes are spaced apart according to the standard lead spacing of 2.54 mm (1/10").

The 3rd digit of the type designation is identical with the number of LEDs of the relevant array (e.g. LD 484 = an array with 4 diodes).

Type	Ordering code
LD 482	Q 62 703-Q 103 (2 diodes per array)
LD 483	Q 62 703-Q 104 (3 diodes per array)
LD 484	Q 62 703-Q 105 (4 diodes per array)
LD 486	Q 62 703-Q 107 (6 diodes per array)
LD 488	Q 62 703-Q 109 (8 diodes per array)

Deviating system numbers per array upon request



e.g. LD 484

Dimensions in mm

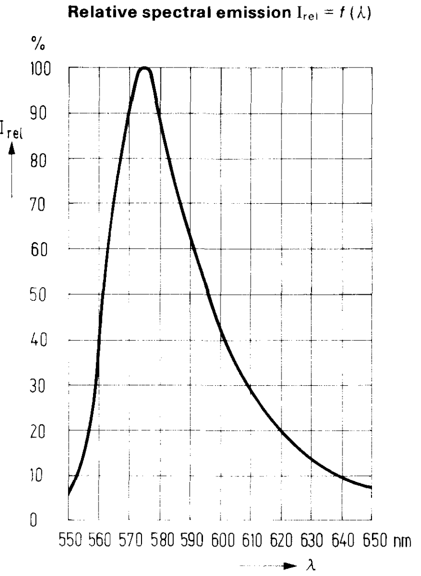
Maximum ratings (Individual diode)

Reverse voltage	V_R	3	V
Forward current	I_F	25	mA
Surge current ($t \leq 10\ \mu s$)	i_{FS}	0.5	A
Storage temperature	T_{stor}	−30 to +80	°C
Junction temperature	T_j	80	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leq 3$ s)	T_s	230	°C
Power dissipation ($T_L = 25°C$)	P_{tot}	85	mW
Thermal resistance			
Junction to air	R_{thJamb}	750	K/W
Junction to solder pin	R_{thJL}	650	K/W

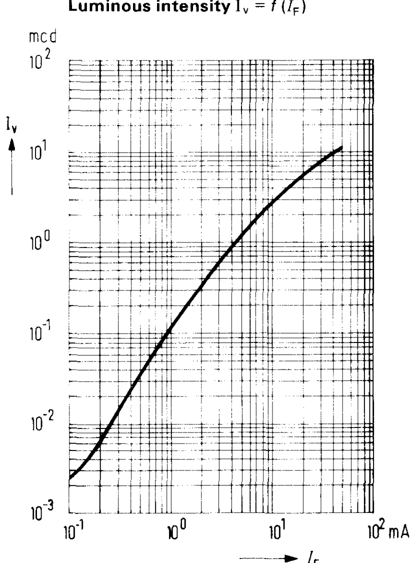
Characteristics (T_{amb} = 25°C)

Luminous intensity (I_F = 20 mA)	I_v	4 to 8	mcd
Wavelength at peak emission	λ_{peak}	575 ±15	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	25	nm
Half angle (limits for 50% of luminous intensity I_v)	φ	50	degree
Forward voltage (I_F = 20 mA)	V_F	2.4 (≦3.0)	V
Reverse current (V_R = 3 V)	I_R	0.1 (≦10)	μA
Capacitance (V_R = 0 V)	C_0	50	pF
Rise time	t_r	50	ns
Fall time	t_f	50	ns
Temperature coefficient of I_v	TC	−0.55	%/K
Temperature coefficient of V_F	TC	−1.6	mV/K
Temperature coefficient of λ_{peak}	TC	0.15	nm/K

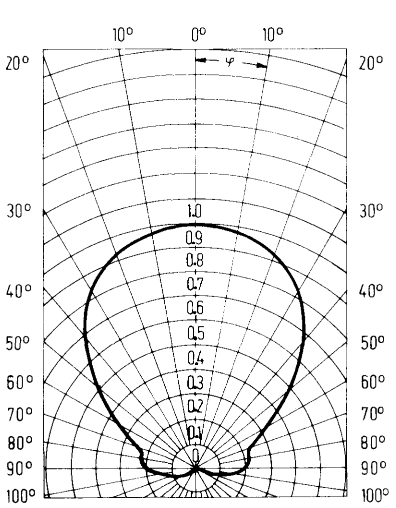
Relative spectral emission $I_{rel} = f(\lambda)$



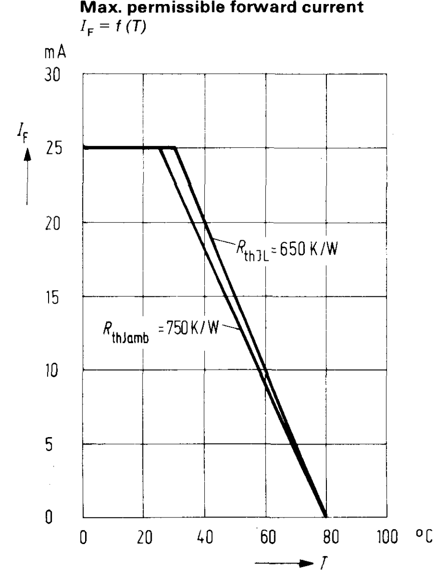
Luminous intensity $I_v = f(I_F)$



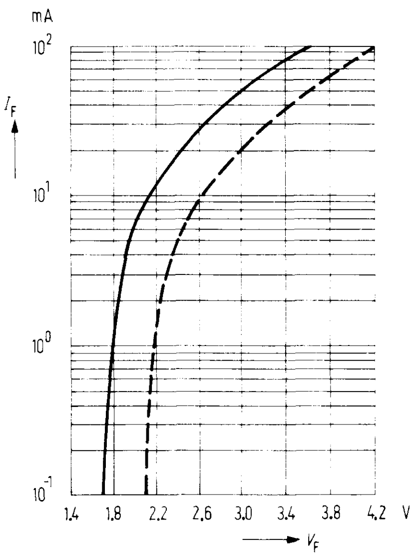
Radiation characteristic $I_{rel} = f(\varphi)$



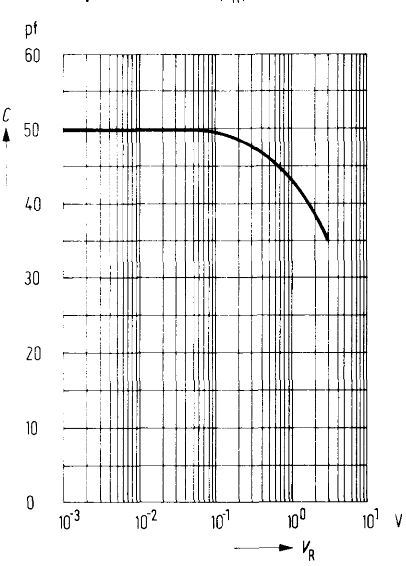
Max. permissible forward current
$I_F = f(T)$



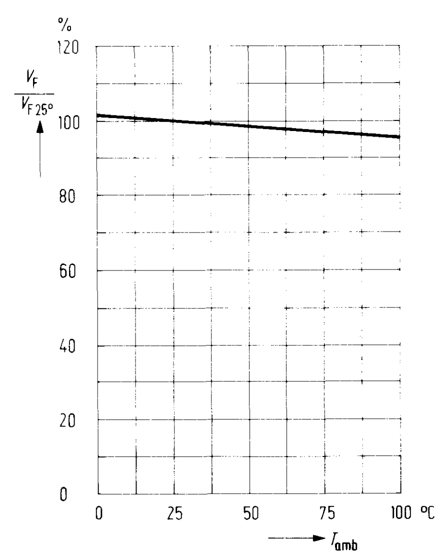
Forward voltage $I_F = f(V_F)$



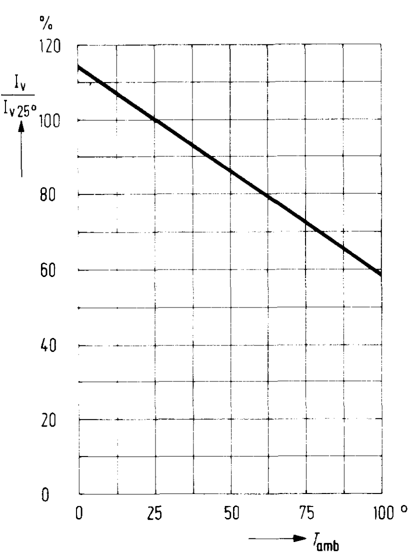
Capacitance $C = f(V_R)$



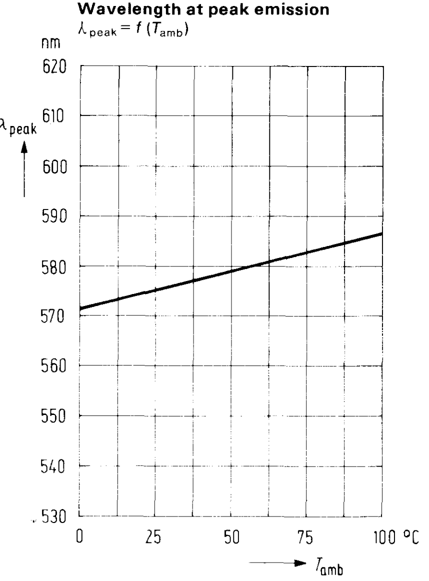
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



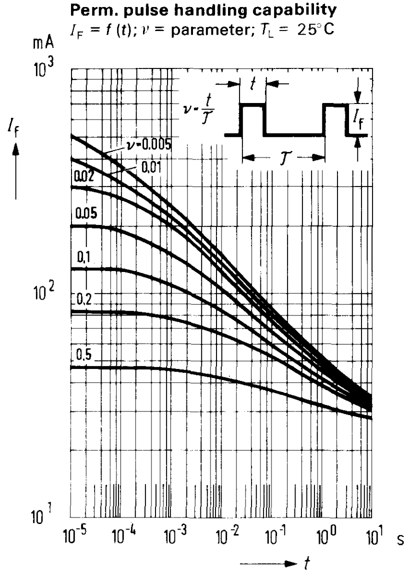
Luminous intensity $\frac{I_v}{I_{v\,25°}} = f(T_{amb})$

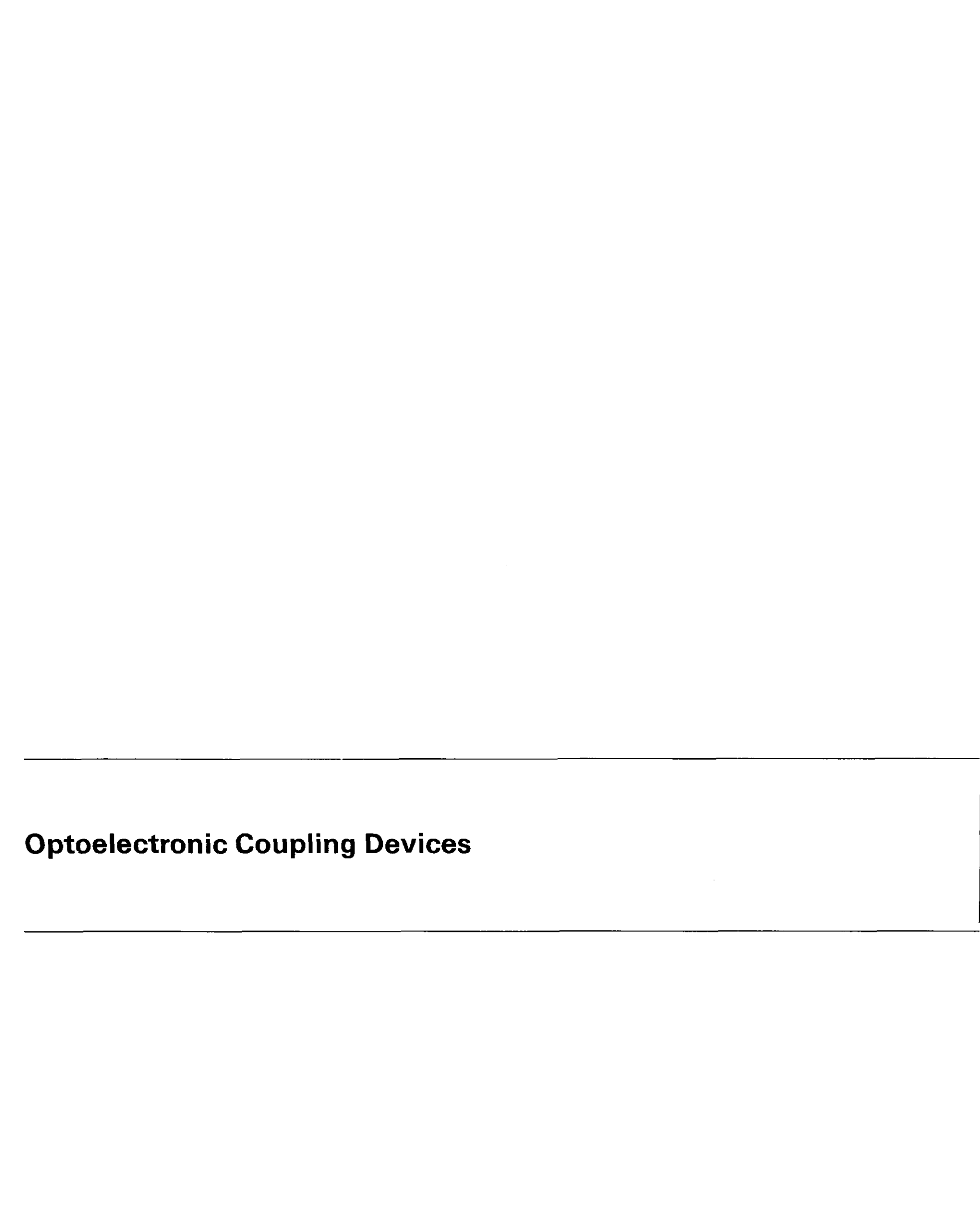


Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$



Perm. pulse handling capability
$I_F = f(t)$; ν = parameter; T_L = 25°C





Optoelectronic Coupling Devices

Optoelectronic Coupler with a Particularly High Current Transfer Ratio

CNY 17

The optically coupled isolator CNY 17 uses as emitter a GaAs infrared emitting diode which is optically coupled with a silicon planar phototransistor acting as detector. The component is incorporated in a plastic plug-in case 20 A 6 DIN 41866.

The coupling device is suitable for signal transmission between two electrically separated circuits. The potential difference between the circuits to be coupled is not allowed to exceed the maximum permissible insulating voltage.

Type	Ordering code
CNY 17/I	Q 62 703-N 1-S 1
CNY 17/II	Q 62 703-N 1-S 2
CNY 17/III	Q 62 703-N 1-S 3
CNY 17/IV	Q 62 703-N 1-S 4

Infrared emitting diode emitter	1 anode
	2 cathode
	3 not wired
Phototransistor detector	4 emitter
	5 collector
	6 base

Dimensions in mm

Approx. weight 0.7 g

Maximum ratings

Emitter (GaAs infrared emitting diode)

Reverse voltage	V_R	3	V
Forward current	I_F	60	mA
Surge current ($t \leq 10\ \mu s$)	i_{FS}	1.5	A
Power dissipation	P_{tot}	100	mW

Detector (Si phototransistor)

Collector-emitter reverse voltage	V_{CEO}	70	V
Emitter-base reverse voltage	V_{EBO}	7	V
Collector current	I_C	100	mA
Power dissipation	P_{tot}	150	mW

Coupler

Storage temperature	T_{stor}	−55 to +125	°C
Operating temperature	T_{amb}	−55 to +100	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leq 3$ s)	T_s	230	°C
Isolation voltage (between emitter and detector referred to standard climate 23/50 DIN 50014; leakage path 8.2 mm min; air path 7.6 mm min)	V_{is}	4000	V

Tracking resistance: Group III (KC ≧ 600 in accordance with VDE 110 § 6, table 3 and DIN 53 480/VDE 0330, part 1.

DIN standard specification and/or VDE instructions under consideration; as to the nominal isolation voltage VDE decision 69 or VDE 0110 and 0160 applies.

Characteristics (T_{amb} = 25°C)

Emitter (GaAs infrared emitting diode)

Forward voltage (I_F = 60 mA)	V_F	1.25 (≦1.65)	V
Breakdown voltage (I_R = 100 µA)	V_{BR}	30 (≧4)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦10)	µA
Capacitance (V_R = 0 V; f = 1 MHz)	C_0	50	pF

Detector (Si phototransistor)

Capacitance (V_{CE} = 0 V; f = 1 MHz)	C_{CE}	10	pF
	C_{CB}	15	pF
	C_{EB}	16	pF

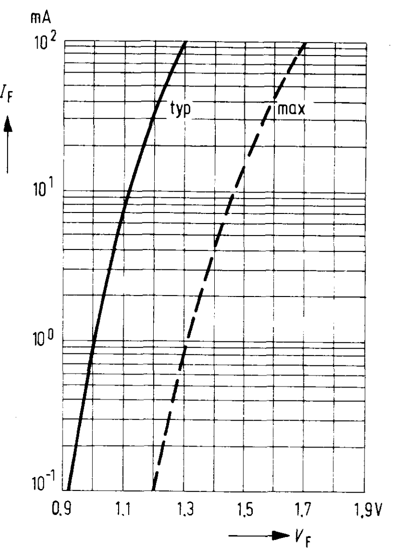
Coupler

Collector-emitter saturation voltage (I_F = 10 mA; I_C = 2.5 mA)	V_{CEsat}	0.3	V
Coupling capacitance	C_K	0.34	pF

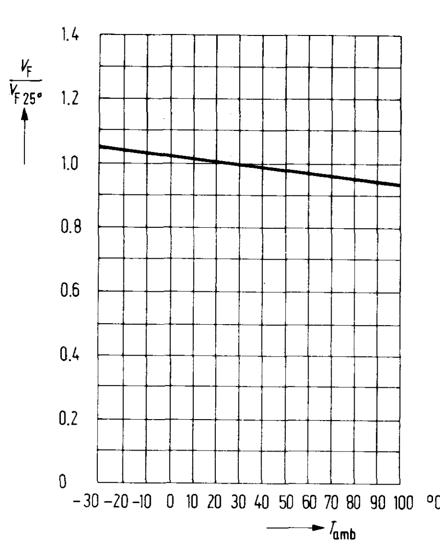
The couplers are grouped in accordance with their current ratio $\frac{I_C}{I_F}$ at I_E = 10 mA and V_{CE} = 5 V and marked by Roman numerals.

Group	I	II	III	IV	
$\frac{I_C}{I_F}$	40 to 80	63 to 125	100 to 200	160 to 320	%
Current gain B (I_C = 10 mA; V_{CE} = 5 V)	250	350	500	700	
Collector-emitter leakage current (V_{CE} = 10 V) I_{CEO}	8 (≦50)	2 (≦50)	5 (≦100)	5 (≦100)	nA

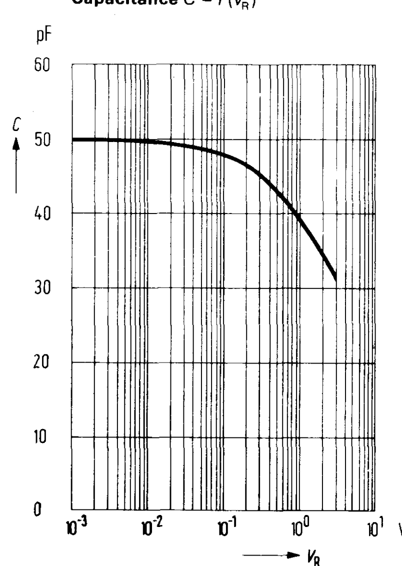
Forward voltage $I_F = f(V_F)$



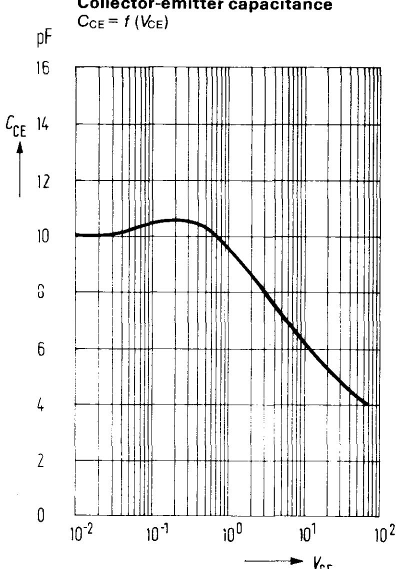
Forward voltage $\frac{V_F}{V_{F\ 25°}} = f(T_{amb})$



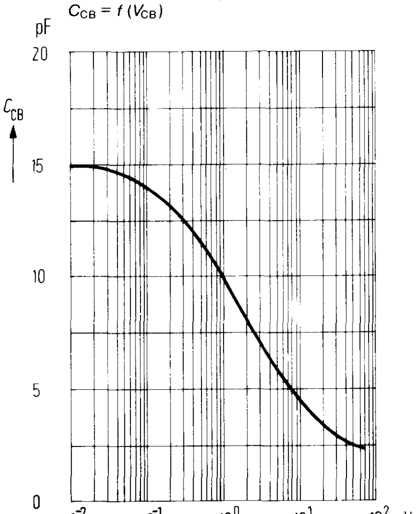
Capacitance $C = f(V_R)$

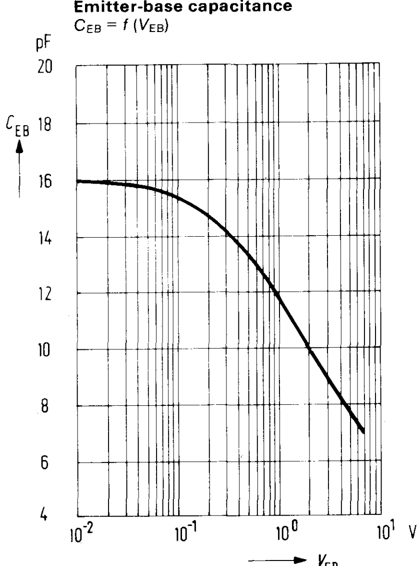


Collector-emitter capacitance
$C_{CE} = f(V_{CE})$

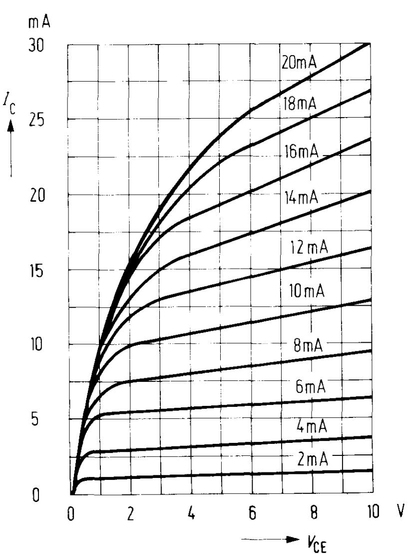


Collector-base capacitance
$C_{CB} = f\,(V_{CB})$

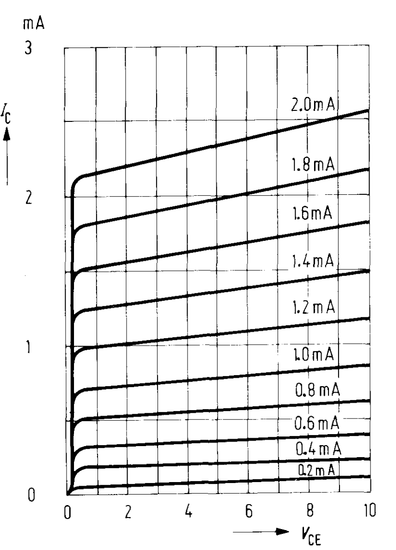




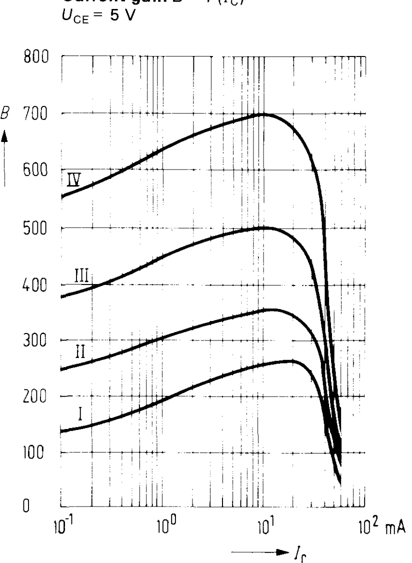
Output characteristics $I_C = f\,(V_{CE})$



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



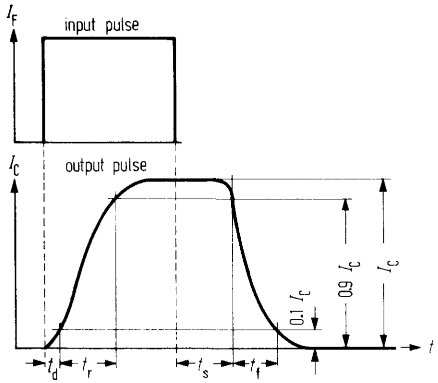
Current gain $B = f(I_C)$
$U_{CE} = 5$ V

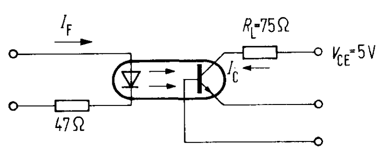


Switching times

Load resistance	R_L	75	Ω
Delay time	t_d	0.5	μs
Rise time	t_r	2	μs
Storage time	t_s	0.2	μs
Fall time	t_f	2	μs
Cut-off frequency	f_g	250	kHz

$I_F = 10$ mA
$V_{CE} = 5$ V
$T_{amb} = 25°C$





With the aid of the figure above, the switching characteristics are defined as follows:

Turn-on time $t_{on} = t_d + t_r$

The turn-on time is that period of time during which the output current (collector current), after switching-on the drive current (base current), reaches 90% of its maximum value. The turn-on time includes the delay time t_d and the rise time t_r. The delay time is that period of time during which the collector current, after switching-on the drive pulse, reaches 10% of its final value. The rise time is that time during which the collector current rises from 10% to 90% of its final value.

Turn-off time $t_{off} = t_s + t_f$

The turn-off time is that period of time during which the output current after switching off the drive pulse falls to 10% of its maximum value. It includes the storage time t_s and the fall time t_f.
The storage time is that period of time in which after switching off the drive current (forward current I_F of the infrared emitting diode) the output current (collector current) falls to 90% of its maximum value.
The fall time is that time during which the output current (collector current) falls from 90% to 10% of its maximum value.

Optoelectronic Coupler

CNY 18

The optically coupled isolator CNY 18 uses as emitter a GaAs infrared emitting diode which is optically coupled with a silicon planar phototransistor acting as detector. The component is incorporated in an 18 A DIN 41876 (To-72) case. The collector of the phototransistor is electrically connected to the metal case.

The coupling device is suitable for signal transmission between two electrically separated circuits. The potential difference between the circuits to be coupled is not allowed to exceed the maximum permissible insulating voltage.

Type	Ordering code
CNY 18/I	Q 62 703-N 2-S 1
CNY 18/II	Q 62 703-N 2-S 2
CNY 18/III	Q 62 703-N 2-S 3
CNY 18/IV	Q 62 703-N 2-S 4

Φ 0.45
ϕ4.7max
13.5±1
$5.2_{-0.3}$
E K
$5.5_{-0.15}$
C A
2.54±0.3

Approx. weight 0.4 g

Dimensions in mm

C connected to case

Maximum ratings

Emitter (GaAs infrared emitting diode)

Reverse voltage	V_R	3	V
Forward current	I_F	60	mA
Surge current ($t \leq 10$ µs)	i_{FS}	1.5	A
Power dissipation	P_{tot}	100	mW

Detector (Si phototransistor)

Collector-emitter reverse voltage	V_{CEO}	32	V
Collector current	I_C	100	mA
Power dissipation	P_{tot}	150	mW

Coupler

Storage temperature	T_{stor}	−55 to +125	°C
Operating temperature	T_{amb}	−55 to +100	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leqq 3$ s)	T_s	230	°C
isolation voltage (between emitter and detector referred to standard climate 23/50 DIN 50014; leakage path 0.35 mm min; air path 0.35 mm min)	V_{is}	500	V

Tracking resistance: Group III (KC ≧ 600) in accordance with VDE 110 § 6, table 3 and DIN 53 480/ VDE 0330, part 1.

DIN standard specification and/or VDE instructions under consideration; as to the nominal Isolation voltage VDE decision 69 or VDE 0110 and 0160 applies.

Characteristics (T_{amb} = 25°C)

Emitter (GaAs infrared emitting diode)

Forward voltage (I_F = 60 mA)	V_F	1.25 (≦1.7)	V
Breakdown voltage (I_R = 100 μA)	V_{BR}	30 (≧4)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≦10)	μA
Capacitance (V_R = 0 V; f = 1 MHz)	C_0	50	pF

Detector (Si phototransistor)

Collector-emitter leakage current (V_{CE} = 10 V)	I_{CEO}	2 (≦100)	nA
Collector-emitter capacitance (V_{CE} = 0 V; f = 1 MHz)	C_{CE}	10	pF

Coupler

Collector-emitter saturation voltage (I_F = 10 mA; I_C = 1 mA)	V_{CEsat}	0.1 (≦0.2)	V

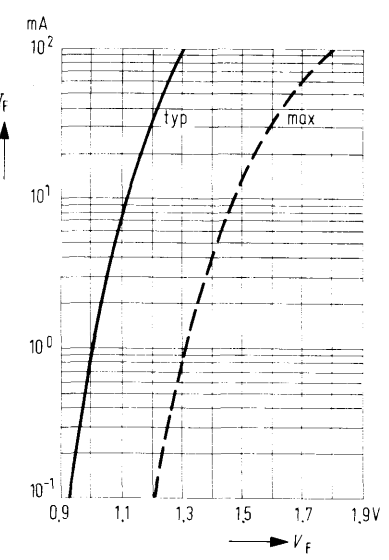
Coupling capacitances (f = 1 MHz)

Infrared emitting diode		Phototransistor			
Anode-cathode short-circuited	——▶	Emitter-collector short-circuited	C_K	1.4	pF
Anode-cathode short-circuited	——▶	Collector (emitter conn. to frame)	C_K	1.1	pF
Anode-cathode short-circuited	——▶	Emitter (collector conn. to frame)	C_K	0.1	pF

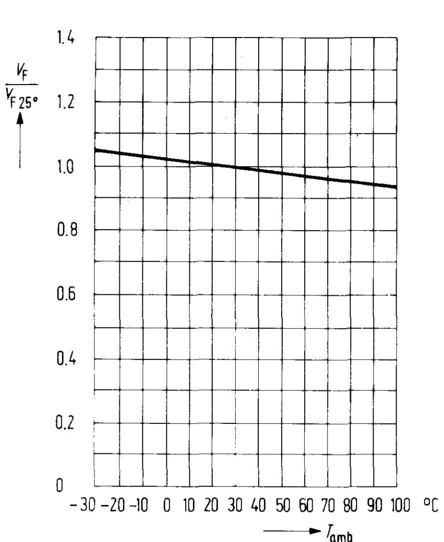
The couplers are grouped in accordance with their current ratio $\frac{I_C}{I_F}$ at I_F = 10 mA and V_{CE} = 5 V and marked by Roman numerals.

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

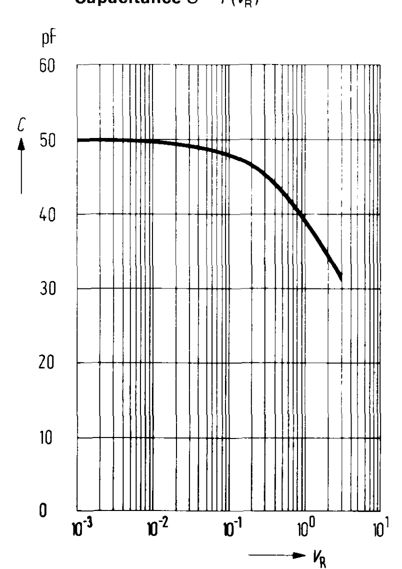
Forward voltage $I_F = f(V_F)$



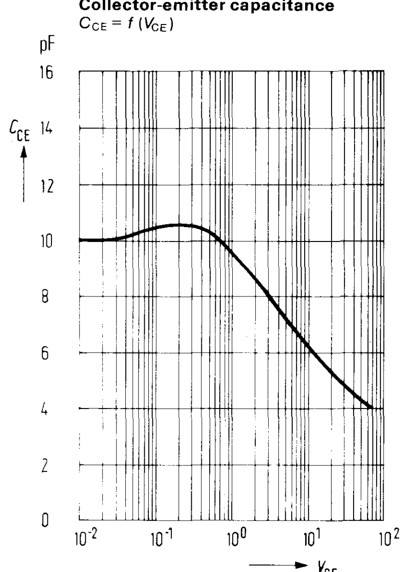
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



Capacitance $C = f(V_R)$



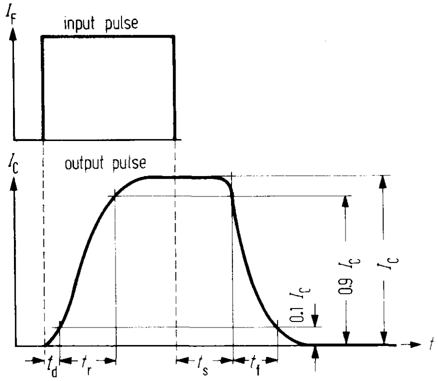
Collector-emitter capacitance
$C_{CE} = f(V_{CE})$

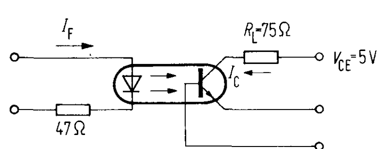


Switching times

Load resistance	R_L	75	Ω
Delay time	t_d	0.5	µs
Rise time	t_r	2	µs
Storage time	t_s	0.2	µs
Fall time	t_f	2	µs
Cut-off-frequency	f_g	250	kHz

I_F = 10 mA
V_{CE} = 5 V
T_{amb} = 25°C





With the aid of the figure above, the switching characteristics are defined as follows:

Turn-on time $t_{on} = t_d + t_r$

The turn-on time is that period of time during which the output current (collector current), after switching-on the drive current (base current), reaches 90% of its maximum value. The turn-on time includes the delay time t_d and the rise time t_r. The delay time is that period of time during which the collector current, after switching-on the drive pulse, reaches 10% of its final value. The rise time is that time during which the collector current rises from 10% to 90% of its final value.

Turn-off time $t_{off} = t_s + t_f$

The turn-off time is that period of time during which the output current after switching off the drive pulse falls to 10% of its maximum value. It includes the storage time t_s and the fall time t_f.
The storage time is that period of time in which after switching off the drive current (forward current I_F of the infrared emitting diode) the output current (collector current) falls to 90% of its maximum value.
The fall time is that time during which the output current (collector current) falls from 90% to 10% of its maximum value.

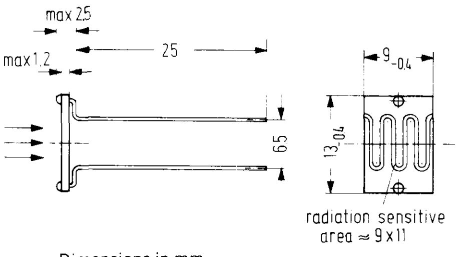
Photoresistors

Photoresistor

FW 9801
FW 9802

FW 9801 and FW 9802 are cadmium sulfide photoresistors with lacquer covering. They are intended for applications, where a low built-in depth is required.

Type	Ordering code
FW 9801	Q 62 705-P 18-F 65
FW 9802	Q 62 705-P 19-F 65



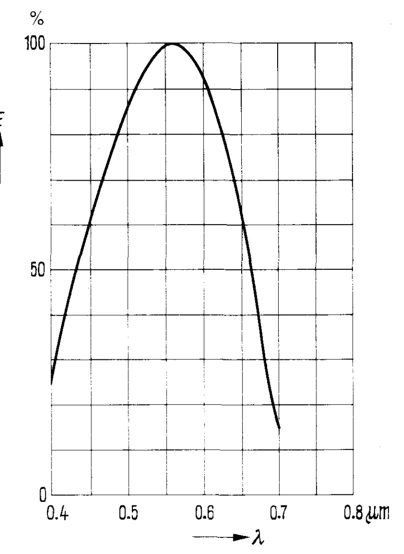
Dimensions in mm

Maximum ratings		**FW 9801**	**FW 9802**	
Power dissipation	P_{tot}	300	300	mW
Operating voltage	V_{op}	100	250	V
Ambient temperature (T_{amb} = 25°C)	T_{amb}	−30 to +60	−30 to +70	°C
Characteristics (T_{amb} = 25°C)				
Dark resistance after 1 sec[1] darkening (min.)	R_0	800	800	kΩ
Light resistance at 50 lx	R_{50}	3	9	kΩ
Resistance tolerance at 50 lx	ΔR	±50	±50	%
Range of spectral sensitivity[2]	λ	350 to 750	350 to 750	nm
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	575 ± 75	575 ± 75	nm
Measuring voltage	V	2	2	V

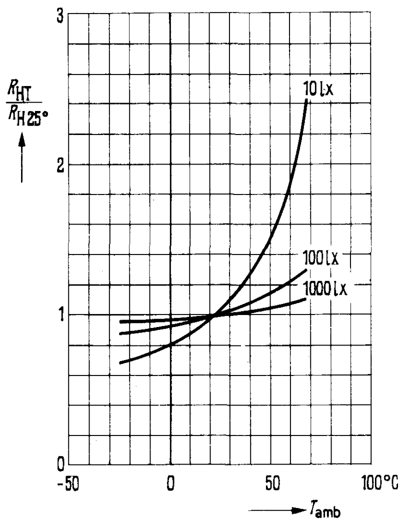
Measuring conditions:
Illuminance = 50 lx, colour temperature of the light source = 2856 K.
Prior to the measurement the photoresistors are stored in darkness at approx. 25°C ambient temperature for at least 24 hours and then exposed to light for approx. 16 hours at 300 lx.

[1] Dark resistance based on 50 lx illuminance
[2] Determined by wavelengths, the sensitivity of which decreased to 10% of the max. value.

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

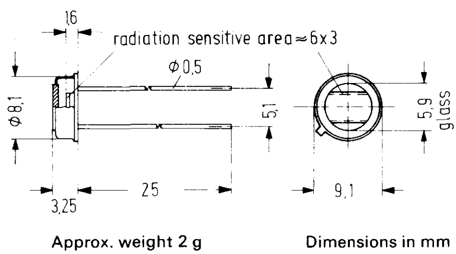


Light resistance as a function of temperature $\frac{R_{HT}}{R_{H25}} = f(T_{amb})$



RPY 60 is a cadmium selenide photoresistor enclosed in a hermetically sealed case similar to TO-5 with a glass window for front illumination. The leads are insulated from the case. The photoresistor is characterized by short decay times.

Type	Ordering code
RPY 60	Q 62 717-P 3



Approx. weight 2 g

Dimensions in mm

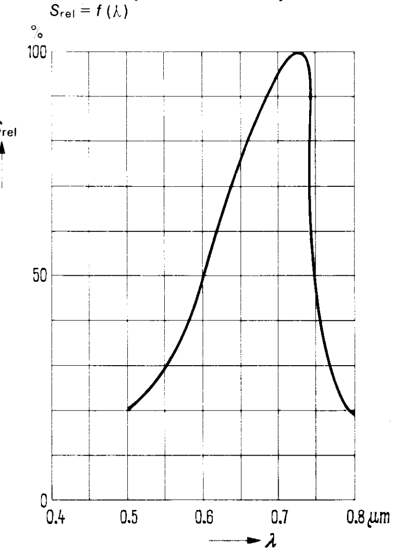
Maximum ratings

Power dissipation	P_{tot}	50	mW
Operating voltage	V_{op}	100	V
Ambient temperature	T_{amb}	−40 to +75	°C

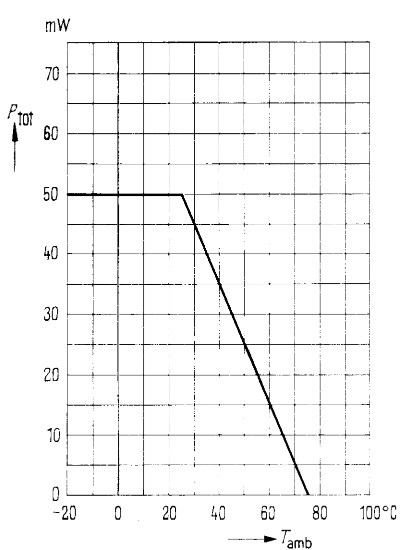
Characteristics (T_{amb} = 25°C)

Dark resistance 1 min after darkening	R_0	$\geq 1 \cdot 10^8$	Ω
Light resistance (E_v = 1000 lx)	R_{1000}	300 to 800	Ω
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	0.72	μm
Temperature coefficient (E_v = 1000 lx; T_{amb} = −25 to +75°C)	TC	1	%/K
Rise time for a resistance decrease from R_0 to 65% of R_{1000}	t_r	1 to 3	ms

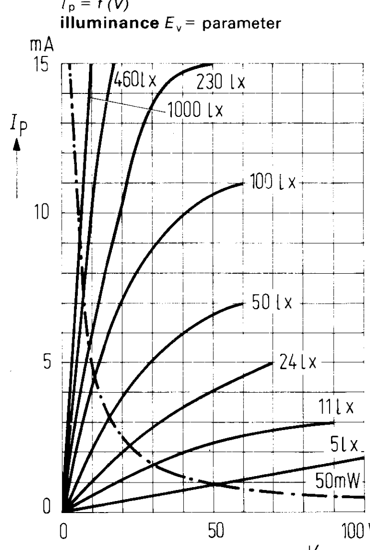
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



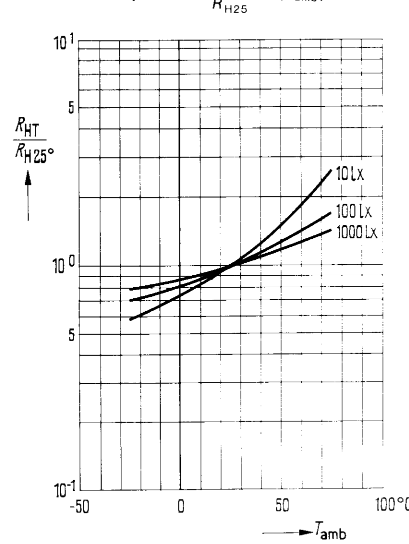
Power dissipation $P_{tot} = f(T_{amb})$



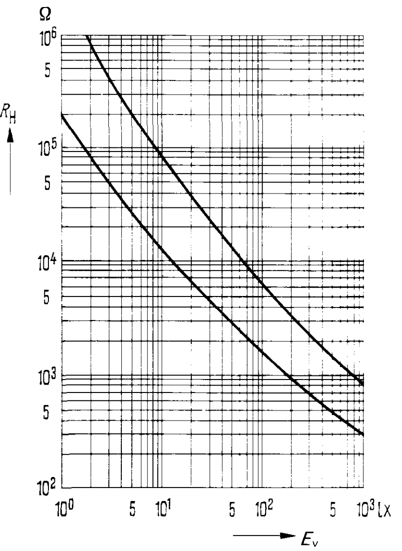
Current-voltage characteristics
$I_p = f(V)$
illuminance E_v = parameter



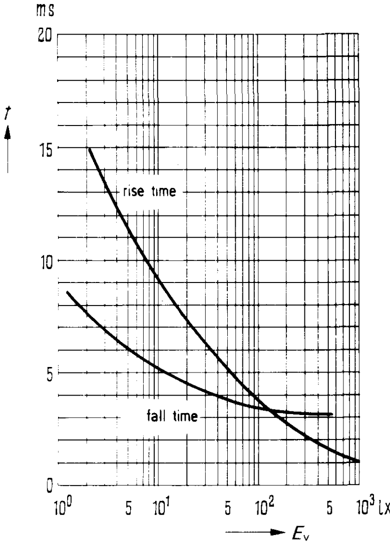
Light resistance as a function of temperature $\frac{R_{HT}}{R_{H25}} = f(T_{amb})$



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

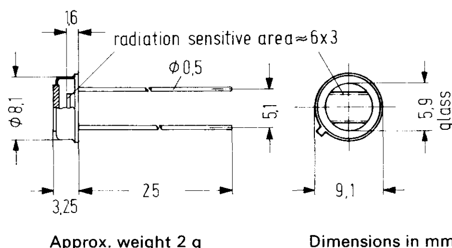


Rise and fall time of the photocurrent to 65% of the final value as a function of illuminance $t = f(E_v)$



RPY 61 is a cadmium sulphoselenide photoresistor enclosed in a hermetically sealed case similar TO-5 with a glass window for front illumination. The leads are insulated from the case. The photoresistor is characterized by short decay times.

Type	Ordering code
RPY 61	Q 62 717-P 4



Approx. weight 2 g

Dimensions in mm

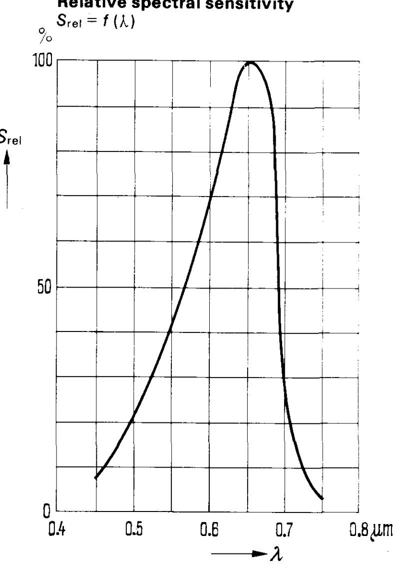
Maximum ratings

Power dissipation	P_{tot}	50	mW
Operating voltage	V_{op}	50	V
Ambient temperature	T_{amb}	−40 to +75	°C

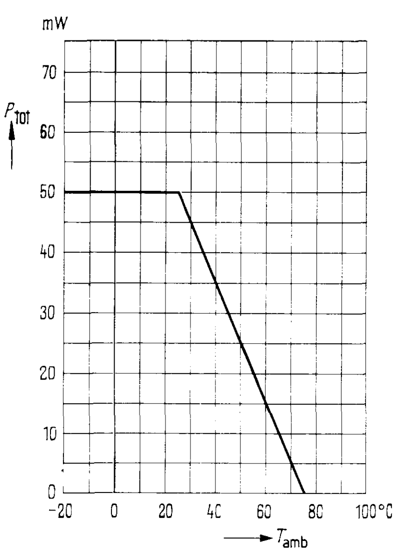
Characteristics (T_{amb} = 25°C)

Dark resistance 1 min after darkening	R_0	$\geq 1 \cdot 10^6$	Ω
Light resistance (E_v = 1000 lx)	R_{1000}	300 to 800	Ω
Wavelength of max. spectral sensitivity	$\lambda_{S\,max}$	0.65	μm
Temperature coefficient (E_v = 1000 lx; T_{amb} = −25 to +75°C)	TC	0.8	%/K
Rise time for a resistance decrease from R_0 to 65% of R_{1000}	t_r	2 to 6	ms

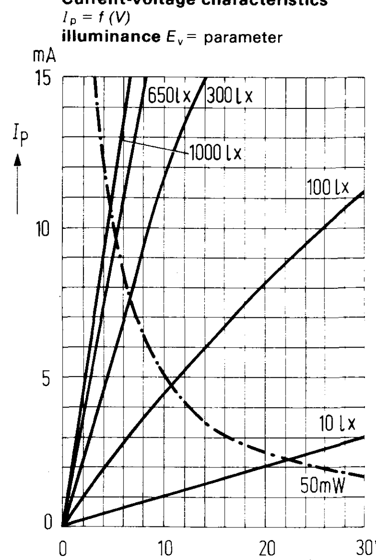
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



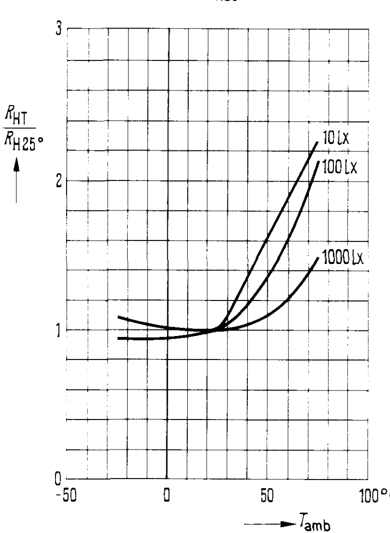
Power dissipation $P_{tot} = f(T_{amb})$



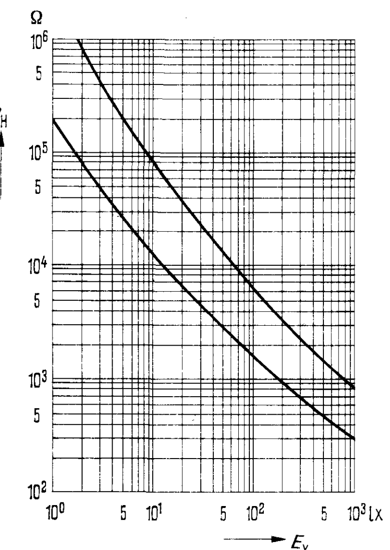
Current-voltage characteristics
$I_p = f(V)$
illuminance E_v = parameter



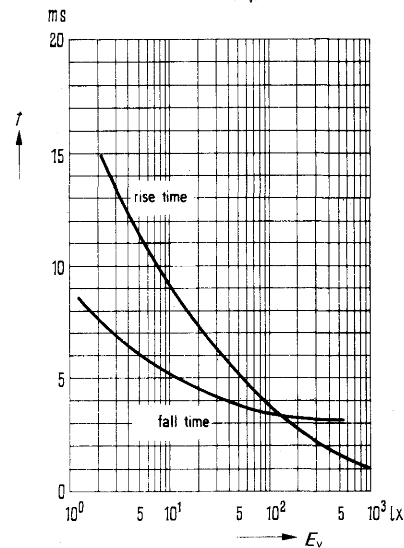
Light resistance as a function of temperature $\frac{R_{HT}}{R_{H25}} = f(T_{amb})$



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

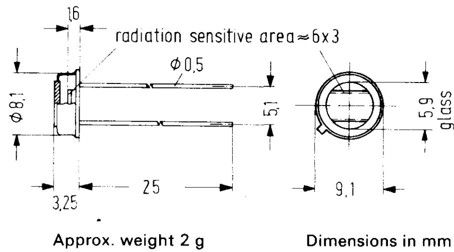


Rise and fall time of the photocurrent to 65% of the final value as a function of illuminance $t = f(E_v)$



RPY 62 is a cadmium sulphoselenide photoresistor enclosed in a hermetically sealed glass case similar to To-5 with a glass window for front illumination. The leads are insulated from the case. The photoresistor is outstanding for short decay times.

Type	Ordering code
RPY 62	Q 62 717-P 5



Approx. weight 2 g

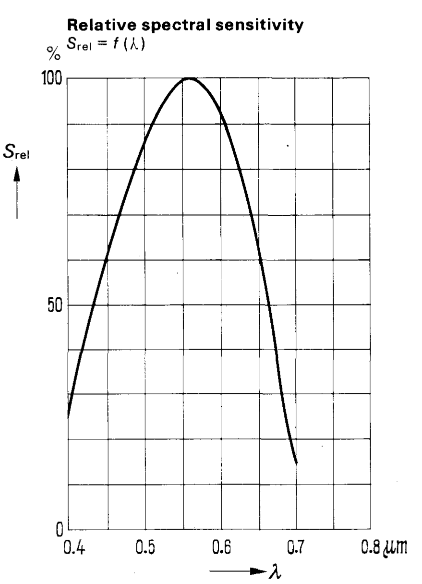
Dimensions in mm

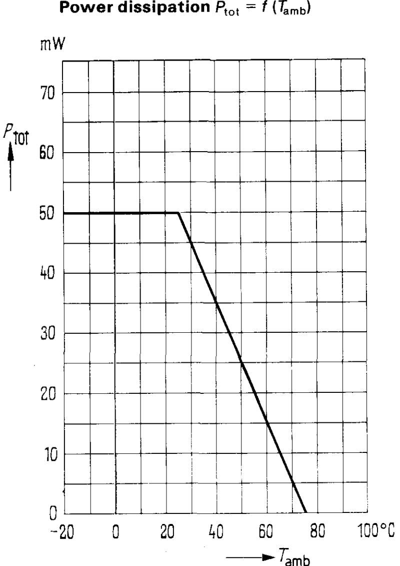
Maximum ratings

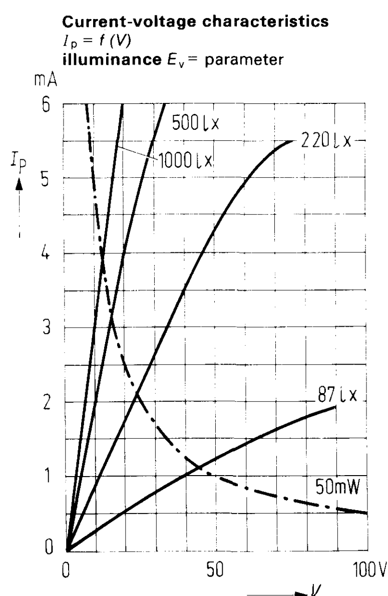
Power dissipation	P_{tot}	50	mW
Operating voltage	V_{op}	100	V
Ambient temperature	T_{amb}	−40 to +75	°C

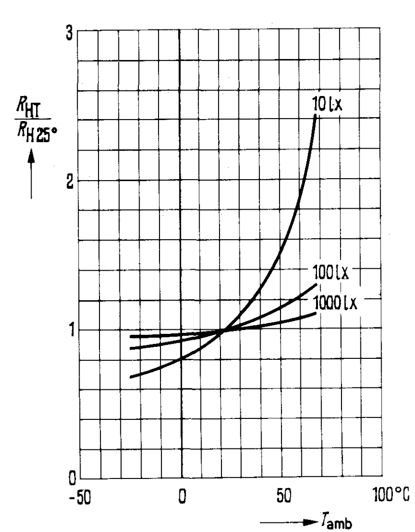
Characteristics (T_{amb} = 25°C)

Dark resistance 1 min after darkening	R_0	$\geq 1 \cdot 10^8$	Ω
Light resistance (E_v = 1000 lx)	R_{1000}	3500	Ω
Wavelength of max. spectral sensitivity	$\lambda_{S\ max}$	0.55	μm
Temperature coefficient (E_v = 1000 lx; T_{amb} = −25 to +75°C)	TC	0.4	%/K
Rise time for a resistance decrease from R_0 to 65% of R_{1000}	t_r	10 to 20	ms

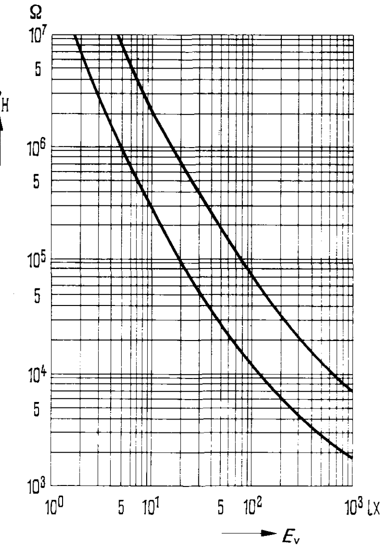

Relative spectral sensitivity
$S_{rel} = f(\lambda)$
%
100
50
0
S_{rel}
0.4
0.5
0.6
0.7
0.8 µm
λ


Power dissipation $P_{tot} = f(T_{amb})$
mW
70
60
50
40
30
20
10
0
P_{tot}
-20
0
20
40
60
80
100°C
T_{amb}

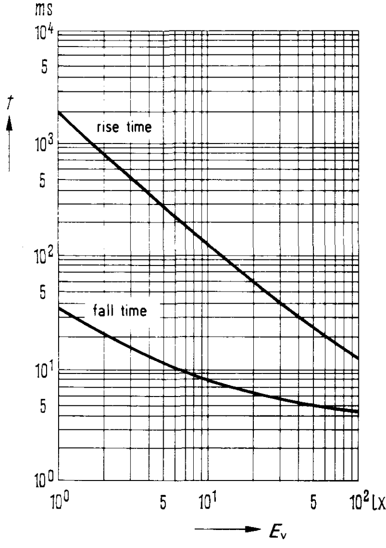

Current-voltage characteristics
$I_p = f(V)$
illuminance E_v = parameter
mA
6
5
4
3
2
1
0
I_p
500 lx
1000 lx
220 lx
87 lx
50mW
0
50
100 V
V


Light resistance as a function
of temperature $\frac{R_{HT}}{R_{H25}} = f(T_{amb})$
3
2
1
0
$\frac{R_{HT}}{R_{H25°}}$
10 lx
100 lx
1000 lx
-50
0
50
100°C
T_{amb}

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

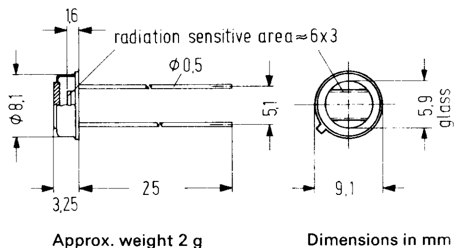


Rise and fall time of the photocurrent to 65% of the final value as a function of illuminance $t = f(E_v)$



RPY 63 is a cadmium sulphoselenide photoresistor enclosed in a hermetically sealed case similar to TO-5 with a glass window for front illumination. The leads are insulated from the case. The photoresistor is outstanding for short decay times.

Type	Ordering code
RPY 63	Q 62 717-P 6



Approx. weight 2 g

Dimensions in mm

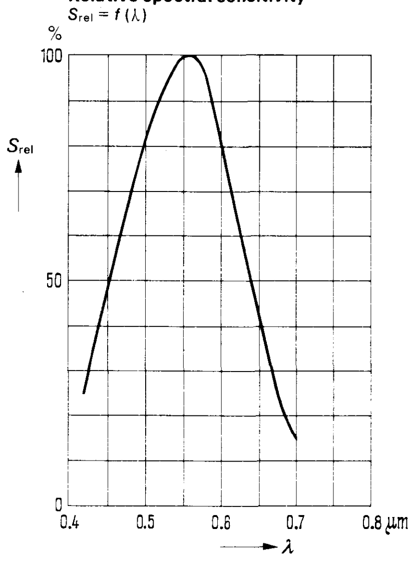
Maximum ratings

Power dissipation	P_{tot}	50	mW
Operating voltage	V_{op}	50	V
Ambient temperature	T_{amb}	−40 to +75	°C

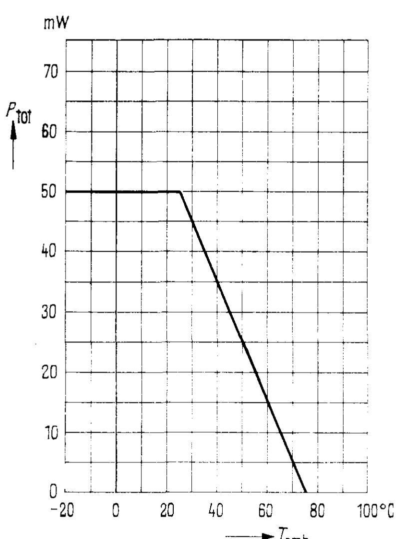
Characteristics (T_{amb} = 25°C)

Dark resistance 1 min after darkening	R_0	≧1 · 10⁶	Ω
Light resistance (E_v = 1000 lx)	R_{1000}	300 to 800	Ω
Wavelength of spectral sensitivity	$\lambda_{S\,max}$	0.55	µm
Temperature coefficient (E_v = 1000 lx; T_{amb} = −25 to +75°C)	TC	0.4	%/K
Rise time for a resistance decrease from R_0 to 65% of R_{1000}	t_r	10 to 20	ms

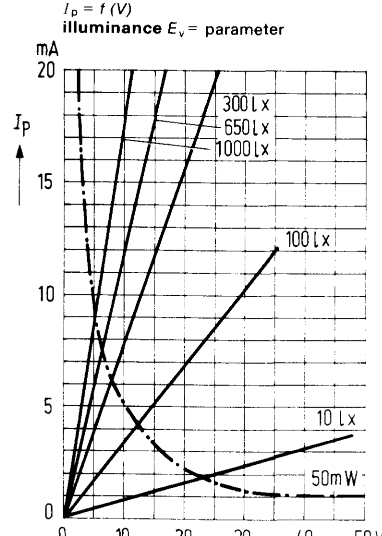
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



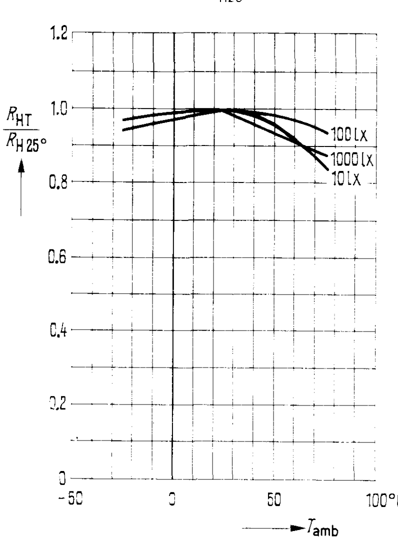
Power dissipation $P_{tot} = f(T_{amb})$



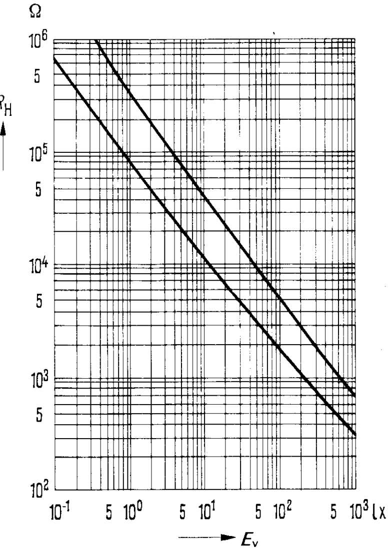
Current-voltage characteristics
$I_p = f(V)$
illuminance E_v = parameter



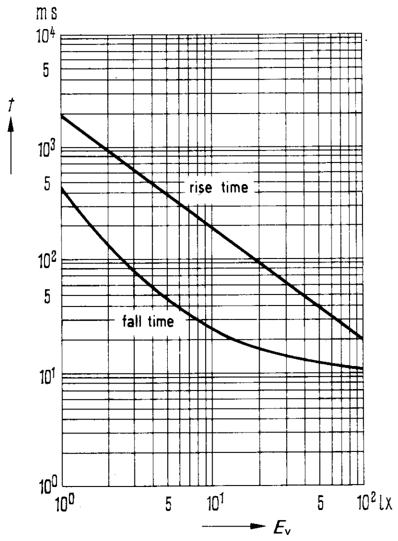
Light resistance as a function of temperature $\frac{R_{HT}}{R_{H25}} = f(T_{amb})$



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



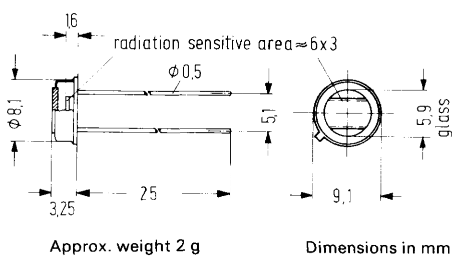
Rise and fall time of the photocurrent to 65% of the final value as a function of illuminance $t = f(E_v)$



Photoresistor

RPY 64 is a cadmium sulfide photoresistor enclosed in a hermetically sealed case similar to TO-5 with a glass window for front illumination. The leads are insulated from the case. The photoresistor is characterized by short decay times.

Type	Ordering code
RPY 64	Q 62 717-P 7



Approx. weight 2 g

Dimensions in mm

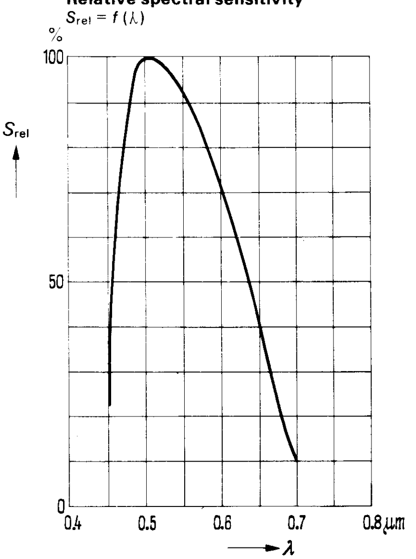
Maximum ratings

Power dissipation	P_{tot}	50	mW
Operating voltage	V_{op}	100	V
Ambient temperature	T_{amb}	−40 to +75	°C

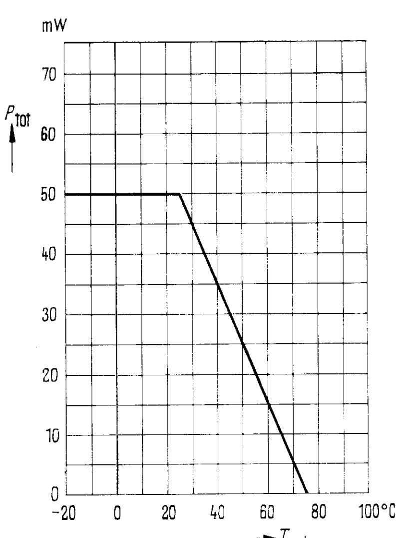
Characteristics (T_{amb} = 25°C)

Dark resistance 1 min after darkening	R_0	≧1 · 10^8	Ω
Light resistance (E_v = 1000 lx)	R_{1000}	3500	Ω
Wavelength of spectral sensitivity	$\lambda_{S\,max}$	0.50	µm
Temperature coefficient (E_v = 1000 lx; T_{amb} = −25 to +75°C)	TC	0.4	%/K
Rise time for a resistance decrease from R_0 to 65% of R_{1000}	t_r	30 to 50	ms

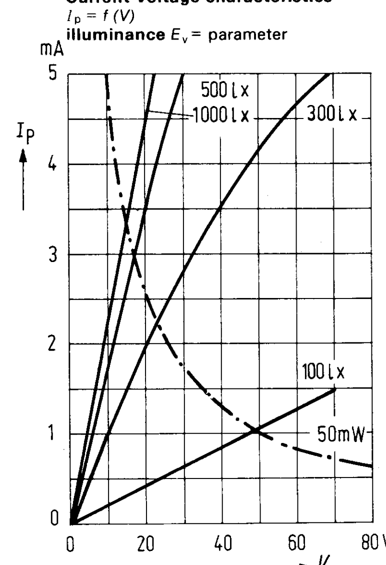
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



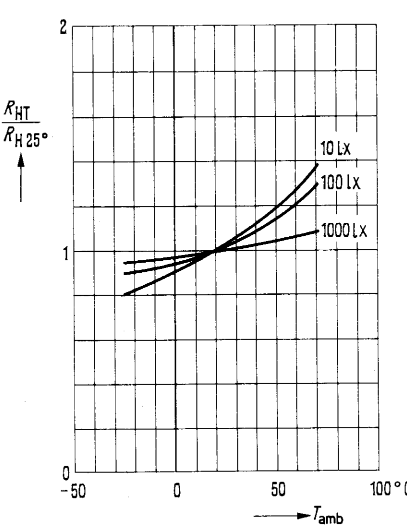
Power dissipation $P_{tot} = f(T_{amb})$



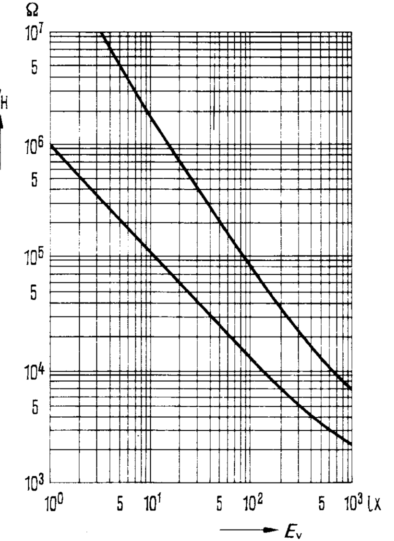
Current-voltage characteristics
$I_P = f(V)$
illuminance E_v = parameter



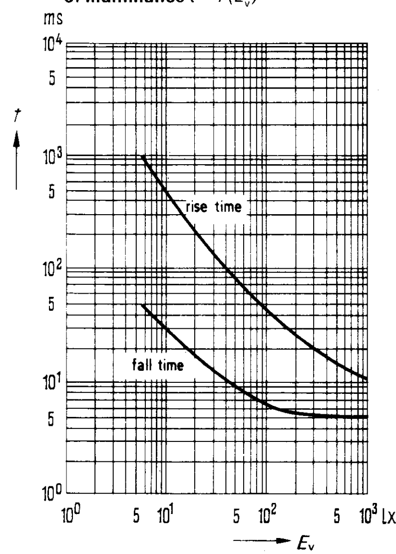
Light resistance as a function of temperature $\frac{R_{HT}}{R_{H25}} = f(T_{amb})$

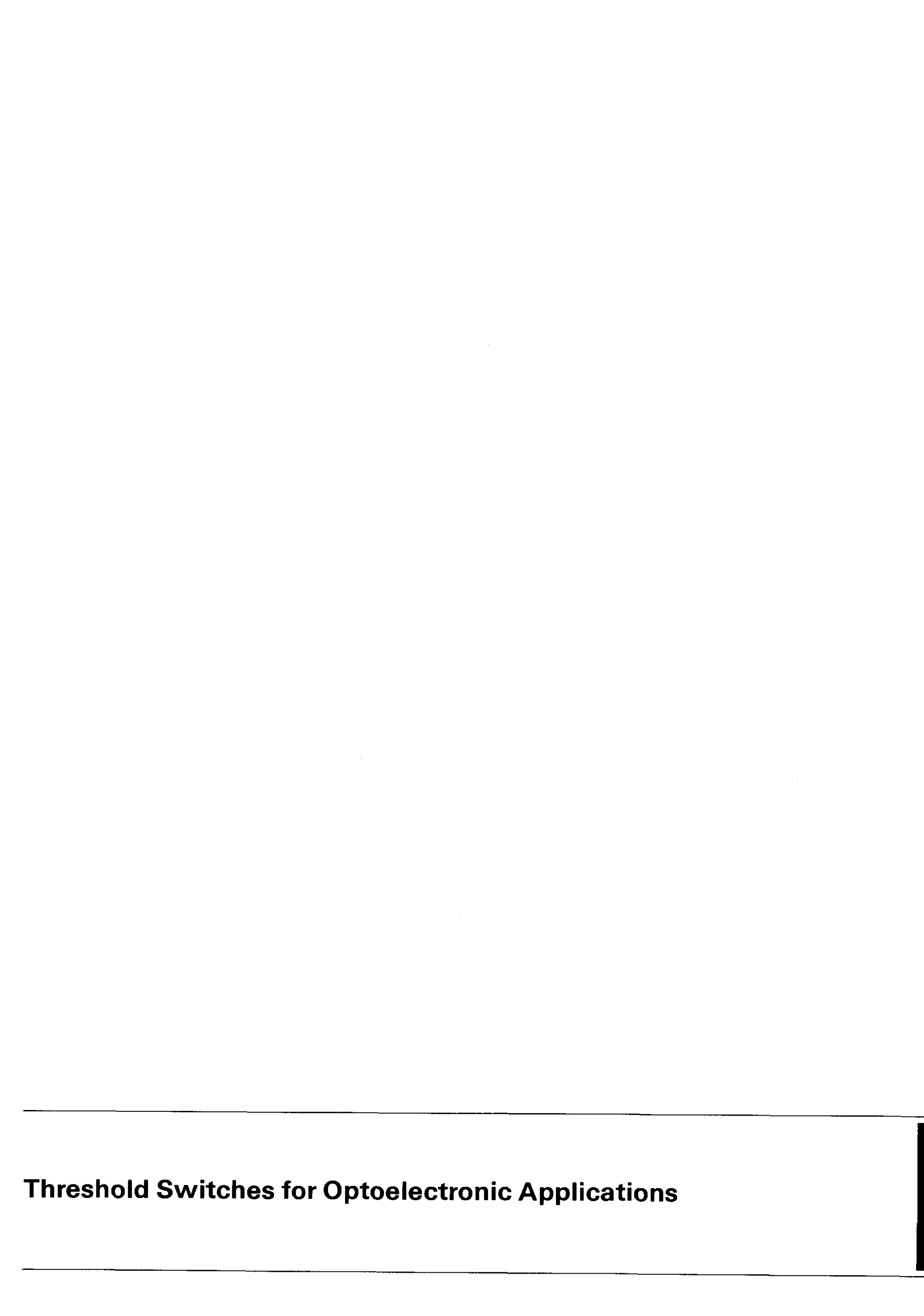


Light resistance as a function of illuminance $R_H = f(E_v)$
(spread)



Rise and fall time of the photocurrent to 65% of the final value as a function of illuminance $t = f(E_v)$





Threshold Switches for Optoelectronic Applications

The threshold switch TPV 63 for photodiodes is a combination of two bipolar transistors connected with one operational amplifier. The threshold switch is suitable for use in automatic exposure meters and optoelectronic circuits.

Type	Ordering code
TPV 63	Q 60 999-A 241

Dimensions in mm

6.5min
4-0.2
6.5min
8
5
1
4
0.4+0.1
1.27
5.5max
0.25
2max

Plastic case, 8 connections
Approx. weight 0.133 g

Maximum ratings

Operating voltage	$V_{batt\ 1}$	+10	V
Operating voltage	$V_{batt\ 2}$	±10	V
Output voltage (potential differences between connection 4 and connection 3)	V_{out}	±20	V
Max. input voltage	V_{in}	±10	V
Max. output current	I_{out}	70	mA
Ambient temperature during operation	T_{amb}	−30 to +70	°C
Storage temperature	T_{stor}	−55 to +125	°C

Electrical characteristics

($V_{batt\,1}$ = + 1.15 V; T_{amb} = 25°C)
($V_{batt\,2}$ = +3.4 V)
−2.2 V)

Input current	I_{in}	+20	pA
Switching threshold	V_{ES}	+0.7	V
Leakage voltage (Potential difference between connection 4 and connection 3 in the connecting-through state, see measuring circuit, fig. 2)	V_{leak}	1.3	V
Output current (V_E = 0 V)	I_{out}	7	μA
Open circuit current input (V_E = 0 V)	$(I_{batt\,1} + I_{batt\,2})$	0.4	mA
Transition width between both the switching states	ΔV_E	1	mV
Speed of rise of V_{out} during not-inverted operation (see measuring circuit, fig. 2) ($V_E = 0\,V \rightarrow V_E = 1.0\,V$)	$\frac{dV_{out}}{dt}$	3.0	$\frac{V}{\mu s}$
Input capacitance	C_E	4	pF

Lead pattern

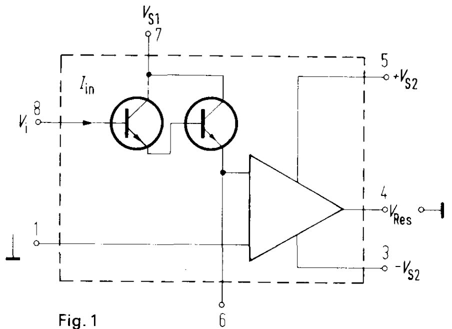


Fig. 1

Measuring circuit

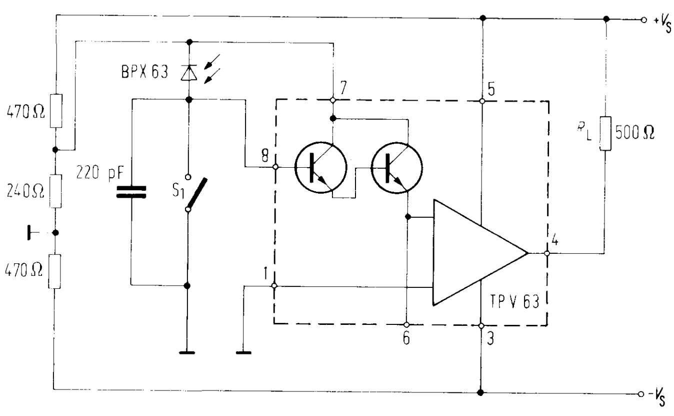


Fig. 2

Circuit example
Automatic exposure and illumination control

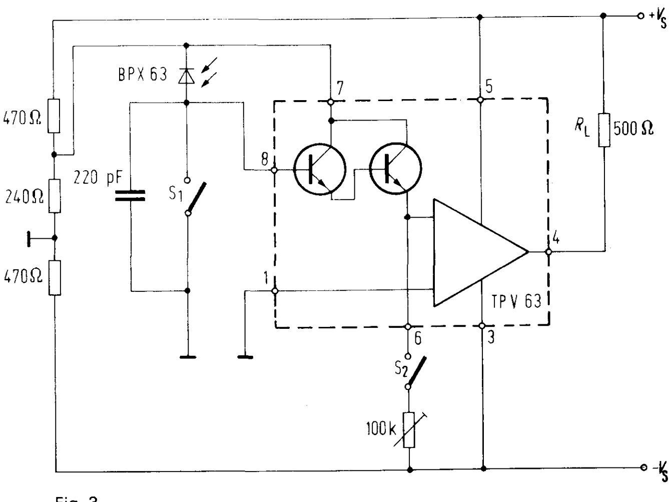


Fig. 3

Circuit example
Automatic exposure with temperature compensation and illumination control

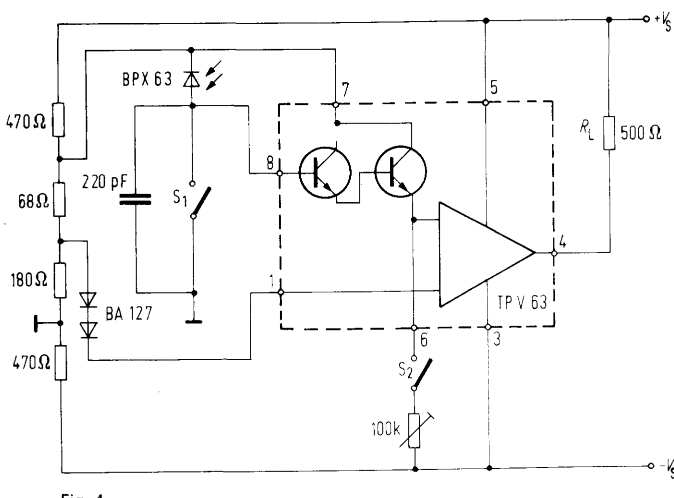


Fig. 4

Data of the automatic exposure meter

	Kind of operation: automatic		
Circuit	Measuring error of exposure time due to a change in T_{amb} (−20°C to +45°C) (E_v = 1 lx)[1] *TC*	Measuring error of exposure time due to a change in V_{batt} (3.8 V to 5.6 V) (E_v = 1 lx)[1] *Fu*	Time of exposure at $E_v = 10^{-1}$ lx[1]) *t*
Fig. 3	−0.6%/K	0	1.5 s
Fig. 4	0%/K	+19%/V	1.5 s

	Kind of operation: illumination control		
Circuit	Potentiometer R_1 E_v = 1 lx[1]) *R*	Measuring error of exposure time due to a change in T_{amb} (−20°C to +45°C) (E_v = 1 lx)[1] *TC*	Measuring error of exposure time due to a change in V_{batt} (3.8 V to 5.6 V) (E_v = 1 lx)[1] *Fu*
Fig. 3	60 kΩ	+0.86%/K	−2.8%/K
Fig. 4	65 kΩ	+0.72%/K	−24%/K

[1]) Illuminance in front of the filter BG 38/1.5 mm

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☎ 72 98 61, Tx 31 233

Contents
Summary of types
General

Photovoltaic Cells

Photodiodes

Phototransistors

Light Emitting Diodes

Optoelectronic Coupling Devices

Photoresistors

Threshold Switches for Optoelectronic Applications

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