SIEMENS

OPTOELECTRONICS CATALOG 1985

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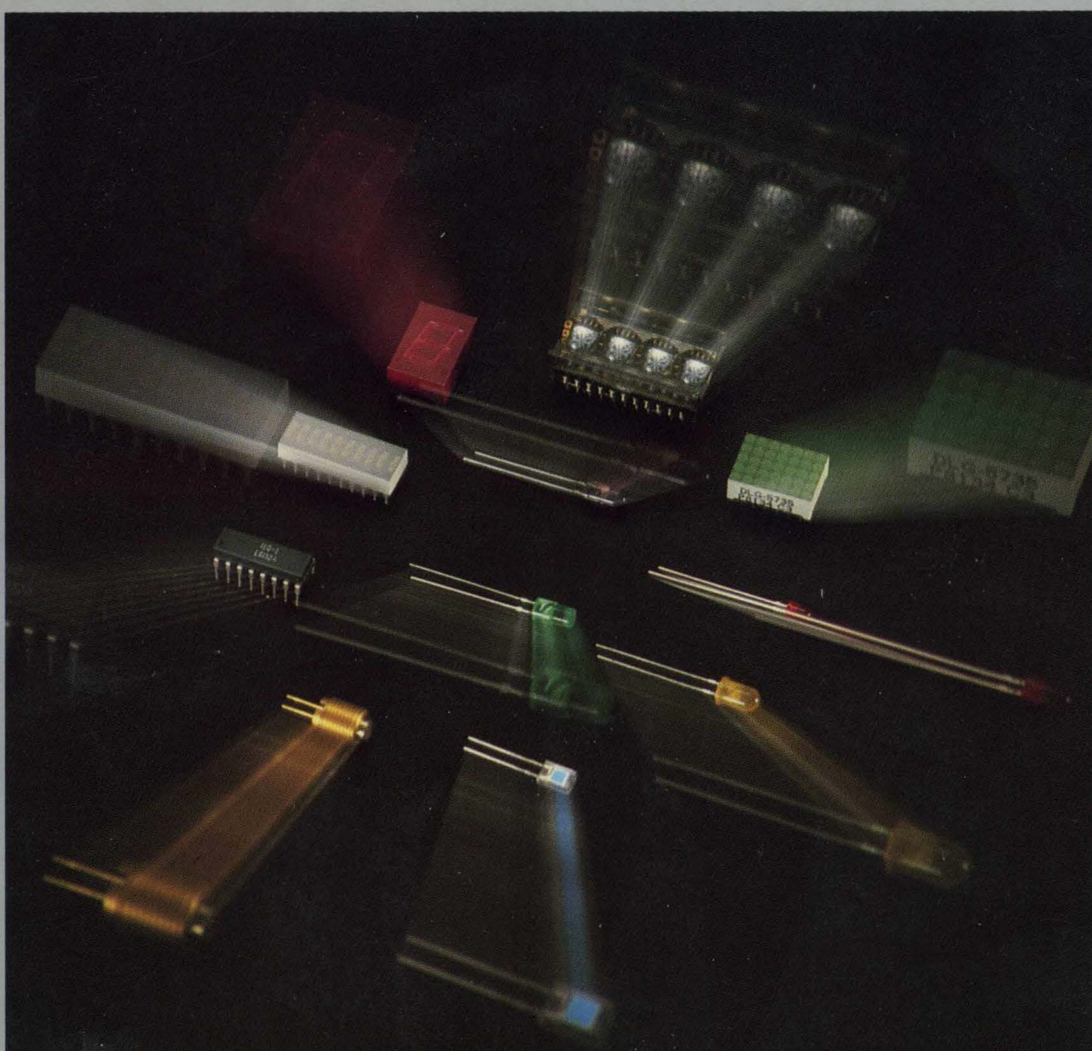
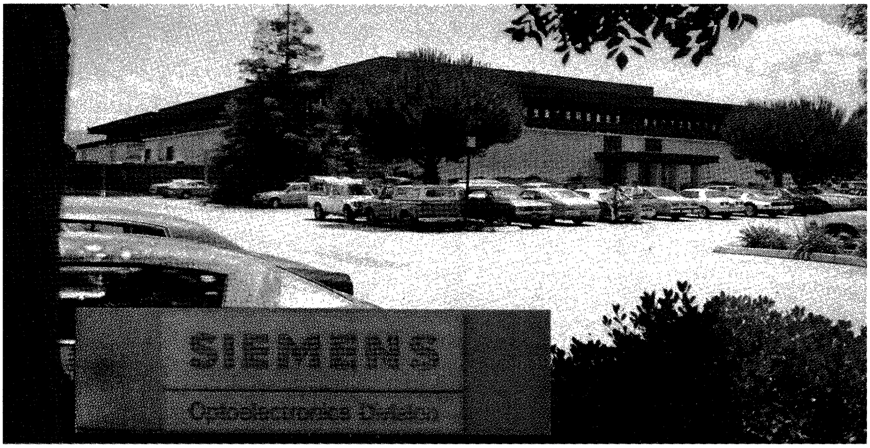
Optoelectronics Catalog 1985





Headquartered in Cupertino, California, Siemens Components Inc. Optoelectronics Division designs, manufactures and markets optoelectronic components and related products worldwide.

Siemens, a world leader in electronics, offers through its Opto Division, a complete line of products based on light-emitting (LED) materials and MOS integrated circuit technology.

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- Programmable Displays™
- Numeric and Alphanumeric LED Displays
- LED Lamps
- Optoisolators
- Infrared Emitting Diodes
- Photodetectors

All aspects of day-to-day production are closely scrutinized to maintain high quality and reliability for the customer. Quality control checks are built into each stage of production. In the production of LEDs, for example, these safeguards include lot-sampling inspection and acceptance after final assembly. The finished product undergoes thorough electrical, optical, dimensional, and visual inspections. This results in products equal to or better than anyone in the industry.

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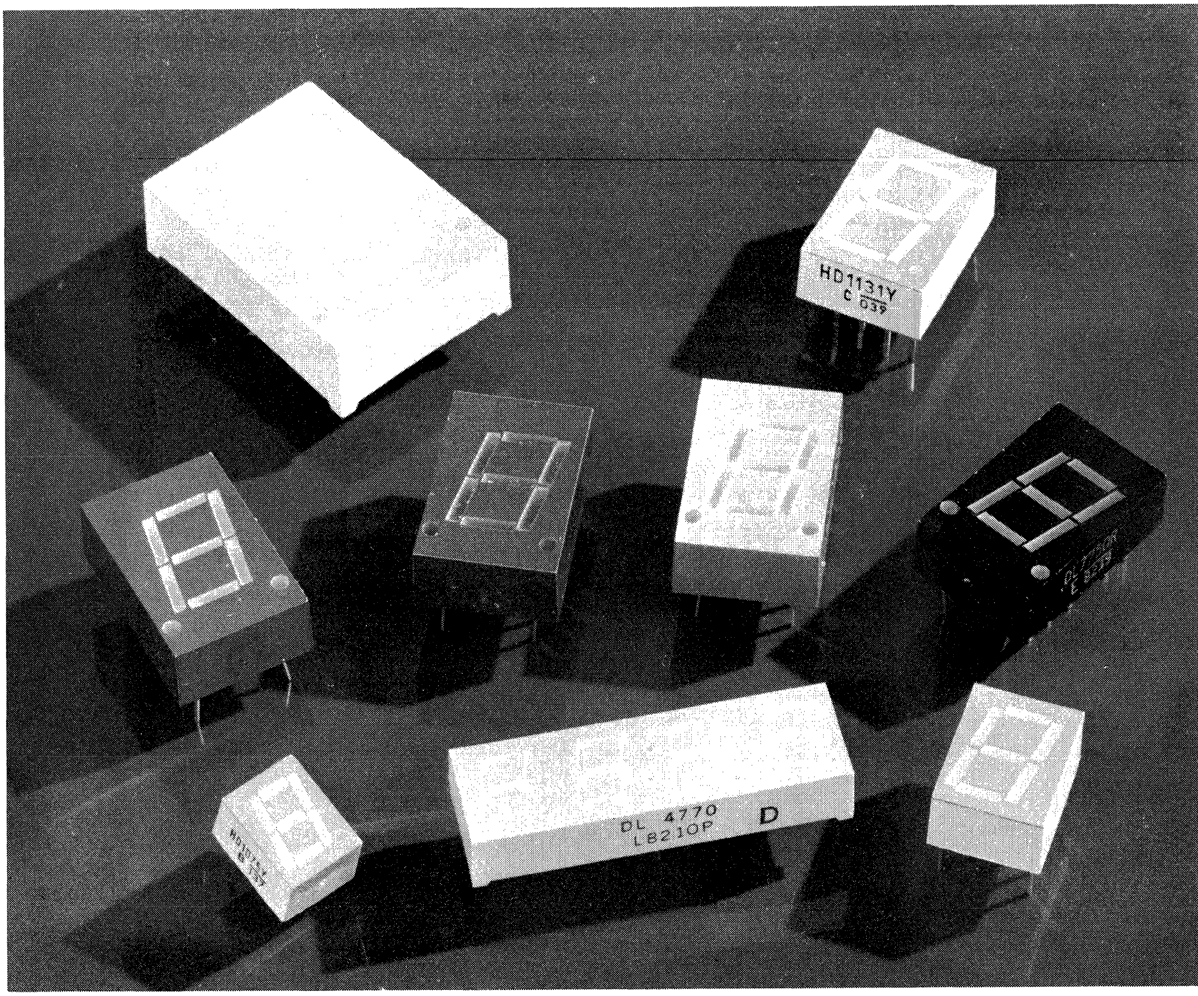
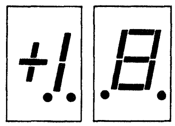
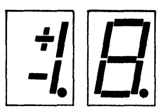
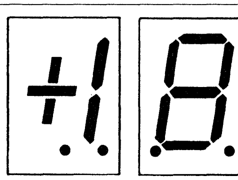
ALPHANUMERIC INDEX

ALPHANUMERIC INDEX (con't)

ALPHANUMERIC INDEX (con't)

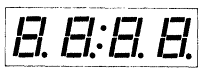
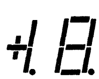

HD1131Y
C 039
DL 4770
L8210P
D

Led Numeric Displays

Package Type	Package Dimensions (Shown Actual Size)	Part Number	Character Height	Description	Polarity	Color	Luminous Intensity Per Segment Typ	@ mA	Page
Single Digit Encap-sulated (Filled Reflector)		DL-7750R	11mm .43"	7 seg. D.P. left	C.A.	Red	400µcd	20	21
		DL-7751R		7 seg. D.P. right					
		DL-7756R		±1 overflow	UNIV.				
		DL-7760R		7 seg. D.P. right	C.C.				
		DL-7650O		7 seg. D.P. left	C.A.	Hi. Eff. Red	1720µcd	20	
		DL-7651O		7 seg. D.P. right					
		DL-7653O		7 seg. D.P. right	C.C.				
		DL-7656O		±1 overflow	UNIV.				
		DL-7660Y		7 seg. D.P. left	C.A.	Yellow	1500µcd	20	
		DL-7661Y		7 seg. D.P. right					
		DL-7663Y		7 seg. D.P. right	C.C.				
		DL-7666Y		±1 overflow	UNIV.				
		DL-7670G		7 seg. D.P. left	C.A.	Green	640µcd	20	
		DL-7671G		7 seg. D.P. right					
	H W D	DL-7673G		7 seg. D.P. right	C.C.				
	.750" .500" .246"	DL-7676G		±1 overflow	UNIV.				
Single Digit Encap-sulated (Filled Reflector)		HD1131R	13.5mm .53"	7 seg. D.P. right	C.A.	Red	1400µcd	35	33
		HD1132R		±1 overflow					
		HD1133R		7 seg. D.P. right	C.C.				
		HD1134R		±1 overflow					
		HD1131O		7 seg. D.P. right	C.A.	Hi. Eff. Red	1400µcd	20	
		HD1132O		±1 overflow					
		HD1133O		7 seg. D.P. right	C.C.				
		HD1134O		±1 overflow					
		HD1131Y		7 seg. D.P. right	C.A.	Yellow	1300µcd	20	
		HD1132Y		±1 overflow					
		HD1133Y		7 seg. D.P. right	C.C.				
		HD1134Y		±1 overflow					
		HG1131G		7 seg. D.P. right	C.A.	Green	1400µcd	20	
	H W D	HG1132G		±1 overflow					
	.691" .488" .238"	HG1133G		7 seg. D.P. right	C.C.				
		HG1134G		±1 overflow					
Single Digit Encap-sulated (Filled Reflector)		DL-3400	20mm .8"	7 seg. D.P. left	C.A.	Red	900µcd	20	15
		DL-3401		7 seg. D.P. right					
		DL-3403		7 seg. D.P. right	C.C.				
		DL-3405		7 seg. D.P. left					
		DL-3406		±1 overflow	UNIV.				
		DLO-3900		7 seg. D.P. left	C.A.	Hi. Eff. Red	2000µcd	20	
		DLO-3901		7 seg. D.P. right					
		DLO-3903		7 seg. D.P. right	C.C.				
	H W D	DLO-3905		7 seg. D.P. left					
	1.09" .780" .330"	DLO-3906		±1 overflow	UNIV.				

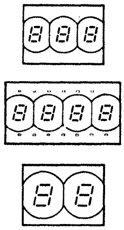
PACKAGE DIMENSIONS: H (HEIGHT), W (WIDTH), D (DEPTH – WITHOUT LEADS OR STANDOFFS)

Led Numeric Displays

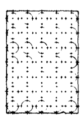
Package Type	Package Dimensions (Shown Actual Size)	Part Number	Character Height	Description	Polarity	Color	Luminous Intensity Per Segment Typ	@ mA	Page
Compact Single Digit Encap-sulated (Filled Reflector)	 H .390" W .295" D .236"	HD1075R	7 mm .28"	7 seg. D.P. right	C.A.	Red	800µcd	20	25
		HD1077R		7 seg. D.P. right	C.C.				
		HD1075O		7 seg. D.P. right	C.A.	Hi. Eff. Red	1000µcd	15	
		HD1077O		7 seg. D.P. right	C.C.				
		HD1075Y		7 seg. D.P. right	C.A.	Yellow	900µcd	15	
		HD1077Y		7 seg. D.P. right	C.C.				
		HG1075G		7 seg. D.P. right	C.A.	Green	1000µcd	15	
		HG1077G		7 seg. D.P. right	C.C.				
Compact Four Digit Encap-sulated (Filled Reflector)	 H .390" W 1.26" D .220"	DL-4770	7 mm .28"	7 seg. D.P. right	C.C.	Red	180µcd	10	17
		DL-4775			C.A.				
		DLO-4770		7 seg. D.P. right	C.C.	Hi. Eff. Red	400µcd	10	
		DLO-4775			C.A.				
Compact Single Digit Encap-sulated (Filled Reflector)	 H .508" W .386" D .236"	HD1105R	10mm .39"	7 seg. D.P. right	C.A.	Red	1000µcd	25	29
		HD1107R		7 seg. D.P. right	C.C.				
		HD1105O		7 seg. D.P. right	C.A.	Hi. Eff. Red	1000µcd	15	
		HD1107O		7 seg. D.P. right	C.C.				
		HD1105Y		7 seg. D.P. right	C.A.	Yellow	900µcd	15	
		HD1107Y		7 seg. D.P. right	C.C.				
		HG1105G		7 seg. D.P. right	C.A.	Green	1000µcd	15	
		HG1107G		7 seg. D.P. right	C.C.				

PACKAGE DIMENSIONS: H (HEIGHT), W (WIDTH), D (DEPTH – WITHOUT LEADS OR STANDOFFS)

Magnified Monolithic Numeric Displays

Package Type	Package Dimensions (Shown Actual Size)	Part Number	Character Height	Description	Polarity	Color	Luminous Intensity Per Segment Typ	@ (mA)	Page
Multi Digit Magnified Monolithic	 H W D DL-330M .435" .595" .230" DL-340M .435" .795" .230" DL-430M .435" .895" .300" DL-440M .435" .595" .300"	DL-330M	2.8mm	7 seg. 3 Digit					
		DL-340M	.11"	7 seg. 4 Digit	C.C.	Red	1500µcd	5	13
		DL-430M	3.8mm	7 seg. 3 Digit	MULTI-				
		DL-440M	.15"	7 seg. 2 Digit	PLEX				

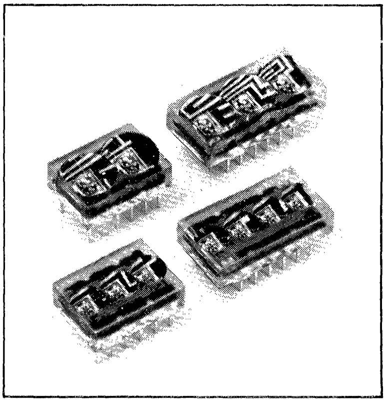
Alpha Numeric Display

Package Type	Package Dimensions (Shown Actual Size)	Part Number	Light Emitting Area	Description	Polarity	Color	Luminous Intensity Per Segment Typ	@ (mA)	Page
Single Char. Encap-sulated (Filled Reflector)	 H W D .705" .505" .250"	DLR-5735			Common cathode row				
		DLR-5736			Common anode row	Red			
			17.5mm	5 x 7 dot matrix	MULTI-PLEX		200µcd	20	19
		DLG-5735	.69"		Common cathode row	Green	650µcd	10	
		DLG-5736			Common anode row				

SIEMENS

DL-330M .11 INCH 3 DIGIT
DL-340M .11 INCH 4 DIGIT
DL-430M .15 INCH 3 DIGIT
DL-440M .15 INCH 2 DIGIT

RED 7 SEGMENT MAGNIFIED MONOLITHIC NUMERIC DISPLAY



FEATURES

- Rugged Encapsulated Package
- Integrated Magnifier Lens
- Monolithic Construction for Maximum Brightness at Minimum Power
- Common Cathode for Simplicity of Multiplexing
- Standard Dual-In-Line Package
- Categorized for Brightness Uniformity

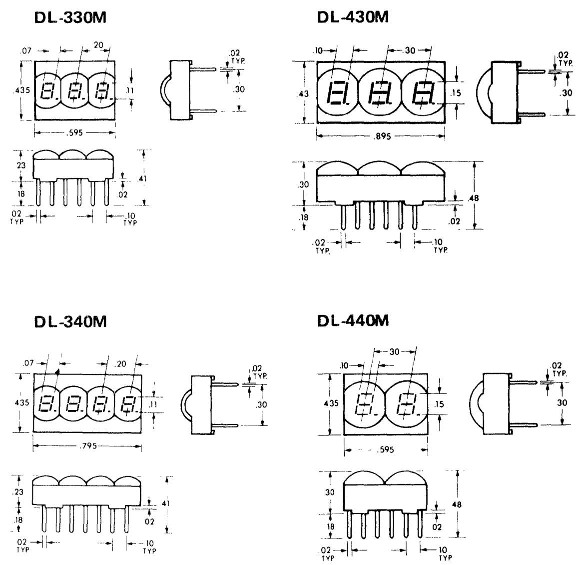
DESCRIPTION

The DL-330M/340M and DL-430M/440M are red numeric LED displays. Low cost is achieved through minimum use of monolithic GaAsP material and magnification to full height using a simple integrated lens construction. A red plexiglass or circularly polarized filter is recommended to enhance visibility and to eliminate glare from the surface of the package.

These displays are designed for multiplex operation, the desired digit being displayed by selecting the appropriate cathode. A right hand decimal point is provided.

All devices are optimized for low power portable battery operated equipment using MOS and CMOS integrated logic circuits such as DMM's and digital thermometers.

Package Dimensions in Inches (mm)



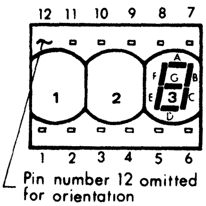
Maximum Ratings (at 25 °C)

Power Dissipation/Digit .... 80 mW
Derating Factor from 25 °C/Digit .... 1.8 mW/°C
Storage and Operating Temperature ...... −20 °C to +70 °C
Continuous Forward Current
  Per Segment and Decimal .... 20 mA
  Per Digit Total .... 40 mA
Peak Inverse Voltage
  Per Segment and Decimal .... 3 V

Opto-Electronic Characteristics (at 25 °C)

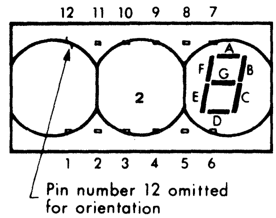
Parameter	Min	Typ	Max	Unit	Test Condition
Luminance	1.5			mcd	$I_F = 5$ mA
Emission Peak Wavelength	650			nm	
Line Half-Width	40			nm	
Forward Voltage		1.7	2.0		$I_F = 20$ mA
Dynamic Resistance	7			Ω	$I_F = 10$ mA
Capacitance	50			pF	V = 0, f = 1 MHz
Reverse Leakage			100	μA	$V_R = 3.0$ V

Specifications subject to change without notice.



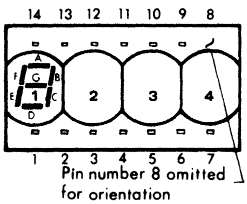
DL-330M

Pin	Function
1	Cathode D1
2	Anode E
3	Anode D
4	Cathode D2
5	Anode C
6	Anode DP
7	Cathode D3
8	Anode B
9	Anode G
10	Anode A
11	Anode F
12	No Pin



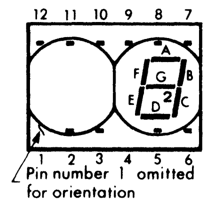
DL-430M

Pin	Function
1	Cathode D1
2	Anode E
3	Anode D
4	Cathode D2
5	Anode C
6	Anode DP
7	Cathode D3
8	Anode B
9	Anode G
10	Anode A
11	Anode F
12	No Pin



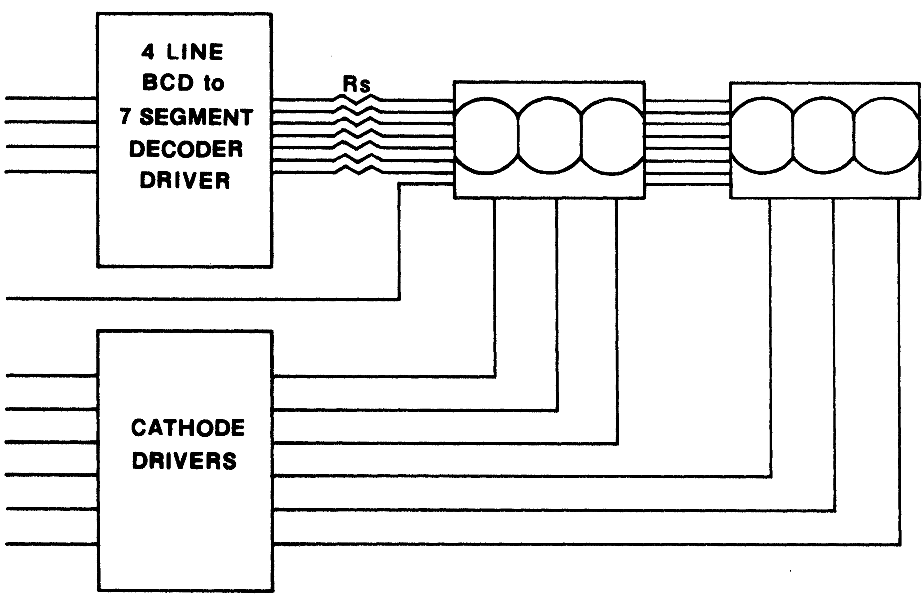
DL-340M

Pin	Function
1	No Connection
2	Anode E
3	Anode D
4	Anode C
5	Anode DP
6	Anode G
7	Cathode 4
8	No Pin
9	Anode B
10	Cathode 3
11	Anode F
12	Cathode 2
13	Anode A
14	Cathode 1



DL-440M

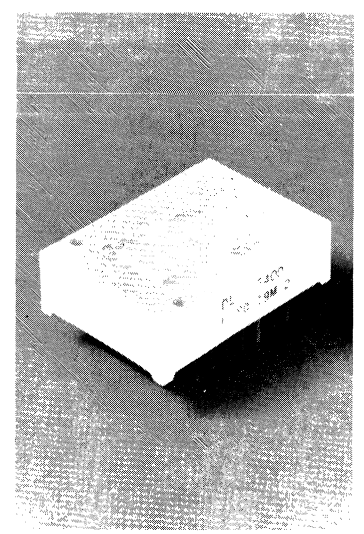
Pin	Function
1	No Pin
2	Anode E
3	Anode D
4	No Pin
5	Anode C
6	Anode DP
7	Cathode D2
8	Anode B
9	Anode G
10	Anode A
11	Anode F
12	Cathode D1



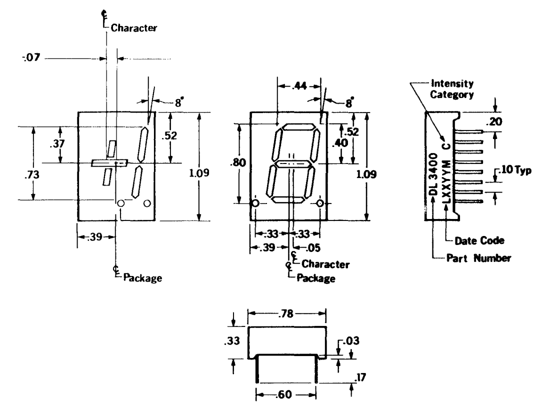
BLOCK DIAGRAM FOR TYPICAL DISPLAY DRIVE CIRCUITRY

SIEMENS

DL-3400 SERIES
RED
DLO-3900 SERIES
HIGH EFFICIENCY RED
0.8 INCH SEVEN SEGMENT NUMERIC DISPLAY



Package Dimensions in Inches



Specifications subject to change without notice.

FEATURES

- **Rugged Encapsulated Package**
- **Filled Reflector Construction**
- **Very Large 0.8 inch (20 mm) Digit Height**
- **Choice of: Common Anode or Common Cathode**
  Left or Right Decimal Point
  Universal Polarity Overflow
- **Wide Viewing Angle**
- **Good "Off" Segment Contrast**
- **Intensity Coded for Display Uniformity**
- **Standard 0.6 inch Dual-In-Line Package with Leads on 0.1 inch Centers**

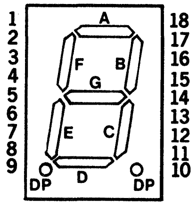
Part Number	Description	
DL-3400	Common Anode	Left Hand Decimal
DL-3401	Common Anode	Right Hand Decimal
DL-3403	Common Cathode	Right Hand Decimal
DL-3405	Common Cathode	Left Hand Decimal
DL-3406	Universal Overflow ±1	Right Hand Decimal
DLO-3900	Common Anode	Left Hand Decimal
DLO-3901	Common Anode	Right Hand Decimal
DLO-3903	Common Cathode	Right Hand Decimal
DLO-3905	Common Cathode	Left Hand Decimal
DLO-3906	Universal Overflow ±1	Right Hand Decimal

DESCRIPTION

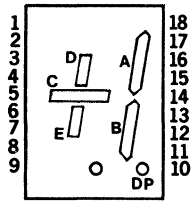
The DL-3400 Series, Red, and DLO-3900 Series, High Efficiency Red, are very large 0.8 inch (20 mm) LED seven segment displays. The series offers the choice of either common anode or common cathode versions, left or right decimal point, as well as a polarity and overflow indicator.

These displays were designed for viewing distances of up to 30 feet and can be used in electronic instruments, point-of-sale systems, clocks, and other general industrial and consumer applications.

These displays are painted to match the appearance of an unlit segment in order to maximize contrast enhancement. Contrast enhancement filters are recommended for use with all displays.



TOP VIEW



TOP VIEW

	FUNCTION					
PIN	-3900 -3400	-3901 -3401	-3903 -3403	-3905 -3405	-3906 -3406	PIN
1	NO PIN	NO PIN	NO PIN	NO PIN	NO PIN	1
2	CATHODE A	CATHODE A	ANODE A	ANODE A	CATHODE A	2
3	CATHODE F	CATHODE F	ANODE F	ANODE F	ANODE D	3
4	ANODE	ANODE	CATHODE	CATHODE	CATHODE D	4
5	CATHODE E	CATHODE E	ANODE E	ANODE E	CATHODE C	5
6	ANODE	ANODE	CATHODE	CATHODE	CATHODE E	6
7	CATHODE DP	NO CONN.	NO CONN.	ANODE DP	ANODE E	7
8	NO PIN	NO PIN	NO PIN	NO PIN	CATHODE DP	8
9	NO PIN	NO PIN	NO PIN	NO PIN	NO PIN	9
10	NO PIN	CATHODE DP	ANODE DP	NO PIN	ANODE DP	10
11	CATHODE D	CATHODE D	ANODE D	ANODE D	CATHODE DP	11
12	ANODE	ANODE	CATHODE	CATHODE	CATHODE B	12
13	CATHODE C	CATHODE C	ANODE C	ANODE C	ANODE B	13
14	CATHODE G	CATHODE G	ANODE G	ANODE G	ANODE C	14
15	CATHODE B	CATHODE B	ANODE B	ANODE B	ANODE A	15
16	NO PIN	NO PIN	NO PIN	NO PIN	NO PIN	16
17	ANODE	ANODE	CATHODE	CATHODE	CATHODE A	17
18	NO PIN	NO PIN	NO PIN	NO PIN	NO PIN	18

MAXIMUM RATINGS

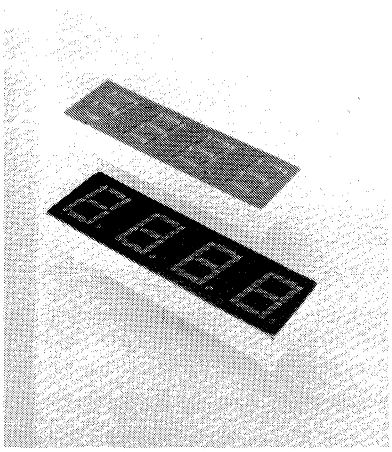
	DL-3400 Series	DLO-3900 Series
Power Dissipation per Segment on D_P ($T_A = 50\,°C$)	100mW	85mW
Operating Temperature	−20 °C to +85 °C	−20 °C to +85 °C
Storage Temperature	−20 °C to +85 °C	−20 °C to +85 °C
Peak Forward Current per Segment or D_P ($T_A = 50\,°C$, Pulse Width < 1.2ms)	200mA	120mA
DC Forward Current per Segment or D_P	50mA	30mA
Derating Factor from 50 °C	1mA/°C	.6mA/°C
Reverse Voltage per Segment or D_P	6.0V	6.0V
Lead Soldering Tempeature (1/16 inch Below Seating Place)	260 °C for 3 sec.	260 °C for 3 sec.

OPTO-ELECTRICAL CHARACTERISTICS @ $T_A = 25\,°C$

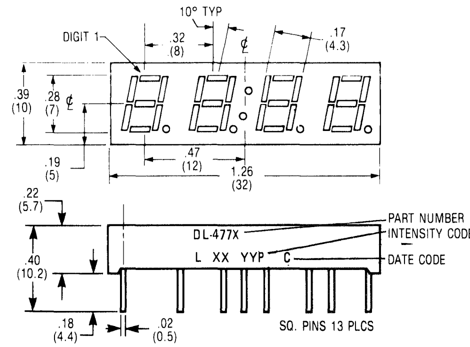
Parameter	Test Condition	Min.	Typ.	Max.	Units
Luminous Intensity/Segment (Digit Average)					
DL-3400 Series	$I_F = 20mA$	500	900		μcd
DLO-3900 Series	$I_F = 20mA$	650	2000		μcd
Forward Voltage					
DL-3400 Series	$I_F = 20mA$		1.6	2.0	V
DLO-3900 Series	$I_F = 20mA$		2.2	2.8	V
Reverse Current					
DL-3400 Series	$V_R = 5V$		10	100	μA
DLO-3900 Series	$V_R = 6V$		10	100	μA
Dominant Wavelength					
DL-3400 Series	λd		640		nm
DLO-3900 Series	λd		625		nm
Rise and Fall Time			10		ns
Temperature Coefficient of Forward Voltage	$I_F = 20mA$		−1.5		mV/°C

SIEMENS

DL-4770/DL-4775
RED
DLO-4770/DLO-4775
HIGH EFFICIENCY RED 7-SEGMENT 4-DIGIT DISPLAY



Package Dimensions in Inches (mm)



FEATURES

- **DL & DLO-4770 Common Cathode**
  DL & DLO-4775 Common Anode
- **0.28 Inch (7 mm) Digit Height**
- **Rugged Encapsulated Package**
- **Filled Reflector Construction**
- **End Stackable Module**
- **Intensity Coded for Display Uniformity**
- **Right Hand Decimal**
- **Colon Included for Clock Applications**

DESCRIPTION

The DL/DLO-4770/4775 is a 0.28 inch (7 mm) four-digit display in a 0.39 × 1.26 inch (10mm × 32mm) package. The units are end stackable and offer a colon for time-keeping and other operations. The DL/DLO-4770/4775 is designed to serve a wide variety of industrial and consumer applications requiring medium-sized digits in a very small package.

Maximum Ratings @ 25°C

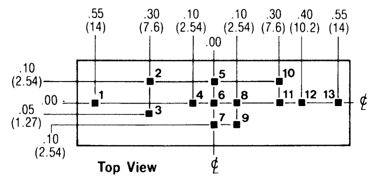
Power Dissipation (package)	820 mW
Derate Linearly from @ 25°C	-13.7 mW/°C
Storage Temperature	-20°C to +85°C
Operating Temperature	-20°C to +85°C
Continuous Forward Current	
DL-4770/5 (per segment)	30 mA
DL-4770/5 (all segments lit)	12 mA/seg
DLO-4770/5 (per segment)	25 mA
DLO-4770/5 (all segments lit)	10 mA/seg
Peak Inverse Voltage	
DL-4770/5	3 V
DLO-4770/5	3 V

Opto-Electronic characteristics Per Segment (@ 25°C)

Parameter	Min	Typ	Max	Unit	Test Condition
Luminous Intensity/Segment (Digit Average)					
DL	.08	.18		mcd	I_F = 10 mA
DLO	.25	.40		mcd	I_F = 10 mA
Forward Voltage					
DL			2.0	V	I_F = 20 mA
DLO			2.8	V	I_F = 20 mA
Reverse Current					
DL			100	μA	V_R = 3 V
DLO			100	μA	V_R = 3 V
Peak Emission Wavelength					
DL		660		nm	
DLO		630		nm	

Specifications are subject to change without notice.

Pin Location



Pin Function

DL & DLO-4775

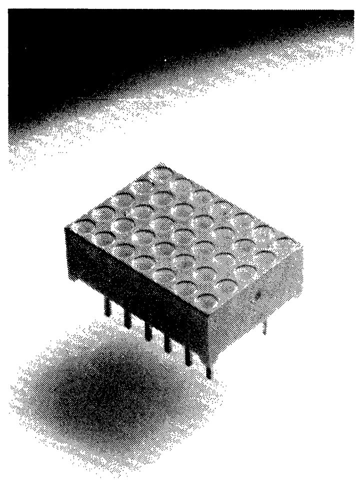
PIN	FUNCTION
1	DIGIT 1 ANODE
2	SEGMENT B CATHODE
3	SEGMENT C CATHODE
4	DIGIT 2 & LOWER COLON ANODE
5	SEGMENT A CATHODE
6	SEGMENT D CATHODE
7	DECIMAL POINT CATHODE
8	DIGIT 3 & UPPER COLON ANODE
9	COLON CATHODE
10	SEGMENT F CATHODE
11	SEGMENT E CATHODE
12	SEGMENT G CATHODE
13	DIGIT 4 ANODE

DL & DLO-4770

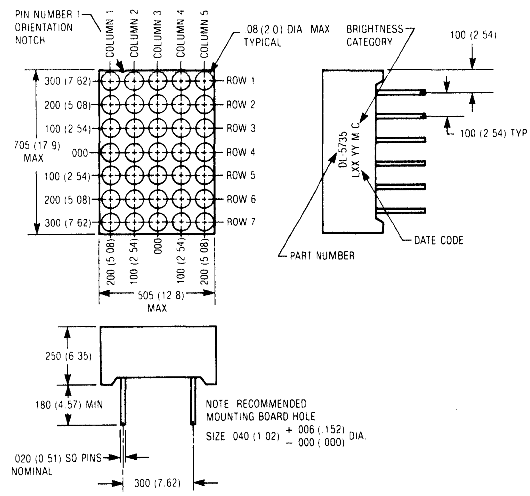
PIN	FUNCTION
1	DIGIT 1 CATHODE
2	SEGMENT B ANODE
3	SEGMENT C ANODE
4	DIGIT 2 & LOWER COLON CATHODE
5	SEGMENT A ANODE
6	SEGMENT D ANODE
7	DECIMAL POINT ANODE
8	DIGIT 3 & UPPER COLON CATHODE
9	COLON ANODE
10	SEGMENT F ANODE
11	SEGMENT E ANODE
12	SEGMENT G ANODE
13	DIGIT 4 CATHODE

SIEMENS

DLR-5735 RED
DLR-5736 RED
DLG-5735 GREEN
DLG-5736 GREEN
0.68" (17.27 mm)
5 × 7 ALPHANUMERIC DISPLAY



Package Dimensions in Inches (mm)



FEATURES

- **DL-5735 Common Row Cathode**
  DL-5736 Common Row Anode
- **5 × 7 Matrix Array with Row-column Select**
- **End & Side Stackable**
- **Rugged Encapsulation (Filled Reflector Construction)**
- **Compatible with ASCII and EBCDIC Format**
- **Standard 12 pin, 0.3" pin spacing, Dual-Inline-Package**
- **Good "OFF" Segment Contrast**
  Grey face with clear segments.

DESCRIPTION

The DLR-573X Series, a gallium arsenide phosphide, and the DLG-573X Series, a gallium phosphide, is a 5x7 dot matrix Light emitting diode alphanumeric display.
Compatible with ASCII and EBCDIC formats, the DL573X is well suited for use in keyboard verifiers, computer peripheral equipment, other applications requiring an alphanumeric display, and stackable both horizontally and vertically to generate large alphanumeric or even graphic displays.

Maximum Ratings @ 25°C

Power Dissipation (Package) .... 750 mW
Derate Linearly from 25°C .... 11.5 mW/°C
Storage Temperature .... -20°C to +70°C
Operating Temperature .... -20°C to +70°C
Continuous Forward Current
  Per Segment .... 20 mA
Pulse Peak Current/Segment
  20% Duty Cycle .... 100 mA
Reverse Voltage .... 3 V
Solder Temperature
  1/16 below seating plane for 5 seconds .... 260°C

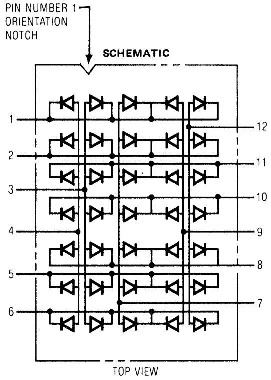
Opto-Electronic Characteristics (@ 25°C)

Parameter	Min	Typ	Max	Unit	Test Condition
Luminous Intensity					
Digit Average					
DLR-573X	100	200		cd	$I_F = 20$ mA
DLG-573X	320	650		cd	$I_F = 10$ mA
Forward Voltage					
DLR-573X		1.7	2.0	V	$I_F = 20$ mA
DLG-573X		2.3	3.0	μV	$I_F = 20$ mA
Reverse Current			100	μA	$V_R = 3$ V
Peak Emission Wavelength					
DLR-573X		650		nm	
DLG-573X		565		nm	
Spectral Line Half-Width					
DLR-573X		40		nm	
DLG-573X		30		nm	
Capacitance					
DLR-573X		115		pf	V = 0
DLG-573X				pf	V = 0

Specifications subject to change without notice.

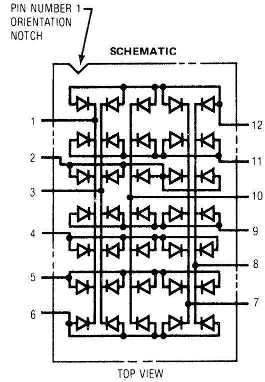
PIN CONFIGURATIONS

DL-5735



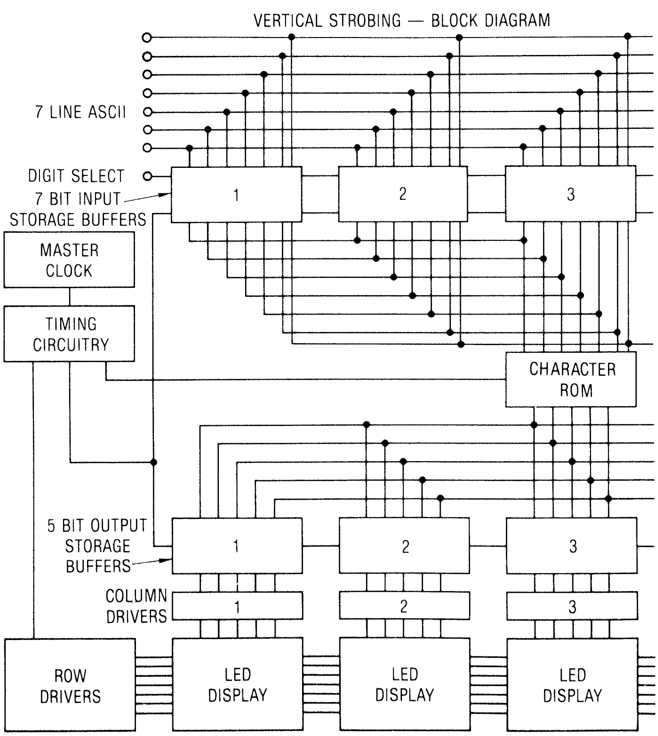
PIN	FUNCTION
1	ROW 1 CATHODE
2	ROW 2 CATHODE
3	COLUMN 2 ANODE
4	COLUMN 1 ANODE
5	ROW 6 CATHODE
6	ROW 7 CATHODE
7	COLUMN 3 ANODE
8	ROW 5 CATHODE
9	COLUMN 4 ANODE
10	ROW 4 CATHODE
11	ROW 3 CATHODE
12	COLUMN 5 ANODE

DL-5736



PIN	FUNCTION
1	COLUMN 1 CATHODE
2	ROW 3 ANODE
3	COLUMN 2 CATHODE
4	ROW 5 ANODE
5	ROW 6 ANODE
6	ROW 7 ANODE
7	COLUMN 4 CATHODE
8	COLUMN 5 CATHODE
9	ROW 4 ANODE
10	COLUMN 3 CATHODE
11	ROW 2 ANODE
12	ROW 1 ANODE

TYPICAL VERTICAL SCAN DISPLAY SYSTEM



SIEMENS

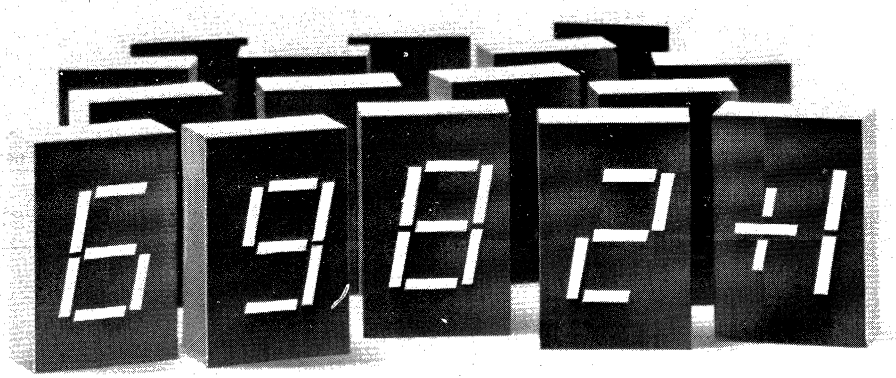
DL-7750R SERIES
RED

DL-7650O SERIES
HIGH EFFICIENCY RED

DL-7660Y SERIES
YELLOW

DL-7670G SERIES
GREEN

0.43 INCH SEVEN SEGMENT NUMERIC DISPLAY



FEATURES

- Rugged Encapsulated (Filled Reflector Construction)
- Choice of Colors (Including High Intensity Red) as well as Common Anode (D. P. Left & Right), Common Cathode and Universal Polarity Overflow
- Sharp, Clear .43 Inch Character for Viewing up to 20 Feet
- Intensity Coded for Matching Uniformity
- Standard 14 Pin, .3 Inch Pin Spacing, Dual-In-Line Package

DESCRIPTION

The DL-7750R, -7650O, -7660Y, -7670G series are large 0.43 inch (10.92 mm) Red; Hi-efficiency Red, Yellow, and Green seven segment displays. These displays are designed for use in instruments, point-of-sale systems, clocks, and other general industrial & consumer applications.

Part Number	Color	Description
DL-7750R	Standard Red	C.A. 7 Segment, D.P. Left
DL-7751R	"	C.A. 7 Segment, D.P. Right
DL-7756R	"	Univ. ±1 Polarity Overflow
DL-7760R	"	C.C. 7 Segment, D.P. Right
DL-7650O	High Efficiency Red	C.A. 7 Segment, D.P. Left
DL-7651O	"	C.A. 7 Segment, D.P. Right
DL-7653O	"	C.C. 7 Segment, D.P. Right
DL-7656O	"	Univ. ±1 Polarity Overflow
DL-7660Y	Yellow	C.A. 7 Segment, D.P. Left
DL-7661Y	"	C.A. 7 Segment D.P. Right
DL-7663Y	"	C.C. 7 Segment, D.P. Right
DL-7666Y	"	Univ. ±1 Polarity Overflow
DL-7670G	Green	C.A. 7 Segment, D.P. Left
DL-7671G	"	C.A. 7 Segment, D.P. Right
DL-7673G	"	C.C. 7 Segment, D.P. Right
DL-7676G	"	Univ. ±1 Polarity Overflow

ELECTRICAL/OPTICAL CHARACTERISTICS AT $T_A = 25°C$

STANDARD RED DL-7750R/7751R/7756R/7760R

Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Units
Luminous Intensity/Segment	I_V	$I_f = 10$ mA	120	350		μcd
	I_V	$I_f = 25$ mA		1000		μcd
Peak Wavelength	λpeak			665		nm
Dominant Wavelength	λd			645		nm
Forward Voltage/Segment or D.P.	V_f	$I_f = 10$ mA		1.6	2.0	V
Reverse Current/Segment or D.P.	I_R	$V_R = 6V$		0.01	10	μA
Rise and Fall Time	t_r, t_f			5		ns

HIGH EFFICIENCY RED DL-7650O/7651O/7653O/7656O

Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Units
Luminous Intensity/Segment	I_V	$I_f = 5$ mA	90	260		μcd
		$I_f = 15$ mA		1000		μcd
Peak Wavelength	λpeak			645		nm
Dominant Wavelength	λd			638		nm
Forward Voltage/Segment or D.P.	V_f	$I_f = 5$ mA		1.9	2.4	V
Reverse Current/Segment or D.P.	I_R	$V_R = 6V$		0.01	10	μA
Rise and Fall Time	t_r, t_f			100		ns

YELLOW DL-7660Y/7661Y/7663Y/7666Y

Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Units
Luminous Intensity/Segment	I_V	$I_f = 5$ mA	90	200		μcd
		$I_f = 15$ mA		900		μcd
Peak Wavelength	λpeak			590		nm
Dominant Wavelength	λd			592		nm
Forward Voltage/Segment or D.P.	V_f	$I_f = 5$ mA		1.9	2.4	V
Reverse Current/Segment or D.P.	I_R	$V_R = 6V$		0.01	10	μA
Rise and Fall Time	t_r, t_f			100		ns

GREEN DL-7670G/7671G/7673G/7676G

Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Units
Luminious Intensity/Segment	I_V	$I_f = 5$ mA D.C.	120	260		μcd
		$I_f = 15$ mA D.C.		1000		μcd
Peak Wavelength	λpeak			560		nm
Dominant Wavelength	λd			561		nm
Forward Voltage/Segment or D.P.	V_f	$I_f = 5$ mA		1.9	2.4	V
Reverse Current/Segment or D.P.	I_R	$V_R = 6V$		0.01	10	μA
Rise and Fall Time	t_r, t_f			50		ns

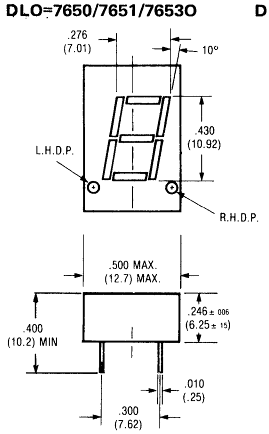
Specifications subject to change without notice.

Maximum Ratings

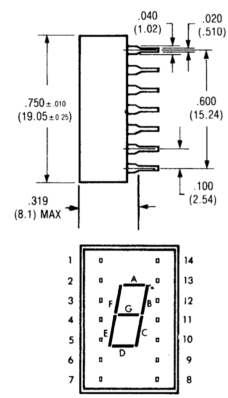
	Standard Red	All Others
Power Dissipation per Segment or D.P. @ 25 °C	50 mW	
Storage Temperature	−40 to +85 °C	
Operating Temperature	−35 to +85 °C	
Peak Forward Current per Segment or D.P. (t ≤ 10μsec)	400 mA	150 mA
Continuous Forward Current per Segment or D.P.	25 mA	17.5 mA
Peak Inverse Voltage per Segment or D.P.	6.0 V	
Lead Soldering Temperature	230 °C for 3 seconds	

Package Dimensions in Inches (mm)

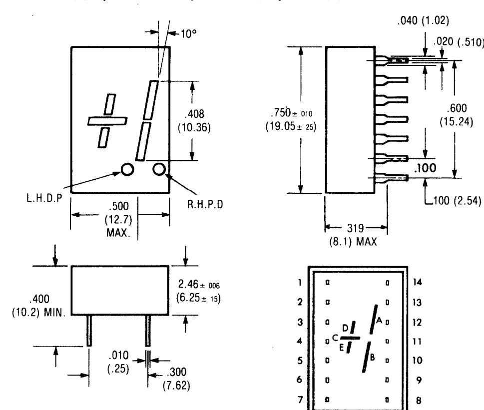
DL-7750/7751/7760R
DLO-7650/7651/7653O



DLG-7670/7671/7673G
DLY-7660/7661/7663Y



DL-7756R/DL-7676G/DL-7656O/DL-7666Y



All untoleranced dimensions are for reference only.

DL-7650O/DL-7660Y, DL-7670G/DL-7750R

Pin	Function
1	Cathode -a
2	Cathode -f
3	Anode
4	No Pin
5	No Pin
6	Cathode -d.p.
7	Cathode -e
8	Cathode -d
9	No Conn.
10	Cathode -c
11	Cathode -g
12	No Pin
13	Cathode -b
14	Anode

DL-7651O/DL-7661Y, DL-7671G/DL-7751R

Pin	Function
1	Cathode -a
2	Cathode -f
3	Anode
4	No Pin
5	No Pin
6	No Conn.
7	Cathode -e
8	Cathode -d
9	Cathode -d.p.
10	Cathode -c
11	Cathode -g
12	No Pin
13	Cathode -b
14	Anode

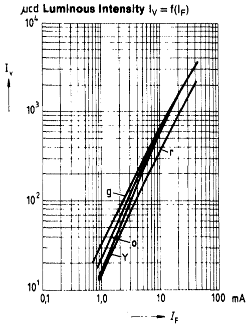
DL-7653O/DL-7663Y, DL-7673G/DL-7760R

Pin	Function
1	Anode -a
2	Anode -f
3	Cathode
4	No Pin
5	No Pin
6	No Conn.
7	Anode -e
8	Anode -d
9	Anode -d.p.
10	Anode -c
11	Anode -g
12	No Pin
13	Anode -b
14	Cathode

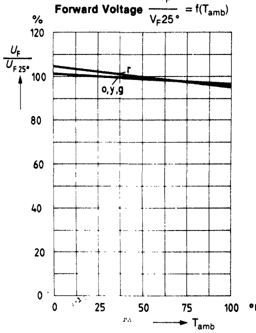
DL-7756R/DL-7676G/DL-7656O/DL-7666Y

Pin	Function	Pin	Function
1	Cathode -d	8	Anode -d.p.
2	Anode -d	9	Cathode -d.p.
3	No Pin	10	Cathode -b
4	Cathode -c	11	Cathode -a
5	Cathode -e	12	No Pin
6	Anode -e	13	Anode -a
7	Anode -c	14	Anode -b

Luminous Intensity $I_V = f(I_F)$

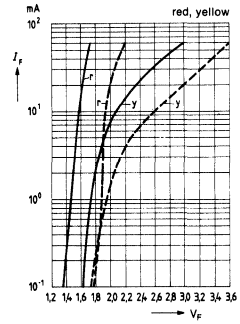


Forward Voltage $\frac{V_F}{V_{F25°}} = f(T_{amb})$



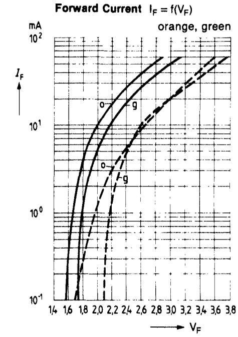
Forward Current $I_F = f(V_F)$

red, yellow



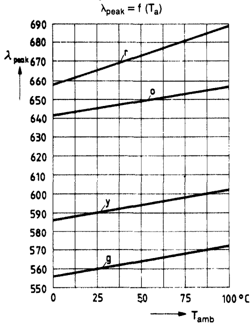
Forward Current $I_F = f(V_F)$

orange, green

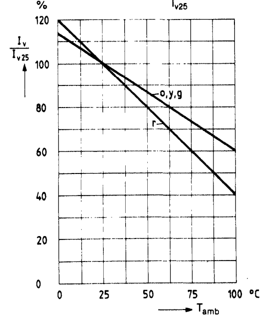


Wavelength at Peak Emission

$\lambda_{peak} = f(T_a)$

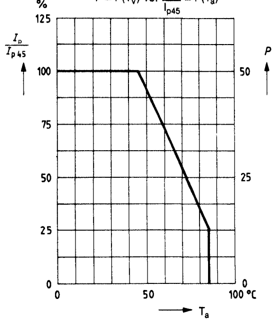


Luminous Intensity $\frac{I_V}{I_{V25}} = f(T_{amb})$

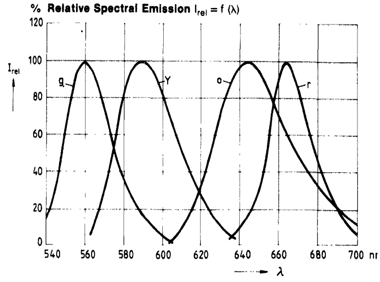


Power Dissipation and Pulse Current

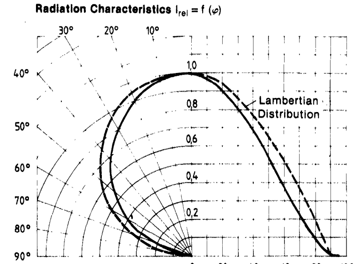
$P = f(T_V)$ vs. $\frac{I_p}{I_{p45}} = f(T_a)$



% Relative Spectral Emission $I_{rel} = f(\lambda)$



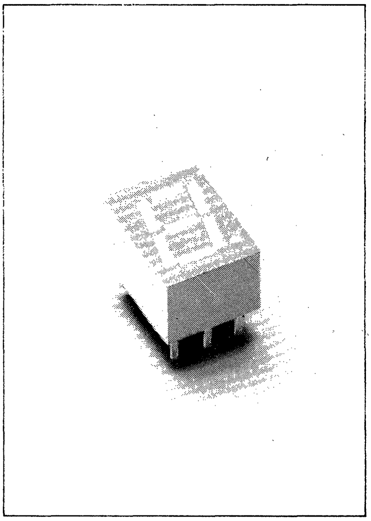
Radiation Characteristics $I_{rel} = f(\varphi)$

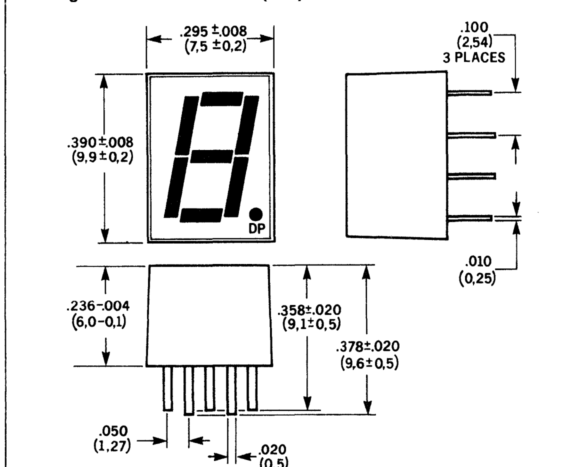


SIEMENS

HD 1075 R, HD 1077 R
RED
HD 1075 O, HD 1077 O
HIGH EFFICIENCY RED
HD 1075 Y, HD 1077 Y
YELLOW
HG 1075 G, HG 1077 G
GREEN

0.28 INCH (7 mm) SEVEN SEGMENT NUMERIC DISPLAY





FEATURES

- Rugged Encapsulated Package
- 0.28 Inch (7 mm) Digit Height
- Choice of Colors
- Common Anode or Common Cathode
- Wide Viewing
- Intensity Coded for Display Uniformity

DESCRIPTION

The 0.28 inch (7 mm) Digit Height Series of HD & HG 1075/1077 Seven Segment Displays offers the choice of common anode or common cathode with right hand decimal point.

These displays have good viewing and can be used in electronic instruments, point-of-sale systems, clocks, and other general industrial and consumer applications. All displays have a light grey face.

Contrast enhancement filters are recommended for use with all displays.

Specifications are subject to change without notice.

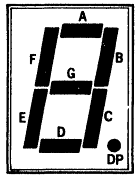
Product	Color	Description
HD1075 R	Red	Common Anode Right Decimal
HD1077 R	Red	Common Cathode Right Decimal
HD1075 O	High Efficiency Red	Common Anode Right Decimal
HD1077 O	High Efficiency Red	Common Cathode Right Decimal
HD1075 Y	Yellow	Common Anode Right Decimal
HD1077 Y	Yellow	Common Cathode Right Decimal
HG1075 G	Green	Common Anode Right Decimal
HG1077 G	Green	Common Cathode Right Decimal

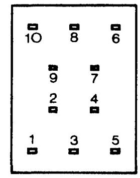
MAXIMUM RATINGS

Power Dissipation (Per Segment)	40 mW
Operating Temperature	–35° to +85°C
Storage Temperature	–40° to +85°C
D.C. Forward Current per segment	
HD1075 R, HD1077 R	20 mA
HD1075 O, HD1077 O, HG1075 G, HG1077 G, HD1075 Y, HD 1077 Y	15 mA
Peak Forward Current (t ⩽ 10 μs)	
HD1075 R, HD1077 R	400 mA
HD1075 O, HD1077 O, HG1075 G, HG1077 G, HD1075 Y, HD1077 Y	150 mA
Reverse Voltage	6 V
Thermal Resistance (Junction to Air)	170 K/W
Soldering Temperature (Less than 5 sec @ min distance of 2 mm)	230°C

Optoelectronic Characteristics @ 25°C

Parameter	Min	Typ	Max	Units	Conditions
Luminous Intensity (Per Segment)					
HD1075 R, HD1077 R	120	350		μcd	I_F = 10 mA
		800		μcd	I_F = 20 mA
HD1075 O, HD1077 O	90	260		μcd	I_F = 5 mA
		1000		μcd	I_F = 15 mA
HD1075 Y, HD1077 Y	90	200		μcd	I_F = 5 mA
		900		μcd	I_F = 15 mA
HG1075 G, HG1077 G	120	260		μcd	I_F = 5 mA
		1000		μcd	I_F = 15 mA
Forward Voltage					
HD1075 R, HD1077 R		1.6	2.0	V	I_F = 10 mA
HD1075 O, HD1077 O, HG1075 G, HG1077 G		1.9	2.4		I_F = 5 mA
HD1075 Y, HD1077 Y		1.9	2.4	V	I_F = 5 mA
Reverse Current		0.01	10	μA	V_R = 6V
Peak Emission Wavelength					
HD1075 R, HD1077 R		665		nm	
HD1075 O, HD1077 O		645		nm	
HG1075 G, HG1077G		560		nm	
HD1075 Y, HD1077 Y		590		nm	
Rise Time/Fall Time					
HD1075 R, HD1077 R		5		ns	
HD1075 O, HD1077 O, HD1075 Y, HD1077 Y		100		ns	
HG1075 G, HG1077 G		50		ns	
Capacitance					
HD1075 R, HD1077 R		40		pf	$V_R = 0_V$ f = 1MHz
HD1075 O, HD1077 O		12		pf	$V_R = 0_V$ f = 1MHz
HG1075 G, HG1077G		45		pf	$V_R = 0_V$ f = 1MHz
HD1075 Y, HD1077Y		10		pf	$V_R = 0_V$ f = 1MHz





TOP VIEW

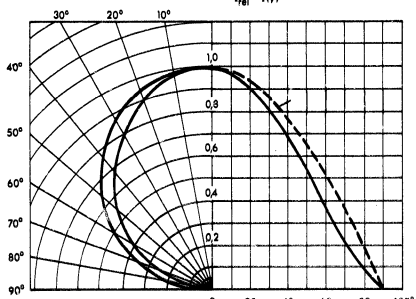
HD & HG 1075

PIN	FUNCTION
1	CATHODE SEGMENT E
2	CATHODE SEGMENT D
3	COMMON ANODE
4	CATHODE SEGMENT C
5	CATHODE DECIMAL POINT
6	CATHODE SEGMENT B
7	CATHODE SEGMENT A
8	COMMON ANODE
9	CATHODE SEGMENT G
10	CATHODE SEGMENT F

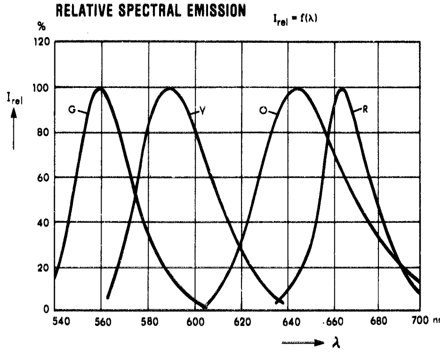
HD & HG 1077

PIN	FUNCTION
1	ANODE SEGMENT E
2	ANODE SEGMENT D
3	COMMON CATHODE
4	ANODE SEGMENT C
5	ANODE DECIMAL POINT
6	ANODE SEGMENT B
7	ANODE SEGMENT A
8	COMMON CATHODE
9	ANODE SEGMENT G
10	ANODE SEGMENT F

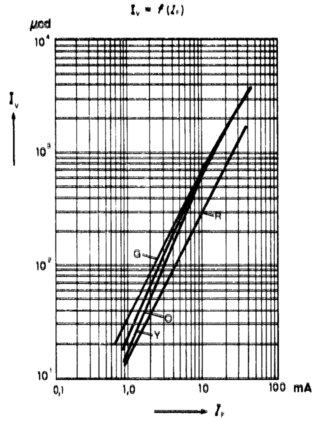
RADIATION CHARACTERISTICS



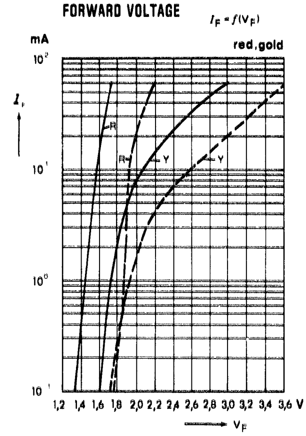
RELATIVE SPECTRAL EMISSION



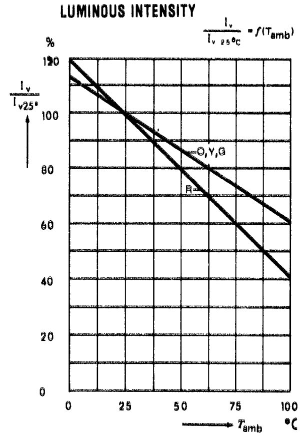
LUMINOUS INTENSITY



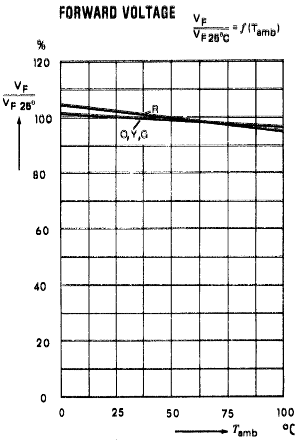
FORWARD VOLTAGE



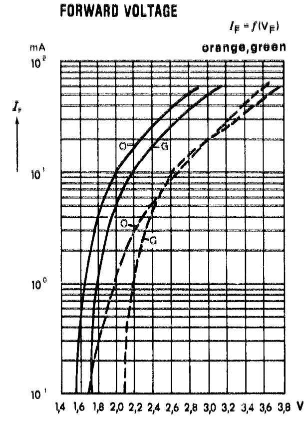
LUMINOUS INTENSITY



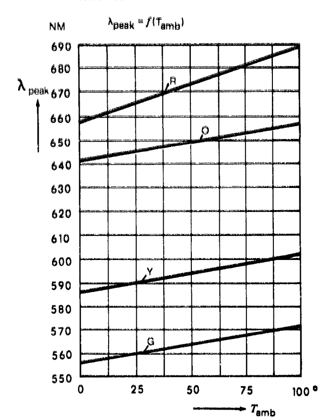
FORWARD VOLTAGE



FORWARD VOLTAGE



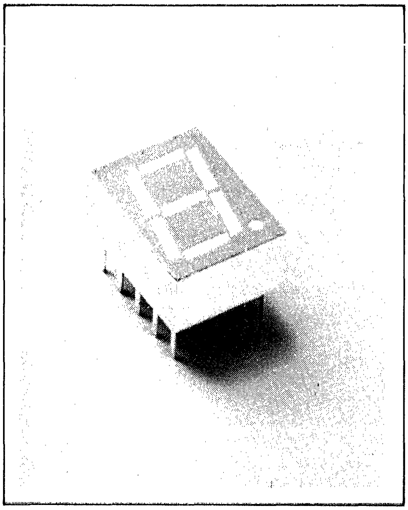
WAVELENGTH AT PEAK EMISSION



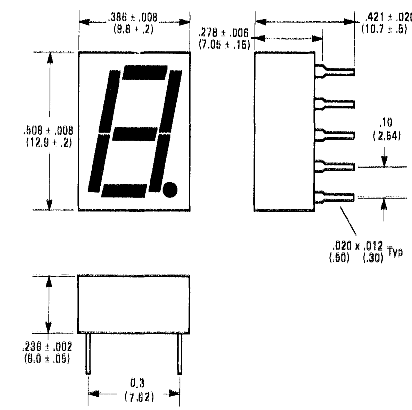
SIEMENS

HD 1105 R, HD 1107 R
RED
HD1105 O, HD 1107 O
HIGH EFFICIENCY RED
HD 1105 Y, HD 1107 Y
YELLOW
HG 1105 G, HG 1107 G
GREEN

0.39 INCH (10 mm) SEVEN SEGMENT NUMERIC DISPLAY



Package Dimensions in Inches (mm)



FEATURES

- Rugged Encapsulated Package
- Large 0.39 Inch (10 mm) Digit Height
- Choice of Colors
- Common Anode or Common Cathode
- Wide Viewing
- Intensity Coded for Display Uniformity
- ±1 Polarity Overflow

DESCRIPTION

The 0.39 inch (10 mm) Digit Height Series of HD & HG 1105/1107 Seven Segment Displays offers the choice of common anode or common cathode with right hand decimal point.

These displays were designed for viewing distances of up to 10 feet and can be used in electronic instruments, point-of-sale systems, clocks, and other general industrial and consumer applications. All displays have a light grey face.

Contrast enhancement filtered are recommended for use with all displays.

Specifications are subject to change without notice.

MAXIMUM RATINGS

Power Dissipation Per Segment (T_{amb} = 45°C) . . . . 50 mW
Operating Temperature . . . . -35° to +85°C
Storage Temperature . . . . -40° to +85°C
D.C. Forward Current Per Segment (T_{amb} = 45°C)
HD1105R, HD1107R . . . . 25 mA
HD1105O, HD1107O . . . . 17.5 mA
HG1105G, HG1107G . . . . 17.5 mA
HD1105Y, HD1107Y . . . . 17.5 mA
Peak Forward Current ($t \leqslant 10\ \mu s$, T_{amb} =45°C)
HD1105R, HD1107R . . . . 400 mA
HD1105O, HD1107O . . . . 150 mA
HG1105G, HG1107G . . . . 150 mA
HD1105y, HD1107Y . . . . 150 mA
Reverse Voltage . . . . 6 V
Thermal Resistance (Junction to Air)
HD & HG 1105/1107 series . . . . 135 K/W

Soldering Temperature (Less than 5 sec @ min distance of 2 mm) . . . . 230°C

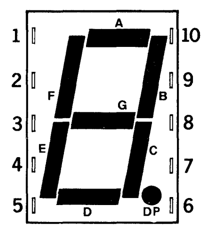
Optoelectronic Characteristics @ 25°C

Parameter	Min	Typ	Max	Units	Conditions
Luminous Intensity (Per Segment)					
HD1105R, HD1107R	120	350		μcd	I_F = 10 mA
		1000		μcd	I_F = 25 mA
HD1105O, HD1107O	90	260		μcd	I_F = 5 mA
		1000		μcd	I_F = 15 mA
HD1105G, HD1107G	120	260		μcd	I_F = 5 mA
		1000		μcd	I_F = 15 mA
HD1105Y, HD1107Y	90	200		μcd	I_F = 5 mA
		900		μcd	I_F = 15 mA
Forward Voltage					
HD1105R, HD1107R		1.6	2.0	V	I_F = 10 mA
HD1105O, HD1107O		1.9	2.4	V	I_F = 5 mA
HG1105G, HG1107G		1.9	2.4	V	I_F = 5 mA
HD1105Y, HD1107Y		1.9	2.4	V	I_F = 5 mA
Reverse Current		0.01	10	μA	V_R = 6 V
Peak Emission Wavelength					
HD1105R, HD1107R		665		nm	
HD1105O, HD1107O		645		nm	
HG1105G, HG1107G		560		nm	
HD1105Y, HD1107Y		590		nm	
Rise Time/Fall Time					
HD1105R, HD1107R		5		ns	
HD1105O, HD1107O		100		ns	
HG1105G, HG1107G		50		ns	
HD1105Y, HD1107Y		100		ns	
Capacitance					
HD1105R, HD1107R		40		pf	$V_R = 0_V$ f = 1MHz
HD1105O, HD1107O		12		pf	$V_R = 0_V$ f = 1MHz
HG1105G, HG1107G		45		pf	$V_R = 0_V$ f = 1MHz
HD1105Y, HD1107Y		10		pf	$V_R = 0_V$ f = 1MHz

Specifications subject to change without notice.

Product	Color	Description
HD1105R	Red	Common Anode Right Decimal
HD1107R	Red	Common Cathode Right Decimal
HD1105O	High Efficiency Red	Common Anode Right Decimal
HD1107O	High Efficiency Red	Common Cathode Right Decimal
HG1105G	Green	Common Anode Right Decimal
HG1107G	Green	Common Cathode Right Decimal
HD1105Y	Yellow	Common Anode Right Decimal
HD1107Y	Yellow	Common Cathode Right Decimal

HD & HG 1105/1107



Top View

HD 1105 R
HD 1105 O
HG 1105 G
HD 1105 Y

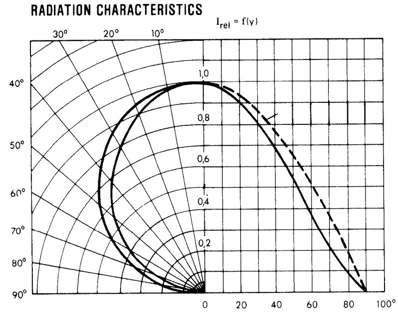
1 Cathode G
2 Cathode F
3 Common Anode
4 Cathode E
5 Cathode D
6 Cathode DP
7 Cathode C
8 Common Anode
9 Cathode B
10 Cathode A

HD 1107 R
HD 1107 O
HG 1107 G
HD 1107 Y

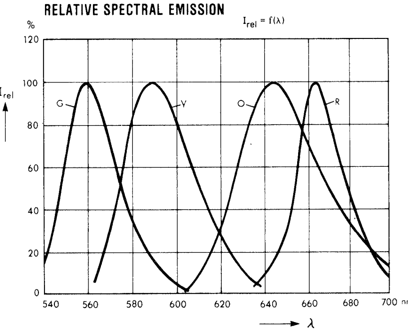
1 Anode G
2 Anode F
3 Common Cathode
4 Anode E
5 Anode D
6 Anode DP
7 Anode C
8 Common Cathode
9 Anode B
10 Anode A

TYPICAL OPTO-ELECTRONIC CHARACTERISTIC CURVES

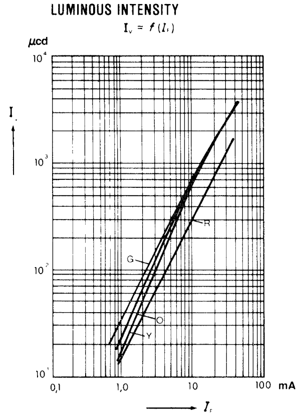
RADIATION CHARACTERISTICS



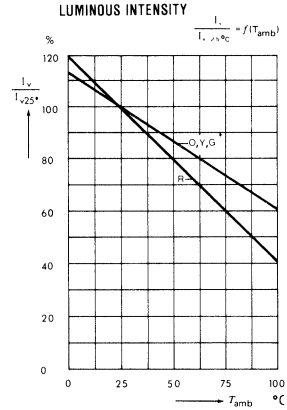
RELATIVE SPECTRAL EMISSION



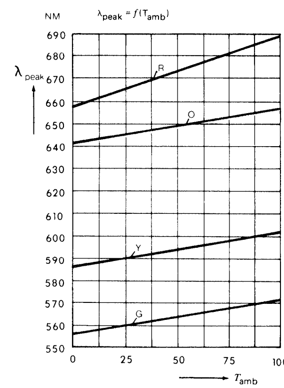
LUMINOUS INTENSITY



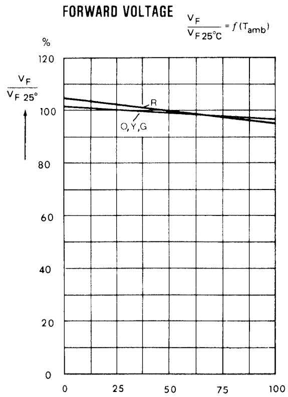
LUMINOUS INTENSITY



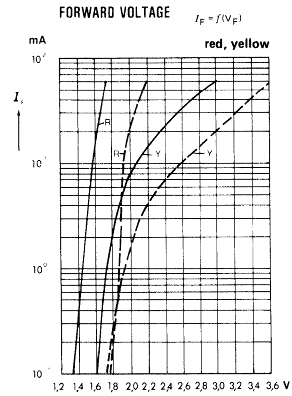
WAVELENGTH AT PEAK EMISSION



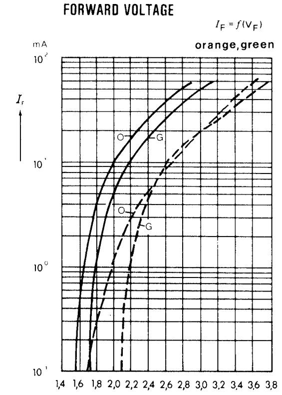
FORWARD VOLTAGE



FORWARD VOLTAGE



FORWARD VOLTAGE



SIEMENS

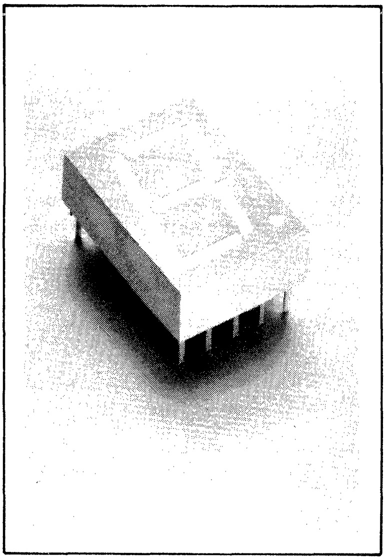
HD 1131 R, HD 1132 R, HD 1133 R, HD 1134 R
RED

HD 1131 O, HD 1132 O, HD 1133 O, HD 1134 O
HIGH EFFICIENCY RED

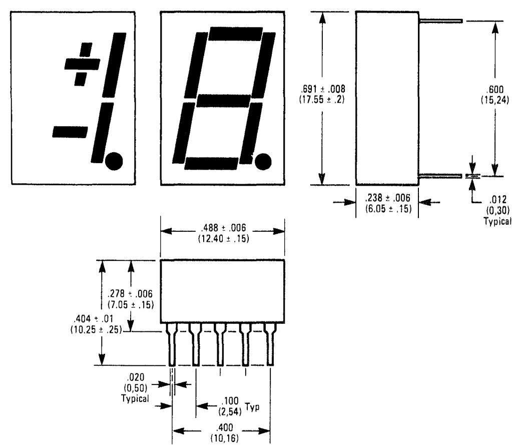
HD 1131 Y, HD 1132 Y, HD 1133 Y, HD 1134 Y
YELLOW

HG 1131 G, HG 1132 G, HG 1133 G, HG 1134 G
GREEN

0.53 (13.5 mm) SEVEN SEGMENT NUMERIC DISPLAY



Package Dimensions in Inches (mm)



FEATURES

- Rugged Encapsulated Package
- Large 0.53 Inch (13.5 mm) Digit Height
- Choice of Colors
- Common Anode or Common Cathode
- Wide Viewing
- Intensity Coded for Display Uniformity
- ±1 Polarity Overflow
- Pin for Pin Compatibility with DL500/DL507, FND500/FND507, MAN6680/MAN6660, TIL322/TIL321

DESCRIPTION

The 0.53 inch (13.5 mm) Digit Height Series of HD & HG1131/1133 Seven Segment Displays offer the choice of common anode or common cathode versions with right hand decimal point.
The HD & HG1132/1134 overflow displays also offer the choice of common anode or common cathode versions with right hand decimal point.

These displays were designed for viewing distances of up to 20 feet and can be used in electronic instruments, point-of-sale systems, clocks, and other general industrial and consumer applications. All displays have a light grey face.

Contrast enhancement filters are recommended for use with all displays.

Specifications subject to change without notice.

MAXIMUM RATINGS

Power Dissipation Per Segment (T_{amb} = 45°C) . . . . . . 60 mW
Operating Temperature . . . . . . –35° to +85°C
Storage Temperature . . . . . . –40° to +85°C
D.C. Forward Current Per Segment (T_{amb} = 45°C)
HD1131R, HD1132R, HD1133R, HD1134R . . . . . . 35 mA
HD1131O, HD1132O, HD1133O, HD1134O . . . . . . 20 mA
HG1131G, HG1132G, HG1133G, HG1134G . . . . . . 20 mA
HD1131Y, HD1132Y, HD1133Y, HD1134Y . . . . . . 20 mA
Peak Forward Current ($t \leqslant 10\,\mu s$, T_{amb} = 45°C)
HD1131R, HD1132R, HD1133R, HD1134R . . . . . . 400 mA
HD1131O, HD1132O, HD1133O, HD1134O . . . . . . 150 mA
HG1131G, HG1132G, HG1133G, HG1134G . . . . . . 150 mA
HD1131Y, HD1132Y, HD1133Y, HD1134Y . . . . . . 150 mA
Reverse Voltage . . . . . . 6 V
Thermal Resistance (Junction to Air)
HD & HG 1131/1133 series . . . . . . 115 K/W
HD & HG 1132/1134 series . . . . . . 155 K/W
Soldering Temperature (Less than 5 sec @ min distance of 2 mm) . . . . . . 230°C

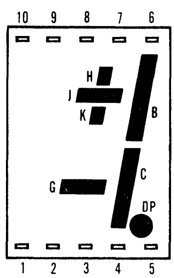
Optoelectronic Characteristics @ 25°C

Parameter	Min	Typ	Max	Units	Conditions
Luminous Intensity (Per Segment)					
HD1131R, HD1132R, HD1133R, HD1134R	120	300		μcd	I_F = 10 mA
		1400		μcd	I_F = 35 mA
HD1131O, HD1132O, HD1133O, HD1134O	90	260		μcd	I_F = 5 mA
		1400		μcd	I_F = 20 mA
HG1131G, HG1132G, HG1133G, HG1134G	120	260		μcd	I_F = 5 mA
		1400		μcd	I_F = 20 mA
HD1131Y, HD1132Y, HD1133Y, HD1134Y	90	200		μcd	I_F = 5 mA
		1300		μcd	I_F = 20 mA
Forward Voltage					
HD1131R, HD1132R, HD1133R, HD1134R		1.6	2.0	V	I_F = 10 mA
HD1131O, HD1132O, HD1133O, HD1134O		1.9	2.4	V	I_F = 5 mA
HG1131G, HG1132G, HG1133G, HG1134G		1.9	2.4	V	I_F = 5 mA
HD1131Y, HD1132Y, HD1133Y, HD1134Y		1.9	2.4	V	I_F = 5 mA
Reverse Current		0.01	10	μA	V_R = 6 V
Peak Emission Wavelength					
HD1131R, HD1132R, HD1133R, HD1134R		665		nm	
HD1131O, HD1132O, HD1133O, HD1134O		645		nm	
HG1131G, HG1132G, HG1133G, HG1134G		560		nm	
HD1131Y, HD1132Y, HD1133Y, HD1134Y		590		nm	
Rise Time/Fall Time					
HD1131R, HD1132R, HD1133R, HD1134R		5		ns	
HD1131O, HD1132O, HD1133O, HD1134O		100		ns	
HG1131G, HG1132G, HG1133G, HG1134G		50		ns	
HD1131Y, HD1132Y, HD1133Y, HD1134Y		100		ns	
Capacitance					
HD1131R, HD1132R, HD1133R, HD1134R		40		pf	$V_R = 0_V$ f = 1MHz
HD1131O, HD1132O, HD1133O, HD1134O		12		pf	$V_R = 0_V$ f = 1MHz
HG1131G, HG1132G, HG1133G, HG1134G		45		pf	$V_R = 0_V$ f = 1MHz
HD1131Y, HD1132Y, HD1133Y, HD1134Y		10		pf	$V_R = 0_V$ f = 1MHz

Specifications subject to change without notice.

Product	Color	Description
HD1131R	Red	Common Anode Right Decimal
HD1132R	Red	Common Anode ±1 Right Decimal
HD1133R	Red	Common Cathode Right Decimal
HD1134R	Red	Common Cathode ±1 Right Decimal
HD1131O	High Efficiency Red	Common Anode Right Decimal
HD1132O	High Efficiency Red	Common Anode ±1 Right Decimal
HD1133O	High Efficiency Red	Common Cathode Right Decimal
HD1134O	High Efficiency Red	Common Cathode ±1 Right Decimal
HG1131G	Green	Common Anode Right Decimal
HG1132G	Green	Common Anode ±1 Right Decimal
HG1133G	Green	Common Cathode Right Decimal
HG1134G	Green	Common Cathode ±1 Right Decimal
HD1131Y	Yellow	Common Anode Right Decimal
HD1132Y	Yellow	Common Anode ±1 Right Decimal
HD1133Y	Yellow	Common Cathode Right Decimal
HD1134Y	Yellow	Common Cathode ±1 Right Decimal

HD & HG 1132/1134



TOP VIEW

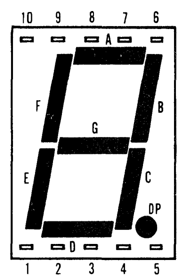
HD1132R
HD1132O
HG1132 G
HD1132Y

1 Cathode G
2 No Connection
3 Common Anode
4 Cathode C
5 Cathode DP
6 Cathode B
7 No Connection
8 Common Anode
9 Cathode HJK
10 No Connection

HD1134R
HD1134O
HG1134 G
HD1134Y

1 Anode G
2 No Connection
3 Common Cathode
4 Anode C
5 Anode DP
6 Anode B
7 No Connection
8 Common Cathode
9 Anode HJK
10 No Connection

HD&HG 1131/1133



TOP VIEW

HD1131 R
HD1131 O
HG1131G
HD1131 Y

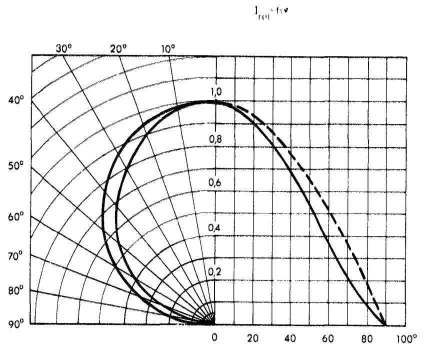
1 Cathode E
2 Cathode D
3 Common Anode
4 Cathode C
5 Cathode DP
6 Cathode B
7 Cathode A
8 Common Anode
9 Cathode F
10 Cathode G

HD1133 R
HD1133 O
HG1133 G
HD1133 Y

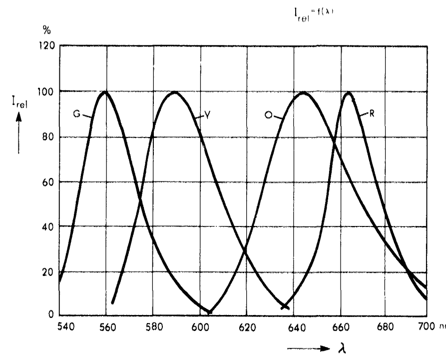
1 Anode E
2 Anode D
3 Common Cathode
4 Anode C
5 Anode DP
6 Anode B
7 Anode A
8 Common Cathode
9 Anode F
10 Anode G

TYPICAL OPTO-ELECTRONIC CHARACTERISTIC CURVES

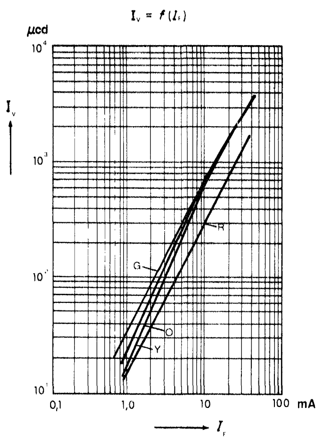
RADIATION CHARACTERISTICS



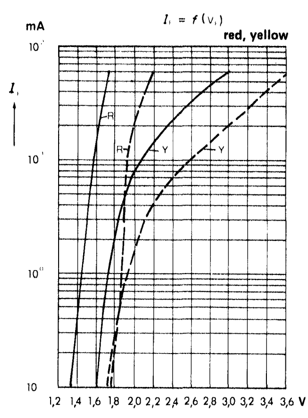
RELATIVE SPECTRAL EMISSION



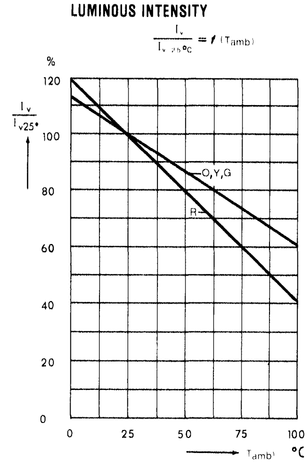
LUMINOUS INTENSITY



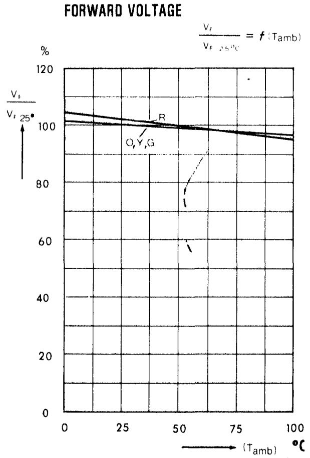
FORWARD VOLTAGE



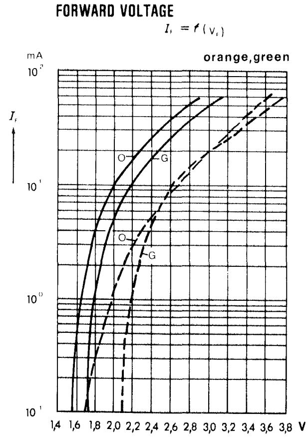
LUMINOUS INTENSITY



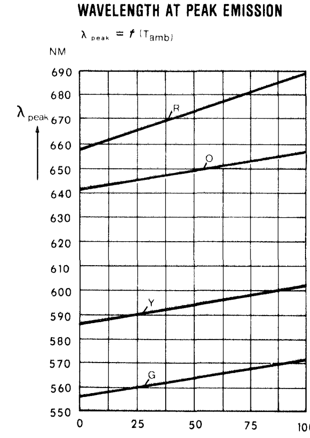
FORWARD VOLTAGE

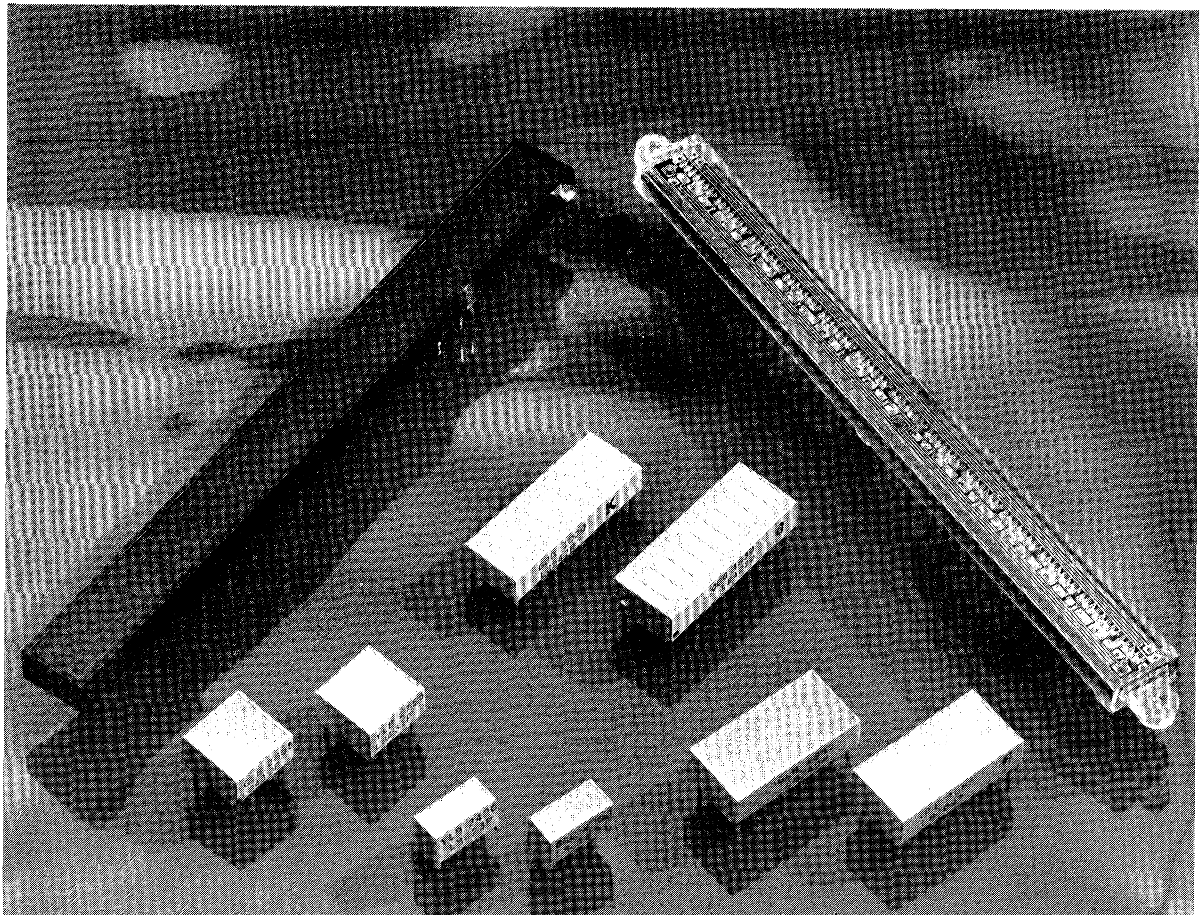


FORWARD VOLTAGE

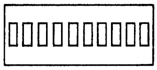
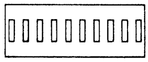


WAVELENGTH AT PEAK EMISSION



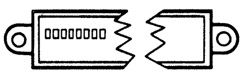
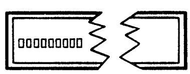


Bar Graphs

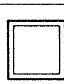
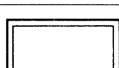
Package Type	Package Outline	Part Number	Light Emitting Area	Description	Polarity	Color	Luminous Intensity Per Segment Typ	@ (mA)	Page
10 Element Encap-sulated (Filled Reflector) DIP	 H .400" W 1.0" D .240"	RBG-4820	.06 x .15"	10 element bar graph standard package	Separately address-able anode and cathode	Red	500µcd	20	44
		OBG-4830				Hi. Eff. Red	2500µcd	20	
		YBG-4840				Yellow	2000µcd	20	
		GBG-4850				Green	2000µcd	20	
10 Element Encap-sulated (Filled Reflector) DIP	 H .360" W .990" D .180"	RBG-1000	.04 x .15"	10 element bar graph small package	Separately address-able anode and cathode	Red	500µcd	20	42
		OBG-1000				Hi. Eff. Red	2500µcd	20	
		YBG-1000				Yellow	2000µcd	20	
		GBG-1000				Green	2000µcd	20	

PACKAGE DIMENSIONS: H (HEIGHT), W (WIDTH), D (DEPTH – WITHOUT LEADS OR STANDOFFS)

Linear Arrays

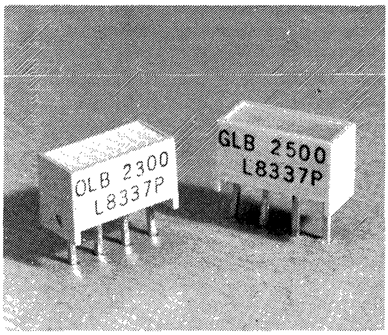
Package Type	Package Outline	Part Number	Light Emitting Area	Description	Drive Scheme	Color	Luminous Intensity Min.	@ (mA)	Page
112 Element clear epoxy backfilled cover Single-in line 100 mil pin centers	 H .392" W 4.165" D .235"	RBG-112	5 x 60 mil 8 per group in 13 groups 13 x 13 mil 11 yellow LEDs, common cathode	101 red elements spaced 1 mm C. to C. 11 Yellow scale marks spaced every 10 red LEDs.	8 x 13 multiplexed common cathode (red) 11 C.C. (yellow) 38 pins	Red bars with yellow scale dots (chips)	240µcd (for both red & yellow)	10 mA	46
101 Element red epoxy backfilled cover (clear on special order) Single-in line 100 mil pin centers	 H .392" W 3.60" D .235"	RBG-8820	5 x 60 mil 10 per group in 10 groups with one separate element	101 red elements spaced 1 mm C. to C.	10 x 10 multiplexed group is selected by the cathode & the individual bar by the anode, addressed by 22 pins.	Red	240 µcd	10 mA	48

Light Bars

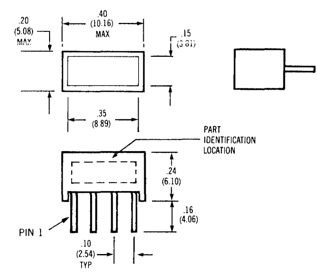
Package Type	Package Outline	Part Number	Light Emitting Area	Description	Color	Luminous Intensity Typ	@mA	Page
Small rectangular Rugged encap-sulated	 H .2" W .4" D .24"	OLB-2300	.15 x .35"	Small rectangular two die light bar. For back lighting legends or indicators.	Hi. Eff. Red	10 mcd	20	39
		YLB-2400			Yellow	6 mcd	20	
		GLB-2500			Green	10 mcd	20	
Square Rugged encap-sulated	 H .4" W .4" D .24"	OLB-2655	.35 x .35"	Square four die light bar. For back lighting legends or indicators.	Hi. Eff. Red	20 mcd	20	40
		YLB-2755			Yellow	12 mcd	20	
		GLB-2855			Green	20 mcd	20	
Large rectangular Rugged encap-sulated	 H .4" W .8" D .24"	OLB-2685	.35 x .75"	Large rectangular eight die light bar. For back lighting legends or indicators.	Hi. Eff. Red	40 mcd	20	41
		YLB-2785			Yellow	24 mcd	20	
		GLB-2885			Green	40 mcd	20	

SIEMENS

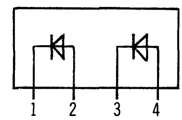
HIGH EFFICIENCY RED OLB 2300
YELLOW YLB 2400
GREEN GLB 2500
LIGHT BARS
Advance Data Sheet



Package Dimensions in Inches (mm)



PIN	PIN FUNCTION
1	Cathode — a
2	Anode — a
3	Cathode — b
4	Anode — b



FEATURES

- **Small Rectangular Package**
- **Uniform Light Emitting Area**
- **Excellent ON/OFF Contrast**
- **Choice of Three Colors**
- **Categorized for Light Output**
- **Yellow and Green Categorized for Dominant Wavelength**
- **Panel or Legend Mountable**
- **Can be Mounted on P.C. Boards or SIP/DFP Sockets**
- **X-Y Stackable**
- **Suitable for Multiplexing**
- **IC Compatible**

APPLICATIONS

These devices are ideally suited for:
- **Message Annunciators**
- **Positions/Status Indicators**
- **Telecommunications Indicators**
- **Bar Graphs**

DESCRIPTION

The OLB 2300/YLB 2400/GLB 2500 series light bars are rectangular displays designed for application requiring a large light emitting area. They are configured in a single in-line package and contain a single light emitting area. The OLB 2300 and YLB 2400 devices utilize two LED chips which are made from GaAsP on a transparent GaP substrate. The GLB 2500 device utilizes two chips made from GaP on a transparent GaP substrate.

Maximum Ratings

	OLB 2300 & GLB 2500	YLB 2400
Average Power Dissipation per LED chip	135mW	85mW
Peak Forward Current per LED chip Ta = 50°C (max pulse width = 2ms)	90mA	60mA
Average Forward Current per LED Pulsed conditions (Ta = 50°C)	25mA	20mA
DC Forward Current Per LED (Ta = 50°C)	30mA	25mA
Reverse Voltage per LED chip	6V	
Operating Temperature	−40°C to +85°C	
Storage Temperature	−40°C to +85°C	
Lead Soldering Temperature, 1/16 inch below seating plane	260°C for 3 sec.	
Junction Temperature	100°C	

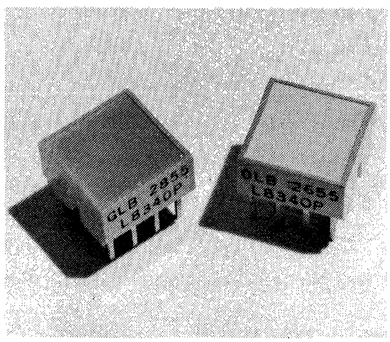
Electrical/Optical Characteristics (@ 25°C)

Parameters	Min.	Typ.	Max.	Units	Test Conditions
Luminous Intensity					
OLB2300	4.5	10		mcd	20mA DC
YLB2400	4	6		mcd	20mA DC
GLB2500	3.7	10		mcd	20mA DC
Peak Wavelength					
OLB2300		635		nm	
YLB2400		583		nm	
GLB2500		565		nm	
Dominant Wavelength					
OLB2300		626		nm	
YLB2400		585		nm	
GLB2500		572		nm	
Forward Voltage					
OLB2300		1.9	2.6	V	$I_F = 20mA$
YLB2400		2	2.6	V	$I_F = 20mA$
GLB2500		2.1	2.6	V	$I_F = 20mA$
Reverse Voltage					
OLB2300	6	15		V	$I_R = 100\mu A$
YLB2400	6	15		V	$I_R = 100\mu A$
GLB2500	6	15		V	$I_R = 100\mu A$

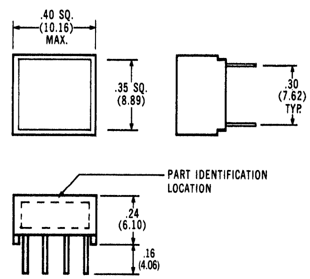
Specifications are subject to change without notice.

SIEMENS

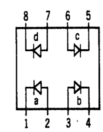
HIGH EFFICIENCY RED OLB 2655
YELLOW YLB 2755
GREEN GLB 2855
LIGHT BARS
Advance Data Sheet



Package Dimensions in Inches (mm)



PIN	PIN FUNCTION
1	Cathode a
2	Anode a
3	Anode b
4	Cathode b
5	Cathode c
6	Anode c
7	Anode d
8	Cathode d



FEATURES

- Square Package
- Uniform Light Emitting Area
- Excellent ON/OFF Contrast
- Choice of Three Colors
- Categorized for Light Output
- Yellow and Green Categorized for Dominant Wavelength
- Panel or Legend Mountable
- Can be Mounted on P.C. Boards or DIP Sockets
- X-Y Stackable
- Suitable for Multiplexing
- IC Compatible

APPLICATIONS

These devices are ideally suited for:
- Message Annunciators
- Positions/Status Indicators
- Telecommunications Indicators
- Bar Graphs

DESCRIPTION

The OLB 2655/YLB 2755/GLB 2855 series light bars are square displays designed for application requiring a large light emitting area. They are configured in a dual in-line package and contain a single light emitting area. The OLB 2655 and YLB 2755 devices utilize four LED chips which are made from GaAsP on a transparent GaP substrate. The GLB 2855 device utilizes four chips made from GaP on a transparent GaP substrate.

Maximum Ratings

	OLB 2655 & GLB 2855	YLB 2755
Average Power Dissipation per LED chip	135mW	85mW
Peak Forward Current per LED chip Ta = 50°C (max pulse width = 2ms)	90mA	60mA
Average Forward Current per LED Pulsed conditions (Ta = 50°C)	25mA	20mA
DC Forward Current Per LED (Ta = 50°C)	30mA	25mA
Reverse Voltage per LED chip	6V	
Operating Temperature	−40°C to +85°C	
Storage Temperature	−40°C to +85°C	
Lead Soldering Temperature, 1/16 inch below seating plane	260°C for 3 sec.	
Junction Temperature	100°C	

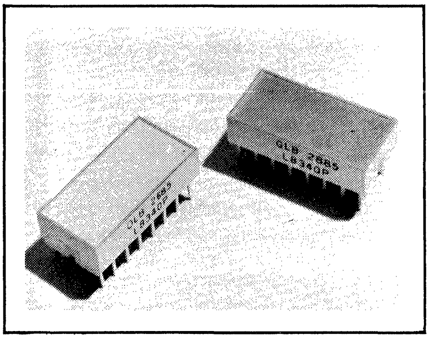
Electrical/Optical Characteristics (@ 25°C)

Parameters	Min.	Typ.	Max.	Units	Test Conditions
Luminous Intensity					
OLB2655	9	20		mcd	20mA DC
YLB2755	8	12		mcd	20mA DC
GLB2855	7.5	20		mcd	20mA DC
Peak Wavelength					
OLB2655		635		nm	
YLB2755		583		nm	
GLB2855		565		nm	
Dominant Wavelength					
OLB2655		626		nm	
YLB2755		585		nm	
GLB2855		572		nm	
Forward Voltage					
OLB2655		2.1	2.6	V	$I_F = 20mA$
YLB2755		2.2	2.6	V	$I_F = 20mA$
GLB2855		2.2	2.6	V	$I_F = 20mA$
Reverse Voltage					
OLB2655	6	15		V	$I_R = 100\mu A$
YLB2755	6	15		V	$I_R = 100\mu A$
GLB2855	6	15		V	$I_R = 100\mu A$

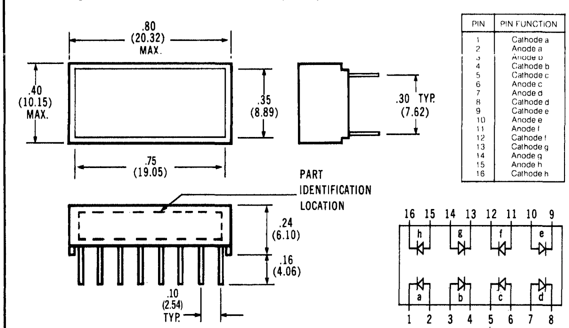
Specifications are subject to change without notice.

SIEMENS

HIGH EFFICIENCY RED OLB 2685
YELLOW YLB 2785
GREEN GLB 2885
LIGHT BARS
Advance Data Sheet



Package Dimensions in Inches (mm)



PIN	PIN FUNCTION
1	Cathode a
2	Anode a
3	Anode b
4	Cathode b
5	Cathode c
6	Anode c
7	Anode d
8	Cathode d
9	Cathode e
10	Anode e
11	Anode f
12	Cathode f
13	Cathode g
14	Anode g
15	Anode h
16	Cathode h

FEATURES

- Large Rectangular Package
- Uniform Light Emitting Area
- Excellent ON/OFF Contrast
- Choice of Three Colors
- Categorized for Light Output
- Yellow and Green Categorized for Dominant Wavelength
- Panel or Legend Mountable
- Can be Mounted on P.C. Boards or DIP Sockets
- X-Y Stackable
- Suitable for Multiplexing
- IC Compatible

APPLICATIONS

These devices are ideally suited for:

- Message Annunciators
- Positions/Status Indicators
- Telecommunications Indicators
- Bar Graphs

DESCRIPTION

The OLB 2685/YLB 2785/GLB 2885 series light bars are rectangular displays designed for application requiring a large light emitting area. They are configured in a dual in-line package and contain a single light emitting area. The OLB 2685 and YLB 2785 devices utilize eight LED chips which are made from GaAsP on a transparent GaP substrate. The GLB 2885 device utilizes eight chips made from GaP on a transparent GaP substrate.

Maximum Ratings

	OLB 2685 & GLB 2885	YLB 2785
Average Power Dissipation per LED chip	135mW	85mW
Peak Forward Current per LED chip Ta = 50°C (max pulse width = 2ms)	90mA	60mA
Average Forward Current per LED Pulsed conditions (Ta = 50°C)	25mA	20mA
DC Forward Current Per LED (Ta = 50°C)	30mA	25mA
Reverse Voltage per LED chip	6V	6V
Operating Temperature	−40°C to +85°C	
Storage Temperature	−40°C to +85°C	
Lead Soldering Temperature, 1/16 inch below seating plane	260°C for 3 sec.	
Junction Temperature	100°C	

Electrical/Optical Characteristics (@ 25°C)

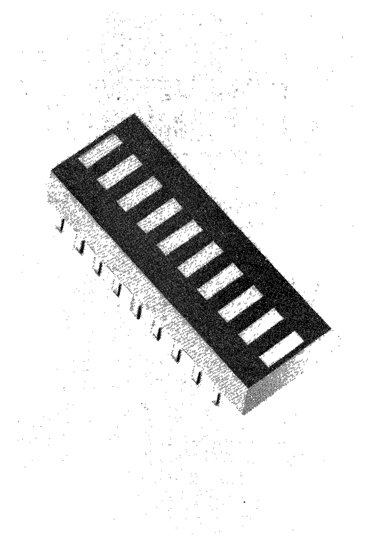
Parameters	Min.	Typ.	Max.	Units	Test Conditions
Luminous Intensity					
OLB2685	18	40		mcd	20mA DC
YLB2785	16	24		mcd	20mA DC
GLB2885	15	40		mcd	20mA DC
Peak Wavelength					
OLB2685		635		nm	
YLB2785		583		nm	
GLB2885		565		nm	
Dominant Wavelength					
OLB2685		626		nm	
YLB2785		585		nm	
GLB2885		572		nm	
Forward Voltage					
OLB2685		2.1	2.6	V	$I_F = 20mA$
YLB2785		2.2	2.6	V	$I_F = 20mA$
GLB2885		2.2	2.6	V	$I_F = 20mA$
Reverse Voltage					
OLB2685	6	15		V	$I_R = 100\mu A$
YLB2785	6	15		V	$I_R = 100\mu A$
GLB2885	6	15		V	$I_R = 100\mu A$

Specifications are subject to change without notice.

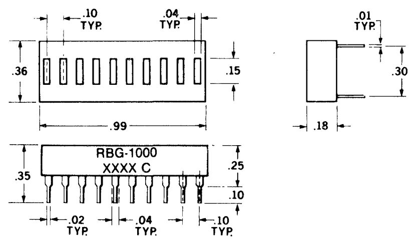
SIEMENS

RBG-1000 RED
OBG-1000 HIGH EFFICIENCY RED
YBG-1000 YELLOW
GBG-1000 GREEN

10 ELEMENT LINEAR DISPLAY



Package Dimensions in Inches (mm)



FEATURES

- **10 Element Display**
- **End Stackable Module**
- **Individual Addressable Anode and Cathode**
- **Intensity Coded for Display Uniformity**
- **Rugged Encapsulation**
- **Choice of Colors**

DESCRIPTION

The Red RBG-1000, Hi-efficiency Red OBG-1000, Yellow YBG-1000, and Green GBG-1000 are 10 individual element linear bar displays. They are contained in a 1 inch long, 20 pin dual-in-line package that can be end stacked as bar-graph displays of various lengths. Applications include: bar graph, solid-state meter movement, position indicator, etc.

Maximum Ratings

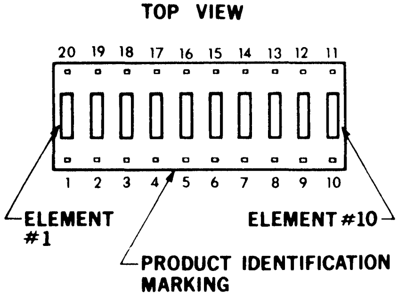
Storage Temperature .... −20° to +85°C
Operating Temperature .... 20° to +85°C
Power Dissipation @25°C .... 450 mW
Derating Factor from 25°C .... 7.5 mW/°C
Continous Forward Current
RBG-1000 per display .... 200 mA
per element .... 20 mA
OBG-1000 / YBG-1000 / GBG-1000 per display .... 156 mA
per element .... 20 mA
Peak Inverse Voltage per Element .... 3 V

Opto-Electronic Characteristics (@25°C)

Parameter	Typ	Max	Unit	Test Condition
Luminous Intensity/ Element (Display Average)				
RBG-1000	.5		mcd	$I_F = 20$ mA/ Segment
OBG-1000	2.5		mcd	$I_F = 20$ mA/ Segment
YBG-1000	2.0		mcd	$I_F = 20$ mA/ Segment
GBG-1000	2.0		mcd	$I_F = 20$ mA/ Segment
Forward Voltage				
RBG-1000	1.7	2.0	V	$I_F = 20$ mA
OBG-1000	2.2	2.8	V	$I_F = 20$ mA
YBG-1000	2.4	3.0	V	$I_F = 20$ mA
GBG-1000	2.4	3.0	V	$I_F = 20$ mA
Reverse Leakage	0.1	100	μA	$V_R = 3$ V
Emission Peak Wavelength				
RBG-1000	660		nm	
OBG-1000	630		nm	
YBG-1000	585		nm	
GBG-1000	565		nm	

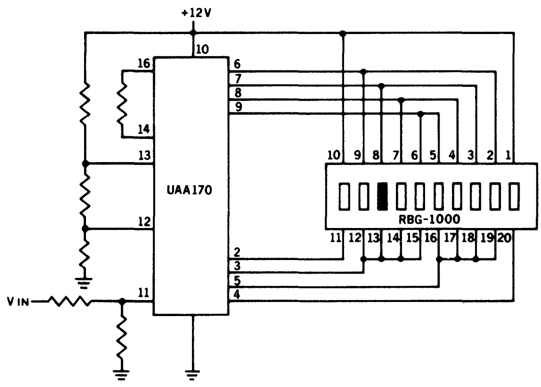
Specifications are subject to change without notice.

RBG-1000, OBG-1000, YBG-1000 AND GBG-1000



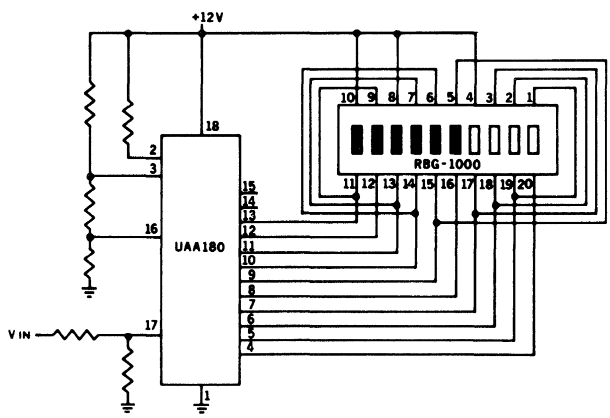
PIN	FUNCTION	PIN	FUNCTION
1	ANODE 1	11	CATHODE 10
2	ANODE 2	12	CATHODE 9
3	ANODE 3	13	CATHODE 8
4	ANODE 4	14	CATHODE 7
5	ANODE 5	15	CATHODE 6
6	ANODE 6	16	CATHODE 5
7	ANODE 7	17	CATHODE 4
8	ANODE 8	18	CATHODE 3
9	ANODE 9	19	CATHODE 2
10	ANODE 10	20	CATHODE 1

TYPICAL APPLICATIONS



LIGHT SPOT DISPLAY

LINEAR DISPLAY DRIVERS
Siemens UAA170
Siemens UAA180
National LM3914
National LM3915
Sharp IR2406



LIGHT BAND DISPLAY

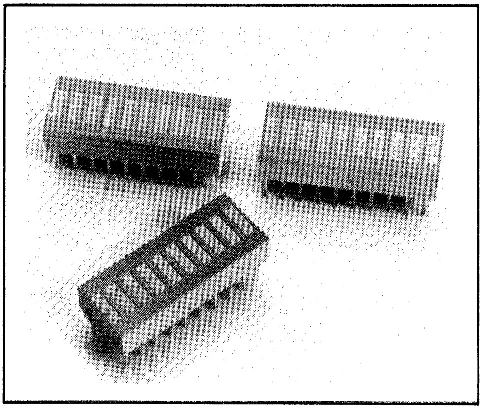
No endorsement or warranty of other manufacturer's products is intended by Litronix

SIEMENS

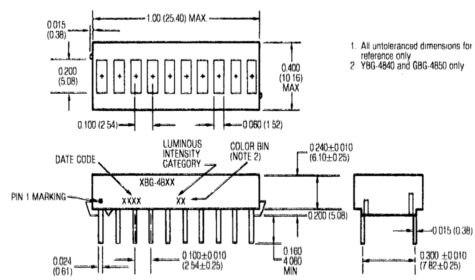
RBG-4820 RED
OBG-4830 HIGH EFFICIENCY RED
YBG-4840 YELLOW
GBG-4850 GREEN

10 ELEMENT LINEAR DISPLAY

Preliminary



Package Dimensions in Inches (mm)



FEATURES

- **10 Element Array**
- **End Stackable With Package Interlock to Assure Alignment**
- **Matched LED's for Uniform Display**
- **Individually Addressable Anode and Cathode**
- **Intensity Coded for Display Uniformity**
- **Wide Viewing Angle**
- **Rugged Encapsulated Construction**
- **Standard Dual-In-Line Package**
- **High On-Off Contrast, Segment to Segment Hue Coded For Uniformity**
- **Choice of Colors**

DESCRIPTION

The Red RBG-4820, Hi-efficiency Red, OBG-4830, Yellow YBG-4840 and Green GBG-4850 are 10 individual element linear bar displays and are designed to display information in easily recognizable bar graph form. They are end stackable for expanded display lengths. The package interlock ensures that each bargraph will align accurately and correctly with the next one. Applications include solid state meters, position indicators, and instrumentation.

Maximum Ratings

Storage Temperature	-20°C to +70°C
Operating Temperature	-20°C to +70°C
Power Dissipation @ 25°C per LED	125mW
Derating Factor from 25°C	1.67mW/°C
Lead Soldering Temperature (1/16 below seating plane)	260°C for 3 sec.
Peak Reverse Voltage Per Led	3V
Continuous Forward Current	
RBG-4820	30mA
OBG-4830	30mA
YBG-4840	20mA
GBG-4850	30mA

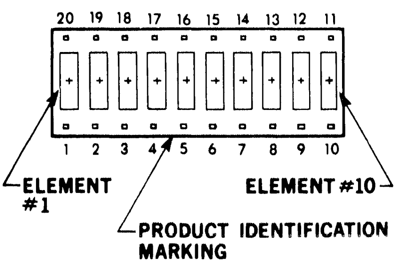
Optoelectronic Characteristics (@ 25°C)

Parameters	Min.	Typ.	Max.	Units	Test Conditions
Luminous Intensity Per Element					
RBG-4820		500		μcd	I_F=20mA
OBG-4830		2500		μcd	I_F=20mA
YBG-4840		2000		μcd	I_F=20mA
GBG-4850		2000		μcd	I_F=20mA
Peak Wavelength					
RBG-4820		655		nm	
OBG-4830		635		nm	
YBG-4840		583		nm	
GBG-4850		566		nm	
Dominant Wavelength					
RBG-4820		645		nm	
OBG-4830		626		nm	
YBG-4840		585		nm	
GBG-4850		571		nm	
Forward Voltage Per LED					
RBG-4820		1.6	2.0	V	I_F=20mA
OBG-4830		2.1	2.5	V	I_F=20mA
YBG-4840		2.2	2.6	V	I_F=20mA
GBG-4850		2.1	2.5	V	I_F=10mA
Reverse Voltage Per LED					
RBG-4820	3	12		V	I_R=100uA
OBG-4830	3	30		V	I_R=100uA
YBG-4840	3	50		V	I_R=100uA
GBG-4850	3	50		V	I_R=100uA

 Specifications subject to change without notice.

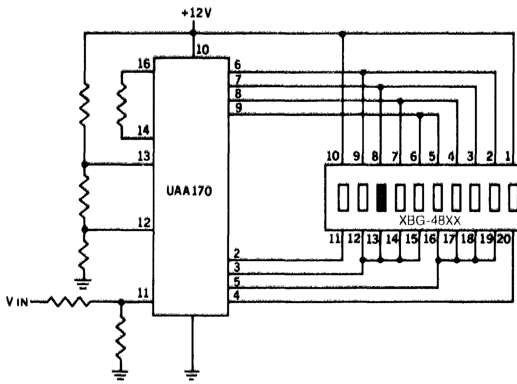
RBG-4820 OBG-4830 YBG-4840 and GBG-4850

TOP VIEW



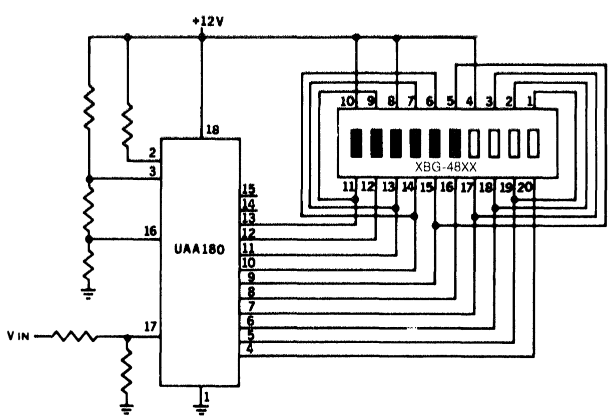
PIN	FUNCTION	PIN	FUNCTION
1	ANODE 1	11	CATHODE 10
2	ANODE 2	12	CATHODE 9
3	ANODE 3	13	CATHODE 8
4	ANODE 4	14	CATHODE 7
5	ANODE 5	15	CATHODE 6
6	ANODE 6	16	CATHODE 5
7	ANODE 7	17	CATHODE 4
8	ANODE 8	18	CATHODE 3
9	ANODE 9	19	CATHODE 2
10	ANODE 10	20	CATHODE 1

TYPICAL APPLICATIONS



LIGHT SPOT DISPLAY

LINEAR DISPLAY DRIVERS
Siemens UAA170
Siemens UAA180
National LM3914
National LM3915
Sharp IR2406



LIGHT BAND DISPLAY

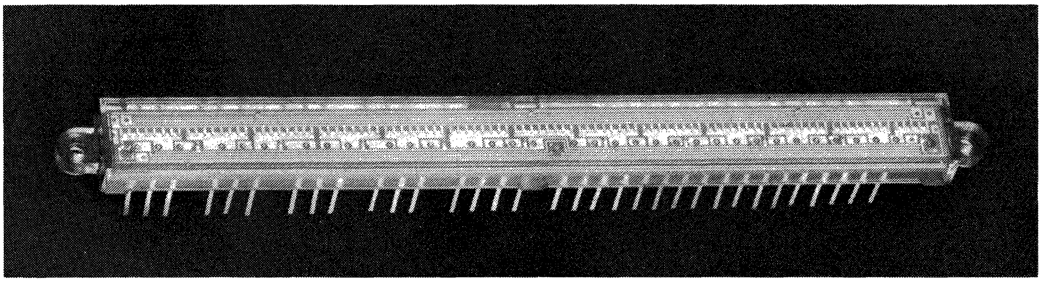
No endorsement or warranty of other manufacturer's products is intended

SIEMENS

RBG-112

112 ELEMENT LINEAR ARRAY WITH SCALE

PRELIMINARY



FEATURES

- **Instrumentation resolution - 1%**
- **Clearly Visible Rectangular Red Elements**
  5 mil × 60 mil light emitting areas
  1 mm center to center spacing
- **Yellow LED scale marks spaced every 10 red LEDs**
- **All LEDs of the same color matched for brightness**
- **Excellent Alignment**
- **Sturdy Construction, epoxy backfilled cover**
- **Single-in-line Package**
  25 mil square pins
  100 mil Industry Standard centers
- **Specifically designed for multiplexed operation**
- **Clear polycarbonate cover standard**

DESCRIPTION:

The RBG-112 is an instrumentation quality 101 element rectangular red LED linear array accompanied by an 11 element yellow linear array which can be used as a programmable scale. It provides a simple high resolution display of digital data when used as an expanding bar or as a position indicator when used as a moving dot.

The RBG-112 is provided with a clear polycarbonate cover which performs two functions; first the cover is backfilled with an epoxy seal resulting in a rugged, environmentally sound package; and second, the clear cover allows the use of a neutral filter of the customer's choice since LEDs of different colors (yellow and red) are used in the assembly.

The LEDs are arranged in a multiplexed arrangement. Red LEDs are in a common cathode array of 8 elements to a group, 13 groups. Yellow LEDs are in a common cathode configuration of 11 elements. Both groups of arrays are addressed through the 38 single-in-line pins extending from the back of the printed circuit board.

MAXIMUM RATINGS @25° C

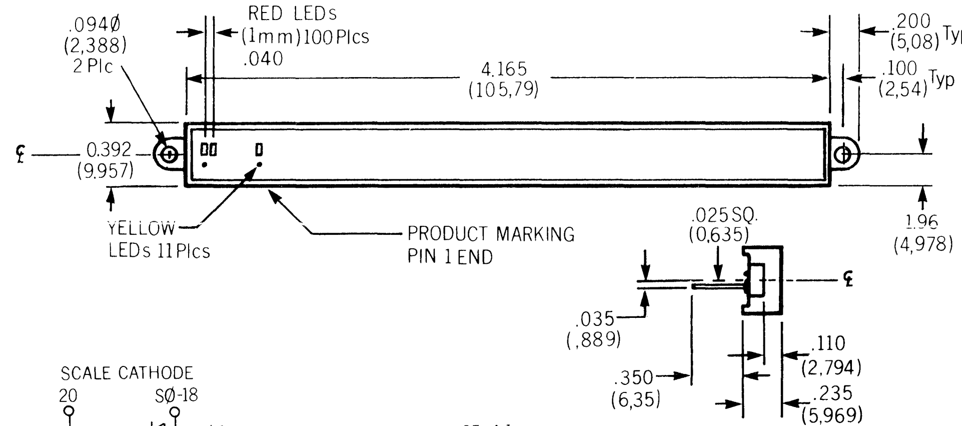
Parameter	Min.		Max.	Units
Average Power per Segment			15	mW
Average DC Forward Current per Segment (Red)			7	mA
Average DC Forward Current per Segment (Yellow)			7	mA
Derating Factor From 70°C			0.16	mA/°C
Peak Forward Current per Seg. Pulse Width-300μs			200	mA
Reverse Voltage/Seg.			5.0	V
Storage Temperature	−40	to	+85	Deg C
Operating Temperature	−40	to	+85	Deg C
Lead Soldering Temperature		260°C for 3 sec.		

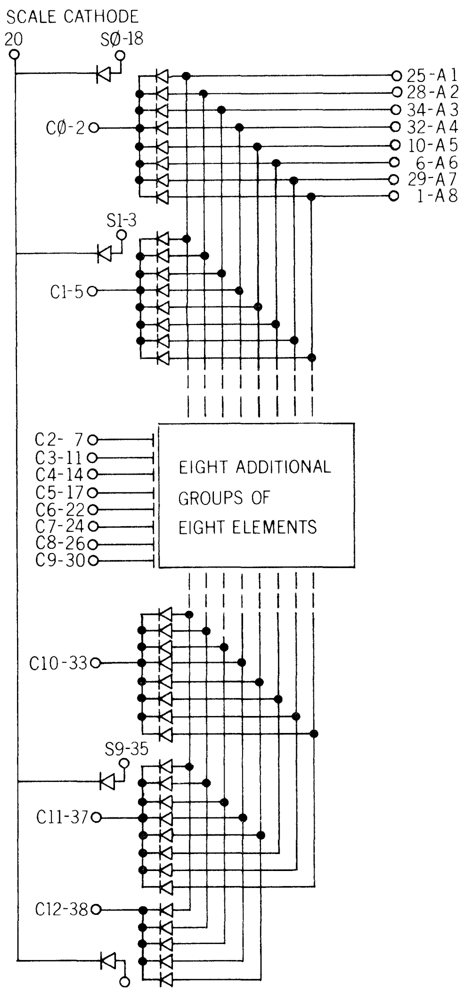
OPTOELECTRONIC CHARACTERISTICS (@25 DEG. C):

Parameter	Min.	Typ.	Max.	Units	Test Condition
Forward Voltage					
(Red)		1.7	2.1	V	IF = 20mA
(Yellow)		1.9	2.4	V	IF = 20mA
Reverse Voltage					
(Red)	3.0			V	IR = 100μA
(Yellow)	3.0			V	IR = 100μA
Luminous Intensity					
(Red)	240			μcd	IF = 10mADC
(Yellow)	240			μcd	IF = 10mADC
Peak Wavelength					
(Red)		655		nm	IF = 20mA
(Yellow)		575		nm	IF = 20mA
Luminous Intensity Segment Matching					
Adjacent Segments			1.6:1		IF = 10mA
All Other Segments			1.8:1		IF = 10mA

Specifications subject to change without notice

Package Dimensions in Inches (mm)





ADDITIONAL SCALE ANODES	PIN
S2	9
S3	13
S4	15
S5	19
S6	23
S7	27
S8	31

Pin	Function	Pin	Function
1	A8	20	SCALE CATH
2	CØ	21	NC
3	S1	22	C6
4	NC	23	S6
5	C1	24	C7
6	A6	25	A1
7	C2	26	C8
8	NC	27	S7
9	S2	28	A2
10	A5	29	A7
11	C3	30	C9
12	NC	31	S8
13	S3	32	A4
14	C4	33	C10
15	S4	34	A3
16	NC	35	S9
17	C5	36	S10
18	SØ	37	C11
19	S5	38	C12

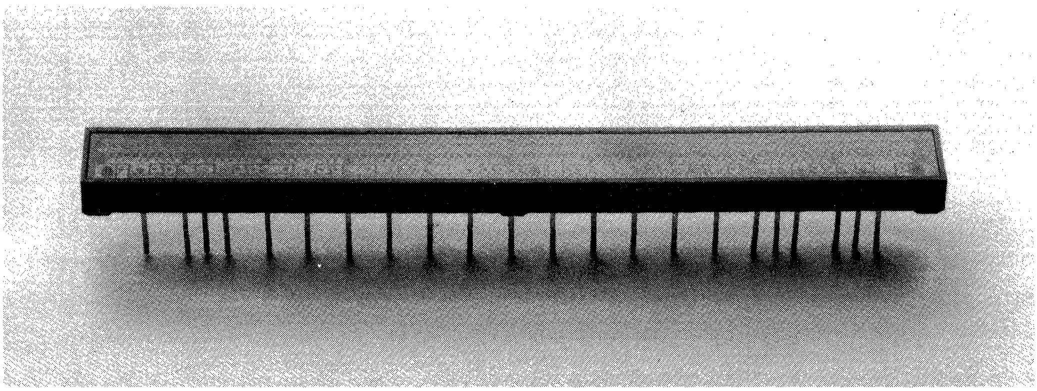
A = Anodes
C = Cathodes
S = Scale Anodes

SIEMENS

RBG-8820

101 ELEMENT LINEAR ARRAY

PRELIMINARY



FEATURES

- **Instrumentation Resolution - 1%**
- **Clearly Visible Rectangular Red Elements**
  5 mil × 60 mil light emitting area
  1 mm center to center spacing
- **All LEDs matched for brightness**
- **Excellent Alignment**
- **Sturdy Construction, epoxy backfilled cover**
- **Single-in-line Package**
  25 mil square pins
  100 mil industry Standard centers
- **Specifically designed for multiplexed operation**
- **Red polycarbonate cover standard**

DESCRIPTION

The RBG-8820 is an instrumentation quality 101 element red LED linear array. It provides a simple, high resolution analog representation of digital data when used as an expanding bar or as a position indicator when used as a moving dot. The RBG-8820 can be provided either with a red or a clear polycarbonate cover. The clear cover is advantageous when the array is used inconjunction with other LED devices and a front panel filter is placed over all displays. The cover is backfilled with an epoxy seal resulting in a rugged, environmentally sound package. The LEDs are connected in a common cathode configuration with 10 LEDs to a group, and 10 groups total. One additional element is brought out separately.

The RBG-8820 is designed for multiplexed operation, the desired group being selected by the cathode, the individual bar by the anode. The array is addressed by 22 single-in-line pins extending from the back of the circuit board.

MAXIMUM RATINGS (at 25°C)

Average power per segment	15 mw
Peak forward current per element	200 ma, pulse width 300 μsec
Average forward current per element	7 ma
Operating temperature range	−40° to +85°C
Storage temperature range	−40° to +85°C
Reverse voltage per element	5.0 volts
Lead solder temperature	260° for 3 sec 1/16″ from body

OPTO-ELECTRONIC CHARACTERISTICS (at 25°C)

Parameter	Min	Typ	Max	Unit	Test Condition
Peak wavelength		665		nM	
Forward voltage		1.7	2.1	V	If = 20 ma
Reverse voltage	3.0			V	I_R = 100 ua
Average luminous intensity per element	8	20		μcd	100 ma pk, 1/110 duty cycle

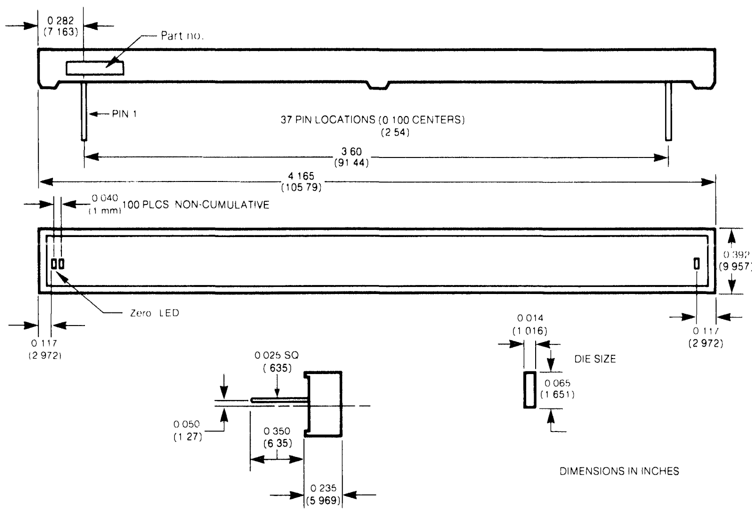
OPTIONS

- Colors available from the factory on special order:
  Orange
  High efficiency red*
  Yellow*
  Green*
- RBG-8820C clear cover

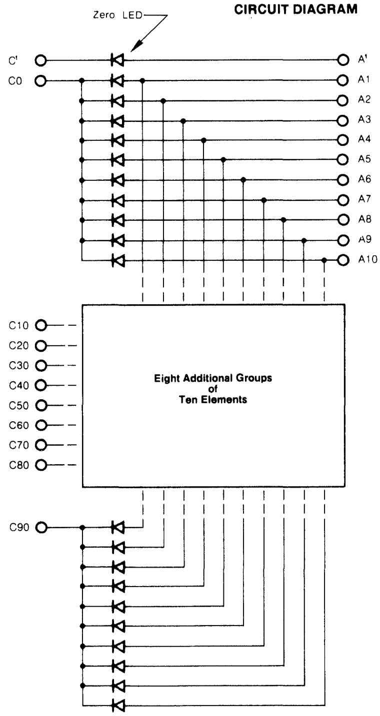
*Note: These colors have a larger light emitting area.

Specifications subject to change without notice

PACKAGE DIMENSIONS

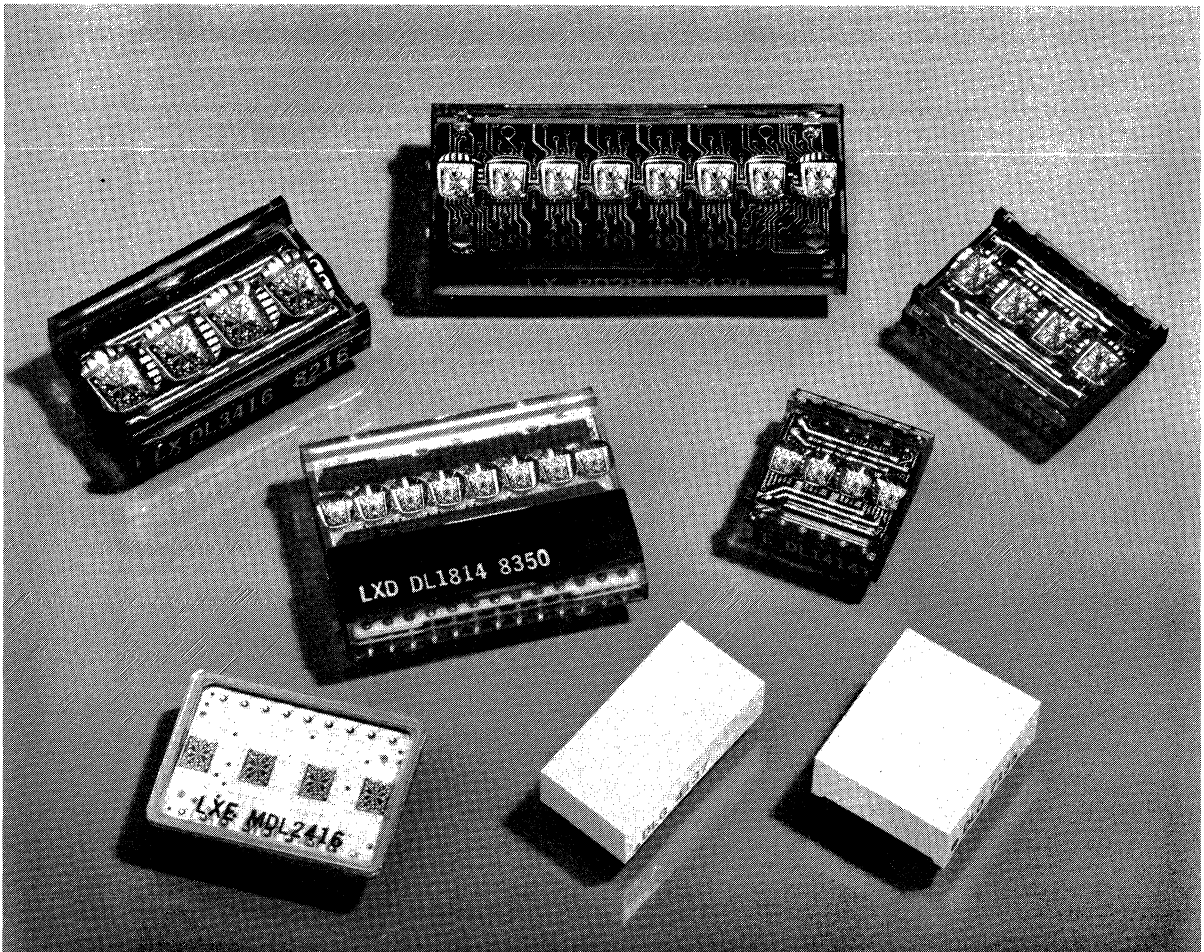


CIRCUIT DIAGRAM

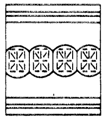
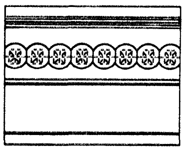
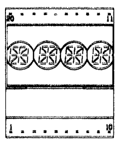
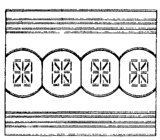
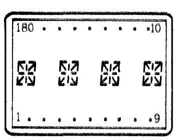
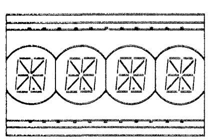
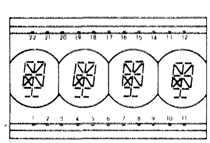


Pin Location	Designation
1	C0
2	A4
3	C'
5	C10
6	A1
7	A8
9	C20
11	A'
13	C30
15	A7
17	C40
19	A2
21	C50
23	A3
25	C60
27	A10
29	C70
31	A9
33	C80
34	A5
35	A6
37	C90

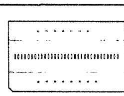
Note: A particular element is selected by the common cathode number and the anode number
For example, element 56 is lighted by addressed C50 and A6


LXD DL1814 8350
LXE MDL2416

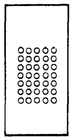
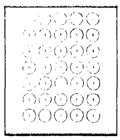
LED Intelligent Displays®

Package Type	Package Outline	Part Number	Character Height	Description	Page
4 Char. Module Encap-sulated		DL-1414	.112″	17 segment, 4 character display with built-in CMOS ASCII decoder, multiplexer, memory and driver. Red.	54
8 Char. Module Encap-sulated		DL-1814	.112″	17 segment, 8 character display with built-in CMOS ASCII decoder, multiplexer, memory and driver. Red.	66
4 Char. Module Encap-sulated		DL-1416B DL-1416T	.160″	16 segment, 4 character display with built-in CMOS ASCII decoder, multiplexer, memory and driver. Red.	58 62
4 Char. Module Hermetic Seal		DL-2416T DL-2416H	.150″	17 segment, 4 character display with built-in CMOS ASCII decoder, multiplexer, memory and driver. Red. Hi-Rel Military Type.	70
4 Char. Module Hermetic Seal		MDL-2416 MDL-2416B	.150″	17 segment, 4 character display with built-in CMOS ASCII decoder, multiplexer, memory and driver. Red. Hi-Rel Military Type.	92
4 Char. Module Encap-sulated		DL-3416 DL-3416H	.225″	17 segment, 4 character display with built-in CMOS ASCII decoder, multiplexer, memory and driver. Red.	74
4 Char. Module Encap-sulated		DL-3422	.170″ upper case .100″ lower case	22 segment, 4 character display, upper and lower case letters with built-in CMOS ASCII decoder, multiplexer, memory and driver. Red. **Phasing out—Not recommended for new designs.**	78

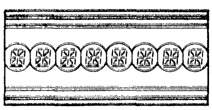
Bar Graph (Linear Array) On Board Intelligence

Package Type	Package Outline	Part Number	Light Emitting Area	Description	Color	Luminous Typ	Intensity @ V	Page
32 Element Encap-sulated DIP		IBR-3	12 x 24 mils	Hi resolution 50 mil spacing. On board; storage, decoding, multiplexing + drive electronics	Red	0.1 mcd	+5 V	90

LED Intelligent Displays®

Package Type	Package Outline	Part Number	Character Height	Description	Page
Single Char. Encapsulated		DLO-4135 DLG-4137	.430″	5x7 Dot Matrix, single character display with built-in CMOS ASCII decoder, multiplexer, memory and driver. Orange. 5x7 Dot Matrix, single character display with built-in CMOS ASCII decoder, multiplexer, memory and driver. Green.	82
Single Char. Encapsulated		DLO-7135 DLG-7137	.68″	5x7 Dot Matrix, single character display with built-in CMOS ASCII decoder, multiplexer, memory and driver. Orange. 5x7 Dot Matrix, single character display with built-in CMOS ASCII decoder, multiplexer, memory and driver. Green.	86

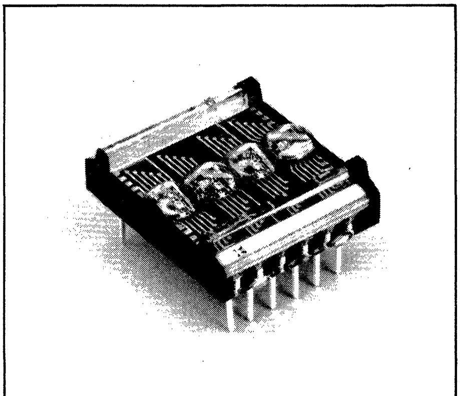
LED Programmable Display™

Package Type	Package Outline	Part Number	Character Height	Description	Page
8 Char. Module Encapsulated		PD-2816	.160″	18 segment (including decimal and character underline), 8 character display with built-in CMOS ASCII decoder, multiplexer, memory and driver. Software driven—true microprocessor peripheral, some additional features over Intelligent Displays include: control and display memory read/write, dimming (3 levels) and blanking, blinking cursor/character, lamp test and digit underline. Red.	96

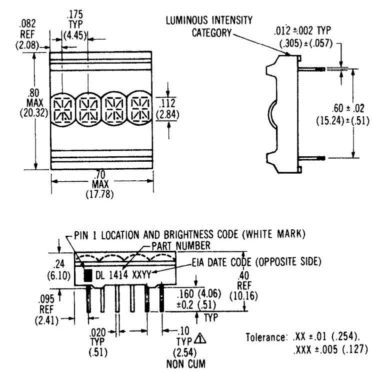
SIEMENS

DL-1414

.112″ RED, 4-DIGIT 17-SEGMENT ALPHANUMERIC Intelligent Display® WITH MEMORY/DECODER/DRIVER



Package Dimensions in Inches (mm)



FEATURES

- **112 Mil High, Magnified Monolithic Char.**
- **Wide Viewing Angle, ±40°**
- **Close Vertical Row Spacing, .800 Inches**
- **Rugged Solid Plastic Encapsulated Package**
- **Fast Access Time, 450 nSEC**
- **Compact Size For Hand Held Equipment**
- **Built-In Memory**
- **Built-In Character Generator**
- **Built-In Multiplex and LED Drive Circuitry**
- **Direct Access To Each Digit Independently and Asynchronously**
- **TTL Compatible, 5 Volt Power**
- **17th Segment For Improved Punctuation Marks**
- **Low Power Consumption, Typically 10 mA per character**
- **Intensity Coded For Display Uniformity**
- **End-Stackable, 4-Character Package**

DESCRIPTION

The DL1414 is a four digit display module having 16 bar segments plus a decimal segment and a built-in CMOS integrated circuit.

The integrated circuit contains memory, ASCII character generator, and LED multiplexing and drive circuitry. Inputs are TTL compatible. A single 5-volt power supply is required. Data entry is asynchronous and random access. A display system can be built using any number of DL1414's since each character in any DL1414 can be addressed independently and will continue to display the character last written until it is replaced by another.

LOADING DATA

Loading data into the DL1414 is straightforward. The desired data code (D_0–D_6) and digit address (A_0, A_1) is presented in parallel and held stable during a write cycle. Data entry may be asynchronous and in random order. (Digit 0 is defined as right hand digit with $A_1 = A_0 = 0$ = low).

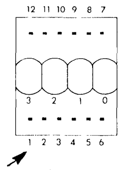
System interconnection is also straightforward. The least significant two address bits (A_0, A_1) are normally connected to the like named inputs of all DL1414's in the system. Data lines are connected to all DL1414's directly and in parallel. Multiple DL1414 systems usually use an external one-of-N decoder chip. The "write" pulse is connected to the CE of the decoder. A 3-to-8 line decoder multiplexer (74138) or a 4-to-16 line decoder/multiplexer (74154) are possible choices. All higher-order address bits (above A_1) become inputs to the decoder.

Important: Refer to Appnote 18, "Using and Handling Intelligent Displays". Since this is a CMOS device, normal precautions should be taken to avoid static damage.

Specifications are subject to change without notice.

Pin	Function	Pin	Function
1	D5 Data Input	7	Gnd
2	D4 Data Input	8	DØ Data Input (LSB)
3	$\overline{WR}$ Write	9	D1 Data Input
4	A1 Digit Select	10	D2 Data Input
5	AØ Digit Select	11	D3 Data Input
6	V_{CC}	12	D6 Data Input (MSB)

TOP VIEW



Product Identification
Markings on Front Surface

OPTO-ELECTRONIC CHARACTERISTICS @ 25°C

MAXIMUM RATINGS

Voltage, Any Pin
Respect to GND . . . . –.5 to +6 VDC
Operating Temperature . . . . . –20°C to 65°C
Storage Temperature . . . . –20°C to 70°C
Relative Humidity (non condensing) @ 65°C, 85%

OPTICAL CHARACTERISTICS (TYPICAL)

Luminous Intensity per digit/8 segments @ 5V . . . . . 0.4 mcd
Off Axis Viewing Angle (Note 1) . . . . ±40°
Digit Size . . . . 112 mils
Spectral Peak Wavelength . . . . 660 nm

DC CHARACTERISTICS

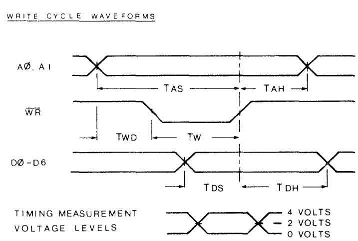
Parameter	–20°C Typ	+25°C (Note 6)	+65°C Typ	Conditions
I_{CC} 4 Digits on (10 seg/Digit)	100 mA	90 mA Max	70 mA	V_{CC} = 5.0 V
I_{CC} Blank		2.7 mA Max		V_{IN} = 0 V_{CC} = 5.0 V $\overline{WR}$ = 5.0 V
I_{IL}	180 μA	160 μA Max	100 μA	V_{IN} = .8 V V_{CC} = 5.0 V
V_{IL}		.8 V Max		V_{CC} = 4.5 V
V_{IH} (Note 4)		2.7 V Min		V_{CC} = 4.5 V
		3.3 V Min		V_{CC} = 5.5 V

AC CHARACTERISTICS
MINIMUM TIMING PARAMETERS @ 4.5 V (nanoseconds)

Parameter	-20°C Typ	25°C Min	+65°C Typ
T_{AS}	300	400	500
T_{WD}	50	75	125
T_W	250	325	375
T_{DS}	200	250	300
T_{DH}	50	50	100
T_{AH}	50	50	100

Access time = 450 ns

TIMING CHARACTERISTICS



Note 1: "Off Axis Viewing Angle" is here defined as: "the minimum angle in any direction from the normal to the display surface at which any part of any segment in the display is not visible".

Note 2: This display contains a CMOS integrated circuit. Normal CMOS handling precautions should be taken to avoid damage due to high static voltages or electric fields.

Note 3: Unused inputs must be tied to an appropriate logic voltage level (either V+ or V-).

Note 4: $Vcc \geqslant V_{IH} \geqslant 0.6$ Vcc.

Note 5: **Warning** – Do not use solvents containing alcohol.

Note 6: V_{cc} = +5.0 VDC ±10%

Note 7: Access time is defined as $T_{AS} + T_{DH}$ (sum of address set up and data hold times).

CHARACTER SET

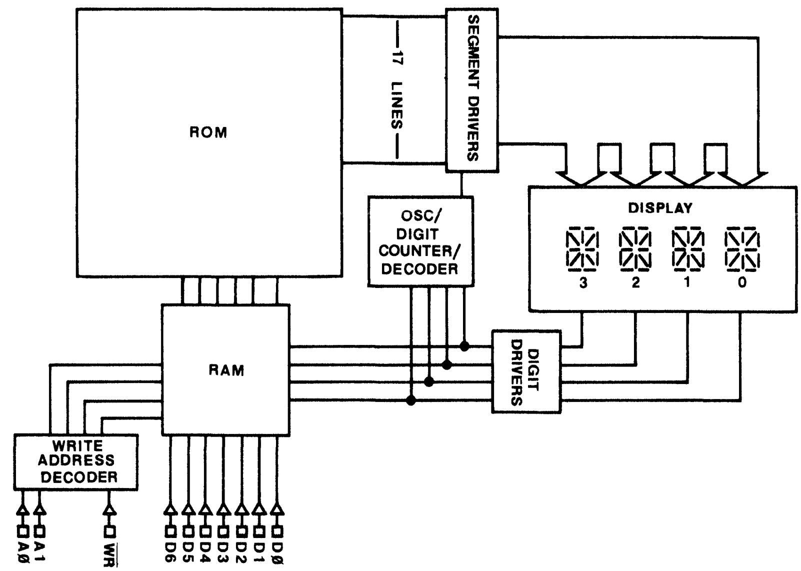
D6 D5 D4 D3 \ D0 D1 D2	D0: L, D1: L, D2: L	D0: H, D1: L, D2: L	D0: L, D1: H, D2: L	D0: H, D1: H, D2: L	D0: L, D1: L, D2: H	D0: H, D1: L, D2: H	D0: L, D1: H, D2: H	D0: H, D1: H, D2: H
L H L L		!	"	#	$	%	&	'
L H L H	(	)	*	+	,	-	.	/
L H H L	0	1	2	3	4	5	6	7
L H H H	8	9	:	;	<	=	>	?
H L L L	@	A	B	C	D	E	F	G
H L L H	H	I	J	K	L	M	N	O
H L H L	P	Q	R	S	T	U	V	W
H L H H	X	Y	Z	[	\	]	^	_

All Other Input Codes Display "Blank"

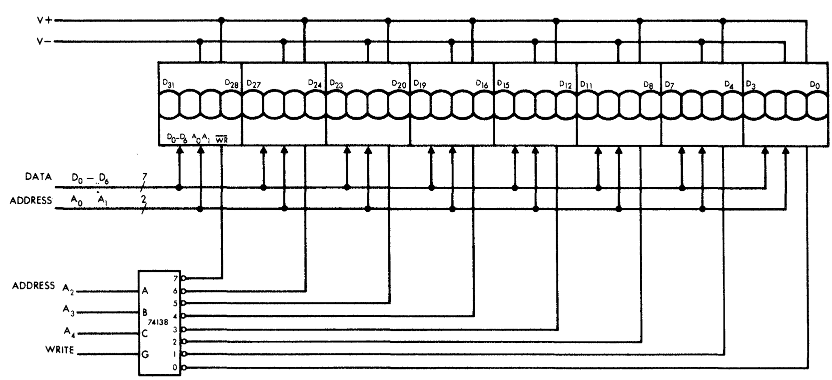
LOADING DATA STATE TABLE

$\overline{WR}$	A1	A0	D6	D5	D4	D3	D2	D1	D0	DIGIT 3	2	1	0
H		PREVIOUSLY LOADED DISPLAY								G	R	E	Y
L	L	L	H	L	L	L	H	L	H	G	R	E	E
L	L	H	H	L	H	L	H	L	H	G	R	U	E
L	H	L	H	L	L	H	H	L	L	G	L	U	E
L	H	H	H	L	L	L	L	H	L	B	L	U	E
L	L	H	H	L	L	L	H	L	H	B	L	E	E
L	L	L	H	L	H	L	H	H	H	B	L	E	W
L	X	X	SEE CHARACTER CODE							SEE CHARACTER SET			

X = DON'T CARE



DL-1414 Block Diagram

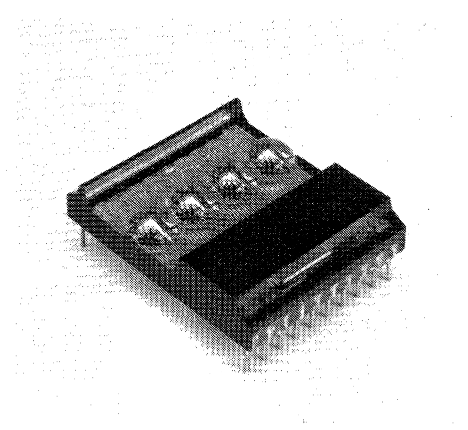


TYPICAL INTERCONNECTION
FOR 32 DIGITS

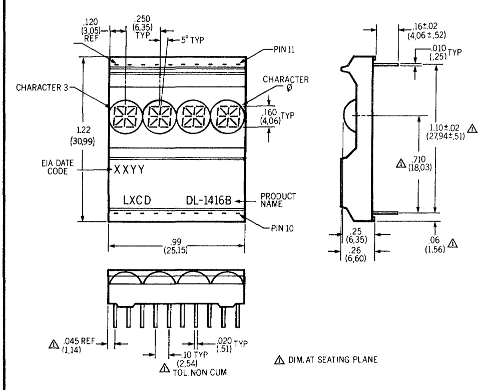
SIEMENS

DL-1416B

.160" RED, 4-DIGIT 16-SEGMENT PLUS DECIMAL ALPHANUMERIC Intelligent Display® WITH MEMORY/DECODER/DRIVER



Package Dimensions in Inches (mm)



FEATURES

- **160 Mil High, Magnified Monolithic Character**
- **17th Segment (Decimal Point) For Improved Punctuation Marks**
- **Improved Viewing Angle, ± 30°**
- **Rugged, Solid Plastic Encapsulated Package**
- **Top Lens Rail For Display Protection**
- **Fast Access Time 500 nS**
- **Full Size Display For Stationary Equipment**
- **Built in Memory**
- **Built in Character Generator**
- **Built in Multiplex and LED Drive Circuitry**
- **Direct Access to Each Digit Independently and Asynchronously**
- **TTL Compatible, 5 Volt Power**
- **Independent Cursor Function**
- **End Stackable, 4 Character Package**
- **Intensity Coded for Display Uniformity**

Important: Refer to Appnote 18, "Using and Handling Intelligent Displays". Since this is a CMOS device, normal precautions should be taken to avoid static damage.

DESCRIPTION

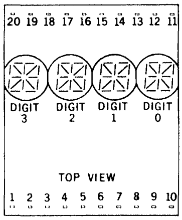
The DL 1416B is a four digit display module having 16 segments plus decimal and a built in CMOS integrated circuit.

The integrated circuit contains memory, ASCII ROM decoder, multiplexing circuitry, and drivers. Data entry is asychronous and can be random. A display system can be built using any number of DL 1416B's since each digit of each DL 1416B can be addressed independently. Each digit will continue to display the character last "written" until replaced by another.

System interconnection is very straightforward. The least significant two address bits (A_0, A_1) are connected to the like inputs of all DL 1416B's in a system. In small systems having 16 digits (four DL-1416B's), the enable ($\overline{CE}$) inputs of the four devices could simply be used directly to select each DL 1416B. In larger display systems, the $\overline{CE}$ inputs would come from a 1 of N decoder integrated circuit. In this case, address lines $A_2 \ldots A_n$ would go to the decoder inputs. Data lines (D_0-D_6) would be connected to all DL 1416B's directly and in parallel. The cursor ($\overline{CU}$) and write ($\overline{WR}$) lines would also be connected directly and in parallel. The display will then behave as a "write only memory".

The cursor function causes all segments of a digit position to illuminate. The cursor is NOT a character, however, and upon removal, the previously displayed character will reappear.

Specifications subject to change without notice.



Pin		Function	Pin		Function
1	D5	Data Input	11	A1	Digit Select
2	D4	Data Input	12	Unused	
3	DØ	Data Input	13	Unused	
4	D1	Data Input	14	Unused	
5	D2	Data Input	15	Unused	
6	D3	Data Input	16	Unused	
7	$\overline{CE}$	Chip Enable	17	Unused	
8	$\overline{W}$	Write	18	V+	
9	$\overline{CU}$	Cursor Input	19	V−	
10	AØ	Digit Select	20	D6	Data Input

OPTO-ELECTRONIC CHARACTERISTICS @ 25°C

MAXIMUM RATINGS	
Voltage, Any Pin Respect to GND	−.5 to 6.0 VDC
Operating Temperature	−20° to 65°C
Storage Temperature	−20° to 70°C
Relative Humidity (non condensing) @65°C	85%

OPTICAL CHARACTERISTICS (TYPICAL)	
Luminous Intensity per digit/8 segments	0.75 mcd
Off Axis Viewing Angle (Note 1)	±30°
Digit Size	160 mils
Spectral Peak Wavelength	660 nm

DC CHARACTERISTICS @ 25°C [4]

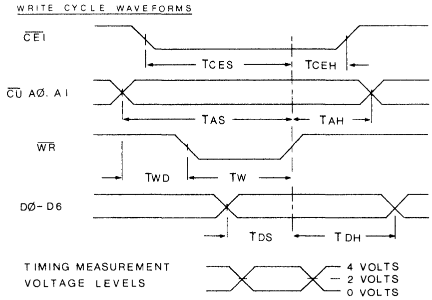
Parameter	Conditions	Min.	Typ.	Max.	Units
I_{CC} Blank	V_{CC} = 5V WR = V_{CC} VIN = 0V		.5	1.0	mA
I_{CC} (10 segs/ Char. 4 digits) [1]	V_{CC} = 5V		80	125	mA
I_{CC} (All seg on Cursor in 4 digits) [2]	V_{CC} = 5V 5 sec. max.		110		mA
VIL (All inputs) [3]	V_{CC} = 5V			.8	V
V_{IH} (All inputs) [3]	V_{CC} = 4.5V	2.7			V
IIL (All inputs) [3]	VIN = .8V			400	uA

[1] Measured at 5 seconds.
[2] 60 sec. max. duration.
[3] $V_{CC} \geq V_{IH} \geq 0.6\,V_{CC}$
[4] V_{CC} = +5.0 VDC ±10%

AC CHARACTERISTICS @ 25°C
MINIMUM TIMING PARAMETERS @ 4.5 V (nanoseconds)

T_{AS}	450
T_{WD}	150
T_{W}	300
T_{DS}	250
T_{DH}	50
T_{AH}	50
T_{CEH}	50
T_{CES}	450

TIMING CHARACTERISTICS



Note 1: This display contains a CMOS integrated circuit. Normal CMOS handling precautions should be taken to avoid damage due to high static voltages or electric fields.
Note 2: Unused inputs must be tied to an appropriate logic voltage level (**either** V+ or V−).
Note 3: **Warning** — Do not use solvents containing alcohol.

LOADING DATA

The chip enable ($\overline{CE}$) held low and cursor ($\overline{CU}$) held high will enable data loading. The desired data code (D_0-D_6) and selected digit address (A_0-A_1) should be held stable while write ($\overline{W}$) is low for storing new data. The timing parameters in the AC characteristics table are minimum and should be observed. There are no maximum timing requirements. Data entry may be asynchronous and in random order. All undefined data codes (see character set) loaded as data will display a blank.

Digit 0 is defined as the right hand digit with $A_1 = A_0 = 0$ =(low).

LOADING CURSOR

The chip enable ($\overline{CE}$) and Cursor ($\overline{CU}$) are held low. A write ($\overline{W}$) signal will now load a cursor into any digit position addressed by (A_0 - A_1); as defined in data entry. A cursor will be stored if D0 = H and removed if D0 = L. The ($\overline{CU}$) pulse width should not be less than write ($\overline{WR}$) pulse or erroneous data may appear in the display.

The cursor display will be over ridden by a blank from an undefined code in that digit position.

TYPICAL LOADING DATA STATE TABLE

			ADDRESS		DATA INPUT										
$\overline{CE}$	$\overline{CU}$	$\overline{W}$	A_1	A_0	D6	D5	D4	D3	D2	D1	D0	DIGIT 3	DIGIT 2	DIGIT 1	DIGIT 0
H	X	X	X	X	X	X	X	X	X	X	X	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE
L	H	L	L	L	H	L	L	L	L	L	H	NO CHANGE	NO CHANGE	NO CHANGE	A
L	H	L	L	H	H	L	L	L	L	H	L	NO CHANGE	NO CHANGE	B	A
L	H	L	H	L	H	L	L	L	L	H	H	NO CHANGE	C	B	A
L	H	L	H	H	H	L	L	L	H	L	L	D	C	B	A
L	H	L	L	L	H	L	L	L	H	L	H	D	C	B	E
L	H	L	H	L	H	L	L	H	L	H	H	D	K	B	E
L	H	L	–	–	–	–	–	–	–	–	–	SEE CHARACTER SET			

X = DON'T CARE

TYPICAL LOADING CURSOR STATE TABLE

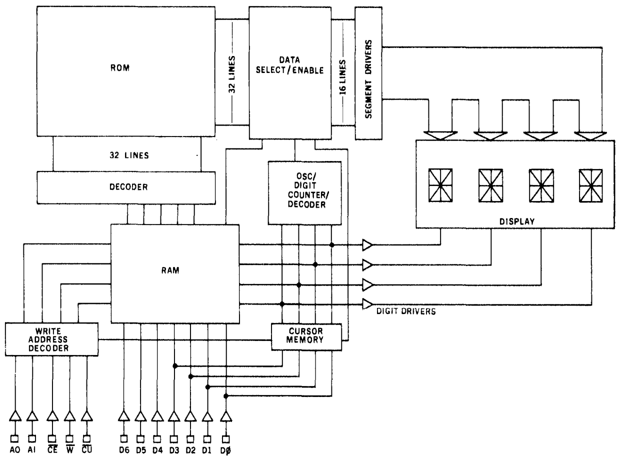
CONTROL			ADDRESS		DATA							DISPLAY DIGIT			
$\overline{CE}$	$\overline{CU}$	$\overline{WR}$	A1	A0	D6	D5	D4	D3	D2	D1	D0	3	2	1	0
X	X	H	PREVIOUSLY LOADED DISPLAY									B	E	A	R
X	X	H	DISPLAY PREVIOUSLY STORED CURSORS									B	E	A	R
L	L	L	L	L	X	X	X	X	X	X	H	B	E	A	▩
L	L	L	L	H	X	X	X	X	X	X	H	B	E	▩	▩
L	L	L	H	L	X	X	X	X	X	X	H	B	▩	▩	▩
L	L	L	H	H	X	X	X	X	X	X	H	▩	▩	▩	▩
L	L	L	H	L	X	X	X	X	X	X	L	▩	E	▩	▩
X	X	H	DISABLE CURSOR DISPLAY									B	E	A	R
L	L	L	H	H	X	X	X	X	X	X	L	B	E	A	R
X	X	H	DISPLAY STORED CURSOR									B	E	▩	▩

X = DON'T CARE

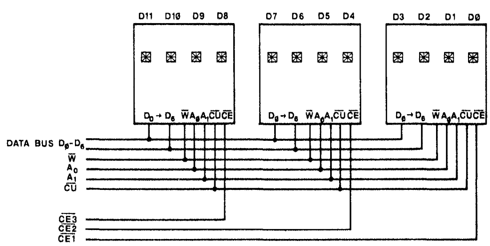
CHARACTER SET

D6 D5 D4 D3 \ D0 D1 D2	L L L	H L L	L H L	H H L	L L H	H L H	L H H	H H H
L H L L		!	"	#	$	%	&	'
L H L H	(	)	*	+	,	-	.	/
L H H L	0	1	2	3	4	5	6	7
L H H H	8	9	:	;	<	=	>	?
H L L L	@	A	B	C	D	E	F	G
H L L H	H	I	J	K	L	M	N	O
H L H L	P	Q	R	S	T	U	V	W
H L H H	X	Y	Z	[	\	]	^	_

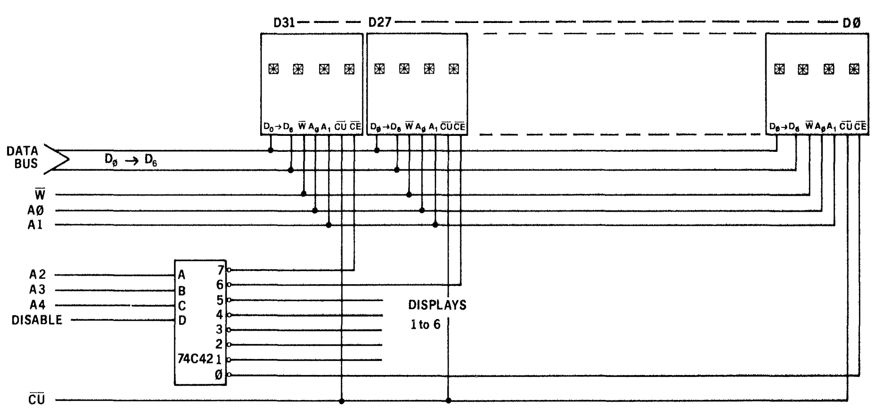
NOTE: All undefined data codes that are loaded or occur on power-up will cause a blank display state.



INTERNAL SCHEMATIC



Typical interconnect
for small systems. 12digits

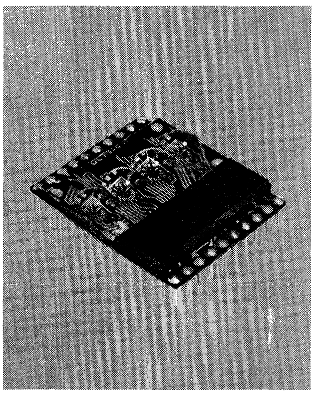


Typical schematic
for 32 digit systems

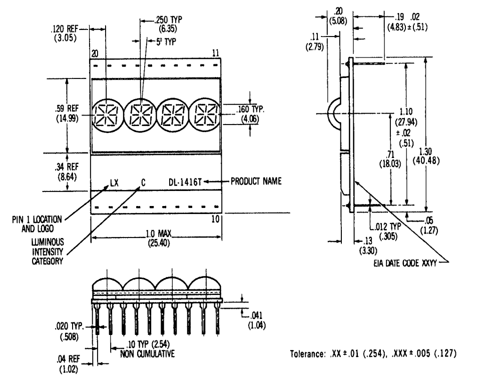
SIEMENS

DL-1416T

.160″ RED, 4-DIGIT 16-SEGMENT ALPHANUMERIC Intelligent Display® WITH MEMORY/DECODER/DRIVER



Package Dimensions in Inches (mm)



FEATURES

- **End-stackable, 4-Character Package**
- **High Contrast, 160 mil High, Magnified Monolithic Characters**
- **Viewing Angle ± 20°**
- **64-Character ASCII Format**
- **Built-in Memory, Decoder, Multiplexer and Drivers**
- **Direct Access to Each Digit Independently and Asynchronously**
- **5 Volt Logic, TTL Compatible**
- **5 Volt Power Supply Only**
- **Independent Cursor Function**
- **Intensity Coded For Display Uniformity**

DESCRIPTION

The DL-1416 Intelligent Display is a four-digit LED display module having a 16-segment font and an on-board CMOS integrated circuit driver.

The CMOS chip includes memory for four digits and cursor, 64 ASCII character generator ROM, and segment/digit drivers with associated multiplexing circuitry. Inputs are TTL compatible as is the power supply requirement. Data entry is asynchronous and random access. A display system can be built using any number of DL-1416s since each digit of each DL-1416 can be addressed independently. Each digit will continue to display the character last "written" until replaced by another.

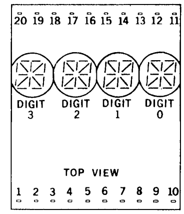
A cursor is defined as all segments of a digit position to be lit. The cursor is *not* a character, however, and upon removal leaves the previously displayed character unchanged. Normally, the cursor would be loaded and unloaded (flash) under software control. This can be used as a pointer in a line of DL-1416 displays or a "lamp test" function is realized by simply storing a cursor in all four digit positions of a display.

System interconnection is very straight forward. The least significant two address bits (A_0, A_1) are connected to the like inputs of all DL-1416s in a system. In small systems having 16 digits (4-DL-1416s), the enable ($\overline{CE}$) inputs of the four devices could simply be used directly to select each DL-1416. In larger displays, the $\overline{CE}$ inputs would come from A 1-of-N decoder integrated circuit. In this case, address lines A_2 . . . A_n would go to the decoder inputs. Data lines (D_0-D_6) would be connected to all DL-1416s directly and in parallel. The cursor ($\overline{CU}$) and write ($\overline{W}$) lines would also be connected directly directly and in parallel. The display will then behave as a "write-only memory."

Important: Refer to Appnote 18, "Using and Handling Intelligent Displays". Since this is a CMOS device, normal precautions should be taken to avoid static damage.

Specifications are subject to change without notice.

Pin		Function	Pin		Function
1	D5	Data Input	11	A1	Digit Select
2	D4	Data Input	12	Unused	
3	DØ	Data Input	13	Unused	
4	D1	Data Input	14	Unused	
5	D2	Data Input	15	Unused	
6	D3	Data Input	16	Unused	
7	$\overline{CE}$	Chip Enable	17	Unused	
8	$\overline{W}$	Write	18	V+	
9	$\overline{CU}$	Cursor Input	19	V−	
10	AØ	Digit Select	20	D6	Data Input



OPTO-ELECTRONIC CHARACTERISTICS @ 25°C

MAXIMUM RATINGS.

Voltage, Any Pin
Respect to GND (V-) . . −0.5 to Vcc +0.5 VDC
Operating Temperature . . . . −20 to +65°C
Storage Temperautre . . . . −20 to +70°C
Relative Humidity
(non condensing) @ 65°C 85%

OPTICAL CHARACTERISTICS (TYPICAL)

Luminous Intensity per digit/8 segments @ 5V, 0.5 mcd
Viewing Angle . . . . ±20°
Digit Size . . . . 160 mils
Spectral Peak Wavelength . . . . 660 nm

DC CHARACTERISTICS

Parameter	−20°C Typ	+25°C[4]	+65°C Typ	Conditions
I_{CC} 4 digits on (10 seg/digit)		75 mA max[1]		V_{CC} = 5.0 V
I_{CC} Cursor[2]		100 mA max[1]		V_{CC} = 5.0 V
I_{CC} Blank	5.0 mA	5 mA max	2.0 mA	V_{IN} = 0 V_{CC} = 5.0 V $\overline{WR}$ = 5.0 V
I_{IL}	20 μA	160 μA max	10 μA	V_{IN} = .8 V V_{CC} = 5.0 V
V_{IL}		.8 V Max		V_{CC} = 4.5 V
V_{IH}[3]		2.7 V Min		V_{CC} = 4.5 V
		3.3 V Min		V_{CC} = 5.5 V

[1] Measured at 5 seconds.
[2] 60 sec. max. duration.
[3] $V_{CC} \geqslant V_{IH} \geqslant 0.6\ V_{CC}$
[4] V_{cc} = +5.0 VDC ±10%

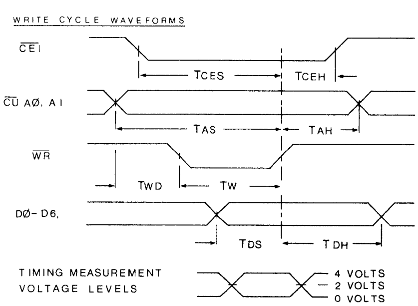
AC CHARACTERISTICS @ 25°C

MINIMUM TIMING PARAMETERS @ 4.5 V (nanoseconds)

Parameter	ns
T_{AS}	1000
T_{WD}	500
T_{W}	500
T_{DS}	1000
T_{DH}	400
T_{AH}	400
T_{CEH}	400
T_{CES}	1000

Access time = 1400 ns

TIMING CHARACTERISTICS



Note 1: This display contains a CMOS integrated circuit. Normal CMOS handling precautions should be taken to avoid damage due to high static voltages or electric fields.
Note 2: Unused inputs must be tied to an appropriate logic voltage level (either V+ or V−).
Note 3: **Warning** — Do not use solvents containing alcohol.
Note 4: Access time is defined as $T_{AS} + T_{DH}$ (sum of address set up and data hold times).

LOADING DATA

The chip enable ($\overline{CE}$) held low and cursor ($\overline{CU}$) held high will enable data loading. The desired data code (D_0-D_6) and selected digit address (A_0-A_1) should be held stable while write ($\overline{W}$) is low for storing new data. The timing parameters in the AC characteristics table are minimum and should be observed. There are no maximum timing requirements. Data entry may be asynchronous and in random order. All undefined data codes (see character set) loaded as data will display a blank.

Digit 0 is defined as the right hand digit with $A_1 = A_0 = 0 =$ low.

LOADING CURSOR

The chip enable ($\overline{CE}$) and Cursor ($\overline{CU}$) are held low. A write (W) signal will now load a cursor into any digit position for which the respective first four data lines (D_0, D_1, D_2, D_3) individually or together are held high. If previously stored, the cursors can only be removed if their respective data lines are held low while $\overline{CE}$, $\overline{CU}$ are low and write ($\overline{W}$) occurs.

The cursor ($\overline{CU}$) should *not* be hardwired high (off). During the power-up of DL-1416s the cursor memory will be in a random state. Therefore, it is recommended for the processor-based system to initialize or write out possible cursors during the system initializing portion of the software.

The cursor display will be over ridden by a blank from an undefined code in that digit position.

TYPICAL LOADING DATA STATE TABLE

$\overline{CE}$	$\overline{CU}$	$\overline{W}$	ADDRESS A_1	ADDRESS A_0	DATA INPUT D6	D5	D4	D3	D2	D1	D0	DIGIT 3	DIGIT 2	DIGIT 1	DIGIT 0
H	X	X	X	X	X	X	X	X	X	X	X	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE
L	H	L	L	L	H	L	L	L	L	L	H	NO CHANGE	NO CHANGE	NO CHANGE	A
L	H	L	L	H	H	L	L	L	L	H	L	NO CHANGE	NO CHANGE	B	A
L	H	L	H	L	H	L	L	L	L	H	H	NO CHANGE	C	B	A
L	H	L	H	H	H	L	L	L	H	L	L	D	C	B	A
L	H	L	L	L	H	L	L	L	H	L	H	D	C	B	E
L	H	L	H	L	H	L	L	H	L	H	H	D	K	B	E
L	H	L	–	–	–	–	–	–	–	–	–	SEE CHARACTER SET			

X = DON'T CARE

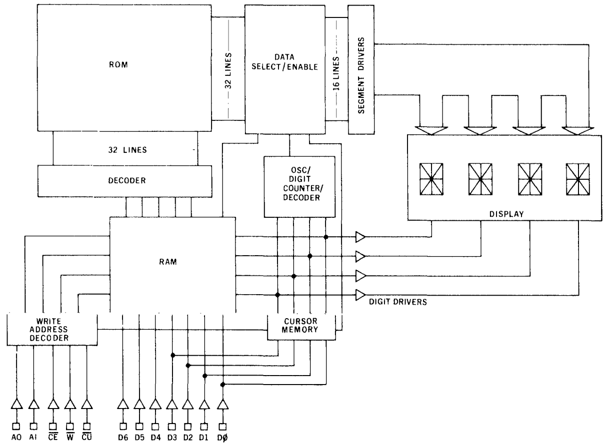
TYPICAL LOADING CURSOR STATE TABLE

$\overline{CE}$	$\overline{CU}$	$\overline{W}$	ADDRESS A_1	ADDRESS A_0	DATA INPUT D6	D5	D4	D3	D2	D1	D0	DIGIT 3	DIGIT 2	DIGIT 1	DIGIT 0
H	X	X	X	X	X	X	X	X	X	X	X	D	K	B	E
L	L	L	X	X	X	X	X	L	L	L	H	D	K	B	▩
L	L	L	X	X	X	X	X	L	L	L	L	D	K	B	E
L	L	L	X	X	X	X	X	L	L	H	L	D	K	▩	E
L	L	L	X	X	X	X	X	L	H	L	L	D	▩	B	E
L	L	L	X	X	X	X	X	H	L	L	L	▩	K	B	E
L	L	L	X	X	X	X	X	H	H	H	H	▩	▩	▩	▩
L	L	L	X	X	X	X	X	L	L	L	L	D	K	B	E

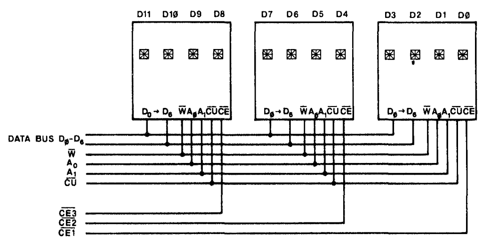
X = DON'T CARE

CHARACTER SET

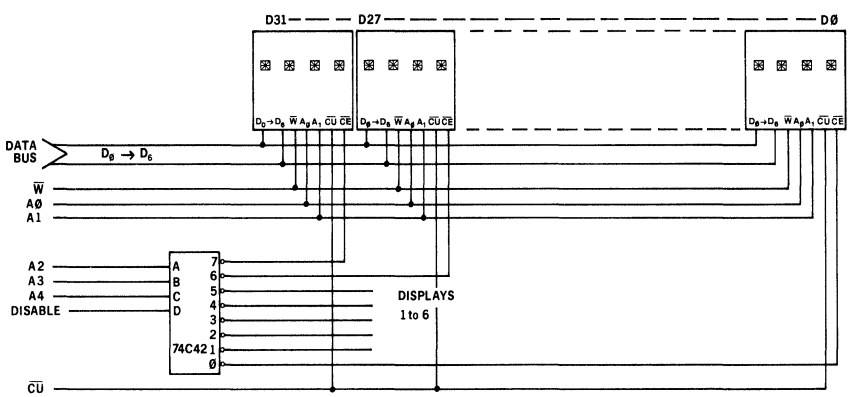
NOTE: All undefined data codes that are loaded or occur on power-up will cause a blank display state.



INTERNAL SCHEMATIC



Typical interconnect for small systems. 12digits

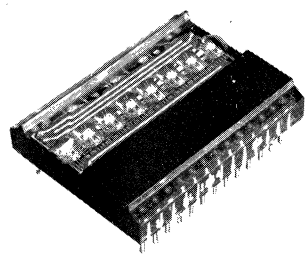


Typical schematic for 32 digit systems

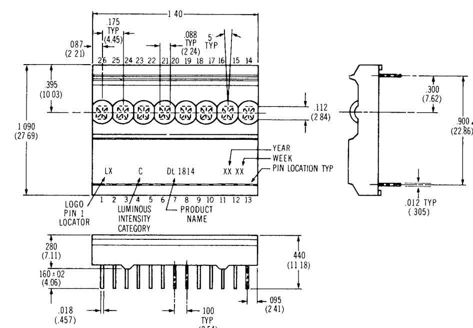
SIEMENS

DL-1814

.112" RED, 8 DIGIT 17-SEGMENT ALPHA NUMERIC Intelligent Display® WITH MEMORY/DECODER/DRIVER



Package Dimensions in Inches (mm)



FEATURES

- 112 Mil High, Magnified Monolithic Character
- Rugged Solid Plastic Encapsulated Package.
- Wide Viewing Angle ± 33°
- Compact Size for Hand Held Equipment
- Fast Access Time, 500 ns.
- Fully Integrated CMOS Drive Electronics
- Direct Access to Each Digit Independently & Asynchronously
- TTL Compatible, 5 Volt Power
- 17th Segment for Improved Punctuation Marks
- Low Power Consumption, Typically 10 mA per Character.
- Display Blank Function
- End-Stackable, Eight Character Package
- Intensity Coded for Display Uniformity

DESCRIPTION

The DL-1814 is an 8 Digit module having 16 bar segments plus a decimal segment and a built-in CMOS integrated circuit.

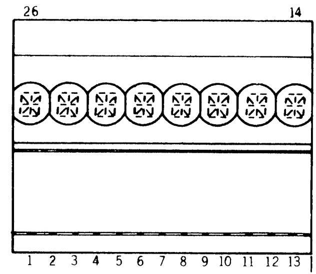
The integrated circuit contains memory, ASCII character generator, and LED multiplexing and drive circuitry. Inputs are TTL compatible. A single 5-volt power supply is required. Data entry is asynchronous and random access. A display system can be built using any number of DL1814's since each character in any DL1814 can be addressed independently and will continue to display the character last written until it is replaced by another.

Important: Refer to Appnote 18, "Using and Handling Intelligent Displays". Since this is a CMOS device, normal precautions should be taken to avoid static damage.

Specifications are subject to change without notice.

Pin	Function		Pin	Function
1	D0	Data input	14	$\overline{BL}$ (Blank)
2	D1	Data input	15	NO PIN
3	D2	Data input	16	NO PIN
4	D3	Data input	17	NO PIN
5	D4	Data input	18	NO PIN
6	D5	Data input	19	NO PIN
7	D6	Data input	20	NO PIN
8	GND		21	NO PIN
9	A0	Address	22	NO PIN
10	A1	Address	23	NO PIN
11	A2	Address	24	NO PIN
12	$\overline{WR}$	Write	25	NO PIN
13	VCC		26	$\overline{CE}$ (Chip Enable)

TOP VIEW



OPTOELECTRONIC CHARACTERISTICS @25° C

MAXIMUM RATINGS:

Voltage, Any Pin
Respect to GND................ –.5 to +6VDC
Operating Temperature .... –20°C to 65°C
Storage Temperature............ –20°C to 70°C
Relative Humidity
(non-condensing).............@65°C, 85%

OPTICAL CHARACTERISTICS (TYPICAL)

Luminous Intensity per digit/8 segments @ 5V 5 mcd
Viewing angle (note 1) .... ±33°
Digit Size .... 122"
Spectral peak wavelength (typ) .... 660 nm

DC CHARACTERISTICS

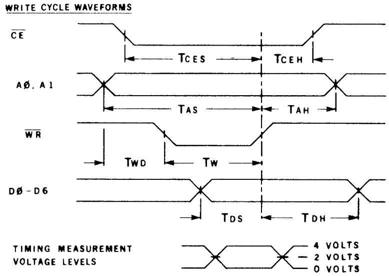
PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNITS
I_{CC} (Blank)	V_{CC} = 5V, $\overline{VIN}$ = 0V, $\overline{WR}$ = V_{CC}		2.0	3.7	mA
I_{CC} (10 seg 8 digits on)	V_{CC} = 5V		80	120	mA
I_{IL} (All inputs)	V_{CC} = 5V			160	uA
V_{IL} (All inputs)	V_{CC} = .5V			1.0	V
V_{IH} (note4) (All inputs)	V_{CC} = 5V	3.0			V

AC CHARACTERISTICS
MINIMUM TIMING PARAMETERS @ 4.5 V

Parameter	Min @ +25°C	Units
T_{WD}	150	ns
T_{CES}	450	ns
T_{DS}	250	ns
T_W	300	ns
T_{DH}	50	ns
T_{AS}	450	ns
T_{CEH}	50	ns
T_{AH}	50	ns
Access time = 500 ns		

TIMING CHARACTERISTICS

WRITE CYCLE WAVEFORMS



Note 1: "Off Axis Viewing Angle" is here defined as: "the minimum angle in any direction from the normal to the display surface at which any part of any segment in the display is not visible."

Note 2: This display contains a CMOS integrated circuit. Normal CMOS handling precautions should be taken to avoid damage due to high static voltages or electric fields. SEE APPNOTE 18.

Note 3: Unused inputs must be tied to an appropriate logic voltage level (either V+ or V–).

Note 4: $Vcc \geq V_{IH} \geq 0.6$ Vcc.

Note 5: **Warning** - Do not use solvents containing alcohol.

Note 6: $V_{CC} = \pm 5.0$ VDC ±10%

Note 7: Access time is defined as $T_{AS} + T_{DH}$ (sum of address set up and data hold times.

LOADING DATA

Loading data into the DL1814 is straightforward. The desired data and chip enable should be present and stable during a write pulse. No synchronization is necessary, and each character will continue to be displayed until it is replaced with another. Multiple displays will require an external decoder IC connected to the chip enable input.

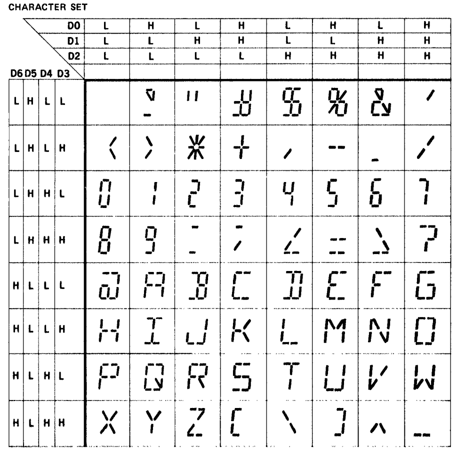
Setting the chip enables $\overline{CE}$ to its true state will enable data loading. The desired data code (D0-D6) and digit address (A_0,A_1,A_2) must be held stable during the write cycle for storing new data. Data entry may be asynchronous and random. (Digit 0 is defined as right hand digit with ($A_2 = A_1 = A_0 = 0$.)

BLANKING THE DISPLAY

Blanking the display may be accomplished by loading a blank or space into each digit of the display or by using the ($\overline{BL}$) display blank input.

Setting the ($\overline{BL}$) input low does not affect the contents of either data. A flashing display can be realized by pulsing ($\overline{BL}$).

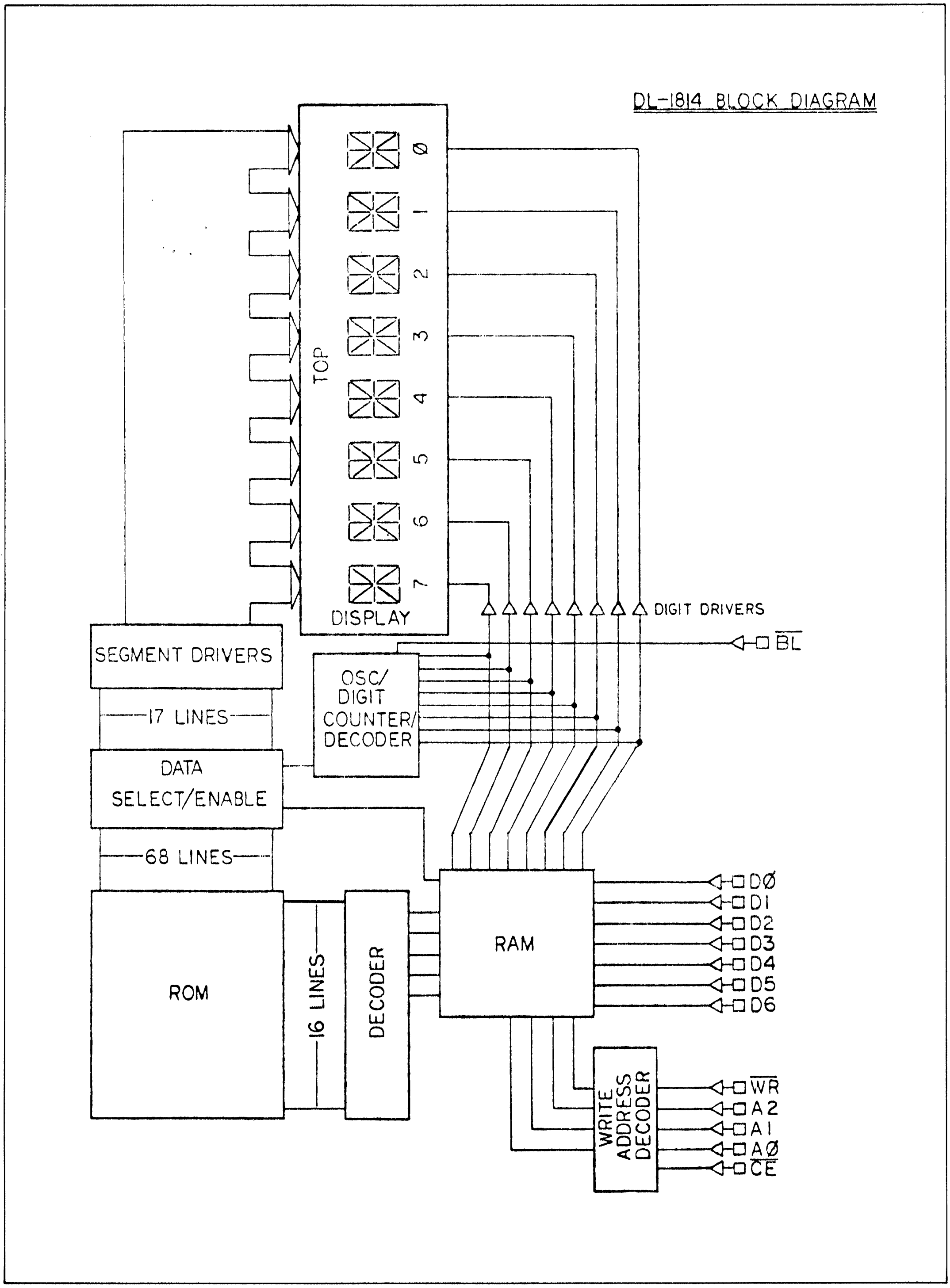
CHARACTER SET



All Other Input Codes Display "Blank"

TYPICAL LOADING DATA STATE TABLE

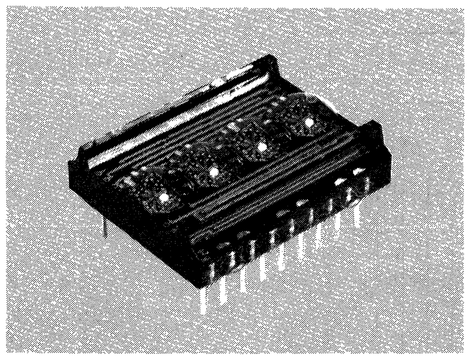
$\overline{BL}$	$\overline{CE}$	$\overline{WR}$	A2	A1	A0	D6	D5	D4	D3	D2	D1	D0	DIGIT 7	6	5	4	3	2	1	0
H	X	H	X	X	X	PREVIOUSLY LOADED DISPLAY							L	I	T	R	O	N	I	X
H	H	X	X	X	X	X	X	X	X	X	X	X	L	I	T	R	O	N	I	X
H	L	L	L	L	L	H	L	L	L	H	L	H	L	I	T	R	O	N	I	E
H	L	L	L	L	H	H	L	H	L	H	L	H	L	I	T	R	O	N	U	E
H	L	L	L	H	L	H	L	L	H	H	L	L	L	I	T	R	O	L	U	E
H	L	L	L	H	H	H	L	L	L	L	H	L	L	I	T	R	B	L	U	E
H	L	L	H	L	L	H	L	L	L	H	L	H	L	I	T	E	B	L	U	E
H	L	L	H	L	H	H	L	H	L	H	L	H	L	I	U	E	B	L	U	E
H	L	L	H	H	L	H	L	L	H	H	L	L	L	L	U	E	B	L	U	E
H	L	L	H	H	H	H	L	L	L	L	H	L	B	L	U	E	B	L	U	E
L	X	H	X	X	X	BLANK DISPLAY														
H	L	L	L	H	H	H	L	L	L	H	H	H	B	L	U	E	G	L	U	E
H	L	L	X	X	X	SEE CHARACTER CODE							SEE CHARACTER SET							


DL-1814 BLOCK DIAGRAM
Ø
1
2
3
4
5
6
7
TOP
DISPLAY
DIGIT DRIVERS
BL
SEGMENT DRIVERS
17 LINES
OSC/
DIGIT
COUNTER/
DECODER
DATA
SELECT/ENABLE
68 LINES
ROM
16 LINES
DECODER
RAM
DØ
D1
D2
D3
D4
D5
D6
WRITE
ADDRESS
DECODER
WR
A2
A1
AØ
CE

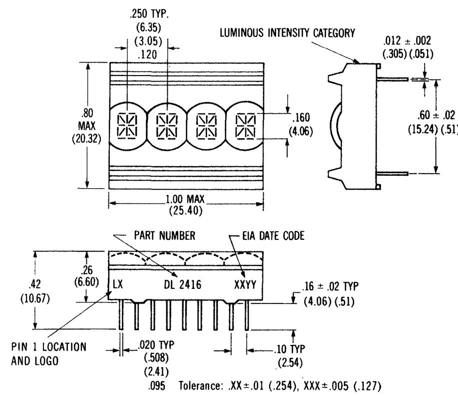
SIEMENS

DL-2416T, DL-2416 H

.160″ RED, 4-DIGIT 16-SEGMENT PLUS DECIMAL ALPHANUMERIC Intelligent Display® WITH MEMORY/DECODER/DRIVER



Package Dimensions in Inches (mm)



FEATURES

- **160 Mil High, Magnified Monolithic Char.**
- **Wide Viewing Angle ± 40°**
- **Close Vertical Row Spacing, .800 Inches**
- **Rugged Solid Plastic Encapsulated Package**
- **Fast Access Time**
  DL-2416 500 nSEC
  DL-2416H 300 nSEC
- **Full Size Display for Stationary Equipment**
- **Built-in Memory**
- **Built-in Character Generator**
- **Built-in Multiplex and LED Drive Circuitry**
- **Direct Access to Each Digit Independently & Asynchronously**
- **TTL Compatible, 5 Volt Power**
- **Independent Cursor Function**
- **17th Segment for Improved Punctuation Marks**
- **Memory Clear Function**
- **Display Blank Function**
- **End-Stackable, 4-Character Package**
- **Intensity Coded for Display Uniformity**

DESCRIPTION

The DL 2416 is a four digit display module having 16 segments plus decimal and a built-in CMOS integrated circuit.

The integrated circuit contains memory, ASCII ROM decoder, multiplexing circuitry, and drivers. Data entry is asychronous and can be random. A display system can be built using any number of DL 2416's since each digit of any DL 2416 can be addressed independently and will continue to display the character last stored until replaced by another.
System interconnection is very straightforward. The least significant two address bits (A_0, A_1) are normally connected to the like named inputs of all DL 2416's in the system. With two chip enables ($\overline{CE1}$, and $\overline{CE2}$) two DL 2416's (16 characters) can easily be interconnected without a decoder.

Alternatively, one-of-n decoder IC's can be used to extend the address for large displays.

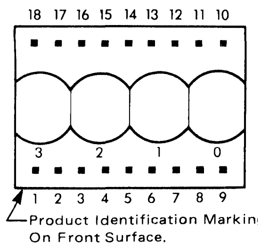
Data lines are connected to all DL 2416's directly and in parallel, as is the write line ($\overline{WR}$). The display will then behave as a write-only memory.

The cursor function causes all segments of a digit position to illuminate. The cursor is *not* a character, however, and upon removal the previously displayed character will reappear.

Important: Refer to Appnote 18, "Using and Handling Intelligent Displays". Since this is a CMOS device, normal precautions should be taken to avoid static damage.

Specifications are subject to change without notice.

TOP VIEW



Pin	Function	Pin	Function
1	$\overline{CE1}$ Chip Enable	10	Gnd
2	$\overline{CE2}$ Chip Enable	11	DØ Data Input
3	$\overline{CLR}$ Clear	12	D1 Data Input
4	CUE Cursor Enable	13	D2 Data Input
5	$\overline{CU}$ Cursor Select	14	D3 Data Input
6	$\overline{WR}$ Write	15	D6 Data Input
7	A1 Digit Select	16	D5 Data Input
8	AØ Digit Select	17	D4 Data Input
9	V_{CC}	18	$\overline{BL}$ Display Blank

OPTO-ELECTRONIC CHARACTERISTICS @ 25°C

MAXIMUM RATINGS

Voltage, Any Pin
Respect to GND . . . . –.5 to 6.0 VDC
Operating Temperature . . . . . . –20° to 65°C
Storage Temperature . . . . –20° to 70°C
Relative Humidity
(non condensing) @ 65°C 85%

OPTICAL CHARACTERISTICS (TYPICAL)

Luminous Intensity per digit/8 segments . . 0.5 mcd
Off Axis Viewing Angle (Note 1) . . . . ±50°
Digit Size . . . . 160 mils
Spectral Peak Wavelength . . . . 660 nm

DC CHARACTERISTICS
DL-2416 AND DL-2416 H

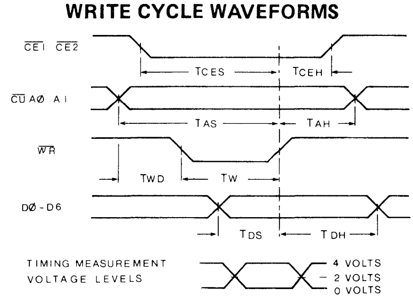
Parameter	–20°C Typ	+25°C⁴	+65°C Typ	Conditions
I_{CC} 4 digits on (10 seg/digit)	135 mA	125 mA max[1]	100 mA	V_{CC} = 5.0 V
I_{CC} Cursor[2]	160 mA	140 mA max[1]	120 mA	V_{CC} = 5.0 V
I_{CC} Blank		3.7 mA max		V_{IN} = 0 V_{CC} = 5.0 V $\overline{WR}$ = 5.0 V
I_{IL}	200 µA	160 µA max	100 µA	V_{IN} = .8 V V_{CC} = 5.0 V
V_{IL}		.8 V max		V_{CC} = 4.5 V
V_{IH}[3]		2.7 V min		V_{CC} = 4.5 V
		3.3 V min		V_{CC} = 5.5 V

1. Measured at 5 sec.
2. 60 sec max duration.
3. $V_{CC} \geqslant V_{IH} \geqslant 0.6\ V_{CC}$.
4. V_{cc} = +5.0 VDC ±10%

AC CHARACTERISTICS
Timing Parameters @ 4.5 V (nanoseconds)

Parameter	–20°C Typ		+25°C Min		+65°C Typ	
	DL-2416	DL-2416 H	DL-2416	DL-2416 H	DL-2416	DL-2416 H
T_{AS}	300	200	450	250	600	400
T_{WD}	50	50	150	50	175	75
T_{W}	250	150	300	200	475	325
T_{DS}	150	100	250	150	350	250
T_{DH}	50	50	50	50	100	100
T_{AH}	50	50	50	50	100	100
T_{CEH}	50	50	50	50	100	100
T_{CES}	300	150	450	250	600	400
T_{CLR}			15 milliseconds		16 milliseconds	
			access time			
			500 ns	300 ns		

TIMING CHARACTERISTICS
WRITE CYCLE WAVEFORMS



Note 1: "Off Axis Viewing Angle" is here defined as: "the minimum angle in any direction from the normal to the display surface at which any part of any segment in the display is not visible".

Note 2: This display contains a CMOS integrated circuit. Normal CMOS handling precautions should be taken to avoid damage due to high static voltages or electric fields.

Note 3: Unused inputs must be tied to an appropriate logic voltage level (either V+ or V–).

Note 4: **Warning** – Do not use solvents containing alcohol.

Note 5: **Access time is defined as $T_{AS} + T_{DH}$ (sum of address set up and data hold times.)**

LOADING DATA

Setting the chip enables ($\overline{CE1}$, $\overline{CE2}$) to their true state will enable data loading. The desired data code (D0-D6) and digit address (A_0, A_1) must be held stable during the write cycle for storing new data.

Data entry may be asynchronous and random. (Digit 0 is defined as right hand digit with $A_1 = A_0 = 0$.)

Clearing of the entire internal four-digit memory can be accomplished by holding the clear ($\overline{CLR}$) low for one complete display multiplex cycle, 15 mS minimum. Loading an illegal data code will display a blank. Clear ($\overline{CLR}$) is inactive during $\overline{BL}$.

LOADING CURSOR

Setting the chip enables ($\overline{CE1}$, $\overline{CE2}$) and cursor select ($\overline{CU}$) to their true state will enable cursor loading. A write ($\overline{WR}$) pulse will now store or remove a cursor into the digit location addressed by A_0, A_1; as defined in data entry. A cursor will be stored if D0 = 1; and will be removed if D0 = 0. Cursor will not be cleared by the CLR signal. The cursor ($\overline{CU}$) pulse width should not be less than the write ($\overline{WR}$) pulse or erroneous data may appear in the display.

For those users not requiring the cursor, the cursor enable signal (CUE) may be tied low to disable display of the cursor function. A flashing cursor can be realized by simply pulsing CUE. If cursor has been loaded to any or all positions in the display, then CUE will control whether the cursor(s) or the characters appear. CUE does not affect the contents of cursor memory.

DISPLAY BLANKING

Blanking the display may be accomplished by loading a blank or space into each digit of the display or by using the ($\overline{BL}$) display blank input.

Setting the ($\overline{BL}$) input low does not affect the contents of either data or cursor memory. A flashing display can be realized by pulsing ($\overline{BL}$).

TYPICAL LOADING DATA STATE TABLE

CONTROL							ADDRESS		DATA							DISPLAY DIGIT			
$\overline{BL}$	$\overline{CE1}$	$\overline{CE2}$	CUE	$\overline{CU}$	$\overline{WR}$	$\overline{CLR}$	A1	A0	D6	D5	D4	D3	D2	D1	D0	3	2	1	0
H	X	X	L	X	H	H	PREVIOUSLY LOADED DISPLAY									G	R	E	Y
H	H	X	L	X	X	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	X	H	L	X	X	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	L	L	L	H	L	H	L	L	H	L	L	L	H	L	H	G	R	E	E
H	L	L	L	H	L	H	L	H	H	L	H	L	H	L	H	G	R	U	E
H	L	L	L	H	L	H	H	L	H	L	L	H	H	L	L	G	L	U	E
H	L	L	L	H	L	H	H	H	H	L	L	L	L	H	L	B	L	U	E
L	X	X	X	X	H	H	X	X	BLANK DISPLAY										
H	L	L	L	H	L	H	H	H	H	L	L	L	H	H	H	G	L	U	E
H	X	X	L	X	H	L	X	X	CLEARS CHARACTER DISPLAYS										
H	L	L	L	H	L	H	X	X	SEE CHARACTER CODE							SEE CHARACTER SET			

X = DON'T CARE

LOADING CURSOR STATE TABLE

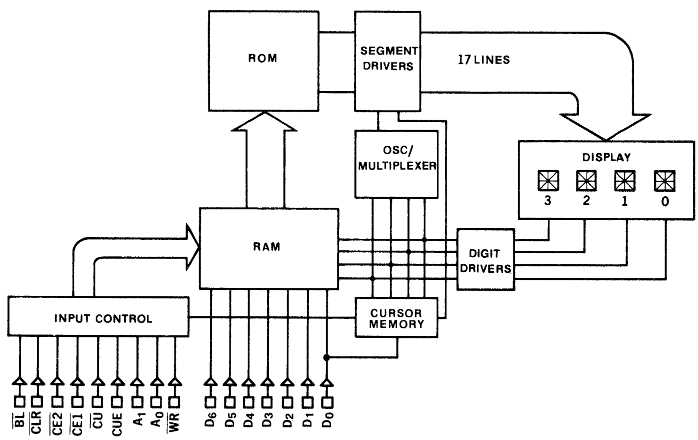
CONTROL							ADDRESS		DATA							DISPLAY DIGIT			
$\overline{BL}$	$\overline{CE1}$	$\overline{CE2}$	CUE	$\overline{CU}$	$\overline{WR}$	$\overline{CLR}$	A1	A0	D6	D5	D4	D3	D2	D1	D0	3	2	1	0
H	X	X	L	X	H	H	PREVIOUSLY LOADED DISPLAY									B	E	A	R
H	X	X	H	X	H	H	DISPLAY PREVIOUSLY STORED CURSORS									B	E	A	R
H	L	L	H	L	L	H	L	L	X	X	X	X	X	X	H	B	E	A	⊠
H	L	L	H	L	L	H	L	H	X	X	X	X	X	X	H	B	E	⊠	⊠
H	L	L	H	L	L	H	H	L	X	X	X	X	X	X	H	B	⊠	⊠	⊠
H	L	L	H	L	L	H	H	H	X	X	X	X	X	X	H	⊠	⊠	⊠	⊠
H	L	L	H	L	L	H	H	L	X	X	X	X	X	X	L	⊠	E	⊠	⊠
H	X	X	L	X	H	H	DISABLE CURSOR DISPLAY									B	E	A	R
H	L	L	L	L	L	H	H	H	X	X	X	X	X	X	L	B	E	A	R
H	X	X	H	X	H	H	DISPLAY STORED CURSOR									B	E	⊠	⊠

X = DON'T CARE

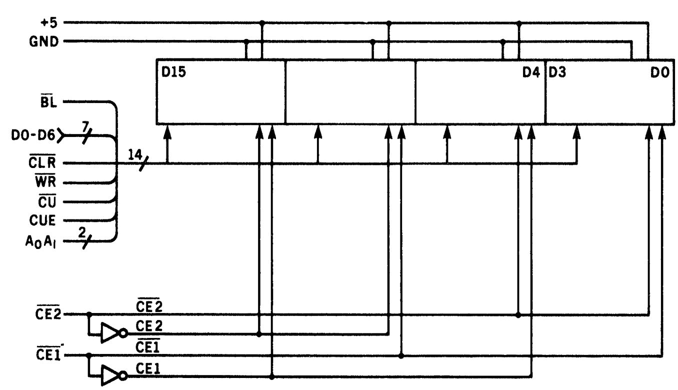
CHARACTER SET

D6	D5	D4	D0	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
			D1	L	L	H	H	L	L	H	H	L	L	H	H	L	L	H	H
			D2	L	L	L	L	H	H	H	H	L	L	L	L	H	H	H	H
			D3	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H
			HEX	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
L	H	L	2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
L	H	H	3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
H	L	L	4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
H	L	H	5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_

All other input codes display "blank"



Internal Block Diagram

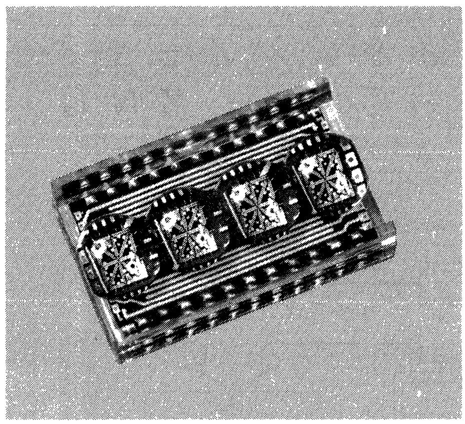


Typical Schematic for 16 Digit System

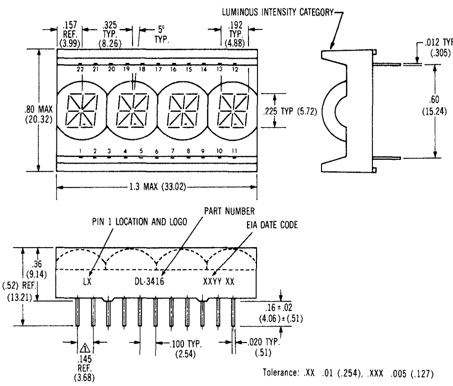
SIEMENS

DL-3416, DL-3416 H

.225″ RED, 4-DIGIT 16-SEGMENT PLUS DECIMAL ALPHANUMERIC Intelligent Display® WITH MEMORY/DECODER/DRIVER



Package Dimensions in Inches (mm)



FEATURES

- **225 Mil High, Magnified Monolithic Char.**
- **Wide Viewing Angle ±40°**
- **Close Vertical Row Spacing, 0.8 Inches**
- **Rugged Solid Plastic Encapsulated Package**
- **Fast Access Time**
  DL-3416 500 nSEC
  DL-3416H 300 nSEC
- **Full Size Display for Stationary Equipment**
- **Built-in Memory**
- **Built-in Character Generator**
- **Built-in Multiplex and LED Drive Circuitry**
- **Each Digit Independently Addressed**
- **TTL Compatible, 5 Volt Power**
- **Independent Cursor Function**
- **17th Segment for Improved Punctuation Marks**
- **Memory Clear Function**
- **Display Blank Function**
- **End Stackable, 4-Character Package**
- **Intensity Coded for Display Uniformity**

DESCRIPTION

The DL 3416 is a four digit display module having 16 segments plus decimal and a built-in CMOS integrated circuit.

The integrated circuit contains memory, ASCII ROM decoder, multiplexing circuitry, and drivers. Data entry is asynchronous and can be random. A display system can be built using any number of DL 3416's since each digit of any DL 3416 can be addressed independently and will continue to display the character last stored until replaced by another.

System interconnection is very straightforward. The least significant two address bits (A_0, A_1) are normally connected to the like named inputs of all DL 3416's in the system. With four chip enables four DL 3416's (16 characters) can easily be interconnected without a decoder.

Alternatively, one-of-n decoder IC's can be used to extend the address for large displays.

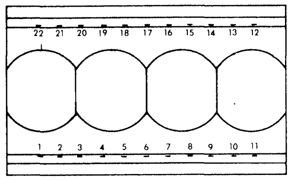
Data lines are connected to all DL 3416's directly and in parallel, as in the write line ($\overline{WR}$). The display will then behave as a write-only memory.

The cursor function causes all segments of a digit position to illuminate. The cursor is *not* a character, however, and upon removal the previously displayed character will reappear.

Important: Refer to Appnote 18, "Using and Handling Intelligent Displays". Since this is a CMOS device, normal precautions should be taken to avoid static damage.

Specifications are subject to change without notice.

TOP VIEW



Product Identification
Marking on Front Surface

Pin	Function	Pin	Function
1	CE1 Chip Enable	12	Gnd
2	$\overline{CE2}$ Chip Enable	13	$\overline{N/C}$
3	$\overline{CE3}$ Chip Enable	14	$\overline{BL}$ Blanking
4	$\overline{CE4}$ Chip Enable	15	N/C
5	$\overline{CLR}$ Clear	16	D0 Data Input
6	VCC	17	D1 Data Input
7	A0 Digit Select	18	D2 Data Input
8	$\overline{A1}$ Digit Select	19	D3 Data Input
9	$\overline{WR}$ Write	20	D4 Data Input
10	$\overline{CU}$ Cursor Select	21	D5 Data Input
11	CUE Cursor Enables	22	D6 Data Input

OPTO-ELECTRONIC CHARACTERISTICS @ 25° C

MAXIMUM RATINGS	
Voltage, any pin respect to GND . .	–.5 to 6.0 VDC
Operating Temperature	–20° to +65°C
Storage Temperature	–20° to +70°C
Relative Humidity (non condensing) @ 65° C	85%

OPTICAL CHARACTERISTICS (TYPICAL)	
Luminous Intensity 8 segments/digit @ 5V,	0.5 mcd
Off Axis Viewing Angle (Note 1)	±40°
Digit Size	225 mils
Spectral Peak Wavelength	660 nm

DC CHARACTERISTICS
DL-3416 AND DL-3416H

Parameter	–20°C Typ	+25°C[4]	+65°C Typ	Conditions
I_{CC} 4 digits on (10 seg/digit)	190 mA	150 mA max[1]	120 mA	V_{CC} = 5.0 V
I_{CC} Cursor[2]	225 mA	175 mA max[1]	150 mA	V_{CC} = 5.0 V
I_{CC} Blank		19 mA max		V_{IN} = 0 $\overline{V_{CC}}$ = 5.0 V $\overline{WR}$ = 5.0 V
I_{IL}	225 μA	160 μA max	150 μA	V_{IN} = .8 V V_{CC} = 5.0 V
V_{IL}		.8 V max		V_{CC} = 4.5 V
V_{IH}[3]		2.7 V min		V_{CC} = 4.5 V
		3.3 V min		V_{CC} = 5.5 V

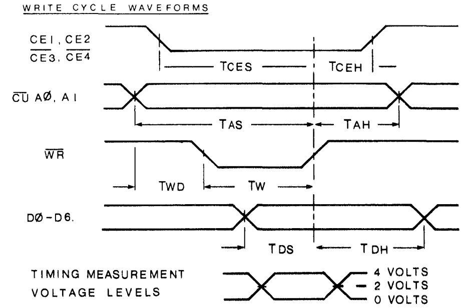
1. Measured at 5 sec.
2. 60 sec max duration.
3. $V_{CC} \geqslant V_{IH} \geqslant 0.6\ V_{CC}$.
4. V_{cc} = +5.0 VDC ±10%

AC CHARACTERISTICS
Timing Parameters @ 4.5 V (nanoseconds)

Parameter	–20°C Typ		+25°C Min		+65°C Typ	
	DL-3416	DL-3416H	DL-3416	DL-3416H	DL-3416	DL-3416H
T_{AS}	300	200	450	250	600	400
T_{WD}	50	50	150	50	175	75
T_W	250	150	300	200	425	325
T_{DS}	150	100	250	150	350	250
T_{DH}	50	50	50	50	100	100
T_{AH}	50	50	50	50	100	100
T_{CEH}	50	50	50	50	100	100
T_{CES}	300	150	450	250	600	400
T_{CLR}			15 milliseconds			
			access time			
			500 ns	300 ns		

TIMING CHARACTERISTICS

WRITE CYCLE WAVEFORMS



Note 1: "Off Axis Viewing Angle" is here defined as: "the minimum angle in any direction from the normal to the display surface at which any part of any segment in the display is not visible".

Note 2: This display contains a CMOS integrated circuit. Normal CMOS handling precautions should be taken to avoid damage due to high static voltages or electric fields.

Note 3: Unused inputs must be tied to an appropriate logic voltage level (either V+ or V–).

Note 4: **Warning** — Do not use solvents containing alcohol.

Note 5: Access time is defined as $T_{AS} + T_{DH}$ (sum of address set up and data hold times).

LOADING DATA

Setting the chip enables (CE1, CE2, $\overline{CE3}$, $\overline{CE4}$) to their true state will enable data loading. The desired data code (D0-D6) and digit address (A_0, A_1) should be held stable during the write cycle for storing new data.

Data entry may be asynchronous and random. (Digit 0 is defined as right hand digit with $A_1 = A_0 = 0$.)

Clearing of the entire internal four-digit memory can be accomplished by holding the clear ($\overline{CLR}$) low for one complete display multiplex cycle, 15 mS minimum.

LOADING CURSOR

Setting the chip enables (CE1, CE2, $\overline{CE3}$, $\overline{CE4}$) and cursor select ($\overline{CU}$) to their true state will enable cursor loading. A write ($\overline{WR}$) pulse will now store or remove a cursor into the digit location addressed by A_0, A_1; as defined in data entry. A cursor will be stored if D0 = 1; and will be removed if D0 = 0. Cursor will <u>not</u> be cleared by the $\overline{CLR}$ signal. The cursor ($\overline{CU}$) pulse width should not be less than the write pulse ($\overline{WR}$) width or erroneous data may appear in the display.

For those users not requiring the cursor, the cursor enable signal (CUE) may be tied low to disable display of the cursor function. A flashing cursor can be realized by simply pulsing CUE. If cursor has been loaded to any or all positions in the display, then CUE will control whether the cursor(s) or the characters appear. CUE does not affect the contents of cursor memory.

DISPLAY BLANKING

Blanking the display may be accomplished by loading a blank or space into each digit of the display or by using the ($\overline{BL}$) display blank input.

Setting the ($\overline{BL}$) input low does not affect the contents of either data or cursor memory. A flashing display can be realized by pulsing ($\overline{BL}$).

TYPICAL LOADING DATA STATE TABLE

$\overline{BL}$	CE1	CE2	$\overline{CE3}$	$\overline{CE4}$	CUE	$\overline{CU}$	$\overline{WR}$	$\overline{CLR}$	A1	A0	D6	D5	D4	D3	D2	D1	D0	DIGIT 3	2	1	0
H	X	X	X	X	L	X	H	H	PREVIOUSLY LOADED DISPLAY									G	R	E	Y
H	L	X	X	X	L	X	X	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	X	L	X	X	L	X	X	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	X	X	H	X	L	X	X	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	X	X	X	H	L	X	X	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	X	X	X	X	L	X	H	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	H	H	L	L	L	H	L	H	L	L	H	L	L	L	H	L	H	G	R	E	E
H	H	H	L	L	L	H	L	H	L	H	H	L	H	L	H	L	H	G	R	U	E
H	H	H	L	L	L	H	L	H	H	L	H	L	L	H	H	L	L	G	L	U	E
H	H	H	L	L	L	H	L	H	H	H	H	L	L	L	L	H	L	B	L	U	E
L	X	X	X	X	X	X	H	H	X	X	BLANK DISPLAY										
H	H	H	L	L	L	H	L	H	H	H	H	L	L	L	H	H	H	G	L	U	E
H	X	X	X	X	L	X	X	L	CLEARS CHARACTER DISPLAY												
H	H	H	L	L	L	H	L	H	X	X	SEE CHARACTER CODE							SEE CHARACTER SET			

X = DON'T CARE

LOADING CURSOR STATE TABLE

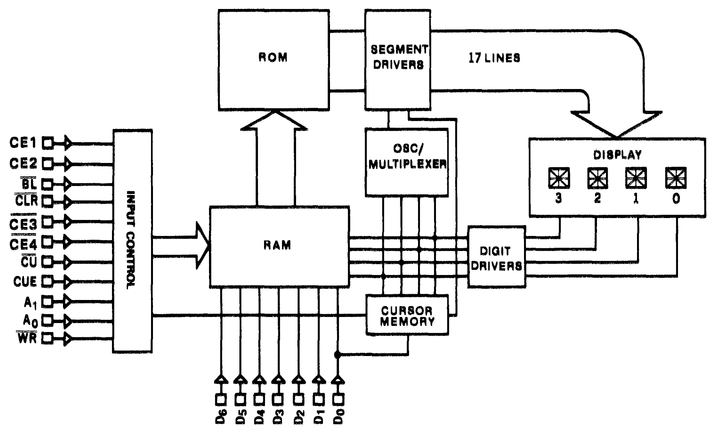
$\overline{BL}$	CE1	CE2	$\overline{CE3}$	$\overline{CE4}$	CUE	$\overline{CU}$	$\overline{WR}$	$\overline{CLR}$	A1	A0	D6	D5	D4	D3	D2	D1	D0	DIGIT 3	2	1	0
H	X	X	X	X	L	X	H	H	PREVIOUSLY LOADED DISPLAY									B	E	A	R
H	X	X	X	X	H	X	H	H	DISPLAY PREVIOUSLY STORED CURSORS									B	E	A	R
H	H	H	L	L	H	L	L	H	L	L	X	X	X	X	X	X	H	B	E	A	▩
H	H	H	L	L	H	L	L	H	L	H	X	X	X	X	X	X	H	B	E	▩	▩
H	H	H	L	L	H	L	L	H	H	L	X	X	X	X	X	X	H	B	▩	▩	▩
H	H	H	L	L	H	L	L	H	H	H	X	X	X	X	X	X	H	▩	▩	▩	▩
H	H	H	L	L	H	L	L	H	H	L	X	X	X	X	X	X	L	▩	E	▩	▩
H	X	X	X	X	L	X	H	H	DISABLE CURSOR DISPLAY									B	E	A	R
H	H	H	L	L	L	L	L	H	H	H	X	X	X	X	X	X	L	B	E	A	R
H	X	X	X	X	H	X	H	H	DISPLAY STORED CURSORS									B	E	▩	▩

X = DON'T CARE

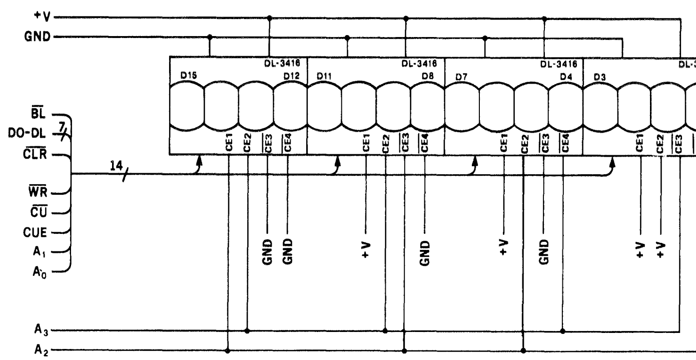
CHARACTER SET

			D0	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
			D1	L	L	H	H	L	L	H	H	L	L	H	H	L	L	H	H
			D2	L	L	L	L	H	H	H	H	L	L	L	L	H	H	H	H
			D3	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H
D6	D5	D4	HEX	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
L	H	L	2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
L	H	H	3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
H	L	L	4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
H	L	H	5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_

ALL OTHER CODES DISPLAY BLANK



Internal Block Diagram

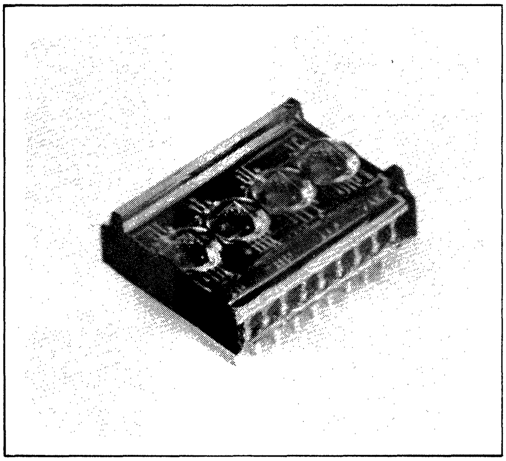


Typical Schematic for 16 Digits

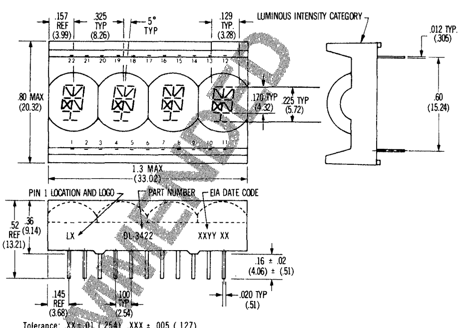
SIEMENS

DL-3422

.170"/.100" (Nom.) UPPER AND LOWER CASE 4-DIGIT 22-SEGMENT ALPHANUMERIC Intelligent Display® WITH MEMORY/DECODER/DRIVER



Package Dimensions in Inches (mm)



FEATURES

- 170 Mil/100 Mil (Nom.) Upper & Lower Case Letters
- Wide Viewing Angle ±40°
- Close Vertical Row Spacing, .800 Inches
- Rugged Solid Plastic Encapsulated Package
- Fast Access Time, 500 nSEC
- Full Size Display for Stationary Equipment
- Built-in Memory
- Built-in Character Generator
- Built-in Multiplex and LED Drive Circuitry
- Direct Access to Each Digit Independently & Asynchronously
- TTL Compatible, 5 Volt Power
- Independent Cursor Function
- 22 Segment for 96 Character ASCII Format Upper & Lower Case Letters
- Memory Clear Function
- Display Blank Function

DESCRIPTION

The DL 3422 is a four digit display module having 22 segments and a built-in CMOS integrated circuit.

The integrated circuit contains memory, ASCII ROM decoder, multiplexing circuitry, and drivers. Data entry is asynchronous and can be random. A display system can be built using any number of DL 3422's since each digit of any DL 3422 can be addressed independently and will continue to display the character last stored until replaced by another.

System interconnection is very straightforward. The least significant two address bits (A_0, A_1) are normally connected to the like named inputs of all DL 3422's in the system. With two chip enables (CE1, and $\overline{CE2}$) four DL 3422's (16 characters) can easily be interconnected without a decoder.

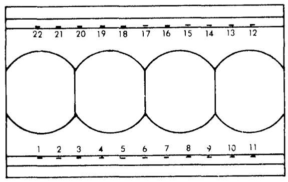
Alternatively, one-of-n decoder 1C's can be used to extend the address for large displays.

Data lines are connected to all DL 3422's directly and in parallel, as is the write line ($\overline{WR}$). The display will then behave as a write-only memory.

The cursor function causes all segments of a digit position to illuminate. The cursor is *not* a character, however, and upon removal the previously displayed character will reappear.

Important: Refer to Appnote 18, "Using and Handling Intelligent Displays". Since this is a CMOS device, normal precautions should be taken to avoid static damage.

Specifications are subject to change without notice.



Pin	Function	Pin	Function
1	CE1 Chip Enable	12	Gnd
2	N/C	13	N/C
3	$\overline{CE2}$ Chip Enable	14	$\overline{BL}$ Blanking
4	N/C	15	N/C
5	$\overline{CLR}$ Clear	16	D0 Data Input
6	VCC	17	D1 Data Input
7	A0 Digit Select	18	D2 Data Input
8	A1 Digit Select	19	D3 Data Input
9	$\overline{WR}$ Write	20	D4 Data Input
10	$\overline{CU}$ Cursor Select	21	D5 Data Input
11	CUE Cursor Enable	22	D6 Data Input

OPTO-ELECTRONIC CHARACTERISTICS @ 25°C

MAXIMUM RATINGS	
Voltage, any pin respect to GND	-.5 to 6.0 VDC
Operating Temperature	-20° to +65°C
Storage Temperature	-20° to +70°C
Relative Humidity (non condensing) @ 65°C	85%

OPTICAL CHARACTERISTICS	
Luminous Intensity 8 Segments @ 5 V	0.5mcd
Off Axis Viewing Angle (Note 1)	±50°
Digit Size	160 mils
Spectral Peak Wavelength	660 nm

DC CHARACTERISTICS

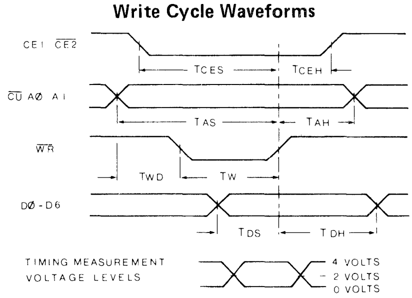
Parameter	-20°C Typ	+25°C[4]	+65°C Typ	Conditions
I_{CC} 4 digits on (10 seg/digit)	135 mA	125 mA max[1]	100 mA	V_{CC} = 5.0 V
I_{CC} 4 digits or Cursor[2]	160 mA	140 mA max[1]	120 mA	V_{CC} = 5.0 V
I_{CC} Blank		3.7 mA max		V_{IN} = 0 V_{CC} = 5.0 V $\overline{WR}$ = 5.0 V
I_{IL}	200 µA	160 µA max	100 µA	V_{IN} = .8 V V_{CC} = 5.0 V
V_{IL}		.8 V max		V_{CC} = 4.5 V
V_{IH}[3]		2.7 V min		V_{CC} = 4.5 V
		3.3 V min		V_{CC} = 5.5 V

1. Measured at 5 sec.
2. 60 sec max duration.
3. $V_{CC} \geqslant V_{IH} \geqslant 0.6\ V_{CC}$.
4. V_{cc} = +5.0 VDC ±10%

AC CHARACTERISTICS
Timing Parameter @ 4.5 V (nanoseconds)

	-20°C Typ	+25°C Min	+65°C Typ
T_{AS}	300	450	600
T_{WD}	50	150	175
T_W	250	300	425
T_{DS}	150	250	350
T_{DH}	50	50	100
T_{AH}	50	50	100
T_{CEH}	50	50	100
T_{CES}	300	450	600
T_{CLR}		15 milliseconds	

TIMING CHARACTERISTICS
Write Cycle Waveforms



Note 1: "Off Axis Viewing Angle" is here defined as: "the minimum angle in any direction from the normal to the display surface at which any part of the segment in the display is not visible".

Note 2: This display contains a CMOS integrated circuit. Normal CMOS handling precautions should be taken to avoid damage due to high static voltages or electric fields.

Note 3: Unused inputs must be tied to an appropriate logic voltage level (either V+ or V−).

Note 4: **Warning** — Do not use solvents containing alcohol.

LOADING DATA

Setting the chip enables (CE1, $\overline{CE2}$) to their true state will enable data loading. The desired data code (D0-D6) and digit address (A_0, A_1) should be held stable during the write cycle for storing new data.

Data entry may be asynchronous and random. (Digit 0 is defined as right hand digit with $A_1 = A_0 = 0$.)

Clearing of the entire internal four-digit memory can be accomplished by holding the clear ($\overline{CLR}$) low for one complete display multiplex cycle, 15 mS minimum. Clear ($\overline{CLR}$) is inactive during $\overline{BL}$.

LOADING CURSOR

Setting the chip enables (CE1, $\overline{CE2}$) and cursor select ($\overline{CU}$) to their true state will enable cursor loading. A write ($\overline{WR}$) pulse will now store or remove a cursor into the digit location addressed by A_0, A_1; as defined in data entry. A cursor will be stored if DO = 1; and will be removed if DO = 0. Cursor will not be cleared by the $\overline{CLR}$ signal.

For those users not requiring the cursor, the cursor enable signal (CUE) may be tied low to disable display of the cursor function. A flashing cursor can be realized by simply pulsing CUE. If cursor has been loaded to any or all positions in the display, then CUE will control whether the cursor(s) or the characters appear. CUE does not affect the contents of cursor memory.

DISPLAY BLANKING

Blanking the display may be accomplished by loading a blank or space into each digit of the display or by using the ($\overline{BL}$) display blank input.

Setting the ($\overline{BL}$) input low does not affect the contents of either data or cursor memory. A flashing display can be realized by pulsing ($\overline{BL}$).

TYPICAL LOADING DATA STATE TABLE

$\overline{BL}$	CE1	$\overline{CE2}$	CUE	$\overline{CU}$	$\overline{WR}$	$\overline{CLR}$	A1	A0	D6	D5	D4	D3	D2	D1	D0	DIGIT 3	2	1	0
H	X	X	L	X	H	H	PREVIOUSLY LOADED DISPLAY									G	R	E	Y
H	L	X	L	X	X	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	X	X	L	X	X	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	X	H	L	X	X	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	X	X	L	X	X	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	X	X	L	X	H	H	X	X	X	X	X	X	X	X	X	G	R	E	Y
H	H	L	L	H	L	H	L	L	H	L	L	L	H	L	H	G	R	E	E
H	H	L	L	H	L	H	L	H	H	L	H	L	H	L	H	G	R	U	E
H	H	L	L	H	L	H	H	L	H	L	L	H	H	L	L	G	L	U	E
H	H	L	L	H	L	H	H	H	H	L	L	L	L	H	L	B	L	U	E
O	X	X	X	X	H	H	BLANK DISPLAY												
H	H	L	L	H	L	H	H	H	H	L	L	L	H	H	H	G	L	U	E
H	X	X	L	X	X	L	CLEARS CHARACTER DISPLAY												
H	H	L	L	H	L	H	X	X	SEE CHARACTER CODE							SEE CHARACTER SET			

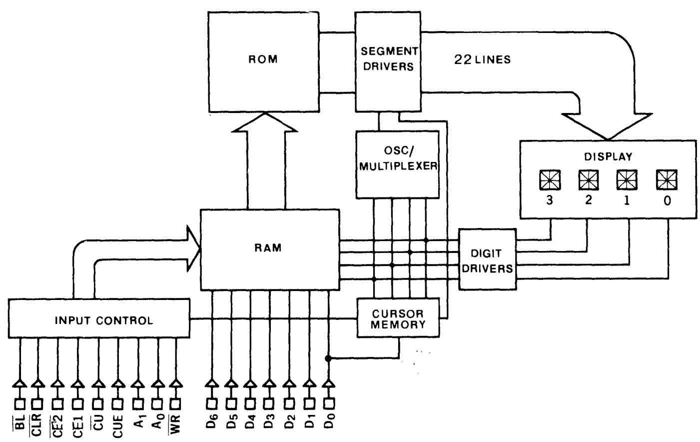
X = DON'T CARE

LOADING CURSOR STATE TABLE

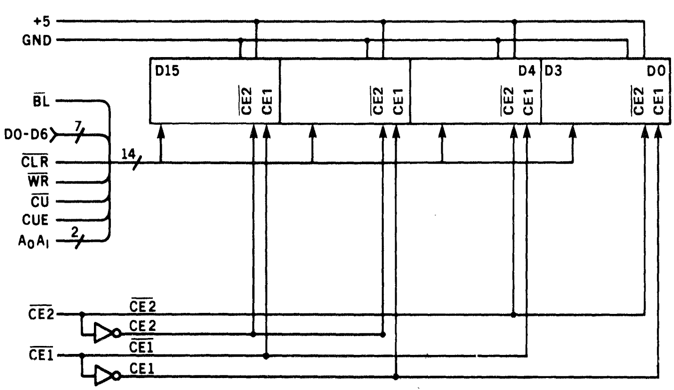
$\overline{BL}$	CE1	$\overline{CE2}$	CUE	$\overline{CU}$	$\overline{WR}$	$\overline{CLR}$	A1	A0	D6	D5	D4	D3	D2	D1	D0	DIGIT 3	2	1	0
H	X	X	L	X	H	H	PREVIOUSLY LOADED DISPLAY									B	E	A	R
H	X	X	H	X	H	H	DISPLAY PREVIOUSLY STORED CURSORS									B	E	A	R
H	H	L	H	L	L	H	L	L	X	X	X	X	X	X	H	B	E	A	⊠
H	H	L	H	L	L	H	L	H	X	X	X	X	X	X	H	B	E	⊠	⊠
H	H	L	H	L	L	H	H	L	X	X	X	X	X	X	H	B	⊠	⊠	⊠
H	H	L	H	L	L	H	H	H	X	X	X	X	X	X	H	⊠	⊠	⊠	⊠
H	H	L	H	L	L	H	H	L	X	X	X	X	X	X	L	⊠	E	⊠	⊠
H	X	X	L	X	H	H	DISABLE CURSOR DISPLAY									B	E	A	R
H	H	L	L	L	L	H	H	H	X	X	X	X	X	X	L	B	E	A	R
H	X	X	H	X	H	H	DISPLAY STORED CURSORS									B	E	⊠	⊠

X = DON'T CARE

CHARACTER SET



Internal Block Diagram



Typical Schematic for 16 Digit System

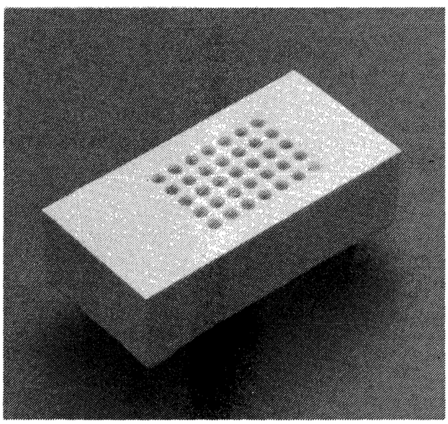
SIEMENS

DLO-4135
ORANGE

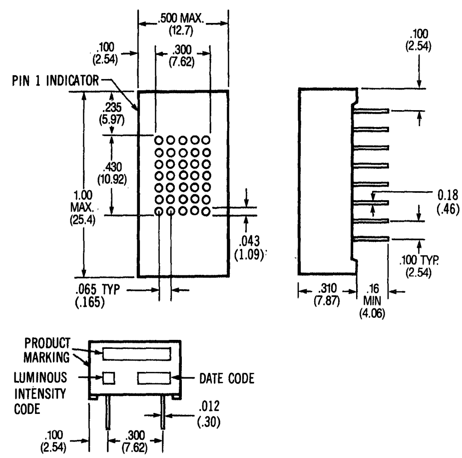
DLG-4137
GREEN

.43" SINGLE CHARACTER 5 x 7 DOT MATRIX Intelligent Display® WITH MEMORY/DECODER/DRIVER

PRELIMINARY



Package Dimension in Inches (mm)



FEATURES

- **.43" High, Hybrid Character**
- **Wide Viewing Angle, ± 50°**
- **Fully Encapsulated, Rugged Solid Plastic Package**
- **Built-In Memory**
- **Built-In Character Generator**
- **Built-In Multiplex and LED Drive Circuitry**
- **Built-In Lamp Test**
- **Intensity Control (4 levels)**
- **96 Character ASCII Format**
- **Microprocessor Buss Compatible**
- **Intensity Coded for Display Uniformity**
- **Single 5-volt power supply required**
- **X/Y stackable**
- **Available in High efficiency red (orange) and green**

DESCRIPTION

The DLX-4135/4137 are single digit 5 × 7 dot matrix Intelligent Displays with .43" character height. The built-in CMOS integrated circuit contains memory, ASCII character generator, LED multiplexing and drive circuitry; thereby eliminating the need for additional circuitry. They will display the 96 ASCII characters.

These devices are TTL and microprocessor compatible and offer the possibility of cascading the displays, allowing for multi-character messages. These displays were designed for viewing distances of up to 20 feet. They require a single 5-volt power supply and parallel ASCII input.

Important: Refer to Appnote 18, "Using and Handling Intelligent Displays". Since this is a CMOS device, normal precautions should be taken to avoid static damage.

Specifications are subject to change without notice.

OPTOELECTRONIC CHARACTERISTICS @25°C

Maximum Ratings	
Voltage, Any Pin Respect to GND	−0.5 to +6.0 VDC
Operating Temperature	−20°C to 65°C
Storage Temperature	−20°C to 70°C
Relative Humidity @65°C (non-condensing)	85%

Optical Characteristics (Typical)	
Luminous Intensity/Dot (Average) @5V	
DLO-4135	500 μcd
DLG-4137	500 μcd
Digit Size	0.43"
Viewing Angle (Note 1)	± 50°
Spectral Peak Wavelength	
DLO-4135	640 nm
DLG-4137	565 nm

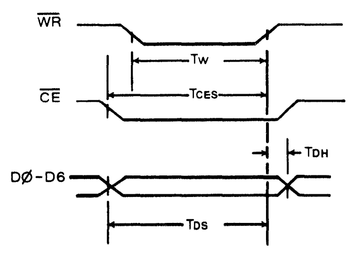
ELECTRICAL PARAMETERS

Parameter	Conditions	Min.	Typ.	Max.	Units
I_{CC} (Blank)	$\overline{BLØ} = \overline{BL1} = 0$, $V_{CC} = 5V$		4.5	8	mA
I_{CC}	$\overline{BLØ} = \overline{BL1} = 1$, $V_{CC} = 5V$		160	200	mA
I_{CC}	$\overline{BLØ} = 0$, $\overline{BL1} = 1$, $V_{CC} = 5V$		80		mA
I_{CC}	$\overline{BLØ} = 1$, $\overline{BL1} = 0$, $V_{CC} = 5V$		40		mA
I_{IL} (any input)	$V_{IN} = 0.8V$, $V_{CC} = 5V$			160	μA
V_{IL} (Any input)	$V_{CC} = 5V$			1	V
V_{IH} (Any input)	$V_{CC} = 5V$	3.0			V

AC CHARACTERISTICS @V_{CC} = 4.5V

Parameter	Min @ +25°C	Units
T_W	200	ns
T_{CES}	200	ns
T_{DS}	200	ns
T_{DH}	100	ns

TIMING CHARACTERISTICS



Note 1: "Off Axis Viewing Angle" is here defined as: "the minimum angle in any direction from the normal to the display surface at which any part of any dot in the display is not visible."

Note 2: **This display contains a CMOS integrated circuit. Normal CMOS handling precautions should be taken to avoid damage due to high static voltages or electric fields. SEE APPNOTE 18.**

Note 3: Unused inputs must be tied to an appropriate logic voltage level (either V+ or GND).

Note 4: V_{cc} = 5.0 VDC ± 10%.

Note 5: Clean only in water, isopropyl alcohol, freon TF, or TE (or equivalent)

LOADING DATA

Loading data into the DLX-4135/4137 is straightforward. Chip enable (CE) should be present and stable during a write pulse (WR). Parallel data information should be stable for the minimum time (T_W) and held for T_{DH} after write has gone high. No synchronization is necessary and each character will continue to be displayed until it is replaced with another. Multiple displays may be stacked together with only an additional decoder IC for chip enable decoding.

Note 6: Either BL0 or BL1 should be held high for display to light up.

LAMP TEST

The lamp test (LT) when activated causes all dots on the display to be illuminated at half brightness. The lamp test function is independent of write (WR) and the settings of the blanking inputs (BL0 , BL1).

This convenient test gives a visual indication that all dots are functioning properly. Lamp test may also be used as a cursor function or pointer which does not destroy previously displayed characters.

DIMMING AND BLANKING THE DISPLAY

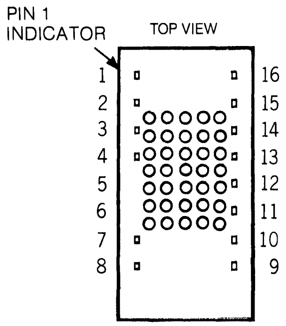
Brightness Level	BL1	BL0
Blank	0	0
¼ Brightness	0	1
½ Brightness	1	0
Full Brightness	1	1

DATA LOADING EXAMPLE

CE	WR	BLO	BL1	LT	D6	D5	D4	D3	D2	D1	DO	
H	X	H	X	H	X	X	X	X	X	X	X	NC
X	X	L	L	H	X	X	X	X	X	X	X	BLANK
X	X	X	X	L	X	X	X	X	X	X	X	LMP TEST
L	L	X	H	H	H	L	X	L	L	L	H	A
L	L	H	H	H	H	H	H	L	L	H	L	r
L	L	H	H	H	L	H	H	L	L	H	H	3
L	L	H	H	H	L	H	L	H	L	H	H	+

(Columns D6–DO are headed DATA INPUT.)

X = Don't Care

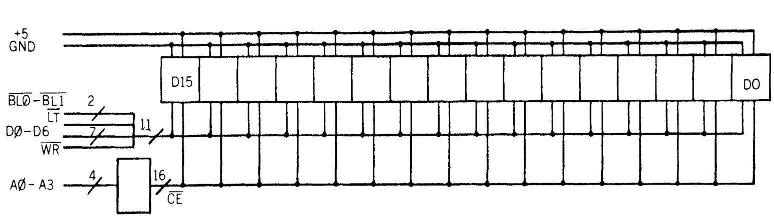


DL-4135 PIN FUNCTIONS			
PIN	FUNCTION	PIN	FUNCTION
1	$\overline{LT}$ LAMP TEST	9	D0 DATA LSB
2	$\overline{WR}$ WRITE	10	D1 DATA
3	$\overline{BL1}$ BRIGHTNESS	11	D2 DATA
4	$\overline{BL0}$ BRIGHTNESS	12	D3 DATA
5	NO PIN	13	D4 DATA
6	NO PIN	14	D5 DATA
7	$\overline{CE}$ CHIP ENABLE	15	D6 DATA MSB
8	GND	16	VCC

CHARACTER SET

			D0	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
			D1	L	L	H	H	L	L	H	H	L	L	H	H	L	L	H	H
			D2	L	L	L	L	H	H	H	H	L	L	L	L	H	H	H	H
			D3	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H
D6	D5	D4	HEX	Ø	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
L	L	L	Ø																
L	L	H	1																
L	H	L	2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
L	H	H	3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
H	L	L	4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
H	L	H	5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
H	H	L	6	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
H	H	H	7	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	▒

16 Digits Interconnection

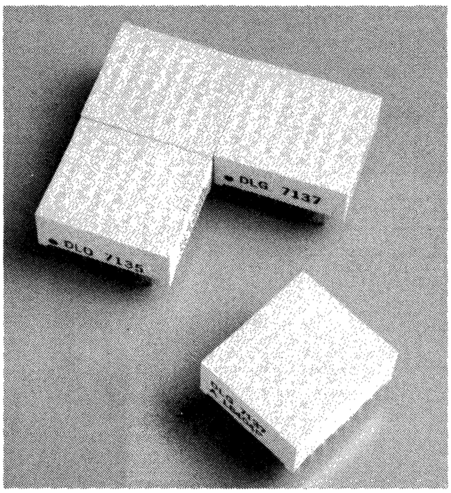


SIEMENS

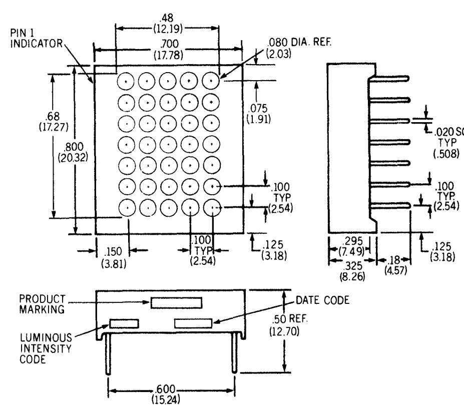
DLO-7135
ORANGE

DLG-7137
GREEN

.68" SINGLE CHARACTER 5 x 7 DOT MATRIX Intelligent Display® WITH MEMORY/DECODER/DRIVER



Package Dimensions in Inches (mm)



FEATURES

- **.68" High, Hybrid Character**
- **Wide Viewing Angle, ± 50°**
- **Fully Encapsulated, Rugged Solid Plastic Package**
- **Built-In Memory**
- **Built-In Character Generator**
- **Built-In Multiplex and LED Drive Circuitry**
- **Built-In Lamp Test**
- **Intensity Control (4 levels)**
- **96 Character ASCII Format**
- **Microprocessor Buss Compatible**
- **Intensity Coded for Display Uniformity**
- **Single 5 volt power supply required**
- **X/Y stackable**
- **Available in High Efficiency Red (Orange) and Green**

DESCRIPTION

The DLX-7135/7137 are single digit 5 × 7 dot matrix Intelligent Displays with .68" character height. The built-in CMOS integrated circuit contains memory, ASCII character generator, LED multiplexing and drive circuitry; thereby eliminating the need for additional circuitry. They will display the 96 ASCII characters.

These devices are TTL and microprocessor compatible and offer the possibility of cascading the displays, allowing for multi-character messages. These displays were designed for viewing up to 25 feet. They require a single 5-volt power supply and parallel ASCII input.

Important: Refer to Appnote 18, "Using and Handling Intelligent Displays". Since this is a CMOS device, normal precautions should be taken to avoid static damage.

Specifications are subject to change without notice.

OPTOELECTRONIC CHARACTERISTICS @25°C

Maximum Ratings

Voltage, Any Pin
Respect to GND . . . . −0.5 to +6.0 VDC
Operating Temperature . . . . . . −20°C to 65°C
Storage Temperature . . . . −20°C to 70°C
Relative Humidity @65°C
(non-condensing) 85%

Optical Characteristics (Typical)

Luminous Intensity/Dot (Average) @5V
DLO-7135 . . . . .500 µcd
DLG-7137 . . . . .500 µcd
Digit Size . . . . .0.68"
Viewing Angle (Note 1) . . . . ±50°
Spectral Peak Wavelength
DLO-7135 . . . . 640nm
DLG-7137 . . . . 565 nm

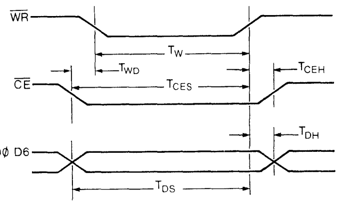
ELECTRICAL PARAMETERS

Parameter	Conditions	Min.	Typ.	Max.	Units
I_{CC}(Blank)	$\overline{BL\emptyset} = \overline{BL1} = 0$, $V_{CC} = 5V$		4.5	8	mA
I_{CC}	$\overline{BL\emptyset} = \overline{BL1} = 1$, $V_{CC} = 5V$		160	200	mA
I_{CC}	$\overline{BL\emptyset} = 0$, $\overline{BL1} = 1$, $V_{CC} = 5V$		80		mA
I_{CC}	$\overline{BL\emptyset} = 1$, $\overline{BL1} = 0$, $V_{CC} = 5V$		40		mA
I_{IL} (any input)	$V_{IN} = 0.8V$, $V_{CC} = 5V$			160	µA
V_{IL} (Any input)	$V_{CC} = 5V$			1	V
V_{IH} (Any input)	$V_{CC} = 5V$	3.0			V

TIMING PARAMETERS @25°C $V_{CC} = 4.5$ V

Symbol	Parameter	Min.	Units
T_{CES}	CHIP ENABLE SET-UP	200	nS
T_{DS}	DATA SET-UP	200	nS
T_W	WRITE PULSE	200	nS
T_{DH}	DATA HOLD	100	nS
T_{WD}	WRITE DELAY	20	nS
T_{CEH}	CHIP ENABLE HOLD	100	nS

TIMING CHARACTERISTICS



Note 1: "Off Axis Viewing Angle" is here defined as: "the minimum angle in any direction from the normal to the display surface at which any part of any dot in the display is not visible."

Note 2: **This display contains a CMOS integrated circuit. Normal CMOS handling precautions should be taken to avoid damage due to high static voltages or electric fields. SEE APPNOTE 18.**

Note 3: Unused inputs must be tied to an appropriate logic voltage level (either V+ or GND).

Note 4: $V_{CC} = 5.0$ VDC ± 10%.

Note 5: Clean only in water, isopropyl alcohol, freon TF, or TE (or equivalent)

LOADING DATA

Loading data into the DLX7135/7137 is straightforward. Chip enable ($\overline{CE}$) should be present and stable during a write pulse ($\overline{WR}$). Parallel data information should be stable for the minimum time (T_W) and held for T_{DH} after write has gone high. No synchronization is necessary and each character will continue to be displayed until it is replaced with another. Multiple displays may be stacked together with only an additional decoder IC for chip enable decoding.

Note 6: Either $\overline{BL0}$ or $\overline{BL1}$ should be held high for display to light up.

LAMP TEST

The lamp test ($\overline{LT}$) when activated causes all dots on the display to be illuminated at half brightness. The lamp test function is independent of write ($\overline{WR}$) and the settings of the blanking inputs ($\overline{BL0}$, $\overline{BL1}$).

This convenient test gives a visual indication that all dots are functioning properly. Lamp test may also be used as a cursor function or pointer which does not destroy previously displayed characters.

DIMMING AND BLANKING THE DISPLAY

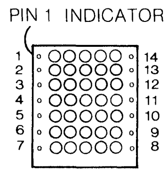
Brightness Level	$\overline{BL1}$	$\overline{BL0}$
Blank	0	0
¼ Brightness	0	1
½ Brightness	1	0
Full Brightness	1	1

DATA LOADING EXAMPLE

$\overline{CE}$	$\overline{WR}$	$\overline{BL0}$	$\overline{BL1}$	$\overline{LT}$	DATA INPUT D6	D5	D4	D3	D2	D1	D0	
H	X	H	X	H	X	X	X	X	X	X	X	NC
X	X	L	L	H	X	X	X	X	X	X	X	BLANK
X	X	X	X	L	X	X	X	X	X	X	X	LMP TEST
L	L	X	H	H	H	L	X	L	L	L	H	A
L	L	H	H	H	H	H	H	L	L	H	L	r
L	L	H	H	H	L	H	H	L	L	H	H	3
L	L	H	H	H	L	H	L	H	L	H	H	+

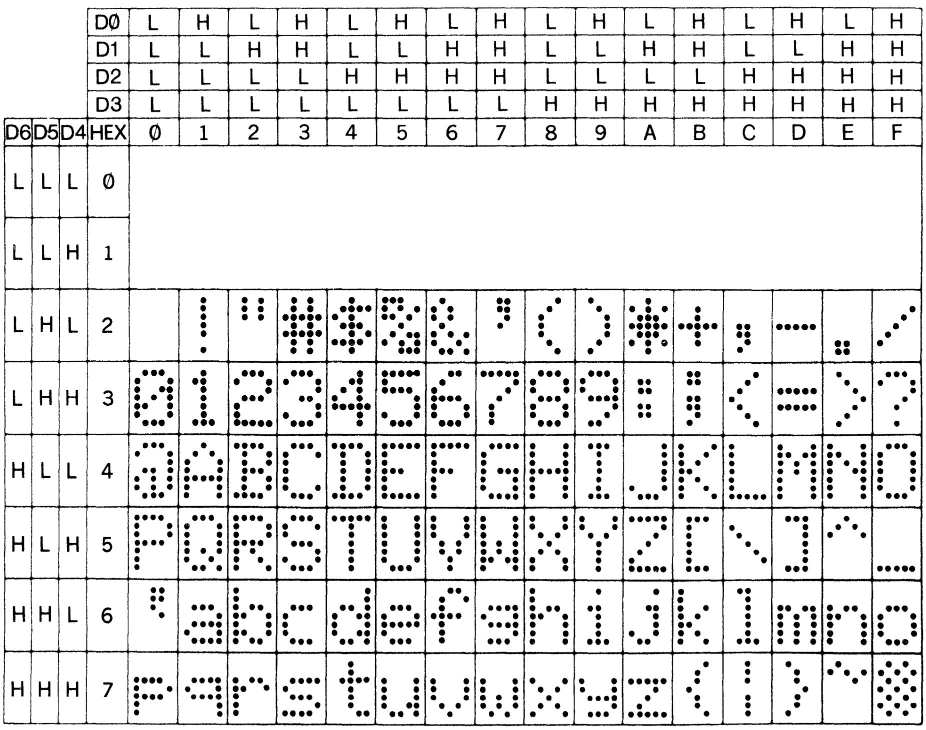
X = DON'T CARE

TOP VIEW

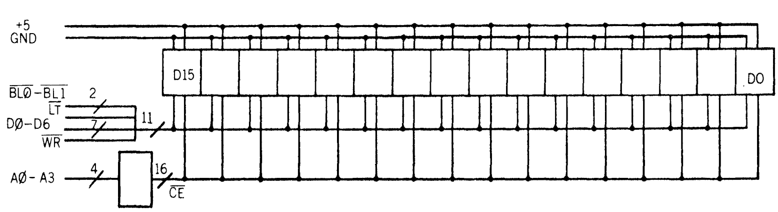


Pin	Function	Pin	Function
1	VCC	14	D6 Data input MSB
2	$\overline{LT}$ Lamp test	13	D5 Data input
3	$\overline{CE}$ Chip enable	12	D4 Data input
4	$\overline{WR}$ Write	11	D3 Data input
5	$\overline{BL1}$ Brightness	10	D2 Data input
6	$\overline{BL0}$ Brightness	9	D1 Data input
7	GND	8	D0 Data input LSB

CHARACTER SET



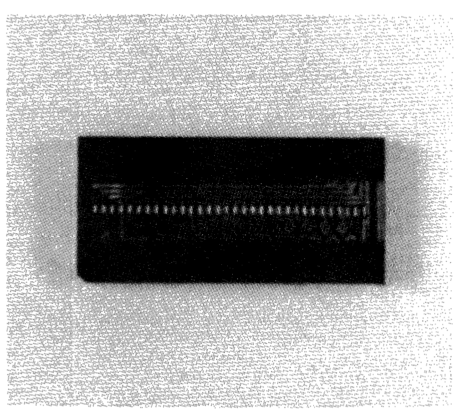
16 Digits Interconnection



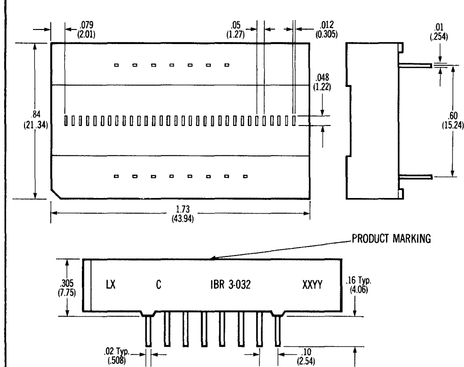
SIEMENS

IBR-3 Series
32 DATA ELEMENT LED INTELLIGENT BAR GRAPH

Preliminary



Package Dimensions in Inches (mm)



FEATURES

- 32 Elements
- High resolution 50 mil spacing
- Red rectangular LEDs
- On board intelligence:
  Storage
  Decoding
  Multiplexing
  Drive Electronics
- Binary Data Input
- CMOS low power controller
- TTL compatible input
- Microprocessor interface
- Single 5-volt power supply
- Built-in:
  Lamp test
  3 level dimming
  Blanking
- Dual in-line packaging

OPTIONS:

- Available on special order:
  High Efficiency Red
  Yellow
  Green
- Factory expandable in 32 element increments up to 128
- Moving dot operation

DESCRIPTION

The IBR-3 is a high resolution instrumentation quality, intelligent bar graph. It is a completely self-contained display subsystem with on-board electronics for data storage, display management and LED Multiplexing. The 32 element unit is less than 1¾ " long and is easily viewable at 10′ to 20′ from broad, off axis, angles.

The design makes it easy to incorporate the Bar Graph into almost any equipment. Encapsulated with dual in-line mounting, it requires standard mounting hardware. The IBR-3 is TTL compatible and requires a single 5 volt power supply. A built-in lamp test provides a quick check of LED operation.

DATA ENTRY - Parallel

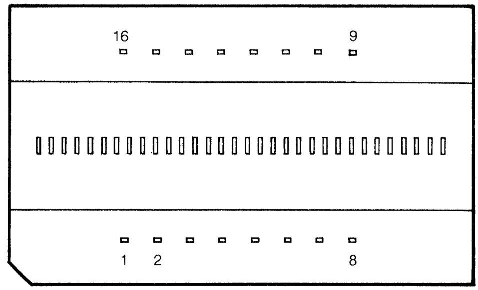
Loading data into the IBR-3-032 is simple and straightforward. There are two modes of operation, either expanding bar or dot mode. D5 controls the mode; 0 equals bar mode, and 1 equals dot mode. The desired binary value is presented in parallel to the inputs D0 through D4 and held stable during a write cycle. D6 must be held high or the display will be blank regardless of data inputs. The display is an expanding bar or moving dot from left to right with respect to pin 1.

OPTICAL CHARACTERISTICS (Std Red):	
Luminous Intensity/segment	0.1 mcd
Off axis viewing angle	±60°
Segment size	12 × 42 mils
Spectral peak wavelength	660 nm

Specifications are subject to change without notice.

INPUT PIN FUNCTIONS:

Pin	Signal	Function
1	D6	Binary data input
2	D5	Binary data input
3	D4	Binary data input
4	D3	Binary data input
5	D2	Binary data input
6	D1	Binary data input
7	D0	Binary data input
8	GND	Ground
9	NC	No connection
10	Vcc	+ 5 volts
11	$\overline{BLO}$	Brightness control
12	$\overline{BLI}$	Brightness control
13	$\overline{WR}$	Write input
14	$\overline{CEO}$	Chip enable
15	$\overline{CEI}$	Chip enable
16	$\overline{LT}$	Lamp test



MAXIMUM RATINGS:

Voltage, any pin to GND	-0.5 to + 6 VDC
Power Dissipation @ 25°C	2.25 W
Operating Temperature	-20°C to + 65°C
Storage Temperature	-20°C to + 70°C

SWITCHING CHARACTERISTICS (25°C, 4.5V)

Symbol	Parameter	Minimum
T_{WR}	Write Pulse	200ns
T_{CE1}	Chip Enable 1	200ns
T_{CE0}	Chip Enable 0	200ns
T_H	Data Hold	100ns

DC CHARACTERISTICS
(@VCC = 5.0V @ 25°C)

PARAMETER	CONDITIONS	MIN.	MAX	UNITS
V_{CC}		4.5	5.5	V
V_{IL}	V_{CC} = 4.5V		.8	V
V_{IH}	V_{CC} = 5.0V	3.0		V
V_{IN}, Any Pin		-.5	V_{CC} +.5	V
I_{CC} Blank Display	V_{IN} = 0 V_{CC} = 5.0V WR, LT = 5.0V		5.5	mA
I_{CC}, 32 Segments On	V_{CC} = 5.0V		150	mA
I_{IL}	V_{CC} = 5.5V V_{IN} = .8V		160	uA

LOAD DATA STATE TABLE (X= Don't Care)

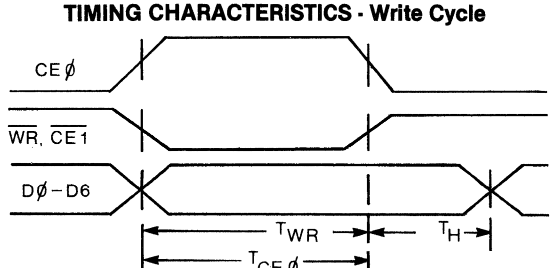
D6	D5	D4	D3	D2	D1	D0	D5 controls dot or bar mode 0=bar mode 1=dot mode.
0	0	X	X	X	X	X	No display; D6 must be 1 to display
0	1	X	X	X	X	X	any information.
1	0	D	D	D	D	D	Normal operating mode; 1 to 32 segments lit depending on binary code.
							For Example:
1	0	0	0	0	0	0	One segment lit (with the exception of the segment 8 option which lights during zero display as a signal the bargraph module is functional).
1	0	0	0	0	0	1	Two segments lit Note 1
1	0	0	0	0	1	0	Three segments lit Note 1
1	0	0	0	0	1	1	Four segments lit Note 1
1	0	0	0	1	0	0	Five segments lit Note 1
1	0	1	1	1	1	0	Thirty one segments lit Note 1
1	0	1	1	1	1	1	Thirty two segments lit.
1	1	D	D	D	D	D	Floating Dot Mode will display on lamp in the 0 to 31 position depending on the data in D0-D4.
1	1	0	0	0	0	0	Displays dot in 0 position Note 1
1	1	0	0	0	0	1	Displays dot in 1 position Note 1
1	1	1	1	1	1	1	Displays dot in 311 position Note 1

Note 1) From left to right with respect to pin #1, viewed from the top.

BLANKING & LT STATE TABLE

$\overline{BLO}$	$\overline{BL1}$	$\overline{LT}$	
1	1	1	NORMAL BRIGHTNESS
0	1	1	3/7 NORMAL BRIGHTNESS
1	0	1	1/7 NORMAL BRIGHTNESS
0	0	1	BLANK
X	X	0	ALL ELEMENTS ON 1/7 NORMAL BRIGHTNESS

TIMING CHARACTERISTICS - Write Cycle

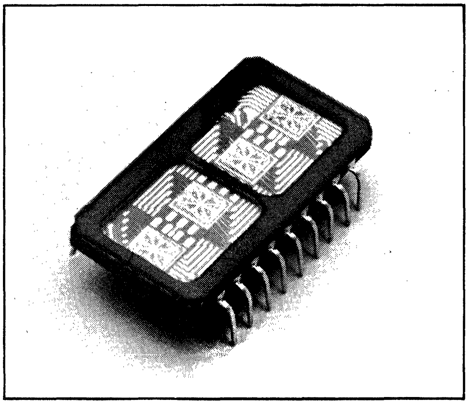


SIEMENS

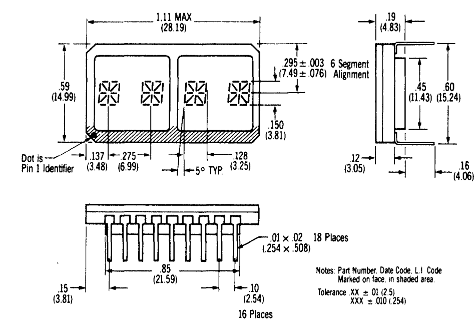
MDL-2416
MDL-2416C

.15" RED, 4-DIGIT, 16 SEGMENT PLUS DECIMAL HI-REL/MILITARY ALPHANUMERIC Intelligent Display® WITH MEMORY/DECODER/DRIVER

Preliminary Data Sheet



Package Dimensions in Inches (mm)



FEATURES

- **Available in two versions**
  MDL-2416, Extended Temperature Range, Hermetic Seal
  MDL-2416C Processed to Selected Portions of MIL Standard 883/Level C
- **150 Mil High, Non-Magnified Monolithic Character**
- **Rugged Ceramic Package, Hermetic Sealed Flat Glass Window**
- **Dual In Line Configuration**
- **Close Vertical Row Spacing, .600 Inches**
- **100 Mil Pin Spacing**
- **Wide Viewing Angle 50° ± 10°**
- **Wide Temperature Operating Range for High Reliability Industrial and Military Use**
- **Fully Integrated CMOS Drive Electronics**
- **Direct Access to Each Digit Independently and Asynchronously**
- **TTL Compatible, 5 Volt Power Supply**
- **Independent Cursor Function**
- **17th Segment for Improved Punctuation Marks**
- **Two Chip Enables**
- **Interdigit Blanking**
- **Display Blank Function**
- **Memory Clear Function**
- **End-Stackable, Four Character Package**
- **Intensity Coded for Display Uniformity**
- **Dimming Capability**

DESCRIPTION

The MDL-2416 is a Hi-Reliability four digit display having a 17 segment font and built-in CMOS drive circuitry that is TTL and microprocessor compatible. The integrated circuit contains memory, ASCII ROM decoder, multiplexing circuitry, and drivers. Data entry is asychronous and can be random. A display system can be built using any number of MDL-2416s since each digit of any MDL-2416 can be addressed independently and will continue to display the character last stored until replaced by another.

The MDL-2416C version is designed for use in extremely harsh environments where only the most reliable product is acceptable. This device is processed to meet the requirement of HI-REL/military applications.

System interconnection is straight-forward. The least significant two address bits (A_0, A_1) are normally connected to the like named inputs of all MDL-2416s in the system. With two chips enables, ($\overline{CE1}$, $\overline{CE2}$,) two MDL-2416s (8 characters) can easily be interconnected without an external decoder.

Important: Since this is a CMOS device, normal precautions should be taken to avoid static damage.

Specifications are subject to change without notice.

OPTOELECTRONIC CHARACTERISTICS @ 25°C

ABSOLUTE MAXIMUM RATINGS	
DC Supply	– 0.5 to + 6.0 Vdc
Input Voltage Relative to Gnd (all inputs)	– 0.5 to V_{CC} + 0.5 V_{dc}
Operating temperature	– 55 to 100°C
Storage temperature	– 55 to 125°C
Temp/Humidity	65°C/90% 10 cycles per 1004.2 15% LTPD Biased non-operating

OPTICAL CHARACTERISTICS	
Spectral Peak Wavelength	660nM typ.
Spectral Line Half-Width	40nM typ.
Viewing Angle	50° ± 10°
Digit Size	.15 in.
Luminous Intensity	0.1 mcd/seg @ V_{CC} = 5V
Intensity matching, Seg. to Seg.	1.8:1 @ V_{CC} = 5V

ELECTRICAL CHARACTERISTICS

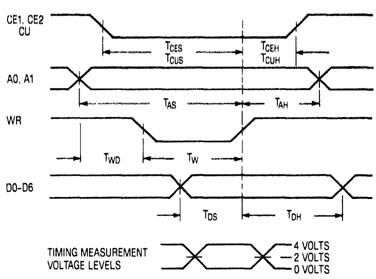
Parameters	Min	Typ	Max	Units	Conditions
V_{CC}	25°C 4.5	25°C 5.0	25°C 5.5	V	
I_{CC} (Blank)	TBD	12.0	19.0	mA	V_{CC} = 5V; $\overline{WR}$ = V_{CC} VIN = 0V
I_{CC} (10 segs/ char. 4 digits on)	TBD	125	150	mA	V_{CC} = 5V
I_{CC} (all seg on cursor in 4 digits)	TBD	150	175	mA	V_{CC} = 5.0V; 5 sec max.
VIL (all inputs)	TBD	TBD	0.8	V	V_{CC} = 5V
*VIH (all inputs)	3.0	TBD	TBD	V	V_{CC} = 5V
IIL (all inputs)	TBD	TBD	160	μA	V_{CC} = 5V; VIN = 0.8V

*NOTE: VIH min. = 60% V_{CC}

AC CHARACTERISTICS

Symbol	Parameter	Min Time – 55°C	Min Time 25°C	Min Time 100°C	Units
T_{CES}	Chip Enable Setup	180	250	340	nS
T_{AS}	Address Setup	180	250	340	nS
T_{WD}	Write Delay	35	50	80	nS
T_{W}	Write Pulse	160	200	250	nS
T_{DS}	Data Setup	65	150	160	nS
T_{CEH}	Chip Enable Hold	20	20	35	nS
T_{AH}	Address Hold	20	20	35	nS
T_{DH}	Data Hold	20	20	35	nS
T_{CUS}	Cursor Setup	180	250	340	nS
T_{CUH}	Cursor Hold	20	20	35	nS
T_{CLR}	Min Time to Clear a 10 Seg Char. in 4 Digits	12	15	17	mS

TIMING CHARACTERISTICS WRITE CYCLE WAVEFORMS



Note 1. "Off Axis Viewing Angle" is here defined as: "the minimum angle in any direction from the normal to the display surface at which any part of any segment in the display is not visible."
Note 2. This display contains a CMOS integrated circuit. Normal CMOS handling precautions should be taken to avoid damage due to high static voltages or electric fields. SEE APPNOTE 18.
Note 3. Unused inputs must be tied to an appropriate logic voltage level (either V+ or V–).

LOADING DATA

Setting the chip enables ($\overline{CE1}$, $\overline{CE2}$) to their true state will enable data loading. The desired data code (D0-D6) and digit address (A_0, A_1) must be held stable during the write cycle for strong new data. Data entry may be asynchronous and random. (Digit 0 is defined as right hand digit with $A_1 = A_0 = 0$.)

Clearing of the entire internal four digit memory can be accomplished by holding the clear ($\overline{CLR}$) low for one complete display multiplex cycle, 15mS minimum. Loading an illegal data code will display a blank.

BLANKING DISPLAY

Blanking the display may be accomplished by loading a blank or space into each digit of the display or by using the ($\overline{BL}$) display blank input.

Setting the ($\overline{BL}$) input low does not affect the contents of either data or cursor memory. A flashing display can be realized by pulsing ($\overline{BL}$).

LOADING CURSOR

Setting the chip enables ($\overline{CE1}$, $\overline{CE2}$) and cursor select ($\overline{CU}$) to their true state will enable cursor loading. A write ($\overline{WR}$) pulse will now store or remove a cursor into the digit location addressed by A_0, A_1; as defined in data entry. A cursor will be stored if D0 = 1; and will be removed if D0 = 0. Cursor will not be cleared by the $\overline{CLR}$ signal. The cursor ($\overline{CU}$) pulse width should not be less than the write ($\overline{WR}$) pluse or erroneous data may appear in the display.

For those users not requiring the cursor, the cursor enable signal (CUE) may be tied low to disable display of the cursor function. A flashing cursor can be realized by simply pulsing CUE. If cursor has been loaded to any or all positions in the display, then CUE will control whether the cursor(s) or the characters appear. CUE does not affect the contents of the cursor memory.

DIMMING

Dimming is accomplished by varying a pulse width on the blanking pin.

DATA LOADING EXAMPLE

						ADDRESS		DATA INPUT							DIGIT	DIGIT	DIGIT	DIGIT
$\overline{CE1}$	$\overline{CE2}$	CUE	$\overline{CU}$	$\overline{WR}$	$\overline{BL}$	A1	A0	D6	D5	D4	D3	D2	D1	D0	3	2	1	0
X	H	L	X	X	H	X	X	X	X	X	X	X	X	X	NC	NC	NC	NC
H	X	L	X	X	H	X	X	X	X	X	X	X	X	X	NC	NC	NC	NC
H	H	L	X	X	H	X	X	X	X	X	X	X	X	X	NC	NC	NC	NC
H	H	L	X	X	H	X	X	X	X	X	X	X	X	X	NC	NC	NC	NC
L	L	L	H	L	H	L	L	H	L	L	L	L	L	H	NC	NC	NC	A
L	L	L	H	L	H	L	H	H	L	L	L	L	H	L	NC	NC	B	A
L	L	L	H	L	H	H	L	H	L	L	L	L	H	H	NC	C	B	A
L	L	L	H	L	H	H	H	H	L	L	L	H	L	L	D	C	B	A
L	L	L	H	L	H	L	L	H	L	L	L	H	L	H	D	C	B	E
L	L	L	H	L	H	H	L	H	L	L	H	L	H	H	D	K	B	E
H	H	L	H	H	L	X	X	X	X	X	X	X	X	X				
H	H	L	H	H	H	X	X	X	X	X	X	X	X	X	D	K	B	E

CURSOR LOADING EXAMPLE

						ADDRESS		DATA INPUT							DIGIT	DIGIT	DIGIT	DIGIT
$\overline{CE1}$	$\overline{CE2}$	CUE	$\overline{CU}$	$\overline{WR}$	$\overline{BL}$	A1	A0	D6	D5	D4	D3	D2	D1	D0	3	2	1	0
H	H	H	H	H	H	X	X	X	X	X	X	X	X	X	D	K	B	E
H	H	H	H	H	H	X	X	X	X	X	X	X	X	X	D	K	B	E
H	H	H	H	H	H	X	X	X	X	X	X	X	X	X	D	K	B	E
H	H	H	H	H	H	X	X	X	X	X	X	X	X	X	D	K	B	E
L	L	H	L	H	H	X	X	X	X	X	X	X	X	X	NC	NC	NC	NC
L	L	H	L	L	H	L	L	X	X	X	X	X	X	H	D	K	B	▩
L	L	H	L	L	H	L	H	X	X	X	X	X	X	H	D	K	▩	▩
L	L	H	L	L	H	H	L	X	X	X	X	X	X	H	D	▩	▩	▩
L	L	H	L	L	H	H	H	X	X	X	X	X	X	H	▩	▩	▩	▩
L	L	L	H	H	H	X	X	X	X	X	X	X	X	X	D	K	B	E
L	L	H	H	H	H	X	X	X	X	X	X	X	X	X	▩	▩	▩	▩
L	L	L	H	H	H	X	X	X	X	X	X	X	X	X	D	K	B	E
L	L	H	L	L	H	L	L	X	X	X	X	X	X	L	▩	▩	▩	E
L	L	H	L	L	H	L	H	X	X	X	X	X	X	L	▩	▩	B	E
L	L	H	L	L	H	H	L	X	X	X	X	X	X	L	▩	K	B	E
L	L	H	L	L	H	H	H	X	X	X	X	X	X	L	D	K	B	E

H = High L = Low X = Don't Care

FUNCTIONAL DESCRIPTION

The block diagram consists of six major blocks.

Display Memory—consists of a 4 by 7-bit RAM block. Each 7-bit location holds the 7-bit ASCII data for the four displays.

Cursor Memory—holds the cursor data for all the displays.

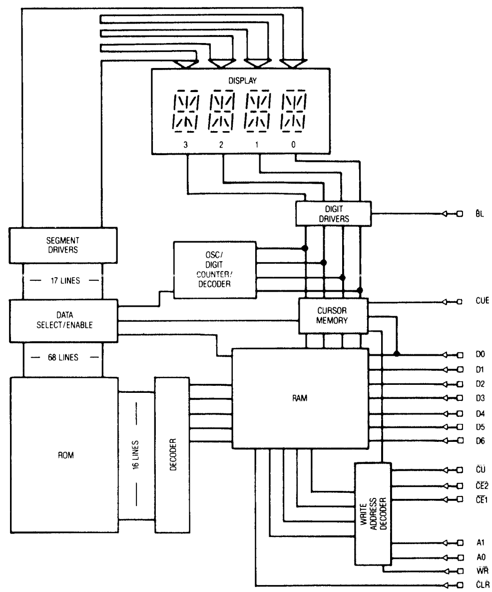
ROM—has a look-up table for the 64 characters.

Oscillator and Multiplex—provides all the necessary timings.

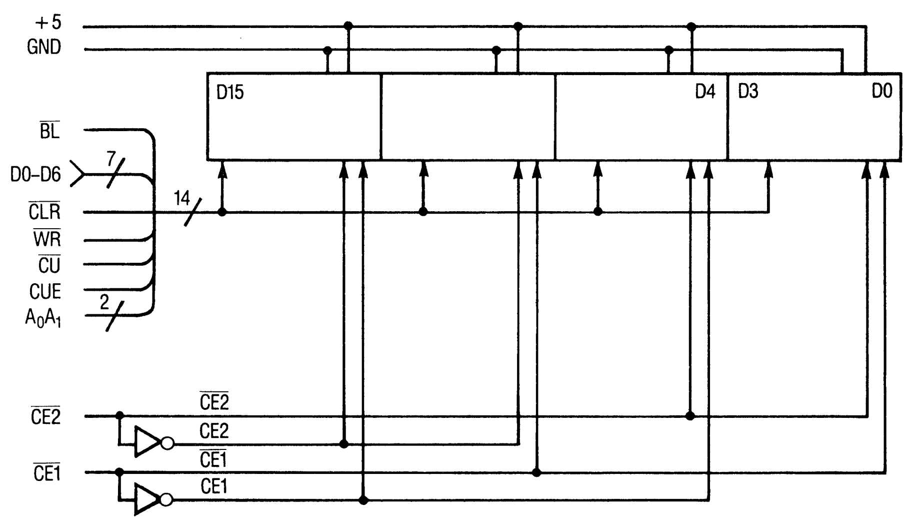
Display Drivers—17 segment drivers and 4 digit drivers.

LED Displays—each display is comprised of 16 segments which make up the alpha-numeric characters and one decimal point.

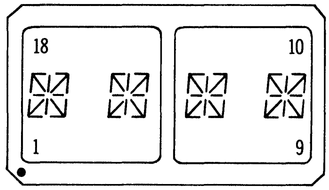
BLOCK DIAGRAM



TYPICAL SCHEMATIC FOR 16 DIGIT SYSTEM



TOP VIEW



Pin	Function	Pin	Function
1	$\overline{CE1}$ Chip Enable	18	$\overline{BL}$ Display Blank
2	$\overline{CE2}$ Chip Enable	17	D4 Data input
3	$\overline{CLR}$ Clear	16	D5 Data input
4	CUE Cursor Enable	15	D6 Data input
5	$\overline{CU}$ Cursor Select	14	D3 Data input
6	$\overline{WR}$ Write	13	D2 Data input
7	A1 Digit Select	12	D1 Data input
8	A0 Digit Select	11	D0 Data input
9	V_{CC}	10	GND

PIN DEFINITIONS

- V_{CC} — Positive power supply.
- Gnd — Negative power supply.
- D0 thru D6 — Data inputs, D0 is the least significant data input and D6 is the most significant data input.
- $\overline{WR}$ — Write input which must be held low to write data into memory.
- $\overline{CE1}$, $\overline{CE2}$ — Two chip enable inputs which must be held low to enable the chip.
- A0 — Least significant address bit.
- A1 — Next to least significant address bit.
- $\overline{CU}$ — Cursor load control which must be held high to store data in the RAM and low to store data in the cursor memory.
- CUE — Cursor function control, displays the cursor in any positions having an "on" in cursor memory.
- $\overline{CLR}$ — An input which clears the RAM when held low for 15ms.
- $\overline{BL}$ — Blanking input. Turns off all segments when held low. Does not affect RAM or cursor memory contents.

HI-REL CONFORMANCE TESTING

Screen	Method	% AQL	Comments
Mechanical Visual (Note 1)	2009.4	1.5%	Mil-Std-883C
Solvent Resistance (Note 1)	2015.4	1.0%	Mil-Std-883C
Solderability (Note 1)	2003.3	1.0%	Mil-Std-883C 2 gm min.
Bond Strength	2011.4 Cond. D	2.5%	Mil-Std-883C
Internal Visual (Note 2)	2017.3	1.0%	Mil-Std-883C
Stabilization Bake	1008.2 Cond. C Table One		24 hrs. @ 150°C Mil-Std-883C
Temperature Cycle	1010.5 Cond. C		10 cycles, −65° to +150°C Mil-Std-883C
Burn-In	1015.4 Cond. B		168 hrs. @ 100°C similar to Mil-Std-883C
Constant Acceleration (centrifuge)	2000.1 Method A		Y1 and Y2 @ 5KG Mil-Std-883C
Gross Leak	1014.5 Cond. C_2		30 psig (for 10 hours) Mil-Std-883C
Fine Leak	1014.5 Cond. A_2		2 atmospheres absolute for 2 hrs. Mil-Std-883C

Note 1: Reduced sample (Mil-Std-105D, Level 1) Note 2: Through glass.

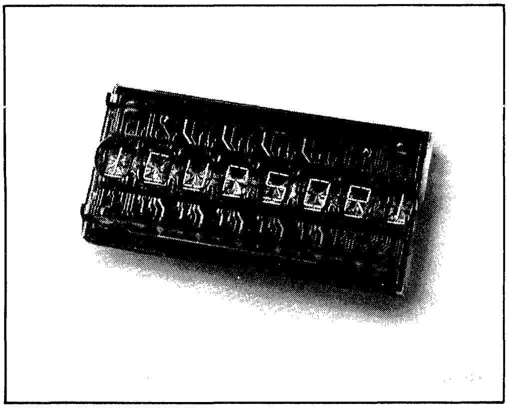
CHARACTER SET

All other input codes display "blank"

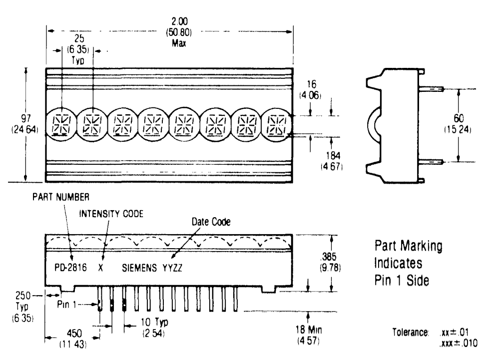
SIEMENS PD-2816

.160" RED, 8 DIGIT, 18 SEGMENT INCLUDING DECIMAL ALPHANUMERIC Programmable Display™ With Built In CMOS Control Functions

Preliminary



Physical Dimensions in inches (mm)



FEATURES

- Microprocessor Compatible
- End Stackable, 8-Character Package 160 Mil High, Magnified Monolithic Char.
- Viewing Angle ± 32°
- 64 Character ASCII Format
- 18-Segment Including Underline and Decimal
- Control & Display Memory Read/Write
- Total Read/Write Time: 200 ns min.
- Built-in Character Generator
- Built-in Multiplex and LED Drive Circuitry
- Software Controlled Features:
  - Programmable Highlight Attribute (Blinking, Non-blinking, Underline)
  - Asynchronous Memory Clear Function
  - Lamp Test
  - Display Blank Function
  - Single or Multiple Character Blinking Function
  - Character Underline Function
  - Programmable Intensity, 3 Brightness Levels
- Intensity Coded For Display Uniformity
- TTL Compatible, Single 5 Volt Power
- Asynchronous Access to Each Digit
- Easily Cascaded
- Internal Or External Clock Source
- Lower CPU Overhead
- Rugged Encapsulated Package

GENERAL DESCRIPTION

The PD-2816 is an 8 digit 18 segment Programmable Display. It is designed to ease the job of interfacing to microcomputer systems by allowing all internal memory and registers to be addressable through the 8 bit bi-directional data bus. A control register accessable through the data bus controls all features of the display. Some of these features include the Highlight Attribute (Blinking, Nonblinking, Underline) and programmable intensity.

The heart of the display device is a built-in CMOS integrated circuit. This integrated circuit contains memory, ASCII ROM character generator, multiplexing circuitry, display drivers, and bus control circuitry. Each display digit is directly addressable and includes a Highlight Attribute control bit. A display system can be built using any number of PD-2816's cascaded together.

The display itself consists of eight 18 segment, 0.160" high characters. Each character contains a decimal point and an underline segment. All displays are intensity coded for ease of brightness matching in multiple module designs.

For further information, refer to PD-2816 data sheet supplement.

Important: Refer to Appnote 18, "Using and Handling Intelligent Displays". Since this is a CMOS device, normal precautions should be taken to avoid static damage.

Specifications are subject to change without notice.

OPTOELECTRONIC CHARACTERISTICS AT 25°C

MAXIMUM RATINGS

Input Voltage Relative to Gnd
(all inputs) −0 5 to V_{CC} +0 5 Vdc
Operating Temperature −20°C to 70°C
Storage Temperature −20°C to 70°C

OPTICAL CHARACTERISTICS

Spectral Peak Wavelength	655nM Typ
Spectral Line Half Width	40nM Typ
Viewing Angle	+/− 32°
Digit Height	160 mils
Luminous Intensity @ VCC = 5V (@ 100% Intensity)	0.15 mcd/Seg
Intensity matching Seg to Seg @ VCC = 5V	1.8:1

D.C. CHARACTERISTICS

Parameters	Conditions	Min.	Typ.	Max.	Units
V_{CC}		4 5		5 5	Volts
I_{CC} (Display Blank)	V_{CC} = 5V, $\overline{WR}$=V_{CC}, VIN=0V	2 0	5 0	10	mA
I_{CC} (10 segs/char 8 digits on)	@ V_{CC}=5V	80	125	150	mA
VIL (All inputs)	@ V_{CC}=5V	-0 5		0 8	Volts
VIH (All inputs) 1)	@ V_{CC}=5V	3 0			Volts
IIL (All inputs)	@ V_{CC}=5V, VIN= 8V			400	μA
CLK Drive CLK I/O Output 2)	@ C_{IN} 15pF / Input	1		6	Devices (PD-2816)

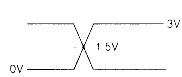
1) VIH Min = 60% V_{CC} 2) See "CASCADING" for explanation.

SWITCHING SPECIFICATIONS (@25°C AND V_{CC} = 4.5V)

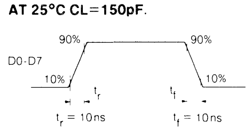
READ CYCLE TIMING		
Parameter	**Description**	**Specification (ns)**
TAS	Address Set up	25 min
TRD	Read pulse	100 min
TDD	Delay before data is valid	150 max
TDH	Data hold valid after $\overline{RD}$	50 typ
TRC	Total cycle time	200 min

WRITE CYCLE TIMING		
Parameter	**Description**	**Specification (ns)**
TWD	Write delay after $\overline{CE1}$, CE2, and Data Stable	50 min
TWR	Write pulse	100 min
TDH	Data hold valid after $\overline{WR}$	50 min
TWC	Total write cycle	200 min

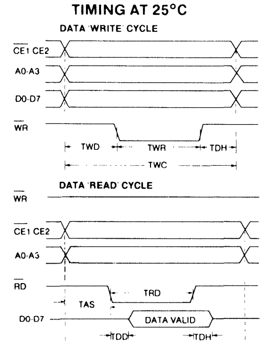
TIMING MEASUREMENT LEVELS



DATA BUS OUTPUT TRANSITIONS AT 25°C CL=150pF.



TIMING AT 25°C



NOTES

Note 1 Off Axis Viewing Angle is here defined as the minimum angle in any direction from the normal to the display surface at which any part of any segment in the display is not visible

Note 2 The display contains a CMOS integrated circuit Normal CMOS handling precautions should be taken to avoid damage due to high static voltages or electric fields

Note 3 Unused inputs must be tied to an appropriate logic voltage level (either V_{CC} or GND)

Note 4 **Warning —** Do not use solvents containing alcohol

CONTROL WORD REGISTER

The control word is addressed by holding line A3 low. The states of the other 3 address lines (A_0-A_2) do not matter. The control word can be read from or written to. The truth table defines each of the bits and their functions.

Bits D0 and D1 control the display brightness. Bits D2, D3 and D4 control the Highlight Attribute function. Bit D5 controls blinking. Bit D6 is a lamp test bit. Bit D7 clears the memory display.

HIGHLIGHT ATTRIBUTE FUNCTION

In the control word bits D2, D3, and D4 control, the Highlight Attribute (Blinking, Non-blinking, Underline).

To control this function, a high must be present on D4.

DISPLAY BRIGHTNESS

The display can be programmed to vary between 25%, 50%, and full brightness. Bits D0 and D1 control the brightness.

DISPLAY BLINKING

The designer has the option of displaying several message priorities by blinking either the character or the underline or both. The entire display can be blinked by writing a high into bit D5 of the control word. This function is independent of the bits D2, D3, & D4. Any character can be blinked by loading the underline and using the proper Highlight Attribute code. Display blinking is approximately at 2Hz.

LAMP TEST

In the control word bit D6 is the Lamp Test bit. In order to limit peak power this sets all segments to a 50% brightness level regardless of what is in the display memory. Setting this bit has no effect on the display memory and clearing it will restore the display to its original condition.

GENERAL FUNCTION

A3	D7	Function
L	L	Various display functions – control word
L	H	Clear
H	L	ASCII character set
H	H	ASCII character set plus underline

Note: Table also applies to control word register.

CONTROL WORD TRUTH TABLE

D7	D6	D5	D4	D3	D2	D1	D0	OPERATION
L	L	X	X	X	X	L	L	BLANK
L	L	X	X	X	X	L	H	25% Brightness
L	L	X	X	X	X	H	L	50% Brightness
L	L	X	X	X	X	H	H	FULL Brightness
L	L	L	H	L	L	B	B	SOLID CHARACTER SOLID UNDERLINE
L	L	L	H	L	H	B	B	BLINK CHARACTER SOLID UNDERLINE
L	L	L	H	H	L	B	B	SOLID CHARACTER BLINK UNDERLINE
L	L	L	H	H	H	B	B	BLINK CHARACTER BLINK UNDERLINE
L	L	L	L	X	X	B	B	DISABLE HIGHLIGHT ATTRIBUTE
L	L	H	X	X	X	B	B	BLINKING DISPLAY (8 Digits)
L	H	L	X	X	X	X	X	LAMP TEST (50% Brightness)
H	L	L	L	L	L	L	L	CLEAR

X = DON'T CARE B = Depending on the selected brightness

DISPLAY BLANKING

The display can be blanked in one of two ways. The first is to clear all display memory locations by writing a high to bit D7 of the control word. This will "clean the slate" and prepare for new data to be displayed. The data in the RAM is cleared. The bit is automatically cleared after the display is cleared.

The second method is a non-destructive method where the display is blanked temporarily and restored again. This is accomplished by writing low in bits D0 and D1 of the control register. The display will be blank until a high is written to either or both bits.

DATA INPUT

The eight words of memory corresponding to the eight display digits are addressed through the address lines (A0-A3) and the chip enable lines ($\overline{CE1}$ and CE2). Address bits A0-A2 address the digits 0 (right most digit) to digit 7 (left most digit). Address bit A3 is held high to address display memory, a low on A3 accesses the control word. Display data is in the 7-bit ASCII format (bits D0-D6). The character set chart shows the resulting font. With the Highlight Attributes (bits D2, D3, & D4) a combination of nonblinking, blinking and underline can be controlled independent of the digit position.

The underline (cursor) is written into the display memory by adding bit D7 to the 6 bit ASCII code of the character. To display the underline, one of the Highlight Attribute control words has to be used see Control Word Truth Table.

READ/WRITE CONTROL ADDRESS TABLE

SIGNALS								OPERATION
$\overline{CE1}$	CE2	$\overline{RD}$	$\overline{WR}$	A3	A2	A1	A0	
L	H	H	H	X	X	X	X	NO OPERATION
X	X	L	L	X	X	X	X	ILLEGAL
L	H	L	H	H	L	L	L	DIGIT 0 (RIGHT) } **READ** DISPLAY DATA RAM
L	H	L	H	H	•	•	•	•
L	H	L	H	H	•	•	•	•
L	H	L	H	H	H	H	H	DIGIT 7 (LEFT)
L	H	L	H	L	X	X	X	READ CONTROL REGISTER
L	H	H	L	H	L	L	L	DIGIT 0 (RIGHT) } **WRITE** DISPLAY DATA RAM
L	H	H	L	H	•	•	•	•
L	H	H	L	H	•	•	•	•
L	H	H	L	H	H	H	H	DIGIT 7 (LEFT)
L	H	H	L	L	X	X	X	WRITE CONTROL REGISTER

X = DON'T CARE

FUNCTIONAL DESCRIPTION

The PD-2816 block diagram includes the major logic blocks and internal registers. Display memory consists of a 9 × 8 bit RAM block. Each of the eight 8-bit words holds the 7-bit ASCII data (bits D0-D6) and 1-bit (bit D7) for underlining each character. The ninth 8-bit memory word is used as control register. A detailed description of the control register and its functions can be found under the heading Control Word Register. Each 8-bit word is addressable and can be read from or written to.

There are five major blocks in addition to the memory. The first is the control word decoder and control logic which dictates all of the special features of the display device. These are discussed under the various headings on the previous page.

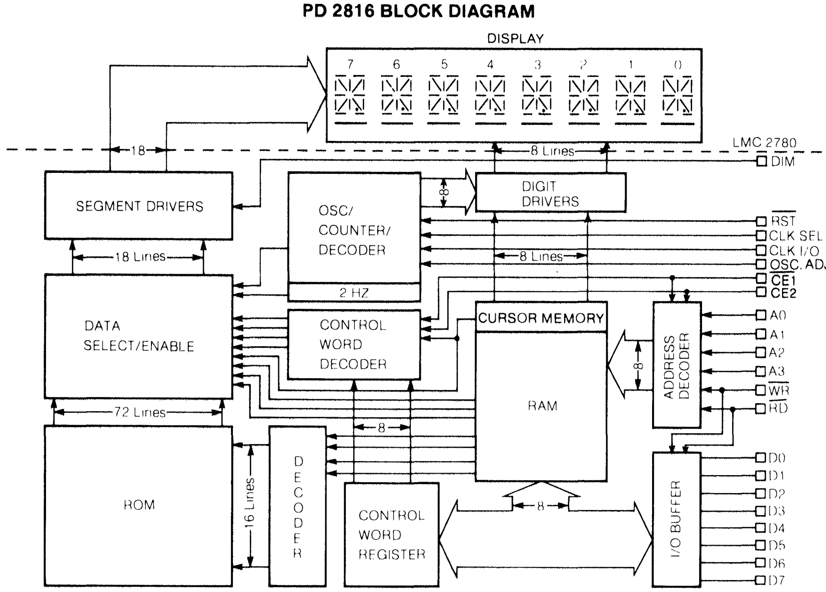
The second block is the character generator ROM. This ROM converts the 7-bit ASCII data into the proper segment configuration for the 64 characters as shown in the character set chart.

The third block is the display multiplexer and timing logic. The clock source can be either from the internal clock or from an external source (usually from the output of another PD-2816 in a multiple module display). The multiplexer controls all display output to the digit drivers so no additional logic is required for a display system.

The fourth block is the display drivers themselves. The segment and digit drivers are located on the CMOS IC and connected directly to the LEDs.

The fifth block is the LEDs. Each of the eight digits is comprised of 16 segments which make up the alpha-numeric characters, one decimal point, and an underline segment. The intensity of the display can be varied by the control word to Blank, 25%, 50%, and full brightness.

PD 2816 BLOCK DIAGRAM



MICROPROCESSOR INTERFACE

The interface to the microprocessor is through the address lines (A0-A3), the data bus (D0-D7), two chip select lines ($\overline{CE1}$, CE2), and the read ($\overline{RD}$) and write ($\overline{WR}$) lines.

Two chip enable lines are provided to simplify address decoding. $\overline{CE1}$ must be low, while CE2 must be high for any read or write operation to take place.

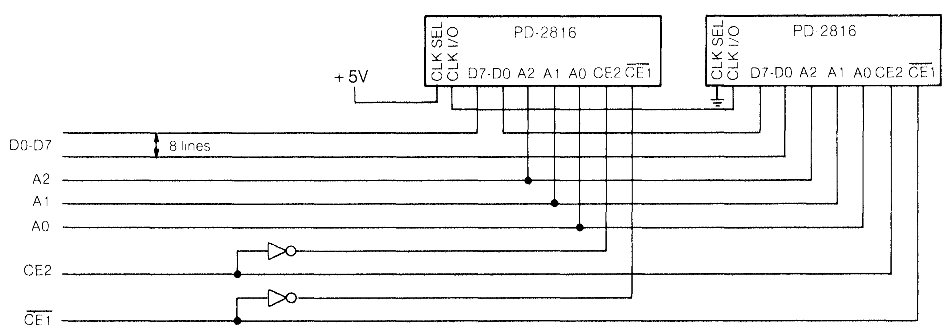
The read and write lines are both active low. During a valid read (ie: chip enable and read low) the data input lines (D0-D7) become output. A valid write will enable the data as input lines.

The address lines determine which RAM or register position will be read or written. If A3 is high then A0-A2 determine the display RAM position. If A3 is low then the operation will be to the control register regardless of the A0-A2 address lines.

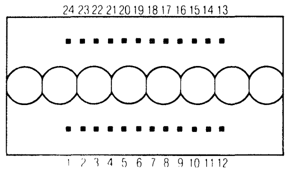
CASCADING

Cascading PD2816's is a simple operation. The requirements for cascading are: 1) decoding the correct address to determine the chip select for each additional device. 2) Selecting one display as the clock source and setting all others to accept clock input (The reason for cascading the clock is to synchronize the flashing of multiple displays). One display as a source is capable of driving 6 other PD2816's (with each input having 15pf input capacitance). If more displays are required a buffer will be necessary.

CASCADING TWO PD-2816s



TOP VIEW



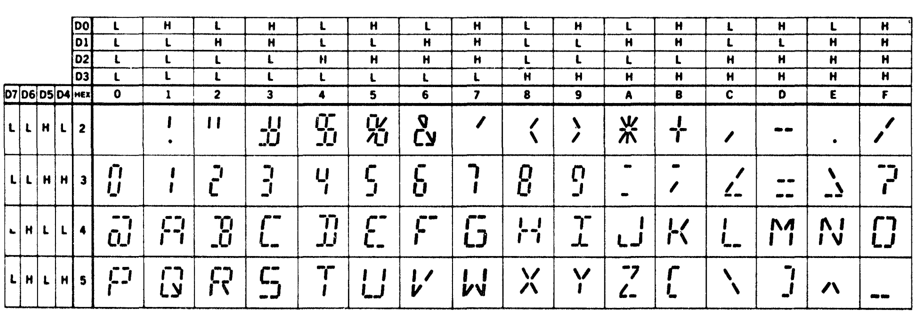
PIN ASSIGNMENTS

Pin	Function		Pin	Function	
1	$\overline{RST}$	RESET	13	DIM	DIMMER
2	A0	ADDRESS LSB	14	$\overline{WR}$	WRITE
3	A1	ADDRESS	15	D0	DATAI/O LSB
4	A2	ADDRESS MSB	16	D1	DATA I/O
5	A3	MODE SELECT D0-D7	17	D2	DATA I/O
			18	D3	DATA I/O
6	$\overline{CE1}$	CHIP SELECT	19	D4	DATA I/O
7	CE2	CHIP SELECT	20	D5	DATA I/O
8	CLK	CLOCK I/O	21	D6	DATA I/O
9	CKS	CLOCK SELECT	22	D7	DATA I/O MSB
10	$\overline{RD}$	READ	23	VCC	
11	OA	OSC ADJUST	24	VCC	
12	GND				

PIN DEFINITIONS

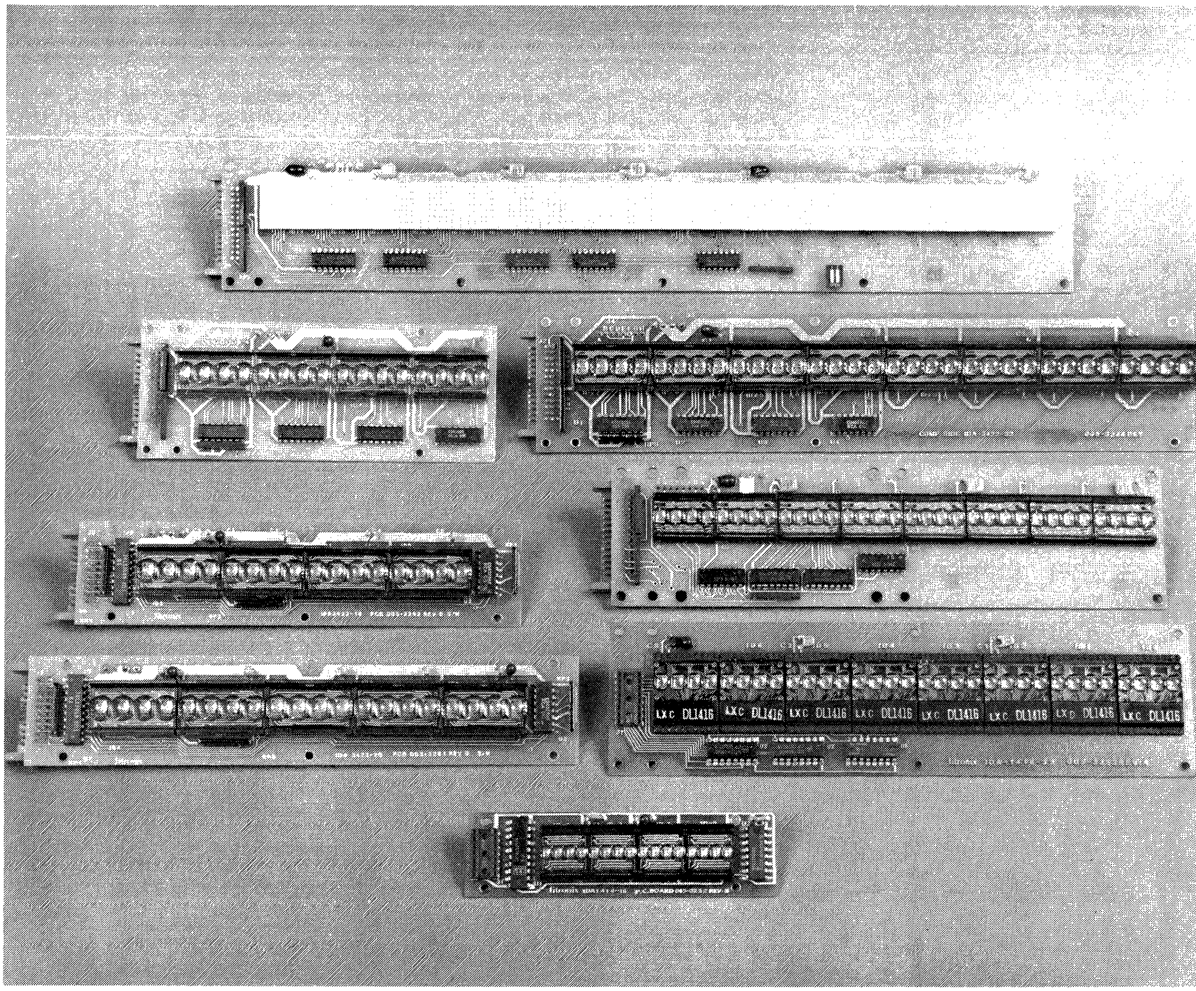
Pin	Function	Description
1	$\overline{RST}$	Active low reset input. Initializes multiplex counter.
2-4	A0-A2	Address inputs for display memory RAM.
5	A3	Selects whether read/write from/to display memory (high) or the control register (low).
6	$\overline{CE1}$	Active low chip enable input
7	CE2	Active high chip enable input.
8	CLK I/O	If CLK SEL is low then this pin inputs external clock source. If CLK SEL is high then this pin outputs internal clock pulses.
9	CLK SEL	Clock select input. When low selects external clock source. When high selects internal clock source
10	$\overline{RD}$	Active low read enable input if the display is selected, a low will enable the output drivers of the data bus.
11	OA	OSC. ADJ. Oscillating Frequency can be adjusted by connecting this pin to V_{CC} through an external resistor.
12	GND	Ground
13	DIM	Hardware display brightness control. When connected through external resistor to V_{CC}, can dim display brightness. For normal operation leave open.
14	$\overline{WR}$	Active low write enable input. If the display is selected a low will write the data on the data bus into the selected register or memory.
15-22	D0-D7	Data Bus. The data bus lines are bidirectional tri state signals connected to the system data bus. The outputs are enabled during a read operation of the display memory or the control register. The outputs are disabled and the inputs read during a write cycle to the display memory or the control register.
23-24	V_{CC}	+5 volt supply – both must be connected.

CHARACTER SET

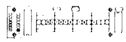
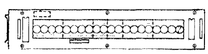
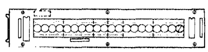
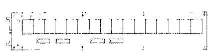


NOTES

1) A3 Must be held high to get into character set
2) All other inputs display Blank
3) When D7 is high, underline is enabled


LXC DL1416
LXC DL1416
LXC DL1416
LXC DL1416
LXC DL1416
LXC DL1416
LXC DL1416
LXC DL1416

LED Intelligent Display Assemblies

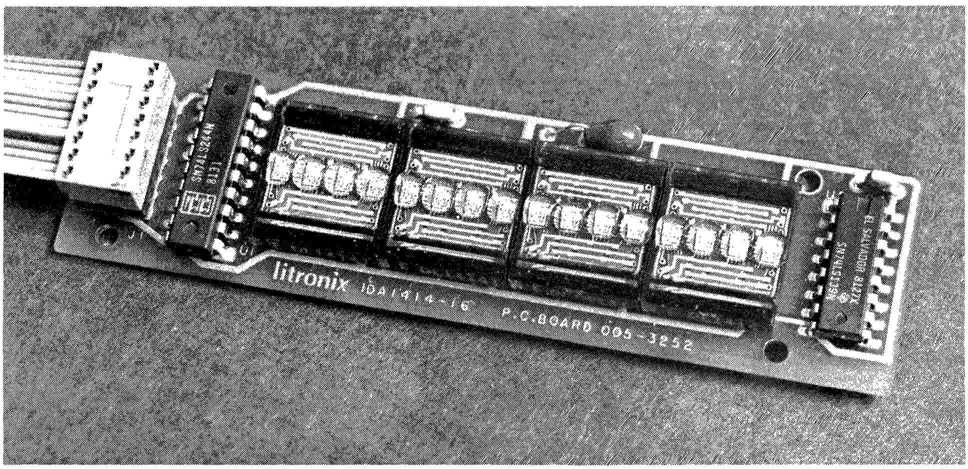
Package Type	Package Outline	Part Number	Character Height	Description	Page
16 Char. Assembly		IDA-1414-16	.112″	16 character assembly containing four DL-1414 displays	105
32 Char. Assembly		IDA-1416-32	.160″	32 character assembly containing eight DL-1416 displays	109
16 & 32 Char. Assembly		IDA-2416-16	.160″	16 character assembly containing four DL-2416 displays	113
		IDA-2416-32		32 character assembly containing eight DL-2416 displays	
16, 20 & 32 Char. Assembly		IDA-3416-16	.225″	16 character assembly containing four DL-3416 displays	117
		IDA-3416-20		20 character assembly containing five DL-3416 displays	
		IDA-3416-32		32 character assembly containing eight DL-3416 displays	
16 & 32 Char. Assembly		IDA-3422-16	.170″/ .100″	16 character assembly containing four DL-3422 displays	121
		IDA-3422-32		32 character assembly containing eight DL-3422 displays. **Phasing out—Not recommended for new designs.**	
16 & 20 Char. Assembly		IDA-7135-16	.68″	16 character, 5x7 dot matrix assembly containing 16 DL-713X displays. Orange.	125
		IDA-7137-16		16 character, 5x7 dot matrix assembly containing 16 DL-713X displays. Green.	
		IDA-7135-20		20 character, 5x7 dot matrix assembly containing 20 DL-713X displays. Orange.	
		IDA-7137-20		20 character, 5x7 dot matrix assembly containing 20 DL-713X displays. Green.	

SIEMENS

IDA-1414-16

.112" Red, 17 Segment, 16 Character DL-1414 Intelligent Display ASSEMBLY

IDA-1414-16-1 Input Data Lines are Buffered
IDA-1416-16-2 Input Data Lines are Not Buffered



FEATURES

- **112 Mil High, Magnified Monolithic Character**
- **Wide Viewing Angle, ± 40°**
- **Complete Alphanumeric Display Assembly Utilizing the DL-1414**
  - **Built-in Multiplex and LED Drive Circuitry**
  - **Built-in Memory**
  - **Built-in Character Generator**
- **Displays 64 Character ASCII Set**
- **Direct Access to Each Digit Independently**
- **Single 5.0 Volt Power Supply**
- **TTL Compatible**
- **Easily Interfaced to a Microprocessor**
- **IDA-1414-16-1 Input Data Lines Are Buffered**
- **IDA-1414-16-2 Input Lines Are Not Buffered**

DESCRIPTION

The IDA-1414-16 Assembly is an extension of the very easy-to-use DL-1414 Intelligent Display™. This product provides the designer with circuitry for display maintenance. It also minimizes interaction and interface normally required between the user's system and a multiplexed alphanumeric display.

The assembly consists of four DL-1414's in a single row, together with decoder and interface buffer on a single printed circuit board. Each DL-1414 provides its own memory, ASCII ROM character decoder, multiplexing circuitry, and drivers for its four 17- segment LED's.

Intelligent Display Assemblies can be used for applications such as data terminals, controllers, instruments, and other products which require an easy to use alpha-numeric display.

IDA 1414-16

Maximum Ratings

V_{CC}	6.0 V
Voltage applied to any input	-0.5 to V_{CC}+0.5 VDC
Operating Temperature	0 to +65° C
Storage Temperature	-20 to +70° C
Relative Humidity (non-condensing) @ 65° C	85%

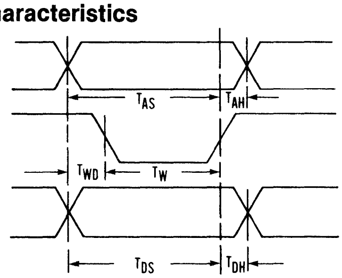
Optoelectronic Characteristics @ 25° C

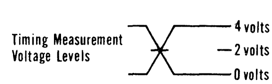
Parameter	Symbol	Min	Typ	Max	Units	Test Conditions
Supply Voltage	V_{CC}	4.75		5.25	V	
Supply Current (Total)	I_{CC}					V_{CC}=5.0 V (10 Segments/Digit)
Supply Current -1				400	mA	
Supply Current -2				380	mA	
Supply Current (Display Blank)	$I_{CCBLANK}$					V_{CC}=5.0 V V_{IN}=0
Supply Current -1				75	mA	
Supply Current -2				25	mA	
Input Voltage — High	V_{IH}					
-1 (D_0-D_6, A_2, A_3, $\overline{WR}$)		2.0			V	
-1 (A_0, A_1)		2.7			V	V_{CC}=4.5 V
		3.5			V	V_{CC}=5.5 V
-2 (D_0-D_6, A_0, A_1)	V_{IH}	2.7			V	V_{CC}=4.5 V
		3.5			V	V_{CC}=5.5 V
-2 (A_2, A_3, $\overline{WR}$)		2.0			V	
Input Voltage — Low	V_{IL}					
All inputs				0.8	V	V_{CC}=4.5 V
Input Current — High	I_{IH}					
Any input				20	μA	V_{CC}=5.5 V, V_I=2.7 V
Input Current — Low	I_{IL}					
Any input				400	μA	V_{CC}=5.5 V, V_I=0.4 V
Luminous Intensity						
Average Per Digit	I_V		0.5		mcd	V_{CC}=5.0 V (8 Segments/Digit)
Peak Emission Wavelength	λpk		660		nm	
Viewing Angle			± 40		Deg	

Switching Characteristics @ 5 V

Parameter	Symbol	(Typ) @ 0°C	(Min) @ 25°C	(Typ) @ 65°C	Units
Write Pulse	T_W	300	325	350	nS
Address/DE Setup Time	T_{AS}	350	400	450	nS
Data Setup Time	T_{DS}	350	400	450	nS
Write Setup	T_{WD}	50	75	100	nS
Data Hold Time	T_{DH}	50	75	100	nS
Address/DE Hold Time	T_{AH}	50	75	100	nS

Timing Characteristics





System Overview

The Intelligent Display Assembly offers the designer 16 alphanumeric characters and operates from just a 5V supply. Based on the previously introduced Litronix DL-1414 four character intelligent display, the IDA 1414-16 adds all the support logic required for direct connection to most microprocessor buses. The system interface takes place through a 14 hole dual in line pattern. The user may solder wires directly into these holes or use a ribbon cable and connectors.

System Power Requirements

Operating from a single +5V power supply, the IDA-1414-16 requires a maximum operating current of 400 mA with ten of the segments lit on each character. With the display blanked, the board circuitry draws 75 mA maximum.

Display Interface

The display interface available on the 14 pin dual in line hole pattern consists of seven data lines (DØ to D6), four address lines (A0 to A3), write pulse, V_{CC}, and Gnd.

$\overline{WR}$ (Write, active low): To store a character in the display memory, this line must be pulsed low for a minimum of 325 ns. See timing diagram for timing and relationships to other signals.

Address lines AØ to A3 are set up so that the right-most character is the lowest address. The left-most character is the highest address. Data lines are set up so that DØ is the least significant bit and D6 is the most significant bit.

Using the Display Interface

Through the use of memory-mapped I/O techniques, the IDA can be treated almost like a memory location—supply the data, address and proper control signals and the characters appear, with each character location independently addressable. The basic signal flow sequence to load a character would start with the address lines going to the desired address. After the address has stabilized, the data can change to the desired values. After the data have stabilized, the $\overline{WR}$ pulse is started, and must remain low for at least 325 ns. Signals must be held stable for 75 ns, minimum, after the rising edge of the $\overline{WR}$ pulse to ensure correct loading, while the addresses must be stable for 400 ns preceding the same rising edge of the $\overline{WR}$ pulse. See the timing diagram for a pictorial explanation.

System Design Considerations

It is often necessary, because of the nature of displays, to use ribbon cable from the CPU board. We have provided a 14 pin dual-in-line hole pattern for this purpose. In those circumstances for cables over 12 inches, use IDA 1414-16-1 (buffered version) instead of IDA 1414-16-2 (non-buffered version). Voltage transients from noisy systems may couple through the cables into the Intelligent Display and can cause serious damage.

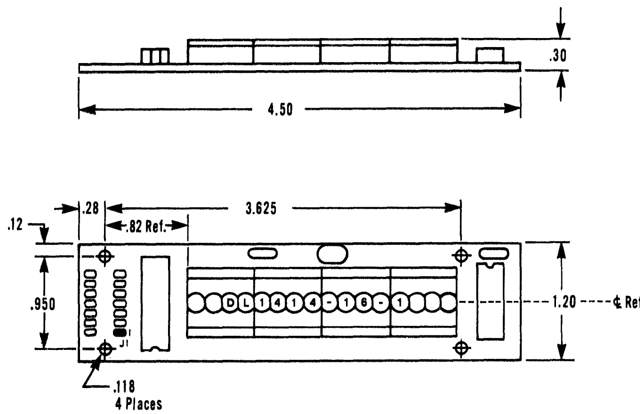
Avoid handling the assembly other than by the edges of the PCB. Static damage can still be a problem, so take the necessary precautions. Keep in conductive material, grounded work areas, etc.

The IDA 1414 assemblies should need minimal cleaning. A gentle wiping with a soft damp cloth should be its only requirement. The solvent that cannot be used on any Intelligent Display product is alcohol. Therefore, if a solvent is used, first check chemical composition before application.

CHARACTER SET

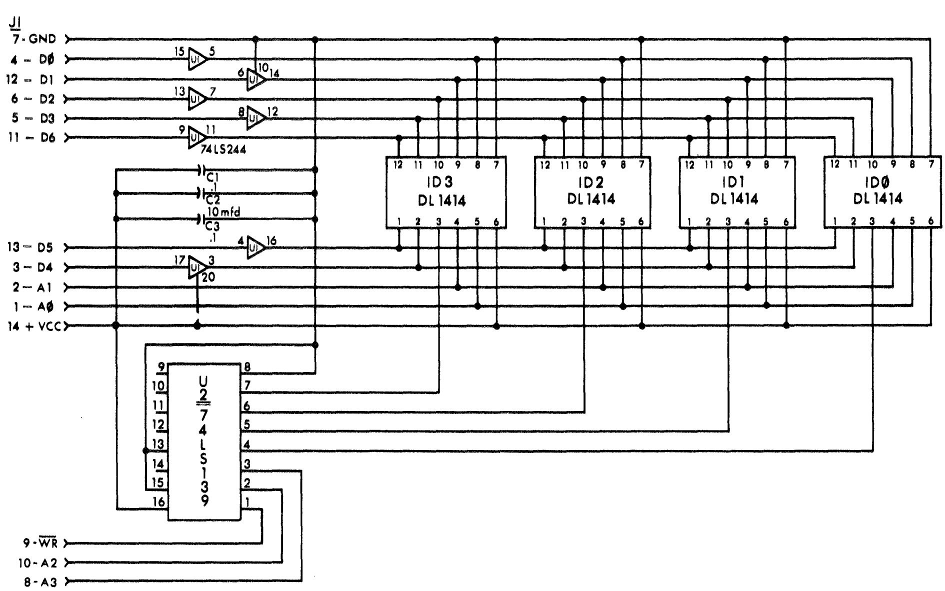
			DO	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
			D1	L	L	H	H	L	L	H	H	L	L	H	H	L	L	H	H
			D2	L	L	L	L	H	H	H	H	L	L	L	L	H	H	H	H
			D3	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H
D6	D5	D4	HEX	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
L	H	L	2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
L	H	H	3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
H	L	L	4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
H	L	H	5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_

Physical Dimensions (in inches)



Wires may be soldered direct to 14 hole dual in line position or contact can be made with ribbon cable and connector such as Berg 65493-006 or Amp 86838-1/86838-2.

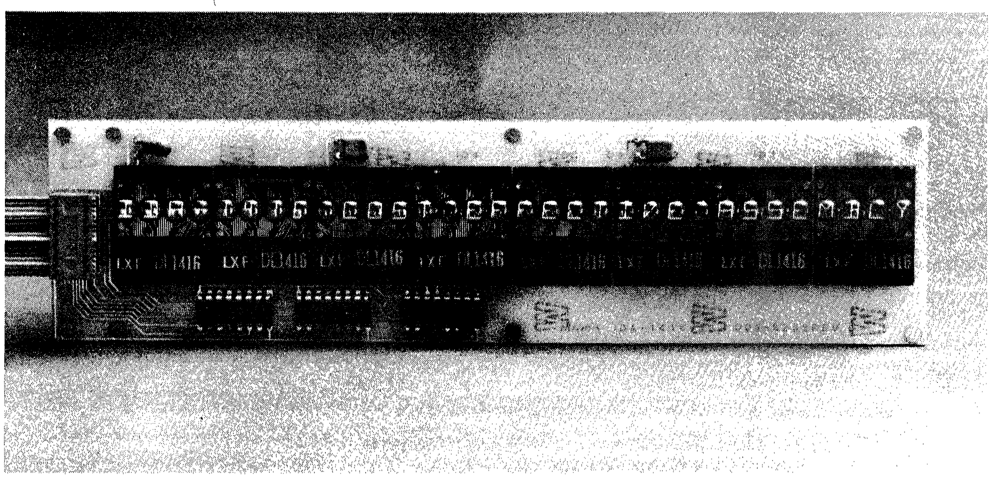
PIN	FUNCTION
1	AØ DIGIT SELECT
2	A1 DIGIT SELECT
3	D4 DATA INPUT
4	DØ DATA INPUT (LSB)
5	D3 DATA INPUT
6	D2 DATA INPUT
7	GND
8	A3 DIGIT SELECT
9	$\overline{WR}$ WRITE
10	A2 DIGIT SELECT
11	D6 DATA INPUT (MSB)
12	D1 DATA INPUT
13	D5 DATA INPUT
14	+VCC



SIEMENS

IDA-1416-32

.160", Red, 16 Segment, 32 Character DL-1416 Intelligent Display ASSEMBLY with Memory/Decoder/Driver



FEATURES

- **160 MIL High Magnified Monolithic Character**
- **Complete Alphanumeric Display Assembly Utilizing the DL-1416**
  - **Built-In Multiplex and LED Drive Circuitry**
  - **Built-In Memory**
  - **Built-In Character Generator**
- **Displays 64 Character ASCII Set**
- **Direct Access to Each Digit Independently**
- **All Inputs are Buffered**
- **Cursor Function**
- **Single 5.0 Volt Power Supply**
- **TTL Compatible**
- **Easily Interfaced to a Microprocessor**

DESCRIPTION

The IDA-1416-32 Assembly is an extension of the very easy-to-use DL-1416 Intelligent Display™. This product provides the designer with circuitry for display maintenance. It also minimizes interaction and interface normally required between the user's system and a multiplexed alphanumeric display.

The assembly consists of eight DL-1416's in a single row together with decoder and interface buffers on a single printed circuit board. Each DL-1416 provides its own memory, ASCII ROM character decoder, multiplexing circuitry, and drivers for its four 16-segment LED's.

Intelligent Display Assemblies can be used for applications such as data terminals, controllers, instruments, and other products which require an easy to use alphanumeric display.

System Overview

The IDA-1416-32 Intelligent Display Assembly offers the designer 32 alphanumeric characters and operates from just a +5 volt supply. Based on the previously introduced Litronix DL-1416 four character Intelligent Display. The IDA-1416-32 adds all the support logic required for direct connection to a host system.

System Power Requirements

Operating from a single +5 volt power supply, the IDA-1416-32 requires a typical operating current of 390mA with ten segments lit for each digit. The maximum operating current with all segments lit for all digits will be 900mA maximum.

Display Interface Signals

The system interface takes place through a 16 hole dual-in-line pattern. The user may solder wires directly into these holes or use a ribbon cable connector. The interface signals available at the 16 holes consist of seven data lines (D∅ to D6), five address (A∅-A4), write and cursor input.

- $\overline{WR}$ (Write, active low): To store a character in the display memory must meet minimum write cycle waveform.
- $\overline{CU}$ (Cursor select, active low): This input must be held high during a write cycle to load ASCII data into memory; and held low during a write cycle to load cursor data into memory. The cursor ($\overline{CU}$) should *not* be hardwired high (off). During the power-up of the DL-1416's the cursor memory will be in a random state. Therefore, it is recommended for the host system to initialize or write out all possible cursors during system initialization. Also, the cursor display will be overridden by a blank from an undefined code in that digit position.

Address lines A∅ to A4 are set up so that the right-most character is the lowest address location. The left-most character is the highest address. Data lines are set up so that D∅ is the least significant bit and D6 is the most significant bit.

Using the Display Assembly

Through the use of memory-mapped I/O techniques, the IDA can be treated almost like a memory location—supply the data, address, proper control signals and the characters appear, with each character location independently addressable. The basic signal flow sequence to load a character would start with the address lines going to the desired address. Data can change to the desired values (including cursor). After the data has stabilized, the write ($\overline{WR}$) pulse is started. See specifications and timing diagram for times and pictorial explanation.

System Design Considerations

It is often necessary, because of the nature of displays, to use cables. Avoid excessively long cables; try to keep them short. Because of current steps due to internal multiplexing, wire length and size will affect load regulation which may cause an incorrect display.

Avoid handling the assembly other than by the edges of the PCB. Static damage can still be a problem, so take the necessary precautions. Keep in conductive material, grounded work areas, etc.

The IDA-1416-32 requires minimal cleaning. A gentle wiping with a soft damp cloth should be its only requirement. The solvent that *cannot* be used on any Intelligent Display product is alcohol, therefore, if a solvent is used, first check chemical composition before application.

CHARACTER SET

NOTE: All undefined data codes that are loaded or occur on power-up will cause a blank display state.

IDA-1416-32

Maximum Ratings

V_{CC} 6.0V
Voltage applied to any input . . . . . -0.5 V to V_{CC} + 0.5V
Operating Temperature . . . . . 0° to +65°C
Storage Temperature . . . . . −20° to +70°C

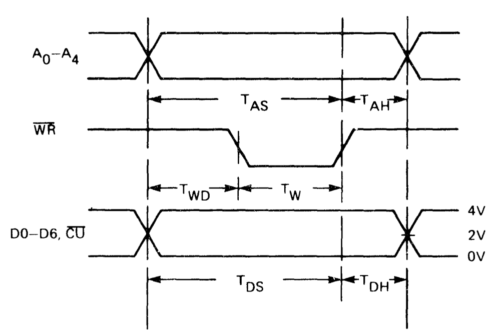
Optoelectronic Characteristic @ 25°C

Parameter	Symbol	Min	Typ	Max	Units	Test Conditions
Supply Voltage	V_{CC}	4.75		5.25	V	
Supply Current	I_{CC}					
Cursor				**900**	mA	V_{CC} = 5V-All segments on.
Blank (Total)				**50**	mA	V_{CC} = 5V Inputs low.
Typical/Digit			390		mA	V_{cc} = 5V (10 segments/digit)
Input Voltage High	V_{IH}	2			V	V_{CC} = 5V
Input Voltage Low	V_{IL}			0.8	V	V_{CC} = 5V
Input Current High	I_{IH}			40	μA	V_{CC} = 5.25 V_I = 2.4V
Input Current Low	I_{IL}			− 1.6	mA	V_{CC} = 5.25 V_I = 0.4V
Luminous Intensity Average per digit	I_V		0.5		mcd	V_{CC} = 5V (8 segment digit)
Peak Emission Wavelength			660		mm	
Viewing Angle			± 20		Deg	

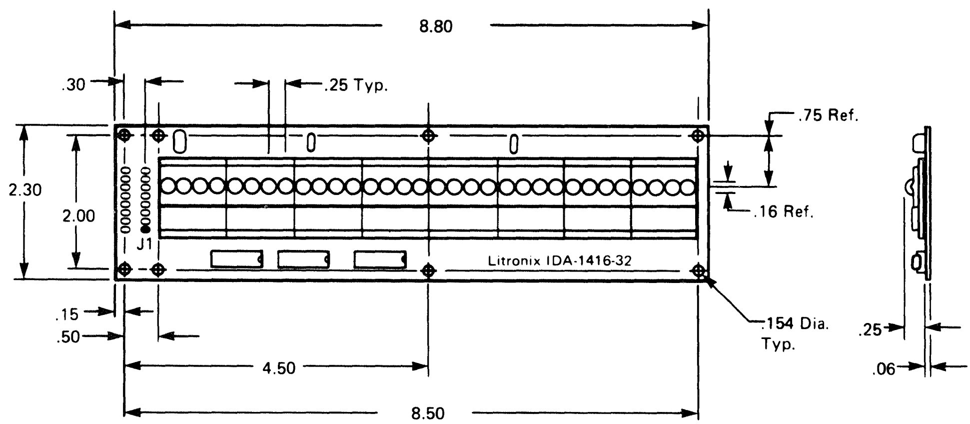
Switching Characteristics

Parameters	Symbol	0°C (Typ)	25°C (Min)	65°C (Typ)	Units
Write Pulse	T_W	475	560	675	nS
Data Setup time	T_{DS}	950	1100	1300	nS
Data hold time	T_{DH}	400	500	600	nS
Address setup time	T_{AS}	950	1100	1300	nS
Address hold time	T_{AH}	400	500	600	nS
Write delay time	T_{WD}	475	540	625	nS

TIMING CHARACTERISTICS

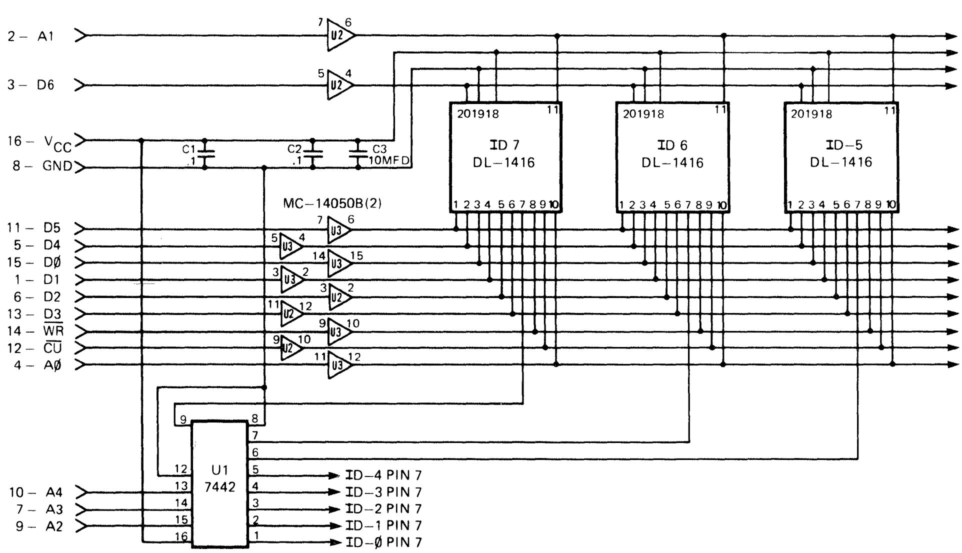


Physical Dimensions (in inches)



PIN	FUNCTION
1	D1 DATA INPUT
2	A1 CHARACTER ADDRESS
3	D6 DATA INPUT
4	AØ CHARACTER ADDRESS
5	D4 DATA INPUT
6	D2 DATA INPUT
7	A3 CHARACTER ADDRESS
8	GND
9	A2 CHARACTER ADDRESS
10	A4 CHARACTER ADDRESS
11	D5 DATA INPUT
12	CU CURSOR INPUT
13	D3 DATA INPUT
14	W WRITE
15	DØ DATA INPUT
16	VCC

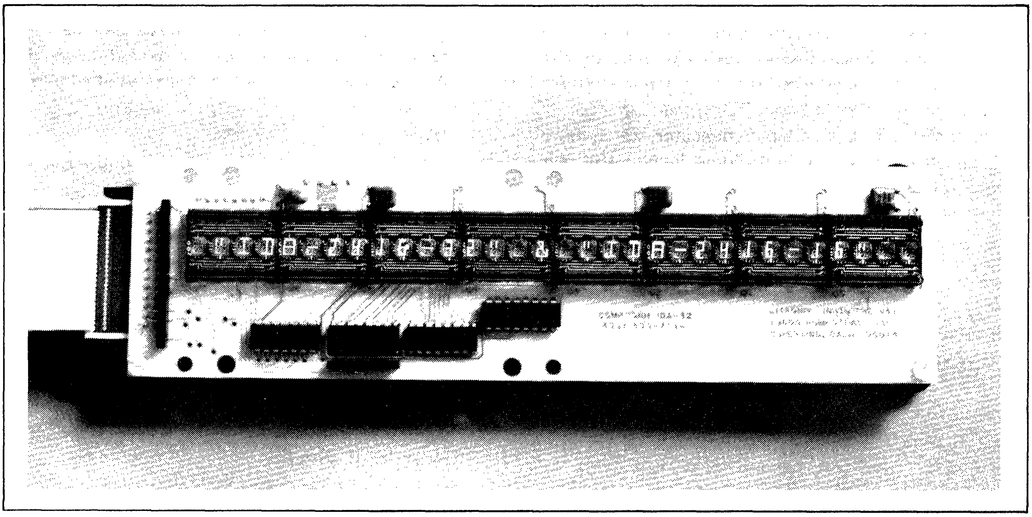
Wires may be soldered directly to 16 hole dual in-line position or contact can be made with ribbon cable and connector such as Berg 65493-008 or Amp 86839-1/86839-2.



SIEMENS

IDA-2416 Series

.160", RED 17 SEGMENT
DL-2416 Intelligent Display ASSEMBLY



FEATURES

- 160 Mil High Magnified Monolithic Character Wide Viewing Angle ± 40°
- Complete Alphanumeric Display Assembly Utilizing the DL-2416
  - Built-in Multiplex and LED Drive Circuitry
  - Built-in Memory
  - Built-in Character Generator
- Displays 64 Character ASCII Set
- Direct Access to Each Digit Independently
- Display Blank Function
- Memory Clear Function
- Cursor Function
- Choice of 16 or 32 Character Display Length (Other lengths optional)
- Single 5.0 Volt Power Supply
- TTL Compatible
- Easily Interfaced to a Microprocessor
- Tri-State or Open-Collector Input Circuitry
- Schmitt Trigger Inputs on Control Lines

The IDA-2416 Series Assembly is an extension of the very easy-to-use DL-2416 Intelligent Display™. This product provides the designer with circuitry for display maintenance. It also minimizes interaction and interface normally required between the user's system and a multiplexed alphanumeric display.

The assembly consists of DL-2416's in a single row together with decoder and interface buffers on a single printed circuit board. Each DL-2416 provides its own memory, ASCII ROM character decoder, multiplexing circuitry, and drivers for its four 17-segment LED's.

Intelligent Display Assemblies can be used for applications such as data terminals, controllers, instruments, and other products which require an easy to use alphanumeric display.

Part Number	Description
IDA-2416-16	Single Line 16 Character Alphanumeric Display Utilizing the DL-2416
IDA-2416-32	Single Line 32 Character Alphanumeric Display Utilizing the DL-2416
	For custom lengths in increments of four characters, consult factory

System Overview

The Intelligent Display Assembly offers the designer a choice of either 16 or 32 alphanumeric characters (the IDA-2416-16 and IDA-2416-32, respectively), and operates from just a +5-V supply. Based on the previously introduced Litronix DL-2416 four-character intelligent display, the IDA-2416 adds all the support logic required for direct connection to most microprocessor buses. The system interface takes place through a 26-pin connector, which has available on it the data and address lines as well as the control signals needed. Two additional connectors are included on the IDA-2416 – one of them is used for the power and ground connections, and the other is used to implement display enable selection.

System Power Requirements

Operating from a single +5-V power supply, the IDA-2416-16 requires a typical operating current of 450 mA with eight of the segments lit on each character. For the 32 character display, the current increases to 850 mA, typical. For the worst-case condition with all segments lit, the 16 character display draws 650 mA and the 32 character display requires 1250 mA. With the display blanked, the board circuitry draws about 70 mA.

Display Interface

The display interface available on the 26-pin connector consists of seven data lines (DØ to D6), five address lines (AØ to A4), four display-enable lines ($\overline{DE1}$ to $\overline{DE4}$), several unused pins, and various control signals. All address, data, and control lines have either pull-up or pull-down 1K ohm resistors.

$\overline{BL}$ (Blanking, active low): When this line is pulled low, it causes the entire IDA display to go blank without affecting the contents of the display memory on the DL-2416s. $\overline{BL}$ is active regardless of address or display enable lines. A flashing display can be realized by pulsing this line.

$\overline{WR}$ (Write, active low): To store a character in the display memory, this line must be pulsed low for a minimum of 350 ns. See timing diagram for timing & relationships to other signals. The $\overline{WR}$ input drives a schmitt-trigger.

CUE (Cursor Enable, active high): When high, this line permits the cursor to be displayed, and when brought low, it disables the cursor function without affecting the stored value. CUE is active regardless of address or display enable lines. A flashing cursor can be created by pulsing the CUE line low.

$\overline{CU}$ (Cursor Select, active low): The cursor function (character with all segments lit) is loaded by selecting the digit address and holding $\overline{CU}$ true. A "1" on DØ writes the cursor. A "Ø" on DØ removes the cursor. The change occurs during the next write pulse per the timing diagram.

$\overline{CLR}$ (Clear, active low): When held low for one display multiplex cycle (see DL-2416 data sheet for more information) of 15 ms, this line will cause all stored characters in the display, except for the cursor, to be cleared. $\overline{CLR}$ is active regardless of address or display enable lines. The $\overline{CLR}$ input drives a schmitt-trigger.

$\overline{DE1}$ to $\overline{DE4}$ (Display Enable, active low): There are four jumper selectable lines, any one of which can be selected to provide one of four board addresses that can be used when multiple IDAs are built into a system. When low, this line enables the selected display to permit data loading. The display enable input drives a schmitt-trigger.

Address lines AØ to A4 are set up so that the right-most character is the lowest address. The left-most character is the highest address. Data lines are set up so that DØ is the least significant bit and D6 is the most significant bit.

Using the Display Interface

Through the use of memory-mapped I/O techniques, the IDA can be treated almost like a memory location – supply the data, address and proper control signals and the characters appear, with each character location independently addressable. The basic signal flow sequence to load a character would start with the address lines going to the desired address while the $\overline{CLR}$ and $\overline{BL}$ lines are high to permit the data to be loaded in and displayed. After the address has stabilized, the data can change to the desired values (including the cursor). After the data have stabilized, the $\overline{WR}$ pulse is started, and must remain low for at least 350 ns. Signals must be held stable for 75 ns, minimum, after the rising edge of the $\overline{WR}$ pulse to ensure correct loading, while the addresses must be stable for 650 ns preceding the same rising edge of the $\overline{WR}$ pulse. See the timing diagram for a pictorial explanation.

Enable Selection

For board enable (the $\overline{DE1}$ through $\overline{DE4}$ lines) the user can choose any one of the four enable signals he has provided on the cable. This signal will be used to provide a master enable to each IDA. All that need be done is to insert the shorting plug in the appropriate position on the pins provided. This allows the user to make the system display the same information on two or more different IDAs or display different information on each of up to four groups of IDA's.

IDA-2416 Series

Maximum Ratings

V_{CC}	6.0 V
Voltage applied to any input	-0.5 to V_{CC} +0.5 VDC
Operating Temperature	Ø to +65°C
Storage Temperature	Ø to +70°C
Relative Humidity (non condensing) @ 65°C	85%

Optoelectronic Characteristics @ 25°C

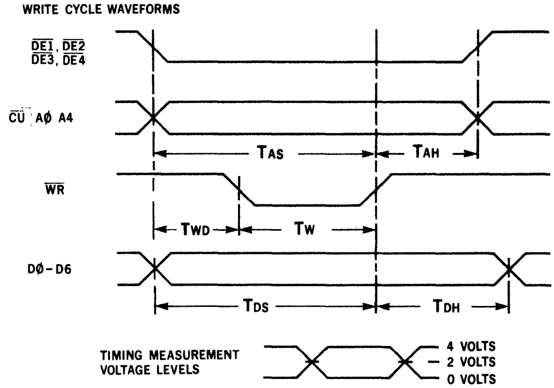
Parameter	Symbol	Min	Typ	Max	Units	Test Conditions
Supply Current/Digit	I_{CC}		25		mA	V_{CC} = 5.0 V (8 Segments/Digit)
Total (IDA-2416-16)	I_{CC}			650	mA	V_{CC} = 5.0 V (All Segments/Digit)
Total (IDA-2416-32)	I_{CC}			1250	mA	V_{CC} = 5.0 V (All Segments/Digit)
Supply Voltage	V_{CC}	4.75	5.00	5.25	V	
Input Voltage — High (All inputs)	V_{IH}	2			V	V_{CC} = 5.0 V ± .25 V
Input Voltage — Low (All inputs)	V_{IL}			0.8	V	V_{CC} = 5
Input Current — High (All inputs)	I_{IH}			40	μA	V_{CC} = 5.5 V, V_I = 2.4 V
Input Current — Low (All inputs)	I_{IL}			2.2	mA	V_{CC} = 5.5 V, V_I = 0.4 V
Luminous Intensity Average Per Digit	I_V		0.5		mcd	V_{CC} = 5.0 V (8 Segments/Digit)
Peak Wavelength	λ_{peak}		660		nm	
Viewing Angle			±45		Deg	Vertical & Horizontal From Normal To Display Plane

Switching Characteristics @ 5 V

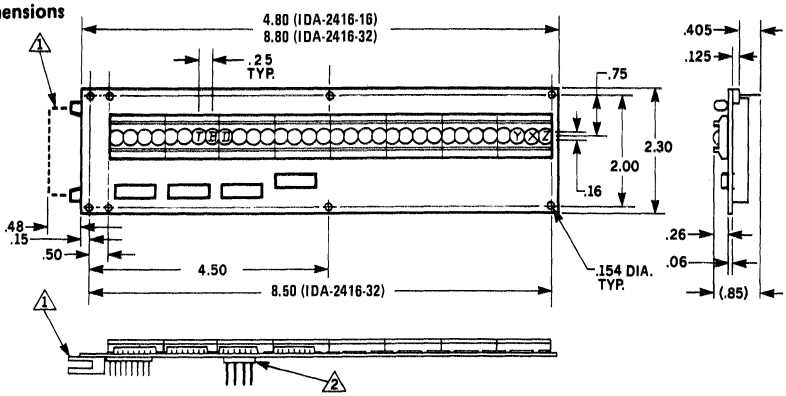
Parameter @ 25°C	Symbol	Min	Units
Write Pulse	T_W	350	nS
Address/DE Setup Time	T_{AS}	550	nS
Data Setup Time	T_{DS}	550	nS
Write Setup	T_{WD}	200	nS
Data Hold Time	T_{DH}	75	nS
Address/DE Hold Time	T_{AH}	75	nS
Clear Time	T_{CLR}	15	mS

TIMING CHARACTERISTICS

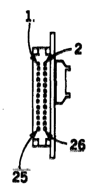
WRITE CYCLE WAVEFORMS



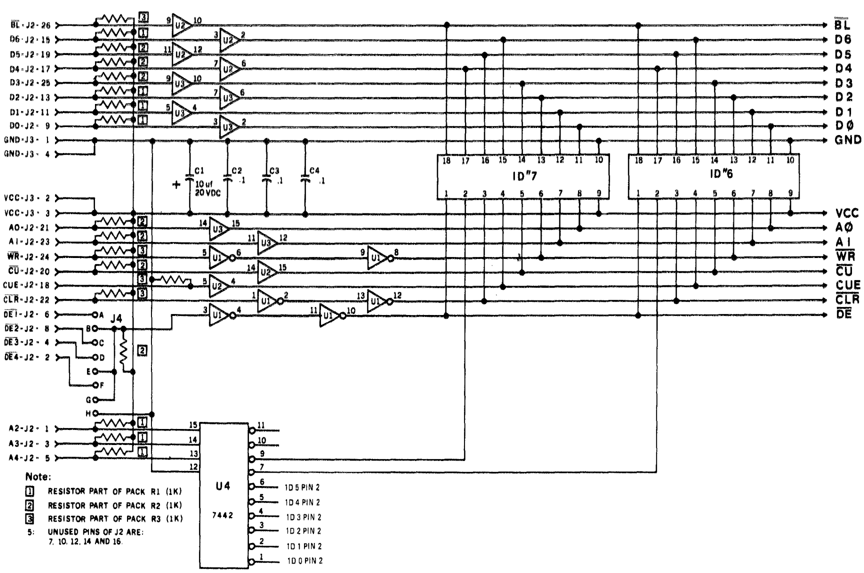
Physical Dimensions



RECOMMENDED MATING CONNECTOR			
Connector	**Function**	**Type**	**Suggested Mfg.**
⚠1 J2	Control/Data	26-Pin Ribbon	BERG P/N 65484-011
⚠2 J3	Power	Molex	AMP P/N 1-87025-3 HOUSING P/N 87026-2

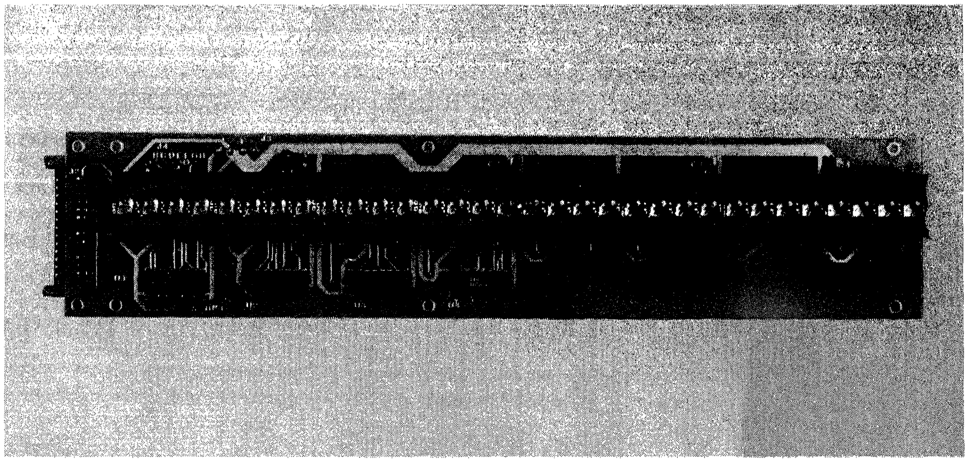


PIN	FUNCTION	PIN	FUNCTION
J2-1	A2 ADDRESS LINE	J2-14	NO CONNECTION
J2-2	$\overline{DE4}$ DISPLAY ENABLE	J2-15	D6 DATA LINE
J2-3	A3 ADDRESS LINE	J2-16	NO CONNECTION
J2-4	$\overline{DE3}$ DISPLAY ENABLE	J2-17	D4 DATA LINE
J2-5	A4 ADDRESS LINE	J2-18	CUE CURSOR ENABLE
J2-6	$\overline{DE1}$ DISPLAY ENABLE	J2-19	D5 DATA LINE
J2-7	NO CONNECTION	J2-20	$\overline{CU}$ CURSOR SELECT
J2-8	$\overline{DE2}$ DISPLAY ENABLE	J2-21	AØ ADDRESS LINE
J2-9	DØ DATA LINE	J2-22	$\overline{CLR}$ CLEAR
J2-10	NO CONNECTION	J2-23	A1 ADDRESS LINE
J2-11	D1 DATA LINE	J2-24	$\overline{WR}$ WRITE
J2-12	NO CONNECTION	J2-25	D3 DATA LINE
J2-13	D2 DATA LINE	J2-26	$\overline{BL}$ BLANKING
J3-1	GND	J3-3	VCC
J3-2	VCC	J3-4	GND



SIEMENS

IDA-3416 Series
.225" Red 17 Segment
DL-3416 Intelligent Display ASSEMBLY



FEATURES

- 225 Mil High Magnified Monolithic Character
- Wide Viewing Angle ± 40°
- Complete Alphanumeric Display Assembly Utilizing the DL-3416
  - Built-in Multiplex and LED Drive Circuitry
  - Built-in Memory
  - Built-in Character Generator
- Displays 64 Character ASCII Set
- Direct Access to Each Digit Independently
- Display Blank Function
- Memory Clear Function
- Cursor Function
- Choice of 16, 20 or 32 Character Display Length (Other lengths optional)
- Single 5.0 Volt Power Supply
- TTL Compatible
- Easily Interfaced to a Microprocessor
- Schmitt Trigger Inputs on Data and Write Lines

The IDA-3416 Series Assembly is an extension of the very easy-to-use DL-3416 Intelligent Display™. This product provides the designer with circuitry for display maintenance. It also minimizes interaction and interface normally required between the user's system and a multiplexed alphanumeric display.

The assembly consists of DL-3416's in a single row together with decoder and interface buffers on a single printed circuit board. Each DL-3416 provides its own memory, ASCII ROM character decoder, multiplexing circuitry, and drivers for its four 17-segment LED's.

Intelligent Display Assemblies can be used for applications such as data terminals, controllers, instruments, and other products which require an easy to use alphanumeric display.

Specifications are subject to change without notice.

Part Number	Description
IDA-3416-16	Single Line 16 Character Alphanumeric Display Utilizing thn DL-3416
IDA-3416-20	Single Line 20 Character Alphanumeric Display Utilizing the DL-3416
IDA-3416-32	Single Line 32 Character Alphanumeric Display Utilizing the DL-3416

For Custom Lengths, in Increments of 4 Characters, Consult the Factory.

IDA-3416 Series

Maximum Ratings	
V_{CC}	6.0 V
Voltage applied to any input	-0.5 to V_{CC} +0.5 VDC
Operating Temperature	0 to +65°C
Storage Temperature	-20 to +70°C

Optoelectronic Characteristics @ 25°C

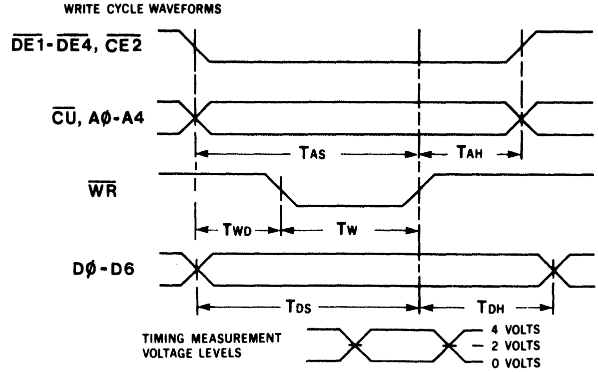
Parameter	Symbol	Min	Typ	Max	Units	Test Conditions
Supply Current/Digit	I_{CC}		25		mA	V_{CC} = 5.0 V (8 Segments/Digit)
Supply Current/Digit	I_{CC}			6	mA	V_{CC} = 5.0 V (Display Blank) VIN = 0V, $\overline{WR}$ = 5V
Total (IDA-3416-16)	I_{CC}			850	mA	V_{CC} = 5.0 V (All Segments/Digit) (See Note 2)
Total (IDA-3416-20)	I_{CC}			1050		V_{CC} = 5.0 V (All Segments/Digit) (See Note 2)
Total (IDA-3416-32)	I_{CC}			1680	mA	V_{CC} = 5.0 V (All Segments/Digit) (See Note 2)
Supply Voltage	V_{CC}	4.75	5.00	5.25	V	
Input Voltage – High (All inputs)	V_{IH}	3.5			V	V_{CC} = 5.0 V ± .25 V
Input Voltage – Low (All inputs)	V_{IL}			0.8	V	V_{CC} = 5
Input Current – High (All inputs)	I_{IH}			40	μA	V_{CC} = 5.5 V, V_I = 2.4 V
Input Current – Low (All inputs)	I_{IL}			6.4	mA	V_{CC} = 5.5 V, V_I = 0.4 V
Luminous Intensity Average Per Digit	I_V		0.8		mcd	V_{CC} = 5.0 V (8 Segments/Digit)
Peak Wavelength	λ_{peak}		660		nm	
Viewing Angle			±40		Deg	Vertical & Horizontal From Normal To Display Plane

Switching Characteristics @ 5 V

Parameter @ 25°C	Symbol	Min	Units
Write Pulse	T_W	350	nS
Address/DE Setup Time	T_{AS}	550	nS
Data Setup Time	T_{DS}	550	nS
Write Setup	T_{WD}	200	nS
Data Hold Time	T_{DH}	75	nS
Address/DE Hold Time	T_{AH}	75	nS
Clear Time	T_{CLR}	15	mS

TIMING CHARACTERISTICS

WRITE CYCLE WAVEFORMS



System Overview

The Intelligent Display Assembly offers the designer a choice of either 16, 20 or 32 alphanumeric characters and operates from just a +5-V supply. Based on the previously introduced Litronix DL-3416 four-character intelligent display, the IDA-3416 adds all the support logic required for direct connection to most microprocessor buses. The system interface takes place through a 20 or 26-pin connector, which has available on it the data and address lines as well as the control signals needed. One additional connector is used for the power and ground connections.

System Power Requirements

Operating from a single +5-V power supply, the IDA-3416 Series Assembly requires a typical operating current of 30 mA per digit with eight of the segments lit on each character. For the worst case condition with all segments lit, the current is 52 mA per digit and with the display blank the current is 6 mA per digit.

Display Interface

The display interface available on the 20 or 26-pin connector consists of seven data lines (DØ to D6), five address lines (AØ to A4), and various control signals. All address, data, and control lines have either pull-up or pull-down 1K ohm resistors. $\overline{BL}$ (Blanking, active low): When this line is pulled low, it causes the entire IDA display to go blank without affecting the contents of the display memory on the DL-3416s. $\overline{BL}$ is active regardless of address or display enable lines. A flashing display can be realized by pulsing this line. $\overline{WR}$ (Write, active low): To store a character in the display memory, this line must be pulsed low for a minimum write time. See timing diagram for timing & relationships to other signals.

CUE (Cursor Enable, active high): When high, this line permits the cursor to be displayed (see Note 2), and when brought low, it disables the cursor function without affecting the stored value. CUE is active regardless of address or display enable lines. A flashing cursor can be created by pulsing the CUE line low.

$\overline{CU}$ (Cursor Select, active low): The cursor function (character with all segments lit) is loaded by selecting the digit address and holding $\overline{CU}$ true. A "1" on DØ inserts the cursor. A "Ø" on DØ removes the cursor. The change occurs during a write pulse per the timing diagram.

$\overline{CLR}$ (Clear, active low): When held low for one display multiplex cycle (see DL-3416 data sheet for more information) of 15 ms, this line will cause all stored characters in the display, except for the cursor, to be cleared. $\overline{CLR}$ is active regardless of address or display enable lines.

$\overline{CE2}$ (Chip Enable, Active Low): To store a character in the display memory, this line must be held low at least 550 nanoseconds preceding the leading edge of the $\overline{WR}$ pulse.

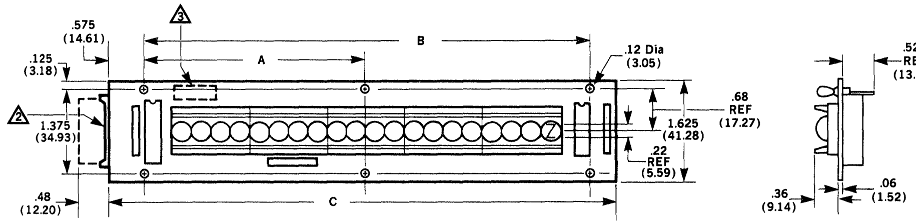
Address lines AØ to A4 are set up so that the right-most character is the lowest address. The left-most character is the highest address. Data lines are set up so that DØ is the least significant bit and D6 is the most significant bit.

Using the Display Interface

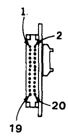
Through the use of memory-mapped I/O techniques, the IDA can be treated almost like a memory location – supply the data, address and proper control signals and the characters appear, with each character location independently addressable. The basic signal flow sequence to load a character would start with the address lines going to the desired address while the $\overline{CLR}$ and $\overline{BL}$ lines are high to permit the data to be loaded in and displayed. After the address has stabilized, the data can change to the desired values (including the cursor). After the data have stabilized, the $\overline{WR}$ pulse is started, and must remain low for at least 350 ns. Signals must be held stable for 75 ns, minimum, after the rising edge of the $\overline{WR}$ pulse to ensure correct loading, while the addresses must be stable for 550 ns preceding the same rising edge of the $\overline{WR}$ pulse. See the timing diagram for a pictorial explanation.

Notes:
1) CMOS Handling precaution – App Note 18
2) Cursor should not be on longer than 60 sec.
3) Cleaning solvents – use NO alcohol

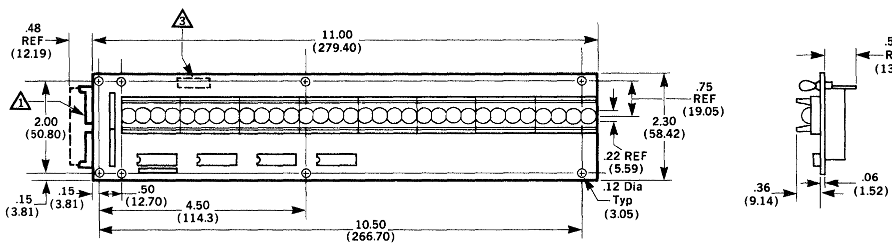
IDA3416 Physical Dimensions

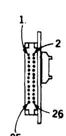


PRODUCT	A	B	C
IDA 3416-16	3.00 (76.20)	6.00 (152.40)	6.95 (176.58)
IDA 3416-20	3.65 (92.71)	7.30 (185.42)	8.25 (209.55)



PIN	FUNCTION	PIN	FUNCTION
J2-1	D6 DATA LINE	J2-11	DI DATA LINE
J2-2	BL BLANKING	J2-12	CE2 CHIP ENABLE
J2-3	D5 DATA LINE	J2-13	DØ DATA LINE
J2-4	UNUSED	J2-14	CU CURSOR SELECT
J2-5	D4 DATA LINE	J2-15	WR WRITE
J2-6	A1 ADDRESS LINE	J2-16	CUE CUSOR ENABLE
J2-7	D3 DATA LINE	J2-17	A3 ADDRESS LINE
J2-8	AØ ADDRESS LINE	J2-18	UNUSED
J2-9	D2 DATA LINE	J2-19	A4 ADDRESS LINE
J2-10	CLR CLEAR	J2-20	A2 ADDRESS LINE
J3-1	GND	J3-3	VCC
J3-2	VCC	J3-4	GND





PIN	FUNCTION	PIN	FUNCTION
J2-1	A2 ADDRESS LINE	J2-14	NO CONNECTION
J2-2	DE4 DISPLAY ENABLE	J2-15	D6 DATA LINE
J2-3	A3 ADDRESS LINE	J2-16	NO CONNECTION
J2-4	DE3 DISPLAY ENABLE	J2-17	D4 DATA LINE
J2-5	A4 ADDRESS LINE	J2-18	CUE CURSOR ENABLE
J2-6	DE1 DISPLAY ENABLE	J2-19	D5 DATA LINE
J2-7	NO CONNECTION	J2-20	CU CURSOR SELECT
J2-8	DE2 DISPLAY ENABLE	J2-21	AØ ADDRESS LINE
J2-9	DØ DATA LINE	J2-22	CLR CLEAR
J2-10	NO CONNECTION	J2-23	A1 ADDRESS LINE
J2-11	D1 DATA LINE	J2-24	WR WRITE
J2-12	NO CONNECTION	J2-25	D3 DATA LINE
J2-13	D2 DATA LINE	J2-26	BL BLANKING
J3-1	GND	J3-3	VCC
J3-2	VCC	J3-4	GND

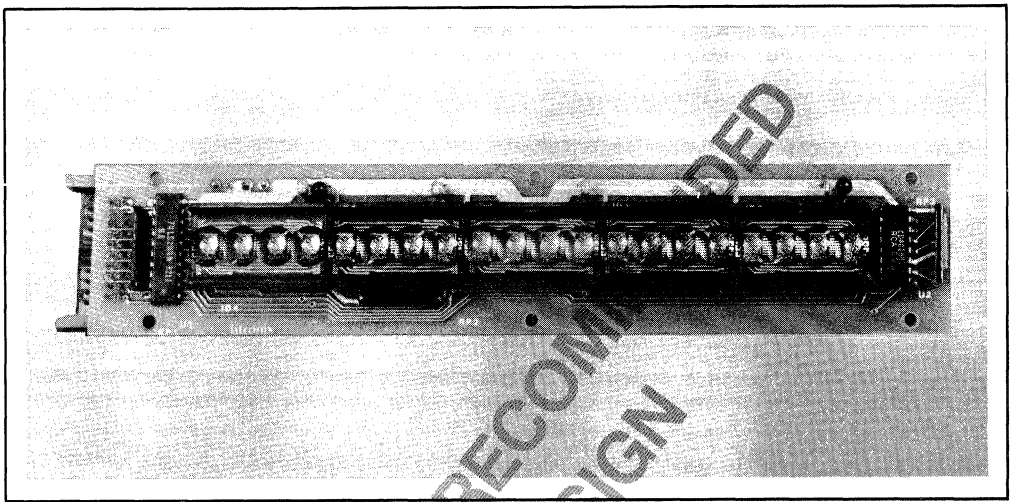
RECOMMENDED MATING CONNECTOR

Connector	Function	Type	Suggested Mfg.
1 J2	Control/Data	20 Pin Ribbon	BERG P/N 65496-007
2 J2	Control Data	26 Pin Ribbon	BERG P/N 65484-011
3 J3	Power	Molex	AMP P/N 1-87205-3 HOUSING P/N 87026-2

SIEMENS

IDA-3422 Series

.170"/.100", Red 17 Segment
DL-3422 Intelligent Display ASSEMBLY



FEATURES

- 170 Mil/100 Mil (NOM) Magnified Monolithic Character
- Wide Viewing Angle ± 50%
- Complete Alphanumeric Display Assembly Utilizing the DL-3422
  - Built-in Multiplex and LED Drive Circuitry
  - Built-in Memory
  - Built-in Character Generator
- Displays 96 Character ASCII Set
- Direct Access to Each Digit Independently
- Display Blank Function
- Memory Clear Function
- Cursor Function
- Choice of 16 or 20 Character Display Length (Other lengths optional)
- Single 5.0 Volt Power Supply
- TTL Compatible
- Easily Interfaced to a Microprocessor
- Schmitt Trigger Inputs on Data and Write Lines

The IDA-3422 Series Assembly is an extension of the very easy-to-use DL-3422 Intelligent Display™. This product provides the designer with circuitry for display maintenance. It also minimizes interaction and interface normally required between the user's system and a multiplexed alphanumeric display.

The assembly consists of DL-3422's in a single row together with decoder and interface buffers on a single printed circuit board. Each DL-3422 provides its own memory, ASCII ROM character decoder, multiplexing circuitry, and drivers for its four 22-segment LED's.

Intelligent Display Assemblies can be used for applications such as data terminals, controllers, instruments, and other products which require an easy to use alphanumeric display.

Specifications are subject to change without notice.

Part Number	Description
IDA-3422-16	Single Line 16 Character Alphanumeric Display Utilizing the DL-3422
IDA-3422-20	Single Line 20 Character Alphanumeric Display Utilizing the DL-3422

For Custom Lengths, in Increments of 4 Characters, Consult the Factory.

IDA-3422 Series

Maximum Ratings	
V_{CC}	6.0 V
Voltage applied to any input	-0.5 to V_{CC} +0.5 VDC
Operating Temperature	0 to +65°C
Storage Temperature	-20 to +70°C

Optoelectronic Characteristics @ 25°C

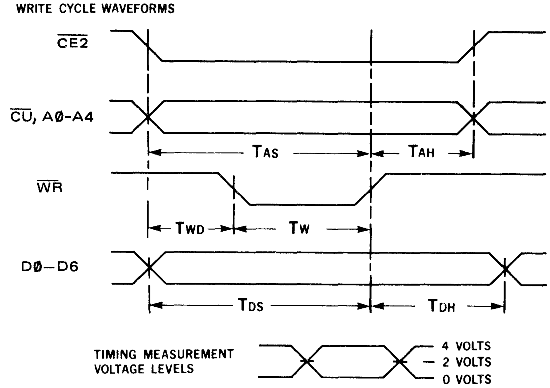
Parameter	Symbol	Min	Typ	Max	Units	Test Conditions
Supply Current/Digit	I_{CC}		20		mA	V_{CC} = 5.0 V (8 Segments/Digit)
Supply Current/Digit	I_{CC}			1	mA	V_{CC} = 5.0 V (Display Blank) VIN = 0V, $\overline{WR}$ = 5V
Total (IDA-3422-16)	I_{CC}			640	mA	V_{CC} = 5.0 V (All Segments/Digit) (See Note 2)
Total (IDA-3422-20)	I_{CC}			800	mA	V_{CC} = 5.0 V (All Segments/Digit) (See Note 2)
Supply Voltage	V_{CC}	4.75	5.00	5.25	V	
Input Voltage — High (All inputs)	V_{IH}	3.5			V	V_{CC} = 5.0 V ± .25 V
Input Voltage — Low (All inputs)	V_{IL}			0.8	V	V_{CC} = 5
Input Current — High (All inputs)	I_{IH}			40	μA	V_{CC} = 5.5 V, V_I = 2.4 V
Input Current — Low (All inputs)	I_{IL}			6.4	mA	V_{CC} = 5.5 V, V_I = 0.4 V
Luminous Intensity Average Per Digit	I_V		0.8		mcd	V_{CC} = 5.0 V (8 Segments/Digit)
Peak Wavelength	λ_{peak}		660		nm	
Viewing Angle			±50		Deg	Vertical & Horizontal From Normal To Display Plane

Switching Characteristics @ 5 V

Parameter @ 25°C	Symbol	Min	Units
Write Pulse	T_W	350	nS
Address/ Setup Time	T_{AS}	550	nS
Data Setup Time	T_{DS}	550	nS
Write Setup	T_{WD}	200	nS
Data Hold Time	T_{DH}	75	nS
Address/ Hold Time	T_{AH}	75	nS
Clear Time	T_{CLR}	15	mS

TIMING CHARACTERISTICS

WRITE CYCLE WAVEFORMS



System Overview

The Intelligent Display Assembly offers the designer a choice of either 16 or 20 alphanumeric characters and operates from just a +5-V supply. Based on the previously introduced Litronix DL-3422 four-character intelligent display, the IDA-3422 adds all the support logic required for direct connection to most microprocessor buses. The system interface takes place through a 20-pin connector, which has available on it the data and address lines as well as the control signals needed. One additional connector is used for the power and ground connections.

System Power Requirements

Operating from a single +5-V power supply, the IDA-3422 Series Assembly requires a typical operating current of 20 mA per digit with eight of the segments lit on each character. For the worst case condition with all segments lit, the current is 52 mA per digit and with the display blank the current is 1 mA per digit.

Display Interface

The display interface available on the 20-pin connector consists of seven data lines (D0 to D6), five address lines (A0 to A4), two unused pins, and various control signals. All address, data, and control lines have either pull-up or pull-down 1K ohm resistors.

$\overline{BL}$ (Blanking, active low): When this line is pulled low, it causes the entire IDA display to go blank without affecting the contents of the display memory on the DL-3422s. $\overline{BL}$ is active regardless of address or display enable lines. A flashing display can be realized by pulsing this line.

$\overline{WR}$ (Write, active low): To store a character in the display memory, this line must be pulsed low for a minimum write time. See timing diagram for timing & relationships to other signals.

CUE (Cursor Enable, active high): When high, this lines permits the cursor to be displayed (see Note 2), and when brought low, it disables the cursor function without affecting the stored value. CUE is active regardless of address or display enable lines. A flashing cursor can be created by pulsing the CUE line low.

$\overline{CU}$ (Cursor Select, active low): The cursor function (character with all segments lit) is loaded by selecting the digit address and holding $\overline{CU}$ true. A "1" on D0 inserts the cursor. A "0" on D0 removes the cursor. The change occurs during a write pulse per the timing diagram.

$\overline{CLR}$ (Clear, active low): When held low for one display multiplex cycle (see DL-3422 data sheet for more information) of 15 ms, this line will cause all stored characters in the display, except for the cursor, to be cleared. $\overline{CLR}$ is active regardless of address or display enable lines.

$\overline{CE2}$ (Chip Enable, Active Low): To store a character in the display memory, this line must be held low at least 550 nanoseconds preceding the leading edge of the $\overline{WR}$ pulse.

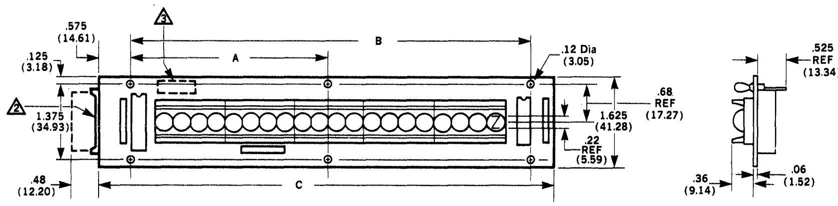
Address lines A0 to A4 are set up so that the right-most character is the lowest address. The left-most character is the highest address. Data lines are set up so that D0 is the least significant bit and D6 is the most significant bit.

Using the Display Interface

Through the use of memory-mapped I/O techniques, the IDA can be treated almost like a memory location – supply the data, address and proper control signals and the characters appear, with each character location independently addressable. The basic signal flow sequence to load a character would start with the address lines going to the desired address while the $\overline{CLR}$ and $\overline{BL}$ lines are high to permit the data to be loaded in and displayed. After the address has stabilized, the data can change to the desired values (including the cursor). After the data have stabilized, the $\overline{WR}$ pulse is started, and must remain low for at least 350 ns. Signals must be held stable for 75 ns, minimum, after the rising edge of the $\overline{WR}$ pulse to ensure correct loading, while the addresses must be stable for 550 ns preceding the same rising edge of the $\overline{WR}$ pulse. See the timing diagram for a pictorial explanation.

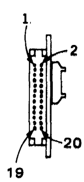
Notes:
1) CMOS Handling Precautions – App Note 18
2) Cursor should not be on any longer than 60 sec.
3) Cleaning solvents – use NO alcohol

Physical Dimensions

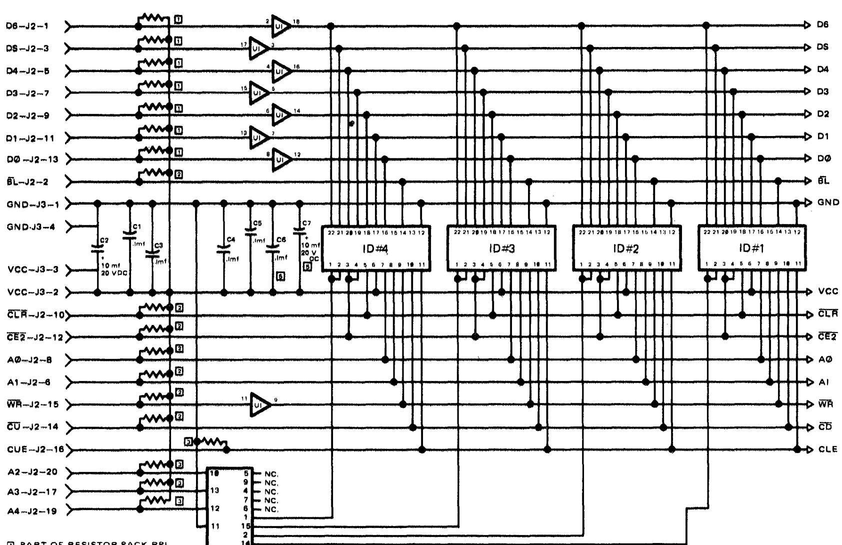


PRODUCT	A	B	C
IDA 3416-16	3.00 (76.20)	6.00 (152.40)	6.95 (176.58)
IDA 3416-20	3.65 (92.71)	7.30 (185.42)	8.25 (209.55)

RECOMMENDED MATING CONNECTOR			
Connector	**Function**	**Type**	**Suggested Mfg.**
2 J2	Control/Data	20 Pin Ribbon	BERG P/N 65496-007
3 J3	Power	Molex	AMP P/N 1-87025-3 HOUSING P/N 87026-2



PIN	FUNCTION	PIN	FUNCTION
J2-1	D6 DATA LINE	J2-11	DI DATA LINE
J2-2	$\overline{BL}$ BLANKING	J2-12	$\overline{CE2}$ CHIP ENABLE
J2-3	D5 DATA LINE	J2-13	DØ DATA LINE
J2-4	UNUSED	J2-14	$\overline{CU}$ CURSOR SELECT
J2-5	D4 DATA LINE	J2-15	$\overline{WR}$ WRITE
J2-6	A1 ADDRESS LINE	J2-16	CUE CUSOR ENABLE
J2-7	D3 DATA LINE	J2-17	A3 ADDRESS LINE
J2-8	AØ ADDRESS LINE	J2-18	UNUSED
J2-9	D2 DATA LINE	J2-19	A4 ADDRESS LINE
J2-10	$\overline{CLR}$ CLEAR	J2-20	A2 ADDRESS LINE
J3-1	GND	J3-3	VCC
J3-2	VCC	J3-4	GND

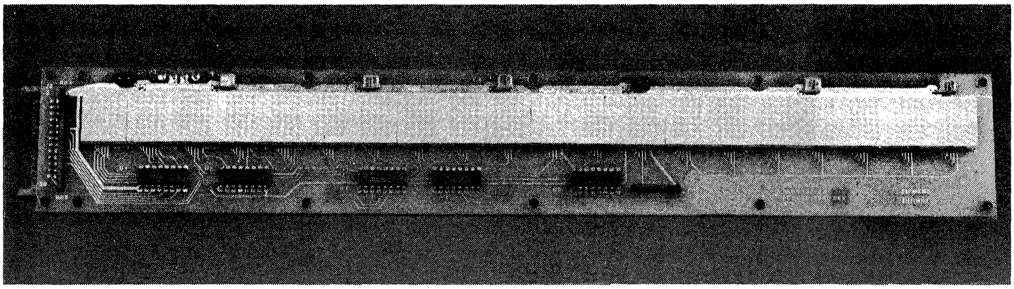


1 PART OF RESISTOR PACK RPI
2 PART OF RESISTOR PACK RP2
3 PART OF RESISTOR PACK RP3
• UNUSED PINS OF J2 ARE: 4&18.
5 USED ON 3422-20 ONLY

SIEMENS

Orange IDA-7135 Series
Green IDA-7137 Series

.68″ HIGH, 5 x 7 DOT MATRIX Intelligent Display® ASSEMBLY



FEATURES

- **A Complete Alphanumeric Display Assembly Utilizing the DLX-713X Series 5 x 7 Dot Matrix Display**
  - **Built-in Multiplex and LED Drive Circuitry**
  - **Built-in Memory**
  - **Built-in Character Generator**
- **Displays 96 Character ASCII Set, Including Both Upper and Lower Case Characters**
- **Direct Access to Each Digit Independently**
- **Three Brightness Levels**
- **Display Blank Function**
- **Lamp Test Function**
- **Wide Viewing Angle, ±50°**
- **Readable in High Ambient Lighting**
- **Available in Orange and Green**
- **Choice of 16 or 20 Character Display Lengths**
- **Single 5.0 Volt Power Supply Requirement**
- **Easily Interfaced to a Microprocessor**
- **TTL Compatible**
- **Fully Buffered Inputs**

DESCRIPTION

The IDA-713X Series Assembly is an extension of the single character DLX-713X, 5 × 7 fully intelligent dot matrix display. This display assembly provides the designer with circuitry for display maintenance, while minimizing the interaction and interface normally required between the user's system and a multiplexed alphanumeric display.

The assembly consists of DLX-713X's in a single row, together with the necessary address decoders and interface buffers, on a single printed circuit board. Each DLX-713X provides its own memory, ASCII ROM character generator, multiplexing circuitry, and drivers for the 35 LED dots.

Intelligent Display Assemblies can be used for applications such as P.O.S. terminals, message systems, industrial equipment, instrumentation, and any other products requiring a large, easily readable, "user friendly", alphanumeric display.

For additional information refer to Appnote 25.
For cleaning we recommend De-ionized water, Isopropyl Alcohol, Freon TE or Freon TF.

Important: Refer to Appnote 18, "Using and Handling Intelligent Displays." Since this is a CMOS device, normal precautions should be taken to avoid static damage.

Specifications are subject to change without notice.

Part Number	COLOR	Description
IDA-7135-16	Orange	Single Line, 16 Character Alphanumeric Display Utilizing the DLO-7135
IDA-7137-16	Green	Single Line, 16 Character Alphanumeric Display Utilizing the DLG-7137
IDA-7135-20	Orange	Single Line, 20 Character Alphanumeric Display Utilizing the DLO-7135
IDA-7137-20	Green	Single Line, 20 Character Alphanumeric Display Utilizing the DLG-7137

MAXIMUM RATINGS	
V_{CC}	6.0 V
Voltage applied to any input	-0.5 to $V_{CC}+0.5$VDC
Operating Temperature	0°C to +65°C
Storage Temperature	−20°C to +65°C
Relative Humidity (non condensing) @ 65°C	85%

SWITCHING CHARACTERISTICS @ 5V

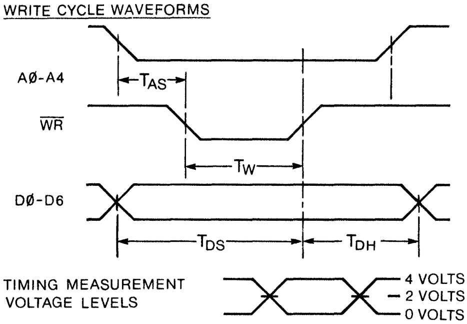
Parameter @ 25°C	Symbol	Minimum	Units
Write Pulse	T_W	200	ns
Data Setup Time	T_{DS}	230	ns
Hold Time	T_{DH}	100	ns
Address Setup	T_{AS}	30	ns

OPTOELECTRONIC CHARACTERISTICS AT 25°C

Parameter	Symbol	Min	Typ	Max	Units	Test Conditions
Supply Current/Digit	I_{CC}		170	220	mA	$V_{CC}=5.0$ V, $\overline{BL0}=\overline{BL1}=1$
Supply Current/Digit (Blank)	I_{CC}		5	10	mA	$V_{CC}=5.0$ V, $\overline{BL0}=\overline{BL1}=0$
Supply Current/Digit	I_{CC}		85		mA	$V_{CC}=5.0$ V, $\overline{BL0}=0$, $\overline{BL1}=1$
Supply Current/Digit	I_{CC}		42		mA	$V_{CC}=5.0$ V, $\overline{BL0}=1$, $\overline{BL1}=0$
Supply Voltage	V_{CC}	4.75		5.25	VDC	
Input Voltage-High (All inputs)	V_{IH}	2.7			VDC	$V_{CC}=5.0V \pm .25V$
Input Voltage-Low (All inputs)	V_{IL}			1.0	VDC	$V_{CC}=5.0V$
Input Current	I_{IL}			160	uA	$V_{CC}=5.0V$
Luminous Intensity/Dot Average	I_V		250		μCD	$V_{CC}=5.0V$
Peak Wave Length						
IDA-7137			565 (Green)		nm	
IDA-7135			640 (Orange)		nm	
Viewing Angle			±50°		Deg	

TIMING CHARACTERISTICS

WRITE CYCLE WAVEFORMS



SYSTEM OVERVIEW

The Intelligent Display Assembly offers the designer a choice of either 16 (IDA-713X-16) or 20 (IDA-713X-20) alphanumeric characters. Based on the DLX-713X intelligent dot matrix display, the IDA-713X adds all the support logic required for direct connection to most microprocessor buses. The system interface takes place through a 26 pin connector, which has the data and address lines as well as the control signals available on it. One additional connector is used for the power and ground connections.

SYSTEM POWER REQUIREMENTS

Operating from a single +5V power supply, the IDA-713X-16 requires a typical operating current of 2720 mA at brightest level. For the 20 character assembly, typical operating current is 3400 mA. For worst case conditions, the 16 character assembly draws 3520 mA, while the 20 character assembly draws 4400 mA. With the display blanked, the board circuitry for the 16 character assembly draws 80 mA, and the 20 character assembly draws 100 mA.

DISPLAY INTERFACE

The display interface available on the 26 pin connector consists of seven data lines (D0 to D6),* five address lines (A0 to A4, see Note 3), two brightness inputs ($\overline{BL0}$ to $\overline{BL1}$), lamp test ($\overline{LT}$), the Chip Enable ($\overline{CE}$), and the Write line ($\overline{WR}$). All address and data lines have 1K ohm pull up resistors.

$\overline{BL0}$ and $\overline{BL1}$ (Brightness, active low): When both of these are pulled low, it causes the entire IDA display to go blank without affecting the contents of the display memory on the DLX-713X's. $\overline{BL}$ is active regardless of address or display enable lines. These two lines are used to vary the intensity of the display to one of four levels.

$\overline{WR}$ (Write, active low): To store a character in the display memory, this line must be pulsed low for a minimum of 200 ns. See timing diagram for timing and relationships to other signals.

$\overline{LT}$ (Lamp test, active low): This line can be pulsed to light all display dots.

*For IDA 713X-16 only.
Four address bits are used.

DIMMING AND BLANKING THE DISPLAY

Brightness Level	$\overline{BL1}$	$\overline{BL0}$
Blank	0	0
¼ Brightness	0	1
½ Brightness	1	0
Full Brightness	1	1

USING THE DISPLAY INTERFACE

Through the use of memory-mapped I/O techniques, the IDA can be treated almost like a memory location—supply the data, address and proper control signals and the characters appear, with each character location independently addressable. The basic signal flow sequence to load a character would start with the address lines going to the desired address. After the address has stabilized, the data can change to the desired values. After the data has stabilized, the $\overline{WR}$ pulse is started and must remain low for at least 200 ns to ensure correct loading. See the timing diagram for a pictorial explanation. Either $\overline{BL0}$ or $\overline{BL1}$ should be held high for displays to light up.

LAMP TEST

The lamp test ($\overline{LT}$) when activated causes all dots on the display to be illuminated at half brightness. The lamp test function is independent of write ($\overline{WR}$) and the settings of the blanking inputs ($\overline{BL0}$), $\overline{BL1}$).

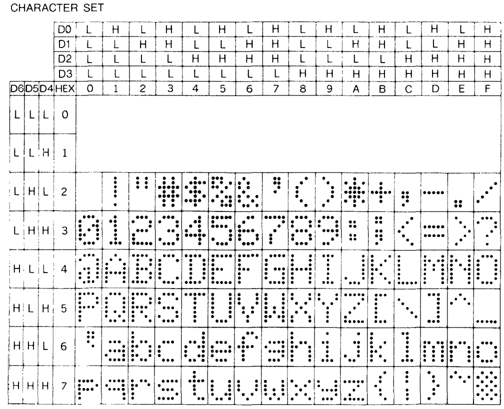
This convenient test gives a visual indication that all dots are functioning properly. Lamp test may also be used as a cursor function or pointer which does not destroy previously displayed characters.

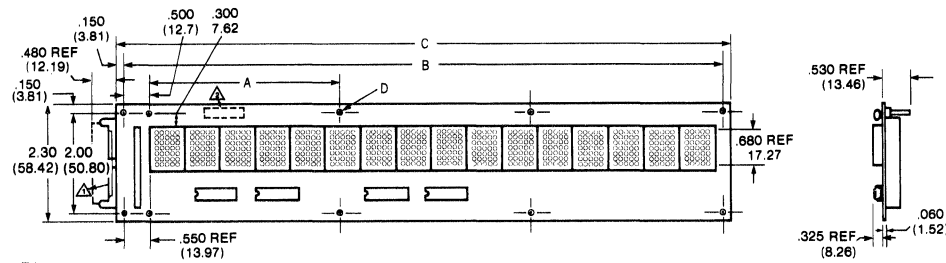
IDA 713X-XX* DIGIT ADDRESSING TRUTH TABLE

Address Bit					Intelligent Display Device Number																			
A4	A3	A2	A1	A0	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
0	0	0	0	0	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
0	0	0	0	1	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
0	0	0	1	0	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
0	0	0	1	1	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
0	0	1	0	0	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
0	0	1	0	1	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H
0	0	1	1	0	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H
0	0	1	1	1	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H
0	1	0	0	0	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H
0	1	0	0	1	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H
0	1	0	1	0	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H
0	1	0	1	1	H	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H
0	1	1	0	0	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H
0	1	1	0	1	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H
0	1	1	1	0	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H
0	1	1	1	1	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H
1	0	0	0	0	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H	H
1	0	0	0	1	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H
1	0	0	1	0	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H
1	0	0	1	1	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L

*Entire area is for 20 characters, smaller portion is for 16 characters.

CHARACTER SET

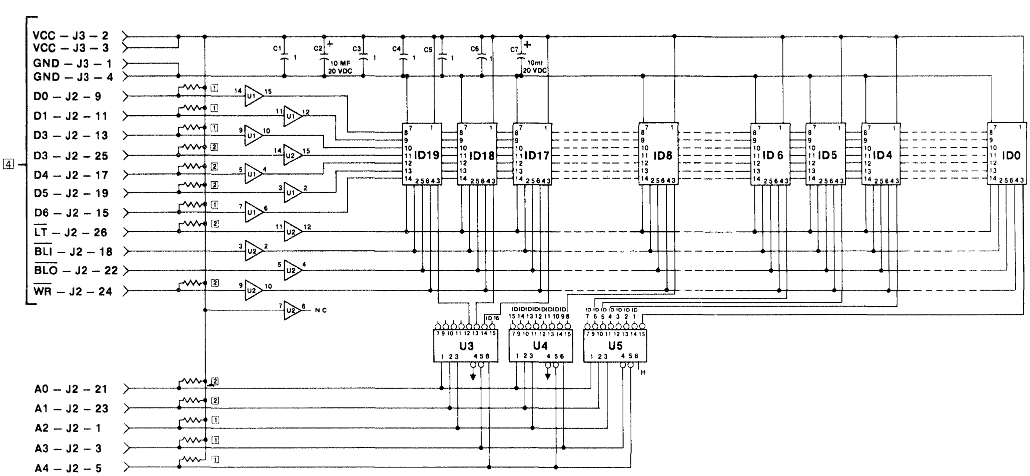




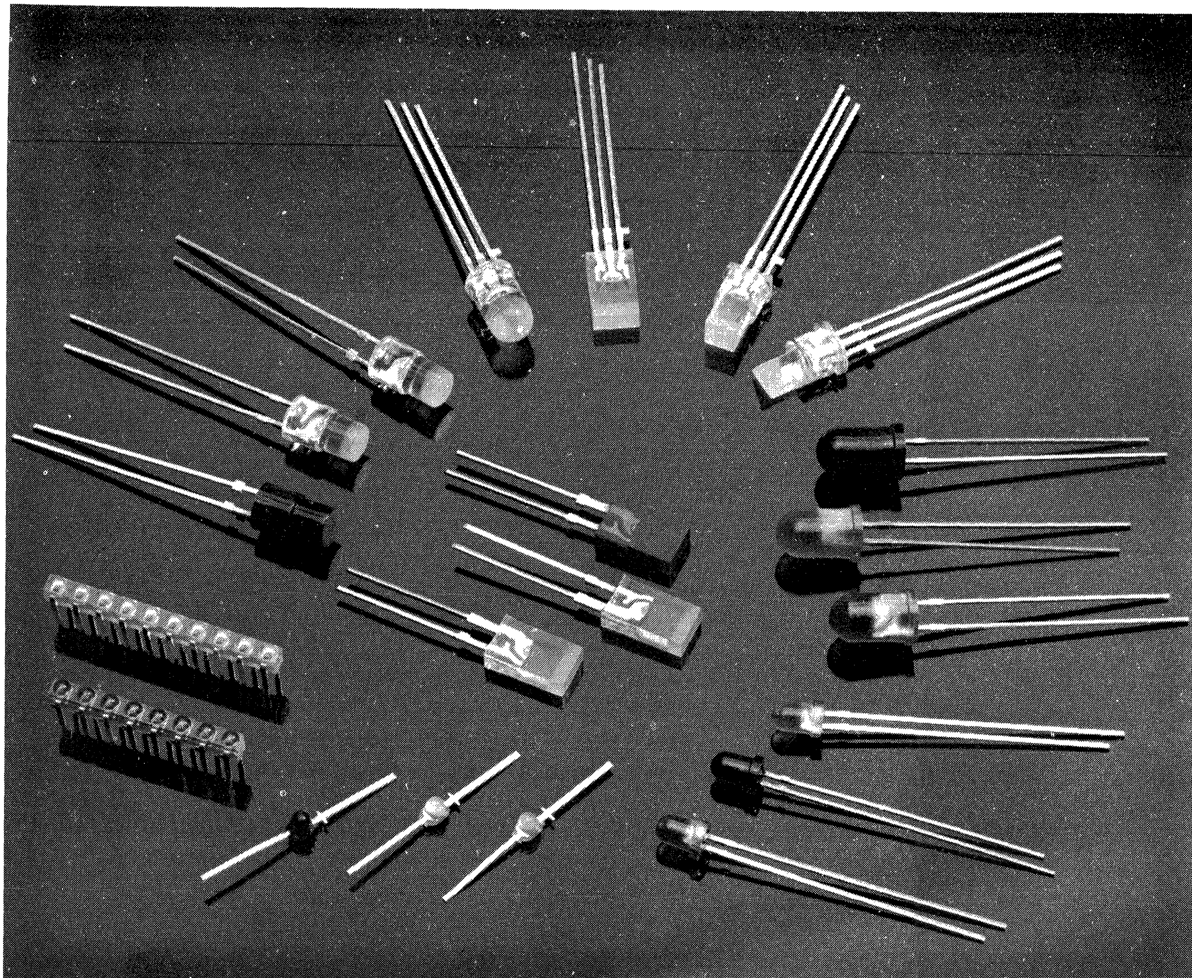
Pin	Function	Pin	Function
J2-1	A2 Address Line	J2-14	No Connection
J2-2	No Connection	J2-15	D6 Data Line
J2-3	A3 Address Line	J2-16	No Connection
J2-4	No Connection	J2-17	D4 Data Line
J2-5	A4 Address Line	J2-18	$\overline{BL1}$ Brightness
J2-6	No Connection	J2-19	D5 Data Line
J2-7	No Connection	J2-20	No Connection
J2-8	No Connection	J2-21	A0 Address Line
J2-9	D0 Data Line	J2-22	$\overline{BL0}$ Brightness
J2-10	No Connection	J2-23	A1 Address Line
J2-11	D1 Data Line	J2-24	$\overline{WR}$ Write
J2-12	No Connection	J2-25	D3 Data Line
J2-13	D2 Data Line	J2-26	$\overline{LT}$ Lamp Test
J3-1	GND Ground	J3-3	V_{CC}
J3-2	V_{CC}	J3-4	GND Ground

Product	A	B	C	D
IDA-7135-16 IDA-7137-16	3.80 Typ. (96.52)	11.90 (302.26)	12.05 (306.07)	.120 Typ 10 places (3.05)
IDA-7135-20 IDA-7137-20	3.55 Typ (90.17)	14.70 (373.38)	14.85 (377.19)	.155 Typ 12 places (3.94)

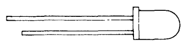
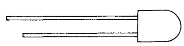
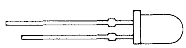
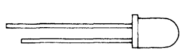
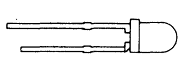
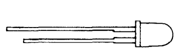
RECOMMENDED MATING CONNECTOR			
Connector	Function	Type	Suggest Mfg.
⚠ J2	Control/Data	26-Pin Ribbon	BERG P/N 65948-011
⚠ J3	Power	Molex	AMP P/N 87066-4



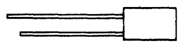
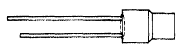
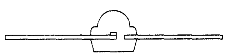
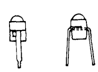
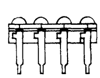
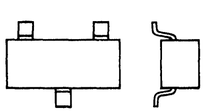
NOTE: 1 Part of Resistor Pack RP1 (IK SIP)
2 Part of Resistor Pack RP2 (IK SIP)
3 Address bits A0-A4 are decoded by ICs, U3-U5 to enable ID0-ID19.
4 All like lines on all displays are tied together; e.g., $\overline{LT}$, $\overline{WR}$, $\overline{BL1}$, $\overline{BL0}$, etc.



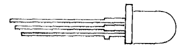
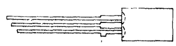
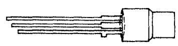
LED LAMPS

Package Type and Spacing	Package Outline	Color	Part Number	Lens	Viewing Angle	Luminous Intensity (mcd)	Luminous Intensity (mA)	Max Fwd. Current (mA)	Page
T1¾ 5mm 1″ Leads 100 mil lead spacing No standoffs		Red	LDR5101	Red Diffused	70°	1.0	20	100	173
			LDR5102			2.5			
			LDR5103			4.0			
		High Efficiency Red	LDH5121			2.0	10	60	
			LDH5122			4.0			
			LDH5123			6.0			
		Yellow	LDY5161	Yellow Diffused		1.0			
			LDY5162			2.5			
			LDY5163			4.0			
		Green	LDG5171	Green Diffused		2.5	20		
			LDG5172			6.0			
T1¾ 5mm 1″ Leads 100 mil lead spacing No standoffs Low profile Flangeless		Red	LDR1201	Red Diffused	70°	1.0	20	100	153
		Yellow	LDY1231	Yellow Diffused		1.0	20	60	
		Green	LDG1251	Green Diffused		2.5	20		
T1¾ 5mm 1″ Leads 100 mil lead spacing With standoffs		Red	LDR5001	Red Diffused	70°	1.0	20	100	165
			LDR5002			2.5			
			LDR5003			4.0			
		High Efficiency Red	LDH5021			20	10	60	
			LDH5022			4.0			
			LDH5023			6.0			
		Yellow	LDY5061	Yellow Diffused		1.0			
			LDY5062			2.5			
			LDY5063			4.0			
		Green	LDG5071	Green Diffused		2.5	20		
			LDG5072			6.0			
T1¾ 5mm 1″ leads 100 mil lead spacing No standoffs		Red	LDR5091	Red Clear	24°	2.5	20	100	169
			LDR5092			4.0			
			LDR5093			10			
		High Efficiency Red	LDH5191	Orange Clear		10	10	60	
			LDH5192			20			
			LDH5193			30			
		Yellow	LDY5391	Yellow Clear		10			
			LDY5392			20			
			LDY5393			30			
		Green	LDG5591	Water Clear		40	20		
			LDG5592			80			
		Blue	SFH710	Water Clear	16°	.05	20	40	197
T1 3mm 1″ leads 100 mil lead spacing No standoffs		Red	LDR1101	Red Diffused	70°	1.0	20	100	149
			LDR1102			2.0			
			LDR1103			4.0			
		High Efficiency Red	LDH1111			2.5	10	60	
			LDH1112			4.0			
			LDH1113			6.0			
		Yellow	LDY1131	Yellow Diffused		1.0			
			LDY1132			2.0			
			LDY1133			4.0			
		Green	LDG1151	Green Diffused		2.5	20		
			LDG1152			6.0			
			LDG1153			10			
T1 3mm 1″ leads 50 mil lead spacing ·No standoffs		Red	LDR3501	Red Diffused		1.0	20	100	157
			LDR3502			2.0			
			LDR3503			4.0			
		High Efficiency Red	LDH3521			2.5	10	60	
			LDH3522			4.0			
			LDH3523			6.0			
		Yellow	LDY3561	Yellow Diffused		1.0			
			LDY3562			2.5			
		Green	LDG3571	Green Diffused		2.5	20		
			LDG3572			6.0			

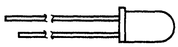
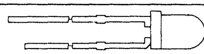
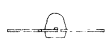
LED LAMPS

Package Type and Spacing	Package Outline	Color	Part Number	Lens	Viewing Angle	Luminous Intensity (mcd)	Luminous Intensity (mA)	Max Fwd. Current (mA)	Page
5mm Rectangular 1″ Leads		Red	LDR3701	Red Diffused	100°	0.4	20	60	161
			LDR3702			.63			
		High Efficiency Red	LDH3601			1.6			
			LDH3602			2.5			
			LDH3603			4.0			
		Yellow	LDY3801	Yellow Diffused		1.0			
			LDY3802			1.6			
			LDY3803			2.5			
		Green	LDG3901	Green Diffused		1.0			
			LDG3902			1.6			
			LDG3903			2.5			
5mm Cylindrical 1″ Leads		Red	LDR5701	Red Diffused		0.4			177
			LDR5702			.63			
		High Efficiency Red	LDH5601			1.6			
			LDH5602			2.5			
		Yellow	LDY5801	Yellow Diffused		1.0			
			LDY5802			1.6			
			LDY5803			2.5			
		Green	LDG5901	Green Diffused		1.0			
			LDG5902			1.6			
			LDG5903			2.5			
Miniature Axial Lead		Red	RL-50	Water Clear	90°	0.5	10		181
			RL-54	Red Diffused		0.4			183
Miniature Axial Lead High dome lens		Red	RL-55	Red Diffused	50°	2.0		40	185
		Yellow	YL-56	Yellow Diffused	40°	2.0		25	187
		Green	GL-56	Green Diffused		1.0			
Miniature Radial Lead 100 mil lead spacing		Red	LDR461	Red Diffused	100°	0.6	20	35	141
		Yellow	LDY481	Yellow Diffused					143
		Green	LDG471	Green Diffused				25	139
2-Element Array		Red	LDR462	Red Diffused	100°	0.6	20	35	141
3-Element Array			LDR463						
4-Element Array			LDR464						
5-Element Array			LDR465						
6-Element Array			LDR466						
7-Element Array			LDR467						
8-Element Array			LDR468						
9-Element Array			LDR469						
10-Element Array			LDR460						
2-Element Array		Green	LDG472	Green Diffused	100°	0.6	20	25	139
3-Element Array			LDG473						
6-Element Array			LDG476						
8-Element Array			LDG478						
10-Element Array			LDG470						
SOT23 Subminiature 1.3mm by 3mm by 1mm high		H.E. Red	LDH2310	Water Clear	140°	1.0	20	12.5 (30 on ceramic sub-strate)	145
		High Efficiency Yellow	LDY2320						
		Green	LDG2330						
		Red and Green	LDRG2340						

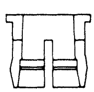
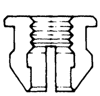
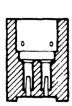
MULTICOLOR LED LAMPS

Package Type and Spacing	Package Outline	Color	Part Number	Lens	Viewing Angle	Luminous Intensity (mcd)	Luminous Intensity (mA)	Max Fwd. Current (mA)	Page
T1¾ 5mm 1″ Leads		Red and Green	LD1005	Water Clear	100°	2.5			133
			LD1006			4.0			
			LD1007			6.3			
5mm Rectanglar 1″ Leads		Red and Green	LD1103	Water Clear	100°	1.0			135
			LD1104			1.6	20	60	
			LD1105			2.5			
5mm Cylindrical 1″ Leads		Red and Green	LD1133	Water Clear	100°				137
			LD1134						
			LD1135						

RESISTOR LED LAMPS

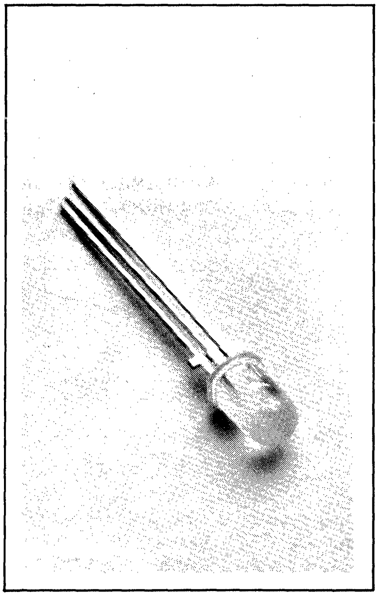
Package Type and Spacing	Package Outline	Color	Part Number	Lens	Viewing Angle	Luminous Intensity (mcd)	Luminous Intensity (Volts)	Max Fwd. Voltage	Page
T1¾ 5mm 1″ Leads No standoff		Red	RRL-3105	Red Diffused	70°	1.0	5	15	191
			RRL-3112			1.0	12		
T1 3mm 1″ Leads		Red	RRL-1100	Red Diffused	70°	1.0	5	15	189
Miniature Axial Lead High Dome Lens		Red	RRL-5601	Red Diffused	40°	0.3	5	6	193
			RRL-5621			0.6			
			RRL-5641			1.0			
		Yellow	RYL-5621	Yellow Diffused		0.3			195
		Green	RGL-5621	Green Diffused		0.2			

LAMP ACCESSORIES

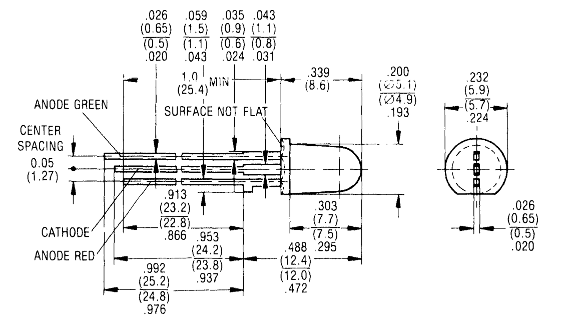
Type	Package	Part Number	Color	Description	Page
T1¾ Clip		004-9002 004-9003	Black Clear	Mounting Clip and Collar for T1¾ LED's	199
T1 Clip		004-9015 006-9016	Clear Black	Mounting Clip and Collar for T1 LED's	
Right Angle Mounting Part		004-9019	Black	Allows right angle mounting of lamps to PC boards and other surfaces	
Reflector		004-9020	Polished	Increases lighted area of T1¾ LED's	

LD 1005/1006/1007

TWO-COLOR, RED AND GREEN T1 ¾ LED LAMP



Package Dimensions in Inches (mm)



FEATURES

- **T1 ¾ Package Size**
- **Colorless Lens**
- **Two-Color Operation, Red and Green**
- **Three Leads, One of Which Is Common Cathode**
- **Minimum Lead Length 1″**
- **.05″ Lead Spacing**

DESCRIPTION

The LD 1005 series has a colorless round, 5 mm case with diffuser layer. Two chips (GaP-green and TSN-red) allow use as optical indicator with two functions.

Because of its very low current consumption and hence low inherent heating as well as high vibration resistance and long service life, this LED is suitable for applications where signal lamps are not or only inadequately useful. Moreover, the LED can be driven by TTL ICs.

Maximum Ratings

Reverse Voltage (V_R)	5 V
Forward Current* (I_F)	60 mA
Surge Current* (i_{FS}), $t \leq 10\,\mu s$	1 A
Storage Temperature (T_{stg})	−55 to +100 °C
Junction Temperature (T_j)	100 °C
Power Dissipation (P_{tot}) $T_{amb} = 25\,°C$	200 mW
Thermal Resistance (R_{thJA}) Junction-to-Air	375 K/W

Characteristics ($T_{amb} = 25\,°C$)

Parameter	Symbol	TSN-red	GaP-green	Unit
Wavelength of the Emitted Light	λ_{peak}	645 ± 15	560 ± 15	nm
Dominant Wavelength	λ_{dom}	638	561	nm
Half Angle (Limits for 50% of Luminous Intensity I_v)	φ	50		degrees
Forward Voltage ($I_F = 20$ mA)	V_F	2.4 (≤3.0)		V
Reverse Current ($V_R = 5$ V)	I_R	0.01 (≤10)		μA
Rise Time	t_r	100	50	ns
Fall Time	t_f	100	50	ns
Capacitance ($V_R = 0$ V, f = 1 MHz)	C_O	12	45	pF

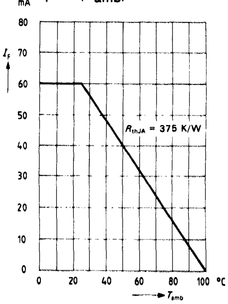
Luminous Intensity

Part Number	Min	Unit	Test Condition
LD 1005	2.5	mcd	20 mA
LD 1006	4.0	mcd	20 mA
LD 1007	6.3	mcd	20 mA

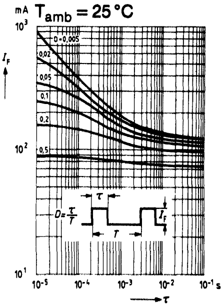
***The ratings indicated for the forward current I_F or the surge current i_{FS}, respectively, are maximum ratings of the component. If both chips are operated simultaneously, the sum of the forward current ratings is not allowed to exceed the indicated maximum value.**

Specifications are subject to change without notice.

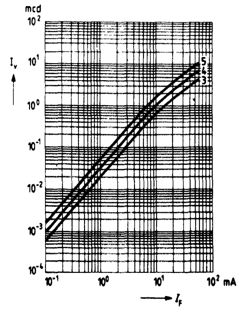
MAX. PERMISSIBLE FORWARD CURRENT
$I_F = f(T_{amb})$



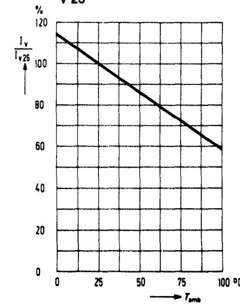
PERM. PULSE HANDLING CAPABILITY $I_F = f(t)$
Duty Cycle D = Parameter;
$T_{amb} = 25\,°C$



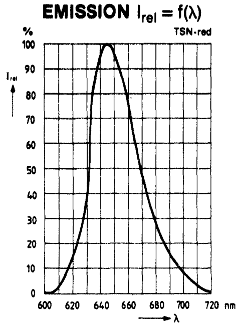
LUMINOUS INTENSITY
$I_v = f(I_F)$



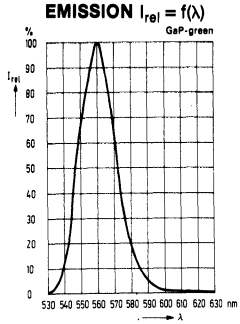
LUMINOUS INTENSITY
$\frac{I_v}{I_{v\,25}} = f(T_{amb})$



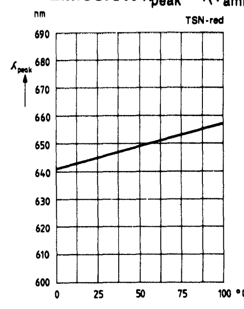
RELATIVE SPECTRAL EMISSION $I_{rel} = f(\lambda)$



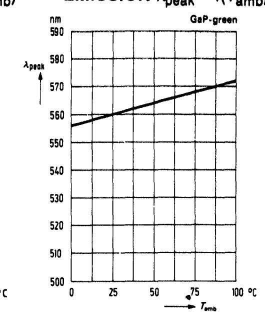
RELATIVE SPECTRAL EMISSION $I_{rel} = f(\lambda)$



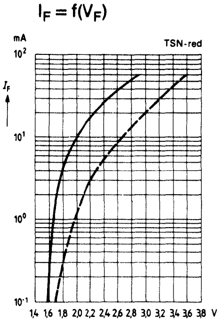
WAVELENGTH OF PEAK EMISSION $\lambda_{peak} = f(T_{amb})$



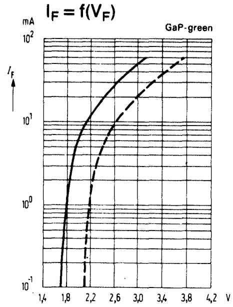
WAVELENGTH OF PEAK EMISSION $\lambda_{peak} = f(T_{amb})$



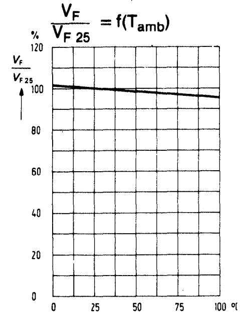
FORWARD CURRENT
$I_F = f(V_F)$



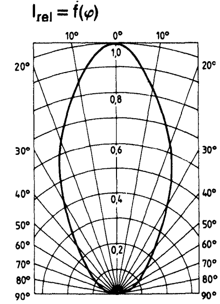
FORWARD CURRENT
$I_F = f(V_F)$



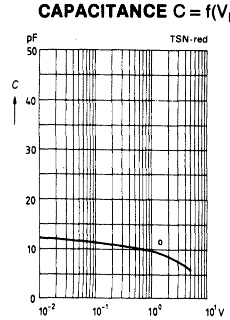
FORWARD VOLTAGE
$\frac{V_F}{V_{F\,25}} = f(T_{amb})$



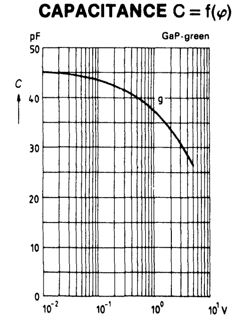
RADIATION CHARACTERISTIC
$I_{rel} = f(\varphi)$



CAPACITANCE $C = f(V_R)$



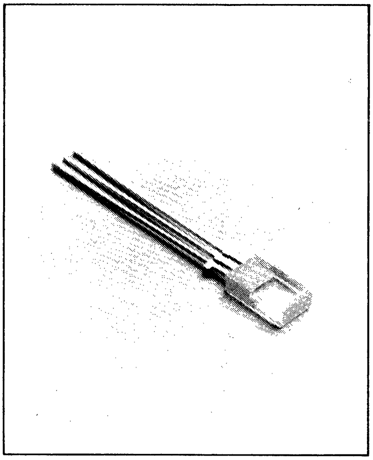
CAPACITANCE $C = f(\varphi)$



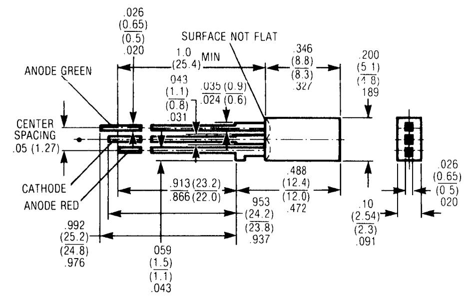
SIEMENS

LD 1103/1104/1105

TWO-COLOR RED AND GREEN RECTANGULAR LED LAMP



Package Dimensions in Inches (mm)



FEATURES

- **Rectangular Shape**
- **Colorless Lens**
- **Two-Color Operation, Red and Green**
- **Three Leads, One of Which Is Common Cathode**
- **Minimum Lead Length 1″**
- **.05″ Lead Spacing**

DESCRIPTION

The LD 1103 series has a colorless case with rectangular, luminous area and diffuser layer. Two chips (GaP-green and TSN-red) enable the use as optical indicator with two functions.

Because of its very low current consumption and hence low inherent heating as well as high vibration resistance and long service life, this LED is suitable for applications where signal lamps are not or only inadequately useful. Moreover, the LED can be driven by TTL ICs.

Maximum Ratings

Reverse Voltage (V_R)	5 V
Forward Current* (I_F)	60 mA
Surge Current (i_{FS}), $t \leq 10\ \mu s$*	1 A
Storage Temperature (T_{stg})	−55 to +100 °C
Junction Temperature (T_j)	100 °C
Power Dissipation (P_{tot}), $T_{amb} = 25$ °C	200 mW
Thermal Resistance Junction-Air (R_{thJA})	375 K/W

Characteristics ($T_{amb} = 25$ °C)

Parameter	Symbol	TSN-red	GaP-green	Unit
Wavelength of the Emitted Light	λ_{peak}	645 ± 15	560 ± 15	nm
Dominant Wavelength	λ_{dom}	638	561	nm
Aperture Cone (Half Angle) (Limits for 50% of Luminous Intensity I_V) Lateral Emission of Light Screened	φ	50		degrees
Forward Voltage ($I_F = 20$ mA)	V_F	2.4 (≤3.0)		V
Reverse Current ($V_R = 5$ V)	I_R	0.01 (≤10)		μA
Rise Time	t_r	100	50	ns
Fall Time	t_f	100	50	ns
Capacitance ($V_R = 0$ V, f = 1 MHz)	C_O	12	45	pF

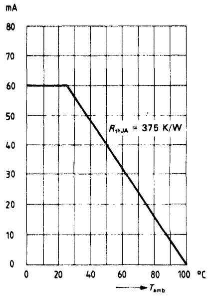
Luminous Intensity

Type	Min	Unit	Test Condition
LD 1103	1.0	mcd	20 mA
LD 1104	1.6	mcd	20 mA
LD 1105	2.5	mcd	20 mA

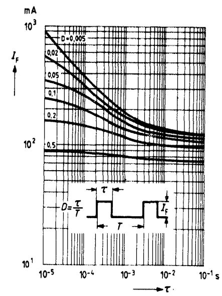
*The ratings indicated for the forward current I_F or the surge current i_{FS}, respectively, are maximum ratings of the component. If both chips are operated simultaneously, the sum of the forward current ratings is not allowed to exceed the indicated maximum value.

Specifications subject to change without notice.

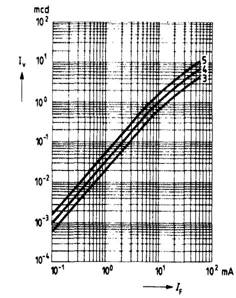
Max. permissible forward current
$I_F = f(T_{amb})$



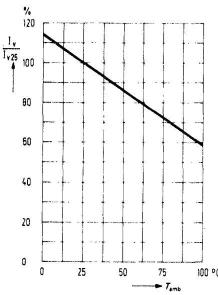
Perm. pulse handling capability
$I_F = f(\tau)$
Duty cycle D = parameter; T_{amb} = 25°C



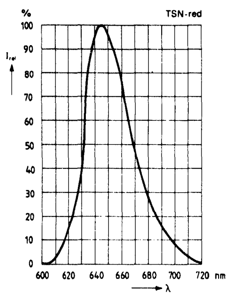
Luminous intensity $I_v = f(I_F)$



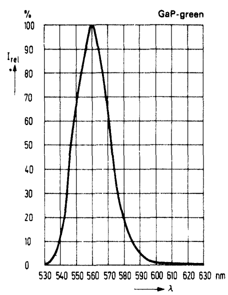
Luminous intensity $\frac{I_v}{I_{v\,25}} = f(T_{amb})$



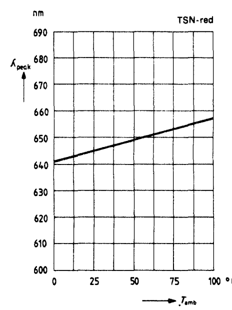
Relative spectral emission $I_{rel} = f(\lambda)$



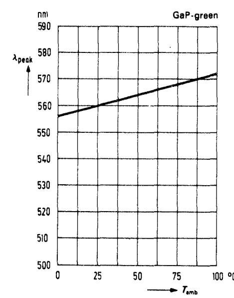
Relative spectral emission $I_{rel} = f(\lambda)$



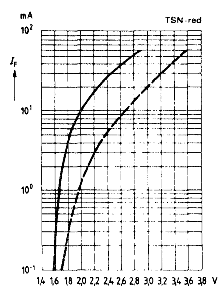
Wavelength of peak emission
$\lambda_{peak} = f(T_{amb})$



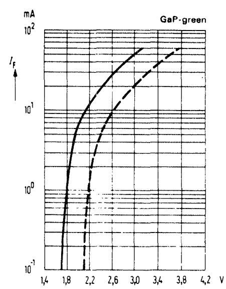
Wavelength of peak emission
$\lambda_{peak} = f(T_{amb})$



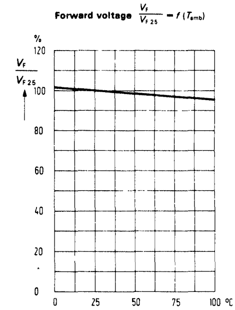
Forward current $I_F = f(V_F)$



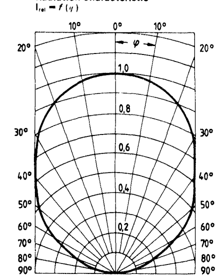
Forward current $I_F = f(V_F)$



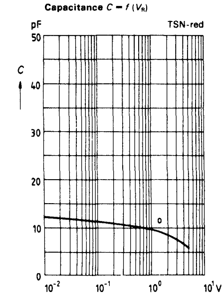
Forward voltage $\frac{V_F}{V_{F\,25}} = f(T_{amb})$



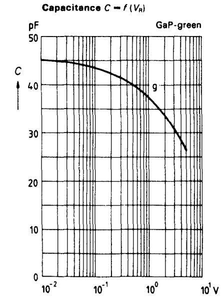
Radiation characteristic
$I_{rel} = f(\varphi)$



Capacitance $C = f(V_R)$

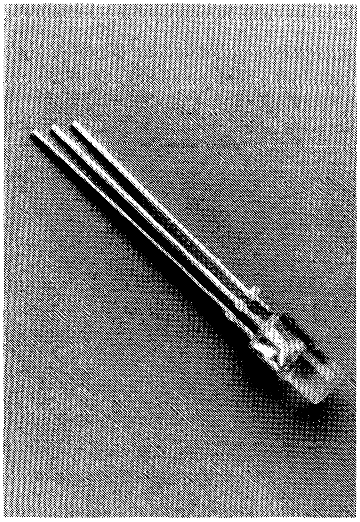


Capacitance $C = f(V_R)$

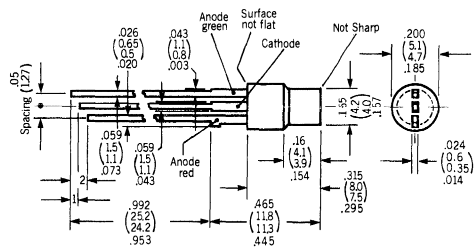


LD 1133/1134/1135

TWO COLOR RED AND GREEN CYLINDER LED LAMP



Package Dimension in Inches (mm)



FEATURES

- **Cylinder Shape**
- **Colorless Lens**
- **Two Color Operation, Red and Green**
- **Three Leads, One of Which Is Common Cathode**
- **Minimum Lead Length 1″**
- **.05″ Lead Spacing**

DESCRIPTION

The LD 1133 series has a colorless case with square, luminous area and a diffuser layer. Two chips (GaP-green and TSN-red) allow use as optical indicator with two functions.

Because of its very low current consumption and hence low inherent heating as well as high vibration resistance and long service life, this LED is suitable for applications where signal lamps are not or only inadequately useful. Moreover, the LED can be driven by TTL ICs.

Maximum Ratings

Reverse Voltage (V_R)	5 V
Forward Current* (I_F)	60 mA
Surge Current (i_{FS}), $t \le 10\ \mu s$*	1 A
Storage Temperature (T_{stg})	−55 to +100 °C
Junction Temperature (T_j)	100 °C
Power Dissipation (P_{tot}), T_{amb} = 25 °C	200 mW
Thermal Resistance Junction-Air (R_{thJA})	375 K/W

Characteristics (T_{amb} = 25 °C)

Parameter	Symbol	TSN-red	GaP-green	Unit
Wavelength of the Emitted Light	λ_{peak}	645 ± 15	560 ± 15	nm
Dominant Wavelength	λ_{dom}	638	561	nm
Aperture Cone (Half Angle) (Limits for 50% of Luminous Intensity I_v) Lateral Emission of Light Screened	φ	50		degrees
Forward Voltage (I_F = 20 mA)	V_F	2.4 (≤ 3.0)		V
Reverse Current (V_R = 5 V)	I_R	0.01 (≤ 10)		μA
Rise Time	t_r	100	50	ns
Fall Time	t_f	100	50	ns
Capacitance (V_R = 0 V, f = 1 MHz)	C_O	12	45	pF

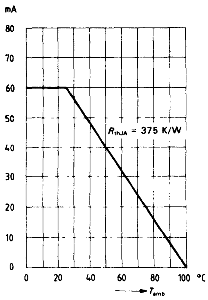
Luminous Intensity

Type	Min	Unit	Test Condition
LD 1133	1.0	mcd	20 mA
LD 1134	1.6	mcd	20 mA
LD 1135	2.5	mcd	20 mA

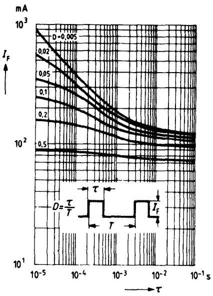
*The ratings indicated for the forward current I_F or the surge current i_{FS}, respectively, are maximum ratings of the component. If both chips are operated simultaneously, the sum of the forward current ratings is not allowed to exceed the indicated maximum value.

Specifications are subject to change without notice.

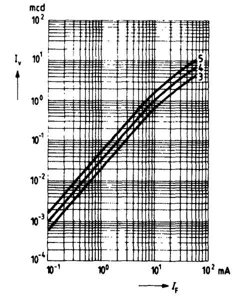
Max. permissible forward current
$I_F = f(T_{amb})$



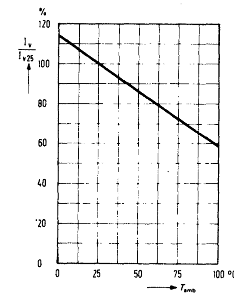
Perm. pulse handling capability
$I_F = f(\tau)$
Duty cycle D = parameter; T_{amb} = 25°C



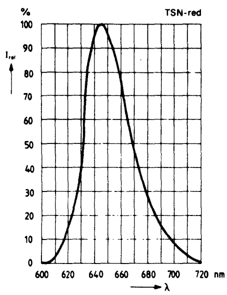
Luminous intensity $I_v = f(I_F)$



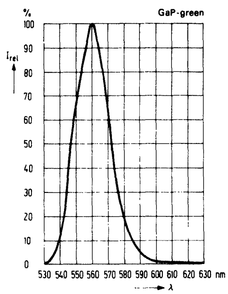
Luminous intensity $\frac{I_v}{I_{v25}} = f(T_{amb})$



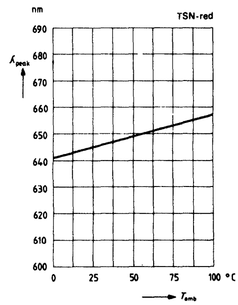
Relative spectral emission $I_{rel} = f(\lambda)$



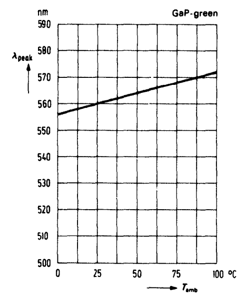
Relative spectral emission $I_{rel} = f(\lambda)$



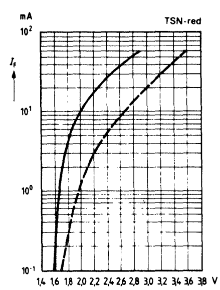
Wavelength of peak emission
$\lambda_{peak} = f(T_{amb})$



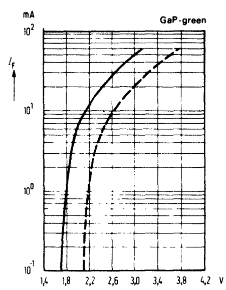
Wavelength of peak emission
$\lambda_{peak} = f(T_{amb})$



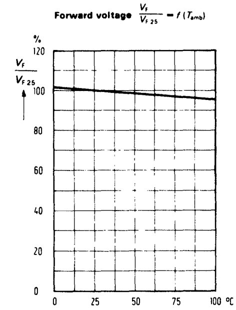
Forward current $I_F = f(V_F)$



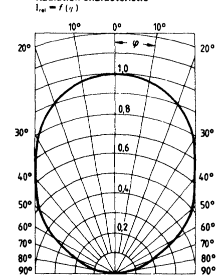
Forward current $I_F = f(V_F)$



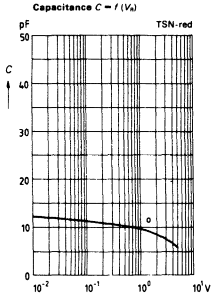
Forward voltage $\frac{V_F}{V_{F25}} = f(T_{amb})$



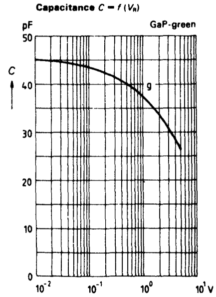
Radiation characteristic
$I_{rel} = f(\varphi)$



Capacitance $C = f(V_R)$

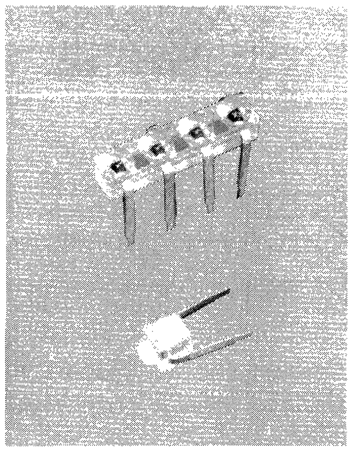


Capacitance $C = f(V_R)$

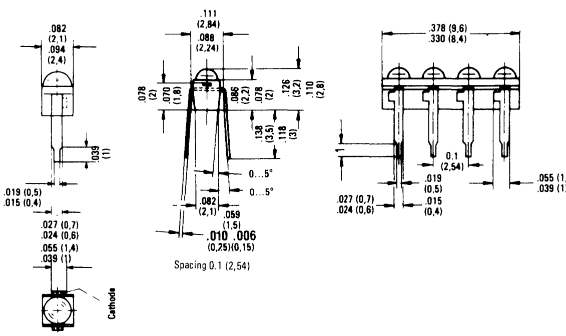


SIEMENS

LDG 470 SERIES
GREEN MINIATURE LED SINGLE LAMP AND ARRAYS



Package Dimensions in Inches (mm)



FEATURES

- **Green Clear Lens**
- **Miniature Size**
- **Selection of 2 thru 10 Diode Arrays As Well As A Single Device**
- **1/10" Lead Spacing**
- **End Stackable to Arrays of Any Length**
- **I/C Compatible**

DESCRIPTION

The LDG 470 Series are green gallium phosphide LED solid state lamps. They have a green plastic encapsulation formed as a lens where the light is emitted. The single lamps or arrays may be used individually or stacked together to form lines of any lengths. Typical applications are position indicators such as meters and scales.

Maximum Ratings (Individual Diode)

Reverse voltage	V_R	5	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_{amb} = 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

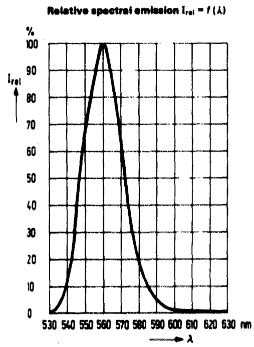
Characteristics (T_{amb} = 25°C)

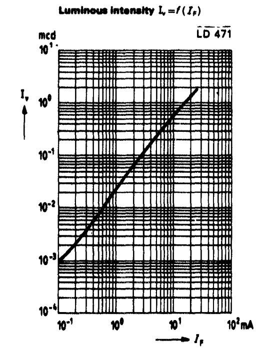
Wavelength at peak emission	λ_{peak}	560 ± 15	nm
Dominant wavelength	λ_{dom}	561	nm
Viewing Angle (limits for 50% of luminous intensity I_v)	φ	100	degree
Forward voltage (I_F = 20 mA)	V_F	2.4 (≤ 3.0)	V
Reverse current (V_R = 3 V)	I_R	0.1 (≤ 10)	µA
Capacitance (V_R = 0 V)	C_0	45	pF
Rise time	t_r	50	ns
Fall time	t_f	50	ns

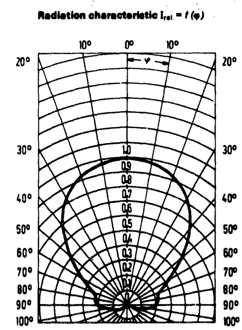
Luminous Intensity

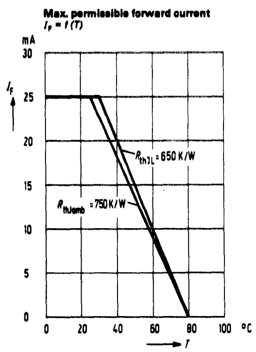
New P/N	Replaces P/N	Number of LEDs	mcd (Min.)	Test Condition
LDG 471	LD 471	1	.6	20 mA
LDG 472	LD 472	2	.6	20 mA
LDG 473	LD 473	3	.6	20 mA
LDG 476	LD 476	6	.6	20 mA
LDG 478	LD 478	8	.6	20 mA
LDG 470	LD 470	10	.6	20 mA

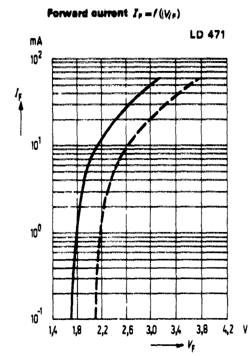
Specifications are subject to change without notice.

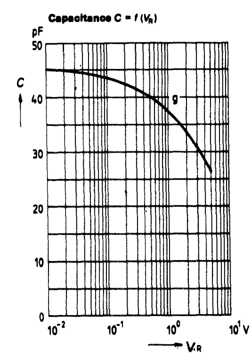

Relative spectral emission $I_{rel} = f(\lambda)$
%
I_{rel}
530 540 550 560 570 580 590 600 610 620 630 nm
λ

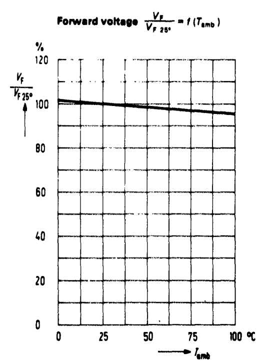

Luminous intensity $I_v = f(I_F)$
mcd
LD 471
I_v
mA
I_F

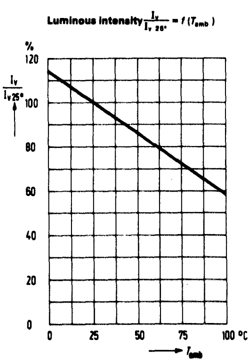

Radiation characteristic $I_{rel.} = f(\varphi)$
10° 0° 10°
20° 30° 40° 50° 60° 70° 80° 90° 100°
1,0 0,9 0,8 0,7 0,6 0,5 0,4 0,3 0,2 0,1

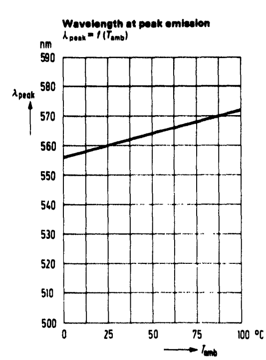

Max. permissible forward current
$I_F = f(T)$
mA
I_F
R_{thJL} = 650 K/W
R_{thJamb} = 750 K/W
0 20 40 60 80 100 °C
T

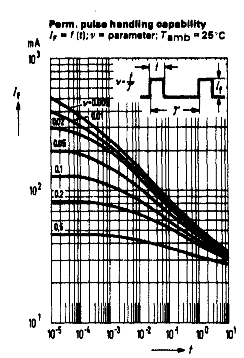

Forward current $I_F = f(V_F)$
LD 471
mA
I_F
1,4 1,8 2,2 2,6 3,0 3,4 3,8 4,2 V
V_F


Capacitance C = f (V_R)
pF
C
V
V_R


Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$
%
0 25 50 75 100 °C
T_{amb}


Luminous intensity $\frac{I_v}{I_{v\,25°}} = f(T_{amb})$
%
0 25 50 75 100 °C
T_{amb}

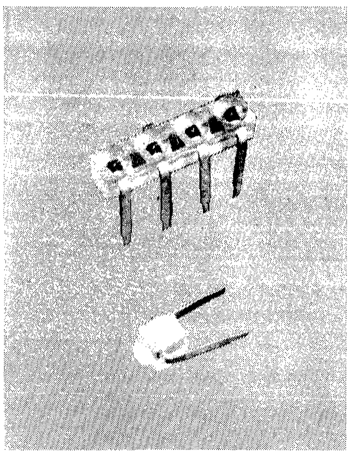

Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$
nm
λ_{peak}
0 25 50 75 100 °C
T_{amb}


Perm. pulse handling capability
$I_F = f(t)$; ν = parameter; T_{amb} = 25 °C
mA
I_F
I_F
s
t

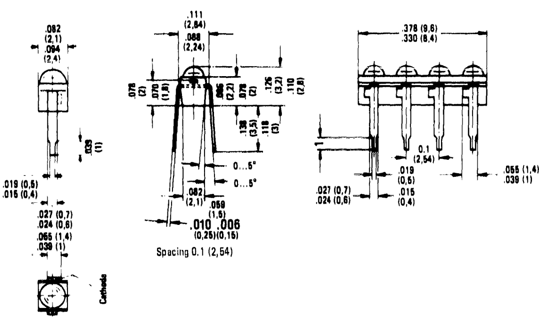
SIEMENS

LDR 460 SERIES

RED MINIATURE LED SINGLE LAMP AND ARRAYS



Package Dimension in Inches (mm)



FEATURES

- **Red Clear Lens, Emits Red Light**
- **Miniature Size**
- **Selection of 2 thru 10 Diode Arrays As Well As A Single Device**
- **1/10″ Lead Spacing**
- **End Stackable to Arrays of Any Length**
- **I/C Compatible**

DESCRIPTION

The LDR 460 Series are red gallium arsenide phosphide LED solid state lamps. They have red plastic encapsulation formed as a lens where the light is emitted. The single lamps or arrays may be used individually or stacked together to form lines of any lengths. Typical applications are position indicators such as meters and scales.

Maximum Ratings (Individual Diode)

Reverse voltage	V_R	5	V
Forward current	I_F	35	mA
Surge current ($t \leq 10\ \mu s$)	i_{FS}	1.0	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_{amb} = 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)

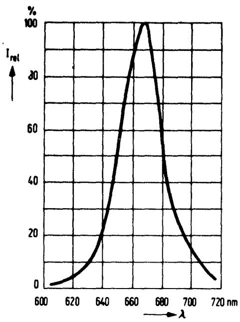
Wavelength at peak emission	λ_{peak}	665 ± 15	nm
Dominant wavelength	λ_{dom}	645	nm
Viewing angle (limits for 50% of luminous intensity I_v)	φ	100	degree
Forward voltage (I_F = 20 mA)	V_F	1.6 (≤ 2.0)	V
Reverse current (V_R = 5 V)	I_R	0.01 (≤ 10)	μA
Rise time	t_r	5	ns
Fall time	t_f	5	ns
Capacitance (V_R = 0 V)	C_0	40	pF

Luminous Intensity

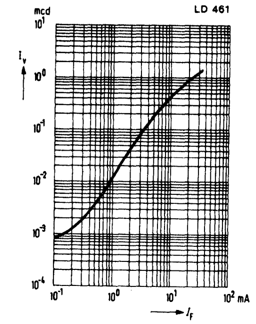
New P/N	Replaces P/N	Number of LEDs	mcd (Min.)	Test Condition
LDR 461	LD 461	1	.6	20 mA
LDR 462	LD 462	2	.6	20 mA
LDR 463	LD 463	3	.6	20 mA
LDR 464	LD 464	4	.6	20 mA
LDR 465	LD 465	5	.6	20 mA
LDR 466	LD 466	6	.6	20 mA
LDR 467	LD 467	7	.6	20 mA
LDR 468	LD 468	8	.6	20 mA
LDR 469	LD 469	9	.6	20 mA
LDR 460	LD 460	10	.6	20 mA

Specifications are subject to change without notice.

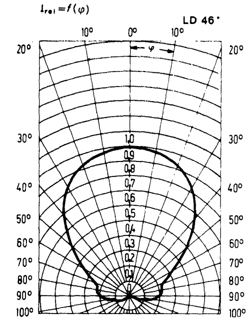
Relative spectral emission $I_{rel} = f(\lambda)$



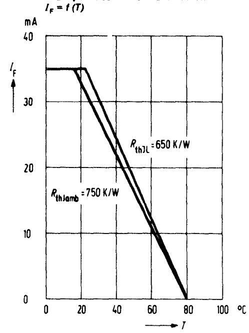
Luminous intensity $I_v = f(I_F)$



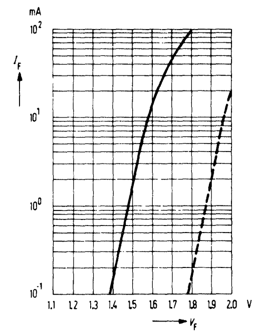
Radiation characteristic
$I_{rel} = f(\varphi)$



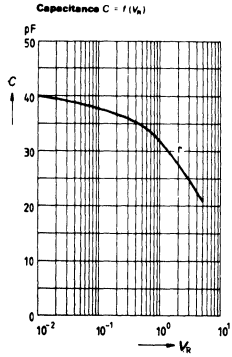
Max. permissible forward current
$I_F = f(T)$



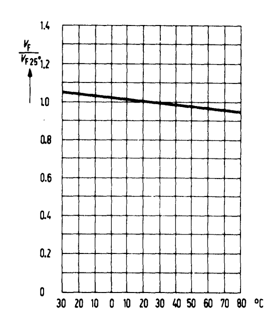
Forward voltage $I_F = f(V_F)$



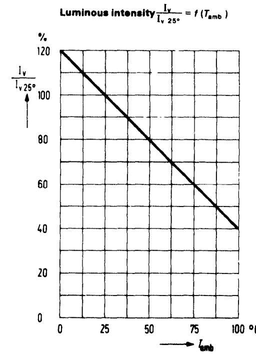
Capacitance $C = f(V_R)$



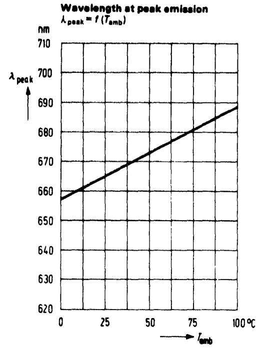
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



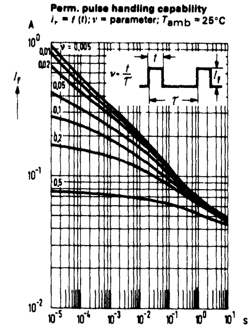
Luminous intensity $\frac{I_v}{I_{v\,25°}} = f(T_{amb})$



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



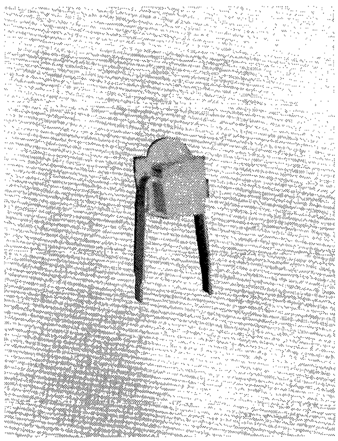
Perm. pulse handling capability
$I_F = f(t)$; ν = parameter; T_{amb} = 25°C



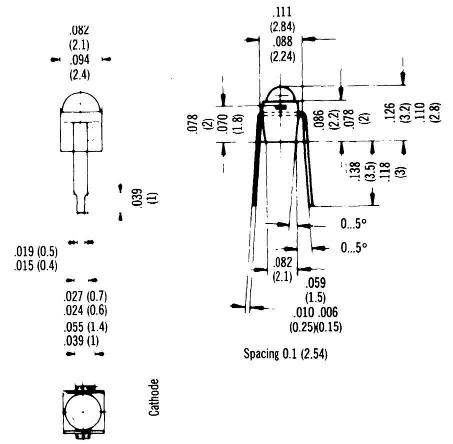
SIEMENS

LDY 481

YELLOW LIGHT EMITTING DIODE



Package Dimensions in Inches (mm)



FEATURES

- **Yellow Clear Lens**
- **Miniature Size**
- **1/10″ Lead Spacing**
- **End Stackable to Arrays of Any Length**
- **I/C Compatible**

DESCRIPTION

The LDY 481 is a yellow gallium phosphide LED solid state lamp. It has a yellow plastic encapsulation formed to a lens where the light is emitted. (Previous P/N was LD 480)

Maximum Ratings

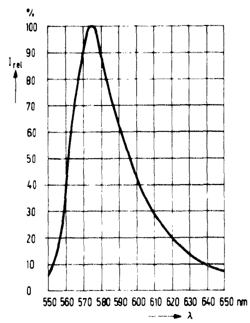
Reverse voltage	V_R	5	V
Forward current	I_F	25	mA
Surge current ($t \leq 10$ μs)	i_{FS}	0.5	A
Storage temperature	T_{stor}	−30 to +80	°C
Junction temperature	T_j	80	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leqq 3$ s)	T_s	230	°C
Power dissipation ($T_L = 25$°C)	P_{tot}	85	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)

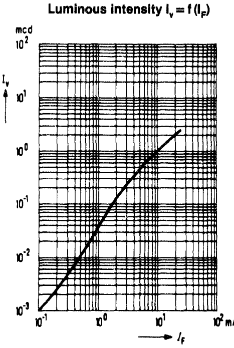
Wavelength at peak emission	λ_{peak}	575 ± 15	nm
Dominant wavelength	λ_{dom}	573	nm
Viewing angle (limits for 50% of luminous intensity I_v)	φ	100	degree
Forward voltage ($I_F = 20$ mA)	V_F	2.4 (≦3.0)	V
Reverse current ($V_R = 3$ V)	I_R	0.1 (≦10)	μA
Capacitance ($V_R = 0$ V)	C_o	45	pF
Rise time	t_r	50	ns
Fall time	t_f	50	ns
Luminous intensity	I_v	>.6	mcd @ 20 mA

Specifications are subject to change without notice.

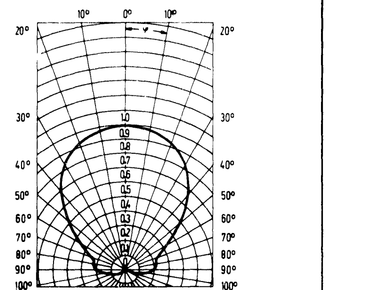
Relative spectral emission $I_{rel} = f(\lambda)$



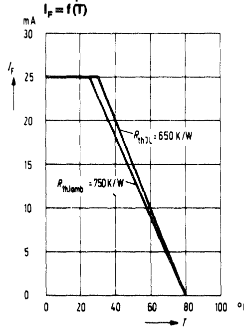
Luminous intensity $I_v = f(I_F)$



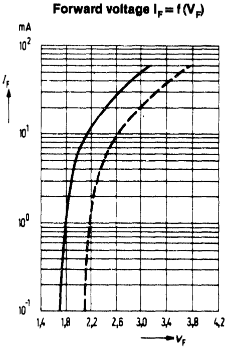
Radiation characteristic $I_{rel} = f(\varphi)$



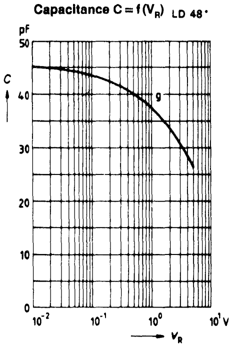
Max. permissible forward current $I_F = f(T)$



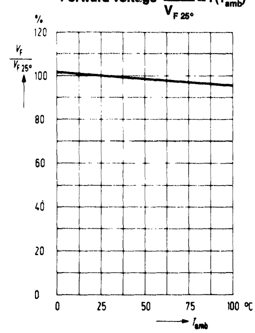
Forward voltage $I_F = f(V_F)$



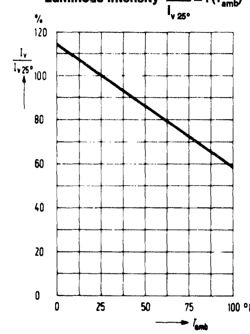
Capacitance $C = f(V_R)$ LD 48*



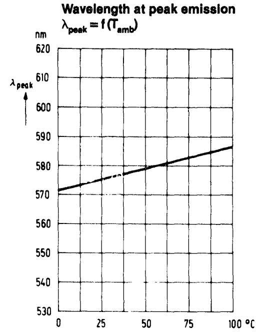
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



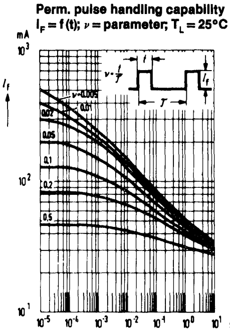
Luminous intensity $\frac{I_v}{I_{v\,25°}} = f(T_{amb})$



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

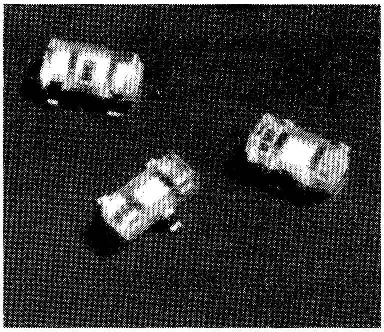


Perm. pulse handling capability $I_F = f(t)$; ν = parameter; $T_L = 25°C$

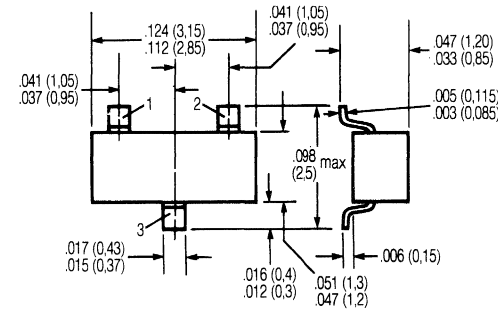


SIEMENS

HIGH EFFICIENCY RED LDH 2310
HIGH EFFICIENCY YELLOW LDY 2320
HIGH EFFICIENCY GREEN LDG 2330
HIGH EFFICIENCY RED/GREEN LDRG 2340
SOT 23 SURFACE MOUNTABLE LAMP
Preliminary



Package Dimensions in Inches (mm)



Pinouts (top view)

Pin	LDH2310, LDY2320, LDG2330	LDRG2340
1	NC	Red
2	Anode	Green
3	Cathode	Common anode

FEATURES

- **Available in...**
  High Efficiency Red, LDH 2310
  Yellow, LDY 2320
  Green, LDG 2330
  Red & Green (two chip), LDRG 2340
- **Subminiature Clear Plastic Rectangular Package, 1.3mm by 3mm by 1mm thick**
- **Wide Viewing Angle, 140°**
- **Ideal for use as failure indicators mounted on printed circuit boards**
- **IC compatible**

DESCRIPTION

This series consists of LED's in subminiature plastic packages 23A3 DIN 41869 (TO236/SOT-23). In the double diode LDRG2340, two LED chips are situated next to each other, one high efficiency red and the other green.

These packages are very suitable for mounting on the wiring side of printed circuit boards. The way the leads are bent makes surface mounting without drilling possible. The LED's can be soldered to the wiring side using the chip mounting technique (iron or reflow soldering). If the LED's are attached with glue beforehand, wave or dip soldering can be used (detailed description concludes this data sheet).

Due to the small dimensions (rectangular SOT23 housing, 1.3 mm X 3 mm, height 1 mm), this subminiature package is excellent for use in touch keyboards as optical failure indicators on printed circuit boards. The flat surface of the housing permits the attachment of optical fiber systems without problems and low loss.

These LED's can be supplied on 8 mm wide film reels according to IEC STANDARDS, 2000 pieces on a 18 cm reel. These tapes can be used on all commercial automatic insertion equipment (special versions of 33 cm reels with 10,000 pieces per reel are available upon special order).

Maximum Ratings

For double diodes (LDRG 2340), apply the following operating condition

1 system on (lit up), 1 system off (dark)

Reverse voltage	V_R	.5	V
Forward current	I_F	12.5	mA
ceramic substrate[1]	I_F	30	mA
Surge current (τ = 10 μs)	i_{FS}	1	A
ceramic substrate[1] (τ = 10μs)	i_{FS}	1	A
Junction temperature	T_j	100	°C
Storage temperature	T_s	−55... + 100	°C
Power dissipation	P_{tot}	70	mW
ceramic substrate[1]	P_{tot}	200	mW
Thermal resistance junction to air	R_{thJU}	1050	K/W
to ceramic[1]	R_{thJSR}	375	K/W

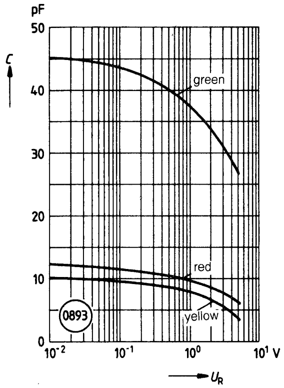
Characteristics (T_{amb}=25°C)

		LDH2310	LDY2320	LDG2330	
Wavelength of emitted light	λ_{peak}	645 ± 15	590 ± 10	560 ± 15	nm
Dominant wavelength	λ_{dom}	638	592	561	nm
Aperture cone (½<) (Limits for 50% of luminous intensity (IV) shielded against lateral emission of light)	φ		70		degrees
Forward voltage (I_F = 20mA)	V_F		2.4 (≤3.0)		V
Reverse current (V_R = 5 V)	I_R		0.1 (≤10)		μA
Luminous intensity (I_F – 20mA)	I_V		typ. 1.8 (≥1)		mcd

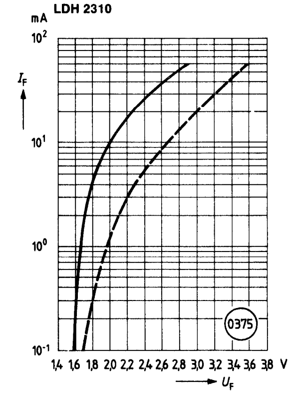
[1]Ceramic substrate 2.5cm² surface area, 0.7mm thick

Specifications are subject to change without notice.

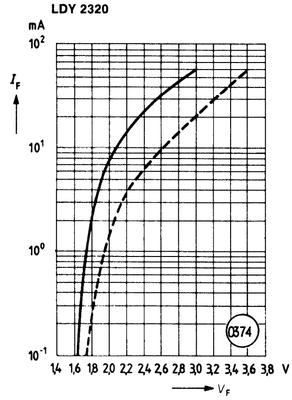
Capacitance
$C = f(V_R)$



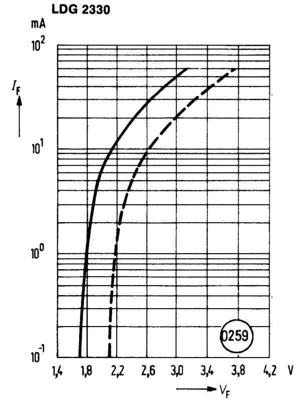
Forward Current $I_F = f(V_F)$
LDH 2310



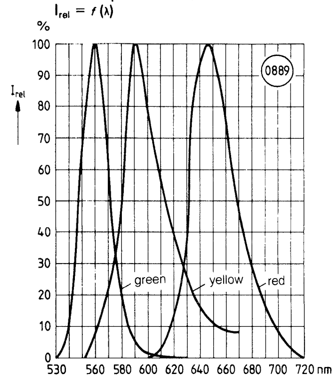
Forward Current $I_F = f(V_F)$
LDY 2320



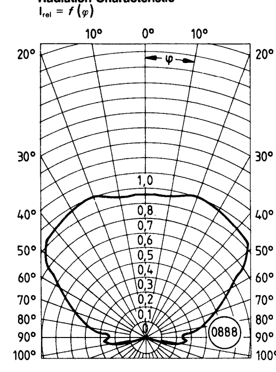
Forward Current $I_F = f(V_F)$
LDG 2330



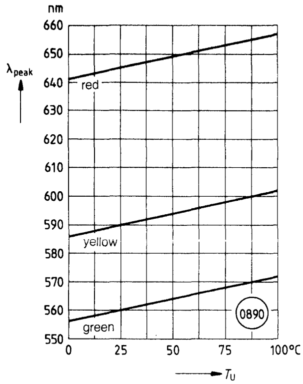
Relative Special Emission
$I_{rel} = f(\lambda)$



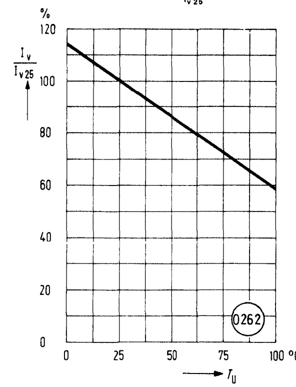
Radiation Characteristic
$I_{rel} = f(\varphi)$



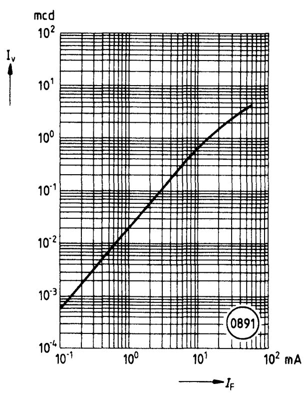
Wavelength of Emission
$\lambda_{peak} = f(T_U)$



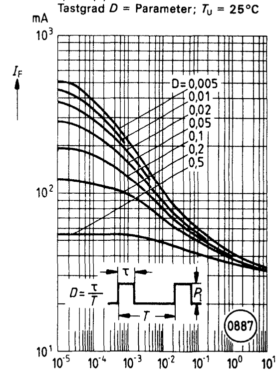
Luminous Intensity $\frac{I_v}{I_{v\,25}} = f(T_U)$



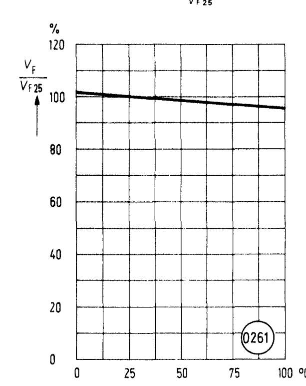
Luminous Intensity $I_v = f(I_F)$



Permanent Pulse Handling Capability
$I_F = f(\tau)$
Tastgrad D = Parameter; T_U = 25°C



Forward Voltage $\frac{V_F}{V_{F\,25}} = f(T_U)$



SOLDERING CONSIDERATIONS

Semiconductor components in plastic packages (SOT-23) are designated as active components for thin and thick film integrated circuits. These soldering directions refer to the use of resistors and LED lamps on PCB substrates with interconnecting conductors which are tin-lead plated through dip soldering.

To achieve reliable bonding, the following criteria should be considered:

1. The right soldering temperature and appropriate soldering flux are important. The soldering flux is not to affect or attack the plastic package. The solvents should easily remove the flux residues and not affect or attack the plastic package.

2. Temperature (240 degree C max for 5 sec max) and rapid temperature changes during the soldering apply high mechanical stress to the substrate and should be avoided to prevent breaking or cracking of the substrate.

3. Placement of the semiconductor components onto the substrate is to be done with the highest precision. The soldering pads must be placed exactly on the conductor traces because there is a high risk of cracking if the hot soldering pads touch the package.

SOLDERING METHODS

The soldering method selection should be made according to production volume, amount of semiconductor components per circuit board, required precision placement, and possibility of exchanging/replacing semiconductor components. Listed below are four mounting methods.

METHOD 1 Wave or Dip Soldering
The components in the SOT-23 housing are first glued onto the thick film substrate (glass, ceramic) or the etched printed circuit board (glass fiber) with silicon glue. The glue can be applied by silk screen printing. Care should be taken that the glue does not cover the contact surfaces. The components are pressed onto the substrate. A film of 60-80 um glue results in excellent adhesion, and when the components are attached, the contact surfaces are not contaminated. Soldering can be done through wave or dip soldering. A good soldering material is Sn-Pb mixture in eutectic proximity with a 3.5-4% Ag additive agent, i.e. Solidanol (170 Sn/Pb/Ag:60/35/4). The bath temperature is to be 225 +/-10 degrees C and the maximum soldering time of 5 seconds. The recommended soldering flux is a non-activated colophonium resin 45%, dissolved in the ethyl alcohol 55% plus glycerin additive agent. After soldering the components, the solder flux residues are to be removed; cleaning baths containing isopropyl alcohol as a washing agent are suitable.

METHOD 2 Reflow Soldering
Here soldering flux is added to the powdered solder and then applied in paste form to the printed circuit board. This procedure is most effective using silk screenprinting. The thickness should be 80um. The substrate with the components is heated for 5 seconds to 240 degrees C by means of a conveyer band or a heating plate. The paste is melted and the soldering process takes place. Further information can be obtained from the reflow soldering paste manufacturer's instructions.

METHOD 3 Pin Soldering
The substrate is placed on a heating plate with a temperature of 100 degrees C. A magnified view of the semiconductor component is used to place it into the right position. It is placed on the substrate by means of a minimum pressure valve. Simultaneously three (still cold) micro soldering pins are placed under pressure on the leads of the component to improve thermal resistance. The soldering pins have to be structured in a way that the thermal conductance takes place only on its peak. The soldering pins will be briefly charged (8 seconds) with 20W each. Within this time span the solder becomes liquid for about 3 seconds which achieves a complete covering. Because of the low thermal capacity the soldering pins cool off rapidly after turn-off. The flux can, while soldering pins are still attached, cool off below their melting temperature. The soldering pins should be made of steel (18% Cr, 8% N) because this material will not be adhesive to solder and has a good resistance against corrosion. Flux colophonium is suitable, which residues have to be removed after soldering with isopropyl alcohol. Using this method, the plastic package will not be heated more than the preheating plate. Provided the preheating plate temperature does not exceed 100 degrees C and the soldering time is not longer than 5 seconds, the risk of substrate cracking beneath the conductor wiring is lowered. The junction temperature will increase to about 250 degrees C with this method.

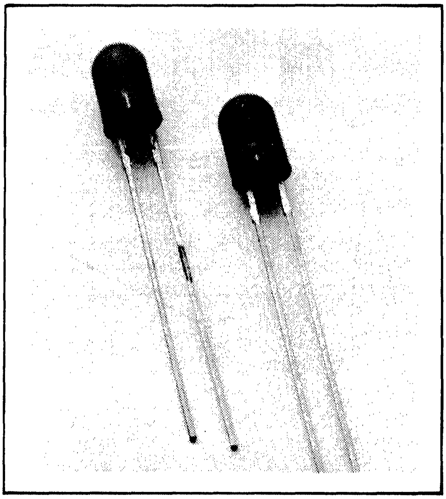
METHOD 4 Iron Soldering
Manual soldering using a miniature soldering has the following disadvantages.

The placement of the component cannot be done very accurately in places where its leads directly touch the substrate as substrate cracks during soldering can occur. Because of the sequential soldering of the leads, mechanical stress can cause substrate damage and consequently disrupt interconnections inside a component. Furthermore, the plastic package can be damaged by the soldering iron. Therefore, this method is only suitable for inserting single semiconductor components.

SIEMENS

RED LDR 110X SERIES
HIGH EFFICIENCY RED LDH 111X SERIES
HIGH EFFICIENCY YELLOW LDY 113X SERIES
HIGH EFFICIENCY GREEN LDG 115X SERIES
T1 LED LAMP

Preliminary



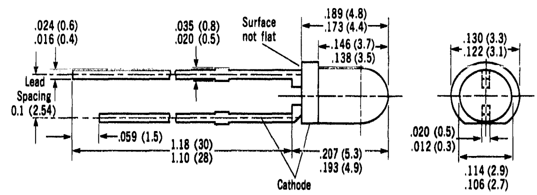
FEATURES

- **High Light Output**
- **Diffused Lens**
- **Wide Viewing Angle 70°**
- **T 1 Size**
- **No Standoffs**
- **1" Lead Length**
- **Front Panel Mounting**
  Snap-in Mounting Clips Available
  Clip/Collar #004-9016 Clear
  #004-9015 Black
- **I/C Compatible**

DESCRIPTION

The LDR 110X Series is a standard red gallium arsenide phosphide (GaAsP) LED lamp. The LDH111X high efficiency red and LDY113X yellow are premium high efficiency light emitting diode lamps fabricated with TSN (transparent substrate nitrogen) technology. The LDG 115X green Series is a gallium phosphide (GaP) lamp. All have a diffused plastic lens which emits a full flooded intense light.

Package Dimension in Inches (mm)



Maximum Ratings

		LDR 110X	LDH 111X LDY 113X LDG 115X	
Reverse voltage	V_R	5	5	V
Forward current	I_F	100	60	mA
Surge current (≤10μs)	i_{FS}	2	1	A
Storage temperature range	T_{stg}	-55 to +100		°C
Junction temperature	T_j	100	100	°C
Total power dissipation (T_{amb}=25°C)	P_{tot}	200	200	mW
Thermal resistance junction to air	R_{thJA}	375	375	K/W

Characteristics (T_{amb}=25°)

		LDR 110X	LDH 111X	LDY 113X	LDG 115X	
Wavelength at peak emission	λ_{peak}	665±15	645±15	590±10	560±15	nm
Dominant wavelength	λ_{dom}	645	638	592	561	nm
Viewing angle (Limits for 50% of luminous intensity I_V)	φ	70	70	70	70	degrees
Forward voltage (I_F = 20mA)	V_F	1.6(≤2.0)		2.4(≤3.0)		V
Reverse current (V_R = 5 V)	I_R			0.01 (≤10)		μA
Rise time	t_r	5	100	200	50	ns
Fall time	t_f	5	100	200	50	ns
Capacitance (V_R = 0 V; f = 1 MHz)	C_0	40	12	10	45	pF

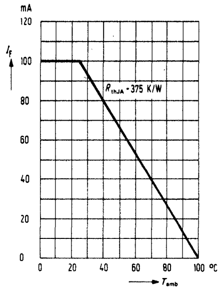
Luminous Intensity

P/N	Replaces	mcd (MIN)	Test conditions
LDR 1101	CQV10-3	1.0	20mA
LDR 1102	CQV10-4, 5	2.0	20mA
LDR 1103	------------	4.0	20mA
LDH 1111	CQV11-4, 5, 6, 7	2.5	10mA
LDH 1112	CQV11-8	4.0	10mA
LDH 1113	CQV11-9	6.0	10mA
LDY 1131	CQV13-4, 5	1.0	10mA
LDY 1132	CQV13-6	2.0	10mA
LDY 1133	CQV13-7	4.0	10mA
LDG 1151	CQV15-3, 4, 5	2.5	20mA
LDG 1152	CQV15-6, 7	6.0	20mA
LDG 1153	------------	10	20mA

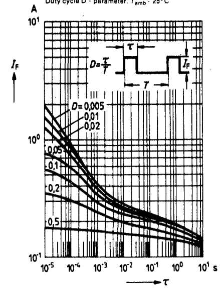
Specifications are subject to change without notice.

LDR 110X SERIES

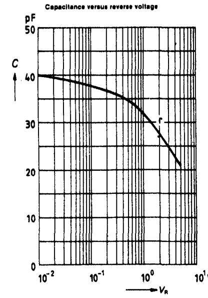
Forward current versus ambient temperature



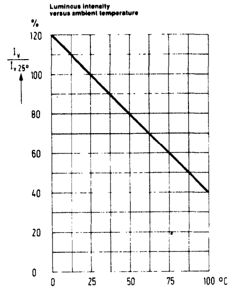
Permissible pulse handling capability
Forward current versus cycle duration
Duty cycle D = parameter, T_{amb} = 25°C



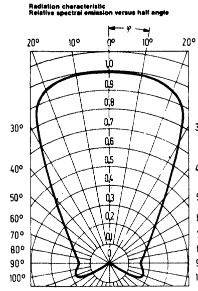
Capacitance versus reverse voltage



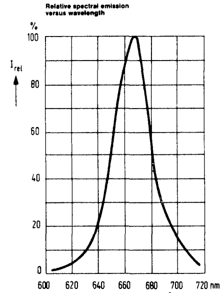
Luminous intensity versus ambient temperature



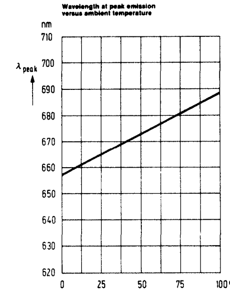
Radiation characteristic
Relative spectral emission versus half angle



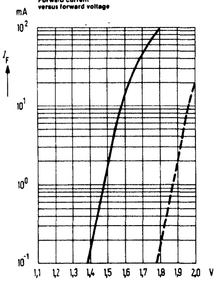
Relative spectral emission versus wavelength



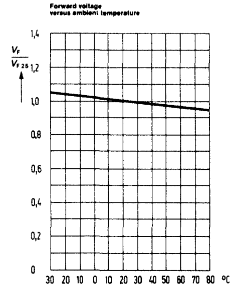
Wavelength at peak emission versus ambient temperature



Forward current versus forward voltage

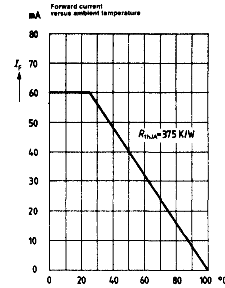


Forward voltage versus ambient temperature

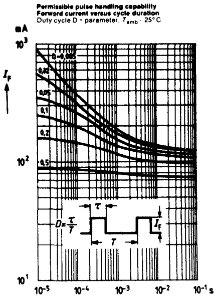


LDH 111X SERIES

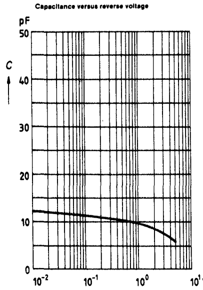
Forward current versus ambient temperature



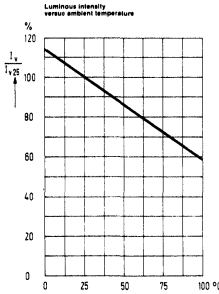
Permissible pulse handling capability
Forward current versus cycle duration
Duty cycle D = parameter, T_{amb} = 25°C



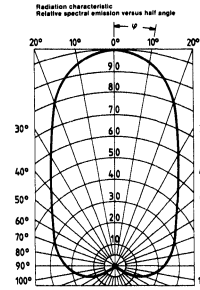
Capacitance versus reverse voltage



Luminous intensity versus ambient temperature

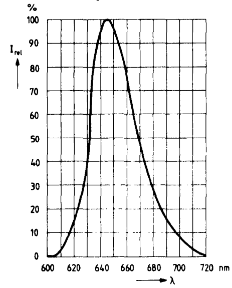


Radiation characteristic
Relative spectral emission versus half angle

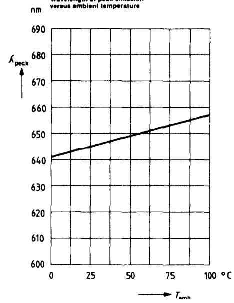


LDH 111X SERIES (Continued)

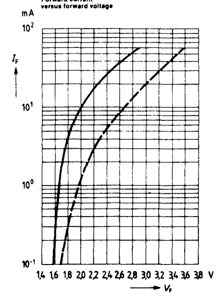
Relative spectral emission versus wavelength



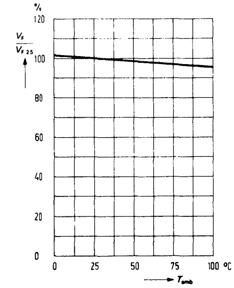
Wavelength at peak emission versus ambient temperature



Forward current versus forward voltage

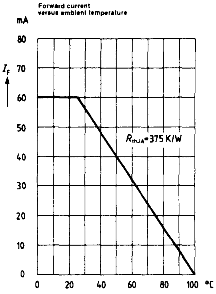


Forward voltage versus ambient temperature

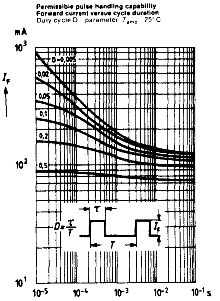


LDY 113X SERIES

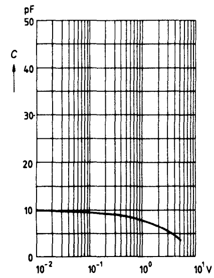
Forward current versus ambient temperature



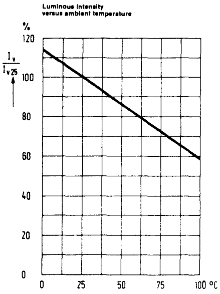
Permissible pulse handling capability
Forward current versus cycle duration
Duty cycle D parameter T_{amb} 25°C



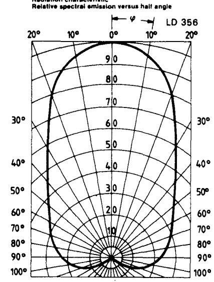
Capacitance versus reverse voltage



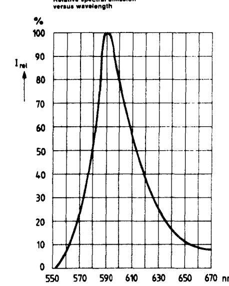
Luminous intensity versus ambient temperature



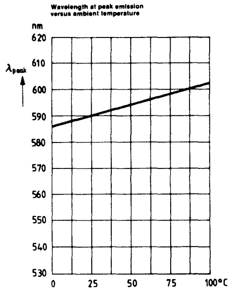
Radiation characteristic
Relative spectral emission versus half angle



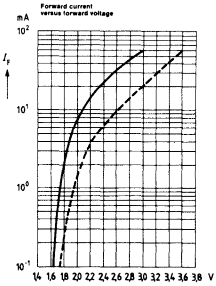
Relative spectral emission versus wavelength



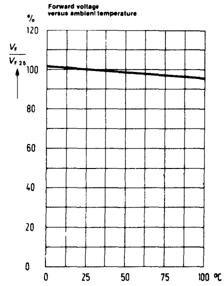
Wavelength at peak emission versus ambient temperature



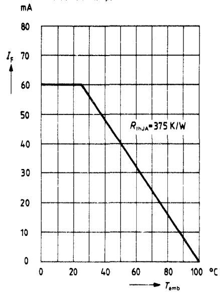
Forward current versus forward voltage



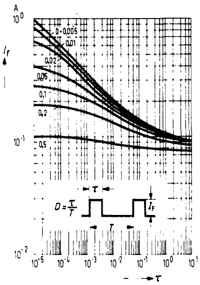
Forward voltage versus ambient temperature



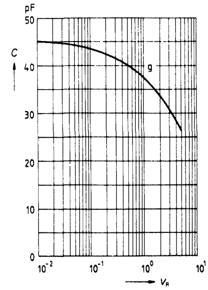
Forward current versus ambient temperature



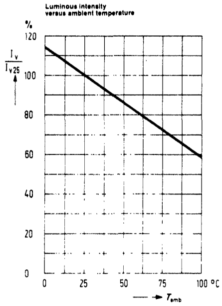
Permissible pulse handling capability
Forward current versus cycle duration
Duty cycle D parameter, T_{amb} 25°C



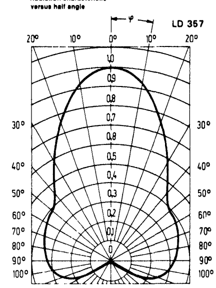
Capacitance versus reverse voltage



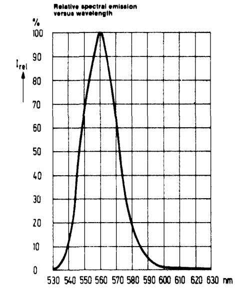
Luminous intensity versus ambient temperature



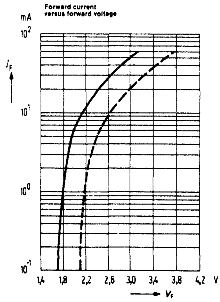
Radiation characteristic versus half angle



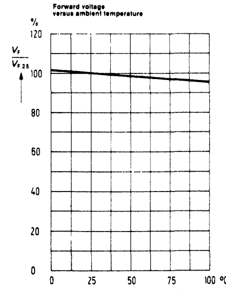
Relative spectral emission versus wavelength



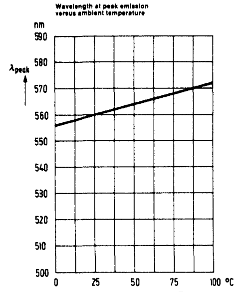
Forward current versus forward voltage



Forward voltage versus ambient temperature



Wavelength at peak emission versus ambient temperature

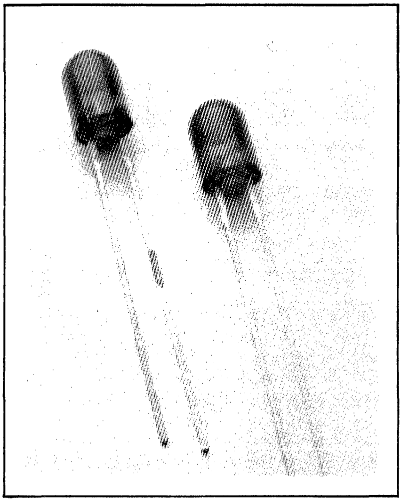


SIEMENS

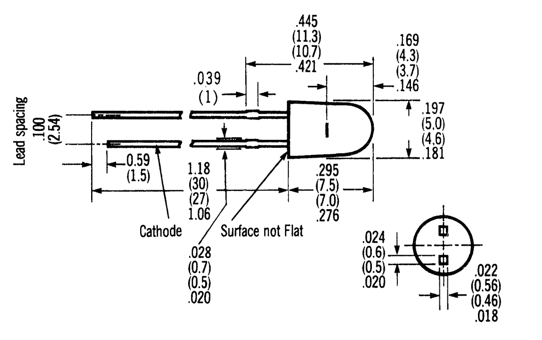
RED LDR 1201
GREEN LDG 1251
YELLOW LDY 1231

T-1¾ FLANGELESS LOW PROFILE LED LAMP

Preliminary



Package Dimensions in Inches (mm)



FEATURES

- **Low Profile**
- **T-1¾ Flangeless Package**
- **1-inch Leads**
- **Diffused Lens**
- **Wide Viewing Angle, 70°**
- **I/C Compatible**

DESCRIPTION

The LDR 1201 is a Gallium Arsenide Phosphide (GaASP) red light emitting diode.

The LDG 1251 is a Gallium Phosphide (GaP) green light emitting diode.

The LDY 1231 is a TSN (Transparent Substrate Nitrogen) yellow light emitting diode.

This is a flangeless LED lamp for applications where a lower seating (clearance) is desirable.

Maximum Ratings

		LDR1201	LDG1251 LDY1231	
Reverse voltage	V_R	5	5	V
Forward current	I_F	100	60	mA
Surge current ($\tau \leq 10$ µs)	i_{FS}	2	1	A
Storage temperature range	T_S	– 55 to + 100		°C
Junction temperature	T_j	100	100	°C
Total power dissipation ($T_{amb} = 25$°C)	P_{tot}	200	200	mW
Thermal resistance, junction to air	R_{thJA}	375	375	K/W

Characteristics ($T_{amb} = 25$°C)

		LDR1201	LDY1231	LDG1251	
Wavelength at peak emission	λ_{peak}	665 ± 15	590 ± 10	560 ± 15	nm
Dominant wavelength	λ_{dom}	645	592	561	nm
Viewing angle (Limits for 50% of luminous intensity I_V)	φ	70	70	70	degrees
Forward voltage ($I_F = 20$ mA)	V_F	1.6(≤ 2.0)	2.4(≤ 3.0)	2.4(≤ 3.0)	V
Reverse current ($V_R = 5$ V)	I_R		0.01(≤ 10)	0.01(≤ 10)	µA
Rise time	t_r	5	100	50	ns
Fall time	t_f	5	100	50	ns
Capacitance ($V_r = 0$ V; f = 1 MHz)	C_o	40	10	45	pF

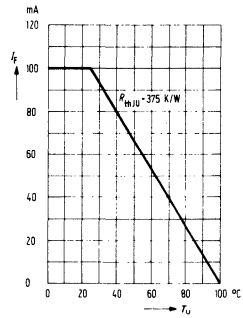
Luminous Intensity Grouping

P/N	Min Mcd	Test Conditions
LDR 1201	1.0	20 mA
LDG 1251	2.5	20 mA
LDY 1231	1.0	20 mA

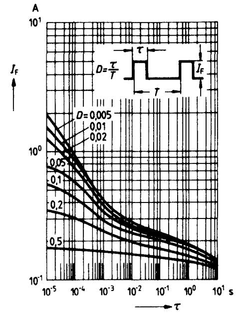
Specifications are subject to change without notice.

LDR 1201

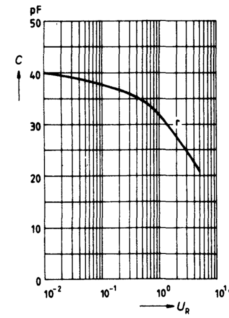
Forward current versus ambient temperature



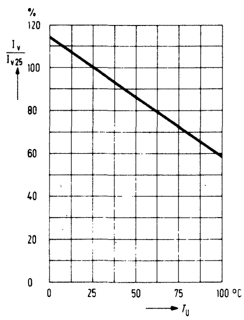
Permissible pulse handling capability
Forward current versus cycle duration
Duty cycle D = parameter; T_{amb} = 25 °C



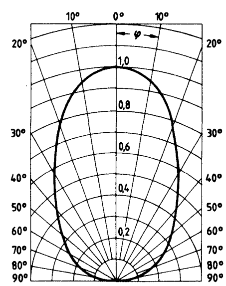
Capacitance versus reverse voltage



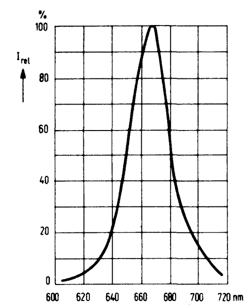
Luminous intensity versus ambient temperature



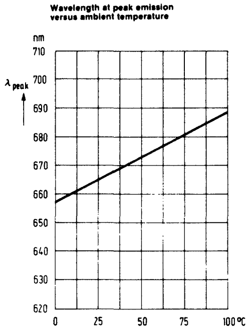
Radiation characteristic
Relative spectral emission versus half angle



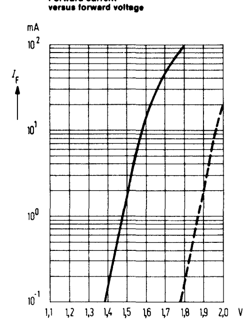
Relative spectral emission versus wavelength



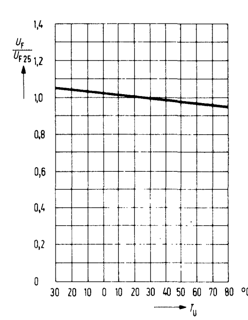
Wavelength at peak emission versus ambient temperature



Forward current versus forward voltage

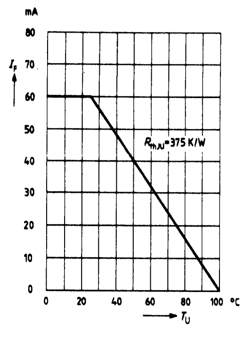


Forward voltage versus ambient temperature

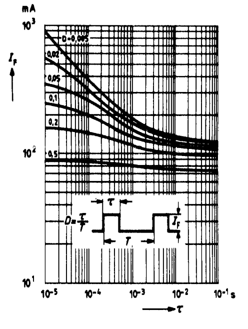


LDY 1231

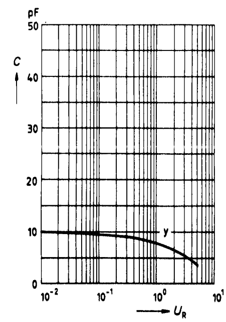
Forward current versus ambient temperature



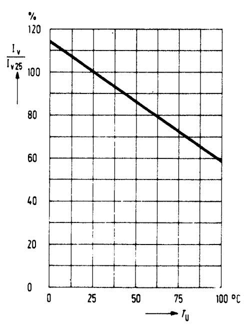
Permissible pulse handling capability
Forward current versus cycle duration
Duty cycle D = parameter, T_{amb} = 25°C



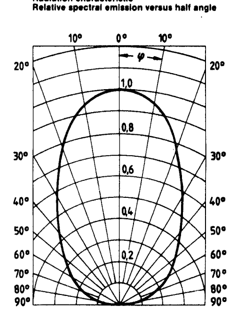
Capacitance versus reverse voltage



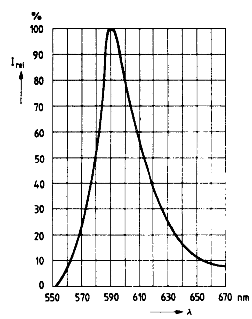
Luminous intensity versus ambient temperature



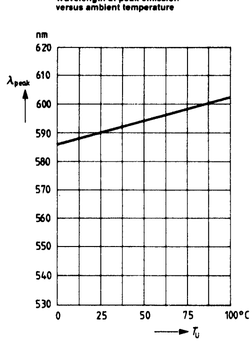
Radiation characteristic
Relative spectral emission versus half angle



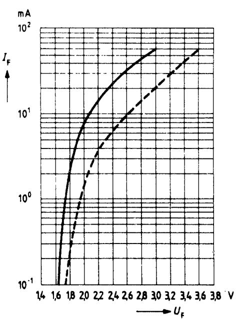
Relative spectral emission versus wavelength



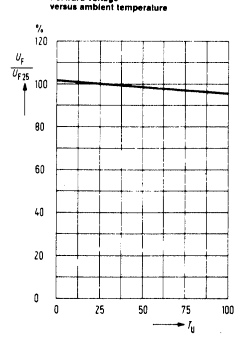
Wavelength at peak emission versus ambient temperature



Forward current versus forward voltage

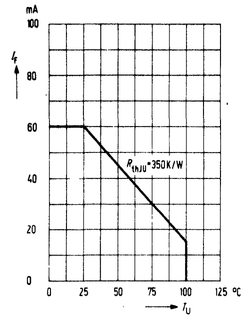


Forward voltage versus ambient temperature

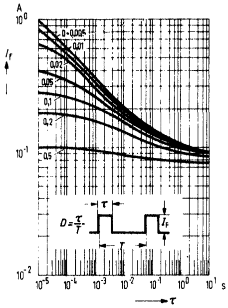


LDG 1251

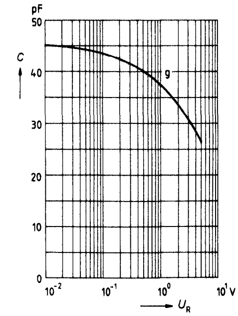
Forward current
versus ambient temperature



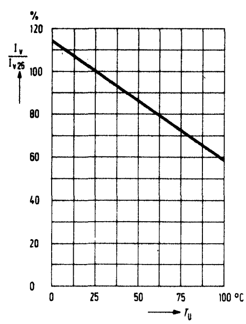
Permissible pulse handling capability
Forward current versus cycle duration
Duty cycle D = parameter; T_{amb} = 25°C



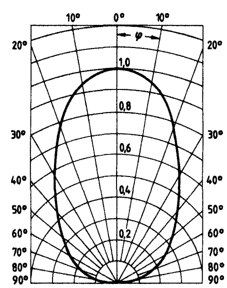
Capacitance versus reverse voltage



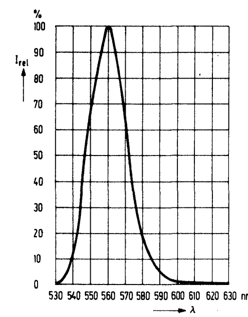
Luminous intensity
versus ambient temperature



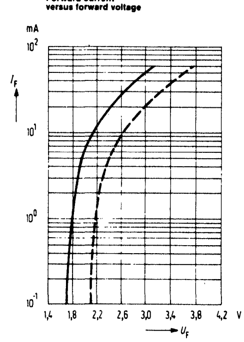
Radiation characteristic
Relative spectral emission versus half angle



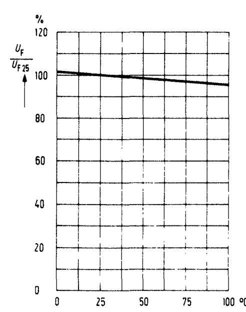
Relative spectral emission
versus wavelength



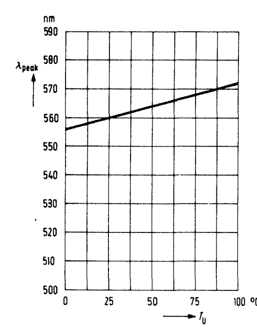
Forward current
versus forward voltage



Forward voltage
versus ambient temperature



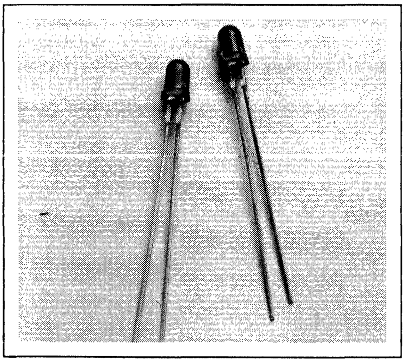
Wavelength at peak emission
versus ambient temperature

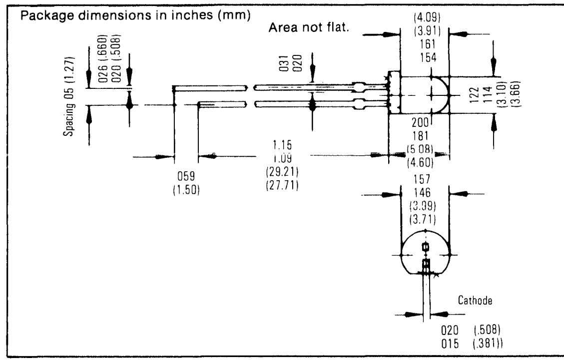


SIEMENS

RED LDR 3500 SERIES
HIGH EFFICIENCY RED LDH 3520 SERIES
HIGH EFFICIENCY YELLOW LDY 3560 SERIES
HIGH EFFICIENCY GREEN LDG 3570 SERIES

T1 LED LAMP





FEATURES

- **High Light Output**
- **Diffused Lens**
- **Wide Viewing Angle 70°**
- **T 1 Size**
- **No Standoffs**
- **1" Lead Length**
- **50 ml Lead Spacing**
- **Front Panel Mounting**
  Snap-in Mounting Clips Available
  Clip/Collar #004-9016 Clear
  #004-9015 Black
- **I/C Compatible**

DESCRIPTION

The LDR 350X Series is a standard red gallium arsenide phosphide (GaAsP) LED lamp. The LDH 352X high efficiency red and LDY 356X yellow are premium high efficiency light emitting diode lamps fabricated with TSN (transparent substrate nitrogen) technology. The LDG 357X green is a gallium phosphide (GaP) lamp. All have a diffused plastic lens which emits a full flooded intense light.

Maximum ratings		LDR 350X	LDH 352X LDY 356X LDG 357X	
Reverse voltage	V_R	5	5	V
Forward current	I_F	100	60	mA
Surge current (≤ 10μs)	i_{FS}	2	1	A
Storage temperature range	T_{stg}		-55 to +100	°C
Junction temperature	T_j	100	100	°C
Total power dissipation (T_{amb} = 25°C)	P_{tot}	200	200	mW
Thermal resistance junction to air	R_{thJA}	375	375	K/W

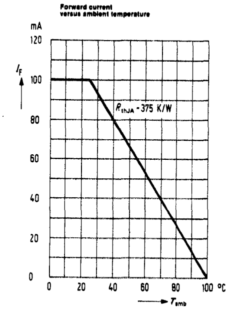
Characteristics (T_{amb} = 25°)		LDR 350X	LDH 352X	LDY 356X	LDG 357X	
Wavelength at peak emission	λ_{peak}	665±15	645±15	590±10	560±15	nm
Dominant wavelength	λ_{dom}	645	638	592	561	nm
Viewing angle (Limits for 50% of luminous intensity I_v	φ	70	70	70	70	degrees
Forward voltage (I_F = 20mA)	V_F	1.6(≤2.0)	2.4(≤3.0)			V
Reverse current (V_R = 5 V)	I_R		0.01 (≤10)			μA
Rise time	t_r	5	100	200	50	ns
Fall time	t_f	5	100	200	50	ns
Capacitance (V_R = 0 V; f = 1MHz)	C_0	40	12	10	45	pF

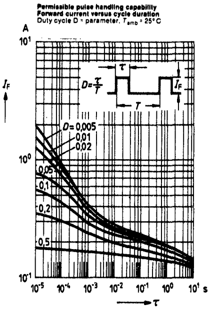
Luminous Intensity grouping

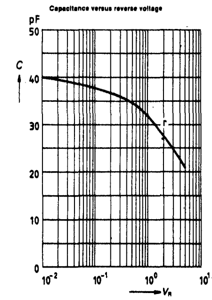
P/N	Replaces	mcd (Min)	Test conditions
LDR 3501	LD 350-3, RL-209A & -1, RL-4484	1.0	20mA
LDR 3502	LD 350-4, RL-209-2	2.0	20mA
LDR 3503	————	4.0	20mA
LDH 3521	LD 352-1-6	2.5	10mA
LDH 3522	LD 352-7 & 8	4.0	10mA
LDH 3523	————	6.0	10mA
LDY 3561	LD 356-4, YL-212, YL-4484	1.0	10mA
LDY 3562	————	2.5	10mA
LDG 3571	LD 357-5, GL-211, GL-4484	2.5	20mA
LDG 3572	LD 357-6	6.0	20mA

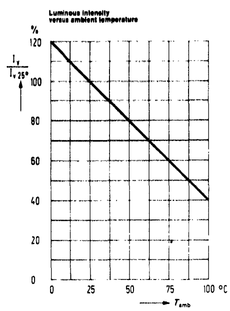
Specifications are subject to change without notice.

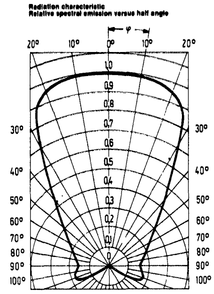
LDR 3500 SERIES

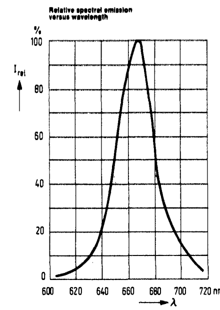


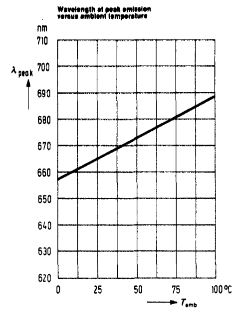


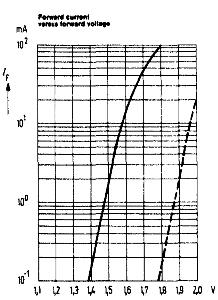


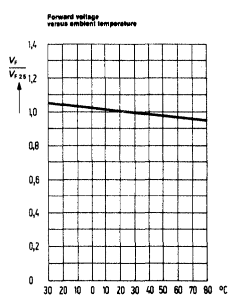




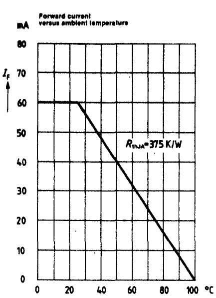


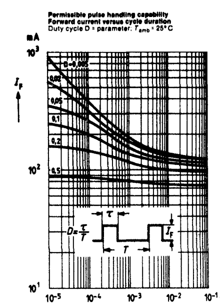


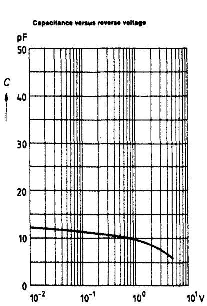


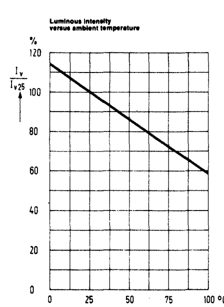


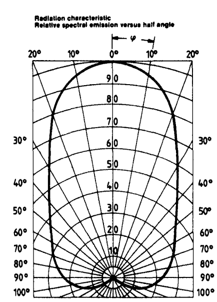
LDH 3520 SERIES



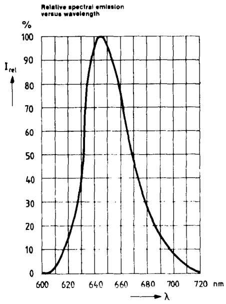


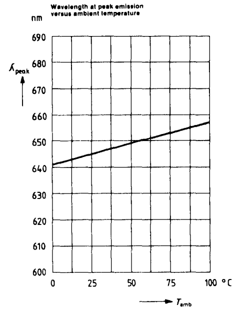


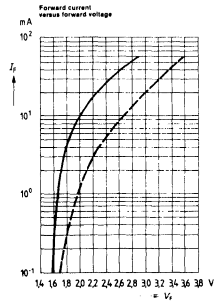


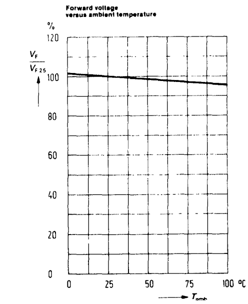


LDH 3520 (Continued)

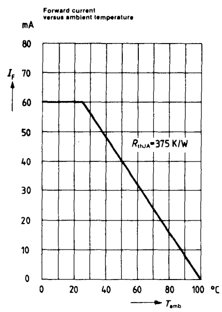


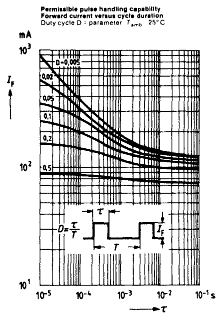


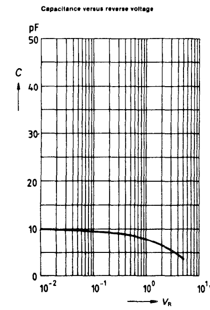


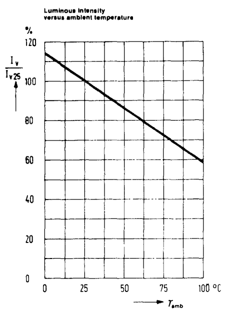


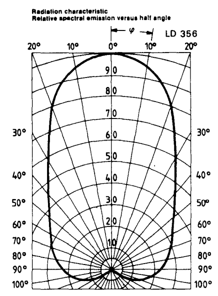
LDY 3560 SERIES

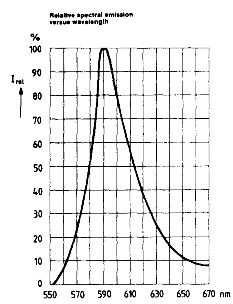


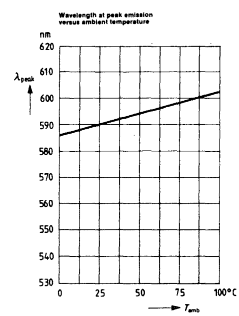


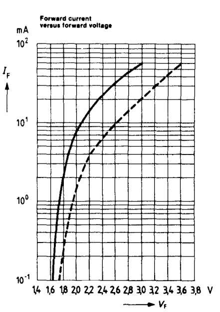


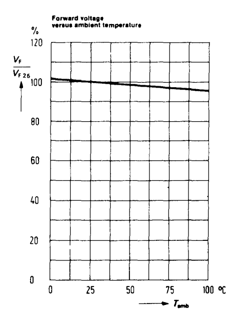






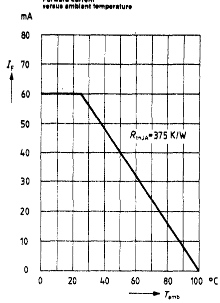




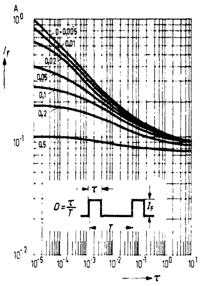


LDG 3570 SERIES

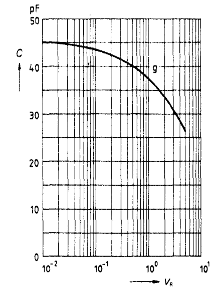
Forward current versus ambient temperature



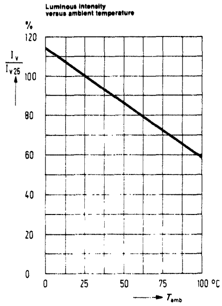
Permissible pulse handling capability
Forward current versus cycle duration
Duty cycle D = parameter, T_{amb} = 25°C



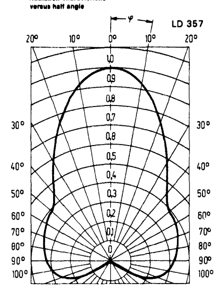
Capacitance versus reverse voltage



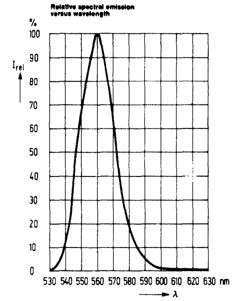
Luminous intensity versus ambient temperature



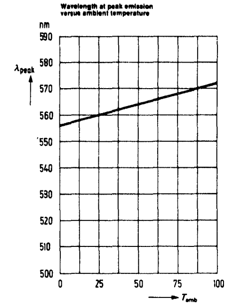
Radiation characteristic versus half angle



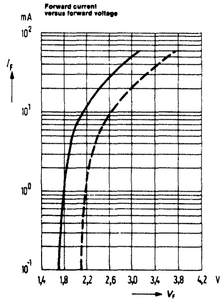
Relative spectral emission versus wavelength



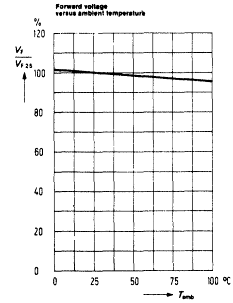
Wavelength at peak emission versus ambient temperature



Forward current versus forward voltage



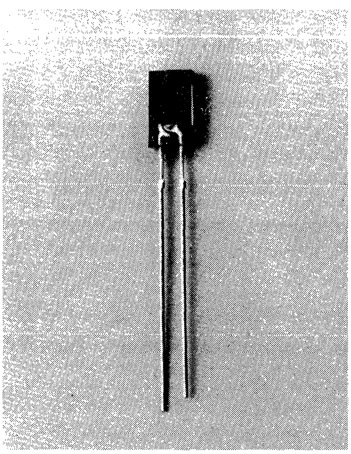
Forward voltage versus ambient temperature



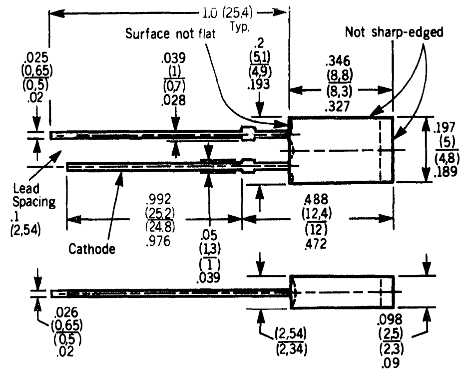
SIEMENS

RED LDR 3700 SERIES
HIGH EFFECIENCY RED LDH 3600 SERIES
YELLOW LDY 3800 SERIES
GREEN LDG 3900 SERIES

RECTANGULAR LED LAMP



Package Dimensions in Inches (mm)



FEATURES

- **Red Diffused Lens, LDR 370X**
  Red Diffused Lens, LDH 360X
  Yellow Diffused Lens, LDY 380X
  Green Diffused Lens, LDG 390X
- **T1 3/4 Size Rectangular Shape**
- **Minimum Lead Length 1″**
- **1/10″ Lead Spacing**
- **I/C Compatible**

DESCRIPTION

The LDR 370X is a standard red GaAsP LED lamp. The LDH 360X high efficiency red and LDY 380X yellow are light emitting diode lamps fabricated wtih TSN (transparent substrate nitrogen) technology. The LDG 390X green is a gallium phosphide LED lamp. All three series have a diffused lens which forms an evenly dispersed rectangular head-on light. They can be used singly as indicators or stacked together to form arrays.

Maximum Ratings

Reverse voltage	V_R	5	V
Forward current	I_F	60	mA
Surge current ($t \leq 10$ s)	i_{FS}	1	A
Storage temperature	T_s	– 55 to + 100	°C
Junction temperature	T_j	100	°C
Power dissipation (T_{amb} = 25 °C)	P_{tot}	200	mW
Thermal resistance junction to air	R_{thJamb}	375	K/W

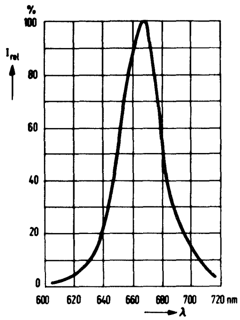
Characteristics T_{amb} = 25 °C

		LDR 370X	LDH 360X	LDY 380X	LDG 390X	
Wave length of emitted light	λ_{peak}	665 ± 15	645 ± 15	590 ± 10	560 ± 15	nm
Dominant wave length	λ_{dom}	645	638	592	561	nm
Viewing Angle (Limits for 50% of luminous intensity I_V) shielded against lateral emission of light	φ	100	100	100	100	deg.
Forward voltage (I_F = 20 mA)	V_F		1.6 (≤2.0)	2.4 (≤3.0)		V
Reverse current (V_R = 5 V)	I_R		0.01 (≤10)	0.01 (≤10)		μA
Rise time	t_r	5	5	100	50	ns
Fall time	t_f	5	5	100	50	ns
Capacitance (V_R = 0 V)	C_o	40	40	10	45	pF

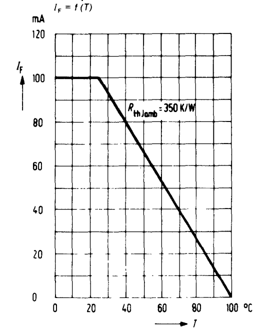
Luminous Intensity

New P/N	Replaces	Min.	Unit	Test Condition
LDR 3701	—	.4	mcd	20 mA
LDR 3702	—	.63	mcd	20 mA
LDH 3601	CQV36-4	1.6	mcd	20 mA
LDH 3602	CQV36-5	2.5	mcd	20 mA
LDH 3603	CQV36-6	4.0	mcd	20 mA
LDY 3801	CQV38-3	1.0	mcd	20 mA
LDY 3802	CQV38-4	1.6	mcd	20 mA
LDY 3803	CQV38-5	2.5	mcd	20 mA
LDG 3901	CQV39-3	1.0	mcd	20 mA
LDG 3902	CQV39-4	1.6	mcd	20 mA
LDG 3903	CQV39-5	2.5	mcd	20 mA

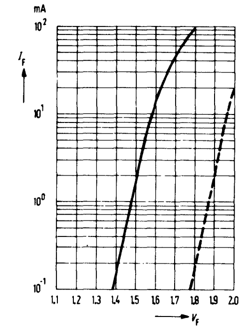
Specifications are subject to change without notice.



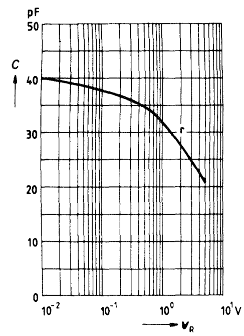
Relative spectral emission $I_{rel} = f(\lambda)$



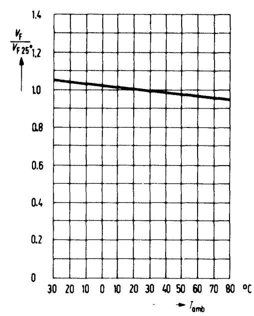
Max. permissible forward current $I_F = f(T)$



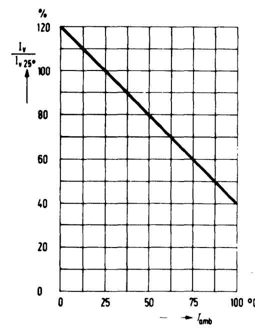
Forward voltage $I_F = f(V_F)$



Capacitance $C = f(V_R)$



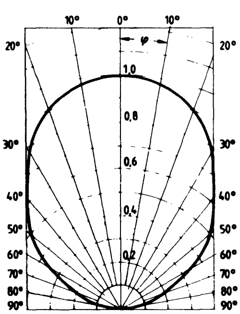
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$

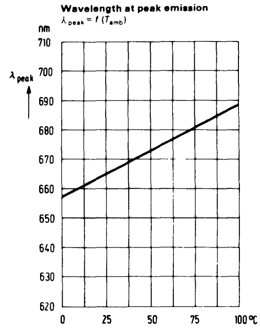


Luminous intensity $\frac{I_v}{I_{v\,25°}} = f(T_{amb})$

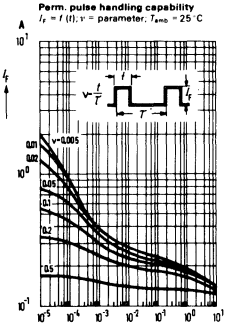
Radiation characteristic $I_{rel} = f(\varphi)$

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



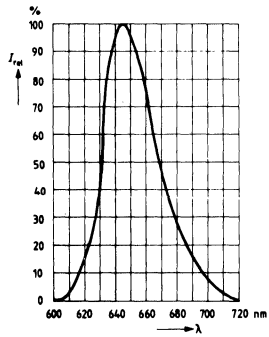


Wavelength at peak emission $\lambda_{peak} = f(T_{amb})$

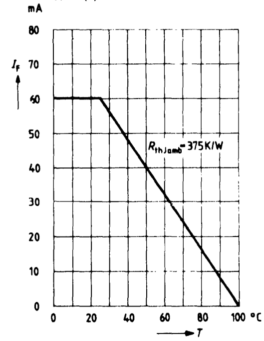


Perm. pulse handling capability $I_F = f(t)$; v = parameter; T_{amb} = 25 °C

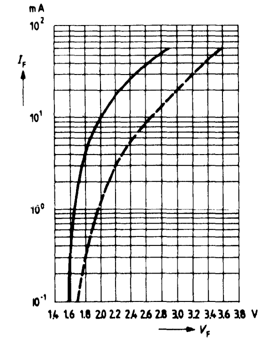
Relative spectral emission $I_{rel} = f(\lambda)$



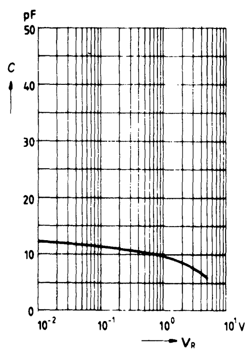
Max. permissible forward current $I_F = f(T)$



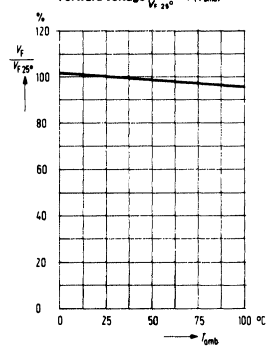
Forward voltage $I_F = f(V_F)$



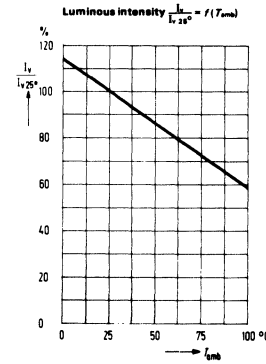
Capacitance $C = f(V_R)$



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

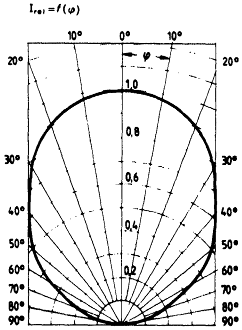


Luminous intensity $\frac{I_V}{I_{V\,25°}} = f(T_{amb})$

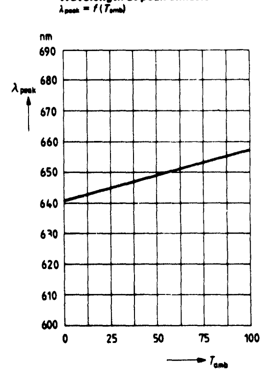


Radiation characteristic $I_{rel} = f(\varphi)$

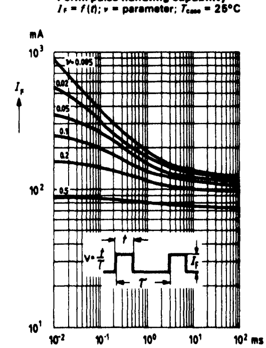
$I_{rel} = f(\varphi)$



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

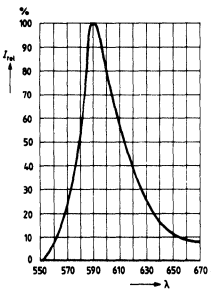


Perm. pulse handling capability
$I_F = f(t)$; v = parameter; T_{case} = 25°C

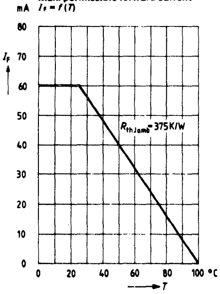


LDY 380X

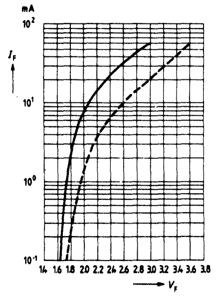
Relative spectral emission $I_{rel} = f(\lambda)$



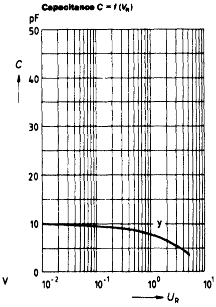
Max. permissible forward current $I_F = f(T)$



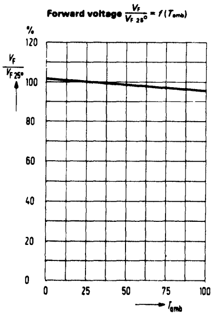
Forward voltage $I_F = f(V_F)$



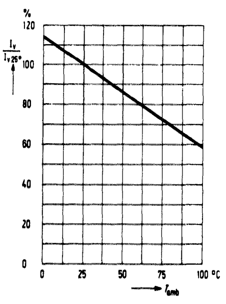
Capacitance $C = f(V_R)$



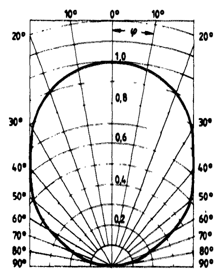
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



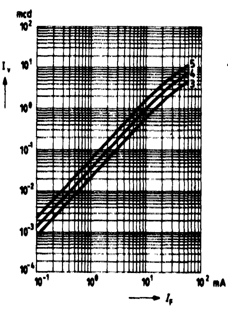
Luminous intensity $\frac{I_V}{I_{V\,25°}} = f(T_{amb})$



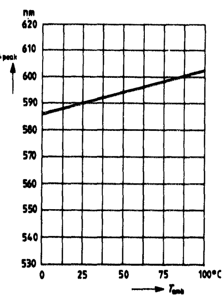
Radiation characteristic $I_{rel} = f(\varphi)$



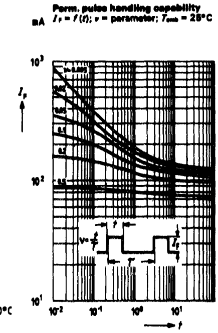
Luminous intensity $I_V = f(I_F)$



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

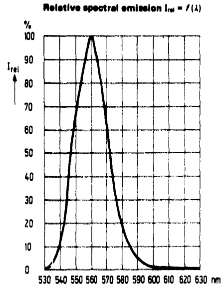


Perm. pulse handling capability $I_F = f(t)$; v = parameter; $T_{amb} = 25 °C$

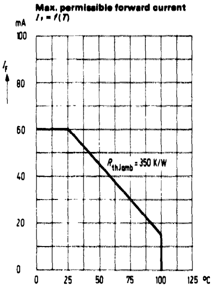


LDG 390X

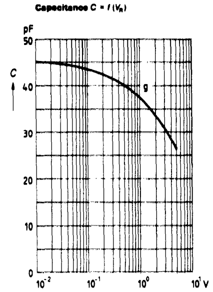
Relative spectral emission $I_{rel} = f(\lambda)$



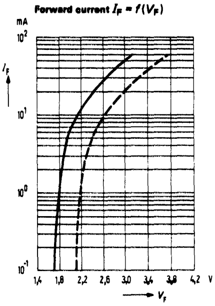
Max. permissible forward current $I_F = f(T)$



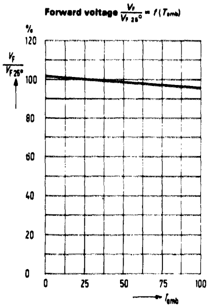
Capacitance $C = f(V_R)$



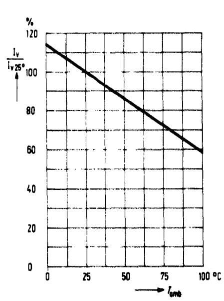
Forward current $I_F = f(V_F)$



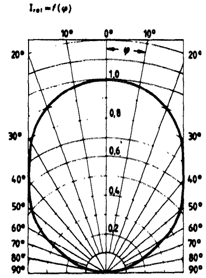
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



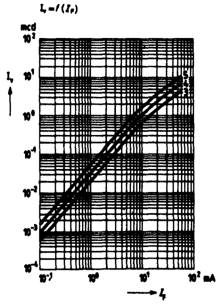
Luminous intensity $\frac{I_V}{I_{V\,25°}} = f(T_{amb})$



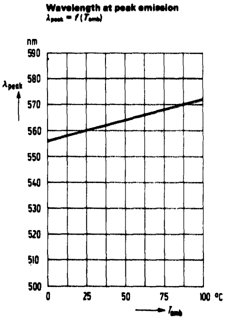
Radiation characteristic $I_{rel} = f(\varphi)$



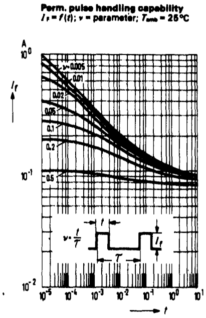
Luminous intensity $I_V = f(I_F)$



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



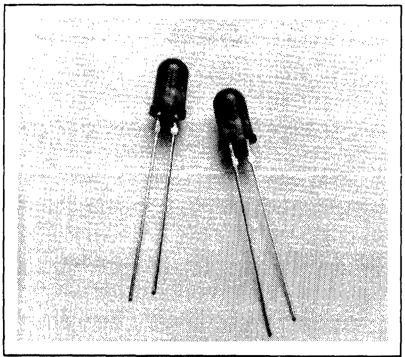
Perm. pulse handling capability $I_F = f(t)$; v = parameter; $T_{amb} = 25 °C$



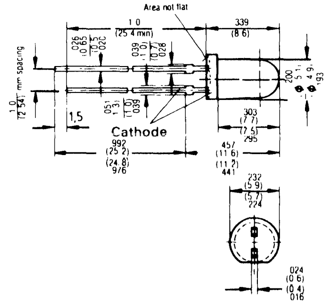
SIEMENS

RED LDR 5000 SERIES
HIGH EFFICIENCY RED LDH 5020 SERIES
HIGH EFFICIENCY YELLOW LDY 5060 SERIES
HIGH EFFICIENCY GREEN LDG 5070 SERIES

T 1¾ LED LAMP



Package Dimensions in Inches (mm)



FEATURES

- **High Light Output**
- **Diffused Lens**
- **Wide Viewing Angle 70°**
- **With Standoffs**
- **T 1¾ Package Size**
- **1" Lead Length**
- **Front Panel Mounting**
  Snap-in Mounting Clips Available
  Clip/Collar #004-9002 Black
  #004-9003 Clear
- **I/C Compatible**

DESCRIPTION

The LDR 500X is a standard red gallium arsenide phosphide (GaAsP) LED lamp. The LDH 502X high efficiency red and LDY 506X yellow are premium high efficiency light emitting diode lamps fabricated with TSN (transparent substrate nitrogen) technology. The LDG 507X green is a gallium phosphide (GaP) lamp. All have a diffused plastic lens which emits a full flooded intense light.

Maximum ratings		LDR 500X	LDH 502X LDY 506X LDG 507X	
Reverse voltage	V_R	5	5	V
Forward current	I_F	100	60	mA
Surge current ($\tau \leq 10\mu s$)	i_{FS}	2	1	A
Storage temperature range	T_{stg}	-55 to +100		°C
Junction temperature	T_j	100	100	°C
Total power dissipation (T_{amb} = 25°C)	P_{tot}	200	200	mW
Thermal resistance junction to air	R_{thJA}	375	375	K/W

Characteristics (T_{amb} = 25°)		LDR 500X	LDH 502X	LDY 506X	LDG 507X	
Wavelength at peak emission	λ_{peak}	665±15	645±15	590±10	560±15	nm
Dominant wavelength	λ_{dom}	645	638	592	561	nm
Half angle (Limits for 50% of luminous intensity I_v)	φ	35	35	35	35	degrees
Forward voltage (I_F = 20mA)	V_F	1.6(≤2.0)		2.4(≤3.0)		V
Reverse current (V_R = 5 V)	I_R			0.01 (≤10)		µA
Rise time	t_r	5	100	200	50	ns
Fall time	t_f	5	100	200	50	ns
Capacitance (V_R = 0 V; f = 1MHz)	C_0	40	12	10	45	pF

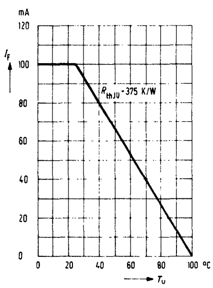
Luminous Intensity grouping

P/N	Replaces	mcd (Min)	Test conditions
LDR 5001	CQV 20-3, LD 500-3, RL-4403 & RL-4850	1.0	20mA
LDR 5002	CQV 20-4 & 5, LD 500-4 & -5, RL-2000	2.5	20mA
LDR 5003	CQV 20-4 & 5, LD 500-4 & -5, RL-2000	4.0	20mA
LDH 5021	CQV 21-4-6, LD 502-5 & 6	2.0	10mA
LDH 5022	CQV 21-7, 8, LD 502-7 & 8	4.0	10mA
LDH 5023	LD 502-9	6.0	10mA
LDY 5061	LD 506-4	1.0	10mA
LDY 5062	LD 506-5 & -6	2.5	10mA
LDG 5071	CQV 25-3-5, LD 507-5	2.5	20mA
LDG 5072	CQV 25-6 & 7, LD 507-6	6.0	20mA

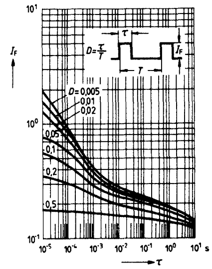
Specifications are subject to change without notice.

LDR 5000 SERIES

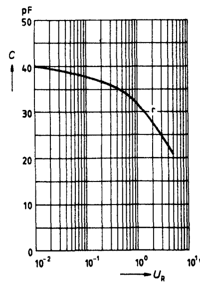
Forward current versus ambient temperature



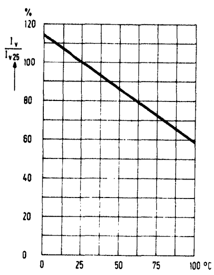
Permissible pulse handling capability
Forward current versus cycle duration
Duty cycle D = parameter; T_{amb} = 25°C



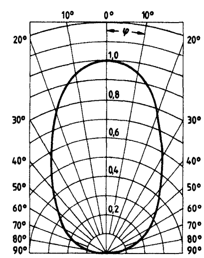
Capacitance versus reverse voltage



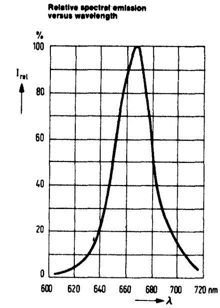
Luminous intensity versus ambient temperature



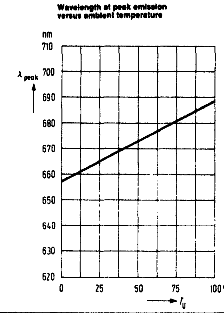
Radiation characteristic
Relative spectral emission versus half angle



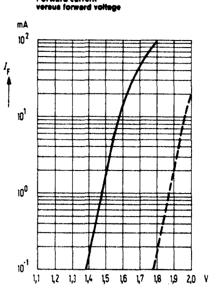
Relative spectral emission versus wavelength



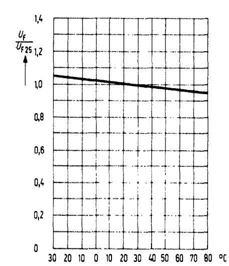
Wavelength at peak emission versus ambient temperature



Forward current versus forward voltage

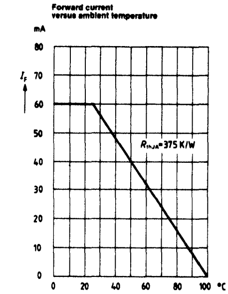


Forward voltage versus ambient temperature

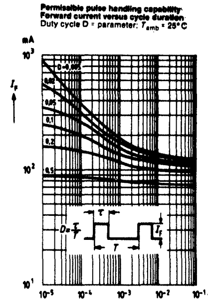


LDH 5020 SERIES

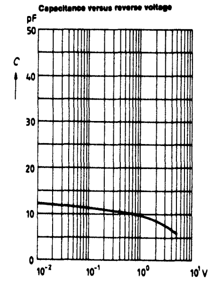
Forward current versus ambient temperature



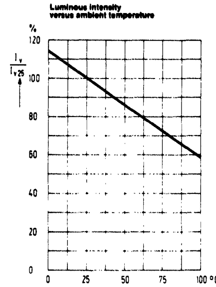
Permissible pulse handling capability
Forward current versus cycle duration
Duty cycle D = parameter; T_{amb} = 25°C



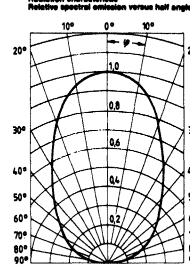
Capacitance versus reverse voltage



Luminous intensity versus ambient temperature

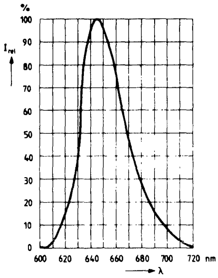


Radiation characteristic
Relative spectral emission versus half angle

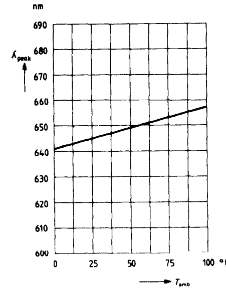


LDH 5020 SERIES (Continued)

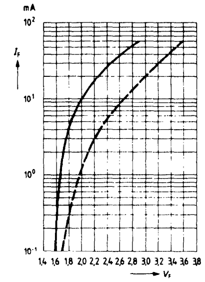
Relative spectral emission
versus wavelength



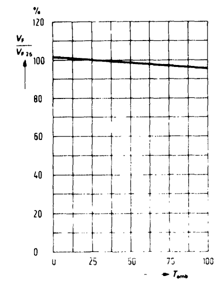
Wavelength at peak emission
versus ambient temperature



Forward current
versus forward voltage

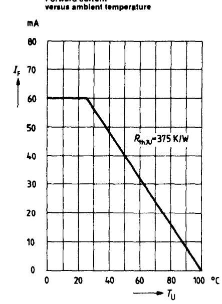


Forward voltage
versus ambient temperature

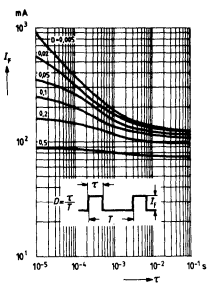


LDY 5060 SERIES

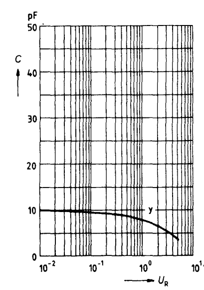
Forward current
versus ambient temperature



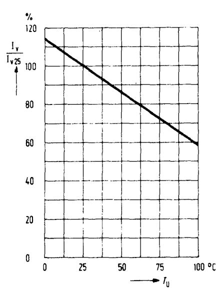
Permissible pulse handling capability
Forward current versus cycle duration
Duty cycle D = parameter, T_{amb} = 25°C



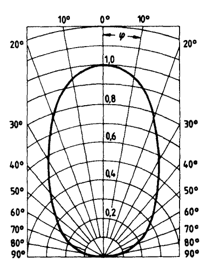
Capacitance versus reverse voltage



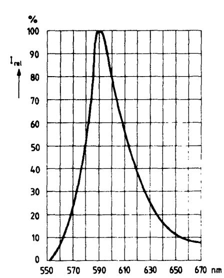
Luminous intensity
versus ambient temperature



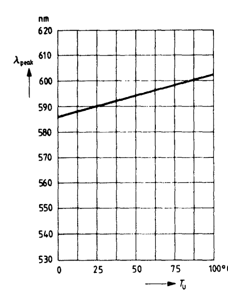
Radiation characteristic
Relative spectral emission versus half angle



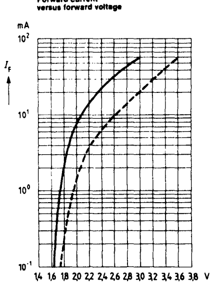
Relative spectral emission
versus wavelength



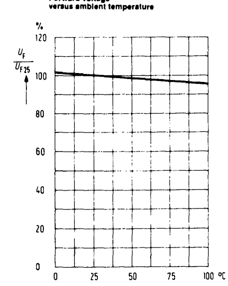
Wavelength at peak emission
versus ambient temperature



Forward current
versus forward voltage

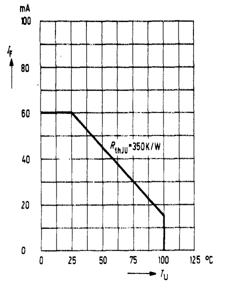


Forward voltage
versus ambient temperature

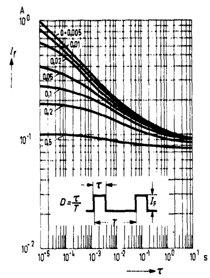


LDG 5070 SERIES

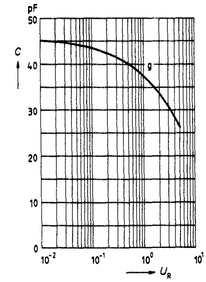
Forward current versus ambient temperature



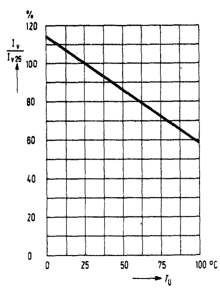
Permissible pulse handling capability
Forward current versus cycle duration
Duty cycle D = parameter; T_{amb} = 25° C



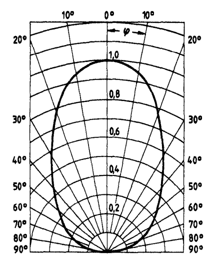
Capacitance versus reverse voltage



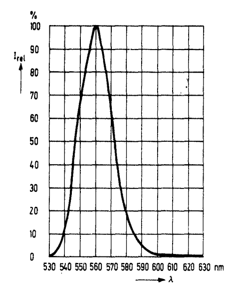
Luminous intensity versus ambient temperature



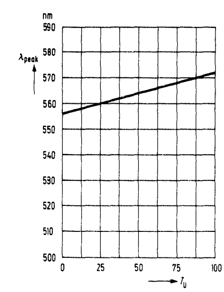
Radiation characteristic
Relative spectral emission versus half angle



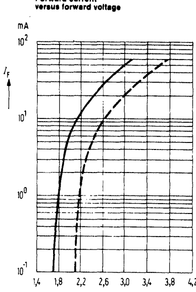
Relative spectral emission versus wavelength



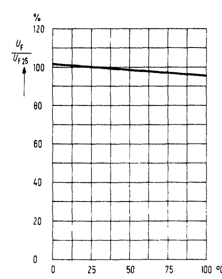
Wavelength at peak emission versus ambient temperature



Forward current versus forward voltage



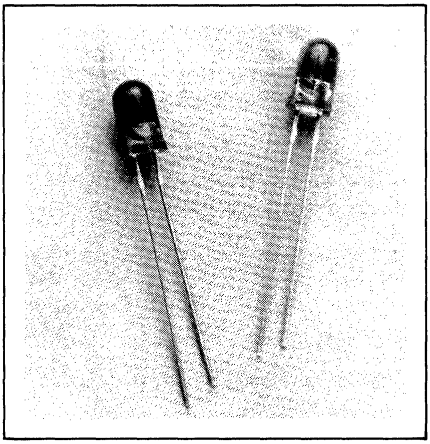
Forward voltage versus ambient temperature



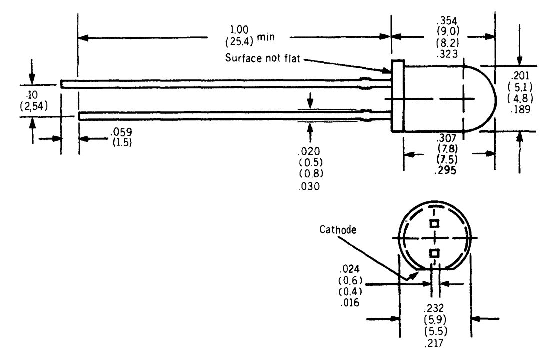
SIEMENS

RED LDR 5091 SERIES
HIGH EFFICIENCY RED LDH 5191 SERIES
YELLOW LDY 5391 SERIES
GREEN LDG 5591 SERIES

T1 ¾ LED LAMP



Package Dimensions in Inches (mm)



FEATURES

- **High Light Output**
- **Lightly tinted clear lens**
- **Viewing Angle, 24°**
- **T1 ¾ Package Size**
- **1" Lead Length**
- **Front Panel Mounting**
  Snap-in Mounting Clips Available
  Clip/Collar #004-9002 Black
  #004-9003 Clear
- **I/C Compatible**

DESCRIPTION

The LDR 509X is a standard red GaAsP light emitting diode lamp. The LDH 519X high efficiency red and LDY 539X yellow lamps are fabricated with TSN (transparent substrate nitrogen) technology. The LDG 559X is a gallium phosphide LED lamp. All four have a lightly tinted clear lens with a narrow viewing angle for the concentration of intense brightness in a head-on position. This is particularly desirable for legend back lighting applications.

Maximum Ratings

		LDR 509X	LDH 519X LDY 539X LDG 559X	
Reverse voltage	V_R	5	5	V
Forward current	I_F	100	60	mA
Surge current ($\tau \leq 10\,\mu s$)	i_{FS}	2	1	A
Storage temperature range	T_{stg}	−55 to +100		°C
Junction temperature	T_j	100		°C
Total power dissipation (T_{amb} = 25°C)	P_{tot}	200		mW
Thermal resistance, junction to air	R_{thJA}	375		K/W

Characteristics (T_{amb} = 25°C)

		LDR 509X	LDH 519X	LDY 539X	LDG 559X	
Wavelength at peak emmision	λ_{peak}	665±15	645±15	590±10	560±15	nm
Dominant wavelength	λ_{dom}	645	638	592	561	nm
Viewing angle (Limits for 50% of luminous intensity I_V)	φ	24	24	24	24	degrees
Forward voltage (I_F = 20mA)	V_F	1.6(≤2.0)		2.4(≤3.0)		V
Reverse current (V_R = 5 V)	I_R			0.01(≤10)		µA
Rise time	t_r	5	100	100	50	ns
Fall time	t_f	5	100	100	50	ns
Capacitance (V_r = 0 V; f = 1 MHz)	C_o	40	12	10	45	pF

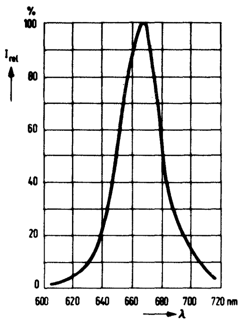
Luminous Intensity Grouping

New P/N	Replaces	Min Mcd	Test Current
LDR 5091	CQV50-5, LD50-2	2.5	20 mA
LDR 5092	CQV50-6 & -7	4.0	20 mA
LDR 5093	CQV50-8	10	20 mA
LDH 5191	CQV51-H	10	10 mA
LDH 5192	CQV51-J	20	10 mA
LDH 5193	CQV51-K	30	10 mA
LDY 5391	CQV53-H	10	10 mA
LDY 5392	CQV53-J	20	10 mA
LDY 5393	CQV53-K	30	10 mA
LDG 5591	CQV55-J & -K	40	20 mA
LDG 5592	—	80	20 mA

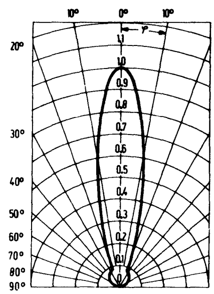
Specifications are subject to change without notice.

LDR 5091

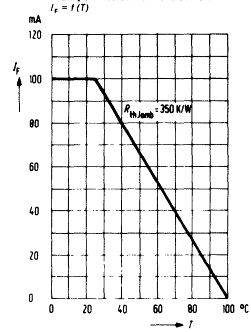
Relative spectral emission $I_{rel} = f(\lambda)$



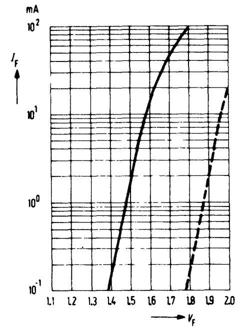
Radiation characteristic $I_{rel} = f(\varphi)$



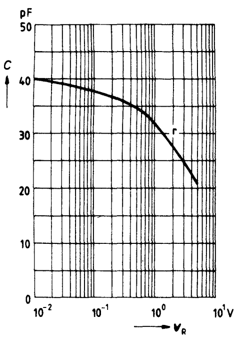
Max. permissible forward current $I_F = f(T)$



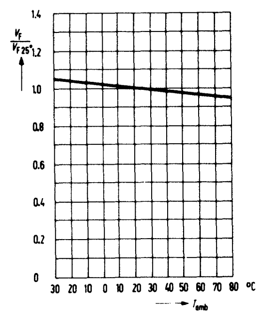
Forward voltage $I_F = f(V_F)$



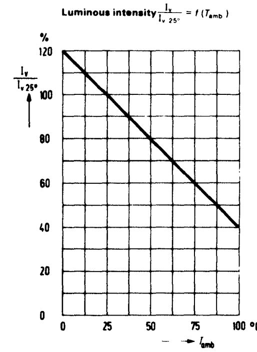
Capacitance $C = f(V_R)$



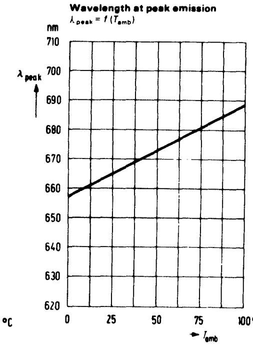
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



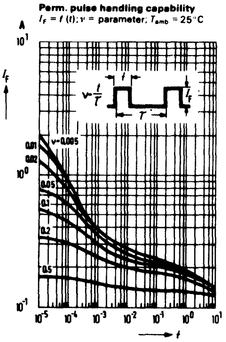
Luminous intensity $\frac{I_v}{I_{v\,25°}} = f(T_{amb})$



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

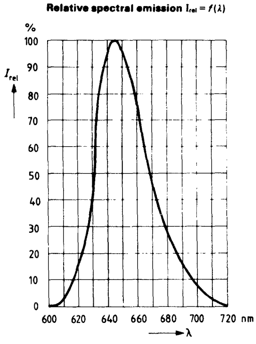


Perm. pulse handling capability $I_F = f(t)$; ν = parameter; $T_{amb} = 25\,°C$

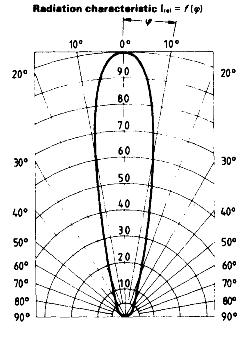


LDH 5191

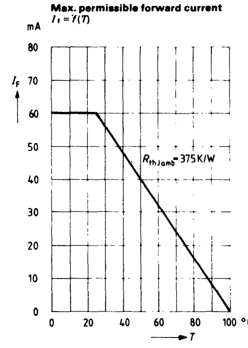
Relative spectral emission $I_{rel} = f(\lambda)$



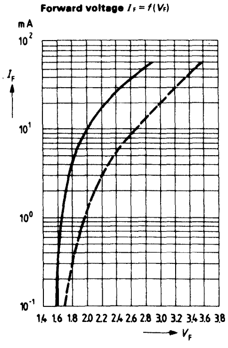
Radiation characteristic $I_{rel} = f(\varphi)$



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

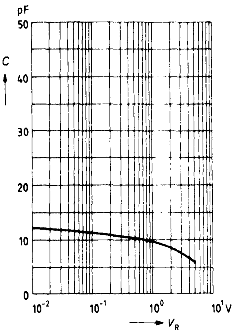


Forward voltage $I_F = f(V_F)$

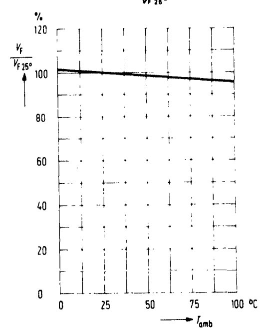


LDH 5191 (CONTINUED)

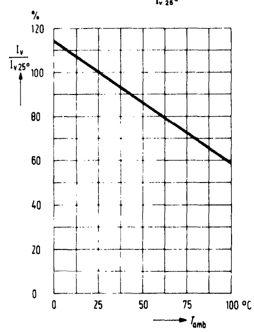
Capacitance $C = f(V_R)$



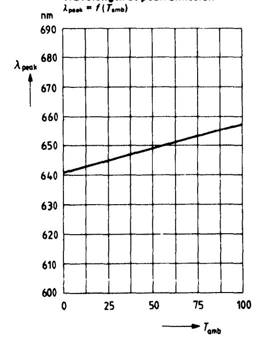
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



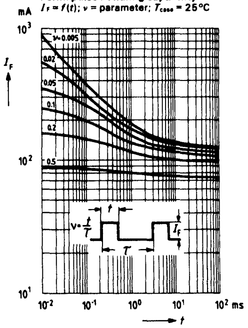
Luminous intensity $\frac{I_V}{I_{V\,25°}} = f(T_{amb})$



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

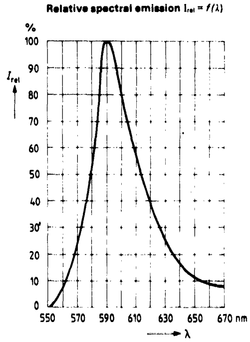


Perm. pulse handling capability
$I_F = f(t)$; v = parameter; $T_{case} = 25°C$

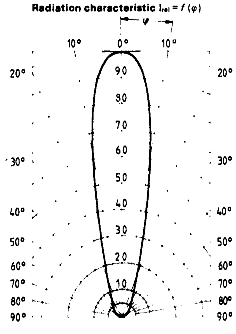


LDY 5391

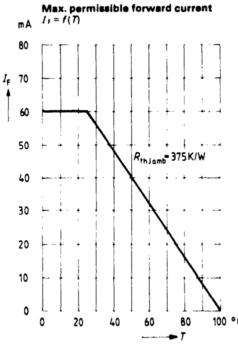
Relative spectral emission $I_{rel} = f(\lambda)$



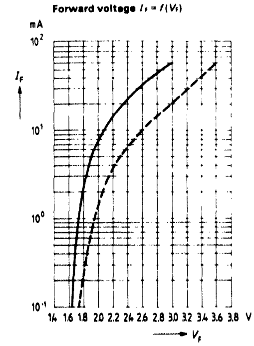
Radiation characteristic $I_{rel} = f(\varphi)$



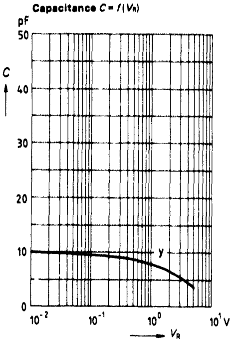
Max. permissible forward current
$I_F = f(T)$



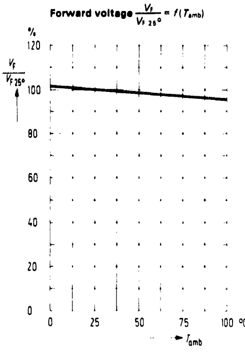
Forward voltage $I_F = f(V_F)$



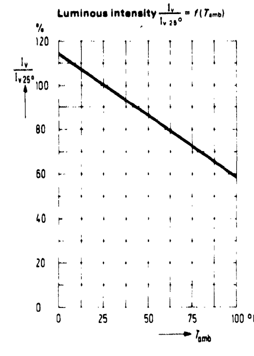
Capacitance $C = f(V_R)$



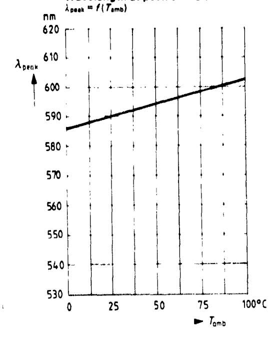
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



Luminous intensity $\frac{I_V}{I_{V\,25°}} = f(T_{amb})$

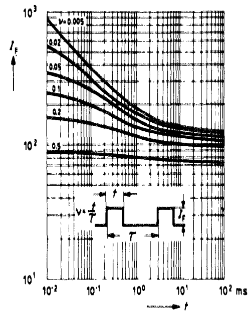


Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$



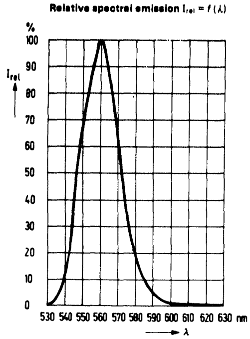
LDY 5391 (CONTINUED)

Permissible pulse handling capability
$I_F = f(t)$; ν = parameter; T_{amb} = 25°C

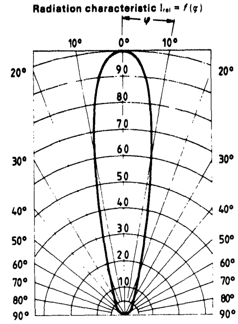


LDG 5591

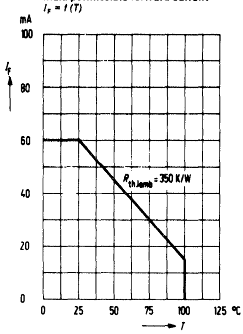
Relative spectral emission $I_{rel} = f(\lambda)$



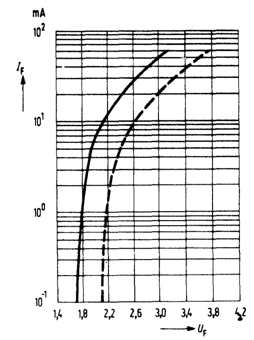
Radiation characteristic $I_{rel} = f(\varphi)$



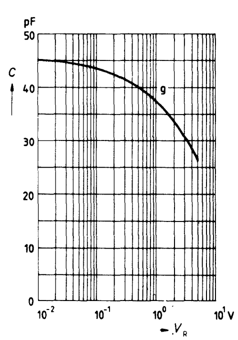
Max. permissible forward current
$I_F = f(T)$



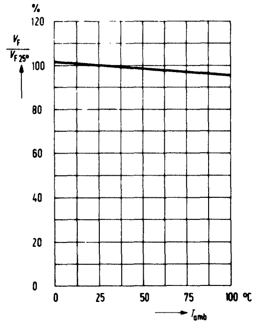
Forward voltage $I_F = f(V_F)$



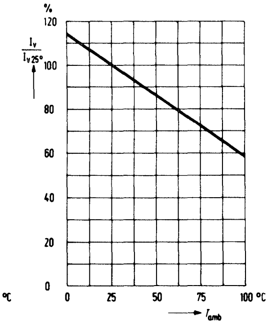
Capacitance $C = f(V_R)$



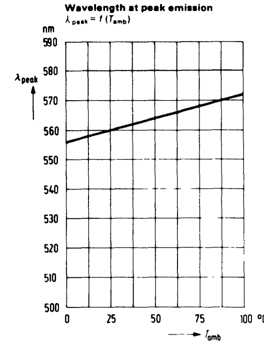
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



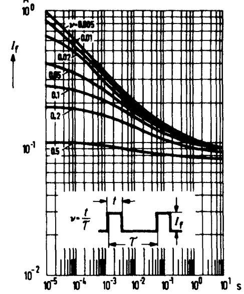
Luminous intensity $\frac{I_v}{I_{v\,25°}} = f(T_{amb})$



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



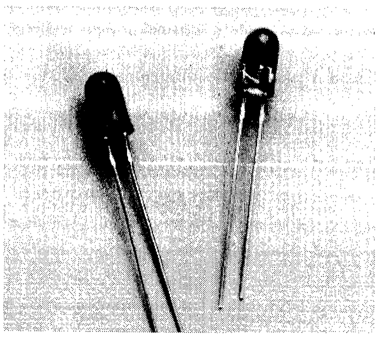
Perm. pulse handling capability
$I_F = f(t)$; ν = parameter; T_{amb} = 25°C



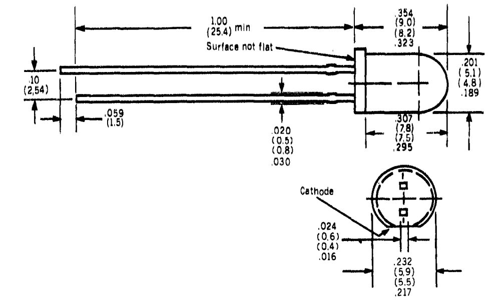
SIEMENS

RED LDR 5100 SERIES
HIGH EFFICIENCY RED LDH 5120 SERIES
HIGH EFFICIENCY YELLOW LDY 5160 SERIES
HIGH EFFICIENCY GREEN LDG 5170 SERIES

T 1¾ LED LAMP



Package Dimensions in Inches (mm)



FEATURES

- High Light Output
- Diffused Lens
- Wide Viewing Angle 70°
- No Standoffs
- T 1¾ Package Size
- 1″ Lead Length
- Front Panel Mounting
  Snap-in Mounting Clips Available
  Clip/Collar #004-9002 Black
  #004-9003 Clear
- I/C Compatible

DESCRIPTION

The LDR 510X Series is a standard red gallium arsenide phosphide (GaAsP) LED lamp. The LDH 512X high efficiency red and LDY 516X yellow are premium high efficiency light emitting diode lamps fabricated with TSN (transparent substrate nitrogen) technology. The LDG 517X green is a gallium phosphide (GaP) lamp. All have a diffused plastic lens which emits a full flooded intense light.

Maximum ratings		LDR 510X	LDH 512X LDY 516X LDG 517X	
Reverse voltage	V_R	5	5	V
Forward current	I_F	100	60	mA
Surge current ($\tau \leq 10\mu s$)	i_{FS}	2	1	A
Storage temperature range	T_{stg}	-55 to +100		°C
Junction temperature	T_j	100	100	°C
Total power dissipation (T_{amb} = 25°C)	P_{tot}	200	200	mW
Thermal resistance junction to air	R_{thJA}	375	375	K/W

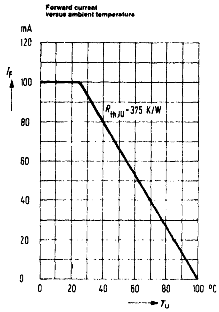
Characteristics (T_{amb} = 25°)		LDR 510X	LDH 512X	LDY 516X	LDG 517X	
Wavelength at peak emission	λ_{peak}	665±15	645±15	590±10	560±15	nm
Dominant wavelength	λ_{dom}	645	638	592	561	nm
Viewing angle (Limits for 50% of luminous intensity I_v	φ	70	70	70	70	degrees
Forward voltage (I_F = 20mA)	V_F	1.6(≤2.0)	2.4(≤3.0)			V
Reverse current (V_R = 5 V)	I_R		0.01 (≤10)			μA
Rise time	t_r	5	100	200	50	ns
Fall time	t_f	5	100	200	50	ns
Capacitance (V_R = 0 V; f = 1MHz)	C_0	40	12	10	45	pF

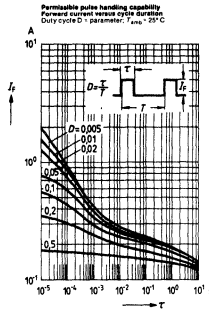
Luminous Intensity grouping

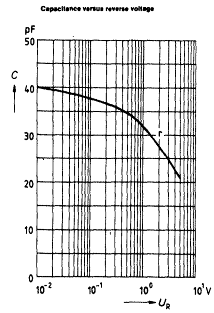
P/N	Replaces	mcd (Min)	Test conditions
LDR 5101	LD 510-3, RL-5053A & -1	1.0	20mA
LDR 5102	LD 510-4 & -5, RL-5053-2 & -3	2.5	20mA
LDR 5103	———	4.0	20mA
LDH 5121	LD 512-4-7	2.0	10mA
LDH 5122	LD 512-8	4.0	10mA
LDH 5123	———	6.0	10mA
LDY 5161	LD 516-4, YL-4550, YL-4850	1.0	10mA
LDY 5162	LD 516-5 & -6	2.5	10mA
LDY 5163	———	4.0	10mA
LDG 5171	LD 517-5, GL-4850, GL-4950	2.5	20mA
LDG 5172	LD 517-6 & -7	6.0	20mA

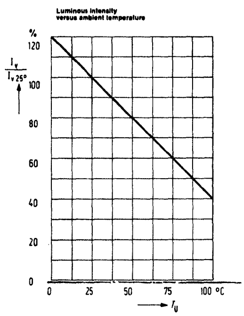
Specifications are subject to change without notice.

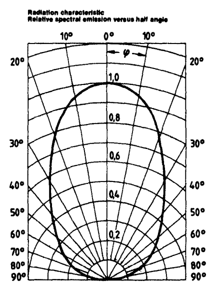
LDR 5100 SERIES

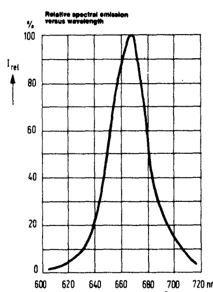


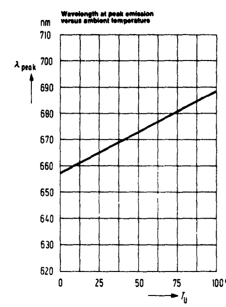


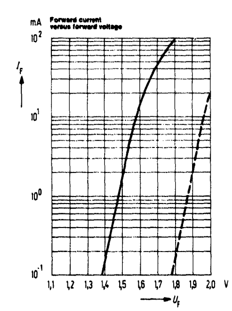


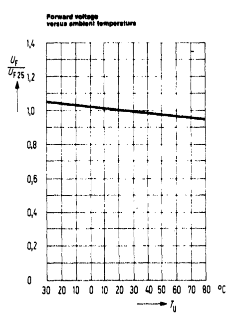




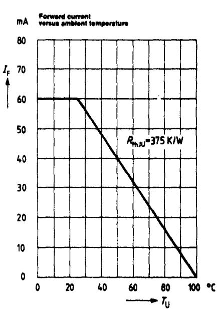


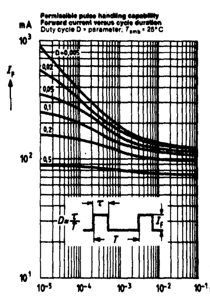


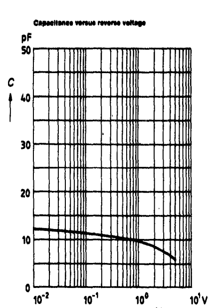


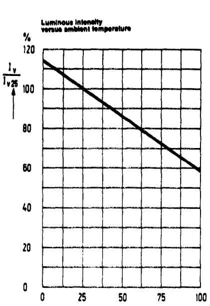


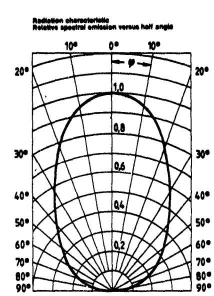
LDH 5120 SERIES





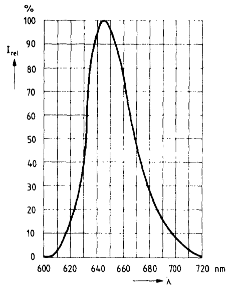




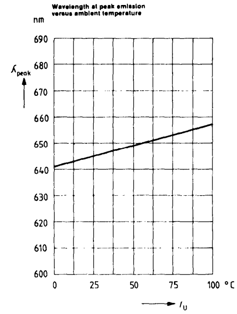


LDH 5120 (Continued)

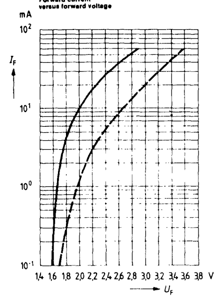
Relative spectral emission versus wavelength



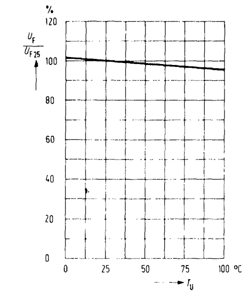
Wavelength at peak emission versus ambient temperature



Forward current versus forward voltage

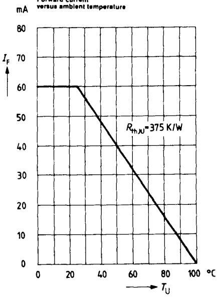


Forward voltage versus ambient temperature

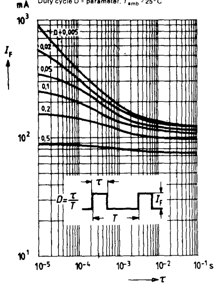


LDY 5160 SERIES

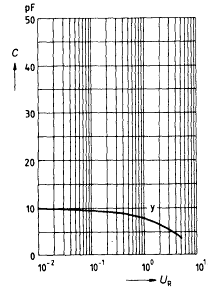
Forward current versus ambient temperature



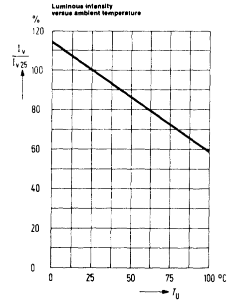
Permissible pulse handling capability
Forward current versus cycle duration
Duty cycle D = parameter, T_{amb} ≤ 25°C



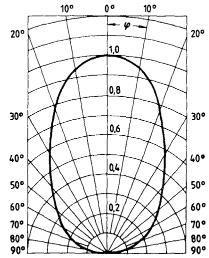
Capacitance versus reverse voltage



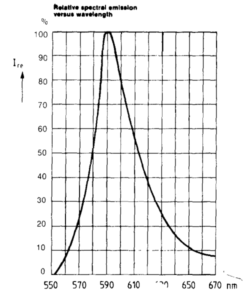
Luminous intensity versus ambient temperature



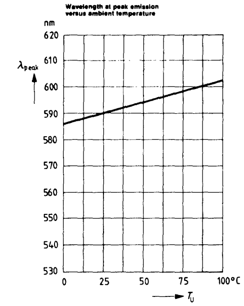
Radiation characteristic
Relative spectral emission versus half angle



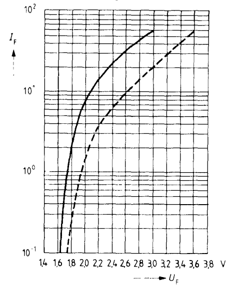
Relative spectral emission versus wavelength



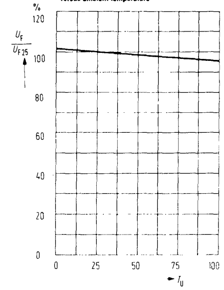
Wavelength at peak emission versus ambient temperature



Forward current versus forward voltage

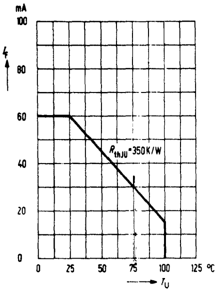


Forward voltage versus ambient temperature

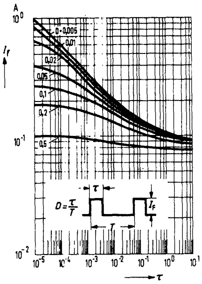


LDG 5170 SERIES

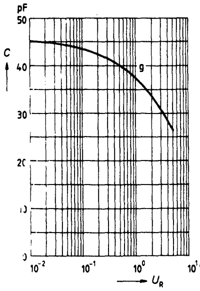
Forward current
versus ambient temperature



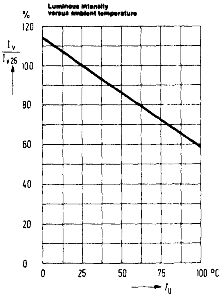
Permissible pulse handling capability
Forward current versus cycle duration
Duty cycle D = parameter; T_{amb} = 25 °C



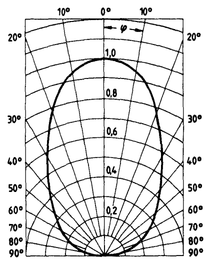
Capacitance versus reverse voltage



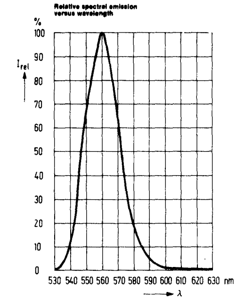
Luminous intensity
versus ambient temperature



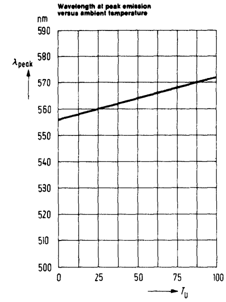
Radiation characteristic
versus half angle



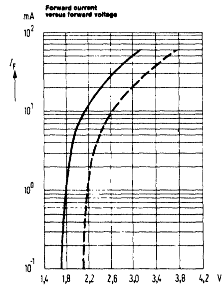
Relative spectral emission
versus wavelength



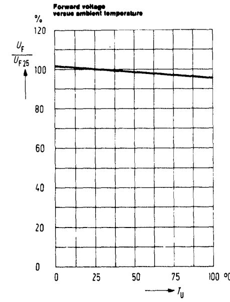
Wavelength at peak emission
versus ambient temperature



Forward current
versus forward voltage



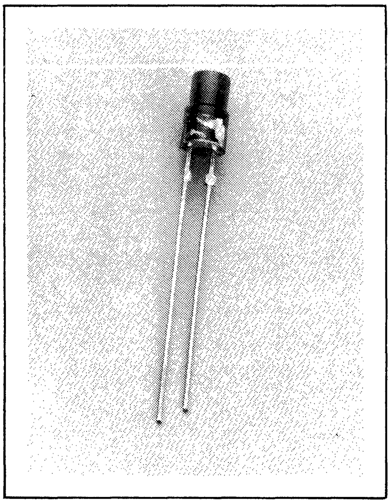
Forward voltage
versus ambient temperature



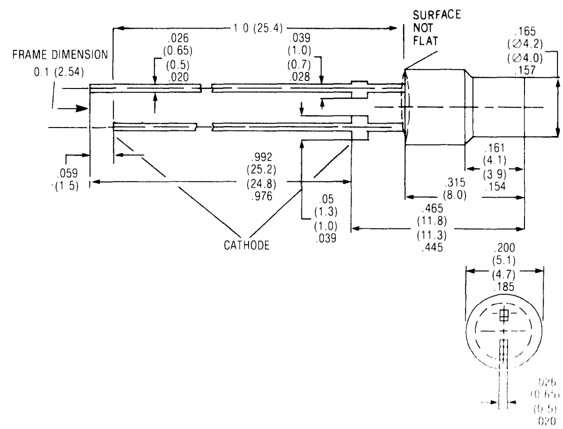
SIEMENS

RED LDR 5700 SERIES
HIGH EFFICIENCY RED LDH 5600 SERIES
YELLOW LDY 5800 SERIES
GREEN LDG 5900 SERIES

CYLINDRICAL LED LAMP



Package Dimensions in Inches (mm)



FEATURES

- **Red Diffused Lens, LDR 570X**
  Red Diffused Lens, LDH 560X
  Yellow Diffused Lens, LDY 580X
  Green Diffused Lens, LDG 590X
- **Cylindrical Shape**
- **Minimum Lead Length 1″**
- **1/10″ Lead Spacing**
- **I/C Compatible**

DESCRIPTION

The LDR 570X is a standard red GaAsP LED lamp. The LDH 560X & LDY 580X are light emitting diode lamps fabricated with TSN (transparent substrate nitrogen) technology. The LDG 590X is a gallium phosphate LED lamp. All the series have a diffused lens which forms an evenly dispersed circular head on light.

Maximum

Reverse voltage	V_R	5	V
Forward current	I_F	60	mA
Surge current ($t \leqslant 10\ \mu s$)	i_{FS}	1	A
Storage temperature	T_s	−55 to +100	°C
Junction temperature	T_j	100	°C
Power dissipation (T_{amb} = 25° C)	P_{tot}	200	mW
Thermal resistance junction to air	R_{thJamb}	375	K/W

Characteristics (T_{AMB} = 25°C)

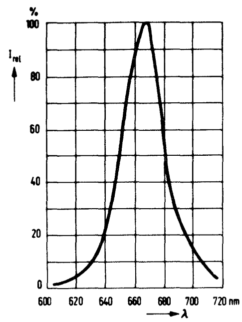
		LDH 570X	LDH 560X	LDY 580X	LDG 590X	
Wave length of emitted light	peak	665 ± 15	645 ± 15	590 ± 10	560 ± 15	nm
Dominant wave length	dom	645	638	592	561	nm
Viewing Angle (Limits for 50% of luminous intensity I_V) shielded against lateral emission of light		100	100	100	100	deg.
Forward voltage (I_F = 20 mA)	V_F	1.6 (≤2.0)		2.4 (≤3.0)		V
Reverse current (V_R = 5 V)	I_R	0.01 (≤10)		0.01 (≤10)		μA
Rise time	t_r	5	100	100	50	nS
Fall time	t_f	5	100	100	50	nS
Capacitance (V_R = 0 V)	C_o	40	12	10	45	pF

Luminous Intensity

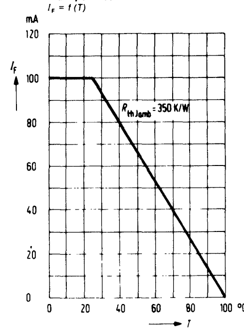
New P/N	Replaces	Min.	Unit	Test Condition
LDR 5701	—	0.4	mcd	20 mA
LDR 5702	—	.63	mcd	20 mA
LDH 5601	CQV56-4	1.6	mcd	20 mA
LDH 5602	—	2.5	mcd	20 mA
LDY 5801	CQV58-3	1.0	mcd	20 mA
LDY 5802	CQV58-4	1.6	mcd	20 mA
LDY 5803	—	2.5	mcd	20 mA
LDG 5901	CQV59-3	1.0	mcd	20 mA
LDG 5902	CQV59-4	1.6	mcd	20 mA
LDG 5903	—	2.5	mcd	20 mA

Specifications are subject to change without notice.

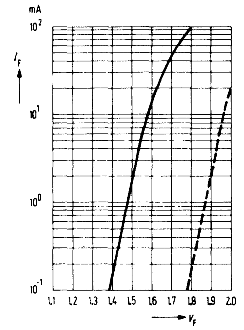
Relative spectral emission $I_{rel} = f(\lambda)$



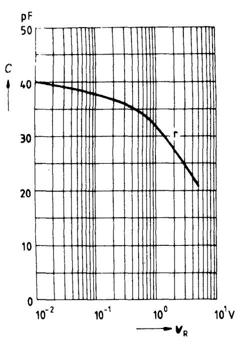
Max. permissible forward current $I_F = f(T)$



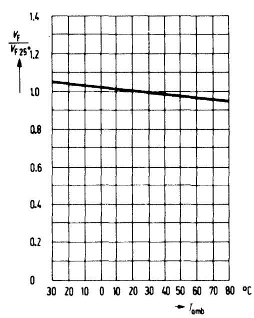
Forward voltage $I_F = f(V_F)$



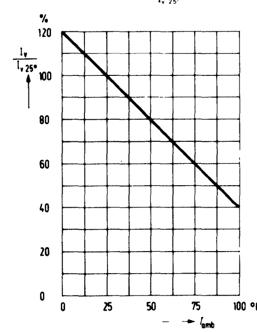
Capacitance $C = f(V_R)$



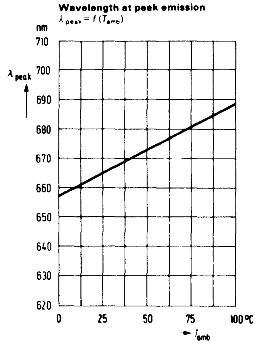
Forward voltage $\frac{V_F}{V_{F\,25}} = f(T_{amb})$



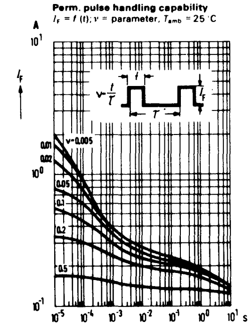
Luminous intensity $\frac{I_v}{I_{v\,25°}} = f(T_{amb})$



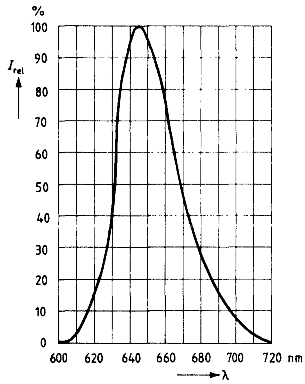
Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$



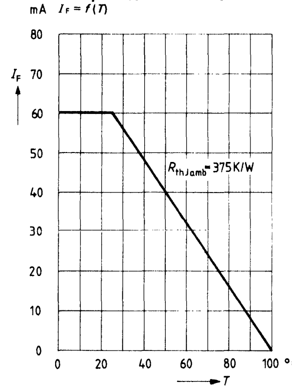
Perm. pulse handling capability
$I_F = f(t)$; ν = parameter, T_{amb} = 25 °C



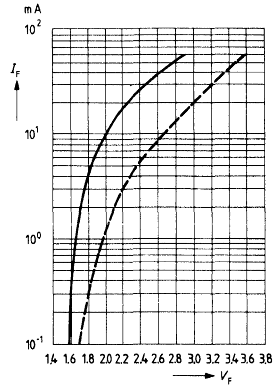
Relative spectral emission $I_{rel} = f(\lambda)$



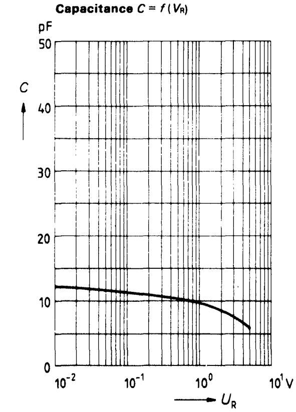
Max. permissible forward current $I_F = f(T)$



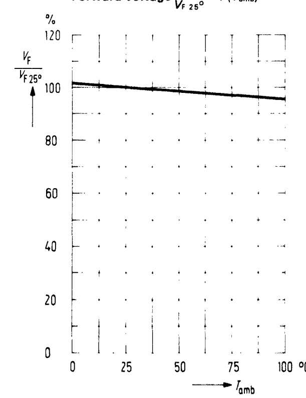
Forward voltage $I_F = f(V_F)$



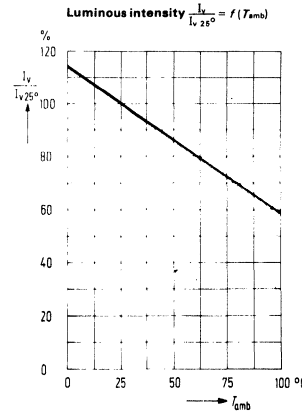
Capacitance $C = f(V_R)$



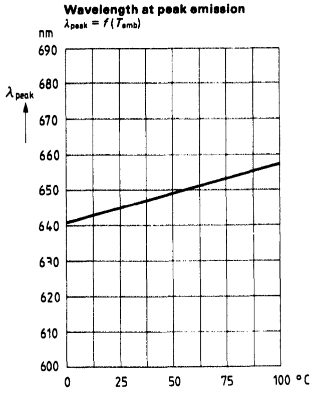
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



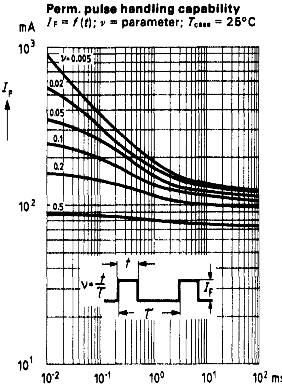
Luminous intensity $\frac{I_v}{I_{v\,25°}} = f(T_{amb})$



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

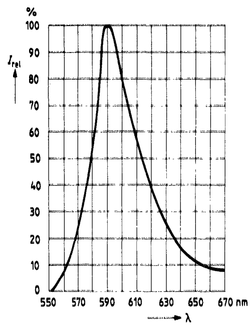


Perm. pulse handling capability
$I_F = f(t)$; v = parameter; T_{case} = 25°C

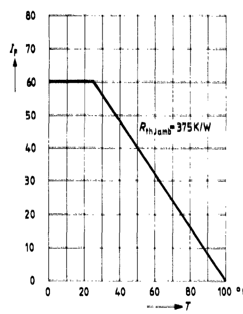


LDY 580X

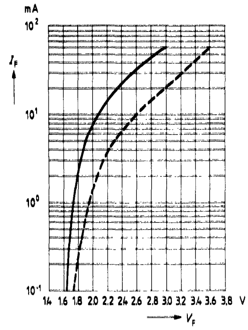
Relative spectral emission $I_{rel} = f(\lambda)$



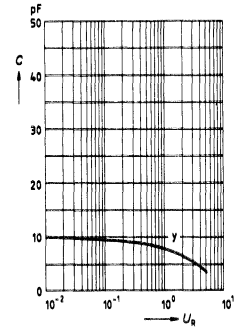
Max. permissible forward current $I_F = f(T)$



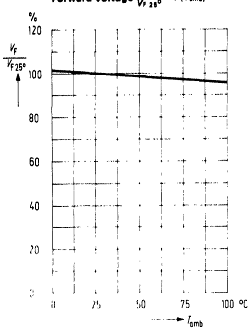
Forward voltage $I_F = f(V_F)$



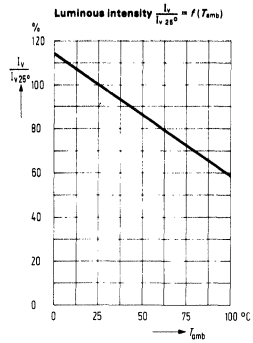
Capacitance $C = f(V_R)$



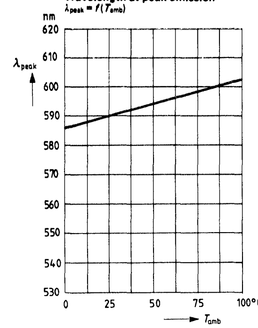
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



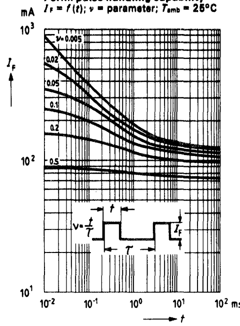
Luminous intensity $\frac{I_V}{I_{V\,25°}} = f(T_{amb})$



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

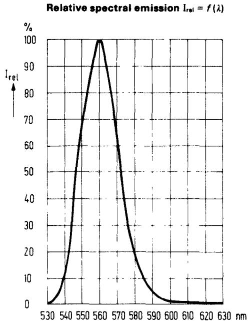


Perm. pulse handling capability $I_F = f(t)$; v = parameter; T_{amb} = 25°C

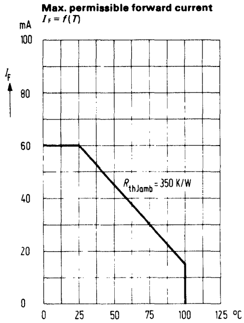


LDG 590X

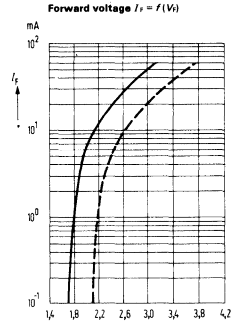
Relative spectral emission $I_{rel} = f(\lambda)$



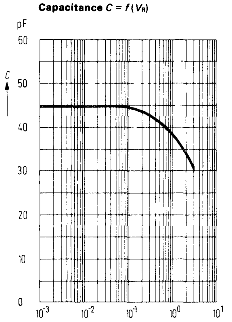
Max. permissible forward current $I_F = f(T)$



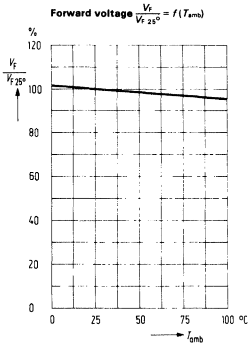
Forward voltage $I_F = f(V_F)$



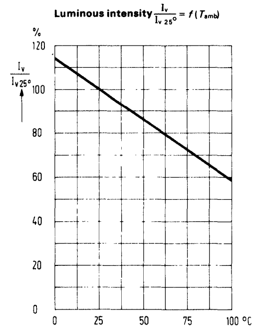
Capacitance $C = f(V_R)$



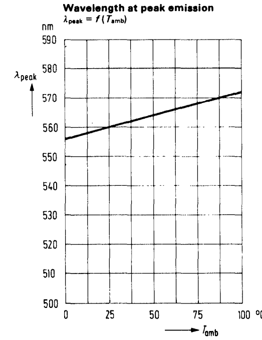
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



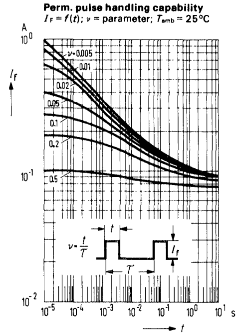
Luminous intensity $\frac{I_V}{I_{V\,25°}} = f(T_{amb})$



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



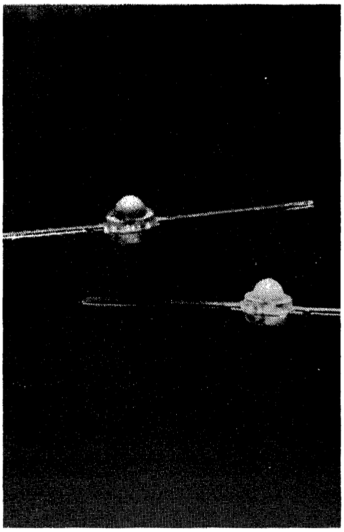
Perm. pulse handling capability $I_F = f(t)$; v = parameter; T_{amb} = 25°C



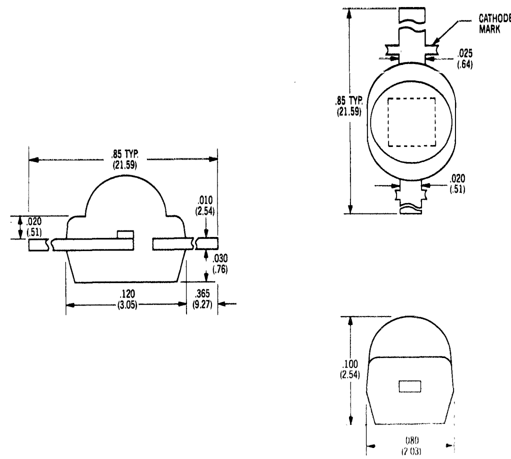
SIEMENS

RL-50

RED MINIATURE AXIAL LEAD LED LAMP



Package Dimensions in Inches (mm)



FEATURES

- **High Luminance—typically 1.0 mcd @ 10mA**
- **Optimum Packaging Design for Maximum Strength at Minimum Linear Spacing**
- **Operates from 5 V IC Logic Supply**
- **Small Size**
- **High Reliability**
- **Water clear lens**

DESCRIPTION

The RL-50 is intended for high volume usage in array and indicator light applications. Major advantages of this device are high luminance at lower currents, long life and low cost.

Maximum Ratings

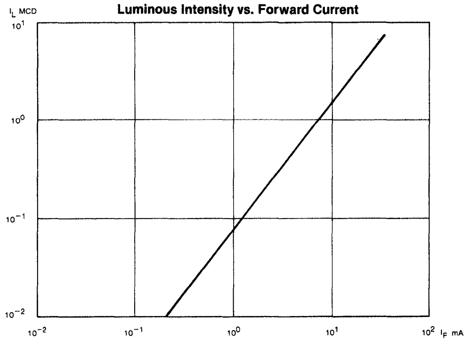
Power Dissipation @ 25°C Ambient .... 80 mW
Derate Linearly from 25°C. .... −1.1 mW/°C
Storage and Operating Temp. Range .... −55°C to +100°C
Continuous Forward Current .... 40 mA
Lead Solder Time @ 260°C (1/16″ from lens) .... 5 sec.
Peak Inverse Voltage .... 3.0 V

Opto-Electronic Characteristics (@ 25°C)

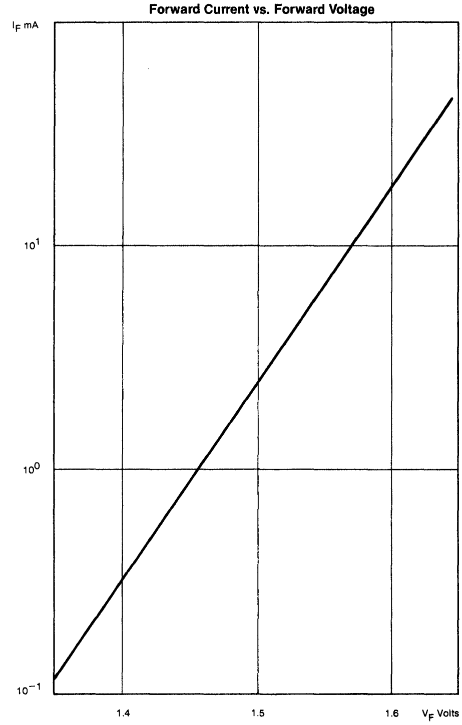
Parameter	Min	Typ	Max	Units	Test Condition
Reverse Current			100	μA	-3.0 V
Forward Voltage		1.6	2.0	V	$I_F = 20$ mA
Luminous Intensity	0.5	1.0		mcd	$I_F = 10$ mA
Viewing Angle		90		degrees	
Peak emission wavelength		660		nm	

Specifications subject to change without notice.

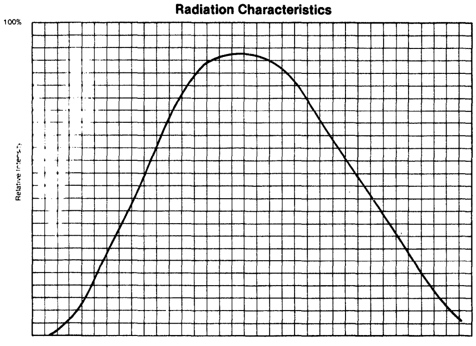
Luminous Intensity vs. Forward Current



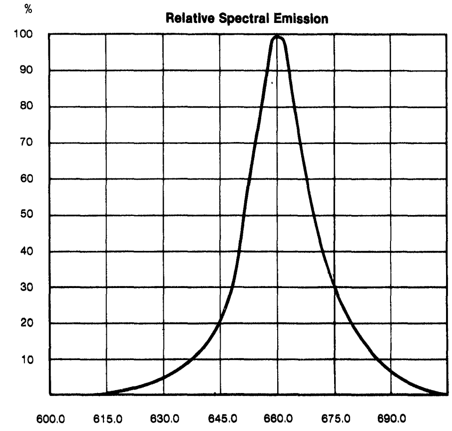
Forward Current vs. Forward Voltage



Radiation Characteristics



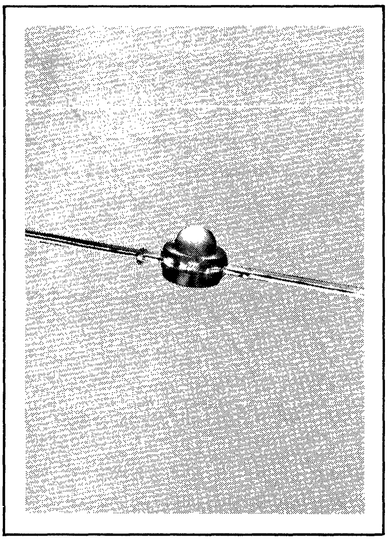
Relative Spectral Emission



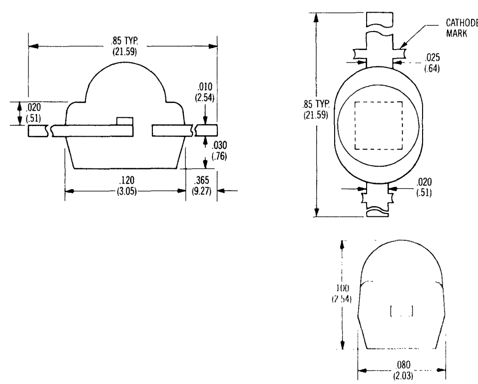
SIEMENS

RL-54

RED MINIATURE AXIAL LEAD LED LAMP



Package Dimensions in Inches (mm)



FEATURES

- **High Luminance—Typically 1.0 mcd @ 10mA**
- **Optimum Packaging Design for Maximum Strength at Minimum Linear Spacing**
- **Operates from 5 V IC Logic Supply**
- **Small Size**
- **High Reliability**
- **Red Diffused lens**

DESCRIPTION

The RL-54 is intended for high volume usage in array and indicator light applications. Major advantages of this device are high luminance at lower currents, long life and low cost.

Maximum Ratings

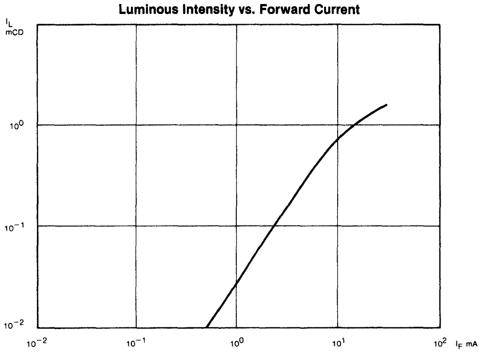
Power Dissipation @ 25°C Ambient .... 80 mW
Derate Linearly from 25°C. .... −1.1 mW/°C
Storage & Operating Temp. Range............ −55°C to +100°C
Continuous Forward Current .... 40 mA
Lead Solder Time @ 260°C (1/16″ from lens) .... 5 sec.
Peak Inverse Voltage .... 3.0 V

Opto-Electronic Characteristics (@ 25°C)

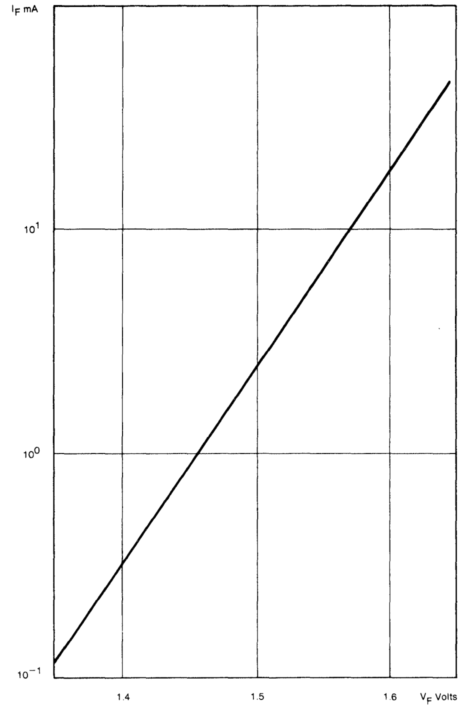
Parameter	Min	Typ	Max	Units	Test Condition
Reverse Current			100	μA	-3.0 V
Forward Voltage		1.6	2.0	V	$I_F = 20$ mA
Luminous Intensity	0.4	0.6		mcd	$I_F = 10$ mA
Viewing Angle		90		degrees	
Peak emission wavelength ...		660		nm	

Specifications subject to change without notice.

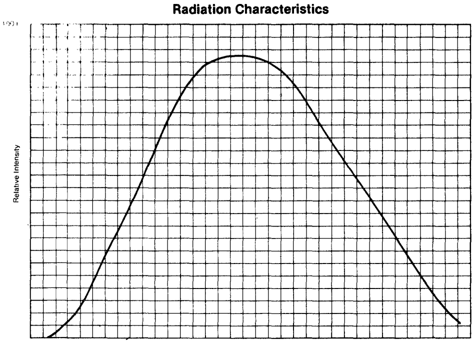
Luminous Intensity vs. Forward Current



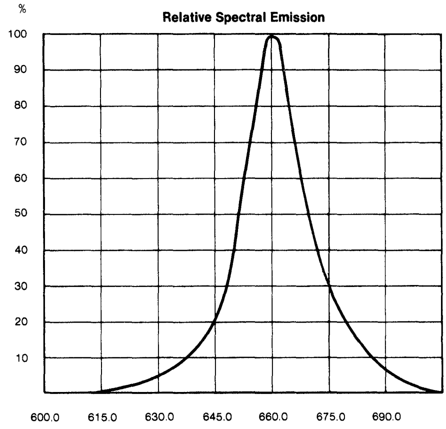
Forward Current vs. Forward Voltage



Radiation Characteristics

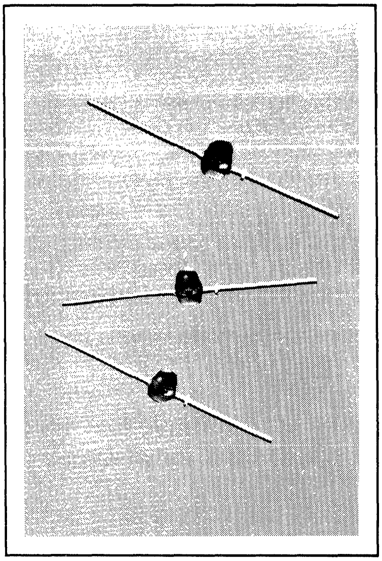


Relative Spectral Emission

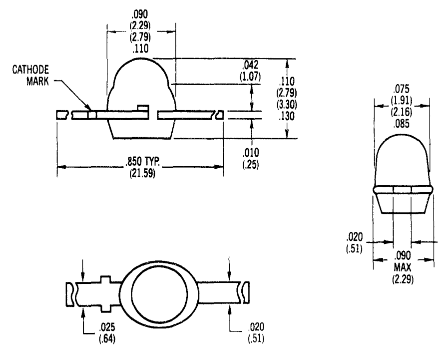


SIEMENS RL-55

RED MINIATURE AXIAL LEAD LED LAMP



Package Dimensions in Inches (mm)



FEATURES

- **2 Gate Load Bright Light—.4 mcd at 3 mA**
- **High on Axis Intensity, typically 2.2 mcd 10 mA**
- **Optimum Packaging Design for Maximum Strength at Minimum Linear Spacing**
- **Operates from 5 V IC Logic Supply**
- **Miniature Axial Lead**
- **High Reliability**
- **RL-55-5—Low Cost Version**

DESCRIPTION

The RL-55 is a Gallium Arsenide Phosphide LED lamp that has high on-axis intensity at low current (3 mA), long life and low cost. It uses a dark red diffused lens and provides a full .080″ flooded light with good contrast. When operated at high current (10 mA) the RL-55 has a very high on-axis intensity of 2.2 mcd @ 10 mA. Applications include mounting on PC boards at low current as diagnostic and circuit status indicators. Function and low voltage indicator on battery powered equipment such as calculators, watches and portable DVMs and in the higher current mode as a back light.

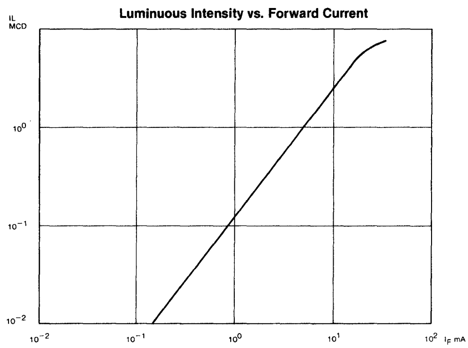
Maximum Ratings:

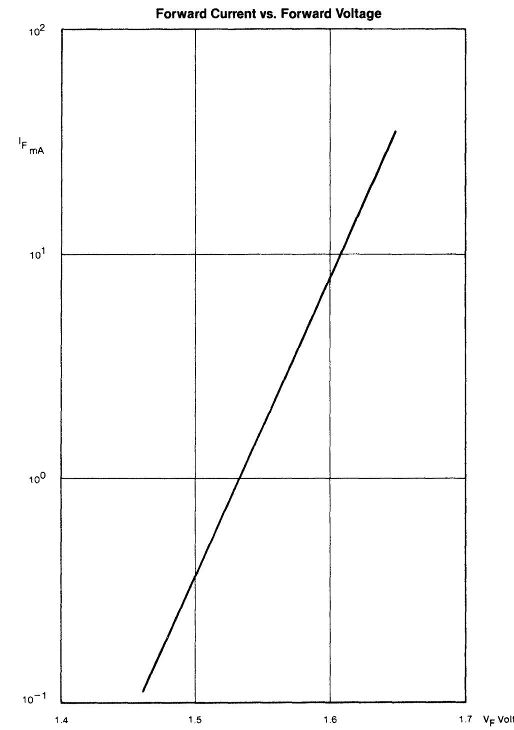
Power Dissipation @ 25°C Ambient .... 80 mW
Derate Linearly From 25°C .... 1.1 mW/°C
Storage and Operating Temperature .... −55°C to +100°C
Continuous Forward Current .... 40 mA
Lead Solder Time @ 260°C (1/16″ from case) .... 5 sec
Peak Inverse Voltage 3V
Peak Forward Current
(1µs pulse, 0.1% duty cycle) .... 400 mA

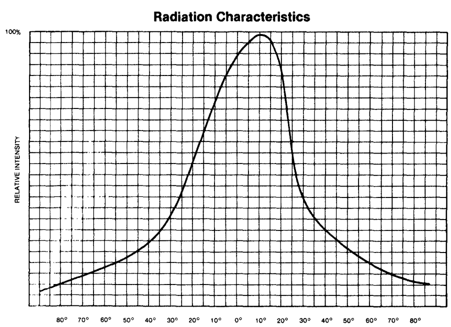
Opto-Electronic Characteristics (@ 25°C)

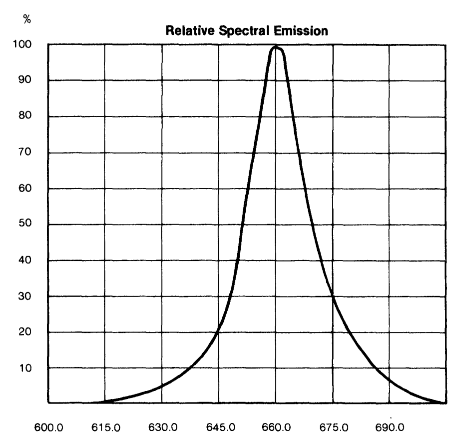
Parameters	Min.	Typ.	Max.	Units	Test Conditions
Reverse Current			10	µA	$V_R = 3$ V
Forward Voltage		1.6	2.0	V	$I_F = 20$ mA
Viewing Angle		50		degrees	
Luminous Intensity					
RL-55	2	2.2		mcd	$I_F = 10$ mA
Capacitance		20		pF	V = 0
Peak Emission Wavelength		660		nm	
Spectral Line Half-Width		40		nm	

Specifications are subject to change without notice.


Luminuous Intensity vs. Forward Current
IL MCD
10^0
10^-1
10^-2
10^-2
10^-1
10^0
10^1
10^2 IF mA

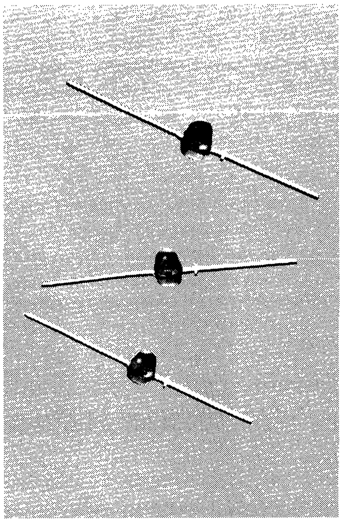

Forward Current vs. Forward Voltage
10^2
IF mA
10^1
10^0
10^-1
1.4
1.5
1.6
1.7 VF Volts


Radiation Characteristics
100%
RELATIVE INTENSITY
80° 70° 60° 50° 40° 30° 20° 10° 0° 10° 20° 30° 40° 50° 60° 70° 80°

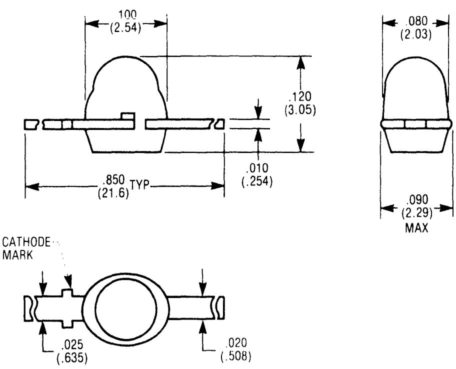

%
Relative Spectral Emission
100
90
80
70
60
50
40
30
20
10
600.0
615.0
630.0
645.0
660.0
675.0
690.0
Wavelength (NM)

SIEMENS

YL-56
YELLOW
GL-56
GREEN
MINIATURE AXIAL LEAD LED LAMP



Package Dimensions in Inches (mm)



FEATURES

- **High on Axis Intensity**
- **Optimum Packaging Design for Maximum Strength at Minimum Linear Spacing**
- **Operates from 5 V IC Logic Supply**
- **Miniature Axial Lead**
- **High Reliability**

DESCRIPTION

The GL-56/YL-56 are Gallium Phosphide LED lamps that have high on-axis intensity, long life and low cost. They are diffused lenses and provide a full 0.080″ flooded light with good contrast. When operated at high current (10 mA) they have high on-axis intensity. Applications include mounting on PC boards at low current as diagnostic and circuit status indicators.

Maximum Ratings

Power Dissipation @ 25° C Ambient	80 mW
Derate Linearly From 25°C	−1.1 mW/°C
Storage and Operating Temperature	−55°C to +100°C
Continuous Forward Current	25 mA
Lead Solder Time @ 260°C (1/16″ from case)	5 sec
Peak Inverse Voltage	3V
Peak Forward Current (1µs pulse, 0.1% duty cycle)	250 mA

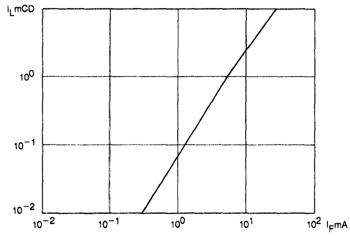
Opto-Electronic Characteristics (@ 25°C)

Parameters	Min.	Typ.	Max.	Units	Test Conditions
Luminous Intensity					
YL-56	2.0	2.2		mcd	$I_F = 10$ mA
GL-56	1.0	1.3		mcd	$I_F = 10$ mA
Forward Voltage					
YL-56		2.4	3.5	V	$I_F = 20$ mA
GL-56		2.2	3.5	V	$I_F = 20$ mA
Viewing Angle		40		degrees	
Reverse Current		0.15	10	µA	$V_R = 3$ V
Peak Emission Wavelength					
YL-56		585		nm	
GL-56		565		nm	

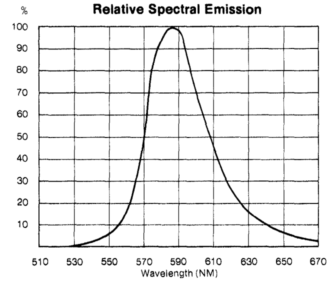
Specifications subject to change without notice.

YL-56

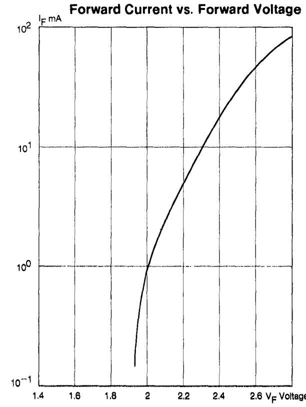
Luminous Intensity vs. Forward Current



Relative Spectral Emission

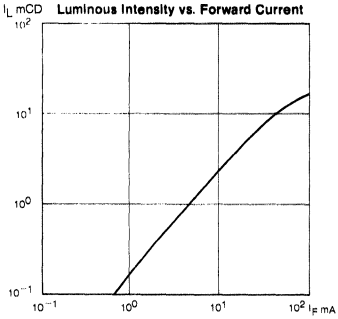


Forward Current vs. Forward Voltage

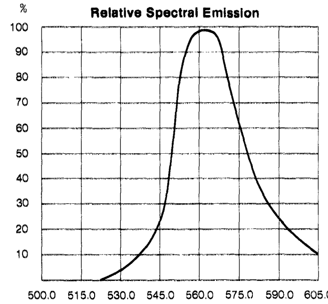


GL-56

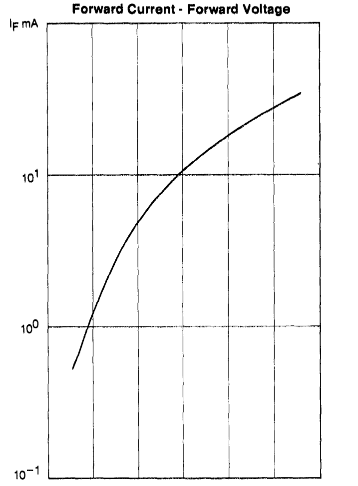
Luminous Intensity vs. Forward Current



Relative Spectral Emission

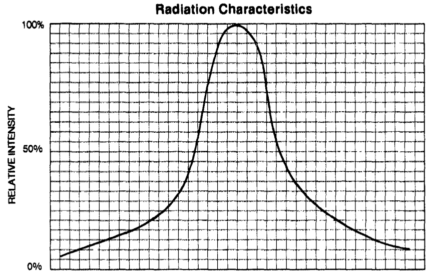


Forward Current - Forward Voltage



YL-56 & GL-56

Radiation Characteristics

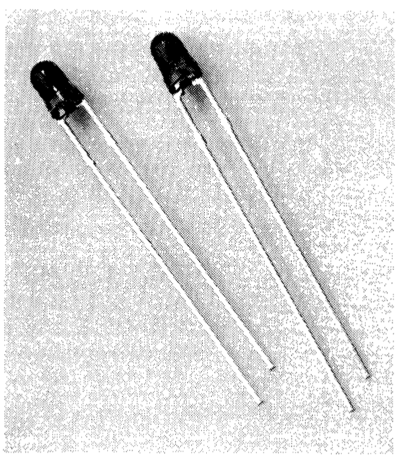


SIEMENS

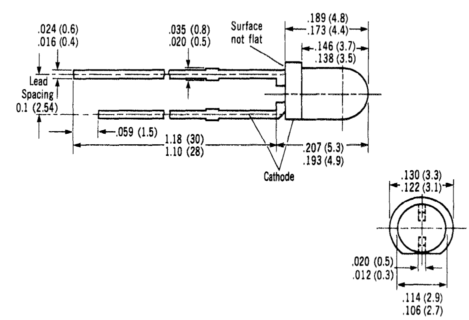
RRL-1100

RED T1 LED RESISTOR LAMP

Preliminary



Package Dimensions in Inches (mm)



FEATURES

- **Integral Current Limiting Resistor**
- **No External Resistor Required with 5 Volt Supply**
- **Red Diffused Lens**
- **High Reliability**
- **T-1 Package Style**
- **1-inch Leads**
- **Wide Viewing Angle, 70°**

DESCRIPTION

The RRL-1100 is a gallium arsenide phosphide LED red lamp containing an integral resistor chip in series with the LED. This allows operation from a 5 volt source without an external current limiting resistor. Applications include mounting on PC boards as diagnostic and circuit status indicators.

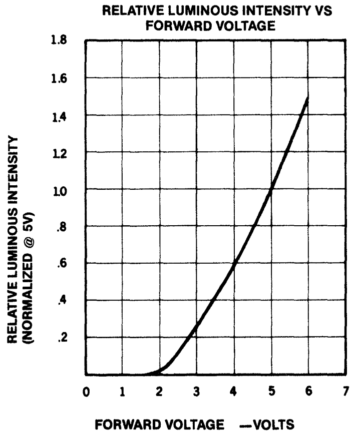
Maximum Ratings

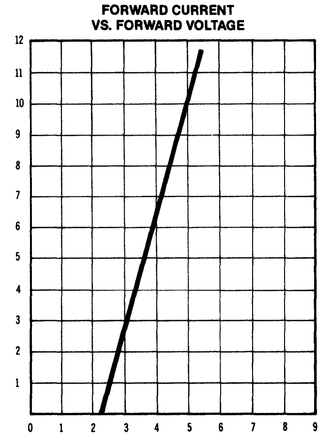
Power Dissipation . . . . 100 mW
DC Forward Voltage . . . . 15 Volts
Reverse Voltage . . . . 9.0 Volts
Storage Temperature . . . . –55°C to 100°C
Operating Temperature . . . . –40°C to 85°C
Lead Soldering Temperature . . . . 260°C
(1/16" from lens for 5 seconds)

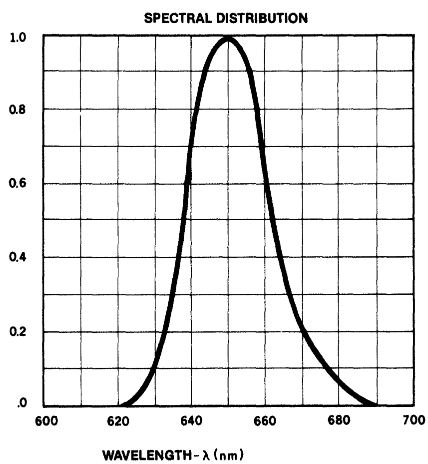
Opto-Electrical Characteristics (@ 25°C)

Parameter	Min.	Typ.	Max.	Units	Test Conditions
Luminous Intensity	1.0	2.0	—	MCD	$V_f = 5.0$ V
Forward Current		10	15	mA	$V_f = 5.0$ V
Reverse Current	7.0			mA	$V_R = 5$ V
Viewing Angle		70		degrees	
Peak Wavelength		650		nm	

Specifications are subject to change without notice.


RELATIVE LUMINOUS INTENSITY VS
FORWARD VOLTAGE
RELATIVE LUMINOUS INTENSITY
(NORMALIZED @ 5V)
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0 1 2 3 4 5 6 7
FORWARD VOLTAGE —VOLTS


FORWARD CURRENT
VS. FORWARD VOLTAGE
12
11
10
9
8
7
6
5
4
3
2
1
0 1 2 3 4 5 6 7 8 9

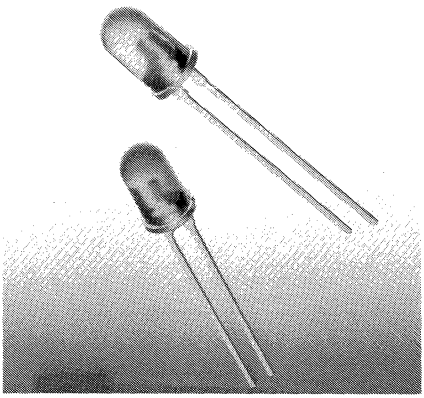

SPECTRAL DISTRIBUTION
1.0
0.8
0.6
0.4
0.2
.0
600 620 640 660 680 700
WAVELENGTH - λ (nm)

SIEMENS

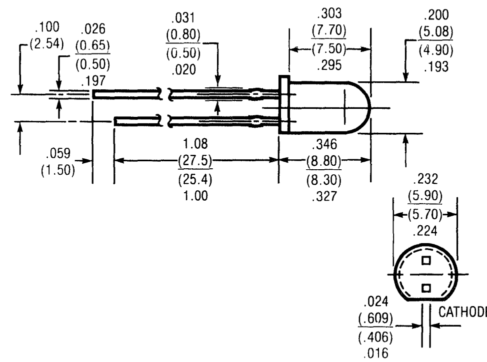
RRL-3105
RRL-3112

RED T1 ¾ RESISTOR LAMP

Preliminary



Package Dimensions in Inches (mm)



FEATURES

- **Integral Current Limiting Resistor**
- **No External Resistor Required with 5 Volt (RRL-3105) or 12 Volt Supply (RRL-3112)**
- **T1 ¾ Package**
- **Red Diffused Lens**
- **High Reliability**

DESCRIPTION

The RRL31XX is a Gallium Arsenide Phosphide LED red lamp containing an integral resistor chip in series with the LED. This allows operation from a 5 volt RRL-3105 or 12 volt RRL-3112 source without an external current limiting resistor. Applications include mounting on PC boards as diagnostic and circuit status indicators.

Maximum Ratings

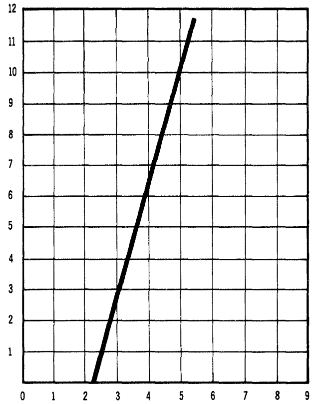
Power Dissipation @ 25° C Ambient	100 mW
DC Forward Voltage	15 Volts
Reverse Voltage	9.0 Volts
Storage Temperature	−55°C to +100°C
Operating Temperature	−40°C to +85°C
Lead Solder Temperature (1/16″ from lens for 5 seconds)	260°

Characteristics ($T_{amb} = 25°C$)

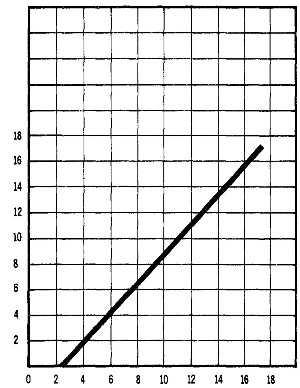
Parameters	Min.	Typ.	Max.	Units	Test Conditions
Dominant Wavelength peak		655		nm	
Viewing Angle		70		degrees	
Forward Current					
RRL-3105		10	15	mA	$V_F = 5$ V
RRL-3112		10	15	mA	$V_F = 12$ V
Reverse Current		0.1	10	μA	6 Volts
Luminous Intensity					
RRL-3105	1.0	2.0	mcd		$V_F = 5$ V
RRL-3112	1.0	2.0	mcd		$V_F = 12$ V

Specifications are subject to change without notice.

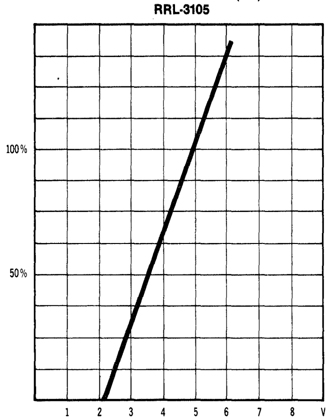
FORWARD CURRENT
VS. FORWARD VOLTAGE
RRL-3105



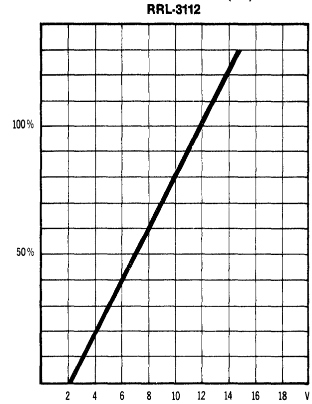
FORWARD CURRENT
VS. FORWARD VOLTAGE
RRL-3112



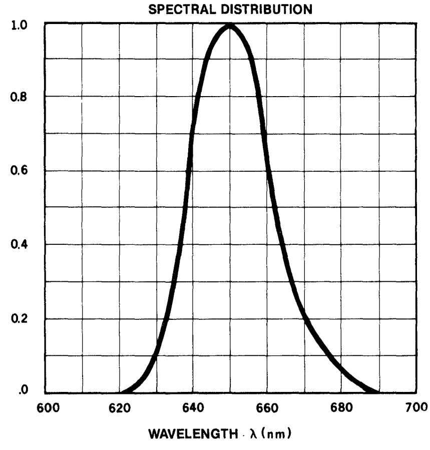
RELATIVE LUMINOUS INTENSITY VS.
FORWARD VOLTAGE (DC)
RRL-3105



RELATIVE LUMINOUS INTENSITY VS.
FORWARD VOLTAGE (DC)
RRL-3112



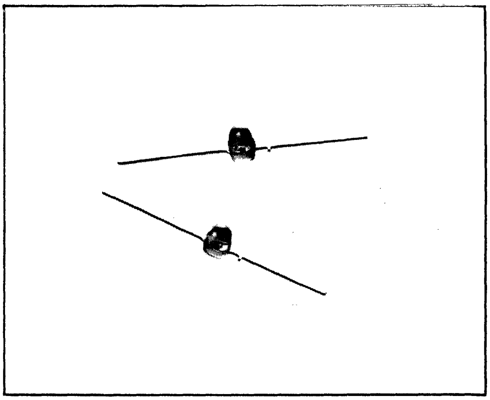
RRL-3105 & RRL-3112
SPECTRAL DISTRIBUTION



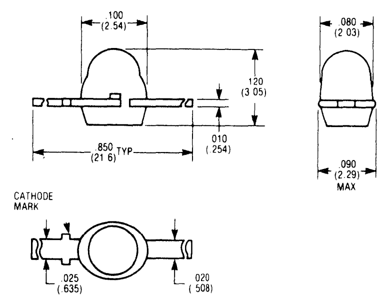
SIEMENS

RRL-5601
RRL-5621
RRL-5641

RED LED RESISTOR LAMP
MINIATURE AXIAL LEAD



Package Dimensions in Inches (mm)



FEATURES

- **Integral current limiting resistor**
- **No external resistor required with 5 volt supply**
- **Miniature axial lead package**
- **Red diffused lens**
- **Three light intensity ranges**
- **High reliability**

DESCRIPTION:

The RRL-56XX is a gallium arsenide phosphide LED red lamp containing an integral resistor chip in series with the LED. This allows operation from a 5 volt source without an external current limiting resistor. Applications include mounting on PC boards as diagnostic and circuit status indicators.

Maximum Ratings

DC Forward Voltage .... 6 volts
Reverse Voltage.................... 6 volts
Operating Temp.................... −55°C to +100°C
Storage Temp .... −40°C to +85°C
Soldering Time
(260°C @ 1/16″ from case)......... 5 sec

Specifications are subject to change without notice.

Opto Electronic Characteristics					
Parameter	**Min.**	**Typ.**	**Max.**	**Unit**	**Test Conditions**
Luminous Intensity					
RRL 5601	.3			mcd	5 volts
RRL 5621	.6	1.2		mcd	5 volts
RRL 5641	1.0	2.0		mcd	5 volts
Forward Current					
RRL 5601	2.0	3.0	4.0	mA	5 volts
RRL 5621	4.0	6.0	8.0	mA	5 volts
RRL 5641	13.0	16.0	21.0	mA	5 volts
Reverse Current		0.1	10	uA	6 volts
Half Angle		20		degrees	
Peak Emission Wavelength		650		nM	

FIG 1. FORWARD CURRENT VS FORWARD VOLTAGE

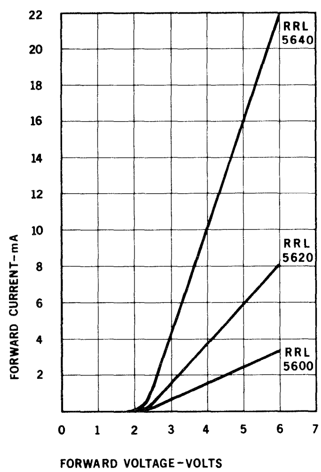


FIG 2. RELATIVE LUMINOUS INTENSITY VS FORWARD VOLTAGE

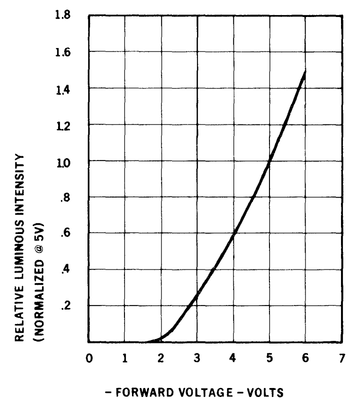
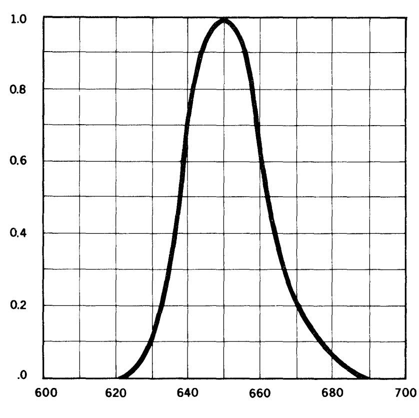
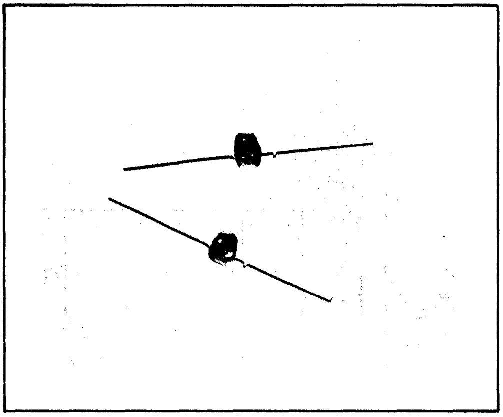


FIG 3. SPECTRAL DISTRIBUTION

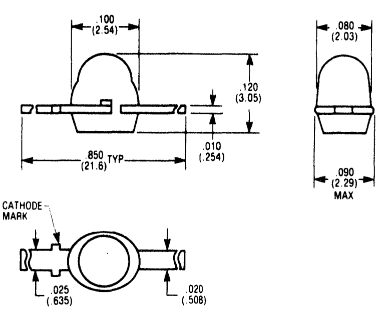


SIEMENS

RGL-5621
GREEN
RYL-5621
YELLOW
MINIATURE AXIAL LEAD LED RESISTOR LAMP



Package Dimensions in Inches (mm)



FEATURES

- **Integral current limiting resistor lamp (no exterior resistor required)**
- **Miniature axial lead package ideal for diagnostic indicator**
- **Operates from 5V IC Logic**
- **RGL-5621 green diffused lens**
  RYL-5621 yellow diffused lens
- **High reliability**

DESCRIPTION:

The RGL-5621 green and RYL-5621 yellow are gallium phosphide LED lamps containing integral resistor chips in series with the LED. This allows operation from a 5V source without an external resistor. Applications include mounting on PC boards as diagnostic and circuit status indicators.

Maximum Ratings:

DC Forward Voltage 6V
Reverse Voltage 6V
Operating Temperature . . . . −55°C to +100°C
Storage Temperature . . . . −55°C to +100°C
Lead solder time
(260°C @ 1/16″ from case) . . 3 sec.

Specifications are subject to change without notice.

Opto Electronic Characteristics					
Parameters	**Min.**	**Typ.**	**Max.**	**Unit**	**Test Conditions**
Luminous Intensity					
RGL-5621	.2	.5		mcd	5V
RYL-5621	.3	.6		mcd	5V
Forward Current	2.8	5.0	6.7	mA	5V
Reverse Current		0.1	10	uA	6V
Half Angle (limits for 50% of luminous intensity		20		degrees	5V
Peak Emission Wavelength					
RGL-5621		565		nm	
RYL-5621		583		nm	

FIG 1 FORWARD CURRENT VS FORWARD VOLTAGE

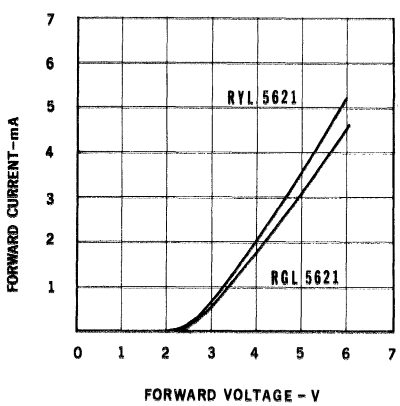


FIG 2 LUMINOUS INTENSITY VS FORWARD VOLTAGE

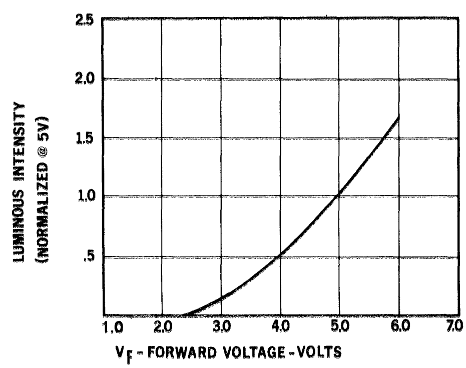
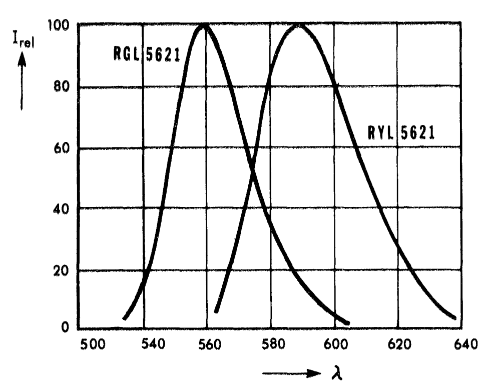


FIG 3 RELATIVE SPECTRAL EMISSION
$I_{rel} = f(\lambda)$

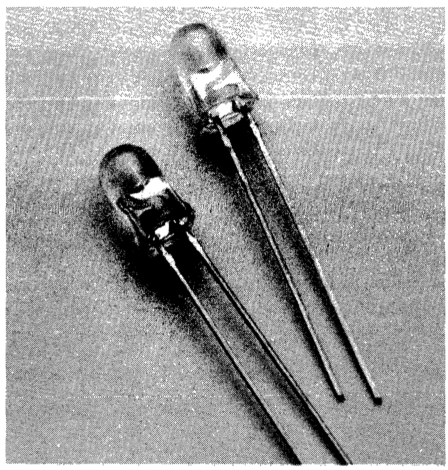


SIEMENS

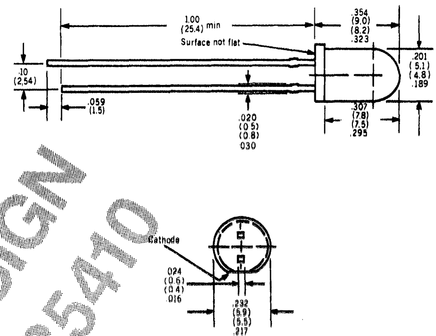
SFH 710

BLUE T1¾ LED LAMP

Advance Data Sheet



Package Dimensions in Inches (mm)



FEATURES

- **Pure Blue Light (480 nm)**
- **Clear T-1¾ Plastic Package**
- **1″ Min. Lead Length**
- **High Brightness**
- **TTL Compatible**

DESCRIPTION

The SFH710 is a Silicon Carbide, Aluminum, Nitride (SiC:Al,N) LED, emitting a pure blue light from a clear T-1¾ plastic package. The SFH710 is suitable for measurement equipment, consumer application, and control apparatus.

Maximum Ratings

Reverse voltage	V_R	1	V
Forward current	I_F	40	mA
Storage temperature range	T_{stor}	−40 to +80	°C
Junction temperature	T_j	80	°C
Total power dissipation (T_{amb} = 25°C)	P_{tot}	170	mW
Thermal resistance Junction to Air	R_{thJamb}	325	K/W

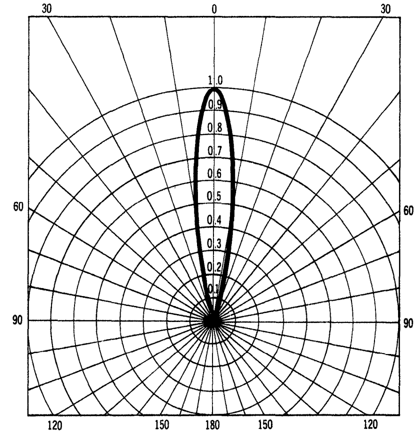
Characteristics (T_{amb} = 25°C)

	Min.	Typ.	Unit	Test Condition
Wavelength at peak emission	λpeak	480	nm	
Dominant wavelength	dom	480	nm	
Viewing angle		16	degrees	
Forward voltage (I_F = 20mA)	V_F	4(≤6)	V	
Reverse breakdown voltage (I_R = 1 A)	V_R	2(≤1)	V	
Spectral half bandwidth		±45	nm	
Luminous intensity	.5	1.6	mcd	20 mA

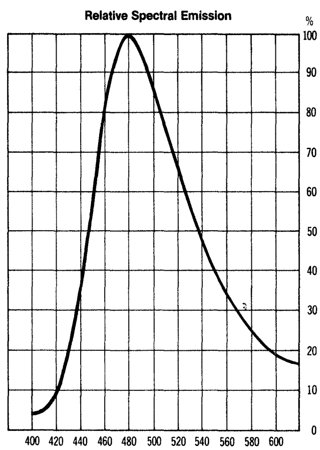
CAUTION: Because of low reverse voltage, the LED connections may not be reversed.

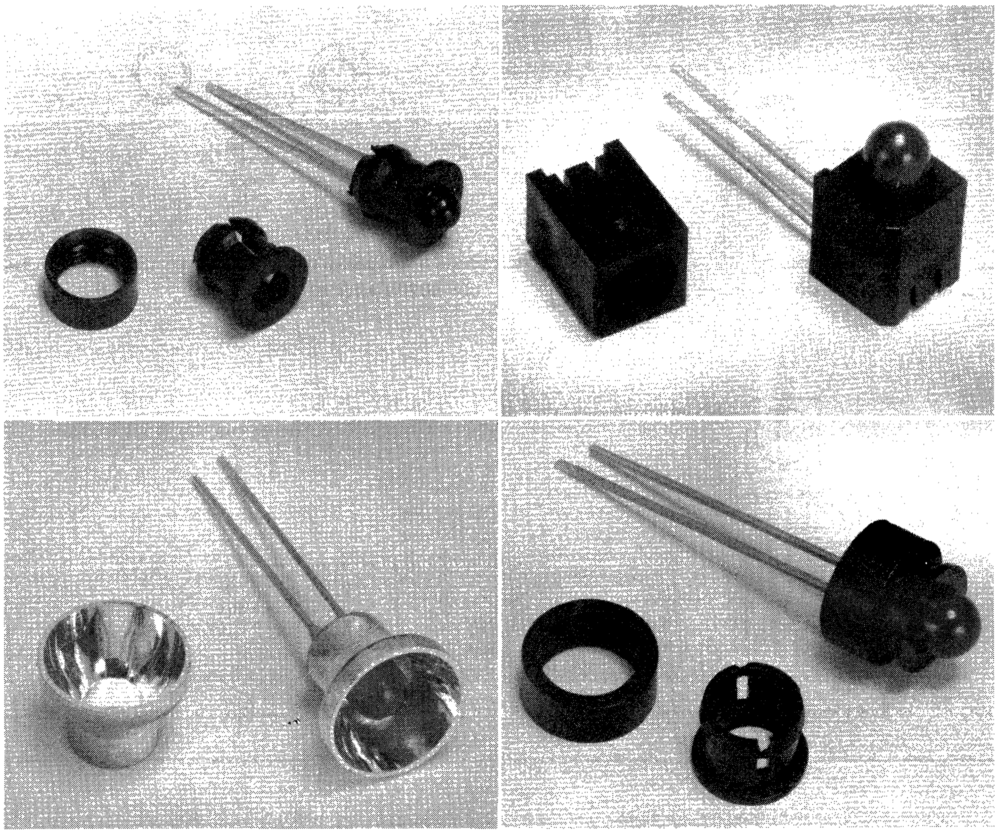
Specifications are subject to change without notice.

Radiation Characteristic



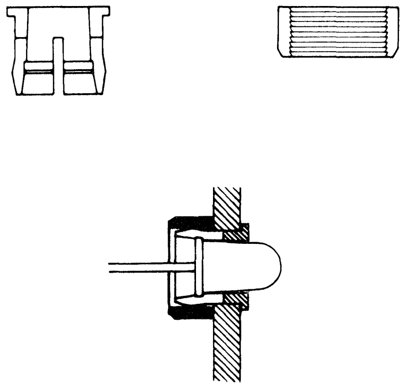
Relative Spectral Emission



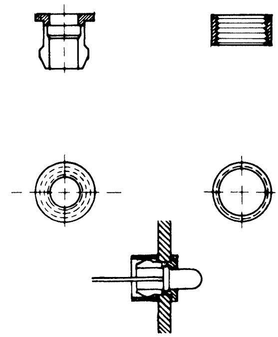


Part Number	Description	Color
2004-9002	Mounting Clip & Collar for T-¾ LED's	Black
2004-9003		Clear
2004-9015	Mounting Clip & Collar for T-1 LED's	Black
2004-9016		Clear
2004-9019	Right Angle Mounting Part Designed to allow right angle mounting of lamps to PC Boards and other surfaces.	Black
2004-9020	Reflector This highly polished reflector greatly increases lighted area and enhances overall brightness of low profile and T-1¾ LED's	Polished

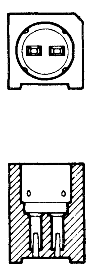
004-9002
004-9003



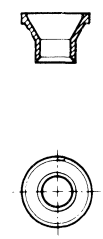
004-9015
004-9016

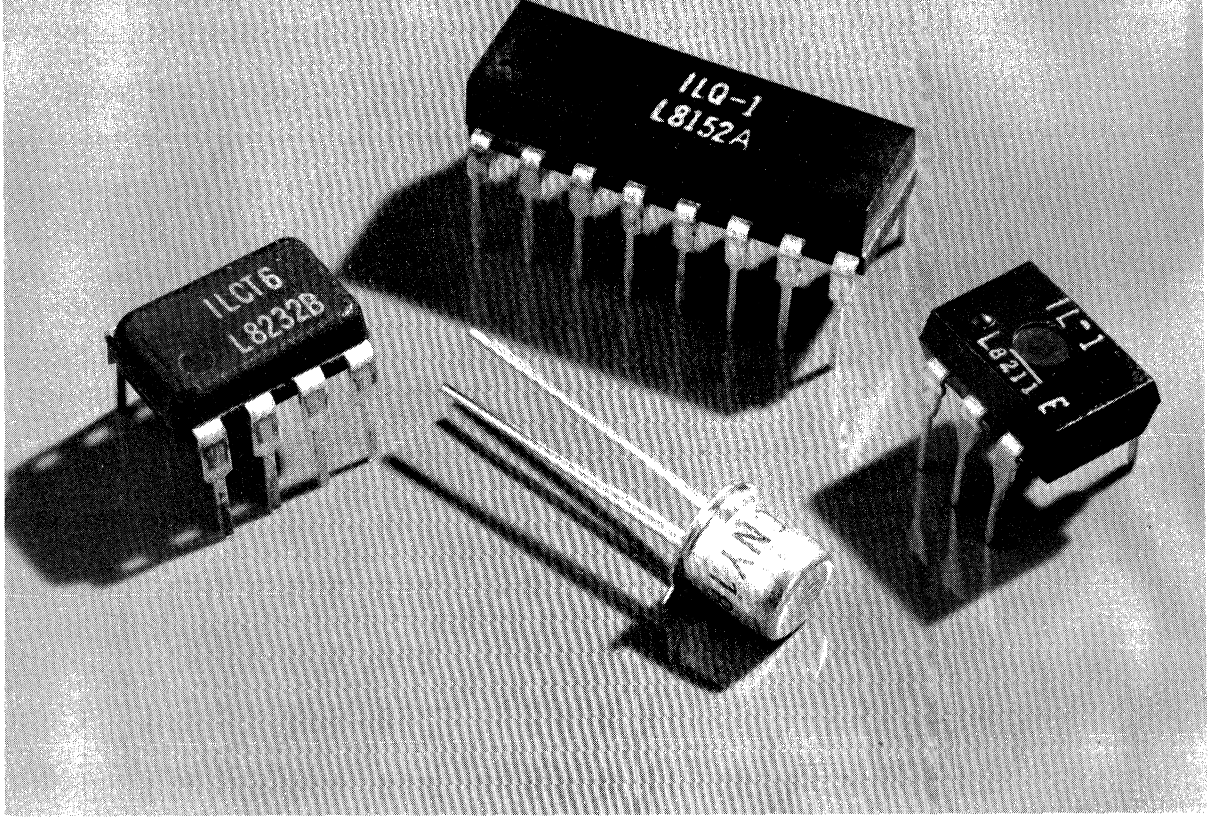


004-9019 Right Angle Mounting Part

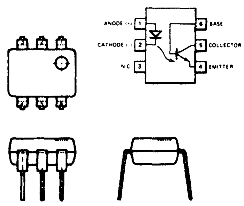
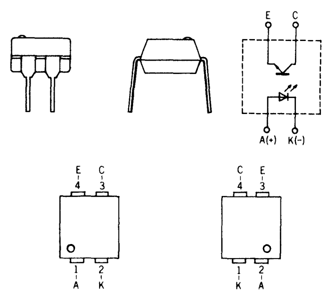
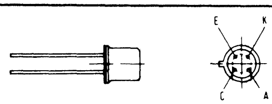
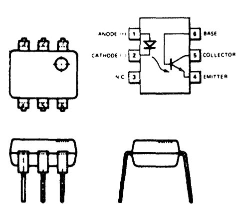
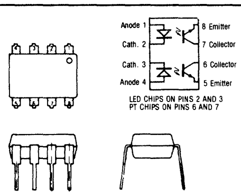


004-9020 Reflector

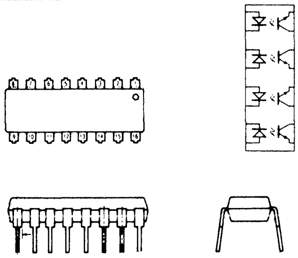
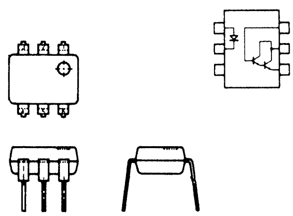
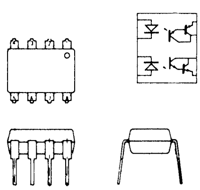
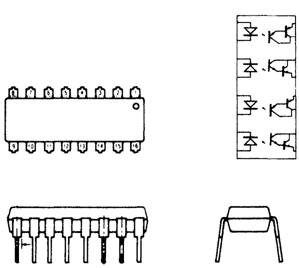



ILCT6
L8232B
ILQ-1
L8152A
IL-1

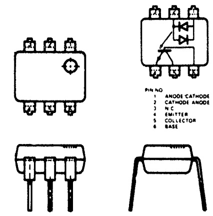
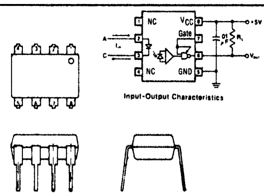
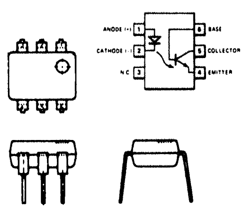
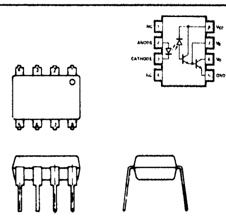
OPTO-COUPLERS

Package and Type	Package Outline	Part Number	Features	Current Transfer Ratio (%) $I_F = 10mA$	Isolation Breakdown Voltage	BV_{CEO}	Page
High Reliability							
6 PIN DIP Single channel Photo-transistor output		SFH600-0	High reliability High current transfer ratios	40-80	2800	70	255
		SFH600-1		63-125			
		SFH600-2		100-200			
		SFH600-3		160-320			
		SFH601-1	Very high reliability High current transfer ratios Pre-conditioned VDE approved #0883	40-80	5300		259
		SFH601-2		63-125			
		SFH601-3		100-200			
		SFH601-4		160-320			
		SFH609-1	Very high reliability High current transfer ratios High BV_{CEO} VDE approved #0883	40-80	5300	90	263
		SFH609-2		63-125			
		SFH609-3		100-200			
		CNY17-1	High reliability High current transfer ratios	40-80	4400	70	212
		CNY17-2		63-125			
		CNY17-3		100-200			
		CNY17-4		160-320			
Miniature 4 Lead DIP Single channel Photo-transistor output		SFH610-1	Miniature size, High Reliability High Current transfer ratios	40-80	2800	70	267
		SFH610-2		63-125			
		SFH610-3		100-200			
		SFH610-4		160-320			
		SFH611-1		40-80			
		SFH611-2		63-125			
		SFH611-3		100-200			
		SFH611-4		160-320			
TO-72 Metal Case Single channel Photo-transistor output	 C connected to case	CNY18-2	Hermetic seal	16-32	500	32	216
		CNY18-3		25-50			
		CNY18-4		40-80			
		CNY18-5		63-125			
General Purpose, Single Channel							
6 PIN DIP Single channel Photo-transistor output		IL-1B	Low cost	20 Min.	6000	30	218
		IL-5B		50 Min.		30	224
		IL-74B		12.5 Min.		20	230
		4N25	Low cost Industry standard	20 Min.		30	206
		4N26					
		4N27		10 Min.			
		4N28					
		4N35		100 Min.			209
		4N36					
		4N37					
General Purpose, Multi Channel							
8 PIN DIP Two channel Photo-transistor output		ILCT-6	Dual coupler	20 Min.	6000		249
		ILD-1		20 Min.		30	218
		ILD-2		100 Min.		20	222
		ILD-74A		12.50 Min.		30	230
		ILD-506		20 Min.		30	252

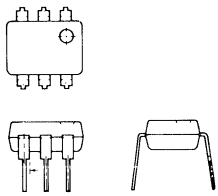
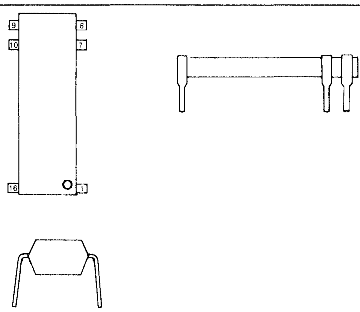
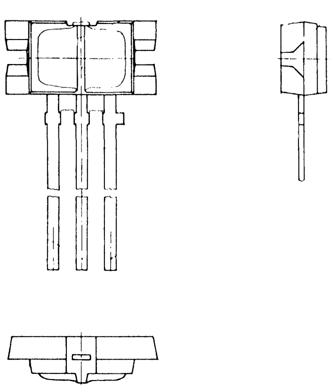
All couplers are Underwriters Lab approved #E52744

Package and Type	Package Outline	Part Number	Features	Current Transfer Ratio (%) $I_F = 10mA$	Isolation Breakdown Voltage	BV_{CEO}	Page
General Purpose, Multi Channel (cont.)							
16 PIN DIP Four channel Photo-transistor output		ILQ-1	Quad coupler	20	6000	30	218
		ILQ-2		100		30	222
		ILQ-74A		12.5		20	230
Special, Photodarlington, Single Channel							
6 PIN DIP Single channel Photo-darlington output		IL-30 (formerly ILCA-2-30)	High gain	100 Min.	6000	30	228
		IL-55 (formerly ILCA-2-55)		100 Min.		55	
		4N32		500 Min.		30	208
		4N33		500 Min.			
Special, Photodarlington, Multi Channel							
8 PIN DIP Two Channel Photo-darlington output		ILD-30	High gain Dual coupler	100 Min.	6000	30	234
		ILD-55				55	
16 PIN DIP Four Channel Photo-darlington output		ILQ-30	High gain Quad coupler	100 Min.	6000	30	
		ILQ-55				55	

All couplers are Underwriters Lab approved #E52744

Package and Type	Package Outline	Part Number	Features	Current Transfer Ratio (%) $I_F = 10mA$	Isolation Breakdown Voltage	BV_{CEO}	Page
	Special, Twin IR Emitter						
6 PIN DIP Bidirectional INPUT		IL-250	AC/DC Bidirectional input	50 Min.	5000	30	243
		IL-251/ H11AA1		20 Min.	2500		245
	Special, High Speed						
				Propagation Delay Time (ns)		Threshold current (mA)	
8 PIN DIP Single channel		IL-100	High speed	65 Typ.	2500	5	236
		IL-101		100 Typ.	1500	5	240
	Special, Low Input Current (C-MOS type)						
						Input current (mA)	
6 PIN DIP Single channel		IL-201	Low input forward current	10 Min.	6000	1	242
		IL-202		30 Min.			
		IL-203		50 Min.			
						Input current (mA)	
8 PIN DIP Single channel		6N138	High gain Low input forward current Low saturation voltage	300 Min.	6000	1.6	210
		6N139		400 Min.		0.5	

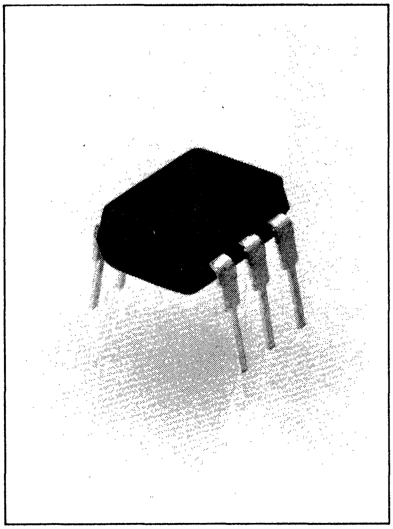
All couplers are Underwriters Lab approved #E52744
All devices meeting UL #E52744 are approved to 7500V. This change will be reflected in the 1986 catalog.

Package and Type	Package Outline	Part Number	Features	Current Transfer Ratio (%) IF = 10mA	Isolation Breakdown Voltage	BVCEO	Page
	Special, SCR						
6 PIN DIP Single channel SCR output		IL-400	Optically Coupled SCR UL approved #E52744	Gate trigger Current 20uA	6000	Fwd. blocking voltage Vdm 400	247
	Special, High Voltage						
4 & 6 PIN DIP Single channel		IL-8	Very high voltage VDE #0730-2P applied for (4 PIN)	20 Min.			226
		IL-9	Very high voltage VDE #0730-2P applied for (6 PIN)	20 Min.			
		IL-10	Very high voltage VDE #0730-2P applied for (4 PIN)	50 Min.	8 KVRMS (1 min.)	30	
		IL-11	Very high voltage VDE #0730-2P applied for (6 PIN) All UL approved #E52744	50 Min.			227
	Special, Reflective Sensor						
Miniature side by side emitter detector pair Plastic package		SFH900		Coupling factor (I_F = 10 mA; V_{CE} = 5V; d = 1 mm) $I_{CE} \geq 0.5$ mA 5.6 mm leads			
		SFH900-1	Reflective interrupter High sensitivity Designed for short distances up to 5 mm	$I_{CE} \geq 0.3$ mA 14.3 mm leads		Power dissipation 150mW	271
		SFH900-2		$I_{CE} \geq 0.5$ mA			

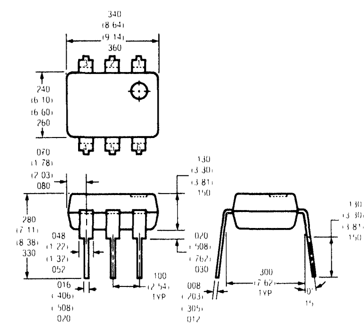
SIEMENS

4N25, 4N26, 4N27, 4N28

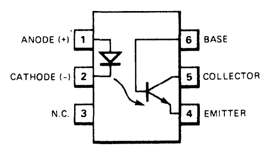
PHOTOTRANSISTOR OPTO-ISOLATORS



Package Dimensions in Inches (mm)



CONNECTION DIAGRAM DIP (TOP VIEW)



PIN NUMBERS

1	Anode (+)	Input Diode
2	Cathode (−)	
3	NC	
4	Emitter	Output npn Phototransistor
5	Collector	
6	Base	

FEATURES

- **6000 Volt Isolation Voltage**
- **High DC Current Transfer Ratio**
- **I/O Compatible with Integrated Circuits**
- **0.5pF Coupling Capacitance**
- **Underwriter Lab Approval #E52744**

DESCRIPTION

The 4N25, 4N26, 4N27, and 4N28 series are optically coupled pairs, each consisting of a Gallium Arsenide infrared LED and a silicon NPN phototransistor. Signal information, including a DC level, can be transmitted by the device while maintaining a high degree of electrical isolation between input and output. They can be used to replace relays and transformers in many digital interface applications. They have excellent frequency response when used in analog applications.

Absolute Maximum Ratings:

Gallium Arsenide LED:

- *Power Dissipation @ 25°C. 150mW
- *Derate Linearly from 25°C . . . . 2.0 mW/°C
- *Continuous Forward Current. 80mA
- *Forward Current Peak (1μs pulse, 300 pps). . . . . 3.0 A
- *Peak Inverse Voltage. 3.0V

Detector (Silicon Photo-Transistor)

- *Power Dissipation @ 25°C. 150mW
- *Derate Linearly from 25°C . . . . 2.0mW/°C
- *Collector-Emitter Breakdown Voltage (BV_{CEO}). . . 30V
- *Emitter-Collector Breakdown Voltage (BV_{ECO}) . . 7.0 V
- *Collector-Base Breakdown Voltage. . (BV_{CBO}) . . . 70V

Package

- *Total Package Dissipation @ 25°C Ambient (equal power in each element) 250mW
- *Derate Linearly from 25°C . . . . 3.3mW/°C
- *Storage Temperature. . . . . −55°C to +150°C
- *Operating Temperature . . . . −55°C to +100°C
- *Lead Soldering Time @ 260°C . . . . 10 sec.

*indicates JEDEC registered values

Specifications subject to change without notice.

ELECTRICAL CHARACTERISTICS

PARAMETERS (at 25° Ambient)

Parameter	Min	Typ	Max	Unit	Test Condition
Gallium Arsenide LED					
*Forward Voltage . .		1.3	1.5	V	I_F=50mA
*Reverse Current . .		0.1	100	µA	V_R=3.0V
Capacitance		100		pF	V_R=0
Photo-transistor Detector					
H_{FE}		150			V_{CE}=5.0V
*BV_{CEO}	30			V	I_C=1mA
*BV_{ECO}	7			V	I_E=100µA
*BV_{CBO}	70			V	I_C=100µA
*I_{CEO} (dark)					
4N25,					
4N26, 4N27. . . .		5	50	nA	V_{CE}=10V
4N28.		10	100	nA	(base open)
*I_{CBO} (dark)		2	20	nA	V_{CB}=10V (emitter open)
Collector-Emitter Capacitance . . .		2		pF	V_{CE}=0
Coupled Characteristics					
*DC Current Transfer Ratio					
4N25,					
4N26	0.2	0.5			I_F=10mA V_{CE}=10V
4N27, 4N28 . .	0.1	0.3			I_F=10mA V_{CE}=10V
Capacitance, Input to Output.		0.5		pF	
Breakdown Voltage					
*4N25.	2500			V	Peak, 60 Hz
*4N26, 4N27. . . .	1500			V	Peak, 60 Hz
*4N28.	500			V	Peak, 60 Hz
*All types	7500			VDC	
*Resistance, Input to Output.	100			GΩ	
Rise and Fall Times		2		µs	I_F=10mA V_{CE}=10V
*Collector-Emitter Saturation Voltage			0.5	V	I_F=50mA I_C=2.0mA

*indicates JEDEC registered values

TYPICAL CURVES

FIGURE 1. RELATIVE OUTPUT VS TEMPERATURE

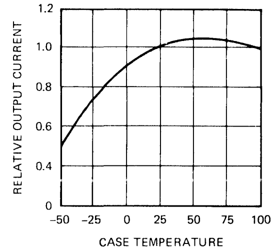


FIGURE 2. DARK CURRENT VS TEMPERATURE

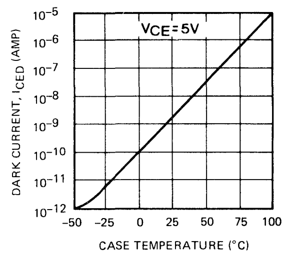


FIGURE 3. TRANSFER CHARACTERISTICS

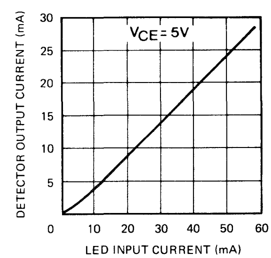
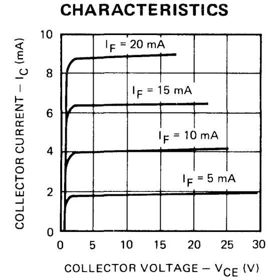


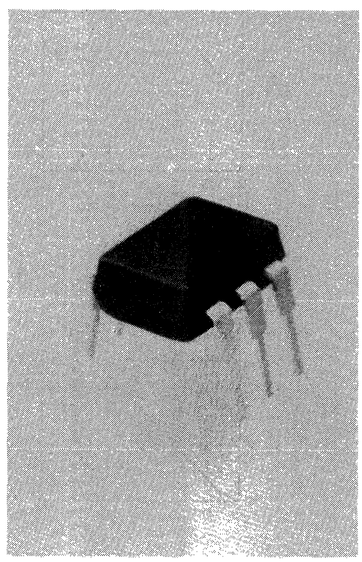
FIGURE 4. DETECTOR OUTPUT CHARACTERISTICS



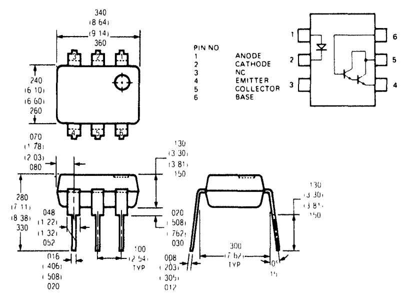
SIEMENS

4N32, 4N33

PHOTO DARLINGTON OPTO-ISOLATOR



Package Dimensions in Inches (mm)



FEATURES

- **6000 Volt Isolation Voltage**
- **Very High Current Transfer Ratio (500% Min.)**
- **High Isolation Resistance (10^{11} Ω Typical)**
- **Low Coupling Capacitance**
- **Standard Plastic Dip Package**
- **Underwriters Lab Approval #E52744**

DESCRIPTION

The 4N32 and 4N33 are optically coupled isolators employing a gallium arsenide infrared emitter and a silicon photo darlington sensor. Switching can be accomplished while maintaining a high degree of isolation between driving and load circuits. They can be used to replace reed and mercury relays with advantages of long life, high speed switching and elimination of magnetic fields.

Maximum Ratings: (At 25°C)

Gallium Arsenide LED (Drive Circuit)
- Power Dissipation at 25°C . . . . . 150 mW
- Derate Linearly From 55°C . . . . . 2 mW/°C
- Continuous Forward Current . . . . . 80 mA
- Peak Reverse Voltage . . . . . 3 V

Photodarlington Sensor (Load Circuit)
- Power Dissipation at 25°C Ambient . . . . . 150 mW
- Derate Linearly From 25°C . . . . . 2.0 mW/°C
- Collector (load) Current . . . . . 125 mA
- Collector-Emitter Breakdown Voltage (BV_{CEO}) . . . . . 30 V
- Collector-Base Breakdown Voltage (BV_{CBO}) . . . . . 50 V
- Emitter-Base Breakdown Voltage (BV_{EBO}) . . . . . 8 V
- Emitter-Collector Breakdown Voltage (BV_{ECO}) . . . . . 5 V

Package
- Total Dissipation at 25°C . . . . . 250 mW
- Derate Linearly From 25°C* . . . . . 3.3 mW/°C
- Storage Temperature* . . . . . -55°C to +150°C
- Operating Temperature . . . . . -55°C to +100°C
- Lead Soldering Time at 260°C . . . . . 10 sec

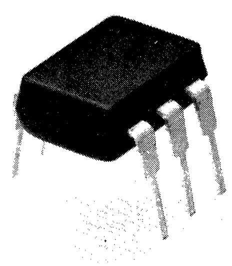
Electrical Characteristics (Tamb = 25°C)

Parameter	Min	Typ	Max	Unit	Condition
GaAs Emitter					
Forward Voltage*		1.25	1.5	V	I_F = 50 mA
Reverse Current*		0.01	100	μA	V_R = 3.0 V
Capacitance		100		pF	V_R = 0
Sensor					
H_{FE}		13K			V_{CE} = 5 V, I_C = 0.5mA
BV_{CEO}*	30			V	I_C = 100μA, I_F = 0
BV_{CBO}*	50			V	I_C = 100μA, I_F = 0
BV_{EBO}*	8			V	I_C = 100μA, I_F = 0
BV_{ECO}*	5			V	I_E = 100μA
I_{CEO}*		1.0	100	nA	V_{CE} = 10 V, I_F = 0
Coupled Characteristics					
Current Transfer Ratio*	500			%	I_F = 10mA, V_{CE} = 10 V
$V_{CE(SAT)}$			1.0	V	I_C = 2 mA, I_F = 8 mA
Isolation Resistance*		10^{11}		ohm	V_{IO} = 500 V
Isolation Capacitance		1.5		pf	
Turn-on Time			5	μs	V_{CC} = 10 V, I_C = 50 mA
Turn-off Time			100	μs	I_F = 200 mA, R_L = 180 Ω, Pulse Width = 8ms
Isolation Voltage	2500				
4N32*	1500			V	Peak, 60 Hz
4N33*	6000			V	Peak, 60 Hz
4N32 & 4N33	7500			VDC	

*Indicates JEDEC Registered Data
Specifications subject to change without notice.

SIEMENS

4N35, 4N36, 4N37
PHOTOTRANSISTOR OPTO-ISOLATOR



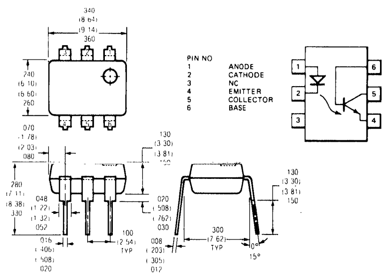
FEATURES

- **6000 Volt Isolation Voltage**
- **High Current-Transfer-Ratio (100% Min)**
- **Industry Standard Dual-In-Line**
- **0.5 pF Coupling Capacitance**
- **Underwriters Lab Approval #E52744**

DESCRIPTION

4N35, 4N36, 4N37 are optically coupled pairs employing a Gallium Arsenide infrared LED and a silicon NPN phototransistor. Signal information, including a DC level, can be transmitted by the device while maintaining a high degree of electrical isolation between input and output. The 4N35, 4N36, 4N37 can be used to replace relays and transformers in many digital interface applications, as well as analog applications such as CRT modulation.

Package Dimensions in Inches (mm)



Maximum Ratings:

Gallium Arsenide LED
- Power Dissipation @ 25°C .... 100 mW
- Derate Linearly from 25°C .... 1.33 mW/°C
- Continuous Forward Current .... 60 mA
- Peak Inverse Voltage .... 6.0 V

Detector (Silicon Phototransistor)
- Power Dissipation @ 25°C .... 300 mW
- Derate Linearly from 25°C .... 4.0 mW/°C
- Collector-Emitter Breakdown Voltage (BV_{CEO}) .... 30 V
- Emitter-Collector Breakdown Voltage (BV_{ECO}) .... 7 V
- Collector-Base Breakdown Voltage (BV_{CBO}) .... 70 V

Package
- Storage Temperature* .... –55 to +150°C
- Operating Temperature* .... –55 to +100°C
- Lead Soldering Time @ 260°C* .... 10 sec
- Relative Humidity @ 85°C* 85%

Electrical Characteristics (at 25° C Ambient)

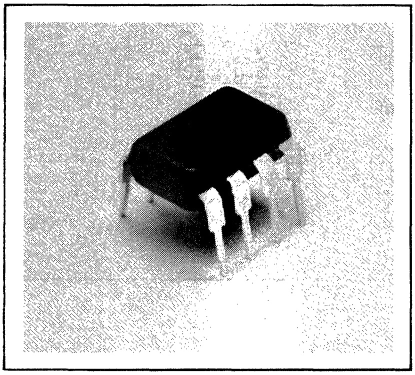
Parameter	Min	Typ	Max	Unit	Test Condition
Gallium Arsenide LED					
Forward Voltage*		1.3	1.5	V	I_F = 10 mA
	0.9		1.7	V	I_F = 10 mA, T_A = –55°C
	0.7		1.4	V	I_F = 10 mA, T_A = 100°C
Reverse Current*		.1	10	μA	V_R = 6.0 V
Capacitance			100	pF	V_R = 0 f = 1 MHz
Phototransistor Detector					
H_{FE}	100	150			V_{CE} = 5.0 V, I_C = 100 μA
BV_{CEO}*	30			V	I_C = 1 mA
BV_{CEO}*	7			V	I_E = 100 μA
I_{CEO} (dark)		5	50	nA	V_{CE} = 10 V, I_F=0
I_{CEO} (dark)*			500	μA	V_{CE} = 30 V, I_F=0, T_A = 100°C
BV_{CBO}*	70			V	I_C = 100 μA
Collector-Emitter Capacitance		2		pF	V_{CE} = 0
Coupled Characteristics					
DC Current Transfer Ratio*	100			%	I_F = 10mA, T_A = 25°C, V_{CE} = 10 V
DC Current Transfer Ratio*	40			%	I_F = 10mA, V_{CE} = 10 V, T_A = 55° to 100°C
Capacitance, Input to Output*			2.5	pF	f = 1.0 MHz
Resistance, Input to Output*		10^{11}		Ω	V_{IO} = 500 V
T_{on}, T_{off}*			10	μs	I_C = 2 mA, R_E = 100Ω, V_{CC} = 10 V
Collector-Emitter Saturation Voltage $V_{CE(sat)}$*			0.3	V	I_F = 10 mA, I_C = 0.5 mA
Input to Output Isolation Current (Pulse Width = 8 m. sec)*					
4N35			100	μA	V_{IO} = 2500 VRMS
4N36			100	μA	V_{IO} = 1750 VRMS
4N37			100	μA	V_{IO} = 1050 VRMS
Isolation Voltage	**7500**			VDC	

*Indicates JEDEC Registered Data
Specifications subject to change without notice.

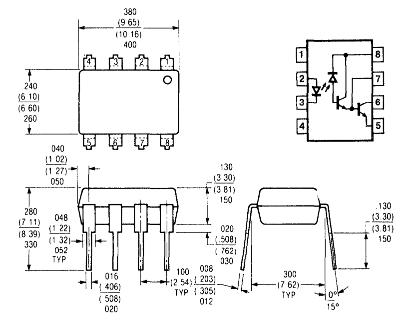
SIEMENS

6N138
6N139

LOW INPUT CURRENT, HIGH GAIN OPTOISOLATORS
Advance Data Sheet



Package Dimensions in Inches (mm)



PIN NO.	FUNCTION
1	NC
2	ANODE
3	CATHODE
4	NC
5	GND
6	Vo
7	V_B
8	V_{CC}

FEATURES

- **6000 Volt Isolation Voltage**
- **High Current Transfer Ratio 800%**
- **Low Input Current Requirement - 0.5mA**
- **TTL Compatible Output - 0.1V V_{OL}**
- **High Common Mode Rejection - 500V/μsec.**
- **High Output Current - 60mA**
- **DC to 1 Megabit / Sec. Operation**
- **Adjustable Bandwidth - Access to Base**
- **Standard Molded Dip Plastic Package**
- **UL Approval # E52744**

DESCRIPTION

High common mode transient immunity and very high current transfer ratio together with 6000 volts DC insulation are achieved by coupling an LED with an integrated high gain photon detector in an 8 pin dual inline package. Separate pins for the photodiode and output stage enable TTL compatible saturation voltages with high speed operation. Photo Darlington operation is achieved by tying the Vcc and Vo terminals together. Access to the base terminal allows adjustment to the gain bandwidth.

The 6N138 is ideal for TTL applications since the 300% minimum current transfer ratio with an LED current of 1.6mA enables operation with 1 unit load in and 1 unit load out with a 2.2K Ω pull-up resistor.

The 6N139 is best suited for low power logic applications involving CMOS and low power TTL. A 400% current transfer ratio with only 0.5mA of LED current is guaranteed from 0°C to 70°C.

APPLICATIONS

- Logic ground isolation – TTL/TTL, TTL/CMOS, CMOS/CMOS, CMOS/TTL
- EIA RS 232C Line Receiver
- Low Input Current Line Receiver – Long Lines, Party Lines
- Telephone Ring Detector
- 117 VAC Line Voltage Status Indication–Low Input Power Dissipation
- Low Power Systems – Ground Isolation

Maximum Ratings

Maximum Temperatures	
Storage Temperatures	−55° to +125°C
Operating Temperatures	0°C to +70°C
Lead Temperature (soldering, 10 sec.)	260°C
Average Input Current (I_F)	20mA
Peak Input Current (I_F) (50% Duty Cycle — 1ms pulse width)	40mA
Reverse Input Voltage (V_R)	5v
Input Power Dissipation	35mW
(Derate linearly above 50% in free air temperature at 0.7mW/°C)	
Output Current — I_o (Pin 6)	60mA
(Derate linearly above 25°C in free air temperature at 0.7mA/°C)	
Emitter-Base Reverse Voltage (Pin 5-7)	0.5V
Supply and Outage Voltage — V_{CC} (Pin 8-5), V_o (Pin 6-5)	
6N138	−0.5 to 7V
6N139	−0.5 to 18V
Output Power Dissipation	100mW
(Derate Linearly Above 25°C in Free Air Temperature at 2.0mW/°C)	

Caution:
Due to the small geometries of this device it should be handled with Electrostatic Discharge (ESD) precautions. Proper grounding would further prevent damage and/or degradation which may be induced by ESD.

Specifications are subject to change without notice.

Electro-Optical Characteristics (T_A = 0°C to 70°C, Unless Otherwise Specified)

Parameter	Device	Min	Typ	Max	Units	Test Conditions	Note
Current Transfer Ratio (CTR)	6N139	400 500	800 900		%	$I_F = 0.5mA$, $V_o = 0.4V$, $V_{CC} = 4.5V$ $I_F = 1.6mA$, $V_o = 0.4V$, $V_{CC} = 4.5V$	5,6
	6N138	300	600		%	$I_F = 1.6mA$, $V_o = 0.4V$, $V_{CC} = 4.5V$	
Logic Low Output Voltage (VOL)	6N139 6N139 6N139		0.1 0.1 0.2	0.4 0.4 0.4	V	$I_F = 1.6mA$, $I_o = 6.4mA$, $V_{CC} = 4.5V$ $I_F = 5mA$, $I_o = 15mA$, $V_{CC} = 4.5V$ $I_F = 12mA$, $I_o = 24mA$, $V_{CC} = 4.5V$	6
	6N138		0.1	0.4	V	$I_F = 1.6mA$, $I_o = 4.8mA$, $V_{CC} = 4.5V$	6
Logic High	6N139		0.05	100	µA	$I_F = 0mA$, $V_o = V_{CC} = 18V$	6
Output Current (I_{OH})	6N138		0.1	250	µA	$I_F = 0mA$, $V_o = V_{CC} = 7V$	
Logic Low Supply Current (ICCL)				0.2	mA	$I_F = 1.6mA$, V_o = OPEN, $V_{CC} = 5v$	6
Logic High Supply Current (ICCH)				10	mA	$I_F = 0mA$, V_o = OPEN, $V_{CC} = 5v$	6
Input Forward Voltage (VF)			1.4	1.7	V	$I_F = 1.6mA$, $T_A = 25°C$	
Input Reverse Breakdown Voltage (BVR)		5			V	$I_R = 10uA$, $T_A = 25°C$	
Temperature Coefficient of Forward Voltage			−1.8		mV/°c	$I_F = 1.6mA$	
Input Capacitance (C_{IN})			60		pF	f = 1MH$_z$, $V_F = 0$	
Input-Output Insulation Leakage Current ($I_{1\text{-}0}$)				1.0	µA	45% Relative Humidity, $T_A = 25°C$ t = 5$_S$, $V_{1\text{-}0}$ = 3000VDC	7
Resistance Input-Output) ($R_{1\text{-}0}$)			10^{12}		Ω	$V_{1\text{-}0}$ = 500V_{DC}	7
Capacitance (Input-Output) ($C_{1\text{-}0}$)			0.6		pF	f = 1MH$_z$	7

Switching Specifications (TA = 25°C)

Parameter	Device	Min	Typ	Max	Units	Test Conditions	Note
Propagation Delay Time	6N139	—	5 0.2	25 1	µs	$I_F = 0.5mA$, $R_L = 4.7kΩ$ $I_F = 12mA$, $R_L = 270Ω$	6,8
To Logic Low at Output tPHL	6N138		1	10	µs	$I_F = 1.6mA$, $R_L = 2.2kΩ$	
Propagation Delay Time	6N139		5 1	60 7	µs	$I_F = 0.5mA$, $R_L = 4.7kΩ$ $I_F = 12mA$, $R_L = 270mAΩ$	6,8
To Logic High at Output tPLH	6N138		4	35	µs	$I_F = 1.6mA$, $R_L = 2.2kΩ$	
Common Mode Transient Immunity at Logic High Level (CM_H) Output			500		v/µs	$I_F = 0mA$, R_L = 2.2kΩ $R_{CC} = 0, /V_{cm}/ = 10V_{p\text{-}p}$	9,10
Common Mode Transient Immunity at Logic Low Level (CM_L) Output			−500		v/µs	$I_F = 1.6mA$, R_L = 2.2kΩ $R_{CC} = 0, /V_{CM}/ = 10V_{p\text{-}p}$	9,10

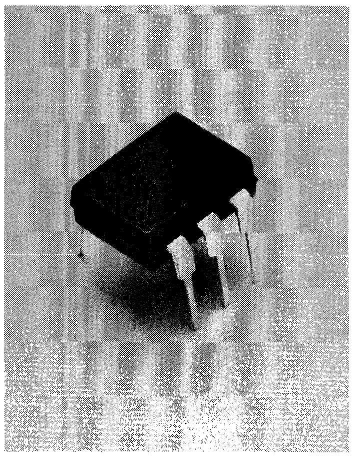
Notes

1. Derate linearly above 50°C free-air temperature at a rate of 0.4mA/°C.
2. Derate linearly above 50°C free-air temperature at a rate of 0.7mW/°C.
3. Derate linearly above 25°C free-air temperature at a rate of 0.7mA/°C.
4. Derate linearly above 25°C free-air temperature at a rate of 2.0mW/°C.
5. DC current transfer ratio is defined as the ratio of output collector current, I_o, to the forward LED input current, $I_F$times 100%
6. Pin 7 open.
7. Device considered a two-terminal device: pins 1,2,3 and 4 shorted together and pins 5,6,7, and 8 shorted together.
8. Use of a resistor between pin 5 and 7 will decrease gain and delay time.
9. Common mode transient immunity in logic high level is the maximum tolerable (positive) d/Vcm/dt on the leading edge of the common mode pulse, V_{cm}, to assure that the output will remain in a logic high state (i.e. $V_o > 2.0V$) common mode transient immunity in logic low level is the maximum tolerable (negative) dVcm/dt on the trailing edge of the common mode pulse signal, V_{cm}, to assure that the output will remain in a logic low state (i.e. $V_p < 0.8V$).
10. In applications where dv/dt may exceed 50,000v/us (such as state discharge) a series resistor, R_{CC} should be included to protect I_C from destructively high surge currents. The recommended value us $R_{CC} \approx \frac{IV}{0.15 I_F (mA)}$ kΩ.

SIEMENS

CNY 17 SERIES

SINGLE CHANNEL PHOTOTRANSISTOR OPTO-ISOLATOR



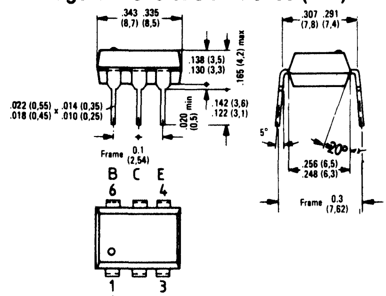
FEATURES

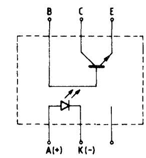
- **4400 Volt Breakdown Voltage**
- **High Current Transfer Ratio, 4 Groups**
  CNY 17-1, 40 to 80%
  CNY 17-2, 63 to 125%
  CNY 17-3, 100 to 200%
  CNY 17-4, 160 to 320%
- **Long Term Stability**
- **Industry Standard Dual-in-Line**
- **Underwriters Lab Approval #E52744**
- **VDE Approval #0883**

DESCRIPTION

The CNY 17 is an optically coupled pair employing a gallium arsenide infrared LED and a silicon NPN phototransistor. Signal information, including a DC level, can be transmitted by the device while maintaining a high degree of electrical isolation between input and output. The CNY 17 can be used to replace relays and transformers in many digital interface applications, as well as analog applications such as CRT modulation.

Package Dimensions in Inches (mm)





1. Anode
2. Cathode
3. Not Connected
4. Emitter
5. Collector
6. Base

Maximum Ratings

Emitter (GaAs infrared emitting diode)			
Reverse voltage	V_R	6	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	50	mA
Collector current (t<1 ms)	I_{CSM}	100	mA
Power dissipation	P_{tot}	150	mW
Coupler			
Storage temperature	T_{stor}	-40 to +150	°C
Operating temperature	T_{amb}	-40 to +100	°C
Junction temperature	T_j	100	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leq 3$ s)	T_s	260	°C
Isolation voltage (between emitter and detector referred to standard climate 23/50 DIN 50014;	V_{is}	4400	V
leakage path, DIN 57883, 6.80		8.2 MIN.	mm
air path, VDE 0883, 6.80		7.6 MIN.	mm

Tracking resistance: Group III (KC ≥ 600 in accordance with VDE 110 § 6, table 3 and DIN 53 480/VDE 0330, part 1.

Isolation voltage @ V_{is} = 500 V	R_{is}	10^{11}	Ω

Characteristics (T_{amb} = 25°C)

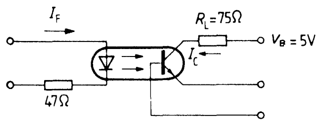
Emitter (GaAs infrared emitting diode)			
Forward voltage (I_F = 60 mA)	V_F	1.25 (≤ 1.65)	V
Breakdown voltage (I_R = 100 μA)	V_{BR}	30 (≥ 6)	V
Reverse current (V_R = 3 V)	I_R	0.01 (≤ 10)	μA
Capacitance (V_R = 0 V; f = 1 MHz)	C_O	40	pF
Thermal Resistance	R_{thJamb}	750	K/W
Detector (Si phototransistor)			
Capacitance (V_{CE} = 0 V; f = 1 MHz)	C_{CE}	6.8	pF
	C_{CB}	8.5	pF
	C_{EB}	11	pF
Thermal Resistance	R_{thJamb}	500	K/W
Coupler			
Collector-emitter saturation voltage (I_F = 10 mA; I_C = 2.5 mA)	V_{CEsat}	.25 (≤ .4)	V
Coupling capacitance	C_K	.30	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.

Specifications subject to change.

Group		CNY 17-1	CNY 17-2	CNY 17-3	CNY 17-4	
$\frac{I_C}{I_F}$		40 to 80	63 to 125	100 to 200	160 to 320	%
Collector-emitter leakage current (V_{CE} = 10 V)	I_{CEO}	2 (≤ 50)	2 (≤ 50)	5 (≤ 100)	5 (≤ 100)	nA

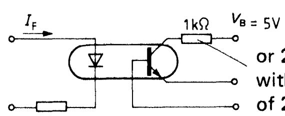
Linear operation (without saturation)



Load resistance	R_L	75	Ω
Delay time	t_d	3,0 (≦5,6)	μs
Rise time	t_r	2,0 (≦4,0)	μs
Storage time	t_s	2,3 (≦4,1)	μs
Fall time	t_f	2,0 (≦3,5)	μs
Cut-off frequency	f_g	250	kHz

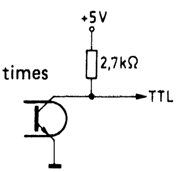
I_F = 10 mA
V_B = 5 V
T_{amb} = 25°C

Switching operation (with saturation)



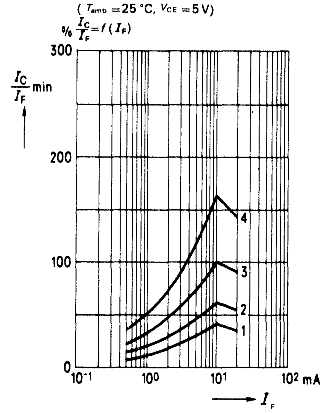
or 2TTL inputs
with pull-up resistor
of 2.7 kΩ

TTL level observed
but no TTL switching times

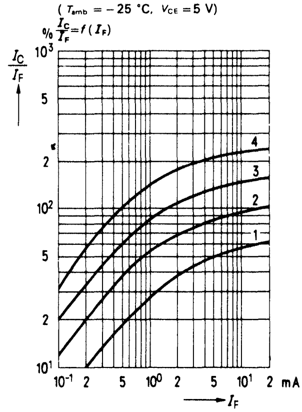


Group		1 I_F=20 mA	2 and 3 I_F=10 mA	4 I_F=5 mA	
Delay time	t_d	3,0 (≦5,5)	4,2 (≦8,0)	6,0 (≦10,5)	μs
Rise time	t_r	2,0 (≦4,0)	3,0 (≦6,0)	4,6 (≦8,0)	μs
Storage time	t_s	18 (≦34)	23 (≦39)	25 (≦43)	μs
Fall time	t_f	11 (≦20)	14 (≦24)	15 (≦26)	μs
	$V_{CE\,sat}$	0,25 (≦0,4)			V

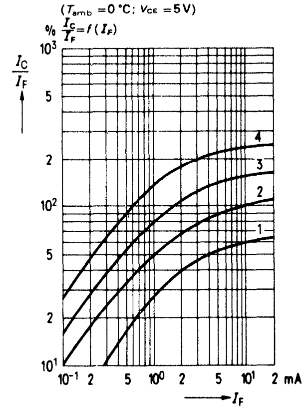
Minimum current transfer ratio as a function of diode current
(T_{amb} = 25 °C, V_{CE} = 5 V)



Current transfer ratio as a function of diode current
(T_{amb} = −25 °C, V_{CE} = 5 V)

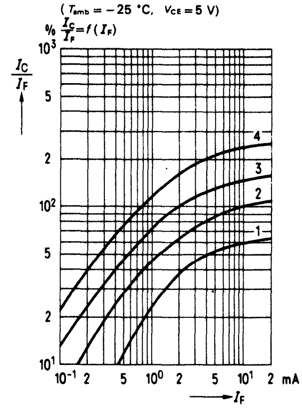


Current transfer ratio as a function of diode current
(T_{amb} = 0 °C; V_{CE} = 5 V)



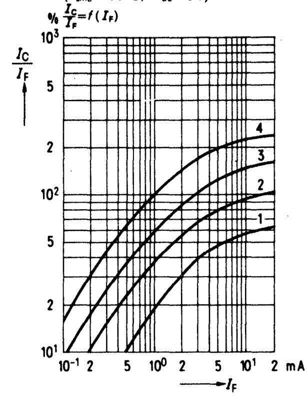
Current transfer ratio as a function of diode current

($T_{amb} = -25$ °C, $V_{CE} = 5$ V)



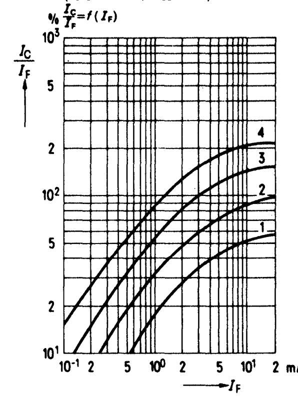
Current transfer ratio as a function of diode current

($T_{amb} = 50$ °C; $V_{CE} = 5$ V)



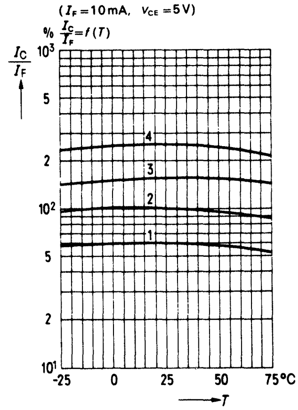
Current transfer ratio as a function of diode current

($T_{amb} = 75$ °C; $V_{CE} = 5$ V)



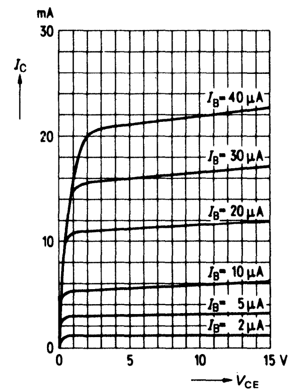
Current transfer ratio as a function of temperature

($I_F = 10$ mA, $V_{CE} = 5$ V)



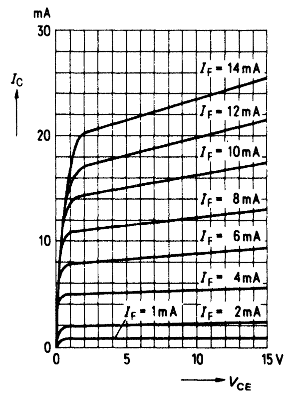
Transistor characteristics

(Current gain B=550)
($T_{amb} = 25$ °C; $I_F = 0$)
$I_C = f(V_{CE})$



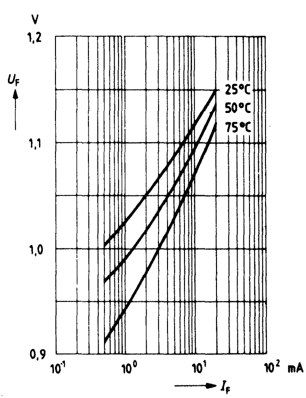
Output characteristics

($T_{amb} = 25$ °C)
$I_C = f(V_{CE})$



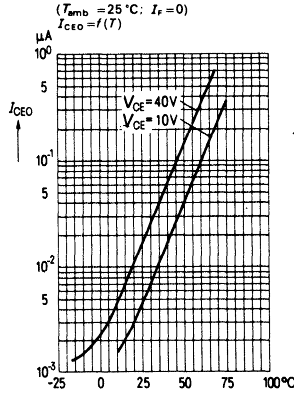
Forward voltage

$V_F = f(I_F)$



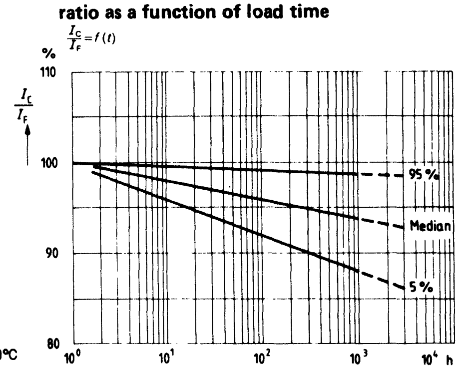
Collector-emitter off-state current

($T_{amb} = 25$ °C; $I_F = 0$)
$I_{CEO} = f(T)$



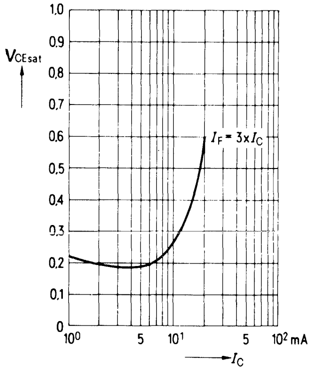
Variation of current transfer ratio as a function of load time

$\frac{I_C}{I_F} = f(t)$



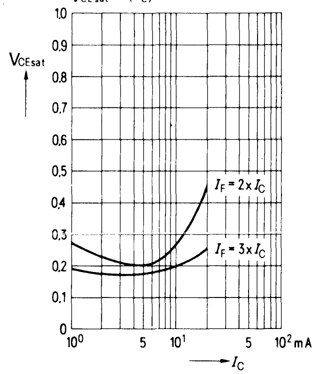
Saturation voltage as a function of collector current and modulation depth for CNY17-1

(T_{amb} = 25 °C)
$V_{CEsat} = f(I_C)$



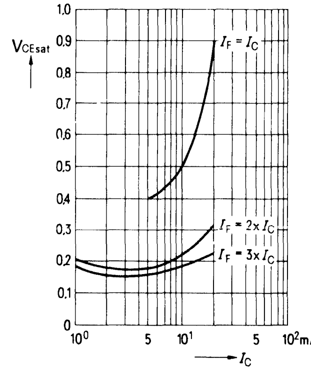
Handling same except for CNY17-2

(T_{amb} = 25 °C)
$V_{CEsat} = f(I_C)$



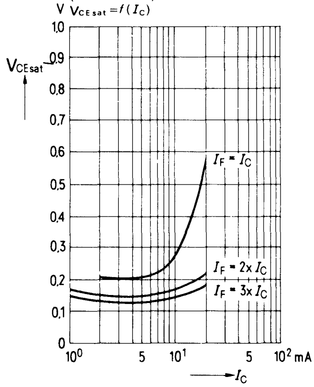
CNY17-3

(T_{amb} = 25 °C)
$V_{CEsat} = f(I_C)$



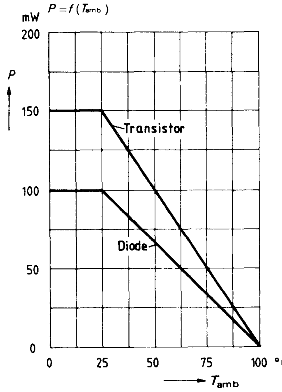
CNY17-4

(T_{amb} = 25 °C)
$V_{CEsat} = f(I_C)$



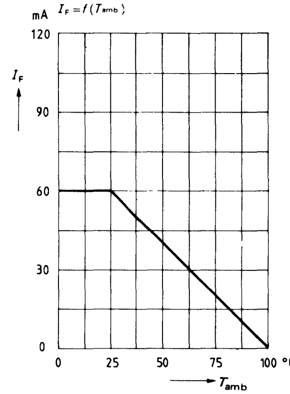
Permissible loss transistor and diode

$P = f(T_{amb})$



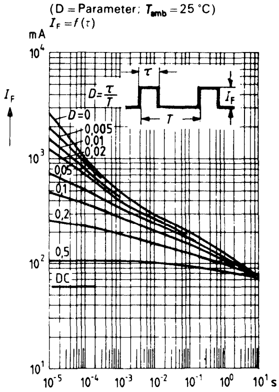
Permissible loss diode

$I_F = f(T_{amb})$



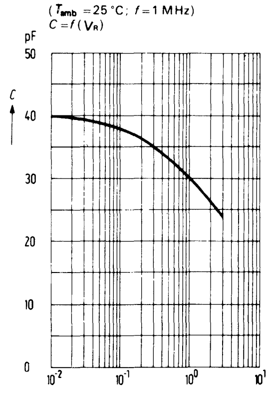
Permissible pulse load

(D = Parameter; T_{amb} = 25 °C)
$I_F = f(\tau)$



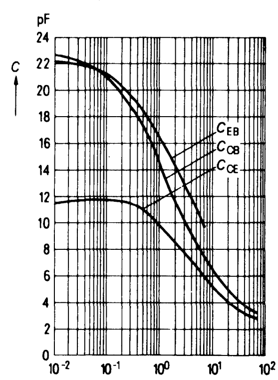
Diode capacitance

(T_{amb} = 25 °C; f = 1 MHz)
$C = f(V_R)$



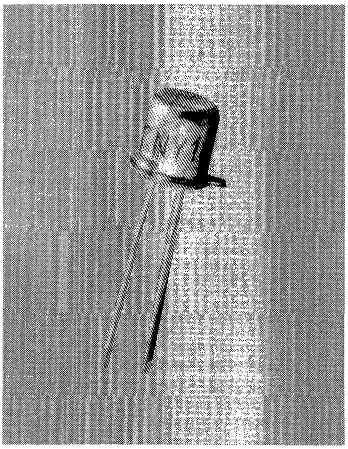
Transistor capacitances

(T_{amb} = 25 °C; f = 1 MHz)
$C = f(V_o)$



CNY 18 SERIES

SINGLE CHANNEL PHOTOTRANSISTOR OPTO-ISOLATOR



FEATURES

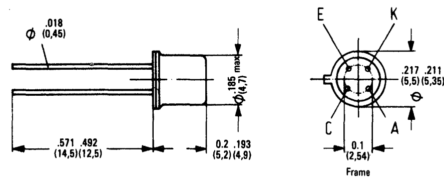
- TO-72 Metal Case Package
- Current Transfer Ratio, 4 Groups
  CNY 18-2, 16 to 32%
  CNY 18-3, 25 to 50%
  CNY 18-4, 40 to 80%
  CNY 18-5, 63 to 125%

DESCRIPTION

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.

Package Dimensions in Inches (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 ($t \leq 10\ \mu s$)	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 ($t \leq 3$ 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 Isola ion 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

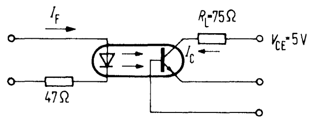
Coupling capacitances (f = 1 MHz)

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.

Group	CNY 18-2	CNY 18-3	CNY 18-4	CNY 18-5	
$\frac{I_C}{I_F}$	16 to 32	25 to 50	40 to 80	63 to 125	%

Specifications are subject to change without notice.

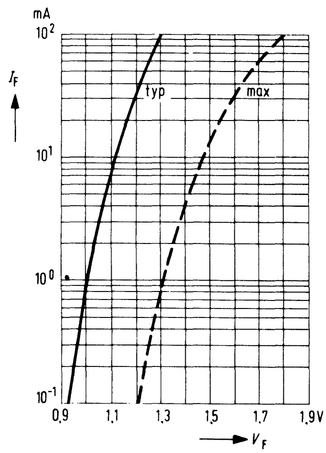


$I_F = 10$ mA
$V_{CE} = 5$ V
$T_{amb} = 25\,°C$

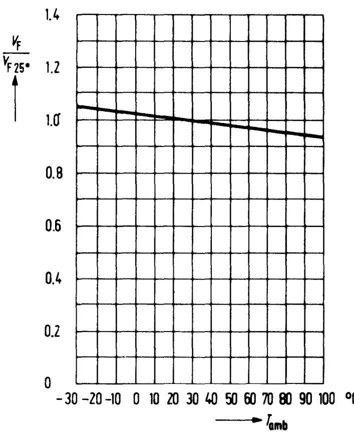
Switching Times

Load Resistance (R_L)	75 Ω
Delay Time (t_d)	3.2 (≤4.6) µs
Rise Time (t_r)	2 (≤3) µs
Storage Time (t_s)	3.0 (≤4.0) µs
Fall Time (t_f)	2.5 (≤3.3) µs
Cut Off Frequency (f_g)	250 kHz

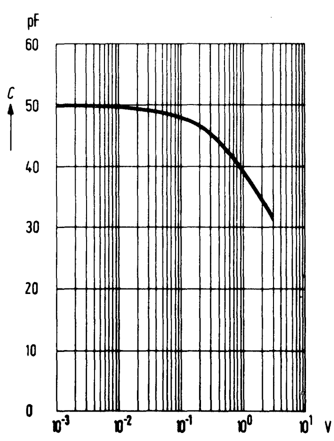
Forward voltage $I_F = f(V_F)$



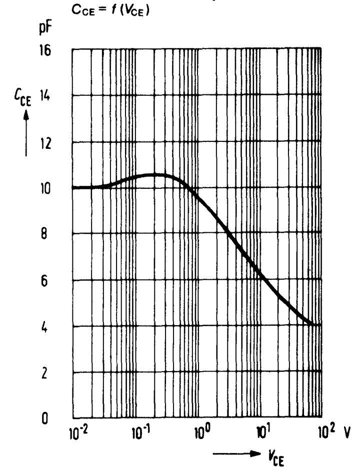
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



Capacitance $C = f(V_R)$



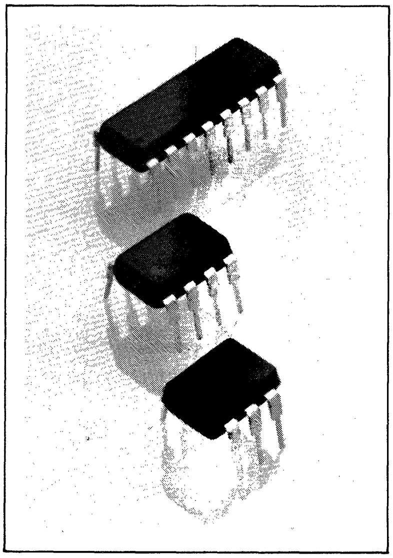
Collector-emitter capacitance
$C_{CE} = f(V_{CE})$



SIEMENS

IL-1B SINGLE CHANNEL
ILD-1 DUAL CHANNEL
ILQ-1 QUAD CHANNEL

PHOTOTRANSISTOR OPTO-ISOLATOR



FEATURES

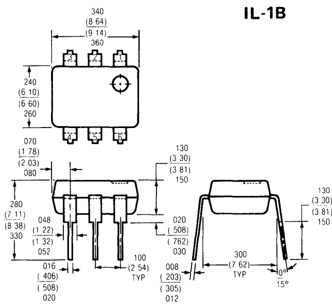
- 7400 Series T^2L Compatible
- 6000 Volt Isolation Voltage
- 0.5 pF Coupling Capacitance
- Industry Standard Dual-In-Line Package
- Single Channel, Dual, and Quad Configurations
- Underwriters Lab Approval #E52744

DESCRIPTION

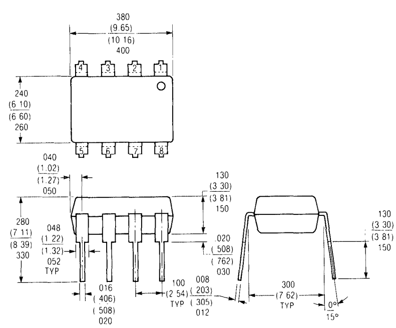
IL-1B is an optically coupled pair employing a Gallium Arsenide infrared LED and a silicon NPN phototransistor. Signal information, including a DC level, can be transmitted by the device while maintaining a high degree of electrical isolation between input and output. The IL-1B is especially designed for driving medium-speed logic, where it may be used to eliminate troublesome ground loop and noise problems. It can also be used to replace relays and transformers in many digital interface applications, as well as analog applications such as CRT modulation. The ILD-1 offers two isolated channels in a single DIP package while the ILQ-1 provides four isolated channels per package.

Package Dimensions in Inches (mm)

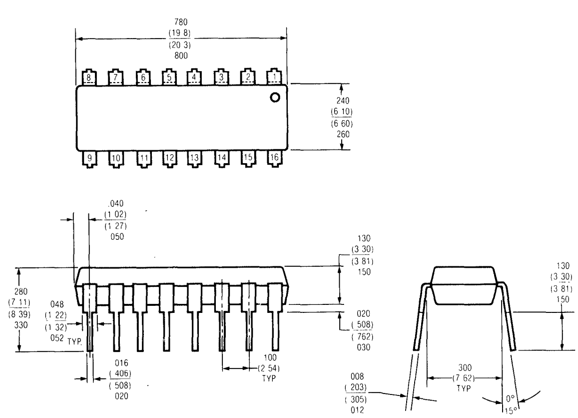
IL-1B



ILD-1



ILQ-1



Specifications subject to change without notice.

MAXIMUM RATINGS

Gallium Arsenide LED (each channel)

Power Dissipation @ 25°C

IL-1B	200 mW
ILD-1	150 mW
ILQ-1	150 mW

Derate Linearly from 25°C

IL-1B	2.6 mW/°C
ILD-1	1.33 mW/°C
ILQ-1	1.33 mW/°C

Continuous Forward Current

IL-1B	100 mA
ILD-1	100 mA
ILQ-1	100 mA

Detector Silicon Phototransistor (each channel)

Power Dissipation @ 25°C

IL-1B	200 mW
ILD-1	150 mW
ILQ-1	150 mW

Derate Linearly from 25°C

IL-1B	2.6 mW/°C
ILD-1	2.0 mW/°C
ILQ-1	2.0 mW/°C
Collector-Emitter Breakdown Voltage	30 V
Emitter-Collector Breakdown Voltage	7 V
Collector-Base Breakdown Voltage (IL-1)	70 V

Package

Total Package Dissipation at 25°C Ambient (LED Plus Detector)

IL-1B	250 mW
ILD-1	400 mW
ILQ-1	500 mW

Derate Linearly from 25°C

IL-1B	3.3 mW/°C
ILD-1	5.33 mW/°C
ILQ-1	6.67 mW/°C
Storage Temperature	–55°C to +150°C
Operating Temperature	–55°C to +100°C
Lead Soldering Time @ 260°C	10 sec

ELECTRICAL CHARACTERISTICS PER CHANNEL (at 25°C Ambient)

Parameter	Min	Typ	Max	Units	Test Conditions
Gallium Arsenide LED					
Forward Voltage		1.3	1.5	V	$I_F = 60$ mA
Reverse Current		0.1	10	μA	$V_R = 3.0$ V
Capacitance		100		pF	$V_R = 0$
Phototransistor Detector					
BV_{ECO}	7	10		V	$I_E = 100$ μA
BV_{CEO}	30	50		V	$I_C = 1$ mA
I_{CEO}		5.0	50	nA	$V_{CE} = 10$ V, $I_F = 0$
Collector-Emitter Capacitance		2.0		pF	$V_{CE} = 0$
Coupled Characteristics					
DC Current Transfer Ratio	20	35		%	$I_F = 10$ mA, $V_{CE} = 10$ V
V_{SAT}		0.25	0.5	V	$I_C = 1.6$ mA, $I_F = 16$ mA
Capacitance, Input to Output		0.5		pF	
Breakdown Voltage	6000	7500		VDC	t = 1 sec.
Resistance, Input to Output		100		GΩ	
Switching Times					
t_{ON}		2.5		μs	$R_E = 100Ω$, $V_{CE} = 10V$
t_{OFF}		2.5		μs	$I_C = 2$ mA

TYPICAL OPTOELECTRONIC CHARACTERISTIC CURVES FOR EACH CHANNEL

FIGURE 1. RELATIVE OUTPUT VS TEMPERATURE

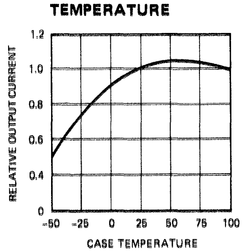


FIGURE 2. DARK CURRENT VS TEMPERATURE

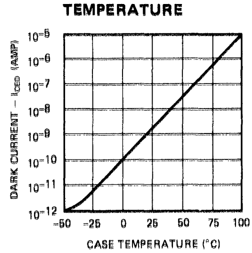


FIGURE 3. TRANSFER CHARACTERISTICS

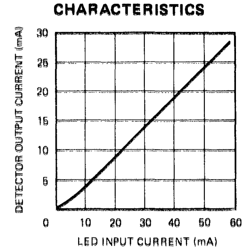


FIGURE 4. DETECTOR OUTPUT CHARACTERISTICS

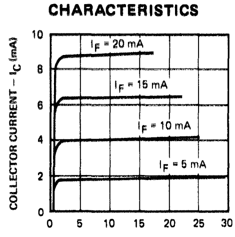
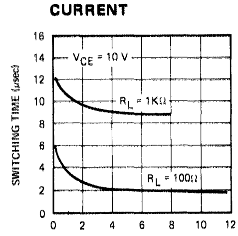


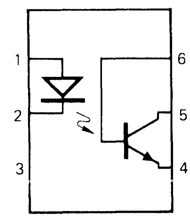
FIGURE 5. SWITCHING TIME VS COLLECTOR CURRENT



PIN CONFIGURATIONS

IL-1B

(TOP VIEW)

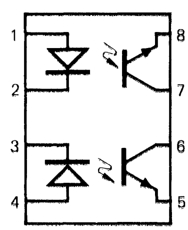


LED CHIP ON PIN 2
PT CHIP ON PIN 5

PIN NO.	FUNCTION
1	ANODE
2	CATHODE
3	NC
4	EMITTER
5	COLLECTOR
6	BASE

ILD-1

(TOP VIEW)

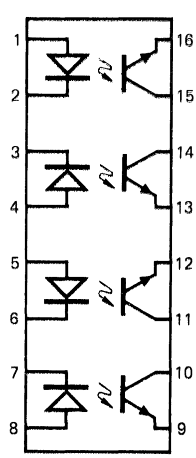


LED CHIPS ON PINS 2 AND 3
PT CHIPS ON PINS 6 AND 7

PIN NO.	FUNCTION
1	ANODE
2	CATHODE
3	CATHODE
4	ANODE
5	EMITTER
6	COLLECTOR
7	COLLECTOR
8	EMITTER

ILQ-1

(TOP VIEW)



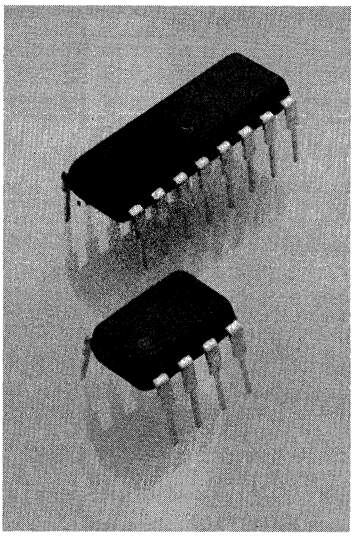
LED CHIPS ON PINS 2, 3, 6, 7
PT CHIPS ON PINS 10, 11, 14, 15

PIN NO.	FUNCTION
1	ANODE
2	CATHODE
3	CATHODE
4	ANODE
5	ANODE
6	CATHODE
7	CATHODE
8	ANODE
9	EMITTER
10	COLLECTOR
11	COLLECTOR
12	EMITTER
13	EMITTER
14	COLLECTOR
15	COLLECTOR
16	EMITTER

SIEMENS

ILD-2 DUAL CHANNEL
ILQ-2 QUAD CHANNEL

PHOTOTRANSISTOR OPTO-ISOLATOR



FEATURES

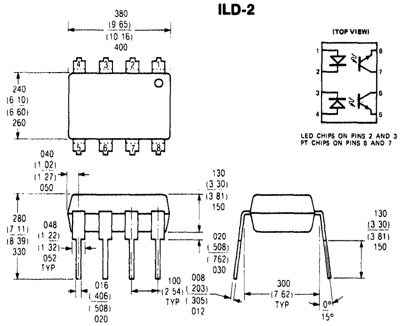
- **100% Minimum Current Transfer Ratio**
- **7400 Series T^2L Compatible**
- **7500 Volt Isolation Voltage**
- **0.5 pF Coupling Capacitance**
- **Industry Standard Dual In-Line Package**
- **Single Channel, Dual, and Quad Configurations**
- **Underwriters Lab Approval #E52744**

DESCRIPTION

ILD2/ILQ2 are optically coupled pairs employing Gallium Arsenide infrared LEDs and silicon NPN phototransistors. Signal information, including a DC level, can be transmitted by the device while maintaining a high degree of electrical isolation between input and output. The ILD2/ILQ2 are especially designed for driving medium-speed logic, where they may be used to eliminate troublesome ground loop and noise problems. They can also be used to replace relays and transformers in many digital interface applications such as CRT modulation. The ILD-2 offers two isolated channels in a single DIP package while the ILQ-2 provides for isolated channels per package.

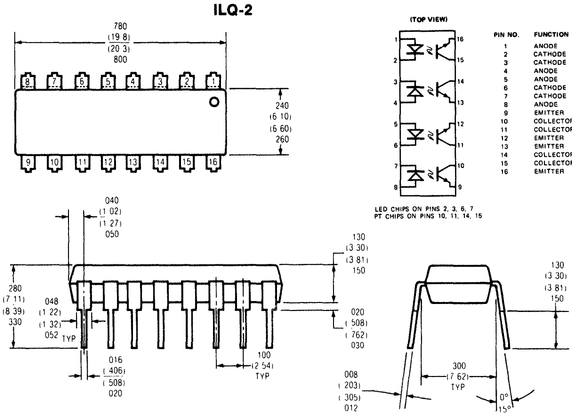
Package Dimensions in Inches (mm)

ILD-2



PIN NO.	FUNCTION
1	ANODE
2	CATHODE
3	CATHODE
4	ANODE
5	EMITTER
6	COLLECTOR
7	COLLECTOR
8	EMITTER

ILQ-2



PIN NO.	FUNCTION
1	ANODE
2	CATHODE
3	CATHODE
4	ANODE
5	ANODE
6	CATHODE
7	CATHODE
8	ANODE
9	EMITTER
10	COLLECTOR
11	COLLECTOR
12	EMITTER
13	EMITTER
14	COLLECTOR
15	COLLECTOR
16	EMITTER

Maximum Ratings

Gallium Arsenide LED (each channel)

Power Dissipation @ 25°C
- ILD-2 .... 150 mW
- ILQ-2 .... 150 mW

Derate Linearly from 25°C
- ILD-2 .... 1.33 mW/°C
- ILQ-2 .... 1.33 mW/°C

Continuous Forward Current
- ILD-2 .... 100 mA
- ILQ-2 .... 100 mA

Detector Silicon Phototransistor (each channel)

Power dissipation @ 25°C
- ILD-2 .... 150 mW
- ILQ-2 .... 150 mW

Derate Linearly from 25°C
- ILD-2 .... 2.0 mW/°C
- ILQ-2 .... 2.0 mW/°C

Collector-Emitter Breakdon Voltage .... 30 V
Emitter-Collector Breakdown Voltage .... 7 V
Collector-Base Breakdown Voltage (IL-1) .... 70 V

Specifications are subject to change without notice.

Maximum Ratings

(Continued From the Previous Page)

Package
- Total Package Dissipation at 25°C Ambient (LED Plus Detector)
  - ILD-2 ... 400mW
  - ILQ-2 ... 500mW
- Derate Linearly from 25°C
  - ILD-2 ... 5.33 mW/°C
  - ILQ-2 ... 6.67 mW/°C
- Storage Temperature ... −55°C to +150°C
- Operating Temperature ... −55°C to +100°C
- Lead Soldering Time @ 260°C ... 10 sec

ELECTRICAL CHARACTERISTICS PER CHANNEL (at 25°C Ambient)

Parameter	Min	Typ	Max	Units	Test Conditions
Gallium Arsenide LED					
Forward Voltage		1.3	1.5	V	I_F = 60 mA
Reverse Current		0.1	10	µA	V_R = 3.0 V
Capacitance		100		pF	V_R = 0
Phototransistor Detector					
BV_{ECO}	7	10		V	I_C = 100 µA
BV_{CEO}	30	50		V	I_C = 1 mA
I_{CEO}		5.0	50	nA	V_{CE} = 10 V, I_F = 0
Collector-Emitter Capacitance		2.0		pF	V_{CE} = 0
Coupled Characteristics					
DC Current Transfer Ratio	100			%	I_F = 10 mA, V_{CE} = 10 V
V_{SAT}		0.25	0.5	V	I_C = 1.6 mA, I_F = 16 mA
Capacitance, Input to Output		0.5		pF	
Breakdown Voltage	7500			VDC	t = 1 sec
Resistance, Input to Output		100		GΩ	
Switching Times					
t_r		2.5		µs	R_E = 100Ω V_{CE} = 10V
t_f		2.5		µs	I_C = 2 mA

TYPICAL OPTOELECTRONIC CHARACTERISTIC CURVES FOR EACH CHANNEL

FIGURE 1. RELATIVE OUTPUT VS TEMPERATURE

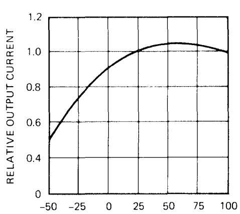


FIGURE 2. DARK CURRENT VS TEMPERATURE

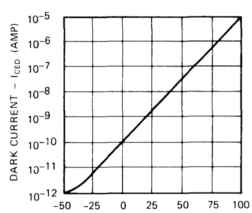


FIGURE 3. TRANSFER CHARACTERISTICS

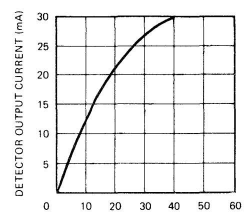


FIGURE 4. DETECTOR OUTPUT CHARACTERISTICS

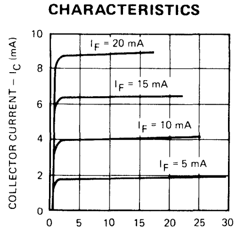
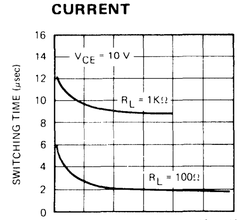


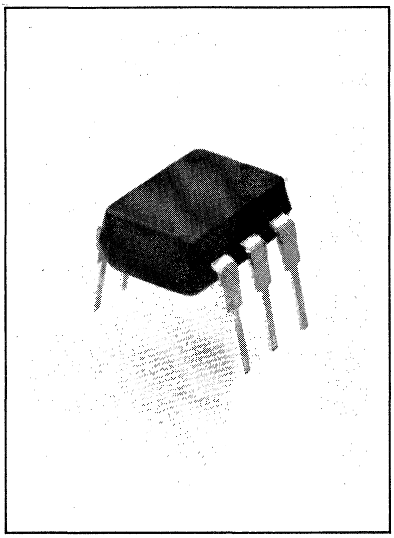
FIGURE 5. SWITCHING TIME VS COLLECTOR CURRENT



SIEMENS

IL-5

PHOTOTRANSISTOR OPTO-ISOLATOR



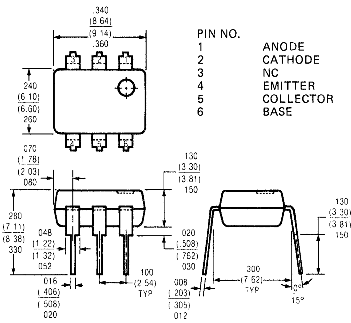
FEATURES

- **6000 Volt Isolation Voltage**
- **70% Typical Transfer Ratio**
- **Industry Standard Dual-In-Line**
- **0.5 pF Coupling Capacitance**
- **Underwriters Lab Approval #E52744**

DESCRIPTION

IL-5 is an optically coupled pair employing a Gallium Arsenide infrared LED and a silicon NPN phototransistor. Signal information, inlcuding a DC level, can be transmitted by the device while maintaining a high degree of electrical isolation between input and output. The IL-5 can be used to replace relays and transformers in many digital interface applications, as well as analog applications such as CRT modulation.

Package Dimensions in Inches (mm)



Maximum Ratings

Gallium Arsenide LED
- Power Dissipation @ 25°C . . . . 200 mW
- Derate Linearly from 25°C . . . . 2.6 mW/°C
- Continuous Forward Current . . . . 100 mA
- Peak Inverse Voltage . . . . 3.0 V

Detector (Silicon Phototransistor)
- Power Dissipation @ 25°C . . . . 200 mW
- Derate Linearly From 25°C . . . . 2.6 mW/°C
- Collector-Emitter Breakdown Voltage (BV_{CEO}) . . . . . . 30 V
- Emitter-Collector Breakdown Voltage (BV_{ECO}) . . . . . . 7 V
- Collector-Base Breakdown Voltage (BV_{CBO}) . . . . . . 70 V

Package
- Total Package Dissipation at 25°C Ambient (LED Plus Detector) . . . . 250 mW
- Derate Linearly From 25°C . . . . 3.3 mW/°C
- Storage Temperature . . . . −55 to +150°C
- Operating Temperature . . . . −55 to +100°C
- Lead Soldering Time @ 260°C . . . . 10 sec

Electrical Characteristics (at 25°C Ambient)

Parameter	Min	Typ	Max	Unit	Test Condition
Gallium Arsenide LED					
Forward Voltage		1.3	1.5	V	I_F = 60 mA
Reverse Current		.1	10	μA	V_R = 3.0 V
Capacitance		100		pF	V_R = 0
Phototransistor Detector					
H_{FE}		450			V_{CE} = 5.0 V I_C = 100 μA
BV_{CEO}	30	50		V	I_C = 1 mA
BV_{ECO}	7	10		V	I_E = 100 μA
I_{CEO} (dark)		5	50	nA	V_{CE} = 10 V I_F = 0
Collector-Emitter Capacitance		2		pF	V_{CE} = 0
Coupled Characteristics					
DC Current Transfer	50	70		%	I_F=10mA, V_{CE}=10V
Collector-Emitter Saturation Voltage $V_{CE(sat)}$		.35	0.5	V	I_F = 16 mA I_C = 1.6 mA
Capacitance, Input to Output		.5		pF	
Breakdown Voltage . . .	7500			VDC	
Resistance, Input to Output		100		GΩ	
Output Rise and Fall Times		2.8		μs	I_C=2mA, R_E=100Ω V_{CC} = 10V

Specifications subject to change without notice.

TYPICAL OPTO-ELECTRONIC CHARACTERISTIC CURVES

FIGURE 1. RELATIVE OUTPUT VS TEMPERATURE

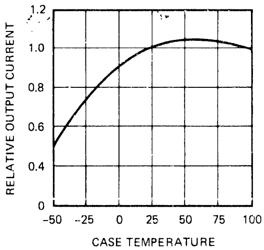


FIGURE 2. DARK CURRENT VS TEMPERATURE

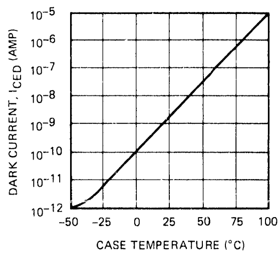


FIGURE 3. TRANSFER CHARACTERISTICS

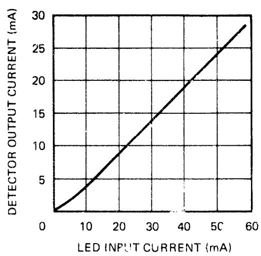


FIGURE 4. DETECTOR OUTPUT CHARACTERISTICS

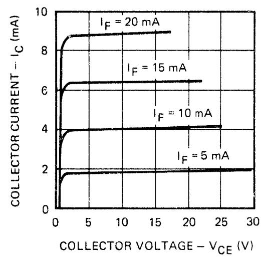
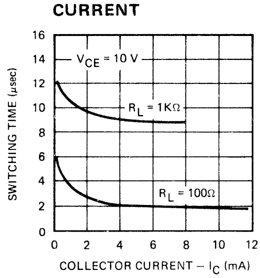


FIGURE 5. SWITCHING TIME VS COLLECTOR CURRENT

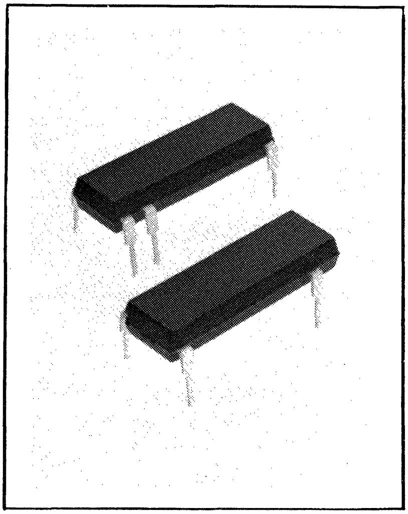


SIEMENS

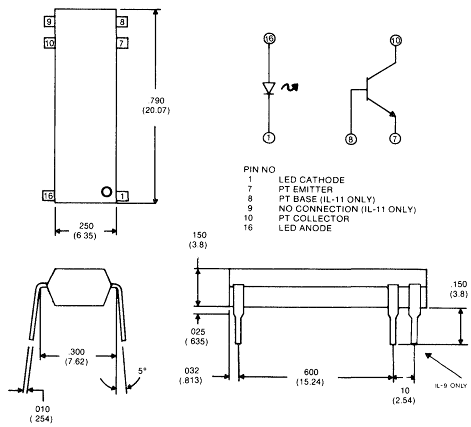
IL-8/IL-9

PHOTOTRANSISTOR OPTO-ISOLATORS

ADVANCE DATA SHEET



Package Dimensions in Inches (mm)



FEATURES:

- **High Isolation Voltage of 8K V_{RMS}**
- **Minimum internal separation of 2.0mm between conductive parts.**
- **Minimum external separation of leads and creepage distance of 13mm.**
- **Standard DIP profile on leads and package.**
- **Machine insertable on PCB**
- **IL-8 is four lead product**
- **IL-9 is six lead with base contact.**
- **VDE applied for**
- **Underwriters Lab approval #E52744**

ABSOLUTE MAXIMUM RATINGS

Storage Temperature .... -55° C to 150° C
Operating Temperature .... -55° C to 100° C
Lead Solder Temperature .... 260° C
(1.6mm from cast for t = 5 sec)
Isolation Voltage .... 8KV_{RMS}
(t = 1 minute)

LED

Forward DC Current 60mA
Peak Forward Current 3.0A
(1μ sec pulse, 300pps)
Reverse Voltage 5.0V
Power Dissipation 100mW
Derate linearly from 25° C .... 1.33mw/° C

Phototransistor

Collector Emitter Voltage 30V
Emitter Base Voltage 7V
Collector Current 100ma
Power Dissipation 300mW
Derate linearly from 25° C .... 4.0mW/° C

DESCRIPTION:

The IL-8 and IL-9 are optically coupled isolators employing a gallium arsenide infrared emitter and a silicon phototransistor. The package is designed to meet or exceed all requirements of VDE standard 0883/6.80 and 730-2.

ELECTRICAL CHARACTERISTICS

(25° C unless otherwise noted)

LED

V_F (I_F = 10mA) .... 1.5V Max.
I_R (V_R = 5V) .... 10μA Max.

Phototransistor

BV_{CEO} (I_C = 1.0mA) .... 30V Min.
BV_{EBO} (I_E = 10μA) .... 7V Min.
I_{CEO} (V_{CE} = 10V) .... 50 nA Max.

Coupled

DC Current Transfer Ratio
(I_F = 10mA, V_{CE} = 10V) .... 20% Min.
Saturation Voltage-Collector to Emitter
(I_F = 20mA I_C = 2.0mA .... 0.4V Max.
T_{ON} = (I_C = 2mA, R_E = 100Ω,
100μs Pulsewidth, 1% Dutycycle) .... 14μs Typ.
T_{OFF} = (I_C = 2mA, R_E = 100Ω,
100μs Pulsewidth, 1% Dutycycle) .... 11μs Typ.

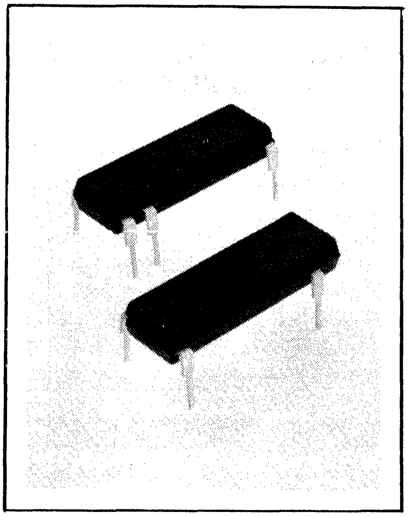
Specifications are subject to change without notice.

SIEMENS

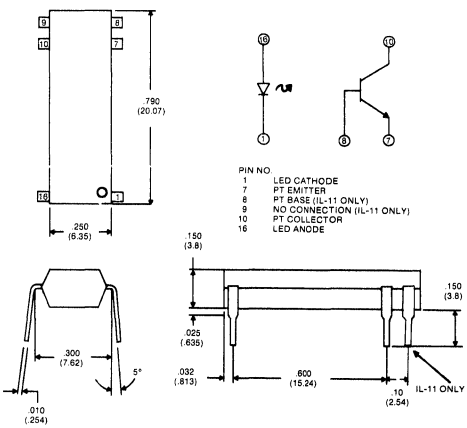
IL-10/IL-11

PHOTOTRANSISTOR OPTO-ISOLATORS

ADVANCE DATA SHEET



Package Dimensions in Inches (mm)



FEATURES:

- High Isolation Voltage of 8K V_{RMS}
- Minimum internal separation of 2.0mm between conductive parts.
- Minimum external separation of leads and creepage distance of 13mm.
- Standard DIP profile on leads and package.
- Machine insertable on PCB
- IL-10 is four lead product
- IL-11 is six lead with base contact.
- VDE applied for
- Underwriters Lab Approval #E52744

ABSOLUTE MAXIMUM RATINGS

Storage Temperature .... -55° C to 150° C
Operating Temperature .... -55° C to 100° C
Lead Solder Temperature .... 260° C
(1.6mm from cast for t = 5 sec)
Isolation Voltage .... 8KV_{RMS}
(t = 1 minute)

LED

Forward DC Current 60mA
Peak Forward Current 3.0A
(1μ sec pulse, 300pps)
Reverse Voltage 5.0V
Power Dissipation 100mW
Derate linearly from 25° C .... 1.33mw/° C

Phototransistor

Collector Emitter Voltage 30V
Emitter Base Voltage 7V
Collector Current 100ma
Power Dissipation 300mW
Derate linearly from 25° C .... 4.0mW/° C

DESCRIPTION:

The IL-10 and IL-11 are optically coupled isolators employing a gallium arsenide infrared emitter and a silicon phototransistor. The package is designed to meet or exceed all requirements of VDE standard 0883/6.80 and 730-2.

ELECTRICAL CHARACTERISTICS

(25° C unless otherwise noted)

LED

V_F (I_F = 10mA) .... 1.5V Max.
I_R (V_R = 5V) .... 10μA Max.

Phototransistor

BV_{CEO} (I_C = 1.0mA) .... 30V Min.
BV_{EBO} (I_E = 10μA) .... 7V Min.
I_{CEO} (V_{CE} = 10V) .... 50 nA Max.

Coupled

DC Current Transfer Ratio
(I_F = 10mA, V_{CE} = 10V) .... 50% Min.
Saturation Voltage-Collector to Emitter
(I_F = 20mA I_C = 2.0mA .... 0.4V Max.
T_{ON} = (I_C = 2mA, R_E = 100Ω,
100μs Pulsewidth, 1% Dutycycle) .... 14μs Typ.
T_{OFF} = (I_C = 2mA, R_E = 100Ω,
100μs Pulsewidth, 1% Dutycycle) .... 11μs Typ.

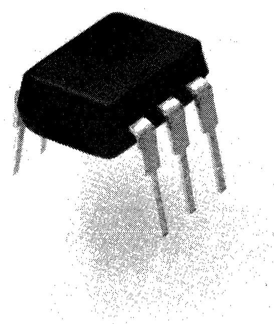
Specifications are subject to change without notice.

SIEMENS

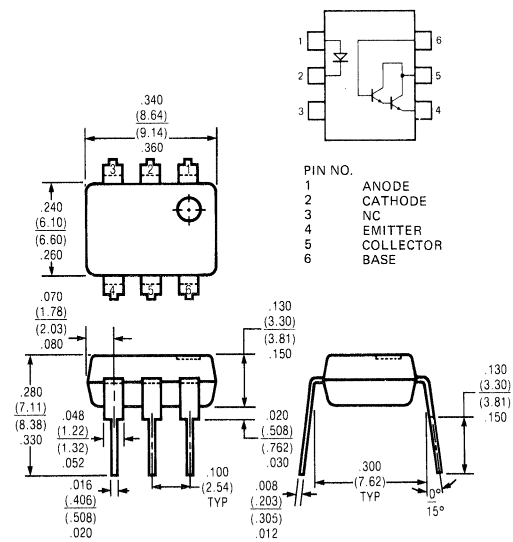
IL-30 SINGLE CHANNEL
(Formerly ILCA2-30)

IL-55 SINGLE CHANNEL
(Formerly ILCA2-55)

PHOTO DARLINGTON OPTO-ISOLATORS



Package Dimensions in Inches (mm)



FEATURES

- **6000 Volt Isolation Voltage**
- **Equivalent to MCA2-30/MCA2-55**
- **125 mA Load Current Rating**
- **Fast Turn On Time — 10μs**
- **Fast Turn Off Time — 35μs**
- **Solid State Reliability**
- **Standard Plastic DIP Package**
- **Underwriter Lab Approval #E52744**

DESCRIPTION

The IL-30 and IL-55 are coupled isolators employing a gallium arsenide infrared emitter and a silicon photo darlington sensor. Switching can be accomplished while maintaining a high degree of isolation between driving and load circuits. They can be used to replace reed and mercury relays with advantages of long life, high speed switching and elimination of magnetic fields.

Maximum Ratings

Gallium Arsenide LED		
Power Dissipation at 25°C	90 mW	
Derate Linearly From 25°C	1.2 mW/°C	
Continuous Forward Current	60 mA	
Peak Reverse Voltage	3V	
Photodarlington Sensor	IL-30	IL-55
Power Dissipation at 25°C Ambient	210 mW	210 mW
Derate Linearly From 25°C	2.8 mW/°C	2.8 mW/°C
Collector (load) Current	125 mA	125 mA
Collector-Emitter Breakdown Voltage (BV_{CEO})	30V	55V
Collector-Base Breakdown Voltage (BV_{CBO})	30V	55V
Emitter-Base Breakdown Voltage (BV_{EBO})	8V	8V
Package		
Total Dissipation at 25°C	250 mW	
Derate Linearly From 25°C	3.3 mW/°C	
Storage Temperature	–55°C to +150°C	
Operating Temperature	–55°C to +100°C	
Lead Soldering Time at 260°C	10 sec	

Specifications are subject to change without notice.

TYPICAL OPTO-ELECTRONIC CHARACTERISTIC CURVES

Electrical Characteristics (at 25° Ambient)

Parameter	Min	Typ	Max	Unit	Test Condition
GaAs Emitter					
Forward Voltage		1.25	1.5	V	$I_F = 20mA$
Reverse Current		0.01	10	μA	$V_R = 3.0V$
Capacitance		50		pF	$V_R = 0$
Sensor					
H_{fe}		13K			$V_{CE} = 5V$, $I_C = 0.5mA$
BV_{CEO}	30/55			V	$I_C = 100\mu A$, $I_F = 0$
BV_{CBO}	30/55			V	$I_C = 10\mu A$, $I_F = 0$
BV_{EBO}	8			V	$I_E = 1\mu A$, $I_F = 0$
I_{CEO}		1.0	100	nA	$V_{CE} = 10V$, $I_F = 0$
Capacitance					
Collector-Emitter		3.4		pF	$V_{CE} = 10V$
Collector-Base		10		pF	$V_{CB} = 10V$
Emitter-Base		10		pF	$V_{EB} = 0.5V$
Coupled Characteristics					
Current Transfer Ratio .	100	400		%	$I_F = 10mA$, $V_{CE} = 5V$
$V_{CE(SAT)}$		0.9	1.0	V	$I_C = 50mA$, $I_F = 50mA$
Rise Time		10		μs	$V_{CC} = 13.5V$
Fall Time		35		μs	$I_F = 50mA$, $R_C = 100\Omega$
Isolation Voltage	6000			VDC	t=1 sec.
Isolation Resistance . . .		10^{12}		ohm	
Isolation Capacitance . .		0.5		pf	

FIGURE 1. GaAs EMITTER: FORWARD CURRENT – VOLTAGE CHARACTERISTICS

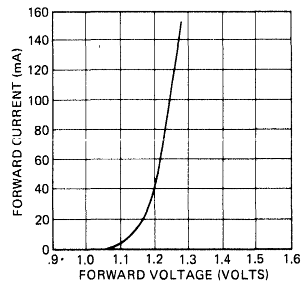


FIGURE 2. DARLINGTON TRANSISTOR OUTPUT CURRENT VS VOLTAGE

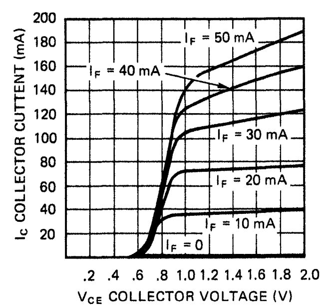


FIGURE 3. DARLINGTON TRANSISTOR CURRENT VS VOLTAGE

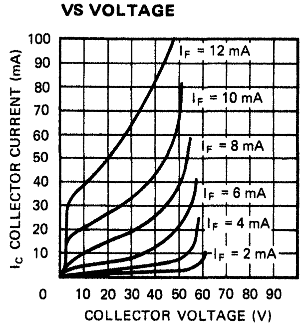
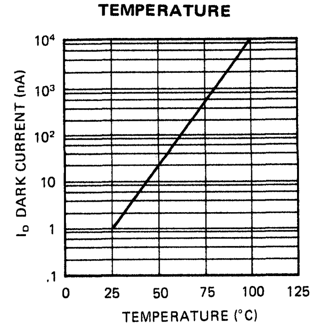
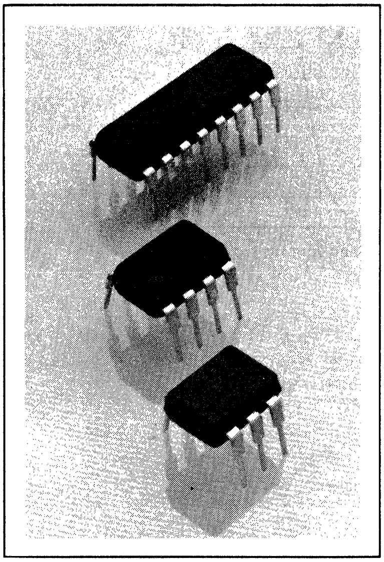


FIGURE 4. DARK CURRENT VS TEMPERATURE



SIEMENS

IL-74 SINGLE CHANNEL
ILD-74 DUAL CHANNEL
ILQ-74 QUAD CHANNEL
PHOTOTRANSISTOR OPTO-ISOLATOR



FEATURES

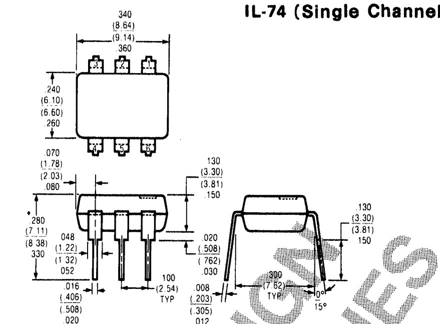
- 7400 Series T^2 L Compatible
- 6000 Volt Isolation Voltage
- 35% typical transfer ratio
- 0.5 pF coupling capacitance
- Industry standard dual-in-line package
- Single channel, dual, and quad configurations
- Underwriters Lab Approval #E52744

DESCRIPTION

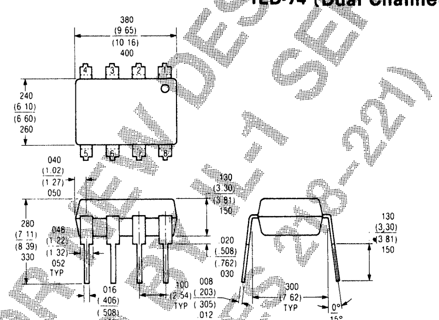
IL-74 is an optically coupled pair employing a Gallium Arsenide infrared LED and a silicon NPN phototransistor. Signal information, including a DC level, can be transmitted by the device while maintaining a high degree of electrical isolation between input and output. The IL-74 is especially designed for driving medium-speed logic, where it may be used to eliminate troublesome ground loop and noise problems. It can also be used to replace relays and transformers in many digital interface applications, as well as analog applications such as CRT modulation. The ILD-74 offers two isolated channels in a single DIP package while the ILQ-74 provides four isolated channels per package.

Package Dimensions in Inches (mm)

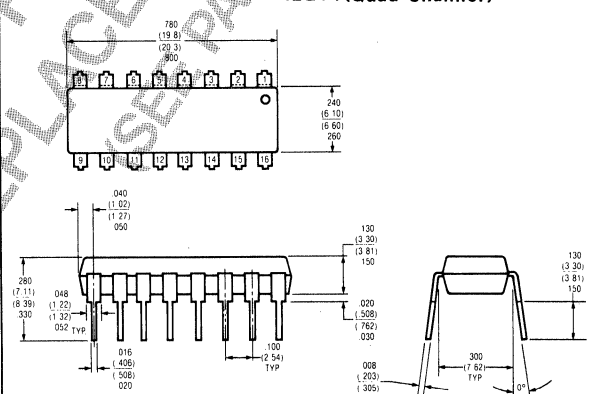
IL-74 (Single Channel)



ILD-74 (Dual Channel)



ILQ-74 (Quad Channel)



Specifications subject to change without notice.

MAXIMUM RATINGS

Gallium Arsenide LED (each channel)
- Power Dissipation @ 25°C .... 150 mW
- Derate Linearly from 25°C .... 1.33 mW/°C
- Continuous Forward Current .... 60 mA
- Peak Inverse Voltage 3.0V

Detector-Silicon Phototransistor (each channel)
- Power Dissipation @ 25°C .... 150 mW
- Derate Linearly from 25°C .... 2.0 mW/°C
- Collector-Emitter Breakdown Voltage (BV_{CEO}) 20V

Package
- Total Package Dissipation at 25°C Ambient (LED Plus Detector)
  - IL-74 .... 200 mW
  - ILD-74 .... 400 mW
  - ILQ-74 .... 500 mW
- Derate Linearly From 25°C
  - IL-74 .... 3.3 mW/°C
  - ILD-74 .... 5.33 mW/°C
  - ILQ-74 .... 6.67 mW/°C
- Storage Temperature .... −55°C to +150°C
- Operating Temperature .... −55°C to +100°C
- Lead Soldering Time @ 260°C .... **10 sec**

ELECTRICAL CHARACTERISTICS PER CHANNEL (at 25°C Ambient)

Parameter	Min	Typ	Max	Units	Test Conditions
Gallium Arsenide LED					
Forward Voltage		1.3	1.5	V	I_F = 20 mA
Reverse Current		0.1	100	μA	V_R = 3.0V
Capacitance		100		pF	V_R = 0
Phototransistor Detector					
BV_{CEO}	20	50		V	I_C = 1 mA
I_{CEO}		5.0	500	nA	V_{CE} = 5V, I_F = 0
Collector-Emitter Capacitance		2.0		pF	V_{CE} = 0
Coupled Characteristics					
DC Current Transfer Ratio	12.5	35		%	I_F = 16 mA, V_{CE} = 5V
V_{SAT}		0.3	0.5	V	I_C = 2 mA, I_F = 16 mA
Capacitance, Input to Output		0.5		pF	
Breakdown Voltage	7500			VDC	
Resistance, Input to Output		100		GΩ	
Switching Times					
t_{ON}		2		μs	R_E = 100 Ω, V_{CE} = 10V
t_{OFF}		2		μs	I_C = 2 mA

Specifications subject to change without notice.

TYPICAL OPTOELECTRONIC CHARACTERISTIC CURVES FOR EACH CHANNEL

FIGURE 1. RELATIVE OUTPUT VS TEMPERATURE

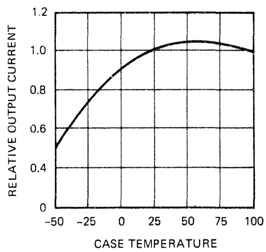


FIGURE 2. DARK CURRENT VS TEMPERATURE

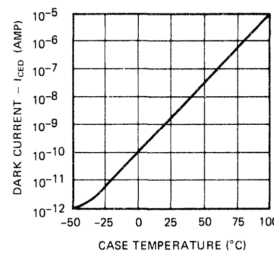


FIGURE 3. TRANSFER CHARACTERISTICS

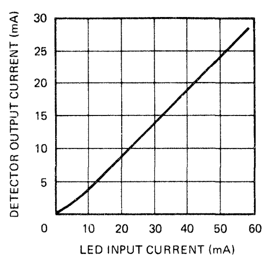


FIGURE 4. DETECTOR OUTPUT CHARACTERISTICS

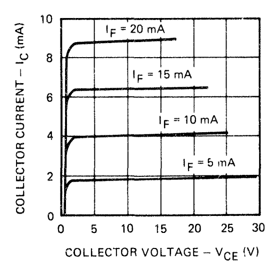
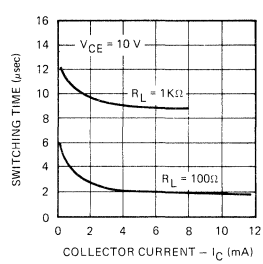


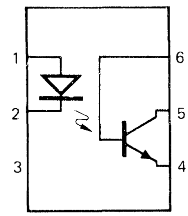
FIGURE 5. SWITCHING TIME VS COLLECTOR CURRENT



PIN CONFIGURATIONS

IL-74

(TOP VIEW)

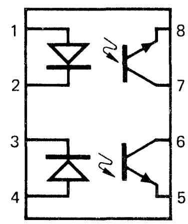


LED CHIP ON PIN 2
PT CHIP ON PIN 5

PIN NO.	FUNCTION
1	ANODE
2	CATHODE
3	NC
4	EMITTER
5	COLLECTOR
6	BASE

ILD-74

(TOP VIEW)

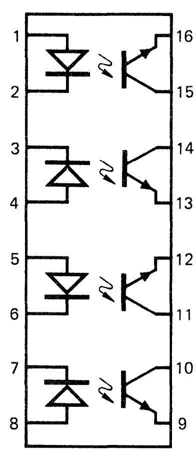


LED CHIPS ON PINS 2 AND 3
PT CHIPS ON PINS 6 AND 7

PIN NO.	FUNCTION
1	ANODE
2	CATHODE
3	CATHODE
4	ANODE
5	EMITTER
6	COLLECTOR
7	COLLECTOR
8	EMITTER

ILQ-74

(TOP VIEW)

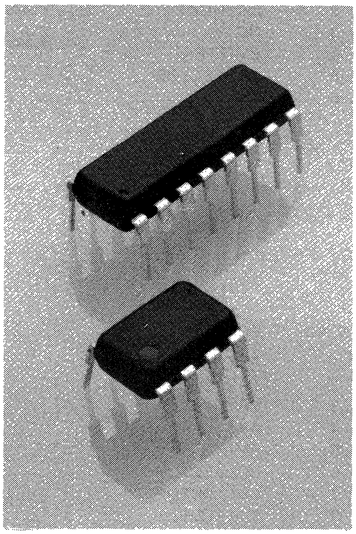


LED CHIPS ON PINS 2, 3, 6, 7
PT CHIPS ON PINS 10, 11, 14, 15

PIN NO.	FUNCTION
1	ANODE
2	CATHODE
3	CATHODE
4	ANODE
5	ANODE
6	CATHODE
7	CATHODE
8	ANODE
9	EMITTER
10	COLLECTOR
11	COLLECTOR
12	EMITTER
13	EMITTER
14	COLLECTOR
15	COLLECTOR
16	EMITTER

SIEMENS

ILD-30, ILD-55 DUAL CHANNEL
ILQ-30, ILQ-55 QUAD CHANNEL
PHOTO DARLINGTON OPTO-ISOLATORS
Preliminary



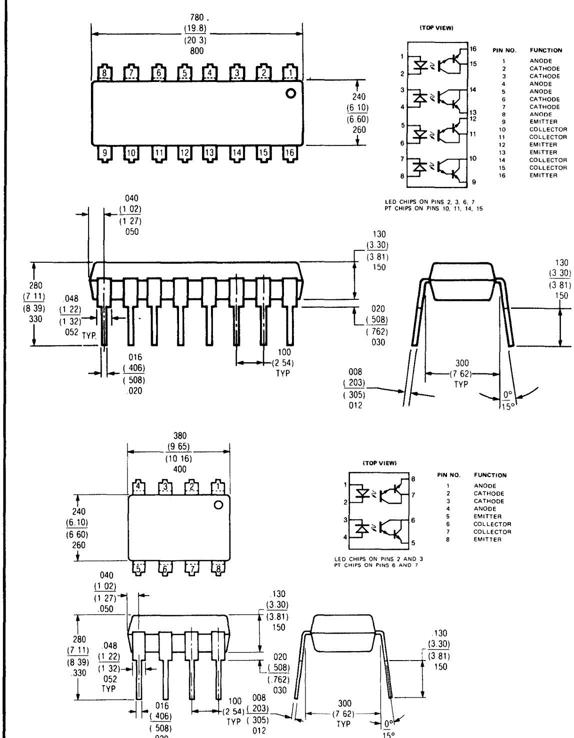
FEATURES

- **6000 volt isolation voltage**
- **125 mA load current rating**
- **Fast rise time — 10 μs**
- **Fast fall time — 35 μs**
- **Solid state reliability**
- **Standard dip package**
- **Underwriter Lab approval #E52744**

DESCRIPTION

The ILD-30/ILD-55 and ILQ-30/ILQ-55 are optically coupled isolators employing a gallium arsenide infrared emitter and a silicon photo darlington sensor. Switching can be accomplished while maintaining a high degree of isolation between driving and load circuits, with no crosstalk between channels. They can be used to replace reed and mercury relays with advantages of long life, high speed switching and elimination of magnetic fields.

Package Dimensions in Inches (mm)



Maximum Ratings

Gallium Arsenide LED (Each Channel)

Power Dissipation at 25 °C	75 mW
Derate Linearly From 25 °C	1.0 mW/ °C
Continuous Forward Current	50 mA
Peak Reverse Voltage	3V

	ILD-30	ILD-55
Photodarlington Sensor (Each Channel)	ILQ-30	ILQ-55
Power Dissipation at 25 °C Ambient	150 mW	150 mW
Derate Linearly From 25 °C	2.0 mW/ °C	2.0 mW/ °C
Collector (load) Current	125 mA	125 mA
Collector Emitter Breakdown Voltage (BV_{CEO})	30V	55V

Package

Storage Temperature	−55 °C to +125 °C
Operating Temperature	−55 °C to +100 °C
Lead Soldering Time at 260 °C	10 sec

Total Package Power Dissipation @25 °C

ILD-30/ILD-55	400 mW
ILQ-30/ILQ-55	500 mW

Derate Linearity From 25 °C

ILD-30/ILD-55	5.33 mW/ °C
ILQ-30/ILQ-55	6.67 mW/ °C

TYPICAL OPTO-ELECTRONIC CHARACTERISTIC CURVES

Electrical Characteristics (at 25° Ambient)

Parameter	Min	Typ	Max	Unit	Test Condition
GaAs Emitter					
Forward Voltage		1.25	1.5	V	I_F = 20mA
Reverse Current		0.01	10	μA	V_R = 3.0V
Capacitance		50		pF	V_R = 0
Sensor					
BV_{CEO}	30/55			V	I_C = 100μA I_F = 0
I_{CEO}		1.0	100	nA	V_{CE} = 10V I_F = 0
Capacitance Collector-Emitter		3.4		pF	V_{CE} = 10V
Coupled Characteristics					
Current Transfer Ratio .	100	400		%	I_F = 10mA V_{CE} = 5V
$V_{CE(SAT)}$		0.9	1.0	V	I_C = 50mA I_F = 50mA
Rise Time		10		μs	V_{CC} = 13.5V
Fall Time		35		μs	I_F = 50mA R_C = 100 Ω
Isolation Voltage	6000			VDC	t = 1 sec.
Isolation Resistance . . .		10^{12}		ohm	
Isolation Capacitance . .		0.5		pf	

FIGURE 1. GaAs EMITTER: FORWARD CURRENT – VOLTAGE CHARACTERISTICS

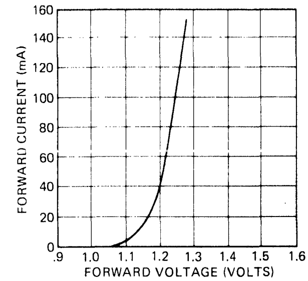


FIGURE 2. DARLINGTON TRANSISTOR OUTPUT CURRENT VS VOLTAGE

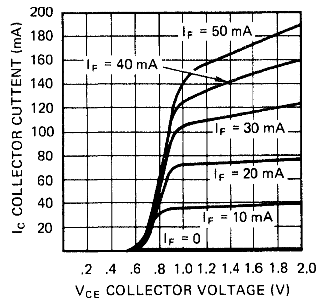


FIGURE 3. DARLINGTON TRANSISTOR CURRENT VS VOLTAGE

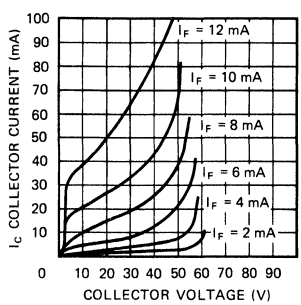
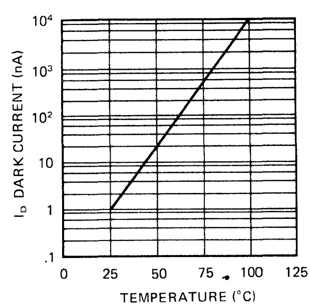


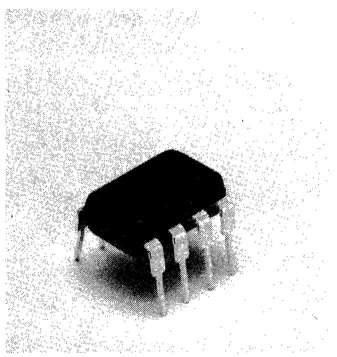
FIGURE 4. DARK CURRENT VS TEMPERATURE



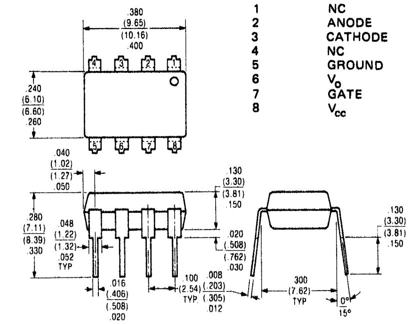
SIEMENS

IL-100

VERY HIGH SPEED THREE STATE OPTO-ISOLATOR



Package Dimensions (inches/mm)



PIN NO.	
1	NC
2	ANODE
3	CATHODE
4	NC
5	GROUND
6	V_o
7	GATE
8	V_{cc}

FEATURES

- **Very High Speed — 65 n-sec typ. prop. delay**
- **Faraday Shielded Photodetector for Improved Common Mode Rejection**
- **DTL/TTL Compatible -5V supply**
- **Three State Output Logic for Multiplexing**
- **Built-in Schmitt Trigger to Avoid Oscillation**
- **Underwriters Lab Approval #E52744**

DESCRIPTION

IL-100 is an optically coupled pair employing a Gallium Arsenide Phosphide LED and a silicon monolithic integra:ed circuit including a photodetector. High speed digital information can be transmitted by the device while maintaining a high degree of electrical isolation between input and output. The IL-100 can be used to replace pulse transformers in many digital interface applications. A built-in Schmitt Trigger provides hysteresis to reduce the possibility of oscillation.

Absolute Maximum Ratings

Storage Temperature .... −55°C to +125°C
Operating Temperature .... 0°C to +70°C
Lead Solder Temperature .... 260°C for 10 Sec.
Input Diode
  Forward DC Current .... 10 mA
  Reverse Voltage 5V
Output - IC
  Supply Voltage - V_{CC} 7V
  Enable Input Voltage - V_E 5.5V
  (Not to exceed V_{CC} by more than 500 mV)
  Output Collector Current - IC .... 100 mA
  Output Collector Power Dissipation .... 100 mW
  Output Collector Voltage - V_{OUT} 7V
Isolation Voltage (Input-Output) .... 6000 V

Electrical Characteristics
Over Recommended Temperature (T_A = 0°C – 70°C)

Parameter	Min.	Typ.	Max.	Units	Test Conditions	Fig.	Note
I_{in} (1): Logic (1) Input Current to Ensure Logic (0) Output	5			mA		1.2	–
I_{in} (0): Logic (0) Input Current to Ensure Logic (1) Output			250	μA		1.2	–
V_G (1): Logic (1) Gate Voltage	2.0			V		–	–
V_G (0): Logic (0) Gate Voltage			.8	V		–	–
I_{out} (off)	−100μA		+ 100μA		V_{CC} = 5.5V, V_o = 1.5V, V_G = 0V, I_{in} = 0, 10mA	–	–

Specifications subject to change without notice.

Electrical Characteristics (Continued)

Over Recommended Temperature (T_A = 0°C – 70°C)

Parameter	Min.	Typ.	Max.	Units	Test Conditions	Fig.	Note
V_{out} (0): Logic (0) Output Voltage		.35	.6	V	V_{CC} = 5.5V, V_G = 2.4V, I_{in} = 5 mA, I_{out} (Sinking) = 16 mA	–	–
I_G (0): Logic (0) Gate Current		-1.6	-2.0	mA	V_{CC} = 5.5V, V_G = 0.5V	–	–
I_G (1): Logic (1) Gate Current		0		mA	V_{CC} = 5.5V, V_G = 2.4V	–	–
I_{CC} (1): Logic (1) Supply Current		18	22	mA	V_{CC} = 5.5V, V_G = 0.5V, I_{in} = 0	–	–
I_{CC} (0): Logic (0) Supply Current		18	22	mA	V_{CC} = 5.5V, V_G = 0.5V, I_{in} = 10 mA	–	–
I_{CC}		13	16		V_{CC} = 5.5, V_G = 2.4V, I_{in} = 0	–	–
I_{CC}		17	21		V_{CC} = 5.5, V_G = 2.4V, I_{in} = 10 mA		

Switching Characteristics at T_A = 25°, V_{CC} = 5V

Parameter	Min.	Typ.	Max.	Units	Test Conditions	Fig.	Note
t_{pd}(1): Propagation Delay Time to Logical (1) Level		65	75	ns	R_L = 350Ω, C_L = 15pF, I_{in} = 7.5 mA	–	1
t_{pd}(0): Propagation Delay Time to Logical (0) Level		65	75	ns	R_L = 350Ω, C_L = 15pF, I_{in} = 7.5 mA	–	2
t_R-t_F: Output Rise-Fall Time (10-90%)		15		ns	R_L = 350Ω, C_L = 15pF, I_{in} = 7.5 mA	–	–
t_G(1): Propagation Delay Time of Gate from V_G(1) to V_G(0)		15		ns	R_L = 350Ω, C_L = 15pF, I_{in} = 7.5 mA, V_G(1) = 2V, V_G(0) = 0.5V	–	3
t_G(0): Propagation Delay Time of Gate from V_G(0) to V_G(1)		15		ns	R_L = 350Ω, C_L = 15pF, I_{in} = 7.5 mA, V_G(1) = 2V, V_G(0) = 0.5V	–	4

Electrical Characteristics—Input-Output at T_A = 25°C

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions	Fig.	Note
Insulation Voltage (Input-Output)	$BV_{I\text{-}O}$	6000	7500		VDC	t = 1 Sec.	–	5
Resistance (Input-Output)	$R_{I\text{-}O}$	10^{12}			Ω	$V_{I\text{-}O}$ = 500V	–	5
Capacitance (Input-Output)	$C_{I\text{-}O}$		0.5	0.8	pF	f = 1MHz	–	5
Common Mode Rejection Voltage to Logical (0) Level	CMRV (1)		60		VAC p-p	f = 10MHz, R_L = 350Ω, V_{out}(min.)= 2V, I_{in} = 0 mA	–	6
Common Mode Rejection Voltage to Logical (1) Level	CMRV (0)		60		VAC p-p	f = 10MHz, R_L = 350Ω, V_{out}(max.)= 0.6V, I_{in} = 7.5 mA	–	6
Current Transfer Ratio	CTR		1000		%	I_{in} = 5.0 mA, V_{CC} = 5V, R_L = 100Ω	–	7

Electrical Characteristics—Input Diode at T_A = 25°C

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions	Fig.	Note
Forward Voltage	V_F	1.2	1.5	1.75	V	I_{in} = 10 mA	1	8
Reverse Breakdown Voltage	V_{BR}	5			V	I_R = 10µA	–	–
Capacitance	C_{in}		25		pF	V = 0, f = 1MHz	–	–

Operating Procedures and Definitions

Logic Convention. The IL-100 is defined in terms of positive logic.

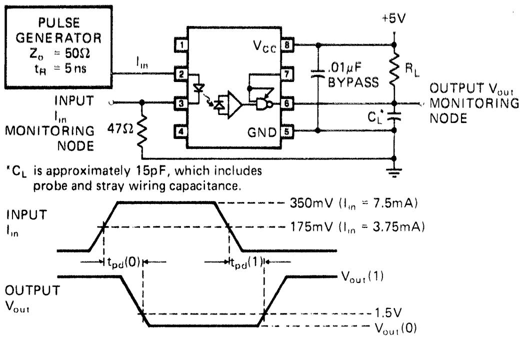
Bypassing. A ceramic capacitor (.01µF min.) should be connected from pin 8 to pin 5. Its purpose is to stabilize the operation of the switching amplifier. Failure to provide the bypassing may impair the switching properties.

Polarities. All voltages are referenced to network ground (pin 5). Current flowing toward a terminal is considered positive.

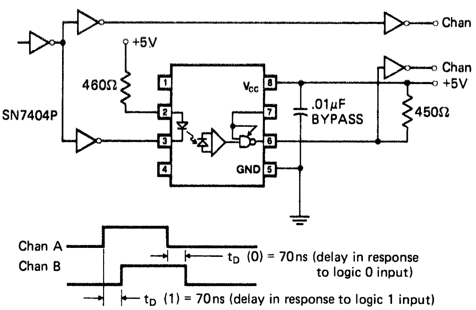
Gate Input. No external pull-up required for a logic (1).

NOTES:

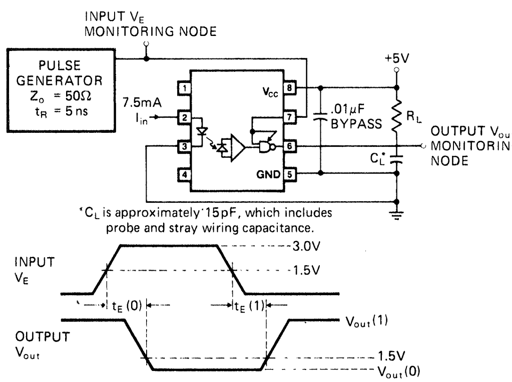
1. The t_{pd}(1) propagation delay is measured from the 3.75 mA point on the trailing edge of the input pulse to the 1.5V point on the trailing edge of the output pulse.
2. The t_{pd}(0) propagation delay is measured from the 3.75 mA point on the input pulse to the 1.5V point on the leading edge of the output pulse.
3. The t_G(1) gate propagation delay is measured from the 1.5V point of the trailing edge of the input pulse to the 1.5V point on the trailing edge of the output pulse.
4. The t_G(0) gate propagation delay is measured from the 1.5V point on the input pulse to the 1.5V point on the leading edge of the output pulse. The input diode is DC biased to 10 mA [I_{in}(1)].
5. Pins 2 and 3 shorted together, and pins 5, 6, 7, and 8 shorted together.
6. CMRV (1) is the maximum tolerable common mode voltage to assure that the output will remain in a logic (1) state (V_{out} > 2.0V). CMRV (0) is the maximum tolerable common mode voltage to assure that the output will remain in a logic (0) state (V_{out} < 0.6V).
7. DC Current Transfer Ratio is defined as the ratio of the output collector current to the forward bias input current times 100%.
8. At 10 mA V_F decreases with increasing temperature at the rate of 1.6mV/°C.



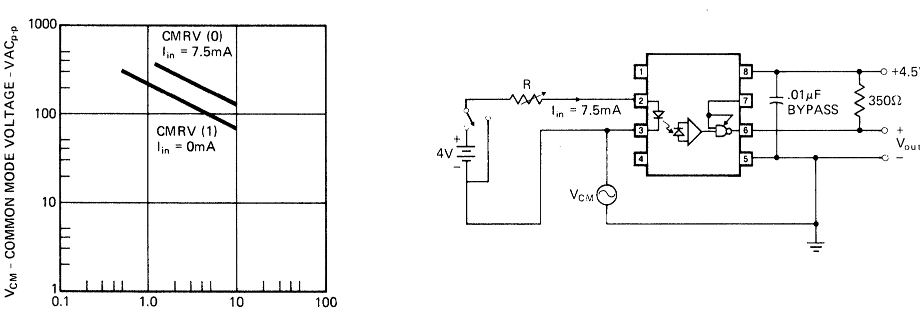
Test Circuit for t_{pd} (0) and t_{pd} (1).



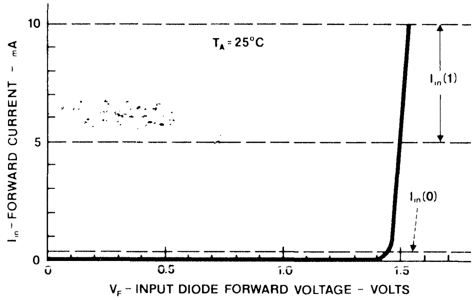
Response Delay Between TTL Gates.



Test Circuit for t_E (0) and t_E (1).



Typical Common Mode Rejection Characteristics/Circuit



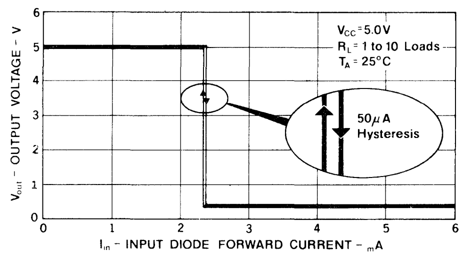
Input Diode Forward Characteristic

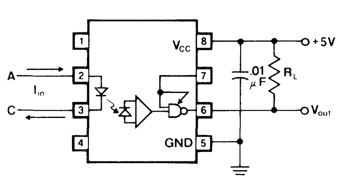
Figure 1

TRUTH TABLE (Positive Logic)

Input*	Enable	Output
1	1	0
0	1	1
1	0	off
0	0	off

*See definition of terms for logic state.





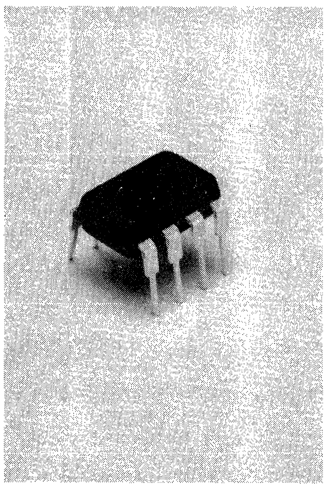
Input-Output Characteristics

Figure 2

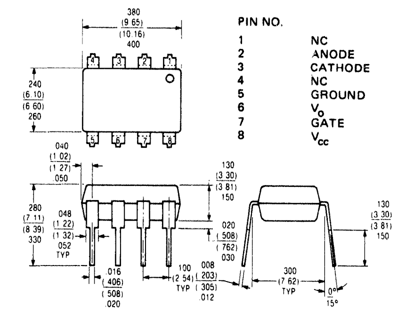
SIEMENS

IL-101

HIGH SPEED THREE STATE OPTO-ISOLATOR



Package Dimensions in Inches (mm)



FEATURES

- **High Speed**
- **Faraday Shielded Photodetector for Improved Common Mode Rejection**
- **DTL/TTL Compatible -5V supply**
- **Three State Output Logic for Multiplexing**
- **Built-in Schmitt Trigger to Avoid Oscillation**
- **Underwriters Lab Approval #E52744**

DESCRIPTION

IL-101 is an optically coupled pair employing a Gallium Arsenide Phosphide LED and a silicon monolithic integrated circuit including a photodetector. High speed digital information can be transmitted by the device while maintaining a high degree of electrical isolation between input and output. The IL-101 can be used to replace pulse transformers in many digital interface applications. A built-in Schmitt Trigger provides hysteresis to reduce the possibility of oscillation.

Absolute Maximum Ratings

Storage Temperature .... −55°C to +125°C
Operating Temperature .... 0°C to +70°C
Lead Solder Temperature .... 260°C for 10 Sec.
Input Diode
  Forward DC Current .... 10 mA
  Reverse Voltage 5V
Output - IC
  Supply Voltage - V_{CC} 7V
  Enable Input Voltage - V_E 5.5V
  (Not to exceed V_{CC} by more than 500 mV)
  Output Collector Current - IC .... 100 mA
  Output Collector Power Dissipation .... 100 mW
  Output Collector Voltage - V_{OUT} 7V
Isolation Voltage (Input-Output) - DC 6000V

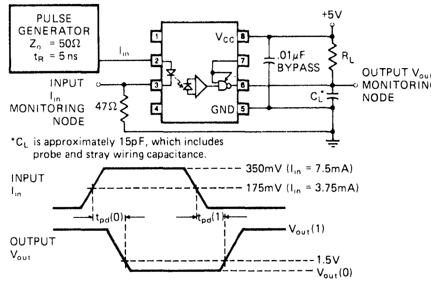
Electrical Characteristics
Over Recommended Temperature (T_A = 0°C – 70°C)

Parameter	Min.	Typ.	Max.	Units	Test Conditions	Fig.	Note
I_{in} (1): Logic (1) Input Current to Ensure Logic (0) Output	5			mA		1	–
I_{in} (0): Logic (0) Input Current to Ensure Logic (1) Output			250	μA		1	–
V_G (1): Logic (1) Gate Voltage	2.0			V		–	–
V_G (0): Logic (0) Gate Voltage			.8	V		–	–
V_{out} (0): Logic (0) Output Voltage		.35	.6	V	V_{CC} = 5.5V, V_G = 2.4V, I_{in} = 5 mA, I_{out} (Sinking) = 16 mA	–	–
I_{CC}		18	22	mA	V_{CC} = 5.5V V_G = 0.5V I_{in} = 0,10 mA		

Specifications are subject to change without notice.

Switching Characteristics at T_A = 25°, V_{CC} = 5V

Parameter	Min.	Typ.	Max.	Units	Test Conditions	Fig.	Note
$t_{pd}(1)$: Propagation Delay Time to Logical (1) Level		175	300	ns	R_L = 350Ω, C_L = 15pF, I_{in} = 7.5 mA	1	1
$t_{pd}(0)$: Propagation Delay Time to Logical (0) Level		70	100	ns	R_L = 350Ω, C_L = 15pF, I_{in} = 7.5 mA	1	2
t_R-t_F: Output Rise-Fall Time (10-90%)		15		ns	R_L = 350Ω, C_L = 15pF, I_{in} = 7.5 mA	–	–



Test Circuit for $t_{pd}(0)$ and $t_{pd}(1)$.

Fig. 1

Electrical Characteristics—Input-Output at T_A = 25°C

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions	Fig.	Note
Insulation Voltage (Input-Output)	$BV_{1\text{-}0}$	6000	7500		VDC	t = 1 Sec.	–	3
Resistance (Input-Output)	$R_{1\text{-}0}$	10^{12}			Ω	$V_{1\text{-}0}$ = 500V	–	3
Capacitance (Input-Output)	$C_{1\text{-}0}$		0.5	0.8	pF	f = 1MHz	–	3

TRUTH TABLE (Positive Logic)

Input*	Enable	Output
1	1	0
0	1	1
1	0	off
0	0	off

***See definition of terms for logic state.**

Electrical Characteristics—Input Diode at T_A = 25°C

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions	Fig.	Note
Forward Voltage	V_F		1.5	1.75	V	I_{in} = 10 mA	–	4
Reverse Breakdown Voltage	V_{BR}	5			V	I_R = 10μA	–	–
Capacitance	C_{in}		10		pF	V = 0, f = 1MHz	–	–

For further details refer to pages 3 & 4 of IL-100 data sheet.

Operating Procedures and Definitions

Logic Convention. The IL-101 is defined in terms of positive logic.

Bypassing. A ceramic capacitor (.01μF min.) should be connected from pin 8 to pin 5. Its purpose is to stabilize the operation of the switching amplifier. Failure to provide the bypassing may impair the switching properties.

Polarities. All voltages are referenced to network ground (pin 5). Current flowing toward a terminal is considered positive.

Gate Input. No external pull-up required for a logic (1).

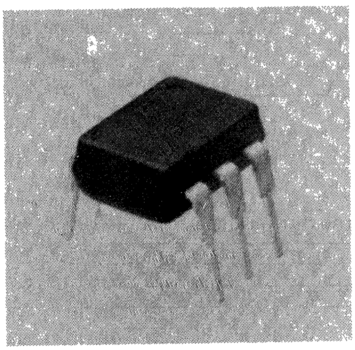
NOTES:

1. The $t_{pd}(1)$ propagation delay is measured from the 3.75 mA point on the trailing edge of the input pulse to the 1.5V point on the trailing edge of the output pulse.
2. The $t_{pd}(0)$ propagation delay is measured from the 3.75 mA point on the input pulse to the 1.5V point on the leading edge of the output pulse.
3. Pins 2 and 3 shorted together, and pins 5, 6, 7, and 8 shorted together.
4. At 10 mA V_F decreases with increasing temperature at the rate of 1.6mV/°C.

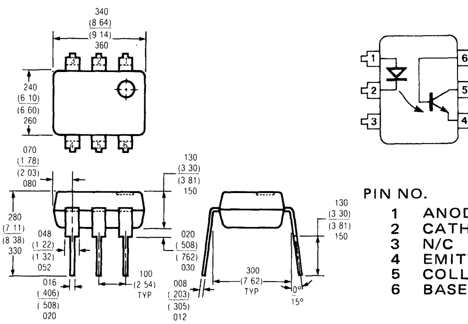
SIEMENS

IL-201, IL-202, IL-203

PHOTOTRANSISTOR OPTO-ISOLATOR



Package Dimensions in Inches (mm)



PIN NO.
1 ANODE
2 CATHODE
3 N/C
4 EMITTER
5 COLLECTOR
6 BASE

FEATURES

- **6000 Volt Isolation Voltage**
- **High Current Transfer-Ratio (75%-450%)**
- **Long Term Stability**
- **Industry Standard Dual-In-Line**
- **Min 10% Current-Transfer-Ratio Guaranteed @I_F = 1 mA**
- **Underwriters Lab Approval** #E52744

DESCRIPTION

IL-201, IL-202, IL-203 are optically coupled pairs employing a Gallium Arsenide infrared LED and a silicon NPN phototransistor. Signal information, including a DC level, can be transmitted by the device while maintaining a high degree of electrical isolation between input and output. The IL-201, IL-202, IL-203 can be used to replace relays and transformers in many digital interface applications, as well as analog applications such as CRT modulation.

Maximum Ratings

Gallium Arsenide LED	
Power Dissipation @ 25°C	200 mW
Derate Linearly from 25°C	2.6 mW/°C
Continuous Forward Current	100 mA
Peak Inverse Voltage	6.0 V
Detector (Silicon Phototransistor)	
Power Dissipation @ 25°C	200 mW
Derate Linearly From 25°C	2.6 mW/°C
Collector-Emitter Breakdown Voltage (BV_{CEO})	30 V
Emitter-Collector Breakdown Voltage (BV_{ECO})	7 V
Collector-Base Breakdown Voltage (BV_{CBO})	70 V
Package	
Total Package Dissipation at 25°C Ambient (LED Plus Detector)	250 mW
Derate Linearly From 25°C	3.3 mW/°C
Storage Temperature	–55 to +150°C
Operating Temperature	–55 to +100°C
Lead Soldering Time @ 260°C	10 sec

Electrical Characteristics (0°C – 70°C unless otherwise specified)

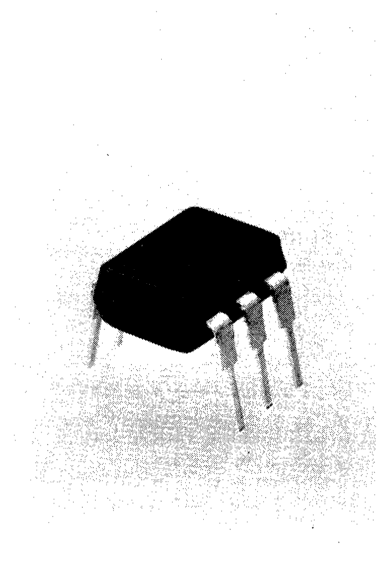
Parameter	Min	Typ	Max	Unit	Test Condition
Gallium Arsenide LED					
Forward Voltage V_F		1.2	1.5	V	I_F = 20 mA
Forward Voltage V_F		1.0	1.2	V	I_F = 1 mA
Reverse Current I_R		0.01	10	μA	V_R = 6 V, T_A = 25°C
Breakdo· Voltage V_R	6	20		V	I_R = 10 μA
Phototransistor Detector					
H_{FE}	100	200			V_{CE} = 5V, I_C = 100 μA
BV_{CEO}	30	50		V	I_C = 1 mA
BV_{ECO}	7	10		V	I_E = 100 μA
BV_{CBO}	70	90		V	I_C = 10 μA
I_{CEO}		5	50	NA	V_{CE} = 10 V, T_A = 25°C
Coupled Characteristics					
Base Current Transfer Ratio (BTR)	0.15			%	I_F = 10 mA, V_{CB} = 10 V
$V_{CE\ (sat)}$			0.4	V	I_F = 10 mA, I_C = 2 mA
DC Current Transfer Ratio (CTR)					
IL-201	75	100	150	%	I_F = 10 mA
IL-202	125	200	250	%	V_{CE} = 10 V
IL-203	225	300	450	%	
DC Current Transfer Ratio (CTR)					
IL-201	10			%	I_F = 1 mA
IL-202	30			%	V_{CE} = 10 V
IL-203	50			%	
Input to Output Isolation Voltage	7500			VDC	

Specifications subject to change without notice.

SIEMENS

IL-250

BIDIRECTIONAL INPUT OPTO-ISOLATOR



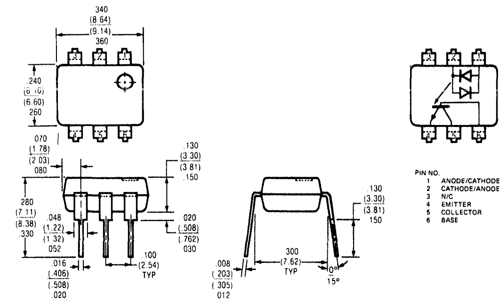
FEATURES

- **AC or Polarity Insensitive Input**
- **5000 Volt Breakdown Voltage**
- **High Current-Transfer-Ratio (>50% min.)**
- **Industry Standard Dual-In-Line**
- **Built-in Reverse Polarity Input Protection**
- **Underwriters Lab Approval #E52744**

DESCRIPTION

The IL250 is a bidirectional input opto-isolator. It consists of two gallium arsenide infrared emitting diodes coupled to a silicon NPN phototransistor in a 6 pin dual in-line plastic package.

Package Dimensions in Inches (mm)



Maximum Ratings

Gallium Arsenide LED

Power Dissipation @ 25°C	200 mW
Derate Linearly from 25°C	2.6 mW/°C
Continuous Forward Current	100 mA
Peak Inverse Voltage	3.0 V

Detector (Silicon Phototransistor)

Power Dissipation @ 25°C	200 mW
Derate Linearly From 25°C	2.6 mW/°C
Collector-Emitter Breakdown Voltage (BV_{CEO})	30 V
Emitter-Base Breakdown Voltage (BV_{ECO})	5 V
Collector-Base Breakdown Voltage (BV_{CBO})	70 V

Package

Total Package Dissipation at 25°C Ambient (LED Plus Detector)	250 mW
Derate Linearly From 25°C	3.3 mW/°C
Storage Temperature	-55 to +150°C
Operating Temperature	-55 to +100°C
Lead Soldering Time @ 260°C	10 sec

Electrical Characteristics (25°C unless otherwise specified)

Parameter	Min	Typ.	Max	Unit	Test Condition
Gallium Arsenide LED					
Forward Voltage V_F		1.2	1.5	V	$I_F = \pm 10$ mA
Phototransistor Detector					
H_{FE}	100	200			$V_{CE} = 5V$, $I_C = 100\ \mu A$
BV_{CEO}	30	50		V	$I_C = 1$ mA
BV_{ECO}	7	10		V	$I_C = 100\ \mu A$
BV_{CBO}	70	90		V	$I_C = 10\ \mu A$
I_{CEO}		5	50	nA	$V_{CE} = 10$ V
Coupled Characteristics					
$V_{CE(sat)}$			0.4	V	$I_F = \pm 16$ mA, $I_C = 2$ mA
DC Current Transfer Ratio (CTR)	50	150		%	$I_F = \pm 10$ mA, $V_{CE} = 10$ V
Symmetry $\frac{\text{CTR @ +10 mA}}{\text{CTR @ -10 mA}}$	0.33	1.0	3.0		
Input to Output Isolation Voltage	5000			V	D.C.

TYPICAL OPTO-ISOLATOR CHARACTERISTIC CURVES

FIGURE 1. INPUT CHARACTERISTICS

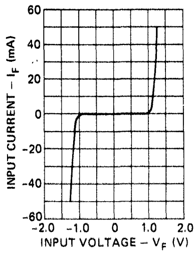


FIGURE 2. TRANSFER CHARACTERISTICS

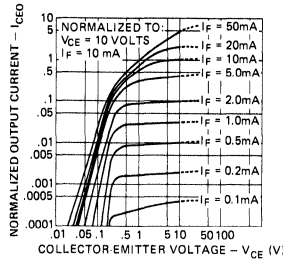


FIGURE 3. OUTPUT VS. INPUT CURRENT

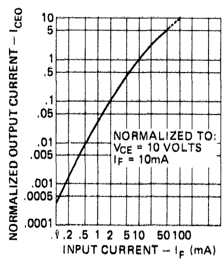


FIGURE 4. OUTPUT CHARACTERISTICS

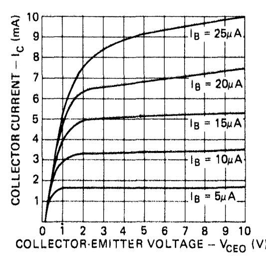


FIGURE 5. DARK CURRENT VS. TEMPERATURE

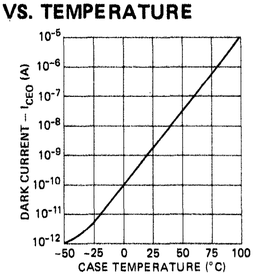
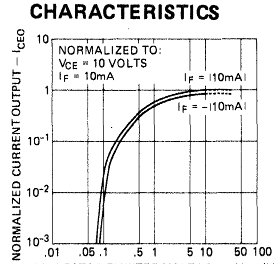


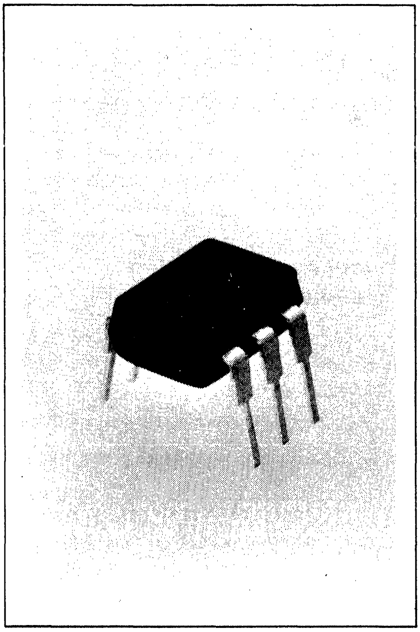
FIGURE 6. SYMMETRY CHARACTERISTICS



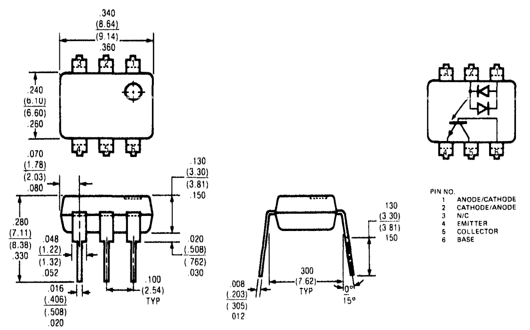
SIEMENS

H11AA1/IL-251

AC INPUT OPTO-ISOLATOR



Package Dimensions in Inches (mm)



FEATURES

- **2500 Volt Isolation Voltage**
- **AC or Polarity Insensitive Input**
- **High Current Transfer Ratio (20% min.)**
- **Built-in Reverse Polarity Input Protection**
- **I/O compatible with integrated circuits**
- **Underwriters Lab Approval #E52744**

DESCRIPTION

The H11AA1/IL-251 is a direct electrical and mechanical replacement of the General Electric series. This bi-directional input optoisolator consists of two gallium arsenide infrared emitting diodes connected in inverse parallel coupled to a silicon NPN phototransistor in a 6 pin dual in-line plastic package.

Maximum Ratings

Gallium Arsenide LED
- Power Dissipation @ 25°C . . . . 100 mW
- Derate Linearly from 25°C . . . . 1.33 mW/°C
- Continuous Forward Current (RMS) . . . . 60 mA

Detector (Silicon Phototransistor)
- Power Dissipation @ 25°C . . . . 300 mW
- Derate Linearly From 25°C . . . . 4.0 mW/°C
- Collector-Emitter Breakdown Voltage (BV_{CEO}) . . . . . . 30 V
- Emitter-Base Breakdown Voltage (BV_{EBO}) . . . . 5 V
- Collector-Base Breakdown Voltage (BV_{CBO}) . . . . 70 V

Package
- Storage Temperature . . . . -55 to +150°C
- Operating Temperature . . . . -55 to +100°C
- Lead Soldering Time @ 260°C . . . . 10.0 sec

Electrical Characteristics (25°C unless otherwise specified)

Parameter	Min	Typ	Max	Unit	Test Condition
Gallium Arsenide LED					
Forward Voltage V_F	–	1.2	1.5	V	$I_F = \pm 10$ mA
Phototransistor Detector					
BV_{CEO}	30	50	–	V	$I_C = 10$ mA
BV_{EBO}	5	9	–	V	$I_E = 100\ \mu A$
BV_{CBO}	70	90	–	V	$I_C = 100\ \mu A$
I_{CEO}	–	5	100	nA	$V_{CE} = 10$ V
Coupled Characteristics					
$V_{CE(sat)}$	–	0.2	0.4	V	$I_F = \pm 10$ mA, $I_C = 0.5$ mA
DC Current Transfer Ratio CTR	20	80	–	%	$I_F = \pm 10$ mA, $V_{CE} = 10$ V
Symmetry $\frac{CTR @ +10 mA}{CTR @ -10 mA}$	0.33	1.0	3.0	–	
Input to Output Isolation Voltage	2500	5000	–	V	D.C.

Specifications subject to change without notice.

TYPICAL OPTO-ISOLATOR CHARACTERISTIC CURVES

FIGURE 1. INPUT CHARACTERISTICS

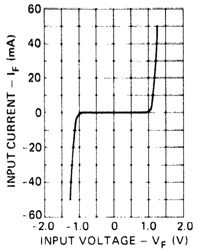


FIGURE 2. TRANSFER CHARACTERISTICS

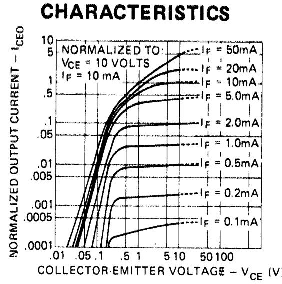


FIGURE 3. OUTPUT VS. INPUT CURRENT

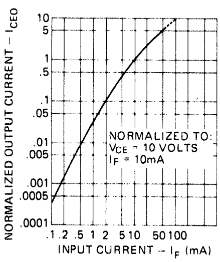


FIGURE 4. OUTPUT CHARACTERISTICS

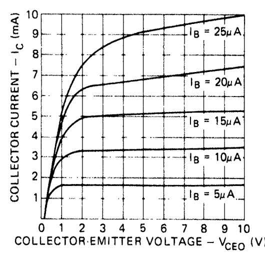


FIGURE 5. DARK CURRENT VS. TEMPERATURE

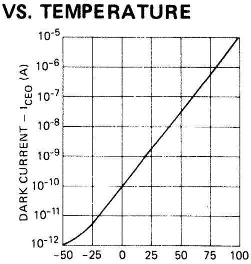
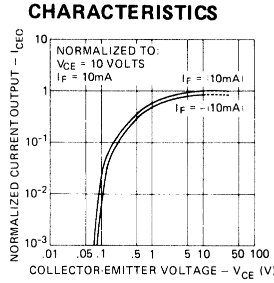


FIGURE 6. SYMMETRY CHARACTERISTICS

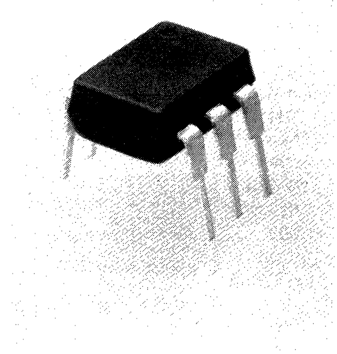


SIEMENS

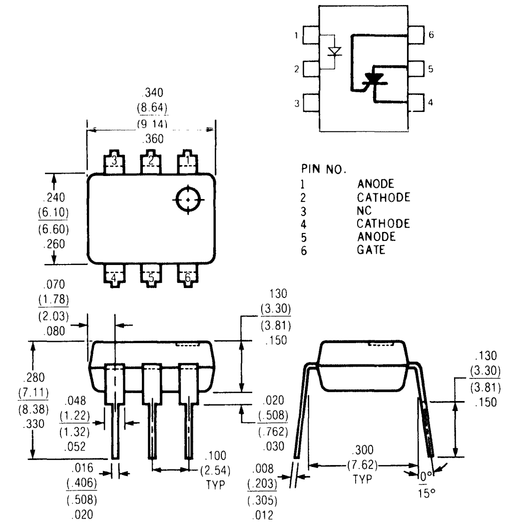
IL-400

OPTICALLY COUPLED SCR

ADVANCE DATA SHEET



Package Dimensions in Inches (mm)



FEATURES:

- **400 volts blocking voltage**
- **Turn on current (I_{ft}) 5.0mA typical**
- **Gate trigger current (I_{GT}) — 20μa**
- **Gate trigger voltage (t_{GT}) — 0.6 volt**
- **6000 volt isolation voltage**
- **Surge anode current — 1.0 amp**
- **Solid state reliability**
- **Standard dip package**
- **Underwriters Lab Approval #E52744**

DESCRIPTION:

The IL-400 is an optically coupled SCR employing a GaAs infrared emitter and a silicon photo SCR sensor. Switching can be accomplished while maintaining a high degree of isolation between triggering and load circuits. It can be used in SCR triac and solid state relay applications where high blocking voltages and low input current sensitivity is required.

Maximum Ratings

Gallium Arsenide LED (Drive Circuit)	
Power dissipation @ 25° C	100mW
Derate linearly from 25° C	1.05mW/° C
Continuous forward current	60mA
Peak reverse voltage	6v
Peak forward current (100μs, 1% duty cycle)	1.0A
SCR Detector (Load circuit):	
Power dissipation @ 25° C ambient	200mw
Derate linearly from 25° C	2.11mW/° C
Anode current	100mA
Surge anode current (5ms duration)	1.0A
Surge gate current (5ms duration)	200mA
Reverse gate voltage	6.0v
Anode voltage (DC or AC peak)	400v
Coupled:	
Isolation voltage	6000vDC
Total package power dissipation	250mW
Derate linearly from 25° C	2.63mW/° C
Operating temperature range	-55° C to 100° C
Storage temperature range	-55° C to 100° C

Specifications subject to change without notice

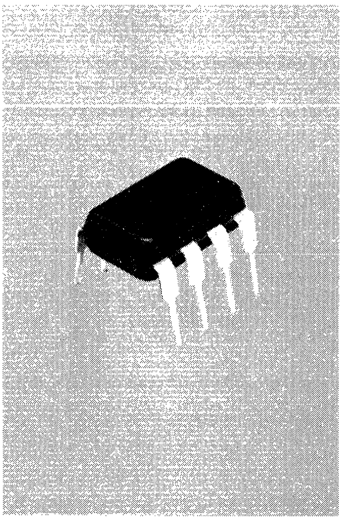
Electrical Characteristics (at 25°C Ambient)

Parameter	Min	Typ	Max	Unit	Test Condition
Input Diode					
Forward Voltage		1.2	1.5	V	I_F = 20mA
Reverse Voltage	5.0			V	I_R = 10μA
Reverse Current			10	μA	V_R=5v
Photo — SCR					
Forward Leakage Current (I_D)		0.2	2.0	μA	R_{GK} = 27Kohm, I_F = 0 V_{RX} = 400v, TA = 25°C
Reverse Leakage Current (I_R)		0.2	2.0	μA	R_{GK} = 27Kohm, I_F = 0 V_{RX} = 400v, TA = 25°C
Forward Blocking Voltage (V_{DM})	400			V	R_{GK} = 10Kohm, TA = 100°C I_d = 150μA
Reverse Blocking Voltage (V_{RM})	400			V	R_{GK} = 10Kohm, TA = 100°C I_d = 150μA
On Voltage (V_t)	-	-	1.2	V	I_T = 100mA
Holding Current (I_H)	-	-	500	μA	R_{GK} = 27Kohm V_{FX} = 50v
Gate Trigger Voltage (V_{GT})	-	0.6	1.0	V	V_{FX} = 100v R_{GK} = 27Kohm R_L = 10Kohm
Gate Trigger Current (I_{GT})		20	50	μA	V_{FX} = 100v R_L = 10Kohm R_{GK} = 27Kohm
Coupled					
Turn-on Current (I_{FT})	0.5	5.0	10.0	mA	V_{FX} = 100v R_{GK} = 27Kohm
Isolation Voltage	6000			V_{DC}	1 second
Isolation Resistance	100			G-ohm	V_{iso} = 500v
Isolation Capacitance			2	PF	f = 1MHz

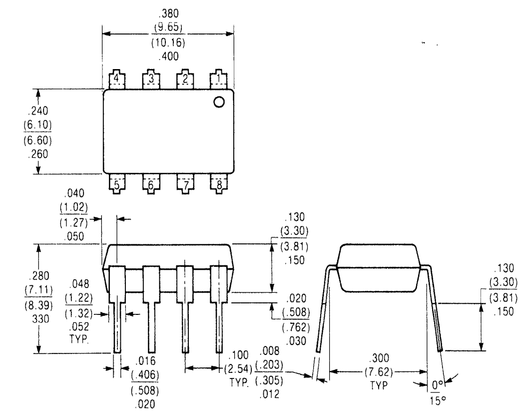
SIEMENS

IL-CT6

DUAL PHOTOTRANSISTOR OPTO-ISOLATOR



Package Dimensions in Inches (mm)



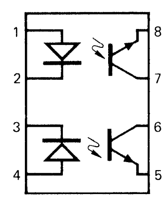
FEATURES

- **Two Isolated Channels Per Package**
- **6000V Isolation**
- **50% Typical Current Transfer Ratio**
- **1 nA Typical Leakage Current**
- **Direct Replacement For MCT6**
- **Underwriter Lab Approval #E52744**

DESCRIPTION

The IL-CT6 is a two channel opto isolator for high density applications. Each channel consists of an optically coupled pair employing a Gallium Arsenide infrared LED and a silicon NPN phototransistor. Signal information, including a DC level, can be transmitted by the device while maintaining a high degree of electrical isolation between input and output. The IL-CT6 is especially designed for driving medium-speed logic, where it may be used to eliminate troublesome ground loop and noise problems. It can also be used to replace relays and transformers in many digital interface applications, as well as analog applications such as CRT modulation.

Pin Configuration



LED CHIPS ON PINS 2 AND 3
PT CHIPS ON PINS 6 AND 7

PIN NO.	FUNCTION
1	ANODE
2	CATHODE
3	CATHODE
4	ANODE
5	EMITTER
6	COLLECTOR
7	COLLECTOR
8	EMITTER

MAXIMUM RATINGS

Maximum Temperatures
- Storage Temperature .... −55°C to +150°C
- Operating Temperature .... −55°C to +100°C
- Lead Temperature (Soldering, 10 seconds) .... 260°C

Input Diode (each channel)
- Rated Forward Current, DC .... 60 mA
- Peak Forward Current (1µs pulse, 300 pps) .... 3 A
- Power Dissipation at 25°C Ambient .... 100 mW
- Derate Linearly From 25°C .... 1.3 mW/°C

Output Transistor (each channel)
- Power Dissipation @ 25°C Ambient .... 150 mW
- Derate Linearly From 25°C .... 2 mW/°C
- Collector Current .... 30 mA

Coupled
- Input to Output Breakdown Voltage .... 6000 VDC
- Total Package Power Dissipation @ 25°C Ambient .... 400 mW
- Derate Linearly From 25°C .... 5.33 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

Parameter	Min	Typ	Max	Units	Test Conditions
Input Diode					
Rated Forward Voltage		1.25	1.50	V	I_F = 20 mA
Reverse Voltage	3.0	8.0		V	I_R = 10 µA
Reverse Current		0.001	10	µA	V_R = 3.0 V
Junction Capacitance		100		pF	V_F = 0V
Output Transistor					
Breakdown Voltage,					
Collector to Emitter	30	65		V	I_C = 1.0 mA
Emitter to Collector	7.0	10		V	I_E = 100 µA
Leakage Current, Collector to Emitter		1.0	100	nA	V_{CE} = 10V
Capacitance Collector to Emitter		8.0		pF	V_{CE} = 0V
Coupled					
DC Current Transfer Ratio (I_C/I_F)	20	50		%	V_{CE} = 10 V, I_F = 10 mA
Saturation Voltage — Collector to Emitter			0.40	V	I_C = 2.0 mA, I_F = 16 mA
Isolation Voltage	7500			VDC	
Isolation Resistance		10^{12}		Ω	V_{I-O} = 500 V
Isolation Capacitance		0.5		pF	f = 1.0 MHz
Breakdown Voltage — Channel-to-Channel		1500		VDC	Relative Humidity = 40%
Capacitance Between Channels		0.4		pF	f = 1.0 MHz
Bandwidth		150		KHz	I_C = 2.0 mA, V_{CC} = 10V R_L = 100 Ω
Switching Times, Output Transistor					
Non-Saturated Rise Time, Fall Time		2.4		µs	I_C = 2.0 mA, V_{CE} = 10V R_L = 100 Ω
Non-Saturated Rise Time, Fall Time		15		µs	I_C = 2.0 mA, V_{CE} = 10V R_L = 1.0 KΩ
Saturated Turn-On Time (From 5.0 V to 0.8 V)		5.0		µs	R_L = 2.0 kΩ, I_F = 15 mA
Saturated Turn-Off Time (From Saturation to 2.0V)		25		µs	R_L = 2.0 KΩ, I_F = 15 mA

Specifications subject to change without notice.

TYPICAL OPTO-ELECTRONIC CHARACTERISTIC CURVES FOR EACH CHANNEL

FIGURE 1. I-V CURVE OF PHOTOTRANSISTOR

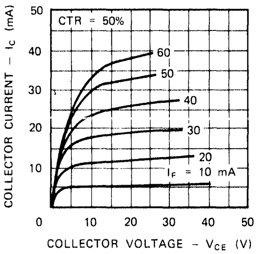


FIGURE 2. I-V CURVE IN SATURATION

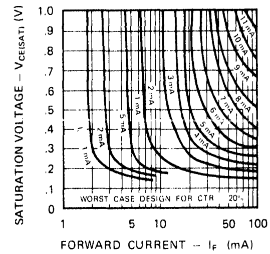


FIGURE 3. CTR VS FORWARD CURRENT

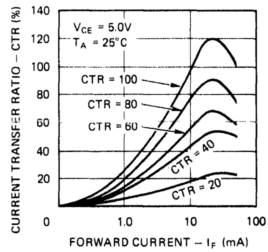


FIGURE 4. CURRENT TRANSFER RATIO VS TEMPERATURE

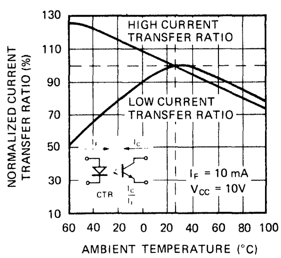


FIGURE 5. I-V CURVE OF LED VS TEMPERATURE

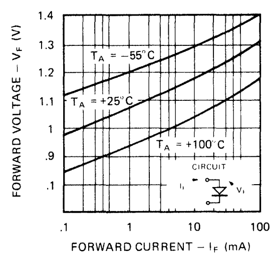


FIGURE 6. LEAKAGE CURRENT VS TEMPERATURE VS COLLECTOR VOLTAGE

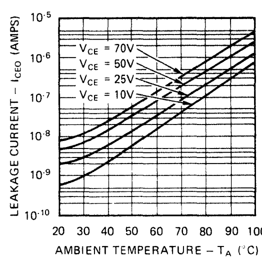
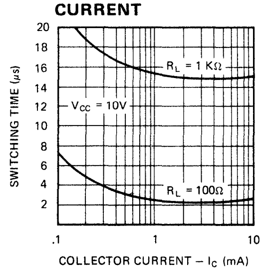
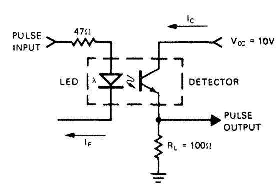


FIGURE 7. SWITCHING TIME VS COLLECTOR CURRENT



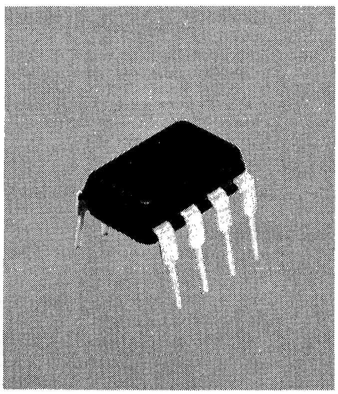


CIRCUIT USED TO OBTAIN SWITCHING TIME VS COLLECTOR CURRENT PLOT

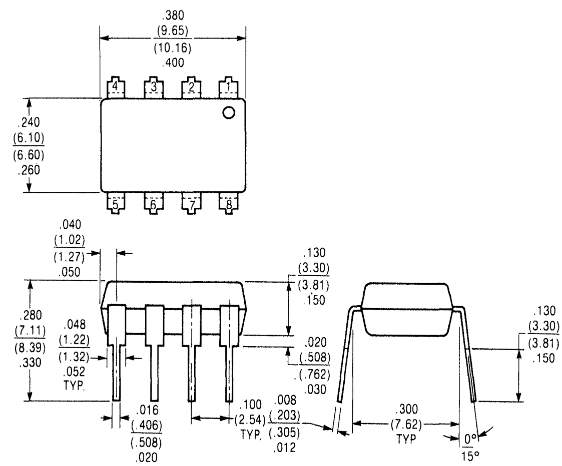
SIEMENS

ILD-506

DUAL PHOTOTRANSISTOR OPTO-ISOLATOR



Package Dimensions in Inches (mm)

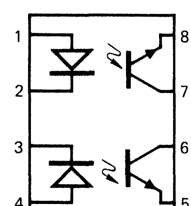


FEATURES

- **Two Isolated Channels Per Package**
- **5000 V Isolation**
- **50% Typical Current Transfer Ratio**
- **1 nA Typical Leakage Current**
- **Replacement for MCT6**
- **Underwriters Lab Approval #E52744**

DESCRIPTION

The IL-506 is a two-channel opto-isolator for high density applications. Each channel consists of an optically coupled pair employing a gallium arsenide infared LED and a silicon NPN phototransistor. Signal information, including a DC level, can be transmitted by the device while maintaining a high degree of electrical isolation between input and output. The IL-506 is especially designed for driving medium-speed logic, where it may be used to eliminate troublesome ground loop and noise problems. It can also be used to replace relays and transformers in many digital interface applications, as well as analog applications such as CRT modulation.



LED CHIPS ON PINS 2 AND 3
PT CHIPS ON PINS 6 AND 7

PIN NO.	FUNCTION
1	ANODE
2	CATHODE
3	CATHODE
4	ANODE
5	EMITTER
6	COLLECTOR
7	COLLECTOR
8	EMITTER

Specifications subject to change without notice.

Maximum Ratings

Maximum Temperatures

Storage Temperature	−55 °C to +150 °C
Operating Temperature	−55 °C to +100 °C
Lead Temperature (Soldering, 10 seconds)	260 °C
Input Diode (Each Channel)	
Rated Forward Current, DC	60 mA
Peak Forward Current (1 μs pulse, 300 pps)	3 A
Power Dissipation @ 25 °C Ambient	100 mW
Derate Linearly from 25 °C	1.3 mW/ °C
Output Transistor (Each Channel)	
Power Dissipation @ 25 °C Ambient	150 mW
Derate Linearly from 25 °C	2 mW/ °C
Collector Current	30 mA
Coupled	
Input-to-Output Breakdown Voltage	5000 VDC
Total Package Power Dissipation @ 25 °C Ambient	400 mW
Derate Linearly from 25 °C	5.33 mW/ °C

Electro-Optical Characteristics (@ 25 °C Free Air Temperature Unless Otherwise Specified)

Parameter	Min	Typ	Max	Units	Test Conditions
Input Diode					
Rated Forward Voltage		1.25	1.50	V	$I_F = 20$ mA
Reverse Voltage	3.0	5.0		V	$I_R = 10$ μA
Reverse Current		0.001	10	μA	$V_R = 3.0$ V
Junction Capacitance		100		pF	$V_F = 0$ V
Output Transistor					
Breakdown Voltage, Collector-to-Emitter	30	50		V	$I_C = 1.0$ mA
Emitter-to-Collector	7.0	10		V	$I_E = 100$ μA
Leakage Current, Collector-to-Emitter		1.0	100	nA	$V_{CE} = 10$ V
Capacitance, Collector-to-Emitter		8.0		pF	$V_{CE} = 0$ V
Coupled					
DC Current Transfer Ratio (I_C/I_F)	20	50		%	$V_{CE} = 10$ V, $I_F = 10$ mA
Saturation Voltage — Collector-to-Emitter		0.25	0.40	V	$I_C = 2.0$ mA, $I_F = 16$ mA
Isolation Voltage	5000	7000		VDC	t = 1 Minute
Isolation Resistance		10^{12}		Ω	$V_{I-O} = 500$ V
Isolation Capacitance		0.5		pF	f = 1.0 MHz
Breakdown Voltage — Channel-to-Channel		2500		VDC	t = 1 Minute
Capacitance Between Channels		0.4		pF	f = 1.0 MHz
Bandwidth		150		kHz	$I_C = 2.0$ mA, $V_{CC} = 10$ V $R_L = 100$ Ω
Switching Times, Output Transistor					
Non-Saturated Rise Time, Fall Time		2.4		μs	$I_C = 2.0$ mA, $V_{CE} = 10$ V $R_L = 100$ Ω
Non-Saturated Rise Time, Fall Time		15		μs	$I_C = 2.0$ mA, $V_{CE} = 10$ V $R_L = 1.0$ kΩ
Saturated Turn-On Time (From 5.0 V to 0.8 V)		5.0		μs	$R_L = 2.0$ kΩ, $I_F = 15$ mA
Saturated Turn-Off Time (From Saturation to 2.0 V)		25		μs	$R_L = 2.0$ kΩ, $I_F = 15$ mA

Specifications subject to change without notice.

TYPICAL OPTO-ELECTRONIC CHARACTERISTIC CURVES FOR EACH CHANNEL

FIGURE 1. I-V CURVE OF PHOTOTRANSISTOR

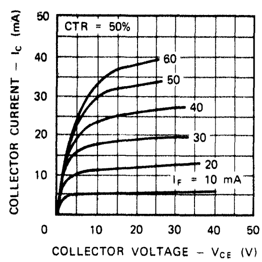


FIGURE 2. I-V CURVE IN SATURATION

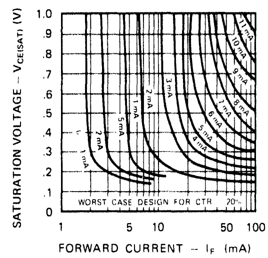


FIGURE 3. CTR VS FORWARD CURRENT

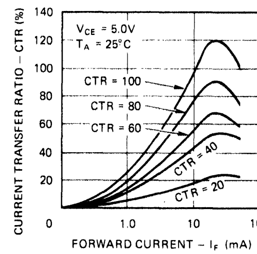


FIGURE 4. CURRENT TRANSFER RATIO VS TEMPERATURE

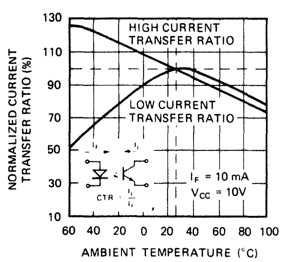


FIGURE 5. I-V CURVE OF LED VS TEMPERATURE

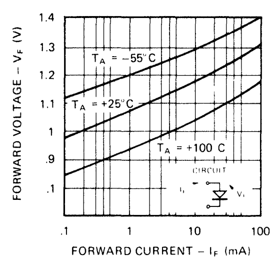


FIGURE 6. LEAKAGE CURRENT VS TEMPERATURE VS COLLECTOR VOLTAGE

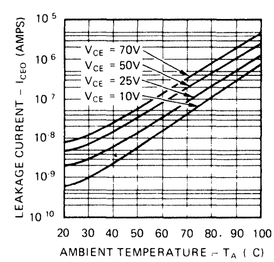
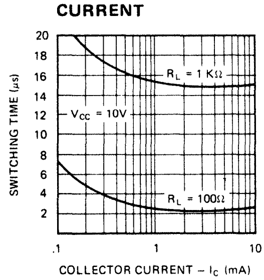
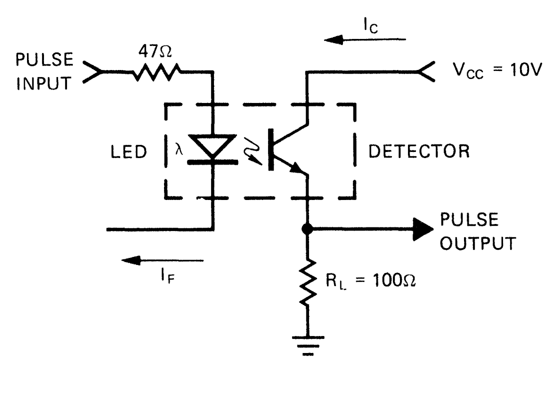


FIGURE 7. SWITCHING TIME VS COLLECTOR CURRENT



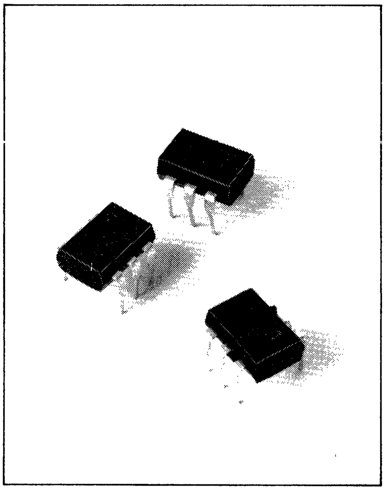
CIRCUIT USED TO OBTAIN SWITCHING TIME VS COLLECTOR CURRENT PLOT



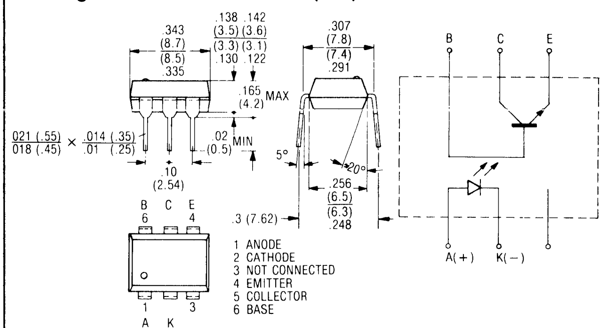
SIEMENS

SFH 600 SERIES

PHOTOTRANSISTOR OPTO-ISOLATOR



Package Dimensions in Inches (mm)



FEATURES

- **High Quality Premium Device**
- **Long Term Stability**
- **High Current Transfer Ratio, 4 Groups**
  SFH 600-0, 40 to 80%
  SFH 600-1, 63 to 125%
  SFH 600-2, 100 to 200%
  SFH 600-3, 160 to 320%
- **2800 Volt Isolation (1 Minute)**
- **Storage Temperature −55 to +150°C**
- **VCE SAT 0.25 (<0.4) Volt** **$I_F = 10$ mA, $I_C = 2.5$ mA**
- **UL Approval #E52744**

DESCRIPTION

The optoelectronic coupler SFH 600 comprises a GaAs LED as the emitter which is optically coupled with a silicon planar phototransistor as the detector. The component is located in a plastic plug-in case 20 AB DIN 41866.

The coupler allows to transfer signals between two electrically isolated circuits. The potential difference between the circuits to be coupled is not allowed to exceed the maximum permissable insulating voltage.

Maximum Ratings

Reverse Voltage (V_R)	6 V
Forward Current (I_F)	60 mA
Surge Current (I_{FS}), $t_p = 10\ \mu s$	1.5 A
Power Dissipation (P_{tot})	100 mW
Detector (Silicon Phototransistor)	
Collector-Emitter Voltage (C_{CEO})	70 V
Emitter-Base Reverse Voltage (V_{EBO})	7 V
Collector Current (I_C)	50 mA
Collector Current (I_{CS}), t = 1 ms	100 mA
Power Dissipation (P_{tot})	150 mW
Coupler	
Storage Temperature (T_{stor})	−55 to +150°C
Ambient Temperature (T_{amb})	−55 to +100°C
Junction Temperature (T_j)	100°C
Soldering Temperature (T_L), 1 Min.	260°C
Isolation Test Voltage (1 Min.) (V_{is}) (between emitter and detector referred to standard climate 23/50 DIN 50014)	2800 V−
Tracking Resistance	Min. 8.2 mm
Air Path	Min. 7.6 mm

Tracking Resistance

Group III (KC = >600) in accordance with VDE0110 § 6
Table 3 and DIN 53480/VDE0303, Part 1

As to nominal isolation voltage DIN57883 or VDC0883 applies.

Isolation Voltage (R_{is}) at V_{is} = 500 V .... $10^{11}\ \Omega$

Climatic Conditions

DIN 40040, Humidity Class F

Flammability

DIN57471 or VDE0471, Part 2, of April 1975 or MIL-202E, Method 11A

Characteristics (T_{amb} = 25°C)

Emitter (GaAs LED)	
Forward Voltage (V_F), I_F = 60 mA	1.25 (≤1.65) V
Breakdown Voltage (V_{BR}), I_R = 100 μA	30 (≥6) V
Reverse Current (I_R), V_R = 3 V	0.01 (≤10) μA
Capacitance (C_O), V_R = 0V, f = 1 MHz	40 pF
Thermal Resistance ($R_{th\ Jamb}$)	750 K/W
Detector (Silicon Phototransistor)	
Capacitance, (V_{CE} = 5 V, f = 1 MHz)	
C_{CE}	5.2 pF
C_{CB}	6.5 pF
C_{EB}	9.5 pF
Thermal Resistance ($R_{th\ Jamb}$)	500 K/W

Specifications subject to change without notice.

Characteristics (Continued)

Coupler

Collector-Emitter Saturation Voltage ($V_{CE\ sat}$)

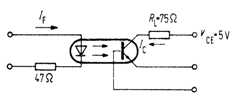
$I_f = 10$ mA. $I_C = 2.5$ mA) .... 0.25 (≤0.4) V

Coupling Capacitance (C_K) .... 0.55 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	0	1	2	3	
$\frac{I_C}{I_F}$	40-80	63-125	100-200	160-320	%
Collector-Emitter Leakage Current ($V_{CE} = 10$ V) I_{CEO}	2 (≤35)	2 (≤35)	2 (≤35)	5 (≤70)	nA

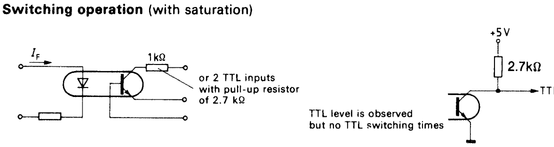
Linear operation (without saturation)



Load Resistance (R_L)	75	Ω
Delay Time (t_d)	3.2 (<4.6)	μs
Rise Time (t_r)	2 (≤3)	μs
Storage Time (t_s)	3.0 (<4.0)	μs
Fall Time (t_f)	2.5 (≤3.3)	μs
Cut-off Frequency (f_g)	250	kHz

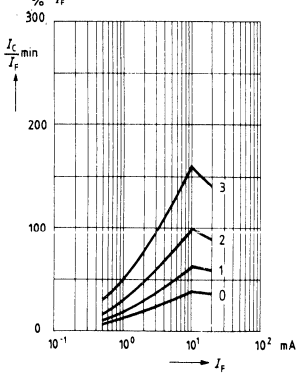
I_F = 10 mA
V_{CE} = 5 V
T_{amb} = 25°C

Switching operation (with saturation)

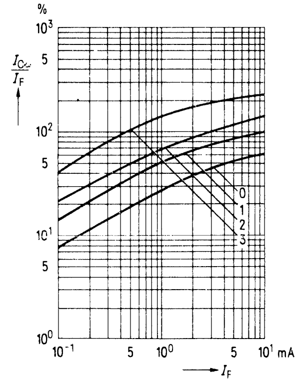


Group	**0**	**1 and 2**	**3**	
	$I_F = 20$ mA	**$I_F = 10$ mA**	**$I_F = 5$ mA**	
Switch-On Time (t_{ein})	3.7 (≤5.8)	4.5 (≤6.2)	5.8 (≤8.0)	μs
Rise Time (t_r)	2.5 (≤4.0)	3 (≤4.2)	4 (≤5.5)	μs
Switch-Off Time (t_{aus})	19 (≤25)	21 (≤27)	24 (≤31)	μs
Fall Time (t_f)	11 (≤14)	12 (≤15)	14 (≤18)	μs
$V_{CE\ sat}$	0.25 (≤0.4)			V

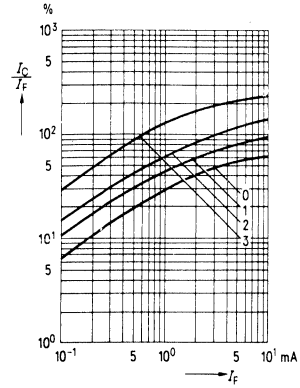
Minimum current transfer ratio as a function of diode current (T_{amb} = 25°C, V_{CE} = 5 V)
$\frac{I_C}{I_F} = f(I_F)$



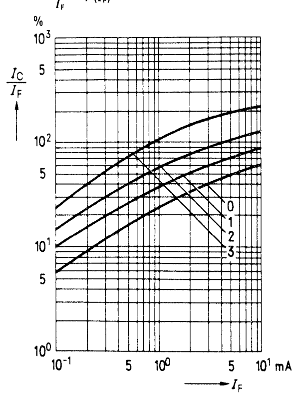
Current transfer ratio as a function of diode current (T_{amb} = −25°C)
$\frac{I_C}{I_F} = f(I_F)$ V_{CE} = 5 V



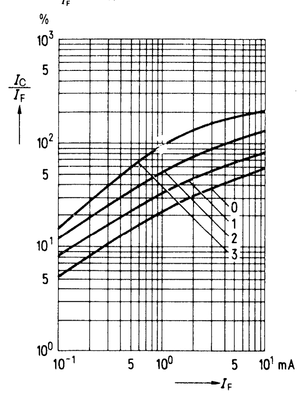
Current transfer ratio as a function of diode current (T_{amb} = 0°C)
$\frac{I_C}{I_F} = f(I_F)$ V_{CE} = 5 V



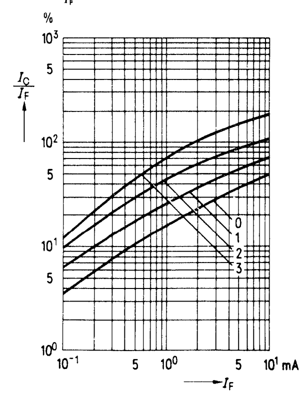
Current transfer ratio as a function of diode current (T_{amb} = 25°C)
$\frac{I_C}{I_F} = f(I_F)$ V_{CE} = 5 V



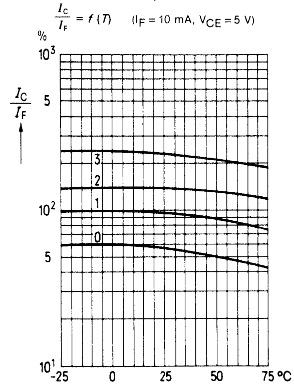
Current transfer ratio as a function of diode current (T_{amb} = 50°C)
$\frac{I_C}{I_F} = f(I_F)$ V_{CE} = 5 V



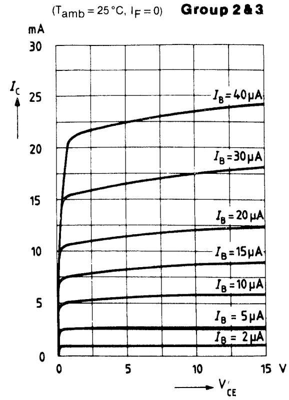
Current transfer ratio as a function of diode current (T_{amb} = 75°C)
$\frac{I_C}{I_F} = f(I_F)$ V_{CE} = 5 V



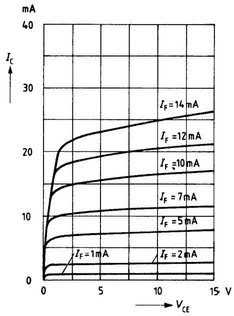
Current transfer ratio as a function of temperature
$\frac{I_C}{I_F} = f(T)$ (I_F = 10 mA, V_{CE} = 5 V)



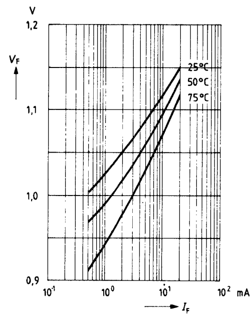
Transistor characteristics (B = 550)
$I_C = f(V_{CE})$
(T_{amb} = 25°C, I_F = 0) **Group 2 & 3**



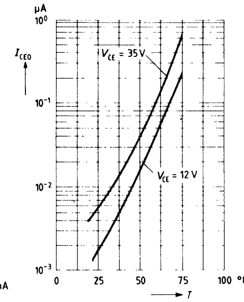
Output characteristics $I_C = f(V_{CE})$
(T_{amb} = 25 °C)! Group 2 & 3



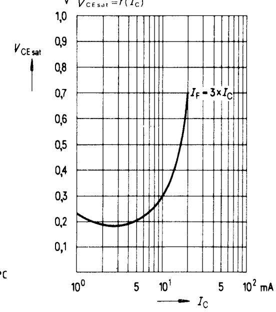
Forward voltage $V_F = f(I_F)$



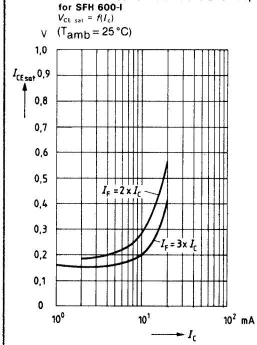
Collector-emitter off-state current
$I_{CEO} = f(V, T)$
(T_{amb} = 25 °C, I_F = 0)



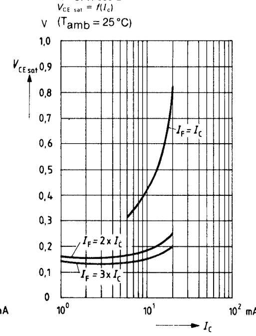
Saturation voltage as a function of collector current and modulation depth for SFH 600-0
(T_{amb} = 25 °C)
$V_{CEsat} = f(I_C)$



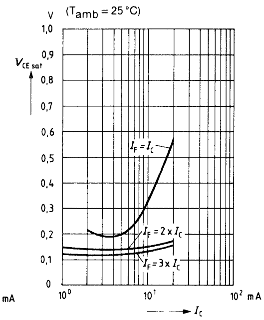
Saruration voltage as a function of collector current and modulation depth for SFH 600-I
$V_{CEsat} = f(I_C)$
(T_{amb} = 25 °C)



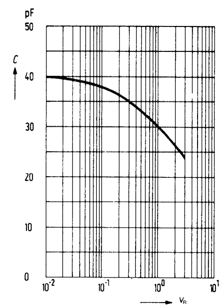
Saturation voltage as a function of collector current and modulation depth for SFH 600-2
$V_{CEsat} = f(I_C)$
(T_{amb} = 25 °C)



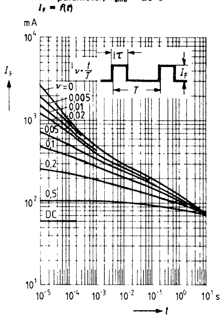
Saturation voltage as a function of collector current and modulation depth for SFH 600-3
$V_{CEsat} = f(I_C)$
(T_{amb} = 25 °C)



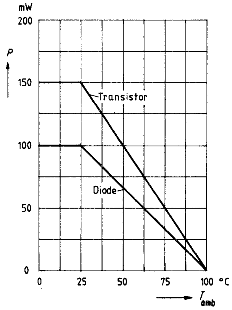
Diode capacitance $C = f(V_R)$
(T_{amb} = 25 °C, f = 1 MHz)



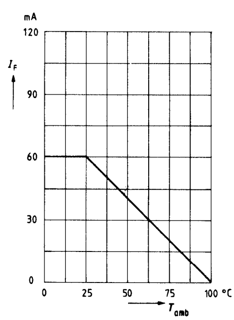
Permissible pulse load
ν = parameter, T_{amb} = 25°C
$I_F = f(t)$



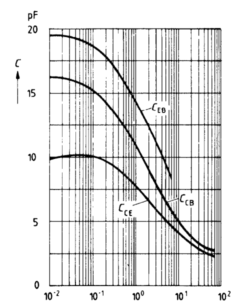
Permissible loss transistor $P_{tot} = f(T_{amb})$ and Diode



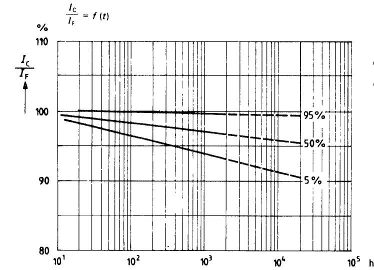
Permissible loss diode $P_{tot} = f(T_{amb})$



Transistor capacitances $C = f(V_0)$
(T_{amb} = 25 °C; f = 1 MHz)



Variation of current transfer ratio as a function of load time
$\frac{I_C}{I_F} = f(t)$

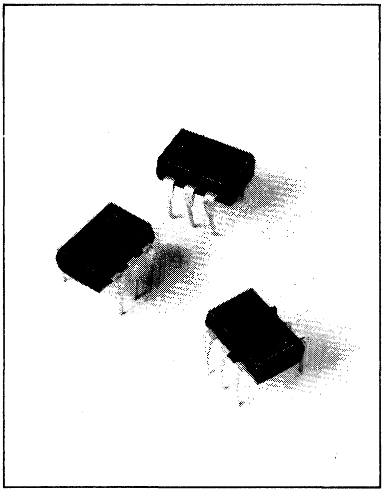


V_{CE} = 5 V
R_L = 1kΩ
T_{amb} = 60°C
I_F = 30 mA = measurement current
R_{thJamb} = 750 K/W
Propability S = 60%

SIEMENS

SFH 601 SERIES

PHOTOTRANSISTOR OPTO-ISOLATOR



FEATURES

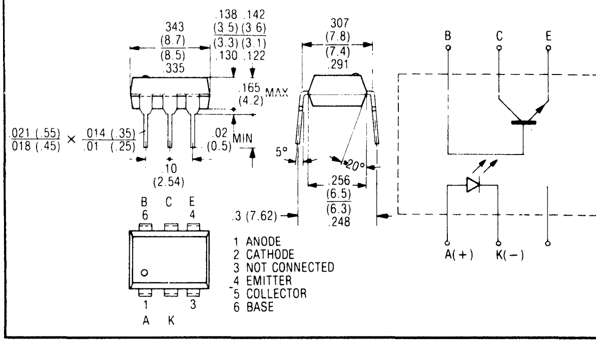
- **Highest Quality Premium Device**
- **Built to Conform to VDE Requirements**
- **Long Term Stability**
- **High Current Transfer Ratios, 4 Groups**
  SFH 601-1, 40 to 80%
  SFH 601-2, 63 to 125%
  SFH 601-3, 100 to 200%
  SFH 601-4, 160 to 320%
- **5300 Volt Isolation (1 Minute)**
- **Storage Temperature −40° to +150°C**
- **V_{CEsat} 0.25 (<0.4) Volt**
  I_F = 10 mA, I_C = 2.5 mA
- **UL Approval #E52744**
- **VDE Approval #0883 & #0830 group C**

DESCRIPTION

The optoelectronic coupler SFH 601 comprises a GaAs LED as the emitter which is optically coupled with a silicon planar phototransistor as the detector. The component is located in a plastic plug-in case 20 AB DIN 41866.

The coupler allows to transfer signals between two electrically isolated circuits. The potential difference between the circuits to be coupled is not allowed to exceed the maximum permissible insulating voltage.

Package Dimensions in Inches (mm)



Maximum Ratings

Reverse Voltage (V_R)	6 V
Forward Current (I_F)	60 mA
Surge Current (I_{FS}), t_p = 10 μs	1.5 A
Power Dissipation (P_{tot})	100 mW
Detector (Silicon Phototransistor)	
Collector-Emitter Voltage (V_{CEO})	70 V
Emitter-Base Reverse Voltage (V_{EBO})	7 V
Collector Current (I_C)	50 mA
Collector Current (I_{CS}), t = 1 ms	100 mA
Power Dissipation (P_{tot})	150 mW
Coupler	
Storage Temperature (T_{stor})	−40 to +150°C
Ambient Temperature (T_{amb})	−40 to +100°C
Junction Temperature (T_j)	100°C
Soldering Temperature (T_L), 10 s Max.	260°C
Isolation Test Voltage (V_{is}), 1 Min. (between emitter and detector referred to standard climate 23/50 DIN 50014)	5300 V−
Tracking Resistance	Min. 8.2 mm
Air Path	Min. 7.6 mm

Tracking Resistance
Group III (KC = >600) in accordance with VDE 0110 § 6
Table 3 and DIN 53480/VDE 0303, Part 1.
As to nominal isolation voltage DIN 57883 or VDE 0883 applies.

Isolation Voltage (R_{is}), @ V_{is} = 500 V	10^{11} Ω

Climatic Conditions
DIN 40040, humidity Class F

Flammability
DIN 57471 or VDE 0471, Part 2,
of April 1975 or MIL202E, Method 11 A

Characteristics (T_{amb} = 25°C)

Emitter (GaAs LED)	
Forward Voltage (V_F), I_F = 60 mA	1.25 (≤1.65) V
Breakdown Voltage (V_{BR}), I_R = 100 μA	30 (≥6) V
Reverse Current (I_R), V_R = 3 V	0.01 (≤10) μA
Capacitance (C_O) (V_R = 0 V; f = 1 MHz)	40 pF
Thermal Resistance (R_{thJamb})	750 K/W
Detector (Silicon Phototransistor)	
Capacitance (V_{CE} = 5 V; f = 1 MHz)	
C_{CE}	6.8 pF
C_{CB}	8.5 pF
C_{EB}	11 pF
Thermal Resistance (R_{thJamb})	500 K/W

Specifications subject to change without notice.

Characteristics (Continued)

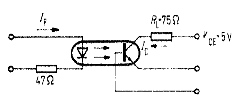
Coupler

Collector-Emitter Saturation Voltage (V_{CEsat})
($I_F = 10$ mA, $I_C = 2.5$ mA) .... 0.25 (< 0.4) V
Coupling Capacitance (C_K) .... 0.30 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 numbers.

Group	1	2	3	4	
$\frac{I_C}{I_F}$	40-80	63-125	100-200	160-320	%
Collector-Emitter Leakage Current ($V_C = 10$ V), I_{CEO}	2 (< 50)	2 (< 50)	5 (< 100)	5 (< 100)	nA

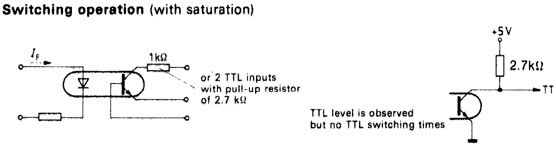
Linear operation (without saturation)



Load Resistance (R_L)	75	Ω
Delay Time (t_d)	3.0 (≤ 5.6)	μs
Rise Time (t_r)	2.0 (≤ 4.0)	μs
Storage Time (t_s)	2.3 (≤ 4.1)	μs
Fall Time (t_f)	2.0 (≤ 3.5)	μs
Cut-off Frequency (f_g)	250	kHz

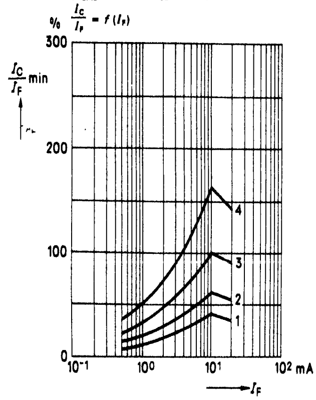
I_F = 10 mA
V_{CE} = 5 V
T_{amb} = 25°C

Switching operation (with saturation)

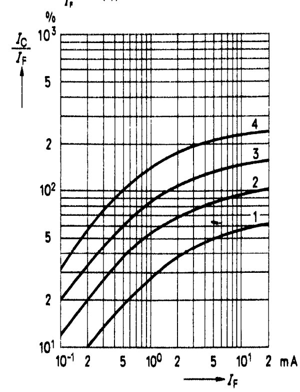


Group	**1**	**2 and 3**	**4**	
	$I_F = 20$ mA	**$I_F = 10$ mA**	**$I_F = 5$ mA**	
Switch-On Time (t_{ein})	3.0 (≤ 5.5)	4.2 (≤ 8.0)	6.0 (≤ 10.5)	μs
Rise Time (t_r)	2.0 (≤ 4.0)	3.0 (≤ 6.0)	4.6 (≤ 8.0)	μs
Switch-Off Time (t_{off})	18 (≤ 34)	23 (≤ 39)	25 (≤ 43)	μs
Fall Time (t_f)	11 (≤ 20)	14 (≤ 24)	15 (≤ 26)	μs
$V_{CE\ sat}$	0.25 (≤ 0.4)			V

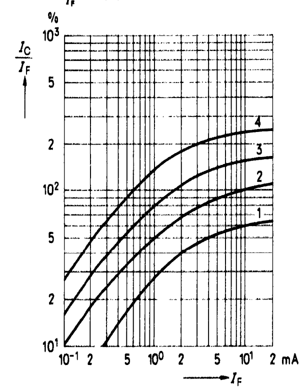
Minimum current transfer ratio as a function of diode current (T_{amb} = 25°C, V_{CE} = 5 V)
$\frac{I_C}{I_F} = f(I_F)$



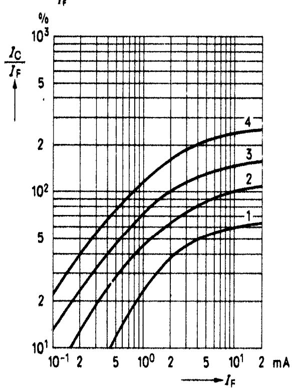
Current transfer ratio as a function of diode current (T_{amb} = −25°C)
$\frac{I_C}{I_F} = f(I_F)$ V_{CE} = 5 V



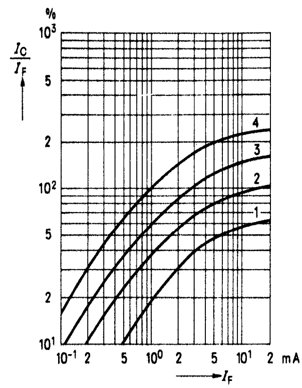
Current transfer ratio as a function of diode current (T_{amb} = 0°C)
$\frac{I_C}{I_F} = f(I_F)$ V_{CE} = 5 V



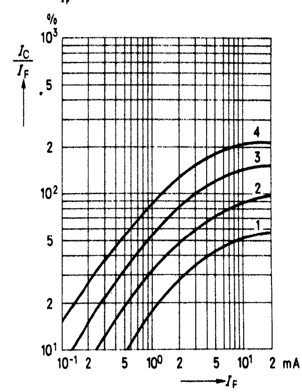
Current transfer ratio as a function of diode current (T_{amb} = 25°C)
$\frac{I_C}{I_F} = f(I_F)$ V_{CE} = 5 V



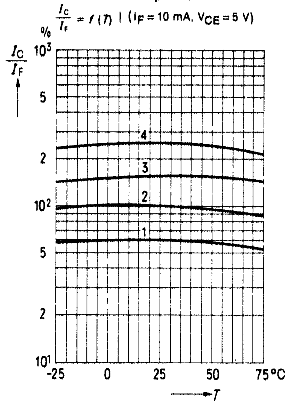
Current transfer ratio as a function of diode current (T_{amb} = 50°C)
$\frac{I_C}{I_F} = f(I_F)$ V_{CE} = 5 V



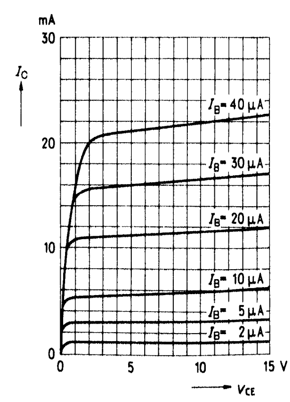
Current transfer ratio as a function of diode current (T_{amb} = 75°C)
$\frac{I_C}{I_F} = f(I_F)$ V_{CE} = 5 V



Current transfer ratio as a function of temperature
$\frac{I_C}{I_F} = f(T)$ | (I_F = 10 mA, V_{CE} = 5 V)

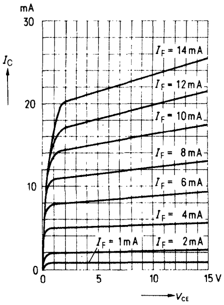


Transistor characteristics (B = 550)
$I_C = f(V_{CE})$ (T_{amb} = 25°C, I_F = 0)

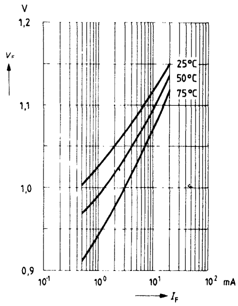


Output characteristics $I_C = f(V_{CE})$

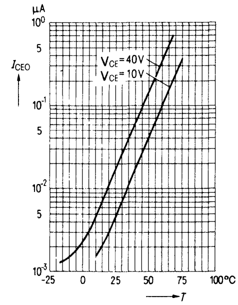
(T_{amb} = 25 °C)



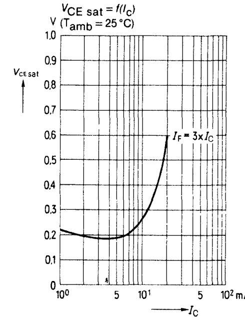
Forward voltage $V_F = f(I_F)$



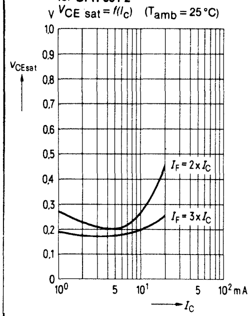
Collector-emitter off-state current
$I_{CEO} = f(V, T)$ (T_{amb} = 25 °C, I_F = 0)



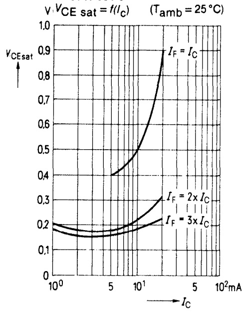
Saturation voltage as a function of collector current and modulation depth for SFH 601-1



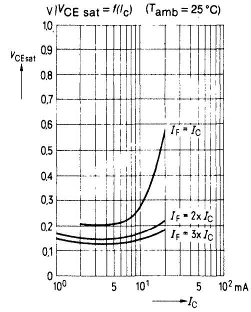
Saruration voltage as a function of collector current and modulation depth for SFH 601-2



Saturation voltage as a function of collector current and modulation depth for SFH 601-3

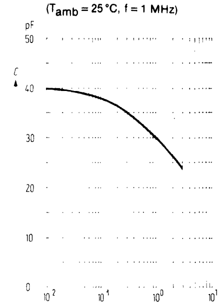


Saturation voltage as a function of collector current and modulation depth for SFH 601-4

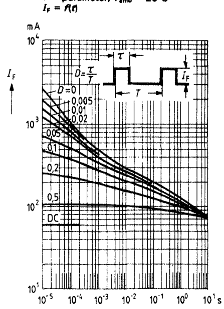


Diode capacitance $C = f(V_R)$

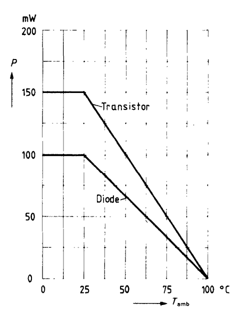
(T_{amb} = 25 °C, f = 1 MHz)



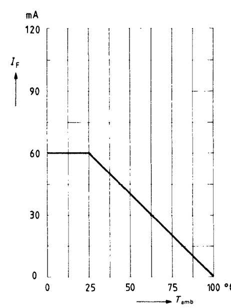
Permissible pulse load
v = parameter, T_{amb} = 25°C
$I_F = f(t)$



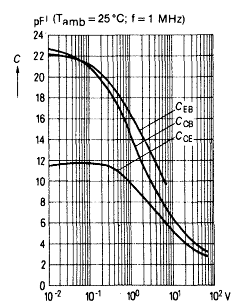
Permissible loss transistor $P_{tot} = f(T_{amb})$



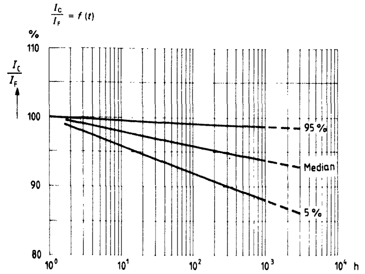
Permissible loss diode $P_{tot} = f(T_{amb})$



Transistor capacitances $C = f(V_o)$



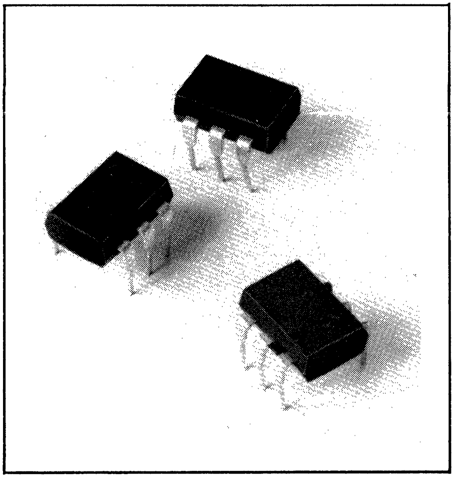
Variation of current transfer ratio as a function of load time
$\frac{I_C}{I_F} = f(t)$



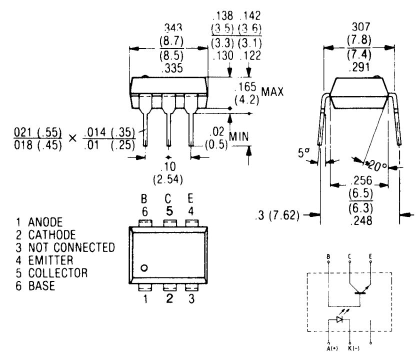
V_{CE} = 5 V
R_L = 1kΩ
T_{amb} = 60°C
I_F = 30 mA = measurement current
R_{thJamb} = 750 K/W
Propability S = 60%

SIEMENS

SFH 609
HIGH RELIABILITY PHOTOTRANSISTOR OPTO-ISOLATOR



Package Dimensions in Inches(mm)



FEATURES

- **Highest Quality Premium Device**
- **Built to Conform to VDE Requirements**
- **Long Term Stability**
- **High Current Transfer Ratios, 3 Groups**
  SFH 609-1, 40 to 80%
  SFH 609-2, 63 to 125%
  SFH 609-3, 100 to 200%
- **5300 Volt Isolation (1 Minute)**
- **Storage Temperature −40° to +150°C**
- **V_{CEsat} 0.25 (<0.4) Volt**
  I_F = 10 mA, I_C = 2.5 mA
- **V_{CEO} 90V**
- **UL Approval #E52744**
- **VDE Approval #0883**

DESCRIPTION

The optically coupled isolator SFH 609 features a high current transfer ratio as well as high isolation voltage, and 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 package 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 isolation voltage.

Maximum Ratings

Emitter (GaAs infrared emitter)			
Reverse voltage	V_R	6	V
DC forward current	I_F	60	mA
Surge forward current ($t \leq 10$ µs)	I_{FSM}	1.5	A
Total power dissipation	P_{tot}	100	mW
Detector (silicon phototransistor)			
Collector-emitter voltage (I_s = 0)	V_{CEO}	90	V
Emitter-base voltage (I_C = 0)	V_{EBO}	7	V
Collector current	I_C	50	mA
Collector current ($t \leq 1$ ms)	I_{CSM}	100	mA
Total power dissipation	P_{tot}	150	mW
Optocoupler			
Storage temperature range	T_{stg}	−40 to +150	°C
Ambient temperature range	T_{amb}	−40 to +100	°C
Junction temperature	T_j	100	°C
Soldering temperature (max. 10 sec)[1]	T_{sold}	260	°C
Isolation voltage (1 min)[2] between emitter and detector referred to standard climate 23/50 DIN 50014	V_{is}	5300	Vdc
AC reference voltage / DC reference voltage	in acc. with DIN 57883, 6.80 and/or VDE 0883, 6.80		
Leakage path		min 8.2	mm
Air path		min 7.6	mm

[1]) Dip soldering: Insertion depth 3.6 mm
[2]) DC test voltage in accordance with DIN 57883, draft 4/78

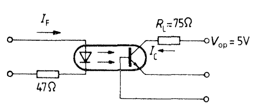
CHARACTERISTICS @25°C

Emitter (GaAs infrared emitter)			
Forward voltage (I_F = 60 mA)	V_F	1.25 (≤1.65)	V
Breakdown voltage (I_R = 100 μA)	$V_{(BR)}$	30 (≥6)	V
Reverse current (V_R = 6 V)	I_R	0.01 (≤10)	μA
Capacitance (V_R = 0 V; f = 1 MHz)	C_O	40	pF
Thermal resistance	R_{thJA}	750	K/W
Detector (silicon phototransistor)			
Capacitance (V_{CE} = 5 V; f = 1 MHz)	C_{CE}	6.8	pF
(V_{CB} = 5 V; f = 1 MHz)	C_{CB}	8.5	pF
(V_{EB} = 5 V; f = 1 MHz)	C_{EB}	11	pF
Thermal resistance	R_{thJA}	500	K/W
Optocoupler			
Collector-emitter saturation voltage (I_F = 10 mA, I_C = 2.5 mA)	V_{CEsat}	0.25 (≤0.4)	V
Coupling capacitance	C_K	0.30	pF

The optocouplers are grouped according to their current transfer ratio I_C/I_F at I_F = 10 mA and V_{CE} = 5V.

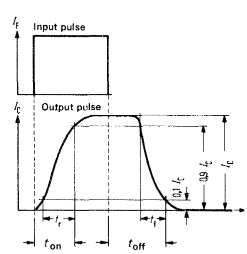
Group	1	2	3	
I_C/I_F	40 to 80	63 to 125	100 to 200	%
Collector-emitter reverse current I_{CEO} (V_{CE} = 10 V)	2 (≤50)	2 (≤50)	5 (≤100)	nA

Linear operation (without saturation)



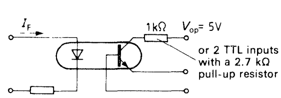
I_F = 10 mA
V_{op} = 5 V
T_{amb} = 25°C

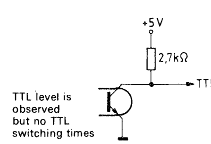
Switching times



Load resistance	R_L	75	Ω
Turn-on time	t_{on}	3.0 (≦ 5.6)	μs
Rise time	t_r	2.0 (≦ 4.0)	μs
Turn-off time	t_{off}	2.3 (≦ 4.1)	μs
Fall time	t_f	2.0 (≦ 3.5)	μs
Cut-off frequency	f_{co}	250	kHz

Switching operation (with saturation)

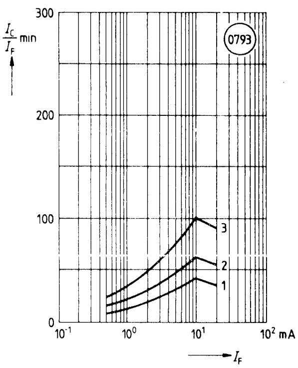




Group		1 I_F = 20 mA	2 and 3 I_F = 10 mA	
Turn-on time	t_{on}	3.0 (≦ 5.5)	4.2 (≦ 8.0)	μs
Rise time	t_r	2.0 (≦ 4.0)	3.0 (≦ 6.0)	μs
Turn-off time	t_{off}	18 (≦ 34)	23 (≦ 39)	μs
Fall time	t_f	11 (≦ 20)	14 (≦ 24)	μs
	V_{CEsat}	0.25 (≦ 0.4)		V

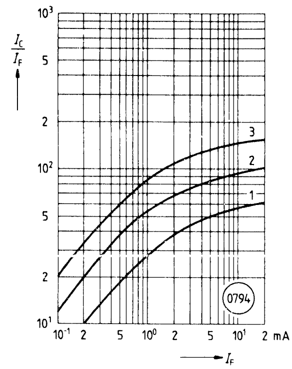
Minimum current transfer ratio versus diode forward current

T_{amb} = 25°C; V_{CE} = 5 V



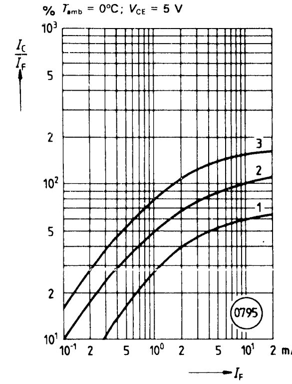
Current transfer ratio (typ.) versus diode forward current

T_{amb} = −25°C; V_{CE} = 5 V



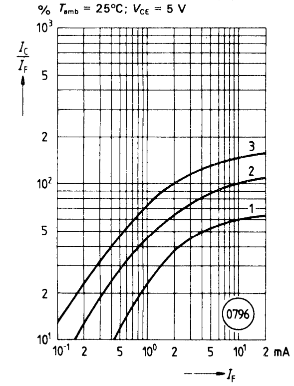
Current transfer ratio (typ.) versus diode forward current

T_{amb} = 0°C; V_{CE} = 5 V



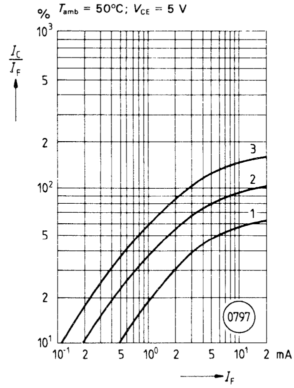
Current transfer ratio (typ.) versus diode forward current

T_{amb} = 25°C; V_{CE} = 5 V



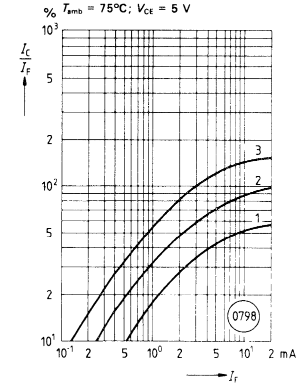
Current transfer ratio (typ.) versus diode forward current

T_{amb} = 50°C; V_{CE} = 5 V



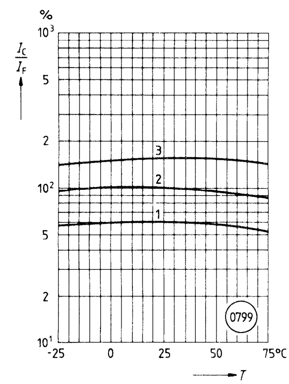
Current transfer ratio (typ.) versus diode forward current

T_{amb} = 75°C; V_{CE} = 5 V



Current transfer ratio (typ.) versus temperature

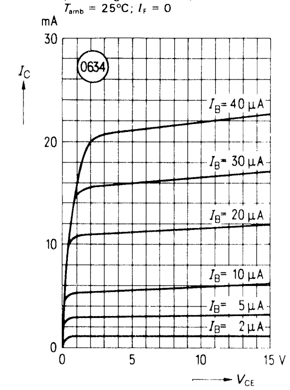
I_F = 10 mA; V_{CE} = 5 V



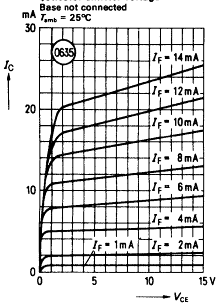
Collector current versus collector-emitter voltage

(Current gain B = 550)

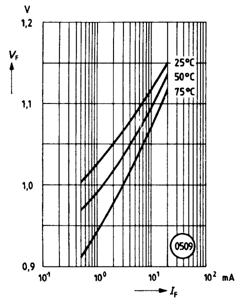
T_{amb} = 25°C; I_F = 0



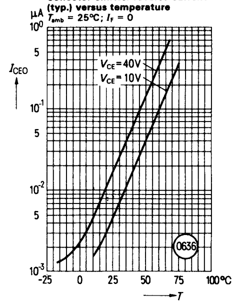
Output characteristics (typ.)
Collector current versus collector-emitter voltage
Base not connected
T_{amb} = 25°C



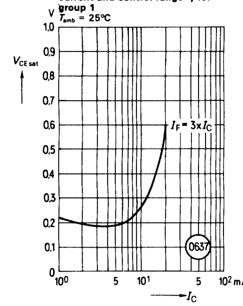
Forward voltage (typ.) of the diode versus forward current



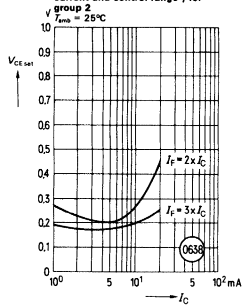
Collector-emitter reverse current (typ.) versus temperature
T_{amb} = 25°C; I_F = 0



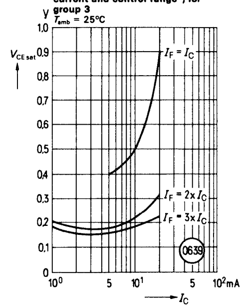
Collector-emitter saturation voltage (typ.) versus collector current and control range [1]) for group 1
T_{amb} = 25°C



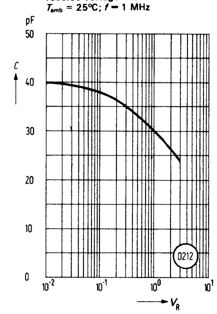
Collector-emitter saturation voltage (typ.) versus collector current and control range [1]) for group 2
T_{amb} = 25°C



Collector-emitter saturation voltage (typ.) versus collector current and control range [1]) for group 3
T_{amb} = 25°C

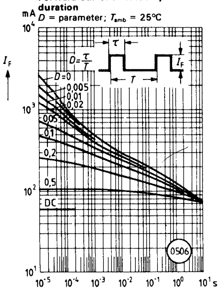


Diode capacitance (typ.) versus reverse voltage
T_{amb} = 25°C; f = 1 MHz

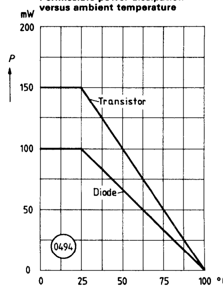


[1]) I_F = 2 x I_C means that the current flow of the diode has to be adjusted to the doubled value of the collector current.

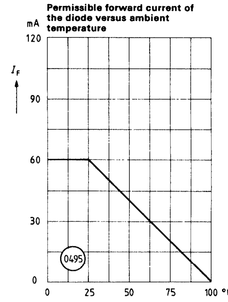
Permissible pulse handling capability
Forward current versus cycle duration
D = parameter; T_{amb} = 25°C



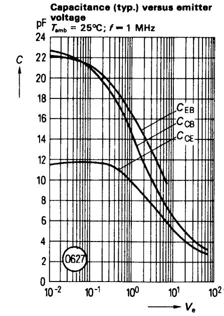
Permissible power dissipation versus ambient temperature



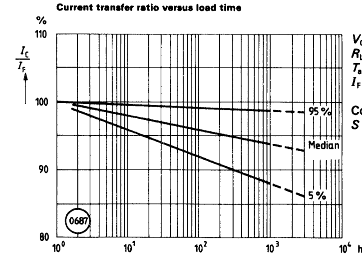
Permissible forward current of the diode versus ambient temperature



Capacitance (typ.) versus emitter voltage
T_{amb} = 25°C; f = 1 MHz



Current transfer ratio versus load time

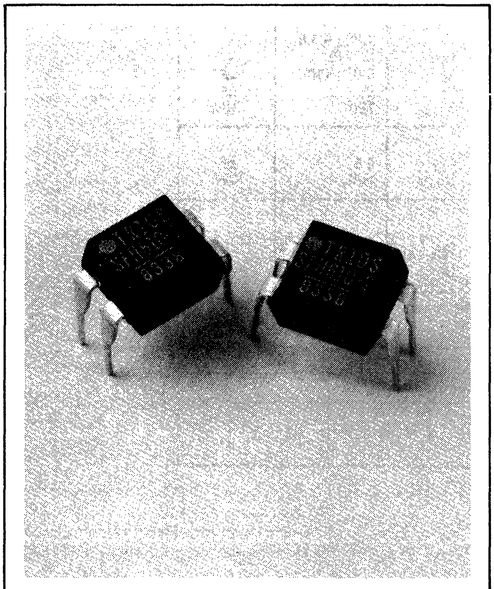


V_{CE} = 5 V
R_L = 1 kΩ
T_{amb} = 25°C
I_F = 60 mA = Measuring current
Confidence coefficient
S = 60%

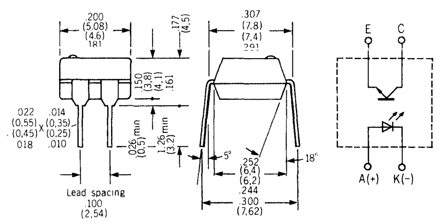
SIEMENS

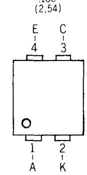
SFH 610
SFH 611

HIGH RELIABILITY PHOTOTRANSISTOR OPTO-ISOLATOR
PRELIMINARY



Package Dimensions in Inches (mm)



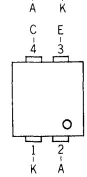


Pin configuration:

SFH 610

1 - Anode, 2 - Cathode: LED (emitter)
3 - Collector, 4 - Emitter: Phototransistor (detector)

The dot identifies the anode terminal



SFH 611

1 - Cathode, 2 - Anode: LED (emitter)
3 - Emitter, 4 - Collector: Phototransistor (detector)

FEATURES

- **Miniature 4 Lead Dip Package**
- **High Reliability, Long Term Stability**
- **High Current Transfer Ratios, 4 Groups**
  - **SFH 610/611-1 40 to 80%**
  - **SFH 610/611-2 63 to 125%**
  - **SFH 610/611-3 100 to 200%**
  - **SFH 610/611-4 160 to 320%**
- **2800 Volt Isolation**
- **$V_{CE\,sat}$ 0.25 (≤ 0.4) volt**
  I_F = 10mA; I_c = 2.5 mA
- **V_{CEO} 70 Volt**
- **VDE Applied For**

DESCRIPTION

The optically coupled isolator, SFH 610/SFH 611 series, features a miniature 4 lead DIP package 300 mils (7.6 mm) long compared to the industry standard 6 lead 340 mils (8.6 mm) package. It incorporates a GaAs Infrared emitter and silicon planar phototransistor detector. It is offered in four high current transfer groups up to 320%, and other pertinant specifications are comparable to other 6 lead industry standard high reliability industry standard opto-isolators.

Maximum Ratings

Emitter (GaAs LED)			
Reverse Voltage	V_R	6	V
DC forward current	I_F	60	mA
Surge forward current (t≤10 μs)	I_{FSM}	1.5	A
Total power dissipation	P_{tot}	100	mW
Detector (silicon phototransistor)			
Collector-emitter voltage	V_{CEO}	70	V
Collector current	I_C	50	mA
Collector current (t≤1 ms)	I_{CSM}	100	mA
Total power dissipation	P_{tot}	150	mW
Optocoupler			
Storage temperature range	T_{stg}	−55... +150	°C
Ambient temperature range	T_{amb}	−55... +100	°C
Junction temperature	T_j	100	°C
Soldering temperature (max. 10 sec)[1]	T_{sold}	260	°C
Isolation test voltage[2] between emitter and detector referred to standard climate 23/50 DIN 50014	V_{IS}	2800	V dc

AC reference voltage / DC reference voltage: in acc. with DIN 57883, 6.80 and/or VDE 0883, 6.80

[1] Dip soldering: Insertion depth <3.6 mm
[2] DC test voltage in accordance with DIN 57883, draft 4/78

Specifications are subject to change without notice.

Isolation resistance at V_{is} = 500V	R_{IS}	10^{11}	Ω

Climatic conditions
Application in acc. with DIN 40040, humidity category F

Flammability
In acc. with DIN 57471 or VDE 0471, part 2 (April '75) and/or MIL 202 E, method 111A

CHARACTERISTICS Tamb @ 25°C			
Emitter (GaAs infrared emitter) Forward voltage (I_F = 60 mA) Breakdown voltage (I_R = 100 μA) Reverse current (V_R = 6V) Capacitance (V_R = 0 V; f = 1 MHz) Thermal resistance[1]	 V_F V_{BR} I_R C_O R_{thJA}	 1.25 (≤ 1.65) 30(≥6) 0.01 (≤10) 25 750	 V V μA pF K/W
Detector (silicon phototransistor) Capacitance (V_{CE} = 5 V; f = 1 MHz) Thermal resistance [1]	 C_{CE} R_{thJA}	 6.8 500	 pF K/W
Optocoupler Collector-emitter saturation voltage (I_F = 10 mA, I_C = 2.5 mA) Coupling capacitance	 $V_{CE\ sat}$ C_K	 0.25 (≤0.4) 0.35	 V pF

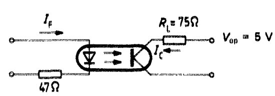
The optocouplers are grouped according to their current transfer ratio I_C/I_F at I_F = 10 mA and V_{CE} = 5V.

Group	1	2	3	4	
I_C/I_F	40...80	63...125	100...200	160...320	%
Collector-emitter reverse current I_{CEO} (V_{CE} = 10 V)	2(≤50)	2(≤50)	5(≤100)	5(≤100)	nA

[1]) Static air, coupler soldered to PCB or base.

Switching characteristics

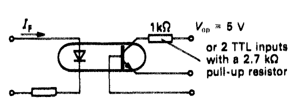
Linear operation (without saturation)



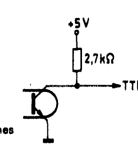
Load resistance	R_L	75	Ω
Turn-on time	t_{on}	3.0 (≤ 5.6)	μs
Rise time	t_r	2.0 (≤ 4.0)	μs
Turn-off time	t_{off}	2.3 (≤ 4.1)	μs
Fall time	t_f	2.0 (≤ 3.5)	μs
Cut-off frequency	f_{co}	250	kHz

I_F = 10 mA
V_{op} = 5 V
T_{amb} = 25°C

Switching operation (with saturation)

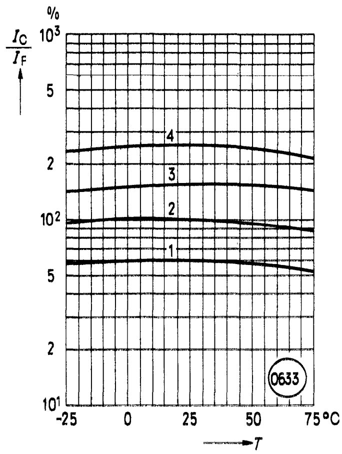


TTL level is observed but no TTL switching times

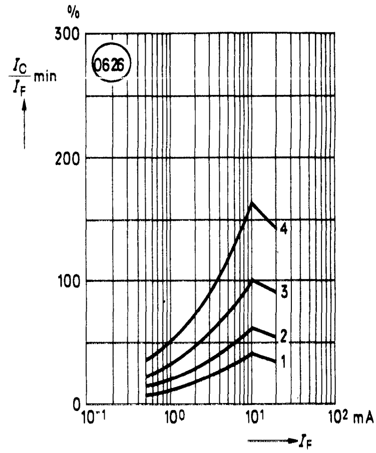


Group		1 I_F = 20 mA	2 and 3 I_F = 10 mA	4 I_F = 5 mA	
Turn-on time	t_{on}	3.0 (≤ 5.5)	4.2 (≤ 8.0)	6.0 (≤ 10.5)	μs
Rise time	t_r	2.0 (≤ 4.0)	3.0 (≤ 6.0)	4.6 (≤ 8.0)	μs
Turn-off time	t_{off}	18 (≤ 34)	23 (≤ 39)	25 (≤ 43)	μs
Fall time	t_f	11 (≤ 20)	14 (≤ 24)	15 (≤ 26)	μs
	$V_{CE\ sat}$	0.25 (≤ 0.4)			V

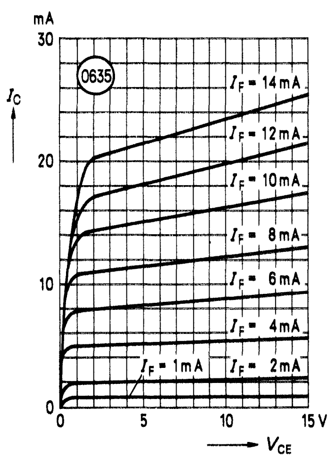
Current transfer ratio (typ.) versus temperature
I_F = 10 mA; V_{CE} = 5 V



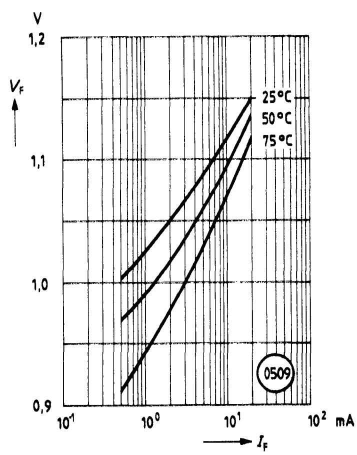
Minimum current transfer ratio versus diode forward current
T_{amb} = 25°C; V_{CE} = 5 V



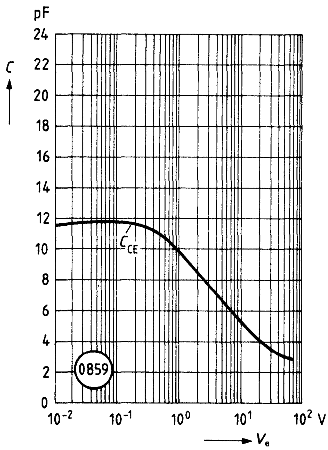
Collector current versus collector-emitter voltage (typ.)
T_{amb} = 25°C



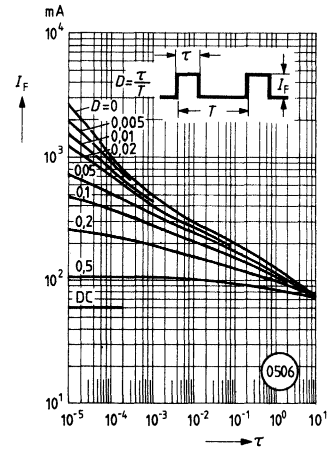
Forward voltage (typ.) of the diode versus forward current



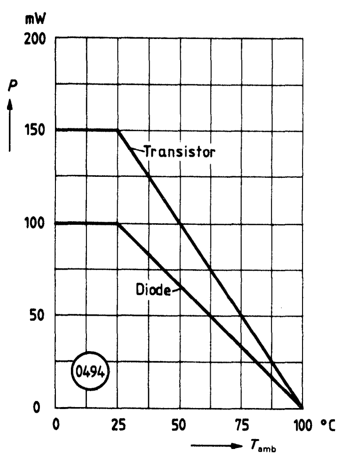
Transistor capacitance (typ.) versus emitter voltage
T_{amb} = 25°C; f = 1 MHz



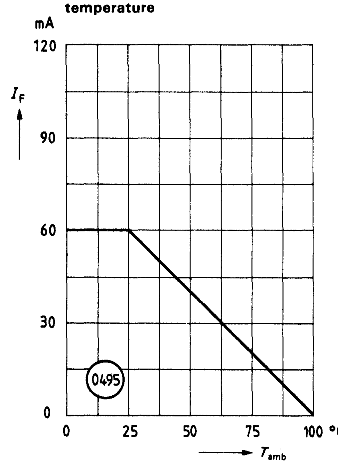
Permissible pulse handling capability
Forward current versus cycle duration
D = parameter; T_{amb} = 25°C



Permissible power dissipation versus ambient temperature



Permissible forward current of the diode versus ambient temperature

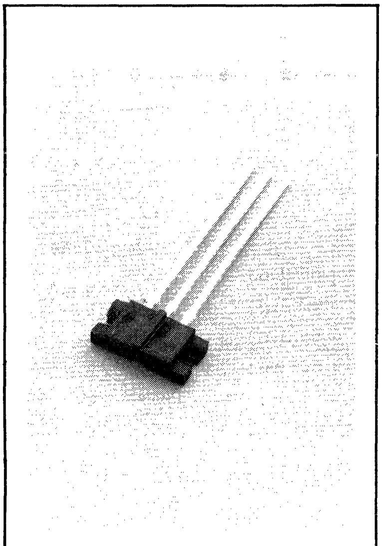


SIEMENS

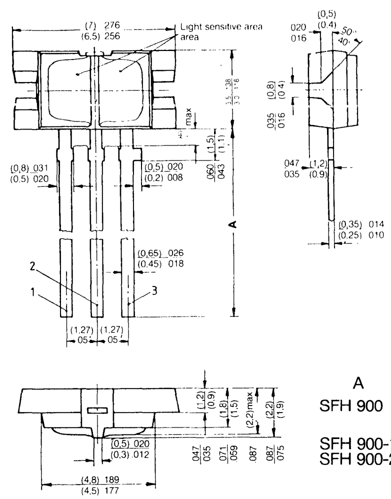
SFH 900 SERIES

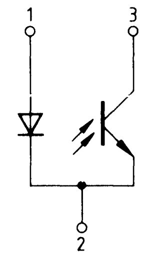
MINIATURE LIGHT REFLECTION EMITTER/SENSOR

Preliminary



Package Dimensions in Inches (mm)





1. EMITTER ANODE
2. EMITTER CATHODE/ DETECTOR EMITTER
3. DETECTOR COLLECTOR

	A	
SFH 900	(5,6)	.220
	(5,2)	.205
SFH 900-1	(14,3)	.563
SFH 900-2	(13,3)	.524

FEATURES

- **IR Emitter and NPN Phototransistor Detector**
- **High Sensitivity**
- **Designed for Short Distances Up to 5 mm**
- **Three Current Transfer Ratio Groups**

SFH 900 — 5.6 mm leads, $I_{ce} > 0.5$ mA
SFH 900-1 — 14.3 mm leads, $I_{ce} > 0.3$ mA
SFH 900-2 — 14.3 mm leads, $I_{ce} > 0.5$ mA

DESCRIPTION

The SFH 900 is a reflex light barrier for short distances, operating in the infrared range, which includes a GaAs IRED as transmitter and an NPN phototransistor with a high photosensitivity as receiver. Both components are manufactured in modern strip-line technique and are mounted side-by-side in a plastic package. A daylight filter screens against undesired light effects.

The miniature relex light barrier is designed for applications in industrial and entertainment electronics, e.g., as position reporting device and end position switch, for speed monitoring or in general, as a sensor element in various types of motion transmitters.

Maximum Ratings

Emitter (GaAs Infrared Diode)

Reverse Voltage (V_R)	6 V
Forward Current (I_F)	50 mA
Surge Current (i_{FS}), $t \leq 10\ \mu s$	1.5 A
Power Dissipation (P_{tot}), $T_{amb} = 40°C$	80 mW

Detector (Silicon Phototransistor)

Collector-Emitter Voltage (V_{CEO})	30 V
Emitter-Base Voltage (V_{EBO})	7 V
Collector Current (J_{CE})	10 mA
Power Dissipation (P_{tot})	100 mW

Package

Storage Temperature (T_{stor})	-40 to +85°C
Operating Temperature (T_{amb})	-40 to +85°C
Junction Temperature (T_j)	100°C
Soldering Temperature (T_s) ($t<3_{sec}$[1])	235°C
	260°C[2]
Power Dissipation	150 mW

Characteristics ($T_{amb} = 25°C$)

Emitter (GaAs Infrared Diode)

Forward Voltage (V_F), I_F=50 mA	1.25 (≤1.65) V
Breakdown Voltage (V_{BR}), ($I_R = 10\mu A$)	30 (≥6) V
Reverse Current (I_R), V_R = 6V	0.01 (≤10) μA
Capacitance (C_O) (V_R = 0 v; f = 1 MHz)	40 pF
Thermal Resistance (R_{thJL})	750 K/W

Detector (Silicon Phototransistor)

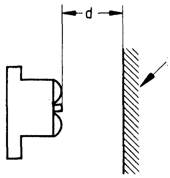
Capacitance (V_{CE} = 5 V; f = 1 MHz)	
C_{CE}	11 pF
C_{CB}	15 pF
C_{EB}	16 pF
Thermal Resistance (R_{thJL})	600 K/W
Collector-Emitter Leakage Current (I_{CEO}) (V_{CE} = 10 V)	20 (≤200) nA
Photo Current (I_p) (V_{CE} = 5 V; E_E = 0.5 mW/cm²)	≤3 mA

[1]) Dip Soldering; 3 mm From Case Bottom.
[2]) With Heat Sink Between Case & Soldering.

 Specifications subject to change without notice.

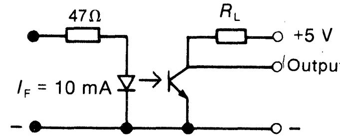
Reflex light barrier

Coupling factor
Collector-emitter current
(I_F = 10 mA; V_{CE} = 5 V; d = 1mm) SFH900 I_{CE} ... ⩾0.5 mA
SFH900-1 I_{CE} ... ⩾0.3 mA
SFH900-2 I_{CE} ... ⩾0.5 mA



Reflector
with 90% reflection
(Kodak neutral white
test card)

Test circuit

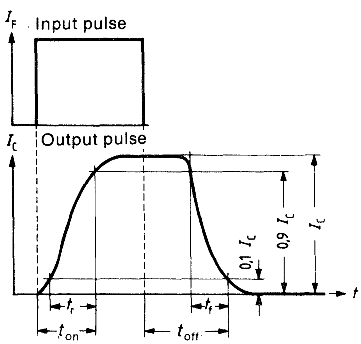


Load resistance	R_L	1	kΩ
Turn-on time	t_{on}	65 (typ.)	µs
Rise time	t_r	50 (typ.)	µs
Turn-off time	t_{off}	55 (typ.)	µs
Fall time	t_f	50 (typ.)	µs

I_F = 10 mA

I_C = 1 mA

Switching characteristics



According to the figure above the times are defined as follows:

Turn-on time t_{on}

The turn-on time t_{on} is the time in which the output current (collector current) I_C rises to 90% of its maximum value after activation of the drive current I_F.

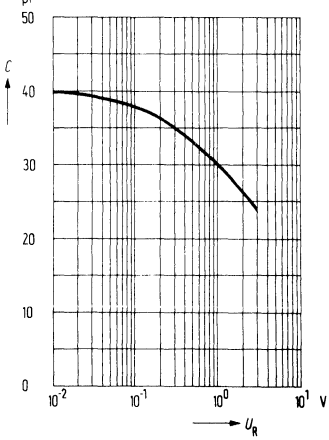
The rise time t_r is the time in which the collector current I_C rises from 10% to 90% of its final value.

Turn-off time t_{off}

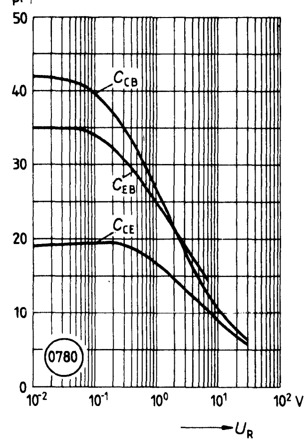
The turn-off time t_{off} is the time in which the output current (collector current) I_C drops to 10% of its maximum value after deactivation of the drive current I_F.

The fall time t_f is the time in which the collector current I_C drops from 90% to 10% of its maximum value.

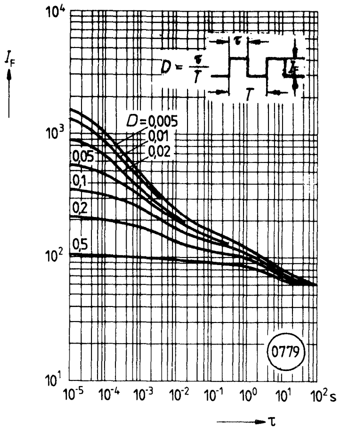
Diode capacitance (typ.)
versus reverse voltage
T_{amb} = 25°C; f = 1 MHz



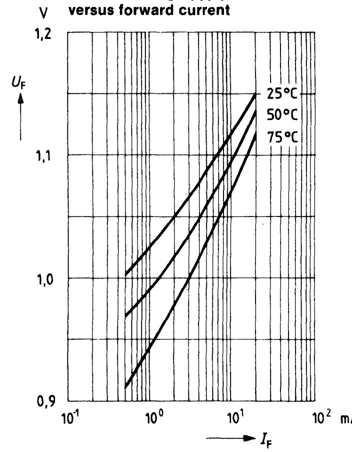
Transistor capacitance (typ.)
versus reverse voltage
T_{amb} = 25°C; f = 1 MHz



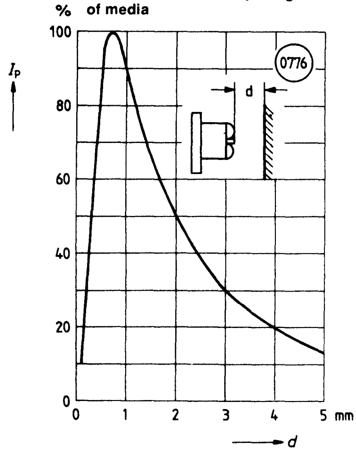
Permissible pulse handling capability
Forward current versus cycle duration
Duty cycle D = parameter
mA T_{amb} = 25°C



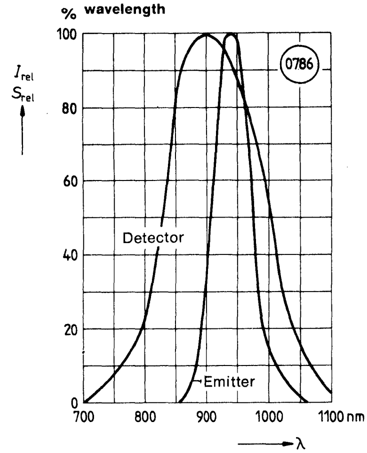
V **Forward voltage (typ.) of diode**
versus forward current



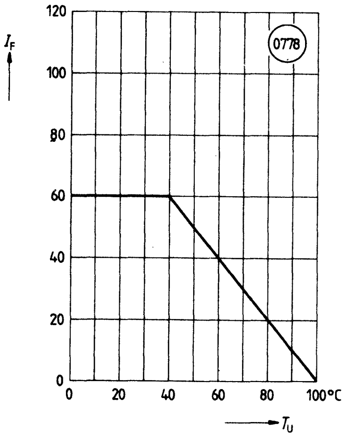
Photocurrent versus spacing
% **of media**



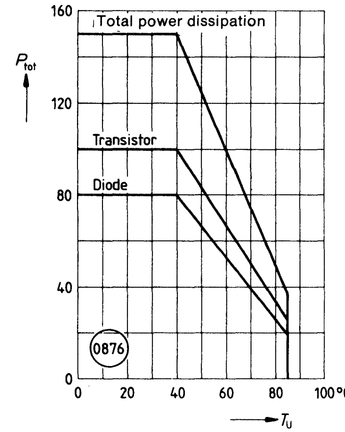
Relative spectral emission
of emitter and detector versus
% **wavelength**



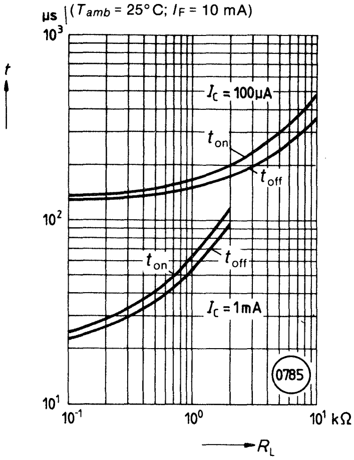
Max. permissable forward current versus ambient temperature



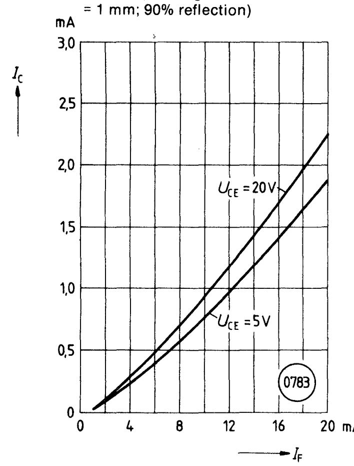
Permissable power dissipation for diode and transistor versus ambient temperature



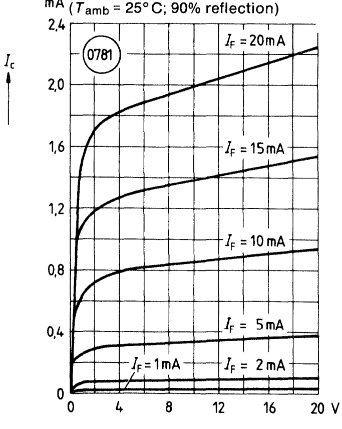
Switching characteristics
t_{on} and t_{off} versus load resistance
(T_{amb} = 25° C; I_F = 10 mA)



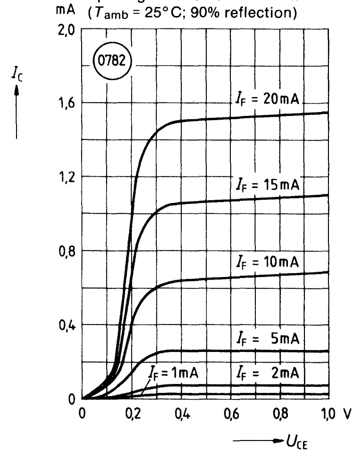
Collector current versus forward current (spacing d to reflector = 1 mm; 90% reflection)

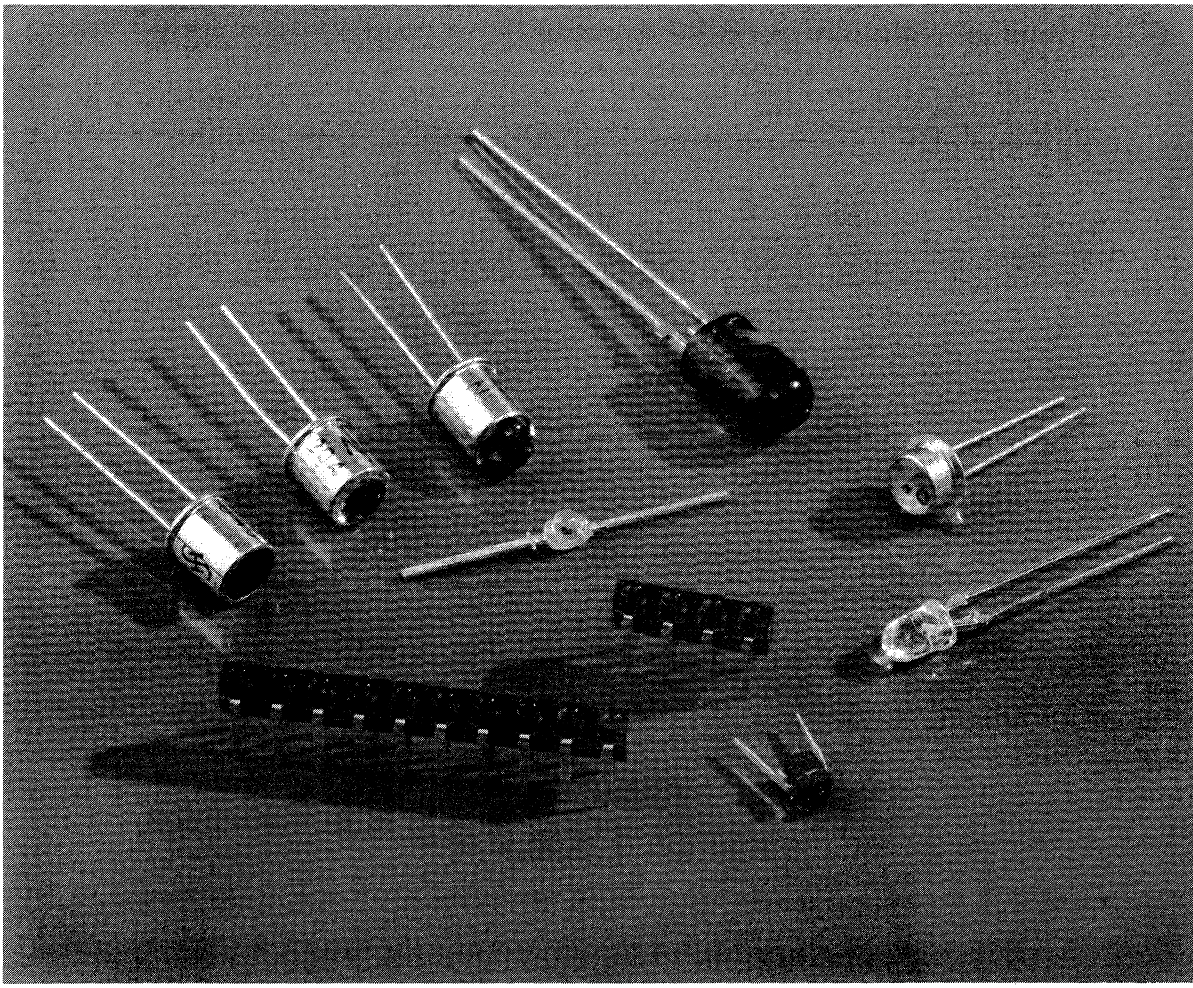


Output characteristics
Collector current versus collector-emitter voltage
Spacing to reflector: d = 1 mm
(T_{amb} = 25° C; 90% reflection)

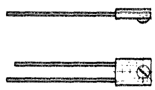
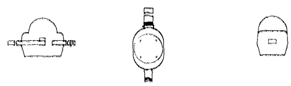
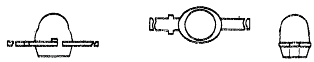
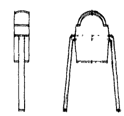
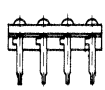
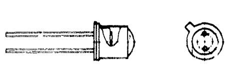


Output characteristics (typ.)
Collector current versus collector-emitter voltage
Spacing to reflector: d = 1 mm
(T_{amb} = 25° C; 90% reflection)

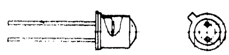
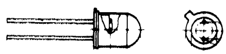
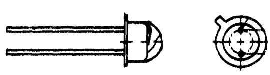
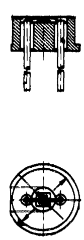
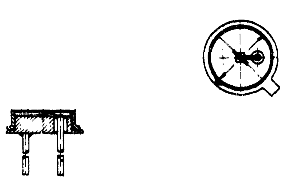




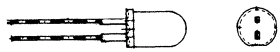
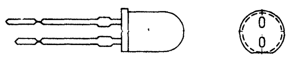
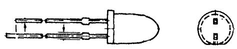
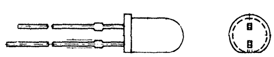
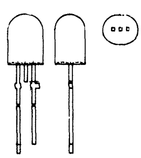
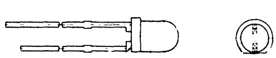
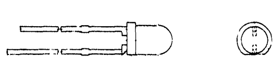
Infrared Emitters

Package Type	Package Outline	Part Number	Half Angle	Radiant Intensity I_e(mW/sr)	@(mA)	Surge Current (t < 10μs) (A)	Features	Page
Miniature Clear Plastic Side Facing	Miniature & Arrays 	IRL-80	40°	2.75(>0.7)	50	3	Ga As, 950 nm, side facing device, wide beam. Matches with LPT-80 phototransistor.	281
		IRL-81	40°	4.5 Typ.	50	2.8	Ga Al As, 880 nm, side facing device. Matches with LPT-80 photo-transistor or LPD-80 photodarlington.	283
Miniature Axial Lead		IRL-60	25°	Total external radiated power >400μW	50	1.5	Small package size Axial Lead Ga As, 900 nm	279
Miniature Axial Lead High Dome Lens		IRL-61	18°	Total external radiated power >400μ W	50	1.5	Small package size Axial Lead Ga As, 900 nm	No Data Sheet
Miniature Radial Lead 1 mm Pkg. Width		SFH405-2 SFH405-3 SFH405-4	16°	1.6-3.2 2.5-5.0 4.0-8.0	50	1.5	Ideal for very short range light barriers. Extremely thin, .039" (1 mm) package width. Radial Lead Ga As, 950 nm Matches with SFH305 phototransistor	306
Miniature Radial Lead 2 mm Pkg. Width		LD261-4 LD261-5	30°	2.0-4.0 3.2-6.3		1.5	Small package size Radial Lead GaAs, 950 nm Matches with BPX81 phototransistor	290
2 Diode Array 3 Diode Array 4 Diode Array 5 Diode Array 6 Diode Array 7 Diode Array 8 Diode Array 9 Diode Array 10 Diode Array		LD262 LD263 LD264 LD265 LD266 LD267 LD268 LD269 LD260	30°	2.0-10	50	1.5	Ideal for card readers. 2 Through 10 diode arrays Ga As, 950 nm Matches with BPX80 family of phototransistors	
TO-18 Round Glass Lens	High Reliability 	SFH400-2 SFH400-3	6°	20-40 32-64	100	5	Hermetic seal for high rel use. Narrow angle Ga As, 950 nm Recommended for use with BPX-43 phototransistor	298
TO-18 Dome Glass Lens		SFH401-2 SFH401-3	15°	10-20 16-32		5	Hermetic seal for high rel use. Very narrow angle. Ga As, 950 nm Recommended for use with BPY62 phototransistor	300

Infrared Emitters

Package Type	Package Outline	Part Number	Half Angle	Radiant Intensity I_e(mW/sr)	@(mA)	Surge Current (t < 10μs) (A)	Features	Page
TO-18 Flat Glass Lens	High Reliability 	SFH402-2 SFH402-3	40°	2.5-5.0 4.0-8.0	100	5	Hermetic seal for high rel use Wide angle Ga As, 950 nm Recommended for use with BPX38 phototransistor or BPX65/BPX66 photodiodes.	302
TO-18 Round Glass Lens		SFH480	6°	50	100	2.5	Hermetic seal for high rel use. Very narrow angle, very high intensity Ga Al As, 880 nm.	312
TO-18 Flat Glass Lens		SFH481	15°	20	100	2.5	Hermetic seal for high rel use. Narrow angle, high intensity Ga Al As, 880 nm.	313
TO-18 Flat Glass Lens		SFH482	40°	7	100	2.5	Hermetic seal for high rel use. Wide angle, Ga Al As, 880 nm.	314
Modified TO-18 Lens Plastic		LD242-2 LD242-3	60°	4.0-8.0 6.3-12.5	100	5	Suitable for sound transmission. Ideal for short range light barriers. Very wide angle High power Ga As, 950 nm Matches with BP103 phototransistor and BPX63 photodiode.	288
TO-46 Flat Plastic Package	Fiber Optics 	SFH404	not applicable	output rad. power approx. 100μW Direct contact optical fiber (ø > 2 mm)	80	.3	Burrus type Long range For fiber optics applications. Ga Al As, 830 nm/ 40 Mbit/s	304
TO-46		SFH407-1 SFH407-2 SFH407-3	not applicable	0.4-0.8 .63-1.25 1.0-2.0	100	.2 (t < 100μs)	For fiber optics applications. Ga As, 900 nm/5 Mbit/s High radiant intensity	308

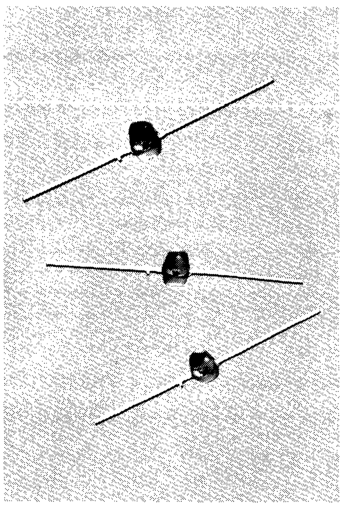
Infrared Emitters

Package Type	Package Outline	Part Number	Half Angle	Radiant Intensity I_e(mW/sr)	@(mA)	Surge Current (t < 10μs) (A)	Features	Page
T1¾ 5 mm Grey Plastic		LD271	25°	10-15	100	2.5	IR remote control. Most commonly used IR emitter. Low cost Wide angle high power Ga As, 950 nm Recommended for use with SFH205 or BP104 photodiode or BP103B phototransistor	292
		LD271H		≧ 16				
		LD271L (1" Leads)		10-15				
T1¾, 5 mm Blue Plastic		LD274	10°	60(≥30)	100	3	IR remote control Ga As, 950 nm, very high intensity, narrow angle, matches with SFH205, TSP104 and BP103B photo-transistor	296
T1¾, 5 mm Clear Plastic		SFH484	8°	100(≥50)	100	2.8	IR remote control Ga Al As, 880 nm. Extremely high intensity, narrow angle.	315
T1¾, 5 mm clear plastic	Infrared Remote Control 	SFH485	18°	30(≥15)	100	2.8	IR remote control Ga Al As, 880 nm. High intensity, medium angle.	317
Grey Oval Plastic Package		LD273	25°	30	100	3	IR Remote control Space Saving IR Emitter. Two IR chips in series Very high power Ga As, 950 nm Recommended for use with SFH205 or BP104 photodiode or BP103B phototransistor	294
T1 3 mm Plastic		SFH409	30°	>5	100	2	IR remote control. Small (T1) size Ga As, 950 nm Matches with SFH309 phototransistor	310
T1, 3 mm Clear Plastic		SFH487	20°	30(≥15)	100	2	IR remote control Ga Al As, 880 nm. High intensity medium angle.	321

SIEMENS

IRL-60

INFRARED EMITTER



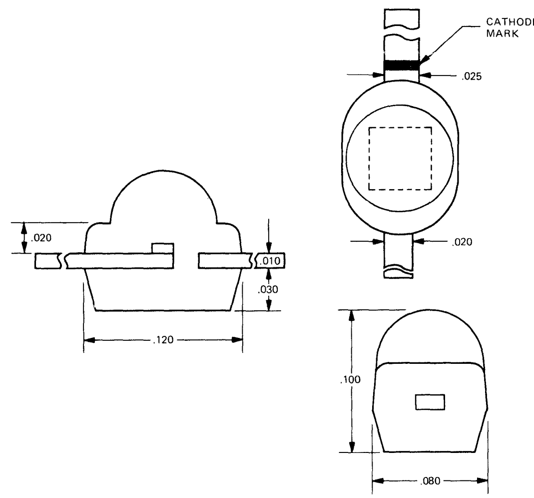
FEATURES

- Spectrally matched to Silicon Sensors
- Maximum package strength consistent with mounting on .087" centers
- Optical Encoding source
- Positioning and counting source
- Solid State reliability

DESCRIPTION

The IRL-60 is a gallium arsenide infrared emitting diode. On forward bias, it emits a spectrally narrow intense band of radiation peaking at 900 nm (the peak sensitivity point of silicon detectors). The packaging of this unit permits close-spacing in linear arrays. Its low cost and volume producibility opens new areas of use anywhere an infrared source is desirable.

DIMENSIONS (in inches, Nominal)



Maximum Ratings

Power Dissipation, 25°C	75 mW
Derate Linearly from 25°C	1.0 mW/°C
Storage and Operating Temperature	−55 + 100°C
Reverse Voltage	3.0 V
DC forward current	50 mA
Lead solder time @ 260°C (Note 1)	10 sec

Opto-Electronic Characteristics

Parameter	Min	Typ	Max	Units	Test Conditions
Total External Radiated Power	400	550		µW	I_F = 50 mA
Forward Voltage		1.3	1.5	V	I_F = 50 mA
Reverse Current		.15	10	µA	I_F = 3.0 V
Radiation Rise and Fall		1.0		n sec	
Capacitance		80		pF	V=0
Peak Emission Wave Length		900		nm	
Spectral Line Half-Width		40		nm	

NOTE:
1) The leads were immersed in 260° molten solder to a distance 1/16" from the body of the device per MIL-S-750.

TYPICAL OPTO-ELECTRONIC CHARACTERISTIC CURVES

Figure 1 — Radiant Intensity vs. Angle

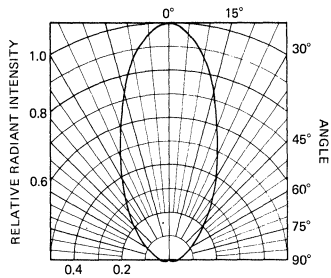


Figure 2 — Output Power vs. Input Current

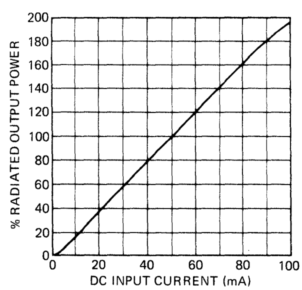
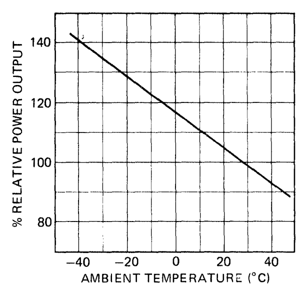


Figure 3 — % Relative Power Output vs. Ambient Temperature

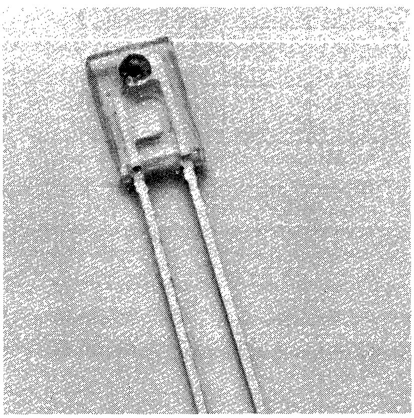


SIEMENS

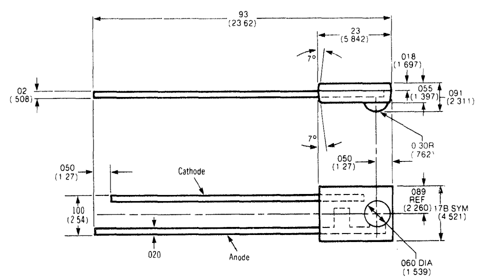
IRL-80

INFRARED EMITTER

Preliminary



Package Dimensions in inches (mm)



FEATURES

- **GaAs Infrared emitting diode**
- **Low Cost**
- **Miniature side facing package**
- **Clear Plastic**
- **Long Term Stability**
- **Wide Beam, 40°**
- **Matches phototransistor LPT-80**

DESCRIPTION

The GaAs infrared emitting diode IRL-80 is designed to emit radiation at a wavelength in the near infrared range. The chip is positioned to emit radiation from the side of the clear plastic miniature package. It operates efficiently with the matching LPT-80 phototransistor.

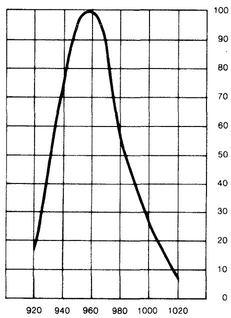
Maximum Ratings

Reverse voltage	V_R	4	V
Forward current	I_F	50	mA
Storage temperature	T_{stor}	−40 to +100	°C
Power dissipation (T_{amb} = 25 °C)	P_{tot}	100	mW
Derate above 25 °C		2.0	mW/°C

Characteristics (T_{amb} = 25 °C)

Wavelength of radiation at I_{max}		950	nm
Spectral bandwidth at 50% of I_{max}		±20	nm
Radiant intensity in axial direction I_F = 50 mA for half angle φ = 40°	I_e	2.75(≥0.7)	mW/sr
Half angle (limits for 50% of radiant intensity I_e)	φ	40	degree
Switching times (Φ_e from 10% to 90%; 90% to 10% I_F = 50mA)	t_r, t_f	2; 1,5	µs
Forward voltage (I_F = 100 mA)	V_F	1.4(≦1.7)	V
Breakdown voltage (I_R = 100 µA)	V_{BR}	30(≧4)	V
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 Φ peak	TC	+0.3	nm/K

Specifications are subject to change without notice

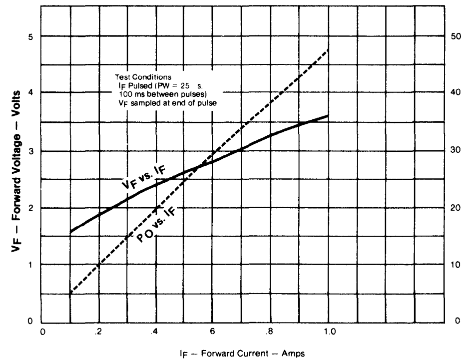


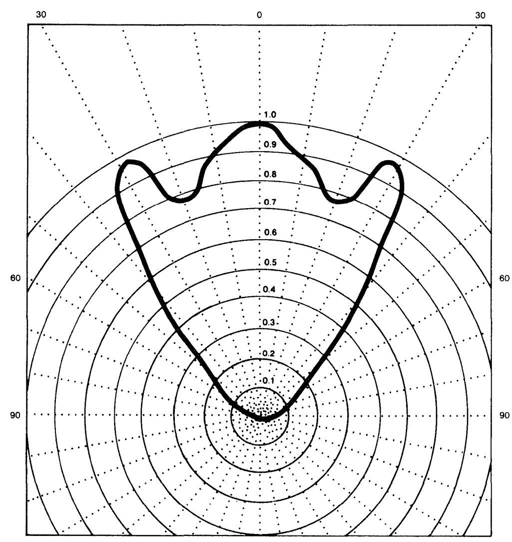
I_{rel}%

Relative Spectral Emission

(LAMBDA) NM

FORWARD VOLTAGE AND POWER OUTPUT vs. FORWARD CURRENT





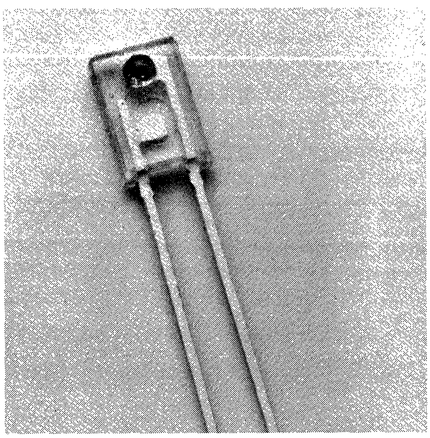
Radiation Characteristics

SIEMENS

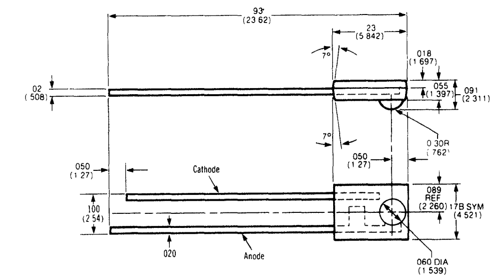
IRL-81

INFRARED EMITTER

Preliminary



Package Dimensions in inches (mm)



FEATURES

- **GaAlAs Infrared emitting diode**
- **Low Cost**
- **Miniature side facing package**
- **Clear Plastic**
- **Long Term Stability**
- **Wide Beam, 40°**
- **Matches phototransistor LPT-80**

DESCRIPTION

The GaAlAs infrared emitting diode IRL-81 is designed to emit radiation at a wavelength in the near infrared range. The chip is positioned to emit radiation from the side of the clear plastic miniature package. It operates efficiently with the matching LPT-80 phototransistor.

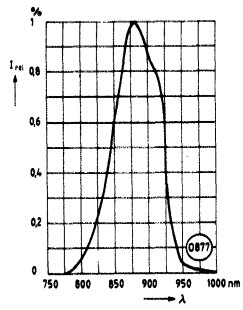
Maximum Ratings

Reverse voltage	V_R	5	V
Forward current	I_F	100	mA
Storage temperature	T_{stor}	− 40 to + 100	°C
Power dissipation (T_{amb} = 25 °C	P_{tot}	200	mW
Derate above 25 °C		1.33	mW/ °C

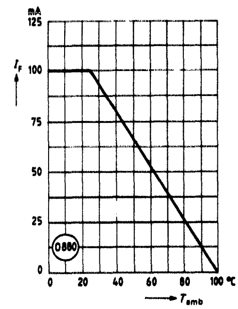
Characteristics (T_{amb} = 25 °C)

Wavelength of radiation at I_{max}	λpk	883	nm
Spectral bandwidth at 50% of I_{max}	Δλ	− 36... + 44	nm
Radiant intensity in axial direction		4.5	
I_F = 50 mA for half angle φ = 40°	I_e	4.5	mW/ sr
Half angle (limits for 50% of radiant intensity I_e)	φ	40	degree
Switching times (Φ from 10% to 90%; 90% to 10% I_F = 100 mA)	t_r, t_f	.6/.5	µs
Forward voltage (I_F = 20 mA)	V_F	1.5 (≤2.0)	µs
Breakdown voltage (I_R = 10 µA)	V_{BR}	30(≥5)	V
Radiant Intensity I_F = 20mA	I_e	≥0.5	mW/sr
Radiant Power Output I_F = 20mA	P_o	1.5	mW
Temperature coefficient of I_e or Φ_e	TC	− 0.50	%/K
Temperature coefficient of V_F	TC	− 0.2	%/K
Temperature coefficient of Φ peak	TC	+ 0.25	nm/K

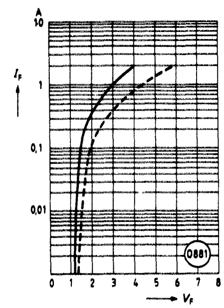
Relative spectral emission
$I_{rel} = f(\lambda)$

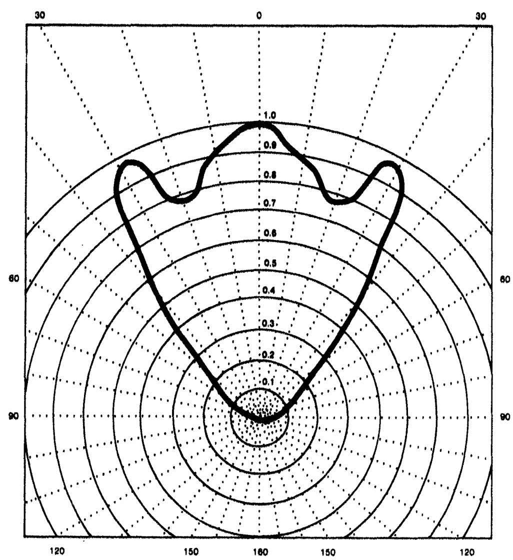


Maximum permissible forward current
$I_F = f(T_{amb})$



Forward current
$I_F = f(V_F)$





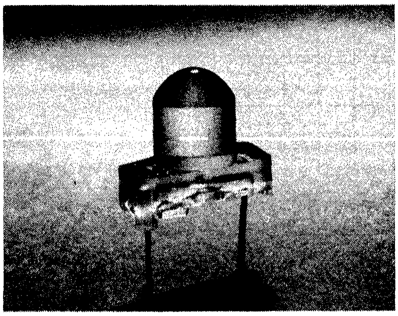
Radiation Characteristics

SIEMENS

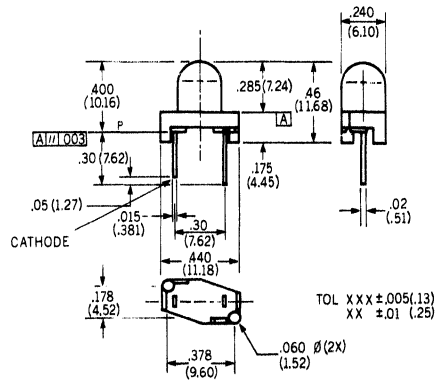
IRL-500

INFRARED EMITTER

Advance Data Sheet



Package Dimensions in Inches (mm)



FEATURES

- **Extremely accurate mechanical to optical alignment.**
- **Package referenced for users to maintain mechanical alignment.**
- **Spot size @ 20 inches is less than 1.5 inches diameter.**
- **Extremely narrow beam—typically 2.5° half angle.**
- **Clear lens.**
- **High intensity—greater than 30 mW/sr @ 100 mA.**
- **Peak emission @ 890 nm—very closely matched to silicon detectors.**
- **Fast on, off. Bandwidth to 7 MHz.**
- **Matches with LPT-500 Phototransistor.**

DESCRIPTION

The IRL-500 is a GaAs infrared emitting diode designed to achieve superior optical coupling between emitter and detector. Because of the precision injection molded housing and manufacturing techniques the optical axis can be referred to any of 3 mechanical references to a tolerance within 2.5 degrees. The emitter's extremely narrow beam of 5 degrees (2.5° half angle) contains about 65% of the emitted flux and is therefore suitable for applications that require more effective optical coupling with the detector and high resolution. It can also be effectively coupled with any detector. This device is also useful as a beam interrupter in security systems, industrial controls and other applications that advantage of the narrow beam and precision alignment. It matches with the LPT-500 phototransistor detector.

MAXIMUM RATINGS

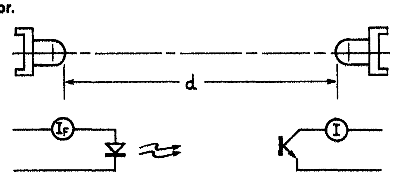
Reverse voltage	V_R	2 V
Forward current	I_F	50 mA
Surge current ($\tau \leq 100\ \mu s$)	i_{FS}	200 mA
Storage temperature range	T_{stg}	−40 . . . +80°C
Junction temperature	T_j	80°C

Characteristics (25° C)

Wavelength of Peak Emission	λpeak	893 nm
Spectral Bandwidth at 50% of Imax	Δλ	35 nm
Radiant intensity in axial direction @ 100 mA	I_e	40 mW/sr
Half Angle (50% of Radiant intensity)	φ	2.5°
Rise Time @ I_F = 100 mA	t_r	50 nS
Fall Time @ I_r = 100 mA	t_f	40 nS
Bandwidth		7 MHz

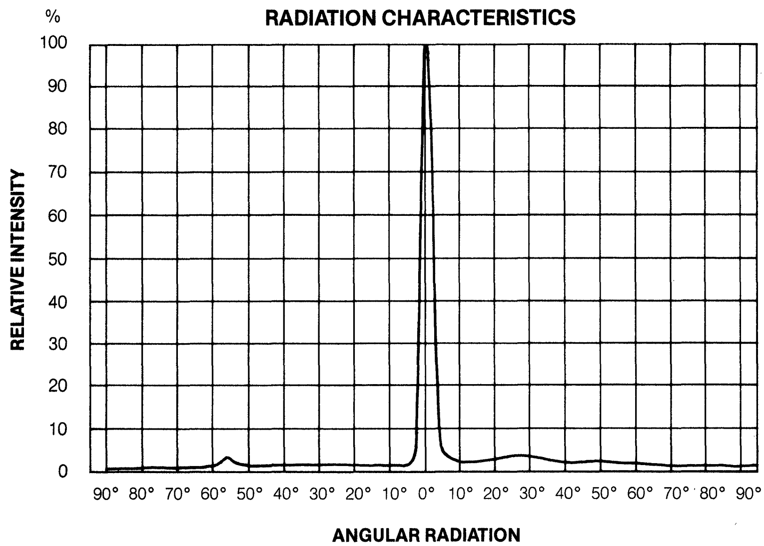
Coupling Characteristics

Typical coupling characteristics using an IRL-500 emitter & LPT-500 phototransistor.

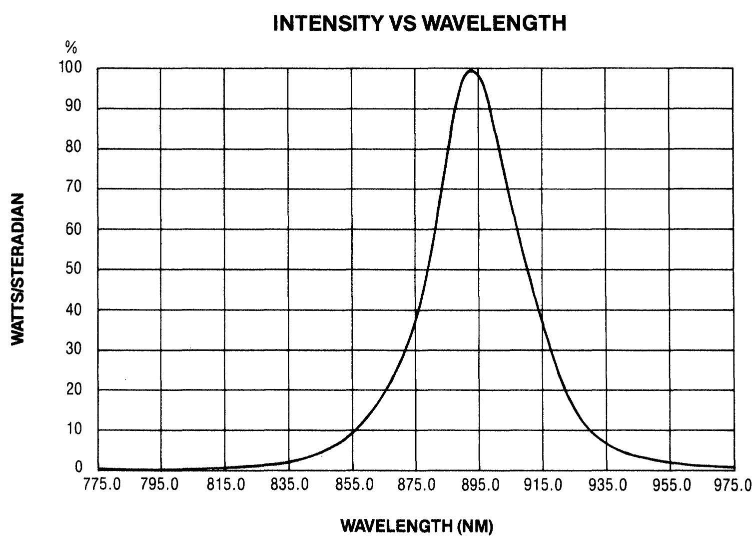


IRL-500 @ I_F	**LPT-500** $I = f(d)$ @ V_{CE} = 5V d = 4 inches	8 inches	20 inches
10 mA	4.35 mA	1.62 mA	.201 mA
20 mA	10.52 mA	4.20 mA	.570 mA
50 mA	20.13 mA	12.82 mA	1.870 mA

Specifications are subject to change without notice.



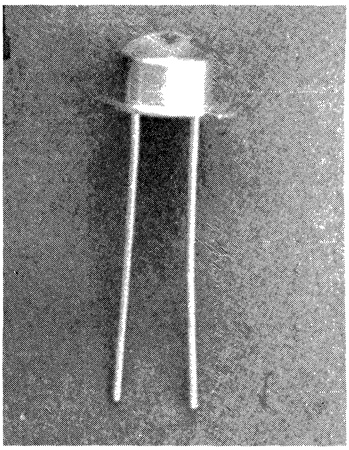
RADIATION CHARACTERISTICS
%
100
90
80
70
60
50
40
30
20
10
0
RELATIVE INTENSITY
90° 80° 70° 60° 50° 40° 30° 20° 10° 0° 10° 20° 30° 40° 50° 60° 70° 80° 90°
ANGULAR RADIATION



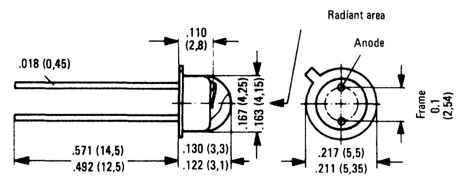
INTENSITY VS WAVELENGTH
%
100
90
80
70
60
50
40
30
20
10
0
WATTS/STERADIAN
775.0 795.0 815.0 835.0 855.0 875.0 895.0 915.0 935.0 955.0 975.0
WAVELENGTH (NM)

SIEMENS

LD 242 SERIES
INFRARED EMITTER



Package Dimensions in Inches (mm)



Maximum Ratings

Reverse voltage	V_R	4	V
Forward current	I_F	300	mA
Surge current ($t \leq 1$ µs)	i_{FS}	5	A
Junction temperature	T_j	100	°C
Storage temperature	T_{stor}	−60 to + 100	°C
Power dissipation	P_{tot}	470	mW
Thermal resistance			
Junction to air	R_{thJamb}	450	K/W
Junction to case	$R_{thJcase}$	135	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_0	40	pF
Forward voltage (I_F = 100 mA)	V_F	1.35 (≤1.7)	V
Forward voltage (I_F = 1 A)	V_F	1.9 (≤2.3)	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

Radiant Intensity & Power

Type	Group	Min	Typ	Max	Unit	Test Condition
LD 242-2	Intensity I_e	4.0		8.0	mW/sr	100 mA
	Φ_e (Total)		10		mW	100 mA
LD 242-3	Intensity I_e	6.3		12.5	mW/sr	100 mA
	Φ_e (Total)		16		mW	100 mA

Specifications are subject to change without notice.

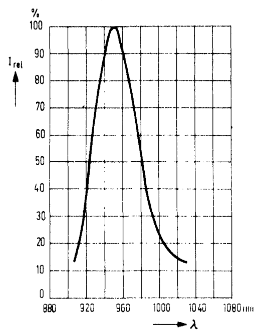
FEATURES

- **Modified TO-18 Size Metal Case**
- **Rounded Plastic Lens**
- **Long Term Stability**
- **Very Wide Beam, 60°**
- **Very High Power, 16 mW Typical**
- **High Intensity, 12.5 mW/sr**

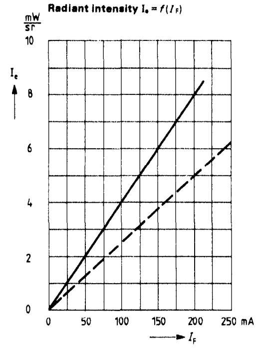
DESCRIPTION

The GaAs infrared emitting diode LD 242 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 anode terminal is marked by the adjacent projection on the rim of the case bottom. The cathode is electrically connected to the case. The LD 242 is particularly suitable for use as emitter for IR sound transmission in radio and TV sets.

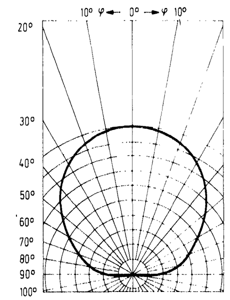
Relative spectral emission $I_{rel} = f(\lambda)$



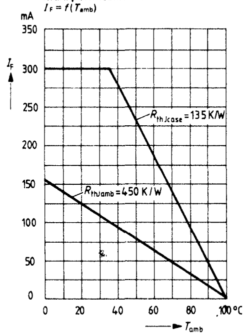
Radiant intensity $I_e = f(I_F)$



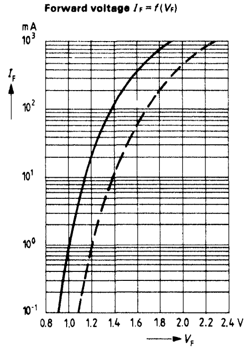
Radiation characteristic $I_{rel} = f(\varphi)$



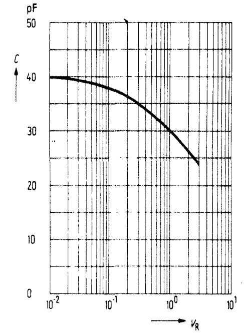
Max. permissible forward current
$I_F = f(T_{amb})$



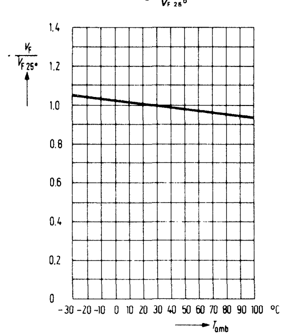
Forward voltage $I_F = f(V_F)$



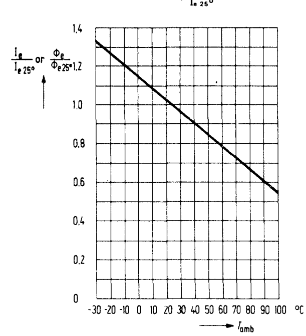
Capacitance $C = f(V_R)$



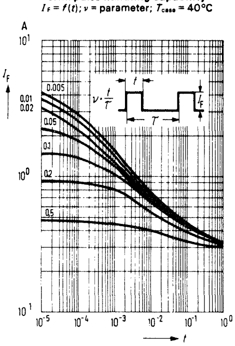
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



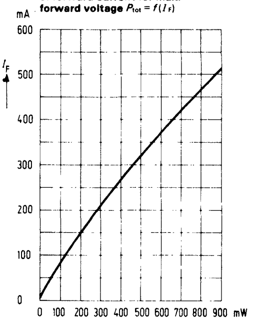
Radiant intensity $\frac{I_e}{I_{e\,25°}} = f(T_{amb})$



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

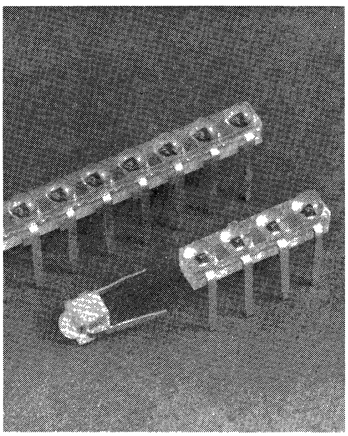


Power dissipation as a function of forward current for max. forward voltage $P_{tot} = f(I_F)$



SIEMENS

LD 261 SERIES
INFRARED EMITTER
SINGLE AND ARRAYS



FEATURES

- Low Cost
- Miniature Size
- Available As Single Unit, LD 261 and Arrays—
  Two Diodes, LD 262
  Three Diodes, LD 263
  Four Diodes, LD 264
  Five Diodes, LD 265
  Six Diodes, LD 266
  Seven Diodes, LD 267
  Eight Diodes, LD 268
  Nine Diodes, LD 269
  Ten Diodes, LD 260
- Medium Wide Beam, 30°
- High Power, 8 mW Typical
- High Intensity, 10 mW/sr

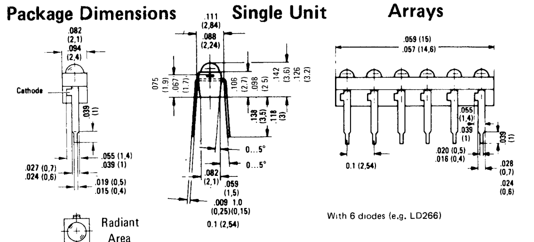
DESCRIPTION

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 grey plastic material provides lens-shaped light output. The plastic is slightly orange colored 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 colored dot.

The LD 261 in conjunction with the BPX 81 phototransistor is suitable for use in light barriers when emitter and detector are spaced approximately 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.

Package Dimensions — Single Unit — Arrays



Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

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)

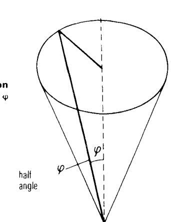
Wavelength at peak emission at I_{max}	λ_{peak}	950	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	±20	nm
Switching times			
(I_e from 10% to 90%; I_F = 50 mA)	t_r; t_f	1	μs
Capacitance at V_R = 0 V	C_0	60	pF
Forward voltage (I_F = 50 mA)	V_F	1.25 (≤ 1.6)	V
Breakdown voltage (I_R = 100 μA)	V_{BR}	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 angle	φ	30	degree

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

Radiant Intensity & Power

Type	Color Code (Cathode)	Group	Min	Typ	Max	Unit	Test Condition
LD 261-4	Yellow	Intensity I_e	2.0		4.0	mW/sr	50 mA
		Φ_e (Total)		3.2		mW	50 mA
LD 261-5	Green	Intensity I_e	3.2		6.3	mW/sr	50 mA
		Φ_e (Total)		5		mW	50 mA
LD 262 thru LD 260		I_e*	2		10	mW/sr	50 mA
LD 262A thru LD 260A		I_e*	2.5		5.0	mW/sr	50 mA
LD 262B thru LD 260B		I_e*	3.15		6.3	mW/sr	50 mA
LD 262C thru LD 260C		I_e*	4.8		8.0	mW/sr	50 mA

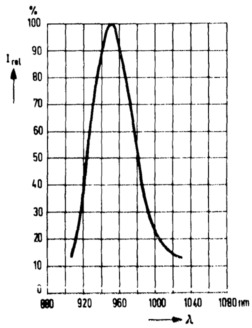
*Radiant flux (radiant power) Φ_e in a cone with a half angle φ of 30



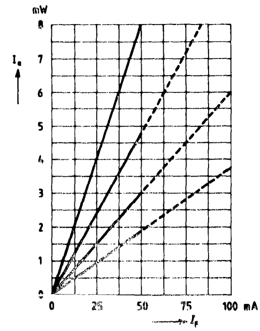
Cone of radiation as a function of the half-angle φ

Specifications are subject to change without notice.

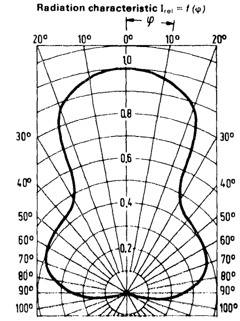
Relative spectral emission $I_{rel} = f(\lambda)$



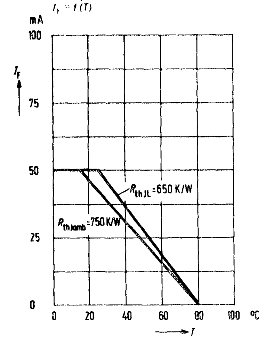
Radiant intensity $I_e = f(I_F)$



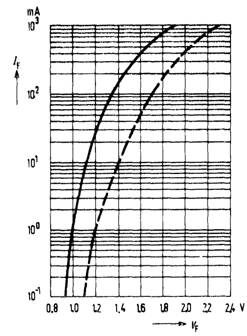
Radiation characteristic $I_{rel} = f(\varphi)$



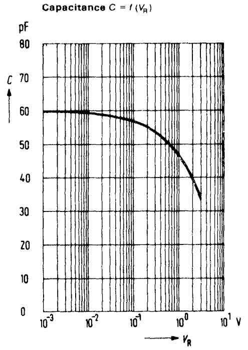
Max. permissible forward current
$I_f = f(T)$



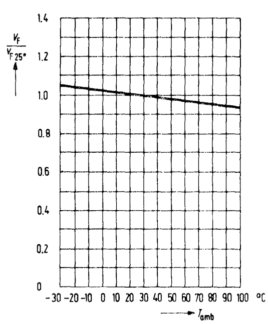
Forward voltage $I_F = f(V_F)$



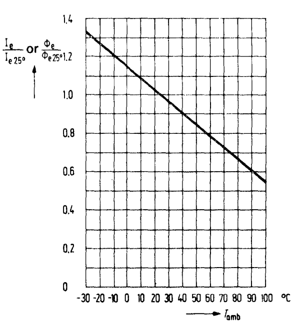
Capacitance $C = f(V_R)$



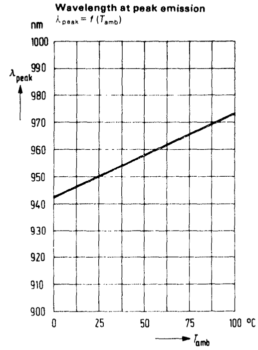
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



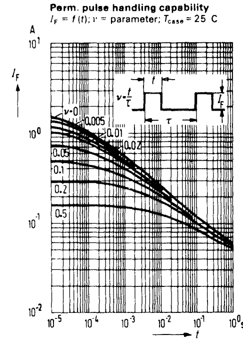
Radiant intensity $\frac{I_e}{I_{e\,25°}} = f(T_{amb})$



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



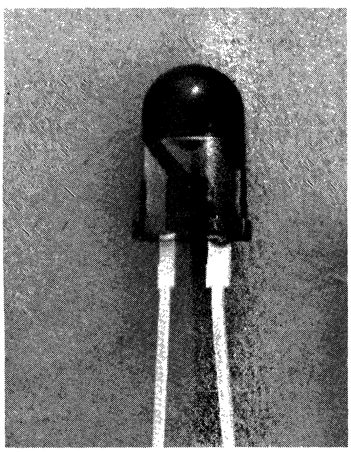
Perm. pulse handling capability
$I_F = f(t)$; ν = parameter; T_{case} = 25 C



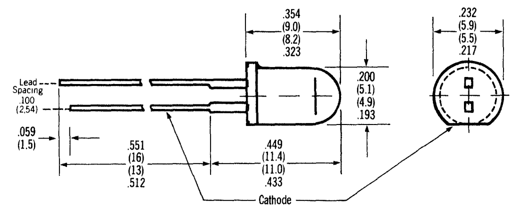
SIEMENS

LD 271 SERIES

INFRARED EMITTER



Package Dimensions in Inches (mm)



FEATURES

- **Low Cost**
- **T-1¾ Package**
- **Lightly Diffused Gray Plastic Lens**
- **LD 271L, 1-inch Leads (Polarized)**
- **Long-Term Stability, Typical 1000 Hour Degradation is Less Than 20%**
- **Medium Wide Beam, 25°**
- **Very High Power, 16 mW Typical**
- **High Intensity, 16 mW/sr**

DESCRIPTION

The GaAs infrared emitting diode LD 271 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. LD 271 in enclosed in a gray plastic package of 5 mm diameter. It is preferably provided for IR remote control of color TV receivers.

Maximum Ratings

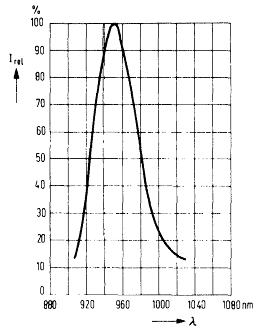
Reverse voltage	V_R	4	V
Forward current	I_F	130	mA
Surge current ($t \leq 10$ µs)	i_{FS}	2.5	A
Junction temperature	T_j	100	°C
Storage temperature	T_{stor}	−55 to + 100	°C
Power dissipation (T_{case} = 40°C)	P_{tot}	210	mW
Thermal resistance Junction to air	R_{thJamb}	350	K/W

Characteristics (T_{amb} = 25°C)

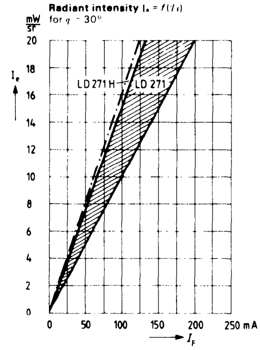
Wavelength of radiation at I_{max}	λ_{peak}	950	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	±20	nm
Radiant intensity in axial direction I_F = 100 mA for half angle φ = 30°			
LD271	I_e	15 (≥ 10)	mW/sr
LD271H		≥ 16	
LD271L		15 (≥10)	
Radiant flux ϕ_e (I_F = 100 mA) total (typ.)	ϕ_e	16	mW
Half angle (limits for 50% of radiant intensity I_e)	φ	25	degree
Switching times (Φ_e from 10% to 90%; I_F = 100 mA)	t_r;t_f	1	µs
Capacitance at V_R = 0 V	C_0	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

Specifications are subject to change without notice.

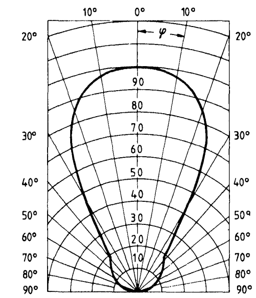
Relative spectral emission $I_{rel} = f(\lambda)$



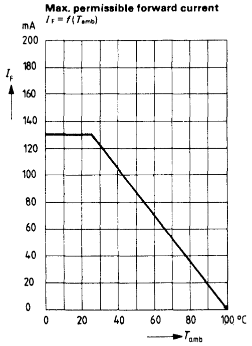
Radiant intensity $I_e = f(I_F)$ for φ = 30°



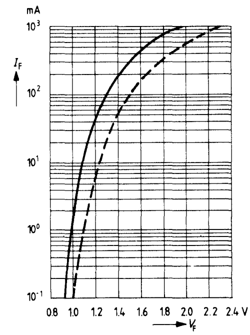
Radiation characteristic $I_{rel} = f(\varphi)$



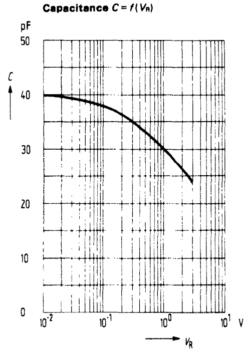
Max. permissible forward current $I_F = f(T_{amb})$



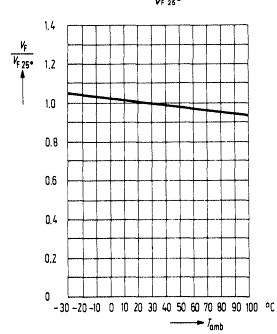
Forward voltage $I_F = f(V_F)$



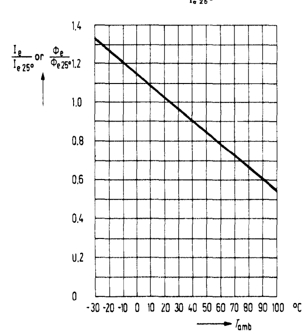
Capacitance $C = f(V_R)$



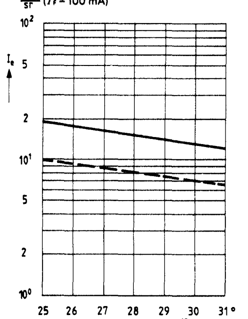
Forward voltage $\frac{V_F}{V_{F\,25°}} = f(T_{amb})$



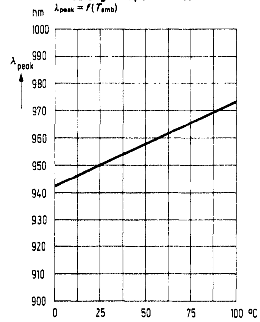
Radiant intensity $\frac{I_e}{I_{e\,25°}} = f(T_{amb})$



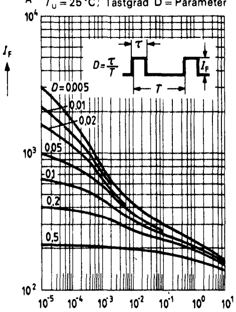
Radiant intensity $I_e = f(\varphi)$ (I_F = 100 mA)



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

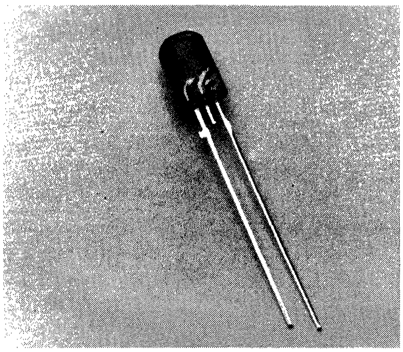


Perm. pulse capability
$I_F = f(\tau)$;
T_U = 25 °C; Tastgrad D = Parameter

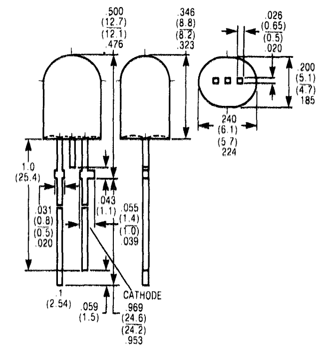


SIEMENS

LD 273
TWO CHIP INFRARED EMITTER



Package Dimensions in inches (mm)



FEATURES

- **Very high radiant intensity greater than 30 mW/sr**
- **Two chip device**
- **Grey oval plastic package**
- **Equivalent to T1¾ size.**

DESCRIPTION

The LD 273 is an infrared emitter consisting of two GaAs-IRLED chips connected in series. This provides a very high radiant intensity of greater than 30 mW/sr. Radiation is emitted in the axial (0°) direction from a smoke colored oval plastic package. This device serves particularly well as a powerful emitter of increased range in remote control applications.

Mounting instruction

In order not to damage the system when soldering in the emitting diodes, the soldering distance to the plastic package has to be dimensioned as large as possible. We recommend a minimum distance of 10 mm between package and soldering point for the usual soldering conditions (260°C/3 sec).

Maximum ratings

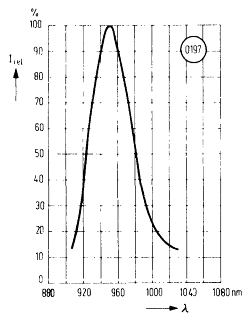
Reverse voltage	V_R	8	V
Forward current	I_F	100	mA
Surge current ($t \leqslant 10\,\mu s$)	i_{FS}	3	A
Junction temperature	T_j	100	°C
Storage temperature range	T_{stg}	−55... +100	°C
Total power dissipation ($T_{case} = 40°C$)	P_{tot}	260	mW
Thermal resistance: junction to ambient air	R_{thJA}	280	K/W

Characteristics ($T_{amb} = 25°C$)

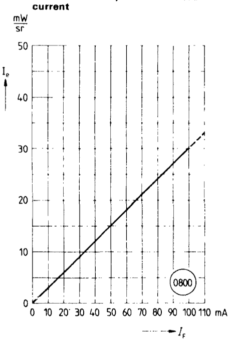
Wavelength at peak emission at I_{max}	λ_{peak}	950	nm
Spectral bandwidth at 50% of I_{max}	$\Delta\lambda$	±20	nm
Radiant intensity in axial direction at $I_F = 100$ mA	I_e	≧30	mW/sr
Half angle Pin terminal plane horizontal (limits for 50% of radiant intensity I_e)	φ_H	25	degrees
Half angle Pin terminal plane vertical (limits for 50% of radiant intensity I_e)	φ_V	15	degrees
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	10	pF
Forward voltage ($I_F = 100$ mA)	V_F	2.55 (≦3.2)	V
Breakdown voltage ($I_R = 100\,\mu A$)	V_{BR}	50 (≧10)	V
Reverse current ($V_R = 10$ V)	I_R	1	µA
Temperature coefficient of I_e or Φ_e	TC	−0.55	%/K
Temperature coefficient of V_F	TC	−3	mV/K
Temperature coefficient of λ_{peak}	TC	+0.3	mm/K

Specifications are subject to change without notice

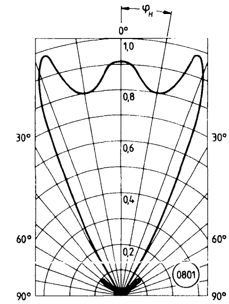
Relative spectral emission versus wavelength



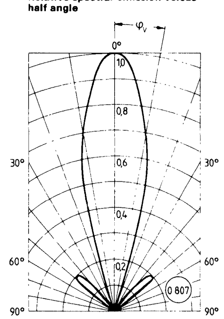
Radiant intensity versus forward current



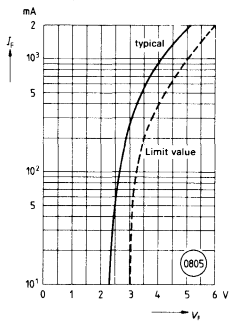
Radiation characteristic horizontally to pin terminal plane Relative spectral emission versus half angle



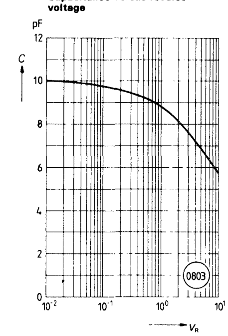
Radiation characteristic vertically to pin terminal plane Relative spectral emission versus half angle



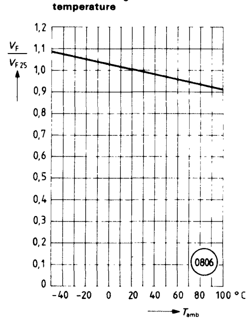
Forward current versus forward voltage



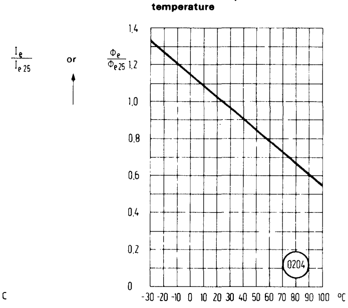
Capacitance versus reverse voltage



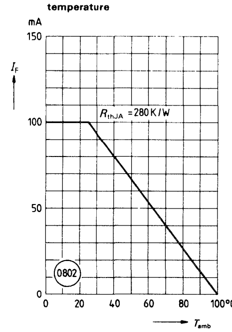
Forward voltage versus ambient temperature



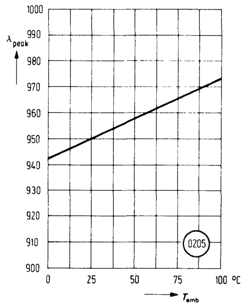
Radiant intensity versus ambient temperature



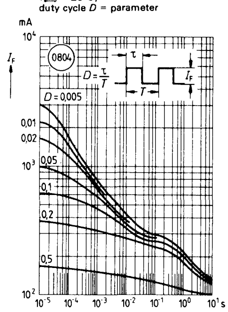
Forward current versus ambient temperature



Wavelength at peak emission versus ambient temperature

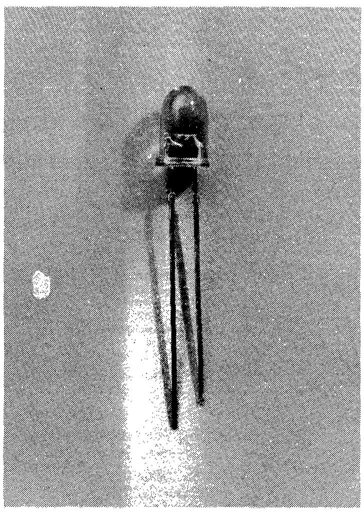


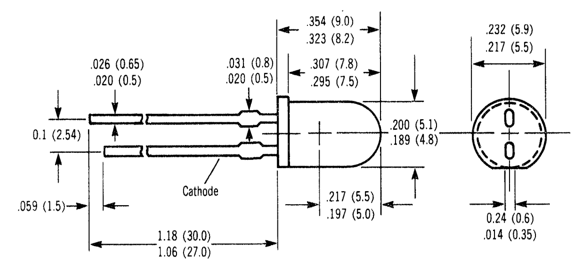
Permissible pulse handling capability Forward current versus cycle duration
T_{amb} = 25°C;
duty cycle D = parameter



SIEMENS

LD 274 Series
INFRARED EMITTER





FEATURES
- **Extremely High Radiant Intensity, 60mW/sr Typical**
- **Low Cost**
- **T 1¾ Package**
- **Lightly Diffused Gray Plastic Lens**
- **Long Term Stability, Typical 1000 Hour Degradation is Less than 20%**
- **Narrow Beam, 10°**
- **Excellent Spectral Match to Silicon Photodetector BP 103B**

DESCRIPTION
The GaAs infrared emitting diode LD 274 emits radiation at a wavelength in the near infrared range. It is enclosed in a T 1¾ plastic package of 5 mm diameter. This device is designed for remote control applications requiring extremely high power.

Maximum Ratings

Storage temperature	T_{stg}	−55 to +100	°C
Soldering temperature			
Distance from casing-solder tab ⩾2mm			
Dip soldering time ⩽5s	T_{sold}	260	°C
Iron soldering time ⩽3s	T_{sold}	300	°C
Junction temperature	T_j	100	°C
Reverse voltage	V_R	5	V
Forward current	I_F	100	mA
Surge current ($\tau = 10\mu s$)	i_{FS}	3	A
Power dissipation (T = 25 °C)	P_{tot}	165	mW
Thermal Resistance	R_{thA}	450	K/W

Characteristics ($T_{amb} = 25°$)

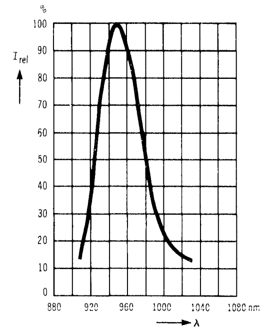
Wavelength at peak emission at			
$I_F = 100$ mA, tp = 20ms, toff = 100ms	λpeak	950 ± 20	nm
Spectral bandwidth at 50% of I_{max}			
at $I_F = 100$mA, $t_p = 20$ ms	$\Delta\lambda$	70	nm
Half angle	φ	10	Degree
Active chip area	A	0.09	mm²
Dimensions of active chip area	L × W	0,3 × 0,3	mm
Distance chip surface to case surface	D	5-5.5	mm
Switching time:			
(I_e from 10% to 90%; $I_F = 100$mA)	t_r, t_f	1	μs
Capacity ($V_R = 0$ V)	C_o	25	pF
Forward Voltage ($I_F = 100$mA)	V_F	1.35(⩽1.65)	V
($I_F = 1$A; $t_p = 100\mu s$)	V_F	2.0 (⩽2.7)	V
Breakdown voltage ($I_R = 100$ μA)	V_{BR}	30 (⩾5)	V
Reverse current ($V_R = 5$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 λpeak	TC	+0,3	nm/K

Radiant intensity I_e in axial direction at a steradian Ω = 0.01 sr, or 6,65°.

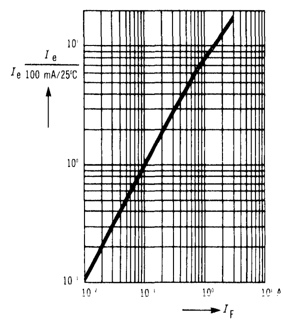
Radiant intensity at			
($I_F = 100$mA, $t_p = 20$ ms)	I_e	(⩾30) 60	mW/sr
$I_F = 1$A; $t_p = 100$ μs	I_e	400	mW/sr
Φ_e = (Total) typ.			
($I_F = 100$mA, $t_p = 20$ ms)	Φ_e	13	mW

Specifications are subject to change without notice.

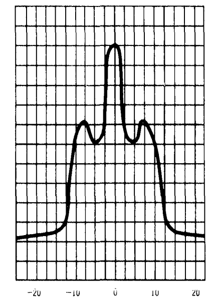
Relative spectral emission
$I_{rel} = f(\lambda)$



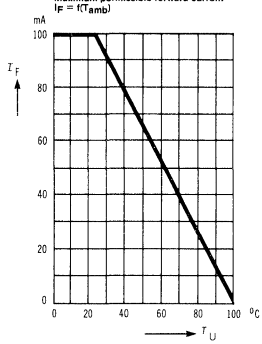
Radiant intensity
$I_e^{rel} = f(I_F)$ (T = 5 μs, T = 5ms)



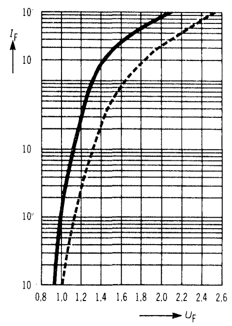
Radiant characteristics
$I_{rel} = f(\varphi)$



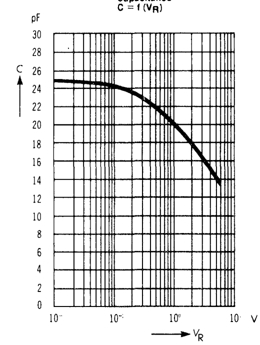
Maximum permissible forward current
$I_F = f(T_{amb})$



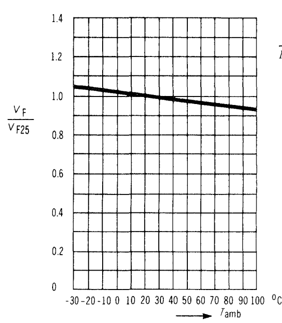
Forward current
$I_F = f(V_F)$



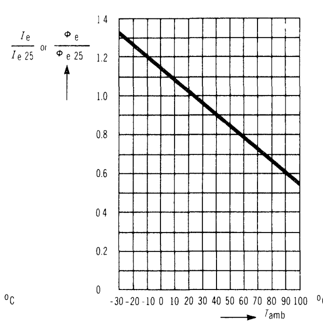
Capacitance
$C = f(V_R)$



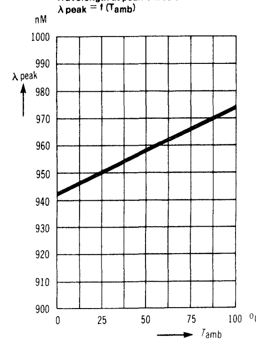
Forward voltage $\frac{V_F}{V_{F\,25}} = f(T_{amb})$



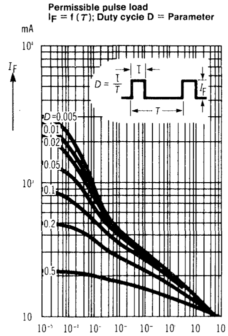
Radiant intensity $\frac{I_e}{I_{e\,25}} = f(T_{amb})$



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



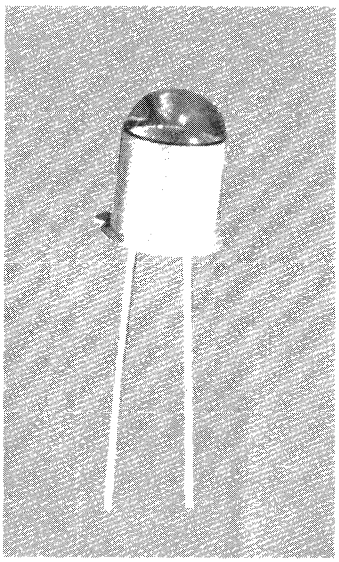
Permissible pulse load
$I_F = f(\tau)$; Duty cycle D = Parameter



SIEMENS

SFH 400 SERIES

INFRARED EMITTER



FEATURES

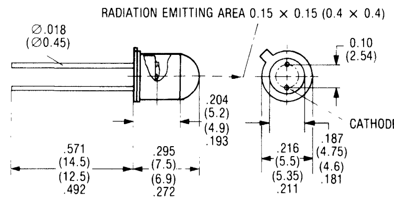
- **TO-18 Hermetic Package**
- **Round Glass Lens**
- **Very Narrow Beam, 6°**
- **Two Very High Power Intensity Ranges**

SFH 400-2, 20 to 40 mW/sr
SFH 400-3, 32 to 64 mW/sr

DESCRIPTION

The SFH-400 GaAs infrared emitting diode 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 anode terminal is marked by the adjacent projection on the rim of the case bottom. The cathode is electrically connected to the case. From $I_F = 100$ mA heat sinks have to be used.

Package Dimensions in Inches (mm)



Maximum Ratings

Reverse Voltage (V_R)	4 V
Forward Current (I_F)	300 mA
Surge Current (i_{FS}), $\tau \leq 1$ μs	5 A
Junction Temperature (T_j)	100 °C
Storage Temperature (T_s)	−55 to +100 °C
Power Dissipation (P_{tot}), $T_G = 25$ °C	470 mW
Thermal Resistance:	
Junction to Air (R_{thJamb})	450 K/W
Junction to Case (R_{thJG})	160 K/W

Characteristics ($T_{amb} = 25$ °C)

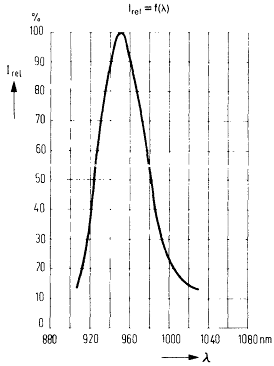
Wavelength at Peak Emission (λ_{peak}), at I_{max}	950 nm
Spectral Bandwidth at 50% ($\Delta\lambda$), of I_{max}	±20 nm
Half Angle (Limits for 50% of Radiant Intensity I_e), (φ)	6 Degrees
Switching Times (I_e from 10% to 90%; I_F = 100 mA),, (t_r;t_f)	1 μs
Capacitance (C_O), $V_R = 0$ V	40 pF
Forward Voltage (V_F)	
$I_F = 100$ mA	1.35 (≤1.7) V
$I_F = 1$ A	1.9 (≤2.3) V
Breakdown Voltage (V_{BR}), $I_R = 100$μA	30 (≥4) V
Reverse Current (I_R)	
$V_R = 3$ V	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

The diodes are grouped according to their radiant intensity I_e = at $I_F = 100$ mA in axial direction.

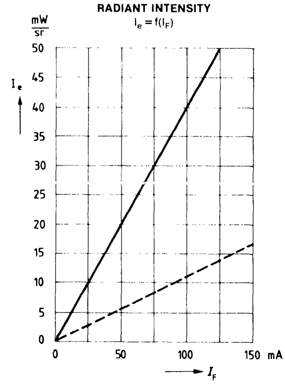
Group	2	3	
Radiant Intensity ($\varphi = 6°$) I_e	20 to 40	32 to 64	mW/sr
Φ_e (Total) typ.	6.3	10	mW

Specifications subject to change without notice.

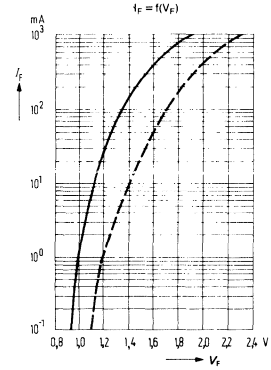
RELATIVE SPECTRAL EMISSION
$I_{rel} = f(\lambda)$



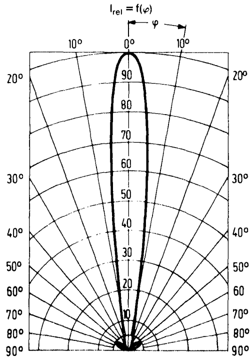
RADIANT INTENSITY
$I_e = f(I_F)$



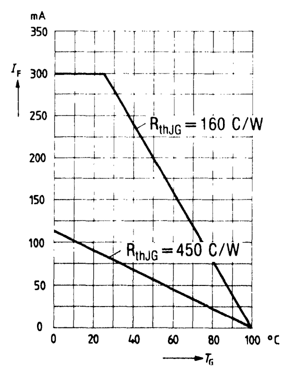
FORWARD CURRENT
$I_F = f(V_F)$



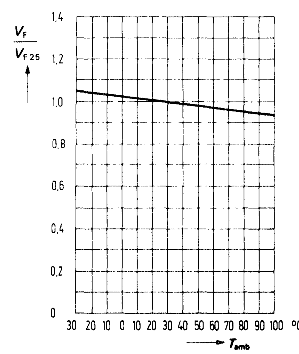
RADIATION CHARACTERISTICS
$I_{rel} = f(\varphi)$



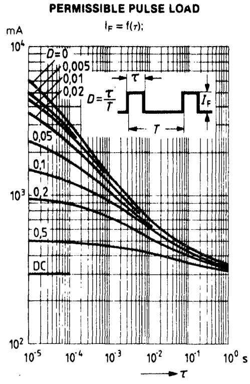
MAXIMUM PERMISSIBLE FORWARD CURRENT $I_F = f(T_G)$



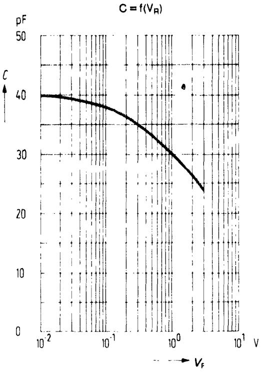
FORWARD VOLTAGE
$\frac{V_F}{V_{F\,25}} = f(T_{amb})$



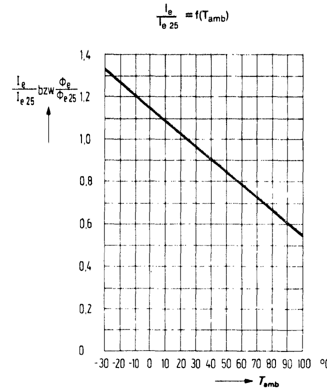
PERMISSIBLE PULSE LOAD
$I_F = f(\tau)$;



CAPACITANCE
$C = f(V_R)$



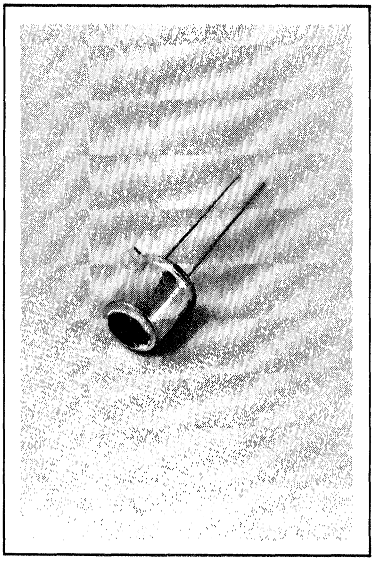
RADIANT INTENSITY
$\frac{I_e}{I_{e\,25}} = f(T_{amb})$



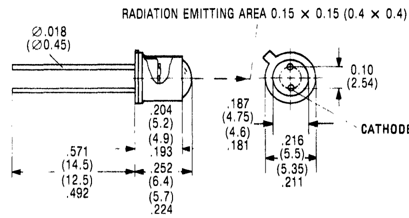
SIEMENS

SFH 401 SERIES

INFRARED EMITTER



Package Dimensions in Inches (mm)



FEATURES

- **TO-18 Hermetic Package**
- **Dome Glass Lens**
- **Narrow Beam, 15°**
- **Two High Power Intensity Ranges**

SFH 401-2, 10 to 20 mW/sr

SFH 401-3, 16 to 32 mW/sr

DESCRIPTION

The SFH 401 GaAs infrared emitting diode 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 DIN41876 (similar to TO-18) is closed by a glass lens. The anode terminal is marked by the adjacent projection on the rim of the case bottom. The cathode is electrically connected to the case. From $I_F = 100$ mA heat sinks have to be used.

Maximum Ratings

Reverse Voltage (V_R) .... 4 V
Forward Current (I_F) .... 300 mA
Surge Current (i_{FS}), $\tau \leq 1\ \mu s$ .... 5 A
Junction Temperature (T_j) .... 100°C
Storage Temperature Range (T_s) .... −55 to +100°C
Power Dissipation (P_{tot}) .... 470 mW
Thermal Resistance
Junction-to-Air (R_{thJamb}) .... 450 K/W
Junction-to-Case (R_{thJG}) .... 160 K/W

Characteristics ($T_{amb} = 25$°C)

Wavelength at Peak Emission (@ I_{max}), λ_{peak} .... 950 nm
Spectral Bandwidth (@ 50% of I_{max}), $\Delta\lambda$ .... ±20 nm
Half-Angle (Limits for 50%
of Radiant Intensity (I_e), φ .... 15 Degrees
Switching Times (I_e from 10% to 90%;
$I_F = 100$ mA), $t_r;t_f$ .... 1 μs
Capacitance ($V_R = 0$ V), C_O .... 40 pF
Forward Voltage (V_F)
($I_F = 100$ mA) .... 1.35 (≤1.7) V
($I_F = 1$ A) .... 1.9 (≤2.3) V
Breakdown Voltage ($I_R = 100\ \mu A$) 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

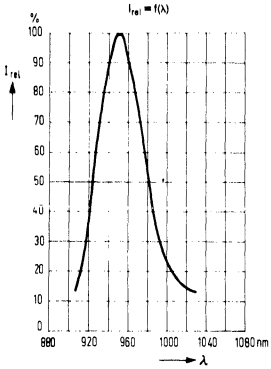
The diodes are grouped according to their radiant intensity I_e at $I_F = 100$ mA in axial direction.

Group	2	3	
Radiant Intensity ($\varphi = 15°$) I_e	10 to 20	16 to 32	mW/sr
Φ_e (Total) typ.	4	10	mW

Specifications subject to change without notice.

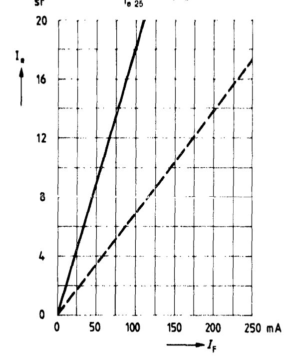
RELATIVE SPECTRAL EMISSION

$I_{rel} = f(\lambda)$



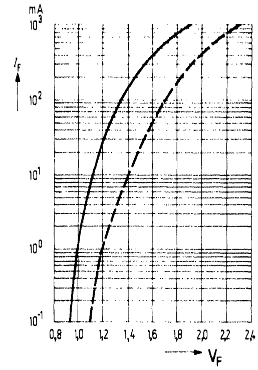
RADIANT INTENSITY

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



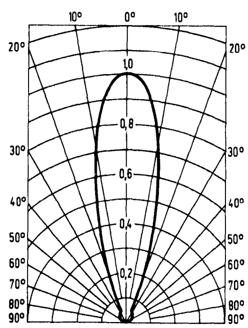
FORWARD CURRENT

$I_F = f(V_F)$

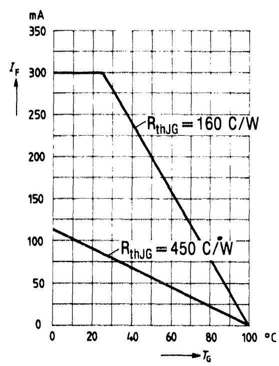


RADIATION CHARACTERISTICS

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

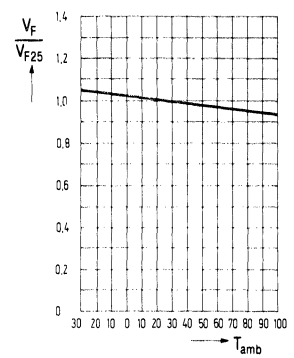


MAXIMUM PERMISSIBLE FORWARD CURRENT $I_F = f(T_G)$



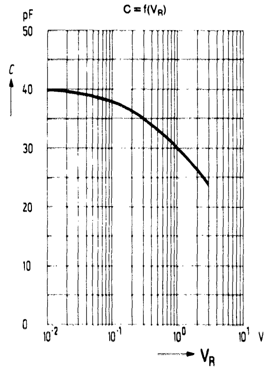
FORWARD VOLTAGE

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



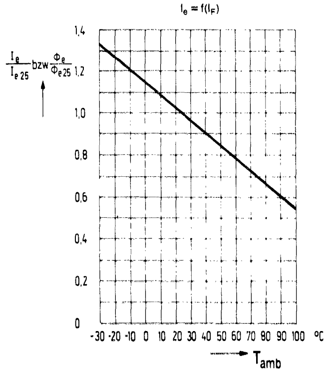
CAPACITANCE

$C = f(V_R)$



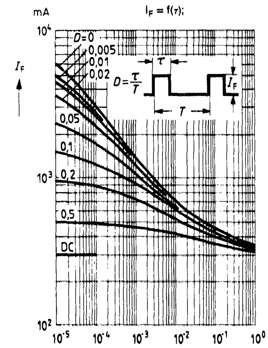
RADIANT INTENSITY

$I_e = f(I_F)$



PERMISSIBLE PULSE LOAD

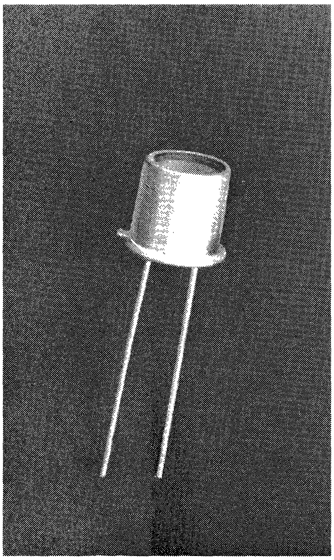
$I_F = f(\tau)$;



SIEMENS

SFH 402 SERIES

INFRARED EMITTER



FEATURES

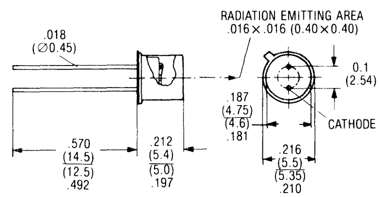
- **TO-18 Hermetic Package**
- **Flat Glass Lens**
- **Wide Beam, 40°**
- **Two Intensity Ranges**

SFH 402-2, 2.5 to 5.0 mW/sr
SFH 402-3, 4.0 to 8.0 mW/sr

DESCRIPTION

The SFH 402 GaAs infrared emitting diode 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 moduled. The case similar to TO-18 is equipped with a flat light window. The anode is marked by the adjacent projection on the rim of the case bottom. The cathode is electrically connected to the case. From I_F = 100 mA heat sinks have to be used.

Package Dimensions in Inches (mm)



Maximum Ratings

Reverse Voltage (V_R) .... 4 V
Forward Current (I_F) .... 300 mA
Surge Current (i_{FS}), $\tau \leq 1 \mu s$ .... 5 A
Junction Temperature (T_j) .... 100 °C
Storage Temperature T_s) .... −55 to +100 °C
Power Dissipation (P_{tot})
(T_{amb} = 25 °C) .... 470 mW
Thermal Resistance
Junction-to-Air (R_{thJamb}) .... 450 K/W
Junction-to-Case (R_{thJG}) .... 160 K/W

Characteristics (T_{amb} = 25 °C)

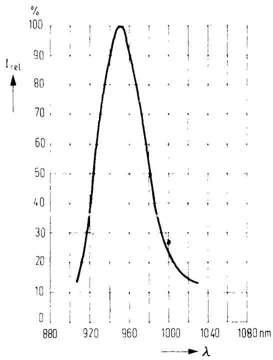
Wavelength at Peak Emission (@ I_{max}), λ_{peak} .... 950 nm
Spectral Bandwidth (@ 50% of I_{max}), $\Delta\lambda$ .... ±20 nm
Half-Angle (Limits for 50%
of Radiant Intensity I_e), φ .... 40 Degrees
Switching Times (I_e from 10% to 90%;
I_F = 100 mA), t_r; t_f .... 1 μs
Capacitance (V_R = 0 V), C_0 .... 40 pF
Forward Voltage (V_F)
(I_F = 100 mA) .... 1.35 (≤1.7) V
(I_F = 1 A) .... 1.9 (≤2.3) 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

The diodes are grouped according to their radiant intensity I_e at I_f = 100 mA in axial direction.

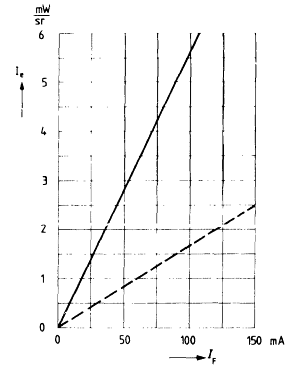
Group	2	3	
Radiant Intensity (φ = 40°) I_e	2.5 to 5	4 to 8	mW/sr
Φ_e (Total) typ.	6.3	10	mW

Specifications subject to change without notice.

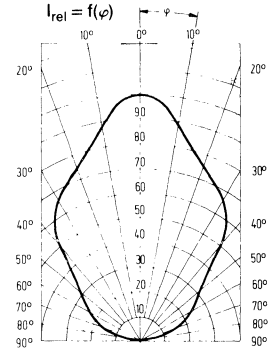
RELATIVE SPECTRAL EMISSION $I_{rel} = f(\lambda)$



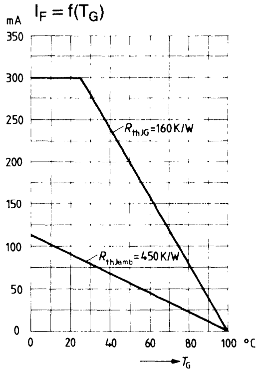
RADIANT INTENSITY $I_e = f(I_F)$



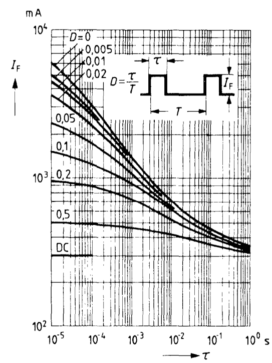
RADIATION CHARACTERISTICS $I_{rel} = f(\varphi)$



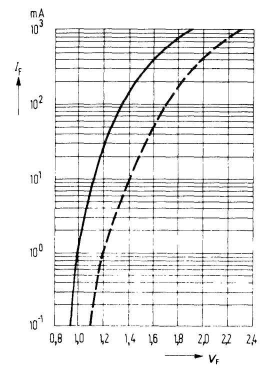
MAXIMUM PERMISSIBLE FORWARD CURENT $I_F = f(T_G)$



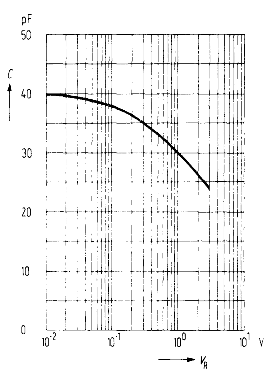
PERMISSIBLE PULSE LOAD $I_F = f(\tau)$



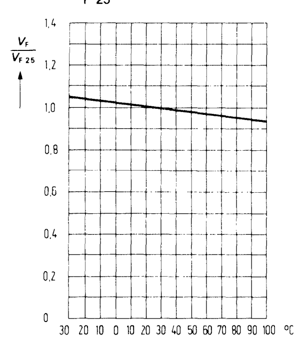
FORWARD CURRENT $I_F = f(V_F)$



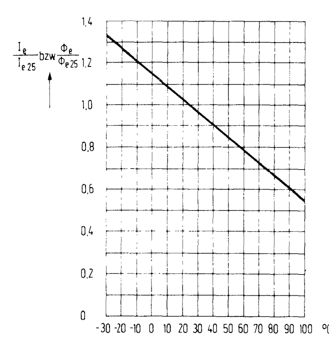
CAPACITANCE $C = f(V_R)$



FORWARD VOLTAGE $\frac{V_F}{V_{F\,25}} = f(T_{amb})$



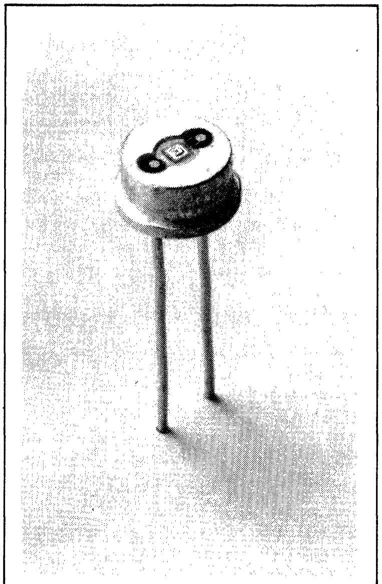
RADIANT INTENSITY $\frac{I_e}{I_{e\,25}} = f(T_{amb})$



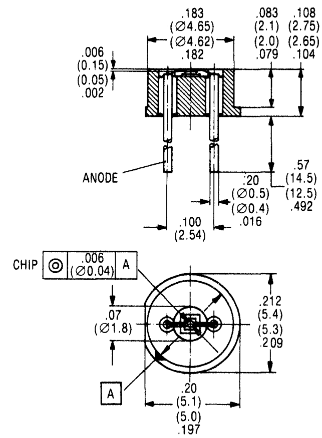
SIEMENS

SFH 404

INFRARED EMITTER



Package Dimensions in Inches (mm)



Maximum Ratings

Reverse Voltage (V_R)	2 V
Forward Current when incorporated in plug for fiber-optic systems(I_F)	180 mA
Forward Current (I_F)	70 mA
Surge Current (i_{FS}), t<10μs	300 mA
Storage Temperature (T_s)	-40 to +80°C
Junction Temperature (T_j)	80°C
Thermal Resistance	
Junction-to-Air (R_{thJamb})	500 K/W
Junction-to-Air ($R_{thJcase}$) When Inserted in LWL Socket	170 K/W

Characteristics (T_{amb} 25°C)

Wavelength at Peak Emission (λ_{peak})	830 ±20 nm
Spectral Bandwidth ($\Delta\lambda$)	40 nm
Radiant Intensity (I_e)	1.5 mW/sr
Coupled-in radiant power (at I_F=100 mA)	
in a gradient profile fiber, core diameter 63 μm, NA =0.22 (ϕ_{in})	>40 μW
in a stepped profile fiber, core diameter 200 μm, NA=0.22 (ϕ_{in})	>300 μW
in a stepped profile fiber, core diameter 200 μm, NA=0.4 (ϕ_{in})	>700 μW
Capacitance (C_o)	370pF
Rise Time (t_r)	15 ns
Fall Time (t_f)	15 ns
Bandwidth (B)	40 MHz
Forward Voltage (V_F)	
I_F=5 mA	1.35 (1.65) V
I_F=50 mA	1.50 (1.80) V
I_F=100 mA	1.65 (1.95) V

Specifications subject to change without notice.

FEATURES

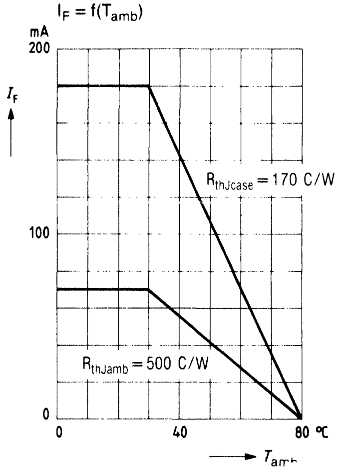
- **Similar to TO-46 Package**
- **Flat Plastic Coating**
- **1/10″ (2.54 mm) Lead Spacing**
- **Burrus Type GaAlAs Emitter**
- **For Fiber Optics Communications Up to 40 MBit/s**
- **Output Radiant Power, 100 μW**

DESCRIPTION

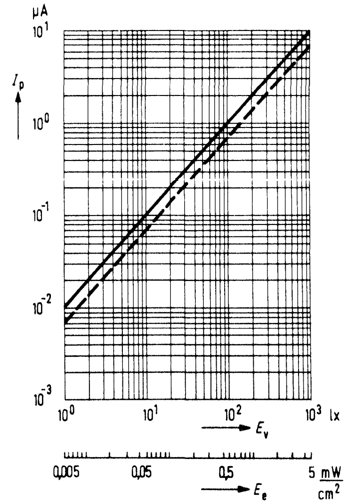
The SFH-404 is a GaAlAs infrared emitting diode of the burrus type. It is designed for applications in fiber optics communications to 40 MBit/s and lengths of several kilometers.

The diode is mounted centrally in a copper case for high performance without additional light pipe connectors. The case allows direct contact with projected light pipe spot face (∅ >2 mm). Anode and cathode are isolated from the case.

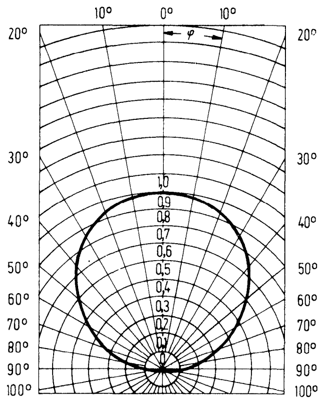
MAXIMUM PERMISSIBLE FORWARD CURRENT
$I_F = f(T_{amb})$



PHOTOCURRENT
$I_P = f(E_v)$



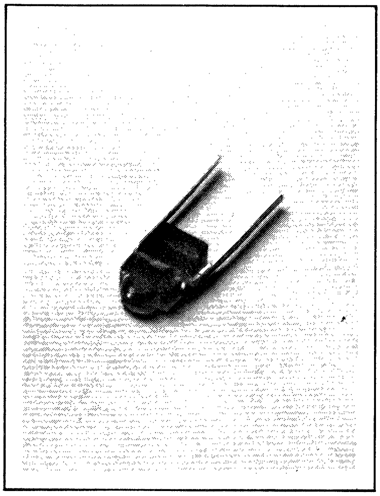
RADIATION CHARACTERISTICS
$I_P = f(\varphi)$



SIEMENS

SFH 405 SERIES

INFRARED EMITTER



FEATURES

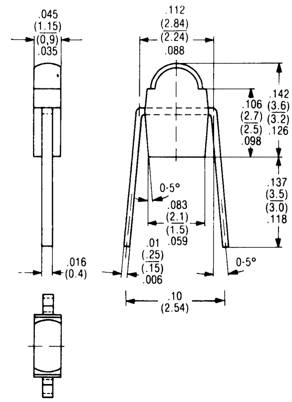
- **Miniature Plastic Package**
- **1/10" (2.54 mm) Lead Spacing**
- **Emitter for SFH-305 Phototransistor Detector**
- **Designed for Maximum Spacing of 10 mm Between Emitter and Detector**
- **Three Radiant Intensity Groups**

DESCRIPTION

The SFH 405 is a GaAs infrared diode which emits radiation at a wavelength in the near infrared. The radiation emitted is excited by current flowing in the forward direction.

The case is transparent plastic with a lens shaped light output. The plastic is slightly smoke colored in order to differentiate between phototransistors of the same type (SFH 305). The terminals are solder pins in 1/10″ (2.54 mm) lead spacing. The infrared emitting diodes are grouped according to radiation intensity. SFH 405 is suitable for use as emitter with the phototransistor SFH 305 to effect miniature light barriers with close spacing between sender and receiver up to 10 mm maximum. The cathode is marked with a colored dot.

Package Dimensions in Inches (mm)



Maximum Ratings

Reverse Voltage (V_R) .... 4 V
Forward Current (I_F) .... 40 mA
Surge Current (i_{FS}), $t \leq 10\ \mu s$ .... 1.5 A
Junction Temperature (T_j) .... 80 °C
Storage Temperature (T_s) .... −40 to +80 °C
Soldering Temperature in a 2 mm case. (T_L)
($t \leq 3$ s) .... 230 °C
Power Dissipation (P_{tot})
($T_{amb} = 25$ °C) .... 65 mW
Thermal Resistance
Junction-to-Air (R_{thJamb}) .... 950 K/W
Junction-to-Case (R_{thJL}) .... 850 K/W

Characteristics ($T_{amb} = 25$ °C)

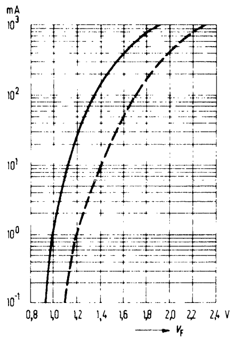
Wavelength at Peak Emission at I_{max}, λ_{peak} .... 950 nm
Spectral Bandwidth at 50% of I_{max}, $\Delta\lambda$ .... ±20 nm
Switching Times (I_e from 10% to 90%;
$I_F = 50$ mA), t_r; t_f .... 1 μs
Capacitance ($V_R = 0$ V), C_O .... 60 pF
Forward Voltage ($I_F = 50$ mA), V_F .... 1.25 ($\leq$1.6) V
Breakdown Voltage ($I_R = 100\ \mu A$), V_{BR} .... 30 ($\geq$4) V
Reverse Current ($V_R = 3$ V), I_R .... 0.01 ($\leq$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 Angle, φ .... 16 Degrees

Group	SFH 405-2	SFH 405-3	SFH 405-4	
Radiant Intensity				
I_e @ $I_F = 50$ mA	1.6 to 3.2	2.5 to 5.0	4.0 to 8.0	mW/sr
Φ_e (Total) typ.	2.5	4	6.3	mW

Specifications subject to change without notice.

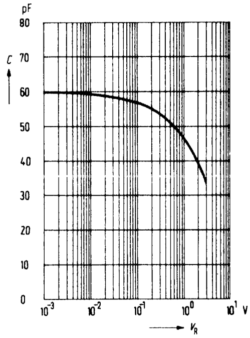
FORWARD CURRENT

$I_F = f(V_F)$



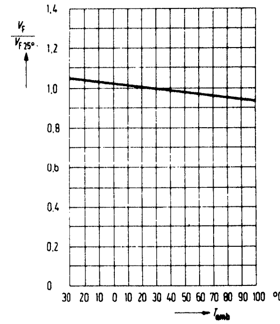
CAPACITANCE

$C = f(V_R)$



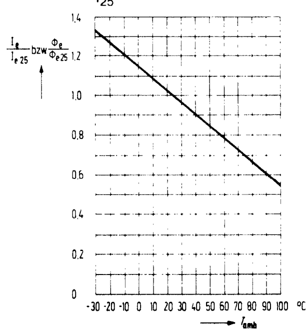
FORWARD VOLTAGE

$\frac{V_F}{V_{F25}} = (T_{amb})$



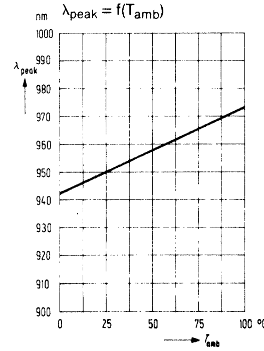
RADIANT INTENSITY

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



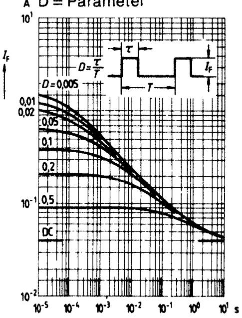
WAVELENGTH AT PEAK EMISSION

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

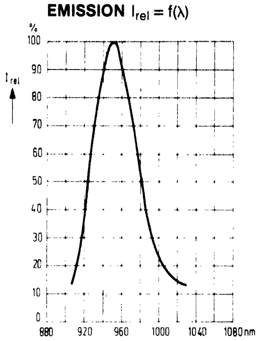


PERMISSIBLE PULSE LOAD

$I_F = f(\tau)$; $T_{amb} = 25\,°C$;
Duty Cycle
D = Parameter

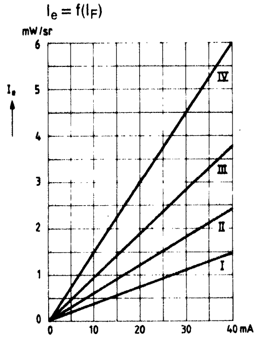


RELATIVE SPECTRAL EMISSION $I_{rel} = f(\lambda)$



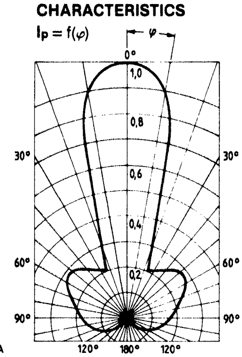
RADIANT INTENSITY

$I_e = f(I_F)$



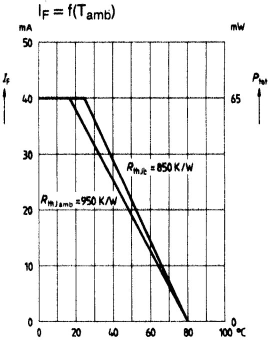
RADIATION CHARACTERISTICS

$I_P = f(\varphi)$



MAXIMUM PERMISSIBLE FORWARD CURRENT

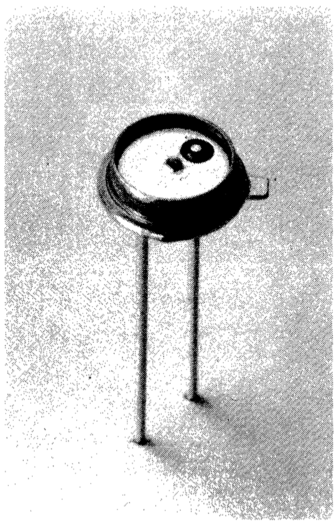
$I_F = f(T_{amb})$



SIEMENS

SFH 407 SERIES

INFRARED EMITTER



FEATURES

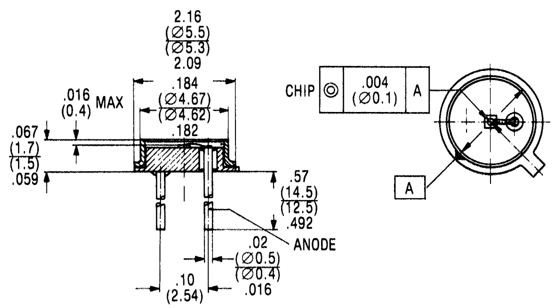
- **TO-46 Package**
- **Flat Epoxy Coating**
- **1/10″ (2.54 mm) Lead Spacing**
- **For Fiber Optic Communications Up to 5 MBit/s**
- **Three Intensity Ranges**
  SFH 4071, .4 to .8 mW/sr
  SFH 4072, .63 to 1.25 mW/sr
  SFH 4073, 1.0 to 2.0 mW/sr

DESCRIPTION

The SFH 407 GaAs diode emits radiation in the near infrared range. The radiation emitted is excited by current flowing in the forward direction and can be modulated. This diode is particularly noted for its high radiation ability.

The SFH 407 is mounted in a TO-46 case with collar casing and is encapsulated with epoxy. It is designed for applications in fiber optics communications up to 5 MBit/s.

Package Dimensions in Inches (mm)



Maximum Ratings

Reverse Voltage (V_R)	2 V
Forward Current (I_F)	50 mA
Forward Current When Mounted in LWL Socket (I_F), ($T_{amb} \leq 25$ °C)	100 mA
Surge Current (I_{FS}), $\tau \leq 100$ µs	200 mA
Storage Temperature Range (T_s)	−40 to +80 °C
Junction Temperature (T_j)	80 °C
Thermal Resistance:	
Junction-to-Air (R_{thJamb})	750 K/W
Junction-to-Air When Inserted in LWL Socket (R_{thJamb})	400 K/W
Junction-to-Case (R_{thJG})	225 K/W

Characteristics ($T_{amb} = 25$ °C)

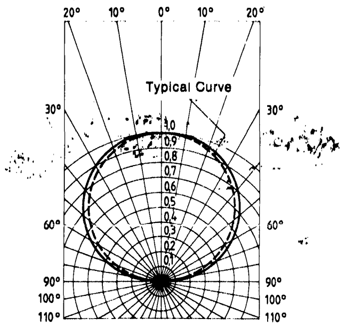
Wavelength at Peak Emission, λ_{peak}	900 ± 20 nm
Spectral Bandwidth, $\Delta\lambda$	40 nm
Half-Life Radiant Intensity in Gradient Profile Fiber with Core Diameter 63µm and NA = 0.2 (I_e = 1 mW/sr), Φ_{in}	2 µW
Rise Time (10% to 90%/I_F = 100 mA), t_r	50 ns
Fall Time (90% to 10%/I_F = 100 mA), t_f	40 ns
Bandwidth, B	7 MHz
Forward Voltage (I_F = 30 mA), V_F	1.22 (≤1.6) V
Reverse Current (V_R = 2 V), I_R	0.01 (≤10) µA
Capacitance (V_R = 0 V), C_0	35 pF

Group	1	2	3	
Radiant Intensity, I_e	0.4 to 0.8	0.63 to 1.25	1.0 to 2.0	mW/sr
Radiant Flux (Radiant Power) (Total) Typ., Φ_e	1.9	3.0	4.7	mW
Gradiant Profile Fiber Optic Cable with Cord Diameter = 63 µm and NA = 0.2 (Total) Typ., Φ_{in}	1.1	1.8	2.8	µW

Specifications subject to change without notice.

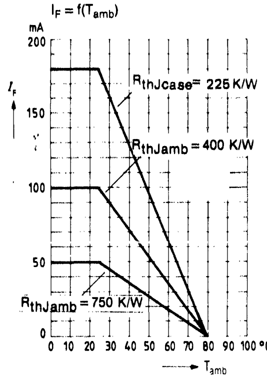
RADIATION CHARACTERISTICS

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

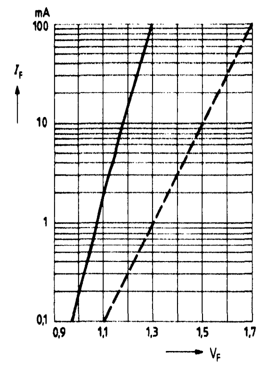


MAXIMUM PERMISSIBLE FORWARD CURRENT

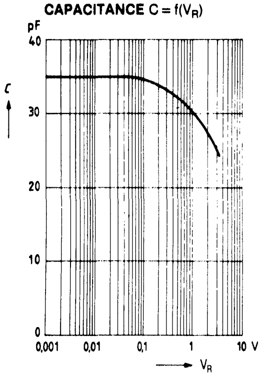
$I_F = f(T_{amb})$



FORWARD CURRENT $I_F = f(V_F)$

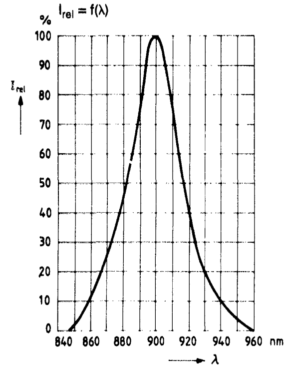


CAPACITANCE $C = f(V_R)$

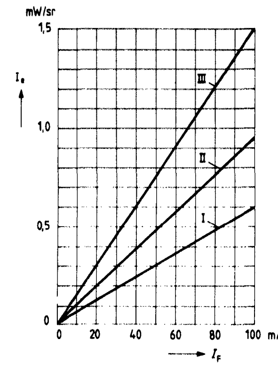


RELATIVE SPECTRAL EMISSION

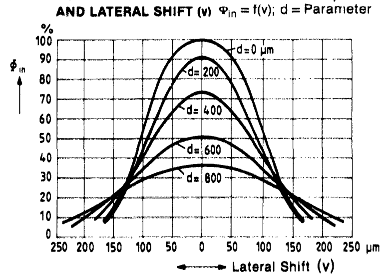
$I_{rel} = f(\lambda)$



RADIANT INTENSITY $I_e = f(I_F)$

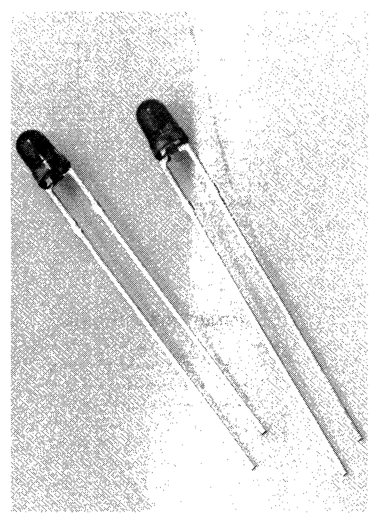


RELATIVE COMBINED RADIATED POWER INDEPENDENT FROM SPACING (d) AND LATERAL SHIFT (v) $\Phi_{in} = f(v)$; d = Parameter



SIEMENS

SFH 409
INFRARED EMITTER



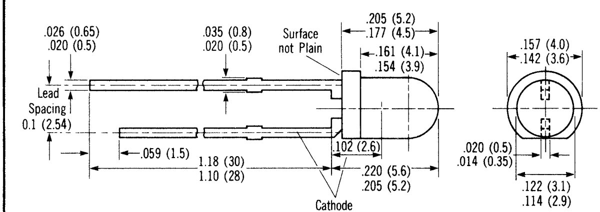
FEATURES

- **High Reliability**
- **3 mm (T1) Size Package**
- **1/10″ (2.54 mm)Lead Spacing**
- **Low Cost**
- **High Pulse Power**
- **Long Term Stability, Typical 1000 hour Degradation is Less Than 20%**
- **Medium Wide Beam, 20°**
- **Excellent Spectral Match with SFH-309 Photodetector**

DESCRIPTION

The SFH-409 is a GaAs Infrared Emitting Diode in a standard T1 size plastic package. It is designed for a variety of low cost, high volume applications such as IR remote control and other consumer and entertainment products.

Package Dimensions in Inches (mm)



Maximum Ratings:

Storage temperature	T_{stg}	−55 to +100	°C
Soldering temperature			
Distance from casing-solder tab≥2mm			
Dip soldering time ≤5s	T_{sold}	260	°C
Iron soldering time≤3s	T_{sold}	300	°C
Junction temperature	T_j	100	°C
Reverse voltage	V_R	5	V
Forward current	I_F	100	mA
Surge current ($\tau = 10\mu s$)	i_{FS}	3	A
Power dissipation (T = 25 °C)	P_{tot}	165	mW
Thermal Resistance	$R_{th\ JC}$	450	K/W

Characteristics ($T_{amb} = 25°$)

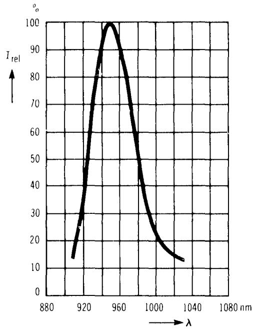
Wave length at peak emission at			
$I_F = 100$ mA tp = 20ms, $t_{off} = 180$ms	λpeak	950 ± 20	nm
Spectral bandwidth at 50% of I_{max}			
at $I_F = 100$mA, $t_p = 20$ ms	Δλ	70	nm
Half angle	φ	20	Degrees
Active chip area	A	0.09	mm²
Dimensions of active chip area	L × W	0,3 × 0,3	mm
Distance chip surface to leadframe standoff	D	2,6	mm
Switching time:			
(I_e from 10% to 90%; $I_F = 100$mA)	t_r, t_f	1	μs
Capacity ($V_R = 0$ V)	C_0	25	pF
Forward Voltage ($I_F = 100$mA)	V_F	1.35(≤1.65)	V
($I_F = 1$A; $t_p = 100\mu s$)	V_F	2.0 (≤2.7)	V
Breakdown voltage ($I_R = 100\ \mu A$)	V_{BR}	30 (≥5)	V
Reverse current ($V_R = 5$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 λpeak	TC	+0,3	nm/K

Radiant intensity I_e in axial direction at a steradian Ω = 0,01 sr, or 6,65°

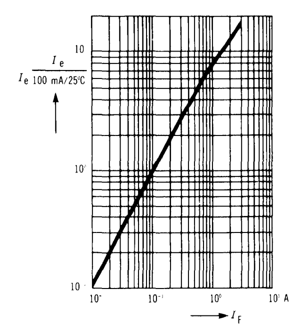
Radiant intensity at			
($I_F = 100$mA, $t_p = 20$ ms)	I_e	(≥6) 15	mW/sr
($I_F = 1$A; $t_p = 100\ \mu s$)	I_e	100	mW/sr
Radiant flux total			
($I_F = 100$mA, $t_p = 20$ ms)	Φ_e	14	mW

Specifications subject to change without notice

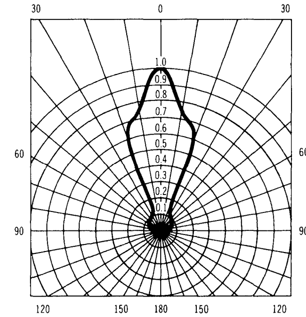
Relative spectral emission
$I_{rel} = f(\lambda)$



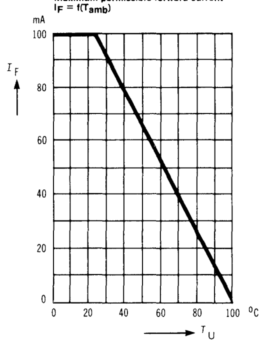
Radiant intensity
$I_e rel = f(I_F)$ (τ = 5 μs, T = 5ms)



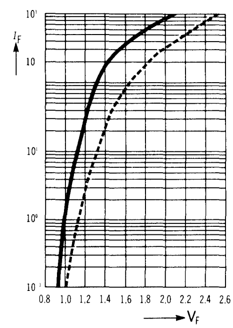
Radiant characteristics
$I_{rel} = f(\varphi)$



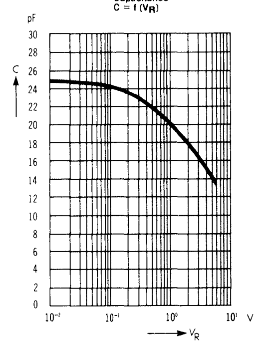
Maximum permissible forward current
$I_F = f(T_{amb})$



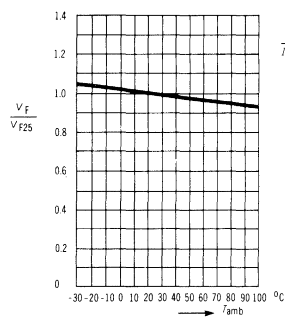
Forward current
$I_F = f(V_F)$



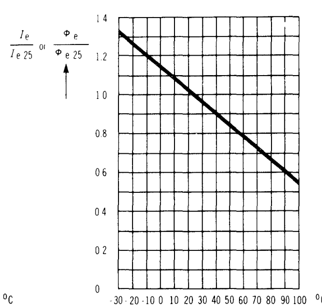
Capacitance
$C = f(V_R)$



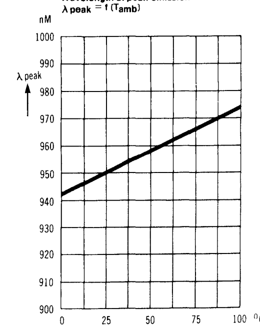
Forward voltage $\frac{V_F}{V_{F\,25}} = f(T_{amb})$



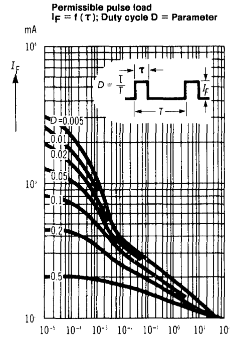
Radiant intensity $\frac{I_e}{I_{e\,25}} = f(T_{amb})$



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



Permissible pulse load
$I_F = f(\tau)$; Duty cycle D = Parameter

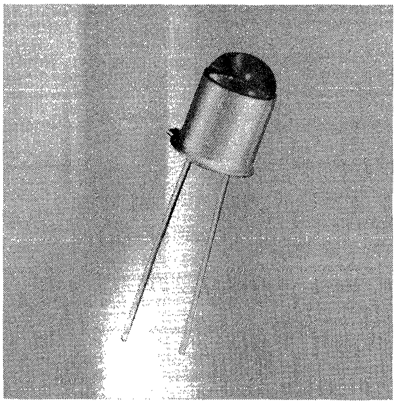


SIEMENS

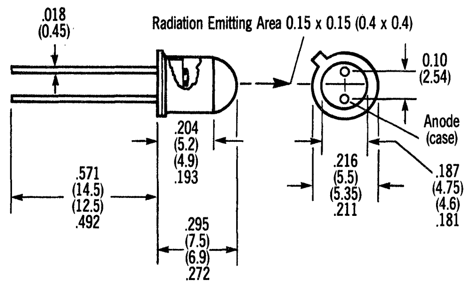
SFH 480

GaAlAs INFRARED EMITTING DIODE

Advance Data Sheet



Package Dimensions in Inches (mm)



FEATURES

- **TO-18 Hermetic Package**
- **Round Glass Lens**
- **Very Narrow Beam, 6°**
- **Very High Power, 8 mW Typical at 100 mA**

DESCRIPTION

The SFH 480 GaAlAs infrared emitting diode 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 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.

Maximum Ratings

Reverse Voltage	V_R	5	V
Forward Current ($T_c \leq 25°C$)	I_F	200	mA
Surge Current ($\tau \leq 10 \mu s$)	i_{FS}	2.5	A
Junction Temperature	T_j	100	°C
Storage Temperature	T_S	−55 to +100	°C
Power Dissipation ($T_c \leq 25°C$)	P_{tot}	470	mW
Thermal Resistance:			
Junction to Air	R_{thJamb}	450	K/W
Junction to Case	R_{thJG}	160	K/W

Characteristics ($T_{amb} = 25°C$)

Wavelength at peak emission at $I_F = 10$ mA;	λpeak	880	nm
Wavelength at peak emission at $I_F = 100$ mA; $t_p = 20$ ms; D = 1:12	λpeak	883	nm
Wavelength at peak emission at $I_F = 1$A $t_p = 100$ µs; D = 1:200	λpeak	886	nm
Spectral bandwidth at 50% of I_{max} at $I_F = 10$ mA	Δλ	−36 +44	nm
Half angle	φ	6	degrees
Active chip area	A	0.16	mm²
Dimensions of active chip area	L x W	0.4 x 0.4	mm
Switching time: (I_e from 10% to 90%; and from 90% to 10% $I_F = 100$ mA)	t_r, t_f	0.6/0.5	µs
Capacitance ($V_R = 0$ V; f = 1 MHz)	C_o	25	pF
Forward Voltage ($I_F = 100$ mA; $t_p = 20$ ms)	V_F	1.5(≤2.0)	V
($I_F = 1$ A; $t_p = 100$ µs)	V_F	3.0(≤4.5)	V
Breakdown voltage ($I_R = 10$ µA)	V_{BR}	30(≥5)	V
Reverse current ($V_R = 5$ V)	I_R	0.01(≤10)	µA
Temperature coefficient of I_e or Φ_e	TC	−0.5	%/K
Temperature coefficient of V_F	TC	−0.2	%/K
Temperature coefficient of λpeak	TC	0.25	nm/K,
Radiant intensity I_e in axial direction at a steradian Ω = 0.01 sr, or 6.5°			
Radiant intensity ($I_F = 100$ mA; $t_p = 20$ ms)	I_e	50	mW/sr
($I_F = 1$ A; $t_p = 100$ µs)	I_e	450	mW/sr
Φ_e (Total) typ. ($I_F = 100$ mA)	Φ_e	8	mW

Specifications are subject to change without notice.

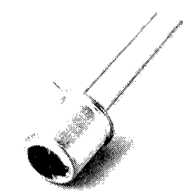
Siemens Components Inc., Optoelectronics Division, 19000 Homestead Road, Cupertino, California 95014 (408) 257-7910/TWX 910-338-0022

SIEMENS

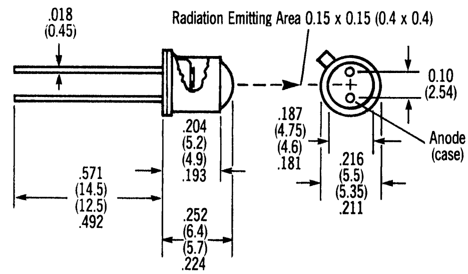
SFH 481

GaAlAs INFRARED EMITTING DIODE

Advance Data Sheet



Package Dimensions in Inches (mm)



FEATURES

- **TO-18 Hermetic Package**
- **Dome Glass Lens**
- **Narrow Beam, 15°**
- **Very High Power, 8 mW Typical at 100 mA**

DESCRIPTION

The SFH 481 GaAlAs infrared emitting diode 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.

Maximum Ratings

Reverse Voltage	V_R	5	V
Forward Current ($T_c \leq 25°C$)	I_F	200	mA
Surge Current ($\tau \leq 10$ µs)	I_{FS}	2.5	A
Junction Temperature	T_j	100	°C
Storage Temperature Range	T_s	−55 to +100	°C
Power Dissipation ($T_c \leq 25°C$)	P_{tot}	470	mW
Thermal Resistance:			
Junction to Air	R_{thJamb}	450	K/W
Junction to Case	R_{thJG}	160	K/W

Characteristics ($T_{amb} = 25°C$)

Wavelength at peak emission at $I_F = 10$ mA	λpeak	880	nm
Wavelength at peak emission at $I_F = 100$ mA $t_p = 20$ ms; D = 1:12	λpeak	883	nm
Wavelength at peak emission at $I_F = 1$ A $t_p = 100$ µs; D = 1:200	λpeak	886	nm
Spectral bandwidth at 50% of I_{max} at $I_F = 10$ mA	Δλ	−36 +44	nm
Half angle	φ	15	degrees
Active chip area	A	0.16	mm²
Dimensions of active chip area	L x W	0.4 x 0.4	mm
Switching time: (I_e from 10% to 90%; and from 90% to 10% $I_F = 100$ mA)	t_r, t_f	0.6/0.5	µs
Capacitance ($V_R = 0$ V; f = 1 MHz)	C_o	25	pF
Forward Voltage ($I_F = 100$ mA; $t_p = 20$ ms)	V_F	1.5(≤2.0)	V
($I_F = 1$ A; $t_p = 100$ µs)	V_F	3.0(≤4.5)	V
Breakdown voltage ($I_R = 10$ µA)	V_{BR}	30(≥5)	V
Reverse current ($V_R = 5$ V)	I_R	0.01(≤10)	µA
Temperature coefficient of I_e or Φ_e	TC	−0.5	%/K
Temperarture coefficient of V_F	TC	−0.2	%/K
Temperature coefficient of λpeak	TC	0.25	nm/K
Radiant intensity I_e in axial direction at a steradian Ω = 0.01 sr, or 6.5°			
Radiant intensity ($I_F = 100$ mA; $t_p = 20$ ms)	I_e	20	mW/sr
($I_F = 1$ A; $t_p = 100$ µs)	I_e	180	mW/sr
Φ_e (Total) typ. ($I_F = 100$ mA)	Φ_e	8	mW

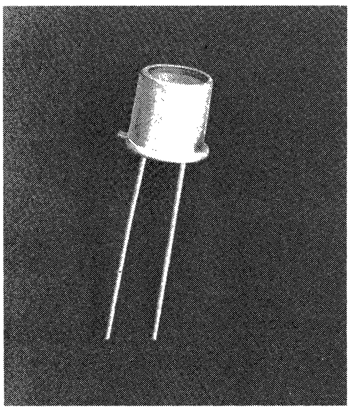
Specifications are subject to change without notice.

SIEMENS

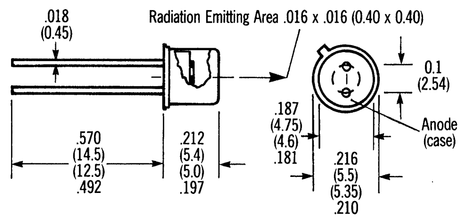
SFH 482

GaAlAs INFRARED EMITTING DIODE

Advance Data Sheet



Package Dimensions in Inches (mm)



FEATURES

- **TO-18 Hermetic Package**
- **Flat Glass Lens**
- **Wide Beam, 40°**
- **Very High Power, 8 mW Typical at 100 mA**

DESCRIPTION

The SFH 482 GaAlAs infrared emitting diode 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.

Maximum Ratings

Reverse Voltage	V_R	5	V
Forward Current ($T_c \leq 25°C$)	I_F	200	mA
Surge Current ($\tau \leq 10$ µs)	i_{FS}	2.5	A
Junction Temperature	T_j	100	°C
Storage Temperature	T_s	−55 to +100	°C
Power Dissipation ($T_c \leq 25°C$)	P_{tot}	470	mW
Thermal Resistance:			
Junction to Air	R_{thJamb}	450	K/W
Junction to Case	R_{thJG}	160	K/W

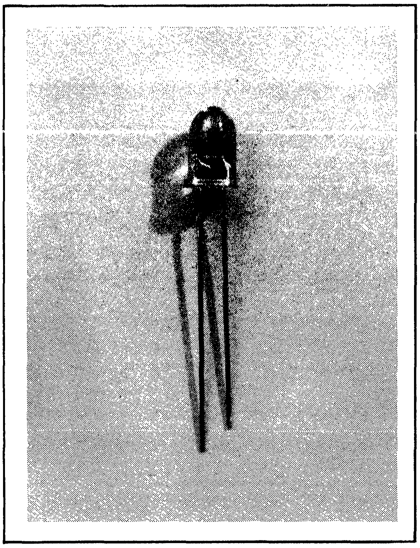
Characteristics ($T_{amb} = 25°C$)

Wavelength at peak emission at $I_F = 10$ mA	λpeak	880	nm
Wavelength at peak emission at $I_F = 100$ mA; $t_p = 20$ ms; D = 1:12	λpeak	883	nm
Wavelength at peak emission at $I_F = 1$ A; $t_p = 100$ µs; D = 1:200	λpeak	886	nm
Spectral bandwidth at 50% of I_{max} at $I_F = 10$ mA	Δλ	−36 +44	nm
Half angle	φ	40	degrees
Active chip area	A	0.16	mm²
Dimensions of active chip area	L x W	0.4 x 0.4	mm
Distance chip surface to case surface	D	5...5.5	mm
Switching time: (I_e from 10% to 90%; and from 90% to 10% $I_F = 100$ mA)	t_r, t_f	0.6/0.5	µs
Capacitance ($V_R = 0$ V; f = 1 MHz)	C_o	25	pF
Forward Voltage ($I_F = 100$ mA; $t_p = 20$ ms)	V_F	1.5(≤2.0)	V
($I_F = 1$ A; $t_p = 100$ µs)	V_F	3.0(≤4.5)	V
Breakdown voltage ($I_R = 10$ µA)	V_{BR}	30(≥5)	V
Reverse current ($V_R = 5$ V)	I_R	0.01(≤10)	µA
Temperature coefficient of I_e or Φ_e	TC	−0.5	%/K
Temperature coefficient of V_F	TC	−0.2	%/K
Temperature coefficient of λpeak	TC	0.25	nm/K
Radiant intensity I_e in axial direction at a steradian Ω = 0.01 sr, or 6.5°			
Radiant intensity ($I_F = 100$ mA; $t_p = 20$ ms)	I_e	7	mW/sr
($I_F = 1$ A; $t_p = 100$ µs)	I_e	63	mW/sr
Φ_e (Total) typ. ($I_F = 100$ mA)	Φ_e	8	mW

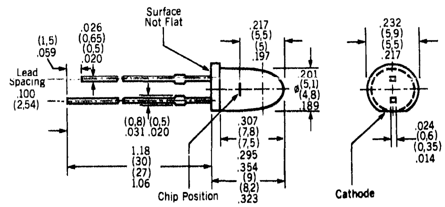
Specifications are subject to change without notice.

SIEMENS

SFH 484
GaAlAs INFRARED EMITTER



Package Dimensions in Inches (mm)



FEATURES

- **Good Spectral Match with Silicon Photo Detector**
- **Gallium Aluminum Arsenide Material**
- **Low Cost**
- **T-1¾ Package**
- **Clear Plastic Lens**
- **Long Term Stability**
- **Narrow Beam, 8°**
- **Very High Power, 20 mW Typical at 100 mA**
- **High Intensity, 100 mW/sr at 100 mA**

DESCRIPTION

The GaAlAs infrared emitting diode SFH 484 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. SFH 484 is enclosed in a plastic package of 5 mm diameter. It is provided for IR remote control of color TV receivers, smoke detectors and other applications requiring very high power such as IR touch screens.

Maximum Ratings

Storage temperature	T_{stg}	– 55... + 100	°C
Soldering temperature at dip soldering: (≥ 2 mm distance from the case bottom; soldering time t ≤ 5 sec)	T_{sold}	260	°C
Soldering temperature at iron soldering: (≥ 2 mm distance from the case bottom; soldering time t ≤ 3 sec)	T_{sold}	300	°C
Junction temperature	T_j	100	°C
Reverse voltage	V_R	5	V
Forward current	I_F	100	mA
Surge current (τ = 10 µs)	i_{FS}	2.5	A
Power dissipation (T = 25°C)	P_{tot}	200	mW
Thermal resistance*	R_{thA}	375	K/W

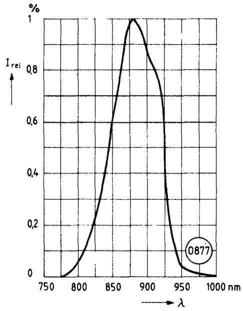
Characteristics (T_{amb} = 25°C)

Wavelength at peak emission at I_F = 10 mA	λpeak	880	nm
Wavelength at peak emission at I_F = 100 mA; t_p = 20 ms, D = 1:12	λpeak	883	nm
Wavelength at peak emission at I_F = 1 A; t_p = 100 µs, D = 1:100	λpeak	886	nm
Spectral bandwidth at 50% of I_{max} at I_F = 10 mA	Δλ	– 36... + 44	nm
Half angle	φ	8	degrees
Active chip area	A	0.16	mm²
Dimensions of active chip area	L × W	0.4 × 0.4	mm
Distance chip surface to case surface	D	4.9...5.5	mm
Switching time: (I_e from 10% to 90%; and from 90% to 10% I_F = 100 mA)	t_r, t_f	0.6/0.5	µs
Capacitance (V_R = 0 V, f = 1 MHz)	C_o	25	pF
Forward Voltage (I_F = 100 mA; t_p = 20 ms)	V_F	1.5 (≤ 2.0)	V
(I_F = 1 A; t_p = 100 µs)	V_F	3.0 (≤ 4.5)	V
Breakdown voltage (I_R = 10 µA)	V_{BR}	30 (≥ 5)	V
Reverse current (V_R = 5 V)	I_R	0.01 (≤ 10)	µA
Temperature coefficient of I_e or Φ_e	TC	– 0.5	%/K
Temperature coefficient of V_F	TC	– 0.2	%/K
Temperature coefficient of λpeak	TC	0.25	nm/K
Radiant intensity I_e in axial direction at a steradian Ω = 0.01 sr or 6.5°			
Radiant intensity (I_F = 100 mA, t_p = 20 ms)	I_e	100 (≥ 50)	mW/sr
(I_F = 1 A; t_p = 100 µs)	I_e	900	mW/sr
Φ_e (Total) typ. (I_F = 100 mA)	Φ_e	20	mW

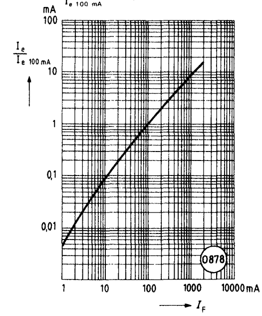
*At 10mm maximum clearance between PC board and bottom of plastic body.

Specifications are subject to change without notice.

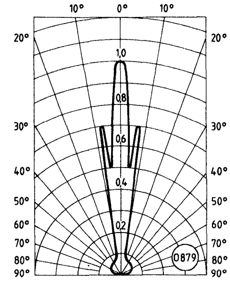
Relative spectral emission
$I_{rel} = f(\lambda)$



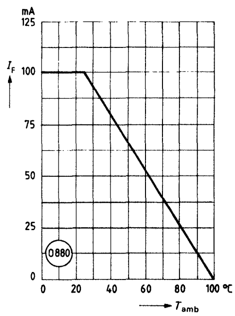
Radiant intensity
$\frac{I_e}{I_{e\,100\,mA}} = f(I_F)$



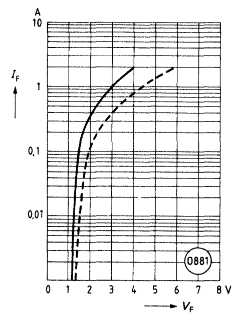
Radiation characteristics
$I_{rel} = f(\varphi)$



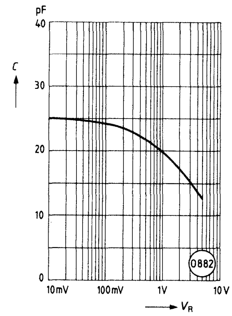
Maximum permissible forward current
$I_F = f(T_{amb})$



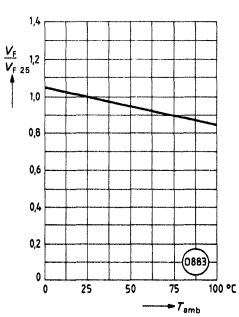
Forward current
$I_F = f(V_F)$



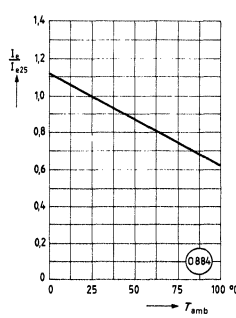
Capacitance
$C = f(V_R)$



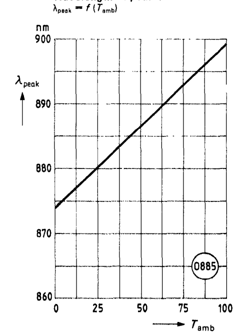
Forward voltage $\frac{V_F}{V_{F\,25}} = f(T_{amb})$



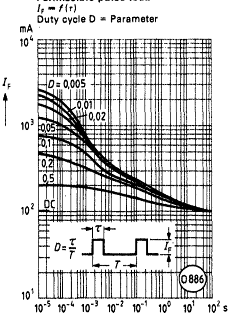
Radiant intensity $\frac{I_e}{I_{e\,25}} = f(T_{amb})$



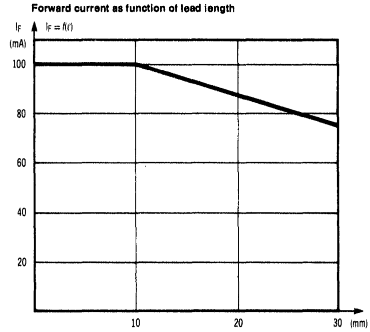
Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$



Permissible pulse load
$I_F = f(\tau)$
Duty cycle D = Parameter



Forward current as function of lead length

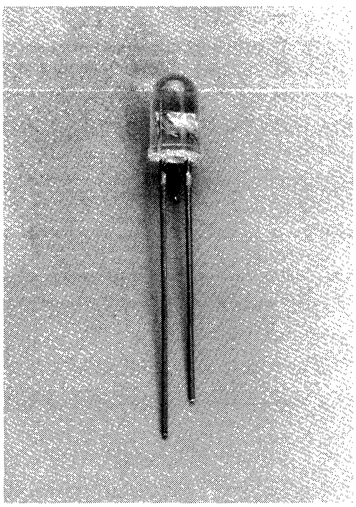


SIEMENS

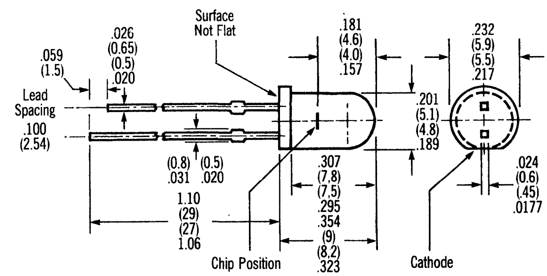
SFH 485

GaAlAs INFRARED EMITTER

Preliminary



Package Dimensions in Inches (mm)



FEATURES

- **Perfect Spectral Match with Silicon Photodetectors**
- **Gallium Aluminum Arsenide Material**
- **Low Cost**
- **T1¾ Package**
- **Clear Plastic Lens**
- **Long Term Stability**
- **Medium wide beam, 20°**
- **Very High Power, 20 mW Typical at 100 mA**
- **High Intensity, 30 mW/sr at 100 mA**

DESCRIPTION

The GaAlAs infrared emitting diode SFH 485 is designed to emit radiation at a wave-length in the near infrared range, 880 nm peak. The radiation emitted is excited by current flowing in forward direction and can be modulated. SFH485 is enclosed in a plastic package of 5 mm diameter. It is provided for IR remote control of color TV receivers and smoke detectors and other applications requiring very high power.

Maximum Ratings

Storage temperature	T_{stor}	−55 to +100	°C
Soldering temperature at dip soldering: (≥2mm distance from the case bottom; soldering time t≤5 sec)	T_{sold}	260	°C
Soldering temperature at iron soldering: (≥2mm distance from the case bottom; soldering time t≤3 sec)	T_{sold}	300	°C
Junction temperature	T_j	100	°C
Reverse voltage	V_R	5	V
Forward current	I_F	100	mA
Surge current (τ = 10 µsec)	i_{FS}	2.5	A
Power dissipation (T_{amb} = 25°C)	P_{tot}	150	mW
Thermal resistance*	$R_{th}JA$	375	K/W

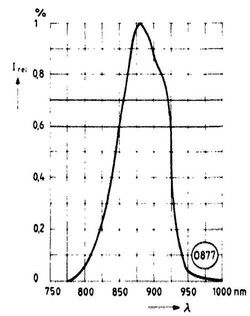
Characteristics (T_{amb} = 25°C)

Wavelength at peak emission at I_F = 10mA	λpeak	880	nm
Spectral bandwidth at 50% of I_{max} at I_F = 10mA	Δλ	−36... +44	nm
Half angle	ϑ	20	Degree
Active chip area	A	0,16	mm²
Dimensions of active chip area	L×W	0,4×0,4	mm
Distance chip surface to case surface	D	4.6...4.0	mm
Switching time: (I_e from 10% to 90%; and from 90% to 10% I_F = 100 mA)	t_r, t_f	.6/.5	µs
Capacitance (V_R = 0V, f = 1MHz)	C_o	25	pF
Forward Voltage (I_F = 100 mA; t_p = 20 ms)	V_F	1.5 (≤2.0)	V
(I_F = 1 A; t_p = 100 µs)	V_F	3.0 (≤4.5)	V
Breakdown voltage (I_R = 10 µA)	V_{BR}	30 (≥5)	V
Reverse current (V_R = 5V)	I_R	0.01 (≤10)	µA
Temperature coefficient of I_e or Φ_e	TC	−0.5	%/K
Temperature coefficient of V_F	TC	−0.2	%/K
Temperature coefficient of λpeak	TC	0.25	nm/K
Radiant intensity I_e in axial direction at a steradian Ω = 0,01 sr, or 6,5°			
Radiant intensity (I_F = 100 mA, t_p = 20 ms)	I_e	40 (≥16)	mW/sr
(I_F = 1 A; t_p = 100 µs)	I_e	360	mW/sr
Φ_e(Total) typ. (I_F = 100 mA)	Φ_e	20	mW

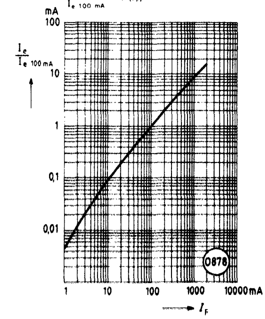
*At 10 mm max clearance between PC board and bottom of plastic body.

Specifications are subject to change without notice.

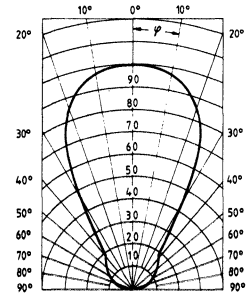
Relative spectral emission
$I_{rel} = f(\lambda)$



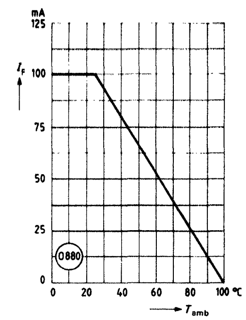
Radiant intensity
$\frac{I_e}{I_{e\ 100\ mA}} = f(I_F)$



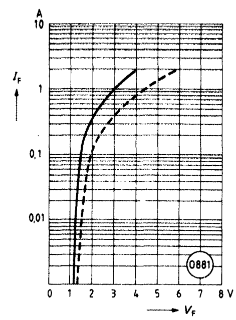
Radiation characteristic $I_{rel} = f(\varphi)$



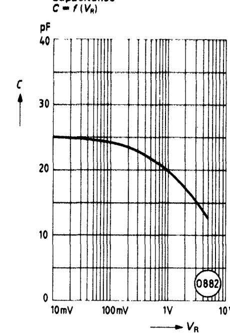
Maximum permissible forward current
$I_F = f(T_{amb})$



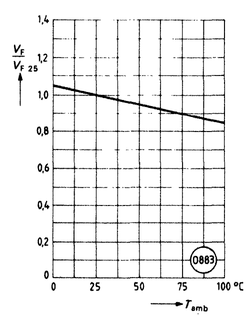
Forward current
$I_F = f(V_F)$



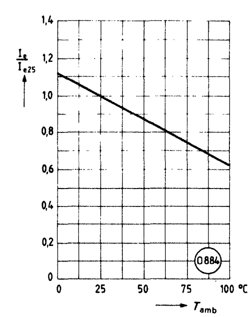
Capacitance
$C = f(V_R)$



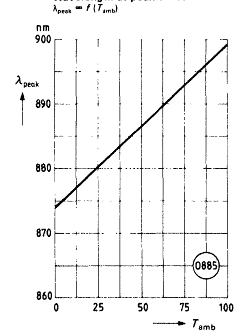
Forward voltage $\frac{V_F}{V_{F\ 25}} = f(T_{amb})$



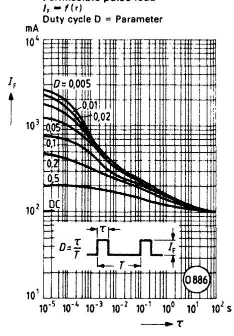
Radiant intensity $\frac{I_e}{I_{e\ 25}} = f(T_{amb})$



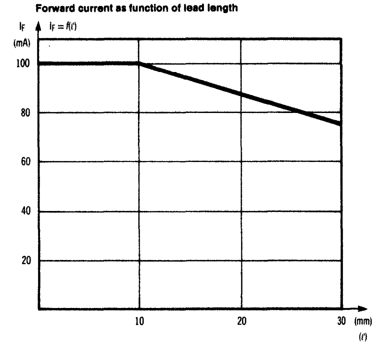
Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$



Permissible pulse load
$I_F = f(\tau)$
Duty cycle D = Parameter



Forward current as function of lead length

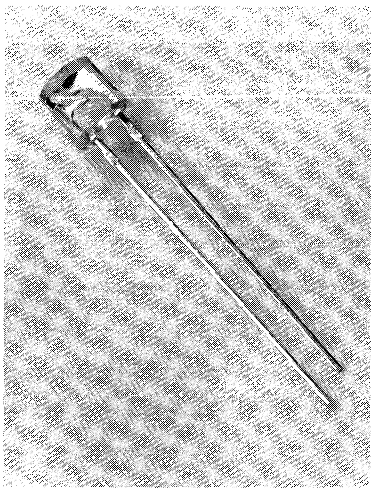


SIEMENS

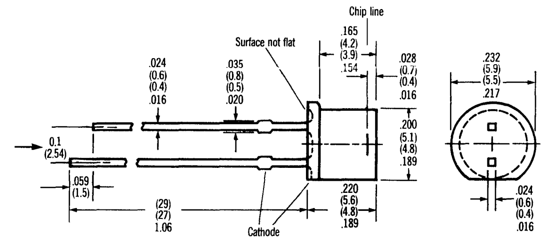
SFH 485P

GaAlAs INFRARED EMITTER

Preliminary



Package Dimensions in Inches (mm)



FEATURES

- **Good Spectral Matching to Silicon Photo Detector**
- **Gallium Aluminum Arsenide Material**
- **Low Cost**
- **T-1¾ Diameter Package**
- **Flat Plastic Top**
- **Long Term Stability**
- **Very Wide Beam, 45°**
- **Very High Power, 20 mW Typical at 100 mA**

DESCRIPTION

The GaAlAs infrared emitting diode SFH 485P 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. SFH 485P is enclosed in a flat plastic top of 5 mm diameter. It is provided for IR remote control applications, IR sound transmission and other applications requiring very high power.

Maximum Ratings

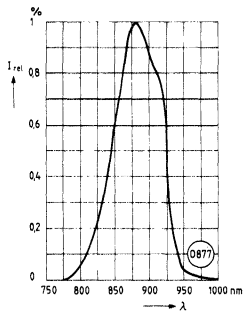
Storage temperature	T_{stg}	– 55... + 100	°C
Soldering temperature at dip soldering: (≥ 2 mm distance from the case bottom; soldering time t ≤ 5 sec)	T_{sold}	260	°C
Soldering temperature at iron soldering: (≥ 2 mm distance from the case bottom; soldering time t ≤ 3 sec)	T_{sold}	300	°C
Junction temperature	T_j	100	°C
Reverse voltage	V_R	5	V
Forward current	I_F	100	mA
Surge current (τ = 10 µs)	i_{FS}	2.5	A
Power dissipation (T = 25°C)	P_{tot}	200	mW
Thermal resistance	R_{thA}	375	K/W

Characteristics (T_{amb} = 25°C)

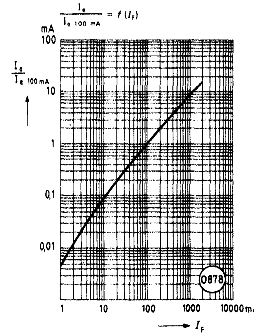
Wavelength at peak emission at I_F = 10 mA	λpeak	880	nm
Wavelength at peak emission at I_F = 100 mA; t_p = 20 ms, D = 1:12	λpeak	883	nm
Wavelength at peak emission at I_F = 1 A; t_p = 100 µs, D = 1:100	λpeak	886	nm
Spectral bandwidth at 50% of I_{max} at I_F = 10 mA	Δλ	– 36... + 44	nm
Half angle	φ	45	degrees
Active chip area	A	0.16	mm²
Dimensions of active chip area	L × W	0.4 × 0.4	mm
Distance chip surface to case surface	D	5...5.5	mm
Switching time: (I_e from 10% to 90%; and from 90% to 10% I_F = 100 mA)	t_r, t_f	0.6/0.5	µs
Capacitance (V_R = 0 V, f = 1 MHz)	C_o	25	pF
Forward Voltage (I_F = 100 mA; t_p = 20 ms)	V_F	1.5 (≤ 2.0)	V
(I_F = 1 A; t_p = 100 µs)	V_F	3.0 (≤ 4.5)	V
Breakdown voltage (I_R = 10 µA)	V_{BR}	30 (≥ 5)	V
Reverse current (V_R = 5 V)	I_R	0.01 (≤ 10)	µA
Temperature coefficient of I_e or Φ_e	TC	– 0.5	%/K
Temperature coefficient of V_F	TC	– 0.2	%/K
Temperature coefficient of λpeak	TC	0.25	nm/K
Radiant intensity I_e in axial direction at a steradian Ω = 0.01 sr or 6.5°			
Radiant intensity (I_F = 100 mA, t_p = 20 ms)	I_e	6	mW/sr
(I_F = 1 A; t_p = 100 µs)	I_e	54	mW/sr
Φ_e (Total) typ. (I_F = 100 mA)	Φ_e	20	mW

Specifications are subject to change without notice.

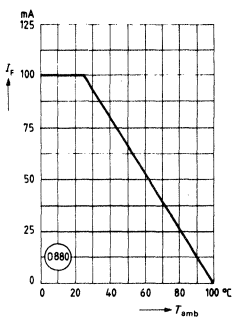
Relative spectral emission
$I_{rel} = f(\lambda)$



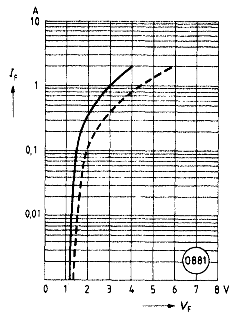
Radiant intensity
$\frac{I_e}{I_{e\ 100\ mA}} = f(I_F)$



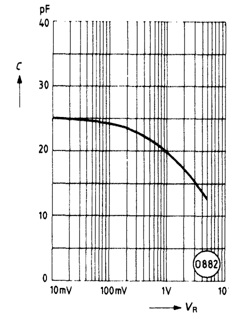
Maximum permissible forward current
$I_F = f(T_{amb})$



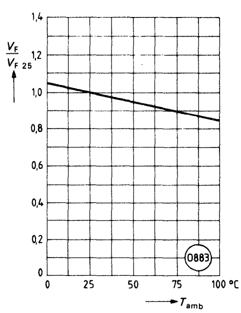
Forward current
$I_F = f(V_F)$



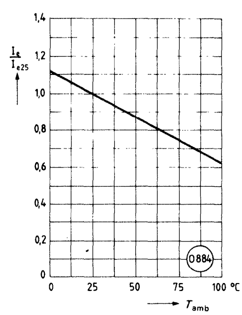
Capacitance
$C = f(V_R)$



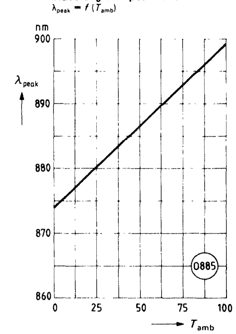
Forward voltage $\frac{V_F}{V_{F\ 25}} = f(T_{amb})$



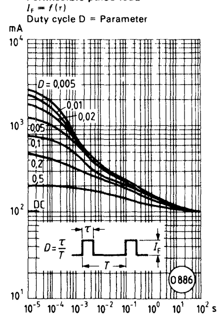
Radiant intensity $\frac{I_e}{I_{e\ 25}} = f(T_{amb})$



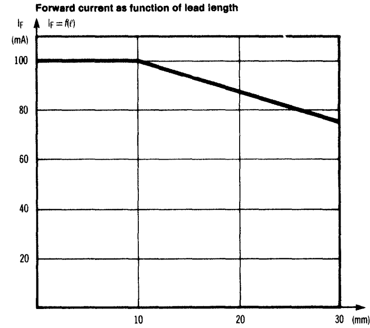
Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$



Permissible pulse load
$I_F = f(\tau)$
Duty cycle D = Parameter



Forward current as function of lead length

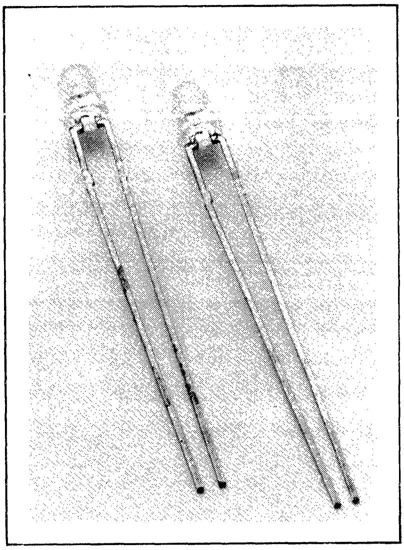


SIEMENS

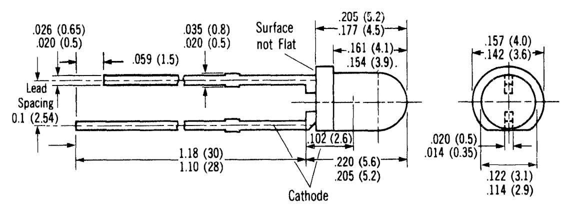
SFH 487

GaAlAs INFRARED EMITTER

Preliminary



Package Dimensions in Inches (mm)



FEATURES

- **Good Spectral Match to Silicon Photo Detector**
- **Gallium Aluminum Arsenide Material**
- **Low Cost**
- **T-1 Package**
- **Clear Plastic Lens**
- **Long-Term Stability**
- **Medium Wide Beam, 20°**
- **Very High Power, 20 mW Typical at 100 mA**
- **High Intensity, 30 mW/sr at 100 mA**

DESCRIPTION

The GaAlAs infrared emitting diode SFH 487 is designed to emit radiation at a wavelength in the near infrared range, 880 nm peak. The radiation emitted is excited by current flowing in forward direction and can be modulated. SFH 487 is enclosed in a plastic package of 3 mm diameter. It is provided for IR remote control of color TV receivers and smoke detectors and other applications requiring very high power, such as IR touch screens.

Maximum Ratings

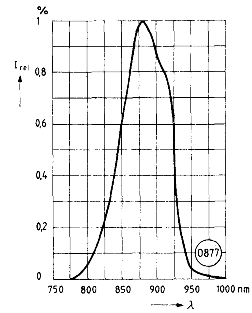
Storage temperature	T_{stg}	$-55 ... +100$	°C
Soldering temperature at dip soldering: (≥2 mm distance from the case bottom; soldering time t≤5 sec)	T_{sold}	260	°C
Soldering temperature at iron soldering: (≥2 mm distance from the case bottom; soldering time t≤3 sec)	T_{sold}	300	°C
Junction temperature	T_j	100	°C
Reverse voltage	V_R	5	V
Forward current	I_F	100	mA
Surge current ($\tau = 10$ µs)	i_{FS}	2.5	A
Power dissipation (T = 25°C)	P_{tot}	200	mW
Thermal resistance	R_{thA}	375	K/W

Characteristics ($T_{amb} = 25$°C)

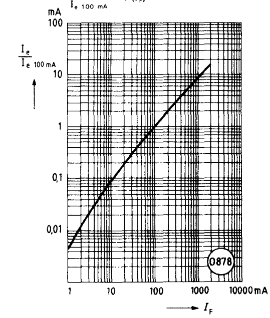
Wavelength at peak emission at $I_F = 10$ mA	λpeak	880	nm
Spectral bandwidth at 50% of I_{max} at $I_F = 10$ mA	Δλ	$-36 ... +44$	nm
Half angle	φ	20	degrees
Active chip area	A	0.16	mm²
Dimensions of active chip area	L×W	0.4×0.4	mm
Distance chip surface to stand off	D	2.6	mm
Switching time: (I_e from 10% to 90%; and from 90% to 10% $I_F = 100$ mA)	t_r, t_f	0.6/0.5	µs
Capacitance ($V_R = 0$ V, f = 1 MHz)	C_o	25	pF
Forward Voltage ($I_F = 100$ mA; $t_p = 20$ ms)	V_F	1.5 (≤2.0)	V
($I_F = 1$ A; $t_p = 100$ µs)	V_F	3.0 (≤4.5)	V
Breakdown voltage ($I_R = 10$ µA)	V_{BR}	30 (≥5)	V
Reverse current ($V_R = 5$ V)	I_R	0.01 (≤10)	µA
Temperature coefficient of I_e or Φ_e	TC	−0.5	%/K
Temperature coefficient of V_F	TC	−0.2	%/K
Temperature coefficient of λpeak	TC	0.25	nm/K
Radiant intensity I_e in axial direction at a steradian Ω = 0.01 sr or 6.5°			
Radiant intensity ($I_F = 100$ mA, $t_p = 20$ ms)	I_e	30 (≥12.5)	mW/sr
($I_F = 1$ A; $t_p = 100$ µs)	I_e	270	mW/sr
Φ_e (Total) typ. ($I_F = 100$ mA)	Φ_e	20	mW

Specifications are subject to change without notice.

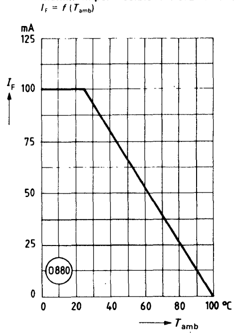
Relative spectral emission
$I_{rel} = f(\lambda)$



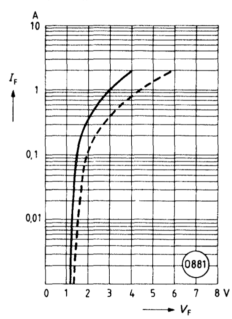
Radiant intensity
$\frac{I_e}{I_{e\,100\,mA}} = f(I_F)$



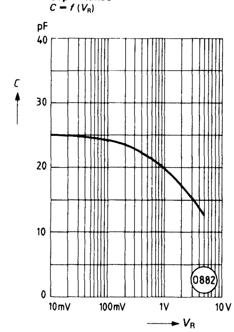
Maximum permissible forward current
$I_F = f(T_{amb})$



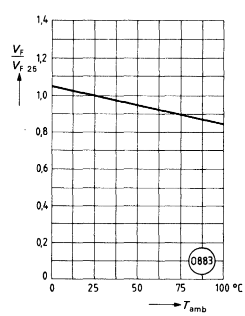
Forward current
$I_F = f(V_F)$



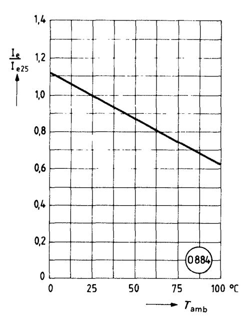
Capacitance
$C = f(V_R)$



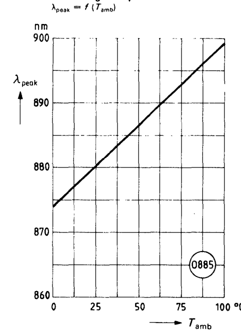
Forward voltage $\frac{V_F}{V_{F\,25}} = f(T_{amb})$



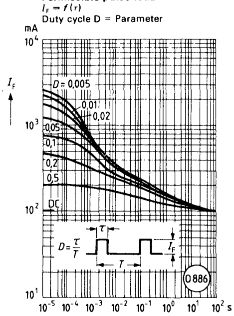
Radiant intensity $\frac{I_e}{I_{e\,25}} = f(T_{amb})$



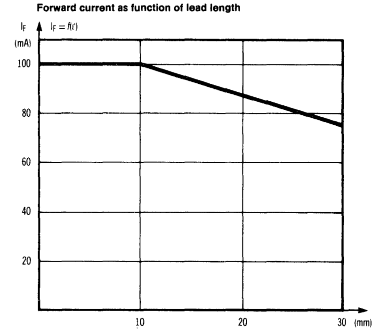
Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$



Permissible pulse load
$I_F = f(\tau)$
Duty cycle D = Parameter



Forward current as function of lead length

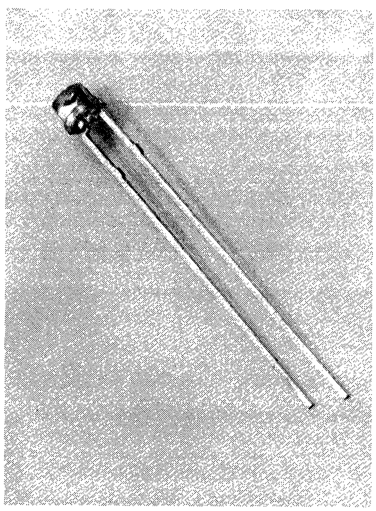


SIEMENS

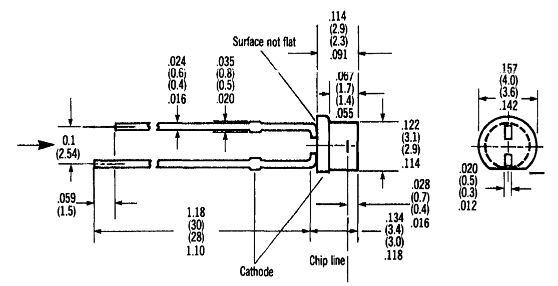
SFH 487P

GaAIAs INFRARED EMITTER

Preliminary



Package Dimensions in Inches (mm)



FEATURES

- **Perfect Spectral Match with Silicon Photo Detector**
- **Gallium Aluminum Arsenide Material**
- **Low Cost**
- **T1 Diameter Package**
- **Flat Plastic Top**
- **Long-Term Stability**
- **Very Wide Beam, 45°**
- **Very High Power, 20 mW Typical at 100 mA**

DESCRIPTION

The GaAIAs infrared emitting diode SFH487P 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. SFH487P is enclosed in a plastic package of 3 mm diameter. Typical applications are in fiber optics and light interruptors for DC and AC operation up to 500 KHz.

Maximum Ratings

Storage temperature	T_{stg}	−55... +100	°C
Soldering temperature at dip soldering: (≥ 2 mm distance from the case bottom; soldering time t ≤ 5 sec)	T_{sold}	260	°C
Soldering temperature at iron soldering: (≥ 2 mm distance from the case bottom; soldering time t ≤ 3 sec)	T_{sold}	300	°C
Junction temperature	T_j	100	°C
Reverse voltage	V_R	5	V
Forward current	I_F	100	mA
Surge current (τ = 10 µs)	i_{FS}	2.5	A
Power dissipation (T = 25°C)	P_{tot}	200	mW
Thermal resistance*	R_{thA}	375	K/W

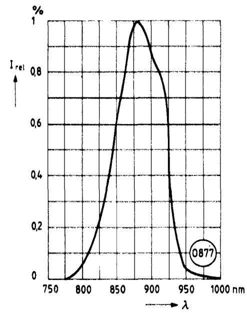
Characteristics (T_{amb} = 25°C)

Wavelength at peak emission at I_F = 10 mA	λpeak	880	nm
Spectral bandwidth at 50% of I_{max} at I_F = 10 mA	Δλ	−36... +44	nm
Half angle	φ	60	degree
Active chip area	A	0.16	mm²
Dimensions of active chip area	L × W	0.4 × 0.4	mm
Distance chip surface to case surface	D	0.7...0.4	mm
Switching time: (I_e from 10% to 90%; and from 90% to 10% I_F = 100 mA)	t_r, t_f	0.6/0.5	µs
Capacitance (V_R = 0 V, f = 1 MHz)	C_o	45	pF
Forward Voltage (I_F = 100 mA; t_p = 20 ms)	V_F	1.5 (≤ 2.0)	V
(I_F = 1 A; t_p = 100 µs)	V_F	3.0 ≤ 4.5)	V
Breakdown voltage (I_R = 10 µA)	V_{BR}	30 (≥ 5)	V
Reverse current (V_R = 5 V)	I_R	0.01 (≤ 10)	µA
Temperature coefficient of I_e or Φ_e	TC	−0.5	%/K
Temperature coefficient of V_F	TC	−0.2	%/K
Temperature coefficient of λpeak	TC	0.25	nm/K
Radiant intensity I_e in axial direction at a steradian Ω = 0.01 sr or 6.5°			
Radiant intensity (I_F = 100 mA, t_p = 20 ms)	I_e	3	mW/sr
(I_F = 1 A; t_p = 100 µs)	I_e	27	mW/sr
Φ_e (Total) typ. (I_F = 100 mA)	Φ_e	20	mW

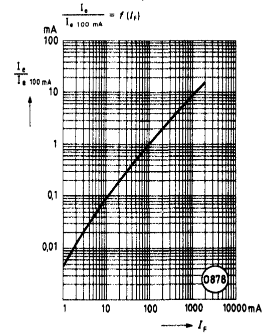
*At 10 mm clearance between PC board and bottom of plastic body.

Specifications are subject to change without notice.

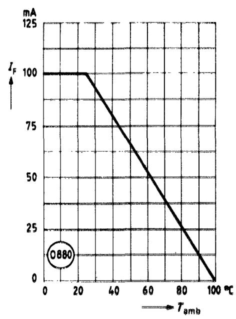
Relative spectral emission
$I_{rel} = f(\lambda)$



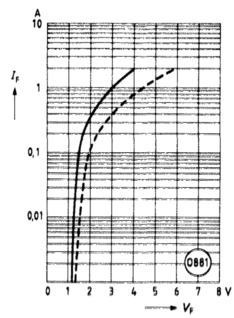
Radiant intensity
$\frac{I_e}{I_{e\ 100\ mA}} = f(I_F)$



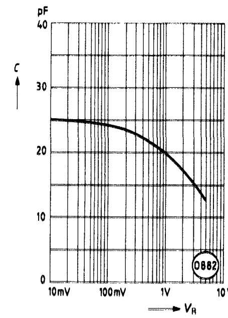
Maximum permissible forward current
$I_F = f(T_{amb})$



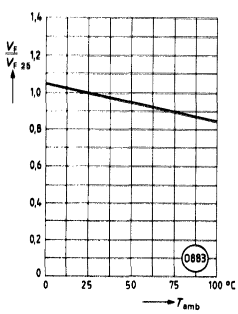
Forward current
$I_F = f(V_F)$



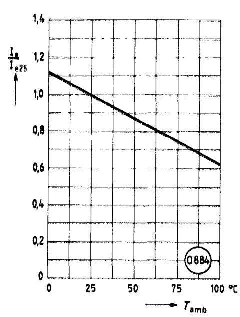
Capacitance
$C = f(V_R)$



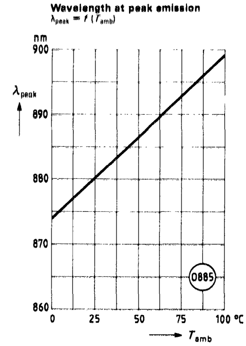
Forward voltage $\frac{V_F}{V_{F\ 25}} = f(T_{amb})$



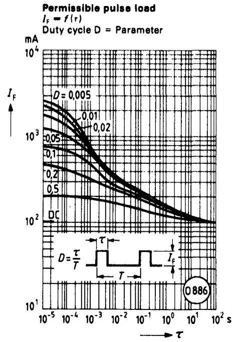
Radiant intensity $\frac{I_e}{I_{e\ 25}} = f(T_{amb})$



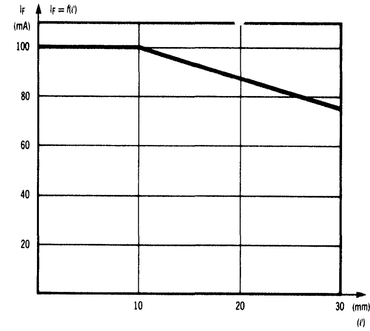
Wavelength at peak emission
$\lambda_{peak} = f(T_{amb})$

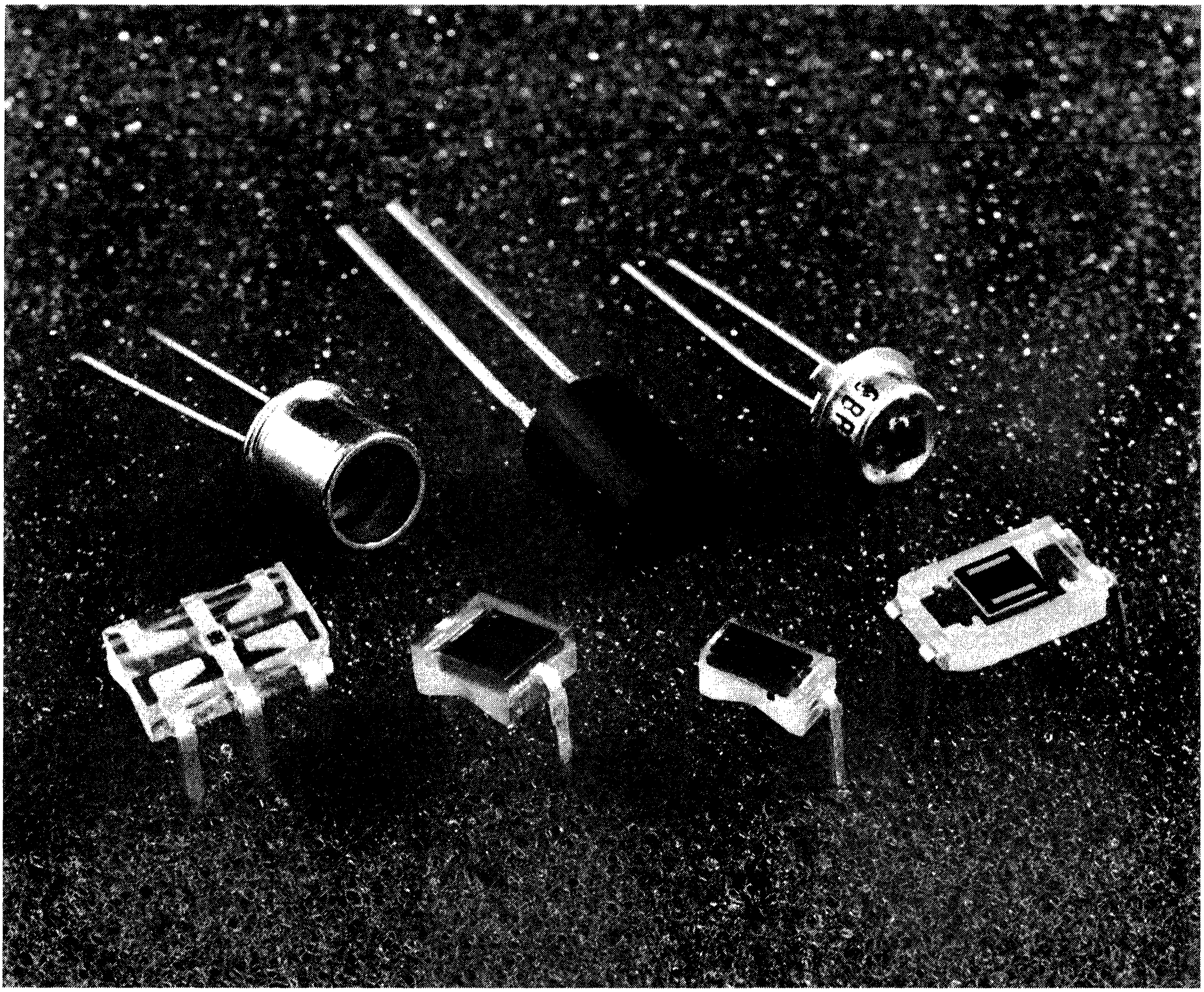


Permissible pulse load
$I_F = f(\tau)$
Duty cycle D = Parameter

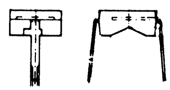
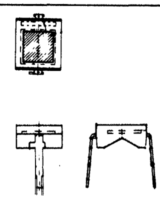
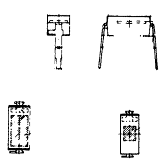
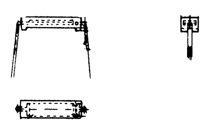
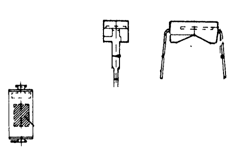
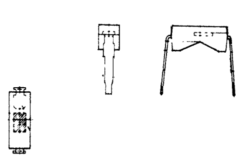


Forward current as function of lead length





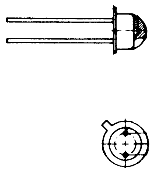
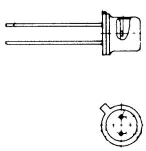
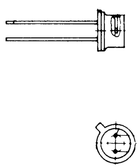
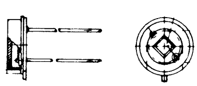
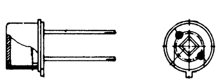
Photodiodes

Package Type	Package Outline	Part Number	Half Angle	Dark Current [V_R] E-O I_R(nA)	Sensitivity s(nA/lx) Typical	Radiant Sensitive Area mm²	Peak Wavelength	Features	Page
Plastic Back	I.R. Remote Control 	BP104	60°	2(< 30) (10V)	$40\mu A \frac{cm^2}{mW}$	5	950	PIN type IR remote control Built in filter	330
Plastic, Colorless Solder Tabs	Large Areas, High Sensitivity, Stackable, Dip Package 	BPW33		20pa(< 100) (1V)	50		800	Transparent for exposure meters	336
		BPW34		2(< 30) (10V)	70	7.6		Transparent for IR Sound transmission	338
		BPX91B		7(< 300) (10V)	50		850	Transparent high blue sensitivity Operates at low luminance	356
		BPX90		5(< 200) (10V)	40	5.0		High sensitivity Superior signal to noise ratio at low luminance	354
		BPX93		0.5(< 50) (10V)	8	1.0		Superior signal to noise ratio at low luminance	360
		BPW32		5pA(< 20) (1V)	10	1.0		Extremely low dark current 5pA	334
Plastic, Colorless Solder Tabs		SFH100	60°	0.4(< 10) (7V)	175	23.5	800	Extremely sensitive Including high blue sensitivity Operates at low luminance	362
		SFH200		20 pA (3V)	20	2.8		High zero crossover For exposure meters and automatic timers	364
Plastic, Colorless Solder Tabs		BPX92	60°	1(< 100) (10V)	7	1.5	850	Superior signal to noise ratio at low luminance	358

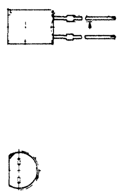
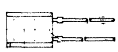
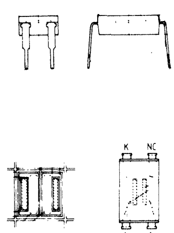
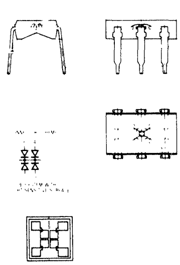
7

*Transparent to I.R. Transmission

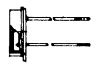
Photodiodes

Package Type	Package Outline	Part Number	Half Angle	Dark Current [VR] E-O IR(nA)	Sensitivity s(nA/lx) Typical	Radiant Sensitive Area mm²	Peak Wavelength	Features	Page
TO-18 Round Plastic Lens		BPX63	75°	5 pA (< 20) (1V)	10		800	Extremely low dark current, 5 pA For exposure meters. Matches with LD242 IR emitter.	348
PIN TO-18 Flat Glass Lens		BPX65	30°	1(< 5) (20V)	10	1		PIN type Very high speed, 5nS Low dark current, 1 mA	350
		BPX66		.15(< 0.3) (1V)	9		850	PIN type Very high speed, 5nS Very low dark current, 15 mA	352
PIN TO-18 Flat Glass Lens	High Reliability 	SFH202	60°	1(< 5) (20V)	10			PIN type For fiber optic transmission over 560 m/bits	366
Similar to TO-5 Flat Glass Lens		BPW21	60°	2(< 30)	9(> 5.5)	7.34	550	Hermetic seal glass lens for high reliability. Incorporates V_2 filter 550 nm.	332
TO-5 Glass Lens		SFH-203	35°	7(< 50)	7.5(> 5.0)	7.6	555	Hermetic seal glass lens for high reliability. BG 38 Filter	368

Photodiodes

Package Type	Package Outline	Part Number	Half Angle	Dark Current [VR] E-O IR(nA)	Sensitivity s(nA/lx) Typical	Radiant Sensitive Area mm²	Peak Wavelength	Features	Page
Plastic, Black, Solder Tabs 1/10" Spacing	Vertical Mounting 	SFH205	70°	2(<30) (10V)	$50\mu A \frac{cm^2}{mW}$	7.6	950	PIN Type built in filter Curved surface Superior s/n ratio at low luminance	372
Plastic, Colorless Solder Tabs 1/10" Spacing		SFH206	60°					PIN Type built in filter Flat surface Superior s/n ratio at low luminance	376
		SFH206K			70		850	PIN Type Transparent flat surface. Superior s/n ratio at low luminance	378
Plastic, Colorless Solder Tabs	Precision Measurements 	BPX48	60°	100(<200) (10V)	32	2x1.5	850	Differential type. Fast response Photodiodes separated by 50 micrometers.	342
Miniature 6 Lead		SFH204	—	0.01(<2) (10V)	.11	4x.01	850	Four quadrant. Two axis precision position control. Fast response. Photodiodes separated by 12 micrometers.	370

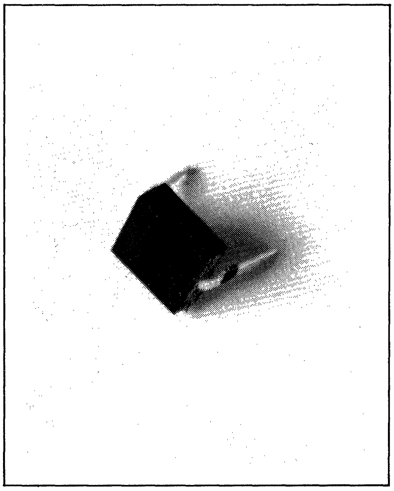
Photodiodes

Package Type	Package Outline	Part Number	Half Angle	Dark Current [V_R] E·O I_R(nA)	Sensitivity s(nA/lx) Typical	Radiant Sensitive Area mm²	Peak Wavelength	Features	Page
Similar to TO-5 Flat Glass Lens	High Reliability 	BPX60	50°	7(< 300) (10V)	50	7.6	850	Superior signal to noise ratio at low luminance	344
		BPX61		2(< 30) (10V)	70			PIN type Superior s/n ratio at low luminance. Low dark current 2 nA.	346

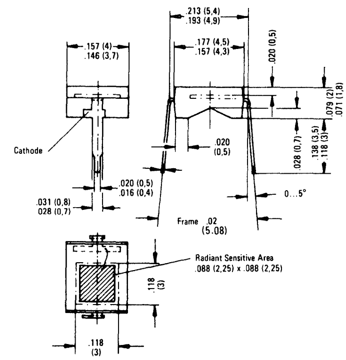
SIEMENS

BP 104

PIN PHOTODIODE



Package Dimensions in Inches (mm)



Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

FEATURES

- **Silicon Planar PIN Photodiode**
- **IR Transparent Filter Plastic Package**
- **2/10" Lead Spacing**
- **High Speed, 10 ns**

DESCRIPTION

BP 104 is a silicon planar PIN photodiode, encapsulated in a plastic package, which simultaneously serves as filter and is transparent to IR radiation. Its terminals are soldering tabs spaced 5.08 mm (2/10") apart. Due to its design the diode can easily be mounted, even 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 universal photodetector is suitable for diode as well as voltaic cell operation. The signal/noise ratio is particularly favorable, even at low illuminances.

The PIN photodiode is outstanding for its low junction capacitance, high maximum frequency, and fast switching times. It is particularly suitable for IR sound transmission

Maximum Ratings

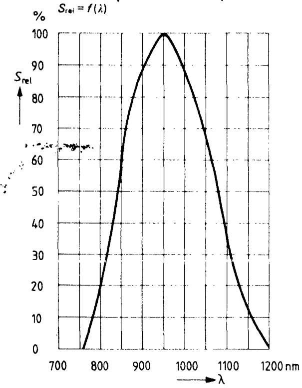
Reverse voltage	V_R	20	V
Operating and storage temperature range	T_{stor}	–40 to +80	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leq 3$ s)	T_s	230	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	150	mW

Characteristics (T_{amb} = 25°C)

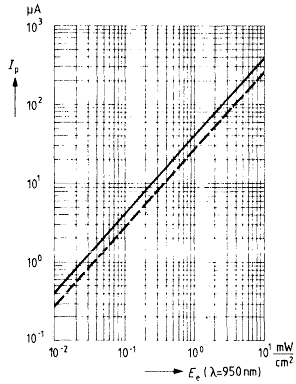
Spectral sensitivity (V_R = 5 V) (λ = 950 nm)	S	40 ($\geq$ 25)	$\mu A \cdot \frac{cm^2}{mW}$
Wavelength of max. spectral sensitivity	$\lambda_{s\,max}$	950	nm
Quantum yield (Electrons per photon) (λ = 950 nm)	η	0.92	$\frac{Electrons}{Photon}$
Spectral sensitivity (λ = 950 nm, V_R = 5 V)	S	0.71	A/W
Rise 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)	$t_r; t_f$	125	ns
(R_L = 1 kΩ; V_R = 10 V; λ = 950 nm)	$t_r; t_f$	10	ns
Temperature coefficient for I_K or I_P	TC	0.18	%/K
Capacitance			
(V_R = 0 V; f = 1 MHz; E = 0)	C_0	48	pF
(V_R = 3 V; f = 1 MHz, E = 0)	C_3	17	pF
Radiant sensitive area	A	5.06	mm^2
Dark current (V_R = 10 V)	I_R	2 ($\leq$ 30)	nA
Noise equivalent power (V_R = 10 V)	NEP	4.2×10^{-14}	$\frac{W}{\sqrt{Hz}}$
Detection limit	D^*	5.4×10^{12}	$\frac{cm\sqrt{Hz}}{W}$

Specifications are subject to change without notice.

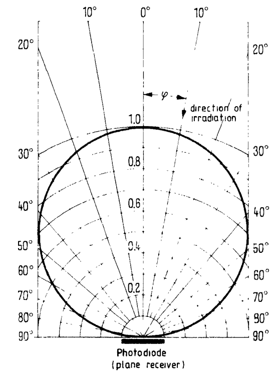
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



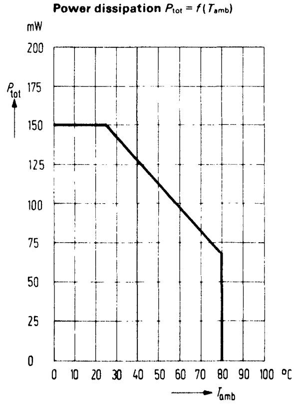
Photocurrent $I_P = f(E_e)$



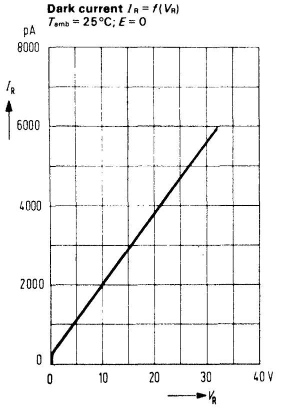
Directional characteristic $S_{rel} = f(\varphi)$



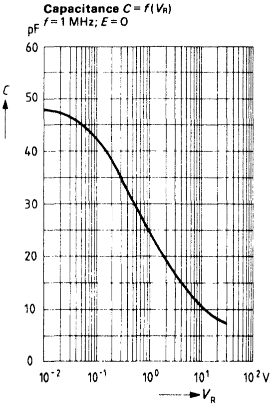
Power dissipation $P_{tot} = f(T_{amb})$



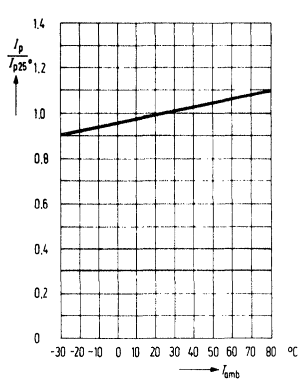
Dark current $I_R = f(V_R)$
$T_{amb} = 25°C$; $E = 0$



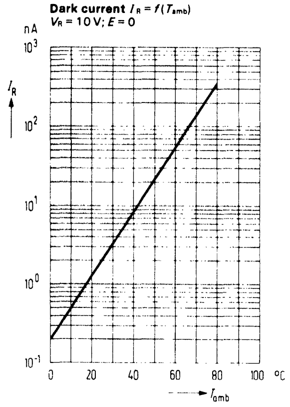
Capacitance $C = f(V_R)$
$f = 1$ MHz; $E = 0$



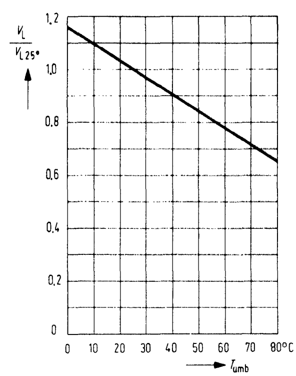
Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$



Dark current $I_R = f(T_{amb})$
$V_R = 10$ V; $E = 0$



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

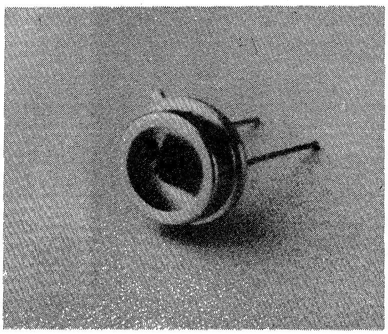


SIEMENS

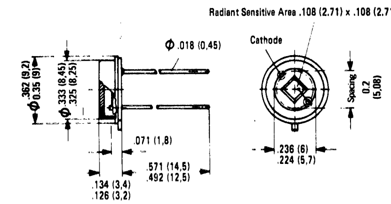
BPW 21

SILICON PHOTODIODE

Preliminary



Package Dimension in Inches (mm)



FEATURES

- **Incorporates, Vλ Filter**
- **High Reliability**
- **Hermetically Sealed, Glass Lens Package, Similar to TO-5**
- **No Testable Degradation**
- **Low Noise**
- **High Open-circuit Voltage as Photovoltaic Cells**
- **Detector for Low Illuminance**
- **Short Switching Time**
- **High Photosensitivity**
- **Strong Logarithmic relation between V_O or I_S and Illuminance of 10^{-2} to 10^{5} lx**
- **Wide Temperature Range**
- **Suitable in the Range of Visible Light**

DESCRIPTION

BPW 21 is a Planer Silicon Photodiode. The N-Si material results in a positive front and negative back contact. These photodetectors can be operated as photodiodes with reverse voltage or as photovoltaic cells. Applications include exposure meters for daylight as well as artificial light of high color temperature in photographic fields and color analysis.

Maximum Ratings

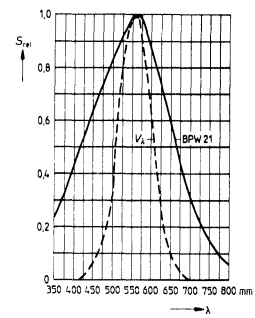
Ambient temperature range	T_{amb}	−40... +85	°C
Storage temperature range	T_{stg}	−40... +85	°C
Soldering temperature in a 1.5 mm distance from the case bottom (t≤5 sec)	T_{sold}	235	°C
Reverse voltage	V_R	10	V
Total power dissipation	P_{tot}	250	mW
Thermal resistance	$R_{th\ JA}$	300	k/W
	$R_{th\ JC}$	80	k/w

Characteristics (T_{amb} = 25 °C)

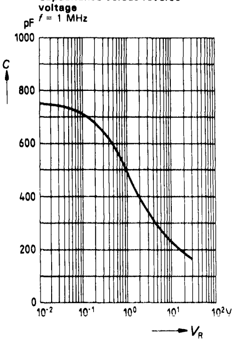
Photosensitivity (V_R = 5 V, standard light A, T = 2856K)	S	9(≥5,5)	nA/lx
Wavelength of max. photosensitivity	$\lambda_{S\ max}$	550	nm
Spectral range of photosensitivity (S = 10% of S_{max})	λ	350...775	nm
Radiant sensitive area	A	7.34	mm²
Dimension of radiant sensitive area	L×B	2.71×2.71	mm
Distance chip surface to case top edge	H	1.9...2.3	mm
Half angle	φ	60	degrees
Dark current (V_R = 5 V)	I_R	2(≤30)	nA
(V_R = 10 mV)	I_R	8	pA
Spectral photosensitivity (σ = 550 nm)	S_σ	0.21	A/W
Quantum yield (σ = 550 nm)	η	0.47	Electrons Photon
Open-circuit voltage (E_V = 1000 lx, standard light A, T = 2856 K)	V_O	390 (≧320)	mV
Short-circuit current (E_V = 1000 lx, standard light A, T = 2856 K)	I_S	9(≥5,5)	μA
(Deviation of I_S linearity in the range of 3 ·10^{-2} to 10^{4} lx: max. 12%)			
Rise and fall time of photocurrent from 10% to 90% and from 90% to 10% of final value (R_L = 1 kΩ, V_R = 10 V, λ = 550 nm, I_p = 9 μA)	tr, tf	1	μs
Forward voltage (I_F = 100 mA, E_e = O)	V_F	1.2	V
Capacitance (V_R = 0 V, f = 1 MHz, E_V = 0 lx)	C_O	750	pF
(V_R = 10 V, f = 1, MHz, E_V = 0 lx)	C_{10}	220	pF
Temperature coefficient of V_0	TC	−2.6	mV/K
Temperature coefficient of I_S	TC	0.12	%K

Specifications are subject to change without notice.

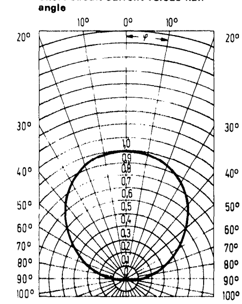
Relative spectral photosensitivity versus wavelength



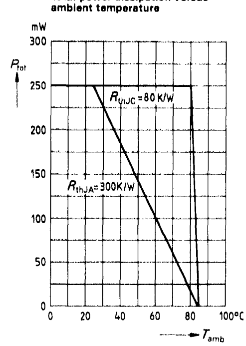
Capacitance versus reverse voltage
f = 1 MHz



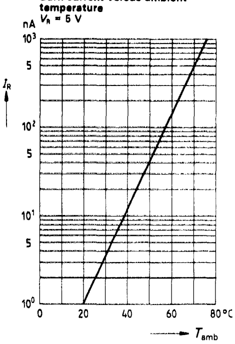
Directional characteristic
Short-circuit current versus half angle



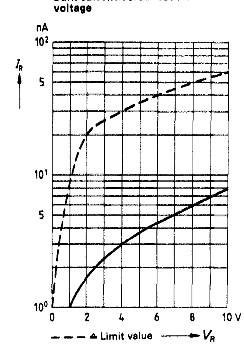
Total power dissipation versus ambient temperature



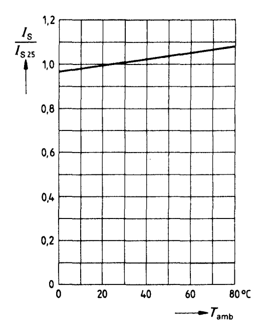
Dark current versus ambient temperature
V_R = 5 V



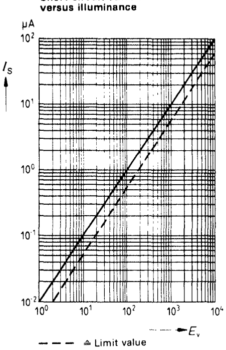
Dark current versus reverse voltage



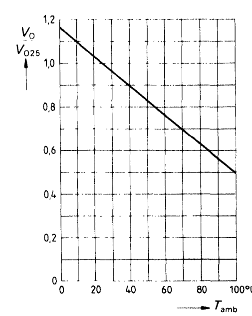
Short-circuit current versus ambient temperature



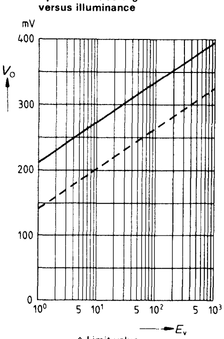
Short-circuit current versus illuminance



Open-circuit voltage versus ambient temperature

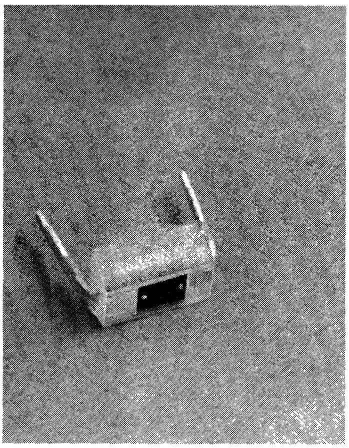


Open-circuit voltage versus illuminance

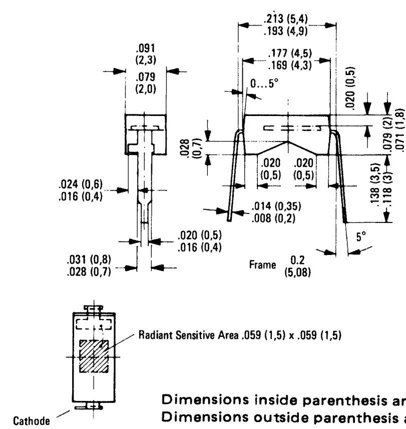


SIEMENS

BPW 32
PHOTODIODE



Package Dimensions



Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

FEATURES

- **Silicon Planar Photodiode**
- **Transparent Plastic Package**
- **2/10" Lead Spacing**
- **Very Low Dark Current, 5 pA**

DESCRIPTION

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.

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)

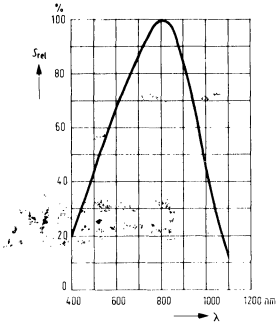
Spectral sensitivity [1]	S	10 (≥ 7)	nA/lx
Zero cross over [2] (E_e = 0 lx; T = 50°C)	S_O	≥ 0.5	mV/pA
Radiant sensitive area	A	1	mm²
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	800	nm
Quantum yield (Electrons per photon) (λ = 800 nm)	η	0.73	Electrons / Photon
Spectral sensitivity (λ = 800 nm)	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 = 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_O	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 color temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306 1).

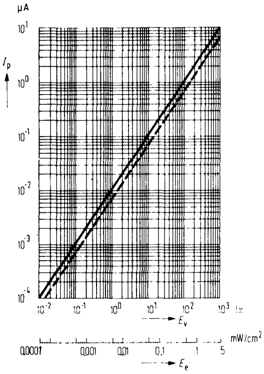
2) S_O is a measure for the lower spectral sensitivity when the photodiode is used in exposure meters. The zero cross over S_O is defined in the diagram.

Specifications are subject to change without notice.

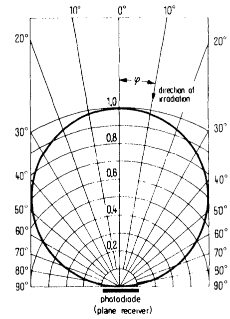
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



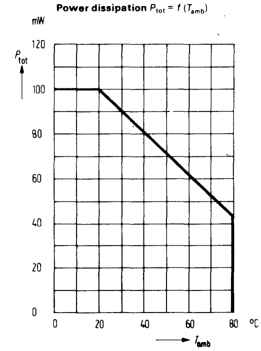
Photocurrent $I_P = f(E_v)$



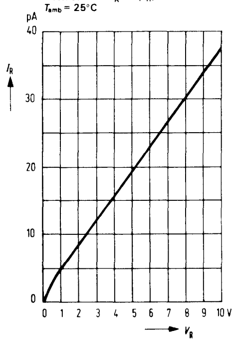
Directional characteristic $I_K = f(\varphi)$



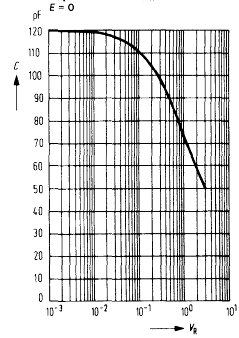
Power dissipation $P_{tot} = f(T_{amb})$



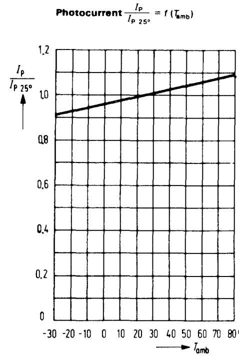
Dark current $I_R = f(V_R)$
$T_{amb} = 25°C$



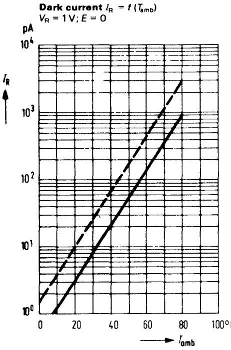
Capacitance $C = f(V_R)$
$E = 0$



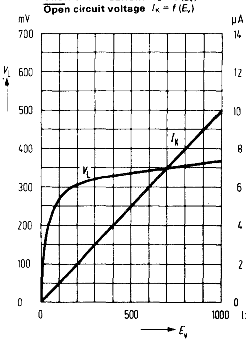
Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$



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



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



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

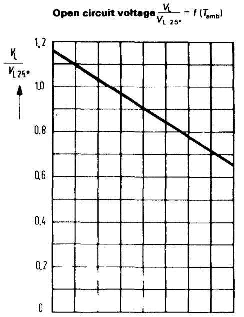
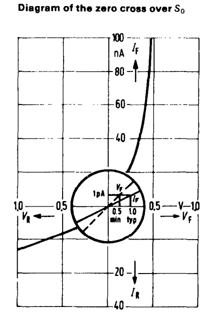
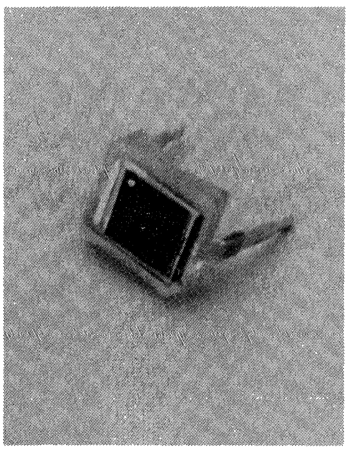


Diagram of the zero cross over S_0



SIEMENS

BPW 33
PHOTODIODE



FEATURES

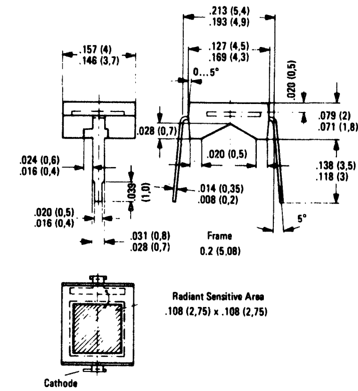
- Silicon Planar Photodiode
- Transparent Plastic Package
- 2/10" Lead Spacing
- Very Low Dark Current, 20 pA
- High Sensitivity, 50 nA/lx

DESCRIPTION

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.

Package Dimensions



Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

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 ($t \leq 3$ s)	T_s	230	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	150	mW

Characteristics (T_{amb} = 25°C)

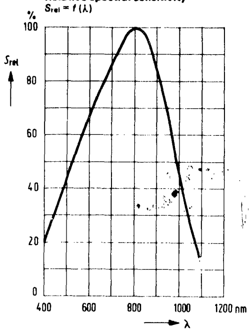
Spectral sensitivity [1]	S	50 (≥ 35)	nA/lx
Zero cross over [2] (E_v = 0; T_{amb} = 50°C)	S_0	≥ 0.05	mV/pA
Radiant sensitive area	A	7.6	mm²
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	800	nm
Quantum yield (Electrons per photon) (λ = 800 nm)	η	0.73	Electrons / Photon
Spectral sensitivity (λ = 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 = 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).

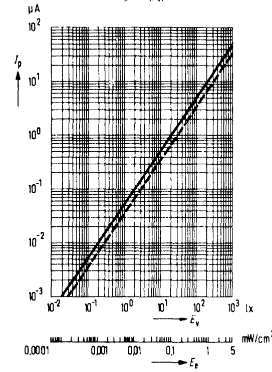
2) S_0 is a measure for the lower spectral sensitivity when the photodiode is used in exposure meters. The zero cross over S_0 is defined in the diagram.

Specifications are subject to change without notice.

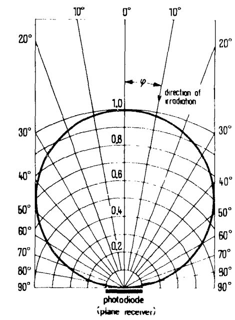
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



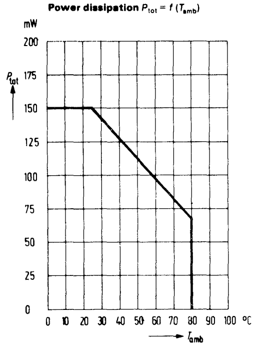
Photocurrent $I_P = f(E_v)$



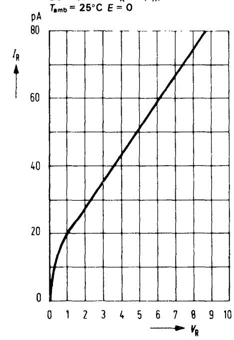
Directional characteristic $I_K = f(\varphi)$



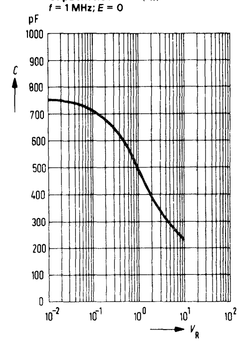
Power dissipation $P_{tot} = f(T_{amb})$



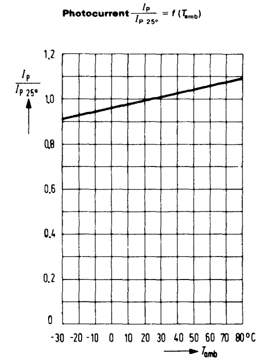
Dark current $I_R = f(V_R)$
$T_{amb} = 25°C$ $E = 0$



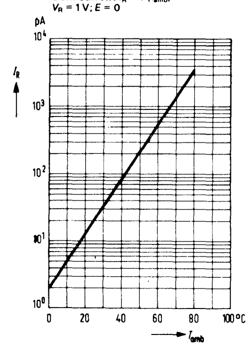
Capacitance $C = f(V_R)$
$f = 1$ MHz; $E = 0$



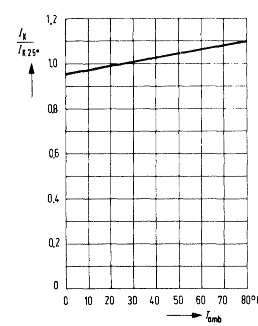
Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$



Dark current $I_R = f(T_{amb})$
$V_R = 1$ V; $E = 0$



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



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

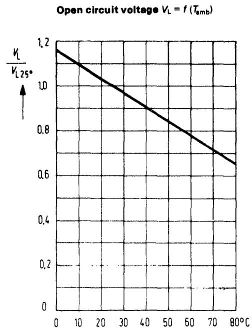
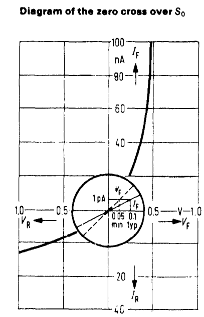


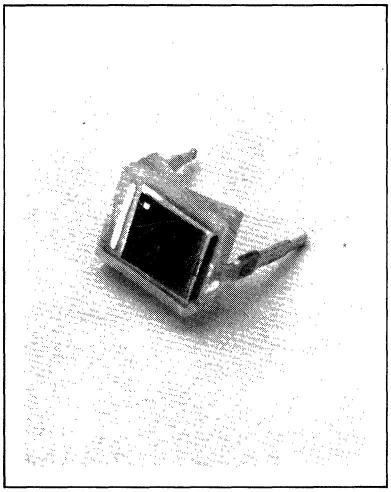
Diagram of the zero cross over S_0



SIEMENS

BPW 34

PIN PHOTODIODE



FEATURES

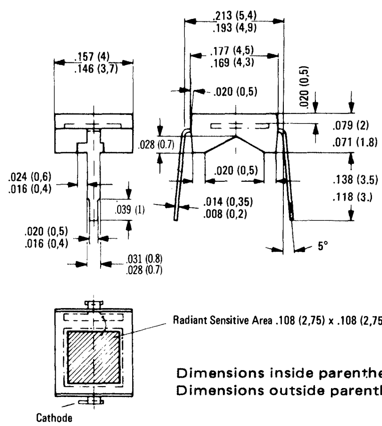
- **Silicon Planar PIN Photodiode**
- **Transparent Plastic Package**
- **2/10″ Lead Spacing**
- **Low Junction Capacitance, ≤ 40 pF**
- **Short Switching Time, 50 ns**
- **High Sensitivity, 70 nA/lx**

DESCRIPTION

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 favorable, 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.

Package Dimensions



Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

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

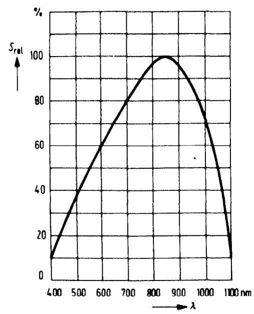
Characteristics (T_{amb} = 25°C)

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	mm²
Dark current (V_R = 10 V)	I_R	2 (≤ 30)	nA
Noise equivalent power (V_R = 10 V)	NEP	4.2 x 10^{-14}	$\frac{W}{\sqrt{Hz}}$
Detection limit	D^*	6.6 x 10^{12}	$\frac{cm\sqrt{Hz}}{W}$

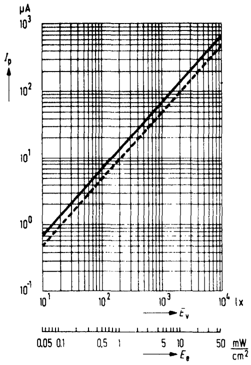
1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a color temperature of 2856 K (standard light A in accordance with DIN 5030 and IEC publ. 306-1).

Specifications are subject to change without notice.

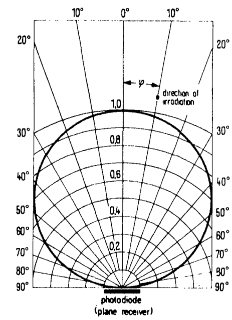
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



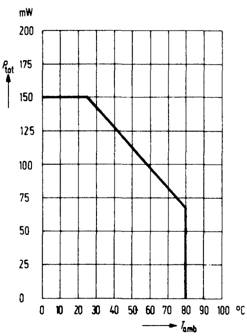
Photocurrent $I_P = f(E_v)$



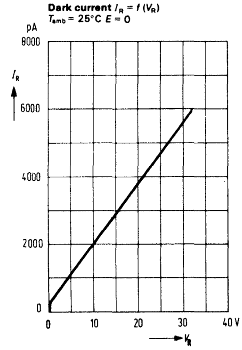
Directional characteristic $S_{rel} = f(\varphi)$



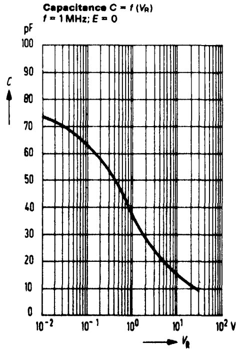
Power dissipation $P_{tot} = f(T_{amb})$



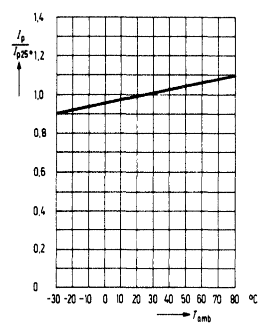
Dark current $I_R = f(V_R)$
$T_{amb} = 25°C$ $E = 0$



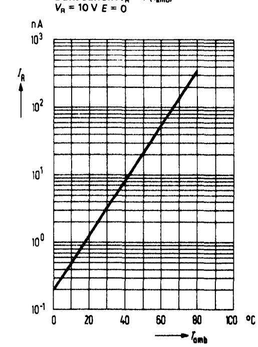
Capacitance $C = f(V_R)$
$f = 1\,MHz$; $E = 0$



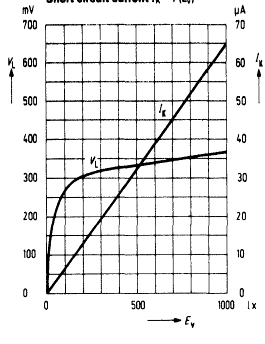
Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$



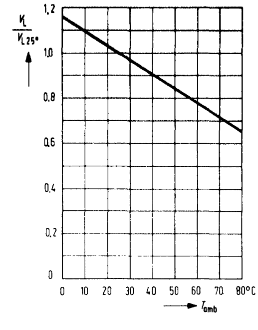
Dark current $I_R = f(T_{amb})$
$V_R = 10\,V$ $E = 0$



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

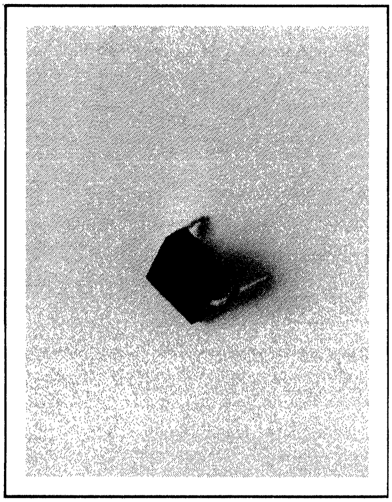


Open circuit voltage $\frac{V_L}{V_{L\,25°}} = f(T_{amb})$

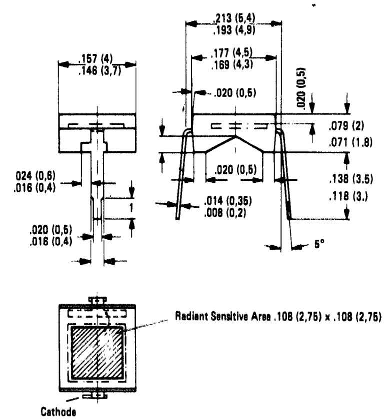


BPW 34F

PIN PHOTODIODE



Package Dimensions in Inches (mm)



FEATURES

- **Silicon Planar Pin Photodiode**
- **Plastic Package**
- **2/10″ Lead Spacing**
- **Low Junction Capacitance, ≤40 pF**
- **Short Switching Time**
- **High Sensitivity**

DESCRIPTION

The BPW 34F is a silicon planar PIN photodiode, which is incorporated in a 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 favorable, 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.

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 ≤ 3 s)	T_s	230	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	150	mW

Characteristics (T_{amb} = 25°C)

Spectral sensitivity (V_R = 5 V, λ = 950 nm)	S	50 (≥30)	$\frac{\mu A\ cm}{mW}$
Wavelength of the max. sensitivity	λs max	950	nm
Spectral range of photosensitivity of (S = 10% of S max)	λ	800-1100	nm
Radiant sensitive area	A	7.34	mm²
Dimensions of the radiant sensitivity area	L x B	2.71 x 2.71	mm
Distance chip surface to package surface	H	0.5	mm
Half angle	φ	±60°	degrees
Dark current (U_R = 10 V)	I_R	2 (≤30)	nA
Spectral sensitivity (λ = 950 nm)	S_λ	0.57	A/W
Quantum yield (λ = 950 nm)	η	0.74	$\frac{Electrons}{Photon}$
Open circuit voltage (E_e = 0.5 mW/cm²; λ = 950 nm)	V_O	327	mV
Short circuit current (E_e = 0.5 mW/cm²; λ = 950 nm)	I_S	25 (≥15)	µA
Rise and fall time of the photo current from 10% to 90%, or from 90% to 10%, of the final value (R_L = 1 kΩ; V_R = 0 V; λ = 950 nm) and a photo current (I_p = 25 µA)	t_r, t_f	125	ns
Forward voltage at (I_F = 100 mA, E_e = 0, T_U = 25°C)	V_F	1.3	V
Temperature coefficient of V_O	TK	−2.6	mV/K
Temperature coefficient of I_S	TK	0.18	%/K
Capacitance (V_R = 0 V; f = 1 MHz; E_V = 0)	C	72	pF
Noise equivalent power (V_R = 10 V)	NEP	4.4×10^{-14}	$\frac{W}{\sqrt{Hz}}$
Detection limit (V_R = 10 V)	D	6.3×10^{12}	$\frac{cm\sqrt{Hz}}{W}$

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

Specifications are subject to change without notice.

RELATIVE SPECTRAL SENSITIVITY

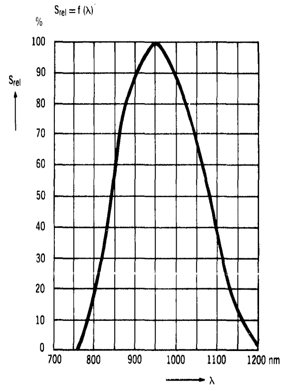
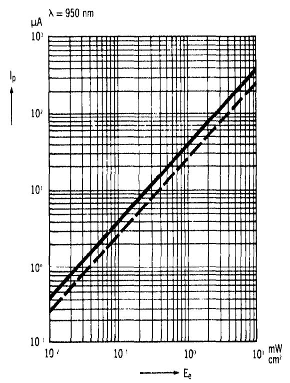
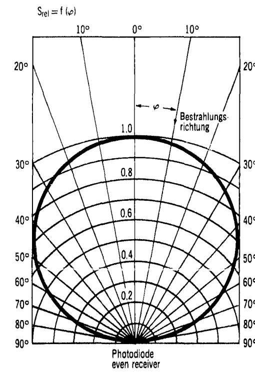


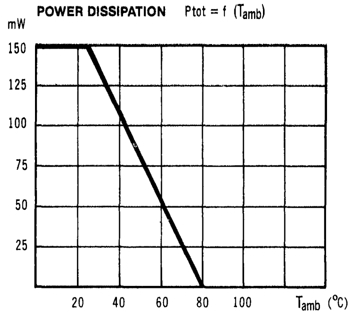
PHOTO CURRENT $I_P = f(E_e)$



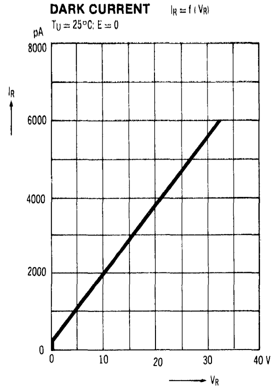
DIRECTIONAL CHARACTERISTIC



POWER DISSIPATION Ptot = f (Tamb)



DARK CURRENT $I_R = f(V_R)$



CAPACITANCE $C = f(V_R)$

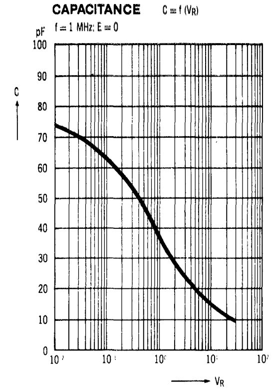
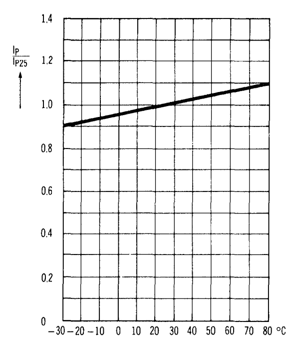
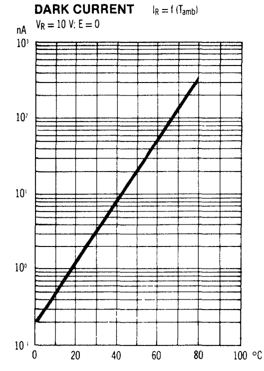


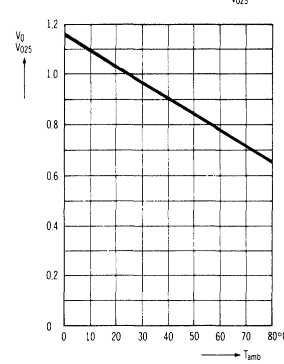
PHOTO CURRENT $\frac{I_P}{I_{P25}} = f(T_{amb})$



DARK CURRENT $I_R = f(T_{amb})$



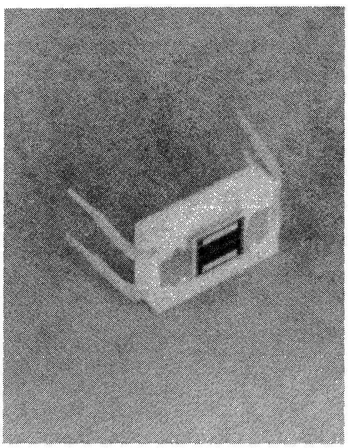
OPEN CIRCUIT VOLTAGE $\frac{V_O}{V_{O25}} = f(T_{amb})$



SIEMENS

BPX 48

DIFFERENTIAL PHOTODIODE



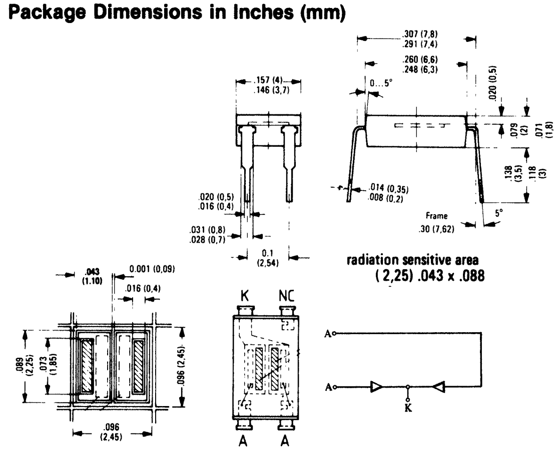
FEATURES

- **Differential Photodiode**
- **Plastic Encapsulated, Strip Line Technique**
- **Tightly Spaced Diodes For Precise Positional Indication**

DESCRIPTION

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 90 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 favorable signal relationships.

Package Dimensions in Inches (mm)



radiation sensitive area

Maximum Ratings

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)

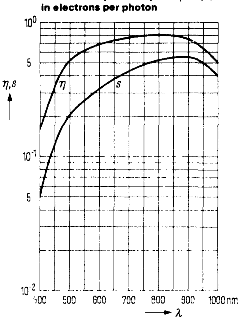
(the data refers to one photodiode system)

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	2 x 2.47	mm2
Dark current (V_R = 10 V; E = 0)	I_R	100 (≤ 200)	nA

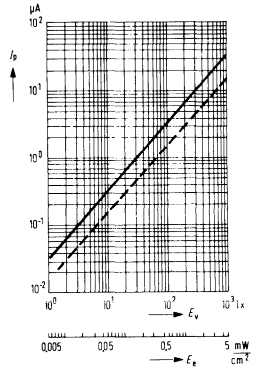
1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a color temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

Specifications are subject to change without notice.

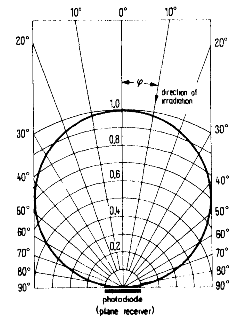
Spectral sensitivity $S = f(\lambda)$ in A/W and quantum yield $\eta = f(\lambda)$ in electrons per photon



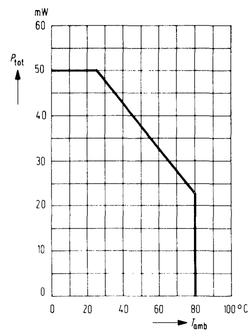
Photocurrent $I_P = f(E_v)$



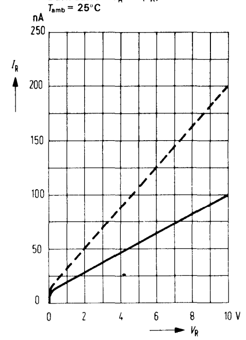
Directional characteristic $I_P = f(\varphi)$



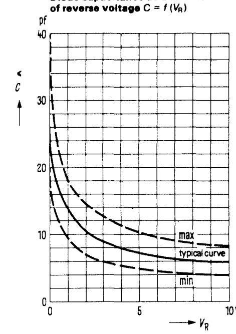
Power dissipation $P_{tot} = f(T_{amb})$



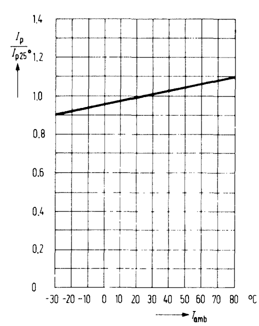
Dark current $I_R = f(V_R)$
T_{amb} = 25°C



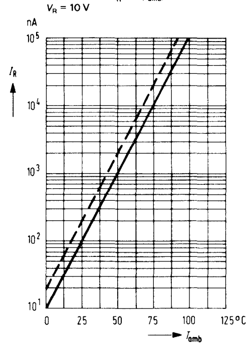
Diode capacitance as a function of reverse voltage $C = f(V_R)$



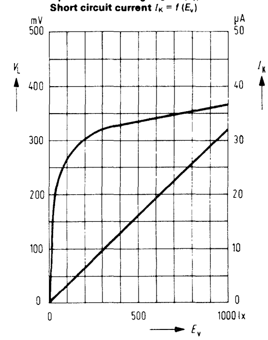
Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$



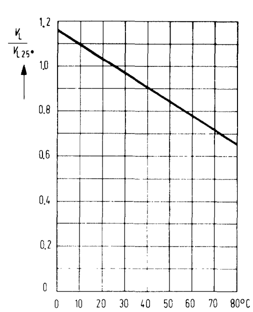
Dark current $I_R = f(T_{amb})$
V_R = 10 V



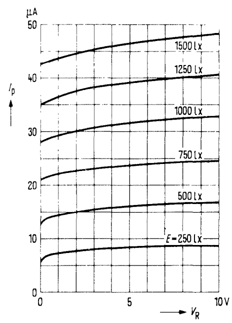
Open circuit voltage $V_L = f(E_v)$
Short circuit current $I_K = f(E_v)$



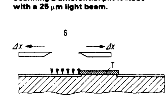
Open circuit voltage $V_L = f(T_{amb})$



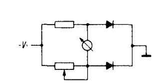
Family of characteristics $I_P = f(V_R)$
E_v = parameter



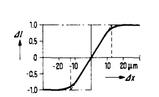
Scanning a differential photodiode with a 25 μm light beam.



Test setup
S – slit (25 μm wide)
T – separation of diodes
Δx – displacement of S



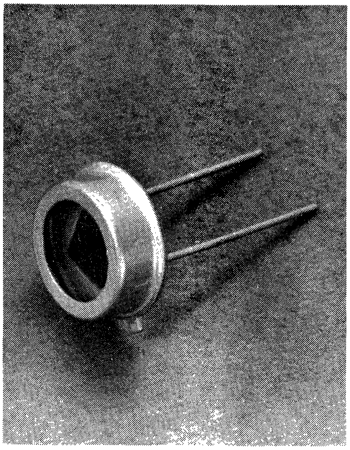
Measuring circuit



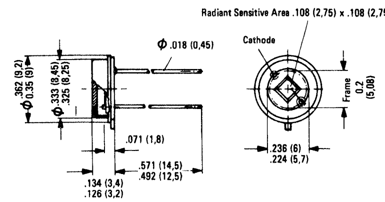
Differential photo signal ΔI (referred to saturation value 1) as a function of the displacement Δx of the slit of light S

SIEMENS

BPX 60
PHOTODIODE



Package Dimensions



Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

FEATURES

- **Silicon Planar Photodiode**
- **Premium Hi-Rel Device**
- **Modified TO-5 Hermetic Case**
- **Flat Glass Lens**
- **Large Photo Sensitive Area**

DESCRIPTION

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 favorable even at low illuminances. The open circuit voltage at low illuminances is higher than with comparable mesa photovoltaic cells.

Maximum Ratings

Reverse voltage	V_R	32	V
Operating and storage temperature range	T_{stor}	−40 to + 100	°C
Junction temperature	T_j	100	°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

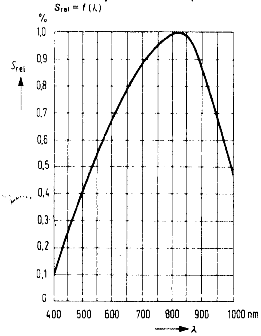
Characteristics (T_{amb} = 25°C)

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
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	mm^2
Dark current (V_R = 10 V; T_{amb} = 25°C; E = 0)	I_R	7 (≤ 300)	nA

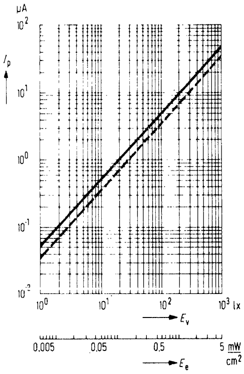
1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

Specifications are subject to change without notice.

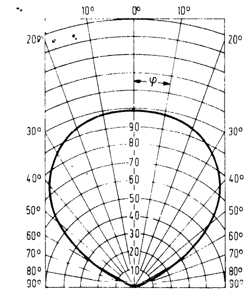
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



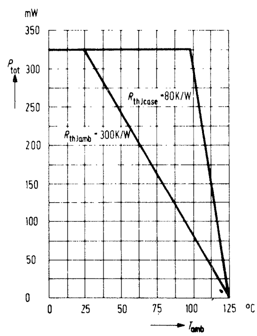
Photocurrent $I_P = f(E_v)$



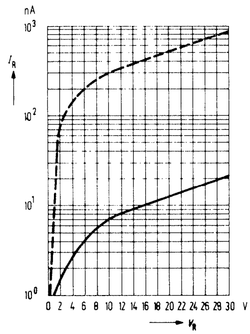
Directional characteristic $I_K = f(\varphi)$



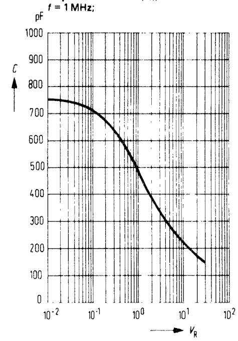
Power dissipation $P_{tot} = f(T_{amb})$



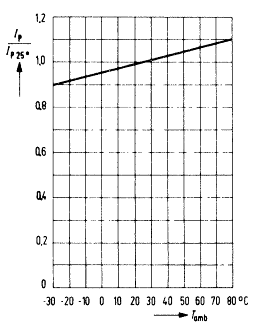
Dark current $I_R = f(V_R)$



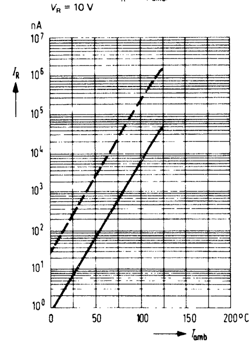
Capacitance $C = f(V_R)$
f = 1 MHz;



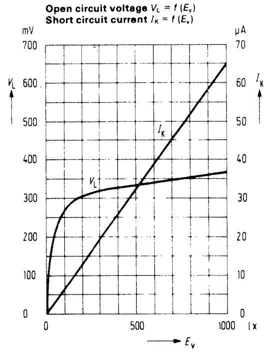
Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$



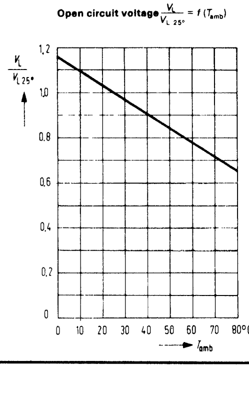
Dark current $I_R = f(T_{amb})$
V_R = 10 V



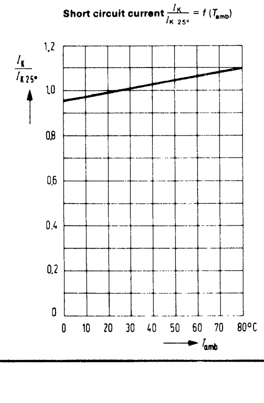
Open circuit voltage $V_L = f(E_v)$
Short circuit current $I_K = f(E_v)$



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



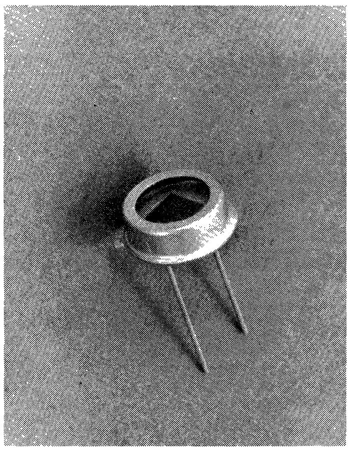
Short circuit current $\frac{I_K}{I_{K\,25°}} = f(T_{amb})$



SIEMENS

BPX 61

PIN PHOTODIODE



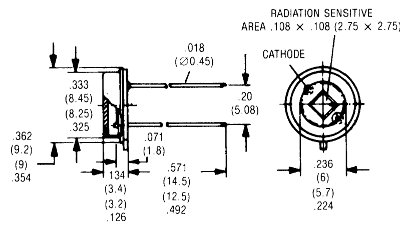
FEATURES

- **Silicon Planar PIN Photodiode**
- **Premium Hi-Rel Device**
- **Modified TO-5 Hermetic Case**
- **Flat Glass Lens**
- **Large Photo Sensitive Area**
- **Low Dark Current, 2 nA**
- **Short Switching Time, 50 ns**

DESCRIPTION

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 favorable 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.

Package Dimensions in Inches (mm)



Maximum Ratings

Reverse voltage	V_R	32	V
Operating and storage temperature range	T_{stor}	−40 to +100	°C
Junction temperature	T_j	100	°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}	325	mW
Thermal resistance	$R_{th\ Jamb}$	300	K/W
	$R_{th\ Jcase}$	80	K/W

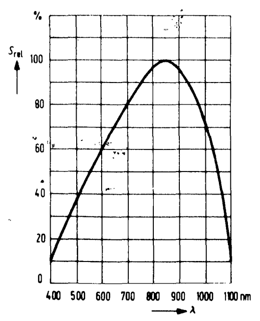
Characteristics (T_{amb} = 25°C)

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	Electrons/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}	$\frac{cm\sqrt{Hz}}{W}$

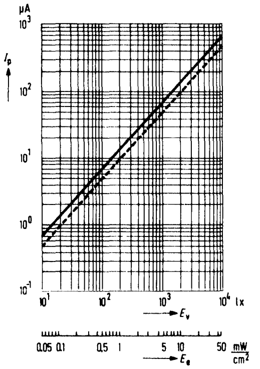
1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a color temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

Specifications are subject to change without notice.

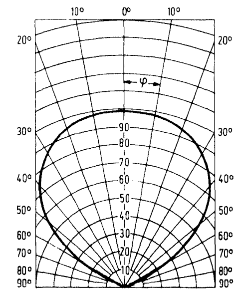
Relative spectral sensitivity $S_{rel} = f(\lambda)$



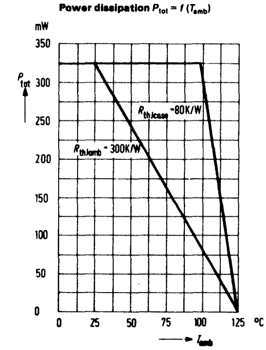
Photocurrent $I_P = f(E_v)$



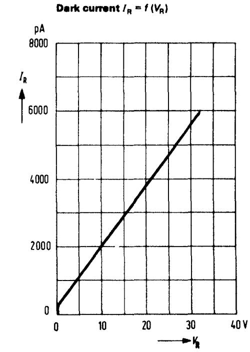
Directional characteristic $I_K = f(\varphi)$



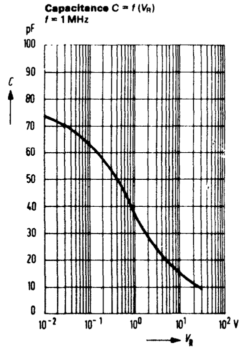
Power dissipation $P_{tot} = f(T_{amb})$



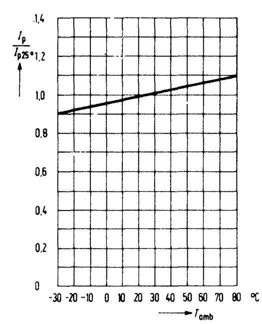
Dark current $I_R = f(V_R)$



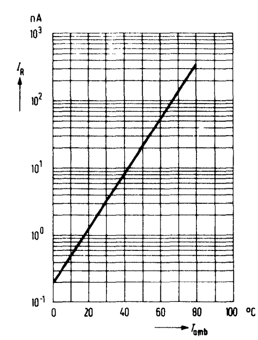
Capacitance $C = f(V_R)$
f = 1 MHz



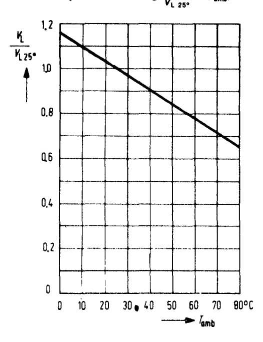
Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$



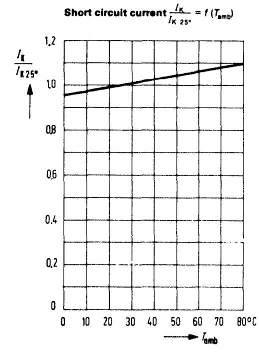
Dark current $I_R = f(T_{amb})$



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

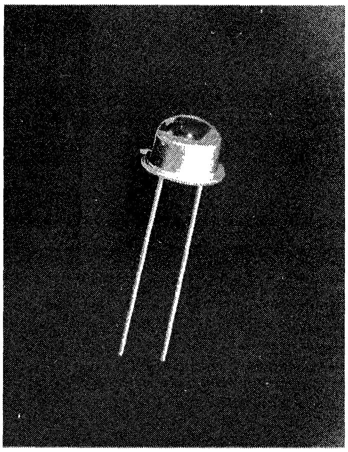


Short circuit current $\frac{I_K}{I_{K\,25°}} = f(T_{amb})$

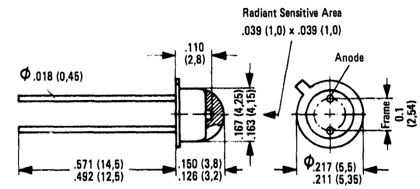


SIEMENS

BPX 63
PHOTODIODE



Package Dimensions



Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

FEATURES

- **Silicon Planar Photodiode**
- **Modified TO-18 Package**
- **Metal Case and Plastic Lens**
- **Very Low Dark Current, 5 pA**

DESCRIPTION

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.

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)

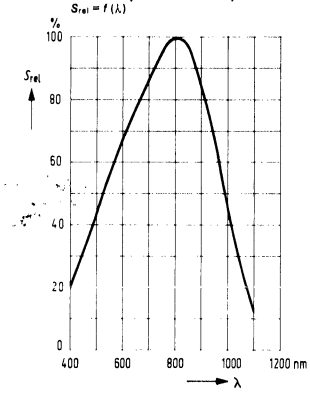
Spectral sensitivity [1]	S	10 (≧ 8)	nA/lx
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	800	nm
Quantum yield (Electrons per photon) (λ = 800 nm)	η	0.73	Electrons / Photon
Spectral sensitivity (λ = 800 nm)	S	0.47	A/W
Forward voltage [2] (E = 0; I_F = 1 pA; T_{amb} = 50°C)	V_F	1 (≧ 0.5)	mV
Rise 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).

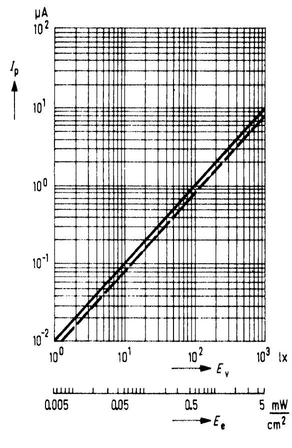
2) V_F is a measure for the lower spectral sensitivity when the photodiode is used in exposure meters.

Specifications are subject to change without notice.

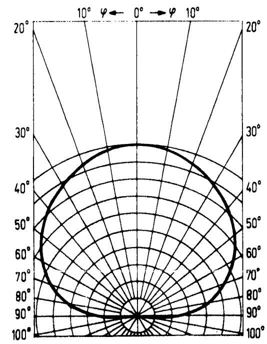
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



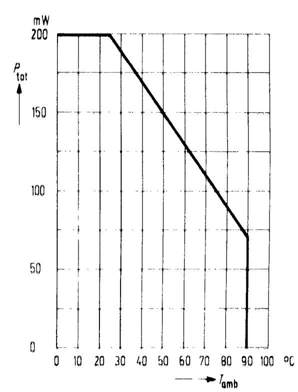
Photocurrent $I_P = f(E_v)$



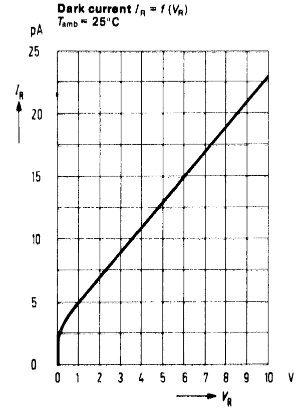
Directional characteristic $I_P = f(\varphi)$



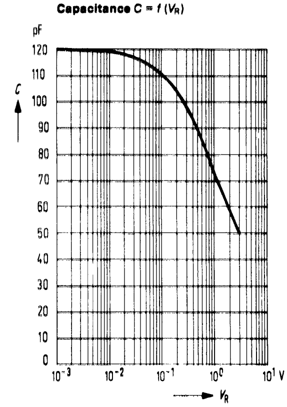
Power dissipation $P_{tot} = f(T_{amb})$



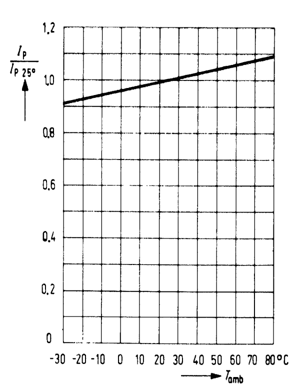
Dark current $I_R = f(V_R)$
$T_{amb} = 25\,°C$



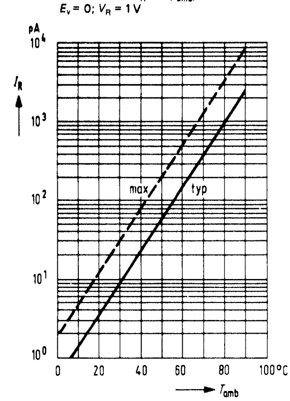
Capacitance $C = f(V_R)$



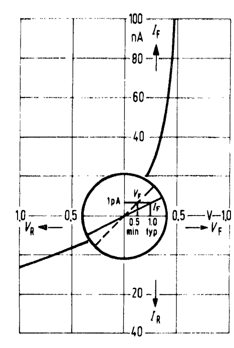
Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$



Dark current $I_R = f(T_{amb})$
$E_v = 0$; $V_R = 1\,V$

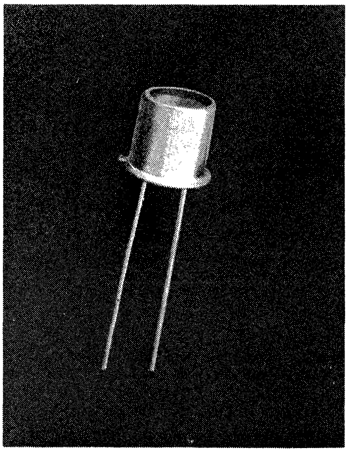


Zero cross over $S_0 = \frac{V_F}{I_F}$



SIEMENS

BPX 65
PIN PHOTODIODE



FEATURES

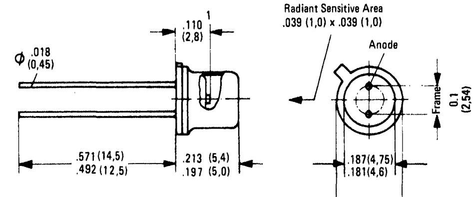
- **Silicon Planar PIN Photodiode**
- **Premium Hi-Rel Device**
- **TO-18 Size Package**
- **Flat Glass Lens**
- **High Speed, 1 ns**
- **Low Dark Current, 1 nA**

DESCRIPTION

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.

Package Dimensions



Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

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

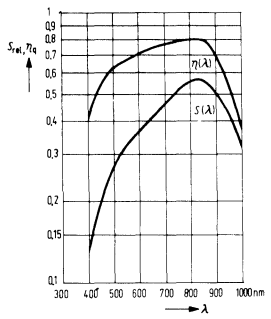
Characteristics (T_{amb} = 25°C)

Radiant sensitive area	A	1	mm²
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 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	3.3×10^{-14}	$\frac{W}{\sqrt{Hz}}$
Detection limit (V_R = 20 V)	D^*	3.1×10^{12}	$\frac{cm\sqrt{Hz}}{W}$
Temperature coefficient for I_P	TC	0.2	%/K

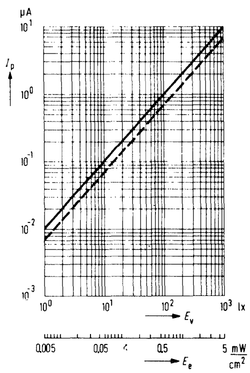
1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a color temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

Specifications are subject to change without notice.

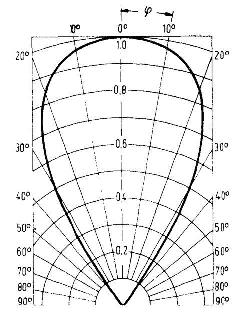
Spectral sensitivity $S_{rel} = f(\lambda)$ **in A/W and quantum yield** $\eta = f(\lambda)$ **in electrons per photon**



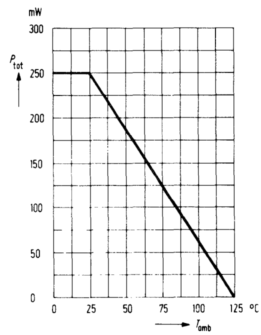
Photocurrent $I_P = f(E_v)$



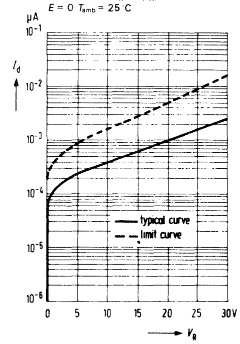
Directional characteristic $I_P = f(\varphi)$



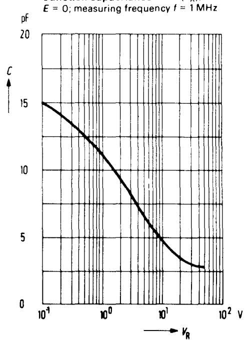
Power dissipation $P_{tot} = f(T_{amb})$



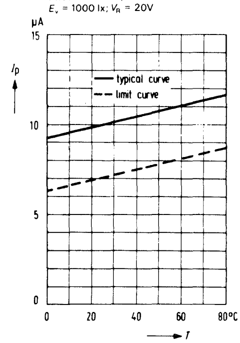
Dark current $I_R = f(V_R)$
$E = 0$ $T_{amb} = 25\,°C$



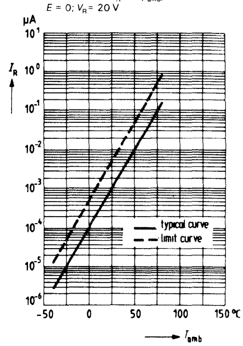
Junction capacitance $C = f(V_R)$;
$E = 0$; measuring frequency $f = 1$ MHz



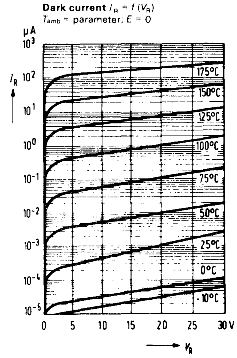
Photocurrent $I_P = f(T)$
$E_v = 1000$ lx; $V_R = 20$V



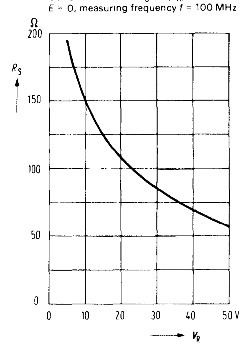
Dark current $I_R = f(T_{amb})$
$E = 0$; $V_R = 20$ V



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

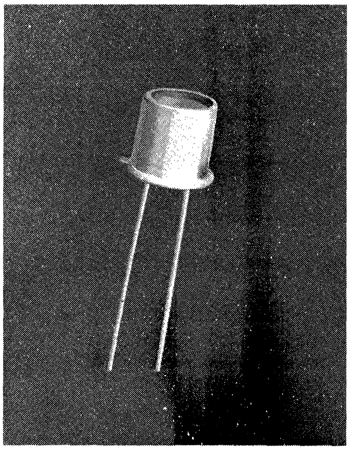


Series resistance $R_S = f(V_R)$
$E = 0$, measuring frequency $f = 100$ MHz

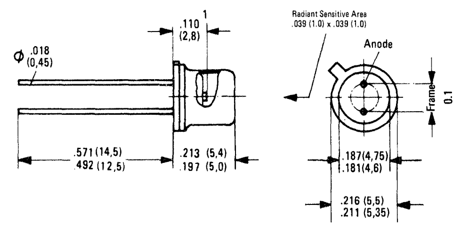


SIEMENS

BPX 66
PIN PHOTODIODE



Package Dimensions



Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

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)

Radiant sensitive area	A	1	mm2
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 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).

Specifications are subject to change without notice.

FEATURES

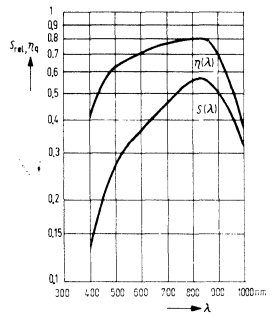
- Silicon Planar PIN Photodiode
- Premium Hi-Rel Device
- TO-18 Size Package
- Flat Glass Lens
- High Speed, 0.5 ns
- Low Dark Current, 0.15 nA

DESCRIPTION

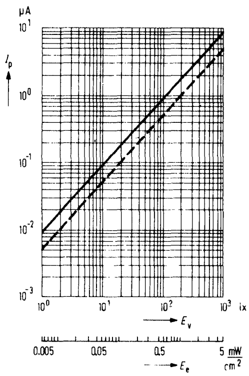
The BPX 66 is a planar silicon PIN photodiode in a case 18 A 2 DIN 41876 (sim. to TO-18) with a flat window and extremely low dark current. The cathode is electrically connected to the case. The flat window has no influence on the beam path of optical lens systems. Because of its high cut-off frequency,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

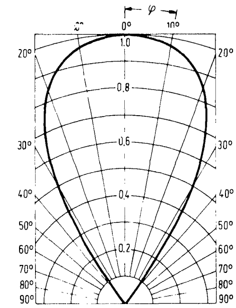
Spectral sensitivity $S_{rel} = f(\lambda)$ in A/W and quantum yield $\eta = f(\lambda)$ in electrons per photon



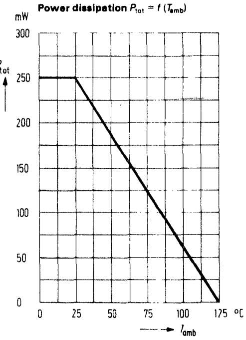
Photocurrent $I_P = f(E_v)$



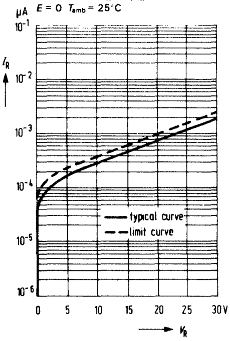
Directional characteristic $I_P = f(\varphi)$



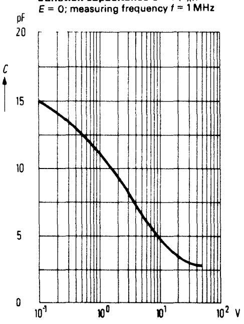
Power dissipation $P_{tot} = f(T_{amb})$



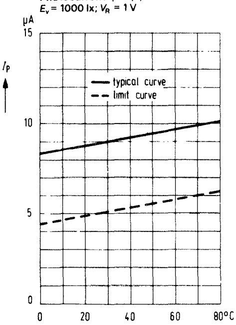
Dark current $I_R = f(V_R)$
$E = 0$ $T_{amb} = 25\,°C$



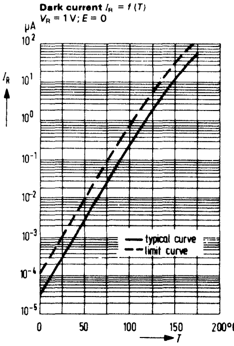
Junction capacitance $C = f(V_R)$;
$E = 0$; measuring frequency $f = 1$ MHz



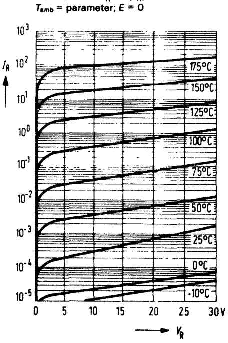
Photocurrent $I_P = f(T)$
$E_v = 1000$ lx; $V_R = 1$ V



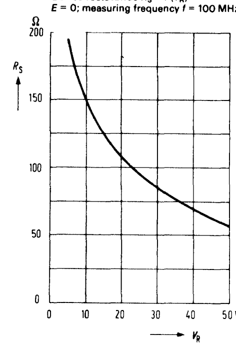
Dark current $I_R = f(T)$
$V_R = 1$ V; $E = 0$



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

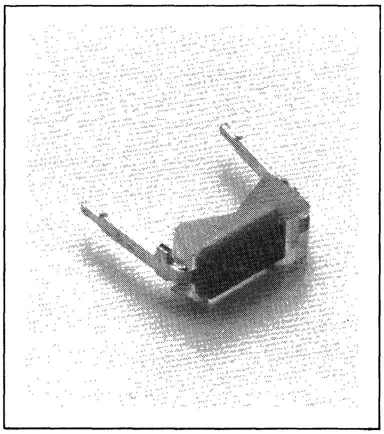


Series resistance $R_S = f(V_R)$
$E = 0$; measuring frequency $f = 100$ MHz

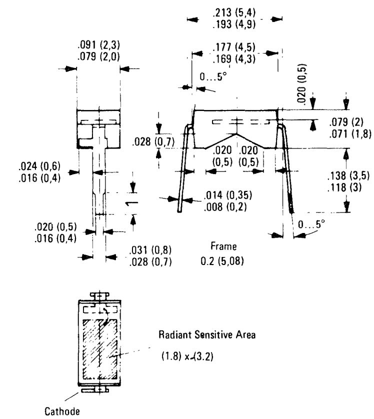


SIEMENS

BPX 90
PHOTODIODE



Package Dimensions in Inches (mm)



Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

FEATURES

- **Silicon Planar Photodiode**
- **Transparent Plastic Package**
- **2/10" Lead Spacing**
- **High Sensitivity, 40 nA/ lx**

DESCRIPTION

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 favorable, even at low illuminances. The open circuit voltage at low illuminances is higher than with comparable mesa photovoltaic cells.

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

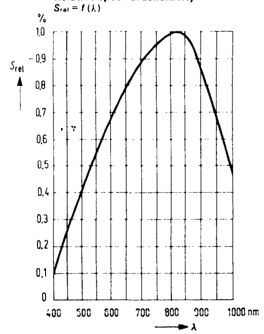
Characteristics (T_{amb} = 25°C)

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

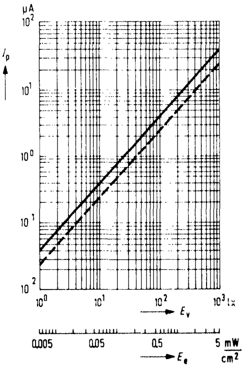
1) The illuminance indicated refers to unfiltered radiation of a tungsten-filament lamp at a color temperature of 2856 K. (Standard light A in accordance with DIN 5033 and IEC publ. 306-1.)

Specifications are subject to change without notice.

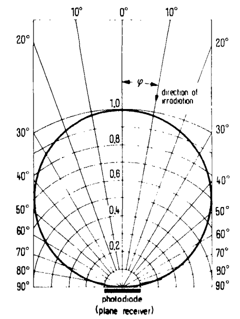
Relative spectral sensitivity $S_{rel} = f(\lambda)$



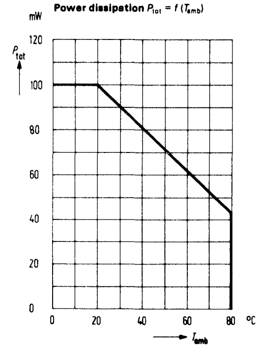
Photocurrent $I_P = f(E_v)$



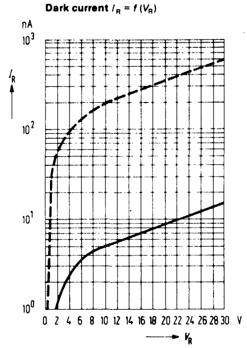
Directional characteristic $I_K = f(\varphi)$



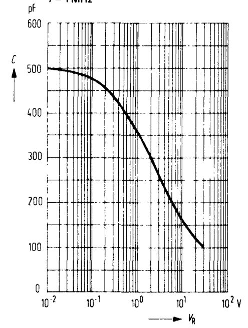
Power dissipation $P_{tot} = f(T_{amb})$



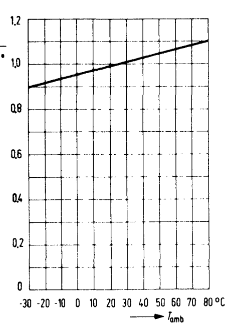
Dark current $I_R = f(V_R)$



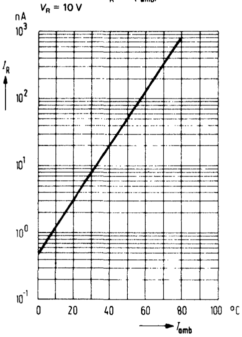
Capacitance C = $f(V_R)$
f = 1 MHz



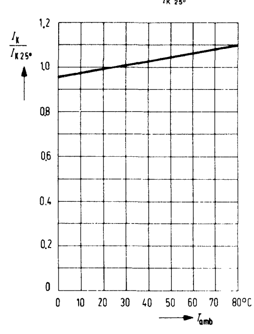
Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$



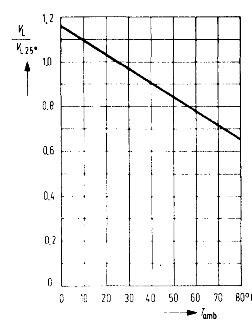
Dark current $I_R = f(T_{amb})$
V_R = 10 V



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



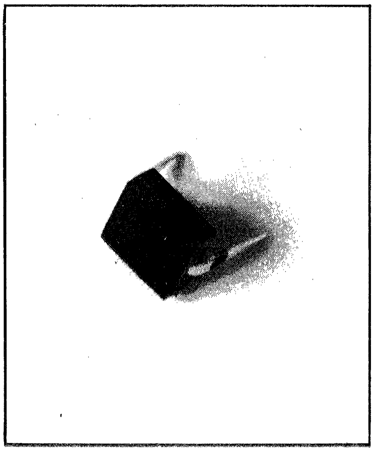
Open circuit voltage $\frac{V_L}{V_{L\,25°}} = f(T_{amb})$



SIEMENS

BPX 91B

PHOTODIODE



Supercedes BPX 91

FEATURES

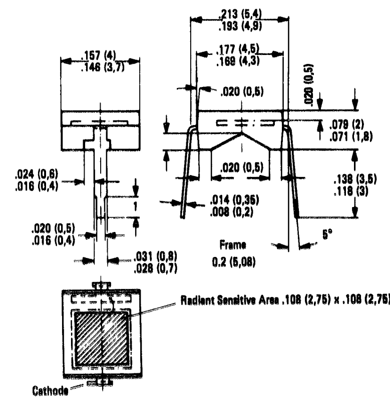
- **Transparent Plastic Package**
- **2/10″ (5.08 mm) Lead Spacing**
- **High Blue Sensitivity, 400 mm = 30% Srel**

DESCRIPTION

The BPX 91B is a planar silicon photodiode, which is incorporated in a transparent plastic package. Its terminals are soldering tabs arranged in 2/10″ (5.08 mm) 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. The increased blue sensitivity with short wavelength makes the BPX 91B particularly suitable for application with high blue light source.

This versatile photodetector is suitable for diode as well as voltaic cell operation. The signal/noise ratio is particularly favorable, 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 tab on the solder lead.

Package Dimensions in Inches (mm)



Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

Maximum Ratings

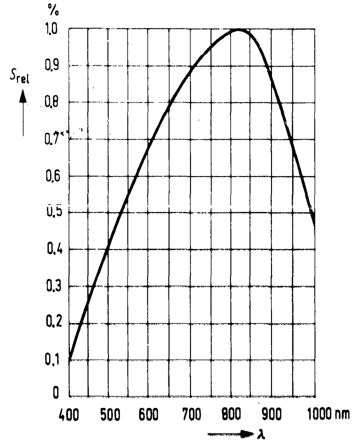
Reverse Voltage (V_R)	10 V
Operating and Storage Temperature Range (T_s)	−40 to +80 °C
Soldering Temperature in a 2 mm Distance from the Case Bottom (T_L), $t \leq 3$ s	230 °C
Power Dissipation (P_{tot}), T_{amb} = 25 °C	150 mW

Characteristics (T_{amb} = 25 °C)

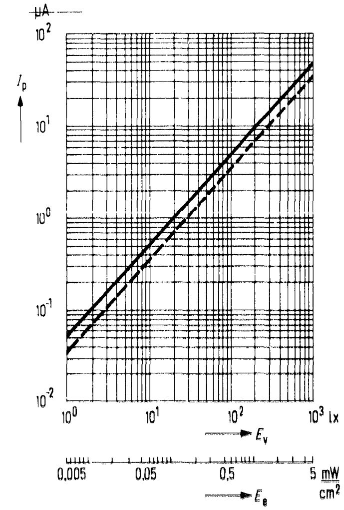
Photo Spectral Sensitivity (S)	50 (≥35) nA/lx
Wavelength of the Max. Sensitivity ($\lambda_{S\,max}$)	850 nm
Quantum Yield (η)	0.73 Electrons/Photon
Spectral Sensitivity (S_λ), λ = 850 nm	0.47 A/W
Open Circuit Voltage (V_L)	
E_v = 100 lx	360 (≥270) mV
E_v = 1000 lx	460 mV
Short Circuit Current (I_K)	
E_v = 100 lx	5 (≥3.5) μA
Rise and Fall Time of the Photo Current (t_r;t_f)	
R_L = 1 kΩ; V_R = 0 V; λ = 950 nm	2.5 μs
R_L = 1 kΩ; V_R = 10 V; λ = 950 nm	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 (I_R)	
V_R = 10 V; E = 0	7 (≤300) nA

Specifications subject to change without notice.

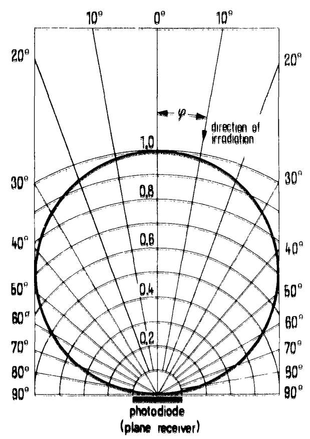
RELATIVE SPECTRAL SENSITIVITY
$S_{rel} = f(\lambda)$



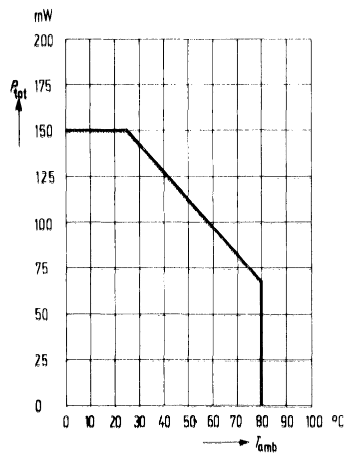
PHOTOCURRENT $I_P = f(E_v)$



DIRECTIONAL CHARACTERISTIC
$I_K = f(\varphi)$

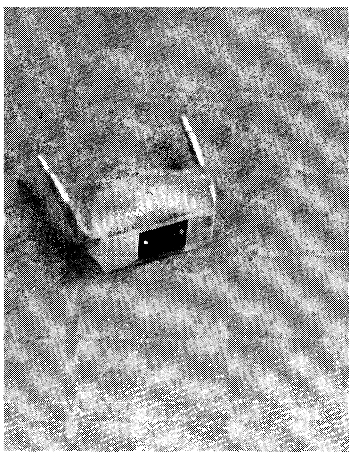


POWER DISSIPATION
$P_{tot} = f(T_{amb})$



SIEMENS

BPX 92
PHOTODIODE



FEATURES

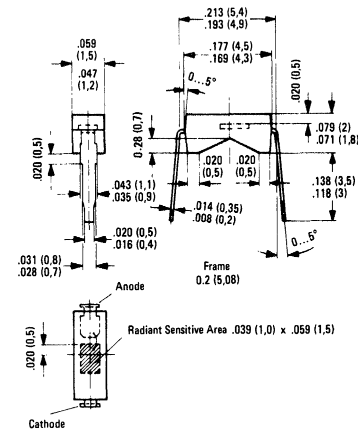
- **Silicon Planar Photodiode**
- **Transparent Plastic Package**
- **2/10" Lead Spacing**
- **Low Dark Current, 1 nA**

DESCRIPTION

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 favorable, even at low illuminances. The open circuit voltage at low illuminances is higher than with comparable mesa photovoltaic cells.

Package Dimensions



Dimensions inside parenthesis are in mm
Dimensions inside parenthesis are in inches

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 ($t \leq 3$ s)	T_s	230	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	50	mW

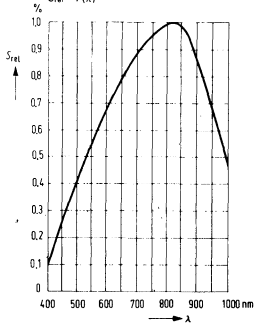
Characteristics (T_{amb} = 25°C)

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	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	1.5	mm2
Dark current (V_R = 10 V; E = 0)	I_R	1 (≦ 100)	nA

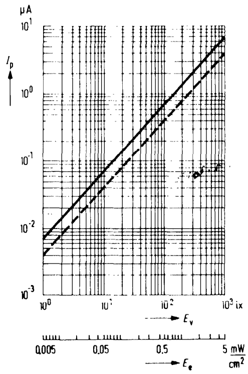
1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

Specifications are subject to change without notice.

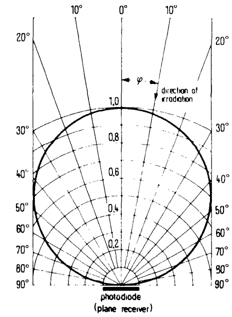
Relative spectral sensitivity $S_{rel} = f(\lambda)$



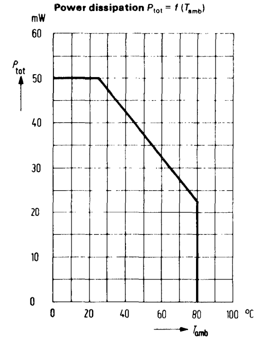
Photocurrent $I_P = f(E_v)$



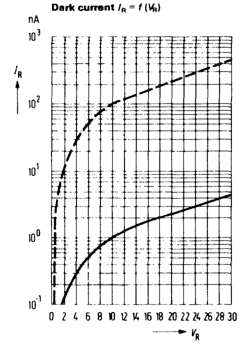
Directional characteristic $I_K = f(\varphi)$



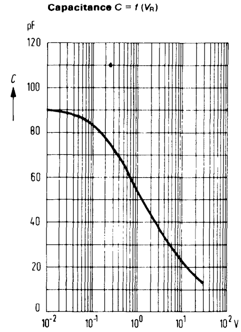
Power dissipation $P_{tot} = f(T_{amb})$



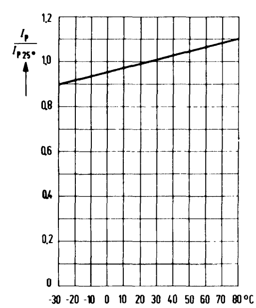
Dark current $I_R = f(V_R)$



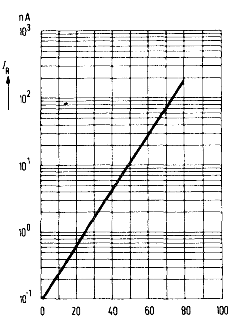
Capacitance $C = f(V_R)$



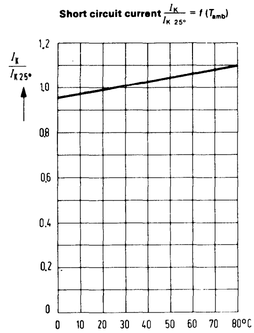
Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$



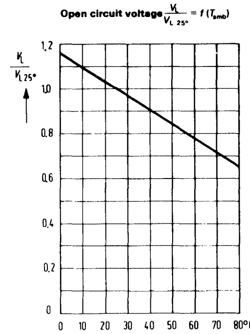
Dark current $I_R = f(T_{amb})$



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

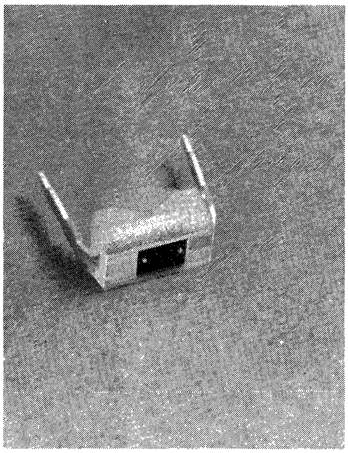


Open circuit voltage $\frac{V_L}{V_{L\,25°}} = f(T_{amb})$



SIEMENS

BPX 93
PHOTODIODE



FEATURES

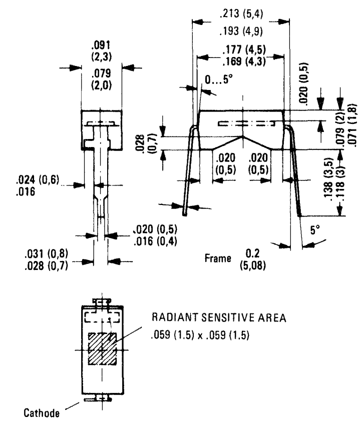
- **Silicon Planar Photodiode**
- **Transparent Plastic Package**
- **2/10" Lead Spacing**
- **Low Dark Current, 0.5 nA**

DESCRIPTION

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 favorable, 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.

Package Dimensions



Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

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 ($t \leq 3$ s)	T_s	230	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	75	mW

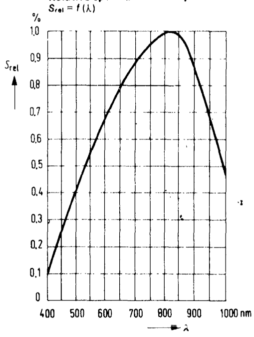
Characteristics (T_{amb} = 25°C)

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

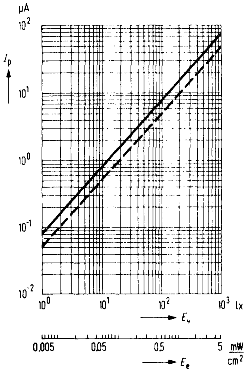
1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

Specifications are subject to change without notice.

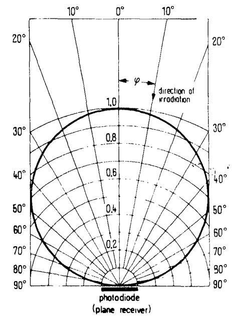
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



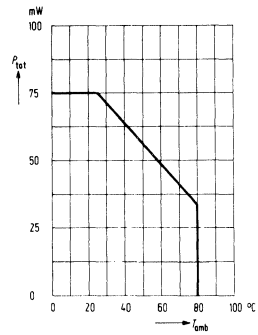
Photocurrent $I_P = f(E_v)$



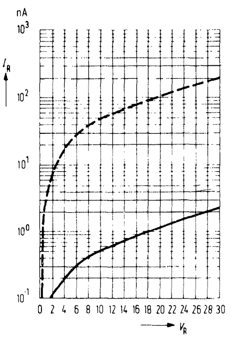
Directional characteristic $I_K = f(\varphi)$



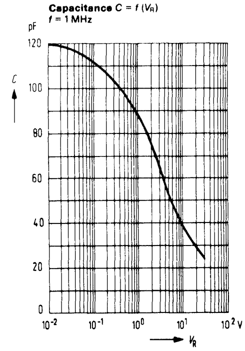
Power dissipation $P_{tot} = f(T_{amb})$



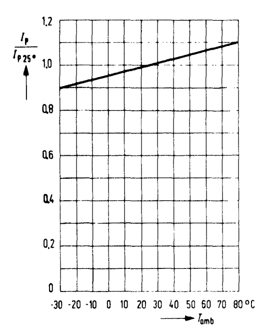
Dark current $I_R = f(V_R)$



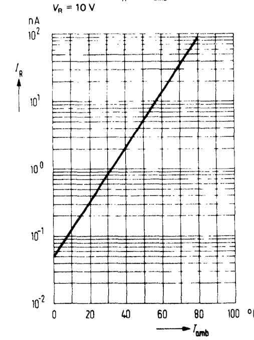
Capacitance $C = f(V_R)$
$f = 1$ MHz



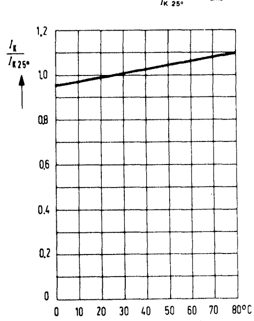
Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$



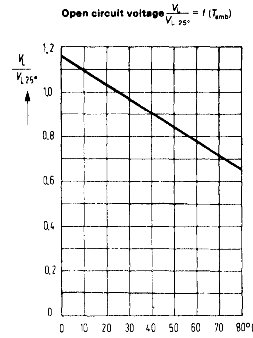
Dark current $I_R = f(T_{amb})$
$V_R = 10$ V



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

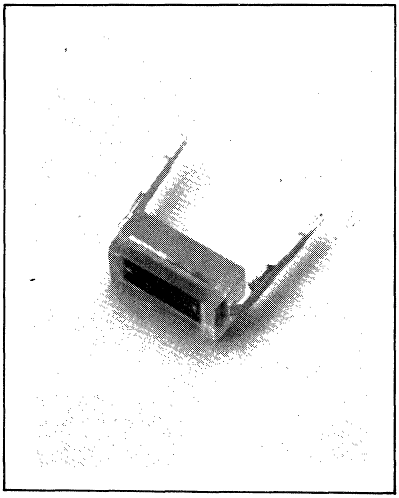


Open circuit voltage $\frac{V_L}{V_{L\,25°}} = f(T_{amb})$



SIEMENS

SFH 100
PHOTODIODE



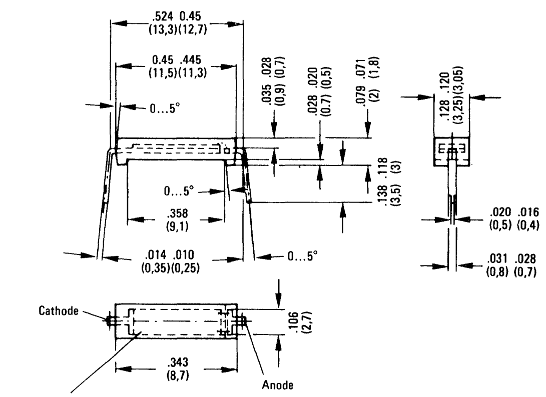
FEATURES

- **Transparent Plastic Package**
- **12.7 mm Lead Spacing**
- **Low Reverse Voltage, 0.1 V**

DESCRIPTION

The SFH100 silicon planar photodiode is supplied for universal applications. It is especially suitable for operation with small reverse voltage (approx. 0.1 V) for the detection of very limited illumination. The increased blue sensitivity of the diode lightens application with luminous source, which has a short wave emission spectrum. The component is built in a transparent plastic package and contains solder tab leads spaced at 12.7 mm.

Package Dimensions in Inches (mm)



Radiant Sensitive Area .343 (8,7) x .106 (2,7)

Maximum Ratings

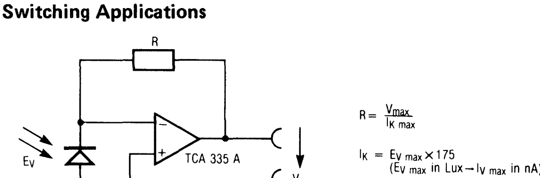
Reverse voltage	V_R	7	V
Operating and storage temperature range	T_s	−40…+80	°C
Soldering temperature in a 2mm distance from the case bottom ($t \leq 3$ s)	T_L	230	°C
Power dissipation	P_{tot}	100	mW

Characteristics (T_{amb} = 25°C)

Spectral sensitivity[1]	S	175 (≥ 150)	nA/lx
Wavelength of max. spectral sensitivity	$\lambda_{S\ max}$	800	nm
Quantum yield (Electrons per photon)(λ = 850 nm)	η	0.88	Electrons / Photon
Spectral sensitivity (λ = 850 nm)	S_λ	0.5	A/W
Open circuit voltage (E_v = 100 lx)[1]	V_L	370	mV
(E_v = 1000 lx)[1]	V_L	430	mV
Short circuit current (E_v = 100 lx)[1]	I_K	175	µA
Rise time (V_R = 3V, R_L = 1KΩ)	t_r	1.2	µs
Temperature coefficient for V_L	TC	−0.6	%/K
Temperature coefficient for I_K	TC	0.2	%/K
Capacitance (V_R = 0 V; E = 0)	C_0	1000	pF
Radiant sensitive area	A	23.5	mm²
Dark current (V_R = 10 V; E = 0)	I_R	0.4 (≤ 10)	nA

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

Switching Applications

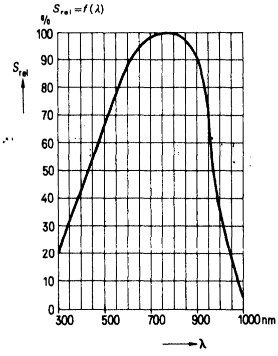


A type with small input current should be used as operational amplifier.

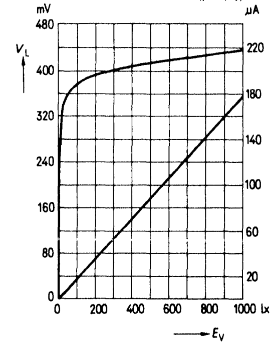
Specifications subject to change without notice.

Relative spectral sensitivity

$S_{rel} = f(\lambda)$

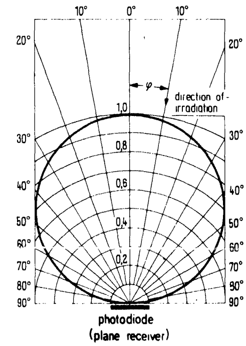


Open circuit voltage $V_L = f(E_V)$
Short circuit current $I_K = f(E_V)$



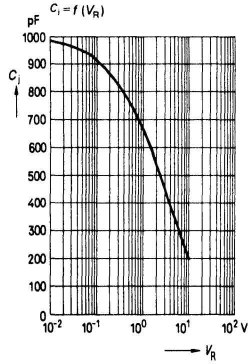
Directional characteristic

$I_K = f(\varphi)$

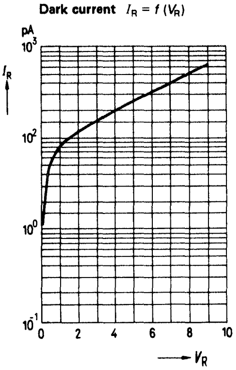


Collector-base capacitance

$C_j = f(V_R)$

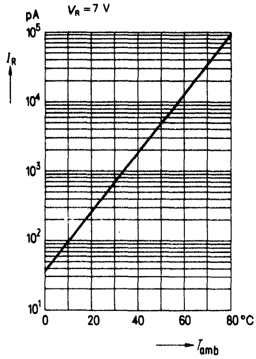


Dark current $I_R = f(V_R)$

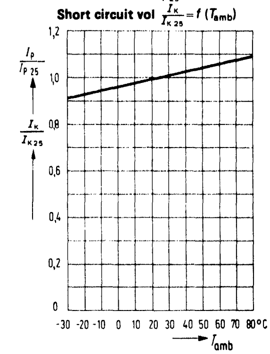


Dark current $I_R = f(T_{amb})$

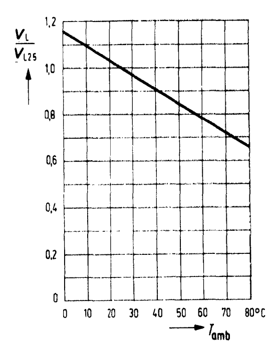
$V_R = 7$ V



Photocurrent $\frac{I_P}{I_{P\,25}} = f(T_{amb})$
Short circuit vol $\frac{I_K}{I_{K\,25}} = f(T_{amb})$

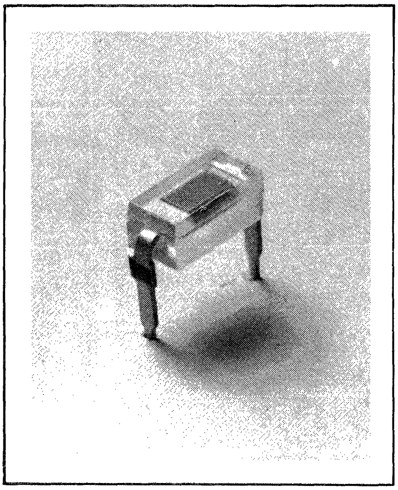


Open circuit voltage $\frac{V_L}{V_{L\,25°}} = f(T_{amb})$



SIEMENS

SFH 200
PHOTODIODE



FEATURES

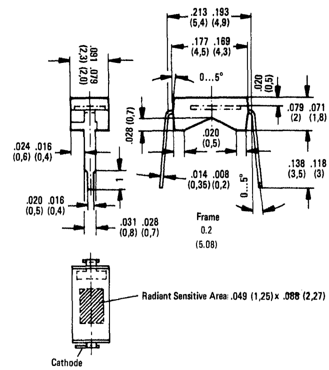
- **Transparent Plastic Case**
- **5.08 mm (2/10″) Lead Spacing**
- **Very Large Zero Crossover, 1 mV/pA**

DESCRIPTION

SFH 200 is a planar silicon photodiode incorporated in a transparent plastic package. Its terminals are solder tabs arranged in 5.08 mm (2/10 inch) lead spacing. The diode can also very easily be mounted on PC boards. The SFH 200 is developed for low luminescence as receiver for such applications as exposure meters. The photo component distinguishes itself by large zero point divisions and by high open circuit voltage with low luminescence.

Type Characterization: notch with blue point. The cathode is marked by a tab on solder lead.

Package Dimensions in Inches (mm)



Temperature

Operating and storage temp. range	T_{stor}	−55…+80	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leq 3$ sec)		230	°C

Characteristics (T_{amb} = 25°C)

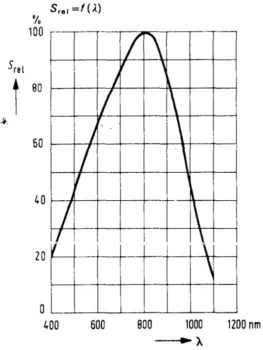
Spectral sensitivity[1]	S	20 (≥ 14)	nA/lx
Zero cross over	S_0	≥ 1	mV/pA
Forward Current (E_e = 0 lx; T_{amb} = 25°C; V_F = 50 mV)	I_F	20	pA
Radiant sensitive area	A	2.8	mm²
Wavelength of max. spectral sensitivity	$\lambda_{S\,max}$	800	nm
Quantum yield (Electrons per photon)(λ = 800 nm)	η	0.73	Electrons/Photon
Spectral sensitivity (λ = 800 nm)	S_λ	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	240	pF
(V_R = 3 V; E = 0)	C_3	100	pF
Temperature coefficient for I_K	TK	0.2	%/K
Dark current (V_R = 3 V; E = 0)	I_R	20	pA

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

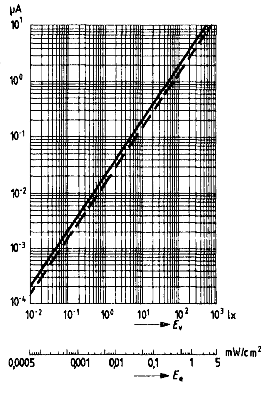
Specifications are subject to change without notice.

Relative spectral sensitivity

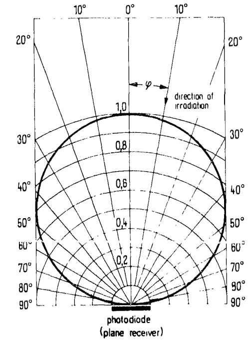
$S_{rel} = f(\lambda)$



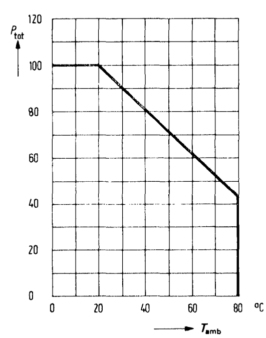
Photocurrent $I_P = f(E_v)$



Directional characteristic $I_K = f(\varphi)$

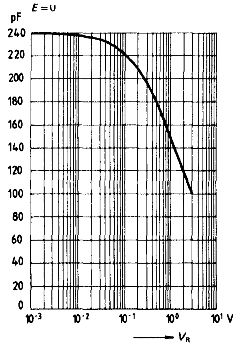


Power dissipation $P_{tot} = f(T_{amb})$



Capacitance $C = f(V_R)$

$E = 0$



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

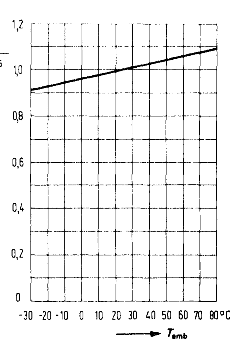
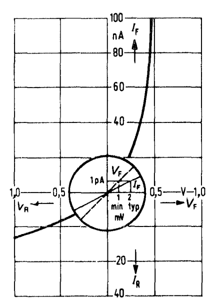


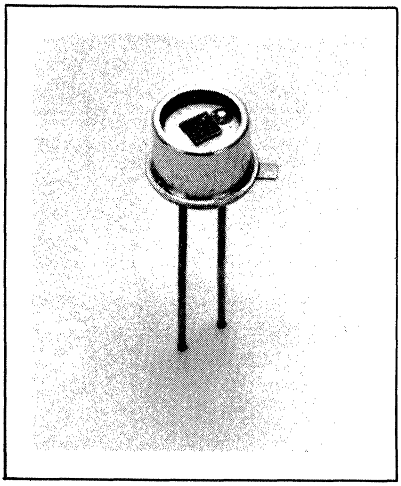
Diagram of zero crossover S_0



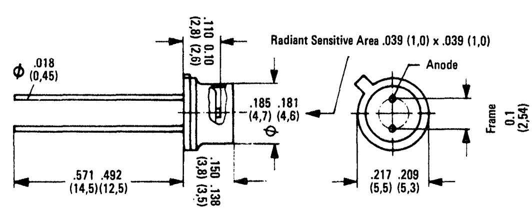
SIEMENS

SFH 202

PIN PHOTO DIODE



Package Dimensions in Inches (mm)



FEATURES

- **TO-18 Hermetic Package**
- **Flat Glass Lens**
- **For Fiber Optic Communications** fg = 500 MHz, tr = 0.5 ns

DESCRIPTION

SFH 202 is a planar silicon PIN-photo diode in case 18A2 DIN 41876 (similar to TO18) with flat glass lens. The cathode is electrically connected with the case. The PIN diode is a receiver with high limiting frequency that distinguishes itself through limited reverse current capacity and short switching time. Through the flat lens the diode is especially suitable for use with fiber optic cables, up to 560 Mbits/s.

Maximum Ratings

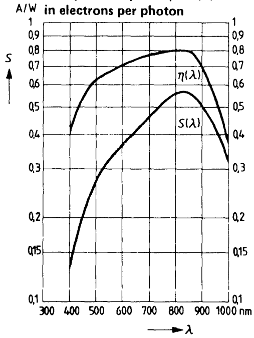
Reverse voltage	V_R	50	V
Junction temperature	T_j	80	°C
Storage temperature range	T_s	-40...+80	°C

Characteristics (T_{amb} = 25°C)

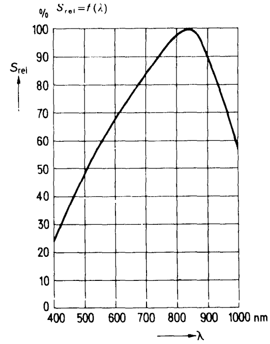
Radiant sensitive area	A	1	mm²
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	850	nm
Quantum yield (Electrons per photon)(λ = 850 nm)	η	0.80	Electrons / Photon
Spectral sensitivity (λ = 850 nm)	S_λ	0.55	A/W
Rise time of the photocurrent (R_L = 50Ω; V_R = 20 V; λ = 900 nm)	t_r	0.5 (≤ 1)	ns
Capacitance			
(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 (R_L = 50Ω; 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 (V_R = 20 V)	S	10 (≥ 7)	nA/lx
Noise equivalent power (V_R = 20 V)	NEP	3.3×10^{-14}	$\frac{W}{\sqrt{Hz}}$
Detection limit (V_R = 20 V)	D^*	3.1×10^{12}	$\frac{cm\sqrt{Hz}}{W}$
Temperature coefficient for I_P	TK	0.2	%/K

Specifications are subject to change without notice.

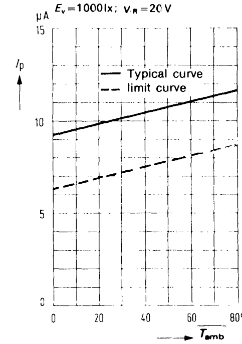
Spectral sensitivity $S = f(\lambda)$
and quantum yield $\eta = f(\lambda)$
in electrons per photon



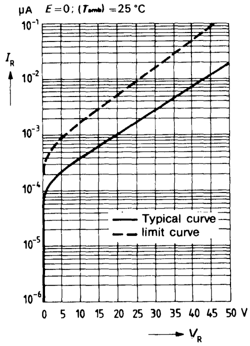
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



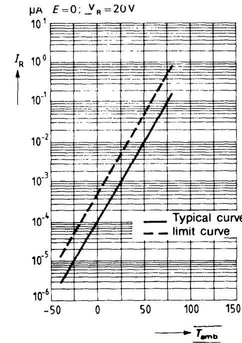
Photocurrent $I_P = f(T_{amb})$
$E_v = 1000\,lx$; $V_R = 20\,V$



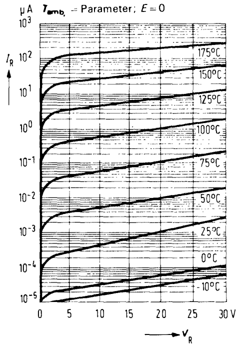
Forward current $I_R = f(V_R)$
$E = 0$; $(T_{amb}) = 25\,°C$



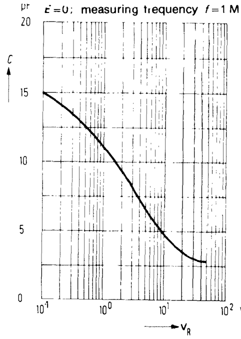
Dark current $I_P = f(T_{amb})$
$E = 0$; $V_R = 20\,V$



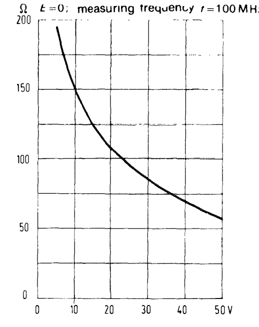
Dark current $I_R = f(V_R)$;
T_{amb} = Parameter; $E = 0$



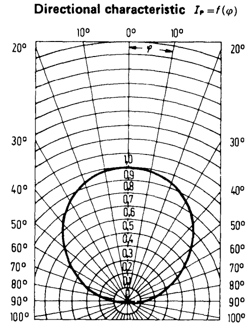
Junction capacitance $C = f(V_R)$;
$E = 0$; measuring frequency $f = 1\,MHz$



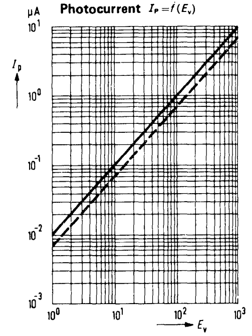
Series resistance $R_S = f(V_R)$;
$E = 0$; measuring frequency $f = 100\,MHz$



Directional characteristic $I_P = f(\varphi)$



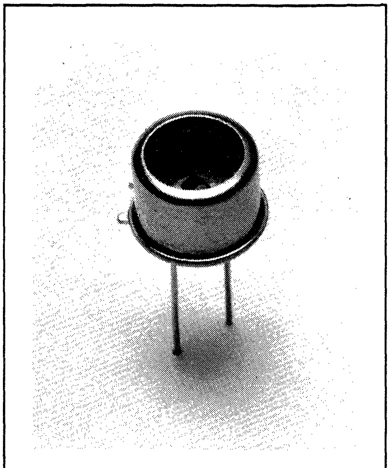
Photocurrent $I_P = f(E_v)$

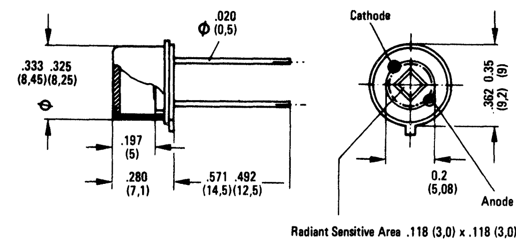


SIEMENS

SFH 203

SILICON PHOTODIODE





Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

FEATURES

- **TO-5 Hermetic Package**
- **Flat Glass Lens**
- **BG 38 Filter for Adaptable Sensitivity**

DESCRIPTION

SFH 203 is a silicon planar photodiode. The large area photo sensitive system is suitable for cell as well as diode operation at very slow reverse voltage level. The hermetic modified TO-5 package is supplied with a flat glass lens that allows operation under extreme conditions. The filtered glass window (Schott & Gen) adapts the system to a sensitive aperture. The SFH 203 is therefore, especially applicable for daylight as well as being suitable for artificial lighting of high color temperature for photography and color analysis.

Maximum Ratings

Reverse voltage	V_R	32	V
Operating and storage temperature range	T_s	-40...+100	°C
Junction temperature	T_j	100	°C
Soldering temperature in a 2 mm distance from the case bottom ($t \leq 3$ s)	T_L	230	°C
Power dissipation	P_{tot}	325	mW
Thermal resistance	$R_{th\ Jamb}$	300	K/W
	$R_{th\ Jcase}$	80	K/W

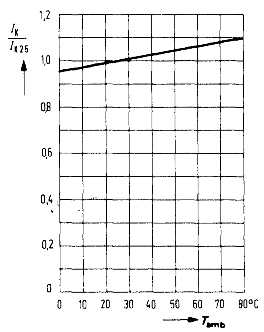
Characteristics (T_{amb} = 25°C)

Spectral sensitivity[1]	S	7.5 (≥ 5)	nA/lx
Wavelength of the max. sensitivity	$\lambda_{S\ max}$	555	nm
Spectral sensitivity (λ = 555 nm)	S_λ	0.21	A/W
Open circuit voltage			
(E_v = 100 lx)[1]	V_L	244	mV
(E_v = 1000 lx)[1]	V_L	380	mV
Short circuit current (E_v = 100 lx)[1]	I_K	0.70	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	2.5	µs
(R_L = 1 kΩ; V_R = 10 V)	t_r; t_f	1.0	µs
Temperature coefficient of V_L	TK	-0.6	%/K
Temperature coefficient of I_K	TK	0.2	%/K
Capacitance			
(V_R = 0 V; f = 1 MHz; E = 0)	C_0	900	pF
(V_R = 3 V; f = 1 MHz; E = 0)	C_3	770	pF
Radiant sensitive area	A	7.6	mm²
Dark current (V_R = 10 V; E = 0)	I_R	7 (≤ 50)	nA

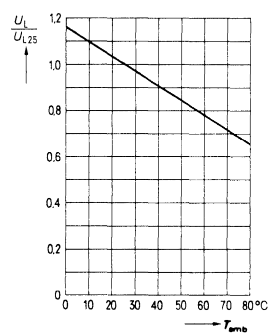
[1] The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a color temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

Specifications are subject to change without notice.

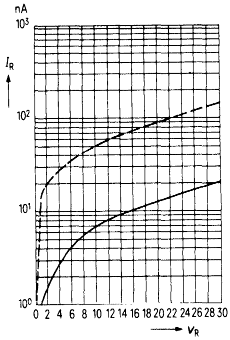
Short circuit current $\frac{I_K}{I_{K\,25}} = f(V_U)$



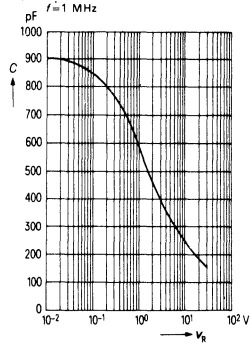
Open circuit voltage $\frac{V_L}{V_{L\,25}} = f(T_{amb})$



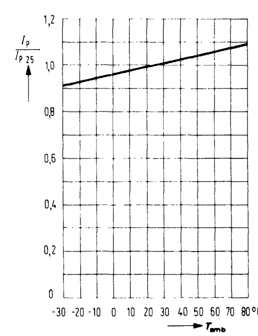
Dark current $I_R = f(V_R)$



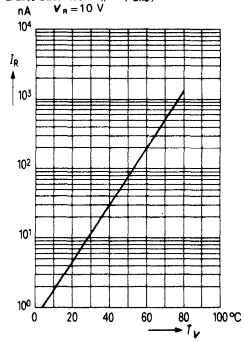
Capacitance $C = f(V_R)$
$f = 1$ MHz



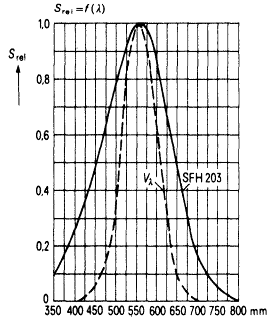
Photocurrent $\frac{I_P}{I_{P\,25}} = f(T_{amb})$



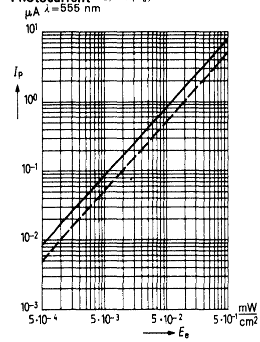
Dark current $I_R = f(T_{amb})$
nA $V_R = 10$ V



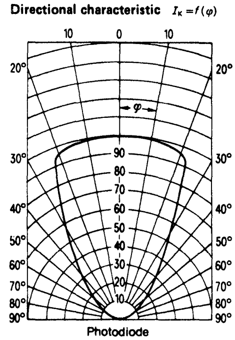
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



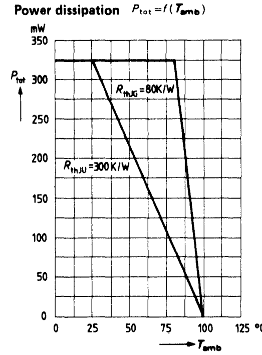
Photocurrent $I_P = f(E_e)$
μA λ=555 nm



Directional characteristic $I_K = f(\varphi)$

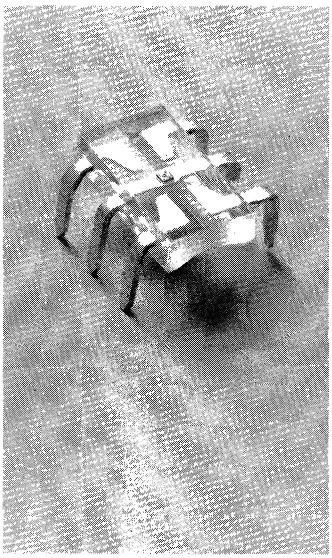


Power dissipation $P_{tot} = f(T_{amb})$



SIEMENS SFH 204

SILICON FOUR QUADRANT PHOTODIODE



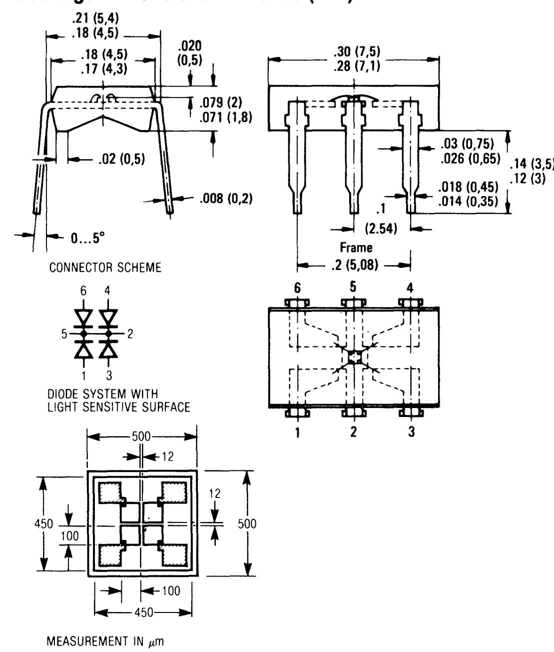
FEATURES

- **Miniature size**
- **Four quadrant active sections**
- **Close spacing of contacts, 12 µm**
- **Can determine if and by how much a light source has deviated**

DESCRIPTION

The SFH 204 silicon planar miniature four quadrant photodiode has application in edge drive, positioning, and path and corner scanning control devices. The active units are spaced at only 12 µm apart from individual contacts. It is therefore possible to get exact positioning with high definition.

Package Dimensions in Inches (mm)



Maximum Ratings

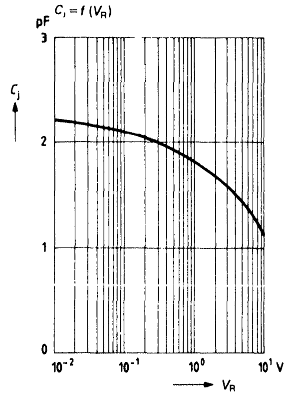
Reverse voltage	V_R	12	V
Junction temperature	T_j	80	°C
Soldering temperature in a 2mm distance from the case bottom ($t \leqslant 3$ s)	T_s	-20. . . +80	°C
Power dissipation	P_{tot}	40	mW

Characteristics (T_{amb} = 25°C)

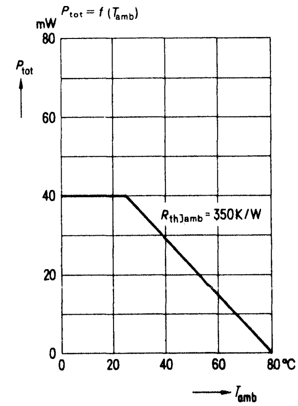
Wavelength of the max. sensitivity	$\lambda_{s\,max}$	850	nm
Spectral sensitivity	S	0.11 (≥0.08)	nA/lx
Spectral sensitivity (λ = 850 nm)	S_λ	> 0.35	A/W
Dark current (V_R = 10 V; T_{amb} = 25°C; E = 0)	I_R	0.01 (≤ 2)	nA
Junction capacitance			
(V_R = 0V; f = 1 MHz; E = 0)	C_0	2.5	pF
(V_R = 10 V; f = 1 MHz; E = 0)	C_{10}	1.5	pF
Rise and fall time of the photocurrent from 10% to 90% and from 90% to 10% of the final value			
(R_L = 50Ω; V_R = 0 V; λ = 950 nm)	t_r; t_f	2	µs
(R_L = 10kΩ; V_R = 10 V; λ = 950 nm)	t_r; t_f	4	µs
Radiant sensitive area	A	4 x 0.01	mm^2
Distance between radiant sensitive areas, breadth of the cross-shaped geometry		12 (≥ 10)	µm
Maximum deviation of the spectral sensitivity of the four systems from the mean	ΔS	< 20	%

Specifications subject to change without notice.

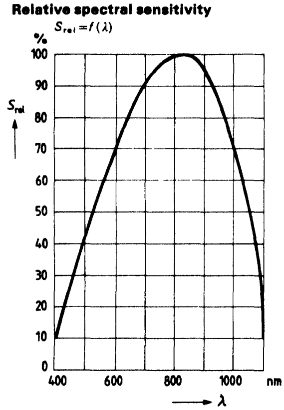
Capacitance



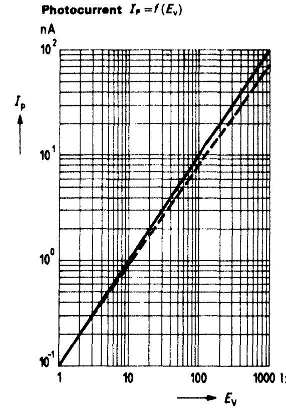
Power Dissipation



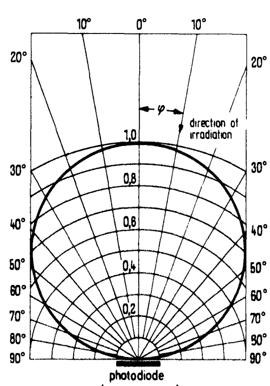
Relative spectral sensitivity



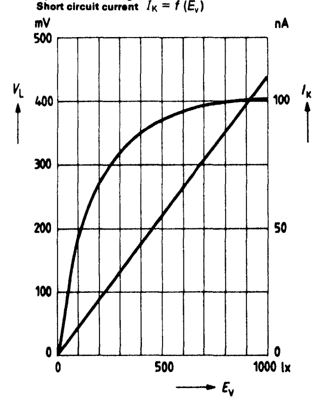
Photocurrent $I_P = f(E_v)$



Directional characteristic $I_K = f(\varphi)$



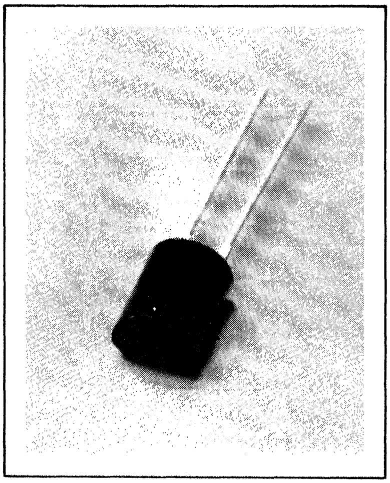
Open circuit voltage $V_L = f(E_v)$
Short circuit current $I_K = f(E_v)$



SIEMENS

SFH 205

PIN PHOTODIODE



FEATURES

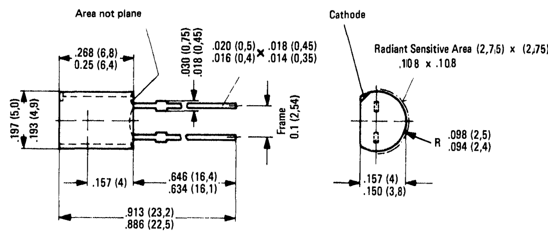
- Black Plastic Encapsulated Package
- 2.54 mm (1/10") Lead Spacing
- Built in Day Light Filter
- Suitable for IR Sound Transmission

DESCRIPTION

The SFH 205 is a silicon planar PIN photodiode, which is incorporated in a plastic package which simultaneously serves as filter and is also transparent for infrared emission. Its terminals are soldering tabs arranged in 2.54 mm (1/10") lead spacing. Due to its design, the diode can vertically be assembled on PC boards. 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 favorable, even at low illuminances.

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 and remote control. The cathode is marked by stamping at the case edge.

Package Dimensions in Inches (mm)



Maximum Ratings

Reverse voltage	V_R	20	V
Operating and storage temperature range	T_s	−40...+80	°C
Soldering temperature in a 1 mm distance from the case bottom ($t \leqslant 3$ s)	T_L	230	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	150	mW

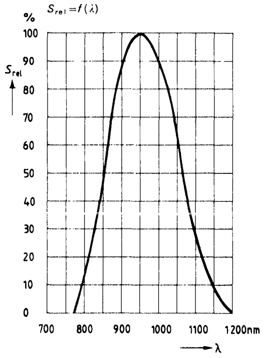
Characteristics (T_{amb} = 25°C)

Spectral sensitivity[1] (V_R = 5 V)	S	50 (≥ 30)	$\frac{\mu A \cdot cm^2}{mW}$
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	950	nm
Quantum yield (Electrons per Photon) (λ = 950 nm)	η	0.74	$\frac{Electrons}{Photon}$
Spectral sensitivity (λ = 950 nm)	S_λ	0.57	A/W
Open circuit voltage (E_e = 0.5 mW/cm², λ = 950 nm)	V_L	327	mV
(E_e = 0.05 mW/cm², λ = 950 nm)	V_L	248	mV
Short circuit current (E_e = 0.05 mW/cm², λ = 950 nm)	I_K	2	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	TK	-2.6	mV/K
Temperature coefficient of I_K or I_P	TK	0.18	%/K
Capacitance (V_R = 0 V; f = 1 MHz; E = 0)	C_0	72	pF
Radiant sensitive area	A	7.6	mm²
Dark current (V_R = 10 V)	I_R	2 (≤ 30)	nA
Noise equivalent power (V_R = 10 V)	NEP	4.4×10^{-14}	$\frac{W}{\sqrt{Hz}}$
Detection limit	D^*	6.3×10^{12}	$\frac{cm\sqrt{Hz}}{W}$

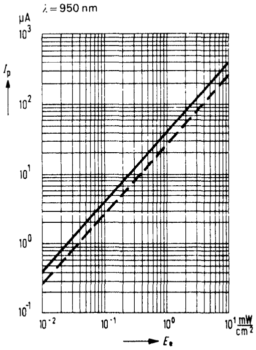
[1] The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a color temperature of 2856 K (standard light A in accordance with DIN 5030 and IEC publ. 306-1).

Specifications are subject to change without notice.

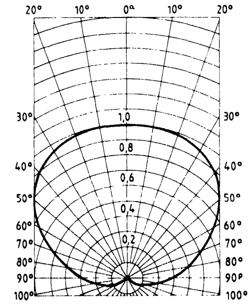
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



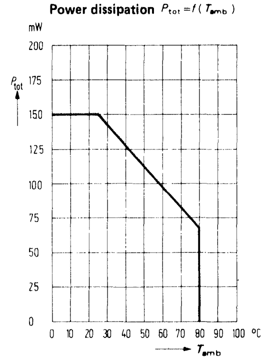
Photocurrent $I_P = f(E_e)$
$\lambda = 950$ nm



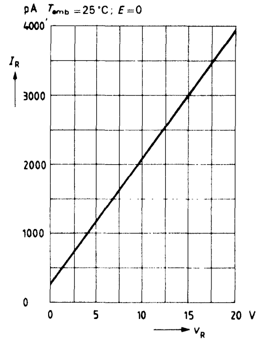
Directional characteristic
$S_{rel} = f(\varphi)$



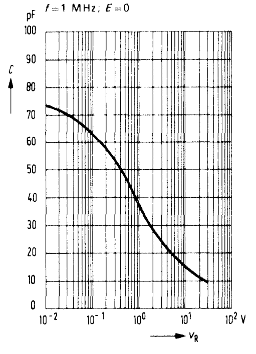
Power dissipation $P_{tot} = f(T_{amb})$



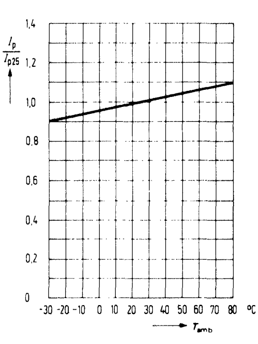
Dark current $I_R = f(V_R)$
pA $T_{amb} = 25\,°C$; $E = 0$



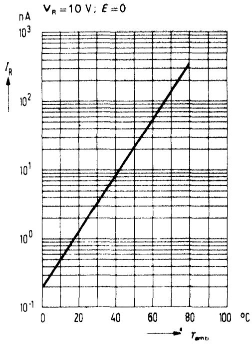
Capacitance $C = f(V_R)$
$f = 1$ MHz; $E = 0$



Photocurrent $\frac{I_P}{I_{P25}} = f(T_{amb})$



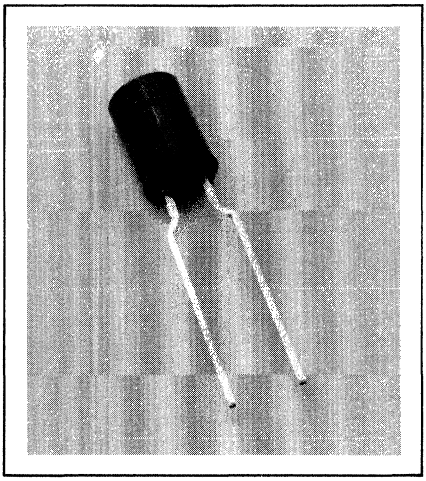
Dark current $I_R = f(T_{amb})$
$V_R = 10$ V; $E = 0$

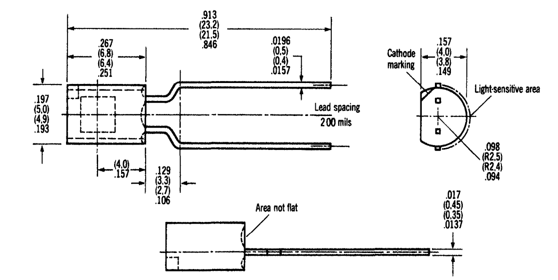


SIEMENS

SFH 205Q2

PIN PHOTODIODE





FEATURES

- **Black Plastic Encapsulated Package**
- **5.08 mm (.20") Lead Spacing**
- **Built-In Daylight Filter**
- **Suitable for IR Sound Transmission**

DESCRIPTION

The SFH 205Q2 is a silicon planar PIN photodiode, which is incorporated in a plastic package which simultaneously serves as filter and is also transparent for infrared emission. Its terminals are soldering tabs arranged in 5.08 mm (.20") lead spacing. Due to its design, the diode can vertically and automatically be assembled on PC boards. 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 favorable, even at low illuminances.

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 and remote control. The cathode is marked by stamping at the case edge.

Maximum Ratings

Reverse voltage	V_R	20	V
Operating and storage temperature range	T_s	−40... +80	°C
Soldering temperature in a 1 mm distance from the case bottom (t ≤ 3 s)	T_L	230	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	150	mW

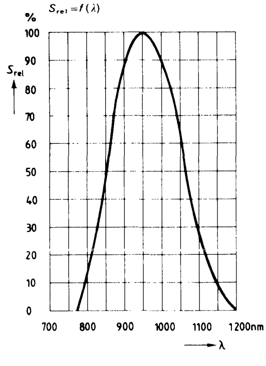
Characteristics (T_{amb} = 25°C)

Spectral sensitivity[1] (V_R = 5 V)	S	50 (≥30)	$\frac{\mu A \cdot cm^2}{mW}$
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	950	nm
Quantum yield (Electrons per Photon)(λ = 950 nm)	η	0.74	Electrons / Photon
Spectral sensitivity (λ = 950 nm)	S_λ	0.57	A/W
Open circuit voltage			
(E_e = 0.5 mW/cm²; λ = 950 nm)	V_L	327	mV
(E_e = 0.05 mW/cm²; λ = 950 nm)	V_L	248	mV
Short circuit current (E_e = 0.05 mW/cm²; λ = 950 nm)	I_K	2	µA
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; 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	TK	−2.6	mV/K
Temperature coefficient of I_K or I_P	TK	0.18	%/K
Capacitance (V_R = 0 V; f = 1 MHz; E = 0)	C_o	72	pF
Radiant sensitive area	A	7.6	mm²
Dark current (V_R = 10 V)	I_R	2 (≤30)	nA
Noise equivalent power (V_R = 10 V)	NEP	4.4×10^{-14}	$\frac{W}{\sqrt{Hz}}$
Detection limit	D*	6.3×10^{12}	$\frac{cm\,\sqrt{Hz}}{W}$

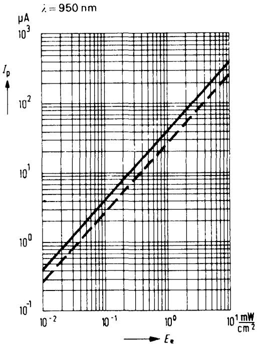
1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a color temperature of 2856 K (standard light A in accordance with DIN 5030 and IEC publ. 306-1).

Specifications are subject to change without notice.

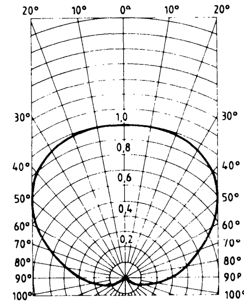
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



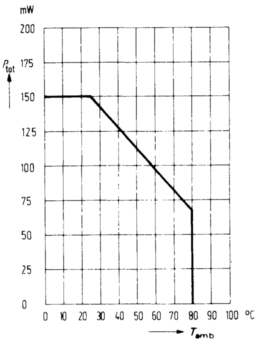
Photocurrent $I_P = f(E_e)$
$\lambda = 950$ nm



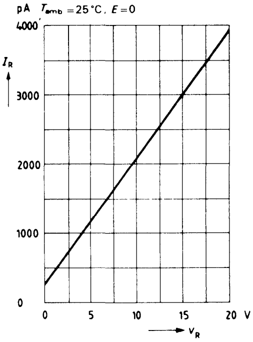
Directional characteristic
$S_{rel} = f(\varphi)$



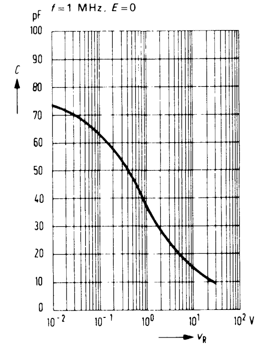
Power dissipation $P_{tot} = f(T_{amb})$



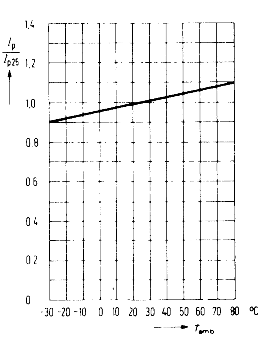
Dark current $I_R = f(V_R)$
pA $T_{amb} = 25\,°C$, $E = 0$



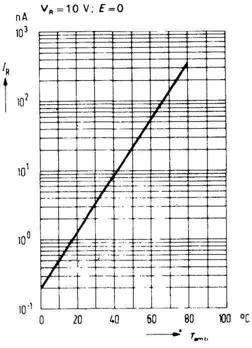
Capacitance $C = f(V_R)$
$f = 1$ MHz, $E = 0$



Photocurrent $\frac{I_P}{I_{P25}} = f(T_{amb})$



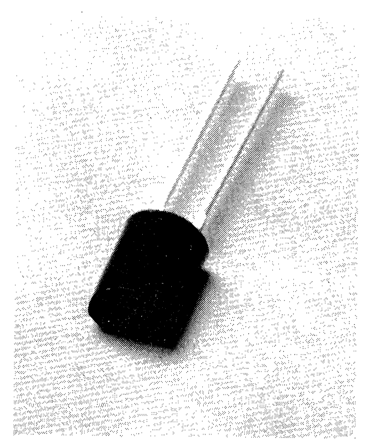
Dark current $I_R = f(T_{amb})$
$V_R = 10$ V; $E = 0$



SIEMENS

SFH 206

PIN PHOTODIODE



FEATURES

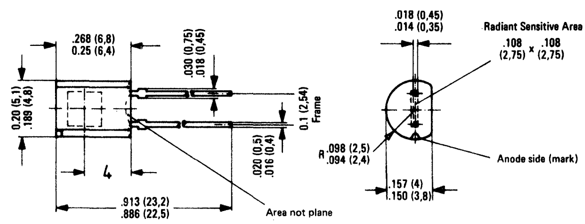
- **Black Plastic Package**
- **2.54 mm (1/10") Lead Spacing**
- **Built in Daylight Filter**

DESCRIPTION

The SFH 206 is a silicon planar PIN photodiode which is incorporated in a black plastic package that serves as a filter for infrared radiation. Its terminals are solder tabs arranged in 2.54 mm (1/10") spacing. Due to its design the diode can vertically be assembled on PC boards. 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 favorable, even at low illuminances.

The PIN photodiode is outstanding for low junction capacitance, high cut off frequency and short switching times. It is particularly suitable for IR sound transmission and remote control. The anode is marked by stamping at the case edge.

Package Dimensions in Inches (mm)



Maximum Ratings

Reverse voltage	V_R	20	V
Operating and storage temperature range	T_s	-40...+80	°C
Soldering temperature in a 1 mm distance from the case bottom ($t \leqslant 3$ s)	T_L	230	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	150	mW

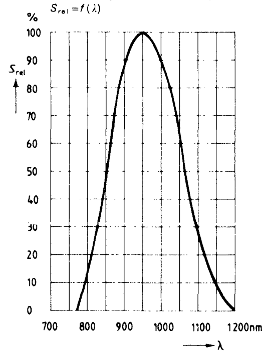
Characteristics

Spectral sensitivity[1] (V_R = 5 V)	S	50 (≥ 32)	$\frac{\mu A \cdot cm^{2}}{mW}$
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	950	nm
Quantum yield (Electrons per Photon)(λ = 950 nm)	η	0.74	$\frac{Electrons}{Photon}$
Spectral sensitivity (λ = 950 nm)	S_λ	0.57	A/W
Open circuit voltage			
(E_e = 0.5 mW/cm², λ = 950 nm)	V_L	327	mV
(E_e = 0.05 mW/cm², λ = 950 nm)	V_L	248	mV
Short circuit current (E_e = 0.05 mW/cm², λ = 950 nm)	I_K	2	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	TK	-2.6	mV/K
Temperature coefficient of I_K or I_P	TK	0.18	%/K
Capacitance (V_R = 0 V; f = 1 MHz; E = 0)	C_0	72	pF
Radiant sensitive area	A	7.6	mm²
Dark current (V_R = 10 V)	I_R	2 (≤ 30)	nA
Noise equivalent power (V_R = 10 V)	NEP	4.9×10^{-14}	$\frac{W}{\sqrt{Hz}}$
Detection limit	D^*	5.6×10^{12}	$\frac{cm\sqrt{Hz}}{W}$

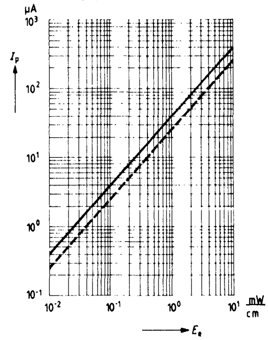
[1]The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a color temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

Specifications are subject to change without notice.

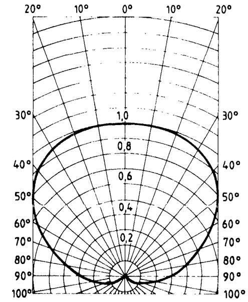
Relative spectral sensitivity $S_{rel} = f(\lambda)$



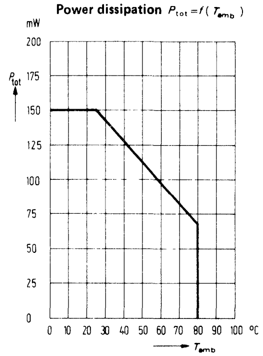
Photocurrent $I_P = f(E_e)$
$\lambda = 950$ nm



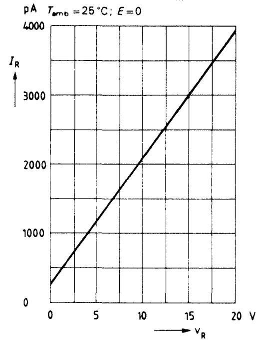
Directional characteristic $S_{rel} = f(\varphi)$



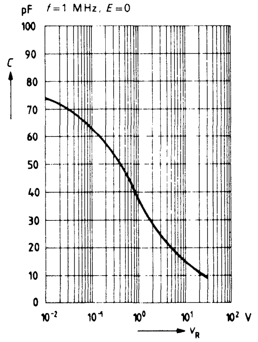
Power dissipation $P_{tot} = f(T_{amb})$



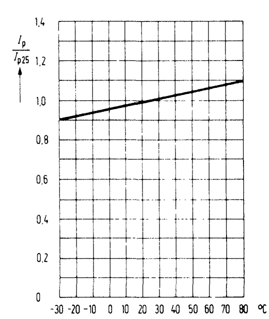
Dark current $I_R = f(V_R)$
pA $T_{amb} = 25\,°C$; $E = 0$



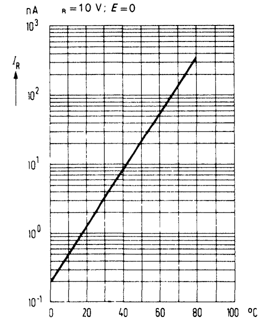
Capacitance $C = f(V_R)$
pF $f = 1$ MHz, $E = 0$



Photocurrent $\frac{I_P}{I_{P25}} = f(T_{amb})$



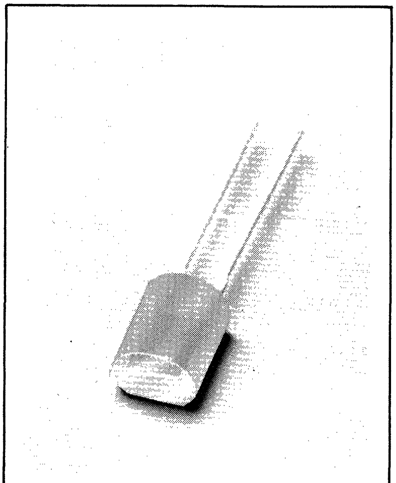
Dark current $I_R = f(T_{amb})$
nA $V_R = 10$ V; $E = 0$



SIEMENS

SFH 206K

PIN PHOTO DIODE



FEATURES

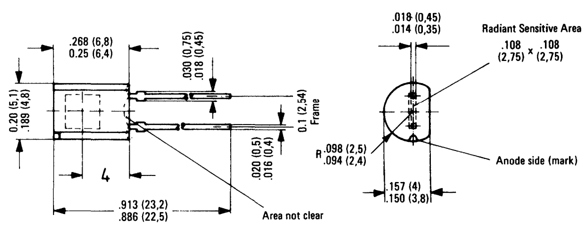
- **Colorless Plastic Package**
- **2.54 mm (1/10") Lead Spacing**
- **Suitable for IR Sound Transmission**

DESCRIPTION

The SFH 206K is a silicon planar PIN photodiode which is incorporated in a colorless plastic package. Its terminals are solder tabs arranged in 2.54 mm (1/10") spacing. Due to its design the diode can vertically be assembled on PC boards. 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 favorable, even at low illuminances.

The PIN photodiode is outstanding for low junction capacitance, high cut off frequency and short switching times. It is particularly suitable for IR sound transmission and remote control. The anode is marked by stamping at the case edge.

Package Dimensions



Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

Maximum Ratings

Reverse voltage	V_R	20	V
Operating and storage temperature range	T_s	−40...+80	°C
Soldering temperature in a 1 mm distance from the case bottom ($t \leq 3$ s)	T_L	260	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	150	mW

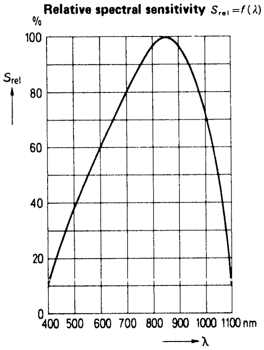
Characteristics (T_{amb} = 25°C)

Spectral sensitivity[1]	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_λ	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	TK	−2.6	mV/K
Temperature coefficient of I_K or I_P	TK	0.18	%/K
Capacitance (V_R = 0 V; f = 1 MHz; E = 0)	C_0	72	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}	$\frac{cm\sqrt{Hz}}{W}$

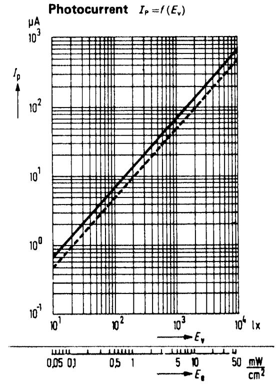
[1]The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a color temperature of 2856 K (standard light A in accordance with DIN 5030 and IEC publ. 306-1).

Specifications are subject to change without notice.

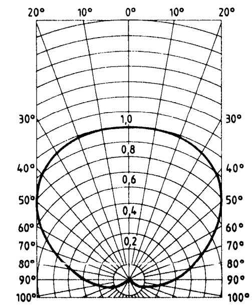
Relative spectral sensitivity $S_{rel} = f(\lambda)$



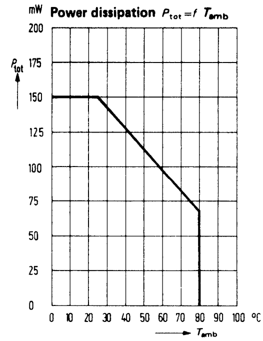
Photocurrent $I_P = f(E_v)$



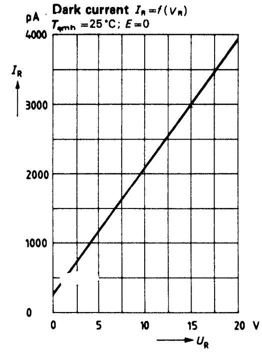
Directional characteristic $S_{rel} = f(\varphi)$



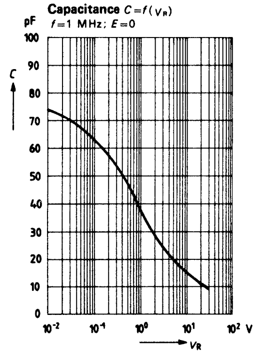
Power dissipation $P_{tot} = f\ T_{amb}$



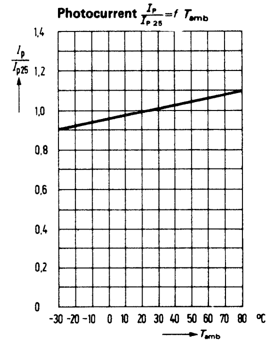
Dark current $I_R = f(V_R)$
$T_{amb} = 25\,°C$; $E = 0$



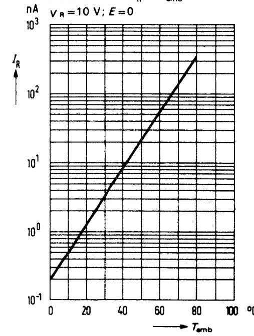
Capacitance $C = f(V_R)$
$f = 1$ MHz; $E = 0$



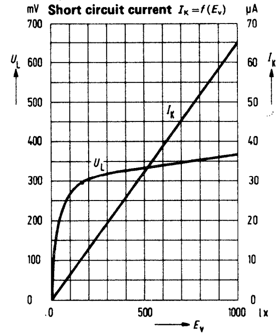
Photocurrent $\frac{I_P}{I_{P\,25}} = f\ T_{amb}$



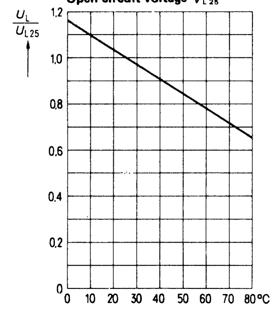
Dark current $I_R = f\ T_{amb}$
$V_R = 10$ V; $E = 0$

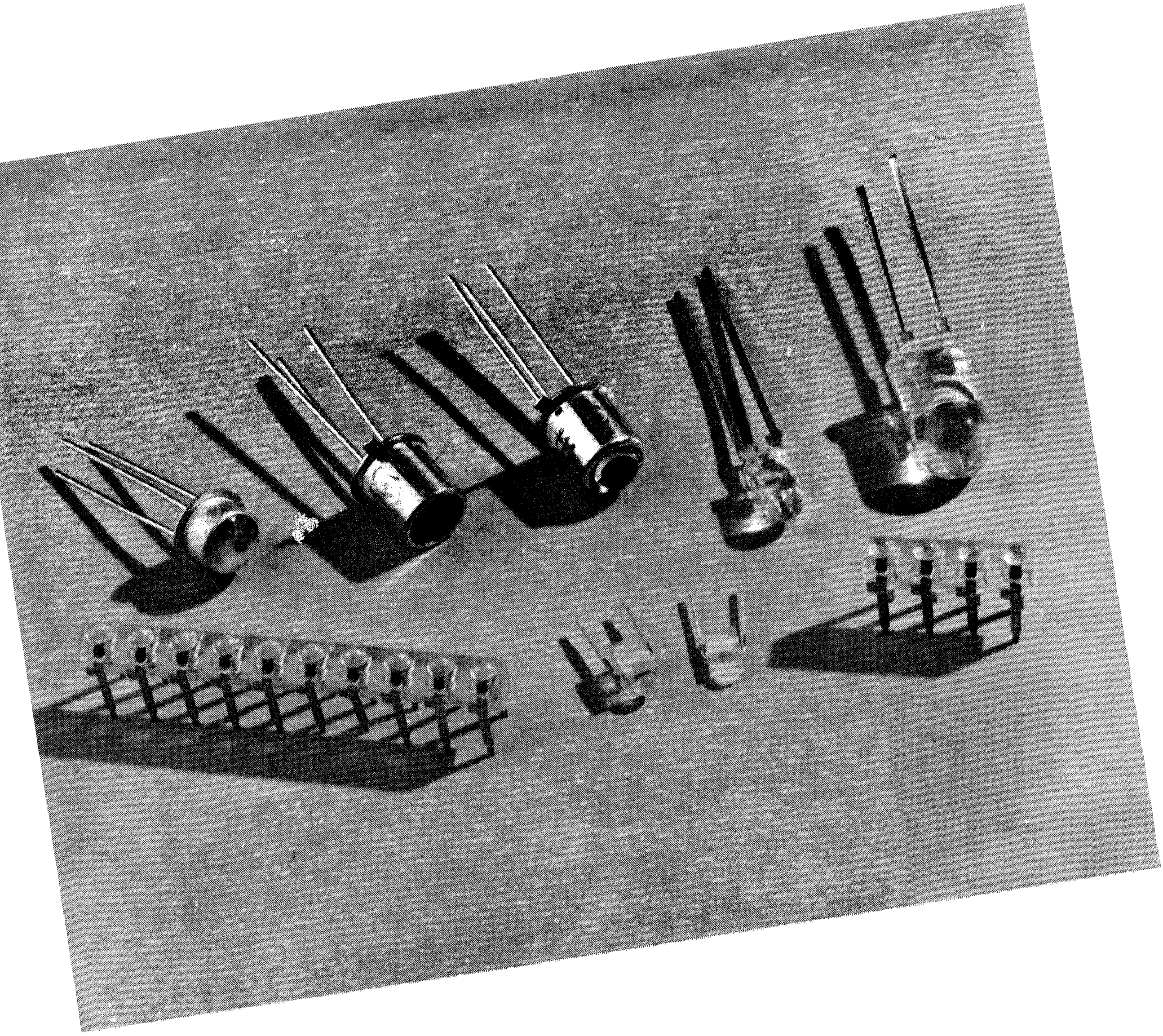


Open circuit voltage $V_L = f(E_v)$
Short circuit current $I_K = f(E_v)$

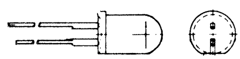
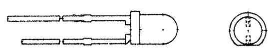
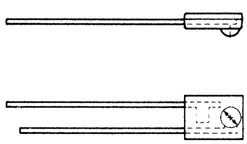
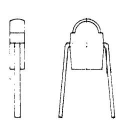
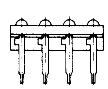


Open circuit voltage $\frac{V_L}{V_{L\,25}} = f\ T_{amb}$

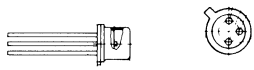
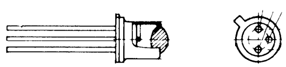
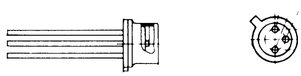




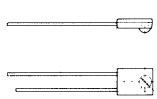
Phototransistors

Package Type		Package Outline	Part Number	Acceptance Half Angle	Photo Current VCE-5V Ev-1000lx (mA)	Collector Emitter Voltage V_{CEO}(V)	Radiant Sensitive Area mm²	Features	Page
T1¾ 5 mm Clear Plastic	IR Remote Control		BP103B-2	16°	2.5-5.0	35	.12	Low Cost Narrow angle High gain 850 nm Matches with LD271 or LD273 infrared emitter	386
			BP103B-3		4.0-8.0				
			BP103B-4		6.3-12.6				
T1 3 mm Clear Plastic			SFH309	16°	1.0	35		Small (T1) Size 850 nm Matches with SFH409 infrared emitter	406
Similar to TO-18 Clear Plastic			BP103-2	60°	.25-0.5	50		Ideal for short range light barriers. Very wide angle 850 nm Matches with LD242 infrared emitter	384
			BP103-3		0.4-0.8				
			BP103-4		.63-12.6				
Miniature Clear Plastic Side Facing			LPT80	40°	660(>100) (uA)	50	.187	Side facing device. 870 nm. Matches with IRL-80.	397
Miniature 1 mm Clear Plastic	Miniature & Arrays		SFH305-2	16°	1.0-2.0	32	.17	Extremely thin .039" (1 mm) package axial lead 850 nm Ideal for very short range light barriers. Matches with SFH405 infrared emitter	404
			SFH305-3		1.6-3.2				
Miniature Clear Plastic	Miniature & Arrays		BPX81-2	18°	1.0-2.0	32	.17	Small package size axial lead 850 nm Matches with LD261 infrared emitter	392
			BPX81-3		1.6-3.2				
			BPX81-4		2.5 min.				
2 Diode Array			BPX82	18°	.63-5.0	32	.17 (per chip)	2 Through 10 diode arrays 850 nm Matches with LD26X infrared emitters	
3 Diode Array			BPX83						
4 Diode Array			BPX84						
5 Diode Array			BPX85						
6 Diode Array			BPX86						
7 Diode Array			BPX87						
8 Diode Array			BPX88						
9 Diode Array			BPX89						
10 Diode Array			BPX80						

Phototransistors

Package Type	Package Outline	Part Number	Acceptance Half Angle	Photo Current V_{CE}-5V E_V-1000lx (mA)	Collector Emitter Voltage V_{CEO}(V)	Radiant Sensitive Area mm²	Features	Page
TO-18 Flat Glass Lens		BPX38-2	40°	.63-1.25	50		Hermetic seal for high rel use Wide angle 870 nm	388
		BPX38-3		1.0-2.0				
		BXP38-4		1.6-3.2		.65		
TO-18 Round Glass Lens	High Reliability 	BPX43-2	20°	2.5-5.0	50		Hermetic seal for high rel use Narrow angle 870 nm	390
		BPX43-3		4.0-8.0				
		BPX43-4		6.3-1.25				
		BPY62-2	8°	2.0-4.0	32	.12	Hermetic seal for high rel use Very narrow angle 800 nm	394
		BPY62-3		3.2-6.3				
TO-18 Flat Glass Lens		SFH500	60°	0.7	15	.14	Monolithic photo amplifier Hermetic seal for high rel use Very wide angle 825 nm Recommended for fiber optics or camera applications	408

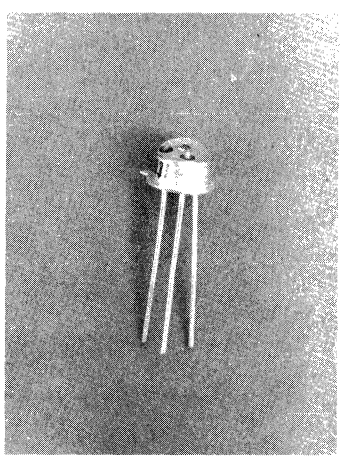
Photodarlington

Package Type	Package Outline	Part Number	Acceptance Half Angle	Photo Current V_{CE}-5V E_V-1000lx (mA)	Collector Emitter Voltage V_{CEO}(V)	Radiant Sensitive Area mm²	Features	Page
Miniature Clear Plastic Side Facing		LPD-80	40°	.5 (V_{CE}=2V)	5	.187	Side facing device. 810 nm Matches with IRL-80 IR emitter.	396

SIEMENS

BP-103 SERIES

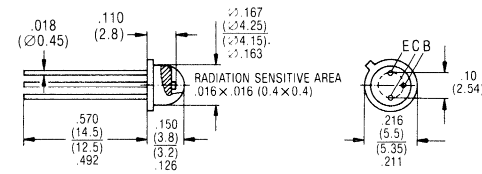
SILICON PHOTOTRANSISTOR



FEATURES
- **Silicon NPN Epitaxial Phototransistor**
- **Modified TO-18 Package**
- **Clear Plastic Lens**
- **Wide Acceptance Angle, 60°**
- **Three Sensitivity Ranges**

DESCRIPTIONS
The BP-103 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 with base integrating circuit and self-excited (high-frequency) breakdown voltage generators (see circuit diagram) and in high Q electronic instructional toys used in filament lamp light and daylight, as well as in combination with GaAs infrared emitting diodes in small light barriers.

Package Dimensions in Inches (mm)



Maximum Ratings

Collector-Emitter Voltage (V_{CEO})	50 V
Emitter-Base Voltage (V_{EBO})	7 V
Collector Current (I_C)	100 mA
Collector Peak Voltage (I_{CM}), $t \leq 10\ \mu s$	200 mA
Junction Temperature (T_j)	125 °C
Storage Temperature (T_{stor})	−55 to +80 °C
Maximum Permissible Soldering Temperature (T_s), $t \leq 5$ s	260 °C
Power Dissipation (P_{tot}), $T_{amb} = 25$ °C	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 (I_{CEO}) ($V_{CE} = 30$ V; $E = 0$)	5 (≤100) nA
Range of Spectral Photosensitivity (λ) ($S = 0.1\ S_{max}$)	440 to 1070 nm
Wavelength of the Max. Sensitivity ($\lambda_{S\ max}$)	850 nm
Typical Spectral Sensitivity of the Collector Base Photodiode (I_{PCB})	
$E_v = 1000$ lx; $V_{CE} = 5$ V	2.1 μA
$E_e = 0.5$ mW/cm^2; $\lambda = 950$ nm; $V_{CE} = 5$ V	0.55 μA
Radiant Sensitive Area (A)	0.12 mm^2
Rise Time to 90% of the Final Value / Fall Time to 10% of the Initial Value (t_r, t_f) ($R_L = 1$ kΩ)[1]	5 (≤10) μs
Capacitance (C_{CE}), $V_{CE} = 0$ V; $f = 1$ MHz; $E = 0$	9 pF
(C_{CB}), $V_{CB} = 0$ V; $f = 1$ MHz; $E = 0$	13 pF
(C_{EB}), $V_{EB} = 0$ V; $f = 1$ MHz; $E = 0$	21 pF
Half-Angle (φ)	60 Degrees

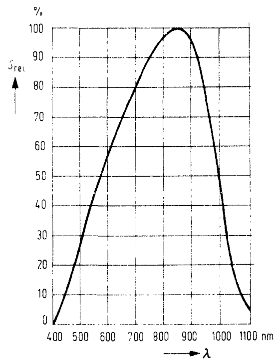
Group	BP 103-2	BP 103-3	BP 103-4	
Photocurrent ($V_{CE} = 5$ V; $E_v = 1000$ lx) I_P	250 to 500	400 to 800	630 min.	μA
Photocurrent ($V_{CE} = 5$ V; $E_e = 20$ mW/cm^2) I_P	1.1 to 2.2	1.8 to 3.6	2.8 min.	mA
Current Gain ($E_v = 1000$ lx; $V_{CE} = 5$ V) $\frac{I_{PCE}^{(1)}}{I_{PCB}}$	280	450	710	
Collector-Emitter/ Saturation Voltage ($I_C = 0.1$ mA; $I_B = 1\ \mu A$; $E = 0$) V_{CEsat}	170	160	160	mV
($I_C = 2.5$ mA; $I_B = 25\ \mu A$; $E = 0$) V_{CEsat}	160	150	150	mV

The illuminances refer to unfiltered radiation of a tungsten filament lamp at a color temperature of 2856K. (Standard light A in accordance with DIN 5033 and IEC 306-11). Irradiance E_e measured with HP radiant flux meter 8334A with option 013.

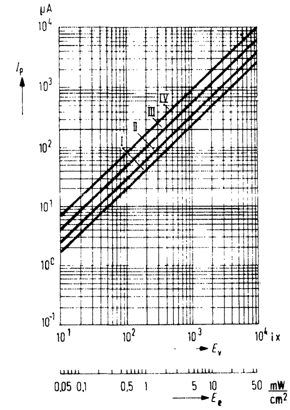
1. Measured with LED $\lambda = 950$ nm. (1) I_{PCE} = Photocurrent of transistors; I_{PCB} = Photocurrent of Collector-Basis-Diode.

Specifications subject to change without notice.

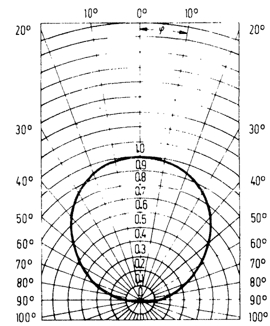
Relative Spectral Sensitivity
$S_{rel} = f(\lambda)$



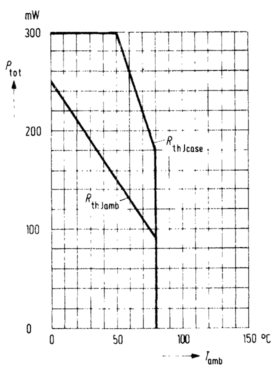
Photocurrent as a Function of
E_v **or** E_e; $I_p = f(E_v)$



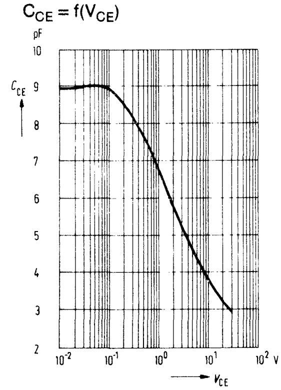
Directional Characteristic $I_p = f(\varphi)$



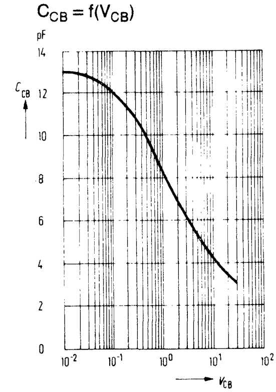
Power Dissipation $P_{tot} = f(T_{amb})$



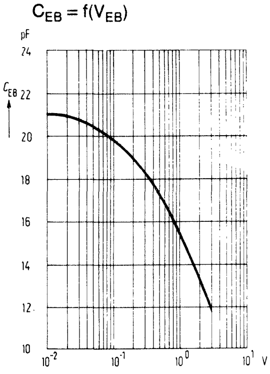
Collector-Emitter Capacitance
$C_{CE} = f(V_{CE})$



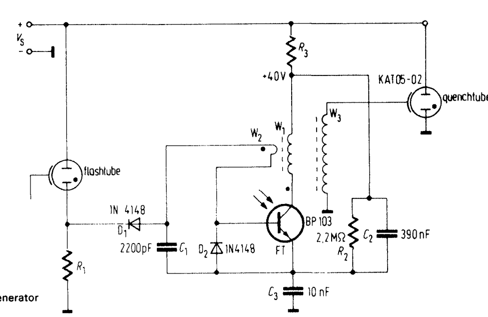
Collector-Base Capacitance
$C_{CB} = f(V_{CB})$



Emitter-Base Capacitance
$C_{EB} = f(V_{EB})$



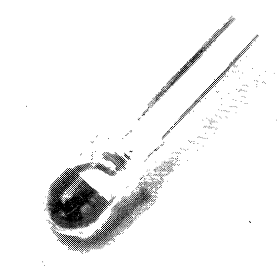
Application Example



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

SIEMENS

BP 103B SERIES
PHOTOTRANSISTOR



FEATURES

- **Silicon NPN Epitaxial Phototransistor**
- **Low Cost**
- **T 1¾ Package**
- **Clear Plastic Lens**
- **Narrow Acceptance Angle 16°**
- **Very High Gain, Ranges Up to 28 mA (min)**

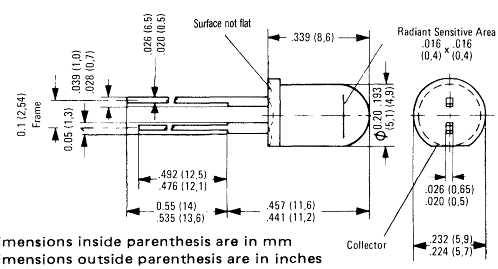
DESCRIPTION

BP103B is an epitaxial NPN silicon phototransistor of high sensitivity. It is enclosed in a tubular 5 mm all-plastic package.

The base terminal is not contacted, control is performed by the incident light. The collector is characterized by a flattening on the package base.

The phototransistor is mainly intended for standard applications and for use in automatic electronic flashes. Due to the tubular plastic shape, it can easily be mounted into holes and performed plastic sleeves; e.g. LED mounting assemblies.

Package Dimensions



Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

Maximum Ratings

Collector-emitter voltage	V_{CEO}	35	V
Emitter-Collector voltage	V_{EBO}	7	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. permissible soldering temperature ($t \leq 5$ s)	T_s	260	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	210	mW
Thermal resistance Collector junction to air	R_{thJamb}	350	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
Collector base – Photodiode (E_v = 1000 lx; V_{CE} = 5 V)	I_{PCB}	10.8	µA
(E_e = 0.5 mW/cm²; λ = 950 nm; V_{CE} = 5 V)	I_{PCB}	2.7	µA
Radiant sensitive area	A	0.12	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}	11	pF
Acceptance half angle	φ	16	degrees

Grouping is done at E_v = 1000 lx.

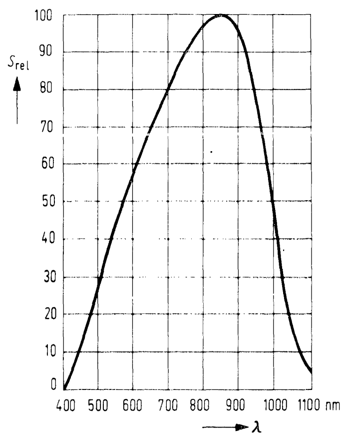
Group	BP 103B-2	BP 103B-3	BP 103B-4	
Photocurrent I_P (V_{CE} = 5 V; E_v = 1000 lx)	2.5 to 5.0	4.0 to 8.0	6.3 min.	mA
Photocurrent approx. I_P (V_{CE} = 5 V; E_e = 20 mW/cm²)	11 to 22	18 to 36	28 min.	mA

The illuminances refer to unfiltered radiation of a tungsten filament lamp at a color 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.

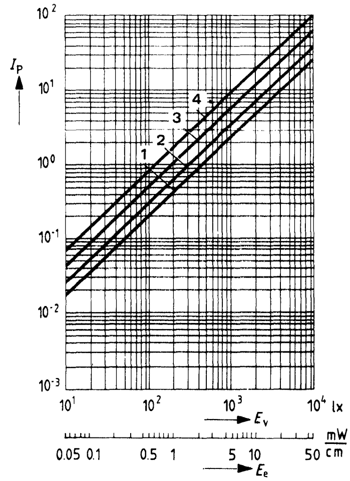
[1] measured with LED λ = 950 nm

Specifications are subject to change without notice.

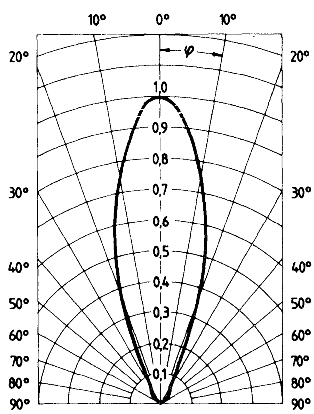
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



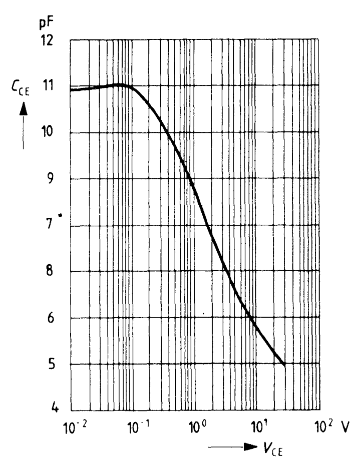
Photocurrent as a function of E_v or E_e; $I_P = f(E_v)$



Directional characteristic $I_P = f(\varphi)$

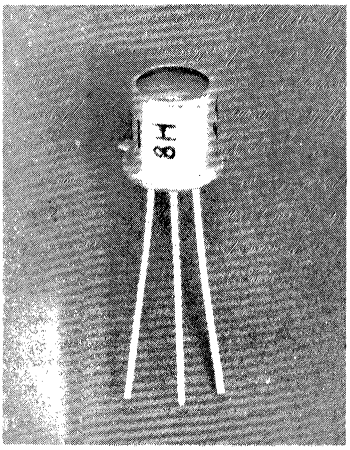


Collector-emitter capacitance
$C_{CE} = f(V_{CE})$



SIEMENS

BPX 38 SERIES
PHOTOTRANSISTOR



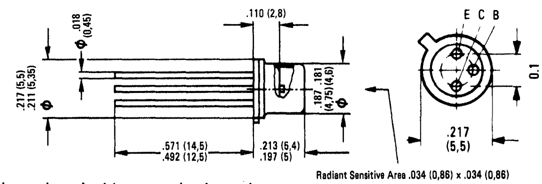
FEATURES

- **Silicon NPN Epitaxial Planar Phototransistor**
- **Premium Hi-Rel Device**
- **TO-18 Size Hermetic Package**
- **Flat Glass Lens**
- **Wide Acceptance Angle, 40°**
- **Moderate Gain, Ranges Up to 7 mA (min)**
- **Three Sensitivity Ranges**

DESCRIPTION

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.

Package Dimensions



Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

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)

Range of spectral sensitivity			
(S = 0.1 S_{max})	λ	450 to 1080	nm
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	870	nm
Collector-base – photodiode			
(E_v = 1000 lx; V_{CE} = 5 V)	I_{PCB}	4.8	µA
(E_e = 0.5 mW/cm²; λ = 950 nm; V_{CE} = 5 V)	I_{PCB}	1.2	µA
Radiant sensitive area	A	0.65	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
Acceptance half angle	φ	40	degree
Grouping is done at E_v = 1000 lx.			

Group	BPX 38-2	BPX 38-3	BPX 38-4	
Photocurrent I_P (V_{CE} = 5 V; E_v = 1000 lx)	0.63 to 1.25	1.0 to 2.0	1.6 min.	mA
Photocurrent approx. I_P (V_{CE} = 5 V; E_e = 20 mW/cm²)	2.5 to 5.0	4.5 to 9.0	7.0 min.	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	6	8	12	µs
Collector-emitter saturation voltage (I_C = 2 mA; I_B = 50 µA; E = 0) V_{CEsat}	175	160	140	mV
Power gain $\frac{I_{P(CE)}}{I_{P(CB)}}$[2] ($E_v$ = 1000 lx; V_{CE} = 5 V)	160	250	400	
Collector-emitter leakage current (V_{CEO} = 25 V; E = 0) I_{CEO}	8 (≤ 200)	12 (≤ 500)	20 (≤ 500)	nA

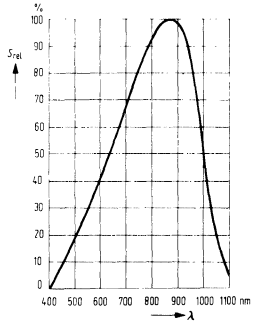
The illuminances refer to unfiltered radiation of a tungsten filament lamp at a color temperature of 2856 K. (standard light A in accordance with DIN 5033 and IEC 306-1). Irradiance E_e measured with HP radiant flux meter 8334A with option 013.

[1] measured with LED λ = 950 nm

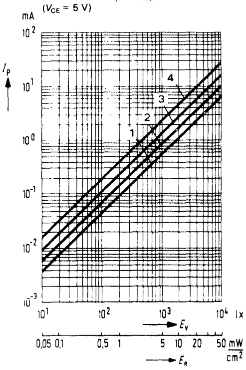
[2] $I_{P(CE)}$ = Photocurrent of the phototransistor
$I_{P(CB)}$ = Photocurrent of the collector-base photodiode

Specifications are subject to change without notice.

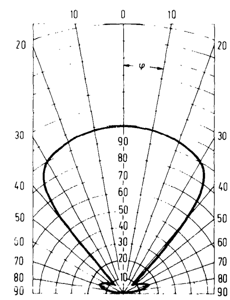
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



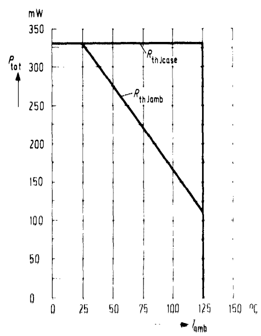
Photocurrent $I_P = f(E_v)$
(V_{CE} = 5 V)



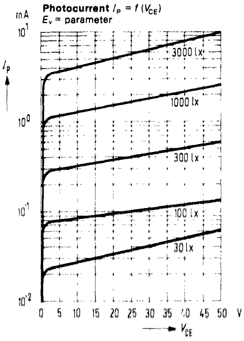
Directional characteristic $I_P = f(\varphi)$



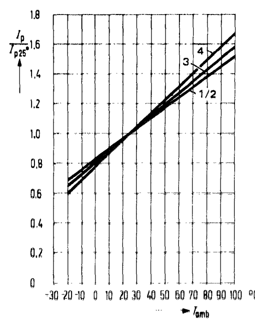
Power dissipation $P_{tot} = f(T_{amb})$



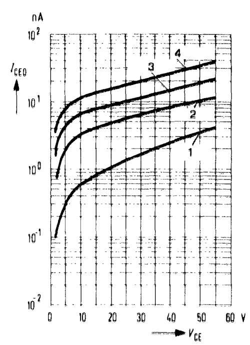
Photocurrent $I_P = f(V_{CE})$
E_v = parameter



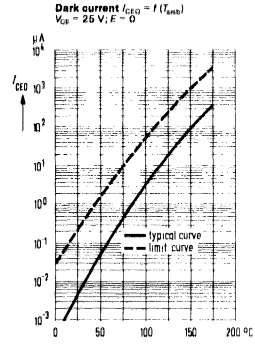
Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$



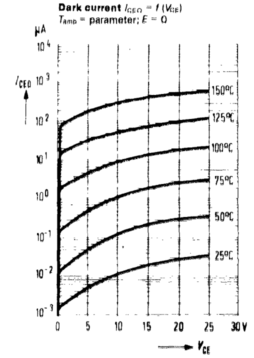
Dark current $I_{CEO} = f(V_{CE})$



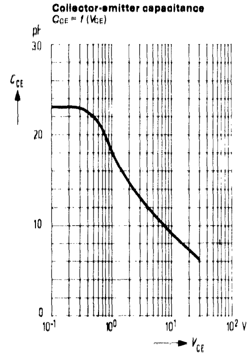
Dark current $I_{CEO} = f(T_{amb})$
V_{CE} = 25 V; E = 0



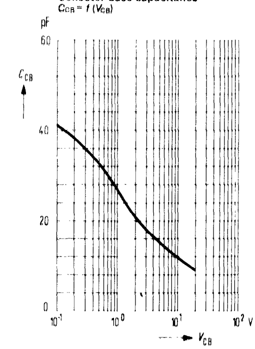
Dark current $I_{CEO} = f(V_{CE})$
T_{amb} = parameter; E = 0



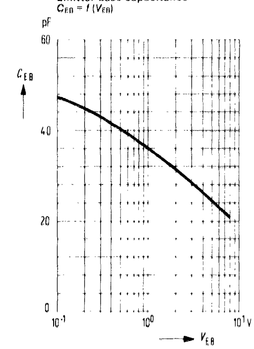
Collector-emitter capacitance
$C_{CE} = f(V_{CE})$



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

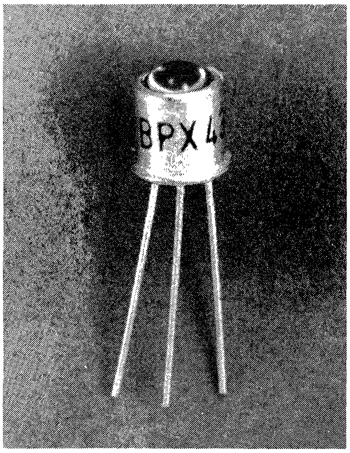


Emitter-base capacitance
$C_{EB} = f(V_{EB})$



SIEMENS

BPX 43 SERIES
PHOTOTRANSISTOR



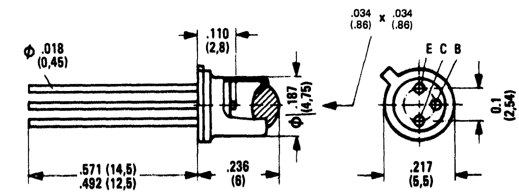
FEATURES

- **Silicon NPN Epitaxial Planar Phototransistor**
- **Premium Hi-Rel Device**
- **TO-18 Size Hermetic Package**
- **Rounded Glass Lens**
- **Narrow Acceptance Angle, 20°**
- **Very High Gain, Ranges Up to 35 mA (min)**
- **Three Sensitivity Ranges**

DESCRIPTION

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.

Package Dimensions



Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

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 ($t \leq$ 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
Collector base – photodiode			
(E_v = 1000 lx; V_{CE} = 5 V)	I_{PCB}	25	μA
(E_e = 0.5 mW/cm²; λ = 950 nm; V_{CE} = 5 V)	I_{PCB}	7.1	μA
Radiant sensitive area	A	0.65	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
Acceptance Half Angle	φ	20	Degrees

Grouping is done at E_v = 1000 lx.

Group	BPX 43-2	BPX 43-3	BPX 43-4	
Photocurrent I_P (V_{CE} = 5 V; E_v = 1000 lx)	2.5 to 5.0	4.0 to 8.0	6.3 min.	mA
Photocurrent approx. I_P (V_{CE} = 5 V; E_e = 20 mW/cm²)	14 to 28	22 to 45	35 min.	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	6	8	12	μs
Collector-emitter saturation voltage (I_C = 2 mA; I_B = 50 μA; E = 0) V_{CEsat}	175	160	140	mV
Power gain $\frac{I_{P(CE)}}{I_{P(CB)}}$[2] ($E_v$ = 1000 lx; V_{CE} = 5 V)	135	215	345	
Collector-emitter leakage current (V_{CEO} = 25 V; E = 0) I_{CEO}	8 (≤ 200)	12 (≤ 500)	20 (≤ 500)	nA

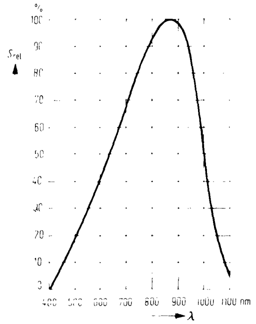
The illuminances refer to unfiltered radiation of a tungsten filament lamp at a color temperature of 2856 K. (standard light A in accordance with DIN 5033 and IEC 306-1). Irradiance E_e measured with HP radiant flux meter 8334A with option 013.

[1] measured with LED λ = 950 nm

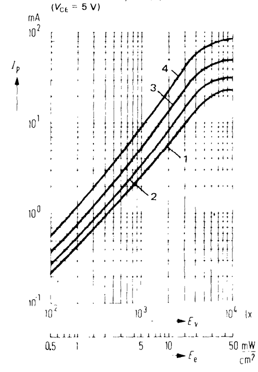
[2] $I_{p\,(CE)}$ = Photocurrent of the phototransistor
$I_{p\,(CB)}$ = Photocurrent of the collector-base photodiode

Specifications are subject to change without notice.

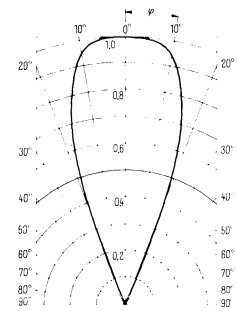
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



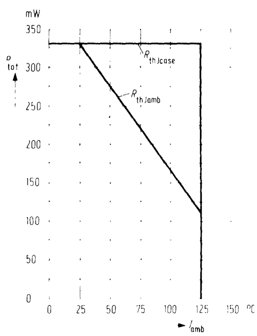
Photocurrent $I_P = f(E_v)$
(V_{CE} = 5 V)



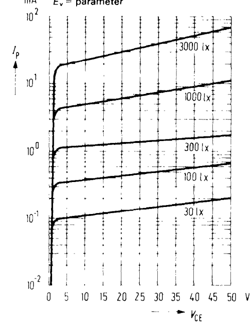
Directional characteristic $I_P = f(\varphi)$



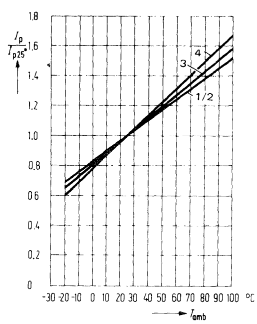
Power dissipation $P_{tot} = f(T_{amb})$



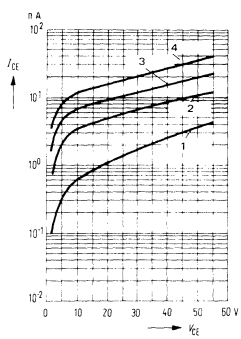
Photocurrent $I_P = f(V_{CE})$
E_v = parameter



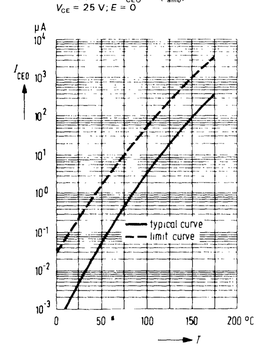
Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$



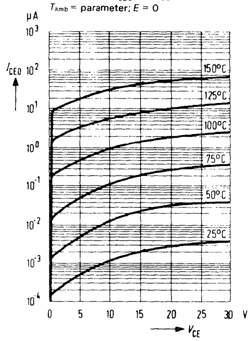
Dark current $I_{CEO} = f(V_{CE})$



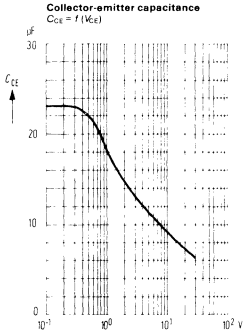
Dark current $I_{CEO} = f(T_{amb})$
V_{CE} = 25 V; E = 0



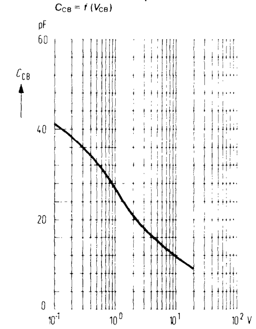
Dark current $I_{CEO} = f(V_{CE})$
T_{amb} = parameter; E = 0



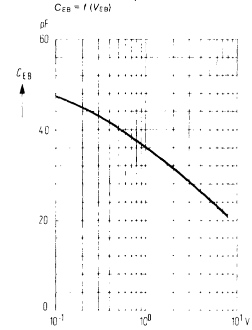
Collector-emitter capacitance
$C_{CE} = f(V_{CE})$



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



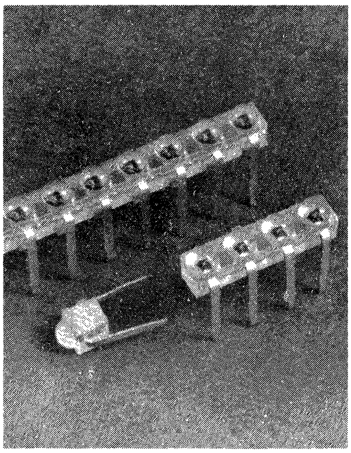
Emitter-base capacitance
$C_{EB} = f(V_{EB})$



SIEMENS

BPX 81 SERIES

PHOTOTRANSISTOR SINGLE AND ARRAYS



FEATURES

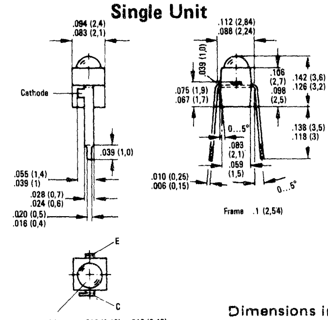
- Silicon NPN Planar Phototransistor
- Low Cost
- Miniature Size
- Available As Single Unit, BPX 81 and Arrays—
  Two Chip, BPX 82
  Three Chip, BPX 83
  Four Chip, BPX 84
  Five Chip, BPX 85
  Six Chip, BPX 86
  Seven Chip, BPX 87
  Eight Chip, BPX 88
  Nine Chip, BPX 89
  Ten Chip, BPX 80
- Narrow Acceptance Angle, 18°
- High Gain, Up to 5 mA

DESCRIPTION

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 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.

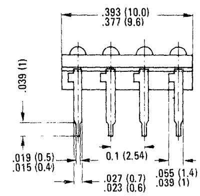
Package Dimensions

Single Unit



Radiant Sensitive Area .016 (0,43) x .016 (0,43)

Arrays



Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

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-base – photodiode			
(E_v = 1000 lx; V_{CE} = 5 V0	I_{PCB}	7.1	µA
(E_e = 0.5 mW/cm²; λ = 950 nm; V_{CE} = 5 V)	I_{PCB}	1.5	µA
(V_{CE} = 5 V)			
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 ($S \geq 0.1\, S_{max}$)	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	mm²
Capacitance (V_{CE} = 0 V; f = 1 MHz; E = 0)	C_{CE}	6	pF
Acceptance half angle	φ	18	degree

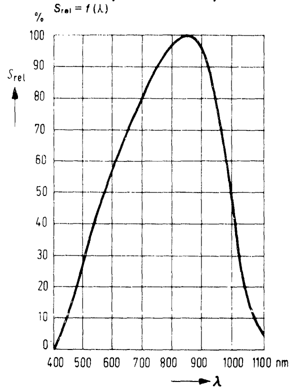
Grouping is done at E_v = 1000 lx.

Group	BPX 81-2	BPX 81-3	BPX 81-4	BPX 82to 80	
Photocurrent I_P (V_{CE} = 5 V; E_v = 1000 lx)	1.0 to 2.0	1.6 to 3.2	2.5 min.	1.25 – 4.0	mA
Photocurrent approx. I_P (V_{CE} = 5 V; E_e =.5 mW/cm²)	.25 to .50	.40 to .80	6.3 min.	.25 to 1.25 20 mW/cm²	mA

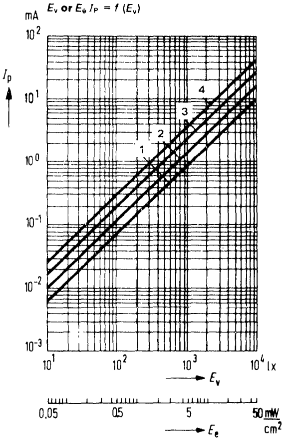
The illuminances refer to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K. (standard light A in accordance with DIN 5033 and IEC 306-1). Irradiance E_e measured with HP radiant flux meter 8334A with option 013.

Specifications are subject to change without notice.

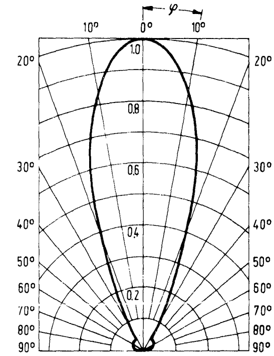
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



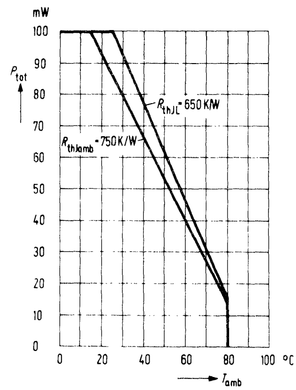
Photocurrent as a function of
E_v or E_e $I_P = f(E_v)$



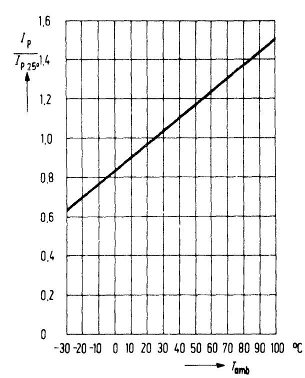
Directional characteristic $I_P = f(\varphi)$



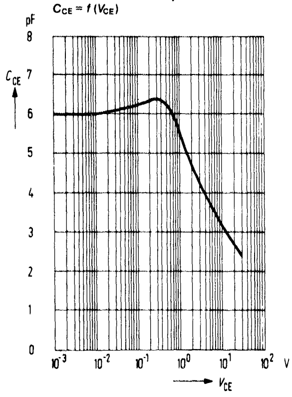
Power dissipation $P_{tot} = f(T_{amb})$



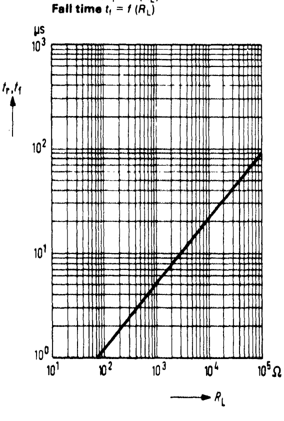
Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$



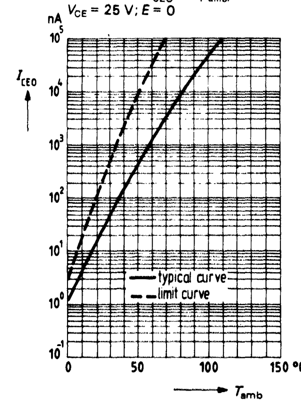
Collector-emitter capacitance
$C_{CE} = f(V_{CE})$



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

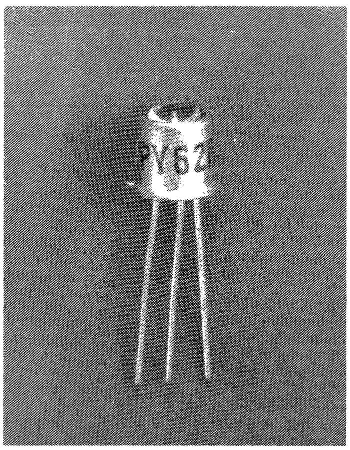


Dark current $I_{CEO} = f(T_{amb})$
$V_{CE} = 25$ V; $E = 0$



SIEMENS

BPY 62 SERIES
PHOTOTRANSISTOR



FEATURES

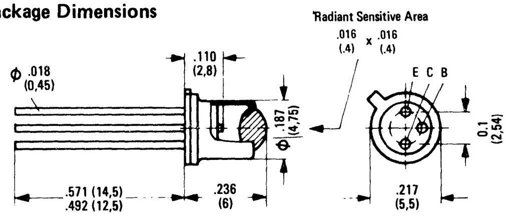
- Silicon NPN Epitaxial Planar Phototransistor
- Premium Hi-Rel Device
- TO-18 Size Hermetic Package
- Rounded Glass Lens
- Very Narrow Acceptance Angle, 8°
- High Gain, Ranges Up to 28 mA

DESCRIPTION

The BPY 62 is a silicon NPN epitaxial 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.

Package Dimensions



Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

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)

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
Collector-base – photodiode			
(E_v = 1000 lx; U_{CE} = 5 V)	I_{PCB}	17	µA
(E_e = 0.5 mW/cm²; λ = 950 nm; V_{CE} = 5 V)	I_{PCB}	3.5	µA
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
Radiant sensitive area	A	0.12	mm²
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
Acceptance half angle	φ	8	degrees

Grouping is done at E_v = 1000 lx.

Group		BPY 62-2	BPY 62-3	
Photocurrent (V_{CE} = 5 V; E_v = 1000 lx;)[1])	I_P	2.0 to 4.0	3.2 to 6.3	mA
(V_{CE} = 5 V; E_e = 20 mW/cm²	approx. I_P	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]	560	900	

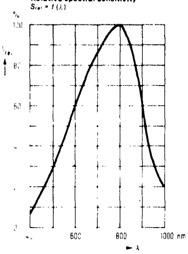
The illuminances refer to unfiltered radiation of a tungsten filament lamp at a color temperature of 2856 K. (standard light A in accordance with DIN 5033 and IEC 306-1). Irradiance E_e measured with HP radiant flux meter 8334A with option 013.

[1]) measured with LED λ = 950 nm

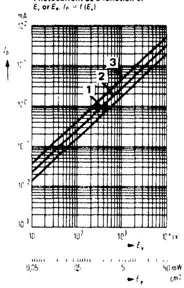
[2]) $I_{p\ (CE)}$ = Photocurrent of the phototransistor
$I_{p\ (CB)}$ = Photocurrent of the collector-base photodiode

Specifications are subject to change without notice.

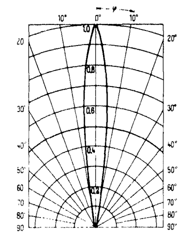
Relative spectral sensitivity $S_{rel} = f(\lambda)$



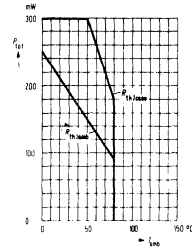
Photocurrent as a function of E_v **or** E_e, $I_P = f(E_v)$



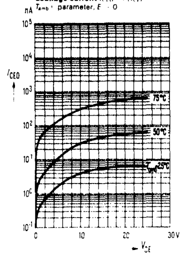
Directional characteristic $I_P = f(\varphi)$



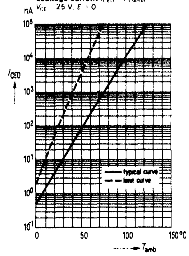
Power dissipation $P_{tot} = f(T_{amb})$
R_{th} = parameter



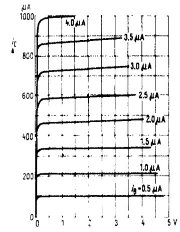
Leakage current $I_{CEO} = f(V_{CE})$
T_{amb} = parameter, $E = 0$



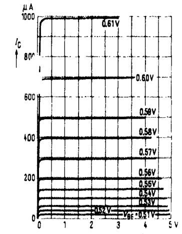
Leakage current $I_{CEO} = f(T_{amb})$
$V_{CE} = 25$ V, $E = 0$



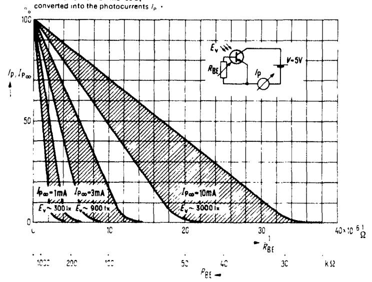
Output characteristics $I_C = f(V_{CE})$
I_B = parameter



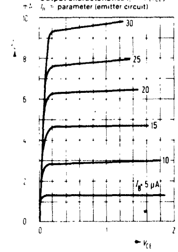
Output characteristics $I_C = f(V_{CE})$
V_{BE} = parameter



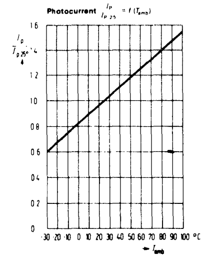
Photocurrent $I_P = f(R_{BE})$ **referred to photocurrent** $I_{P\infty}$ **during operation with open base** ($R_{BE} = \infty$)
Parameter is the illuminance E_v converted into the photocurrents $I_{P\infty}$



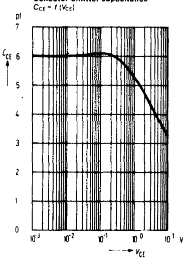
Output characteristics $I_C = f(V_{CE})$
I_B = parameter (emitter circuit)



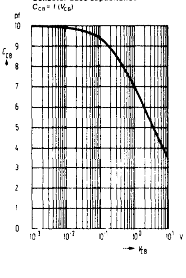
Photocurrent $\frac{I_P}{I_{P\,25°}} = f(T_{amb})$



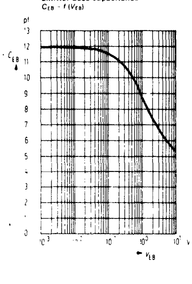
Collector-emitter capacitance
$C_{CE} = f(V_{CE})$



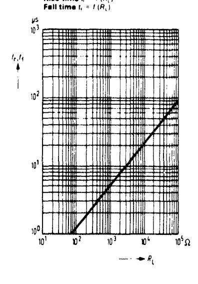
Collector-base capacitance
$C_{CB} = f(V_{CB})$



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

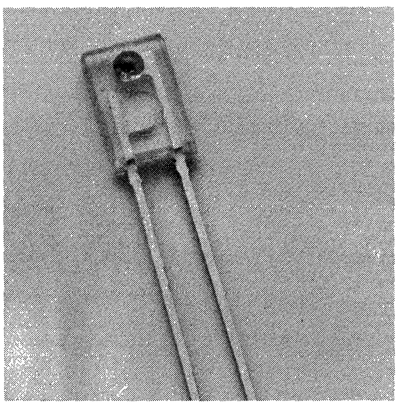


Rise time $t_r = f(R_L)$
Fall time $t_f = f(R_L)$

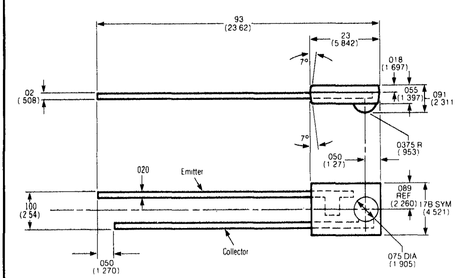


SIEMENS

LPD-80
PHOTODARLINGTON
PRELIMINARY



Package Dimensions in inches (mm)



FEATURES

- **Silicon NPN Photodarlington**
- **Miniature Side Facing Package**
- **Low Cost**
- **High Sensitivity**
- **Matches IRL-80 Infrared Emitter**

DESCRIPTION

The LPD-80 is an epitaxial NPN silicon photodarlington. The chip is positioned to accept radiation from the side of the clear miniature package. It efficiently receives infrared radiation from the matching IRL-80.

MAXIMUM RATINGS

Collector Emitter Voltage	V_{CE}	30	V
Emitter Collector Voltage	V_{EC}	5	V
Storage Temperature	T_{STOR}	−40 to +100	°C
Operating Temperature	T_{OP}	−40 to +100	°C
Junction Temperature	T_J	100	°C
Power Dissipation	P_{TOT}	100	mW
Deviate Above 25°C		—	mW/°C

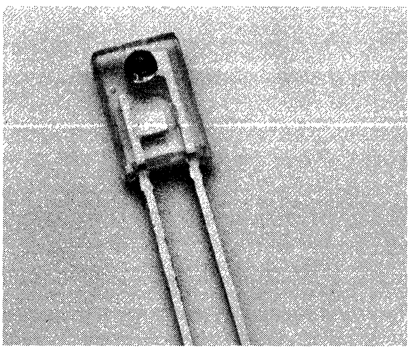
CHARACTERISTICS (T_{amb} = 25°C)

		Min.	Typ.	Max.
Photocurrent (V_{CE} = 2V, E_e = 1mW/cm², R_L = 50Ω)	I_{CE}	.5	4	mA
Collector Emitter Leakage Current (V_{CE} = 10V, E_e = 0)	I_{CEO}		100	nA
Rise Time (V_{CE} = 5V, Tw = 100μsec f = 100Hz, λ = 940nm, R_L = 75Ω)	t_r		5	μs
Fall Time (V_{CE} = 5V, Tw = 100μsec f = 100Hz, λ = 940nm, R_L = 75Ω)	t_f		16	μs
Collector-Emitter Saturation Voltage (I_C = 4mA, E_e = 1mW/cm²)	$V_{CE(SAT)}$		.7	1.1V
Wavelength of max. sensitivity			810	nm
Acceptance of half angle			40	degree

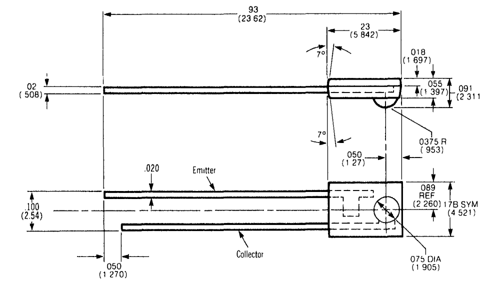
Specifications are subject to change without notice.

SIEMENS

LPT-80
PHOTOTRANSISTOR
PRELIMINARY



Package Dimensions in inches (mm)



FEATURES
- **Silicon NPN Epitaxial Phototransistor**
- **Low Cost**
- **Miniature sidefacing package**
- **Clear Plastic**
- **Matches IRL-80**

DESCRIPTION

The LPT-80 is an epitaxial NPN silicon phototransistor. The chip is positioned to accept radiation from the side of the clear plastic miniature package. It efficiently receives infrared radiation from the matching IRL-80 in|frared emitter.

Maximum Ratings

Collector-emitter voltage	V_{CEO}	50	V
Emitter-Collector voltage	V_{EBO}	5	V
Collector current	I_C	50	mA
Collector peak current (t = lms)	I_{CM}	100	mA
Storage and operating temperature	T	− 40 to + 100	°C
Max. permissible soldering temperature (t ≦ 5 s)	T_s	240	°C
Power dissipation (T_{amb} = 25 °C)	P_{tot}	100	mW
Derate above 25 °C		2.0	mW/°C

Characteristics (T_{amb} = 25 °C)

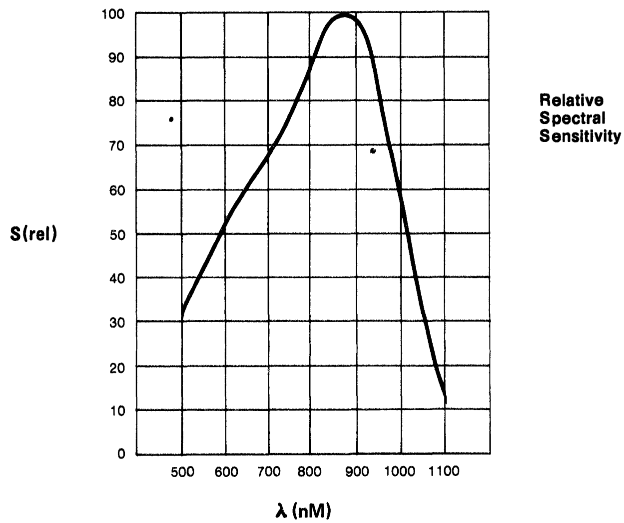
Collector-emitter leakage current (V_{CE} = 30V; E = O)	I_{CEO}	≦100	nA
Range of spectral sensitivity (S = 0.1 S_{max})		450-1080	nm
Wavelength of the max. sensitivity		870	nm
Radiant sensitive area	A	.187	mm²
Rise time to 90% of the final value Fall time to 10% of the intial value (R_L = 1 kΩ, I_{CE} = 1mA V_{CE} = 5V)	$t_r t_f$	20	µs
Acceptance half angle	φ	40	degrees
Photo current (V_{CE} = 5V E_e = 0.5mW/cm²)	I_p	660(≧100)	µA

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

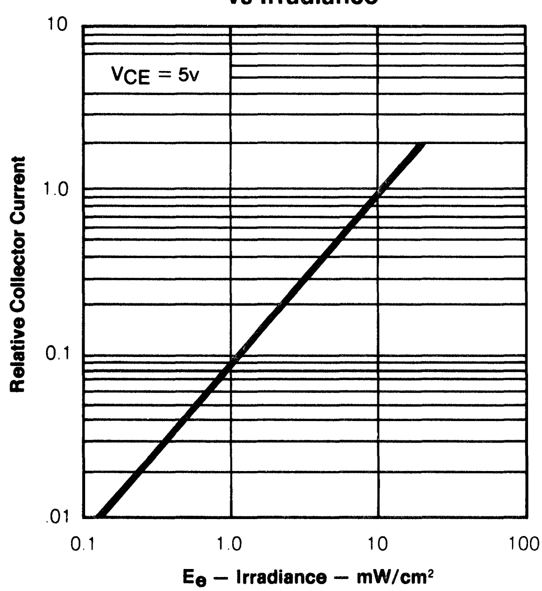
[1] measured with LED λ = 950 nm

Specifications are subject to change without notice.

Relative Spectral Sensitivity



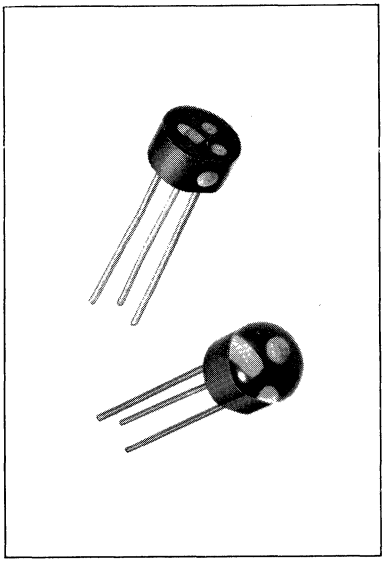
Relative Collector Current vs Irradiance



SIEMENS

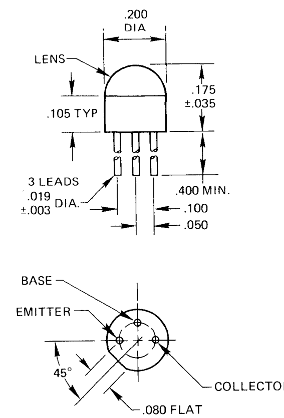
LPT-100/110 SERIES

PHOTOTRANSISTOR



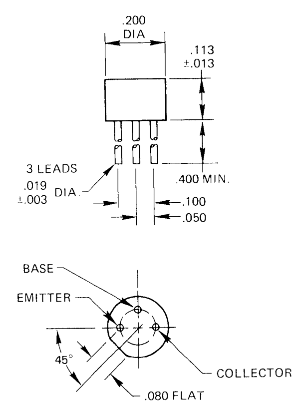
Package Dimensions (in inches)

LPT100/LPT100A/LPT100B



NOTE: ALL LEADS ELECTRICALLY ISOLATED FROM CASE

LPT110/LPT110A/LPT110B



NOTE 1: ALL LEADS ELECTRICALLY ISOLATED FROM CASE.
NOTE 2: FLATNESS VARIATION OF TOP OF CUP IS ±.015.
NOTE 3: PHOTOSENSITIVE AREA IS WITHIN A .030 DIAMETER CIRCLE WITH CENTER OF CIRCLE COINCIDENT WITH THE CENTER OF PACKAGE.

Specifications are subject to change without notice.

FEATURES

- Collector Dark Current 0.25 nA Typ
- Responsivity
  0.6μA/mW/cm^2 Min (Tungsten)
  1.8μA/mW/cm^2 Min (GaAs)
- Photo Current
  0.2 mA Min (Tungsten)
  0.6 mA Min (GaAs)
- Rise and Fall Time 2.8μs Typ

APPLICATIONS

- Position Detector
- Intrusion Alarm Sensor
- Optical Tachometer

BENEFITS

- Flexible Circuit Design
  Base Lead Availability
  Large Range of Sensitivities
- Greater Power Dissipation — Ceramic Case
- Reliable — Exceptionally Stable Characteristics

MAXIMUM RATINGS

Maximum Temperatures/Humidity
- Storage Temperature . . . . . −55°C to +100°C
- Operating Junction Temperature . . . . . −55°C to +85°C
- Relative Humidity at Temperature . . . . . 98% at +65°C

Maximum Power Dissipation (Notes 1 and 2)
- Total Dissipation at +25°C Case Temperature . . . . . 200 mW
- Total Dissipation at +25°C Ambient Temperature . . . . . 100 mW

Maximum Voltages (Note 5)
- BV_{CBO} Collector to Base Voltage 50V
- LV_{CEO} Collector to Emitter Sustaining Voltage 30V

Maximum Current
- I_C Collector Current . . . . . 100 mA

OPTO-ELECTRICAL CHARACTERISTICS (25°)

Symbols	Parameter	LPT-100/A/B Min	LPT-100/A/B Typ	LPT-100/A/B Max	LPT-110/A/B Min	LPT-110/A/B Typ	LPT-110/A/B Max	Units	Test Conditions
I_{CBO}	Collector Dark Current		0.25	25		0.25	25	nA	V_{CB} = 10V (Note 5)
I_{CBO} (65°C)	Collector Dark Current		0.025	0.5		0.025	0.5	μA	V_{CB} = 10V (Note 5)
I_{CEO}	Collector Dark Current		2.0	100		2.0	100	nA	V_{CE} = 5.0V (Note 5)
R_{CB}	Responsivity (Tungsten)	0.6	1.6		0.6	1.0		μA/mW/cm²	V_{CB} = 10V (Notes 3 and 8)
R_{CB}	Responsivity (GaAs)	1.8	4.8		1.8	3.0		μA/mW/cm²	V_{CB} = 10V (Notes 4 and 8)
$I_{CE(L)}$	Photo Current (Tungsten)								
	LPT-100 and LPT-110	0.2	1.4		0.2	0.88		mA	V_{CE} = 5.0V
	"A" Only	1.0		3.0	0.6		1.8	mA	H = 5.0 mW/cm²
	"B" Only	1.3		2.6	0.8		1.6	mA	(Notes 3 and 7)
$I_{CE(L)}$	Photo Current (GaAs)	0.6	4.2		0.6	2.7		mA	V_{CE} = 5.0V H = 5.0 mW/cm² (Notes 4 and 7)
t_r, t_f	Light Current Rise Time		2.8			2.8		μs	(Note 6)
$V_{CE(SAT)}$	Collector to Emitter Saturation Voltage		0.16			0.16		V	I_C = 500μA H = 20 mW/cm²
BV_{CBO}	Collector to Base Breakdown Voltage	50	120		50	120		V	I_C = 100μA (Note 5)
LV_{CEO}	Collector to Emitter Sustaining Voltage	30	50		30	50		V	I_C = 1.0 mA (Note 5)
BV_{ECO}	Emitter to Collector Breakdown		7.0			7.0		V	I_{EC} = 100μA (Note 5)

Note 1: These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Note 2: These ratings give a maximum junction temperature of +85°C and junction to case thermal resistance of +300°C/W (derating factor of 3.33 mW/°C) and a junction to ambient thermal resistance of +600°C/W (derating factor of 1.67 mW/°C).

Note 3: Measured at noted irradiance as emitted from a tungsten filament lamp at a color temperature of 2854°K.

Note 4: These are values obtained at noted irradiance as emitted from a GaAs source at 0.9μ.

Note 5: Measured with radiation flux intensity of less than 0.1μW/cm² over the spectrum from 100 to 1500 nm.

Note 6: Rise time is defined as the time required for I_{CE} to rise from 10% to 90% of peak value. Fall time is defined as the time required for I_{CE} to decrease from 90% to 10% of peak value. Test conditions are: I_{CE} = 4.0 mA, V_{CE} = 5.0V, R_L = 100 Ohms, GaAs Source.

Note 7: No electrical connection to base lead.

Note 8: No electrical connection to emitter lead.

TYPICAL OPTO-ELECTRONIC CHARACTERISTICS

FIGURE 1. PHOTO CURRENT CHARACTERISTICS

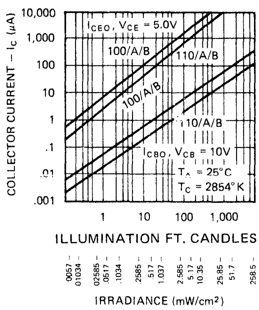


FIGURE 2. COLLECTOR CURRENT VS COLLECTOR VOLTAGE

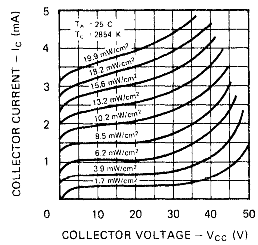


FIGURE 3. COLLECTOR BASE CHARACTERISTICS

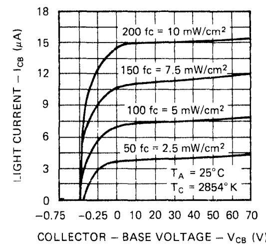


FIGURE 4. ANGULAR RESPONSE

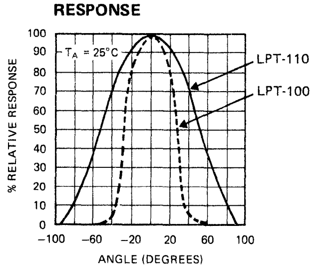


FIGURE 5. COLLECTOR DARK CURRENT VS TEMPERATURE

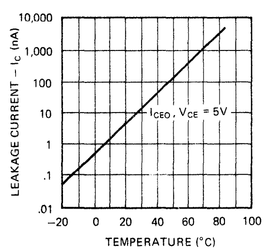


FIGURE 6. SPECTRAL CHARACTERISTICS

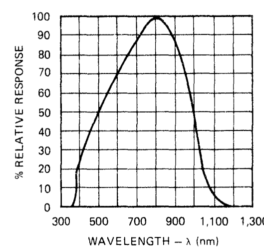


FIGURE 7. RISE AND FALL TIME VS COLLECTOR CURRENT (SHOWN IN FIGURE 10)

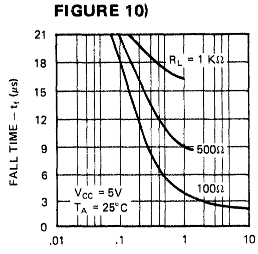


FIGURE 8. TURN-OFF DELAY TIMES FOR CURRENT (SHOWN IN FIGURE 11)

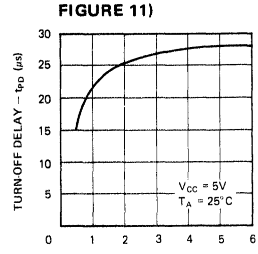
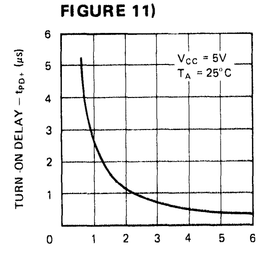


FIGURE 9. TURN-ON DELAY TIMES FOR CIRCUIT (SHOWN IN FIGURE 11)

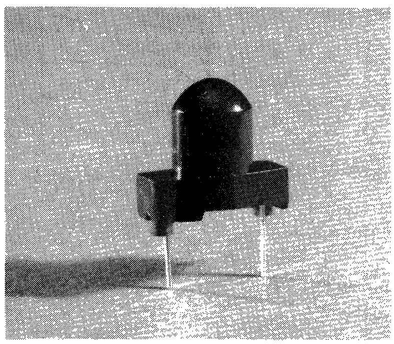


SIEMENS

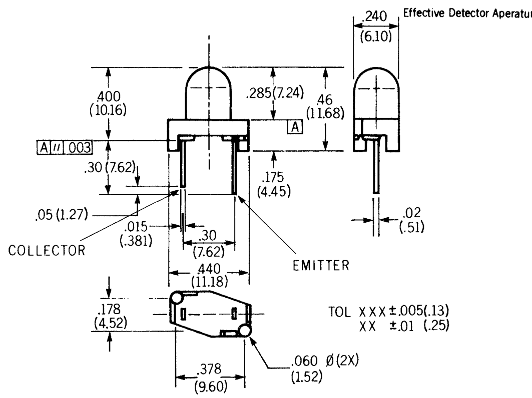
LPT-500

PHOTOTRANSISTOR

Advance Data Sheet



Package Dimensions in Inches (mm)



FEATURES

- **Extremely Accurate Mechanical to Optical Alignment**
- **Package Referenced for Users to Maintain Mechanical Alignment**
- **An Effective Active Area Aperture of .240 Diameter**
- **Extremely Narrow Acceptance Angle—Typically 2.5° Half-Angle**
- **Built-In Daylight Filter**
- **Peak Response at 880 nm**
- **Matches with IRL-500 Infrared Emitter**

Maximum Ratings

Collector-Emitter Voltage	V_{CEO}	30	V
Emitter-Collector Voltage	V_{ECO}	7	V
Collector Current	I_C	100	mA
Junction Temperature	T_S	−55° to +85°	C
Storage Temperature	T_S	−20° to +70°	C
Power Dissipation @ 25°C	P_{TOT}	100	mW

DESCRIPTION

The IPT-500 is an epitaxial NPN silicon phototransistor. The chip is mounted in a precision injection molded housing that guarantees a very accurate alignment tolerance, typically 2.5 degrees. Its detection angle matches with the IRL-500 infrared emitter of 5 degrees (2.5° half angle). The lens is opaque to visible and transparent to IR emission and thus receives efficiently IR light from the matching IRL-500.

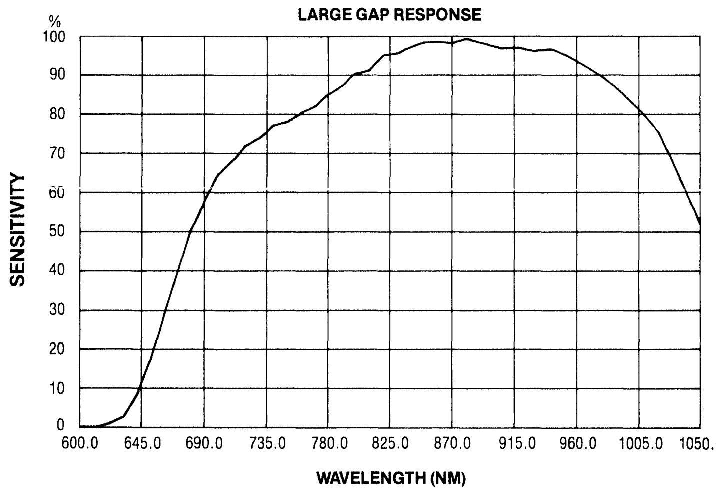
Characteristics (T_{amb} = 25°C)

Spectral Sensitivity	λ	880	nm
Photocurrent* (V_{CE} = 5.0 V, E_e = 0.5 mW/cm²)	$I_{CE(L)}$	20	mA
Risetime (I_C = 4 mA, V_{CE} = 5 V, R_L = 1 KΩ)	tr	2.8	µS
Falltime (I_C = 4 mA, V_{CE} = 5 V, R_L = 1 KΩ)	tf	2.8	µS
Collector-Emitter Saturation Voltage (I_C = 2.0 mA, H = 5 mW/cm²)	$V_{CE(SAT)}$	.26	V
Collector Dark Current (V_{CE} = 5 V)	I_{CEO}	2.0	nA

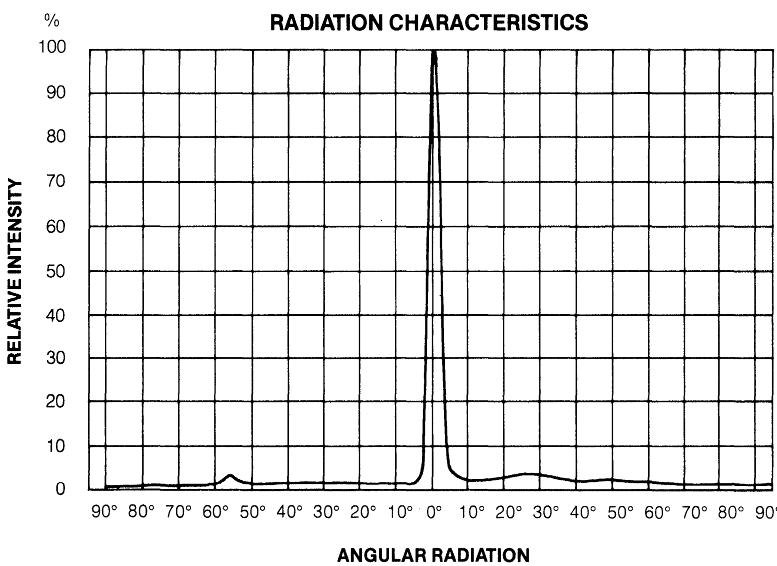
*Measured with tungsten filament bulb at 2856°K color temperature per IEC 306-1, DIN 3055, CIE Illuminant A.

Specifications are subject to change without notice

RELATIVE SPECTRAL SENSITIVITY VS WAVELENGTH



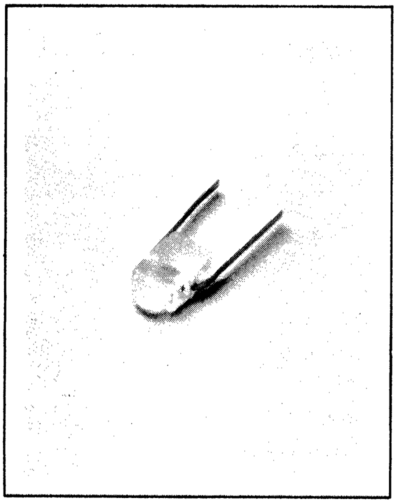
RADIATION CHARACTERISTICS



SIEMENS

SFH 305 SERIES

PHOTOTRANSISTOR



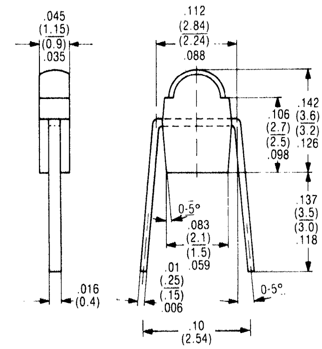
FEATURES

- Miniature Plastic Package
- 2.5 mm (1/10″) Lead Spacing
- Detector for SFH 405 Infrared Emitter
- Designed for Maximum Spacing of 10 mm Between Emitter & Detector

DESCRIPTION

The SFH 305 is a NPN silicon planar photo transistor in clear plastic encapsulation with solder PIN terminals. The connectors in the form of solder tabls are spaced 2.54 mm (1/10 inch). The photo transistors are grouped according to photo sensitivity. The SFH 305 is suitable for use as detector for the infrared diode SFH 405 to effect miniature light barriers with close spacing between sender and receiver up to 10 mm maximum. Also, the SFH 305 is suitable for application with glow-lamp light, i.e. daylight. The collector is marked with a colored dot.

Package Dimensions in Inches (mm)



Maximum Ratings

Collector-emitter voltage	V_{CEO}	32	V
Junction temperature	T_j	90	°C
Collector current	I_C	50	mA
Storage temperature	T_S	−40...+80	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	75	mW
Max. soldering temperature ($t \leq 5$ s)	T_L	230	°C
Thermal resistance			
Collector junction to air	R_{thJamb}	950	K/W
Collector junction to case	R_{thJL}	850	K/W

Characteristics (T_{amb} = 25°C)

Collector-emitter leakage current (V_{CE} = 30 V; E = 0)	I_{CEO}	3 (≤ 20)	nA
Collector-emitter saturation voltage (I_C = 500 µA; I_B = 25 µA; E = 0)	V_{CEsat}	0.2	V
Range of spectral sensitivity (S = 0.1 S_{max})	λ	440...1070	nm
Wavelength of the max. sensitivity	$\lambda_{S\ max}$	850	nm
Radiant sensitive area			
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
Radiant sensitive area	A	0.17	mm²
Capacitance (V_{CE} = 0 V; f = 1 MHz; E = 0)	C_{CE}	8	pF
Half Angle	φ	16	Degrees

[1] measured with LED λ = 950 nm

Group		I[2]	SFH 305-2	SFH 305-3	IV[2]	
Photocurrent (V_{CE}=5 V; E_v=1000 lx)	I_P		1.0 to 2.0	1.6 to 3.2		mA
Photocurrent[1]) (V_{CE}=5 V; E_e= 0.5 mW/cm2)	I_P		0.25 to 0.5	0.4 to 0.8		mA

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

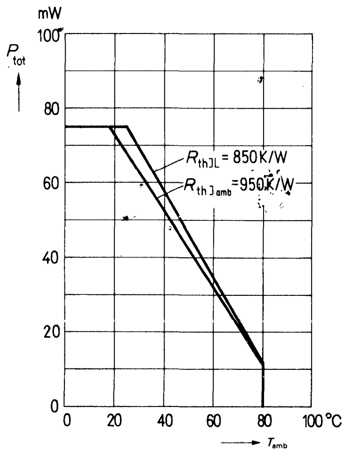
Irradiance E_e measured with HP radiant flux meter 8334A with option 013.

1) Measured with LED λ=950 nm.

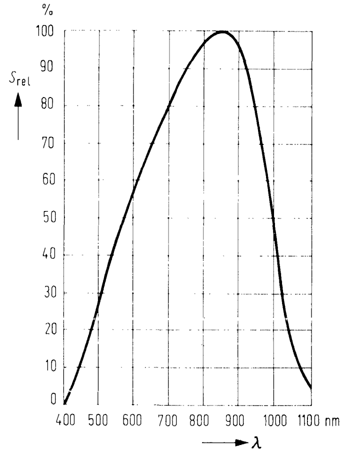
2) In preparation.

Specifications are subject to change without notice.

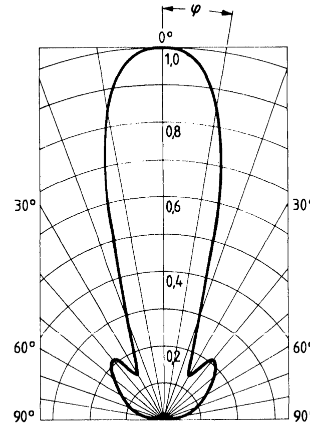
Power dissipation $P_{tot} = f(T_{amb})$



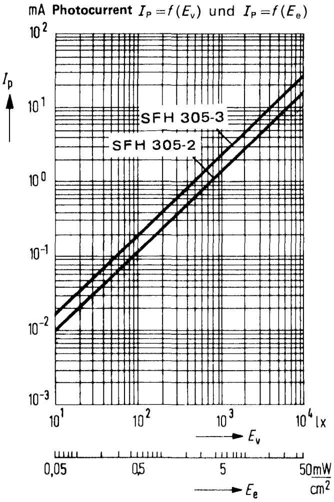
Relative spectral sensitivity $S_{rel} = f(\lambda)$



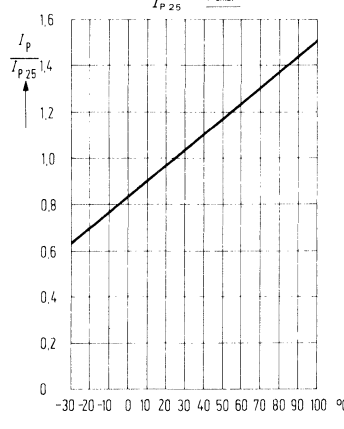
Directional characteristic $I_P = f(\varphi)$



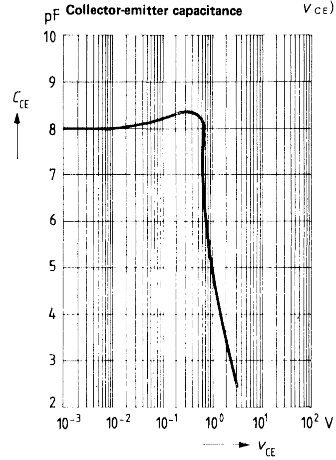
mA **Photocurrent** $I_P = f(E_v)$ und $I_P = f(E_e)$



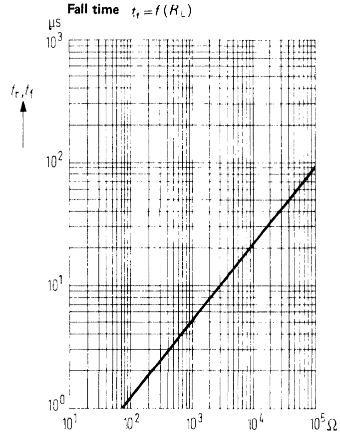
Photocurrent $\frac{I_P}{I_{P25}} = f(T_{amb})$



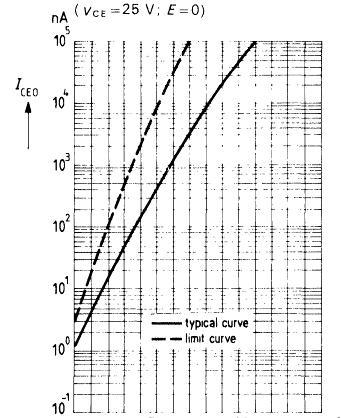
pF **Collector-emitter capacitance** V_{CE})



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



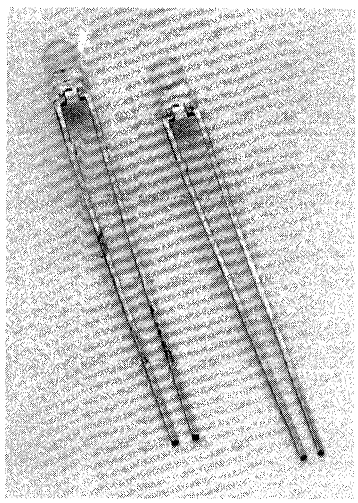
Leakage current $I_{CEO} = f(T_{amb})$
(V_{CE} = 25 V; $E = 0$)



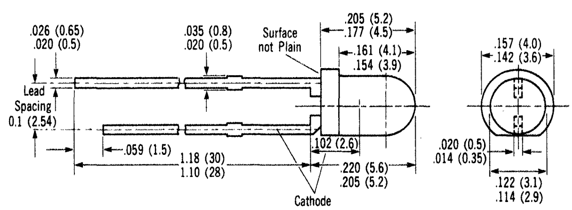
SIEMENS

SFH 309

T1 SILICON PHOTOTRANSISTOR



Package Dimensions in Inches (mm)



FEATURES

- **High Reliability**
- **3 mm (T1) Size Package**
- **.10 Inch (2.54 mm) Lead Spacing**
- **Low Cost**
- **High Radiant Intensity**
- **Good Linearity**
- **Matches with SFH-409 Infrared Emitter**

DESCRIPTION

The SFH-309 is a silicon NPN phototransistor in a standard T1 size plastic package. It is designed for a variety of low cost, high volume applications such as IR remote control and other consumer and entertainment products.

Maximum Ratings

Storage temperature	T_{stg}	− 55 to + 100	°C
Soldering temperature			
Distance from casing-solder tab ≥2mm			
Dip soldering, time ≤ 5s	T_{sold}	260	°C
Iron soldering, time ≤ 3s	T_{sold}	300	°C
Collector - emitter voltage	V_{CEO}	35	V
Collector current	I_C	75	mA
Collector peak current (τ<10 μs)	$I_{C\ peak}$	200	mA
Power dissipation	P_{tot}	165	mW
Thermal resistance	$R_{th\ JA}$	450	K/W

Characteristics $T_{amb} = 25\,°C$)

Wavelength at the max. photo sensitivity	$\lambda_{s\ max}$	875	nm
Range of spectral photo sensitivity S = 10% of S_{max}	λ	420...1125	nm
Radiant sensitive area	A	0,038	mm²
Dimensions at radiant sensitive area	ϕ	0,220	mm
Distance chip surface to leadframe stand off	H	2,6	mm
Half angle	φ	20	degrees
Photo current of collector-base photo diode			
(E_v = 1000 Lx; V_{CE} = 5V)	I_{PCB}	11,3	μA
(E_e = 0,5 mW/cm²; λ = 950 nm; V_{CE} = 5V)	I_{PCB}	3	μA
Capacitance			
(V_{CE} = 0V; f = 1 MHz; E = 0 lux)	C_{CE}	5,3	pF
(V_{CB} = 0V; f = 1 MHz; E = 0 lux)	C_{CB}	7,2	pF
Photo current			
(E_v = 1000 lux; V_{CE} = 5V)	I_p	(≥1) typ. 5	mA
(E_e = 0,5mW/cm²; λ = 95onm; V_{CE} = 5V)	I_p	(≥0,25) typ. 1.3	mA
Rise time/fall time			
(I_c = 1mA; V_{CE} = 5V; R_L = 1Kohm)	t_r, t_f	25	μs
Collector-emitter saturation voltage			
(I_C = 2mA; I_B = 50μA; E = 0 lx)	$V_{CE\ sat}$	200	mV
Current gain			
(E_v = 1000 lux; V_{CE} = 5V)	$\frac{I_{PCE}}{I_{PCB}}$	typ. 400-600	
(E_e = 0,5mW/cm²; λ = 950nm; V_{CE} = 5V)			
Collector-emitter reverse current			
(V_{CEO} = 25V; E = 0lx)	I_{CEO}	60(≤200)	nA

Specifications subject to change without notice

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

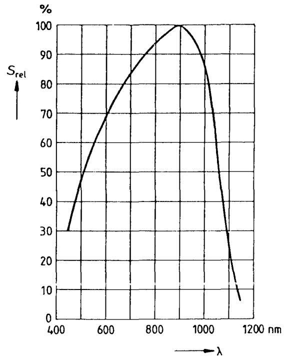
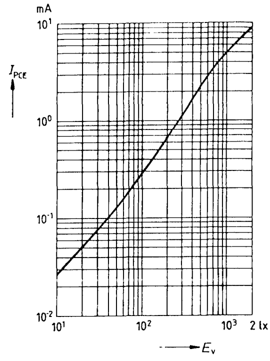
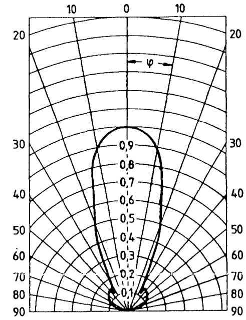


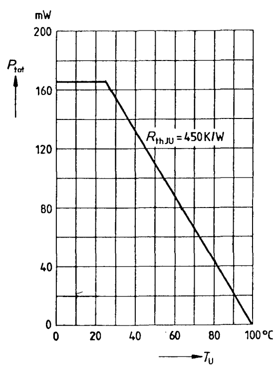
Photo current
$I_{PCE} = f(E_v)$
$(V_{CE} = 5\ V)$



Directional characteristic
$I_P = f(\varphi)$



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



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

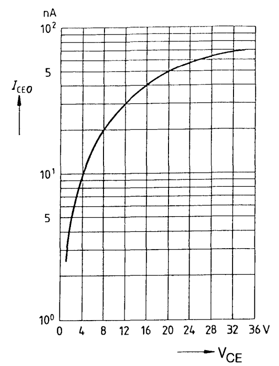


Photo current
$I_{PCE} = f(V_{CE})$

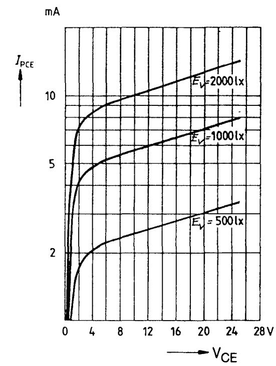
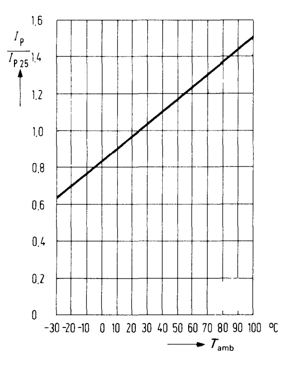
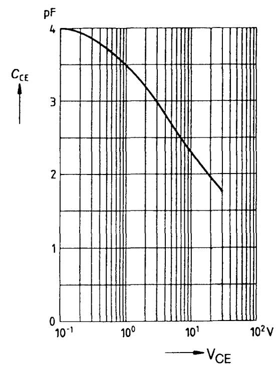


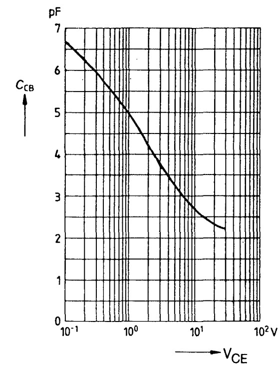
Photo current
$\frac{I_P}{I_{P\,25}} = f(T_{amb})$



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



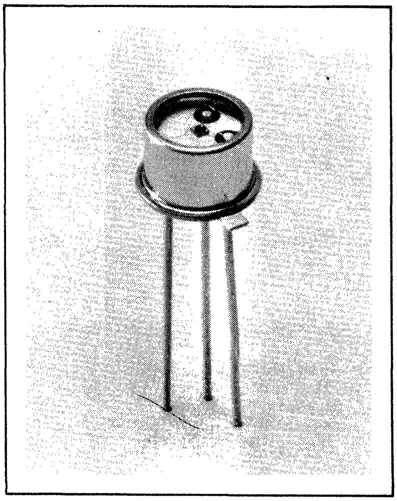
Collector-base capacitance
$C_{CB} = f(V_{CE})$



SIEMENS

SFH 500

PHOTO TRANSISTOR



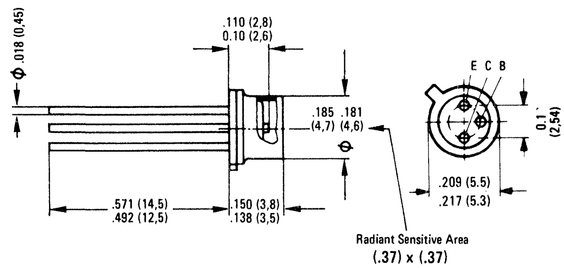
FEATURES

- **TO-18 Package**
- **Flat Glass Lens**
- **Fast Speed, 2 MHz**

DESCRIPTION

SFH 500 is a fast NPN silicon planar photodetector with a frequency to 2 MHz and a wide range of modulation from 10^2 to 10^4 LUX. The chip is mounted in a TO-18 package with flat glass lens window. The photodetector is especially suitable for light wave conductor application through the small cap body (up to 2 Mbits/s). Also suitable for industrial electronics and in camera applications where a wider sensitivity range is necessary. The case is electrically connected to the collector.

Package Dimensions



Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

Maximum Ratings

Collector-emitter voltage	V_{CEO}	15	V
Emitter-base voltage	V_{EBO}	7	V
Collector current	I_C	20	mA
Junction temperature	T_j	100	°C
Storage temperature	T_s	−55...+100	°C
Max. soldering temperature ($t \leq 5$ s)	T_L	260	°C
Power dissipation (T_{amb} = 25°C)	P_{tot}	100	mW
Thermal resistance			
Collector junction to air	R_{thJamb}	600	K/W
Collector junction to case	$R_{thJcase}$	250	K/W

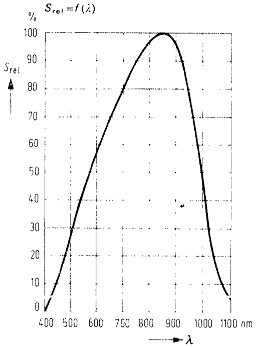
Characteristics (T_{amb} = 25°C)

Photocurrent			
(V_{CE} = 5 V; E_v = 1000 lx)[1]	I_p	700 (≥ 450)	µA
(V_{CE} = 5 V; E_e = 0.5 mW/cm²)[2]	I_p	185	µA
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	825	nm
Quantum yield (Electrons per photon) (λ = 850 nm)	η	0.84	Electrons / Photon
Spectral sensitivity (λ = 850 nm)	S_λ	0.56	A/W
Collector-emitter leakage current (V_{CE} = 10 V; E = 0)	I_{CEO}	20 (≤ 50)	nA
Collector-emitter saturation voltage (I_C = 500 µA; I_B = 25 µA; E = 0)	V_{CEsat}	0.8 (≤ 1.2)	V
Range of spectral sensitivity ($S = 0.1\,S_{max}$)	λ	420...1100	nm
Typ. spectral sensitivity of the collector base photodiode	S	1.17	nA/lx
Radiant sensitive area	A	0.14	mm²
Rise and fall time of the photocurrent			
Rise time to 90% of the final value			
Fall time to 10% of the initial value			
(V_{CE} = 12 V, I_C = 5 mA, R_L = 50 Om)	t_r; t_f	0.25	µs
Capacitance			
(V_{CE} = 5 V; f = 1 MHz; E = 0)	C_{CE}	2.7	pF
(V_{CB} = 5 V; f = 1 MHz; E = 0)	C_{CB}	5.6	pF
Cut-off frequency			
(R_L = 50 Ω; V = 12 V; I = 5 mA)	f_g	2	MHz
Current gain (V_{CE} = 5 V; I_C = 0.1 mA)	B	600	–

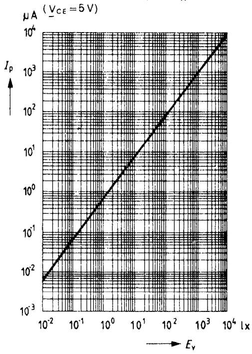
[2] $I_{p\,(CE)}$ = Photocurrent of the phototransistor
$I_{p\,(CB)}$ = Photocurrent of the collector-base photodiode

Specifications are subject to change without notice.

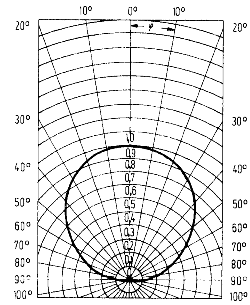
Relative spectral emission $S_{rel} = f(\lambda)$



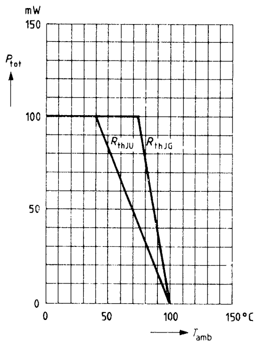
Photocurrent $I_P = f(E_v)$ ($V_{CE} = 5$ V)



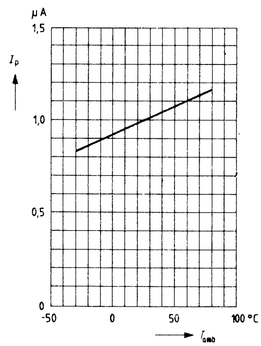
Directional characteristic $I_P = f(\varphi)$



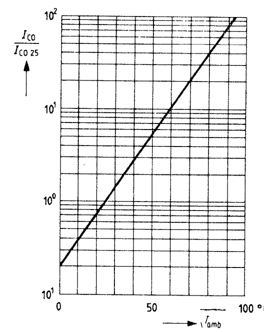
Power dissipation $P_{tot} = f(T_{amb})$



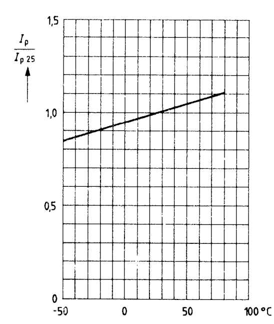
Photocurrent $I_P = f(T_{amb})$



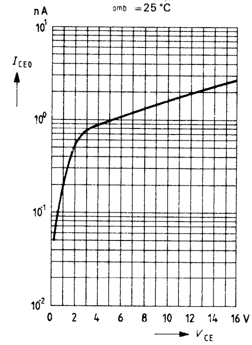
Leakage current $\frac{I_{CO}}{I_{CO25}} = f(T_{amb})$



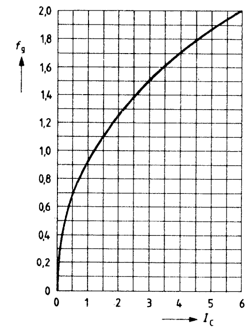
Photocurrent $\frac{I_P}{I_{P25}} = f(T_{amb})$



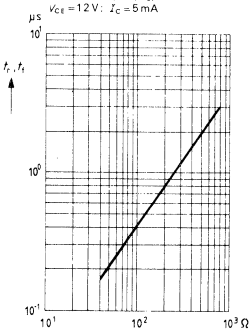
Leakage current $I_{CEO} = f(V_{CE})$
$T_{amb} = 25$ °C



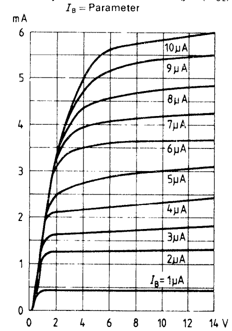
Cutoff frequency $f_g = f(I_C)$
$V_{CE} = 12$ V; $R_L = 50\,\Omega$



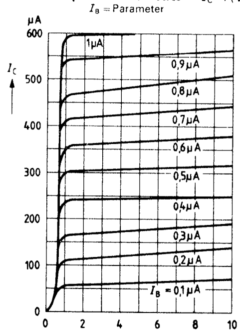
Rise time $t_r = f(R_L)$
Fall time $t_f = f(R_L)$
$V_{CE} = 12$ V; $I_C = 5$ mA



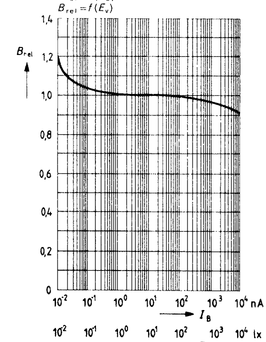
Output characteristics $I_C = f(V_{CE})$
I_B = Parameter



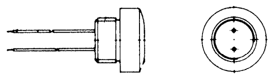
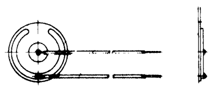
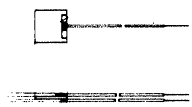
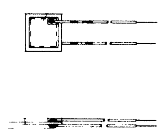
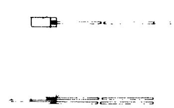
Output characteristics $I_C = f(V_{CE})$
I_B = Parameter



Current gain
$B_{rel} = f(I_B)$
$B_{rel} = f(E_v)$



Photovoltaic Cells

Package Type	Package Outline	Part Number	Half Angle	Sensitivity s(nA/lx) Typical	Dark Current V_R = IV; E = 0 I_R (μA)	Radiant Sensitive Area mm²	Peak Wavelength	Capacitance (V_R = OV; E = 0) C_O nF	Page
Chip with Leads Encapsulated		TP60	60°	1.0	25	1.5 cm²		16	418
Chip with Leads		TP61	60°	1.0	25		850		
Chip with Leads		BPY64P	60°	.25	4	.32 cm²		3	416
Chip with Leads		BPX79	60°	135 nA/lx	0.3(<50)	20	800	2500pF	412
Chip with Leads		BPY11P-4		47-63					
		BPY11P-5	60°	56-75	1(<10)	7	850	.8	414
		BPY11P-6		>71					

SIEMENS

BPX 79
PHOTOVOLTAIC CELL

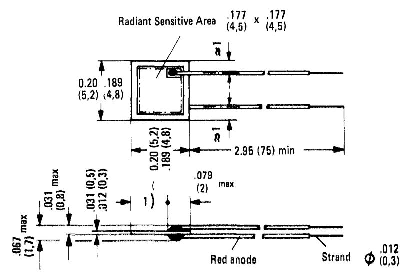
FEATURES

- **Silicon Planar Photovoltaic Cell**
- **Medium Size Radiation Sensitive Surface**
- **High Sensitivity, 0.1 μA/lx (min)**

DESCRIPTION

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 blue. 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.

Package Dimensions



Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

Maximum Ratings

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

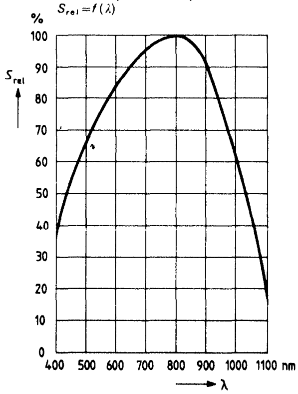
Characteristics (T_{amb} = 25°C)

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

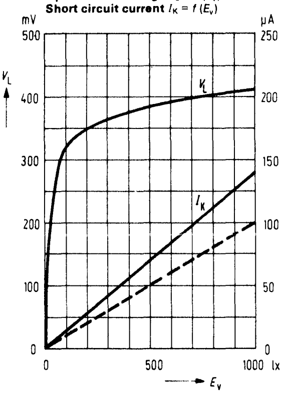
1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

Specifications are subject to change without notice.

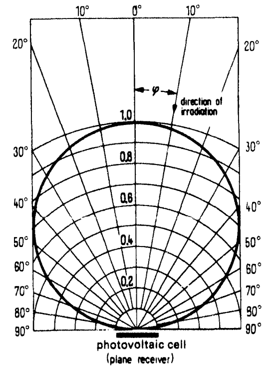
Relative spektrale Empfindlichkeit
$S_{rel} = f(\lambda)$



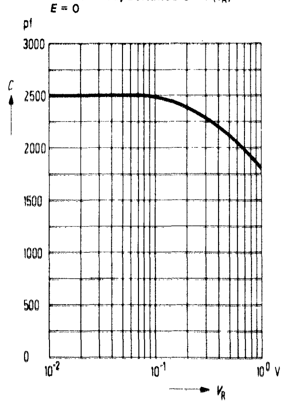
Open circuit voltage $V_L = f(E_v)$
Short circuit current $I_K = f(E_v)$



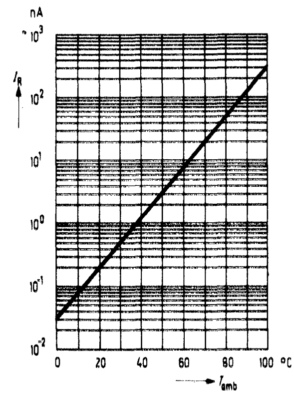
Directional characteristic $I_K = f(\varphi)$



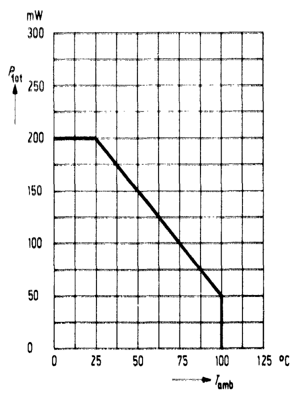
Junction capacitance $C = f(V_R)$
$E = 0$



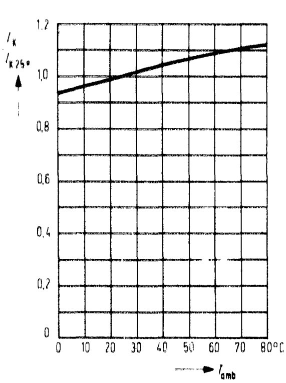
Dark current $I_R = f(T_{amb})$



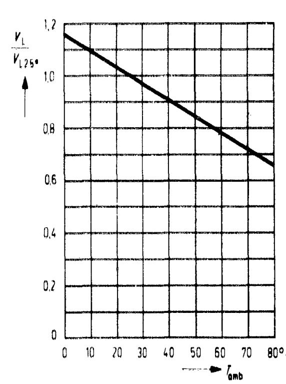
Power dissipation $P_{tot} = f(T_{amb})$



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



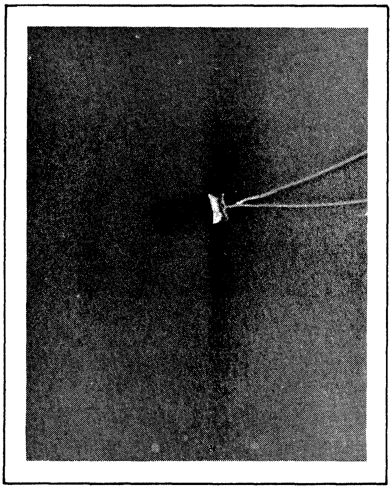
Open circuit voltage $\frac{V_L}{V_{L\,25°}} = f(T_{amb})$



SIEMENS

BPY 11 P SERIES

SILICON PHOTOVOLTAIC CELL



FEATURES

- **Small Package**
- **May Be Stacked Tightly Together**
- **Choice of 3 Sensitivity Groups**
- **Fast Response Time**

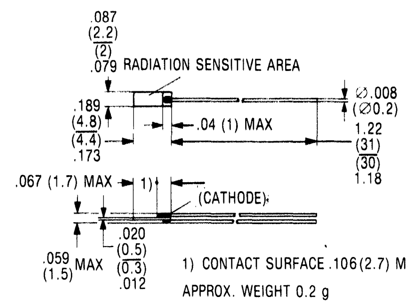
DESCRIPTION

BPY 11 P is a photovoltaic cell, fabricated with planar technology.

The silicon protovoltaic cell 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 universal application feasible.

Since this cell is not encased, the assembly of high efficient scanning systems can be realized. For this purpose the cells may be cemented closely together on suitable mounting assemblies.

Package Dimensions in Inches (mm)



1) CONTACT SURFACE .106(2.7) MIN

APPROX. WEIGHT 0.2 g

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	50 (≧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	310 (≧180)	mV
Open circuit voltage (E_v = 1000 lx)[1]	V_L	410 (≧260)	mV
Short circuit current (E_v = 1000 lx)[1]	I_K	50	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	0.8	nF
Radiant sensitive area	A	7	mm^2
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

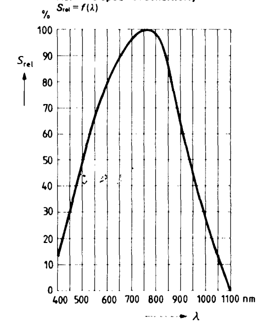
Spectral Sensitivity Groups

Type	Short circuit current I_K (µA) E_v = 100 lx[1]	Color code
BPY 11P-4	4.7 to 6.3	yellow
BPY 11P-5	5.6 to 7.5	green
BPY 11P-6	≧7.1	blue

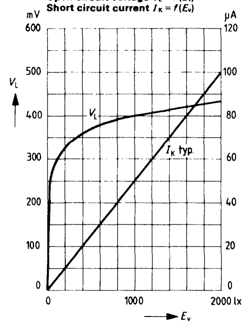
[1] The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a colour temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306−1).

Specifications subject to change without notice.

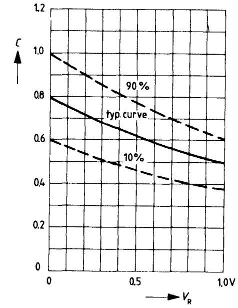
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



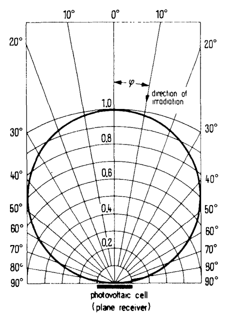
Open circuit voltage $V_L = f(E_v)$
Short circuit current $I_K = f(E_v)$



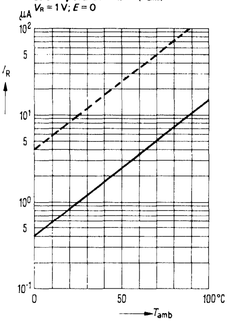
Junction capacitance $C = f(V_R)$
$E = 0$



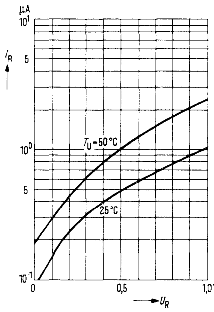
Directional characteristic $I_K = f(\varphi)$



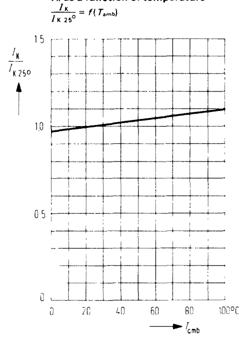
Dark current as a function of temperature $I_R = f(T_{amb})$
$V_R = 1\,V$; $E = 0$



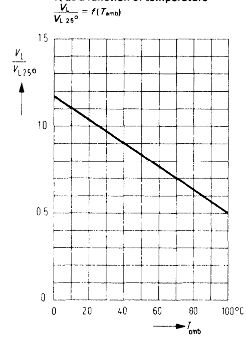
Dark current $I_R = f(V_R)$
T_U = Parameter; $E = 0$



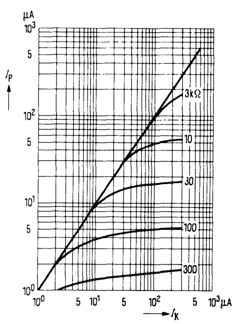
I_K as a function of temperature
$\frac{I_K}{I_{K\,25°}} = f(T_{amb})$



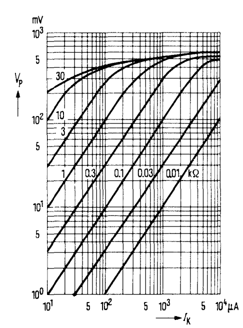
V_L as a function of temperature
$\frac{V_L}{V_{L\,25°}} = f(T_{amb})$



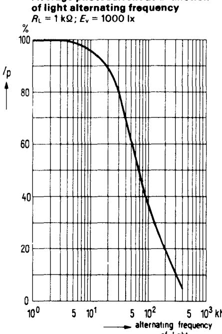
Photocurrent $I_P = f(I_K$; R_L = parameter



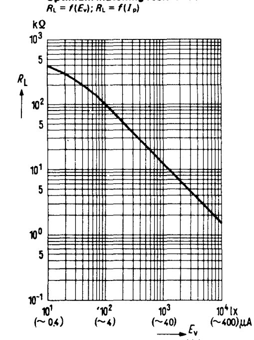
Photovoltage $V_P = f(I_K)$; R_L = parameter



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

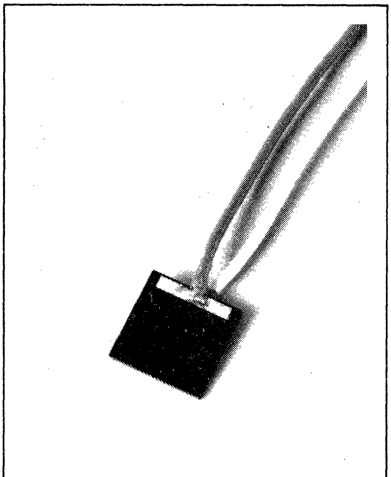


Optimum matching resistance
$R_L = f(E_v)$; $R_L = f(I_P)$



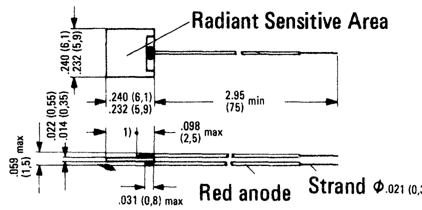
SIEMENS

BPY 64P
PHOTOVOLTAIC CELL



Supercedes BPY 64

Package Dimensions in Inches (mm)



1) CONTACT SURFACE .138 (3.5) MIN.

Maximum Ratings

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

FEATURES

- **Silicon Photovoltaic Cell**
- **Medium Size Radiation Sensitive Surface**
- **High Sensitivity, 0.18 μA/lx**

Characteristics (T_{amb} = 25°C)

Spectral sensitivity 1) (Short circuit current I_K)	S	0.25 (≥ 0.18)	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
(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	cm²
Temperature coefficient of V_L (see diagram)	TC	− 2.6	mV/K
Temperature coefficient of I_K (see diagram)	TC	0.2	%/K
Capacitance (V_R = 0 V; E = 0)	C_0	3	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).

DESCRIPTION

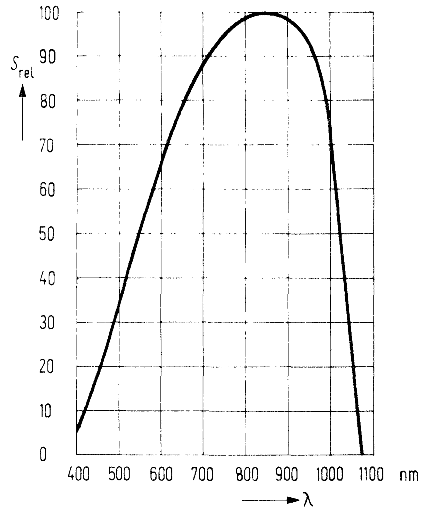
The BPY 64P is suitable for versatile applications in control and drive circuits. It can be used, like all silicon photovoltaic cells, as detector for light of filament lamps or daylight.

For mounting instructions see photovoltaic cell application note.

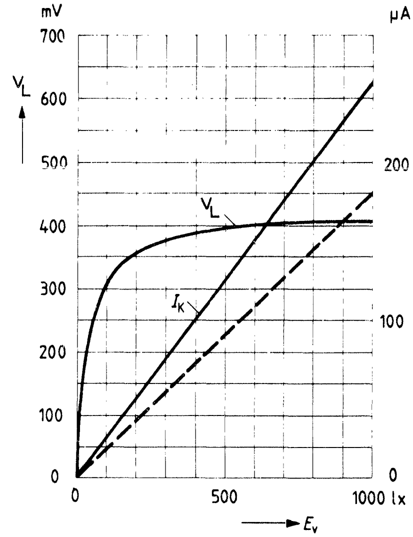
Specifications are subject to change without notice.

Relative spectral sensitivity

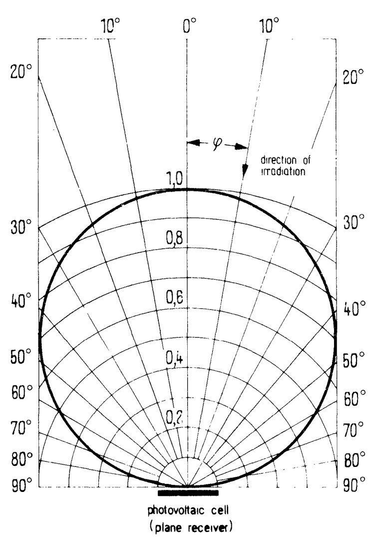
$S_{rel} = f(\lambda)$



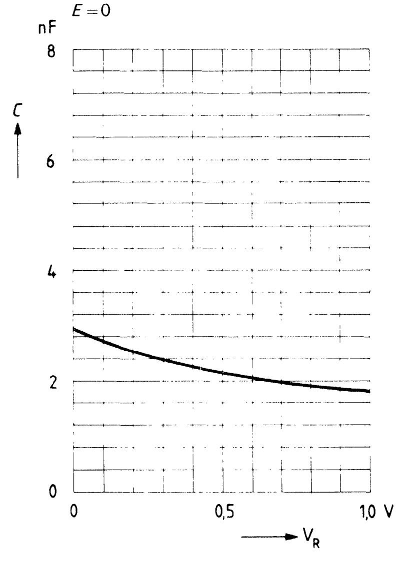
Open circuit voltage $V_L = f(E_v)$
Short circuit voltage $I_K = f(E_v)$



Directional characteristic $I_K = f(\varphi)$



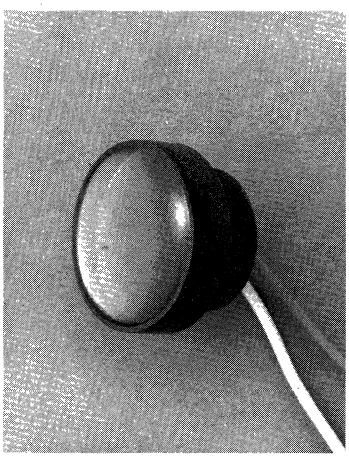
Capacitance $C = f(V_R)$; $E = 0$



SIEMENS

TP 60, TP 61

SILICON PHOTOVOLTAIC CELLS



FEATURES

- **Silicon Photovoltaic Cell**
- **Stud Package, TP 60**
- **Wide Temperature Range, –55° to +100°, TP 61**
- **Very High Sensitivity, .7 μA/lx Min**

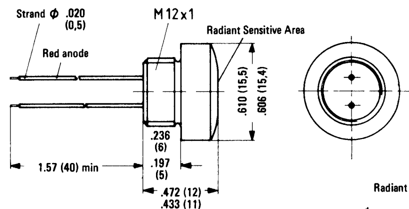
DESCRIPTION

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.

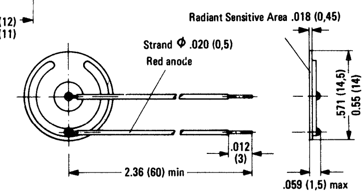
For mounting instructions see photovoltaic cell application note.

Package Dimensions

TP 60



TP 61



Dimensions inside parenthesis are in mm
Dimensions outside parenthesis are in inches

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

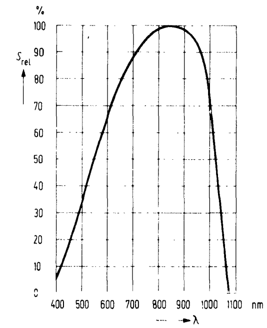
Characteristics (T_{amb} = 25°C)

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	cm2
Tolerance of the radiant sensitive area	A tol	± 0.1	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	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

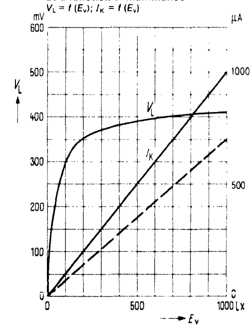
1) The illuminance indicated refers to unfiltered radiation of a tungsten filament lamp at a color temperature of 2856 K (standard light A in accordance with DIN 5033 and IEC publ. 306-1).

Specifications are subject to change without notice.

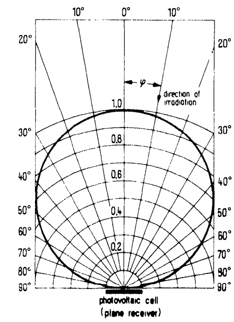
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



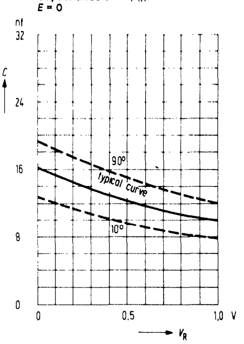
Open circuit voltage and short circuit current as a function of illuminance
$V_L = f(E_v)$; $I_K = f(E_v)$



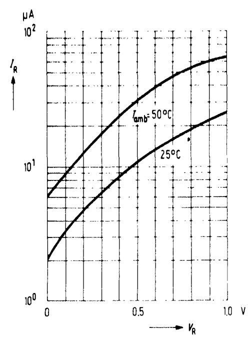
Directional characteristic $I_K = f(\varphi)$



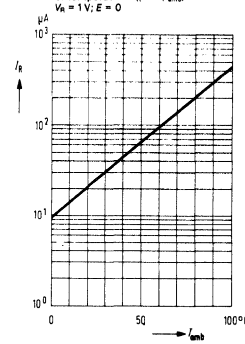
Capacitance $C = f(V_R)$
$E = 0$



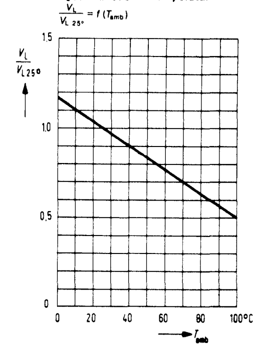
Dark current $I_R = f(V_R)$
T_{amb} = parameter; $E = 0$



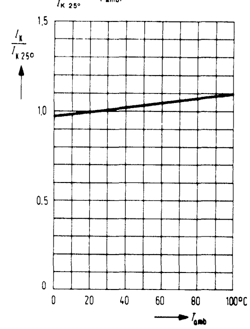
Dark current as a function of temperature $I_R = f(T_{amb})$
$V_R = 1$ V; $E = 0$



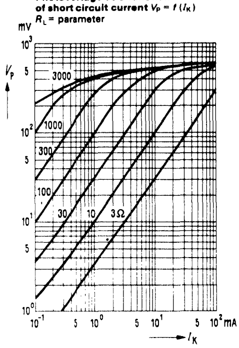
V_L as a function of temperature
$\frac{V_L}{V_{L\,25°}} = f(T_{amb})$



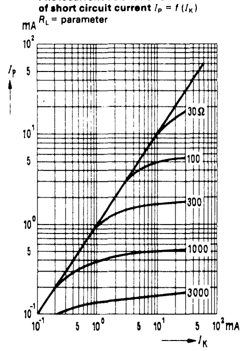
I_K as a function of temperature
$\frac{I_K}{I_{K\,25°}} = f(T_{amb})$



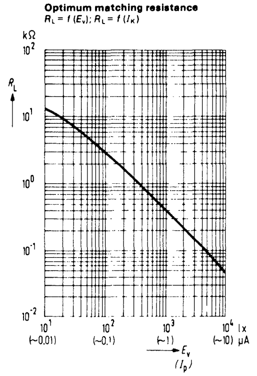
Photovoltage as a function of short circuit current $V_P = f(I_K)$
R_L = parameter



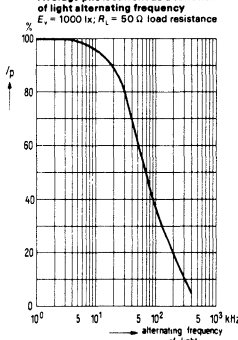
Photocurrent as a function of short circuit current $I_P = f(I_K)$
R_L = parameter



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; $R_L = 50\ \Omega$ load resistance



LIST OF APPLICATION NOTES

SIEMENS

Appnote 1

LED'S & PHOTOMETRY

by George Smith

The observed spectrum of electromagnetic radiations, extends from a few Hz, to beyond 10^{24} Hz, covering some 80 octaves. The narrow channel from 430 THz to 750 THz would be entirely negligible, except for the fact that more information is communicated to human beings, in this channel, than is obtained from the rest of the spectrum. This radiation has a wavelength ranging from 400nm to 700nm, and is detectable by the sensory mechanisms of the human eye. Radiation observable by the human eye is commonly called light.

Measurements of the physical properties of light and light sources, can be described in the same terms as any other form of electromagnetic energy. Such measurements are commonly called Radiometric Measurements.

Measurements of the psychophysical attributes of the electromagnetic radiation we call light, are made in terms of units, other than these radiometric units. Those attributes which relate to the luminosity (sometimes called visibility) of light and light sources, are called photometric quantities, and the measurement of these aspects is the subject of Photometry.

The electronics engineer who is starting to apply light emitting diodes and other opto-electronic devices to perform useful tasks, will find the subject of photometry to be a confused mass of strange units, confusing names for photometric quantities, and general disagreement as to what the important requirements are for his application.

The photometric quantities are related to the corresponding radiometric quantities by the C.I.E. Standard Luminosity Function (Fig. 1), which we may colloquially refer to as the standard eyeball. We can think of the luminosity function, as the transfer function of a filter which approximates the behavior of the average human eye under good lighting conditions.

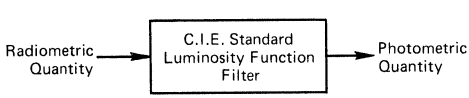


Figure 1. Relationship between radiometric units and photometric units.

The eye responds to the rate at which radiant energy falls on the retina, i.e., on the radiant flux density expressed as Watts/m^2. The corresponding photometric quantity is Lumens/m^2. The standard luminosity function is then, a plot of Lumens/Watt as a function of wavelength.

The function has a maximum value of 680 Lumens/Watt at 555nm and the ½ power points occur at 510nm and 610nm (Fig. 2).

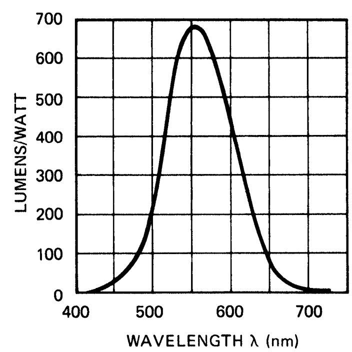


Figure 2. CIE standard photopic luminosity function.

The LUMEN is the unit of LUMINOUS FLUX and corresponds to the watt as the unit of radiant flux.

Thus the total luminous flux emitted by a light source in all directions is measured in lumens, and can be traced back to the power consumed by the source to obtain an efficiency number.

Since it is generally not practical to collect all the flux from a light source, and direct it in some desired direction, it is desirable to know how the flux is distributed spatially about the source. If we treat the source as a point (far field measurement), we can divide the space around the source into elements of solid angle (dω), and inquire as to the luminous flux (dF) contained in each element of solid angle ($\frac{df}{d\omega}$). The resulting quantity is Lumens/Steradian and is called LUMINOUS INTENSITY (I), (Fig. 3). The unit of Luminous intensity is called the CANDELA, sometimes loosely called the candle, or candle power.

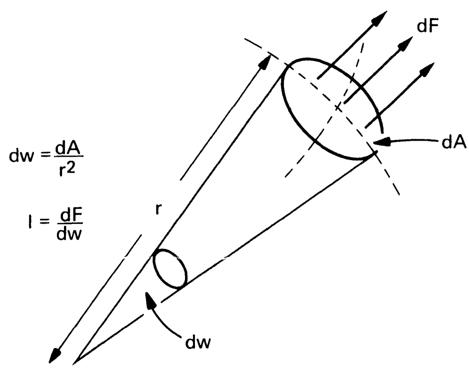


Figure 3. Solid angles and luminous intensity.

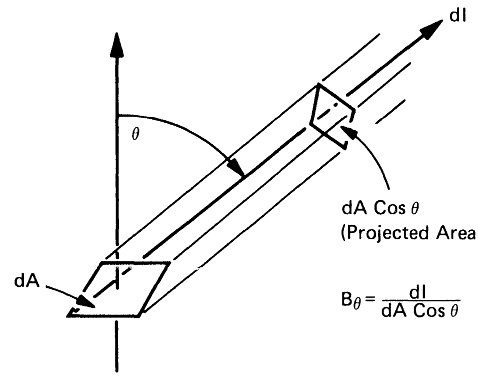


Figure 5. Definition of luminance.

Since the space surrounding a point contains 4 π steradians, it is apparent that an isotropic radiator of one candela intensity, emits a total luminous flux of 4 π Lumens.

No real light source is isotropic, so it is quite common to show a plot of Luminous intensity versus angle off the axis (Fig. 4). If the source has no axis of symmetry, a more complex diagram is required.

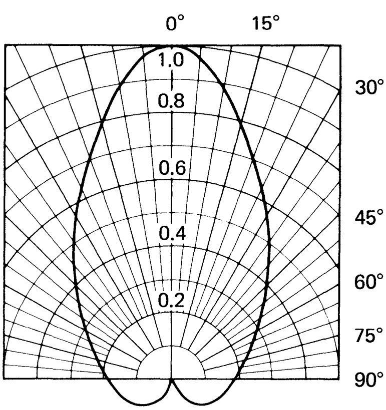


Figure 4. Spatial distribution pattern.

For an extended radiating surface, (such as an LED chip), each element of area contributes to the luminous intensity of the source, in any given direction. The luminous intensity contribution in the given direction, divided by the projected area of the surface element in that direction, is called the LUMINANCE (B) of the source (in that direction), (Fig. 5). The quantity is sometimes called photometric brightness, or simply brightness. The use of the term brightness on its own, should be discouraged, as this involves various subjective properties such as texture, color, sparkle, apparent size, etc. that have psychological implications.

The fundamental quantitative standard of the photometric system of units is the standard of luminance.

The luminance of a black body radiator at the temperature of freezing platinum (2043.8°K) is 60 candela per square centimeter. [A blackbody radiator is a perfect absorber of all electromagnetic energy incident on it. In thermal equilibrium at a given temperature, it emits radiation, spectrally distributed according to Plancks Formula

$$(W_\lambda = \frac{c_1 \lambda^{-5}}{\exp\left(\frac{c_2}{\lambda}\right) - 1})]$$

The units of Luminance in present use are an engineering nightmare.

1 candela/cm^2 is called a *Stilb*
1/π candela/cm^2 is called a *Lambert*
1 candela/m^2 is called a *Nit*
1/π candela/m^2 is called an *Apostilb*
1/π candela/ft^2 is called a *foot-Lambert*

The foot Lambert is the most commonly used unit in this country.

Of particular interest is a source whose angular distribution pattern is a circle (Fig. 6). For such a source we have $I_\theta = I_0 \cos\theta$, the luminance of such a source in a given direction θ, is then given by

$$B_\theta = \frac{d\ I_\theta}{d\ A \cos\theta} = \frac{d\ I_0 \cos\theta}{d\ A \cos\theta} = \frac{d\ I_0}{dA}$$

The luminance is seen to be the same in all directions. Such a source is called a LAMBERTIAN SOURCE. It can be shown that a perfectly diffusing surface behaves in this fashion. The formula governing a diffusing surface $I_\theta = I_0 \cos\theta$ is called Lambert's Cosine Law.

It can be shown that a flat LED chip is a very good approximation to a Lambertian Source.

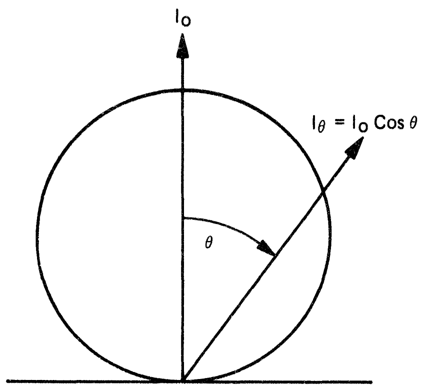


Figure 6. Lambertian radiation pattern.

If we now take a surface element (dA) and determine the intensity contribution in each direction we can determine the total flux (dF) emitted by the surface element. The resultant ratio $(\frac{dF}{dA})$ Lumens/m^2 is called the LUMINOUS EMITTANCE (L). For a flat surface we may calculate L from

$$L = 2\pi \int_0^{\pi/2} B(\theta) \, S_{IN}\, \theta \, \cos\theta \, d\theta$$

The corresponding radiant emittance in watts/m^2 is of considerable interest for GaAs infrared LED's where total output power is an important parameter.

The total luminous flux emitted by a light source can then be calculated from $F_{total} = \int LdA$.

These photometric quantities are sufficient to describe the properties of light sources such as light emitting diodes.

When light falls on a receiving surface, it is either partially reflected in the case of a purely passive surface, or partly converted into some other form of energy by what we may describe as an active surface (such as a phototransistor or photomultiplier cathode). In either case we are interested in how much flux falls on each element of the surface; Lumens/m^2 in the case of a passive surface which we wish to illuminate, or the eye; and Watts/m^2 in the case of other active surfaces. The quantity Lumens/m^2 in this case is called the ILLUMINANCE sometimes loosely referred to as the illumination. The unit of illuminance is the LUX also referred to as the metercandle. Another commonly used unit of illuminance, in this country is the FOOT CANDLE, equal to one lumen per square foot. One lumen per square cm is called a PHOT.

Many of these photometric quantities and units are in common use in the field of illumination engineering, with the English units being most common in this country. It should be apparent to the reader that a mixed system of units is involved in common usage.

APPLICATION TO LIGHT EMITTING DIODES

The above description of photometric quantities should indicate to the reader that there are many ways in which the photometric properties of LED's can be stated. There is no general agreement among LED makers and users, as to the best way to specify LED performance, and this has lead to much confusion and misunderstanding.

Many factors must be taken into account when evaluating LED specifications for a particular application, and electronic engineers will need to develop a knowledge of these factors to put LED's to effective use in new designs.

Presently available light emitting diodes are made from the so-called III-V compound semiconductors, with Gallium Arsenide Phosphide and Gallium Phosphide being the major materials. Gallium Aluminum Arsenide is also used but is less common. Gallium Arsenide is commonly included in this group, but it should be remembered that GaAs emits only infra-red radiation around 900nm, which is not visible to the eye, and is thus not properly called light. All specifications of GaAs emitters must be in radiametric units.

GaP emits green light between 520 and 570nm peaking 550nm very close to the peak eye sensitivity. It also can emit red light between 630 and 790nm peaking at 690nm.

$GaAs_{(1-x)}P_x$ emits light over a broad orange red range depending on the percentage of phosphorus in the material (x). For x in the 0.4 region, red light between 640 and 700nm peaking at 660nm, is obtained. For x = 0.5, amber light peaking around 610nm is obtained.

$Ga_{(1-x)}Al_xA_s$ as presently available, emits red light between 650 and 700nm peaking at 670nm.

The efficiency of these materials is very dependent on the emitted wavelength, with drastic fall off in efficiency as the wavelength gets shorter. Fortunately the standard eyeball filter, favors the shorter wavelength (down to 555nm) and gives some measure of compensation. Some typical efficiencies reported by device makers, and the resulting overall luminous efficiency (Lumens/electrical watt) are as follows:

GaP.red .72% @ 20Lum/Watt =
.14 Lum/Watt overall (Opcoa)
$GaAs_{.6}P_{.4}$red .3% @ 50Lum/Watt =
.15 Lum/Watt overall (Litronix)
GaAlAs red .06% @ 40Lum/Watt =
.024 Lum/Watt overall (Mitsubishi)
GaP green .006% @ 675Lum/Watt =
.04 Lum/Watt overall (Monsanto)
$GaAs_{.5}P_{.5}$amber .0044% @ 340Lum/Watt –
.015 Lum/Watt overall (Monsanto)

For simple status indicator applications, front panel lamps and similar applications, several factors must be taken into account:

(1) Color. Generally the designer has Henry Ford's color choice; various similar shades of red. Amber and green are available in small quantity, because of availability of suitable raw material.

(2) Apparent source size. Various combinations of chip size and optical systems are available so that apparent source sizes from about 5 mils to about 300 mils diameter are available as standard products. Other things being equal, a larger source size is more visible.

(3) Angular distribution. GaAsP diode chips are nearly Lambertian, but GaP are nearly isotropic. With suitable optical design, the angular distribution pattern can be changed from very broad to quite narrow. By placing the chip at the focus of the lens system a narrow high intensity beam is obtained. The off axis visibility is drastically reduced. By using diffusing lens materials, a large area source with good off axis visibility is obtained. In this case the luminance is reduced.

(4) Luminous intensity. This will govern the visibility under optimum background contrast conditions, when viewed at normal distances. 1 millicandela is typical for red lamps of either GaAsP or GaP at normal operating conditions.

(5) Luminance. When it is not possible to provide a dark contrasting background, or when the source is viewed at very close distances, the luminance becomes important. Values from 100 ft-L to 5000 ft-L are typical.

These factors are all related to the design of the device and the user should understand the trade offs. High luminance values in excess of 10,000 ft-L are easily obtained by running very high current densities in the LED chip, but this can lead to shortened life if carried too far.

For a given drive current the luminous intensity of two different chips will be similar, while the luminance will be inversely proportional to the active area of the chip.

If the designer can use filter screens or circularly polarizing filters in front of the light source, excellent protection from background illumination can be obtained. In this case a diffusive lens giving a large apparent source with lower luminance, is more visible than a high luminance point source.

When a LED is used with an optical system to activate a remote sensor such as a cadmium sulphide or cadmium selenide cell (red light), or a GaAs IR emitter is used with a silicon photo detector, the performance requirements are somewhat different. It can be shown that for a given optical arrangement the irradiance of the detector determines the detected signal and this is proportional to the radiance of the source, which is comparable to the luminance (brightness) of the source. The intensity of the source will not be a factor unless the detector active area is larger than the incident beam.

When average power consumption must be minimized but good visibility is required, or detection at a considerable distance is required, pulsed operation can be used. With GaAs and GaAsP emitters using low duty cycle short pulses, very high peak intensity levels can be reached permitting communication over considerable distances. This technique is not useful with GaP diodes since they do not exhibit a linear relationship between optical output and instantaneous forward current, becoming saturated at moderate current levels. GaP also has a 50% higher rate of fall off in light output with temperature increase, than GaAsP which further inhibits high power applications.

The use of LED's to give a "Heads Up" projected display, such as for an automobile speedometer readout, or aircraft cockpit application, places severe requirements on the display luminance. For easy visibility, the projected image must be sufficiently contrasted with the ambient illumination. This requires very high luminance values for the LED's together with the use of photochromic windshields and probably polarizing screens.

The foregoing is a necessarily simplified, description of a very complex subject. The reader should avail himself of the standard textbook literature on these subjects.

References:

R. Kingslake, *Applied Optics & Optical Engineering*
Committee on Colorimetry of the O.S.A., *The Science of Color.*
Warren J. Smith, *Modern Optical Engineering.*

APPLICATIONS OF OPTO-ISOLATORS

by George Smith

The IL-IB is the first in a family of Opto-Isolators. These products are also called photon coupled isolators, photo-couplers, photo-coupled pairs and optically coupled pairs. All of the characteristics of the IL-IB are electrical: it has no external optical properties. Hence opto-isolators are not OPTO-ELECTRONIC DEVICES; they are in fact one of the simplest of all ELECTRO-OPTICAL SYSTEMS.

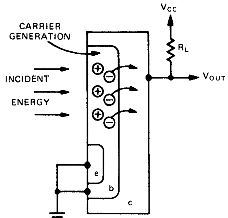
The Iso-Lit 1 consists of a Gallium Arsenide infrared emitting diode, and a silicon phototransistor mounted together in a DIP package.

When forward current (I_F) is passed through the Gallium Arsenide diode, it emits infrared radiation peaking at about 900nm wavelength. This radiant energy is transmitted through an optical coupling medium and falls on the surface of the NPN phototransistor.

Photo-transistors are designed to have large base areas; and hence a large base-collector junction area; and a small emitter area. Some fraction of the photons that strike the base area cause the formation of electron-hole pairs in the base region. This fraction is called the QUANTUM EFFICIENCY of the photodetector.

If we ground the base and emitter, and apply a positive voltage to the collector of the photo-transistor, the device operates as a photo diode.

The high field across the collector base junction quickly draws the electrons across into the collector region. The holes drift towards the base terminal attracting electrons from the terminal.

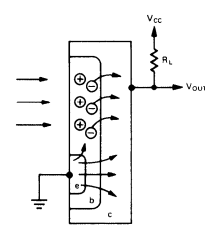


Thus a current flows from collector to base, causing a voltage drop across the load resistance (R_L).

The high junction capacitance, C_{cb}, results in an output circuit time constant R_LC_{cb}, with a corresponding output voltage rise time.

The output current in this configuration is quite small and hence this connection is not normally used.

The commonest circuit configuration is to leave the base connection open. With this connection, the holes generated in the base region cause the base potential to rise, forward biasing the base-emitter junction. Electrons are then injected into the base from the emitter, to try to neutralize the excess holes. Because of the close proximity of the collector junction, the probability of an electron recombining with a hole is small and most of the injected electrons are immediately swept into the collector region. As a result, the total collector current is much higher than the photo-generated current, and is in fact β times as great.



The total collector current is then several hundred times greater than for the previous connection.

This gain comes with a penalty of much slower operation. Any drop in collector voltage is coupled to the base via the collector-base capacitance tending to turn off the injected current. The only current available to charge this junction capacitance is the original photo-current. Thus, the rate of change of the output voltage is the same for both the diode and transistor connections. In the latter case, the voltage swing is β times as great, so the total rise time is β times as great as for the diode connection. Thus the effective output time constant is $\beta\ R_LC_{cb}$.

For the IL-IB this results in a typical 2 μs rise time for 100Ω load.

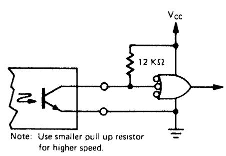
The ratio of the output current from the photo-transistor (I_C or I_E), to the input current in the Gallium Arsenide diode, is called the Current Transfer Ratio (CTR). For the IL-IB CTR is specified at 20% minimum with 35% being typical at I_F = 10 mA.* Thus for 10 mA input current the minimum output current is 2 mA. Other important parameters are V_F typically 1.3V at 100 mA I_F.

DIGITAL INTERFACES

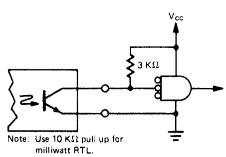
Output Sensing Circuits

The output of the photo-transistor can directly drive the input of standard logic circuits such as the 930 DTL and 7400 TTL families. The worst case input current for the 74 series gate is −1.6 mA for V_{IN} = 0.4 Volts. This can be easily supplied by the Iso-Lit 1, with 10 mA input to the infrared diode.

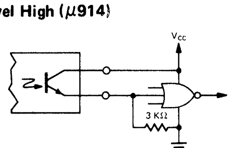
DTL or TTL Active Level Low (930 or 7400)



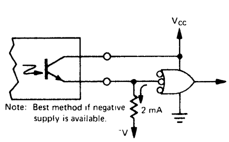
RTL Active Level Low (μ914)

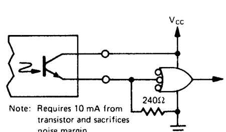


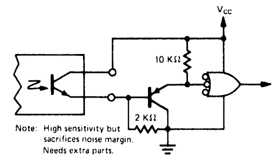
RTL Active Level High (μ914)

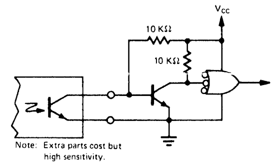


It is more difficult to operate into DTL and TTL gates in the active level high configuration. Some possible methods are as follows;

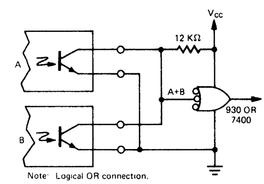


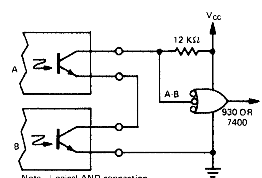






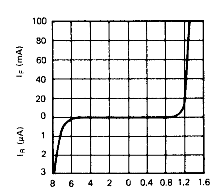
Obviously, several Iso-Lit output transistors can be connected to perform logical functions.





Input Driving Circuits

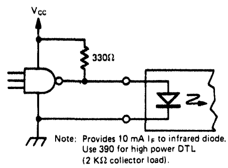
The input side of the IL-IB has a diode characteristic as shown.



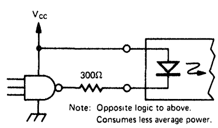
The forward current must be controlled to provide the desired operating condition.

The input can be conveniently driven by integrated circuit logic elements in a number of different ways.

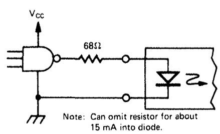
DTL Active Level High (930 Series)



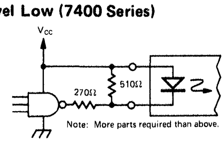
DTL Active Level Low (930 Series)

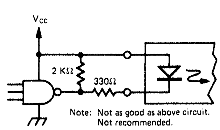


TTL Active Level High (7400 Series)



TTL Active Level Low (7400 Series)





There are obviously many other ways to drive the device with logic signals, but the commonest needs can be met with the above circuits. All provide 10 mA into the LED giving 2 mA minimum out of the photo-transistor. The 1 Volt diode knee and its high capacitance (typically 100 pF), provides good noise immunity. The rise time and propagation delay can be reduced by biasing the diode on to perhaps 1 mA forward current, but the noise performance will be worse.

All previous configurations show medium speed digital interfaces. These circuits have various advantages over other ways of doing the task.

(1) They can replace relays and reed relays, giving much faster switching speeds, no contact bounce, better reliability, and usually better electrical isolation exçept for special configurations. However relays have high current capability, higher output voltage, lower on resistance and offset voltage and higher off resistance.

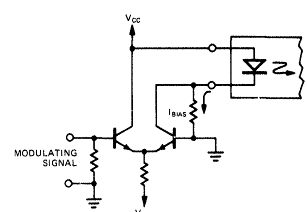
(2) They can replace pulse transformers in many floating applications. Opto-isolators can transmit DC signal components and low frequency AC, whereas pulse transformers couple only the high frequency components, and a latch is required to restore the DC information. Pulse transformers have faster rise time than photo-transistor opto-isolators.

(3) Integrated circuit line drivers and receivers are used to transmit digital information over long lines in the presence of common mode noise. The maximum common mode noise voltage permissible is usually in the 30 Volt range. There are many practical situations where common mode noise voltages of several hundred Volts can be be induced in long lines. For these applications opto-isolators provide protection against several thousand Volts.

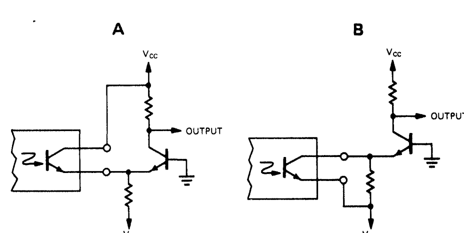
LINEAR APPLICATIONS

The curve of input current versus output current for the IL-IB is somewhat non-linear, because of the variation of β with current for the photo-transistor, and the variation of infrared radiation out versus forward current in the GaAs diode. The useful range of input current is about 1 mA to 100 mA, but higher currents may be used for short duty cycles.

For linear applications the LED must be forward biased to some suitable current (usually 5 mA to 20 mA). Modulating signals can then be impressed on this DC bias. A differential amplifier is a good way to accomplish this.

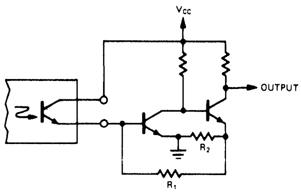


Sensing in linear applications can be done in several ways depending on the requirements. For high frequency performance, the photo-transistor should be operated into a low impedance input current amplifier. The simplest such scheme is a grounded base amplifier.



The circuit will work equally well either way, with a phase inversion between the two. Obviously a PNP transistor would work as well.

A feedback amplifier could also be used to get a low impedance input.



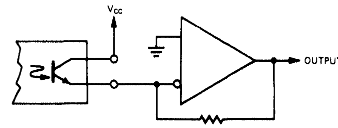
The current gain is $\left(1 + \frac{R_1}{R_2}\right)$.

The input impedance is approximately

$$\left(\frac{R_1}{1 + \frac{V_{CC} - 2V_{BE}}{.026}}\right)$$

For example if R_1 = 900Ω, R_2 = 100Ω, V_{CC} = 5V; we would have a current gain of 10 and an input impedance of about 6.3Ω. This would give a considerable speed improvement over a 100Ω load.

A high speed operational amplifier could be used to give excellent performance.



Note that in all cases the output can be taken from either the collector, or the emitter of the phototransistor depending on the polarity desired. The operating speed is the same in either case.

CONCLUSION

This appnote covers the most commonly used ways of applying photo-transistor opto-isolators. The design engineer will see many ways to expand on these circuits to achieve his end goals. The devices are extremely versatile, and can provide better solutions to many systems problems than other competing components. Special designs are possible to optimize certain parameters such as coupling capacitance, or transfer ratio, and the engineer can expect to see a variety of these products in the future.

SUMMARY OF PROPERTIES OF SIGNAL COUPLING DEVICES

Device	Advantages	Disadvantages
Opto-Isolator	Economical. Solid state reliability. Medium to high speed signal transmission. DC & low frequency transmission. High voltage isolation. High isolation impedance. Small size DIP Package. No contact bounce Low power operation.	Finite ON Resistance Finite OFF Resistance. Limited ON state current. Limited OFF state voltage. Low transmission efficiency. (Low CTR)
Relays	High power capability. Low ON resistance. DC transmission. High voltage isolation.	High cost. High power consumption. Unreliable. Very slow operation. Physically large.
Pulse Transformers	High speed signal transmission. Moderate size. Good transmission efficiency.	No DC or low frequency transmission. Expensive for high isolation impedance or voltage.
Differential line Drivers and Receivers	Solid state reliability. Small size DIP package. High speed transmission. DC transmission. Low cost.	Very low breakdown Voltage. Low isolation impedance.

SIEMENS Appnote 3

MULTIPLEXING LED DISPLAYS

by George Smith

In digital displays, such as would be used in a D.V.M. or counter of conventional design, all digits are operated in parallel, with a separate decoder-driver for each digit operated from data generally stored in a quad latch.

In many cases, a reduction in cost can be effected by operating the display in a time division multiplexed mode. The question of cost effectiveness depends on the particular application. As a general rule, the greater the number of digits in the display, the more advantageous the multiplex system becomes from the cost standpoint. Because of the great variety of situations possible, it is difficult to say at what number of digits the change should be made. In some circumstances, non-multiplexed operation of less than 8 digits is more economical. On the other hand, there are circumstances under which multiplexing is used for three and four digit displays at a cost saving. This application note attempts to show some of the many ways of multiplexing digits, and it is left to the designer to decide whether his own system application would be lower in cost if he used a multiplex scheme.

The properties of light emitting diodes (LED) make them particularly suitable for multiplexed operation, and hence it is the preferred method to use, if a scheme can be designed which is cost competitive with non-multiplexed operation.

Throughout this paper, it will be generally assumed that we are talking of a system using TTL type logic families, with MSI functions being used where applicable. In most production situations this will be the most economical approach. There will be some cases where discrete gates and flip-flops may yield a lower cost. There are also cases where a single MOS chip contains all the necessary logic functions, and only interface driver circuits are required.

The seven segment numeric displays with a common anode connection made by Litronix provide compatibility with the most widely available decoder-drivers, which are active level low outputs. The commonest devices are SN7447, 8T04, 9317 and similar. Any of these is suitable for driving the DL-76XX Series type display. For common cathode displays such as the Litronix DL-340M SN7448, 8T06 and 9307 decoders can be used, and anode drivers become cathode drivers.

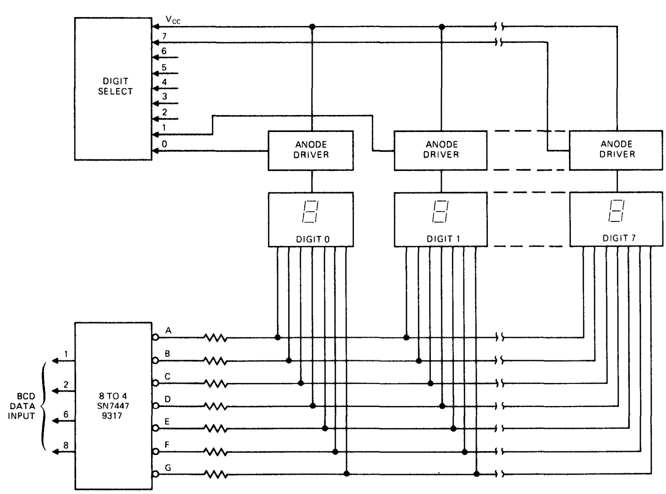


Figure 1

In a multiplex system, the corresponding cathodes of each digit are bussed together, and driven from one seven segment decoder-driver, via the usual current limiting resistors. The display data is presented serially by digit, to the decoder-driver, together with an enable signal to the appropriate digit anode Figure 1.

Each digit anode is driven by a switch, capable of passing the full current of all segments. The simplest switch would be a PNP high current switch or amplifier transistor, such as a core driver type.

In operation, the anode switches are activated one at a time, in the desired sequence, while the appropriate digital data is presented at the input to the decoder-driver. The amount of circuitry required in Figure 1 is much less than that used in the non-multiplexed scheme. The question of overall economy is dependent on the amount of circuitry required to sequence the anodes and present the data at the decoder input. Let us consider some typical situations.

CASE 1:

An 8-digit counter-timer display, with the data stored in multiple latch circuits. This is the most common situation present in a counter-timer of conventional design. A quad latch (SN7475) is used to store each digit, and this data is periodically updated. To scan this data, a 4 pole 8 position switch is required (SN74151). To select the appropriate digit, an octal counter (SN7493) and a 1 of 8 decoder (SN7442) are required. The complete circuit is as in Figure 2.

The total package count is about the same for this arrangement, as for non-multiplexed operation, but most of the packages are lower cost than the seven segment decoder. The scheme shown is a 20% cost reduction over non-multiplexed operation, based on O.E.M. prices for the components. For less than eight digits, it would be difficult to compete with non-multiplexed operation using this scheme.

CASE 2:

Multiplexing becomes more attractive, when the data is stored in a shift register, rather than in latches. In this case the data is circulated around the register, at some suitable rate, and is sequentially presented at the input of the seven-segment decoder-driver. The anode drive can be obtained from a counter and decoder as in Figure 2, or from a parallel output shift register – Figure 3.

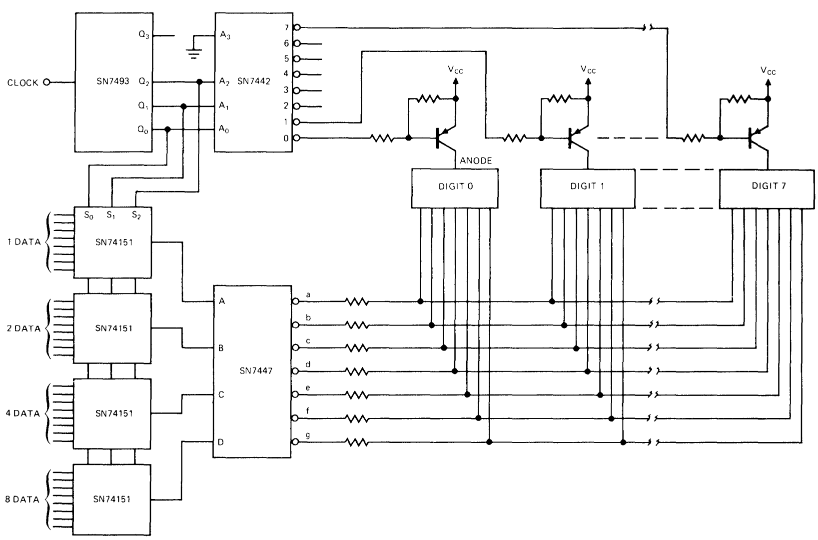


Figure 2

This circuit, which can be expanded to any number of digits, circulates a single zero, and thus can directly drive the PNP anode switches. Systems using recirculating memories generally require this digit timing circuitry for other reasons, so it is generally available in the system already.

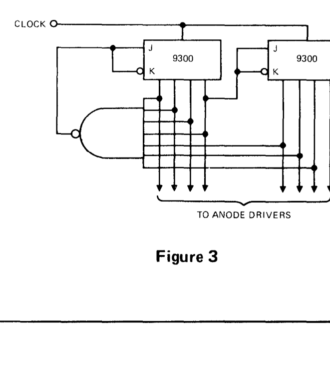


Figure 3

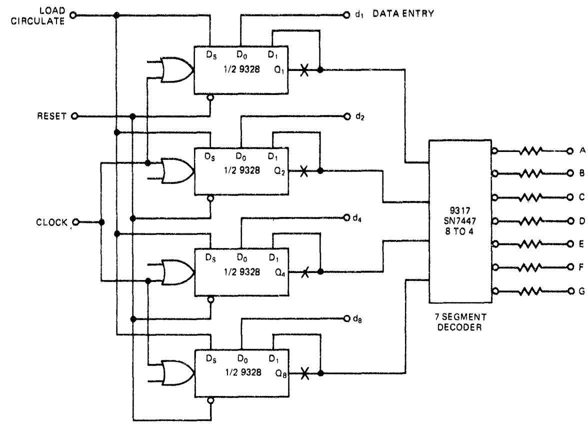


Figure 4

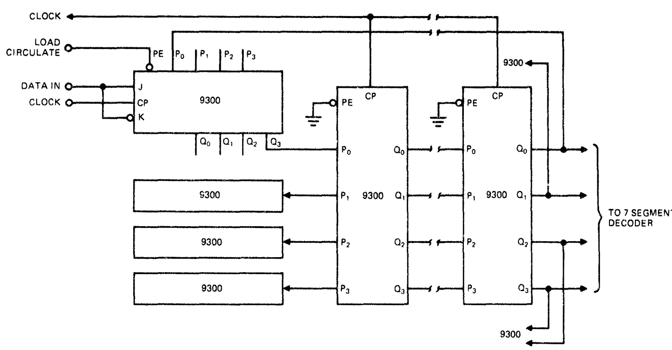


Figure 5

For displays of 8 digits; a very common number in counter-timer instruments, the 9328 dual 8 bit shift register makes a very good circulating shift register. Two packages are required to store and circulate 8 digits – Figure 4.

The scheme can be extended to more digits by adding a 4 bit parallel shift register such as the 9300, for each extra digit; the extra shift bits are inserted at the points marked X in Figure 4. The same circuit can be used for less than 8 digits, if a 12-1/2% duty cycle is satisfactory. For less than 8 digits, where maximum available duty cycle must be maintained, the scheme shown in Figure 5 can be used.

The preceding schemes demonstrate that systems containing recirculating data are very effectively coupled to multiplexed LED displays. Many multi-digit systems such as calculating machines use L.S.I. MOS circuits to provide their logic, and these naturally lend themselves to recirculating data. It is now practical to use custom L.S.I. to provide the logic functions of a D.V.M. or a counter-timer type of instrument, employing multiplexed LED displays, at a significant cost savings over conventional instrument designs.

Apart from the strictly logical problems involved in a multiplexed display, the designer must choose suitable operating conditions for the LED's. Peak forward current, current pulse width, duty cycle and repetition rate, are all factors which the designer must determine.

The luminous intensity, or the luminance of GaAsP LED's, is essentially proportional to forward current over a wide range, but certain phenomena modify this condition. At low currents, the presence of non-radiative recombination processes, results in less light output than the linear relationship would predict. This effect is noticeable in the region below about 5 mA per segment (for 1/4 inch characters). The result is that noticeable difference in luminance from segment to segment can occur at low currents. At high currents, the power dissipation in the chip causes substantial temperature rise, and this reduces the efficiency of the chip. As a result the light output versus forward current curve falls below the straight

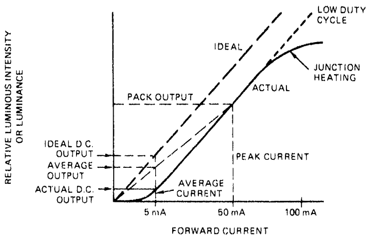


Figure 6

line, at high currents (Figure 6). It should be emphasized that this latter effect is entirely due to self heating. If the power dissipation is limited, by running short pulses at low duty cycle, the output follows the straight line up to very high current densities. Whereas 100 A/cm^2 may be used in DC operation, as much as 10^4 A/cm^2 can be used under pulsed conditions, with a proportionate increase in peak intensity. (If this did not occur, GaAsP lasers could not be built.) Gallium Phosphide, however, has an inherent saturation mechanism that causes a drastic reduction in efficiency at high current densities even if the junction temperature remains constant. This effect is due to competing non-radiative recombination mechanisms at high current density.

As a first approximation the brightness of a pulsed LED will be similar to that when operated at a DC forward current equal to the average pulsed current. For example, for 40 mA peak current at 25% duty cycle, the brightness will be similar to DC operation at 10 mA. The actual brightness comparison will depend on the actual pulsing conditions. Under most legitimate conditions the brightness will be greater for pulsed operation.

Figure 6 shows how the actual light output at 5 mA DC is substantially less than expected from the ideal curve, because of the "foot" on the curve at low currents. Operation at 50 mA peak current and 10% duty cycle yields a high peak output as shown, and an integrated average output that is much closer to the ideal value. It should be obvious that variations in the "foot" from segment to segment cause a significant variation in light output at a low DC current, but a much smaller variation in the average output when operated in a pulsed mode. As well as an increase in luminance, or luminous intensity due to pulsing, there is an increase in brightness because of the behavior of the eye. The eye does not behave as an integrating photometer, but as a partially integrating and partially peak reading photometer. As a result, the eye perceives a brightness that is somewhere between the peak and the average brightness.

The net result is that a low duty cycle high intensity pulse of light looks brighter than a DC signal equal to the average of the pulsed signal. The practical benefit of multiplexed operation then, is an improvement in display visibility for a given average power consumption besides the lower cost. The brightness variation from segment to segment and digit to digit is also reduced by time-sharing. The gain in brightness over DC operation can be as much as a factor of 5 at low duty cycles of 1 or 2 percent, and peak currents of 50 to 100 mA.

A number of factors must be taken into account when deciding on the design of a multiplexed display. Besides the optical output, thermal considerations are very important.

Most 1/4" size LED numerics are rated at 30 mA DC max per segment. Under pulsed operation, higher currents can be used provided several thermal considerations are taken into account.

(1) The average power dissipation must not exceed the maximum rated power.

(2) The power pulse width must be short enough to prevent the junction from overheating during the pulse. This implies that the pulse width must get shorter as the amplitude increases.

Present experience indicates that for pulses of 10 μs, the amplitude should be limited to 100 mA max. Shorter pulses of higher amplitude may be used but the circuit problems become severe if the pulse width is very short. As more information on thermal parameters of the devices becomes available, more specific design rules can be given to assist the designer.

SIEMENS

Appnote 4

DRIVING HIGH-LEVEL LOADS WITH OPTO-ISOLATORS

by David M. Barton

Frequently a load to be driven by an Iso-Lit requires more current, voltage, or both, than an Iso-Lit can provide at its output.

Available opto-isolator output current, of course, is found by multiplying input (LED section) current by the "CTR" or current - transfer-ratio. For worst-case design, the minimum specified value would be used. The minimum CTR of the IL-IB is 20%. Temperature derating is not usually necessary over the 0 to +60 degree Celcius range because the LED light output and transistor beta have approximately compensating coefficients.

Multiplying the minimum CTR by 0.9 would ensure a safe design over this temperature range. Over a wide range, more margin would be required.

The LED source current is limited by its rated power dissipation. Table I shows maximum allowable I_F vs maximum ambient temperature.

Values for Table I are based on a 1.33 mW/°C derate from the 100 mW at 25°C power rating.

Table I

MAXIMUM TEMPERATURE	I_F MAXIMUM
40°C	65 mA
60°C	48 mA
80°C	25 mA

Obviously, one can increase the available output current then by either choosing a higher CTR-rated Iso-Lit, by providing more current, or both. Table II shows the minimum available output current of each device assuming 60°C derating (from Table I) and a 10 percent margin for temperature effects.

Table II

P/N	I_{CE}(MIN) mA
IL-IB	8.6

If the IL-IB is being operated from logic with 5 volt driving transistor and 0.2 volt V_{CE} saturation is assumed for the driving transistor, a 75 ohm R_{IF} resistor will provide the 48 mA. The forward voltage of the IR-emitting LED is about 1.2 volts. Figures 1A and 1B show two such drive circuits.

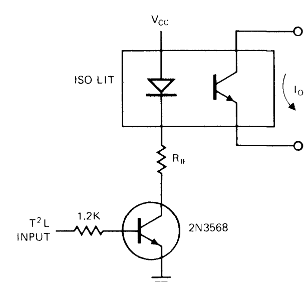


Figure 1A. NPN Driver

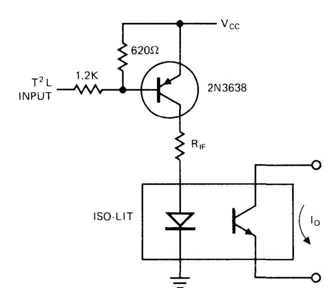


Figure 1B. PNP Driver

A "buffer-gate," such as the SN7440 or Signetics 8855, provides a very good alternative to discrete transistor drivers. Figure 2 shows how this is done. Note that the gate is used in the "current-sinking" rather than the "current-sourcing" mode. In other words, conventional current flows *into* the buffer-gate to turn on the LED. This makes use of the fact that a T^2L gate will sink more current than it will source. The SN7440 is specified to drive thirty 1.6 mA loads or 48 mA. Changing R_{IF} from 75 to 68 ohms adjusts for the higher saturation voltage of the monolithic device.

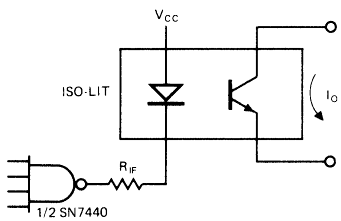


Figure 2. Buffer-Gate Drive

MORE CURRENT

For load currents greater than 8.6 mA, a current amplifier is required. Figures 3A and 3B show two simple one-transistor current amplifier circuits.

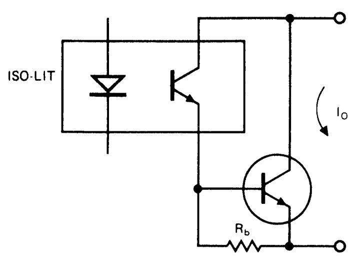


Figure 3A. NPN Current Booster

Since the transistor in the opto-siolator is treated as a two-terminal device, no operational difference exists between the NPN and the PNP circuits. R_b provides a return path for I_{CBO} of the output transistor. Its value is: R_b = 400 mV/I_{CBO} (T) where I_{CBO}(T) is found for the highest *junction* temperature expected.

Assume that leakage currents double every ten degrees. Use the maximum dissipated power, the specified maximum junction-to-ambient thermal resistance,

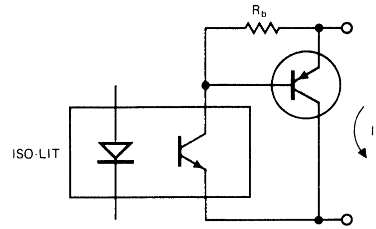


Figure 3B. PNP Current Booster

and the maximum design ambient temperature in conjunction with the specified maximum 25 degree I_{CBO} to calculate I_{CBO}(T).

As an example, suppose a 2N3568 is used to provide a 100 mA load current. Also assume a maximum steady-state transistor power dissipation of 100 mW and a 60°C maximum ambient. The transistor junction-to-ambient thermal resistance is 333°C/watt, so a maximum junction temperature of 60 + 33 or 93°C is expected. This is about 7 decades above 25°C. Therefore, I_{CBO}(T) = I_{CBO}(max) x 27 = 50 nA x 128 = 6.5 μA. A safe value for R_b is 400 mV/6.5 μA = 62 kilohms.

Working backwards, maximum base current under load will be I_O/h_{FE}(min) = 100mA/100 = 1 mA. Current in R_b is V_{BE}/R_b = 600 mV/60k = 10 μA, which is negligible. An IL-1B with 9 mA drive would operate effectively.

If the load requires more current than can be obtained with the highest beta transistor available, then more than one transistor must be used in cascade. For example, suppose 3 amperes load current and 10 watt dissipation are needed. A Motorola MJE3055 might be used for the output transistor, driven by a MJE205 as shown in Figure 4. Using a 5°/watt heat sink and the rated MJE3055 junction-to-case thermal resistance of 1.4°/watt, we find that junction temperature rise is 6.4 x 10, or 64°. Therefore maximum junction temperature is 124°C. This is 10 decades above 25°C making $I_{CBO}(T) = 2^{10} I_{CBO}(max) = 10^3 I_{CBO}(max)$.

I_{CBO}(max) at 30 volts or less is not given, but I_{CEO} is. Using (for safety) a value of 20 for the minimum low-current h_{FE} of the device, I_{CBO} could be as large as

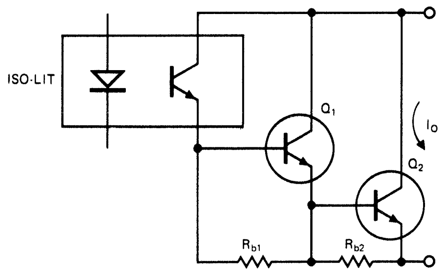


Figure 4. Two-NPN Current Booster

$I_{CEO}/20 = 35\ \mu A$. Then $I_{CBO}(T)$ is 35 mA and R_{b2} = 400 mV/35 mA = 11 ohms. For I_b use I_o/h_{FE}(min @ 4A) = 3A/20 = 150 mA. I_{Rb2} = 600 mV/10 ohms = 60 mA, so $I_{e(Q1)}$ = 210 mA.

Maximum Power in Q_1 will be about 1/14 the power in Q_2 since its current is lower by that ratio and the two collector-to-emitter voltages are nearly the same. This means Q_1 must dissipate 700 mW.

Assuming a small "flag" heat sink having 50°/watt thermal resistance, we find the junction at about 95°C. The 150°C case temperature I_{CBO} rating for this device is 2 mA, so one can work backwards and assume about 1/30 of this value, or 70 μA. On the other hand, the 25° rated I_{CBO} is 100 μA. Choosing the larger of these contradictory specifications, R_{b1} = 400 mV/0.1 mA = 4k ≈ 3.9k. Q_1 base current is $I_{E(Q1)}/h_{FE(Q1\text{-}min)}$ = 210 mA/50* = 4.2 mA. Total current is $I_{b(Q1)} + I_{Rb1}$ = 4.2 + 0.24 = 4.5 mA. Table II shows that an Iso-Lit 1 could be used here.

MORE LOAD VOLTAGES

All of the current-gain circuits shown so far have one common feature: load voltage is limited by the 30 volt rating of the IL-1B not by the voltage or power rating of the transistor(s). Figure 5A shows a method of overcoming this limitation. This circuit will stand off BV_{CEO} of Q_1. The voltage rating of the phototransistor is irrelevant since its maximum collector-emitter voltage is the base-emitter voltage of Q_1 (about 0.7 volts).

Unlike the "Darlington" configurations shown previously, this circuit operates "normally-ON." When no current flows in the LED the phototransistor, being OFF, allows R_2 current to flow into the base of Q_1, turning Q_1 ON. When the Iso-Lit is energized, its phototransistor "shorts out" the R_2 current turning Q_1 OFF.

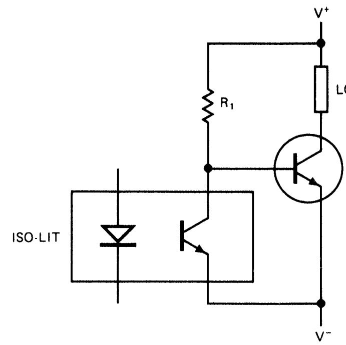


Figure 5A. NPN HV Booster

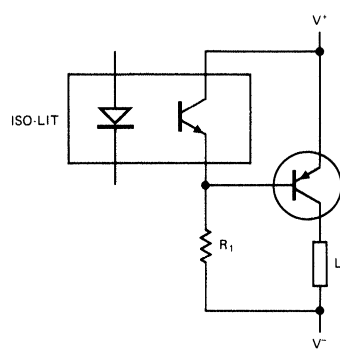


Figure 5B. PNP HV Booster

The value of R_1 depends only on the load-supply voltage $V^+ - V^-$, and the *maximum* required Q_1 base current. This is derived from the minimum beta of Q_1 at minimum temperature and the load current. The required current-drive capability is the same as I_{R1}, since I_{R1} changes negligibly when the circuit goes between its "ON" and "OFF" states.

In some applications either more current gain will be required than one transistor can provide or the power dissipated in R_1 will be objectionable. In these cases, simply use the Darlington high-voltage booster shown in Figure 6A.

*Minimum h_{FE} is obtained using the specification at I_{CE} = 2A and the "Normalized DC Current Gain" graph given in the Motorola "Semiconductor Data Book," 5th Edition, pp. 7 – 232, 3.

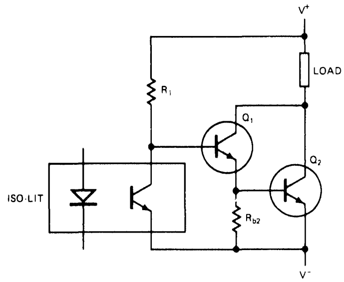


Figure 6A. NPN Darlington HV Booster

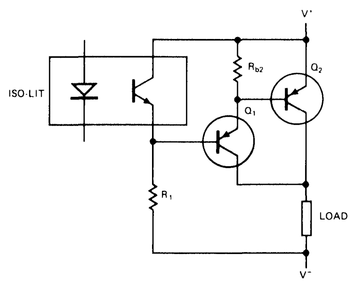


Figure 6B. PNP Darlington HV Booster

If more than one load is being driven and their negative terminals must be in common, use the PNP circuit, Figure 6B. Otherwise, the NPN is better because the transistors cost less. Of course performance characteristics of the NPN and PNP versions are identical if the device parameters are also the same.

APPLICATIONS

Opto-isolator isolated circuits are useful wherever ground loop problems exist in systems, or where dc voltage level translations are needed. In many systems so-called interpose relays are used between a logic circuit section (which may be a mini-computer) and the devices being controlled. Sometimes *two levels* of interpose relays are used in cascade either because of the load power level or because of extreme difficulties with EMI. Opto-isolators aided by booster circuits such as those described, can replace many of the relays in these systems.

The reed relays, typically used as the first level of interpose and mounted on the interface logic cards in the electronic part of the system, are almost always replaceable by opto-isolator since their load is just the coil of a larger relay. This relay may have a coil power of 1/2 to 5 watts and operate on 12, 24 or 48 volts dc.

Assuming worst-case design techniques are carefully followed, system reliability should improve in proportion to the number of relays replaced.

SIEMENS Appnote 5

MORE SPEED FROM OPTICAL ISOLATORS

by David M. Barton

Figure 1 shows a typical circuit employing an opto-isolator to transmit logic signals between electrically isolated parts of a system. In the circuit shown, the opto-isolator must "sink" the current from one T^2L load plus a pull-up resistor to V_{CC}. The resistor in series with the LED half of the opto-isolator must supply the worst-case load current divided by the "current transfer ratio" or CTR of the opto-isolator. If an IL-IB is used, having a min CTR of 0.2, and 30 percent variation in the load is allowed. 8.1 mA is required. This is supplied by the 430Ω resistor.

The maximum repetition rate at which this circuit will operate is only about 3 kHz. The severe speed limitation is due entirely to the characteristics of the photo-transistor half of the Iso-Lit. This device has a large base-collector junction area and a very thick base region in order to make it sensitive to light. C_{ob} is typically 25 pF. This capacitance is, in the circuit of Figure 1, effectively multiplied by a large factor due to the "Miller effect." Also, because the base region volume is large, so is base storage time.

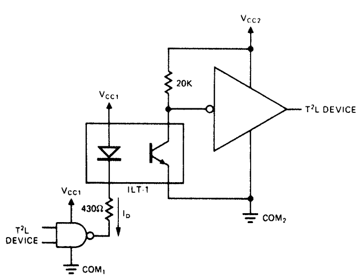


Figure 1

A very simple method of reducing both of these effects is to add a resistor between the base and emitter as shown in Figure 2. This resistor helps by reducing the time constant due to C_{ob} and by removing stored charge from the base region faster than recombination can. When a base-emitter resistor is used, of course, the required LED drive is increased since much of the photo-current generated in the base-collector junction is now deliberately "dumped."

Using this method does not usually result in a large power supply current drain since *average* repetition rate is low in most applications.

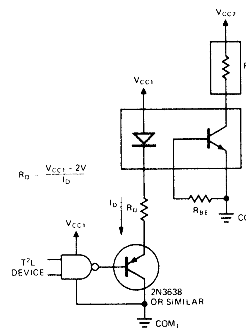


Figure 2

As drive is increased and R_{BE} reduced, turn-on time and turn-off time both decrease. The total amount of charge stored can also be reduced by decreasing the LED drive pulse duration. Also, as higher drive levels are used, the load resistance, R_L can be reduced to further enhance the speed of the circuit. These parameters are related to each other such that all should be changed together for best results.

One important generalization can be made concerning their interdependence. The LED drive pulse duration, T_{in}, output fall time, t_f, output rise time, t_r and propagation delay, t_p, should occur in a 1.5:1:1:1 ratio, approximately. If this relationship does not occur, the circuit will not operate at as high a repetition rate as it could at the same drive level. T_{out} equals T_{in} at low currents but stretches out at high currents.

Figure 3 is a graph relating the important parameters for a typical IL-IB whose CTR is 0.25. The optimum values of T_{in}, R_{BE}, and R_L are shown versus LED pulse current as are the resultant output pulse width and maximum full-swing frequency. Rise, fall and propagation time can be read as 2/3 of T_{in}.

Figure 3 shows that increasing drive to 200 mA and using optimum R_{BE} and R_L will increase the maximum repetition rate from 3 kHz to 500 kHz, a 167:1 improvement.

Lower grade isolators will behave similarly if the LED drive level is scaled appropriately to allow for a lower CTR.

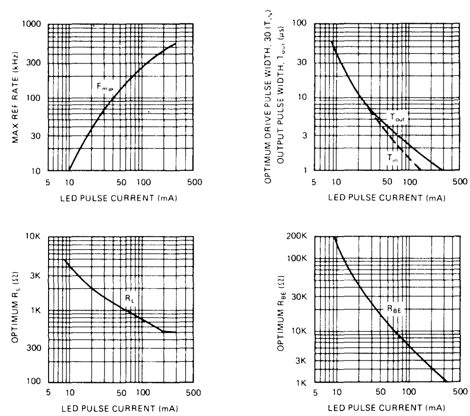


Figure 3. Parameters vs LED Pulse Current

Another method of increasing speed is to operate the photo-transistor as a photo-diode. In this method, bias voltage is supplied between the collector and base terminal, the emitter being unused. Operation to at least 10 MHz is possible this way, but the price is the need for external amplification. Figure 4 is a graph

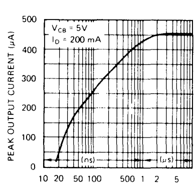


Figure 4. Diode Mode Output Current vs Drive Pulse Duration

showing peak output current versus drive pulse duration for 200 mA peak drive current.

Since output current is small, some type of wide-bandwidth amplifier must be employed in order to drive T^2L loads.

One simple solution for intermediate speed operation is the use of a low-power T^2L inverter (1/6 74L04). The collector of the photo-transistor is connected to its input along with a 100K pullup resistor. The base is connected to system output-side common. This inverter will in turn drive one 7400 series device.

Another device which will provide a good interface is an integrated comparator amplifier. The photo-transistor collector goes to V_{CC}. Its base has a 200Ω load resistor to ground and goes to one input of the comparator. Also, a resistor goes from this node to the minus supply. This resistor is chosen to supply 50 μA. The other comparator input is grounded. The voltage at the comparator input will switch from −10 mV to +10 mV or more when the diode turns on and the output will drive the T^2L loads.

Of course discrete-component amplifiers could be used and may be best in some applications.

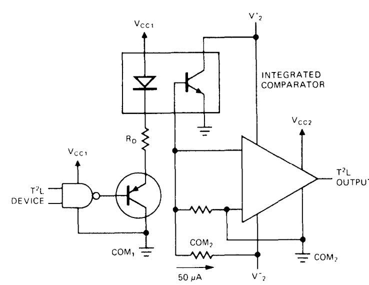


Figure 5

CONCLUSIONS

For operation to 500 kHz, the addition of a base-emitter resistor and a high-current driver is probably the best method of increasing opto-isolator speed. Above 500 kHz one must revert to photodiode mode and use an external amplifier to drive most loads, particularly T^2L.

SIEMENS Appnote 6

OPERATING LED'S ON AC POWER

by David M. Barton

Introduction

Frequently it is desirable to operate LEDs on AC power rather than DC. Typically, the power source is 120 VRMS 60 Hz. The most obvious method is to rectify this power with a series diode and use a resistor to limit LED current as shown in Figure 1.

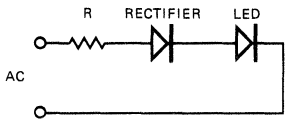


FIGURE 1. The Power Resistor Method

This method, though sound, results in very high power dissipation in the resistor since the LED operates on only 1.6 volts.

The Method

Figure 2 shows a better method. Here a capacitor is used to control LED current and a shunt silicon diode provides rectification.

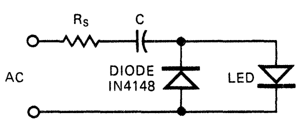


FIGURE 2.

Since, for current in either direction, voltage drop across the LED or rectifier is a negligible part of the supply voltage, current in the capacitor is almost exactly equal to the AC supply voltage divided by the reactance of the capacitor. Average capacitor current is then

1. I_C (AV) = .9 X VRMS/X_C

   and average half-cycle LED or rectifier current is

2. $I_{LED\ (AV)}$ = 1/2 I_D (AV) = .45 VRMS/X_C

   or, for 120 VRMS, 60 Hz operation,

3. $I_{LED\ (AV)}$ = 20 mA X CμF

   or $C\mu F = \dfrac{I_{LED\ (AV)}}{20\ mA}$

Figure 3 shows the value of the series capacitor needed for a range of average LED currents assuming 60 Hz, 120 volt power.

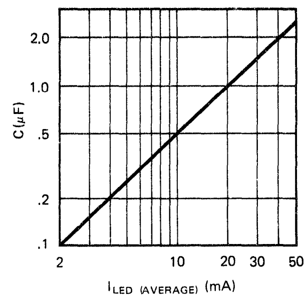


FIGURE 3. Series Capacitor Value vs Average LED Current for 120 VRMS 60 Hz.

A resistor is necessary in series with the capacitor to limit turn-on transient currents. A value of 100 ohms will be adequate in most cases.

The current in the LED, of course, flows almost exactly in quadrature with the line voltage. For this reason, power dissipation is low, being limited to the expected LED and rectifier power loss, the loss in series resistor and to losses in the capacitor. The latter term will be extremely low if high quality capacitors are used. Although power consumption of a circuit may not be of much significance in terms of the cost of the power, it certainly can be important to reduce heat generation within an enclosure.

If more than one LED is to be operated from the same source, simply put the LEDs in series in the same circuit, as shown in Figure 4. For small numbers of LEDs the current will be, for practical purposes, the same as for one.

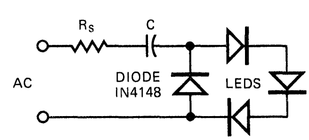


FIGURE 4.

Conclusion

Cost of the series capacitor (mylar) will be similar to the cost of a series power resistor. The shunt diode, a IN4148 or similar, will cost about two cents; much less than a series rectifier which must have a several hundred volt PIV rating.

So, the capacitor method is both lower in cost and lower in heat generation and power consumption than the resistor method.

APPLYING THE DL-1416 Intelligent Display®

by Dave Takagishi

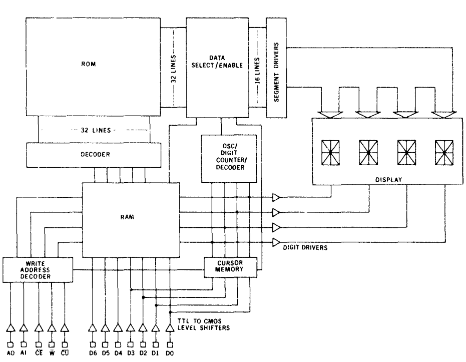
This application note is intended to serve as design and application guide for users of the DL-1416 Alphanumeric Display. The information presented covers: device electrical description and operation, considerations for general circuit designs, multi-digit display systems and interfacing to the 6800, Z80, and 8080 microprocessors.

The DL-1416 was designed to provide an easy-to-use alphanumeric display for the 64 character ASCII systems. Only twelve interconnect pins plus power and ground are needed to drive a single four digit display. The overall package is designed to allow end stacking of the DL-1416 to form any desired character length display.

ELECTRICAL DESCRIPTION

The on-board electronics of the DL-1416 eliminates all the traditional difficulties of using displays—segment decoding, driving, and multiplexing. The DL-1416 has gone further and provided internal memory for the four digits. This approach allows the user to address one of four digits, load the desired data asynchronously to the multiplex rate and continue.

Figure 1 is a block diagram of the circuitry in the DL-1416. The unit consists of a display and a single integrated circuit chip. The display is four 16-segment alphanumeric monolithic LED die magnified to a height of 160 mils. The IC chip contains the 16 segment drivers, 4 digit drivers, 64-character ROM, four-word 7-bit RAM, internal oscillator for multiplexing, multiplex counter/decoder, cursor RAM, write address decoder, and level shifters for the inputs.



INTERNAL SCHEMATIC
FIGURE 1

The inputs to the DL-1416 are:

$\overline{CE}$ CHIP ENABLE (active low)
This determines which device in an array will actually execute the loading of data. When the chip enable is in the high state, all inputs are inhibited.

A_0, A_1 DIGIT ADDRESS
The address to the DL-1416 determines the digit in which the data will be written. Address order is right-to-left for positive-true address.

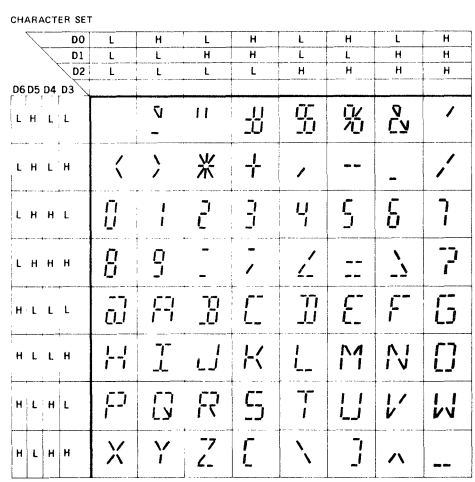
$D_0 - D_6$ DATA LINES
The seven data input lines are designed to accept the 64 ASCII code set. See Table 1 for character set.

$\overline{W}$ WRITE (active low)
Data to be written into the DL-1416 must be present before the leading edge of write. The data and address must be stable until after the trailing edge.

$\overline{CU}$ CURSOR (active low)
When the $\overline{CU}$ is held low, the DL-1416 enables the user to write or remove a cursor in any digit position. The cursor function lights all 16 segments in the selected digits without erasing the data. After the cursor is removed, the digit will again display the previously written character.

V+ POSITIVE SUPPLY
TTL compatible + 5 volts

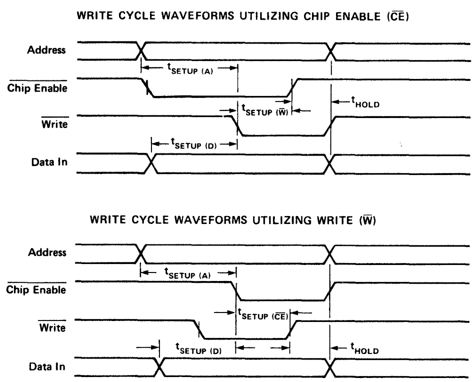
V− NEGATIVE SUPPLY
Ground



Note: All undefined codes will display a blank.
TABLE 1

OPERATION

Loading data into the DL-1416 is similar to writing into a RAM. The data and address must be present before the leading edge of the write signal ($\overline{W}$) and must be present until after the trailing edge. The waveforms of Figure 2 demonstrate the relationship of the signals required to generate a write cycle utilizing chip enable ($\overline{CE}$) and write ($\overline{W}$) (Check data sheet for minimum values).
As can be seen from the waveforms, $\overline{CE}$ and $\overline{W}$ are interchangeable. The true internal "write" function is formed by the "and-of-the-nots".



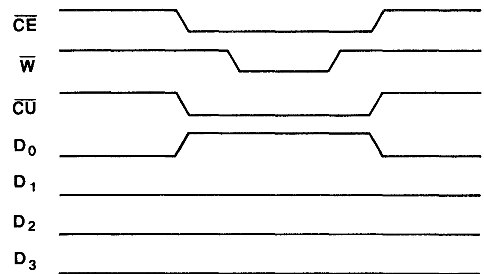
ADDRESS TABLE
FIGURE 2

Multiplexed display systems sequentially read and display data from a memory device. In *synchronous* systems, control circuitry must compare the location of data to be read and displayed to the location of new data to be stored, i.e. synchronize, before a write can be done. This can be slow if there are many memory locations. It can also be cumbersome.

Data entry of the DL-1416 is *asynchronous* and data may be stored in random order. Each digit will continue to display the character last "written" until replaced by another.

The cursor function causes all 16 segments of a digit to light. The cursor can indicate the position in the display of the next character to be entered. The cursor *is not* a character but overrides display of the stored character. Upon removal of the cursor, the display will again show the character stored in memory.

The cursor can be written into any digit position by enabling chip enable ($\overline{CE}$), cursor ($\overline{CU}$), the positional data, and a write ($\overline{W}$) signal. The position of the cursor will be dependent on which of the first four data lines (D_0, D_1, D_2, D_3) are held high. A high on data line D_0 will place a cursor display in the right-most digit and respectively a high on data line D_3 will place a cursor display in the left-most digit. The cursor can be loaded into, or erased from more than one position simultaneously by simply holding more than one data line high during the cursor write cycle.



CURSOR WRITE CYCLE
FIGURE 3

The cursor will remain displayed after the cursor ($\overline{CU}$) and write ($\overline{W}$) signals have been removed. The wave forms in Figure 3 show a cursor being placed in Digit 0 and erased from Digit 1, Digit 2, and Digit 3 simultaneously.

Hardwiring the cursor (CU) line high is not recommended. This internal cursor memory will be randomly loaded on power-up and all positions must be cleared before a cursor-free display is ensured.

GENERAL CIRCUIT DESIGN CONSIDERATIONS

Using positive-true address logic, address order is from right to left. For left to right address order, use the "ones-complement" or simple inversion of the addresses.

For systems with only a 6 bit ASCII code format, data line D_6 cannot be left open. Data D_6 must be the complement of data line D_5. If an illegal code is loaded into the DL-1416, it will display a blank in the digit accessed.

A "display test" function can be realized by simply storing a cursor in all digits simultaneously. This is done by holding D_0, D_1, D_2 and D_3 high and $\overline{CU}$ low during a cursor write cycle. The same operation, with the data lines low will end "display test".

Because of the random state of the cursor RAM after power up, it is necessary to clear it initially to assure that all the cursors are off.

When using DL-1416's on a separate display board having more than 6 inches of cable length, it may be necessary to buffer all DL-1416 inputs. This is most easily achieved with hex-non-inverting buffers such as 74365 IC's. The object is to prevent transient current in the DL-1416 protection diodes. The buffers should be located on the display board near the DL-1416's. Local power supply bypass capacitors are also needed in many cases. These should be 6 or 10 volt tantalum type having 10μF or greater capacitance. Low internal resistance is important to eliminate voltage transients due to the current steps which result from the internal multiplexing of the DL-1416.

If small wire cables are used, it is good engineering practice to calculate the wire resistance of the ground plus the +5 volt wires. More than 0.1 volt drop (at 25mA per digit worst case) should be avoided, since this loss is in addition to any inaccuracies or load regulation limitations of the power supply. limitations of the power supply.

GENERAL INTERFACE

The most general and straight-forward interface approach would be to use the parallel I/O device of a microprocessor. This interface scheme can be completely software dependent. One eight bit output port can handle the seven input data bits and the cursor. Another eight bit output port can contain the address and chip enable information with one bit reserved for the write signal.

An 8080 system shown in Figure 4 illustrates a 16 character display using a 8255 programmable peripheral interface I/O device with a 7442 one-of-ten decoder added for ease of programming. The following program will display a simple 16 character message using the parallel I/O interface.

```
INIT:     MVI A, 80H;       control data mode 0
          OUT CONTROL;      load control register
CUSR:     MVI A, 00H;       clear cursor data
          OUT PORTA;        load data port
          MVI B, OFH;       set counter
CUSR1:    MOV A, B
          CALL DSPWT;       write subroutine
          DCR B;            decrement counter
          JNZ CUSR1;        16 characters
DISP:     LXI H, TABLE;     set table
DISP1:    MOV A, M
          OUT PORTA;        load data output
          MOV A, B
          CALL DSPWT;       load address & write
          INX H;            increment table address
          INR B;            increment counter
          MVI A, 10H;       set # of digits
          CMP B
          JNZ DISP1;        16 characters
          HLT;              end of program
DSPWT:    ORI 80H;          set write bit off
          OUT PORTB;        load address
          ANI 7FH;          set write bit on
          OUT PORTB;        load write
          ORI 80H;          set write bit off
          OUT PORTB;        load write
          RET
TABLE:    DB                OC3H
          DB                OC9H
          DB                OD4H
          DB                OD3H
          DB                OC1H
          DB                OD4H
          DB                OCEH
          DB                OC1H
          DB                OC6H
          DB                OA0H
          DB                OD3H
          DB                OD4H
          DB                OC8H
          DB                OC7H
          DB                OC9H
          DB                OCCH
```

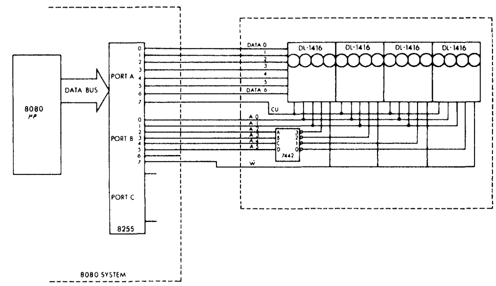


FIGURE 4

I/O OR MEMORY MAPPED ADDRESSING

Some designers may wish to avoid the additional cost of a parallel I/O device in their system. Structuring the addressing architecture for the DL-1416 to look like a set of output devices (I/O mapped) or RAM's, ROM's (memory mapped) is ideal. However, the set-up and hold times of the DL-1416 are too slow for some present μP's running at maximum speed.

To operate at maximum clock rates, the processor must be made to pause for the required display write cycle interval.

DL 1416/8080 INTERFACE

Microprocessors like the 8080 and Z80 have the ability to generate "wait states" for use with relatively slow memories. Figure 5 shows a circuit which utilizes "wait states" to interface the DL-1416 display to an 8080 system with a T cycle = 500 nS.

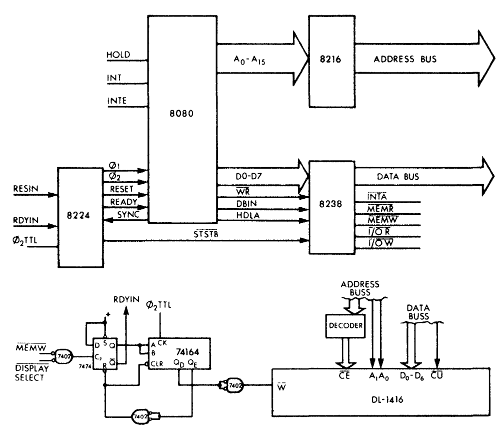


FIGURE 5

The signal $\overline{\text{MEMW}}$ • $\overline{\text{DISPLAY SELECT}}$ defines a DL-1416 display write cycle and initiates the RDYIN signal. $\overline{\text{MEMW}}$ alone would generate wait states for all write cycles and would slow down total computation. The shift register, 74164, is useful for generating a DL-1416 write signal which meets the setup times for different processor clock rates. The timing diagram, Figure 6, illustrates the relationship between write, wait, and DL-1416 write.

*Note: System controller 8238 required for an early MEMW signal.

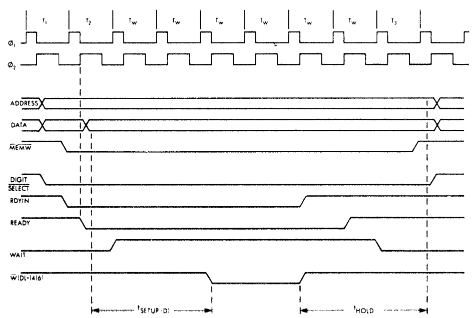


FIGURE 6

DL-1416/Z80 INTERFACE

The organization of the Z80 is very similar to the 8080 processor. Both processors utilize wait states for slow memory and, as can be seen in Figure 7, the interface can be identical to the 8080 System. For T cycle = 500 nS, only signal names are different.

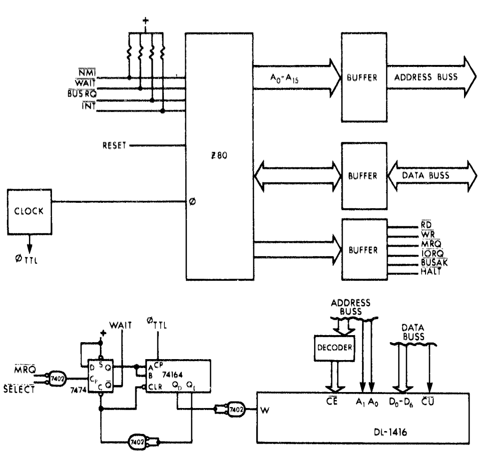


FIGURE 7

DL-1416/6800 Interface

For processors such as the 6800 that do not have wait state capability, clock pulse stretching techniques can be used. Microprocessor clocks such as the Motorola MC6871B have the ability to hold either Ø1 or Ø2. Figure 8 uses the same interface techniques as for the 8080 and Z80. The signal $\overline{\text{H2}}$ extends the Ø2 clock. All address and data lines will remain valid until $\overline{\text{H2}}$ is released. $\overline{\text{H2}}$ was taken from the output of the first stage of the shift register in this case to synchronize with Ø2; otherwise a narrow Ø1 may result.

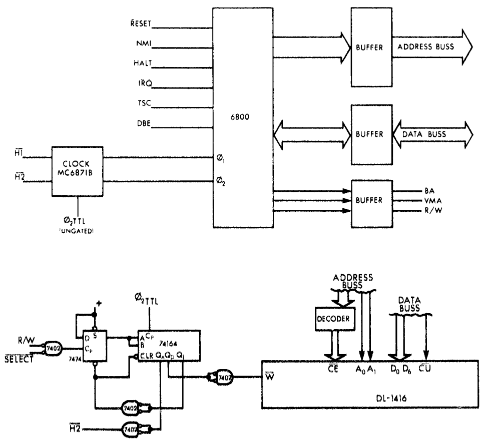


FIGURE 8

CONCLUSION

The interface schemes shown demonstrate the general simplicity of DL-1416 use with microprocessors. The differences among the examples are in providing proper write signals. Because of the setup and hold times of the DL-1416, many microprocessor systems will require some type of interface circuitry for compatibility. The techniques used in these examples were chosen for their versatility in accepting a wide range of clock rates. The user will undoubtedly invent other schemes to optimize his particular system to its requirements.

This application note is not intended to imply specific endorsement or warranty of other manufacturer's products by Litronix.

SIEMENS

Appnote 11

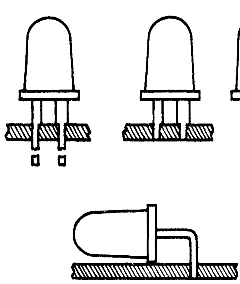
MOUNTING CONSIDERATIONS FOR LED LAMPS AND DISPLAYS

by Dave Takagishi

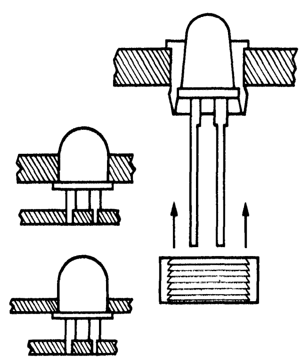
There are numerous ways to mount an LED lamp into a panel or a piece of equipment and this application note is written as an aid to designers and engineers when using LED lamps and displays.

MOUNTING TECHNIQUES:

There are several ways to mount LED lamps such as the Litronix RL2000 by soldering directly into PCB's, plugging into sockets, or panel mounting with or without clips. Bending of the leads is allowed bearing the following guidelines in mind. Leads must not be bent closer than 0.65 inches from the base of case when leads are not in excess of .020 inch in diameter. Leads should be clamped next to the case during bending of leads to relieve stresses. Under no circumstances must any mechanical force be applied to case while bending the leads. Also, incorrectly spaced holes in the printed circuit board will place mechanical stress on the plastic case which can cause failure during soldering.



Displays of the DL747 or DL707 type can be soldered directly into a printed circuit board or be plugged into sockets. Stick display products such as the DL4530 can be plugged into a connector or soldered to a cable directly. Stick products can also be provided with pins suitable for soldering or special clip-on pins can be flow soldered directly to the board such as from Precision Concepts. Many displays can be end-stacked (butted end-to-end) to obtain longer displays with more digits. This usually causes no break in digit spacing. In applications using screw-down mounting, a flexible washer should be used to avoid strain from misalignment or board warpage.



Connector/Socket Suppliers	(Partial List)
Aries	Frenchtown, NJ
Augat	Attleboro, MA
Berg	New Cumberland, PA
EMC	Woonsocket, RI
Robinson Nugent	New Albany, IND
Precision Concept, Inc.	Bohemia, NY

THERMAL CONSIDERATIONS:

Most LED failures can be traced to excess thermal stress. A typical LED chip is mounted on a substrate or lead frame with a wire bond from the top of the chip to a metallized trace on the substrate and is encapsulated in epoxy. Temperature changes cause these various materials to expand and contract at different rates. Extreme low temperatures are most likely to cause structural failure. High temperatures, usually cause reduced lifetime rather than immediate failures.

The internal LED junction temperature depends on ambient temperature, power applied to the LED, and the thermal resistance, LED chip-to-ambient.

Long-term degradation of the LED chips, causing reduced light output, will occur if junction temperature exceeds 125 deg. C. Also the epoxy material overcoating the LED chips may gradually become opaque if it is subjected to temperatures above 125 deg. C.

For these reasons, all Litronix LED products carry derating specifications designed to limit LED junction temperature to 100 deg. C.

Particular care is needed in designing multiplexed systems. Here, increased forward voltage and the effects of the thermal time constant, chip to ambient (about 10mS typical) can cause "thermal ripple" peak excursions above 100 deg. C while calculated average temperature is much lower.

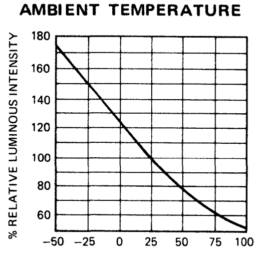
A separate reason for keeping LED chip temperature down is the reduced light output, shown in Figure 1. One can reach a point of diminishing returns, particularly in multiplexed systems, in which an increase in current reduces reliability while actually resulting in little or no increase in display visibility. In such cases, one would be well advised to put his money in higher brightness-grade displays.

A well-designed display system, especially if high power levels or multiplexed operations are involved, should:

1. Allow for convection airflow around the display.
2. Place other heat-generating components* either away from or above, but never below the display (*Display current-control resistors, for example).
3. Take the increased forward voltage and "thermal ripple" peaks into account, in multiplexed systems, and not allow peak temperature to exceed 100 deg. C.

In common with many semiconductor products, LED displays offer the user the most reliable and longest lifetime product available. These good properties do depend, however, on proper usage. Semiconductor products are well-known to be rather unforgiving of abuse when compared to the older technologies. LED's are not different, they are, in fact, hybrid integrated circuits.

LUMINOUS INTENSITY VS AMBIENT TEMPERATURE



SOLDERING CONSIDERATIONS:

Care should be taken not to overheat LED's when soldering. Effectiveness and safety in soldering are related to three basic parameters: temperature, time, and distance. In general, soldering time should not exceed 3 seconds at 1/16 inch from case at 260°C. Some packages allow greater latitude, as indicated on individual data sheets.

OPTICAL CONSIDERATIONS:

Litronix recommends the use of a contrast enhancing filter in front of LED displays. This filter will increase the contrast ratio of digit to surrounding area and help remove reflected light and glare from the PCB and components around the display. Insetting the display to reduce direct ambient light on the display should also be considered.

Litronix displays have been designed to maximize contrast ratio. Displays such as the DL747 series have a black matte plastic cap surrounding the segments. Some multi-digit displays have a red cap to enhance the contrast. Other displays with clear caps will require a filter.

ROHM & HAAS red "Plexiglass" #2423 makes a good general purpose filter for the 640-660 nm Peak Emission Wavelength of red LEDs. A 1/16 inch thick sheet of this inexpensive material is quite effective. Additional information on this and other filter materials may be obtained by contacting the following suppliers:

ROHM & HAAS	Philadelphia, PA
HOMALITE	Wilmington, DEL
PANELGRAPHIC	West Caldwell, NJ
3M	St. Paul, MIN
POLAROID	Cambridge, MASS
FOR RED LEDS	
ROHM & HAAS	Plexiglass 2423
HOMALITE	1670, 1605
PANELGRAPHIC	Red 60, Red 63, Red 65, Purple 90
POLAROID	HRCP
FOR GREEN LEDS	
ROHM & HAAS	Plexiglas 38168
PANELGRAPHIC	Green 48
HOMALITE	1425, 1440
FOR YELLOW LEDS	
PANELGRAPHICS	Yellow 25, Amber 23
HOMALITE	1720, 1726
NEUTRAL DENSITY FILTER	
HOMALITE	Neutral Gray 10

SIEMENS **Appnote 13**

DISPLAYING MESSAGE SYSTEMS WITHOUT A MICROPROCESSOR

by Dave Takagishi

The DL-1416, 4 digit 16 segment, alphanumeric "Intelligent" display, and succeeding products in the family, have on board memory, decoder and drive circuitry. This makes it particularly well suited to marry directly to a microprocessor. However, small multi-message systems of 4, 8, 12, 16 character length need not have a microprocessor to drive the Alpha-Numeric Display. The DL-1416 with the aid of PROM can combine lighted indicators, status displays, annunciator messages or symbols, or a "canned message" into a single display.

ANNUNCIATOR DISPLAYS

An automobile, for example, has several switches each lighting its own status or annunciator indicator. A single DL-1416 Alphanumeric Display could easily display messages alternately upon interrogation of the appropriate switches.

The circuit shown in Figure 1 will display four character messages sequentially for each open switch and continue to display until switches are returned to their normally closed positions. The Counters U4 and U5 address the PROM U6 and select switches on U1. The Data Selector, U1, sequentially selects one of eight switches (oil, temperature, catalytic, generator, brake, door, belt, and null). The eighth switch or null state can display a blank for a normal or off condition. The output of U1 enables the DL-1416, $\overline{CE}$. When this signal goes high, the Monostable, U2, will fire and inhibit the Oscillator U3 for approximately a two second display time. The PROM, U6, generates the ASCII code data for each word. Expansion of the display can easily be achieved by adding a PROM for each additional DL-1416.

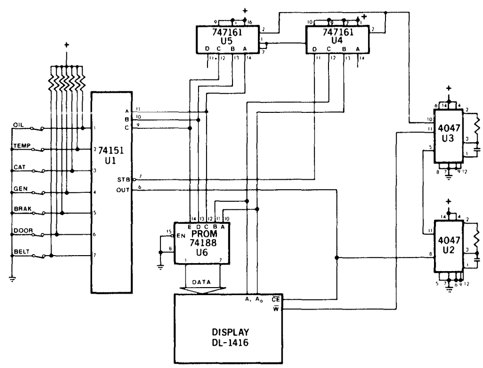


FIGURE 1

Another annunciator type display is shown in Figure 2. This display has a message of up to 16 characters and will continue to display the same line until the 6 bit input code changes state. With this scheme, it can be seen that the 16 character X64 line message PROM can easily be adapted for other message and character length combinations.

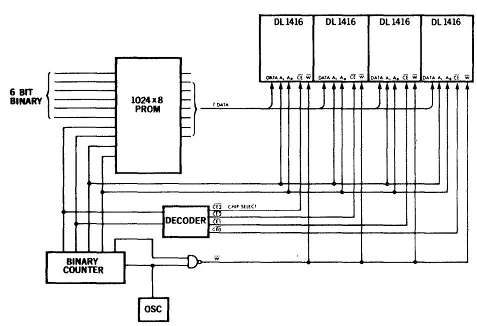


FIGURE 2
TYPICAL CIRCUIT FOR
64 MESSAGES OF 16 CHARACTERS LONG

CANNED MESSAGES

The canned message type display can be an ideal sales, marketing or instructional aid. The message can be altered by replacing the PROM.

The technique for this display would be to sequentially display a word or group of words, depending on the character length of the display, through the entire message. The system could either continue to repeat itself or could go through the complete sequence once each time a switch is operated.

Figure 3 is the schematic for a sales demo box for the DL-1416. A 256X8 PROM was used to display an 8 digit-32 word message. The oscillator, U1, increments the counters U2U3U4 providing the address for the DL1416's and PROM U9. After eight counts the monostable U10 is fired, inhibiting the oscillator for a two second display time. Devices U5 and U8 were added for cursor control. Decoder U8 will alternately enable or disable a data bit for a cursor to proceed writing new data into each digit. The multiplexer U5 will select the character data or the cursor data for the D0–D3 data lines. Inverters on the address lines cause data entry to occur from the left rather than from the right.

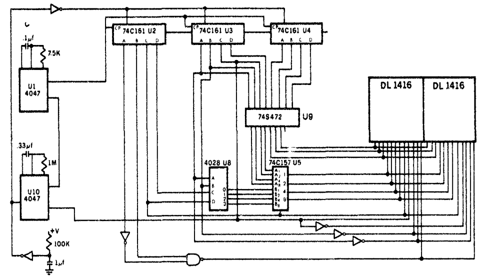


FIGURE 3

Applying the DL-2416 Intelligent Display®

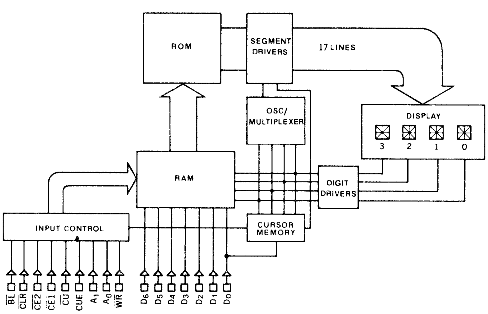
by Dave Takagishi

This application note is intended to serve as a design and application guide for users of the DL-2416 alphanumeric intelligent display. The information presented covers device electrical description and operation, considerations for general circuit design, and interfacing the DL-2416 to microprocessors.

ELECTRICAL & MECHANICAL DESCRIPTION

The internal electronics in the DL-2416 intelligent display eliminates all the traditional difficulties of using multi-digit light emitting displays (segment decoding, drivers, and multiplexing). The intelligent display also provides internal memory for the four digits. This approach allows the user to asynchronously address one of four digits, and load new data without regard to the LED multiplex timing.

Figure 1 is a block diagram of the DL-2416. The unit consists of four 17-segment monolithic LED die and a single CMOS integrated circuit chip. The LED die are magnified to a height of 160 mils by built-in lenses. The IC chip contains 17 segment drivers, four digit drivers, 64 character ROM, four word x 7 bit Random Access Memory, oscillator for multiplexing, multiplex counter/decoder, cursor memory, address decoder, and Miscellaneous Control logic.



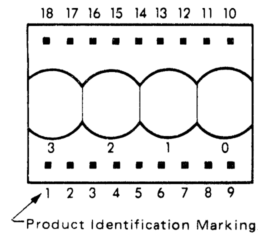
Internal Block Diagram

Figure 1

PACKAGING

Packaging consists of a transfer-molded lexan or nylon lens which also serves as a "encapsulation shell" since it covers five of the six "faces". The assembled and tested substrate (ceramic or "PTF" multilayer), is placed within the shell and the entire assembly is then filled with a water-clear IC-grade epoxy. This yields a very rugged part, which is quite impervious to moisture, shock and vibration. Although not "hermetic", the device will easily withstand total immersion in water/detergent solutions.

TOP VIEW



Pin	Function	Pin	Function
1	$\overline{CE1}$ Chip Enable	10	Gnd
2	$\overline{CE2}$ Chip Enable	11	DØ Data Input
3	$\overline{CLR}$ Clear	12	D1 Data Input
4	CUE Cursor Enable	13	D2 Data Input
5	$\overline{CU}$ Cursor Select	14	D3 Data Input
6	$\overline{WR}$ Write	15	D6 Data Input
7	A1 Digit Select	16	D5 Data Input
8	AØ Digit Select	17	D4 Data Input
9	V_{CC}	18	$\overline{BL}$ Display Blank

Figure 2

ELECTRICAL INPUTS TO THE DL-2416

V_{CC} — Positive supply +5 volts

Gnd — Ground

D0-D6 — Data Lines
The seven data input lines are designed to accept the first 64 ASCII characters. See Figure 3 for character set. (The DL-2416 interprets all undefined codes as a blank).

A_0, A_1 — Address Lines
The address determines the digit position to which the data will be written. Address order is right to left for positive-true logic.

$\overline{WR}$ — Write (Active Low)
Data and address to be loaded must be present and stable before and after the trailing edge of write. (See data sheet for timing information).

$\overline{CE1}$, $\overline{CE2}$ — Chip Enable (Active Low)
This determines which device in an array will actually accept data. When either or both chip enable is in the high state, all inputs are inhibited.

$\overline{CLR}$ — Clear (Active Low)
When held low for 15 mS, the data RAM will be cleared.

CUE — Cursor Enable. Activates Cursor function.

Cursor will not be displayed regardless of cursor memory contents when cue is Low.

$\overline{CU}$ Cursor Select (Active Low)
This input must be held high to store data in data memory and low to store data into the cursor memory.

$\overline{BL}$ Display Blank (Active Low)
Blanking the entire display may be accomplished by holding the $\overline{BL}$ input low. This is not a stored function, however. When $\overline{BL}$ is released, the stored characters are again displayed.

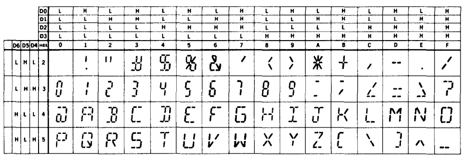


Figure 3

CLEAR MEMORY

Clearing of the entire internal four-digit memory may be accomplished by holding the clear line ($\overline{CLR}$) low for one complete internal display multiplex cycle, 15 mS minimum; less time may leave some data uncleared. $\overline{CLR}$ does not clear the cursor memory.

DISPLAY BLANKING

Blanking the display may be accomplished by loading a blank, space or illegal code into each digit of the display or by using the ($\overline{BL}$) display blank input. Setting the ($\overline{BL}$) input low does not affect the contents of either data or cursor memory. A flashing display can be realized by pulsing ($\overline{BL}$).

OPERATION

Multiplexed display systems sequentially read and display data from a memory device. In synchronous systems, control circuitry must compare the location of data to be read to the location or position of new data to be stored or displayed, i.e., synchronize before a Write can be done. This can be slow and cumbersome.

Data entry in "intelligent displays" is asynchronous and may be done in any random order. Loading data is similar to writing into a RAM. Each digit has its own memory location and will display until replaced by another code.

The waveforms of Figure 4 demonstrate the relationships of the signals required to generate a write cycle.

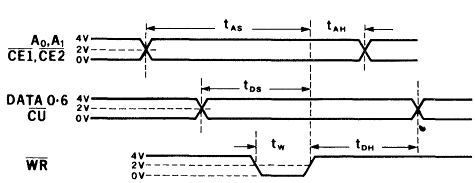


Figure 4

(Check individual data sheet for minimum values). As can be seen from the waveforms, all signals are referenced from the rising or trailing edge of write.

CURSOR

The cursor function causes all 16 line-segments of a digit to light. The cursor can be used to indicate the position in the display of the next character to be entered. The cursor is not a character but overrides the display of a stored character. Upon removal of the cursor, the display will again show the character stored in memory.

The cursor can be written into any digit position by setting the cursor enable (CUE) high, setting the digit address (A_1, A_0), enabling Chip Enable, ($\overline{CE1}$, $\overline{CE2}$), cursor select ($\overline{CU}$), Write ($\overline{WR}$) and Data (D0). A high on data line D0 will place a cursor into the position set by the address A_0 & A_1. Conversely, a low on D0 will remove the cursor. The cursor will remain displayed after the cursor ($\overline{CU}$) and write ($\overline{WR}$) signals have been removed. During the cursor-write sequence, data lines D1 through D6 are ignored by the DL-2416.

If the user does not wish to utilize the cursor function, the cursor enable (CUE) can be tied low to disable the cursor function. A flashing cursor can be realized by simply pulsing the CUE line after cursor data has been stored.

LOADING DATA

$\overline{BL}$	$\overline{CE1}$	$\overline{CE2}$	CUE	$\overline{CU}$	$\overline{WR}$	$\overline{CLR}$	A_1	A_0	D6	D5	D4	D3	D2	D1	D0	DIGIT 3	DIGIT 2	DIGIT 1	DIGIT 0
L	X	X	X	H	X	H	X	X	X	X	X	X	X	X	X	BLANK			
H	H	X	L	H	X	H	X	X	X	X	X	X	X	X	X	PREVIOUS CHARACTERS			
H	X	H	L	H	X	H	X	X	X	X	X	X	X	X	X	NC	NC	NC	NC
H	X	X	L	H	H	H	X	X	X	X	X	X	X	X	X	NC	NC	NC	NC
H	L	L	L	H	L	H	L	L	H	L	L	L	L	L	H	NC	NC	NC	A
H	L	L	L	H	L	H	L	H	H	L	L	L	L	H	L	NC	NC	B	A
H	L	L	L	H	L	H	H	L	H	L	L	L	L	H	H	NC	C	B	NC
H	L	L	L	H	L	H	H	H	H	L	L	L	H	L	L	D	C	NC	A
H	L	L	L	H	L	H	L	L	H	L	L	L	H	L	H	D	C	B	E
H	L	L	L	H	L	H	H	L	H	L	L	H	L	H	H	D	K	B	E
H	L	L	L	H	L	H	–	–	–	–	–	–	–	–	–	SEE CHARACTER SET			

LOADING CURSOR

$\overline{BL}$	$\overline{CE1}$	$\overline{CE2}$	CUE	$\overline{CU}$	$\overline{WR}$	$\overline{CLR}$	A_1	A_0	D6	D5	D4	D3	D2	D1	D0	DIGIT 3	DIGIT 2	DIGIT 1	DIGIT 0
H	L	L	L	H	X	H	X	X	X	X	X	X	X	X	X	Normal Data Entry			
H	L	L	H	H	H	H	X	X	X	X	X	X	X	X	X	Enable Previous Stored Cursors			
H	L	L	H	L	L	H	L	L	X	X	X	X	X	X	H	NC	NC	NC	⊠
H	L	L	H	L	L	H	L	H	X	X	X	X	X	X	H	NC	NC	⊠	⊠
H	L	L	H	L	L	H	H	L	X	X	X	X	X	X	H	NC	⊠	⊠	⊠
H	L	L	H	L	L	H	H	H	X	X	X	X	X	X	H	⊠	⊠	⊠	⊠
H	L	L	L	H	H	H	X	X	X	X	X	X	X	X	X	D	K	B	E
H	L	L	L	L	L	H	L	L	X	X	X	X	X	X	L	D	K	B	E
H	L	L	H	H	H	H	X	X	X	X	X	X	X	X	X	⊠	⊠	⊠	E

X = Don't care
NC = No change from previously displayed characters

Figure 5

GENERAL DESIGN CONSIDERATIONS

Using Positive true logic, address order is from right to left. For left to right address order, use the "ones complement" or simple inversion of the addresses.

For systems with only a 6-bit (abbreviated ASCII) code format, Data Line D6 cannot be left open. Data D6 must be the complement of Data Line D5.

A "display test" or "lamp test" function can be realized by simply storing a cursor into all digits.

Because of the random state of the cursor RAM after power up, if the cursor function is to be used, it will be necessary to clear cursors initially to assure that all cursor memories contain its zero state.

When using DL-2416's on a separate display board having more than 6 inches of cable length, it may be necessary to buffer all DL-2416 inputs. This is most easily achieved with Hex non-inverting buffers such as the 74365. The object is to prevent transient current in the DL-2416 protection diodes. The buffers should be located on the display board near the DL-2416's.

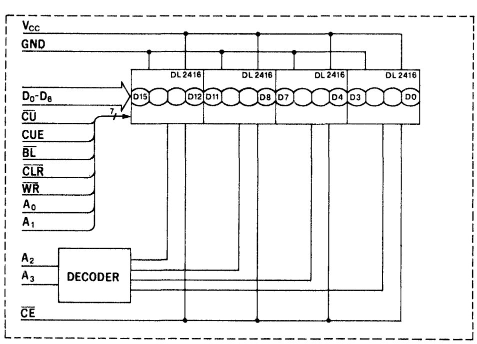
Local power supply bypass capacitors are also needed in many cases. These should be 6 or 10 volt, tantalum type having 10μF or greater capacitance. Low internal resistance is important due to current steps which result from the internal multiplexing of the DL-2416.

If small wire cables are used, it is good engineering practice to calculate the wire resistance of the ground plus the +5 volt wires. More than 0.1 volt drop, (at 25mA per digit worst cast) should be avoided, since this loss is in addition to any inaccuracies or load regulation limitations of the power supply.

The 5-volt power supply for the DL-2416's should be the same one supplying V_{CC} to all logic devices which drive the display devices. If a separate supply must be used, then local buffers using hex non-inverting gates should be used on all DL-2416 inputs and these buffers should be powered from the display power supply. This precaution is to avoid logic inputs higher than display V_{CC} during power up or line transients.

INTERFACING THE DL-2416

A general and straight-forward interface circuit is shown in Figure 6. This scheme can easily interface to μP systems or any other systems which can provide the seven data lines, appropriate address and control lines.



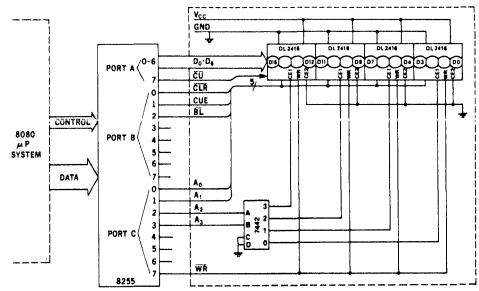
GENERAL INTERFACE CIRCUIT

Figure 6

PARALLEL I/O

The parallel I/O device of a microprocessor can easily be connected to the circuit in Figure 6. One eight bit output port can provide the seven input data bits and the cursor ($\overline{CU}$). Another eight bit output port can contain the address and chip enable information and the other control signals.

Figure 7. illustrates a 16-character display with an 8080 system using the 8255 programmable peripheral interface I/O device. The following program will display a simple 16-character message using this interface.



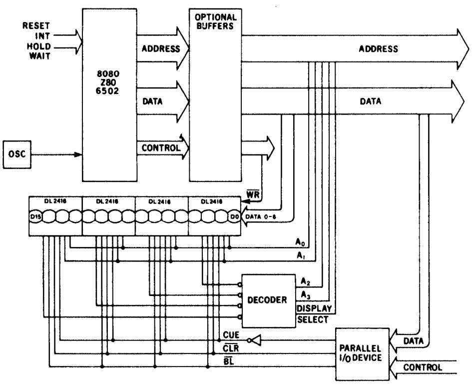
16 DIGIT PARALLEL I/O SYSTEM

Figure 7

```
INIT:    MVI  A,80H     ; CONTROL DATA MODE ø
         OUT CONTROL ;  LOAD CONTROL REGISTER
CUSR:    MVI  A,00H     ; CLEAR CURSOR DATA
         OUT PORT A     ; LOAD DATA PORT
         MVI B, øFH     ; SET CHARACTER COUNTER
CUSRI:   MOV A, B       ;
         CALL DSPWT     ; WRITE SUBROUTINE
         DCR B          , DECREMENT COUNTER
         JNZ CUSRI      ; DIGIT ø?
         MOV A, B       ;
         CALL DSPWT     ;
         MVI A, FFH     ; SET DATA FOR CONTROL
         OUT PORT B     ; LOAD CONTROL LINES
DISP:    LXI H, TABLE   ; SET TABLE ADDRESS
DISP1:   MOV  A, M      ; MOVE TABLE DATA INTO ACCUMULATOR
         OUT PORT A     ; LOAD DATA PORT
         MOV A,B        ;
         CALL DSPWT     ; LOAD ADDRESS AND CONTROL
         INX H          ; INCREMENT TABLE ADDRESS
         INR B          ; INCREMENT COUNTER
         MVI A, 10H     ; SET # OF DIGITS
         CMP  B         ;
         JNZ DISP1      ; 16 CHARACTERS?
         HALT           ; END OF PROGRAM
DSPWT:   ORI F0H        ; SET CONTROL BITS OFF
         OUT PORT C     ; LOAD CONTROL
         ANI 7FH        ; SET WRITE BIT ON
         OUT PORT C     ; LOAD WRITE
         ORI F0H        ; SET WRITE BIT OFF
         OUT PORT C     ; LOAD CONTROL
         RET
TABLE:   DB             ; 0C3H
         DB             ; 0C9H
         DB             ; 0D4H
         DB             ; 0D3H
         DB             ; 0C1H
         DB             ; 0D4H
         DB             ; 0CEH
         DB             ; 0C1H
         DB             ; 0C6H
         DB             ; 0A0H
         DB             ; 0D3H
         DB             ; 0D4H
         DB             ; 0C8H
         DB             ; 0C7H
         DB             ; 0C9H
         DB             ; 0CCH
```

I/O OR MEMORY MAPPED ADDRESSING

Some designers may wish to avoid the additional cost of a parallel I/O in their system. Structuring the addressing architecture for the DL-2416 to look like a set of peripheral or output devices (I/O mapped) or RAM's and ROM's (memory mapped), is very easy. Figure 8 shows the simplicity of interfacing to microprocessors, such as 8080, Z80 and 6502 as examples.



MAPPED INTERFACE

Figure 8

The interface with the 6800 microprocessor in Figure 9 illustrates the need for designers to check the timing requirements of the DL-2416 and the μP. The typical data output hold time is only 30 ns for DBE = ϕ 2 timing; two inverters in the DBE line are added to increase the data output hold time for compatibility with the 50 nS minimum spec of the DL-2416.

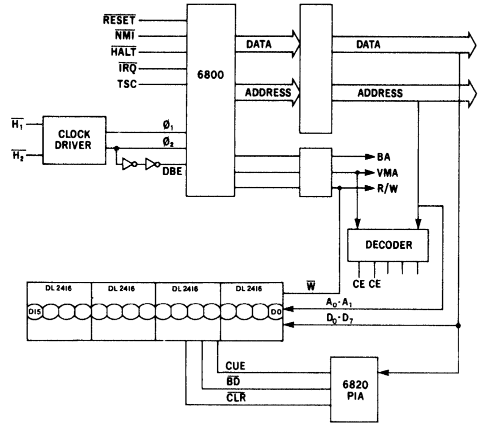


Figure 9

CONCLUSION

Note that although other manufacturer's products are used in examples, this application note does not imply specific endorsement, or recommendation or warranty of other manufacturer's products by Litronix.

The interface schemes shown demonstrate the simplicity of using the DL-2416 with microprocessors. The slight differences encountered with various microprocessors to interface with the DL-2416 are similar to those encountered when using different RAM's. The techniques used in the examples were shown for their generality. The user will undoubtedly invent other schemes to optimize his particular system to its requirements.

SIEMENS Appnote 15

APPLYING THE DL-1414 Intelligent Display®

by Dave Takagishi

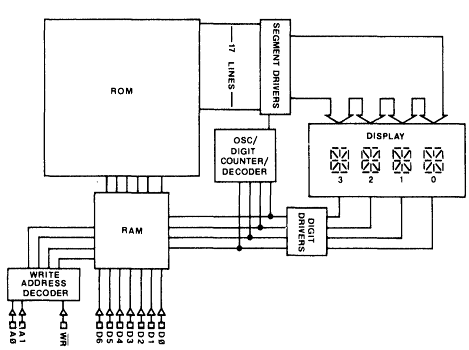
This application note is intended to serve as a design and application guide for users of the DL-1414 alphanumeric intelligent display. The information presented covers device electrical description and operation, considerations for general circuit design, and interfacing the DL-1414 to microprocessors.

ELECTRICAL & MECHANICAL DESCRIPTION

General

The internal electronics in the DL-1414 intelligent display eliminates all the traditional difficulties of using multi-digit light emitting displays (segment decoding, drivers and multiplexing). The intelligent display also provides internal memory for the four digits. This approach allows the user to asynchronously address one of four digits, and load new data without regard to the LED multiplex timing.

Figure 1 is a block diagram of the DL-1414. The unit consists of four 17 segment monolithic LED die and a single CMOS integrated circuit chip. The LED die are magnified to a height of 112 mils by the built-in lenses. The IC chip contains 17 segment drivers, four digit drivers, 64 character ROM, four word x 7 bit Random Access Memory, oscillator for multiplexing, multiplex counter/decoder, address decoder and miscellaneous control logic.



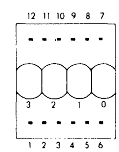
DL-1414 Block Diagram

FIGURE 1

PACKAGING

Packaging consists of an injection-molded plastic lens which also serves as an "encapsulation shell" since it covers five of the six "faces". The assembled and tested substrate (ceramic or "PTF" multilayer) is placed within the shell ana the entire assembly is then filled with a water-clear IC-grade epoxy.

This yields a very rugged part which is quite impervious to moisture, shock and vibration. Although not "hermetic", the device will easily withstand total immersion in water/detergent solutions.



TOP VIEW

Pin	Function	Pin	Function
1	D5 Data Input	7	Gnd
2	D4 Data Input	8	DØ Data Input (LSB)
3	$\overline{WR}$ Write •	9	D1 Data Input
4	A1 Digit Select	10	D2 Data Input
5	AØ Digit Select	11	D3 Data Input
6	V_{CC}	12	D6 Data Input (MSB)

PIN FUNCTION

FIGURE 2

ELECTRICAL INPUTS TO THE DL-1414

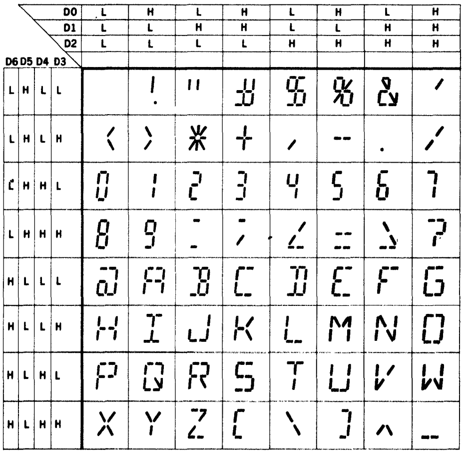
V_{CC} POSITIVE SUPPLY +5 volts

Gnd GROUND

D0-D6 DATA LINES
The seven data input lines are designed to accept the first 64 ASCII characters. See Figure 3 for character set. (The DL-1414 interprets all undefined codes as a blank).

A_0, A_1 ADDRESS LINES
The address determines the digit position to which the data will be written. Address order is right to left for positive-true logic.

$\overline{WR}$ WRITE (Active Low).
Data and address to be loaded must be present and stable before and after the trailing edge of write. (See data sheet for timing info).



All Other Input Codes Display "Blank"

CHARACTER SET

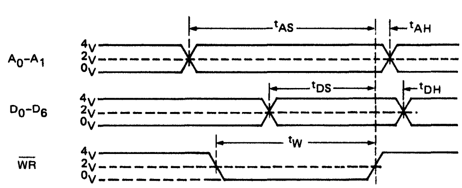
FIGURE 3

OPERATION

Multiplexed display systems sequentially read and display data from a memory device. In synchronous systems, control circuitry must compare the location of data to be read to the location or position of new data to be stored or displayed, i.e., synchronize before a Write can be done. This can be slow and cumbersome.

Data entry in "intelligent displays" is asynchronous and may be done in any random order. Loading data is similar to writing into a RAM. Each digit has its own memory location and will display until replaced by another code.

The waveforms of Figure 4 demonstrate the relationships of the signals required to generate a Write cycle. (Check individual data sheet for minimum values.) As can be seen from the waveforms, all signals are referenced from the rising or trailing edge of Write.



WRITE CYCLE WAVEFORM

FIGURE 4

$\overline{WR}$	ADDRESS A_1	A_0	DATA INPUT D6	D5	D4	D3	D2	D1	D0	DIGIT 3	DIGIT 2	DIGIT 1	DIGIT 0
H	X	X	X	X	X	X	X	X	X	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE
L	L	L	H	L	L	L	L	L	H	NO CHANGE	NO CHANGE	NO CHANGE	A
L	L	H	H	L	L	L	L	H	L	NO CHANGE	NO CHANGE	B	A
L	H	L	H	L	L	L	L	H	H	NO CHANGE	C	B	A
L	H	H	H	L	L	L	H	L	L	D	C	B	A
L	L	L	H	L	L	L	H	L	H	D	C	B	E
L	H	L	H	L	L	H	L	H	H	D	K	B	E
L	–	–	–	–	–	–	–	–	–	SEE CHARACTER SET			

X = DON'T CARE

DATA LOADING TABLE

FIGURE 5

GENERAL DESIGN CONSIDERATIONS

Using positive true logic, address order is from right to left. For left to right address order, use the "ones complement" or simple inversion of the addresses.

For systems with only a 6-bit (abbreviated ASCII) code format, Data Line D6 cannot be left open. Data D6 must be the complement of Data Line D5.

When using DL-1414's on a separate display board having more than 6 inches of cable length, it may be necessary to buffer all DL-1414 inputs. This is most easily achieved with Hex non-inverting buffers such as the 74365. The object is to prevent transient current in the DL-1414 protection diodes. The buffers should be located on the display board near the DL-1414's.

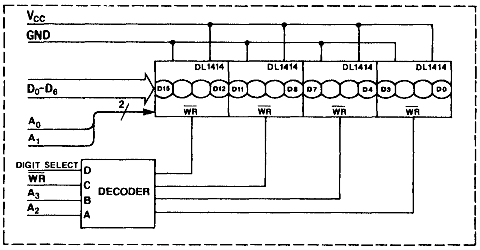
Local power supply bypass capacitors are also needed in many cases. These should be 6 or 10 volt, tantalum type having 10 μF or greater capacitance. Low internal resistance is important due to current steps which result from the internal multiplexing of the DL-1414.

If small wire cables are used, it is good engineering practice to calculate the wire resistance of the ground plus the +5 volt wires. More than 0.1 volt drop, (at 25 mA per digit worst case) should be avoided, since this loss is in addition to any inaccuracies or load regulation limitations of the power supply.

The 5-volt power supply for the DL-1414's should be the same one supplying V_{CC} to all logic devices which drive the display devices. If a separate supply must be used, then local buffers using hex, non-inverting gates should be used on all DL-1414 inputs and these buffers should be powered from the display power supply. This precaution is to avoid logic inputs higher than display V_{CC} during power up or line transients.

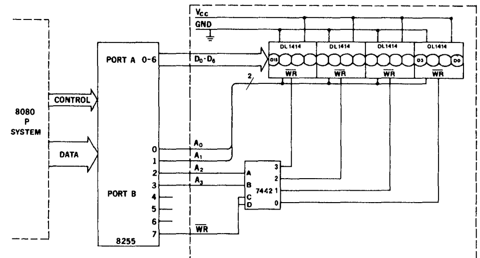
INTERFACING THE DL-1414

A general and straight-forward interface circuit is shown in Figure 6. This scheme can easily interface to μP systems or any other systems which can provide the seven data lines, appropriate address and control lines.



GENERAL INTERFACE CIRCUIT

FIGURE 6



16 DIGIT PARALLEL I/O SYSTEM

FIGURE 8

The DL-1414 does not have a chip enable input. Therefore, each DL-1414 in a system requires its Write pulse be gated with appropriate address signals. Figure 7A shows the use of a 74154 decoder (4 line to 16 line) for up to a 64 character display. Using the G1 input for display select (address select in a memory mapped system) and the G2 input to gate the Write signal. Another approach (Figure 7B & 7C) which minimizes logic for a 16 or 32 digit display takes advantage of decoding scheme of the 7442 decoder.

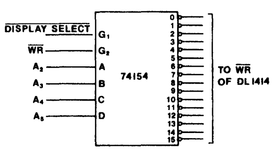


FIG. 7A

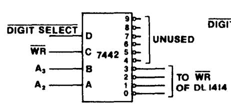


FIG. 7B

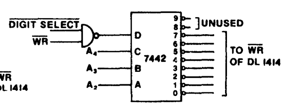


FIG. 7C

GATING THE WRITE PULSE

FIGURE 7

PARALLEL I/O

The parallel I/O device of a microprocessor can easily be connected to the circuit in Figure 6. One eight bit output port can provide the seven input data bits. Another eight bit output port can contain the address and control signals.

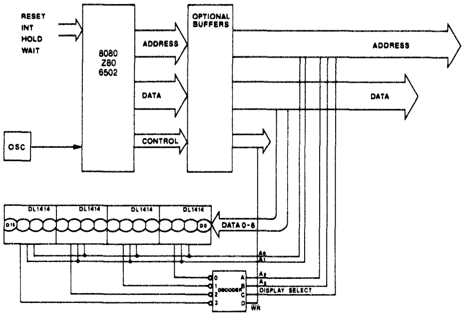
Figure 8 illustrates a 16-character display with an 8080 system using the 8255 programmable peripheral interface I/O device. The following program will display a simple 16-character message using this interface.

SAMPLE I/O PROGRAM

```
INIT:   MVI A,80H     ; CONTROL DATA MODE 0
        OUT CONTROL   ; LOAD CONTROL REGISTER
        MVI B,00H     ; SET COUNTER = 0
DISP:   LXI H,TABLE   ; SET TABLE ADDRESS
DISP1:  MOV A,M       ; MOVE TABLE DATA TO ACCUMULATOR
        OUT PORTA     ; LOAD DATA PORT
        MOV A,B
        CALL DSPWT    ; LOAD ADDRESS AND CONTROL
        INX H         ; INCREMENT TABLE ADDRESS
        INR B         ; INCREMENT COUNTER
        MVI A,10H     ; SET # OF DIGITS
        CMP B
        JNZ DISP1     ; 16 CHARACTERS ?
        HALT          ; END OF PROGRAM
DSPWT:  ORI F0H       ; SET CONTROL BITS OFF
        OUT PORTB     ; LOAD CONTROL
        ANI 7FH       ; SET WRITE BIT ON
        OUT PORTB     ; LOAD WRITE
        ORI F0H       ; SET WRITE BIT OFF
        OUT PORTB     ; LOAD CONTROL
        RET
TABLE:  DL            ; 0C3H
        DB            ; 0C9H
        DB            ; 0D4H
        DB            ; 0D3H
        DB            ; 0C1H
        DB            ; 0D4H
        DB            ; 0CEH
        DB            ; 0C1H
        DB            ; 0C6H
        DB            ; 0A0H
        DB            ; 0D3H
        DB            ; 0D4H
        DB            ; 0C8H
        DB            ; 0C7H
        DB            ; 0C9H
        DB            ; 0CCH
```

I/O OR MEMORY MAPPED ADDRESSING

Some designers may wish to avoid the additional cost of a parallel I/O in their system. Structuring the addressing architecutre for the DL-1414 to look like a set of peripheral or output devices (I/O mapped) or RAM's and ROM's (memory mapped), is very easy. Figure 9 shows the simplicity of interfacing to microprocessors, such as 8080, Z80 and 6502 as examples.



MAPPED INTERFACE

FIGURE 9

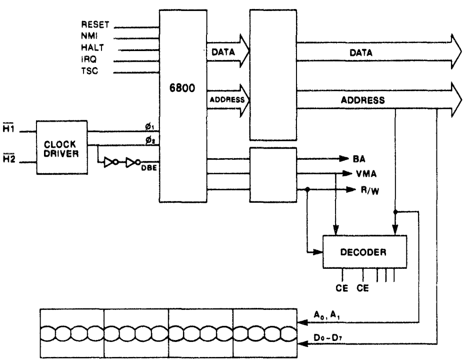


FIGURE 10

The interface with the 6800 microprocessor in Figure 10 illustrates the need for designers to check the timing requirements of the DL-1414 and the μP. The typical data output hold time is only 30 ns for DBE = ϕ 2 timing; two inverters in the DBE line are added to increase the data output hold time for compatibility with the 50 ns minimum spec of the DL-1414.

CONCLUSION

Note that although other manufacturer's products are used in examples, this application note does not imply specific endorsement, or recommendation or warranty of other manufacturer's products by Litronix.

The interface schemes shown demonstrate the simplicity of using the DL-1414 with microprocessors. The slight differences encountered with different microprocessors to interface with the DL-1414 are similar to those encountered when using different RAM's. The techniques used in the examples were shown for their generality. The user will undoubtedly invent other schemes to optimize his particular system to its requirements.

SIEMENS

Appnote 16

SILICON PHOTOVOLTAIC CELLS, SILICON PHOTODIODES AND PHOTOTRANSISTORS

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.

Depending upon the application either photovoltaic cells or photodiodes 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.

PHOTOVOLTAIC CELLS

Photovoltaic cells are active two-poles with a comparably low 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).

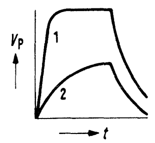
In case 1) the photovoltage rise is analogous to the charging of a capacitor via a resistor from a constant voltage source. In photovoltaic cells the junction capacitance C_j must be charged. The rise occurs by the time constant $\tau = R_L \cdot C_j$, R_L being the load resistor (the low ohmic resistance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

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

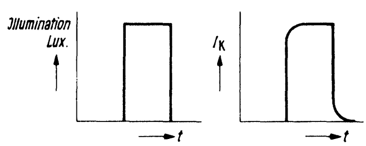
Time constant $\tau = R_L \cdot C_j$.

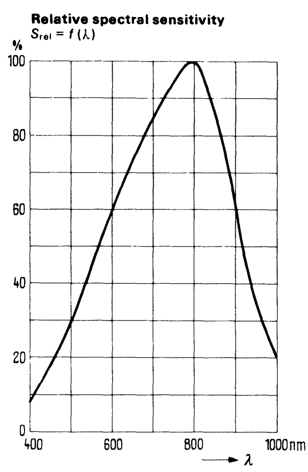
Case 2) Rise time $t_r = \frac{V_P \cdot C_j}{I_K}$

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.





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.

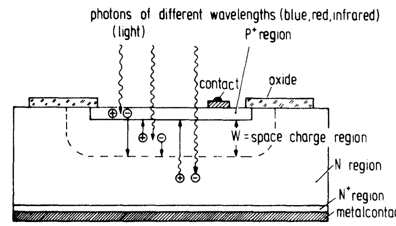


Figure 1

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.

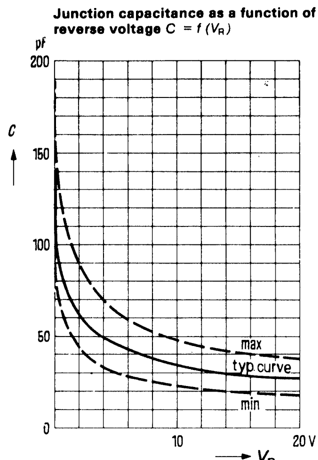


Figure 2

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.

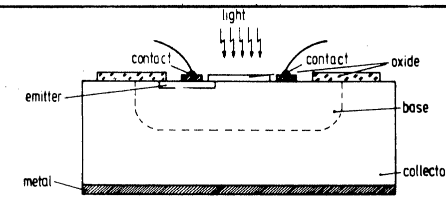


Figure 3

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 abosrbed 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.

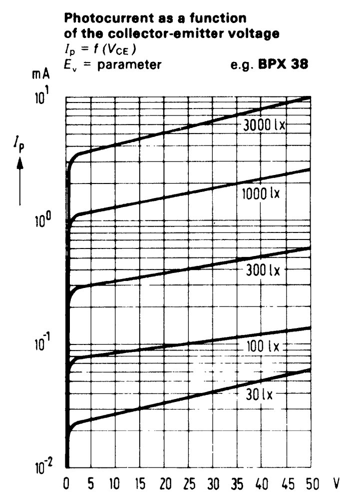


Figure 4

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.

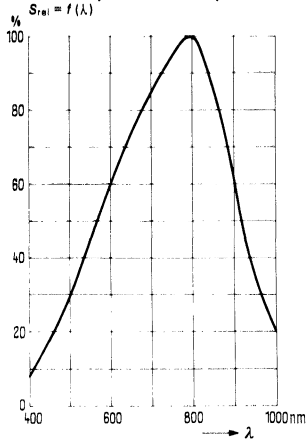
At the types mentioned, the user may preset the operating point of the phototransistor by wiring the base leads. The rapidity of response may thus be increased and the photosensitivity reduced. A fixed bias can reverse the phototransistor. Coincidence circuits can be realized by scanning this bias.

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
$S_{rel} = f(\lambda)$



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 trademart (Sichel-Werke, Hannover)

GUIDELINES FOR HANDLING AND USING Intelligent Displays®

IMPORTANT!
This Appnote contains vital information for optimum design and performance of Intelligent Displays.™

by Malcolm Howard, David Takagishi

Siemens Intelligent Displays are four and eight digit LED modules, having a 16, 17 or 22 segment font and an on-board CMOS integrated circuit driver. The CMOS chip provides segment decoding, drivers, multiplexing and memory for easy interfacing to most microprocessors.

Since Siemens began manufacturing the Intelligent Display in 1978, several questions concerning their use have arisen. This application note is a guide for considerations in design and handling of this product.

SYSTEM DESIGN CONSIDERATIONS

The practical circuit design (i.e. design of PCB, etc.) should be such that the voltage to *any input* must *never exceed the power supply inputs* (i.e. Gnd<Vin< Vcc). If these conditions are not met, then malfunction, or at worst, device destruction can occur. The most common cause of this condition is circuit noise due to noise on the input leads and transient power supply changes.

Good Circuit Layout. The principles of good circuit layout are those for all logic circuitry, but the tolerance of MOS circuitry for deviations is much less than that of bipolar logic. The most important principle is to keep the lead length from the output of one device to the input of another as short as possible. This is to reduce the coupling effect between input signals.

Buffering. The second most common deviation from good design practice is the use of parallel tracking. Avoid PCB design which allow an interconnection track to run parallel to another. This is particularly true if one of the tracks is a power bus when the fluctuations of power supply current can cause inductively coupled change in the input track. Possibly the worst example of parallel tracking is the ribbon cable: it is physically neat and convenient, but can be electrically destructive for the MOS circuits.

It is often necessary, because of the very nature of the Intelligent Display, to use ribbon cable from the CPU board to the display assembly board. In those circumstances for *cables over 15 cm* (6 inches), *use a TTL buffer for each used input.* This is especially true for noisy systems which have motors, relays, etc. The buffers must be on the display end of the cable; thus maintaining a minimum distance between their outputs and the display inputs. Long cables can be a poor transmission line for speed pulses. Line drivers, line receivers, or schmidt trigger gates may be required to shape pulses.

Voltage Transients. It has become common practice to provide 0.01 uf bypass capacitors liberally in digital systems. For intelligent displays, the emphasis is on adequate decoupling. Like other CMOS circuitry, the Intelligent Display controller chip has very low power consumption and the usual 0.01 uf would be adequate were it not for the LEDs. The module itself can, in some conditions, use up to 100 mA (multiplexed). In order to prevent power supply transients, capacitors with low inductance and high capacitance at high frequencies are required. This suggests a solid tantalum or ceramic disc for high frequency bypass. For larger displays, distribute the bypass capacitors evenly, keeping *capacitors as close to the power pins as possible.* Do not rely on existing on-board decoupling, *use a 10 uf and 0.01 uf* for *every 3 or 4 Intelligent Displays* to decouple the displays themselves, *at* the displays.

See Figure 1

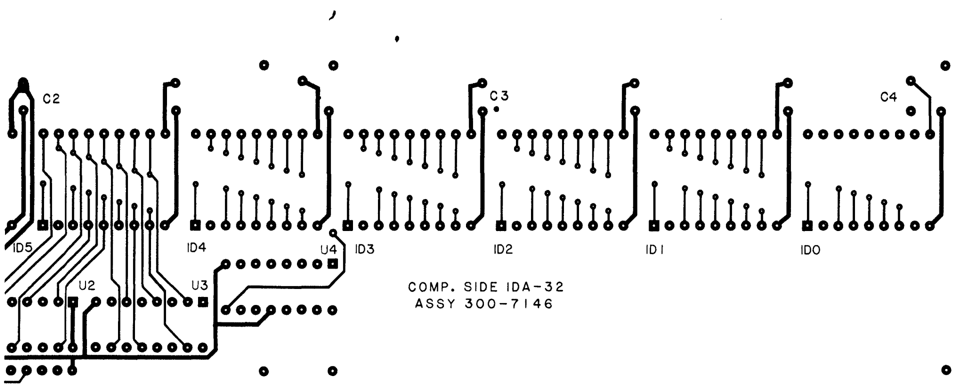


Figure 1 is an actual PCB layout for a line of DL 2416 intelligent displays. Capacitors are spaced evenly and close to the displays with room for additional capacitors should the system require them.

Functional Limitations. Several parameters in the intelligent display data sheets which may affect your design will be emphasized again. While this may not be destructive, it may affect reliability and/or functional operation. (See May 1981 or newer data sheet.)

1. The length of *time all cursors may be lit* should be *1 minute max.*
2. The timing parameters for 25° C will increase with increased temperature.
3. The timing parameters will increase with increased Vcc.

MANUFACTURING CONSIDERATIONS

Handling. The static voltages generated by friction with modern synthetic materials (i.e. carpets, clothing, device carriers, etc.) are often measured in thousands of volts. Although there is usually little energy in these *static charges,* to MOS circuitry that energy is *sufficient to cause destruction* if applied between circuit inputs. Input protection diodes can minimize the vulnerability of the circuits, but there is a limit to their protection capabilities. Under certain conditions, static charges can exceed that limit. The most effective protection is to avoid the generation of static charges. When they are inevitable, prevent that charge from coming in contact with the device pins.

1. *Avoid touching the pins; handle the body only.*
2. *Keep the devices in anti-static tubes or conductive material when transporting.*
3. *Use conductive and grounded working area.* (conductive flooring, conductive work benches, individual wrist straps, etc.)

Intensity Codes. Display uniformity is a concern when two or more displays are in a system. Siemens has adopted a letter code to maintain a uniform display. It is recommended a single letter code be used per system. Because this may be difficult due to yield and delivery, adjacent codes (i.e. D with E or E with F) can be used with minimal problems. Jumping over a code (i.e. D with F) may be noticed by the most critical observer.

Soldering. Because of the plastic housing of the Intelligent Displays, it is necessary to control the solder temperature, soldering time and solder distance. A *maximum of 260° C* for 3 seconds at a distance of greater than 1/16 inch is required. An additional requirement for wave soldering is the Intelligent Display package cannot exceed 70° C.

Cleaning. The cleaning process for the Intelligent Displays is crucial to maintain the optical performance of the plastic housing. The solvent that *cannot* be used on the Intelligent Display product is alcohol. Alcohol will attack the lens material causing cracking, crazing and destruction of the clear optical properties of the lens.

In the *suggested category* are the chlorinated hydrocarbons (Acetone, 1.1.1 Trichloroethane, etc.) or freon TF, freon TA or warm DI water. One note of caution, do not specify a freon solvent without first finding the chemical composition. Some manufacturers use some form of alcohol as an additive, so beware.

SIEMENS

Appnote 19
Cleaning LED Opto Products

by Dave Takagishi/Rick Rachford

Now that you have selected the right optoelectronic device for your application and designed the circuitry, the next step is to install the devices. This application note is a cleaning solvent selection guide for Litronix Optoelectronic products.

PURPOSE OF CLEANING

In the manufacturing of your product, the components will be handled and soldered. It is important to clean the board and remove both flux rosin and ionic residues after soldering to insure a reliable product operation.

Opto products have to be treated differently than other semiconductor devices with respect to cleaning. LED devices for visual applications require special materials for their optical properties. Exposure to a cleaning solvent must not degrade these properties in any way. For this reason, only certain cleaning solvents and their applications may be used for LED components.

Optoelectronic products are built using differing manufacturing packaging techniques depending upon the device and cost. (See Table 1). For this reason, different types of solvents and cleaning techniques may be required. (See Table 3 for solvent summary).

TABLE 1

OPTOELECTRONIC PACKAGING

1. Without housing (photovoltaic, etc.)
2. Cast or molded
3. Lensed (filled or non-filled)
4. Light pipe
5. Reflector (filled or non-filled)

CLEANING TECHNIQUES

The most common cleaning techniques used in the electronic industry are:

1. Brush/wipe
2. Immerse/spray
3. Vapor degreaser

Dipping a short hard bristle brush into a solvent and applying to the area desired is used mostly for touch-up or rework areas where localized cleaning is required. This technique can be used on all optoelectronic products if care is taken to maintain their optical properties.

Immersing the printed circuit board into a pan of solvent with slight agitation is another method of cleaning. Spraying the cleaner, in a dishwasher type machine, is a method for removing water soluble type flux.

The most common technique is the vapor degreaser. This method elevates the solvent to its vapor state. The object is placed into this vapor area allowing condensation into a liquid solvent and dissolving the soil.

Regardless of the solvent, the non-filled lensed and the non-filled reflector type products can allow moisture to become entrapped within the display and degrade its optical properties.

SOLVENTS

There are many different solvents today. Some may be used only at room temperature; some are more effective with a vapor degreaser. Table 2 is a list of major solvent manufacturers.

TABLE 2

MAJOR SOLVENT MANUFACTURERS

Allied Chemical Corporation
Specialty Chemical Division
PO Box 1087
Morristown, N.J. 07960

Baron-Blakeslee
1620 S. Laramie Avenue
Chicago, Ill 60650

Dow Chemical
2020 Dow Center
Midland, MI 48640

EI DuPont de Nemours & Co.
1007 Market Street
Wilmington, DE 19898

Cost should not be the only criteria for choosing a specific cleaning solvent. Any assembly that has a variety of components makes it mandatory to analyze the effects of any given solvent on all components. The component likely to be affected the most by any solvent should control your choice of solvent.

CONCLUSION

The list of suitable/not suitable solvents in Table 3 represents a small part of available solvents. Some others may be compatible, but more likely, most will not be compatible. Another area of concern is that solvent manufacturers make comparable products, not exact products. Additives and concentrations are slightly different from manufacturer to manufacturer which may affect a solvent's acceptability.

Litronix does not assume any responsibility for damage caused to product/s by use of solvents mentioned above. This application note is only a guide to solvents that have been found satisfactory when tested under our own controlled conditions. We recommend that components be evaluated under your solvent conditions before committing to use on a production basis.

TABLE 3

SUITABLE/NOT SUITABLE SOLVENTS FOR SIEMENS OPTOELECTRONIC PRODUCTS

Product	TF	TP-35	TCM	TMC	TMS+	TE	TA	TES	Acetone	Isopropyl Alcohol	III Trichloethane
Visible Lamp											
All Types	S	S	N	N	S	S	N	N	N	S	N
IR Emitter/Detector											
All Types	S	S	N	N	S	S	N	N	N	S	N
Isolator											
All Types	S	S	N	N	S	S	N	N	N	S	N
Displays—Group 1											
HD XXXX	S	S	N	N	S	S	N	N	N	S	N
DLX 34XX	S	S	N	N	S	S	N	N	N	S	N
DLX 413X	S	S	N	N	S	S	N	N	N	S	N
DLX 477X	S	S	N	N	S	S	N	N	N	S	N
DLX 573X	S	S	N	N	S	S	N	N	N	S	N
DLX 713X	S	S	N	N	S	S	N	N	N	S	N
DL 76XX	S	S	N	N	S	S	N	N	N	S	N
DL 77XX	S	S	N	N	S	S	N	N	N	S	N
DLO 39XX	S	S	N	N	S	S	N	N	N	S	N
XBG 1000	S	S	N	N	S	S	N	N	N	S	N
XLB 2XXX	S	S	N	N	S	S	N	N	N	S	N
XBG 48X0	S	S	N	N	S	S	N	N	N	S	N
Displays—Group 2											
DL 3XXM/DL 4XXM	S	N	N	N	N	N	S	N	S	N	S
DL 1414T	S	N	N	N	N	N	S	N	S	N	S
DL 1416T	S	N	N	N	N	N	S	N	S	N	S
DL 1416B	S	N	N	N	N	N	S	N	S	N	S
DL 1814	S	N	N	N	N	N	S	N	S	N	S
DL 2416H, T	S	N	N	N	N	N	S	N	S	N	S
DL 3416	S	N	N	N	N	N	S	N	S	N	S
DL 3422	S	N	N	N	N	N	S	N	S	N	S
IDA 1414	S	N	N	N	N	N	S	N	S	N	S
IDA 1416	S	N	N	N	N	N	S	N	S	N	S
IDA 2416	S	N	N	N	N	N	S	N	S	N	S
IDA 3416	S	N	N	N	N	N	S	N	S	N	S
PD 2816	S	N	N	N	N	N	S	N	S	N	S

S = Suitable
N = Not suitable
X = Substitute for specific part designation

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Appnote 20
Moving Messages using Litronix Alphanumeric Intelligent Displays® and 8748 Microprocessor

Reprinted from Siemens Design Examples of Integrated Circuits Edition 1980/81

Output and display of texts including an important operator information are not only limited to devices of data processing systems but they are more and more applied in other fields of electronics, e.g. in industrial and consumer as well as control engineering. If data of different kinds (e.g. program results, error indications, decision criteria, test results, etc.) are displayed as moving news, they have a striking effect calling the operator's attention.

The text can easily be read when each character remains for 0.25 s on the display. A special advantage of a moving news panel being controlled by a microcomputer is in that the information can immediately be modified. The described circuit of **Fig. 1** operates with SAB 8748. Its program memory capacity (EPROM) is 1K Byte and up to 900 characters can be stored. If the microcomputer is replaced by another one incorporating a different program, the information which is to be displayed is also exchanged.

The described circuit offers the advantage in requiring a minimum of components. The single-chip microcomputer SAB 8748 operates in conjunction with an alphanumeric 16-segment-LED-display DL-2416. It incorporates memory decoder and driver.

Hardware

The ASCII-coded data is transferred from the SAB 8748 to the display ICs via the bus port (DBØ to DB6) and via the $\overline{WR}$-output (strobe). The information at pins P20 and P21 addresses the specific digits of the display-IC DL2416.
The signals at P22 to P26 select the individual ICs via the chip enable input $\overline{CE1}$. When one pin of port 1 is connected to ground, the microcomputer supplies the corresponding text. An output of 4 different texts is possible.

The text may have any length as long as the memory capacity of 900 bytes is not exceeded. There are no additional components required than indicated in the circuit of **Fig. 2.**

Software

The first 100 bytes of the EPROM are reserved for the program. As the program counter can only be read as data memory within 256 bytes, additional instructions are necessary (see listing). At the beginning of the program port 1 is read. If a signal with low level is available at one of the pins, the starting address of the corresponding text is loaded to register 2 (low address) and 3 (high address). Now output registers 20H to 32H have to be filled with blanks. Then the first letter is transfered from text memory to data memory. Now the microprocessor operates in a waiting loop, determining the speed of the moving news. At an oscillator frequency of 3 MHz the timer has an overflow after $\frac{1}{3} \times 10^{-6}\,\mu s \times 15 \times 32 \times 256 = 40.96$ ms. The moving-news text is stepping four times per second after 6 overflows have occurred, that means the 900 characters need in total 3¾ minutes. If the 8-bit-word zero (figure Ø, not the ASCII-character for Ø) is read as character, the text end is recognized by the program. Therefore a counting is not necessary, that means all characters have been transferred. Now the program returns to read port 1.

The flowchart is shown in **Fig. 3** and **Fig. 4** presents the complete listing.

Components for circuit 2

1	8-bit single chip microcomputer (1-KByte-EPROM, 3-MHz-version)	SAB 8748-8-D
5	4-digit alphanumeric LED-displays with memory, decoder and driver, (4 mm character height, 16 segments)	DL 2416
1	Crystal	3 MHz
4	Push buttons for pc board mounting, 2 break-make contacts, lateral operation	

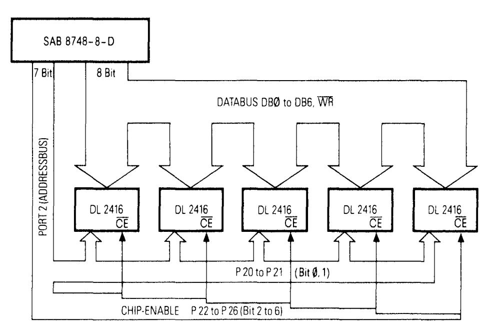


Fig. 1

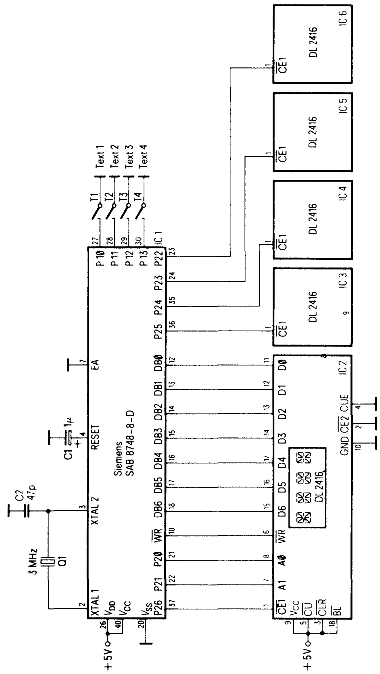


Fig. 2

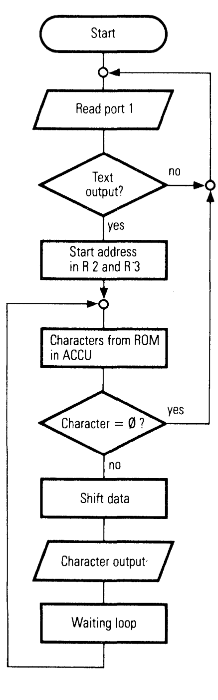


Fig. 3

```
ASM48 APP20

ISIS-II MCS-48/UPI-41 MACRO ASSEMBLER, V3.0                 PAGE    1
APPNOTE 20 MOVING MESSAGE USING DL-2416S

 LOC  OBJ         LINE        SOURCE STATEMENT

                     1 $LIST PAGING SYMBOLS XREF MACROFILE DEBUG
                     2 $TITLE('APPNOTE 20 MOVING MESSAGE USING DL-2416S')
                     3          ;
                     4          ;*******************************************************
                     5          ;* THIS PROGRAM WILL DISPLAY FOUR-32 CHARACTER MESSAGES  *
                     6          ;* IN A "TIMES-SQUARE" MOVING MESSAGE FORMAT. IT USES    *
                     7          ;* FIVE OF THE TIME TESTED SIEMENS/LITRONIX DL-2416      *
                     8          ;* INTELLIGENT DISPLAYS(R)                               *
                     9          ;*******************************************************
                    10          ;17 FEBRUARY 1982
 0000 0A            11           IN     A,P2                     ;KEY POLLING
 0001 37            12           CPL    A
 0002 120C          13           JB0    AUS1
 0004 3212          14           JB1    AUS2
 0006 5218          15           JB2    AUS3
 0008 721E          16           JB3    AUS4
 000A 0400          17           JMP    0
 000C BA80          18 AUS1:     MOV    R2,#LOW(TEXT1-1)
 000E BB00          19           MOV    R3,#HIGH(TEXT1-1)        ;ADDRESS TEXT 1
 0010 0422          20           JMP    ANFANG
 0012 BAA1          21 AUS2:     MOV    R2,#LOW(TEXT2-1)
 0014 BB00          22           MOV    R3,#HIGH(TEXT2-1)        ;ADDRESS TEXT 2
 0016 0422          23           JMP    ANFANG
 0018 BAC2          24 AUS3:     MOV    R2,#LOW(TEXT3-1)
 001A BB00          25           MOV    R3,#HIGH(TEXT3-1)        ;ADDRESS TEXT 3
 001C 0422          26           JMP    ANFANG
 001E BAE3          27 AUS4:     MOV    R2,#LOW(TEXT4-1)
 0020 BB00          28           MOV    R3,#HIGH(TEXT4-1)        ;ADDRESS TEXT 4
                    29
 0022 55            30 ANFANG:   STRT T
 0023 B820          31           MOV    R0,#20H
 0025 BD14          32           MOV    R5,#20
 0027 2320          33           MOV    A,#20H                   ;BLANK
 0029 A0            34 LOECH:    MOV    @R0,A
 002A 18            35           INC    R0
 002B ED29          36           DJNZ   R5,LOECH                 ;BLANK IN RAM 20H-32H
 002D 1464          37 SCHL:     CALL   EINFUE                   ;NEXT CHARACTER
 002F C600          38 HALT:     JZ     0                        ;LAST CHARACTER
 0031 BD14          39           MOV    R5,#20
 0033 B820          40           MOV    R0,#20H
 0035 20            41 SCHL1:    XCH    A,@R0                    ;SHIFT
 0036 18            42           INC    R0
 0037 ED35          43           DJNZ   R5,SCHL1
 0039 B820          44           MOV    R0,#20H
 003B BCF8          45           MOV    R4,#0F8H                 ;CHIP SELECT 1 DISPLAY
 003D 1459          46           CALL   AUS4BY                   ;OUTPUT 4 DIGITS
 003F BCF4          47           MOV    R4,#0F4H                 ;CHIP SELECT 2 DISPLAY
 0041 1459          48           CALL   AUS4BY
 0043 BCEC          49           MOV    R4,#0ECH                 ;CHIP SELECT 3 DISPLAY
 0045 1459          50           CALL   AUS4BY
 0047 BCDC          51           MOV    R4,#11011100B            ;CHIP SELECT 4 DISPLAY
 0049 1459          52           CALL   AUS4BY
 004B BCBC          53           MOV    R4,#10111100B            ;CHIP SELECT 5 DISPLAY
 004D 1459          54           CALL   AUS4BY
 004F BD0A          55           MOV    R5,#10
 0051 1655          56 WARTE:    JTF    WEITER                   ;WAIT 240 MS
 0053 0451          57           JMP    WARTE
 0055 ED51          58 WEITER:   DJNZ   R5,WARTE
 0057 042D          59           JMP    SCHL
                    60
                    61           ;OUTPUT 4 DIGITS SUBROUTINE
                    62           ;R0 OUTPUT DIGIT POINTER
                    63           ;R4 CHIP SELECT & 2 BIT ADDRESS
                    64           ;R5 LOOP COUNTER
                    65
 0059 BD04          66 AUS4BY:   MOV    R5,#4
 005B FC            67 AUS4B1:   MOV    A,R4
 005C 39            68           OUTL   P1,A
 005D 1C            69           INC    R4
 005E F0            70           MOV    A,@R0
 005F 02            71           OUTL   BUS,A
 0060 18            72           INC    R0
 0061 ED5B          73           DJNZ   R5,AUS4B1
 0063 83            74           RET
                    75
                    76           ;FETCH NEXT CHARACTER SUBROUTINE
                    77           ;ADDRESS R2(LOW) & R3(HIGH)
                    78           ;JUMPS TO CORRECT PAGE FOR TEXT
                    79           ;& RETURNS TO MAIN PROGRAM
                    80
 0064 1A            81 EINFUE:   INC    R2
 0065 FA            82           MOV    A,R2
 0066 966B          83           JNZ    UMGEH
 0068 BA02          84           MOV    R2,#2
 006A 1B            85           INC    R3
 006B FB            86 UMGEH:    MOV    A,R3
 006C 036F          87           ADD    A,#JMPADR
 006E B3            88           JMPP   @A
 006F 73            89 JMPADR:   DB     JMPADR +4
 0070 76            90           DB     JMPADR +7
 0071 79            91           DB     JMPADR +10
 0072 7C            92           DB     JMPADR +13
 0073 FA            93           MOV    A,R2
 0074 047F          94           JMP    DATEN           ;PAGE 0
 0076 FA            95           MOV    A,R2
 0077 2400          96           JMP    100H            ;PAGE 1
 0079 FA            97           MOV    A,R2
 007A 4400          98           JMP    200H            ;PAGE 2
 007C FA            99           MOV    A,R2
 007D 6400         100           JMP    300H            ;PAGE 3
                   101
 007F A3           102 DATEN:    MOVP   A,@A
 0080 83           103           RET
 0081 54455854     104 TEXT1:    DB     'TEXTAUSGABE 1                 ',0
 0085 41555347
 0089 41424520
 008D 31202020
 0091 20202020
 0095 20202020
 0099 20202020
 009D 20202020
 00A1 00
 00A2 54455854     105 TEXT2:    DB     'TEXTAUSGABE 2                 ',0
 00A6 41555347
 00AA 41424520
 00AE 32202020
 00B2 20202020
 00B6 20202020
 00BA 20202020
 00BE 20202020
 00C2 00
 00C3 54455854     106 TEXT3:    DB     'TEXTAUSGABE 3                 ',0
 00C7 41555347
 00CB 41424520
 00CF 33202020
 00D3 20202020
 00D7 20202020
 00DB 20202020
 00DF 20202020
 00E3 00
 00E4 54455854     107 TEXT4:    DB     'TEXTAUSGABE 4
 00E8 41555347
 00EC 41424520
 00F0 34202020
 00F4 20202020
 00F8 20202020
 00FC 20202020
 0100 A3           108           MOVP   A,@A            ;THIS INSTRUCTION
 0101 83           109           RET                    ;MUST BE INSERTED
 0102 20202020     110           DB          ',0        ;@100H,200H,300H
 0106 00
                   111                                  ;BEFORE EACH PAGE
                   112           END

USER SYMBOLS
ANFANG 0022   AUS1   000C   AUS2   0012   AUS3   0018   AUS4   001E
EINFUE 0064   HALT   002F   JMPADR 006F   LOECH  0029   SCHL   002D
TEXT3  00C3   TEXT4  00E4   UMGEH  006B   WARTE  0051   WEITER 0055

AUS4B1 005B   AUS4BY 0059   DATEN  007F
SCHL1  0035   TEXT1  0081   TEXT2  00A2

ASSEMBLY COMPLETE,   NO ERRORS
```

Fig. 4

SIEMENS

Silver Plated Tarnished Leads Appnote 21

by Dave Takagishi

Silver plating, as an alternative to gold plating, has excellent electrical conductivity, LED die attach, and wire bonding properties. But tarnished leads can cause soldering difficulties. This application note will discuss silver tarnish and solderability.

Effects of Tarnish

Solderability means the metals or surfaces to be soldered must be types that will go into solution with tin-lead alloys.

When exposed to the atmosphere, all metals form oxides or tarnish of varying degree which reduce the ability of solder alloys to adhere to the metals. Silver tarnish is formed when silver chemically reacts with sulfur to form silver sulfide (Ag_2S). This tarnish is the reason for poor solderability of silver plated products. However, the amount of tarnish and the kind of solder flux used actually determine the solderability. As the tarnish increases, a more active flux must be used to penetrate and remove the tarnish.

Prevention and Handling

Prevention is the best method for inhibiting the formation of tarnish and insuring good solderability of silver plated devices. To inhibit silver tarnish, do not expose the silver plating to sulfur and sulfur compounds. One source of sulfur is free air. Another is paper products such as bags and cardboard.

Listed below are a few suggestions for storing silver plated products.

1. Store the unused devices in polyethylene sheet to keep out free air.
2. Loose devices may be stored in zip-lock or sealed plastic bags.
3. For long term storage, place petroleum napthalene (mothballs) with product inside plastic packages to help keep out free air.
4. The silver leads may be wrapped in "Silver Saver" paper for protection. "Silver Saver" is manufactured by:
   Daubert Coated Products
   1200 Jorie Drive
   Oak Brook, Ill. 60521
   (312) 582-1000
5. Tapes such as adhesive, electrical, and masking should not be used because the adhesive may leave a film and will need to be removed before soldering.

The best defense against the formation of tarnish is to keep silver plated devices in protective packaging until just prior to soldering.

Fluxes

Depending on the amount of tarnish, different types of flux may be required. Below is a list of flux in order of increasing strength.

Type R: Un-activated Rosin Flux
: A pure water-white gum rosin without any additives. Flux and its residue are non-conductive and non-corrosive.

Type RMA: Mildly Activated Rosin Flux
: A WW rosin flux with a small amount of activating agent. Flux its residue are non-conductive and non-corrosive.

Type RA: Activated Rosin Flux
: Similar to RMA flux but with greater amounts of activating agents. Flux and its residue are non-conductive & non-corrosive.

Types AC: Organic Acid Flux
: A fully active organic flux with greater flux ability than a rosin flux. Due to its organic nature, the flux residues decompose at soldering temperatures but must be removed to prevent conductive and corrosive aftereffects.

Recommended flux types with respect to the various tarnish amount:

1. Tarnish free may be soldered with Alpha 100, Kester 135, or equivalent Type R flux.
   (Identified by a bright surface)
2. Minor tarnish will require Alpha 611, Kester 197, or equivalent Type RMA flux.
   (Identified by a medium bright surface)
3. Mild tarnish will require Alpha 711, Kester 1544, or equivalent Type RA flux.
   (Identified by a light tint surface)
4. Moderate tarnish will require Alpha 830, Kester 1429, or equivalent Type AC flux.
   (Identified by a light tan color on the surface)
5. If severe tarnish is present, as identified by a dark tan to black color, a cleaner/surface conditioner Alpha 140, Kester 5560, or equivalent must be used. A few seconds and at room temperature is all that is required. These conditioners are acidic; therefore, a thorough wash and rinse is recommended. Care is advised to only immerse the leads and not the body, because optical properties may be damaged.

Soldering

To obtain reliable circuit operation, good soldering is necessary. For wave soldering, Sn60 is the most commonly used solder for electronic components. Two alternatives are Sn63 and Sn62 solder. A high quality rosin core flux is recommended for hand solder operations. Typically the core is an RMA type flux.

Two major soldering suppliers are:

Alpha Metals
600 Rt 440
Jersey City, NJ 07304
(201) 434-6778

Kester Solder
4201 Wrightwood Ave.
Chicago, Ill 60639
(312) 235-1600

Regardless of the flux and solder technique used, care should be taken to assure the optical properties of the optoelectronic product are not degraded in any manner.

Litronix does not assume any responsibility for damage caused by products mentioned above.

SIEMENS

Socket Selection Guide Appnote 22

by Dave Takagishi

This application note is a guide to locate a suitable socket for various SIEMENS/LITRONIX products.

The selection of a socket is first based on the number of pins and the pin spacing required. Sockets for displays require an orientation and sometimes stackability. Other requirements may be:

- Contact type (ie. side vs edge)
- Plating type (ie. tin vs gold)
- PCB mounting (ie. solder vs wirewrap)
- Height of socket

To use this guide, (1) Find SIEMENS/LITRONIX product part number, (2) Note number of pins, (3) Note spacing & orientation . . . (Example 300 H) (4) Go to chart, find # of pin with corresponding spacing/orientation and follow to suggested socket.

The purpose of this application note has been to guide you to possible vendors and suggest one out of many possible socket choices. It is recommended that the part numbers given be used as a starting point with a vendor for choosing a socket. The part number will depend on your requirement and application.

This guide is not intended to imply specific endorsement or warranty of other manufacturers products by SIEMENS/LITRONIX.

List of possible vendors.

ARIES ELECTRONICS COMPANY
P.O. Box 130
Frenchtown, New Jersey 08825
201-996-6841

GARRY MANUFACTURING
1010 Jersey Ave.
New Brunswick, New Jersey 08902
201-545-2424

ROBINSON-NUGENT
800 E. Eighth St.
New Albany, Indiana 47150
812-945-0211

SAMTEC
810 Progress Blvd.
New Albany, Indiana 47150
812-944-6733

Part Number	# of pins	Spacing
DL-57	14 pins	.300 V
DL-330M	12 pins	.300 H
DL-340M	14 pins	.300 H
DL-416	22 pins	(SPC)
DL-430M	12 pins	.300 H
DL-440M	12 pins	.300 H
DL-1414	12 pins	.600 H
DL-1416	20 pins	(SPC)
DL-2416	18 pins	.600 H
DL-3416	22 pins	.600 H
DL-3422	22 pins	.600 H
DL-3400,3401,3403,3405,3406	16 pins	.600 V
DL-4770, DLO-4770	13 pins	(SPC)
DL-7750R,7751R,7756R,7760R	14 pins	.300 V
DL-5735, DLG-5735	12 pins	.300 V
DL-7670G,7671G,7673G,7676G	14 pins	.300 V
DLO-3900,3901,3903,3905,3906	16 pins	.600 V
DL-76500,76510,76530,76560	14 pins	.300 V
DL-7660Y,7661Y,7663,7666Y	14 pins	.300 V
HD-1075G,1075O,1075R,1075Y	10 pins	(SPC)
HD-1077G,1077O,1077R,1077Y	10 pins	(SPC)
HD-1105G,1105O,1105R,1105Y	10 pins	.300 V
HD-1106G,1106O,1106R,1106Y	10 pins	.300 V
HD-1107G,1107O,1107R,1107Y	10 pins	.300 V
HD-1108G,1108O,1108R,1108Y	10 pins	.300 V
HD-1131G,1131O,1131R,1131Y	10 pins	.600 H
HD-1132G,1132O,1132R,1132Y	10 pins	.600 H
HD-1133G,1133O,1133R,1133Y	10 pins	.600 H
HD-1134G,1134O,1134R,1134Y	10 pins	.600 H
Isolites 6 pin	6 pins	.300 B
8 pin	8 pins	.300 B
16 pin	16 pins	.300 B
Arrays	2 pins thru 20 pins	.100 B

# of pins	row-row spacing	ARIES N.J.	GARRY MFG N.J.	R-N IND.	SAMTEC IND.
12	.300 H	12-513-10	(2)102-06-X	(2)ICN-063-X	
14	.300 H	14-511-10	102-14-X-X-X	ICL-143-S6-X	ICC-314-T
18	.600 V	18-6511-10	300-18-X-X-X		IC-618-X
22	.600 V	24-6513-10	300-22-XX-X		ICC-624-X
22	SPC	———	———	———	———
13	SPC	———	———	———	———
12	.300 V	12-513-10			
14	.300 V	14-511-10	102-14-X-X-X	ICL-143-S6-X	ICC-314
14	.600 V	14-6511-10	300-14-X-X-X		IC-614-X
20	.300 H	20-511-10	102-20-CC-X-X	ICL-203-S6-X	ICC-320
10	SPC	———	———	———	———
10	.300 V				IC-310-X
10	.600 V	10-6511-10			IC-610-X
18	.300 V	18-511-10	102-18-X-X-X		ICC-318
6	.300 B	6-513-10	102-06-X	ICN-063-S3-X	IC 306-X
8	.300 B	8-511-10	102-8-X-X-X	ICN-083-S3-X	ICC-308
16	.300 B				
2-20	.100 B	PIN-LINE SERIES	SERIES 200 SERIES 2002	SB-25-100X	SSA-1XX-XSERIES ICK-1XX-XSERIES
Others		yes	yes	yes	

NOTES:

1. All sockets are 0.100 pin-to-pin spacing.
2. Products listed are generally tin plated PCB solder type. Contact vendor for other types.
3. Row-row spacing of pins
   (H)-pins are horizontal w/respect to viewing of display
   (V)-pins are vertical w/respect to viewing of display
   (B)-pins can be either horz or vert
   (SPC)-pins not standard 0.100 or row-row spacing
4. Others—Special sockets for display such as Rt angle, etc. Contact vendor for details.
5. Consult vendor for stackability.
6. Strip in-line sockets may be used. (Cut to length, req'd)
7. Vendor may have other products also suitable for your application.

SIEMENS

LED Filter Selection Appnote 23

by Dave Takagishi

The most important design consideration for a piece of equipment using LED products is the ability to display information to an observer clearly. This information must be easily and accurately recognized in various ambient light conditions. This application note will discuss the design considerations and recommendations for filtering.

Since the quality of readability is very subjective, the best judge of the performance of a product is the human eye and in the user's conditions. To improve the readability of a display it will be necessary to employ certain techniques such as contrast enhancement, wavelength filtering, special filtering, and mounting.

Contrast Enhancement

The objective of contrast enhancement is to maximize the contrast between the display segments 'ON' and 'OFF' states. This is done by reducing the ambient light reflected from the surface of the display and allowing as much of the emitted light to reach the observer. This can be accomplished by painting the front surface of the display to match as close as possible the color of an 'OFF' segment. This reduces the distracting areas around the display and therefore enhances the 'ON' segments.

Contrast enhancement may be improved further by the use of selected wavelength filters. Under bright ambient conditions, contrast enhancement is more difficult and additional techniques such as louvered filters and/or shading may be necessary.

Filters

The majority of display applications use plastic filter material for their low cost and ease of assembly. The filter requirements for different ambient lighting conditions and different color displays make it necessary to become familiar with the various relative transmittance characteristics. Most filter manufacturers will provide transmittance curves for their products.

When selecting a filter, the shape of the transmittance curve vs wavelength should be considered in relationship to the LED radiated spectrum to obtain maximum contrast enhancement. For standard red displays, a long wavelength pass filter having a sharp cutoff in the 600nm to 620nm range is ideal. The same applies for high efficiency red displays with a long wavelength pass filter in the 570nm to 590nm range. The yellow and green displays are more difficult to filter effectively. The most effective filter for yellow displays is a yellow-orange or amber filter. Yellow-only filters are very poor for contrast enhancement. Green displays will require a band-pass yellow-green filter which peaks at 565nm.

A choice among available filters must be made on the basis of which filter and LED combination is most effective, but experimentation with each choice must be made to choose the most esthetic combination.

Effectiveness of Wavelength Filters with Different Lighting

Contrast is very dependent upon the ambient lighting. If the ambient light is outside the spectrum of the LED, then it is very easy to reduce the reflected light. This is the case for a red LED display in fluorescent lighting or a green LED in incandescent lighting. Bright sunlight has a flat spectral distribution curve and when it is directly incident upon a display the background may meet or exceed the light output of the display. It should be obvious that a wavelength filter alone is not sufficient in daylight ambient conditions.

Other Techniques

An acceptable contrast is difficult to achieve if high ambient light is parallel to the viewing axis (the incident light is perpendicular to the face of the display). If the incident light is not parallel to the viewing axis, the use of louvered filters or shading and recessing is recommended. It is the shading of louvered filters that reduces the incident light to allow for more contrast. The drawback to this filter is the restricted viewing angle.

Circular polarizing filters are effective in reducing the reflected light from the highly reflective (glossy) surfaces of bubble lensed products, such as the Intelligent Displays.

Glare can still be present from the surface of filters, therefore, an anti-reflection surface is recommended. This can be incorporated into the filter. The trade-off is that both ambient and display light are diffused and the display may appear fuzzy if not mounted close enough to the filter.

Care should be taken to design the printed circuit board to keep all reflective surfaces away from display area or display side of the board or consider a dark coating on the reflective surfaces.

Mounting Considerations

The designer should consider recessing the display and bezel assembly to add some shading effect. The shading will reduce the indirect lighting for better contrast.

It is essential to design the unit to allow sufficient air flow for circulation and mount current limiting resistors on another board or any heat generating components away from the displays.

Filter Material Manufacturers

Panelgraphic Corporation
10 Henderson Drive
West Caldwell, New Jersey 07006
201-227-1500

SGL Homalite
11 Brookside Drive
Wilmington, Delaware 19804
302-652-3686

3M Company
Visual Products Division
3M Center, Bldg 220-10W
St. Paul, Minnesota 55101
612-733-0128

Rohm and Haas
Independence Mall West
Philadelphia, Penn 19105
215-592-3000

Polaroid Corporation
Polarizer Division
549 Technology Square
Cambridge, Mass 02139
617-864-6000

Bezel & Filter Assembly Manufacturers

R.M.F. PRODUCTS
P.O. Box 413
Batavia, Illinois 60510
312-879-0020

NOBEX COMPONENTS
Nobex Division
Griffith Plastic Corp
1027 California Dr.
Burlingame, Ca 94010
415-342-8170

PHOTO CHEMICAL PRODUCTS OF CALIFORNIA
1715 Berkeley Street
Santa Monica, Ca 90404
213-828-9561

I.E.E.-Atlas
Industrial Electronic Engrs Inc.
7740 Lemona Avenue
Van Nuys, Ca 91405
213-787-0311

Filter Recommendation

Visible Filters

Manufacturer	Red	Hi-Eff	Ylw	Grn	Spcls
Homalite	1605	1670	1720 1726	1425 1440	
Panelgraphic	Red 60 Red 63	Red 65	Ylw 25 Amb 23	Grn 48	Gray 10
Rohm & Haas	2423	2444			2412
3-M					Louvered Filters
Polaroid					Circular Polarizing

Near IR Filter

3-M	# IR9320

SIEMENS

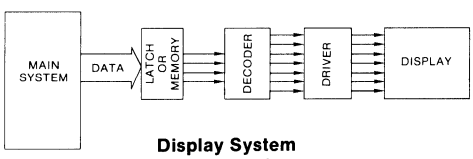
Drivers For Light Emitting Displays Appnote 24

by Dave Takagishi

The purpose of this application note is to provide some information on the integrated circuits presently available to drive Light Emitting Diodes (LED) displays and how to interface them to the various displays.

Background

LED displays come in various sizes (0.1" to 0.8"), colors (red, high-efficiency red, green, yellow), fonts (7/9/14/16 segment, dot-matrix, or bar graph), and types (common anode, common cathode, multi-digit). The brightness is essentially proportional to the current through an LED and each element within a display should have the same current or a brightness variation may be apparent. A display subsystem can be made up from several elements.



Display System
FIGURE 1

The partitioning of these elements are dependent on the drivers used; therefore, the display driver chosen is dependent on the specifications of the display and the application.

Also some types of displays require using a multiplexing technique because of the internal interconnections. This is only applicable for multi-digit displays.

Typical Circuits

Figure 1 shows a very basic circuit for driving an LED. The series resistance can be easily calculated from the following formula.

$$Rs = \frac{Vb - Vf}{If}$$

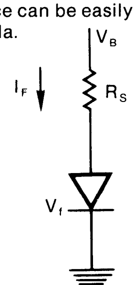
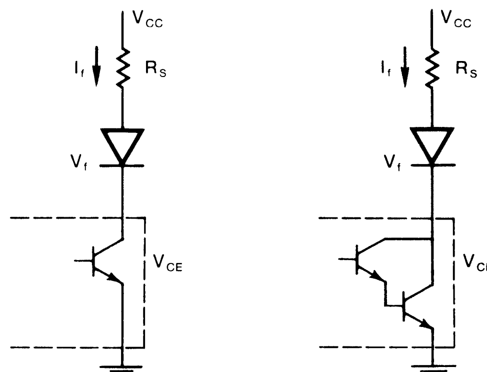


FIGURE 2

For circuits using TTL Logic or transistors (fig 3).

$$Rs = \frac{Vcc - Vce - Vf}{If}$$



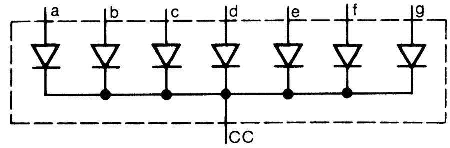
TTL or Transistor **Darlington Transistor**

FIGURE 3

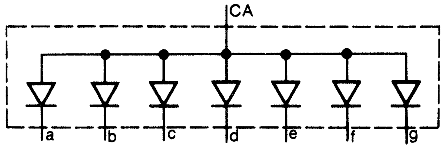
It can be seen that the term Vce(saturation voltage) for the driver is going to be a factor in determining the series limiting resistor. Therefore, a darlington vs a single output transistor will have different current limiting resistor values to maintain a constant current through the LED.

Selection

One factor in choosing the display and/or driver will be whether the display is a common cathode or common anode type display.

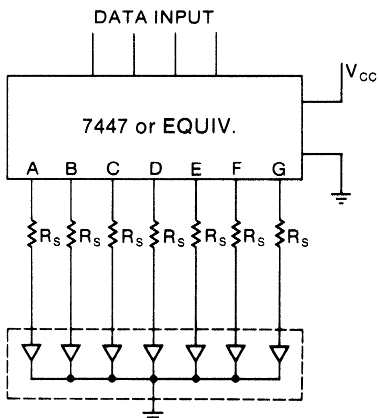


Common Cathode Display
FIGURE 4

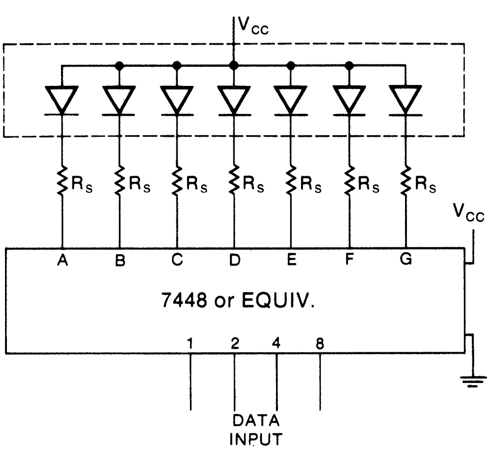


Common Anode Display
FIGURE 5

Another factor is the different drivers go low or high,

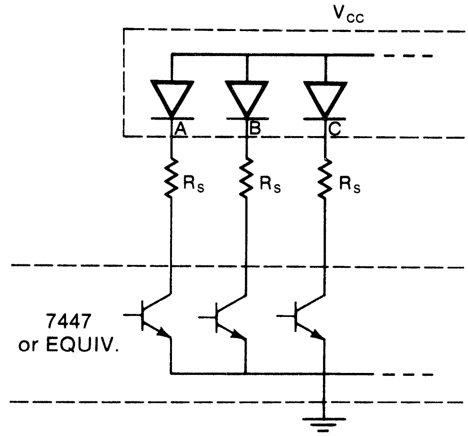


Common Cathode Display w/Driver
FIGURE 6

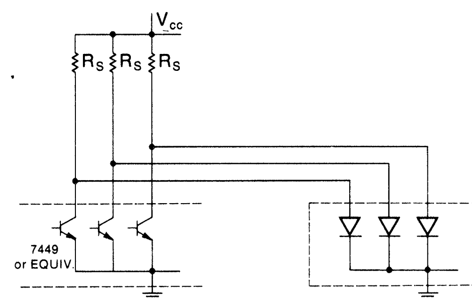


Common Anode Display w/Driver
FIGURE 7

or can be wired into different configurations.



Open Collector Type Driver
w/Common Anode Display
FIGURE 8



Open Collector Type Driver
w/Common Cathode Display
FIGURE 9

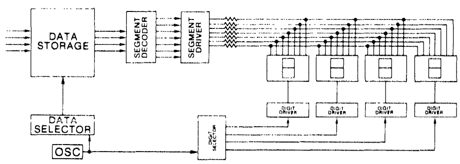
From figures 6/7/8/9, it may appear obvious to combine the seven (7) series resistors (Rs) into one common resistor in the common line. However this should not be done because of the possible variation in Vf from segment to segment. This variation in Vf can cause a variation in current, resulting in segment brightness differences.

Table 1 is a list of some of the most common LED drivers available. Besides having different current drive capabilities, one product may have a feature which may make them easier to use in a particular application.

- Serial vs parallel input data
- Data latching type drivers
- Blanking
  - Drive the ripple blanking input (rbo) with pulse width modulation to very brightness.
- Multi-digit drivers
- Constant current drivers
- Advantage of a constant current driver is the change of Vf will not affect the brightness. This is important with different color LED's.

Multiplexing

In a multiplex system, the corresponding segment of each digit is bussed together and driven from one segment drive via the usual current limiting resistors. The display data is presented serially by digit to the decoder driver together with the appropriate digit signal (figure 10). For more information on multiplexing, see Appnote #3 (Multiplexing LED Displays).



Block Diagram of a 4-Digit Multiplexed Display
FIGURE 10

One way to simplify the design procedure for alphanumeric displays would be to consider the Siemens Intelligent Display®. This device family incorporates all necessary interface control with drivers and memory built-in with the display. This means the designer need not be concerned about the memory, multiplex circuitry, character generator, or drivers for these are provided inside a modular unit. More information on these products is available in the Intelligent Display Product Guide.

Circuits herein mentioned are not the responsibility of Siemens-Optoelectronics Division and are for reference only. Products are continually being improved by vendors and/or are obsoleted; therefore, consultation with the factory is recommended.

TABLE 1

Single Digit Decoder/Drivers

PART #	MFGR	If/seg	TYPE	COMMENTS
7447 74247 7446	Fairchild Hitachi Motorola National Signetics Teledyne TI	40 ma	CA	BCD-to-7 seg, open coll, ripple blnkng
7448 74248	Fairchild Hitachi Motorola National Signetics TI	6 ma	CC	BCD-to-7 seg, int pull-up, ripple blnkng
7449 74249	Fairchild Hitachi Motorola National Signetics TI	8 ma	CC	BCD-to-7 seg, open coll, blnkng input
DS8857	National	60 ma	CA	BCD-to-7 seg decoder, ripple blnkng
DS8858	National	50 ma	CC	BCD-to-7 seg decoder, ripple blnkng
CD4511 4511B MC14511	Fairchild National Motorola	25 ma	CC	BCD-to-7 seg, latched, blnkng
DS8647 DS8648	National	10 ma	CC	9 seg drivers
NE587	Signetics	50 ma	CA	BCD-to-7 seg, latched, ripple blnkng, vari current
NE589	Signetics	50 ma	CC	BCD-to-7 seg, latched, ripple blnkng, vari current
CA3161E	RCA	25 ma	CA	BCD-to-7 seg, constant current drivers
9368	Fairchild	20 ma	CC	BCD-to-7 seg, ripple blnkng
9374	Fairchild	15 ma	CA	BCD-to-7 seg, ripple blnkng

TABLE 1, Continued

Multi-Digit Display Drivers:

MM5450	National	25 ma	CA	34 seg serial input, brightness control
MM5451	National	25 ma	CA	35 seg serial input, brightnes control
MM74C912	National	100 ma	CC	6 digit, 7 seg+decimal, BCD decoder, output enble
MM74C911	National	100 ma	CC	4 digit, 8 seg controller/seg driver
MM74917	National	100 ma	CC	6 digit, 7 seg+decimal, Hex decoder, output enble
DS8669	National	25 ma	CA	Dual BCD-to-7 seg decoder/driver
CA3168E	RCA	25 ma	CA	Dual BCD-to-7 seg decoder/driver
ICM7212 ICM7212A ICM7212M ICM7212AM	Intersil	8 ma	CA	4 digit, latched, 28 seg drivers, brightness cntl
ICM7218A	Intersil	20 ma	CA	8 digit, 8 seg (decoded/spcl), w/mem/drivers
ICM7218B	Intersil	10 ma	CC	8 digit, 8 seg (decoded/spcl), w/mem/drivers
ICM7218C	Intersil	20 ma	CA	8 digit, 8 seg(hex/bcd), w/mem drivers
ICM7218D	Intersil	10 ma	CC	8 digit, 8 seg(hex/bcd), w/mem/drivers
ICM7218E	Intersil	20 ma	CA	8 digit, 8 seg (decoded/spcl), w/mem drivers, cntls avble
TSC700A	Teledyne	11 ma	CA	4 digit decoder/driver, parallel output, brightness cntl
TSC7212A	Teledyne	5 ma	CA	4 digit decoder/driver, parallel output, brightness cntl
SAA1060	Signetics	40 ma	CA	16 element serial in/parallel out driver
SDA2014	Siemens	12 ma	CC	2 or 4 digit, serial bcd input
SDA2131	Siemens	20 ma	CA	16 element, serial input

Other Drivers:

XR-2000	Exar	400 ma	sink	5 darlington transistors, MOS-to-LED
XR-2201 XR-2202 XR-2203 XR-2204	Exar	500 ma	sink	7 darlington transistors, open collector w/diodes TTL-to-LED, compatible to Sprague (ULN-xxxx)
CA3081	RCA	100 ma	sink	7 common emitter transistor array
CA3082	RCA	100 ma	source	7 common collector transistor array
9665 9667	Fairchild	250 ma	sink	7 common emitter darlington transistor array

Bar Graph Drivers:

UAA180	Siemens	10 ma	n.a.	12 element bar driver
LM3914	National	2-20 ma	n.a.	10 element dot/bar linear output driver
LM3915	National	1-30 ma	n.a.	10 element dot/bar log output driver

SIEMENS

The DLX-713x 5x7 Dot Matrix Intelligent Display Appnote 25

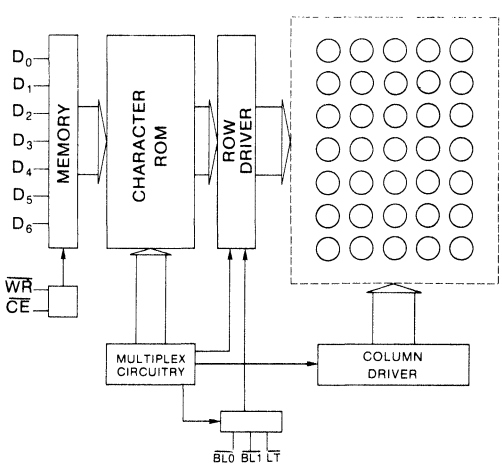
by Dave Takagishi

This application note is intended to serve as a design and application guide for users of the DLO-7135, and DLG-7137 Siemens Optoelectronics Division Intelligent Displays. The information presented covers device electrical description, operation, general circuit design considerations, and interfacing to microprocessors.

Electrical Description

If you have never designed a system using a dot matrix display before, you cannot appreciate the simplicity of using the DLX-713x Intelligent Alphanumeric 5x7 Dot Matrix Display. The intelligent display contains memory, character generator, multiplexing circuits, and drivers built into a single package.

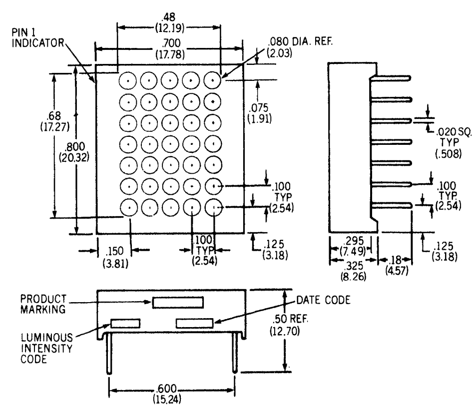
Figure 1 is a block diagram of the DLX-713x. The unit consists of 35 LED die arranged in a 5x7 pattern and a single CMOS integrated circuit chip. The IC chip contains the segment drivers, digit drivers, 96 character generator ROM, memory, multiplex and blanking circuitry.



DLX-713x Block Diagram
FIGURE 1

Package

The 35 dots form a 0.48 x 0.68 inch overall character size in a 0.700 x 0.800 inch dual-in-line package. The ±50 degree wide viewing angle complements the large display and is the ideal display for the industrial control application. Display construction is a filled reflector type with the intregrated circuit in the back and then filled with IC-grade epoxy. This results in a very rugged part which is quite impervious to moisture, shock, and vibration.



Physical Dimension Inches
FIGURE 2

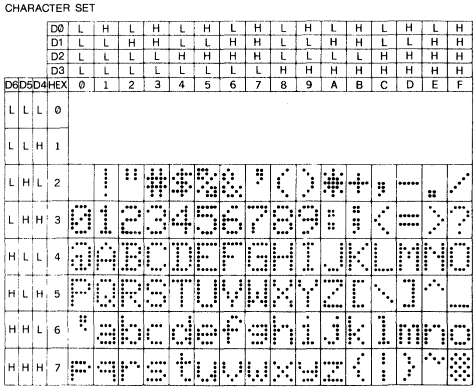
Electrical Inputs

PIN	Name	PIN	Name
1	Vcc	14	D6 data input (msd)
2	$\overline{LT}$ lamp test	13	D5 data input
3	$\overline{CE}$ chip enable	12	D4 data input
4	$\overline{WR}$ write	11	D3 data input
5	$\overline{BL1}$ brightness	10	D2 data input
6	$\overline{BL0}$ brightness	9	D1 data input
7	GND	8	D0 data input (lsd)

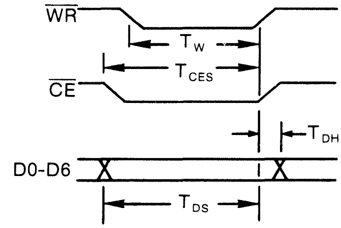
Pin Description

Vcc	Positive Supply +5 volts
GND	Ground
D0-D6	Data Lines see figure 3 for character set
$\overline{CE}$	Chip Enable (active low) This determines which device in an array will accept data
$\overline{WR}$	Write (active low) Data and chip enable must be present and stable before and after the write pulse (see data sheet for timing)
$\overline{BL0}$,$\overline{BL1}$	Blanking Control Input (active low) Used to control the level of display brightness
$\overline{LT}$	Lamp Test (active low) Causes all dots to light at ½ brightness

CHARACTER SET



Character Set
Figure 3



Timing Characteristics
Figure 4

Operation

In a dot matrix display system, it is advantageous to use a multiplexed approach with 12 drivers (5 digit + 7 segments) rather than 35 segment drivers. This obviously reduces the number of drivers and interconnections required. A multiplexed system must be a synchronous system or the digits or elements may have different on (lit) times and therefore varying brightness.

The DLX-713*x* is an internally multiplexed display but the data entry is asynchronous. Loading data is similar to writing into a RAM. Present the data, select the chip, and give a write signal. For a multi-digit system, each digit has its own unique location and will display its contents until replaced by another code.

The waveforms of figure 4 demonstrates the relationship of the signals required to generate a write cycle. Check the data sheet for minimum values required for each signal.

Display Blanking and Dimming

The DLX-713*x* Intelligent Display has the capability of three levels of brightness plus blank. Figure 5 shows the combination of $\overline{BL0}$ and $\overline{BL1}$ for the different levels of brightness. The $\overline{BL0}$ and $\overline{BL1}$ inputs are independent of write and chip enable and does not affect the contests of the internal memory. A flashing display can be achieved by pulsing the blanking pins at a 1-2 hertz rate. Either $\overline{BL0}$ or $\overline{BL1}$ should be held high to light up the display.

Dimming and Blanking Control

Brightness Level	$\overline{BL1}$	$\overline{BL0}$
Blank	0	0
¼ brightness	0	1
½ brightness	1	0
full brightness	1	1

Lamp Test

The lamp test when activated causes all dots on the display to be illuminated at half brightness. It does not destroy any previously stored characters. The lamp test function is independent of chip enable, write, and the settings of the blanking inputs.

This convenient test gives a visual indication that all dots are functioning properly. Because of the lamp test not affecting the display memory, it can be used as a cursor or pointer in a line of displays.

General Design Considerations

When using the DLX-713x on a separate display board having more than 6 inches of cable length, it may be necessary to buffer all of the input lines. A non-inverting 74365 hex buffer can be used. The object is to prevent transient current into the DLX-713x protection diodes. The buffers should be located on the display board and as close to the displays as possible.

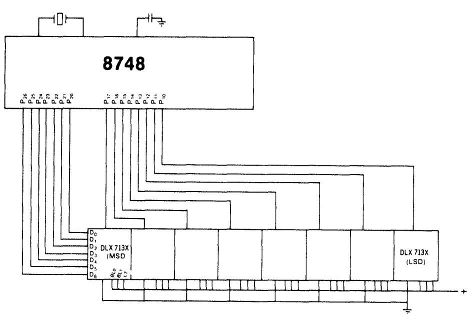
Because of high switching currents caused by the multiplexing, local power supply by-pass capacitors are also needed in many cases. These should be 6 or 10 volt, tantalum type having 5 - 10 uf capacitance. The capacitors may only be required every 6-7 displays depending on the line regulation and other noise generators.

If small wire cables are used, it is good engineering practice to calculate the wire resistance of the ground and the +5 volt wires. More than 0.2 volt drop (at 100ma per digit) should be avoided, since this loss is in addition to any inaccuracies or load regulation of the power supply.

The 5 volt power supply for the DLX-713x should be the same one supplying the Vcc to all logic devices. If a separate supply must be used, then local buffers should be used on all the inputs and these buffers should be powered from the display power supply. This precaution is to avoid line transients or any logic signals to be higher than Vcc during power up.

Interfacing

For an eight digit display using the DLX-713x, interfacing to a single chip microprocessor such as the 8748 is easy and straight forward. One approach may be to dedicate one port for the six data signals and another 8-bit port for the write signals. The schematic is shown in Figure 6.

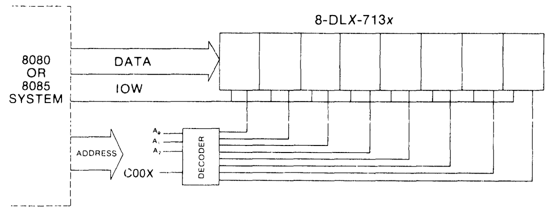


DLX-713x with 8748
Figure 6

```
                          ; SUBROUTINE TO LOAD AN 8-DIGIT
                          ; DISPLAY USING THE DL7135
                          ; DATA IN RAM 10H-17H (MSD-LSD)
INIT:   ORL   P1,#0FFH    ; PORT 1 ALL HIGH (WRITE)
        ORL   P2,#00H     ; PORT 2 ALL LOW (DATA)
        MOV   R1,#OFH     ; RAM ADDRESS — 1
        MOV   R2,#0FEH    ; WRITE PULSE
        MOV   R3,#08H     ; COUNTER
START:  INC   R1          ; INCREMENT RAM POINTER
DATA:   MOV   A,@R1       ; FETCH DATA FROM RAM
        OUTL  P2,A        ; LOAD PORT 2
        MOV   A,R2        ; RECALL WRITE
        RR    A           ; SHIFT A TO NEXT WRITE
        MOV   R2,A        ; SAVE WRITE
WRITE:  OUTL  P1,A        ; SEND WRITE PULSE
        MOV   A,#OFFH     ; WAIT
        OUTL  P1,A        ; RESET WRITE PULSE
        DJNZ  R3, START   ; LOAD COMPLETE?
        RET               ; RETURN TO MAIN PROGRAM
```

I/O or Memory Mapped System

For a memory mapped system using a processor such as the 8080 or 8085, the interfacing is also straight-forward. Each display is treated as a memory location with its own address, like another I/O or RAM location.



Block Diagram for 8-Digit DLX-713x Dot Matrix Display
Figure 7

```
                          ; ROUTINE FOR AN 8 DIGIT DISPLAY
                          ; USING THE DLX-713x AND
                          ; 8085 OR 8080 MICROPROCESSOR
                          ;
                          ; DATA TO BE DISPLAYED IS IN
                          ; A0(LSD) THRU A8(MSD)
                          ;
                          ; DISPLAY ADDRESS C00X
                          ; LSD IS RIGHT MOST DIGIT
                          ;
                          ; DOES NOT SAVE REG A,B,H,L,D,E
DADD    EQU   0A000H      ; DATA ADDRESS LOCATION
DPAD    EQU   0C000H      ; DISPLAY ADDRESS LOCATION
LEN     EQU   08H         ; DISPLAY LENGTH
                          ;
ORG     100H
                          ;
DISP:   LXI   H,DADD      ; LOAD DATA ADDRESS
        LXI   D,DPAD      ; LOAD DISPLAY ADDRESS
        MVI   B,LEN       ; LOAD DISPLAY LENGTH
DISP1:  MOV   A,M         ; GET DATA
        XCHG              ; XCHG H/L & D/E
        MOV   M,A         ; LOAD DISPLAY FROM REG A
        XCHG              ; RESTORE H/L & D/E
        INX   D           ; INCREMENT DISPLAY ADDRESS
        INX   H           ; INCREMENT DATA ADDRESS
        DCR   B           ; DECREMENT LENGTH COUNTER
        JNZ   DISP1       ; END OF DISPLAY?
        RET               ; RETURN TO MAIN PROGRAM
```

Conclusion

Note that although other manufacturer's products are used in the examples, this application note does not imply specific endorsement, or warranty of other manufacturer's products by Siemens. The interface schemes shown demonstrate the simplicity of using the DLX-713x Dot Matrix Intelligent Display. Slight timing differences may be encountered for various microprocessors, but can be resolved similar to those encountered when using different RAM's. The techniques used in the examples were shown for their generality. The user will undoubtedly invent other schemes to optimize his particular system to its requirements.

SIEMENS

Application Note 26

SFH 900 – a Low-Cost Miniature Reflex Optical Sensor

Whether for an industrial plant or a hobbyists' drilling machine, an electric drive will hardly be acceptable nowadays without speed control. Incremental bar patterns simply applied to rotating shafts can be detected by the new Siemens reflex optical sensor, the SFH 900. The information can be processed with a minimum of circuitry, whether for a high rate of black-to-white transitions or just single, slow transitions.

Construction

The SFH 900 optical sensor is a remarkable component even by virtue of its shape alone. Its maximum height of 2.2 mm is in the trend of today's electronics, of putting a large number of functions into a very small space. The small dimensions allow it to be used where ordinary optical sensors run into space or other problems. **Fig. 1** is an enlarged picture of the device. Dimensions and pin configuration are shown in **Fig. 2.**

Fabricated by lead frame technique in a thermoplastic package, the sensor uses a GaAs infra-red diode as a radiation emitter and a large-area phototransistor as the detector. High sensitivity is ensured by a 1 mm^2 radiation sensitive area and a current gain of almost 1000. The effect of unwanted ambient light is almost screened out by a filter.

Two fixing notches are a help in mounting the device. Lead frame technology accurately locates the optically active areas relative to these notches and thus to the component body. **Fig. 3** is an example of one form of mounting.

Fig. 1 SFH 900 reflex optical sensor, front and back view, shown here three times normal size

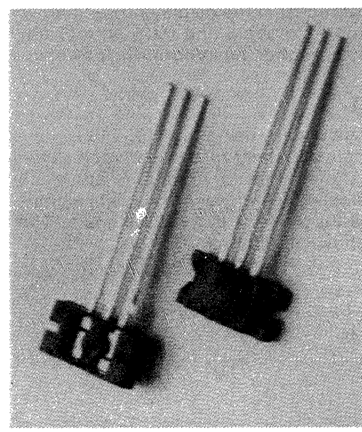
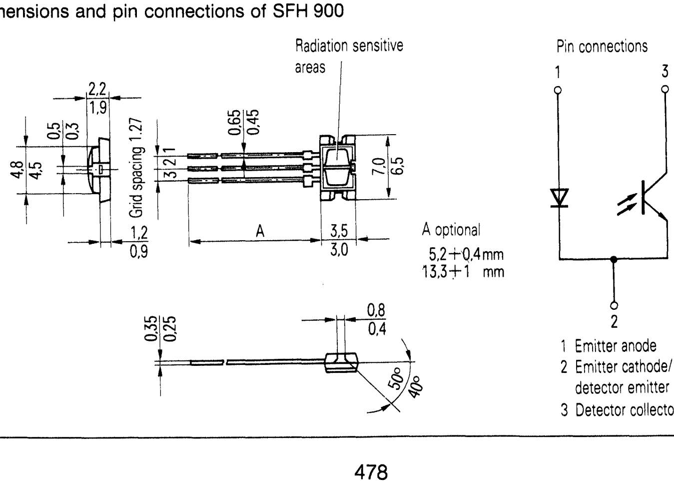


Fig. 2 Outline dimensions and pin connections of SFH 900



Characteristics

Main technical data are given in the **Table**. Turn-on and turn-off times are also important. These depend essentially on the collector current I_C and the load resistance R_L. Typical switching times for I_C = 1 mA and R_L = 1 kΩ are 50 to 70 μs.

The user will be mainly concerned with the following points:

- What collector current, I_C, can be expected under given static conditions?
- What are the signal amplitudes when scanning bar patterns of different pitches?
- What is the temperature dependence of the collector current and what is the repeatability of the measured values?

Collector current

Dependence of collector current on emitter diode forward current I_F is almost linear at forward currents above 10 mA, as can be seen from **Fig. 4.** At currents below 1 mA the dependency shows almost a square law. The measurement was made with a standard reflector (Kodak neutral white test card, r = 90%) at a distance of 1 mm. **Fig. 5** shows I_C characteristics for distances of 0.2 to 10 mm at a constant forward current of 10 mA. The curves are for four different reflecting materials: two standard Kodak reflectors with 15% and 90% reflection, polished aluminium and a strongly absorbing foil. DC-fix adhesive tapes and other tapes commonly used for printed circuit layouts proved particularly suitable. It should be mentioned that the curve for polished aluminium in **Fig. 5** is very similar to the Kodak reflector response with r = 90%, in spite of the reflection being mirrored by the metal and diffused by the standard reflector, as a result of the wide directional characteristics of the emitter and detector.

At short distances (e. g. d = 0.25 mm) very large changes of current per unit distance are obtained. Because of these steep edges, which can only be used dynamically, the SFH 900 may also be utilized as a microphone.

Fig. 3 Suggestion for mounting the SFH 900. Projections N in the flexible plastic clamp locate in corresponding notches in the body of the optical sensor

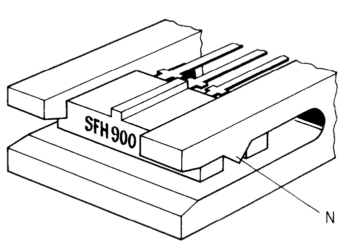


Fig. 4 SFH 900 collector current I_C as a function of forward current I_F with 90% diffuse reflectin at distance d = 1 mm and with U_S = 5 V

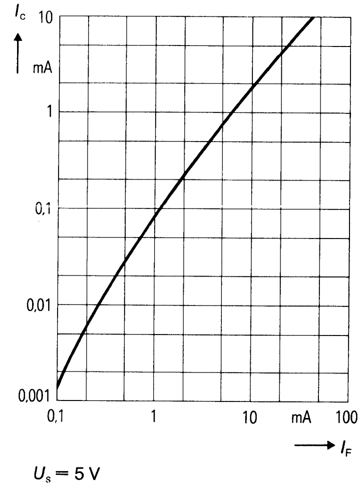
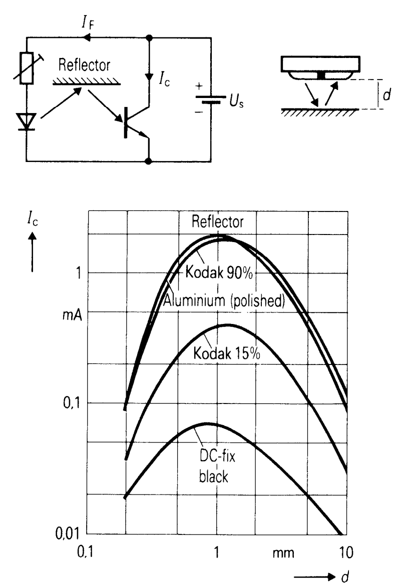


Fig. 5 SFH 900 collector current I_C as a function of reflector distance d with different reflector materials



Forward current I_F = 10 mA
Operating voltage U_S = 5 V.

Emitter (GaAs infra-red diode)				
Reverse voltage		U_R	6	V
Forward dc current		I_F	50	mA
Surge current ($t \leq 10$ µs)		i_{FSM}	1.5	A
Power dissipation (T_{amb} = 40 °C)		P_{tot}	80	mW
Thermal resistance		R_{thJU}	750	K/W
Detector (silicon phototransistor)				
Collector-emitter voltage		U_{CEO}	30	V
Emitter-collector voltage		U_{ECO}	7	V
Collector current		I_C	10	mA
Total power dissipation (T_{amb} = 40 °C)		P_{tot}	100	mW
Collector-emitter leakage current (U_{CE} = 10 V)		I_{CEO}	20 (≤ 200)	nA
Photocurrent under ambient light (U_{CE} = 5 V) (E_E = 0.5 mW/cm²)		I_P	≤ 3	mA
Reflex optical sensor				
Storage temperature range		T_S	−40 to +85	°C
Ambient temperature range		T_U	−40 to +85	°C
Junction temperature		T_j	100	°C
Total power dissipation (T_{amb} = 40 °C)		P_{tot}	150	mW
Collector current	SFH 900-1	I_{CE}	≥ 0.3	mA
(I_F = 10 mA; U_{CE} = 5 V; d= 1 mm)	SFH 900-2	I_{CE}	≥ 0.5	mA

Table Selective characteristics of SFH 900

Resolution of black-and-white patterns

As can be seen from **Fig. 5**, strongly reflecting and badly reflecting materials give collector currents differing by a factor of about 25. Strongly reflecting means »white«, badly reflecting »black«.

If a black-to-white transition is scanned, the displacement distance between the »fully white« signal and the »fully black« signal is 4 to 5 mm **(Fig. 6).**

If, in contrast, a regular bar pattern is scanned, the signal amplitude becomes smaller the smaller the bar width. **Fig. 7** shows clearly how the excursion is affected: the maximum white signal becomes smaller with decreasing bar width, while the minimum black signal becomes larger. **Fig. 8** shows the signal excursion itself, to make it clearer. Here a regular pattern and a single white bar are compared. The excursion is referred to a single black-to-white transition corresponding to a 100% signal excursion.

A bar width of 3 mm can thus be detected without significant loss of sensitivity. The signal excursion, however, drops to as low as 10% using a grid of 1 mm bar

Fig. 7 Maximum and minimum collector current when scanning a black-white pattern

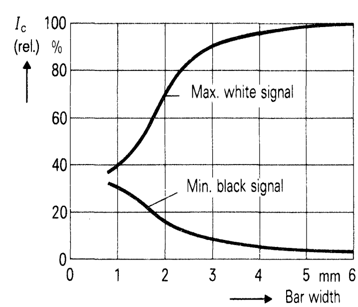
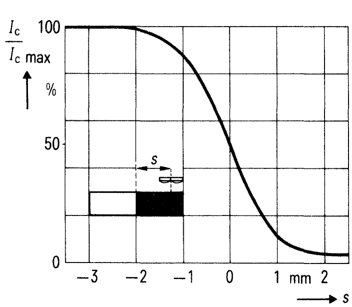


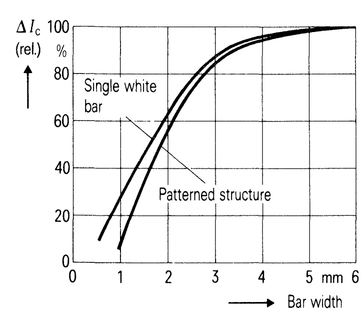
Fig. 6 Resolution of a black-to-white transition. Relative collector current as a function of sensor position s



Reflector distance d = 1 mm
Emitter diode current I_F = 10 mA

Fig. 8 Relative signal excursion as a function of white bar width

I_F = 10 mA, d = 1 mm



width. An apparently higher signal excursion is obtained when a single 1 mm wide white bar on a black background is scanned. The result is then about a 30%, as shown in **Fig. 8.**

The optical sensor can be used for scanning in any position, regardless of whether the emitter-detector axis is at right-angles to the scanning direction. Tests have shown that the device sensitivity is independent of direction. If a white spot on a black background (or vice-versa) is to be detected without loss of sensitivity, this should have a minimum area of 5×5 mm. From this we can conclude that a pattern bar must not be larger than 5 mm.

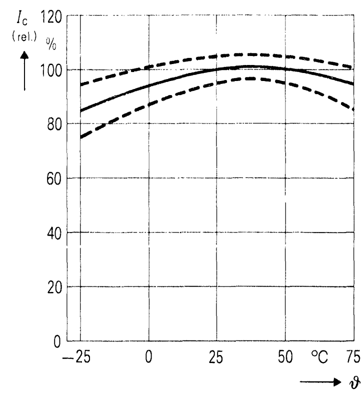
Thus the resolution capability of the SFH 900 seems to be limited to bar widths of 1 to 2 mm minimum. In fact, however, considerably higher resolutions can be obtained when gratings are used. An example is given below.

Temperature dependence

The temperature dependence of the output signal is shown in **Fig. 9.** This fortunately very small dependence results from the combination of the temperature dependent diode emission (approx. −0.55%/K) with the temperature dependent current gain of the phototransistor (approx. +0.9%/K). As these two parameters partly compensate for each other the temperature dependence of the output signal is fairly small.

There is a spread of characteristics in the different devices but they remain within the specified tolerance range, allowing for ageing, with a probability of at least 95%.

Fig. 9 Relative collector current as a function of temperature



U_s = 5 V d = 1 mm
I_F = 10 mA r = 90%
—— typical response
---- spread of characteristics
(including long-term effects)

Applications

Speed control for dc motors

A simple speed regulator circuit for small dc motors can be designed using the TCA 955 device. **Fig. 10** is an example. The teeth of a toothed wheel on the motor shaft serve as reflectors (40 teeth on a wheel of approx. 60 mm diameter). Pulses from the optical sensor are converted by the TCA 955 into a dc voltage proportional to speed. The pulse signal is first amplified, then frequency doubled, then fed to a monostable which produces a square wave with a constant pulse duration determined by the R_1 C_1 product. The mean value of this pulse train is determined by capacitor C2 and an 8.7 kΩ internal resistor.

The voltage present at C2, still with a slight triangular modulation, is compared with an internal set value. The difference is amplified and determines the duty cycle in the subsequent mark-to-space ratio converter. The motor is connected to the operating voltage via a BD 675 switching stage, which runs to the rhythm of the duty cycle. A larger mark-to-space ratio causes the speed to increase. The desired frequency can be set by P1 over a wide range.

Speed control for ac motors

This is mainly intended for use in the consumer field, in such things as kitchen appliances and drilling machines. It is important that the speed indicator should have a very low current consumption as it is supplied from a simple line rectifier circuit using a series resistor. The specimen circuit in **Fig. 11** has an emitter diode current of only 2 mA. Signal processing and triac triggering are done by the new TLB 3101 phase control IC. Total current needed for control is around 7 mA, including the SFH 900.

Pulses from the optical sensor are first amplified, then converted by a monostable to constant pulse width and finally filtered to give a mean value. By comparison with a sawtooth voltage the gate trigger time for the triac is fixed. A soft start is given by transistor T1.

The range of speed regulation is 5000 to 15000 rpm. The reflector is a disc mounted on the motor shaft, and at its periphery this disc has, as an example, 5 pairs of black and white segments.

Shaft encoder with direction sensing

This example shows how gratings can be used to give a considerable increase in resolution. A transparent disc of about 130 mm diameter has an array of 200 opaque bars at its periphery **(Fig. 12a).** The bar width is thus about 1 mm. A second grating with reflecting white bars is placed under the disc. If the disc pattern and the grating beneath are set gap to gap, the detector »sees« 100% black. If the bars of the two gratings are on top of each other the image appears as 50% white. So, when the disc is rotating the useful amplitude is therefore about 50% of the full black-to-white excursion.

The grating pattern is constructed so that one half is displaced by 90° of a grid period with respect to the other half. If a reflex optical sensor is assigned to each half, on rotation of the disc the output signals will be roughly sinusoidal and displaced by 90° from each other. This means that patterns of half bar width can be successfully resolved.

In further processing both sinewave voltages are converted into square waveforms, also phase-shifted by 90° **(Fig. 13).**

Fig. 10 Speed regulator using SFH 900 reflex optical sensor and TCA 955 integrated speed control

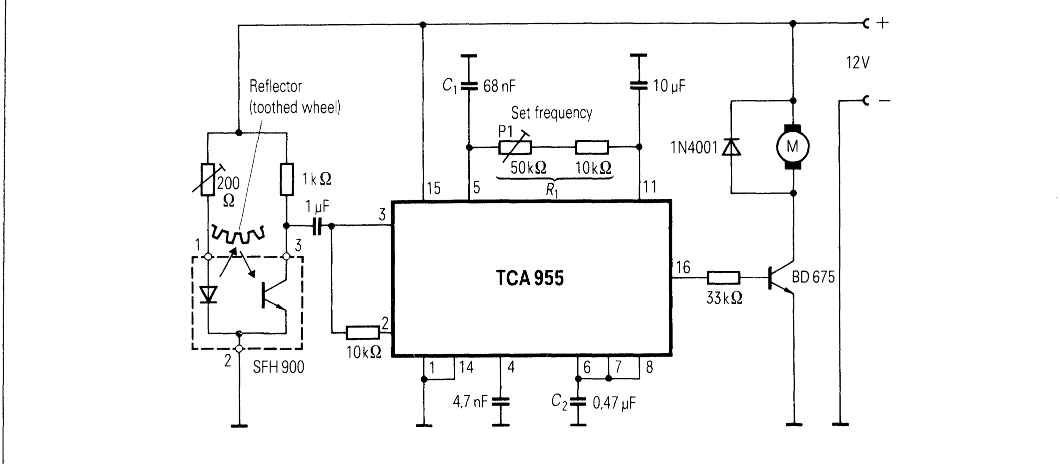
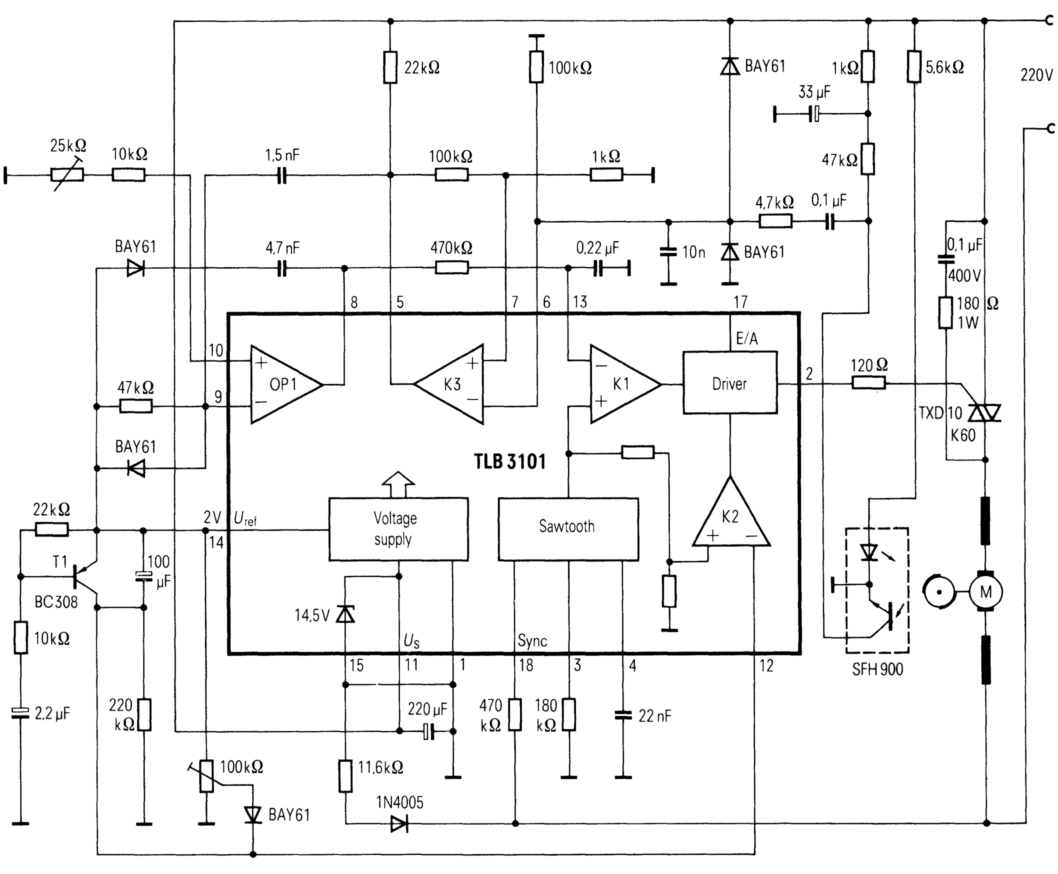


Fig. 11 Speed regulator for an ac motor using SFH 900 and TLB 3101



The rising edge of on square-wave (signal 1) is used for counting. It triggers a monoflop which generates a pulse of short duration relative to the square-wave period. The other, 90° shifted, square-wave controls the direction of the counter (Low = forward, High = backward).
According to the direction command, the conditions in **Fig. 13** come into effect. The active clock edge coincides with either the low level or the high level of signal 2. Counting therefore takes place in accordance with forward or backward rotation of the shaft. **Fig. 14** gives the detailed circuit diagram of the shaft encoder.
The counter used has a range of two decades and gives the BCD separately for each digit.
A 7-segment decoder-driver follows this for each of the two LED displays. The number of digits can be increased by cascading several stages.
For the purposes of explanation any bar in the pattern can be considered as the starting point and the counter reset to zero using the reset key. If now the disc is turned at any speed in either direction with respect to the stationary mark, the counter indicates the bar number difference with respect to the starting point. As only dc voltage coupling is used the rotational speed may have any arbitrary minimum value.

Fig. 13 Waveforms showing the operation of a shaft encoder with direction sensing

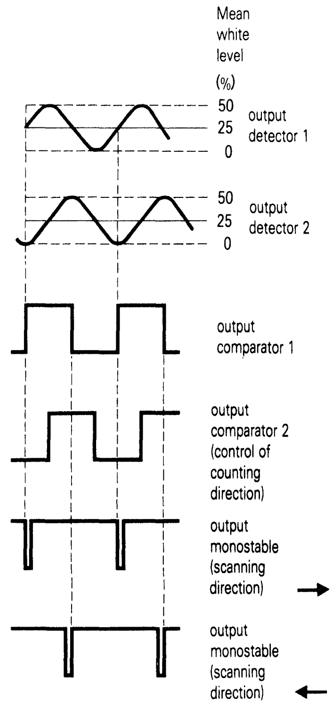


Fig. 12 Example of a patterned disc (a) and its counting grid (b)

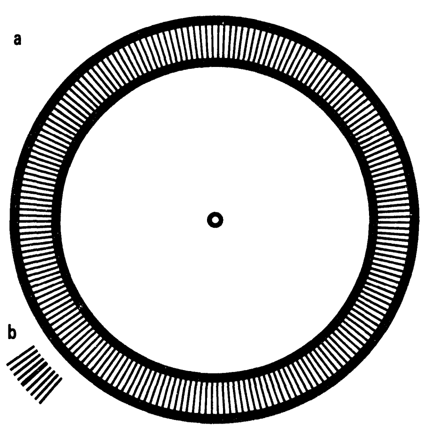
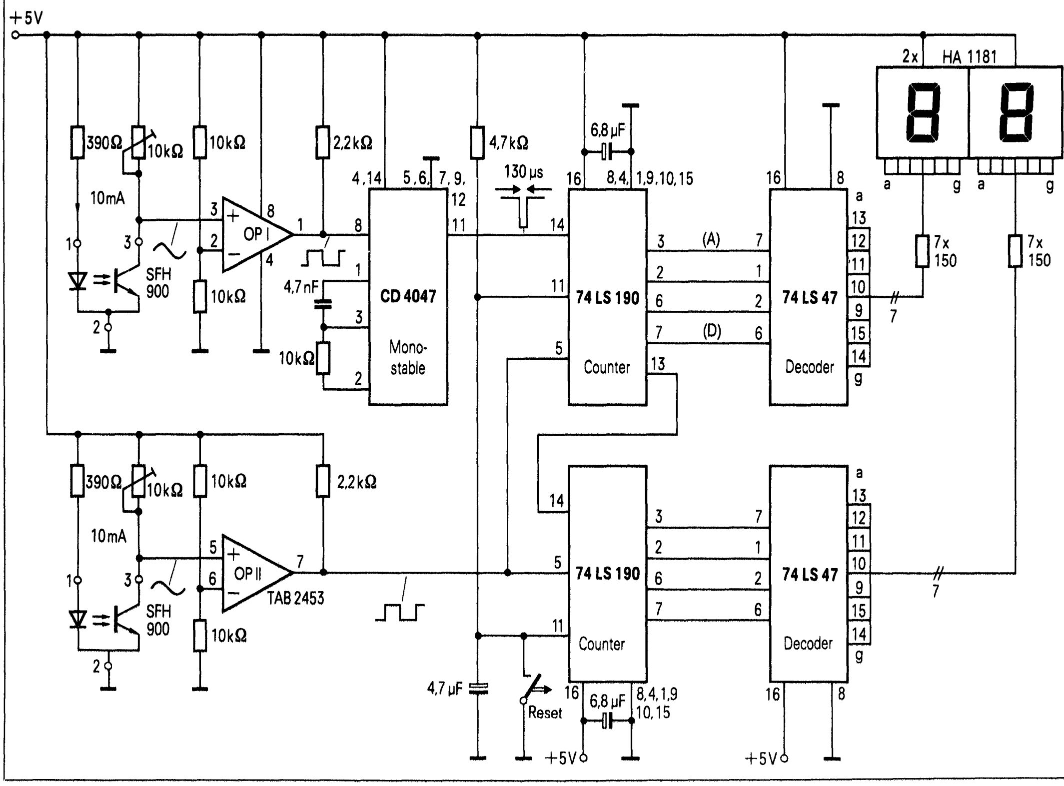


Fig. 14 SFH 900: circuit for shaft encoder with direction sensing



The DLX-413x 5x7 Dot Matrix Intelligent Display Appnote 28

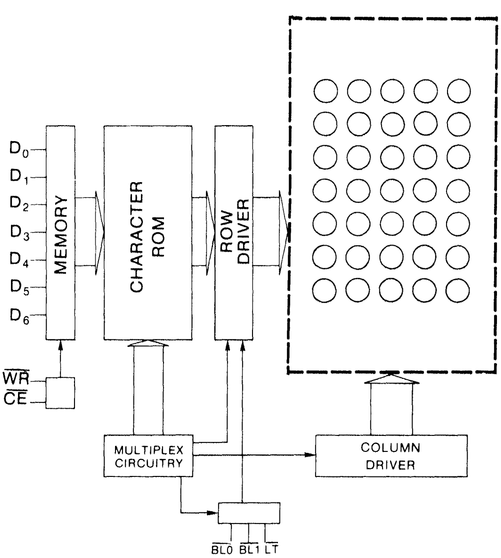
by Dave Takagishi

This application note is intended to serve as a design and application guide for users of the DLO-4135 and DLG-4137 Siemens Optoelectronics Division Intelligent Displays. The information presented covers device electrical description, operation, general circuit design considerations, and interfacing to microprocessors.

Electrical Description

If you have never designed a system using a dot matrix display before, you cannot appreciate the simplicity of using the DLX-413X Intelligent Alphanumeric 5x7 Dot Matrix Display. The intelligent display contains memory, character generator, multiplexing circuits, and drivers built into a single package.

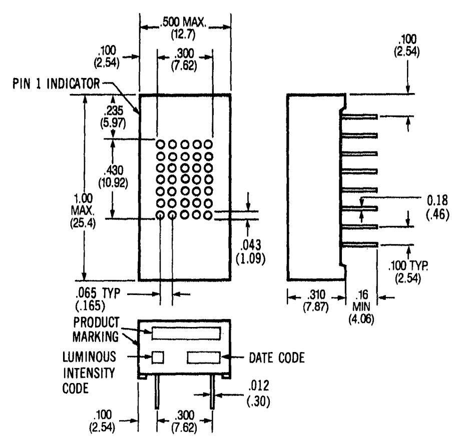
Figure 1 is a block diagram of the DLX-413X. The unit consists of 35 LED die arranged in a 5x7 pattern and a single CMOS integrated circuit chip. The IC chip contains the segment drivers, digit drivers, 96 character generator ROM, memory, multiplex and blanking circuitry.



DLX-413X BLOCK DIAGRAM
FIGURE 1

Package

The 35 dots form a 0.30 x 0.43 inch overall character size in a .500 x 1.00 inch dual-in-line package. The ±50 degree wide viewing angle complements the display and is the ideal display for the industrial control application. Display construction is a filled reflector type with the inregrated circuit in the back and then filled with IC-grade epoxy. This results in a very rugged part which is quite impervious to moisture, shock, and vibration.



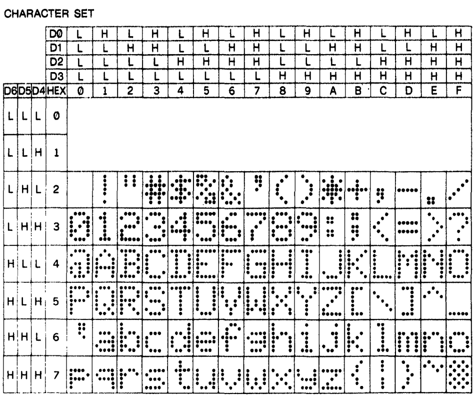
Physical Dimension Inches
FIGURE 2

Electrical Inputs

PIN	Name	PIN	Name
1	Vcc	14	D6 data input (msd)
2	$\overline{LT}$ lamp test	13	D5 data input
3	$\overline{CE}$ chip enable	12	D4 data input
4	$\overline{WR}$ write	11	D3 data input
5	$\overline{BL1}$ brightness	10	D2 data input
6	$\overline{BL0}$ brightness	9	D1 data input
7	GND	8	D0 data input (lsd)

Pin Description

Vcc	Positive Supply +5 volts
GND	Ground
D0-D6	Data Lines see figure 3 for character set
$\overline{CE}$	Chip Enable (active low) This determines which device in an array will accept data
$\overline{WR}$	Write (active low) Data and chip enable must be present and stable before and after the write pulse (see data sheet for timing)
$\overline{BL0}$,$\overline{BL1}$	Blanking Control Input (active low) Used to control the level of display brightness
$\overline{LT}$	Lamp Test (active low) Causes all dots to light at ½ brightness



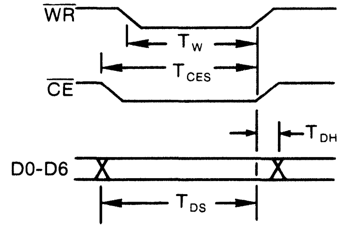
Character Set
Figure 3

Operation

In a dot matrix display system, it is advantageous to use a multiplexed approach with 12 drivers (5 digit + 7 segments) rather than 35 segment drivers. This obviously reduces the number of drivers and interconnections required. A multiplexed system must be a synchronous system or the digits or elements may have different on (lit) times and therefore varying brightness.

The **DLX-413x** is an internally multiplexed display but the data entry is asynchronous. Loading data is similar to writing into a RAM. Present the data, select the chip, and give a write signal. For a multi-digit system, each digit has its own unique location and will display its contents until replaced by another code.

The waveforms of figure 4 demonstrates the relationship of the signals required to generate a write cycle. Check the data sheet for minimum values required for each signal.



Timing Characteristics
Figure 4

Display Blanking and Dimming

The DLX-413x Intelligent Display has the capability of three levels of brightness plus blank. Figure 5 shows the combination of $\overline{BL0}$ and $\overline{BL1}$ for the different levels of brightness. The $\overline{BL0}$ and $\overline{BL1}$ inputs are independent of write and chip enable and does not affect the contents of the internal memory. A flashing display can be achieved by pulsing the blanking pins at a 1-2 hertz rate. Either $\overline{BL0}$ or $\overline{BL1}$ should be held high to light up the display.

Dimming and Blanking Control

Brightness Level	$\overline{BL1}$	$\overline{BL0}$
Blank	0	0
¼ brightness	0	1
½ brightness	1	0
full brightness	1	1

Lamp Test

The lamp test when activated causes all dots on the display to be illuminated at half brightness. It does not destroy any previously stored characters. The lamp test function is independent of chip enable, write, and the settings of the blanking inputs.

This convenient test gives a visual indication that all dots are functioning properly. Because of the lamp test not affecting the display memory, it can be used as a cursor or pointer in a line of displays.

General Design Considerations

When using the DLX-413x on a separate display board having more than 6 inches of cable length, it may be necessary to buffer all of the input lines. A non-inverting 74365 hex buffer can be used. The object is to prevent transient current into the DLX-413x protection diodes. The buffers should be located on the display board and as close to the displays as possible.

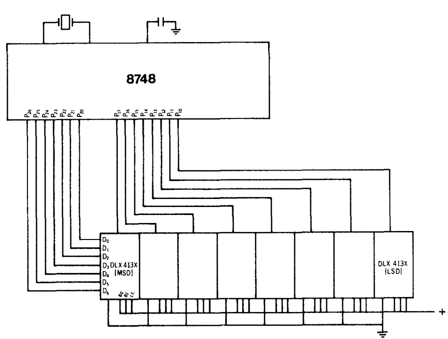
Because of high switching currents caused by the multiplexing, local power supply by-pass capacitors are also needed in many cases. These should be 6 or 10 volt, tantalum type having 5 - 10 uf capacitance. The capacitors may only be required every 6-7 displays depending on the line regulation and other noise generators.

If small wire cables are used, it is good engineering practice to calculate the wire resistance of the ground and the +5 volt wires. More than 0.2 volt drop (at 100ma per digit) should be avoided, since this loss is in addition to any inaccuracies or load regulation of the power supply.

The 5 volt power supply for the DLX-413x should be the same one supplying the Vcc to all logic devices. If a seprate power supply must be used, then local buffers should be used on all the inputs and these buffers should be powered from the display power supply. This precaution is to avoid line transients or any logic signals to be higher than Vcc during power up.

Interfacing

For an eight digit display using the DLX-413x, interfacing to a single chip microprocessor such as the 8748 is easy and straight forward. One approach may be to dedicate one port for the six data signals and another 8-bit port for the write signals. The schematic is shown in Figure 6.

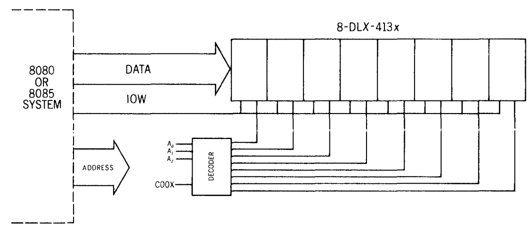


DLX-413x with 8748
Figure 6

```
                         ; SUBROUTINE TO LOAD AN 8-DIGIT
                         ; DISPLAY USING THE DL7135
                         ; DATA IN RAM 10H-17H (MSD-LSD)
INIT:   ORL   P1,#0FFH   ; PORT 1 ALL HIGH (WRITE)
        ORL   P2,#00H    ; PORT 2 ALL LOW (DATA)
        MOV   R1,#OFH    ; RAM ADDRESS — 1
        MOV   R2,#0FEH   ; WRITE PULSE
        MOV   R3,#08H    ; COUNTER
START:  INC   R1         ; INCREMENT RAM POINTER
DATA:   MOV   A,@R1      ; FETCH DATA FROM RAM
        OUTL  P2,A       ; LOAD PORT 2
        MOV   A,R2       ; RECALL WRITE
        RR    A          ; SHIFT A TO NEXT WRITE
        MOV   R2,A       ; SAVE WRITE
WRITE:  OUTL  P1,A       ; SEND WRITE PULSE
        MOV   A,#OFFH    ; WAIT
        OUTL  P1,A       ; RESET WRITE PULSE
        DJNZ  R3, START  ; LOAD COMPLETE?
        RET              ; RETURN TO MAIN PROGRAM
```

I/O or Memory Mapped System

For a memory mapped system using a processor such as the 8080 or 8085, the interfacing is also straight-forward. Each display is treated as a memory location with its own address, like another I/O or RAM location.



Block Diagram for 8-Digit
DLX-413x Dot Matrix Display
Figure 7

```
                        ; ROUTINE FOR AN 8 DIGIT DISPLAY
                        ; USING THE DLX-713x AND
                        ; 8085 OR 8080 MICROPROCESSOR

                        ; DATA TO BE DISPLAYED IS IN
                        ; A0(LSD) THRU A8(MSD)

                        ; DISPLAY ADDRESS C00X
                        ; LSD IS RIGHT MOST DIGIT

                        ; DOES NOT SAVE REG A,B,H,L,D,E

DADD    EQU   0A000H    ; DATA ADDRESS LOCATION
DPAD    EQU   0C000H    ; DISPLAY ADDRESS LOCATION
LEN     EQU   08H       ; DISPLAY LENGTH
                        ;
ORG     100H
                        ;
DISP:   LXI   H,DADD    ; LOAD DATA ADDRESS
        LXI   D,DPAD    ; LOAD DISPLAY ADDRESS
        MVI   B,LEN     ; LOAD DISPLAY LENGTH
DISP1:  MOV   A,M       ; GET DATA
        XCHG            ; XCHG H/L & D/E
        MOV   M,A       ; LOAD DISPLAY FROM REG A
        XCHG            ; RESTORE H/L & D/E
        INX   D         ; INCREMENT DISPLAY ADDRESS
        INX   H         ; INCREMENT DATA ADDRESS
        DCR   B         ; DECREMENT LENGTH COUNTER
        JNZ   DISP1     ; END OF DISPLAY?
        RET             ; RETURN TO MAIN PROGRAM
```

Conclusion

Note that although other manufacturer's products are not used in the examples, this application note does not imply specific endorsement, or warranty of other manufacturer's products by Siemens. The interface schemes shown demonstrate the simplicity of using the DLX-413x Dot Matrix Intelligent Display. Slight timing differences may be encountered for various microprocessors, but can be resolved similar to those encountered when using different RAM's. The techniques used in the examples were shown for their generality. The user will undoubtedly invent other schemes to optimize his particular system to its requirements.

Quality Assurance

The Quality Assurance Group at Siemens Optoelectronics Division serves a vital function in our organization, enabling the Division to maintain constant product quality standards. As such, Quality Assurance monitors and verifies all aspects of production, ensuring that all materials, processes, manufacturing and test equipment, and piece parts meet precise engineering specifications. Quality Assurance activities begin with carefully assessing the quality of raw materials. QA work continues through in-process monitoring, and concludes with outgoing audits as outlined below:

■ **Raw Material**
- —Vendor surveys
- —Vendor qualifications
- —Incoming inspections
- —Vendor rating systems

■ **In-process Monitors**
- —Die attach monitors
- —Lead bond monitors
- —Encapsulation monitors
- —Finishing operations monitors

■ **Outgoing Audits**
- —Outgoing audits (all lots)
- —Finished goods monitor (random)

Figure 2 further exemplifies the basic quality control procedures employed by the Division in the production of LEDs.

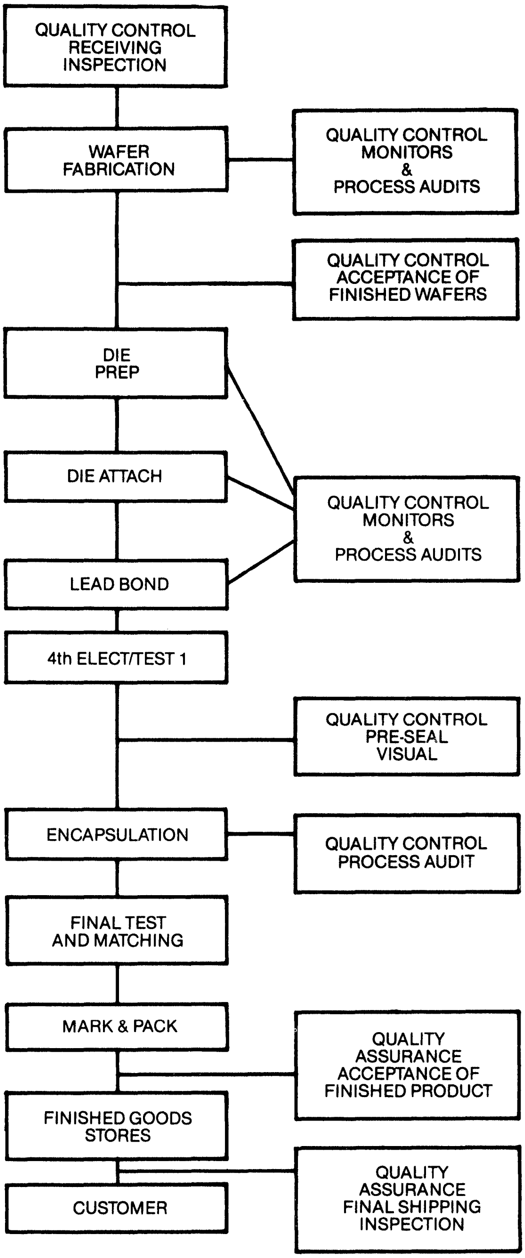


Figure 2 LED Quality Assurance Flowchart

Reliability

The fundamental objective of the Reliability program at Siemens Optoelectronic Division is to quantitatively/qualitatively determine that all products produced by the Division meet or exceed the performance requirements of our Engineering Group and our customers. To ensure achievement of this goal, the Reliability group constantly monitors products by generic groups. Routine monitoring provides continually updated measurement of product reliability in specific operating environments. Typical tests include temperature cycling, thermal shock, temperature and humidity, high-temperature burn-in, solder-heat test, high- and low-temperature storage and intermittent operating life.

Standard Reliability Matrix Test Format

Temperature Cycle: 100 Cycles from −40 °C to 100 °C
Thermal Shock: 30 Cycles from 0 °C to 100 °C
Ambient Life Test: Max rated power for 1000 hours
Elevated Life Test: Max rated power at 70 °C for 1000 hours.
High Temperature Storage: Max storage temperature, 1000 hours
Low Temperature Storage: Minimum storage temperature, 1000 hours
Temperature Humidity: 85 °C - 85% RH, 500 hours
Solder Heat Test: 260 °C, 5 seconds

Reliability test equipment ranges from multiple burn-in racks and table testers to a scanning electron-beam microscope. We've even designed and produced our own automatic microprocessor-based read/record tester.

Figure 4 Reliability Test Data (1982-1983 Monitoring Data)

Type of Test	Lamps	Standard Displays	Intelligent Displays	Opto-isolators
Temperature Cycle (100 CY)				
Sample Size	467	1031	2084	2236
Total Cycles	47K	103K	208K	2236
Total Reject	0	0	5	0
Percent Reject	0.0%	0.0%	0.2%	0.0%
Thermal Shock (30 CY)				
Sample Size	466	976	1228	1468
Total Cycles	14K	29K	37K	44K
Total Reject	0	0	0	3
Percent Reject	0.0%	0.0%	0.0%	0.3%
Room Temperature Burn-In (1000 Hrs)				
Sample Size	110	492	525	294
Total Hours	110K	492K	525K	294K
Total Reject	0	0	0	1
FR* (%)	0.0%	0.0%	0.0%	0.3%
High Temperature Burn-In (1000 Hrs)				
Sample Size	110	222	525	492
Total Hours	110K	222K	525K	492K
Total Reject	0	0	1	1
FR*	0.0%	0.0%	0.2%	0.2%
Solder Heat Test (260 °C, 5 sec.)				
Sample Size	253	456	853	478
Total Reject	0	0	1	0
Percent Reject	0.0%	0.0%	0.1%	0.0%

*FR = Failure Rate, % per 1000 hours.

Special testing covers a broad spectrum of environmental and life-stress tests. How well a sample performs under these highly-accelerated conditions indicates its reliability potential under service-life conditions.

Special testing affords us vital information in many important areas:

- New product performance
- New processes
- New manufacturing technique
- New material quality
- Special customer specifications
- Long-term reliability prediction

Reliability is also concerned with failure analysis.
To determine the cause of failure, we selectively test and section products to localize and identify their failure mechanism. Selective isolation enables us to gauge the precise effects of stresses induced during reliability testing.

Figure 5 Description of Tests - Reliability Monitor Program

Type of Test	Military Standard	Pre Test Readings	Test	Post Test Readings
Temp Cycle (T/C)	MIL STD 883B, Method 1010.2	GO/NO GO	10 cycles per sub group, 15 min. dwell, 5 sec. transfer time, max. storage temp. ranges vary by product	GO/NO GO
Thermal Shock (T/S)	MIL STD 883B, Method 1011.1	GO/NO GO	30 cycles: boiling water; then ice water with 5 min. dwell time at each extreme	GO/NO GO
Life Test (L/T)	MIL STD 833B, Method 1005.2	Read/Record	Room temperature burn-in at max. rated conditions, 1000 hours duration	Read/Record at 168,500 and 1000 hours
High Temp Burn In (HI BI)	MIL STD 883B, Method 1005.2	Read/Record	Maximum rated operating temp. determined from product spec. and derated current as compensation for thermal dissipation, 1000 hours duration	Read/Record at 168,500 and 1000 hours
Solder Heat Test	—	GO/NO GO	Temp = 260 °C, dwell time = 5 seconds	GO/NO GO

Conclusion

Siemens Optoelectronic Division is firmly committed to the design, development and production of innovative optoelectronic components and assemblies of the highest quality and reliability. Working to achieve this goal, every group within the Division—Management, Engineering, R & QA, Manufacturing—provides a vital service, enabling us to achieve and maintain the consistent product quality and levels of reliability required by our customers in the electronics industry.

Due in large part to the efforts of the Reliability and Quality Assurance department and our successful PPM and SQC efforts, Siemens Optoelectronic Division will continue to maintain its leadership position in a highly competitive future-oriented industry.

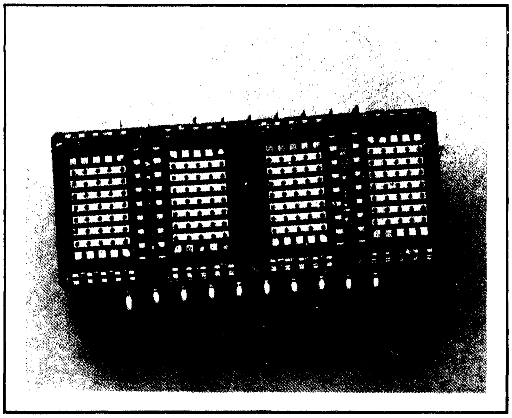
For complete reliability information please request booklet, "Quality Assurance Paper."

SIEMENS

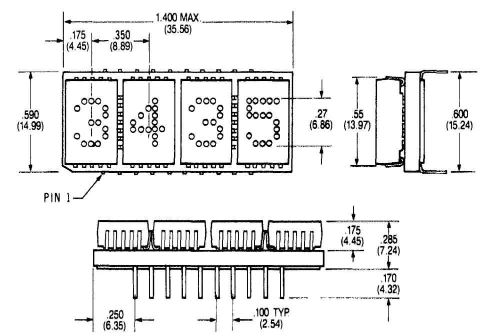
PD-3435
HER (Orange)
PD-3437
Green

.270" 4-Character, 5x7 Dot Matrix ALPHANUMERIC Programmable Display™ With Built-In CMOS Control Functions

Advance Data Sheet



Package Dimensions in Inches (mm)



ORDERING CODE (for Europe only)
PD 3435 Q 68000-A4462-F114
PD 3437 Q 68000-A4463-F114

FEATURES

- **Built-In Memory, Decoders, Multiplexer and Drivers**
- **8-Bit Bidirectional Data BUS**
- **READ/WRITE Capability**
- **Four .27" character subassemblies, surface mounted on ceramic substrates**
- **Dual In-line package configuration, 600 mil wide, 100 mil pin centers**
- **End-Stackable Package**
- **Internal or External Clock**
- **Viewing Angle ±50°**
- **96-Character ASCII Format**
- **Built-In Character Generator ROM**
- **TTL Compatible**
- **Easily Cascaded for Multidisplay Operation**
- **Less CPU Time Required**
- **Software Controlled Features:**
  - **Programmable Highlight Attribute (Blinking, Non-blinking)**
  - **Asynchronous Memory Clear Function**
  - **Lamp Test**
  - **Display Blank Function**
  - **Single or Multiple Character Blinking Function**
  - **Programmable Intensity, Three Brightness Levels**

GENERAL DESCRIPTION

The PD-3435 (high efficiency red/orange) and PD-3437 (green) are four-digit dot matrix Programmable Displays that are aimed at satisfying the most demanding dot matrix requirements. The devices are constructed in a hybrid fashion using four .27-inch-high surface-mounted 5x7 displays. The devices incorporate the latest in CMOS technology which is the heart of the device intelligence. The CMOS controller chip is so organized that the ASCII data and attribute data are word driven and is controlled by a user supplied eight-bit data word on the bidirectional BUS. This approach makes the PD-3435 and PD-3437 interface using the same techniques as a microprocessor peripheral.

Important: Refer to Appnote 18, "Using and Handling Intelligent Displays". Since this is a CMOS device, normal precautions should be taken to avoid static damage.

Specifications are subject to change without notice.

OPTOELECTRONIC CHARACTERISTICS AT 25°C

MAXIMUM RATINGS	
DC Supply Voltage	−0.5 to +6.0 Vdc
Input Voltage Levels Relative to GND (all inputs)	−0.5 to V_{CC} + 0.5 Vdc
Operating Temperature	−20°C to +70°C
Storage Temperature	−20°C to +70°C
Relative Humidity @ 60°C	90%

OPTICAL CHARACTERISTICS @ 25°C	
Spectral Peak Wavelength	(3435) 635nm Typ.
	(3437) 565nm Typ.
Viewing Angle	±50°
Digit Size	0.27 inch high
Luminous Intensity	Min. 50 μcd/dot @ V_{CC} = 5 Vdc
Dot-to-Dot Intensity Matching	Max. 1.8:1.0

DC CHARACTERISTICS

Parameters	Conditions	Limits Min.	Limits Typ.	Limits Max.	Units
V_{CC}		4.5		5.5	Volts
I_{CC} Blank (All Inputs Low)	V_{CC} = 5V V_{IN} = .8V WR = 5V			45	mA
I_{CC} Lamp (½ Brightness)			42		mA
I_{CC} 80 dots/unit (100% Bright)	Va = 5.0V		160	192	mA
V_{IL} (All Inputs)	V_{CC} = 5V	−0.5		0.8	Volts
V_{IH} (All Inputs)	V_{CC} = 5V	2.4		5.5	Volts
I_{IL} (All Inputs)	V_{CC} = 5V V_{IN} = 0.8V			100	μA

Note 1: Average LED drive current is 2 mA. Peak current at 1/7 multiplex rate is 14 mA.

SWITCHING SPECIFICATIONS (@ 25°C and V_{CC} = 4.5V)

READ CYCLE TIMING

Parameter	Description	Specification (ns) Minimum
TAD	Address delay after $\overline{CE0}$, CE1, and $\overline{RD}$ are stable	0
TAS	Address stable time	125
TDD	Delay before data is valid	75 max.
TDH	Data hold valid after address	50 max.
TRC	Total cycle time	200

WRITE CYCLE TIMING

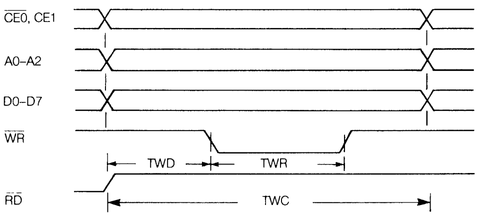
Parameter	Description	Specification (ns) Minimum
TWD	Write delay after $\overline{CE0}$, CE1, and Data Stable	50
TWR	Write pulse	100
TWC	Total write cycle	200

OUTPUT ENABLE TIMING

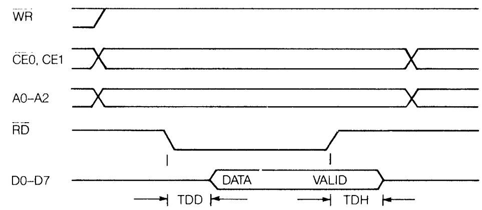
Parameter	Description	Specification (ns)
TDD	Data bus enabled	100
TDH	Data hold valid after read	50

TIMING CHARACTERISTICS AT 25°C

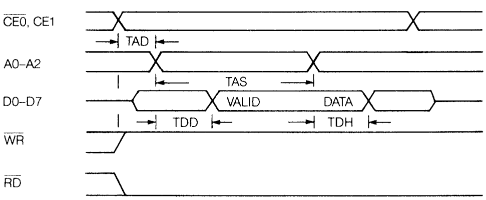
DATA WRITE CYCLE TIMING WAVEFORMS



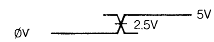
OUTPUT ENABLE TIMING



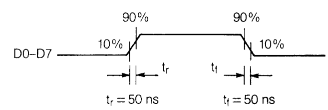
DATA READ CYCLE TIMING WAVEFORMS



TIMING MEASUREMENT LEVELS



DATA BUS TRANSITIONS (@ 25°C, $C_L = 150$ pF)



FUNCTIONAL DESCRIPTION

The PD-3435 (PD-3437) block diagram includes the major blocks and internal registers. Display memory consists of a 5x8 bit RAM block. Each of the four 8-bit words holds the 7-bit ASCII data (bits D0–D6). The fifth 8-bit memory word is used as control word register. A detailed description of the control register and its functions can be found under the heading Control Word Register. Each 8-bit word is addressable and can be read from or written to.

There are five major blocks in addition to the memory. The first is the control word decoder and control logic which dictates all of the special features of the display device and is discussed in the Control Word Register paragraph on the next page.

The second block is the character generator ROM. This ROM converts the 7-bit ASCII data into the proper dot pattern for the 96 characters as shown in the character set chart.

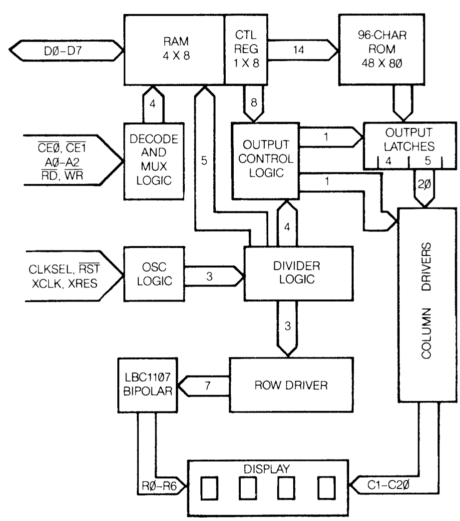
The third block is the display multiplexer and timing logic. The clock source can be either from the internal clock or from an external source—usually from the output of another PD-3435 (PD-3437) in a multiple module display. The multiplexer controls all display output to the digit drivers so no additional logic is required for a display system.

The fourth block is the display drivers themselves. The column drivers are located on the CMOS IC and connected directly to the LEDs.

The fifth block is the LEDs. Each of the four digits is comprised of 35 LEDs which make up the alphanumeric characters.

The intensity of the display can be varied by the control word in steps of Blank, 25%, 50%, and full brightness.

BLOCK DIAGRAM



DATA INPUT VS CONTROL WORD INPUT

If Address line (A2) is high during the write cycle, then the information on the data lines will be loaded into the data registers. If (A2) is low, the information will be loaded into the control word register.

D7 Defined

Bit (D7) of the data word can control several functions in the PD-3435 (PD-3437).

1. As part of the control word data, D7 will clear the memory of all previously loaded data.

2. As part of the normal ASCII data, D7 is now a control bit and its function will be determined by the control word loaded and being acted on by that control word.

2a. Control word functions acted on because of D7.
  A. All functions with cursors in Table 3.
  B. Enable blinking character.

A2 Defined

At first glance A2 might be mistakenly used as an address bit. But this is not needed, because the PD-3435 is a four-digit device. In the PD-3435 (PD-3437) A2 is used for mode selection (see Table 4) to determine if the data being loaded is ASCII data or control word data.

1. A2 = 'H' = ASCII data
2. A2 = 'L' = Control word data

CONTROL WORD REGISTER

The control word is addressed by holding line A2 low. The states of the other two address lines (A0–A1) do not matter. The control word can be read from or written to. The Truth Table 2 defines each of the data bits and their functions.

Bits D0 and D1 control the display brightness (see Truth Table 1). Bits D2, D3 and D4 control the Highlight Attribute function. Bit D5 controls blinking. Bit D6 is a lamp test bit. Bit D7 clears the memory display.

BRIGHTNESS—TRUTH TABLE 1

D0	D1	Operation
0	0	0% Blank
1	0	25% Brightness
0	1	50% Brightness
1	1	100% Brightness

DATA INPUT COMMANDS—TRUTH TABLE 2

$\overline{CE0}$	CE1	$\overline{RD}$	$\overline{WR}$	A2	A1	A0	D0	D1	D2	D3	D4	D5	D6	D7	OPERATION
1	0	X	X	X	X	X	X	X	X	X	X	X	X	X	No Change
0	1	0	1	1	0	0	X	X	X	X	X	X	X	X	Read Digit 0 Data To Bus
0	1	1	0	1	0	0	0	0	1	0	0	1	0	X	($) Written To Digit 0
0	1	1	0	1	0	1	1	1	1	0	1	0	1	X	(W) Written To Digit 1
0	1	1	0	1	1	0	0	1	1	0	0	1	1	X	(f) Written To Digit 2
0	1	1	0	1	1	1	1	1	0	0	1	1	0	X	(3) Written To Digit 3
0	1	1	0	1	0	0	X	X	X	X	X	X	X	1	Char. Written To Digit 0 And Cursor Enabled

MICROPROCESSOR INTERFACE

The interface to the microprocessor is through the address lines (A0–A1), the data bus (D0–D7), two chip select lines ($\overline{CE0}$, CE1), read ($\overline{RD}$) and write ($\overline{WR}$) lines, and control bit (A2).

Two chip enable lines are provided to simplify address decoding. $\overline{CE0}$ must be low, while CE1 must be high for any read or write operation to take place.

The read and write lines are both active low. During a valid read, i.e., chip enable ($\overline{CE0}$) and read low, the data input lines (D0–D7) become outputs. A valid write will enable the data as input lines.

The address lines determine which RAM or RAM position will be read or written. If A2 is high, then A0–A1 determine the display RAM position. If A2 is low, then the operation will be to the control register regardless of the A0–A1 address lines.

CONTROL COMMANDS—TRUTH TABLE 3

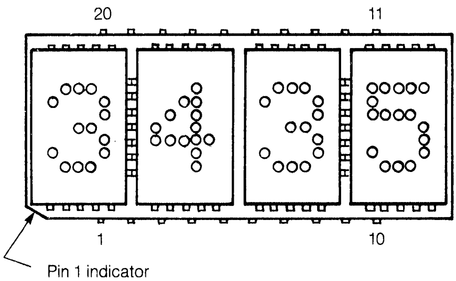
$\overline{CE0}$	CE1	$\overline{RD}$	$\overline{WR}$	A2	A1	A0	D0	D1	D2	D3	D4	D5	D6	D7	OPERATION
0	1	1	0	0	X	X	X	X	X	X	X	X	X	1	Clear Data In All Digits
0	1	1	0	0	X	X	X	X	X	X	X	X	1	0	Lamp Test At 50% Brightness
0	1	1	0	0	X	X	X	X	X	X	X	1	0	0	Blink Display At 2 Hz
0	1	1	0	0	X	X	%	%	X	X	0	0	0	0	Disable Cursor (D5 = 0)
0	1	1	0	0	X	X	%	%	0	0	1	0	0	0	Enable Cursor (Non-Blinking)
0	1	1	0	0	X	X	%	%	1	0	1	0	0	0	Enable Blinking (Character)
0	1	1	0	0	X	X	%	%	0	1	1	0	0	0	Enable Blinking (Cursor)
0	1	1	0	0	X	X	%	%	1	1	1	0	0	0	Enable Alternate Character/Cursor

MODE SELECTION—TRUTH TABLE 4

$\overline{CE0}$	CE1	$\overline{RD}$	$\overline{WR}$	A2	A1	A0	D0	D1	D2	D3	D4	D5	D6	D7	OPERATION
X	X	0	0	X	X	X	X	X	X	X	X	X	X	X	Illegal
1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	No Change
X	0	X	X	X	X	X	X	X	X	X	X	X	X	X	No Change
X	X	1	1	X	X	X	X	X	X	X	X	X	X	X	No Change
0	1	1	0	1											Write Display Data To RAM
0	1	0	1	1			———SEE TRUTH TABLE 2———								Read Display Data From RAM
0	1	1	0	0	X	X	X								Write Control Data To Control Word Register
0	1	0	1	0	X	X	X —SEE TRUTH TABLE 3—								Read Data From Control Word Register

NOTE: 0 = Low Logic Level, 1 = High Logic Level, X = Don't Care. For Brightness Control Code (%), see Truth Table 1.

TOP VIEW



PIN ASSIGNMENTS

PD-3435, PD-3437 PINOUT			
Pin	**Function**	**Pin**	**Function**
1 $\overline{RD}$	READ	11 $\overline{WR}$	WRITE
2 CLK I/O	CLOCK I/O	12 D7	DATA MSB
3 CLKSEL	CLOCK SELECT	13 D6	DATA
4 ★	$\overline{RESET}$	14 D5	DATA
5 CE1	CHIP ENABLE	15 D4	DATA
6 $\overline{CE0}$	CHIP ENABLE	16 D3	DATA
7 A2	MODE SELECT	17 D2	DATA
8 A1	ADDRESS	18 D1	DATA
9 A0	ADDRESS	19 D0	DATA LSB
10 GND		20 V_{CC}	

★ Currently NC, but will be $\overline{RESET}$ in the future

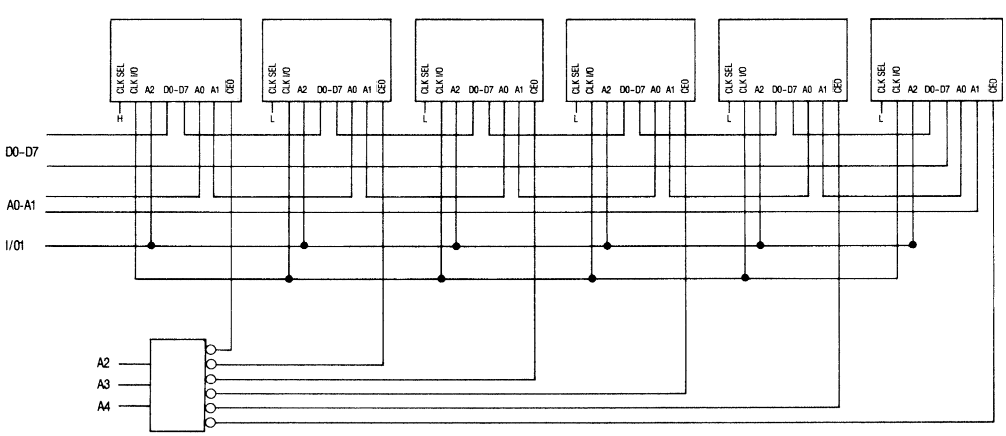
PIN DEFINITIONS

Pin

1. $\overline{RD}$ — Active low, will enable to read all registers in the PD-3435 (PD-3437).
2. CLK I/O — If CLK SEL (pin 3) is low, then expect an external clock source into this pin. If CLK SEL is high, then this pin will be the master or source for all the other devices which have CLK SEL low.
3. CLK SEL — CLock SELect, determines the action of pin 2. CLK I/O, see the section on Cascading for an example.
4. N/C — No Connection. In the future this pin will become $\overline{RESET}$
5. CE1 — Chip enable (active high).
6. $\overline{CE0}$ — Chip enable (active low).
7. A2 — Selects whether read/write from/to display memory (high) or read/write from/ to control word register (low).
8. A1 — Address input.
9. A0 — Address input.
10. Gnd — Ground.
11. $\overline{WR}$ — Write Active Low. If the device is selected, a low on the write input loads the data into the PD-3435's (PD-3437's) memory.
12. D7 — Data Bus bit 7 (MSB).
13. D6 — Data Bus bit 6.
14. D5 — Data Bus bit 5.
15. D4 — Data Bus bit 4.
16. D3 — Data Bus bit 3.
17. D2 — Data Bus bit 2.
18. D1 — Data Bus bit 1.
19. D0 — Data Bus bit 0 (LSB).
20. V_{CC} — Plus 5 volts power pin.

CASCADING

Cascading PD-3435s (PD-3437s) is a simple operation. The requirements for cascading are: 1) decoding the correct address to determine the chip select for each additional device. 2) selecting one display as the clock source and setting all others to accept clock input (the reason for cascading the clock is to synchronize the flashing of multiple displays). One display as a source is capable of driving six other PD-3435s (PD-3437s)—with each input having 15pf input capacitance. If more displays are required, a buffer will be necessary.



CASCADING THE PD-3435 (PD-3437)

HOW TO LOAD INFORMATION INTO THE PD-3435 (PD-3437)

Information loaded into the PD-3435 can be either ASCII data or control word data. The following procedure (see also typical loading sequence) will demonstrate a typical loading sequence and the resulting visual display. The word STOP is used in all of the following examples.

SET BRIGHTNESS

Step 1 Set the brightness level of the entire display to your preference (example: 100%).

LOAD FOUR CHARACTERS

Step 2 Load an "S" in the left-hand digit.

Step 3 Load a "T" in the next digit.

Step 4 Load an "O" in the next digit.

Step 5 Load a "P" in the right-hand digit.

If you loaded the information correctly, the PD-3435 should now show the word "STOP."

BLINK A SINGLE CHARACTER

Step 6 Into the digit, second from the right, load the hex code "CF," which is the code for an "O" with the D7 bit added as a control bit.

NOTE: the "O" is the only digit which has the control bit (D7) added to normal ASCII data.

Step 7 Load enable blinking character into the control word register.

The PD-3435 should now display "STOP" with a flashing "O."

ADD ANOTHER BLINKING CHARACTER

Step 8 Into the left hand digit, load the hex code "D3" which is for an "S" with the D7 bit added as a control bit.

The PD-3435 should display "STOP" with a flashing "O" and a flashing "S."

ALTERNATE CHARACTER/ CURSOR ENABLE

Step 9 Load enable alternate character/cursor into the control word register.

The PD-3435 should now display "STOP" with the "O" and the "S" alternating between the letter and a cursor (which is all dots lit).

INITIATE FOUR-CHARACTER BLINKING

(Regardless of Control Bit setting)

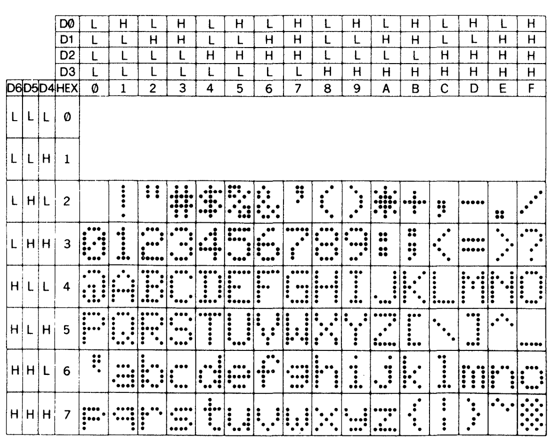
Step 10 Load enable display blinking.

The PD-3435 should now display the entire word "STOP" blinking.

TYPICAL LOADING SEQUENCE

	$\overline{CE0}$	CE1	$\overline{RD}$	$\overline{WR}$	A2	A1	AØ	DØ	D1	D2	D3	D4	D5	D6	D7
1.	L	H	H	L	L	X	X	1	1	0	0	0	0	0	0
2.	L	H	H	L	H	H	H	1	1	0	0	1	0	1	0
3.	L	H	H	L	H	H	L	0	0	1	0	1	0	1	0
4.	L	H	H	L	H	L	H	1	1	1	1	0	0	1	0
5.	L	H	H	L	H	L	L	0	0	0	0	1	0	1	0
6.	L	H	H	L	H	L	H	1	1	1	1	0	0	1	1
7.	L	H	H	L	L	X	X	1	1	1	0	1	0	0	0
8.	L	H	H	L	H	H	H	1	1	0	0	1	0	1	1
9.	L	H	H	L	L	X	X	1	1	1	1	1	0	0	0
10.	L	H	H	L	L	X	X	1	1	0	0	0	1	0	0

CHARACTER SET

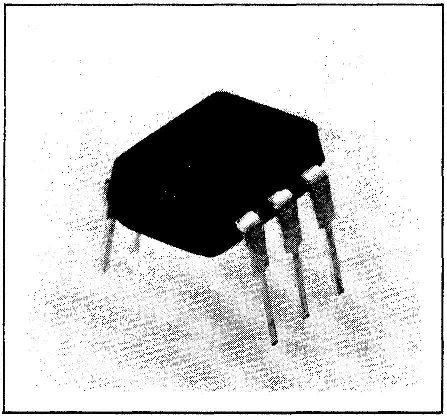


SIEMENS

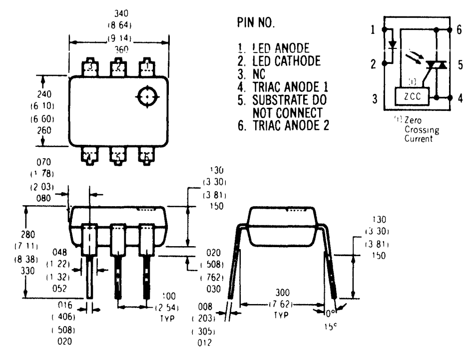
IL-410

ZERO CROSSING PHOTOTRIAC OPTO-ISOLATOR

Advance Data Sheet



Package Dimensions in Inches (mm)



FEATURES

- **Very High Blocking Voltage: V_{DRM} = 600 V**
- **Very High Output Interference Immunity: Static and Commutating dv/dt, 2000 V/μs (typ)**
- **Very High Input Sensitivity: I_{FT} (typ) < 5 mA**
- **Zero Voltage Crossing Detector: V_{IH} < 20 V**
- **Very Low Leakage Current: < 10 μA (typ)**
- **High Isolation Voltage: V_{ISO} = 4.4 KV_{AC}**
- **Uses MOSFET Technology**
- **Inverse Parallel SCRs Output**
- **Small 6-Pin Dip Package**
- **UL Approval #E52744**

DESCRIPTION

The IL-410 consists of a GaAs IRLED optically coupled to an output chip integrating an NPN phototransistor driving a MOSFET transistor. The MOSFET, in turn, triggers the integrated SCR driver. The addition of the MOSFET interface reduces the light output of the IRLED required to trigger the triac, yielding a very high input sensitivity compared to bipolar devices. This low I_F will permit off-line loads to be driven directly from a microprocessor. A zero-crossing circuit limits triac triggering to the zero-crossing point of the AC line.

The IL-410 offers a significant increase in both static and commutating dv/dt, improving interference immunity to false triggering. MOS technology yields static dv/dt ratings typically 2000 V/μs for improved protection from transient voltage spikes on the AC line. The very high commutating dv/dt due to the MOS technology and the inverse-parallel SCR arrangement will permit elimination of snubber networks required when controlling inductive loads.

The 600 V blocking voltage will permit control of off-line voltages up to 240 VAC with a safety factor greater than two and is sufficient for even 380 VAC.

The IL-410 isolates low-voltage logic from 120 and 220 VAC lines to control resistive, inductive or capacitive loads including motors, solenoids, high current thyristors or triacs and relays. Applications include solid-state relays, industrial controls, office equipment and consumer appliances.

Maximum Ratings

Parameter	Symbol	Max
GaAs IRLED		
Reverse Voltage (@ 100 μA)	V_R	6.0 V
Forward Current	I_F	60 mA
Forward Surge Current	I_{FSM}	1.5 A
Total Power Dissipation	P_D	100 mW
Derating Factor (above 25°C)		1.33 mW/°C
Output Driver (TRIAC)		
Off-State Output Terminal Voltage	V_{DRM}	600 V
On-State RMS Current	$I_{T\,(RMS)}$	135 mA
Peak Non-Repetitive Surge Current	I_{TSM}	1.2 A
Total Power Dissipation	P_D	300 mW
Derating Factor (above 25°C)		4.0 mW/°C
Total Package		
Isolation Surge Voltage	V_{ISO}	4.4 KVAC (t = 1m)
Total Power Dissipation	P_D	325 mW
Storage Temperature	T_{stg}	−55°C to +150°C
Operating Temperature	T_A	−55°C to +100°C
Lead Soldering Temperature		260°C for 5s.

Electrical Characteristics (T_{amb} = 25°C)

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions
LED Characteristics						
Forward Voltage	V_F		1.3	1.5	V	$I_F = 60$ mA
Reverse Current	I_R		0.1	10	μA	$V_R = 6$ V
Output Detector Characteristics						
Peak Blocking Current (Note 1)	I_{DRM1}		10	100	μA	$V_{DRM} = 600$ V
Peak On-State Voltage (Note 1)	V_{TM}		1.8	3.0	V	$I_{TM} = 100$ mA
Critical Rate Rise Off-State Voltage (Note 2)	dv/dt		2000		V/μs	$V_{DRM} = 400$ V
Critical Rate Rise Commutating Voltage (Note 2)	dv/dt		2000		V/μs	$V_{DRM} = 400$ V
Coupled Characteristics						
LED Trigger Current	I_{FT}		2	10	mA	$V_{AK} = 5$ V
Holding Current	I_H		65	200	μA	
Zero Crossing Characteristics						
Inhibit Voltage (Note 3)	V_{IH}		12	20	V	I_F = Rated I_{FT}
Leakage Current	I_{DRM2}			10	μA	$V_{DRM} = 120$ V

Notes:
1—Either direction.
2—Both directions.
3—Voltage above which the device will not turn on.

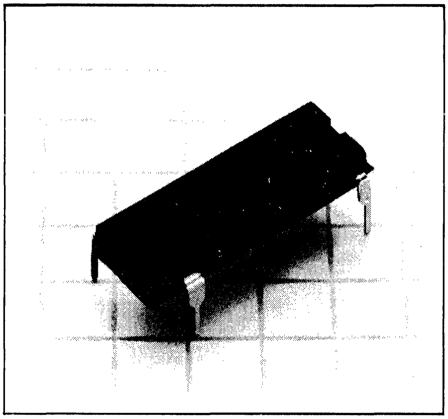
Specifications are subject to change without notice.

SIEMENS

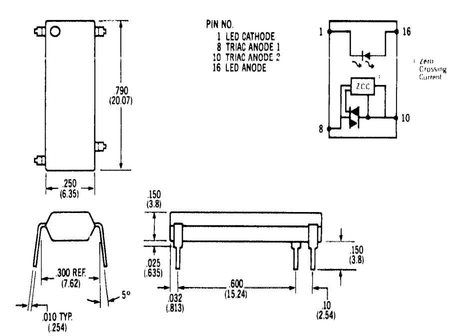
IL-416

ZERO CROSSING PHOTOTRIAC OPTO-ISOLATOR

Advance Data Sheet



Package Dimensions in Inches (mm)



FEATURES

- **Very High Blocking Voltage: $V_{DRM}=600$ V**
- **Very High Output Interference Immunity: Static and Commutating dv/dt, 2000 V/μs (typ)**
- **Very High Input Sensitivity: I_{FT} (typ) <5 mA**
- **Zero Voltage Crossing Detector: V_{IH} <20 V**
- **Very Low Leakage Current: <10 μA (typ)**
- **High Isolation Voltage: $V_{ISO}=3.5$ KV_{AC}**
- **Uses MOSFET Technology**
- **Inverse Parallel SCRs Output**
- **Designed to Meet VDE Requirements**
- **TO-116 Pinout**

DESCRIPTION

The IL-416 consists of a GaAs IRLED optically coupled to an output chip integrating an NPN phototransistor driving a MOSFET transistor. The MOSFET, in turn, triggers the integrated SCR driver. The addition of the MOSFET interface reduces the light output of the IRLED required to trigger the triac, yielding a very high input sensitivity compared to bipolar devices. This low I_F will permit off-line loads to be driven directly from a microprocessor. A zero-crossing circuit limits triac triggering to the zero-crossing point of the AC line.

The IL-416 offers a significant increase in both static and commutating dv/dt, improving interference immunity to false triggering. MOS technology yields static dv/dt ratings typically 2000 V/μs for improved protection from transient voltage spikes on the AC line. The very high commutating dv/dt due to the MOS technology and the inverse-parallel SCR arrangement will permit elimination of snubber networks required when controlling inductive loads.

The 600 V blocking voltage will permit control of off-line voltages up to 240 VAC with a safety factor greater than two and is sufficient for even 380 VAC.

The IL-416 isolates low-voltage logic from 120 and 220 VAC lines to control resistive, inductive or capacitive loads including motors, solenoids, high current thyristors or triacs and relays. Applications include solid-state relays, industrial controls, office equipment and consumer appliances.

The device is packaged in a 16-lead DIP package with only four external leads.

Maximum Ratings

Parameter	Symbol	Max
GaAs IRLED		
Reverse Voltage (@ 100 μA)	V_R	6.0 V
Forward Current	I_F	60 mA
Forward Surge Current	I_{FSM}	1.5 A
Total Power Dissipation	P_D	100 mW
Derating Factor (above 25°C)		1.33 mW/°C
Output Driver (TRIAC)		
Off-State Output Terminal Voltage	V_{DRM}	600 V
On-State RMS Current	$I_{T\,(RMS)}$	135 mA
Peak Non-Repetitive Surge Current	I_{TSM}	1.2 A
Total Power Dissipation	P_D	300 mW
Derating Factor (above 25°C)		4.0 mW/°C
Total Package		
Isolation Surge Voltage	V_{ISO}	3536 VAC (t = 1m)
Total Power Dissipation	P_D	325 mW
Storage Temperature	T_{stg}	−55°C to +150°C
Operating Temperature	T_A	−55°C to +100°C
Lead Soldering Temperature		260°C for 5s.

Electrical Characteristics (T_{amb} = 25°C)

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
LED Characteristics						
Forward Voltage	V_F		1.3	1.5	V	$I_F = 60$ mA
Reverse Current	I_R		0.1	10	μA	$V_R = 6$ V
Output Detector Characteristics						
Peak Blocking Current (Note 1)	I_{DRMI}		10	100	μA	$V_{DRM} = 600$ V
Peak On-State Voltage (Note 1)	V_{TM}		1.8	3.0	V	$I_{TM} = 100$ mA
Critical Rate Rise Off-State Voltage (Note 2)	dv/dt		2000		V/μs	$V_{DRM} = 400$ V
Critical Rate Rise Commutating Voltage (Note 2)	dv/dt		2000		V/μs	$V_{DRM} = 400$ V
Coupled Characteristics						
LED Trigger Current	I_{FT}		5	10	mA	$V_{AK} = 5$ V
Holding Current	I_H		65	200	μA	
Zero Crossing Characteristics						
Inhibit Voltage (Note 3)	V_{IH}		12	20	V	I_F = Rated I_{FT}
Leakage Current	I_{DRM2}			10	μA	$V_{DRM} = 120$ V

Notes:
1—Either direction.
2—Both directions.
3—Voltage above which the device will not turn on.

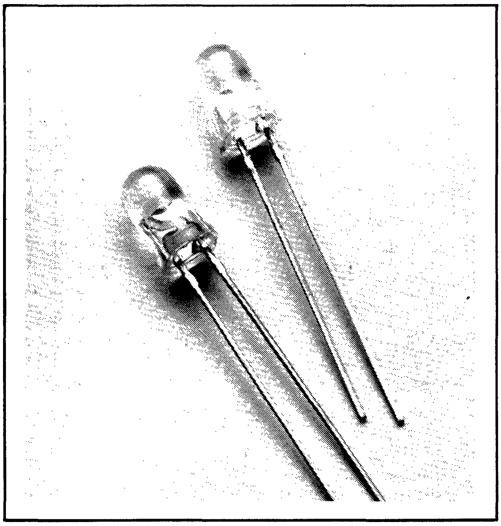
Specifications are subject to change without notice.

SIEMENS

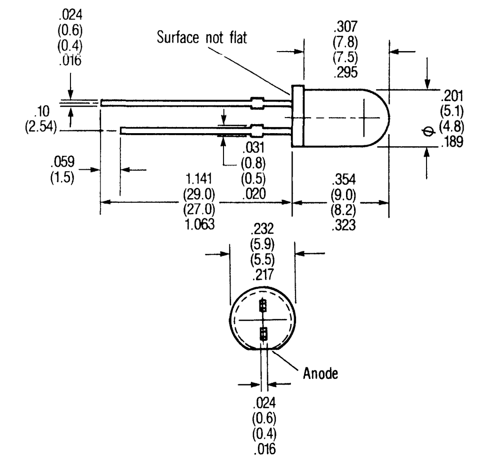
LDB5410

BLUE T1¾ LED LAMP

Preliminary Data Sheet



Package Dimensions in Inches (mm)



FEATURES

- **Pure Blue Light (480 nm)**
- **Clear T-1¾ Plastic Package**
- **1″ Min. Lead Length**
- **High Brightness**
- **TTL Compatible**

DESCRIPTION

The LDB5410 is a Silicon Carbide (SiC) LED, emitting a pure blue light from a clear T-1¾ plastic package. The LDB5410 is ideal for such applications as: spectroscopy, calibration, and light sources in medical equipment.

Maximum Ratings

Reverse voltage	V_R	1	V
Forward current	I_F	25	mA
Storage temperature range	T_{stor}	−55 to +100	°C
Junction temperature	T_j	100	°C
Total power dissipation (T_{amb} = 25°C)	P_{tot}	150	mW
Thermal resistance Junction to Air	R_{thJamb}	500	K/W

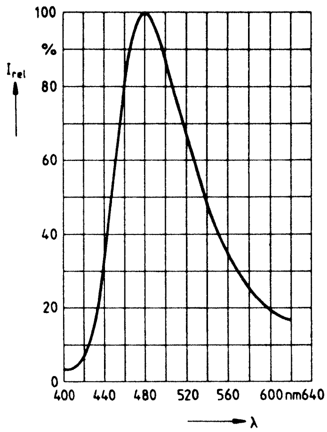
Characteristics (T_{amb} = 25°C)

	Min.	Typ.	Unit
Wavelength at peak emission	λpeak	480	nm
Dominant wavelength	dom	480	nm
Viewing angle		16	degrees
Forward voltage (I_F = 20 mA)	V_F	4(≤8)	V
Reverse current (V_R = IV)	I_R	0.01(≤10)	μA
Capacitance (V_R = 0 V; f = 1 MHz)	C_o	160	pF
Luminous intensity (I_F = 20 mA)	2.5	6.0	mcd

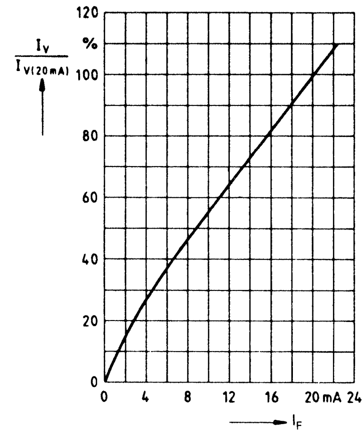
CAUTION: Because of low reverse voltage, the polarity of the LDB5410 should be checked before inserting into a circuit.

Specifications are subject to change without notice.

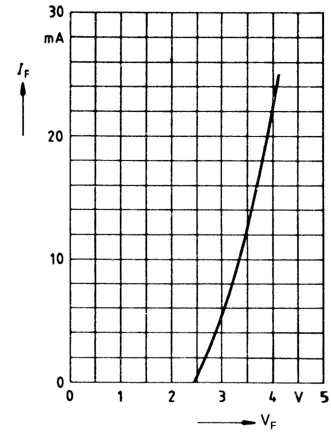
Relative spectral emission versus wavelength



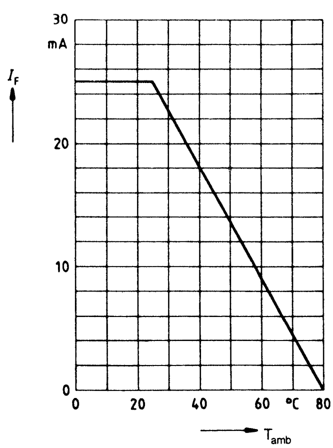
Relative luminous intensity versus forward current



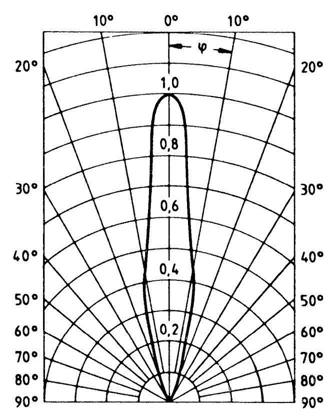
Forward current versus forward voltage



Forward current versus ambient temperature



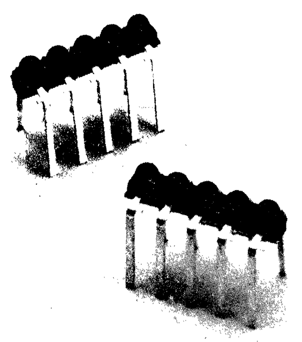
Radiation characteristic
Relative spectral emission versus half angle



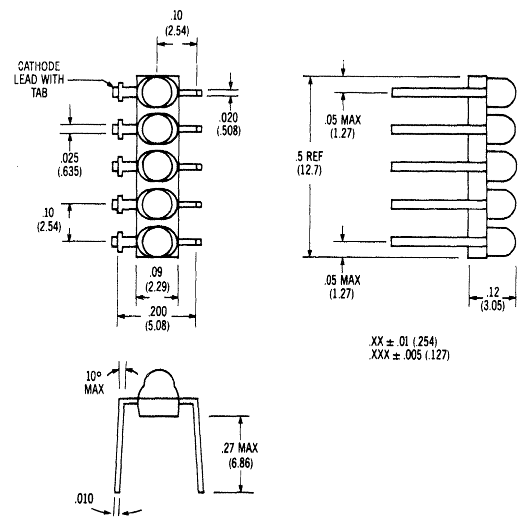
SIEMENS

LDR 4555

RED MINIATURE LED
5 DIODE ARRAY



Package Dimensions in Inches (mm)



FEATURES

- **Red Diffused Lens, Emits Red Light**
- **5 Diode Array**
- **Miniature Size**
- **2/10″ Lead Spacing**
- **End Stackable to Arrays of Multiple Length**
- **I/C Compatible**

DESCRIPTION

The LDR 4555 is a red gallium arsenide phosphide LED solid state lamp. It has red plastic encapsulation formed as a lens where the light is emitted. This array may be used individually or stacked together to form lines of multiple lengths. Typical applications are position indicators such as meters and scales.

Maximum Ratings (Individual Diode)

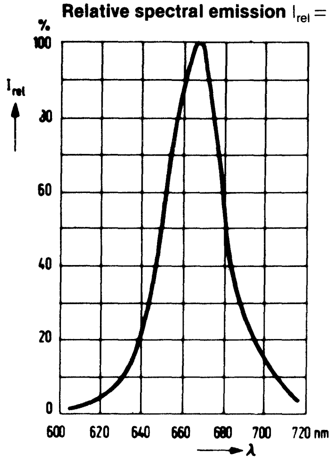
Reverse voltage	V_R	3	V
Forward current/LED	I_F	35	mA
Surge current (t < 10 µs)	i_{FS}	250	mA
Storage temperature	T_{stor}	−55 to +100	°C
Junction temperature	T_j	80	°C
Soldering temperature in a 2 mm distance from the case bottom (t < 5s)	T_s	230	°C
Power dissipation (T_{AMB} = 25°C)	P_{tot}	85	mW

Characteristics (T_{amb} = 25°C)

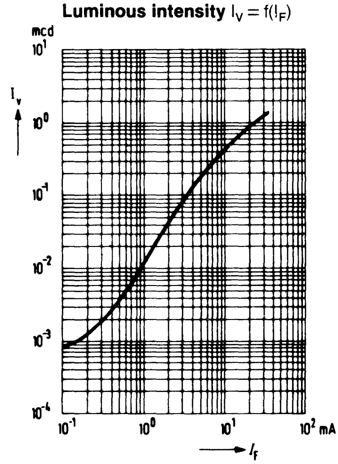
Wavelength at peak emission	λpeak	665 ± 15	nm
Dominant wavelength	λdom	645	nm
Viewing angle	φ	40	degree
Forward voltage (I_F = 20 mA)	V_F	1.6 (≦2.0)	V
Reverse current (V_R = 3V)	I_R	0.01 (≦10)	µA
Luminous Intensity (per diode)	I_V	>.8	mcd @10mA

Specifications are subject to change without notice.

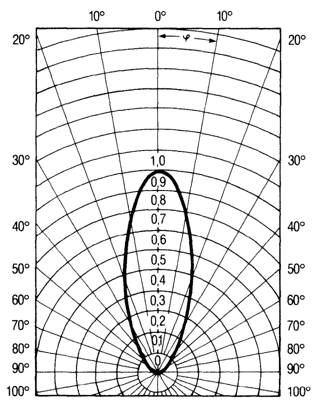
Relative spectral emission $I_{rel} = f(\lambda)$



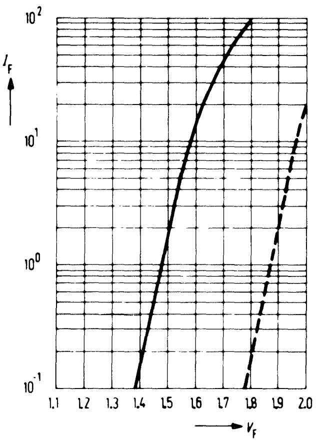
Luminous intensity $I_V = f(I_F)$



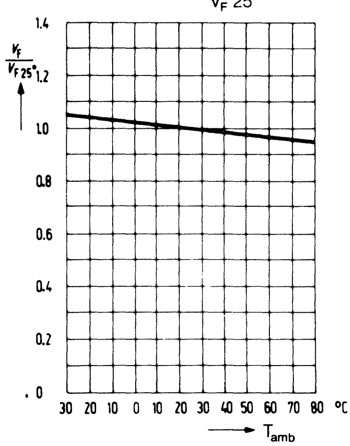
Radiation characteristic $I_{rel} = f(\varphi)$



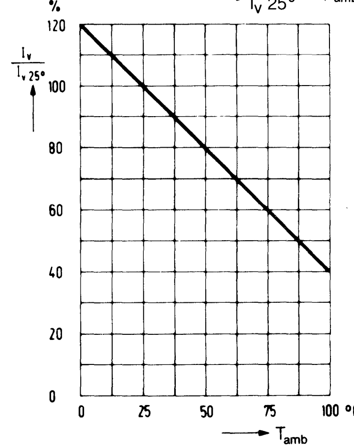
Forward voltage $I_F = f(V_F)$



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



Luminous intensity $\frac{I_V}{I_V\ 25°} = f(T_{amb})$

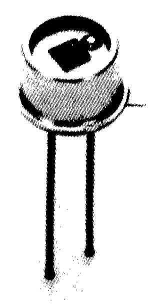


SIEMENS

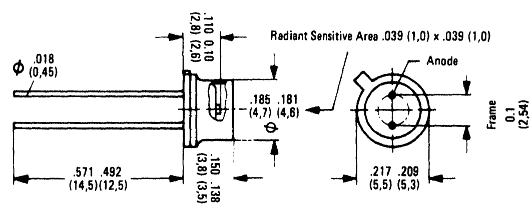
SFH202a

PIN PHOTO DIODE

Preliminary



Package Dimensions in Inches (mm)



FEATURES

- **TO-18 Hermetic Package**
- **Flat Glass Lens**
- **For Fiber Optic Communications**

DESCRIPTION

SFH 202a is a planar silicon PIN-photo diode. The case (18A2 DIN 41876—similar to TO-18) has a flat glass lens top. The cathode is electrically connected to the case. The diode is a receiver with high operating frequency, very low reverse current, and fast switching time. Because of the flat lens, the diode is especially suitable for use with fiber optic cables.

Maximum Ratings

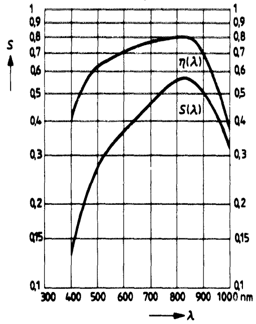
Reverse voltage	V_R	50	V
Junction temperature	T_j	80	°C
Storage temperature range	T_s	−40 . . . +80	°C

Characteristics ($T_{amb} = 25°C$)

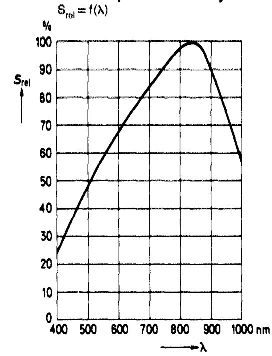
Radiant sensitive area	A	1	mm²
Wavelength of the max. sensitivity	$\lambda_{S\,max}$	850	nm
Quantum yield (Electrons per photon)($\lambda = 850$ nm)	η	0.80	Electrons / Photon
Spectral sensitivity ($\lambda = 850$ nm)	S_λ	0.55	A/W
($\lambda = 950$ nm)	S_λ	0.45 (≥0.35)	A/W
Rise time of the photocurrent ($R_L = 50\Omega$; V = 50 V; $\lambda = 850$ nm)	t_r	3	ns
Capacitance			
($V_R = 0$ V)	C_0	13	pF
($V_R = 1$ V)	C_1	7	pF
($V_R = 12$ V)	C_{12}	3.3	pF
($V_R = 20$ V)	C_{20}	3	pF
Cut-off frequency ($R_L = 50\Omega$; $V_R = 20$ V; $\lambda = 850$ nm)	f_g	200	MHz
Dark current ($V_R = 20$ V; E = 0)	I_R	1 (≤5)	nA
Noise equivalent power ($V_R = 20$ V)	NEP	3.3×10^{-14}	$\frac{W}{\sqrt{Hz}}$
Detection limit ($V_R = 20$ V)	D*	3.1×10^{12}	$\frac{cm\sqrt{Hz}}{W}$
Temperature coefficient for I_P	TK	0.2	%/K

Specifications are subject to change without notice.

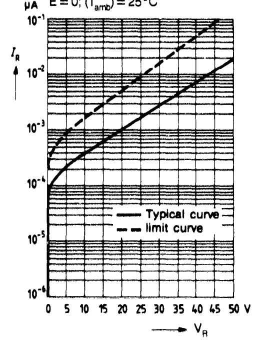
Spectral sensitivity $S = f(\lambda)$
and quantum yield $\eta = f(\lambda)$
in electrons per photon



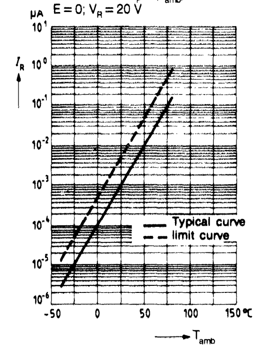
Relative spectral sensitivity
$S_{rel} = f(\lambda)$



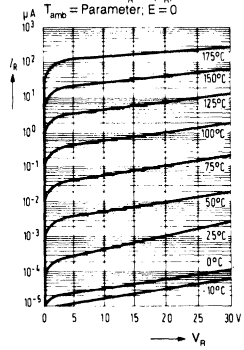
Forward current $I_R = f(V_R)$
E = 0; $(T_{amb}) = 25°C$



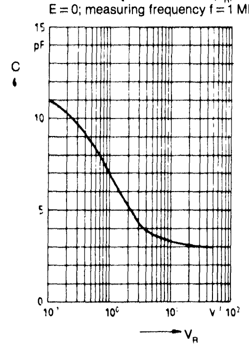
Dark current $I_P = (T_{amb})$
E = 0; $V_R = 20$ V



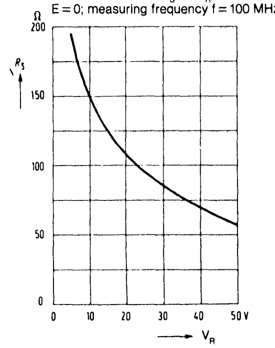
Dark current $I_R = f(V_R)$
T_{amb} = Parameter; E = 0



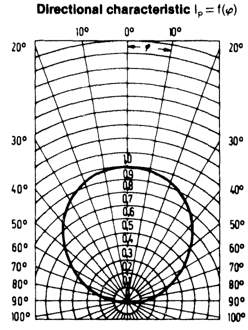
Junction capacitance $C = f(V_R)$
E = 0; measuring frequency f = 1 MHz



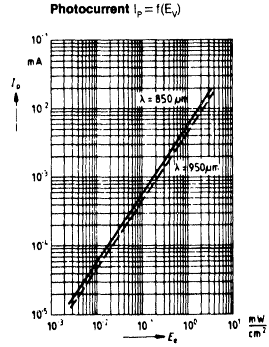
Series resistance $R_S = f(V_R)$
E = 0; measuring frequency f = 100 MHz



Directional characteristic $I_P = f(\varphi)$



Photocurrent $I_P = f(E_V)$



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Phone (206) 453-5844
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  Phone (714) 855-0233

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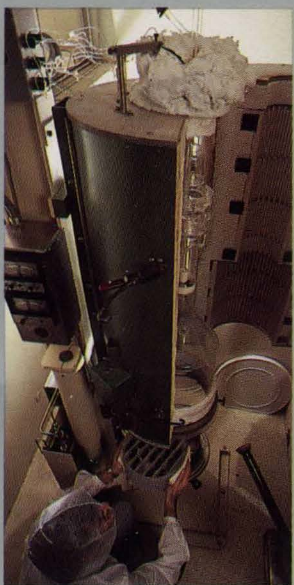

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