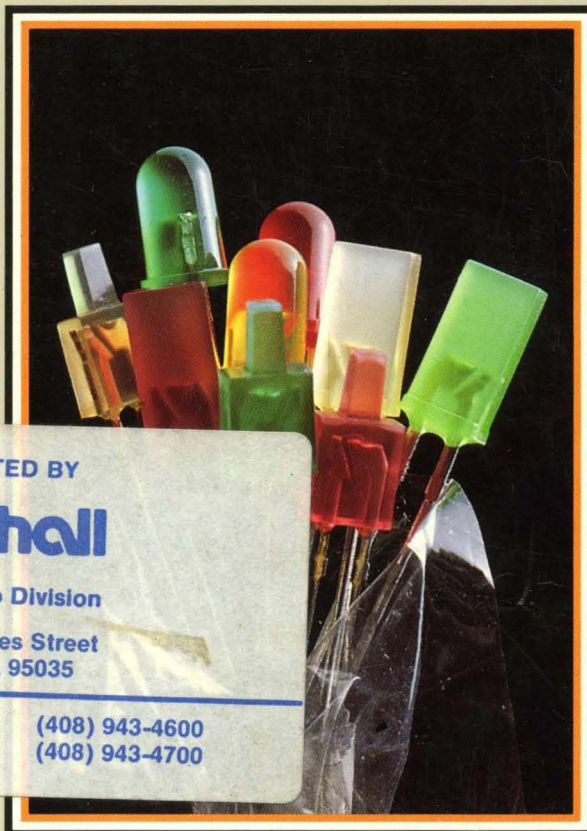


OPTOELECTRONIC PRODUCTS

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DATA BOOK

**1985
OPTOELECTRONICS
DATA BOOK**

March 1985

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GENERAL INFORMATION

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Introduction

The Optoelectronics Catalog illustrates the broad line of devices that NEC offers to designers and manufacturers. The variety of components gives greater design alternatives and the ability to choose the part that truly fits the product needs. NEC's components are designed to satisfy industrial, communication, instrumentation, and consumer applications.

Designed for easy reference, the catalog is divided into the following sections.

General Information — Selection guides, cross reference, ordering information and handling precautions.

Quality and Reliability — Detailed specifications of Q and R product testing.

Standard LED's and Fashion LED's — Light Emitting Diodes are available in red, green, amber, and infrared wavelengths. Standard shapes and sizes, as well as NEC designed fashion lamps are also available.

Photo Couplers — NEC's photo couplers come in standard configurations, as well as proprietary high-performance devices.

Photo Interrupters — These devices are available in standard and unique NEC sizes. All have superior efficiency, stability and operating characteristics.

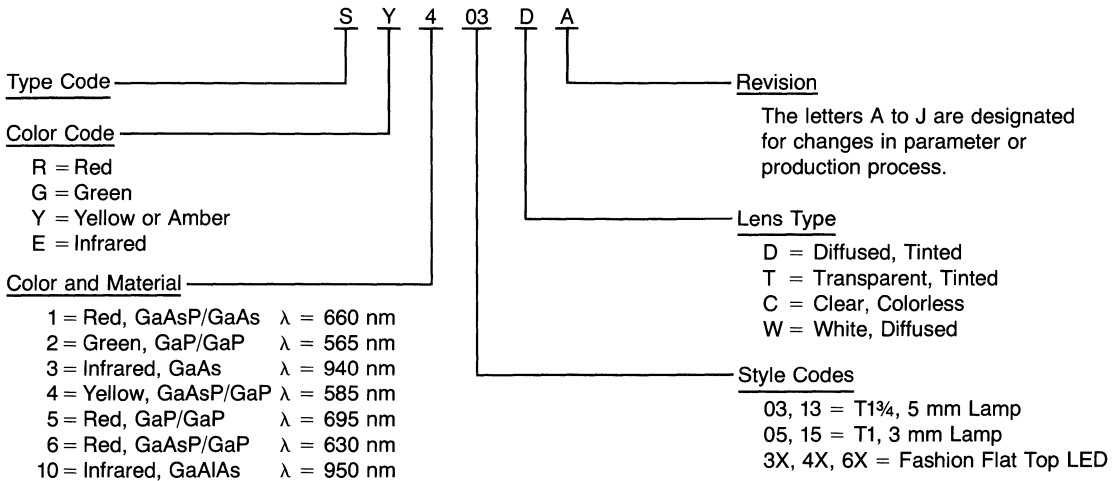
Photo Transistors and Photo Diodes — NEC has a wide variety of components available to meet a majority of design applications.

Ordering Information

NEC Electronics offers a broad line of optoelectronic products in the NEPOC series, giving the designer flexibility and the latest in semiconductor technology.

NEC has maintained technological leadership in all facets of optoelectronics, including visible LEDs, infrared (IR) LEDs, photo interrupters, photo sensors, and photo couplers. These devices are designed to cover industrial, communication, instrumentation, and consumer applications with NEC's high quality and reliability.

Numbering System



SELECTION GUIDES

Red — Light Emitting Diodes

NEC Part Number	MAX			Typical		
	P _D (mW)	I _F (mA)	V _F (V)	I _R (μA)	I _V (mcd)	Wavelength (nm)
SR106D/C	80	40	1.6	0.01	1.5/2.5	660
SR503D/C/W	60	30	2.0	0.01	5/10/5	695
SR505D/C/W	60	30	2.0	0.01	3.5/6/3.5	695
SR506D/C	60	30	2.0	0.01	1/2	695
SR513D/C/W	60	30	2.0	0.01	5/10/5	695
SR531D	60	30	2.0	0.01	0.5	695
SR533D	60	30	2.0	0.01	0.5	695
SR535D	60	30	2.0	0.01	0.5	695
SR536D	60	30	2.0	0.01	0.5	695
SR537D	60	30	2.0	0.01	0.5	695
SR538D	60	30	2.0	0.01	0.5	695
SR539D	60	30	2.0	0.01	0.5	695
SR540D	60	30	2.0	0.01	0.7	695
SR603D/C/W	100	50	2.0	0.01	3/6/3	630
SR605D/C/W	80	40	2.0	0.01	5/10/5	630
SR613D/C/W	100	50	2.0	0.01	7/20/7	630
SR615D/C/W	100	50	2.0	0.01	8/16/8	630
SR632D	100	40	2.0	0.01	1.2	630
SR661D	100	40	2.0	0.01	1.0	630

Note: V_F Measured at I_F=10 mA, except SR106 I_F=20 mA.
 I_R Measured at V_R=4.5V, except SR106 V_R=3V.
 I_V Measured at I_F=10 mA, except SR106 I_F=20 mA.
 Wavelength measured at I_F=10 mA.

Green—Light Emitting Diodes

NEC Part Number	MAX			Typical		
	P _D (mW)	I _F (mA)	V _F (V)	I _R (μA)	I _V (mcd)	Wavelength (nm)
SG203DA/TA	100	40	2.0	0.01	8/13	565
SG205D/T	100	40	2.0	0.01	3/5	565
SG206D/T	100	40	2.0	0.01	1.5/3	565
SG213D/T	100	40	2.0	0.01	15/45	565
SG215D/T	100	40	2.0	0.01	10/20	565
SG231D	100	40	2.0	0.01	1.0	565
SG233D	100	40	2.0	0.01	1.0	565
SG235D	100	40	2.0	0.01	1.0	565
SG236D	100	40	2.0	0.01	1.0	565
SG237D	100	40	2.0	0.01	1.0	565
SG238D	100	40	2.0	0.01	1.0	565
SG239D	100	40	2.0	0.01	1.0	565
SG240D	100	40	2.0	0.01	1.5	565
SG261D	100	40	2.0	0.01	1.5	565

Note: V_F Measured at I_F = 10mA.
 I_R Measured at V_R = 4.5V.
 I_V Measured at I_F = 10mA.
 Wavelength measured at I_F = 10mA.

Amber/Yellow — Light Emitting Diodes

NEC Part Number	MAX			Typical		
	P _D (mW)	I _F (mA)	V _F (V)	I _R (μA)	I _V (mcd)	Wavelength (nm)
SY403DA/TA	100	40	2.0	0.01	10/30	590
SY405D/T	100	40	2.2	0.01	2/4	590
SY406D/T	100	40	2.0	0.01	3/4	590
SY413D/T	100	40	2.0	0.01	10/30	590
SY415D/T	100	40	2.0	0.01	10/20	590
SY431D	100	40	2.0	0.01	1.0	590
SY432D	100	40	2.0	0.01	1.2	590
SY433D	100	40	2.0	0.01	1.0	590
SY435D	100	40	2.0	0.01	1.0	590
SY436D	100	40	2.0	0.01	1.0	590
SY437D	100	40	2.0	0.01	1.0	590
SY438D	100	40	2.0	0.01	1.0	590
SY439D	100	40	2.0	0.01	1.0	590
SY440D	100	40	2.0	0.01	1.5	590
SY461D	100	40	2.0	0.01	1.5	590

Note: V_F Measured at I_F=10 mA
 I_R Measured at V_R=4.5V
 I_V Measured at I_F=10 mA
 Wavelength measured at I_F=10 mA.

Infrared Light Emitting Diodes (IR LEDs)

NEC Part Number	MAX			Typical		
	P _D (mW)	I _F (mA)	V _F /I _F (V/mA)	I _R (μA)	P _O (mW)	Typical Wavelength
SE301A	150	100	1.2 /50	0.01	6	940nm
SE302A	75	50	1.2 /30	0.01	1.5	940nm
SE303A	150	100	1.25/50	0.01	6.5	940nm
SE306	100	50	1.1 /10	10	0.5	940nm
SE307	150	100	1.45/50	N/A	15	940nm
SE308	100	50	1.14/20	10	0.85	940nm
SE1003	150	50	1.25/50	0.01	20	950nm

Note: I_R tested at V_R=3V.
 P_O tested at I_F=30 mA.
 Wavelength tested at I_F=30 mA.
 T_A = 25°C for all data.



GENERAL INFORMATION

SELECTION GUIDES (Cont)

Photo Couplers

NEC Part Number	MAX							
	I _F (mA)	I _C (mA)	V _{ISO} (VAC)	V _F /I _F (V/mA)	I _{CEO} (nA)	CTR/I _F (%/mA)	V _{CE(sat)} (IC=2mA)	BV _{CEO} (V)
4N25	80	100	2500*	1.4/10	50	20/20	0.3	30
MCT2	80	100	2000	1.4/10	50	20/20	0.3	30
PS2002B	50	50	2500*	1.9/5	400	100/5	1.2	40
PS2004B	50	200	2000	1.4/20	400	1300/5	1.2	30
PS2005B	150	50	2000	2.0/100	200	10/100	0.3 (4mA)	30
PS2006B	25	8	3000*	1.7/16	N/A	15	N/A	
PS2007B	10	50	3000*	1.7/10	TTL	600	TTL out	
PS2010	80	100	2000	1.4/10	50	20/20	0.3	30
PS2021	80	100	4000	1.4/10	50	50/10	0.3	40
PS2022	80	100	4000	1.4/10	100	200/10	1.0	40
PS2031	80	100	2000	1.4/10	50	20/20	0.3	200
PS2401A	80	80	5000	1.4/10	100	80/5	0.3	40

Note: I_{CEO} measured at V_{CE}=10V and I_F=0.
*Denotes DC volts; all others in AC volts.

Photo Couplers—SCR Type

NEC Part Number	MAX						
	V _{DRM} (V)	I _T (mA)	V _{ISO} (V _{RMS})	V _F /I _F (V/mA)	I _{DRM} (μA)	V _{TM} (V)	I _{FT} (mA)
PS3001	200	300	2000	1.4/20	100	1.3	12
PS3002	400	300	2000	1.4/20	100	1.3	12
PS3001(1)	200	300	2500	1.4/20	100	1.3	12
PS3002(1)	400	11	2500	1.4/20	100	1.3	12

Note: I_{DRM} with R_{GK} = 27kΩ and T_A = 100°C.
V_{TM} with I_T = 300 mA.
I_{FT} with V_D = 6V and R_{GK} = 27Ω.
*Maximum Value

Photo Transistors

NEC Part Number	MAX					
	P _C (mW)	I _C (mA)	V _{CEO} (V)	I _{CEO} (nA)	V _{CE(sat)} (V)	I _L (mA)
PH101	100	50	20	500	1.5	4
PH102	100	40	30	200	0.3	.050
PH103	100	50	30	400	1.5	2
PH104	100	40	30	100	0.3	.020
PH106	100	40	30	100	0.3	.060
PH108	100	40	30	100	0.3 (IC=0.5mA)	0.3 (V _{CE} =5V)
					(H = 5.0mW/cm ²)	(H = 0.5mW/cm ²)

Note: I_{CEO} tested at V_{CE}=10V — L=0.
V_{CE(sat)} tested at L=1000lx.
I_L tested at V_{CE}=2V — L=100lx.
*Minimum Value

Photo Interrupters

NEC Part Number	MAX						
	I _F (mA)	V _{CEO} (V)	I _C (mA)	V _F (V)	I _{CEO} (nA)	V _{CE(sat)} (V)	CTR (%)
PS4001	50	30	50	1.1	400	1.2	20
PS4003	50	30	50	1.1	400	1.2	15
PS4005	50	30	50	1.1	400	1.2	20
PS4007	50	30	50	1.1	400	1.2	20
PS4008	50	30	40	1.1	100	0.3	0.5
PS4009	50	30	50	1.1	400	1.2	20
PS4010	50	30	50	1.1	400	1.2	20
PS4011	50	30	50	1.1	400	1.2	20
PS4014	50	30	40	1.1	100	0.3	0.5
PS6001	50	30	40	1.4	N/A	0.3	N/A

Note: V_F tested at I_F=20mA, except PS6001A I_F=30mA.
I_{CEO} tested at V_{CE}=10V and I_F=0.
V_{CE(sat)} tested at I_F=10 mA—I_C=0.5 mA.
CTR tested at I_F=10 mA—V_{CE}=2V.
PS4008/PS6001 V_{CE(sat)} tested at I_F=10 mA—I_C=50 μA.
The PS6001 is a photo reflective sensor.

Photo Diodes

NEC Part Number	MAX					
	V _R (V)	P _C (mW)	I _F (mA)	Sensitivity (nA/lx)	I _D (pA)	t _r (nS)
PH201A	5	N/A	1	90**	3.0	150μS
PH302	32	150	N/A	50	30	50
PH302B	32	150	N/A	32	30	50
PH305	20	150	N/A	30	10	30
PH309	20	150	N/A	50	30	30

Note: t_r tested at R_L=1KΩ.
I_D tested at V_R=10V, except PH201 V_R=2.0V.
Sensitivity in units of nA/lx, except PH201 L=100lx.
Wavelength of maximum sensitivity is 940nm.
*Maximum Value
**Measured in nA

CROSS REFERENCE GUIDE

Photo Couplers

Fairchild No.	NEC No.	Notes
FCD810	PS2010	1
FCD810C	PS2021	1
FCD820	PS2010	1
FCD820C	PS2021	1
FCD825	PS2010L/K	1
FCD825C	PS2021	1
FCD830	PS2010	1
FCD830C	PS2021	1
FCD831	PS2010	1
FCD831C	PS2021	1
FCD836	PS2010	1
FCD836C	PS2021	1

General Electric No.

General Electric No.	NEC No.	Notes
CNY17I	PS2021M	2,3
CNY17II	PS2021M	2,3
CNY17III	PS2021	2,3
CNY17IV	PS2021	2,3
CNY30	PS3001	1
CNY31	PS2022	3
CNY32	PS2021	3
CNY34	PS3002L	1
CNY47	PS2010M	1
CNY47A	PS2010L/K	1
CNY48	PS2022L	1
CNY51	PS2021K	2,3
H11A1	PS2010L/K	1
H11A2	PS2010	1
H11A3	PS2010	1
H11A4	PS2010	1
H11A5	PS2010	1
H11A520	PS2021L	2,3
H11A550	PS2021L	2,3
H11A5100	PS2021K	2,3
H11B1	PS2022L/K	1
H11B2	PS2022	1
H11B255	PS2022	4
H11B3	PS2022	1
H11C1	PS3001(1)	1
H11C2	PS3001	1
H11C3	PS3001	1
H11C4	PS3002(1)	1
H11C5	PS3002	1
H11C6	PS3002	1
H15A1	PS2021	3
H15A2	PS2021	3
H15B1	PS2022	3
H15B2	PS2022	3

General Instrument No.

General Instrument No.	NEC No.	Notes
MCA230	PS2022	3
MCA231	PS2022	3
MCA255	PS2022	2
MCA8	PS4001	
MCA81	PS4001	

MCS2	PS3001(1)	1
MCS2400	PS3002(1)	1
MCT2	PS2010	1
MCT2E	PS2021	1
MCT26	PS2010	1
MCT210	PS2021K	1
MCT271	PS2021M	2
MCT272	PS2021L	2
MCT273	PS2021K	2
MCT277	PS2021K	1
MCT4	PS1001	4
MCT4R	PS1001	4
MCT6	PS2401A-2	4
MCT66	PS2401A-2	4
MCT8	PS4014	
MCT81	PS4014	

Hewlett-Packard No.	NEC No.	Notes
6N135	PS2006B	1
6N136	PS2006B	1
6N137	PS2007B	1
HCPL-2502	PS2006B	2
HCPL-2601	PS2007B	4

Jedec No.	NEC No.	Notes
4N25	PS2021	1,3
4N25A	PS2010	1
4N26	PS2010	1
4N27	PS2010	1
4N28	PS2010	1
4N29	PS2022	2,3
4N29A	PS2022	2,3
4N30	PS2022	2,3
4N31	PS2022	2,3
4N32	PS2022	2,3
4N32A	PS2022	2,3
4N33	PS2022	2,3
4N35	PS2021L	1
4N36	PS2010K	1
4N37	PS2010K	1
4N39	PS3001	1
4N40	PS3002	1

Litronics No.	NEC No.	Notes
IL-1	PS2010	1
IL-12	PS2010	2
IL-15	PS2010	2
IL-16	PS2010	2
IL-100	PS2007B	4
IL-101	PS2007B	4
IL-5	PS2010M	2
ILA-30	PS2022	1
ILA-55	PS2022	2,3

- Notes:**
1. Direct replacement.
 2. Equivalent (minor electrical difference).
 3. Equivalent (minor mechanical difference).
 4. Different (significant difference, electrical or mechanical).



GENERAL INFORMATION

CROSS REFERENCE GUIDE (Cont)

Photo Couplers

Litronics No. (cont.)	NEC No.	Notes
ILCA2-30	PS2022	1
ILCA2-55	PS2022	2, 3
ILCT-6	PS2401A-2	4
ILD-74	PS2401A-2	4
ILQ-74	PS2401A-4	4

Siemens No.	NEC No.	Notes
CNY17I	PS2021M	2, 3
CNY17II	PS2021L/M	2, 3
CNY17III	PS2021L	2, 3
CNY17IV	PS2021K	2, 3
CNY18II	PS1001	4
CNY18III	PS1001	4
CNY18IV	PS1001	4
CNY18V	PS1001	4
SFH600I	PS2010L	2
SFH600II	PS2010K	2
SFH600III	PS2021K	2, 3
SFH601-1	PS2021M	2, 3
SFH601-2	PS2021M	2, 3
SFH601-3	PS2021L	2, 3
SFH601-4	PS2021K	2, 3

Spectronics No.	NEC No.	Notes
SCD11B1	PS2022	3
SCD11B2	PS2022	3
SCD11B3	PS2022	3
SPX-103	PS2021L/K	2, 3
SPX-2	PS2021	3
SPX-2E	PS2021	3
SPX-26	PS2021	3
SPX-33	PS2021	3
SPX-35	PS2021L/K	2, 3
SPX-4	PS2021	3
SPX-5	PS2021	3
SPX-53	PS2021	3
SPX-6	PS2021	2, 3

Telefunken No.	NEC No.	Notes
CQY-80	PS2021L/K	2

Texas Instrument No.	NEC No.	Notes
TIL102	PS1001	4
TIL111	PS2010	1
TIL112	PS2010	1
TIL113	PS2022	1
TIL114	PS2010	1
TIL115	PS2010	1
TIL116	PS2010	1
TIL117	PS2010L	1
TIL118	PS2010	1
TIL119	PS2022	2

Light Emitting Diode Lamps

Hewlett-Packard No.	NEC No.	Notes
5082-4650	SR603D	
5082-4655	SR603D	
5082-4657	SR603C	
5082-4658	SR603C	
5082-4684	SR605D	
5082-4160	SR605D	
5082-4550	SY403DA	
5082-4555	SY403DA	
5082-4557	SY403TA	
5082-4558	SY403TA	
5082-4584	SY405D	
5082-4150	SY406D	
5082-4950	SG203DA	
5082-4955	SG203DA	
5082-4957	SG203TT	
5082-4958	SG203TT	
5082-4984	SG205D	
5082-4190	SG206D	
5082-4850	SR503D	
5082-4855	SR503D	
5082-4484	SR505D	
5082-4494	SR505D	
5082-4480	SR505D	
5082-4483	SR505W	
5082-4486	SR505C	
5082-4880	SR503D	
5082-4881	SR503D	
5082-4882	SR503D	
5082-4883	SR503C	
5082-4884	SR503C	
5082-4885	SR503C	
5082-4886	SR503W	
5082-4887	SR503W	
5082-4888	SR503W	
5082-4420	SR504W	
5082-4620	_____	
5082-4520	SY404D	
5082-4920	SG204D	

- Notes:**
1. Direct replacement.
 2. Equivalent (minor electrical difference).
 3. Equivalent (minor mechanical difference).
 4. Different (significant difference, electrical or mechanical).

CROSS REFERENCE GUIDE (Cont)

Light Emitting Diode Lamps

Dialight No. (cont.)	NEC No.	Notes			
521-9217	SR503D		MV5053	SR503D	
521-9185	SR106C		MV5054-1	SR503D	
			MV5054-2	SR503D	
			MV5054-3	SR503D	
Litronix No.	NEC No.	Notes	MV5055	SR503D	
RL-20	SR503D		MV5056	SR503D	
RL-20-02			MV5074B/C	SR505D	
RL-20-03	SR503W		MV5075B/C	SR505D	
RL-20-04	SR503C		MV5152	SY403TA	
RL-21	SR505D		MV5153	SY503DA	
RL-21-02			MV5154	SY403DA	
RL-21-04	SR515C		MV5252	SG203TA	
RL-50	SR106V		MV5253	SG203DA	
RL-50-01	SR106D		MV5254	SG203DA	
RL-50-02			MV5352	SY403TA	
RL-50-03			MV5353	SY403DA	
RL-209	SR505D		MV5752	SR603C	
RL-209-02			MV5753	SR603D	
RL-209-03	SR505W		MV5354	SY403DA	
RL-209-04	SR505C		MV5274B/C	SG205D	
RL-54	SR106D		MV5374B/C	SY405D	
RL-55	SR106D		MV5774B/C	SR603D	
RL-4484	SR505D		ME60	SE302A	
RL-2000	SR503D		ME61	SE302A	
RL-4403	SR503D		ME7161	SE302A	
RL4440	SR503D		ME7021		
RL4850	SR503D		ME7161		
RL-5054-1	SR503D		Motorola No.	NEC No.	Notes
RL-5054-2	SR503D		MLED60	SE302A	
OL-30	SY403D		MLED90	SE302A	
OL-31	SY405D		MLED500		
YL4850	SY403DA		MLED630	SR104D	
YL4484	SY405D		MLED650	SR503D	
YL56	SY406D		MLED750	SG203DA	
GL4850	SG203DA		Intermetall No.	NEC No.	Notes
GL4484	SG205D		CQY65	SR105D	
GL56	SG206D		Stanley No.	NEC No.	Notes
IRL40	SE301A		GD-2-301R		
IRL60	SE302A		GD-2-301C	SR106C	
			GD-2-301G	SG206T	
General Instrument No.	NEC No.	Notes	GD-4-203		
MV50	SR106D		GD-4-204RD	SR503D	
MV54	SR106D		GD-4-204CD	SR503W	
MV52	SG206D		GD-4-204GD	SG203DA	
MV53	SY406D		GD-4-204YD	SY403DA	
MV55	SY106D		GD-4-205RD	SR503D	
MV5020	SR503C		GD-4-205CD	SR503W	
MV5021	SR503W		GD-4-205GD	SG203DA	
MV5022			GD-4-205YD	SY403DA	
MV5023	SR503D		GD-4-505RD	SR505D	
MV5024	SR503D				
MV5025	SR503D				
MV5026	SR503D				
MV5050	SR503C				
MV5051	SR503W				
MV5052					

- Notes:**
1. Direct replacement.
 2. Equivalent (minor electrical difference).
 3. Equivalent (minor mechanical difference).
 4. Different (significant difference, electrical or mechanical).



CROSS REFERENCE GUIDE (Cont)

Light Emitting Diode Lamps

Stanley No. (cont.)	NEC No.	Notes	CQY86	SG205D	
GD-4-505CD	SR505W		V179P	SG205D	
GD-4-505GD	SG205D		CQX12	SY403DA	
GD-4-505YD	SY405D		CQY74L	SY403DA	
SG2-01B	_____		V170P	SY403DA	
SG2-02B	_____		CQY75	SY406D	
SG2-03B	_____		CQY87	SY405D	
SG2-04B	SR505D		V180P	SY405D	
SG2-05B	SG205D		CQY32	SE301A	
SG2-06B	SY405D		CQY35	SE301A	
			CQY34	SE301A	
			CQY37	SE302A	
Texas Instrument No.	NEC No.	Notes	Matsushita No.	NEC No.	Notes
TIL203	SR101C		LN21	SR503D	
TIL204	SR104D		LN21W	SR503W	
TIL209	SR505D		LN21RP	SR503D	
TIL210	SE301A		LN22	_____	
Siemens No.	NEC No.	Notes			
CQY17	SE301A		LN23	_____	
CQY18	SE301A		LN23S	SR505W	
LD261	SE302A		LN23S(R)	_____	
LD30B	SR505D		LN25	_____	
LD30C	SR505C		LN25D	_____	
LD40I	SR503D		LN26D	_____	
LD40II	SR503D		LN31	SG203DA	
LD50I	SR503D		LN32	SG205D	
LD50II	SR503D		LN35	_____	
			LN35D	_____	
Telefunken No.	NEC No.	Notes			
CQX10	SR503D		LN45	_____	
CQX40L	SR503D		LN45D	_____	
CQX40/5VL	SR503D		LN322M	_____	
CQX40/12VL	SR503D		LN322S	SR505D	
CQX41	SR106D		LN51F/51FT	SE301A	
CQY85	SR505D		LN51L/51LT	SE301A	
V136PL	SR503C		LN52	_____	
V137PL	SR503W		LN55	SE301A	
V138P	SR106C		LN60	SE301A	
V139P	_____		LN70	_____	
V169P	SR503D		LN71	_____	
V178P	SR105D				
CQX11	SR203DA		OKI No.	NEC No.	Notes
CQX40L	SR503D		OLD414	SR104D, SR104DA	
CQX40/5VL	SR503D		OLD414DG	SR104D, SR104DA	
CQX40/12VL	SR503D		OLD415	SR505C	
CQX41	SR106D		OLD415C	_____	
CQY85	SR505D		OLD415T	SR505C	
V137PL	SR503C		OLD416	SR106C	
V137PL	SR503W		OLD416LC	_____	
V138P	SR106C		OLD416LD	SR106D	
V139P	_____		OLD416LT	SR106C	
V169	SR503D		OLD419	_____	
V178P	SR105D		OLD419C	_____	
CQX11	SG203D		OLD4101C	_____	
CQY72L	SG203DA				
V169P	SG203DA				
CQY73	SG206D				

- Notes:**
1. Direct replacement.
 2. Equivalent (minor electrical difference).
 3. Equivalent (minor mechanical difference).
 4. Different (significant difference, electrical or mechanical).

CROSS REFERENCE GUIDE (Cont)

Light Emitting Diode Lamps

OKI No. (cont.)	NEC No.
OLD4101D	SR503D
OLD41011	SR503C
OLD314D	SG204D
OLD314DG	SG204D
OLD315C	_____
OLD315D	SG205D
OLD316LC	SG206T
OLD316LT	_____
OLD319C	_____
OLD319D	_____
OLD3101C	SG203TA
OLD3101D	SG203DA
OLD31011T	_____
OLD714D	SY404D
OLD714DG	SY404D
OLD715D	SY405D
OLD716LC	SY406T
OLD716LT	_____
OLD719D	_____
OLD7101C	SY403TA
OLD7101D	SY403DA
OLD7101T	_____
OLD122	SE301A
OLD124	SE301A
Sharp No.	NEC No.
GL-3PR1	SR505D
GL-3PR2	SR505D
GL-5PR1	SR503D
GL-5PR2	SR503D
GL30PR	SR505D
GL-30PR3	SE505W
GL-30PR8	SR505C
GL-40PR	_____
GL-40PR3	_____
GL-31AR	SR505D
GL-31AR8	SR505C
GL-32AR	SR505D
GL-41AR	_____
GL-41AR3	_____
GL-51AR	SR104D

Notes	Notes	Notes
	GL-30PG	SG203DA
	GL-30PG8	_____
	GL-40PG	_____
	GL-40PG3	_____
	GL-50PG	SG204D
	GL50PG1	_____
	GL32PG	SG205D
	GL52PG	SG203DA
	GL52AY	SY403DA
	GL503	SE301A
	GL504	SE301A
	GL50G	SE301A
	GLE503	SE301A
	GLE503F	SE301A
Notes	Toshiba No.	NEC No.
	TLR101	SR104D
	TLR102	SR505D
	TLR103	_____
	TLR104	SR503D
	TLR105	_____
	TLR106	SR503W
	TLR107	_____
	TLR108	SR505C
	TLR109	SR505W
	TLR110	SR503C
	TLR113	SR503C
	TLR114	SR503D
	TLR115	_____
	TLR116	SR504D
	TLR120	SR503C
	TLR202	_____
	TLG102	SG205D
	TLG103	SG203TA
	TLG105	_____
	TLG107	_____
	TLG108	SG205T
	TLG113	SG203T
	TLG115	_____
	TLG202	_____
	TLN101	SE301A
	TLN103	SE301A



- Notes:**
1. Direct replacement.
 2. Equivalent (minor electrical difference).
 3. Equivalent (minor mechanical difference).
 4. Different (significant difference, electrical or mechanical).

Handling Precautions:

1. Full resin-molded LED lamps generally have slightly lower mechanical and thermal strength than other resin-molded semiconductor devices, as they have less additives. Therefore, please note the following.
 - (a) Leads should be soldered at a point 5mm or more from the root of the leads at 260°C and within 5s.
 - (b) If the temperature of the molded portion rises, in addition to the residual stress between leads, the possibility of open or short circuiting due to deformation or breakdown of the resin will increase.
2. On cleaning the device:
 - (a) Cleaning with unsuitable solvent may damage the resin of the package. The following solvents should be used at a temperature of less than 45°C with an immersion time of less than 3 min:
 - Freon TE, Freon TF, ethanol, methanol
 - Difron-solvent, isopropyl-alcohol
 - (b) Ultrasonic cleaning will place stress on the devices. The degree of stress varies with the output power, the size of the PCB, and the mounting methods. It therefore should be confirmed experimentally, under actual conditions, that such cleaning does not have an adverse effect on the devices.

Section 2 — Quality and Reliability

Quality and Reliability 2-1

Quality and Reliability

When it comes to quality and reliability, NEC is totally committed. Our “zero defects” goal is woven into the very fabric of the company.

Our Quality and Reliability Department is one of the most powerful departments in NEC. Products are not only tested upon completion, they are tested at every phase of production — from the earliest design, to manufacturing production.

This is NEC’s TQC concept — Total Quality Control. It guarantees our customers the highest possible quality performance of NEC products.

Our optoelectronic components are guaranteed to an AQL of 0.1%. At least 9,999 of every 10,000 devices will pass stringent electrical tests.

While zero defects may be an impossible goal, NEC comes closer to it than anyone else in the industry. And we’re well on our way to an even higher quality standard of only one defect per every 100,000 parts produced.

NEC takes pride in offering the broadest variety of components to fit your product needs. And all with the highest quality and reliability available.

Photo Couplers — Plastic Dip

Sub Group	Inspection Item	LTPD
1	Major Defects (Open, Short Visual, etc.)	1%
2	Reliability Parameters (V_F , I_R , I_{CEO})	3%
3	Operating Parameters (CTR, $V_{CE(sat)}$, R1-2)	5%
4	Minor Defects (Visual and Mechanical, etc.)	5%

Process Reliability Conformance Test

Sub Group	Test	Method MIL750B	Size Sample	Test Condition
1	External Appearance	2066	11	_____
2	Soldering Temperature	2301.1		260 + 5°C for 10 + s once.
	Temperature Cycling	1051.1	22	-40 to +125°C for 5 cycles.
	Thermal Shock	1056.1		0 to 100°C for 5 cycles.
3	Shock	2016.1		1500g for 0.5ms, Axis X, Y, and Z, 5 cycles
	Vibration Var. Freq.	2056.1	22	20G at 100Hz to 2kHz, Axis X, Y, and Z, 4min.
	Constant Acceleration	2006		20 kG, X, Y, and Z axis 1min/4 cycles.
4	Terminal Strength (Lead Fatigue)	2036.1	11	227g, 90°, 3 times.
5	Salt Atmosphere	1046.1	11	35°C, 24hr 10 to 50g/m2/day.
6*	D.C. Operating Life	1026.1	22	If: Absolute maximum current $V_{CE} = 5V$, for 1000 hours.
7*	High Temperature Storage Life	1031.1	22	125°C for 1khr
8*	Low Temperature Storage	1031.1	22	-40°C for 1khr
9*	High Temp. and High Humidity Storage	1021.1	22	80°C at 90% R.H. for 1khr
10*	High Temp. Biased	1031.1	22	125°C, $V_{CE} = 30V$ for 1khr
11*	Temperature Cycle	1051.1	100	-40 to +125°C 50, 100, 200 cycles (see diag.)

*Testing frequency is once every month.

Acceptance Criteria After Reliability Conformance Test

Item	Minimum	Maximum	Test Conditions
V_F (LED)	_____	$U \times 1.2$	Refer to data book
I_R (LED)	_____	$U \times 2.0$	Refer to data book
I_{CEO}	_____	$U \times 4.0$	Refer to data book
CTR*	-30%L	+30%U	Refer to data book

Note: U = Upper limit specified on data sheet. L = Lower limit specified on data sheet.

* Checked at 168 hours with -15%L, +15%U as acceptance criteria.

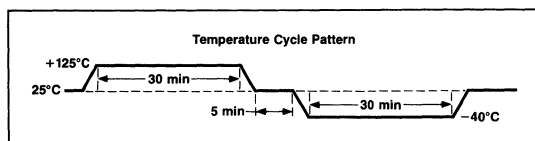


Table 2-1
An Example of Manufacturing Process Flow Chart for Light Emitting Diode (Plastic Molded Package)

Process	Control Item	Frequency	Remarks
<pre> graph TD Materials --> LED_Wafer[LED Wafer] Materials --> Aluminum Materials --> Lead_Frame[Lead Frame] Materials --> Gold_Bond_Wire[Gold Bond Wire] Materials --> Molding_Compound[Molding Compound] Acceptance_Inspection --> LED_Wafer Acceptance_Inspection --> Aluminum Acceptance_Inspection --> Lead_Frame Acceptance_Inspection --> Gold_Bond_Wire Acceptance_Inspection --> Molding_Compound LED_Wafer --> Diffusion Aluminum --> Metallization Diffusion --> Metallization Metallization --> Wafer_Sorting[Wafer Sorting] Wafer_Sorting --> Pelletizing Pelletizing --> Die_Mounting[Die Mounting] Lead_Frame --> Die_Mounting Die_Mounting --> Wire_Bonding[Wire Bonding] Gold_Bond_Wire --> Wire_Bonding Wire_Bonding --> Molding Molding_Compound --> Molding Molding --> Thermal_Aging[Thermal Aging] Thermal_Aging --> Lead_Solder_Plating[Lead Solder Plating] Lead_Solder_Plating --> Lead_Shearing[Lead Shearing] Lead_Shearing --> Electrical_Sorting[Electrical Sorting] Electrical_Sorting --> Reliability_Verification_Test[Reliability Verification Test] Reliability_Verification_Test --> Diffusion Reliability_Verification_Test --> Incoming_Warehouse_Inspection[Incoming Warehouse Inspection] Incoming_Warehouse_Inspection --> Storage Storage --> Shipment </pre>	Resistivity Sheet Resistance Breakdown Voltage Appearance	Every Lot	Magnification (40-400)
	Al Thickness Appearance	Every Lot	Magnification (40-400)
	Electrical Characteristics	100%	
	Appearance	100%	Magnification (40-100)
	Appearance	Every Lot	Magnification (20-40)
	Appearance Bond Strength	Every Shift Every Shift	Magnification (20-40)
	Appearance	Every Lot	Magnification (1)
	Temperature Duration	Every Day	
	Appearance	Every Lot	Magnification (1)
	Appearance	Every Lot	Magnification (1)
	Electrical Characteristics (100% Sorting)	100%	
	Life Test Environmental Test	Every Test Lot	
	Electrical Characteristics Appearance	LTPD 1~3% LTPD 1~5%	Magnification (1)

2

Note: LTPD is according to MIL-S-19500 sampling plan.

Table 2-2
An Example of Initial Characteristics Test (Incoming Warehouse Inspection) for Light Emitting Diode (Plastic Molded Package)

Group	Item	Sampling Inspection Plan*		
		LTPD	Sample Size	Acceptance Number
Open and Short	Open, Short	1%	231	0
Cutoff Current, Forward Voltage and Light Current	I_R, I_L, V_F	3%	129	1
Appearance (Major Defect)	Molded Body Breakage/Crack Lead Breakage	1%	231	0
Appearance (Minor Defect)	Molded Body Damage/Bubble Dirtiness, Lead Bent	5%	77	1

*LTPD is according to MIL-S-19500's LTPD Sampling Plan.

Table 2-3
Acceptance for Light Emitting Diode (Plastic Molded Package) After Reliability Test

Test Item	Failure Criteria			
	Item	Minimum	Maximum	Unit
Resistance to Soldering Heat	Reverse Current (I_R)	—	U x 2	μA
Temperature Cycling	Forward Voltage (V_F)	—	U x 1.1	V
Thermal Shock	Lighting Current (I_L)	-50	—	%
Mechanical Shock				
Vibration, Variable Frequency				
Constant Acceleration				
Salt Atmosphere				
Intermittent Life				
High-Temperature Storage				
Low-Temperature Storage				
High-Temperature High-Humidity Storage				
Terminal Strength (Fatigue)	Terminal's Appearance	No Breaking and No Loosening		—
Salt Atmosphere	Terminal's Appearance	No Extreme Rust and No Corrosion		—

Note: U = Upper limit specified on data sheet.

Table 2-4
An Example of Reliability Test for Light Emitting Diode (Plastic Molded Package)

Test Item	Equivalent Test Method				Test Condition	Sample Size	Acceptance Number
	JIS-C -7021	MIL-STD -202	MIL-STD -750	LEC PUB 68			
Resistance to Soldering	A-1 Cond. A	210 Cond. B	2031	Tb Method A	260°C, 10s, once without flux		
Temperature Cycling	A-6	107	1051	Na	T _{STG MIN} ~ T _{STG MAX} 30 cycles (30 min) (air)	22	0
Thermal Shock	A-3 Method II	—	1056 Cond. B	Nc	100°C ~ C, 5 cycles (5 min) (liquid)		
Mechanical Shock	A-7 Cond. F	213	2016	Ea	1500G, 0.5ms X, Y, Z, 5 times each		
Vibration, Variable Frequency	A-10 Cond. D	—	2056	Fc	20G, 100 ~ 2000 ~ 100Hz 4 min, X, Y, Z, 4 times each	22	0
Constant Acceleration	A-9 Cond. A	212	2006	Ga	20,000G, 1 min, X, Y, Z		
Terminal Strength Lead Fatigue	—	211 Cond. C	2036 Cond.E	Ub	At the specified weight, 90°, 3 times	11	0
Salt Atmosphere	A-12 Cond. B	101	1041	Ka	T _A = 35°C, concentration 5% 0.5 ~ 3.0ml/80cm ² /hr, 24 hr	11	0
Intermittent Life	—	—	1026	—	T _A = 25°C, specified current, specified cycle, 1000 hr	20	1
High-Temperature Storage	B-10	108	1031	Ba	T _{STG MAX} , 1000 hr	20	1
Low-Temperature Storage	B-12	—	—	Aa	T _{STG MIN} , 1000 hr	20	1
High-Temperature, High-Humidity Storage	B-11 Cond. B-C	103	—	Ca	T _A = 60°C, RH = 90% 1000 hr	20	0

2

STANDARD LEDS

3

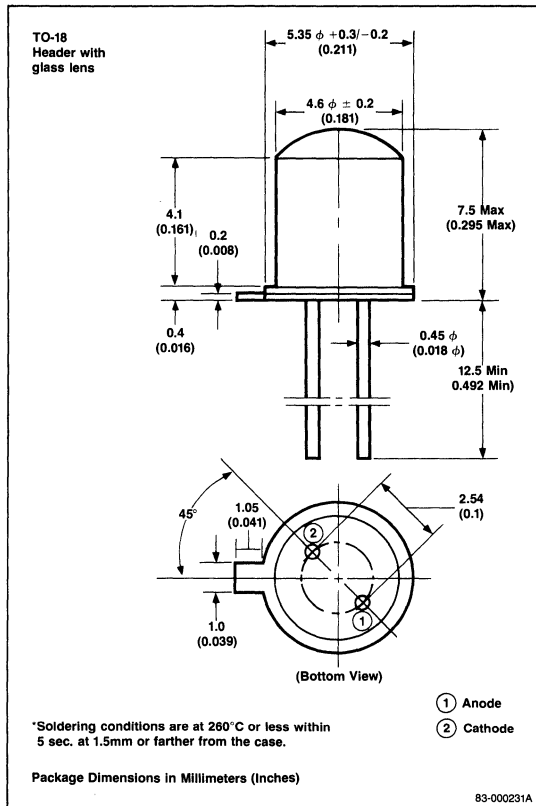
Section 3 — Standard LEDs

SE301A GaAs Infrared Emitting Diode 3-3
SE302A GaAs Infrared Emitting Diode 3-5
SE303A GaAs Infrared Emitting Diode 3-7
SE306 GaAs Infrared Emitting Diode 3-9
SE307 GaAs Infrared Emitting Diode 3-11
SE308 GaAs Infrared Emitting Diode 3-13
SE1003 GaAlAs on GaAs Infrared Emitting Diode 3-15
SG203DA, SG203TA (Green) GaP High Intensity LEDs 3-17
SG205D, SG205T (Green) GaP LEDs 3-19
SG206D, SG206T, SY406D, SY406T, SR506C, SR506D
(Green, Amber, Red) GaP LEDs 3-21
SG213D, SG213T (Green) GaP High Intensity LEDs 3-23
SG215D, SG215T (Green) GaP High Intensity LEDs 3-25
SR106C, SR106D (Red) GaAsP LEDs 3-27
SR503C, SR503D, SR503W (Red) GaP High Intensity LEDs 3-29
SR505C, SR505D, SR505W (Red) GaP High Intensity LEDs 3-31
SR513C, SR513D, SR513W (Red) GaP High Intensity LEDs 3-33
SR603C, SR603D, SR603W (Red) GaAsP(N) High Intensity LEDs 3-35
SR605C, SR605D, SR605W (Red) GaAsP(N) High Intensity LEDs 3-37
SR613C, SR613D, SR613W (Red) GaAsP(N) High Intensity LEDs 3-39
SR615C, SR615D, SR615W (Red) GaAsP(N) High Intensity LEDs 3-41
SY403DA, SY403TA (Amber) GaAsP(N) High Intensity LEDs 3-43
SY405D, SY405T (Amber) GaAsP(N) High Intensity LEDs 3-45
SY406D, SY406T (Amber) GaAs LEDs 3-47
SY413D, SY413T (Amber) GaAsP High Intensity LEDs 3-49
SY415D, SY415T (Amber) GaAsP High Intensity LEDs 3-51

Description

The SE301A is a GaAs (Gallium Arsenide) infrared emitting diode which is mounted on a TO-18 hermetically sealed header with a glass lens. On forward bias, it emits a spectrally narrow band of radiation peaking at 940nm. The close wavelength match of this device to silicon sensors makes it ideally suited for all source-sense applications. Its low cost and volume producibility opens new areas of use anywhere an infrared source is desirable.

Package Dimensions



Features

- Low cost
- High output power — 3mW min
- Fast switching time
- Long life-solid state reliability
- Compact, rugged, lightweight
- Spectrally matched to silicon sensors

Applications

- Paper tape and punch card readers
- Optical encoders
- Photo choppers
- High speed optoelectronic data links

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	150mW
Forward Current, I_F	100mA
Peak Forward Current, I_{PEAK}^1	1000mA
Reverse Voltage, V_R	5.0V
Junction Temperature, T_J	+125°C
Storage Temperature, T_{STG}	-65°C ~ +125°C

Electro-Optical Characteristics

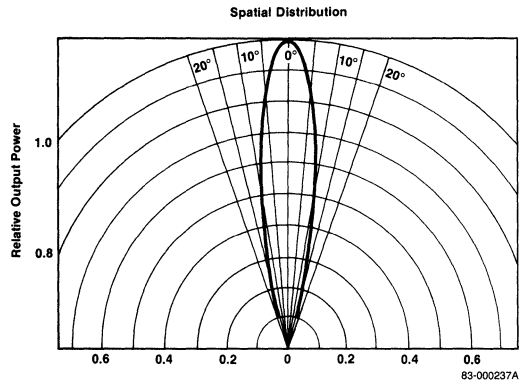
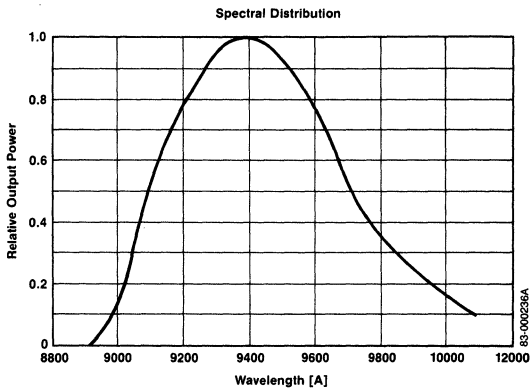
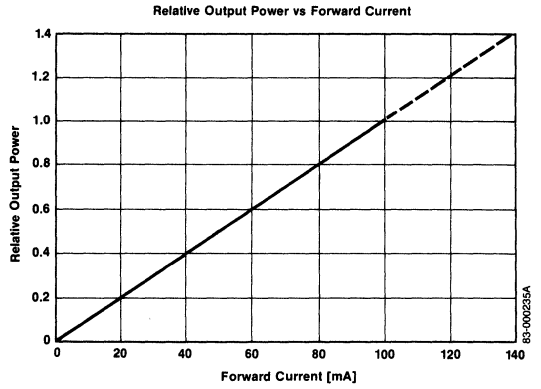
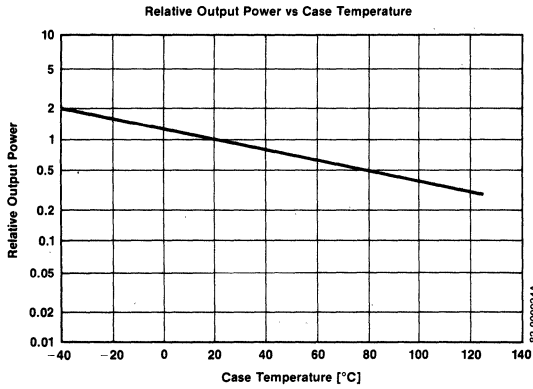
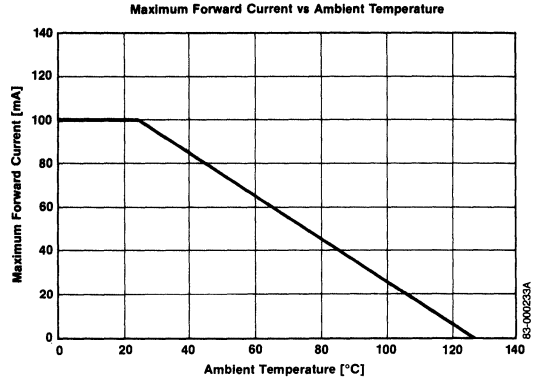
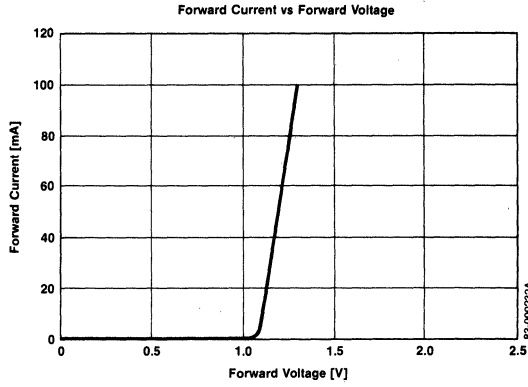
$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F		1.45		V	$I_F = 50\text{mA}$
Pulse Forward Voltage	V_F		5.0		V	$I_F = 1.0\text{A}$
Capacitance	C		100		pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}		940		nm	$I_F = 50\text{mA}$
Spectral Line Half Width	$\Delta\lambda$		60		nm	$I_F = 50\text{mA}$
Output Power	P_O	3.0			mW	$I_F = 50\text{mA}$
Peak Output Power	P_{PEAK}^1	15			mW	$I_F = 1.0\text{mA}$
Light Turn-On and Turn-Off	t_{ON}, t_{OFF}		1		μs	

Note: 1. $f = 1.0\text{kHz}$, duty cycle 1%.

Typical Characteristics (cont)

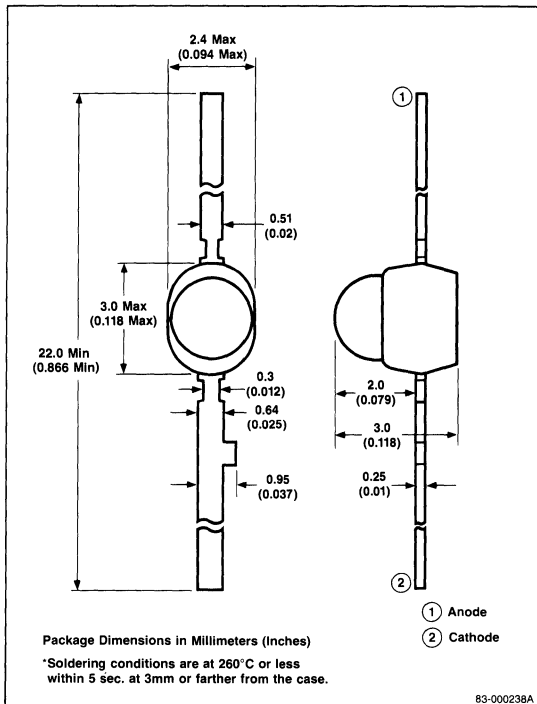
T_A = +25°C



Description

The SE302A is a GaAs (Gallium Arsenide) infrared emitting diode which is mounted on a lead frame and molded in a clear plastic lens. On forward bias, it emits a spectrally narrow band of radiation peaking at 940nm. The close wavelength match of this device to silicon sensors makes it ideally suited for all source-sense applications. Its low cost and volume producibility open new areas of use anywhere an infrared source is desirable.

Package Dimensions



Features

- Low cost
- High output power
- Fast switching time
- Long life, solid state reliability
- Compact, rugged, lightweight
- Spectrally matched to silicon sensors (Good compatibility with Darlington photo transistor (PH101))
- Easily assembled in linear arrays
- Compatible with integrated circuits

Applications

- Electro optical switches
- Card and tape reader sources
- Optical encoders
- Photo choppers, isolator
- High speed optoelectronic data links
- Photo coupler

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	75mW
Forward Current, I_F	50mA
Reverse Voltage, V_R	3.0V
Junction Temperature, T_J	+80°C
Storage Temperature, T_{STG}	-30°C ~ +80°C

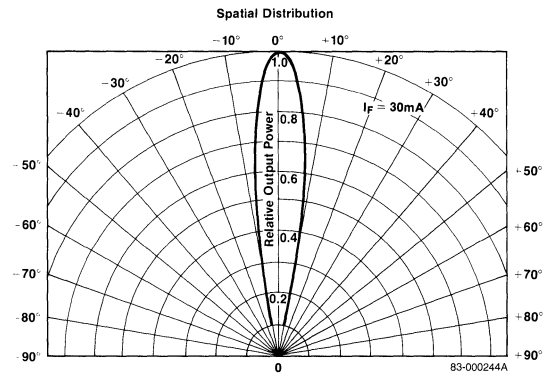
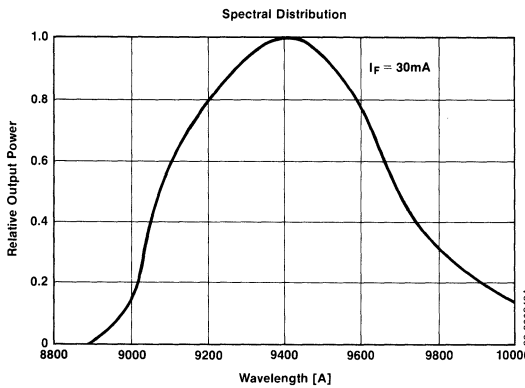
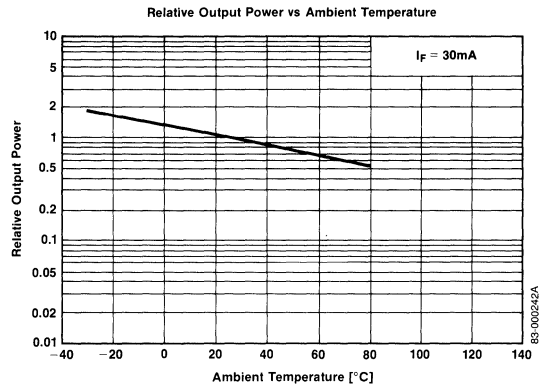
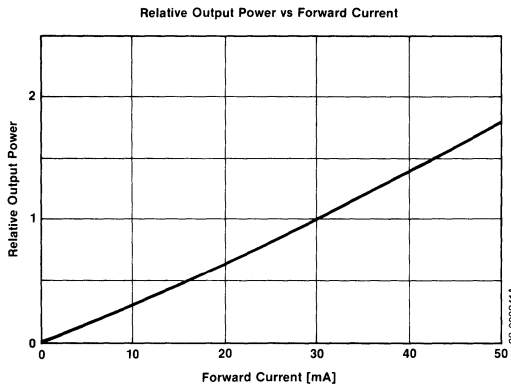
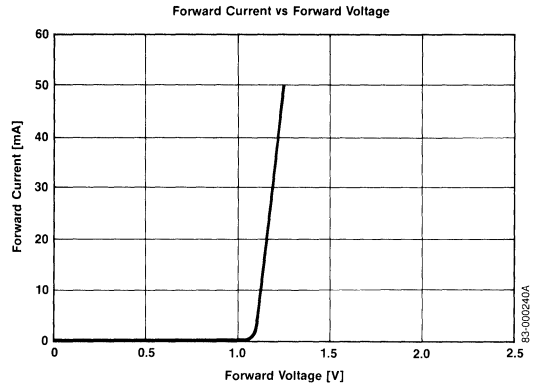
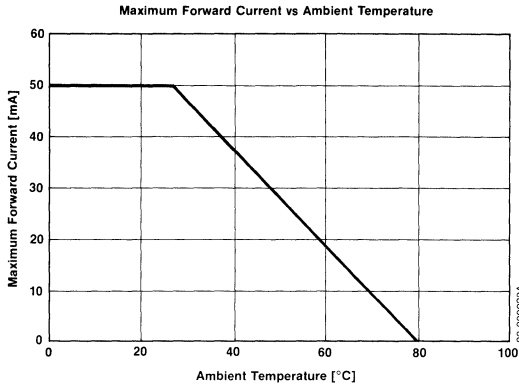
Electro-Optical Characteristics

$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F		1.2	1.4	V	$I_F = 50\text{mA}$
Reverse Current	I_R			5.0	μV	$V_R = 3.0\text{V}$
Capacitance	C		100		pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}		940		nm	$I_F = 50\text{mA}$
Spectral Line Half Width	$\Delta\lambda$		60		nm	$I_F = 50\text{mA}$
Output Power	P_O	1.0	1.5		mW	$I_F = 50\text{mA}$
Light Turn-On and Turn-Off	t_{ON}, t_{OFF}		1.0		μs	

Typical Characteristics

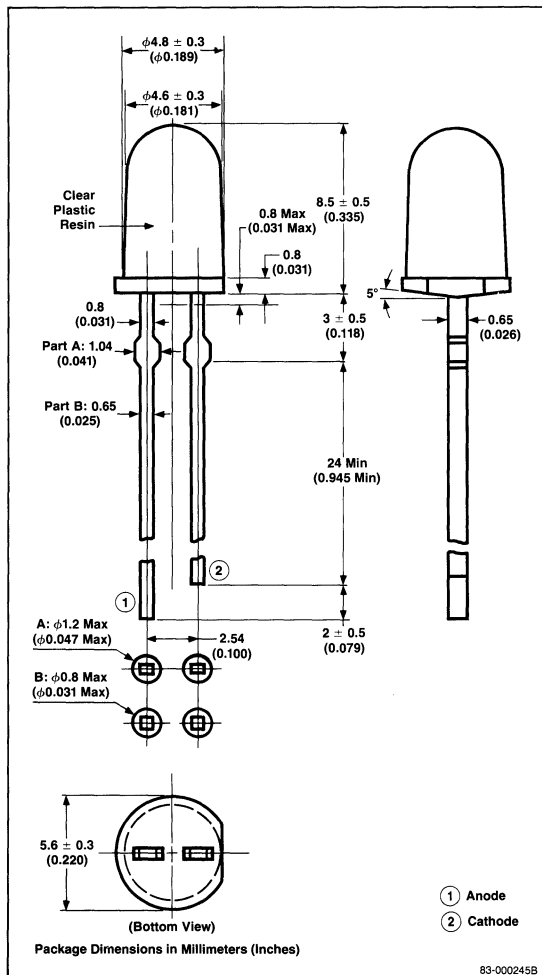
$T_A = +25^\circ\text{C}$



Description

The SE303A is a GaAs (gallium arsenide) infrared emitting diode which is mounted on the lead frames and molded in plastic. On forward bias, it emits a spectrally narrow band of radiation peaking at 940nm.

Package Dimensions



Features

- Economical
- High output power
- Wide half angle
- Good linearity
- Spectrally matched to silicon sensors
- Long lead

Applications

- Light source for TV remote control
- Light source for smoke detector
- Optical encoders
- Photo choppers, isolator

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	150mW
Forward Current, I_F	100mA
Pulse Forward Current, I_{FP}^1	1.0A
Reverse Voltage, V_R	5.0V
Junction Temperature, T_J	+80°C
Storage Temperature, T_{STG}	-30°C to +80°C

Electro-Optical Characteristics

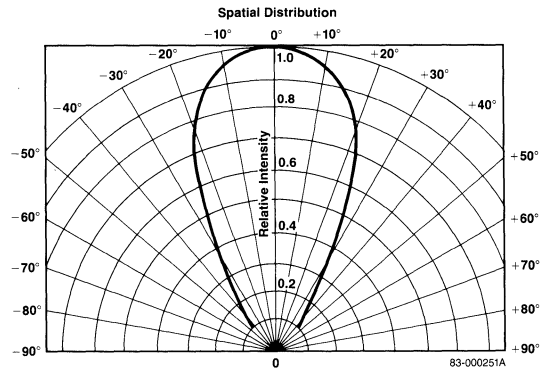
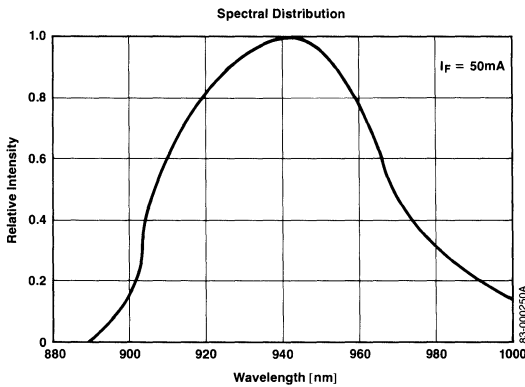
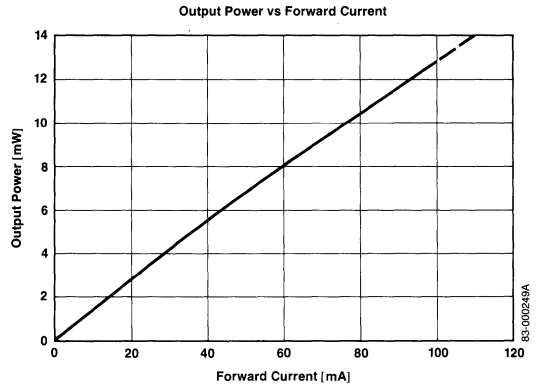
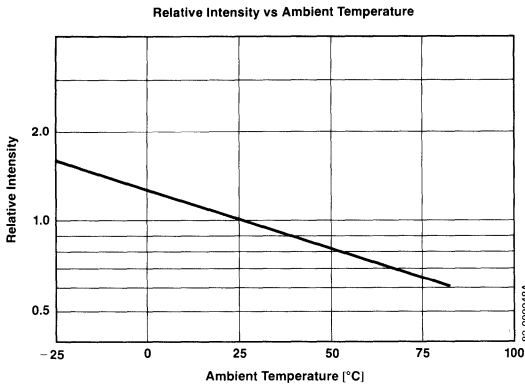
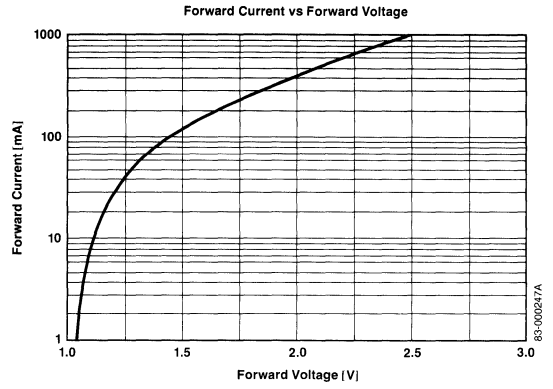
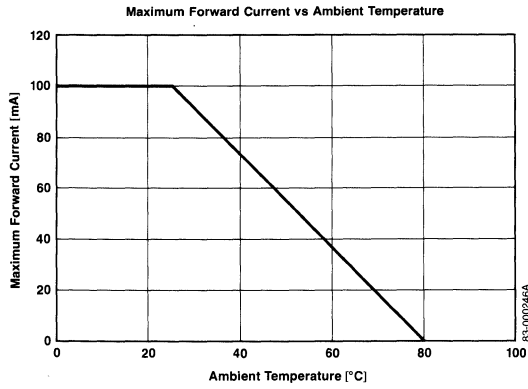
$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F		1.25	1.45	V	$I_F = 50\text{mA}$
Pulse Forward Voltage	V_{FP}^1		2.5	3.0	V	$I_{FP} = 1.0\text{A}$
Capacitance	C_T		40		pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}		940		nm	$I_F = 50\text{mA}$
Spectral Line Half Width	$\Delta\lambda$		60		nm	$I_F = 50\text{mA}$
Output Power	P_O	3.0	6.5		mW	$I_F = 50\text{mA}$
Peak Output Power	P_{FP}^1	15			mW	$I_{FP} = 1.0\text{A}$
Light Turn-On and Turn-Off	t_{ON}, t_{OFF}		1		μs	

Note: 1. $f = 1.0\text{kHz}$, duty cycle 1%.

Typical Characteristics

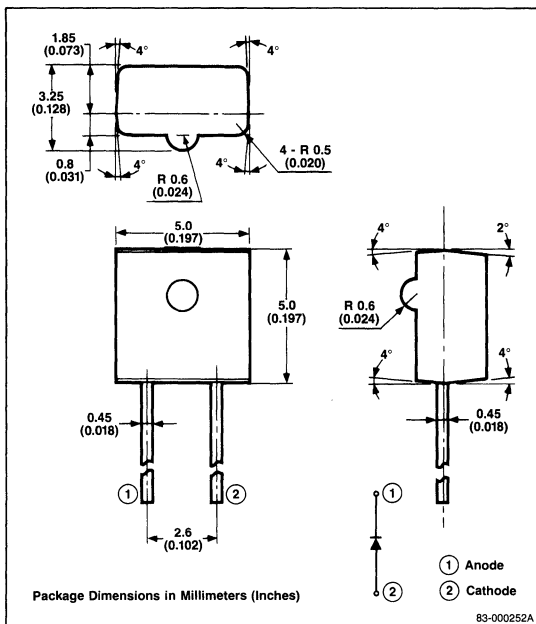
$T_A = +25^\circ\text{C}$



Description

The SE306 is a GaAs (Gallium Arsenide) infrared LED in a plastic molded package, and is very suitable for a detector of a photo interrupter. On forward bias, it emits a spectrally narrow band of radiation peaking at 940nm.

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$	
Power Dissipation, P_D	100mW
Forward Current, I_F	50mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

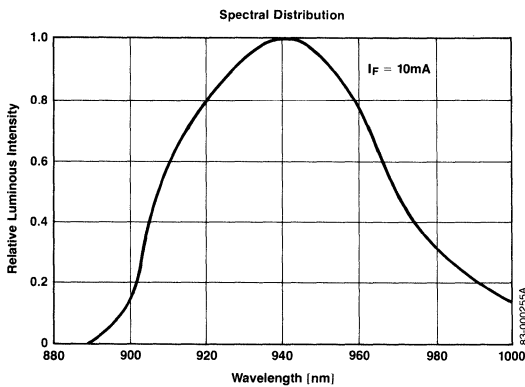
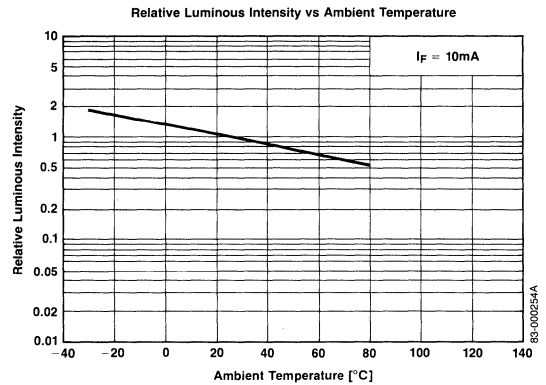
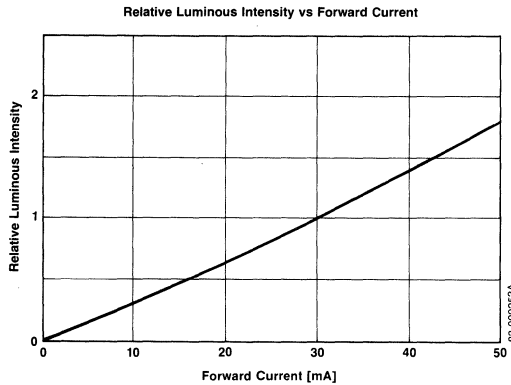
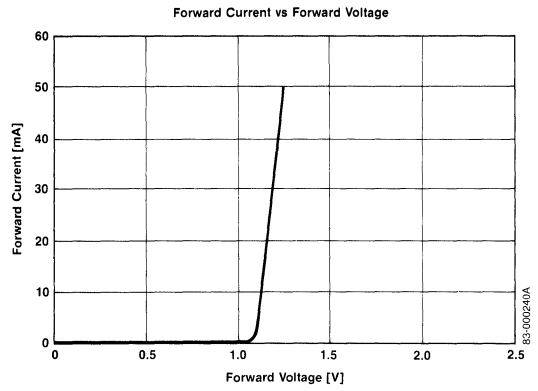
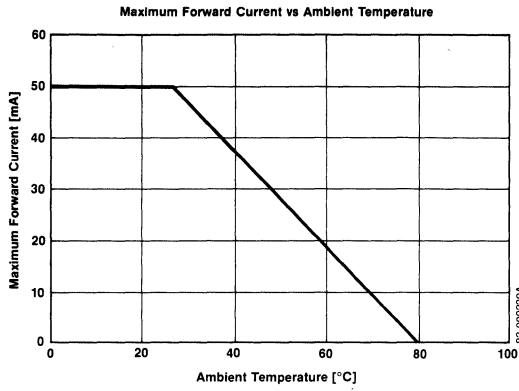
Electrical Characteristics

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F			1.4	V	$I_F = 10\text{mA}$
Reverse Current	I_R			10	μA	$V_R = 5\text{V}$
Capacitance	C_T		100		pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}		940		nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$		60		nm	$I_F = 10\text{mA}$
Output Power	P_O	0.2			mW/sr	$I_F = 10\text{mA}$

3

Typical Characteristics

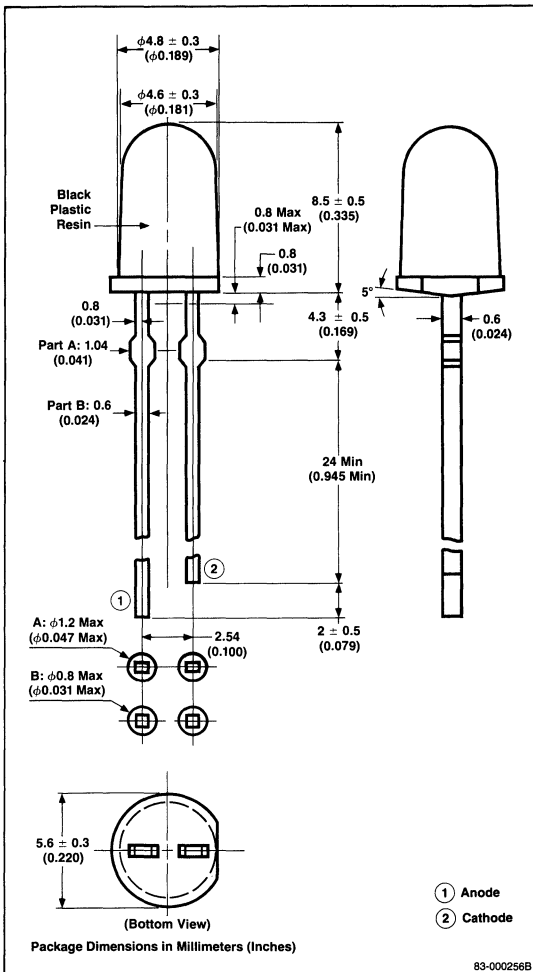
$T_A = +25^\circ\text{C}$



Description

The SE307 is a GaAs (Gallium Arsenide) infrared emitting diode which is mounted on the lead frames and molded in plastic. On forward bias, it emits a spectrally narrow band of radiation peaking at 940nm.

Package Dimensions



Features

- Economical
- High radiant intensity
- Narrow half angle
- Good linearity
- Spectrally matched to silicon sensors
- Long lead

Applications

- Light source for TV remote control
- Light source for smoke detector
- Optical encoders
- Photo choppers, isolators

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	150mW
Forward Current, I_F	100mA
Pulse Forward Current, I_{FP}^1	1.5A
Reverse Voltage, V_R	5.0V
Junction Temperature, T_J	+80°C
Storage Temperature, T_{STG}	-30°C to +80°C

Electro-Optical Characteristics

$T_A = +25^\circ\text{C}$

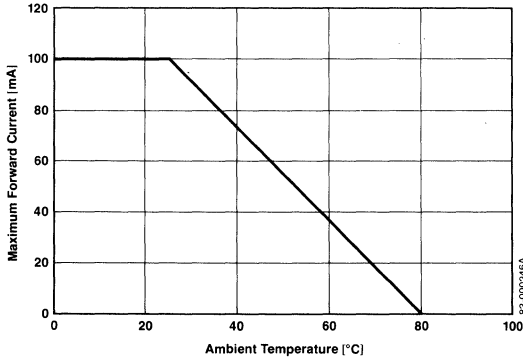
Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F	1.25	1.45		V	$I_F = 50\text{mA}$
Pulse Forward Voltage	V_{FP}^1	2.5	3.0		V	$I_{FP} = 1.0\text{A}$
Capacitance	C_T	40			pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}	940			nm	$I_F = 50\text{mA}$
Spectral Line Half Width	$\Delta\lambda$	60			nm	$I_F = 50\text{mA}$
Radiant Intensity	I_E	10	30		mW/sr	$I_F = 50\text{mA}$
Peak Output Power	P_{FP}^1	15			mW	$I_{FP} = 1.0\text{A}$
Light Turn-On and Turn-Off	t_{ON}, t_{OFF}	1			μs	

Note: 1. $f = 1.0\text{kHz}$, duty cycle 1%.

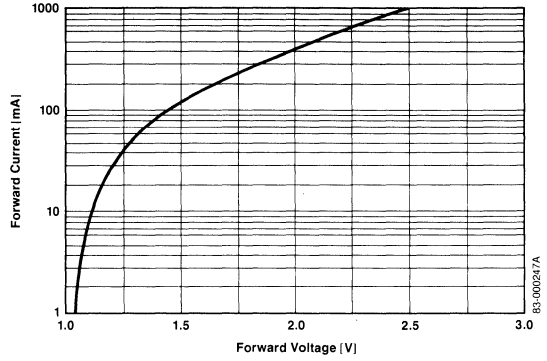
Typical Characteristics

T_A = +25°C

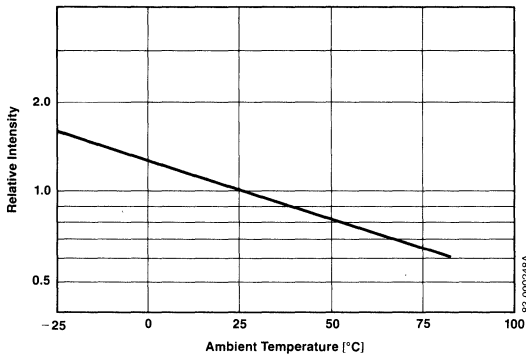
Maximum Forward Current vs Ambient Temperature



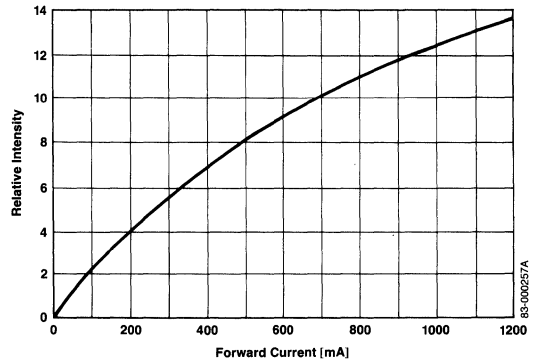
Forward Current vs Forward Voltage



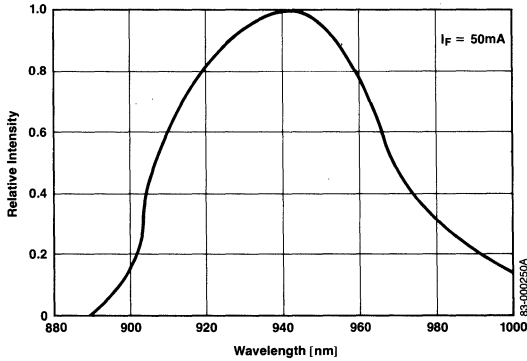
Relative Intensity vs Ambient Temperature



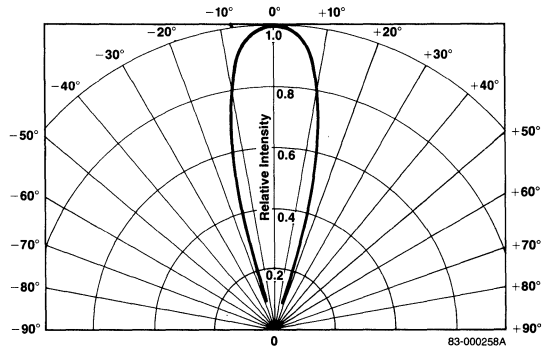
Relative Intensity vs Forward Current



Spectral Distribution



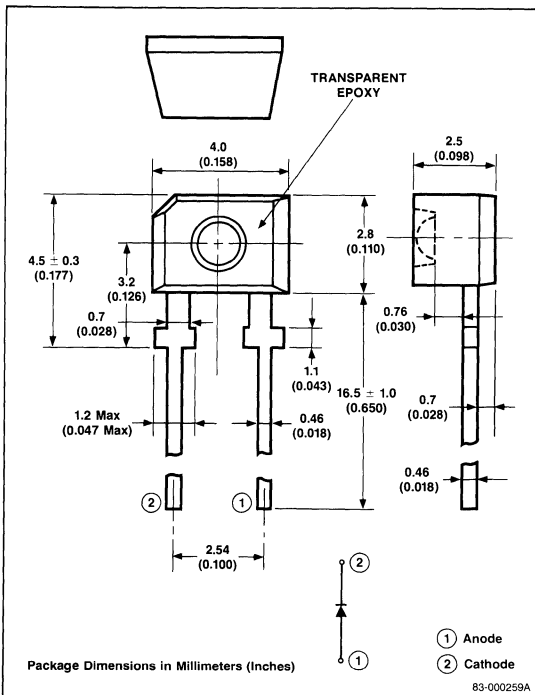
Spatial Distribution



Description

The SE308 is a GaAs (Gallium Arsenide) infrared LED in a plastic molded package, and is very suitable as a detector of a photo interrupter. On forward bias, it emits a spectrally narrow band of radiation peaking at 940nm.

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	100mW
Forward Current, I_F	50mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Operating Temperature, T_{OPT}	-20°C ~ +80°C
Storage Temperature, T_{STG}	-40°C ~ +100°C

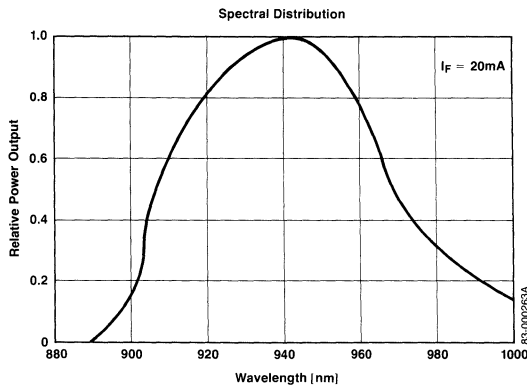
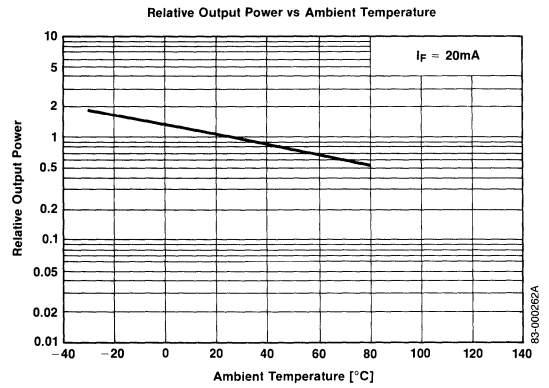
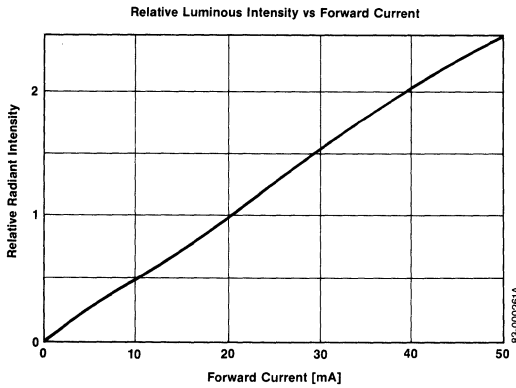
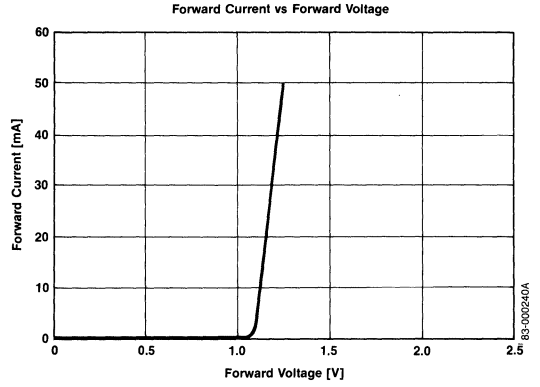
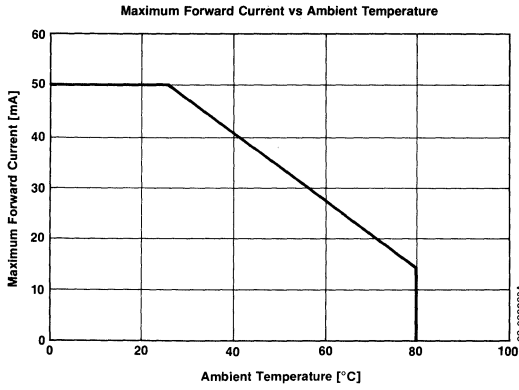
Electrical Characteristics

$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F		1.1	1.4	V	$I_F = 20\text{mA}$
Reverse Current	I_R			5	μA	$V_R = 5\text{V}$
Capacitance	C_T		100		pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}		940		nm	$I_F = 20\text{mA}$
Spectral Line Half Width	$\Delta\lambda$		60		nm	$I_F = 20\text{mA}$
Radiant Intensity	I_E	0.5	0.85		mW/sr	$I_F = 20\text{mA}$
Response Time	t_{ON}, t_{OFF}		1		μs	$I_F = 20\text{mA}$

Typical Characteristics

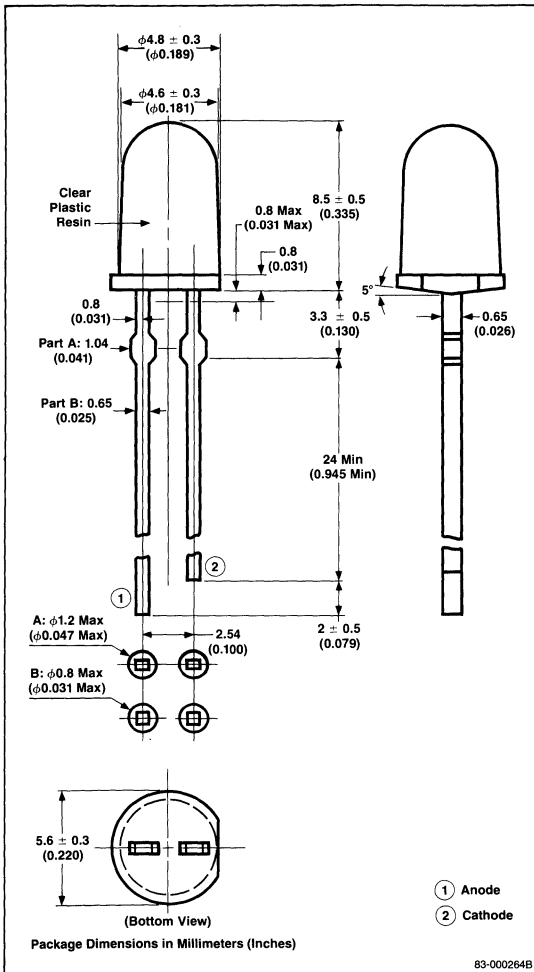
T_A = +25°C



Description

The SE1003 is a GaAlAs on GaAs Infrared Emitting Diode which is mounted on a lead frame and molded in plastic. On forward bias, it emits a spectrally narrow band of radiation peaking at 950nm.

Package Dimensions



Features

- Economical
- High output power
- Wide half angle
- Good linearity
- Spectrally matched to silicon sensors
- Long lead

Applications

- Light source for TV remote control
- Light source for smoke detector
- Optical encoders
- Photo choppers, isolators

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	150mW
Forward Current, I_F	100mA
Pulse Forward Current, I_{FP1}	1.0A
Reverse Voltage, V_R	5.0V
Junction Temperature, T_J	+80°C
Storage Temperature, T_{STG}	-30°C to +80°C

Electro-Optical Characteristics

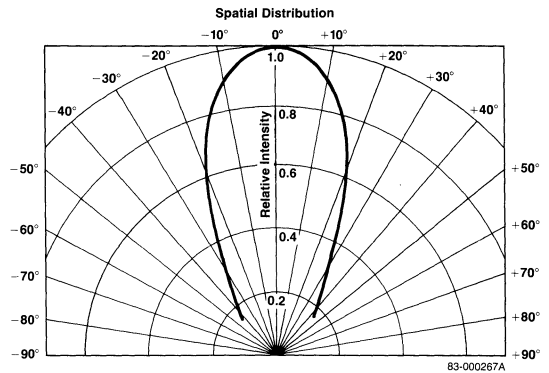
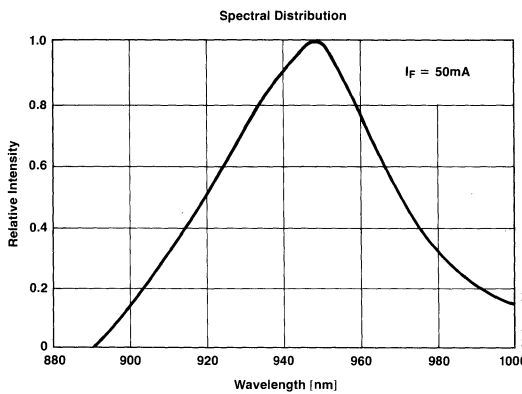
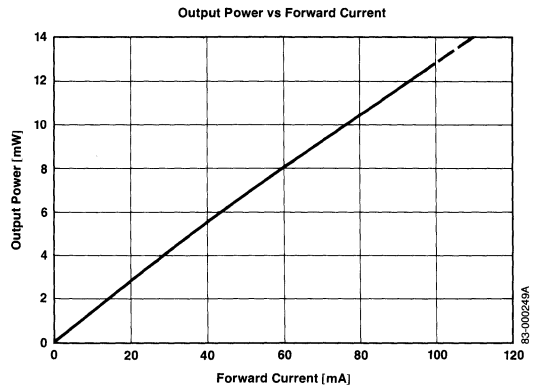
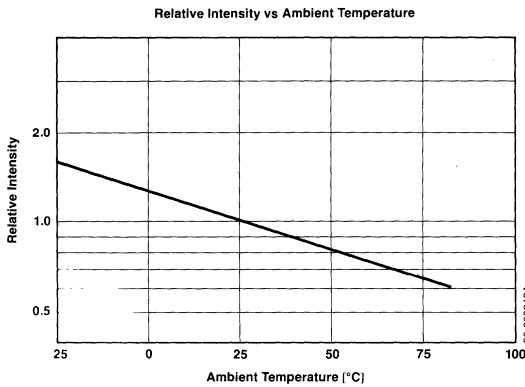
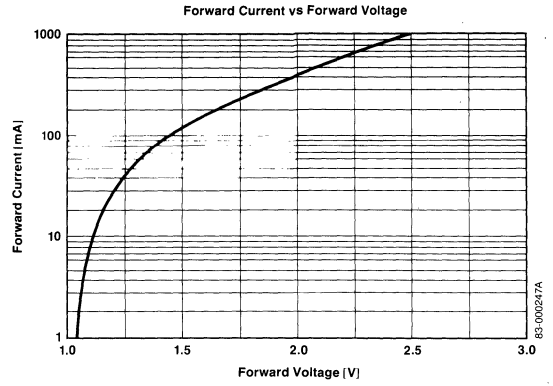
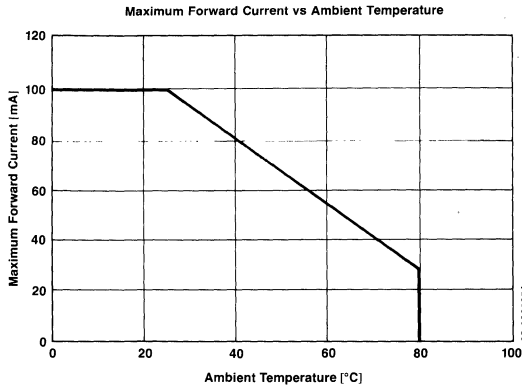
$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F	1.27	1.45		V	$I_F = 50\text{mA}$
Pulse Forward Voltage	V_{FP1}		2.9	3.4	V	$I_{FP} = 1.0\text{A}$
Capacitance	C_T		40		pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}		950		nm	$I_F = 50\text{mA}$
Spectral Line Half Width	$\Delta\lambda$		50		nm	$I_F = 50\text{mA}$
Output Power	I_E	12	20		mW/sr	$I_F = 50\text{mA}$
Light Turn-On and Turn-Off	t_{ON}, t_{OFF}		1		μs	

Note: 1. $f = 1.0\text{kHz}$, duty cycle 1%.

Typical Characteristics

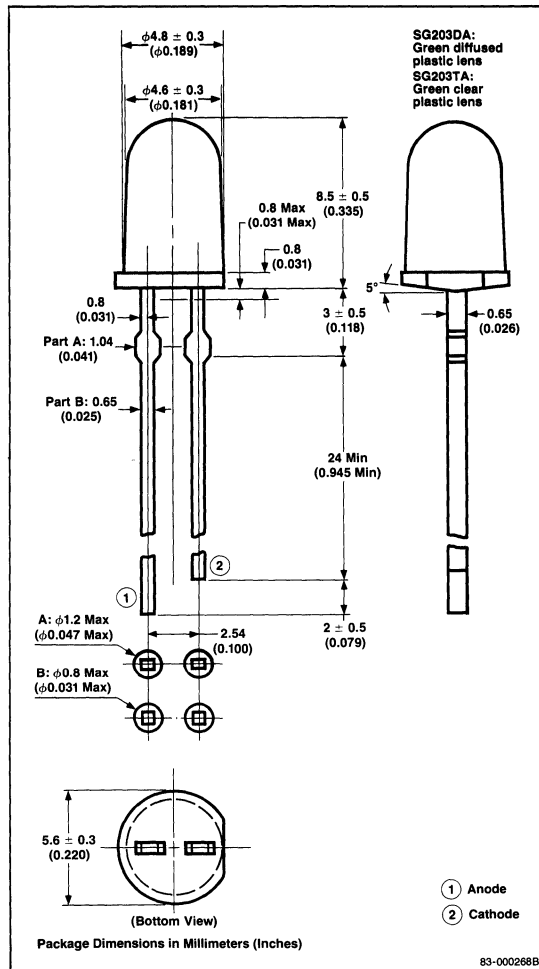
$T_A = +25^\circ\text{C}$



Description

The SG203DA and SG203TA are full resin-molded LED lamps and emit bright and vivid green light. They are especially suitable for electronic equipment in audio applications which require high-brightness displays.

Package Dimensions



Features

- High intensity
- Wide angle
- Long lead
- Low cost
- Compatible with integrated circuits

Applications

- Visual displays
- Guard systems
- Mobile equipment indicators
- Stereo equipment indicators
- Transceiver indicators

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	100mW
Forward Current, I_F	40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

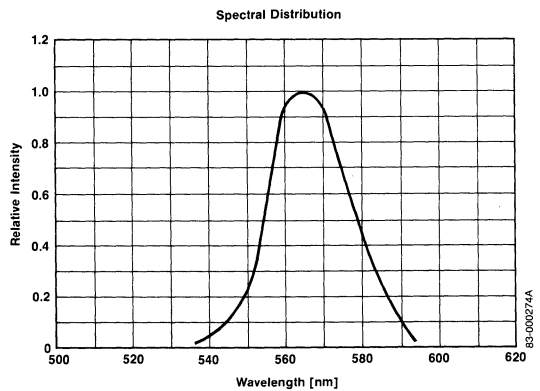
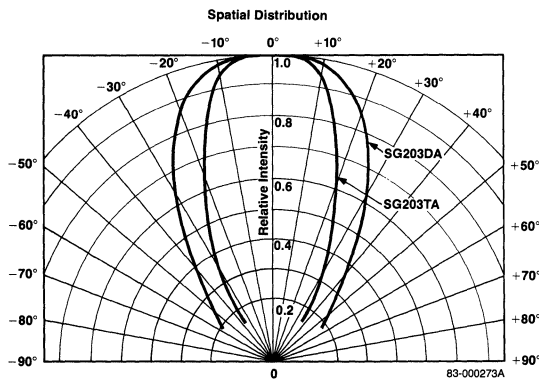
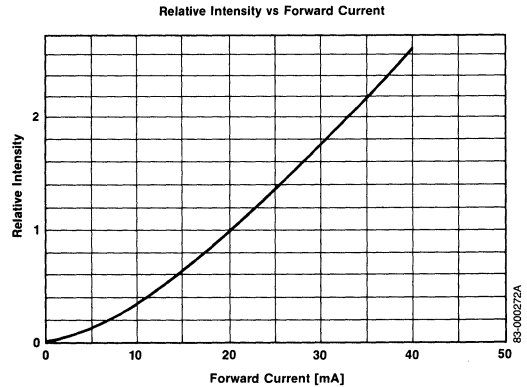
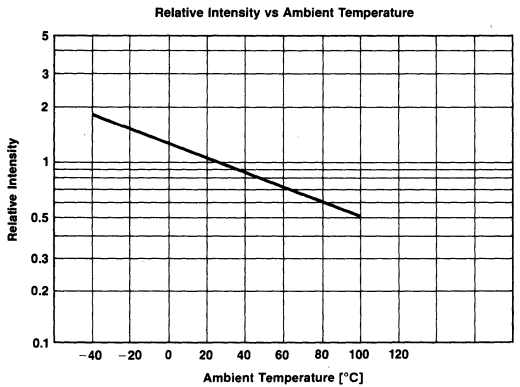
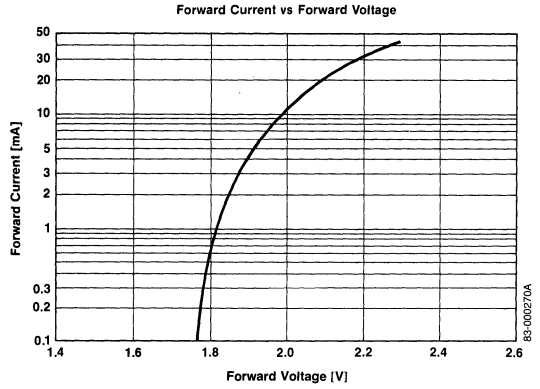
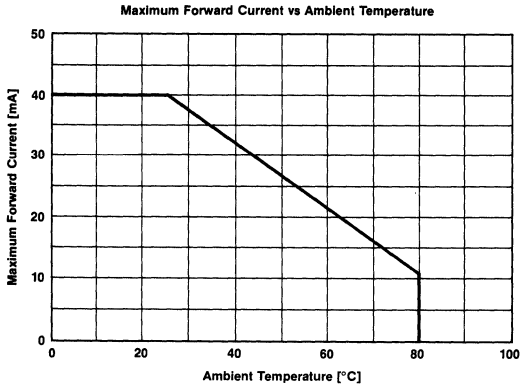
Electro-Optical Characteristics

$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F	2.2	2.5		V	$I_F = 10\text{mA}$
Reverse Current	I_R	0.01	10		μA	$V_R = 4.5$
Capacitance	C_T	60			pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}	565			nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
Luminous Intensity (SG203DA)	I_V	2	8		mcd	$I_F = 10\text{mA}$
Luminous Intensity (SG203TA)	I_V	5	13		mcd	$I_F = 10\text{mA}$

Typical Characteristics

T_A = +25°C



Description

The SG205D and SG205T are GaP (Gallium Phosphide) light emitting diodes which are mounted on lead frames and molded in diffused green and clear green plastic, respectively. They are ideally suited for front panel indicator applications.

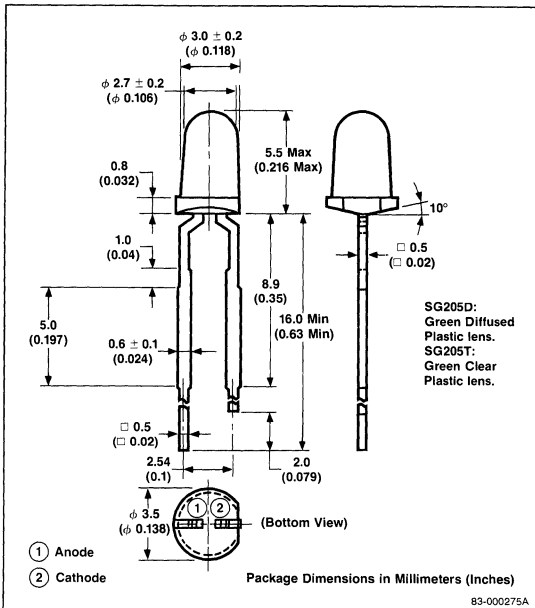
Features

- Long life—solid state reliability
- Low cost
- High intensity with low current
- Versatile mounting on PC board or panel
- Compatible with integrated circuits
- Fast switching time

Applications

- Visual displays
- Guard systems
- Radio or stereo equipment indicators
- Measuring instruments, terminals

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$	
Power Dissipation, P_D	100mW
Forward Current, I_F	40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	+80°C
Storage Temperature, T_{STG}	-30°C to +80°C

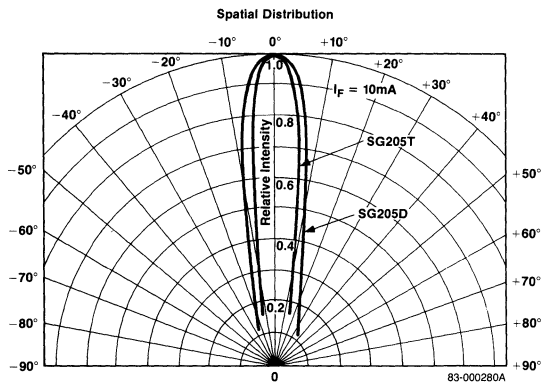
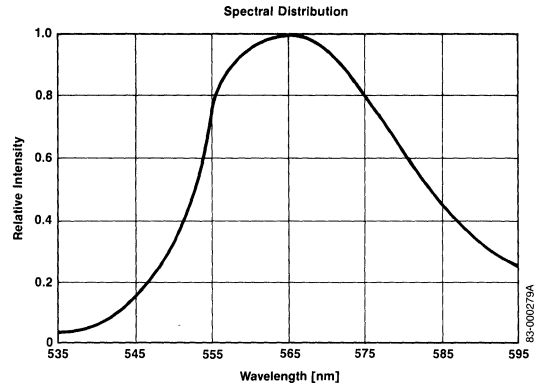
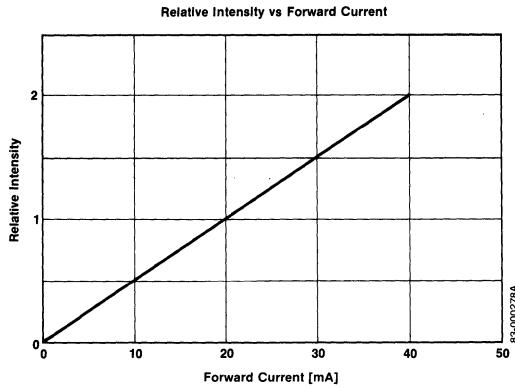
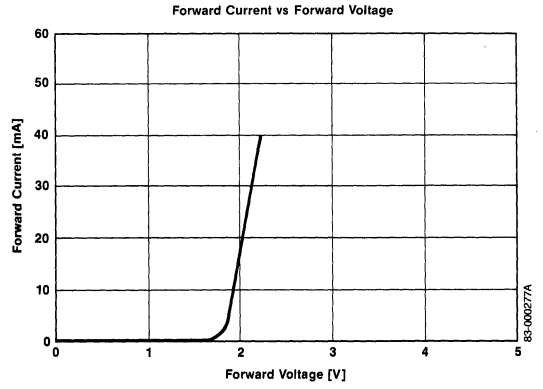
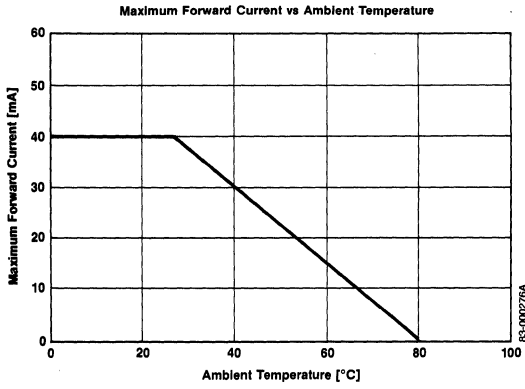
Electro-Optical Characteristics

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F			2.5	V	$I_F = 10\text{mA}$
Reverse Current	I_R		0.01	50	μA	$V_R = 4.5\text{V}$
Capacitance	C_T		60		pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}		565		nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$		30		nm	$I_F = 10\text{mA}$
Luminous Intensity	$I_{V1}/I_{V2}^{1/2}$	1/2	3/5		mcd	$I_F = 10\text{mA}$

Notes: 1. $I_{V1}/I_{V2}^{1/2}$: Luminous intensity of SG205D/luminous intensity of SG205T.

Typical Characteristics

$T_A = +25^\circ\text{C}$



Description

These six LEDs are full resin-molded LED lamps which uniformly emit brilliant red, green and amber light. They are especially suitable for electronic equipment in audio applications which require fancy displays.

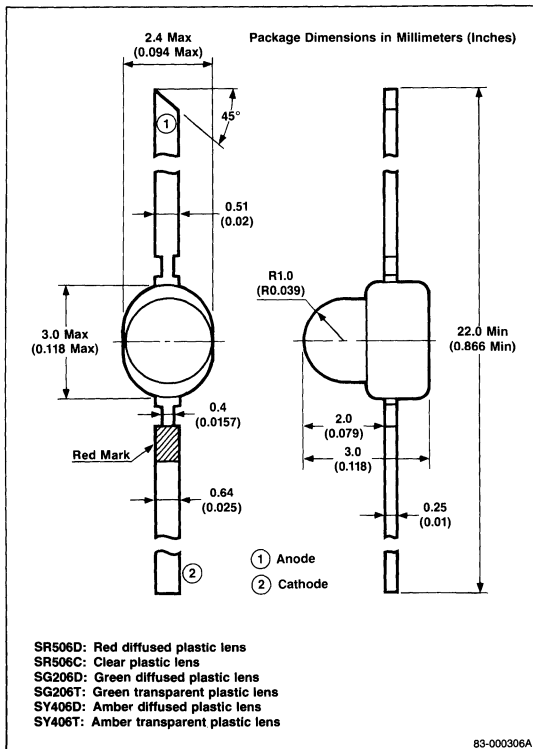
Features

- Small size
- Low cost
- Easily assembled in arrays
- Bright red, green or amber
- Compatible with integrated circuits

Applications

- Visual displays
- Radio and stereo equipment indicators
- Portable equipment indicators
- Camera indicators

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$	
Power Dissipation, P_D	60/100mW
Forward Current, I_F	30/40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

Note: 1. SR506D, SR506C/SG206D, SG206T, SY406D, SY406T.

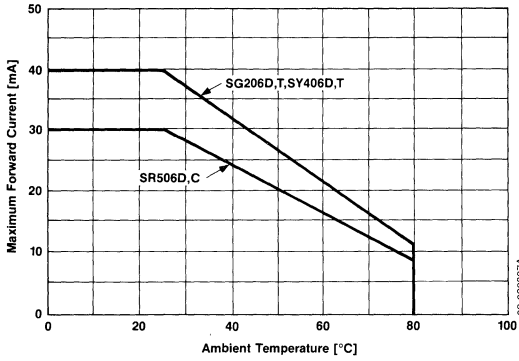
Electro-Optical Characteristics

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage						
SR506D/SR506C	V_F	2.0	2.6		V	$I_F = 10\text{mA}$
SG206D/SG206T	V_F	2.0	2.6		V	$I_F = 10\text{mA}$
SY406D/SY406T	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
Reverse Current						
SR506D/SR506C	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
SG206D/SG206T	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
SY406D/SY406T	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
Capacitance						
SR506D/SR506C	C_T	100			pF	$V = 0, f = 1.0\text{MHz}$
SG206D/SG206T	C_T	100			pF	$V = 0, f = 1.0\text{MHz}$
SY406D/SY406T	C_T	100			pF	$V = 0, f = 1.0\text{MHz}$
Peak Emission Wavelength						
SR506D/SR506C	λ_{PEAK}	695			nm	$I_F = 10\text{mA}$
SG206D/SG206T	λ_{PEAK}	565			nm	$I_F = 10\text{mA}$
SY406D/SY406T	λ_{PEAK}	590			nm	$I_F = 10\text{mA}$
Spectral Line Half Width						
SR506D/SR506C	$\Delta\lambda$	100			nm	$I_F = 10\text{mA}$
SY206D/SY206T	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
SG406D/SG406T	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
Luminous Intensity						
SR506D/SR506C	I_V	0.5/1	1/2		mcd	$I_F = 10\text{mA}$
SG206D/SG206T	I_V	0.5/1	1.5/3		mcd	$I_F = 10\text{mA}$
SY406D/SY406T	I_V	0.5/1	1.5/3		mcd	$I_F = 10\text{mA}$

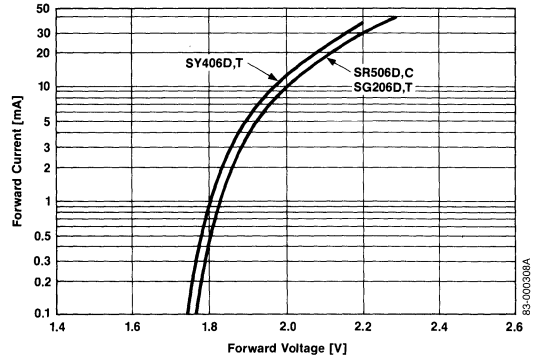
Typical Characteristics

$T_A = +25^\circ\text{C}$

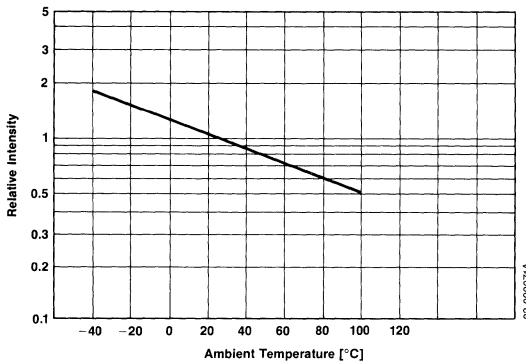
Maximum Forward Current vs Ambient Temperature



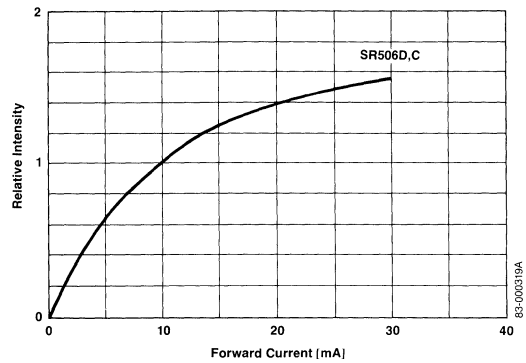
Forward Current vs Forward Voltage



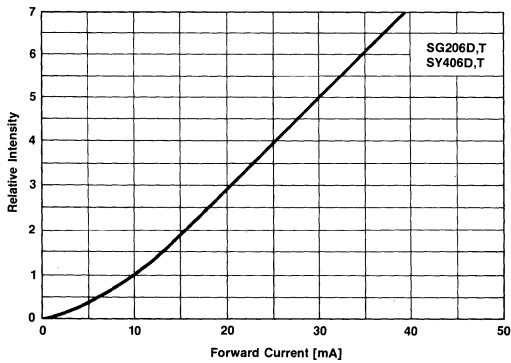
Relative Intensity vs Ambient Temperature



Relative Intensity vs Forward Current



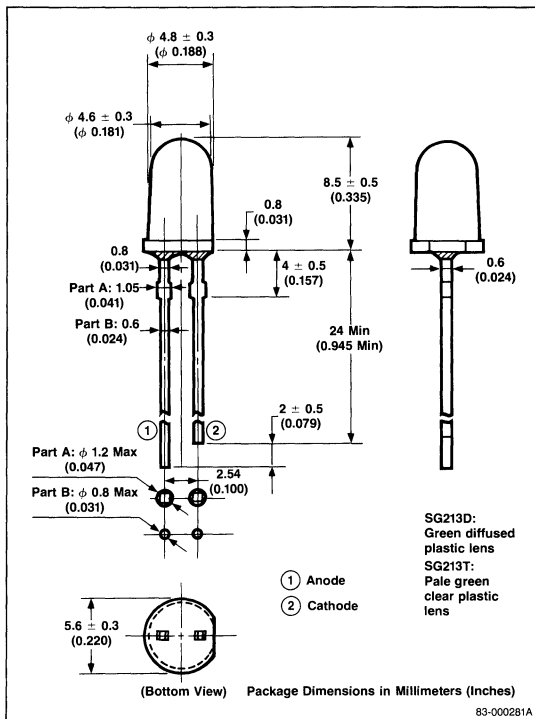
Relative Intensity vs Forward Current



Description

The SG213D and SG213T are full resin-molded LED lamps which emit bright, brilliant, uniform green light proportional to the forward current (I_F). They are especially suitable for electronic equipment in audio applications which require bright, vivid displays. The SG213T is especially suitable as a backlighting source.

Package Dimensions



Features

- High intensity
- Bright green
- Long lead
- Low cost
- Compatible with integrated circuits

Applications

- Visual displays
- Guard systems
- Mobile equipment indicators
- Stereo equipment indicators
- Transceiver indicators

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	100mW
Forward Current, I_F	40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

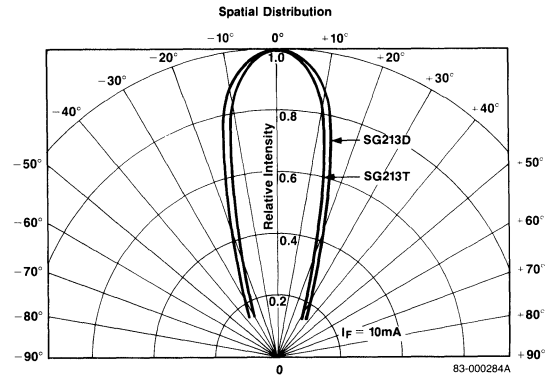
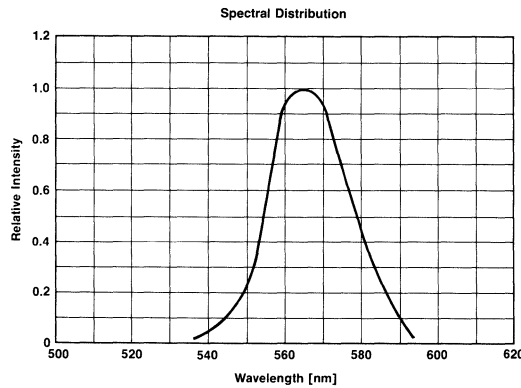
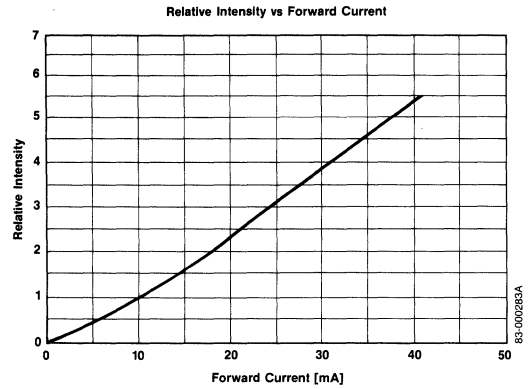
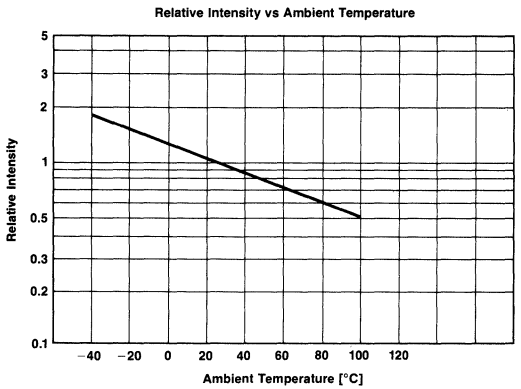
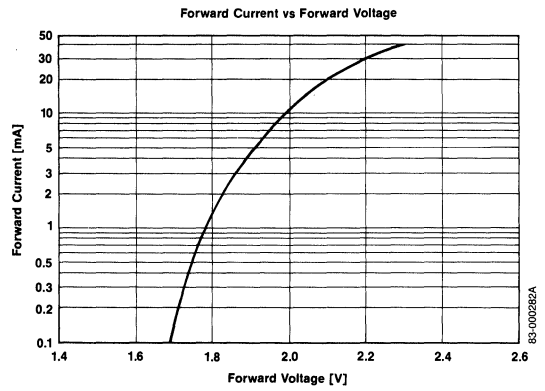
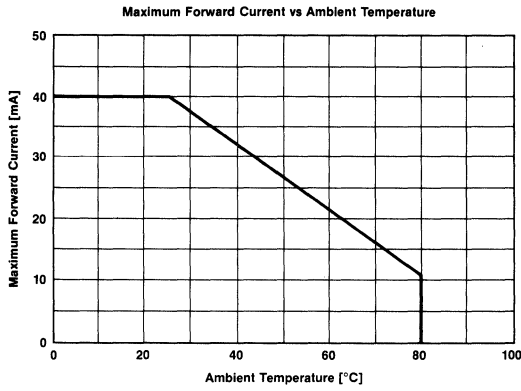
Electro-Optical Characteristics

$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
Reverse Current	I_R	0.01	10		μA	$V = 4.5$
Capacitance	C_T	60			pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}	565			nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
Luminous Intensity (SG213D)	I_V	3	15		mcd	$I_F = 10\text{mA}$
Luminous Intensity (SG213T)	I_V	12	45		mcd	$I_F = 10\text{mA}$

Typical Characteristics

T_A = +25°C



Description

The SG215D and SG215T are medium-size plastic resin-encapsulated LED lamps from which brilliant green light is emitted uniformly and intensely in proportion to the forward current (I_F). They are suitable for use as bright and distinguishable illuminators or indicators on the panels of audio/video equipment and elsewhere.

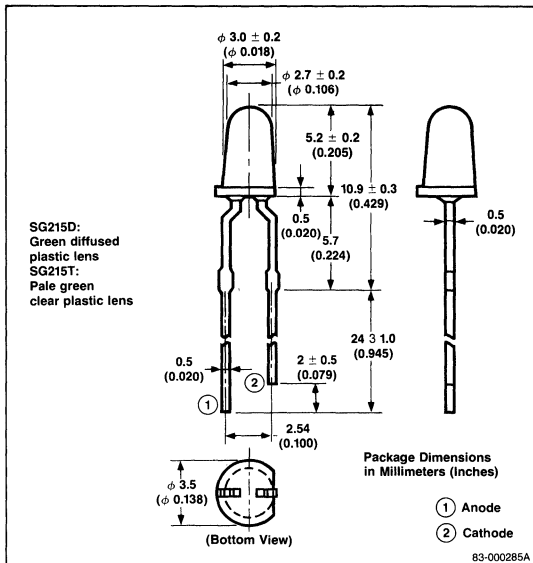
Features

- High intensity
- Bright red
- Long lead
- Low cost
- Compatible with integrated circuits

Applications

- Visual displays
- Guard systems
- Mobile equipment indicators
- Stereo equipment indicators
- Transceiver indicators

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	100mW
Forward Current, I_F	40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

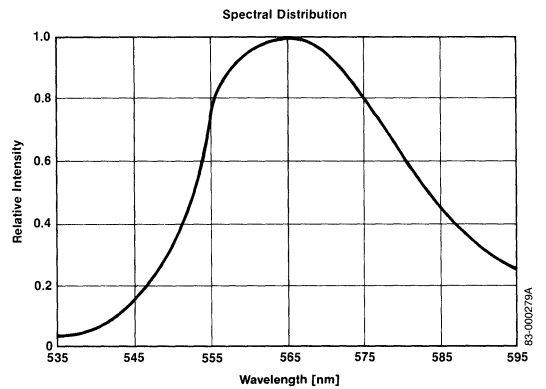
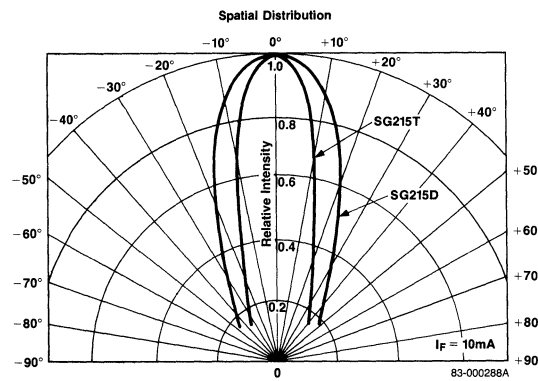
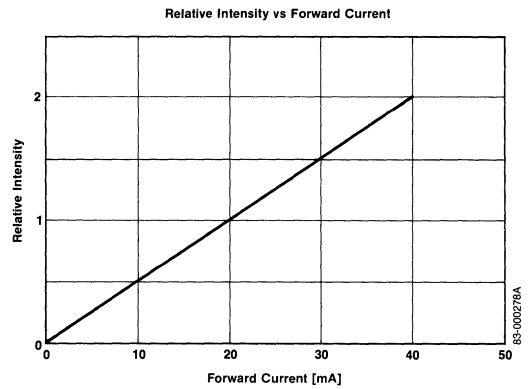
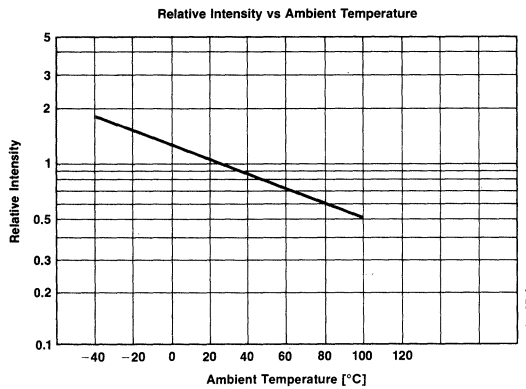
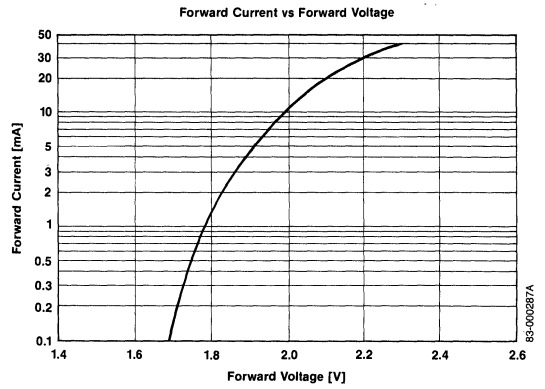
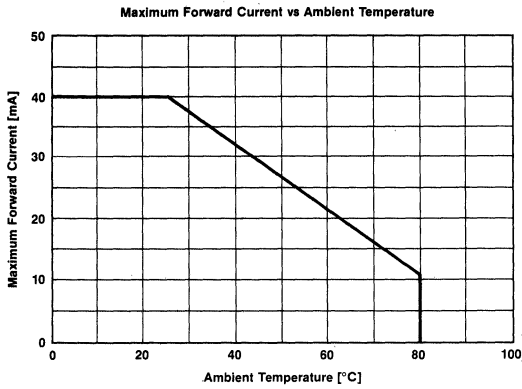
Electro-Optical Characteristics

$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
Reverse Current	I_R	0.01	10		μA	$V_R = 4.5$
Capacitance	C_T	60			pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}	565			nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
Luminous Intensity (SG215D)	I_V	3	10		mcd	$I_F = 10\text{mA}$
Luminous Intensity (SG215T)	I_V	6	20		mcd	$I_F = 10\text{mA}$

Typical Characteristics

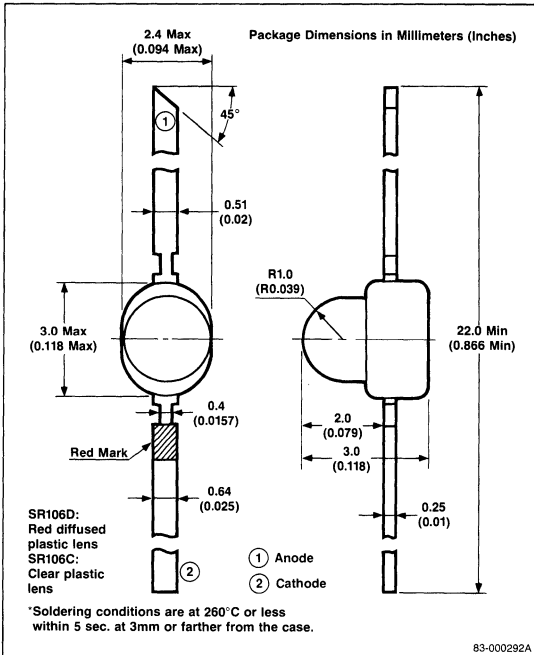
$T_A = +25^\circ\text{C}$



Description

The SR106D and SR106C are GaAsP (Gallium Arsenide Phosphide) light emitting diodes which are mounted on lead frames and molded in diffused red and clear plastic, respectively. They are ideally suited for front panel indicator applications

Package Dimensions



Features

- Small size
- Low cost
- Bright
- Easily assembled in arrays
- Compatible with integrated circuits
- Fast switching time

Applications

- Visual displays
- Dial indicators
- Portable equipment indicators
- Camera indicators
- Desk-top calculator indicators

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	80mW
Forward Current, I_F	40mA
Reverse Voltage, V_R	3.0V
Junction Temperature, T_J	80°C
Storage Temperature, T_{STG}	-30°C to +80°C

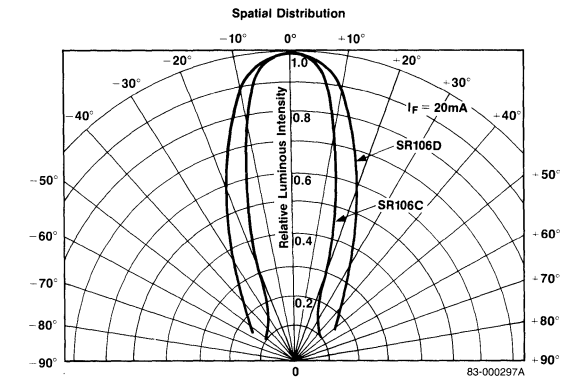
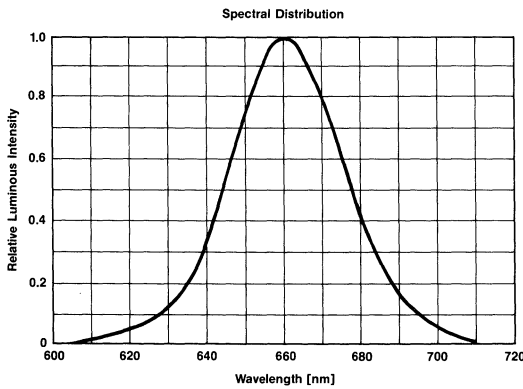
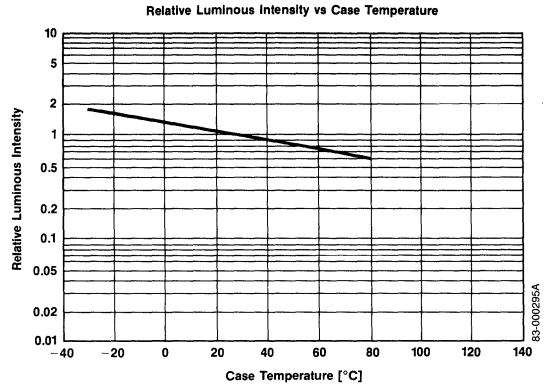
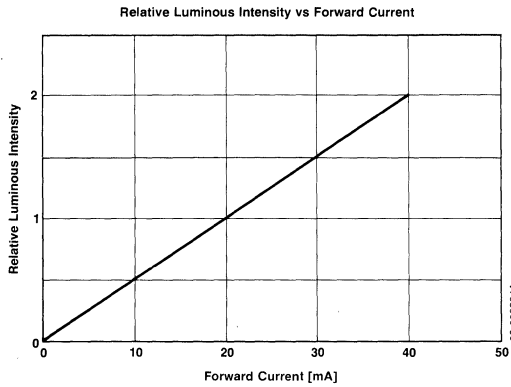
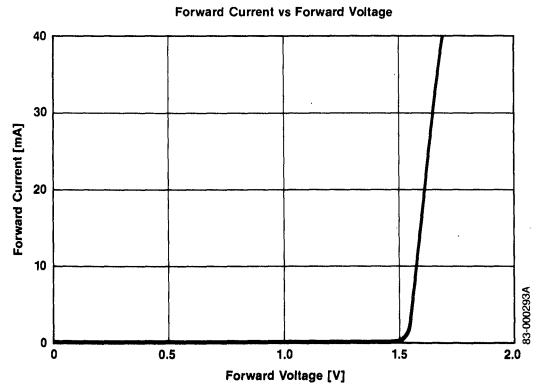
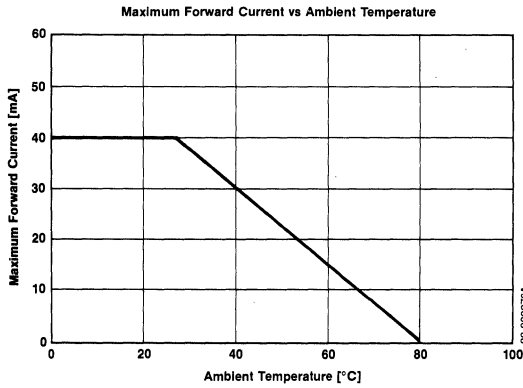
Electro-Optical Characteristics

$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F		1.6	2.0	V	$I_F = 20\text{mA}$
Reverse Current	I_R		0.01	50	μA	$V_R = 3.0\text{V}$
Capacitance	C_T		50		pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}		660		nm	$I_F = 20\text{mA}$
Spectral Line Half Width	$\Delta\lambda$		35		nm	$I_F = 20\text{mA}$
Luminous Intensity	I_V		1.5		mcd	$I_F = 20\text{mA}$

Typical Characteristics

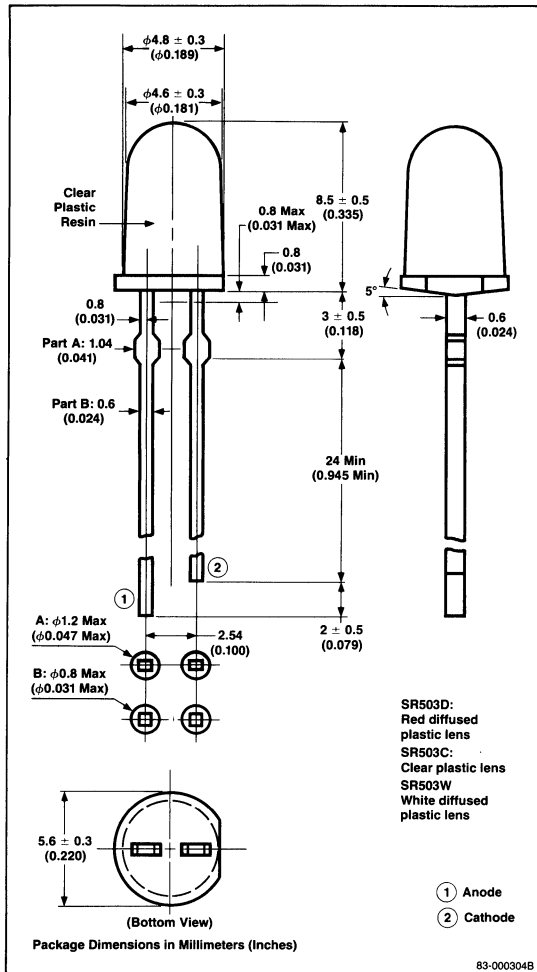
$T_A = +25^\circ\text{C}$



Description

The SR503D, SR503C and SR503W are full resin-molded LED lamps which emit brilliant red light at comparatively low current. They are especially suitable for electronic devices such as battery-driven equipment and audio equipment requiring low-power displays.

Package Dimensions



Features

- Low cost
- High intensity with low current
- Compatible with integrated circuits
- Long lead
- Wide view angle
- Bright red

Applications

- Visual displays
- Guard systems
- Radio and stereo equipment indicators
- Measuring instruments, terminals
- Optical switching light sources

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	60mW
Forward Current, I_F	30mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

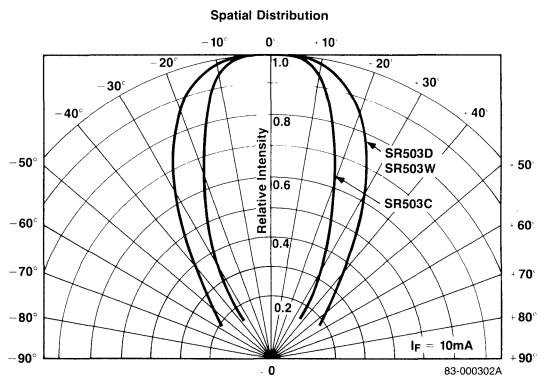
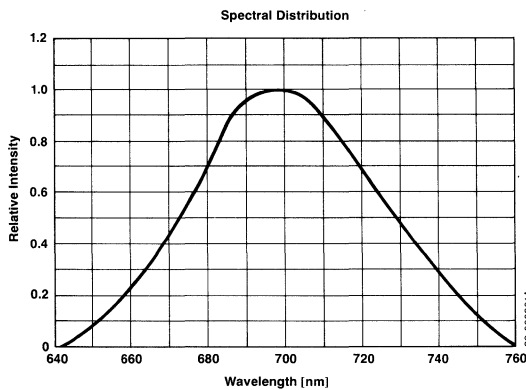
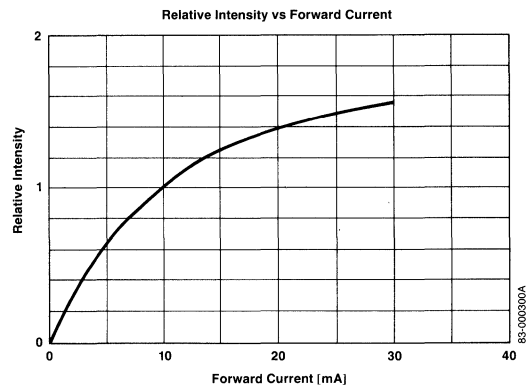
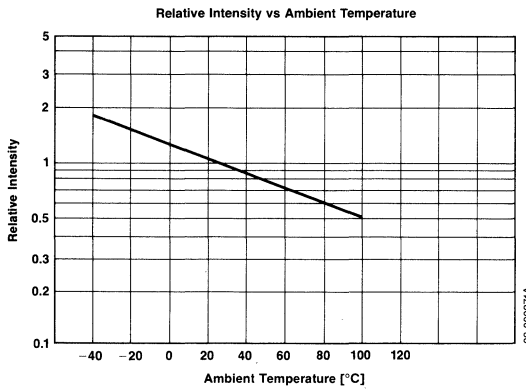
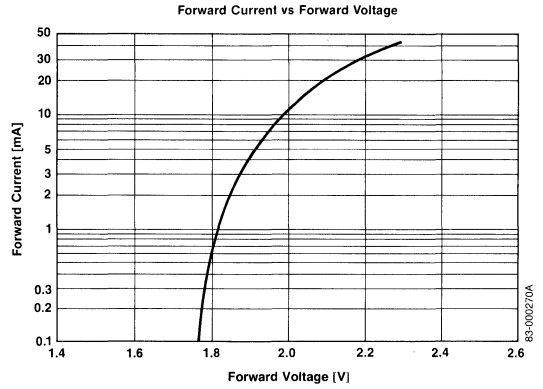
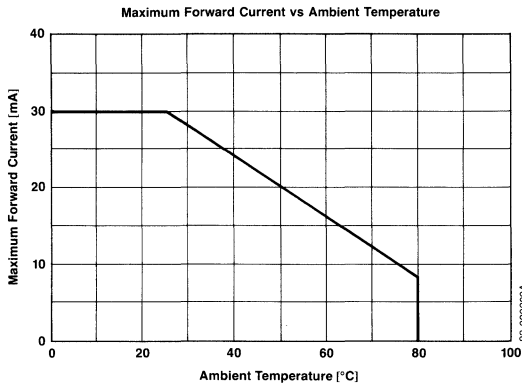
Electro-Optical Characteristics

$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
Reverse Current	I_R	0.01	10		μA	$V_R = 4.5$
Capacitance	C_T	100			pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}	695			nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$	100			nm	$I_F = 10\text{mA}$
Luminous Intensity (SR503D, SR503W)	I_V	1.5	5		mcd	$I_F = 10\text{mA}$
Luminous Intensity (SR503C)	I_V	4	10		mcd	$I_F = 10\text{mA}$

Typical Characteristics

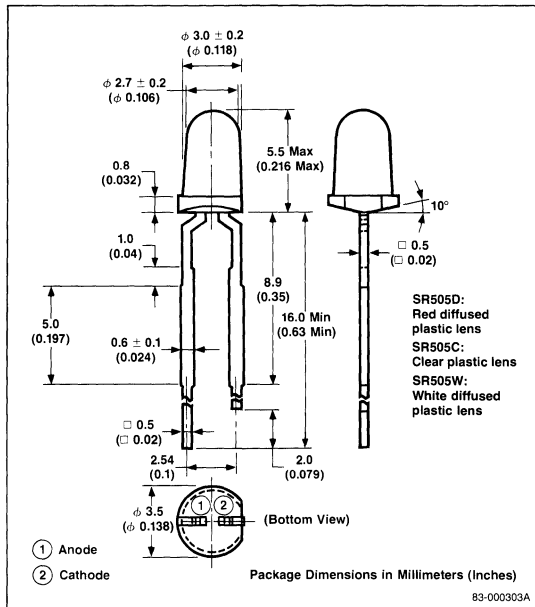
$T_A = +25^\circ\text{C}$



Description

The SR505D, SR505C and SR505W are medium-size, full resin-molded LED lamps which emit brilliant red light at comparatively low current. They are especially suitable for electronic devices such as battery-driven equipment and audio equipment requiring low-power displays.

Package Dimensions



Features

- Low cost
- High intensity at low current
- Compatible with integrated circuits
- Bright red

Applications

- Radio and stereo equipment indicators
- Visual displays
- Guard systems
- Measuring instruments, terminals
- Optical switching light sources

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	60mW
Forward Current, I_F	30mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

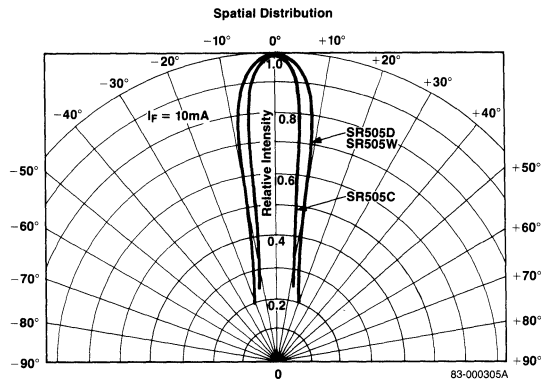
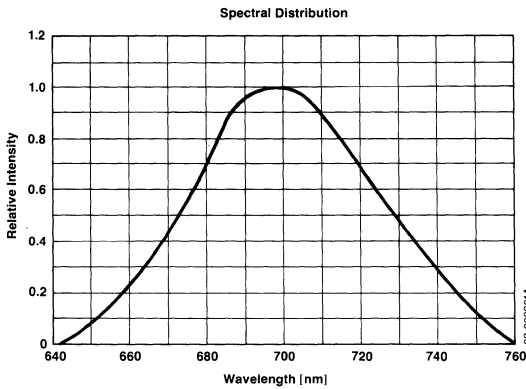
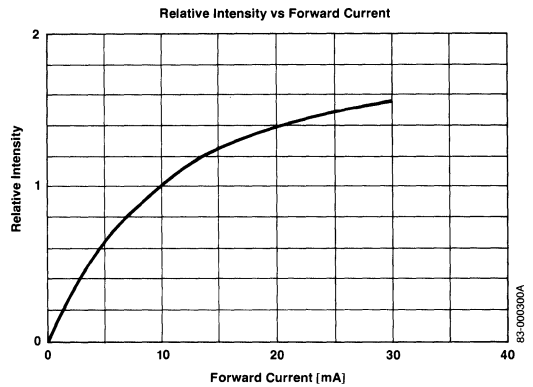
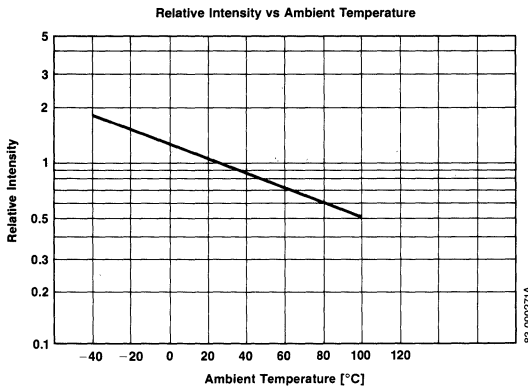
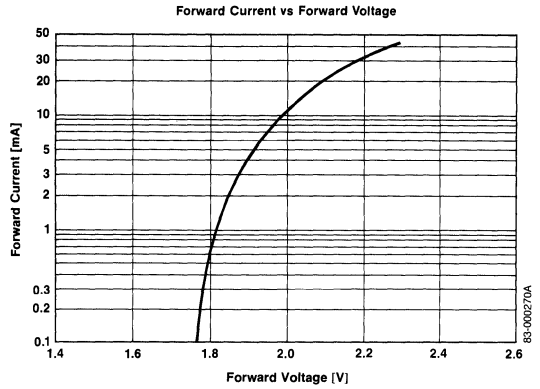
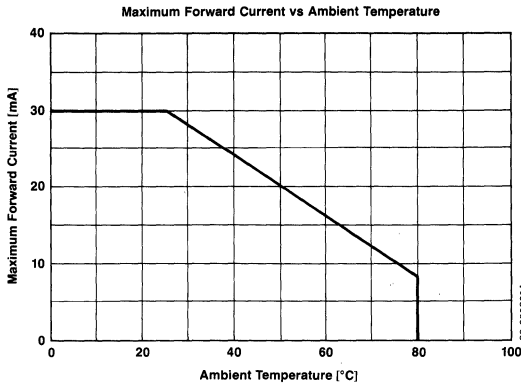
Electro-Optical Characteristics

$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
Reverse Current	I_R	0.01	10		μA	$V_R = 4.5$
Capacitance	C_T	50			pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}	695			nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$	100			nm	$I_F = 10\text{mA}$
Luminous Intensity (SR505D, SR505W)	I_V	1	3.5		mcd	$I_F = 10\text{mA}$
Luminous Intensity (SR505C)	I_V	2	6		mcd	$I_F = 10\text{mA}$

Typical Characteristics

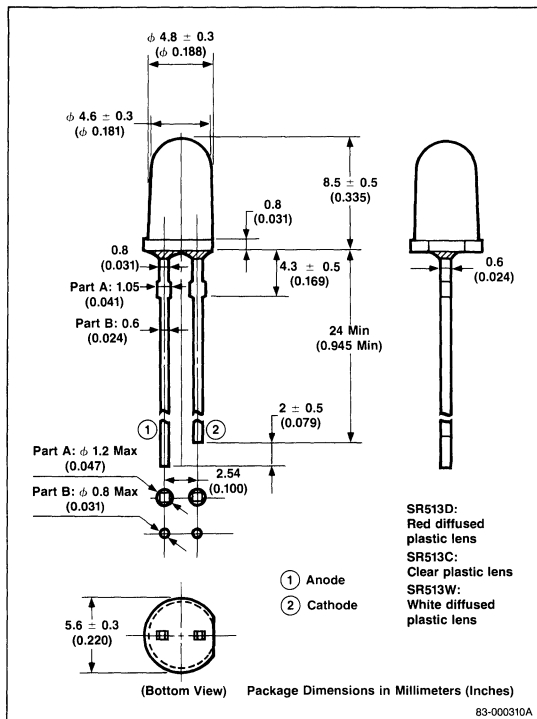
$T_A = +25^\circ\text{C}$



Description

The SR513D, SR513C and SR513W are full resin-molded LED lamps which emit brilliant, uniform red light at comparatively low current. They are especially suitable for electronic devices such as battery-driven and audio equipment requiring low-power displays.

Package Dimensions



Features

- High intensity
- Bright red
- Long lead
- Low cost
- Compatible with integrated circuits

Applications

- Visual displays
- Guard systems
- Mobile equipment indicators
- Stereo equipment indicators
- Transceiver indicators

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	60mW
Forward Current, I_F	30mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

Electro-Optical Characteristics

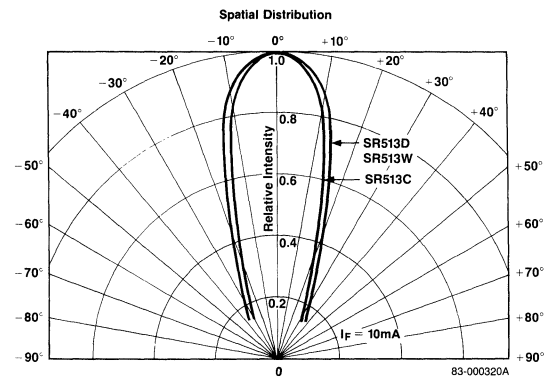
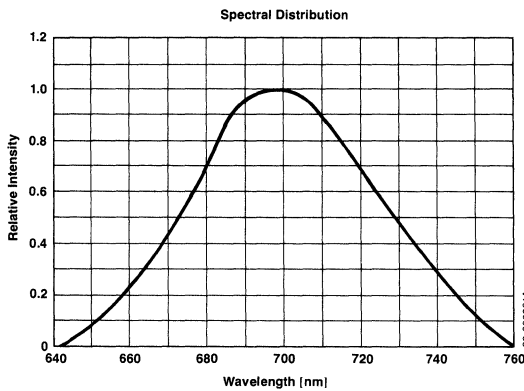
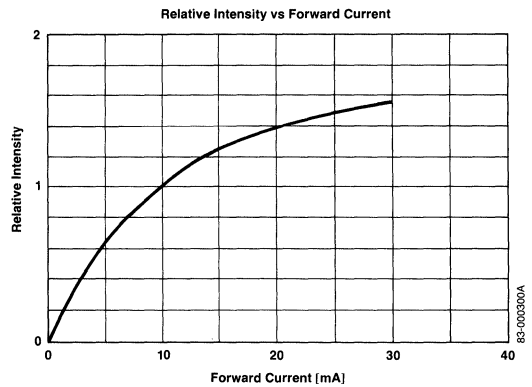
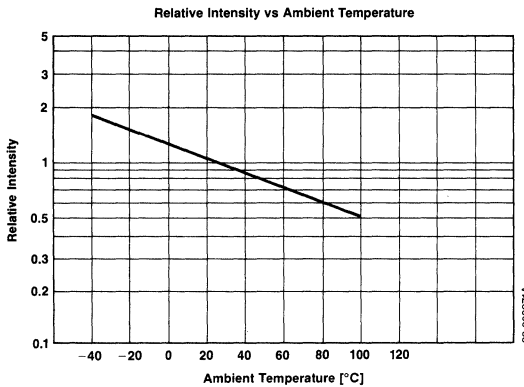
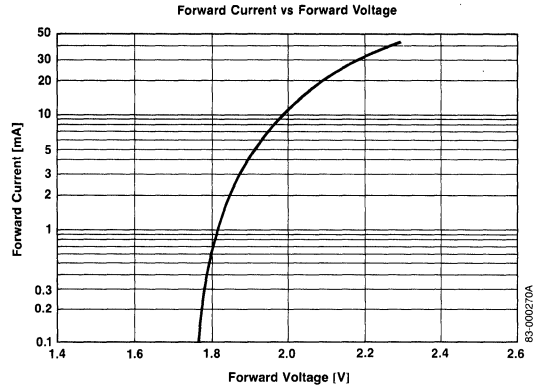
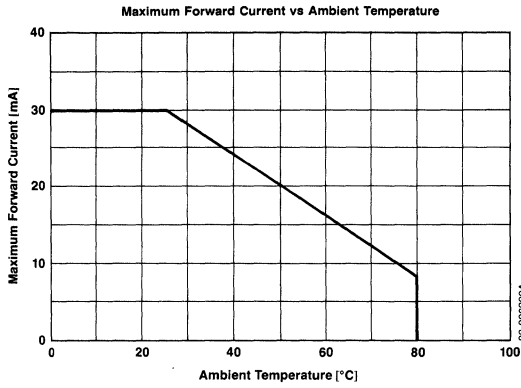
$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F		2	2.5	V	$I_F = 10\text{mA}$
Reverse Current	I_R		0.01	10	μA	$V_R = 4.5\text{V}$
Capacitance	C_T		50		pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}		695		nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$		100		nm	$I_F = 10\text{mA}$
Luminous Intensity (SR513D, SR513W)	I_V	1.5	5		mcd	$I_F = 10\text{mA}$
Luminous Intensity (SR513C)	I_V	4	10		mcd	$I_F = 10\text{mA}$

3

Typical Characteristics

$T_A = +25^\circ\text{C}$



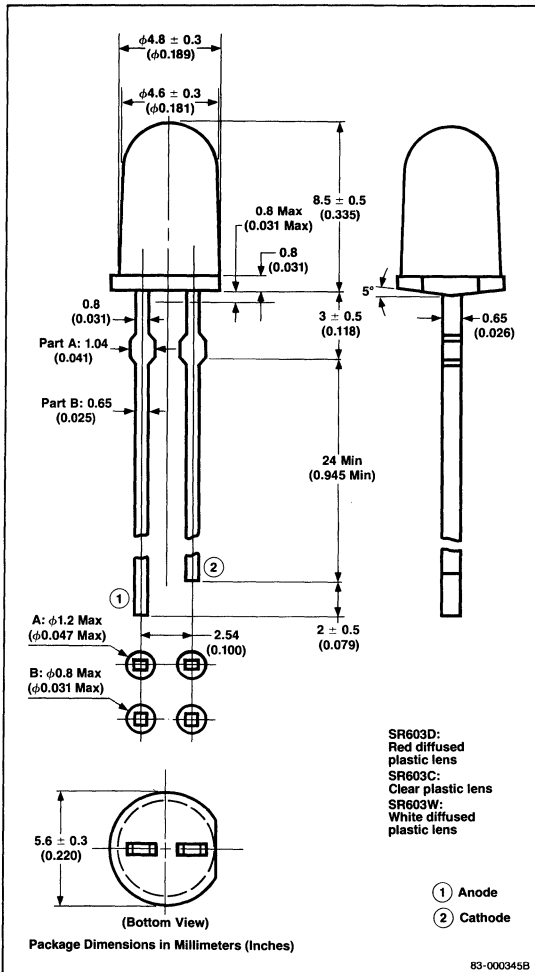
Description

The SR603D, SR603C and SR603W are full resin-molded LED lamps which emit brilliant, uniform red light proportional to the forward current (I_F). They are especially suitable for electronic equipment in audio applications which require bright, vivid displays.

Features

- Low cost
- High intensity
- Compatible with integrated circuits
- Long lead
- Wide view angle
- Bright red

Package Dimensions



Applications

- Visual displays
- Guard systems
- Radio, stereo equipment indicators
- Measuring instrument terminals
- Optical switching light sources

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	100mW
Forward Current, I_F	50mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

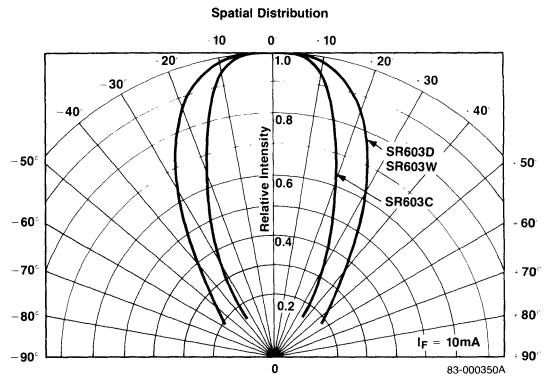
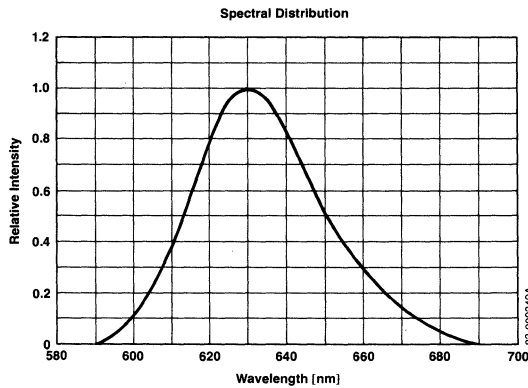
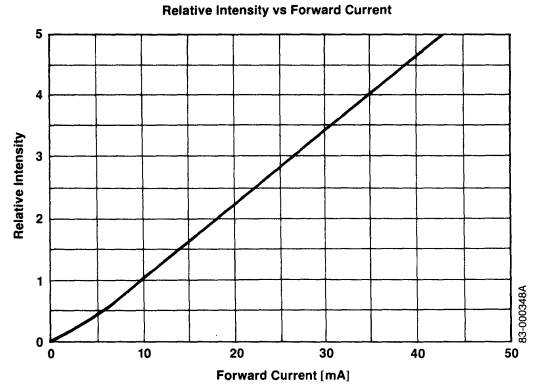
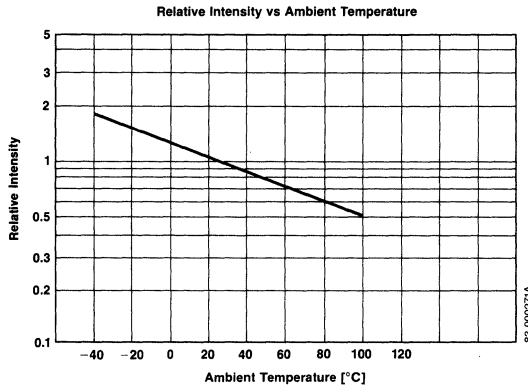
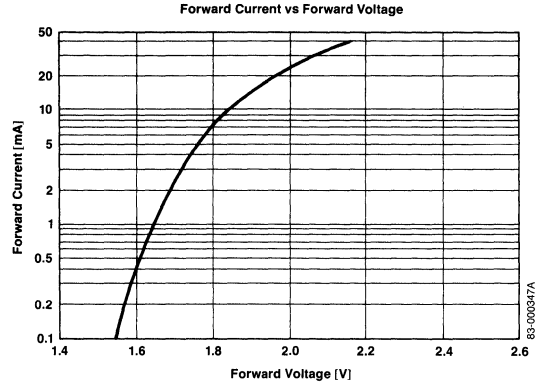
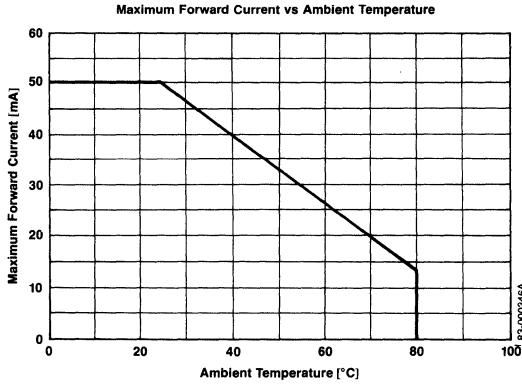
Electro-Optical Characteristics

$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F	2.0	2.4		V	$I_F = 10\text{mA}$
Reverse Current	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
Capacitance	C_T	100			pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}	630			nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
Luminous Intensity (SR603D, SR603W)	I_V	1.5	3		mcd	$I_F = 10\text{mA}$
Luminous Intensity (SR603C)	I_V	4	6		mcd	$I_F = 10\text{mA}$

Typical Characteristics

$T_A = +25^\circ\text{C}$



Description

The SR605D, SR605C and SR605W are full resin-molded medium-size LED lamps which emit brilliant, uniform red light proportional to the forward current (I_F). They are especially suitable for electronic equipment in audio applications which require bright, vivid displays.

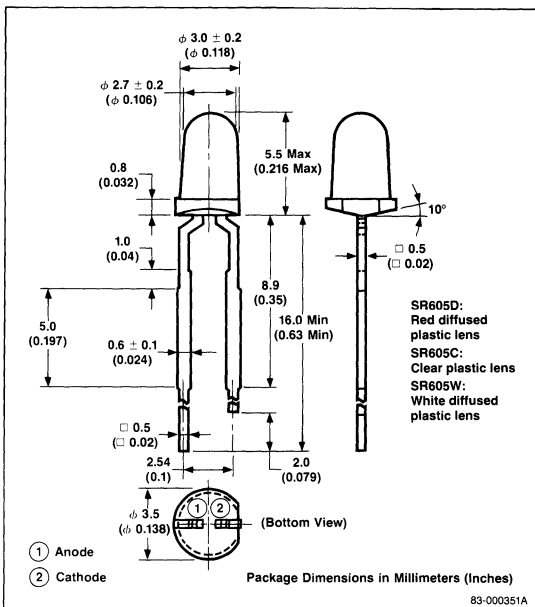
Features

- Low cost
- High intensity
- Compatible with integrated circuits
- Bright red

Applications

- Visual displays
- Guard systems
- Radio and stereo equipment indicators
- Measuring instrument terminals
- Optical switching light sources

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$	
Power Dissipation, P_D	80mW
Forward Current, I_F	40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

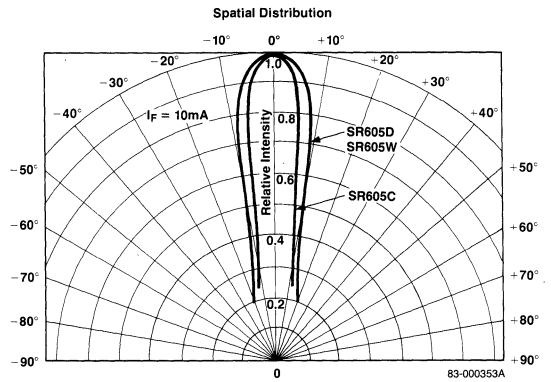
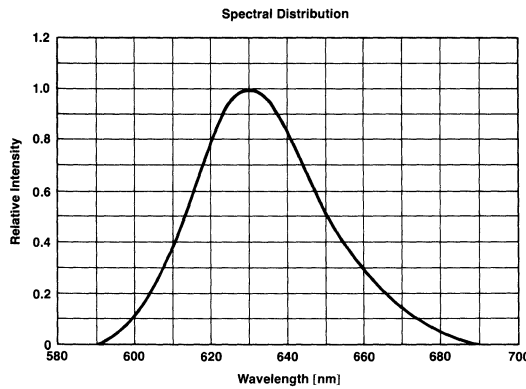
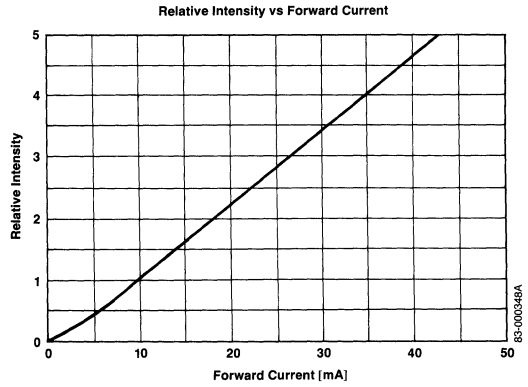
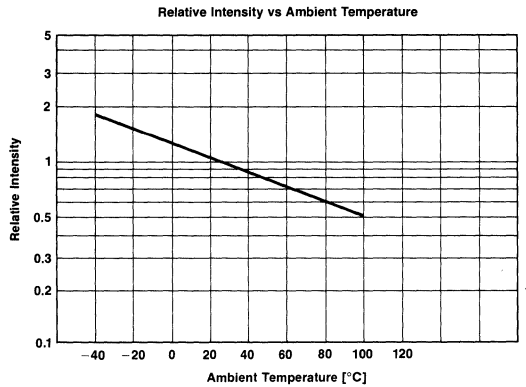
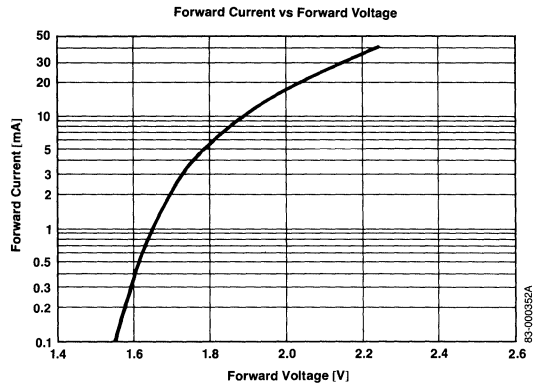
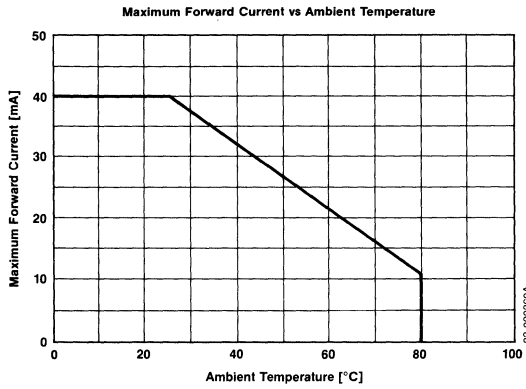
Electro-Optical Characteristics

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F	2.0	2.4		V	$I_F = 10\text{mA}$
Reverse Current	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
Capacitance	C_T	100			pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}	630			nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
Luminous Intensity (SR605D, SR605W)	I_V	1.5	5		mcd	$I_F = 10\text{mA}$
Luminous Intensity (SR605C)	I_V	3	10		mcd	$I_F = 10\text{mA}$



Typical Characteristics

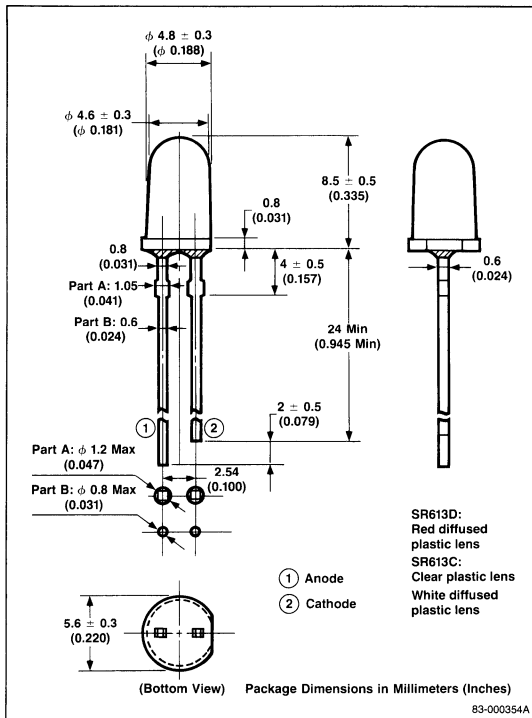
$T_A = +25^\circ\text{C}$



Description

The SR613D, SR613C and SR613W are full resin-molded LED lamps which emit brilliant, uniform red light proportional to the forward current (I_F). They are especially suitable for electronic equipment in audio applications which require bright, vivid displays. The SR613C is especially suitable as a backlighting source.

Package Dimensions



Features

- High intensity
- Bright red
- Long lead
- Low cost
- Compatible with integrated circuits

Applications

- Visual displays
- Guard systems
- Mobile equipment indicators
- Stereo equipment indicators
- Transceiver indicators

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	100mW
Forward Current, I_F	50mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

Electro-Optical Characteristics

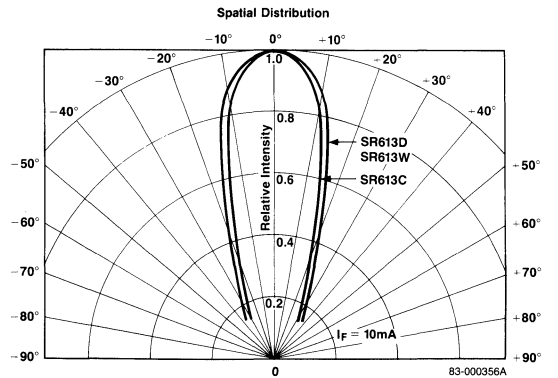
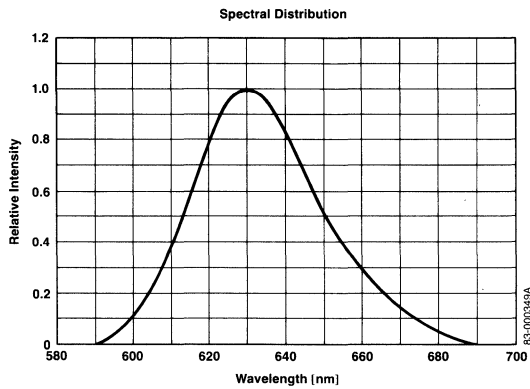
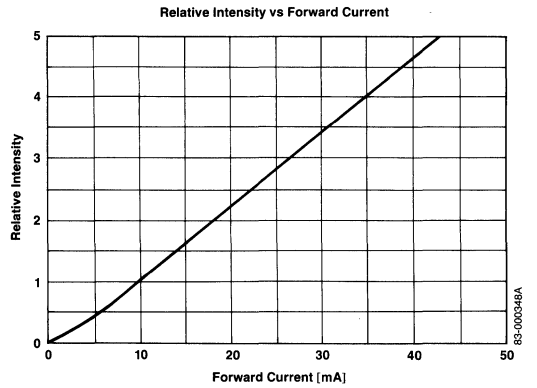
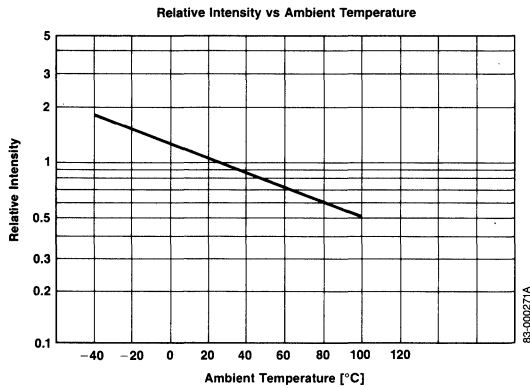
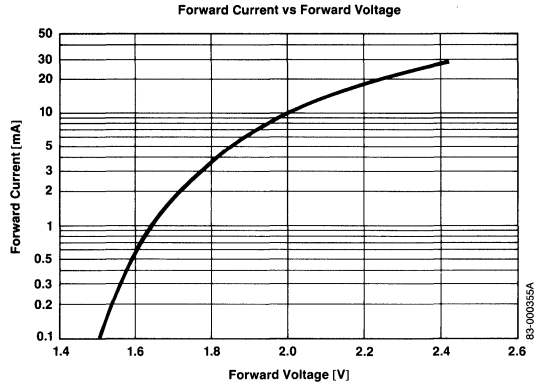
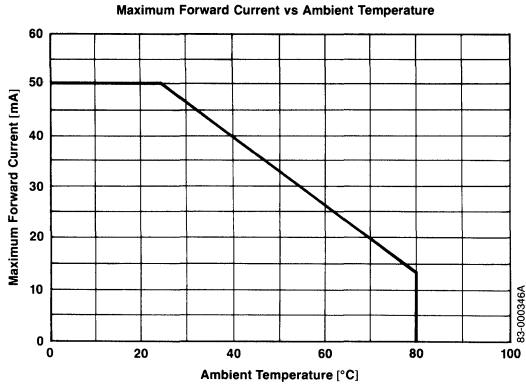
$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F	2.0	2.4		V	$I_F = 10\text{mA}$
Reverse Current	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
Capacitance	C_T	100			pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}	630			nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
Luminous Intensity (SR613D, SR613W)	I_V	3	7		mcd	$I_F = 10\text{mA}$
Luminous Intensity (SR613C)	I_V	10	20		mcd	$I_F = 10\text{mA}$



Typical Characteristics

$T_A = +25^\circ\text{C}$



Description

The SR615D, SR615C and SR615W are medium-size plastic-resin-encapsulated LED lamps from which brilliant red light is emitted uniformly and intensely in proportion to the forward current (I_F). They are suitable for use as bright, distinguishable illuminators or indicators on the panels of audio-video equipment and elsewhere.

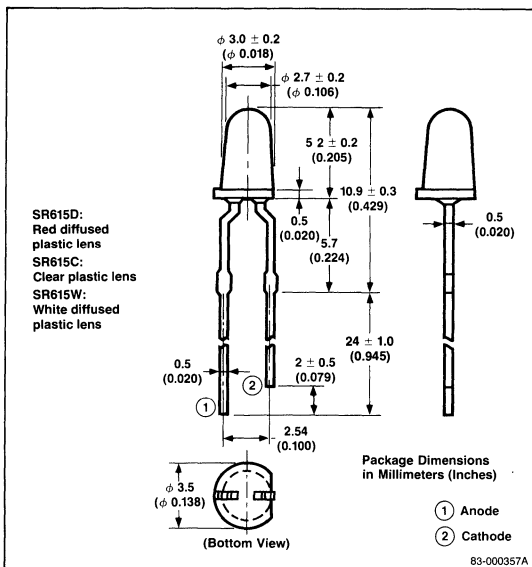
Features

- High intensity
- Bright red
- Long lead
- Low cost
- Compatible with integrated circuits

Applications

- Visual displays
- Guard systems
- Mobile equipment indicators
- Stereo equipment indicators
- Transceiver indicators

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	100mW
Forward Current, I_F	40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

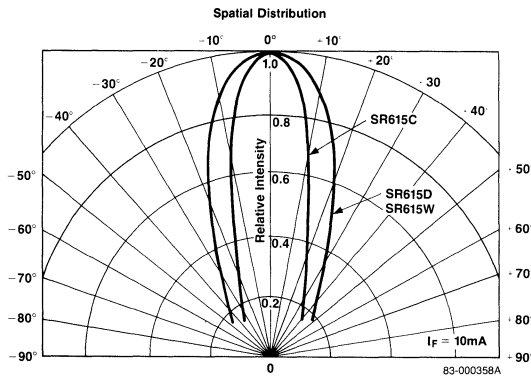
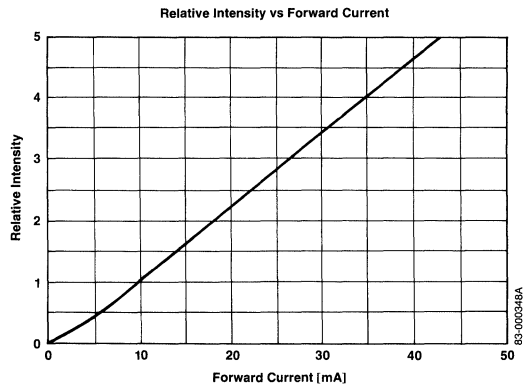
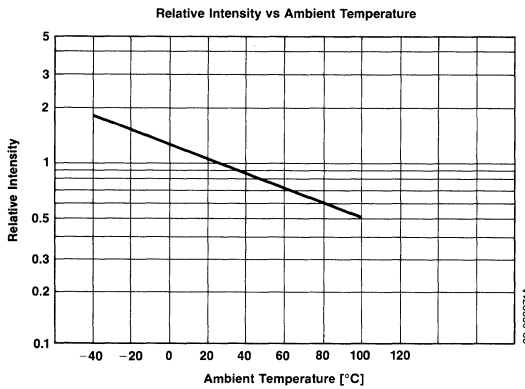
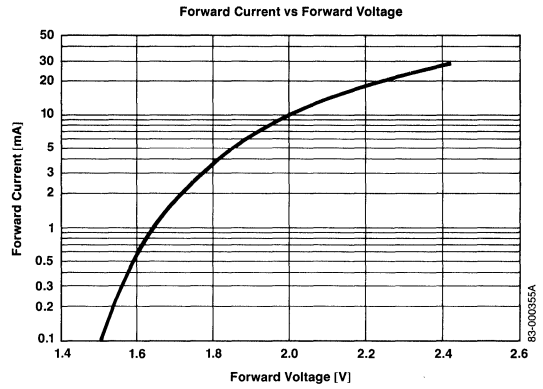
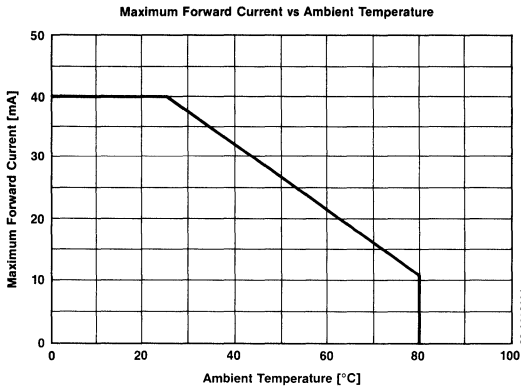
Electro-Optical Characteristics

$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
Reverse Current	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
Capacitance	C_T	100			pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}	630			nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
Luminous Intensity (SR615D, SR615W)	I_V	3	8		mcd	$I_F = 10\text{mA}$
Luminous Intensity (SR615C)	I_V	6	16		mcd	$I_F = 10\text{mA}$

Typical Characteristics

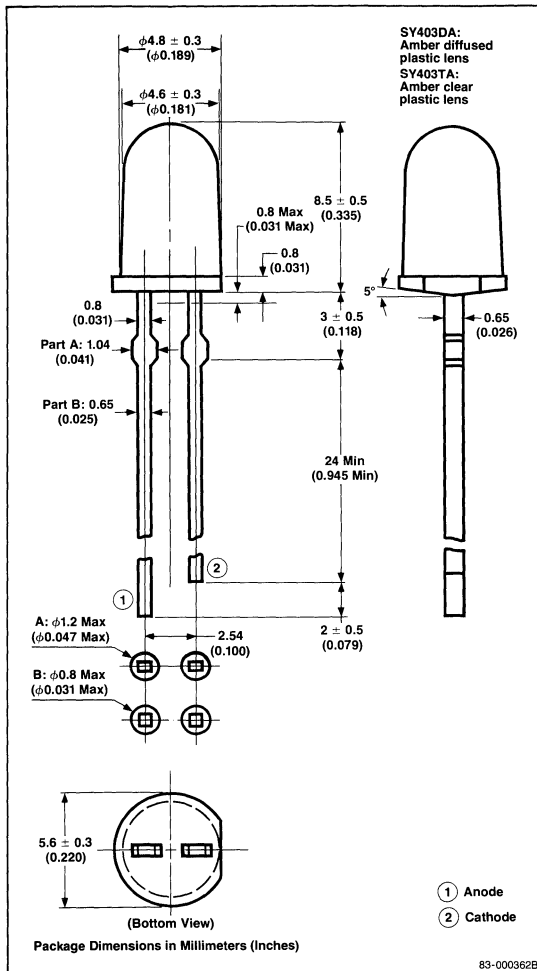
T_A = +25°C



Description

The SY403DA and SY403TA are full resin-molded lamps which emit bright, vivid amber light. They are especially suitable for electronic equipment in audio applications which require high-brightness displays.

Package Dimensions



Features

- High intensity
- Wide angle
- Long lead
- Good sensitivity—590nm
- Low cost
- Compatible and integrated circuits

Applications

- Visual displays
- Guard systems
- Mobile equipment indicators
- Stereo equipment indicators
- Transceiver indicators

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	100mW
Forward Current, I_F	40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

Electro-Optical Characteristics

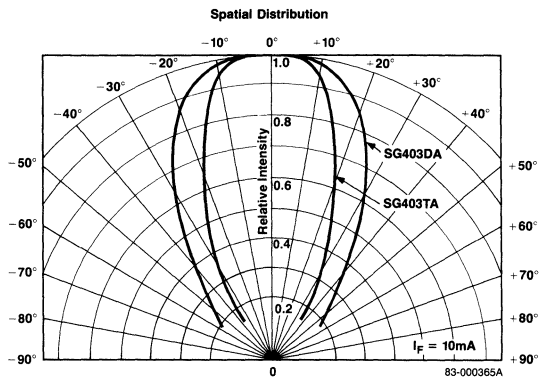
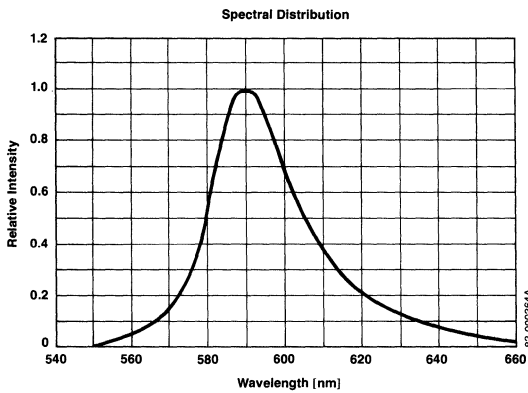
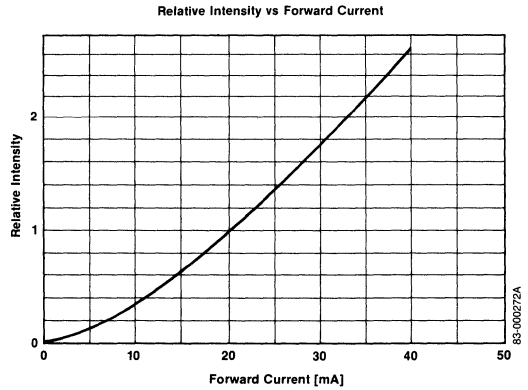
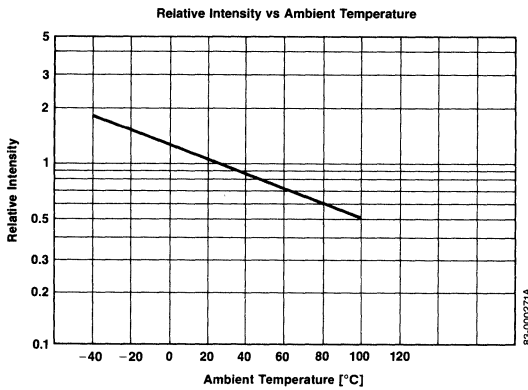
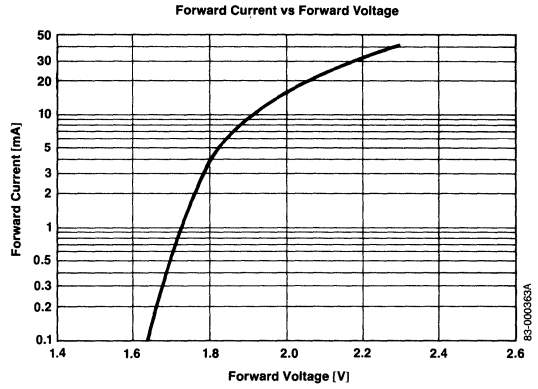
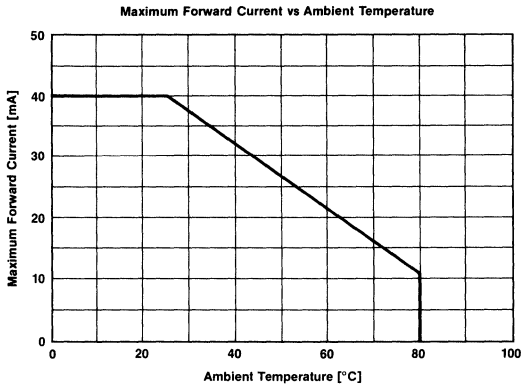
$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F		2.1	2.5	V	$I_F = 10\text{mA}$
Reverse Current	I_R		0.01	10	μA	$V_R = 4.5\text{V}$
Capacitance	C_T		60		pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}		590		nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$		40		nm	$I_F = 10\text{mA}$
Luminous Intensity (SR403DA)	I_V	2	5		mcd	$I_F = 10\text{mA}$
Luminous Intensity (SR403TA)	I_V	5	10		mcd	$I_F = 10\text{mA}$

3

Typical Characteristics

$T_A = +25^\circ\text{C}$



Description

The SY405D and SY405T are GaAsP & Gallium Arsenide Phosphide) light emitting diodes which are mounted on lead frames and molded in diffused amber and clear amber plastic, respectively. They are ideally suited for front panel indicator applications.

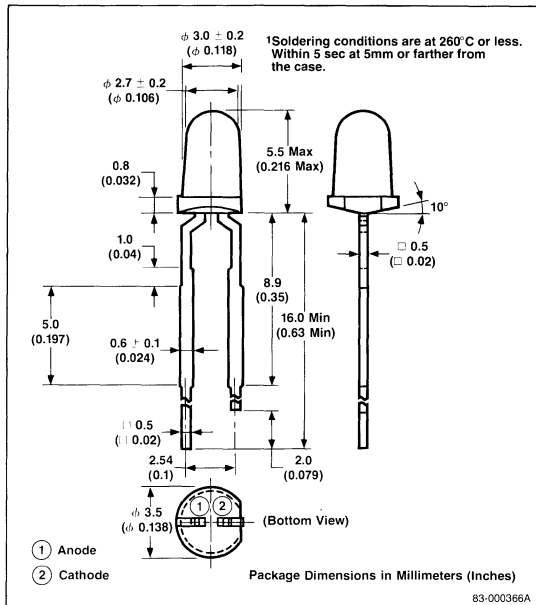
Features

- Good sensitivity—590nm
- Long life—solid state reliability
- Low cost
- High intensity with low current
- Versatile mounting on PC board or panel
- Compatible with integrated circuits
- Fast switching time

Applications

- Visual displays
- Guard systems
- Radio and stereo equipment indicators
- Measuring instruments, terminals

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	100mW
Forward Current, I_F	40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	80°C
Storage Temperature, T_{STG}	-30°C to +80°C

Electro-Optical Characteristics

$T_A = +25^\circ\text{C}$

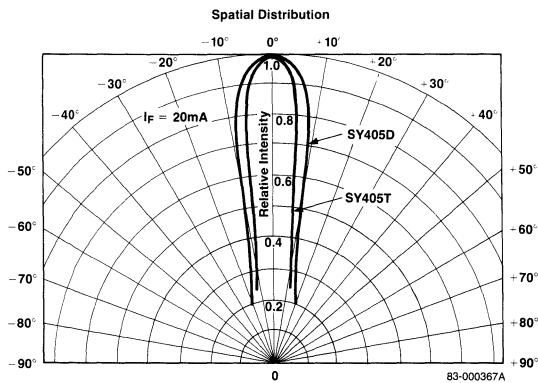
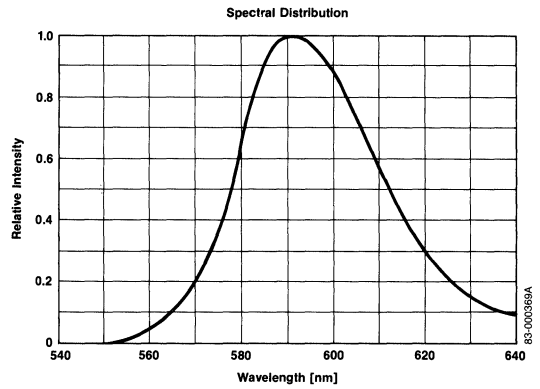
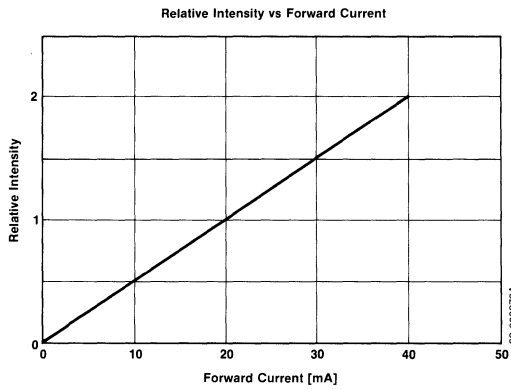
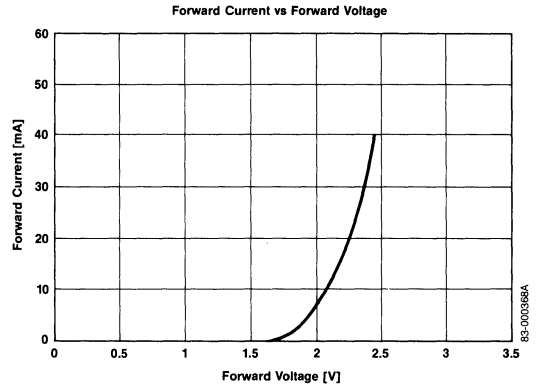
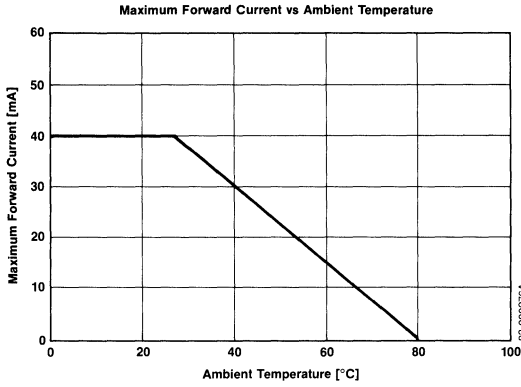
Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F	2.2	2.5		V	$I_F = 10\text{mA}$
Reverse Current	I_R	0.01	50		μA	$V_R = 4.5$
Capacitance	C_T	60			pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}	590			nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$	35			nm	$I_F = 10\text{mA}$
Luminous Intensity	I_{V1}/I_{V2}	1/3	3/5		mcd	$I_F = 10\text{mA}$

Note: 1. I_{V1}/I_{V2} : Luminous intensity of SY 405D/luminous intensity of SY405T.

3

Typical Characteristics

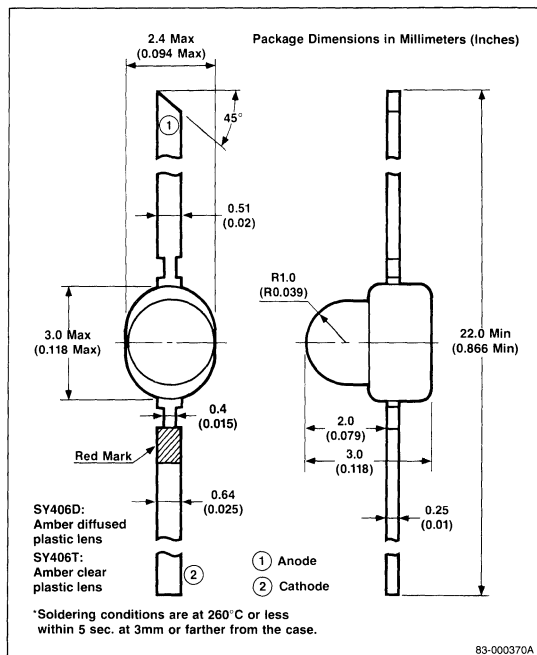
$T_A = +25^\circ\text{C}$



Description

The SY406D and SY406T are GaAsP (Gallium Arsenide Phosphide) light emitting diodes which are mounted on lead frames and molded in diffused amber and clear amber plastic, respectively. They are ideally suited for front panel indicator applications.

Package Dimensions



Features

- Good sensitivity — 590nm
- Small size
- Bright
- Easily assembled in arrays
- Compatible with integrated circuits
- Fast switching time

Applications

- Visual displays
- Panel indicators
- Desk top calculator indicators
- Portable equipment indicators
- Camera indicators

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	100mW
Forward Current, I_F	40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	80°C
Storage Temperature, T_{STG}	-30°C to +80°C

Electro-Optical Characteristics

$T_A = +25^\circ\text{C}$

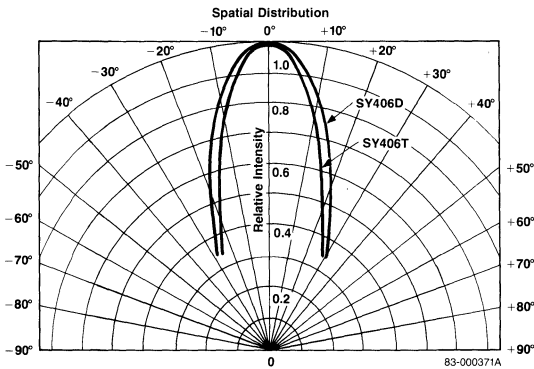
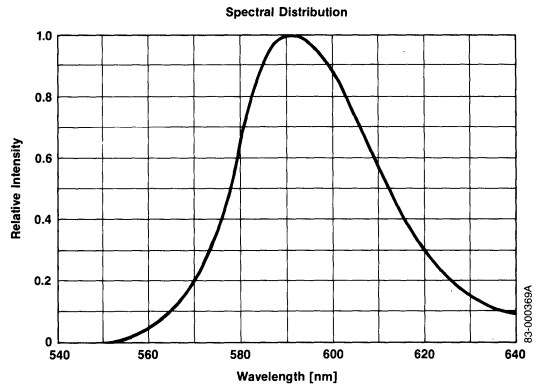
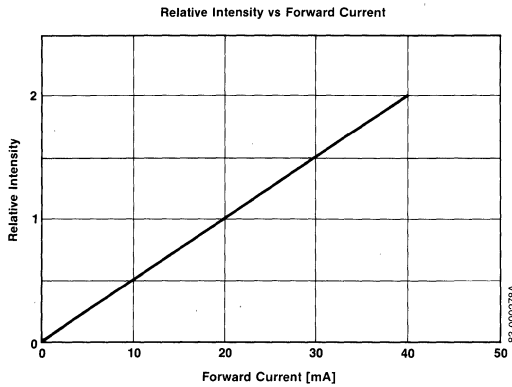
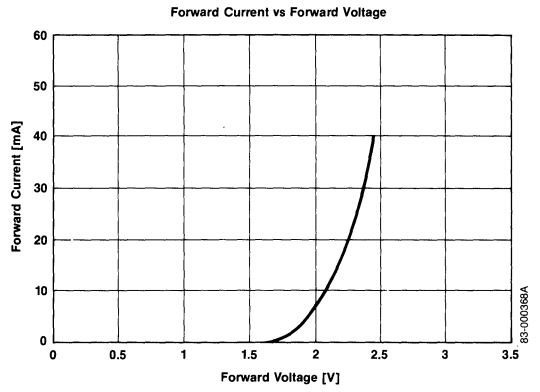
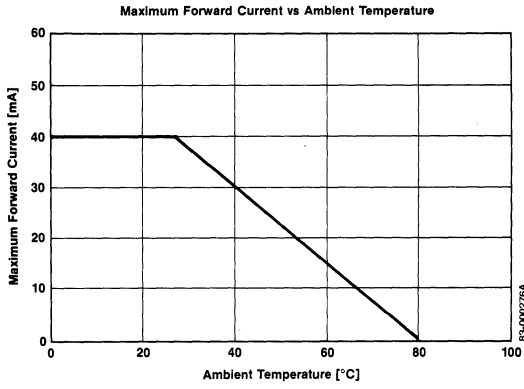
Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F		2.2	2.5	V	$I_F = 20\text{mA}$
Reverse Current	I_R		0.01	50	μA	$V_R = 4.5\text{V}$
Capacitance	C_T		60		pF	$V = 0,$ $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}		590		nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$		35		nm	$I_F = 10\text{mA}$
Luminous Intensity	I_{V1}/I_{V2}	1/2	2/4		mcd	$I_F = 10\text{mA}$

* I_{V1}/I_{V2} : Luminous Intensity of SY406D/Luminous Intensity of SY406T.

3

Typical Characteristics

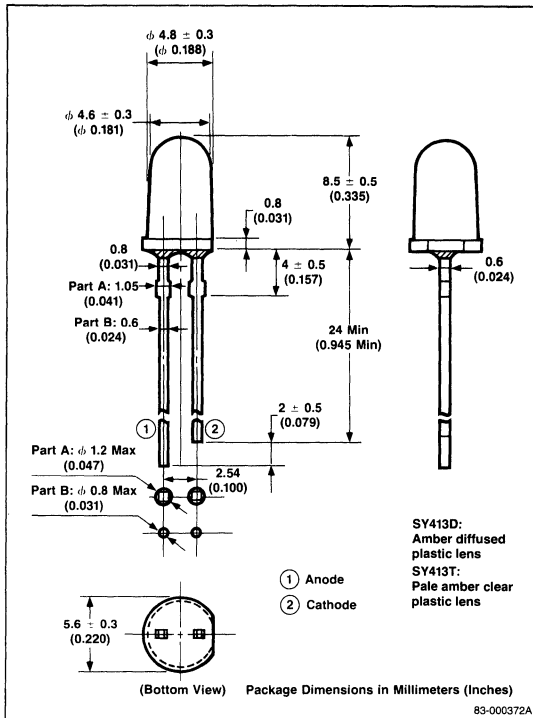
$T_A = +25^\circ\text{C}$



Description

The SY413D and SY413T are full resin-molded LED lamps which emit bright, brilliant, uniform amber light proportional to the forward current (I_F). They are especially suitable for electronic equipment which require bright, vivid displays. The SY413T is especially suitable as a backlighting source.

Package Dimensions



Features

- High intensity
- Bright amber
- Long lead
- Low cost
- Compatible with integrated circuits

Applications

- Visual displays
- Guard systems
- Mobile equipment indicators
- Stereo equipment indicators
- Transceiver indicators

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$	
Power Dissipation, P_D	100mW
Forward Current, I_F	40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

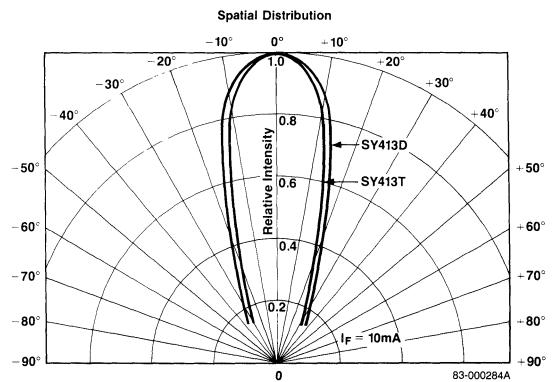
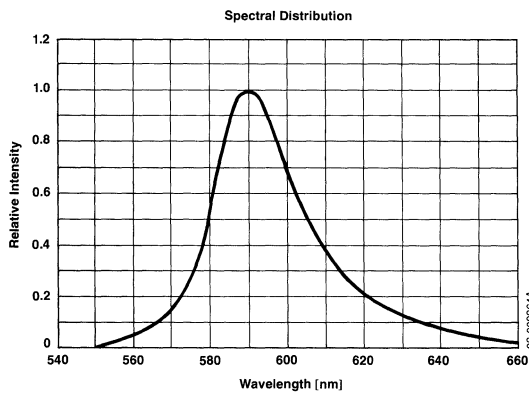
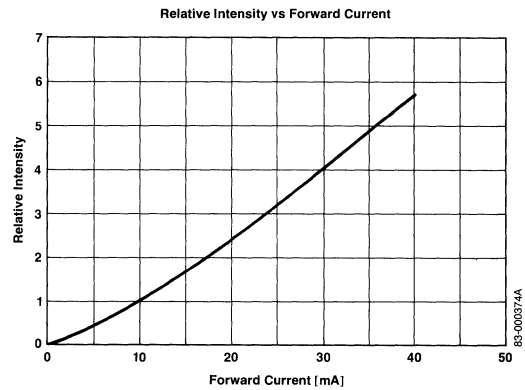
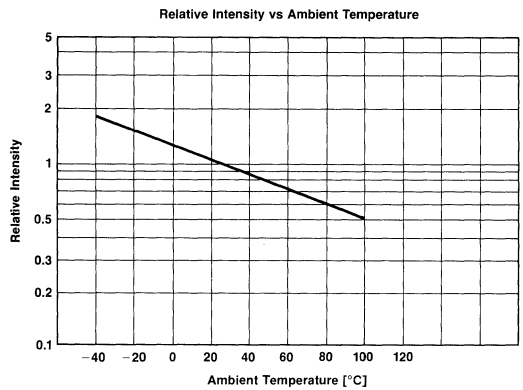
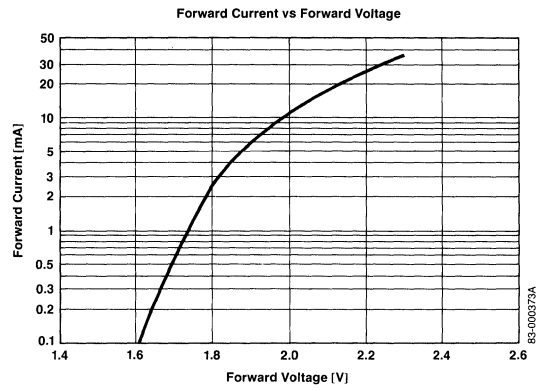
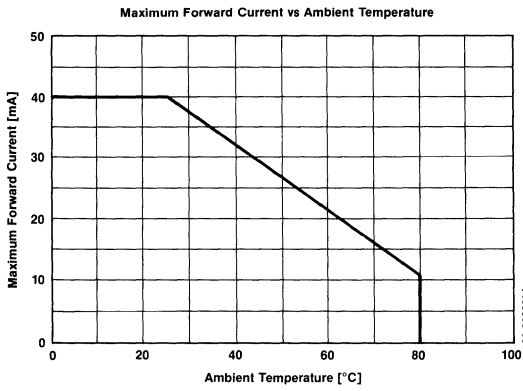
Electro-Optical Characteristics

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
Reverse Current	I_R	0.01	10		μA	$V = 4.5\text{V}$
Capacitance	C_T	60			pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}	590			nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
Luminous Intensity (SY413D)	I_V	4	10		mcd	$I_F = 10\text{mA}$
Luminous Intensity (SY413T)	I_V	12	30		mcd	$I_F = 10\text{mA}$

3

Typical Characteristics

$T_A = +25^\circ\text{C}$



Description

The SY415D and SY415T are medium-size plastic resin-encapsulated LED lamps which emit brilliant amber light uniformly and intensely in proportion to the forward current (I_F). They are suitable as bright, distinguishable illuminators or indicators on the panels of audio/video equipment and elsewhere.

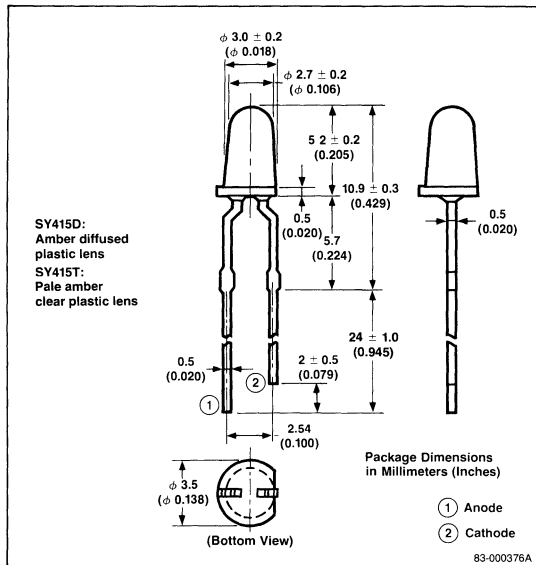
Features

- High intensity
- Bright amber
- Long lead
- Low cost
- Compatible with integrated circuits

Applications

- Visual displays
- Guard systems
- Mobile equipment indicators
- Stereo equipment indicators
- Transceiver indicators

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	100mW
Forward Current, I_F	40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

Electro-Optical Characteristics

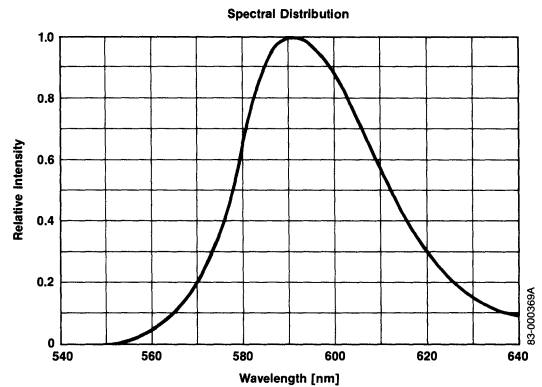
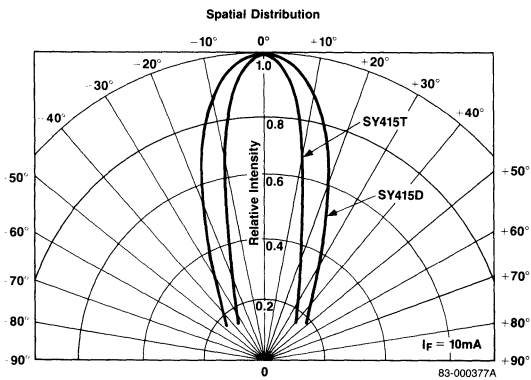
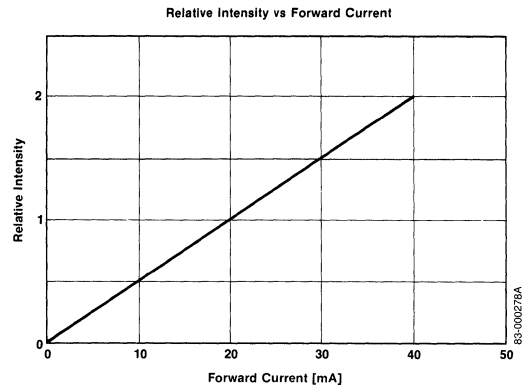
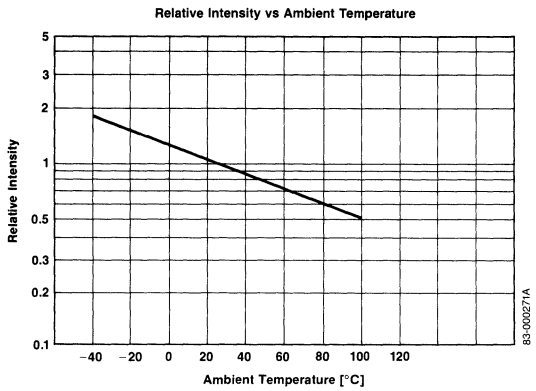
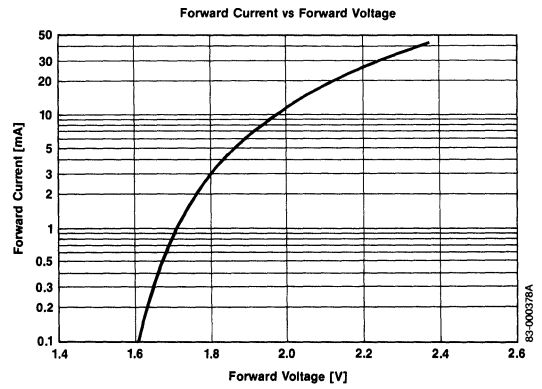
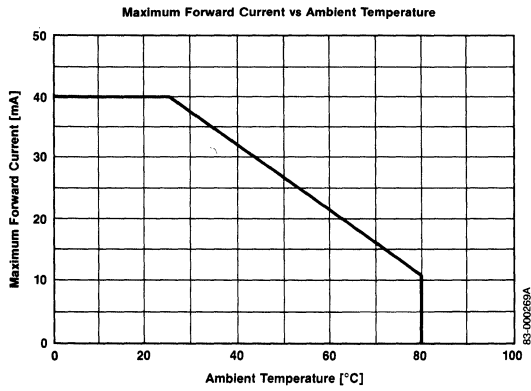
$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
Reverse Current	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
Capacitance	C_T	60			pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}	590			nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
Luminous Intensity (SY415D)	I_V	4	10		mcd	$I_F = 10\text{mA}$
Luminous Intensity (SY415T)	I_V	7	20		mcd	$I_F = 10\text{mA}$

3

Typical Characteristics

$T_A = +25^\circ\text{C}$



FASHION LEDs

4

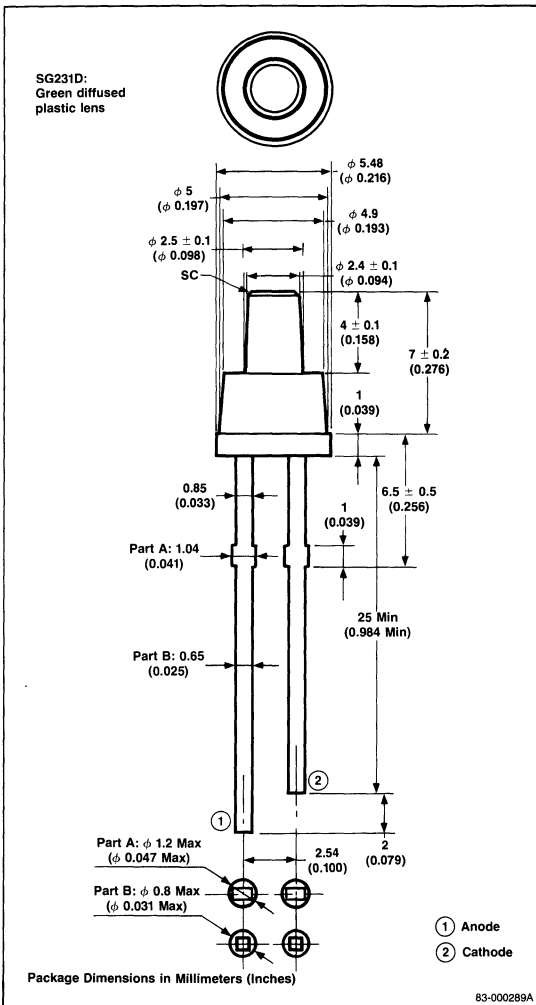
Section 4 — Fashion LEDs

SG231D (Green) GaP Fashion LED 4-3
SG232D (Green) GaP Fashion LED 4-5
SG233D, SY433D, SR533D (Green, Amber, Red) Fashion LEDs 4-7
SG235D, SY435D, SR535D (Green, Amber, Red) Fashion LEDs 4-9
SG236D, SY436D, SR536D (Green, Amber, Red) Fashion LEDs 4-11
SG237D, SY437D, SR537D (Green, Amber, Red) Fashion LEDs 4-13
SG238D (Green) Fashion LED 4-15
SG239D, SY439D, SR539D (Green, Amber, Red) Fashion LEDs 4-17
SG240D, SY440D, SR540D (Green, Amber, Red) Fashion LEDs 4-19
SG261D, SY461D, SR661D (Green, Amber, Red) Fashion LEDs 4-21
SR531D (Red) Fashion LED 4-23
SR538D (Red) Fashion LED 4-25
SR632D (Red) GaAsP(N) Fashion LED 4-27
SY431D (Amber) GaAsP Fashion LED 4-29
SY432D (Amber) Fashion LED 4-31
SY438D (Amber) Fashion LED 4-33

Description

The SG231D is a full resin-molded LED lamp with a flat rectangular face which uniformly emits brilliant green light. It is especially suitable for electronic equipment in audio applications which require fancy displays.

Package Dimensions



Features

- Flat circular face
- Low cost
- Long lead
- Bright green
- Compatible with integrated circuits
- Red (SR531D) and amber (SY431D) LEDs are available in the same package

Applications

- Visual displays
- Radio and stereo equipment indicators
- Measuring instruments, terminals

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	100mW
Forward Current, I_F	40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

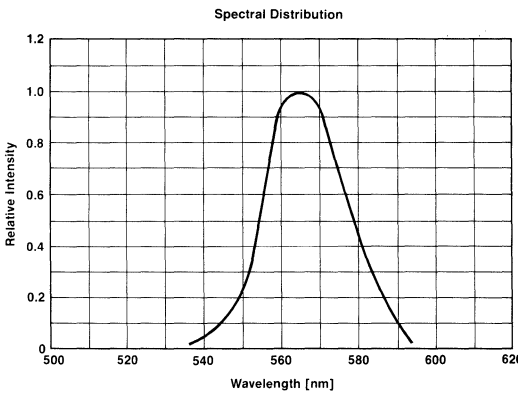
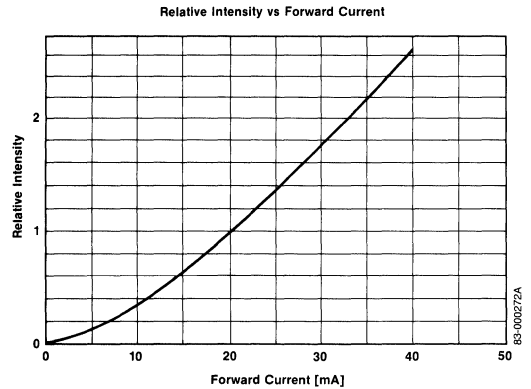
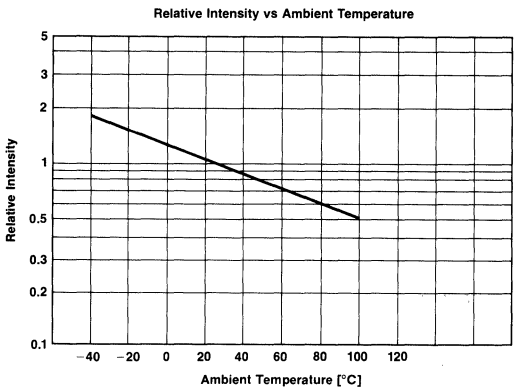
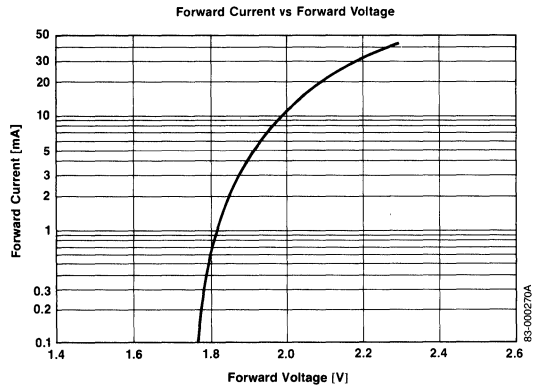
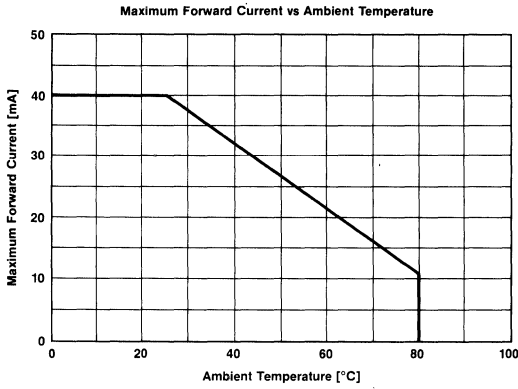
Electro-Optical Characteristics

$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F		2.0	2.5	V	$I_F = 10\text{mA}$
Reverse Current	I_R		0.01	10	μA	$V_R = 4.5\text{V}$
Capacitance	C_T		60		pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}		565		nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$		35		nm	$I_F = 10\text{mA}$
Luminous Intensity	I_V	0.1	0.3		mcd	$I_F = 10\text{mA}$

Typical Characteristics

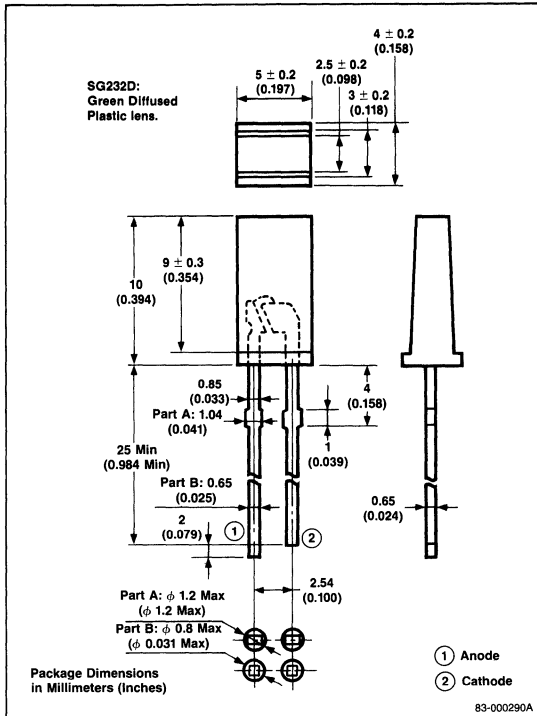
T_A = +25°C



Description

The SG232D is a full resin-molded LED lamp with a flat rectangular face which uniformly emits brilliant green light. It is especially suitable for electronic equipment in audio applications which require fancy displays.

Package Dimensions



Features

- Flat rectangular face
- Low cost
- Long lead
- Bright green
- Compatible with integrated circuits
- Red (SR632D) and amber (SY432D) LEDs are available in the same package style

Applications

- Visual displays
- Peak level indicators
- Radio and stereo equipment indicators
- Measuring instruments, terminals

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	100mW
Forward Current, I_F	40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40 to +100°C

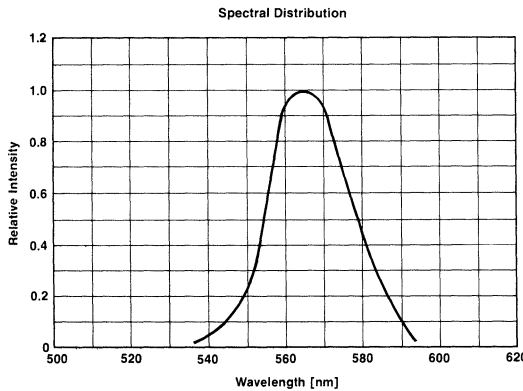
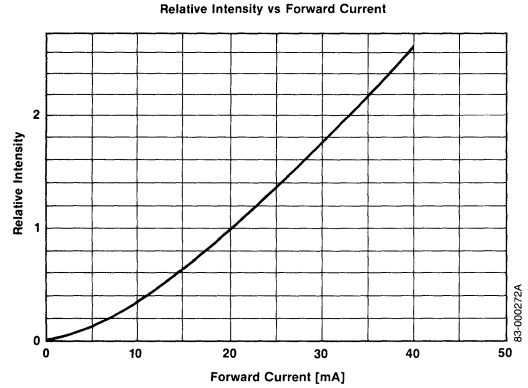
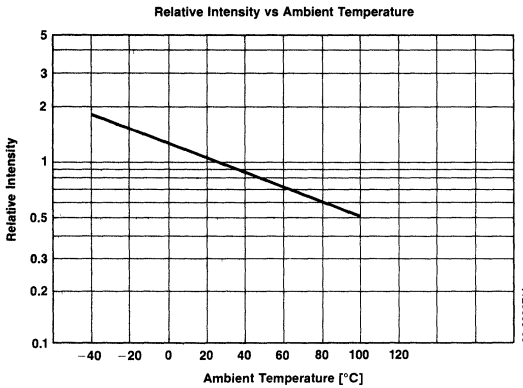
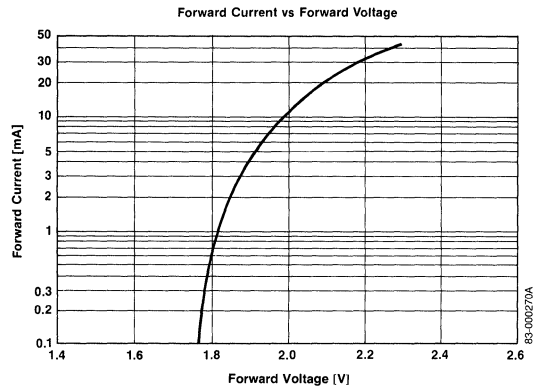
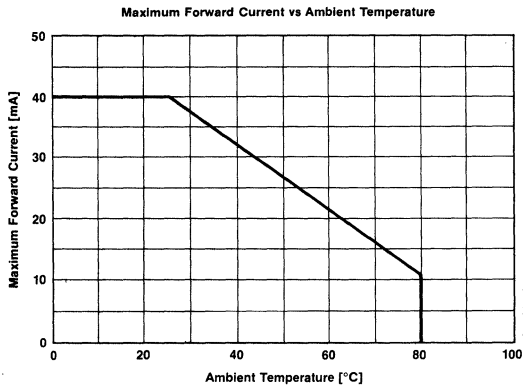
Electro-Optical Characteristics

$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F		2.0	2.5	V	$I_F = 10\text{mA}$
Reverse Current	I_R		0.01	10	μA	$V_R = 4.5\text{V}$
Capacitance	C_T		100		pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}		565		nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$		40		nm	$I_F = 10\text{mA}$
Luminous Intensity	I_V	0.2	0.5		mcd	$I_F = 10\text{mA}$

Typical Characteristics

$T_A = +25^\circ\text{C}$



Description

These three LEDs are full resin-molded LED lamps and have flat triangular faces which uniformly emit brilliant red, green and amber light. They are especially suitable for electronic equipment in audio applications which require fancy displays.

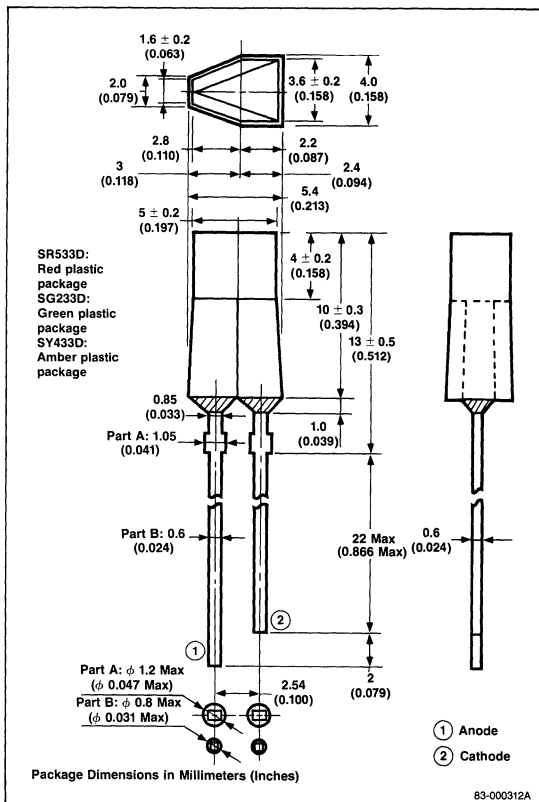
Features

- Flat triangular face
- Low cost
- Long lead
- Bright red, green or amber
- Compatible with integrated circuits

Applications

- Visual displays
- Radio and stereo equipment indicators
- Measuring instrument terminals
- Direction indicators

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$	
Power Dissipation, P_{D1}	60/100mW
Forward Current, I_F	30/40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

Note: 1. SR533D/SG233D, SY433D.

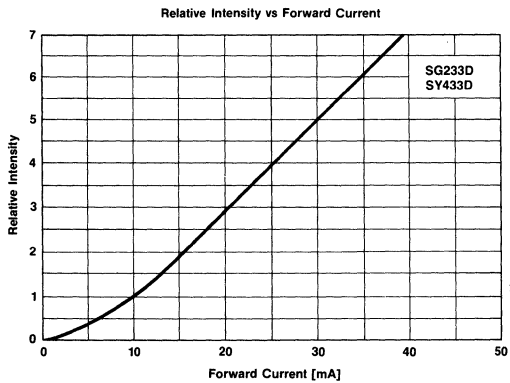
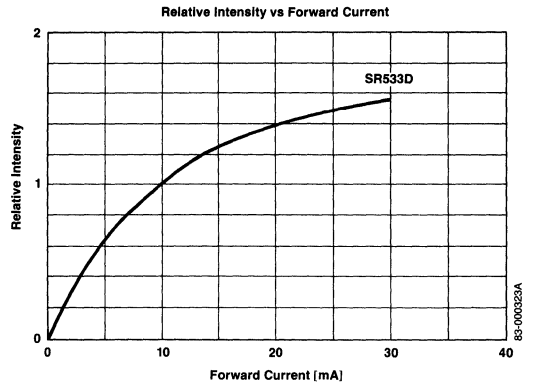
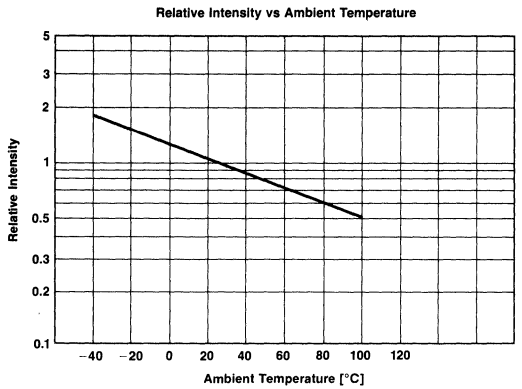
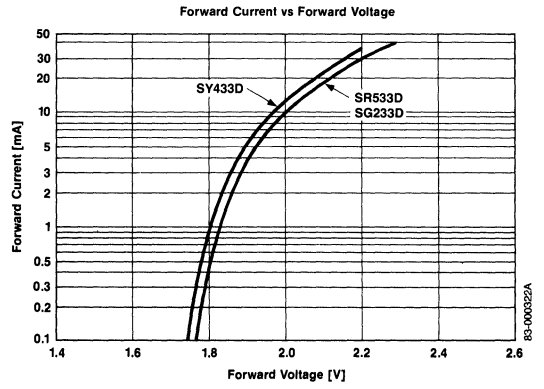
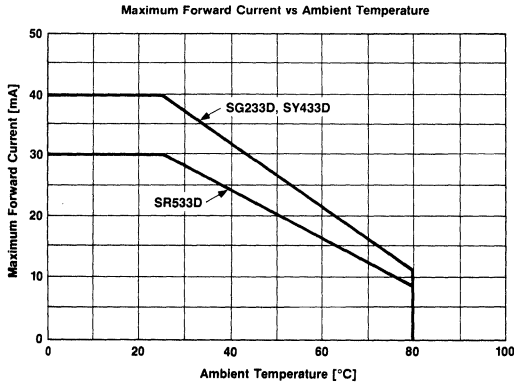
Electro-Optical Characteristics

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage						
SR533D	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
SG233D	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
SY433D	V_F	2.0	2.4		V	$I_F = 10\text{mA}$
Reverse Current						
SR533D	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
SG233D	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
SY433D	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
Capacitance						
SR533D	C_T	100			pF	$V = 0$, $f = 1.0\text{MHz}$
SG233D	C_T	100			pF	$V = 0$, $f = 1.0\text{MHz}$
SY433D	C_T	60			pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength						
SR533D	λ_{PEAK}	695			nm	$I_F = 10\text{mA}$
SG233D	λ_{PEAK}	565			nm	$I_F = 10\text{mA}$
SY433D	λ_{PEAK}	590			nm	$I_F = 10\text{mA}$
Spectral Line Half Width						
SR533D	$\Delta\lambda$	100			nm	$I_F = 10\text{mA}$
SY233D	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
SR433D	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
Luminous Intensity						
SR533D	I_V	0.2	0.5		mcd	$I_F = 10\text{mA}$
SG233D	I_V	0.2	0.7		mcd	$I_F = 10\text{mA}$
SY433D	I_V	0.2	0.7		mcd	$I_F = 10\text{mA}$

4

Typical Characteristics

$T_A = +25^\circ\text{C}$



Description

These three LEDs are full resin-molded LED lamps with flat rectangular faces which uniformly emit brilliant red, green and amber light. They are especially suitable for electronic equipment in audio applications which require fancy displays.

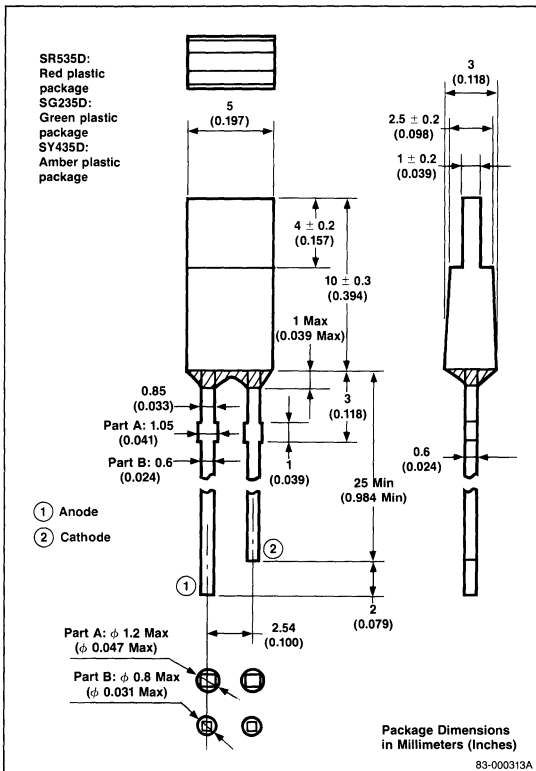
Features

- Flat rectangular face
- Low cost
- Long lead
- Bright red, green or amber
- Compatible with integrated circuits

Applications

- Visual displays
- Radio and stereo equipment indicators
- Measuring instrument terminals

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$	
Power Dissipation, P_D	60/100mW
Forward Current, I_F	30/40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

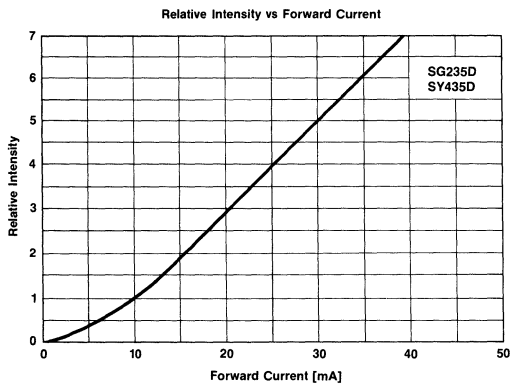
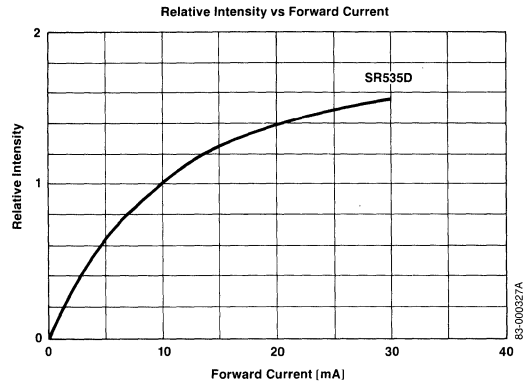
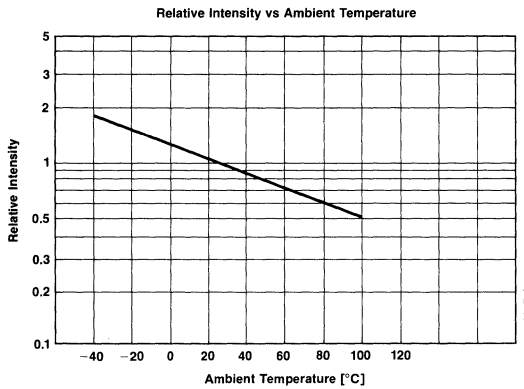
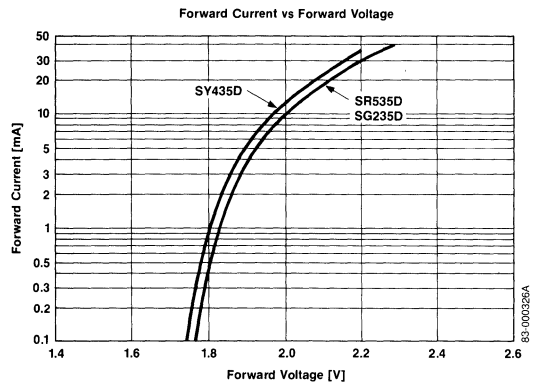
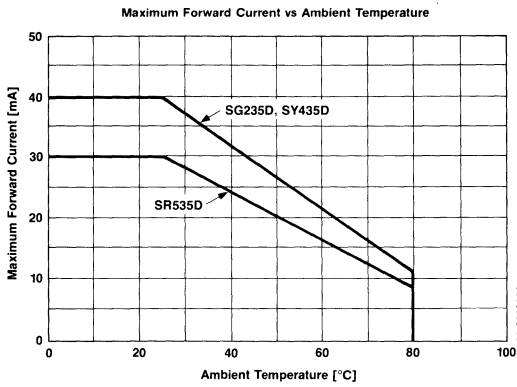
Note: 1. SR535D/SG235D, SY435D

Electro-Optical Characteristics

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage						
SR535D	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
SG235D	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
SY435D	V_F	2.0	2.4		V	$I_F = 10\text{mA}$
Reverse Current						
SR535D	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
SG235D	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
SY435D	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
Capacitance						
SR535D	C_T	100			pF	$V = 0$, $f = 1.0\text{MHz}$
SG235D	C_T	100			pF	$V = 0$, $f = 1.0\text{MHz}$
SY435D	C_T	60			pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength						
SR535D	λ_{PEAK}	695			nm	$I_F = 10\text{mA}$
SG235D	λ_{PEAK}	565			nm	$I_F = 10\text{mA}$
SY435D	λ_{PEAK}	590			nm	$I_F = 10\text{mA}$
Spectral Line Half Width						
SR535D	$\Delta\lambda$	100			nm	$I_F = 10\text{mA}$
SY235D	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
SR435D	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
Luminous Intensity						
SR535D	I_V	0.2	0.5		mcd	$I_F = 10\text{mA}$
SG235D	I_V	0.2	0.7		mcd	$I_F = 10\text{mA}$
SY435D	I_V	0.2	0.7		mcd	$I_F = 10\text{mA}$

Typical Characteristics

$T_A = +25^\circ\text{C}$



Description

These three LEDs are full resin-molded LED lamps with flat hexagonal faces which uniformly emit brilliant red, green and amber light. They are especially suitable for electronic equipment in audio applications which require fancy displays.

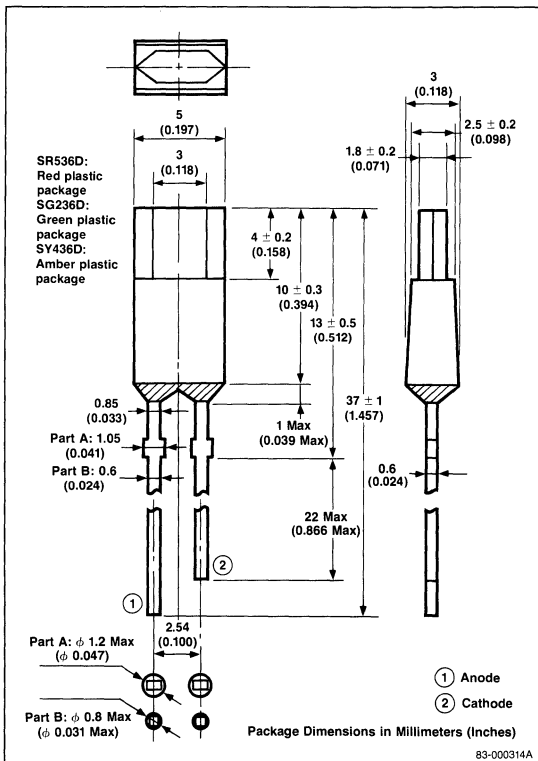
Features

- Flat hexagonal face
- Low cost
- Long lead
- Bright red, green or amber
- Compatible with integrated circuits

Applications

- Visual displays
- Radio and stereo equipment indicators
- Measuring instrument terminals

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$	
Power Dissipation, P_D	60/100mW
Forward Current, I_F	30/40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

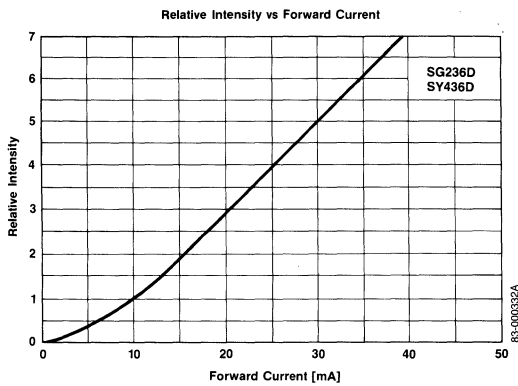
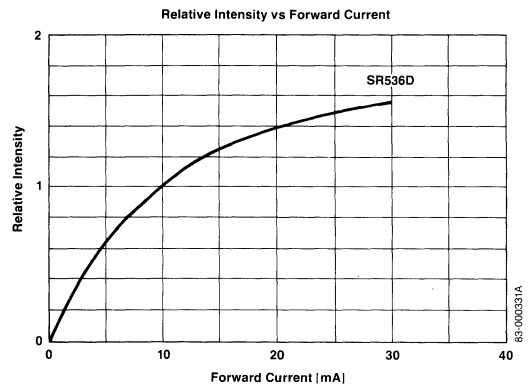
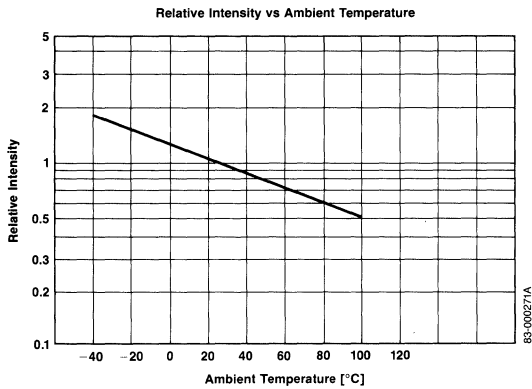
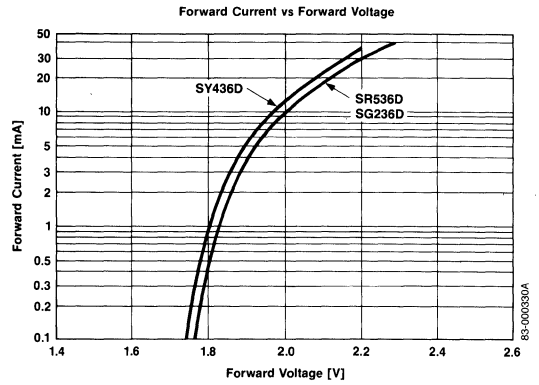
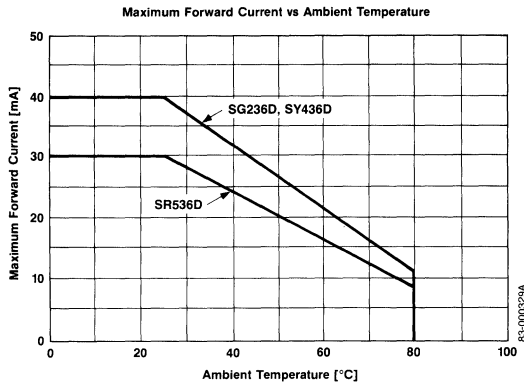
Note: 1. SR536D/SG236D, SY436D

Electro-Optical Characteristics

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage						
SR536D	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
SG236D	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
SY436D	V_F	2.0	2.4		V	$I_F = 10\text{mA}$
Reverse Current						
SR536D	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
SG236D	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
SY436D	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
Capacitance						
SR536D	C_T	100			pF	$V = 0, f = 1.0\text{MHz}$
SG236D	C_T	100			pF	$V = 0, f = 1.0\text{MHz}$
SY436D	C_T	60			pF	$V = 0, f = 1.0\text{MHz}$
Peak Emission Wavelength						
SR536D	λ_{PEAK}	695			nm	$I_F = 10\text{mA}$
SG236D	λ_{PEAK}	565			nm	$I_F = 10\text{mA}$
SY436D	λ_{PEAK}	590			nm	$I_F = 10\text{mA}$
Spectral Line Half Width						
SR536D	$\Delta\lambda$	100			nm	$I_F = 10\text{mA}$
SY236D	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
SR436D	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
Luminous Intensity						
SR536D	I_V	0.2	0.5		mcd	$I_F = 10\text{mA}$
SG236D	I_V	0.2	0.7		mcd	$I_F = 10\text{mA}$
SY436D	I_V	0.2	0.7		mcd	$I_F = 10\text{mA}$

Typical Characteristics

$T_A = +25^\circ\text{C}$



Description

These three LEDs are full resin-molded LED lamps with flat elliptical faces which uniformly emit brilliant red, green and amber light. They are especially suitable for electronic equipment in audio applications which require fancy displays.

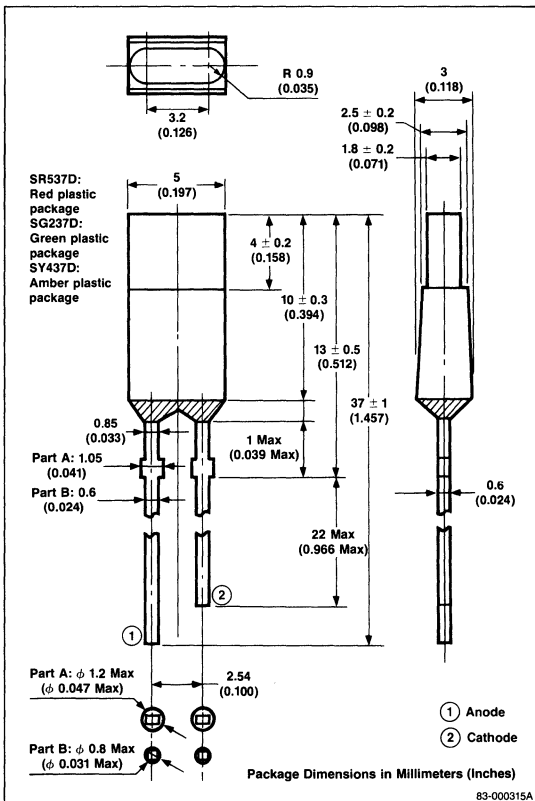
Features

- Flat elliptical face
- Low cost
- Long lead
- Bright red, green or amber
- Compatible with integrated circuits

Applications

- Visual displays
- Radio and stereo equipment indicators
- Measuring instrument terminals

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	60/100mW
Forward Current, I_F	30/40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

Note: 1. SR537D/SG237D, SY437D

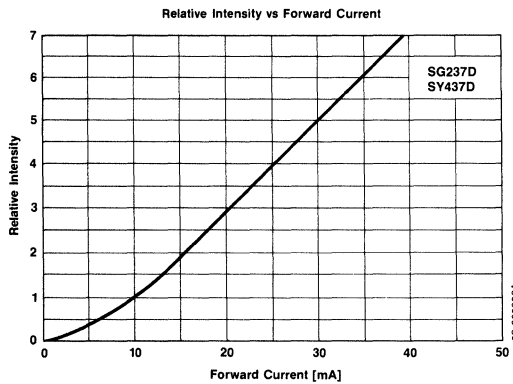
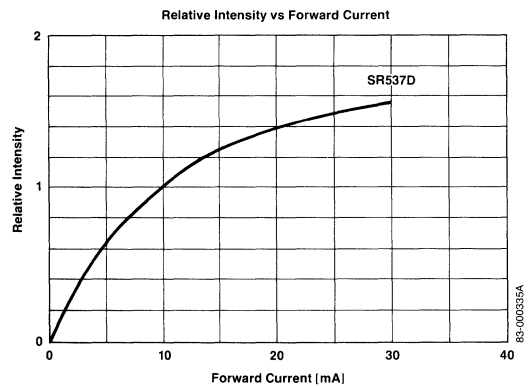
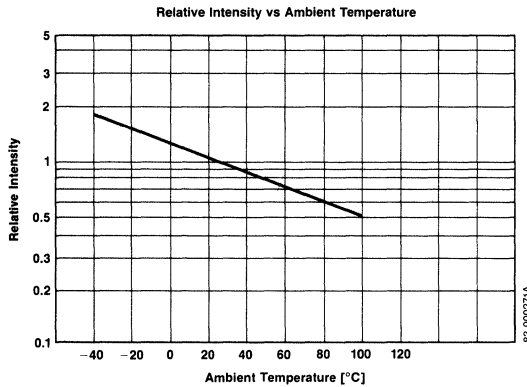
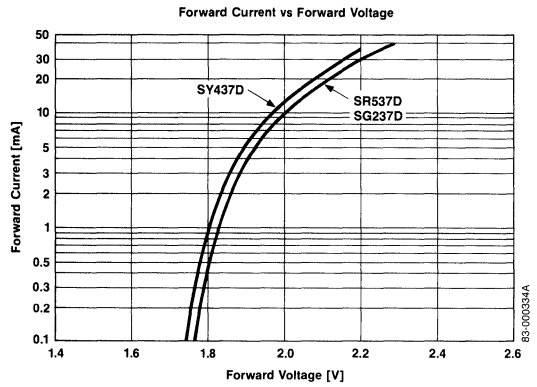
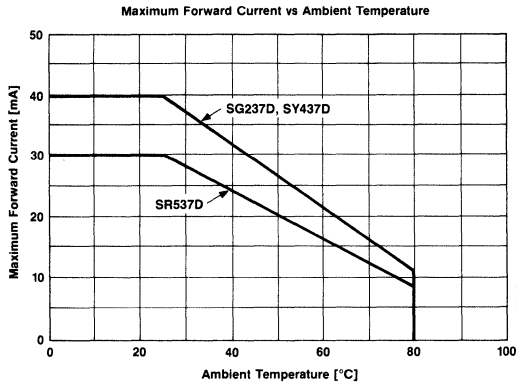
Electro-Optical Characteristics

$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage						
SR537D	V_F		2.0	2.5	V	$I_F = 10\text{mA}$
SG237D	V_F		2.0	2.5	V	$I_F = 10\text{mA}$
SY437D	V_F		2.0	2.4	V	$I_F = 10\text{mA}$
Reverse Current						
SR537D	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
SG237D	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
SY437D	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
Capacitance						
SR537D	C_T		100		pF	$V = 0$, $f = 1.0\text{MHz}$
SG237D	C_T		100		pF	$V = 0$, $f = 1.0\text{MHz}$
SY437D	C_T		60		pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength						
SR537D	λ_{PEAK}		695		nm	$I_F = 10\text{mA}$
SG237D	λ_{PEAK}		565		nm	$I_F = 10\text{mA}$
SY437D	λ_{PEAK}		590		nm	$I_F = 10\text{mA}$
Spectral Line Half Width						
SR537D	$\Delta\lambda$		100		nm	$I_F = 10\text{mA}$
SY237D	$\Delta\lambda$		40		nm	$I_F = 10\text{mA}$
SR437D	$\Delta\lambda$		40		nm	$I_F = 10\text{mA}$
Luminous Intensity						
SR537D	I_V	0.2	0.5		mcd	$I_F = 10\text{mA}$
SG237D	I_V	0.2	0.7		mcd	$I_F = 10\text{mA}$
SY437D	I_V	0.2	0.7		mcd	$I_F = 10\text{mA}$

Typical Characteristics

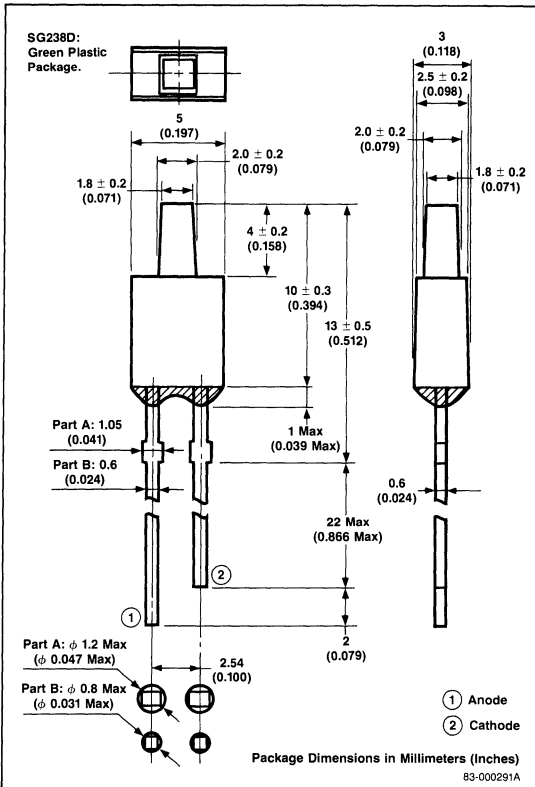
$T_A = +25^\circ\text{C}$



Description

The SG238D is a full resin-molded LED lamp with a flat rectangular face which uniformly emits brilliant green light. It is especially suitable for electronic equipment in audio applications which require fancy displays.

Package Dimensions



Features

- Flat rectangular face
- Low cost
- Long lead
- Bright green
- Compatible with integrated circuits
- Red (SR538D) and amber (SY438D) LEDs are available in the same package style

Applications

- Visual displays
- Peak level indicators
- Radio and stereo equipment indicators
- Measuring instruments, terminals

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	100mW
Forward Current, I_F	40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40 to +100°C

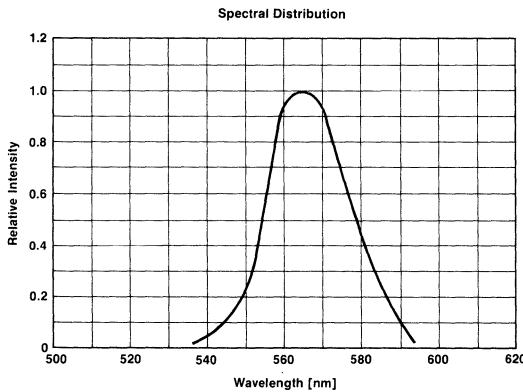
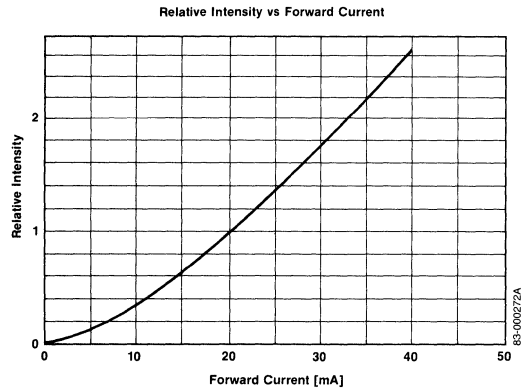
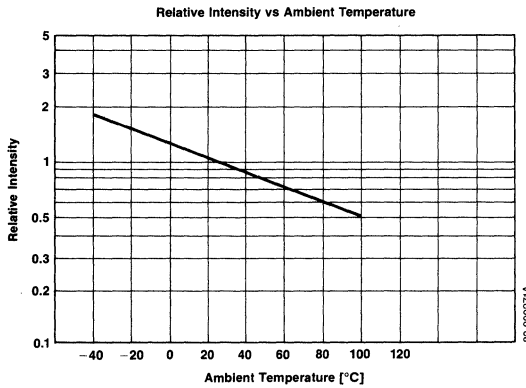
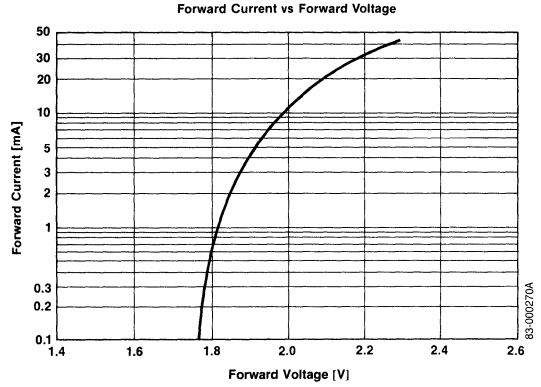
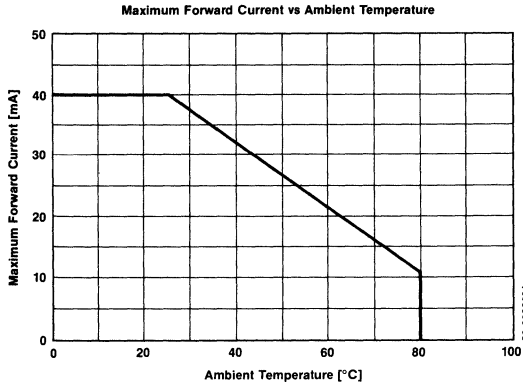
Electro-Optical Characteristics

$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
Reverse Current	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
Capacitance	C_T	100			pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}	565			nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
Luminous Intensity	I_V	0.2	0.5		mcd	$I_F = 10\text{mA}$

Typical Characteristics

T_A = +25°C



Description

These three LEDs are full resin-molded LED lamps with flat circular faces which uniformly emit brilliant red, green and amber light. They are especially suitable for electronic equipment in audio applications which require fancy displays.

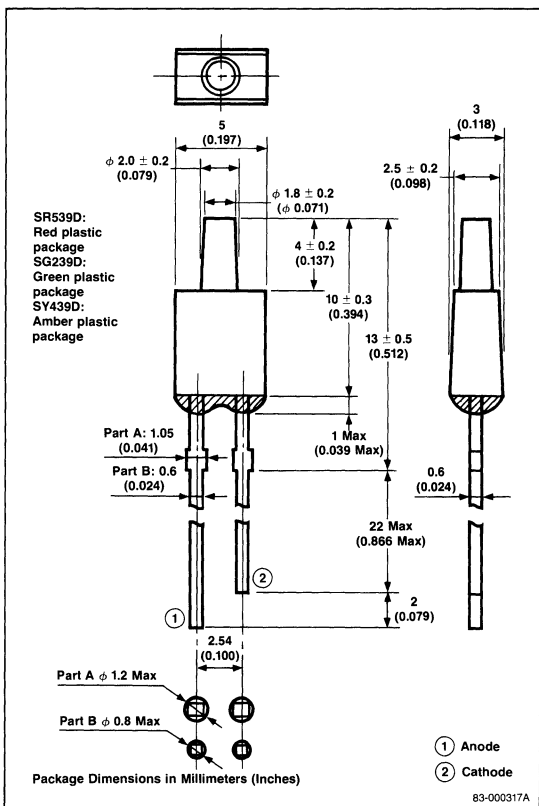
Features

- Flat circular face
- Low cost
- Long lead
- Bright red, green or amber
- Compatible with integrated circuits

Applications

- Visual displays
- Radio and stereo equipment indicators
- Measuring instrument terminals

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	60/100mW
Forward Current, I_F	30/40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

Note: 1. SR539D/SG239D, SY439D

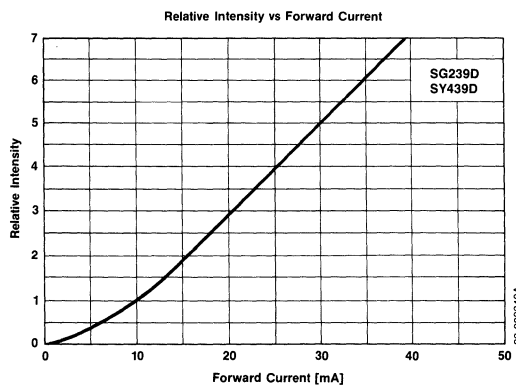
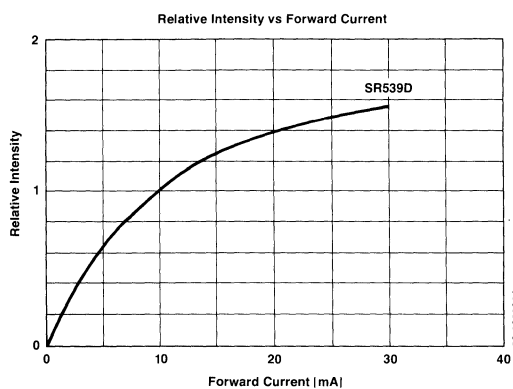
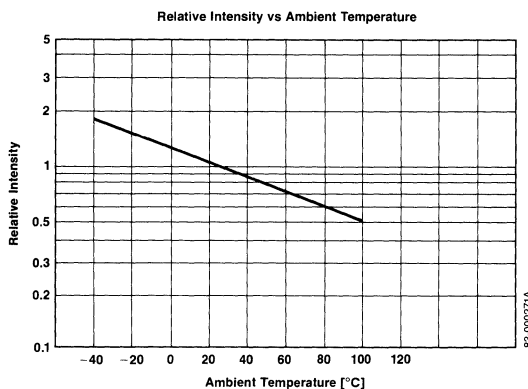
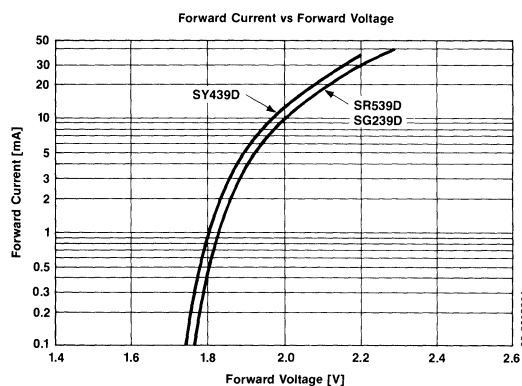
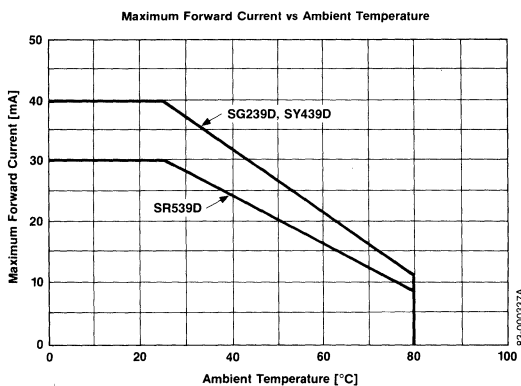
Electro-Optical Characteristics

$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage						
SR539D	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
SG239D	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
SY439D	V_F	2.0	2.4		V	$I_F = 10\text{mA}$
Reverse Current						
SR539D	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
SG239D	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
SY439D	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
Capacitance						
SR539D	C_T	100			pF	$V = 0$, $f = 1.0\text{MHz}$
SG239D	C_T	100			pF	$V = 0$, $f = 1.0\text{MHz}$
SY439D	C_T	60			pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength						
SR539D	λ_{PEAK}	695			nm	$I_F = 10\text{mA}$
SG239D	λ_{PEAK}	565			nm	$I_F = 10\text{mA}$
SY439D	λ_{PEAK}	590			nm	$I_F = 10\text{mA}$
Spectral Line Half Width						
SR539D	$\Delta\lambda$	100			nm	$I_F = 10\text{mA}$
SY239D	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
SR439D	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
Luminous Intensity						
SR539D	I_V	0.2	0.5		mcd	$I_F = 10\text{mA}$
SG239D	I_V	0.2	0.7		mcd	$I_F = 10\text{mA}$
SY439D	I_V	0.2	0.7		mcd	$I_F = 10\text{mA}$

Typical Characteristics

$T_A = +25^\circ\text{C}$



Description

These three LEDs are full resin-molded LED lamps with flat rectangular faces which uniformly emit brilliant red, green and amber light. They are especially suitable for electronic equipment in audio applications which require fancy displays.

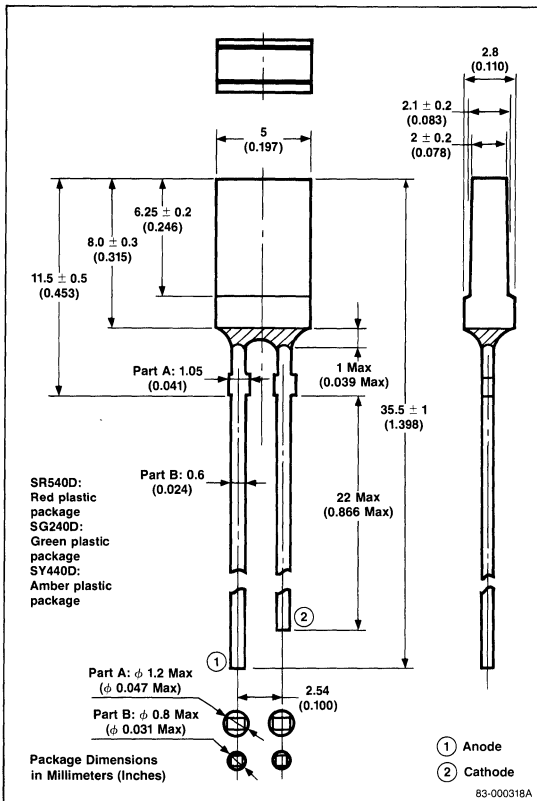
Features

- Flat rectangular face
- Low cost
- Long lead
- Bright red, green or amber
- Compatible with integrated circuits

Applications

- Visual displays
- Radio and stereo equipment indicators
- Measuring instrument terminals

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$	
Power Dissipation, P_D	60/100mW
Forward Current, I_F	30/40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

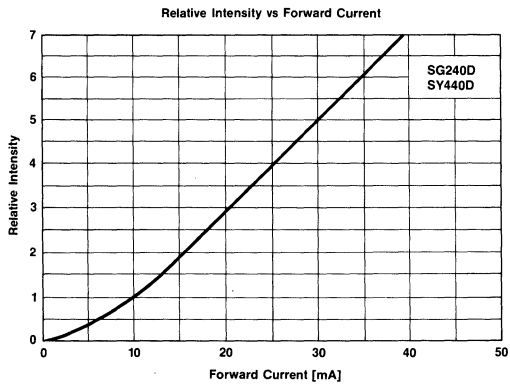
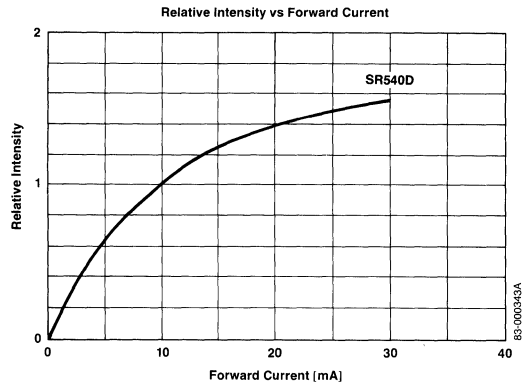
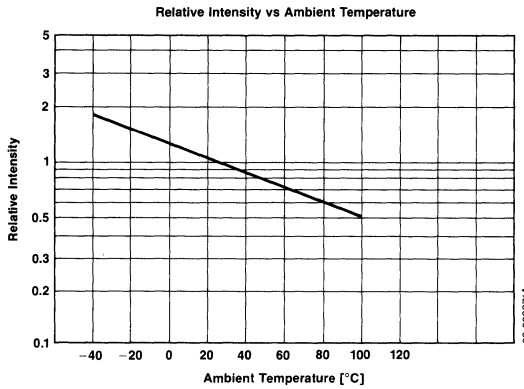
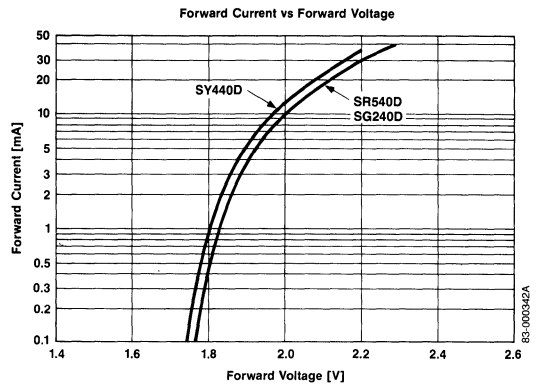
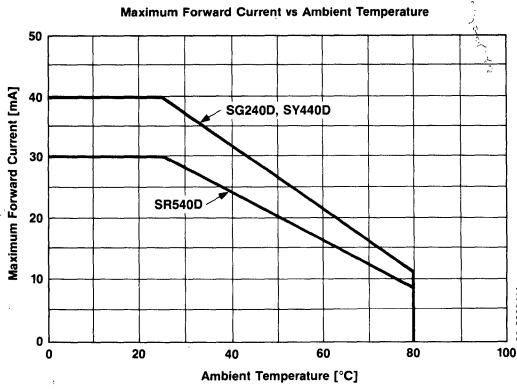
Note: 1. SR540D/SG240D, SY440D

Electro-Optical Characteristics

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage						
SR540D	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
SG240D	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
SY440D	V_F	2.0	2.4		V	$I_F = 10\text{mA}$
Reverse Current						
SR540D	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
SG240D	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
SY440D	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
Capacitance						
SR540D	C_T	100			pF	$V = 0$, $f = 1.0\text{MHz}$
SG240D	C_T	100			pF	$V = 0$, $f = 1.0\text{MHz}$
SY440D	C_T	60			pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength						
SR540D	λ_{PEAK}	695			nm	$I_F = 10\text{mA}$
SG240D	λ_{PEAK}	565			nm	$I_F = 10\text{mA}$
SY440D	λ_{PEAK}	590			nm	$I_F = 10\text{mA}$
Spectral Line Half Width						
SR540D	$\Delta\lambda$	100			nm	$I_F = 10\text{mA}$
SY240D	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
SR440D	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
Luminous Intensity						
SR540D	I_V	0.3	0.8		mcd	$I_F = 10\text{mA}$
SG240D	I_V	0.7	1.5		mcd	$I_F = 10\text{mA}$
SY440D	I_V	0.7	1.5		mcd	$I_F = 10\text{mA}$

Typical Characteristics

$T_A = +25^\circ\text{C}$



Description

The SR661D, SG261D and SY461D are rectangular (2mm × 3mm) plastic-resin-encapsulated LED lamps which uniformly emit brilliant red, green and amber light. They are suitable for use as fashionable indicators on the panels of audio/video equipment and elsewhere.

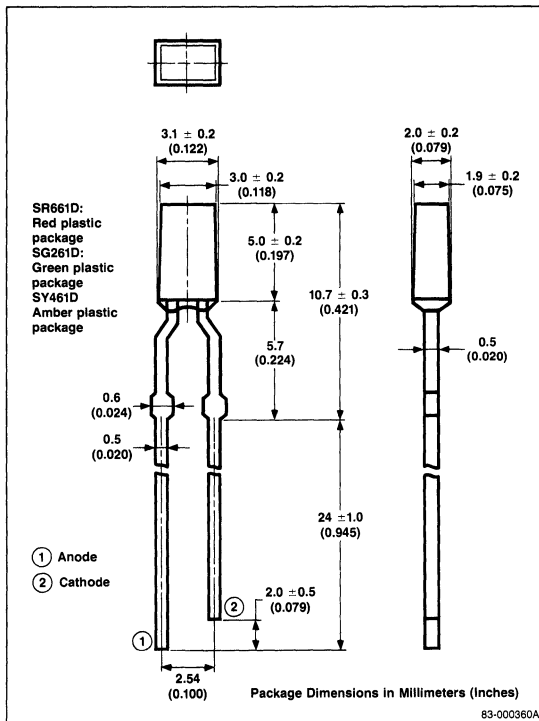
Features

- Flat rectangular face
- Low cost
- Long lead
- Bright red, green or amber
- Compatible with integrated circuits

Applications

- Visual displays
- Radio and stereo equipment indicators
- Measuring instrument terminals

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$	
Power Dissipation, P_D	100mW
Forward Current, I_F	40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

Electro-Optical Characteristics

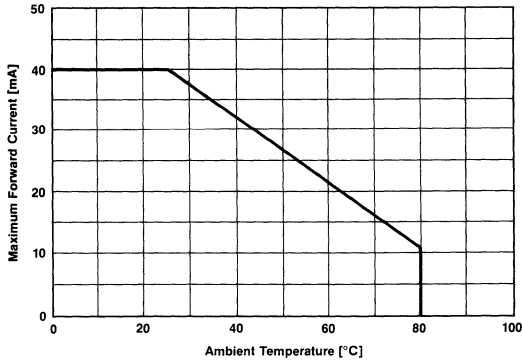
Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage						
SR661D	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
SG261D	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
SY461D	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
Reverse Current						
SR661D	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
SG261D	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
SY461D	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
Capacitance						
SR661D	C_T	100			pF	$V = 0, f = 1.0\text{MHz}$
SG261D	C_T	100			pF	$V = 0, f = 1.0\text{MHz}$
SY461D	C_T	60			pF	$V = 0, f = 1.0\text{MHz}$
Peak Emission Wavelength						
SR661D	λ_{PEAK}	630			nm	$I_F = 10\text{mA}$
SG261D	λ_{PEAK}	565			nm	$I_F = 10\text{mA}$
SY461D	λ_{PEAK}	590			nm	$I_F = 10\text{mA}$
Spectral Line Half Width						
SR661D	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
SG261D	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
SY461D	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
Luminous Intensity						
SR661D	I_V	0.4	1.0		mcd	$I_F = 10\text{mA}$
SG261D	I_V	0.4	1.5		mcd	$I_F = 10\text{mA}$
SY461D	I_V	0.4	1.5		mcd	$I_F = 10\text{mA}$

4

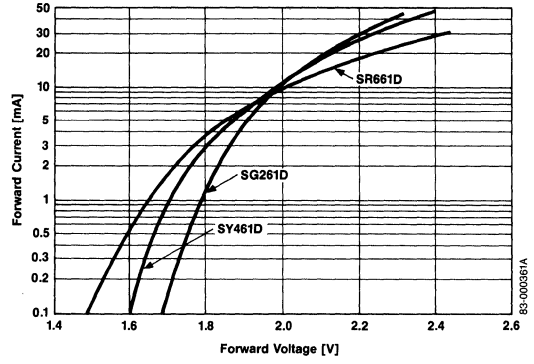
Typical Characteristics

$T_A = +25^\circ\text{C}$

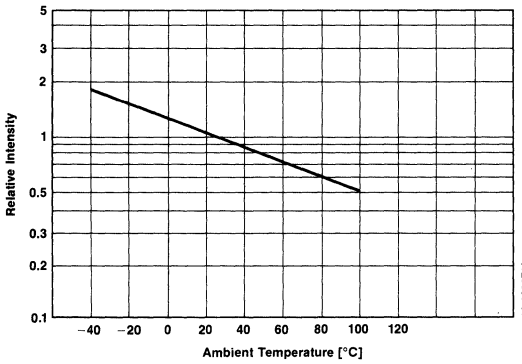
Maximum Forward Current vs Ambient Temperature



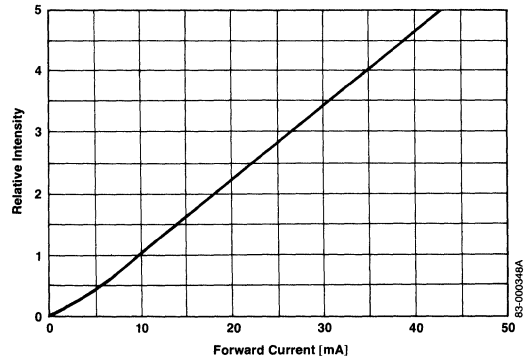
Forward Current vs Forward Voltage



Relative Intensity vs Ambient Temperature



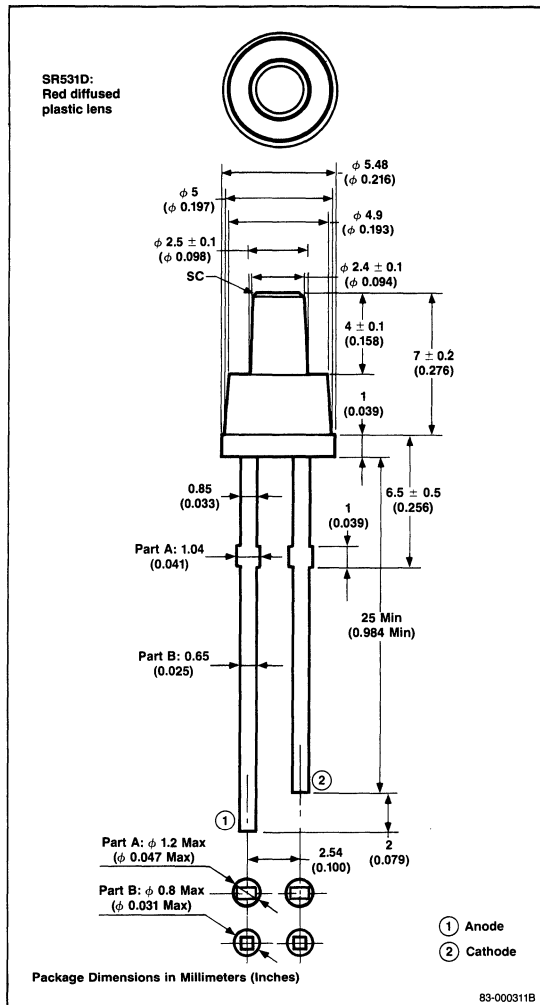
Relative Intensity vs Forward Current



Description

The SR531D is a full resin-molded LED lamp with a flat circular face which uniformly emits brilliant red light. It is especially suitable for electronic equipment in audio applications which require fancy displays.

Package Dimensions



Features

- Flat circular face
- Low cost
- Long lead
- Bright red
- Compatible with integrated circuits
- Green (SG231D) and amber (SY431D) LEDs are available in the same package style

Applications

- Visual displays
- Radio and stereo equipment indicators
- Measuring instruments, terminals

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	60mW
Forward Current, I_F	30mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

Electro-Optical Characteristics

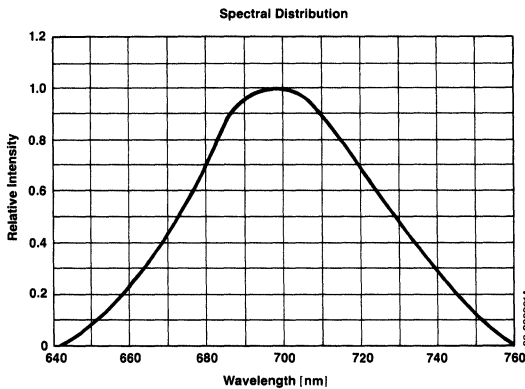
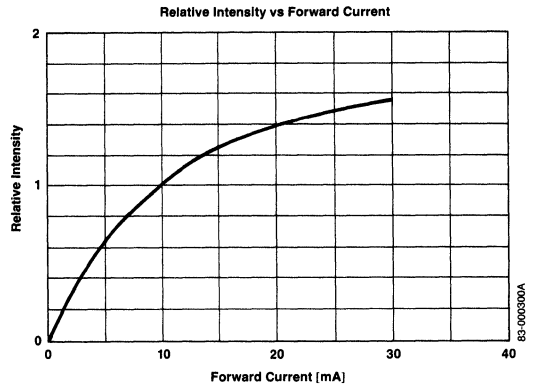
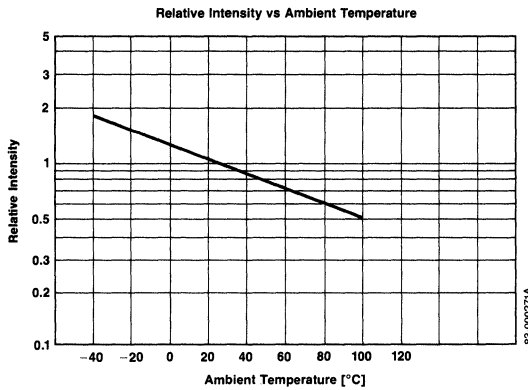
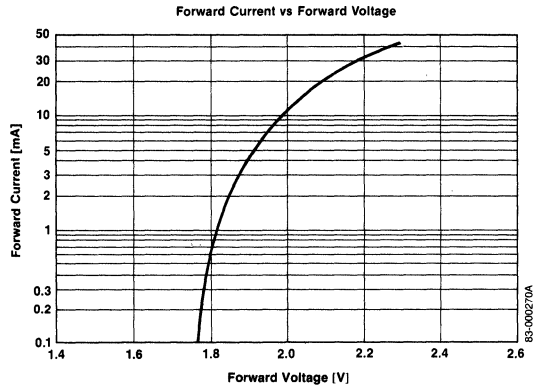
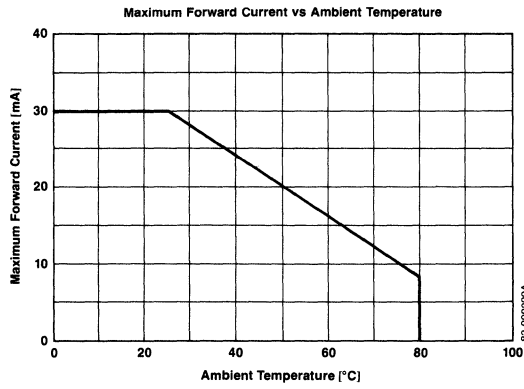
$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F		2	2.5	V	$I_F = 10\text{mA}$
Reverse Current	I_R		0.01	10	μA	$V_R = 4.5$
Capacitance	C_T		100		pF	$V = 0$ $F = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}		695		nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$		100		nm	$I_F = 10\text{mA}$
Luminous Intensity	I_V	0.2	0.5		mcd	$I_F = 10\text{mA}$



Typical Characteristics

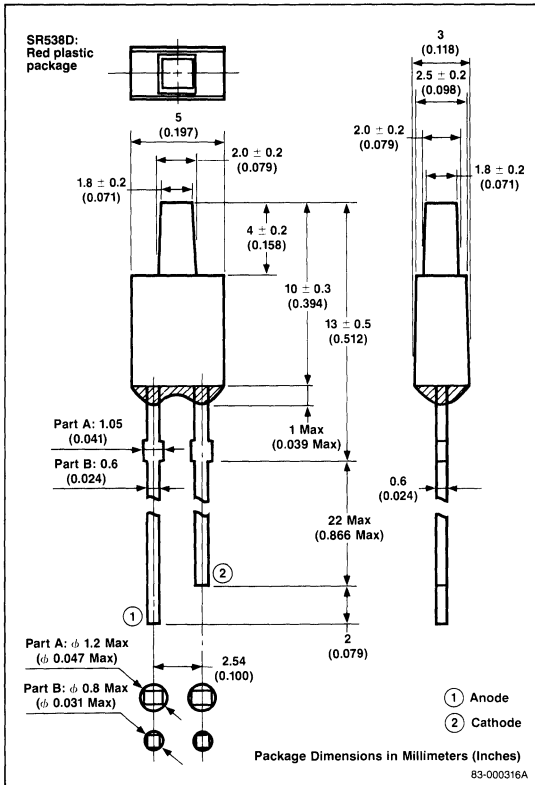
T_A = +25°C



Description

The SR538D is a full resin-molded LED lamp with a flat rectangular face which uniformly emits brilliant red light. It is especially suitable for electronic equipment in audio applications which require fancy displays.

Package Dimensions



Features

- Flat rectangular face
- Low cost
- Long lead
- Bright red
- Compatible with integrated circuits
- Green (SG238D) and amber (SY438D) LEDs are available in the same package style

Applications

- Visual displays
- Radio and stereo equipment indicators
- Measuring instruments, terminals

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	60mW
Forward Current, I_F	30mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

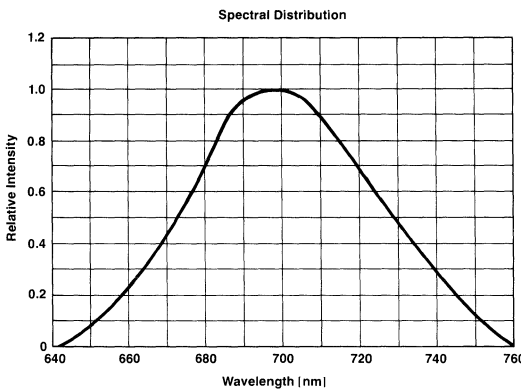
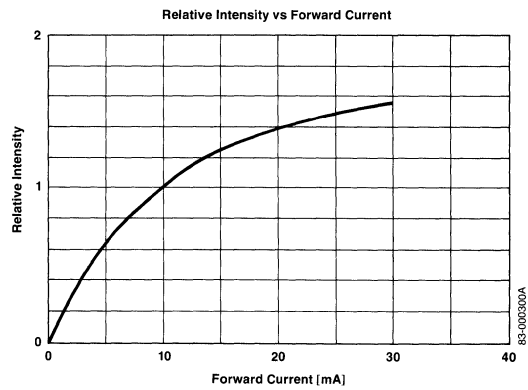
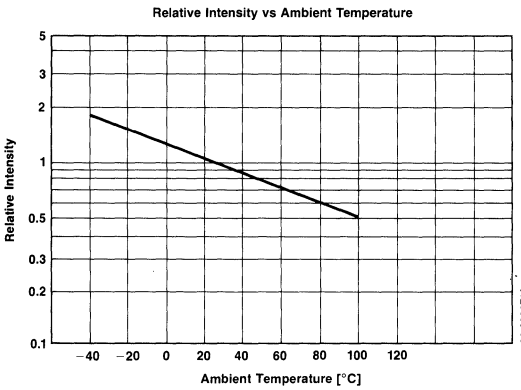
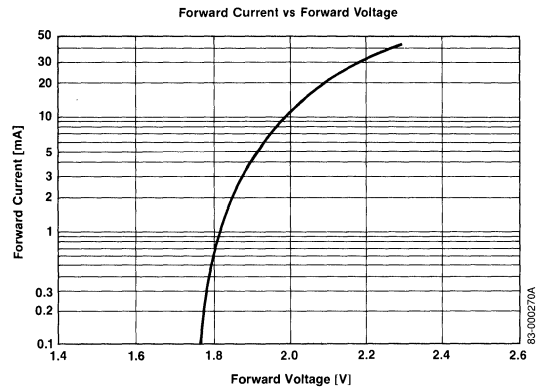
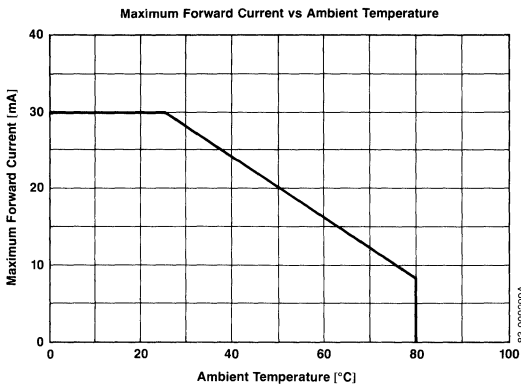
Electro-Optical Characteristics

$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F	2.0	2.5		V	$I_F = 10\text{mA}$
Reverse Current	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
Capacitance	C_T		100		pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}		695		nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$		100		nm	$I_F = 10\text{mA}$
Luminous Intensity	I_V	0.2	0.5		mcd	$I_F = 10\text{mA}$

Typical Characteristics

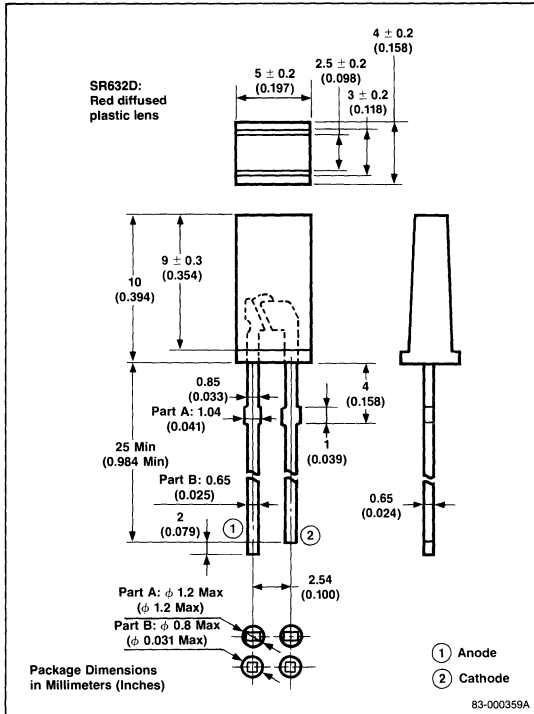
T_A = +25°C



Description

The SR632D is a full resin-molded LED lamp with a flat rectangular face which uniformly emits brilliant red light. It is especially suitable for electronic equipment in audio applications which require fancy displays.

Package Dimensions



Features

- Flat rectangular face
- Low cost
- Long lead
- Bright red
- Compatible with integrated circuits
- Green (SG232D) and amber (SY432D) LEDs are available in the same package style

Applications

- Visual displays
- Radio and stereo equipment indicators
- Measuring instruments, terminals

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	100mW
Forward Current, I_F	40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

Electro-Optical Characteristics

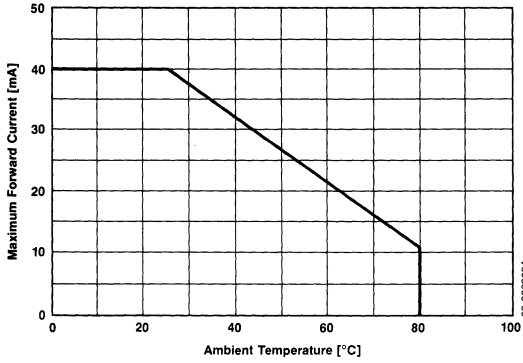
$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F	2.0	2.4		V	$I_F = 10\text{mA}$
Reverse Current	I_R	0.01	10		μA	$V_R = 5\text{V}$
Capacitance	C_T	100			pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}	630			nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
Luminous Intensity	I_V	0.5	1.2		mcd	$I_F = 10\text{mA}$

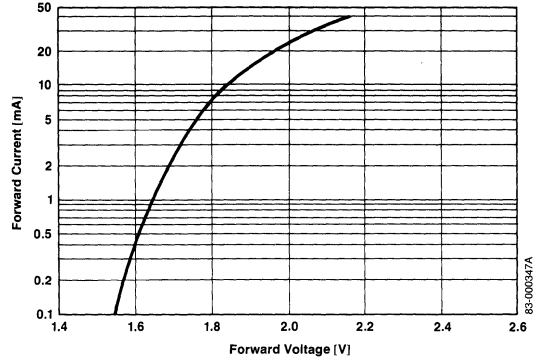
Typical Characteristics

T_A = +25°C

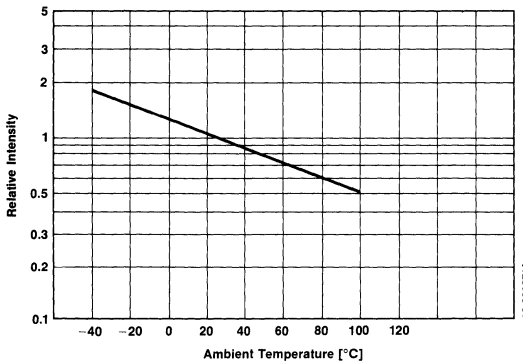
Maximum Forward Current vs Ambient Temperature



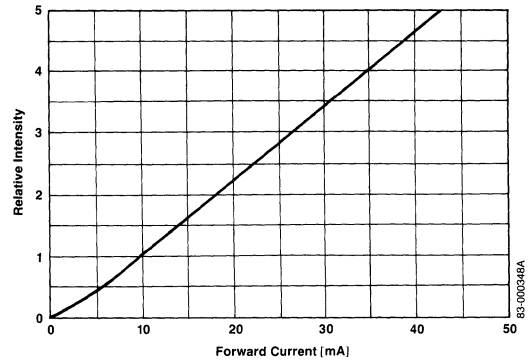
Forward Current vs Forward Voltage



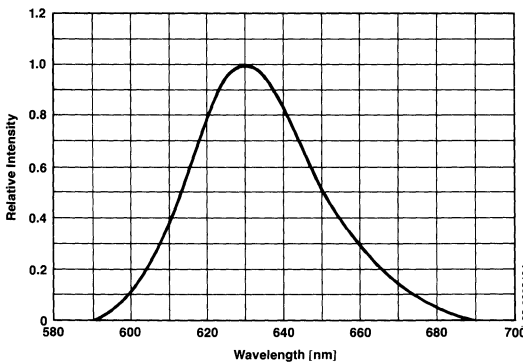
Relative Intensity vs Ambient Temperature



Relative Intensity vs Forward Current



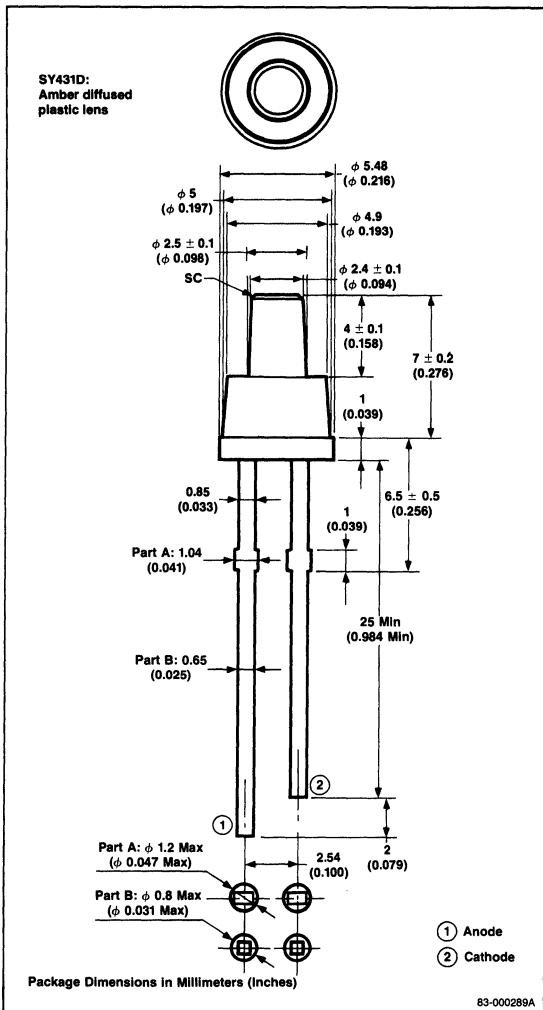
Spectral Distribution



Description

The SY431D is a full resin-molded LED lamp and has a circular flat face which emits brilliant amber light uniformly. It is especially suitable for electronic equipment as for audio uses which require some fancy looking displays.

Package Dimensions



Features

- Circular flat face type
- Low cost
- Long lead
- Bright amber
- Compatible with integrated circuits
- Red (SR531D) and green (SG231D) LEDs are available in the same package

Applications

- Visual displays
- Radio and stereo equipment indicators
- Measuring instrument, terminal

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	100mW
Forward Current, I_F	40mA
Reverse Voltage, V_R	5A
Junction Temperatures, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

Electro-Optical Characteristics

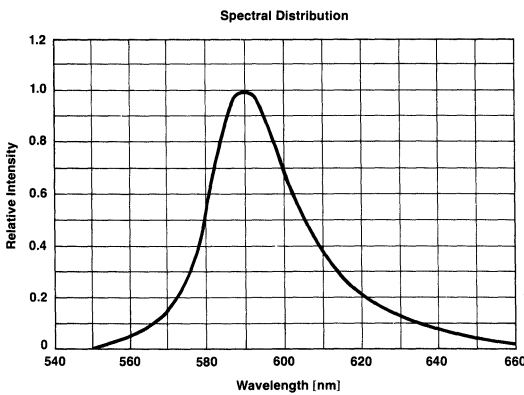
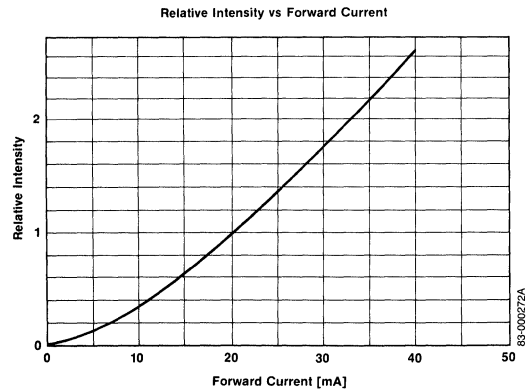
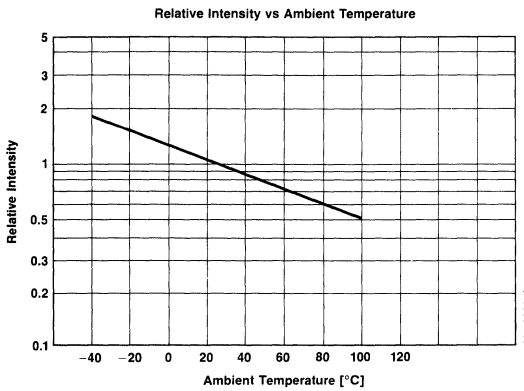
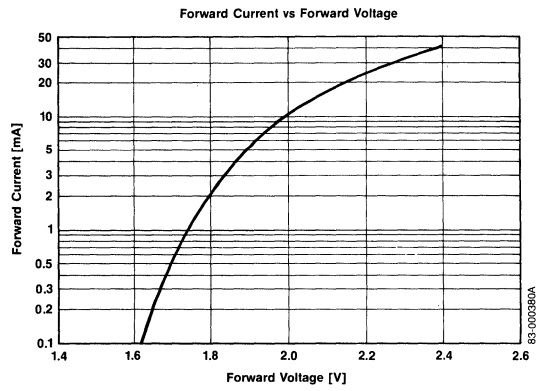
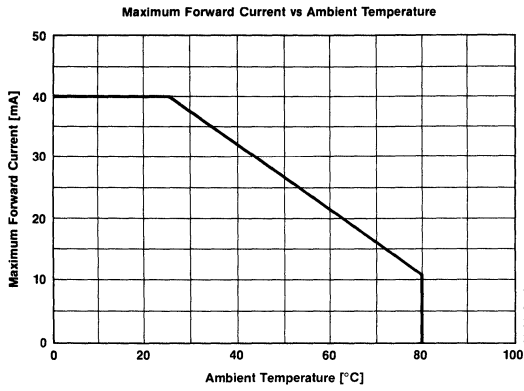
$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F	2.0	2.4		V	$I_F = 10\text{mA}$
Reverse Current	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
Capacitance	C_T	60			pF	$V = 0, f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}	590			nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
Luminous Intensity	I_V	0.1	30		mcd	$I_F = 10\text{mA}$



Typical Characteristics

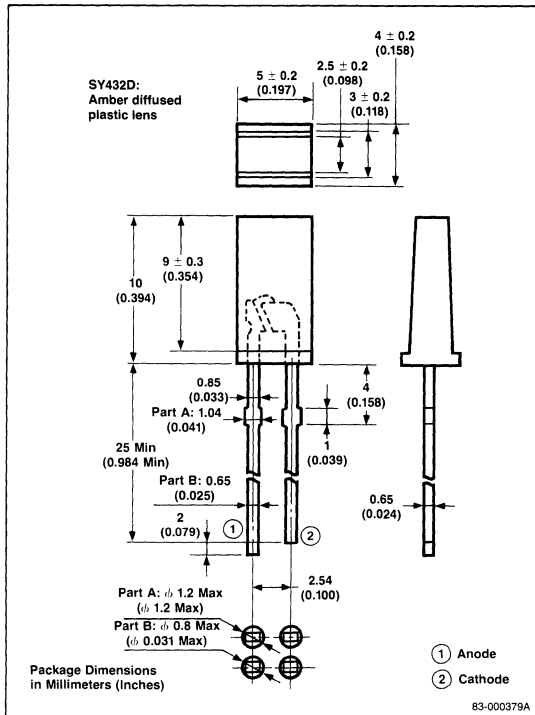
$T_A = +25^\circ\text{C}$



Description

The SY432D is a full resin-molded LED lamp with a flat rectangular face which uniformly emits brilliant amber light. It is especially suitable for electronic equipment in audio applications which require fancy displays.

Package Dimensions



Features

- Flat rectangular face
- Low cost
- Long lead
- Bright amber
- Compatible with integrated circuits
- Red (SR632D) and green (SG232D) LEDs are available in the same package style

Applications

- Visual displays
- Peak level indicators
- Radio and stereo equipment indicators
- Measuring instruments, terminals

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	100mW
Forward Current, I_F	40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

Electro-Optical Characteristics

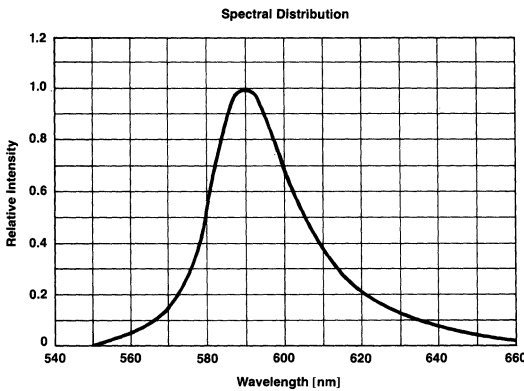
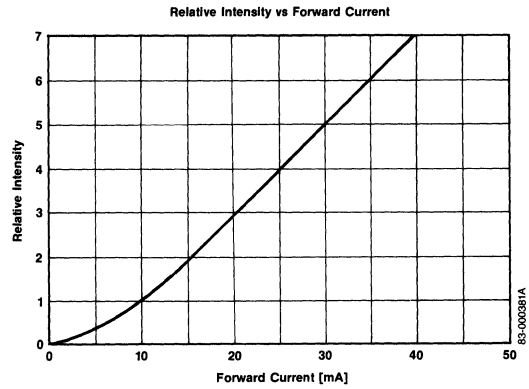
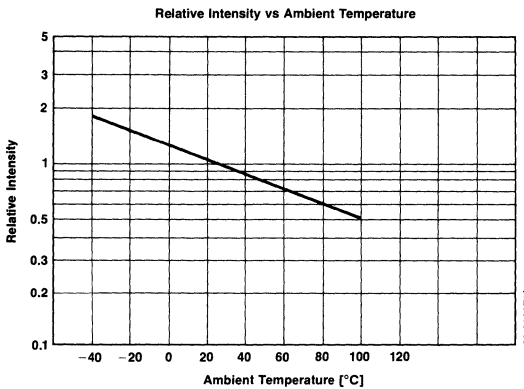
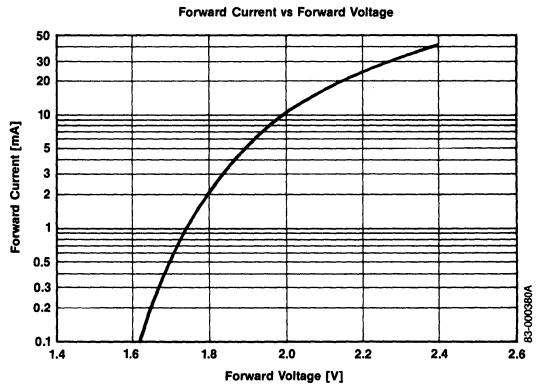
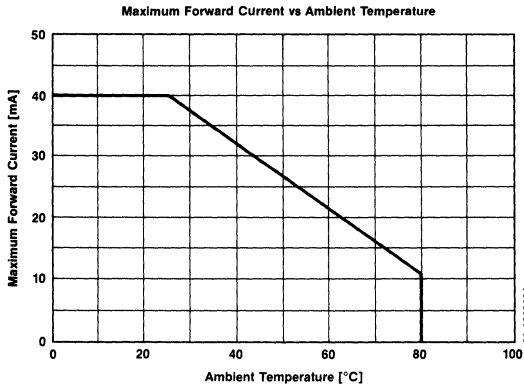
$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F	2.0	2.4		V	$I_F = 10\text{mA}$
Reverse Current	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
Capacitance	C_T		100		pF	$V = 0, f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}		590		nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$		40		nm	$I_F = 10\text{mA}$
Luminous Intensity	I_V	0.2	0.5		mcd	$I_F = 10\text{mA}$

4

Typical Characteristics

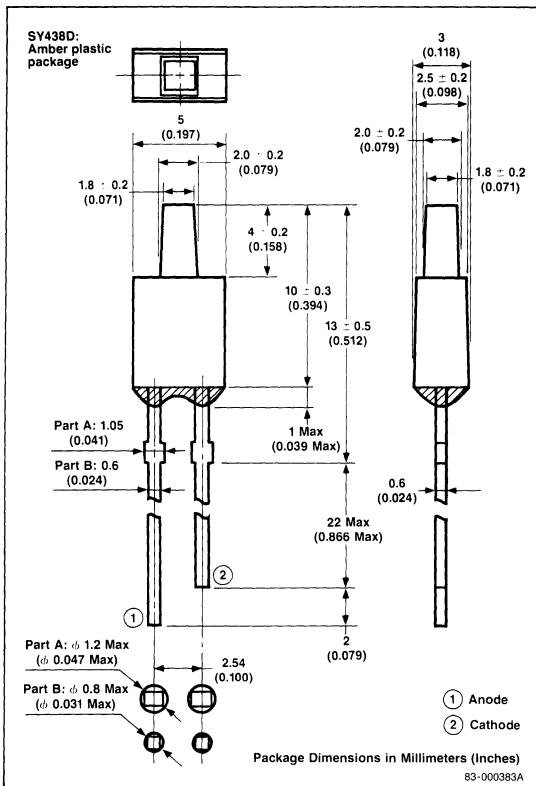
$T_A = +25^\circ\text{C}$



Description

The SY438D is a full resin-molded LED lamp with a flat rectangular face which uniformly emits brilliant amber light. It is especially suitable for electronic equipment in audio applications which require fancy displays.

Package Dimensions



Features

- Flat rectangular face
- Low cost
- Long lead
- Bright amber
- Compatible with integrated circuits
- Red (SR538D) and green (SG238D) LEDs are available in the same package style

Applications

- Visual displays
- Peak level indicators
- Radio and stereo equipment indicators
- Measuring instruments, terminals

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Power Dissipation, P_D	100mW
Forward Current, I_F	40mA
Reverse Voltage, V_R	5V
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

Electro-Optical Characteristics

$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F	2.0	2.4		V	$I_F = 10\text{mA}$
Reverse Current	I_R	0.01	10		μA	$V_R = 4.5\text{V}$
Capacitance	C_T	100			pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}	590			nm	$I_F = 10\text{mA}$
Spectral Line Half Width	$\Delta\lambda$	40			nm	$I_F = 10\text{mA}$
Luminous Intensity	I_V	0.2	0.5		mcd	$I_F = 10\text{mA}$

4

Typical Characteristics

$T_A = +25^\circ\text{C}$

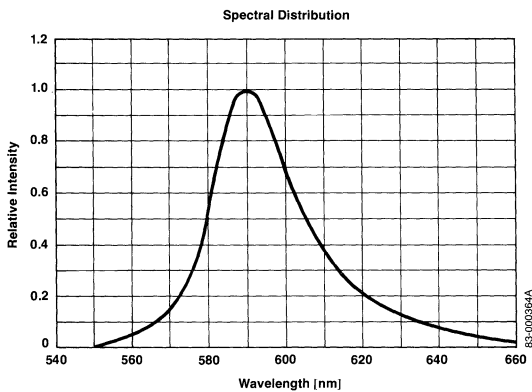
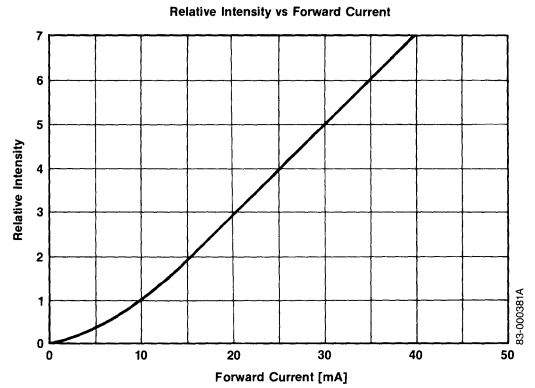
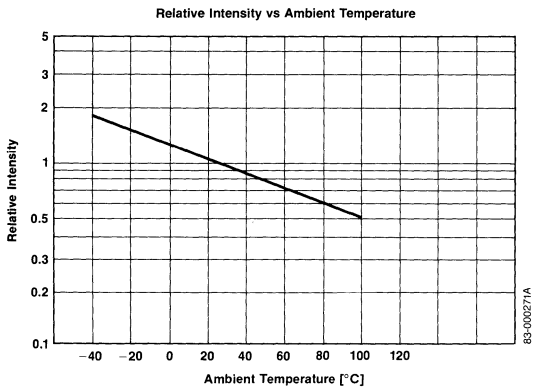
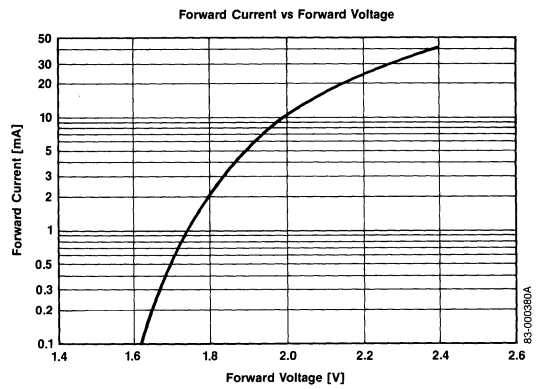
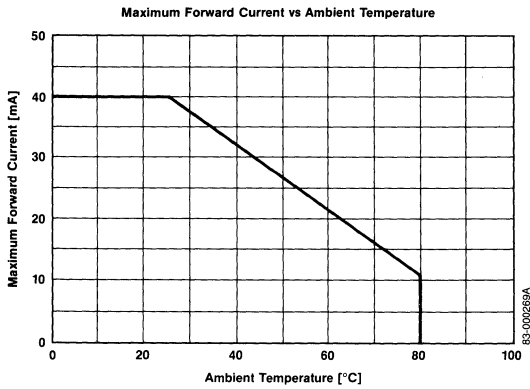


PHOTO COUPLERS

5

Section 5 — Photo Couplers

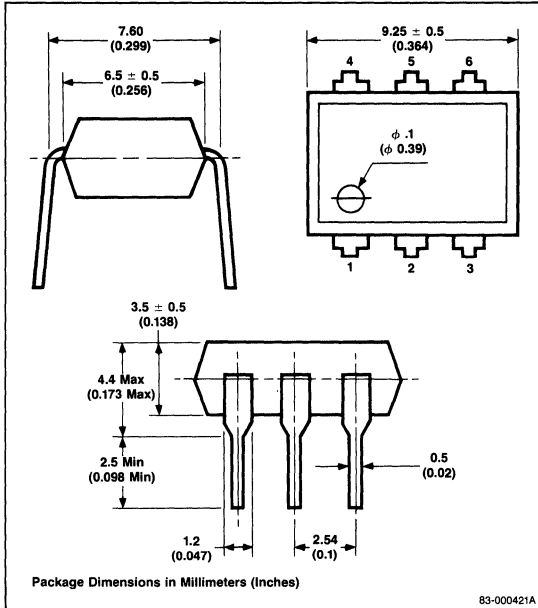
4N25 Photo Coupler, Single Transistor	5-3
6N136 High Speed Photo Coupler	5-7
6N137 High Speed Photo Coupler	5-11
MCT2 Photo Coupler, Single Transistor	5-15
PS2002B Photo Coupler Darlington Transistor	5-19
PS2004B Photo Coupler Darlington Transistor	5-23
PS2005B Photo Coupler High Impact Current Single Transistor	5-27
PS2006B PS2006B(1) High Speed Photo Couplers	5-31
PS2007B High Speed Photo Coupler	5-35
PS2010 Photo Coupler Single Transistor	5-39
PS2021 Photo Coupler High Isolation Voltage Single Transistor	5-43
PS2022 Photo Coupler High Isolation Voltage Darlington Transistor	5-47
PS2401A-1, PS2401A-2, PS2401A-3, S2401A-4 Multichannel Photo Coupler High Isolation Voltage Single Transistors	5-51
PS3001, PS3002 SCR Photo Couplers	5-55
PS3001(1), PS3002(1) SCR Photo Couplers	5-59

Note: All Photo Couplers are UL approved. UL file #E72422.

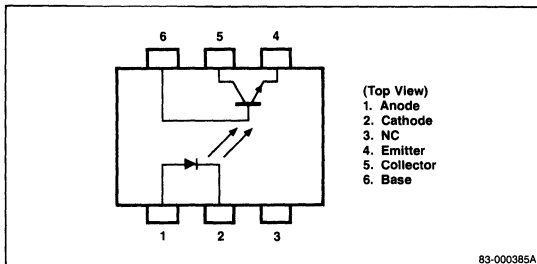
Description

The 4N25 is an optically coupled isolator containing a GaAs light emitting diode and an NPN silicon photo transistor.

Package Dimensions



Pin Connection



Features

- High isolation voltage: 2500V_{DC}
- High transfer ratio: 20% min
- High speed switching: $t_r, t_f = 4\mu s$ typ
- Economical, compact, dual in-line plastic package

Applications

- Interface circuit for various instruments and control equipment
- Chopper circuits
- Computer and peripheral manufacture
- Pulse transformers
- Data communication equipment

Absolute Maximum Ratings

$T_A = +25^\circ C$

Diode	
Reverse Voltage, V_R	5.0V
Forward Current (DC), I_F	80mA
Power Dissipation, P_D	150mW
Peak Forward Current (300 μs , 2% duty cycle), $I_{F(peak)}$	3A
Transistor	
Collector to Emitter Voltage, V_{CEO}	30V
Collector to Base Voltage, V_{CBO}	70V
Emitter to Collector Voltage, V_{ECO}	7V
Collector Current, I_C	100mA
Power Dissipation, P_D	150mW
Isolation Voltage ¹ , BV	2500V _{DC}
Isolation Voltage ¹ , BV	2000V _{AC}
Storage Temperature, T_{STG}	-55°C to +150°C
Operating Temperature, T_{OPT}	-55°C to +100°C
Lead Temperature (Soldering 10s)	260°C
Total Power Dissipation, P_T	250mW

Electrical Characteristics

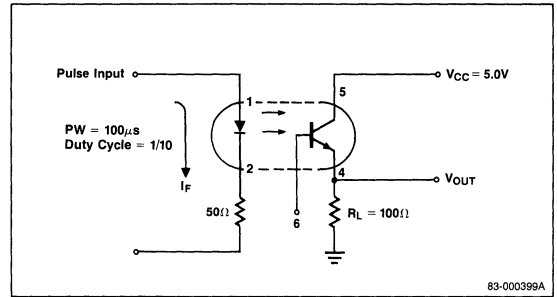
$T_A = +25^{\circ}\text{C}$

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Diode						
Forward Voltage	V_F	1.1	1.4		V	$I_F = 10\text{mA}$
Forward Voltage	V_F	1.2	1.5		V	$I_F = 50\text{mA}$
Reverse Current	I_R			10	μA	$V_R = 5\text{V}$
Junction Capacitance	C		50		pF	$V = 0$, $f = 1.0\text{MHz}$
Transistor						
Collector to Emitter Dark Current	I_{CEO}			50	nA	$V_{CE} = 10\text{V}$, $I_F = 0$
DC Current Gain	h_{FE}		500			$I_C = 2\text{mA}$, $V_{CE} = 5.0\text{V}$
Collector to Emitter Breakdown Voltage	BV_{CEO}	30	60		V	$I_C = 1\text{mA}$, $I_B = 0$
Collector to Base Breakdown Voltage	BV_{CBO}	70	120		V	$I_C = 100\mu\text{A}$, $I_E = 0$
Emitter to Collector Breakdown Voltage	BV_{ECO}	7	9		V	$I_E = 100\mu\text{A}$, $I_B = 0$
Coupled Current Transfer Ratio	CTR (I_C/I_F)		20		%	$I_F = 10\text{mA}$, $V_{CE} = 5.0\text{V}$
Collector Saturation Voltage	$V_{CE(sat)}$			0.3	V	$I_F = 10\text{mA}$, $I_C = 2.0\text{mA}$
Isolation Resistance	R_{1-2}		10^{11}		Ω	$V_{IN-OUT} = 1.0\text{KV}$
Isolation Capacitance	C_{1-2}		0.8		pF	$V = 0$, $f = 1.0\text{MHz}$
Rise Time	t_r		4		μs	$V_{CC} = 5.0\text{V}$, $I_C = 2\text{mA}$, $R_L = 100\Omega^2$
Fall Time	t_f		4		μs	$V_{CC} = 5.0\text{V}$, $I_C = 2\text{mA}$, $R_L = 100\Omega^2$

Notes: 1. Measuring Conditions: DC or AC voltage for 1 min at $T_A = +25^{\circ}\text{C}$, RH = 60% between input (pins 1, 2, and 3 common) and output (pins 4, 5, and 6 common).

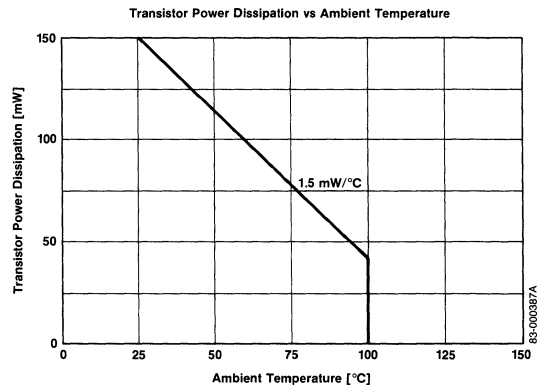
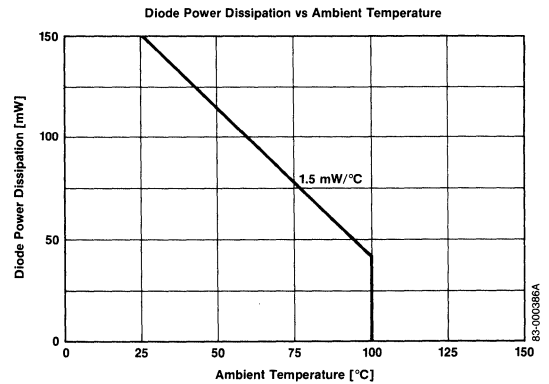
2. Test circuit for switching time.

Test circuit for switching time



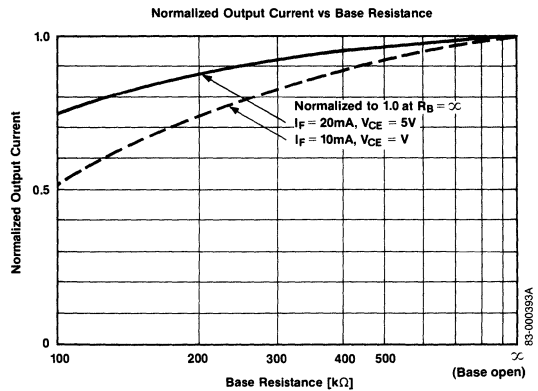
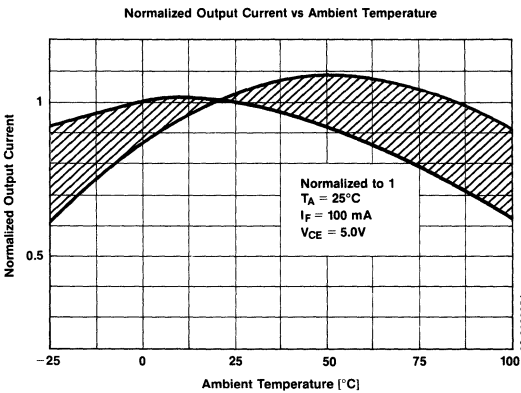
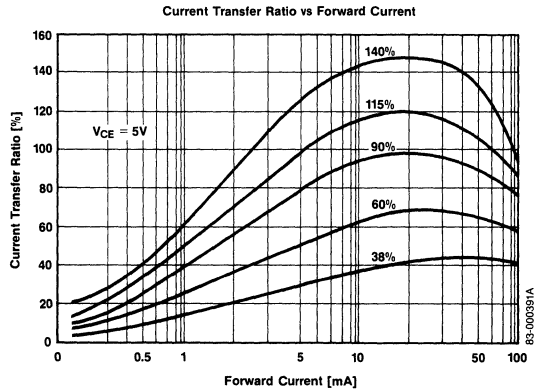
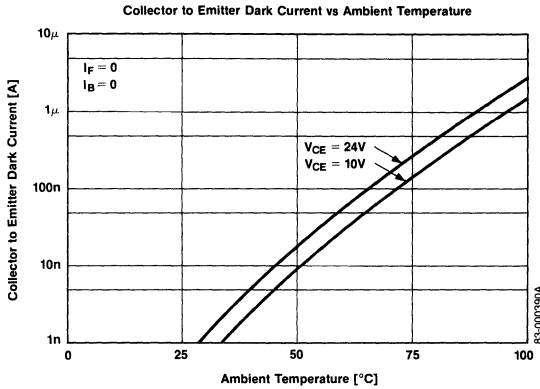
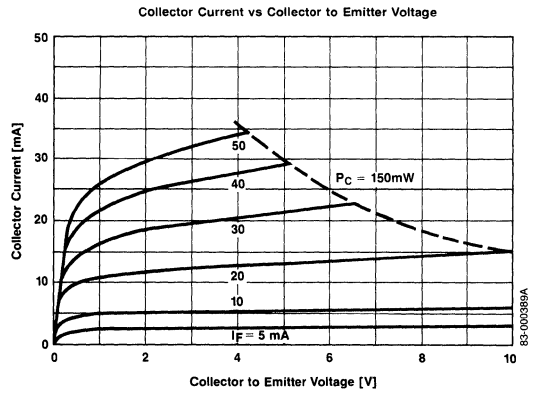
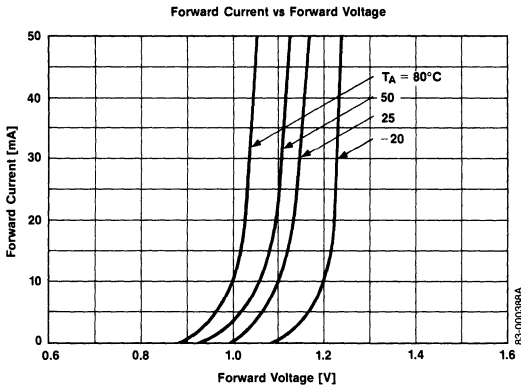
Typical Characteristics

$T_A = +25^{\circ}\text{C}$



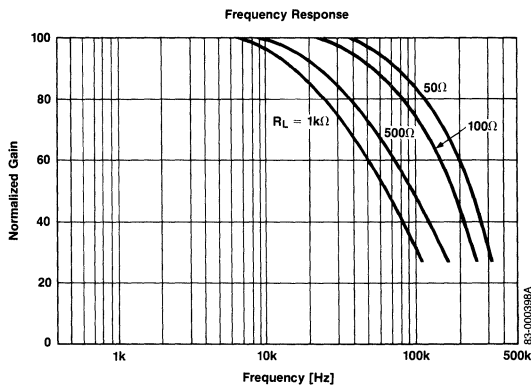
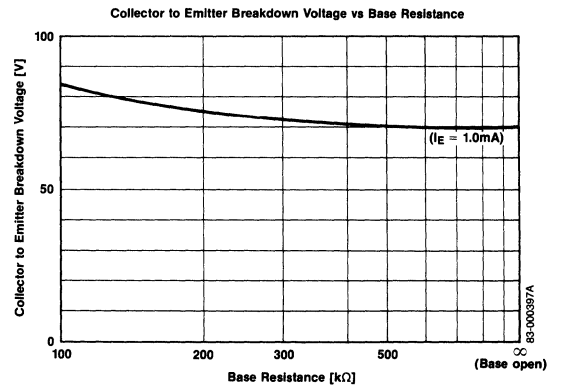
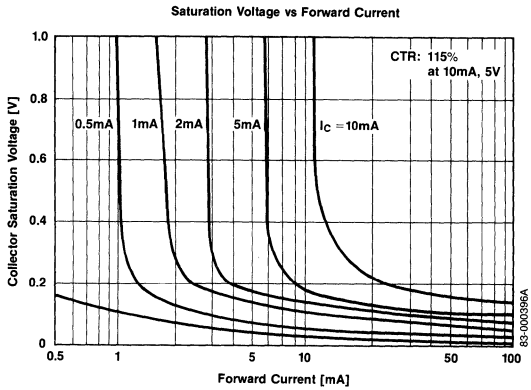
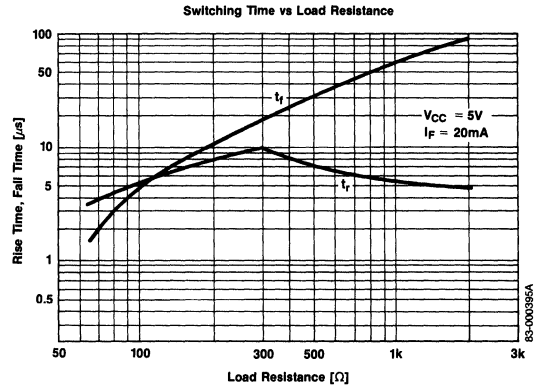
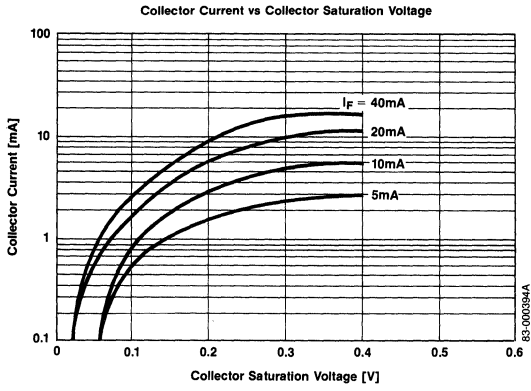
Typical Characteristics (cont)

$T_A = +25^\circ\text{C}$



Typical Characteristics (cont)

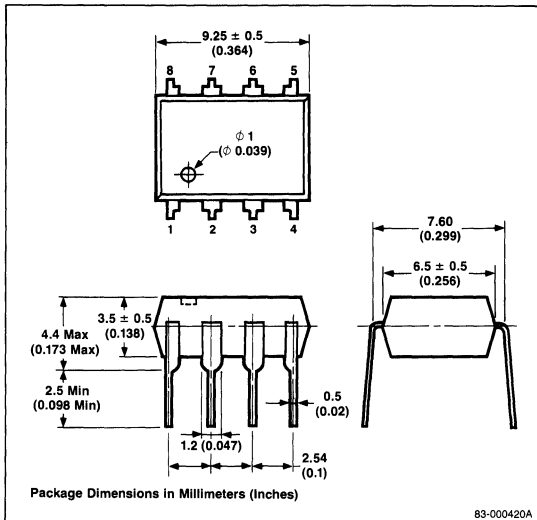
$T_A = +25^\circ\text{C}$



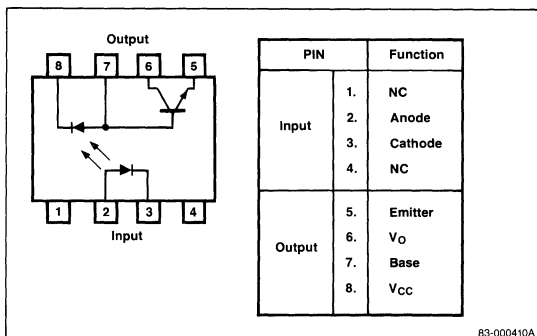
Description

The 6N136 is a high speed photo coupler containing GaAsP light emitting diode and a PN photo diode connected to a high speed transistor. The CTR is 15% min.

Package Dimensions



Pin Connection



Features

- High isolation voltage: 3000V_{DC} min
- High speed response: t_{PHL}, t_{PLH} = 300ns typ
- Compact, dual in-line plastic package

Applications

- Interface circuit for various instruments and control equipment
- Floating power supply feedback networks
- Computer and peripheral manufacture
- Pulse transformers
- High speed digital and analog line receivers

Absolute Maximum Ratings

T_A = +25°C

Diode	
Reverse Voltage, V _R	5V
Forward Current, I _F	25mA
Power Dissipation, P _D	45mW
Detector	
Supply Voltage, V _{CC}	-0.5V to +15V
Output Voltage, V _O	-0.5V to +15V
Output Current, I _O	8mA
Emitter to Base Voltage, V _{EB0}	5V
Power Dissipation, P _D	100mW
Isolation Voltage ¹ , BV	3000V _{DC}
Storage Temperature, T _{STG}	-55°C to +125°C
Operating Temperature, T _{OPT}	-55°C to +100°C

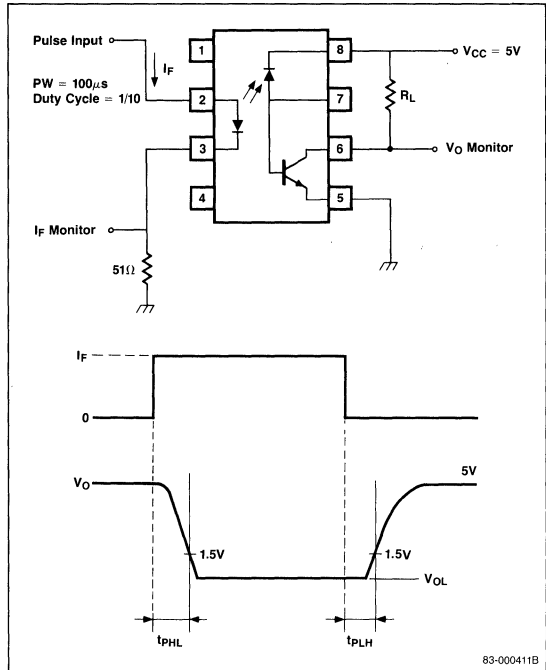
Electrical Characteristics

$T_A = +25^\circ\text{C}$

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Diode						
Forward Voltage	V_F	1.43	1.7		V	$I_F = 16\text{mA}$
Reverse Current	I_R	0.01	10		μA	$V_R = 5\text{V}$
Forward Voltage Temperature Coefficient	$\Delta V_F/\Delta T$	-1.51			$\text{mV}/^\circ\text{C}$	$I_F = 16\text{mA}$
Capacitance	C_T	60			pF	$V = 0, f = 1\text{MHz}$
Detector						
High Level Output Current	I_{OH1}	3	500		nA	$I_F = 0\text{mA}, V_{CC} = 5.5\text{V}, V_O = 5.5\text{V}$
High Level Output Current	I_{OH2}		100		μA	$I_F = 0\text{mA}, V_{CC} = 15\text{V}, V_O = 15\text{V}$
DC Current Gain	h_{FE}	120				$V_O = 5\text{V}, I_O = 3\text{mA}$
Coupled						
Current Transfer Ratio	CTR	15	22		%	$I_F = 16\text{mA}, V_{CC} = 4.5\text{V}, V_O = 0.4\text{V}$
Low Level Output Voltage	V_{OL}	0.1	0.4		V	$I_F = 16\text{mA}, V_{CC} = 4.5\text{V}, I_O = 2.4\text{mA}$
Low Level Supply Current	I_{CCL}	50			μA	$I_F = 16\text{mA}, V_O = \text{Open}, V_{CC} = 15\text{V}$
High Level Supply Current	I_{CCH}	0.01	1		μA	$I_F = 0\text{mA}, V_O = \text{Open}, V_{CC} = 15\text{V}$
Isolation Resistance	R_{1-2}	10^{12}			Ω	$V_{IN-OUT} = 1\text{kV}$
Isolation Capacitance	C_{1-2}	0.7			pF	$V = 0, f = 1\text{MHz}$
Propagation Delay Time to Low Output Level	t_{PHL}^2	0.3/ .05	0.8/ 1.5		μs	$I_F = 16\text{mA}, V_{CC} = 5\text{V}, R_L = 1.9\text{k}\Omega/4.1\text{k}\Omega$
Propagation Delay Time to High Output Level	t_{PLH}^2	0.3/ .05	0.8/ 1.5		μs	$I_F = 16\text{mA}, V_{CC} = 5\text{V}, R_L = 1.9\text{k}\Omega/4.1\text{k}\Omega$

- Notes:** 1. Measuring Conditions: DC voltage for 1 min at $T_A = +25^\circ\text{C}$, RH = 60% between input (pins 1, 2, 3, and 4 common) and output (pins 5, 6, 7, and 8 common).
 2. Measuring circuit.

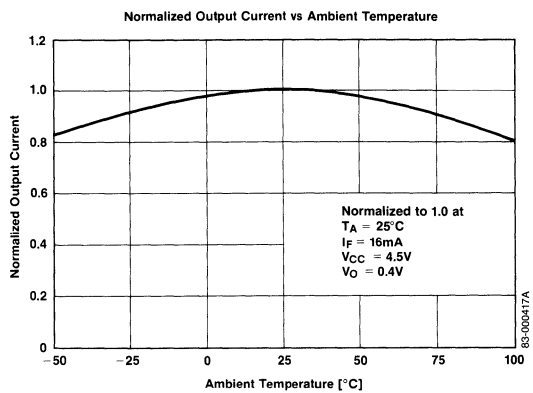
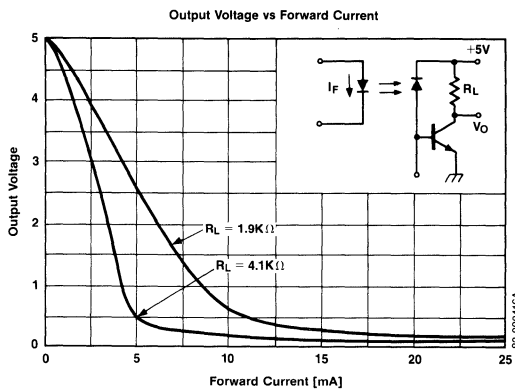
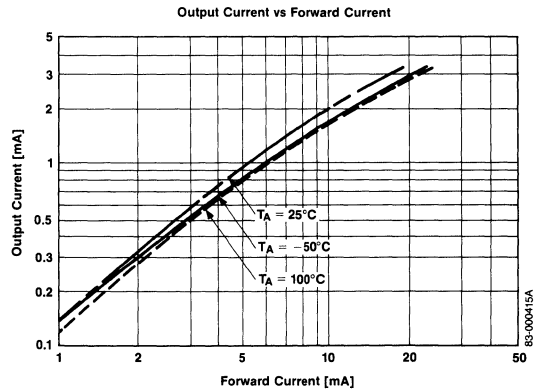
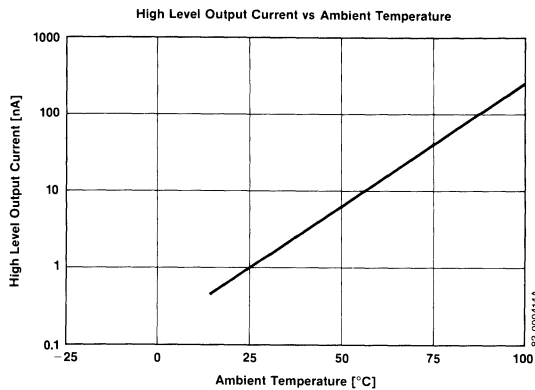
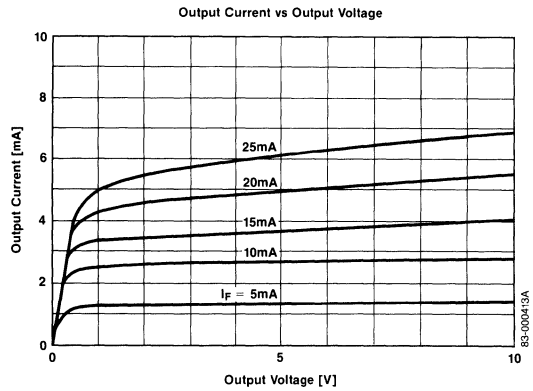
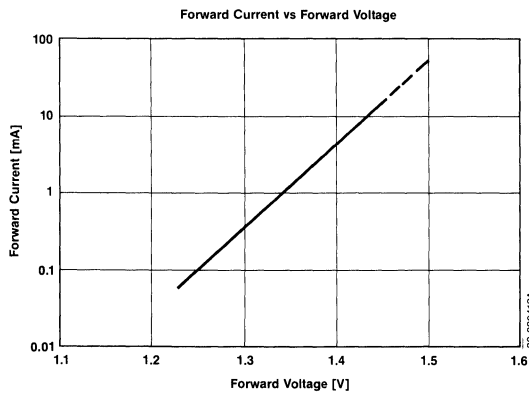
Measuring circuit



83-000411B

Typical Characteristics

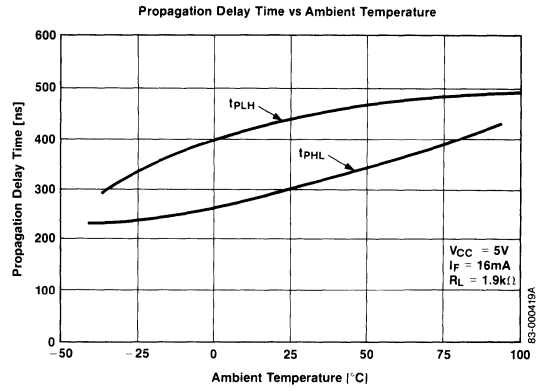
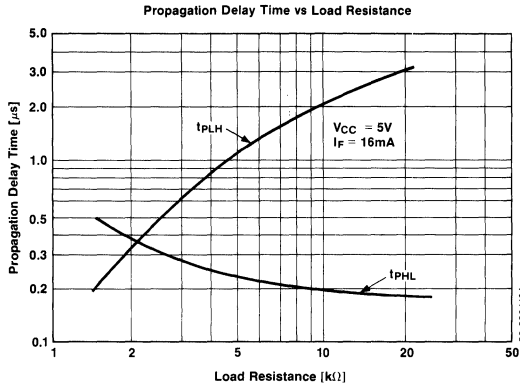
$T_A = +25^\circ\text{C}$



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Typical Characteristics (cont)

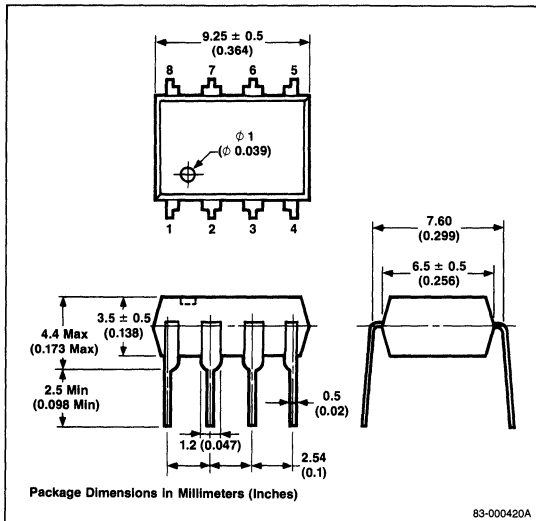
$T_A = +25^\circ\text{C}$



Description

The 6N137 is a high speed photo coupler containing a GaAsP light emitting diode and an integrated detector consisting of a photo diode and a high gain linear amplifier that drives a Schottky clamped open collector output transistor in a plastic DIP (Dual In-line Package).

Package Dimensions



Features

- Ultra high speed (50ns typ)
- High isolation voltage (3000V_{DC} min)
- Low input current requirement (5mA)
- Economical, compact, plastic dual in-line package
- TTL compatible (5V supply)

Applications

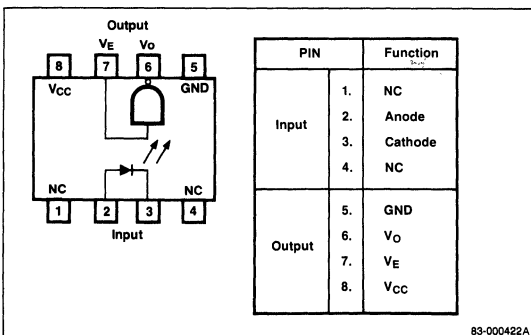
- Line receiver
- Floating power supply
- Computer and peripheral memory
- Replaceable with mechanical relays and reed relays
- Replaceable with pulse transformer

Absolute Maximum Ratings

T_A = +25°C

Diode	
Reverse Voltage, V _R	5V
Forward Current, I _F	10mA
Detector	
Supply Voltage, V _{CC}	7V
Output Voltage, V _O	7V
Output Current, I _O	50mA
Enable Voltage, V _E	5.5V
Power Dissipation, P _D	85mW
Isolation Voltage, BV ¹	3000V _{DC}
Storage Temperature, T _{STG}	-55°C to +125°C
Operating Temperature, T _{OPR}	0°C to +70°C

Pin Connection



Electrical Characteristics

$T_A = 0 \text{ to } +75^\circ\text{C}$

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Diode						
Forward Voltage	V_F	1.42	1.7		V	$I_F = 10\text{mA}$, $T_A = 25^\circ\text{C}$
Reverse Current	I_R	0.01	10		μA	$V_R = 5\text{V}$, $T_A = 25^\circ\text{C}$
Capacitance	C_T	60			pF	$V = 0$, $f = 1.0\text{MHz}$
Detector						
High Level Enable Current	I_{EH}	-0.8			mA	$V_{CC} = 5.5\text{V}$, $V_{EH} = 2.0\text{V}$
Low Level Enable Current	I_{EL}	-1.2	-2.0		mA	$V_{CC} = 5.5\text{V}$, $V_{EL} = 0.5\text{V}$
Coupled						
High Level Output Current	I_{OH}	30	250		μA	$V_{CC} = 5.5\text{V}$, $V_O = 5.5\text{V}$, $I_F = 250\mu\text{A}$, $V_E = 2.0\text{V}$
Low Level Output Voltage	V_{OL}	0.4	0.6		V	$V_{CC} = 5.5\text{V}$, $V_E = 2.0\text{V}$, $I_F = 5\text{mA}$, $I_O = 13\text{mA}$
Low Level Supply Current	I_{CCL}	10	18		mA	$V_{CC} = 5.5\text{V}$, $V_E = 2\text{V}$, $I_F = 10\text{mA}$
High Level Supply Current	I_{CCH}	7	15		mA	$V_{CC} = 5.5\text{V}$, $V_E = 0.5\text{V}$, $I_F = 0\text{mA}$

Electrical Characteristics (cont)

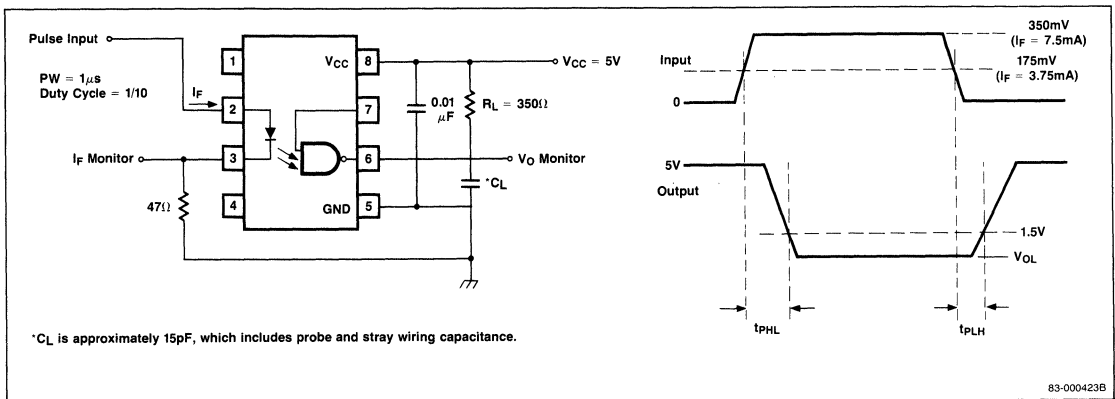
$T_A = +25^\circ\text{C}$

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Coupled						
Current Transfer Ratio	CTR	600			%	$I_F = 5\text{mA}$, $V_{CC} = 5\text{V}$, $R_L = 100\Omega$
Isolation Resistance	R_{I-2}	10^{12}			Ω	$V_{IN-OUT} = 1\text{kV}$
Isolation Capacitance	C_{I-2}	0.7			pF	$V = 0$, $f = 1\text{MHz}$
Propagation Delay Time to Low Output Level	t_{PHL}^2	50	75		ns	$I_F = 7.5\text{mA}$, $V_{CC} = 5\text{V}$, $R_L = 350\Omega$, $C_L = 15\text{pF}$
Propagation Delay Time to High Output Level	t_{PLH}^2	50	75		ns	
Propagation Delay Time of Enable to Low Output Level	t_{EHL}	15			ns	$I_F = 7.5\text{mA}$, $V_{CC} = 5\text{V}$, $R_L = 350\Omega$, $V_{EH} = 3\text{V}$, $C_L = 15\text{pF}$
Propagation Delay Time of Enable to High Output Level	t_{ELH}	30			ns	

Notes: 1. Measuring conditions: DC voltage for 1 min at $T_A = 25^\circ\text{C}$, $R_H = 60\%$ between input (pins 1, 2, 3, 4 common) and output (pins 5, 6, 7, 8 common)

2. Measuring circuit

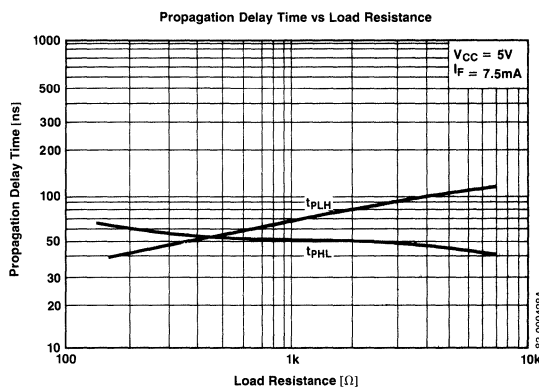
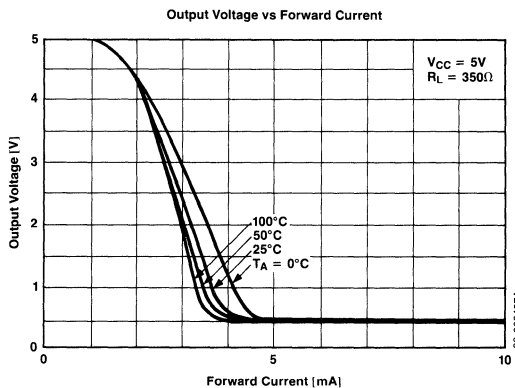
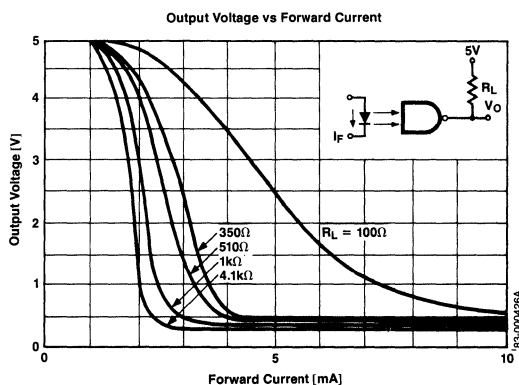
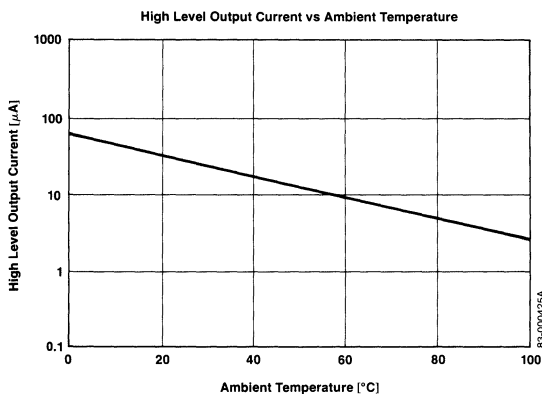
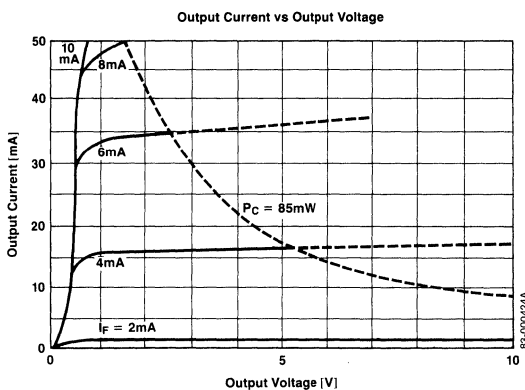
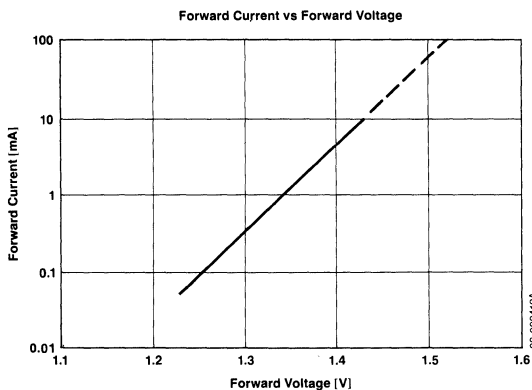
Measuring circuit



83-000423B

Typical Characteristics

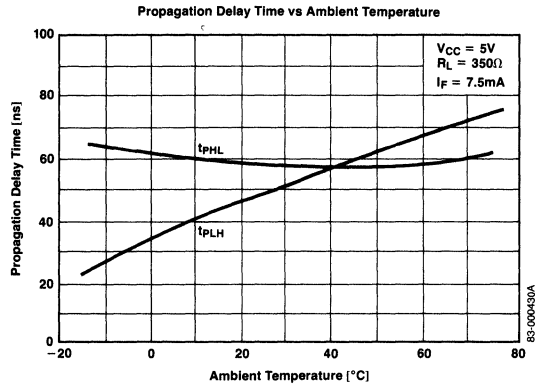
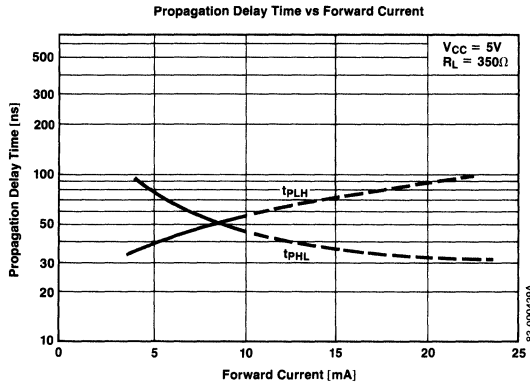
$T_A = +25^\circ\text{C}$



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Typical Characteristics (cont)

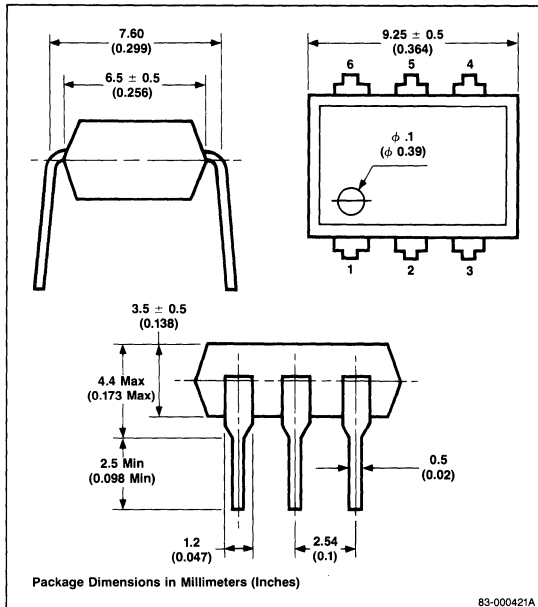
$T_A = +25^\circ\text{C}$



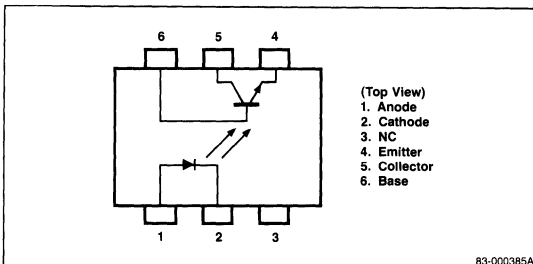
Description

The MCT2 is an optically coupled isolator containing a GaAs light emitting diode and an NPN silicon photo transistor.

Package Dimensions



Pin Connection



Features

- High isolation voltage: 2000V_{AC}, 2500V_{DC}
- High transfer ratio: 20% min
- High speed switching: $t_r, t_f = 4\mu s$ typ
- Economical, compact, dual in-line plastic package

Applications

- Interface circuit for various instruments and control equipment
- Chopper circuits
- Computer and peripheral manufacture
- Pulse transformers
- Data communication equipment

Absolute Maximum Ratings

$T_A = +25^\circ C$

Diode	
Reverse Voltage, V_R	5.0V
Forward Current (DC), I_F	80mA
Power Dissipation, P_D	150mW
Peak Forward Current (300 μs , 2% duty cycle), $I_{F(peak)}$	3A
Transistor	
Collector to Emitter Voltage, V_{CEO}	30V
Collector to Base Voltage, V_{CBO}	70V
Emitter to Collector Voltage, V_{ECO}	7V
Collector Current, I_C	100mA
Power Dissipation, P_D	150mW
Isolation Voltage ¹ , BV	2500V _{DC}
Isolation Voltage ¹ , BV	2000V _{AC}
Storage Temperature, T_{STG}	-55°C to +150°C
Operating Temperature, T_{OPT}	-55°C to +100°C
Lead Temperature (Soldering 10s)	260°C
Total Power Dissipation, P_T	250mW

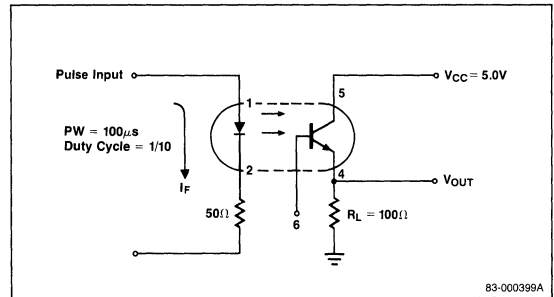
Electrical Characteristics

$T_A = +25^{\circ}\text{C}$

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Diode						
Forward Voltage	V_F		1.1	1.4	V	$I_F = 10\text{mA}$
Forward Voltage	V_F		1.2	1.5	V	$I_F = 50\text{mA}$
Reverse Current	I_R			10	μA	$V_R = 5\text{V}$
Junction Capacitance	C		50		pF	$V = 0$, $f = 1.0\text{MHz}$
Transistor						
Collector to Emitter Dark Current	I_{CEO}			50	nA	$V_{CE} = 10\text{V}$, $I_F = 0$
DC Current Gain	h_{FE}		700			$I_C = 2\text{mA}$, $V_{CE} = 5.0\text{V}$
Collector to Emitter Breakdown Voltage	BV_{CEO}	30	60		V	$I_C = 1\text{mA}$, $I_B = 0$
Collector to Base Breakdown Voltage	BV_{CBO}	70	120		V	$I_C = 100\mu\text{A}$, $I_E = 0$
Emitter to Collector Breakdown Voltage	BV_{ECO}	7	9		V	$I_E = 100\mu\text{A}$, $I_B = 0$
Coupled Current Transfer Ratio ²	CTR (I_C/I_F)	20			%	$I_F = 10\text{mA}$, $V_{CE} = 5.0\text{V}$
Collector Saturation Voltage	$V_{CE(sat)}$			0.3	V	$I_F = 10\text{mA}$, $I_C = 2.0\text{mA}$
Isolation Resistance	R_{1-2}	10^{11}			Ω	$V_{IN-OUT} = 1.0\text{kV}$
Isolation Capacitance	C_{1-2}		0.8		pF	$V = 0$, $f = 1.0\text{MHz}$
Rise Time ³	t_r		4		μs	$V_{CC} = 5.0\text{V}$, $I_C = 2\text{mA}$, $R_L = 100\Omega$
Fall Time ³	t_f		4		μs	$V_{CC} = 5.0\text{V}$, $I_C = 2\text{mA}$, $R_L = 100\Omega$

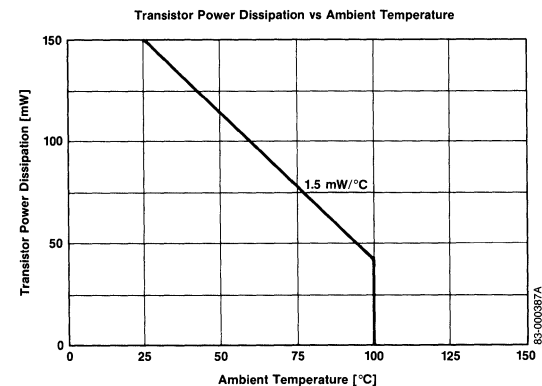
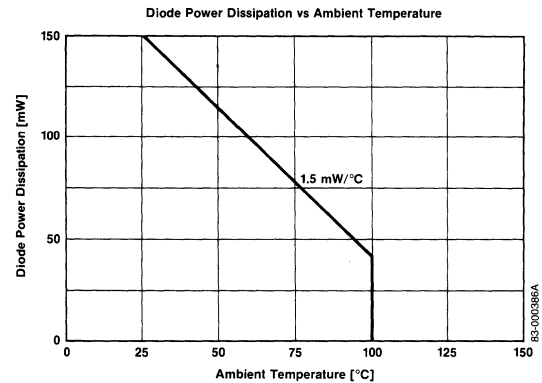
- Notes:**
1. Measuring Conditions: DC or AC voltage for 1 min at $T_A = +25^{\circ}\text{C}$, RH = 60% between input (pins 1, 2, and 3 common) and output (pins 4, 5, and 6 common).
 2. CTR rank: K: 80% ~ 210%, L: 50% ~ 110%, M: 20% ~ 70%.
 3. Test circuit for switching time.

Test circuit for switching time



Typical Characteristics

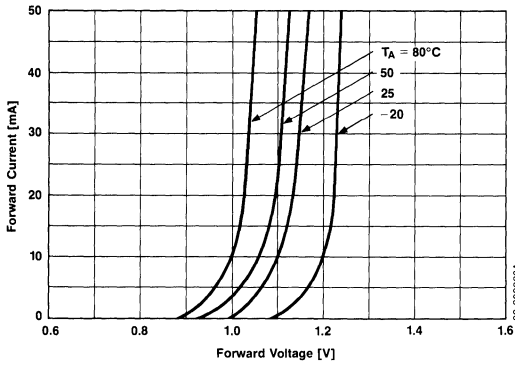
$T_A = +25^{\circ}\text{C}$



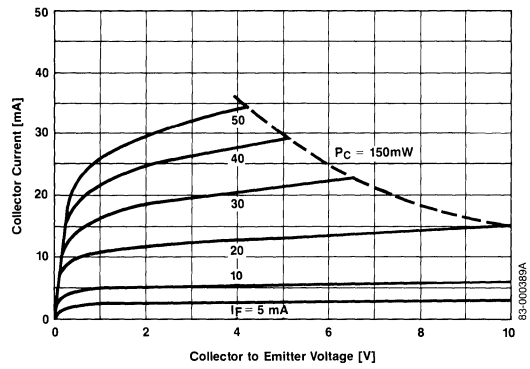
Typical Characteristics (cont)

$T_A = +25^\circ\text{C}$

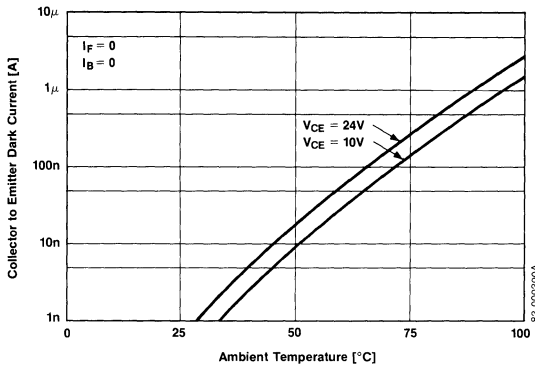
Forward Current vs Forward Voltage



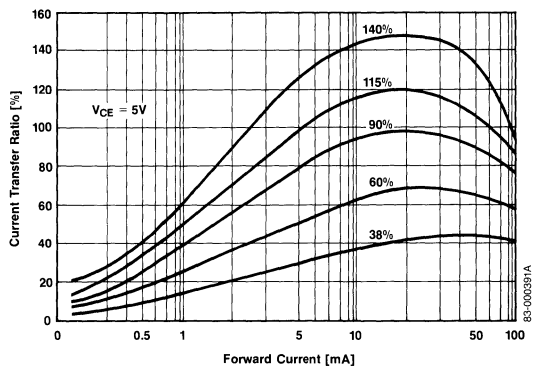
Collector Current vs Collector to Emitter Voltage



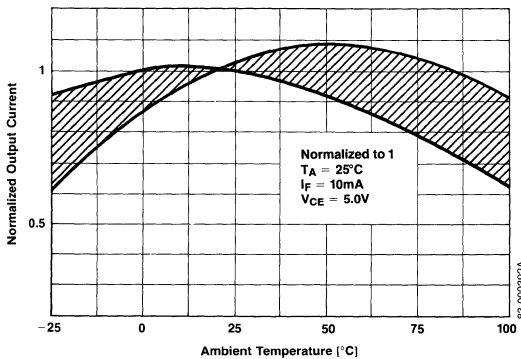
Collector to Emitter Dark Current vs Ambient Temperature



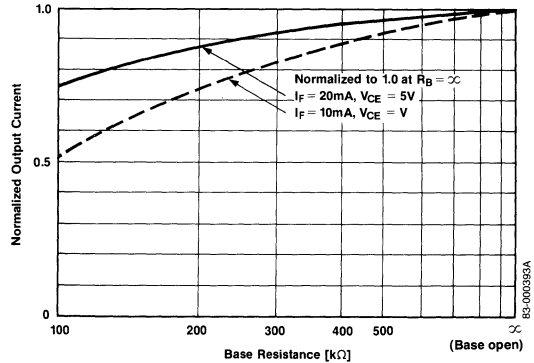
Current Transfer Ratio vs Forward Current



Normalized Output Current vs Ambient Temperature

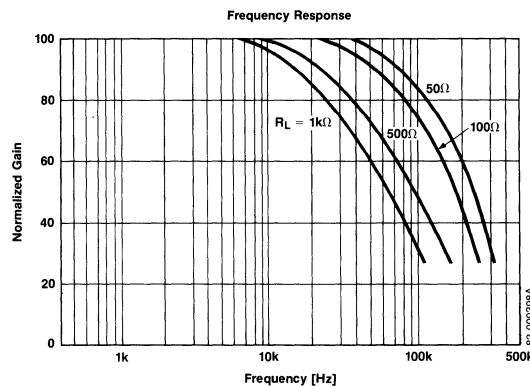
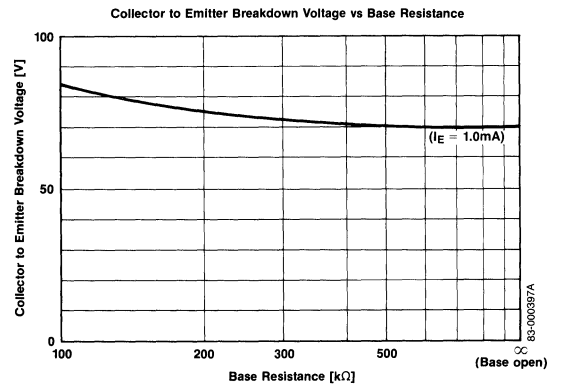
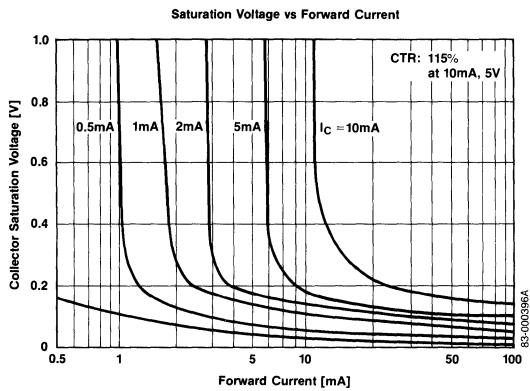
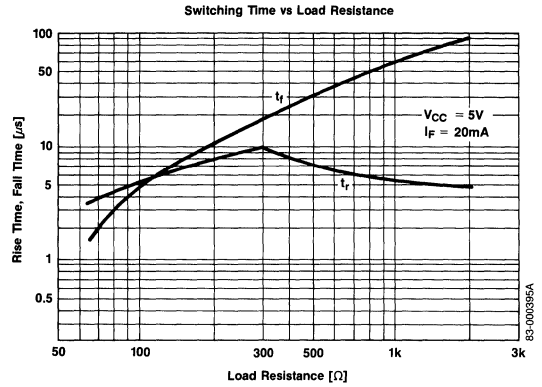
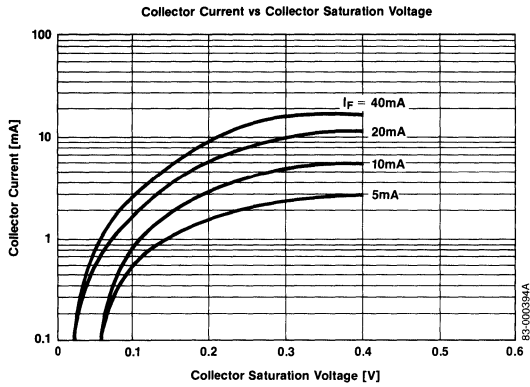


Normalized Output Current vs Base Resistance



Typical Characteristics (cont)

$T_A = +25^\circ\text{C}$



Description

The PS2002B is an optically coupled isolator containing a GaAsP light emitting diode and an NPN silicon Darlington-connected photo transistor.

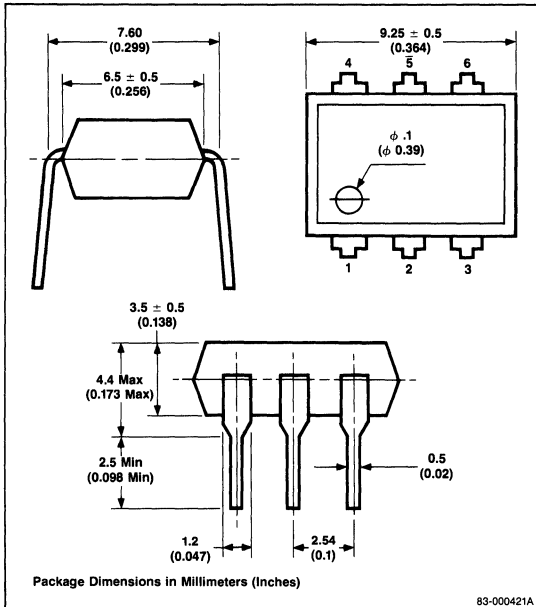
Features

- High-voltage isolation: 2500V_{DC} min
- High transfer ratio: 100% min
- Economical, compact, plastic dual in-line package

Applications

- ECR
- Automat
- Replacement of pulse transformers
- Replacement of mechanical and reed relays

Package Dimensions

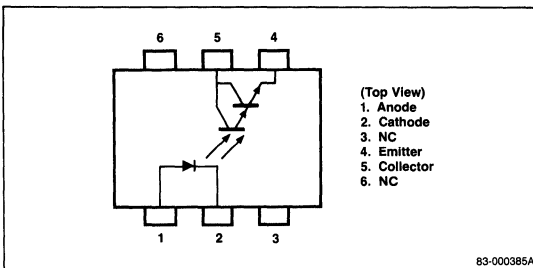


Absolute Maximum Ratings

T_A = +25°C

Diode	
Reverse Voltage, V _R	7.0V
Forward Current, I _F	50mA
Power Dissipation, P _D	100mW
Transistor	
Collector to Emitter Voltage, V _{CEO}	40V
Collector Current, I _C	50mA
Power Dissipation, P _D	100mW
Isolation Voltage ¹ , BV	2500V _{DC}
Storage Temperature, T _{STG}	-55°C to +125°C
Operating Temperature, T _{OPT}	-55°C to +100°C

Pin Connection



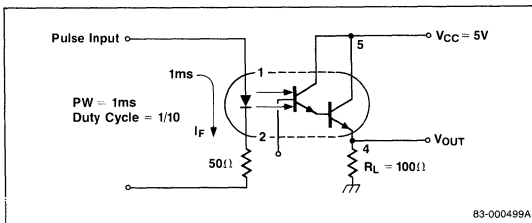
Electrical Characteristics

T_A = +25°C

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Diode						
Forward Voltage	V _F			1.9	V	I _F = 5.0mA
Reverse Current	I _R			2.0	μA	V _R = 4.0V
Junction Capacitance	C		100		pF	V = 0, f = 1.0MHz
Transistor						
Collector to Emitter Dark Current	I _{CEO}			400	nA	V _{CE} = 10V, I _F = 0
DC Current Gain	h _{FE}		5000			I _C = 4.0mA, V _{CE} = 2.0V
Coupled						
Current Transfer Ratio	CTR (I _C /I _F)	100			%	I _F = 5.0mA, V _{CE} = 2.0V
Collector Saturation Voltage	V _{CE(sat)}			1.2	V	I _F = 5.0mA, I _C = 2.0mA
Isolation Resistance	R ₁₋₂	10 ¹¹			Ω	V _{IN-OUT} = 1.0kV
Isolation Capacitance	C ₁₋₂		0.8		pF	V = 0, f = 1.0MHz
Rise Time ²	t _r		100		μs	V _{CC} = 5.0V, I _F = 10mA, R _L = 100Ω
Fall Time ²	t _f		120		μs	V _{CC} = 5.0V, I _F = 10mA, R _L = 100Ω

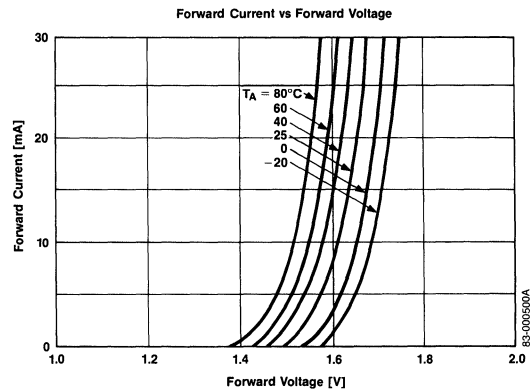
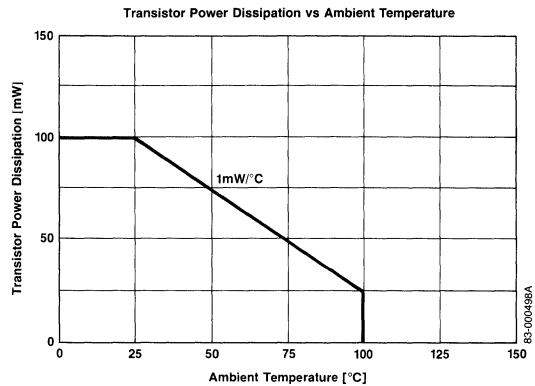
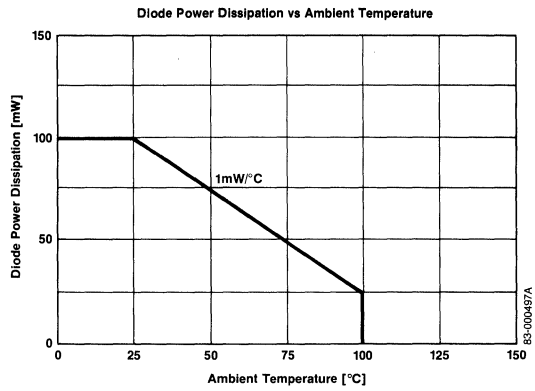
- Notes: 1. Measuring Conditions: DC or AC voltage for 1 min at T_A = +25°C, RH = 60% between input (pins 1, 2, and 3 common) and output (pins 4, 5, and 6 common).
 2. Test circuit for switching time.

Test circuit for switching time



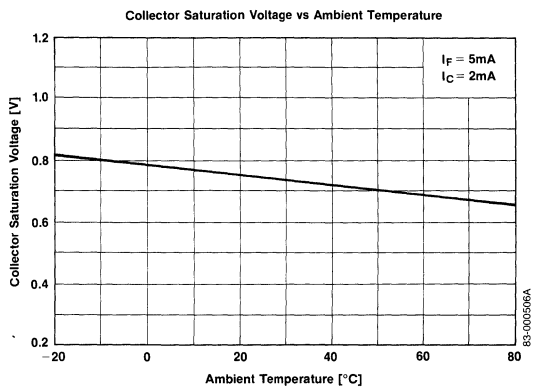
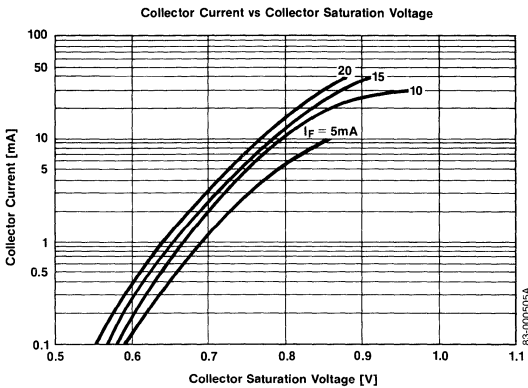
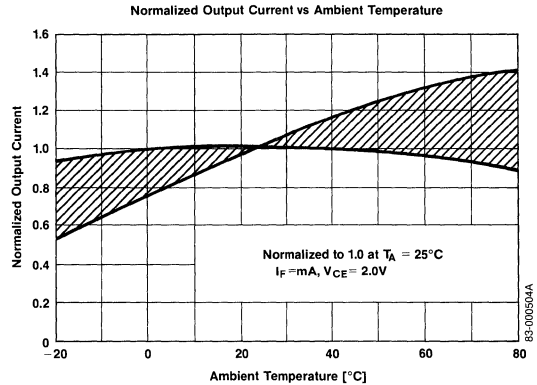
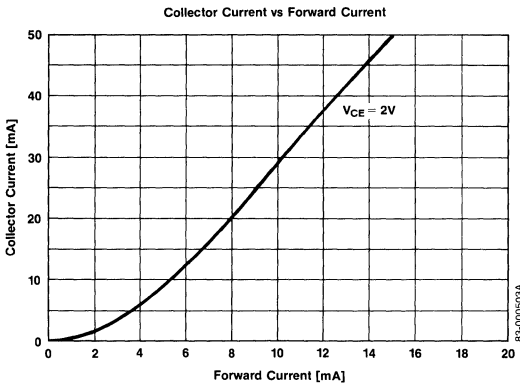
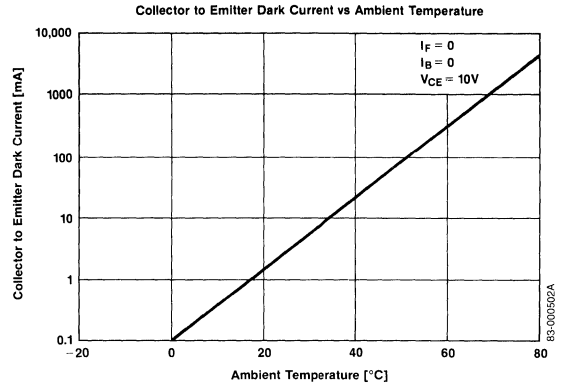
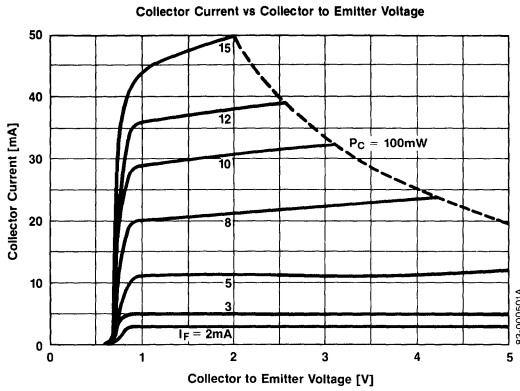
Typical Characteristics

T_A = +25°C



Typical Characteristics (cont)

$T_A = +25^\circ\text{C}$

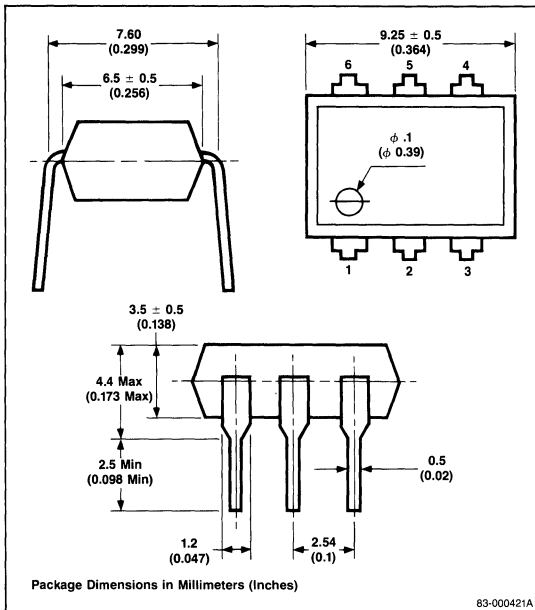


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Description

The PS2004B is an optically coupled isolator containing a GaAs light emitting diode and an NPN silicon Darlington photo transistor in a plastic DIP (Dual In-line Package).

Package Dimensions



Features

- High-voltage isolation: 2500V min
- Ultra high transfer ratio: 1300% min
- High output current: 200mA max
- Economical, compact, plastic dual in-line package

Applications

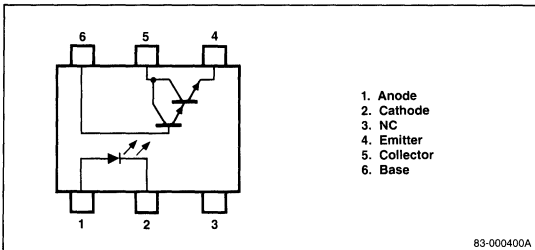
- Copy machine
- Replacement for mechanical and reed relays
- Replacement of pulse transformers

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Diode	
Reverse Voltage, V_R	5.0V
Forward Current, I_F	50mA
Power Dissipation, P_D	100mW
Transistor	
Collector to Emitter Voltage, V_{CE0}	30V
Collector Current, I_C	200mA
Power Dissipation, P_D	200mW
Total Power Dissipation, P_{TOTAL}	250mW
Isolation Voltage ¹ , BV	2500V _{DC}
Isolation Voltage ¹ , BV	2000V _{AC} (rms)
Storage Temperature, T_{STG}	-55°C to +125°C
Operating Temperature, T_{OPT}	-55°C to +100°C

Pin Connection



Electrical Characteristics

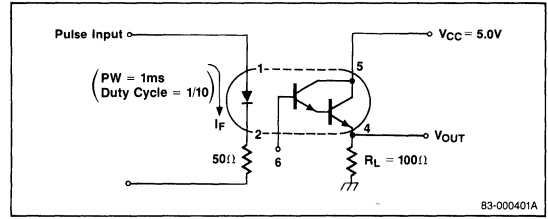
T_A = 25°C

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Diode						
Forward Voltage	V _F		1.4		V	I _F = 20mA
Reverse Current	I _R		5.0		μA	V _R = 4.0V
Junction Capacitance	C	100			pF	V = 0, f = 1.0MHz
Transistor						
Collector to Emitter Dark Current	I _{CEO}		400		nA	V _{CE} = 10V, I _F = 0
Coupled						
Current Transfer Ratio	CTR (I _C /I _F)	1300			%	I _F = 5.0mA, V _{CE} = 2.0V
Collector Saturation Voltage	V _{CE(sat)}		1.2		V	I _F = 5.0mA, I _C = 2.0mA
Isolation Resistance	R ₁₋₂	10 ¹¹			Ω	V _{IN-OUT} = 1.0kV
Isolation Capacitance	C ₁₋₂	0.8			pF	V = 0, f = 1.0MHz
Rise Time	t _r	100			μs	V _{CC} = 5.0V, I _F = 5.0mA, R _L = 100Ω ²
Fall Time	t _f	250			μs	V _{CC} = 5.0V, I _F = 5.0mA, R _L = 100Ω ²

Notes: 1. Measuring Conditions: DC or AC voltage for 1 min at T_A = +25°C, RH = 60% between input (pins 1, 2, and 3 common) and output (pins 4, 5, and 6 common).

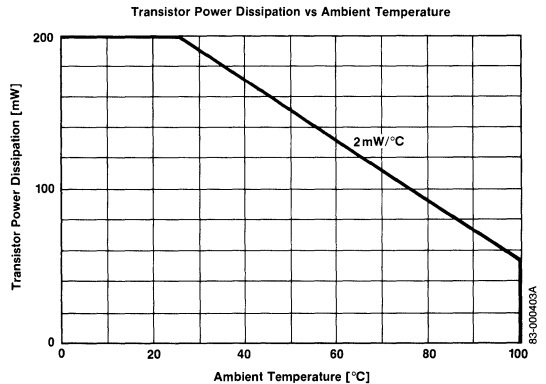
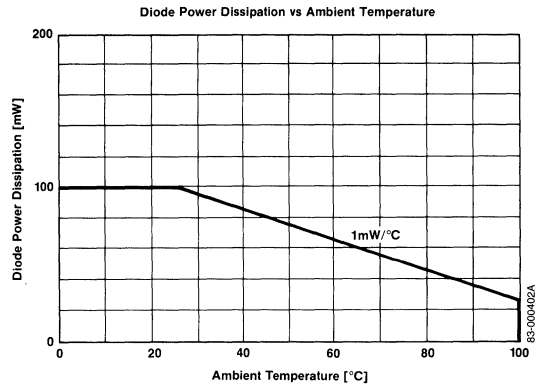
2. Test circuit for switching time.

Test circuit for switching time



Typical Characteristics

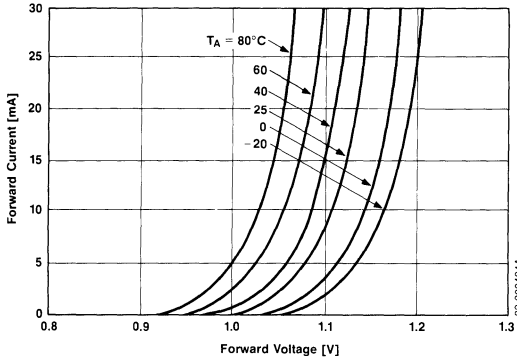
T_A = +25°C



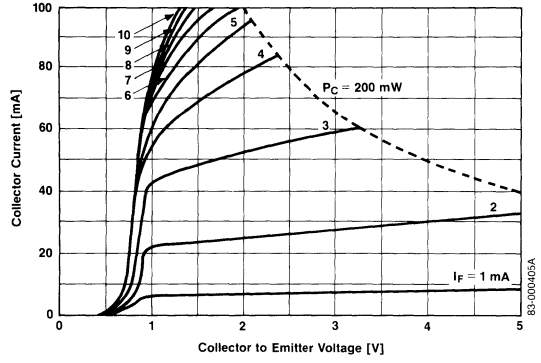
Typical Characteristics (cont)

$T_A = +25^\circ\text{C}$

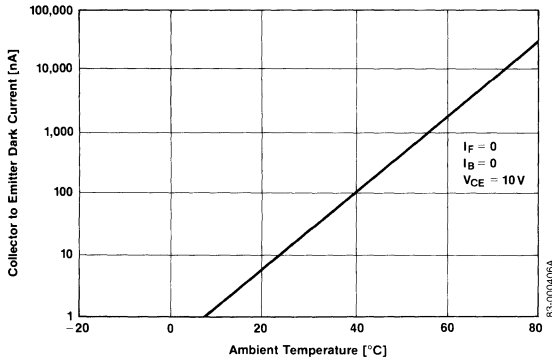
Forward Current vs Forward Voltage



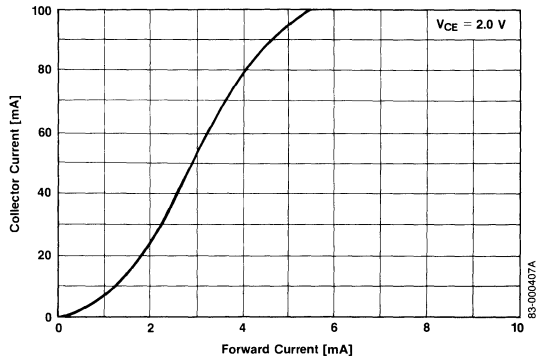
Collector Current vs Collector to Emitter Voltage



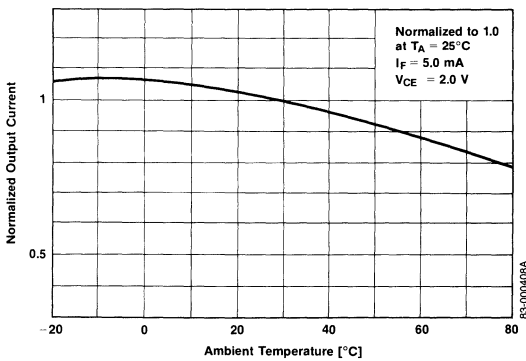
Collector to Emitter Dark Current vs Ambient Temperature



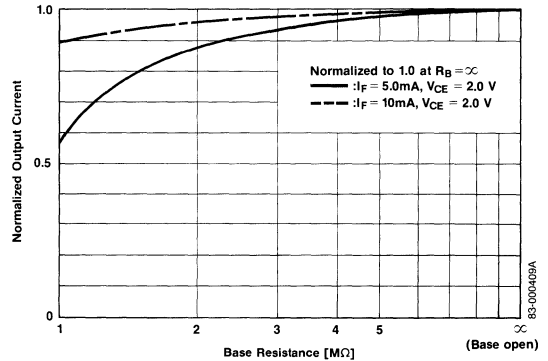
Collector Current vs Forward Current



Normalized Output Current vs Ambient Temperature



Normalized Output Current vs Base Resistance

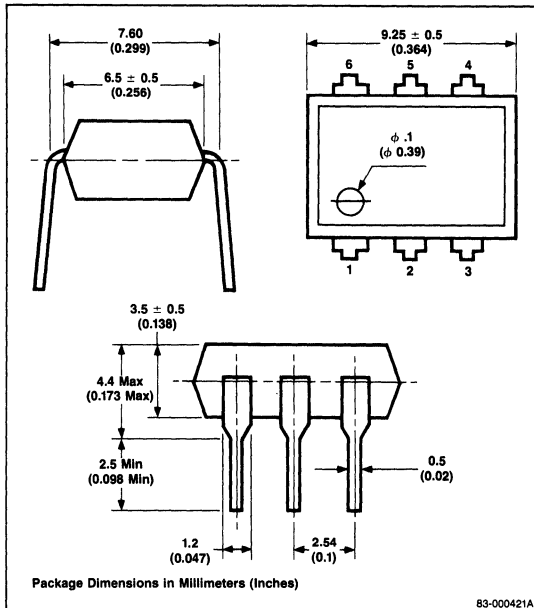


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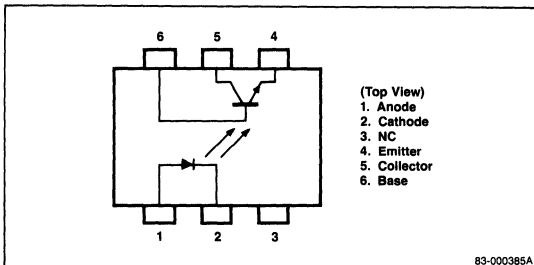
Description

The PS2005B is an optically coupled isolator containing a GaAsP light emitting diode and an NPN silicon photo transistor.

Package Dimensions



Pin Connection



Features

- High-voltage isolation: 2500V
- Large forward input (current): 150mA max
- High transfer ratio: 10% min
- High speed switching: $t_r, t_f = 5\mu s$ typ
- Economical, compact, dual in-line plastic package

Applications

- Telephone/telegraph line receivers
- Replacement for reed relays

Absolute Maximum Ratings

$T_A = +25^\circ C$

Diode	
Reverse Voltage, V_R	7.0V
Forward Current, I_F	150mA
Power Dissipation, P_D	200mW
Transistor	
Collector to Emitter Voltage, V_{CEO}	30V
Collector Current, I_C	50mA
Power Dissipation, P_D	150mW
Total Power Dissipation, P_{TOTAL}	250mW
Isolation Voltage ¹ , BV	2500V _{DC}
Isolation Voltage ¹ , BV	2000V _{AC (rms)}
Storage Temperature, T_{STG}	-55°C to +125°C
Operating Temperature, T_{OPT}	-55°C to +100°C

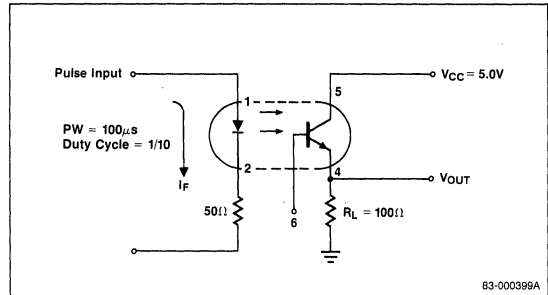
Electrical Characteristics

T_A = +25°C

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Diode						
Forward Voltage	V _F		2.0		V	I _F = 100mA
Reverse Current	I _R			5.0	μA	V _R = 4.0V
Junction Capacitance	C		250		pF	V = 0, f = 1.0MHz
Transistor						
Collector to Emitter Dark Current	I _{CEO}			200	nA	V _{CE} = 10V, I _F = 0
DC Current Gain	h _{FE}		400			I _C = 4.0mA, V _{CE} = 5.0V
Coupled						
Current Transfer Ratio	CTR (I _C /I _F)	10			%	I _F = 100mA, V _{CE} = 5.0V
Collector Saturation Voltage	V _{CE(sat)}		0.3		V	I _F = 100mA, I _C = 4.0mA
Isolation Resistance	R ₁₋₂	10 ¹¹			Ω	V _{IN-OUT} = 1.0kV
Isolation Capacitance	C ₁₋₂	0.8			pF	V = 0, f = 1.0MHz
Rise Time	t _r		5.0		μs	V _{CC} = 5.0V, I _F = 100mA, R _L = 100Ω ²
Fall Time	t _f		5.0		μs	V _{CC} = 5.0V, I _F = 100mA, R _L = 100Ω ²

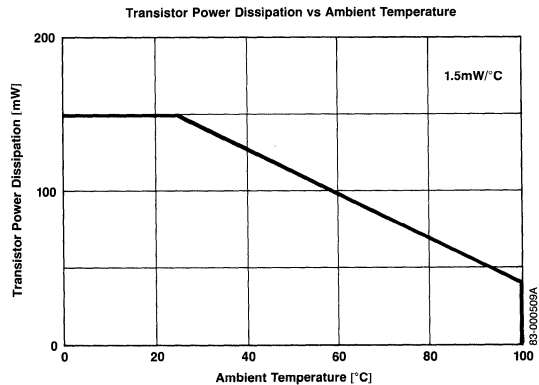
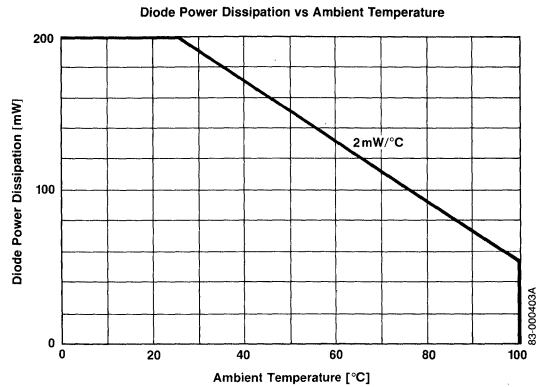
- Notes:**
1. Measuring Conditions: DC or AC voltage for 1 min at T_A = +25°C, RH = 60% between input (pins 1, 2, and 3 common) and output (pins 4, 5, and 6 common).
 2. Test circuit for switching time.

Test circuit for switching time



Typical Characteristics

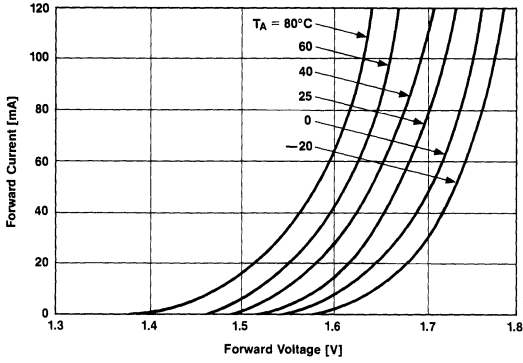
T_A = +25°C



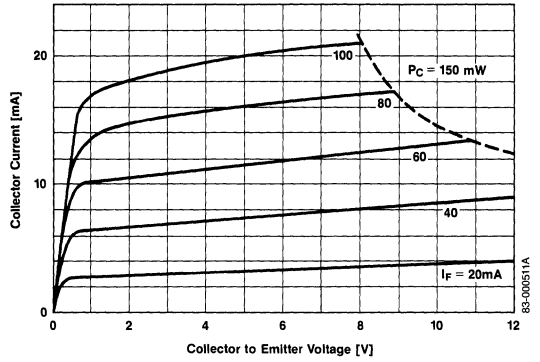
Typical Characteristics (cont)

$T_A = +25^\circ\text{C}$

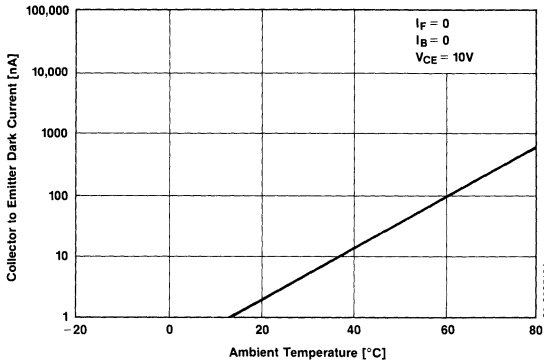
Forward Current vs Forward Voltage



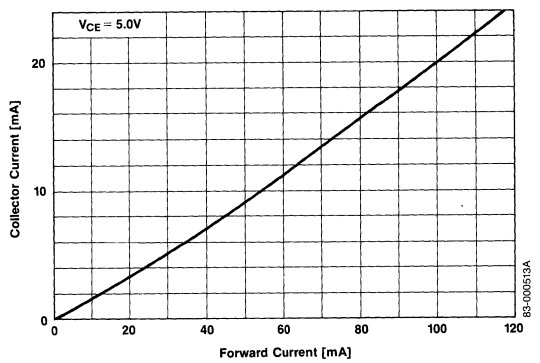
Collector Current vs Collector to Emitter Voltage



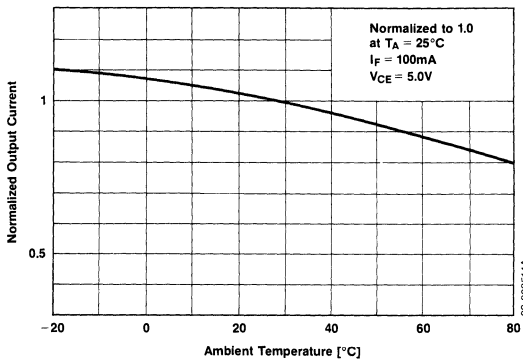
Collector to Emitter Dark Current vs Ambient Temperature



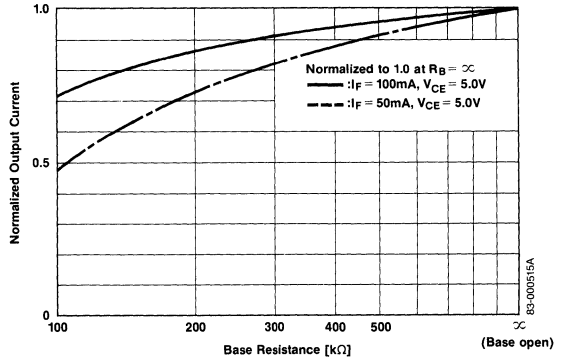
Collector Current vs Forward Current



Normalized Output Current vs Ambient Temperature



Normalized Output Current vs Base Resistance



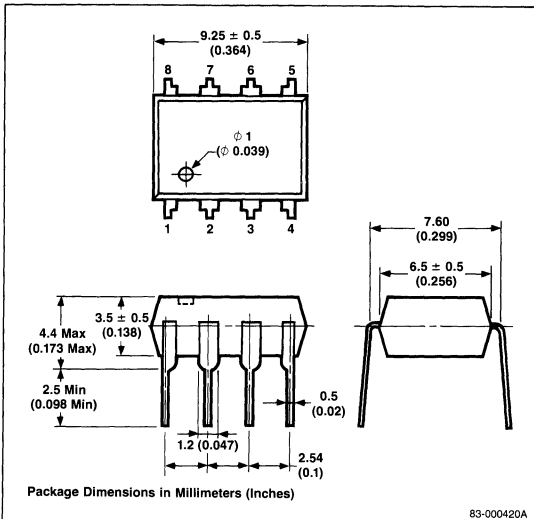
5

Description

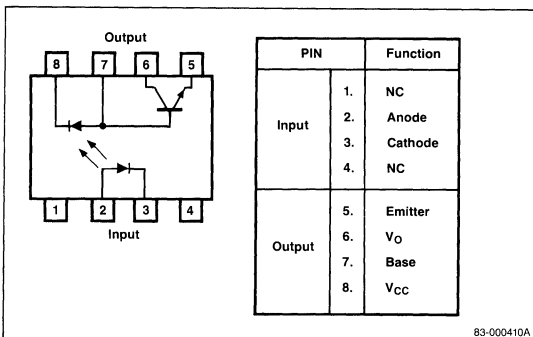
The PS2006B and PS2006B(1) are high speed photo couplers containing a GaAsP light emitting diode and a p-n photo diode connected to a high speed transistor.

The CTR are 15%min for PS2006B and 7% min for PS2006B(1).

Package Dimensions



Pin Connection



Features

- High isolation voltage: 3000V_{DC} min
- High speed response: t_{PHL}, t_{PLH} = 300ns typ
- Compact, dual in-line plastic package
- Equivalent to 6N135, 6N136

Applications

- Interface circuit for various instruments and control equipment
- Floating power supply feedback networks
- Computer and peripheral manufacture
- Pulse transformer
- High speed digital and analog line receivers

Absolute Maximum Ratings

T_A = +25°C

Diode

Reverse Voltage, V _R	5V
Forward Current, I _F	25mA
Power Dissipation, P _D	45mW

Detector

Supply Voltage, V _{CC}	-0.5V to +15V
Output Voltage, V _O	-0.5V to +15V
Output Current, I _O	8mA
Emitter to Base Voltage, V _{EBO}	5V
Power Dissipation, P _D	100mW

Isolation Voltage¹, BV 3000V_{DC}

Storage Temperature, T_{STG} -55°C to +125°C

Operating Temperature, T_{OPT} +55°C to +100°C

Electrical Characteristics

$T_A = +25^\circ\text{C}$

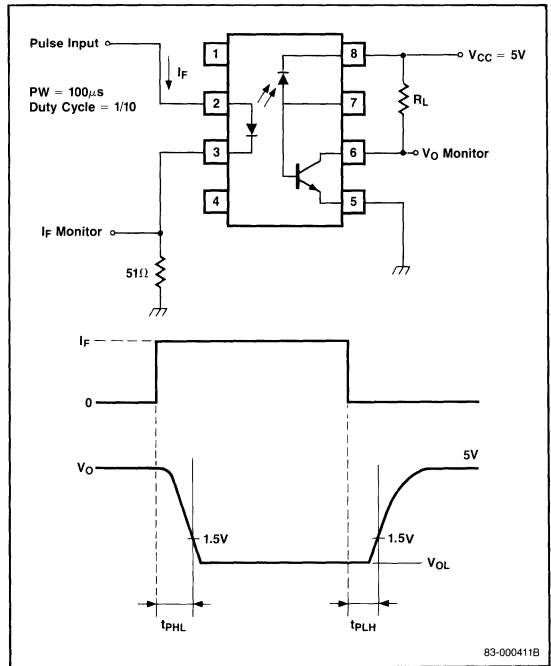
Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Diode						
Forward Voltage	V_F	1.43	1.7		V	$I_F = 16\text{mA}$
Reverse Current	I_R	0.01	10		μA	$V_R = 5\text{V}$
Forward Voltage Temperature Coefficient	$\frac{\Delta V_F}{\Delta T}$	-1.51			mV/ $^\circ\text{C}$	$I_F = 16\text{mA}$
Capacitance	C_T	60			pF	$V = 0$, $f = 1\text{MHz}$
Detector						
High Level Output Current	I_{OH}^1	3	500		nA	$I_F = 0\text{mA}$, $V_{CC} = 5.5\text{V}$
High Level Output Current	I_{OH}^2		100		μA	$I_F = 0\text{mA}$, $V_{CC} = 15\text{V}$
DC Current Gain	h_{FE}	120				$V_O = 5\text{V}$, $I_O = 3\text{mA}$
Coupled						
Current Transfer Ratio	CTR	15/7	22		%	$I_F = 16\text{mA}$, $V_{CC} = 4.5\text{V}$, $V_O = 0.4\text{V}$
Low Level Output Voltage	V_{OL}	0.1	0.4		V	$I_F = 16\text{mA}$, $V_{CC} = 4.5\text{V}$, $I_O = 2.4\text{mA}/1.1\text{mA}$
Low Level Supply Current	I_{CCL}	50			μA	$I_F = 16\text{mA}$, $V_O = \text{Open}$, $V_{CC} = 15\text{V}$
High Level Supply Current	I_{CCH}	0.01	1		μA	$I_F = 0\text{mA}$, $V_O = \text{Open}$, $V_{CC} = 15\text{V}$
Isolation Resistance	R_{1-2}	10^{12}			Ω	$V_{IN-OUT} = 1\text{kV}$
Isolation Capacitance	C_{1-2}	0.7			pF	$V = 0$, $f = 1\text{MHz}$
Propagation Delay Time to Low Output Level	t_{PHL}^2	0.3/ 0.5	0.8/ 1.5		μs	$I_F = 16\text{mA}$, $V_{CC} = 5\text{V}$, $R_L = 1.9\text{k}\Omega/4.1\text{k}\Omega$
Propagation Delay Time to High Output Level	t_{PLH}^2	0.3/ 0.8	0.8/ 1.5		μs	$I_F = 16\text{mA}$, $V_{CC} = 5\text{V}$, $R_L = 1.9\text{k}\Omega/4.1\text{k}\Omega$

Notes: In the "Min", "Typ" and "Max" columns, figures to the left and right of the slash represent values for the PS2006B and PS2006B(1), respectively.

1. Measuring Conditions: DC voltage for 1 min at $T_A = +25^\circ\text{C}$, RH = 60% between input (pins 1, 2, 3, and 4 common) and output (pins 5, 6, 7, and 8 common).

2. Measuring Circuit.

Measuring circuit

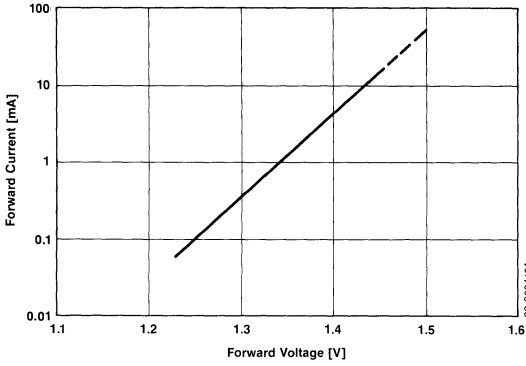


83-00041B

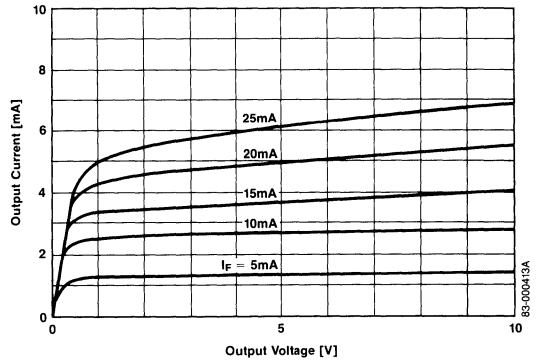
Typical Characteristics

$T_A = +25^\circ\text{C}$

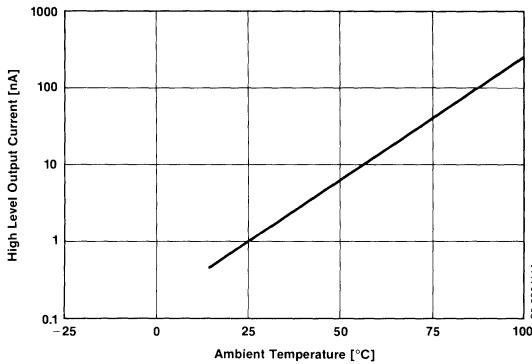
Forward Current vs Forward Voltage



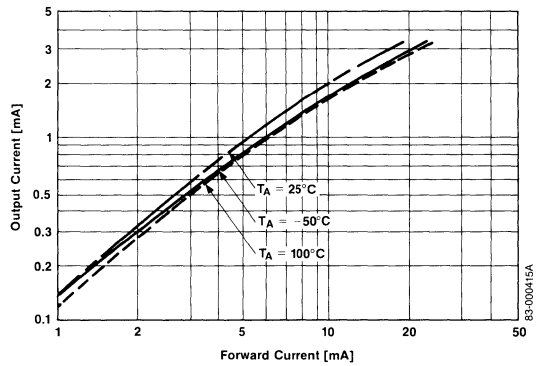
Output Current vs Output Voltage



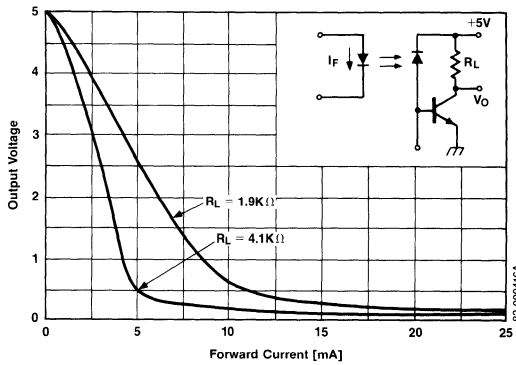
High Level Output Current vs Ambient Temperature



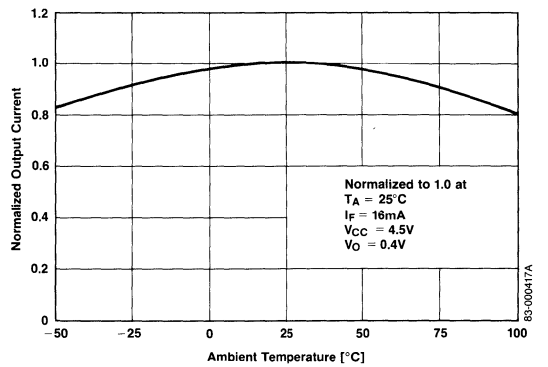
Output Current vs Forward Current



Output Voltage vs Forward Current

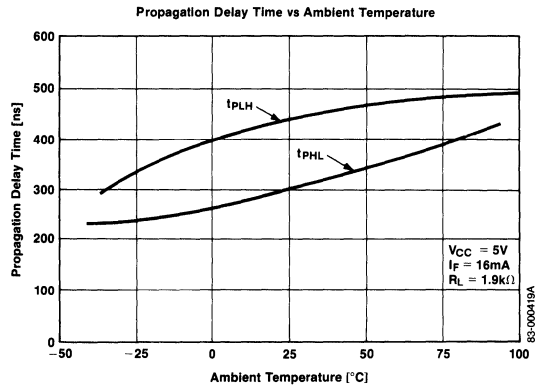
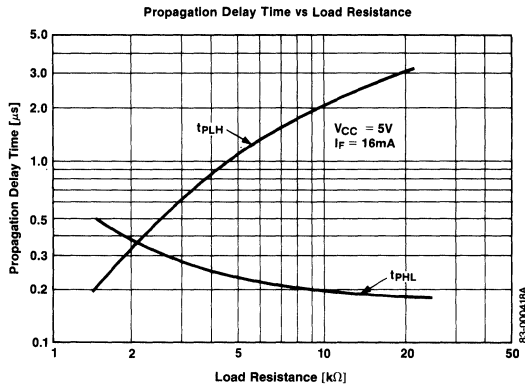


Normalized Output Current vs Ambient Temperature



Typical Characteristics (cont)

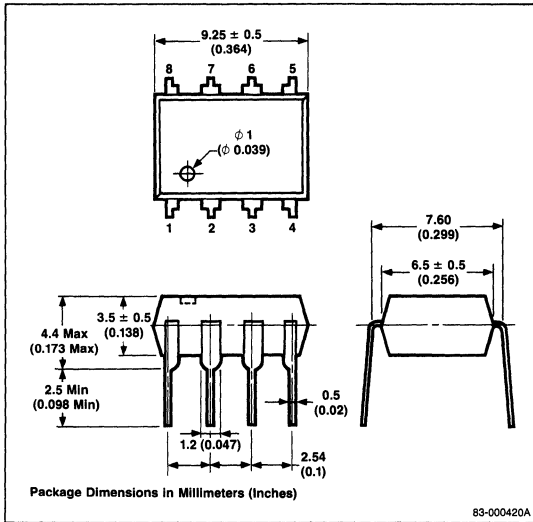
$T_A = +25^\circ\text{C}$



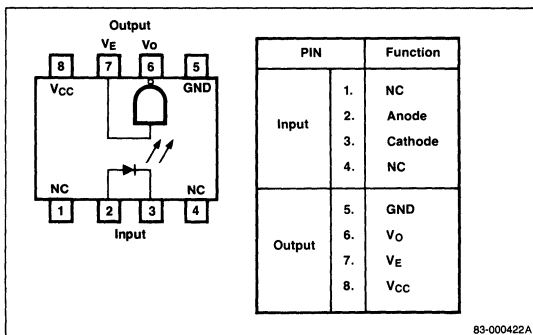
Description

The PS2007B is a high speed photo coupler containing a GaAsP light emitting diode and an integrated detector consisting of a photo diode and a high gain linear amplifier that drives a Schottky clamped open collector output transistor in a plastic DIP (Dual In-line Package).

Package Dimensions



Pin Connection



Features

- Ultra high speed: 50ns typ
- High isolation voltage: 3000V_{DC} min
- Low input current requirement: 5mA
- Economical, compact, plastic dual in-line package
- TTL compatible: 5V supply
- Equivalent to 6N137

Applications

- Line receivers
- Floating power supplies
- Computer and peripheral memory
- Replacement for mechanical and reed relays
- Replacement for pulse transformers

Absolute Maximum Ratings

T_A = +25°C

Diode	
Reverse Voltage, V _R	5V
Forward Current, I _F	10mA
Detector	
Supply Voltage, V _{CC}	7V
Output Voltage, V _O	7V
Output Current, I _O	50mA
Enable Voltage, V _E	5.5V
Power Dissipation, P _D	85mW
Isolation Voltage, BV ¹	3000V _{DC}
Storage Temperature, T _{STG}	-55°C to +125°C
Operating Temperature, T _{OPT}	0°C to +70°C

Electrical Characteristics

$T_A = 0 \text{ to } +70^\circ\text{C}$

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Diode						
Forward Voltage	V_F	1.42	1.7		V	$I_F = 10\text{mA}$, $T_A = +25^\circ\text{C}$
Reverse Current	I_R	0.01	10		μA	$V_R = 5\text{V}$, $T_A = +25^\circ\text{C}$
Capacitance	C_T	60			pF	$V = 0$, $f = 1.0\text{MHz}$
Detector						
High Level Enable Current	I_{EH}	-0.8			mA	$V_{CC} = 5.5\text{V}$, $V_{EH} = 2.0\text{V}$
Low Level Enable Current	I_{EL}	-1.2	-2.0		mA	$V_{CC} = 5.5\text{V}$, $V_{EL} = 0.5\text{V}$
Coupled						
High Level Output Current	I_{OH}	30	250		μA	$V_{CC} = 5.5\text{V}$, $V_O = 5.5\text{V}$, $I_F = 250\mu\text{A}$, $V_E = 2.0\text{V}$
Low Level Output Voltage	V_{OL}	0.4	0.6		V	$V_{CC} = 5.5\text{V}$, $V_E = 2.0\text{V}$, $I_F = 5\text{mA}$, $I_O = 13\text{mA}$
Low Level Supply Current	I_{CCL}	10	18		mA	$V_{CC} = 5.5\text{V}$, $V_E = 2\text{V}$, $I_F = 10\text{mA}$
High Level Supply Current	I_{CCH}	7	15		mA	$V_{CC} = 5.5\text{V}$, $V_E = 0.5\text{V}$, $I_F = 0\text{mA}$

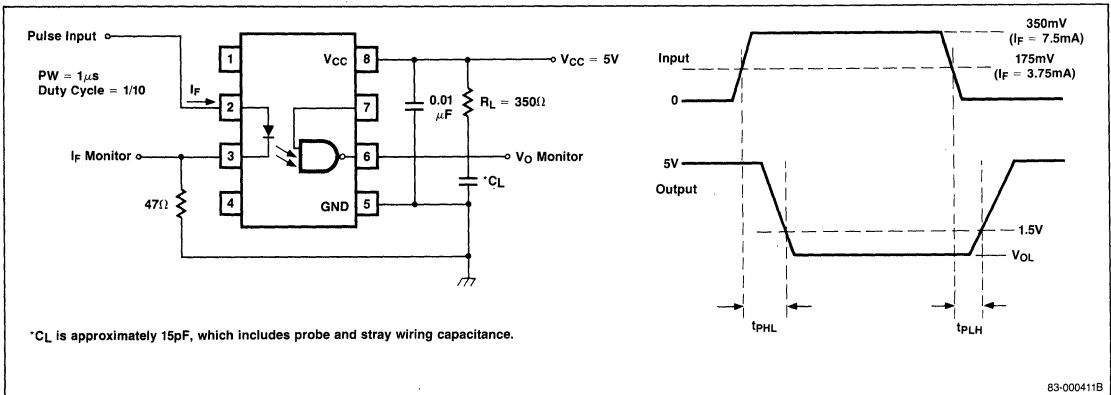
Electrical Characteristics (cont)

$T_A = +25^\circ\text{C}$

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Coupled						
Current Transfer Ratio	CTR		600		%	$I_F = 5\text{mA}$, $V_{CC} = 5\text{V}$, $R_L = 100\Omega$
Isolation Resistance	R_{1-2}		10^{12}		Ω	$V_{IN-OUT} = 1\text{kV}$
Isolation Capacitance	C_{1-2}		0.7		pF	$V = 0$, $f = 1\text{MHz}$
Propagation Delay Time to Low Output Level	t_{PHL2}		50	75	ns	$I_F = 7.5\text{mA}$, $V_{CC} = 5\text{V}$, $R_L = 350\Omega$, $C_L = 15\text{pF}$
Propagation Delay Time to High Output Level	t_{PLH2}		50	75	ns	
Propagation Delay Time of Enable to Low Output Level	t_{EHL}		15		ns	$I_F = 7.5\text{mA}$, $V_{CC} = 5\text{V}$, $R_L = 350\Omega$, $V_{EH} = 3\text{V}$, $C_L = 15\text{pF}$
Propagation Delay Time of Enable to High Output Level	t_{ELH}		30		ns	

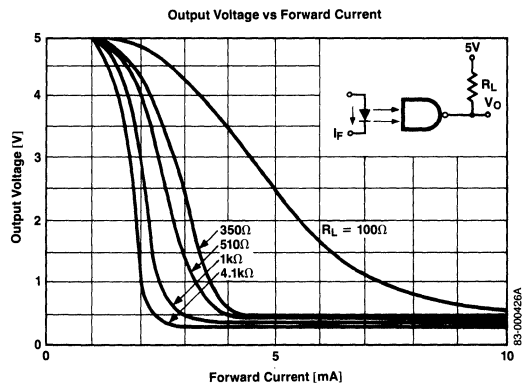
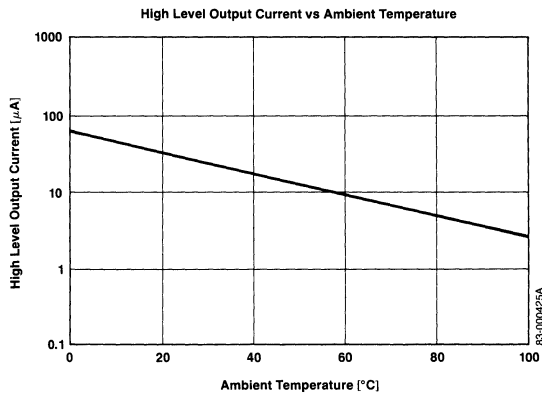
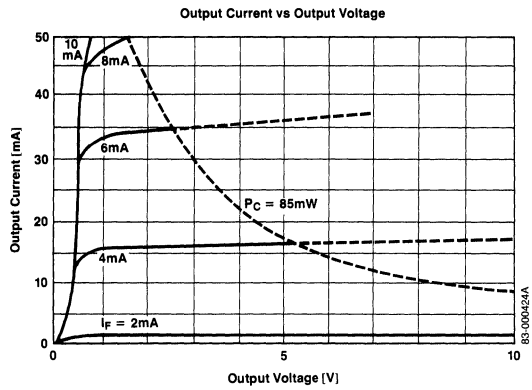
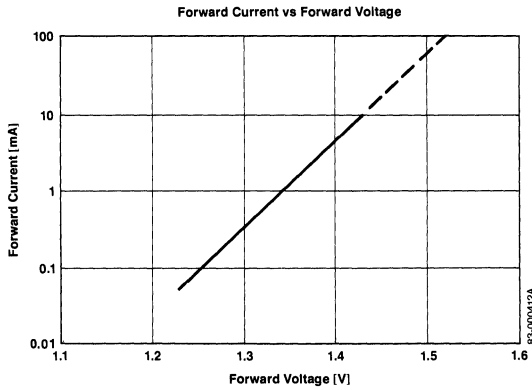
Notes: 1. Test Conditions: DC voltage for 1 min at $T_A = +25^\circ\text{C}$, RH = 60% between input (pins 1, 2, 3, and 4 common) and output (Pins 5, 6, 7, and 8 common).
2. Measuring Circuit.

Measuring circuit

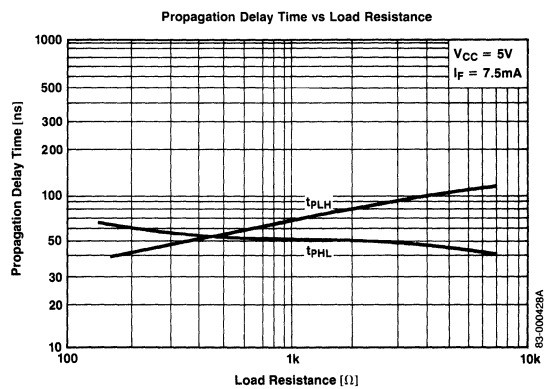
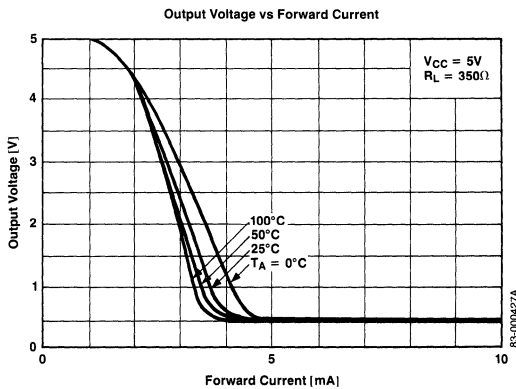


Typical Characteristics

$T_A = +25^\circ\text{C}$

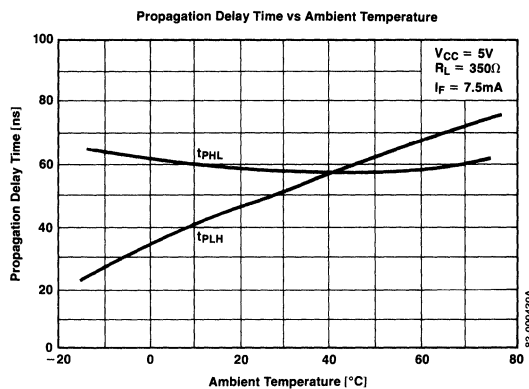
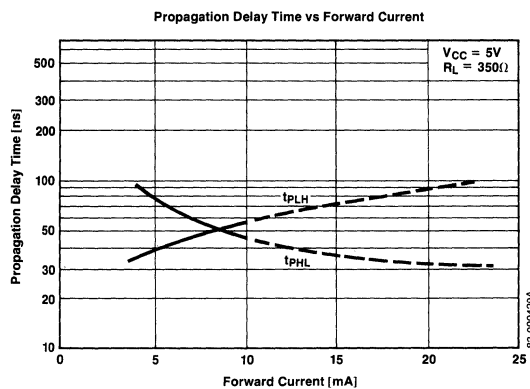


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Typical Characteristics (cont)

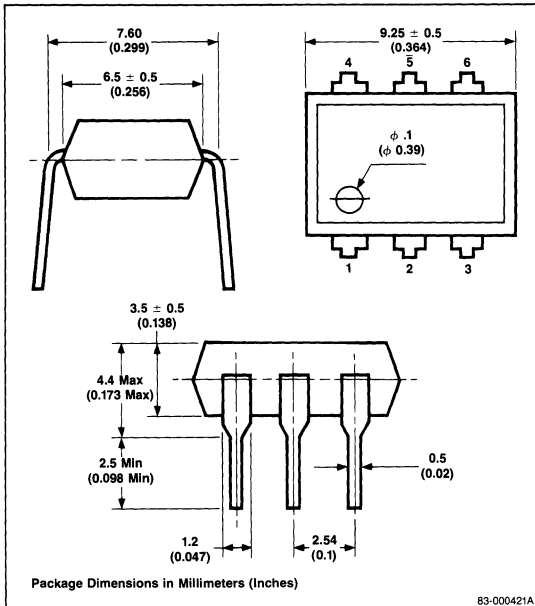
$T_A = +25^\circ\text{C}$



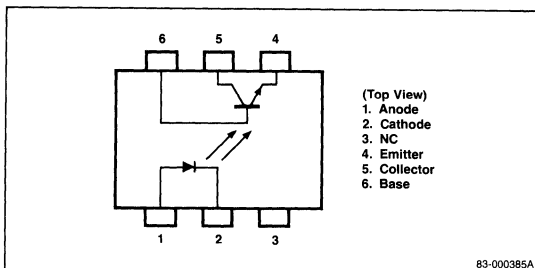
Description

The PS2010 is an optically coupled isolator containing a GaAs light emitting diode and an NPN silicon photo transistor. Compatible with MCT2, H11A1-H11A5 and 4N25-4N28.

Package Dimensions



Pin Connection



Features

- High isolation voltage: 2000V_{AC}
- High transfer ratio: 20% min
- High speed switching: $t_r, t_f = 4\mu s$ typ
- Economical, compact, dual in-line plastic package

Applications

- Interface circuit for various instruments and control equipment
- Chopper circuits
- Computer and peripheral manufacture
- Pulse transformers
- Data communication equipment

Absolute Maximum Ratings

$T_A = +25^\circ C$

Diode	
Reverse Voltage, V_R	5.0V
Forward Current (DC), I_F	80mA
Power Dissipation, P_D	150mW
Peak Forward Current (300 μs , 2% duty cycle), I_F (peak)	3A
Transistor	
Collector to Emitter Voltage, V_{CE0}	30V
Collector to Base Voltage, V_{CBO}	70V
Emitter to Collector Voltage, V_{ECO}	7V
Collector Current, I_C	100mA
Power Dissipation, P_D	150mW
Isolation Voltage ¹ , BV	2500V _{DC}
Isolation Voltage ¹ , BV	2000V _{AC}
Storage Temperature, T_{STG}	-55°C to +150°C
Operating Temperature, T_{OPT}	-55°C to +100°C
Lead Temperature (Soldering 10s)	260°C
Total Power Dissipation, P_T	250mW

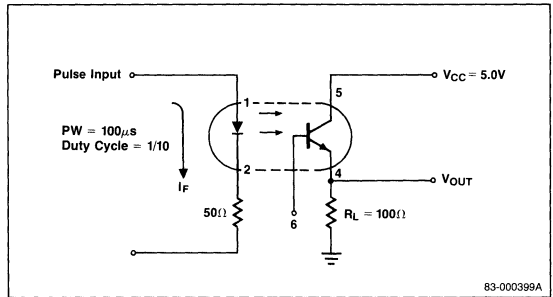
Electrical Characteristics

$T_A = +25^{\circ}\text{C}$

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Diode						
Forward Voltage	V_F	1.1	1.4		V	$I_F = 10\text{mA}$
Forward Voltage	V_F	1.2	1.5		V	$I_F = 50\text{mA}$
Reverse Current	I_R			10	μA	$V_R = 5\text{V}$
Junction Capacitance	C	50			pF	$V = 0, f = 1.0\text{MHz}$
Transistor						
Collector to Emitter Dark Current	I_{CEO}			50	nA	$V_{CE} = 10\text{V}, I_F = 0$
DC Current Gain	h_{FE}		700			$I_C = 2\text{mA}, V_{CE} = 5.0\text{V}$
Collector to Emitter Breakdown Voltage	BV_{CEO}	30	60		V	$I_C = 1\text{mA}, I_B = 0$
Collector to Base Breakdown Voltage	BV_{CBO}	70	120		V	$I_C = 100\mu\text{A}, I_E = 0$
Emitter to Collector Breakdown Voltage	BV_{ECO}	7	9		V	$I_E = 100\mu\text{A}, I_B = 0$
Coupled Current Transfer Ratio ²	CTR (I_C/I_F)	20			%	$I_F = 10\text{mA}, V_{CE} = 5.0\text{V}$
Collector Saturation Voltage	$V_{CE(sat)}$			0.3	V	$I_F = 10\text{mA}, I_C = 2.0\text{mA}$
Isolation Resistance	R_{1-2}	10^{11}			Ω	$V_{IN-OUT} = 1.0\text{kV}$
Isolation Capacitance	C_{1-2}	0.8			pF	$V = 0, f = 1.0\text{MHz}$
Rise Time ³	t_R	4			μs	$V_{CC} = 5.0\text{V}, I_C = 2\text{mA}, R_L = 100\Omega$
Fall Time ³	t_F	4			μs	$V_{CC} = 5.0\text{V}, I_C = 2\text{mA}, R_L = 100\Omega$

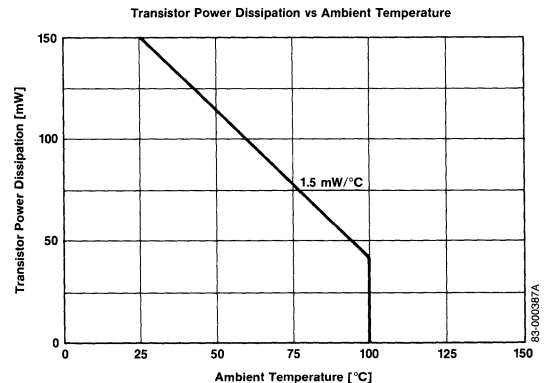
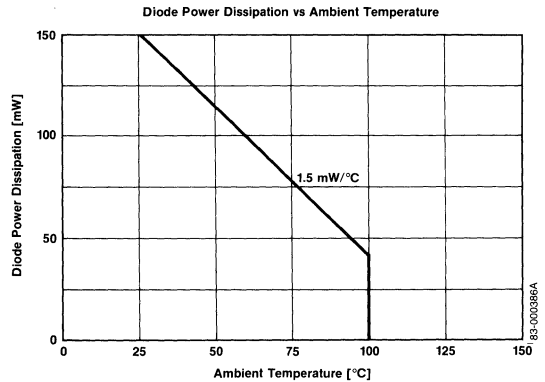
- Notes:**
1. Measuring Conditions: DC or AC voltage for 1 min at $T_A = +25^{\circ}\text{C}$, RH = 60% between input (pins 1, 2, and 3 common) and output (pins 4, 5, and 6 common).
 2. CTR rank: K: 80%~210%, L: 50%~110%, M: 20%~70%.
 3. Test circuit for switching time.

Test circuit for switching time



Typical Characteristics

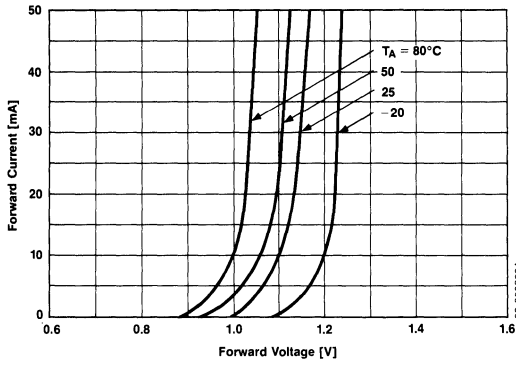
$T_A = +25^{\circ}\text{C}$



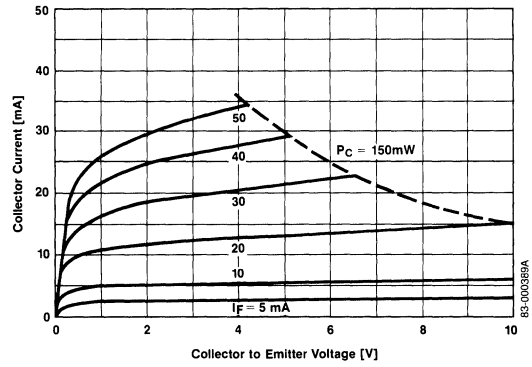
Typical Characteristics (cont)

$T_A = +25^\circ\text{C}$

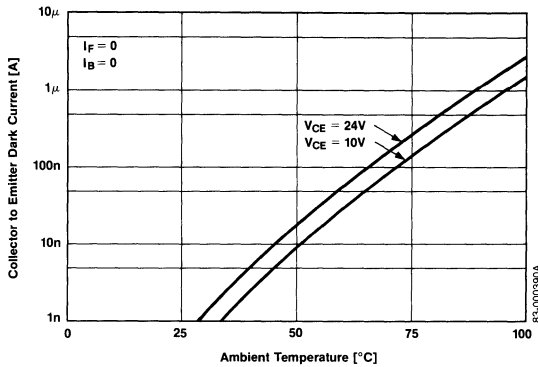
Forward Current vs Forward Voltage



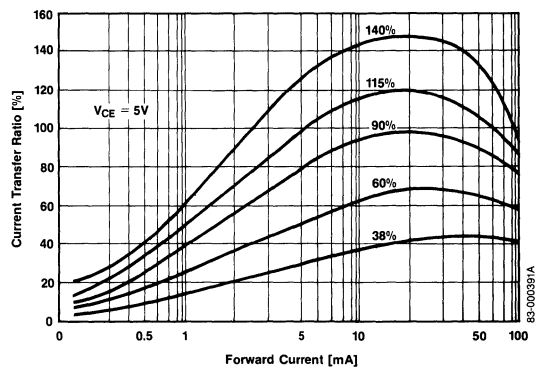
Collector Current vs Collector to Emitter Voltage



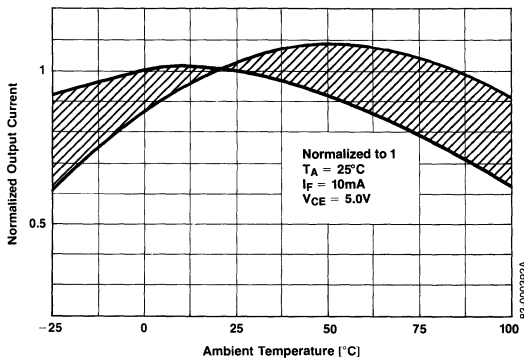
Collector to Emitter Dark Current vs Ambient Temperature



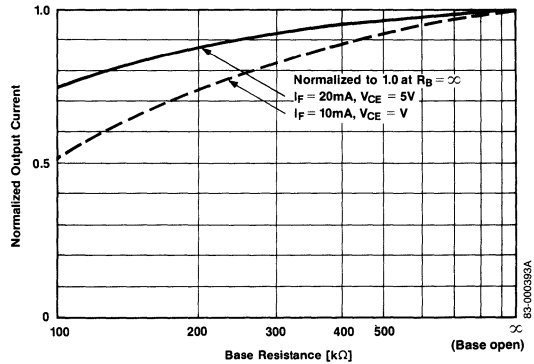
Current Transfer Ratio vs Forward Current



Normalized Output Current vs Ambient Temperature



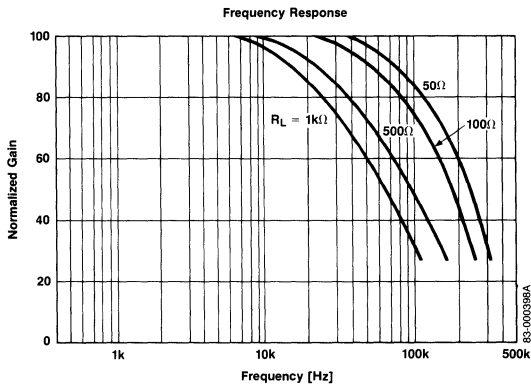
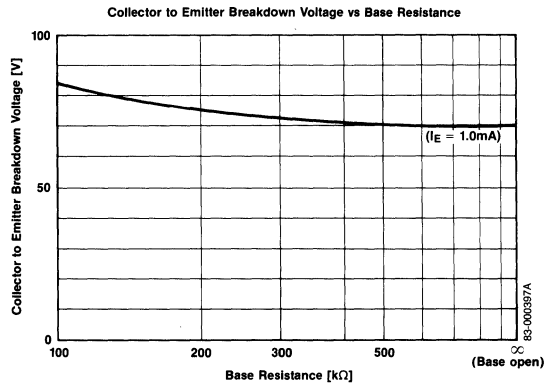
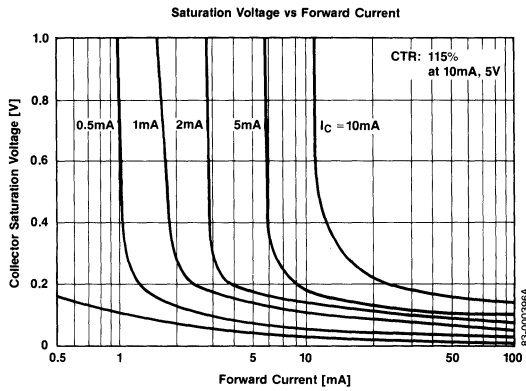
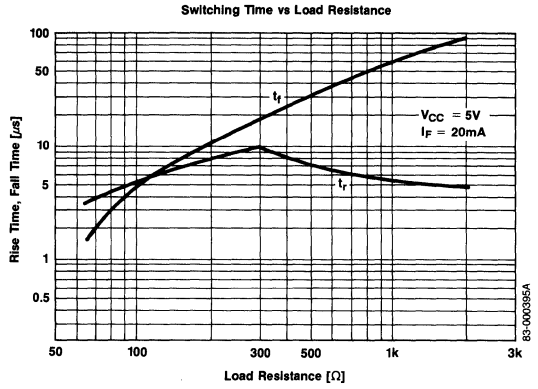
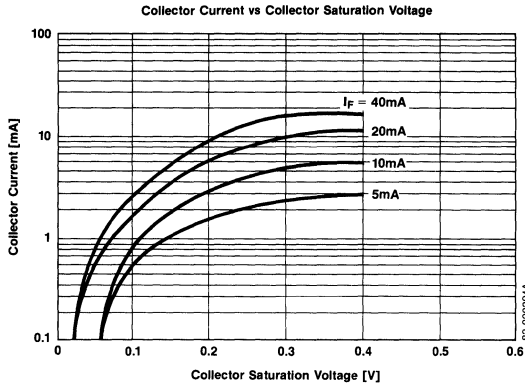
Normalized Output Current vs Base Resistance



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Typical Characteristics (cont)

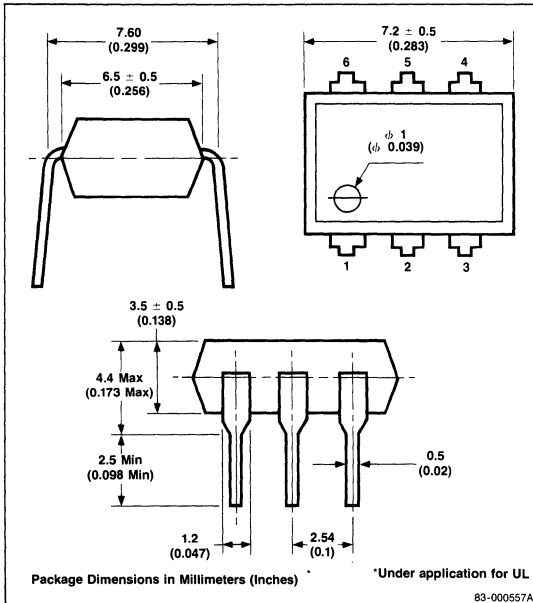
$T_A = +25^\circ\text{C}$



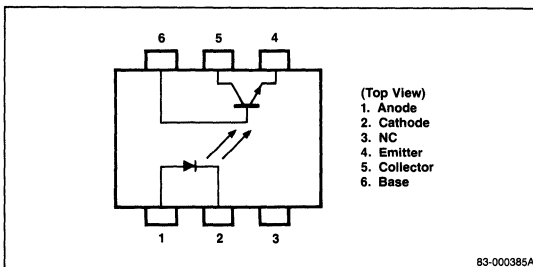
Description

The PS2021 is an optically coupled isolator containing a GaAs light emitting diode and an NPN silicon photo transistor.

Package Dimensions



Pin Connection



Features

- Small package: $7.2 \times 6.5 \times 3.5$ mm
- High isolation voltage: $4000V_{AC}$ rating
- High transfer ratio: 50% min
- High speed switching: $t_r, t_f = 3\mu s$ typ
- Economical, compact, dual in-line plastic package

Applications

- Interface circuit for various instruments and control equipment
- Chopper circuits
- Computer and peripheral manufacture
- Pulse transformers
- Data communication equipment

Absolute Maximum Ratings

$T_A = +25^\circ C$

Diode	
Reverse Voltage, V_R	5.0V
Forward Current (DC), I_F	80mA
Power Dissipation, P_D	150mW
Peak Forward Current(300 μs , 2% duty cycle), I_F (peak)	3A
Transistor	
Collector to Emitter Voltage, V_{CEO}	40V
Collector to Base Voltage, V_{CBO}	70V
Emitter to Collector Voltage, V_{ECO}	7V
Collector Current, I_C	100mA
Power Dissipation, P_D	150mW
Isolation Voltage ¹ , BV	4000V _{AC}
Storage Temperature, T_{STG}	-55 $^\circ C$ to +150 $^\circ C$
Operating Temperature, T_{OPT}	-55 $^\circ C$ to +100 $^\circ C$
Lead Temperature (Soldering 10s)	260 $^\circ C$
Total Power Dissipation, P_T	250mW

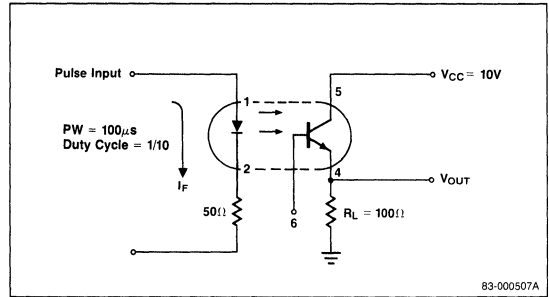
Electrical Characteristics

T_A = +25°C

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Diode						
Forward Voltage	V _F	1.1	1.4		V	I _F = 10mA
Forward Voltage	V _F	1.2	1.5		V	I _F = 50mA
Reverse Current	I _R			10	μA	V _R = 5V
Junction Capacitance	C	50			pF	V = 0, f = 1.0MHz
Transistor						
Collector to Emitter Dark Current	I _{CEO}		50		nA	V _{CE} = 10V, I _F = 0
DC Current Gain	h _{FE}	700				I _C = 2mA, V _{CE} = 5.0V
Collector to Emitter Breakdown Voltage	BV _{CEO}	40	60		V	I _C = 1mA, I _B = 0
Collector to Base Breakdown Voltage	BV _{CBO}	70	120		V	I _C = 100μA, I _E = 0
Emitter to Collector Breakdown Voltage	BV _{ECO}	7	9		V	I _E = 100μA, I _B = 0
Coupled Current Transfer Ratio ²	CTR (I _C /I _F)	50			%	I _F = 10mA, V _{CE} = 5.0V
Collector Saturation Voltage	V _{CE(sat)}		0.3		V	I _F = 10mA, I _C = 2.0mA
Isolation Resistance	R ₁₋₂	10 ¹¹			Ω	V _{IN-OUT} = 1.0kV
Isolation Capacitance	C ₁₋₂	0.5			pF	V = 0, f = 1.0MHz
Rise Time ³	t _r	3			μs	V _{CC} = 10V, I _C = 2mA, R _L = 100Ω
Fall Time ³	t _f	3			μs	V _{CC} = 10V, I _C = 2mA, R _L = 100Ω

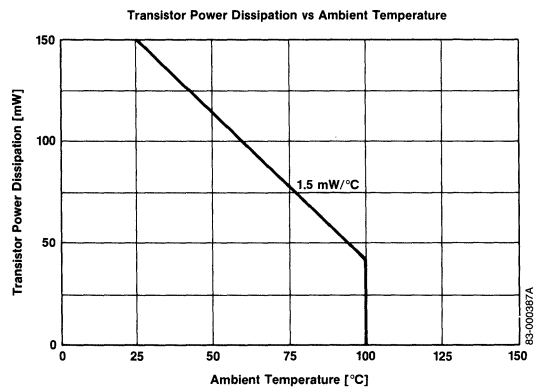
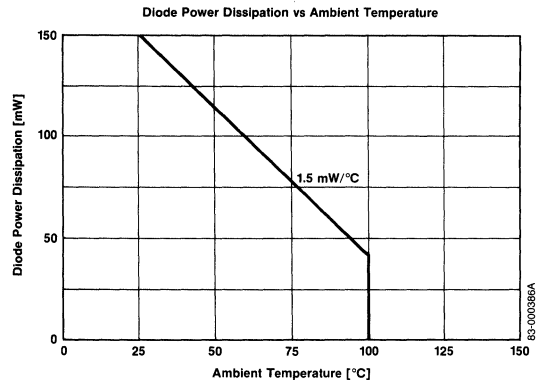
- Notes:**
1. Measuring Conditions: DC or AC voltage for 1 min at T_A = +25°C, RH = 60% between input (pins 1, 2, and 3 common) and output (pins 4, 5, and 6 common).
 2. CTR rank: K: 150%~300%, L: 90%~180%, M: 50%~110%.
 3. Test circuit for switching time.

Test circuit for switching time



Typical Characteristics

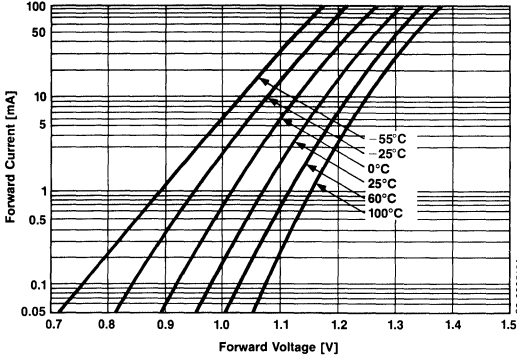
T_A = +25°C



Typical Characteristics (cont)

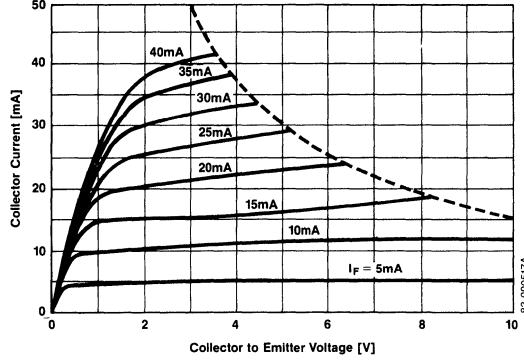
$T_A = +25^\circ\text{C}$

Forward Current vs Forward Voltage



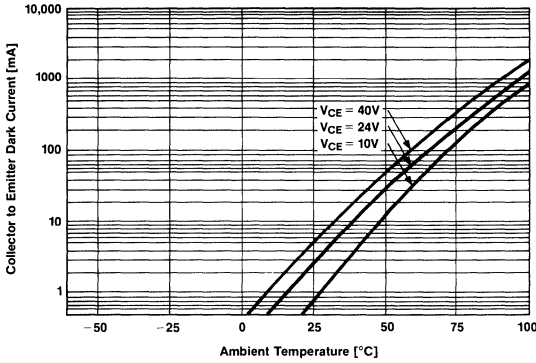
83-000516A

Collector Current vs Collector to Emitter Voltage



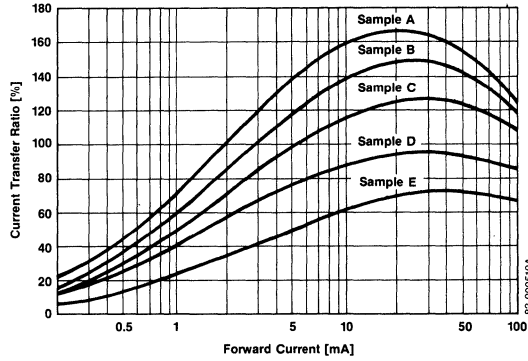
83-000517A

Collector to Emitter Dark Current vs Ambient Temperature



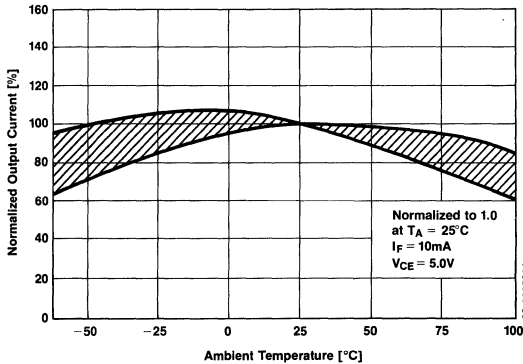
83-000518A

Current Transfer Ratio vs Forward Current



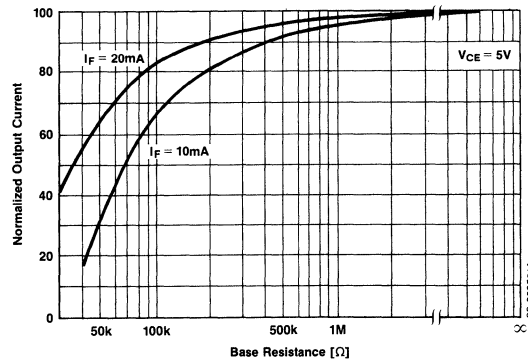
83-000519A

Normalized Output Current vs Ambient Temperature



83-000520A

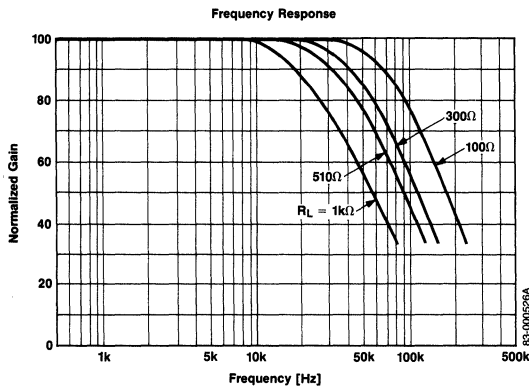
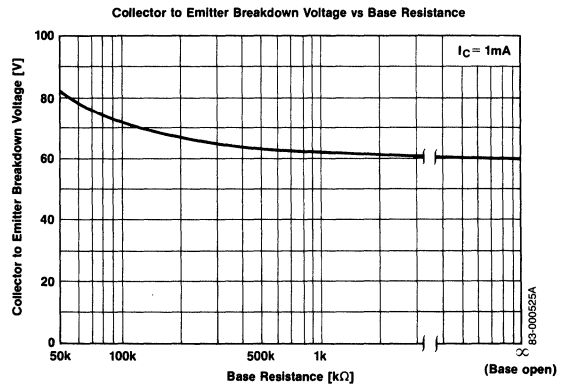
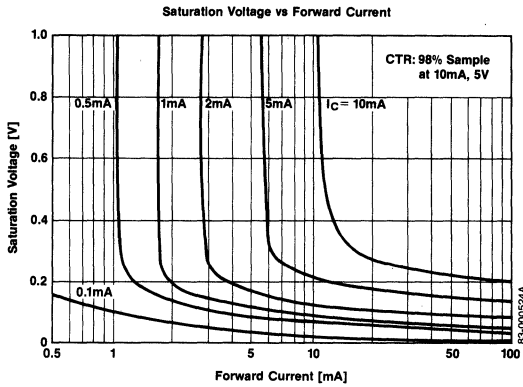
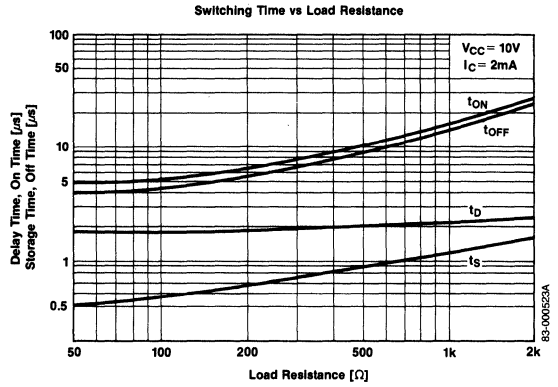
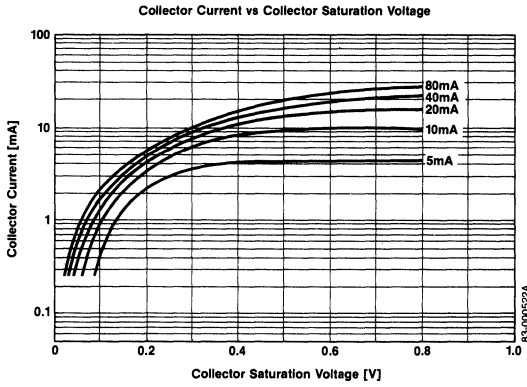
Normalized Output Current vs Base Resistance (Typical)



83-000521A

Typical Characteristics (cont)

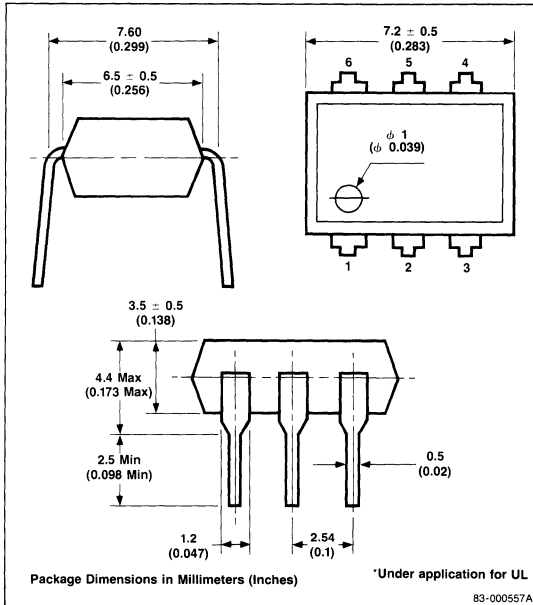
$T_A = +25^\circ\text{C}$



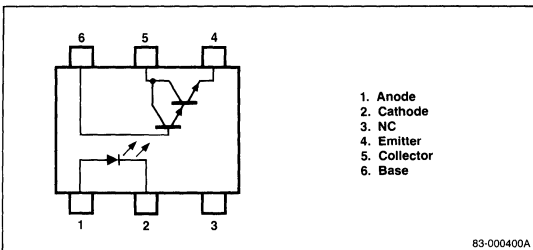
Description

The PS2022 is an optically coupled isolator containing a GaAs light emitting diode and an NPN silicon Darlington-connected photo transistor.

Package Dimensions



Pin Connection



Features

- Small package: $7.2 \times 6.5 \times 3.5\text{mm}$
- High isolation voltage: $4000V_{AC}$ rating
- High transfer ratio: 200% min
- High speed switching: $t_r, t_f = 80\mu\text{s}$ typ
- Economical, compact, dual in-line plastic package

Applications

- Interface circuit for various instruments and control equipment
- Chopper circuits
- Computer and peripheral manufacture
- Pulse transformers
- Data communication equipment

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Diode	
Reverse Voltage, V_R	5.0V
Forward Current (DC), I_F	80mA
Power Dissipation, P_D	150mW
Peak Forward Current (300 μs , 2% duty cycle), I_F (peak)	3A
Transistor	
Collector to Emitter Voltage, V_{CE0}	40V
Collector to Base Voltage, V_{CBO}	40V
Emitter to Collector Voltage, V_{ECO}	7V
Collector Current, I_C	100mA
Power Dissipation, P_D	150mW
Isolation Voltage ¹ , BV	4000V _{AC}
Storage Temperature, T_{STG}	-55°C to +150°C
Operating Temperature, T_{OPT}	-55°C to +100°C
Lead Temperature (Soldering 10s)	260°C
Total Power Dissipation, P_T	250mW

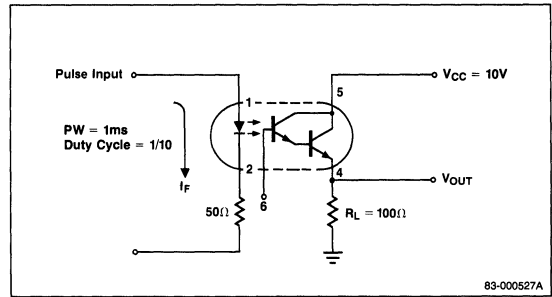
Electrical Characteristics

$T_A = +25^\circ\text{C}$

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Diode						
Forward Voltage	V_F	1.1	1.4		V	$I_F = 10\text{mA}$
Forward Voltage	V_F	1.2	1.5		V	$I_F = 50\text{mA}$
Reverse Current	I_R		10		μA	$V_R = 5\text{V}$
Junction Capacitance	C	50			pF	$V = 0$, $f = 1.0\text{MHz}$
Transistor						
Collector to Emitter Dark Current	I_{CEO}		100		nA	$V_{CE} = 10\text{V}$, $I_F = 0$
DC Current Gain	h_{FE}					$I_C = 0.5\text{mA}$, $V_{CE} = 5.0\text{V}$
Collector to Emitter Breakdown Voltage	BV_{CEO}	40	60		V	$I_C = 1\text{mA}$, $I_B = 0$
Collector to Base Breakdown Voltage	BV_{CBO}	40	90		V	$I_C = 100\mu\text{A}$, $I_E = 0$
Emitter to Collector Breakdown Voltage	BV_{ECO}	7	9		V	$I_E = 100\mu\text{A}$, $I_B = 0$
Coupled Current Transfer Ratio ²	CTR (I_C/I_F)	200			%	$I_F = 10\text{mA}$, $V_{CE} = 5.0\text{V}$
Collector Saturation Voltage	$V_{CE(sat)}$		1.0		V	$I_F = 5\text{mA}$, $I_C = 2.0\text{mA}$
Isolation Resistance	R_{1-2}	10^{11}			Ω	$V_{IN-OUT} = 1.0\text{kV}$
Isolation Capacitance	C_{1-2}	0.5			pF	$V = 0$, $f = 1.0\text{MHz}$
Rise Time ³	t_R	80			μs	$V_{CC} = 10\text{V}$, $I_C = 50\text{mA}$, $R_L = 100\Omega$
Fall Time ³	t_F	80			μs	$V_{CC} = 10\text{V}$, $I_C = 50\text{mA}$, $R_L = 100\Omega$

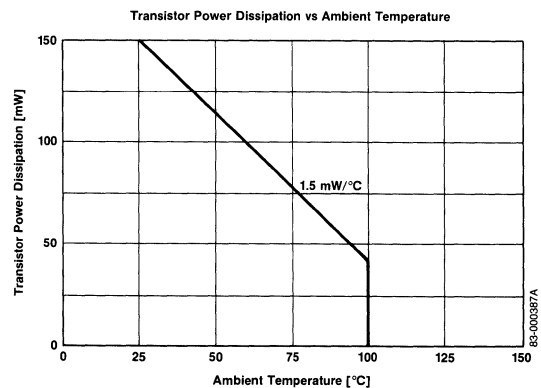
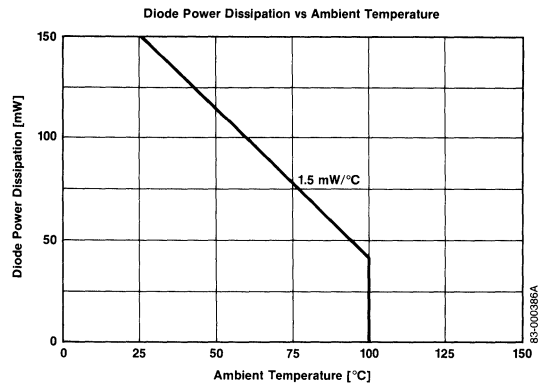
- Notes:**
1. Measuring Conditions: DC or AC voltage for 1 min at $T_A = +25^\circ\text{C}$, RH = 60% between input (pins 1, 2, and 3 common) and output (pins 4, 5, and 6 common).
 2. CTR rank: K: ~ 900%, L: ~ 500%, M: ~ 200%.
 3. Test circuit for switching time.

Test circuit for switching time



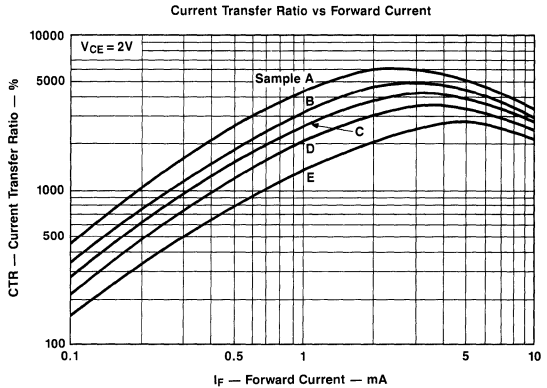
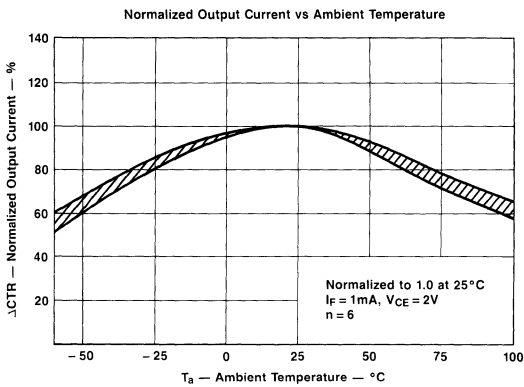
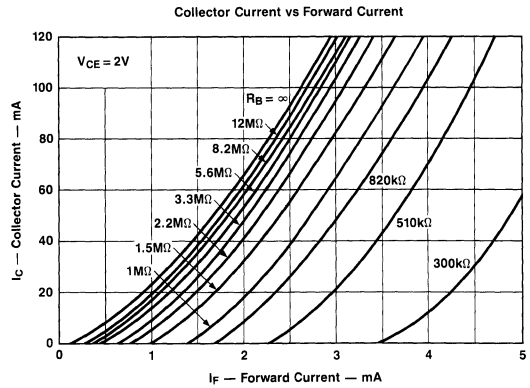
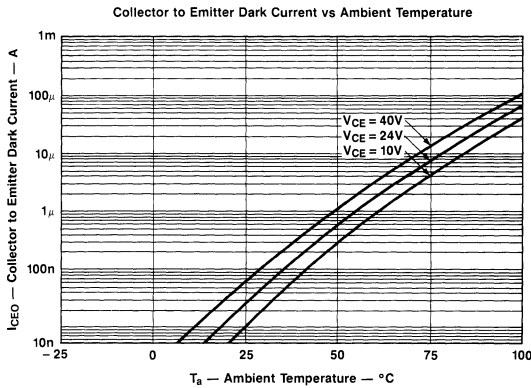
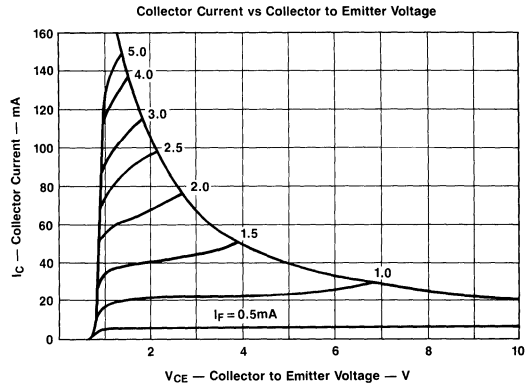
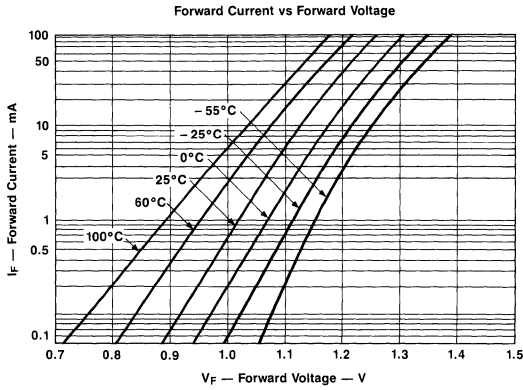
Typical Characteristics

$T_A = +25^\circ\text{C}$



Typical Characteristics (cont)

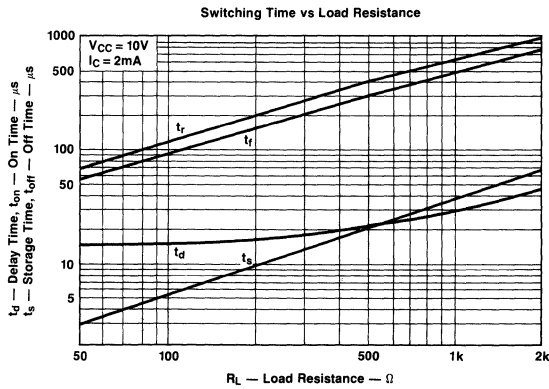
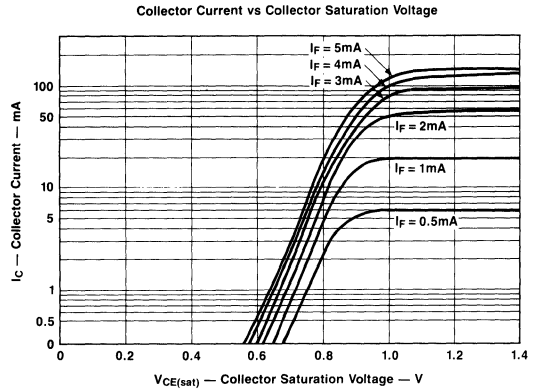
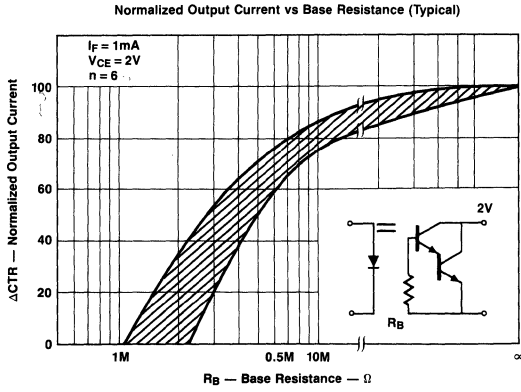
$T_A = +25^\circ\text{C}$



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Typical Characteristics (cont)

$T_A = +25^\circ\text{C}$



Description

The PS2401A-1, -2, -3, and -4 series are optically coupled isolators containing a GaAs light emitting diode and an NPN silicon photo transistor. Each is mounted in a dual in-line package.

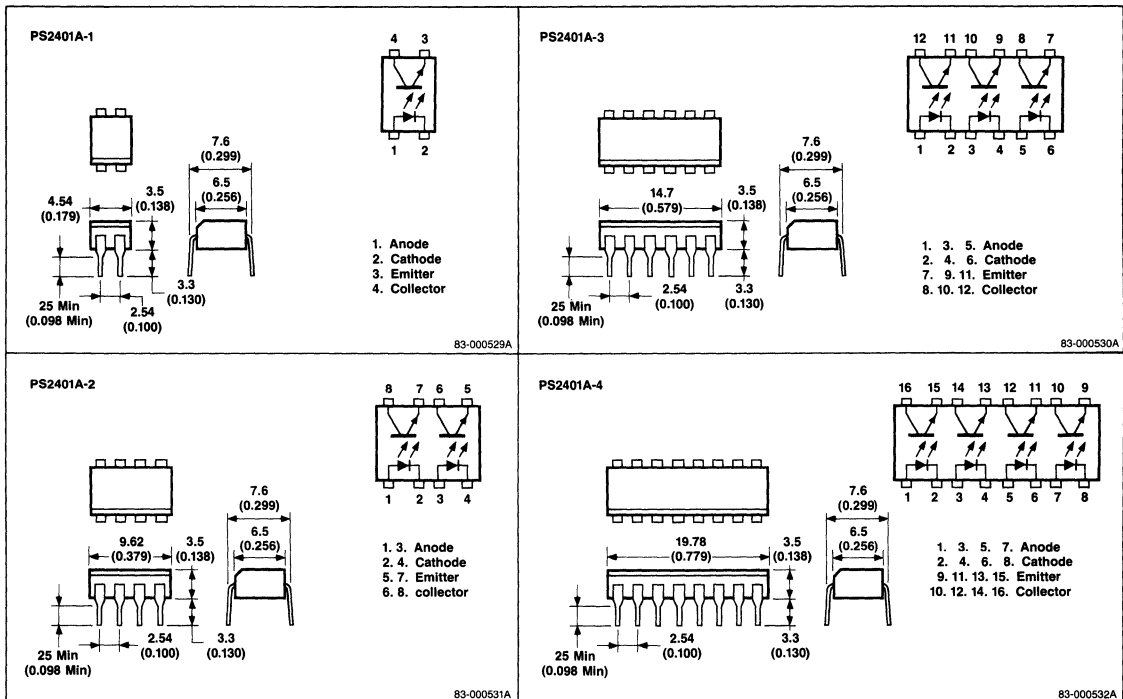
Features

- Small package size
- Isolated channels
- High isolation voltage: 5000V_{AC} rating
- High transfer ratio: 300 % typ
- High speed switching: $t_r, t_f = 3\mu s$ typ
- Low cost

Applications

- Interface circuit for various instrumentations, control equipment
- AC line digital logic: isolate high voltage transients
- Digital logic: eliminate spurious ground loops
- Twisted pair line receiver: eliminate ground loop pick-up
- Telephone/telegraph line receiver: isolate high voltage transients
- High frequency power supply: feedback control, maintain floating ground
- Relay contact monitor: isolate floating grounds and transients
- Power supply monitor: isolate transients and ground systems

Package Dimensions



5

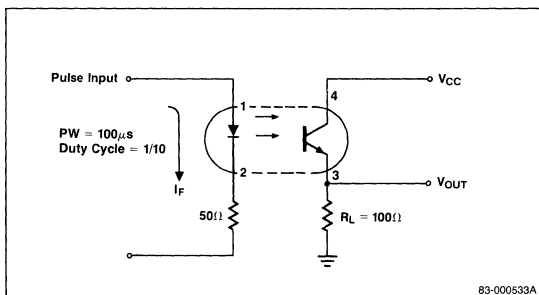
Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Diode	
Reverse Voltage, V_R	6.0V
Forward Current (DC), I_F	80mA
Power Dissipation, P_D	150mW
Peak Forward Current (300 μs , 2% duty cycle), I_F (peak)	3A
Transistor	
Collector to Emitter Voltage, V_{CE0}	40V
Emitter to Collector Voltage, V_{ECO}	7V
Collector Current, I_C	100mA
Power Dissipation, P_D	150mW
Isolation Voltage ¹ , BV	5000V _{AC}
Storage Temperature, T_{STG}	-55 $^\circ\text{C}$ to +150 $^\circ\text{C}$
Operating Temperature, T_{OPT}	-55 $^\circ\text{C}$ to +100 $^\circ\text{C}$
Lead Temperature (Soldering 10s), T_{SOL}	260 $^\circ\text{C}$
Total Power Dissipation, P_T	250mW

- Notes:**
1. Measuring Conditions: AC voltage for 1 min at $T_A = +25^\circ\text{C}$, RH = 60%.
 2. CTR rank: (PS2401A-1 only) K: 300% to 600%, L: 200% to 400%, M: 80% to 240%.
 3. Test circuit for switching time.

Test circuit for switching time



Electrical Characteristics

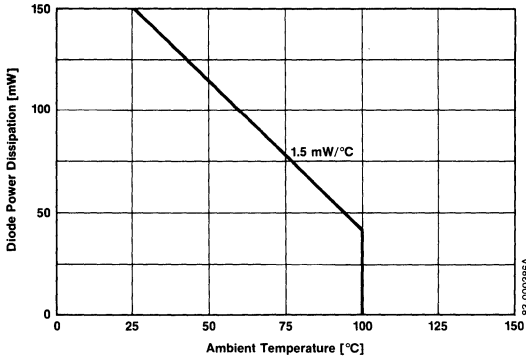
$T_A = +25^\circ\text{C}$

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Diode						
Forward Voltage	V_F	1.1	1.4		V	$I_F = 10\text{mA}$
Reverse Current	I_R			5	μA	$V_R = 5\text{V}$
Junction Capacitance	C		50		pF	$V = 0$, $f = 1.0\text{MHz}$
Transistor						
Collector to Emitter Dark Current	I_{CE0}			50	nA	$V_{CE} = 10\text{V}$, $I_F = 0$
Collector to Emitter Dark Current	I_{CE0}			100	nA	$V_{CE} = 40\text{V}$, $I_F = 0$
Collector to Emitter Breakdown Voltage	BV_{CE0}	40	60		V	$I_C = 1\text{mA}$, $I_B = 0$
Emitter to Collector Breakdown Voltage	BV_{ECO}	7	9		V	$I_E = 100\mu\text{A}$, $I_B = 0$
Coupled Current Transfer Ratio ²	CTR (I_C/I_F)	80		600	%	$I_F = 10\text{mA}$, $V_{CE} = 5.0\text{V}$
Collector Saturation Voltage	$V_{CE(sat)}$			0.3	V	$I_F = 10\text{mA}$, $I_C = 2.0\text{mA}$
Isolation Resistance	R_{1-2}	10^{11}			Ω	$V_{IN-OUT} = 1.0\text{kV}$
Isolation Capacitance	C_{1-2}		0.5		pF	$V = 0$, $f = 1.0\text{MHz}$
Rise Time ³	t_r		3		μs	$V_{CC} = 10\text{V}$, $I_C = 2\text{mA}$, $R_L = 100\Omega$
Fall Time ³	t_f		3		μs	$V_{CC} = 10\text{V}$, $I_C = 2\text{mA}$, $R_L = 100\Omega$

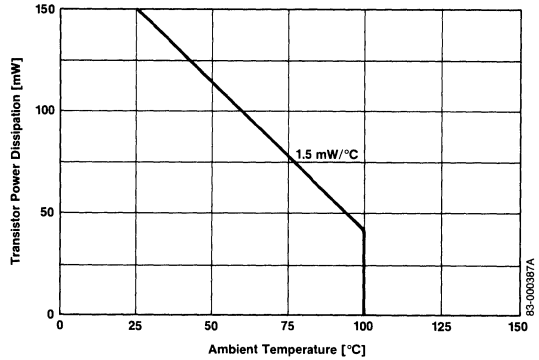
Typical Characteristics

$T_A = +25^\circ\text{C}$

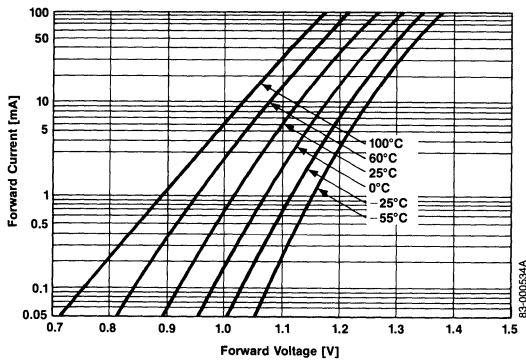
Diode Power Dissipation vs Ambient Temperature



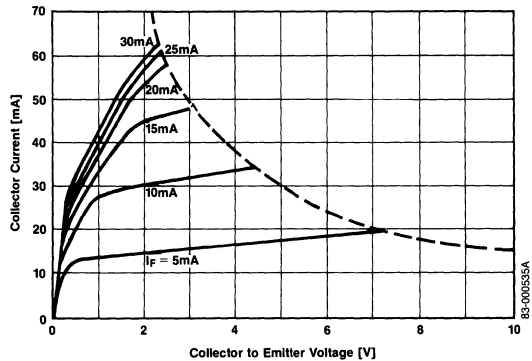
Transistor Power Dissipation vs Ambient Temperature



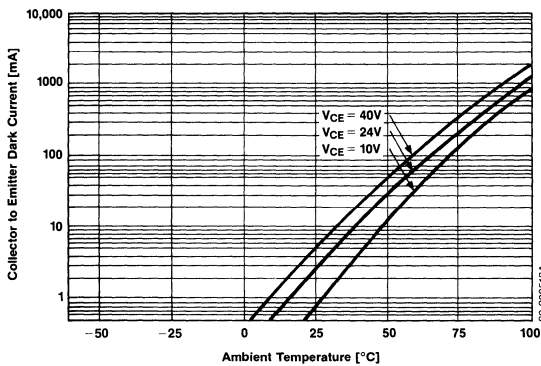
Forward Current vs Forward Voltage



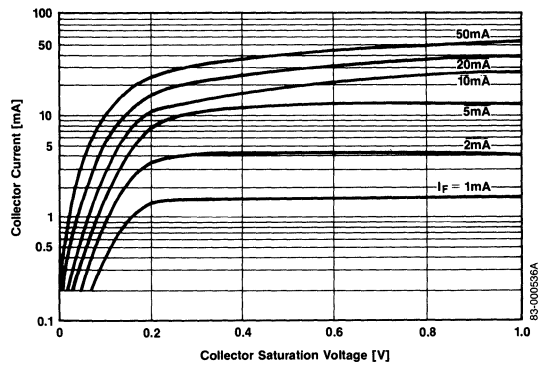
Collector Current vs Collector to Emitter Voltage



Collector to Emitter Dark Current vs Ambient Temperature

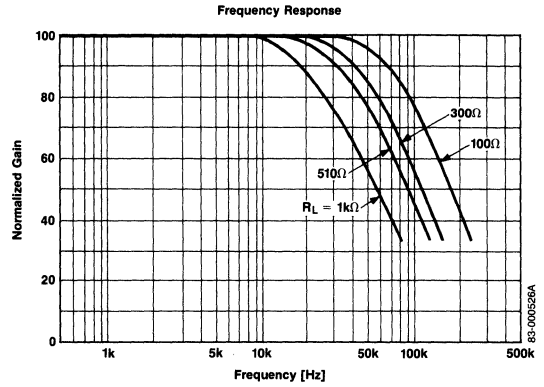
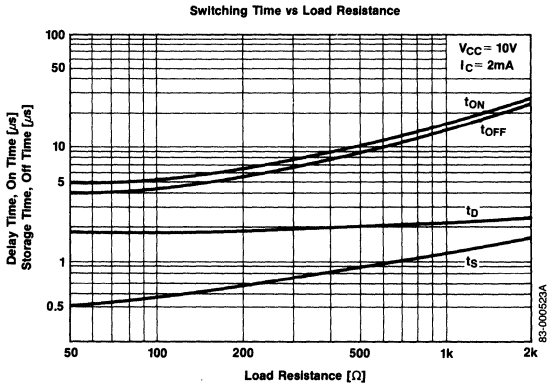
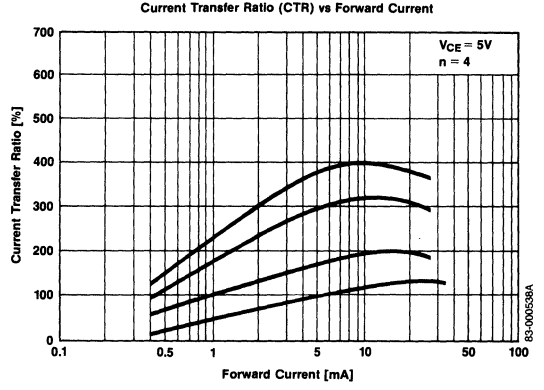
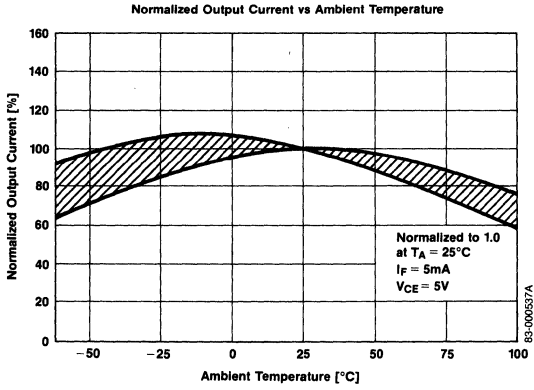


Collector Current vs Collector Saturation Voltage



Typical Characteristics (cont)

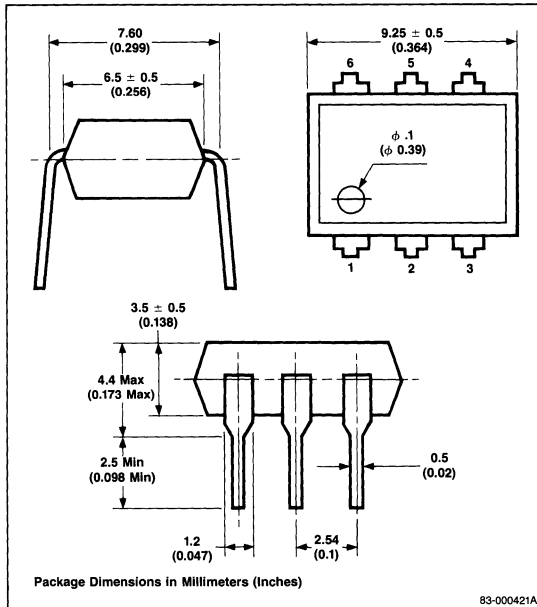
$T_A = +25^\circ\text{C}$



Description

The PS3001 and PS3002 are optically coupled isolators containing a GaAs infrared emitting diode and a PNP silicon photo SCR.

Package Dimensions



Features

- High voltage isolation: 2000V_{AC} min
- Low turn-on current: 12mA max
- Plastic dual-in-line package
- High-speed switching
- Economical, compact

Applications

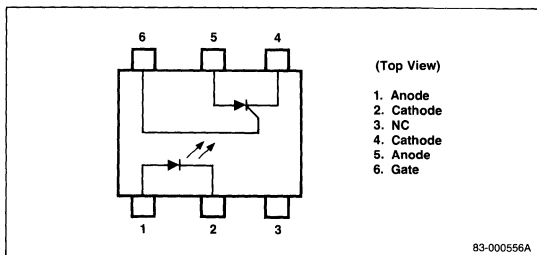
- Interface circuit for various instruments and control equipment
- Replacement for reed relays

Absolute Maximum Ratings

T_A = +25°C

Diode	
Reverse Voltage, V _R	6V
Forward Current (DC), I _F	80mA
Peak Forward Current, I _{FP}	3A
Power Dissipation, P _D	100mW
SCR	
Peak Off and Reverse Voltage, V _{DRM} , V _{RRM}	PS3001 200V
Peak Off and Reverse Voltage, V _{DRM} , V _{RRM}	PS3002 400V
Direct On-Site Current, I _T	300mA
Peak Pulse Current ¹ , I _{TP}	3A
Peak Surge on Current, I _{TSM}	3A
Power Dissipation, P _D	350mW
Isolation Voltage ² , BV	2500V _{DC}
Storage Temperature, T _{STG}	-55°C to +125°C
Operating Temperature, T _{OPT}	-55°C to +100°C
Lead Soldering Time (at 260°C)	10s

Pin Connection



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Electrical Characteristics

$T_A = +25^\circ\text{C}$

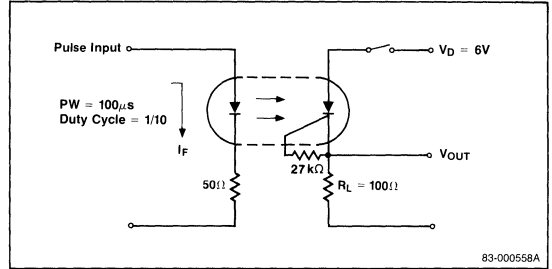
Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Diode						
Forward Voltage	V_F	1.1	1.4		V	$I_F = 20\text{mA}$
Reverse Current	I_R		10		μA	$V_R = 6\text{V}$
Junction Capacitance	C_T	50			pf	$V = 0$, $f = 1.0\text{MHz}$
Photo SCR						
Peak Off-State Current	I_{DRM}		10		μA	$V_{DRM} = \text{Rated}$ $R_{GK} = 27\text{k}\Omega$ $T_A = +100^\circ\text{C}$
Reverse Current	I_{RRM}		10		μA	
On State Voltage	V_{TM}		1.3		V	$I_T = 300\text{mA}$
Holding Current	I_H	0.2	1		mA	$R_{GK} = 27\text{k}\Omega$, $V_D = 24\text{V}$
Rate of Rise of Forward Blocking Voltage	dV/dt	0.5	1.0		$\text{V}/\mu\text{s}$	$V_{DRM} = \text{Rated}$ $R_{GK} = 27\text{k}\Omega$, $T_A = +100^\circ\text{C}$
Coupled Turn on Current	I_{FT}	5	12		mA	$V_D = 6\text{V}$, $R_{GK} = 27\text{k}\Omega$
Isolation Breakdown Voltage	V_{1-2}	2500			V_{DC}	DC/1 min
Isolation Resistance	R_{1-2}	10^{11}			Ω	$V_{IN-OUT} = 1.0\text{kV}$
Isolation Capacitance	C_{1-2}	0.8			pF	$V = 0$, $f = 1.0\text{MHz}$
Turn-on Time ³	t_{ON}	10			μs	$I_{FT} = 50\text{mA}$, $V_D = 6\text{V}$, $R_{GK} = 27\text{k}\Omega$, $R_L = 100\Omega$

Notes: 1. Pulse width = $100\mu\text{s}$, repetition frequency = 100Hz .

2. Measuring Conditions: DC voltage for 1 minute at $T_A = +25^\circ\text{C}$; RH = 60% between input (pins 1, 2, and 3 common) and output (pins 4, 5, and 6 common).

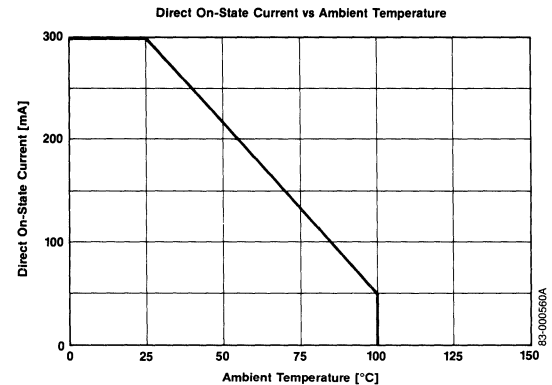
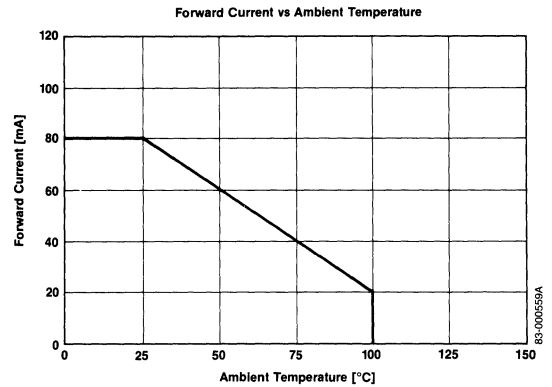
3. Turn-on time test circuit.

Turn-on test circuit



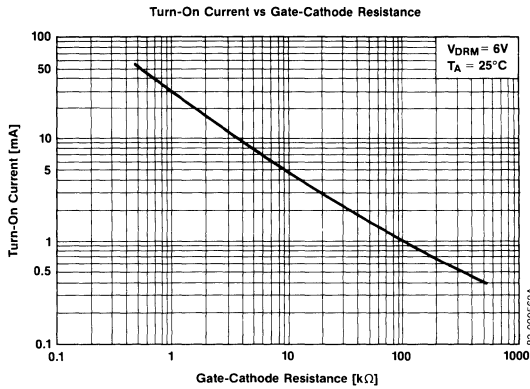
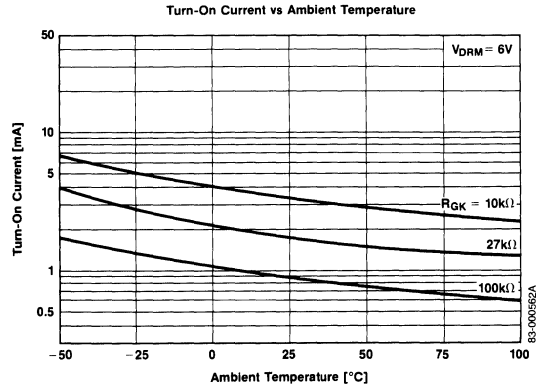
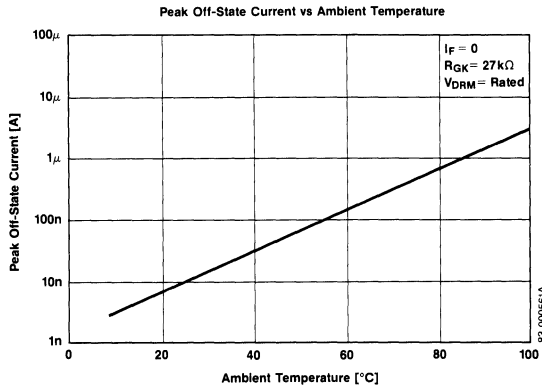
Typical Characteristics

$T_A = +25^\circ\text{C}$



Typical Characteristics (cont)

$T_A = +25^\circ\text{C}$

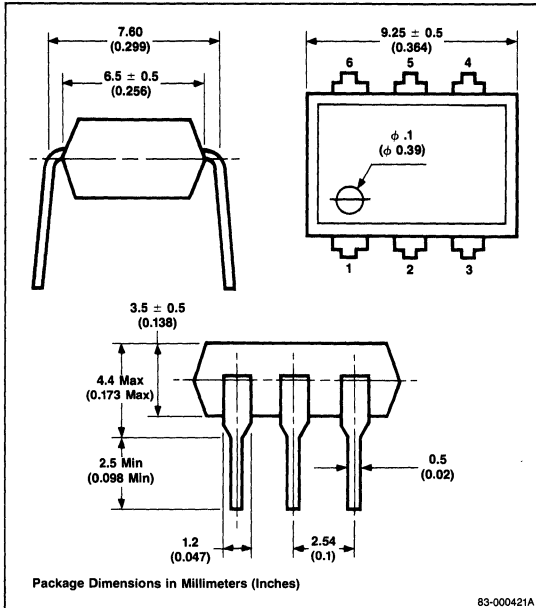


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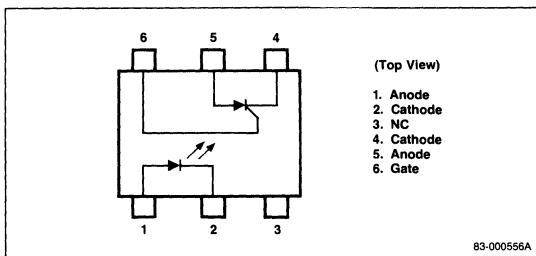
Description

The PS3001(1) and PS3002(1) are optically coupled isolators containing a GaAs infrared emitting diode and a PNP silicon photo SCR.

Package Dimensions



Pin Connection



Features

- High voltage isolation: 2500V_{AC} min
- Low turn-on current: 12mA max
- Plastic dual in-line package
- High-speed switching
- Economical, compact

Applications

- Interface circuits for various instruments and control equipment
- Replacement for reed relays

Absolute Maximum Ratings

T_A = +25°C

Diode	
Reverse Voltage, V _R	6V
Forward Current (DC), I _F	80mA
Peak Forward Current, I _{PF}	3A
Power Dissipation, P _D	100mW
SCR	
Peak Off and Reverse Voltage, V _{DRM} , V _{RRM}	PS3001(1) 200V
Peak Off and Reverse Voltage, V _{DRM} , V _{RRM}	PS3002(1) 400V
Direct On-State Current, I _T	300mA
Peak Pulse Current ¹ , I _{TP}	3A
Peak Surge on Current, I _{TSM}	3A
Power Dissipation, P _D	350mW
Isolation Voltage ² , BV	2500V _{AC}
Storage Temperature, T _{STG}	-55°C to +125°C
Operating Temperature, T _{OPT}	-55°C to +100°C
Lead Soldering Time (at 260°C)	10s

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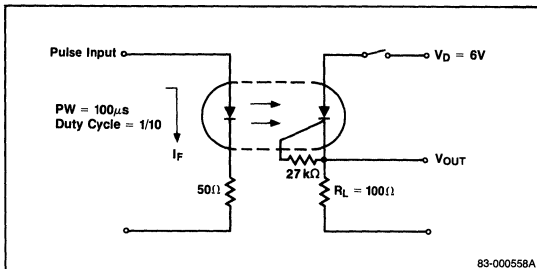
Electrical Characteristics

$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Diode						
Forward Voltage	V_F	1.1	1.4		V	$I_F = 20\text{mA}$
Reverse Current	I_R			10	μA	$V_R = 6\text{V}$
Junction Capacitance	C_T	50			pF	$V = 0$, $f = 1.0\text{MHz}$
Photo SCR						
Peak Off-State Current	I_{DRM}			10	μA	$V_{DRM} = \text{rated}$ $R_{GK} = 27\text{k}\Omega$ $T_A = +100^\circ\text{C}$
Reverse Current	I_{RRM}			10	μA	
On State Voltage	V_{TM}			1.3	V	$I_T = 300\text{ma}$
Holding Current	I_H	0.2	1		mA	$R_{GK} = 27\text{k}\Omega$, $V_D = 24\text{V}$
Rate of Rise of Forward Blocking Voltage	dV/dt	0.5	1.0		$\text{V}/\mu\text{s}$	$V_{DRM} = \text{Rated}$ $R_{GK} = 27\text{k}\Omega$, $T_A = +100^\circ\text{C}$
Coupled						
Turn on Current	I_{FT}		5	12	mA	$V_D = 6\text{V}$, $R_{GK} = 27\text{k}\Omega$
Isolation Breakdown Voltage	V_{1-2}	2500			V_{DC}	DC/1 min
Isolation Resistance	R_{1-2}	10^{11}			Ω	$V_{IN-OUT} = 1.0\text{kV}$
Isolation Capacitance	C_{1-2}	0.8			pF	$V = 0$, $f = 1.0\text{MHz}$
Turn On Time ³	t_{ON}		10		μs	$I_{FT} = 50\text{mA}$, $V_D = 6\text{V}$ $R_{GK} = 27\text{k}\Omega$, $R_L = 100\Omega$

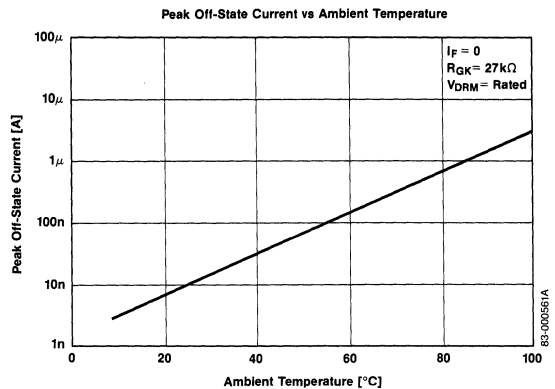
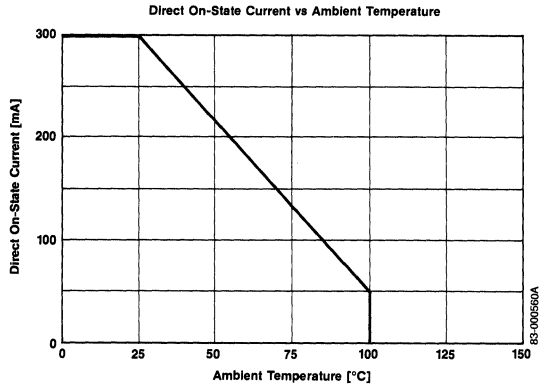
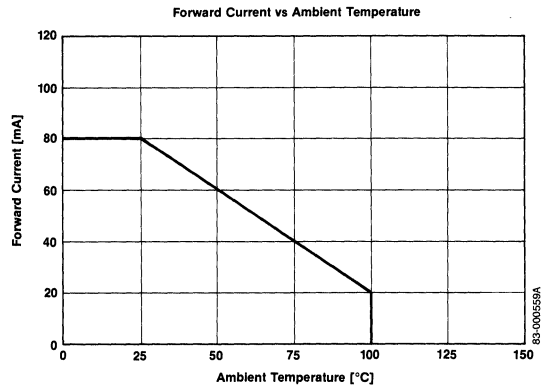
- Notes:**
1. Pulse width = $100\mu\text{s}$, repetition frequency = 100Hz.
 2. Measuring Conditions: DC voltage for 1 min at $T_A = +25^\circ\text{C}$; RH = 60% between input (pins 1, 2, and 3 common) and output (pins 4, 5, and 6 common).
 3. Turn-on time test circuit.

Turn-on test circuit



Typical Characteristics

$T_A = +25^\circ\text{C}$



Typical Characteristics (cont)

$T_A = +25^\circ\text{C}$

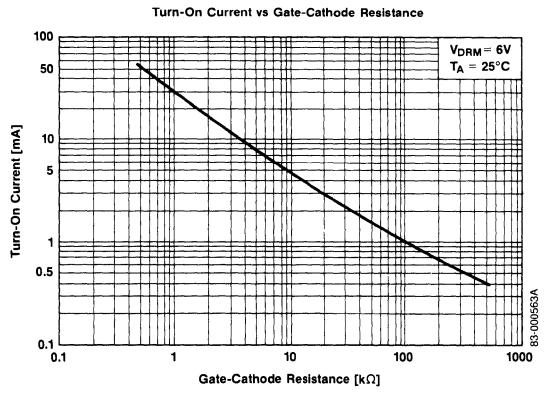
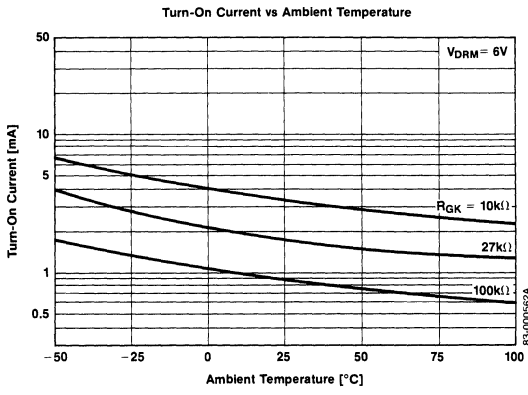


PHOTO INTERRUPTERS

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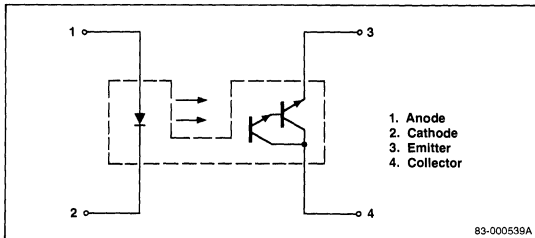
Section 6 — Photo Interrupters

PS4001, PS4003, PS4005, PS4007, PS4009, PS4010, PS4011 Photo Interrupters 6-3
PS4008 Photo Interrupter 6-9
PS4014 Photo Interrupter 6-11
PS6001A Photo Reflective Sensor 6-13
Optoelectronics Applications Note Photo Interrupter 6-17

Description

The PS4001, PS4003, PS4005, PS4007, and PS4009 are photo coupled interrupter modules containing a GaAs light emitting diode and an NPN silicon Darlington connected photo transistor.

Pin Connection



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Diode	
Reverse Voltage, V_R	5.0V
Forward Current, I_F	50mA
Power Dissipation, P_D	100mW
Transistor	
Collector to Emitter Voltage, V_{CE0}	30V
Collector Current, I_C	50mA
Power Dissipation, P_D	100mW
Storage Temperature, T_{STG}	-40°C to $+100^\circ\text{C}$
Operating Temperature, T_{OPT}	-20°C to $+80^\circ\text{C}$

Electrical Characteristics

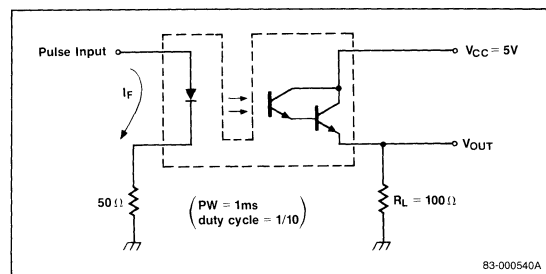
$T_A = +25^\circ\text{C}$

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Diode						
Forward Voltage	V_F	1.1	1.4		V	$I_F = 20\text{mA}$
Reverse Current	I_R		20		μA	$V_R = 4.0\text{V}$
Junction Capacitance	C	100			pF	$V = 0$, $f = 1.0\text{MHz}$
Transistor						
Collector to Emitter Dark Current	I_{CEO}		400		nA	$V_{CE} = 10\text{V}$, $I_F = 0$
Coupled						
Current Transfer Ratio	CTR (I_C/I_F)	20 ¹			%	$I_F = 10\text{mA}$, $V_{CE} = 2.0\text{V}$
Collector Saturation Voltage	$V_{CE(sat)}$		1.2		V	$I_F = 10\text{mA}$, $I_C = 0.5\text{mA}$
Rise Time	t_r		200		μs	$V_{CC} = 5.0\text{V}$, $I_C = 2.0\text{mA}$, $R_L = 100\Omega^2$
Fall Time	t_f		200		μs	$V_{CC} = 5.0\text{V}$, $I_C = 2.0\text{mA}$, $R_L = 100\Omega^2$

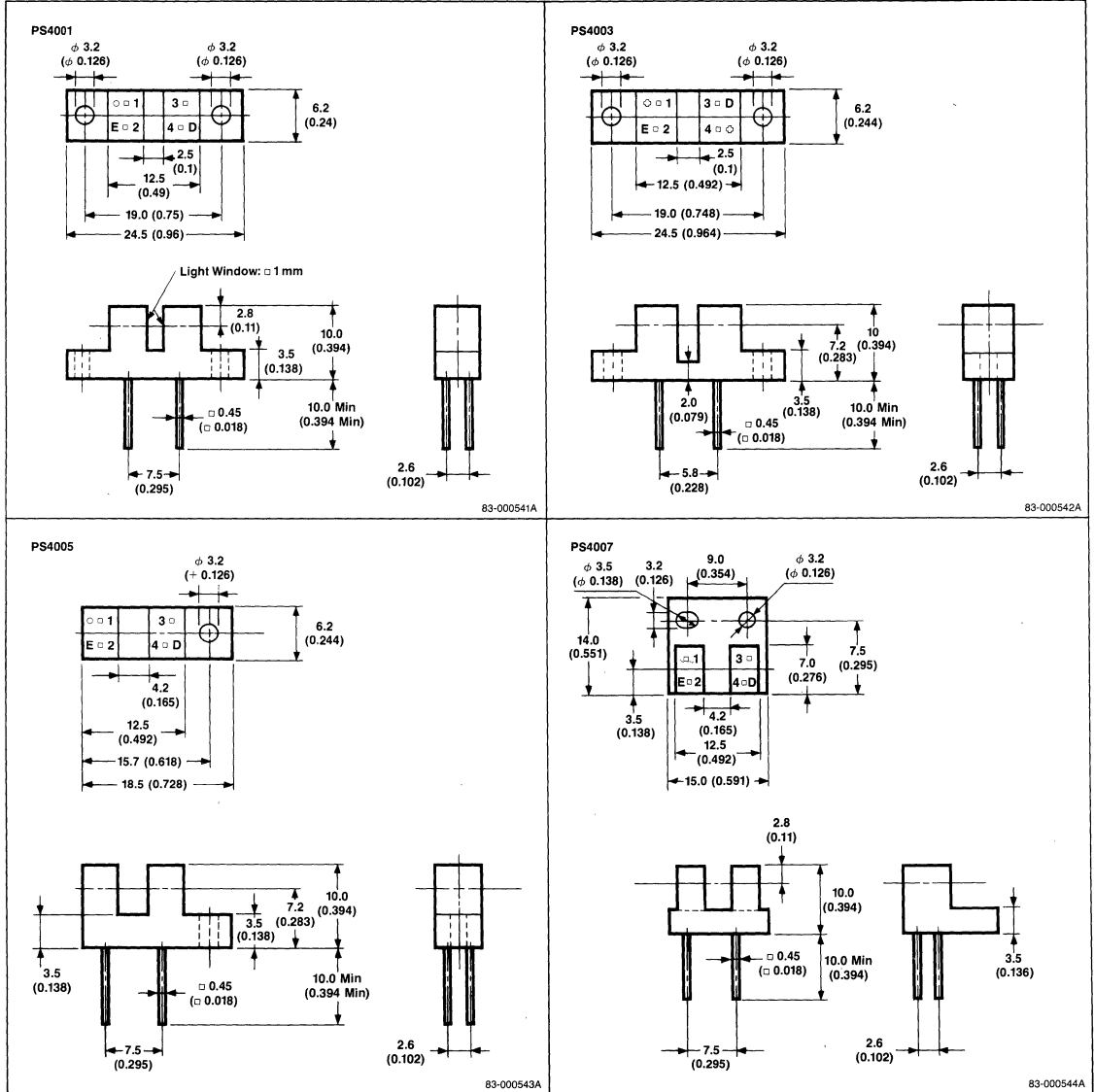
Notes: 1. PS4003: 15% min., others: 20% min.

2. Test circuit for switching time.

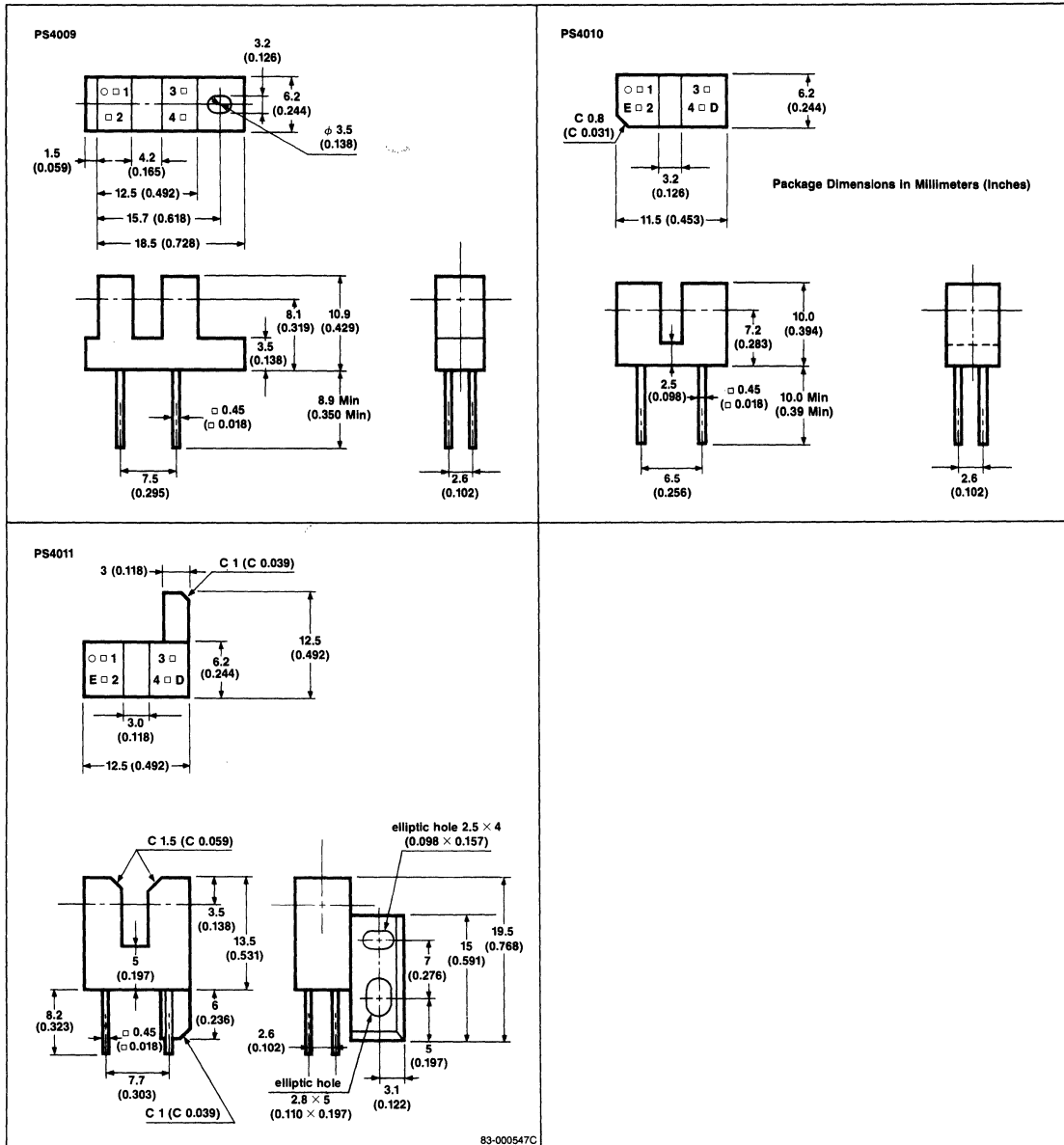
Test circuit for switching time



Package Dimensions

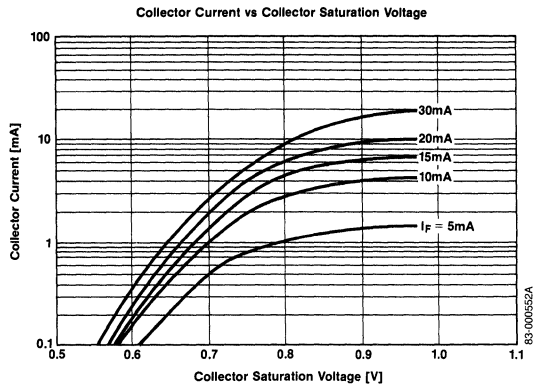
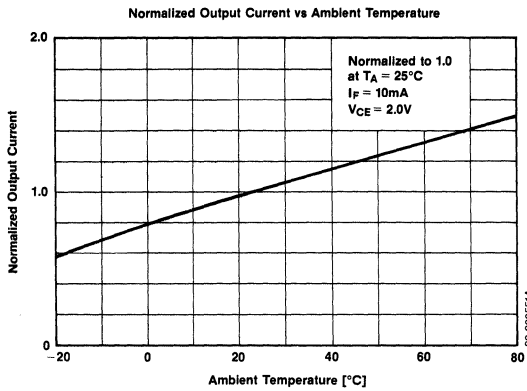
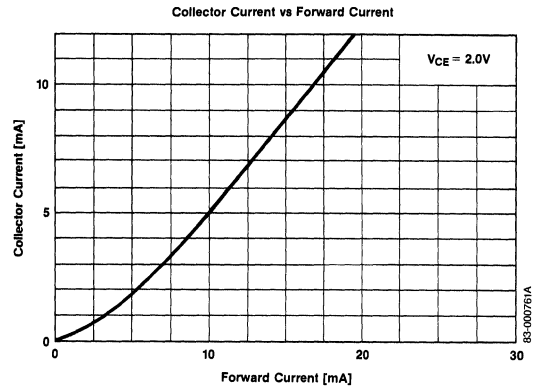
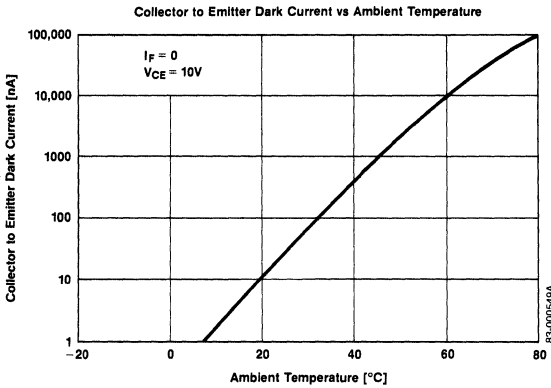
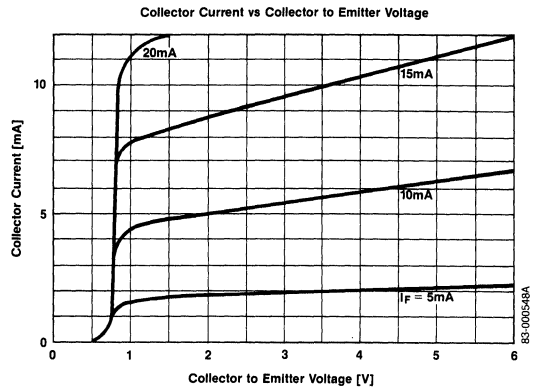
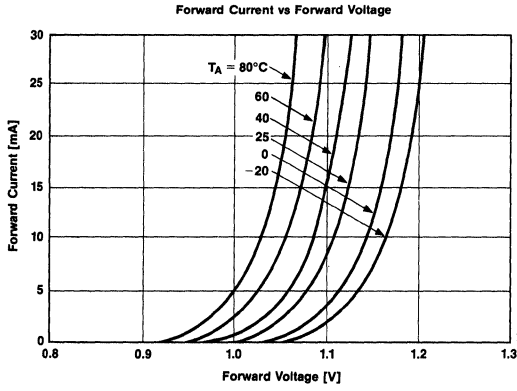


Package Dimensions (cont)



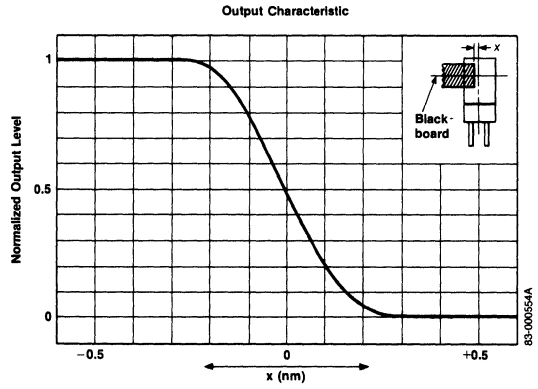
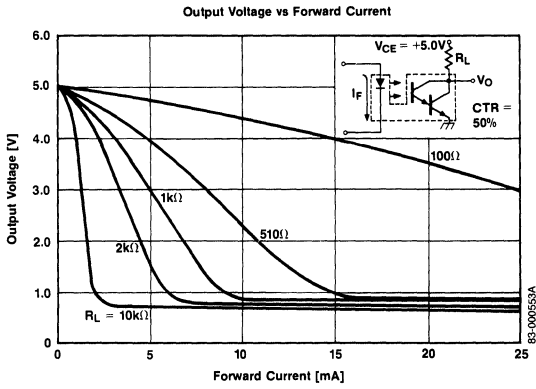
Typical Characteristics

$T_A = +25^\circ\text{C}$

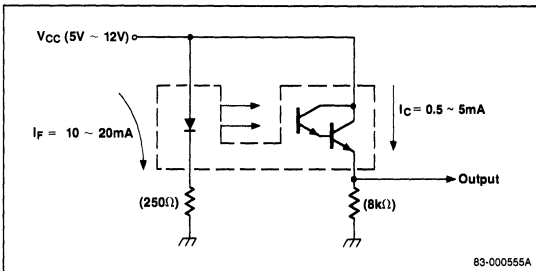


Typical Characteristics (cont)

$T_A = +25^\circ\text{C}$



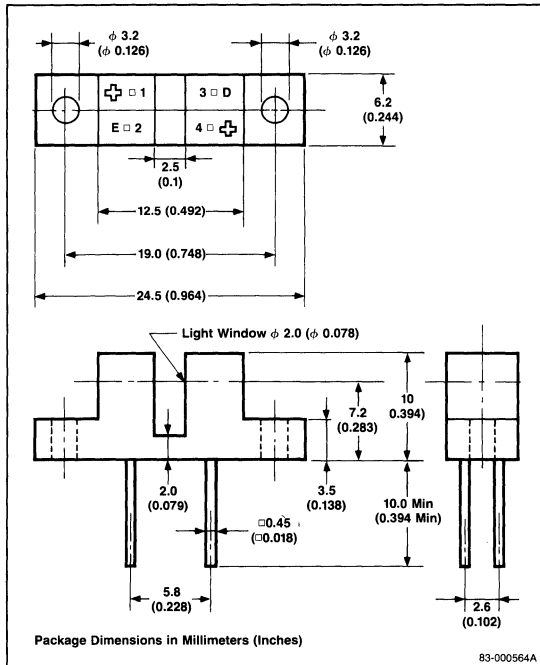
Typical Applications



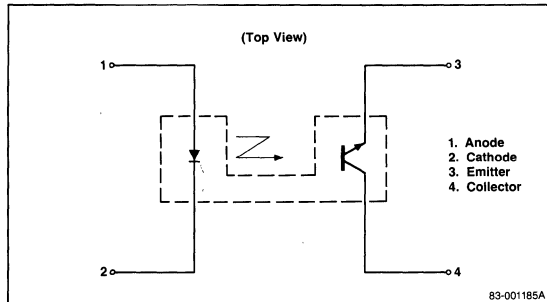
Description

The PS4008 is a photo coupled interrupter module containing a GaAs light emitting diode and an NPN silicon photo transistor.

Package Dimensions



Pin Connection



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

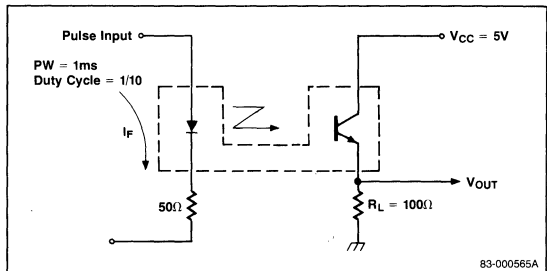
Diode	
Reverse Voltage, V_R	5.0V
Forward Current, I_F	50mA
Power Dissipation, P_D	100mW
Transistor	
Collector to Emitter Voltage, V_{CE0}	30V
Collector Current, I_C	40mA
Power Dissipation, P_D	100mW
Storage Temperature, T_{STG}	-40°C to $+100^\circ\text{C}$
Operating Temperature, T_{OPT}	-20°C to $+80^\circ\text{C}$

Electrical Characteristics

$T_A = +25^\circ\text{C}$

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Diode						
Forward Voltage	V_F	1.1	1.4		V	$I_F = 20\text{mA}$
Reverse Current	I_R		20		μA	$V_R = 4.0\text{V}$
Junction Capacitance	C	100			pF	$V = 0$, $f = 1.0\text{MHz}$
Transistor						
Collector to Emitter Dark Current	I_{CE0}		100		nA	$V_{CE} = 10\text{V}$, $I_F = 0$
Coupled Output Current	I_C	50	200		μA	$I_F = 10\text{mA}$, $V_{CE} = 2.0\text{V}$
Collector Saturation Voltage	$V_{CE(sat)}$		0.3		V	$I_F = 10\text{mA}$, $I_C = 50\mu\text{A}$
Rise Time	t_r		5		μs	$V_{CC} = 5.0\text{V}$, $I_C = 50\mu\text{A}$, $R_L = 100\Omega^1$
Fall Time	t_f		5		μs	$V_{CC} = 5.0\text{V}$, $I_C = 50\mu\text{A}$, $R_L = 100\Omega^1$

Notes: 1. Test circuit for switching time.

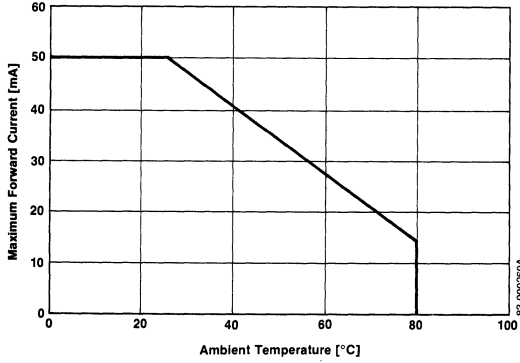


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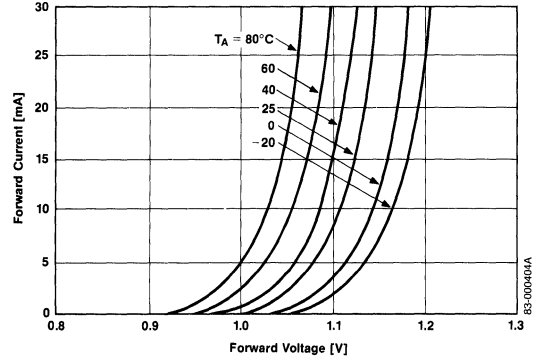
Typical Characteristics

$T_A = +25^\circ\text{C}$

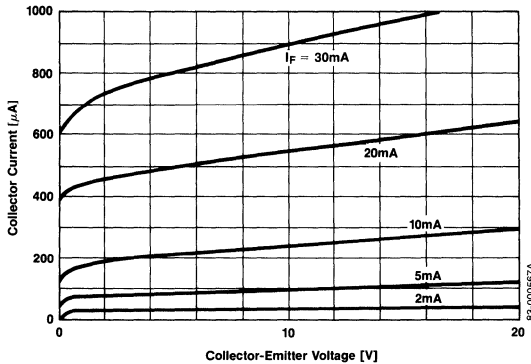
Maximum Forward Current vs Ambient Temperature



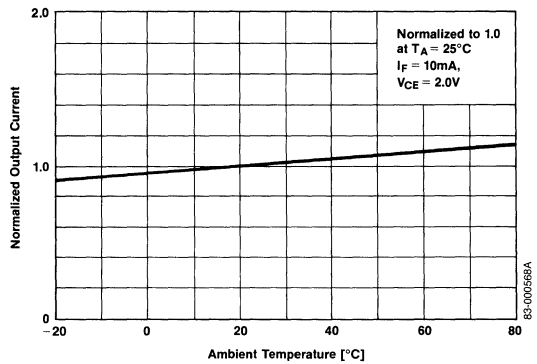
Forward Current vs Forward Voltage



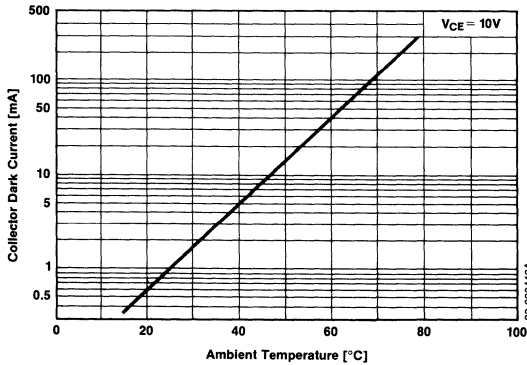
Collector Current vs Collector Emitter Voltage



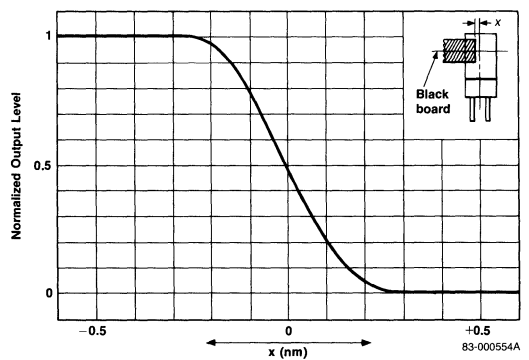
Normalized Output Current vs Ambient Temperature



Collector Dark Current vs Ambient Temperature



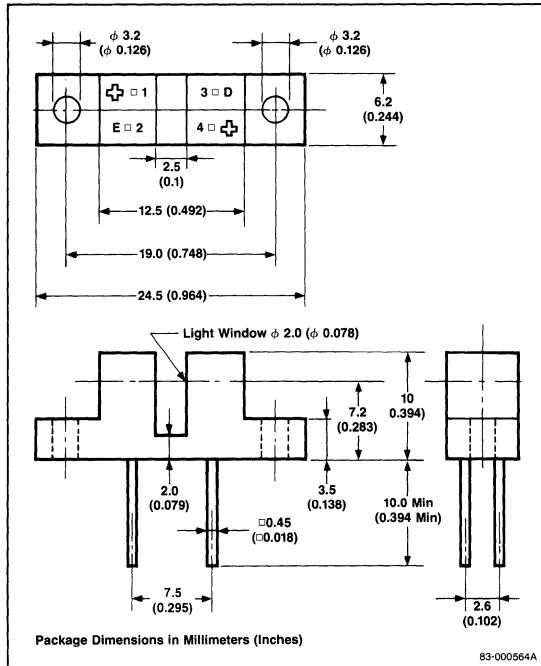
Output Characteristic



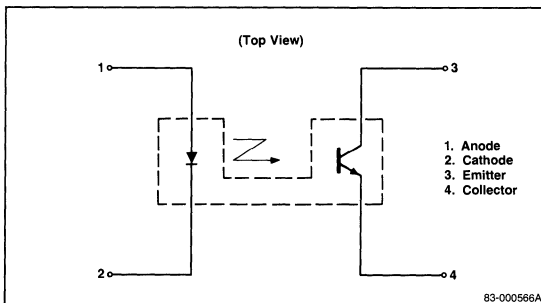
Description

The PS4014 is a photo coupled interrupter module containing a GaAs light emitting diode and an NPN silicon photo transistor.

Package Dimensions



Pin Connection



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

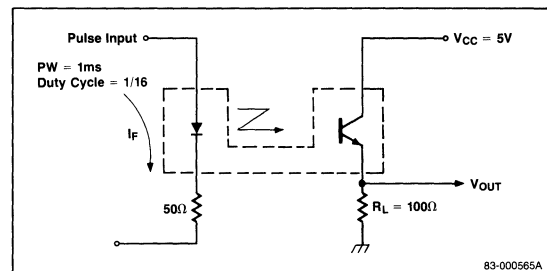
Diode	
Reverse Voltage, V_R	5.0V
Forward Current, I_F	50mA
Power Dissipation, P_D	100mW
Transistor	
Collector to Emitter Voltage, V_{CE0}	30V
Collector Current, I_C	40mA
Power Dissipation, P_D	100mW
Storage Temperature, T_{STG}	-40°C to $+100^\circ\text{C}$
Operating Temperature, T_{OPT}	-20°C to $+80^\circ\text{C}$

Electrical Characteristics

$T_A = +25^\circ\text{C}$

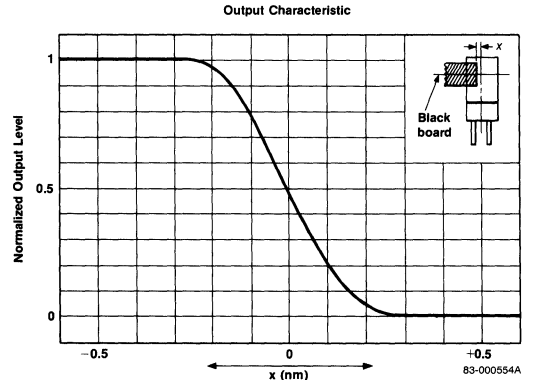
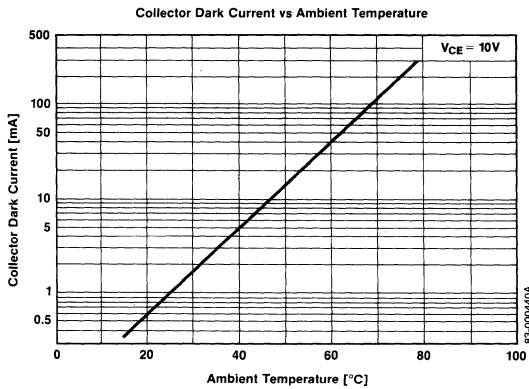
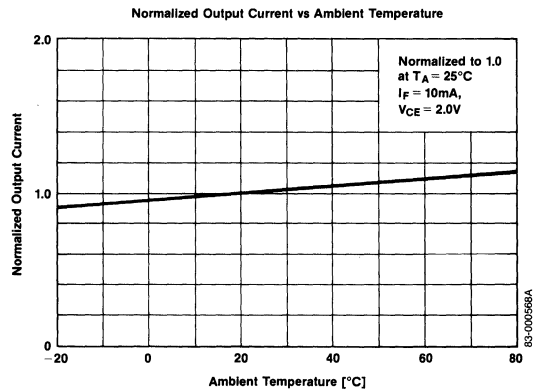
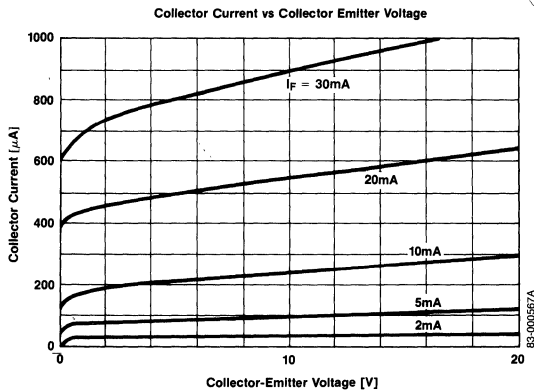
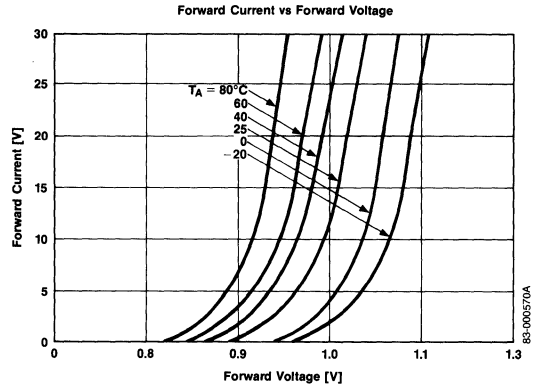
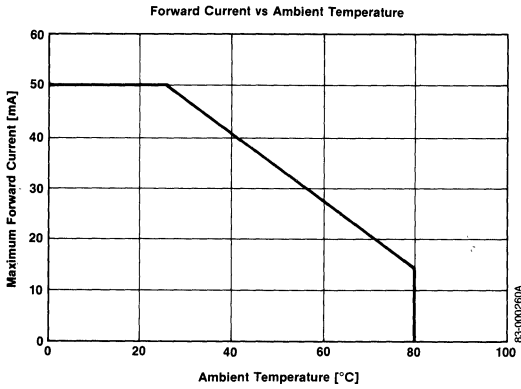
Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Diode						
Forward Voltage	V_F	1.1	1.4		V	$I_F = 20\text{mA}$
Reverse Current	I_R		20		μA	$V_R = 4.0\text{V}$
Junction Capacitance	C	100			pF	$V = 0$, $f = 1.0\text{MHz}$
Transistor						
Collector to Emitter Dark Current	I_{CE0}		100		nA	$V_{CE} = 10\text{V}$, $I_F = 0$
Coupled						
Output Current	I_C	200	500		μA	$I_F = 20\text{mA}$, $V_{CE} = 5.0\text{V}$
Collector Saturation Voltage	$V_{CE(sat)}$		0.3		V	$I_F = 10\text{mA}$, $I_C = 50\mu\text{A}$
Rise Time	t_r		5		μs	$V_{CC} = 5.0\text{V}$, $I_C = 50\mu\text{A}$, $R_L = 100\Omega$
Fall Time	t_f		5		μs	$V_{CC} = 5.0\text{V}$, $I_C = 50\mu\text{A}$, $R_L = 100\Omega$

Note: 1. Test circuit for switching time



Typical Characteristics

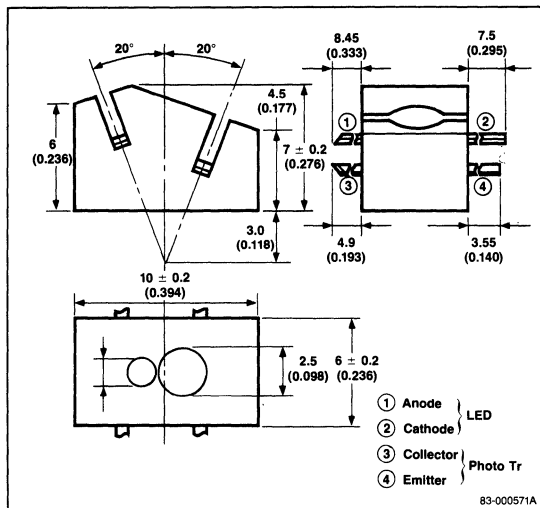
$T_A = +25^\circ\text{C}$



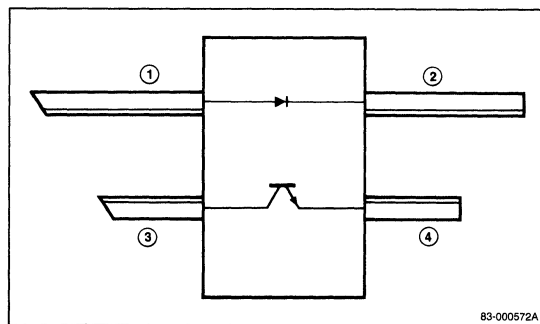
Description

The PS6001A is a photo reflective sensor containing a GaAs light emitting diode and an NPN silicon photo transistor.

Package Dimensions



Pin Connection



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

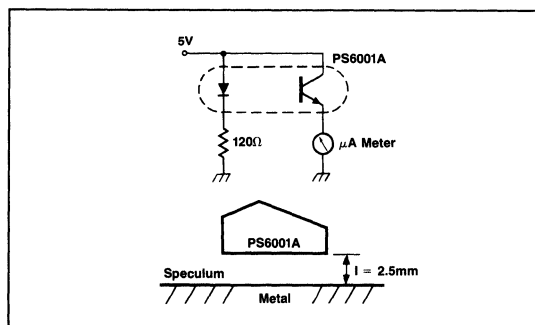
Diode	
Reverse Voltage, V_R	3V
Forward Current, I_F	50mA
Power Dissipation, P_D	75mW
Transistor	
Collector to Emitter Voltage, V_{CE0}	30V
Collector Current, I_C	40mA
Power Dissipation, P_D	100mW
Junction Temperature, T_J	80°C
Storage Temperature, T_{STG}	-30°C to +80°C

Electrical Characteristics

$T_A = +25^\circ\text{C}$

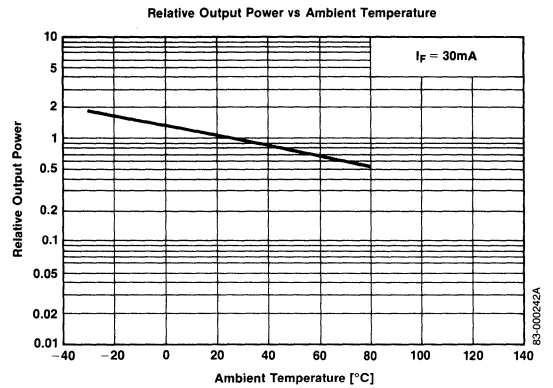
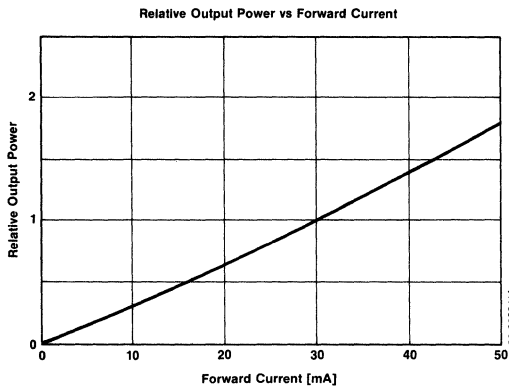
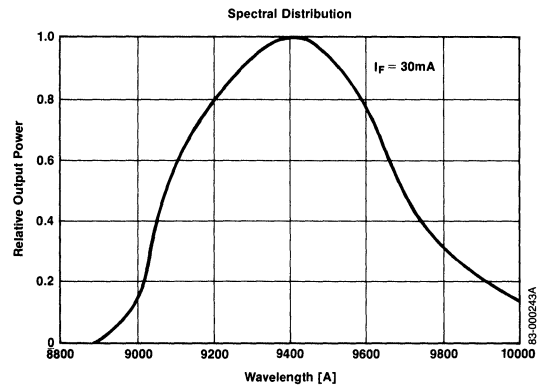
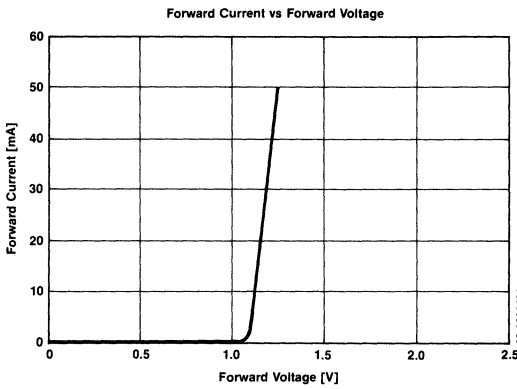
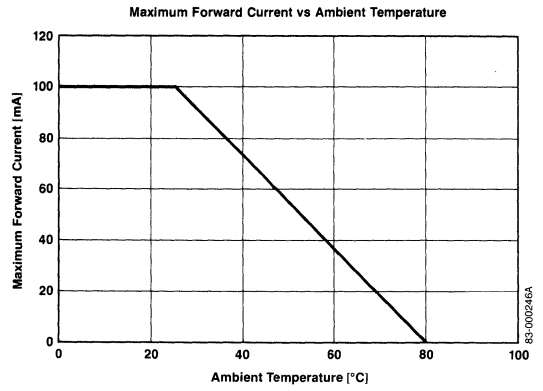
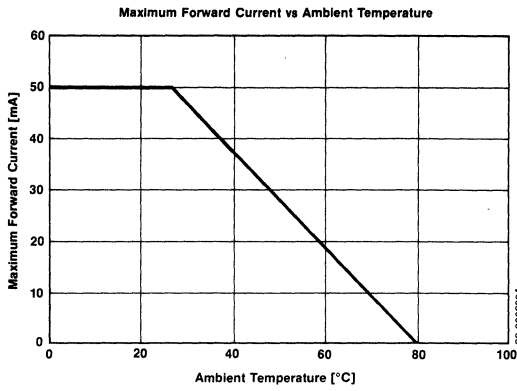
Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F		1.2	1.4	V	$I_F = 30\text{mA}$
Reverse Current	I_R			50	μA	$V_R = 3\text{V}$
Peak Emission Wavelength	λ_{PEAK}		940		nm	$I_F = 30\text{mA}$
Collector Saturation Voltage	$V_{CE(SAT)}$		0.3		V	$I_C = 20\mu\text{A}$
Output Leak Current	I_{LEAK}			1.0	μA	$I_F = 30\text{mA}$, $V_{CE} = 5\text{V}$, $L = 0\text{lx}$
Output Current	I_C	100	200		μA	Note 1

Note 1: Test circuit for switching time.



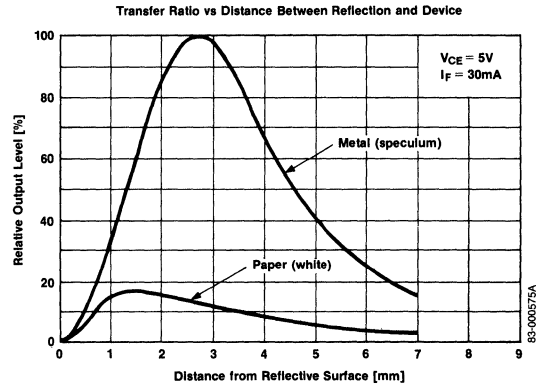
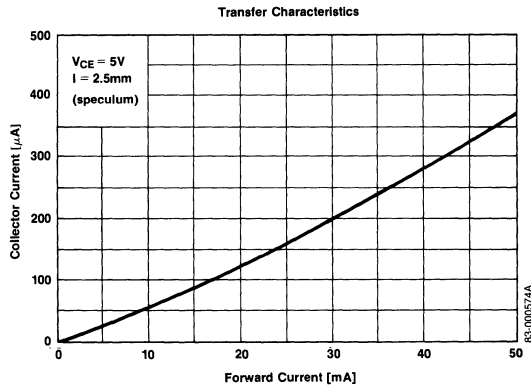
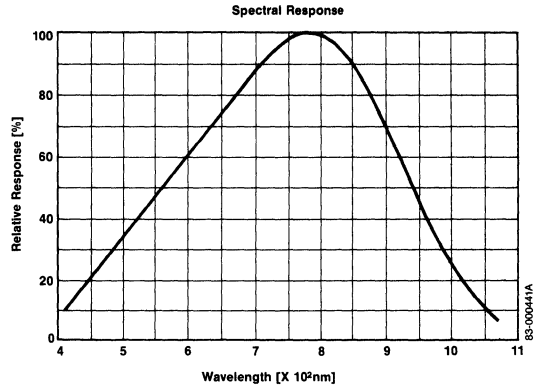
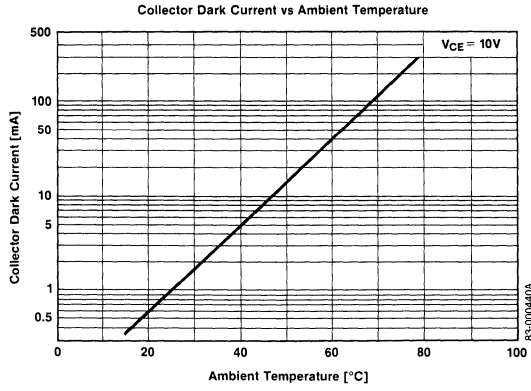
Typical Characteristics

$T_A = +25^\circ\text{C}$



Typical Characteristics (cont)

$T_A = +25^\circ\text{C}$



This application note is written for the designer of non-contact detector systems using photo interrupters, to choose the appropriate photo emitting and photo detecting elements.

1. Photo Emitter and Detector

The two photo emitters to be discussed in this note are the NEC SE304 (Infrared LED) and the SR110 (Red LED). The two photo detectors to be discussed are the NEC PH103 (Darlington Photo Transistor) and the PH104 (Photo Transistor). Other devices in these categories are available, but their use as photo detector elements is not recommended.

One of the most important electrical characteristics of photo interrupter devices is the efficiency of photo energy transfer from the emitter to the detector. Current Transfer Ratio (CTR) is generally measured at some given distance. In the graph of Figures 1 and 2 the distance from emitter to detector is 4.2mm (which matches that of the PS4001 photo interrupter device), using the SE304 Infrared LED and the SR110 Red LED as emitters and the PH103 and PH104 Photo transistors as detectors, respectively.

Infrared LEDs are more efficient as emitters, and NEC recommends the SE304 in combination with either the PH103 or PH104 in the majority of applications. All photo interrupters produced by NEC are designed by using one of these combinations because of their superior efficiency, stability, and operating characteristics.

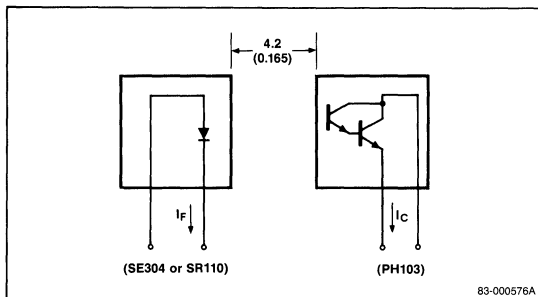
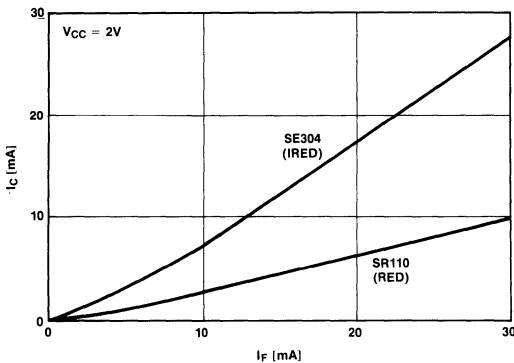


Figure 1. CTR with the PH103 as a Photo Detector

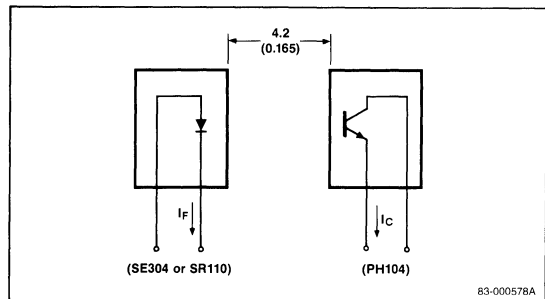
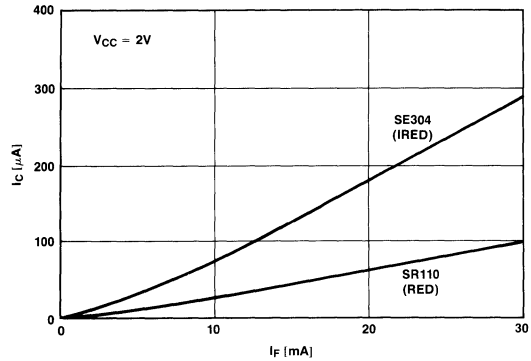


Figure 2. CTR with the PH104 as a Photo Detector

2. Light Receiving Characteristics of Photo Transistors

The shape and material used in manufacturing photo interrupters are major design considerations. The primary consideration is the relationship of output current of the photo transistor to the proportion of the sensitive area being masked. Figure 3 illustrates the characteristic curve of the PH103 with the surface views and schematic. As shown, just a 0.3mm displacement of the interrupter with respect to the detector die will shift the output level from 99% (A) to 10% (C).

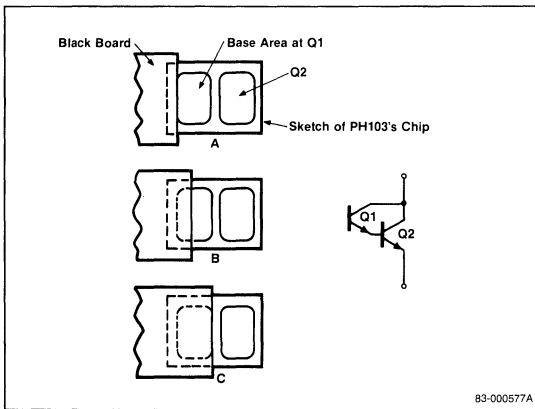
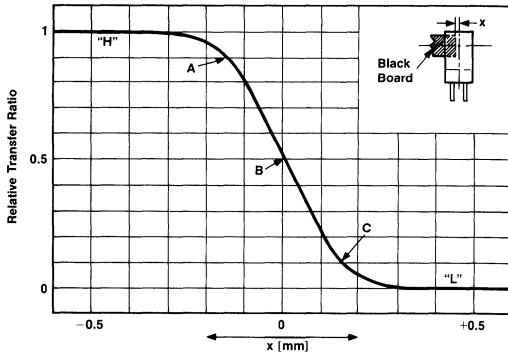


Figure 3. Masking (Shade) Effect

3. Using the PS4008 as a High-Speed Interrupter

This application deals with interrupters using a rotating disk as the interrupting element. Using a Darlington photo transistor (PH103 type) as the detector device, the frequency range of the transistor is generally the limiting factor. In this example the limit is about 1kHz. Since most of the applications for this type of interrupter involve frequencies below 1kHz, speed is not a problem. In applications requiring speeds greater than 1kHz, a single photo transistor (PH104) is recommended.

The PS4008 photo interrupter is used to illustrate the following application and its characteristics are shown in Figure 5.

The slotted disk shown in Figure 4 was rotated at 10,000 to 30,000RPM, and the output of the PS4008 was monitored on an oscilloscope. The output frequency ranged from 7kHz to 20kHz. At 7kHz and $I_F = 10\text{mA}$, the photo transistor load R_L could go as high as 10K Ω , and an output voltage of 900mV peak to peak could still be obtained. The data in Figure 5 shows the resulting data

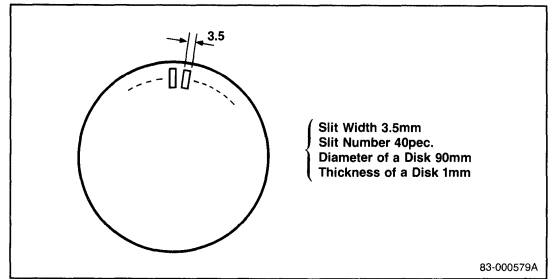


Figure 4. Sketch of a Disk

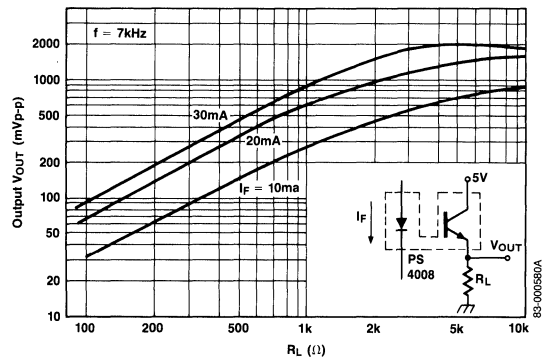


Figure 5. PS4008 Switching Characteristics

taken with the emitter loaded. Loading the collector would give similar results.

Figure 6 shows the output voltage to LED forward current (I_F) at 7kHz and a fixed load of 1.1K Ω .

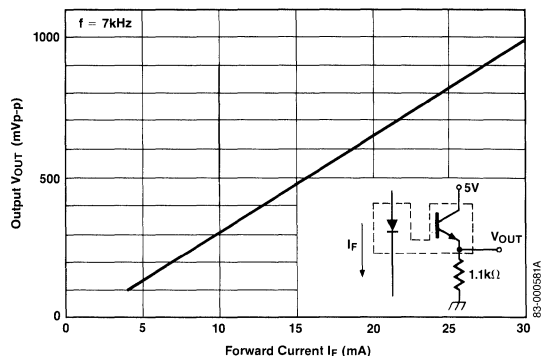


Figure 6. $I_F - V_{OUT}$ Characteristic

Figure 7 illustrates the output voltage versus frequency characteristics when the output frequency range is from 7kHz to 20kHz and the load resistance is 1.1kΩ. The implementation of a mechanical interrupter at 20kHz generally is difficult, but most of the problems can be overcome by using the application circuit in Figure 8 and reshaping the output waveform with a precision comparator.

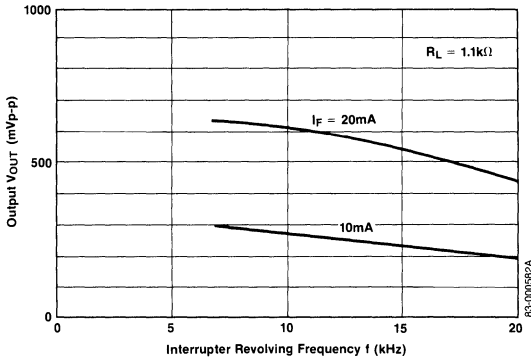


Figure 7. PS4008 Frequency Characteristics

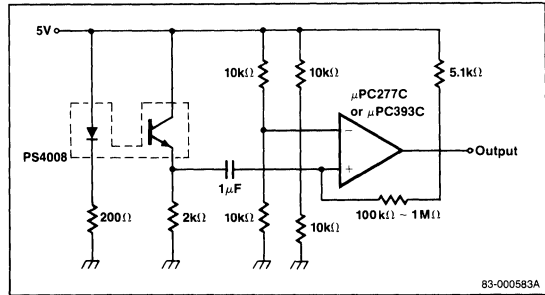


Figure 8. PS4008 Application Circuit

PHOTO TRANSISTORS AND PHOTO DIODES

7

Section 7 — Photo Transistors and Photo Diodes

PH101 NPN Epitaxial Darlington Photo Transistor Photo Detector 7-3
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Description

The PH101 is a miniature NPN silicon photo transistor having exceptionally stable characteristics and high illuminance sensitivity mounted in a two-terminal MICRO-DISK package. The spectral response, extending from 4000 to 10,000Å, is compatible with daylight, tungsten and gallium arsenide sources. The packaging of this unit permits close spacing in linear arrays. Its low cost and volume producibility open new areas of use anywhere a photo detector is desirable.

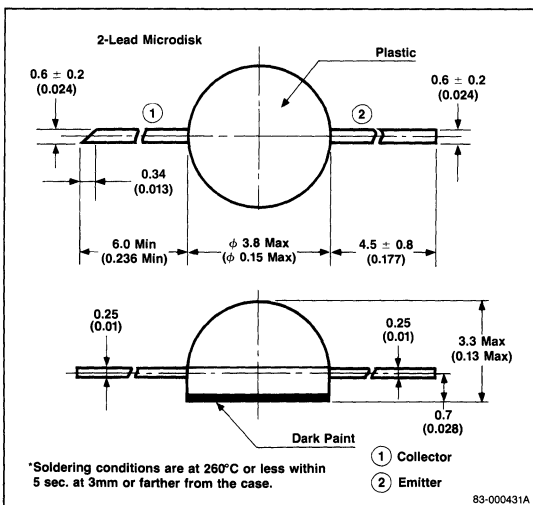
Features

- Low cost
- Low leakage current
- Wide spectral response
- Convenient MICRODISK package
- Wide temperature range
- Compact, rugged, light-weight
- High sensitivity

Applications

- Optical switching and encoding
- Intrusion alarms
- Tape and card reader sensors
- Level controls
- Motor governors

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Collector to Emitter Voltage, V_{CE0}	20V
Collector Current, I_C	50mA
Power Dissipation, P_D	100mW
Junction Temperature, T_J	80°C
Storage Temperature, T_{STG}	-30°C to +80°C

Electro-Optical Characteristics

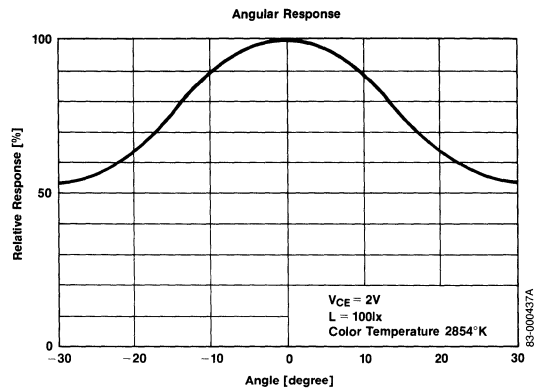
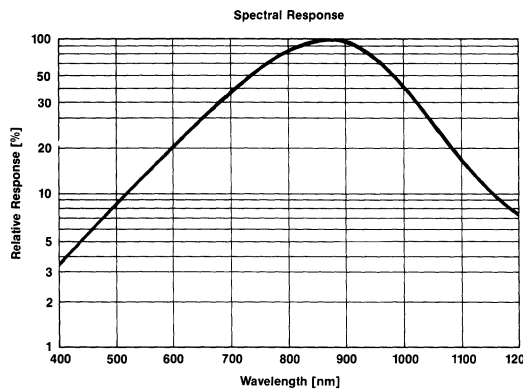
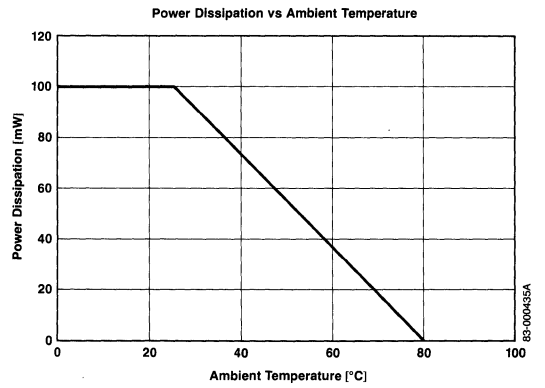
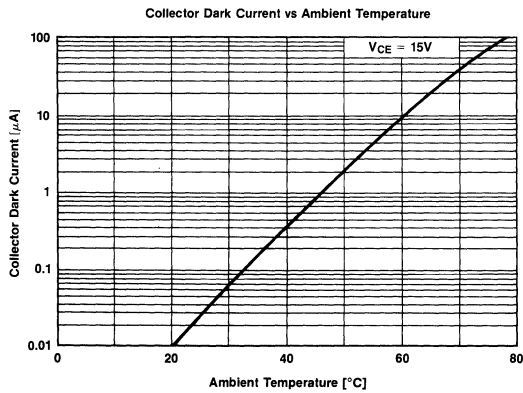
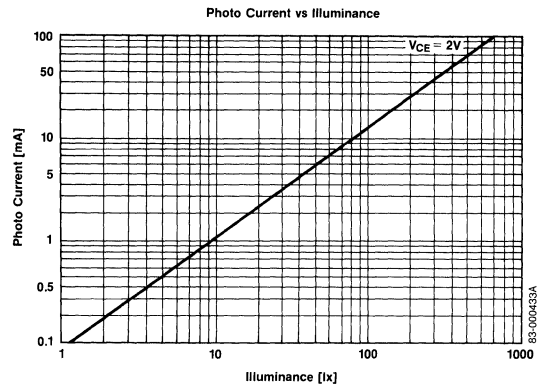
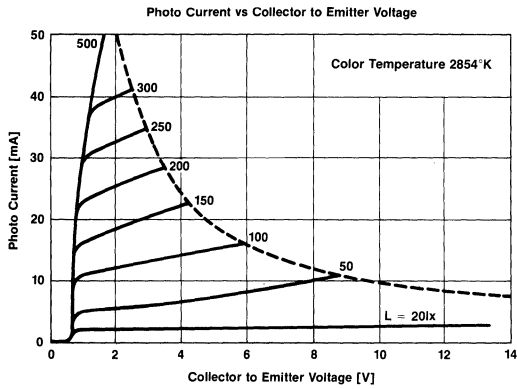
$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Collector to Emitter Dark Current	I_{CE01}		0.5		μA	$V_{CE} = 15\text{V}$, $L = 0$
Collector to Emitter Dark Current	I_{CE02}		500		μA	$V_{CE} = 15\text{V}$, $L = 0$, $T_A = +80^\circ\text{C}$
Collector Saturation Voltage	$V_{CE(sat)}$	0.7	1.5		V	$I_C = 10\text{mA}$, $L^1 = 1000\text{lx}$
Photo Current	I_L	4	12		mA	$V_{CE} = 2.0\text{V}$, $L^1 = 100\text{lx}$

Note: 1. Measured with a tungsten filament lamp operated at a color temperature of 2854K.

Typical Characteristics

$T_A = +25^\circ\text{C}$



Description

The PH102 is a miniature NPN silicon photo transistor having exceptionally stable characteristics and is mounted in a two-terminal MICRODISK package. The spectral response, extending from 400 to 1000nm, is compatible with daylight, tungsten and gallium arsenide sources. The packaging of this unit permits close spacing in linear arrays. Its low cost and volume producibility open new areas of use anywhere a photo detector is desirable.

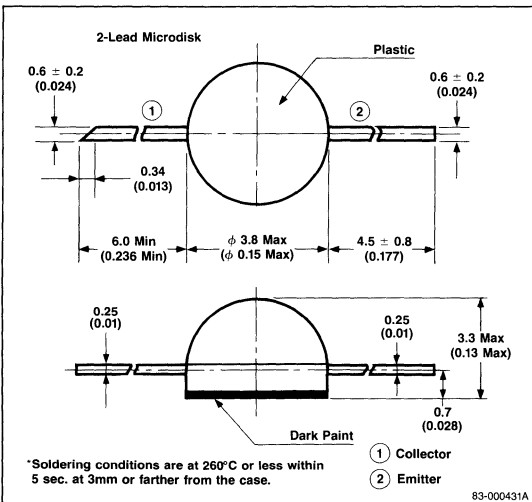
Features

- High speed
- Low cost
- Low leakage current
- Wide spectral response
- Wide temperature range
- Compact, rugged, light-weight
- High sensitivity

Applications

- Optical switching and encoding
- Intrusion alarms
- Tape and card reader sensors
- Level controls
- Motor governors

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$	
Collector to Emitter Voltage, V_{CE0}	30V
Collector Current, I_C	40mA
Power Dissipation, P_D	100mW
Junction Temperature, T_J	80°C
Storage Temperature, T_{STG}	-30°C to +80°C

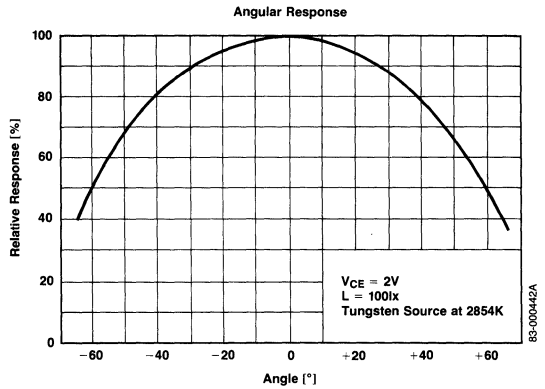
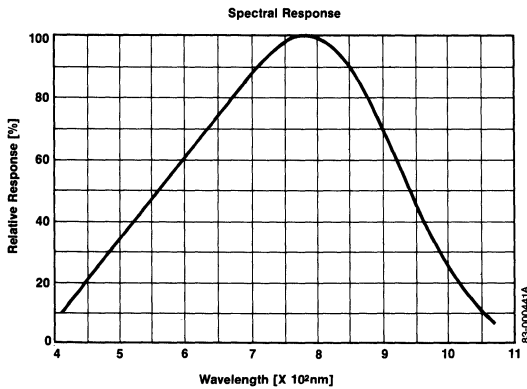
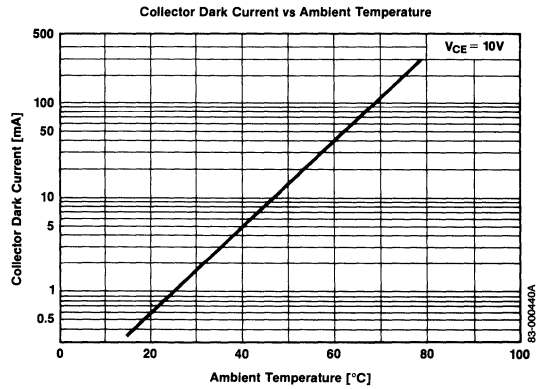
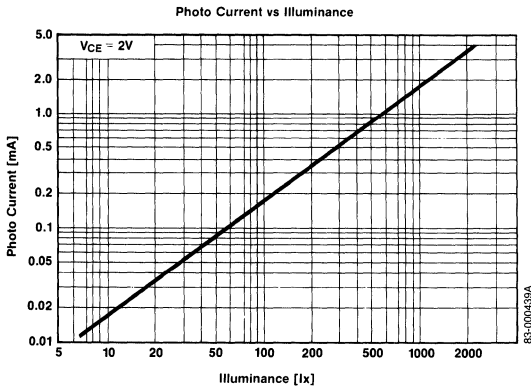
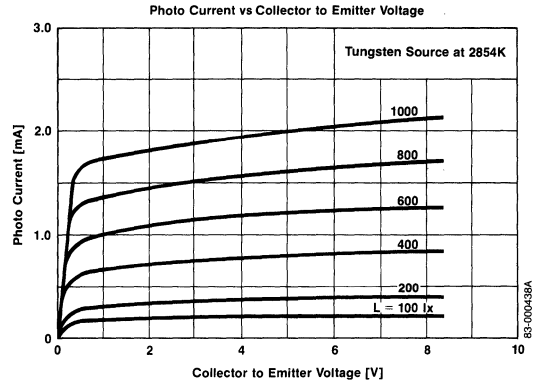
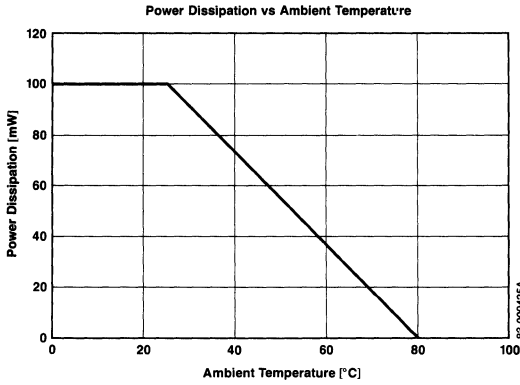
Electro-Optical Characteristics

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Collector to Emitter Dark Current	I_{CE0}			200	nA	$V_{CE} = 10V$, $L = 0lx$
Collector Saturation Voltage	$V_{CE(sat)}$			0.3	V	$I_C = 0.5mA$, $L^1 = 1000lx$
Photo Current	I_L	50	180		μA	$V_{CE} = 2.0V$, $L^1 = 100lx$
Fall Time	t_f		5		μs	$V_{CE} = 10V$, $I_L = 2mA$, $R_L = 100\Omega$
Rise Time	t_r		5		μs	$V_{CE} = 10V$, $I_L = 2mA$, $R_L = 100\Omega$

Note: 1. Measured with a tungsten filament lamp operated at a color temperature of 2854K.

Typical Characteristics

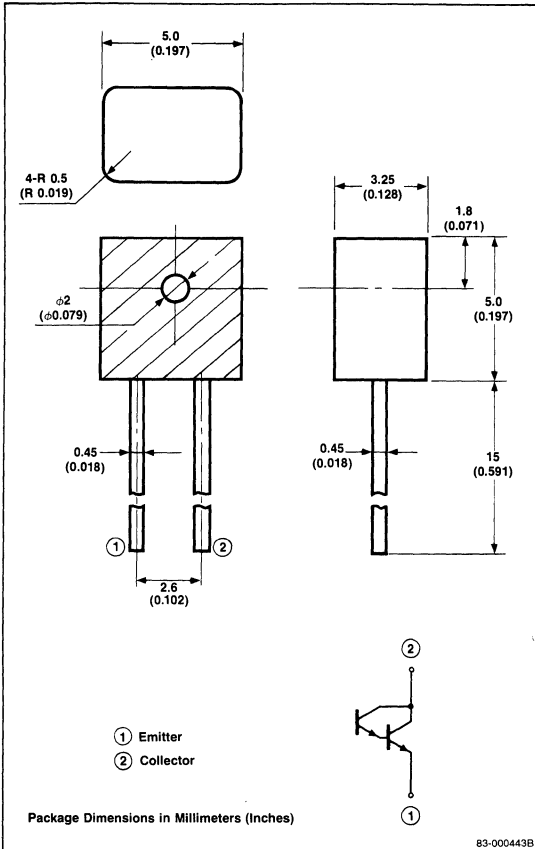
$T_A = +25^\circ\text{C}$



Description

The PH103 is a Darlington photo transistor in a plastic molded package, and is very suitable for a detector of a photo interrupter.

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Collector to Emitter Voltage, V_{CE0}	30V
Collector Current, I_C	50mA
Power Dissipation, P_D	100mW
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

Electrical Characteristics

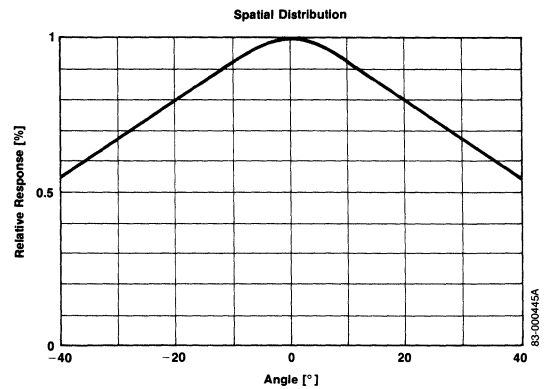
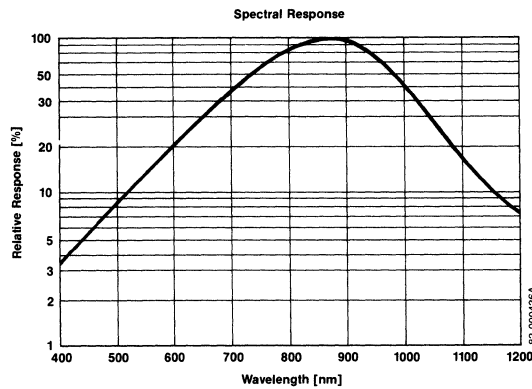
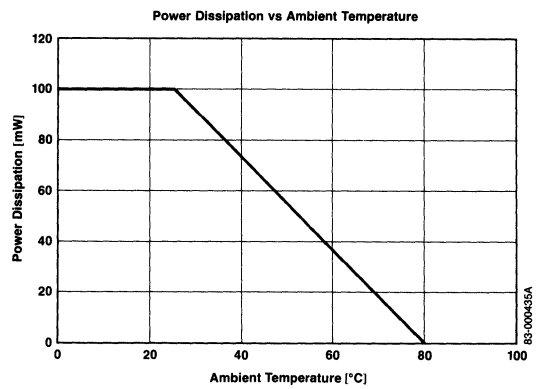
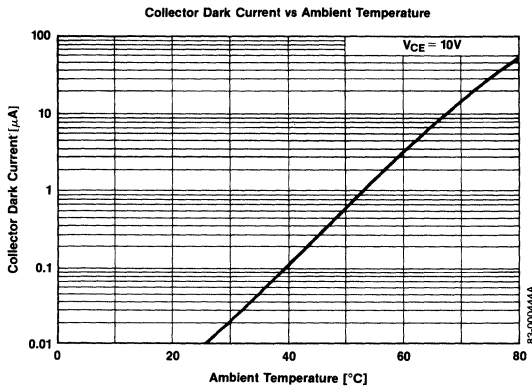
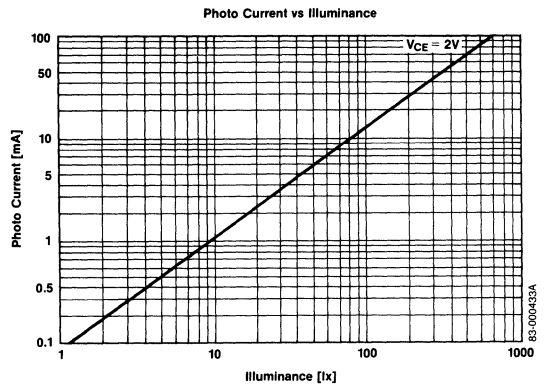
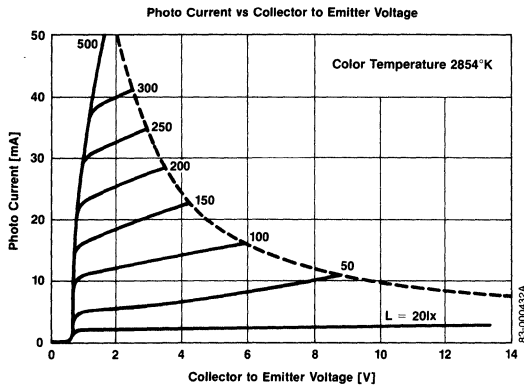
$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Collector to Emitter Dark Current	I_{CE0}	10	400		nA	$V_{CE} = 10V$, $L = 0lx$
Collector Saturation Voltage	$V_{CE(sat)}$	0.7	1.5		V	$I_C = 10mA$, $L = 1000lx^1$
Photo Current	I_L	2.0			mA	$V_{CE} = 2V$, $L = 100lx^1$

Note: 1. Measured with a tungsten filament lamp operated at a color temperature of 2854K.

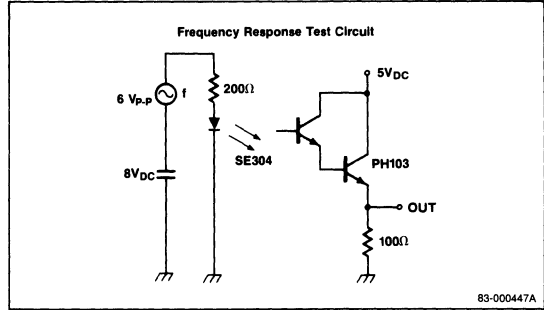
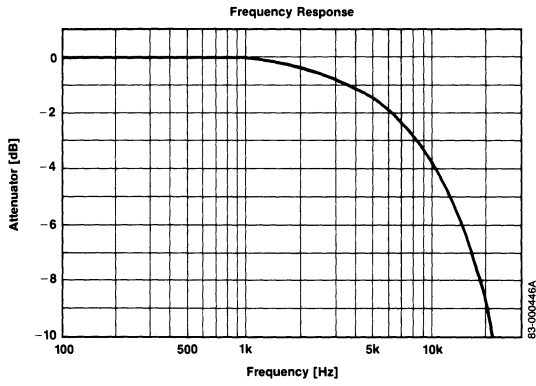
Typical Characteristics

$T_A = +25^\circ\text{C}$



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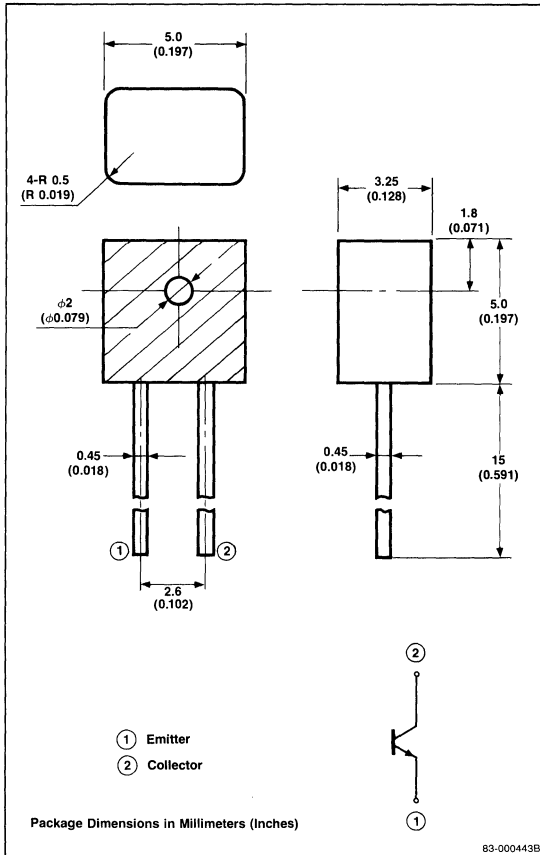
$T_A = +25^\circ\text{C}$



Description

The H104 is a photo transistor in a plastic molded package, and is very suitable for use as a detector in a photo interrupter.

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Collector to Emitter Voltage, V_{CE0}	30V
Collector Current, I_C	40mA
Power Dissipation, P_D	100mW
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

Electrical Characteristics

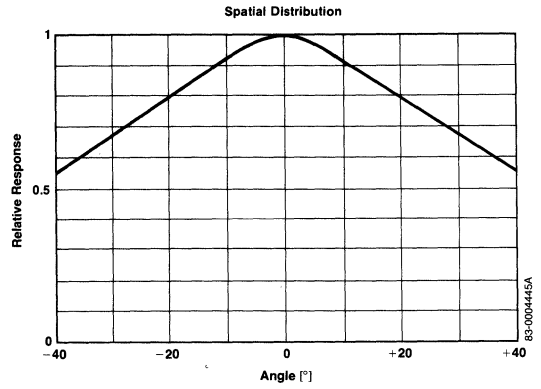
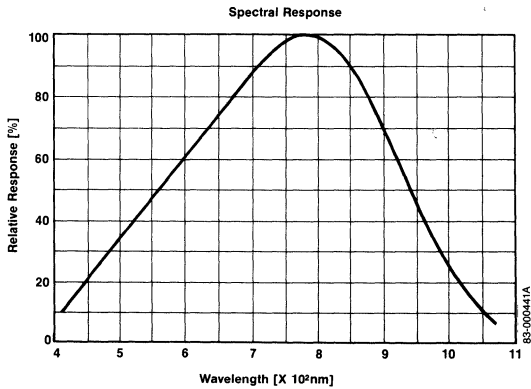
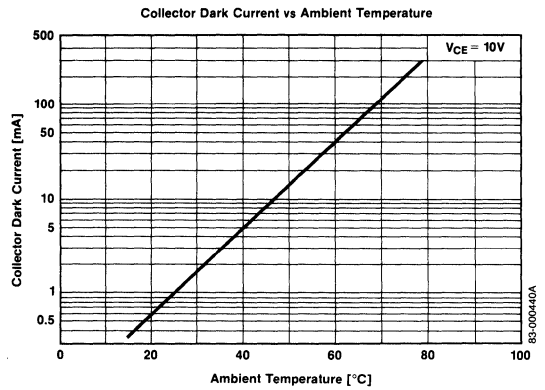
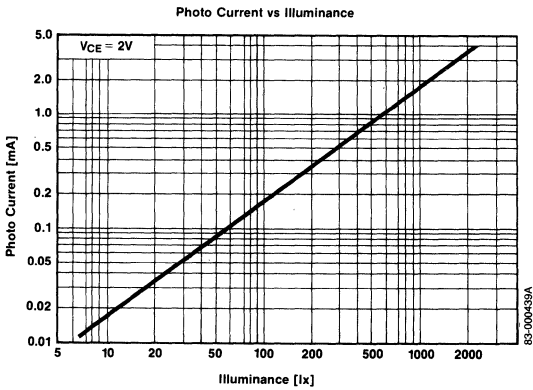
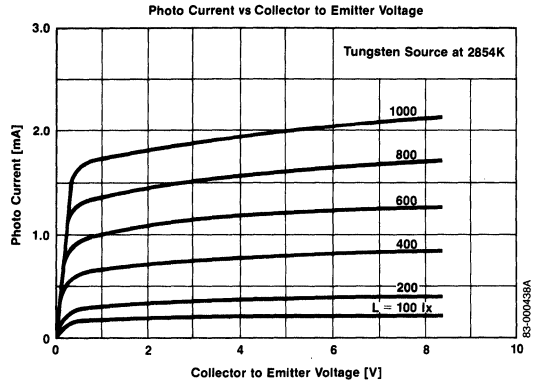
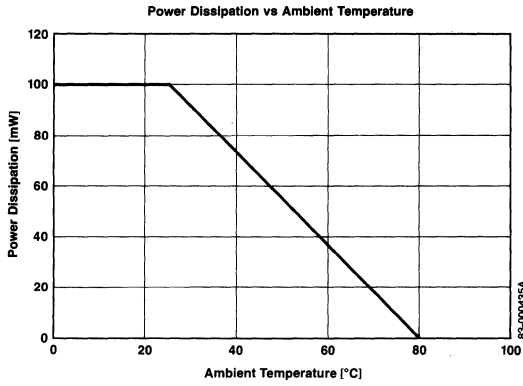
$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Collector to Emitter Dark Current	I_{CE0}		100		nA	$V_{CE} = 10V$, $L = 0lx$
Collector Saturation Voltage	$V_{CE(sat)}$		0.3		V	$I_C = 0.5mA$, $L = 1000lx^1$
Photo Current	I_L	20			μA	$V_{CE} = 2.0V$, $L = 100lx^1$
Fall Time	t_f		5		μS	$V_{CC} = 10V$, $I_L = 2mA$, $R_L = 100\Omega$

Note: 1. Measured with a tungsten filament lamp operated a color temperature of 2854K.

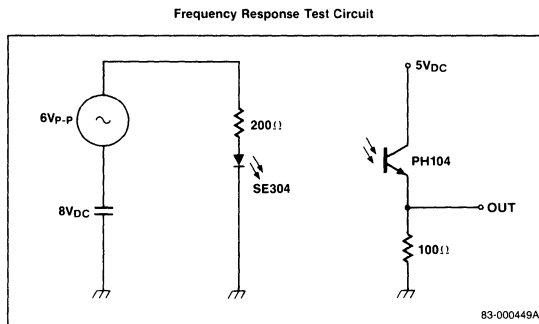
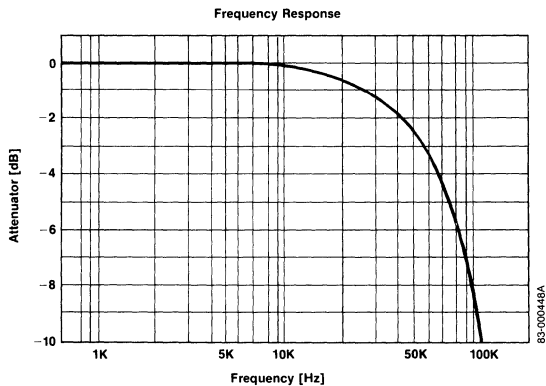
Typical Characteristics

$T_A = +25^\circ\text{C}$



Typical Characteristics (cont)

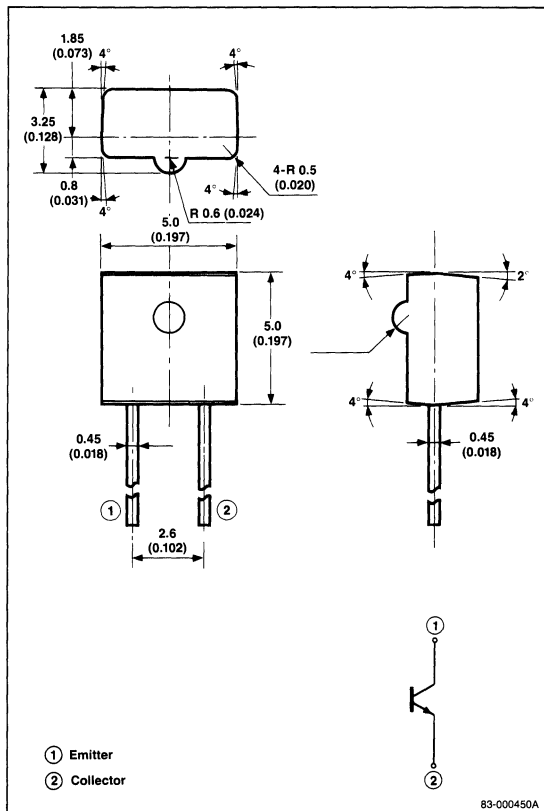
$T_A = +25^\circ\text{C}$



Description

The PH106 is a photo transistor in a plastic molded package and is very suitable as a detector of a photo interrupter.

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$	
Collector to Emitter Voltage, V_{CE0}	30V
Collector Current, I_C	40mA
Power Dissipation, P_D	100mW
Junction Temperature, T_J	100°C
Storage Temperature, T_{STG}	-40°C to +100°C

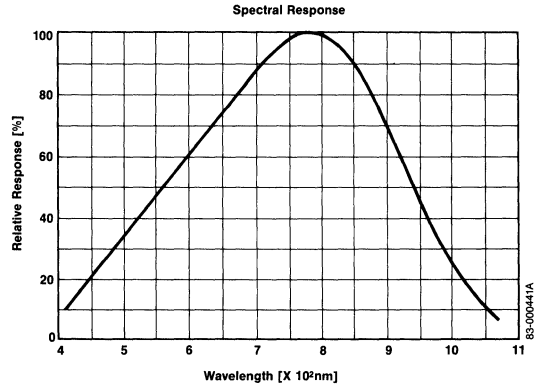
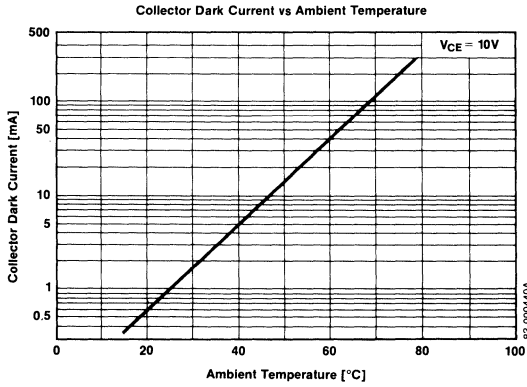
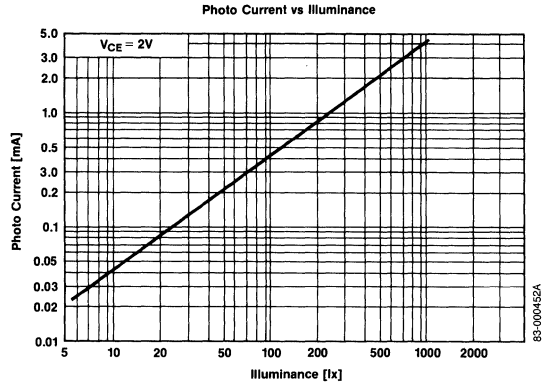
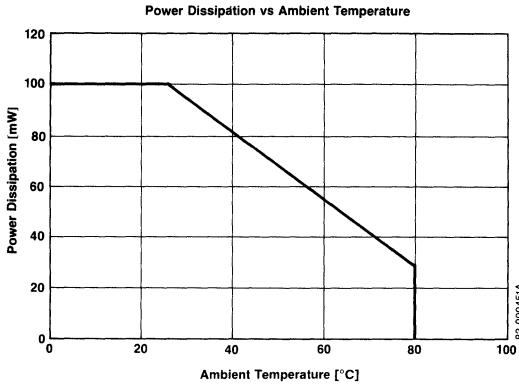
Electrical Characteristics

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Collector to Emitter Dark Current	I_{CEO}			100	nA	$V_{CE} = 10V$, $L = 0\Omega$
Collector Saturation Voltage	$V_{CE(sat)}$			0.3	V	$I_C = 0.5mA$, $L = 1000\Omega$
Photo Current	I_L	100			μA	$V_{CE} = 2.0V$, $L = 100\Omega$
Fall Time	t_f		5		μs	$V_{CC} = 10V$, $I_L = 0.5mA$, $R_L = 100\Omega$

Note: 1. Measured with a tungsten filament lamp operated at a color temperature of 2854K.

Typical Characteristics

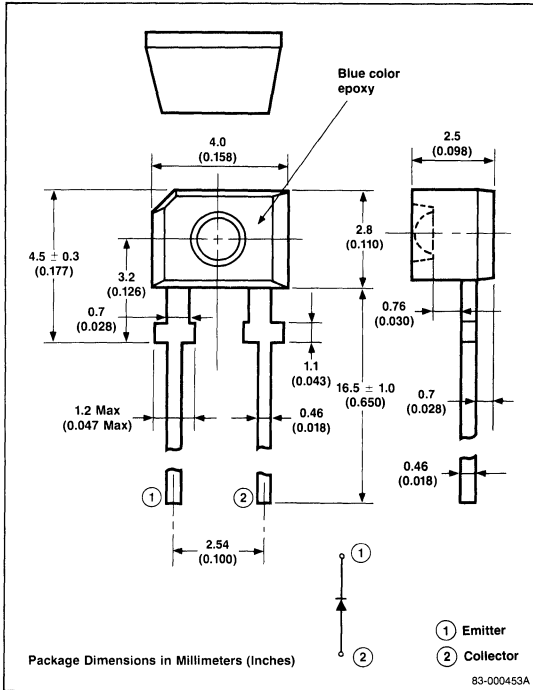
$T_A = +25^\circ\text{C}$



Description

The PH108 is a highly sensitive photo transistor in a small plastic molded package and is suitable as a detector of a photo interrupter.

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$	
Collector-Emitter Voltage, V_{CE0}	30V
Collector Current, I_C	40mA
Power Dissipation, P_D	100mW
Junction Temperature, T_J	100°C
Operating Temperature, T_{OPT}	-20°C ~ +80°C
Storage Temperature, T_{STG}	-40°C ~ +100°C

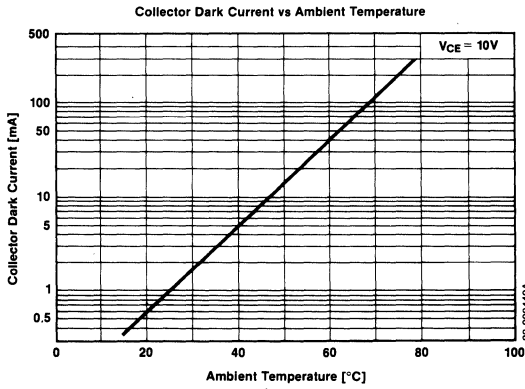
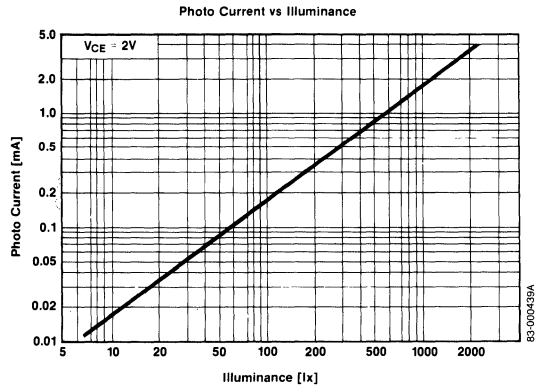
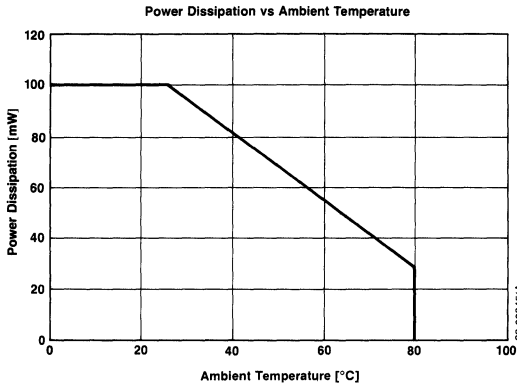
Electrical Characteristics

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Dark Current	I_{CEO}			100	nA	$V_{CE} = 10V$, $H = 0mW/cm^2$
Collector Saturation Voltage	$V_{CE(sat)}$			0.3	V	$I_C = 0.5mA$, $H = 5mW/cm^2$
Photo Current	I_L	0.3	0.9		mA	$V_{CE} = 5V$, $H = 0.5mW/cm^2$
Rise and Fall Time	t_r, t_f			40	μ	$V_{CC} = 10V$, $H = 0.5mW/cm^2$, $R_L = 1.0k\Omega$
50% Response Angle	$I_{L0}/2$		15		°C	Between 50% sensitivity points

Note: *When exposed to infrared light of wavelength $\lambda_p = 940nm$.

Typical Characteristics

T_A = +25°C

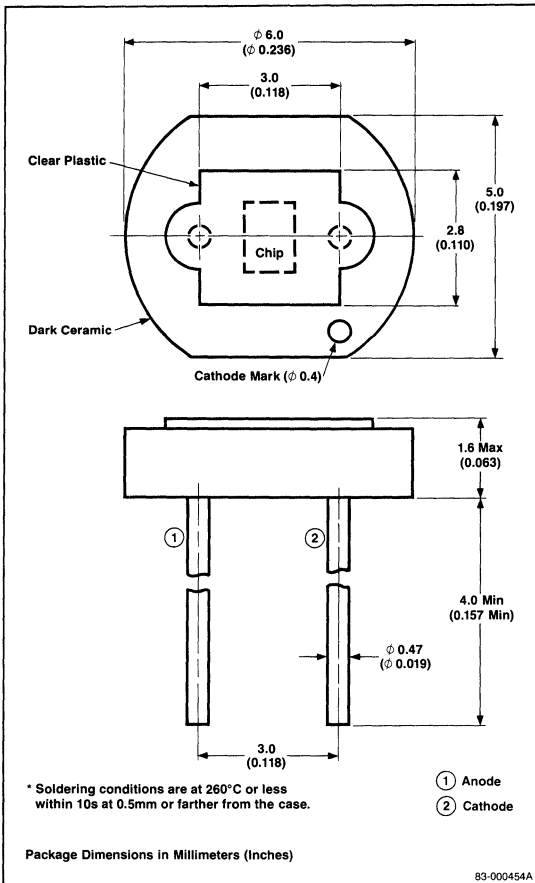


Description

The PH201A is a GaAsP (Gallium Arsenide Phosphide) photo diode designed for use as a photo detector in electronic cameras.

It features a wide active area, spectral response close to that of the human eye and a wide photo current range.

Package Dimensions



Features

- Suitable for photo detector application in cameras
- No filter is required, the spectral response matches that of the human eye
- Low dark current

Absolute Maximum Ratings

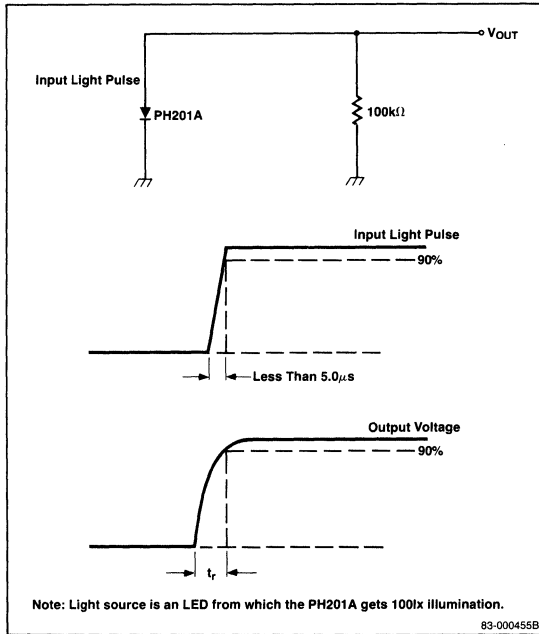
$T_A = +25^\circ\text{C}$	
Reverse Voltage, V_R	5.0V
Forward Current, I_F	1.0mA
Operating Temperature, T_{OP}	-30°C to $+60^\circ\text{C}$
Storage Temperature, T_{STG}	-40°C to $+80^\circ\text{C}$

Electro-Optical Characteristics

$T_A = +25^\circ\text{C}$		Limits			Test Conditions
Parameters	Symbol	Min	Typ	Max	Unit
Photo Current	I_{SH}	60	90	120	nA
Dark Current	I_D		0.3	3.0	pA
Photo Current Ratio	R^1		10^6		$0.001 \sim 1,000 \text{ lx}^3$
Relative Spectral Response		See Fig.1			
Rise Time	t_r		150		μs
Variation of Photo Current	Δ^2		13		%

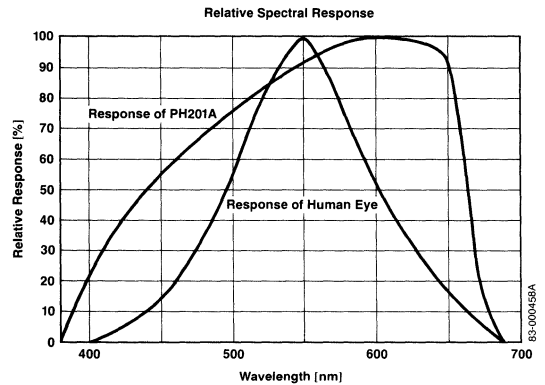
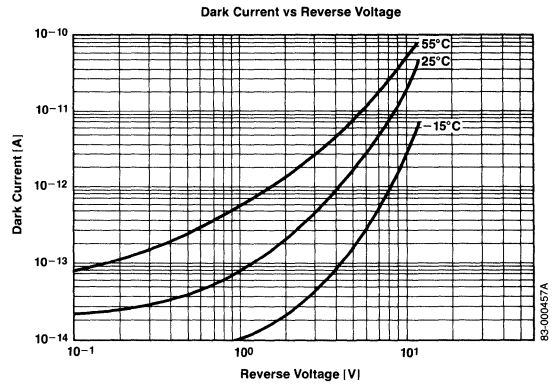
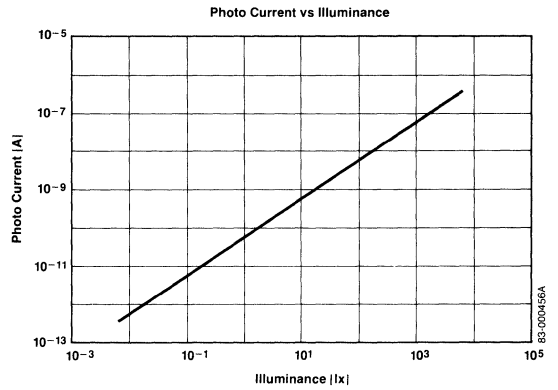
- Notes: 1. $R = \frac{I_{SH} \text{ at } 1000 \text{ lx}}{I_{SH} \text{ at } 0.001 \text{ lx}}$
2. $\Delta = \frac{I_{SH} \text{ at a color temperature of } 2854\text{K} - I_{SH} \text{ at a color temperature of } 4870\text{K}}{I_{SH} \text{ at a color temperature of } 2854\text{K}} \times 100(\%)$.
3. Measured with a tungsten filament lamp operated at a color temperature of 2854K.
4. Measured at a color temperature of 4870K.

Rise Time Test Circuit



Typical Characteristics

$T_A = +25^\circ\text{C}$



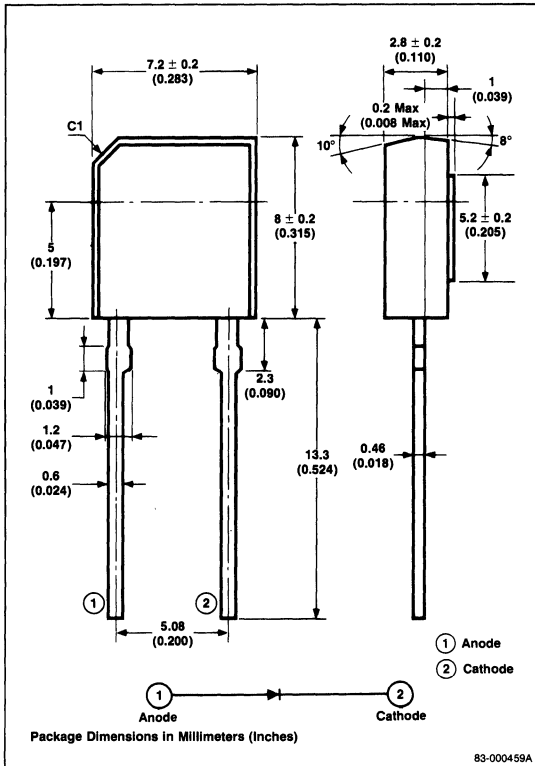
Description

The PH302 is a photo diode with a PIN structure. It has a wide photo-receiving area and high-speed response enabling applications for various types of remote control equipment. The resin material used for the package has the filter effect of transmitting only infrared.

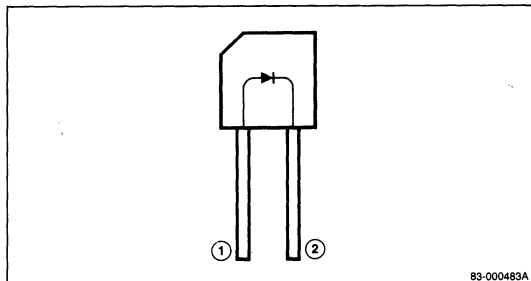
Features

- Ultrahigh-speed response ($t_r, t_f = 50\text{ns}$)
- The wavelength of maximum sensitivity matches that of an infrared LED ($\lambda_{S-MAX} = 940\text{nm}$)
- High sensitivity (50nA/lx)
- Wide dynamic range

Package Dimensions



Pin Connection



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Reverse Voltage, V_R	32V
Power Dissipation, P_D	150mW
Junction Temperature, T_J	80°C
Storage Temperature, T_{STG}	-40°C to +80°C

Electrical Characteristics

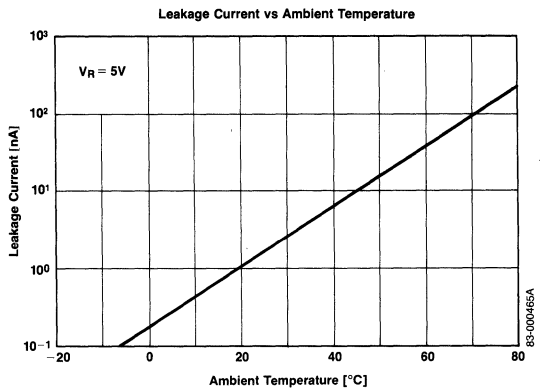
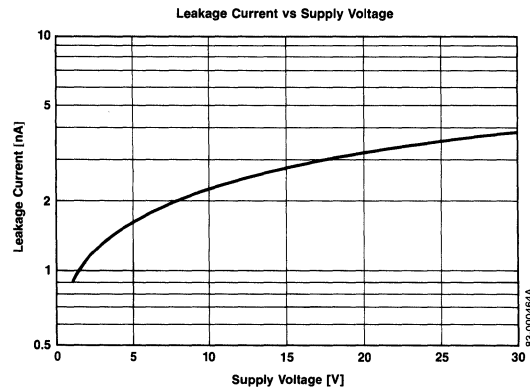
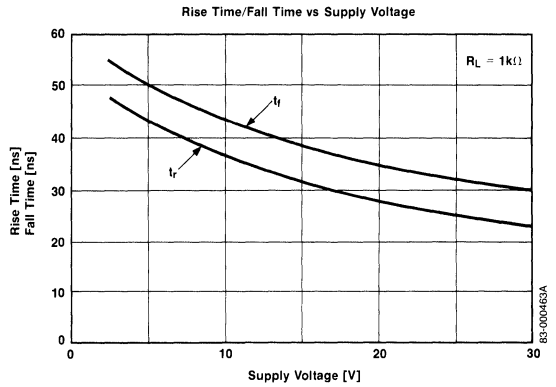
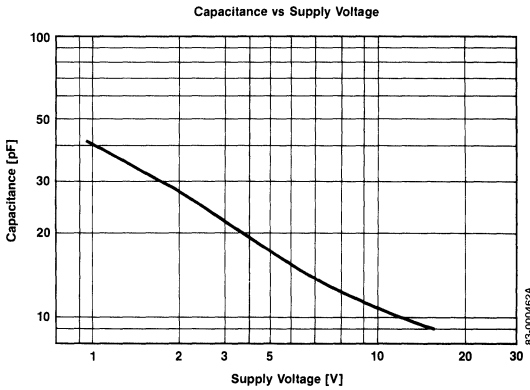
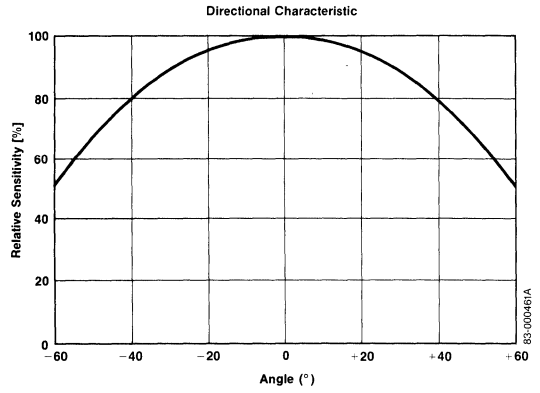
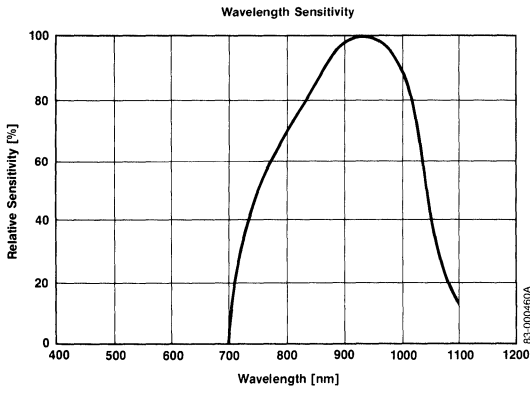
$T_A = +25^\circ\text{C}$

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Dark Current	I_R			30	nA	$V_R = 10V$
Maximum Sensitivity Wavelength	λ_{MAX}		940		nm	
Quantum Efficiency	η		0.88			$\lambda = 940\text{nm}$
Spectral Sensitivity	S	35	50		nA/lx	$V_R = 5V$
Spectral Sensitivity	S		0.6		A/W	$\lambda = 940\text{nm}$
Open Circuit Voltage	V_L		285		mV	$E_V = 100\text{lX}$
Open Circuit Voltage	V_L		365		mV	$E_V = 1000\text{lX}$
Rise and Fall Time of the Photo Current from 10% to 90% and 90% to 10% of the Final Value	t_r, t_f		125		ns	$R_L = 1\text{k}\Omega$ $V_R = 0V$ $\lambda = 940\text{nm}$
	t_r, t_f		50		ns	$R_L = 1\text{k}\Omega$ $V_R = 5V$ $\lambda = 940\text{nm}$
Capacitance	C_T		14		pF	$V_R = 5V$ $f = 1\text{MHz}$
Radiant Sensitive Area	A		9		mm ²	
Noise Equivalent Power	NEP		4.2×10^{-14}		W/ $\sqrt{\text{Hz}}$	$V_R = 10V$
Detection Limit	D		6.6×10^{12}		cm $\sqrt{\text{Hz/W}}$	

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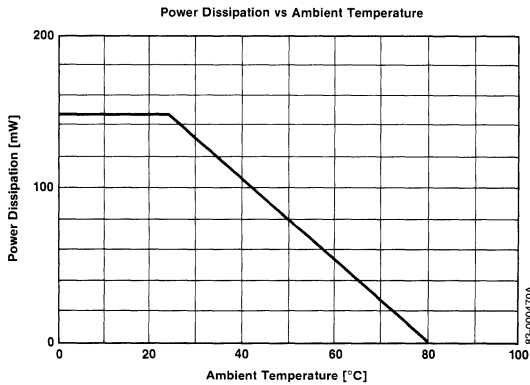
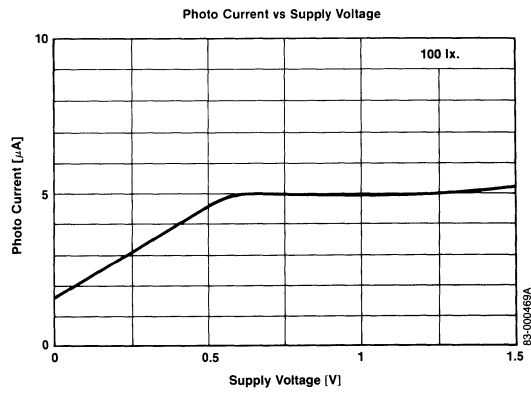
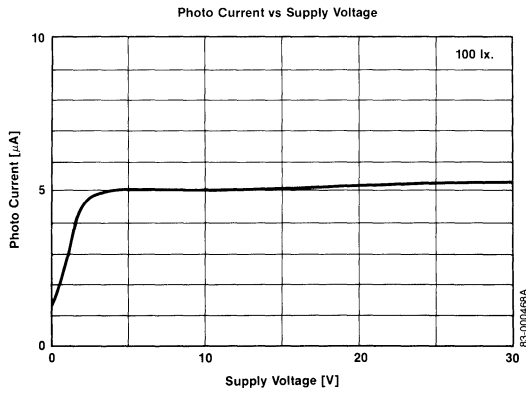
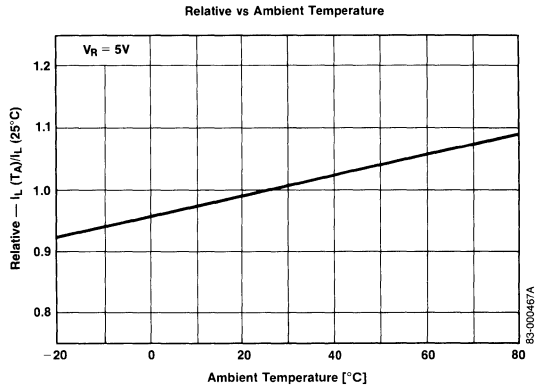
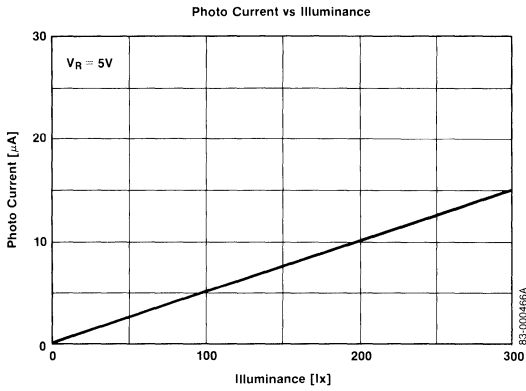
Typical Characteristics

$T_A = +25^\circ\text{C}$



Typical Characteristics (cont)

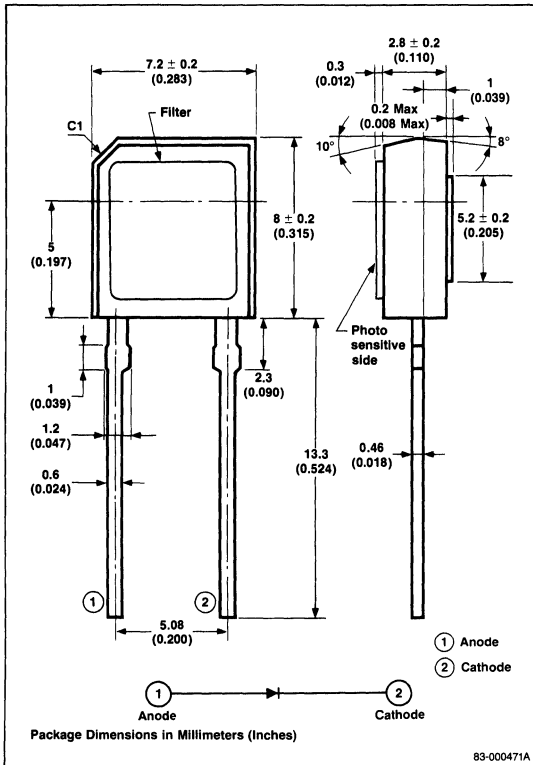
$T_A = +25^\circ\text{C}$



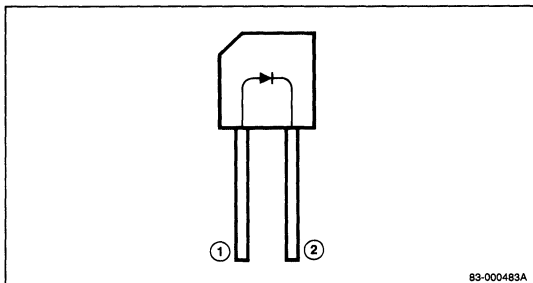
Description

The PH302B is a PIN photo diode similar to the PH302 but with an added filter which filters out visible light. The narrow spectral response range beginning at 840nm prevents any malfunction under fluorescent light. The large sensitive area and fast response make it suitable for various remote control applications.

Package Dimensions



Pin Connection



Features

- Ultrahigh-speed response ($t_r, t_f = 50\text{ns}$)
- The maximum sensitive wavelength matches that of an infrared LED ($\lambda_{S-MAX} = 940\text{nm}$)
- High sensitivity (34nA/lx)
- Wide dynamic range
- Visible light filtration (minimum sensitive wavelength: 840nm)

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

Reverse Voltage, V_R	32V
Power Dissipation, P_D	150mW
Junction Temperature, T_J	80°C
Storage Temperature, T_{STG}	-40°C ~ +80°C

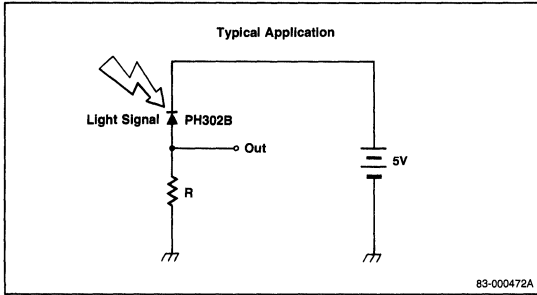
Note: 1. The maximum ratings of T_J and T_{STG} are those of the PH302. Because of the adhesive between the filter and diode, storage and operating temperature should be kept between -20°C and +60°C.

Electrical Characteristics

$T_A = +25^\circ\text{C}$

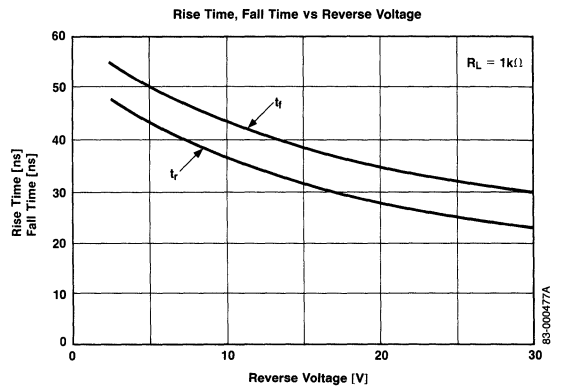
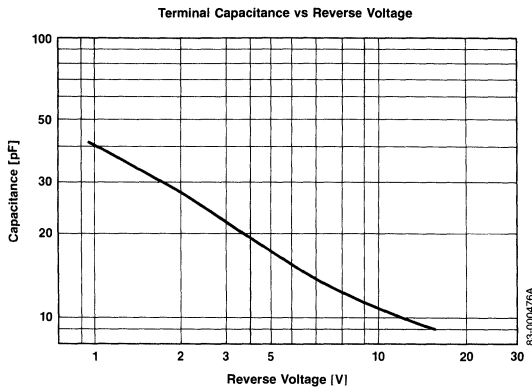
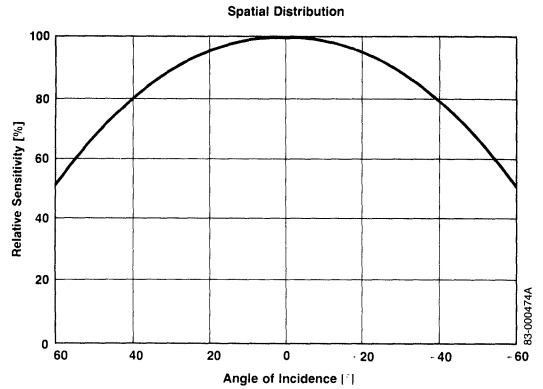
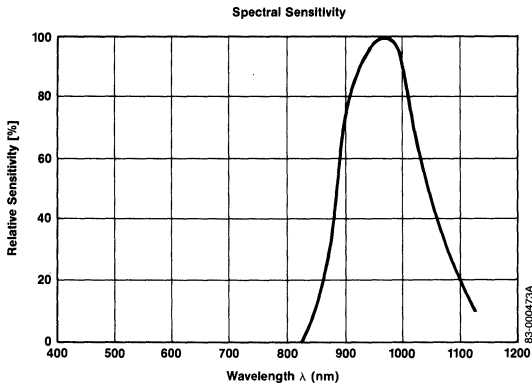
Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Dark Current	I_R		30		nA	$V_R = 10\text{V}$
Maximum Sensitive Wavelength	λ_{MAX}		940		nm	
Quantum Efficiency	η		0.88			$\lambda = 940\text{nm}$
Spectral Sensitivity	S	22	32		nA/lx ¹	$V_R = 5\text{V}$
Spectral Sensitivity	S		0.6		A/W	$\lambda = 940\text{nm}$
Rise and Fall Time	t_r, t_f		125		ns	$R_L = k\Omega$ $V_R = 0$ $\lambda = 940\text{nm}$
Rise and Fall Time	t_r, t_f		50		ns	$R_L = k\Omega$ $V_R = 5\text{V}$ $\lambda = 940\text{nm}$
Capacitance	C_T		14		pF	$V_R = 5\text{V}$ $f = 1\text{MHz}$
Radiant Sensitive Area	A		9		mm ²	

Note: 1. Measured at a color temperature of 2854K.



Typical Characteristics

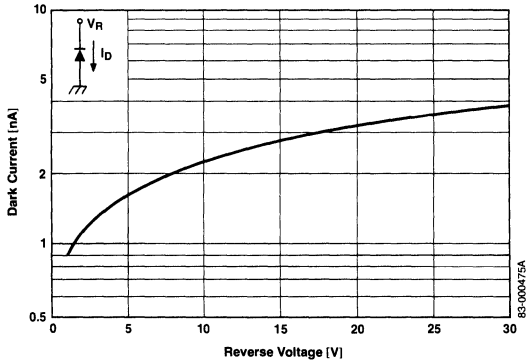
$T_A = +25^\circ\text{C}$



Typical Characteristics (cont)

$T_A = +25^\circ\text{C}$

Dark Current vs Reverse Voltage



Dark Current vs Ambient Temperature

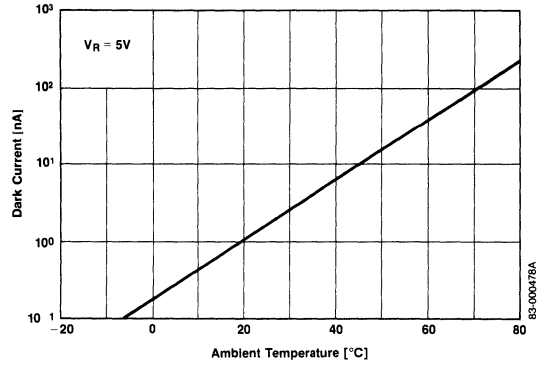


Photo Current vs Illumination

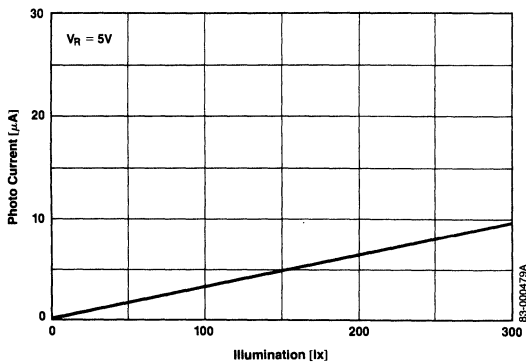


Photo Current vs Ambient Temperature

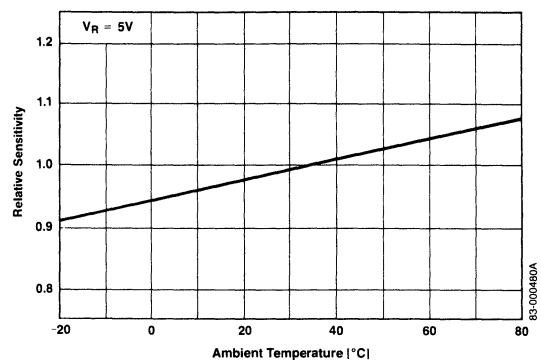


Photo Current vs Reverse Voltage

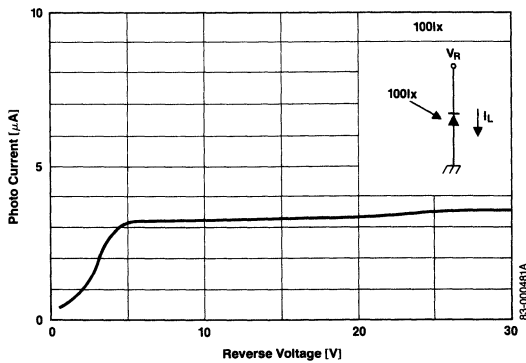
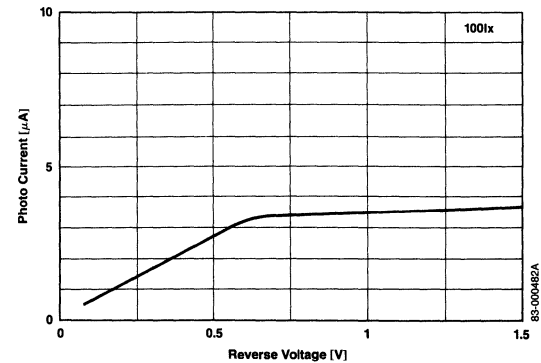


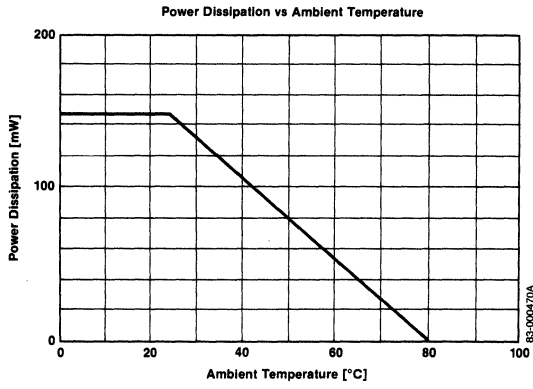
Photo Current vs Reverse Voltage



7

Typical Characteristics (cont)

$T_A = +25^\circ\text{C}$



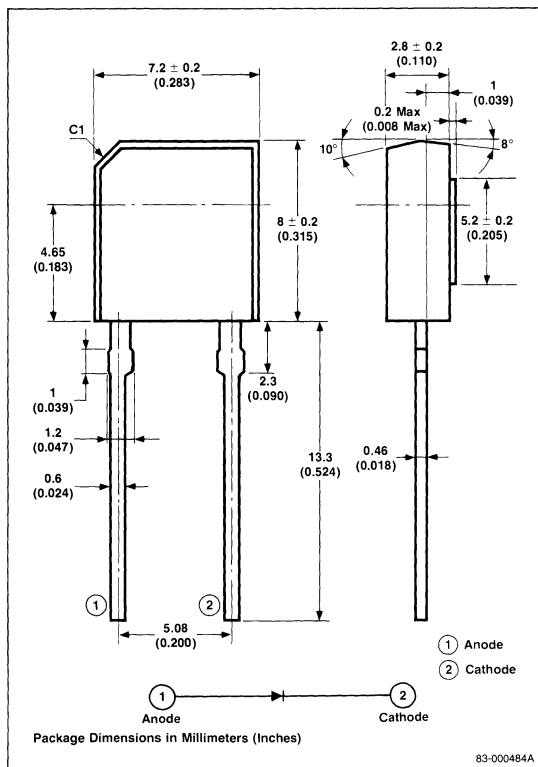
Description

The PH305 is a photo diode with PIN structure. It is very suitable for a light detector with a 7-10m remote controller or a 0.3-5m opto-interrupter. The resin material used for the package has the filter effect of transmitting only infrared radiation.

Features

- Ultrahigh-speed response ($t_r, t_f = 30\text{ns}$)
- The wavelength of maximum sensitivity matches that of an infrared LED ($\lambda_{S-MAX} = 940\text{nm}$)
- High sensitivity (32nA/lx)
- Wide dynamic range

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$

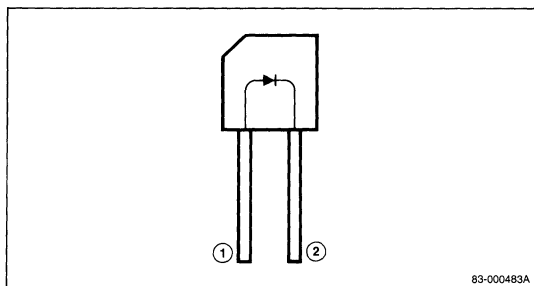
Reverse Voltage, V_R	20V
Power Dissipation, P_D	150mW
Junction Temperature, T_J	80°C
Storage Temperature, T_{STG}	-40°C to +80°C

Electrical Characteristics

$T_A = +25^\circ\text{C}$

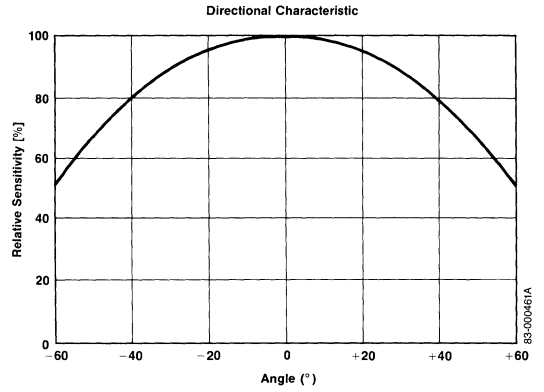
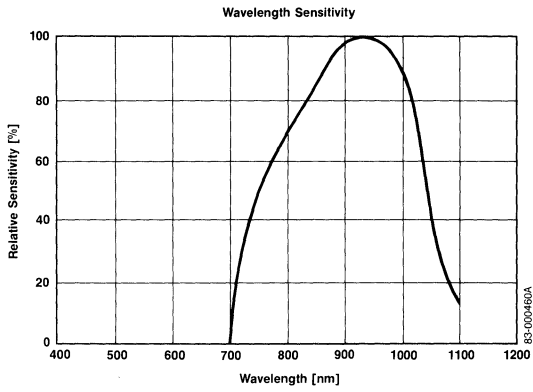
Parameters	Symbol	Limits			Test Conditions
		Min	Typ	Max	
Dark Current	I_R			30	nA $V_R = 10\text{V}$
Wavelength of Maximum Sensitivity	$\lambda_s \text{ MAX}$		940		nm
Quantum Efficiency	η		0.88		$\lambda = 940\text{nm}$
Spectral Sensitivity	S	23	32		nA/lx $V_R = 5\text{V}$
Spectral Sensitivity	S		0.6		A/W $\lambda = 940\text{nm}$
Rise and Fall Time of the Photo Current from 10% to 90% and 90% to 10% of the Fianl value	t_r, t_f		125		ns $R_L = 1\text{k}\Omega, V_R = 0\text{V}, \lambda = 940\text{nm}$
Capacitance	C_T		11		ns $R_L = 1\text{k}\Omega, V_R = 5\text{V}, \lambda = 940\text{nm}$
Radiant Sensitive Area	A		5.3		mm ² $V_R = 5\text{V}, f = 1\text{MHz}$

Pin Connection



Typical Characteristics

T_A = +25°C



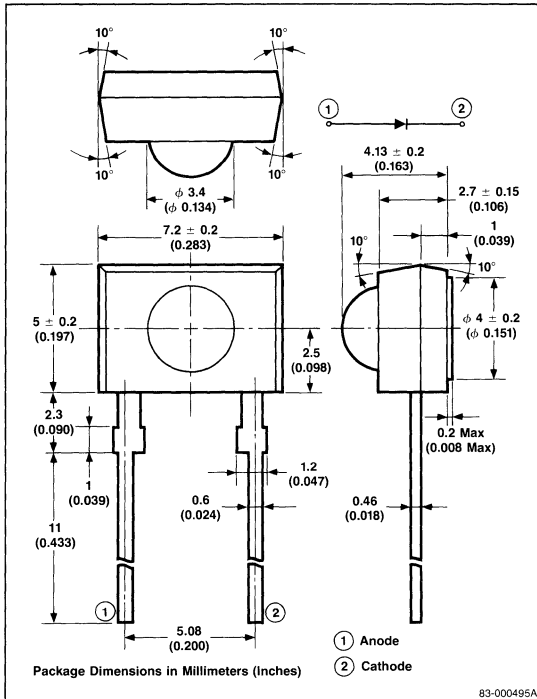
Description

The PH309 is a photo diode with a PIN structure. It has a wide photo-receiving area and high-speed response enabling applications for various types of remote control equipment. The resin material used for the package has the filter effect of transmitting infrared radiation.

Features

- Ultrahigh-speed response ($t_r, t_f = 30\text{ns}$)
- The wavelength of maximum sensitivity matches that of an infrared LED ($\lambda_{S-MAX} = 940\text{nm}$)
- High sensitivity (31nA/lx)
- Wide dynamic range

Package Dimensions



Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$	
Reverse Voltage, V_R	20V
Power Dissipation, P_D	150mW
Junction Temperature, T_J	80°C
Storage Temperature, T_{STG}	-40°C to +80°C

Electro-Optical Characteristics

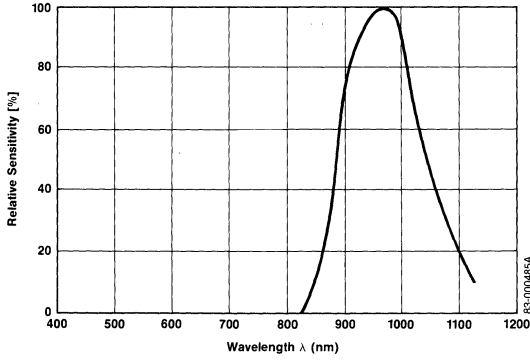
Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Dark Current	I_R			30	nA	$V_R = 10\text{V}$
Wavelength of Maximum Sensitivity	λ_{MAX}		940		nm	
Quantum Yield	η		0.88			$\lambda = 940\text{nm}$
Spectral Sensitivity	S		50		nA/lx	$V_R = 5\text{V}$
Spectral Sensitivity	S_{IR}		4.7		μA	$V_R = 5\text{V}$, $H = 0.1\text{mW/cm}^2$
Rise and Fall Time of the Photo Current from 10% to 90% and 90% to 10% of the Final Value	t_r, t_f		120		ns	$R_L = 1\text{k}\Omega$, $V_R = 0\text{V}$, $\lambda = 940\text{nm}$
	t_r, t_f		30		ns	$R_L = 1\text{k}\Omega$, $V_R = 5\text{V}$, $\lambda = 940\text{nm}$
Capacitance	C_T		11		pF	$V_R = 5\text{V}$, $f = 1\text{MHz}$
Radiant Sensitive Area	A		5.3		mm^2	

* $\lambda = 940\text{nm}$

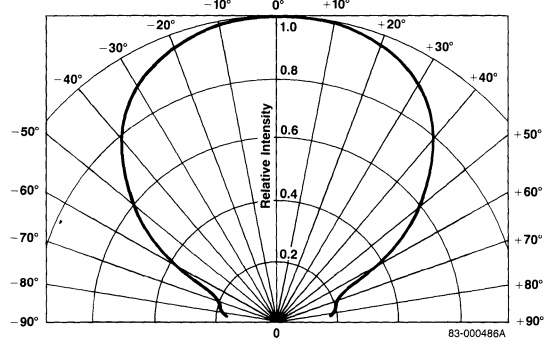
Typical Characteristics

$T_A = +25^\circ\text{C}$

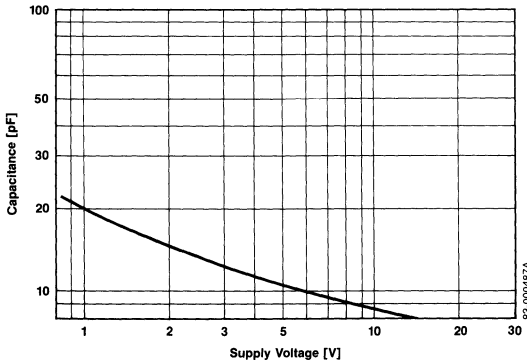
Wavelength Sensitivity



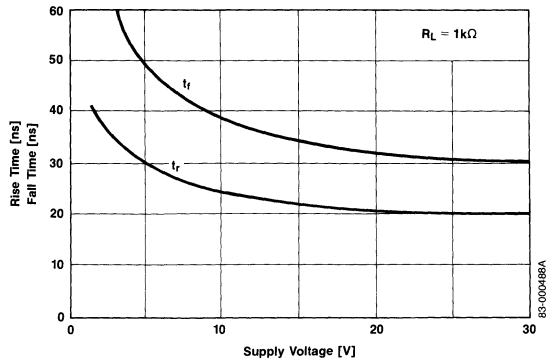
Directional Characteristic



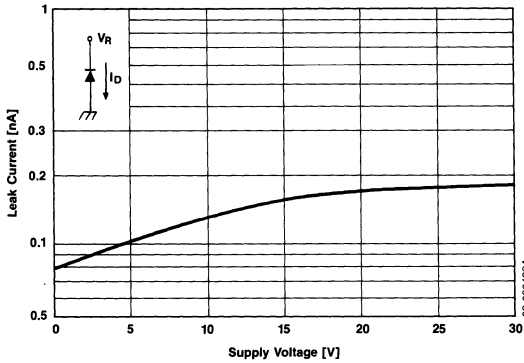
Capacitance vs Supply Voltage



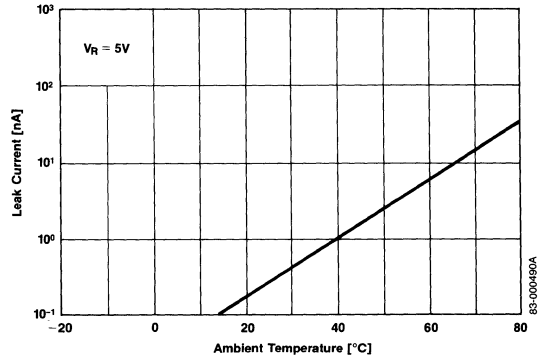
Rise Time and Fall Time vs Supply Voltage



Leak Current vs Supply Voltage



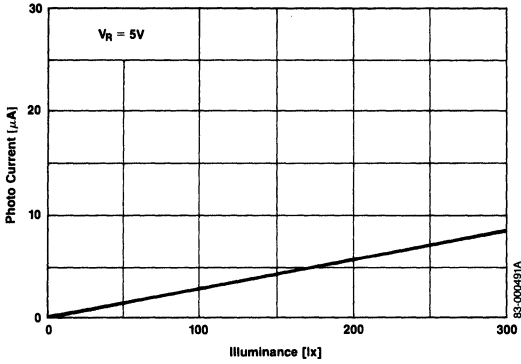
Leak Current vs Ambient Temperature



Typical Characteristics (cont)

$T_A = +25^\circ\text{C}$

Photo Current vs Illuminance



Relative vs Ambient Temperature

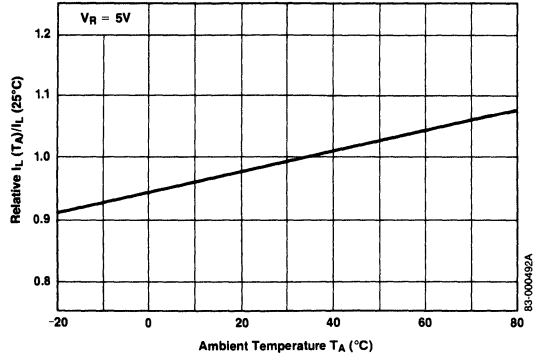


Photo Current vs Supply Voltage

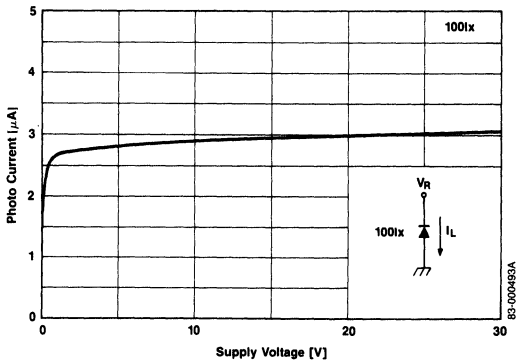
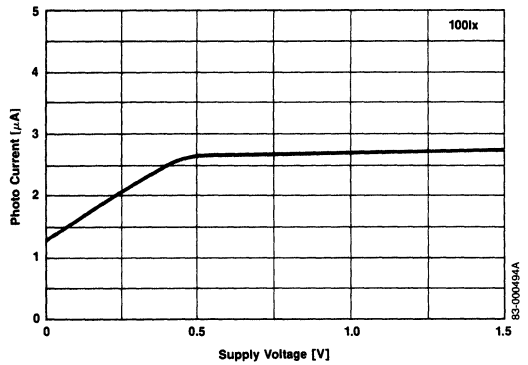
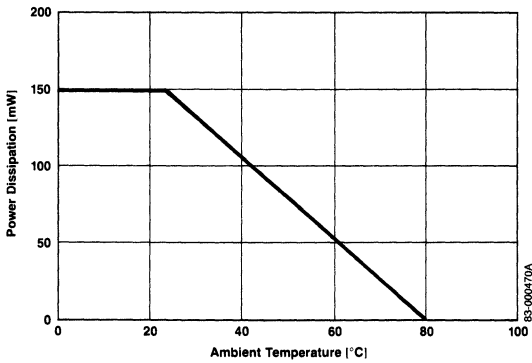


Photo Current vs Supply Voltage



Power Dissipation vs Ambient Temperature



The basic photo interrupter is made up of two components: the emitter, which is generally a light emitting diode (LED) in the red or infrared light spectrum, and the detector, which is generally a photo transistor or photo Darlington structure.

Figure 1 illustrates the basic photo interrupter. Light in the visible or infrared region is emitted from an LED (D1). The light beam then travels some predetermined distance (usually less than 6mm) and arrives at the base of the photo transistor (Q1). The light energy creates a base current, which in turn forward biases the base emitter junction and turns the transistor on. When the light beam is broken, no base current is available and the photo transistor (Q1) is turned off.

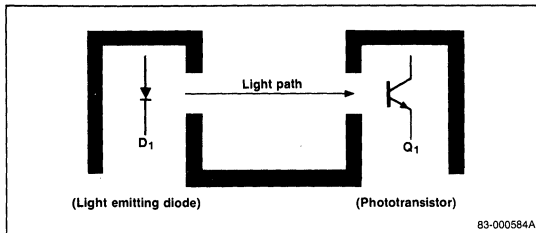


Figure 1. Basic Configuration of a Photo Interrupter

Prepackaged photo interrupter units have made the job of designing interrupter-based circuits simple and cost effective. As can be seen in Figure 2, the basic photo interrupter design is implemented in a one-piece assembly for mass production, and although the package and emitter/detector distance changes, the basic structure and electrical characteristics are very similar.

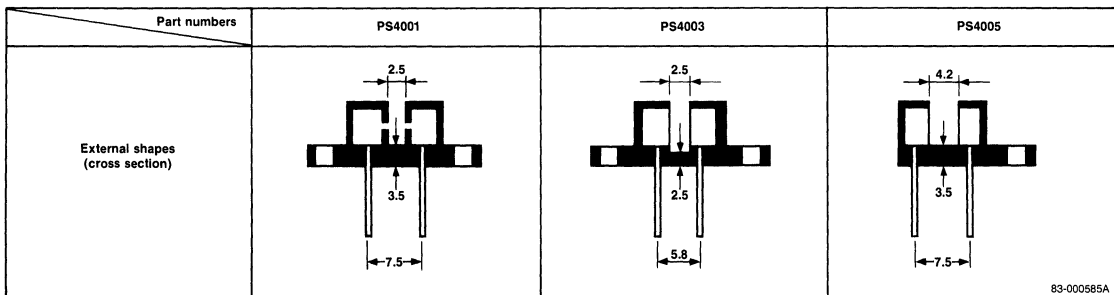
In applications where the one-piece photo interrupter cannot be used, an equivalent circuit can be implemented by using discrete devices. Figure 3 shows the same basic circuit that we saw in Figure 1, but in this case the two elements are discrete devices in the form of a photo diode and photo transistor and the distance between units can be varied. The distance between, and the alignment of, the emitter and detector units are critical factors in discrete designs. If the spacing between elements is small (less than 2mm), then a standard photo transistor will suffice. But for long distances (greater than 2.5mm), a Darlington photo transistor is recommended. In either case the emitting element should be in the infrared region to realize maximum energy transfer between emitter and detector.

Table 1 shows the discrete devices available from NEC which are recommended for photo interrupter applications.

		External Shape		
		($\phi 2 \sim \phi 3.8$)	($\phi 4.8$)	(F5)
A (Light Emitting)	Visible Red Light	SR106C	SR503C SR603C	SR110
	Infrared Light	SE302A	*SE303	SE304
B (Light Receiving)	Single Photo Transistor	PH102	*PH105	PH104
	Darlington Photo Transistor	PH101	—	PH103

*Under development (for detailed specifications, please refer to catalog).

Table 1. Discrete Devices for Photo Interrupters



*Each of these devices uses an infrared LED and a Darlington photo transistor.

Figure 2. One-Piece Photo Interrupters

Basic Photo Interrupter Design Hints

A critical consideration in the design of photo interrupter circuits is the current transfer ratio (CTR) of the circuit at a predetermined emitter/detector distance.

If the current through the LED (D1) is I_F and the current through the photo transistor (Q1) is I_C , then the CTR can be calculated as shown in Figure 3.

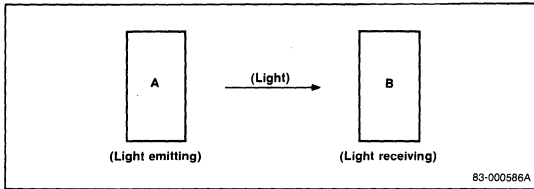


Figure 3. Current Transfer Ratio (CTR)

Photo emitters can be light emitting diodes (LEDs) in either the red or infrared light spectrum. At identical forward current (I_F), the infrared (I_R) emitter efficiency is three to five times that of the red emitter. At the same time, the spectral sensitivity of silicon photo transistors is two to three times greater in the infrared region (800 to 960nm) than in the red region (630 to 680 nm). The graph in Figure 4 illustrates the relative light sensitivity of a photo transistor.

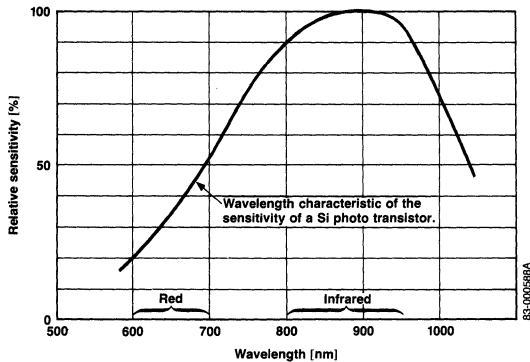


Figure 4. Relative Sensitivity of Photo Transistor

In Figure 5, the output voltage of the photo transistor in Figure 4 can be calculated by first finding the forward current (I_F), where:

$$I_F = \frac{V_1 - V_F}{R_1}$$

V_F = LED forward voltage drop

V_1 = LED anode voltage

R_1 = LED cathode (current limit) resistor

Assuming that CTR is η (%), the output level of the photo transistor in the on state is:

$$I_C = I_F \times \eta \dots \text{and } V_{OUT} = R_L \times I_C = R_L \times I_F \times \eta = R_L \div I_F \times \eta =$$

$$\frac{R_L}{R_1} \times (V_1 - V_F) \times \eta$$

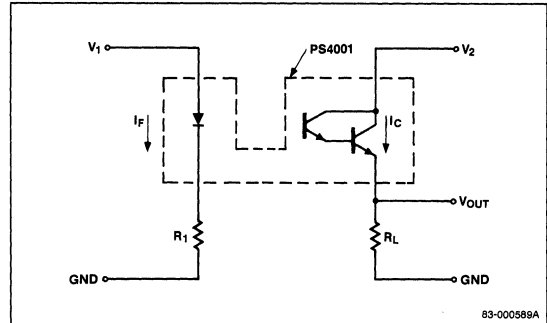


Figure 5. Typical Photo Interrupter Circuit Calculating V_O

If R_1 and R_L are selected for V_{OUT} greater than V_2 , the transistor will be in saturation. But if R_1 and R_L are chosen so that the output level $V_2 > V_{OUT} >$ ground, then the transistor will be in the unsaturated or linear mode. Since the CTR is prone to drift in the unsaturated linear mode, this type of operation is not recommended.

Temperature

The temperature dependence of CTR is shown in Figure 6. At a constant current, the output power of LEDs decreases as the temperature increases. On the other hand, with a constant bias voltage the sensitivity of the photo transistor increases as the temperature increases. The graph in Figure 6 illustrates these characteristics using the SE304 Infrared LED with both the PH103 Darlington transistor and the PH104 single transistor.

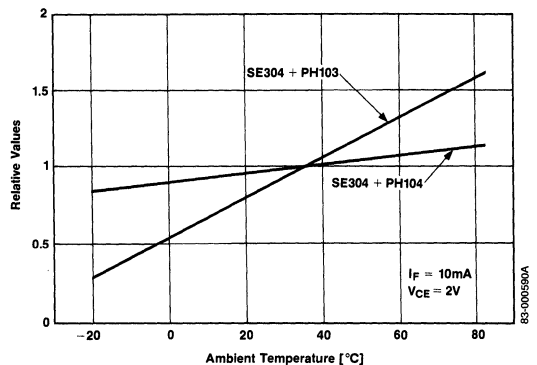


Figure 6. Temperature Characteristics of CTR

Distance

Since the amount of light detected is inversely proportional to the distance between the light source and the detector, the effective sensitivity of the detector will be $1/\eta^2$ when the distance from a point light source is increased η -fold. If we use an LED as the point light source, and if the distance to the photo transistor is d , then:

$$d = \eta \text{ and } \dots \text{CTR} \propto \frac{1}{d^2}$$

This characteristic is shown graphically in Figure 7 using the SE304 as the emitting device and the PH103 as the detecting device.

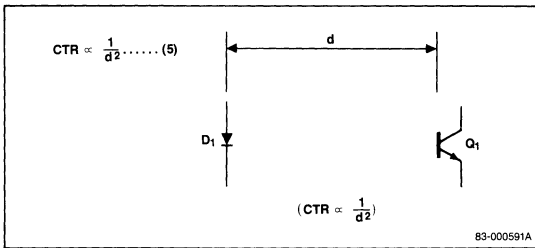


Figure 7. CTR vs. Distance

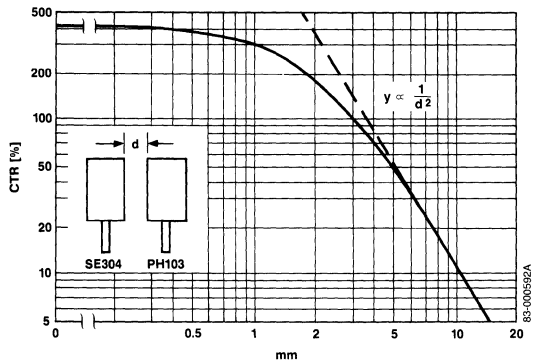


Figure 8. CTR vs Distance Characteristic

Life Test

Highly reliable circuits cannot be designed without understanding the change in characteristics of the devices as they age. As is illustrated in Figures 9 through 12, the aging of photo interrupter devices has only a nominal effect on performance, with the exception of the CTR, which can easily be compensated for during the design cycle if necessary.

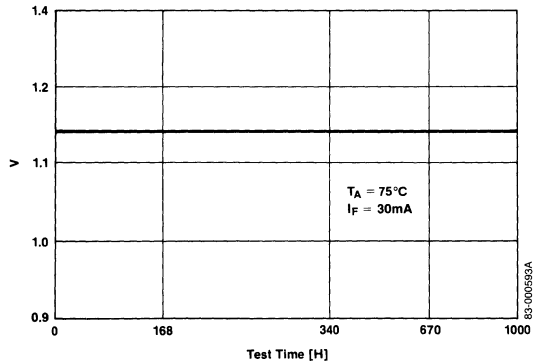


Figure 9. V_F Life Test

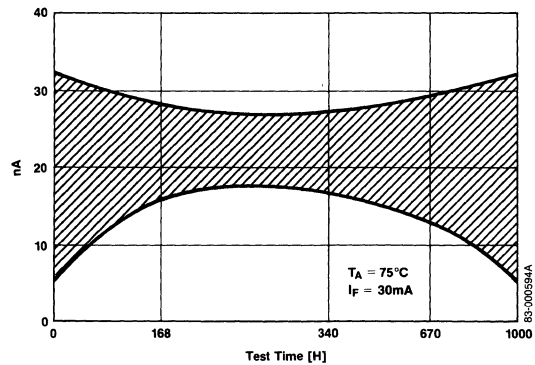


Figure 10. I_{CEO} Life Test

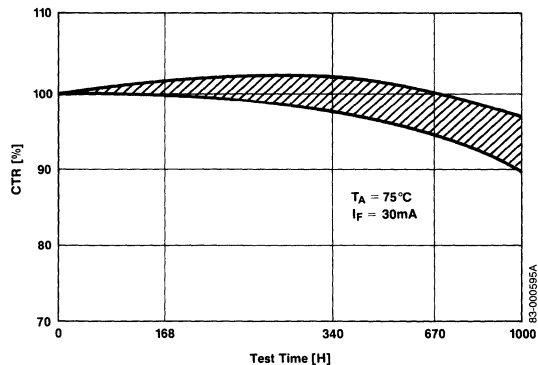


Figure 11. CTR Life Test

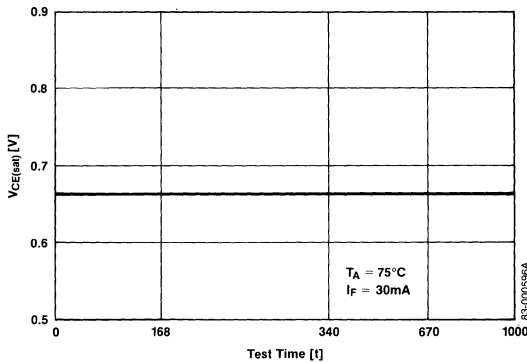


Figure 12. $V_{CE(sat)}$ Life Test

Switching Speed

The importance of switching speed in photo interrupters depends on the application. In mechanical interrupter systems where high-speed slotted disks are used to count or time events, high speed may be an important factor. The PH102 and PH104 have a rise time (t_r) and fall time (t_f) of $5\mu s$ with $R_L = 100\Omega$. The PH101 and PH103 Darlington devices have rise and fall times of 200 to $500\mu s$ at $R_L = 100\Omega$. This means that some trade-off of CTR versus speed will be necessary

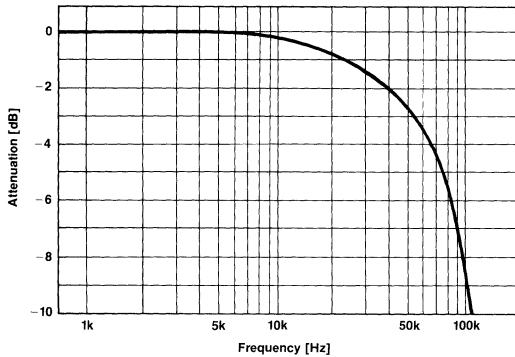


Figure 14. Frequency Characteristics of the PH104 Single

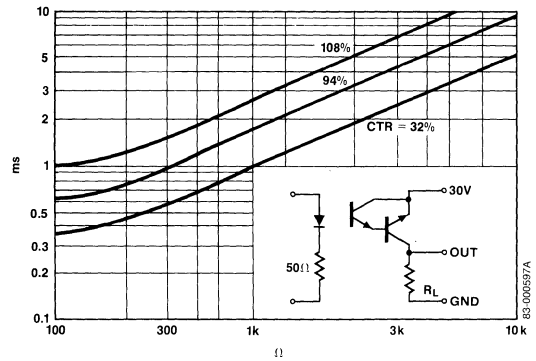


Figure 13. t_R vs R_L of the PS4001

in high-speed designs, since single-transistor devices have a much lower CTR than the slower Darlington. This problem is generally overcome by adding a high-speed comparator, as a buffer stage, to the output of the photo transistor.

Figures 13, 14, and 15 show graphically the switching and frequency characteristics of the PS4001 photo interrupter, the PH104 single transistor, and the PH103 Darlington transistor under sinusoidal wave light.

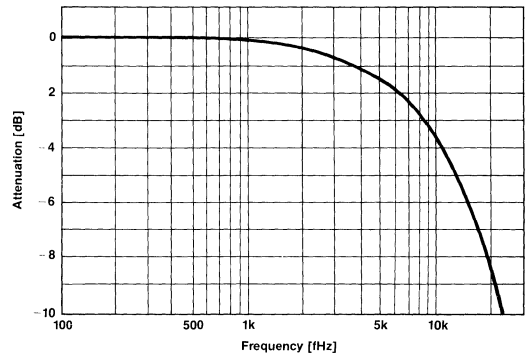
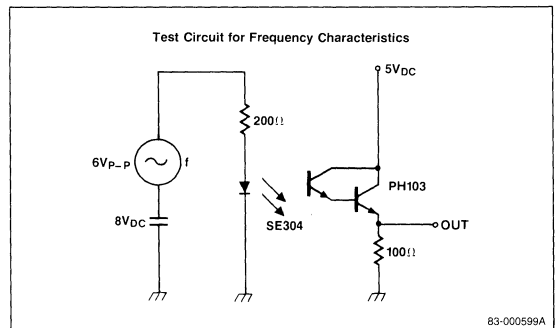
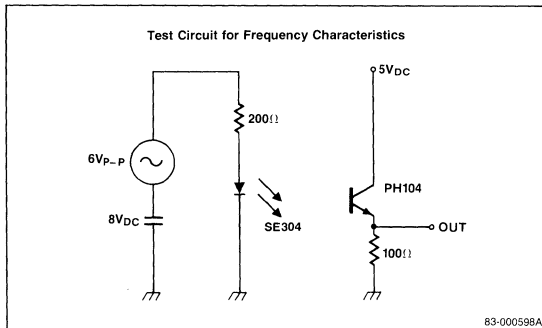


Figure 15. Frequency Characteristics of the PH103 Darlington



The relationship of the moving distance of the shielding object to the output voltage of the photo interrupter circuit when the interrupting device moves across the light path is critical to the proper design of high-speed systems. Figure 16 shows that the difference between high and low output level takes place in 0.5 to 0.6mm of movement.

Figure 17 shows the characteristic difference between a flat surface photo transistor and the lens effect surface transistor. In the flat surface (plane) devices the output level will change over the distance b to c. For lens effect surfaces, the shielding object must move from a to d to change the output level. This means that although the lens devices have a larger CTR, the movement of the shielding device to interrupt the light path becomes longer.

Ultrahigh-Speed Photo Interrupters

The typical switching speed of a single photo transistor is about $5\mu s$ at $R_L = 100\Omega$. Although the high-speed devices will suffice in the majority of applications, higher speeds can be attained by employing PIN photo diodes as the sensing elements. The switching speed for these devices is less than 100ns, making the circuit extremely fast. The drawback to using PIN photo diodes is their low photo sensitivity, which would require high gain amplification of the very small current or voltage generated.

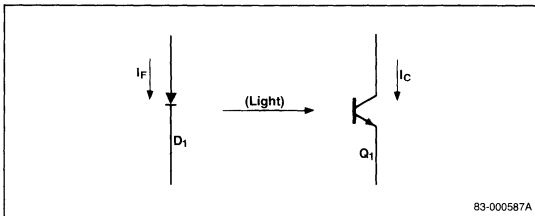


Figure 16. Shielding Characteristics of the PS1004

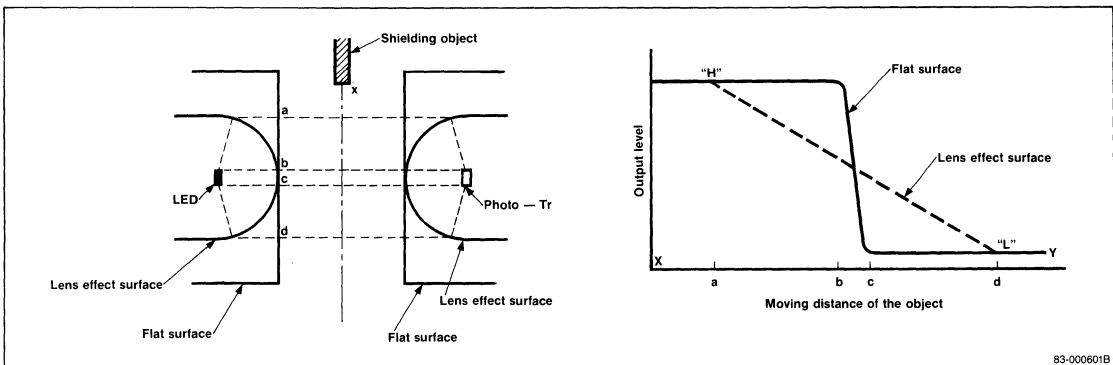


Figure 17. Shielding Characteristics Caused by Surface Design

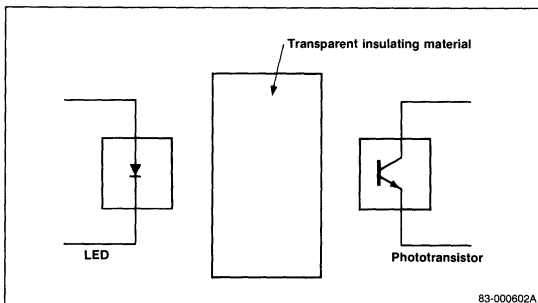


Figure 18. Application to Ultrahigh Breakdown Voltage Photo Coupler

Infrared transmitter/receiver circuits using a combination of LED and PIN diode devices have virtually replaced the ultrasonic and hard-wired remote control systems used for short-distance remote control. Some of the major advantages of IR systems are:

- Simple miniaturization
- Elimination of physical connections
- Fast response speed
- Limited Doppler-caused errors
- Limited effect on other equipment
- No effect on animals

This application note is designed to aid the designer of remote control systems using the SE303A IR LED and the PH302 PIN photo diode manufactured by NEC specifically for IR control systems.

The SE303A is a light emitting diode which emits infrared in the 940nm range. The SE303A is made by growing a p-n junction on a gallium arsenide (GaAs) crystal using the liquid phase epitaxial technique. Featuring high output and wide directional angle, the SE303A is ideal for use in consumer and industrial applications.

Table 1 is a listing of the absolute maximum ratings and the electro-optical characteristics of the SE303A.

The directional pattern of the SE303A is shown in Figure 1. This pattern shows the light output power as a function of the angle from the optical axis. If the optical axis relative power is assumed to be 1.0, then the half-power point is the angle at which the relative light output equals 0.5. We can see in Figure 1 that the maximum output is reached at approximately 5° to either side of zero and the half-power point is reached at about 28° either side of zero.

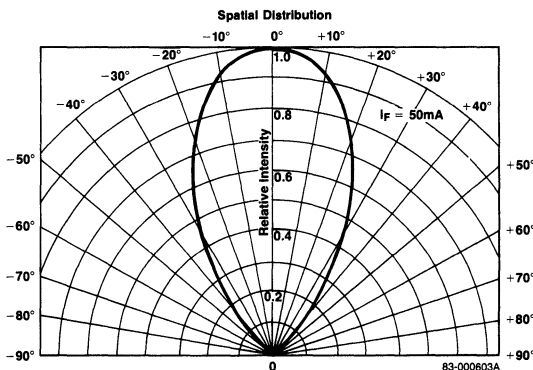


Figure 1. Light Output Power Distribution

Absolute Maximum Ratings

$T_A = +25^\circ\text{C}$	
Power Dissipation, P_D	150mW
Forward Current, I_F	100mA
Pulse Forward Current, I_{FP}^1	1.0A
Reverse Voltage, V_R	5V
Junction Temperature, T_J	80°C
Storage Temperature, T_{STG}	-30°C to +80°C

Electro-Optical Characteristics

Parameters	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Forward Voltage	V_F	1.27	1.45		V	$I_F = 50\text{mA}$
Pulse Forward Voltage	V_{FP}^1	2.45	3.0		V	$I_{FP} = 1.0\text{A}$
Terminal Capacitance	C_T	40			pF	$V = 0$, $f = 1.0\text{MHz}$
Peak Emission Wavelength	λ_{PEAK}	940			nm	$I_F = 50\text{mA}$
Spectral Half Power Value	$\Delta\lambda$	60			nm	$I_F = 50\text{mA}$
Light Output Power	P_0	3.0	6		mW	$I_F = 40\text{mA}$
Response Time	t_{ON}, t_{OFF}	1			μs	

Note: 1. $f = 1\text{kHz}$, duty cycle = 1%.

Table 1.

Figure 2 shows the relationship of the forward current (I_F) to the forward voltage (V_F). The majority of transmitter applications are hand-held units powered by dry cells in the 4.5 to 9.0V range, using two or three LEDs.

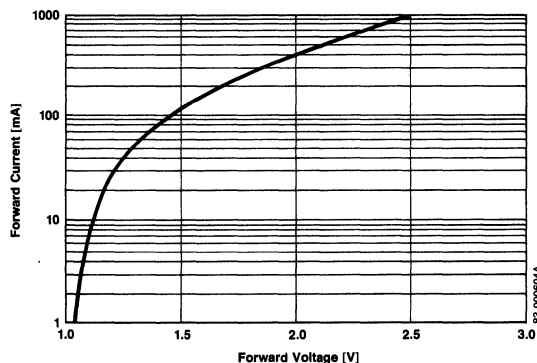


Figure 2. Forward Current vs Forward Voltage

In this case, if V_F is high, the current required exceeds the supply capability. The SE303A was designed so that when the pulsed forward current (I_{FP}) equals 1.0A at a pulse width of $350\mu s$, V_F is typically 2.45V, which is the ideal relationship to the typical voltage source.

For example, if one IR LED is used in the application, the pulsed forward current (I_{FP}) would be 300mA and the forward voltage (V_F) about 1.8V. A 3V supply would be sufficient for this design. On the other hand, if three LEDs are used, then V_F becomes 1.8×3 or 5.4V and the required supply voltage would be 6.0 to 9.0V and allows the designer to use either four 1.5V cells or a single 9V battery. In any case, the extra voltage supplied allows for other voltage drops in the circuit.

The PH302 is a silicon PIN photo diode designed as a light sensing device for infrared remote control systems. Designed in an all resin-molded, vertical-contour package, the PH302 is ideal for low-cost, high-quality applications.

The PIN construction allows high-speed operation and the wide chip area allows high sensitivity. The molded resin is chosen for its selective filtering property, which only transmits infrared radiation above 700nm in wavelength, with maximum efficiency at 940nm. This cancels spurious light from fluorescent lamps, and gives the PH302 excellent noise-free characteristics. This feature eliminates the need for an external IR filter.

The absolute maximum ratings of the PH302 are shown in Table 2, and Figure 3 illustrates the light sensitivity characteristics.

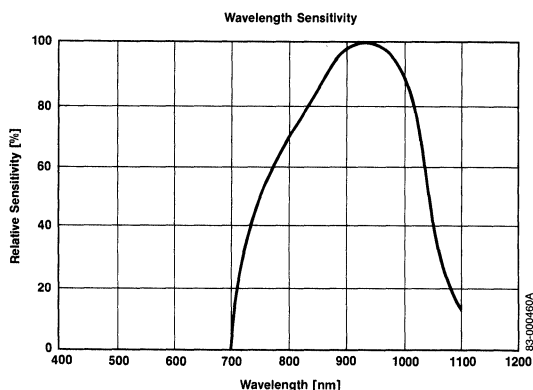


Figure 3. Spectral Sensitivity Characteristic

Absolute Maximum Ratings

$T_A = +25^\circ C$	
Reverse Voltage, V_R	32V
Power Dissipation, P_D	150mW
Junction Temperature, T_J	80°C
Storage Temperature, T_{STG}	-40°C to +80°C

Electrical Characteristics

$T_A = +25^\circ C$		Limits			Test Conditions
Parameters	Symbol	Min	Typ	Max	Unit
Dark Current	I_R			30	nA $V_R = 10V$
Maximum Sensitivity Wavelength	λ_{MAX}		940		nm
Quantum Efficiency	η		0.88		$\lambda = 940nm$
Sensitivity	S	35	50		nA/lx ¹ $V_R = 5V$
Energetic Sensitivity	S		0.6		A/W $\lambda = 940nm$
Open Voltage	V_L		285		mV $E_V = 100lx^1$
Open Voltage	V_L		365		mV $E_V = 1000lx^1$
Rise Time	t_r, t_f		125		ns $R_L = 1k\Omega, V_R = 0, \lambda = 940nm$
Fall Time	t_r, t_f		50		ns $R_L = 1k\Omega, V_R = 5V, \lambda = 940nm$
Terminal Capacitance	C_T		14		pF $V_R = 5V, f = 1MHz$
Light Sensitive Area	A		9		mm ²
Noise Equivalent Power Limit	NEP		4.2×10^{-14}		W/√Hz $V_R = 10V$
Detection Limit	D		6.6×10^{-12}		cm/√Hz/W

Note: 1. Light source color temperature 2854°K.

Table 2.

SE303A and PH302 Combined Characteristics

It is difficult to design a system on the basis of individual characteristics. The following illustrates several characteristics when two devices, the SE303A and the PH302, are combined.

Figure 4 shows the relative light output power and pulsed forward current of the PH303A when the pulse width is $300\mu s$ and duty cycle is 16%. Light output power is the relative value of light output, 1.0, when the forward current (I_F) is 50mA.

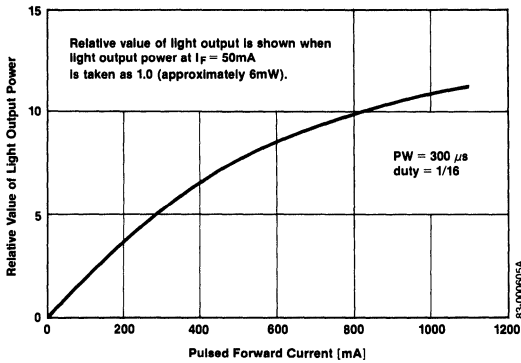


Figure 4. SE303A Relative Value of Light Output — Pulsed Forward Current

Figure 5 illustrates the photo current (I_L) and pulsed forward current (I_{FP}) characteristic. The photo current I_L is generated in the PH302 when the pulsed forward current (I_{FP}) of the SE303A is at a maximum and pulsed for $300\mu s$ pulse width at 16% duty cycle. The LED and PIN diode are placed 30cm apart. The PH302 in this example has a light sensitivity of $50nA/lx$, which is typical for the PH302. The dashed line in Figure 5 represents the minimum light output power of the SE303A (with $P_O = 3 mW$ and $I_F = 50mA$), combined with the typical light sensitivity of the PH302 results in a light current (I_L) of $6nA$ minimum.

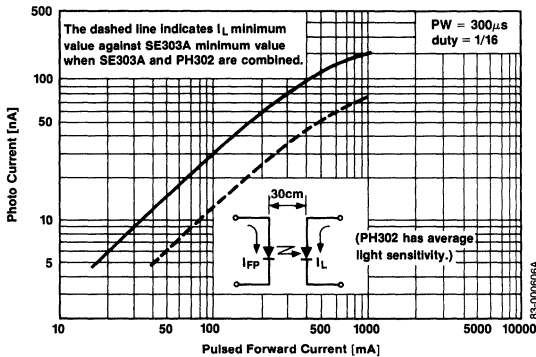


Figure 5. SE303A-PH302 $I_L - I_{FP}$ Characteristic

The radiation intensity of infrared radiation emitted from the SE303A decreases in inverse proportion to the square of the distance between the emitting and receiving devices. If the photo current generated by the PH302, combined with the SE303A, is I_L , and the distance is y , then:

$$I_L \propto \frac{1}{y^2},$$

therefore

$$\log I_L \propto -2 \log y$$

Figure 6 illustrates the $I_L - \gamma$ characteristic of the SE303A and PH302 when combined, and I_{FP} is used as a parameter.

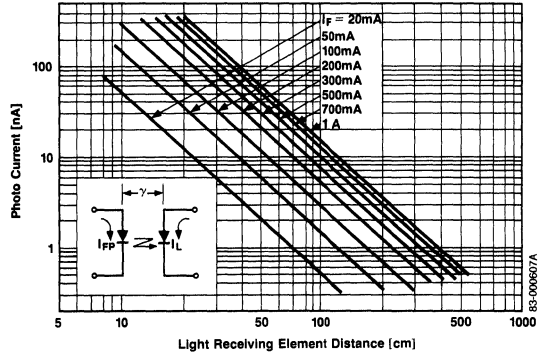


Figure 6. SE303A-PH302 $I_L - \gamma$ Characteristic

Designing an Infrared Remote Control System

When designing a remote control system, the first step is to decide how much photo current (I_L) can be generated at a given distance from the emitting source. In this case the PH302 is used as the receiver and the SE303A is the emitting source. From the information given in the preceding section, the drive conditions of pulsed forward current, the receiving amplifier gain and the photo current (I_L) are determined. Note at this point that high gain in the first stage of amplification should be avoided, as noise and spurious light are also amplified. Figure 7 shows a block diagram of normal design procedures.

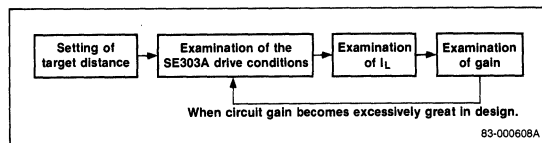


Figure 7. Block Diagram

Circuit Examples

Shown in Figures 8 and 9 are examples of pulse driving using the SE303A and pulse receiving circuitry using the PH302.

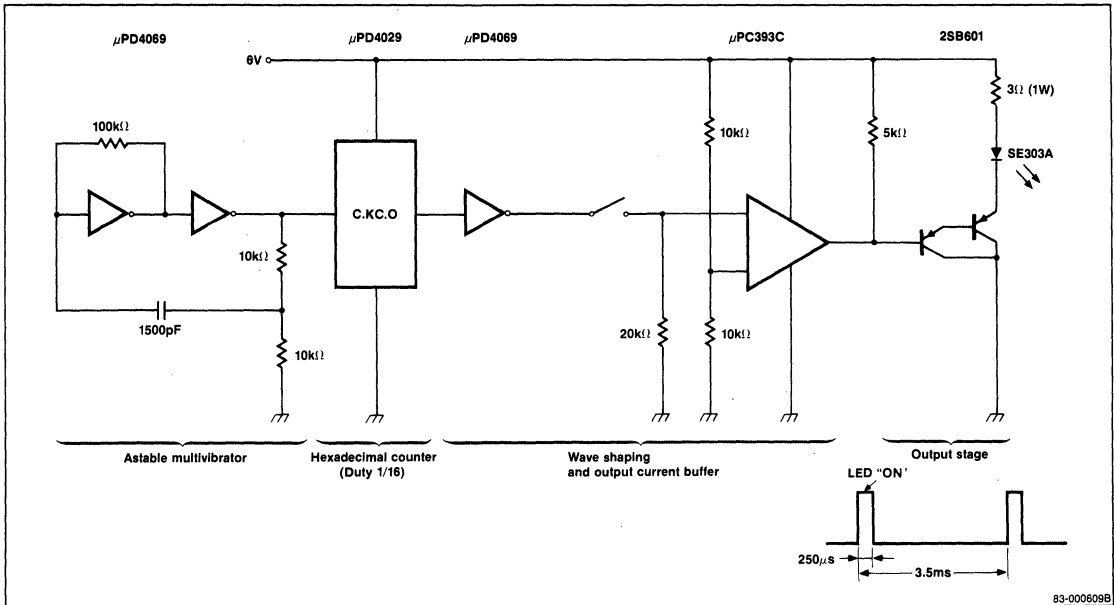


Figure 8. SE303A Pulse Driving Circuit

Figure 8 shows an astable multivibrator composed of a μ PD4049C. The duty cycle of 1/16 is generated by a hex counter. The μ PC393C provides wave shaping, and the 2SB601 is used as an output current buffer. The saturation voltage of the 2SB601 is about 1V and the forward voltage of the SE303A is about 2.5V, so the resultant pulsed forward current is about 800 to 900mA. As shown in Figure 9, the light received by the PH302 is converted to current and is then amplified to 10 times the original current by a 2SK163 FET Pre-amplifier. The

μ PC4559C then amplifies the signal by 100. The signal is then passed to a μ PC393C comparator, which drives a monostable multivibrator (one-shot). The output of the one-shot drives a 2SB601, which drives the output. The output loading can be changed by narrowing the pulse interval or changing the time constant of the one-shot. The 1000pF capacitor between the 2SK163 and the μ PC4559 are used to eliminate 50 to 60Hz 1A line interference.

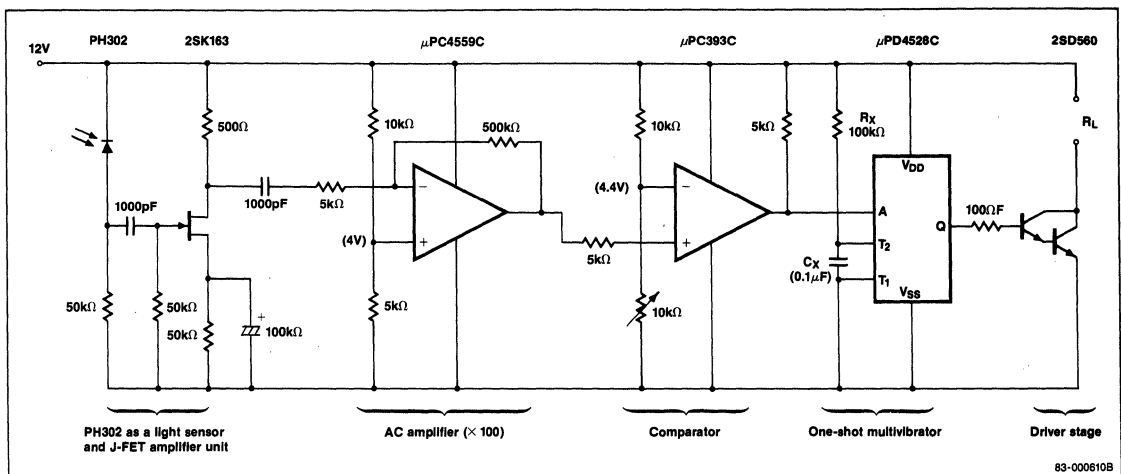


Figure 9. PH302 Pulse Receiving Circuit

Television remote control is the most popular use for infrared remote control circuits. Generally, the housekeeping and signal generation for these systems is provided by control ICs, which offer a wide variety of pulse modulation formats from manufacturer to manufacturer.

The following circuit employs the NEC μ PC1986 IR transmitter and the μ PD1987 receiver ICs shown in Figures 10 and 11. For details of the μ PD1986 and μ PD1987, please refer to the data sheets for these devices.

Conclusion

Although the application of IR remote circuits is primarily for television and VCR applications, as the systems are improved and modified other longer-ranged systems may be developed. NEC is constantly striving to bring new technologies to the marketplace, and the devices used in this application are not only the beginning. For further information on other controllers and infrared emitting and receiving devices, contact: NEC Electronics Inc., 401 Ellis Street, P.O. Box 7241, Mountain View, CA 94039. Attention: Semiconductor Marketing/Applications.

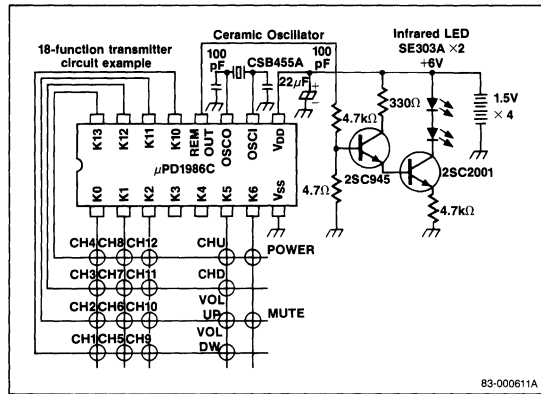


Figure 10. TV Remote Control Transmitter Circuit

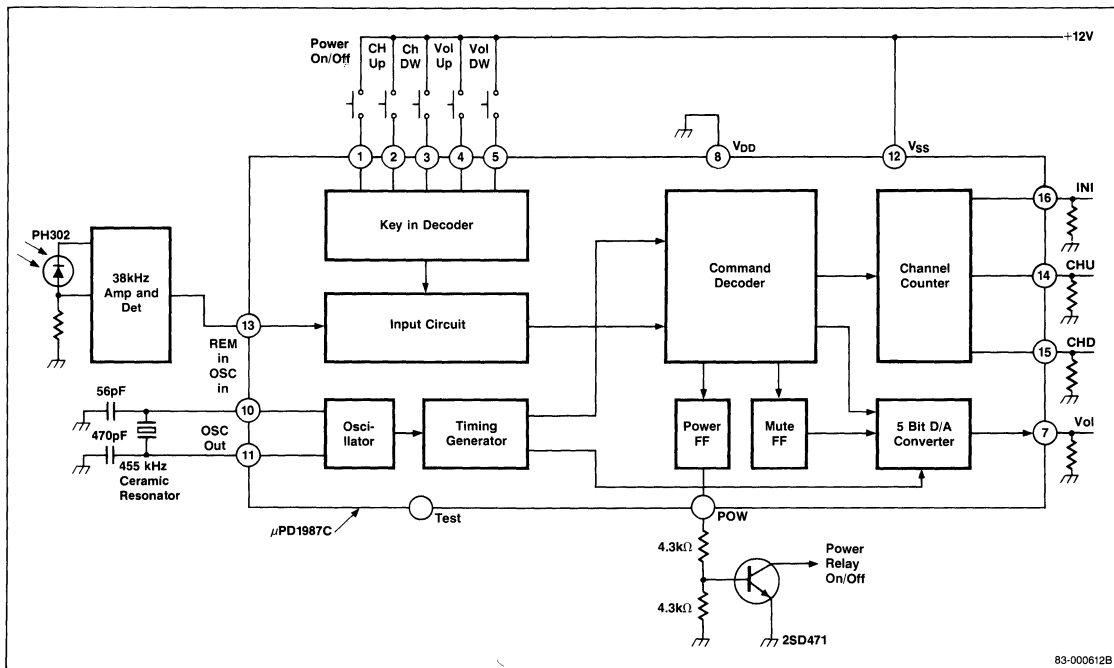


Figure 11. TV Remote Control Receiver Circuit

Introduction

Optical remote control systems are used extensively in television receivers, and also are gradually finding application in audio and video equipment and air conditioners.

A combination of an infrared light emitting diode and a PIN photo diode is used to implement an optical remote control. NEC now produces the SE303A infrared light emitting diodes (LEDs) and PH302 PIN photo diodes as remote control devices.

The data in this note, together with the NEC technical data in "Application Note for SE303A and PH302: Infrared Remote Control" (LEA-507), describes the allowable pulsed forward current, which is an important factor in the use of the SE303A and PH302 for remote control. The data here serves as reference information.

1. Allowable Pulsed Forward Current

In the design of a remote control circuit of a television receiver, a relatively high pulsed forward current must be supplied to the infrared light emitting diode. This is necessitated by the high signal-to-noise ratio and high photo current required, because control may be implemented from a distance of 10 to 20m. On the other hand, the pulsed forward current is limited by the power

applied and by the allowable junction temperature of the IR LED. It therefore must be kept within the limits defined by these factors. Figure 1 shows the pulsed forward current versus the duty ratio characteristic of the SE303A. Figure 2 shows the pulsed forward current versus the pulse width characteristic.

See Section 3 for general information on how to determine the pulsed forward current I_{FP} , the duty ratio D , and the pulse width PW .

2. Degradation Change in Radiant Output Power of SE303A with Pulsed Forward Current

As described above, the allowable pulsed forward current value of a device indicates only the maximum curve of pulsed forward current tolerated before thermal breakdown of the device. In this case, no consideration is given to the degradation change in radiant output power. Figures 3(a) and 3(b) illustrate what degree of degradation change occurs in the radiant output power of a high current-pulsed SE303A.

In Figure 3, a very large degradation change can be seen at $PW = 5ms$ and $I_{FP} = 1A$. Suppose an SE303A is normally used for remote control in a TV receiver for about 10 years. Then the SE303A will have an actual operating time of around 200 to 300 hours. This will not pose a problem in practical use.

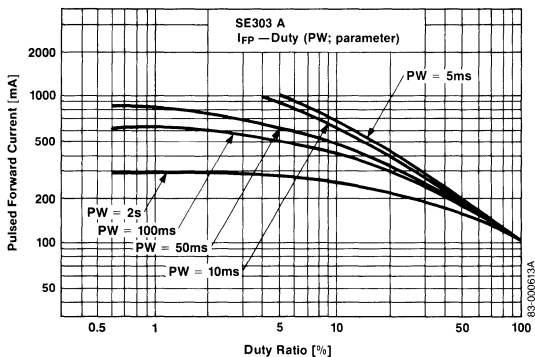


Figure 1. Pulsed Forward Current vs. Duty Ratio Characteristic

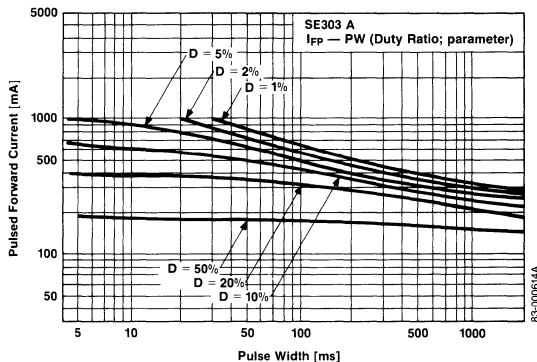


Figure 2. Pulsed Forward Current vs. Pulse Width Characteristic

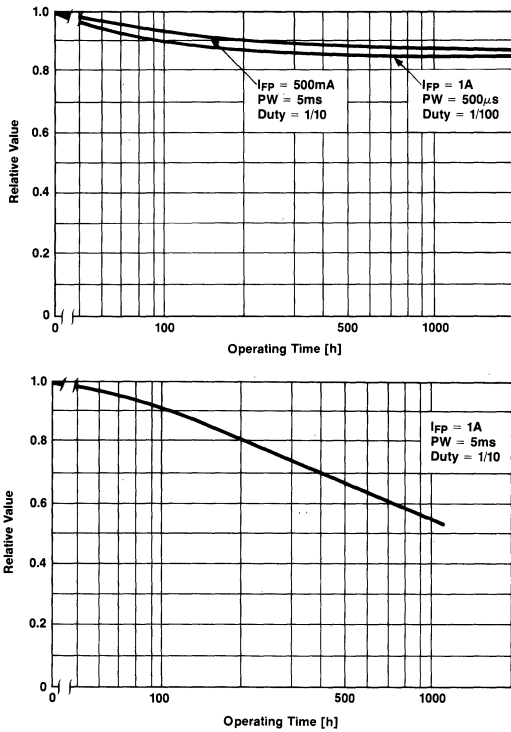


Figure 3. Degradation Change In Radiant Output Power of SE303A with Pulsed Forward Current

3. How to Determine Allowable Pulsed Forward Current

The pulsed forward current can generally be determined by the average power method shown below. In this case, the repetitive pulse train of Figure 4(a) can be changed to the pulse train model of Figure 4(b).

Convert the train of power pulses up to the (n-1)th into the average power, and estimate to what value the junction temperature rises by the peak power at the nth or (n+1)th pulse, and then set the junction temperature so it is within the specified range. If T is the repetition period, t_p for the pulse width, and P_D for the applied power, the applied average power P_{ave} is:

$$P_{ave} = \frac{t_p}{T} P_D$$

Using the superposition principle, decompose Figure 4(b) as shown in Figure 5 Pulses Decomposed by the Superposition Principle.

From Figure 5, the junction temperature T_{JN} at the end of the nth pulse becomes:

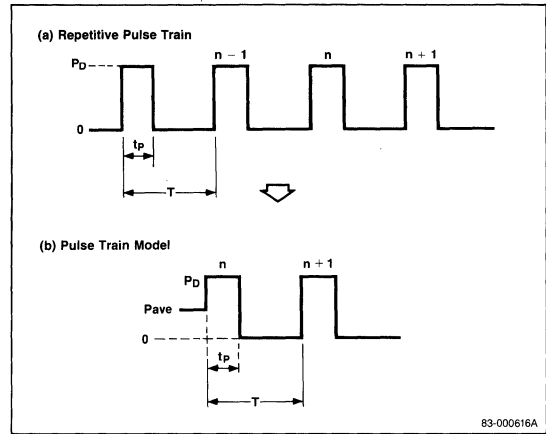


Figure 4. Modeling of Repetitive Pulse Train

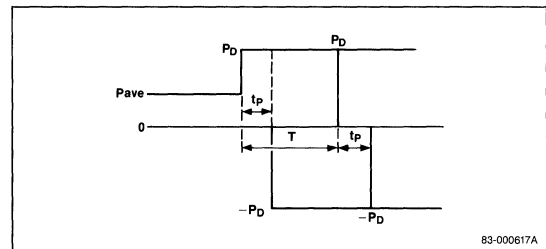


Figure 5.

$$T_{JN} = P_{ave} \cdot R_T + (P_D - P_{ave}) \cdot \gamma(t_p) + T_A \quad (1)$$

where: T_{JN} is junction temperature at the end of nth pulse; R_T the saturation thermal resistance; t_p the pulse width; $\gamma(t_p)$ the transient thermal resistance for t_p ; T_A the ambient temperature.

Substituting $t_p/T = D$ (duty ratio) into eq. (1) gives:

$$T_{JN} = D \cdot R_T + (1 - D) \cdot \gamma(t_p) \cdot P_D + T_A \quad (2)$$

At the end of the (n+1)th pulse, the junction temperature T_{JN+1} is:

$$\begin{aligned} T_{JN+1} &= P_{ave} \cdot R_T + (P_D - P_{ave}) \cdot \gamma(T + t_p) - P_D \cdot \gamma(T) + P_D \cdot \gamma(t_p) + T_A \\ &= P_D \cdot \frac{t_p}{T} \cdot R_T + (1 - \frac{t_p}{T}) \cdot \gamma(T + t_p) - \gamma(T) + \gamma(t_p) + T_A \\ &= P_D \cdot D \cdot R_T + (1 - D) \cdot \gamma(T + t_p) - \gamma(T) + \gamma(t_p) + T_A \quad (3) \end{aligned}$$

where $\gamma(t_p)$ is the transient thermal resistance for $t = 0 \sim t_p$; $\gamma(T)$ the transient thermal resistance for $t = 0 \sim T$; $\gamma(T + t_p)$ the transient thermal resistance for $t = 0 \sim (T + t_p)$.

The junction temperature given by eq. (3) is slightly lower and is closer to the actual value than that given by eq. (2), but eq. (2) generally is used because it is simpler than eq. (3). Moreover, eq. (2) estimates the junction temperature with a value higher than the actual value, leaving a margin for the allowable value. Since $P_D = I_F \cdot V_F$, eq. (2) becomes:

$$T_J - T_A = I_F \cdot V_F \cdot D \cdot R_T + (1 - D) \cdot \gamma \cdot (t_p) \quad (4)$$

When t_p and T are known, γ (t_p) can be determined from transient thermal resistance data. Therefore, $I_F \cdot V_F$ is:

$$I_F \cdot V_F = \frac{D \cdot R_T + (1 - D) \cdot \gamma \cdot (t_p)}{T_J - T_A} \quad (5)$$

I_F can be determined from the I_F vs. $I_F \cdot V_F$ characteristic data.

Figure 6 illustrates the transient thermal resistance vs. pulse width characteristic of the SE303A, and

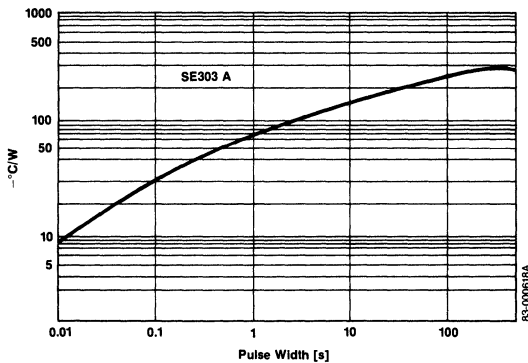


Figure 6. Transient Thermal Resistance vs. Pulse Width Characteristic

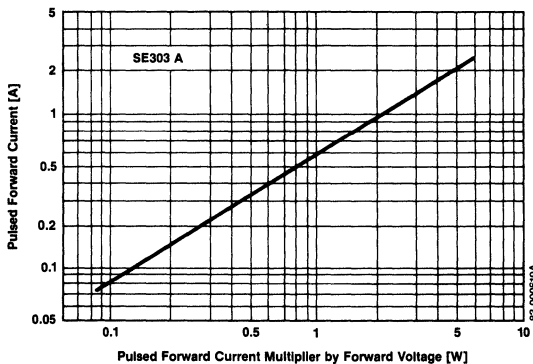


Figure 7. Pulsed Forward Current vs. Pulsed Forward Current by Forward Voltage Characteristic

Figure 7 shows the pulsed forward current vs pulsed forward current with forward voltage characteristic of the SE303A.

For example, when $T_J = 80^\circ\text{C}$, $T_A = 25^\circ\text{C}$, $D = 10\%$, $t_p = 0.1\text{s}$, and $R_T = 280^\circ\text{C/W}$, $r(t_p = 0.1\text{s}) = 30^\circ\text{C/W}$. Therefore,

$$I_F \cdot V_F = \frac{80 - 25}{0.1 \times 280 + (1 - 0.1) \times 30} = 1$$

From the I_F vs. $I_F \cdot V_F$ characteristic graph, $I_F = 530\text{mA}$.

The pulsed forward current thus calculated should be derated for safety. In general, it is usual to allow a 20% margin.

Reference data: F.W. Gutzwiller, T.P. Sylvan. "Power Semiconductor Ratings Under Transient and Intermittent Loads," *AIEE Transactions*, vol. 79, Jan. 1961.

4. Measurement of the Radiant Output Power of an Infrared Light Emitting Diode

A photo conductive cell, photo diode, photo multiplier or solar cell can be used to detect the radiant output power of an infrared light emitting diode (IR LED). The reason for this is that solar cells with a wide detecting area are stable in their characteristics for long periods of time, and have excellent spectrum matching with IR LEDs, good frequency response, and good reproducibility. They also are inexpensive and easy to use.

If the output of a solar cell (the voltage across a resistor connected in parallel with the solar cell) is calibrated in milliwatts of radiant output power, the radiant power output can be determined simply by measuring the solar cell output.

Figure 8 shows a simple, convenient radiant output power detector using a solar cell.

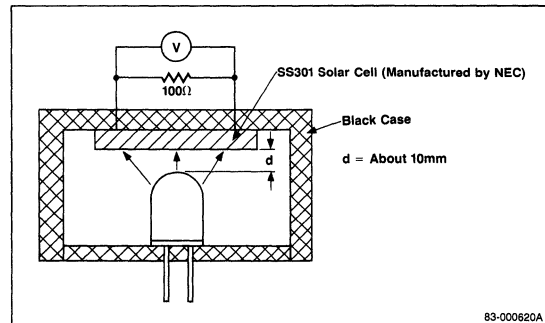


Figure 8. Radiant Output Power Measuring Instrument

5. Example of Application of SE303A

5.1 Simple remote control circuit using the SE303A and PH302

Figure 9 shows a simple remote control circuit using a SE303A and a PH302. The infrared radiation emitted from the SE303A is received by the PH302 and then amplified. The μ PC1373H is a preamplifier manufactured specifically for infrared light remote control. For details of the μ PC1373H, refer to the data sheet.

5.2 Application to TV remote control

Figure 10 is an example of a circuit used for TV remote control. The μ PD1913C/ μ PD1943G is an exclusive IC used for the remote control system on the transmission side. The infrared light from the SE303A is received by the PH302, and then amplified by the μ PC1373H preamplifier (used only for remote control) before being processed as signals by the μ PD550C 4-bit microcomputer.

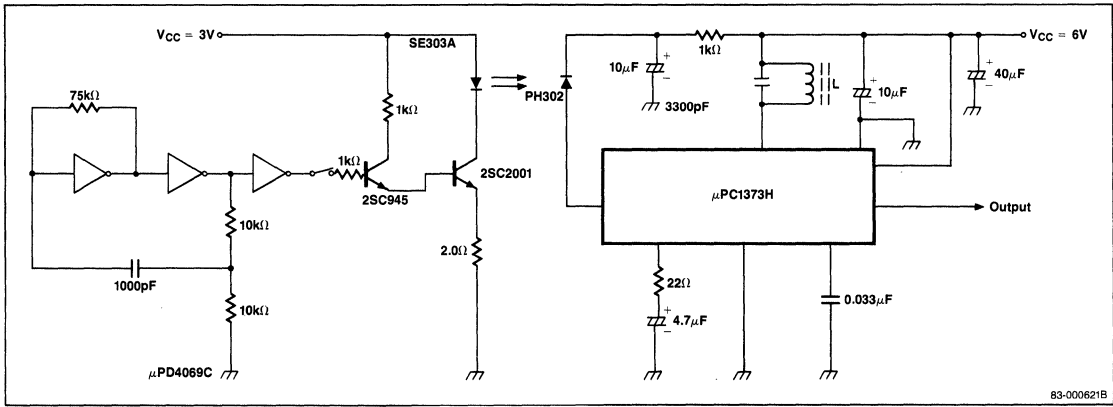


Figure 9. Simple Remote Control Circuit Using SE303A and PH302

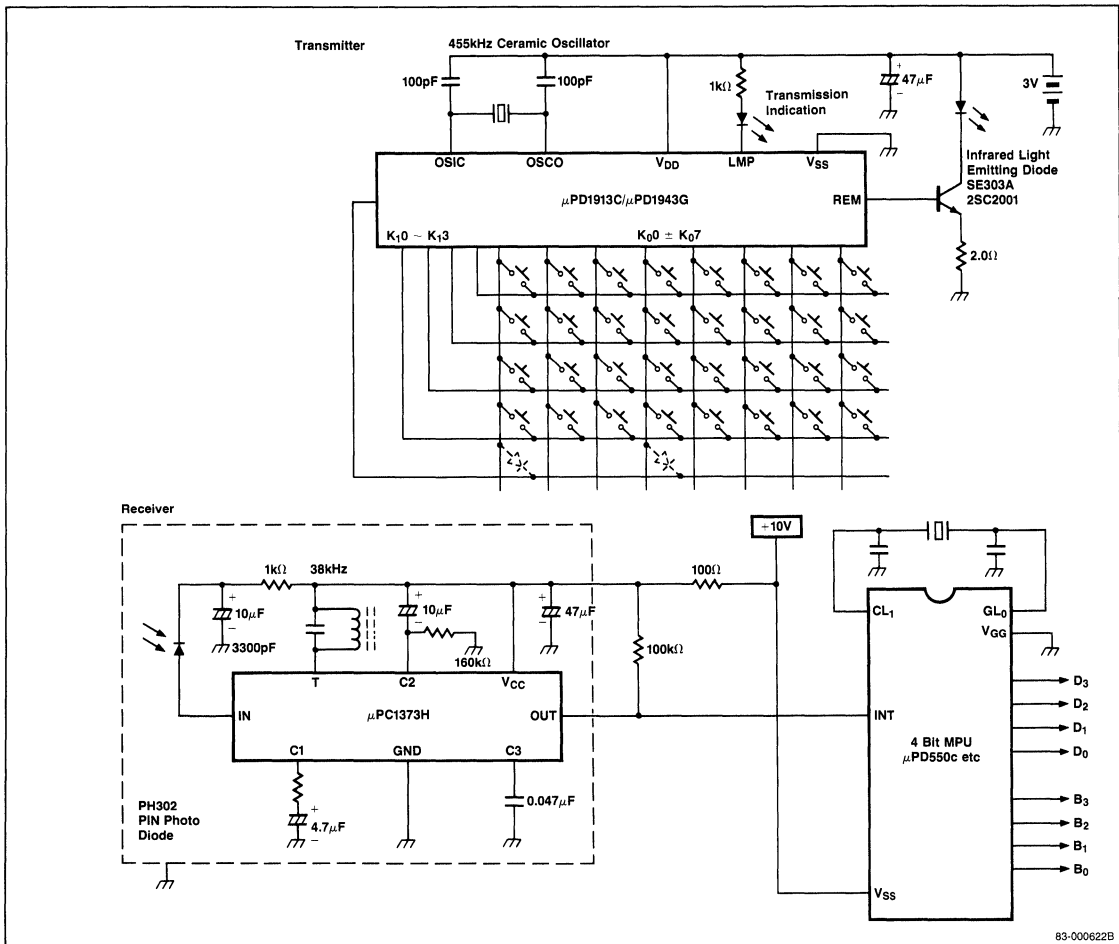


Figure 10. Application to TV Remote Control

The above circuit examples and the circuit constants used are not designed for mass production. Accordingly, no consideration is given to the tolerances or temperature characteristics of each part of the circuits. NEC makes no representations as to any patents on the circuits.

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