IEEE 802.11

WIRELESS ACCESS METHODS AND PHYSICAL LAYER SPECIFICATIONS

Title

Infrared Components Characteristics for EXIRLAN-FQPSK and other Wireless Systems

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1. Summary

For the EXIRLAN-Expandable Infrared Local Area Network [ref 1 - 5], currently being standardized by the IEEE 802.11 Wireless Local Area Networks committee (Ref Document IEEE P802.11-94/65R-Template, editor P. Blomeyer March 1994) as well as considered by other European and international organizations we describe the characteristics of typical readily available, low cost and power efficient Infrared transmit and receive diodes suitable for implementation of these FQPSK systems [ref 6 - 17] in the 1 Mb/s to 10 Mb/s range and could be used even for higher data rates.
As stated in Siemens submission IEEE 802.11-94/71 of March 1994 [ref 18] currently Siemens is considering even a higher level of system and component integration than the components/ characteristics described in this paper. This ongoing development program is going to be further intensified and speeded up as soon as the committees finalize the FQPSK based Exirlan standards.
Low cost/high power Infrared transmit diodes in the DC to 30 MHz range are the most practical for the first generations of robust implementations.

2. Characteristics of INFRARED COMPONENTS

2.1. Description of typical available transmitter diodes

IR emitters proposed for IR-wireless applications differ by chip and by package. The chip determines wavelength, speed, power etc. whereas the package may influence light extraction efficiency and power dissipation/max. current rating. Due to its high extraction efficiency and lower cost we have chosen the standard T 1 3/4 (=5 mm) plastic package for a comparison of various emitter chip types. Table 1 shows three high-speed emitters, compared by some key data:

SFH 477 is a typical GaAlAs Double Hetero junction diode on a transparent substrate with 880 nm wavelength and 25 mW/@100 mA powerlevel and a beam width of less than 20 degrees (see fig. 1), which will suffice for transmission up to about 10 meters, depending on receiver design. 100 mA forward current is the max. permissible DC-value, given by the thermal limitations of 165 mW maximum power dissipation of this package, whereas pulsed operation up to 2 amps peak is permitted. It should work well in EXIRLAN applications up to about 12 MHz. Its wavelength fits well to the maximum of the spectral response curve of silicon photodiodes (see fig. 2).

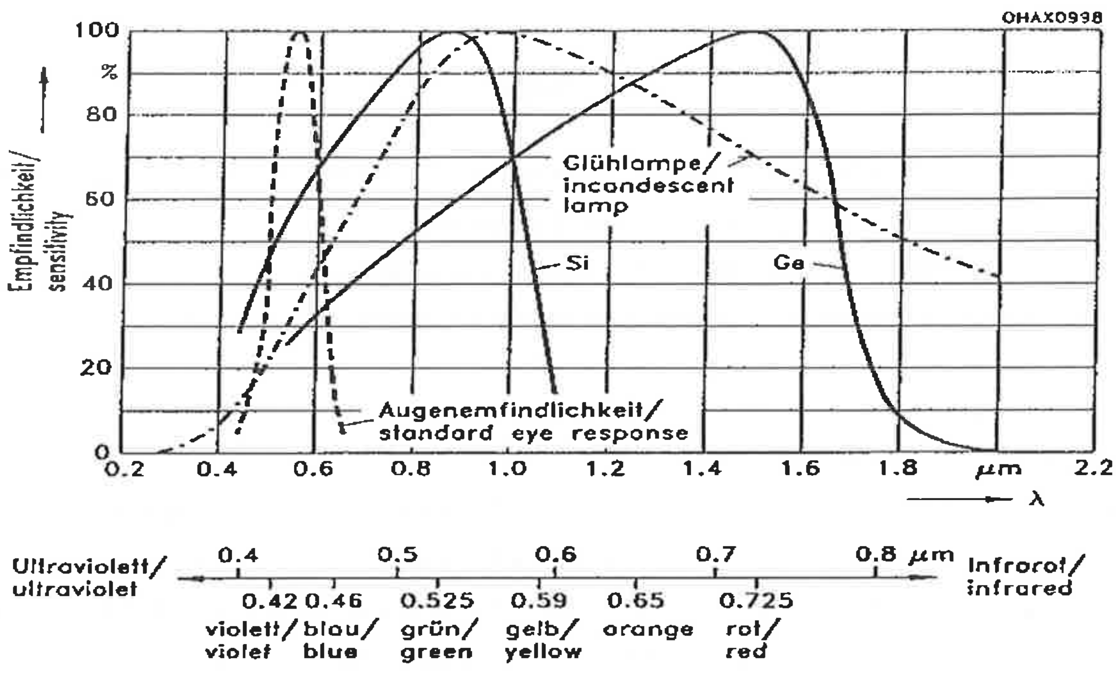

Fig. 2: Relative sensitivity of different light-sensitive detectors

Some detailed data can be seen in table 2. Except power, wavelength, speed and current handling capability, the other important factors are forward voltage V_F and beam angle resp. radiant intensity I_e. A low V_F is important with respect to power dissipations of the emitter itself and in the drive circuitry. As long as point to point setups of the communication partners are desired, a narrow beam angle should be preferred and consequently a high radiant intensity I_e

thereby obtaining high signal to noise ratio at large distances and for high interference immunity. The price for this is a fixed setup that needs some adjustment and that should not be interrupted by obstacles. For "room filling" applications, a wider beam angle is desirable and can be provided by a lensless package containing the same chip, e.g. PL-CC2 see SFH 423/417 in fig 3.

The price there is a low radiant intensity of 4 mW/sr with all the other data being the same. As with all small high power optical emitters, care should be taken in the practitcal implementation of a system, to comply with the safety requirements of IEC 825 which make basically no difference between stimulated emitters (lasers) and spontaneous emitters.

SFH 495 P is a stimulated emitter with excellent speed, good for up to 30 MHz, high power efficiency and low forward voltage at high currents, making it an excellent choice for pulsed high speed baseband systems, but only for low duty cycles since its threshold of about 100 mA forbids any use in a CW-mode with reasonable power output. Therefore it will not be considered for EXIRLAN in this paper.

F 237 A is a GaAlAs Double hetero junction on a transparent substrate, like SFH 477/423/427 but more optimized for high power output at moderate currents (e.g. 100 mA), but with some compromise in speed, making it an optimum solution for EXIRLAN applications up to about 10 MHz. The high forward voltage at 1 A is a drawback only in high-current pulsed applications whereas at moderate currents, it does not exceed the limits set by 5 V circuitry and by its thermal dissipation capability.

2.2. Future developments of IR-Emitters

GaAlAs hetero junction devices, in the 800 - 900 nm range, seem to have some future potential in speed a well as in power. Experimental devices with rise/fall times tr/tf of 10 ns at 20 mW have been implemented, and commercial devices may be expected in due course of time. Nevertheless the trade off between maximum power efficiency and highest speed seems to be permanent in this class of diodes.

Another direction of future progress may be the reduction of threshold currents in stimulated emitters, as a spin-off from optical fiber communication developments, possibly leading to more efficient and higher speed devices to support EXIRLAN. Eventually this may be enhanced by the application of packages with higher thermal conductivity (higher priced, though). The third aspect for future IR-LANs will be the application of various wavelengths e.g. 880 - 1300 - 1500 nm. It may be expected that, particularly for point to point communication, efficient and low cost filtering techniques will become available, thereby expanding the effective available handwidth.

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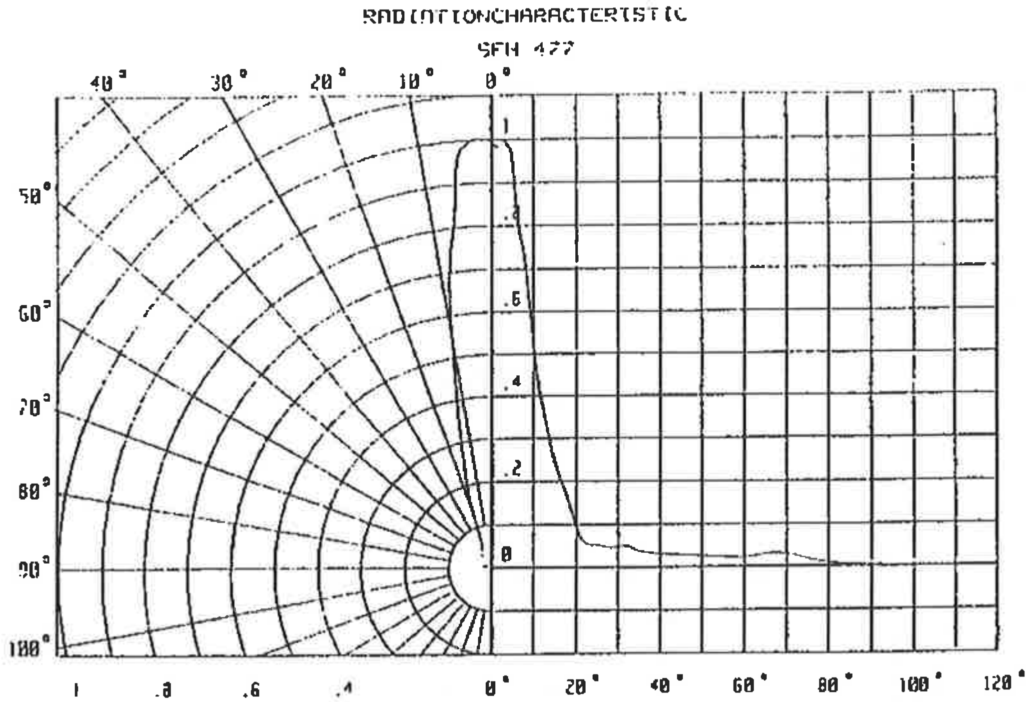
IEEE 802.11-94/71, Wireless Access Methods and Physical Layer Specifications,
March 1994.

Fast emitter

important data

	SFH 477	SFH 495 P	F 237 A	
tr / tf	20	7	30	ns
phie (100 mA)	25	5	50	mW
phie (1 A)	250	700	--	mW
lambda	880	945	830	nm
Vf (1 A)	3	2	10	V
Vf (100 mA)	1,5	N.A.	2,4	V

Table 1



Semiconductor Group 5

<u>Figure 1</u>

SFH 477
PRELIMINARY DATA

Kennwerte (T_A = 25 °C)
Characteristics

Bezeichnung Description	Symbol Symbol	Wert Value	Einheit Unit
Wellenlänge der Strahlung Wavelength at peak emission I_F = 100 mA, t_p = 20 ms	λ_{peak}	880	nm
Spektrale Bandbreite bei 50% von I_{max} Spectral bandwidth at 50% of I_{max} I_F = 100 mA	$\Delta\lambda$	45	nm
Abstrahlwinkel Half angle	φ	±8	Grad deg.
Aktive Chipfläche Active chip area	A	0.105	mm^2
Abmessungen der aktiven Chipfläche Dimension of the active chip area	$L \times B$ $L \times W$	0.325 x 0.325	mm
Schaltzeiten, I_e von 10% auf 90% und von 90% auf 10%, bei I_F = 100 mA, R_L = 50 Ω Switching times, I_e from 10% to 90% and from 90% to10%, I_F = 100 mA, R_L = 50 Ω	t_r, t_f	20	ns
Kapazität Capacitance V_R = 0 V, f = 1 MHz	C_o	25	pF
Durchlaßspannung Forward voltage I_F = 100 mA, t_p = 20 ms I_F = 1 A, t_p = 100 µs	 V_F V_F	 1.5(≤2) 3 (≤4)	 V V
Gesamtstrahlungsfluß Total radiant flux I_F = 100 mA, t_p = 20 ms	Φ_e	26	mW
Temperaturkoeffizient von I_e bzw. Φ_e, I_F = 100 mA Temperature coefficient of I_e or Φ_e, I_F = 100 mA	TC_I	–0.3	%/K
Temperaturkoeffizient von V_F, I_F = 100 mA Temperature coefficient of V_F, I_F = 100 mA	TC_V	–2	mV/K
Temperaturkoeffizient von λ, I_F = 100 mA Temperature coefficient of λ, I_F = 100 mA	TC_λ	+0.2	nm/K
Strahlstärke Radiant intensity I_F = 100 mA, t_p = 20 ms	$I_{e\,min}$ $I_{e\,typ.}$	40 90	mW/sr
Strahlstärke Radiant intensity I_F = 1 A, t_p = 100 µs	$I_{e\,typ.}$	700	mW/sr

Table 2

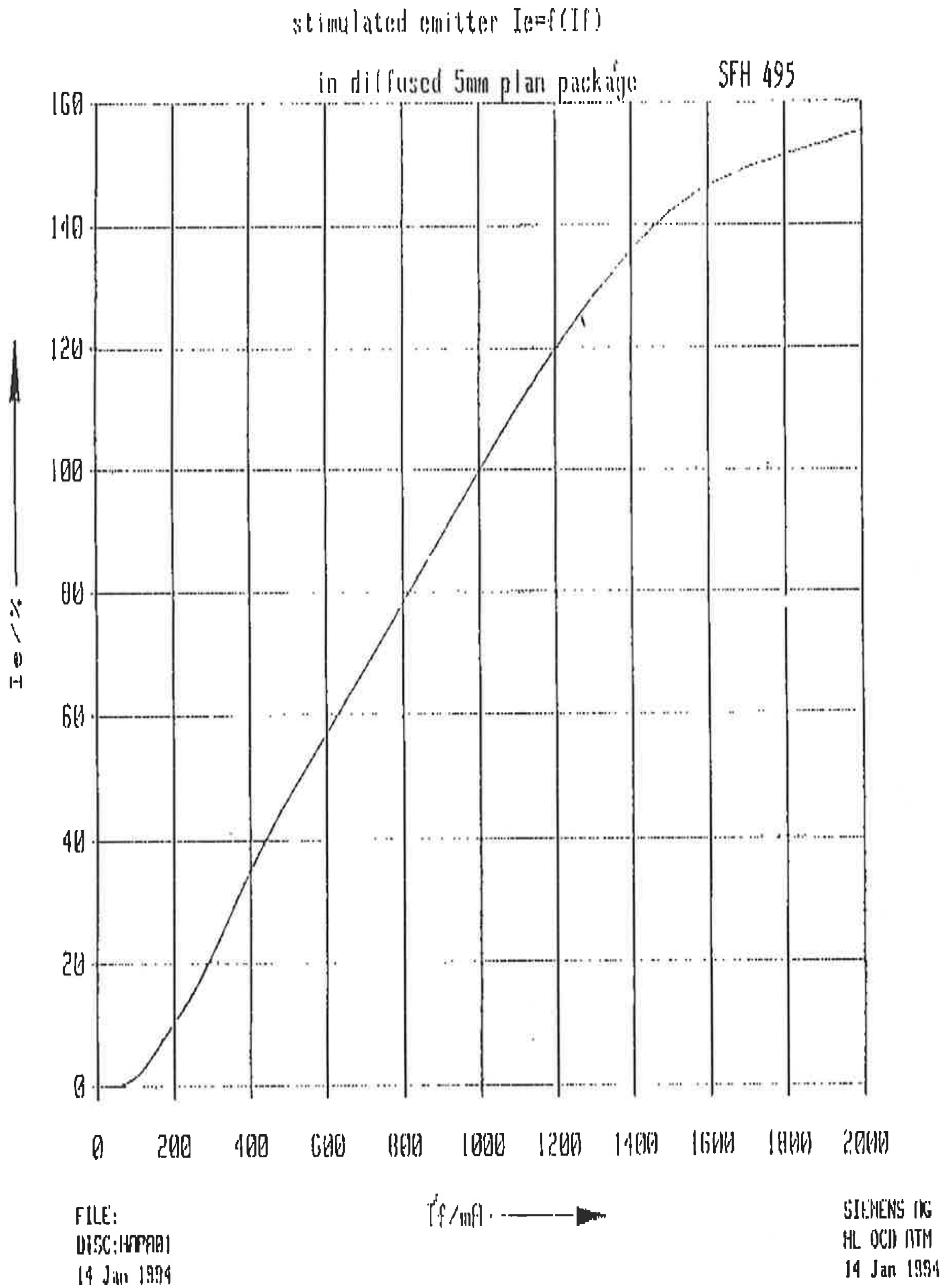
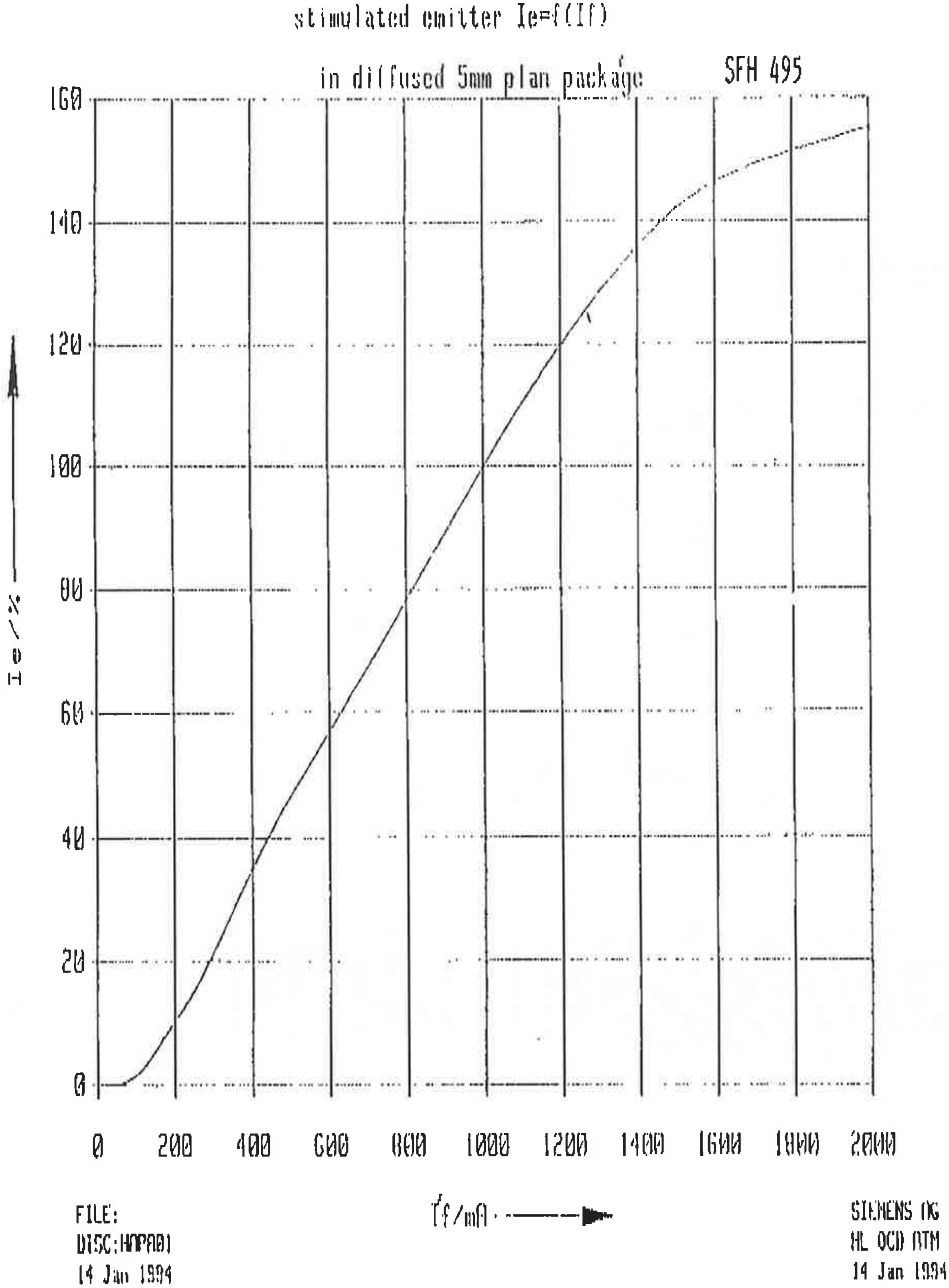

stimulated emitter Ie=f(If)
in diffused 5mm plan package
SFH 495
160
140
120
100
80
60
40
20
0
Ie / %
0
200
400
600
800
1000
1200
1400
1600
1800
2000
If/mA
FILE:
DISC:HAPA01
14 Jan 1994
SIEMENS AG
HL OCD ATM
14 Jan 1994

Figure 1a


stimulated emitter Ie=f(If)
in diffused 5mm plan package
SFH 495
Ie/%
0
20
40
60
80
100
120
140
160
0
200
400
600
800
1000
1200
1400
1600
1800
2000
If/mA
FILE:
DISC:HOPA01
14 Jan 1994
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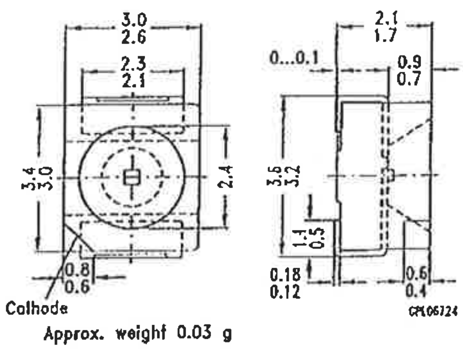
HL OCD ATM
14 Jan 1994

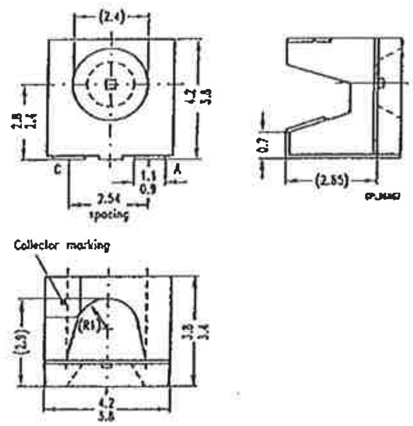
Figure 2A

SFH 423
SFH 427

Gruppierung der Strahlstärke I_e in Achsrichtung
gemessen bei einem Raumwinkel $\Omega = 0.01$ sr
Grouping at radiant intensity I_e in axial direction
at a steradian of $\Omega = 0.01$ sr

Bezeichnung Description	Symbol	Werte Values	Einheit Unit
Strahlstärke Radiant intensity $I_F = 100$ mA, $t_p = 20$ ms	I_e	≥ 4	mW/sr





Directional characteristics $S_{rel} = f$ (φ)

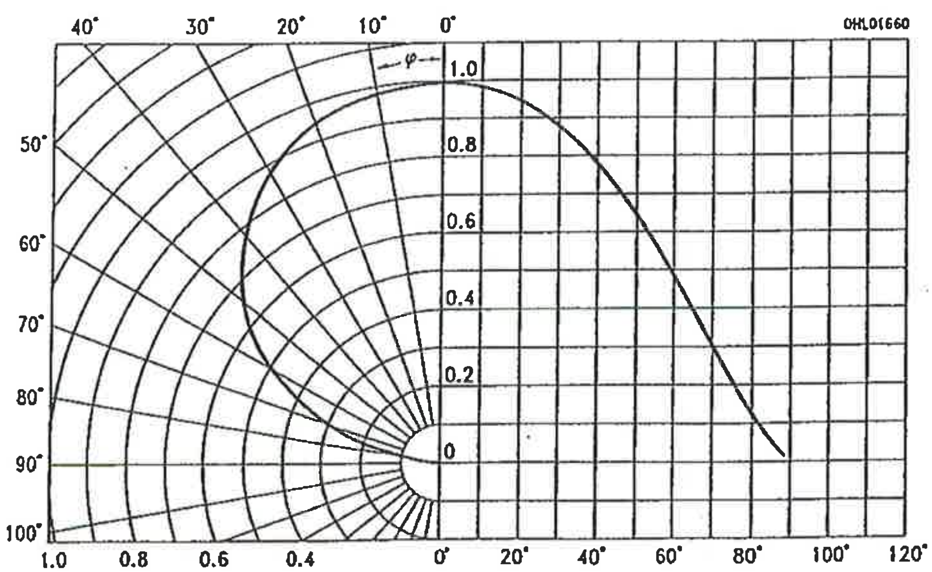


Figure 3