Catalog of Optoelectronic Products 1986/87

GENERAL INSTRUMENT

General Instrument Optoelectronic Products 1986/87

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Optoelectronics Division
3400 Hillview Avenue
Palo Alto, California 94304

GENERAL INSTRUMENT

ALL SPECIFICATIONS SUBJECT TO CHANGE

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About General Instrument Optoelectronics

Experience
For the last seventeen years—first as Monsanto and now as General Instrument—we have been a leading manufacturer of optoelectronic products. As a result of this experience and our leadership in developing III-V materials technology, we have contributed many firsts to the field of optoelectronics—in LED lamps, displays and optocouplers.

Quality Control
Because we are one of the few vertically integrated optoelectronic manufacturers, we exercise total control over each stage of production—through growing our own crystals to epitaxial deposition and water manufacturing. This ensures quality and reliability in our products.

Reliable Products
At both our manufacturing plants, in Palo Alto and Kuala Lumpur, extensive reliability testing (see pg. xv) and advanced manufacturing techniques ensure the highest standards of production. We are committed to the concept of providing state-of-the-art dependable products at competitive prices.

Broad Product Range
We offer high performance optoelectronic devices in four major categories; optocouplers, displays, lamps, and light bars and bargraph arrays. This catalog contains detailed specifications on our complete line of optoelectronic products.

Product Availability
A worldwide network of stocking distributors assures immediate availability of most standard products. General Instrument authorized distributors are located worldwide. In addition, four General Instrument Direct Sales Offices in the United States and eleven International Sales Offices serving major world markets, provide a complete range of all General Instrument Optoelectronic products. See how to order in the following section.

Efficient Service
If you have a question or a problem, just pick up the phone and call the nearest General Instrument Technical Representative. These highly qualified sales engineers can offer assistance in design and product selection. The lists on pages 411 and 414 will enable you to locate one in your area.

In addition, our staff of factory product engineers can provide information, discuss specific problems and offer applications assistance. The answer to your question is only a phone call away.

You can depend on General Instrument.

About This Catalog

This catalog describes in detail our complete line of optoelectronic products. For your convenience, the catalog is divided into four major product groups—optocouplers, displays, lamps, and light bars and bargraph arrays.

A selection guide will be found at the begining of each product section. This provides brief basic information on the product line to assist you in selecting the device best suited to your requirements.

Full specification sheets are located within each section.

For fast reference, an alphanumeric listing appears on page xi which lists all products individually with the appropriate data sheet page number. An alphanumeric listing also appears at the beginning of each product section.

Application notes starting on page 367 provide useful technical information to assist you in selecting and testing optoelectronic devices.

DATA SHEET CLASSIFICATIONS

CLASSIFICATION	PRODUCT STAGE	DISCLAIMERS
Preview DATA SHEET	Formative or Design	This document contains the design specifications for product under development. Specifications may be changed in any manner without notice.
Advance Information DATA SHEET	Sampling or Pre-Production	This is advanced information, and specifications are subject to change without notice.
Preliminary DATA SHEET	First Production	Supplementary data may be published at a later date.

How to Order

All General Instrument Optoelectronic products may be ordered through any of the International Sales Offices and Direct Sales Offices listed on the back cover. For immediate delivery of General Instrument optoelectronic products, contact any of the stocking distributors located in your area. See pages 412 and 414.

Warranties

Seller warrants all items against defects in material and workmanship under normal use and service for a period of one (1) year from the date of shipment; provided, however, that Seller's liability under said warranty shall be limited, at Seller's option, to crediting Buyer's account or replacing or repairing items or parts thereof which Seller's inspection shall have disclosed to its satisfaction to have been defective in the form in which it was shipped by Seller, prior to its use in further manufacture or assembly. This warranty shall not apply to items or parts thereof that have been (a) subjected to misuse, neglect, accident, damage in transit, abuse or unusual hazard; (b) repaired, altered or modified by anyone other than Seller; or (c) used in violation of instructions furnished by Seller. All requests for return of items must receive the written authorization of Seller.

Seller's warranties extend to the Buyer and to no other person or entity.

Seller's warranties as hereinabove set forth shall not be enlarged, diminished or affected by, and no obligation or liability shall arise or grow out of, Seller's rendering of technical advice or service in connection with Buyer's order of the goods furnished hereunder.

THE FOREGOING ARE IN LIEU OF ALL WARRANTIES, EXPRESS, IMPLIED, OR STATUTORY, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE AND ANY OTHER WARRANTY OBLIGATION ON THE PART OF THE SELLER.

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General Instrument Reliability

At General Instrument, product dependability is assured through an active program which includes:

New Product Qualification

All new products evolve through an orderly design-to-manufacture flow. At each stage reliability engineering is present to ensure that the defined reliability requirements are met.

The reliability plan is implemented in the development stage where actual testing begins. Stress tests are performed to show potential problem areas and the reliability of the new product is compared directly with that of a previously qualified product of a similar generic type.

During limited production, where components must meet defined reliability goals, samples from a minimum of three lots are taken for extensive testing. These samples must meet or exceed defined goals in order for the product to be considered qualified and transferred to the reliability monitoring program.

Quality Control

Quality control is a vital function at General Instrument. To minimize variations in the product and to maintain quality and hence reliability, the following in-process control activities are routinely performed:

- Incoming inspection of all piece parts and raw materials.
- Die-attach process control gate.
- Wire-bond control gate.
- Encapsulation control gate.
- Equipment monitors.
- Final Q.A. gate of all lots.
- Finished goods stores monitor.
- Frequent process line audits for conformance to specification.

Monitor Program

To ensure that qualified products continue to meet reliability targets, a monitor program tests generic device families on a periodic basis and provides information for the reliability data bank.

*Not all tests apply to all products.

Reliability monitoring consists of the following tests.*

- D.C. Operating Life
  T_A = 25°C or High Temperature
  Time = 1000 hours
  I_F = max. rated
- High Temperature Storage
  T_A = 150°C or specified
  Time = 1000 hours
- Low Temperature Storage
  T_A = -55°C or specified
  Time = 1000 hours
- 85/85 No Bias
  T_A = 85°C
  RH = 85%
  Time = 1000 hours
- HTRB
  T_A = 100°C or specified
  Voltage = 80% max. rated
  Time = 1000 hours
- Thermal Shock per MIL-STD-883C, Method 1011
  T_A = 0°C to 100°C (Air to Air)
  No. of cycles = 30
- Temperature Cycle per MIL-STD-883C, Method 1010
  T_A = per device based on storage temperature (Air to Air)
  No. of cycles = 50
- Pressure Pot pressure = 15 PSI
  Time = 96 hours
  T_A = 121°C ± 1°C
- 85/85 and Pressure Pot tests are not required per MIL-STD-883C for Hermetic Products.
- Solder Heat Tests (visible products only) per MIL-STD-883C Method 2003.3
  T_A = 260°C ± 5°C
  Duration = 10 sec.

Reliability Test Facilities

Both in Palo Alto and Kuala Lumpur (Malaysia), test facilities are equipped with:

- Automated Testing.
- Life test equipment— High and Low Temperature.
- Temperature/humidity chambers.
- High Temperature ovens.
- T/S and T/C equipment.

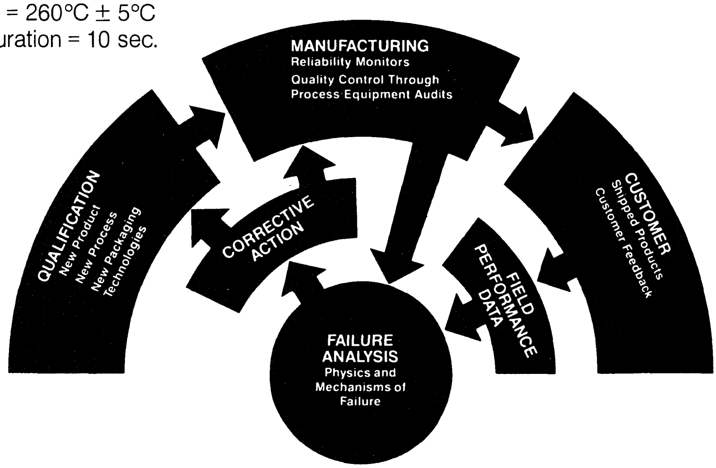
In addition, the failure analysis lab facilities in Palo Alto and Kuala Lumpur have the following capabilities:

- Electrical testing and verification.
- Pin-to-pin measurements.
- Package dissection and cross-sectioning.
- Chemical etching.
- Optical photomicroscopy.
- Micromanipulators.
- Access to scanning electron microscope with X-ray spectrometry.
- Access to Augur analysis.

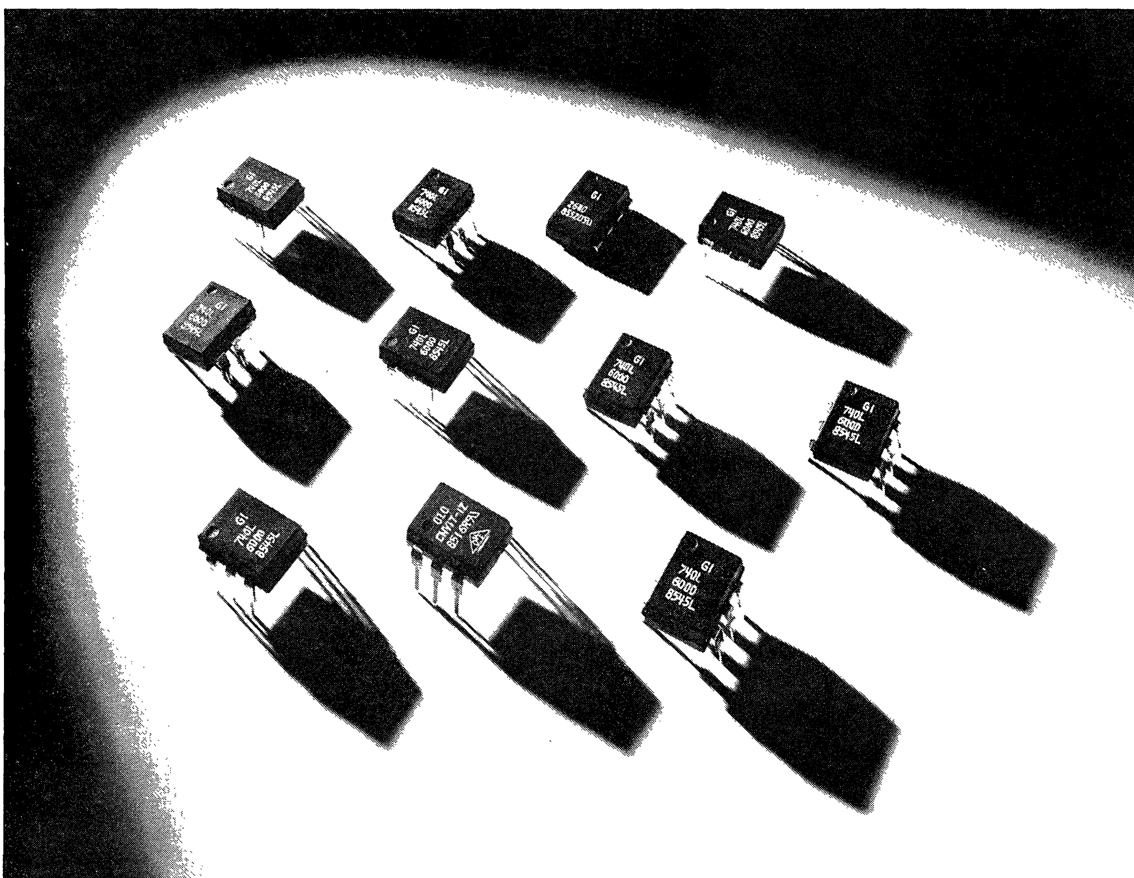
Failure Analysis and Qualitative Reliability

When a reliability failure does occur, a detailed analysis is performed to provide data for corrective action, as well as guidelines for the design of future new products.

This on-going activity and the resulting feedback and action is illustrated in the accompanying diagram.



Optocouplers 1



Optocouplers

Alphanumeric Product Listing

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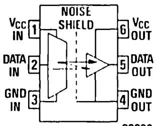
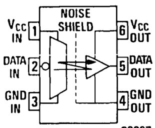
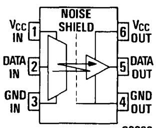
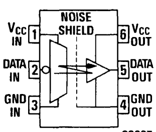
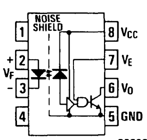
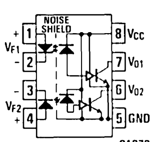
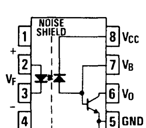
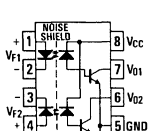
OPTOCOUPLERS HIGH SPEED

FAN-IN/FAN-OUT AND CTR AT 0-70° C; ALL WITHSTAND TEST VOLTAGES ARE 2500 VAC RMS 1 MIN.

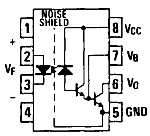
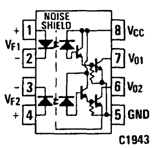
EQUIVALENT CIRCUIT	PART NUMBER	INPUT	OUPUT	V_{CCI}/V_{CCO} OR BV_{CEO}	FAN-IN/FAN-OUT OR CTR MIN. @ I_F = mA	DATA RATE (NRZ) TYP.	CMR TYP.	PAGE	COMMENT
 C2086	74OL6000	Logic 1 LSTTL Load	Logic 10 TTL Loads Totem Pole	5 V/5 V	0.4 mA/16 mA	15 Mbit/s	15 kV/μs	35	Buffer
 C2087	74OL6001	Logic 1 LSTTL Load	Logic 10 TTL Loads Totem Pole	5 V/5 V	0.4 mA/16 mA	15 Mbit/s	15 kV/μs	35	Inverter
 C2086	74OL6010	Logic 1 LSTTL Load	Logic 10 TTL Loads Open Coll.	5 V/5-15 V	0.4 mA/16 mA	8 Mbit/s	15 kV/μs	35	Buffer
 C2087	74OL6011	Logic 1 LSTTL Load	Logic 10 TTL Loads Open Coll.	5 V/5-15 V	0.4 mA/16 mA	8 Mbit/s	15 kV/μs	35	Inverter
 C2092	6N137 MCL2601 HCPL-2601	LED	Logic 8 TTL Loads Open Coll.	—/5 V	5 mA/13 mA Recommended I_F = 6.3 mA	10 Mbit/s	10 kV/μs	91	
 C1979	MCL2630 MCL2631 HCPL-2630 HCPL-2631	Dual LED	Dual Logic 8 TTL Loads Open Coll.	—/5V	5 mA/13 mA Recommended I_F = 6.3 mA	10 Mbit/s	10 kV/μs	97	
 C1982	MCL2501	LED	Transistor	to 15 V	14% @ 8 mA 17% @ 16 mA	1 Mbit/s	10 kV/μs	77	Guaranteed Switch Times **0-70°C**
	6N136[1]	LED	Transistor	to 15 V	15% @ 16 mA	1 Mbit/s	10 kV/μs		Recommended I_F is 20% Above Rated I_F
	MCL2502 HCPL-2502	LED	Transistor	to 15 V	15-22% @ 16 mA	1 Mbit/s	10 kV/μs		
	MCL2503 HCPL-2503	LED	Transistor	to 15 V	9% @ 16 mA	1 Mbit/s	10 kV/μs		
	6N135	LED	Transistor	to 15 V	5% @ 16 mA	1 Mbit/s	10 kV/μs		
 C1944	MCL2531 HCPL-2531	Dual LED	Dual Transistor	to 15 V	15% @ 16 mA	1 Mbit/s	10 kV/μs	85	Recommended I_F is 20% Above Rated I_F
	MCL2530 HCPL-2530	Dual LED	Dual Transistor	to 15 V	5% @ 16 mA	1 Mbit/s	10 kV/μs		

[1]Inquire About Base-less Version MCL/HCPL-4502

Continued next page

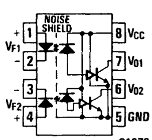
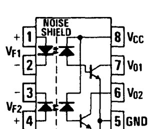
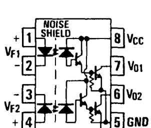
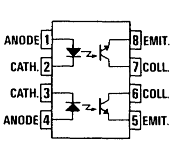
OPTOCOUPLERS HIGH SPEED Continued

FAN-IN/FAN-OUT AND CTR AT 0-70° C; ALL WITHSTAND TEST VOLTAGES ARE 2500 VAC RMS 1 MIN.

EQUIVALENT CIRCUIT	PART NUMBER	INPUT	OUPUT	V_{CCI}/V_{CCO} OR BV_{CEO}	FAN-IN/FAN-OUT OR CTR MIN. @ I_F = mA	DATA RATE (NRZ) TYP.	CMR TYP.	PAGE	COMMENT
 C1984	6N139	LED	Darlington	to 18 V	400% @ 0.5 mA 500% @ 1.6 mA	100 kbit/s	10 kV/µs	31	Low $V_{CE(SAT)}$ of 0.4 V Recommended I_F is 20% Above Rated I_F
	6N138	LED	Darlington	to 7 V	300% @ 1.6 mA	100 kbit/s	10 kV/µs		
 C1943	MCL2731 HCPL-2731	LED	Darlington	to 18 V	400% @ 0.5 mA 500% @ 1.6 mA	100 kbit/s	10 kV/µs		Recommended I_F is 20% Above Rated I_F
	MCL2730 HCPL-2730	LED	Darlington	to 7 V	300% @ 1.6 mA	100 kbit/s	10 kV/µs		

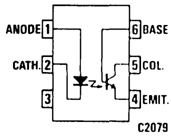
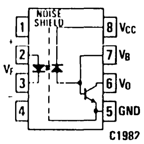
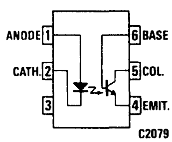
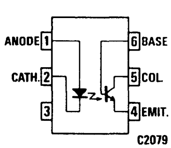
OPTOCOUPLERS DUALS

ALL WITHSTAND TEST VOLTAGE 2500 VAC RMS 1 MIN.

EQUIVALENT CIRCUIT	PART NUMBER	OUPUT	V_{CC} OR BV_{CEO}	$CTR_{CE(SAT)}$ MIN. @ I_F = mA or F_I/F_O	DATA RATE (NRZ) TYP.	CMR TYP.	PAGE	COMMENT
 C1979	MCL2630 HCPL-2630 MCL2631 HCPL-2631	Logic	5 V	5 mA/13 mA	10 Mbit/s	10 kV/µs	97	See Also High-Speed
 C1944	MCL2530 HCPL-2530	Transistor	to 15 V	5% @ 16 mA	1 Mbit/s	10 kV/µs	85	See Also High-Speed
	MCL2531 HCPL-2531	Transistor	to 15 V	15% @ 16 mA	1 Mbit/s	10 kV/µs		
 C1943	MCL2730 HCPL-2730	Split Darlington	to 7 V	300% @ 1.6 mA	100 kbit/s	10 kV/µs	101	
	MCL2731 HCPL-2731	Split Darlington	to 18 V	400% @ 0.5 mA 500% @ 1.6 mA	100 kbit/s	10 kV/µs		
 C2085	MCT62 MCT61 MCT66 MCT6	Transistor	30 V	12.5% @ 16 mA 12.5% @ 16 mA 5% @ 40 mA 12.5% @ 16 mA	15 kbit/s 10 kbit/s 5 kbit/s 1 kbit/s		187	$CTR_{CE(MIN)}$ = 100, 5 mA/5 V $CTR_{CE(MIN)}$ = 50, 5 mA/5 V Low Cost Low Cost

OPTOCOUPLERS TRANSISTOR-OUTPUT LOW SPEED

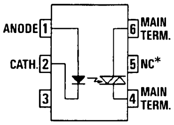
LISTED BY INCREASING I_F AND DECREASING $CTR_{CE(SAT)}$

EQUIVALENT CIRCUIT	PART NUMBER	$CTR_{CE(SAT)}$ MIN. @ I_F =	mA	0-70°C CTR	CTR_{CE} MIN. @ $V_{CE} \geq 5$ V @ I_F =	mA	CTR_{CB} MIN. = I_F	BV_{CEO} MIN. VOLT.	CMR TYP.	VDE[4] AVAIL.	WITHSTAND TEST VOLTAGE	PAGE
	MCT5211	75%	**1.0**		110%	1	0.25%	30	5 kV/μs	5	2500 VAC RMS	181
	MCT5211	100%	**1.6**		150%	1.6	0.3 %	30	5 kV/μs	5	2500 VAC RMS	181
	Also See Darlington											
	MCT5210	60%	**3.0**		70%	3.0	0.2 %	30	5 kV/μs	5	2500 VAC RMS	181
	MCT210	50%	**3.2**		150%	10	—	30	—		2500 VAC RMS	133
	MCT5201	120%	**5.0**		TYP 300%	5.0	0.28%	30	5 kV/μs	5	2500 VAC RMS	175
	(MCT6)	See Duals									2500 VAC RMS	187
	MCL2501[1]	14%	**8.0**		See High Speed			15	10 kV/μs		2500 VAC RMS	77
	MCL2503	11%	**8.0**		See High Speed			15	10 kV/μs		2500 VAC RMS	77
	(MCL2530/31)	See Duals			See High Speed			15	10 kV/μs		2500 VAC RMS	85
	MCT5200	75%	**10**		TYP 200%	10	0.2 %	30	5 kV/μs	5	7500 VAC PEAK	175
	CNX35	40-160%	**10**		—	—	—	30	—		4400 VDC	43
	MCT2200	25%	**10**		20%	10	—	30	—	VDE	7500 VAC PEAK	137
	MCT2201	25%	**10**		100%	10	—	30	—	VDE	7500 VAC PEAK	137
	MCT2202	25%	**10**		63-125%	10	—	30	—	VDE	7500 VAC PEAK	137
	CNY17-1	25%	**10**		40-80%	10	—	70	—	VDE	7500 VAC PEAK	47
	CNY17-2	25%	**10**		63-125%	10	—	70	—	VDE	7500 VAC PEAK	47
	CNY17-3	25%	**10**		100-200%	10	—	70	—	VDE	7500 VAC PEAK	47
	CNY17-4	25%	**10**		160-320%	10	—	70	—	VDE	7500 VAC PEAK	47
	MCT270	20%	**10**		50%	10	—	30	—		2500 VAC RMS	143
	4N35	20%	**10**		[3]40%	10	—	30	—		2500 VAC RMS	27
	4N36	20%	**10**		[3]40%	10	—	30	—		2500 VAC RMS	27
	4N37	20%	**10**		[3]40%	10	—	30	—		2500 VAC RMS	27
4-PIN	CNY65	10%	**10**		50%	10	—	32	—	VDE	11.6 kVDC	51
	H11A1	5%	**10**		50%	10	—	30	—	VDE	7500 VAC PEAK	55
	H11AA1, 2, 3, 4 See AC-Input										2500 VAC RMS	59
	H11D1[2]	5%	**10**		20%	10	—	300	—	VDE	7500 VAC PEAK	61
	H11D2[2]	5%	**10**		20%	10	—	300	—	VDE	7500 VAC PEAK	61
	H11D3[2]	5%	**10**		20%	10	—	200	—	VDE	7500 VAC PEAK	61
	MCT277	40%	**16**		100%	10	—	30	—		2500 VAC RMS	167
	MCT2	12.5%	**16**		20%	10	—	30	—		2500 VAC RMS	125
	MCT2E	12.5%	**16**		20%	10	—	30	—		2500 VAC RMS	129
	MCT271	12.5%	**16**		45-90%	10	—	30	—		2500 VAC RMS	147
	MCT272	12.5%	**16**		75-150%	10	—	30	—		2500 VAC RMS	151
	MCT274	12.5%	**16**		225-400%	10	—	30	—		2500 VAC RMS	155
	MCT275[2]	12.5%	**16**		70-210%	10	—	80	—		2500 VAC RMS	159
	MCT276	12.5%	**16**		15-60%	10	—	30	—		2500 VAC RMS	163
	MCT277	40%	**20**		100%	10	—	30	—		2500 VAC RMS	167
	MCT26	1.25%	**20**		6%	10	—	30	—		2500 VAC RMS	141
	4N25	4%	**50**		20%	10	—	30	—		2500 VAC RMS	19
	4N26	4%	**50**		20%	10	—	30	—		2500 VAC RMS	19
	4N27	4%	**50**		10%	10	—	30	—		2500 VAC RMS	19
	4N28	4%	**50**		10%	10	—	30	—		2500 VAC RMS	19

[1] Guaranteed Switching Times Over 0-70°C
[2] High Volt
[3] At T_A = -55 to +100°C
[4] To Order VDE Device, Add Z Suffix To Part Number Except CNY65
[5] Inquire About Pending VDE Qualification

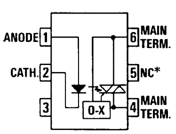
OPTOCOUPLERS NON-ZERO-CROSS TRIACS

Optocouplers

EQUIVALENT CIRCUIT	PART NUMBER	I_{FT} MAX.	V_{DRM} MIN.	VDE[1] AVAIL.	WITHSTAND TEST VOLTAGE	PAGE
	MCP3023	5 mA	400 V	[2]	7500 VAC PEAK	109
	MCP3022	10 mA	400 V	VDE		113
	MCP3021	15 mA	400 V	VDE		113
	MCP3020	30 mA	400 V	VDE		113
	MCP3012	5 mA	250 V			
	MCP3011	10 mA	250 V			105
	MCP3010	15 mA	250 V			
C2081	MCP3009	30 mA	250 V			

[1]To Order VDE Device, Add Z Suffix To Part Number
[2]Inquire About Pending VDE Qualification.

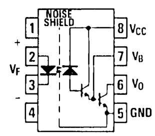
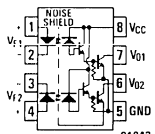
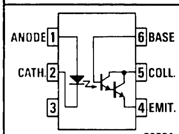
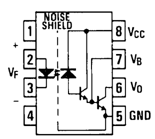
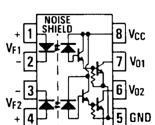
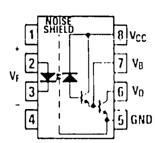
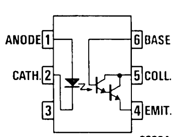
OPTOCOUPLERS ZERO-CROSS TRIACS

EQUIVALENT CIRCUIT	PART NUMBER	I_{FT} MAX.	V_{DRM}[1] MIN.	VDE[2] AVAIL.	WITHSTAND TEST VOLTAGE	PAGE
	MCP3043	5 mA	400 V	[3]	7500 VAC PEAK	121
	MCP3042	10 mA	400 V	[3]		121
	MCP3041	15 mA	400 V	VDE		117
	MCP3040	30 mA	400 V	VDE		117
	MCP3033	5 mA	250 V			121
	MCP3032	10 mA	250 V			121
C2080	MCP3031	15 mA	250 V			117
	MCP3030	30 mA	250 V			117

[1]Inquire About Availability of New 600 V Triac Couplers.
[2]To Order VDE Device, Add Z Suffix To Part Number
[3]Inquire About Pending VDE Qualification.

OPTOCOUPLERS DARLINGTON-OUTPUT

LISTED BY INCREASING I_F AND DECREASING $CTR_{CE(SAT)}$ MIN.

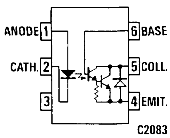
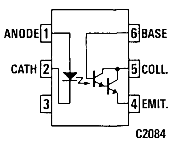
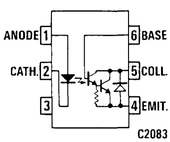
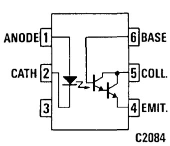
EQUIVALENT CIRCUIT	PART NUMBER	$CTR_{CE(SAT)}$ MIN. @ I_F =	mA	$V_{CE(SAT)}$	0-70°C CTR	CTR_{CE} MIN. @ I_F =	mA	BV_{CEO} MIN. VOLT.	CMR TYP.	VDE[1] AVAIL.	WITHSTAND TEST VOLTAGE	PAGE	COMMENTS
 C1984	6N139	400%	**0.5**	0.4 V		—	—	18	10 kV/µs		2500 VAC RMS	31	Hi-Speed
 C1943	MCL2731	400%	**0.5**	0.4 V		See: Duals			10 kV/µs		2500 VAC RMS	101	Hi-Speed
 C2084	MCA2231Z	200%	**1.0**	1.0 V		500%	10	30		VDE	7500 VAC PEAK	73	
	MCA231	200%	**1.0**	1.0 V		200%	10	30	—		2500 VAC RMS	69	
	(MCT5211)	75%	**1.0**	0.4 V				30	.5 kV/µs	[2]	7500 VAC PEAK	181	See: Transistor Output Couplers
 C1984	6N139	500%	**1.6**	0.4 V				18	10 kV/µs		2500 VAC RMS	31	Hi-Speed
 C1943	MCL2731	500%	**1.6**	0.4 V		See: Duals		18	10 kV/µs		2500 VAC RMS	101	Hi-Speed
 C1984	6N138	300%	**1.6**	0.4 V				7	10 kV/µs		2500 VAC RMS		Hi-Speed
 C2084	(MCT5211)	100%	**1.6**	0.4 V				30	5 kV/µs	[2]		181	See: Transistor Output Couplers
	MCA2231Z	200%	**5.0**	1.0 V		500%	10	30	—	VDE	7500 VAC PEAK	73	
	MCA231	200%	**5.0**	1.0 V		200%	10	30	—		2500 VAC RMS	69	
	4N33	25%	**8.0**	1.0 V		500%	10	30	—		2500 VAC RMS	23	
	4N32	25%	**8.0**	1.0 V		500%	10	30	—		2500 VAC RMS		

[1]To Order VDE Device, Add Z Suffix To Part Number
[2]Inquire About Pending VDE Qualification

Continued next page

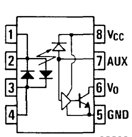
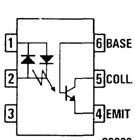
OPTOCOUPLERS DARLINGTON-OUTPUT Continued

LISTED BY INCREASING I_F AND DECREASING $CTR_{CE(SAT)}$ MIN.

EQUIVALENT CIRCUIT	PART NUMBER	$CTR_{CE(SAT)}$ MIN. @ I_F =	mA	$V_{CE(SAT)}$	0-70°C CTR	CTR_{CE} MIN. @ I_F =	mA	BV_{CEO} MIN. VOLT.	CMR TYP.	VDE[1] AVAIL.	WITHSTAND TEST VOLTAGE	PAGE	COMMENTS
	MCA11G1	1000%	**10**	1.0 V		500%	1.0	100	—		2500 VAC RMS	65	H11G1 Hi-Volt
	MCA11G2	1000%	**10**	1.0 V		500%	1.0	80	—		2500 VAC RMS	65	H11G2 Hi-Volt
	MCA2231Z	500%	**10**	1.2 V		500%	10	30	—	VDE	7500 VAC PEAK	73	
	MCA231	500%	**10**	1.2 V		200%	10	30	—		2500 VAC RMS	69	
	MCA11G3	250%	**20**	1.2 V		200%	1.0	55	—		2500 VAC RMS	65	H11G3 Hi-Volt
	MCA2255Z	100%	**50**	1.0 V		500%	10	55	—	VDE	7500 V_{AC} PEAK	73	
	MCA255	100%	**50**	1.0 V		100%	10	55	—		2500 VAC RMS	69	
	MCA2230Z	100%	**50**	1.0 V		500%	10	30	—	VDE	7500 V_{AC} PEAK	73	
	MCA230	100%	**50**	1.0 V		100%	10	30	—		2500 VAC RMS	69	

[1]To Order VDE Device, Add Z Suffix To Part Number
[2]Inquire About Pending VDE Qualification

OPTOCOUPLERS AC-INPUT LINE MONITORS

EQUIVALENT CIRCUIT	PART NUMBER	OUTPUT	V_{CC} OR BV_{CEO} MIN.	INPUT/OUTPUT CURRENT IN SATURATION	CTR_{CE} MIN. @ V_{CE} = 10 V @ I_F = 10 mA	PAGE
	MID400	Logic 10 TTL Loads	5 V	4 mA RMS/16 mA **0-70° C**		191
	H11AA1 H11AA2 H11AA3 H11AA4	Transistor	30 V	10 mA/0.5 mA	20% 10% 50% 100%	59

GENERAL INSTRUMENT

UL PACKAGE CODES

UL APPROVED OPTOCOUPLERS

UL LISTING - YELLOW CARD

A UL yellow card may either specify the optocoupler manufacturer's own device part number or a package code. General Instrument's optocouplers are listed as a package code consisting of a single capital letter.

UL "YELLOW CARD"

FPQU2 March 27, 1986
Component – Optical Isolators

GENERAL INSTRUMENT CORP OPTOELECTRONICS DIV E50151 (S)
3400 HILLVIEW AVE , PALO ALTO CA 94304

Insulation system in optical isolated switch, Types Systems C, D, G, #L, M, P, R, S+. May be followed by four digits and one letter.
#Preceeds with 740 and system is preceeded by numbers and one letter.
+Model designation: CNY followed by two digits.
Marking: Company name or trademark "GI" and type designation.

See General Information Preceding These Recognitions.

For use only in equipment where the acceptability of the combination is determined by Underwriters Laboratories Inc.

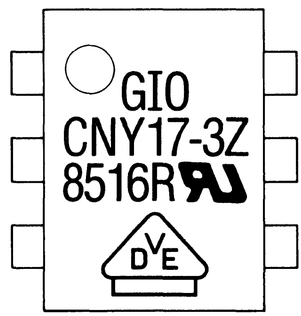
Report: **April 25, 1972.**

Replaces E50151 dated September 4, 1985.
678911001 **Underwriters Laboratories Inc.®** D11/0027041

UL "yellow card" listing codes C, D, G, L, P, R, and S.

GENERAL

All General Instrument's optocouplers are always UL approved prior to introduction to the marketplace. Devices which are approved by both UL and VDE have a suffix "Z" following the part number and are marked with both the UL and VDE logos.



C2006

The UL code will be found following the date code; in this case an "R". VDE approved devices use "GIO", while non-VDE parts use "GI" as the logo for General Instrument Optoelectronics Division.

UL CODE CONVERSION TO GI PART NUMBER

PACKAGE CODE	RATING	GI DEVICE PART NUMBER
C	4.4 kVDC, 1 min.	CNX36
D	2.5 kVAC RMS, 1 min.	MCL2XXX, 6NXXX, MID400, HCPL-2XXX
G	2.5 kVAC RMS, 1 min.	4NXX, H11GX, MCA11GX, MCA2XX, MCT52XX, MCT2, MCT2X, MCT2XX, MCT6, MCT6X
L	2.5 kVAC RMS, 1 min.	Optologic 74**OL**6000, 74**OL**6001, 74**OL**6010, 74**OL**6011
P or R	5.3 kVAC RMS, 5 sec.	CNY17-X, H11AX, H11DX, MCT22XX, MCP3XXX
R (VDE)	5.3 kVAC RMS, 5 sec.	CNY17-XZ, H11A1Z, H11DXZ, MCA22XXZ, MCT22XXZ, MCP3020Z, MCP3021Z, MCP3022Z, MCP3040Z, MCP3041Z
S	11.6 kVDC, 1 min.	CNY65

GENERAL INSTRUMENT

VDE APPROVED HIGH-VOLTAGE OPTOCOUPLERS

VDE RATINGS*

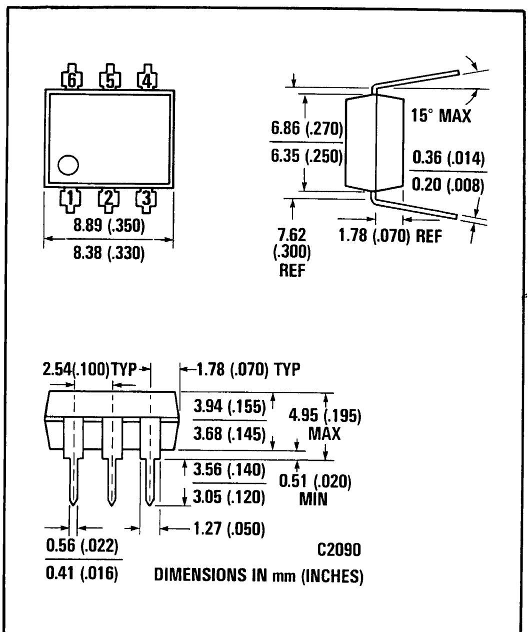
Ambient operating temperature range .... -55° C to +100° C
Storage temperature range ..... -55° C to +150° C
Climatic test class 55/150/21
DC isolation voltage (1 minute) .... 4400 VDC
Nominal operating voltage for isolation group C acc. to VDE 0110B... 500 VAC/600 VDC
Isolation creepage path .... 8.0 mm minimum
Isolation clearance/air path ..... 8.0 mm minimum
Internal distance through insulation .... 0.4 mm minimum
Package tracking resistance index ...... KB 275/A

**Per approval certificate 39 419*

ELECTRICAL MAXIMUM RATINGS AND CHARACTERISTICS

See standard product data sheet specifications, i.e. CNY17-1Z see CNY17-1.

PACKAGE DIMENSIONS



VDE APPROVED OPTOCOUPLERS

General Instrument Optoelectronics Division's optocouplers can be supplied with approval to VDE component standard 0883/6.80 and equipment standards DIN 57 804/VDE 0804/1.83 and DIN IEC 65/VDE 0860/8.81.

Approved parts are denoted by a "Z" suffix to the part number.

Transistor Output

- CNY17-1Z, CNY17-2Z, CNY17-3Z, CNY17-4Z
- MCT2200Z, MCT2201Z, MCT2202Z
- H11A1Z, H11D1Z, H11D2Z, H11D3Z

Darlington Output

- MCA2230Z, MCA2231Z, MCA2255Z

Triac, Non-Zero-Crossing

- MCP3020Z, MCP3021Z, MCP3022Z

Triac, Zero-Crossing

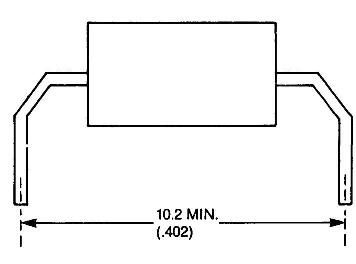
- MCP3040Z, MCP3041Z

OPTION W

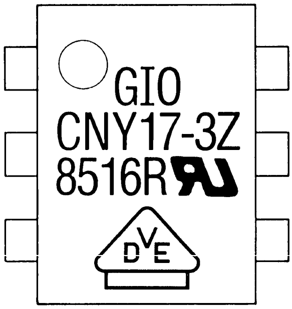
The VDE 0883/6.80 calls for a minimum 8.0 mm creepage distance between any point on the input terminals to any point on the output terminals of an optocoupler.

This also applies to the creepage distance over the PCB. The equipment designer may chose to break up that creepage path by stamping a slot in the PCB under the optocoupler or he may use our leadbend option W.

(Continued next page)



MARKING EXAMPLE



C2006

OPTION W *(Continued)*

When ordering a VDE-approved optocoupler with 10 mm leadbend, then add the suffix W as in MCT2200ZW. The W will not show on the optocoupler marking, but on the shipping tube label.

By making this option available, GIOD does not assume any responsibility or liability for meeting 8.0 mm creepage distance in any customer's product.

GENERAL INSTRUMENT

RELIABILITY CONDITIONED OPTOCOUPLERS

OPTO PLUS

DESCRIPTION

OPTO PLUS reliability conditioning is offered for any of General Instrument's 6-lead and 8-lead MCA or MCT optocouplers with transistor or darlington output. This special conditioning is designed to reduce the infant mortality failures in optocouplers.

- OPTO PLUS 1 offers 48 hour burn-in
- OPTO PLUS 2 offers 160 hour burn-in

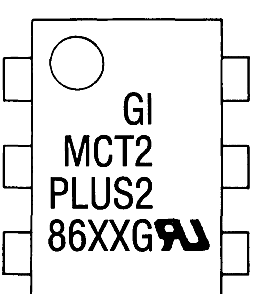
ORDER INFORMATION

To order a MCAXXXX or MCTXXXX with OPTO PLUS 1 add R1 to part number, i.e., MCT5200R1. To order OPTO PLUS 2 add R2 to part number, i.e., MCT61R2.

RELIABILITY CONDITIONING

The following flow outlines the 100% pre-conditioning testing.

TEST PERFORMED	CONDITION
Stabilization Bake	MIL-STD-883C Method 1008.1 Condition C. 150° C, 24 hours.
Temperature Cycle	MIL-STD-883C Method 1010.2 Condition B. 5 Cycles -55° C to 125° C, 30 min. at extremes
Burn-in PLUS 1— 48 hrs. (+8/-0) PLUS 2—160 hrs. (+8/-0)	MIL-STD-883C Method 1015.2 Condition C. T_A = 25° C I_F = 10 mA V_{CE} = 10 V
Hot Track Testing	T_A = 100° C Functional Test
Final Test	T_A = 25° C Electrical test per specification
Outgoing Q.A.	0.25% AQL



Example of Opto Plus marking

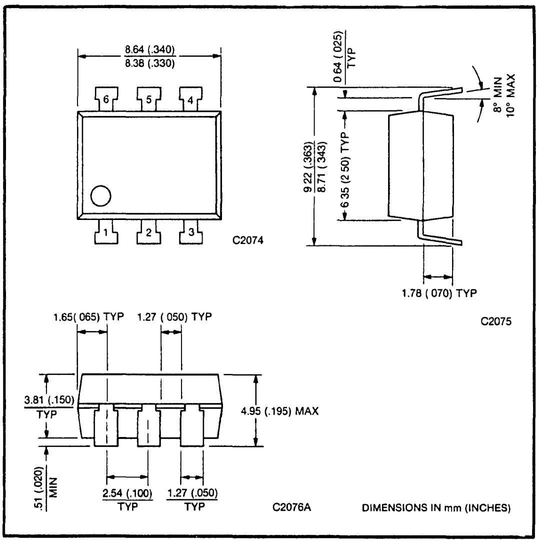
C2093

PRELIMINARY DATA SHEET

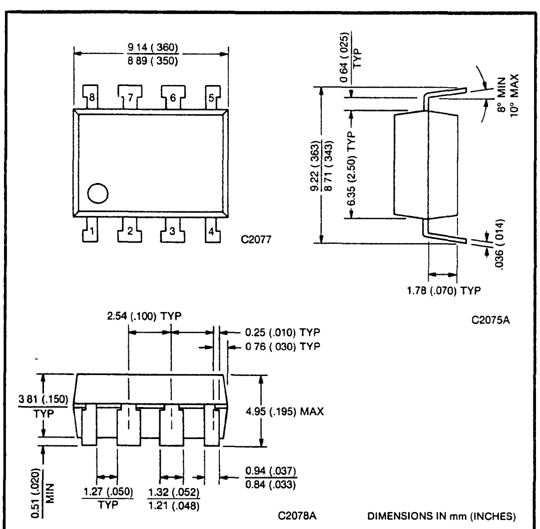
GENERAL INSTRUMENT

SMD OPTION 100

PACKAGE DIMENSIONS



6-Pin Optocoupler



8-Pin Optocoupler

FEATURES

- Surface mountable
- Lead co-planarity with 0.1 mm or .004 inches
- Compatible with vapor phase reflow soldering
- All 6-pin and 8-pin optocouplers
- All electrical specifications remain unchanged
- Come in standard anti-static shipping tubes

ORDER INFORMATION

Option 100 is available for all 6-pin and 8-pin optocouplers in plastic package with certain minimum quantity restrictions.

To order this SMD version of an optocoupler just add –100 to the part number, for example:

74OL6000-100	Optologic
MCT62-100	Dual Transistor Output
HCPL-2631-100	Dual Logic Output
MCT2-100	Single Transistor Output
MCP3041-100	Triac Output, Zero-Cross

DESCRIPTION

Option 100 is a standard DIP plastic package optocoupler with the leads cut off at the standoff. This provides a low cost SMD-version of a large variety of optocouplers. Option 100, in many cases, can be tested and handled by the same equipment as a standard DIP package, which eliminates costly duplication of testers and handlers.

The distance from the bottom of the Option 100 to the PCB is a minimum of 0.51 mm or .020 inches, in order to accommodate PCB cleaning after soldering. The height of the Option 100 over the PCB is maximum 4.95 mm or .195 inches.

SPECIFICATIONS

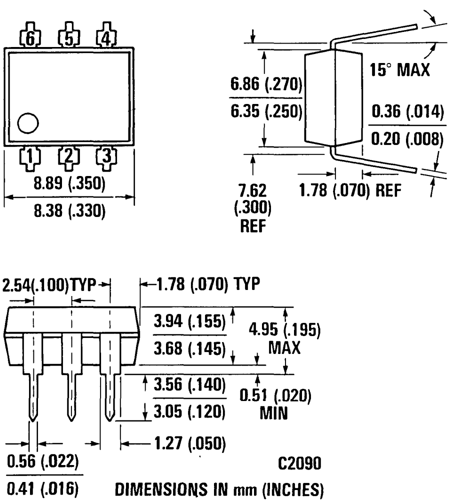
The electrical specifications for optocouplers with Option 100 remain unchanged. See applicable datasheet. In addition, the device will withstand standard vapor phase reflow soldering at 215° C for 30 seconds.

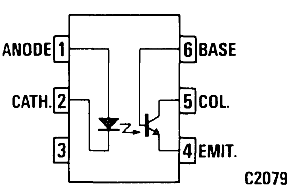
GENERAL INSTRUMENT

PHOTOTRANSISTOR OPTOCOUPLERS

4N25 4N27
4N26 4N28

PACKAGE DIMENSIONS





Equivalent Circuit

DESCRIPTION

The 4N25, 4N26, 4N27, and 4N28 series of optocouplers have an NPN silicon planar phototransistor optically coupled to a gallium arsenide diode.

FEATURES & APPLICATIONS

- AC line/digital logic isolator
- Digital logic/digital logic isolator
- Telephone/telegraph line receiver
- Twisted pair line receiver
- High frequency power supply feedback control
- Relay contact monitor
- Power supply monitor
- Small package size and low cost
- Excellent frequency response
- UL recognized — File E50151
- High isolation voltage
  V_{ISO} = 2500 V RMS — 1 minute

ABSOLUTE MAXIMUM RATINGS

*Storage temperature . . . . −55°C to 150°C
*Operating temperature at junction . . . . −55°C to 100°C
*Lead temperature (soldering, 10 sec) . . . . 260°C
*Total package power dissipation at 25°C ambient (LED plus detector) . . . . 250 mW
*Derate linearly from 25°C . . . . 3.3 mW/°C

Input diode
*Forward DC current continuous . . . . 80 mA
*Reverse voltage . . . . 3.0 V
*Peak forward current
(300 μs, 2% duty cycle) . . . . 3.0 A
*Power dissipation at 25°C ambient . . . . . . 150 mW
*Derate linearly from 25°C . . . . 2.0 mW/°C

Output transistor
*Collector emitter voltage (BV_{CEO}) . . . . 30 V
*Collector base voltage (BV_{CBO}) . . . . 70 V
*Emitter collector voltage (BV_{ECO}) . . . . 7 V
*Power dissipation at 25°C ambient . . . . . . 150 mW
*Derate linearly from 25°C . . . . 2.0 mW/°C

*Indicates JEDEC Registered Data.

ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTICS	SYMBOL	MIN.	TYP.	GUAR. MAX.	UNITS	TEST CONDITIONS
Input diode						
*Forward voltage	V_F		1.20	1.50	V	I_F = 10 mA
Capacitance	C		150		pF	V_R = 0 V, f = 1 MHz
*Reverse leakage current			.05	100	μA	V_R = 3.0 V, R_L = 1.0 MΩ
Output transistor						
DC forward current gain	h_{FE}		250			V_{CE} = 5 V, I_C = 500 μA
*Collector to emitter breakdown voltage	BV_{CEO}	30	65		V	I_C = 1.0 mA, I_B = 0
*Collector to base breakdown voltage	BV_{CBO}	70	165		V	I_C = 100 μA, I_E = 0
*Emitter to collector breakdown voltage	BV_{ECO}	7	14		V	I_E = 100 μA, I_B = 0
*Collector to emitter leakage current (4N25, 4N26, 4N27)	I_{CEO}		3.5	50	nA	V_{CE} = 10 V Base Open
*Collector to emitter leakage current (4N28)				100	nA	
*Collector to base leakage current	I_{CBO}		0.1	20	nA	V_{CB} = 10 V Emitter Open
Coupled						
*Collector output current (a) (4N25, 4N26)	I_C	2.0	5.0	—	mA	V_{CE} = 10 V, I_F = 10 mA, I_B = 0
(4N27, 4N28)		1.0	3.0	—		
Isolation voltage (b) (4N25, 4N26, 4N27, 4N28)	V_{ISO}	2500	—	—	V	RMS, t = 1 minute
*(4N25)		2500	—	—	V	Peak
*(4N26, 4N27)		1500	—	—	V	Peak
*(4N28)		500	—	—	V	Peak
Isolation resistance (b)			10^{11}		Ω	V = 500 VDC
*Collector-emitter saturation	V_{CE}(SAT)		0.2	0.5	V	I_C = 2.0 mA, I_F = 50 mA
Isolation capacitance (b)			1.3		pF	V = 0, f = 1.0 MHz
Bandwidth (c) (also see note 2)	B_W		300		kHz	I_C = 2.0 mA, R_L = 100 Ω (Figure 13)

*Indicates JEDEC Registered Data.
(a) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2.0%
(b) For this test LED pins 1 and 2 are common and Phototransistor pins 4, 5 and 6 are common.
(c) If adjusted to yield I_C = 2 mA and i_c = 0.7 mA RMS; Bandwidth referenced to 10 kHz.

SWITCHING TIMES		TYP.	UNITS	TEST CONDITIONS
Non-saturated Collector				
Delay time	t_d	0.5	μs	R_L = 100 Ω, I_C = 2 mA, V_{CC} = 10 V (Fig. 7 and 13)
Rise time	t_r	2.5	μs	
Fall time	t_f	2.6	μs	
Non-saturated Collector				
Delay time	t_d	2.0	μs	R_L = 1kΩ, I_C 2 mA, V_{CC} = 10 V (Fig. 7 and 13)
Rise time	t_r	15	μs	
Fall time	t_f	15	μs	
Saturated				
t_{on} (from 5 V to 0.8 V)	t_{on} (SAT)	5	μs	R_L = 2kΩ, I_F = 15 mA, V_{CC} = 5 V
t_{off} (from SAT to 2.0 V)	t_{off} (SAT)	25	μs	R_B = Open (Circuit No. 1)
Saturated				
t_{on} (from 5 V to 0.8 V)	t_{on} (SAT)	5	μs	R_L = 2kΩ, I_F = 20 mA, V_{CC} = 5 V
t_{off} (from SAT to 2.0 V)	t_{off} (SAT)	18	μs	R_B = 100kΩ (Circuit No. 1)
Non-saturated Base — Collector photo diode				
Rise time	t_r	175	ns	R_L = 1kΩ, V_{CB} = 10 V
Fall time	t_f	175	ns	

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25° C Free Air Temperature Unless Otherwise Specified)

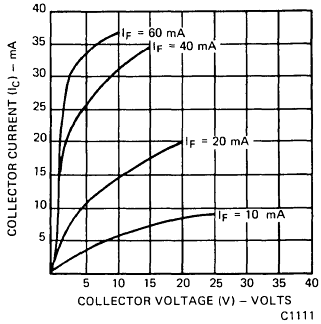


Fig. 1. Collector Current vs. Collector Voltage

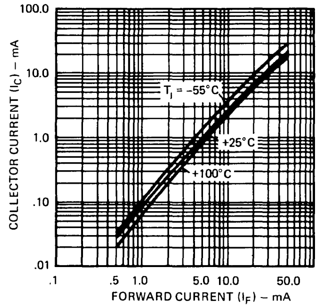


Fig. 2. Collector Current vs. Forward Current

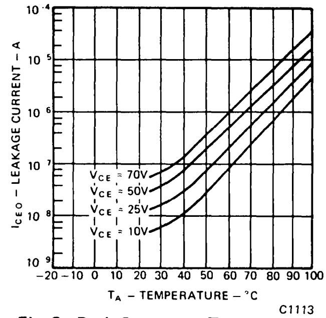


Fig. 3. Dark Current vs. Temperature

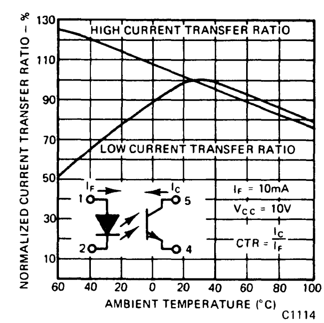


Fig. 4. Current Transfer Ratio vs. Temperature

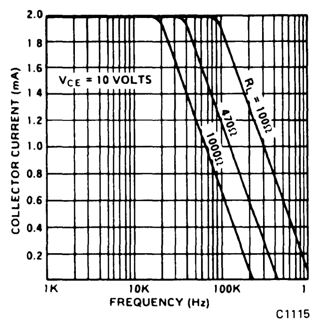


Fig. 5. Collector Current vs. Frequency (see Fig. 12 for circuit)

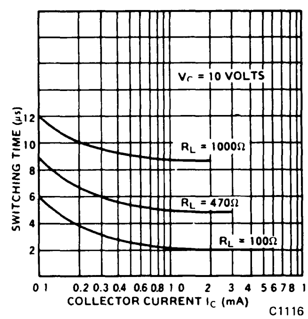
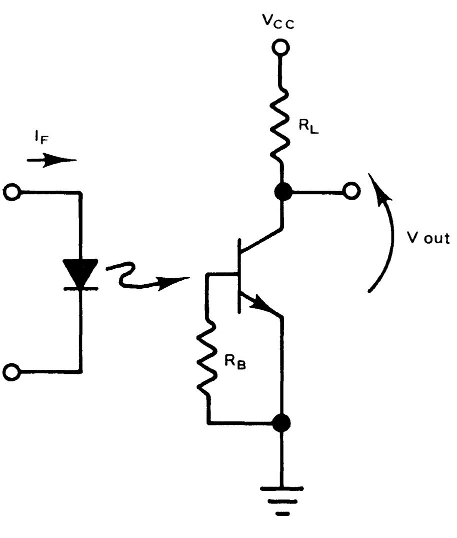


Fig. 6. Switching Time vs. Collector Current (see Fig. 13 for Circuit)



Circuit 1

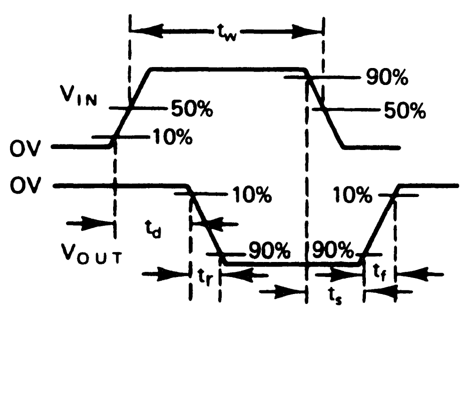


Fig. 7. Pulse Test Definition (Note 3)

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (Cont'd)

(25° C Free Air Temperature Unless Otherwise Specified)

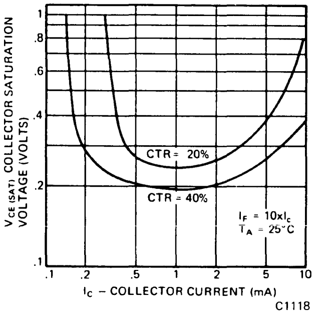


Fig. 8. Saturation Voltage vs. Collector Current

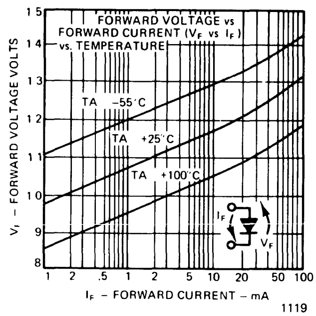


Fig. 9. Forward Voltage vs. Forward Current

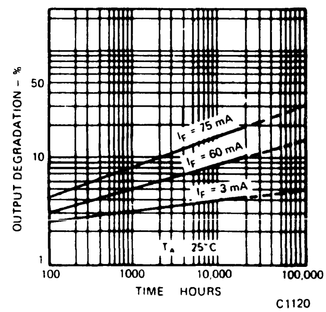


Fig. 10. Lifetime vs. Forward Current

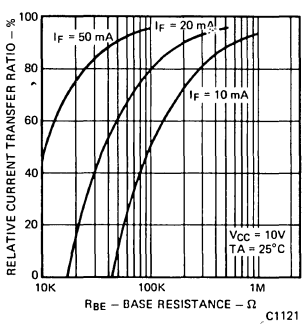


Fig. 11. Sensitivity vs. Base Resistance

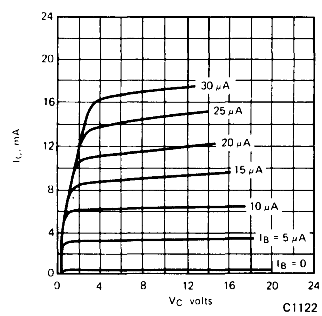


Fig. 12. Detector h_{fe} Curves

OPERATING SCHEMATICS

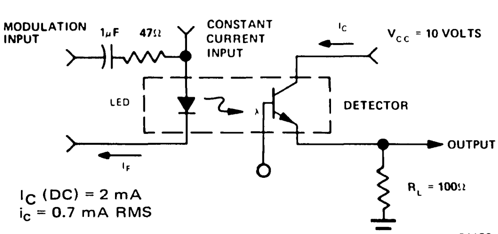


Fig. 13. Modulation Circuit Used to Obtain Output vs. Frequency Plot

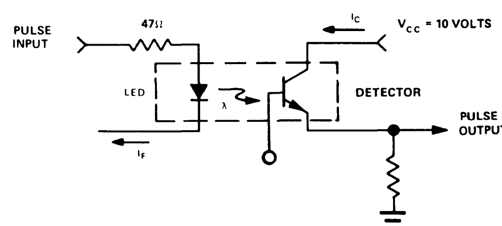


Fig. 14. Circuit Used to Obtain Switching Time vs. Collector Current Plot

NOTES

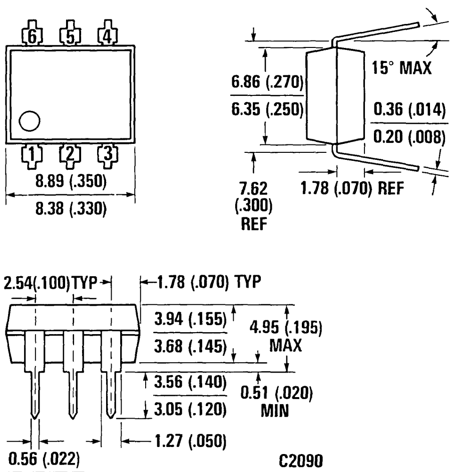
1. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.*
2. *The frequency at which i_c is 3dB down from the 10 kHz value.*
3. *Rise time (t_r) is the time required for the collector current to increase from 10% of its final value to 90%. Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value to 10%.*

GENERAL INSTRUMENT

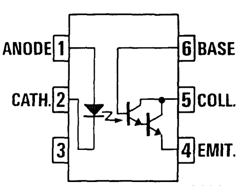
PHOTODARLINGTON OPTOCOUPLERS

4N32
4N33

PACKAGE DIMENSIONS



C2090
DIMENSIONS IN mm (INCHES)



C2084

Equivalent Circuit

DESCRIPTION

The 4N32 and 4N33 have a gallium arsenide infrared emitter optically coupled to a silicon planar photo-darlington.

FEATURES & APPLICATIONS

- High isolation resistance — $10^{11}\ \Omega$
- High dielectric strength, input to output 2500 V RMS — 1 minute
- Low coupling capacitance — 1.0 pF
- Convenient package — plastic dual-in-line
- Long lifetime, solid state reliability
- Low weight — 0.4 grams
- UL recognized — File E50151

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

*Storage Temperature . . . . −55°C to 150°C
*Operating Temperature at Junction . . . . −55° C to 100° C
*Lead Soldering time @ 260° C . . . . 10 seconds
*Total power dissipation @ 25° C ambient . . . . 250 mW
*Derate linearly from 25° C . . . . 3.3 mW/° C

LED (GaAs Diode)
*Power dissipation @ 25° C ambient . . . . 150 mW
*Derate linearly from 55° C . . . . 2 mW/° C
*Continuous forward current . . . . 80 mA
Reverse current . . . . 10 mA
*Peak forward current (300 μsec, 2% duty cycle) . . 3.0 A

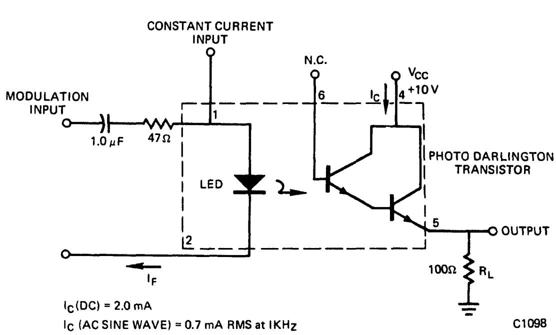
DETECTOR (Silicon Photo Darlington Transistor)
*Power dissipation @ 25° C ambient . . . . 150 mW
*Derate linearly from 25° C . . . . 2.0 mW/° C
*Collector-emitter breakdown voltage (BV_{CEO}) . . . . 30 V
*Collector-base breakdown voltage (BV_{CBO}) . . . . . . 50 V
Emitter-base breakdown voltage (BV_{EBO}) . . . . 8.0 V
*Emitter-collector breakdown voltage (BV_{ECO}) . . . . . 5 V

*Indicated JEDEC Registered data.

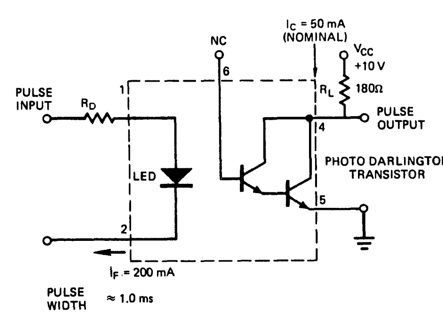
ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION
LED CHARACTERISTICS (T_A = 25°C unless otherwise noted)						
*Reverse leakage current	I_R		0.05	100	μA	V_R = 3.0 V
*Forward voltage	V_F		1.2	1.5	Volts	I_F = 10 mA
Capacitance	C		150		pF	V_R = 0 V, f = 1.0 MHz
PHOTOTRANSISTOR CHARACTERISTICS (T_A = 25°C and I_F = 0 unless otherwise noted)						
*Collector-emitter dark current	I_{CEO}			100	nA	V_{CE} = 10 V, base open
*Collector-base breakdown voltage	BV_{CBO}	30			Volts	I_C = 100 μA, I_E = 0
*Collector-emitter breakdown voltage	BV_{CEO}	30			Volts	I_C = 100 μA, I_B = 0
*Emitter-collector breakdown voltage	BV_{ECO}	5.0			Volts	I_E = 100 μA, I_B = 0
DC current gain	h_{FE}		5000			V_{CE} = 5.0 V, I_C = 500 μA
COUPLED CHARACTERISTICS (T_A = 25°C unless otherwise noted)						
*Collector output current (Note 1)						
4N32, 4N33	I_C	50			mA	V_{CE} = 10 V, I_F = 10 mA, I_B = 0
Isolation voltage (Note 2)						
4N32, 4N33	V_{ISO}	2500	—	—	V	V RMS, t = 1 minute
*(4N32)		2500	—	—	V	VDC
*(4N33)		1500	—	—	V	VDC
Isolation capacitance (Note 2)	R_{ISO}		10^{11}		Ohms	V = 500 VDC
*Collector-emitter saturation voltage (1)	$V_{CE(SAT)}$					
4N32, 4N33				1.0	Volts	I_C = 2.0 mA, I_F = 8.0 mA
Isolation capacitance (Note 2)			0.8		pF	V = 0, f = 1.0 MHz
Bandwidth (3) (Test Circuit #1)			30		kHz	
SWITCHING CHARACTERISTICS (Test Circuit #2)						
Turn-on time	t_{ON}		0.6	5.0	μs	I_C = 50 mA, I_F = 200 mA, V_{CC} = 10 V
Turn-off time						
4N32, 4N33	t_{OFF}		45	100		V_{CC} = 10 V

*Indicates JEDEC Registered Data.
(1) Pulse test: pulse width = 300 μs, duty cycle ≤ 2.0%
(2) For this test LED pins 1 and 2 are common and phototransistor pins 4, 5 and 6 are common.
(3) I_F adjusted to I_C = 2.0 mA and ic = 0.7 mA RMS.
(4) t_d and t_r are inversely proportional to the amplitude of I_F; t_s and t_f are not significantly affected by I_F.



FREQUENCY RESPONSE TEST CIRCUIT #1

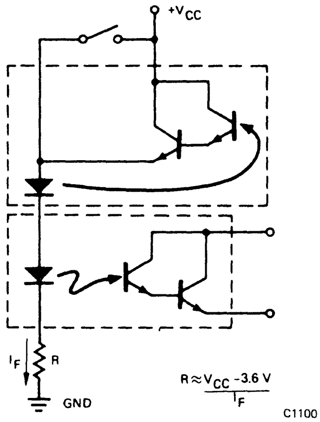


SWITCHING TIME TEST CIRCUIT #2

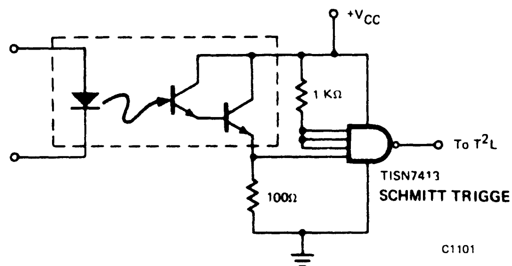
Optocouplers

APPLICATION INFORMATION

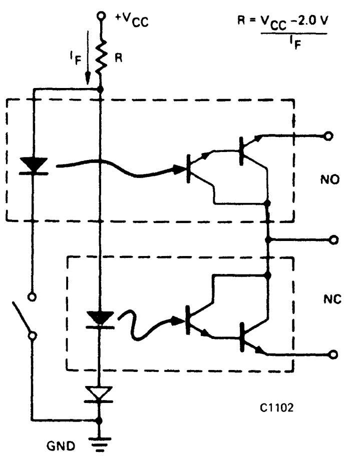
LATCH



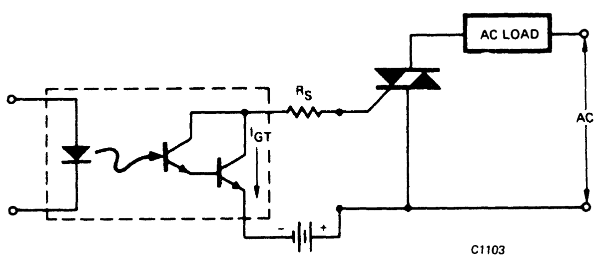
T^2L LOGIC ISOLATION



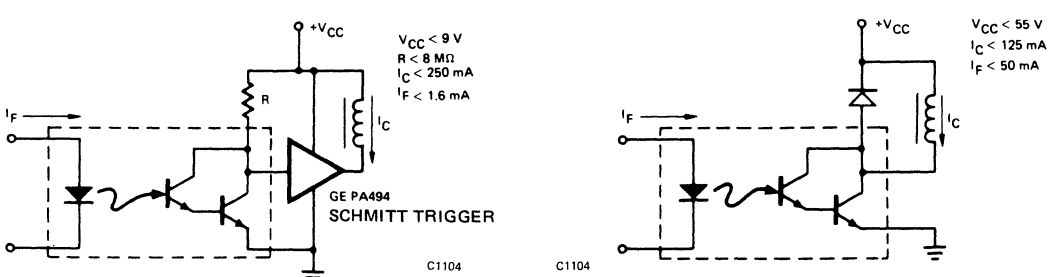
FORM C CONTACT



TRIAC TRIGGER



OPERATING A RELAY COIL



TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25° C Free Air Temperature Unless Otherwise Specified)

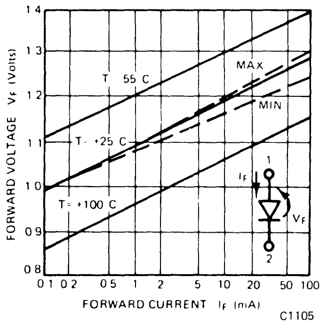


Fig. 1. Forward Voltage Drop vs. Forward Current

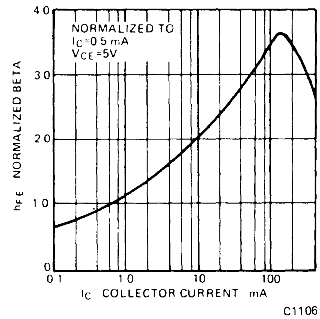


Fig. 2. Normalized Beta vs. Collector Current

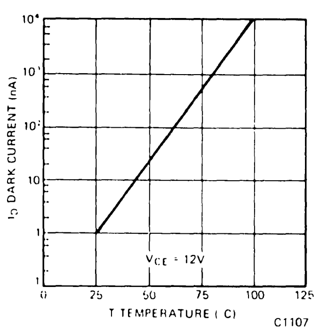


Fig. 3. Dark Current vs. Temperature

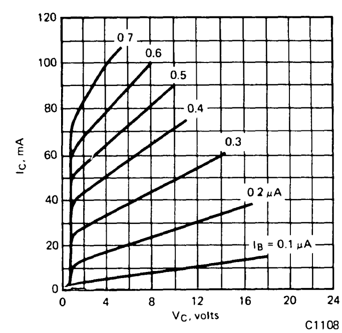


Fig. 4. Detector Standard Transfer Curves

NOTES

1. The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.
2. The frequency at which i_C is 3dB down from the 1 kHz value.
3. t_{ON} is measured from 10% of the leading edge of the input pulse to the 90% point on the leading edge of the output pulse. t_{OFF} is measured from 90% of the trailing edge of the input pulse to the 10% point on the trailing edge of the output pulse.

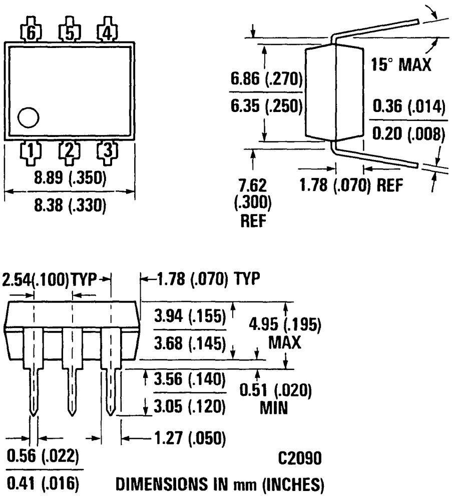
GENERAL INSTRUMENT

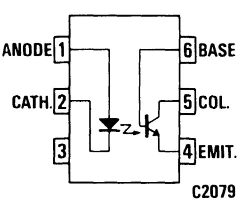
PHOTOTRANSISTOR OPTOCOUPLERS

Optocouplers

4N35
4N36
4N37

PACKAGE DIMENSIONS





Equivalent Circuit

DESCRIPTION

The 4N35, 4N36, and 4N37 series of optocouplers have an NPN silicon planar phototransistor optically coupled to a gallium arsenide infrared emitting diode.

FEATURES & APPLICATIONS

- AC line/digital logic isolator
- Digital logic/digital logic isolator
- Telephone/telegraph line receiver
- Twisted pair line receiver
- High frequency power supply feed-back control
- Relay contact monitor
- Power supply monitor
- Industrial controls
- Covered under UL component recognition program, reference File E50151
- High DC current transfer ratio
- High isolation voltage V_{ISO} = 2500 V RMS, 1 minute

ABSOLUTE MAXIMUM RATINGS

*Relative humidity 85% @ 85°C
*Storage temperature −55°C to 150°C
*Operating temperature −55°C to 100°C
*Lead temperature (soldering, 10 sec) 260°C

Input Diode

*Forward DC current (continuous) . . . . . 60 mA
Reverse voltage . . . . 6 volts
*Peak forward current
(1 μs pulse, 300 pps). . . . . 3.0 A
*Power dissipation at T_A = 25°C . . . . 100 mW†
*Power dissipation at T_C = 25°C . . . . 100 mW†
(T_C indicates collector lead temp 1/32″ from case)

Output Transistor

*Power dissipation at 25°C ambient . . . . . 300 mW
Derate linearly above 25°C . . . . 4 mW/°C
*Power dissipation at T_C = 25°C . . . . . . 500 mW††
(T_C indicates collector lead temp 1/32″ from case)

*V_{CEO} . . . . 30 volts
*V_{CBO} . . . . 70 volts
*V_{ECO} . . . . 7 volts
*Collector current (continuous) . . . . 100 mA

*Indicates JEDEC registered values
†Derate 1.33 mW/°C above 25°C.
††Derate 6.7 mW/°C above 25°C.

ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Input Diode						
*Forward voltage	V_F	.8		1.50	V	I_F = 10 mA
*Forward voltage temp. coefficient	V_F	.9		1.7	V	I_F = 10 mA, T_A = −55°C
*Forward voltage	V_F	.7		1.4	V	I_F = 10 mA, T_A = +100°C
*Junction capacitance	C_J			100	pF	V_F = 0 V, f = 1 mHz
*Reverse leakage current			.01	10	μA	V_R = 6.0 V
Output Transistor						
DC forward current gain	h_{FE}		250			V_{CE} = 5 V, I_C = 100 μA
*Collector to emitter breakdown voltage	BV_{CEO}	30	65		V	I_C = 10 mA, I_F = 0
*Collector to base breakdown voltage	BV_{CBO}	70	165		V	I_C = 100 μA
*Emitter to collector breakdown voltage	BV_{ECO}	7	14		V	T_E = 100 μA, I_F = 0
Collector to emitter, leakage current	I_{CEO}		5	50	nA	V_{CE} = 10 V, I_F = 0
*Collector to emitter leakage current (dark)	I_{CEO}			500	μA	V_{CE} = 30 V, I_F = 0, T_A = 100°C
Capacitance collector to emitter			8		pF	V_{CE} = 0
Capacitance collector to base			20		pF	V_{CB} = 10 V
Capacitance base to emitter	C_{BEO}		10		pF	V_{BE} = 0
Coupled						
†*DC current transfer ratio	CTR	100			%	I_F = 10 mA, V_{CE} = 10 V
†*DC current transfer ratio	CTR	40			%	I_F = 10 mA, V_{CE} = 10 V, T_A = − 55°C
†*DC current transfer ratio	CTR	40			%	I_F = 10 mA, V_{CE} = 10 V, T_A = +100°C
*Saturation voltage—collector to emitter	$V_{CE(SAT)}$			.3	volts	I_F = 10 mA, I_C = 0.5 mA
Isolation voltage all devices	V_{ISO}	2500			volts	RMS, t = 1 minute
*Input to output isolation current (pulse width = 8 msec) (see Note 1)	I_{I-O}					
*Input to output voltage = 3550 V (peak)		4N35		100	μA	
*Input to output voltage = 2500 V (peak)		4N36		100	μA	
*Input to output voltage = 1500 V (peak)		4N37		100	μA	
*Input to output resistance	R_{I-O}	100			gigaohms	Input to output voltage = 500 V (see Note 1)
*Input to output capacitance	C_{I-O}			2.5	picofarads	Input to output voltage = 0 V, f = 1 MHz (see Note 1)
*Turn on time—t_{on}	t_{ON}		5	10	μsec	V_{CC} = 10 V, I_C = 2 mA, R_L = 100Ω, (see Fig. 15)
*Turn off time—t_{off}	t_{OFF}		5	10	μsec	V_{CC} = 10 V, I_C = 2 mA, R_L = 100Ω, (see Fig. 15)

*Indicates JEDEC registered values

†Pulse test: pulse width = 300μS, duty cycle ≤ 2.0%

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25° C Free Air Temperature Unless Otherwise Specified)

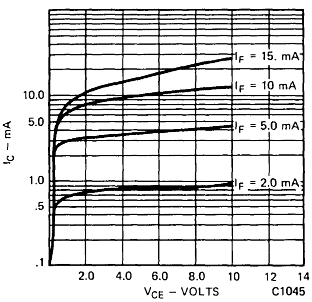


Fig. 1. Collector Current vs. Collector Voltage

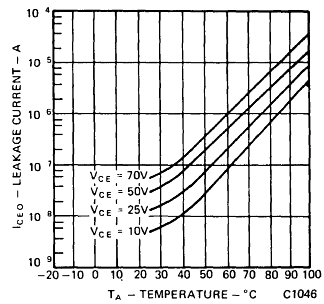


Fig. 2. Dark Current vs. Temperature

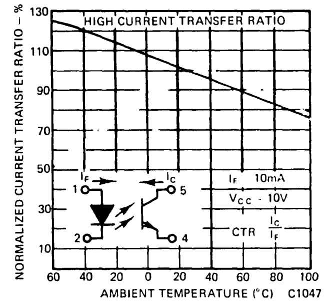


Fig. 3. Current Transfer Ratio vs. Temperature

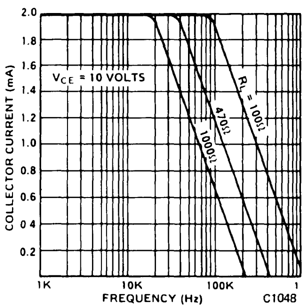


Fig. 4. Collector Current vs. Frequency

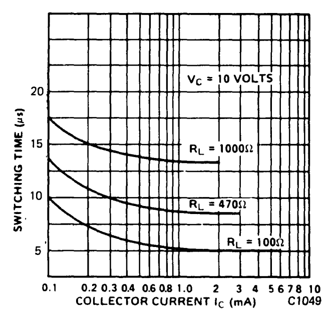


Fig. 5. Switching Time vs. Collector Current

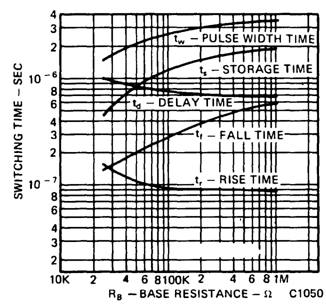


Fig. 6. Switching Time vs. Base Resistance

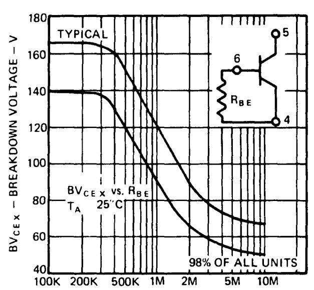


Fig. 7. Collector–Emitter Breakdown Voltage vs. Base Resistance

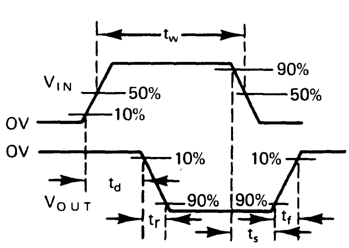


Fig. 8. Test Pulse Definition (Note 3)

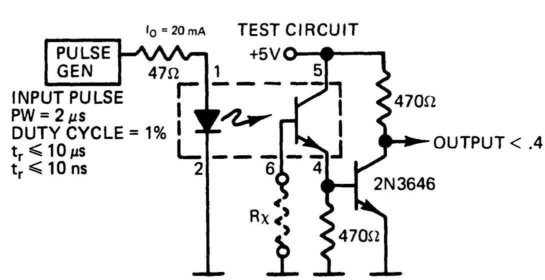


Fig. 9. Pulse Test Circuit for Fig. 7

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25° C Free Air Temperature Unless Otherwise Specified)

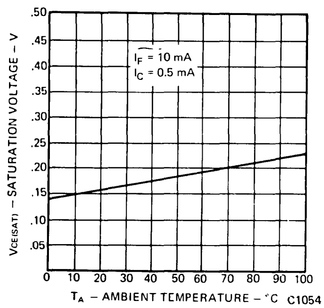


Fig. 10. Saturation Voltage vs. Temperature

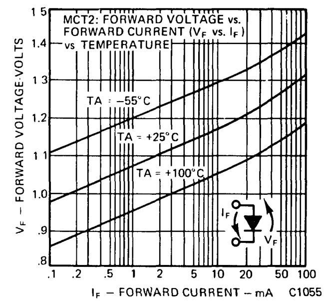


Fig. 11. Forward Voltage vs. Forward Current

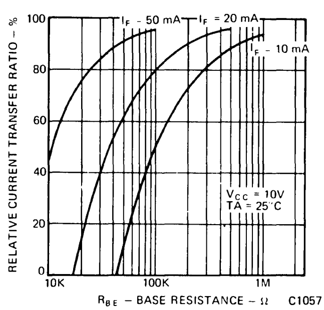


Fig. 12. Sensitivity vs. Base Resistance

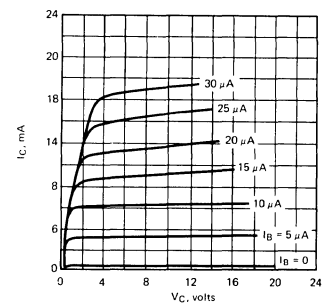


Fig. 13. Detector Standard Transfer Curves

OPERATING SCHEMATICS

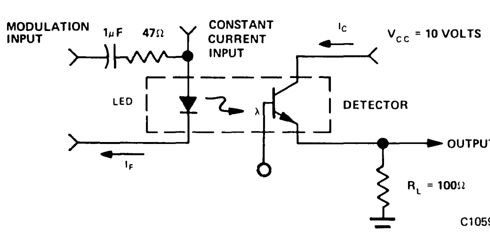


Fig. 14. Modulation Circuit Used to Obtain Output vs. Frequency Plot (Fig. 4)

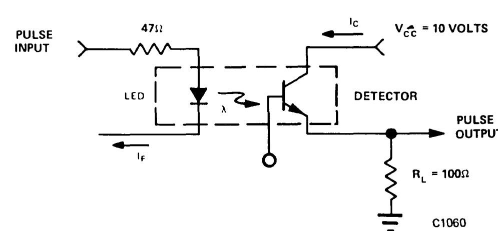


Fig. 15. Circuit Used to Obtain Switching Time vs. Collector Current Plot (Fig. 5)

NOTES

1. *Tests of input to output isolation current resistance and capacitance are performed with the input terminals (diode) shorted together and the output terminals (transistor) shorted together.*
2. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.*
3. *Rise time (t_r) is the time required for the collector current to increase from 10% of its final value, to 90%. Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value to 10%.*

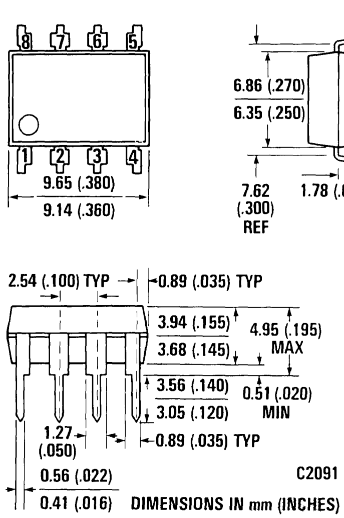
GENERAL INSTRUMENT

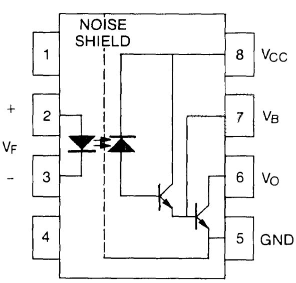
HIGH GAIN SPLIT-DARLINGTON OPTOCOUPLERS

FOR 6N135/6 SEE MCL2501 DATA SHEET
FOR 6N137 SEE MCL/HCPL-2601 DATA SHEET

1.6 mA 6N138
0.5 mA 6N139

PACKAGE DIMENSIONS





Equivalent Circuit C1984

DESCRIPTION

The 6N138/9 single channel optocouplers contain a 700 nm GaAsP LED emitter which is optically coupled to a high gain detector in a split Darlington configuration, providing extremely high current transfer ratio.

The split darlington configuration separating the input photodiode and the first stage gain from the output transistor permits lower output saturation voltage and higher speed operation than possible with conventional darlington phototransistor optocoupler.

The combination of a very low input current of 0.5 mA and a high current transfer ratio of 2000% makes this family particularly useful for input interface to MOS, CMOS, LSTTL and EIA RS232C, while output compatibility is ensured to CMOS as well as high fan-out TTL requirements.

An internal noise shield provides exceptional common mode rejection of 10 kV/μs. An improved package allows superior insulation permitting a 480 V working voltage compared to industry standard 220 V.

FEATURES

- Low current — 0.5 mA
- Superior CTR — 2000%
- Superior CMR — 10 kV/μs
- Double working voltage — 480 V RMS
- CTR guaranteed 0-70°C
- U.L. recognized (File #E50151)
- Superior insulation; 2500 VAC RMS, 1 min

APPLICATIONS

- Digital logic ground isolation
- Telephone ring detector
- EIA RS-232C line receiver
- High common mode noise line receiver
- μP bus isolation
- Current loop receiver

ABSOLUTE MAXIMUM RATINGS

Storage temperature .... -55°C to +125°C
Operating temperature .... 0°C to +70°C
Lead solder temperature .... 260°C for 10 sec
Average input current .... 20 mA *(1)*
Peak input current .... 40 mA
(50% duty cycle, 1 ms P.W.)
Peak transient input current — I_F .... 1.0 A
(≤ 1 μsec P.W., 300 pps)

Reverse input voltage .... 5 V
Input power dissipation .... 35 mW *(2)*
Output current (Pin 6) .... 60 mA *(3)*
Emitter-base reverse voltage (Pin 5-7) .... .5 V
Supply and output voltage—V_{CC} (Pin 8-5), V_O (Pin 6-5)
6N138 .... -0.5 to 7 V
6N139 .... -0.5 to 18 V
Output power dissipation .... 100 mW *(4)*

ELECTRICAL SPECIFICATIONS (T_A = 0°C to +70°C Unless Otherwise Specified)

PARAMETER	SYMBOL	DEVICE	MIN.	TYP.**	MAX.	UNITS	TEST CONDITIONS
Current transfer ratio (Notes 5, 6)	CTR	6N139	400*	2000		%	I_F = 0.5 mA, V_O = 0.4 V, V_{CC} = 4.5 V
			500*	2000			I_F = 1.6 mA, V_O = 0.4 V, V_{CC} = 4.5 V
		6N138	300*	2000		%	I_F = 1.6 mA, V_O = 0.4 V, V_{CC} = 4.5 V
Logic low output voltage (Note 6)	V_{OL}	6N139		0.06	0.4	V	I_F = 1.6 mA, I_O = 6.4 mA, V_{CC} = 4.5 V
				0.08	0.4		I_F = 5 mA, I_O = 15 mA, V_{CC} = 4.5 V
				0.09	0.4		I_F = 12 mA, I_O = 24 mA, V_{CC} = 4.5 V
		6N138		0.06	0.4	V	I_F = 1.6 mA, I_O = 4.8 mA, V_{CC} = 4.5 V
Logic high output current (Note 6)	I_{OH}	6N139		0.1	100*	μA	I_F = 0 mA, V_O = V_{CC} = 18 V
		6N138		0.001	250*	μA	I_F = 0 mA, V_O = V_{CC} = 7 V
Logic low supply current (Note 6)	I_{CCL}			0.20		mA	I_F = 1.6 mA, V_O = Open, V_{CC} = 5 V
Logic high supply current (Note 6)	I_{CCH}			10.0		nA	I_F = 0 mA, V_O = Open, V_{CC} = 5 V
Input forward voltage	V_F			1.45	1.7*	V	I_F = 1.6 mA, T_A = 25°C
Reverse breakdown voltage	BV_R		5*			V	I_R = 10 μA, T_A = 25°C
Temperature coefficient of forward voltage	$\frac{\Delta V_F}{\Delta T_A}$			-1.8		mV/°C	I_F = 1.6 mA
Input capacitance	C_O			60		pF	f = 1 MHz, V_F = 0
Isolation leakage (Input-Output) (Note 7)	$I_{I\text{-}O}$				1.0*	μA	45% Relative Humidity, T_A = 25°C $V_{I\text{-}O}$ = 3000 V, t_d = 5 sec
Withstand isolation test voltage	V_{ISO}		2500			V_{RMS}	RH ≤ 50%, T_A = 25°C, t = 1 min
Resistance (Input-Output) (Note 7)	$R_{I\text{-}O}$			10^{12}		Ω	$V_{I\text{-}O}$ = 500 Vdc
Capacitance (Input-Output) (Note 7)	$C_{I\text{-}O}$			0.6		pF	f = 1 MHz

SWITCHING SPECIFICATIONS (T_A = 25°C, V_{CC} = 5.0 V)

PARAMETER	SYMBOL	DEVICE	MIN.	TYP.**	MAX.	UNITS	TEST CONDITIONS
Propagation delay time to logic low at output (see Fig. 8; Notes 6, 8)	t_{PHL}	6N139		5.0	25*	μs	I_F = 0.5 mA, R_L = 4.7 k Ω
		6N139		0.2	1*	μs	I_F = 12 mA, R_L = 270 Ω
		6N138		1.0	10*	μs	I_F = 1.6 mA, R_L = 2.2 k Ω
Propagation delay time to logic high at output (see Fig. 8; Notes 6, 8)	t_{PLH}	6N139		1.0	60*	μs	I_F = 0.5 mA, R_L = 4.7 k Ω
		6N139		1.0	7*	μs	I_F = 12 mA, R_L = 270 Ω
		6N138		4.0	35*	μs	I_F = 1.6 mA, R_L = 2.2 k Ω
Common mode transient immunity at logic high level output (see Fig. 9; Note 9)	CM_H		1000	10,000		V/μs	I_F = 0 mA, R_L = 2.2 k Ω $\|V_{cm}\|$ = 10 $V_{p\text{-}p}$
Common mode transient immunity at logic low level output (see Fig. 9; Note 9)	CM_L		-1000	-10,000		V/μs	I_F = 1.6 mA, R_L = 2.2 k Ω $\|V_{cm}\|$ = 10 $V_{p\text{-}p}$

**JEDEC registered data*
***All typicals at T_A = 25°C and V_{CC} = 5 V*

NOTES

1. Derate linearly above 50°C free-air temperature at a rate of 0.4 mA/°C.
2. Derate linearly above 50°C free-air temperature at a rate of 0.7 mW/°C.
3. Derate linearly above 25°C free-air temperature at a rate of 0.7 mA/°C.
4. Derate linearly above 25°C free-air temperature at a rate of 2.0 mW/°C.
5. DC CURRENT TRANSFER RATIO is defined as the ratio of output collector current, I_O, to the forward LED input current, I_F, times 100%.
6. Pin 7 Open.
7. Device considered a two-terminal device: Pins 1, 2, 3, and 4 shorted together and Pins 5, 6, 7, and 8 shorted together.
8. Use of a resistor between pin 5 and 7 will decrease gain and delay time.
9. Common mode transient immunity in Logic High level is the maximum tolerable (positive) dv_{cm}/dt on the leading edge of the common mode pulse, V_{cm}, to assure that the output will remain in a Logic High state (i.e., $V_O > 2.0$ V). Common mode transient immunity in Logic Low level is the maximum tolerable (negative) dv_{cm}/dt on the trailing edge of the common mode pulse signal, V_{cm}, to assure that the output will remain in a Logic Low state (i.e., $V_O < 0.8$ V).

ELECTRICAL CHARACTERISTIC CURVES (T_A = 25° C Unless Otherwise Specified)

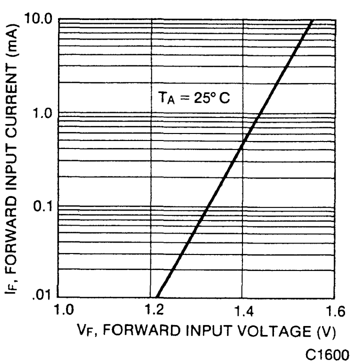


Fig. 1. Input Diode Forward Current vs. Forward Voltage

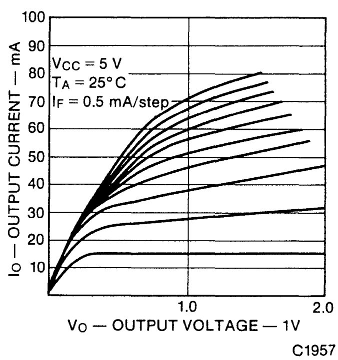


Fig. 2. 6N138/9 DC Transfer Characteristics

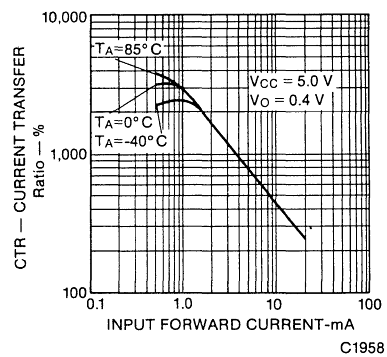


Fig. 3. Current Transfer Ratio vs. Input Forward Current

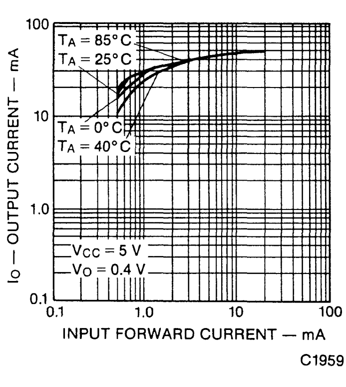


Fig. 4. 6N138 Output Current vs. Input Diode Forward Current

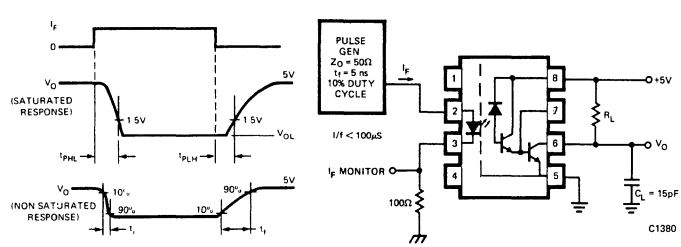


Fig. 5. Switching Test Circuit

ELECTRICAL CHARACTERISTIC CURVES (T_A = 25° C Unless Otherwise Specified)

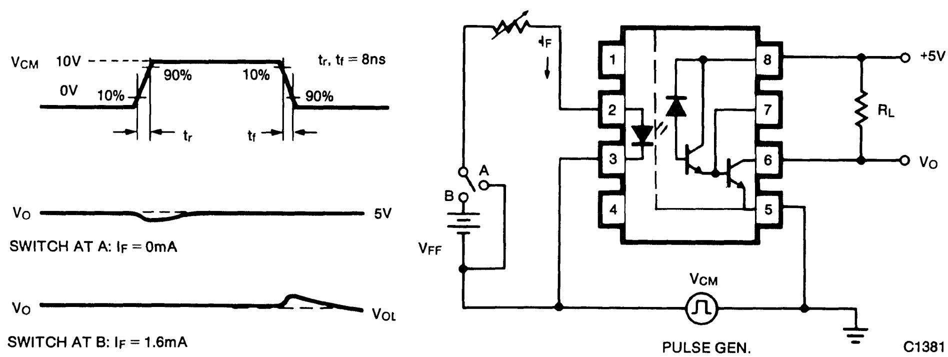
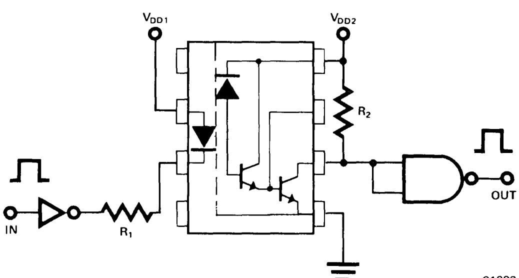
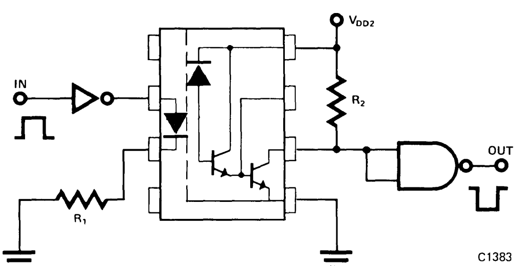


Fig. 6. Test Circuit for Transient Immunity and Typical Waveforms



NON-INVERTING LOGIC INTERFACE



INVERTING LOGIC INTERFACE

$$R_1 \text{ (NON-INVERT)} = \frac{V_{DD1} - V_{DF} - V_{OL1}}{I_F}$$

$$R_1 \text{ (INVERT)} = \frac{V_{DD1} - V_{OH1} - V_{DF}}{I_F}$$

$$R_2 = \frac{V_{DD2} - V_{OLX}(@\ I_L + I_2)}{I_L}$$

WHERE:
- V_{DD1}: INPUT SUPPLY VOLTAGE
- V_{DD2}: OUTPUT SUPPLY VOLTAGE
- V_{DF}: DIODE FORWARD VOLTAGE
- V_{OL1}: LOGIC "0" VOLTAGE OF DRIVER
- V_{OH1}: LOGIC "1" VOLTAGE OF DRIVER
- I_F: DIODE FORWARD CURRENT
- V_{OLX}: SATURATION VOLTAGE OF MCC670
- I_L: LOAD CURRENT THROUGH RESISTOR R_2
- I_2: INPUT CURRENT OF OUTPUT GATE.

CURRENT LIMITING RESISTOR CALCULATION

INPUT			OUTPUT						
			CMOS @ 5V	CMOS @ 10V	74XX	74LXX	74SXX	74LSXX	74HXX
		R_1 (Ω)	R_2 (Ω)	R_2 (Ω)	R_2 (Ω)	R_2 (Ω)	R_2 (Ω)	R_2 (Ω)	R_2 (Ω)
CMOS @ 5V	NON-INV.	2000	1000	2200	750	1000	1000	1000	560
	INV.	510							
CMOS @ 10V	NON-INV.	5100							
	INV.	4700							
74XX	NON-INV.	2200							
	INV.	180							
74LXX	NON-INV.	1800							
	INV.	100							
74SXX	NON-INV.	2000							
	INV.	360							
74LSXX	NON-INV.	2000							
	INV.	180							
74HXX	NON-INV.	2000							
	INV.	180							

RESISTOR VALUES FOR LOGIC INTERFACE

GENERAL INSTRUMENT

HIGH-SPEED LOGIC-TO-LOGIC OPTOCOUPLERS

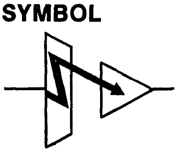
OPTOLOGIC™

LSTTL to TTL BUFFER 74OL6000
LSTTL to TTL INVERTER 74OL6001
LSTTL to CMOS BUFFER 74OL6010
LSTTL to CMOS INVERTER 74OL6011

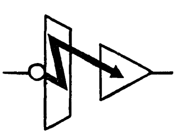
ORDER INFORMATION

PART NUMBER	LOGIC COMPATIBILITY INPUT	LOGIC COMPATIBILITY OUTPUT	LOGIC FUNCTION	OUTPUT CONFIGURATION
74OL6000	LSTTL	TTL	BUFFER	TOTEM POLE
74OL6001	LSTTL	TTL	INVERTER	TOTEM POLE
74OL6010	LSTTL	CMOS	BUFFER	OPEN COLLECTOR
74OL6011	LSTTL	CMOS	INVERTER	OPEN COLLECTOR

SYMBOL



Buffer



Inverter

APPLICATIONS

- Transmission line interface — receiver and driver
- Excellent as bridged receiver in fast LAN highways
- Bus interface
- Logic family interface with ground loop noise elimination
- High speed AC/DC voltage sensing
- Driver for power semiconductor devices
- Level shifting
- Replaces fast pulse transformers

FEATURES

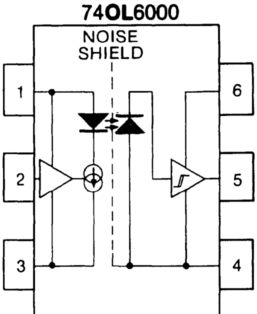
- Industry first LSTTL to TTL and LSTTL to CMOS complete logic-to-logic optocoupler
- Incorporates LED drive circuitry — use as logic gate
- Very high speed — supports datacom up to 15 MBaud
- Choice of buffer or inverter
- Choice of TTL or CMOS compatible output up to 15 volts
- Fan-out of 10 TTL loads, fan-in 1 LSTTL load
- Internal noise shield — very high CMR of ±15 kV/μs
- Provides superior 2500 VRMS Withstand Test Voltage (WTV) — guarantees 480 VAC operation
- Compact 6-pin DIP
- UL recognized (File #E50151)
- Same noise immunity as LSTTL/TTL.

PIN CONFIGURATION

1 - V_{CCI} (Input V_{CC})	6 - V_{CCO} (Output V_{CC})
2 - V_{IN} (Data in)	5 - V_O (Data out)
3 - GND_I (Input GND)	4 - GND_O (Output GND)

EQUIVALENT CIRCUITS

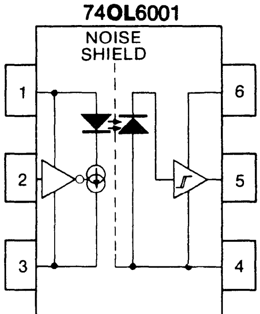
74OL6000



C2004

LSTTL to TTL Buffer

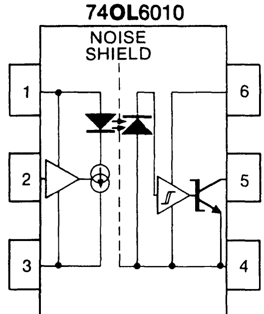
74OL6001



C2005

LSTTL to TTL Inverter

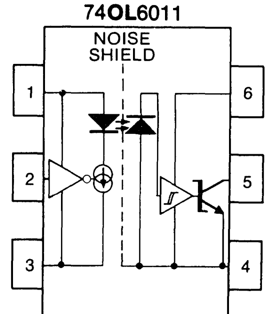
74OL6010



C2002

LSTTL to CMOS Buffer

74OL6011



C2003

LSTTL to CMOS Inverter

DESCRIPTION

OPTOLOGIC™ is the first family of truly logic compatible optically coupled logic interface gates.

The family consists of four device types offering LSTTL to TTL and LSTTL to CMOS interfacing. Each of these interfacing functions is available as a buffer (A=B), or as an inverter (A=$\bar{B}$).

The LSTTL input compatibility is provided by an input integrated circuit, with industry standard logic levels. This input amplifier IC switches a temperature compensated current source driving a high speed GaAsP/GaAs 700 nm LED emitter.

This novel integration scheme eliminates CTR degradation over time and temperature.

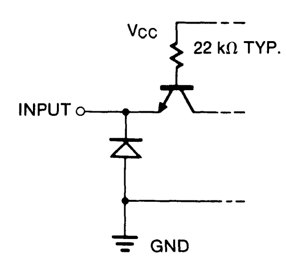
The emitter is optically coupled to an integrated photodetector/high-gain, high-speed output amplifier IC. The superior 15 kV/µs common-mode noise rejection is ensured through the use of an optically transparent noise shield.

The TTL compatible output has a totem-pole with a fan-out of 10. The CMOS compatible output has an open collector Schottky-clamped transistor that interfaces to any CMOS logic between 4.5 and 15 volts.

The 74OL6010/11 may also be used to drive power MOS FETS or transistors up to 15 volts.

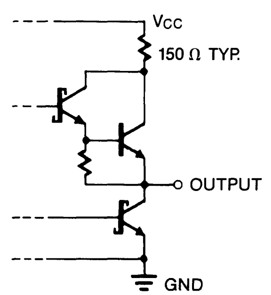
The Optologic coupler family typically offers propagation delays of 60 ns and can support 15 MBaud data communication.

The two input chips and the output chip are assembled in a 6-pin DIP high insulation voltage plastic package. It provides a withstand test voltage of 2500 VRMS (1 minute), which is recognized as a working voltage of 480 VRMS.



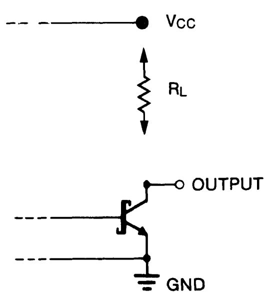
LSTTL INPUT CIRCUIT
C2010

All Inputs



TTL OUTPUT CIRCUIT
C2009

74OL6000/01 Output



CMOS OUTPUT CIRCUIT
C2026

74OL6010/11 Output

ABSOLUTE MAXIMUM RATINGS 74OL6000/01

Storage temperature range	-55°C to +125°C
Operating temperature range	0°C to +70°C
Input supply voltage	7 V
Input voltage	7 V
Output supply voltage	7 V
Output voltage	7 V
Output current	40 mA
Power dissipation	350 mW
Lead temperature (soldering, 10 sec)	260°C

ABSOLUTE MAXIMUM RATINGS 74OL6010/11

Storage temperature range	-55°C to +125°C
Operating temperature range	0°C to +70°C
Input supply voltage	7 V
Input voltage	7 V
Output supply voltage	18 V
Output voltage	18 V
Output current	40 mA
Power dissipation	350 mW*
Lead temperature (soldering, 10 sec)	260°C

*See Fig. 12 for maximum allowable output supply voltage.

ELECTRICAL CHARACTERISTICS (T_A = 0° C to 70° C Unless Otherwise Specified)

TTL OUTPUT 74OL6000/01

PARAMETER	SYM	MIN	TYP*	MAX	UNITS	TEST CONDITIONS 74OL6000	TEST CONDITIONS 74OL6001	TEST CONDITIONS 74OL6000/01	FIG.	NOTES
Input supply voltage	V_{CCI}	4.5	5.0	5.5	V					1
Output supply voltage	V_{CCO}	4.5	5.0	5.5	V					1
High-level input voltage	V_{IH}	2.0			V					1
Low-level input voltage	V_{IL}			0.8	V					1
Input clamp voltage	V_{IK}			-1.2	V			V_{CCI} = 4.5 V, I_I = −18 mA		1
High-level input current	I_{IH}		1.0	40.0	μA			V_{CCI} = 5.5 V, V_{IH} = 4.5 V		1
Low-level input current	I_{IL}		-200.0	-400.0	μA			V_{CCI} = 5.5 V, V_{IL} = 0.4 V		1
Input supply current (high)	I_{CCIH}		10.0	14.0	mA			V_{CCI} = 5.5 V, V_{IN} = V_{IH}		1
Input supply current (low)	I_{CCIL}		10.0	14.0	mA			V_{CCI} = 5.5 V, V_{IN} = V_{IL}		1
High-level output voltage	V_{OH}	2.4	3.0		V	V_{IN} = 2.0 V	V_{IN} = 0.8 V	V_{CCI} = 4.5 V, V_{CCO} = 4.5 V, I_{OH} = −400 μA		1
Low-level output voltage	V_{OL}		0.3	0.6	V	V_{IN} = 0.8 V	V_{IN} = 2.0 V	V_{CCI} = 4.5 V, V_{CCO} = 4.5 V, I_{OL} = 16 mA		1
				0.5	V			V_{CCI} = 4.5 V, V_{CCO} = 4.5 V, I_{OL} = 4 mA		
High-level output current	I_{OH}		-8.0	-10.0	mA	V_{IN} = V_{IH}	V_{IN} = V_{IL}	V_{CCI} = 4.5 V, V_{CCO} = 4.5 V, V_{OH} = 2.4 V		1
Low-level output current	I_{OL}	16.0			mA	V_{IN} = 0.8 V	V_{IN} = 2.0 V	V_{CCI} = 4.5 V, V_{CCO} = 4.5 V, V_{OL} = 0.6 V		1
Short-circuit output current	I_{OS}	-5.0	-25.0	-40.0	mA	V_{IN} = V_{IH}	V_{IN} = V_{IL}	V_{CCI} = 5.5 V, V_{CCO} = 5.5 V		1
Output supply current (high)	I_{CCOH}		9.0	15.0	mA	V_{IN} = V_{IH}	V_{IN} = V_{IL}	V_{CCI} = 5.5 V, V_O = V_{OH}, V_{CCO} = 5.5 V		1
Output supply current (low)	I_{CCOL}		8.0	12.0	mA	V_{IN} = V_{IL}	V_{IN} = V_{IH}	V_{CCI} = 5.5 V, V_O = V_{OL}, V_{CCO} = 5.5 V		1

**All typical values are at T_A = 25° C*

SWITCHING CHARACTERISTICS (T_A = 25°C Unless Otherwise Specified)

TTL OUTPUT 74OL6000/01

PARAMETER	SYM	MIN	TYP	MAX	UNITS	TEST CONDITIONS	FIG.	NOTES
Propagation delay time for output low level	t_{PHL}		60	100	ns	V_{CCI} = 5 V, V_{CCO} = 5 V	15, 17	1
Propagation delay time for output high level	t_{PLH}		70	100	ns		15, 17	1
Output rise time for output high level	t_r		45		ns		15, 17	1
Output fall time for output low level	t_f		5		ns		15, 17	1

ELECTRICAL CHARACTERISTICS (T_A = 0° C to 70° C Unless Otherwise Specified)

CMOS OUTPUT 74OL6010/11

PARAMETER	SYM	MIN	TYP*	MAX	UNITS	TEST CONDITIONS 74OL6010	TEST CONDITIONS 74OL6011	TEST CONDITIONS 74OL6010/11	FIG.	NOTES
Input supply voltage	V_{CCI}	4.5	5.0	5.5	V					1
Output supply voltage	V_{CCO}	4.5		15.0	V					1, 3
High-level input voltage	V_{IH}	2.0			V					1
Low-level input voltage	V_{IL}			0.8	V					1
Input clamp voltage	V_{IK}			-1.2	V			V_{CCI} = 4.5 V, I_I = −18 mA		1
High-level input current	I_{IH}		1.0	40.0	μA			V_{CCI} = 5.5 V, V_{IH} = 4.5 V		1
Low-level input current	I_{IL}		-200.0	-400.0	μA			V_{CCI} = 5.5 V, V_{IL} = 0.4 V		1
Input supply current (high)	I_{CCIH}		10.0	14.0	mA			V_{CCI} = 5.5 V, V_{IN} = V_{IH}		1
Input supply current (low)	I_{CCIL}		10.0	14.0	mA			V_{CCI} = 5.5 V, V_{IN} = V_{IL}		1
Low-level output voltage	V_{OL}		0.4	0.6	V	V_{IN} = 0.8 V	V_{IN} = 2.0 V	V_{CCI} = 4.5 V, V_{CCO} = 4.5 V, I_{OL} = 16 mA		1
				0.5				V_{CCI} = 4.5 V, V_{CCO} = 4.5 V, I_{OL} = 4 mA		
High-level output voltage	I_{OH}		1.0	100.0	μA	V_{IN} = V_{IH}	V_{IN} = V_{IL}	V_{CCI} = 4.5 V, V_{OH} = 15 V, V_{CCO} = 4.5 −15 V		1
Low-level output current	I_{OL}	16.0				V_{IN} = 0.8 V	V_{IN} = 2.0 V	V_{CCI} = 4.5 V, V_{OL} = 0.6 V, V_{CCO} = 4.5 −15 V		1
Output supply current (high)	I_{CCOH}		9.0	12.0		V_{IN} = V_{IH}	V_{IN} = V_{IL}	V_{CCI} = 5.5 V, V_O = V_{OH}, V_{CCO} = 4.5 V		1
			11.0	18.0				V_{CCI} = 5.5 V, V_O = V_{OH}, V_{CCO} = 15 V		
Output supply current (low)	I_{CCOL}		8.0	12.0	mA	V_{IN} = V_{IL}	V_{IN} = V_{IH}	V_{CCI} = 5.5 V, V_O = V_{OL}, V_{CCO} = 4.5 V,		1
			11.0	18.0				V_{CCI} = 5.5 V, V_O = V_{OL}, V_{CCO} = 15 V		

**All typical values are at T_A = 25° C*

SWITCHING CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

CMOS OUTPUT 74OL6010/11

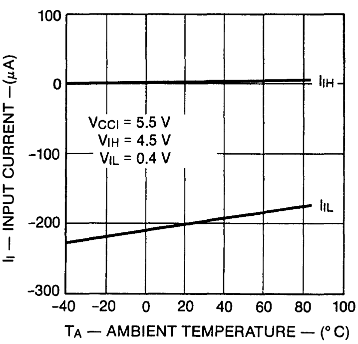
PARAMETER	SYM	MIN	TYP	MAX	UNITS	TEST CONDITIONS	FIG.	NOTES
Propagation delay time for output low level	t_{PHL}		60	120	ns	V_{CCI} = 5 V, V_{CCO} = 5 V, R_L = 470 Ω	15, 18	1
Propagation delay time for output high level	t_{PLH}		100	180	ns		15, 18	1
Output rise time for output high level	t_r		50		ns		15, 18	1
Output fall time for output low level	t_f		5		ns		15, 18	1

ISOLATION AND INSULATION ($T_A = 25°C$)

74OL6000/01/10/11

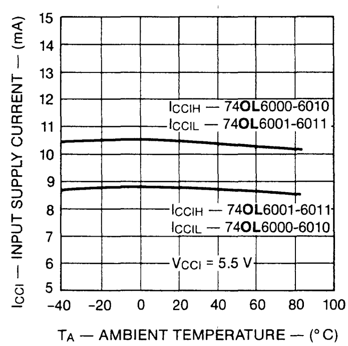
PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS	FIG.	NOTES
Common mode transient immunity at logic high level output	CM_H	5000	15000		V/µs	$V_{CCI} = 5$ V, $V_{CCO} = 5$ V, $V_{CM} = 50\ V_{p-p}$	16,19	
Common mode transient immunity at logic low level output	CM_L	-5000	-15000		V/µs		16,19	
Common mode coupling capacitance	C_{CM}		0.005		pF			
Capacitance (input-output)	C_{I-O}		0.7		pF	$V_{I-O} = 0$, f = 1 MHz		2
Withstand insulation test voltage	V_{ISO}	2500			VRMS	RH≤50%, $T_A = 25°C$, t = 1 min		2
Insulation resistance	R_{ISO}		10^{11}		Ω	$V_{I-O} = 500$ VDC		2

TYPICAL CHARACTERISTIC CURVES ($T_A = 25°C$ Unless Otherwise Specified)



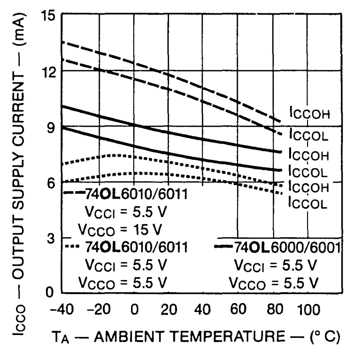
C2028

Fig. 1. Input Current vs. Ambient Temperature



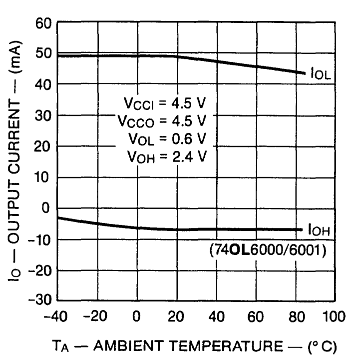
C2029

Fig. 2. Input Supply Current vs. Ambient Temperature



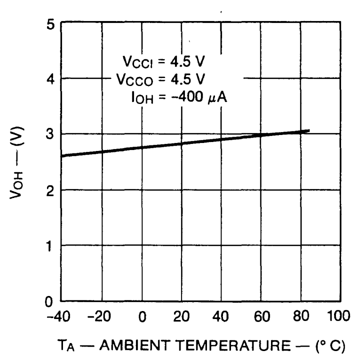
C2030

Fig. 3. Output Supply Current vs. Ambient Temperature



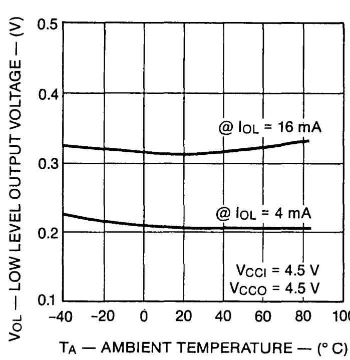
C2031

Fig. 4. Output Current vs. Ambient Temperature



C2032

Fig. 5. High-level Output Voltage vs. Ambient Temperature



C2033

Fig. 6. Low-Level Output Voltage vs. Ambient Temperature

TYPICAL CHARACTERISTIC CURVES (T$_A$ = 25°C Unless Otherwise Specified)

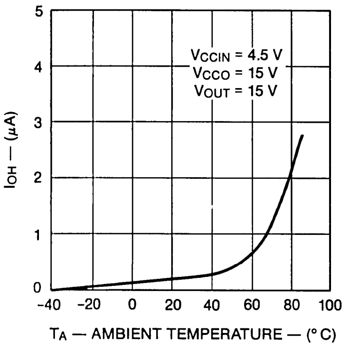


Fig. 7. 74OL6010/11 Leakage Current vs. Ambient Temperature

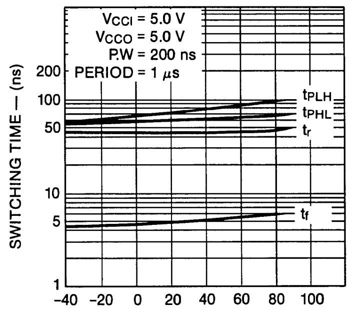


Fig. 8. 74OL6000/01 Switching Times vs. Ambient Temperature

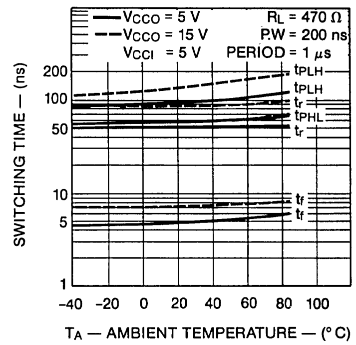


Fig. 9. 74OL6010/11 Switching Times vs. Ambient Temperature

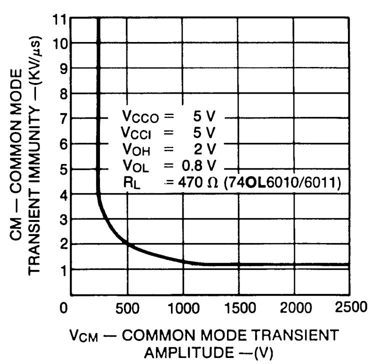


Fig. 10. Common Mode Rejection vs. Common Mode Voltage

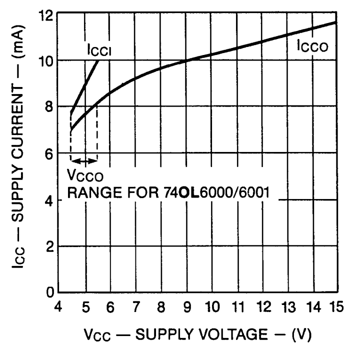


Fig. 11. Supply Current vs. Supply Voltage

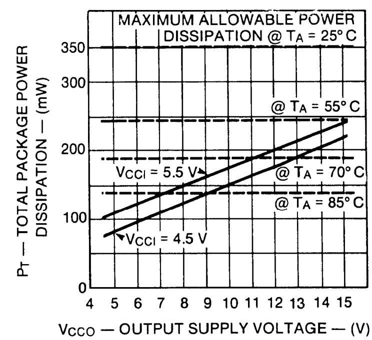


Fig. 12. Power Dissipation vs. Ambient Temperature

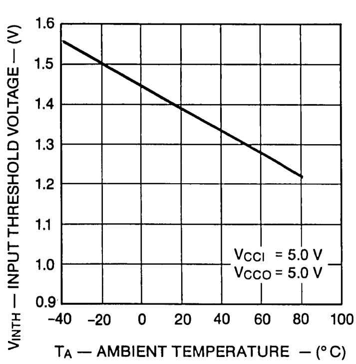


Fig. 13. Input Threshold Voltage vs. Ambient Temperature

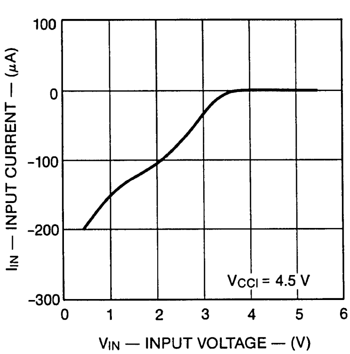


Fig. 14. Input Current vs. Input Voltage

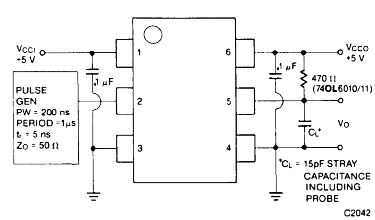


Fig. 15. Switching Time Test Circuit

TYPICAL CHARACTERISTIC CURVES (T_A = 25° C Unless Otherwise Specified)

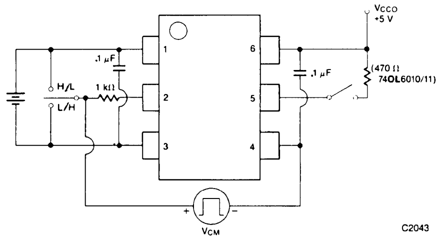


Fig. 16. Common Mode Rejection Test Circuit

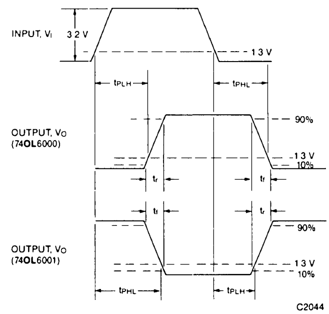


Fig. 17. Switching Parameters 74OL6000/01

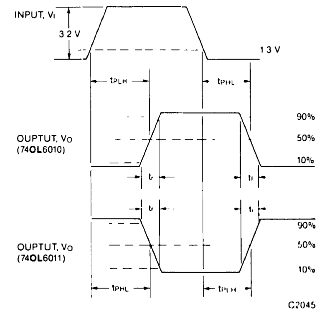
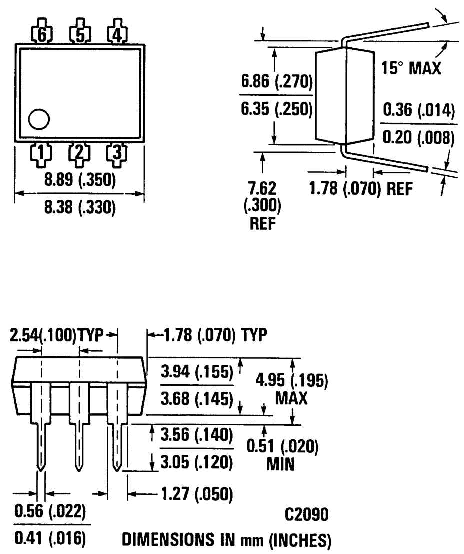


Fig. 18. Switching Parameters 74OL6010/11

PACKAGE DIMENSIONS



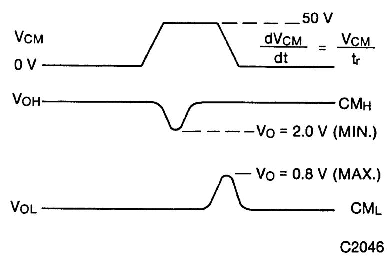


Fig. 19. Common Mode Rejection Wave-forms

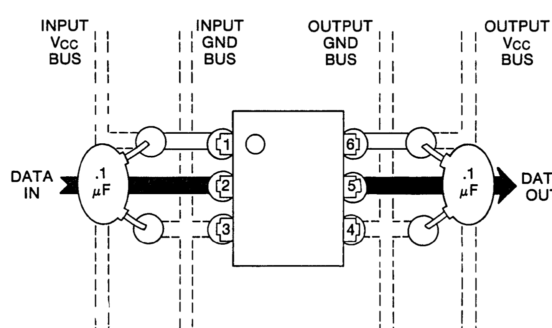
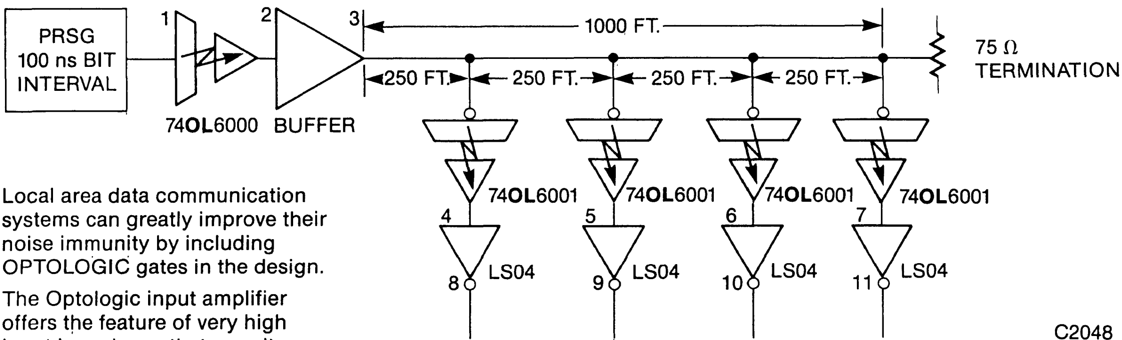


Fig. 20. Suggested PCB Lay-out

NOTES

1. *The V_{CCO} and V_{CCI} supply voltages to the device must each be bypassed by a 0.1 μf capacitor or larger. This can be either a ceramic or solid tantalum capacitor with good high frequency characteristics. Its purpose is to stabilize the operation of the high-gain amplifiers. Failure to provide the bypass will impair the DC and switching properties. The total lead length between capacitor and optocoupler should not exceed 1.5mm. See Fig. 20.*
2. *Device considered a two-terminal device: Pins 1, 2 and 3 shorted together, and Pins 4, 5 and 6 shorted together.*
3. *For example, assuming a V_{CCI} of 5.0 V, and an ambient temperature of 70° C, the maximum allowable V_{CCO} is 12.1 V.*

APPLICATION



Local area data communication systems can greatly improve their noise immunity by including OPTOLOGIC gates in the design.

The Optologic input amplifier offers the feature of very high input impedance that permits their use as bridged line receivers. The system shown above illustrates an optically isolated transmitter and multidrop receiver system. The network uses a 74OL6000 and buffer (Figure D) to isolate the transmitter and drive the 75 Ω coax cable. This application uses a 1000 ft. aerial suspension 75 Ω CATV coax cable with data taps at 250 ft. intervals. The 74OL6001s function as bridged receivers, and as many as 30 receivers could be placed along the line with minimal signal degradation. The communication cable is terminated with a single 75 Ω load at the far end of the line.

Signal quality "Eye Pattern" is shown in Figures A, B and C with a 10MBaud NRZ Psuedo-Random Sequence (PRS). Traces 1-3 in Figure A describes the transmitter section. Traces 4-7 in Figure B show the output of the four Optologic bridged terminations. Traces 8-11 in Figure C illustrate "Eye Pattern" as seen at the output of a 74LS04 logic gate. The data quality is well preserved in that only a 30% Eye closure is seen at the receiver located 1000 ft. from the transmitter.

The data communication system is completely optically isolated from all of the terminal equipments. Power for the transmitter (V_{CCO}) and receivers (V_{CCI}) is taken from an isolated power supply and distributed through a drain or messenger wire.

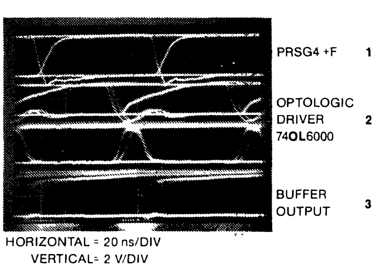


Figure A

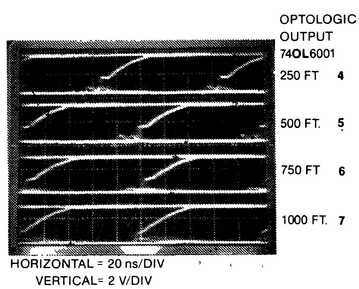


Figure B

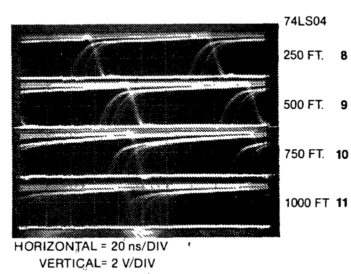


Figure C

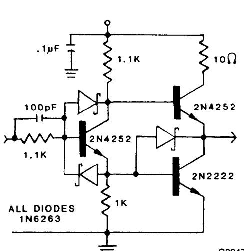


Figure D Buffer

NOTES

— *All Optologic Gate Input and Output Amplifiers Bypassed With 0.1 μF Capacitors*
— *PRSG = Pseudo Random Sequence Generator*
— *1 to 11 Refer To Testpoints; See Waveforms on Figs. A, B and C*

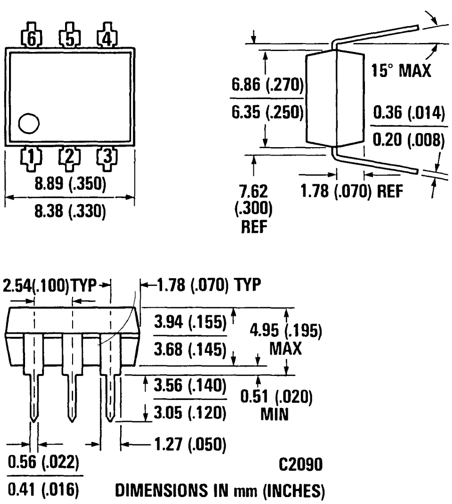
GENERAL INSTRUMENT

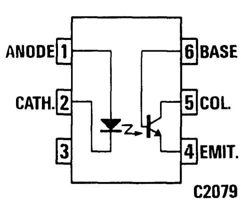
PHOTOTRANSISTOR OPTOCOUPLER

Optocouplers

CNX35

PACKAGE DIMENSIONS





Equivalent Circuit

DESCRIPTION

The CNX 3X is a phototransistor-type optically coupled isolator. An infrared emitting diode manufactured from specially grown gallium arsenide is selectively coupled with an NPN silicon phototransistor. The device is supplied in a standard plastic six-pin dual-in-line package.

FEATURES

- High isolation voltage 4400V DC 1 min
- Minimum saturation current transfer ratio of CNX 35—40%
- Underwriters Laboratory (UL) recognized File #E50151

APPLICATIONS

- Power supply regulators
- Digital logic inputs
- Microprocessor inputs
- Applicance sensor systems
- Industrial controls

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

TOTAL PACKAGE

Storage temperature .... -55° C to 150° C
Operating temperature .... -55° C to 100° C
Lead temperature
(Soldering, 10 sec) .... 260° C
Total package power dissipation at 25° C
(LED plus detector) .... 260 m/W
Derate linearly from 25° C .... 3.5 mW/° C

INPUT DIODE

Forward DC current .... 100 mA
Reverse voltage .... 6 V
Peak forward current
(1μs pulse, 300 pps) .... 3.0 A
Power dissipation 25° C ambient .... 150 mV
Derate linearly from 25° C .... 1.8 mW/° C

OUTPUT TRANSISTOR

Power dissipation at 25° C .... 150 mW
Derate linearly from 25° C .... 2.67 mW/° C
V_{CEO} .... 30 V
V_{CBO} .... 70 V
V_{ECO} .... 7 V
Collector Current (continuous) .... 100 mA

ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

TRANSFER CHARACTERISTICS

	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current Transfer Ratio, collector to emitter	CTR	40		160	%	I_F = 10 mA, V_{CE} = 0.4 V
DC		I_{CE1}	150			μA	T_A < 70° C, I_F = 2 mA, V_{CE} = 0.4 V
DC		I_{CE2}			15	μA	T_A < 70° C, V_F = 0.8 V, V_{CE} = 15 V
DC	Saturation voltage	$V_{CE\,(SAT)}$		0.1	.40	V	I_F = 10 mA; I_C = 4 mA
DC	Collector cut-off current (dark)	I_{CEW}			200	nA	Working voltage = 1500 V_{DC} V_{CC} = 10 V, I_F = 0, see Fig. 16
DC					100	μA	Working voltage = 1500 V_{DC} V_{CC} = 10 V, I_F = 0, T = 70° C See Fig. 16
SWITCHING TIMES	Non-saturated						(V_{CE} = 10 V, I_{CE} = 2 mA, R_L = 100Ω) See Fig. 18
SWITCHING TIMES	Turn-on	t_{on}		2		μs	
SWITCHING TIMES	Turn-off time	t_{off}		2		μs	
SWITCHING TIMES	Non-saturated						(V_{CB} = 10 V, I_{CB} = 50 μA, R_L = 100 Ω) See Fig. 18
SWITCHING TIMES	Turn-on	t_{on}		300		ns	
SWITCHING TIMES	Turn-off time	t_{off}		300		ns	
ISOLATION	Isolation voltage	V_{ISO}	4400			V_{DC} RMS	Relative humidity ≤ 50% I_{I-O} ≤ 10 μA, 1 minute
ISOLATION		V_{ISO}	3734			V_{AC} RMS	Relative humidity ≤ 50% I_{I-O} ≤ 10 μA, 1 second
ISOLATION	Isolation resistance	R_{ISO}	10^{11}			ohms	V_{I-O} = 500 VDC
ISOLATION	Isolation capacitance	C_{ISO}		0.5		pF	f = 1 MHz

INDIVIDUAL COMPONENT CHARACTERISTICS

	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.1	1.50	V	I_F = 10 mA
INPUT DIODE	Forward voltage temp coefficient			-1.8		mV/° C	
INPUT DIODE	Reverse voltage	V_R	3.0	25		V	I_R = 10μA
INPUT DIODE	Junction capacitance	C_J		50		pF	V_F = O V, f = 1 MHz
INPUT DIODE				65		pF	V_F = 1 V, f = 1 MHz
INPUT DIODE	Reverse leakage current	I_R		0.35	10	μA	V_R = 3.0 V
OUTPUT TRANSISTOR	Breakdown voltage						
OUTPUT TRANSISTOR	Collector to emitter	BV_{CEO}	30	45		V	I_C = 1.0 mA, I_F = 0
OUTPUT TRANSISTOR	Collector to base	BV_{CBO}	70	130		V	I_C = 10 μA
OUTPUT TRANSISTOR	Emitter to collector	BV_{ECO}	7	10		V	I_E = 100 μA, I_F = 0
OUTPUT TRANSISTOR	Leakage current						
OUTPUT TRANSISTOR	Collector to emitter	I_{CEO}		5	50	nA	V_{CE} = 10 V, I_F = 0
OUTPUT TRANSISTOR	Collector to base	I_{CBO}			20	nA	V_{CB} = 10 V, I_F = 0
OUTPUT TRANSISTOR	Capacitance						
OUTPUT TRANSISTOR	Collector to emitter			2		pF	V_{CE} = 10, f = 1 MHz
OUTPUT TRANSISTOR	Collector to base			20		pF	V_{CB} = 5, f = 1 MHz
OUTPUT TRANSISTOR	Emitter to base			10		pF	V_{EB} = 0, f = 1 MHz

ELECTRICAL CHARACTERISTIC CURVES (T_A = 25° C Unless Otherwise Specified)

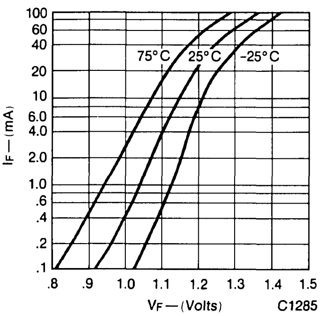


Fig. 1. Forward Voltage vs. Forward Current

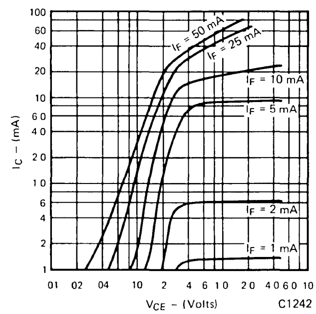


Fig. 2. Collector Current vs. Collector to Emitter Voltage

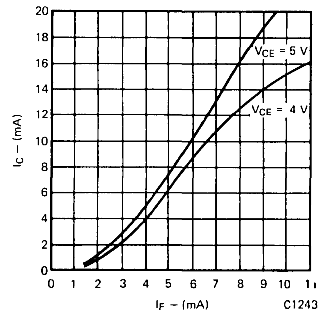


Fig. 3. Collector Current vs. Forward Current

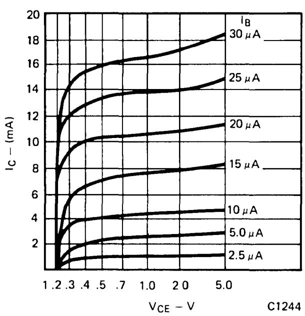


Fig. 4. Collector Current vs. Collector to Emitter Voltage

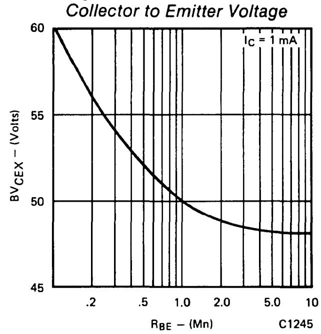


Fig. 5. Collector to Emitter Breakdown Voltage vs. Base to Emitter Resistance

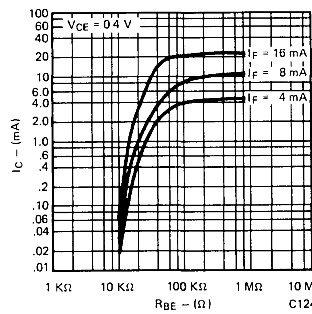


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

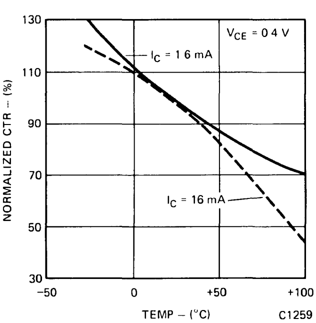


Fig. 7. Current Transfer Ratio (saturated) vs. Temperature

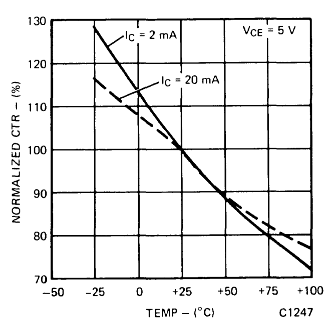


Fig. 8. Current Transfer Ratio (unsaturated) vs. Temperature

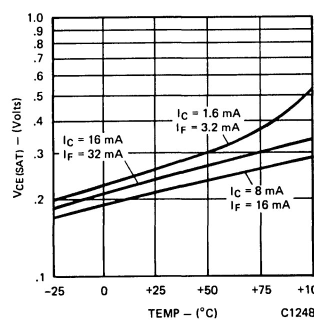


Fig. 9. Collector to Emitter Saturation Voltage vs. Temperature

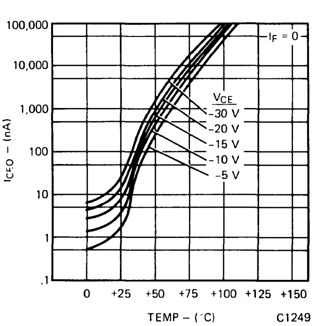


Fig. 10. Collector to Emitter Leakage Current vs. Temperature

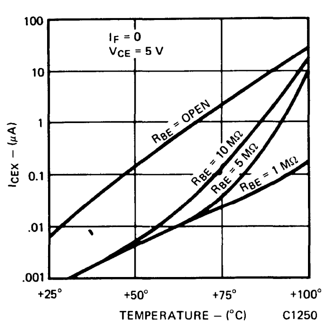


Fig. 11. Collector To Emitter Leakage Current vs. Temperature

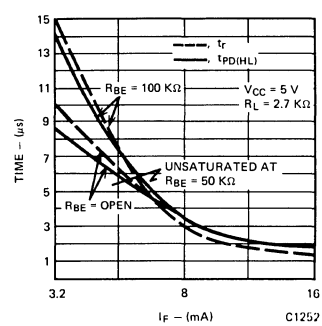


Fig. 12. Switch-on Time vs. I_F Drive (saturated)

SWITCHING CHARACTERISTICS

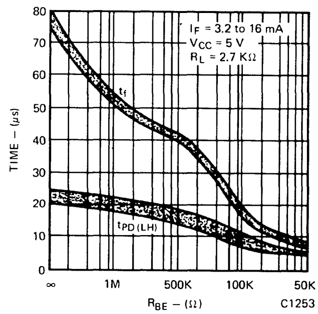


Fig. 13. Switch-off time vs. Base to Emitter Resistance (saturated)

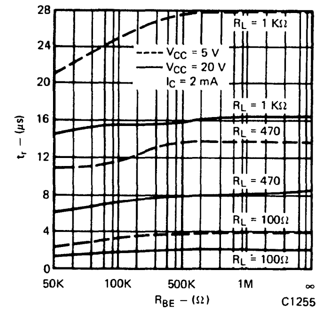


Fig. 14. Rise Time vs. Base to Emitter Resistance (non-saturated)

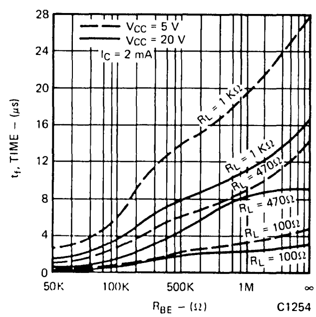


Fig. 15. Fall Time vs. Base to Emitter Resistance (non-saturated)

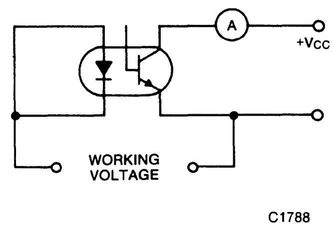


Fig. 16. I_{CEW} Test Circuit

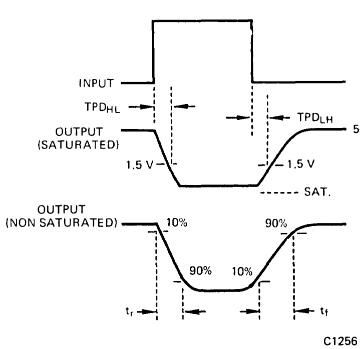


Fig. 17. Switching Time Waveforms

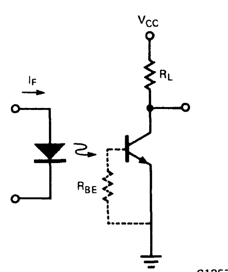


Fig. 18. Switching Time Test Circuits

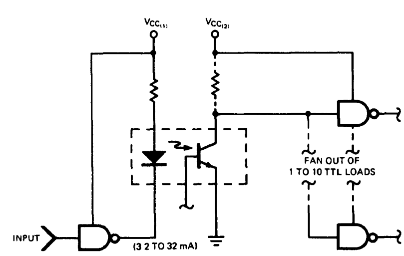


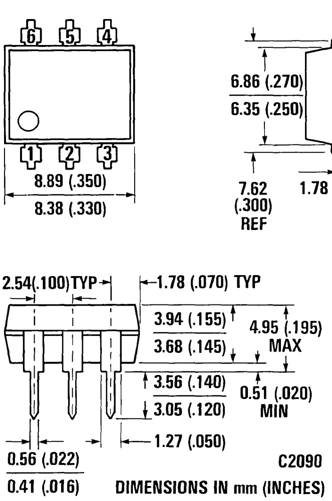
Fig. 19. Typical TTL interface at Operating Temperatures of 0° to 70° C

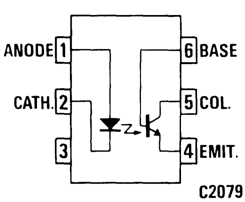
GENERAL INSTRUMENT

VDE APPROVED PHOTOTRANSISTOR OPTOCOUPLERS

CNY17-1/1Z CNY17-3/3Z CNY17-2/2Z CNY17-4/4Z

PACKAGE DIMENSIONS





Equivalent Circuit

DESCRIPTION

The CNY17 series consists of a Gallium Aresnide IRED coupled with an NPN phototransistor.

FEATURES

- High isolation voltage
  5300 VAC RMS—5 seconds
  7500 VAC PEAK—5 seconds
- High BV_{CEO} minimum 70 volts
- Current transfer ratio in selected groups:
  CNY17-1: 40%- 80%
  CNY17-2: 63%-125%
  CNY17-3: 100%-200%
  CNY17-4: 160%-320%
- Maximum switching time in saturation specified
- Underwriters Laboratory (UL) recognized File #E50151
- See VDE datasheet

APPLICATIONS

- Power supply regulators
- Digital logic inputs
- Microprocessor inputs
- Appliance sensor systems
- Industrial controls

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	−55°C to 150°C
Operating temperature	−55°C to 100°C
Lead temperature (Soldering, 10 sec)	260°C
Total package power dissipation @ 25°C (LED plus detector)	260 mW
Derate linearly from 25°C	3.5 mW/°C

INPUT DIODE

Forward DC current	90 mA
Reverse voltage	3 V
Peak forward current (1 μs pulse, 300 pps)	3.0 A
Power dissipation 25°C ambient	135 mW
Derate linearly from 25°C	1.8 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C	200 mW
Derate linearly from 25°C	2.67 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)

	TRANSFER CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current Transfer Ratio, collector to emitter	CTR				%	I_F = 10 mA; V_{CE} = 5 V
	CNY17-1		40		80		
	CNY17-2		63		125		
	CNY17-3		100		200		
	CNY17-4		160		320		
	Saturation voltage	$V_{CE(SAT)}$		0.27	.40	V	I_F = 10 mA; I_C = 2.5 mA
SWITCHING TIMES	Non-saturated						R_L = 100 Ω; I_C = 2 mA; V_{CC} = 10 V See figure 10.
	Turn-on time	t_{on}		6.0	10	μs	
	Turn-off time	t_{off}		5.5	10	μs	
ISOLATION	Isolation Voltage	V_{iso}	5300			V_{AC} RMS	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA, 5 seconds
		V_{iso}	7500			V_{AC} PEAK	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA, 5 seconds
	Isolation resistance	R_{iso}	10^{11}			ohms	V_{I-O} = 500 VDC
	Isolation capacitance	C_{iso}		0.5		pF	f = 1 MHz

	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SATURATED SWITCHING TIMES	Turn-on time	t_{on}					
	CNY17-1			3.0	5.5	μs	I_F = 20 mA, V_{CE} = 0.4 V
	CNY17-2, CNY17-3			4.2	8.0	μs	I_F = 10 mA, V_{CE} = 0.4 V
	Rise-time	t_r					
	CNY17-1			2.0	4.0	μs	I_F = 20 mA, V_{CE} = 0.4 V
	CNY17-2, CNY17-3			3.0	6.0	μs	I_F = 10 mA, V_{CE} = 0.4 V
	Turn-off time	t_{off}					
	CNY17-1			18	34	μs	I_F = 20 mA, V_{CE} = 0.4 V
	CNY17-2, CNY17-3			23	39	μs	I_F = 10 mA, V_{CE} = 0.4 V
	Fan-time	t_f					
	CNY17-1			11	20	μs	I_F = 20 mA, V_{CE} = 0.4 V
	CNY17-2, CNY17-3			14	24	μs	I_F = 10 mA, V_{CE} = 0.4 V

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.3	1.50	V	I_F = 60 mA
	Forward voltage temp. coefficient			-1.8		mV/°C	
	Reverse voltage	V_R	3.0	25		V	I_R = 10 μA
	Junction capacitance	C_J		50		pF	V_F = 0 V, f = 1 MHz
				65		pF	V_F = 1 V, f = 1 MHz
	Reverse leakage current	I_R		.35	10	μA	V_R = 3.0 V
OUTPUT TRANSISTOR	DC forward current gain	h_{FE}	100	500			V_{CE} = 5 V, I_C = 100 μA
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	70			V	I_C = 1.0 mA, I_F = 0
	Collector to base	BV_{CBO}	70			V	I_C = 10 μA
	Emitter to collector	BV_{ECO}	7			V	I_E = 100 μA, I_F = 0
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	V_{CE} = 10 V, I_F = 0
	Collector to base	I_{CBO}			20	nA	V_{CB} = 10 V, I_F = 0
	Capacitance						
	Collector to emitter			8		pF	V_{CE} = 0, f = 1 MHz
	Collector to base			20		pF	V_{CB} = 5, f = 1 MHz
	Emitter to base			10		pF	V_{EB} = 0, f = 1 MHz

ELECTRICAL CHARACTERISTIC CURVES (25° C Free Air Temperature Unless Otherwise Specified)

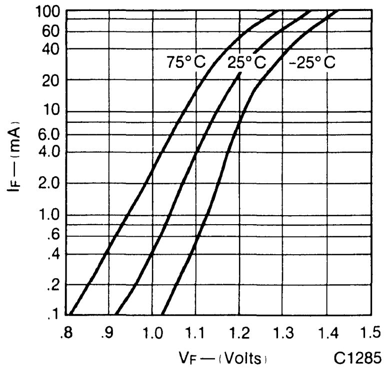


Fig. 1. Forward Voltage vs. Forward Current

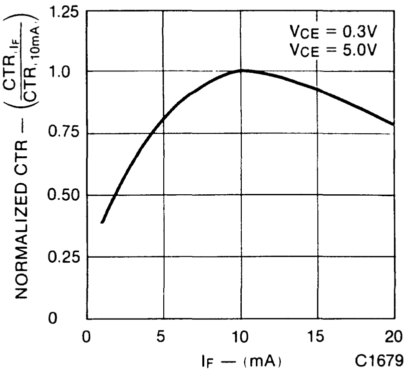


Fig. 2. Normalized Current Transfer Ratio vs. Forward Current

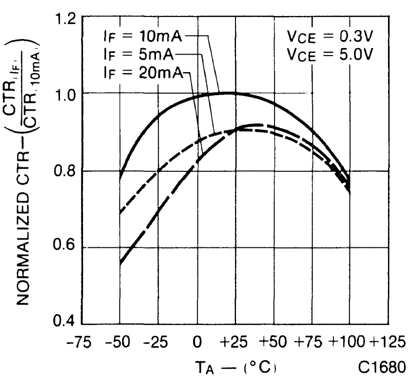


Fig. 3. Normalized Current Transfer Ratio vs. Ambient Temperature

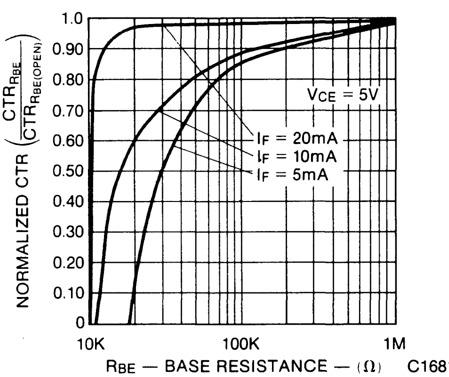


Fig. 4. C_{TR} vs. R_{BE}

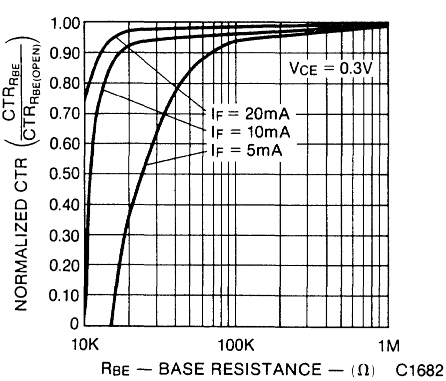


Fig. 5. C_{TR} vs. R_{BE}

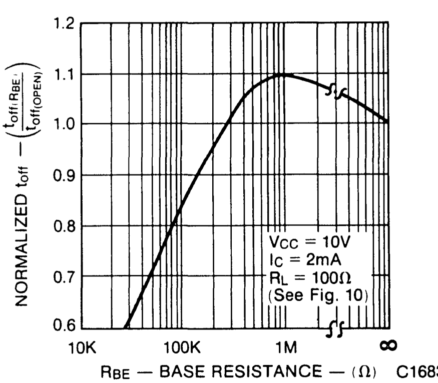


Fig. 6. Normalized t_{off} vs. R_{BE}

ELECTRICAL CHARACTERISTIC CURVES (25°C Free Air Temperature Unless Otherwise Specified)

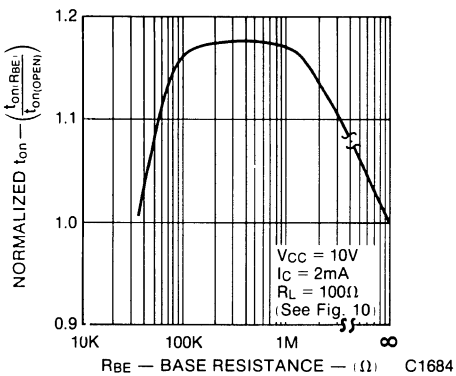


Fig. 7. Normalized t_{on} vs. R_{BE}

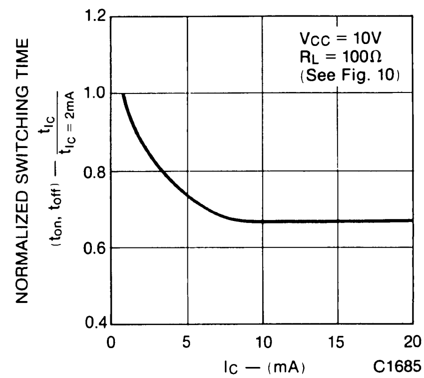
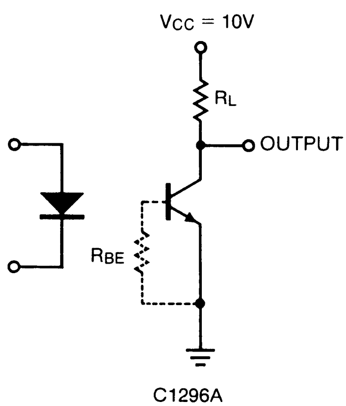


Fig. 8. Normalized Switching Time vs. Collector Current



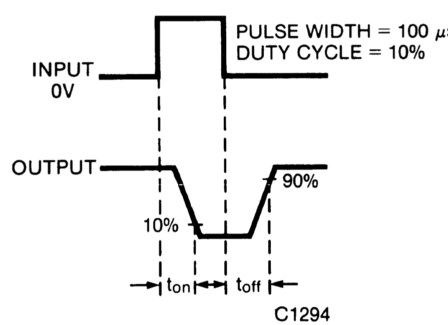


Fig. 9. Switching Time Test Circuit and Waveform

GENERAL INSTRUMENT

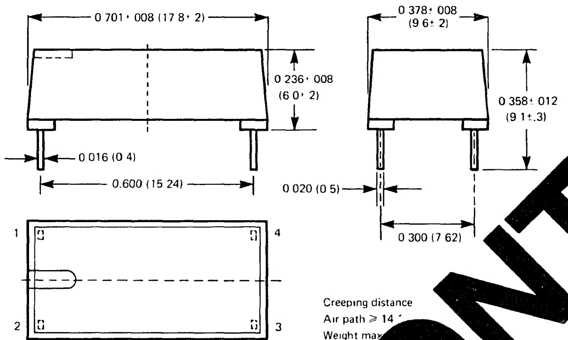
VDE APPROVED HIGH-VOLTAGE OPTOCOUPLER

Optocouplers

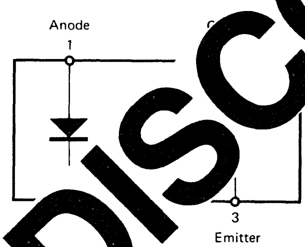
CNY65

DISCONTINUED

PACKAGE DIMENSIONS



Creeping distance
Air path ≥ 14 ...
Weight ma...



C1623

...quivalent Circuit

DESCRIPT...

The CNY6... which combines a GaAs L... ...ototransistor. This devic... ...ation voltage of 11.6 kV DC ... ...ved for continous 1000 VAC ...

...ES

- ...olation voltage 11.6 kV
- ...minal isolation operating voltage[2] 1000 VAC ...r 1200 VDC for isolation group B according to VDE 0110b/2.79
- Test class 25/100/21 DIN 40 045
- Low coupling capacity typ. 0.3. pF
- Current transfer ratio typ. 100%

APPLICATIONS

- Medical Instrumentation
- Industrial Controls
- Power supply monitor
- Solid state relays
- High frequency power supply feedback control
- AC line to digital logic isolation

ABSOLUTE MAXIMUM RATINGS

INPUT-LED CIRCUIT

Reverse Voltage 5V
Forward Current 75mA
Forward surge current (tp ≤10μs) 1.5A
Power dissipation (T_A ≤ 25°C) 120mW
Junction temperature . . . . 100°C

OUTPUT-DETECTOR CIRCUIT

Collector-emitter voltage 32V
Emitter-collector voltage 7V
Collector current 50mA
Peak collector current (tp/T = 0.5, tp ≤ 10ms) 100mA
Power dissipation (T_A ≤ 25°C) 130mW
Junction temperature . . . . 100°C

TOTAL PACKAGE

Storage temperature . . . . -55°C to +100°C
DC isolation voltage (t = 1 minute)[3] 11.6kV
Power dissipation (T_A ≤ 25°C) 250mW

ELECTRICAL CHARACTERISTICS (25° C Temperature Unless Otherwise Specified)

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	CONDITIONS
INPUT LED						
Forward Voltage	V_F *		1.25	1.6	V	I_F = 50mA
Reverse Breakdown Voltage	BV_R *	5			V	I_R = 100μA
Junction Capacitance	C_J		50		pF	[illegible] = 0, f = 1mHz
OUTPUT DETECTOR						
Collector-Emitter Breakdown Voltage	BV_{CEO} *	32			V	[illegible]
Emitter-Collector Breakdown Voltage	BV_{ECO} *	7			[illegible]	[illegible]0μA
Collector Leakage Current	I_{CEO} *		10	200	[illegible]	[illegible] $_{CE}$ = 20V
COUPLED CHARACTERISTICS						
Current Transfer Ratio	CTR*	50	100	[illegible]	[illegible]	I_F = 10mA, V_{CE} = 5V
Current Transfer Ratio	CTR*	60	[illegible]	[illegible]	[illegible]	I_F = 20mA, V_{CE} = 5V
Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$ *		[illegible]	[illegible]	V	I_F = 10mA, I_C = 1mA
DC Isolation Voltage[1]	V_{ISO} **	11.6			kV	t = 1 min.
Isolation Resistance	R_{ISO}		1[illegible]		Ω	V_{ISO} = 1000V, 40% R.H.
Isolation Capacitance	C_{ISO}		[illegible]		pF	f = 1mHz
Bandwidth	BW		[illegible]		kHz	I_F = 10mA, V_{CE} = 5V, R_L = 100Ω

* AQL = 0.65%
** AQL = 2.5%
1 Related to standard climate 23/50 D[illegible]

DISCONTINUED

SWITCHING CHARAC[illegible]

CHARACTERISTIC[illegible]	SYMBOL	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Delay time	[illegible]		2.5		μs	
Rise time	[illegible]r		4.5		μs	V_{CC} = 5V,
Turn-on tim[illegible]	t_{on}		7.0		μs	I_C = 5mA,
Storage-t[illegible]	t_s		0.3		μs	R_L = 100Ω
Fall time	t_f		3.7		μs	See test circuit.
Turn-off tim[illegible]	t_{off}		4.0		μs	

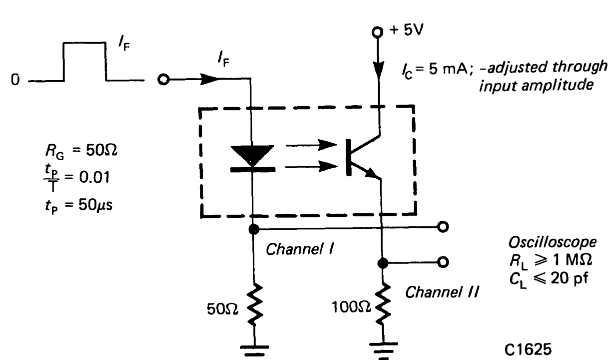


Fig. 2. Switching Time Test Circuit

TYPICAL ELECTRICAL CHARACTERISTIC CURVES (25° C Free Air Temperature Unless Otherwise Specified)

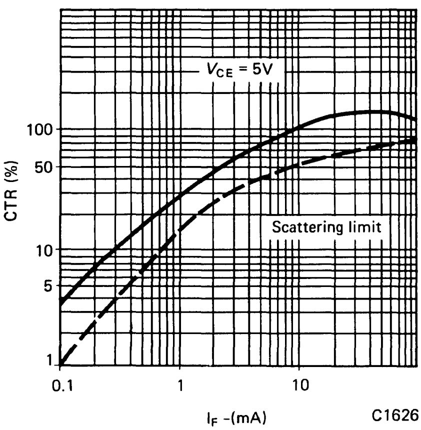


Fig. 3. Current Transfer Ratio vs. Forward Current

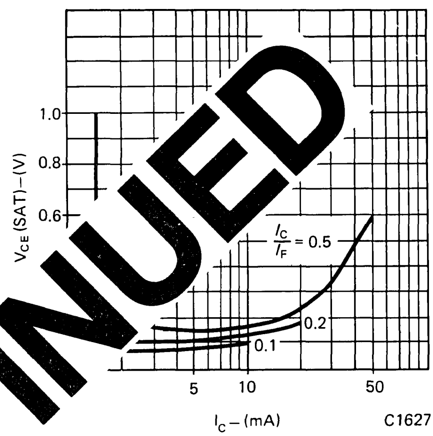


Fig. 4. V_{CE} (SAT) vs. Collector Current

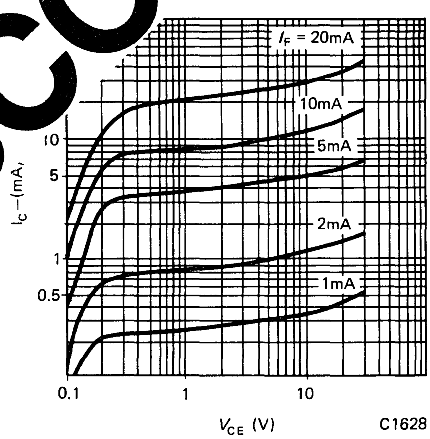


Fig. 5. Collector Current vs. Collector Voltage

NOTES

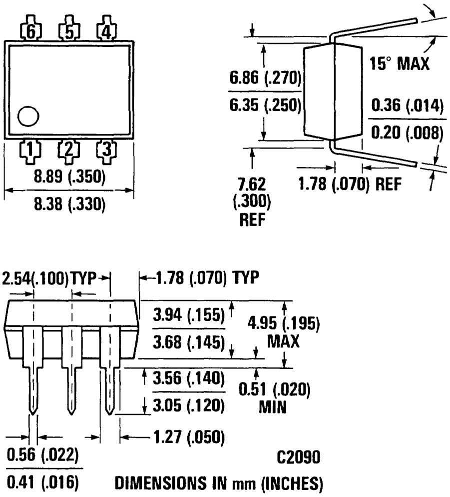
1. *Creeping current resistance: Group III (KB>600–KC>600) according to VDE 0110b/2.79 table 3 and DIN 53 480/VDE 0303 part 1/10.76.*
2. *According to VDE test certificate dated 3/19/82.*
3. *Related to standard climate 23/50 DIN 50 014.*

GENERAL INSTRUMENT

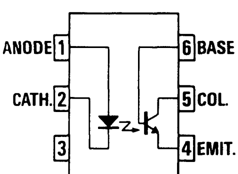
VDE APPROVED TRANSISTOR OUTPUT OPTOCOUPLER

H11A1
H11A1Z

PACKAGE DIMENSIONS



C2090
DIMENSIONS IN mm (INCHES)



C2079

Equivalent Circuit

DESCRIPTION

The H11A1 is a phototransistor-type optically coupled isolator. An infrared emitting diode manufactured from specially grown gallium arsenide is selectively coupled with an NPN silicon phototransistor in a standard plastic six-pin dual-in-line package.

FEATURES

- High isolation voltage
  5300 VAC RMS — 5 seconds
  7500 VAC PEAK — 5 seconds
- Minimum current transfer ratio of 50%
- Underwriters Laboratory (UL) recognized
  File #E50151
- VDE approval Certificate 39 419 for H11A1Z

APPLICATIONS

- Power supply regulators
- Digital logic inputs
- Microprocessor inputs
- Appliance sensor systems
- Industrial controls

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

TOTAL PACKAGE

Storage temperature	-55° C to 150° C
Operating temperature	-55° C to 100° C
Lead temperature (Soldering, 10 sec)	260° C
Total package power dissipation at 25° C (LED plus detector)	260 mW
Derate linearly from 25° C	3.5 mW/° C

INPUT DIODE

Forward DC current	60 mA
Reverse voltage	6 V
Peak forward current (1 μs pulse, 300 pps)	3.0 A
Power dissipation 25° C ambient	100 mW
Derate linearly from 25° C	1.8 mW/° C

OUTPUT TRANSISTOR

Power dissipation at 25° C	150 mW
Derate linearly from 25° C	2.67 mW/° C
V_{CEO}	30 V
V_{CBO}	70 V
V_{ECO}	7 V
Collector current (continuous)	100 mA

ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

	TRANSFER CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current Transfer Ratio collector to emitter	CTR	50				I_F = 10 mA, V_{CE} = 10 V
	Saturation voltage	$V_{CE(SAT)}$		0.1	0.4	V	I_F = 10 mA, I_C = 0.5 mA
SWITCHING TIMES	Non-saturated						
	Turn-on time	t_{on}		2		μs	(V_{CE} = V, I_{CE} 2 mA, R_L = 100 Ω) See Figure 9
	Turn-off time	t_{off}		2		μs	
	Non-saturated						
	Turn-on time	t_{on}		300		ns	(V_{CB} = 10 V, I_{CB} 50 μA, R_L = 100 Ω) See Figure 9
	Turn-off time	t_{off}		300		ns	
ISOLATION	Isolation voltage	V_{ISO}	5300			V_{AC} RMS	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA, 5 seconds
			7500			V_{AC} PEAK	Relative humidity ≤ 50% I_{I-O} ≤ 10 μA, 5 seconds
	Isolation resistance	R_{ISO}	10^{11}			ohms	V_{I-O} = 500 VDC
	Isolation capacitance	C_{ISO}		0.5		pF	f = 1 MHz

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.1	1.50	V	I_F = 10 mA
	Forward voltage temperature coefficient			-1.8		mV/°C	
	Reverse voltage	V_R	3.0	25		V	I_R = 10 μA
	Junction capacitance	C_J		50		pF	V_F = 0 V, f = 1 MHz
				65		pF	V_F = 1 V, f = 1 MHz
	Reverse leakage current	I_R		0.35	10	μA	V_R = 3.0 V
OUTPUT TRANSISTOR	Breakdown voltage						
	Collector to emitter	BV_{CEO}	30	45		V	I_C = 10 mA, I_F - 0
	Collector to base	BV_{CBO}	70	130		V	I_C = 100 μA, I_F = 0
	Emitter to collector	BV_{ECO}	7	10		V	I_E = 100 μA, I_F = 0
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	V_{CE} = 10 V, I_F = 0
	Collector to base	I_{CBO}			20	nA	V_{CB} = 10 V, I_F = 0
	Capacitance						
	Collector to emitter			8		pF	V_{CE} = 0, f = 1 MHz
	Collector to base			20		pF	V_{CB} = 5, f = 1 MHz
	Emitter to base			10		pF	V_{EB} = 0, f = 1 MHz

ELECTRICAL CHARACTERISTIC CURVES (T_A = 25°C Unless Otherwise Specified)

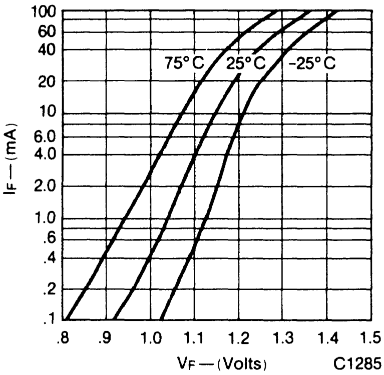


Fig. 1. Forward Voltage vs. Forward Current

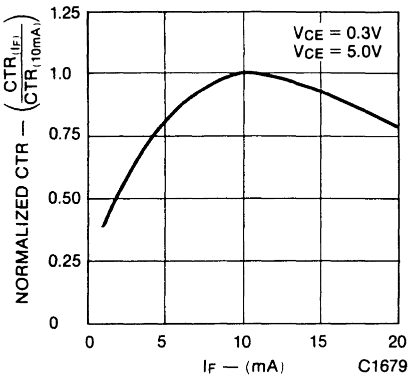


Fig. 2. Normalized Current Transfer Ratio vs. Forward Current

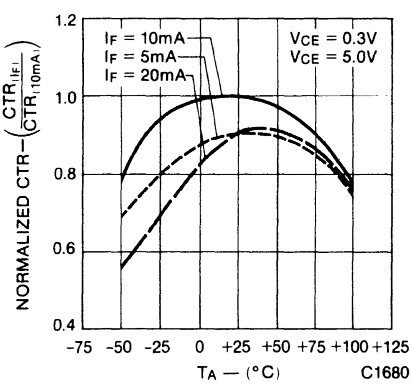


Fig. 3. Normalized Current Transfer Ratio vs. Ambient Temperature

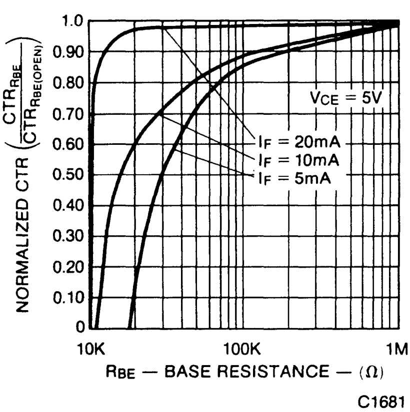


Fig. 4. C_{TR} vs. R_{BE}

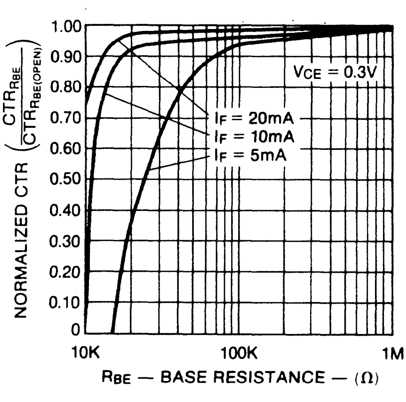


Fig. 5. C_{TR} vs. R_{BE}

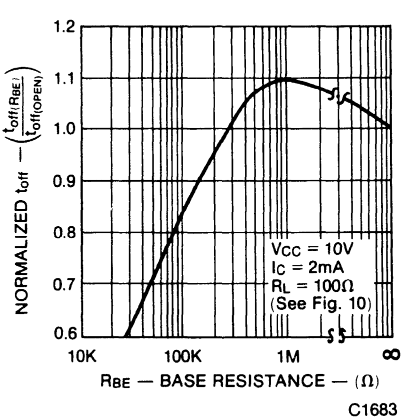


Fig. 6. Normalized t_{off} vs. R_{BE}

ELECTRICAL CHARACTERISTIC CURVES (TA = 25° C Unless Otherwise Specified)

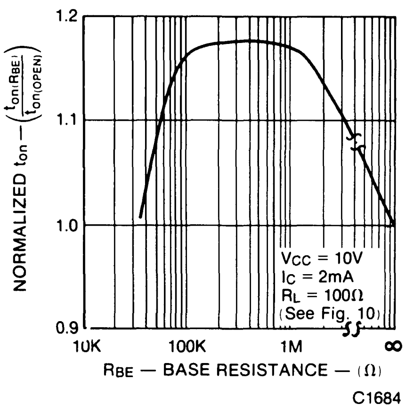


Fig. 7. Normalized t_{on} vs. R_{BE}

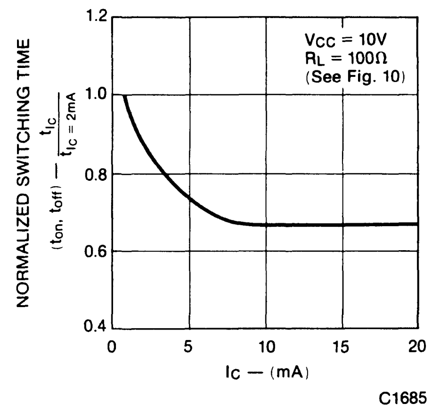


Fig. 8. Normalized Switching Time vs. Collector Current

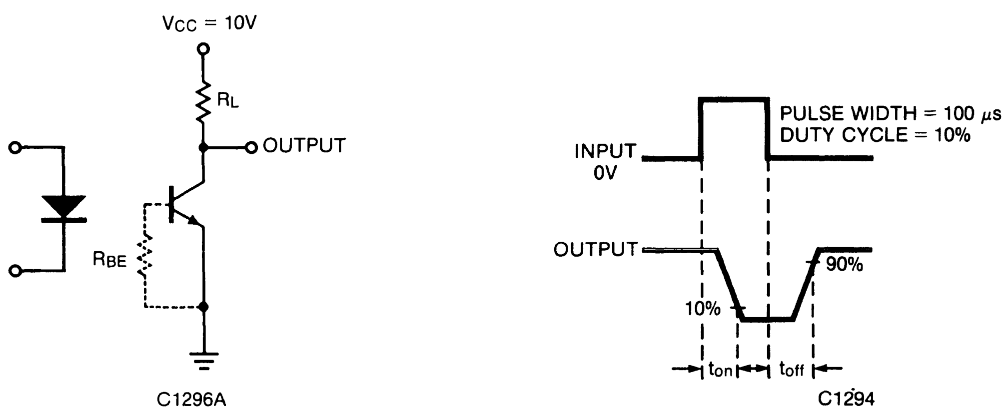


Fig. 9. Switching Time Test Circuit and Waveform

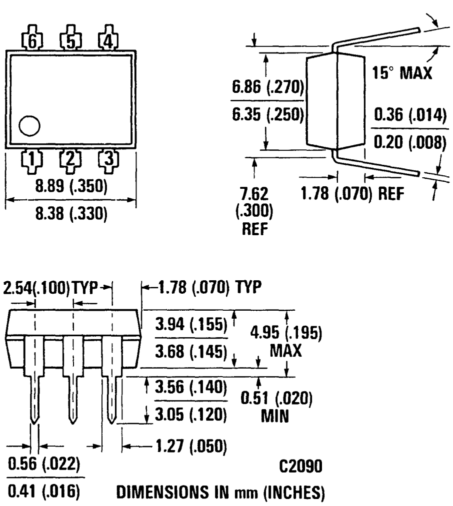
PRELIMINARY DATA SHEET

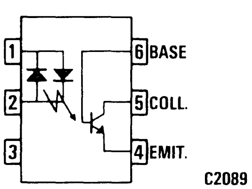
GENERAL INSTRUMENT

AC INPUT/PHOTOTRANSISTOR OPTOCOUPLERS

H11AA1 H11AA3
H11AA2 H11AA4

PACKAGE DIMENSIONS





Equivalent Circuit

DESCRIPTION

The H11AAX family of devices has two GaAs emitters connected in inverse parallel driving a single silicon phototransistor output.

FEATURES

- Bi-polar emitter input
- Built-in reverse polarity input protection
- UL recognized (File #50151)

APPLICATIONS

- AC line monitor
- Unknown polarity DC sensor

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature .... -55°C to 150°C
Operating temperature .... -55°C to 100°C
Lead temperature (soldering, 10 sec.) .... 260°C

INPUT DIODE

Forward current .... 60 mA RMS
Peak forward current (1 μs pulse, 300 pps) ... ±1.0 A
Power dissipation .... 100 mW
Derate linearly from 25°C .... 1.33 mW/°C

OUTPUT TRANSISTOR

Power dissipation .... 300 mW
Derate linearly from 25°C .... 4.0 mW/°C

ISOLATION AND INSOLATION (T_A = 25°C Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Package capacitance input/output	C_{I-O}		0.7		pF	V_{I-O} = 0, f = 1 MHz
Withstand insulation test voltage	V_{ISO}	2500			$V_{AC(RMS)}$	Relative humidity ≤ 50% $I_{I-O} \leq 10\ \mu A$ 1 minute
Insulation resistance	R_{ISO}	10^{11}			Ohms	V_{I-O} = 500 V

INDIVIDUAL COMPONENT CHARACTERISTICS (T_A = 25°C Unless Otherwise Specified)

	CHARACTERISTIC	SYMBOL	DEVICE	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F V_F	H11AA1,3,4 H11AA2		1.3	1.5 1.8	V V	$I_F = \pm10$ mA $I_F = \pm10$ mA
	Forward voltage coefficient	$\Delta V_F/\Delta T_A$	ALL		-1.9		mV/°C	I_F = 2 mA
	Junction capacitance	C_J	ALL		18		pF	V_F = 0 V, f = 1 MHz
OUTPUT TRANSISTOR	Breakdown voltage Collector to emitter Collector to base Emitter to base	BV_{CEO} BV_{CBO} BV_{EBO}	ALL	30 70 5			V V V	I_C = 10 mA, I_F = 0 $I_C = 100\ \mu A$, I_F = 0 $I_C = 100\ \mu A$, I_F = 0
	Leakage current	I_{CEO} I_{CEO}	H11AA1,3,4 H11AA2			100 200	nA nA	V_{CE} = 10 V, I_F = 0 V_{CE} = 10 V, I_F = 0
	Capacitance Collector to emitter Collector to base Emitter to base	C			10 80 15		pF pF pF	V_{CE} = 0, f = 1 MHz V_{CB} = 0, f = 1 MHz V_{EB} = 0, f = 1 MHz

TRANSFER CHARACTERISTICS
(T_A = 25°C Unless Otherwise Specified)

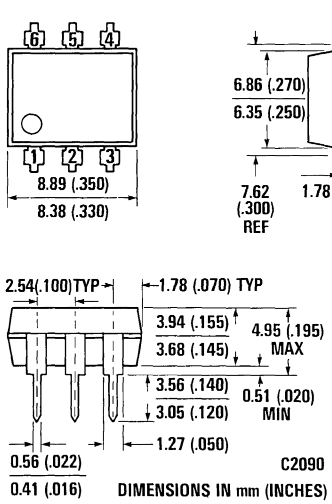
CHARACTERISTIC	SYMBOL	DEVICE	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Current transfer ratio (Collector-Emitter)	CTR_{CE}	H11AA4	100			%	$I_F = \pm10$ mA, V_{CE} = 10 V
		H11AA3	50				$I_F = \pm10$ mA, V_{CE} = 10 V
		H11AA1	20				$I_F = \pm10$ mA, V_{CE} = 10 V
		H11AA2	10				$I_F = \pm10$ mA, V_{CB} = 10 V
Current transfer ratio symmetry		H11AA1,3,4	0.33		3.0		$I_F = \pm10$ mA, V_{CE} = 10 V
Saturation voltage (Collector-Emitter)	$V_{CE\ SAT}$	ALL			0.4	V	$I_F = \pm10$ mA, I_{CE} = 0.5 mA

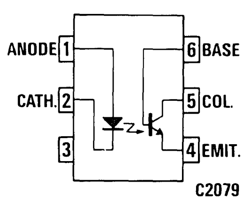
GENERAL INSTRUMENT

HIGH-VOLTAGE VDE APPROVED PHOTOTRANSISTOR OPTOCOUPLERS

H11D1/1Z
H11D2/2Z
H11D3/3Z

PACKAGE DIMENSIONS





Equivalent Circuit

DESCRIPTION

The H11DX is a phototransistor-type optically coupled isolator. An infrared emitting diode manufactured from specially grown gallium arsenide is selectively coupled with an NPN silicon phototransistor. The device is supplied in a standard plastic six-pin dual-in-line package.

FEATURES

- High voltage
  H11D1-D2, BV_{CER} = 300 V
  H11D3, BV_{CER} = 200 V
- High isolation voltage
  5300 VAC RMS — 5 seconds
  7500 VAC PEAK — 5 seconds
- Minimum current transfer ratio of
  H11D1, H11D2, H11D3—20%
- Underwriters Laboratory (UL) recognized
  File #E50151

APPLICATIONS

- Power supply regulators
- Digital logic inputs
- Microprocessor inputs
- Appliance sensor systems
- Industrial controls

ABSOLUTE MAXIMUM RATINGS (T_A=25° C Unless Otherwise Specified)

TOTAL PACKAGE

Storage temperature	-55° C to 150° C
Operating temperature	-55° C to 100° C
Lead temperature (Soldering, 10 sec)	260° C
Total package power dissipation at 25° C (LED plus detector)	260° mW
Derate linearly from 25° C	3.5mW/° C

INPUT DIODE

Forward DC current	60 mA
Reverse voltage	6 V
Peak forward current (1μs pulse, 300 pps)	3.0 A
Power dissipation 25° C ambient	100 mW
Derate linearly from 25° C	1.8 mW/° C

OUTPUT TRANSISTOR

Power dissipation at 25° C	300 mW
Derate linearly from 25° C	4.0 mW/° C

	H11D1-D2	H11D3
V_{CER}	300 V	200 V
V_{CBO}	300 V	200 V
V_{ECO}	6 V	6 V
Collector current (continuous)	100 mA	100 mA

ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

	TRANSFER CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current Transfer Ratio, collector to emitter	CTR					I_F = 10 mA; V_{CE} = 10V
	H11D1, H11D2, H11D3		20			%	R_{BE} = 1 meg
			10			%	
	Saturation voltage	$V_{CE(SAT)}$		0.1	.40	V	I_F = 10 mA; I_C = 0.5mA R_{BE} = 1 meg
SWITCHING TIMES	Non-saturated						
	Turn-on	t_{on}		5		μs	V_{CE} = 10V, I_{CE} = 2mA, R_L = 100Ω
	Turn-off time	t_{off}		5		μs	
ISOLATION	Isolation Voltage	*V_{ISO}	5300			V_{AC}RMS	Relative humidity≤50% I_{I-O} ≤ 10 μA, 5 seconds
		*V_{ISO}	7500			V_{AC} PEAK	Relative humidity ≤50% I_{I-O} ≤ 10 μA, 5 seconds
	Isolation resistance	R_{ISO}	10^{11}			ohms	V_{I-O} = 500 VDC
	Isolation capacitance	C_{ISO}		0.5		pF	f = 1 MHz

Additional specification for General Instrument devices.

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.1	1.50	V	I_F = 10 mA
	Forward voltage temp. coefficient			-1.8		mV/° C	
	Reverse breakdown voltage	V_R	3.0	25		V	I_R = 10 μA
	Junction capacitance	C_J		50		pF	V_F = 0 V, f = 1 MHz
				65		pF	V_F = 1 V, f = 1 MHz
	Reverse leakage current	I_R		0.35	10	μA	V_R = 3.0 V
OUTPUT TRANSISTOR	Breakdown voltage						
	Collector to emitter	BV_{CER}					
	H11D1, H11D2,		300			V	I_C = 1 mA; I_F = 0,
	H11D3		200			V	R_{BE} = 1 meg
	Collector to base	BV_{CBO}					
	H11D1, H11D2,		300			V	I_C = 100μA; I_F = 0
	H11D3		200			V	
	Emitter to base	BV_{EBO}	5	7		V	I_E = 100μA, I_F = 0
	Leakage current						
	Collector to emitter	I_{CER}					R_{BE} = 1 meg.
	H11D1, H11D2,				100	nA	V_{CE} = 200V; I_F = 0; T_A=25° C
					250	μA	V_{CE} = 200V; I_F=0; T_A=100° C
	H11D3	I_{CER}			100	nA	V_{CE} = 100V; I_F = 0; T_A=25° C
					250	μA	V_{CE} = 100V; I_F=0; T_A=100° C

TYPICAL CHARACTERISTICS

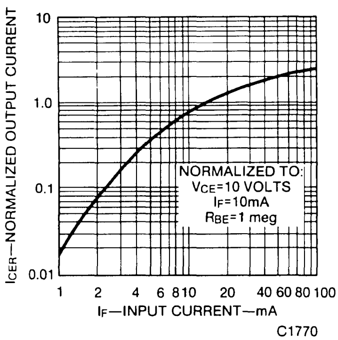


Fig. 1. Output Current vs. Input Current

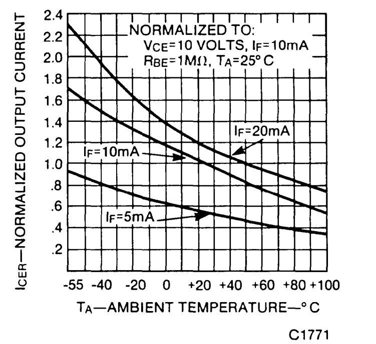


Fig. 2. Output Current vs. Temperature

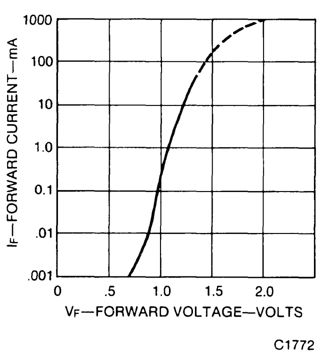


Fig. 3. Input Characteristics

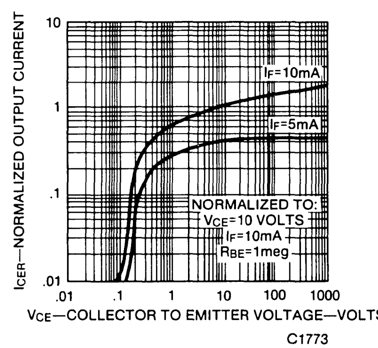


Fig. 4. Output Characteristics

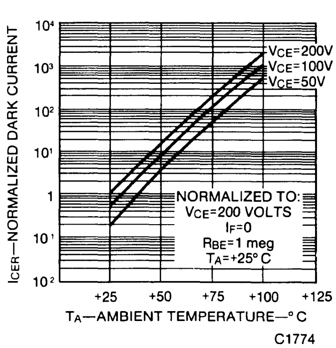


Fig. 5. Normalized Dark Current vs. Temperature

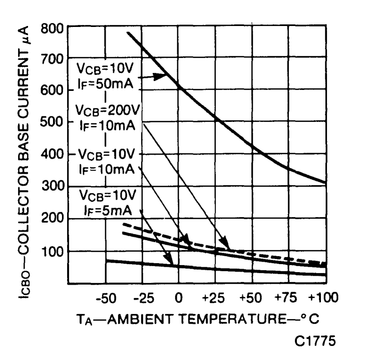


Fig. 6. Collector Base Current vs. Temperature

Optocouplers

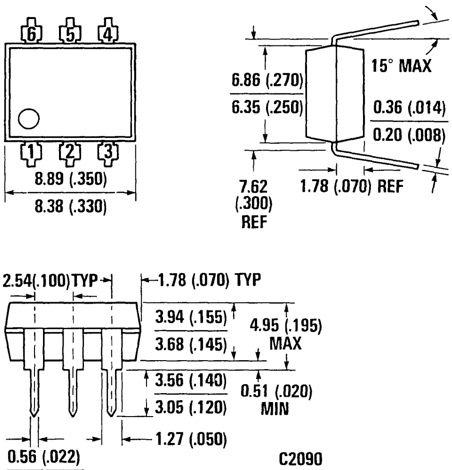
GENERAL INSTRUMENT

HIGH VOLTAGE PHOTODARLINGTON OPTOCOUPLERS

Optocouplers

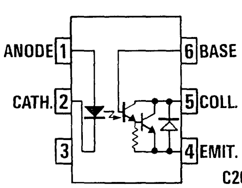
MCA11G1 (H11G1)
MCA11G2 (H11G2)
MCA11G3 (H11G3)

PACKAGE DIMENSIONS



C2090

DIMENSIONS IN mm (INCHES)



C2083

Equivalent Circuit

DESCRIPTION

The MCA11G1 and MCA11G2 are photodarlington-type optically coupled optoisolators. Both devices have a gallium arsenide infrared emitting diode coupled with a silicon darlington connected phototransitor which has an integral base-emitter resistor to optimize elevated temperature characteristics.

FEATURES

- High BV_{CEO}
  Minimum 100V for MCA11G1
  Minimum 80V for MCA11G2
- Pin for pin replacement for H11G1, H11G2, H11G3
- High sensitivity to low input current—Minimum 500 percent CTR at I_F = 1 mA
- High isolation voltage
  2500 VAC RMS—Steady State Rating
- Low leakage current at elevated temperature (maximum 100 μA at 80° C).
- Underwriters Laboratory (UL) recognized File #50151

APPLICATIONS

- CMOS logic interface
- Telephone ring detector
- Low input TTL interface
- Power supply isolation
- Replace pulse transformer

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature ....-55° C to 150° C
Operating temperature...........-55° C to 100° C
Lead temperature
(Soldering, 10 sec.)...................... 260° C
Total package power dissipation @ 25° C
(LED plus detector) .... 260 mW
Derate linearly from 25° C ....3.5 mW/° C
Isolation voltage .... 2.5 kV RMS

INPUT DIODE

Forward DC current .... 60 mA
Reverse voltage .... 6 V
Peak forward current (1 μs pulse, 300 pps) .. 3.0 A
Power dissipation 25° C ambient .... 100 mW
Derate linearly from 25° C .... 1.8 mW/° C

OUTPUT TRANSISTOR

Power dissipation @ 25° C .... 200 mW
Derate linearly from 25° C ....2.67 mW/° C
Collector to emitter voltage
MCA11G1 ....100 V
MCA11G2 .... 80 V
MCA11G3 .... 55 V

ELECTRO-OPTICAL CHARACTERISTICS (25° C Temperature Unless Otherwise Specified)

	TRANSFER CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current Transfer Ratio collector to emitter	CTR					
	MCA11G1/2		1000			%	I_F = 10 mA; V_{CE} = 1 V
	MCA11G1/3		500			%	I_F = 1 mA; V_{CE} = 5 V
	MCA11G3		200			%	I_F = 1 mA; V_{CE} = 5 V
	Saturation voltage	$V_{CE(SAT)}$		0.85	1.0	V	I_F = 16 mA; I_C = 50 mA
				0.75	1.0	V	I_F = 1 mA; I_C = 1 mA
SWITCHING TIMES	Turn-on time	t_{on}		5		μs	R_L = 100Ω; I_F = 10 mA
	Turn-off time	t_{off}		100		μs	V_{CE} = 5V Pulse width ≤ 300 μsec, f ≤ 30 Hz
ISOLATION	Surge isolation	V_{iso}	4000			VDC	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA
			3000			VAC-rms	1 second
	Steady state isolation	V_{iso}	3500			VDC	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA
			2500			VAC-rms	1 minute
	Isolation resistance	R_{iso}	10^{11}			ohms	V_{I-O} = 500 VDC
	Isolation capacitance	C_{iso}		0.5		pF	f = 1 MHz

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.3	1.50	V	I_F = 10 mA
	Forward voltage temp. coefficient			-1.8		mV/°C	
	Reverse breakdown voltage	BV_R	3.0	25		V	I_R = 10 μA
	Junction capacitance	C_J		50		pF	V_F = 0 V, f = 1 MHz
				65		pF	V_F = 1 V, f = 1 MHz
	Reverse leakage current	I_R		0.35	10	μA	V_R = 3.0 V
OUTPUT DARLINGTON	Breakdown voltage						
	Collector to emitter	BV_{CEO}					
	MCA11G1		100			V	I_C = 1.0 mA, I_F = 0
	MCA11G2		80				
	MCA11G3		55				
	Collector to base	BV_{CBO}					
	MCA11G1		100			V	I_C = 100 μA
	MCA11G2		80				
	MCA11G3		55				
	Emitter to base	BV_{EBO}	7	10		V	I_E = 100 μA, I_F = 0
	Leakage current						
	Collector to emitter	I_{CEO}					
	MCA11G1				100	nA	V_{CE} = 80 V, I_F = 0
	MCA11G2				100	nA	V_{CE} = 60 V, I_F = 0
	MCA11G1				100	μA	V_{CE} = 80 V, I_F = 0, T_A = 80° C
	MCA11G2				100	μA	V_{CE} = 60 V, I_F = 0, T_A = 80° C
	MCA11G3				100	μA	V_{CE} = 30 V, I_F = 0,

TYPICAL ELECTRICAL CHARACTERISTIC CURVES
(25° C Free Air Temperature Unless Otherwise Specified)

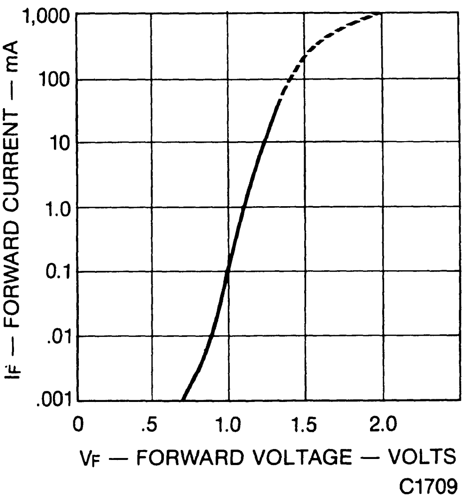


Fig. 1. Forward Voltage vs. Forward Current

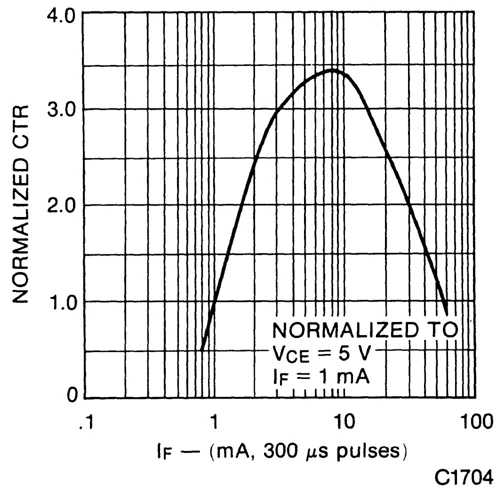


Fig. 2. Normalized CTR vs. Input Current

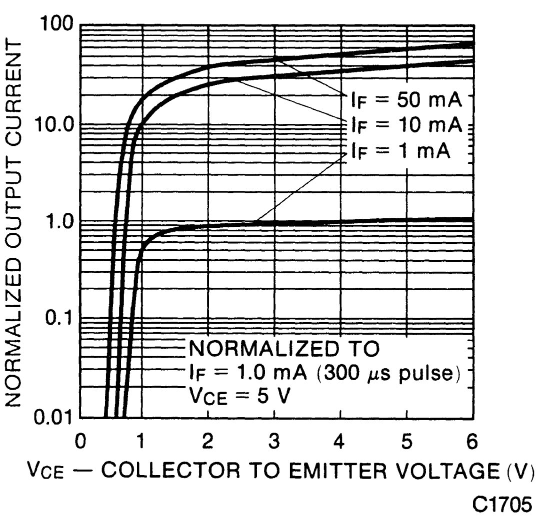


Fig. 3. Output Characteristics

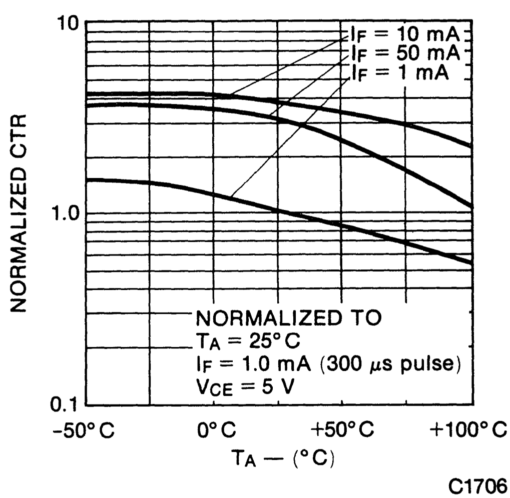


Fig. 4. Normalized CTR vs. Temperature

TYPICAL ELECTRICAL CHARACTERISTIC CURVES (Cont'd)

(25° C Free Air Temperature Unless Otherwise Specified)

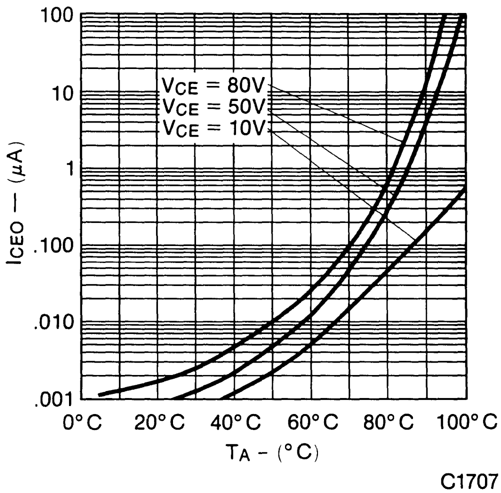


Fig. 5. Dark Current vs. Temperature

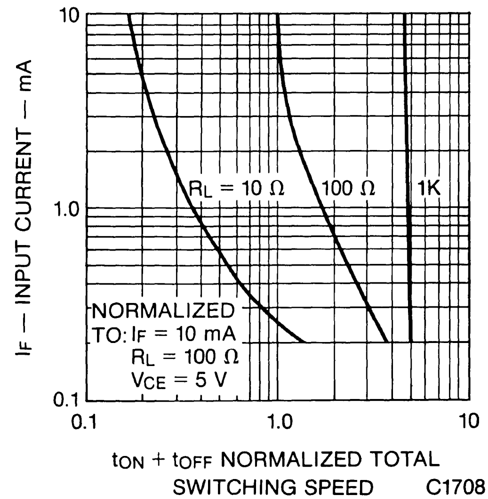


Fig. 6. Switching Speed

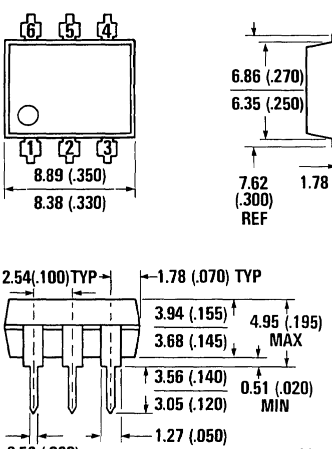
GENERAL INSTRUMENT

PHOTODARLINGTON OPTOCOUPLERS

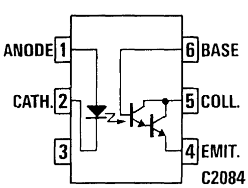
Optocouplers

MCA230
MCA231
MCA255

PACKAGE DIMENSIONS



DIMENSIONS IN mm (INCHES)



Equivalent Circuit

DESCRIPTION

The MCA230, MCA231 and MCA255 are photodarlington optically coupled isolators. An infrared emitting diode coupled with a silicon photodarlington transistor. The device is supplied in a standard plastic six-pin dual-in-line package.

FEATURES

- High current transfer ratio
  MCA230/255 - 100% min.
  MCA231/ - 200% min.
- Underwriters Laboratory (UL) recognized file #E50151
- 55 volt BV_{CEO} for MCA255

APPLICATIONS

- Replace reed relays for 50 mA, 55 V DC loads
- Replace pulse transformers
- Form multiple contact, NO/NC relays
- Useful for telephone lines, SCR triggers, hospital monitoring systems, airborne systems, remote data gathering systems and remote control systems.
- Use a low-current alarm monitor for battery powered supplies.

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C Unless Otherwise Specified)

TOTAL PACKAGE

Storage temperature	-55°C to 150°C
Operating temperatue	-55°C to 100°C
Lead temperature (soldering, 10 sec.)	260°C
Total package power dissipation at 25°C (LED plus detector)	260 mW
Derate linearly from 25°C	3.5 mW/°C

DETECTOR

Power dissipation	210 mW
Derate linearly from 25°C	2.8 mW/°C
Collector-emitter breakdown voltage (BV_{CEO})	
MCA230	30 V
MCA231	30 V
MCA255	55 V
Collector-base breakdown voltage (BV_{CBO})	
MCA230	30 V
MCA231	30 V
MCA255	55 V
Emitter-collector breakdown voltage (BV_{ECO})	7 V

INPUT DIODE

Forward DC Current	60 mA
Reverse voltage	6 V
Peak forward current (1 μs pulse, 300 pps)	3.0 A
Power dissipation	135 mW
Derate linearly from 25°C	1.8 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

	TRANSFER CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	DC current transfer ratio (Collector-emitter)						
	MCA230, MCA255	CTR	100			%	I_F = 10 mA, V_{CE} = 5 V
	MCA231	CTR	200			%	I_F = 10 mA, V_{CE} = 5 V
	Saturation voltage						
	MCA230, MCA255	$V_{CE(SAT)}$			1.0	V	I_C = I_F = 50 mA
	MCA231	$V_{CE(SAT)}$			1.0	V	I_C = 2 mA, I_F = 1 mA
					1.0	V	I_C = 10 mA, I_F = 5 mA
					1.2	V	I_C = 50 mA, I_F = 10 mA
SWITCHING TIME	Non saturated						
	Turn-on time	t_{on}		10		μs	See switching time
	Turn-off time	t_{off}		100		μs	Test circuit (Fig. 7)
ISOLATION	Surge insulation voltage	V_{iso}	3550			VDC	Relative humidity ≤ 50% T_A = +25°C, I_{I-O} ≤ 10 μA
			2500			VAC-rms	1 second
	Dielectric withstand test voltage	V_{iso}	3150			VDC	Relative humidity ≤ 50% T_A = +25°C, I_{I-O} ≤ 10 μA
			2250			VAC-rms	1 minute
	Isolation resistance	R_{iso}	10^{11}			ohms	V_{I-O} = 500 VDC, T_A = +25°C
	Package capacitance (input-output)	C_{iso}		0.5		pF	f = 1 MHz

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.2	1.50	V	I_F = 20 mA
	Forward voltage temp. coefficient			-1.8		mV/°C	
	Reverse voltage	V_R	3.0	25		V	I_R = 10 μA
	Junction capacitance	C_J		50		pF	V_F = 0V, f = 1 MHz
OUTPUT DETECTOR	Breakdown voltage						
	Collector to emitter						
	MCA230	BV_{CEO}	30			V	I_C = 100 μA, I_F = 0
	MCA231	BV_{CEO}	30			V	I_C = 100 μA, I_F = 0
	MCA255	BV_{CEO}	55			V	I_C = 100 μA, I_C = 0
	Collector to base						
	MCA230	BV_{CBO}	30			V	I_C = 10 μA, I_F = 0
	MCA231	BV_{CBO}	30			V	I_C = 10 μA, I_F = 0
	MCA255	BV_{CBO}	55			V	I_C = 10 μA, I_F = 0
	Emitter to base	BV_{EBO}	5			V	I_E = 10 μA, I_F = 0
	Collector dark current	I_{CEO}			100	nA	V_{CE} = 10 V, I_F = 0

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25°C Unless Otherwise Specified)

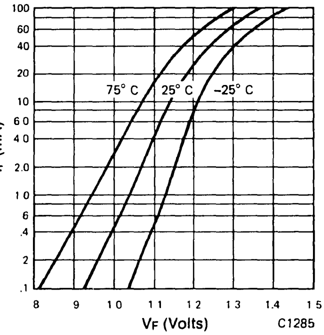


Fig. 1. Forward Voltage vs. Forward Current

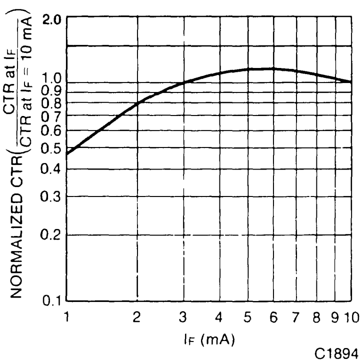


Fig. 2. Normalized CTR vs. I_F

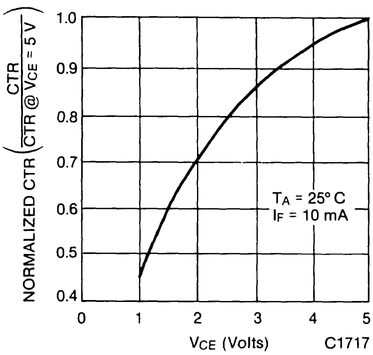


Fig. 3. Normalized CTR vs V_{CE}

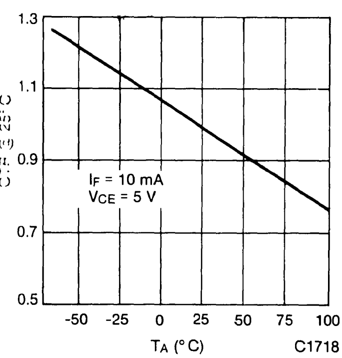


Fig. 4. Normalized CTR vs. Temperature

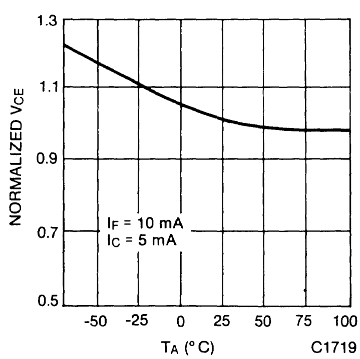


Fig. 5. Normalized V_{CE} vs. Temperature

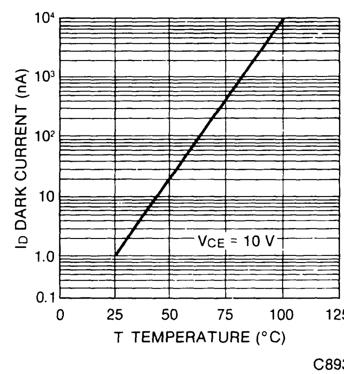


Fig. 6. Dark Current vs. Temperature

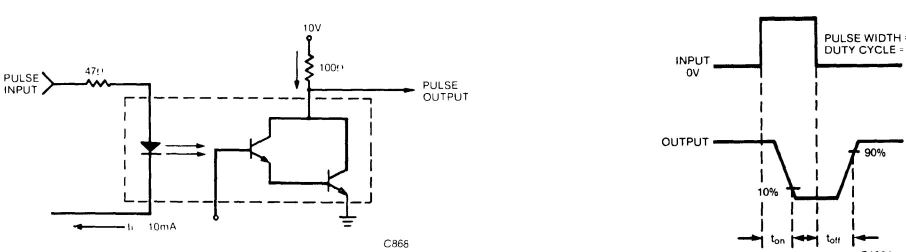


Fig. 7. Switching Time Test Circuit

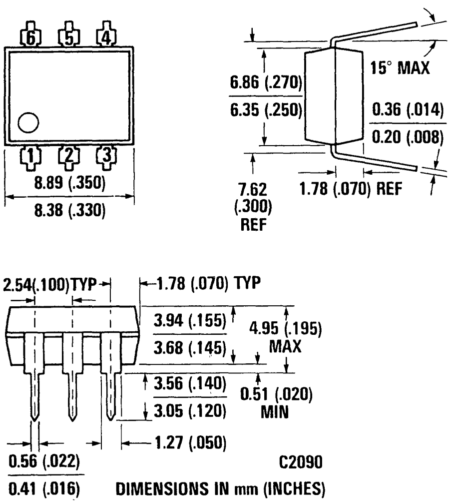
GENERAL INSTRUMENT

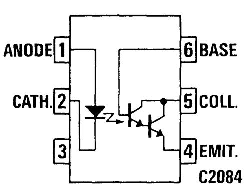
VDE APPROVED PHOTODARLINGTON OPTOCOUPLERS

Optocouplers

MCA2230Z
MCA2231Z
MCA2255Z

PACKAGE DIMENSIONS





Equivalent Circuit

DESCRIPTION

The MCA2230, MCA2231 and MCA2255 are photodarlington optically coupled isolators. An infrared emitting diode coupled with a silicon photodarlington transistor. The device is supplied in a standard plastic six-pin dual-in-line package.

FEATURES

- High-isolation voltage
  5300 VAC RMS — 5 seconds
  7500 VAC PEAK — 5 seconds
- High current transfer ratio
  MCA2230 —100% min
  MCA2231, 2255—500% min
- Underwriters Laboratory (UL) recognized file #E50151
- 55 volt BV_{CEO} for MCA2255

APPLICATIONS

- Replace reed relays for 50 mA, 55 V DC loads
- Replace pulse transformers
- Form multiple contact, NO/NC relays
- Useful for telephone lines, SCR triggers, hospital monitoring systems, airborne systems, remote data gathering systems and remote control systems.
- Use a low-current alarm monitor for battery powered supplies.

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

TOTAL PACKAGE

Storage temperature .... -55° C to 150° C
Operating temperature .... -55° C to 100° C
Lead temperature (Soldering, 10 sec) .... 260° C
Total package power dissipation @ 25° C
(LED plus detector) .... 260 mW
Derate linearly from 25° C .... 3.5 mW/° C

DETECTOR

Power dissipation @ 25° C ambient .... 210 mW
Derate linearly from 25° C .... 2.8 mW/° C
Collector-emitter breakdown voltage (BV_{CEO})
MCA2230 .... 30 V
MCA2231 .... 30 V
MCA2255 .... 55 V
Collector-base breakdown voltage (BV_{CBO})
MCA2230 .... 30 V
MCA2231 .... 30 V
MCA2255 .... 55 V
Emitter-base breakdown voltage (BV_{EBO}) .... 6 V

INPUT DIODE

Forward DC Current .... 60 mA
Reverse voltage .... 6 V
Peak forward current (1 μs pulse, 300 pps) ..... 3.0 A
Power dissipation 25° C ambient .... 135 mW
Derate linearly from 25° C .... 1.8 mW/° C

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25°C$ Unless Otherwise Specified)

	TRANSFER CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	DC current transfer ratio (Collector-emitter)						
	MCA2230	CTR	100			%	I_F = 10 mA, V_{CE} = 5 V
	MCA2231, MCA2255	CTR	500			%	I_F = 10mA, V_{CE} = 5 V
			200			%	I_F = 1mA, V_{CE} = 1 V
	Saturation voltage						
	MCA2230, MCA2255	$V_{CE(SAT)}$			1.0	V	$I_C = I_F$ = 50 mA
	MCA2231	$V_{CE(SAT)}$			1.0	V	I_C = 2 mA, I_F = 1 mA
					1.0	V	I_C = 10 mA, I_F = 5 mA
					1.2	V	I_C = 50 mA, I_F = 10 mA
SWITCHING TIME	Non saturated						
	Turn-on time	t_{on}		10		μs	See Switching Time
	Turn-off time	t_{off}		100		μs	Test Circuit (Fig. 7)
ISOLATION	Isolation Voltage	V_{ISO}	5300			V_{AC}RMS	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA, 5 seconds
		V_{ISO}	7500			V_{AC}PEAK	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA, 5 seconds
	Isolation resistance	R_{ISO}	10^{11}			ohms	V_{I-O} = 500 VDC
	Isolation capacitance	C_{ISO}		0.5		pF	f = 1 MHz

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.3	1.50	V	I_F = 20 mA
	Forward voltage temp. coefficient			-1.8		mV/°C	
	Reverse voltage	V_R	3.0	25		V	I_R = 10 μA
	Junction capacitance	C_J		50		pF	V_F = 0 V, f = 1 MHz
OUTPUT DETECTOR	Breakdown voltage						
	Collector to emitter						
	MCA2230	BV_{CEO}	30			V	I_C = 100 μA, I_F = 0
	MCA2231	BV_{CEO}	30			V	I_C = 100 μA, I_F = 0
	MCA2255	BV_{CEO}	55			V	I_C = 100 μA, I_F = 0
	Collector to base						
	MCA2230	BV_{CBO}	30			V	I_C = 10 μA, I_F = 0
	MCA2231	BV_{CBO}	30			V	I_C = 10 μA, I_F = 0
	MCA2255	BV_{CBO}	55			V	I_C = 10 μA, I_F = 0
	Emitter to base	BV_{EBO}	5			V	I_E = 10 μA, I_F = 0
	Collector dark current	I_{CEO}			100	nA	V_{CE} = 10 V, I_F = 0

ELECTRICAL CHARACTERISTIC CURVES (TA = 25° C Unless Otherwise Specified)

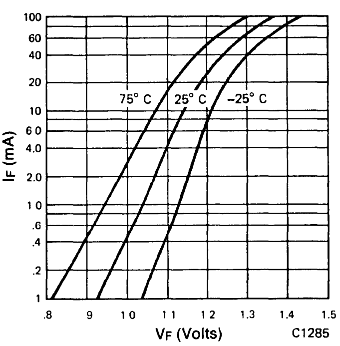


Fig. 1. Forward Voltage vs. Forward Current

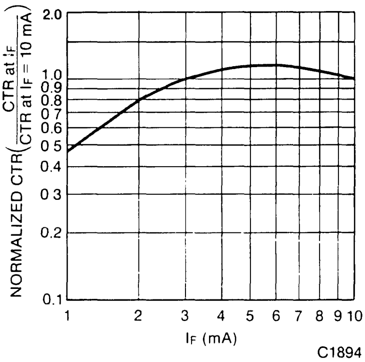


Fig. 2. Normalized CTR vs. I_F

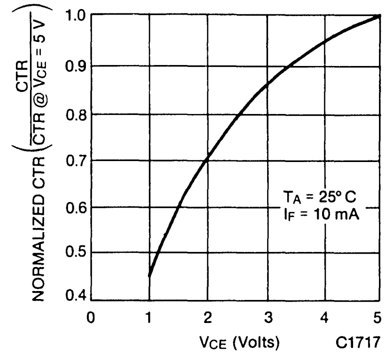


Fig. 3. Normalized CTR vs V_{CE}

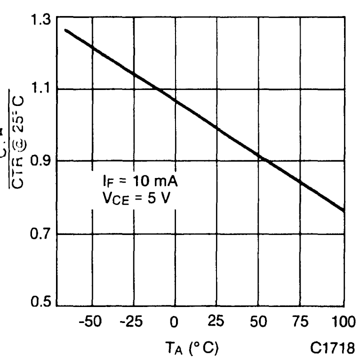


Fig. 4. Normalized CTR vs. Temperature

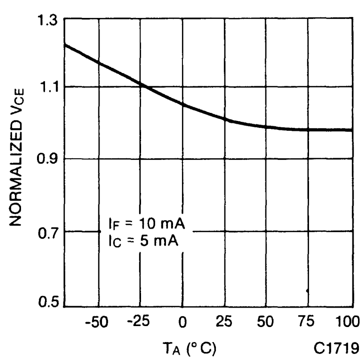


Fig. 5. Normalized V_{CE} vs. Temperature

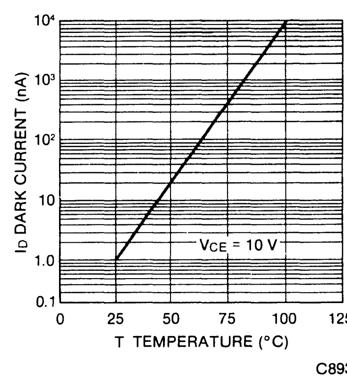


Fig. 6. Dark Current vs. Temperature

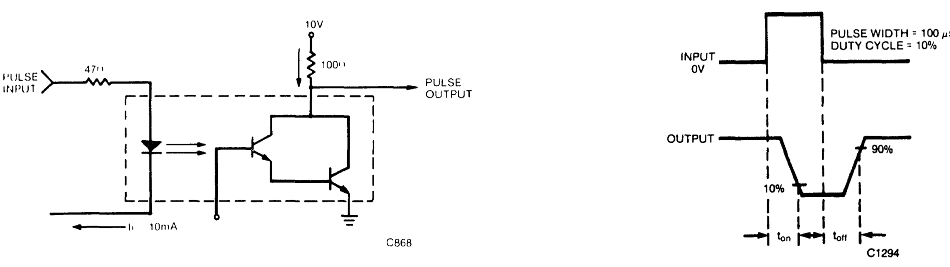


Fig. 7. Switching Time Test Circuit

GENERAL INSTRUMENT

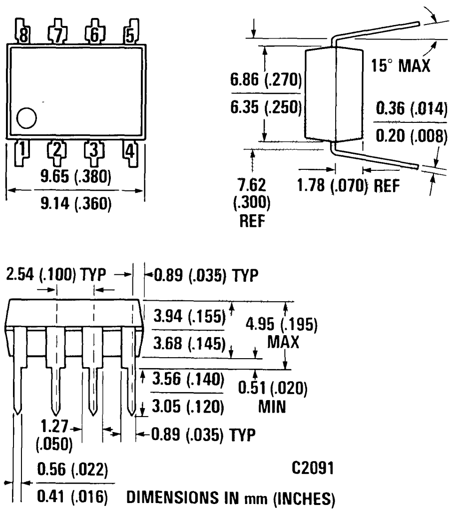
HIGH-SPEED TRANSISTOR OPTOCOUPLERS

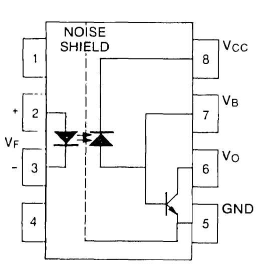
MCL2501 MCL2503 (HCPL-2503) MCL2502 (HCPL-2502) 6N136 6N135

MINIMUM CTR SELECTION CHART

	CTR @ I_F = 8 mA		CTR @ I_F = 16 mA	
	0-70°C	25°C	0-70°C	25°C
MCL 2501	14%	17%	17%	21%
MCL/HCPL-2503	11%	15%	9%	12%
6N136	—	—	15%	19%
6N135	—	—	5%	7%
MCL/HCPL-2502	—	—	—	15%-22% MAX

PACKAGE DIMENSIONS





Equivalent Circuit C1982

PROPAGATION DELAY COMPARISON

I_F = 8 mA		I_F = 16 mA	
0-70°C	25°C	0-70°C	25°C
MCL2501	MCL/ HCPL-2503	MCL2501	MCL/ HCPL-2502 6N136 6N135

DESCRIPTION

The MCL2501, MCL/HCPL-2503/02 and 6N136/5 optocouplers contain a 700 nm GaAsP LED emitter, which is optically coupled to a high speed photodetector transistor.

A separate connection for the bias of the photodiode improves the speed by several orders of magnitude over conventional phototransistor optocouplers by reducing the base-collector capacitance of the input transistor.

An internal noise shield provides superior common mode rejection of 10 kV/μs. An improved package allows superior insulation permitting a 480 V working voltage compared to industry standard of 220 V.

The prime device in this family is MCL2501 which guarantees all DC parameters including CTR as well as all switching parameters over 0-70° C at both 8 mA and 16 mA input current.

FEATURES

- MCL2501 completely guaranteed 0-70° C at 8 and 16 mA.
- High Speed — 1 MBit/s
- Superior CMR — 10 kV/μs
- Superior insulation — 2500 V RMS 1 min
- Double working voltage — 480 V RMS
- CTR guaranteed 0-70° C
- U.L. recognized (File #E50151)

APPLICATIONS

- Line receivers
- Pulse transformer replacement
- Output interfact to CMOS-LSTTL-TTL
- Wide bandwidth analog coupling

ELECTRICAL CHARACTERISTICS (T_A = 0°C to 70°C Unless Otherwise Specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MCL2501			MCL/HCPL-2503			MCL/HCPL-2502			UNITS
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Current transfer ratio	CTR	I_F=16mA, V_O=0.4V, V_{CC}=4.5V, T_A=25°C	21	28		12	18		15		22	%
		I_F=16mA, V_O=0.5V, V_{CC}=4.5V	17			9						
		I_F=8mA, V_O=0.5V, V_{CC}=4.5V, T_A=25°C	17	36		15						
		I_F=8mA, V_O=0.5V, V_{CC}=4.5V Note 5, Fig. 1, 2	14			11						
Logic low output voltage	V_{OL}	I_F=16mA, I_O=1.1mA, V_{CC}=4.5V					0.2	0.5				V
		I_F=16mA, I_O=2.4mA, V_{CC}=4.5V		0.1	0.4					0.1	0.4	
		I_F=8mA, I_O=0.7mA, V_{CC}=4.5V		0.2	0.5		0.2	0.5				
Logic high output current	I_{OH}	I_F=0mA, V_O=V_{CC}=5.5V, T_A=25°C								.003	.5	μA
		I_F=0mA, V_O=V_{CC}=15V, T_A=25°C		0.01	1					0.01	1	
		I_F=0mA, V_O=V_{CC}=15V Fig. 7			50						50	
Logic low supply current	I_{CCL}	I_F=16mA, V_O=Open, V_{CC}=15V								40		μA
		I_F=8mA, V_O=Open, V_{CC}=5.5V		20			20					
Logic high supply current	I_{CCH}	I_F=0mA, V_O=Open, V_{CC}=15V, T_A=25°C		0.02	1					0.02	1	μA
		I_F=0mA, V_O=Open, V_{CC}=15V			2						2	
Input forward voltage	V_F	I_F=16mA, T_A=25°C		1.5	1.7		1.5	1.7		1.5	1.7	V
		I_F=8mA, T_A=25°C Fig. 3		1.5	1.7		1.5	1.7				
Input reverse breakdown voltage	BV_R	I_F=10μA, T_A=25°C	5			5			5			V
Temp. coefficient of forward voltage	V_F	I_F=16mA		-1.6			-1.6			-1.6		mV/°C
Input-Output insulation leakage	$I_{I\text{-}O}$	45% Relative Humidity t=5sec $V_{I\text{-}O}$=3000V_{DC}, T_A=25°C Note 6		—			—			—		μA
Withstand insulation test voltage	V_{ISO}	RH ≤ 50% t = 1min T_A=25°C Notes 6, 11, 12	2500			2500			2500			V RMS
Resistance (Input-Output)	$R_{I\text{-}O}$	$V_{I\text{-}O}$=500V_{DC} Note 6		10^{12}			10^{12}			10^{12}		Ω
Capacitance (Input-Output)	$C_{I\text{-}O}$	F=1MHz Note 6		0.6			0.6			0.6		pF
DC current gain	h_{FE}	I_O=3mA, V_O=5V		150			150			150		—

All typical values are at T_A=25°C

Optocouplers

ELECTRICAL CHARACTERISTICS (T_A = 0°C to 70°C Unless Otherwise Specified)

PARAMETER	SYMBOL	TEST CONDITIONS	6N136			6N135			UNITS
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Current transfer ratio	CTR	I_F=16mA, V_O=0.4V, V_{CC}=4.5V, T_A=25°C	*19	24		*7	18		%
		I_F=16mA, V_O=0.5V, V_{CC}=4.5V	15			5			
		I_F=8mA, V_O=0.5V, V_{CC}=4.5V, T_A=25°C							
		I_F=8mA, V_O=0.5V, V_{CC}=4.5V Note 5, Fig. 1.2							
Logic low output voltage	V_{OL}	I_F=16mA, I_O=1.1mA, V_{CC}=4.5V					0.1	0.4	V
		I_F=16mA, I_O=2.4mA, V_{CC}=4.5V		0.1	0.4				
		I_F=8mA, I_O=0.7mA, V_{CC}=4.5V							
Logic high output current	I_{OH}	I_F=0mA, V_O=V_{CC}=5.5V, T_A=25°C		.003	*.5		.003	*.5	μA
		I_F=0mA, V_O=V_{CC}=15V, T_A=25°C		0.01	1		0.01	1	
		I_F=0mA, V_O=V_{CC}=15V Fig. 7			50			50	
Logic low supply current	I_{CCL}	I_F=16mA, V_O=Open, V_{CC}=15V		40			40		μA
		I_F=8mA, V_O=Open, V_{CC}=5.5V							
Logic high supply current	I_{CCH}	I_F=0mA, V_O=Open, V_{CC}=15V, T_A=25°C		0.02	*1		0.02	*1	μA
		I_F=0mA, V_O=Open, V_{CC}=15V			2			2	
Input forward voltage	V_F	I_F=16mA, T_A=25°C		1.5	1.7		1.5	1.7	V
		I_F=8mA, T_A=25°C Fig. 3							
Input reverse breakdown voltage	BV_R	I_F=10μA, T_A=25°C	*5			*5			V
Temp. coefficient of forward voltage	V_F	I_F=16mA		−1.6			−1.6		mV/°C
Input-Output insulation leakage	I_{I-O}	45% Relative Humidity t=5sec V_{I-O}=3000V_{DC}, T_A=25°C Note 6			*1.0			*1.0	μA
Withstand insulation test voltage	V_{ISO}	RH ≤ 50% t = 1min T_A=25°C Notes 6, 11, 12	2500			2500			V RMS
Resistance (Input-Output)	R_{I-O}	V_{I-O}=500V_{DC} Note 6		10^{12}			10^{12}		Ω
Capacitance (Input-Output)	C_{I-O}	F=1MHz Note 6		0.6			0.6		pF
DC current gain	h_{FE}	I_O=3mA, V_O=5V		150			150		—

**JEDEC Registered Data*
All typical values are at T_A=25°C

SWITCHING CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified) V_{CC} = 5.0 V

PARAMETER	SYMBOL	TEST CONDITIONS	MCL2501			MCL/HCPL-2503			MCL/HCPL-2502			UNITS
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Propogation delay time to logic low at output	t_{PHL}	I_F=16mA, R_L=4.1K										μs
		I_F=16mA, R_L=1.9K								.35	0.8	
		I_F=16ma, R_L=1.9K, 0-70° C		.35	0.8							
		I_F=16ma, R_L=4.7K					0.4	1.5				
		I_F=8mA, R_L=7.5K					1.0	1.5				
		I_F=8mA, R_L=7.5K, 0-70° C Notes 8, 9 Fig. 12		.8	1.5							
Propogation delay time to logic high at output	t_{PLH}	I_F=16mA, R_L=4.1K										μs
		I_F=16mA, R_L=1.9K								.25	0.8	
		I_F=16ma, R_L=1.9K, 0-70° C		.20	.35							
		I_F=16ma, R_L=4.7K					1.5	2.5				
		I_F=8mA, R_L=7.5K					1.5	2.5				
		I_F=8mA, R_L=7.5K, 0-70° C Notes 8, 9 Fig. 12		.80	1.30							
Common mode transient immunity at logic high output level	CM_H	V_{CM}=10V_p, R_L=4.1K										V/μs
		V_{CM}=10V_p, R_L=1.9K								10K		
		V_{CM}=10V_p, R_L=4.7K					10K					
		V_{CM}=50V_p, R_L=1.9K Notes 7, 8, 9 Fig. 11	1K	10K								
Common mode transient immunity at logic low output level	CM_L	V_{CM}=10V_p, R_L=4.1K										V/μs
		V_{CM}=10V_p, R_L=1.9K								-10K		
		V_{CM}=10V_p, R_L=4.7K					-10K					
		V_{CM}=50V_p, R_L=1.9K Notes 7, 8, 9 Fig. 11	-1K	-10K								
Bandwidth	BW	R_L=100 Note 10 Fig. 10		3			2			2		MHz

*JEDEC Registered Data

ABSOLUTE MAXIMUM RATINGS†

Storage temperature .... -55°C to 125°C
Operating temperature .... -55°C to 100°C
Lead solder temperature .... 260°C for 10s
Average forward input current .... 25 mA *(1)*
Peak forward input current .... 50 mA *(2)*
(50% duty cycle, 1ms P.W.)
Peak transient input current - I_F .... 1.0 A
(≤1 μs P.W., 300 pps)

Reverse input voltage .... 5 V
Input power dissipation .... 45 mW *(3)*
Average output current .... 8 mA
Peak output current .... 16 mA
Emitter-base reverse voltage .... 5 V
Supply and output voltage .... -0.5 V to 15 V
Base current .... 5 mA
Output power dissipation .... 100 mW*(4)*

†*Absolute Maximum Ratings are JEDEC Registered Data for 6N136 and 6N135. 6N136 and 6N135 are the only JEDEC Registered Parts on this data sheet.*

SWITCHING CHARACTERISTICS (T_A = 25°C Unless Otherwise Specified) V_{CC} = 5.0 V

PARAMETER	SYMBOL	TEST CONDITIONS	6N136 MIN.	6N136 TYP.	6N136 MAX.	6N135 MIN.	6N135 TYP.	6N135 MAX.	UNITS
Propogation delay time to logic low at output	t_{PHL}	I_F=16mA, R_L=4.1K					0.5	*1.5	μs
		I_F=16mA, R_L=1.9K		0.35	*0.8				
		I_F=16ma, R_L=1.9K							
		I_F=16ma, R_L=4.7K							
		I_F=8mA, R_L=7.5K							
		I_F=8mA, R_L=7.5K Notes 8, 9 Fig. 12							
Propogation delay time to logic high at output	t_{PLH}	I_F=16mA, R_L=4.1K					0.4	*1.5	μs
		I_F=16mA, R_L=1.9K		.25	*0.8				
		I_F=106ma, R_L=1.9K							
		I_F=16ma, R_L=4.7K							
		I_F=8mA, R_L=7.5K							
		I_F=8mA, R_L=7.5K Notes 8, 9 Fig. 12							
Common mode transient immunity at logic high output level	CM_H	V_{CM}=10V_p, R_L=4.1K				1K	10K		V/μs
		V_{CM}=10V_p, R_L=1.9K	1K	10K					
		V_{CM}=10V_p, R_L=4.7K							
		V_{CM}=50V_p, R_L=1.9K Notes 7, 8, 9 Fig. 11	1K	10K					
Common mode transient immunity at logic high output level	CM_L	V_{CM}=10V_p, R_L=4.1K				-1K	-10K		V/μs
		V_{CM}=10V_p, R_L=1.9K	-1K	-10K					
		V_{CM}=10V_p, R_L=4.7K							
		V_{CM}=50V_p, R_L=1.9K Notes 7, 8, 9 Fig. 11	-1K	-10K					
Bandwidth	BW	R_L=100 Note 10 Fig. 10		2			2		MHz

*JEDEC Registered Data

NOTES:

1. *Derate linearly above 70°C free-air temperature at a rate of 0.8 mA/°C.*
2. *Derate linearly above 70°C free-air temperature at a rate of 1.6 mA/°C.*
3. *Derate linearly above 70°C free-air temperature at a rate of 0.9 mW/°C.*
4. *Derate linearly above 70°C free-air temperature at a rate of 1.0 mW/°C.*
5. *CURRENT TRANSFER RATIO is defined as the ratio of output collector current, I_O, to the forward LED input current, I_F, times 100%.*
6. *Device considered a two-terminal device: Pins 1, 2, 3, and 4 shorted together and Pins 5, 6, 7, and 8 shorted together.*
7. *Common mode transient immunity in Logic High level is the maximum tolerable (positive) dV_{CM}/dt on the leading edge of the common mode pulse V_{CM}, to assure that the output will remain in a Logic High state (i.e., $V_O > 2.0$ V). Common mode transient immunity in Logic Low level is the maximum tolerable (negative) dV_{CM}/dt on the trailing edge of the common mode pulse signal, V_{CM} to assure that the output will remain in a Logic Low state (i.e., $V_O < 0.8$ V).*
8. *The 4.1 KΩ load represents 1 LSTTL unit load of 0.36 mA and 6.1 KΩ.*
9. *The 1.9 KΩ load represents 1 TTL unit load of 1.6 mA and the 5.6 KΩ pull-up resistor.*
10. *The frequency at which the ac output voltage is 3 dB below the low frequency asymptote.*
11. *This is a proof test to validate the UL440 VAC rating.*
12. *The 2500 Vac/1 min capability is validated by a factory 3.1K Vac (rms)/1 sec dielectric voltage withstand test.*

TYPICAL CHARACTERISTIC CURVES (T_A = 25° C Unless Otherwise Specified)

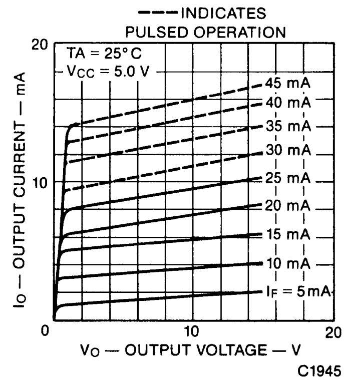


Fig. 1. DC and Pulsed Transfer Characteristics

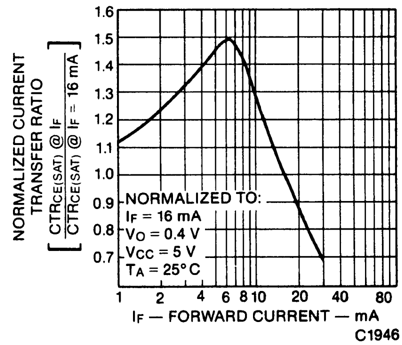


Fig. 2. Normalized Current Transfer Ratio vs. Forward Current

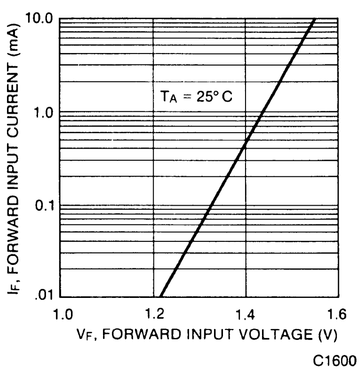


Fig. 3. Forward Input Current vs. Forward Input Voltage

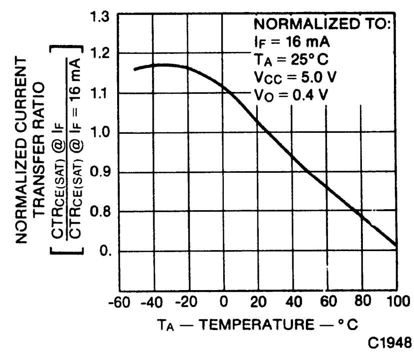


Fig. 4. Normalized Current Transfer Ratio vs. Temperature

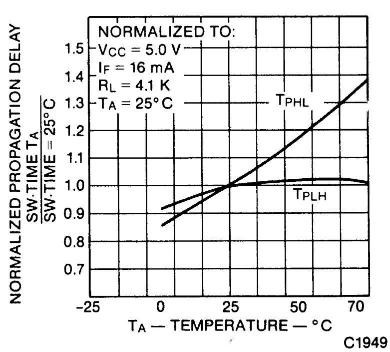


Fig. 5. Normalized Propagation Delay vs. Temperature at I_F = 16 mA

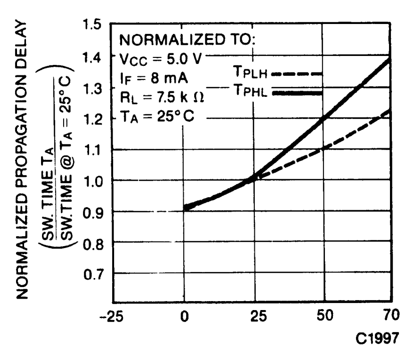


Fig. 6. Normalized Propagation Delay vs. Temperature at I_F = 8 mA

TYPICAL CHARACTERISTIC CURVES (T_A = 25° C Unless Otherwise Specified)

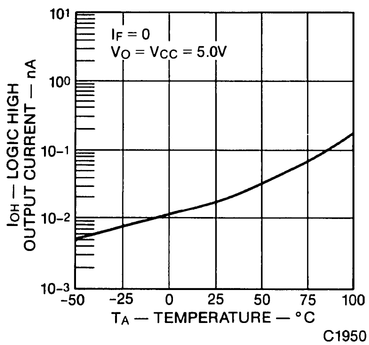


Fig. 7. Logic High Ouput Current vs. Temperature

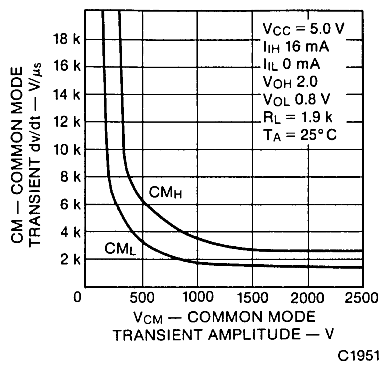


Fig. 8. Common Mode Transient Immunity vs. Common Mode Transient Amplitude

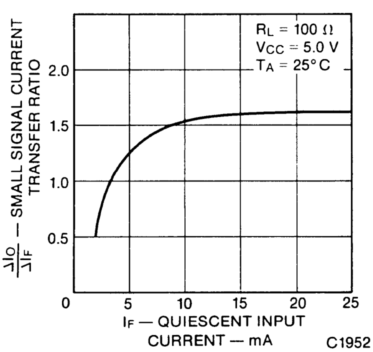


Fig. 9. Small Signal Transfer Ratio vs. Quescent Input Current

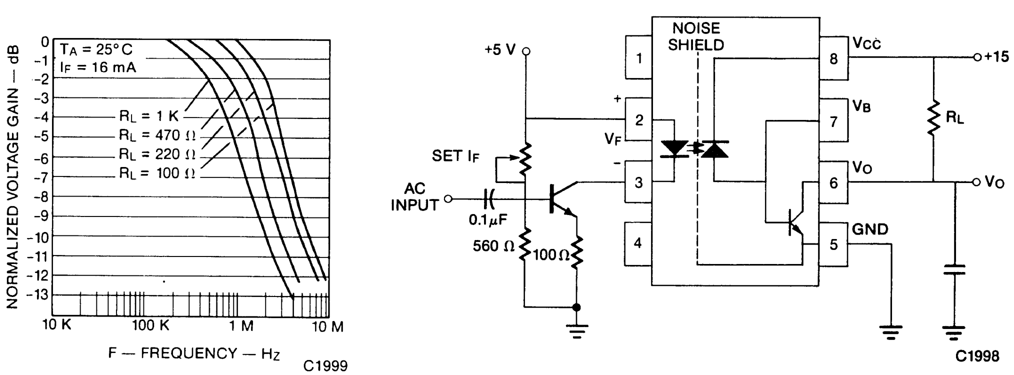


Fig. 10. Frequency Response

TYPICAL CHARACTERISTIC CURVES (T_A = 25°C Unless Otherwise Specified)

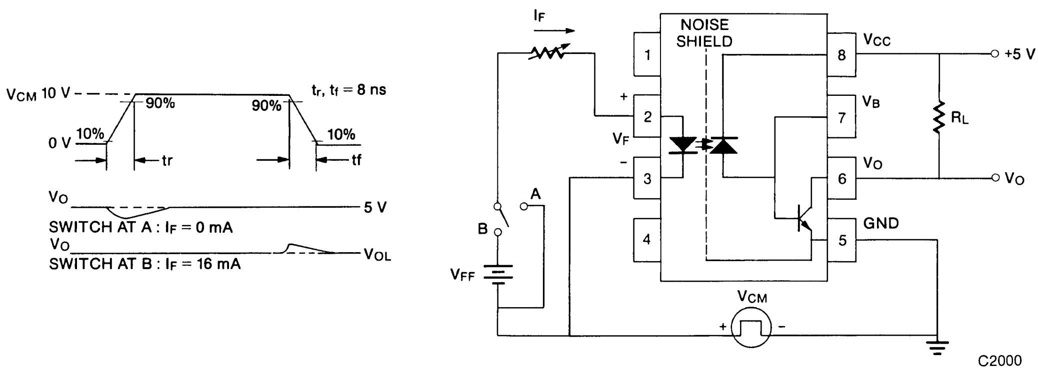


Fig. 11. Test Circuit for Transient Immunity and Typical Waveforms

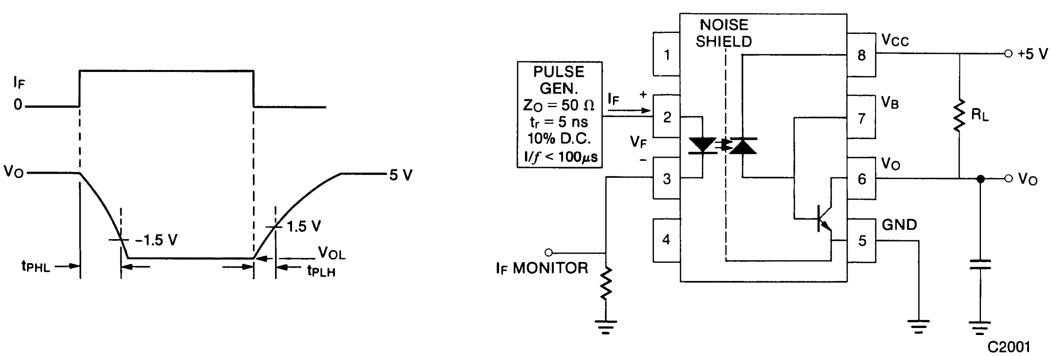


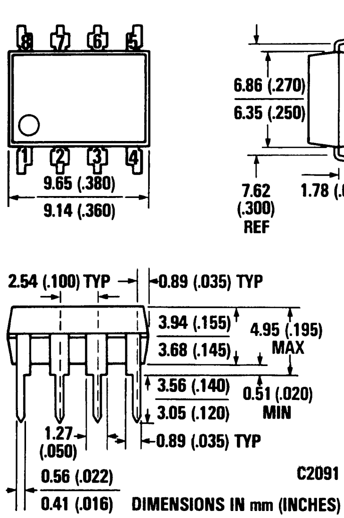
Fig. 12. Switching Test Circuit

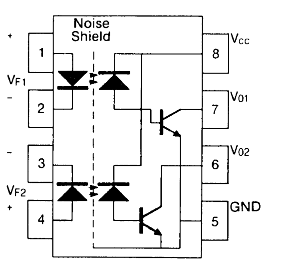
GENERAL INSTRUMENT

DUAL HIGH-SPEED TRANSISTOR OPTOCOUPLERS

DUAL HIGH-SPEED MCL2530 (HCPL-2530) MCL2531 (HCPL-2531)

PACKAGE DIMENSIONS





Equivalent Circuit C1944

DESCRIPTION

The MCL/HCPL-2530/31 dual optocouplers contain two completely separated 700 nm GaAsP LED emitters each optically coupled to a high speed photodetector transistor.

A separate pin for the bias of the photodiodes improves the speed by several orders of magnitude by reducing the base-collector capacitance.

An internal noise shield provides superior common mode rejection of 10 kV/μs. An improved package allows superior insulation permitting a 480 V working voltage compared to industry standard of 220 V.

FEATURES

- High speed 1 MBit/s
- Superior CMR — 10 kV/μs
- Superior insulation — 2500 V RMS 1 min
- Double working voltage — 480 V RMS
- CTR guaranteed 0-70° C
- U.L. recognized (File # E50151)

APPLICATIONS

- Line receivers
- Pulse transformer replacement
- Output interface to CMOS-LSTTL-TTL
- Wide bandwidth analog coupling

ABSOLUTE MAXIMUM RATINGS

Storage temperature .... -55° C to 125° C
Operating temperature .... -55° C to 100° C
Lead solder temperature........... 260° C for 10s
Average forward input current
(each channel) ....25 mA
Peak forward input current
(each channel) ....50 mA
(50% duty cycle, 1 ms pulse width)
Peak transient input current - I_F (each channel) ($\leq$1μs P.W., 300 pps)............ 1.0 A

Reverse input voltage (each channel) ....5 V
Input power dissipation
(each channel) .... 45 mW
Average output current (each channel)......8 mA
Peak output current (each channel) ....16 mA
Supply and output voltage .... -0.5 V to 15 V
Output power dissipation
(each channel) .... 35 mW

ELECTRICAL CHARACTERISTICS (T_A = 0° C to 70° C Unless Otherwise Specified)

PARAMETER	SYM.	DEVICE MCL or HCPL	MIN.	TYP.*	MAX.	UNITS	TEST CONDITIONS	FIG.	NOTE
Current transfer ratio	CTR	2530	7	18		%	I_F = 16 mA T_A = 25° C, V_O = 0.5 V, V_{CC} = 4.5 V	1, 2	5, 6
		2531	19						
		2530	5	21			I_F = 16 mA, V_O = 0.5 V, V_{CC} = 4.5 V	1, 2	5, 6
		2531	15						
Logic low output voltage	V_{OL}	2530		.1	0.5	V	I_F =16 mA I_O = 1.1 mA, V_{CC} = 4.5 V T_A = 25°C		5
		2531		.1	0.5	V	I_F = 16 mA I_O = 2.4 mA, V_{CC} = 4.5 V T_A = 25° C		
Logic high output current	I_{OH}			.02	250	nA	I_{F1} = I_{F2} = 0 mA, T_A = 25° C V_{O1} = V_{O2} = V_{CC} = 5.5 V	6	5
					10	μA	I_{F1} = I_{F2} = 0 mA V_{O1} = V_{O2} = V_{CC} = 15 V		5
Logic low supply current	I_{CCL}			80		μA	I_{F1} = I_{F2} = 16 mA, V_{CC} = 15 V V_{O1} = V_{O2} = Open		
Logic high supply current	I_{CCH}			.01	4	μA	I_{F1} = I_{F2} = 0 mA, V_{CC} = 15 V V_{O1} = V_{O2} = Open		
Input forward voltage	V_F			1.5	1.7	V	I_F = 16 mA, T_A = 25°C	3	5
Input reverse breakdown volt.	B_{VR}		5			V	I_F = 10 A, T_A = 25° C		5
Temp. coefficient of forward volt.	$\frac{\Delta V_F}{\Delta T_A}$			-1.6		mV/° C	I_F = 16 mA		5
Input capacitance	C_{IN}			60		pF	V_F = 0 V, f = 1 MHz		5
Withstand Insulation test voltage	V_{ISO}		2500			V_{RMS}	RH ≤ 50% T_A = 25° C, t = 1 min		7, 13
Resistance (input-output)	R_{I-O}			10^{12}		Ω	V_{I-O} = 500 VDC		7
Capacitance (input-output)	C_{I-O}			0.6		pF	f = 1 MHz		7
Input-Input insulation leakage current	I_{I-I}			0.005		μA	RH ≤ 50% V_{I-I} = 500 VDC t = 5 s		8
Resistance (input-input)	R_{I-I}			10^{11}		Ω	V_{I-I} = 500 VDC		8
Capacitance (input-input)	C_{I-I}			0.25		pF	f = 1 MHz		8

***All typicals at T_A = 25° C**

SWITCHING CHARACTERISTICSS (T_A = 25° C V_{CC} = 5.0 V)

PARAMETER	SYM.	DEVICE MCL or HCPL	MIN.	TYP.*	MAX.	UNITS	TEST CONDITIONS		FIG.	NOTE
Propagation delay time (For output low level)	t_{PHL}	2530		0.5	1.5	μs	I_F = 16 mA, R_L = 4.1 k Ω		5, 10	10, 11
		2531		0.3	0.8	μs	I_F = 16 mA, R_L = 1.9 k Ω			
Propagation delay time (For output high level)	t_{PLH}	2530		0.2	1.5	μs	I_F = 16 mA, R_L = 4.1 k Ω		5, 10	10, 11
		2531		0.1	0.8	μs	I_F = 16 mA, R_L = 1.9 k Ω			
Common mode transient immunity at logic high level output	CM_H	2530	1000	10000		V/μs	R_L = 4.1 k Ω	I_F = 0 mA, V_{CM} = 10 V_{p-p}	11	9, 10, 11
		2531	1000	10000			R_L = 1.9 k Ω			
Common mode transient immunity at logic low level output	CM_L	2530	-1000	-10000		V/μs	R_L = 4.1 k Ω	I_F = 16 mA, V_{CM} = 10 V_{p-p}	11	9, 10, 11
		2531	-1000	-10000			R_L = 1.9 k Ω			
Bandwidth	BW			3		MHz	R_L = 100 Ω		9	12

**All typicals at* T_A = 25° C

NOTES:

1. *Derate linearly above 70° C free-air temperature at a rate of 0.8 mA/° C.*
2. *Derate linearly above 70° C free-air temperature at a rate of 1.6 mA/° C.*
3. *Derate linearly above 70° C free-air temperature at a rate of 0.9 mW/° C.*
4. *Derate linearly above 70° C free-air temperature at a rate of 1.0 mW/° C.*
5. *Each channel.*
6. *CURRENT TRANSFER RATIO is defined as the ratio of output collector current,* I_O*, to the forward LED input current,* I_F*, times 100%.*
7. *Device considered a two-terminal device: Pins 1, 2, 3, and 4 shorted together and Pins 5, 6, 7, and 8 shorted together.*
8. *Measured between pins 1 and 2 shorted together, and pins 3 and 4 shorted together.*
9. *Common mode transient immunity in Logic High level is the maximum tolerable (positive)* dV_{CM}/dt *on the leading edge of the common mode pulse* V_{CM}*, to assure that the output will remain in a logic High State (i.e.,* V_O*) 2.0 V). Common mode transient immunity in Logic Low level is the maximum tolerable (negative)* dV_{CM}/dt *on the trailing edge of the common mode pulse signal,* V_{CM} *to assure that the output will remain in a Logic Low state (i.e.,* V_O *(0.8 V).*
10. *The 1.9 KΩ load represents 1 TTL unit load of 1.6 mA and the 5.6 KΩ pull-up resistor.*
11. *The 4.1 KΩ load represents 1 LSTTL unit load of 0.36 mA and 6.1 KΩ pull-up resistor.*
12. *The frequency at which the ac output voltage is 3dB below the low frequency asymptote.*
13. *The 2500* $V_{RMS}/1$ *min capability is validated by a factory 3.1* $kV_{RMS}/1$ *sec dielectric voltage withstand test.*

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25° Unless Otherwise Specified)

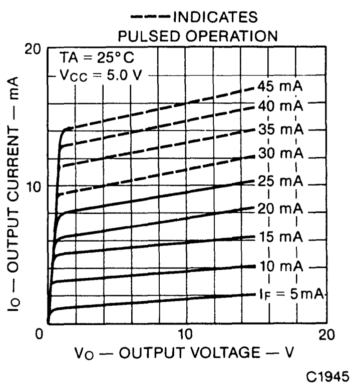


Fig. 1. DC and Pulsed Transfer Characteristics

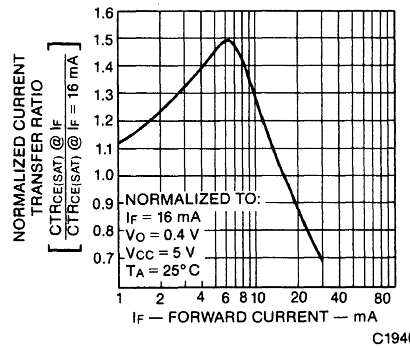


Fig. 2. Normalized Current Transfer Ratio vs. Forward Current

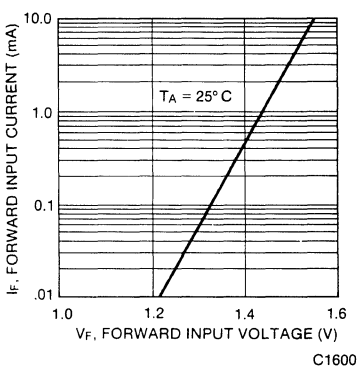


Fig. 3. Forward Input Current vs. Forward Input Voltage

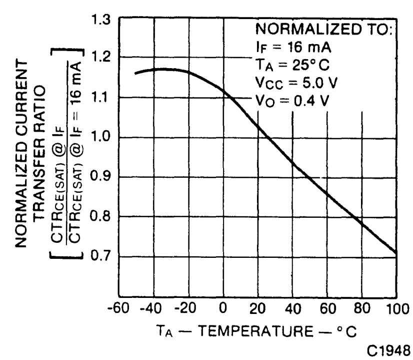


Fig. 4. Normalized Current Transfer Ratio vs. Temperature

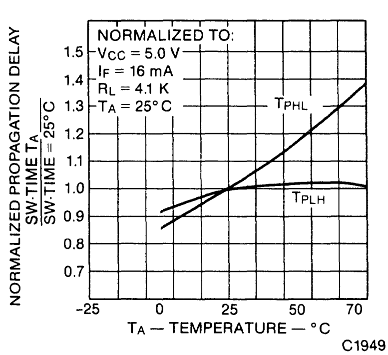


Fig. 5. Normalized Propagation Delay vs. Temperature

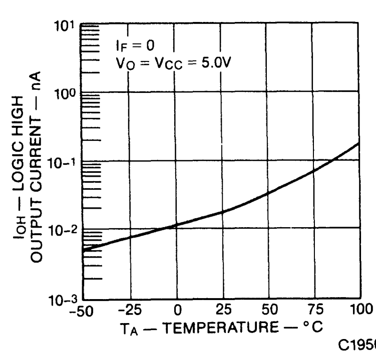


Fig. 6. Logic High Output Current vs. Temperature

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25° Unless Otherwise Specified)

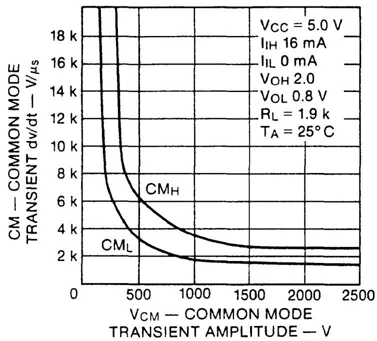


Fig. 7. Common Mode Transient Immunity vs. Common Mode Transient Amplitude

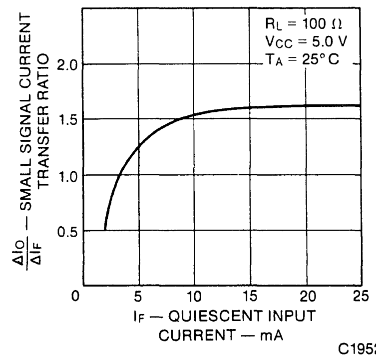


Fig. 8. Small Signal Transfer Ratio vs Quiescent Input Current

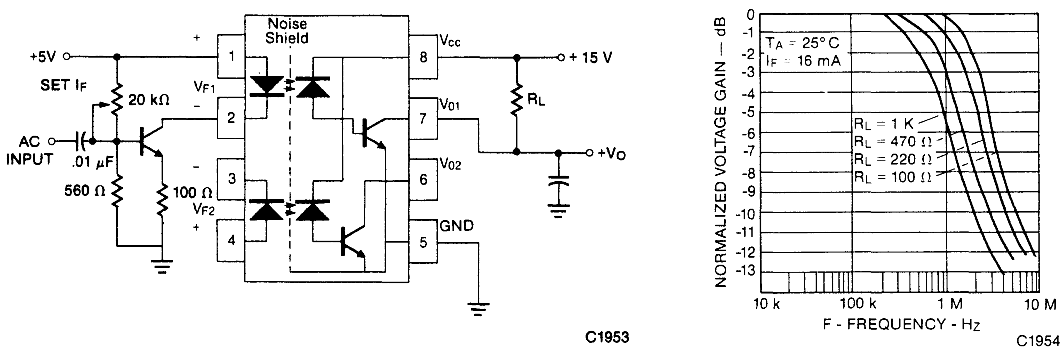


Fig. 9. Frequency Response

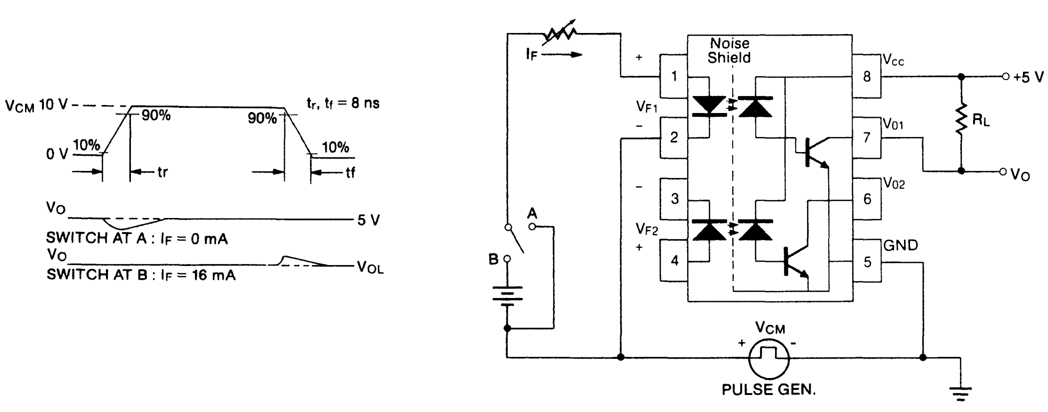


Fig. 10. Test Circuit For Transient Immunity and Typical Waveforms

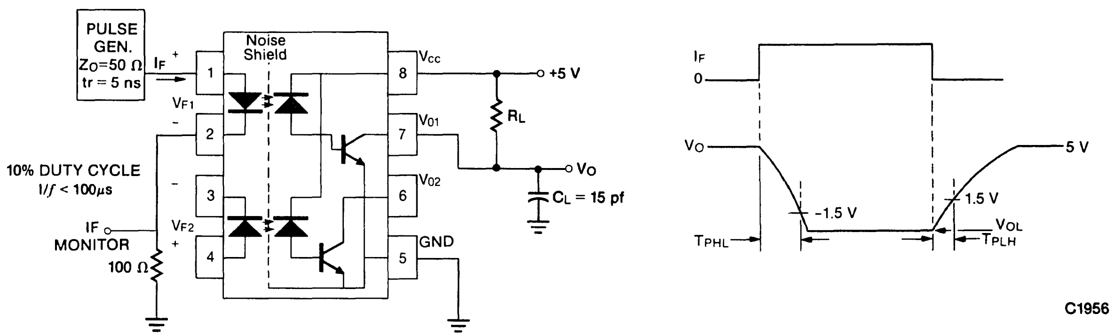


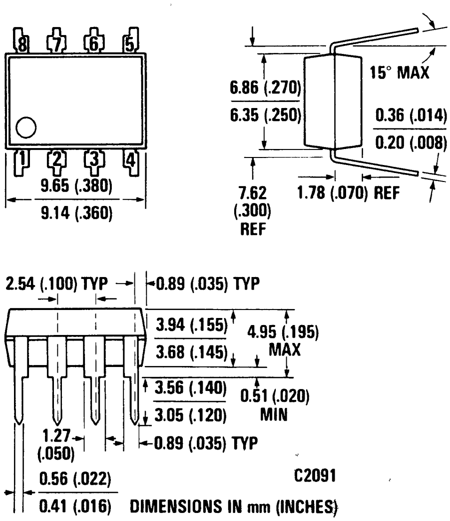
Fig. 11. Switching Test Circuit

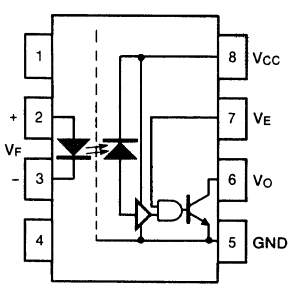
GENERAL INSTRUMENT

VERY HIGH-SPEED LOGIC GATE OPTOCOUPLERS

10 MBit/s LOGIC GATE 6N137 MCL2601 (HCPL-2601)

PACKAGE DIMENSIONS





Equivalent Circuit

TRUTH TABLE
(Positive Logic)

Input	Enable	Output
H	H	L
L	H	H
H	L	H
L	L	H

A 0.1μF bypass capacitor must be connected between pins 8 and 5. (See note 1)

DESCRIPTION

The 6N137 and MCL/HCPL-2601 single-channel optocouplers consists of a 700 nm GaAsP LED, optically coupled to a very high speed integrated photodetector logic gate with a strobable output. This output features an open collector, thereby permitting wired-OR outputs. The coupled parameters are guaranteed over the temperature range of 0-70° C. A maximum input signal of 5 mA will provide a minimum output sink current of 13 mA (fan-out of 8).

An internal noise shield provides superior common mode rejection of typically 10 kV/μs. The MCL/HCPL-2601 has a minimum CMR of 1 kV/μs.

An improved package allows superior insulation, permitting a 480 V working voltage compared to industry standard 220 V.

FEATURES

- Very high speed — 10 MBit/s
- Superior CMR — 10 k V/μs
- Superior insulation — 2500 V RMS 1 min.
- Double working voltage — 480 V
- Fan-out of 8 over 0-70° C
- Logic gate output
- Strobable output
- Wired-OR — open collector
- U.L. recognized (File #E50151)

APPLICATIONS

- Ground loop elimination
- LSTTL to TTL, LSTTL or 5-volt CMOS
- Line receiver, data transmission
- Data multiplexing
- Switching power supplies
- Pulse transformer replacement
- Computer-peripheral interface

ABSOLUTE MAXIMUM RATING

Storage temperature .... -55° C to + 125° C
Operating temperature .... 0° C to + 70° C
Lead solder temperature .... 260° C for 10 s
DC/average forward input current .... 20 mA
Enable input voltage, (V_E)
(Not to exceed V_{CC} by more than 500 mV) ... 5.5 V

Reverse input voltage .... 5.0 V
Reverse supply voltage ($-V_{CC}$) .... -500 mV
Supply voltage, (V_{CC}) .... 7.0 V/1 minute maximum
Output current, (I_O) .... 25 mA
Output voltage , (V_O) .... 7.0 V
Collector output power dissipation .... 40 mW

RECOMMENDED OPERATING CONDITIONS

	SYMBOL	MIN.	MAX.	UNITS
Input current, low level	I_{FL}	0	250	μA
Input current, high level	I_{FH}	*6.3	15	mA
Supply voltage, output	V_{CC}	4.5	5.5	V
Enable voltage low level	V_{EL}	0	0.8	V
Enable voltage high level	V_{EH}	2.0	V_{CC}	V
Operating temperature	T_A	0	70	°C
Fan out (TTL load)	N		8	

**6.3 mA is a guard banded value which allows for at least 20% CTR degradation. Initial input current threshold value is 5.0 mA or less.*

ELECTRICAL CHARACTERISTICS (T_A = 0° C to 70° C Unless Otherwise Specified)

PARAMETER	SYM.	TEST CONDITIONS	6N137 MIN.	6N137 TYP.**	6N137 MAX.	MCL(HCPL)-2601 MIN.	MCL(HCPL)-2601 TYP.*	MCL(HCPL)-2601 MAX.	UNITS
High level output current	I_{OH}	V_{CC} = 5.5 V, V_O = 5.5 V I_F = 250 μA, V_E = 2.0 V		.02	250*		.02	250	μA
Low level output voltage	V_{OL}	V_{CC} = 5.5 V, I_F = 5 mA V_E = 2.0 V, I_{OL} = 13 mA		.34	0.6*		.34	0.6	V
High level supply current	I_{CCH}	V_{CC} = 5.5 V, I_F = 0 mA V_E = 0.5 V		10	15*		10	15	mA
Low level supply current	I_{CCL}	V_{CC} = 5.5 V, I_F = 10 mA V_E = 0.5 V		15	18*		15	18	mA
Low level enable current	I_{EL}	V_{CC} = 5.5 V, V_E = 0.5 V		-1.5	-2.0*		-1.5	-2.0	mA
High level enable current	I_{EH}	V_{CC} = 5.5 V, V_E = 2.0 V		-1.0			-1.0		mA
High level enable voltage	V_{EH}	V_{CC} = 5.5 V, I_F = 10 mA	2.0			2.0			V
Low level enable voltage	V_{EL}	Note: 11			0.8			0.8	V
Input forward voltage	V_F	I_F = 10 mA, T_A = 25° C		1.55	1.75*		1.55	1.75	V
Input reverse breakdown voltage	B_{VR}	I_R = 10 μA, T_A = 25° C	5.0*			5.0			V
Input capacitance	C_{IN}	V_F = 0, f= 1 MHz		60			60		pF
Input diode temperature coefficient	$\Delta V_F/\Delta T_A$	I_F = 10 mA		-1.4			-1.4		mV/°C
Input-output Insulation leakage current	I_{I-O}	Relative humidity = 45% T_A = 25° C, t = 5 s V_{I-O} = 3000 VDC Note: 10			1.0*			1.0	μA
Withstand insulation test voltage	V_{ISO}	RH < 50 % T_A = 25° C t = 1 min.	2500			2500			V_{RMS}
Resistance (Input to output)	R_{I-O}	V_{I-O} = 500 V, Note: 10		10^{12}			10^{12}		Ω
Capacitance (Input to output)	C_{I-O}	f = 1 MHz, Note: 10		0.6			0.6		pF

SWITCHING CHARACTERISTICS ($T_A = 25°C$, $V_{CC} = 5.0$ V)

PARAMETER	SYM.	TEST CONDITIONS	6N137 MIN.	6N137 TYP.**	6N137 MAX.	MCL(HCPL)-2601 MIN.	MCL(HCPL)-2601 TYP.*	MCL(HCPL)-2601 MAX.	UNITS
Propagation delay time (For output high level)	T_{PLH}			48	75*		48	75	ns
Propagation delay time (For output low level)	T_{PHL}	$R_L = 350\ \Omega$ $C_L = 15$ pF		48	75*		48	75	ns
Output rise time (10-90%)	t_r	$I_F = 7.5$ mA		30			30		ns
Output fall time (90-10%)	t_f	Notes 2, 3, 4 & 5, Figure 10		14			14		ns
Enable propagation delay time (For output high level)	t_{ELH}	$I_F = 7.5$ mA $V_{EH} = 3.0$ V $V_{EL} = 0$ V		25			25		ns
Enable propagation delay time (For output low level)	t_{EHL}	$R_L = 350\ \Omega$, $C_L = 15$ pf Notes 6 & 7, Figure 11		14			14		ns
Common mode transient immunity (At output high level)	CM_H	$V_{CM} = 50$ V (Peak) $I_F = 0$ mA, V_{OH} (Min.) = 2.0 V $R_L = 350\ \Omega$, Note 9 Figure 16, 15		10,000		1000	10,000		V/μs
Common mode transient immunity (At output low level)	CM_L	$V_{CM} = 50$ V (Peak) $I_f = 7.5$ mA, V_{OL} (Max.) = 0.8 V $R_L = 350\ \Omega$ Note 8, Figure 16, 15		-10,000		-1000	-10,000		V/μs

**JEDEC Registered Data*
***All typical values are at $V_{CC} = 5$ V, $T_A = 25°C$.*

TYPICAL CHARACTERISTIC CURVES ($T_A = 25°C$ Unless Otherwise Specified)

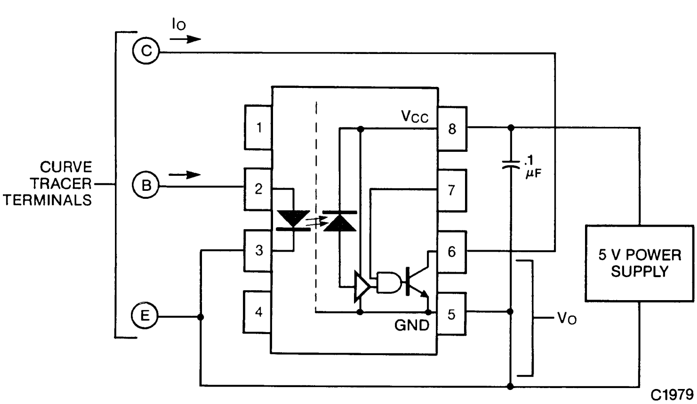


Fig. 1. Curve Tracer Connection to Obtain Collector Characteristics

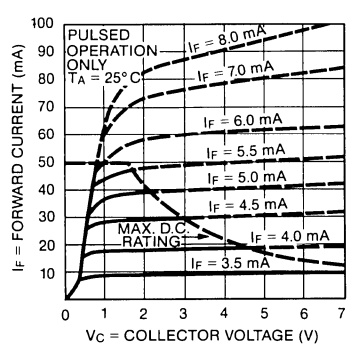


Fig. 2. Optocoupler Collector Characteristics

TYPICAL CHARACTERISTIC CURVES (T$_A$ = 25° C Unless Otherwise Specified)

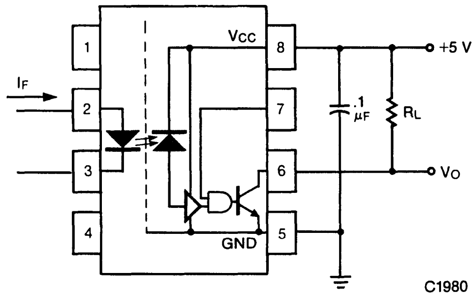


Fig. 3. Input-Output Schematic

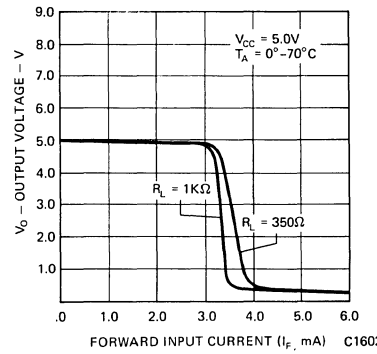


Fig. 4. Output Voltage vs. Forward Input Current

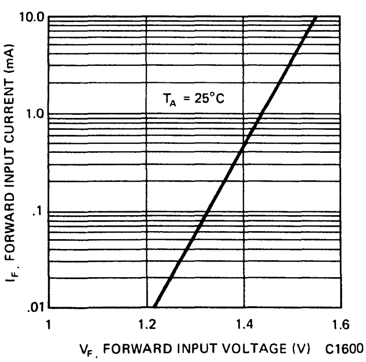


Fig. 5. Forward Input Current vs. Forward Input Voltage

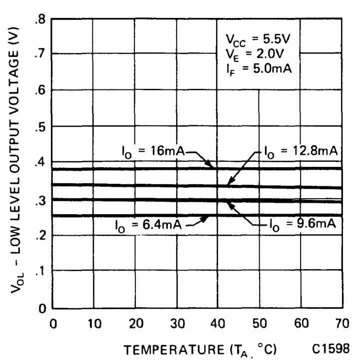


Fig. 6. Low Level Output Voltage vs. Temperature

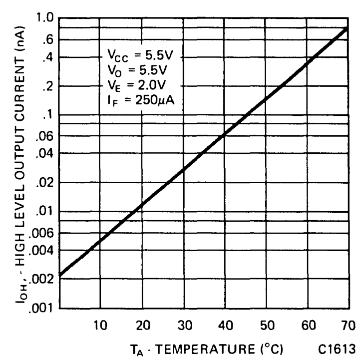


Fig. 7. High Level Output Current vs. Temperature

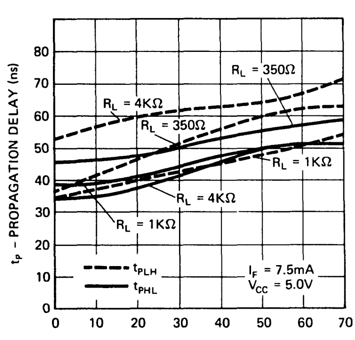


Fig. 8. Propagation Delay vs. Temperature

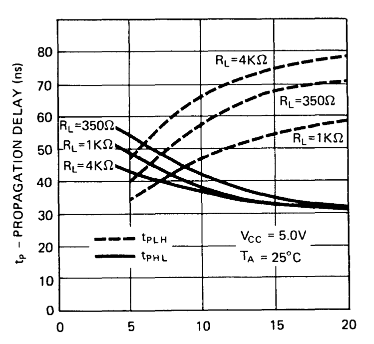


Fig. 9. Propagation Delay vs. Pulse Input Current

TYPICAL CHARACTERISTIC CURVES (T_A = 25° C Unless Otherwise Specified)

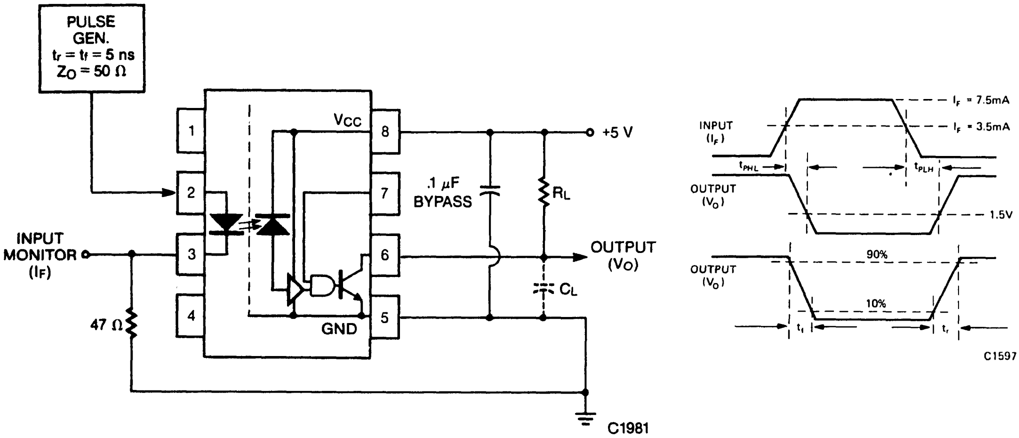


Fig. 10. Test Circuit and Waveforms for t_{PLH}, t_r, and t_f

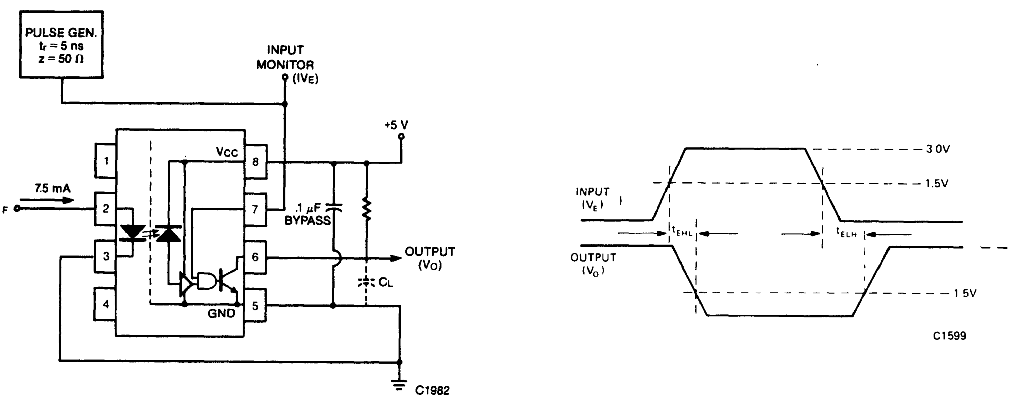


Fig. 11. Test Circuit t_{EHL} and t_{ELH}

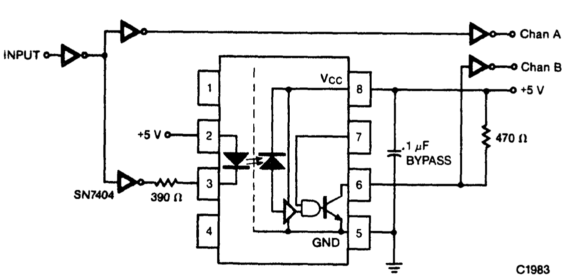


Fig. 12. Response Delay Between TTL Gates

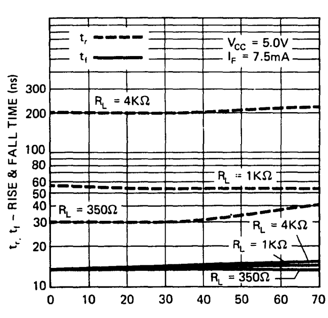


Fig. 13. Rise and Fall Time vs. Temperature

TYPICAL CHARACTERISTIC CURVES (T_A = 25° C Unless Otherwise Specified)

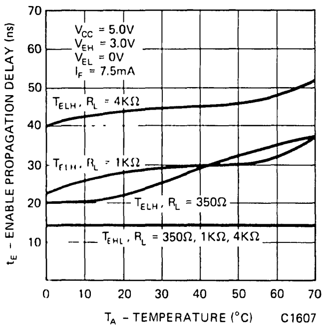


Fig. 14. Enable Propagation Delay vs. Temperature

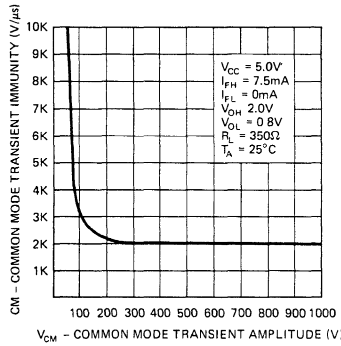


Fig. 15. Relative Common Mode Transient Immunity vs. Common Mode Transient Amplitude

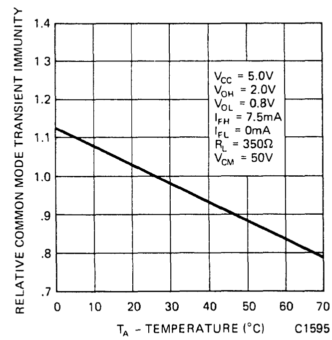


Fig. 16. Relative Common Mode Transient Immunity vs. Temperature

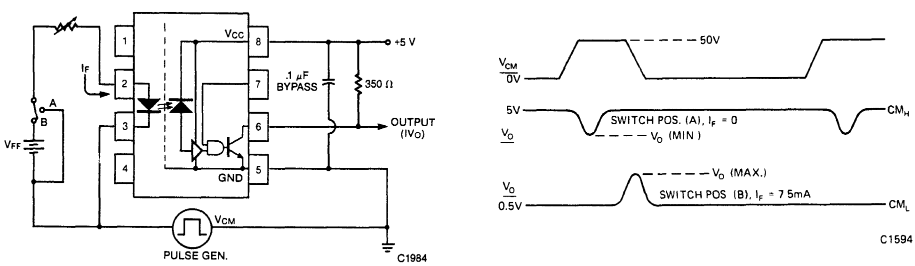


Fig. 17. Test Circuit Common Mode Transient Immunity

NOTES

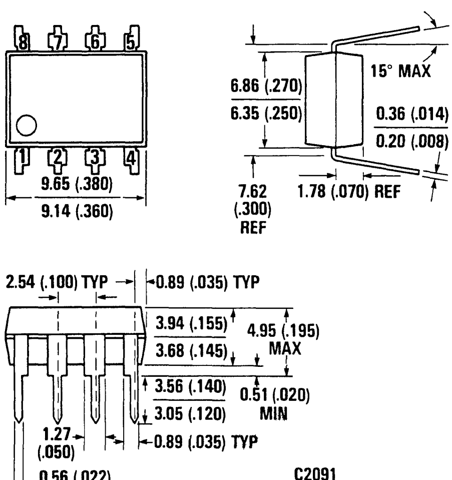
1. The V_{CC} supply voltage to each 6N137 isolator must be bypassed by a 0.1 μF capacitor or larger. This can be either a ceramic or solid tantalum capacitor with good high frequency characteristic and should be connected as close as possible to the package V_{CC} and GND pins of each device.
2. t_{PHL} - Propagation delay is measured from the 3.75 mA level on the LOW to HIGH transition of the input current pulse to the 1.5 V level on the HIGH to LOW transition of the output voltage pulse.
3. t_{PHL} - Propagation delay is measured from the 3.75 mA level on the LOW to HIGH transition of the input current pulse to the 1.5 V level on the HIGH to LOW transition of the output voltage pulse.
4. t_f - Fall time is measured from the 10% to the 90% levels of the HIGH to LOW transition on the output pulse.
5. t_r - Rise time is measured from the 90% to the 10% levels of the LOW to HIGH transition on the output pulse.
6. t_{EHL} - Enable input propagation delay is measured from the 1.5 V level on the LOW to HIGH transition of the input voltage pulse to the 1.5 V level on the HIGH to LOW of the output voltage pulse.
7. t_{ELH} - Enable input propagation delay is measured from the 1.5 V level on the HIGH to LOW transition of the input voltage pulse to the 1.5 V level on the LOW to HIGH transition of the output voltage pulse.
8. CM_L - The maximum tolerable rate of fall of the common mode voltage to ensure the output will remain in the low output state (i.e., $V_{OUT} < 0.8$ V). Measured in volts per microsecond (V/μs).
9. CM_H - The maximum tolerable rate of rise of the common mode voltage to ensure the output will remain in the high state (i.e., $V_{OUT} > 2.0$ V). Measured in volts microsecond (V/μs).
10. - Device considered a two-terminal device: Pins 1, 2, 3 and 4 shorted together, and Pins 5, 6, 7 and 8 shorted together. The 2500 V_{AC}/1 minute capability guarantees 3000 V_{DC}/5 sec. as registered with JEDEC and is validated by a factory 3.1 K V_{AC}/1 second.
11. Enable Input - No pull up resistor required as the device has an internal pull up resistor.
12. - DC current transfer ratio is defined as the ratio of the output collector current to the forward bias input current times 100%.

GENERAL INSTRUMENT

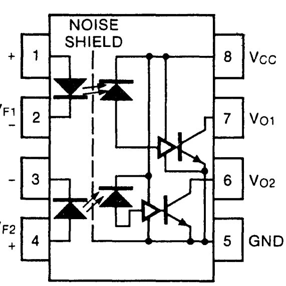
DUAL VERY HIGH-SPEED LOGIC GATE OPTOCOUPLERS

DUAL 10 MBit/s LOGIC GATE MCL2630 (HCPL-2630) MCL2631 (HCPL-2631)

PACKAGE DIMENSIONS



C2091
DIMENSIONS IN mm (INCHES)



C1979

Equivalent Circuit

A 0.1μF bypass capacitor must be connected between pins 8 and 5. (See note 1)

DESCRIPTION

The MCL/HCPL-2630 and MCL/HCPL-2631 dual channel optocouplers have two channels, each consisting of a 700 nm GaAsP LED, optically coupled to a very high speed integrated photodetector logic gate. The outputs feature open collectors, thereby permitting wired-OR outputs. The coupled parameters are guaranteed over the temperature range of 0-70° C. A maximum input signal of 5 mA will provide a minumum output sink current of 13 mA (fan-out of 8).

An internal noise shield provides superior common mode rejection of typically 10 kV/μs. The MCL/HCPL 2631 has a minimum CMR of 1 kV/μs.

An improved double-molded package allows superior insulation, permitting a 480 V working voltage compared to industry standard 220 V.

FEATURES

- Very high speed — 10 MBit/s
- Superior CMR — 10 kV/μs
- Superior insulation — 2500 V RMS 1 min.
- Double working voltage — 480 V
- Fan-out of 8 over 0-70° C
- Logic gate output
- Wired-OR — open collector
- U.L. recognized (File #E50151)

APPLICATIONS

- Ground loop elimination
- LSTTL to TTL, LSTTL or 5-volt CMOS
- Line receiver, data transmission
- Data multiplexing
- Switching power supplies
- Pulse transformer replacement
- Computer-peripheral interface

ABSOLUTE MAXIMUM RATINGS

Storage temperature .... -55° C to + 125° C
Operating temperature .... 0° C to + 70° C
Lead solder temperature.......... 260° C for 10 s
DC/Average forward input current
(each channel)......................... 15 mA
Peak forward input current
(each channel)...... 30 mA (≤ 1 msec duration)

Reverse input voltage (each channel)........ 5.0 V
Reverse supply voltage ($-V_{CC}$) .... -500 mV
Supply voltage, (V_{CC}) ... 7.0 V/1 minute maximum
Output current, (I_O) (each channel) .... 16 mA
Output voltage, (V_O) (each channel)......... 7.0 V
Collector output power dissipation .... 60 mW

RECOMMENDED OPERATING CONDITIONS

	SYMBOL	MIN.	MAX.	UNITS
Input current, low level	I_{FL}	0	250	μA
Input current, high level	I_{FH}	6.3*	15	mA
Supply voltage, output	V_{CC}	4.5	5.5	V
Operating temperature	T_A	0	70	°C
Fan out (TTL Load)	N		8	

6.3 mA is a guard banded value which allows for at least 20% CTR degradation. Initial input current threshold value is 5.0 mA or less.

ELECTRICAL CHARACTERISTICS (T_A = 0° C - 70° C Unless Otherwise Specified)

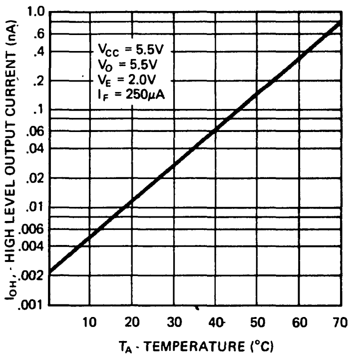
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
High level output current	I_{OH}		2	250	μA	V_{CC} = 5.5 V, V_O = 5.5 V I_F = 250 μA, Note 6
Low level output voltage	V_{OL}		0.34	0.6	V	V_{CC} = 5.5 V, I_F = 5 mA Note 6, I_{OL} = 13 mA
High level supply current	I_{CCH}		14	30	mA	V_{CC} = 5.5 V, I_F = 0 mA (Both channels)
Low level supply current	I_{CCL}		26	36	mA	V_{CC} = 5.5 V, I_F = 10 mA (Both channels)
Input forward voltage	V_F		1.55	1.75	V	I_F = 10 mA, T_A = 25 °C
Input reverse breakdown voltage	B_{VR}	5.0			V	I_R = 10 μA, T_A = 25° C
Input capacitance	C_{IN}		60		pF	V_F = 0, f= 1 MHz
Input diode temperature coefficient	$\Delta V_F/\Delta T_A$		-1.4		mV/° C	I_F = 10 mA
Input-input insulation leakage current	I_{I-I}		0.005		μA	Relative humidity = 45% t = 5 s, V_{I-I} = 500 V, Note 7
Resistance (input-input)	R_{I-I}		10^{11}		Ω	V_{I-I} = 500 V, Note 7
Capacitance (input-input)	C_{I-I}		0.25		pF	f = 1 MHz, Note 7
Input-output insulation leakage current	I_{I-O}			1.0	μA	Relative humidity = 45% T_A = 25° C, t = 5 s V_{I-O} = 3000 V dc Note 10
Resistance (input to output) Capacitance (input to output)	R_{I-O} C_{I-O}		10^{12} 0.6		Ω pF	V_{I-O} = 500 V, Note 10 f = 1 MHz, Note 10
Withstand insulation test voltage	V_{ISO}	2500			V_{RMS}	RH < 50% T_A = 25° C t = 1 min

All typical values are at V_{CC} = 5 V, T_A 25° C (each channel).

SWITCHING CHARACTERISTICS (T_A = 25° C, V_{CC} = 5.0 V Unless Otherwise Specified)

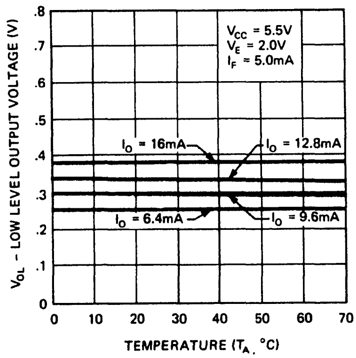
PARAMETER	SYMBOL	DEVICE	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Propagation delay time (For output high level)	t_{PLH}			48	75	ns	
Propagation delay time (For output low level	t_{PHL}			48	75	ns	R_L = 350 Ω C_L = 15 pF
Output rise time (10-90%)	t_r			30		ns	I_F = 7.5 mA
Output fall time (90-10%)	t_f			14		ns	Notes, 2, 3, 4 & 5, Fig. 8
Common mode transient immunity (At output high level)	CM_H	2631 2630	1000	10,000 10,000		V/μs	V_{CM} = 50 V (peak) I_F = 0 mA, V_{OL} (min) = 2.0 V R_L = 350 Ω, Note 9, Fig. 12
Common mode transient immunity (At output low level)	CM_L	2631 2630	-1000	-10,000 -10,000		V/μs	V_{CM} = 50 V (peak) I_F = 7.5 mA, V_{OL} (max) = 0.8 V R_L = 350 Ω, Note 8, Fig. 12

TYPICAL CHARACTERISTIC CURVES (TA = 25° C Unless Otherwise Specified)



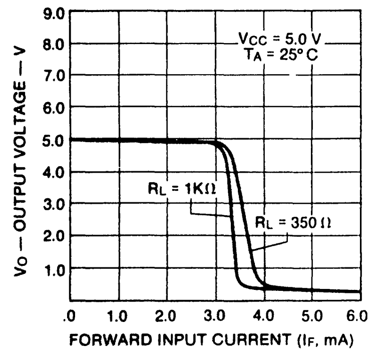
C1613

Fig. 2. High Level Output Current vs. Temperature



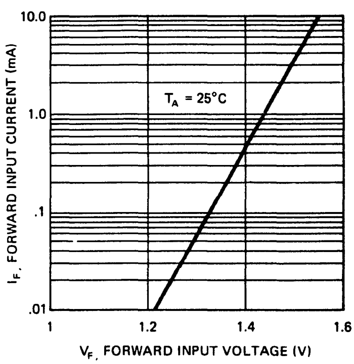
C1598

Fig. 3. Low Level Output Voltage vs. Temperature



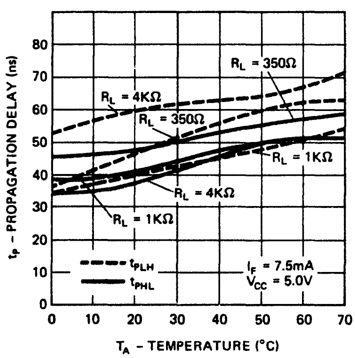
C1602

Fig. 4. Output Voltage vs. Forward Input Current



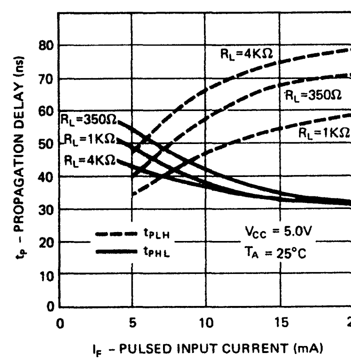
C1600

Fig. 5. Forward Input Current vs. Forward Input Voltage



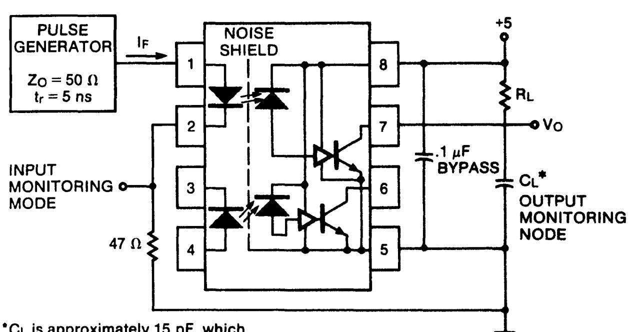
C1604

Fig. 6. Propagation Delay vs. Temperature



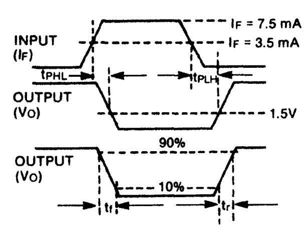
C1603

Fig. 7. Propagation Delay vs. Pulse Input Current



*CL is approximately 15 pF, which includes probe and stray wiring capacitance

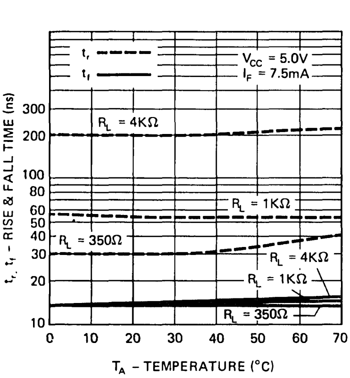
C1980



C1790

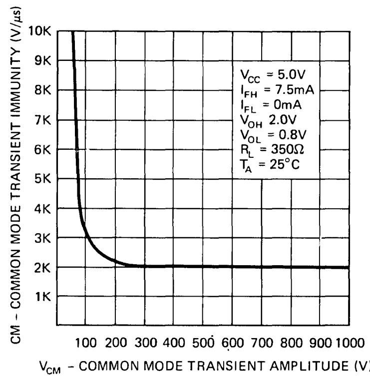
Fig. 8. Test CircuitZ t_{PHL}, t_{PLH}, t_r and t_f

TYPICAL CHARACTERISTIC CURVES (T_A = 25° C Unless Otherwise Specified)



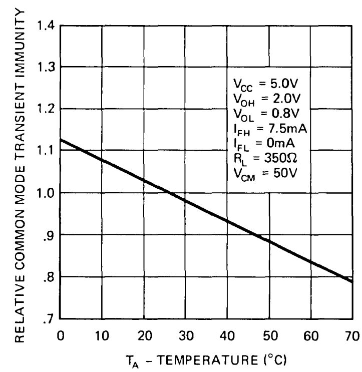
C1601

Fig. 9. Rise and Fall Time vs. Temperature



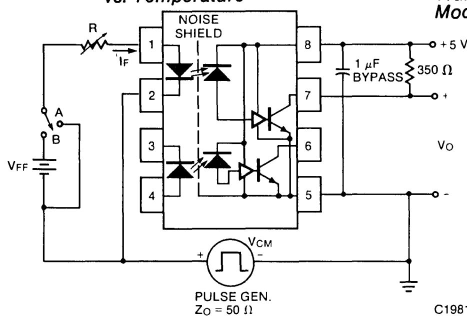
C1590

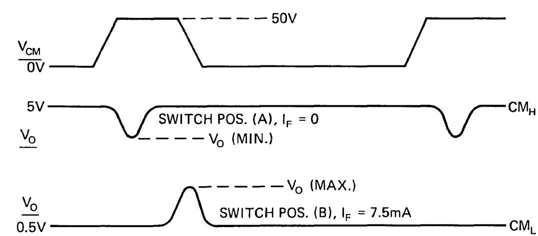
Fig. 10. Relative Common Mode Transient Immunity vs. Common Mode Transient Complitude



C1595

Fig. 11. Relative Common Mode Transient Immunity vs. Temperature





C1594

Fig. 12. Test Circuit for Transient Immunity and Typical Waveforms

NOTES:

1. *The V_{CC} supply voltage to each MCL2630 isolator must be bypassed by a 0.1 μF capacitor or larger. This can be either a ceramic or solid tantalum capacitor with good high frequency characteristic and should be connected as close as possible to the package V_{CC} and GND pins of each device.*
2. *t_{PHL} - Propagation delay is measured from the 3.75 mA level on the LOW to HIGH transition of the input current pulse to the 1.5 V level on the HIGH to LOW transition of the output voltage pulse.*
3. *t_{PLH} - Propagation delay is measured from the 3.75 mA level on the HIGH to LOW transition of the input current pulse to the 1.5 V level on the Low to High transition of the output voltage pulse.*
4. *t_f - Fall time is measured from the 10% to the 90% levels of the HIGH to LOW transition on the output pulse.*
5. *t_r - Rise time is measured from the 90% to the 10% levels of the LOW to HIGH transition on the output pulse.*
6. *Each channel.*
7. *Measured between pins 1 and 2 shorted together, and pins 3 and 4 shorted together.*
8. *CM_L - The maximum tolerable rate of fall of the common mode voltage to ensure the output will remain in the low output state (i.e., V_{OUT} > 0.8 V). Measured in volts per microsecond (V/%s).*
9. *CM_H - The maximum tolerable rate of rise of the common mode voltage to ensure the output will remain in the high state (i.e., V_{OUT}> 2.0 V). Measured in volts per microsecond (V/μs).*

   Volts/microsecond can be translated to sinusoidial voltages:

   $$V/\mu s = \frac{(dV_{CM})}{dt} \text{ Max.} = \pi f_{CM} V_{CM} (p.p.)$$

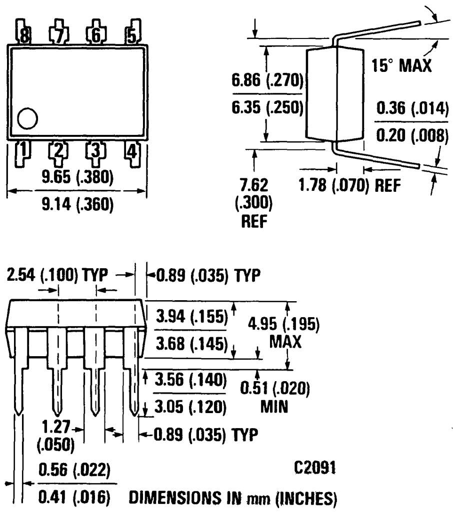
   Example: V_{CM} = 318 V_{pp} when f_{CM} = 1 MHz using CM_L and CM_H = 1000 V/μs.
10. *-Device considered a two-terminal device: Pins 1, 2, 3 and 4 shorted together, and Pins 5, 6, 7 and 8 shorted together.*

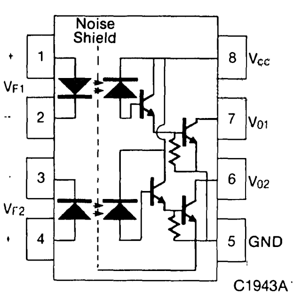
GENERAL INSTRUMENT

DUAL SPLIT-DARLINGTON OPTOCOUPLERS

1.6 mA DUAL MCL2730 (HCPL-2730)
0.5 mA DUAL MCL2731 (HCPL-2731)

PACKAGE DIMENSIONS





Equivalent Circuit

DESCRIPTION

The MCL/HCPL-2730/31 dual channel optocouplers contain two completely separated 700nm GaAsP LED emitters. Each channel is optically coupled to high gain detector in a split Darlington Configuration, which provides extremely high current transfer ratio.

The split darlington configuration separating the input photodiode and the first stage gain from the output transistor permits lower output saturation voltage and higher speed operation than possible with conventional darlington phototransistor optocoupler. An integrated emitter-base resistor provides superior stability over temperature.

The combination of a very low input current of 0.5 mA and a high current transfer ratio of 2000% make this family particularly useful for input interface to MOS, CMOS, LSTTL and EIA RS232C, while output compatibility is ensured to CMOS as well as high fan-out requirements.

An internal noise shield provides exceptional common mode rejection of 10 kV/μs. An improved package allows superior insulation permitting a 480 V working voltage compared to industry standard 220 V.

FEATURES

- Low current — 0.5 mA
- Superior CTR — 2000%
- Superior CMR — 10 kV/μs
- Double working voltage — 480 V RMS
- CTR guaranteed 0-70° C
- U.L. recognized (File #50151)
- Superior insulation; 2500 VAC RMS, 1 min

APPLICATIONS

- Digital logic ground isolation
- Telephone ring detector
- U.L. recognized (File #E50151)
- High common-mode-noise line receiver

ABSOLUTE MAXIMUM RATINGS

Storage temperature .... -55° C to +125° C
Operating temperature .... -40° C to +85° C
Lead solder temperature .... 260° C for 10 s
DC/Average forward input current
(each channel) .... 20 mA *(1)*
Peak forward input current
(each channel) .... 40 mA
(≤ 1 msec duration, 50% duty cycle)(1)

Reverse input voltage (each channel) ...... 5.0 V
Input power dissipation
(each channel) .... 35 mW *(2)*
Output current (each channel) .... 60 mA *(3)*
Supply and output voltage (V_{CC}, V_O)
MCL2730 (HCPL-2730) .... -0.5 to 7 V
MCL2731 (HCPL-2731) .... -0.5 to 18 V
Output power dissipation
(each channel) .... 100 mW *(4)*

ELECTRICAL CHARACTERISTICS (T_A = **0°C to 70°C** Unless Otherwise Specified)

PARAMETER	SYM.	DEVICE	MIN.	TYP.*	MAX.	UNITS	TEST CONDITIONS	FIG.	NOTE
Current transfer ratio	CTR	2730	300	2000		%	I_F = 1.6 mA, V_O = 0.4 V, V_{CC} = 4.5 V	2	5, 6
		2731	400	2000		%	I_F = 0.5 mA, V_O = 0.4 V, V_{CC} = 4.5 V		
			500	2000		%	I_F = 1.6 mA, V_O = 0.4 V, V_{CC} = 4.5 V		
Logic low output voltage	V_{OL}	2730		.1	0.4	V	I_F = 1.6 mA, I_O = 4.8 mA, V_{CC} = 4.5 V	1	5
		2731		.1	0.4	V	I_F = 0.5 mA, I_O = 2 mA, V_{CC} = 4.5 V		
				.1	0.4	V	I_F = 1.6 mA, I_O = 8 mA, V_{CC} = 4.5 V		
				.1	0.4	V	I_F = 5 mA, I_O = 15 mA. V_{CC} = 4.5 V		
				.2	0.4	V	I_F = 12 mA, I_O = 24 mA, V_{CC} = 4.5 V		
Logic high output current	I_{OH}	2730		0.01	100	μA	I_F = 0 mA, V_O = V_{CC} = 7 V		5
		2731		0.01	100	μA	I_F = 0 mA, V_O = V_{CC} = 18 V		
Logic low supply current	I_{CCL}	2730		.4		mA	I_{F1} = I_{F2} = 1.6 mA, V_{CC} = 7 V		
		2731		.5		mA	V_{O1} = V_{O2} = Open, V_{CC} = 18 V		
Logic high supply current	I_{CCH}	2730		4		nA	I_{F1} = I_{F2} = 0 mA. V_{CC} = 7 V		
		2731		5		nA	V_{O1} = V_{O2} = Open, V_{CC} = 18 V		
Input forward voltage	V_F			1.5	1.7	V	I_F = 1.6 mA, T_A = 25°C	4	5
Input reverse breakdown voltage	B_{VR}		5			V	I_R = 10 μA, T_A = 25°C		5
Temperature coefficient of foward voltage	$\frac{\Delta V_F}{\Delta T_A}$			−1.6		mV/°C	I_F = 1.6 mA		5
Input capacitance	C_{IN}			60		pF	V_F = 0, f = 1 MHz		5
Withstand insulation test voltage	V_{ISO}		2500			V_{RMS}	RH ≤ 50%, T_A = 25°C t = 1 min		10, 11
Resistance (Input-Output)	R_{I-O}			10^{12}		Ω	V_{I-O} = 500 VDC		10
Capacitance (Input-Output)	C_{I-O}			0.6		pF	f = 1 MHz		10
Insulation leakage current (Input-Input)	I_{I-I}			0.005		μA	RH ≤ 50%, V_{I-I} = 500 VDC t = 5 sec		7
Resistance (Input-Input)	R_{I-I}			10^{11}		Ω	V_{I-I} = 500 VDC		7
Capacitance (Input-Input)	C_{I-I}			0.25		pF	f = 1 MHz		7

**All typicals at T_A = 25°C*

SWITCHING CHARACTERISTICS $T_A = 25°C$, $V_{CC} = 5.0\ V$

PARAMETER	SYM.	DEVICE	MIN.	TYP.*	MAX.	UNITS	TEST CONDITIONS	FIG.	NOTE
Propagation delay time (For output low level)	t_{PHL}	2730/1		4	20	μs	$I_F = 1.6\ mA$, $R_L = 2.2\ k\Omega$	6	5
				0.5	2	μs	$I_F = 12\ mA$, $R_L = 270\ \Omega$		
		2731		25	100	μs	$I_F = 0.5\ mA$, $R_L = 4.7\ k\Omega$		
Propagation delay time (For output high level)	t_{PLH}	2730/1		12	35	μs	$I_F = 1.6\ mA$, $R_L = 2.2\ k\Omega$	6	5
				4	10	μs	$I_F = 12\ mA$, $R_L = 270\ \Omega$		
		2731		20	60	μs	$I_F = 0.5\ mA$, $R_L = 4.7\ k\Omega$		
Common mode transient Immunity at logic high level output	CM_H		1000	10000		V/μs	$I_F = 0mA$, $R_L = 2.2\ k\Omega$ $V_{CM} = 10\ V_{p-p}$	7	5, 9
Common mode transient Immunity at logic low level output	CM_L		-1000	-10000		V/μs	$I_F = 1.6\ mA$, $R_L = 2.2\ k\Omega$ $V_{CM} = 10\ V_{p-p}$	7	5, 8

**All typicals at $T_A = 25°C$*

NOTES:

1. *Derate linearly above 70° C free-air temperature at a rate of 0.5 mA/° C.*
2. *Derate linearly above 70° C free-air temperature at a rate of 0.9 mA/° C.*
3. *Derate linearly above 70° C free-air temperature at a rate of 0.6 mW/° C.*
4. *Derate linearly above 35° C free-air temperature at a rate of 1.7 mW/° C. Output power = (Collector output power) + (supply power).*
5. *Each channel.*
6. *CURRENT TRANSFER RATIO is defined as the ratio of output collector current, I_O, to the forward LED input current, I_F, times 100%.*
7. *Measured between pins 1 and 2 shorted together, and pins 3 and 4 shorted together.*
8. *CM_L - The maximum tolerable rate of the common mode voltage to ensure the output will remain in the low output state (i.e., $V_{OUT} > 0.8\ V$). Measured in volts per microsecond (V/μS).*
9. *CM_H - The maximum tolerable rate of rise of the common mode voltage to ensure the output will remain in the high state (i.e., $V_{OUT} > 2.0\ V$). Measured in volts per microsecond (V/μS).*

$$V/\mu s = \frac{dV_{CM}}{dt} \qquad Max = \pi f_{CM} V_{CM}(p.p.)$$

10. *Device considered a two-terminal device: Pins 1, 2, 3 and 4 shorted together, and Pins 5, 6, 7 and 8 shorted together.*
11. *The 2.5 kV RMS/1 minute capability is validated by a factory 3.1 kV RMS/1 sec.*

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 0°C$ to $70°C$ Unless Otherwise Specified)

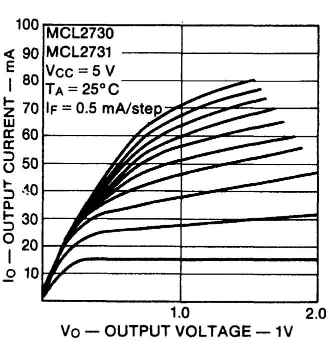


Fig. 1. DC Transfer Characteristics

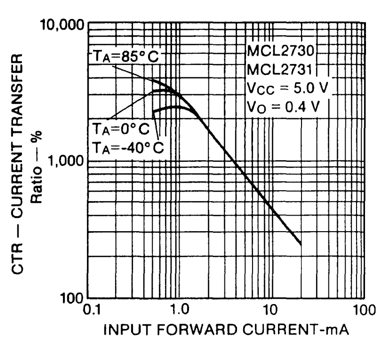


Fig. 2. Current Transfer Ratio vs. Input Forward Current

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

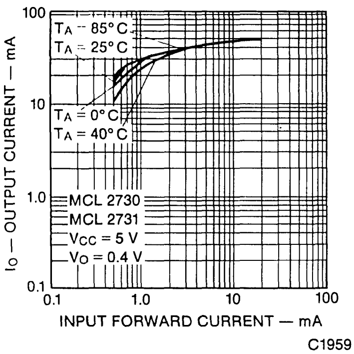


Fig. 3. Output Current vs. Input Forward Current

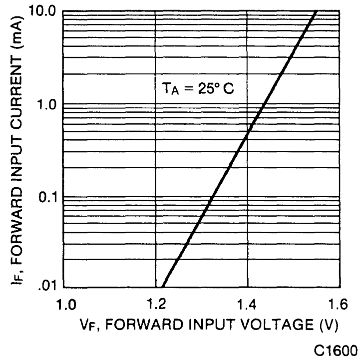


Fig. 4. Forward Input Current vs. Forward Input Voltage

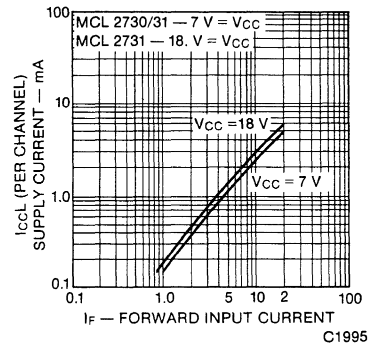


Fig. 5. Supply Current Per Channel vs. Input Forward Current

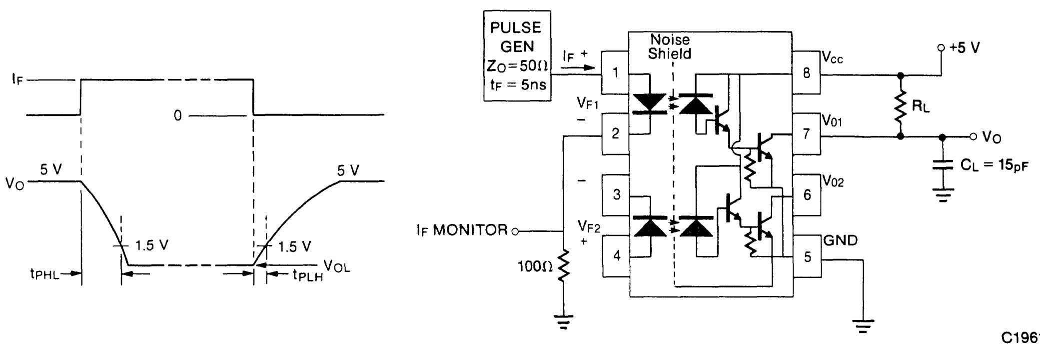


Fig. 6. Switching Test Circuit and Waveforms

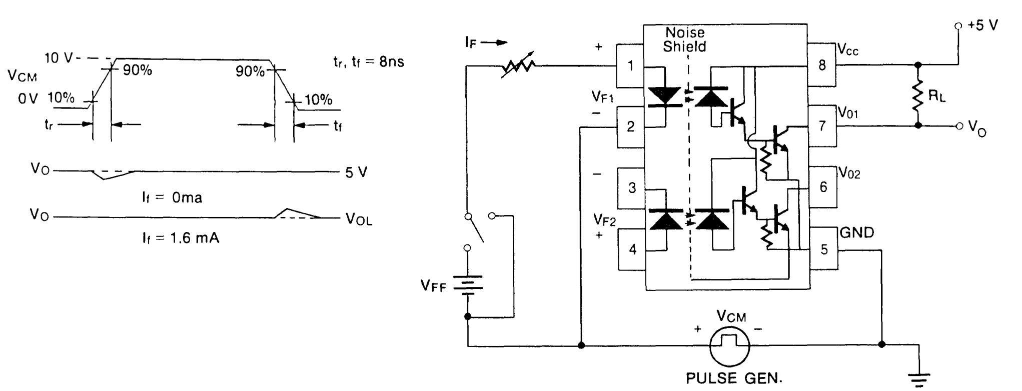


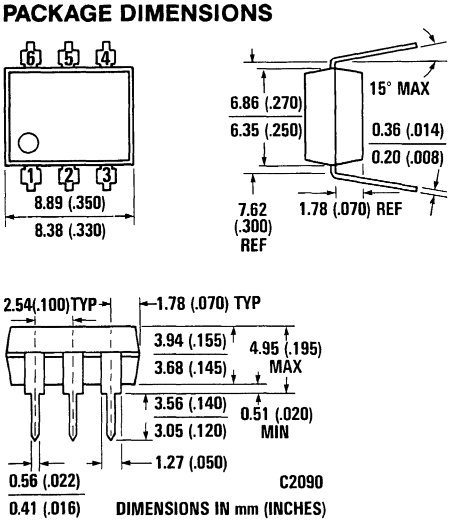
Fig. 7. Test Circuit for Common Mode Transient Immunity and Waveforms

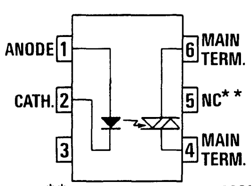
GENERAL INSTRUMENT

NON-ZERO-CROSSING TRIACS

30 mA MCP3009*
NON-ZERO-CROSSING 15 mA MCP3010
10 mA MCP3011

PACKAGE DIMENSIONS





Equivalent Circuit

**DO NOT CONNECT C2081
(TRIAC SUBSTRATE)

DESCRIPTION

The MCP3009, MCP3010 and MCP3011 are optically isolated triac driver devices. These devices contain a GaAs infrared emitting diode and a light activated silicon bilateral switch, which functions like a triac. This series is designed for interfacing between electronic controls and power triacs to control resistive and inductive loads for 120 VAC operations.

FEATURES

- Low input current required (typically 5mA — MCP3011)
- Minimum commutating dv/dt is specified at 0.1V/μsec
- Pin for pin replacement for the MOC3009, 3010 and 3011 devices
- High isolation voltage — minimum 7500 VAC peak
- Underwriters Laboratory (UL) recognized — File E50151

APPLICATIONS

- Triac driver
- Industrial controls
- Traffic lights
- Vending machines
- Motor control
- Solid state relay

*Not Recommended
For New Designs

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	-55°C to 150°C
Operating temperature	-40°C to 100°C
Lead temperature (Soldering 10 sec	260°C
Total package power dissipation @ 25°C (LED plus detector)	330 mW
Derate linearly from 25°C	4.0 mW/°C
Withstand test voltage	7500 VAC Peak (50-60 Hz)

INPUT DIODE

Forward DC current	60 mA
Reverse voltage	3 V
Peak forward current (1 μs pulse, 300 pps)	3.0 A
Power dissipation 25°C ambient	100 mW
Derate linearly from 25°C	1.33 mW/°C

OUTPUT DRIVER

Off-state output terminal voltage		250 volts
On-state RMS current	$T_A = 25°C$	100 mA
(Full cycle, 50 to 60 Hz)	$T_A = 70°C$	50 mA
Peak nonrepetitive surge current (PW = 10 ms, DC = 10%)		1.2 A
Total power dissipation @ $T_A = 25°C$		300 mW
Derate above 25°C		4.0 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)

	TRANSFER CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	LED Trigger Current (Current Required to latch output) MCP3009	I_{FT}	–	15.0	30	mA	Main terminal voltage = 3.0 V
	MCP3010		–	10.0	15		
	MCP3011		–	5.0	10		
	Holding Current	I_H	–	200	–	μA	Either direction
dv/dt RATING	Critical Rate of Rise of Off-State Voltage	dv/dt	–	10.0	–	V/μs	Static dv/dt (see Figure 5)
	Critical Rate of Rise of Commutating Voltage	dv/dt	0.1	0.2	–	V/μS	Commutating dv/dt I_{LOAD} = 15 mA (see Figure 5)
ISOLATION	Isolation Voltage	V_{iso}	5300			V_{AC}RMS	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA, 5 seconds
		V_{iso}	7500			V_{AC}PEAK	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA, 5 seconds
	Isolation resistance	R_{iso}	10^{11}			ohms	V_{I-O} = 500 VDC
	Isolation capacitance	C_{iso}		0.5		pF	f = 1 MHz

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.3	1.50	V	I_F = 30 mA
	Forward voltage temp. coefficient			-1.8		mV/°C	
	Reverse breakdown voltage	BV_R	3.0	25		V	I_R = 10 μA
	Junction capacitance	C_J		50		pF	V_F = 0 V, f = 1 MHz
				65		pF	V_F = 1 V, f = 1 MHz
	Reverse leakage current	I_R		.35	10	μA	V_R = 3.0 V
OUTPUT DETECTOR	Peak Blocking Current, Either Direction	I_{DRM}	–	10	100	nA	V_{DRM} = 250 V, Note 1
	Peak On-State Voltage, Either Direction	V_{TM}	–	2.0	3.0	Volts	I_{TM} = 100 mA Peak

Note 1. Test voltage must be applied within dv/dt rating.

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25° C Free Air Temperature Unless Otherwise Specified)

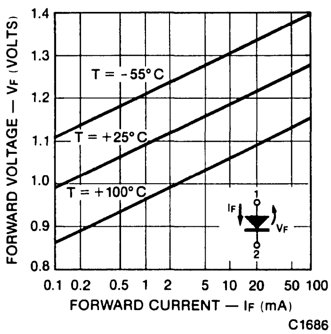


Fig. 1. Forward Voltage Drop vs. Forward Current

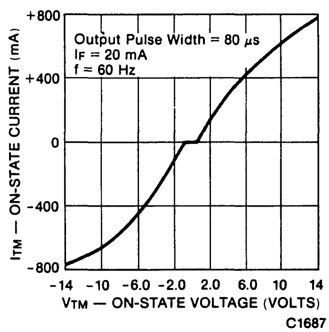


Fig. 2. On-State Characteristics

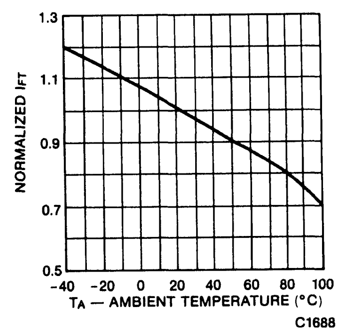


Fig. 3. Trigger Current vs. Temperature

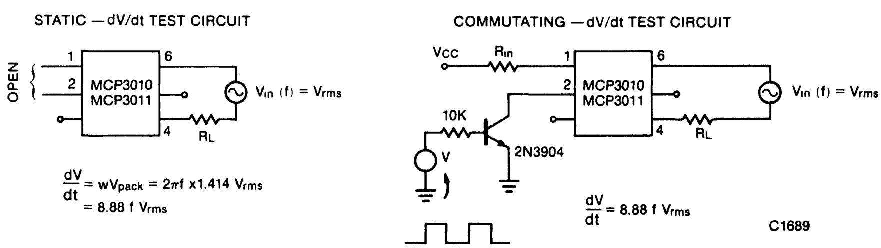


Fig. 4. dV/dt Test Circuits

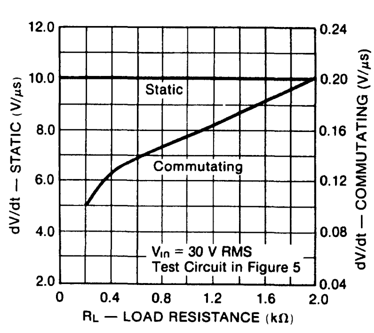


Fig. 5. dV/dt vs. Load Resistance

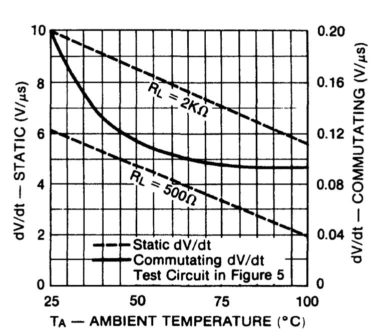


Fig. 6. dV/dt vs. Temperature

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25° C Temperature Unless Otherwise Specified)

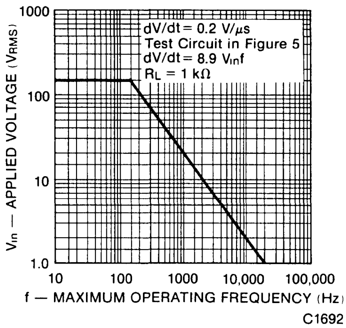


Fig. 7. Commutating dV/dt vs Frequency

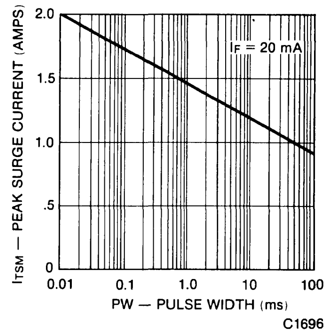


Fig. 8. Maximum Nonrepetitive Surge Current

TYPICAL APPLICATION CIRCUITS

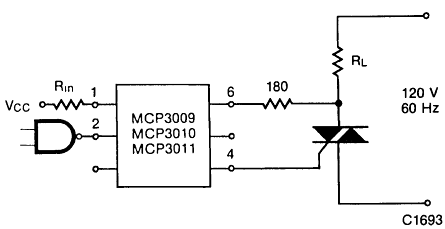


Fig. 9. Resistive Load

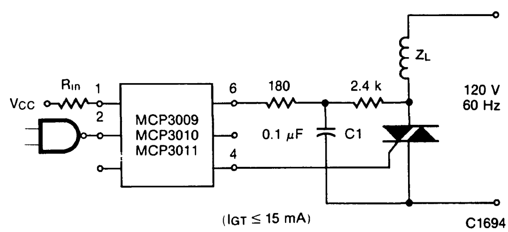


Fig. 10. Inductive Load With Sensitive Gate Triac

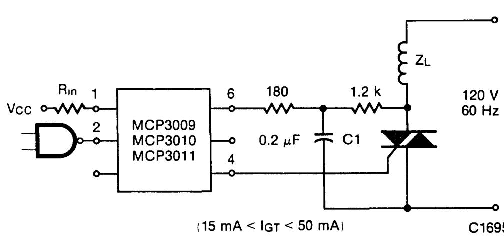
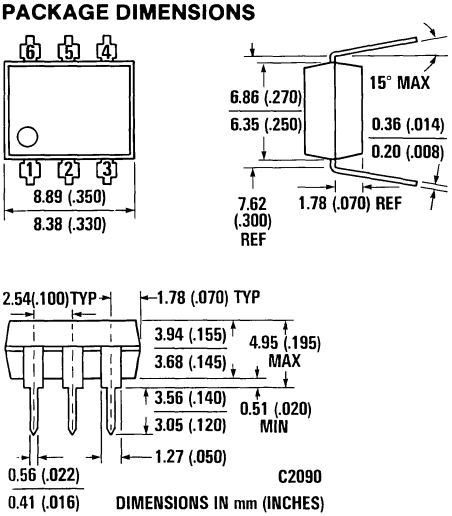
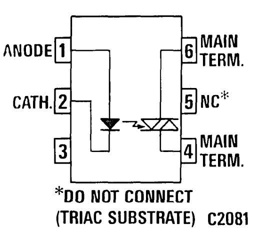


Fig. 11. Inductive Load With Non-Sensitive Gate Triac

AlGaAs NON-ZERO-CROSSING 5 mA MCP3012 MCP3023

PACKAGE DIMENSIONS





Equivalent Circuit

DESCRIPTION

The MCP3011A, MCP3012, MCP3022A and MCP3023 are optically isolated triac driver devices. These devices contain a very low degradation Aluminum Gallium Arsenide (AlGaAs) infrared emitting diode and a photosensitive silicon bilateral switch, which functions like a triac. This series is designed for interfacing between electronic controls and power triacs to control resistive and inductive loads for 240 VAC operations.

FEATURES

- Low input current, I_{FT} = 5 mA MCP3012, MCP3023
- Minimum commutating dV/dt is specified at 0.1 V/μsec
- High isolation voltage—minimum 7500 VAC peak
- Underwriters Laboratory (UL) recognized—File E50151
- Excellent I_{FT} stability—IR emitting diode has very low degradation.

APPLICATIONS

- European applications for 240 VAC
- Triac driver
- Industrial control
- Traffic lights
- Motor control
- Solid state relay

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C Unless Otherwise Specified)

TOTAL PACKAGE

Storage temperature	-55°C to 150°C
Operating temperature	-40°C to 100°C
Lead temperature (Soldering, 10 sec)	260°C
Total package power dissipation (LED plus detector)	330 mW
Derate linearly from 25°C	4.0 mW/°C
Surge isolation voltage	7500 VAC Peak

INPUT DIODE

Forward DC current	40 mA
Reverse voltage	3 V
Peak forward current (1 μs pulse, 300 pps)	3.0 A
Power dissipation	100 mW
Derate linearly from 25°C	1.33 mW/°C

OUTPUT DRIVER

Off-state output terminal voltage	
MCP3012	250 V
MCP3023	400 V
On-state RMS current T_A = 25°C	100 mA
(Full cycle, 50 to 60 Hz) T_A = 70°C	50 mA
Peak nonrepetitive surge current	
(PW = 10 ms, DC = 10%)	1.2 A
Total power dissipation	300 mW
Derate above 25°C	4.0 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

	TRANSFER CHARACTERISTICS						
	CHARACTERISTIC	**SYMBOL**	**MIN.**	**TYP.**	**MAX.**	**UNITS**	**TEST CONDITIONS**
DC	LED trigger current (current required to latch output) MCP3012, MCP3023	I_{FT}			5	mA	Main terminal voltage = 3 V
	Holding current	I_H		200		μA	Either direction
dv/dt RATING	Critical rate of rise of off-state voltage						
	MCP3023	dV/dt		15		V/μs	Static dv/dt, T_A = 85°C
	MCP3012			10		V/μs	(see Figure 6)
	Critical rate of rise of commutating voltage	dV/dt	0.1	0.2		V/μs	Commutating dv/dt I_{LOAD} = 15 mA (see Figure 7)
ISOLATION	Isolation Voltage	V_{iso}	5300			V_{AC}RMS	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA, 5 seconds
		V_{iso}	7500			V_{AC}PEAK	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA, 5 seconds
	Isolation resistance	R_{iso}	10^{11}			ohms	V_{I-O} = 500 VDC
	Isolation capacitance	C_{iso}		0.5		pF	f = 1 MHz

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	**SYMBOL**	**MIN.**	**TYP.**	**MAX.**	**UNITS**	**TEST CONDITIONS**
INPUT DIODE	Forward voltage	V_F		1.3	1.5	V	I_F = 10 mA
	Forward voltage temperature coefficient			-1.8		mV/°C	
	Reverse voltage	V_R	3.0	25		V	I_R = 10 μA
	Junction capacitance	C_J		50		pF	V_F = 0 V, f = 1 MHz
OUTPUT DETECTOR	Peak blocking current, either direction						
	MCP3012	I_{DRM}		10	100	nA	V_{DRM} = 250 V, Note 1
	MCP3023	I_{DRM}		10	100	nA	V_{DRM} = 400 V, Note 1
	Peak on-state voltage, either direction	V_{TM}		2.0	3.0	V	I_{TM} = 100 mA peak
	Note 1. Test voltage must be applied within dV/dt rating.						

TYPICAL ELECTRICAL CHARACTERISTIC CURVES (T_A = 25°C Unless Otherwise Specified)

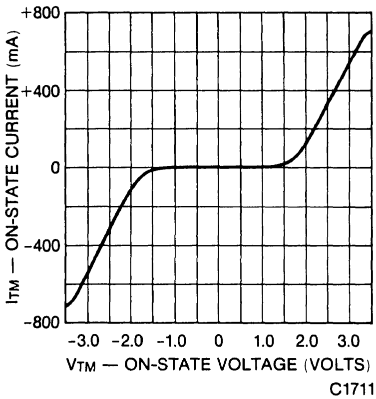


Fig. 1 On-State Characteristics

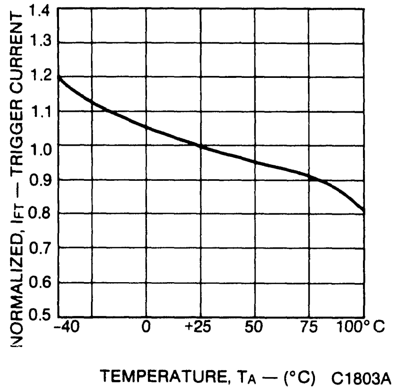


Fig. 2. Trigger Current vs. Temperature

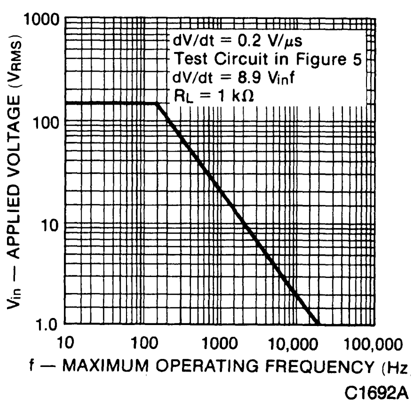


Fig. 3. Commutating dV/dt vs. Frequency

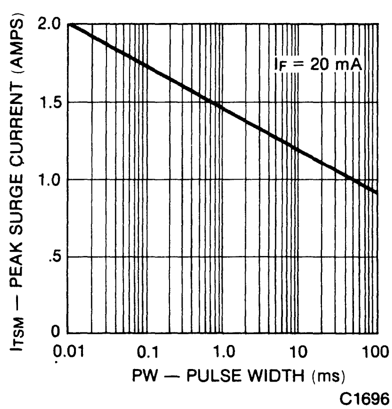
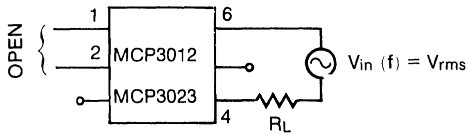


Fig. 4. Maximum Nonrepetitive Surge Current

TEST CIRCUITS FOR dV/dt MEASUREMENTS



$$\frac{dV}{dt} = wV_{pack} = 2\pi f \times 1.414\ V_{rms}$$
$$= 8.88\ f\ V_{rms}$$

Fig. 5. Static dV/dt

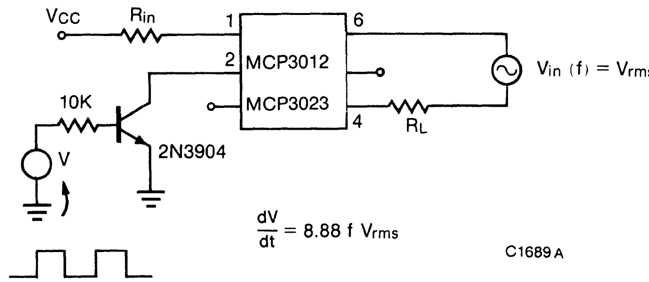


Fig. 6. Commutating dV/dt

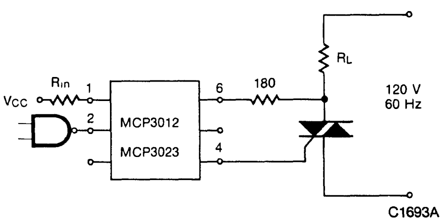


Fig. 7. Resistive Load

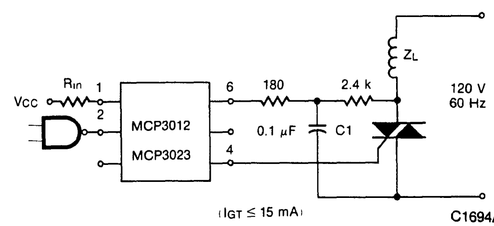


Fig. 8. Inductive Load With Sensitive Gate Triac

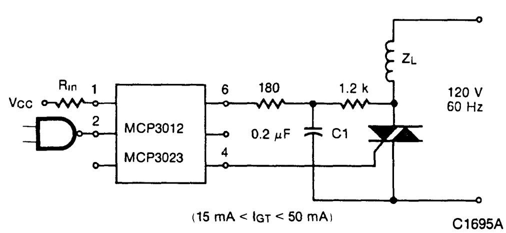


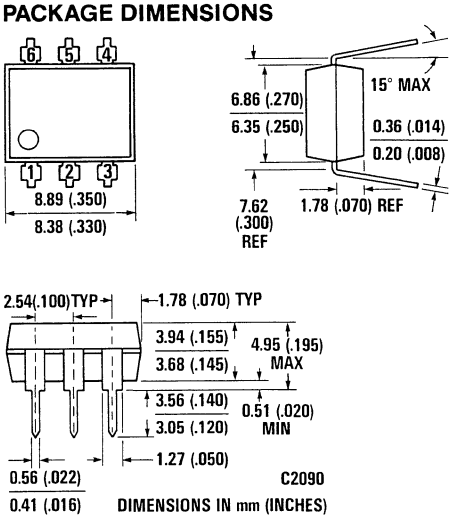
Fig. 9. Inductive Load With Non-Sensitive Gate Triac

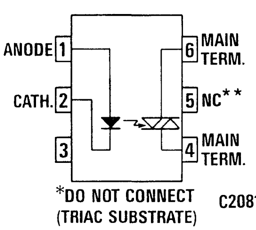
GENERAL INSTRUMENT

VDE APPROVED NON-ZERO-CROSSING TRIACS

NON-ZERO-CROSING
30 mA MCP3020/0Z*
15 mA MCP3021/1Z
10 mA MCP3022/2Z

PACKAGE DIMENSIONS





Equivalent Circuit

DESCRIPTION

The MCP3020, MCP3021 and MCP3022 are optically isolated triac driver devices. These devices contain a GaAs infrared emitting diode and a light activated silicon bilateral switch, which functions like a triac. This series is designed for interfacing between electronic controls and power triacs to control resistive and inductive loads for 240 VAC operations.

FEATURES

- Minimum commutating dv/dt is specified at 0.1 V/μsec
- Excellent I_{FT} stability—IR emitting diode has low degradation
- Pin for pin replacement for the MOC3020, MOC3021 and MOC3022
- High isolation voltage—minimum 7500 VAC peak
- Underwriters Laboaratory (UL) recognized—File #E50151

APPLICATIONS

- European applications for 240 VAC
- Triac driver
- Industrial controls
- Traffic lights
- Vending machines
- Motor control
- Solid state relay

*Not Recommended For New Designs

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature . . . . −55°C to 150°C
Operating temperature . . . . −40°C to 100°C
Lead temperature
(Soldering, 10 sec) . . . . 260°C
Total package power dissipation @ 25°C
(LED plus detector) . . . . 330 mW
Derate linearly from 25°C . . . . 4.0 mW/°C
Surge Isolation voltage . . . . 7500 VAC Peak

INPUT DIODE

Forward DC current . . . . 60 mA
Reverse voltage . . . . 3 V
Peak forward current
(1 μs pulse, 300 pps) . . . . 3.0 A
Power dissipation 25°C ambient . . . . 100 mW
Derate linearly from 25°C . . . . 1.33 mW/°C

OUTPUT DRIVER

Off-State Output Terminal Voltage . . . . . 400 Volts
On-State RMS Current T_A = 25°C . . . 100 mA
(Full Cycle, 50 to 60 Hz) T_A = 70°C . . . . 50 mA
Peak Nonrepetitive Surge Current . . . . 1.2 A
(PW = 10 ms, DC = 10%)
Total Power Dissipation @ T_A = 25°C . . . . . 300 mW
Derate above 25°C . . . . 4.0 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)

	TRANSFER CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	LED Trigger Current (Current Required to latch output) MCP3020	I_{FT}	–	15	30	mA	Main terminal voltage = 3.0 V
	MCP3021		–	8	15		
	MCP3022		–	5	10		
	Holding Current	I_H	–	200	–	μA	Either direction
dv/dt RATING	Critical Rate of Rise of Off-State Voltage	dv/dt	–	15	–	V/μs	Static dv/dt, T_A = 85°C (see Figure 4)
	Critical Rate of Rise of Commutating Voltage	dv/dt	0.1	0.2	–	V/μS	Commutating dv/dt I_{LOAD} = 15 mA (see Figure 5)
ISOLATION	Isolation Voltage	V_{iso}	5300			V_{AC}RMS	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA, 5 seconds
		V_{iso}	7500			V_{AC}PEAK	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA, 5 seconds
	Isolation resistance	R_{iso}	10^{11}			ohms	V_{I-O} = 500 VDC
	Isolation capacitance	C_{iso}		0.5		pF	f = 1 MHz

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.3	1.50	V	I_F = 30 mA
	Forward voltage temp. coefficient			-1.8		mV/°C	
	Reverse breakdown voltage	BV_R	3.0	25		V	I_R = 10 μA
	Junction capacitance	C_J		50		pF	V_F = 0 V, f = 1 MHz
				65		pF	V_F = 1 V, f = 1 MHz
	Reverse leakage current	I_R		.35	10	μA	V_R = 3.0 V
OUTPUT DETECTOR	Peak Blocking Current, Either Direction	I_{DRM}	–	10	100	nA	V_{DRM} = 400 V, Note 1
	Peak On-State Voltage, Either Direction	V_{TM}	–	2.0	3.0	Volts	I_{TM} = 100 mA Peak
	Note 1. Test voltage must be applied within dv/dt rating.						

TYPICAL ELECTRICAL CHARACTERISTIC CURVES (25°C Free Air Temperature Unless Otherwise Specified)

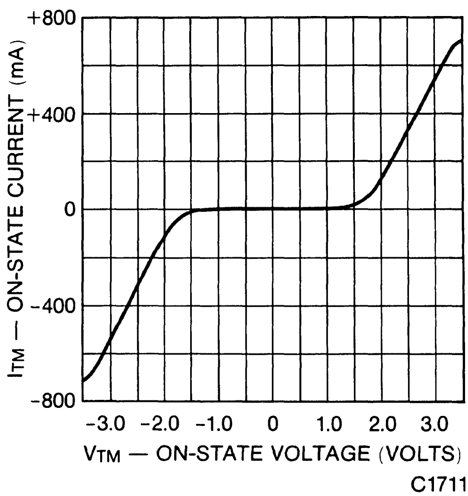


Fig. 1 On-State Characteristics

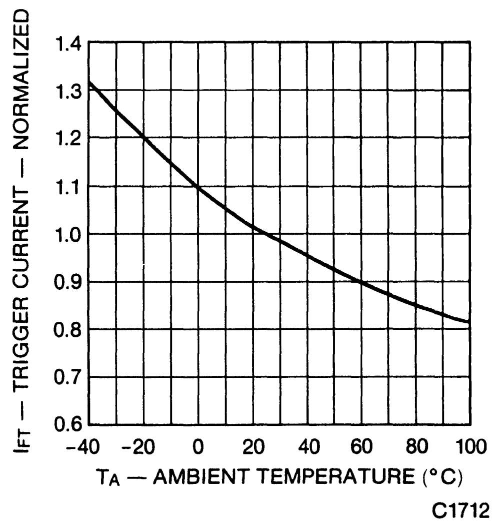
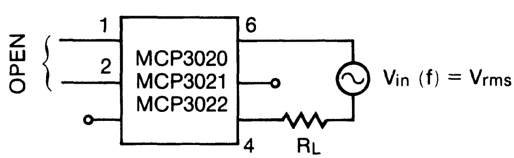


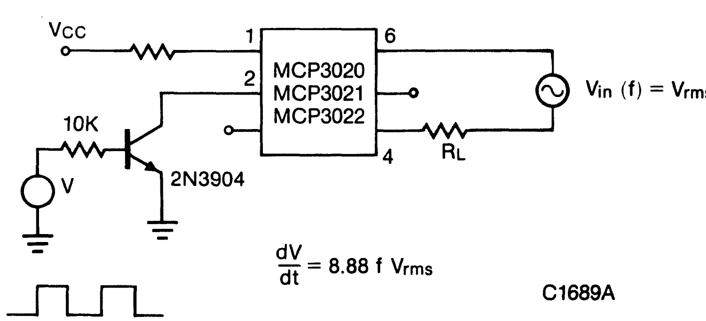
Fig. 2 Trigger Current vs. Temperature

TEST CIRCUITS FOR dV/dt MEASUREMENTS



$$\frac{dV}{dt} = wV_{pack} = 2\pi f \times 1.414\ V_{rms}$$
$$= 8.88\ f\ V_{rms}$$

Fig. 3. Static dV/dt



$$\frac{dV}{dt} = 8.88\ f\ V_{rms}$$

C1689A

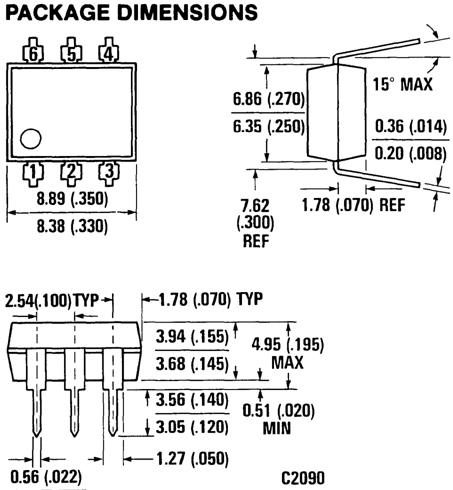
Fig. 4. Commutating dV/dt

GENERAL INSTRUMENT

VDE APPROVED ZERO-CROSSING TRIACS

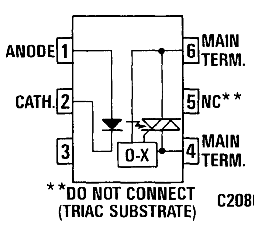
ZERO-CROSSING 30 mA MCP3030* MCP3040/0Z* 15 mA MCP3031 MCP3041/1Z

PACKAGE DIMENSIONS



C2090

DIMENSIONS IN mm (INCHES)



**DO NOT CONNECT (TRIAC SUBSTRATE) C2080

Equivalent Circuit

DESCRIPTION

These devices are optically isolated zero-crossing triac drivers. They consist of a Gallium Arsenide infrared emitting diode optically coupled to a photosensitive silicon detector which functions as a zero voltage crossing bilateral triac driver. This series is designed for interfacing between electronic controls, motors, solenoids and consumer appliances, etc.

FEATURES

- Logic control for 110 VAC or 220 VAC Power
- High isolation voltage — minimum 7500 VAC peak
- Underwriters Laboratory (UL) recognized File #E50151
- Pin for pin replacement for the MOC3030, MOC3031, MOC3040, MOC3041
- Excellent I_{FT} stability — IR emitting diode has low degradation.

APPLICATIONS

- Triac driver
- Industrial controls
- Solid state relay
- Traffic lights
- Motor controls
- Home appliances

*Not Recommended For New Designs

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

TOTAL PACKAGE

Storage temperature	-55° C to 150° C
Operating temperature	-40° C to 100° C
Lead temperature (Soldering, 10 sec)	260° C
Total package power dissipation @ 25° C (LED plus detector)	330 mW
Derate linearly from 25° C	4.0 mW/° C
Surge Isolation voltage	7500 VAC Peak
Withstand test voltage	7500 VAC Peak (50-60Hz)

INPUT DIODE

Forward DC current	60 mA
Reverse voltage	6 V
Peak forward current (1 μs pulse, 300 pps)	3.0 A
Power dissipation 25° C ambient	100 mW
Derate linearly from 25° C	1.33 mW/° C

OUTPUT DRIVER

Off-State Output Terminal Voltage	
MCP3030, MCP3031	250 V
MCP3040, MCP3041	400 V
On-State RMS Current T_A = 25° C	100 mA
(Full Cycle, 50 to 60 Hz) T_A = 70° C	50 mA
Peak Nonrepetitive Surge Current (PW = 10 ms, DC = 10%)	1.2 A
Total Power Dissipation @ T_A = 25° C	300 mW
Derate above 25° C	4.0 mW/° C

ELETRO-OPTICAL CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

TRANSFER CHARACTERISTICS							
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	LED trigger current (current required to latch output)						
	MCP3030, MCP3040	I_{FT}		16	30	mA	Main terminal
	MCP3031, MCP3041	I_{FT}		7	15	mA	voltage = 3.0 V
	Holding current	I_H		200		μA	Either direction
ZERO CROSSING	Inhibit voltage (MT1-MT2 voltage above which device will not trigger)	V_{IH}		15	25	V	I_F = Rated I_{FT}
	Leakage in inhibited state						I_F = Rated I_{FT},
	MCP3030, MCP3031	I_{DRM2}		100	200	μA	V_{DRM} = 250 V
	MCP3040, MCP3041	I_{DRM2}		100	300	μA	V_{DRM} = 400 V
ISOLATION	Isolation Voltage	V_{iso}	5300			V_{AC}RMS	Relative humidity ≤ 50%, $I_{I\text{-}O}$ ≤ 10 μA, 5 seconds
		V_{iso}	7500			V_{AC}PEAK	Relative humidity ≤ 50%, $I_{I\text{-}O}$ ≤ 10 μA, 5 seconds
	Isolation resistance	R_{iso}	10^{11}			ohms	$V_{I\text{-}O}$ = 500 VDC
	Isolation capacitance	C_{iso}		0.5		pF	f = 1 MHz

INDIVIDUAL COMPONENT CHARACTERISTICS							
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.3	1.50	V	I_F = 30 mA
	Forward voltage temp. coefficient			-1.8		mV/° C	
	Reverse voltage	V_R	3.0	25		V	I_R = 10 μA
	Junction capacitance	C_J		50		pF	V_F = 0 V, f = 1 MHz
				65		pF	V_F = 1 V, f = 1 MHz
OUTPUT DETECTOR	Peak Blocking Current, Either Direction						
	MCP3030, MCP3031	I_{DRM1}		2	100	nA	V_{DRM} = 250 V, Note 1
	MCP3040, MCP3041	I_{DRM1}		2	100	nA	V_{DRM} = 400 V, Note 1
	Peak On-State Voltage, Either Direction	V_{TM}		1.8	3.0	Volts	I_{TM} = 100 mA Peak
	Critical rate of rise of off-state voltage	dV/dt		1000		V/μs	
	Note 1. Test voltage must be applied within dV/dt rating.						

CAUTION: Normal anti-static precautions are required when handling this product.

TYPICAL ELECTRICAL CHARACTERISTIC CURVES (T_A = 25° C Unless Otherwise Specified)

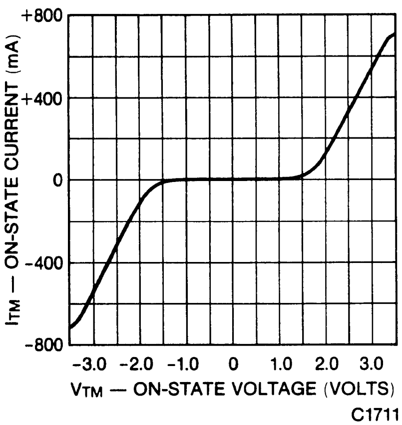


Fig. 1
On-State Characteristics

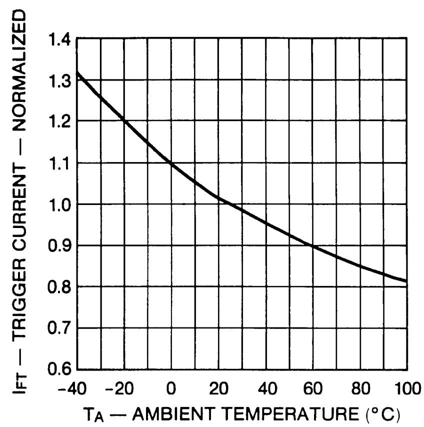


Fig. 2. Trigger Current vs. Temperature

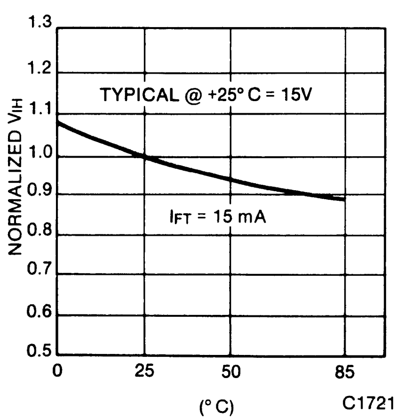


Fig. 3. Normalized Inhibit Voltage (V_{IH}) vs. Temperature

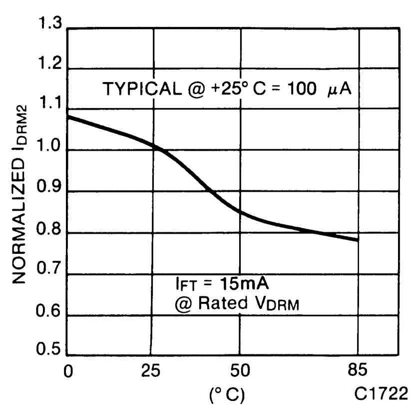


Fig. 4. Normalized I_{DRM2} vs. Temperature

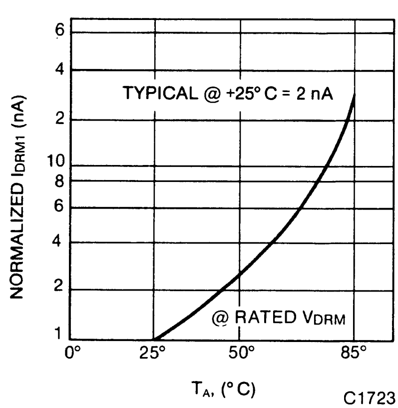


Fig. 5. Normalized I_{DRM1} vs. Temperature

APPLICATIONS

Typical TTL Logic → AC Power Interface

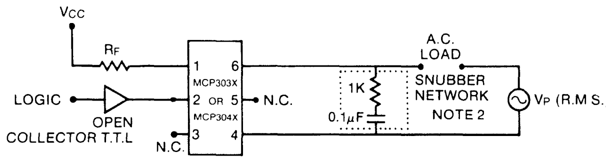
I. LED Trigger Current Requirements

DEVICE	V_{CC}	R_F (MAX)	I_{FT}
MCP30X1	5V	160Ω	15mA
MCP30X1	12V	560Ω	15mA
MCP30X0	5V	86Ω	30mA
MCP30X0	12V	290Ω	30mA

II. Device/Line Voltage/Load Selection

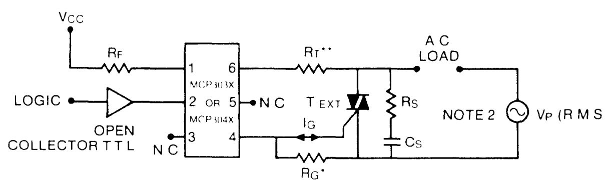
DEVICE	V_P (RMS)	LOAD TYPE	SNUBBER REQUIREMENT
MCP303X	≤120V	Resistive	No
MCP304X	≤240V	Resistive	No
MCP303X	≤120V	Inductive	Yes
MCP304X	≤240V	Inductive	Yes

III. Typical Circuits @ $T_A \leq 70°C$



C1731

Figure 6 For Load Current $I_L \leq 50mA$ RMS - Direct Load Interface



C1732

Figure 7 For Load Current $I_L > 50mA$ RMS - Interface Via External Triac (T_{EXT})

* R_G = 1kΩ optional for sensitive gate T_{EXT} - $I_G < 10mA$
** R_T = 180Ω for $I_G < 100mA$
R_T=86Ω for 100mA < I_G < 200mA

Typical Snubber Values — Fig. 7. Circuit Driving Inductive Load:

T_{EXT} dV/dt (V/μs)	RMS LOAD CURRENT I_L (A) — LEGEND: R_SΩ/C_S(μF)						
	100mA	500mA	1A	2A	5A	10A	50A
1	33k / 0.015	5.6k / 0.068	3.3k / 0.15	1k / 0.22	560 / 0.68	330 / 1.5	56 / 6.8
2	56k / 0.0033	8.2k / 0.022	5.6k / 0.033	3.3k / 0.068	820 / 0.22	560 / 0.33	86 / 2.20
5	no snubber	33k / 0.0033	10k / 0.005	6.8k / 0.01	3.3k / 0.02	1k / 0.05	330 / 0.33
10	no snubber	no snubber	33k / 0.0022	10k / 0.0033	6.8k / 0.0068	3.3k / 0.015	620 / 0.068

Given:
1. RMS Load Current
2. ≤240 V (RMS) Line
3. Commutating $\frac{dV}{dt}$ rating of T_{EXT}

NOTES

1. *MCP304X and T_{EXT} $V_{DRM} \geq 400$ V recommended for 120 V Inductive Loads - Fig. 7*
2. *Capacitor Working Voltage ≥ 2X RMS Line Voltage (V_P)*

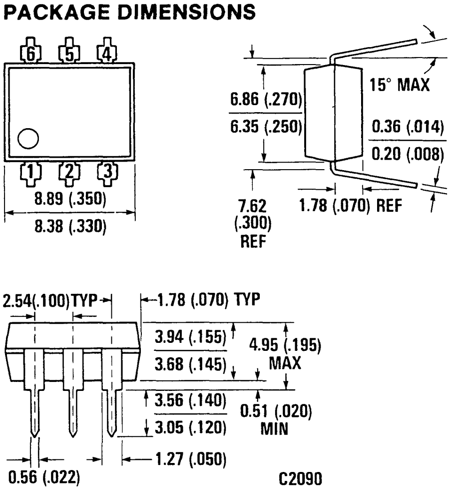
GENERAL INSTRUMENT

ZERO-CROSSING TRIACS

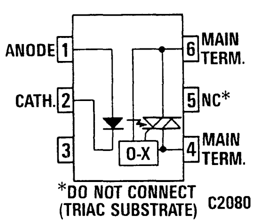
Optocouplers

AlGaAs ZERO-CROSSING 10 mA MCP3032 MCP3042 5 mA MCP3033 MCP3043

PACKAGE DIMENSIONS



DIMENSIONS IN mm (INCHES)



Equivalent Circuit

DESCRIPTION

These devices are optically isolated zero-crossing triac drivers. They consist of a very low degradation Aluminum Gallium Arsenide (AlGaAs) infrared emitting diode optically coupled to a photosensitive silicon detector which functions as a zero voltage crossing bilateral triac driver. This series is designed for interfacing between electronic controls, motors, solenoids and consumer appliances, etc.

FEATURES

- Low input current, I_{FT} = 5 mA (MCP3033, MCP3043)
- Logic control for 110 VAC or 220 VAC Power
- High isolation voltage—minimum 7500 VAC peak
- Underwriters Laboratory (UL) recognized File #E50151
- Excellent I_{FT} stability—IR emitting diode has very low degradation.

APPLICATIONS

- Triac driver
- Industrial controls
- Solid state relay
- Traffic lights
- Motor controls
- Home appliances

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

TOTAL PACKAGE

Storage temperature .... -55° C to 150° C
Operating temperature .... -40° C to 100° C
Lead temperature (Soldering, 10 sec) .... 260° C
Total package power dissipation
@ 25° C (LED plus detector) .... 330 mW
Derate linearly from 25° C .... 4.0 mW/° C
Surge isolation voltage .... 7500 VAC Peak
Withstand test voltage...... 7500 VAC Peak (50-60 Hz)

INPUT DIODE

Forward DC current .... 40 mA
Reverse voltage .... 3 V
Peak forward current (1 μs pulse, 300 pps) .... 3.0 A
Power dissipation .... 100 mW
Derate linearly from 25° C .... 1.33 mW/° C

OUTPUT DRIVER

Off-state output terminal voltage
MCP3032, MCP3033 .... 250 V
MCP3042, MCP3043 .... 400 V
On-state RMS current T_A = 25° C .... 100 mA
(Full cycle, 50 to 60 Hz) T_A = 70° C .... 50 mA
Peak nonrepetitive surge current
(PW = 10 ms, DC = 10%) .... 1.2 A
Total Power Dissipation .... 300 mW
Derate above 25° C .... 4.0 mW/° C

ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25°C Unless Otherwise Specified)

TRANSFER CHARACTERISTICS

	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	LED trigger current (current required to latch output)						Main terminal voltage = 3.0 V either direction
	MCP3032, MCP3042	I_{FT}		7	10	mA	
	MCP3033, MCP3043	I_{FT}		3.5	5	mA	
	Holding current	I_H		200		μA	
ZERO CROSSING	Inhibit voltage (MT1-MT2 voltage above which device will not trigger)	V_{IH}		15	25	V	I_F = Rated I_{FT}
	Leakage in inhibited state						I_F = Rated I_{FT}
	MCP3032, MCP3033	I_{DRM2}		100	200	μA	V_{DRM} = 250 V
	MCP3042, MCP3043	I_{DRM2}		100	300	μA	V_{DRM} = 400 V
ISOLATION	Isolation Voltage	V_{iso}	5300			V_{AC}RMS	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA, 5 seconds
		V_{iso}	7500			V_{AC}PEAK	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA, 5 seconds
	Isolation resistance	R_{iso}	10^{11}			ohms	V_{I-O} = 500 VDC
	Isolation capacitance	C_{iso}		0.5		pF	f = 1 MHz

INDIVIDUAL COMPONENT CHARACTERISTICS

	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.3	1.5	V	I_F = 10 mA
	Forward voltage temperature coefficient			-1.8		mV/°C	
	Reverse voltage	V_R	3.0	25		V	I_R = 10 μA
	Junction capacitance	C_J		50		pF	V_F = 0 V, f = 1 MHz
				65		pF	V_F = 1 V, f = 1 MHz
OUTPUT DETECTOR	Peak blocking current, either direction						
	MCP3032, MCP3033	I_{DRM1}		2	100	nA	V_{DRM} = 250 V, Note 1
	MCP3042, MCP3043	I_{DRM1}		2	100	nA	V_{DRM} = 400 V, Note 1
	Peak on-state voltage, either direction	V_{TM}		1.8	3.0	V	I_{TM} = 100 mA peak
	Critical rate of rise of off-state voltage	dV/dt		1000		V/μs	

Note 1. Test voltage must be applied within dV/dt rating.

CAUTION: Normal anti-static precautions are required when handling this product.

TYPICAL ELECTRICAL CHARACTERISTIC CURVES (T_A = 25° C Unless Otherwise Specified)

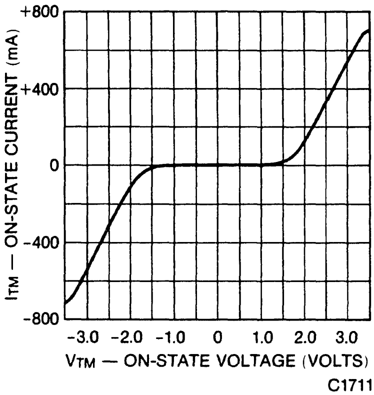


Fig. 1. On-State Characteristics

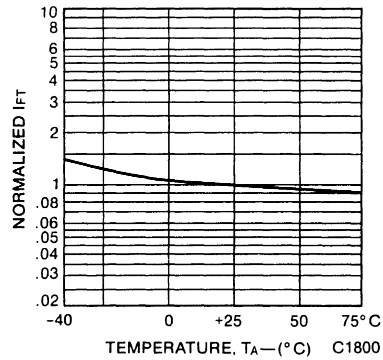


Fig. 2. Trigger Current vs. Temperature

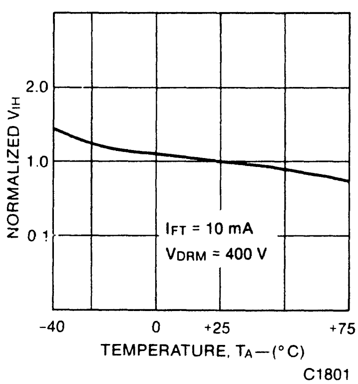


Fig. 3. Normalized Inhibit Voltage (V_{IH}) vs. Temperature

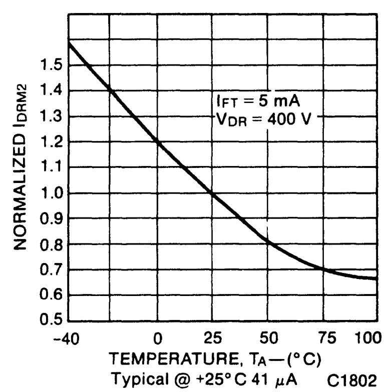


Fig. 4. Normalized I_{DRM2} vs. Temperature

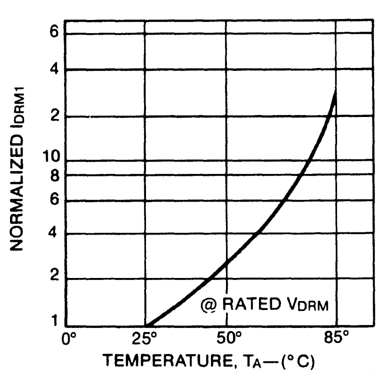


Fig. 5. Normalized I_{DRM1} vs. Temperature

APPLICATIONS

Typical TTL Logic → AC Power Interface

I. LED Trigger Current Requirements

DEVICE	V_{CC}	R_F	I_{FT}
MCP30X2	5V	330Ω	10 mA
MCP30X2	12V	1000Ω	10 mA
MCP30X3	5V	620Ω	5 mA
MCP30X3	12V	2000Ω	5 mA

II. Device/Line Voltage/Load Selection

DEVICE	V_P (RMS)	LOAD TYPE	SNUBBER REQUIREMENT
MCP303X	≤120V	Resistive	No
MCP304X	≤240V	Resistive	No
MCP303X	≤120V	Inductive	Yes
MCP304X	≤240V	Inductive	Yes

III. Typical Circuits @ $T_A \leq 70°C$

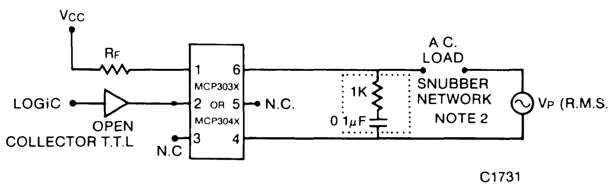


Figure 6 For Load Current $I_L \leq 50mA$ RMS - Direct Load Interface

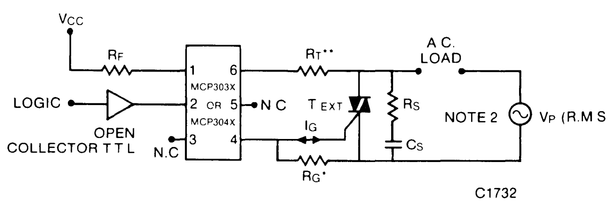


Figure 7 For Load Current $I_L > 50mA$ RMS - Interface Via External Triac (T_{EXT})

* R_G = 1kΩ optional for sensitive gate T_{EXT} - $I_G < 10mA$
** R_T = 180Ω for $I_G < 100mA$
R_T=86Ω for 100mA < $I_G < 200mA$

Typical Snubber Values — Fig. 7. Circuit Driving Inductive Load:

T_{EXT} dV/dt (V/μs)	RMS LOAD CURRENT I_L (A) LEGEND: R_SΩ/C_S(μF)						
	100mA	500mA	1A	2A	5A	10A	50A
1	33k / 0.015	5.6k / 0.068	3.3k / 0.15	1k / 0.22	560 / 0.68	330 / 1.5	56 / 6.8
2	56k / 0.0033	8.2k / 0.022	5.6k / 0.033	3.3k / 0.068	820 / 0.22	560 / 0.33	86 / 2.20
5	no snubber	33k / 0.0033	10k / 0.005	6.8k / 0.01	3.3k / 0.02	1k / 0.05	330 / 0.33
10	no snubber	no snubber	33k / 0.0022	10k / 0.0033	6.8k / 0.0068	3.3k / 0.015	620 / 0.068

Given:
1. RMS Load Current
2. ≤240 V (RMS) Line
3. Commutating $\frac{dv}{dt}$ rating of T_{EXT}

NOTES

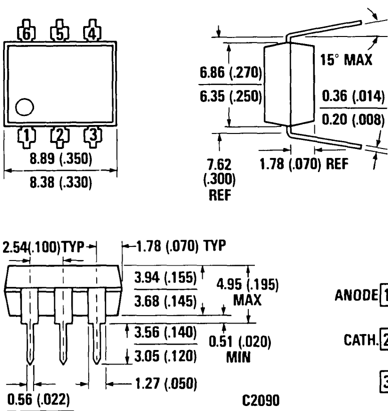
1. *MCP304X and T_{EXT} $V_{DRM} \geq 400$ V recommended for 120 V Inductive Loads - Fig. 7*
2. *Capacitor Working Voltage ≥ 2X RMS Line Voltage (V_P)*

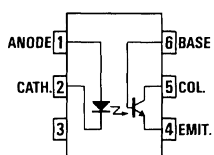
GENERAL INSTRUMENT

PHOTOTRANSISTOR OPTOCOUPLER

MCT2

PACKAGE DIMENSIONS





Equivalent Circuit

DESCRIPTION

The MCT2 is a NPN silicon planar phototransistor optically coupled to a gallium arsenide infrared emitting diode.

FEATURES AND APPLICATIONS

- AC line/digital logic isolator
- Digital logic/digital logic isolator
- Telephone/telegraph line receiver
- Twisted pair line receiver
- High frequency power supply feedback control
- Relay contact monitor
- Power supply monitor
- UL recognized — File E50151

ABSOLUTE MAXIMUM RATINGS

Storage temperature .... -55° C to 150° C
Operating temperature .... -55° C to 100° C
Lead soldering temperature (10 sec) .... 260° C
Input Diode
  Forward current .... 60 mA
  Reverse voltage .... 3.0 V
  Peak forward current
    (1 μs pulse, 300 pps) .... 3.0 A
  Power dissipation at 25° C ambient .... 200 mW
  Derate linearly from 25° C .... 2.6 mW/° C
Output Transistor
  Power dissipation at 25° C ambient .... 200 mW
  Derate linearly from 25° C .... 2.6 mW/° C
Input to output voltage isolation .... 1500 VDC
Total package power dissipation at 25° C ambient
  (LED plus detector) .... 250 mW
Derate linearly from 25° C .... 3.3 mW/° C
Collector-Emitter Current (I_{CE}) .... 50 mA

ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature Unless Otherwise Specified)

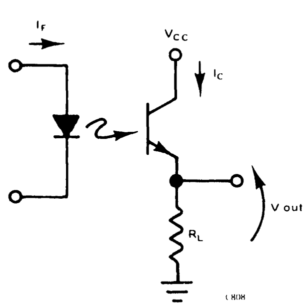
CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Input Diode						
Forward Voltage	V_F		1.25	1.50	V	I_F = 20 mA
Reverse Voltage	V_R	3.0	25		V	I_R = 10 μA
Junction Capacitance	C_J		50		pF	V_F = 0 V
Reverse Leakage Current	I_R		.01	10	μA	V_R = 3.0 V
Output Transistor						
DC Forward Current Gain	h_{FE}		250			V_{CE} = 5 V, I_C = 100 μA
Collector To Emitter Breakdown Volt.	BV_{CEO}	30	85		V	I_C = 1.0 mA, I_F = 0
Collector To Base Breakdown Voltage	BV_{CBO}	70	165		V	I_C = 10 μA
Emitter to Collector Breakdown Voltage	BV_{ECO}	7	14		V	I_E = 100 μA, I_F = 0
Collector To Emitter, Leakage Current	I_{CEO}		5	50	nA	V_{CE} = 10 V, I_F = 0
Collector To Base Leakage Current	I_{CBO}		0.1	20	nA	V_{CB} = 10 V, I_F = 0

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

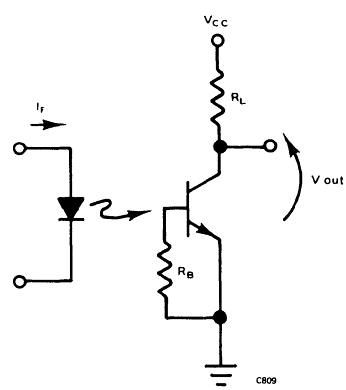
CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Capacitance Collector To Emitter	C_{CEO}		8		pF	$V_{CE}=0$
Capacitance Collector To Base	C_{CBO}		20		pF	$V_{CB}=10$ V
Capacitance Emitter To Base	C_{EBO}		10		pF	$V_{BE}=0$
Coupled						
DC Collector Current Transfer Ratio	CTRCE	20	60		%	$V_{CE}=10$ V, $I_F=10$ mA, Note 1
DC Base Current Transfer Ratio	CTRCB		.35		%	$V_{CB}=10$ V, I_F-10 mA
Isolation Voltage		3500			VDC	
		2500			VRMS	f=60 Hz
Isolation Resistance		10^{11}	10^{12}		Ω	$V_{I-O}=500$ V
Isolation Capacitance			.5		pF	f=1MHz
Collector-Emitter, Saturation Voltage	V_{CE}(sat)		0.24	0.4	V	I_C = 2.0 mA, I_F = 16 mA
Bandwidth (see note 2)	B_W		150		KHz	$I_C=2$ mA, $V_{CE}=10$ V, $R_L=100$ Ω (Circuit No. 1)

SWITCHING TIMES		TYP.	UNITS	TEST CONDITIONS
Saturated				
t on (from 5 V to 0.8 V)	t_{on} (SAT)	10	μs	$R_L=2$ KΩ, $I_F=15$ mA, $V_{CC}=5$ V
t off (from SAT to 2.0 V)	t_{off} (SAT)	30		R_B=open (Circuit No. 2)
Saturated				
t on (from 5 V to 0.8 V)	t_{on} (SAT)	10	μs	$R_L=2$ KΩ, $I_F=20$ mA, $V_{CC}=5$ V
t off (from SAT to 2.0 V)	t_{off} (SAT)	27		$R_B=100$ KΩ (Circuit No. 2)
Non-Saturated				
Base Rise Time	t_r	300	ns	$R_L=1$ KΩ, $V_{CB}=10$ V
Fall Time	t_f	300	ns	

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES
(25°C Free Air Temperature Unless Otherwise Specified)



Circuit 1



Circuit 2

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (Cont'd)

(25° C Free Air Temperature Unless Otherwise Specified)

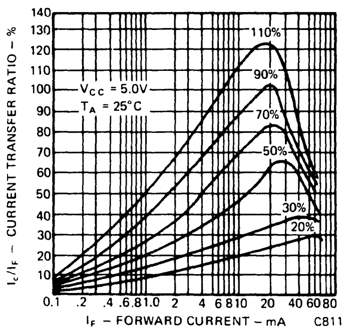


Fig. 1. Current Transfer Ratio vs. Forward Current

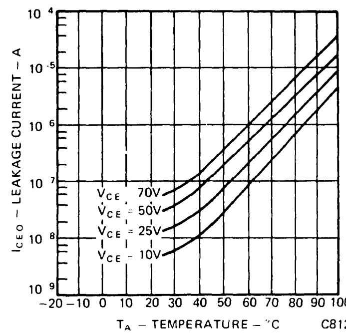


Fig. 2. Dark Current vs. Temperature

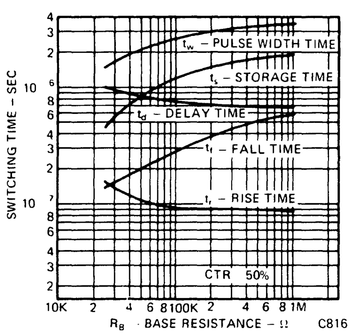


Fig. 3. Switching Time vs. Base Resistance

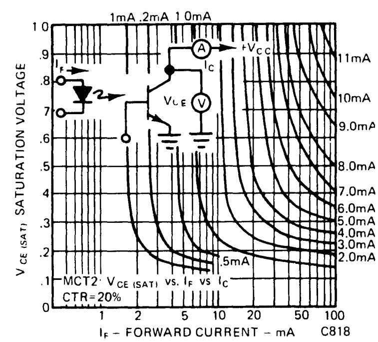


Fig. 4. Saturation Voltage vs. Forward Current

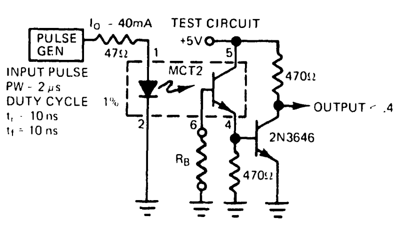


Fig. 5. Circuit for Figure 3

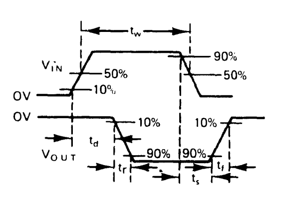


Fig. 6. Waveforms for Figure 3

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (Cont'd)

(25° C Free Air Temperature Unless Otherwise Specified)

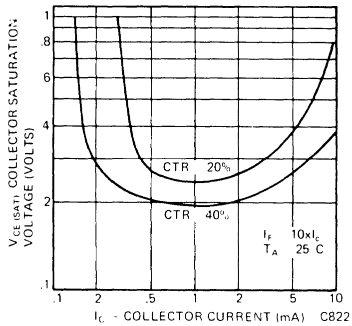


Fig. 7. Saturation Voltage vs. Collector Current

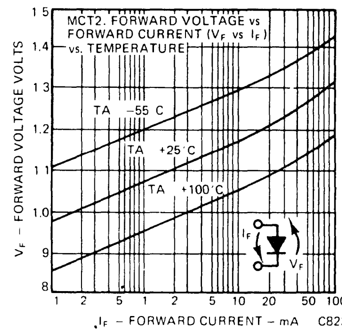


Fig. 8. Forward Voltage vs. Forward Current

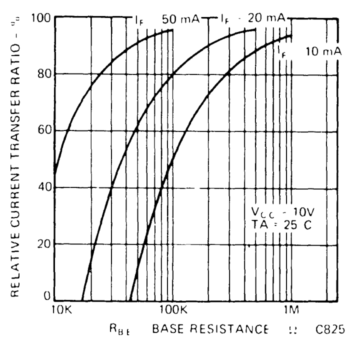


Fig. 9. Sensitivity vs. Base Resistance

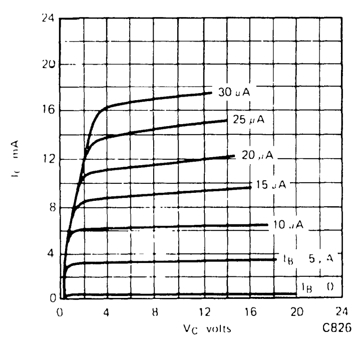


Fig. 10. Detector Typical h_{fe} Curves

NOTES

1. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.*
2. *The frequency at which i_c is 3 dB down from the 1 kHz value.*
3. *Rise time (t_r) is the time required for the collector current to increase from 10% of its final value, to 90%.*
   Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value, to 10%.

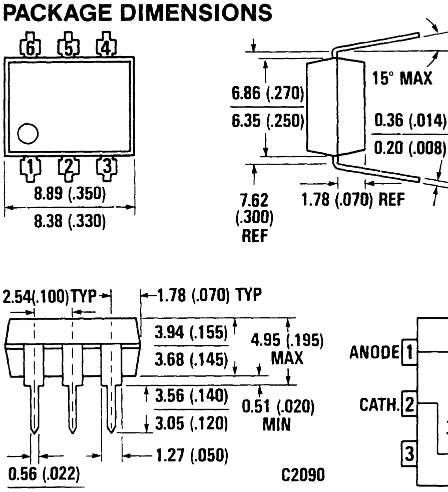
GENERAL INSTRUMENT

PHOTOTRANSISTOR OPTOCOUPLER

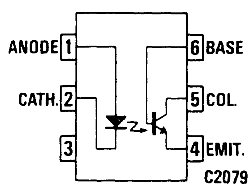
Optocouplers

MCT2E

PACKAGE DIMENSIONS



DIMENSIONS IN mm (INCHES)



Equivalent Circuit

DESCRIPTION

The MCT2E is a NPN silicon planar phototransistor optically coupled to a gallium arsenide infrared emitting diode.

FEATURES & APPLICATIONS

- Utility/economy isolator
- AC line/digital logic isolator
- Digital logic/digital logic isolator
- Telephone/telegraph line receiver
- Twisted pair line receiver
- High frequency power supply feedback control
- Relay contact monitor
- Power supply monitor
- UL recognized — File E50151
- High isolation voltage
  V_{ISO} = 2500 V RMS, 1 minute

ABSOLUTE MAXIMUM RATINGS

Storage temperature .... -55°C to 150°C
Operating temperature .... -55°C to 100°C
Lead soldering temperature (10 sec) .... 260°C
Input Diode
  Forward current .... 60 mA
  Reverse voltage .... 3.0 V
  Peak forward current
    (1 μs pulse, 300 pps) .... 3.0 A
  Power dissipation at 25°C ambient .... 200 mW
  Derate linearly from 25°C .... 2.6 mW/°C
Output Transistor
  Power dissipation at 25°C ambient .... 200 mW
  Derate linearly from 25°C .... 2.6 mW/°C
Input to output voltage isolation .... 3550 VDC
Total package power dissipation at 25°C ambient
  (LED plus detector) .... 250 mW
Derate linearly from 25°C .... 3.3 mW/°C
Collector-Emitter Current (I_{CE}) .... 50 mA

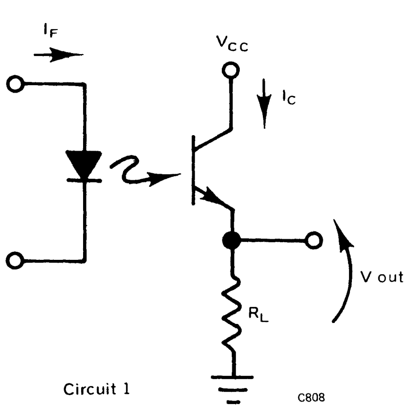
ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Input Diode						
Forward Voltage	V_F		1.25	1.50	V	I_F = 20 mA
Reverse Voltage	V_R	3.0	25		V	I_R=10 μA
Junction Capacitance	C_J		50		pF	V_F=0 V
Reverse Leakage Current	I_R		.01	10	μA	V_R=3.0 V
Output Transistor						
DC Forward Current Gain	h_{FE}	100	250			V_{CE}=5 V, I_C=100 μA
Collector To Emitter Breakdown Volt.	BV_{CEO}	30	85		V	I_C=1.0 mA, I_F=0
Collector To Base Breakdown Voltage	BV_{CBO}	70	165		V	I_C=10 μA
Emitter to Collector Breakdown Voltage	BV_{ECO}	7	14		V	I_E = 100 μA, I_F = 0
Collector To Emitter, Leakage Current	I_{CEO}		5	50	nA	V_{CE}=10 V, I_F=0
Collector To Base Leakage Current	I_{CBO}		0.1	20	nA	V_{CB}=10 V, I_F=0

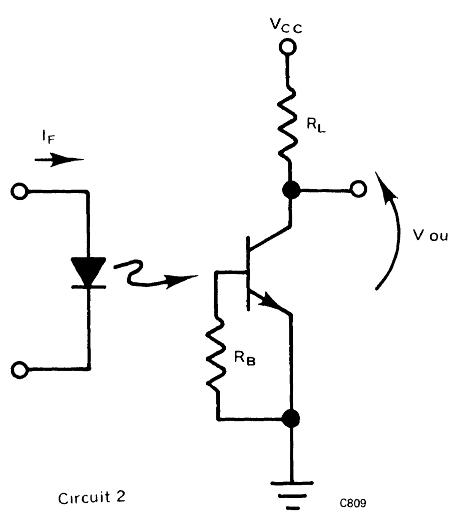
ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	GUAR. MIN.	TYP.	GUAR. MAX.	UNITS	TEST CONDITIONS
Capacitance Collector To Emitter	C_{CEO}		8		pF	V_{CE}=0
Capacitance Collector To Base	C_{CBO}		20		pF	V_{CB}=10 V
Capacitance Emitter To Base	C_{EBO}		10		pF	V_{BE}=0
Coupled						
DC Collector Current Transfer Ratio	CTR_{CE}	20	60		%	V_{CE}=10 V, I_F=10 mA, Note 1
DC Base Current Transfer Ratio	CTR_{CB}		.35		%	V_{CB}=10 V, I_F-10 mA
Surge isolation voltage	V_{iso}	4000			VDC	Relative humidity ≤ 50% T_A = +25°C, I_{I-O} ≤ 10 μA
		3000			VAC-rms	1 second
Steady state isolation voltage	V_{iso}	3500			VDC	Relative humidity ≤ 50%, T_A = +25°C, I_{I-O} ≤ 10 μA
		2500			VAC-rms	1 minute
	B_V(I-O)	3500			VDC	
Isolation Resistance		10^{11}	10^{12}		Ω	V_{I-O}=500 V
Isolation Capacitance			.5		pF	f=1MHz
Collector-Emitter, Saturation Voltage	V_{CE}(sat)		0.24	0.4	V	I_C = 2.0 mA, I_F = 16 mA
Bandwidth (see note 2)	B_W		150		KHz	I_C=2 mA, V_{CE}=10 V, R_L=100 Ω (Circuit No. 1)

SWITCHING TIMES		SYMBOL	TYP.	UNITS	TEST CONDITIONS
Non-Saturated Collector	Delay Time	t_d	0.5	μs	R_L=100 Ω, I_C=2 mA, V_{CC}=10 V (Circuit No. 1)
	Rise Time	t_r	2.5		
	Storage Time	t_s	0.1		
	Fall Time	t_f	2.6		
Non-Saturated Collector	Delay Time	t_d	2.0	μs	R_L=1 KΩ, I_C=2 mA, V_{CC}=10V (Circuit No. 1)
	Rise Time	t_r	15		
	Storage Time	t_s	0.1		
	Fall Time	t_f	15		
Saturated					
t on (from 5 V to 0.8 V)		t_{on} (SAT)	5	μs	R_L=2 KΩ, I_F=15 mA, V_{CC}=5 V
t off (from SAT to 2.0 V)		t_{off} (SAT)	25		R_B=open (Circuit No. 2)
Saturated					
t on (from 5 V to 0.8 V)		t_{on} (SAT)	5	μs	R_L=2 KΩ, I_F=20 mA, V_{CC}=5 V
t off (from SAT to 2.0 V)		t_{off} (SAT)	18		R_B=100 KΩ (Circuit No. 2)
Non-Saturated Base	Rise Time	t_r	175	ns	R_L=1 KΩ, V_{CB}=10 V
	Fall Time	t_f	175	ns	



Circuit 1



Circuit 2

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25° C Free Air Temperature Unless Otherwise Specified)

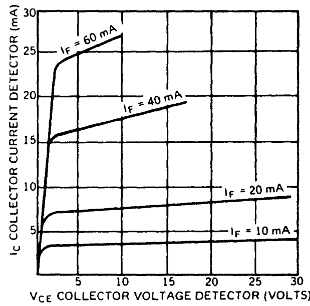


Fig. 1 Collector Current vs. Collector Voltage (for Typical CTR 30%)

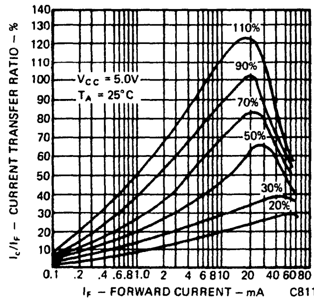


Fig. 2 Current Transfer Ratio vs. Forward Current

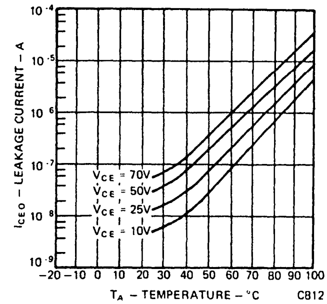


Fig. 3 Dark Current vs. Temperature

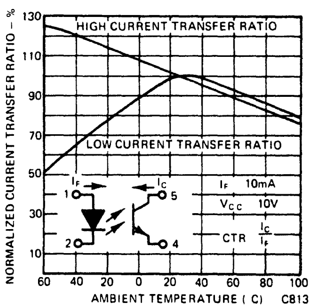


Fig. 4 Current Transfer Ratio vs. Temperature

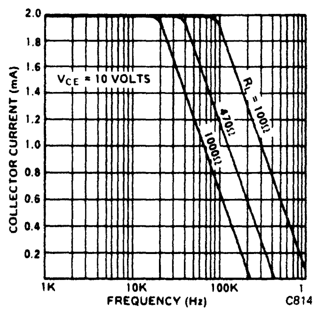


Fig. 5 Collector Current vs. Frequency

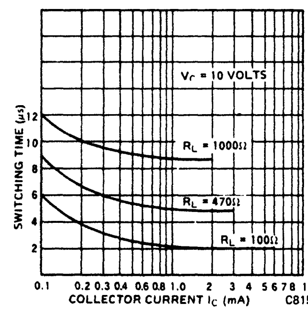


Fig. 6 Switching Time vs. Collector Current

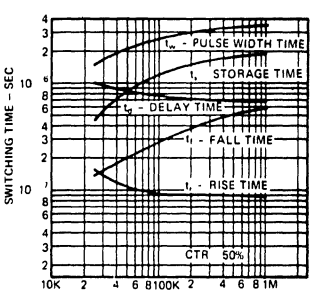


Fig. 7 Switching Time vs. Base Resistance

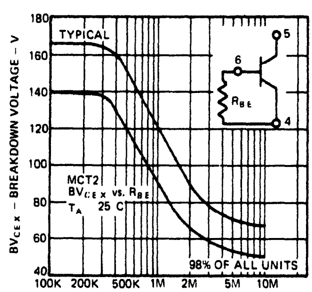


Fig. 8 Collector – Emitter Breakdown Voltage vs. Base Resistance

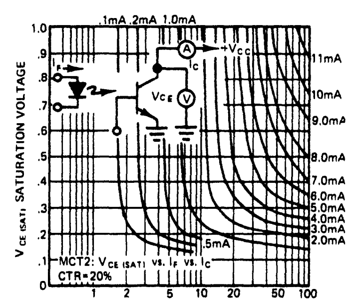


Fig. 9 Saturation Voltage vs. Forward Current

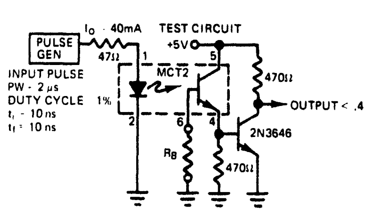


Fig. 10 Circuit for Figure 7

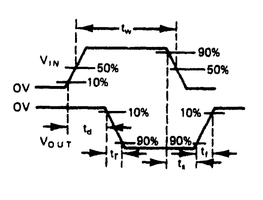


Fig. 11 Waveforms for Figure 7

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (Cont'd)

(25° C Free Air Temperature Unless Otherwise Specified)

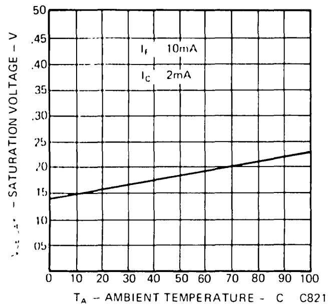


Fig. 12. Saturation Voltage vs. Temperature

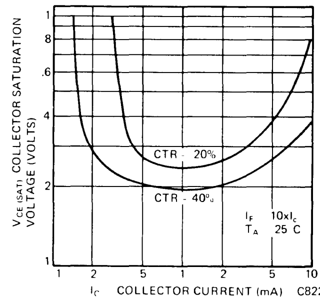


Fig. 13. Saturation Voltage vs. Collector Current

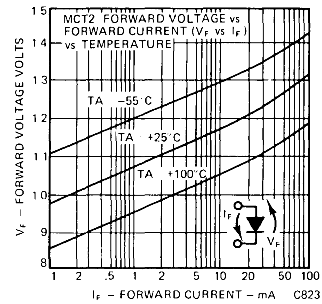


Fig. 14. Forward Voltage vs. Forward Current

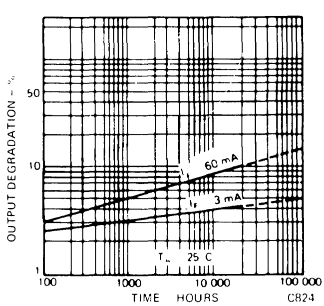


Fig. 15. Lifetime vs. Forward Current (Note 4)

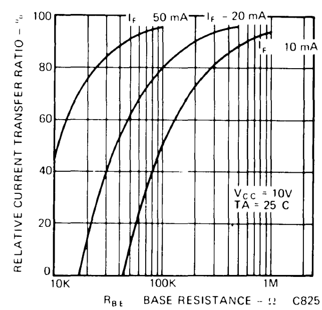


Fig. 16. Sensitivity vs. Base Resistance

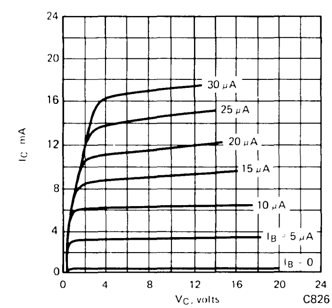
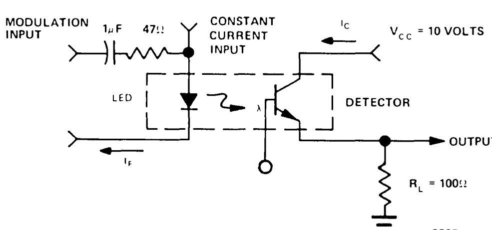
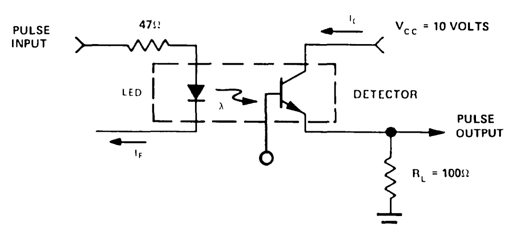


Fig. 17. Detector Typical h_{fe} Curves

OPERATING SCHEMATICS



Modulation Circuit Used to Obtain Output vs Frequency Plot



Circuit Used to Obtain Switching Time vs Collector Current Plot

NOTES

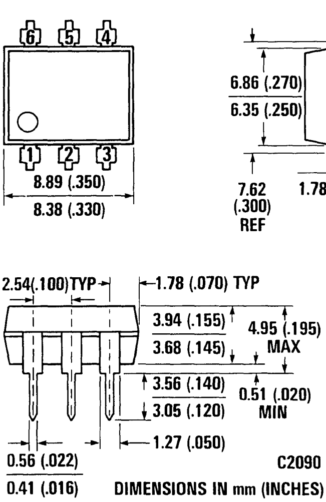
1. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.*
2. *The frequency at which i_c is 3 dB down from the 1 kHz value.*
3. *Rise time (t_r) is the time required for the collector current to increase from 10% of its final value, to 90%.*
   Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value, to 10%.

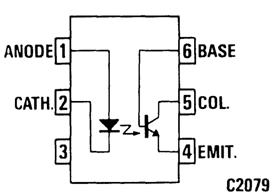
GENERAL INSTRUMENT

PHOTOTRANSISTOR OPTOCOUPLER

0-70°C MCT210

PACKAGE DIMENSIONS





Equivalent Circuit

DESCRIPTION

The MCT210 incorporates a NPN silicon planar phototransistor optically coupled to a galium arsenide infrared emitting diode. The MCT210 has a specified minimum CTR of 50%, saturated, and 150%, unsaturated.

FEATURES

- TTL compatible 1-10 gate loads
- High CTR with transistor output MCT210—150% min.
- Specified CTR over temperature range
- Good logic load characteristics
  V_{OL} = 0.4 V @ 1.6 mA to 16 mA output sinking (I_{OL})
- UL recognized (File #50151)

APPLICATIONS

- Digital logic isolation
- Line receivers
- Feedback control circuits
- Monitoring circuits

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	−55°C to 150°C
Operating temperature	−55°C to 100°C
Lead temperature (Soldering, 10 sec)	260°C
Total package power dissipation @ 25°C (LED plus detector)	260 mW
Derate linearly from 25°C	3.4 mW/°C
Surge isolation	4000 VDC 3000 VRMS
Steady state isolation	3500 VDC 2500 VRMS

INPUT DIODE

Forward current	60 mA
Reverse voltage	3.0 V
Peak forward current (1 μs pulse, 300 pps)	3.0 A
Power dissipation 25°C to 70°C ambient	90 mW
Derate linearly from +70°C	2.0 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C	200 mW
Derate linearly from 25°C	2.67 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (0°C to +70°C Temperature Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.25	1.50	V	I_F = 40 mA
	Forward voltage temp. coefficient			−1.8		mV/°C	
	Reverse breakdown voltage	BV_R	6.0	15		V	I_R = 10 μA
	Junction capacitance	C_J		50		pF	V_F = 0 V, f = 1 MHz
				65		pF	V_F = 1 V, f = 1 MHz
	Reverse leakage current	I_R		.01	10	μA	V_R = 6.0 V
OUTPUT TRANSISTOR	DC forward current gain	h_{FE}		400			V_{CE} = 5 V, I_C = 10 mA
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	30	45		V	I_C = 1.0 mA, I_F = 0
	Collector to base	BV_{CBO}	30			V	I_C = 10 μA
	Emitter to collector	BV_{ECO}	6	8		V	I_E = 100 μA, I_F = 0
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	V_{CE} = 5 V, I_F = 0, T_A = +25°C
					30	μA	V_{CE} = 5 V, I_F = 0,
	Capacitance						
	Collector to emitter			8		pF	V_{CE} = 0, f = 1 MHz
	Collector to base			20		pF	V_{CB} = 5, f = 1 MHz
	Emitter to base			10		pF	V_{EB} = 0, f = 1 MHz

TRANSFER CHARACTERISTICS

	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current transfer ratio, collector to emitter	I_{CE}/I_F					
	MCT210 (a)		50	70		%	V_{CE} = 0.4 V, I_F = 3.2 mA to 32 mA
			150	225		%	V_{CE} = 5.0 V, I_F = 10 mA
	Current transfer ratio, collector to base	I_{CB}/I_F		0.6		%	V_{CB} = 5.0 V, I_F = 10 mA
	Saturation voltage collector to emitter	$V_{CE(SAT)}$					
	MCT210			0.2	0.4	V	I_C = 16 mA, I_F = 32 mA
ISOLATION	Surge isolation	V_{iso}	4000			VDC	Relative humidity ≤ 50%, T_A = +25°C, $I_{I\text{-}O}$ ≤ 10 μA
			3000			VAC-rms	1 second
	Steady state isolation	V_{iso}	3500			VDC	Relative humidity ≤ 50%, T_A = +25°C, $I_{I\text{-}O}$ ≤ 10 μA
			2500			VAC-rms	1 minute
	Isolation resistance	R_{iso}	10^{11}	5×10^{12}		ohms	$V_{I\text{-}O}$ = 500 VDC, T_A = +25°C
	Isolation capacitance	C_{iso}		1.0		pF	f = 1 MHz
SWITCHING TIMES	Non-saturated						
	Rise time	t_r		4		μs	R_L = 100 Ω, I_C = 2 mA, V_{CC} = 5 V
	Fall time	t_f		5		μs	See Figures 17 and 18
	Saturated						
	Rise time	t_r		2.5		μs	R_L = 560 Ω, I_F = 16 mA
	Fall time	t_f		25		μs	See Figures 17 and 18
	Propagation delay						
	High to low	$T_{PD(HL)}$		2		μs	R_L = 2.7K, I_F = 16 mA
	Low to high	$T_{PD(LH)}$		10		μs	See Figures 17 and 18

TYPICAL ELECTRICAL CHARACTERISTIC CURVES (25° C Free Air Temperature Unless Otherwise Specified)

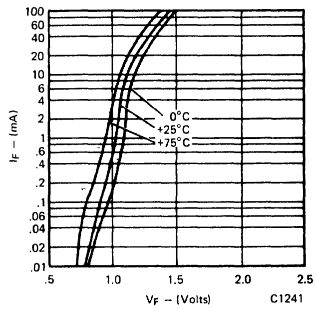


Fig. 1. Forward Voltage vs. Forward Current

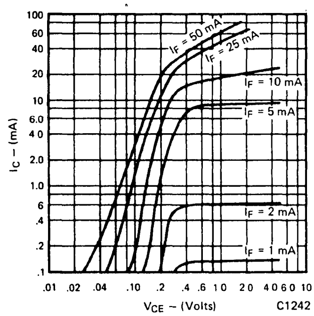


Fig. 2. Collector Current vs. Collector to Emitter Voltage

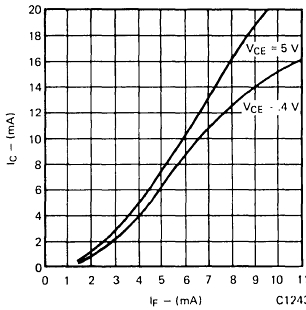


Fig. 3. Collector Current vs. Forward Current

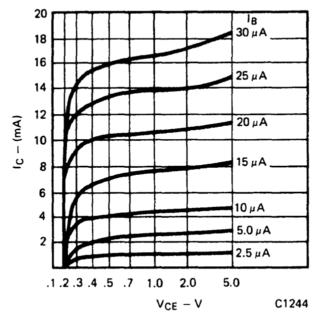


Fig. 4. Collector Current vs. Collector to Emitter Voltage

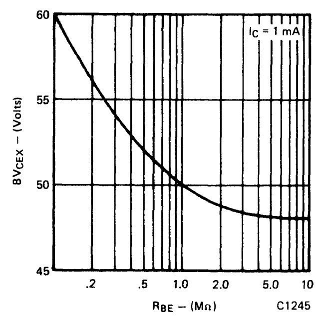


Fig. 5. Collector to Emitter Breakdown Voltage vs. Base to Emitter Resistance

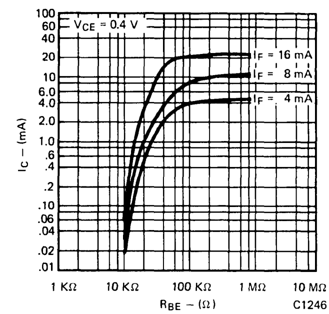


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

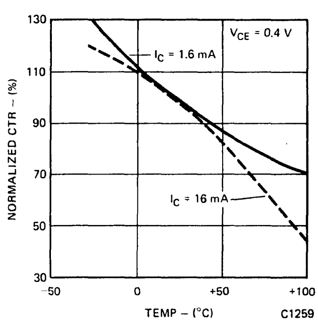


Fig. 7. Current Transfer Ratio (saturated) vs. Temperature

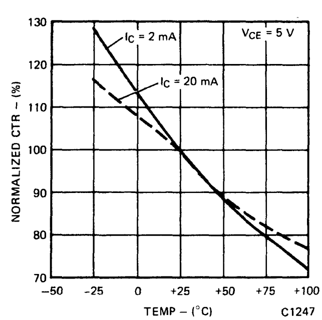


Fig. 8. Current Transfer Ratio (unsaturated) vs. Temperature

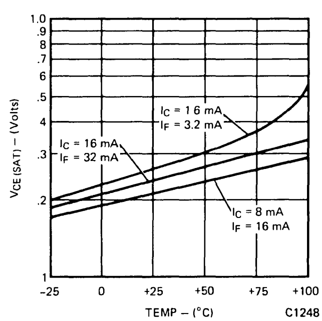


Fig. 9. Collector to Emitter Saturation Voltage vs. Temperature

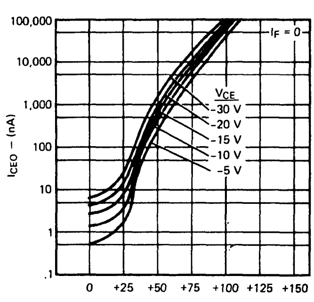


Fig. 10. Collector to Emitter Leakage Current vs. Temperature

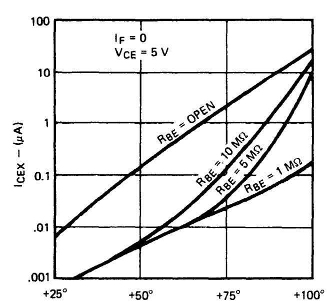


Fig. 11. Collector to Emitter Leakage Current vs. Temperature

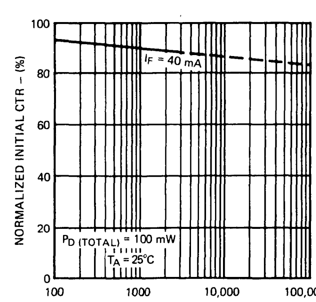


Fig. 12. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

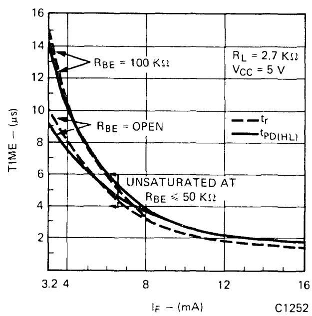


Fig. 13. Switch-on Time vs. I_F Drive (saturated)

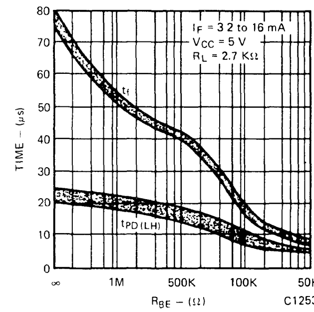


Fig. 14. Switch-off Time vs. Base to Emitter Resistance (saturated)

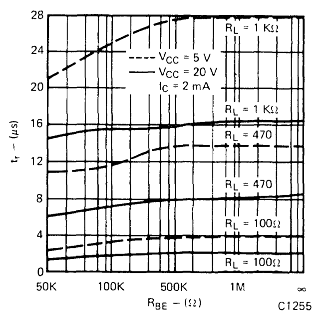


Fig. 15. Rise Time vs. Base to Emitter Resistance (non-saturated)

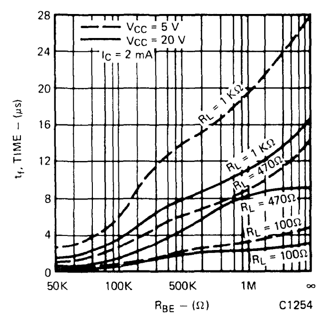


Fig. 16. Fall Time vs. Base to Emitter Resistance (non-saturated)

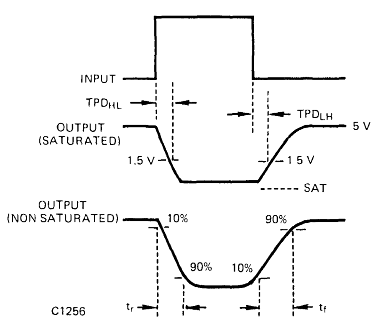


Fig. 17. Switching Time Waveforms

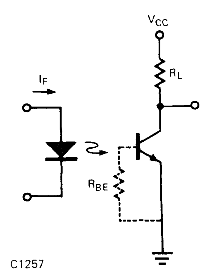


Fig. 18. Switching Time Test Circuits

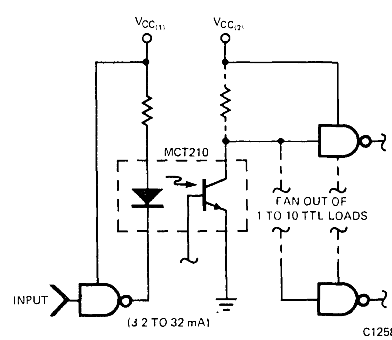


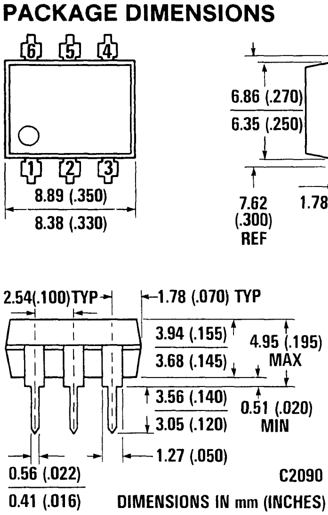
Fig. 19. Typical TTL Interface at Operating Temperatures of 0° to 70° C

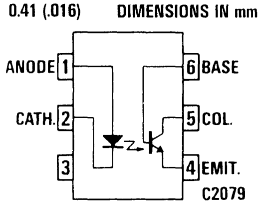
GENERAL INSTRUMENT

VDE APPROVED PHOTOTRANSISTOR OPTOCOUPLERS

MCT2200/0Z
MCT2201/1Z
MCT2202/2Z

PACKAGE DIMENSIONS





Equivalent Circuit

DESCRIPTION

The MCT2200, MCT2201 and MCT2202 are opto-isolators with phototransistor output. A gallium arsenide infrared emitting diode is selectively coupled with an NPN silicon phototransistor.

FEATURES

- High isolation voltage:
  5300 VAC RMS—5 seconds
  7500 VAC PEAK—5 seconds
- Minimum current transfer ratio of 100%
- Maximum turn-on, turn-off time:
  MCT2200—20 μs
  MCT2201—10 μs
  MCT2201—10 μs
- Underwriters Laboratory (UL) recognized File #350151

APPLICATIONS

- Power supply regulators
- Digital logic inputs
- Appliance sensor systems
- Industrial controls

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature .... -55° C to 150° C
Operating temperature .... -55° C to 100° C
Lead soldering temperature (10 sec.) .... 260° C
Total package power dissipation at 25° C ambient
(LED) plus detector) .... 260 mW
Derate linearly from 25° .... 3.5 mW/° C

INPUT DIODE

Forward current .... 60 mA
Reverse voltage .... 3.0 V
Peak forward current (1 μs pulse, 300 pps) .... 3.0 A
Power disipation at 25° C ambient .... 135 mW
Derate linearly from 25° C .... 1.8 mW/° C

OUTPUT TRANSISTOR

Power dissipation at 25° C ambient .... 200 mW
Derate linearly from 25° C .... 2.67 mW/° C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Unless Otherwise Specified)

	TRANSFER CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current Transfer Ratio, collector to emitter	CTR					
	MCT2200		20	60		%	
	MCT2201		100	200		%	I_F = 10 mA; V_{CE} = 5 V
	MCT2202		63	95	125	%	
	Saturation voltage	$V_{CE(SAT)}$		.21	.40	V	I_F = 10 mA; I_C = 2.5 mA
SWITCHING TIMES	Non-saturated						R_L = 100 ±; I_C = 2 mA; V_{CC} = 10 V See Figure 10.
	Turn-on time	t_{on}		6.0	10	μs	
	Turn-off time	t_{off}		5.5	10	μs	
ISOLATION	Isolation voltage	V_{iso}	5300			V_{AC} RMS	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA, 5 seconds
		V_{iso}	7500			V_{AC} PEAK	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA, 5 seconds
	Isolation resistance	R_{iso}	10^{11}			ohms	V_{I-O} = 500 VDC
	Isolation capacitance	C_{iso}		0.5		pF	f = 1 MHz

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.3	1.50	V	I_F = 20 mA
	Forward voltage temperature coefficient			-1.8		mV/°C	
	Reverse voltage	V_R	3.0	25		V	I_R = 10 μA
	Junction capacitance	C_J		50		pF	V_F = 0 V, f = 1 MHz
				65		pF	V_F = 0 V, f = 1 MHz
	Reverse leakage current	I_R		.35	10	μA	V_R = 3.0 V
OUTPUT TRANSISTOR	Breakdown voltage						
	Collector to emitter	BV_{CEO}	30	45		V	I_C = 1.0 mA, I_F = 0
	Collector to base	BV_{CBO}	70	130		V	I_C = 10 μA
	Emitter to base	BV_{EBO}	5	7		V	I_E = 100 μA, I_F = 0
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	V_{CE} = 10 V, I_F = 0
	Collector to base	I_{CBO}			20	nA	V_{CB} = 10 V, I_F = 0
	Capacitance						
	Collector to emitter			8		pF	V_{CE} = 0, f = 1 MHz
	Collector to base			20		pF	V_{CB} = 5, f = 1 MHz
	Emitter to base			10		pF	V_{EB} = 0, f = 1 MHz

ELECTRICAL CHARACTERISTIC CURVES (25°C Free Air Temperature Unless Otherwise Specified)

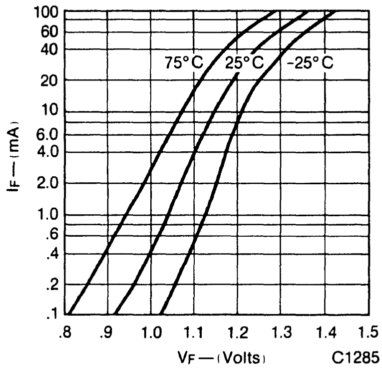


Fig. 1 Forward Voltage vs. Forward Current

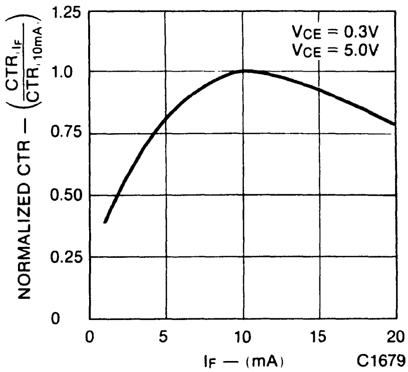


Fig. 2 Normalized Current Transfer Ratio vs. Forward Current

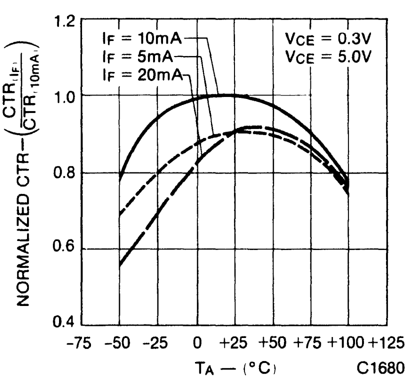


Fig. 3 Normalized Current Transfer Ratio vs. Ambient Temperature

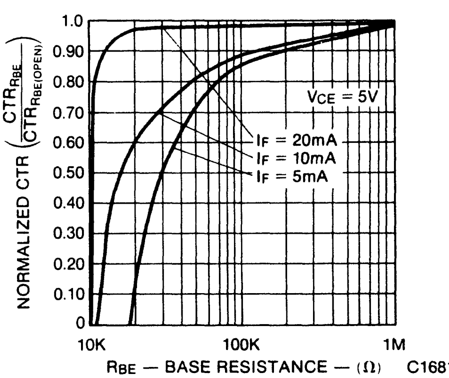


Fig. 4 C_{TR} vs. R_{BE}

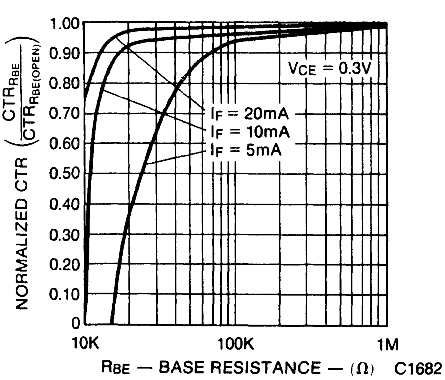


Fig. 5 C_{TR} vs. R_{BE}

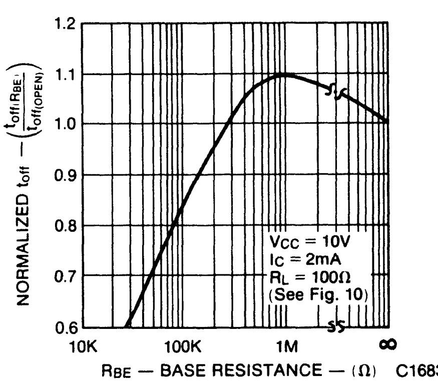


Fig. 6 Normalized t_{off} vs. R_{BE}

ELECTRICAL CHARACTERISTIC CURVES (25° C Free Air Temperature Unless Otherwise Specified)

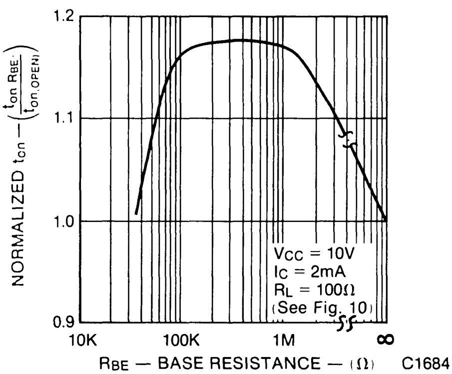


Fig. 7 Normalized t_{on} vs. R_{BE}

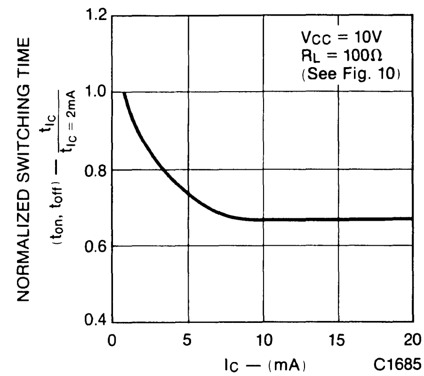


Fig. 8 Normalized Switching Time vs. Collector Current

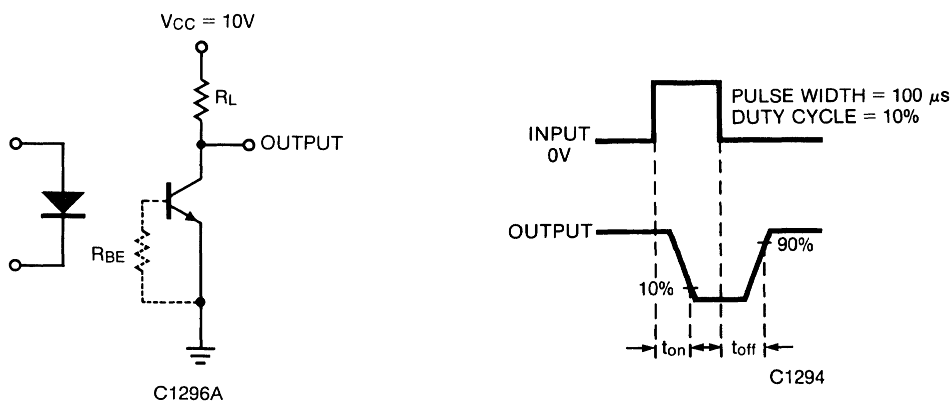


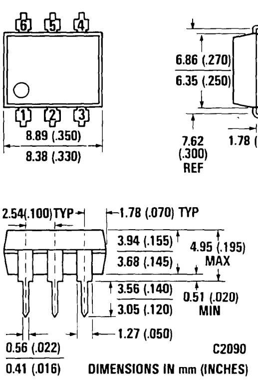
Fig. 9 Switching Time Test Circuit and Waveform

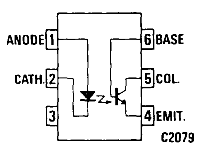
GENERAL INSTRUMENT

PHOTOTRANSISTOR OPTOCOUPLER

MCT26

PACKAGE DIMENSIONS





Equivalent Circuit

FEATURES AND APPLICATIONS

- AC line/digital logic isolator
- Digital logic/digital logic isolator
- Telephone/telegraph line receiver
- Twisted pair line receiver
- High frequency power supply feedback control
- Relay contact monitor
- Power supply monitor
- UL recognized — File E50151
- High isolation voltage
  V_{ISO} = 2500 V RMS, 1 minute

ABSOLUTE MAXIMUM RATINGS

Storage temperature .... -55°C to 150°C
Operating temperature .... -55°C to 100°C
Lead soldering temperature (10 sec) .... 260°C

Input Diode
- Forward current .... 60 mA
- Reverse voltage .... 3.0 V
- Peak forward current (1 μs pulse, 300 pps) ...... 3.0 A

Output Transistor
- Power dissipation at 25°C ambient .... 200 mW
- Derate linearly from 25°C .... 2.6 mW/°C

Input to output voltage isolation .... 2500 VDC
Total package power dissipation at 25°C ambient
(LED plus detector) .... 250 mW
Derate linearly from 25°C .... 3.3 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Emitter					
Forward voltage V_F	—	1.25	1.5	V	I_F = 20 mA
Reverse current I_R	—	.15	10	μA	V_R = 3.0 V
Capacitance C_J	—	50	—	pF	V = 0
Detector					
h_{FE}	—	150	—		V_{CE} = 5 V, I_C = 100 μA
BV_{CEO}	30	85	—	V	I_C = 1.0 mA, I_F = 0
BV_{ECO}	7	12	—	V	I_E = 100 μA, I_F = 0
I_{CEO}	—	5	100	nA	V_{CE} = 5 V, I_F = 0
Capacitance Collector-emitter C_{CE}	—	8	—	pF	V_{CE} = 0
BV_{CBO}	30	165	—	V	I_C = 10 μA
I_{CBO} (dark)	—	1	100	nA	V_{CB} = 5 V, I_F = 0
Coupled					
DC current transfer ratio CTR	6	14	—	%	I_F = 10 mA, V_{CE} = 10 V, note 1
Breakdown voltage	4000	—	—	VDC	t = 1 second
	2500	—	—		VAC, RMS @ f = 60 Hz, t = 1 minute
Resistance emitter-detector $R_{I\text{-}O}$	10^{11}	10^{12}		Ω	$V_{E\text{-}D}$ = 500 VDC
V_{CE} (SAT)	—	0.2	0.3	V	I_C = 250 μA, I_F = 20 mA
	—	0.2	0.5	V	I_C = 1.6 mA, I_F = 60 mA
Capacitance LED to detector $C_{I\text{-}O}$	—	0.5	—	pF	f = 1 MHz
Bandwidth (see figure 5) B_W	—	300	—	kHz	I_C = 2 mA, note 2
Rise time + fall time (see oper. schematics) t_r t_f		2	—	μs	I_C = 2 mA, V_{CE} = 10 V, note 3

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25° C Free Air Temperature Unless Otherwise Specified)

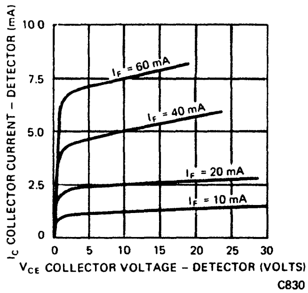


Fig. 1 Detector Output Characteristics

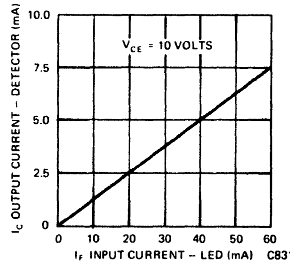


Fig. 2 Input Current vs. Output Current

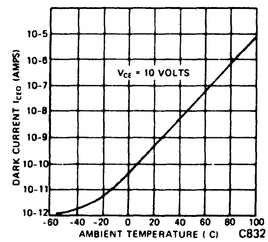


Fig. 3 Dark Current vs. Temperature (°C)

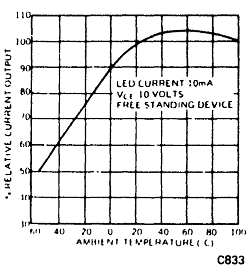


Fig. 4 Current Output vs. Temperature

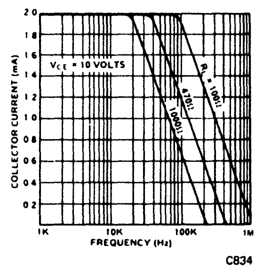


Fig. 5 Output vs. Frequency

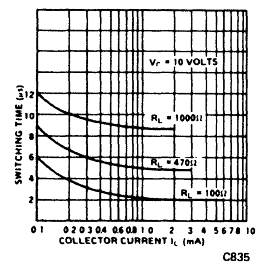
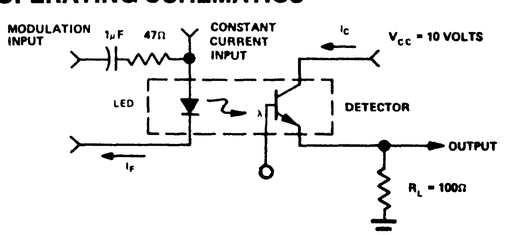


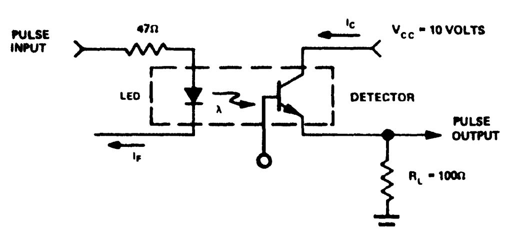
Fig. 6 Switching Time vs. Collector Current

For additional characteristic curves, see figures 2, 3, 5, 6, 8, 11, 12, & 13 on MCT2.

OPERATING SCHEMATICS



Modulation Circuit Used to Obtain Output vs. Frequency Plot



Circuit Used to Obtain Switching Time vs. Collector Current Plot

NOTES

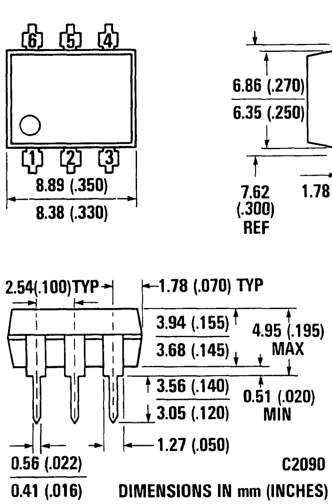
1. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.*
2. *The frequency at which i_C is 3 dB down from the 1 kHz value.*
3. *Rise time (t_r) is the time required for the collector current to increase from 10% of its final value to 90%. Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value to 10%.*

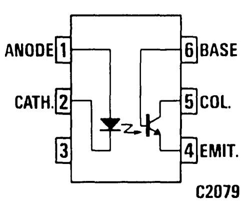
GENERAL INSTRUMENT

PHOTOTRANSISTOR OPTOCOUPLER

MCT270

PACKAGE DIMENSIONS





Equivalent Circuit

DESCRIPTION

The MCT270 is a phototransistor-type optically coupled isolator. A gallium arsenide infrared emitting diode is selectively coupled with an NPN silicon phototransistor.

FEATURES

- Isolation voltage
  2500VAC RMS – Steady State Rating
  3000VAC RMS – Surge Rating
- Minimum current transfer ratio of 50%
- Maximum turn-on, turn-off time 10μ seconds specified
- Underwriters Laboratory (UL) recognized File E50151

APPLICATIONS

- Power supply regulators
- Digital logic inputs
- Microprocessor inputs
- Appliance sensor systems
- Power supply regulators
- Industrial controls

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	–55°C to 150°C
Operating temperature	–55°C to 100°C
Lead temperature (Soldering, 10 sec)	260°C
Total package power dissipation @ 25°C (LED plus detector)	260 mW
Derate linearly from 25°C	3.5 mW/°C

INPUT DIODE

Forward DC current	90 mA
Reverse voltage	3 V
Peak forward current (1 μs pulse, 300 pps)	3.0 A
Power dissipation 25°C ambient	135 mW
Derate linearly from 25°C	1.8 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C	200 mW
Derate linearly from 25°C	2.67 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

	TRANSFER CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current Transfer Ratio, collector to emitter	CTR_{CE}	50	115		%	$I_F = 10$ mA; $V_{CE} = 10$ V
	Current Transfer Ratio, collector to base	CTR_{CB}	0.045	0.15		%	$I_F = 16$ mA; $V_{CB} = 10$ V
	Saturation voltage	$V_{CE(SAT)}$		.21	.40	V	$I_F = 10$ mA; $I_C = 2$ mA
SWITCHING TIMES	Non-saturated						
	Turn-on time	t_{on}		6.0	10	μs	$R_L = 100\ \Omega$; $I_C = 2$ mA; $V_{CC} = 5$ V; See figures 11, 13
	Turn-off time	t_{off}		5.5	10	μs	
	Saturated						
	Turn-on time	t_{on}		3.9		μs	$I_F = 16$ mA; $R_L = 1.9$ KΩ; See figures 12, 14
	Turn-off time	t_{off}		48		μs	
	(Approximates a typical TTL interface)						
	Turn-on time	t_{on}		3.9		μs	$I_F = 16$ mA; $R_L = 4.7$ KΩ; See figures 12, 14
	Turn-off time	t_{off}		110		μs	
	(Approximates a typical low power TTL interface)						
ISOLATION	Surge isolation	V_{iso}	4000			VDC	Relative humidity ≤ 50%, $I_{I-O} \leq 10\ \mu A$
			3000			VAC-rms	1 second
	Steady state isolation	V_{iso}	3500			VDC	Relative humidity ≤ 50%, $I_{I-O} \leq 10\ \mu A$
			2500			VAC-rms	1 minute
	Isolation resistance	R_{iso}	10^{11}			ohms	$V_{I-O} = 500$ VDC
	Isolation capacitance	C_{iso}		0.5		pF	f = 1 MHz

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.3	1.50	V	$I_F = 20$ mA
	Forward voltage temp. coefficient			-1.8		mV/°C	
	Reverse voltage	V_R	3.0	25		V	$I_R = 10\ \mu A$
	Junction capacitance	C_J		50		pF	$V_F = 0$ V, f = 1 MHz
				65		pF	$V_F = 1$ V, f = 1 MHz
	Reverse leakage current	I_R		0.35	10	μA	$V_R = 3.0$ V
OUTPUT TRANSISTOR	DC forward current gain	h_{FE}	100	500			$V_{CE} = 5$ V, $I_C = 100\ \mu A$
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	30	45		V	$I_C = 1.0$ mA, $I_F = 0$
	Collector to base	BV_{CBO}	70	130		V	$I_C = 10\ \mu A$
	Emitter to base	BV_{EBO}	5	7		V	$I_E = 100\ \mu A$, $I_F = 0$
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	$V_{CE} = 10$ V, $I_F = 0$
	Collector to base	I_{CBO}			20	nA	$V_{CB} = 10$ V, $I_F = 0$
	Capacitance						
	Collector to emitter			8		pF	$V_{CE} = 0$, f = 1 MHz
	Collector to base			20		pF	$V_{CB} = 5$, f = 1 MHz
	Emitter to base			10		pF	$V_{EB} = 0$, f = 1 MHz

Optocouplers

TYPICAL ELECTRICAL CHARACTERISTIC CURVES (25° C Free Air Temperature Unless Otherwise Specified)

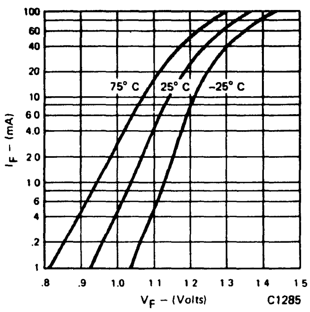


Fig. 1. Forward Voltage vs. Forward Current

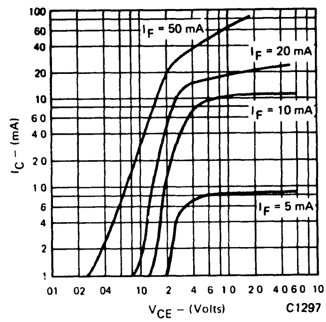


Fig. 2. Collector Current vs. Collector to Emitter Voltage

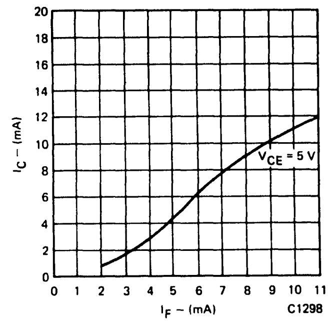


Fig. 3. Collector Current vs. Forward Current

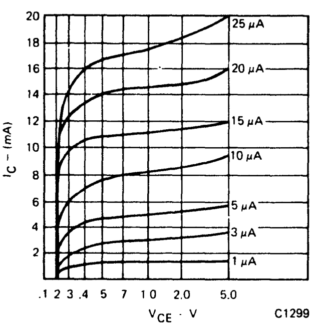


Fig. 4. Collector Current vs. Collector to Emitter Voltage

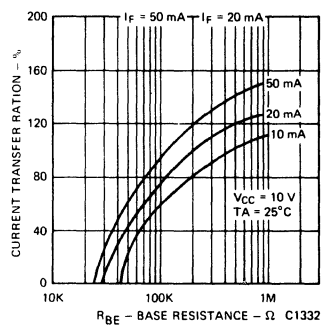


Fig. 5. Sensitivity vs. Base Resistance

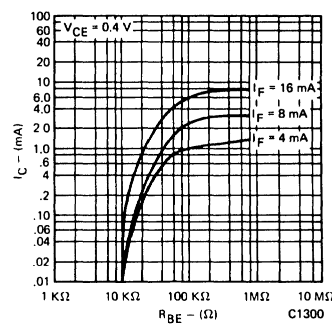


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

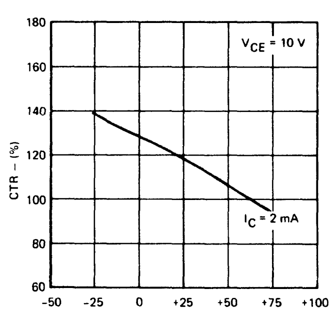


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

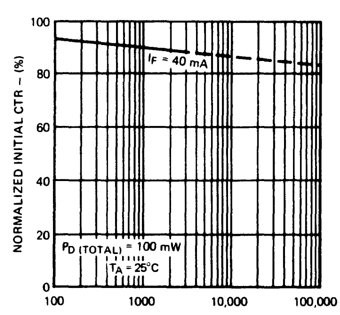


Fig. 8. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

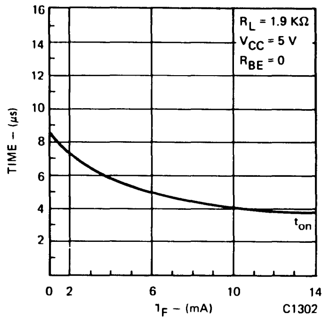


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

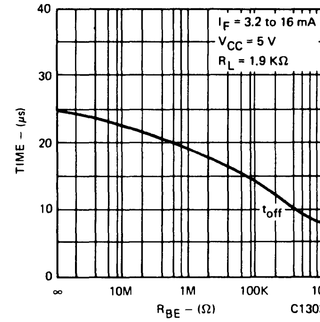


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

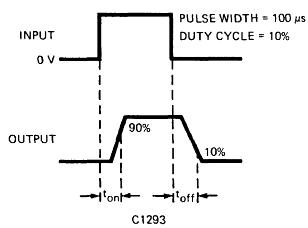


Fig. 11.

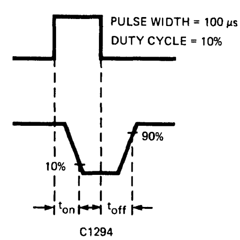


Fig. 12.

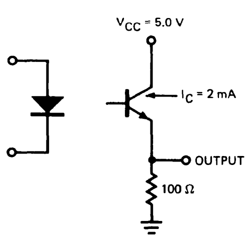


Fig. 13.

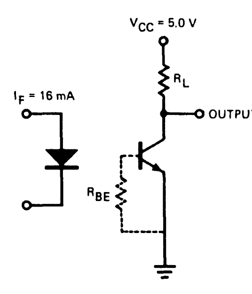


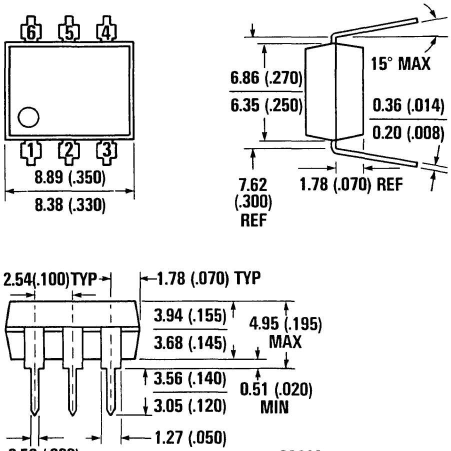
Fig. 14.

GENERAL INSTRUMENT

PHOTOTRANSISTOR OPTOCOUPLER

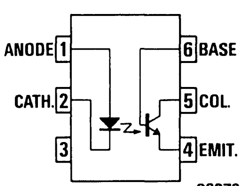
MCT271

PACKAGE DIMENSIONS



C2090

DIMENSIONS IN mm (INCHES)



C2079

Equivalent Circuit

DESCRIPTION

The MCT271 is a phototransistor-type optically coupled isolator. A gallium arsenide infrared emitting diode is selectively coupled with an NPN silicon phototransistor.

FEATURES

- Controlled Current Transfer Ratio — 45% to 90% (specified conditions)
- Maximum Turn-on time — 7 μseconds (specified condition)
- Maximum Turn-off time — 7 μseconds (specified condition)
- Surge Isolation Rating — 4000 volts DC 3000 volts AC, rms
- Steady-state Isolation Rating — 3500 volts DC 2500 volts AC, rms
- Underwriters Laboratory (U.L.) recognized — File E50151

APPLICATIONS

- Switching networks
- Power supply regulators
- Digital logic inputs
- Microprocessor inputs
- Appliance sensor systems

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature .... -55°C to 150°C
Operating temperature .... -55°C to 100°C
Lead temperature
(Soldering, 10 sec) .... 260°C
Total package power dissipation @ 25°C
(LED plus detector) .... 260 mW
Derate linearly from 25°C .... 3.4 mW/°C

INPUT DIODE

Forward DC current .... 60 mA
Reverse voltage .... 3 V
Peak forward current
(1 μs pulse, 300 pps) .... 3.0 A
Power dissipation 25°C ambient .... 90 mW
Derate linearly from 25°C .... 1.2 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C .... 200 mW
Derate linearly from 25°C .... 2.67 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)

	TRANSFER CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current Transfer Ratio, collector to emitter (a)	CTR_{CE}	45	67	90	%	$I_F = 10$ mA; $V_{CE} = 10$ V
			12.5			%	$I_F = 16$ mA; $V_{CE} = 0.4$ V
	Current Transfer Ratio, collector to base	CTR_{CB}		0.15		%	$I_F = 10$ mA; $V_{CB} = 10$ V
	Saturation voltage	$V_{CE(SAT)}$		0.14	.40	V	$I_F = 16$ mA; $I_C = 2$ mA
SWITCHING TIMES	Non-saturated						
	Turn-on time	t_{on}		4.9	7	μs	$R_L = 100\ \Omega$; $I_C = 2$ mA; $V_{CC} = 5$ V
	Turn-off time	t_{off}		4.5	7	μs	See figures 11, 13
	Saturated						
	Turn-on time	t_{on}		5.2		μs	$I_F = 16$ mA; $R_L = 1.9$ KΩ
	Turn-off time	t_{off}		38		μs	See figures 12, 14
	(Approximates a typical TTL interface)						
	Turn-on time	t_{on}		4.9		μs	$I_F = 16$ mA; $R_L = 4.7$ KΩ
	Turn-off time	t_{off}		90		μs	See figures 12, 14
	(Approximates a typical low power TTL interface)						
ISOLATION	Surge isolation	V_{iso}	4000			VDC	Relative humidity ⩽ 50%, $I_{I-O} \leqslant 10\ \mu A$
			3000			VAC-rms	1 second
	Steady state isolation	V_{iso}	3500			VDC	Relative humidity ⩽ 50%, $I_{I-O} \leqslant 10\ \mu A$
			2500			VAC-rms	1 minute
	Isolation resistance	R_{iso}	10^{11}			ohms	$V_{I-O} = 500$ VDC
	Isolation capacitance	C_{iso}		0.5		pF	f = 1 MHz

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.20	1.50	V	$I_F = 20$ mA
	Forward voltage temp. coefficient			-1.8		mV/°C	
	Reverse voltage	V_R	3.0	25		V	$I_R = 10\ \mu A$
	Junction capacitance	C_J		50		pF	$V_F = 0$ V, f = 1 MHz
				65		pF	$V_F = 1$ V, f = 1 MHz
	Reverse leakage current	I_R		0.35	10	μA	$V_R = 3.0$ V
OUTPUT TRANSISTOR	DC forward current gain	h_{FE}	100	420			$V_{CE} = 5$ V, $I_C = 100\ \mu A$
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	30	45		V	$I_C = 1.0$ mA, $I_F = 0$
	Collector to base	BV_{CBO}	70	130		V	$I_C = 10\ \mu A$
	Emitter to base	BV_{EBO}	5	7		V	$I_E = 100\ \mu A$, $I_F = 0$
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	$V_{CE} = 10$ V, $I_F = 0$
	Capacitance						
	Collector to emitter			8		pF	$V_{CE} = 0$, f = 1 MHz
	Collector to base			20		pF	$V_{CB} = 5$, f = 1 MHz
	Emitter to base			10		pF	$V_{EB} = 0$, f = 1 MHz

TYPICAL ELECTRICAL CHARACTERISTIC CURVES (25° C Free Air Temperature Unless Otherwise Specified)

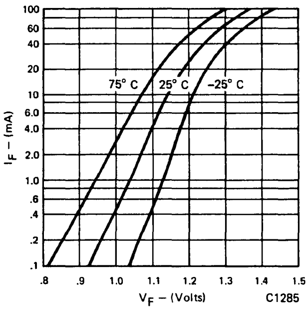


Fig. 1. Forward Voltage vs. Forward Current

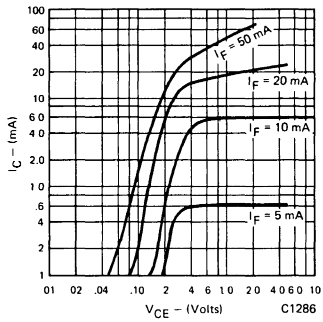


Fig. 2. Collector Current vs. Collector to Emitter Voltage

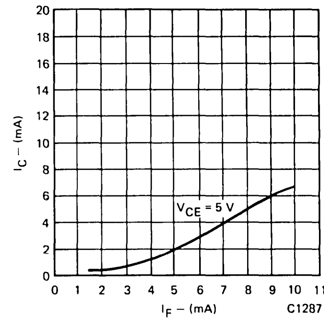


Fig. 3. Collector Current vs. Forward Current

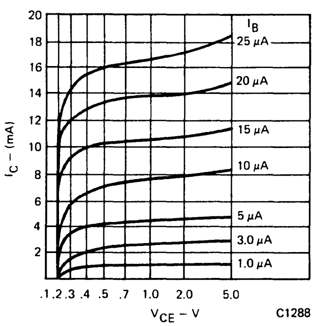


Fig. 4. Collector Current vs. Collector to Emitter Voltage

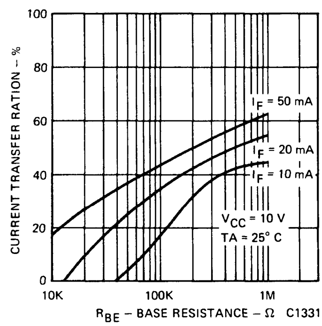


Fig. 5. Sensitivity vs. Base Resistance

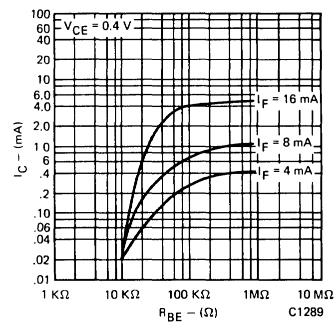


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

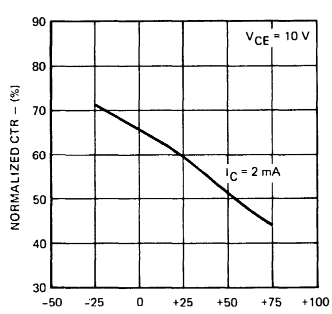


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

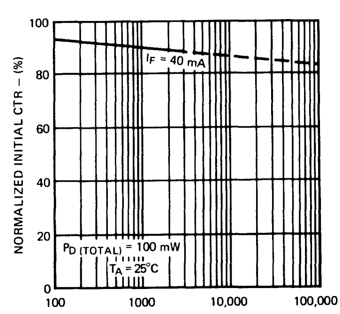


Fig. 8. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

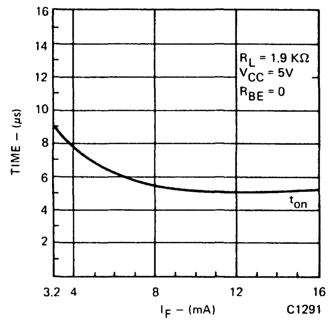


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

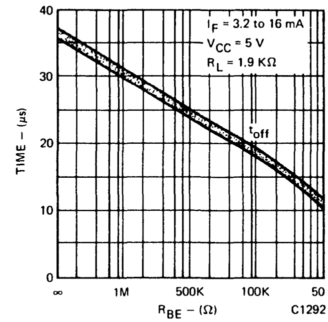


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

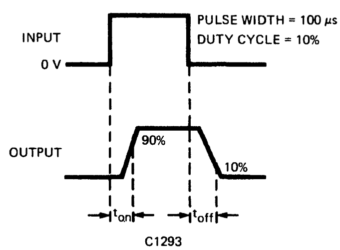


Fig. 11.

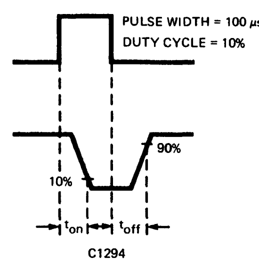


Fig. 12.

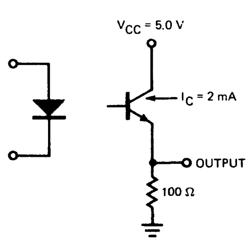


Fig. 13.

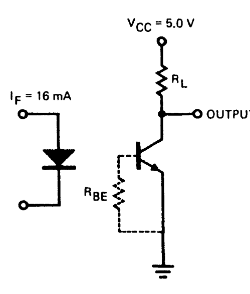


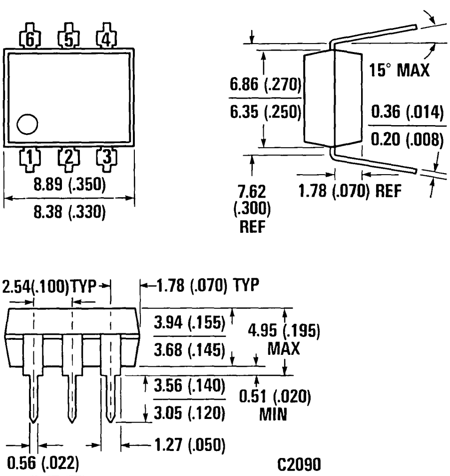
Fig. 14.

GENERAL INSTRUMENT

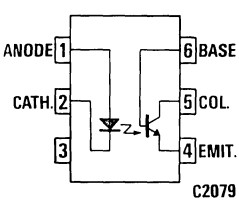
PHOTOTRANSISTOR OPTOCOUPLER

MCT272

PACKAGE DIMENSIONS



DIMENSIONS IN mm (INCHES)



Equivalent Circuit

DESCRIPTION

The MCT272 is a phototransistor-type optically coupled isolator. A gallium arsenide infrared emitting diode is selectively coupled with an NPN silicon phototransistor.

FEATURES

- Controlled Current Transfer Ratio – 75% to 150% (specified conditions)
- Maximum Turn-on time – 10 μseconds (specified condition)
- Maximum Turn-off time – 10 μseconds (specified condition)
- Surge Isolation Rating – 4000 volts DC 3000 volts AC, rms
- Steady-state Isolation Rating – 3500 volts DC 2500 volts AC, rms
- Underwriters Laboratory (U.L.) recognized – File E50151

APPLICATIONS

- Power supply regulators
- Digital logic inputs
- Microprocessor inputs
- Appliance sensor systems
- Power supply regulators
- Industrial controls

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	-55°C to 150°C
Operating temperature	-55°C to 100°C
Lead temperature (Soldering, 10 sec)	260°C
Total package power dissipation @ 25°C (LED plus detector)	260 mW
Derate linearly from 25°C	3.5 mW/°C

INPUT DIODE

Forward DC current	60 mA
Reverse voltage	3 V
Peak forward current (1 μs pulse, 300 pps)	3.0 A
Power dissipation 25°C ambient	90 mW
Derate linearly from 25°C	1.2 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C	200 mW
Derate linearly from 25°C	2.67 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)

	TRANSFER CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current Transfer Ratio, collector to emitter (a)	CTR_{CE}	75	115	150	%	$I_F = 10$ mA; $V_{CE} = 10$ V
			12.5			%	$I_F = 16$ mA; $V_{CE} = 0.4$ V
	Current Transfer Ratio, collector to base	CTR_{CB}		0.15		%	$I_F = 10$ mA; $V_{CB} = 10$ V
	Saturation voltage	$V_{CE(SAT)}$		0.12	.40	V	$I_F = 16$ mA; $I_C = 2$ mA
SWITCHING TIMES	Non-saturated						
	Turn-on time	t_{on}		6.0	10	μs	$R_L = 100\ \Omega$; $I_C = 2$ mA; $V_{CC} = 5$ V
	Turn-off time	t_{off}		5.5	10	μs	See figures 11, 13
	Saturated						
	Turn-on time	t_{on}		3.9		μs	$I_F = 16$ mA; $R_L = 1.9$ KΩ
	Turn-off time	t_{off}		48		μs	See figures 12, 14
	(Approximates a typical TTL interface)						
	Turn-on time	t_{on}		3.9		μs	$I_F = 16$ mA; $R_L = 4.7$ KΩ
	Turn-off time	t_{off}		110		μs	See figures 12, 14
	(Approximates a typical low power TTL interface)						
ISOLATION	Surge isolation	V_{iso}	4000			VDC	Relative humidity ≤ 50%, $I_{I-O} \leq 10\ \mu A$
			3000			VAC-rms	1 second
	Steady state isolation	V_{iso}	3500			VDC	Relative humidity ≤ 50%, $I_{I-O} \leq 10\ \mu A$
			2500			VAC-rms	1 minute
	Isolation resistance	R_{iso}	10^{11}			ohms	$V_{I-O} = 500$ VDC
	Isolation capacitance	C_{iso}		0.5		pF	f = 1 MHz

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.20	1.50	V	$I_F = 20$ mA
	Forward voltage temp. coefficient			-1.8		mV/°C	
	Reverse voltage	V_R	3.0	25		V	$I_R = 10\ \mu A$
	Junction capacitance	C_J		50		pF	$V_F = 0$ V, f = 1 MHz
				65		pF	$V_F = 1$ V, f = 1 MHz
	Reverse leakage current	I_R		0.35	10	μA	$V_R = 3.0$ V
OUTPUT TRANSISTOR	DC forward current gain	h_{FE}	100	500			$V_{CE} = 5$ V, $I_C = 100\ \mu A$
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	30	45		V	$I_C = 1.0$ mA, $I_F = 0$
	Collector to base	BV_{CBO}	70	130		V	$I_C = 10\ \mu A$
	Emitter to base	BV_{EBO}	5	7		V	$I_E = 100\ \mu A$, $I_F = 0$
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	$V_{CE} = 10$ V, $I_F = 0$
	Capacitance						
	Collector to emitter			8		pF	$V_{CE} = 0$, f = 1 MHz
	Collector to base			20		pF	$V_{CB} = 5$, f = 1 MHz
	Emitter to base			10		pF	$V_{EB} = 0$, f = 1 MHz

TYPICAL ELECTRICAL CHARACTERISTIC CURVES (25° C Free Air Temperature Unless Otherwise Specified)

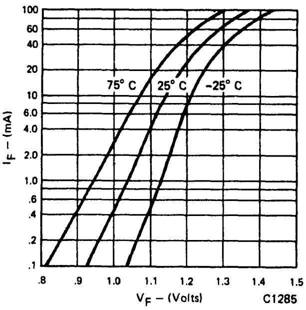


Fig. 1. Forward Voltage vs. Forward Current

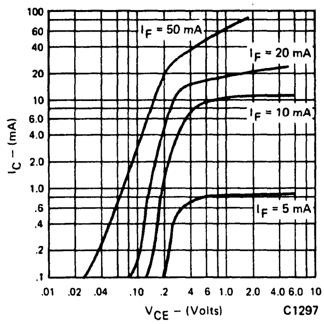


Fig. 2. Collector Current vs. Collector to Emitter Voltage

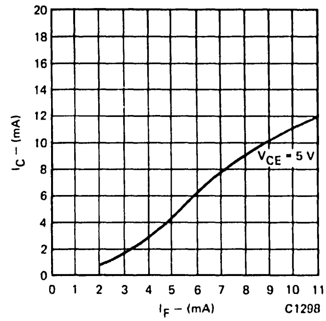


Fig. 3. Collector Current vs. Forward Current

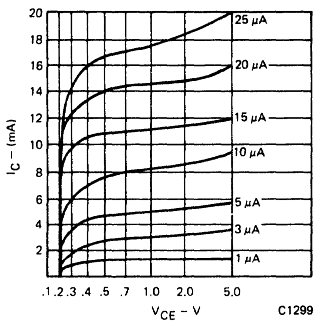


Fig. 4. Collector Current vs. Collector to Emitter Voltage

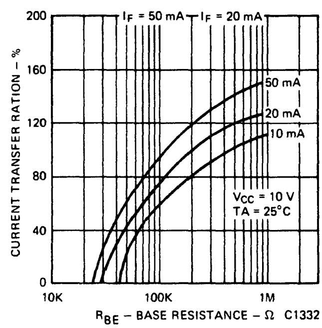


Fig. 5. Sensitivity vs. Base Resistance

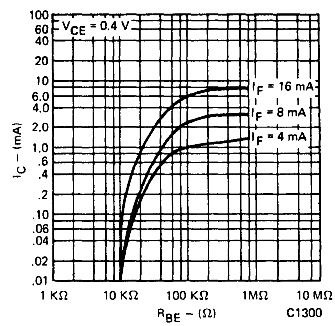


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

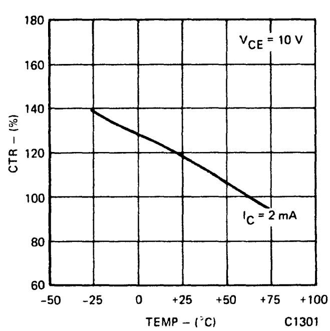


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

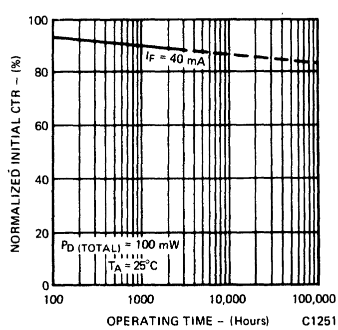


Fig. 8. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

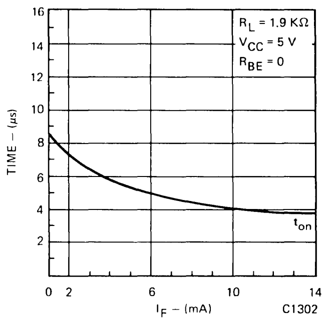


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

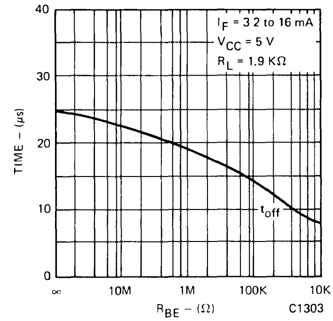


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

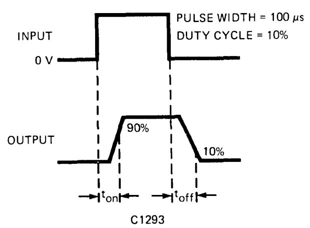


Fig. 11.

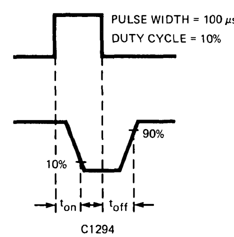


Fig. 12.

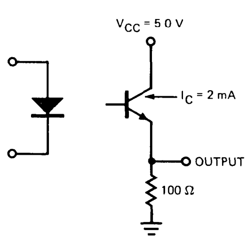


Fig. 13.

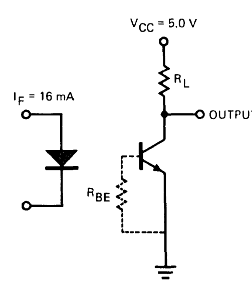


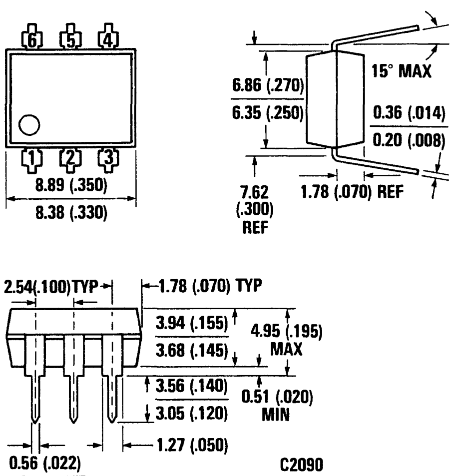
Fig. 14.

GENERAL INSTRUMENT

PHOTOTRANSISTOR OPTOCOUPLER

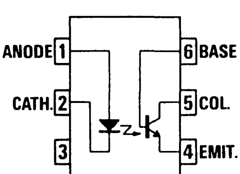
MCT274

PACKAGE DIMENSIONS



C2090

DIMENSIONS IN mm (INCHES)



C2079

Equivalent Circuit

DESCRIPTION

The MCT274 is a phototransistor-type optically coupled isolator. A gallium arsenide infrared emitting diode is selectively coupled with an NPN high-gain silicon phototransistor.

FEATURES

- Controlled Current Transfer Ratio – 225% to 400% (specified conditions)
- Maximum Turn-on time – 25 μseconds (specified condition)
- Maximum Turn-off time – 25 μseconds (specified condition)
- Surge Isolation Rating –
  4000 volts DC 3000 volts AC, rms
- Steady-state Isolation Rating –
  3500 volts DC 2500 volts AC, rms
- Underwriters Laboratory (U.L.) recognized – File E50151

APPLICATIONS

- Control Relays
- Digital controls
- Microprocessor controls
- Replace slow photodarlington types with better switching speeds and equivalent gain devices
- Multiple gate interface

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature . . . . -55°C to 150°C
Operating temperature . . . . -55°C to 100°C
Lead temperature
(Soldering, 10 sec) . . . . 260°C
Total package power dissipation @ 25°C
(LED plus detector) . . . . 260 mW
Derate linearly from 25°C . . . . 3.5 mW/°C

INPUT DIODE

Forward DC current . . . . 60 mA
Reverse voltage . . . . 3 V
Peak forward current
(1 μs pulse, 300 pps) . . . . 3.0 A
Power dissipation 25°C ambient . . . . 90 mW
Derate linearly from 25°C . . . . 1.2 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C . . . . 200 mW
Derate linearly from 25°C . . . . 2.67 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)

	TRANSFER CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current Transfer Ratio, collector to emitter (a)	CTR_{CE}	225	305	400	%	I_F = 10 mA; V_{CE} = 10 V
			12.5			%	I_F = 16 mA; V_{CE} = 0.4 V
	Current Transfer Ratio, collector to base	CTR_{CB}		0.15		%	I_F = 10 mA; V_{CB} = 10 V
	Saturation voltage	$V_{CE(SAT)}$		0.16	.40	V	I_F = 16 mA; I_C = 2 mA
SWITCHING TIMES	Non-saturated						
	Turn-on time	t_{on}		9.1	25	μs	R_L = 100 Ω; I_C = 2 mA; V_{CC} = 5 V
	Turn-off time	t_{off}		7.9	25	μs	See figures 11, 13
	Saturated						
	Turn-on time	t_{on}		3.0		μs	I_F = 16 mA; R_L = 1.9 KΩ
	Turn-off time	t_{off}		95		μs	See figures 12, 14
	(Approximates a typical TTL interface)						
	Turn-on time	t_{on}		3.0		μs	I_F = 16 mA; R_L = 4.7 KΩ
	Turn-off time	t_{off}		185		μs	See figures 12, 14
	(Approximates a typical low power TTL interface)						
ISOLATION	Surge isolation	V_{iso}	4000			VDC	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA
			3000			VAC-rms	t = 1 second
	Steady state isolation	V_{iso}	3500			VDC	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA
			2500			VAC-rms	t = 1 minute
	Isolation resistance	R_{iso}	10^{11}			ohms	V_{I-O} = 500 VDC
	Isolation capacitance	C_{iso}		0.5		pF	f = 1 MHz

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.20	1.50	V	I_F = 20 mA
	Forward voltage temp. coefficient			-1.8		mV/°C	
	Reverse voltage	V_R	3.0	25		V	I_R = 10 μA
	Junction capacitance	C_J		50		pF	V_F = 0 V, f = 1 MHz
				65		pF	V_F = 1 V, f = 1 MHz
	Reverse leakage current	I_R		0.35	10	μA	V_R = 3.0 V
OUTPUT TRANSISTOR	DC forward current gain	h_{FE}		360			V_{CE} = 5 V, I_C = 100 μA
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	30	45		V	I_C = 1.0 mA, I_F = 0
	Collector to base	BV_{CBO}	70	130		V	I_C = 10 μA
	Emitter to base	BV_{EBO}	5	7		V	I_E = 100 μA, I_F = 0
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	V_{CE} = 10 V, I_F = 0
	Capacitance						
	Collector to emitter			8		pF	V_{CE} = 0, f = 1 MHz
	Collector to base			20		pF	V_{CB} = 5, f = 1 MHz
	Emitter to base			10		pF	V_{EB} = 0, f = 1 MHz

TYPICAL ELECTRICAL CHARACTERISTIC CURVES (25° C Free Air Temperature Unless Otherwise Specified)

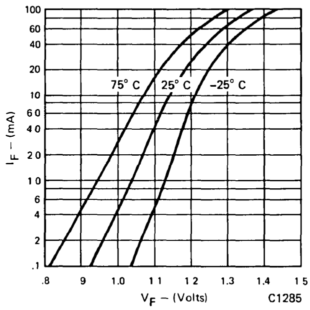


Fig. 1. Forward Voltage vs. Forward Current

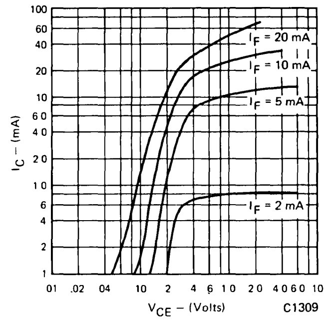


Fig. 2. Collector Current vs. Collector to Emitter Voltage

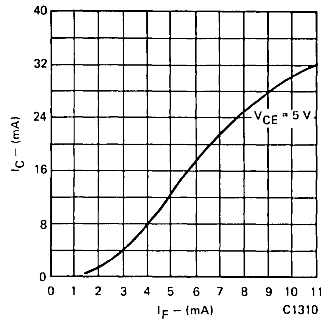


Fig. 3. Collector Current vs. Forward Current

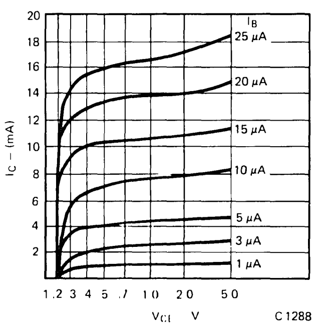


Fig. 4. Collector Current vs. Collector to Emitter Voltage

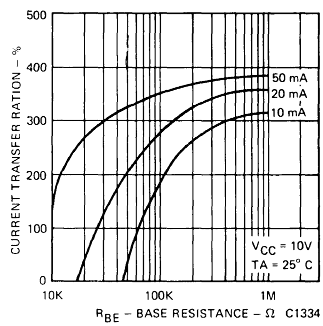


Fig. 5. Sensitivity vs. Base Resistance

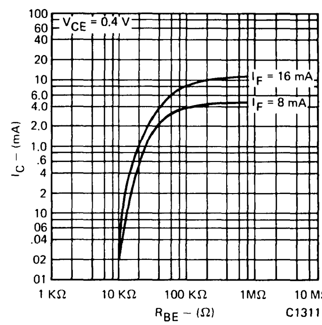


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

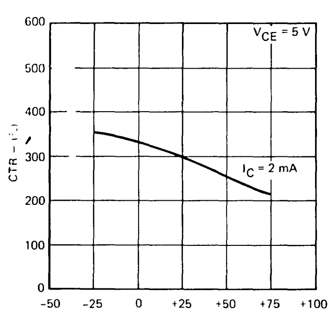


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

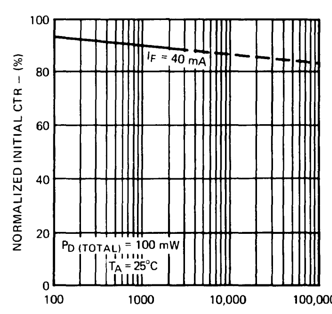


Fig. 8. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

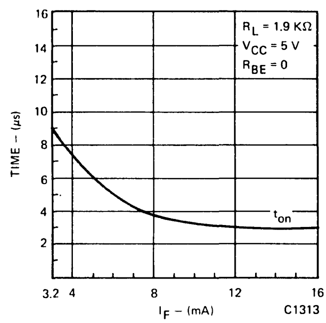


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

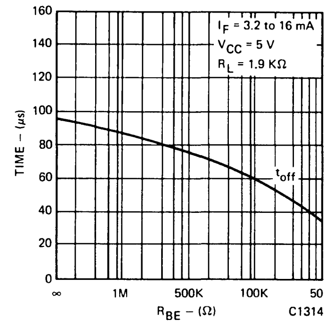


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

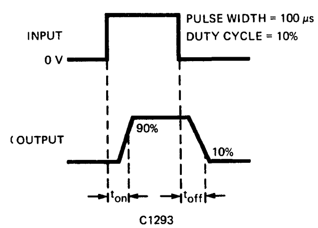


Fig. 11.

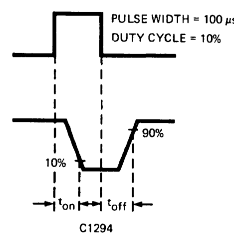


Fig. 12.

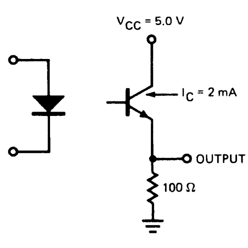


Fig. 13.

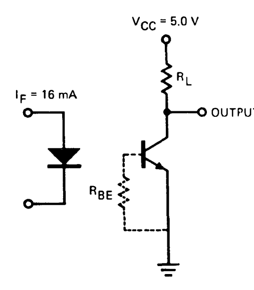


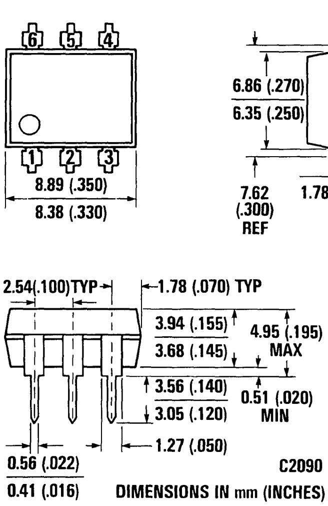
Fig. 14.

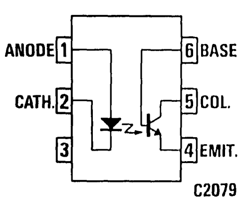
GENERAL INSTRUMENT

PHOTOTRANSISTOR OPTOCOUPLER

MCT275

PACKAGE DIMENSIONS





Equivalent Circuit

DESCRIPTION

The MCT275 is a phototransistor-type optically coupled isolator. A gallium arsenide infrared emitting diode is selectively coupled with a high voltage NPN silicon phototransistor.

FEATURES

- High voltage output — 80 volts, BV_{CEO}
- Controlled Current Transfer Ratio — 70% to 210% (specified conditions)
- Maximum Turn-on time — 15 μseconds (specified condition)
- Maximum Turn-off time — 15 μseconds (specified condition)
- Surge Isolation Rating — 4000 volts DC 3000 volts AC, rms
- Steady-state Isolation Rating — 3500 volts DC 2500 volts AC, rms
- Underwriters Laboratory (U.L.) recognized — File E50151

APPLICATIONS

- Telephone circuits
- Digital input to telecommunications
- Industrial control of high DC voltage
- Telephone relay driver

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature .... -55°C to 150°C
Operating temperature .... -55°C to 100°C
Lead temperature
(Soldering, 10 sec) .... 260°C
Total package power dissipation @ 25°C
(LED plus detector) .... 260 mW
Derate linearly from 25°C .... 3.5 mW/°C

INPUT DIODE

Forward current .... 60 mA
Reverse voltage .... 3 V
Peak forward current
(1 μs pulse, 300 pps) .... 3.0 A
Power dissipation 25°C ambient .... 90 mW
Derate linearly from 25°C .... 1.2 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C .... 200 mW
Derate linearly from 25°C .... 2.67 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)

TRANSFER CHARACTERISTICS

	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current Transfer Ratio, collector to emitter (a)	CTR_{CE}	70	125	210	%	$I_F = 10$ mA; $V_{CE} = 10$ V
			12.5			%	$I_F = 16$ mA; $V_{CE} = 0.4$ V
	Current Transfer Ratio, collector to base	CTR_{CB}		0.15		%	$I_F = 10$ mA; $V_{CB} = 10$ V
	Saturation voltage	$V_{CE(SAT)}$		0.25	.40	V	$I_F = 16$ mA; $I_C = 2$ mA
SWITCHING TIMES	Non-saturated						
	Turn-on time	t_{on}		4.5	15	μs	$R_L = 100\ \Omega$; $I_C = 2$ mA; $V_{CC} = 5$ V
	Turn-off time	t_{off}		3.5	15	μs	See figures 11, 13
	Saturated						
	Turn-on time	t_{on}		3.2		μs	$I_F = 16$ mA; $R_L = 1.9$ KΩ
	Turn-off time	t_{off}		50		μs	See figures 12, 14
	(Approximates a typical TTL interface)						
	Turn-on time	t_{on}		3.1		μs	$I_F = 16$ mA; $R_L = 4.7$ KΩ
	Turn-off time	t_{off}		90		μs	See figures 12, 14
	(Approximates a typical low power TTL interface)						
ISOLATION	Surge isolation	V_{iso}	4000			VDC	Relative humidity ≤ 50%, $I_{I-O} \leq 10$ μA
			3000			VAC-rms	t = 1 second
	Steady state isolation	V_{iso}	3500			VDC	Relative humidity ≤ 50%, $I_{I-O} \leq 10$ μA
			2500			VAC-rms	t = 1 minute
	Isolation resistance	R_{iso}	10^{11}			ohms	$V_{I-O} = 500$ VDC
	Isolation capacitance	C_{iso}		0.5		pF	f = 1 MHz

INDIVIDUAL COMPONENT CHARACTERISTICS

	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.20	1.50	V	$I_F = 20$ mA
	Forward voltage temp. coefficient			−1.8		mV/°C	
	Reverse voltage	V_R	3.0	25		V	$I_R = 10$ μA
	Junction capacitance	C_J		50		pF	$V_F = 0$ V, f = 1 MHz
				65		pF	$V_F = 1$ V, f = 1 MHz
	Reverse leakage current	I_R		0.35	10	μA	$V_R = 3.0$ V
OUTPUT TRANSISTOR	DC forward current gain	h_{FE}		170			$V_{CE} = 5$ V, $I_C = 100$ μA
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	80	85		V	$I_C = 1.0$ mA, $I_F = 0$
	Collector to base	BV_{CBO}	100	150		V	$I_C = 10$ μA
	Emitter to base	BV_{EBO}	5	7		V	$I_E = 100$ μA, $I_F = 0$
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	$V_{CE} = 10$ V, $I_F = 0$
	Capacitance						
	Collector to emitter			8		pF	$V_{CE} = 0$, f = 1 MHz
	Collector to base			20		pF	$V_{CB} = 5$, f = 1 MHz
	Emitter to base			10		pF	$V_{EB} = 0$, f = 1 MHz

TYPICAL ELECTRICAL CHARACTERISTIC CURVES (25° C Free Air Temperature Unless Otherwise Specified)

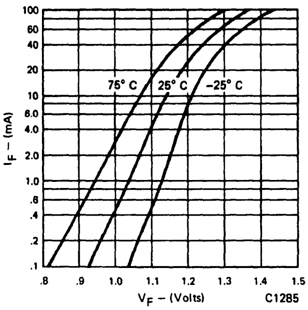


Fig. 1. Forward Voltage vs. Forward Current

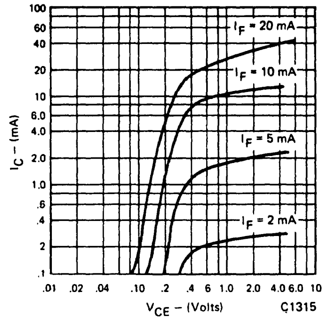


Fig. 2. Collector Current vs. Collector to Emitter Voltage

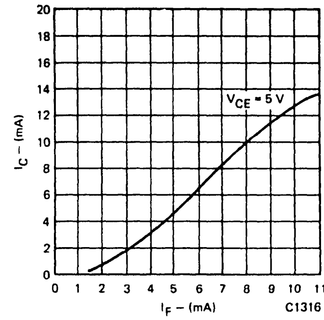


Fig. 3. Collector Current vs. Forward Current

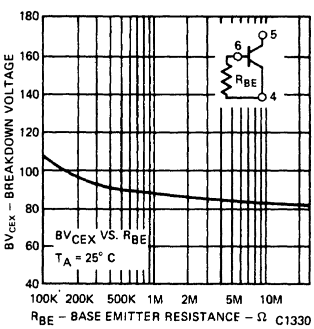


Fig. 4. Collector-Emitter Breakdown Voltage vs. Base Resistance

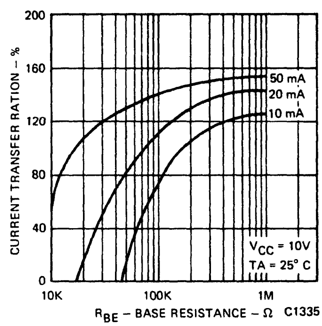


Fig. 5. Sensitivity vs. Base Resistance

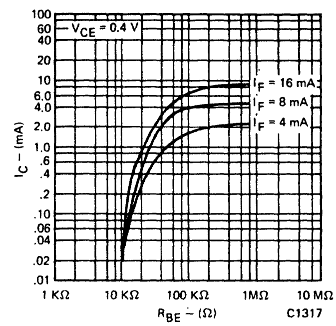


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

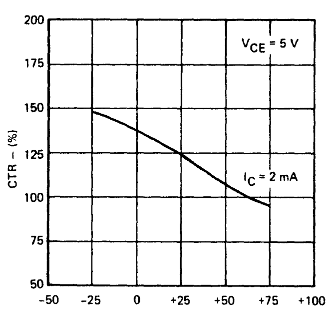


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

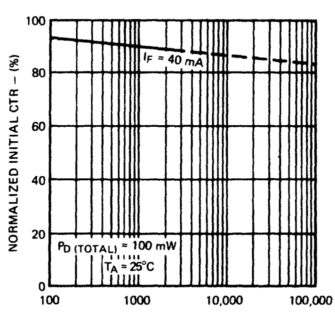


Fig. 8. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

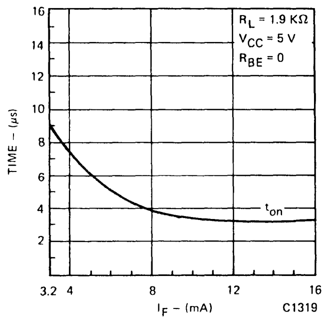


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

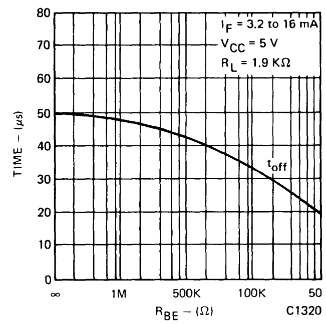


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

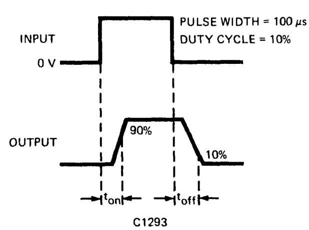


Fig. 11.

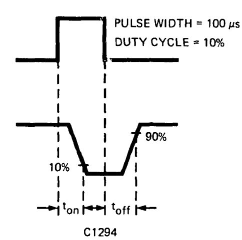


Fig. 12.

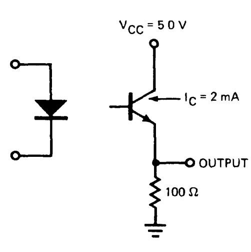


Fig. 13.

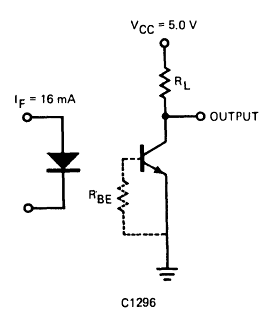


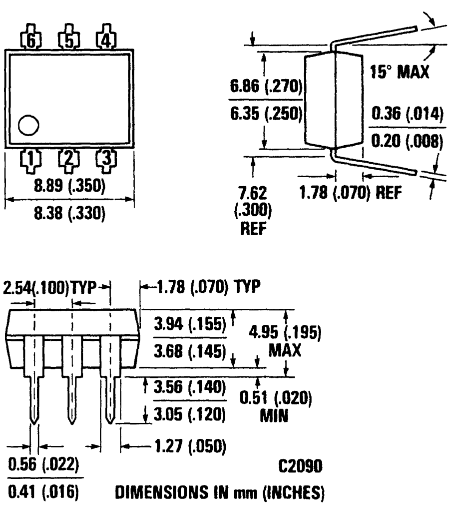
Fig. 14.

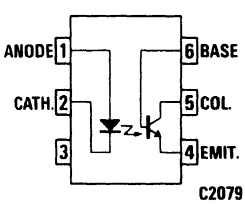
GENERAL INSTRUMENT

PHOTOTRANSISTOR OPTOCOUPLER

MCT276

PACKAGE DIMENSIONS





Equivalent Circuit

DESCRIPTION

The MCT276 is a phototransistor-type optically coupled isolator. A gallium arsenide infrared emitting diode is selectively coupled with a high speed NPN silicon phototransistor.

FEATURES

- Highest speed discrete phototransistor optoisolator
- Controlled Current Transfer Ratio – 15% to 60% (specified conditions)
- Maximum Turn-on time – 3.5 μseconds (specified condition)
- Maximum Turn-off time – 3.5 μseconds (specified condition)
- Surge Isolation Rating –
  4000 volts DC 3000 volts AC, rms
- Steady-state Isolation Rating –
  3500 volts DC 2500 volts AC, rms
- Underwriters Laboratory (U.L.) recognized – File E50151

APPLICATIONS

- Data communications
- Digital ground isolation
- Digital logic inputs
- Microprocessor inputs
- Appliance sensor systems

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	-55°C to 150°C
Operating temperature	-55°C to 100°C
Lead temperature (Soldering, 10 sec)	260°C
Total package power dissipation @ 25°C (LED plus detector)	260 mW
Derate linearly from 25°C	3.5 mW/°C

INPUT DIODE

Forward DC current	60 mA
Reverse voltage	3 V
Peak forward current (1 μs pulse, 300 pps)	3.0 A
Power dissipation 25°C ambient	90 mW
Derate linearly from 25°C	1.2 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C	200 mW
Derate linearly from 25°C	2.67 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25° C Temperature Unless Otherwise Specified)

	TRANSFER CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current Transfer Ratio, collector to emitter (a)	CTR_{CE}	15	30	60	%	I_F = 10 mA; V_{CE} = 10 V
			12.5			%	I_F = 16 mA; V_{CE} = 0.4 V
	Current Transfer Ratio, collector to base	CTR_{CB}		0.15		%	I_F = 10 mA; V_{CB} = 10 V
	Saturation voltage	$V_{CE(SAT)}$		0.24	.40	V	I_F = 16 mA; I_C = 2 mA
SWITCHING TIMES	Non-saturated						
	Turn-on time	t_{on}		2.4	3.5	μs	R_L = 100 Ω; I_C = 2 mA; V_{CC} = 5 V
	Turn-off time	t_{off}		2.2	3.5	μs	See figures 11, 13
	Saturated						
	Turn-on time	t_{on}		6.8		μs	I_F = 16 mA; R_L = 1.9 KΩ
	Turn-off time	t_{off}		16		μs	See figures 12, 14
	(Approximates a typical TTL interface)						
	Turn-on time	t_{on}		5.4		μs	I_F = 16 mA; R_L = 4.7 KΩ
	Turn-off time	t_{off}		32		μs	See figures 12, 14
	(Approximates a typical low power TTL interface)						
ISOLATION	Surge isolation	V_{iso}	4000			VDC	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA
			3000			VAC-rms	t = 1 second
	Steady state isolation	V_{iso}	3500			VDC	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA
			2500			VAC-rms	t = 1 minute
	Isolation resistance	R_{iso}	10^{11}			ohms	V_{I-O} = 500 VDC
	Isolation capacitance	C_{iso}		0.5		pF	f = 1 MHz

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.20	1.50	V	I_F = 20 mA
	Forward voltage temp. coefficient			-1.8		mV/°C	
	Reverse voltage	V_R	3.0	25		V	I_R = 10 μA
	Junction capacitance	C_J		50		pF	V_F = 0 V, f = 1 MHz
				65		pF	V_F = 1 V, f = 1 MHz
	Reverse leakage current	I_R		0.35	10	μA	V_R = 3.0 V
OUTPUT TRANSISTOR	DC forward current gain	h_{FE}		90			V_{CE} = 5 V, I_C = 100 μA
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	30	45		V	I_C = 1.0 mA, I_F = 0
	Collector to base	BV_{CBO}	70	130		V	I_C = 10 μA
	Emitter to base	BV_{EBO}	5	7		V	I_E = 100 μA, I_F = 0
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	V_{CE} = 10 V, I_F = 0
	Capacitance						
	Collector to emitter			8		pF	V_{CE} = 0, f = 1 MHz
	Collector to base			20		pF	V_{CB} = 5, f = 1 MHz
	Emitter to base			10		pF	V_{EB} = 0, f = 1 MHz

TYPICAL ELECTRICAL CHARACTERISTIC CURVES (25° C Free Air Temperature Unless Otherwise Specified)

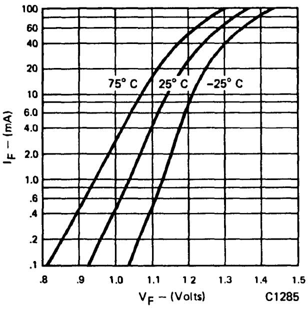


Fig. 1. Forward Voltage vs. Forward Current

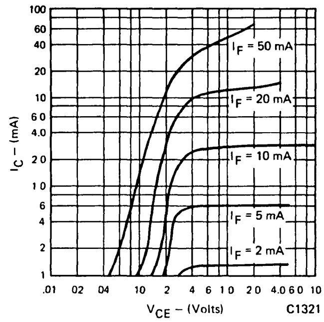


Fig. 2. Collector Current vs. Collector to Emitter Voltage

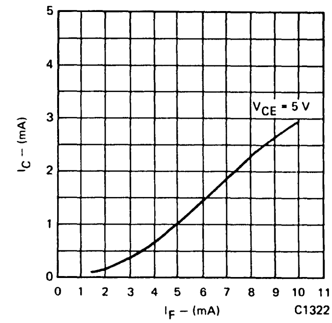


Fig. 3. Collector Current vs. Forward Current

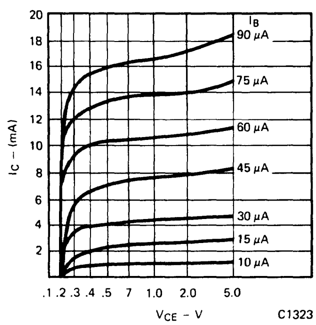


Fig. 4. Collector Current vs. Collector to Emitter Voltage

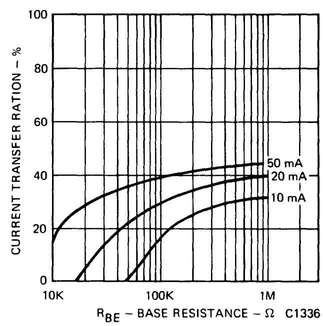


Fig. 5. Sensitivity vs. Base Resistance

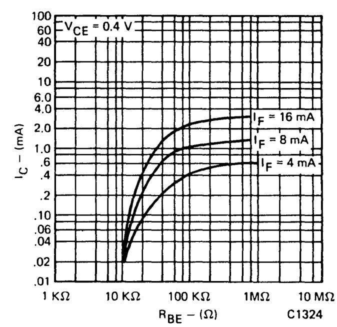


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

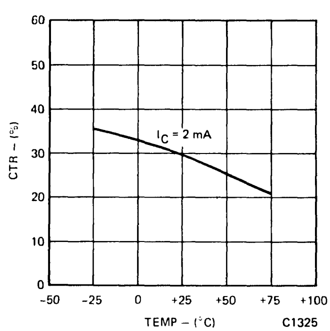


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

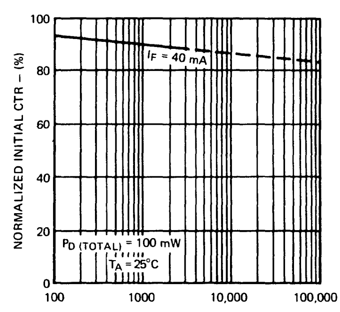


Fig. 8. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

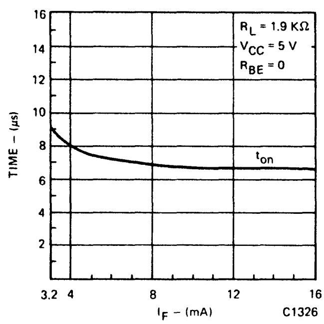


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

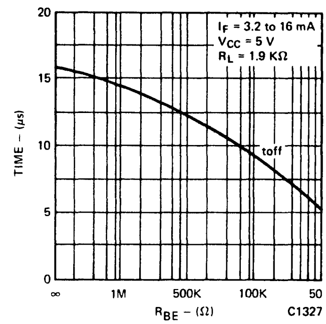


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

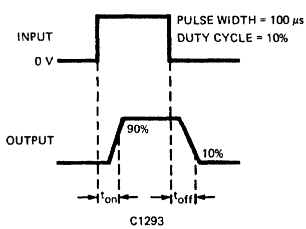


Fig. 11.

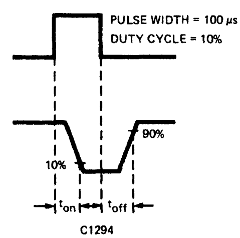


Fig. 12.

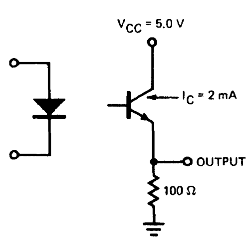


Fig. 13.

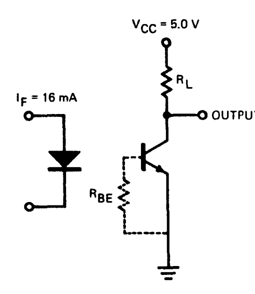


Fig. 14.

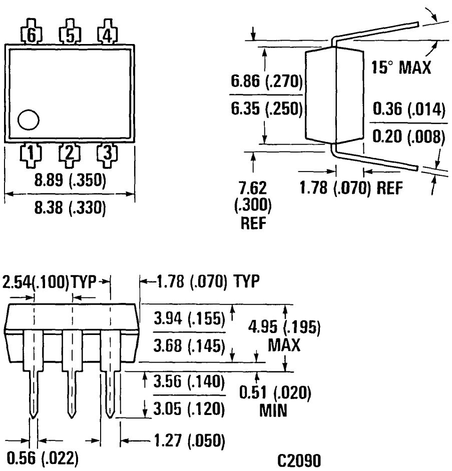
GENERAL INSTRUMENT

PHOTOTRANSISTOR OPTOCOUPLER

Optocouplers

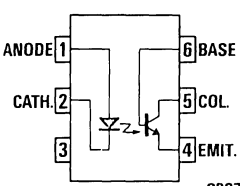
MCT277

PACKAGE DIMENSIONS



C2090

DIMENSIONS IN mm (INCHES)



C2079

Equivalent Circuit

DESCRIPTION

The MCT277 is a phototransistor-type optically coupled isolator. A gallium arsenide infrared emitting diode is selectively coupled with an NPN silicon phototransistor.

FEATURES

40% Transfer ratio at $V_{CE(SAT)}$ of 0.4 volts for multiple gate interface

- Temperature – stable from 0°C to 25°C
- Maximum Turn-on time – 15 µseconds (specified condition)
- Maximum Turn-off time – 15 µseconds (specified condition)
- Surge Isolation Rating – 4000 volts DC 3000 volts AC, rms
- Steady-state Isolation Rating – 3500 volts DC 2500 volts AC, rms
- Underwriters Laboratory (U.L.) recognized – File E50151

APPLICATIONS

- Digital to digital system interface
- Sensor to many gates
- Ground loop isolation
- Power supply regulation

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature .... -55°C to 150°C
Operating temperature .... -55°C to 100°C
Lead temperature
(Soldering, 10 sec) .... 260°C
Total package power dissipation @ 25°C
(LED plus detector) .... 260 mW
Derate linearly from 25°C .... 3.5 mW/°C

INPUT DIODE

Forward DC current .... 60 mA
Reverse voltage .... 3 V
Peak forward current
(1 µs pulse, 300 pps) .... 3.0 A
Power dissipation 25°C .... 90 mW
Derate linearly from 25°C .... 0.8 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C .... 200 mW
Derate linearly from 25°C .... 2.67 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)

	TRANSFER CHARACTERISTICS						
	CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current Transfer Ratio, collector to emitter (a)	CTR_{CE}	100			%	I_F = 10 mA; V_{CE} = 10 V
			40			%	I_F = 16 mA; V_{CE} = 0.4 V
	Current Transfer Ratio, collector to base	CTR_{CB}		0.4		%	I_F = 10 mA; V_{CB} = 10 V
SWITCHING TIMES	Non-saturated						
	Turn-on time	t_{on}			15	μs	R_L = 100 Ω; I_C = 2 mA; V_{CC} = 5 V
	Turn-off time	t_{off}			15	μs	See figures 15, 17
	Saturated						
	Turn-on time	t_{on}		3.8		μs	I_F = 16 mA; R_L = 1.9 KΩ
	Turn-off time	t_{off}		90		μs	See figures 16, 18
	(Approximates a typical TTL interface)						
	Turn-on time	t_{on}		3.7		μs	I_F = 16 mA; R_L = 4.7 KΩ
	Turn-off time	t_{off}		190		μs	See figures 16, 18
	(Approximates a typical low power TTL interface)						
ISOLATION	Surge isolation	V_{iso}	4000			VDC	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA
			3000			VAC-rms	t = 1 second
	Steady state isolation	V_{iso}	3500			VDC	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA
			2500			VAC-rms	t = 1 minute
	Isolation resistance	R_{iso}	10^{11}			ohms	V_{I-O} = 500 VDC
	Isolation capacitance	C_{iso}		1.0		pF	f = 1 MHz

	INDIVIDUAL COMPONENT CHARACTERISTICS						
	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.20	1.50	V	I_F = 20 mA
	Forward voltage temp. coefficient			−1.8		mV/°C	
	Reverse voltage	V_R	3.0	25		V	I_R = 10 μA
	Junction capacitance	C_J		50		pF	V_F = 0 V, f = 1 MHz
				65		pF	V_F = 1 V, f = 1 MHz
	Reverse leakage current	I_R		0.35	10	μA	V_R = 3.0 V
OUTPUT TRANSISTOR	DC forward current gain	h_{FE}		420			V_{CE} = 5 V, I_C = 100 μA
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	30	45		V	I_C = 1.0 mA, I_F = 0
	Collector to base	BV_{CBO}	70	130		V	I_C = 10 μA
	Emitter to base	BV_{EBO}	5	7		V	I_E = 100 μA, I_F = 0
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	V_{CE} = 10 V, I_F = 0
	Capacitance						
	Collector to emitter			8		pF	V_{CE} = 0, f = 1 MHz
	Collector to base			20		pF	V_{CB} = 5, f = 1 MHz
	Emitter to base			10		pF	V_{EB} = 0, f = 1 MHz

TYPICAL ELECTRICAL CHARACTERISTIC CURVES (25° C Free Air Temperature Unless Otherwise Specified)

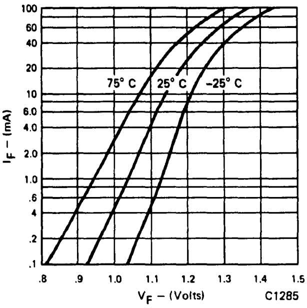


Fig. 1. Forward Voltage vs. Forward Current

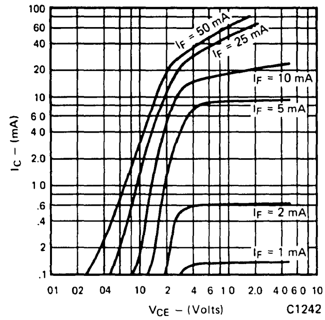


Fig. 2. Collector Current vs. Collector to Emitter Voltage

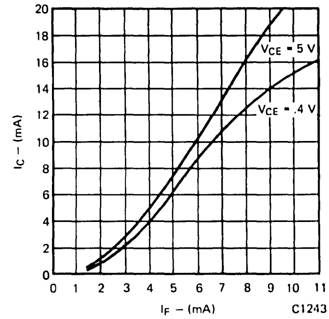


Fig. 3. Collector Current vs. Forward Current

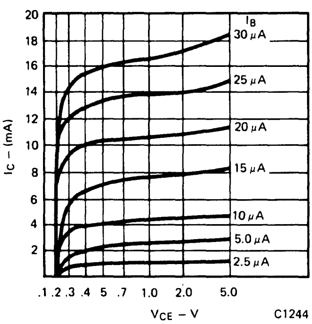


Fig. 4. Collector Current vs. Collector to Emitter Voltage

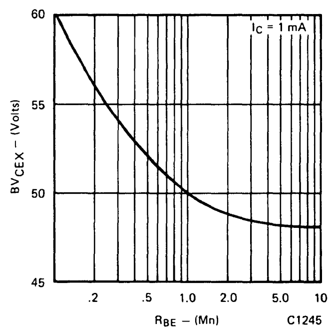


Fig. 5. Collector to Emitter Breakdown Voltage vs. Base to Emitter Resistance

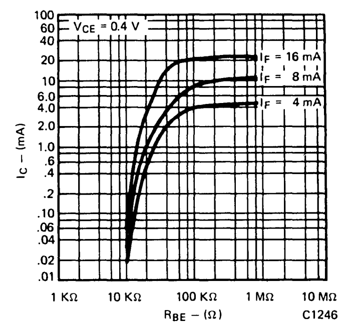


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

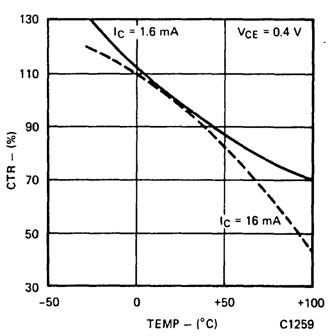


Fig. 7. Current Transfer Ratio (saturated) vs. Temperature

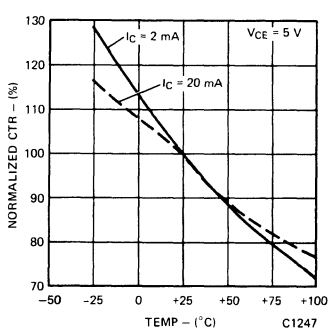


Fig. 8. Current Transfer Ratio (unsaturated) vs. Temperature

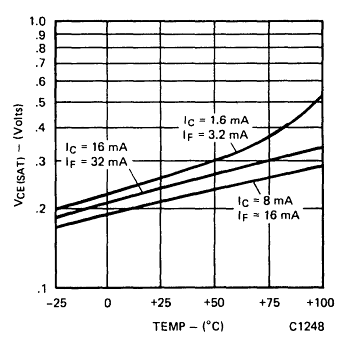


Fig. 9. Collector to Emitter Saturation Voltage vs. Temperature

TYPICAL ELECTRICAL CHARACTERISTIC CURVES (25° C Free Air Temperature Unless Otherwise Specified)

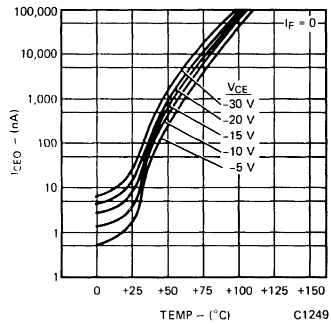


Fig. 10. Collector to Emitter Leakage Current vs. Temperature

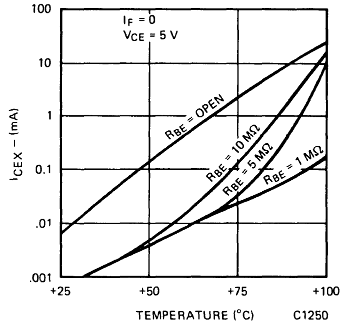


Fig. 11. Collector to Emitter Leakage Current vs. Temperature

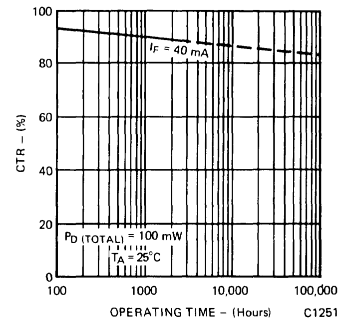


Fig. 12. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

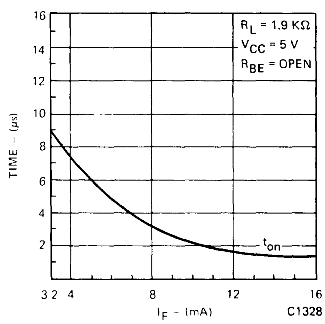


Fig. 13. Switch-on Time vs. I_F Drive (saturated)

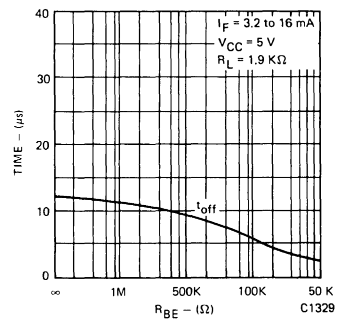


Fig. 14. Switch-off Time vs. Base to Emitter Resistance (saturated)

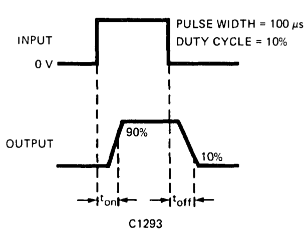


Fig. 15.

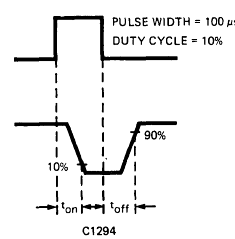


Fig. 16.

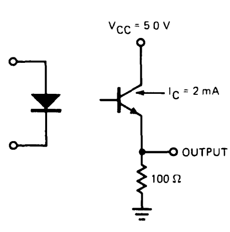


Fig. 17.

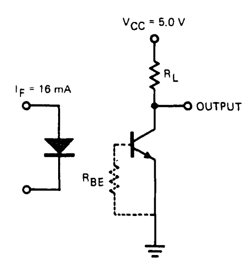


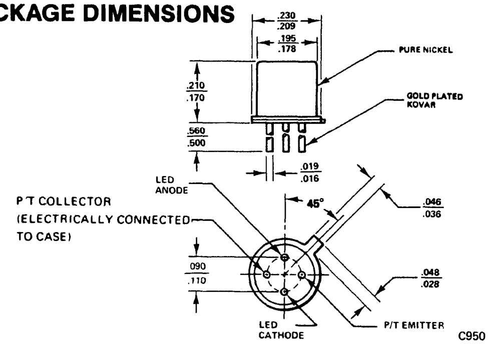
Fig. 18.

GENERAL INSTRUMENT

HERMETIC PHOTOTRANSISTOR OPTOCOUPLER

MCT4

PACKAGE DIMENSIONS



DESCRIPTION

The MCT4 is a standard four-lead, TO-18 package containing a GaAs infrared emitting diode optically coupled to an NPN silicon planar phototransistor.

FEATURES

- Hermetic package
- High current transfer ratio; typically 35%
- High isolation resistance; 10^{11} ohms at 500 volts
- High voltage isolation emitter to detector

ABSOLUTE MAXIMUM RATINGS

Storage temperature .... -65°C to 150°C
Operating temperature .... -55°C to 125°C
Lead soldering temperature (10 sec) .... 260°C
LED (GaAs Diode)
Power dissipation at 25°C ambient .... 90 mW
Derate linearly from 25°C .... 1.2 mW/°C
Continuous forward current .... 40 mA
Reverse voltage .... 3.0 V

Peak forward current (1 μs pulse, 300 pps) .... 3.0 A
Total power dissipation .... 250 mW
Derate linearly from 25°C .... 3.3 mW/°C
DETECTOR (Silicon phototransistor)
Power dissipation at 25°C ambient .... 200 mW
Derate linearly from 25°C .... 2.67 mW/°C
Collector-emitter breakdown voltage (BV_{CEO}) .... 30 V
Emitter-collector breakdown voltage (BV_{ECO}) ...... 7.0 V
ISOLATION VOLTAGE .... 1000 VDC

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Emitter					
Forward voltage		1.3	1.5	V	I_F=40 mA
Reverse current		.15	10	μA	V_R=3.0 V
Capacitance		150		pF	V=0
Detector					
BV_{CEO}	30			V	I_C=1.0 mA, I_F=0
BV_{ECO}	7	12		V	I_E = 100 μA, I_F = 0
I_{CEO}(Dark)		5	50	nA	V_{CE}=10 V, I_F=0
Capacitance collector-emitter		2		pF	V_{CE}=0
Coupled					
DC current transfer ratio	15	35		%	I_F=10 mA, V_{CE}=10 V
Breakdown voltage	1000	1500		VDC	t = 1 second
Resistance emitter-detector	10^{11}	10^{12}		ohms	V = 500 VDC
$V_{CE(SAT)}$		0.1		V	I_C=500μA, I_F= 10 mA
		0.2	0.5	V	I_C=2 mA, I_F=50 mA
Capacitance LED to detector		1.8		pF	
Bandwidth (see figure 5)		300		kHz	Note 2
Rise time and fall time (see operating schematic)		2		μs	I_C=2 mA, V_{CE}=10 V Note 3

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25° C Free Air Temperature Unless Otherwise Specified)

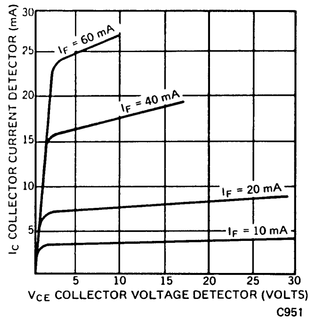


Figure 1 Detector Output Characteristics

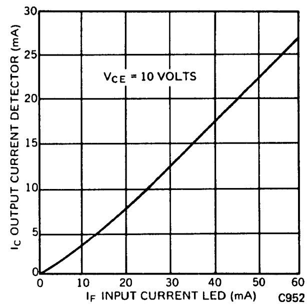


Figure 2 Input Current vs. Output Current

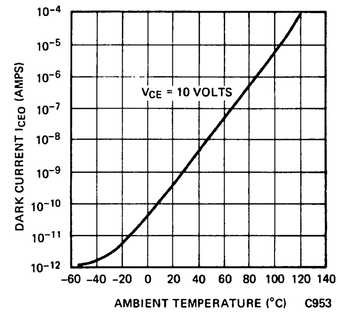


Figure 3 Dark Current vs. Temperature (°C)

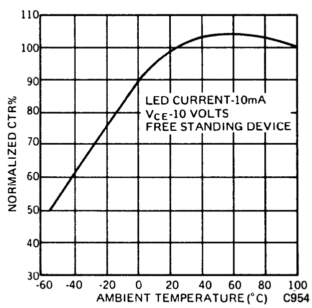


Figure 4 Current Output vs. Temperature

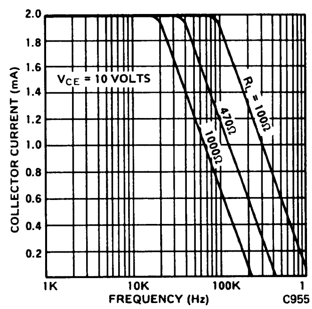


Figure 5 Output vs. Frequency

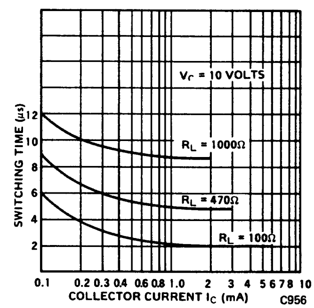
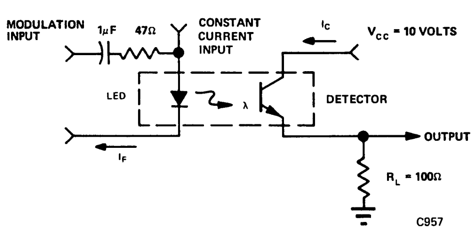


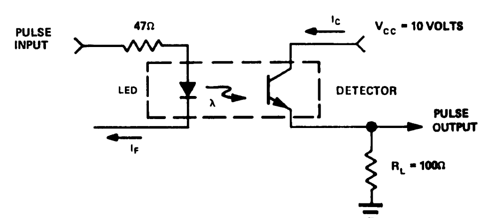
Figure 6 Switching Time vs. Collector Current

For additional characteristic curves, see MCT2

OPERATING SCHEMATICS



Modulation Circuit Used to Obtain Output vs. Frequency Plot



Circuit Used to Obtain Switching Time vs. Collector Current Plot

NOTES

1. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.*
2. *The frequency at which i_C is 3 dB down from the 1 kHz value.*
3. *Rise time (t_r) is the time required for the collector current to increase from 10% of its final value, to 90%. Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value to 10%.*

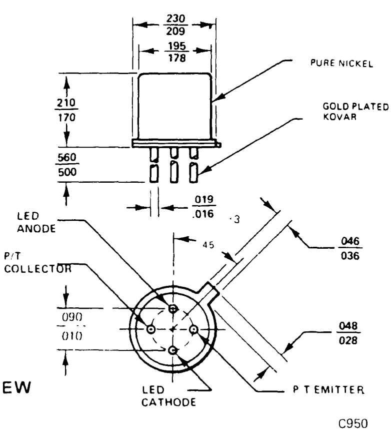
GENERAL INSTRUMENT

RELIABILITY CONDITIONED HERMETIC PHOTOTRANSISTOR OPTOCOUPLER

Optocouplers

MCT4R

PACKAGE DIMENSIONS



BOTTOM VIEW

DESCRIPTION

The MCT4R is a standard four-lead, TO-18 package containing a GaAs infrared emitting diode optically coupled to a silicon planar phototransistor.

FEATURES

- Hermetic package
- High current transfer ratio; typically 35%
- High isolation resistance, 10^{11} ohms at 500 volts
- High voltage isolation emitter to detector
- Screened to MIL-STD-883 Class B

APPLICATIONS

The General Instrument MCT4R is designed and manufactured to conform to the requirements of military systems. Reliability testing has proven the product capable of conforming to the screening and quality conformance requirements of MIL-STD-883C Class B devices.

SCREEN — 100%

Characteristic	Method
Internal Visual	2010 – Characteristics applicable to device
Stabilization Bake	1008 – 150°C. for 48 hours
Temperature Cycle	1010 – 10 cycles; −55°C., 25°C., 150°., 25°C.
Centrifuge	2001 – Test Condition E
Hermeticity	1014 – Fine and Gross
Critical Electrical	– Data Sheet
Burn In	1015 – 160 hours @ 125°C
Final Electrical	– Data Sheet
Group A Sample Inspection	5005 Table I Subgroups
External Visual	2009

LOT QUALIFICATION TESTS

Characteristic	Method	LTPD
Subgroup I		
Visual Mechanical		
Marking Permanency	2008	15%
Physical Dimensions		
Subgroup II		
Solderability	2003	15%
Subgroup III		
Thermal Shock	1011 –15 cycles; 150°C. to –65°C.	
Temperature Cycle	1010 –10 cycles; –55°C., 25°C., 150°C., 25°C.	15%
Moisture Resistance	1004	
Critical Electrical	– Data Sheet	
Subgroup IV		
Mechanical Shock	2002 – Condition B	15%
Vibration Fatigue	2005 – Condition A	
Vibration Variable Frequency	2007 – Condition A	
Constant Acceleration	2001 – Condition E	
Critical Electrical	– Data Sheets	
Subgroup V		
Lead Fatigue	2004 – Condition B_2	15%
Hermeticity	1014 – Fine Condition A	
	Gross Condition C	
Subgroup VI		
Salt Atmosphere	1009 – Condition A	15%

LIFE TESTING 7% LTPD

Characteristic	Method	LTPD
Subgroup VII		
High Temperature Storage	1008 – 150°C. for 1000 hours	7%
Critical Electrical	– Data Sheet	
Subgroup VIII		
Operating Life	1005 – Condition B	7%
Critical Electrical	– Data Sheets	
Subgroup IX		
Steady State Reverse Bias	1015 – Condition A; 72 hours at 150°C.	7%
Subgroup X		
Bond Strength	2001 –Condition C; 10 devices only	

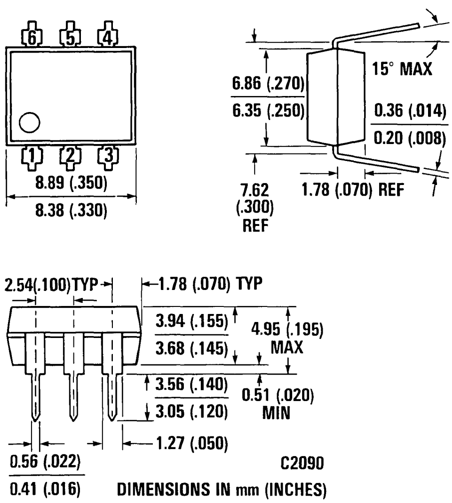
Reference: MIL-STD-883C Test Methods and Procedures for Microelectronics.

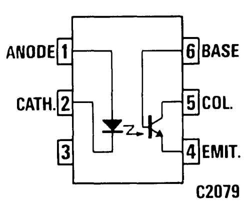
GENERAL INSTRUMENT

HIGH-PERFORMANCE AlGaAs PHOTOTRANSISTOR OPTOCOUPLERS

AlGaAs 10 mA MCT5200 5 mA MCT5201

PACKAGE DIMENSIONS





Equivalent Circuit

DESCRIPTION

The MCT520X are high performance logic compatible phototransistor type optically coupled isolator products. They are constructed using a very low degradation and high-efficiency AlGaAs, 890 nm infrared emitter, coupled to a high speed NPN phototransistor, in a high insulation double molded six-pin dual-in-line package. They provide a very high current transfer ratio (CTR), high switching speed and 2500 VAC withstand test voltage performance. The critical circuit design parameters of CTR_{CE} and CTR_{CB} are guaranteed over a temperature range of 0–70° C resulting in guaranteed switching propagation delays when interfaced to LSTTL logic.

The MCT5201 has a minimum saturated CTR of 120% for a LED input current of 5 mA. Maximum LSTTL interface propagation delays of 30 μs are guaranteed with the use of an external 330K resistor between the base and emitter. The MCT5200 is specified for a minimum saturated CTR of 75% for an input current of 10 mA.

FEATURES

- High $CTR_{CE\ (SAT)}$ comparable to Darlingtons
- Guaranteed switching speed with LSTTL load
- Performance guaranteed over 0° C to 70° C
- High withstand test voltage 2500 VAC
- High common mode rejection—5 kV/μs
- Data rates up to 150 kbits/s (NRZ)
- Underwriters Laboratory (UL) recognized file #E50151

APPLICATIONS

- LSTTL digital logic isolation
- IEEE 488 isolated inputs
- Switching power supply
- High speed industrial interfaces
- Isolated microprocessor inputs

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	-55° C to 150° C
Operating temperature	-55° C to 100° C
Lead temperature (soldering, 10 sec)	260° C
Total package, power dissipation (LED plus detector)	260 mW
Derate linearly from 25° C	3.5 mW/° C

INPUT DIODE

Forward DC current	40 mA
Reverse voltage	6 V
Peak forward current (1μs pulse, 300 pps)	1.0 A
Power dissipation	54 mW
Derate linearly from 25°C	0.7 mW/°C

OUTPUT TRANSISTOR

Power dissipation	200 mW
Derate linearly from 25°C	2.67 mW/°C

TRANSFER CHARACTERISTICS (Over Recommended Temperature, T_A = **0°C to 70°C** Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	DEVICE	MIN.	TYP.*	MAX.	UNITS	TEST CONDITIONS	FIG.	NOTE
Saturated current transfer ratio (collector to emitter)	$CTR_{CE(SAT)}$	MCT-5200	75	150		%	I_F = 10 mA, V_{CE} = 0.4V	2, 3, 4	1
		MCT-5201	120	225			I_F = 5.0 mA, V_{CE} = 0.4 V	2, 3, 5	
Current transfer ratio (collector to emitter)	$CTR_{(CE)}$	MCT-5200		200		%	I_F = 10 mA, V_{CE} = 5.0 V		1
		MCT-5201		300			I_F = 5 mA, V_{CE} = 5.0 V		
Current transfer ratio (collector to base)	CTR_{CB}	MCT-5200	0.2	0.3		%	I_F = 10 mA, V_{CB} = 4.3V	6, 7	2
		MCT-5201	0.28	0.5			I_F = 5.0 mA, V_{CB} = 4.3 V		
Saturation voltage (collector to emitter)	$V_{CE(SAT)}$	MCT-5200		0.2	0.4	V	I_F = 10 mA, I_{CE} = 7.5 mA		
		MCT-5201		0.2	0.4		I_F = 5 mA, I_{CE} = 6 mA		

**All typicals T_A = 25° C*

SWITCHING CHARACTERISTICS (Over Recommended Temperature T_A = **0°C to 70°C** Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	DEVICE	MIN.	TYP.*	MAX.	UNITS	TEST CONDITIONS	FIG.	NOTE
Delay time	t_d	MCT-5200		3	7	μs	I_F = 10 mA, V_{CE} = 0.4 V, R_L = 1.0 K, R_{BE} = 330 K, V_{CC} = 5.0 V	15, 18	3,4 5,6
Rise time	t_r			2	6				
Storage time	t_s			12	18				
Fall time	t_f			17	30				
Propagation delay H→L	t_{PHL}			5	12		I_F = 10 mA, V_{CE} = 0.4 V, V_{CC} = 5.0 V, R_L = (Fig. 18), R_{BE} = 330 K		7
Propagation delay L→H	t_{PLH}			13	20				
Delay time	t_d	MCT-5201		7	15	μs	I_F = 5 mA, V_{CE} = 0.4 V, R_L = 1.0 K, R_{BE} = 330 K, V_{CC} = 5.0 V	13, 18	3,4 5,6
Rise time	t_r			6	20				
Storage time	t_s			8	13				
Fall time	t_f			19	30				
Propagation delay H→L	t_{PHL}			12	30		I_F = 5 mA, V_{CE} = 0.4 V, V_{CC} = 5.0 V, R_L = (Fig. 18), R_{BE} = 330 K		7
Propagation delay L→H	t_{PLH}			8	13				

**All typicals T_A=25°C*

NOTES

1. *DC current transfer ratio (CTR_{CE}) is defined as the transistor collector current (I_{CE}) divided by input LED current (I_F) x 100%, at a specified voltage collector to emitter (V_{CE}).*
2. *Current transfer ratio is defined as the collector to base photocurrent (I_{CB}) divided by the input LED current (I_F) times 100%.*
3. *Switching delay time (t_d) is measured for 50% of LED current to 90% falling edge of V_O.*
4. *Rise time (t_r) is measured from the 90% to 10% of V_O falling edge.*
5. *Storage time (t_s) is measured from 50% of falling edge of LED current to 10% of rise edge of V_O.*
6. *Fall time (t_f) is measured from the 10% to 90% of the rising edge of V_O.*
7. *The t_{PLH} propagation delay is measured from 50% point on the falling edge of the input pulse to the 1.3 V point on the rising edge of the output pulse. The t_{PHL} propagation delay is measured from 50% point on the rising edge of input to 1.3 V point on falling edge of output pulse.*
8. *Device considered a two terminal device: Pins 1, 2, and 3 are shorted together. Pins 4, 5, and 6 are shorted together.*

Optocouplers

ISOLATION AND INSULATION (T_A = 25° C Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	DEVICE	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	FIG.	NOTE
Common mode rejection— output high	CM_H	MCT5200 & MCT5201		5000		v/μs	V_{CM} = 50 V_{p-p} R_L = 1 KΩ, I_F = 0	17	
Common mode rejection— output low	CM_L			5000		v/μs	V_{CM} = 50 V_{p-p} R_L = 1 KΩ, I_F = 5 mA		
Common mode coupling capacitor	C_{cm}			0.2		pF		8	
Package capacitance input/output	C_{I-O}			0.7		pF	V_{I-O} = 0, f = 1 MHz	9	
Withstand insulation test voltage	V_{ISO}		2500			$V_{AC(RMS)}$	Relative humidity ≤ 50%	10	8
	V_{ISO}		3500			$V_{AC(Peak)}$	I_{I-O} ≤ 10 μA, 1 minute		
Insulation resistance	R_{ISO}		10^{11}			Ohms	V_{I-O} = 500 V		

INDIVIDUAL COMPONENT CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

	CHARACTERISTIC	SYMBOL	DEVICE	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	FIG.	NOTE
INPUT DIODE	Forward voltage	V_F	MCT5200 & MCT5201		1.3	1.5	V	I_F = 5 mA	1	
	Forward voltage coefficient	$\Delta V_F/\Delta T_A$			-1.9		mV/° C	I_F = 2 mA	1	
	Reverse voltage	V_R		6			V	I_R = 10 μA		
	Junction capacitance	C_J			18		pF	V_F = 0 V, f = 1 MHz		
					112			V_F = 1 V, f = 1 MHz		
OUTPUT TRANSISTOR	DC forward current gain	$h_{FE(SAT)}$	MCT5200 & MCT5201		400		—	V_{CE} = 0.4 V, I_{CE} = 6 mA	8, 9	
	Breakdown voltage		MCT5200 & MCT5201							
	Collector to emitter	BV_{CEO}		30	45		V	I_C = 1.0 mA, I_F = 0		
	Collector to base	BV_{CBO}		30	70		V	I_C = 10 μA		
	Emitter to base	BV_{EBO}		5	7		V	I_E = 10 μA		
	Leakage									
	Collector to emitter	I_{CER}			5	100	nA	V_{CE} = 10 V, I_F = 0, R_{BE} = 1 MΩ	11	
	Capacitance									
	Collector to emitter	C			8		pF	V_{CE} = 0, f = 1 MHz	12	
	Collector to base				20		pF	V_{CB} = 5, f = 1 MHz		
	Emitter to base				7		pF	V_{EB} = 0, f = 1 MHz		

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

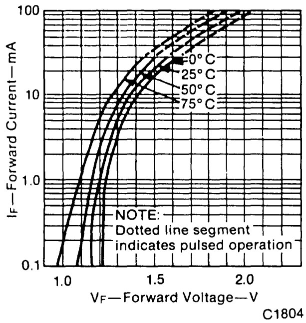


Fig. 1. Forward Voltage vs. Forward Current

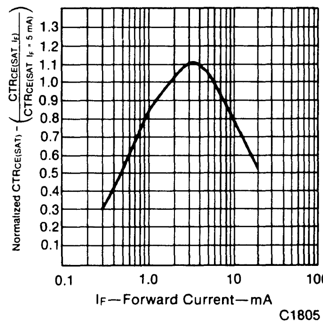


Fig. 2. Normalized Current Transfer Ratio vs. Forward Current

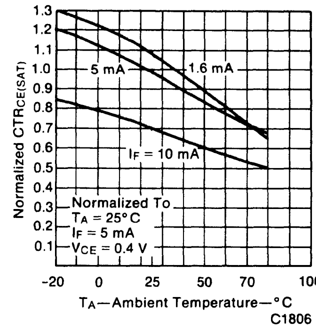


Fig. 3. Normalized CTR vs. Temperature

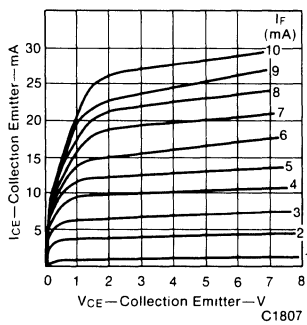


Fig. 4. MCT5200 Collector Current vs. Collector to Emitter Voltage

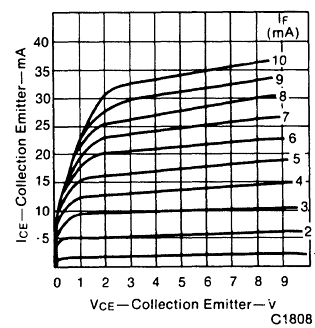


Fig. 5. MCT 5201 Collector Current vs. Collector to Emitter Voltage

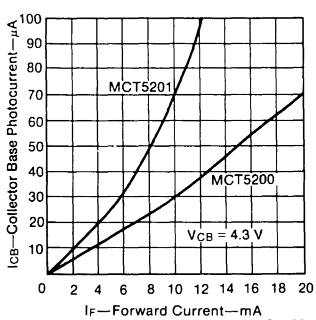


Fig. 6. Collector Base Photocurrent vs. Forward Current

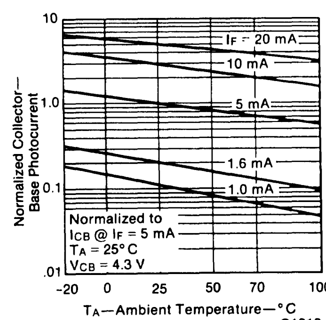


Fig. 7 Normalized Collector Base Photocurrent vs. Ambient Temperature

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25°C Unless Otherwise Specified)

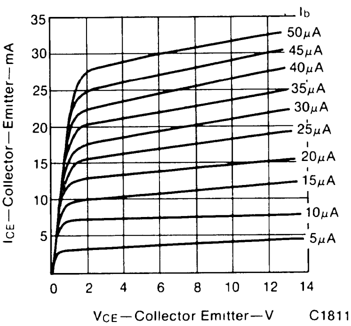


Fig. 8. Collector Current vs. Collector to Emitter Voltage

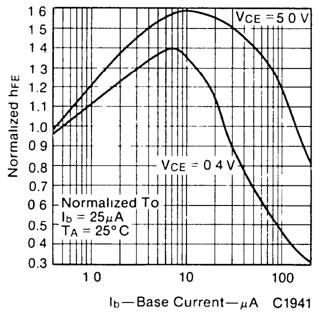


Fig. 9 Normalizec h_{FE} vs. Base Current

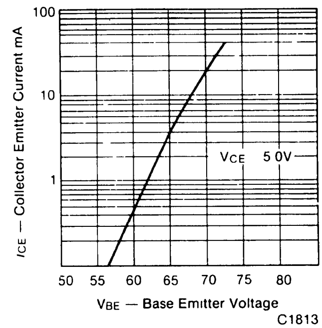


Fig. 10. Collector Current (I_{CE}) vs. Base Emitter Voltage (V_{BE})

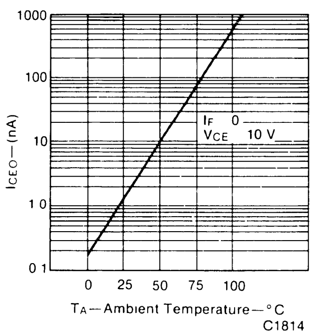


Fig. 11. Collector to Emitter Leakage Current vs. Temperature

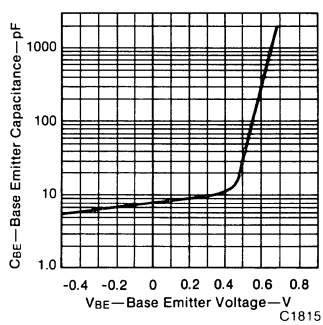


Fig. 12. Base Emitter Capacitance vs. Base Emitter Voltage

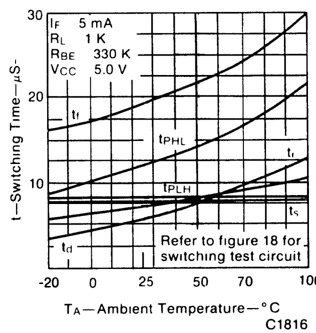


Fig. 13. Switching Time vs. Temperature I_F=5 mA R_{BE}=330 K

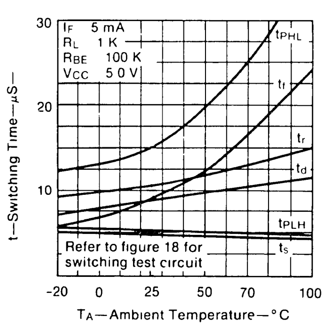


Fig. 14. Switching Speed vs. Temperature I_F=5 mA R_{BE}=100 K

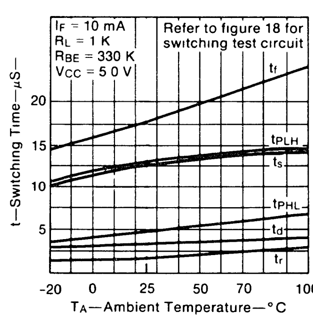


Fig. 15. Switching Speed vs. Temperature I_F=5 mA R_{BE}=330 K

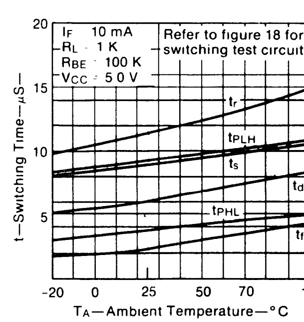


Fig. 16. Switching Speed vs. Temperature I_F=5 mA R_{BE}=100 K

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

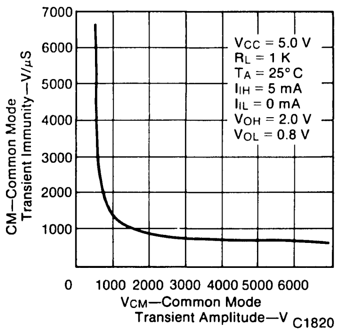


Fig. 17. Common Mode Transient Rejection vs. Common Mode Transient Voltage

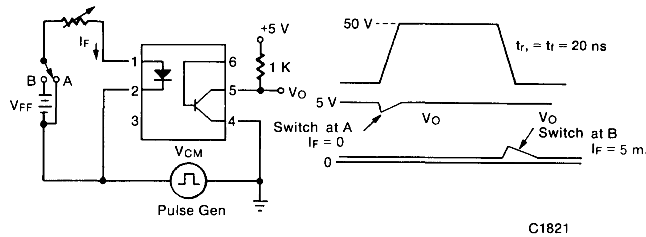
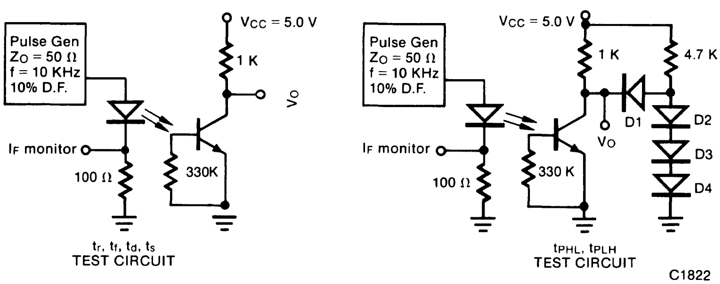


Fig. 17. Text Circuit for Transient Immunity and Typical Waveforms



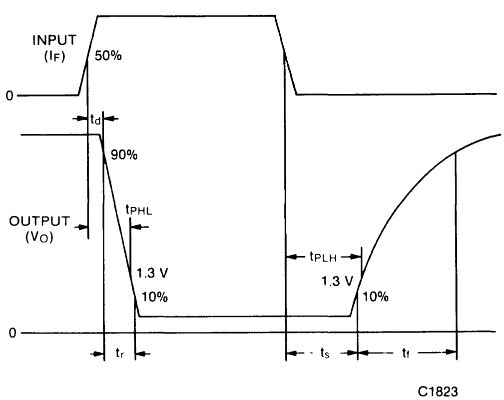
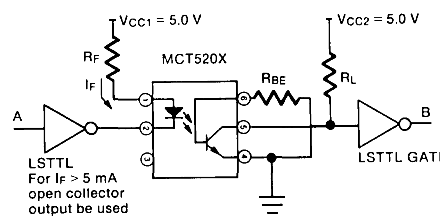


Fig. 18. Switching Circuit Waveforms



IF mA	RF Ω	RL Ω	RBE Ω	tPHL μs	tPLH μs	DATA* RATE NRZ
1.6	2 K	10 K	∞	15	12	37 K
3.0	1.1 K	4.7 K	470 K	10	10	50 K
5.0	620	1 K	330 K	12	8	50 K
10.0	330	1 K	100 K	7	11	56 K
10.0	330	2 K	47 K	3	4	140 K

$$\text{*NRZ data} = \frac{1}{t_{PLH} + t_{PHL}}$$

C1824

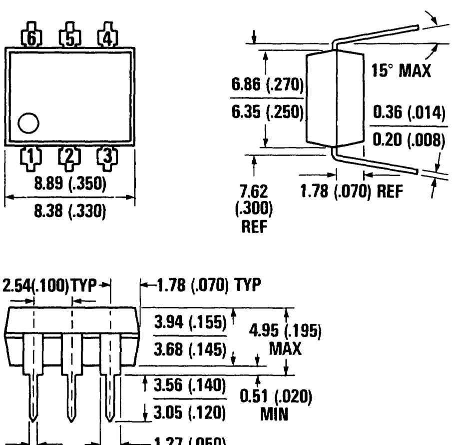
Fig. 19. Typical Non-Inverting LSTTL to LSTTL Interface

GENERAL INSTRUMENT

HIGH-PERFORMANCE AlGaAs PHOTOTRANSISTOR OPTOCOUPLERS

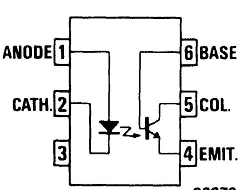
AlGaAs 3 mA MCT5210 1 mA MCT5211

PACKAGE DIMENSIONS



C2090

DIMENSIONS IN mm (INCHES)



C2079

Equivalent Circuit

DESCRIPTION

The MCT-521X are high performance CMOS/LSTTL logic compatible phototransistor type optically coupled isolator products. They are constructed using a very low degradation and high-efficiency AlGaAs, infrared emitter, coupled to a photoefficient high gain NPN phototransistor in a high insulation double molded six pin dual-in-line package. This package provides a minimum of 2500VAC Withstand Test Insulation, and 5000 V/μs common mode transient rejection.

The MCT-5211 is well suited for CMOS to LSTTL/TTL interfaces, for it offers 250% $CTR_{CE(SAT)}$ with 1 mA of LED input current. When an LED input current of 1.6 mA is supplied data rates to 20K bits/s are possible.

The MCT-5210 can easily interface LSTTL to LSTTL/TTL, and with use of an external base to emitter resistor data rates of 100 K bits/s can be achieved.

FEATURES

- High $CTR_{CE\,(SAT)}$ comparable to Darlingtons
- CTR guaranteed 0°C to 70°C
- High withstand test voltage 2500 VAC
- High common mode transient rejection—5 kV/μs
- Data rates up to 50 kbits/s (NRZ)
- Underwriters Laboratory (UL) recognized file #E50151

APPLICATIONS

- CMOS to CMOS/LSTTL logic isolation LSTTL to CMOS/LSTTL logic isolation
- RS-232 line receiver
- Telephone ring detector
- AC line voltage sensing

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	-55°C to 150°C
Operating temperature	-55°C to 100°C
Lead temperature (soldering, 10 sec.)	260°C
Total package power dissipation at 25°C (LED plus detector)	260 mW
Derate linearly from 25°C	3.5 mW/°C

INPUT DIODE

Forward DC current	40 mA
Reverse voltage	6 V
Peak forward current (1 μs pulse, 300 pps)	1.0 A
Power dissipation	54 mW
Derate linearly from 25°C	0.7 mW/°C

OUTPUT TRANSISTOR

Power dissipation	200 mW
Derate linearly from 25°C	2.67 mW/°C

TRANSFER CHARACTERISTICS OVER RECOMMENDED TEMPERATURE

(T_A = 0° C to 70° C Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	DEVICE	MIN	TYP*	MAX	UNITS	TEST CONDITIONS	FIG.	NOTE
Saturated current Transfer ratio (Collector to Emitter)	$CTR_{CE\ SAT}$	MCT-5210	60	350		%	I_F = 3.0 mA, V_{CE} = 0.4 V	2	1
		MCT-5211	100	300			I_F = 1.6 mA, V_{CE} = 0.4 V	3	
			75	250			I_F = 1.0 mA, V_{CE} = 0.4 V		
Current transfer ratio (Collector to Emitter)	CTR_{CE}	MCT-5210	70	400		%	I_F = 3.0 mA, V_{CE} = 5.0 V	5	1
		MCT-5211	150	350			I_F = 1.6 mA, V_{CE} = 5.0 V	4	
			110	300			I_F = 1.0 mA, V_{CE} = 5.0 V		
Current transfer ratio (Collector to Base)	CTR_{CB}	MCT-5210	0.2	0.9		%	I_F = 3.0 mA, V_{CB} = 4.3 V	6	2
		MCT-5211	0.3	0.75			I_F = 1.6 mA, V_{CB} = 4.3 V	7	
			0.25	0.6			I_F = 1.0 mA, V_{CB} = 4.3 V		
Saturation voltage (Collector to Emitter)	$V_{CE\ SAT}$	MCT-5210		0.2	0.4	V	I_F = 3.0 mA, I_{CE} = 1.8 mA		
		MCT-5211		0.2	0.4		I_F = 1.6 mA, I_{CE} = 1.6 mA		

All typicals T_A = 25° C

SWITCHING CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	DEVICE	MIN	TYP	MAX	UNITS	TEST CONDITIONS		FIG.	NOTE
Propagation delay H-L	t_{PHL}	MCT-5210		10		µs	R_L = 330 Ω, R_{BE} = ∞	I_F = 3.0 mA	12	3
				12			R_L = 3.3 K, R_{BE} = 39 K	V_{CC} = 5.0 V	13	
		MCT-5211		20			R_L = 750 Ω, R_{BE} = ∞	I_F = 1.6 mA		
				25			R_L = 4.7 K, R_{BE} = 91 K	V_{CC} = 5.0 V		
				40			R_L = 1.5 K, R_{BE} = ∞	I_F = 1.0 mA		
				45			R_L = 10 K, R_{BE} = 160 K	V_{CC} = 5.0 V		
Propagation delay L-H	t_{PLH}	MCT-5210		10		µs	R_L = 330 Ω, R_{BE} = ∞	I_F = 3.0 mA	12	4
				12			R_L = 3.3 K, R_{BE} = 39 K	V_{CC} = 5.0 V	13	
		MCT-5211		20			R_L = 750 Ω, R_{BE} = ∞	I_F = 1.6 mA		
				25			R_L = 4.7 K, R_{BE} = 91 K	V_{CC} = 5.0 V		
				40			R_L = 1.5 K, R_{BE} = ∞	I_F = 1.0 mA		
				45			R_L = 10 K, R_{BE} = 160 K	V_{CC} = 5.0 V		

NOTES:

1. *DC Current Transfer Ratio (CTR_{CE}) is defined as the transistor collector current (I_{CE}) divided by the input LED current (I_F) x 100%, at a specified voltage between the collector and emitter (V_{CE}).*
2. *The collector base Current Transfer Ratio (CTR_{CB}) is defined as the collector base photocurrent (I_{CB}) divided by the input LED current (I_F) time 100%.*
3. *Referring to Figure 13 the t_{PHL} propagation delay is measured from the rising edge of the data input (A) to the rising edge of the rising edge of the data output (B).*
4. *Referring to Figure 13 the t_{PLH} propagation delay is measured from the falling edge of data input (A) to the falling edge of the data output (B).*
5. *C_{CM} is the capacitance between the LED (input assembly) to the base of the phototransistor.*
6. *$C_{I\text{-}O}$ is the capacitance between the input (pins 1, 2, 3 connected) and the output, (pins 4, 5, 6 connected).*
7. *Device considered a two terminal device: Pins 1, 2, and 3 shorted together, and pins 5, 6, and 7 are shorted together.*

ISOLATION AND INSULATION (T_A = 25°C Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	DEVICE	MIN	TYP	MAX	UNITS	TEST CONDITIONS	FIG.	NOTE
Common mode transient Rejection - output high	CM_H	MCT5210 & MCT5211		5000		v/μs	V_{CM} = 50 V_{p-p}, R_L = 750 Ω I_F = 0	14	
Common mode transient Rejection - output low	CM_L			5000		v/μs	V_{CM} = 50 I_{p-p} R_L = 750 Ω I_F = 1.6 mA		
Common mode coupling capacitor	C_{CM}			0.2		pF		14	5
Package capacitance input/output	C_{I-O}			0.7		pF	V_{I-O} = 0, f = 1 MHz		6
Withstand insulation test voltage	V_{ISO}		2500			$V_{AC(RMS)}$	Relative humdity ≤ 50% I_{I-O} ≤ 10 μA, 1 minute		7
	V_{ISO}		3500			$V_{AC(Peak)}$			
Insulation resistance	R_{ISO}		10^{11}			Ohms	V_{I-O} = 500 V		

INDIVIDUAL COMPONENT CHARACTERISTICS (T_A = 25°C Unless Otherwise Specified)

	CHARACTERISTIC	SYMBOL	DEVICE	MIN	TYP	MAX	UNITS	TEST CONDITIONS	FIG.	NOTE
INPUT DIODE	Forward voltage	V_F	MCT5210 & MCT5211		1.3	1.5	V	I_F = 5 mA	1	
	Forward voltage coefficient	$\Delta V_F/\Delta T_A$			-1.9		mV/°C	I_F = 2 mA	1	
	Reverse voltage	V_R		5			V	I_R = 10 μA		
	Junction capacitance	C_J			18			V_F = 0 V, f = 1 MHz		
					112		pF	V_F = 1 V, f = 1 MHz		
OUTPUT TRANSISTOR	DC forward current gain	$h_{FE(SAT)}$	MCT5210 & MCT5211		350		—	V_{CE} = 0.4 V, I_{CE} = 2 mA	8, 9	
	Breakdown voltage		MCT5210 & MCT5211							
	Collector to emitter	BV_{CEO}		30	45		V	I_C = 1.0 mA, I_F = 0		
	Collector to base	BV_{CBO}		30	70		V	I_C = 10 μA		
	Emitter to base	BV_{EBO}		5	7		V	I_C = 10 μA, I_F = 0		
	Leakage current									
	Collector to emitter	I_{CER}				100	nA	V_{CE} = 10 V, I_F = 0, R_{BE} = 1 MΩ		
	Capacitance	C								
	Collector to emitter				10		pF	V_{CE} = 0, f = 1 MHz		
	Collector to base				80		pF	V_{CB} = 0, f = 1 MHz		
	Emitter to base				15		pF	V_{EB} = 0, f = 1 MHz	11	

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25°C Unless Otherwise Specified)

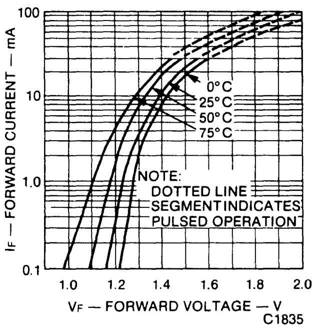


Fig. 1. Forward Voltage vs. Forward Current

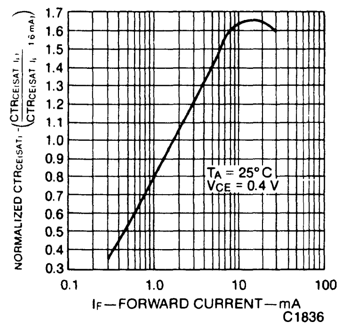


Fig. 2. Normalized Current Transfer Ratio vs. Forward Current

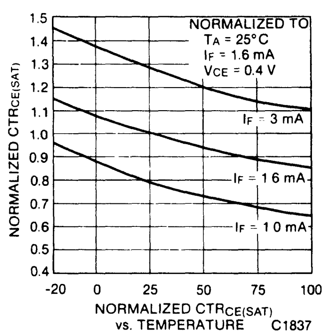


Fig. 3. Normalized CTR vs. Temperature

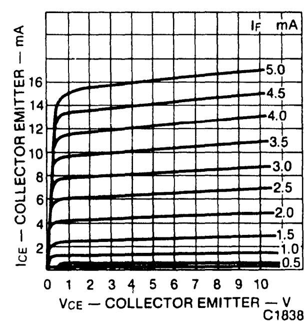


Fig. 4. DC Characteristics MCT5210

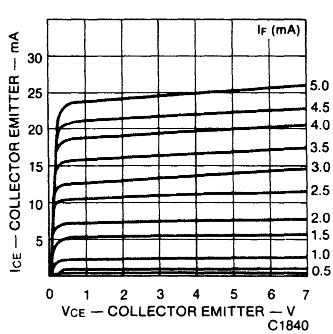


Fig. 5. DC Characteristics MCT5211

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25°C Unless Otherwise Specified)

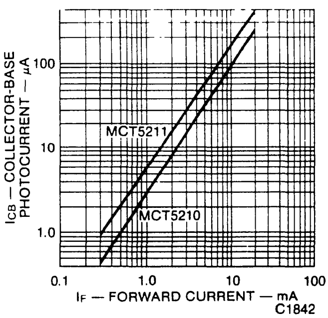


Fig. 6. Collector Base Photocurrent vs. Forward Current

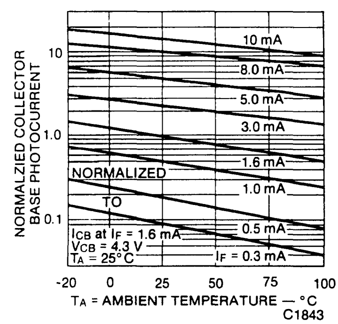


Fig. 7. Normalized Collector Base Photocurrent vs. Temperature

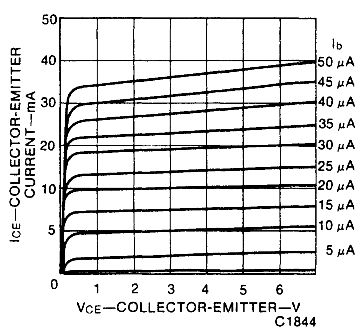


Fig. 8. Transistor DC Characteristics

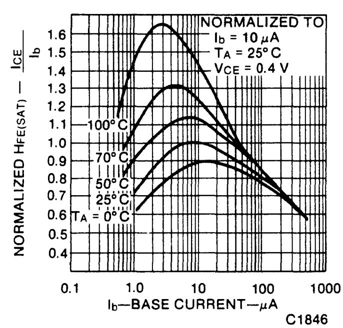


Fig. 9. $h_{FE(SAT)}$ vs. I_b vs. Temperature

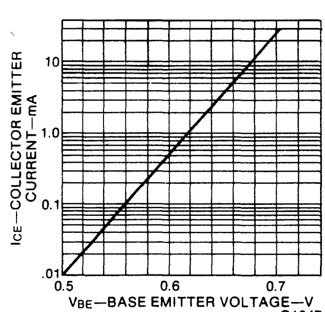


Fig. 10. Collector Current vs. Base Emitter Voltage

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25°C Unless Otherwise Specified)

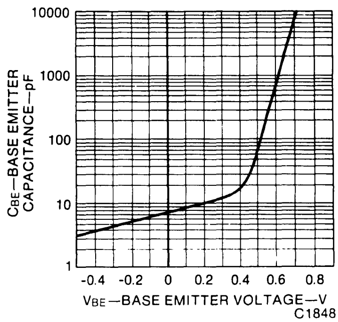


Fig. 11. C_{BE} vs. V_{BE}

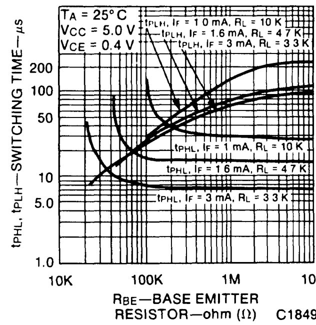
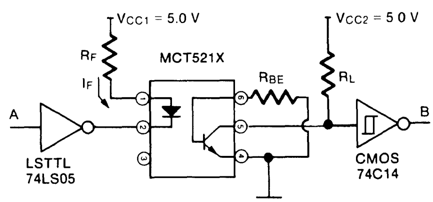
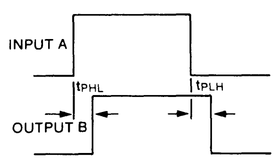


Fig. 12. Switching Time vs. R_{BE}





TYPICAL SWITCHING TIME T_A = 25°C

I_F mA	R_F KΩ	R_L KΩ	R_{BE} KΩ	t_{PHL} μs	t_{PLH} μs	Data K bit/s
1 0	3 3	1.5	∞	40	40	12.5
1 0	3 3	10	160	45	45	11
1.6	2 0	750	∞	20	20	25
1 6	2 0	4.7	91	25	25	20
3 0	1.1	.33	∞	10	10	50
3 0	1.1	3 3	39	12	12	42

C1850

Fig. 13. Switching Speed Test Circuit

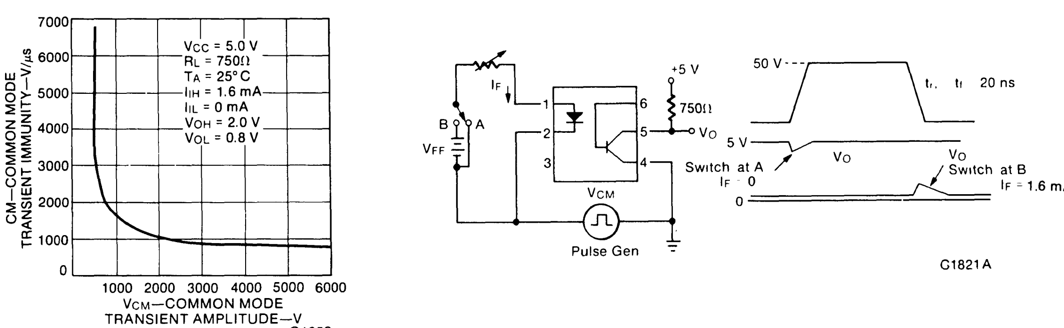


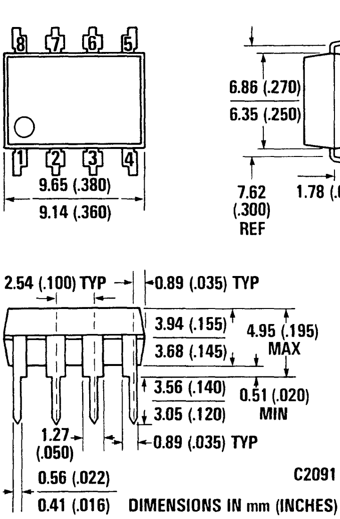
Fig. 14. Common Mode Transient Rejection & Test Circuit

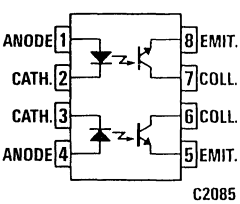
GENERAL INSTRUMENT

DUAL PHOTOTRANSISTOR OPTOCOUPLERS

NEW DUALS MCT6 (20%) MCT62 (100%) MCT61 (50%) MCT66 (6%)

PACKAGE DIMENSIONS





Equivalent Circuit

DESCRIPTION

The MCT6X optoisolators have two channels for high density applications. For four channel applications, two-packages fit into a standard 16-pin DIP socket. Each channel is an NPN silicon planar phototransistor optically coupled to a gallium arsenide infrared emitting diode.

FEATURES

- Two isolated channels per package
- Two packages fit into a 16 lead DIP socket
- 2500 volt isolation
- Choice of 4 current transfer ratios
- Underwriters Laboratory (U.L.) recognized File E50151

APPLICATIONS

- AC Line/Digital Logic — Isolate high voltage transients
- Digital Logic/Digital Logic — Eliminate spurious grounds
- Digital Logic/AC Triac Control — Isolate high voltage transients
- Twisted pair line receiver — Eliminate ground loop feedthrough
- 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

ABSOLUTE MAXIMUM RATINGS

Storage Temperature . . . . −55°C to 150°C
Operating Temperature . . . . −55°C to 100°C
Lead Temperature . . . . . . (soldering, 10 sec.) 250°C

INPUT DIODE (each channel)
Forward current 60mA
Reverse voltage 3.0V
Peak forward current (1µs pulse, 300 pps) 3A

TOTAL INPUT
Power dissipation at 25°C ambient 100mW
Derate linearly from 25°C . . . . 1.3mW/°C

OUTPUT TRANSISTOR (each channel)
Power dissipation @ 25°C ambient 150mW
Derate linearly from 25°C . . . . 2mW/°C
Collector Current 30mA

COUPLED
Input to output breakdown voltage . . 2500 volts V_{RMS}
Total package power dissipation
@ 25°C ambient 400mW
Derate linearly from 25°C . . . . 5.33mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE					
Rated forward voltage V_F		1.25	1.50	V	I_F = 20mA
Reverse voltage V_R	3.0	25		V	I_R = 10μA
Reverse current I_R		.001	10	μA	V_R = 3.0V
Junction capacitance C_J		50		pF	V_F = 0V
OUTPUT TRANSISTOR (I_F = 0)					
Breakdown voltage, collector to emitter BV_{CEO}	30	85		V	I_C = 1.0mA
Breakdown voltage, emitter to collector BV_{ECO}	6	13		V	I_E = 100μA
Leakage current, collector to emitter I_{CEO}		5	100	nA	V_{CE} = 10V
Capacitance collector to emitter C_{CE}		8		pF	V_{CE} = 0V
COUPLED					
DC current transfer ratio (I_C/I_F) = CTR					
MCT6	20			%	V_{CE} = 10V, I_F = 10mA
MCT61	50			%	V_{CE} = 5 V, I_F = 5 mA
MCT62	100			%	V_{CE} = 5 V, I_F = 5 mA
MCT66	6			%	V_{CE} = 10V, I_F = 10mA
Isolation voltage $BV_{(I-O)}$	2500			V_{RMS}	t = 1 minute
Isolation resistance MCT6X– $R_{(I-O)}$	10^{11}	10^{12}		Ω	V_{I-O} = 500VDC
Breakdown voltage — channel-to-channel MCT6X		500		VDC	Relative humidity = 40% f = 1MHz
Capacitance between channels		0.4		pF	
Saturation voltage — collector to emitter $V_{CE(SAT)}$					
MCT6, 61, 62		0.2	0.4	V	I_C = 2mA, I_F = 16mA
MCT66		0.2	0.4	V	I_C = 2mA, I_F = 40mA
Bandwidth B_W		150		kHz	I_C = 2mA, V_{CC} = 10V, R_L = 100Ω
SWITCHING TIMES, OUPUT TRANSISTOR					
Non-saturated rise time, fall time (Note 3)		2.4		μs	I_C = 2mA, V_{CE} = 10V, R_L = 100Ω
Non-saturated rise time, fall time (Note 3)		15		μs	I_C = 2mA, V_{CE} = 10V, R_L = 1KΩ
Saturated turn-on time (from 5.0V to 0.8V)		5		μs	R_L = 2KΩ, I_F = 40mA
Saturated turn-off time (from saturation to 2.0V)		25		μs	R_L = 2KΩ, I_F = 40mA

MCT6 TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25° C Free Air Temperature Unless Otherwise Specified)

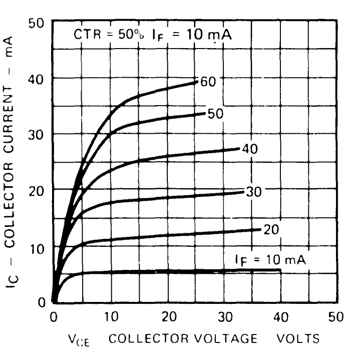


Fig. 1. I-V Curve of Phototransistor

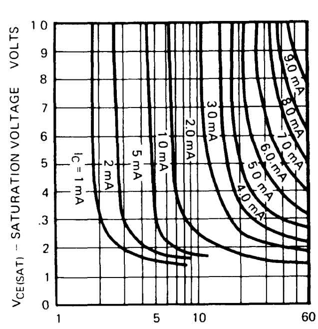


Fig. 2. I-V Curve in Saturation

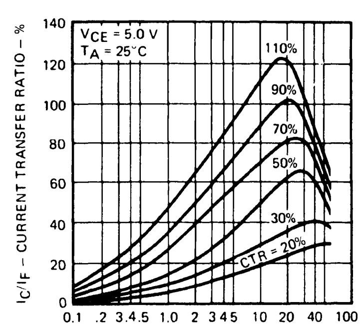


Fig. 3. CTR vs. Forward Current

MCT6 TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (Cont'd)

(25° C Free Air Temperature Unless Otherwise Specified)

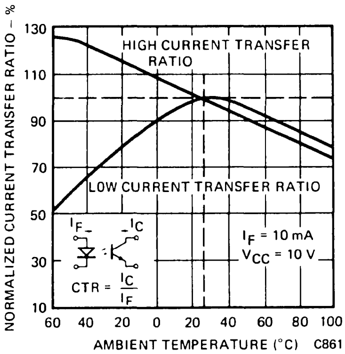


Fig. 4. Current Transfer Ratio vs. Temperature

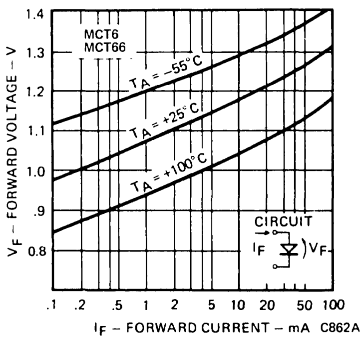


Fig. 5. I-V Curve of LED vs. Temperature

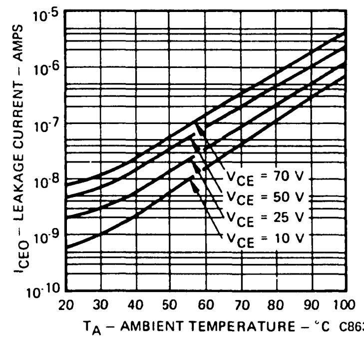


Fig. 6. Leakage Current vs. Temperature vs. Collector Voltage

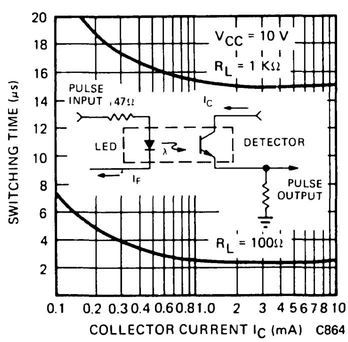


Fig. 7. Switching Time vs. Collector Current

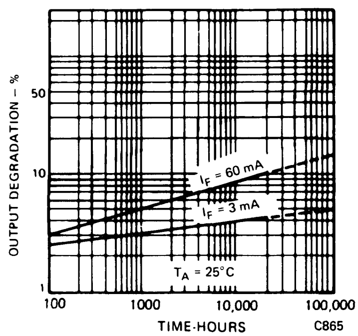


Fig. 8. Lifetime vs. Forward Current (Note 1)

MCT66 TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25° C Free Air Temperature Unless Otherwise Specified)

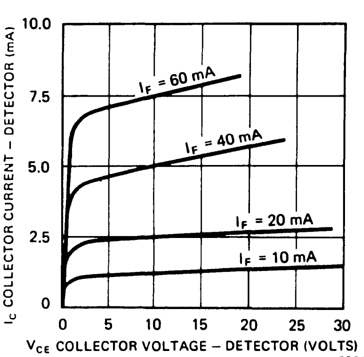


Fig. 1. Detector Output Characteristics

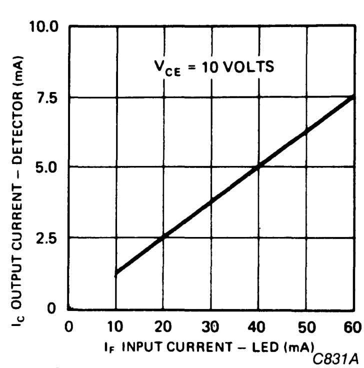


Fig. 2. Input Current vs. Output Current

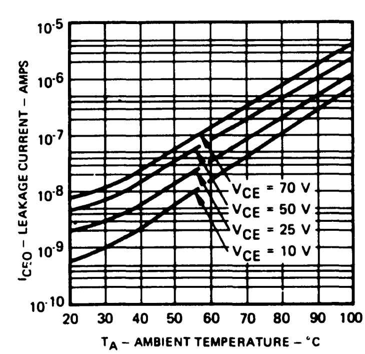


Fig. 3. Leakage Current vs. Temperature vs. Collector Voltage

MCT66 TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (Cont'd)

(25° C Free Air Temperature Unless Otherwise Specified)

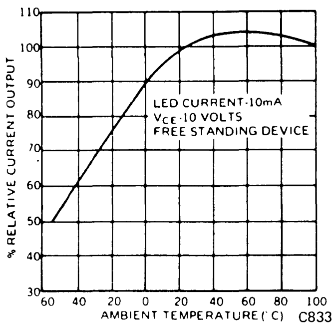


Fig. 4. Current Output vs. Temperature

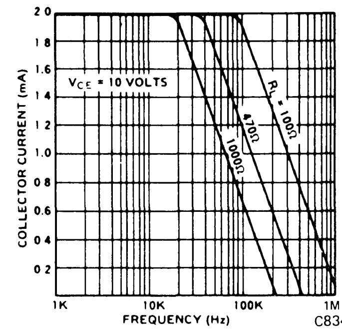


Fig. 5. Output vs. Frequency

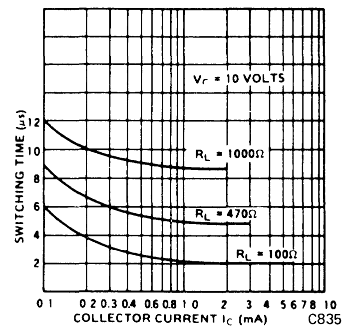


Fig. 6. Switching Time vs. Collector Current

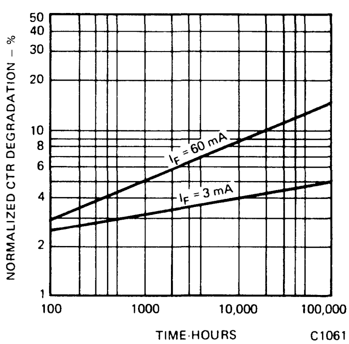
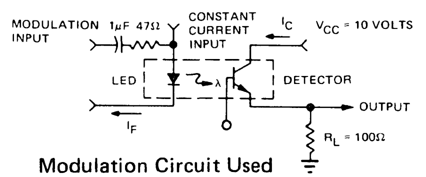
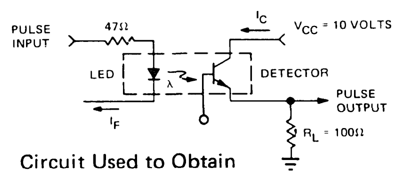


Fig. 7. Lifetime vs. Forward Current



Modulation Circuit Used to Obtain Figure 5

C837



Circuit Used to Obtain Figure 6

C838

NOTES

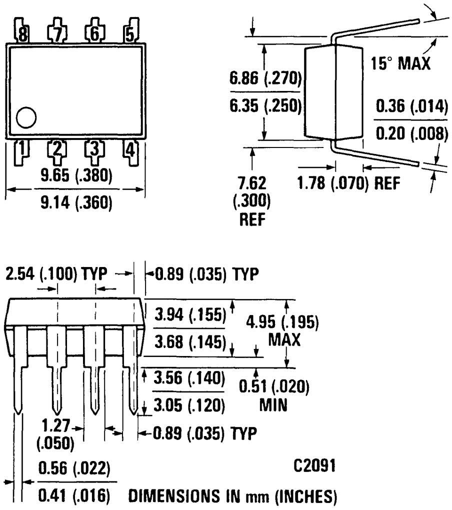
1. Normalized CTR degradation $= \frac{CTR_O - CTR}{CTR_O}$
2. The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.
3. The frequency at which i_C is 3 dB down from the 1 kHz value.
4. Rise time (t_r) is the time required for the collector current to increase from 10% of its final value to 90%.
   Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value to 10%.

GENERAL INSTRUMENT

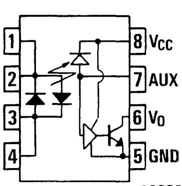
AC LINE MONITOR LOGIC-OUT DEVICE

MID400

PACKAGE DIMENSIONS



C2091



C2088

Equivalent Circuit

DESCRIPTION

The MID400 is an optically isolated AC line-to-logic interface device. It is packaged in an 8-lead plastic DIP. The AC line voltage is monitored by two back-to-back GaAs LED diodes in series with an external resistor. A high gain detector circuit senses the LED current and drives the output gate to a logic low condition.

The MID400 has been designed solely for use as an AC line **monitor**. It is recommended for use in any AC-to-DC control application where excellent optical isolation, solid state reliability, TTL compatibility, small size, low power, and low frequency operation are required.

FEATURES

- Direct operation from any line voltage with the use of an external resistor
- Externally adjustable time delay
- Externally adjustable AC voltage sensing level
- High voltage isolation between input and output
- Compact plastic DIP package
- Logic level compatibility
- UL recognized (File #E50151)

APPLICATIONS

- Monitoring of the AC/DC "line-down" condition
- "Closed-loop" interface between electro-mechanical elements such as solenoids, relay contacts, small motors, and microprocessors
- Time delay isolation switch

ABSOLUTE MAXIMUM RATINGS

INPUT – LED CIRCUIT

RMS Current	25 mA
DC Current	±30 mA
Power Dissipation at 25°C Ambient	45 mW
Derate Linearly from 70°C	2.0 mW/°C

OUTPUT – DETECTOR CIRCUIT

Low Level Output Current (I_{OL})	20 mA
High Level Output Voltage (V_{OH})	7.0 V
Supply Voltage (V_{CC})	7.0 V
Power Dissipation at 25°C Ambient	70 mW
Derate Linearly from 70°C	2.0 mW/°C

TOTAL PACKAGE

Storage Temperature	−55°C to +125°C
Operating Temperature	−40°C to +85°C
Lead Soldering Temperature, 10 Sec.	260°C
Power Dissipation at 25°C Ambient	115 mW
Derate Linearly from 70°C	4.0 mW/°C
Surge Isolation	3550 VDC 2500 V RMS
Steady State Isolation	3200 VDC 2250 V RMS

ELECTRICAL CHARACTERISTICS

(0°C to 70°C Free Air Temperature Unless Otherwise Specified—All Typical Values Are At 25°C)

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS
LED Forward Voltage	V_F			1.5	V	$I_F = \pm 30$ mA DC
On-state RMS Input Voltage	$V_{I(ON)}$ RMS	90			V	$V_O = 0.4$ V, $I_O = 16$ mA $V_{CC} = 4.5$ V, $R_{IN} = 22$ KΩ
Off-state RMS Input Voltage	$V_{I(OFF)}$ RMS			5.5	V	$V_O = V_{CC} = 5.5$ V, $I_O \leq 100\mu A$, $R_{IN} = 22$ KΩ
On-state RMS Input Current	$I_{I(ON)}$ RMS	4.0			mA	$V_O = 0.4$ V, $I_O = 16$ mA $V_{CC} = 4.5$ V $24 V \leq V_{I(ON)}$ RMS ≤ 240 V
Off-state RMS Input Current	$I_{I(OFF)}$ RMS			.15	mA	$V_O = V_{CC} = 5.5$ V, $I_O \leq 100\mu A$, $V_{I(OFF)}$ RMS ≥ 5.5 V
Logic Low Output Voltage	V_{OL}		.18	0.40	V	$I_{IN} = I_{I(ON)}$ RMS $I_O = 16$ mA, $V_{CC} = 4.5$ V $24 V \leq V_{I(ON)}$ RMS ≤ 240 V
Logic High Output Current	I_{OH}		.02	100	μA	$I_{IN} = 0.15$ mA RMS $V_O = V_{CC} = 5.5$ V $V_{I(OFF)}$ RMS ≥ 5.5 V
Logic Low Output Supply Current	I_{CCL}			3.0	mA	$I_{IN} = 4.0$ mA RMS V_O = Open, $V_{CC} = 5.5$ V $24 V \leq V_{I(ON)}$ RMS ≤ 240 V
Logic High Output Supply Current	I_{CCH}			0.80	mA	$I_{IN} = 0.15$ mA RMS $V_{CC} = 5.5$ V $V_{I(OFF)}$ RMS ≥ 5.5 V
SWITCHING TIME ($T_A = +25°C$)						
Turn-On Time	t_{ON}		1.0		mS	$I_{IN} = 4.0$ mA RMS $I_O = 16$ mA, $V_{CC} = 4.5$ V $R_{IN} = 22$ KΩ (See Test Circuit 2)
Turn-Off Time	t_{OFF}		1.0		mS	I_{IN} 4.0 mA RMS $I_O = 16$ mA, $V_{CC} = 4.5$ V $R_{IN} = 22$ KΩ (See Test Circuit 2)
ISOLATION ($T_A = +25°C$)						
Surge Isolation Voltage	V_{ISO}	3550			VDC	Relative Humidity $\leq 50\%$, $I_{I-O} \leq 10\mu A$
		2500			VACRMS	1 Second, 60 Hz
Steady State Isolation Voltage	V_{ISO}	3200			VDC	Relative Humidity $\leq 50\%$, $I_{I-O} \leq 10\mu A$
		2250			VACRMS	1 Minute, 60 Hz
Isolation Resistance	R_{ISO}	10^{11}			Ω	$V_{I-O} = 500$ VDC
Isolation Capacitance	C_{ISO}		2		pF	f = IMHZ

(RMS = True RMS Voltage at 60 Hz, THD ≤ 1%.)

DESCRIPTION/APPLICATIONS

The input of the MID400 consists of two back-to-back LED diodes which will accept and convert alternating currents into light energy. An integrated photo diode-detector amplifier forms the output network. Optical coupling between input and output provides 3550 V DC voltage isolation. A very high current transfer ratio, (defined as the ratio of the DC output current and the DC input current) is achieved through the use of a high gain amplifier. The detector amplifier circuitry operates from a 5 V DC supply and drives an open collector transistor output. The switching times are intentionally designed to be slow in order to enable the MID400, when used as an AC line monitor, to respond only to changes of input voltage exceeding many milliseconds. The short period of time during zero-crossing which occurs once every half cycle of the power line is completely ignored. To operate the MID400, always add a resistor, R_{IN}, in series with the input (as shown in Fig. 1) to limit the current to the required value. The value of the resistor can be determined by the following equation:

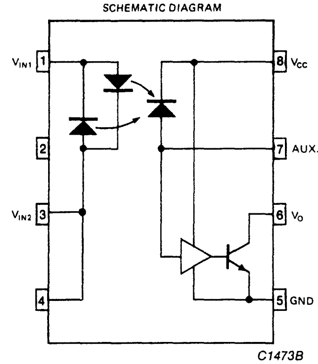
$$R_{IN} = \frac{V_{IN} - V_F}{I_{IN}}$$

Where V_{IN} (RMS) is the input voltage.
V_F is the forward voltage drop across the LED.
I_{IN} (RMS) is the desired input current required to sustain a logic "O" on the output.

PIN DESCRIPTION

DESIGNATION	PIN #	FUNCTION
V_{IN1}, V_{IN2}	1, 3	Input terminals.
V_{CC}	8	Supply voltage, output circuit.
AUX.	7	Auxiliary terminal. Programmable capacitor input to adjust AC voltage sensing level and time delay.
V_O	6	Output terminal; open collector.
GND	5	Circuit ground potential.

SCHEMATIC DIAGRAM



NOTE: DO NOT CONNECT PIN 2 AND 4

GLOSSARY

VOLTAGES

$V_{I(ON)}$ RMS — On-state RMS input voltage
The RMS voltage at an input terminal for a sqecified input current with output conditions applied that according to the product specification will cause the output switching element to be sustained in the on-state within one full cycle.

$V_{I(OFF)}$ RMS — Off-state RMS input voltage
The RMS voltage at an input terminal for a specified input current with output conditions applied that according to the product specification will cause the output switching element to be sustained in the off-state within one fill cycle.

V_{OL} — Low-level output voltage
The voltage at an output terminal for a specific output current I_{OL} with input conditions applied that according to the product specification will establish a low-level at the output.

V_{OH} — High-level output voltage
The voltage at an output terminal for a specified output current I_{OH} with input conditions applied that according to the product specification will establish a high-level at the output.

V_F — LED forward voltage
The voltage developed across the LED when input current I_F is applied to the anode of the LED.

CURRENTS

$I_{I(ON)}$ RMS — On-state RMS input current
The RMS current flowing into an input with output conditions applied that according to the product specification will cause the output switching element to be sustained in the on-state within one full cycle.

$I_{I(OFF)}$ RMS — Off-state RMS input current
The RMS current flowing into an input with output conditions applied that according to the product specification will cause the output switching element to be sustained in the off-state within one full cycle.

I_{OH} — High-level output current
The current flowing into * an output with input conditions applied that according to the product specification will establish a high-level at the output.

I_{OL} — Low-level output current
The current flowing into * an output with input conditions applied that according to the product specification will establish a low-level at the output.

I_{CCL} — Supply current, output low
The current flowing into * the V_{CC} supply terminal of a circuit when the output is at a low-level voltage.

I_{CCH} — Supply current, output high
The current flowing into * the V_{CC} supply terminal of a circuit when the output is at a high-level voltage.

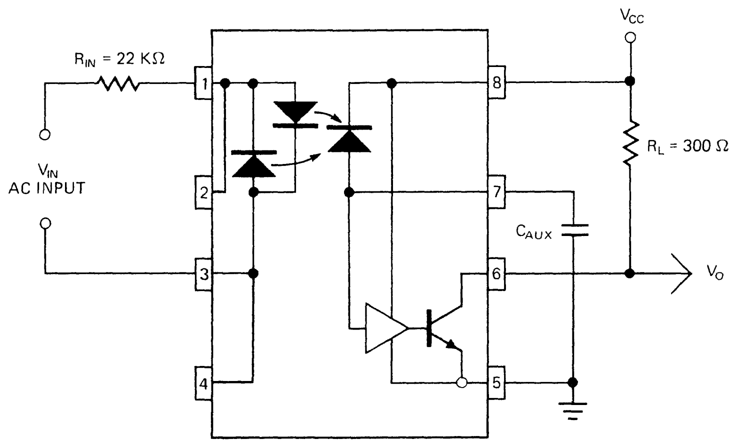
DYNAMIC CHARACTERISTICS

t_{ON} — Turn-on time
The time between the specified reference points on the input and the output voltage waveforms with the output changing from the defined high-level to the defined low-level.

t_{OFF} — Turn-off time
The time between the specified reference points on the input and output voltage waveforms with the output changing from the defined low-level to the defined high-level.

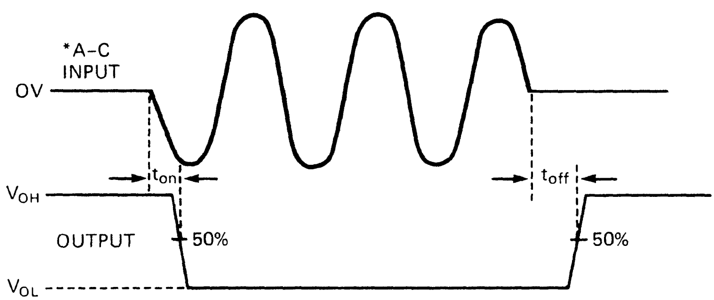
*Current flowing out of a terminal is a negative value.

OPERATING SCHEMATICS

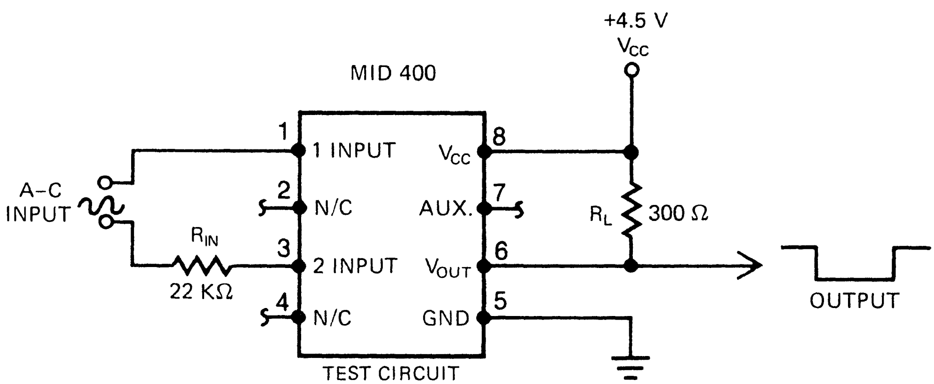


INPUT CURRENT VS. CAPACITANCE, C_{AUX} CIRCUIT
TEST CIRCUIT 1

C1478A



*INPUT TURNS ON AND OFF AT ZERO CROSSING.

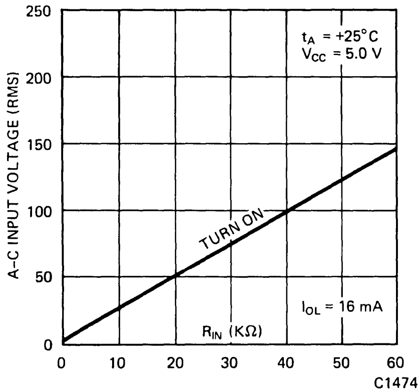


TEST CIRCUIT 2

MID400 Switching Time

C1479 B

TYPICAL CURVES



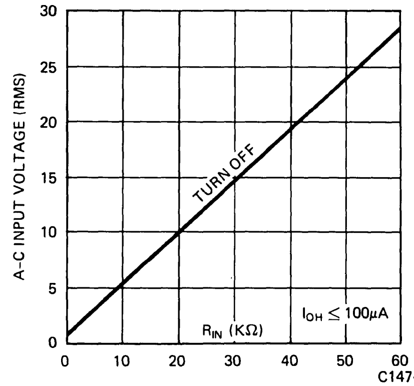


Fig. 2. Input Voltage vs. Input Resistance

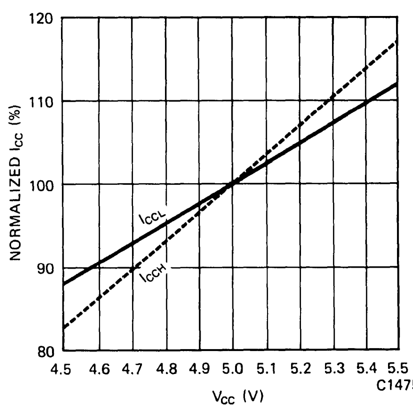


Fig. 3. Supply Current vs. Supply Voltage

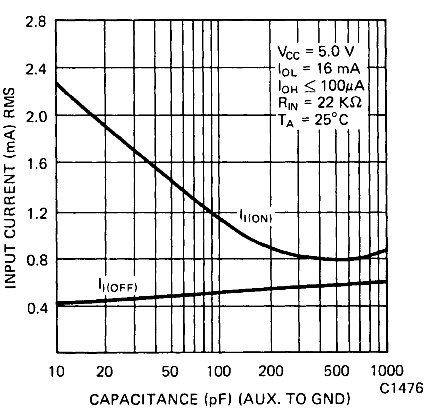


Fig. 4. Input Current vs. Capacitance
(See test circuit 1)

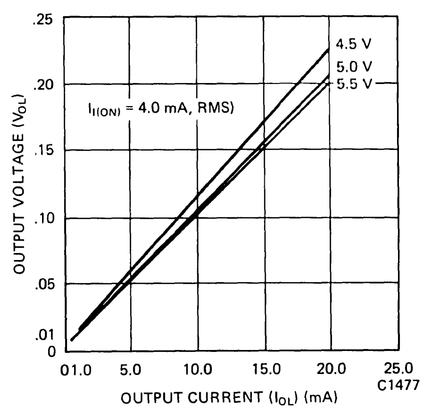
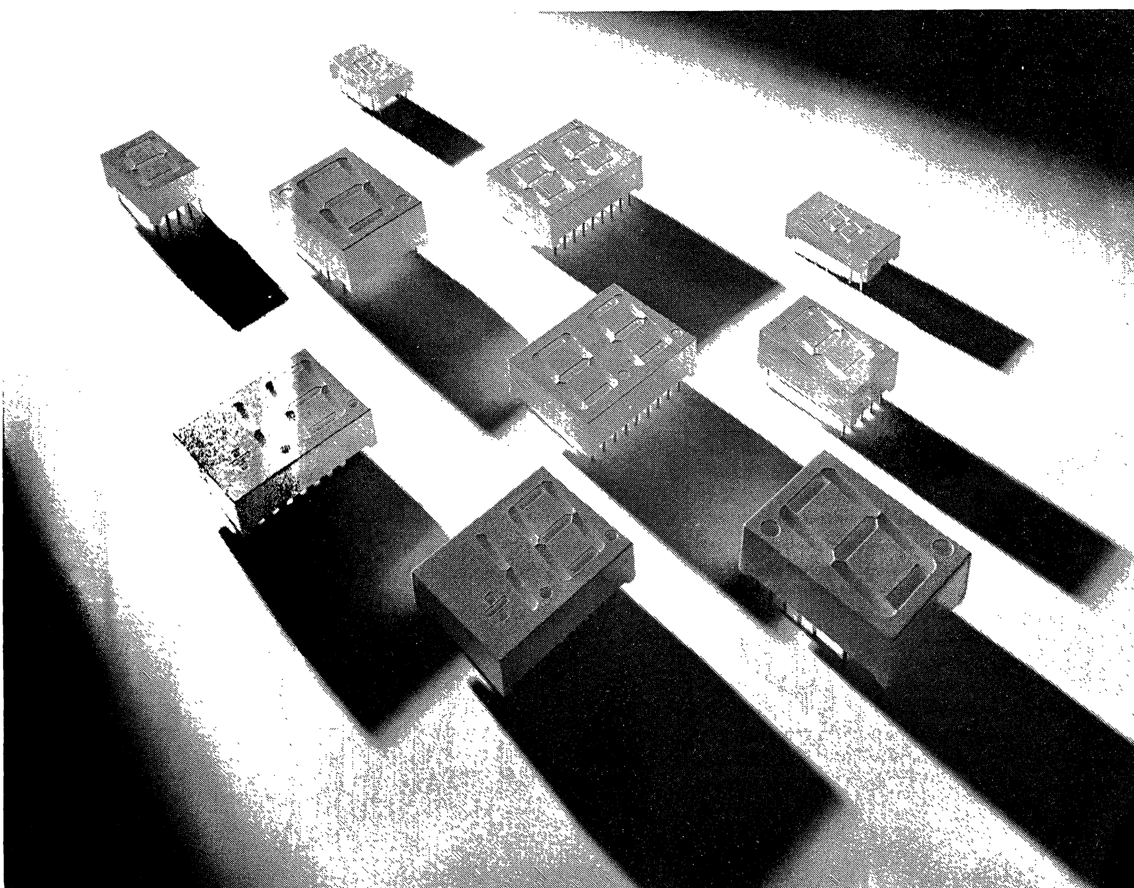


Fig. 5. Output Voltage vs. Output Current

Displays 2



Displays

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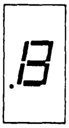
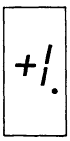
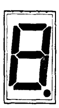
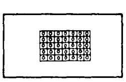
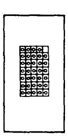
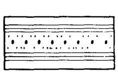
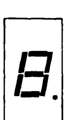
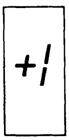
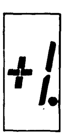
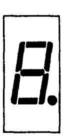
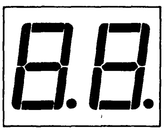
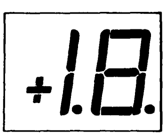
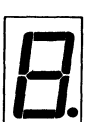
DISPLAYS

PACKAGE	PART NUMBER	COLOR	DESCRIPTION	BRIGHTNESS OR LUMINOUS INTENSITY (TYPICAL)	PAGE
	5082-7650 5082-7750	High Efficiency Red Red	.43-Inch; Common Anode; LHDP	550 μcd @ 5 mA 700 μcd @ 20 mA	205
	5082-7651 5082-7653 5082-7751 5082-7760	High Efficiency Red High Efficiency Red Red Red	.43-Inch; Common Anode; RHDP .43-Inch; Common Cathode; RHDP .43-Inch; Common Anode; RHDP .43-Inch; Common Cathode; RHDP	550 μcd @ 5 mA 550 μcd @ 5 mA 700 μcd @ 20 mA 700 μcd @ 20 mA	205
	5082-7656 5082-7756	High Efficiency Red Red	.43-Inch; Universal Overflow ±1; RHDP	550 μcd @ 5 mA 700 μcd @ 20 mA	205
	FND350 FND360	Red High Bright Red	.362-Inch; Common Anode; RHDP	240 μcd @ 20 mA 590 μcd @ 20 mA	
	FND317 FND357 FND367	High Efficiency Red Red High Bright Red	.362-Inch; Common Cathode; RHDP	4000 μcd @ 20 mA 450 μcd @ 20 mA 900 μcd @ 20 mA	209 313 213
	MAN1A MAN10A	Red	.270-Inch; Common Anode; LHDP; Direct View	180 μcd @ 20 mA 180 μcd @ 10 mA	217
	MAN2A	Red	.320-Inch; X-Y 35 Diode, Alpha-numeric; Direct View; Encapsulated	300 μcd @ 10 mA	219
	MAN24 MAN27 MAN28 MAN29	High Efficiency Green Red Yellow High Efficiency Red	.32-Inch; 5 x 7 Dot Matrix; LHDP	750 μcd @ 10 mA 250 μcd @ 10 mA 600 μcd @ 10 mA 500 μcd @ 10 mA	221
	MAN2815	Red	.135-Inch; Common Cathode; 14 Segment Alphanumeric; 8-Characters	100 μcd @ 2.5 mA (average current)	225
	MAN3410A MAN3610A MAN3810A MAN3910A MAN71A	High Efficiency Green Orange Yellow High Efficiency Red Red	.3-Inch; Common Anode; RHDP	2000 μcd @ 10 mA 1400 μcd @ 10 mA 1200 μcd @ 10 mA 1500 μcd @ 10 mA 280 μcd @ 10 mA	229 229 229 241 229

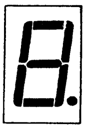
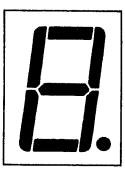
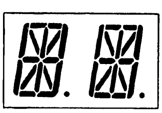
DISPLAYS

PACKAGE	PART NUMBER	COLOR	DESCRIPTION	BRIGHTNESS OR LUMINOUS INTENSITY (TYPICAL)	PAGE
	MAN3420A	High Efficiency Green	.3-Inch; Common Anode; LHDP	2000 μcd @ 10 mA	229
	MAN3620A	Orange		1400 μcd @ 10 mA	229
	MAN3820A	Yellow		1200 μcd @ 10 mA	229
	MAN3920A	High Efficiency Red		1500 μcd @ 10 mA	241
	MAN72A	Red		280 μcd @ 10 mA	229
	MAN3630A	Orange	.3-Inch; Common Anode; Polarity and Overflow	1400 μcd @ 10 mA	229
	MAN73A	Red		280 μcd @ 10 mA	
	MAN3440A	High Efficiency Green	.3-Inch; Common Cathode; RHDP	2000 μcd @ 10 mA	229
	MAN3640A	Orange		1400 μcd @ 10 mA	229
	MAN3840A	Yellow		1200 μcd @ 10 mA	229
	MAN3940A	High Efficiency Red		1500 μcd @ 10 mA	241
	MAN74A	Red		280 μcd @ 10 mA	229
	MAN3480A	High Efficiency Green	.3-Inch; Common Anode; RHDP; 10-Pin	2000 μcd @ 10 mA	235
	MAN3680A	Orange		1400 μcd @ 10 mA	
	MAN3880A	Yellow		1200 μcd @ 10 mA	
	MAN3980A	High Efficiency Red		1500 μcd @ 10 mA	
	MAN78A	Red		280 μcd @ 10 mA	
	MAN4705A	Red	.4-Inch; Universal (CA/CC) Overlfow ±1; RHDP	280 μcd @ 10 mA	245
	MAN4410A	High Efficiency Green	.4-Inch; Common Anode; RHDP	2000 μcd @ 10 mA	245
	MAN4610A	Orange		1400 μcd @ 10 mA	245
	MAN4710A	Red		280 μcd @ 10 mA	245
	MAN4910A	High Efficiency Red		1500 μcd @ 10 mA	251
	MAN4440A	High Efficiency Green	.4-Inch; Common Cathode; RHDP;	2000 μcd @ 10 mA	245
	MAN4640A	Orange		1400 μcd @ 10 mA	245
	MAN4740A	Red		280 μcd @ 10 mA	245
	MAN4940A	High Efficiency Red		1500 μcd @ 10 mA	251

DISPLAYS

PACKAGE	PART NUMBER	COLOR	DESCRIPTION	BRIGHTNESS OR LUMINOUS INTENSITY (TYPICAL)	PAGE
	MAN6110 MAN6140	High Efficiency Red	0.56-Inch; Common Anode; RHDP; 2-Digit 0.56-Inch; Common Cathode; RHDP; 2-Digit	370 μcd @ 2 mA	255
	MAN6410 MAN6440	High Efficiency Green	0.56-Inch; Common Anode; RHDP; 2-Digit 0.56-Inch; Common Cathode; RHDP; 2-Digit	2000 μcd @ 10 mA	259
	MAN6610 MAN6640	Orange	0.56-Inch; Common Anode; RHDP; 2-Digit 0.56-Inch; Common Cathode; RHDP; 2-Digit	1600 μcd @ 10 mA	263
	MAN6710 MAN6740	Red	0.56-Inch; Common Anode; RHDP; 2-Digit 0.56-Inch; Common Cathode; RHDP; 2-Digit	350 μcd @ 10 mA	267
	MAN6910 MAN6940	High Efficiency Red	0.56-Inch; Common Anode; RHDP; 2-Digit 0.56-Inch; Common Cathode; RHDP; 2-Digit	1600 μcd @ 10 mA	271
	MAN6130 MAN6150	High Efficiency Red	0.56-Inch; Common Anode; RHDP; 1½-Digit 0.56-Inch; Common Cathode; RHDP; 1½-Digit	370 μcd @ 2 mA	255
	MAN6630 MAN6650	Orange	0.56-Inch; Common Anode; RHDP; 1½-Digit 0.56-Inch; Common Cathode; RHDP; 1½-Digit	1600 μcd @ 10 mA	263
	MAN6730 MAN6750	Red	0.56-Inch; Common Anode; RHDP; 1½-Digit 0.56-Inch; Common Cathode; RHDP; 1½-Digit	350 μcd @ 10 mA	267
	MAN6930 MAN6950	High Efficiency Red	0.56-Inch; Common Anode; Overflow ±1.8, RHDP 0.56-Inch; Common Cathode; Overflow ±1.8, RHDP	1600 μcd @ 10 mA	271
	MAN6160 MAN6180	High Efficiency Red	0.56-Inch; Common Anode; RHDP; 0.56-Inch; Common Cathode; RHDP	370 μcd @ 2 mA	255
	MAN6460 MAN6480	High Efficiency Green	0.56-Inch; Common Anode; RHDP; 0.56-Inch; Common Cathode; RHDP	2000 μcd @ 10 mA	259
	MAN6660 MAN6680	Orange	0.56-Inch; Common Anode; RHDP; 0.56-Inch; Common Cathode; RHDP	1600 μcd @ 10 mA	263

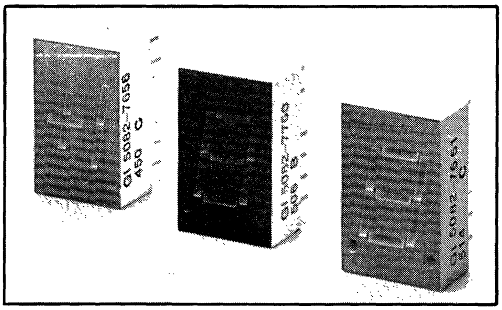
DISPLAYS

PACKAGE	PART NUMBER	COLOR	DESCRIPTION	BRIGHTNESS OR LUMINOUS INTENSITY (TYPICAL)	PAGE
	MAN6760 MAN6780	Red	0.56-Inch; Common Anode; RHDP; 0.56-Inch; Common Cathode; RHDP	350 μcd @ 10 mA	267
	MAN6960 MAN6980	High Efficiency Red	0.56-Inch; Common Anode; RHDP; 0.56-Inch; Common Cathode; RHDP	1600 μcd @ 10 mA	271
	MAN6175 MAN6195	High Efficiency Red	0.56-Inch; Common Anode; RHDP; ±1 Overflow 0.56-Inch; Common Cathode; RHDP; ±1 Overflow	370 μcd @ 2 mA	255
	MAN6675 MAN6695	Orange	0.56-Inch; Common Anode; RHDP; ±1 Overflow 0.56-Inch; Common Cathode; RHDP; ±1 Overflow	1600 μcd @ 10 mA	263
	MAN8410 MAN8440	High Efficiency Green	.800-Inch; Common Anode; RHDP; .800-Inch; Common Cathode; RHDP	2000 μcd @ 10 mA	275
	MAN8610 MAN8640	Orange	.800-Inch; Common Anode; RHDP; .800-Inch; Common Cathode; RHDP	1600 μcd @ 10 mA	279
	MAN8910 MAN8940	High Efficiency Red	.800-Inch; Common Anode; RHDP; .800-Inch; Common Cathode; RHDP	1600 μcd @ 10 mA	283
	MMA54420 MMA56420 MMA58420 MAN59420	High Efficiency Green Orange Yellow High Efficiency Red	0.5-Inch; 2-Character; 16-Segment, Multiplex Common Cathode Display	1200 μcd @ 10 mA 1000 μcd @ 10 mA 900 μcd @ 10 mA 730 μcd @ 10 mA	287

GENERAL INSTRUMENT

0.43-INCH SEVEN SEGMENT DISPLAYS

HIGH EFFICIENCY RED 5082-7650 SERIES
RED 5082-7700 SERIES



FEATURES

- Industry-standard 0.43-inch displays
- High Efficiency Red and standard Red models
- Left or right decimal versions
- Common anode or common cathode
- Solid state reliability — long operating life
- Impact-resistant plastic construction
- Standard 14 pin DIP configuration
- Categorized for Luminous Intensity
- Wide viewing angle . . . 150°
- Directly compatible with integrated circuits

APPLICATIONS

- Instrumentation
- Point of sale terminals
- Appliances
- Digital clocks
- Industrial control equipment

DESCRIPTION

The 5082-7650 and 5082-7700 Series are families of High Efficiency Red and Red seven segment LED displays with 0.43-inch digit height. For maximum ON/OFF contrast, 5082-7650 Series displays have Red face and Red segment color. 5082-7700 Series have Black face and Red segment color.

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION
5082-7650	High Efficiency Red	Common Anode; Left Hand Decimal
5082-7651	High Efficiency Red	Common Anode; Right Hand Decimal
5082-7653	High Efficiency Red	Common Cathode; Right Hand Decimal
5082-7656	High Efficiency Red	Universal Overflow ±1; Right Hand Decimal
5082-7750	Red	Common Anode; Left Hand Decimal
5082-7751	Red	Common Anode; Right Hand Decimal
5082-7756	Red	Universal Overflow ±1; Right Hand Decimal
5082-7760	Red	Common Cathode; Right Hand Decimal

ABSOLUTE MAXIMUM RATINGS

	HIGH EFFICIENCY RED		RED	
	5082-7650 5082-7651 5082-7653	5082-7656	5082-7750 5082-7751 5082-7760	5082-7756
Power dissipation at 50°C ambient	840 mW	630 mW	520 mW	390 mW
Derate linearly from 50°C	-16 mW/C°	-12 mW/C°	-6.9 mW/C°	-5.2 mW/C°
Storage and operating temperature	-40° C to +85° C		-40° C to +85° C	
Continuous forward current				
Total	240 mA	180 mA	200 mA	150 mA
Per segment or decimal point	30 mA	30 mA	25 mA	25 mA
Reverse voltage				
Per segment or decimal point	3 V	3 V	3 V	3 V
Soldering time at 260°C (See Notes 4 and 5.)	3 sec.	3 sec.	3 sec.	3 sec.

ELECTRO-OPTICAL CHARACTERISTICS

(Per Diode at 25° C Free Air Temperature Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
5082-7650 Series						
Luminous Intensity	I_L	200	550		μcd	I_F = 5 mA DC
(Digit average, seven segments			3025		μcd	I_F = 20 mA DC
Notes 1, 2)			1765		μcd	I_F = 60 mA pk, 1:6 DF
Peak emission wavelength	λ_p		630		nm	
Spectral line halfwidth	$\Delta\lambda_{1/2}$		40		nm	
Forward voltage	V_F		2.0	2.5	V	I_F = 20 mA DC
Dynamic resistance	R_d		26		Ω	I_{FTH}, V_{FTH}
Capacitance	C		35		pf	V_F = 0
Reverse current	I_R			100	μA	V_R = 3.0 V
Ratio I_L (max. I_L/min. I_L)	r			2.0:1		I_F = 20 mA DC
5082-7750 Series						
Luminous Intensity	I_L	240	700		μcd	I_F = 20 mA
(Digit average, seven segments			610		μcd	I_F = 100 mA Pk
Notes 1, 2)						1:10 DF
Peak emission wavelength	λ_p		650		nm	
Spectral line halfwidth	$\Delta\lambda_{1/2}$		20		nm	
Forward voltage	V_F		1.6	2.0	V	I_F = 20 mA
Dynamic resistance	R_d		2.0		Ω	I_{FTH}, V_{FTH}
Capacitance	C		35		pf	V_F = 0
Reverse current	I_R			100	μA	V_R = 5.0 V
Ratio I_L (max. I_L/min. I_L)	r			2.0:1		I_F = 20 mA

TYPICAL THERMAL CHARACTERISTICS

	5082-765X	5082-775X	SYMBOL	TEST CONDITIONS
Thermal resistance junction to ambient	280°C/W	280°C/W	Θ_{JA}	
Wavelength temperature coefficient (case temp.) ..	0.1 nm/°C	0.3 nm/°C	$\Delta\lambda/\Delta T$	I_F = 20 mA
Forward voltage temperature coefficient	-2.2 mV/°C	-1.6 mV/°C	$\Delta V_F/\Delta T$	I_F = 2 mA

TYPICAL CURVES

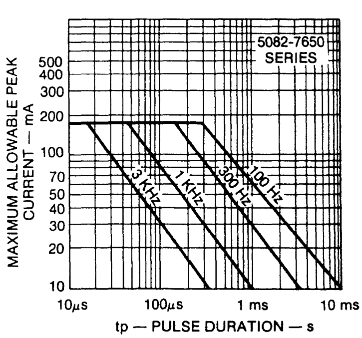


Fig. 1. Maximum Tolerable Peak Current vs. Pulse Duration

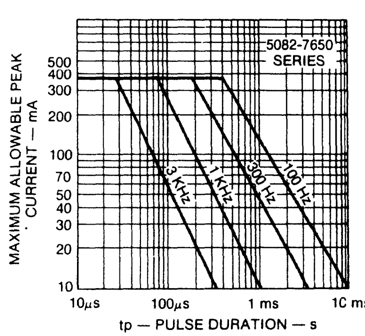


Fig. 2. Maximum Tolerable Peak Current vs. Pulse Duration

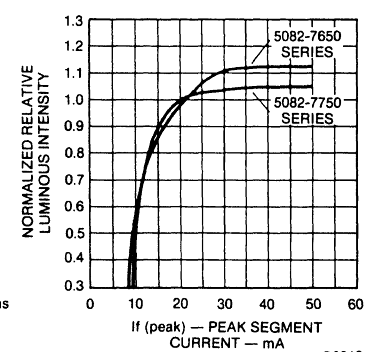


Fig. 3. Relative Efficiency (Average Luminous Intensity Per Unit Current) vs. Peak Current Per Segment

TYPICAL CURVES (Continued)

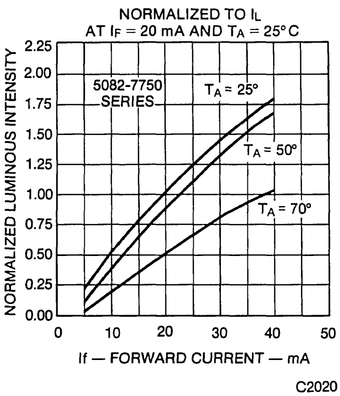


Fig. 4. Normalized Luminous Intensity vs. Forward Current Over Temperature

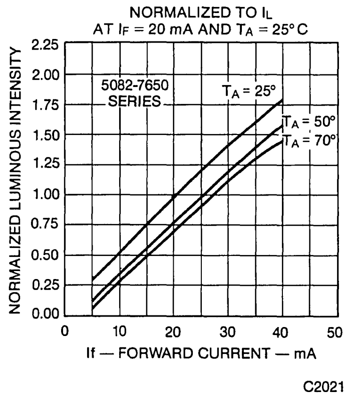


Fig. 5. Normalized Luminous Intensity vs. Forward Current Over Temperature

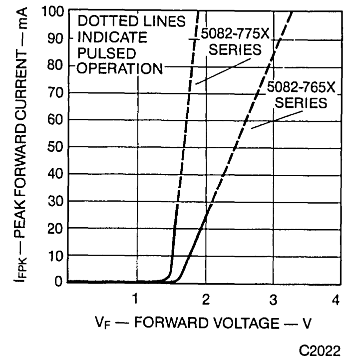


Fig. 6. Peak Forward Current vs. Forward Voltage

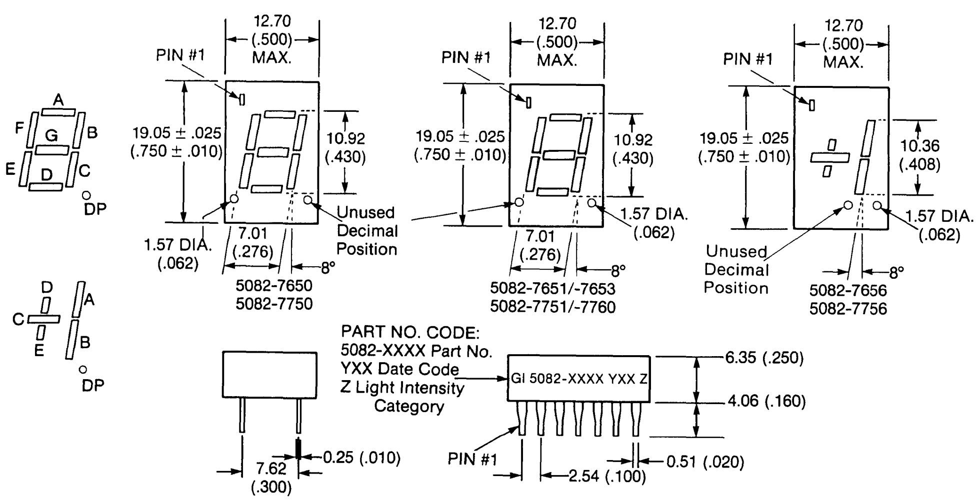
Displays

RECOMMENDED OPTICAL FILTER

5082-7650 Series
Panelgraphic Scarlet 65
Homalite 100-1670
Panelgraphic Gray 10
Homalite 100-126

5082-7750 Series
Panelgraphic Red 60
Homalite 100-1605

PACKAGE OUTLINE



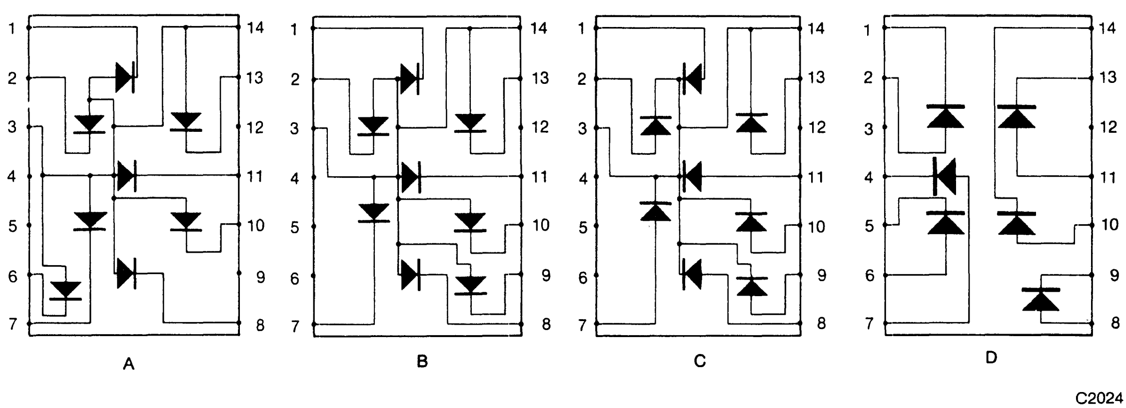
DIMENSIONS IN MILLIMETERS (INCHES).
TOLERANCES ± 0.25 (± 0.010) UNLESS OTHERWISE INDICATED.

C2023

PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS			
	A	B	C	D
	5082-7650/-7750	5082-7651/-7751	5082-7653/-7760	5082-7656/-7756
1	Cathode A	Cathode A	Anode A	Cathode D
2	Cathode F	Cathode F	Anode F	Anode D
3	Common Anode	Common Anode	Common Cathode	No Pin
4	No Pin	No Pin	No Pin	Cathode C
5	No Pin	No Pin	No Pin	Cathode E
6	Cathode D.P.	No Connection	No Connection	Anode E
7	Cathode E	Cathode E	Anode E	Anode C
8	Cathode D	Cathode D	Anode D	Anode D.P.
9	No Connection	Cathode D.P.	Anode D.P.	Cathode D.P.
10	Cathode C	Cathode C	Anode C	Cathode B
11	Cathode G	Cathode G	Anode G	Cathode A
12	No Pin	No Pin	No Pin	No Pin
13	Cathode B	Cathode B	Anode B	Anode A
14	Common Anode	Common Anode	Common Cathode	Anode B

ELECTRICAL SCHEMATIC



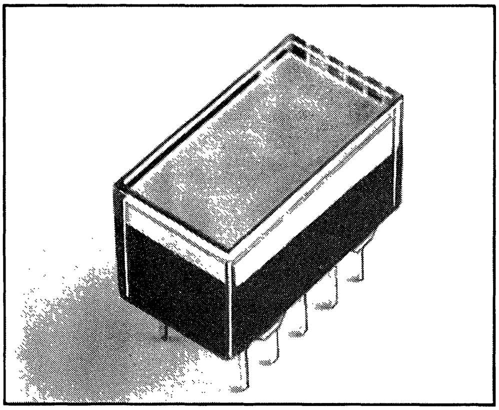
NOTES

1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments excluding decimal points. Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *All displays are categorized for Liminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.*
3. *Intensity adjusted for smaller areas of the "+" and decimal points.*
4. *Leads immersed to 1/16 inch from the body of the device. Maximum unit surface temperature is 140° C.*
5. *For flux removal, use Freon TF, Freon TE, Isoproponal, or water up to their boiling points.*

GENERAL INSTRUMENT

0.362-INCH SEVEN SEGMENT DISPLAY

HIGH EFFICIENCY RED FND317



DESCRIPTION

The FND317 is a High Efficiency Red GaP seven segment LED display with nominal 0.362-inch digit height. This display is suitable for applications where the viewer is within fifteen feet and in high ambient light environments.

FEATURES

- Exactly pin and package compatible with popular FND357 and FND367 Series displays
- Compact — 10 digits in 3-inch panel width
- Right-hand decimal configuration
- Wide viewing angle
- Categorized for Luminous Intensity
- Contrast maximized by integral filter cap
- Rugged plastic construction
- Clear cover and Grey face for maximum contrast in high light ambients
- Four times brighter than FND360 family

APPLICATIONS

- Digital readout displays
- Instrumentation panels
- Point of sales terminals
- Business and office equipment

MODEL NUMBER

PART NUMBER	COLOR	DESCRIPTION
FND317	High Efficiency Red	Common Cathode Seven Segment Display

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° ambient	500 mW
Derate linearly from 25° C	-9.8 mW/° C
Storage and operating temperature	-25° to +85° C
Continuous forward current	
Total	200 mA
Per segment or decimal point	25 mA
Reverse voltage	
Per segment or decimal point	6 V
Soldering time at 260° C (See Note 1)	5.0 sec.

ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25°C Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity (digit average; per diode. See Note 2) FND317	I_V	2800	4000		μcd	I_F = 20 mA
Luminous Intensity, matching (exclusive of d.p.)	$\Delta I_V/I_{V(AVG)}$					
Segment to segment			±50		%	I_F = 20 mA
Within one light category			±25		%	I_F = 20 mA
Viewing angle to half intensity	$\theta_{1/2}$		±27		deg	I_F = 20 mA
Peak wavelength	λp		630		nm	I_F = 20 mA
Forward voltage (per diode)	V_F			2.5	V	I_F = 20 mA
Reverse breakdown voltage	V_{BR}				V	I_F = 1.0 mA
Dynamic resistance (per diode)	R_d		26		ohm	$V_{F(th)}$ = 1.67 V $I_{F(th)}$ = 5 mA
Capacitance (per diode)	C		35		pF	V = O, F = 1 MHz

TYPICAL THERMAL CHARACTERISTICS

		SYMBOL
Thermal resistance junction to free air	300°C/W	Θ_{JA}
Wavelength temperature coefficient (case temp)	0.1 nm/°C	$\Delta\lambda/\Delta T$
Forward voltage temperature coefficient	-2.0 mV/°C	$\Delta V_F/\Delta T$

TYPICAL CURVES

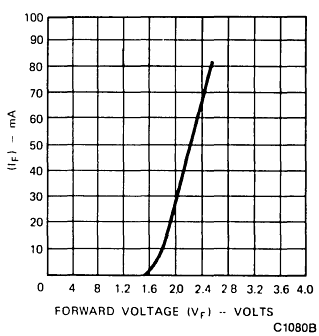


Fig. 1. Forward Current vs. Forward Voltage

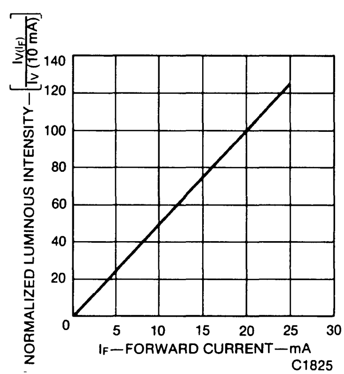


Fig. 2. Normalized Luminous Intensity vs. Forward Current

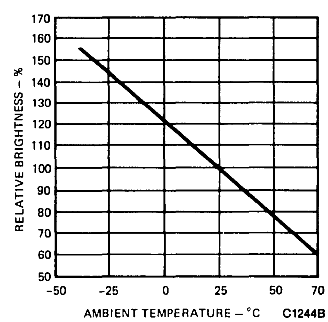


Fig. 3. Luminous Intensity vs. Temperature

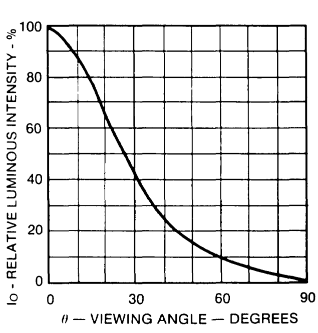


Fig. 4. Angular Distribution of Luminous Intensity

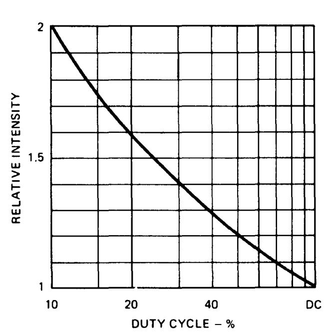


Fig. 5. Relative Luminous Efficiency (mcd per mA) vs. Peak Current per Segment

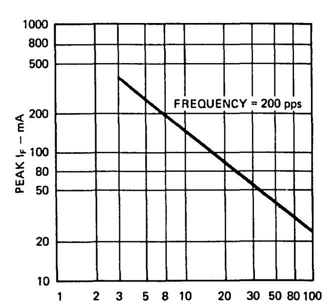


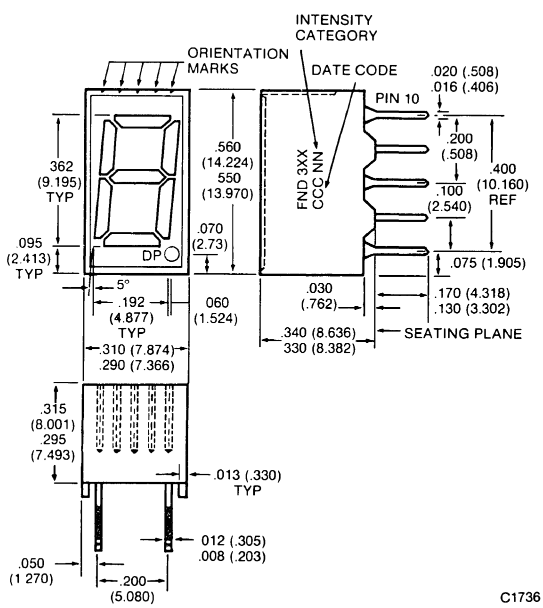
Fig. 6. Maximum Average Current Rating vs. Ambient Temperature

RECOMMENDED OPTICAL FILTER

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

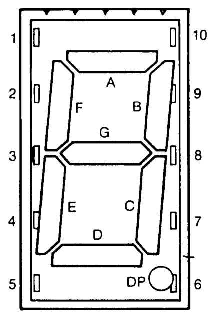
AMBIENT	OPTICAL FILTER
DIM 25 - 75 fc	Long Pass 65% transmission 630 nm SGL Homalite H100-1670 LR-72 Panelgraphics Scarlet Red #65 Chequers Engraving #110 3M Co. R6310
MODERATE 75 - 200 fc	RED Long Pass, 40% transmission 630 nm SGL Homalite H100-1670 LR-92 Chequers Engraving #112 Panelgraphics Scarlet Red #65 3M Co. R6310
BRIGHT 200 - 1000 fc	Neutral Grey 18-23% transmission 630 nm SGL Homalite H100-1266 Chequers Engraving #105 3M Co. ND0220 Panelgraphics Grey #10 T=23% Grey #15 T=17% Rohm & Haas 2074

PACKAGE OUTLINE



ALL DIMENSIONS IN INCHES AND MILLIMETERS (PARENTHESES)
TOLERANCE UNLESS SPECIFIED = ±.015 (±.381)

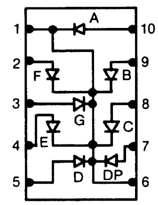
PIN CONNECTIONS



Pin	FND317
1	Common Cathode
2	Segment F
3	Segment G
4	Segment E
5	Segment D
6	Common Cathode
7	Decimal Point DP
8	Segment C
9	Segment B
10	Segment A

C1738

ELECTRICAL SCHEMATIC



FND317

NOTES

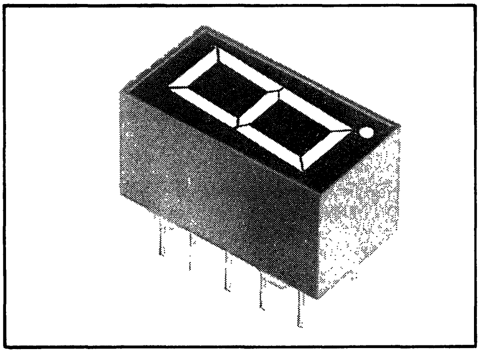
1. *Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature 140° C.*
2. *Luminous Intensity measurements are made under pulsed drive conditions (5 ms), and calibrated to DC via Gamma Scientific C-3 Spectral Scanning System.*

GENERAL INSTRUMENT

0.362-INCH SEVEN SEGMENT DISPLAYS

RED FND350 FND357
HIGH BRIGHT RED FND360 FND367

Displays



FEATURES

- Exactly identical to displays with same part number formerly manufactured by Fairchild Optoelectronics Division.
- Compact — 10 digits in 3-inch panel width
- Right-hand decimal configuration
- Wide viewing angle
- Categorized for Luminous Intensity
- Contrast maximized by integral filter cap
- Rugged plastic construction

APPLICATIONS

- Digital readout displays
- Instrumentation panels
- Point of sales terminals
- Business and office equipment

DESCRIPTION

The FND350, FND360, FND357 and FND367 are Red GaAsP seven segment LED displays with a 0.362-inch digit height. These displays are for applications where the viewer is within fifteen feet of the panel.

MODEL NUMBER

PART NUMBER	COLOR	DESCRIPTION
FND350	Red	Common Anode Seven Segment Display
FND357	Red	Common Cathode Seven Segment Display
FND360	High Bright Red	Common Anode Seven Segment Display
FND367	High Bright Red	Common Cathode Seven Segment Display

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° ambient .... 400 mW
Derate linearly from 25° C .... -6.5 mW/° C
Storage and operating temperature .... -25° to +85° C
Continuous forward current
  Total .... 200 mA
  Per segment or decimal point .... 25 mA
Reverse voltage
  Per segment or decimal point .... 3.0 V
Soldering time at 260° C (See Note 1) .... 5.0 sec.

ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Luminous Intensity (digit average; per diode, See Note 2)	I_L					
FND350, 357, 358		240	450		μcd	I_F = 20 mA
FND360, 367, 368		590	900		μcd	I_F = 20 mA
Luminous Intensity Matching (exclusive of d.p.)	$\Delta I_L/I_{LAV}$					
segment to segment			±50		%	I_F = 20 mA
within one light category			±25		%	I_F = 20 mA
Viewing angle to half intensity	$\theta_{1/2}$		±27		deg	I_F = 20 mA
Peak wavelength	λ_p		665		nm	I_F = 20 mA
Forward voltage (per diode)	V_F		1.7	2.0	V	I_F = 20 mA
Reverse breakdown voltage	V_{BR}	3.0	12		V	I_F = 1.0 mA
Dynamic resistance (per diode)	R_d		1.7		ohm	V_F (th) = 1.67V, I_F (th) = 5 mA
Capacitance (per diode)	C		23		pF	V = 0

TYPICAL THERMAL CHARACTERISTICS

		SYMBOL
Thermal resistance junction to free air wavelength	300° C/W	Θ_{JA}
Wave length temperature coefficient (case temperature)	0.3 nm/° C	$\Delta\lambda/\Delta T$
Forward voltage temperature coefficient	-1.6 mV/° C	$\Delta V_F/\Delta T$

TYPICAL CURVES

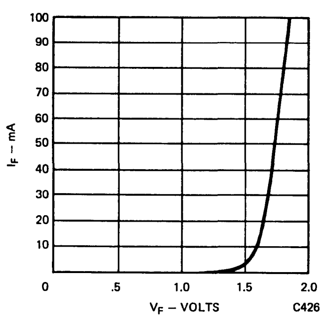


Fig. 1. - Forward Current vs. Forward Voltage

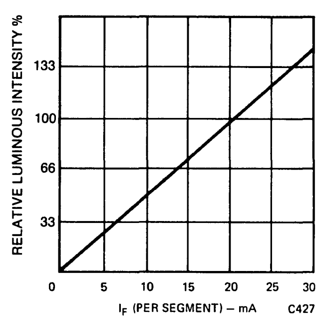


Fig. 2. - Luminous Intensity vs. Forward Current

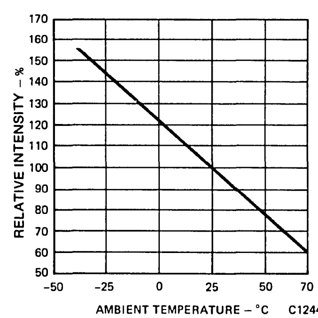


Fig. 3. - Luminous Intensity vs. Temperature

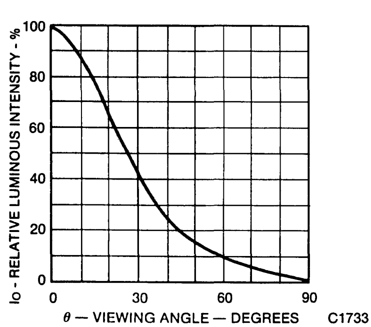


Fig. 4. - Angular Distribution of Luminous Intensity

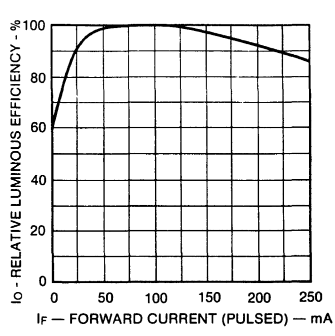


Fig. 5. - Relative Luminous Efficiency (mcd per mA) vs. Peak Current per Segment

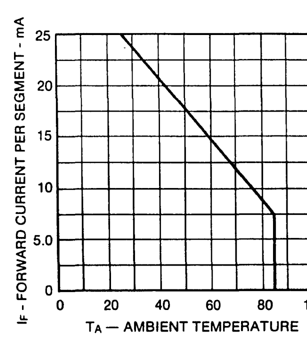


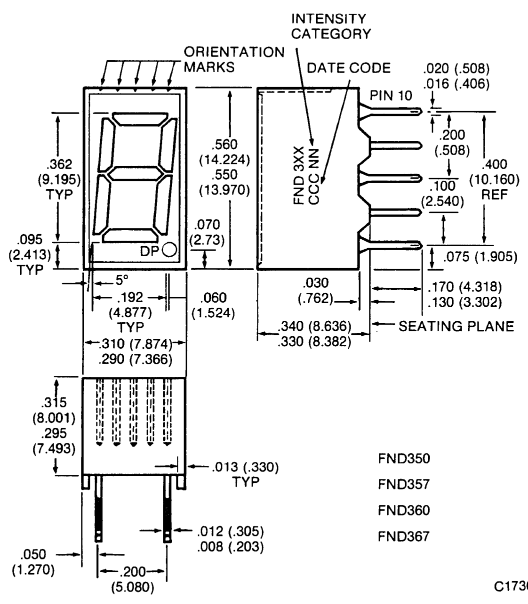
Fig. 6. - Maximum Average Current Rating vs. Ambient Temperature

RECOMMENDED OPTICAL FILTER

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

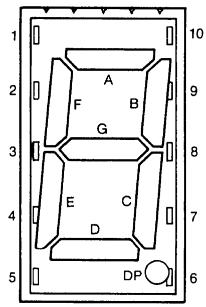
AMBIENT	OPTICAL FILTER
DIM	Long Pass 70% Transmission 655 nm
25 - 75 fc	SGL Homalite H100-1650 LR-72
	Rohm & Haas 2423
	Panelgraphics Ruby Red #60
	Chequers Engraving #118
	3M Co. R6510
MODERATE	RED Long Pass, 45% Transmission 655 nm
75 - 200 fc	SGL Homalite H100-1650 LR-92
	Chequers Engraving #112
	Panelgraphics Dark Red #63
	3M Co. Purple P7710
BRIGHT	Neutral Grey 18 - 26% Transmission 655 nm
200 - 1000 fc	SGL Homalite H100-1266
	Chequers Engraving #105
	3M Co. ND0220
	Panelgraphic Grey #10 T=23%
	Panelgraphic Grey #10 T=23%
	Rohm & Haas 2074

PACKAGE OUTLINE



ALL DIMENSIONS IN INCHES AND MILLIMETERS (PARENTHESES)
TOLERANCE UNLESS SPECIFIED = ±.015 (±.381)

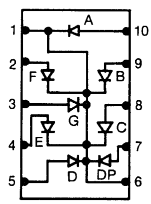
PIN CONNECTIONS



Pin	FND357/367	FND350/360
1	Common Cathode	Common Anode
2	Segment F	Segment F
3	Segment G	Segment G
4	Segment E	Segment E
5	Segment D	Segment D
6	Common Cathode	Common Anode
7	Decimal Point DP	Decimal Point DP
8	Segment C	Segment C
9	Segment B	Segment B
10	Segment A	Segment A

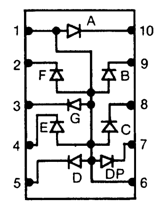
C1738

ELECTRICAL SCHEMATIC



FND 357
FND 367

C1740



FND 350
FND 360

C1741

NOTES

1. *Leads of the device immersed to 1/16 in. from the body. Maximum device surface temperature 140° C.*
2. *Luminous Intensity measurements are made under pulsed drive conditions (5ms), and calibrated to DC via Gamma Scientific C-3 Spectral Scanning System.*

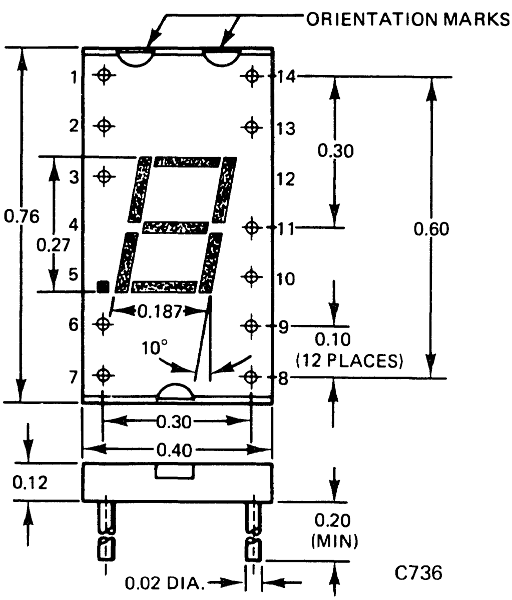
GENERAL INSTRUMENT

0.27-INCH SEVEN SEGMENT DISPLAYS

RED MAN1A
RED MAN10A

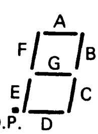
Displays

PACKAGE DIMENSIONS



PIN 1	CATHODE A	PIN 9	ANODE COMMON
PIN 2	CATHODE F	PIN 10	CATHODE C
PIN 3	ANODE COMMON	PIN 11	CATHODE G
PIN 4	NO PIN	PIN 12	NO PIN
PIN 5	NO PIN	PIN 13	CATHODE B
PIN 6	DECIMAL POINT CATHODE	PIN 14	ANODE COMMON
PIN 7	CATHODE E	JUMPER PINS 3, 9, AND 14	
PIN 8	CATHODE D	ON CIRCUIT BOARD	

ALL DIMENSIONS NOMINAL IN INCHES DUAL, IN LINE CONFIGURATION



DESCRIPTION

The MAN1A and MAN10A are seven segment diffused planar GaAsP light emitting diode arrays. They are mounted on a dual-in-line 14 pin substrate and then encapsulated in Red epoxy for protection. They are capable of displaying all digits and nine distinct letters.

FEATURES

- High brightness
- Categorized for Luminous Intensity (See Note 6)
- Single plane, wide angle viewing... 150°
- Unobstructed emitting surface
- Standard 14 pin dual-in-line package configuration
- Long operating life, solid state realibility
- Shock resistant
- Operates with IC voltage requirements
- Small size; offering unique styling advantages
- All numbers plus 9 distinct letters
- Usable for wide viewing angle requirements
- Usable in vibrating environment, impervious to vibration
- Directly compatible with integrated circuits

APPLICATIONS

The MAN1A/MAN10A are for industrial and military applications such as:

- Digital readout displays
- Cockpit readout displays

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° ambient .... 750 mW
Derate linearly from .... 10 mW/° C
Storage and operating temperature ... -55° to 100° C
Continuous forward current
  Total .... 240 mA
  Per segment .... 30 mA
  Decimal point .... 30 mA
Reverse voltage
  Per segment .... 10.0 V
  Decimal point .... 5.0 V
Soldering time at 260° C (See Note 5) .... 5 sec.

ELECTRO-OPTICAL CHARACTERISTICS (25° C Ambient Temperature Unless Otherwise Specified)

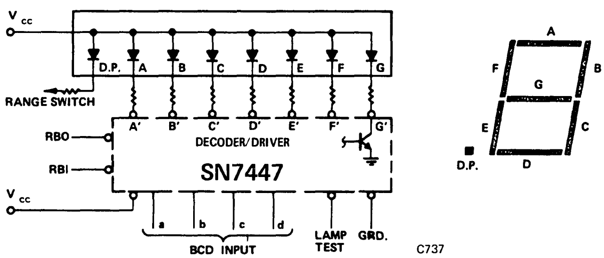
CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS MAN1A	TEST CONDITIONS MAN10A
Luminous Intensity (See Notes 1 and 6)						
Segment	74	180		μcd	I_F = 20 mA, λ = 660 nm	I_F = 10 mA, λ 660 nm
Decimal point	74	180		μcd	I_F = 20 mA, λ = 660 nm	I_F = 10 mA, λ 660 nm
Peak emission wavelength	630		700	nm		
Spectral line half width		20		nm		

ELECTRO-OPTICAL CHARACTERISTICS (Cont'd) (25° C Ambient Temperature Unless Otherwise Specified)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS MAN1A	TEST CONDITIONS MAN10A
Forward voltage						
Segment		3.4	4.0	V	I_F=20 mA	I_F=10 mA
Decimal point		1.6	2.0	V	I_F=20 mA	I_F=10 mA
Dynamic resistance						
Segment		11		Ω	I_F=20 mA	I_F=20 mA
Decimal point		5.5		Ω	I_F=20 mA	I_F=20 mA
Capacitance						
Segment		80		pF	V=0	V=0
Decimal point		135		pF	V=0	V=0
Reverse current						
Segment			100	μA	V_R=10.0 volts	V_R=10.0 volts
Decimal point			100	μA	V_R= 5.0 volts	V_R= 5.0 volts

DECODER/DRIVER FUNCTIONAL DIAGRAM

General Instrument MAN1A/MAN10A



TYPICAL TRUTH TABLE

INPUT CODE				OUTPUT STATE							DISPLAY
d	c	b	a	A'	B'	C'	D'	E'	F'	G'	
0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	1	1	0	0	1	1	1	1	1
0	0	1	0	0	0	1	0	0	1	0	2
0	0	1	1	0	0	0	0	1	1	0	3
0	1	0	0	1	0	0	1	1	0	0	4
0	1	0	1	0	1	0	0	1	0	0	5
0	1	1	0	1	1	0	0	0	0	0	6
0	1	1	1	0	0	0	1	1	1	1	7
1	0	0	0	0	0	0	0	0	0	0	8
1	0	0	1	0	0	0	1	1	0	0	9

TYPICAL CURVES

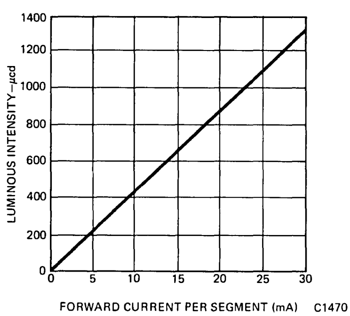


Figure 1 Luminous Intensity vs. Forward Current

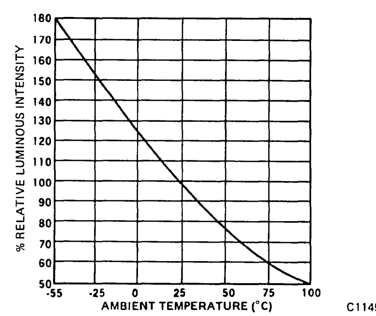


Figure 2 Luminous Intensity vs. Temperature

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance (See Note 4) junction to free air Θ_{JA} .... 440° C/W
Wavelength temperature coefficient (case temperature) .... 3.0 Å/° C
Forward voltage temperature coefficient .... -3.0 mV/° C

NOTES

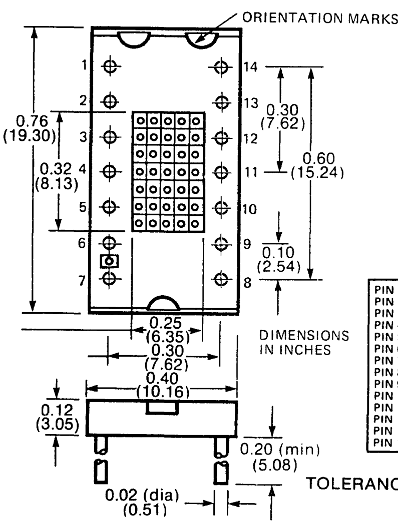
1. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±50% between all segments.*
2. *The curve in Figure 2 is normalized to the brightness at 25° C to indicate the relative efficiency over the operating temperature range.*
3. *For contrast improvement Polaroid HRCP7 circular polarizer filter can be used. Non-glare circular polarizer filter will provide further enhancement in display visibility.*
4. *Thermal resistance (junction to ambient) value of any one segment with all segments in operation.*
5. *Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140° C.*
6. *All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.*

GENERAL INSTRUMENT

0.32-INCH ALPHANUMERIC DISPLAY

RED MAN2A

PACKAGE DIMENSIONS



PIN 1	COLUMN 2,	+
PIN 2	ROW 1,	–
PIN 3	ROW 3,	–
PIN 4	ROW 4,	–
PIN 5	COLUMN 1,	+
PIN 6	N.C.	
PIN 7	D.P.	+
PIN 8	COLUMN 3,	+
PIN 9	ROW 7,	–
PIN 10	ROW 6,	–
PIN 11	ROW 5,	–
PIN 12	ROW 2,	–
PIN 13	COLUMN 5,	+
PIN 14	COLUMN 4,	+

TOLERANCE ±.015" (0.381)

C416

DESCRIPTION

The MAN2A is a 35 diode diffused planar GaAsP LED alphanumeric array with a decimal point. It is mounted on a dual-in-line, 14-pin substrate with a high contrast Red epoxy lens. It is capable of displaying the full character ASCII code.

FEATURES AND APPLICATIONS

- X-Y matrix drive
- Visible, bright Red, high contrast display
- Categorized for Luminous Intensity (See Note 5)
- 35 light emitting diodes including decimal point
- Capable of displaying full ASCII characters
- Single plane, wide angle viewing
- Long life, shock resistant, small size

It is ideal for industrial and military applications such as:

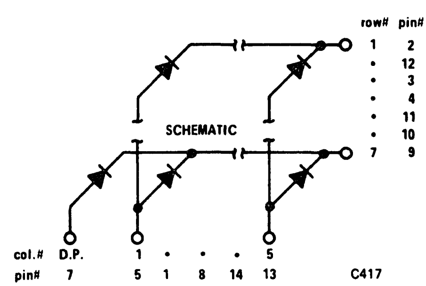
- Keyboard verifiers
- Film annotation—2^{36} bits available
- Avionics displays
- Computer peripheral displays

ABSOLUTE MAXIMUM RATINGS

Single Diode
- DC forward current .... 20 mA
- Pulsed forward current peak (50 μs, 20% duty cycle) ...... 100 mA
- Reverse voltage .... 5 V
- Storage temperature .... -40° C to 85° C
- Operating temperature .... -40° C to 85° C

Diode Array
- Average power dissipation at 25° C ambient .... 750 mW
- Derate linearly from 25° C .... 12.5 mW/° C
- DC current per diode for worst case A/N .... 20 mA
- DC current per diode for all 35 diodes plus DP .... 11 mA

Soldering time at 260° C (See Notes 3 and 4) .... 5 sec.



RECOMMENDED FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

Panelgraphic Red 60
Homalite 100-1670

Displays

TYPICAL CURVES

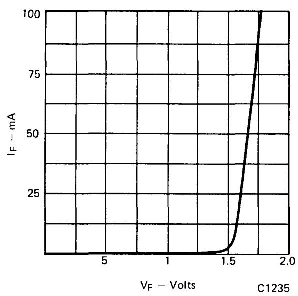


Fig. 1. Forward Current vs. Forward Voltage Each LED

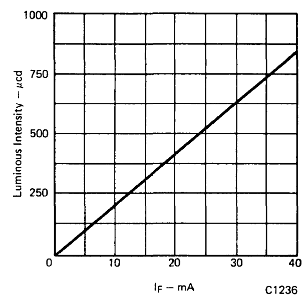


Fig. 2. Light Intensity vs. Forward Current Each LED

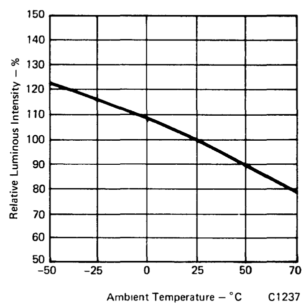


Fig. 3. Relative Luminous Intensity vs. Ambient Temperature

ELECTRO-OPTICAL CHARACTERISTICS (PER DIODE)

(25° C Ambient Temperature Unless Otherwise Specified)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Average Luminous Intensity per character (See Notes 1 and 5)	125	300		μcd	$I_F = 10$ mA
Peak emission wavelength		660		nm	
Spectral line half width		20		nm	
Forward voltage			2.0	V	$I_F = 20$ mA
Capacitance		200		pF	$V = 0$
Reverse current			100	μA	$V_R = 5$ V

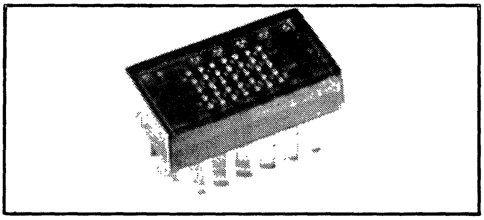
NOTES

1. *The characteristic average Luminous Intensity is obtained by summing the Luminous Intensity of each diode and dividing by 35. As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all diodes in a character.*
2. *The curve in Figure 3 is normalized to the brightness of 25° C to indicate the relative Luminous Intensity over the operating temperature range.*
3. *Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140° C.*
4. *For flux removal, Freon TF, Freon TE, Isoproponal or water may be used up to their boiling points.*
5. *All displays are categorized for Luminous Intensity. The Luminous Intensity category is marked on each part as a suffix letter to the part number.*

GENERAL INSTRUMENT

0.32-INCH DOT MATRIX DISPLAYS

HIGH EFFICIENCY GREEN MAN24
RED MAN27
YELLOW MAN28
HIGH EFFICIENCY RED MAN29



DESCRIPTION

The MAN20A Series is a family of 5 x 7 LED dot matrix displays with nominal 0.32-inch character height. A wrap-around plastic cover provides an integral filter for direct viewing. Each unit is sealed by epoxy backfill.

FEATURES

- Bright, 0.32-inch character
- 5 x 7 dot matrix format with left decimal
- Available in four crisp colors
- Categorized for Luminous Intensity
- Rugged, reliable air-gap construction
- Tinted wrap-around plastic cover for enhanced contrast
- Standard 14-pin DIP configuration
- Column common anode X-Y matrix drive
- Capable of displaying full ASCII characters

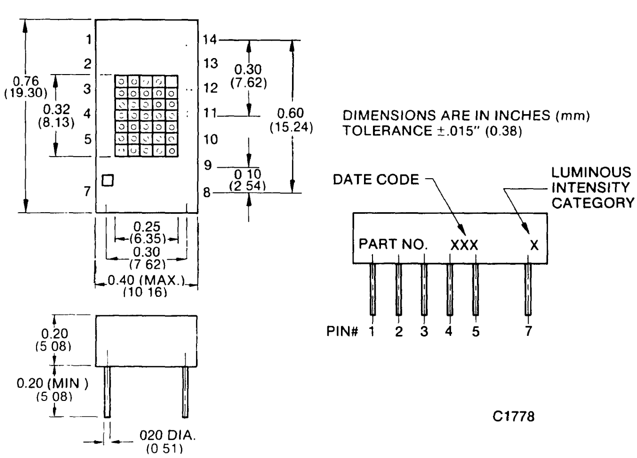
APPLICATIONS

- Computer peripherals
- Instrumentation
- Test and measurement equipment
- Industrial control equipment

MODEL NUMBERS

PART NUMBER	LED COLOR	LENS COLOR
MAN24	High Efficiency Green	Green
MAN27	Red	Red
MAN28	Yellow	Yellow
MAN29	High Efficiency Red	Red

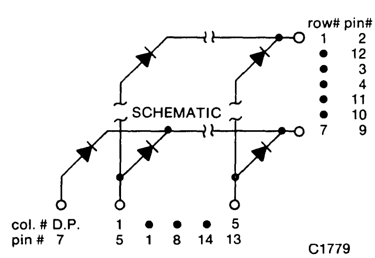
PACKAGE DIMENSIONS



C1778

ELECTRICAL CONNECTION

PIN 1	COLUMN 2	ANODE
PIN 2	ROW 1	CATHODE
PIN 3	ROW 3	CATHODE
PIN 4	ROW 4	CATHODE
PIN 5	COLUMN 1	ANODE
PIN 6	NO CONNECTION	
PIN 7	D.P.	ANODE
PIN 8	COLUMN 3	ANODE
PIN 9	ROW 7	CATHODE
PIN 10	ROW 6	CATHODE
PIN 11	ROW 5	CATHODE
PIN 12	ROW 2	CATHODE
PIN 13	COLUMN 5	ANODE
PIN 14	COLUMN 4	ANODE



C1779

MAN24 MAN27 MAN28 MAN29

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

Single Diode

- D.C. forward current .... 20 mA
- Pulsed forward current peak (See Figures 1 and 2)
  - MAN27 .... 200 mA
  - MAN24, MAN28, MAN29 .... 100 mA
- Reverse voltage .... 5 V
- Storage and operating temperature .... -40° C to 85° C
- Junction temperature — pulsed operation .... 50° C

Diode Array: Assuming 14 Diodes On

- Average power dissipation at 25° C Ambient .... 750 mW
- Derate linearly from 25° C .... -12.5 mW/° C
- Pulsed operation average current (See Figures 1 and 2) .... 20 mA

Solder time at 260° C (See Notes 2 and 3) .... 5 sec

TYPICAL THERMAL CHARACTERISTICS

- Thermal resistance (junction to free air) Θ_{JA} .... 400° C/W
- Thermal resistance 325Hz, 1:7 duty factor .... 125° C/W

ELECTRICAL OPTICAL CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

(EACH DIODE)

	SYMBOLS	MAN24	MAN27	MAN28	MAN29	UNITS	TEST CONDITIONS
Minimum Luminous Intensity Character average (See Note 1)	I_V	510	125	510	320	μcd	I_F = 10 mA
Typical Luminous Intensity Character average (See Note 1)	I_V	750	250	600	500	μcd	I_F = 10 mA
Peak emission wavelength	λ_p	565	660	585	635	nm	I_F = 10 mA
Typical forward voltage	V_F	2.2	1.6	2.1	1.9	V	I_F = 20 mA
Maximum forward voltage	V_{Fmax}	3.0	1.8	2.6	2.6	V	I_F = 20 mA
Dynamic resistance	R_D	16	3	16	16	Ω	I_F = 20 mA
Threshold voltage	V_{TH}	1.9	1.55	1.8	1.65	V	I_{FTH} = 5 mA
Capacitance	C	35	35	35	35	pF	V = 0, f = 1 MHz
Maximum reverse current	I_R	100	100	100	100	μA	V_R = 5V

TYPICAL CURVES (Unless Otherwise Noted)

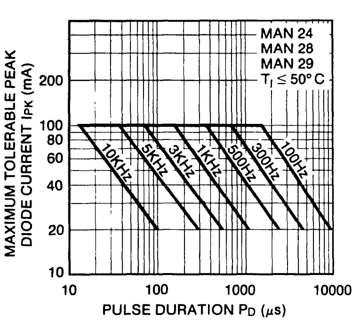


Fig. 1. Maximum Tolerable Peak Diode Current vs. Pulse Duration

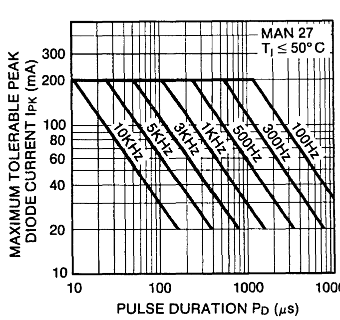


Fig. 2. Maximum Tolerable Peak Diode Current vs. Pulse Duration

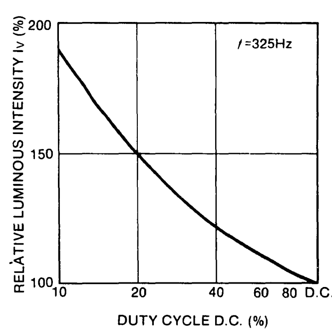


Fig. 3. Relative Luminous Intensity vs. Duty Cycle

TYPICAL CURVES (Unless Otherwise Specified)

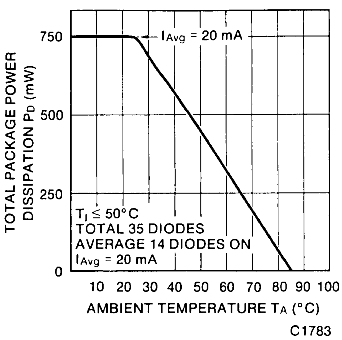


Fig. 4. Total Package Power Dissipation vs. Ambient Temp.

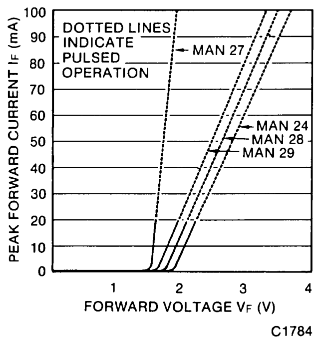


Fig. 5. Peak Forward Voltage vs. Peak Forward Current

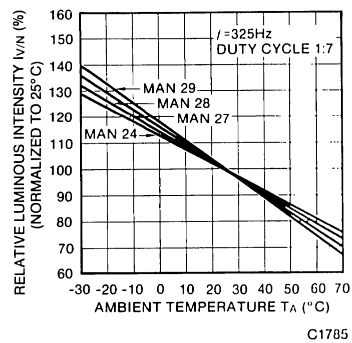


Fig. 6. Relative Luminous Intensity vs. Ambient Temperature

Displays

RECOMMENDED FILTERS FOR CONTRAST ENHANCEMENT

	AMBIENT		
COLOR	**DIM (Office) 25-75 FC**	**MODERATE (Test Floor) 75-200 FC**	**BRIGHT (Outdoors) 200-1000 FC**
HIGH EFFICIENCY RED	Red Long Pass 65%	Red Long Pass 40%	Grey 18-23%
635 nm	H, H100-1650	H, F100-1650	H, H100-1266
STANDARD RED	C, 1100	C, 112	C, 105
670 nm	3M, R6310		3M, ND0220
	POL, HNCP37; HTCP	POL, HACP; HRCP (HT)	HNCP 10, 22
YELLOW	Yellow Band Pass 30%	Amber Long Pass 40%	Grey 18-23%
583 nm	H, H100-1720	H, H100-1726	H, H100-1266
	C, 106	C, 106	C, 105
	P, Yellow 27	P, Amber 23	P, Grey 10
	POL, HNCP37	3M, A5910	RH, 0538
		POL, HACP	POL, HACP
HIGH EFFICIENCY GREEN	Green Band Pass 30%	Grey 20-25%	Grey 18-23%
569 nm	H, H100-1440	H, H100-1425	H, H100-1266
	C, 107	C, 107	C, 105
	P, Green 48	P, Green 48	P, Grey 10
	POL, HNCP37	POL, HGCP	POL, HGCP

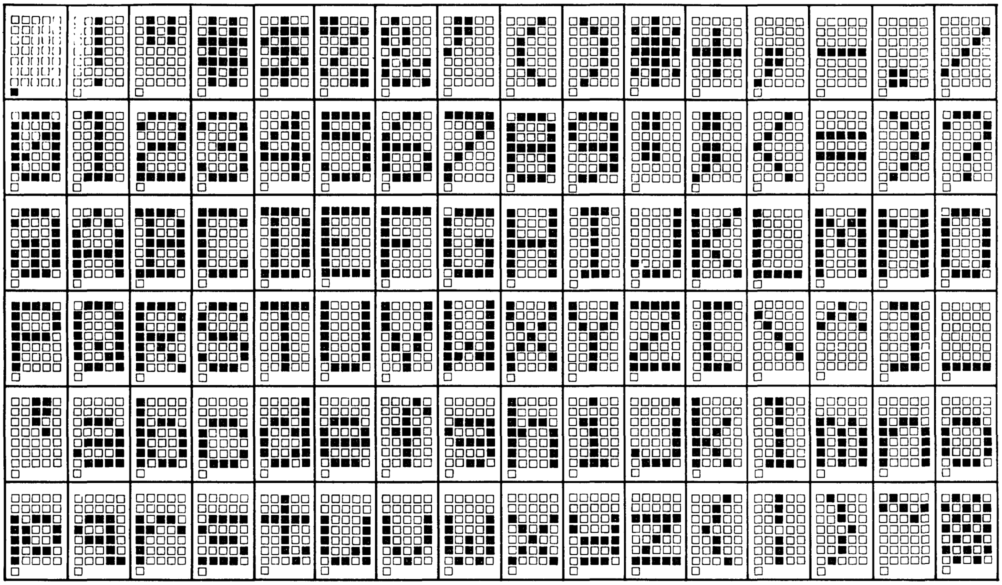
LEGEND:

C, 106 — Chequers #106
RH — Rohm & Haas
3M — 3M Company
POL — Polaroid Corporation
H — SGL Homalite
C — Chequers Engraving
P — Panelgraphics

NOTES

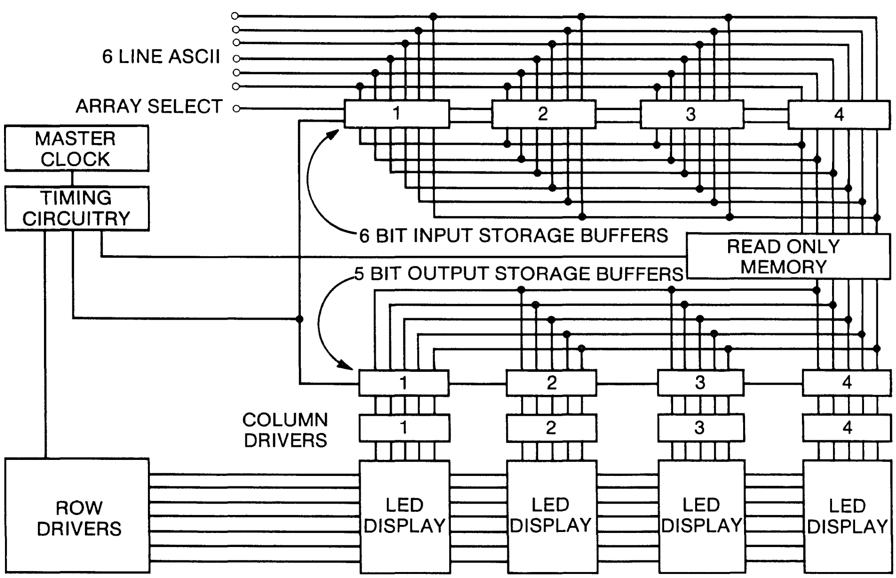
1. *The characteristic averaqe Luminous Intensity is obtained by summing the Luminous Intensity of each diode and dividing by 35. Intensity will not vary mـ re than ±33.3% between all diodes in a character.*
2. *Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140° C.*
3. *For flux removal, Freon TF, Freon TE, isoproponal or water may be used up to their boiling points.*
4. *All displays are categorized for Luminous Intensity. The Luminous Intensity category is marked on each part as a suffix letter to the part number.*

CHARACTER SET



C1786

TYPICAL DRIVE SCHEME



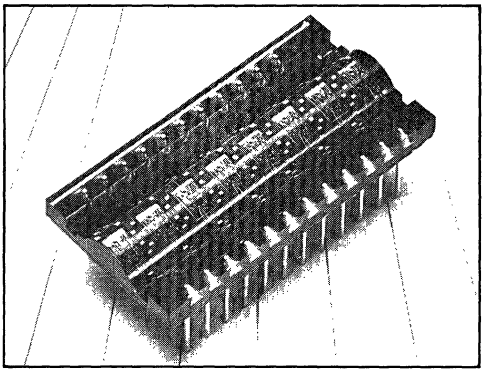
ROW SCANNING BLOCK DIAGRAM

C1787

GENERAL INSTRUMENT

0.135-INCH 8 CHARACTER 14 SEGMENT ALPHANUMERIC DISPLAY

RED MAN2815



FEATURES

- Low power consumption (as low as 0.5 mA average current or 1.0 mW per segment)
- Aesthetically designed characters
- Sculptured continuous segments
- Complete alphanumerics plus special characters
- Voltage and current compatibility for interfacing ease with microprocessors and related circuitry
- 0.135-inch character height
- 0.175-inch character spacing allowing as much as 32 characters in 5.6-inch linear panel space
- Common cathode
- Internally wired for multiplexing

DESCRIPTION

The MAN2815 is an eight character alphanumeric display which is end-stackable and capable of displaying all alpha and numeric characters plus symbols. Each character is constructed from a monolithic, Red GaAsP chip formatted into a 14 segment font with a decimal point.

APPLICATIONS

- Computer terminals — lightweight, mobile, compact
- Test and measurement equipment
- Desk top calculators
- Communications — message centers
- Verification systems

ABSOLUTE MAXIMUM RATINGS

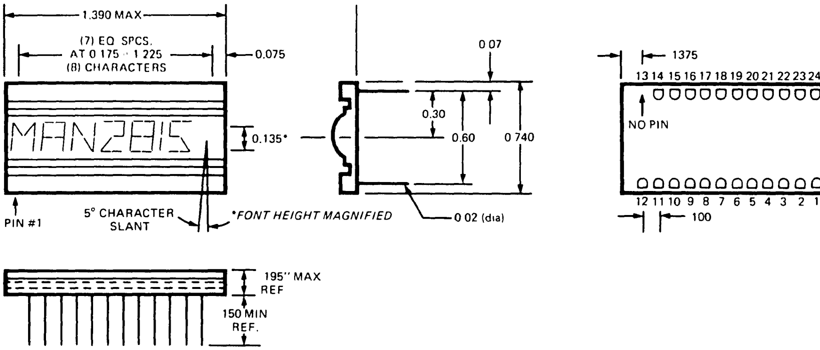
Average forward current per segment	10 mA
Peak forward current per segment (≤ 200 μs, ≤4% duty cycle)	250 mA
Reverse voltage	5.0 V
Storage and operating temperature	0° C to 70° C
Soldering temperature (t ≤ 5 sec.) (See Notes 2 and 3)	255° C
Average power dissipation (total package) at T_A = 50° C	1200 mW
Derate linearly from 50° C	-17.1 mW/° C

RECOMMENDED FILTERS

The following filters or equivalent are recommended to provide optimum ON and OFF contrast ratio:

Panelgraphic Red 60
Homalite 100—1605
Plexiglas 2423

PACKAGE DIMENSIONS

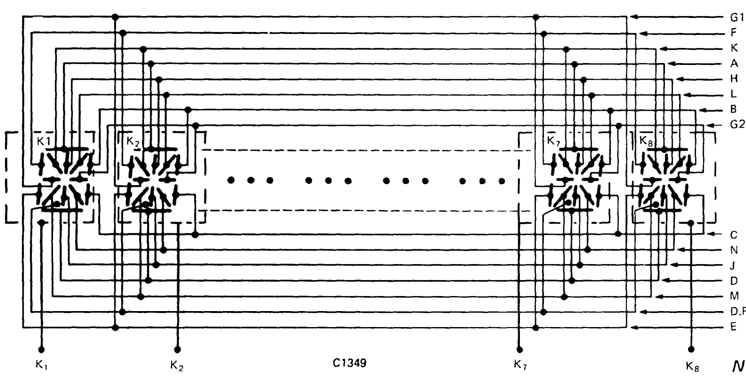


REFERENCE DESIGNATOR	
PIN NO.	DESCRIPTION
1	K1 CATHODE
2	K2 CATHODE
3	K3 CATHODE
4	(D) ANODE
5	K4 CATHODE
6	K5 CATHODE
7	(J) ANODE
8	K6 CATHODE
9	(DP) ANODE
10	K7 CATHODE
11	(M) ANODE
12	K8 CATHODE
13	NO PIN
14	(N) ANODE
15	(C) ANODE
16	(E) ANODE
17	(G2) ANODE
18	(G1) ANODE
19	(B) ANODE
20	(L) ANODE
21	(F) ANODE
22	(K) ANODE
23	(H) ANODE
24	(A) ANODE

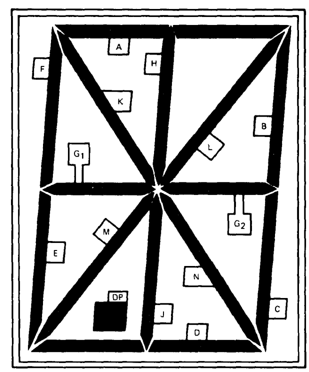
TOLERANCES: ± .015

C1348

ELECTRICAL CONNECTIONS



C1349



C1351

NOTE: Segments A & D appear as 2 segments each, but both halves are driven together. (See wiring diagram.)

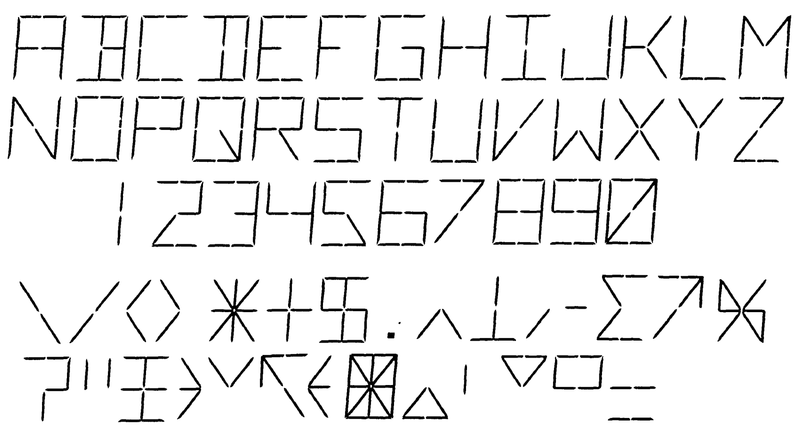


Fig. 8. 14 Segment Character Font

TYPICAL CURVES (Unless Otherwise Specified)

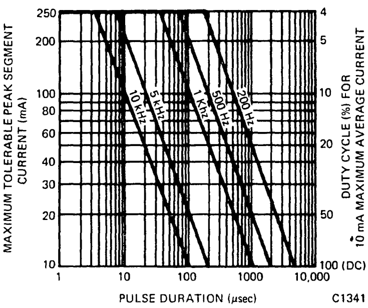


Fig. 1. Maximum Tolerable Peak Segment Current vs. Pulse Duration

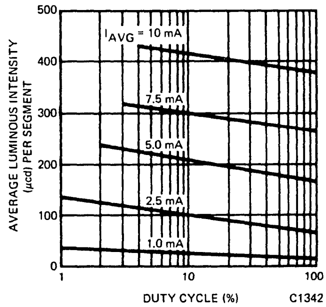


Fig. 2. Average Luminous Intensity/Segment vs. Duty Cycle

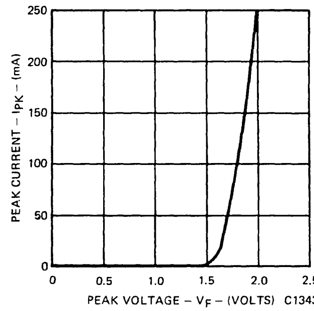


Fig. 3. Peak Current vs. Peak Voltage

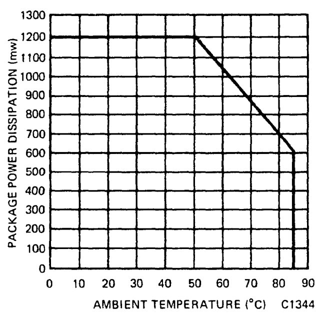


Fig. 4. Max. Tolerable Power Dissipation

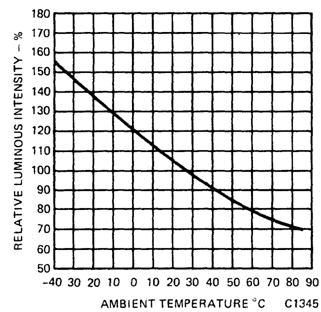


Fig. 5. Luminous Intensity vs. Temperature

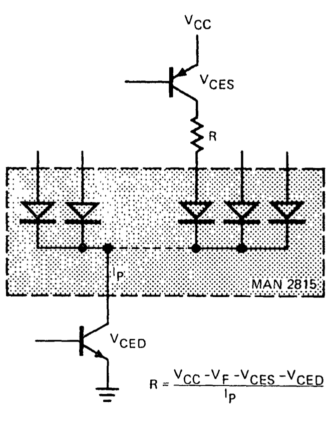


Fig. 6. Display Drive Consideration

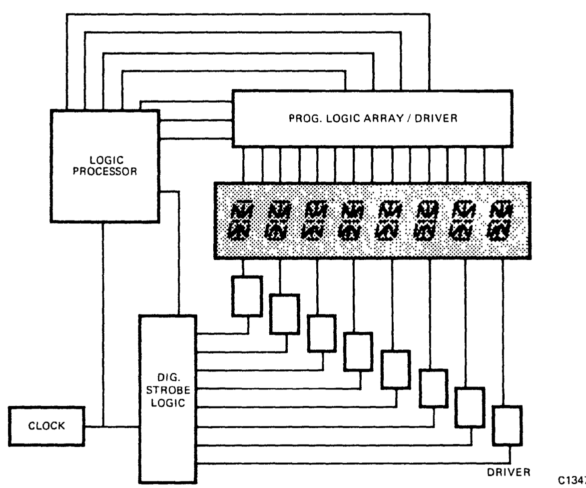


Fig. 7. MAN2815 in a Typical Application

ELECTRICAL OPTICAL CHARACTERISTICS ($T_A = 25°C$)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Average Luminous Intensity per segment (See Note 1)	60	100		μcd	$I_{avg} = 2.5$ mA $I_{pk} = 20$ mA Duty cycle = 1/8
Luminous Intensity ratio Segment-to-segment within a character			3.2:1		
Luminous Intensity ratio Character-to-character within a display			2.0:1		
Forward voltage		1.65	2.0	V	$I_{pk} = 20$ mA
Reverse voltage	5.0			V	$I_R = 100$ μA/segment
Peak emission wavelength		660		nm	

ELECTRICAL/OPTICAL CONSIDERATIONS

A. DETERMINATION OF MAXIMUM ALLOWABLE STROBING CONDITIONS:

1. From number of characters, determine duty cycle (DC).
   Ex: 32 Characters
   DC = 1/32 = 3.125%
2. Establish refresh frequency (f) and calculate pulse duration (PW).
   Ex: f = 500 HZ
   PW = DC/f = .03125/500 HZ = 62.5 μs
3. The corresponding maximum peak current per segment from Fig. 1 is 250 mA. The intersection of 500 HZ and 62.5 μs pulse duration lies in the <4% duty cycle condition. I_{AVG} = 250 mA X .03125 = 7.8 mA which is the maximum average current for operation at T_A (ambient temperature) = 25°C.
4. If operating temperature is above 50°C, then power dissipation must be derated. Using Derating Factor of −17.1 mW/°C for total package: Or see Fig. 4.
   Ex: T_A = 70°C
   1200 mW − (70°C − 50°C) X (17.1 mW/°C) = 858 mW/package
   OR 107 mW/character
   Assume normal operation where there are no greater than 8 segments on at one time within a character. Then average power (P_{AVG}) (max)/segment = 13.4 mW/seg. At a peak current of 250 mA, maximum V_F = 2.4V; which yields:
   $I_{AVG} = \frac{13.4}{2.4}$ = 5.58 mA which is the max. avg. current for operation up to T_A = 70°C.

B. DETERMINATION OF THE OPERATION WITHIN THE ALLOWABLE CONDITIONS AS ESTABLISHED BY THE AMBIENT SURROUNDING:

1. Ex: Assume ambient light defines the average Luminous Intensity for each segment to be 120 μcd.
   32 characters; DC = 3.125%
2. Establish I_{AVG} and calculate I_{PK}.
   Referring to Fig. 2, 120 μcd at a duty cycle of 3.125% corresponds to I_{AVG} = 2.5 mA/seg.
   $\therefore I_{PK} = \frac{2.5\text{ mA}}{.03125}$ = 80 mA/seg.

NOTES

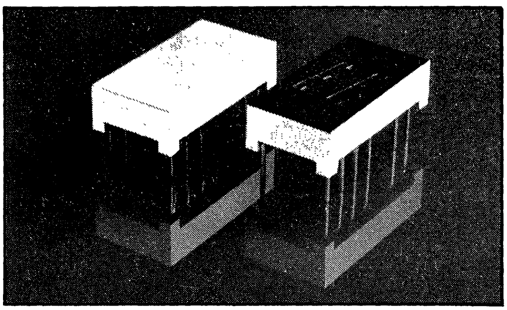
1. *The average Luminous Intensity per segment is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments as measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
2. *Leads immersed to 1/16 inch from the body of the device. Maximum units surface temperature is 140° C.*
3. *For flux removal, use Freon TE, Isoproponal or water may be used up to their boiling points.*

GENERAL INSTRUMENT

0.300-INCH SEVEN SEGMENT DISPLAYS

HIGH EFFICIENCY GREEN MAN3400A RED MAN70A
ORANGE MAN3600A YELLOW MAN3800A

Displays



DESCRIPTION

The MAN3400A, MAN3600A, MAN70A and MAN3800A Series provides a choice of color of LED displays. Standard units are available in Red, Green, Orange and Yellow. They can be mounted in arrays with 0.400-inch (10.16 mm) center-to-center spacing. Yellow and High Efficiency Green displays are constructed with Grey face and neutral segment color. Red displays have Black faces and Red segment color. Others have face and segment color corresponding to the emitted light.

FEATURES

- Common anode or common cathode models
- Red, Yellow, Green and Orange
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Impact resistant plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 6)
- Standard 14 pin dual-in-line package configuration
- Wide angle viewing . . . 150°

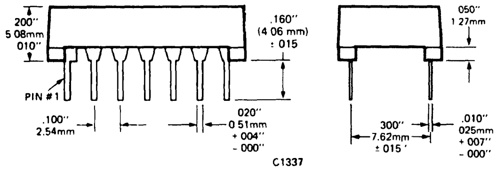
APPLICATIONS

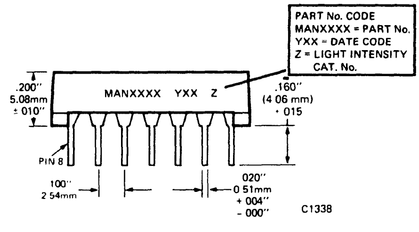
- Digital readout displays
- Instrument panels
- Point of sale equipment
- Calculators
- Digital clocks

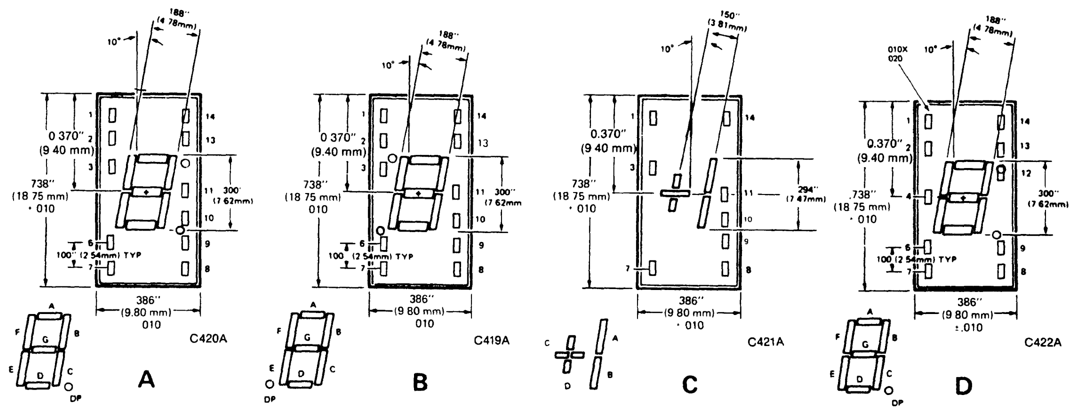
MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION
MAN3410A	High Efficiency Green	Common Anode; Right Hand Decimal
MAN3420A	High Efficiency Green	Common Anode; Left Hand Decimal
MAN3440A	High Efficiency Green	Common Cathode; Right Hand Decimal
MAN3610A	Orange	Common Anode; Right Hand Decimal
MAN3620A	Orange	Common Anode; Left Hand Decimal
MAN3630A	Orange	Common Anode; Overflow ±1
MAN3640A	Orange	Common Cathode; Right Hand Decimal
MAN71A	Red	Common Anode; Right Hand Decimal
MAN72A	Red	Common Anode; Left Hand Decimal
MAN73A	Red	Common Anode; Overflow ±1
MAN74A	Red	Common Cathode; Right Hand Decimal
MAN3810A	Yellow	Common Anode; Right Hand Decimal
MAN3820A	Yellow	Common Anode; Left Hand Decimal
MAN3840A	Yellow	Common Cathode; Right Hand Decimal

PACKAGE DIMENSIONS



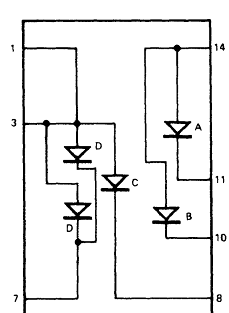




ELECTRICAL CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS			
	A MAN3410A, 3610A, 71A, 3810A	B MAN3420A, 72A, 3620A, 3820A	C MAN3630A, 73A	D MAN3440A, 3640A, 74A, 3840A
1	Cathode A	Cathode A	Anode C, D	Anode F
2	Cathode F	Cathode F	No Pin	Anode G
3	Common Anode	Common Anode	Anode C, D	No Pin
4	No Pin	No Pin	No Pin	Common Cathode
5	No Pin	No Pin	No Pin	No Pin
6	No Connection	Cathode D.P.	No Pin	Anode E
7	Cathode E	Cathode E	Cathode D	Anode D
8	Cathode D	Cathode D	Cathode C	Anode C
9	Cathode D.P.	No Connection	No Connection	Anode D.P.
10	Cathode C	Cathode C	Cathode B	No Pin
11	Cathode G	Cathode G	Cathode A	No Pin
12	No Pin	No Pin	No Pin	Common Cathode
13	Cathode B	Cathode B	No Pin	Anode B
14	Common Anode	Common Anode	Anode A, B	Anode A

ELECTRICAL SCHEMATIC



MAN3630A, 73A

ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature Unless Otherwise Specified)

Device	Parameter	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
MAN3410A, 3420A, 3440A	Luminous Intensity, digit average	510	2000		μcd	$I_F = 10$ mA
	(See Notes 1 and 3)	710	2700		μcd	$I_F = 60$ mA peak, 1:6 DF
	Peak emission wavelength		562		nm	
	Spectral line half width		30		nm	
	Forward voltage					
	Segment		2.2	3.0	V	$I_F = 20$ mA
	Decimal point		2.2	3.0	V	$I_F = 20$ mA
	Dynamic resistance					
	Segment		12		Ω	$I_F = 20$ mA
	Decimal point		12		Ω	$I_F = 20$ mA
	Capacitance					
	Segment		40		pF	$V = 0$
	Decimal point		40		pF	$V = 0$
	Reverse current					
	Segment			100	μA	$V_R = 5.0$ V
	Decimal point			100	μA	$V_R = 5.0$ V
MAN3610A, 3620A, 3630A, 3640A	Luminous Intensity, digit average (See Note 1)	510	1400		μcd	$I_F = 10$ mA
	Decimal point (See Note 3)	265	700		μcd	$I_F = 10$ mA
	Segment "C" or "D" of MAN3630A	265	700		μcd	$I_F = 10$ mA
	Peak emission wavelength		630		nm	
	Spectral line half width		40		nm	
	Forward voltage					
	Segment			2.5	V	$I_F = 20$ mA
	Decimal point			2.5	V	$I_F = 20$ mA
	Dynamic resistance					
	Segment		26		Ω	$I_F = 20$ mA
	Decimal point		26		Ω	$I_F = 20$ mA
	Capacitance					
	Segment		35		pF	$V = 0$
	Decimal point		35		pF	$V = 0$
	Reverse current					
	Segment			100	μA	$V_R = 5.0$ V
	Decimal point			100	μA	$V_R = 5.0$ V
MAN71A, 72A, 73A, 74A	Luminous Intensity, digit average (See Note 1)	125	280		μcd	$I_F = 10$ mA
	Decimal point (See Note 3)	60	140		μcd	$I_F = 10$ mA
	Segment "C" or "D" of MAN73A	60	140		μcd	$I_F = 10$ mA
	Peak emission wavelength		660		nm	
	Spectral line half width		20		nm	
	Forward voltage					
	Segment			2.0	V	$I_F = 20$ mA
	Decimal point			2.0	V	$I_F = 20$ mA
	Dynamic resistance					
	Segment		2		Ω	$I_{pk} = 100$ mA
	Decimal point		2		Ω	$I_{pk} = 100$ mA
	Capacitance					
	Segment		35	80	pF	$V = 0$
	Decimal point		35	80	pF	$V = 0$
	Reverse current					
	Segment			100	μA	$V_R = 5.0$ V
	Decimal point			100	μA	$V_R = 5.0$ V
MAN3810A, 3820A, 3840A	Luminous Intensity, digit average (See Note 1)	320	1200		μcd	$I_F = 10$ mA
	Decimal point (See Note 3)	160	600		μcd	$I_F = 10$ mA
	Segment "C" or "D" of MAN73A	160	600		μcd	$I_F = 10$ mA
	Peak emission wavelength		585		nm	
	Spectral line half width		40		nm	
	Forward voltage					
	Segment			3.0	V	$I_F = 20$ mA
	Decimal point			3.0	V	$I_F = 20$ mA
	Dynamic resistance					
	Segment		26		Ω	$I_F = 20$ mA
	Decimal point		26		Ω	$I_F = 20$ mA
	Capacitance					
	Segment		35		pF	$V = 0$
	Decimal point		35		pF	$V = 0$
	Reverse current					
	Segment			100	μA	$V_R = 5.0$ V
	Decimal point			100	μA	$V_R = 5.0$ V

TYPICAL CURVES

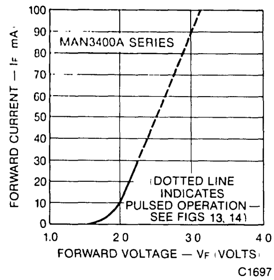


Fig. 1. Forward Current vs. Forward Voltage

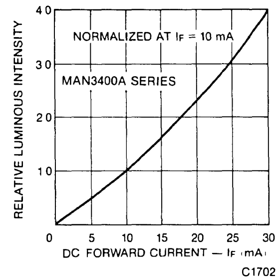


Fig. 2. Relative Luminous Intensity vs. DC Forward Current

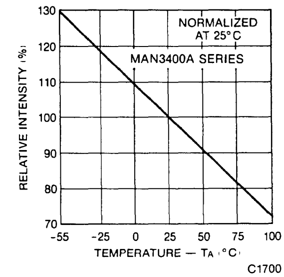


Fig. 3. Relative Luminous Intensity vs. Temperature

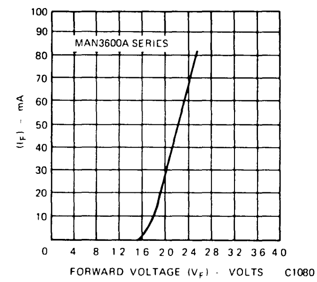


Fig. 4. Forward Current vs. Forward Voltage

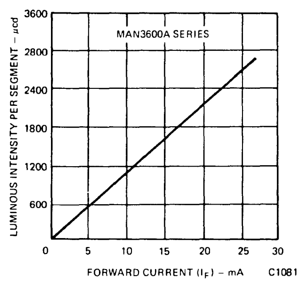


Fig. 5. Luminous Intensity vs. Forward Current

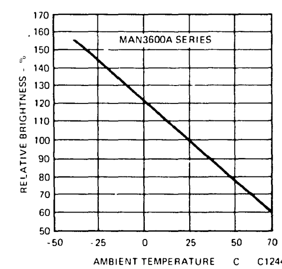


Fig. 6. Luminous Intensity vs. Temperature

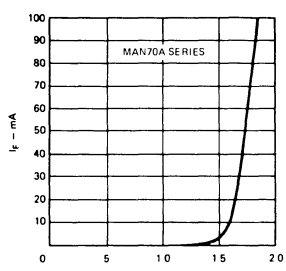


Fig. 7. Forward Current vs. Forward Voltage

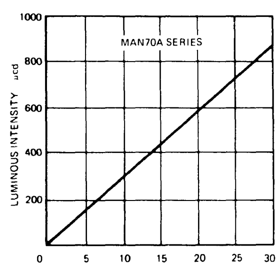


Fig. 8. Luminous Intensity vs. Forward Current

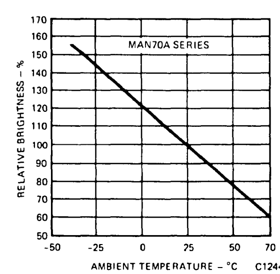


Fig. 9. Luminous Intensity vs. Temperature

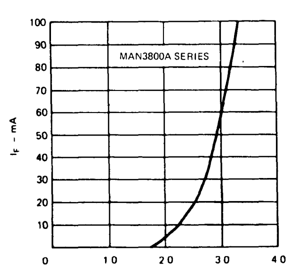


Fig. 10. Forward Current vs. Forward Voltage

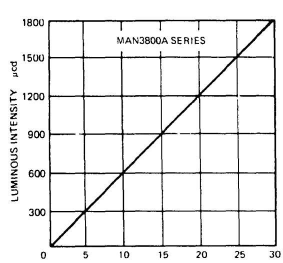


Fig. 11. Luminous Intensity vs. Forward Current

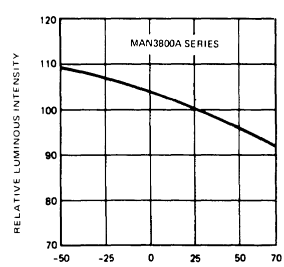


Fig. 12. Luminous Intensity vs. Temperature

TYPICAL CURVES

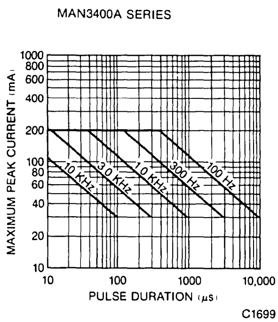


Fig. 13. Maximum Peak Current vs. Pulse Duration

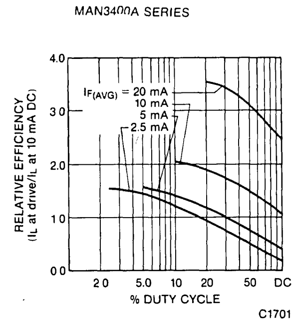


Fig. 14. Relative Efficiency vs. Duty Cycle

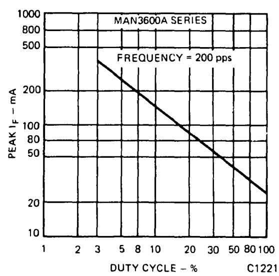


Fig. 15. Max Peak Current vs. Duty Cycle

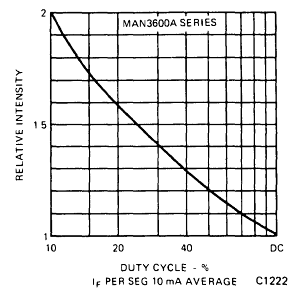


Fig. 16. Luminous Intensity vs. Duty Cycle

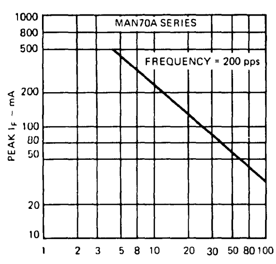


Fig. 17. Max Peak Current vs. Duty Cycle

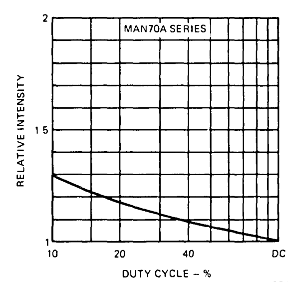


Fig. 18. Luminous Intensity vs. Duty Cycle

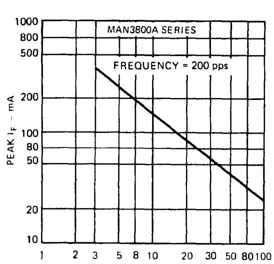


Fig. 19. Max Peak Current vs. Duty Cycle

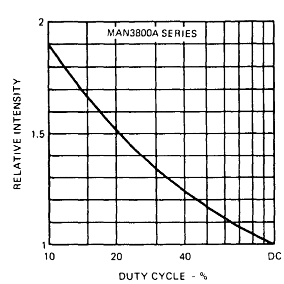


Fig. 20. Luminous Intensity vs. Duty Cycle

ABSOLUTE MAXIMUM RATINGS

	HIGH EFF. GREEN	RED	
	MAN3410A MAN3420A MAN3440A	MAN71A MAN72A MAN74A	MAN73A
Power dissipation at 25° C ambient	600 mW	480 mW	300 mW
Derate linearly from 50° C	−12 mW/° C	−6.9 mW/° C	−4.29 mW/° C
Storage and operating temperature	−40° C to +85° C	−40° C to +85° C	−40° C to +85° C
Continuous forward current			
Total	240 mA	240 mA	150 mA
Per segment	30 mA	30 mA	30 mA
Decimal point	30 mA	30 mA	30 mA
Reverse voltage			
Per segment	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V
Soldering time at 260° C (See Notes 4 and 5)	5 sec.	5 sec.	5 sec.

	YELLOW	ORANGE	
	MAN3810A MAN3820A MAN3840A	MAN3610A MAN3620A MAN3640A	MAN3630A
Power dissipation at 25° C ambient	600 mW	600 mW	375 mW
Derate linearly from 50° C	−10.3 mW/° C	−8.6 mW/° C	−5.36 mW/° C
Storage and operating temperature	−40° C to +85° C	−40° C to +85° C	−40° C to +85° C
Continuous forward current			
Total	200 mA	240 mA	150 mA
Per segment	25 mA	30 mA	30 mA
Decimal point	25 mA	30 mA	30 mA
Reverse voltage			
Per segment	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V
Soldering time at 260° C (See Notes 4 and 5)	5 sec.	5 sec.	5 sec.

RECOMMENDED FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER	DEVICE TYPE	FILTER
MAN3610A MAN3620A MAN3630A MAN3640A	Panelgraphic Scarlet 65 Homalite 100-1670	MAN71A MAN72A MAN73A MAN74A	Panelgraphic Red 60 Homalite 100-1605
MAN3410A MAN3420A MAN3440A	Panelgraphic Green 48 Homalite 100-1440 Green	MAN3810A MAN3820A MAN3840A	Panelgraphic Yellow 25 or Amber 23 Homalite 100-1720 or 100-1726 Panelgraphic Grey 10 Homalite 100-1266 Grey

TYPICAL THERMAL CHARACTERISTICS

GREEN/YELLOW

Thermal resistance junction to free air Φ_{JA} .... 160° C/W

Wavelength temperature coefficient (case temperature) .... 1.0 Å/° C

Forward voltage temperature coefficient .... −1.5 mV/° C

RED/ORANGE

Thermal resistance junction to free air Φ_{JA} .... 160° C/W

Wavelength temperature coefficient (case temperature) .... 1.0 Å/° C

Forward voltage temperature coefficient .... −2.0 mV/° C

NOTES

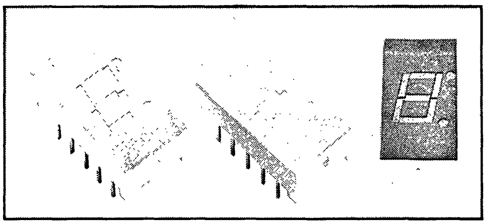
1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments as measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *The curve in Figures 3, 6, 9, and 12 is normalized to the brightness at 25° C to indicate the relative Luminous Intensity over the operating temperature range.*
3. *The decimal point is designed to have the same surface brightness as the segments, therefore, the Luminous Intensity of the decimal point is .3 times the Luminous Intensity of the segments, since the area of the decimal point is .3 times the area of the average segment.*
4. *Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140° C.*
5. *For flux removal, Freon TF, Freon TE, Isoproponal or water may be used up to their boiling points.*
6. *All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.*

GENERAL INSTRUMENT

0.300-INCH SEVEN SEGMENT DISPLAYS

HIGH EFFICIENCY GREEN MAN3480A
ORANGE MAN3680A
RED MAN78A
YELLOW MAN3880A
HIGH EFFICIENCY RED MAN3980A

Displays



DESCRIPTION

The MAN3480A, MAN3680A, MAN78A, MAN3880A and MAN3980A are common cathode displays which provide a choice of color of LED displays. They are pin and functional replacements for the 0.300-inch Hewlett-Packard common cathode displays. The series is complementary to the MAN3400A, MAN3600A, MAN70A, MAN3800A and MAN3900A families of displays. They can be mounted in arrays with 0.400-inch (10.16 mm) center-to-center spacing. Yellow and High Efficiency Green displays are constructed with Grey face and neutral segment color. Red displays have Black faces and Red segment color. Others have face and segment color corresponding to the emitted light.

FEATURES

- Hewlett-Packard compatible common cathode displays
- Red, Yellow, Green, Orange and High Efficiency Red
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Impact resistant plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 6)
- Standard 10 pin dual-in-line package configuration
- Wide angle viewing . . . 150°

APPLICATIONS

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Calculators
- Digital clocks

MODEL NUMBERS

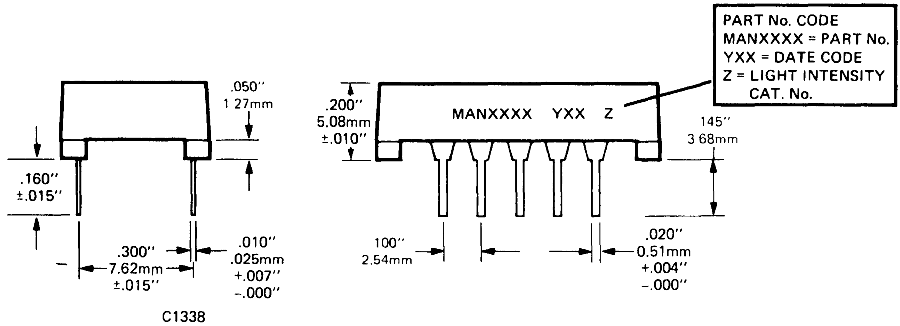
PART NUMBER	COLOR	DESCRIPTION
MAN3480A	High Efficiency Green	Common Cathode; Right Hand Decimal
MAN3680A	Orange	Common Cathode; Right Hand Decimal
MAN78A	Red	Common Cathode; Right Hand Decimal
MAN3880A	Yellow	Common Cathode; Right Hand Decimal
MAN3980A	High Efficiency Red	Common Cathode; Right Hand Decimal

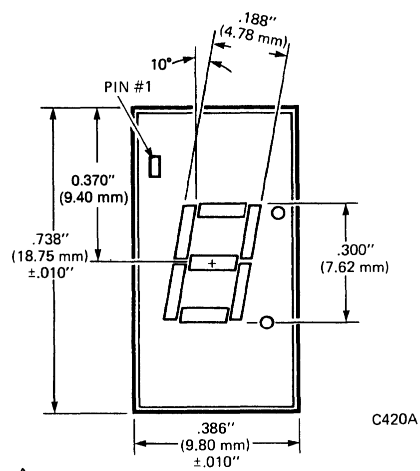
RECOMMENDED FILTERS

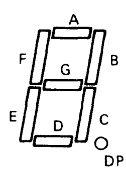
For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER	DEVICE TYPE	FILTER
MAN3480A	Panelgraphic Green 48 Homalite 100-1440 Green	MAN3980A MAN78A	Panelgraphic Red 60 Homalite 100-1605
MAN3680A	Panelgraphic Scarlet 65 Homalite 100-1670	MAN3880A	Panelgraphic Yellow 25 or Amber 23 Homalite 100-1720 or 100-1726 Panelgraphic Grey 10 Homalite 100-1266 Grey

MAN3480A MAN3680A MAN78A MAN3880A MAN3980A







PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS
1	Common Cathode
2	Anode F
3	Anode G
4	Anode E
5	Anode D
6	Common Cathode
7	Anode D.P.
8	Anode C
9	Anode B
10	Anode A

ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature Unless Otherwise Specified)

Device	Parameter	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
MAN3480A	Luminous Intensity, digit average	510	2000		µcd	I_F = 10 mA
	(See Notes 1 and 3)	710	2700		µcd	I_F = 60 mA peak, 1:6 DF
	Peak emission wavelength		562		nm	
	Spectral line half width		30		nm	
	Forward voltage					
	Segment		2.2	3.0	V	I_F = 20 mA
	Decimal point		2.2	3.0	V	I_F = 20 mA
	Dynamic resistance					
	Segment		12		Ω	I_F = 20 mA
	Decimal point		12		Ω	I_F = 20 mA
	Capacitance					
	Segment		40		pF	V = 0
	Decimal point		40		pF	V = 0
	Reverse current					
	Segment			100	µA	V_R = 5.0 V
	Decimal point			100	µA	V_R = 5.0 V
MAN3680A	Luminous Intensity, digit average (See Note 1)	510	1400		µcd	I_F = 10 mA
	Decimal point (See Note 3)	265	700		µcd	I_F = 10 mA
	Peak emission wavelength		630		nm	
	Spectral line half width		40		nm	
	Forward voltage					
	Segment			2.5	V	I_F = 20 mA
	Decimal point			2.5	V	I_F = 20 mA
	Dynamic resistance					
	Segment		26		Ω	I_F = 20 mA
	Decimal point		26		Ω	I_F = 20 mA
	Capacitance					
	Segment		35		pF	V = 0
	Decimal point		35		pF	V = 0
	Reverse current					
	Segment			100	µA	V_R = 5.0 V
	Decimal point			100	µA	V_R = 5.0 V
MAN78A	Luminous Intensity, digit average (See Note 1)	125	280		µcd	I_F = 10 mA
	Decimal point (See Note 3)	60	140		µcd	I_F = 10 mA
	Peak emission wavelength		660		nm	
	Spectral line half width		20		nm	
	Forward voltage					
	Segment			2.0	V	I_F = 20 mA
	Decimal point			2.0	V	I_F = 20 mA
	Dynamic resistance					
	Segment		2		Ω	I_{pk} = 100 mA
	Decimal point		2		Ω	I_{pk} = 100 mA
	Capacitance					
	Segment		35	80	pF	V = 0
	Decimal point		35	80	pF	V = 0
	Reverse current					
	Segment			100	µA	V_R = 5.0 V
	Decimal point			100	µA	V_R = 5.0 V
MAN3880A	Luminous Intensity, digit average (See Note 1)	320	1200		µcd	I_F = 10 mA
	Decimal point (See Note 3)	160	600		µcd	I_F = 10 mA
	Peak emission wavelength		585		nm	
	Spectral line half width		40		nm	
	Forward voltage					
	Segment			3.0	V	I_F = 20 mA
	Decimal point			3.0	V	I_F = 20 mA
	Dynamic resistance					
	Segment		26		Ω	I_F = 20 mA
	Decimal point		26		Ω	I_F = 20 mA
	Capacitance					
	Segment		35		pF	V = 0
	Decimal point		35		pF	V = 0
	Reverse current					
	Segment			100	µA	V_R = 5.0 V
	Decimal point			100	µA	V_R = 5.0 V
MAN3980A	Luminous Intensity, digit average (See Note 1)	320	1500		µcd	I_F = 10 mA
	Decimal point (See Note 3)	165	750		µcd	I_F = 10 mA
	Peak emission wavelength		635		nm	
	Spectral line half width		40		nm	
	Forward voltage					
	Segment			2.5	V	I_F = 20 mA
	Decimal point			2.5	V	I_F = 20 mA
	Dynamic resistance					
	Segment		26		Ω	I_F = 20 mA
	Decimal point		26		Ω	I_F = 20 mA
	Capacitance					
	Segment		35		pF	V = 0
	Decimal point		35		pF	V = 0
	Reverse current					
	Segment			100	µA	V_R = 5.0 V
	Decimal point			100	µA	V_R = 5.0 V

TYPICAL CURVES

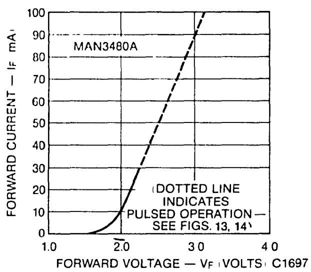


Fig. 1. Forward Current vs. Forward Voltage

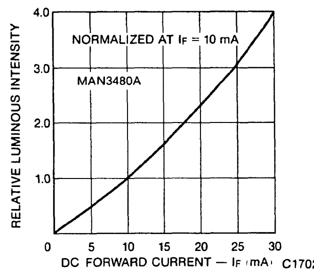


Fig. 2. Relative Luminous Intensity vs. DC Forward Current

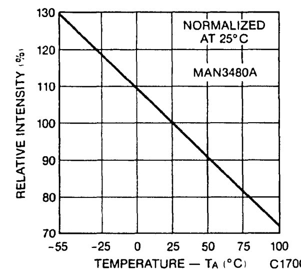


Fig. 3. Relative Luminous Intensity vs. Temperature

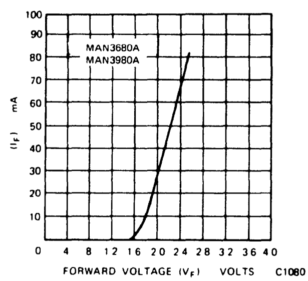


Fig. 4. Forward Current vs. Forward Voltage

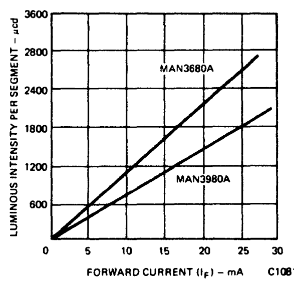


Fig. 5. Luminous Intensity vs. Forward Current

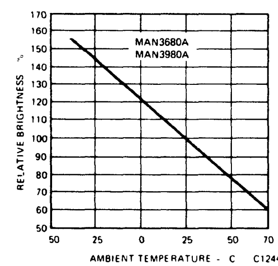


Fig. 6. Luminous Intensity vs. Temperature

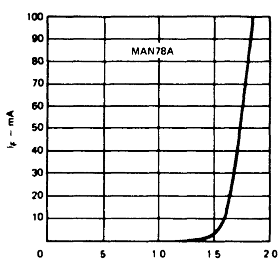


Fig. 7. Forward Current vs. Forward Voltage

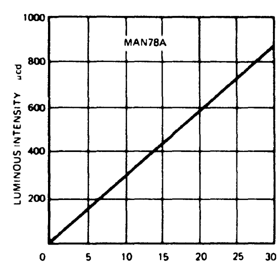


Fig. 8. Luminous Intensity vs. Forward Current

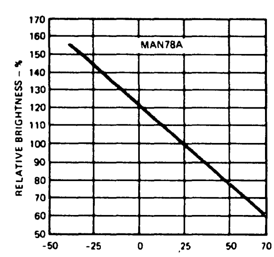


Fig. 9. Luminous Intensity vs. Temperature

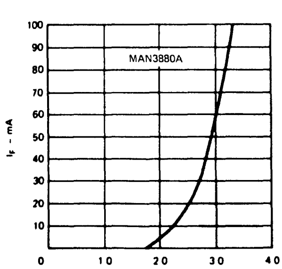


Fig. 10. Forward Current vs. Forward Voltage

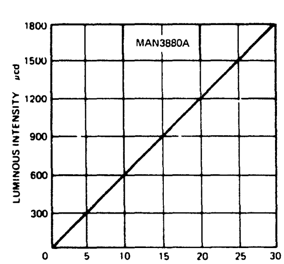


Fig. 11. Luminous Intensity vs. Forward Current

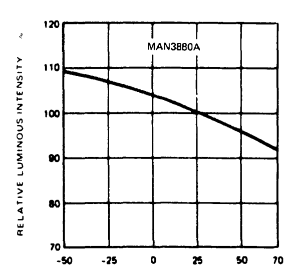


Fig. 12. Luminous Intensity vs. Temperature

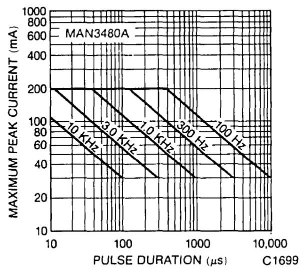


Fig. 13. Maximum Peak Current vs. Pulse Duration

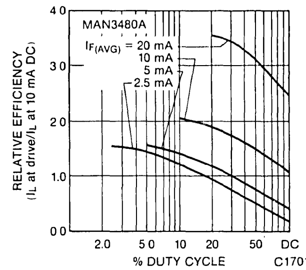


Fig. 14. Relative Efficiency vs. Duty Cycle

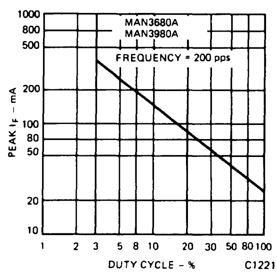


Fig. 15. Max Peak Current vs. Duty Cycle

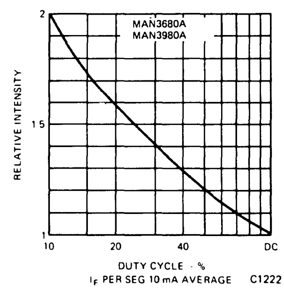


Fig. 16. Luminous Intensity vs. Duty Cycle

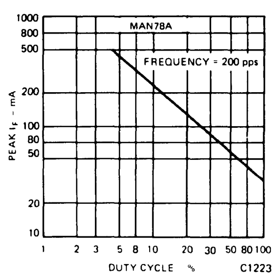


Fig. 17. Max Peak Current vs. Duty Cycle

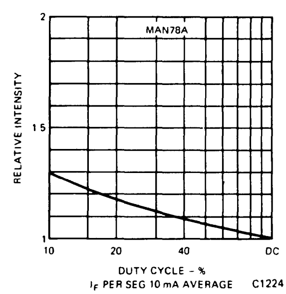


Fig. 18. Luminous Intensity vs. Duty Cycle

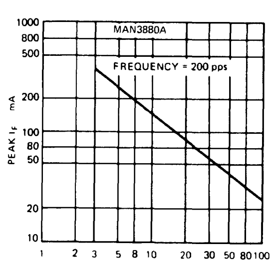


Fig. 19. Max Peak Current vs. Duty Cycle

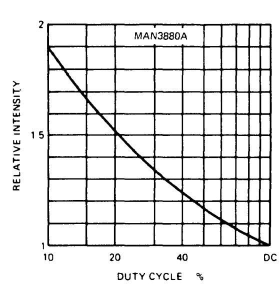


Fig. 20. Luminous Intensity vs. Duty Cycle

ABSOLUTE MAXIMUM RATINGS

	HIGH EFF. GREEN	RED	ORANGE YELLOW HIGH EFF. RED
	MAN3480A	MAN78A	MAN3680A MAN3680A MAN3980A
Power dissipation at 25° C ambient	600 mW	480 mW	600 mW
Derate linearly from 50° C	-12 mW/° C	-6.9 mW/° C	-10.3 mW/° C
Storage and operating temperature	-40° C to +85° C	-40° C to +85° C	-40° C to +85° C
Continuous forward current			
Total	240 mA	240 mA	200 mA
Per segment	30 mA	30 mA	25 mA
Decimal point	30 mA	30 mA	25 mA
Reverse voltage			
Per segment	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V
Soldering time at 260° C (See Notes 4 and 5)	5 sec.	5 sec.	5 sec.

TYPICAL THERMAL CHARACTERISTICS

GREEN/YELLOW

Thermal resistance junction to free air Φ_{JA} .... 160° C/W
Wavelength temperature coefficient (case temperature) .... 1.0 Å/° C
Forward voltage temperature coefficient .... -1.5 mV/° C

RED/ORANGE/HIGH EFFICIENCY RED

Thermal resistance junction to free air Φ_{JA} .... 160° C/W
Wavelength temperature coefficient (case temperature) .... 1.0 Å/° C
Forward voltage temperature coefficient .... -2.0 mV/° C

NOTES

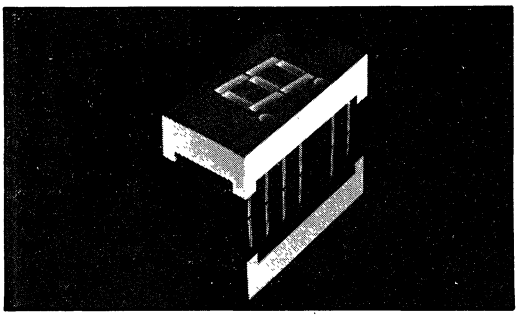
1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments as measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *The curve in Figures 3, 6, 9, and 12 is normalized to the brightness at 25° C to indicate the relative Luminous Intensity over the operating temperature range.*
3. *The decimal point is designed to have the same surface brightness as the segments, therefore, the Luminous Intensity of the decimal point is .3 times the Luminous Intensity of the segments, since the area of the decimal point is .3 times the area of the average segment.*
4. *Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140° C.*
5. *For flux removal, Freon TF, Freon TE, Isopropanol or water may be used up to their boiling points.*
6. *All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.*

GENERAL INSTRUMENT

0.300-INCH SEVEN SEGMENT DISPLAYS

HIGH EFFICIENCY RED MAN3900A SERIES

Displays



DESCRIPTION

The MAN3900A Series is a High Efficiency Red LED display. Standard units are also available in Red, Green, Orange and Yellow, with common anode right hand decimal, common anode left hand decimal, and common cathode right hand decimal. They can be mounted in arrays with 0.400-inch (10.16 mm) center-to-center spacing. Units are constructed with Red face and segment color.

FEATURES

- Common anode or common cathode models
- High Efficiency Red
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Impact resistant plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 6)
- Standard dual-in-line package configuration
- Wide angle viewing . . . 150°
- These devices have a Red face and Red segments

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Calculators
- Digital clocks

MODEL NUMBERS

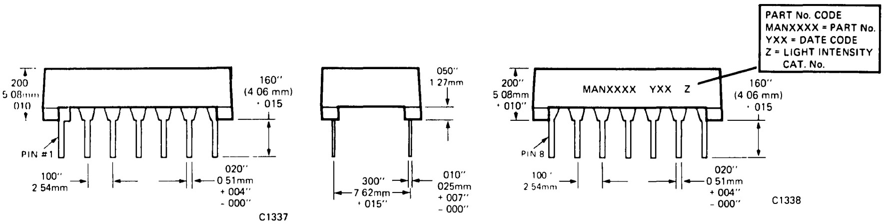
PART NUMBER	COLOR	PACKAGE	DESCRIPTION	PIN OUT SPECIFICATION
MAN3910A	High Efficiency Red	A	Common Anode; Right Hand Decimal	A
MAN3920A	High Efficiency Red	B	Common Anode; Left Hand Decimal	B
MAN3940A	High Efficiency Red	C	Common Cathode; Right Hand Decimal	C
MAN3980A	High Efficiency Red	D	Common Cathode; Right Hand Decimal	D

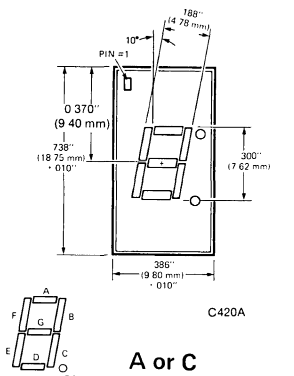
RECOMMENDED FILTERS

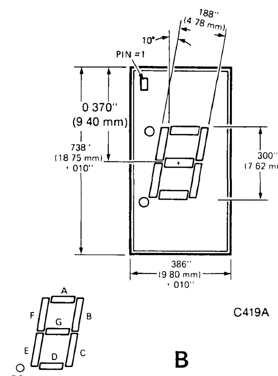
For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

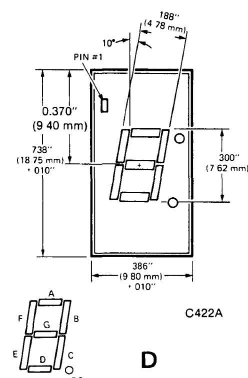
DEVICE TYPE	FILTER
MAN3910A	
MAN3920A	Panelgraphic Scarlet 65
MAN3940A	Homalite 100-1670
MAN3980A	

MAN3900A SERIES









PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS			
	A MAN3910A	B MAN3920A	C MAN3940A	D MAN3980A
1	Cathode A	Cathode A	Anode F	Common Cathode
2	Cathode F	Cathode F	Anode G	Anode F
3	Common Anode	Common Anode	No Pin	Anode G
4	No Pin	No Pin	Common Cathode	Anode E
5	No Pin	No Pin	No Pin	Anode D
6	No Connection	Cathode D.P.	Anode E	Common Cathode
7	Cathode E	Cathode E	Anode D	Anode D.P.
8	Cathode D	Cathode D	Anode C	Anode C
9	Cathode D.P.	No Connection	Anode D.P.	Anode B
10	Cathode C	Cathode C	No Pin	Anode A
11	Cathode G	Cathode G	No Pin	
12	No Pin	No Pin	Common Cathode	
13	Cathode B	Cathode B	Anode B	
14	Common Anode	Common Anode	Anode A	

Displays

ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature Unless Otherwise Specified)

MAN3910A, 3920A, 3940A, 3980A

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity, digit average (See Note 1)	320	1500		μcd	$I_F = 10$ mA
Decimal point (See Note 3)	165	750		μcd	$I_F = 10$ mA
Segment "C" or "D" of MAN3630A	165	750		μcd	$I_F = 10$ mA
Peak emission wavelength		635		nm	
Spectral line half width		40		nm	
Forward voltage					
Segment			2.5	V	$I_F = 20$ mA
Decimal point			2.5	V	$I_F = 20$ mA
Dynamic resistance					
Segment		26		Ω	$I_F = 20$ mA
Decimal point		26		Ω	$I_F = 20$ mA
Capacitance					
Segment		35		pF	$V = 0$
Decimal point		35		pF	$V = 0$
Reverse current					
Segment			100	μA	$V_R = 5.0$ V
Decimal point			100	μA	$V_R = 5.0$ V

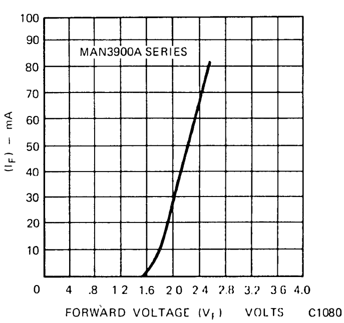


Fig. 1. Forward Current vs. Forward Voltage

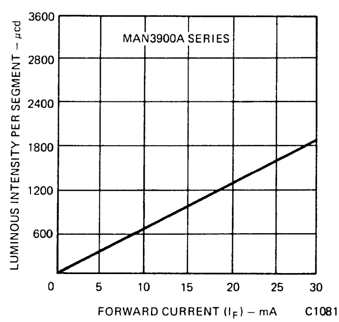


Fig. 2. Luminous Intensity vs. Forward Current

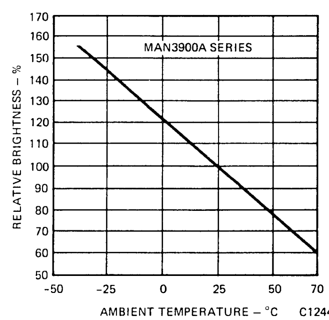


Fig. 3. Luminous Intensity vs. Temperature

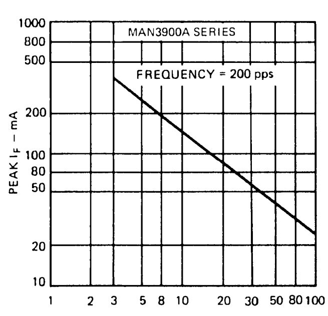


Fig.4. Max Peak Current vs. Duty Cycle

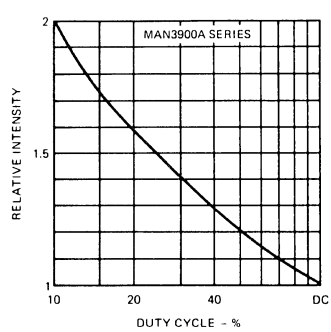


Fig. 5. Luminous Intensity vs. Duty Cycle

ABSOLUTE MAXIMUM RATINGS

	MAN3910A MAN3920A MAN3940A MAN3980A
Power dissipation at 25° C ambient	600 mW
Derate linearly from 50° C	-8.6 mW/° C
Storage and operating temperature	-40° C to +85° C
Continuous forward current	
Total	240 mA
Per segment	30 mA
Decimal point	30 mA
Reverse voltage	
Per segment	6.0 V
Decimal point	6.0 V
Soldering time at 260° C (See Notes 4 and 5)	5 sec.

TYPICAL THERMAL CHARACTERISTICS

HIGH EFFICIENCY RED

Thermal resistance junction to free air Φ_{JA}	160° C/W
Wavelength temperature coefficient (case temperature)	1.0 Å/° C
Forward voltage temperature coefficient	-2.0 mV/° C

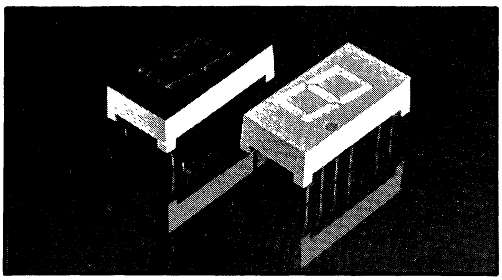
NOTES

1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments as measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *The curve in Figure 3 is normalized to the brightness at 25° C to indicate the relative Luminous Intensity over the operating temperature range.*
3. *The decimal point is designed to have the same surface brightness as the segments, therefore, the Luminous Intensity of the decimal point is .3 times the Luminous Intensity of the segments, since the area of the decimal point is .3 times the area of the average segment.*
4. *Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140° C.*
5. *For flux removal, Freon TF, Freon TE, Isoproponal or water may be used up to their boiling points.*
6. *All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.*

GENERAL INSTRUMENT

0.400-INCH SEVEN SEGMENT DISPLAYS

HIGH EFFICIENCY GREEN MAN4400A SERIES
ORANGE MAN4600A SERIES
RED MAN4700A SERIES



DESCRIPTION

The MAN4400, MAN4600, MAN4700 and MAN4800 Series provides superior brightness in a choice of color LED displays. Standard units are available in Red, Green, and Orange. They can be mounted in arrays with 0.400-inch (10.16 mm) center-to-center spacing. The Green displays are constructed with Grey face and neutral segment color. Red displays have Black faces and Red segment color. Others have face and segment color corresponding to the emitted light.

FEATURES

- Common anode or common cathode models
- Red, Green and Orange
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Impact resistant plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 6)
- Standard 14 pin dual-in-line package configuration
- Wide angle viewing . . . 150°
- Package size and lead configuration is the same as MAN50A/3600A/70A/80A Series

APPLICATIONS

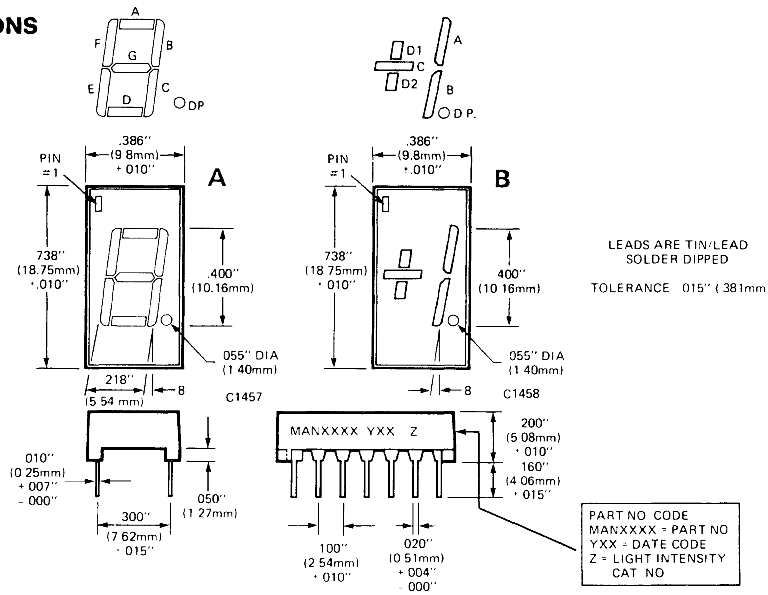
For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Calculators
- Digital clocks
- High ambient light conditions

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN OUT SPECIFICATION
MAN4410A	Green	Common Anode; Right Hand Decimal	A	A
MAN4440A	Green	Common Cathode; Right Hand Decimal	A	C
MAN4610A	Orange	Common Anode; Right Hand Decimal	A	A
MAN4630A	Orange	Common Anode; Overflow ±1; Right Hand Decimal	B	B
MAN4640A	Orange	Common Cathode; Right Hand Decimal	A	C
MAN4705A	Red	Universal (CA or CC) Overflow ±1; Right Hand Decimal	B	D
MAN4710A	Red	Common Anode; Right Hand Decimal	A	A
MAN4740A	Red	Common Cathode; Right Hand Decimal	A	C

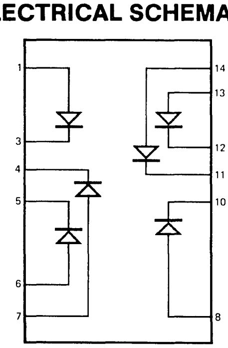
PACKAGE DIMENSIONS



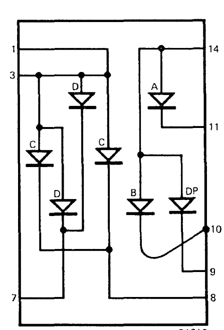
PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS			
	A MAN4410/4610/4710	B MAN4630	C MAN4440/4640/4740	D MAN4705
1	Cathode A	Anode C, D	Anode F	Anode D1
2	Cathode F	No Pin	Anode G	No Pin
3	Common Anode	Anode C, D	No Pin	Cathode D1
4	No Pin	No Pin	Common Cathode	Cathode C
5	No Pin	No Pin	No Pin	Cathode D2
6	No Pin	No Connection	Anode E	Anode D2
7	Cathode E	Cathode D	Anode D	Anode C
8	Cathode D	Cathode C	Anode C	Anode D.P.
9	Cathode D.P.	Cathode D.P.	Anode D.P.	No Pin
10	Cathode C	Cathode B	No Pin	Cathode D.P.
11	Cathode G	Cathode A	No Connection	Cathode B
12	No Pin	No Pin	Common Cathode	Cathode A
13	Cathode B	No Pin	Anode B	Anode A
14	Common Anode	Anode A, B, & D.P.	Anode A	Anode B

ELECTRICAL SCHEMATIC



MAN4705



MAN4630

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

Device	Parameter	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
MAN4410/4440A	Luminous Intensity, digit average (See Note 1)	510	2000		µcd	$I_F = 10$ mA
	Decimal point (See Note 3)	700	2700		µcd	$I_F = 10$ mA
	Segment "C" or "D" of MAN4450	700	2700		µcd	$I_F = 10$ mA
	Peak emission wavelength		562		nm	
	Forward voltage					
	Segment		2.2	3.0	V	$I_F = 20$ mA
	Decimal point		2.2	3.0	V	$I_F = 20$ mA
	Dynamic resistance					
	Segment		12		Ω	$I_F = 20$ mA
	Decimal point		12		Ω	$I_F = 20$ mA
	Capacitance					
	Segment		40		pF	V = 0
	Decimal point		40		pF	V = 0
	Reverse current					
	Segment			100	µA	$V_R = 5.0$ V
	Decimal point			100	µA	$V_R = 5.0$ V
MAN4610/4630/4640A	Luminous Intensity, digit average (See Note 1)	510	1400		µcd	$I_F = 10$ mA
	Decimal point (See Note 3)	250	700		µcd	$I_F = 10$ mA
	Segment "C" or "D" of MAN4630 or 4605	250	700		µcd	$I_F = 10$ mA
	Peak emission wavelength		630		nm	
	Forward voltage					
	Segment		2.2	2.5	V	$I_F = 20$ mA
	Decimal point		2.2	2.5	V	$I_F = 20$ mA
	Dynamic resistance					
	Segment		26		Ω	$I_F = 20$ mA
	Decimal point		26		Ω	$I_F = 20$ mA
	Capacitance					
	Segment		35		pF	V = 0
	Decimal point		35		pF	V = 0
	Reverse current					
	Segment			100	µA	$V_R = 5.0$ V
	Decimal point			100	µA	$V_R = 5.0$ V
MAN4705/4710/4740A	Luminous Intensity, digit average (See Note 1)	125	280		µcd	$I_F = 10$ mA
	Decimal point (See Note 3)	60	140		µcd	$I_F = 10$ mA
	Segment "C" or "D" of MAN4705	60	140		nm	
	Peak emission wavelength		660		nm	
	Forward voltage					
	Segment		1.6	2.0	V	$I_F = 20$ mA
	Decimal point		1.6	2.0	V	$I_F = 20$ mA
	Dynamic resistance					
	Segment		2		Ω	$I_F = 20$ mA
	Decimal point		2		Ω	$I_F = 20$ mA
	Capacitance					
	Segment		35	80	pF	V = 0
	Decimal point		35	80	pF	V = 0
	Reverse current					
	Segment			100	µA	$V_R = 5.0$ V
	Decimal point			100	µA	$V_R = 5.0$ V

TYPICAL CURVES

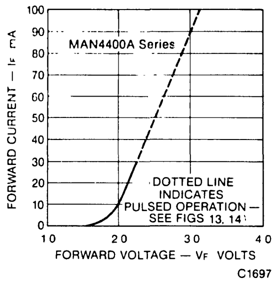


Fig. 1. Forward Current vs. Forward Voltage

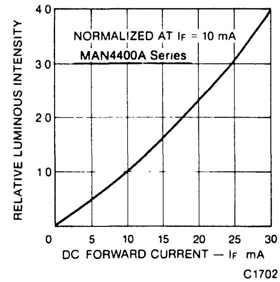


Fig. 2. Luminous Intensity vs. Forward Current

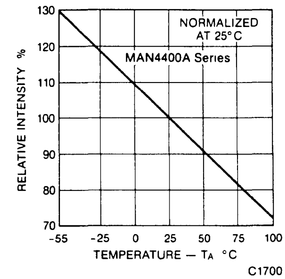


Fig. 3. Luminous Intensity vs. Temperature

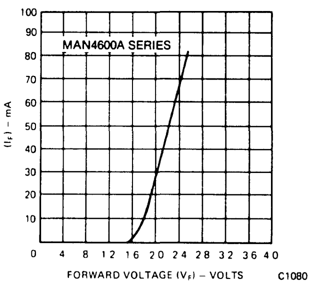


Fig. 4. Forward Current vs. Forward Voltage

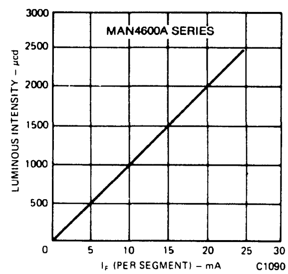


Fig. 5. Luminous Intensity vs. Forward Current

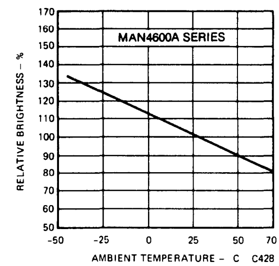


Fig. 6. Luminous Intensity vs. Temperature

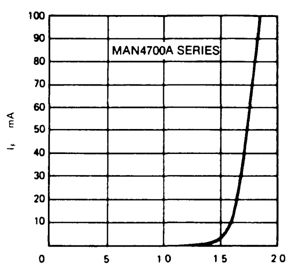


Fig. 7. Forward Current vs. Forward Voltage

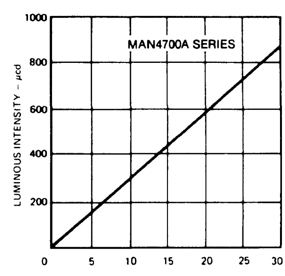


Fig. 8. Luminous Intensity vs. Forward Current

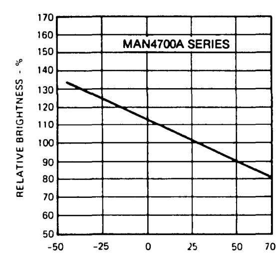


Fig. 9. Luminous Intensity vs. Temperature

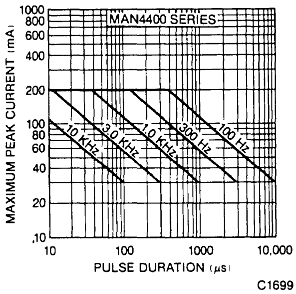


Fig. 10. Max Peak Current vs. Duty Cycle

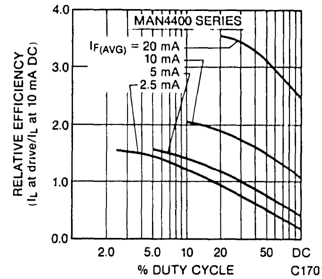


Fig. 11. Luminous Intensity vs. Duty Cycle

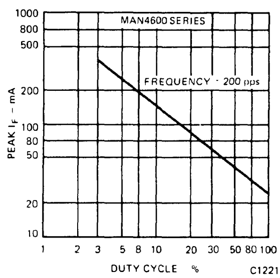


Fig. 12. Max Peak Current vs. Duty Cycle

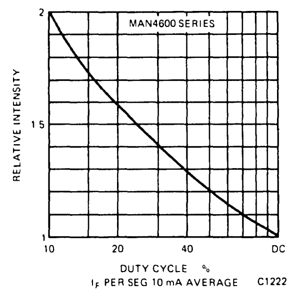


Fig. 13. Luminous Intensity vs. Duty Cycle

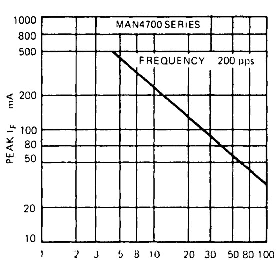


Fig. 14. Max Peak Current vs. Duty Cycle

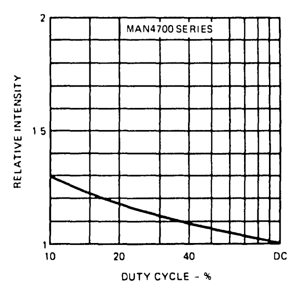


Fig. 15. Luminous Intensity vs. Duty Cycle

Displays

ABSOLUTE MAXIMUM RATINGS

	MAN4410A MAN4440A	MAN4705A	MAN4710A MAN4740A
Power dissipation at 25°C ambient	600 mW	360 mW	480 mW
Derate linearly from 50°C	-12 mW/°C	-5.2 mW/°C	-6.9 mW/°C
Storage and operating temperature	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C
Continuous forward current			
Total	240 mA	180 mA	240 mA
Per segment	30 mA	30 mA	30 mA
Decimal point	30 mA	30 mA	30 mA
Reverse voltage			
Per segment	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V
Soldering time at 260°C (See Notes 4 and 5)	5 sec.	5 sec.	5 sec.

	MAN4630A	MAN4610A MAN4640A
Power dissipation at 25°C ambient	450 mW	600 mW
Derate linearly from 50°C	-6.4 mW/°C	-8.6 mW/°C
Storage and operating temperature	-40°C to +85°C	-40°C to +85°C
Continuous forward current		
Total	180 mA	240 mA
Per segment	30 mA	30 mA
Decimal point	30 mA	30 mA
Reverse voltage		
Per segment	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V
Soldering time at 260°C (See Notes 4 and 5)	5 sec.	5 sec.

RECOMMENDED FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER
MAN4410A, MAN4440A	Panelgraphic Green 48
MAN4610A, MAN4630A, MAN4640A	Panelgraphic Scarlet 65, Homalite 100-1670
MAN4705A, MAN4710A, MAN4740A	Panelgraphic Red 60, Homalite 100-1605

NOTE: When using the Grey face MAN4480 or MAN4880 in situations of high ambient light, a neutral density filter can be used to achieve a greater contrast. The following or equivalent can be used: Panelgraphic Grey 10.

TYPICAL THERMAL CHARACTERISTICS

GREEN/YELLOW

Thermal resistance junction to free air Φ_{JA}	160°C/W
Wavelength temperature coefficient (case temperature)	1.0 Å/°C
Forward voltage temperature coefficient	-1.5 mV/°C

RED/ORANGE

Thermal resistance junction to free air Φ_{JA}	160°C/W
Wavelength temperature coefficient (case temperature)	1.0 Å/°C
Forward voltage temperature coefficient	-2.0 mV/°C

NOTES

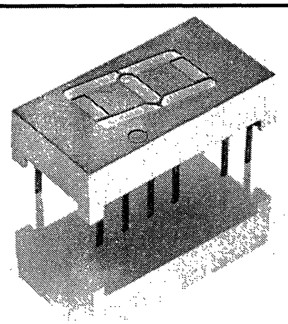
1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments as measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *The curve in Figures 3, 6, 9, and 12 is normalized to the brightness at 25°C to indicate the relative Luminous Intensity over the operating temperature range.*
3. *The decimal point is designed to have the same surface brightness as the segments, therefore, the Luminous Intensity of the decimal point is .3 times the Luminous Intensity of the segments, since the area of the decimal point is .3 times the area of the average segment.*
4. *Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140°C.*
5. *For flux removal, Freon TF, Freon TE, Isoproponal or water may be used up to their boiling points.*
6. *All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.*

GENERAL INSTRUMENT

0.400-INCH SEVEN SEGMENT DISPLAYS

HIGH EFFICIENCY RED MAN4900A SERIES

Displays



DESCRIPTION

The MAN4900A Series provides superior brightness High Efficiency Red LED display. Standard units are also available in Red, Green, and Orange. They can be mounted in arrays with 0.400-inch (10.16 mm) center-to-center spacing. Units are constructed with Red face and segment color.

FEATURES

- Common anode or common cathode models
- High Efficiency Red
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Impact resistant plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 6)
- Standard dual-in-line package configuration
- Wide angle viewing . . . 150°
- Package size and lead configuration is the same as MAN50A/3600A/70A/80A Series
- These devices have a Red face and Red segments

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Calculators
- Digital clocks
- High ambient light conditions

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN OUT SPECIFICATION
MAN4910A	High Efficiency Red	Common Anode; Right Hand Decimal	A	A
MAN4940A	High Efficiency Red	Common Cathode; Right Hand Decimal	A	B

RECOMMENDED FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER
MAN4910A	Panelgraphic Scarlet 65
MAN4940A	Homalite 100-1670

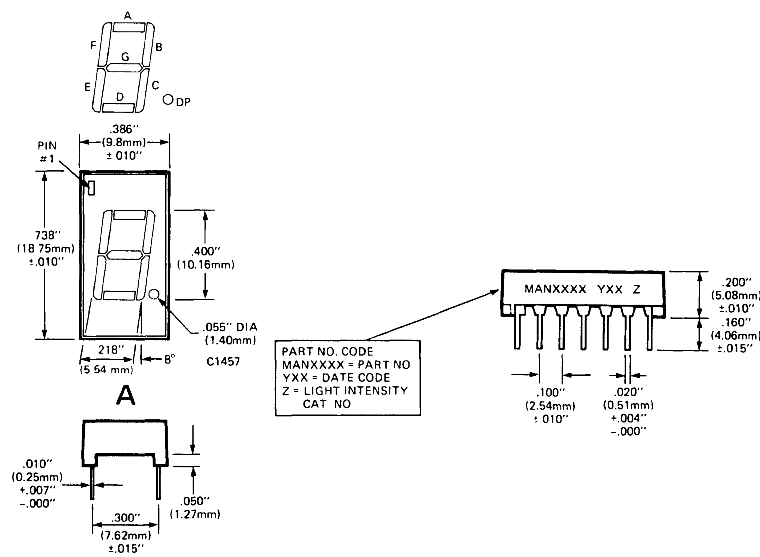
ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature Unless Otherwise Specified)

Device	Parameter	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
MAN4910A/4940A	Luminous Intensity, digit average (See Note 1)	320	1500		μcd	$I_F = 10$ mA
	Decimal point (See Note 3)	160	750		μcd	$I_F = 10$ mA
	Segment "C" or "D" of MAN4930A or 4905A	160	750		μcd	$I_F = 10$ mA
	Peak emission wavelength		635		nm	
	Forward voltage					
	Segment		2.2	2.5	V	$I_F = 20$ mA
	Decimal point		2.2	2.5	V	$I_F = 20$ mA
	Dynamic resistance					
	Segment		26		Ω	$I_F = 20$ mA
	Decimal point		26		Ω	$I_F = 20$ mA
	Capacitance					
	Segment		35		pF	V = 0
	Decimal point		35		pF	V = 0
	Reverse current					
	Segment			100	μA	$V_R = 5.0$ V
	Decimal point			100	μA	$V_R = 5.0$ V

PACKAGE DIMENSIONS

LEADS ARE TIN/LEAD SOLDER DIPPED

TOLERANCE .015" (.381mm)



PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS A MAN4910A	ELECTRICAL CONNECTIONS B MAN4940A
1	Cathode A	Anode F
2	Cathode F	Anode G
3	Common Anode	No Pin
4	No Pin	Common Cathode
5	No Pin	No Pin
6	No Connection	Anode E
7	Cathode E	Anode D
8	Cathode D	Anode C
9	Cathode D.P.	Anode D.P.
10	Cathode C	No Pin
11	Cathode G	No Connection
12	No Pin	Common Cathode
13	Cathode B	Anode B
14	Common Anode	Anode A

TYPICAL CURVES

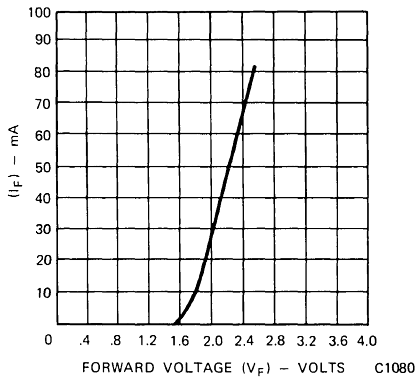


Fig. 1. Forward Current vs. Forward Voltage

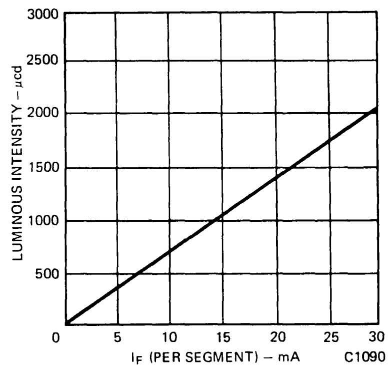


Fig. 2. Luminous Intensity vs. Forward Current

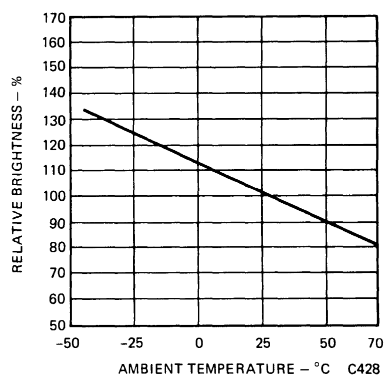


Fig. 3. Luminous Intensity vs. Temperature

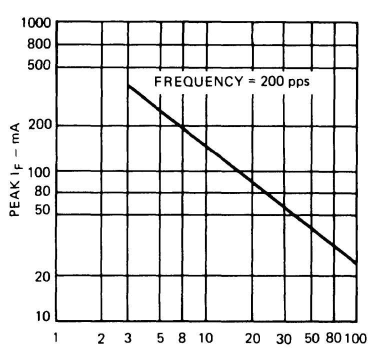


Fig. 4. Max Peak Current vs. Duty Cycle

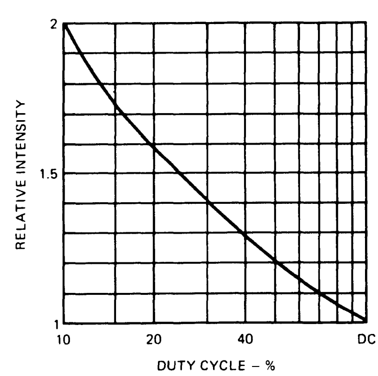


Fig. 5. Luminous Intensity vs. Duty Cycle

Displays

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° C ambient	600 mW
Derate linearly from 50° C	-8.6 mW/° C
Storage and operating temperature	-40° C to +85° C
Continuous forward current	
Total	240 mA
Per segment	30 mA
Decimal point	30 mA
Reverse voltage	
Per segment	6.0 V
Decimal point	6.0 V
Soldering time at 260° C (See Notes 4 and 5)	5 sec.

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Φ_{JA}	160° C/W
Wavelength temperature coefficient (case temperature)	1.0 Å/° C
Forward voltage temperature coefficient	-2.0 mV/° C

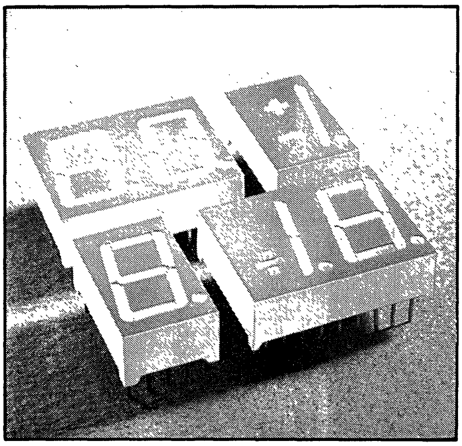
NOTES

1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments as measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *The curve in Figure 3 is normalized to the brightness at 25° C to indicate the relative Luminous Intensity over the operating temperature range.*
3. *The decimal point is designed to have the same surface brightness as the segments, therefore, the Luminous Intensity of the decimal point is .3 times the Luminous Intensity of the segments, since the area of the decimal point is .3 times the area of the average segment.*
4. *Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140° C.*
5. *For flux removal, Freon TF, Freon TE, Isoproponal or water may be used up to their boiling points.*
6. *All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.*

GENERAL INSTRUMENT

0.560-INCH SEVEN SEGMENT DISPLAYS

LOW CURRENT HIGH EFFICIENCY RED MAN6100 SERIES



DESCRIPTION

The MAN6100 Series is a family of large digits which includes double and single digits. The series features the sculptured font which minimizes "gappiness" at the segment intersections. Available models include two-digit, one and one-half digits with polarity sign, single digit, and single digit overflow with polarity sign. All models have right hand decimal points and are available in common anode or common cathode configuration. This device has a Grey face and clear segments.

FEATURES

- High Efficiency Red nitrogen-doped GaAsP on GaP
- LED chips designed for low current operation
- Pin and package compatible with popular 0.56-inch displays
- Large, easy to read, digits
- Common anode or common cathode models
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Rugged plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 6)
- Wide angle viewing . . . 150°
- Low forward voltage
- Two-digit package simplifies alignment and assembly

APPLICATIONS

For industrial and consumer applications such as:

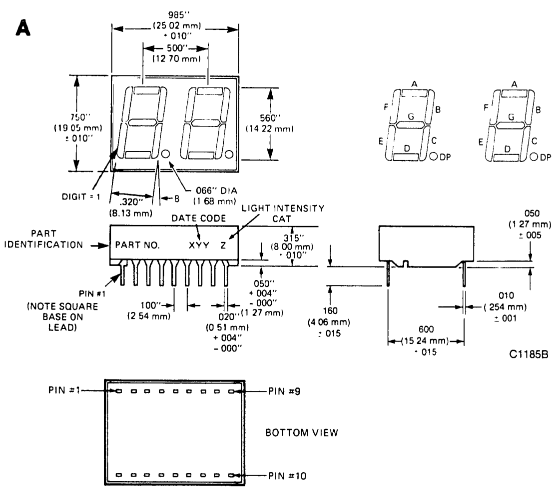
- Digital readout displays
- Instrument panels
- Point of sale equipment
- Digital clocks
- TV and radios

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN OUT SPECI-FICATION
MAN6110	High Eff. Red	2 Digit; Common Anode; Rt. Hand Decimal	A	A
MAN6130	High Eff. Red	1½ Digit; Common Anode; Overflow ±1.8; Rt. Hand Decimal	B	B
MAN6140	High Eff. Red	2 Digit; Common Cathode; Rt. Hand Decimal	A	C
MAN6150	High Eff. Red	1½ Digit; Common Cathode; Overflow ±1.8; Rt. Hand Decimal	B	D
MAN6160	High Eff. Red	Single Digit; Common Anode; Rt. Hand Decimal	C	E
MAN6175	High Eff. Red	Single Digit; Common Anode; Overflow ±1.0; Rt. Hand Decimal	D	G
MAN6180	High Eff. Red	Single Digit; Common Cathode; Rt. Hand Decimal	C	F
MAN6195	High Eff. Red	Single Digit; Common Cathode; Overflow ±1.0; Rt. Hand Decimal	D	H

PACKAGE DIMENSIONS

A



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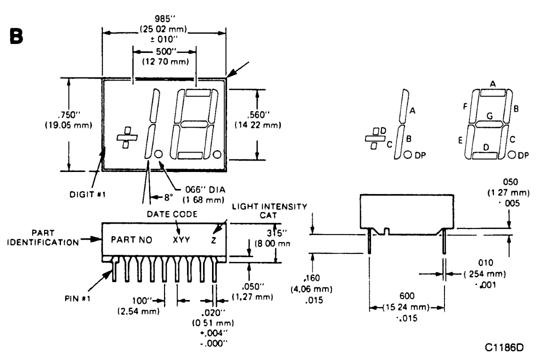

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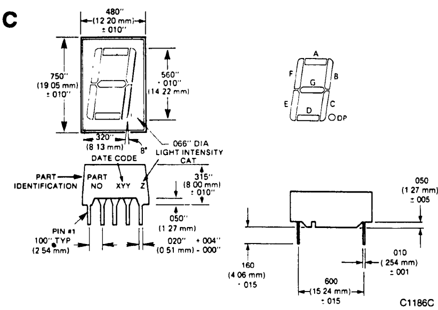
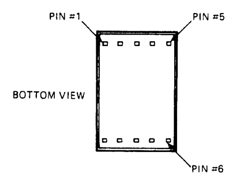
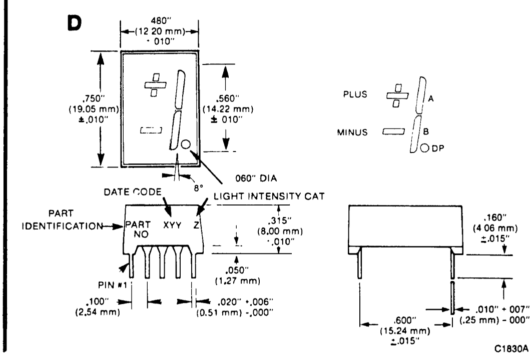




NOTE: When placing double digits and single digits together on a board, allowance should be made for .150" spacing between the end leads of the double digit and the end leads of the single digit.

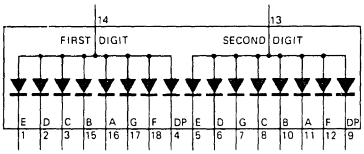
D



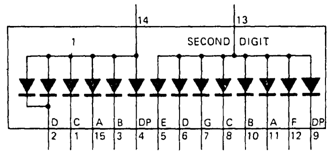
PIN CONNECTIONS

PIN No.	ELECTRICAL CONNECTIONS							
	A MAN6110	B MAN6130	C MAN6140	D MAN6150	E MAN6160	F MAN6180	G MAN6175	H MAN6195
1	E Cath. (#1)	C Cath. (#1)	E An. (#1)	C An. (#1)	E Cath.	E An.	Minus Cath.	Minus An.
2	D Cath. (#1)	D Cath (#1)	D An. (#1)	D An. (#1)	D Cath.	D An.	Com. An. +/-	Com. Cath. +/-
3	C Cath. (#1)	B Cath. (#1)	C An. (#1)	B An. (#1)	Com. An.	Com. Cath.	Seg. B. Cath.	Seg. B An.
4	DP Cath. (#1)	DP Cath. (#1)	DP An. (#1)	DP An. (#1)	C Cath.	C An.	Com. An. A, B, DP	Com. Cath. A, B, DP
5	E Cath. (#2)	E Cath. (#2)	E An. (#2)	E An. (#2)	DP Cath.	DP An.	DP Cath.	DP An.
6	D Cath. (#2)	D Cath. (#2)	D An. (#2)	D An. (#2)	B Cath.	B An.	Seg. A Cath.	Seg. A An.
7	G Cath. (#2)	G Cath. (#2)	G An. (#2)	G An. (#2)	A Cath.	A An.	Com. An. A, B, DP	Com. Cath. A, B, DP
8	C Cath. (#2)	C Cath. (#2)	C An. (#2)	C An. (#2)	Com. An.	Com. Cath.	Com. An. +/-	Com. Cath. +/-
9	DP Cath. (#2)	DP Cath. (#2)	DP An. (#2)	DP An. (#2)	F Cath.	F An.	Plus Cath.	Plus An.
10	B Cath. (#2)	B Cath. (#2)	B An. (#2)	B An. (#2)	G Cath.	G An.	N.C.	N.C.
11	A Cath. (#2)	A Cath. (#2)	A An. (#2)	A An. (#2)				
12	F Cath. (#2)	F Cath. (#2)	F An. (#2)	F An. (#2)				
13	Digit #2 An.	Digit #2 An.	Digit #2 Cath.	Digit #2 Cath				
14	Digit #1 An.	Digit #1 An.	Digit #1 Cath.	Digit #1 Cath				
15	B Cath (#1)	A Cath. (#1)	B An. (#1)	A An. (#1)				
16	A Cath. (#1)	N.C.	A An. (#1)	N.C.				
17	G Cath. (#1)	N.C.	G An. (#1)	N.C.				
18	F Cath. (#1)	N.C.	F. An. (#1)	N.C.				

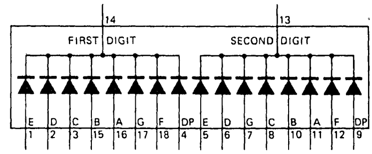
INTERNAL CONNECTIONS



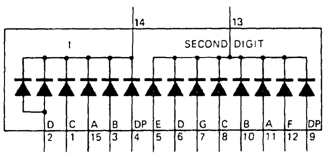
MAN6110 C1195



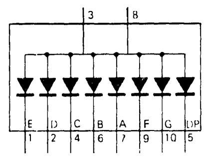
MAN6130 C1196



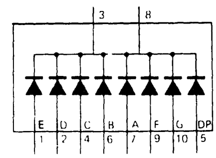
MAN6140 C1197



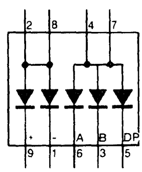
MAN6150 C1198



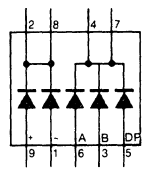
MAN6160 C1238



MAN6180 C1239



MAN6175
C1828



MAN6195
C1829

Displays

ABSOLUTE MAXIMUM RATINGS

	MAN6110 MAN6140	MAN6130 MAN6150	MAN6160 MAN6180	MAN6175 MAN6195
Power dissipation at 25° C ambient	240 mW	210 mW	120 mW	75 mW
Storage and operating temperature	-40° C to +85° C	-40° C to +85° C	-40° C to +85° C	-40° C to +85° C
Continuous forward current				
Total	120 mA	105 mA	60 mA	38 mA
Per segment	7.5 mA	7.5 mA	7.5 mA	7.5 mA
Decimal point	7.5 mA	7.5 mA	7.5 mA	7.5 mA
Reverse voltage				
Per segment	6.0 V	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V	6.0 V
Soldering time at 260° C (See Notes 4 and 5)	5 sec.	5 sec.	5 sec.	5 sec.

ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity, digit average	200	370		μcd	$I_F = 20$ mA
Decimal point, "+" or "–"	100			μcd	$I_F = 20$ mA
Peak emission wavelength		635		nm	
Spectral line half width		40		nm	
Forward voltage					
Segment		1.8	2.2	V	$I_F = 20$ mA
Decimal point		1.8	2.2	V	$I_F = 20$ mA
Dynamic resistance					
Segment				Ω	$I_F = 20$ mA
Decimal point				Ω	$I_F = 20$ mA
Capacitance					
Segment				pF	$V = 0$
Decimal point				pF	$V = 0$
Reverse current					
Segment			100	μA	$V_R = 3.0$ V
Decimal point			100	μA	$V_R = 3.0$ V

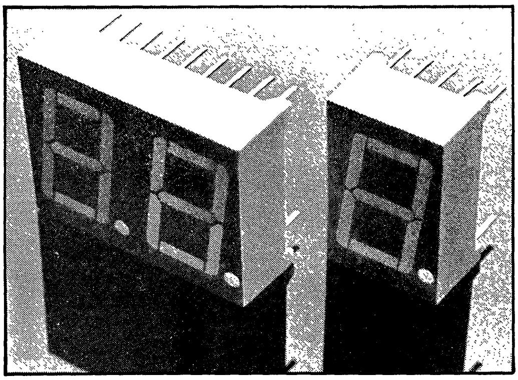
TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Φ_{JA} .... 300° C/W
Wavelength temperature coefficient (case temperature) .... 1.0 Å/° C
Forward voltage temperature coefficient .... -2.0 mV/° C

GENERAL INSTRUMENT

0.560-INCH SEVEN SEGMENT DISPLAYS

HIGH EFFICIENCY GREEN MAN6400 SERIES



DESCRIPTION

The MAN6400 Series is a family of large digits which includes double and single digits. The series features the sculptured font which minimizes "gappiness" at the segment intersections. All models have right hand decimal points and are available in common anode or common cathode configuration. This device has a Grey face and clear segment to enhance ON and OFF contrast.

FEATURES

- High Efficiency Green nitrogen-doped GaAsP on GaP
- Large, easy to read, digits
- Common anode or common cathode models
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Rugged plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 5)
- Wide angle viewing . . . 150°
- Low forward voltage
- Two-digit package simplifies alignment and assembly

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Digital clocks
- TV and radios

MODEL NUMBERS

PART NUMBER.	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN OUT SPECIFICATION
MAN6410	High Eff. Green	2 Digit; Common Anode; Rt. Hand Decimal	A	A
MAN6440	High Eff. Green	2 Digit; Common Cathode; Rt. Hand Decimal	A	B
MAN6460	High Eff. Green	Single Digit; Common Anode; Rt. Hand Decimal	B	C
MAN6480	High Eff. Green	Single Digit; Common Cathode; Rt. Hand Decimal	B	D

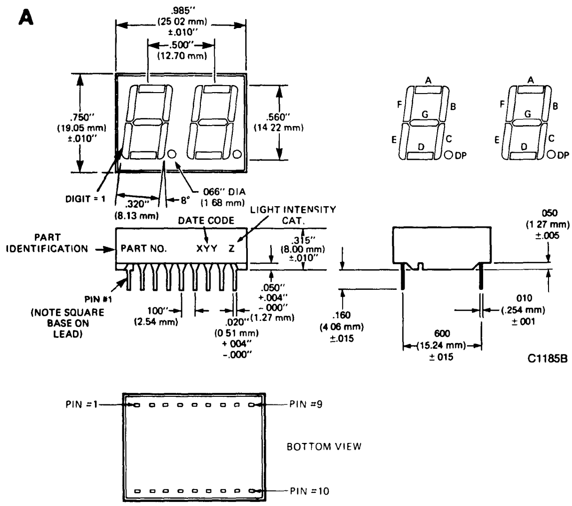
RECOMMENDED FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER
MAN6400 Series	Panelgraphic Green 48 Homalite 100-1440 Green Panelgraphic Grey 10 Homalite 100-1266 Grey

PACKAGE DIMENSIONS

A



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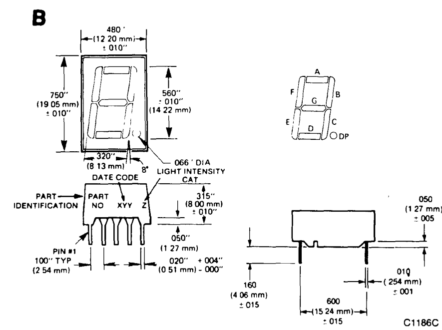
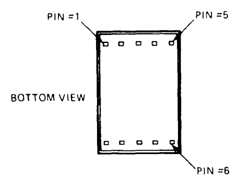




NOTE: When placing double digits and single digits together on a board, allowance should be made for .150" spacing between the end leads of the double digit and the end leads of the single digit.

PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS			
	A MAN6410	B MAN6440	C MAN6460	D MAN6480
1	Cathode E 1	Anode E 1	Cathode E	Anode E
2	Cathode D 1	Anode D 1	Cathode D	Anode D
3	Cathode C 1	Anode C 1	Common Anode	Common Cathode
4	Cathode D.P. 1	Anode D.P. 1	Cathode C	Anode C
5	Cathode E 2	Anode E 2	Cathode D.P.	Anode D.P.
6	Cathode D 2	Anode D 2	Cathode B	Anode B
7	Cathode G 2	Anode G 2	Cathode A	Anode A
8	Cathode C 2	Anode C 2	Common Anode	Common Cathode
9	Cathode D.P. 2	Anode D.P. 2	Cathode F	Anode F
10	Cathode B 2	Anode B 2	Cathode G	Anode G
11	Cathode A 2	Anode A 2		
12	Cathode F 2	Anode F 2		
13	Anode Digit 2	Cathode Digit 2		
14	Anode Digit 1	Cathode Digit 1		
15	Cathode B 1	Anode B 1		
16	Cathode A 1	Anode A 1		
17	Cathode G 1	Anode G 1		
18	Cathode F 1	Anode F 1		

TYPICAL CURVES

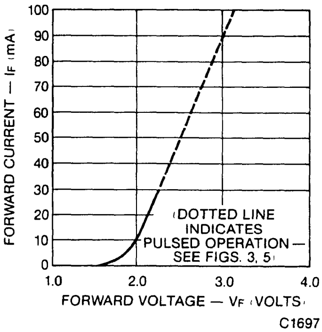


Fig. 1. Forward Current vs. Forward Voltage

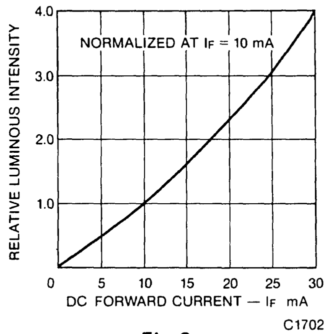


Fig. 2. Relative Luminous Intensity vs. DC Forward Current

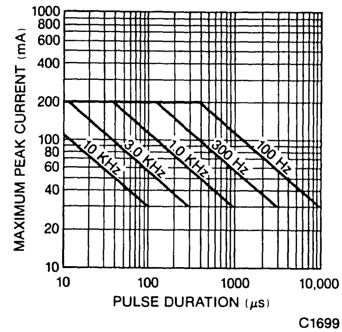


Fig. 3. Maximum Peak Current vs. Pulse Duration

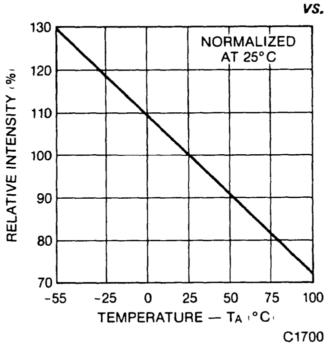


Fig. 4. Relative Luminous Intensity vs. Temperature

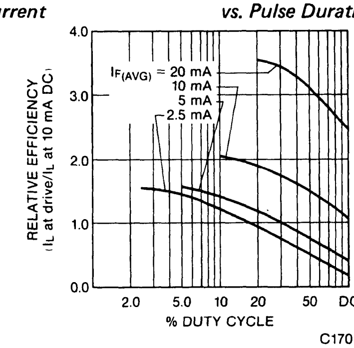
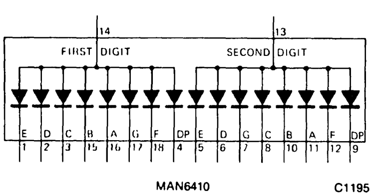
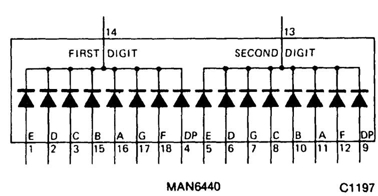
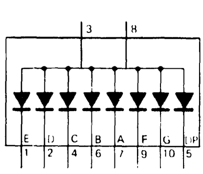


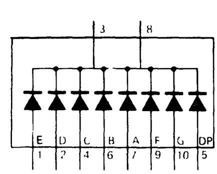
Fig. 5. Relative Efficiency vs. Duty Cycle

INTERNAL CONNECTIONS









ABSOLUTE MAXIMUM RATINGS

	MAN6410 MAN6440	MAN6460 MAN6480
Power dissipation at 25° C ambient	1140 mW	570 mW
Derate linearly from 50° C	-24 mW/° C	-12 mW/° C
Storage and operating temperature	-40° C to +85° C	-40° C to +85° C
Continuous forward current		
Total	480 mA	240 mA
Per diode	30 mA	30 mA
Reverse voltage		
Per diode	6.0 V	6.0 V
Soldering time at 260° C (See Notes 2 and 3)	5 sec.	5 sec.

ELECTRO-OPTICAL CHARACTERISTICS

(Per Diode at 25° C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity, digit average (See Notes 1 and 4)	510	2100		μcd	$I_F = 10$ mA
Pulsed Luminous Intensity, digit average	710	2900		μcd	$I_F = 60$ mA peak, 1:6 DF
Peak emission wavelength		562		nm	
Dominant wavelength		567		nm	
Spectral line half width		30		nm	
Forward voltage		2.2	3.0	V	$I_F = 20$ mA
Dynamic resistance (See Figure 1)		12		Ω	$I_F = 20$ mA
Light rise time		500		nsec	$I_F = 10$ mA
Capacitance		40		pF	V = 0, f = 1 MHz
Reverse current			100	μA	$V_R = 3.0$ V

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Φ_{JA}	160° C/W
Wavelength temperature coefficient (case temperature)	1.0 Å/° C
Forward voltage temperature coefficient	-1.4 mV/° C

NOTES

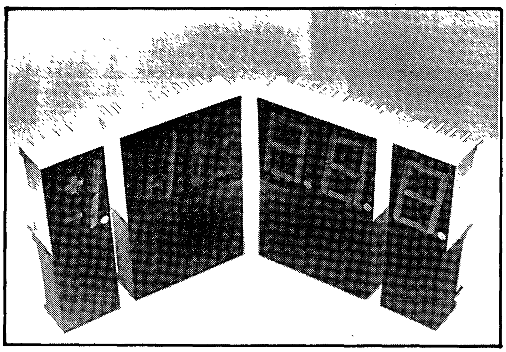
1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments as measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140° C.*
3. *For flux removal, Freon TF, Freon TE, Isoproponal or water may be used up to their boiling points.*
4. *Intensity adjusted for smaller areas of the "+" and decimal points*
5. *All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.*

GENERAL INSTRUMENT

0.560-INCH HIGH PERFORMANCE DISPLAYS

ORANGE MAN6600 SERIES

Displays



DESCRIPTION

The MAN6600 Series is a family of large digits which includes double and single digits. The series features the sculptured font which minimizes "gappiness" at the segment intersections. Available models include two-digit, one and one-half digits with polarity sign, single digits, and single polarity/overflow digits. All models have right hand decimal points and are available in common anode or common cathode configuration. Units are constructed with Orange face and segment color.

FEATURES

- High performance nitrogen-doped GaAsP on GaP
- Large, easy to read, digits
- Common anode or common cathode models
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Rugged plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 6)
- Wide angle viewing . . . 150°
- Low forward voltage
- Two-digit package simplifies alignment and assembly

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Digital clocks
- TV and radios

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN OUT SPECIFICATION
MAN6610	Orange	2 Digit; Common Anode; Rt. Hand Decimal	A	A
MAN6630	Orange	1½ Digit; Common Anode; Overflow ±1.8; Rt. Hand Decimal	B	B
MAN6640	Orange	2 Digit; Common Cathode; Rt. Hand Decimal	A	C
MAN6650	Orange	1½ Digit; Common Cathode; Overflow ±1.8; Rt. Hand Decimal	B	D
MAN6660	Orange	Single Digit; Common Anode; Rt. Hand Decimal	C	E
MAN6675	Orange	Single Digit; Common Anode; Overflow ±1.0; Rt. Hand Decimal	D	G
MAN6680	Orange	Single Digit; Common Cathode; Rt. Hand Decimal	C	F
MAN6695	Orange	Single Digit; Common Cathode; Overflow ±1.0; Rt. Hand Decimal	D	H

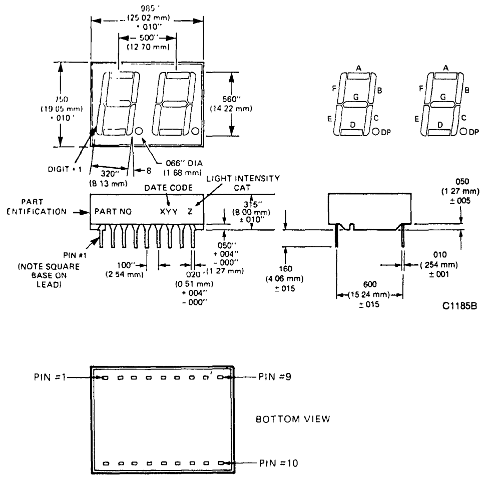
RECOMMENDED FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER
MAN6600 Series	Panelgraphic Scarlet 65 Homalite 100-1670

PACKAGE DIMENSIONS

A



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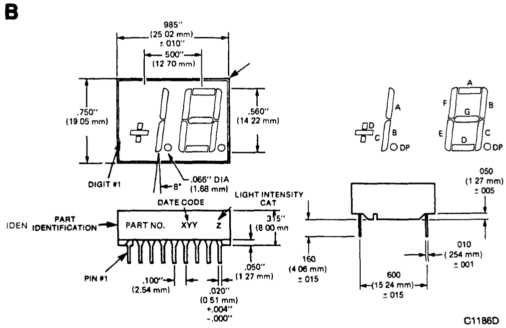
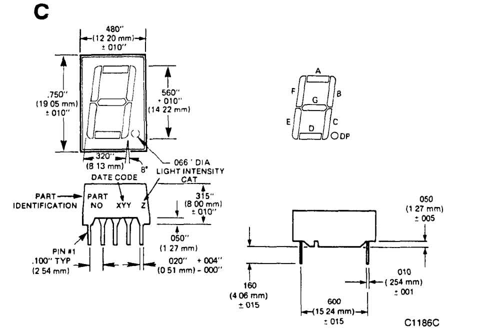
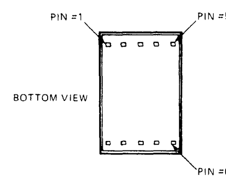


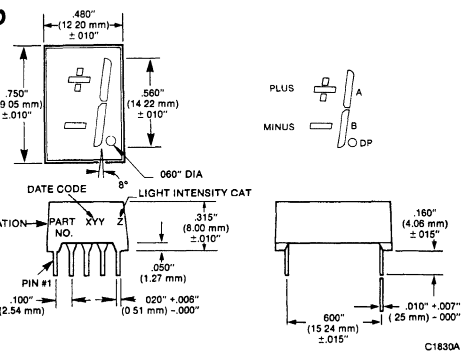
C





NOTE: When placing double digits and single digits together on a board, allowance should be made for .150" spacing between the end leads of the double digit and the end leads of the single digit.

D



PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS							
	A MAN6610	B MAN6630	C MAN6640	D MAN6650	E MAN6660	F MAN6680	G MAN6675	H MAN6695
1	E Cath. (#1)	C Cath. (#1)	E An. (#1)	C An. (#1)	E Cath.	E An.	Minus Cath.	Minus An.
2	D Cath. (#1)	D Cath (#1)	D An. (#1)	D An. (#1)	D Cath.	D An.	Com. An. +/-	Com. Cath. +/-
3	C Cath. (#1)	B Cath. (#1)	C An. (#1)	B An. (#1)	Com. An.	Com. Cath.	Seg. B Cath.	Seg. B An.
4	DP Cath. (#1)	DP Cath. (#1)	DP An. (#1)	DP An. (#1)	C Cath.	C An.	Com. An. A, B, DP	Com. Cath. A, B, DP
5	E Cath. (#2)	E Cath. (#2)	E An. (#2)	E An. (#2)	DP Cath.	DP An.	DP Cath.	DP An.
6	D Cath. (#2)	D Cath. (#2)	D An. (#2)	D An. (#2)	B Cath.	B An.	Seg. A Cath.	Seg. A An.
7	G Cath. (#2)	G Cath. (#2)	G An. (#2)	G An. (#2)	A Cath.	A An.	Com. An. A, B, DP	Com. Cath. A, B, DP
8	C Cath. (#2)	C Cath. (#2)	C An. (#2)	C An. (#2)	Com. An.	Com. Cath.	Com. An. +/-	Com. Cath. +/-
9	DP Cath. (#2)	DP Cath. (#2)	DP An. (#2)	DP An. (#2)	F Cath.	F An.	Plus Cath.	Plus An.
10	B Cath. (#2)	B Cath. (#2)	B An. (#2)	B An. (#2)	G Cath.	G An.	N.C.	N.C.
11	A Cath. (#2)	A Cath. (#2)	A An. (#2)	A An. (#2)				
12	F Cath. (#2)	F Cath. (#2)	F An. (#2)	F An. (#2)				
13	Digit #2 An.	Digit #2 An.	Digit #2 Cath.	Digit #2 Cath.				
14	Digit #1 An.	Digit #1 An.	Digit #1 Cath.	Digit #1 Cath.				
15	B Cath. (#1)	A Cath. (#1)	B An. (#1)	A An. (#1)				
16	A Cath. (#1)	N.C.	A An. (#1)	N.C.				
17	G Cath. (#1)	N.C.	G An. (#1)	N.C.				
18	F Cath. (#1)	N.C.	F An. (#1)	N.C.				

TYPICAL CURVES

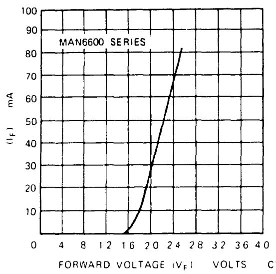


Fig. 1. Forward Current vs. Forward Voltage

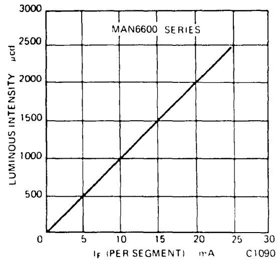


Fig. 2. Luminous Intensity vs. Forward Current

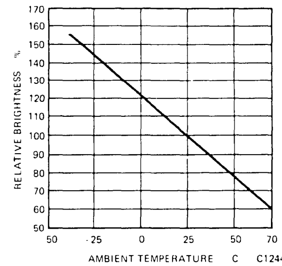


Fig. 3. Luminous Intensity vs. Temperature (see Note 2)

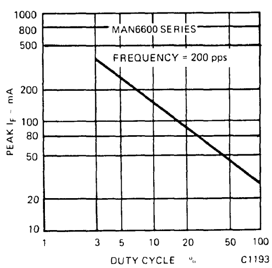


Fig. 4. Max Peak Current vs. Duty Cycle

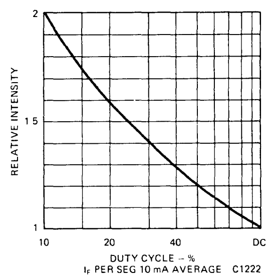
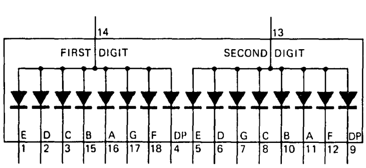
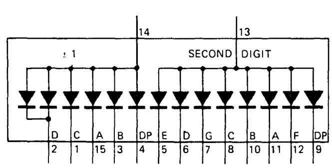


Fig. 5. Luminous Intensity vs. Duty Cycle

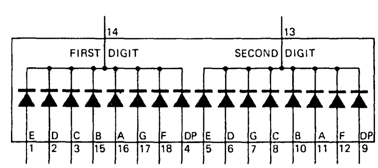
INTERNAL CONNECTIONS



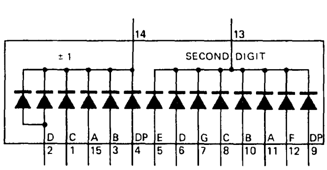
MAN6610 C1195



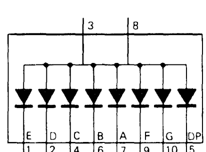
MAN6630 C1196



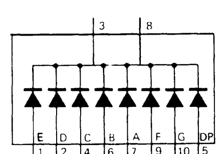
MAN6640 C1197



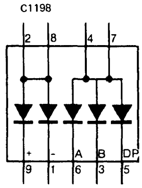
MAN6650 C1198



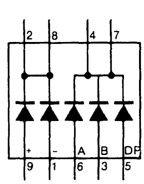
MAN6660 C1238



MAN6680 C1239



MAN6675 C1828



MAN6695 C1829

ABSOLUTE MAXIMUM RATINGS

	MAN6610 MAN6640	MAN6630 MAN6650	MAN6660 MAN6680	MAN6675 MAN6695
Power dissipation at 25° C ambient	1200 mW	1050 mW	600 mW	375 mW
Derate linearly from 50° C	-17.1 mW/° C	-15.0 mW/° C	-8.6 mW/° C	-5.4 mW/° C
Storage and operating temperature	-40° C to +85° C	-40° C to +85° C	-40° C to +85° C	-40° C to +85° C
Continuous forward current				
Total	480 mA	420 mA	240 mA	150 mA
Per segment	30 mA	30 mA	30 mA	30 mA
Decimal point	30 mA	30 mA	30 mA	30 mA
Reverse voltage				
Per segment	6.0 V	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V	6.0 V
Soldering time at 260° C (See Notes 4 and 5)	5 sec.	5 sec.	5 sec.	5 sec.

ELECTRO-OPTICAL CHARACTERISTICS

(Per Diode at 25° C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity, digit average (See Note 1)	510	1600		μcd	$I_F = 10$ mA
Decimal point, "+" or "-" (See Note 5)	200	510		μcd	$I_F = 10$ mA
Peak emission wavelength		630		nm	
Spectral line half width		40		nm	
Forward voltage					
Segment			2.5	V	$I_F = 20$ mA
Decimal point			2.5	V	$I_F = 20$ mA
Dynamic resistance					
Segment		26		Ω	$I_F = 20$ mA
Decimal point		26		Ω	$I_F = 20$ mA
Capacitance					
Segment		35		pF	V = 0
Decimal point		35		pF	V = 0
Reverse current					
Segment			100	μA	$V_R = 3.0$ V
Decimal point			100	μA	$V_R = 3.0$ V
Ratio I_L			2:1	—	$I_F = 10$ mA

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Φ_{JA} .... 160° C/W
Wavelength temperature coefficient (case temperature) .... 1.0 Å/° C
Forward voltage temperature coefficient .... -2.0 mV/° C

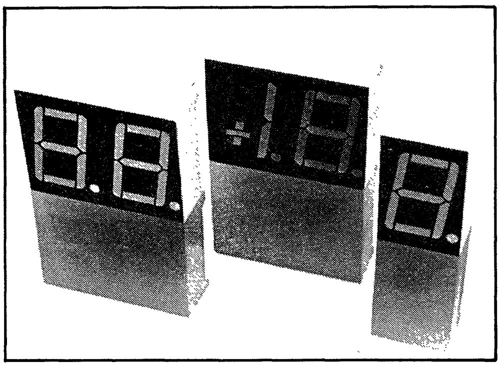
NOTES

1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments as measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *The curve in Figure 3 is normalized to the brightness at 25° C to indicate the relative efficiency over the operating temperature range.*
3. *Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140° C.*
4. *For flux removal, Freon TF, Freon TE, Isoproponal or water may be used up to their boiling points.*
5. *Intensity adjusted for smaller areas of the "+" and decimal points.*
6. *All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.*

GENERAL INSTRUMENT

0.560-INCH HIGH PERFORMANCE DISPLAY

RED MAN6700 SERIES



DESCRIPTION

The MAN6700 Series is a family of large digits which includes double and single digits. The series features the sculptured font which minimizes "gappiness" at the segment intersections. Available models include two-digit, one and one-half digits with polarity sign, and single digits. All models have right hand decimal points and are available in common anode or common cathode configuration. Units are constructed with Black face and Red segment color.

FEATURES

- High performance GaAsP
- Large, easy to read, digits
- Common anode or common cathode models
- Also available in Orange (MAN6600 Series)
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Rugged plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 7)
- Wide angle viewing . . . 150°
- Standard double-dip lead configuration
- Low forward voltage
- Two-digit package simplifies alignment and assembly

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Digital clocks
- TV and radios

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN OUT SPECIFICATION
MAN6710	Red	2 Digit; Common Anode; Rt. Hand Decimal	A	A
MAN6730	Red	1½ Digit; Common Anode; Overflow ±1.8; Rt. Hand Decimal	B	B
MAN6740	Red	2 Digit; Common Cathode; Rt. Hand Decimal	A	C
MAN6750	Red	1½ Digit; Common Cathode; Overflow ±1.8; Rt. Hand Decimal	B	D
MAN6760	Red	Single Digit; Common Anode; Rt. Hand Decimal	C	E
MAN6780	Red	Single Digit; Common Cathode; Rt. Hand Decimal	C	F

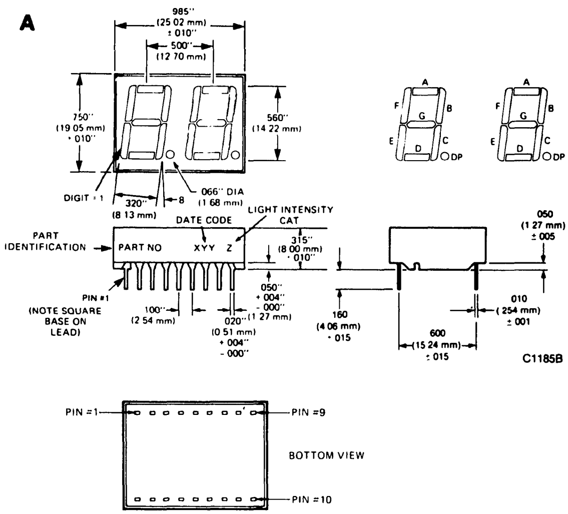
RECOMMENDED FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

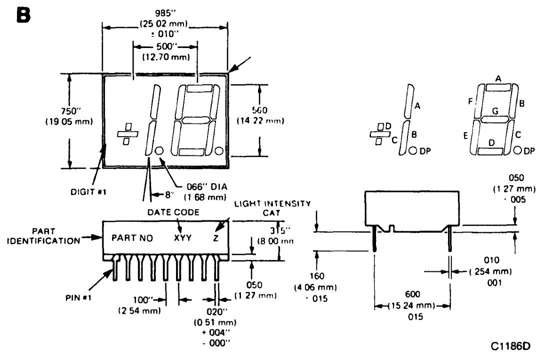
DEVICE TYPE	FILTER
MAN6700 Series	Panelgraphic Red 60 Homalite 100-1605

PACKAGE DIMENSIONS

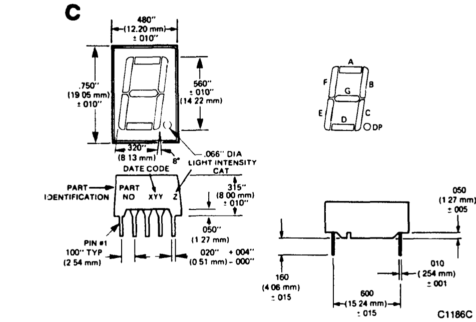
A

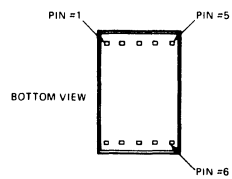


B



C





NOTE: When placing double digits and single digits together on a board, allowance should be made for .150" spacing between the end leads of the double digit and the end leads of the single digit.

PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS					
	A MAN6710	B MAN6730	C MAN6740	D MAN6750	E MAN6760	F MAN6780
1	Cathode E 1	Cathode C 1	Anode E 1	Anode C 1	Cathode E	Anode E
2	Cathode D 1	Cathode D 1	Anode D 1	Anode D 1	Cathode D	Anode D
3	Cathode C 1	Cathode B 1	Anode C 1	Anode B 1	Com. Anode	Com. Cathode
4	Cathode D.P. 1	Cathode D.P. 1	Anode D.P. 1	Anode D.P. 1	Cathode C	Anode C
5	Cathode E 2	Cathode E 2	Anode E 2	Anode E 2	Cathode D.P.	Anode D.P.
6	Cathode D 2	Cathode D 2	Anode D 2	Anode D 2	Cathode B	Anode B
7	Cathode G 2	Cathode G 2	Anode G 2	Anode G 2	Cathode A	Anode A
8	Cathode C 2	Cathode C 2	Anode C 2	Anode C 2	Com. Anode	Com. Cathode
9	Cathode D.P. 2	Cathode D.P. 2	Anode D.P. 2	Anode D.P. 2	Cathode F	Anode F
10	Cathode B 2	Cathode B 2	Anode B 2	Anode B 2	Cathode G	Anode G
11	Cathode A 2	Cathode A 2	Anode A 2	Anode A 2		
12	Cathode F 2	Cathode F 2	Anode F 2	Anode F 2		
13	Anode Digit 2	Anode Digit 2	Cathode Digit 2	Cathode Digit 2		
14	Anode Digit 1	Anode Digit 1	Cathode Digit 1	Cathode Digit 1		
15	Cathode B 1	Cathode A 1	Anode B 1	Anode A 1		
16	Cathode A 1	No Connection	Anode A 1	No Connection		
17	Cathode G 1	No Connection	Anode G 1	No Connection		
18	Cathode F 1	No Connection	Anode F 1	No Connection		

TYPICAL CURVES

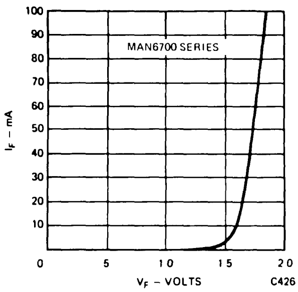


Fig. 1. Forward Current vs. Forward Voltage

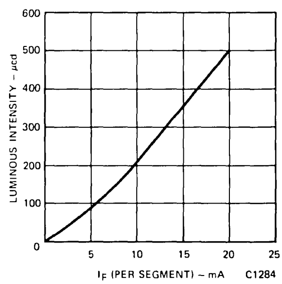


Fig. 2. Luminous Intensity vs. Forward Current

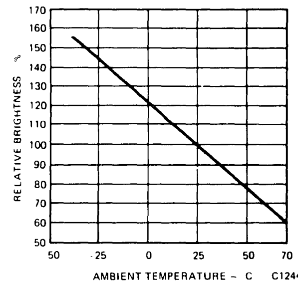


Fig. 3. Luminous Intensity vs. Temperature (See Note 2)

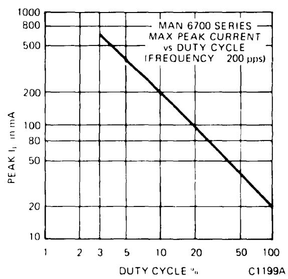


Fig. 4. Max Peak Current vs. Duty Cycle

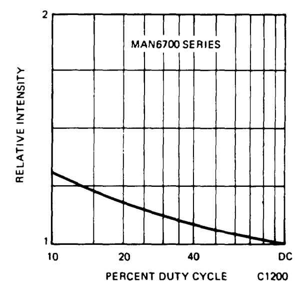
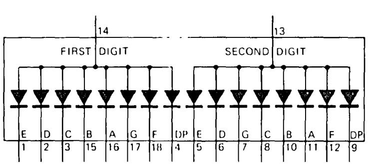
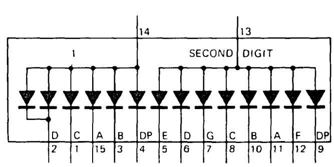


Fig. 5. Luminous Intensity vs. Duty Cycle

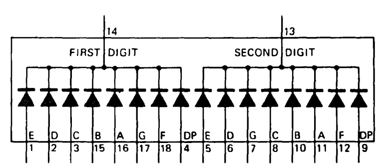
INTERNAL CONNECTIONS



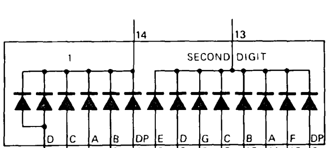
MAN6710 C1195



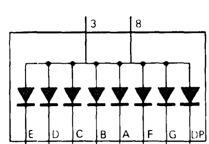
MAN6730 C1196



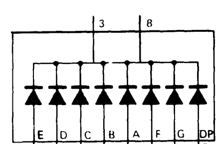
MAN6740 C1197



MAN6750 C1198



MAN6760 C1238



MAN6780 C1239

ABSOLUTE MAXIMUM RATINGS

	MAN6710 MAN6740	MAN6730 MAN6750	MAN6760 MAN6780
Power dissipation at 25° C ambient	960 mW	840 mW	480 mW
Derate linearly from 25° C	-13.7 mW/° C	-12.0 mW/° C	-6.9 mW/° C
Storage and operating temperature	-40° C to +85° C	-40° C to +85° C	-40° C to +85° C
Continuous forward current			
Total	480 mA	420 mA	240 mA
Per segment	30 mA	30 mA	30 mA
Decimal point	30 mA	30 mA	30 mA
Reverse voltage			
Per segment	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V
Soldering time at 260° C (See Notes 4 and 5)	5 sec.	5 sec.	5 sec.

ELECTRO-OPTICAL CHARACTERISTICS

(Per Diode at 25° C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity, digit average (See Note 1)	125	350		μcd	$I_F = 10$ mA
Decimal point, "+" or "–" (See Note 5)	55	150		μcd	$I_F = 10$ mA
Peak emission wavelength		650		nm	
Spectral line half width		20		nm	
Forward voltage					
Segment			2.0	V	$I_F = 20$ mA
Decimal point			2.0	V	$I_F = 20$ mA
Dynamic resistance					
Segment		2		Ω	$I_F = 20$ mA
Decimal point		2		Ω	$I_F = 20$ mA
Capacitance					
Segment		35		pF	V = 0
Decimal point		35		pF	V = 0
Reverse current					
Segment			100	μA	$V_R = 5.0$ V
Decimal point			100	μA	$V_R = 5.0$ V
Segment C or D of "+" (6730/6750)			100	μA	$V_R = 5.0$ V

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Φ_{JA}	160° C/W
Wavelength temperature coefficient (case temperature)	3.0 Å/° C
Forward voltage temperature coefficient	-2.0 mV/° C

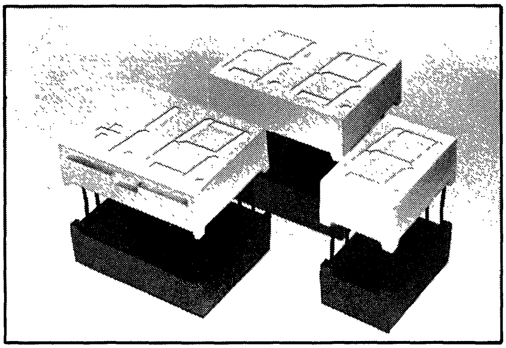
NOTES

1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments as measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *The curve in Figure 3 is normalized to the brightness at 25° C to indicate the relative efficiency over the operating temperature range.*
3. *Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140° C.*
4. *For flux removal, Freon TF, Freon TE, Isoproponal or water may be used up to their boiling points.*
5. *Intensity adjusted for smaller areas of the "+/–" and decimal points.*
6. *Pins 3 and 8 on MAN6760 and MAN6780 are redundant anodes or cathodes.*
7. *All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.*

GENERAL INSTRUMENT

0.560-INCH SEVEN SEGMENT DISPLAYS

HIGH EFFICIENCY RED MAN6900 SERIES



DESCRIPTION

The MAN6900 Series is a family of large digits which includes double and single digits. The series features the sculptured font which minimizes "gappiness" at the segment intersections. Available models include two-digit, one and one-half digits with polarity sign, and single digits. All models have right hand decimal points and are available in common anode or common cathode configuration. This device has a Red face and Red segments.

FEATURES

- High Efficiency Red nitrogen-doped GaAsP on GaP
- Large, easy to read, digits
- Common anode or common cathode models
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Rugged plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 6)
- Wide angle viewing . . . 150°
- Low forward voltage
- Two-digit package simplifies alignment and assembly

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Digital clocks
- TV and radios

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN OUT SPECIFICATION
MAN6910	High Eff. Red	2 Digit; Common Anode; Rt. Hand Decimal	A	A
MAN6930	High Eff. Red	1½ Digit; Common Anode; Overflow ±1.8; Rt. Hand Decimal	B	B
MAN6940	High Eff. Red	2 Digit; Common Cathode; Rt. Hand Decimal	A	C
MAN6950	High Eff. Red	1½ Digit; Common Cathode; Overflow ±1.8; Rt. Hand Decimal	B	D
MAN6960	High Eff. Red	Single Digit; Common Anode; Rt. Hand Decimal	C	E
MAN6980	High Eff. Red	Single Digit; Common Cathode; Rt. Hand Decimal	C	F

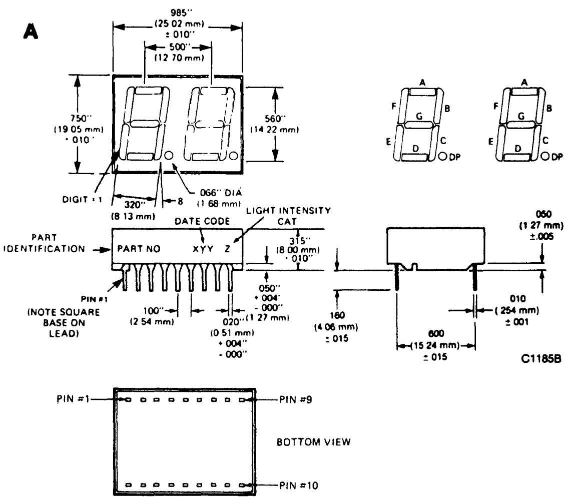
RECOMMENDED FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

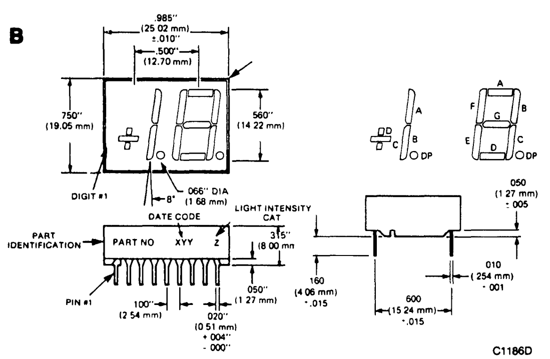
DEVICE TYPE	FILTER
MAN6900 Series	Panelgraphic Scarlet 65 Homalite 100-1670

PACKAGE DIMENSIONS

A



B



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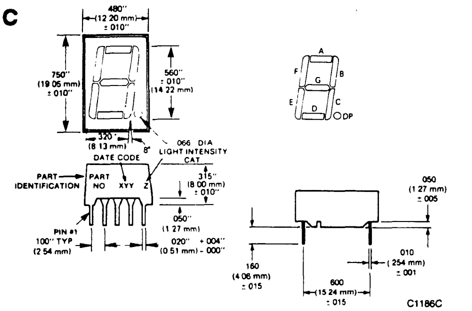
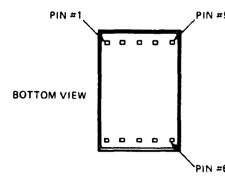




NOTE: When placing double digits and single digits together on a board, allowance should be made for .150" spacing between the end leads of the double digit and the end leads of the single digit.

PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS					
	A MAN6910	B MAN6930	C MAN6940	D MAN6950	E MAN6960	F MAN6980
1	Cathode E 1	Cathode C 1	Anode E 1	Anode C 1	Cathode E	Anode E
2	Cathode D 1	Cathode D 1	Anode D 1	Anode D 1	Cathode D	Anode D
3	Cathode C 1	Cathode B 1	Anode C 1	Anode B 1	Com. Anode	Com. Cathode
4	Cathode D.P. 1	Cathode D.P. 1	Anode D.P. 1	Anode D.P. 1	Cathode C	Anode C
5	Cathode E 2	Cathode E 2	Anode E 2	Anode E 2	Cathode D.P.	Anode D.P.
6	Cathode D 2	Cathode D 2	Anode D 2	Anode D 2	Cathode B	Anode B
7	Cathode G 2	Cathode G 2	Anode G 2	Anode G 2	Cathode A	Anode A
8	Cathode C 2	Cathode C 2	Anode C 2	Anode C 2	Com. Anode	Com. Cathode
9	Cathode D.P. 2	Cathode D.P. 2	Anode D.P. 2	Anode D.P. 2	Cathode F	Anode F
10	Cathode B 2	Cathode B 2	Anode B 2	Anode B 2	Cathode G	Anode G
11	Cathode A 2	Cathode A 2	Anode A 2	Anode A 2		
12	Cathode F 2	Cathode F 2	Anode F 2	Anode F 2		
13	Anode Digit 2	Anode Digit 2	Cathode Digit 2	Cathode Digit 2		
14	Anode Digit 1	Anode Digit 1	Cathode Digit 1	Cathode Digit 1		
15	Cathode B 1	Cathode A 1	Anode B 1	Anode A 1		
16	Cathode A 1	No Connection	Anode A 1	No Connection		
17	Cathode G 1	No Connection	Anode G 1	No Connection		
18	Cathode F 1	No Connection	Anode F 1	No Connection		

TYPICAL CURVES

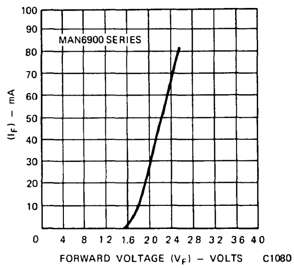


Fig. 1. Forward Current vs. Forward Voltage

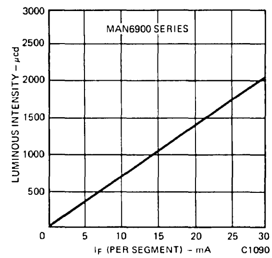


Fig. 2. Luminous Intensity vs. Forward Current

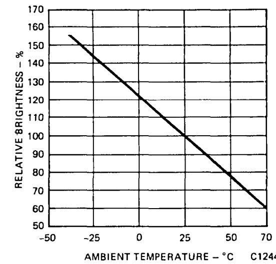


Fig. 3. Luminous Intensity vs. Temperature (See Note 2)

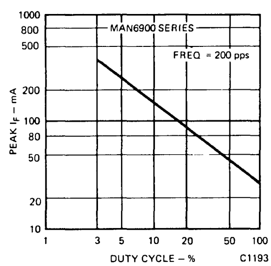


Fig. 4. Max Peak Current vs. Duty Cycle

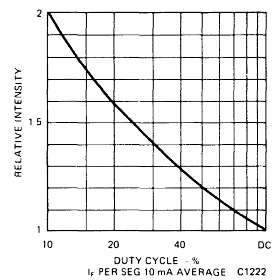
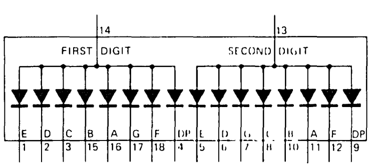


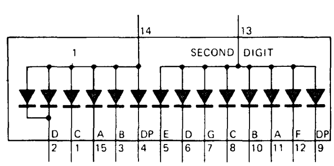
Fig. 5. Luminous Intensity vs. Duty Cycle

Displays

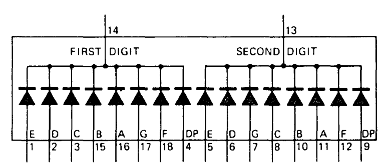
INTERNAL CONNECTIONS



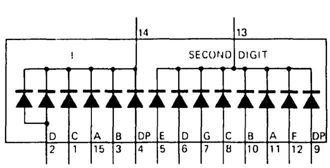
MAN6910 C1195



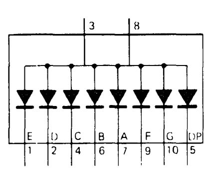
MAN6930 C1196



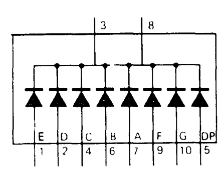
MAN6940 C1197



MAN6950 C1198



MAN6960 C1238



MAN6980 C1239

ABSOLUTE MAXIMUM RATINGS

	MAN6910 MAN6940	MAN6930 MAN6950	MAN6960 MAN6980
Power dissipation at 25° C ambient	1200 mW	1050 mW	600 mW
Derate linearly from 50° C	-17.1 mW/° C	-15.0 mW/° C	-8.6 mW/° C
Storage and operating temperature	-40° C to +85° C	-40° C to +85° C	-40° C to +85° C
Continuous forward current			
Total	480 mA	420 mA	240 mA
Per segment	30 mA	30 mA	30 mA
Decimal point	30 mA	30 mA	30 mA
Reverse voltage			
Per segment	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V
Soldering time at 260° C (See Notes 4 and 5)	5 sec.	5 sec.	5 sec.

ELECTRO-OPTICAL CHARACTERISTICS

(Per Diode at 25° C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity, digit average (See Note 1)	320	1600		μcd	$I_F = 10$ mA
Decimal point (See Note 5)	125			μcd	$I_F = 10$ mA
Segment of "+" or "–" (6930/6950)	125			μcd	$I_F = 10$ mA
Peak emission wavelength		635		nm	
Spectral line half width		40		nm	
Forward voltage					
Segment			2.5	V	$I_F = 20$ mA
Decimal point			2.5	V	$I_F = 20$ mA
Dynamic resistance					
Segment		26		Ω	$I_F = 20$ mA
Decimal point		26		Ω	$I_F = 20$ mA
Capacitance					
Segment		35		pF	$V = 0$
Decimal point		35		pF	$V = 0$
Reverse current					
Segment			100	μA	$V_R = 5.0$ V
Decimal point			100	μA	$V_R = 5.0$ V

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Φ_{JA}	160° C/W
Wavelength temperature coefficient (case temperature)	1.0 Å/° C
Forward voltage temperature coefficient	-2.0 mV/° C

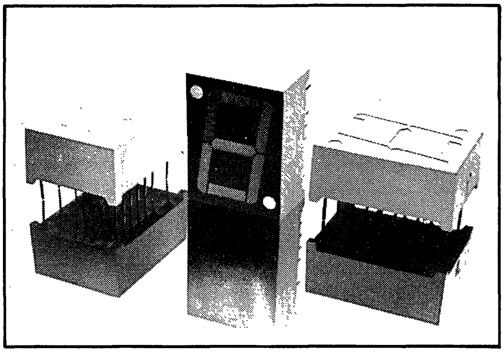
NOTES

1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments as measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *The curve in Figure 3 is normalized to the brightness at 25° C to indicate the relative efficiency over the operating temperature range.*
3. *Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140° C.*
4. *For flux removal, Freon TF, Freon TE, Isoproponal or water may be used up to their boiling points.*
5. *Intensity adjusted for smaller areas of the "+" and decimal points.*
6. *All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.*

GENERAL INSTRUMENT

0.800-INCH SEVEN SEGMENT HIGH PERFORMANCE DISPLAYS

HIGH EFFICIENCY GREEN MAN8400 SERIES



DESCRIPTION

The MAN8400 Series is a family of large digits 0.8-inchs in height. This series combines high brightness, large size, good aesthetics and is designed to be used where accurate readable displays need to be viewed over a distance. All models use right hand decimal points. The display ON and OFF contrast has been optimized for high ambient light conditions by use of a neutral Grey face and diffused White segments. Construction makes use of a metal leadframe, plastic reflector cap with epoxy-filled segments and back.

FEATURES

- High Efficiency Green nitrogen-doped GaAsP on GaP
- Large, easy to read, digits
- Common anode or common cathode models
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Rugged plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 5)
- Wide angle viewing . . . 150°
- Low forward voltage
- Two-digit package simplifies alignment and assembly

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Digital clocks
- TV and radios

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION	PACKAGE DRAWING
MAN8410	High Efficiency Green	Common Anode; Right Hand Decimal	1
MAN8440	High Efficiency Green	Common Cathode; Right Hand Decimal	1

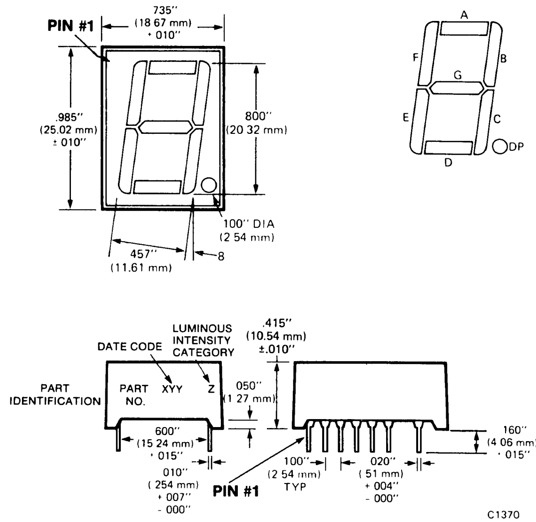
RECOMMENDED FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER
MAN8400 Series	Panelgraphic Green 48 Homalite 100-1440 Green Panelgraphic Grey 10 Homalite 100-1266 Grey

PACKAGE DIMENSIONS

1



PIN CONNECTIONS

ELECTRICAL CONNECTIONS		
	MAN8410	**MAN8440**
	Digit	Digit
	Common Anode	Common Cathode
PIN #	Package Dimensions	Package Dimensions
1	No Connection	No Connection
2	A Cathode	A Anode
3	F Cathode	F Anode
4	Common Anode	Common Cathode
5	E Cathode	E Anode
6	—	—
7	E Cathode	E Anode
8	—	—
9	D Cathode	Common Cathode
10	DP Cathode	DP Anode
11	D Cathode	D Anode
12	Common Anode	Common Cathode
13	C Cathode	C Anode
14	G Cathode	G Anode
15	B Cathode	B Anode
16	—	—
17	Common Anode	Common Anode
18	—	—

TYPICAL CURVES

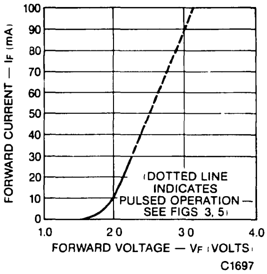


Fig. 1. Forward Current vs. Forward Voltage

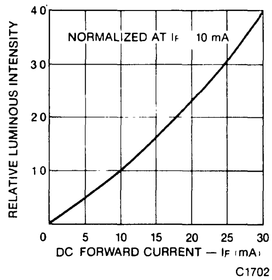


Fig. 2. Relative Luminous Intensity vs. DC Forward Current

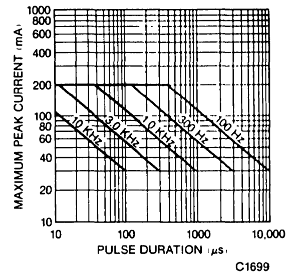


Fig. 3. Maximum Peak Current vs. Pulse Duration

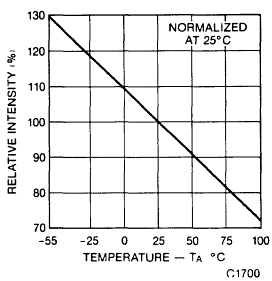


Fig. 4. Relative Luminous Intensity vs. Temperature

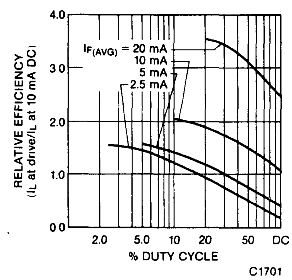
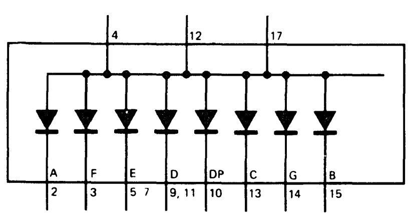
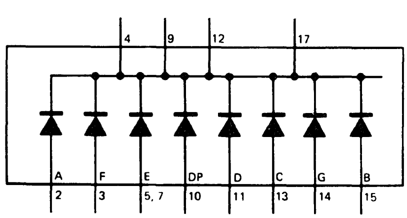


Fig. 5. Relative Efficiency vs. Duty Cycle

INTERNAL CONNECTIONS



MAN8410



MAN8440

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° C ambient .... 600 mW
Derate linearly from 50° C .... -12 mW/° C
Storage and operating temperature .... -40° C to +85° C
Continuous forward current
  Total .... 240 mA
  Per segment .... 30 mA
  Decimal point .... 30 mA
Reverse voltage
  Per segment .... 6.0 V
  Decimal point .... 6.0 V
Soldering time at 260° C (See Notes 3 and 4) .... 5 sec.

ELECTRO-OPTICAL CHARACTERISTICS

(Per Diode at 25° C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity, digit average (See Notes 1 and 4)	510	2000		μcd	$I_F = 10$ mA
Pulsed Luminous Intensity, digit average	710	2700		μcd	$I_F = 60$ mA peak 1:6 DF
Peak emission wavelength		562		nm	
Dominant wavelength		567		nm	
Spectral line half width		30		nm	
Forward voltage		2.2	3.0	V	$I_F = 20$ mA
Dynamic resistance (See Figure 1)		12		Ω	$I_F = 20$ mA
Light rise time		500		nsec	$I_F = 10$ mA
Capacitance		40		pF	V = 0, f = MHz
Reverse current			100	μA	$V_R = 3.0$ V

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Φ_{JA} .... 160° C/W
Wavelength temperature coefficient (case temperature) .... 1.0 Å/° C
Forward voltage temperature coefficient .... -1.4 mV/° C

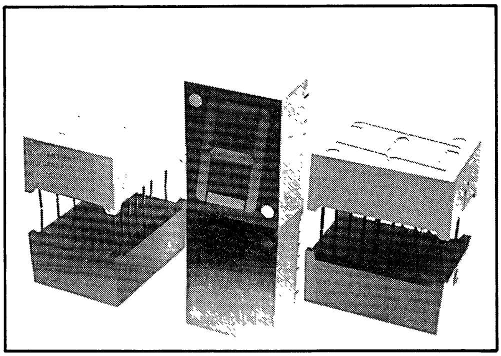
NOTES

1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments as measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140° C.*
3. *For flux removal, Freon TF, Freon TE, Isoproponal or water may be used up to their boiling points.*
4. *Intensity adjusted for smaller areas of the "+" and decimal points.*
5. *All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.*

GENERAL INSTRUMENT

0.800-INCH HIGH PERFORMANCE DISPLAYS

HIGH EFFICIENCY RED (ORANGE) MAN8600 SERIES



DESCRIPTION

The MAN8600 Series is a family of large digits 0.8-inches in height. This series combines high brightness, large size, good aesthetics and is designed to be used where accurate readable displays need to be viewed over a distance. All models use right hand decimal points. Units are constructed with Grey face and neutral segment color.

FEATURES

- High performance nitrogen-doped GaAsP on GaP
- Large, easy to read, digits
- Common anode or common cathode models
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Rugged plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 6)
- Wide angle viewing . . . 150°
- Low forward voltage
- Grey face for use in high ambient light conditions

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Digital clocks
- TV and radios

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION	PACKAGE DRAWING
MAN8610	High Efficiency Red (Orange)	Common Anode; Right Hand Decimal	1
MAN8640	High Efficiency Red (Orange)	Common Cathode; Right Hand Decimal	1

RECOMMENDED FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

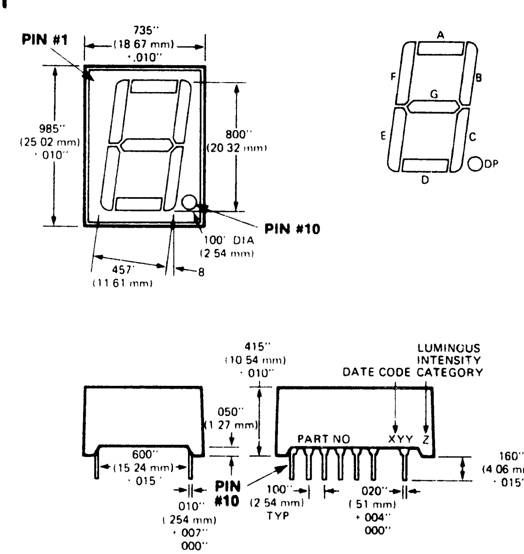
Panelgraphic Scarlet 65
Homalite 100-1670

In situations of high ambient light, contrast with the Grey face can be enhanced by using a neutral density filter. The following or an equivalent can be used:

Panelgraphic Grey 10

PACKAGE DIMENSIONS

1



C1370

PIN CONNECTIONS

ELECTRICAL CONNECTIONS		
	MAN8610	MAN8640
	Digit	Digit
	Common Anode	Common Cathode
PIN #	Package Dimensions	Package Dimensions
1	No Connection	No Connection
2	A Cathode	A Anode
3	F Cathode	F Anode
4	Common Anode	Common Cathode
5	E Cathode	E Anode
6	—	—
7	E Cathode	E Anode
8	—	—
9	D Cathode	Common Cathode
10	DP Cathode	DP Anode
11	D Cathode	D Anode
12	Common Anode	Common Cathode
13	C Cathode	C Anode
14	G Cathode	G Anode
15	B Cathode	B Anode
16	—	—
17	Common Anode	Common Anode
18	—	—

TYPICAL CURVES

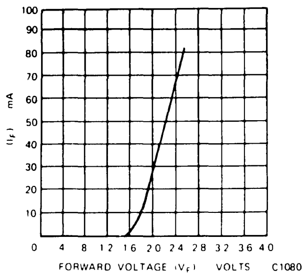


Fig. 1. Forward Current vs. Forward Voltage

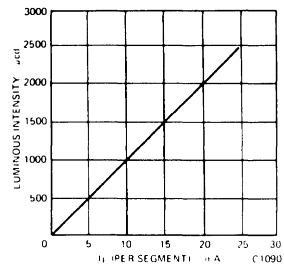


Fig. 2. Luminous Intensity vs. Forward Current

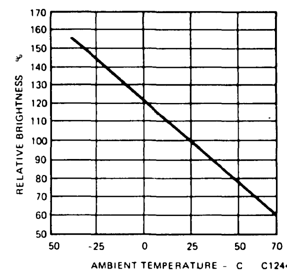


Fig. 3. Luminous Intensity vs. Temperature (See Note 2)

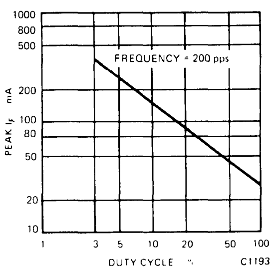


Fig. 4. Max Peak Current vs. Duty Cycle

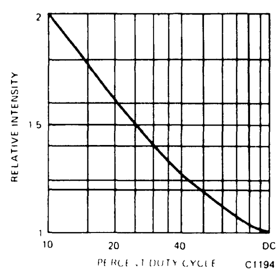


Fig. 5. Luminous Intensity vs. Duty Cycle

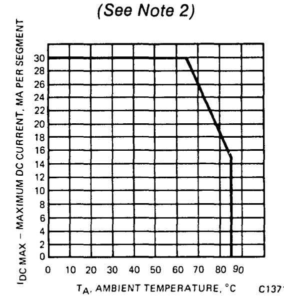
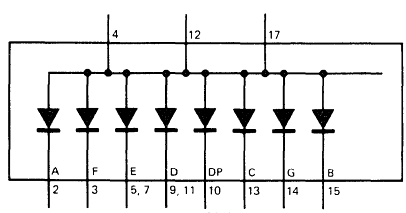
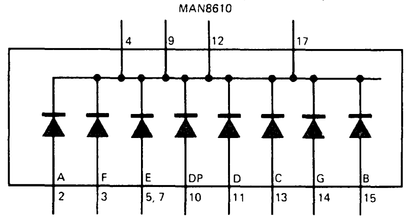


Fig. 6. Maximum DC Current vs. Temperature

INTERNAL CONNECTIONS



MAN8610



MAN8640

Displays

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° C ambient	600 mW
Derate linearly from 50° C	-8.6 mW/° C
Storage and operating temperature	-40° C to +85° C
Continuous forward current	
Total	240 mA
Per segment	30 mA
Decimal point	30 mA
Reverse voltage	
Per segment	6.0 V
Decimal point	6.0 V
Soldering time at 260° C (See Note 4)	5 sec.
Peak forward current per segment (I_{max}) (See Figure 4)	—

ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity, digit average (See Notes 1 and 6)	600	1600		μcd	$I_F = 10$ mA
Decimal point (See Note 5)	240	600		μcd	$I_F = 10$ mA
Peak emission wavelength		630		nm	
Spectral line half width		40		nm	
Forward voltage					
Segment			2.5	V	$I_F = 20$ mA
Decimal point			2.5	V	$I_F = 20$ mA
Dynamic resistance					
Segment		26		Ω	$I_F = 20$ mA
Decimal point		26		Ω	$I_F = 20$ mA
Capacitance					
Segment		35		pF	$V = 0$
Decimal point		35		pF	$V = 0$
Reverse current					
Segment			100	μA	$V_R = 3.0$ V
Decimal point			100	μA	$V_R = 3.0$ V
Luminous Intensity Ratio I_L (segment-to-segment)			2:1	—	$I_F = 10$ mA

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Φ_{JA}	160° C/W
Wavelength temperature coefficient (case temperature)	1.0 Å/° C
Forward voltage temperature coefficient	-2.0 mV/° C

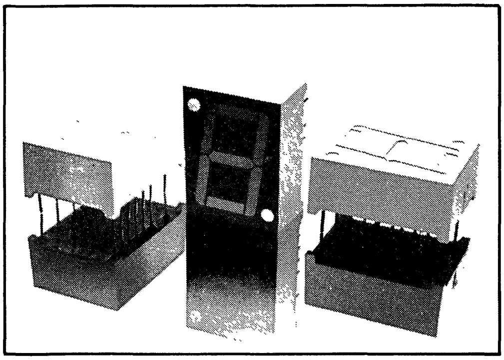
NOTES

1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments as measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *The curve in Figure 3 is normalized to the brightness at 25° C to indicate the relative efficiency over the operating temperature range.*
3. *Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140° C.*
4. *For flux removal, Freon TF, Freon TE, Isoproponal or water may be used up to their boiling points.*
5. *Intensity adjusted for smaller areas of the "+" and decimal points.*
6. *All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.*

GENERAL INSTRUMENT

0.800-INCH SEVEN SEGMENT HIGH PERFORMANCE DISPLAYS

HIGH EFFICIENCY RED MAN8900 SERIES



DESCRIPTION

The MAN8900 Series is a family of large digits 0.8-inches in height. This series combines high brightness, large size, good aesthetics and is designed to be used where accurate readable displays need to be viewed over a distance. All models use right hand decimal points.

FEATURES

- High performance nitrogen-doped GaAsP on GaP
- Large, easy to read, digits
- Common anode or common cathode models
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Rugged plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 6)
- Wide angle viewing . . . 150°
- Low forward voltage
- Red face and Red segment for good ON or OFF contrast
- These devices have a Red face and Red segments

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Digital clocks
- TV and radios

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION	PACKAGE DRAWING
MAN8910	High Efficiency Red	Common Anode; Right Hand Decimal	1
MAN8940	High Efficiency Red	Common Cathode; Right Hand Decimal	1

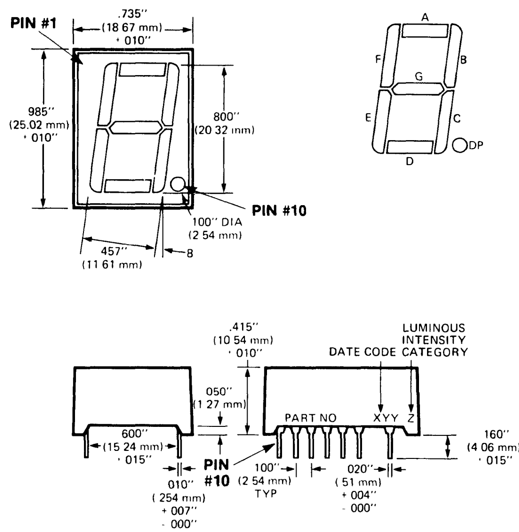
RECOMMENDED FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

Panelgraphic Scarlet 65
Homalite 100-1670

PACKAGE DIMENSIONS

1



C1370

PIN CONNECTIONS

	ELECTRICAL CONNECTIONS	
	MAN8910	MAN8940
	Digit	Digit
	Common Anode	Common Cathode
PIN #	Package Dimensions	Package Dimensions
1	No Connection	No Connection
2	A Cathode	A Anode
3	F Cathode	F Anode
4	Common Anode	Common Cathode
5	E Cathode	E Anode
6	—	—
7	E Cathode	E Anode
8	—	—
9	D Cathode	Common Cathode
10	DP Cathode	DP Anode
11	D Cathode	D Anode
12	Common Anode	Common Cathode
13	C Cathode	C Anode
14	G Cathode	G Anode
15	B Cathode	B Anode
16	—	—
17	Common Anode	Common Anode
18	—	—

TYPICAL CURVES

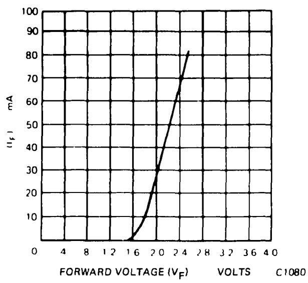


Fig. 1. Forward Current vs. Forward Voltage

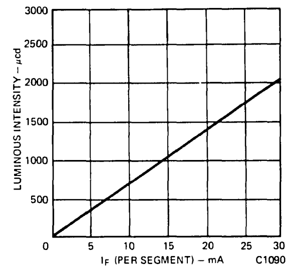


Fig. 2. Luminous Intensity vs. Forward Current

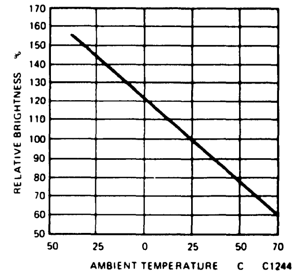


Fig. 3. Luminous Intensity vs. Temperature (See Note 2)

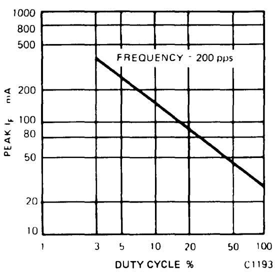


Fig. 4. Max Peak Current vs. Duty Cycle

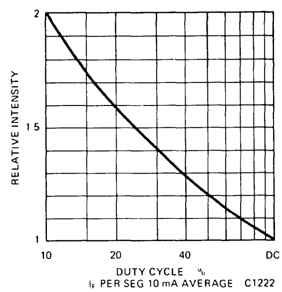


Fig. 5. Luminous Intensity vs. Duty Cycle

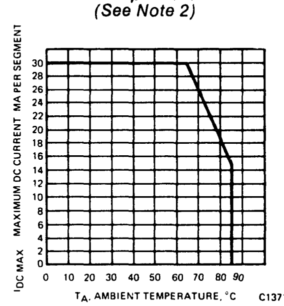
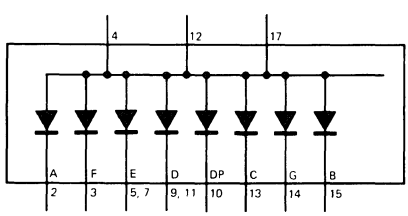


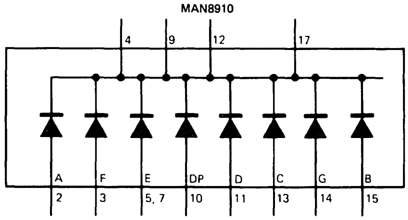
Fig. 6. Maximum DC Current vs. Temperature

Displays

INTERNAL CONNECTIONS



MAN8910



MAN8940

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° C ambient	600 mW
Derate linearly form 50° C	−8.6 mW/° C
Storage and operating temperature	−40° C to +85° C
Continuous forward current	
Total	240 mA
Per segment	30 mA
Decimal point	30 mA
Reverse voltage	
Per segment	6.0 V
Decimal point	6.0 V
Soldering time at 260° C (See Note 4)	5 sec.
Peak forward current per segment ($I_{max.}$) (See Figure 4)	—

ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity, digit average (See Note 1)	320	1600		μcd	$I_F = 10$ mA
Decimal point (See Note 5)	130	600		μcd	$I_F = 10$ mA
Peak emission wavelength		635		nm	
Spectral line half width		40		nm	
Forward voltage					
Segment			2.5	V	$I_F = 20$ mA
Decimal point			2.5	V	$I_F = 20$ mA
Dynamic resistance					
Segment		26		Ω	$I_F = 20$ mA
Decimal point		26		Ω	$I_F = 20$ mA
Capacitance					
Segment		35		pF	$V = 0$
Decimal point		35		pF	$V = 0$
Reverse current					
Segment			100	μA	$V_R = 3.0$ V
Decimal point			100	μA	$V_R = 3.0$ V
Luminous Intensity Ratio I_L (segment-to-segment)			2:1	—	$I_F = 10$ mA

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Φ_{JA}	160° C/W
Wavelength temperature coefficient (case temperature)	1.0 Å/° C
Forward voltage temperature coefficient	−2.0 mV/° C

NOTES

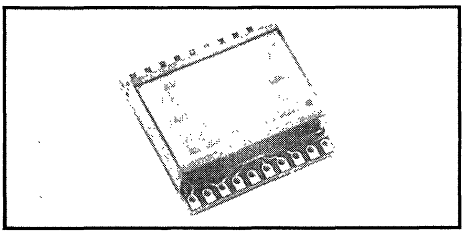
1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments as measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *The curve in Figure 3 is normalized to the brightness at 25° C to indicate the relative efficiency over the operating temperature range.*
3. *Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140° C.*
4. *For flux removal, Freon TF, Freon TE, Isoproponal or water may be used up to their boiling points.*
5. *Intensity adjusted for smaller areas of the "+" and decimal points.*
6. *All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.*

GENERAL INSTRUMENT

0.500-INCH HIGH 16 SEGMENT HIGH PERFORMANCE ALPHANUMERIC DISPLAYS

HIGH EFFICIENCY GREEN MMA54420 **YELLOW MMA58420**
ORANGE MMA56420 **HIGH EFFICIENCY RED MMA59420**

Displays



FEATURES

- Two 0.5-inch high, sixteen segment characters
- Right hand decimal point
- Choice of four bright colors
- Sharply defined emitting areas
- Categorized for intensity matching
- Cover lens provides integral filter
- Reliable, end-stackable packages
- Mounting holes for user-supplied pins

DESCRIPTION

The MMA50000 Series is a family of dual character, sixteen segment alphanumeric displays made with high brightness GaP LED chips. Multiplex operation of each unit is achieved through common cathode addressing and dual edge tab connections.

APPLICATIONS

- Industrial controls
- Test and measurement equipment
- Point of sale
- Systems status indication
- Consumer products
- Computer terminals
- Automotive instrumentation

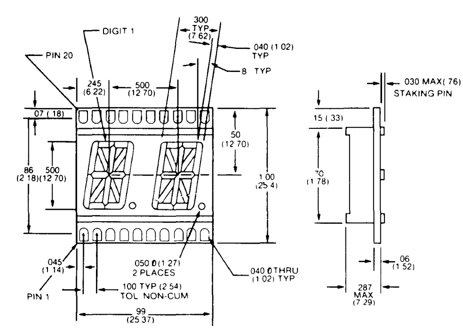
DESCRIPTION

Common cathode, dual character, multiplex drive.

MODEL NUMBERS

PART NUMBER	LED COLOR	LENS COLOR
MMA54420	HI EFF. GREEN	HI EFF. GREEN
MMA56420	ORANGE	ORANGE
MMA58420	YELLOW	CLEAR
MMA59420	HI EFF. RED	RED

PACKAGE DIMENSIONS

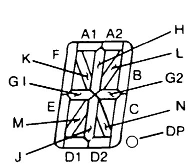


ELECTRICAL CONNECTION

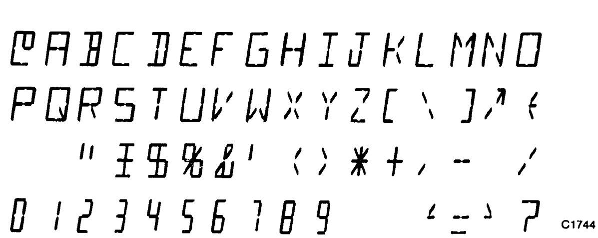
MMA -5X420

PIN	FUNCTION
1	SEG D1 ANODE
2	SEG D2 ANODE
3	DIGIT 1 CATHODE
4	DP ANODE
5	DIGIT 2 CATHODE
6	SEG C ANODE
7	SEG M ANODE
8	SEG E ANODE
9	SEG N ANODE
10	NO CONNECTION
11	SEG J ANODE
12	SEG G2 ANODE
13	SEG B ANODE
14	SEG L ANODE
15	SEG H ANODE
16	SEG A2 ANODE
17	SEG A1 ANODE
18	SEG K ANODE
19	SEG F ANODE
20	SEG G1 ANODE

FONT AND CHARACTER SET



SEGMENT DESIGNATION



ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° ambient........ 2200 mW
Derate linearly from 45° C.............. 50 mW/° C
Storage and operating temp........ −40° to +85° C
D.C. Continuous forward current
  Total .... 425 mA
  Per segment .... 25 mA
  Decimal point .... 25 mA

  Junction temperature .... 90° C
Reverse voltage
  Per segment .... 5.0 V
  Decimal point .... 5.0 V
Soldering time at 260° C
  (See Notes 4 and 5) .... 10 sec.
Peak forward current (See Figure 1) .... 0.5 A

ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25° C)

	MMA 54420	MMA 56420	MMA 58420	MMA 59420	UNITS UNITS	TEST CONDITIONS
Minimum Luminous Intensity, digit average (See Notes 1 and 3)	510	510	510	320	μcd	I_F = 10 mA
Typical Luminous Intensity, digit average (See Notes 1 and 3)	1200	1010	900	730	μcd	I_F = 10 mA
Peak emission wavelength	562	630	585	630	nm	
Typical forward voltage Segment or decimal point	2.5	2.2	2.5	2.2	V	I_F = 20 mA
Maximum forward voltage Segment or decimal point	3.0	2.6	3.0	2.6	V	I_F = 20 mA
Dynamic resistance Segment or decimal point	26	26	26	26	Ω	I_F = 20 mA
Capacitance Segment or decimal point	35	35	35	35	pF	V = 0
Maximum reverse current	100	100	100	100	μA	V_R = 5 V

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Φ_{JA} .... 200° C/W
Forward voltage temperature coefficient .... −2.2 mV/° C

TYPICAL CURVES (Unless Otherwise Specified)

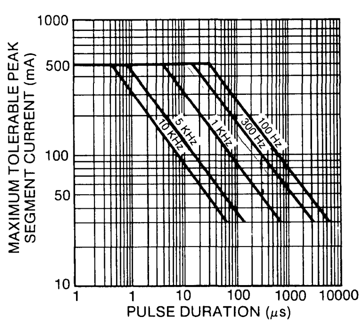


Fig. 1. Maximum Tolerable Peak Segment Current vs. Pulse Duration

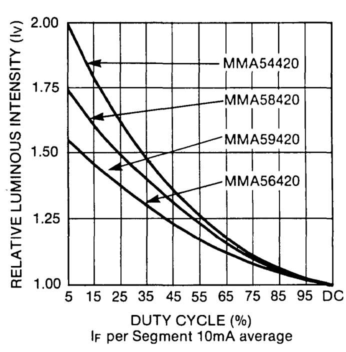


Fig. 2. Relative Luminous Intensity vs. Duty Cycle

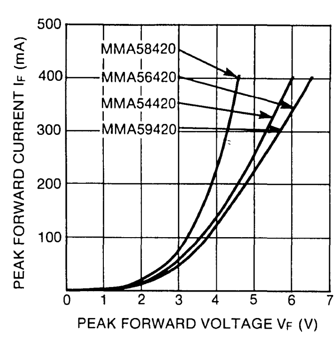
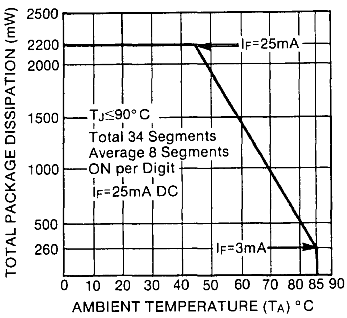


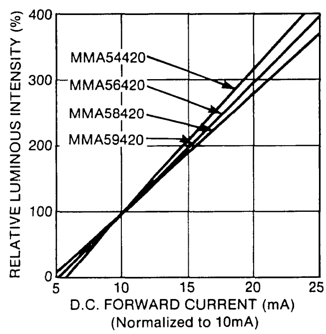
Fig. 3. Peak Forward Voltage vs. Peak Forward Current

TYPICAL CURVES (Unless Otherwise Specified)



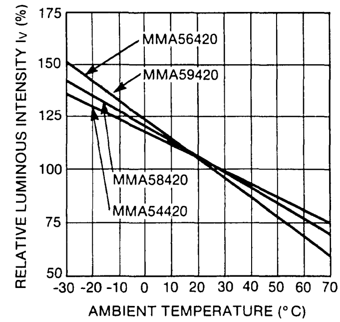
C1748

Fig. 4. Total Package Power Dissipation vs. Ambient Temp.



C1749

Fig. 5. Relative Luminous Intensity vs. Forward Current



C1750

Fig. 6. Relative Luminous Intensity vs. Ambient Temperature

Displays

MMA5X420 RECOMMENDED FILTERS FOR CONTRAST ENHANCEMENT

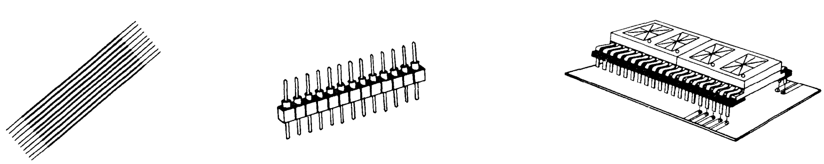
	AMBIENT		
COLOR	**DIM (Office) 25-75 FC**	**MODERATE (Test Floor) 75-200 FC**	**BRIGHT (Outdoors) 200-1000 FC**
HIGH EFFICIENCY RED ORANGE 635 nm	Red Long Pass 65% H, H100-1650 C, 1100 3M, R6310	Red Long Pass 40% H, H100-1650 C, 112	Grey 18-23% H, H100-1266 C, 105 3M, ND0220
YELLOW 583 nm	Yellow Band Pass 30% H, H100-1720 C, 106 P, Yellow 27	Amber Long Pass 40% H, H100-1726 C, 106 P, Amber 23 3M, A5910	Grey 18-23% H, H100-1266 C, 105 P, Grey 10 RH, 2538
GREEN 569 nm	Green Band Pass 30% H, H100-1440 C, 107 P, Green 48	Grey 20-25% H, H100-1425 C, 107 P, Green 48	Grey 18-23% H, H100-1266 C, 105 P, Grey 10 RH, 2538

LEGEND:

C, 106 — Chequers #106
RH — Rohm & Haas
3M — 3M Company
POL — Polaroid Corporation
H — SGL Homalite
C — Chequers Engraving
P — Panelgraphics

SOCKETING

DESCRIPTION	**PART NUMBER**	**SUPPLIER**
Terminal Strip	TS120 Series	Samtec Electronic Hardware
Right Angle Terminal Strip	TS120 Series	Samtec Electronic Hardware
Cable Jumpers	CJ-20-C-12	Samtec Electronic Hardware
Edge Card Connector	100 Series	Circuit Assembly Connectors
Strip Line Plugs	SP Series	Circuit Assembly Connectors
Right Angle Strip Line Plugs	SP Series	Circuit Assembly Connectors



C1751

TYPICAL DRIVE SCHEMES FOR MMA5X420 DISPLAYS

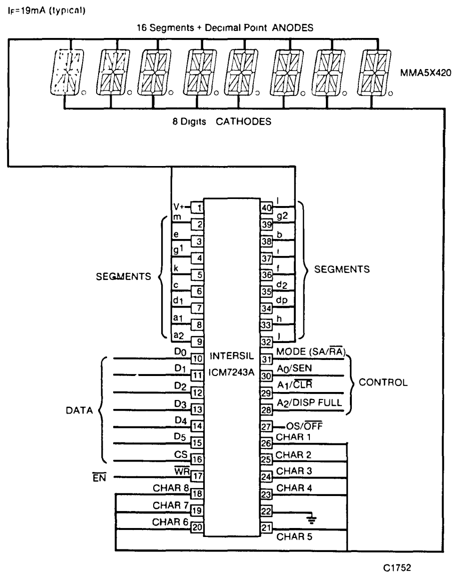


Figure 1. Direct Drive Method

$$I_F(PEAK) = \frac{V_{LED} - V_F - 1.4V}{R_L}$$

$$= I_{F(DC)} \times \text{Number of Digits}$$

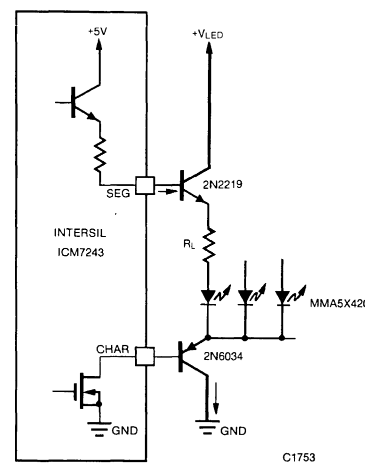
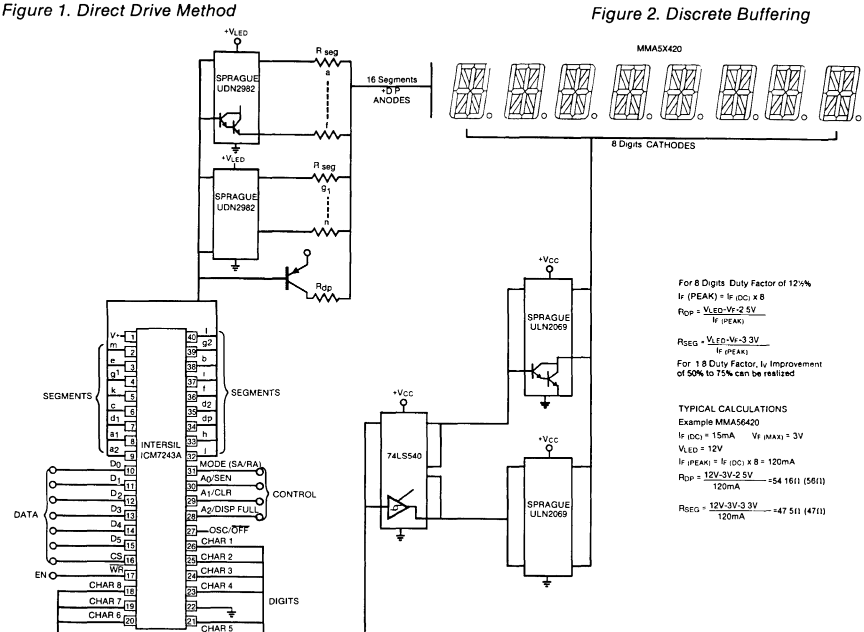


Figure 2. Discrete Buffering



For 8 Digits Duty Factor of 12½%

I_F (PEAK) = $I_{F(DC)} \times 8$

$$R_{DP} = \frac{V_{LED} - V_F - 2.5V}{I_{F(PEAK)}}$$

$$R_{SEG} = \frac{V_{LED} - V_F - 3.3V}{I_{F(PEAK)}}$$

For 1:8 Duty Factor, I_V Improvement of 50% to 75% can be realized

TYPICAL CALCULATIONS

Example MMA56420

$I_{F(DC)} = 15mA$ $V_{F(MAX)} = 3V$

$V_{LED} = 12V$

$I_{F(PEAK)} = I_{F(DC)} \times 8 = 120mA$

$$R_{DP} = \frac{12V - 3V - 2.5V}{120mA} = 54.16\Omega\ (56\Omega)$$

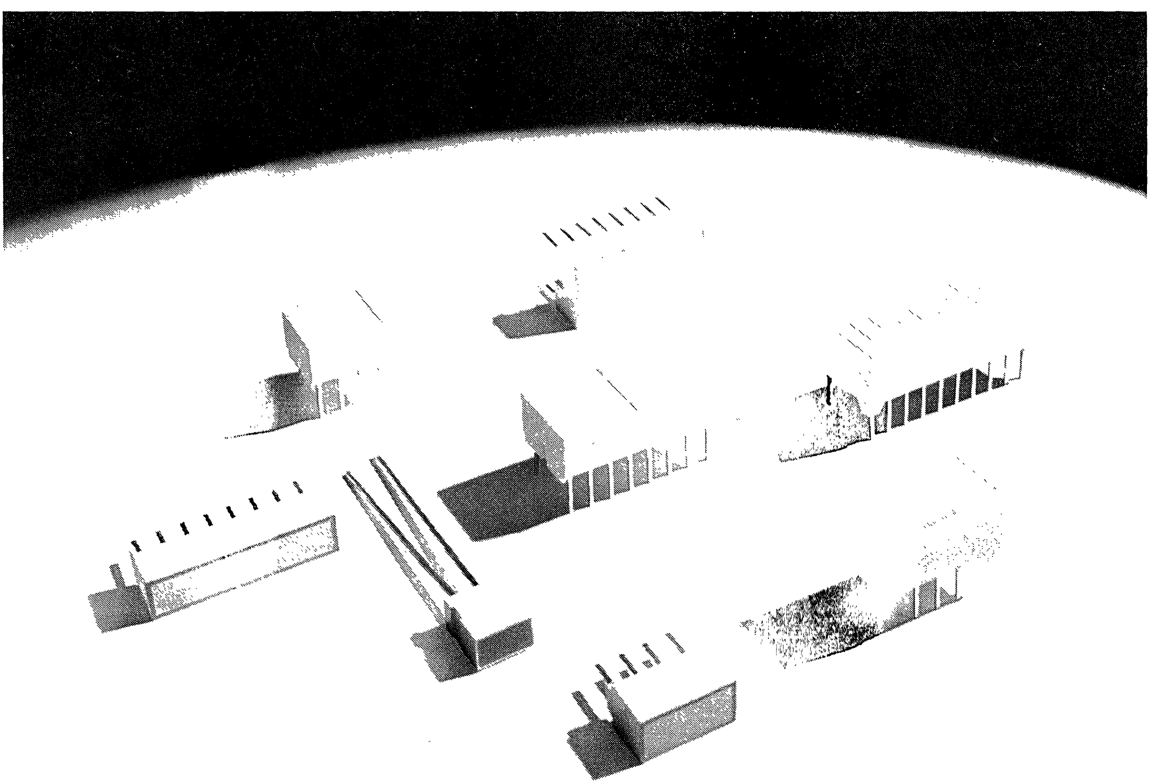
$$R_{SEG} = \frac{12V - 3V - 3.3V}{120mA} = 47.5\Omega\ (47\Omega)$$

Figure 3. I.C. Buffering

NOTES

1. The digit average Luminous Intensity is obtained by summing the total number of segments. The standard of measurement is the Photo Research Spectra Microcandela Meter corrected for wavelength. Intensity will not vary more than ±33.3% from digit to digit.
2. The curve in Figure 6 is normalized to the brightness at 25° C to indicate the relative efficiency over the operating temperature range.
3. The decimal point is designed to have the same surface brightness as the segments, therefore, the Luminous Intensity of the decimal point is .18 times the luminous Intensity of the segments, since the area of the decimal point is .18 times the area of the average segment.
4. These high performance multi-digit displays are not sealed and should not be immersed during flux and clean operations. Immersion may cause condensation of flux or cleaner on the inner surface of the lens. Immerse only the edge connectors.
5. For flux removal, Freon TF or Isoproponal at room temperature.

Light Bars and Bargraph Arrays 3

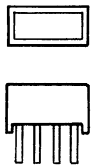
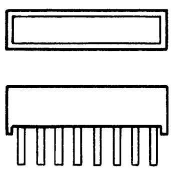
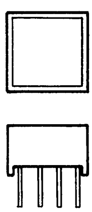
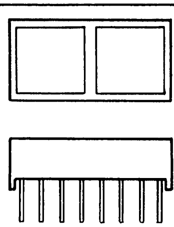
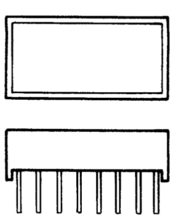


Light Bars and Bargraph Arrays

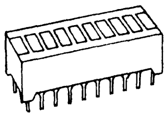
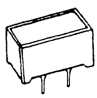
Alphanumeric Product Listing

Product	Page
HLMP-2300	297
HLMP-2350	297
HLMP-2400	297
HLMP-2450	297
HLMP-2500	297
HLMP-2550	297
HLMP-2655	297
HLMP-2670	297
HLMP-2685	297
HLMP-2755	297
HLMP-2770	297
HLMP-2785	297
HLMP-2855	297
HLMP-2870	297
HLMP-2885	297
MP73	302
MV53124	303
MV53164	309
MV53173	305
MV54124	303
MV54164	309
MV54173	305
MV56124	303
MV57124	303
MV57164	309
MV57173	305

LED LIGHT BARS

PACKAGE	PART NUMBER	DESCRIPTION			TYPICAL LUMINOUS INTENSITY @ 20 mA	TYPICAL FORWARD VOLTAGE @ 20 mA	PAGE
		COLOR	PACKAGE	LENS			
	HLMP-2300	Hi. Eff. Red	4 Pin In-Line; .100" Centers; .400"L x .195"W x .240"H (0.350" x 0.150" Emitting Area)	Diff.	20 mcd	2.0 V	297
	HLMP-2400	Yellow		Diff.	20 mcd	2.1 V	
	HLMP-2500	Green		Green Diff.	25 mcd	2.2 V	
	HLMP-2350	Hi. Eff. Red	8 Pin In-Line; .100" Centers; .800"L x .195"W x .240"H (0.750" x 0.150" Emitting Area)	Diff.	35 mcd	2.0 V	297
	HLMP-2450	Yellow		Diff.	35 mcd	2.1 V	
	HLMP-2550	Green		Green Diff.	50 mcd	2.2 V	
	HLMP-2655	Hi. Eff. Red	8 Pin DIP; .100" Centers; .400"L x .400"W x .240"H Square Arrangement (0.350" x 0.350" Emitting Area)	Diff.	35 mcd	2.0 V	297
	HLMP-2755	Yellow		Diff.	35 mcd	2.1 V	
	HLMP-2855	Green		Green Diff.	50 mcd	2.2 V	
	HLMP-2670	Hi. Eff. Red	16 Pin DIP; .100" Centers; .800"L x .400"W x .240"H Dual Square Arrangement	Diff.	35 mcd	2.0 V	297
	HLMP-2770	Yellow		Diff.	35 mcd	2.1 V	
	HLMP-2870	Green		Green Diff.	50 mcd	2.2 V	
	HLMP-2685	Hi. Eff. Red	16 Pin DIP; .100" Centers; .800"L x .400"W x .240"H Single Bar Arrangement (0.350" x 0.700" Emitting Area)	Diff.	70 mcd	2.0 V	297
	HLMP-2785	Yellow		Diff.	70 mcd	2.1 V	
	HLMP-2885	Green		Green Diff.	100 mcd	2.2 V	

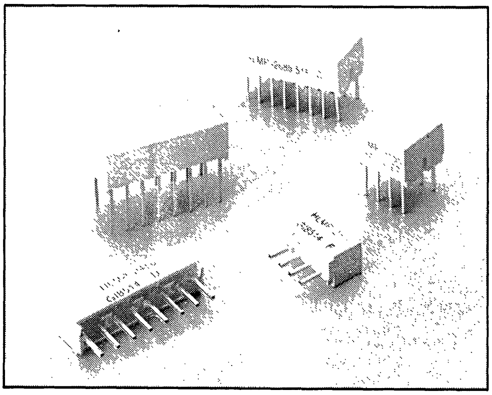
BARGRAPHS PANEL INDICATORS RECTANGULARS

PACKAGE	PART NUMBER	SOURCE COLOR	SEGMENT/ FACE COLOR	I_V TYP. mcd/mA	$2\theta_{1/2}$	PAGE
10 Element	MV53164	Yellow	Untinted Diff./Grey			
	MV54164	Hi. Eff. Green	Untinted Diff./Grey	1.0/10	130	309
	MV57164	Hi. Eff. Red	Red Diff./Grey			
.5-Inch Rectangular	MV53173	Yellow	Yellow Diff.			
	MV54173	Hi. Eff. Green	Untinted Diff.	1.0/20	130	305
	MV57173	Hi. Eff. Red	Red Diff.			
	MV53124	Yellow				
	MV54124	Hi. Eff. Green	Tinted Diffused	4.0/20	100	303
	MV56124	Orange				
	MV57124	Hi. Eff. Red				

GENERAL INSTRUMENT

LED LIGHT BARS

HIGH EFFICIENCY RED HLMP-2300/2600 SERIES
YELLOW HLMP-2400/2700 SERIES
HIGH EFFICIENCY GREEN HLMP-2500/2800 SERIES



DESCRIPTION

The General Instrument LED Light Bar series are bright, large emitting area, rectangular devices that are designed for backlighting legend/ message annunciators.

These devices are offered in single-in-line and dual-in-line packages that contain single or segmented light-emitting areas. Each package style is offered in High Efficiency Red, Yellow, or Green emission color.

FEATURES

- Large area, uniform, bright light-emitting surfaces
- Select from six package styles
- Choice of three colors
- Categorized for intensity and color
- X-Y stackable
- Easily driven with I.C.s
- Alternate source for popular backlighting components

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION	PACKAGE	PIN OUT
HLMP-2300 HLMP-2400 HLMP-2500	High Efficiency Red Yellow High Efficiency Green	2 LED Single-in-line 0.35 in. × 0.15 in. Area	A	A
HLMP-2350 HLMP-2450 HLMP-2550	High Efficiency Red Yellow High Efficiency Green	4 LED Single-in-line 0.75 in. × 0.15 in. Area	B	B
HLMP-2655 HLMP-2755 HLMP-2855	High Efficiency Red Yellow High Efficiency Green	4 LED Dual-in-line 0.35 in. × 0.35 in. Area	C	C
HLMP-2670 HLMP-2770 HLMP-2870	High Efficiency Red Yellow High Efficiency Green	Dual 0.35 in. × 0.35 in. Area Dual-in-line package	D	D
HLMP-2685 HLMP-2785 HLMP-2885	High Efficiency Red Yellow High Efficiency Green	8 LED 0.35 in. × 0.75 in. Area Dual-in-line package	E	D

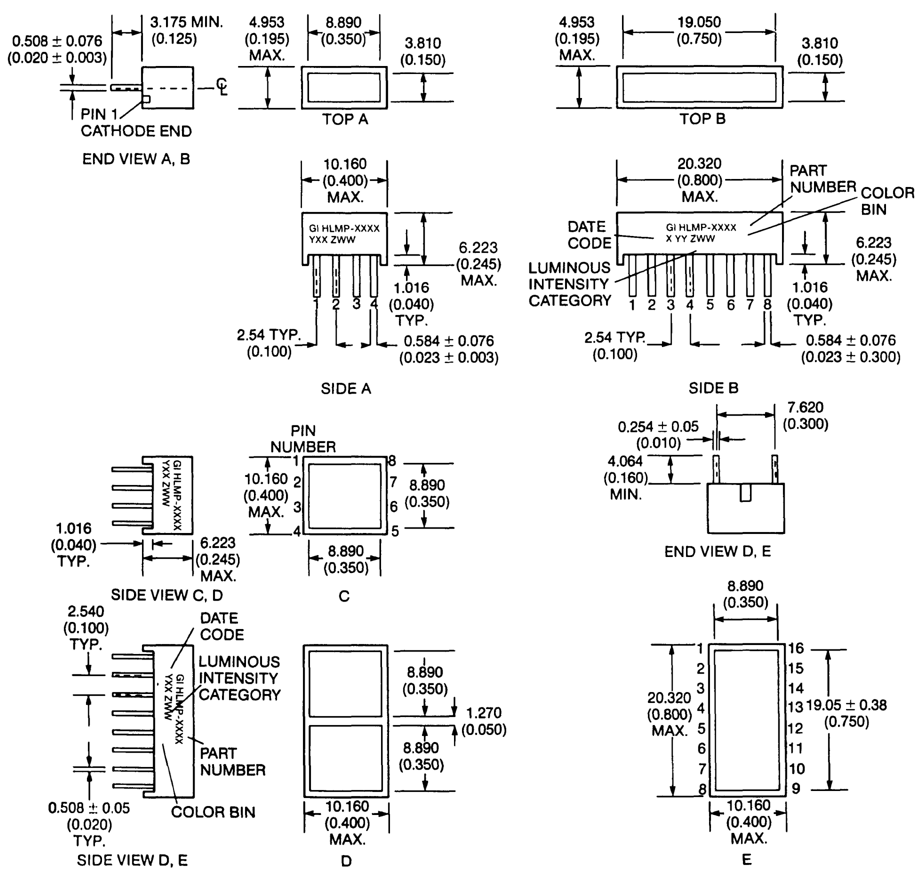
ABSOLUTE MAXIMUM RATINGS T_A = 25°C (Unless Otherwise Stated.)

	HIGH EFFICIENCY RED HIGH EFFICIENCY GREEN HLMP-2300/-2500 -2600/-2800 SERIES	YELLOW HLMP-2400/ -2700 SERIES
Power dissipation per LED chip (See Note 1)	135 mW	85 mW
Peak forward current per LED chip, T_A = 50°C (max. pulse width = 2 μs) (See Notes 1 and 2)	90 mA	60 mA
Average forward per LED chip pulsed conditions, T_A = 50°C (See Note 2)	25 mA	20 mA
DC forward current per LED chip, T_A = 50°C (See Note 3)	30 mA	25 mA
Reverse voltage per LED chip	6V	6V
Storage and operating temperature range	-40°C to +85°C	-40°C to +85°C
Soldering time at 260°C (See Note 4)	260°C for 3 sec.	260°C for 3 sec.

NOTES

1. *For HLMP-2300/-2500/-2600/-2800 Series, derate above T_A = 25°C at 1.8 mW/°C per LED chip. For HLMP-2400/-2700 Series, derate above T_A = 50°C at 1.8 mW/°C per LED chip.*
2. *See Figure 1/2 to establish pulse operating conditions.*
3. *For HLMP-2300/-2500/-2600/-2800 Series, derate above T_A = 50°C at 0.5 mA/°C per LED chip. For HLMP-2400/-2700 Series derate above T_A = 60°C at 0.5 mA/°C per LED chip.*
4. *Leads immersed to 1/16 in. from body of the device. Maximum unit surface temperature is 140°C.*

PACKAGE DIMENSIONS



DIMENSIONS IN MILLIMETERS (INCHES). TOLERANCES ± 0.25 (± 0.010) UNLESS OTHERWISE INDICATED

C2015

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25°C$)
HIGH EFFICIENCY RED

PARAMETER		SYMBOL	HLMP -2300	-2350	-2655	-2670	-2685	UNIT	TEST CONDITIONS
Luminous Intensity	min.	I_V	4.5	9	9	9	18	mcd	
	typ.		20	35	35	35	70		$I_F = 20$ mA
	typ.		30	50	50	50	100		$I_F = 60$ mA pK, 1:3 D.F.
Forward voltage	max.	V_F	2.6	2.6	2.6	2.6	2.6	V	$I_F = 20$ mA
	typ.		2.0	2.0	2.0	2.0	2.0		
Peak wavelength	typ.	λ_p	630	630	630	630	630	nm	
Dominant wavelength	typ.	λ_d	626	626	626	626	626	nm	
Capacitance	typ.	C	45	45	45	45	45	pF	$V_F = 0$, f = 1 MHz
Reverse voltage	min.	V_R	6	6	6	6	6	V	$I_R = 100\ \mu A$
Thermal resistance	typ.	θ_{JL}	150	150	150	150	150	°C/W/ LED chip	

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25°C$)
YELLOW

PARAMETER		SYMBOL	HLMP -2400	-2450	-2755	-2770	-2785	UNIT	TEST CONDITIONS
Luminous Intensity	min.	I_V	4	8	8	8		mcd	
	typ.		20	35	35	35	70		$I_F = 20$ mA
	typ.		33	60	60	60	115		$I_F = 60$ mA pK, 1:3 D.F.
Forward voltage	max.	V_F	2.6	2.6	2.6	2.6	2.6	V	$I_F = 20$ mA
	typ.		2.1	2.1	2.1	2.1	2.1		
Peak wavelength	typ.	λ_p	585	585	585	585	585	nm	
Dominant wavelength	typ.	λ_d	588	588	588	588	588	nm	
Capacitance	typ.	C	35	35	35	35	35	pF	$V_F = 0$, f = 1 MHz
Reverse voltage	min.	V_R	6	6	6	6	6	V	$I_R = 100\ \mu A$
Thermal resistance	typ.	θ_{JL}	150	150	150	150	150	°C/W/ LED chip	

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25°C$)
HIGH EFFICIENCY GREEN

PARAMETER		SYMBOL	HLMP -2500	-2550	-2855	-2870	-2885	UNIT	TEST CONDITIONS
Luminous Intensity	min.	I_V	3.7	7.5	7.5	7.5	15	mcd	
	typ.		25	50	50	50	100		$I_F = 20$ mA
	typ.		38	75	75	75	150		$I_F = 60$ mA pK, 1:3 D.F.
Forward voltage	max.	V_F	2.6	2.6	2.6	2.6	2.6	V	$I_F = 20$ mA
	typ.		2.2	2.2	2.2	2.2	2.2		
Peak wavelength	typ.	λ_p	565	565	565	565	565	nm	
Dominant wavelength	typ.	λ_d	567	567	567	567	567	nm	
Capacitance	typ.	C	40	40	40	40	40	pF	$V_F = 0$, f = 1 MHz
Reverse voltage	min.	V_R	6	6	6	6	6	V	$I_R = 100\ \mu A$
Thermal resistance	typ.	θ_{JL}	150	150	150	150	150	°C/W/ LED chip	

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

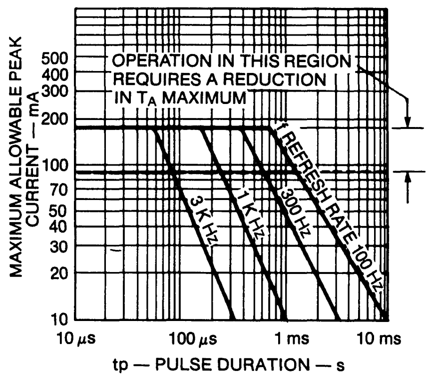


Fig. 1. Maximum Tolerable Peak Current per LED Chip vs. Pulse Duration for HLMP-23X0/-26XX/-25X0/-28XX

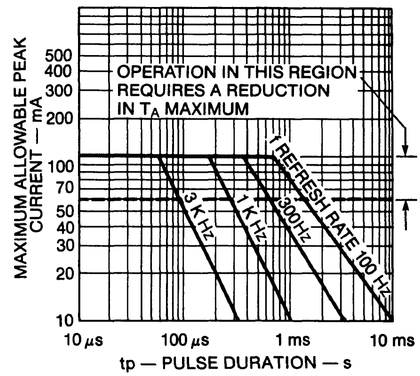


Fig. 2. Maximum Tolerable Peak Current per LED Chip vs. Pulse Duration for HLMP-24X0/-27XX Devices

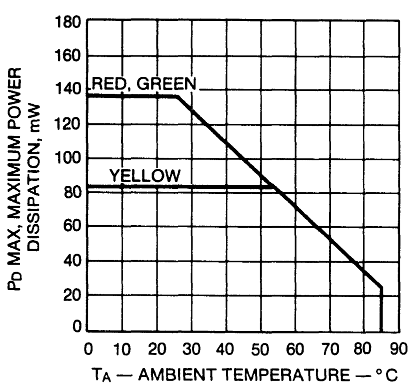


Fig. 3. Maximum Power Dissipation per LED vs. Ambient Temperature

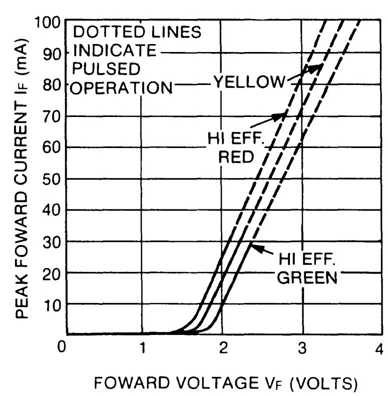


Fig. 4. Forward Current vs. Forward Voltage

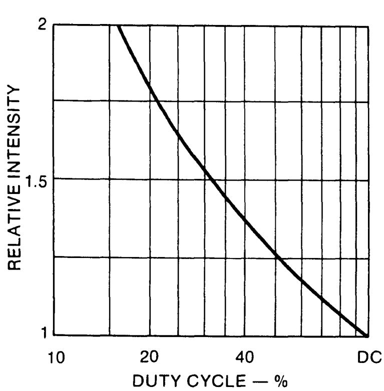


Fig. 5. Luminous Intensity vs. Duty Cycle

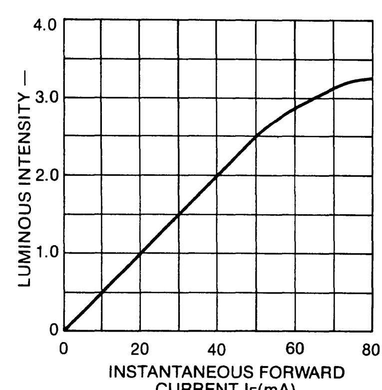


Fig. 6. Luminous Intensity vs. Forward Current

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVE

(25°C Free Air Temperature Unless Otherwise Specified)

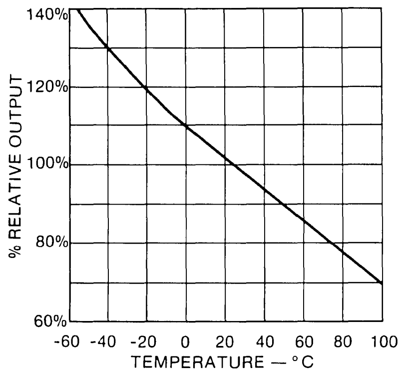
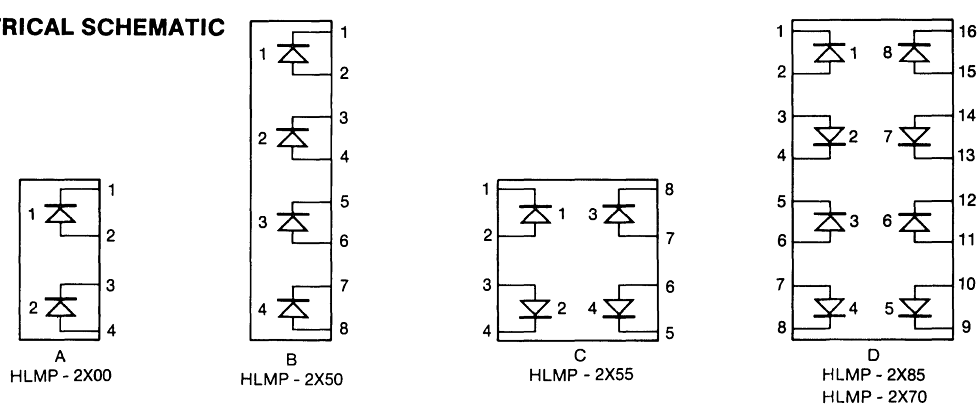


Fig. 7. Output vs. Temperature

PIN CONNECTIONS TO ELECTRICAL SCHEMATIC

PIN	ELECTRICAL CONNECTION			
	HLMP-2X00	HLMP-2X50	HLMP-2X55	HLMP-2X70/-2X85
1	1 Cathode	1 Cathode	1 Cathode	1 Cathode
2	1 Anode	1 Anode	1 Anode	1 Anode
3	2 Cathode	2 Cathode	2 Anode	2 Anode
4	2 Anode	2 Anode	2 Cathode	2 Cathode
5		3 Cathode	3 Cathode	3 Cathode
6		3 Anode	3 Anode	3 Anode
7		4 Cathode	4 Anode	4 Anode
8		4 Anode	4 Cathode	4 Cathode
9				5 Cathode
10				5 Anode
11				6 Anode
12				6 Cathode
13				7 Cathode
14				7 Anode
15				8 Anode
16				8 Cathode

ELECTRICAL SCHEMATIC

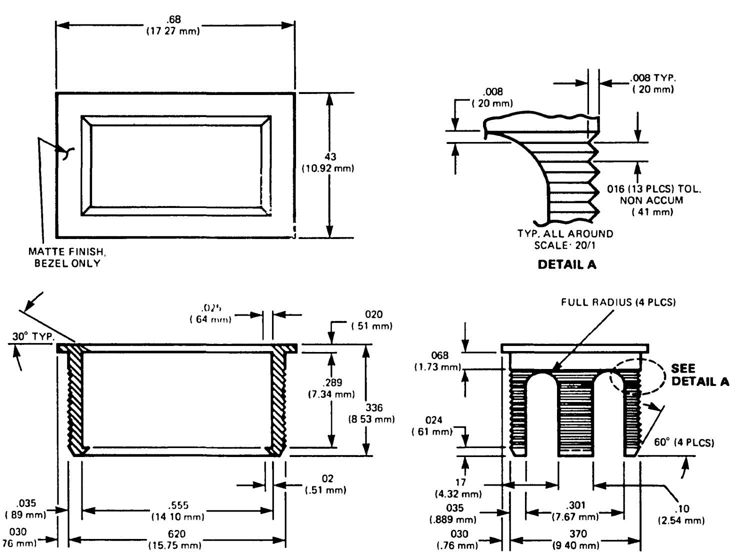


GENERAL INSTRUMENT

PANEL MOUNTING GROMMET FOR .500-INCH RECTANGULAR INDICATOR

MP73

PACKAGE DIMENSIONS

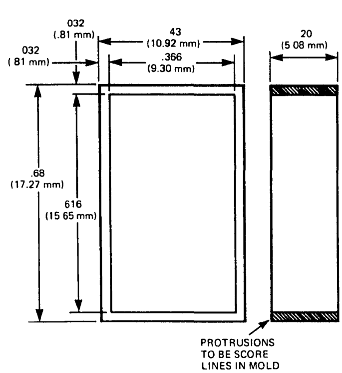


MATERIAL: POLYPROPYLENE – BLACK C 1480

DESCRIPTION

The MP73 mounting grommet is intended for panel mounting the MV57173 rectangular lamp. The grommets are made of Black plastic and provide the user with an easy-to-mount, professional appearance when viewed on a front panel.

The MP73 can be used on any panel thickness up to .125-inch (3.18 mm).



MATERIAL: POLYPROPYLENE – BLACK C 1481

PANEL HOLE PUNCHING

Punches may be ordered from one of the following sources:

W.A. WHITNEY COMPANY
650 Race Street
Rockford, IL 61105
(815) 964-6771

ROTEX PUNCH COMPANY, INC.
2350 Alvarado Street
San Leandro, CA 94577
(415) 357-3600

GENERAL INSTRUMENT

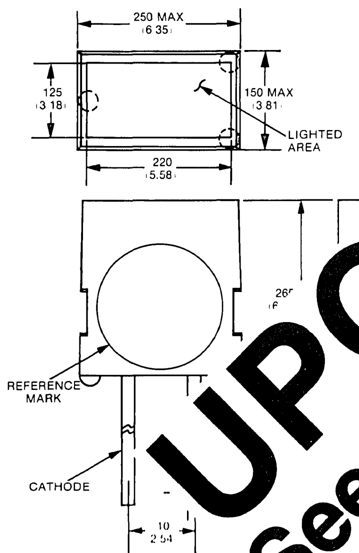
RECTANGULAR REFLECTOR CAP SOLID STATE LAMPS

YELLOW MV53124
HIGH EFFICIENCY GREEN MV54124
SOFT ORANGE MV56124
HIGH EFFICIENCY RED MV57124

UPGRADED

See pages 361 & 362!

PACKAGE DIMENSIONS



C1245

DESCRIP...

This se... solid state indic... w, Red and O... is uniformly ...

... lighted area
... direction without crosstalk
... — typically 4 mcd at 20 mA
... ability
... ugged, lightweight
... leakage from unit sides
... ing grommet available (See MP65) as ... arate order item

APPLICATIONS

- Legend backlighting
- Illuminated pushbutton
- Panel indicator
- Bargraph meter

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C Temperature Unless Otherwise Specified)

	MV53124 MV56124 MV57124	MV54124
Power dissipation	120 mW	120 mW
Derate linearly from 50°C	1.6 mW/°C	1.6 mW/°C
Storage and operating temperature	-55°C to +100°C	-55°C to +100°C
Peak forward current (1 μsec. pulse width, 300 pps)	1 A	90 mA
Forward current	35 mA	30 mA
Lead soldering time at 260°C (See Note 1)	5 sec.	5 sec.
Reverse voltage	5.0 V	5.0 V

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)

PARAMETER		SYMBOL	MV53124	MV54124	MV56124	MV57124	UNITS	TEST CONDITIONS
Forward voltage	typ.	V_F	2.0	2.2	2.0	2.0	V	I_F = 20 mA
	max.		3.0	3.0	3.0	3.0	V	I_F = 20 mA
Luminous Intensity	min.	I_V	1.0	1.0	1.0	1.0	mcd	I_F = 20 mA
	typ.		4.0	4.0	4.0	4.0	mcd	I_F = 20 mA
Peak wavelength		λp	585	562	605	635	nm	I_F = 20 mA
Spectral line half width			45	30	45	45	nm	I_F = 20 mA
Reverse voltage	min.	V_{BR}	5	5	5	5	V	I_R = 100 μA
Reverse current	max.	I_R	100	100	100	100		V_R = 5.0V
Capacitance		C	45	20	45	45		V = 0, f = 1 MHz
Viewing angle (total)		$2\Theta½$	100	100	100	10[illegible]		

UPGRADED
See pages 361 & 362!

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (2[illegible] Specified)

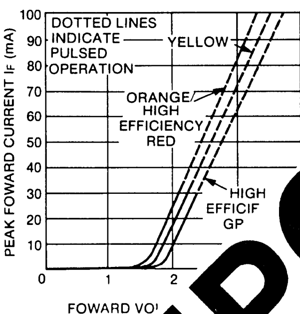


Fig. 1. F[illegible]

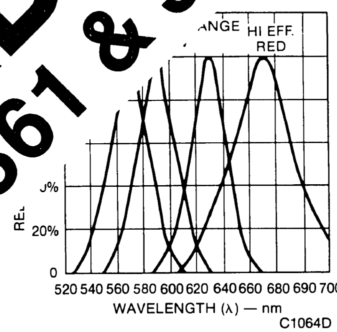


Fig. 2. Spectral Response

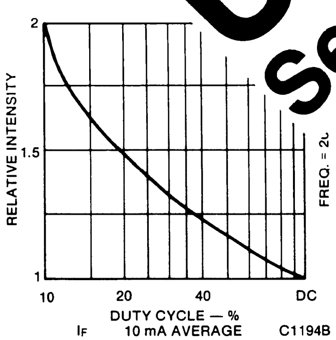


Fig. 3. Luminous Intensity vs. Duty Cycle

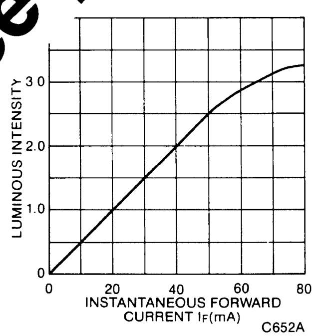


Fig. 4. Luminous Intensity vs. Forward Current

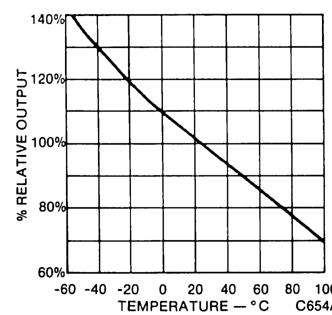


Fig. 5. Output vs. Temperature

NOTES

1. *The leads of the device were immersed in molten solder, heated to a temperature of 260°C, to a point 1/16 inch (1.6 mm) from the body of the device per MIL-S-750, with dwell time of 5 seconds.*
2. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*

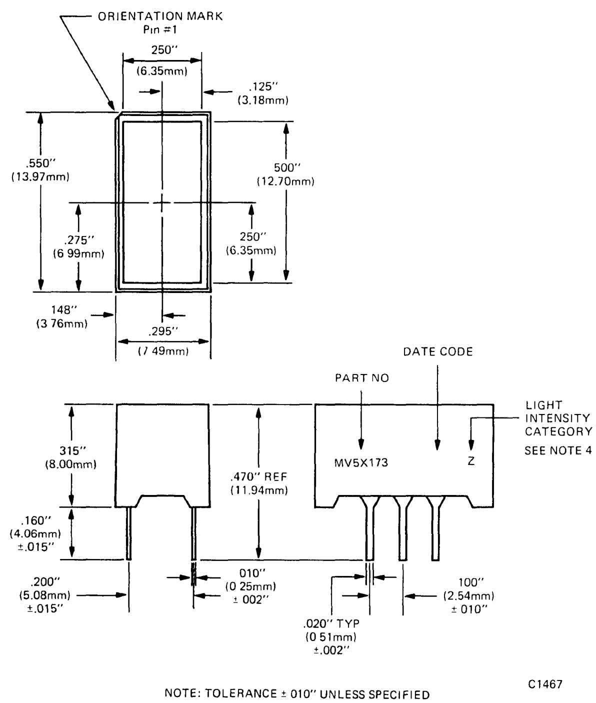
GENERAL INSTRUMENT

SOLID STATE INDICATORS

YELLOW MV53173
HIGH EFFICIENCY GREEN MV54173
HIGH EFFICIENCY RED MV57173

Light Bars and Bargraph Arrays

PACKAGE DIMENSIONS



NOTE: TOLERANCE ±.010" UNLESS SPECIFIED

DESCRIPTION

The MV5X173 series is a large rectangular lamp which contains two LED chips with separate anodes and cathodes for each light. The illuminated area is 0.500-inches x 0.250-inches (12.7 mm x 6.35 mm).

FEATURES

- .500-inch x .250-inch lighted area available in three colors
- Solid state reliability
- Fast switching — excellent for multiplexing
- Low power consumption
- Directly compatible with IC's
- Wide viewing angle
- .2 inch DIP lead spacing
- Mounting hardware available
- Categorized for Luminous Intensity (See Note 1)

APPLICATIONS

- Panel indicators
- Backlight legends
- Light arrays

ABSOLUTE MAXIMUM RATINGS

	MV53173	MV54173	MV57173
Power dissipation at 25°C	200 mW	200 mW	200 mW
Derate linearly from 50°C	-4.3 mW/°C	-4.5 mW/°C	-4.3 mW/°C
Storage temperature	-40°C to +100°C	-40°C to +100°C	-40°C to +100°C
Operating temperature	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C
Continuous forward current per light (25°C)	25 mA	30 mA	35 mA
Peak forward current per LED chip (1 μsec pulse width, 300 pps)	1.0 A	90 mA	1.0 A
Lead soldering time at 260°C (See Notes 3 and 5)	5 sec.	5 sec.	5 sec.

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

PARAMETER	TEST CONDITIONS	MV53173	MV54173	MV57173	UNITS
Forward voltage (V_F)					
Typ.	I_F = 20 mA	2.0	2.2	2.0	V
Max.	I_F = 20 mA	2.5	3.0	2.5	V
Luminous Intensity					
Min. (See Note 1)	I_F = 20 mA	4.5	4.5	4.5	mcd
Peak wavelength					
Typ.	I_F = 20 mA	585	562	635	nm
Spectral line half width	I_F = 20 mA	45	30	45	nm
Capacitance					
Typ.	V = 0, f = 1 MHz	35	20	35	pF
Reverse voltage (V_R)					
Min.	I_R = 100 μA	5	5	5	V
Typ.	I_R = 100 μA	25	50	25	V
Viewing angle (total)		120	120	120	degrees

TYPICAL THERMAL CHARACTERISTICS

	MV53173	MV54173	MV57173
Thermal resistance junction to free air Φ_{JA}	160°C/W	160°C/W	160°C/W
Wavelength temperature coefficient (case temp.)	1.0 A/°C	1.0 A/°C	1.0 Å/°C
Forward voltage temperature coefficient	-1.5 mV/°C	-1.4 mV/°C	-2.0 mV/°C

TYPICAL CURVES (Per LED Chip Unless Indicated) (25°C Free Air Temperature)

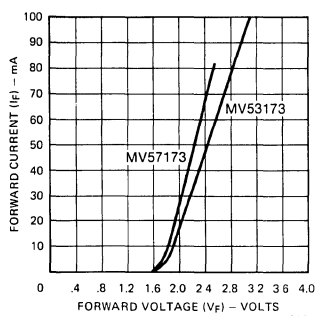


Fig. 1. Forward Current vs. Forward Voltage

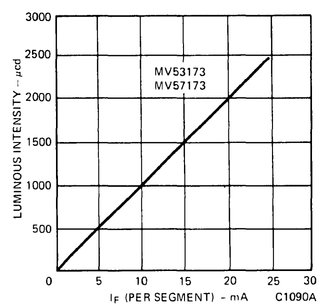


Fig. 2. Luminous Intensity vs. Forward Current (Both LED Chips ON)

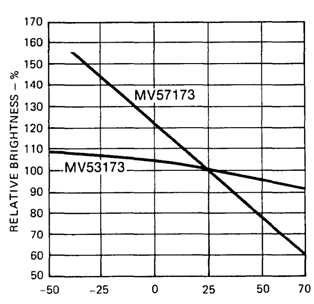


Fig. 3. Luminous Intensity vs. Temperature (See Note 2)

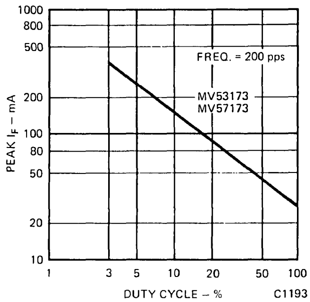


Fig. 4. Max Peak Current vs. Duty Cycle

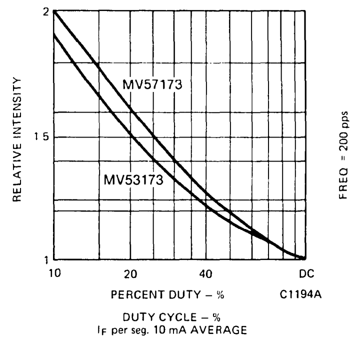


Fig. 5. Luminous Intensity vs. Duty Cycle

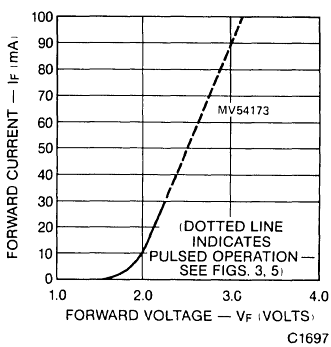


Fig. 6. Forward Current vs. Forward Voltage

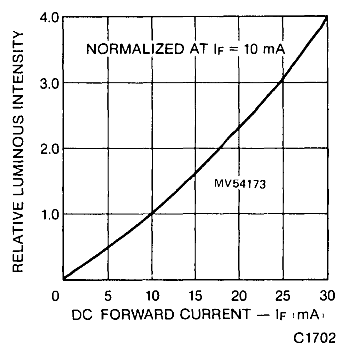


Fig. 7. Relative Luminous Intensity vs. DC Forward Current (Both LED Chips ON)

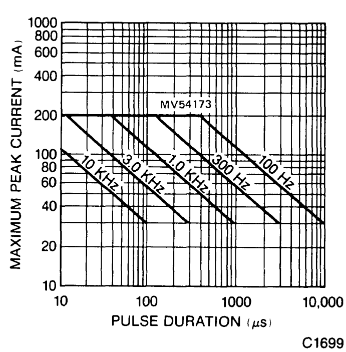


Fig. 8. Maximum Peak Current vs. Pulse Duration

Light Bars and Bargraph Arrays

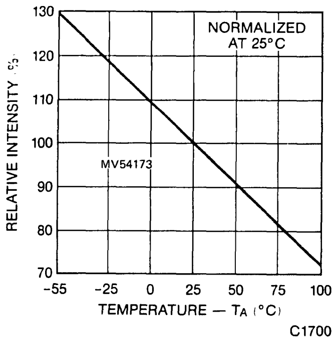


Fig. 9. Relative Luminous Intensity vs. Temperature

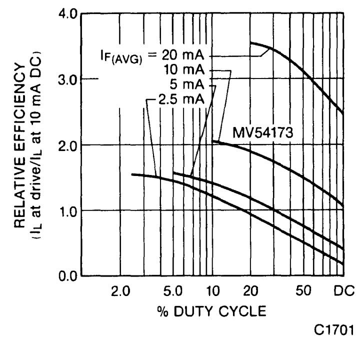
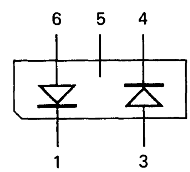


Fig. 10. Relative Efficiency vs. Duty Cycle

PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS
1	Cathode 1
2	No Pin
3	Anode 2
4	Cathode 2
5	NC
6	Anode 1



SCHEMATIC

FILTER RECOMMENDATIONS

For optimum ON and OFF contrast, one of the following filters or equivalents may be used over the lamp:

MV53173	MV54173	MV57173
Panelgraphic Yellow 25 or Amber 23	Panelgraphic Green 48	Panelgraphic Red 60
Homalite 190 — 1720 or 100 — 1726	Homalite 100 — 1440 Green	Homalite 100 — 1605

In situations of high ambient light, a neutral density filter can be used to achieve greater contrast:

Panelgraphic Grey 10

Panelgraphic Grey 10
Homalite 100 — 1266 Grey

NOTES

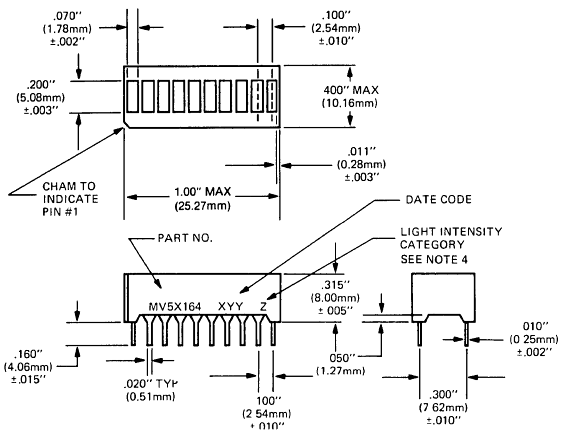
1. *The average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. The standard of measurement is the Photo Research Corp. "Spectra" Microcandela Meter (Model IV-D) corrected for wavelength. Intensity will not vary more than ±33.3% between all segments within a unit.*
2. *The curve in Figure 3 is normalized to the brightness at 25°C to indicate the relative efficiency over the operating temperature range.*
3. *Leads immersed to 1/16 inch (1.6 mm) from the body of the device. Maximum unit surface temperature is 140°C.*
4. *All units are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.*
5. *For flux removal, Freon TF, Freon TE, Isoproponal or water may be used up to their boiling points.*

GENERAL INSTRUMENT

BARGRAPH DISPLAYS

YELLOW MV53164
HIGH EFFICIENCY GREEN MV54164
HIGH EFFICIENCY RED MV57164

PACKAGE DIMENSIONS



NOTE: TOLERANCES ±.010" UNLESS SPECIFIED

C1468A

DESCRIPTION

The MV5X164 series is a 10 segment bargraph display with separate anodes and cathodes for each light segment. The packages are end-stackable.

FEATURES

- Large segments, closely spaced
- End-stackable
- Fast switching — excellent for multiplexing
- Low power consumption
- Directly compatible with IC's
- Wide viewing angle
- Standard .3-inch DIP lead spacing
- Categorized for Luminous Intensity (See Note 4)

Light Bars and Bargraph Arrays

ABSOLUTE MAXIMUM RATINGS

	MV53164	MV54164	MV57164
Power dissipation at 25°C ambient	750 mW	750 mW	750 mW
Derate linearly from 50°C	-14.3 mW/°C	-14.3 mW/°C	-14.3 mW/°C
Storage and operating temperature	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C
Continuous forward current			
Total	200 mA	300 mA	300 mA
Per segment	25 mA	30 mA	30 mA
Reverse voltage			
Per segment	6.0 V	6.0 V	6.0 V
Soldering time at 260°C (See Notes 3 and 5)	5 sec.	5 sec.	5 sec.

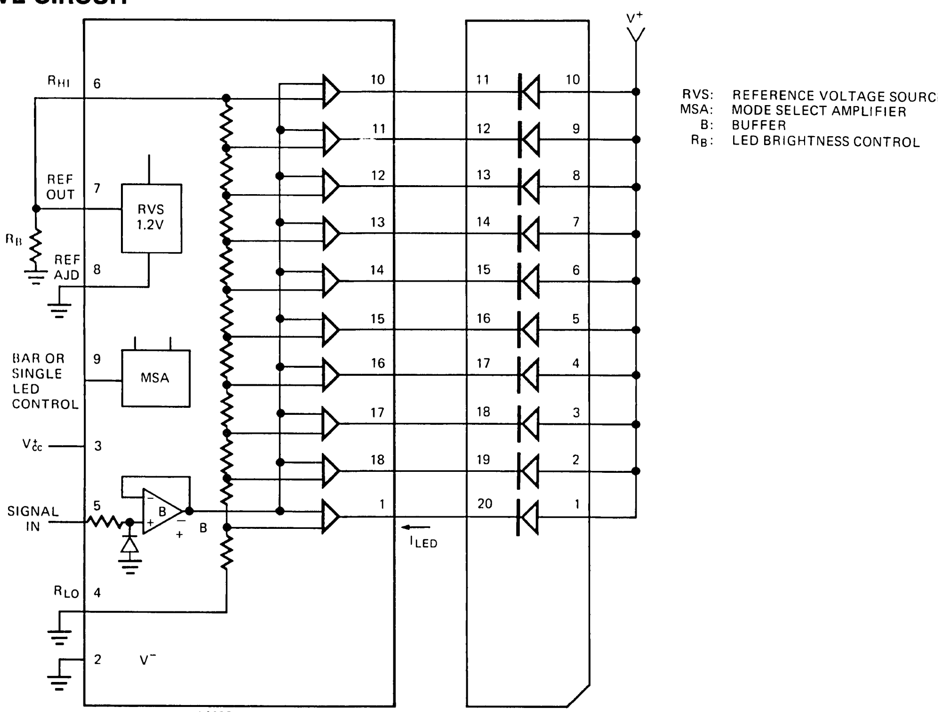
TYPICAL THERMAL CHARACTERISTICS

	MV53164	MV54164	MV57164
Thermal resistance junction to free air Φ_{JA}	160°C/W	160°C/W	160°C/W
Wavelength temperature coefficient (case temp.)	1.0 A/°C	1.0 A/°C	1.0 A/°C
Forward voltage temperature coefficient	-1.5 mV/°C	-1.4 mV/°C	-2.0 mV/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward voltage MV53164, MV57164/MV54164		2.0/2.2	2.5/3.0	V	I_F = 10 mA
Luminous Intensity (unit average) (See Note 1)	510	1800		µcd	I_F = 10 mA
Pulsed Luminous Intensity (MV54164)	710	2500		µcd	I_F = 60 mA peak; 1:6 DF
Peak emission wavelength					
MV53164		585		nm	
MV54164		562		nm	
MV57164		630		nm	
Spectral line half width MV53164, MV57164/MV54164		40/30		nm	
Dynamic resistance					
Segment MV53164, MV57164/MV54164		26/12		Ω	I_F = 20 mA
Capacitance MV53164, MV57164/MV54164		35/40		pF	V = 0, f = 1 MHz
Switching time		500		ns	I_F = 10 mA
Reverse voltage	6.0				I_R = 100 µA

TYPICAL DRIVE CIRCUIT



PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS	PIN NO.	ELECTRICAL CONNECTIONS	PIN NO.	ELECTRICAL CONNECTIONS	PIN NO.	ELECTRICAL CONNECTIONS
1	Bar 1 Anode	6	Bar 6 Anode	11	Bar 10 Cathode	16	Bar 5 Cathode
2	Bar 2 Anode	7	Bar 7 Anode	12	Bar 9 Cathode	17	Bar 4 Cathode
3	Bar 3 Anode	8	Bar 8 Anode	13	Bar 8 Cathode	18	Bar 3 Cathode
4	Bar 4 Anode	9	Bar 9 Anode	14	Bar 7 Cathode	19	Bar 2 Cathode
5	Bar 5 Anode	10	Bar 10 Anode	15	Bar 6 Cathode	20	Bar 1 Cathode

TYPICAL CURVES MV53164 MV57164 (PER SEGMENT) (25°C Free Air Temperature)

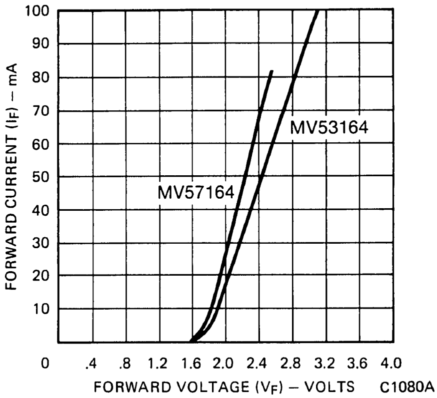


Fig. 1. Forward Current vs. Forward Voltage

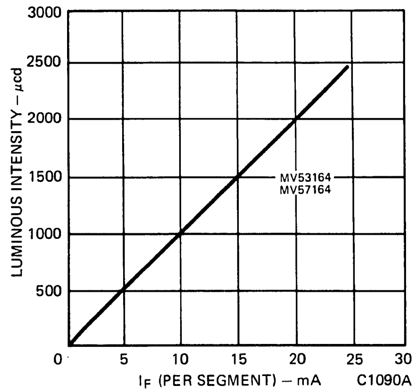


Fig. 2. Luminous Intensity vs. Forward Current

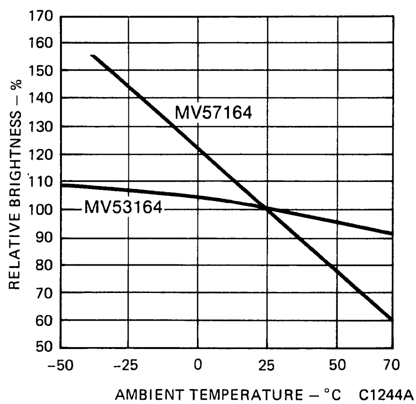


Fig. 3. Luminous Intensity vs. Temperature (See Note 2)

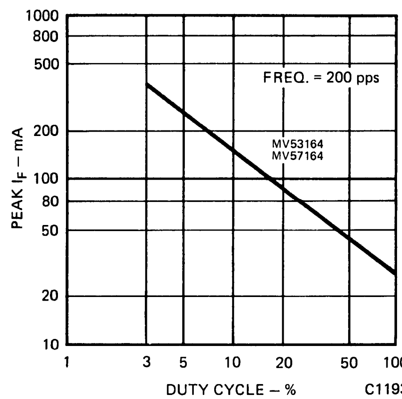


Fig. 4. Max Peak Current vs. Duty Cycle

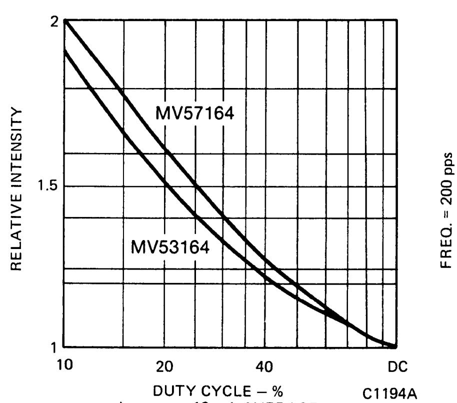


Fig. 5. Luminous Intensity vs. Duty Cycle

Light Bars and Bargraph Arrays

TYPICAL CURVES MV54164 (PER SEGMENT) (25°C Free Air Temperature)

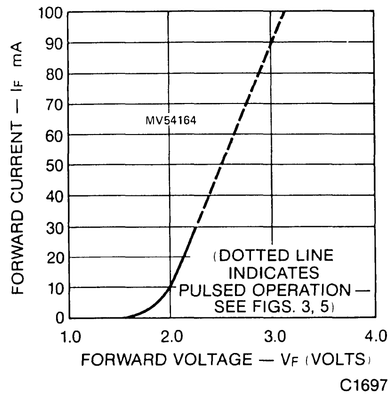


Fig. 6. Forward Current vs. Forward Voltage

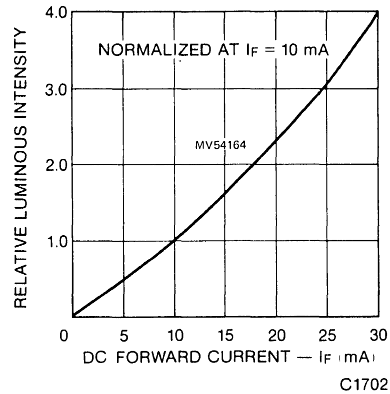


Fig. 7. Relative Luminous Intensity vs. DC Forward Current

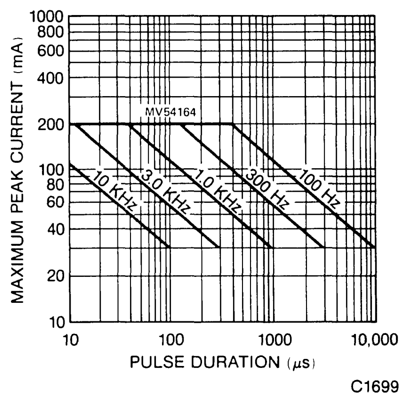


Fig. 8. Maximum Peak Current vs. Pulse Duration

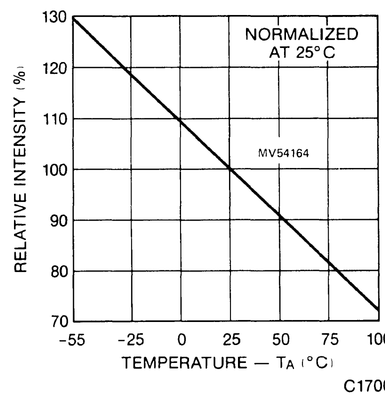


Fig. 9. Relative Luminous Intensity vs. Temperature

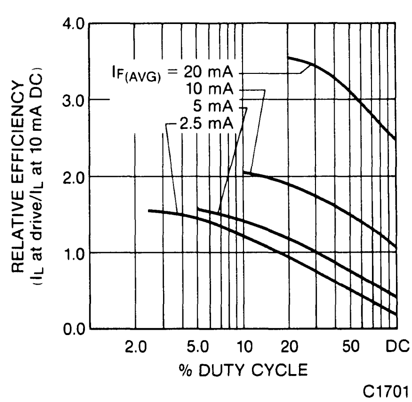


Fig. 10. Relative Efficiency vs. Duty Cycle

FILTER RECOMMENDATIONS

For optimum ON and OFF contrast, one of the following filters or equivalents may be used over the lamp:

MV53164	MV54164	MV57164
Panelgraphic Yellow 25 or Amber 23	Panelgraphic Green 48	Panelgraphic Red 60
Homalite 190 — 1720 or 100 — 1726	Homalite 100 — 1440 Green	Homalite 100 — 1605

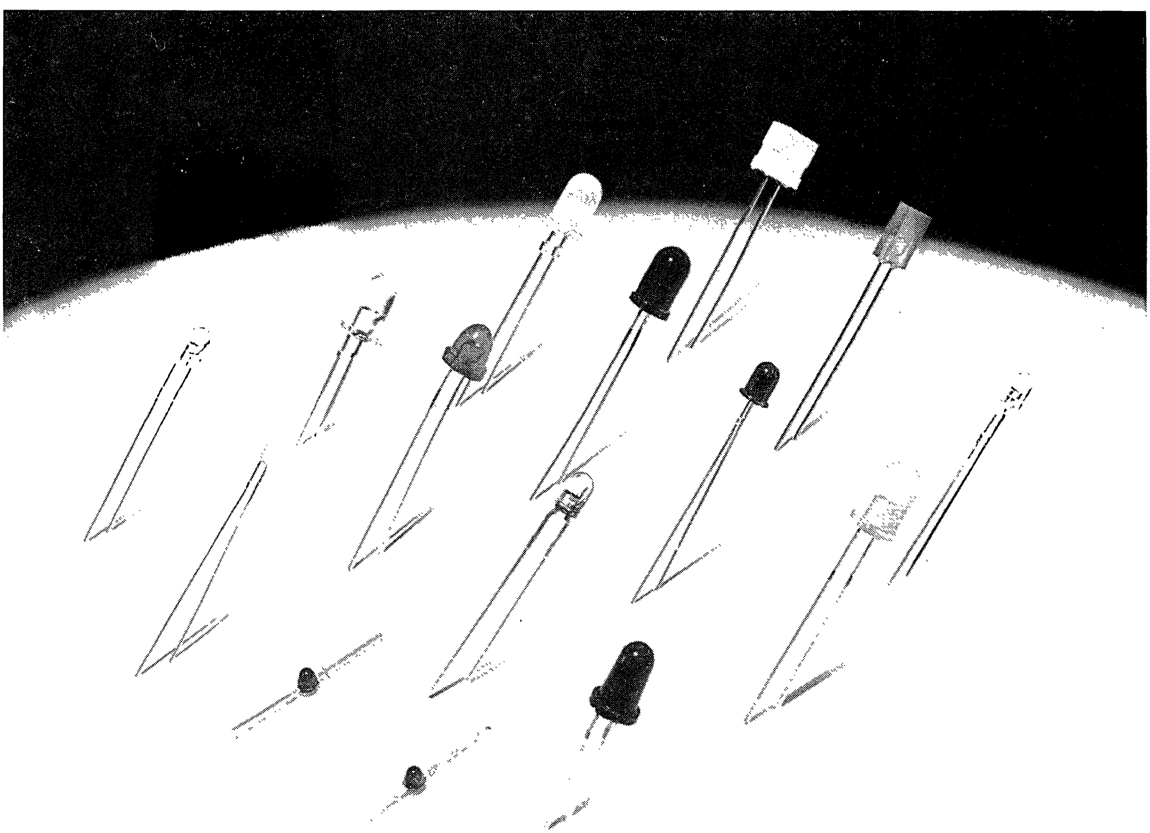
In situations of high ambient light, a neutral density filter can be used to achieve greater contrast:

Panelgraphic Grey 10	Panelgraphic Grey 10	
	Homalite 100 — 1266 Grey	

NOTES

1. *The average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. The standard of measurement is the Photo Research Corp. "Spectra" Microcandela Meter (Model IV-D) corrected for wavelength. Intensity will not vary more than ±33.3% between all segments within a unit.*
2. *The curve in Figure 3 is normalized to the brightness at 25°C to indicate the relative efficiency over the operating temperature range.*
3. *Leads immersed to 1/16 inch (1.6 mm) from the body of the device. Maximum unit surface temperature is 140°C.*
4. *All units are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.*
5. *For flux removal, Freon TF, Freon TE, Isoproponal or water may be used up to their boiling points.*

Lamps 4

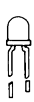


Lamps

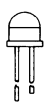
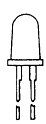
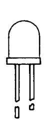
Alphanumeric Product Listing

Product	Page	Product	Page	Product	Page	Product	Page
FLV110	351	MV2454	331	MV53154	339	MV5754A	349
HLMP-0300	359	MV3350	341	MV5352	347	MV5760	329
HLMP-0301	359	MV3450	341	MV5353	349	MV57620	329
HLMP-0400	359	MV3750	341	MV5354A	349	MV57621	329
HLMP-0401	359	MV49124A	361	MV5360	329	MV57622	329
HLMP-0503	359	MV50B	323	MV53621	329	MV57640	333
HLMP-0504	359	MV50152	339	MV53622	329	MV57641	333
HLMP-1300	333	MV50154	339	MV53640	333	MV57642	333
HLMP-1301	333	MV5021	337	MV53641	333	MV5774C	327
HLMP-1302	333	MV5022	337	MV53642	333	MV5777C	325
HLMP-1320	329	MV5023	337	MV5374C	327	MV6053	343
HLMP-1321	329	MV5024	337	MV5377C	325	MV6151	353
HLMP-1340	329	MV5025	337	MV54B	323	MV6152	347
HLMP-1420	329	MV5026	337	MV54123	357	MV6153	349
HLMP-1440	329	MV5052	343	MV54124A	361	MV6154A	349
HLMP-1503	333	MV5053	343	MV54152	339	MV6351	353
HLMP-1520	329	MV5054-1	345	MV54154	339	MV6352	347
HLMP-1521	329	MV5054-2	345	MV5452	347	MV6353	349
HLMP-1523	333	MV5054-3	345	MV5453	349	MV6354A	349
HLMP-1540	329	MV5054A-1	343	MV5454A	349	MV64B	323
HLMP-1700	331	MV5054A-2	343	MV5460	329	MV6451	353
HLMP-1719	331	MV5054A-3	343	MV54624	329	MV64520	347
HLMP-3300	351	MV5055	343	MV54643	333	MV64521	347
HLMP-3301	351	MV50640	333	MV54644	333	MV64530	349
HLMP-3315	351	MV5074C	327	MV5474C	327	MV64531	349
HLMP-3316	351	MV5075C	327	MV5477C	325	MV6454A	349
HLMP-3750	341	MV5077C	325	MV5491A	355	MV6752	347
HLMP-3850	341	MV5094A	355	MV55AB	323	MV6753	349
HLMP-3950	341	MV5152	347	MV57B	323	MV6754A	349
HLMP-4700	331	MV5153	349	MV57123	357	MV6951	353
HLMP-4719	331	MV5154A	349	MV57124A	361	TAPE AND REEL	363
MP22	364	MV53B	323	MV57152	339		
MP52	364	MV53123	357	MV57154	339		
MP65	365	MV53124A	361	MV5752	347		
MV10B	335	MV53152	339	MV5753	349		

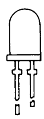
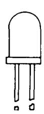
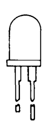
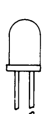
LAMPS

PACKAGE	PART NUMBER	SOURCE COLOR	LENS TYPE	VIEWING ANGLE $2\theta_{1/2}$	LUMINOUS INTENSITY (TYP. mcd/mA)	PAGE
T-¾	MV50B	Standard Red	Water Clear	80	1.4/20	323
	MV54B	Standard Red	Red Clear	80	1.0/20	
	MV53B	Yellow	Yellow Clear	80	2.0/20	
	MV64B	High Eff. Green	Green Clear	80	2.0/20	
	MV55AB	High Eff. Red	Red Clear	40	0.5/5	
	MV57B	High Eff. Red	Red Clear	80	2.0/20	
T-1 Low Profile	MV5077C	Standard Red	Red Diffused	110	1.75/20	325
	MV5377C	Yellow	Yellow Diffused	180	2.0/20	
	MV5477C	Hi. Eff. Green	Green Diffused	180	2.5/20	
	MV5777C	Hi. Eff. Red	Red Diffused	180	3.0/20	
T-1	MV5074C	Standard Red	Red Clear	70	2.5/20	327
	MV5075C	Standard Red	Red Diffused	90	1.5/20	
	MV5374C	Yellow	Yellow Diffused	90	4.0/20	
	MV5474C	Hi. Eff. Green	Green Diffused	90	4.0/20	
	MV5774C	Hi. Eff. Red	Red Diffused	90	5.0/20	
T-100 Clear Lens	HLMP-1440	Yellow	Pale Yellow Tint	24	60/20	329
	MV5360 (HLMP-1420)	Yellow	Pale Yellow Tint	45	12/10	
	MV53621	Yellow	Yellow Clear	45	4/10	
	MV53622	Yellow	Yellow Clear	45	8/10	
	HLMP-1540	Hi. Eff. Green	Pale Green Tint	24	60/20	
	MV5460 (HLMP-1520)	Hi. Eff. Green	Pale Green Tint	45	12/20	
	MV54624 (HLMP-1521)	Hi. Eff. Green	Green Clear	45	12/20	
	HLMP-1340	Hi. Eff. Red	Pink Tint	24	60/20	
	MV5760 (HLMP-1320)	Hi. Eff. Red	Pink Tint	45	12/10	
	MV57620	Hi. Eff. Red	Red Clear	45	2/10	
	MV57621	Hi. Eff. Red	Red Clear	45	4/10	
	MV57622 (HLMP-1321)	Hi. Eff. Red	Red Clear	45	12/10	

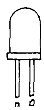
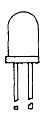
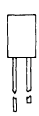
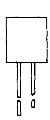
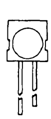
LAMPS

PACKAGE	PART NUMBER	SOURCE COLOR	LENS TYPE	VIEWING ANGLE 2Θ½	LUMINOUS INTENSITY (TYP. mcd/mA)	PAGE
T-100 Diffused	MV50640	Standard Red	Red Diffused	90	1.5/20	333
	HLMP-1719	Yellow	Yellow Diffused	50	2.0/2	331
	MV53640	Yellow	Yellow Diffused	90	2.0/10	333
	MV53641	Yellow	Yellow Diffused	90	3.0/10	333
	MV53642	Yellow	Yellow Diffused	90	4.5/10	333
	MV54643 (HLMP-1503)	Hi. Eff. Green	Green Diffused	90	5/20	333
	MV54644 (HLMP-1523)	Hi. Eff. Green	Green Diffused	90	10/20	333
	HLMP-1700	Hi. Eff. Red	Red Diffused	50	2.0/2	331
	MV57640 (HLMP-1300)	Hi. Eff. Red	Red Diffused	90	2.0/10	333
	MV57641 (HLMP-1301)	Hi. Eff. Red	Red Diffused	90	2.5/10	333
	MV57642 (HLMP-1302)	Hi. Eff. Red	Red Diffused	90	4.0/10	333
TO-18 	MV10B	Standard Red	Water Clear	90	0.8/10	335
T-1¾ Taper	MV5021	Standard Red	White Diffused	90	1.6/20	337
	MV5022	Standard Red	Red Clear	90	1.6/20	
	MV5023	Standard Red	Red Diffused	90	1.6/20	
	MV5024	Standard Red	Red Diffused	60	3.0/20	
	MV5025	Standard Red	Red Diffused	180	0.4/20	
	MV5026	Standard Red	Deep Red Diffused	90	0.6/20	
T-1¾ Bullet	MV50152	Standard Red	Red Clear	45	2.0/10	339
	MV53152	Yellow	Amber Clear	45	5.0/10	
	MV54152	Hi. Eff. Green	Green Clear	45	5.0/10	
	MV57152	Hi. Eff. Red	Orange Clear	45	8.0/10	
	MV50154	Standard Red	Red. Lightly Diff.	50	1.5/10	
	MV53154	Yellow	Amber Lightly Diff.	50	-3.0/10	
	MV54154	Hi. Eff. Green	Green Lightly Diff.	50	3.0/10	
	MV57154	Hi. Eff. Red	Red Lightly Diff.	50	4.0/10	
T-1¾ Low Profile 	FLV110	Standard Red	Red. Diffused	70	3.0/20	351

LAMPS

PACKAGE	PART NUMBER	SOURCE COLOR	LENS TYPE	VIEWING ANGLE $2\theta_{1/2}$	LUMINOUS INTENSITY (TYP. mcd/mA)	PAGE
T-1¾ Clear Stand-off 	HLMP-3850 (Ultrabright)	Yellow	Pale Yellow Tint	24	150/20	
	HLMP-3950 (Ultrabright)	Hi. Eff. Green	Pale Green Tint	24	150/20	341
	HLMP-3750 (Ultrabright)	Hi. Eff. Red	Pink Tint	24	150/20	
T-1¾ Clear 	MV5052	Standard Red	Red Clear	72	2.0/20	343
	MV3350 (Ultrabright)	Yellow	Pale Yellow Tint	24	150/20	341
	MV5352/MV6352	Yellow	Yellow Clear	28	45/20	347
	MV3450 (Ultrabright)	Hi. Eff. Green	Pale Green Tint	24	150/20	341
	MV5452/MV64520	Hi. Eff. Green	Green Clear	35	25/20	347
	MV64521	Hi. Eff. Green	Green Clear	35	60/20	347
	MV5152/MV6152	Hi. Eff. Red	Amber Clear	28	40/20	347
	MV3750 (Ultrabright)	Hi. Eff. Red	Pink Tint	24	150/20	341
	MV5752/MV6752	Hi. Eff. Red	Red Clear	28	40/20	347
	HLMP-3315	Hi. Eff. Red	Red Clear	35	18/10	351
	HLMP-3316	Hi. Eff. Red	Red Clear	35	30/10	351
T-1¾ Stand-off 	MV5054-1	Standard Red	Red Diffused	40	2.0/10	
	MV5054-2	Standard Red	Red Diffused	40	3.0/10	345
	MV5054-3	Standard Red	Red Diffused	40	4.0/10	
T-1¾ Diffused Narrow Angle 	MV5054A-1	Standard Red	Red Diffused	40	2.0/10	343
	MV5054A-2	Standard Red	Red Diffused	40	3.0/10	343
	MV5054A-3	Standard Red	Red Diffused	40	4.0/10	343
	HLMP-4719	Yellow	Yellow Diffused	50	2.0/2	331
	MV5354A/MV6354A	Yellow	Yellow Diffused	24	20.0/20	349
	MV2454	Hi. Eff. Green	Green Diffused	35	3.0/3.5	331
	MV5454A/MV6454A	Hi. Eff. Green	Green Diffused	24	20.0/20	349
	MV5154A/MV6154A	Hi. Eff. Red	Amber Diffused	24	20.0/20	349
	HLMP-4700	Hi. Eff. Red	Red Diffused	50	2.0/2	331
	MV5754A/MV6754A	Hi. Eff. Red	Red Diffused	24	20.0/20	349

LAMPS

PACKAGE	PART NUMBER	SOURCE COLOR	LENS TYPE	VIEWING ANGLE $2\theta_{1/2}$	LUMINOUS INTENSITY (TYP. mcd/mA)	PAGE
T-1¾ Diffused Wide Angle	MV5053/MV6053	Standard Red	Red Diffused	80	1.6/20	343
	MV5055	Standard Red	Red Diffused	150	0.1/20	343
	MV5353/MV6353	Yellow	Yellow Diffused	65	8.0/20	349
	MV5453/MV64530	Hi. Eff. Green	Green Diffused	75	6.0/20	349
	MV64531	Hi. Eff. Green	Green Diffused	75	14.0/20	349
	MV5153/MV6153	Hi. Eff. Red	Amber Diffused	65	6.0/20	349
	MV5753/MV6753	Hi. Eff. Red	Red Diffused	65	9.0/20	349
	HLMP-3300	Hi. Eff. Red	Red Diffused	65	3.5/10	351
	HLMP-3301	Hi. Eff. Red	Red Diffused	65	7.0/10	351
T-1¾ Max. Contrast White Diffused	MV6351	Yellow	White Diffused	70	12.0/20	353
	MV6451	Hi. Eff. Green	White Diffused	70	12.0/20	353
	MV6151	Hi. Eff. Red	White Diffused	70	12.0/20	353
	MV6951	Deep Red	White Diffused	70	12.0/20	353
	MV5094A (Bipolar)	Red/Red	White Diffused	75	6.0/20	355
	MV5491A (Bicolor)	Red/Green	White Diffused	100	6.0/20	355
Rectangular						
	MV53123	Yellow	Yellow Diffused	100	4.0/20	
	MV54123	Hi. Eff. Green	Green Diffused	100	4.0/20	357
	MV57123	Hi. Eff. Red	Red Diffused	100	4.0/20	
	HLMP-0400	Yellow	Yellow Diffused	100	2.5/20	
	HLMP-0401	Yellow	Yellow Diffused	100	5.0/20	
	HLMP-0503	Hi. Eff. Green	Green Diffused	100	3.0/20	359
	HLMP-0504	Hi. Eff. Green	Green Diffused	100	5.0/20	
	HLMP-0300	Hi. Eff. Red	Red Diffused	100	2.5/20	
	HLMP-0301	Hi. Eff. Red	Red Diffused	100	5.0/20	
	MV53124A	Yellow	Yellow Diffused	100	6.0/20	
	MV54124A	Hi. Eff. Green	Green Diffused	100	6.0/20	
	MV57124A	Hi. Eff. Red	Red Diffused	100	6.0/20	361
	MV49124A (Bicolor)	Red/Green	White Diffused	100	6.0/20	

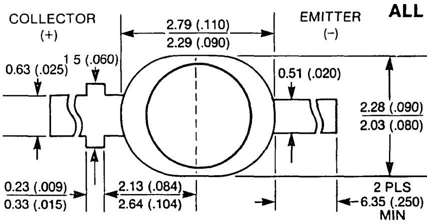
GENERAL INSTRUMENT

SUBMINIATURE T-¾ SOLID STATE LAMPS

YELLOW MV53B
HIGH EFFICIENCY RED MV64B
STANDARD RED MV50B HIGH EFFICIENCY RED MV55AB
STANDARD RED MV54B HIGH EFFICIENCY RED MV57B

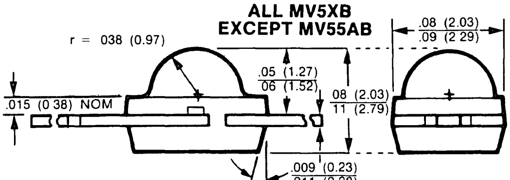
PACKAGE DIMENSIONS

ALL MV5XB



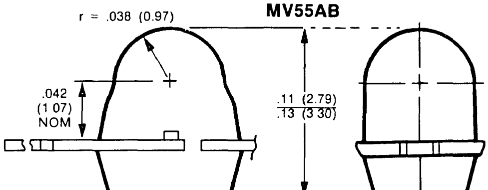
C1994A

ALL MV5XB EXCEPT MV55AB



C576A

MV55AB



C593A

NOTES:
1. ALL DIMENSIONS IN INCHES (mm)
2. TOLERANCES ARE ± .010 INCH UNLESS SPECIFIED

DESCRIPTION

The family of MV53B, MV54B, MV57B, and MV64B are non-diffused, tinted subminiature T-¾ radial lamps with wide viewing angle.

The MV50B is Water Clear with wide viewing angle while MV55AB is tinted, non-diffused narrow viewing angle specified at 5 mA.

FEATURES

These subminiature LED lamps are intended for high volume, low-cost status indication on PC boards and for backlighting switches and keyboard keys. The lamps are compatible with vapor phase reflow surface mount and conventional soldering switches.

- Subminiature package
- All colors
- Solid state reliability
- Choice of viewing angle

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS EFFECT
MV50B	Standard Red	Water Clear
MV54B	Standard Red	Red
MV53B	Yellow	Yellow
MV64B	High Efficiency Green	Green
MV55AB	High Efficiency Red	Red/Narrow
MV57B	High Efficiency Red	Red

Lamps

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

PARAMETER	YELLOW HI EFF. RED MV53B MV55AB MV57B	STD. RED MV50B MV54B	HI EFF. GREEN MV64B	UNITS	NOTES
Power dissipation	105	105	105	mW	
Average forward current	35 (1)	50 (2)	30 (3)	mA	1,2,3
Peak forward current (1 μs, PW 0.1% DF)	400	1000	90	mA	
Lead soldering time at 230° C	5	5	5	sec	4
Storage and operating temperatures		-55° C to +100° C			

NOTES

1. *Derate linearly from 50° C at 0.7 mA/° C*
2. *Derate linearly from 50° C at 1.0 mA/° C*
3. *Derate linearly from 50° C at 0.6 mA/° C*

ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

PARAMETER		SYMBOL	MV50B	MV53B	MV54B	MV55AB	MV57B	MV64B	UNITS	CONDITIONS
Luminous	min.	I_V	0.5	1.0	0.4	*	1.0	1.0	mcd	I_F = 20 mA
Intensity (5)	typ.		1.4	2.0	1.0	2.0	20	2.0	mcd	I_F = 20 mA
Forward	max.	V_F	2.0	3.0	2.0	*	3.0	3.0	V	I_F = 20 mA
voltage	typ.		1.65	2.1	1.65	2.2	2.1	2.2	V	I_F = 20 mA
Peak wavelength		λ_p	660	585	660	635	635	565	nm	
Spectral line halfwidth	typ.		20	35	20	45	35	35	nm	
Reverse breakdown voltage	min.	V_{BR}	5	5	5	5	5	5	V	I_R = 100 μA
Total viewing angle (6)	typ.	$2\theta_{1/2}$	80	80	80	40	80	80	degrees	

*MV55AB I_V min = 0.2 mcd/5 mA, I_{VTYP} = 0.5 mcd/5 mA, V_F max = 2.0 V/5 mA, V_{FTYP} = 1.6V/5 mA

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (T_A = 25° C Unless Otherwise Specified)

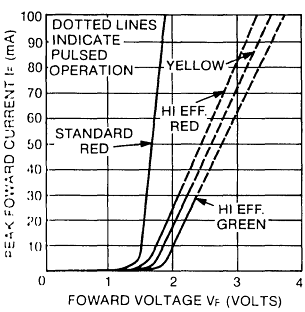


Fig. 1. Forward Current vs. Forward Voltage

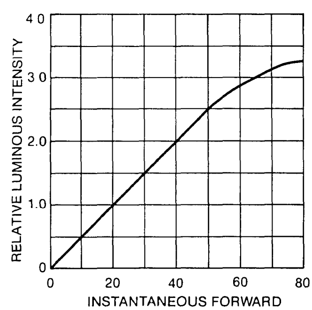


Fig. 2. Luminous Intensity vs. Forward Current

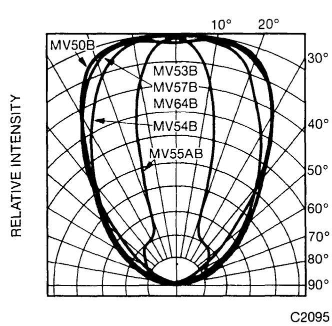


Fig. 3. Spatial Distribution

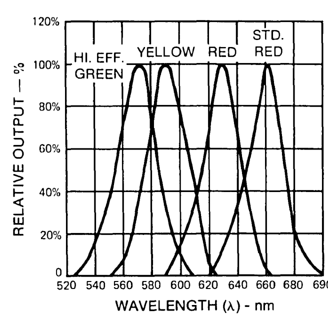


Fig. 4. Spectral Distribution

NOTES

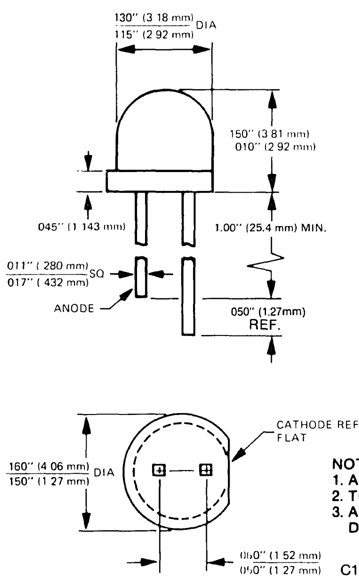
4. *The leads of the device were immersed in molten solder, heated to a temperature of 230° C, to a point 1/16 inch (1.6mm) from the body of the device per MIL-S-750, with dwell time of 5 sec.*
5. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
6. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*

GENERAL INSTRUMENT

LOW PROFILE T-1 SOLID STATE LAMPS

STANDARD RED MV5077C **HIGH EFFICIENCY GREEN MV5477C**
YELLOW MV5377C **HIGH EFFICIENCY RED MV5777C**

PACKAGE DIMENSIONS



NOTES:
1. ALL DIMENSIONS ARE IN INCHES (mm)
2. TOLERANCES ARE ±.010" INCH UNLESS SPECIFIED
3. AN EPOXY MENISCUS MAY EXTEND ABOUT .040" (1mm) DOWN THE LEADS

C1132A

DESCRIPTION

These solid state indicators offer a low profile T-1 package. The High Efficiency Red, Green and Yellow devices are made with a gallium arsenide phosphide on gallium phosphide. All are encapsulated in epoxy packages. Their small size (approximately T-1 size), good viewing angle, and small square leads contribute to their versatility as all purpose indicators.

FEATURES

- Square leads (will fit into .020-inch (.508 mm) diameter holes)
- Compact size
- Bright (up to 3.0 mcd at 20 mA)
- Very wide viewing angle
- Long life, rugged
- Mount on approximately 3/16-inch (4.72 mm) centers
- Tinted diffused

Lamps

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

Power dissipation	105 mW
Derate linearly from 25° C	-1.14 mW/° C
Storage and operating temperature	-55° C to +100° C
Continuous forward current	35 mA
Peak forward current (μsec pulse 0.3% duty cycle) (MV5477C=90 mA)	1.0 A
Reverse voltage	5.0 V
Lead soldering time at 260° C (See Note 2)	5 sec.

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	PACKAGE STYLE
MV5077C	Standard Red	Red Diffused	Wide Beam	Low Profile
MV5377C	Yellow	Yellow Diffused	Wide Beam	Low Profile
MV5477C	High Efficiency Green	Green Diffused	Wide Beam	Low Profile
MV5777C	Red	Red Diffused	Wide Beam	Low Profile

ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

PARAMETER		SYMBOL	TEST COND.	UNITS	MV5077C	MV5377C	MV5477C	MV5777C
Forward voltage	typ.	V_F	I_F = 20 mA	V	1.6	2.1	2.2	2.0
	max.		I_F = 20 mA	V	2.0	3.0	3.0	3.0
Luminous Intensity (See Note 1)	min.	I_V	I_F = 20 mA	mcd	0.3	1.0	1.0	1.0
	typ.		I_F = 20 mA	mcd	1.75	2.0	2.5	3.0
Peak wavelength		λ_p	I_F = 20 mA	nm	660	585	565	635
Spectral line half width			I_F = 20 mA	nm	20	35	35	45
Capacitance	typ.	C	V = 0	pF	23	45	20	45
Reverse voltage	min.	V_R	I_R = 100 μA	V	5	5	5	5
	typ.		I_R = 100 μA	V	15	25	25	25
Viewing angle (total)	(Fig. 3)	$2\Theta½$		degrees	110	180	180	180

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES
(25° C Free Air Temperature Unless Otherwise Specified)

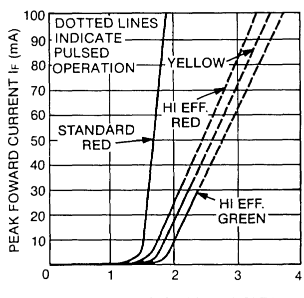


Fig. 1. Forward Current vs. Forward Voltage

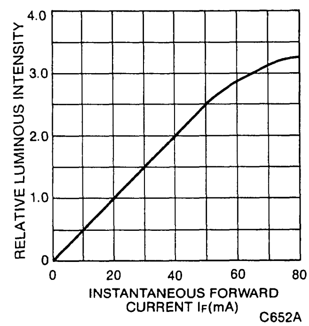


Fig. 2. Luminous Intensity vs. Forward Current

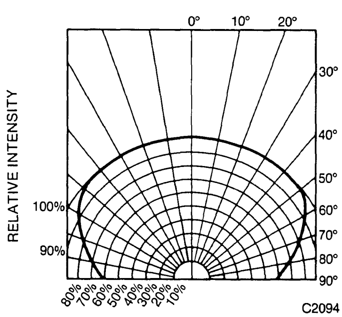


Fig. 3. Spatial Distribution

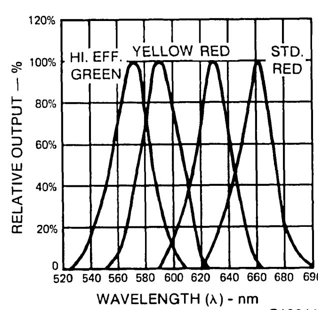


Fig. 4. Spectral Distribution

NOTES

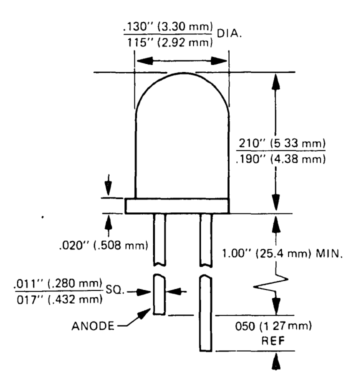
1. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The leads of the device were immersed in molten solder, at 260° C, to a point 1/16 inch (1.6 mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

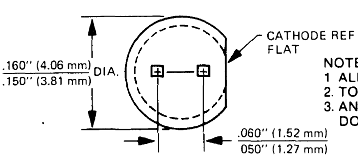
GENERAL INSTRUMENT

T-1 SOLID STATE LAMPS

STANDARD RED MV5074C
STANDARD RED MV5075C
YELLOW MV5374C
HIGH EFFICIENCY GREEN MV5474C
HIGH EFFICIENCY RED MV5774C

PACKAGE DIMENSIONS





NOTES:
1. ALL DIMENSIONS ARE IN INCHES (mm)
2. TOLERANCES ARE ±.010" INCH UNLESS SPECIFIED
3. AN EPOXY MENISCUS MAY EXTEND ABOUT .040" (1mm) DOWN THE LEADS

C1128B

DESCRIPTION

These solid state indicators offer a variety of color selection. The High Efficiency Red, Green and Yellow devices are made with a gallium arsenide phosphide on gallium phosphide. All are encapsulated in epoxy packages. Their small size (approximately T-1 size), good viewing angle, and small square leads contribute to their versatility as all purpose indicators.

FEATURES

- Square leads (will fit into .020-inch (.508mm) diameter hole)
- Compact size
- Bright (typically 2.0 mcd at 20 mA)
- Long life, rugged
- 1-inch (25.4 mm) minimum lead length
- Mount on approximately 3/16-inch (4.72 mm) centers

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

Power dissipation	105 mW
Derate linearly from 25° C	–1.14 mW/° C
Storage and operating temperature	-55° C to +100° C
Lead soldering time at 260° C (See Note 2)	5 sec.
Continuous forward current	35 mA
Peak forward current (μsec pulse 0.3% duty cycle) (MV5474C=90 mA)	1.0 A
Reverse voltage	5.0 V

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	PACKAGE STYLE
MV5074C	Standard Red	Red Clear	Narrow Beam	High Profile
MV5075C	Standard Red	Red Diffused	Wide Beam	High Profile
MV5374C	Yellow	Yellow Diffused	Wide Beam	High Profile
MV5474C	High Efficiency Green	Green Diffused	Wide Beam	High Profile
MV5774C	High Efficiency Red	Red Diffused	Wide Beam	High Profile

ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

PARAMETER		SYMBOL	TEST COND.	UNITS	MV5074C	MV5075C	MV5374C	MV5474C	MV5774C
Forward voltage	typ.	V_F	I_F = 20 mA	V	1.6	1.6	2.1	2.2	2.0
	max.		I_F = 20 mA	V	2.0	2.0	3.0	3.0	3.0
Luminous Intensity (See Note 1)	min.	I_V	I_F = 20 mA	mcd	0.7	0.6	1.5	1.2	1.5
	typ.		I_F = 20 mA	mcd	2.5	1.5	4.0	4.0	5.0
Peak wavelength		λ_p	I_F = 20 mA	nm	660	660	585	565	635
Spectral line half width			I_F = 20 mA	nm	20	20	35	35	45
Capacitance	typ.	C	V = 0	pF	23	23	45	20	45
Reverse voltage	min.	V_{BR}	I_R = 100 μA	V	5	5	5	5	5
	typ.		I_R = 100 μA	V	15	15	25	25	25
Reverse current	max.		V_R = 5.0 V	μA	100	100	100	100	100
Viewing angle (total)		$2\Theta_{1/2}$	See Fig. 3	degrees	70	90	90	90	90

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES
(25° C Free Air Temperature Unless Otherwise Specified)

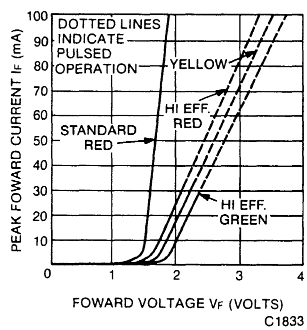


Fig. 1. Forward Current vs. Forward Voltage

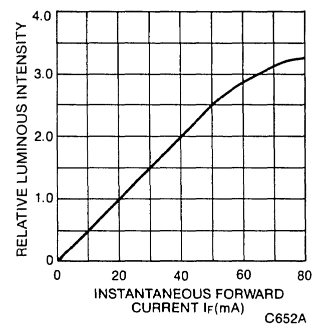


Fig. 2. Luminous Intensity vs. Forward Current

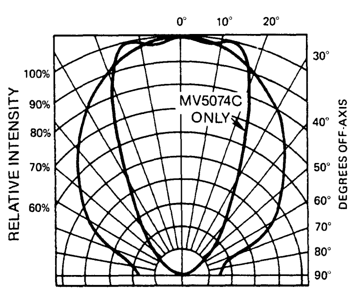


Fig. 3. Spatial Distribution

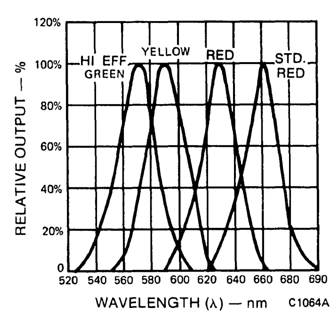


Fig. 4. Spectral Distribution

NOTES

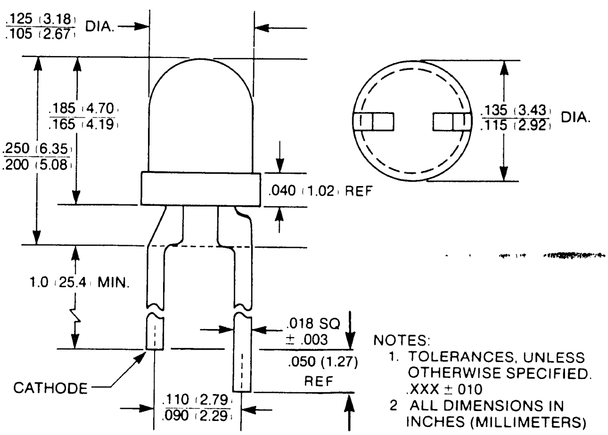
1. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The leads of the device were immersed in molten solder, at 260° C, to a point 1/16 inch (1.6 mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

GENERAL INSTRUMENT

CLEAR LENS T-100 SOLID STATE LAMPS

YELLOW MV5362X TINTED, HLMP-1440, MV5360 PALE TINT
HIGH EFFICIENCY GREEN MV5462X TINTED, HLMP-1540, MV5460 PALE TINT
HIGH EFFICIENCY RED MV5762X TINTED, HLMP-1340, MV5760 PALE TINT

PACKAGE DIMENSIONS



NOTES:
1. TOLERANCES, UNLESS OTHERWISE SPECIFIED. .XXX ± .010
2. ALL DIMENSIONS IN INCHES (MILLIMETERS)

C1533G

DESCRIPTION

These solid state indicators offer a variety of color selection. The High Efficiency Red and Yellow devices are made with gallium arsenide phosphide on gallium phosphide. All are encapsulated in epoxy packages and have clear lenses. Their small size, wide viewing angle, and small square leads contribute to their versatility as all-purpose indicators. All types are tinted to aid identification.

FEATURES

- Standard and Ultrabright devices
- Clear tinted lenses
- 100 mil lead spacing
- High efficiency GaP
- Versatile mounting on PC board or panel
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight
- T-1 diameter
- Replacement for the HLMP-1X20/1 Series
- Excellent for switch backlighting

Lamps

PHYSICAL CHARACTERISTICS

	TYPE	SOURCE COLOR	LENS EFFECT	LUMINOUS INTENSITY at 25°C (mcd) MIN.	TYP.	TEST CONDITION
Ultrabright	HLMP-1440	Yellow	Pale Tint	24.0	60.0	I_F = 20 mA
	MV5360 (HLMP-1420)	Yellow	Pale Tint	6.0	12.0	
	MV53621	Yellow	Tinted	3.0	4.0	
	MV53622	Yellow	Tinted	6.0	8.0	
Ultrabright	HLMP-1540	High Efficiency Green	Pale Tint	24.0	60.0	I_F = 20 mA
	MV5460 (HLMP-1520)	High Efficiency Green	Pale Tint	6.0	12.0	
	MV54624 (HLMP-1521)	High Efficiency Green	Tinted	6.0	12.0	
Ultrabright	HLMP-1340	High Efficiency Red	Pale Tint	24.0	60.0	I_F = 20 mA
	MV5760 (HLMP-1320)	High Efficiency Red	Pale Tint	6.0	12.0	
	MV57620	High Efficiency Red	Tinted	1.5	2.0	I_F = 10 mA
	MV57621	High Efficiency Red	Tinted	3.0	4.0	
	MV57622 (HLMP-1321)	High Efficiency Red	Tinted	6.0	12.0	

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

Power dissipation .... 120 mW
Derate linearly from 50° .... 0.4 mA/° C
Storage and operating temperature .... -55° C to +100° C
Lead soldering time at 260° C (1/16 inch from body) .... 5 sec.
Continuous forward current .... 30 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle) .... 90 mA
Reverse voltage .... 5.0 V

ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature Unless Otherwise Specified)

PARAMETER	TEST CONDITIONS	UNITS	MV5362X MV5360	MV5462X MV5460	MV5762X MV5760	HLMP-1340	HLMP-1440	HLMP-1540
Forward voltage (V_F)								
typ.	I_F = 10 mA	V	2.1	2.1*	2.0	2.2*	2.2*	2.2*
max.			3.0	3.0*	3.0	3.0*	3.0*	3.0*
Peak wavelength		nm	585	565	635	635	585	565
Spectral line half width		nm	35	40	45	45	35	40
Capacitance typ.	f = 1 MHz, V = 0	pF	45	20	45	45	45	20
Reverse voltage (V_R) min.	I_R = 100 μA	V	5.0	5.0	5.0	5.0	5.0	5.0
Viewing angle (total) typ.	See Fig. 3	degrees	45	45	45	24	24	24

I_F = 20 mA

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25° C Free Air Temperature Unless Otherwise Specified)

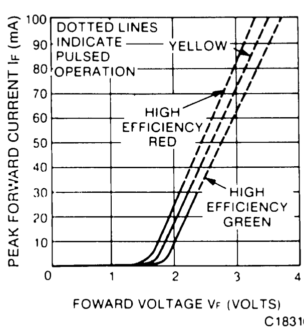


Fig. 1. Forward Current vs. Forward Voltage

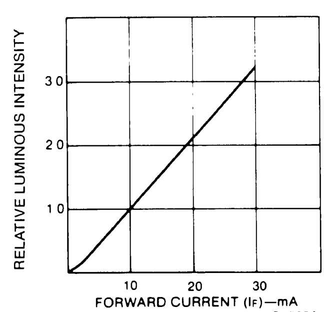


Fig. 2. Relative Luminous Intensity vs. Forward Current

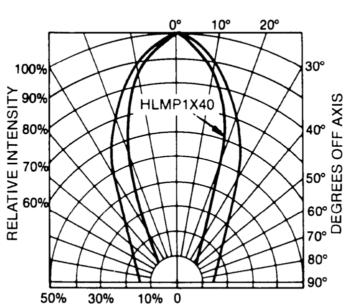


Fig. 3. Spatial Distribution

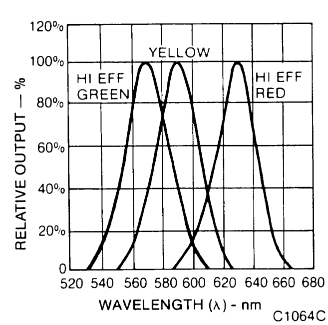


Fig. 4. Spectral Distribution

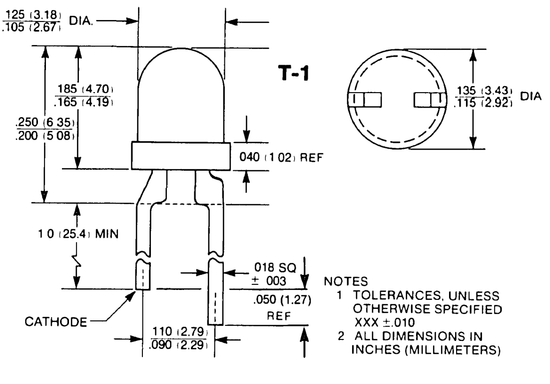
GENERAL INSTRUMENT

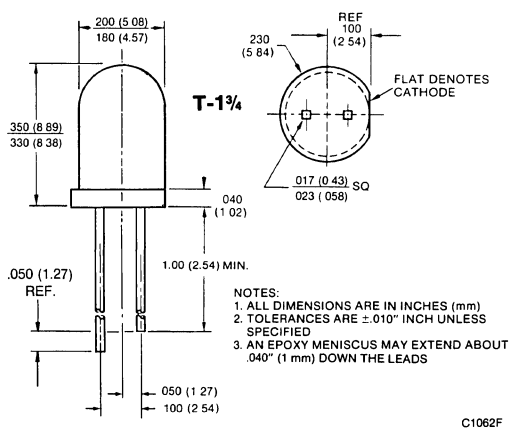
LOW CURRENT T-100 & T-1¾ SOLID STATE LAMPS

2 mA

HIGH EFFICIENCY RED **HLMP-1700 HLMP-4700**
YELLOW **HLMP-1719 HLMP-4719**
HIGH EFFICIENCY GREEN **MV2454**

PACKAGE DIMENSIONS





DESCRIPTION

The T-1¾ HLMP-4700 Series and T-1 HLMP-1700 Series are direct pin-for-pin replacements for the Hewlett-Packard lamps with the same part numbers. All devices are tinted diffused with a medium-wide viewing angle. The design of the LED chips is optimized for low current applications and is far superior in Luminous Intensity compared to standard LED lamps at very low current.

These low current lamps are primarily intended for direct view.

FEATURES

- Very low power — 4 mW
- 2 mA drive from low power TTL or CMOS
- All three colors
- Power savings in portable equipment
- Sturdier leads for easy assembly
- Both T-1¾ and T-1
- Use MP52 panel mounting grommet with HLMP-4700, HLMP-4719 and MV2454

APPLICATIONS

- Portable battery driven digital or linear electronic equipment like test instruments, robots and toys
- Multiple lamp applications to reduce power drain by 5 to 10 times and decrease power supply size and cost as in phones, PBX and signs

Lamps

PHYSICAL CHARACTERISTICS

SIZE	TYPE	SOURCE COLOR	LENS EFFECT
T-1	HLMP-1700	High Efficiency Red	Red Diffused
	HLMP-1719	Yellow	Yellow Diffused
T-1¾	HLMP-4700	High Efficiency Red	Red Diffused
	HLMP-4719	Yellow	Yellow Diffused
	MV2454	High Efficiency Green	Green Diffused

ABSOLUTE MAXIMUN RATINGS (T_A = 25° C Unless Otherwise Specified)

PARAMETER	HI. EFF. RED	YELLOW	HI. EFF. GREEN	UNITS	NOTES
Power dissipation	27	24	27	mW	1
DC forward current	7.5	7.5	7.5	mA	
Peak forward current (PW ≤ 1 ms, DF ≤ 30%)	25	25	25	mA	
Lead soldering time at 260° C	5	5	5	sec	2
Operating and storage temperatures		-55° C to +100° C			

NOTES
1) *Derate linearly from 92° C at 1 mA/° C.*
2) *At 1/16 inch (1.6 mm) from bottom of lamp.*

ELECTRO-OPTICAL CHARACTERISTICS (T_A= 25° C Unless Otherwise Specified)

			T-1¾			T-1			
PARAMETER		SYMBOL	HI. EFF. RED HLMP-4700	YELLOW HLMP-4719	HI. EFF. GREEN MV2454	HI. EFF. RED HLMP-1700	YELLOW HLMP-1719	UNITS	TEST COND.
Luminous Intensity	min.	I_V	1.2	1.2	1.2*	1.0	1.0	mcd	I_F = 2 mA
	typ.		2.0	2.0	3.0*	2.0	2.0	mcd	I_F = 2 mA
Forward voltage	max.	V_F	2.2	2.7	2.7	2.2	2.7	V	I_F = 2 mA
	typ.		1.8	1.9	1.9	1.8	1.9	V	I_F = 2 mA
Peak wavelength	typ.	λ_p	635	585	565	635	585	nm	I_F = 2 mA
Reverse breakdown voltage	min.	V_{BR}	5	5	5	5	5	V	I_R = 100 μA
Viewing angle (total)	typ.	$2\Theta½$	50	50	35	50	50	degrees	

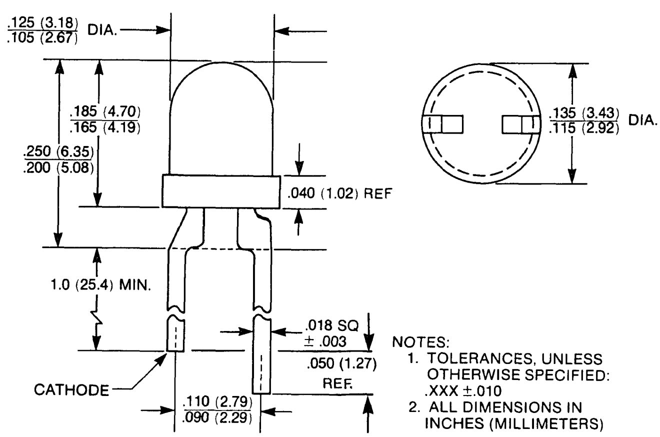
*MV2454 Luminous Intensity is measured at 3.5 mA

GENERAL INSTRUMENT

DIFFUSED T-100 SOLID STATE LAMPS

RED MV50640
YELLOW MV5364X
HIGH EFFICIENCY GREEN MV5464X/HLMP-15X3
HIGH EFFICIENCY RED MV5764X/HLMP-130X

PACKAGE DIMENSIONS



NOTES:
1. TOLERANCES, UNLESS OTHERWISE SPECIFIED: .XXX ±.010
2. ALL DIMENSIONS IN INCHES (MILLIMETERS)

C1533G

DESCRIPTION

These solid state indicators offer a variety of color selection. The High Efficiency Red and Yellow devices are made with gallium arsenide phosphide on gallium phosphide. The High Efficiency Green utilizes an improved gallium phosphide light emitting diode. All are encapsulated in epoxy packages with diffused lenses. Their small size, wide viewing angle, and small square leads contribute to their versatility as all-purpose indicators.

FEATURES

- Replacement for the HLMP-1300 and -1500 product series
- 100 mil lead spacing T-1
- High efficiency GaP light
- Versatile mounting on PC board or panel
- Wide viewing angle
- Diffused tinted lens

Lamps

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS EFFECT	LUMINOUS INTENSITY at 25° C (mcd) MIN.	TYP.	TEST CONDITIONS
MV50640	Standard Red	Red Diffused	0.5	1.5	$I_F = 20$ mA
MV53640			1.0	2.0	
MV53641	Yellow	Yellow Diffused	1.5	3.0	$I_F = 10$ mA
MV53642			2.5	4.5	
MV54643 (HLMP-1503)	High Efficiency Green	Green Diffused	2.0	5.0	$I_F = 20$ mA
MV54644 (HLMP-1523)			6.0	10.0	
MV57640 (HLMP-1300)			1.0	2.0	
MV57641 (HLMP-1301)	High Efficiency Red	Red Diffused	2.0	2.5	$I_F = 10$ mA
MV57642 (HLMP-1302)			3.0	4.0	

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

	ALL BUT GREEN	GREEN
Power dissipation at 25° C ambient	120 mW	120 mW
Derate linearly from 50° C	1.6 mA/° C	1.6 mA/° C
Storage and operating temperatures	-55° C to +100° C	-55° C to +100° C
Lead soldering time at 260° C (1/16 inch from body)	5 sec.	5 sec.
Continuous forward current at 25° C	30 mA	30 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle)	1.0 A	90 mA
Reverse voltage	5.0 V	5.0 V

ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature Unless Otherwise Specified)

PARAMETER		SYMBOL	TEST COND.	UNITS	MV50640* RED	MV5364X YELLOW	MV5464X HI. EFF. GREEN	MV5764X HI. EFF. RED
Forward voltage	typ.	V_F	I_F = 10 mA	V	1.6	2.1	2.2*	2.0
	max.				2.0	3.0	3.0*	3.0
Peak wavelength		λ	I_F = 10 mA	nm	660	585	562	635
Spectral line half width			I_F = 10 mA	nm	20	35	30	45
Capacitance	typ.	C	V = 0, f = 1 MHz,	pF	23	45	20	45
Reverse voltage	min.	V_{BR}	I_F = 100 μA	V	5.0	5.0	5.0	5.0
Viewing angle (total)	typ.	2Θ½	See Fig. 3	degrees	90	90	90	90

I_F = 20 mA

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES
(25° C Free Air Temperature Unless Otherwise Specified)

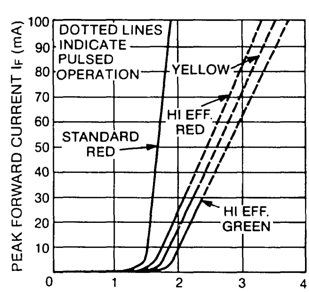


Fig. 1. Forward Current vs. Forward Voltage

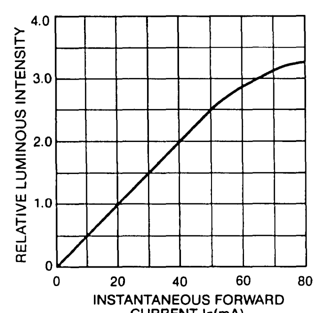


Fig. 2. Luminous Intensity vs. Forward Current

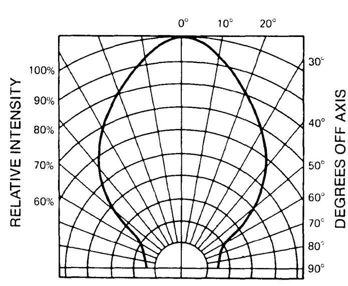


Fig. 3. Spatial Distribution

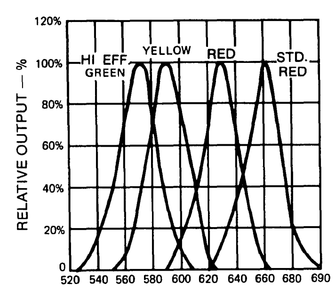


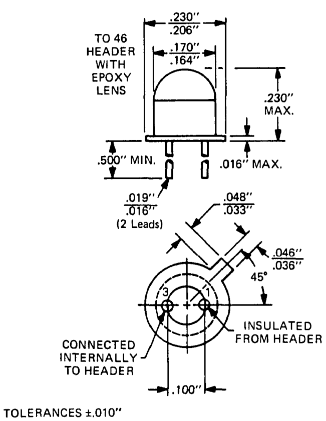
Fig. 4. Spectral Distribution

GENERAL INSTRUMENT

TO-18 SOLID STATE LAMP

STANDARD RED MV10B

PACKAGE DIMENSIONS



DESCRIPTION

The MV10B is a GaAsP light emitting diode mounted on a TO-18 header with a clear epoxy lens. On forward bias, it emits a spectrally narrow band of radiation which peaks at 660 nm.

FEATURES

- Long life — solid state reliability
- Low power requirements
- Compatible with integrated circuits
- Compact, rugged, lightweight

Lamps

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

Power dissipation	175 mW
Derate linearly from 25° C	2.33 mW/° C
Storage and operating temperatures	-55° C to +100° C
Lead soldering time at 260° C (See Note 2)	7.0 sec.
Continuous forward current	70 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle)	1.0 A
Reverse voltage	5.0 V

ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

PARAMETER	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity (See Note 1)	0.8		mcd	I_F = 10 mA
Peak emission wavelength	660		nm	
Spectral line half width	20		nm	
Forward voltage	1.65	2.0	V	I_F = 50 mA
Forward dynamic resistance	2.0		Ω	I_F = 50 mA
Capacitance	135		pF	V = 0

ELECTRO-OPTICAL CHARACTERISTICS (Continued)

PARAMETER	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Light rise time and fall time		50		ns	50 Ω system, $I_F = 50$ mA
Reverse current		50		nA	$V_R = 3.0$ V
Reverse breakdown voltage	3	15		V	$I_R = 100\ \mu A$
Luminous flux		3.7		mLumens	$I_F = 50$ mA
View angle		90		degrees	Between 50% points

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Φ_{JA} .... 320° C/W
Thermal resistance junction to case Φ_{JC} .... 155° C/W
Wavelength temperature coefficient (case temperature) .... 0.3 nm/° C
Forward voltage temperature coefficient .... −2.0 mV/° C

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(T_A = 25° C Unless Otherwise Specified)

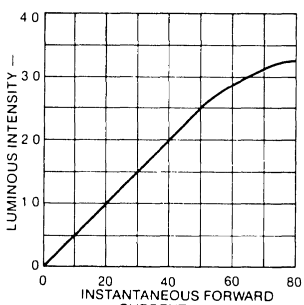


Fig. 1. Luminous Intensity vs. Forward Current

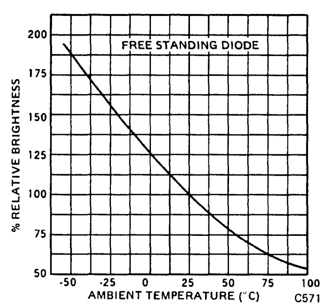


Fig. 2. Brightness vs. Temperature

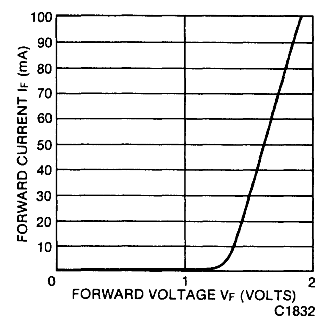


Fig. 3. Forward Current vs. Forward Voltage

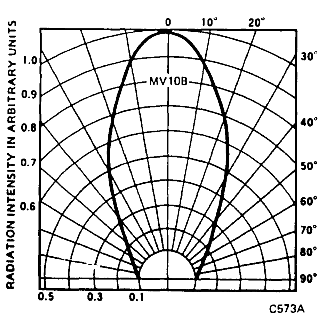


Fig. 4. Spatial Distribution (Note 3)

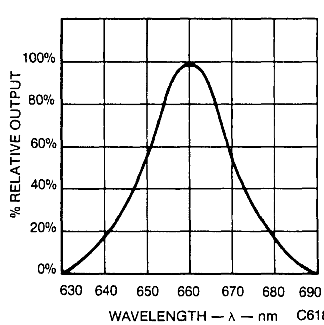


Fig. 5. Spectral Distribution

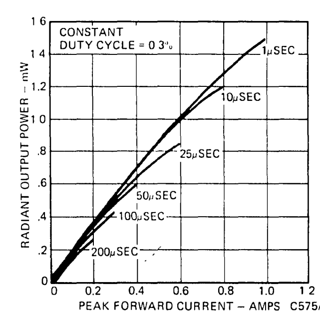


Fig. 6. Peak Power Output vs. Pulsed Forward Current

NOTES

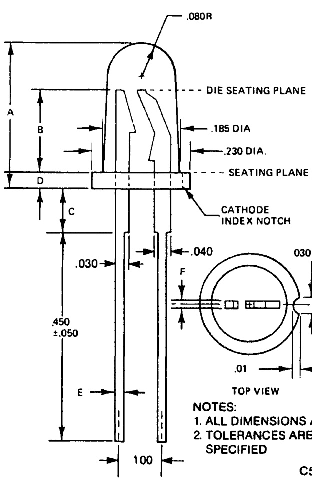
1. *As measured with a Photo research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The leads of the MV10B were immersed in molten solder, heated to 260° C, to a point 1/16 inch (1.6 mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*
3. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*

GENERAL INSTRUMENT

TAPERED PACKAGE T-1¾ SOLID STATE LAMPS

STANDARD RED MV502X

PACKAGE DIMENSIONS



NOTES:
1. ALL DIMENSIONS ARE IN INCHES (mm)
2. TOLERANCES ARE ±.010" INCH UNLESS SPECIFIED

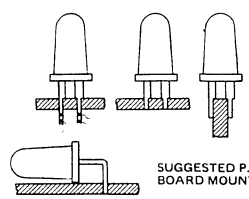
C599

DESCRIPTION

The MV502X Series of solid state indicators is made with gallium arsenide phosphide light emitting diodes. Encapsulation and lens is epoxy. Various lens effects are available for many indicator applications.

FEATURES

- Tapered barrel T-1¾
- High Intensity Red light source with various lens colors and effects
- T-1¾ with stand-off
- Versatile mounting on PC board or panel
- Snap in panel mounting clip available (See MP22 for clip detail)



SUGGESTED P.C. BOARD MOUNTING

C601

Lamps

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° C ambient	180 mW
Derate linearly from 25° C	2 mW/° C
Storage and operating temperatures	-55° C to +100° C
Lead soldering time at 260° C (See Note 2)	5 sec.
Continuous forward current at 25° C	100 mA
Peak forward current (1μsec pulse, 0.3% duty cycle)	1.0 A
Reverse voltage	5.0 V

PHYSICAL CHARACTERISTICS

TYPE	A	B	C	D	E & F	SOURCE COLOR	LENS COLOR	LENS EFFECT	POP-IN MOUNTING	CIRCUIT BOARD MOUNTING
MV5021	.340	.190	.100	.040	.025	Red	Clear Diffused	Soft	X	X
MV5022	.340	.190	.100	.040	.025	Red	Transparent Red	Point	X	X
MV5023	.340	.190	.100	.040	.025	Red	Red Diffused	Soft	X	X
MV5024	.340	.160	.130	.040	.025	Red	Red Diffused	Soft	X	X
MV5025	.340	.160	.130	.040	.025	Red	Red Diffused	Flooded	X	X
MV5026	.340	.160	.130	.040	.025	Red	Dark Red Diffused	Flooded	X	X

ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature Unless Otherwise Specified)

PARAMETER		TEST CONDITIONS	UNITS	5021	5022	5023	5024	5025	5026
Luminous Intensity	min.	20 mA	mcd	0.5	0.6	0.4	0.9	0.1	0.1
(See Note 1)	typ.	20 mA	mcd	1.6	1.6	1.6	3.0	0.4	0.6
Peak wavelength		20 mA	nm	660	660	660	660	660	660
Spectral line half width		20 mA	nm	20	20	20	20	20	20
Forward voltage	typ.	20 mA	V	1.65	1.65	1.65	1.65	1.65	1.65
V_F	max.	20 mA	V	2.0	2.0	2.0	2.0	2.0	2.0
Reverse current I_R	max.	$V_R = 5.0$ V	μA	100	100	100	100	100	100
Reverse voltage V_R	min.	$I_R = 100$ μA	V	5.0	5.0	5.0	5.0	5.0	5.0
Capacitance	typ.	V = 0	pF	35	35	35	35	35	35
Viewing angle		Between 50% Points	degrees	90	90	90	60	180	90
Rise time		10%-90% 50 Ω system	nsec	50	50	50	50	50	50
and fall time	typ.	90%-10% 50 Ω system	nsec	50	50	50	50	50	50

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

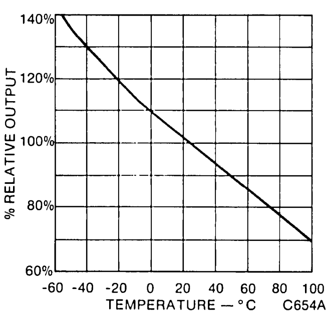


Fig. 1. Output vs. Temperature

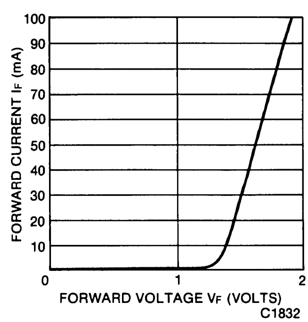


Fig. 2. Forward Current vs. Forward Voltage

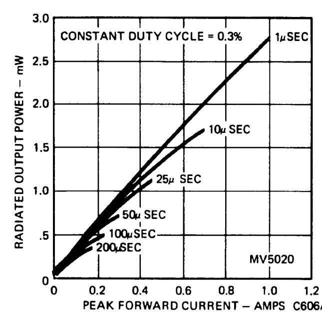


Fig. 3. Radiated Output Power vs. Peak Forward Current

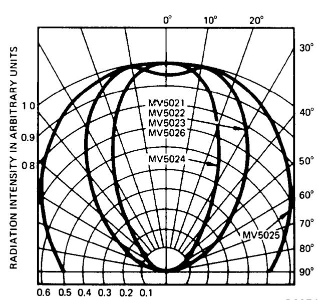


Fig. 4. Spatial Distribution

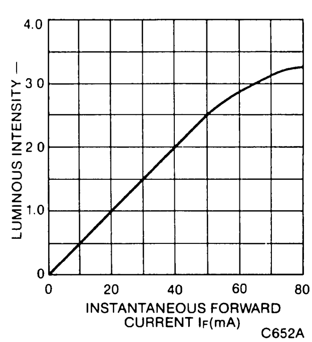


Fig. 5. Luminous Intensity vs. Forward Current

NOTES

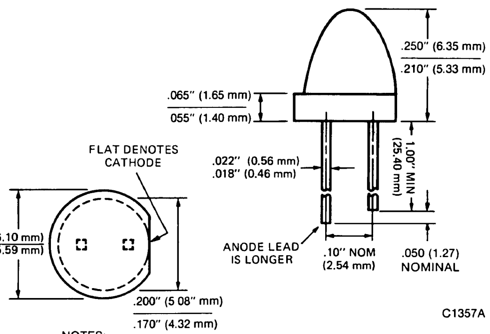
1. *As measured with a Photo Research Corp., "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The leads of the device were immersed in molten solder at 260° C to a point 1/16 inch (1.6 mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

GENERAL INSTRUMENT

BULLET PROFILE T-1¾ SOLID STATE LAMPS

STANDARD RED MV50152/4 YELLOW MV53152/4 HIGH EFFICIENCY GREEN MV54152/4 HIGH EFFICIENCY RED MV57152/4

PACKAGE DIMENSIONS



NOTES:
1 ALL DIMENSIONS ARE IN INCHES (mm)
2. TOLERANCES ARE .010 INCH UNLESS SPECIFIED
3. AN EPOXY MENISCUS MAY EXTEND ABOUT .040"(1 mm) DOWN THE LEADS

DESCRIPTION

These solid state indicators offer a variety of lens effects and color availability in a short barrel T-1¾ package. The High Efficiency Red, High Efficiency Green and Yellow devices are made with gallium phosphide.

FEATURES

- High intensity light source with two lens effects
- Red, High Efficiency Red, High Efficiency Green and Yellow colors available
- Versatile mounting on PC board or panel
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight
- High efficiency
- MV5X154 diffused, MV5X152 non-diffused
- Short T-1¾ size

Lamps

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

Power dissipation (MV5015X)	180 mW
Power dissipation	105 mW
Derate linearly from 25° C (MV5015X)	2.0 mW/° C
Derate linearly from 25° C	1.14 mW/° C
Storage and operating temperatures	-55° C to +100° C
Lead soldering time at 260° C (See Note 3)	5 sec.
Continuous forward current (MV5015X)	100 mA
Continuous forward current	35 mA
Peak forward current (1μsec pulse, 0.3% duty cycle) (MV5415X=90 mA)	1.0 A
Reverse voltage	5.0 V

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT
MV50152	Standard Red	Red Clear	Point Source
MV50154	Standard Red	Red Lightly Diffused	Soft Point Source
MV53152	Yellow	Amber Clear	Point Source
MV53154	Yellow	Amber Lightly Diffused	Soft Point Source
MV54152	High Efficiency Green	Green Clear	Point Source
MV54154	High Efficiency Green	Green Lightly Diffused	Soft Point Source
MV57152	High Efficiency Red	Red Clear	Point Source
MV57154	High Efficiency Red	Red Lightly Diffused	Soft Point Source

ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

PARAMETER		SYMBOL	TEST COND.	UNITS	50152	50154	53152	53154	54152	54154	57152	57154
Forward voltage	typ.	V_F	10 mA	V	1.6	1.6	2.1	2.1	2.2	2.2	2.0	2.0
	max.		10 mA		2.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0
Luminous Intensity	min.	I_V	10 mA	mcd	0.6	0.4	3.0	1.5	2.5	2.0	4.0	2.0
(See Note 1)	typ.		10 mA	mcd	2.0	1.5	5.0	3.0	5.0	3.0	8.0	4.0
Peak wavelength		λp	10 mA	nm	660	660	585	585	565	565	630	630
Spectral line half width			10 mA	nm	20	20	35	35	35	35	45	45
Capacitance	typ.	C	V = 0	pF	30	30	45	45	20	20	45	45
Reverse voltage	min.	V_{BR}	I_R = 100 μA	V	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Reverse current	max.	I_R	V_R = 5.0 V	μA	100	100	100	100	100	100	100	100
Viewing angle (total) (See Fig. 3)		$2\Theta½$		degrees	45	50	45	50	45	50	45	50

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25° C Free Air Temperature Unless Otherwise Specified)

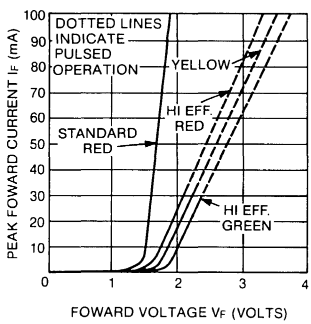


Fig. 1. Forward Current vs. Forward Voltage

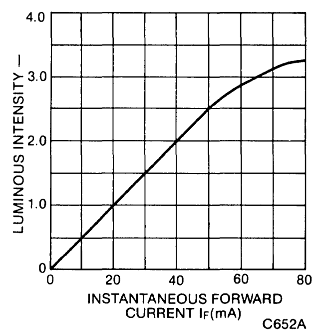


Fig. 2. Luminous Intensity vs. Foward Current

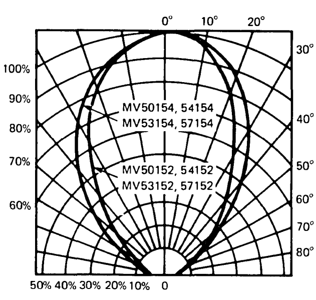


Fig. 3. Spatial Distribution (Note 2)

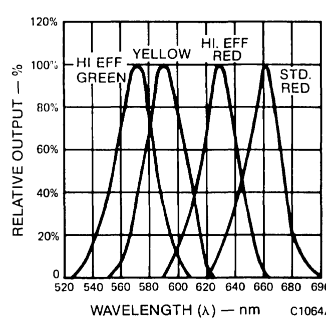


Fig. 4. Spectral Distribution

NOTES

1. *As measured with a Photo Research Corp., "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*
3. *The leads of the device were immersed in molten solder at 260° C to a point 1/16 inch (1.6 mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

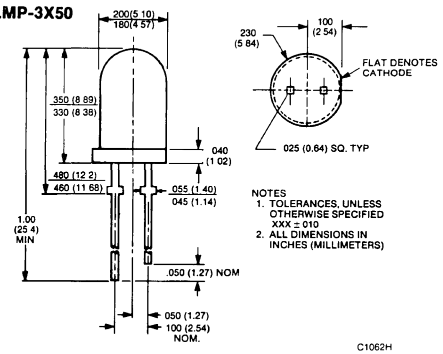
GENERAL INSTRUMENT

ULTRABRIGHT T-1¾ SOLID STATE LAMPS

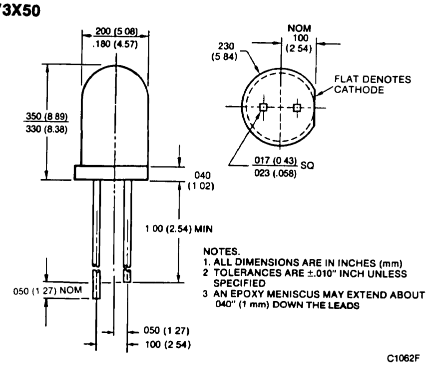
ULTRABRIGHT HLMP-3X50 SERIES MV3X50 SERIES

PACKAGE DIMENSIONS

HLMP-3X50



MV3X50



DESCRIPTION

The Ultrabright HLMP-3X50 Series are direct, pin-for-pin replacements for the Hewlett-Packard devices with the same part numbers.

HLMP-3X50 in High Efficiency Red, Yellow and High Efficiency Green are very narrow viewing angle Clear lamps in a standard T-1¾ package.

By using more efficient LED chips, these lamps are superior in Luminous Intensity compared to other lamps.

Lamps have Pale Tinted package to aid identification.

FEATURES

- Minimum 80 mcd
- All three colors
- Pale Tint avoids mix problems
- Sturdy leads with or without stand-off on T-1¾
- Excellent for small area backlighting
- High Efficiency Red
  HLMP-3750
  MV3750
- High Efficiency Gree
  HLMP-3950
  MV3450
- Yellow
  HLMP-3850
  MV3350

Lamps

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

PARAMETER	HI. EFF. RED	YELLOW	HI. EFF. GREEN	UNITS	NOTES
Power dissipation	135	85	135	mW	1
Peak forward current	90	60	90	mA	
Average forward current	25	20	25	mA	
Continuous DC forward current	30	20	30	mA	2
Lead soldering time at 260° C	5	5	5	seconds	3
Operating and storage temperature		-55 to +100° C			

1) *For High Efficiency Red and High Efficiency Green, derate power linearly from 25° C at 1.8 mA/° C. For Yellow derate power linearly from 50° C at 1.6 mW° C.*

2) *For High Efficiency Red and High Efficiency Green derate linearly from 50° C. For Yellow derate linearly from 50° C at 0.2 mA/° C.*

3) *To a point of minimum 1/16 inch (1.6 mm) from the bottom of the lamp.*

ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

PARAMETER		SYMBOL	MV3750 HLMP-3750	MV3350 HLMP-3850	MV3450 HLMP-3950	UNITS	TEST CONDITIONS
Luminous Intensity	min.	I_V	80	80	80	mcd	I_F = 20 mA
	typ.		150	150	150	mcd	I_F = 20 mA
Forward voltage	min.	V_F	3.0	3.0	3.0	V	I_F = 20 mA
	typ.		2.2	2.2	2.2	V	I_F = 20 mA
Peak wavelength	typ.	λp	635	585	565	nm	I_F = 10 mA
Capacitance	typ.	C	45	45	20	pF	V_F = 0, f = 1 MHz
Reverse breakdown voltage	min.	BV_R	5	5	5	V	I_R = 100 μA
Total viewing angle between half Luminous Intensity points	typ.	$2\Theta\frac{1}{2}$	24	24	24	degrees	

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES
(25° C Free Air Temperature Unless Otherwise Specified)

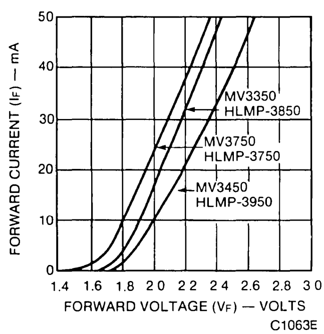


Fig. 1. Forward Voltage/ Forward Current

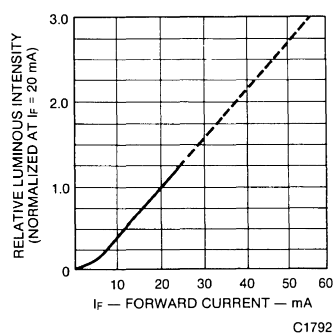


Fig. 2. Relative Luminous Intensity vs. DC Forward Current

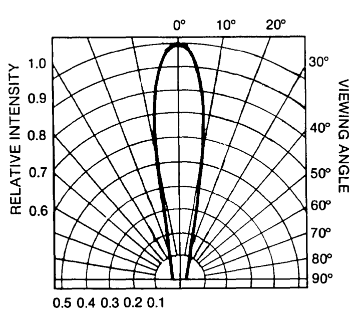


Fig. 3. Spatial Distribution

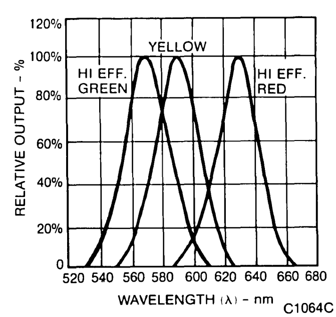


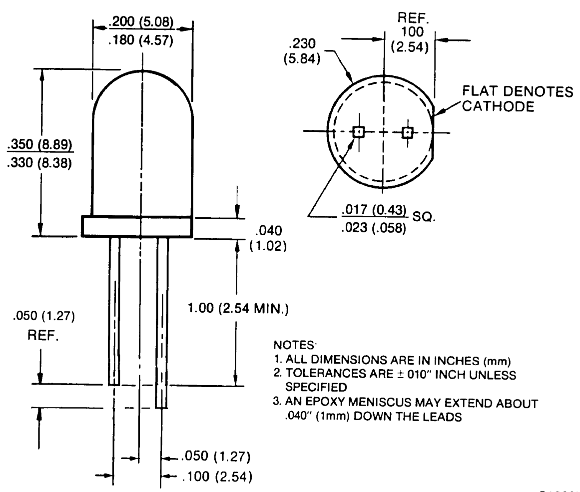
Fig. 4. Spectral Distribution

GENERAL INSTRUMENT

STANDARD RED T-1¾ SOLID STATE LAMPS

MV5052 MV5054A-1/2/3
MV5053/6053 MV5055

PACKAGE DIMENSIONS



NOTES:
1. ALL DIMENSIONS ARE IN INCHES (mm)
2. TOLERANCES ARE ± .010" INCH UNLESS SPECIFIED
3. AN EPOXY MENISCUS MAY EXTEND ABOUT .040" (1mm) DOWN THE LEADS

C1062L

DESCRIPTION

The MV505X Series of industry standard solid state indicators is made with gallium arsenide phosphide light emitting diodes encapsulated in epoxy lenses. Various lens effects give different design possibilities.

FEATURES

- Standard Red light source with various lens colors and effects
- Versatile mounting on PC board or panel
- Snap in mounting grommet MP52
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight

Lamps

PHYSICAL CHARACTERISTICS

CATHODE LONG	SOURCE COLOR	LENS TYPE	LENS EFFECT	APPLICATION
MV5052	Standard Red	Red Tint	Point Source	Backlighting
MV5053*	Standard Red	Red Diffused	Wide Beam	Direct View
MV5054A-1	Standard Red	Red Diffused	Narrow Beam	Direct View
MV5054A-2	Standard Red	Red Diffused	Narrow Beam	Direct View
MV5054A-3	Standard Red	Red Diffused	Narrow Beam	Direct View
MV5055	Standard Red	Red Diffused	Very Wide Beam	Direct View

*MV6053 - Anode Long also available.

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

Power dissipation .... 180 mW
Derate linearly from 25° .... 2.0 mW/° C
Storage and operating temperatures .... −55° C to +100° C
Lead soldering time at 260° C (See Note 3) .... 5 sec.
Continuous forward current .... 100 mA
Peak forward current (1μsec pulse, 0.3% duty cycle) .... 1.0 A
Reverse voltage .... 5.0 V

ELECTRO OPTICAL CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

PARAMETER	TEST COND.	5052	6053 5053	5054A-1	5054A-2	5054A-3	5055	UNIT
Luminous Intensity	I_F = 20 mA	0.7	0.5				0.1	mcd
I_V min. (See Note 1)	I_F = 10 mA			1.0	2.0	3.0		mcd
Forward voltage	I_F = 20 mA	2.2	2.2				2.2	V
V_F mcd	I_F = 10 mA			2.2	2.2	2.2		V
Peak wavelengths λ_p typical	I_F = 20 mA	660	660	660	660	660	660	nm
Spectral line half width typical	I_F = 20 mA	20	20	20	20	20	20	nm
Capacitance typical	V = 0 f = 1 MHz	30	30	30	30	30	30	pF
Reverse current I_R max.	V_R = 5.0 V	100	100	100	100	100	100	μA
Viewing angle typical, See Figures		72	80	40	40	40	150	degrees

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature)

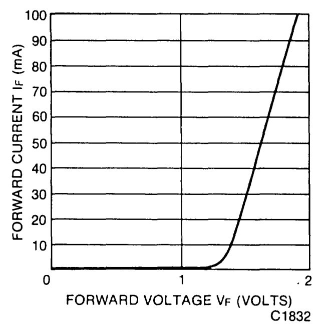


Fig. 1. Forward Current vs. Forward Voltage

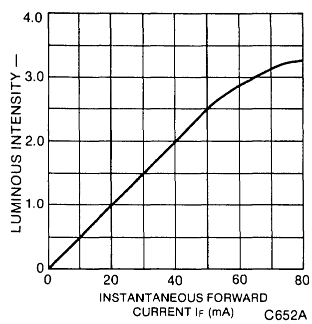


Fig. 2. Luminous Intensity vs. Forward Current

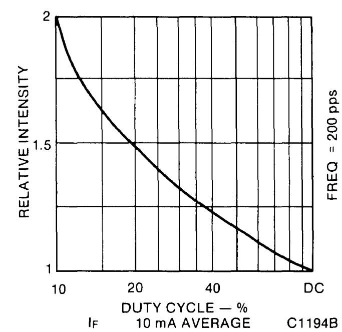


Fig. 3. Luminous Intensity vs. Duty Cycle

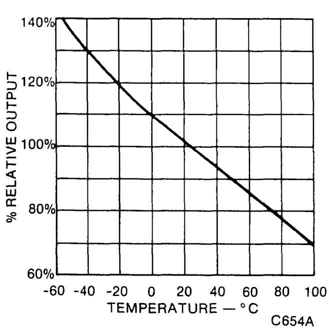


Fig. 4. Output vs. Temperature

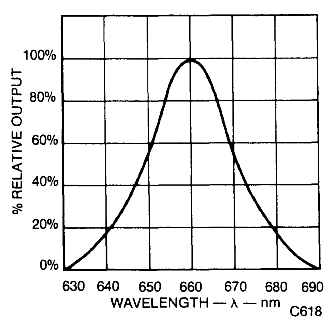


Fig. 5. Spectral Distribution

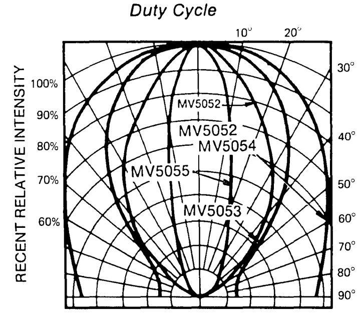


Fig. 6. Spatial Distribution (Note 2)

NOTES

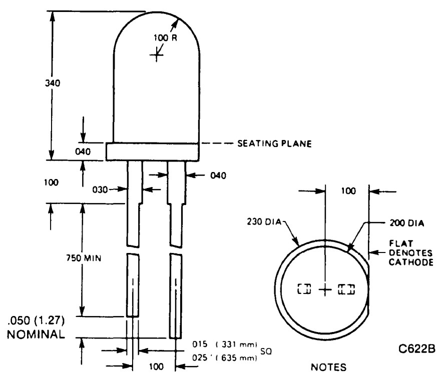
1. *As measured with Photo Research Corp., "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*
3. *The leads of the device were immersed in molten solder at 260° C to a point 1/16 (1.6 mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

GENERAL INSTRUMENT

DIFFUSED T-1¾ SOLID STATE LAMPS

STANDARD RED MV5054-1
STANDARD RED MV5054-2
STANDARD RED MV5054-3

PACKAGE DIMENSIONS



NOTES
1 ALL DIMENSIONS ARE IN INCHES (mm)
2 TOLERANCES ARE 010 INCH UNLESS SPECIFIED

DESCRIPTION

The MV5054 Series lamps are made with gallium arsenide phosphide diodes mounted in a Red epoxy package.

FEATURES

- Three light intensity selections
- Illuminates a ¼" diameter circle
- Straight barrel T-1¾ with stand-off
- Versatile mounting on PC board
- Mounting grommet MP52 available as separate order item
- For new designs see MV5054A-1/2/3 data sheet

Lamps

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° C ambient .... 180 mW
Derate linearly from 25° C .... 2.0 mW/° C
Storage and operating temperatures .... -55° C to +100° C
Lead soldering time at 260° C (See Note 3) .... 5 sec.
Continuous forward current at 25° C .... 100 mA
Peak forward current (μsec pulse 0.3% duty cycle) .... 1.0 A
Reverse voltage .... 5.0 V

ELECTRO-OPTICAL CHARACTERISTICS (25° C Ambient Temperature)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity (See Note 1)					
MV5054-1	1.0	2.0		mcd	I_F = 10 mA
MV5054-2	2.0	3.0		mcd	I_F = 10 mA
MV5054-3	3.0	4.0		mcd	I_F = 10 mA
Forward voltage		1.8	2.2	V	I_F = 10 mA
Capacitance		35		pF	V = 0, f = 1 MHz
Reverse current			100	μA	V_R = 5.0 V
Rise and fall time		50		ns	50 Ω System
Viewing angle (total)		40		degrees	Between 50% intensity points
Peak wavelength		660		nm	I_F = 10 mA

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES
(25°C Free Air Temperature Unless Otherwise Specified)

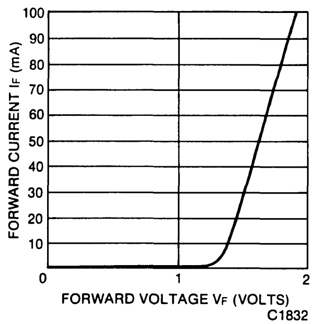


Fig. 1. Forward Current vs. Forward Voltage

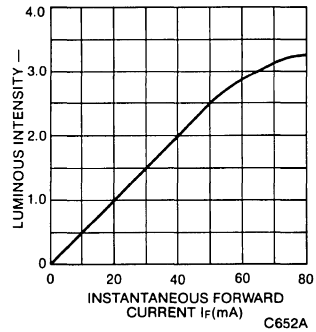


Fig. 2. Luminous Intensity Forward Current

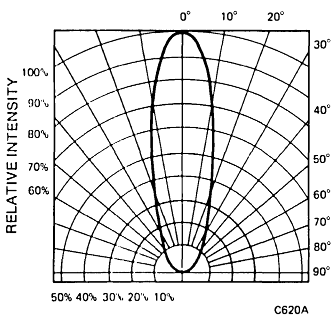


Fig. 3. Spatial Distribution (Note 2)

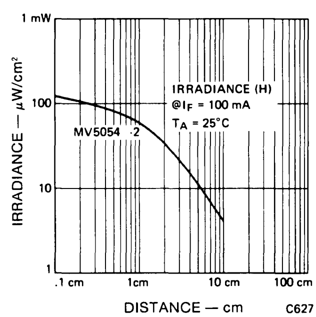


Fig. 4. Irradiance vs. Distance

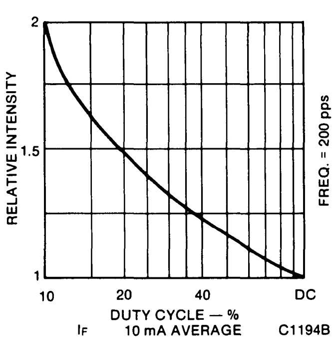


Fig. 5. Luminous Intensity vs. Duty Cycle

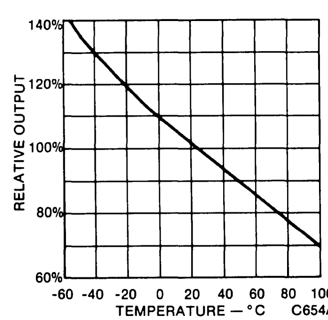


Fig. 6. Output vs. Temperature

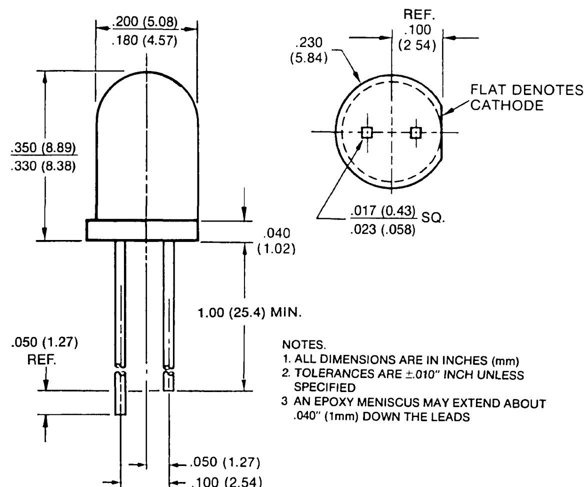
GENERAL INSTRUMENT

CLEAR LENS T-1¾ SOLID STATE LAMPS

ORANGE **MV5152** **MV6152**
YELLOW **MV5352** **MV6352**
HIGH EFFICIENCY GREEN **MV5452** **MV64520** **MV64521**
HIGH EFFICIENCY RED **MV5752** **MV6752**

PACKAGE DIMENSIONS

MV5X52 - LEAD CUT CATHODE LONG MIN. 0.8"
MV6X52X - LEAD CUT ANODE LONG MIN. 1.025"



NOTES.
1. ALL DIMENSIONS ARE IN INCHES (mm)
2. TOLERANCES ARE ±.010" INCH UNLESS SPECIFIED
3. AN EPOXY MENISCUS MAY EXTEND ABOUT .040" (1mm) DOWN THE LEADS

C1062L

DESCRIPTION

These Clear Tinted solid state indicators offer high brightness and color availability. The High Efficiency Red and Yellow devices are made with gallium arsenide phosphide on gallium phosphide. The High Efficiency Green units are made with gallium phosphide on gallium phosphide. All devices are available with cathode long as MV5X5X, or with anode long as MV6X5X.

FEATURES

- High on-axis light output
- High efficiency GaP light sources
- Versatile mounting on PC board or panel
- Snap in grommet MP52 available as separate order item
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight

Lamps

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

	RED, YELLOW AND H. E. RED	GREEN
Power dissipation	120 mW	120 mW
Derate linearly from 25° C (MVX452/4A from 50° C)	1.6 mW/° C	1.6 mW/° C
Storage and operating temperatures	-55° C to +100° C	-55° C to +100° C
Lead soldering time at 260° C (See Note 3)	5 sec.	5 sec.
Continuous forward current	35 mA	30 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle)	1.0 A	90 mA
Reverse voltage	5.0 V	5.0 V

PHYSICAL CHARACTERISTICS

CATHODE LONG	ANODE LONG	SOURCE COLOR	LENS TYPE	LENS EFFECT	APPLICATION
MV5152	MV6152	High Efficiency Red	Amber Clear	Point Source	Backlighting
MV5352	MV6352	Yellow	Yellow Clear	Point Source	Backlighting
MV5452	MV64520	High Efficiency Green	Green Clear	Point Source	Backlighting
—	MV64521	High Efficiency Green	Green Clear	Point Source	Backlighting
MV5752	MV6752	High Efficiency Red	Red Clear	Point Source	Backlighting

ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature)

PARAMETER	TEST COND.	UNITS	MV6152 MV5152	MV6352 MV5352	MV64520 MV5452	MV64521	MV6752 MV5752
Forward voltage (V_F)							
typ.	I_F = 20 mA	V	2.0	2.1	2.2	2.2	2.0
max.	I_F = 20 mA	V	3.0	3.0	3.0	3.0	3.0
Luminous Intensity							
(See Note 1) min.	I_F = 20 mA	mcd	17.0	10.0	12.0	30.0	17.0
typ.	I_F = 20 mA	mcd	40.0	45.0	25.0	60.0	40.0
Peak wavelength	I_F = 20 mA	nm	635	585	562	562	635
Spectral line half width	I_F = 20 mA	nm	45	35	30	30	45
Capacitance							
typ.	V = 0, f = 1 MHz	pF	45	45	20	20	45
Reverse voltage (V_R)							
min.	I_R = 100 μA	V	5	5	5	5	5
Reverse current (I_R)							
max.	V_R = 5.0 V	μA	100	100	100	100	100
Viewing angle (total)	See Fig. 4	degrees	28	28	35	35	28

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (25° C Free Air Temperature Unless Otherwise Specified)

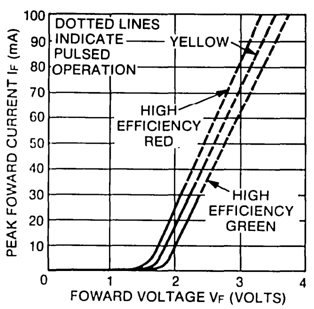


Fig. 1. Forward Current vs. Forward Voltage

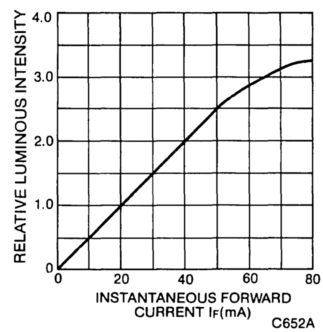


Fig. 2. Luminous Intensity vs. Forward Current

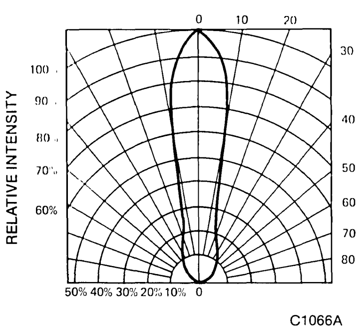


Fig. 3. Spatial Distribution (Note 2)

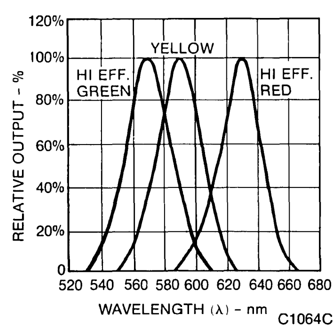


Fig. 4. Spectral Distribution

NOTES

1. *As measured with Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The axis of spatial distribution are typically within a 10° cone within reference to the central axis of the device.*
3. *The leads of the device were immersed in molten solder, at 260° C, to a point 1/16 inch (1.6 mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

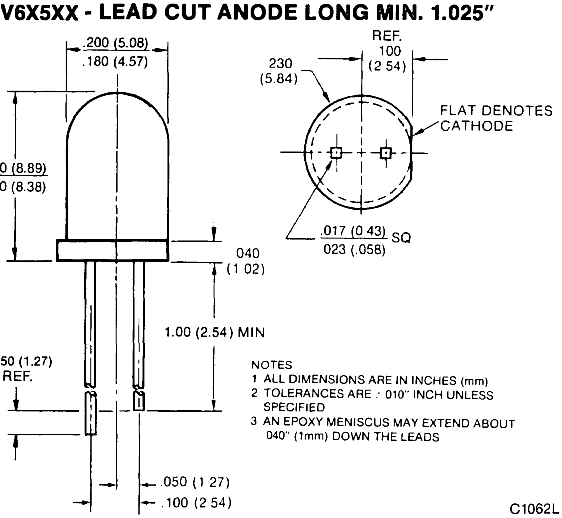
GENERAL INSTRUMENT

DIFFUSED T-1¾ SOLID STATE LAMPS

ORANGE MV5153/4A MV6153/4A
YELLOW MV5353/4A MV6353/4A
HIGH EFFICIENCY GREEN MV5453/4A MV64530/1 MV6454A
HIGH EFFICIENCY RED MV5753/4A MV6753/4A

PACKAGE DIMENSIONS

MV5X5X - LEAD CUT CATHODE LONG MIN 0.8"
MV6X5XX - LEAD CUT ANODE LONG MIN. 1.025"



DESCRIPTION

These solid state indicators offer a variety of diffused lens effects and color availability. The High Efficiency Red and Yellow devices are made with gallium arsenide phosphide on gallium phosphide. The Green units are made with gallium phosphide on gallium phosphide. All devices are available with cathode long as MV5X5X, or with anode long as MV6X5X.

FEATURES

- High efficiency GaP light source with various lens effects
- Versatile mounting on PC board or panel
- Snap in grommet MP52 available as separate order item
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

	H.E. RED, YELLOW, ORANGE	GREEN
Power dissipation at 25° C ambient	120 mW	120 mW
Derate linearly from 25° C (MVX453/4A from 50° C)	1.6 mW/° C	1.6 mW/° C
Storage and operating temperatures	-55° C to +100° C	-55° C to +100° C
Lead soldering time at 260° C (See Note 3)	5 sec.	5 sec.
Continuous forward current at 25° C	35 mA	30 mA
Peak forward current (1 µsec pulse, 0.3% duty cycle)	1.0 A	90 mA
Reverse voltage	5.0 V	5.0 V

PHYSICAL CHARACTERISTICS

CATHODE LONG	ANODE LONG	SOURCE COLOR	LENS TYPE	LENS EFFECT	APPLICATION
MV5153	MV6153	High Efficiency Red	Amber Diffused	Wide Beam	Direct View
MV5154A	MV6154A	High Efficiency Red	Amber Diffused	Narrow Beam	High Bright Direct View
MV5353	MV6353	Yellow	Yellow Diffused	Wide Beam	Direct View
MV5354A	MV6354A	Yellow	Yellow Diffused	Narrow Beam	High Bright Direct View
MV5453	MV64530/1	High Efficiency Green	Green Diffused	Wide Beam	Direct View
MV5454A	MV6454A	High Efficiency Green	Green Diffused	Narrow Beam	High Bright Direct View
MV5753	MV6753	High Efficiency Red	Red Diffused	Wide Beam	Direct View
MV5754A	MV6754A	High Efficiency Red	Red Diffused	Narrow Beam	High Bright Direct View

ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature)

PARAMETER	TEST COND.	UNITS	6153 5153	6154A 5154A	6353 5353	6354A 5354A	64530 5453	64531	6454A 5454A	6753 5753	6754A 5754A
Forward voltage (V_F) typ.	I_F = 20 mA	V	2.0	2.0	2.1	2.1	2.2	2.2	2.2	2.0	2.0
max.	I_F = 20 mA	V	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Luminous Intensity (See Note 1) min.	I_F = 20 mA	mcd	3.0	10.0	2.5	10.0	3.0	7.0	10.0	3.0	10.0
typ.	I_F = 20 mA	mcd	6.0	20.0	8.0	20.0	6.0	14.0	20.0	9.0	20.0
Peak wavelength	I_F = 20 mA	nm	635	635	585	585	562	562	562	635	635
Spectral line half width	I_F = 20 mA	nm	45	45	35	35	30	30	30	45	45
Capacitance typ.	V = 0	pF	45	45	45	45	20	20	20	45	45
Reverse voltage (V_R) min.	f = 1MHz; I_R = 100 μA	V	5	5	5	5	5	5	5	5	5
Reverse current (I_R) max.	V_R = 5.0 V	μA	100	100	100	100	100	100	100	100	100
Viewing angle (total)	See Fig. 3	degrees	65	24	65	24	75	75	24	65	24

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (25° C Free Air Temperature Unless Otherwise Specified)

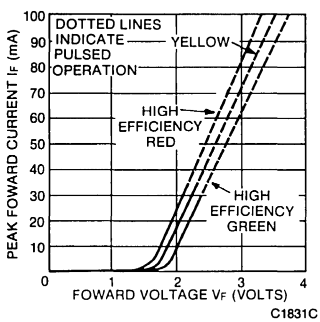


Fig. 1. Forward Current vs. Forward Voltage

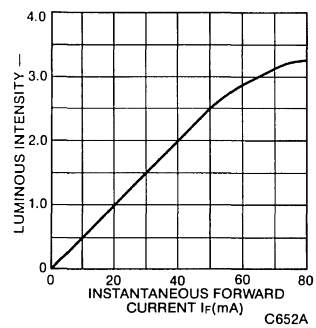


Fig. 2. Luminous Intensty vs. Forward Current

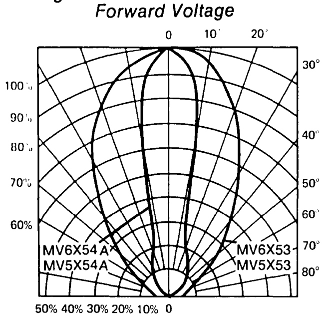


Fig. 3. Spatial Distribution (See Note 2)

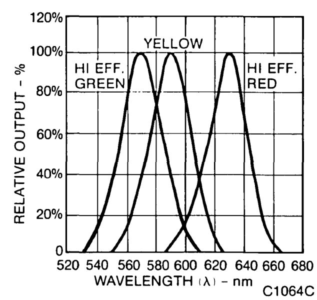


Fig. 4. Spectral Distribution

NOTES

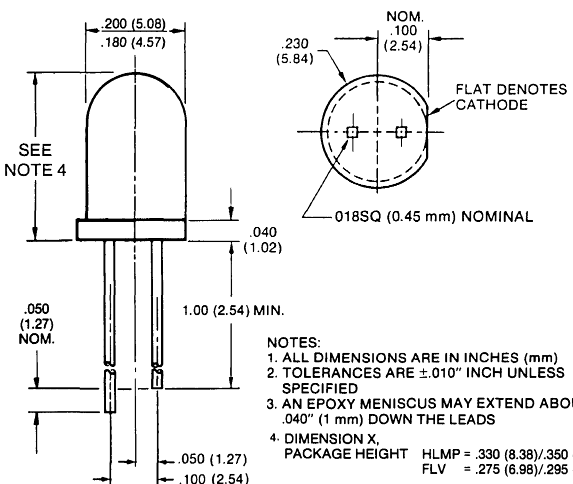
1. *As measured with Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*
3. *The leads of the device were immersed in molten solder, at 260° C, to a point 1/16 inch (1.6 mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

GENERAL INSTRUMENT

SECOND SOURCE T-1¾ SOLID STATE LAMPS

HIGH EFF. RED HLMP-3300 **HIGH EFF. RED HLMP-3315**
STANDARD RED FLV110 **HIGH EFF. RED HLMP-3301** **HIGH EFF. RED HLMP-3316**

PACKAGE DIMENSIONS — HLMP



NOTES:
1. ALL DIMENSIONS ARE IN INCHES (mm)
2. TOLERANCES ARE ±.010" INCH UNLESS SPECIFIED
3. AN EPOXY MENISCUS MAY EXTEND ABOUT .040" (1 mm) DOWN THE LEADS
4. DIMENSION X, PACKAGE HEIGHT HLMP = .330 (8.38)/.350 (8.89)
   FLV = .275 (6.98)/.295 (7.49)

C1062M

DESCRIPTION

Direct replacements for popular T-1¾ lamps from Fairchild and Hewlett-Packard. The FLV110 is a Standard Red Lamp with a low profile (.285 inch) lens. HLMP-33XX parts are High Efficiency Red with a standard T-1¾ package.

FLV110, HLMP-3300 and HLMP-3301 are diffused.

HLMP-3315 and HLMP-3316 are non-diffused.

FEATURES

- Replace Fairchild and Hewlett-Packard devices
- Popular, general purpose lamps
- Wide and narrow viewing angle devices for direct view or backlighting
- Solid state reliability
- Sturdy leads for easier assembly

Lamps

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

Power dissipation .... 135 mW
Derate linearly from 25° C .... 1.8 mW/° C
Storage and operating temperatures .... –55° C to +100° C
Lead soldering time @ 260° C (See Note 2) .... 5 sec.
Continuous forward current .... 30 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle) (FLV110 1 amp) .... 90 mA
Reverse voltage .... 5.0 V

ELECTRO-OPTICAL CHARACTERISTICS (25° C Ambient Temperature)

PARAMETER		SYMBOL	HLMP-3300	HLMP-3301	HLMP-3315	HLMP-3316	FLV* 110	UNITS	TEST CONDITIONS
Luminous Intensity	min.	I_V	2.0	4.0	12	20	0.8*	mcd	$I_F = 10$ mA
(See Note 1)	typ.		3.5	7.0	18	30	3.0*	mcd	$I_F = 10$ mA
Forward voltage	max.	V_F	3.0	3.0	3.0	3.0	2.0	V	$I_F = 10$ mA
	typ.		2.2	2.2	2.2	2.2	1.6	V	$I_F = 10$ mA
Peak wavelength	typ.	λp	635	635	635	635	665	nm	$I_F = 10$ mA
Capacitance	typ.	C	45	45	45	45	30	pF	V= 0, f = 1 MHz
Reverse breakdown voltage	min.	V_{BR}	5	5	5	5	5	V	$I_R = 100\ \mu A$
Total viewing angle between half Luminous Intensity points	typ.	$2\Theta½$	65	65	35	35	70	degrees	

*For FLV110 Test I_F = 20 mA

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS CURVES

(25° C Free Air Temperature Unless Otherwise Specified)

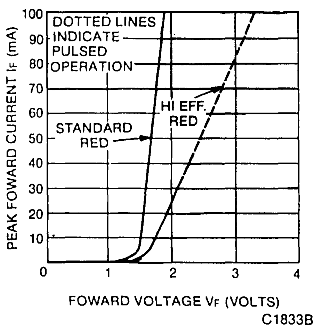


Fig. 1. Forward Current vs. Forward Voltage

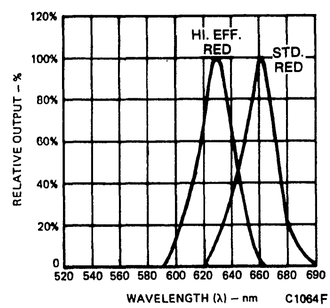


Fig. 2. Spectral Distribution

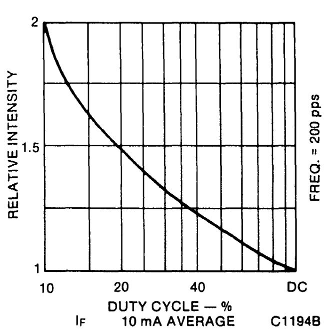


Fig. 3. Luminous Intensity vs. Duty Cycle

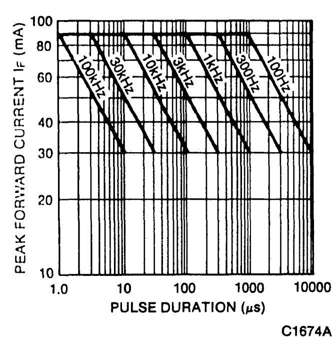


Fig. 4. Maximum Peak Forward Current vs. Pulse Duration (HLMP)

NOTES

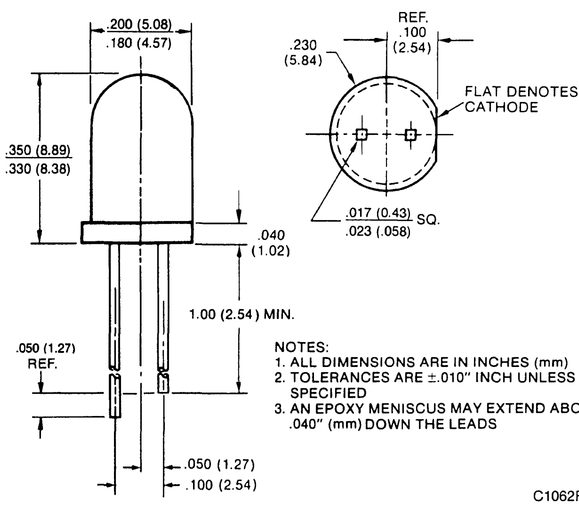
1. *As measured with a Photo Research Corp. "SPECTRA" Microandela Meter (Model IV-D).*
2. *From a point minimum 1/16 inch (1.6 mm) from the bottom of the lamp.*

GENERAL INSTRUMENT

HIGH CONTRAST T-1¾ SOLID STATE LAMPS

HIGH EFFICIENCY RED (ORANGE) MV6151 YELLOW MV6351 HIGH EFFICIENCY GREEN MV6451 AlGaAs RED MV6951

PACKAGE DIMENSIONS



NOTES:
1. ALL DIMENSIONS ARE IN INCHES (mm)
2. TOLERANCES ARE ±.010" INCH UNLESS SPECIFIED
3. AN EPOXY MENISCUS MAY EXTEND ABOUT .040" (mm) DOWN THE LEADS

C1062F

DESCRIPTION

This White Diffused family of T-1¾ lamps gives maximum ON/OFF contrast in high ambient lighting levels. The family features Orange, AlGaAs Red (Dark Red), Yellow and High Efficiency Green as well as High Efficiency Red, which here is Orange. The family exhibits wide viewing angle intended for direct view.

FEATURES

- Excellent ON/OFF contrast
- Non-tinted, White Diffused
- AlGaAs Red plus 3 bright colors: High Efficiency Red/Orange, Yellow and Green
- Alternative for popular MV6X53 family
- Snap-in grommet MP52 available as separate order item

Lamps

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	APPLICATION
MV6151	High Efficiency Red	White Diffused	Orange Diffused	Direct View
MV6351	Yellow	White Diffused	Yellow Diffused	Direct View
MV6451	High Efficiency Green	White Diffused	Green Diffused	Direct View
MV6951	AlGaAs Red	White Diffused	Red Diffused	Direct View

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

PARAMETER	HI. EFF. RED, YELLOW, RED	GREEN	UNITS	NOTES
Power dissipation	120	120	mW	1
Continuous forward current	35	30	mA	
Peak forward current (1μs, 0.3% DF)	1000	90	mA	
Lead soldering time at 260° C	5	5	seconds	2
Storage and operating temperatures		-55° C to +100° C		

NOTES

1. *Derate linearly from 25° C (MV6451 from 50° C) at 1.6 mW/° C.*
2. *From a point minimum 1/16 inch (1.6 mm) from the bottom of the lamp.*

ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25°C Unless Otherwise Specified)

PARAMETER		SYMBOL	MV6151	MV6351	MV6451	MV6951	UNITS	TEST CONDITIONS	NOTES
Luminous Intensity	min.	I_V	3.0	3.0	3.0	3.0	mcd	I_F = 20mA	1
	typ.		12	12	12	12	mcd	I_F = 20mA	
Forward voltage	max.	V_F	3.0	3.0	3.0	3.0	V	I_F = 20mA	
	typ.		2.1	2.2	2.3	2.4	V	I_F = 20mA	
Peak wavelength	typ.	λ_p	635	585	565	670	nm	I_F = 20mA	
Reverse breakdown voltage	min.	V_{BR}	5	5	5	5	V	I_R = 100μA	
Total viewing angle between half luminous points	typ.	$2\Theta_{1/2}$	70	70	70	70	degrees	I_F = 20mA	2

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES
(25°C Free Air Temperature Unless Otherwise Specified)

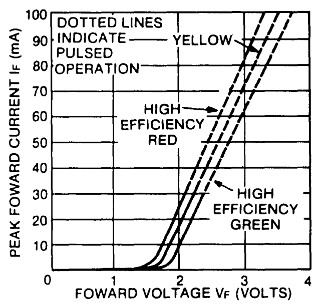


Fig. 1. Forward Current vs. Forward Voltage

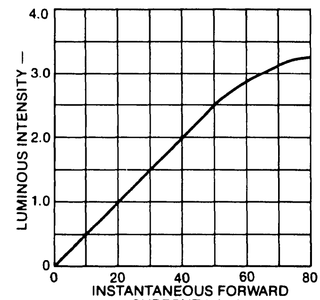


Fig. 2. Luminous Intensity vs. Forward Current

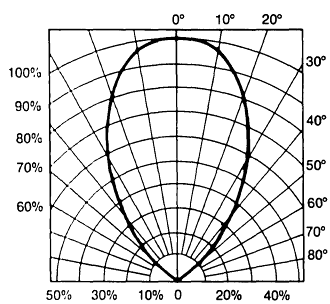


Fig. 3. Spatial Distribution

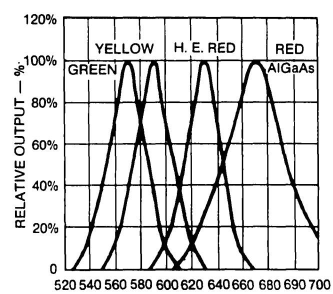


Fig. 4. Spectral Distribution

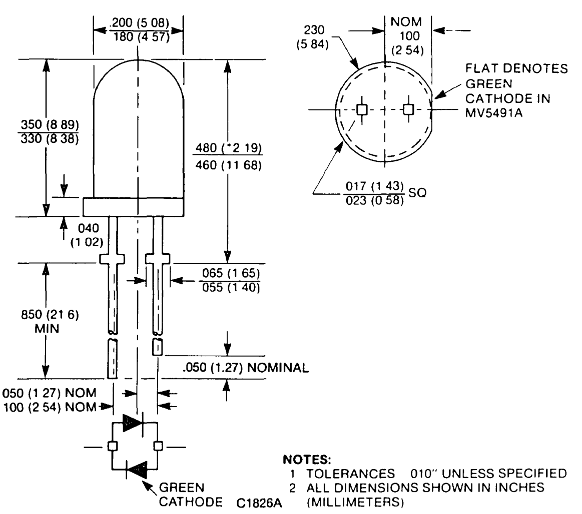
NOTES
1. *As measured with a Photo Research Corp. "SPECTRA" Microandela Meter (Model IV-D).*
2. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*

GENERAL INSTRUMENT

BICOLOR AND BIPOLAR T-1¾ SOLID STATE LAMPS

HIGH EFFICIENCY GREEN/AlGaAs RED MV5491A
HIGH EFFICIENCY RED/AlGaAs RED MV5094A

PACKAGE DIMENSIONS



DESCRIPTION

The Green/Red MV5491A and Red/Red MV5094A are superior drop-in replacements for General Instrument's bicolor Green/Red MV5491 or MV9475 and for bipolar Red/Red MV5094 or MV9775. The MV5491A is a White Diffused, very wide viewing angle, dual chip, 4-state lamp utilizing Deep Red AlGaAs and High Efficiency Green. AC-driven, the LED lamp appears Orange. The MV5094A is a Red Diffused, very wide viewing angle bipolar Red (AC) lamp featuring Red AlGaAs and High Efficiency Red chips.

FEATURES

- Excellent uniformity and visual appeal
- Very wide viewing angle for perfect direct view
- Increased reliability
- Radically improved die-off-center characteristics
- Same current for both colors for minimum component count
- Improved solder heat durability
- 4-state; Green, Red, Orange, OFF (MV5491A)
- 1" leads
- May be panel mounted — MP52 is separate order item

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

PARAMETERS	RATING	UNITS	NOTES
Power dissipation	135	mW	1
Peak current	90	mA	
Average current	30	mA	2
Lead soldering time	5	seconds	
Storage and operating temperatures	-55° C to +100° C		3

NOTES

1. *Derate power linearly from 25° C at 1.8 mW/° C.*
2. *Derate power linearly from 50° C at 0.5 mA/° C.*
3. *To a point minimum 1/16 inch (1.6 mm) from the bottom of the lamp.*

ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25°C Unless Otherwise Specified)

PARAMETER		SYMBOL	MV5491A	MV5094A	UNITS	TEST CONDITIONS
Luminous Intensity	min.	I_V	2.0	2.0	mcd	I_F = 20 mA
	typ.		6.0	6.0	mcd	I_F = 20 mA
Forward voltage	max.	V_F	3.0	3.0	V	I_F = 20 mA
	typ.		2.3	2.3	V	I_F = 20 mA
Dominant wavelength	typ.	λ_d	568/650	630/650	nm	I_F = 20 mA
Reverse breakdown	min.	V_{BR}	5.0	5.0	V	I_R = 100 μA
Total viewing angle between half Luminous Intensity points	typ.	$2\Theta_{1/2}$	100	75	degrees	I_F = 20 mA

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES
(T_A = 25°C Unless Otherwise Specified)

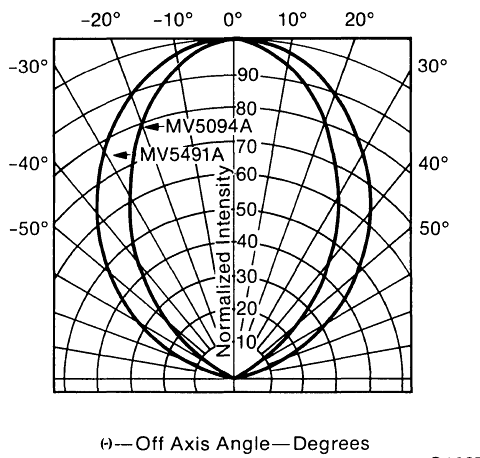


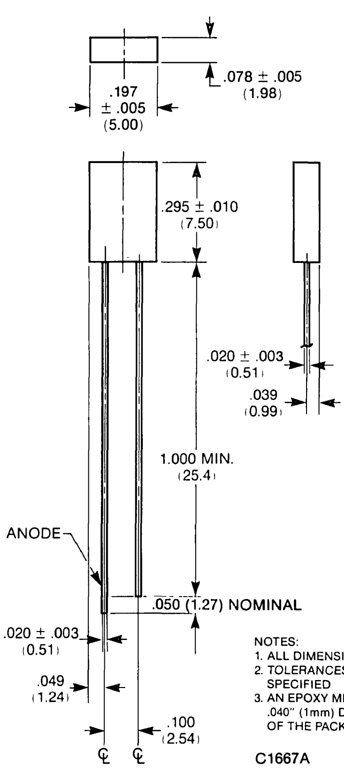
Fig. 1. Spatial Distribution

GENERAL INSTRUMENT

RECTANGULAR SOLID STATE LAMPS

YELLOW MV53123
HIGH EFFICIENCY GREEN MV54123
HIGH EFFICIENCY RED MV57123

PACKAGE DIMENSIONS



NOTES:
1. ALL DIMENSIONS ARE IN INCHES (mm)
2. TOLERANCES ARE ±010" INCH UNLESS SPECIFIED
3. AN EPOXY MENISCUS MAY EXTEND ABOUT .040" (1mm) DOWN THE LEADS. THE BASE OF THE PACKAGE IS NOT FLAT

C1667A

DESCRIPTION

These rectangular LED lamps provide a lighted surface area 2 x 5 mm. The High Efficiency Red and Yellow solid state lamps contain a gallium arsenide phosphide on gallium phosphide light emitting diode. The High Efficiency Green Lamps utilize an improved gallium phosphide light emitting diode.

FEATURES

- 2 x 5 mm lighted area
- Stackable in X or Y direction
- High brightness—typically 4 mcd at 20 mA
- Solid state reliability
- Compact, rugged, lightweight

APPLICATIONS

- Legend backlighting
- Illuminated pushbutton
- Panel indicator
- Bargraph meter

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

	MV53123 MV57123	MV54123
Power dissipation	120 mW	120 mW
Derate linearly from 50° C	1.6 mW/° C	1.6 mW/° C
Storage and operating temperatures	-55° C to +100° C	-55° C to +100° C
Peak forward current (1 μsec pulse width 300 pps)	1.0 A	90 mA
Forward current	35 mA	30 mA
Lead soldering time at 260° C (See Note 1)	5 sec.	5 sec.
Reverse voltage	5.0 V	5.0 V

ELECTRO OPTICAL CHARACTERISTICS (25° C Unless Otherwise Specified)

PARAMETER	TEST COND.	UNITS	MV53123	MV54123	MV57123
Forward voltage (V_F)					
typ.	$I_F = 20$ mA	V	2.1	2.2	2.0
max.	$I_F = 20$ mA	V	3.0	3.0	3.0
Luminous Intensity					
(See Note 2) min.	$I_F = 20$ mA	mcd	1.0	1.0	1.0
typ.	$I_F = 20$ mA	mcd	4.0	4.0	4.0
Peak wavelength		nm	585	562	635
half width	$I_F = 20$ mA	nm	45	30	45
Capacitance					
typ.	V = 0, f = 1 MHz	pF	45	20	45
Reverse voltage (V_R)					
min.	$I_R = 100\ \mu A$	V	5.0	5.0	5.0
Viewing angle (total)		degrees	100	100	100

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS CURVES (25° Free Air Temperature)

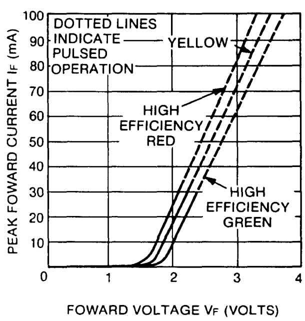


Fig. 1. Forward Current vs. Forward Voltage

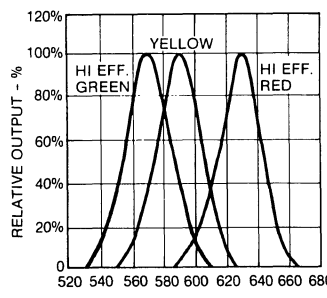


Fig. 2. Spectral Distribution

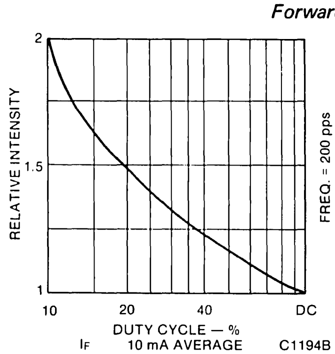


Fig. 3. Luminous Intensity vs. Duty Cycle

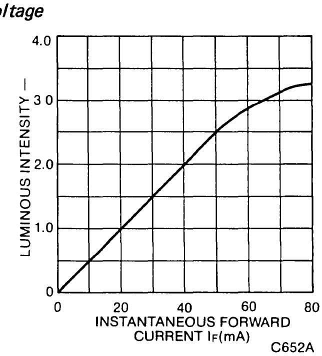


Fig. 4. Luminous Intensity vs. Forward Current

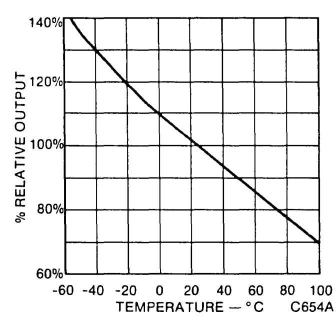


Fig. 5. Output vs. Temperature

NOTES

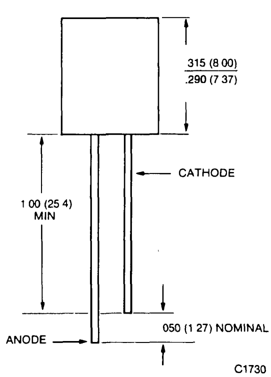
1. *The leads of the device immersed in molten solder, heated to a temperature of 260° C, to a point 1/16 inch (1.6 mm) from the body of the device per MIL-S-750, with dwell time of 5 seconds.*
2. *As measure with a Photo Research Spectra Corp. Microcandela Meter (Model IV-D).*

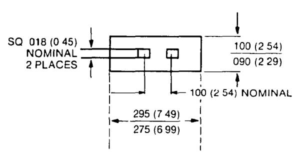
GENERAL INSTRUMENT

RECTANGULAR SOLID STATE LAMPS

HIGH EFFICIENCY RED HLMP-0300/1
YELLOW HLMP-0400/1
HIGH EFFICIENCY GREEN HLMP-0503/4

PACKAGE DIMENSIONS





NOTES:
1. ALL DIMENSIONS ARE IN INCHES (mm)
2. TOLERANCES ARE ±.010" INCH UNLESS SPECIFIED
3. AN EPOXY MENISCUS MAY EXTEND ABOUT .040" (1mm) DOWN THE LEADS. THE BASE OF THE PACKAGE IS NOT FLAT

DESCRIPTION

The HLMP-0X0X Series of rectangular lamps are direct replacements for Hewlett-Packard's series with the same part numbering. The series is similar to MV5X123 except for the larger lens size. Like the MV5X123, the HLMP-0X0X is stackable. The lamps are tinted diffused and intended for direct view.

FEATURES

- 3 High Efficiency colors
- Stackable in both directions
- Rectangular light area
- Inexpensive panel indicators

PHYSICAL CHARACTERISTICS

DEVICE	SOURCE COLOR	LENS COLOR	LENS EFFECT	Iv MIN. AT 20 mA
HLMP-0300	High Efficiency Red	Red Diffused	Very Wide Beam	1.0
HLMP-0301	High Efficiency Red	Red Diffused	Very Wide Beam	2.5
HLMP-0400	Yellow	Yellow Diffused	Very Wide Beam	1.5
HLMP-0401	Yellow	Yellow Diffused	Very Wide Beam	3.0
HLMP-0503	High Efficiency Green	Green Diffused	Very Wide Beam	1.5
HLMP-0504	High Efficiency Green	Green Diffused	Very Wide Beam	3.0

ABSOLUTE MAXIMUM RATINGS (T_A = 25° C Unless Otherwise Specified)

Power dissipation at 25° C ambient .... 135 mW
Derate linearly from 25° C .... 1.6 mW/° C
Storage and operating temperatures .... -55° C to +100° C
Lead soldering time at 260° C (See Note 2) .... 5 sec.
Continuous forward current at 25° C .... 30 mA
Peak forward current (1μsec pulse, 0.3% DF) .... 1.0 A

ELECTRO-OPTICAL CHARACTERISTICS (T_A=25° C Unless Otherwise Specified)

PARAMETER		SYMBOL	HLMP- HI. EFF. RED 0300	0301	YELLOW 0400	0401	HI. EFF. GREEN 0503	0504	UNITS	TEST CONDITIONS
Luminous Intensity (See Note 1)	min.	I_V	1.0	2.5	1.5	3.0	1.5	2.5	mcd	I_F=20 mA
	typ.		2.5	5.0	2.5	5.0	3.0	5.0	mcd	I_F=20 mA
Forward voltage	max	V_F	3.0	3.0	3.0	3.0	3.0	3.0	V	I_F=20 mA
	typ.		2.1	2.1	2.2	2.2	2.3	2.3	V	I_F=20 mA
Peak wavelength	typ.	λ_p	635	635	585	585	565	565	nm	I_F=20 mA
Spectral line half width	typ.	$\Delta\lambda/2$	45	45	35	35	35	35	nm	I_F=20 mA
Capacitance	typ.	C	45	45	45	45	20	20	pF	V_F=0, f=1 MHz
Reverse breakdown voltage	min.	BV_R	5	5	5	5	5	5	V	I_R=100 μA
Total viewing angle between half Luminous Intensity points	typ.	$2\Theta_{1/2}$	100	100	100	100	100	100	degrees	

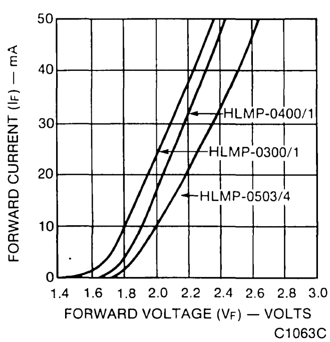


Fig. 1 Forward Current vs. Forward Voltage

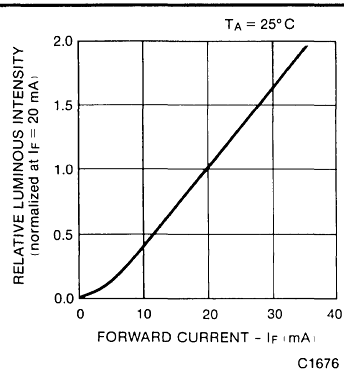


Fig. 2. Luminous Intensity vs. Forward Current

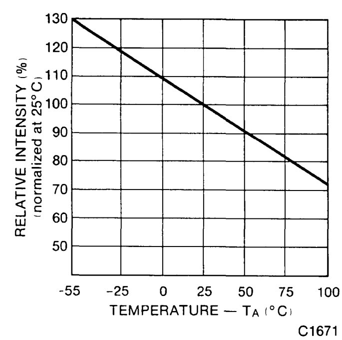


Fig. 3. Relative Luminous Intensity vs. Temperature

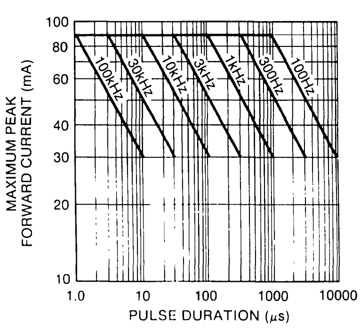


Fig. 4. Maximum Peak Forward Current vs. Pulse Duration

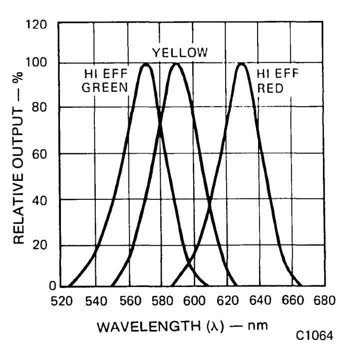


Fig. 5. Spectral Distribution

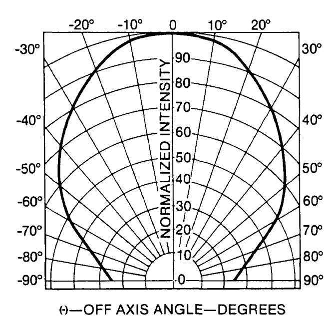


Fig. 6. Spatial Distribution

NOTES

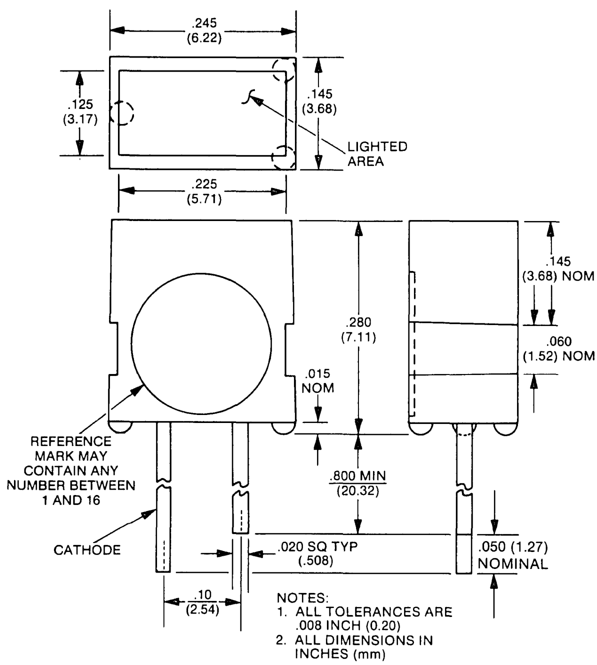
1. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The leads of the device were immersed in molten solder, at 260° C, to a point 1/16 inch (1.6mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

GENERAL INSTRUMENT

RECTANGULAR SOLID STATE LAMPS

YELLOW MV53124A
HIGH EFFICIENCY GREEN MV54124A
HIGH EFFICIENCY RED MV57124A
HIGH EFFICIENCY GREEN/AlGaAs RED MV49124A

PACKAGE DIMENSIONS



C1245B

DESCRIPTION

The MV5X124A Series of rectangular high performance LED lamps with reflector cap has been engineered for much improved light uniformity which is especially important in direct view and legend backlighting. Includes a Green/Red version—MV49124A. The Green chip is the same as is used in MV54124A, while the Red chip is AlGaAs at 660 nm to achieve a bright Dark Red color in the non-tinted diffused epoxy.

FEATURES

- Uniform illumination
- Increased typical brightness.
- Tighter mechanical tolerances for base of design
- Stackable in X or Y direction without crosstalk
- .220" x .125" lighted area for direct view or legend backlighting
- Use Black MP65 two piece grommet for panel mounting
- Superior quality

APPLICATIONS

- Legend backlighting
- Panel indicator
- High quality bargraphs

Lamps

ABSOLUTE MAXIMUM RATINGS

(T_A = 25° C Unless Otherwise Specified)

PARAMETER	All DEVICES	UNITS	NOTES
Power dissipation	120	mW	1
Continous forward current	30	mA	
Peak forward current (1μs, 0.3% DF)	90	mA	
Lead soldering time at 260° C	5	seconds	2
Operating and storage temperature	-55° to + 100° C		

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS EFFECT
MV53124A	Yellow	Yellow Diffused
MV54124A	High Eff. Green	Green Diffused
MV57124A	High Eff. Red	Red Diffused
MV49124A	High Eff. Green/ AlGaAs Red	White Diffused

NOTES

1) Derate linearly from 25° C at 1.6 mW/° C.

2) From a point 1/16 inch (1.6mm) from the bottom of lamp.

ELECTRO-OPTICAL CHARACTERISTICS (25° C Temperature Unless Otherwise Specified)

PARAMETER		SYMBOL	MV 53124A	MV 54124A	MV 56124A	MV 57124A	MV 49124A	UNITS	TEST COND.	NOTES
Luminous	min.	I_V	1.0	1.0	1.0	1.0	1.0	mcd	$I_F = 20$ mA	3
Intensity	typ.		6.0	6.0	6.0	6.0	6.0	mcd	$I_F = 20$ mA	3
Forward voltage	typ.	V_F	2.0	2.2	2.0	2.0	2.2	V	$I_F = 20$ mA	
	max.		3.0	3.0	3.0	3.0	3.0	V	$I_F = 20$ mA	
Peak wavelength		λp	585	562	605	635	562/660	nm	$I_F = 20$ mA	
Spectral line half width			45	30	45	45	30/45	nm	$I_F = 20$ mA	
Reverse voltage	min.	V_{BR}	5	5	5	5	5	V	$I_R = 100\ \mu A$	
Reverse current	max.	I_R	100	100	100	100	100	μA	$V_R = 5.0$ V	
Capacitance		C	45	20	45	45	20/30	pF	V= 0, f = 1 MHz	
Viewing angle (total)		$2\Theta½$	100	100	100	100	100	degrees		

NOTE

3) As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (25° C Temperature Unless Otherwise Specified)

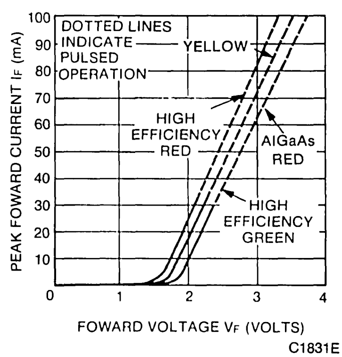


Fig. 1. Forward Current vs. Forward Voltage

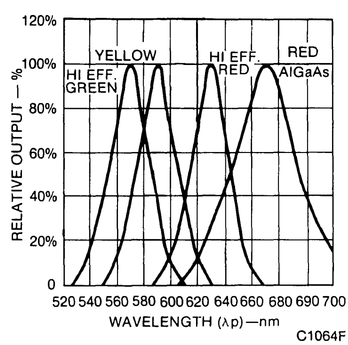


Fig. 2. Spectral Distribution

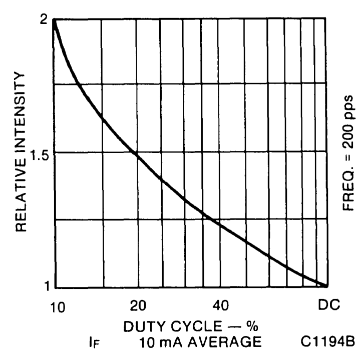


Fig. 3. Luminous Intensity vs. Duty Cycle

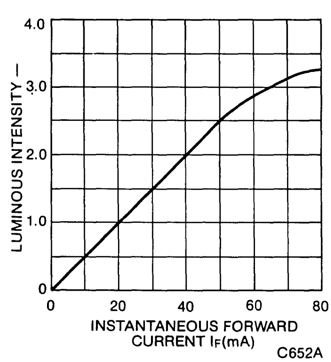


Fig. 4. Luminous Intensity vs. Forward Current

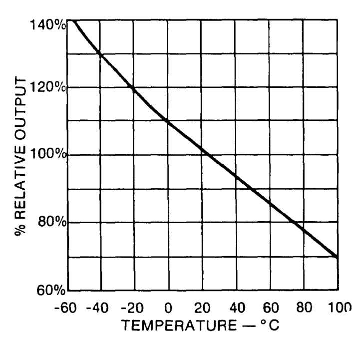


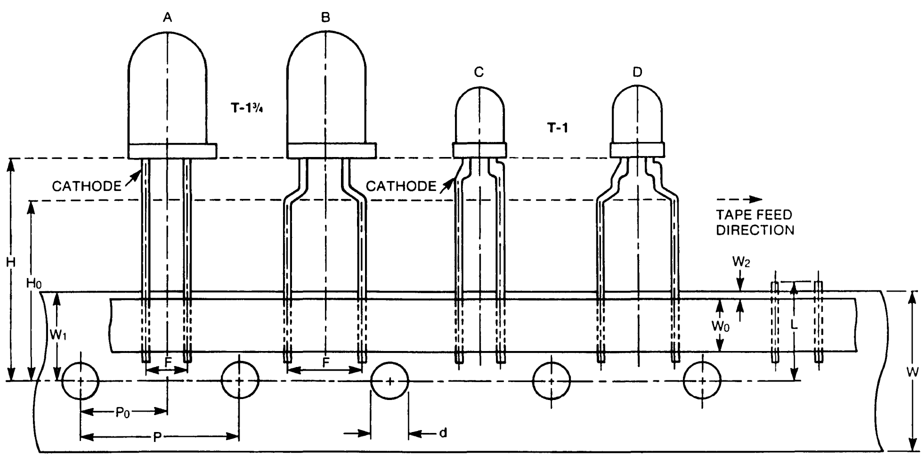
Fig. 5. Output vs. Temperature

GENERAL INSTRUMENT

TAPE AND REEL

TAPE AND REEL

PACKAGE DIMENSIONS



C1834A

	A	B	C	D
H	16.5	—	16.5	—
	18.5	—	18.5	—
	22.5	22.5	22.5	22.5
H_0	—	16	—	16
W_0	6.0 ± 0.3			
W	$18.0 \pm ^{1}_{0.5}$			
W_1	$9.0 \pm ^{0.75}_{0.5}$			
W_2	≤ 0.5 mm			
P	12.7 ± 0.3			
P_0	6.35 ± 1.0			
d	4.0 ± 0.2			
F	$2.54 \pm ^{0.6}_{0.1}$	$5.08 \pm ^{0.6}_{0.1}$	$2.54 \pm ^{0.6}_{0.1}$	$5.08 \pm ^{0.6}_{0.1}$
Δh	$\pm 2°$			
L	11.0 MAX			

All dimensions in mm

FEATURES

- Automatic PCB assembly of most T-1¾ and T-1 with radial lead insertion machines
- Meets ANSI/EIA standard RS-464 (1981
- Standard .100-inch lead spacing or preformed to .200-inch
- Choice of H = 16.5, 18.5 or 22.5 mm
- Standard reel
- T-1¾; MV5X5X, MV5X9XA, GIOD HLMP-3XXX
- T-1; MV5X6XX, GIOD HLMP-1XXX

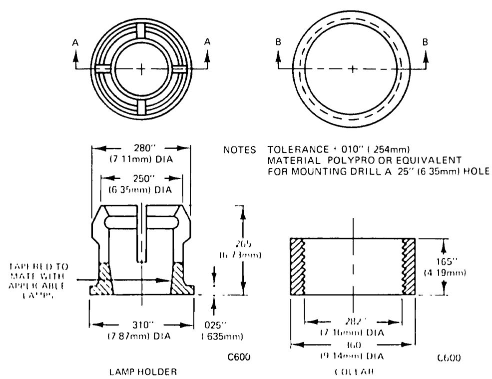
Lamps

GENERAL INSTRUMENT

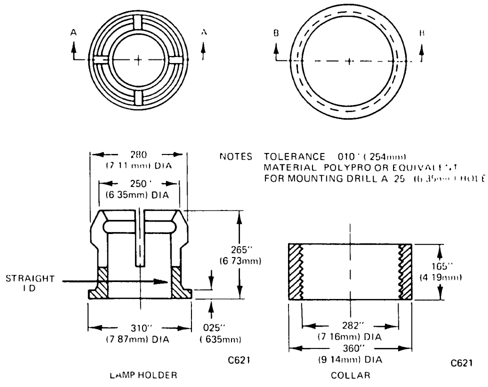
T-1¾ PANEL MOUNTING GROMMETS

MP22 MP52

PACKAGE DIMENSIONS



MP22 TWO-PIECE POP-INS FOR MV5X2X



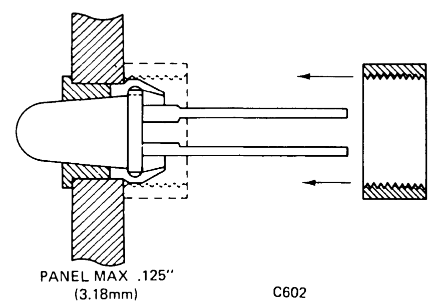
MP52 TWO-PIECE POP-INS FOR MV6X5X AND MV5X5X

DESCRIPTION

The MP Series of mounting grommets is intended for panel mounting of any standard T-1¾ General Instrument light emitting diode indicators. The grommets are made of plastic and are available in Black only.

The MP Series will easily mount the applicable lamps on any panel thickness up to .125-inch (3.18 mm).

TYPICAL MOUNTING TECHNIQUE FOR EITHER TYPE

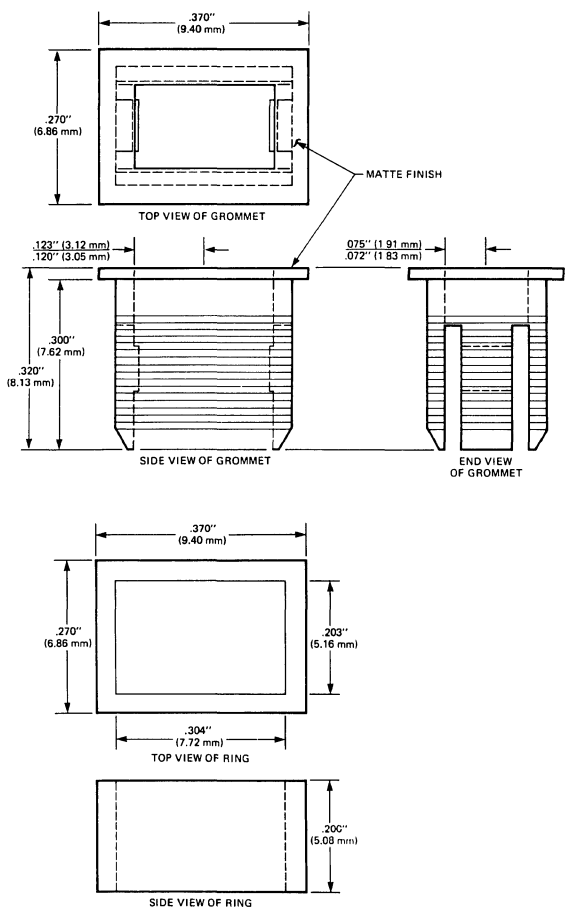


GENERAL INSTRUMENT

MV5X124 PANEL MOUNTING GROMMET

MP65

PACKAGE DIMENSIONS



C1455

DESCRIPTION

The MP65 mounting grommet is intended for panel mounting the MV5X124 Series of rectangular lamps. The grommets are made of Black plastic and provide the user with an easy-to-mount, professional appearance when viewed on a front panel.

The MP65 can be used on any panel thickness up to .125-inch (3.18 mm).

PANEL HOLE PUNCHING

Punches can be ordered from one of the follow- ıw- ing sources:

W. A. WHITNEY COMPANY
650 Race Street
Rockford, IL 61105
(815) 964-6771
(Request a 28xx series punch with dimensions of 5/16" x 7/32")

ROTEX PUNCH COMPANY, INC.
2350 Alvarado Street
San Leandro, CA 94577
(415) 357-3600
(Request a 3506 series punch with dimensions of 5/16" x 7/32")

Applications 5

Applications Index

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GENERAL INSTRUMENT

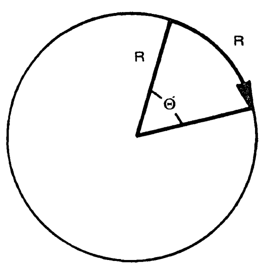
AN601
The Photometry of LED's
A Primer in Photometry

REVIEW OF GEOMETRIC PRINCIPLES

Any short discourse on the subject of photometry requires a brief review of geometric principles utilized.

RADIAN

In plane geometry the angle whose arc is equal to the radius generating it is called a radian. Therefore, if $C = 2\pi R$ (Circumference of a circle) $2\pi R = 360°$. Radian = $180°/\pi$ = 57.27° (approx.)

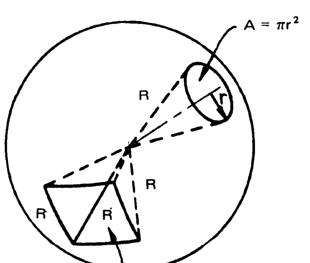


TWO DIMENSIONAL FIGURE

FIGURE 1

STERADIAN

In solid geometry one steradian is the solid angle subtended at the center of a sphere by a portion of the surface area equal to the square of the radius of the sphere. Therefore, if $AREA/R^2 = 1 = 1$ steradian and the area on the surface of a sphere equals $4\pi R^2$, then $4\pi R^2/R^2$ or 4π steradians of solid angle ω about the center of a sphere. The steradian is usually abbreviated as STER.



$$A = \frac{R \times R}{R^2} = \frac{R^2}{R^2} = 1$$

THREE DIMENSIONAL FIGURE

FIGURE 2

Other abbreviations of immediate concern are:

Ae = Area of emitting (or reflecting) surface.
Ap = Apparent area of an emitting source whose image is projected in space and viewed at some angle, Θ.
Ad = Detection area. Whether a physical target or merely a defined spatial area, it is the area of interest.

PHOTOMETRIC TERMINOLOGY

FLUX (Symbol F)

Any radiation, whether visible or otherwise, can be expressed by a number of FLUX LINES about the source, the number being proportional to the intensity of that source. This LUMINOUS flux is expressed in LUMENS for visible radiation.

LUMINOUS EMITTANCE (Symbol L)

A source measurement parameter. It is defined as the ratio of the luminous flux emitted from a source to the area of that source, or L = F/Ae. Typically expressed in units of:

lumens/cm^2 or one PHOT,
lumens/m^2 or one LUX (or one METER CANDLE),
lumens/ft^2 or one FOOT CANDLE.
The foot candle is the more common term used in this country.

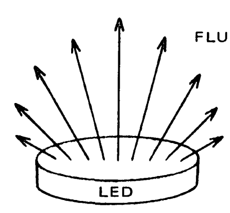


FIGURE 3

Applications

ILLUMINANCE (Symbol E)

This is a target or detector area measurement parameter. It is the ratio of flux lines incident on a surface to the area of that surface or E = L/Ad. Typical measurement units are the same for LUMINOUS EMITTANCE (above) i.e. lumen/cm^2 = one phot, lumen/m^2 = one lux, and lumen/ft^2 = one ft. candle.

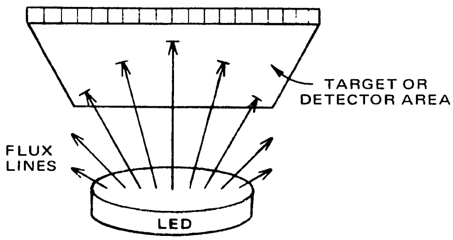


FIGURE 4

LUMINOUS INTENSITY (Symbol I)

A spatial flux density concept. It is the ratio of luminous flux of a source to the solid angle subtended by the detected area and that source. The LUMINOUS INTENSITY of a source assumes that source to be point rather than an area dimension. The LUMINOUS INTENSITY (or CANDLE POWER) of a source is measured in LUMENS/STERADIAN which is equal to one CANDELA (or loosely, one CANDLE).

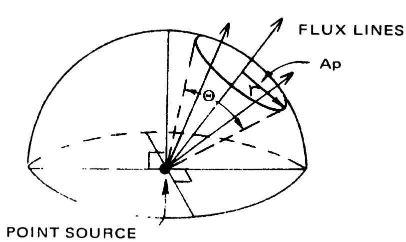


FIGURE 5

LUMINANCE (Symbol B)

Sometimes called photometric brightness (although the term brightness should not be used alone as it encompasses other physiological factors such as color, sparkle, texture, etc.) it is applied to sources of appreciable area size. Mathematically, if the area of an emitter (circular for example) has a diameter or diagonal dimension greater than 0.1 the distance to the detector, it can be considered as an area source. If less than this 10% figure, the source can be treated as point in nature. This one to ten ratio of source diameter to distance is offered as it MATHEMATICALLY very closely approximates results obtained when comparing an area source to its point equivalent. LUMINANCE presents itself as an extremely useful parameter as it applies a figure of merit to:

1. Apparent or protected area of the source (Ap).
2. Amount of luminous flux contained within the projected area of the source (Ap).
3. Solid angle the projected area generates with respect to the center of the source.

NOTE: The projected area Ap varies directly as the cosine of Θ i.e. max. at 0° or normal to the surface and minimum at 90°

$$Ap = Ae \cos \Theta$$

LUMINANCE is defined as the ratio of LUMINOUS INTENSITY to the projected area of the source Ap.

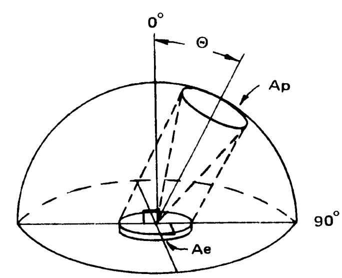


FIGURE 6

$$\frac{\text{LUMINOUS INTENSITY}}{\text{Ap}} = \frac{\frac{\text{LUMENS}}{\text{STERADIAN}}}{\text{Ae} \cos \Theta} = \frac{\text{CANDELAS}}{\text{(Sq. Unit)}}$$

And depending on the units used for area:

1 CANDELA/cm^2 = 1 STILB
1 CANDELA/m^2 = 1 NIT
1 CANDELA/in^2 =)
1 CANDELA/ft^2 =) no designator available.

Also:

1/π candela/cm^2 = LAMBERT
1/π candela/m^2 = APOSTILB (or BLONDEL)
1/π candela/in^2 = no designator available
1/π candela/ft^2 = FOOT LAMBERT

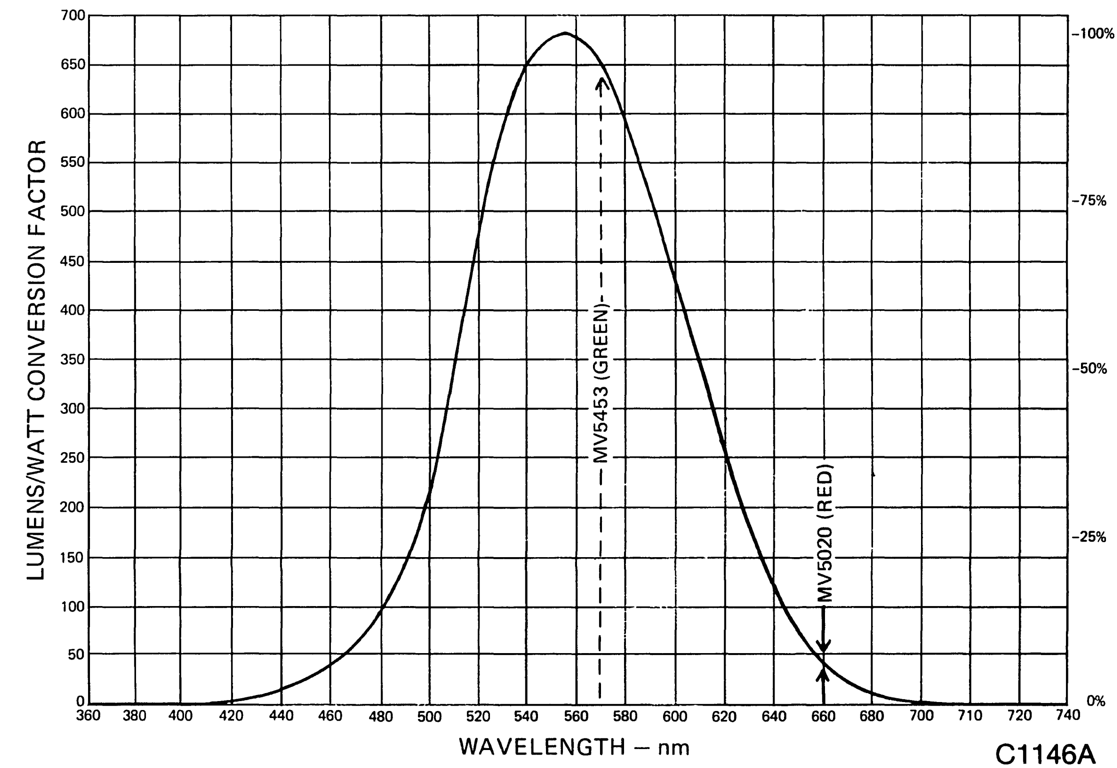
CIE CURVE

Following is the standard observer curve or "standard eyeball" established by the Commission Internationale de l'Eclair (commonly called the CIE curve). Whereas one watt of radiated energy at any frequency corresponds to one watt of radiated energy at any other frequency, this relationship fails to hold true for photometric measurement. The CIE curve is essential therefore, not only in determining the eye's efficiency at any particular wavelength, but also the corresponding lumens per watt conversion of that particular wavelength.

For example, the MV5020 which emits 180 μW of radiant energy at 6600Å (typical) or 41.4 lumens per watt has

$$180 \times 10^{-6} \text{ watts} \times \frac{41.4 \text{ lumens}}{\text{watt}} = 7.45 \text{ mLumens}$$

of flux emitted from it.



Similarly, a green emitter such as the MV5453 operating at an identical input power as the red will emit 10 μwatts of radiant energy or

$$10 \times 10^{-6} \text{ watts} \times \frac{649 \text{ lumens}}{\text{watt}} = 6.49 \text{ mLumens}$$

of flux emitted from it. In short although there exists at least an order of magnitude difference in radiant power the eyes' compensating effect "magnifies" the green to appear equally bright.

LUMINOUS INTENSITY versus LUMINANCE

The successful application of either measurement parameter as a yardstick to duplicate mathematically the visual stimulation experienced by an observer is a controversy which will probably rage for some time. As the entire electromagnetic spectrum is bounded only by the capabilities of a detector to discern it, so for within the visual spectrum the eye is the limiting factor. SUBJECTIVELY speaking, the eye can discern finer increments of arc (computed from target to eye) than a 1 to 10 relationship, or approximately 5° 43 min. In fact, it can be shown that for view angles of much less than 2 minutes, the eye translates the source into a point and thus the photometric measurement of LUMINOUS INTENSITY (in candelas) most directly correlates with subjective brightness. For view angles of much greater than approximately 2 minutes, the eye sees the source as an area source, and thus the photometric measurement of LUMINANCE most directly correlates with subjective brightness. A two minute view angle computes to a 1/1666 ratio of source diameter to distance ratio. For the MV5025 this computes to approximately 22 feet (1666 x .16" diameter, approximately 22 feet) well within the expected normal viewing distance of an observer.

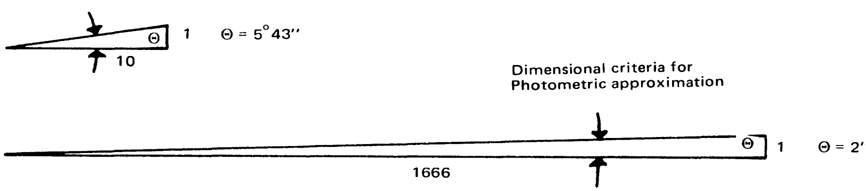


FIGURE 7

Considering that the usage of the discrete MV5025 LED is as an indicator and as such is utilized arms length or approximately 30" away, it can be seen that the LUMINANCE parameter and its basic unit, the FOOT LAMBERT, most closely correlates with subjective brightness.

RADIOMETRY

While photometric units are concerned with only the visible spectrum of wavelength, all frequencies of emission, including the visible are expressable in RADIOMETRIC terms. Radiometric terms and their photometric equivalents are as follows:

RADIOMETRIC	PHOTOMETRIC
Radiant flux (Symbol P) expressed in watts	**Luminous flux** (F) expressed in lumens
Irradiance (Symbol H) expressed in watts/sq. unit	**Illuminance** (E) expressed in lumens/sq. unit
Radiant Emittance (Symbol W) expressed in watts/sq. unit	**Luminous Emittance** (L) expressed in lumens/sq. unit
Radiant Intensity (Symbol J) expressed in watts/steradian	**Luminous Intensity** (Symbol I) expressed in lumens/steradian
Radiance (Symbol N) expressed in watts/ster/sq. unit	**Luminance** (B) expressed in lumens/ster/sq. unit

GENERAL INSTRUMENT

AN603 Improper Testing Methods for LED Devices

In any manufacturing operation it is essential that the materials used in the fabrication process meet the minimum quality specifications of the device under production. To that end, prudent manufacturers establish some sort of incoming quality assurance system to make sure that defective materials are culled at the door. It is equally important, however, that the screening system used in the Q.A. inspection does not reject materials which are acceptable, and that the testing procedures utilized in the system do not inadvertently damage materials which are otherwise acceptable. Unfortunately, this latter aspect of quality assurance procedures is often neglected, and whenever a device is rejected because of inappropriate testing methods, both the manufacturer and the vendor are subject to a great deal of unnecessary expense and inconvenience. Because many manufacturers who buy LED components are relatively inexperienced with the features and limitations of III-V devices, problems involving improper testing methods and unnecessary materials rejection are of particular concern to LED vendors. This note is intended to familiarize the user with the basic electrical and opto-electrical properties of LED devices and to clear up some of the problems involved in testing them.

THE MATERIAL

Historically, silicon and germanium were the first semiconductor materials to have been used for p-n junction devices such as transistors, diodes, and solar cells. However, following closely upon the invention of the germanium transistor in 1948, work was begun on predicting the semiconductivity of a material from its chemical compound. Based on energy band-gap experimentation, it was discovered that III-V materials have semiconductor properties.[1]

Gallium semiconducting materials, Gallium Arsenide (GaAs), Gallium Arsenide Phosphide (GaAsP), and Gallium Phosphide (GaP) are the materials from which LED's are fabricated. These materials have the ability to emit a narrow band of monochromatic light in either the visible or infrared spectrum, depending on the constituent and ratio of ingredients. The mechanism for this emission of radiant energy is best described in terms of semiconductor Energy-Band Theory. When an external, forward-biasing voltage is applied to a p-n junction, the conduction mechanism is such that electrons are excited by the electric field, gaining enough energy to cross the energy gap from the valence band to the conduction band, and then to relax back from the conduction band into the valence band. During the transition from the valence band to the conduction band, the electrons take energy from the field. As they pass back into the valence band, the electrons release this energy in the form of light photons. The amount of energy released is determined by the width of the energy gap. (The wavelength, or color, or the light is a function of the energy gap.) The light is emitted directly from the electrons within the depletion region formed between the two sides of the junction.

The electrical characteristics of LED's are also related to the energy gap. For example, the conduction threshold, or "knee" point on the I_f/V_f curve in the forward-biased direction occurs at approximately 1.0 volts for infrared LED's, at approximately 1.3 volts for visible red LED's, and from 1.8 to 2 volts for yellow and green LED's. The brightness of the light is directly proportional to the operating current flowing in the forward direction.

GALLIUM VS. SILICON

As a semiconductor, III-V compounds using Gallium have several advantages over silicon and germanium—reverse leakage current is several orders of magnitude lower; forward current is lower below the "knee" point; inherent thermal noise is lower; and carrier mobility is high. Perhaps the greatest advantage, certainly where LED's are concerned, is the ability to produce light directly from electron flow.

Figure 1 shows a comparison between the forward conduction characteristics of diodes formed from III-V materials and silicon. Notice that the "knee" of the conduction curve for the Gallium diodes occurs at higher voltages, and is harder than the "knee" of silicon diodes. Notice also that as the wavelength progresses from the infrared toward the blue end of the spectrum, the GaAsP "knee" points get progressively higher and the slope of the I_f/V_f curve tends to decrease. Excluding exotic devices such as Schottky or Esaki diodes, silicon diode de-

[1] E.G. Bylander, *Materials for Semiconductor Functions* (New York, 1971), p. 17.

Applications

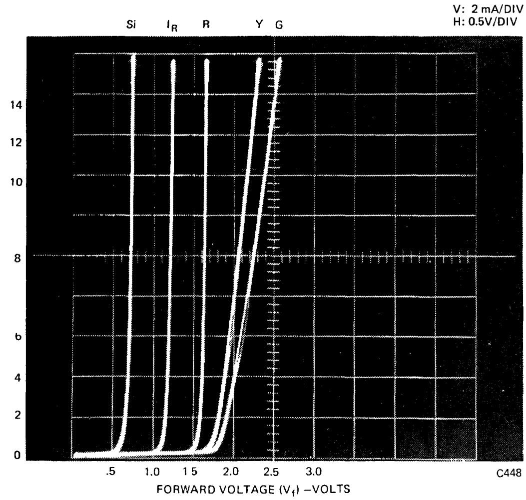


Fig. 1. Typical I_f/V_f Curves of Silicon, GaAs, and GaAsP, GaP (Silicon-IN914, IR-ME7024, Red-MV5053, Yellow-MV5353, Green-MV5253)

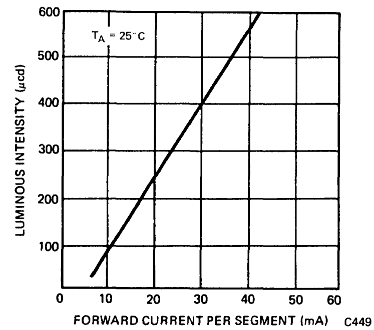


Fig. 2. Typical LED Curve Luminous Intensity vs. Forward Current for Constant Temperature

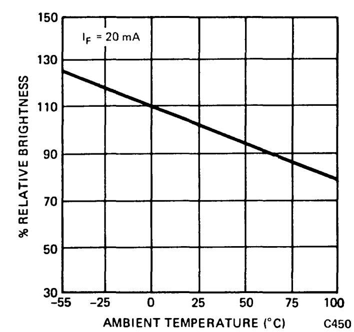


Fig. 3. Typical LED Curve Brightness vs. Temperature for Constant Current

vices normally show little difference in the forward conduction curve.

The reverse characteristics of III-V materials are similar to those of silicon except that silicon's thermal leakage current is higher at very low reverse voltages. The reverse breakdown voltages of silicon are typically higher, and the characteristics of silicon devices are usually controlled for reverse breakdown at particular voltages. The reverse breakdown characteristics of diodes used in LED devices are not particularly controlled, since the quality of light emission is the first priority. The MANX and MANXX series displays use LED's which have a typical reverse-mode breakdown voltage range of from 5 to 20 volts. However for guard-band purposes, the reverse voltage is specified on the data sheets at 5 volts minimum.

If a silicon device is subject to junction damage, it will often continue to perform adequately because of silicon's inherent annealing capability. When damage occurs to the junction of an LED device, however, the result is usually a softening of the "knee" or a flattening of the I_f/V_f curve. Although the device may continue to operate, performance will be less than satisfactory, and early failure may result.

DAMAGE MECHANISMS

The discussion which follows will treat, in some detail, the most common errors in LED test set-ups and will suggest either alternative testing methods or means by which improper testing methods can be corrected to produce more reliably accurate results.

Testing for Fabrication Defects

Thermal Shock—is a passive mode test involving a rapid refrigerate/heat cycle in which no current is applied to the device. This test is a good method for detecting weak bonds and, therefore, locating defective devices, but it should be used cautiously, especially with LED's. In LED's a 1-mil gold wire is bonded from the top of the die over to the side contact, whether it is lead frame or substrate. The wire is surrounded by the epoxy which encloses the die and forms the package. When heat is applied, the epoxy, the gold, and the lead frame all expand at different rates. Thus, when the device is heated up too rapidly, the effects on the bond are similar to giving the wire a hard jerk. This action constitutes thermal shock and tends to weaken even good bonding and, consequently, shorten life expectancy.

Burn-In—consists of operating the device at elevated temperatures, thus accelerating the effects of operationally imposed heating. This method is frequently used in testing semiconductors, but its use is **not** advised with LED's, especially if the testing involves operating with excess current or current which exceeds the device ratings for several hours. LED's exhibit a gradual degradation of brightness as a function of current, time, and

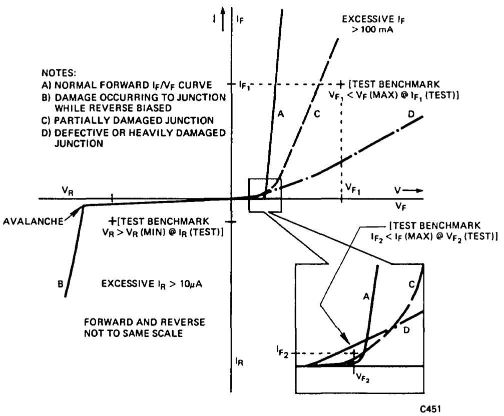


Fig. 4. Effects of Improper Testing Procedure

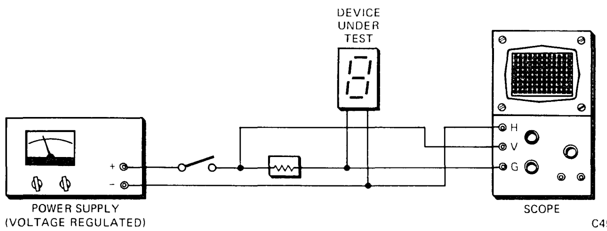


Fig. 5. Potentially Damaging Forward-Mode Test Setup

temperature, and the higher the current, the faster the degradation. The graphs in Figures 2 and 3 illustrate typical LED responses to forward current and temperature. Exceeding the rated parameters in test can result in rapid degradation beyond an acceptable level. For the same reasons, burn-in is particularly inadvisable with LED's if the test set-up involves slow on-off cycles of overcurrent (cyclic room temperature to high temperature and then cooling).

Thermal Cycling—is an on-off cycling method which simulates operational heating effects. The device is allowed to heat up from room temperature with rated current, and is then cooled down. Thermal cycling is an excellent method for finding defective devices (poor bonds, fractures in the metalization, voids in the die-attach, etc.), and its use is recommended for testing LED's. Too often, such thermal cycling occurs in actual use, and defects are detected too late. However, to insure against exceeding the rated capabilities of a particular device, a thermal cycling test program (or operational program) should not be established without factory guidance.

Reverse Conduction Mode Problems

Reverse voltage testing can be hazardous since it may involve a system capable of delivering voltages and currents which considerably exceed the reverse voltage and power ratings of the device under test. Too much current at the avalanche voltage will dissipate excessive power, resulting in heat which will degrade the junction rapidly. The importance of adequate current limiting cannot be over-emphasized. Without it, damage to the junction can result from testing into the avalanche region and/or from the sudden application of voltage which exceeds the rated avalanche breakdown voltage of the device. Damage in the avalanche region is usually the result of an improperly set testing apparatus. As Figure 4 indicates, damage may not be immediately apparent, but it could result in poor performance during other test situations and possible rejection of the device due to excessive voltage or current values.

Forward Conduction Mode Problems

Forward mode testing is used to check such performance criteria as the forward V/I curve of the diode, brightness, ROP, and luminescence. The potential danger in examining the forward curve is damage to the diode junction, since the test circuitry can sometimes deliver very high energy bursts. For example, if a 50-volt regulated power supply is set for 5 volts to supply the test fixture, and if power is supplied through a switch as shown in Figure 5, it is possible to deliver current pulses of a high enough amplitude to result in junction damage. This problem is easily avoided by supplying low voltage power with current limiting to the test fixture. Another acceptable method, and the one which is used by General Instrument quality assurance engineers, is to use a power supply which is both full voltage regulated and current limited.

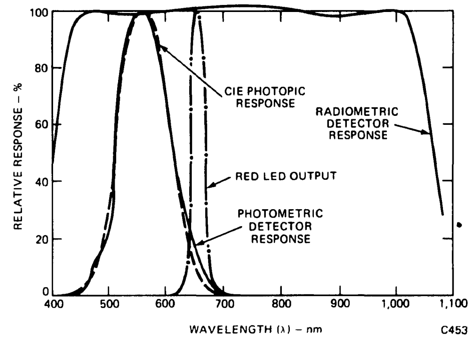


Fig. 6. Responses of Two Detectors to the Output of a Visible Red LED

Brightness Tests

Optical measurements are typically, and in most instances, unavoidably, of very low accuracy. Optical measurements with errors of less than 1% are rare, and accuracy within 5% is difficult to obtain. With an experienced technician using good equipment it is possible to secure accuracy within 10% to 20% on a routine basis, but even here a slight difference in technique can result in errors in excess of 50%.

Detectors—A good detector approximates the CIE curve area with 2%. However, it is important to note that even when the detector is within 2% of perfect, it is still possible to produce mismatches at specific wavelengths which can cause the percentage of error to increase considerably. Therefore, in order to determine the margin of possible error, it is imperative that one know the detector's spectral response within the wavelength range of the device to be measured. To illustrate the problem of spectral mismatch, the reader is referred to Figure 6 where we show the responses of two detectors, a radiometric detector and a photometric detector, to the output of a visible red LED. The response of the radiometric detector is about 3% high. Notice, however, that the photometric detector, which provides a very close match to the CIE curve, produces a +25% error.[2]

Additional factors which must be considered are detector aging and filter deterioration, nonlinear detector responses, circuitry which is not temperature-compensated, and stray light. Periodic calibration is essential if a reasonable degree of accuracy is to be maintained.

Correlation Samples—Unless the testing apparatus is reciprocally related to a vendor-supplied correlation sample, test results may erroneously indicate that many devices in a shipment do not meet the minimum brightness that was specified on the order, and could result in the rejection of devices which do meet minimum standards. Correlation samples are also essential for the correction of instrumentation drift.

Subjectivity Problems—In some instances a visual comparison may be the best method for brightness testing. However, the manner by which the human eye "sees" is affected by various factors such as the nature of the light source, viewing distance, color, texture, the observer's visual acuity, and even the viewer's emotional state. Therefore, because of these highly subjective factors involved in human visual perception, such tests alone are usually inadequate and should be used only as a supplement to or in correlation with instrumentation. It has been our experience that manufacturers who rely solely on visual testing return many devices, a fair percentage of which can be reshipped and accepted.

Testing to Parameters Other Than Those Specified—This is a particularly important consideration when a manufacturer specifies his own parameters distinct from those normally specified. To avoid unnecessary rejection of devices, it is imperative that a device is **always tested to the parameters under which it will be expected to operate.**

SUGGESTIONS FOR PROPER TESTING

That which follows is a quick check list of "do's" which enable manufacturers to avoid many of the problems associated with running incoming quality assurance tests on LED's.

- In cooperation with the vendor, establish specifications which are economically feasible and ensure that devices are screened at their point of origin.
- Always obtain a correlation sample from the vendor before setting up the test procedure.
- Establish a reliable test procedure.
- Measure relevant parameters at relevant points.
- Make sure that the test circuitry will not erroneously indicate defects and that it will not generate failures later in the manufacturing cycle.
- Work closely with the vendor in establishing the test system.

[2]Michael A. Zaha, "Shedding Some Needed Light on Optical Measurements," *Electronics*, November 6, 1972, pp. 94-96.

GENERAL INSTRUMENT

AN1071 Optocoupler Input Drive Circuits MCT270 Series

An optocoupler is a combination of a light source and a photo-sensitive detector. In the optocoupler, or photon coupled pair, the coupling is achieved by light being generated on one side of a transparent insulating gap and being detected on the other side of the gap without an electrical connection between the two sides (except for a minor amount of coupling capacitance). In the General Instrument optocouplers, the light is generated by an infrared light emitting diode, and the photo-detector is a silicon diode, transistor, or SCR. The sensitivity of the silicon material peaks at the wavelength emitted by the LED, giving maximum signal coupling.

Since the input to all the optocouplers is a LED, the input characteristics will be the same, independent of the type of detector employed. The LED diode characteristics are shown in Figure 1. The forward bias current threshold is shown at approximately 1 volt, and the current increases exponentially, the useful range of I_F between 1 mA and 100 mA being delivered at a V_F between 1.2 and 1.3 volts. The dynamic values of the forward bias impedance are current dependent and are shown on the insert graph for R_{DF} and ΔR as defined in the figure. Reverse leakage is in the nanoampere range before avalanche breakdown.

The LED equivalent circuit is represented in Figure 2, along with typical values of the components. The diode equations are provided if needed for computer modeling and the constants of the equations are given for the IR LED's. Note that the junction capacitance is large and increases with applied forward voltage. An actual plot of this capacitance variation with applied voltage is shown on the graph of Figure 3. It is this large capacitance controlled by the driver impedance which influences the pulse response of the LED. The capacitance must be charged before there is junction current to create light emission. This effect causes an inherent delay of 10-20 nanoseconds or more between applied current and light emission in fast pulse conditions.

The LED is used in the forward biased mode. Since the current increases very rapidly above threshold, the device should always be driven in a current mode, not voltage driven. The simplest method of achieving the current drive is to provide a series current-limiting resistor, as shown in Figure 4, such that the difference between V_F and V_{APP} is dropped across the resistor at the desired I_F, determined from other criteria. A silicon diode is shown installed inversely parallel to the LED. This diode is used to protect the reverse breakdown of the LED and is the simplest method of achieving this protection. The LED must be protected from excessive power dissipation in the reverse avalanche region. A small amount of reverse current will not harm the LED, but it must be guarded against unexpected current surges.

The forward voltage of the LED has a negative temperature coefficient of 1.05 mW/°C and the variation is shown in Figure 5.

The brightness of the IR LED slowly decreases in an exponential fashion as a function of forward current (I_F) and time. The amount of light degradation is graphed in Figure 6 which is based on experimental data out to 20,000 hours. A 50% degradation is considered to be the failure point. This degradation must be considered in the initial design of optoisolator circuits to allow for the decrease and still remain within design specifications on current-transfer-ratio (CTR) over the design lifetime of the equipment. Also, a limitation on I_F drive is shown to extend useful lifetime of the device.

In some circumstances it is desirable to have a definite threshold for the LED above the nominal 1.1 volts of the diode V_F. This threshold adjustment can be obtained by shunting the LED by a resistor, the value of which is determined by a ratio between the applied voltage, the series resistor, and the desired threshold. The circuit of Figure 7 shows the relationship between these values. The calculations will determine the resistor values required for a given I_{FT} and V_A. It is also quite proper to connect several LED's in series to share the same I_F. The V_F of the series is the sum of the individual V_F's. Zener diodes may also be used in series.

Where the input applied voltage is reversible or alternating and it is desired to detect the phase or polarity of the input, the bipolar input circuit of Figure 8 can be employed. The individual optocouplers could control different functions or be paralleled to become polarity independent. Note that in this connection, the LED's protect each other in reverse bias.

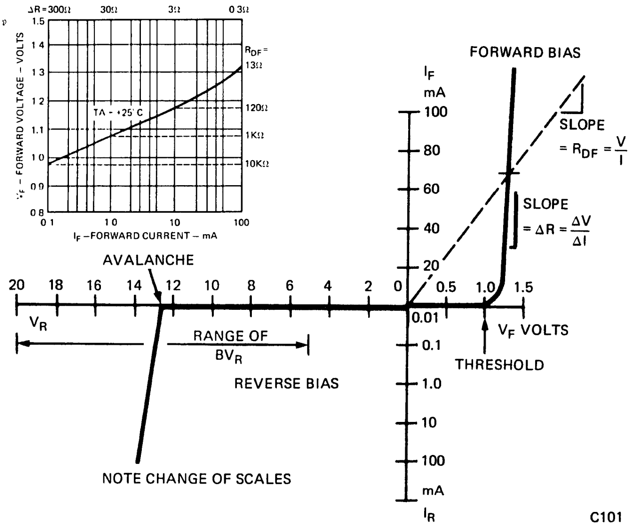
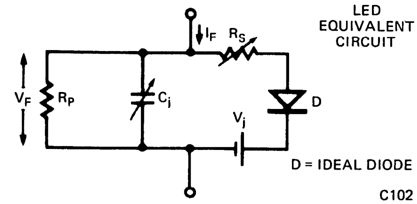


Fig. 1. Characteristics of IR LED



V_F	-5	0	-	-	.	V
I_F	-	-	1	10	100	mA
C_j	55	100	300	500	-	pF
V_j		1.0	1 1	1 2	1 3	V
I_R	<10	0	-	-	-	nA
R_S		∞	30	3	0 3	Ω
R_P	>10[9]	-	-	-	-	Ω

$$I_F = I_{FT} \exp \frac{V_F - V_{FT}}{k}$$

$$V_F = V_{FT} + k \log \frac{I_F}{I_{FT}}$$

FOR IR IN OPTO-ISOLATORS

V_{FT} = 0.98 VOLT
I_{FT} = 0.10 mA
k = 0.360

$$R_S = \frac{0.03\ (V)}{I_F\ (A)}$$

Fig. 2. Equivalent Circuit Equations

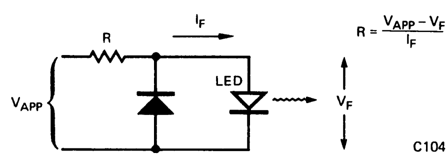


Fig. 4. Typical LED Drive Circuit

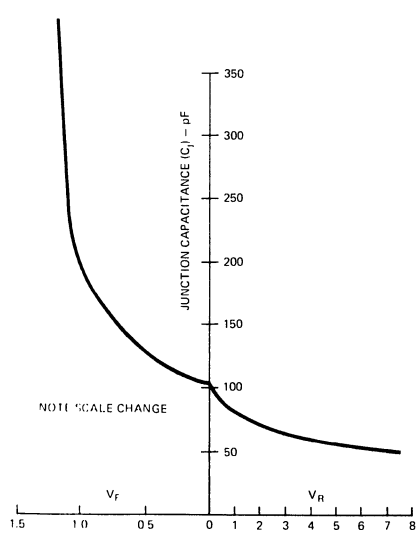


Fig. 3. Voltage Dependence of Junction Capacitance

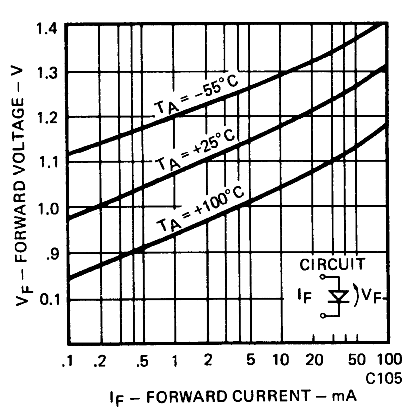


Fig. 5. IR Forward Voltage vs. Forward Current and Temperature

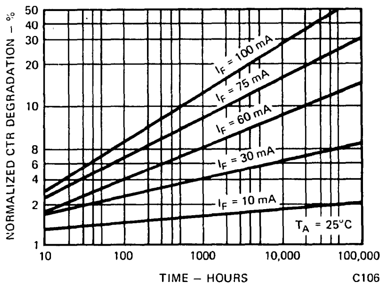


Fig. 6. Brightness Degradation vs. Forward Current and Time

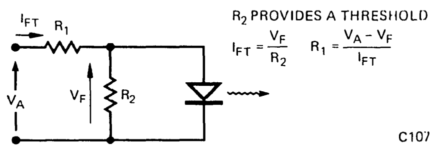


Fig. 7. LED Threshold Adjustment

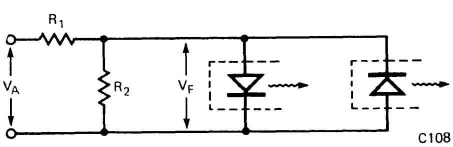


Fig. 8. Bipolar Input Selects LED

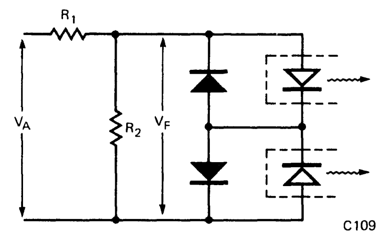


Fig. 9. High Threshold Bipolar Input

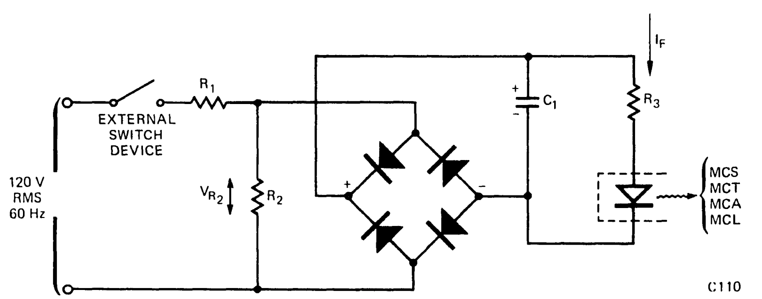


Fig. 10. AC Input to LED Drive Circuit

Another method of obtaining a high threshold for high level noise immunity is shown in Figure 9, where the LED's are in inverse series with inverse parallel diodes to conduct the opposite polarity currents. In this circuit the V_F is the total forward drop of the LED and silicon diode in series. The resistors serve their normal threshold and current limiting functions. The silicon diodes could be replaced by LED's from other optocouplers or visible signal indicators.

In some situations it may be necessary to drive the LED from a 120 VRMS, 60 Hz or 400 Hz source. Since the LED responds in nanoseconds, it will follow the AC excursions faithfully, turning on and off at each zero-crossing of the input. If a constant output is desired from the optocoupler detector, as in AC to logic coupling, it is necessary to rectify and filter the input to the LED. The circuit of Figure 10 illustrates a simple filtering scheme to deliver a DC current to the LED. In some cases the filter could be designed into the detector side of the optocoupler, allowing the LED to pulse at line frequency. In the circuit of Figure 10, the value of C_1 is selected to reduce the variations in the I_F between half cycles below the current that is detectable by the detector portion. This condition usually means that the detector is functioning in saturation, so that minor variations of I_F will not be sensed. The values of R_1, R_2

and R_3 are adjusted to optimize the filtering function, R_3C_1 time constant, etc. Speed of turn-off may be a determining factor. More complicated transistor filtering may be required, such as that shown in Figure 11, where a definite time delay, rise time and fall time can be designed in. In this circuit, C_1 and R_3 serve the same basic function as in Figure 10. The transistor provides a high impedance load to the R_4C_2 filter network, which, once reaching the V_F value, suddenly turns on the LED and pulls the transistor quickly into saturation. The turn-off transient consists of the discharge of C_1 through R_3 and the LED.

In logic-to-logic coupling using the optocoupler, a simple transistor drive circuit can be used as shown in Figure 12. In the normally-off situation, the LED is energized only when the transistor is in saturation. The design equations are given for calculating the value of the series current limiting resistor. With the transistor off, only minor collector leakage current will flow through the LED. If this small leakage is detectable in the optocoupler detector, the leakage can be bypassed around the LED by the addition of another resistor in parallel with the LED shown as R_1. The value of R_1 can be large, calculated so that the leakage current develops less than threshold V_F (~0.8 volt) from Figure 5. The drive transistor can be the normal output current sink of a TTL or DTL integrated circuit, which will sink 16 mA at 0.2 volt nominal and up to 50 mA in saturation.

If the logic is not capable of sinking the necessary I_F, an auxiliary drive transistor can be employed to boost current capability. The circuit of Figure 13 shows how a PNP transistor is connected as an emitter follower, or common collector, to obtain current gain. When the output of the gate (G_1) is low, Q_1 is turned on and current flows through the LED. The calculation of R_1 must now include the base-emitter forward biased voltage drop, V_{BE}, as shown in the figure.

In the normally on situation of Figure 14, the transistor is required to shunt the I_F around the LED, with a V_{SAT} of less than threshold V_F. Typical switching

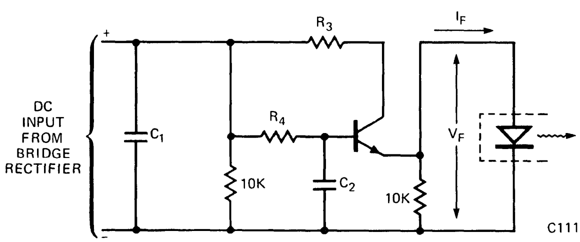


Fig. 11. R-C-Transistor Filter Circuit

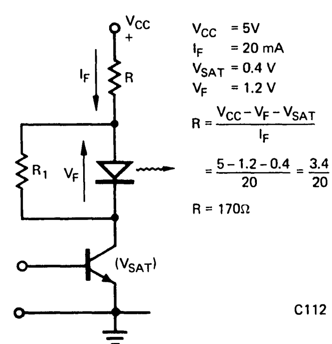


Fig. 12. Transistor Drive, Normally Off

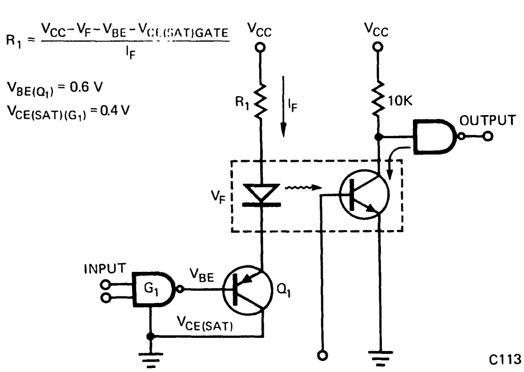


Fig. 13. Logic to LED Series Booster

transistors have saturation voltages less than 0.4 volts at I_C=20 mA or less. The value of the series resistor is determined to provide the required I_F with the transistor off.

Again, if the logic cannot sink the I_F, a booster transistor can be employed as shown in Figure 15. With the output of the gate low the transistor Q_1 will be on, and the sum of V_{CE} (SAT) of G_1 and V_{BE} of Q_1 will be less than the threshold V_F of the LED. With the gate high, Q_1 is not conducting and the LED is. The value of R_1 is calculated normally, but shunt current will be greater than I_F. The normally-on or normally-off conditions are selected depending on the required function of the detector portion of the optocoupler and fail-safe operation of the circuits.

In many applications it is found necessary to pulse drive the LED to values beyond the DC ratings of the device. In these situations a "pulse" is defined as an on-off transient occurring and ending before thermal equilibrium is established between the LED, the lead frame, and the ambient. This equilibrium will normally occur within one millisecond. For a pulse width in the microsecond range, the I_F can be driven above the DC ratings, if the duty cycle is low. The chart of Figure 16 shows the relationship between the amount of overdrive, duty cycle, and pulse width. The overdrive is normalized to the I_{DC} value listed as maximum on the device data sheet. Average power dissipation is the limiting parameter at high duty cycles and short pulse widths. For longer pulse widths, the equilibrium temperature occurs at lower duty cycle values, and peak power is the limiting parameter.

For duty cycles of 1% or less the pulse becomes similar to a non-recurrent surge allowing additional ratings such as the I^2t used in rectifier diodes. Average current is used for lifetime calculation. The pulse response of the detector must be considered in choosing drive conditions.

There are situations where it is not desirable to pass all of the input current through the LED. One method to achieve this is to provide a bypass resistor as suggested in Figure 7 for threshold adjustment. This method is satisfactory where the input current is switched on and off completely, but, if the information on the current is only a small variation riding on a constant DC level, the bypass resistor also bypasses a large portion of the desired signal around the LED. Two methods can be used to retrieve the signal with little attenuation. If the signal

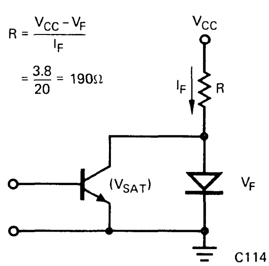


Fig. 14. Transistor Drive, Normally On

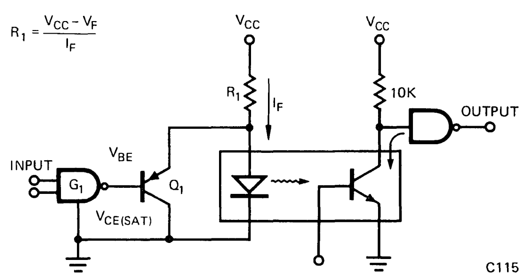


Fig. 15. Logic to LED Shunt Booster

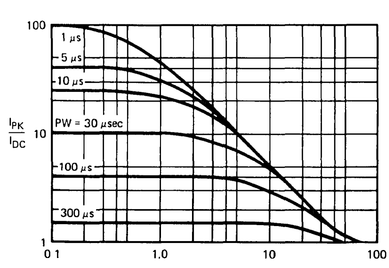


Fig. 16. Maximum Peak I_F Pulse Normalized to Max I_{DC} for Pulse Width (PW) and Duty Cycle (%)

has a rapid variation (e.g., the audio signal on a telephone line), the DC component can be cancelled in the detector by feedback circuits. If the variation is slow, a dynamic shunt can be used instead of the fixed resistor. If a constant-current device or circuit is used in parallel with the LED, as shown in Figure 17, the adjusted component of the DC will flow through the dynamic impedance, and any current variations will result in a change of terminal voltage. Therefore, the total current change will flow through the paralleled LED circuit. The graph of Figure 18 shows the performance of this particular circuit adjusted to center on I_L = 120 mA and a circuit node voltage of 3.4 volts. In the circuit shown the detector portions of the MCT276 and MCT274 were employed for convenience. Note that in Figure 18 most of the current variation occurs as I_F. The ratio between the DC resistance (R_D) and dynamic impedance (Rd) for the shunt is 50, which represents the signal transfer gain achieved over a fixed resistor.

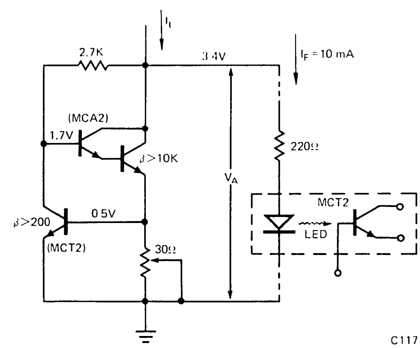


Fig. 17. Constant-Current Shunt Impedance

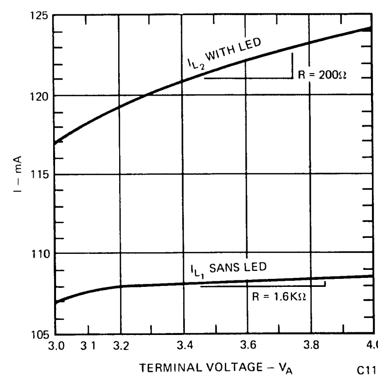


Fig. 18. Shunt Impedance Performance

GENERAL
INSTRUMENT

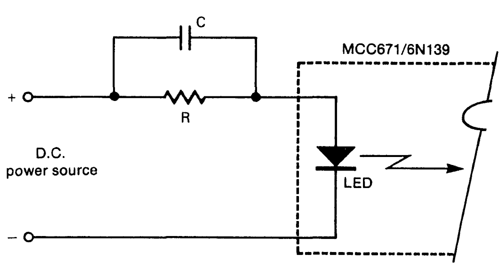
AN1074
Low Current Input Circuit Ideas
6N139/138 Series

Introduction

Advancements in opto-coupling and LED technology have given us the MCC671 which also meets the specifications of JEDEC Registration 6N139. This unique optocoupler, having an input LED current specification at 500 microamperes, has opened some interesting design doors. Besides the obvious and much written about ability to be directly driven by CMOS circuits, the 6N139 can be considered for signal detection, transient detection, matrices and non-loading line receiving. Following are but a few circuit ideas to stimulate the designer's interest.

Signal Detection

The detection of noise, spikes or oscillations can easily and directly be detected by the input of the 6N139 as shown in the circuit of Figure 1.



C1459

Figure 1. 6N139 Input Cirucit For Signal Detection

For the detection of undesirable signals on a D.C. power source use:

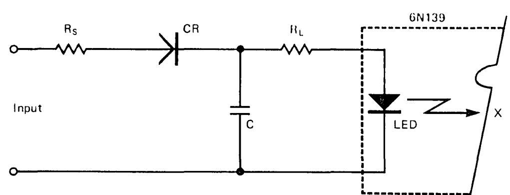
$$R = \frac{\text{Power supply voltage} - 1.5 \text{ volts}}{50 \text{ microamperes}}$$

C = To effect 500 microamperes into LED
X = Latching or non-latching output circuitry to follow
LED = Input diode of 6N139

The LED is provided with a 50 microampere forward current to charge the LED capacity to the V_F level. In this way, the LED is not causing conduction in its output circuitry but is prepared to conduct very quickly. Any noise or oscillation on the "D.C. power source" is coupled through "C" which develops a signal across the LED. Even small unwanted signals can cause a large change in the LED forward current. Once the LED's forward current equals or exceeds 500 microamperes, the output circuitry will conduct indicating the presence of the unwanted signal.

Transient Detection

The detection of the presence or absence of waveforms can easily be detected by the circuit in Figure 2.



C1460

Figure 2. Pulse or Waveform Detection Circuit

For the detection of the presence of a desired signal, pulse or waveform use:

CR = Silicon diode

$$R_L = \frac{(\text{Positive Vpk. of input}) - 2.5 \text{ volts}}{1 \text{ milliampere}}$$

$$C_{min} = \frac{\text{Pulse interval of } 1/_F}{R_L}$$

$$R_{S}max = \frac{\text{Pulse width or } 1/4F}{5C}$$

X = Non-latching output circuitry to follow
LED = Input diode of 6N139

Examples:

A desired pulse train to be present is shown in Figure 3.

Applications

The resulting LED forward current that will keep the output circuitry conducting is shown as the result of proper design.

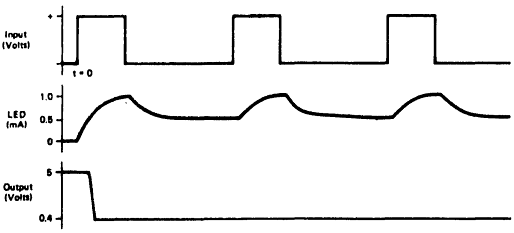


Figure 3. Pulse Train Waveforms

A desired sine wave to be present is shown in Figure 4. The resulting LED forward current that will keep the output circuitry conducting is shown as the result of proper design.

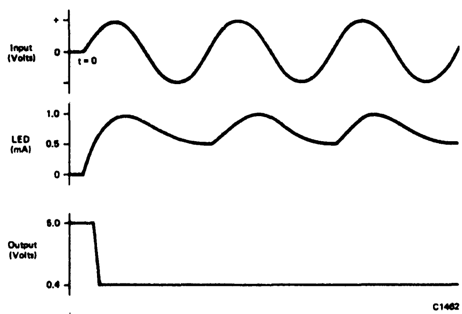


Figure 4. Sine Wave Waveforms

Matrices Opto-Coupling

With the low input LED current advantage of the 6N139, the ability to drive matrices with but one TTL output is now possible as shown in figure 5.

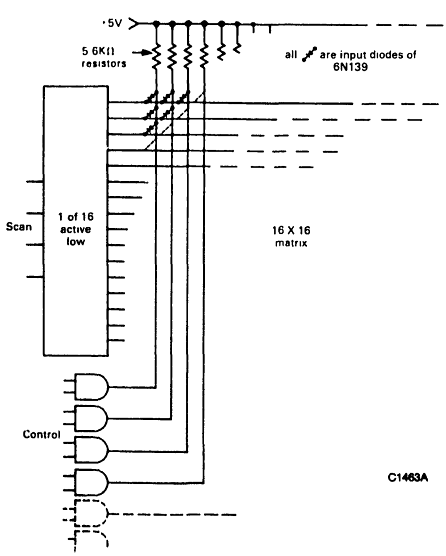


Figure 5. Opto-Coupling out of Matrices

Non-Loading Line Receiver

For virtual non-loading, the 6N139 is compatible with the differential amplifier circuit of Figure 6.

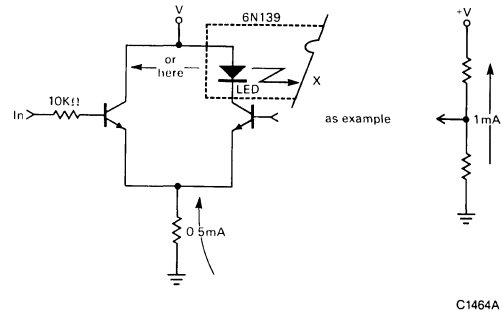


Figure 6. Differential Amplifier Drive

For a virtual no-load optosiolator circuit use:

X = Non-latching output circuitry to follow

LED = Input diode of 6N139

Current requirement at "in" will be less than 20 micro-amperes.

Example:

If "REF" is made to be +1.4 volts and the resistor common to the emitters is 1.2KΩ, the circuit will respond nicely to TTL "0" and "1" levels. That is, a "0" at "In" will cause LED current resulting in the conduction of the output circuitry. Conversely, a "1" at "In" will result in no LED current. Notice that depending upon which collector the LED is in series with it will give the option of LED current flowing with a "0" or a "1" at "In".

6N139 Output Circuitries

The following are two examples of 6N139 output circuitry. One latching (Figure 7); the other non-latching (Figure 8), but both capable of driving a TTL gate directly.

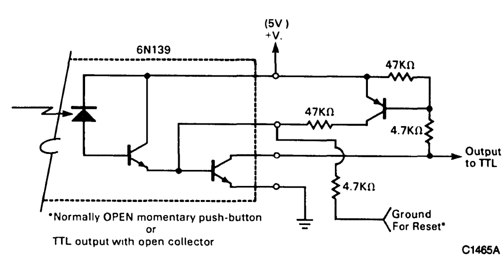


Figure 7. Latching Output Circuit for 6N139

Referring to Figure 7 and assuming that the "RESET" has been actuated by a momentary ground and no input signal is being received, all transistors shown are non-conducting (Output high, "1"). The arrival of an input signal will cause all transistors to turn on. (Output low, "0"). The PNP transistor, being turned on by the output transistor, will in turn latch that same output transistor or until the "RESET" is again initiated.

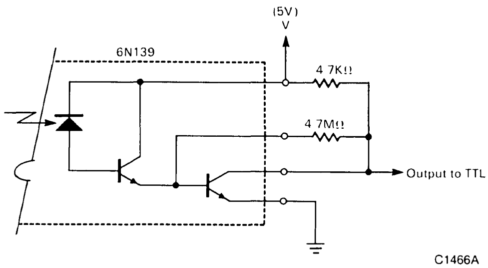


Figure 8. Non-Latching Output Circuit For 6N139

In Figure 8, where no signal is being received, the input transistor is not conducting. The output transistor is very slightly conducting. The 4.7MΩ resistor causing this slight conduction will *not* bring the "Output" to a "0" level. The purpose of this slight conduction is to reduce the turn-on delay time. When a signal is received, both input and output transistors are turned on causing the "Output" to a logic "0" state. The 4.7MΩ resistor will now tend to reduce the output transistor's turn-off time.

If you have not looked over the 6N139 specification sheet, you may not be totally aware of the current capabilities of General Instrument's optocouplers.

Applications

GENERAL INSTRUMENT

AN1075
MID400 Power Line Monitor

INTRODUCTION

The MID400 is an optically isolated AC line-to-logic interface device for monitoring ON or OFF status of an AC power line. The logic circuitry operates from a standard 5V supply. The MID400 is packaged in a compact 8-pin plastic MINI-DIP. The optical isolation provided by the MID400 makes it suitable for power-to-logic interface applications such as industrial control medical equipment computers and other fail-safe type monitor systems in which status information about the AC line is essential.

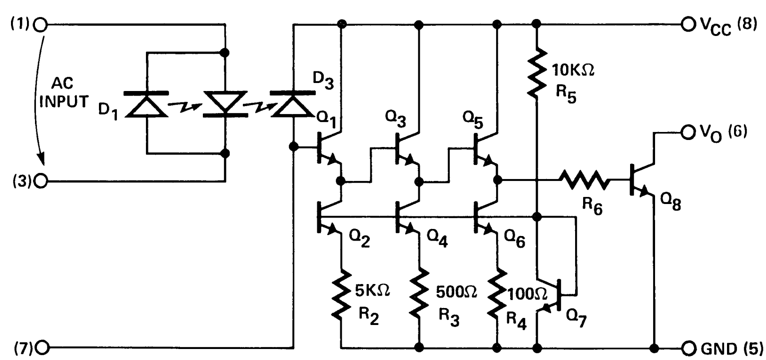
INTERNAL COMPONENTS

During assembly two infrared GaAs LED diodes are mounted on an input lead frame, and a photodetector/amplifier chip is mounted on an output frame. Use of two separate lead frames insures high electrical isolation between input and output terminals after trimming of the lead frame edges. Light emitted by the input LED's is optically coupled through solid transparent material to the surface of the photodetector. The LED's are connected back-to-back, and power line status is monitored by the LED's in series with an external current limiting resistor. When the high gain photodetector and amplifier senses light output from the two LED's, it drives an output NPN transistor to the ON state.

The photodetector amplifier circuit is shown in Figure 1. The Photodiode D3 is coupled into a high gain 3 stage emitter follower current amplifier ($Q_1 Q_3 Q_5$) driving into an output transistor Q_8. The emitter follower loads are comprised of constant current circuits formed by Q_2, R_2, Q_4, R_3, Q_6, and R_4. Constant current level in these devices is established by the constant voltage source formed by the base emitter voltage of Q_7 and R_5.

The common point of the output photodiode/amplifier is brought out to pin 7 to allow connection of an external integrator capacitor or other circuits. Because the amplifier has a high current gain factor of 10,000 to 100,000, its input impedance (at pin 7) is extremely high.

Switching time of the amplifier is intentionally designed to be slow, so that the MID400 only responds to an absence of input signal over a few milliseconds, and not during the short zero-crossing period of the AC input voltage waveform.



C1436A

Fig. 1. Circuit Schematic of MID400 AC Line Monitor

Applications

BASIC CIRCUIT OPERATION

Consider the test circuit shown in Figure 2. Back-to-back input diodes D_1 and D_2 each conduct on every half cycle of the AC input waveform, producing 120Hz light pulses. The light output causes the photodiode to conduct, raising the potential of the input to the amplifier, and in turn driving the output NPN transistor ON. When input current is removed, light from the two LED's ceases, charge established by the photodiode current on the input amplifier leaks away, and the NPN transistor turns OFF. There are basically three operation modes: Saturated, unsaturated, and the "OFF" STATE mode.

SATURATED MODE

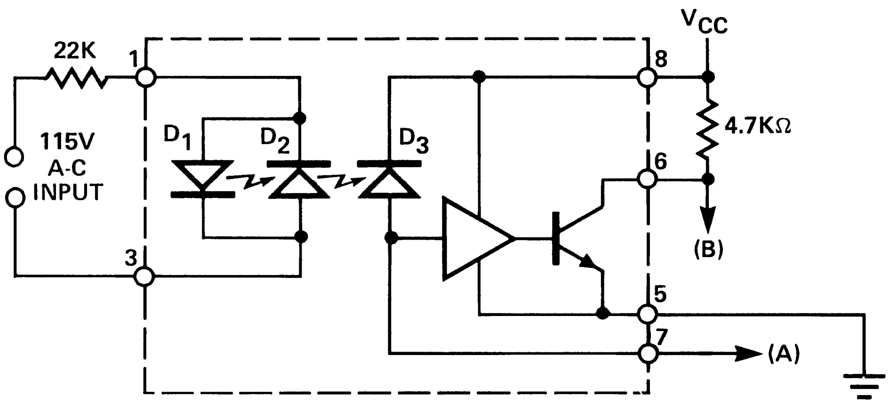
When input AC is above the recommended 4mA RMS minimum input current, the 120Hz photodiode pulses are sufficient to saturate the amplifier, so that the MID400 output is low at pin 6 as long as AC input signal is present, (see Figure 3).

UNSATURATED MODE

If input current is dropped below the recommended 4mA RMS, the amplifier drops out of saturation during the zero-crossing periods of the input AC waveform and 120Hz pulses appear on MID400 output pin 6, (see Figure 4). Under these conditions the device makes an attractive, simple 120Hz clock generator that is free from most of the normal power line transients for many digital applications.

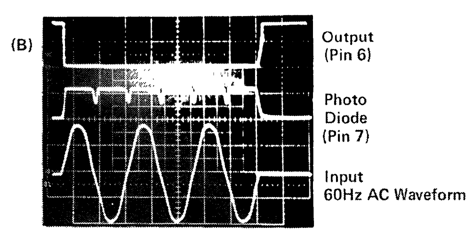
OFF-STATE MODE

When the input RMS AC input current is below 0.15mA the MID400 output will be in the high state as per specifications.



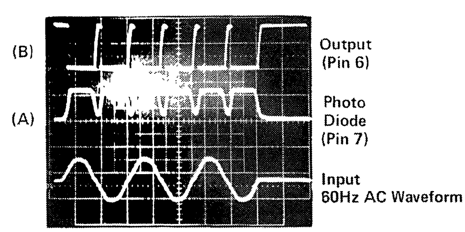
C1512A

Fig. 2. Test Circuit



Horiz. = 5mS/cm
Vert. = Uncalibrated

Fig. 3. Saturated Operation



Horiz. = 5mS/cm
Vert. = Uncalibrated

Fig. 4. Unsaturated Operation

NOTE: Normal specified 4mA RMS input I_F current. Output saturated (latched). The 120Hz pulses from the photodiode D_3 are above the threshold of the amplifier; therefore, the MID400 output is low anytime the AC current is present.

NOTE: Below normal specified 4mA RMS input I_F current. The level of 120Hz pulses from the photodiode are now below the input threshold of the amplifier and the pulses appear on the output. The output pulse width depends on the AC input drive level.

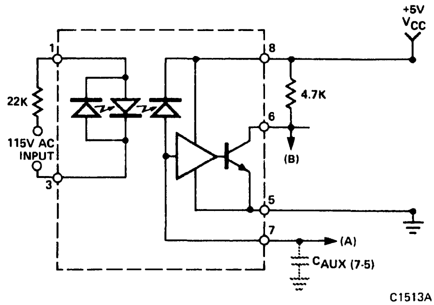


Fig. 5. Circuit With Addition of Capacitor at Pin 7

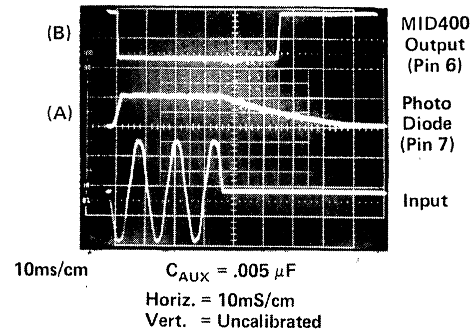


Fig. 6. Waveforms with Capacitor Added at Pin 7

OPERATION WITH AN EXTERNAL CAPACITOR

Figure 5 shows a basic delay circuit obtained by addition of an integrating capacitor C_X to the photodiode/amplifier input point pin 7. Delay at POWER ON is short, as the photodiode, when conducting, has a low impedance providing a fast charge to the capacitor. The delay when AC is removed is long, because the capacitor discharges through various leakages of the amplifier and the photodiode. The waveforms in Figure 6 shows the capacitance on both TURN-ON and TURN-OFF delays. Figures 7 and 8 show plots of capacitance versus turn-on and turn-off time.

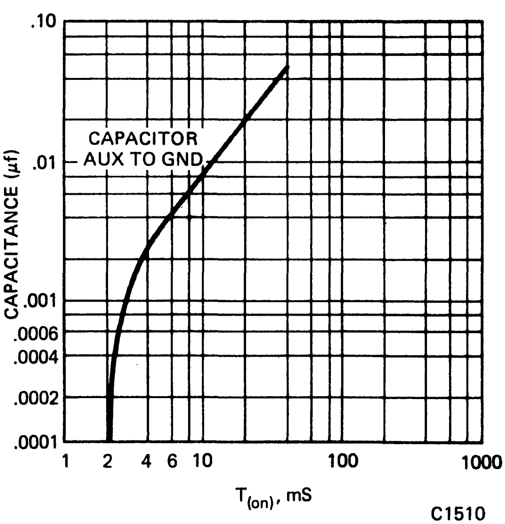


Fig. 7. Plot of Capacitance Versus Turn-on Time

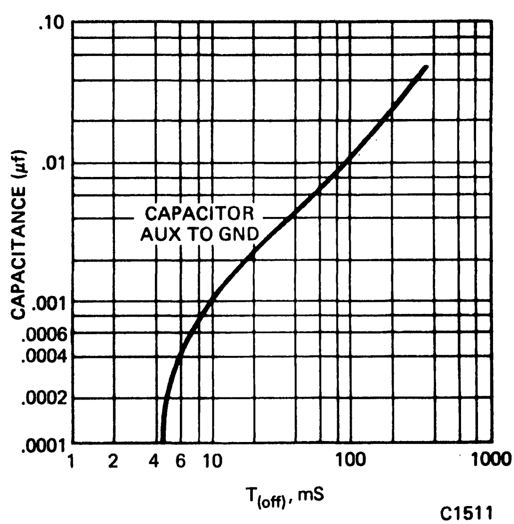


Fig. 8. Plot of Capacitance Versus Turn-off Time

MID400 INTERFACE CIRCUITS USING A 555 TIMER

Addition of a 555 Timer at the MID400 output, as shown in Figure 9, produces an interface circuit with improved drive capability and output switching times, and better noise immunity. Figure 10 illustrates these switching time improvements.

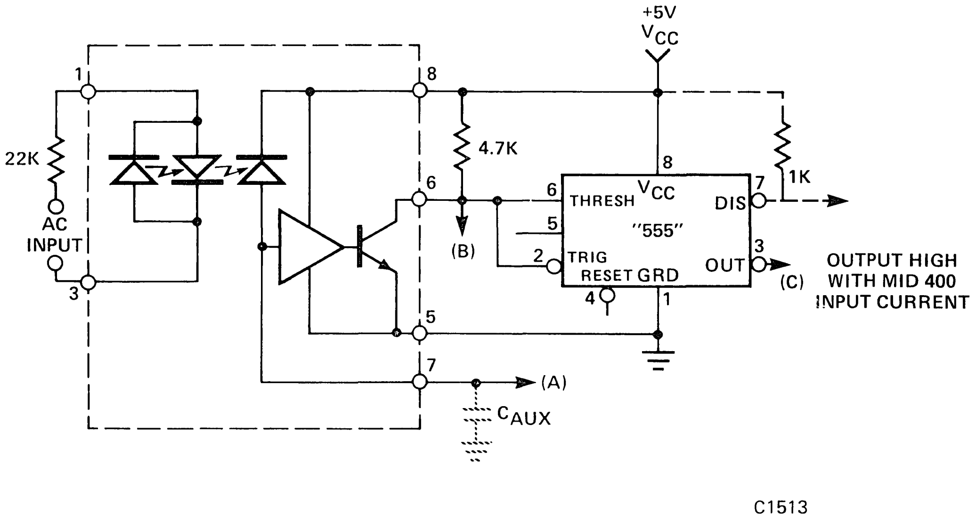


Fig. 9. Circuit with 555 Timer Added

The 555 Timer is basically being used as a SCHMITT trigger circuit with well defined input thresholds. The input HIGH state is 2/3 V_{CC}, (+5 volts in this case), and its LOW state is 1/3 V_{CC}.

The output may be taken from either 555 pin 3 or from pin 7 discharge point with a pullup resistor. Both these pins are high when AC current is applied to the MID400. The 555 output is capable of supplying both sink and source currents up to 200mA. One advantage of using the 555 discharge output pin is that it can be tied to another similar unit to provide the "AND" function. That is both AC inputs to both units must be present before the 555 outputs can be high.

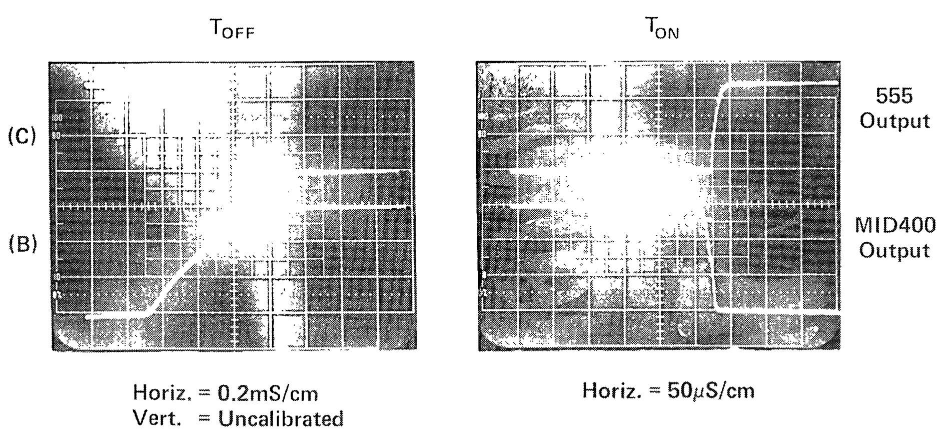


Fig. 10. Output Waveforms for T_{ON} T_{OFF}. Pin 7 Auxiliary Input Open Using the 555 Circuit (Fig. 9)

Figure 11 shows a circuit which includes a 555 Timer for shaping of waveforms. This circuit can provide an adjustable delay either at power on or power off. Delay is adjusted by the time constant of R_X and C_X. Insertion of diode D_1 across R_X provides either a fast charge and slow discharge of C_X, or a slow charge and fast discharge when diode polarity is reversed. See waveforms in Figures 12 through 14. Because charge on capacitor is established by the output of MID400, the delay will vary according to whether MID400 is operated in saturated mode or unsaturated mode. In the unsaturated mode delay will depend upon the ratio of the pulse ON to OFF time (Duty Factor).

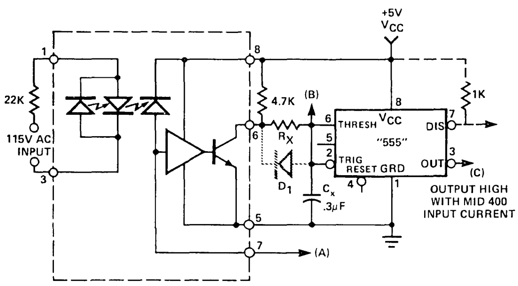


Fig. 11. Adjustable Delay Turn Off/On Circuit

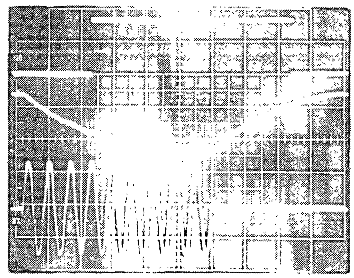
Without D_1

Turn on and off Delay

(C) 555 Output

(B) 555 Input

AC Input



Horiz. = 20mS/cm
Vert. = Uncalibrated

R_X = 200KΩ
C_X = 0.3μF

Fig. 12. Output Without D_1 Diode

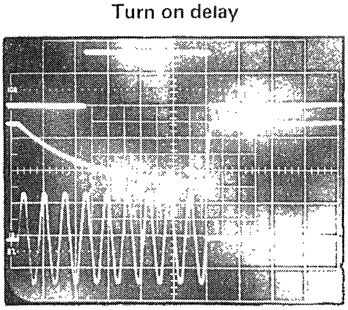
With D_1

Turn on delay

(C) 555 Output

(B) 555 Input

AC Input



Horiz. = 20mS/cm
Vert. = Uncalibrated

R_X = 200KΩ
C_X = 0.3μF

Fig. 13. Delayed Turn On. Diode D_1 Connected Opposite to Shown in Circuit Schematic

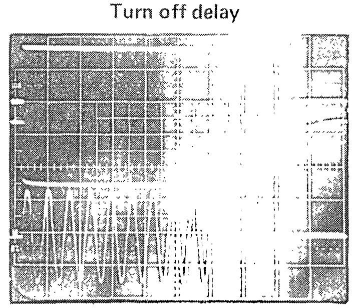
With D_1

Turn off delay

(C) 555 Output

(B) 555 Input

AC Input



Horiz. = 20mS/cm
Vert. = Uncalibrated

R_X = 200KΩ
C_X = 0.3μF

Fig. 14. Delayed Turn Off. Diode D_1 Connected As Shown in Circuit Schematic

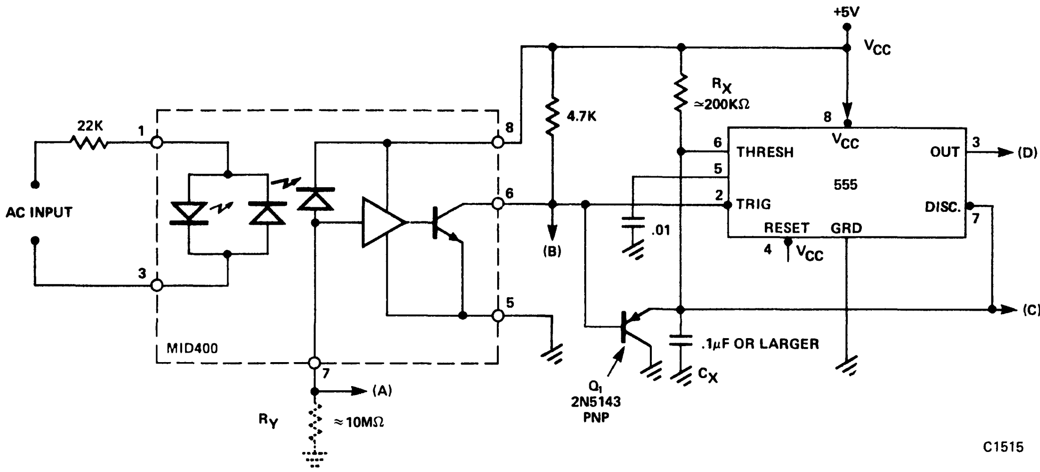
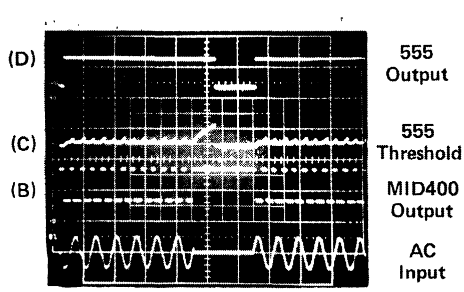


Fig. 15. Precision Delay Circuit

Figure 15 shows a precision delay circuit. Here delay is provided by using the 555 Timer as a missing pulse detector or one-shot. The time out is independent of whether the MID400 is operated in saturated or unsaturated mode. In unsaturated mode the Timer is continuously being reset by the 120Hz pulses from the MID400 and output of the 555 is high. When an AC line fails, there are no 120 Hz pulses, the 555 times out and the output then goes low. Refer to waveforms in Figure 16.

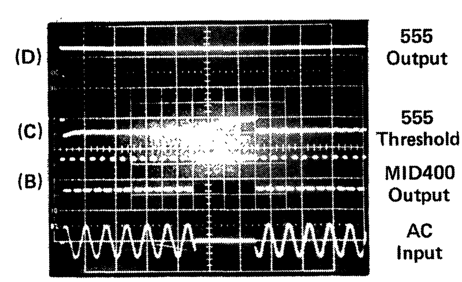
A larger capacitor at C_X will increase the time-out period of the 555 causing it not to detect the missing input cycles as shown in Figure 17.

With the MID400 operated in the saturated mode, output of MID400 is low, which turns on the PNP transistor Q_1, stopping C_X from charging, and the 555 output is high.



20mS/cm (C_X = .1µF)

Fig. 16. Unsaturated Mode—Detects Missing AC Input Cycles (when more than one cycle is missing)



20mS/cm (C_X = .4µF)

Fig. 17. Unsaturated Mode—Does NOT Detect Missing AC Input Cycles

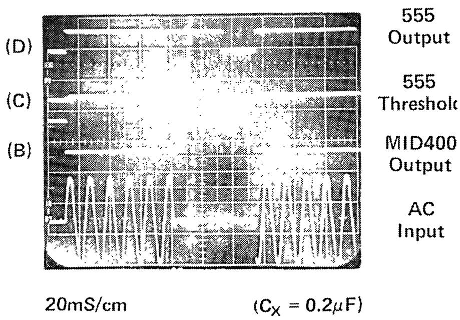


Fig. 18. Saturated Mode—Detects Missing AC Input Cycles

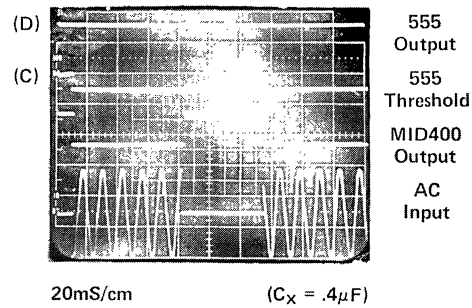


Fig. 19. Saturated Mode—Does NOT Detect Missing AC Input Cycles

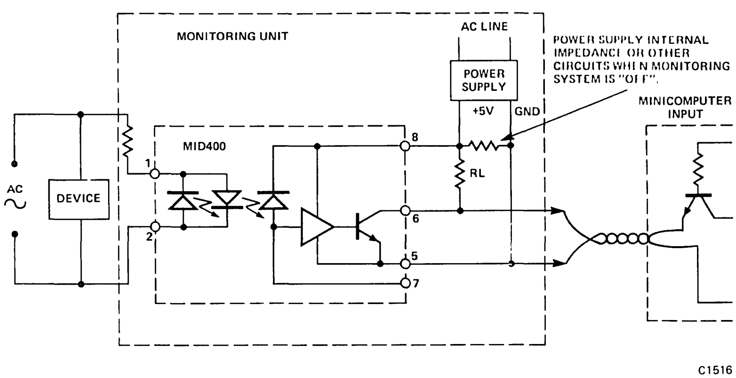


Fig. 20. Example For Fail-Safe Considerations

On AC line failure the MID400 goes high, causing Q_1 to turn off and allowing C_X to charge, so that after the required time the 555 is allowed to go LOW. Refer to the waveform in Figure 18.

By the choice of the time constant R_XC_X the circuit in either a saturated or unsaturated mode can be made to either respond or not respond to one or more AC input cycles as shown in Figures 16 through 19.

OTHER SPECIAL DESIGN CONSIDERATIONS

Special mention must be made about effects on MID400 operation caused by leakage at pin 7. To avoid problems keep impedance at 10 megohm or greater. If a capacitor is connected to pin 7, make sure it is a high quality type (such as Mylar) that exhibits very low leakage. (Even current leakage between printed circuit traces can have noticeable effects on circuit operation if the board material has poor dielectric insulation characteristics.)

DESIGNS FOR FAIL-SAFE OPERATION

In those industrial, military, computer, and medical system applications where fail-safe operation is important, circuit response must also be considered when AC input or the V_{CC} supply, (or even both), switch off. Table I lists the MID400 output response under these conditions. This "Truth Table" shows that the MID400 output NPN transistor can be ON (conducting) only when AC current is flowing through MID400 input LED diodes **and** the 5V V_{CC} to the MID400 is present (ON).

Table 1. FAIL-SAFE TRUTH TABLE

AC Line Input	+5 V_{CC} Supply	MID400 Output Condition
ON	ON	ON (conducting)
ON	OFF	OPEN (non-conducting)
OFF	ON	OPEN (non-conducting)
OFF	OFF	OPEN (non-conducting)

This truth table reflects a MID400 being operated from a +5 volt supply which has a high impedance when not "ON." However, other external factors can influence the apparent state of the MID400 output. For example, Figure 20 shows an application where the MID400 is monitoring the AC voltage of a device. The MID400 is

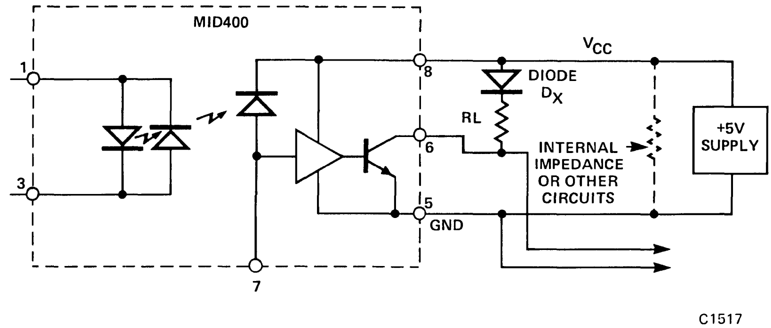


Fig. 21. Diode D_X Added to Stop Reverse Current When MID400 +5v V_{CC} Line is Off

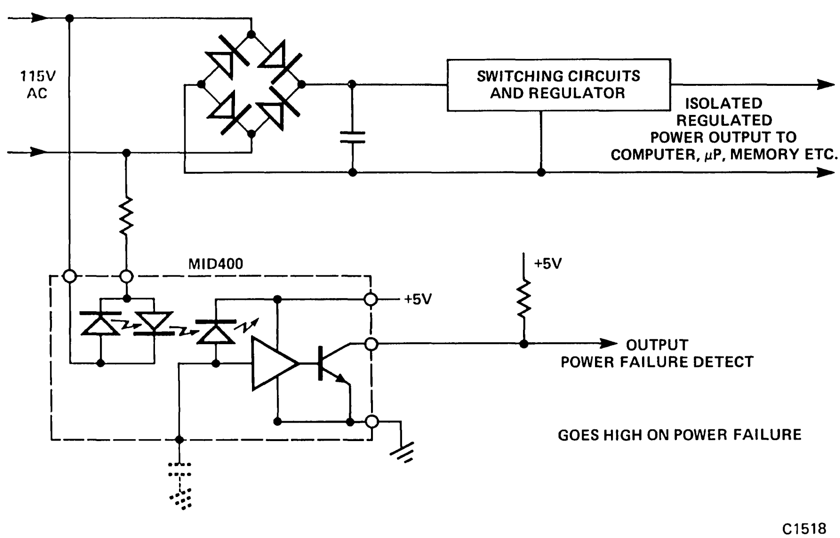


Fig. 22. Circuit for Switching Power Supply

supplied by a separate 5V supply in the "MONITOR UNIT" fed from a separate AC line. The output of MID400 is fed to a remote minicomputer with a TTL type input circuit.

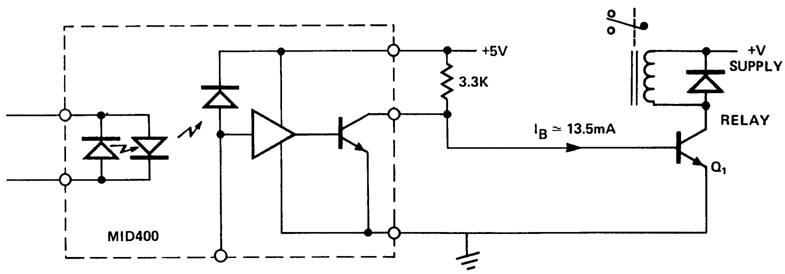
In this system it is quite feasible to get an erroneous apparent output from the MID400 if R_L is 1000 ohms, or less, and the 5V power supply in the monitor system presents a low impedance when OFF. The TTL input to the minicomputer might appear low due to current being forced through R_L and the low impedance of the OFF 5V power supply. This can be eliminated by the addition of a diode D_X as shown in Figure 21.

In some applications additional circuitry may have to be added to insure fail-safe operation. One such example is the monitor circuit shown later, Figure 24. There both voltage and current are monitored.

Another interesting condition to consider is operation of the MID400 if its LED input diodes are "blown out" by excessive current. In this case the MID400 output will be in the high state, still indicating an error condition.

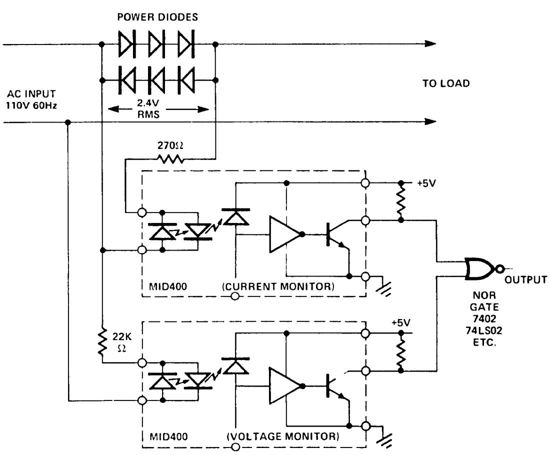
APPLICATION CIRCUITS

Figure 22 shows a circuit for a switching power supply to give advanced warning of power failure to computer, microprocessor, memory etc., so that an orderly power down sequence can be initiated. Such a circuit is useful because a switching power supply inherently provides power storage for a limited period of time after removal of AC input power.



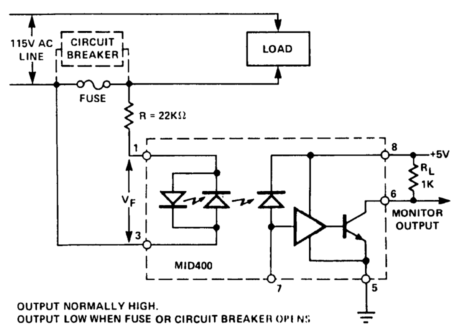
C1519

Fig. 23. Relay Interface Circuit



C1520

Fig. 24. AC Power Line Voltage and Current Monitor



C1521

Fig. 25. Fuse or Circuit Breaker Monitor

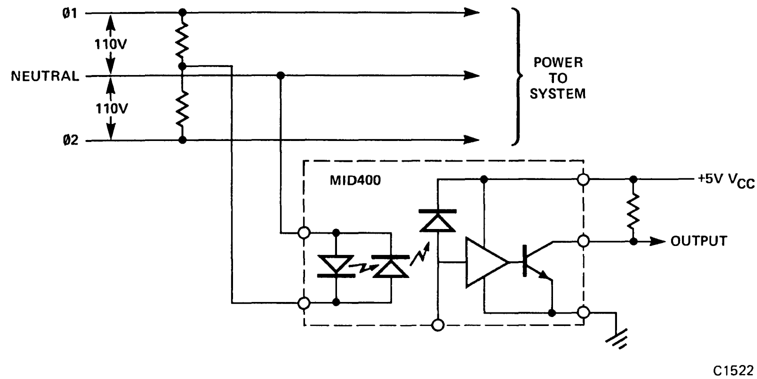
Applications

Figure 23 shows a circuit that allows a relay or solenoid of almost any voltage and current rating to be controlled by the MID400. NPN transistor Q_1 must have adequate beta and voltage/current ratings for the application. Relay is energized when no AC current is flowing in the MID400 input diodes.

Figure 24 shows a circuit that uses two MID400s to monitor both voltage and current. When both voltage and current are being supplied to the load, the output of "NOR" gate is high. If load current drops due to either open circuit or failure, the output of "NOR" gate is low.

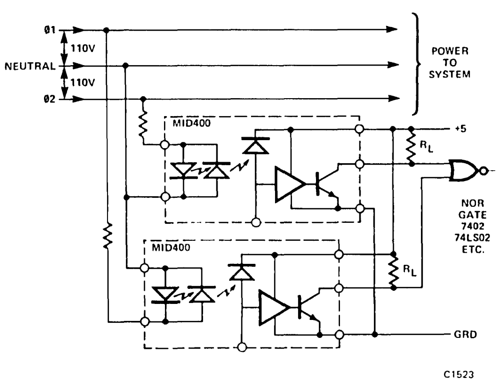
If both voltage and current are not present the output is low. Care must be taken in overall systems design to insure fail-safe operation is achieved for all possible conditions. This topic was discussed previously in this Note.

Figure 25 shows a circuit to monitor a fuse or a circuit breaker. With this circuit consideration must be given to Fail-Safe operation. Note that if load is a very high impedance there might not be sufficient current to operate the MID400. In other words, the output of MID400 is low on open fuse or breaker. If V_{CC} to MID400 is off and fuse opens, no MID400 indication will result.



NOTE: Circuit detects failure of either but not both phases

Fig. 26. Monitor Circuit for Two Phase Power Line



NOTE: Circuit detects failure of either or both phases

Fig. 27. Alternate Monitor Circuit for Two Phase Power Line

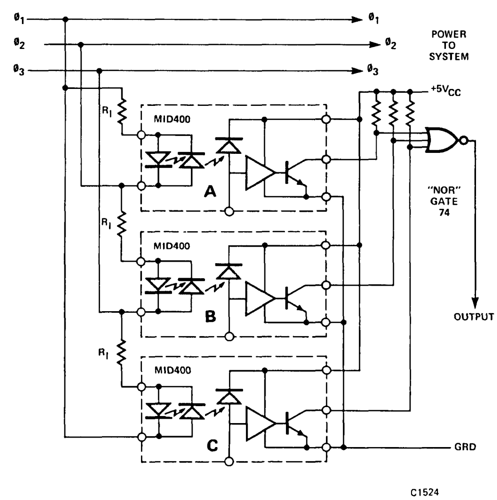


Fig. 28. Monitor Circuit for Three Phase Power Line

ADDITIONAL APPLICATION IDEAS

The following circuits are included for their intrinsic value, but may need further refining for use in a specific application.

Figure 26 shows a circuit to detect failure of either but not **both** phases on a two phase AC power line. The MID400 output goes LOW when a phase fails. Figure 27 shows a more complicated circuit that will detect failure of either or both phases on a two phase line. The NOR gate output stays HIGH so long as **both** phases are present, but switches to LOW if either or both phases fail.

Figure 28 shows a circuit to monitor a three phase line. This circuit detects a failure on a single phase, as well as all phases failing simultaneously. The output from the NOR gate is normally high when all phases are present.

The input current limiting resistor R_L is chosen so the MID400s operate in saturated mode. If a phase fails, for example phase 01 goes open circuit, this effectively places MID400's #A and #B in series, causing them now to operate in non-saturated mode and produce 120Hz pulses. Therefore the output "NOR" gate outputs pulses to indicate phase failure. The output NOR gate is low when there is no power on any phase.

In some applications, for example when monitoring the power to a three phase motor, if a phase opens when the motor is running, it might run "single phase." The motor might then generate sufficient back EMF on the open phase to keep input current to MID400, and under such a condition this MID400 monitoring system is not effective.

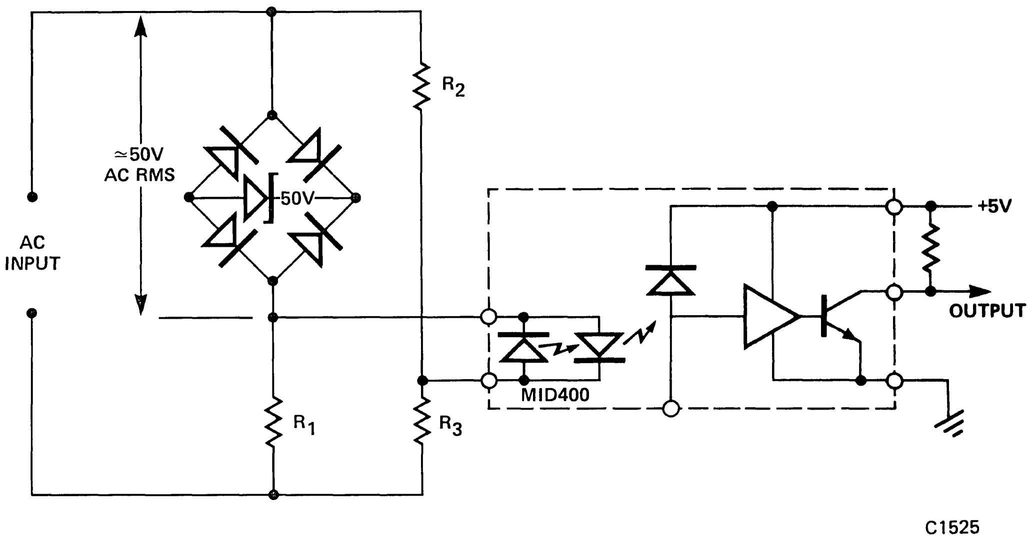


Fig. 29. AC Voltage Deviation Monitor

Figure 29 illustrates the basic circuit concept for an AC voltage deviation monitor. Here the zener diode and bridge rectifier establish a given AC voltage, irrespective of AC input voltage, over a given range. This is compared with the voltage developed by R_2 and R_3. Depending upon choice of zener voltage and ratio of R_2 and R_3 the circuit can operate in a number of modes:

1. Voltage Deviation Monitor to give a low output when AC voltage deviates from set standard. The voltage at junction of R_2 and R_3 is made equal to zener voltage for given AC input voltage. A deviation from standard causes current flow through MID400 diodes.
2. Over Voltage Monitor (over given range). For normal AC input voltage R_2 and R_3 are chosen for a current flow through the MID400; when AC input voltage goes too high the current ceases through MID400 input diodes.
3. Under Voltage Monitor (over given range). Similar to above, except R_2 and R_3 are chosen so current through MID400 input diodes ceases if AC with low input voltage is too low.

It should be noted that in this circuit the magnitude of current through the MID400 input diodes is governed by choice of R_1, R_2, and R_3 resistor values.

MID400 BENEFITS

This small size device connects through an external resistor directly to AC power lines and offers both input-to-output noise immunity as well as electrical surge isolation, up to 2500 VRMS (or 3550 VDC). Its output is compatible with TTL logic. Also the MID400 is UL recognized (File #E50151), has low power consumption, and operates from a single V_{CC} supply up to 7 volts. Besides inputs from power lines, the MID400 can also be connected to AC sources of other frequencies and even to DC sources (for detection of power). Output current is 16mA when a minimum 4mA RMS input current is applied to the input LEDs. When the inexpensive and readily available 555 Timer is connected to the MID400 output, circuits can be built having high sink and source current drive capabilities. These simple circuits can also be designed for a wide range of adjustable delay, and with rise and fall times compatible with TTL computer circuits.

CONCLUSION

This Application Note has summarized internal operation of the MID400 and described several classes of application circuits. Refer to the MID400 Data Sheet for a listing of Absolute Maximum Ratings and specifications for its Electrical Characteristics.

GENERAL INSTRUMENT

OPTOLOGIC™

AN3000 Applications and Operation of Optologic™

INTRODUCTION

Since the introduction of the optically coupled isolator, digital design engineers have struggled with the problem of achieving logic-in to logic-out compatibility over temperature, minimizing the effects of LED degradation, and obtaining high speed operation. Typically this problem is approached by selecting input/output resistors, and often by trial and error.

This guesswork type of interfacing is now a thing of the past. Enter the new OPTOLOGIC™ family of logic-to-logic compatible, optically coupled isolators. This easy to use logic element offers LSTTL-in to TTL-out or LSTTL-in to CMOS-out. The device eliminates the resistor selection and features guaranteed DC parameters over temperature.

This ease of design-in and operation is made possible through use of an input amplifier that provides the interface between the driving LSTTL gate and the LED emitter. The output circuitry consists of a multistage high speed amplifier available with either a totem pole or open collector output. The input amplifier, LED, and output amplifier are assembled in an industry standard six-pin package.

The Optologic devices not only provide the isolated logic-to-logic interface function, but due to many unique features of the input amplifier, offer solutions for high speed data communications and precise DC level sensing. These applications, and the operation of the Optologic interface gate, will be discussed in this application note.

OPTOLOGIC OPERATION

Functionally the Optologic gate consists of an input amplifier, high speed GaAsP/GaAs LED emitter, and an output amplifier. Figure 1 illustrates the block diagram of the LSTTL to TTL logic gate.

The input network is a hybrid assembly of a silicon IC amplifier and LED emitter. The input functionally consists of four elements: 1) open emitter input with Schottky diode clamp, 2) differential comparator, 3) voltage reference, and 4) current steering LED driver.

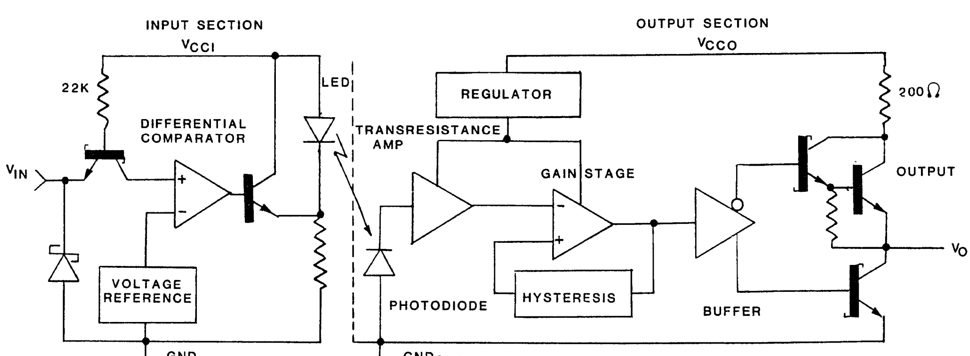
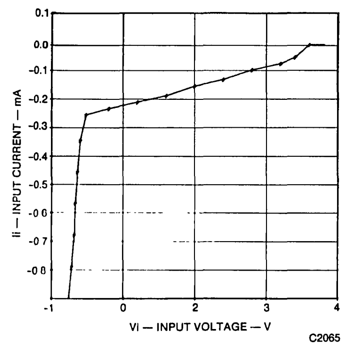


Fig. 1. 74OL6000 Block Diagram

Applications

The input of the IC is very similar to standard bipolar logic. It consists of a Schottky clamp diode connected between the emitter of an NPN transistor and ground. The input sources input current over the nominal LSTTL logic levels. Figure 2 shows the typical input current/voltage characteristics. The input offers a 20K ohm input resistance between -0.5 to 3.0 V. The input resistance drops to 7.5 K from 3.0 to 3.4 V, while between 3.4 to 7 V the resistance is greater than 1 megohm. Input voltages more negative than 0.5 V activate the Schottky diode clamp.



Input Current vs. Input Voltage

The collector of the input transistor is connected to a differential comparator, whose output switches when the input signal exceeds the reference voltage. The effects of temperature and power supply variations are minimized through the use of a voltage reference.

Figure 3 shows V_{IN} vs V_{OUT} of the 74**O**L6000 illustrating the input voltage switching point of 1.34 V.

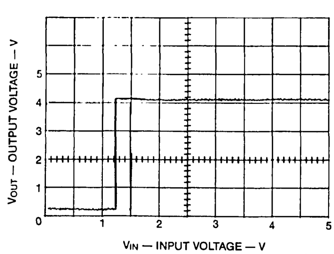


*Fig. 3. 74**O**L6000*

The output of the comparator controls a current steering LED driver. The LED is enabled when the transistor is OFF. When the transistor is driven into saturation, it steers the current away from the LED by dropping the LED voltage below its 1.5 V conduction threshold. This technique of driving has the advantage of pre-biasing the LED, thus minimizing the switching speed reduction caused by the diode junction capacitance. It has the added advantage of greatly reducing power supply noise.

The output IC consists of seven functional circuits. These include: 1) PN photodiode, 2) transresistance amplifier, 3) differential gain stage, 4) hysteresis loop, 5) buffer amplifier, 6) output stage, and 7) voltage regulator.

The optical flux developed by the LED emitter is converted to an electrical current by a reversed biased PN photodiode. This photocurrent is amplified and converted to a voltage by a transresistance gain stage. This stage is connected to the inverting input of a differential amplifier, while the hysteresis network is connected to the non-inverting input. The output of this amplifier drives a buffer that provides the level shifts and signal splitting needed to drive the totem pole output stage. Power supply noise is rejected through the use of a voltage regulator that powers the transresistance amplifier and the differential gain stage.

The output of the amplifier is offered as either an open collector (74**O**L6010/11) or a totem pole (74**O**L6000/01). The open collector output is designed to interface with CMOS logic, with a supply voltage up to 15 volts. The output transistor will drive 10 standard TTL loads with a V_{OL} of 0.4 V, and its safe operating range allows it to sink up to 60 mA peak. The active pull-up will source an I_{OH} in excess of 10 mA with a V_{OH} greater than 2.4 V. The output characteristics of the Optologic gates are shown in Figures 4 and 5.

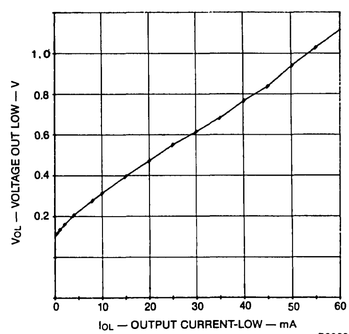


*Fig. 4. 74**O**L6000 V_{OL} vs I_{OL}*

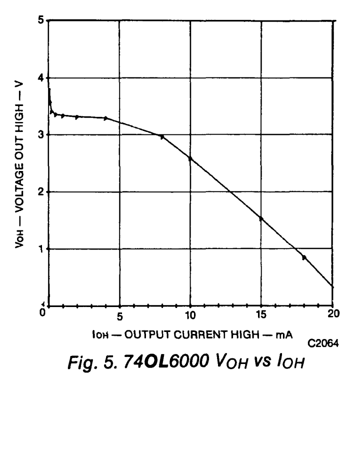


*Fig. 5. 74**O**L6000 V_{OH} vs I_{OH}*

The effects of common mode transients and other noise sources on the output amplifier are reduced by an optically transparent, electrically conductive noise shield, as well as by amplifier hysteresis. The shield shunts the noise away from the input stage and channels it to logic ground. The amplifier hysteresis eliminates false output pulses caused by a slowly varying input signal, or power supply noise found on the input network of the Optologic gate.

These three chips are assembled in an industry standard six-pin dual-in-line package. General Instrument uses its patented over/under split lead-frame assembly process. This process has proven to be very reliable given environments typically found in industrial interface applications. This package is recognized under Underwriters Laboratories File E#50151, and with a withstand test voltage of 2500 V_{RMS}, guarantees continuous operation at 440 VAC.

SWITCHING OPERATION

The Optologic optocoupler was designed to interface directly with LSTTL at the input and either TTL or CMOS at the output. In addition, the switching levels are identical to the standards established for each of these logic families.

There are four Optologic devices currently available. Two of these devices are LSTTL to TTL compatible. The 74**OL**6000 is a logic buffer and the 74**OL**6001 is an inverter logic. LSTTL to CMOS is provided by the 74**OL**6010 buffer and the 74**OL**6011 inverter. The switching operation is shown below.

DEVICE	INPUT	LED	OUTPUT
74**OL**6000	HIGH	OFF	HIGH
	LOW	ON	LOW
74**OL**6001	HIGH	ON	LOW
	LOW	OFF	HIGH
74**OL**6010	HIGH	OFF	OFF
	LOW	ON	ON
74**OL**6011	HIGH	ON	ON
	LOW	OFF	OFF

The preceding table indicates that the Optologic gate is effectively two cascaded logic gates. The first is the input network and the second the output. Both the totem pole and open collector output amplifier function as inverters. Thus, when the LED is ON, the output will be in a logic low state. Therefore, in order to create an Optologic buffer (74**OL**6000, 74**OL**6010), the input amplifier must function as an inverter for controlling the LED emitter. The Optologic inverter gates (74**OL**6001, 74**OL**6011) use a non-inverting input amplifier.

One will note that the output chip is always HIGH (OFF) when the LED is OFF, and the output is forced LOW (ON) when the LED is ON. Thus, the Optologic input has a switching threshold of 1.34 V.

The operational sequence of LED and input/output chips will give the designer insight when combinations of inverters and buffers are used in parallel data transfer applications. In these types of applications, the rate of data transfer is greatly affected by the propagation delay difference between the slowest to fastest Optologic gate. The propagation delay is the sum of the delays of the input chip, LED, and output amplifier. The typical delay times for the 74**OL**6000/01 are 65ns, with rise times of 45ns and fall times of 5ns. The rise and fall time difference is the result of the operation of the output amplifier. The typical switching characteristics of the 74**OL**6000/01 are shown in Figures 6 and 7. When output edge detection is used, the fastest response will be obtained when the falling edge (H-L) is sensed. This is true for both the inverter and buffer Optologic gates.

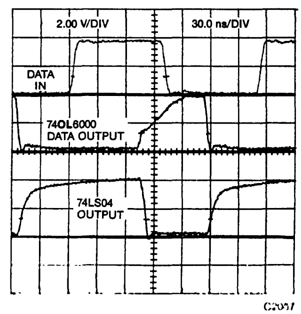


*Fig. 6. 74**OL**6000 Switching Characteristics*

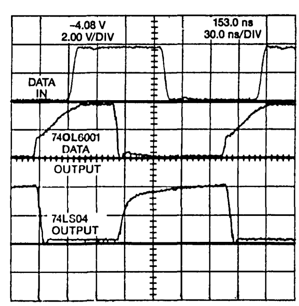


*Fig. 7. 74**OL**6001 Switching Characteristics*

The CMOS compatible output family (74**OL**6010/11) satisfies the V_{OH} by using an open collector transistor and an external pull-up resistor. The high to low propagation delay and fall time is very similar to the 74**OL**6000/01 Optologic gates. The low to high propagation delay and rise time is greatly influenced by the value of the pull-up resistor. When a 470 ohm pull-up resistor is used, the typical propagation delay for low to high is 100ns. The typical switching characteristics of the 74**OL**6010/11 are shown in Figures 8 and 9.

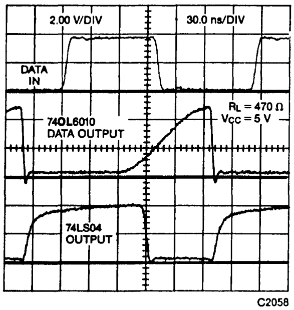


*Fig. 8. 74**OL**6010 Switching Characteristics*

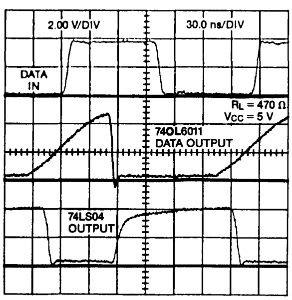


*Fig. 9. 74**OL**6011 Switching Characteristics*

The Optologic gate's input and output chips ensure a constant propagation delay over the temperature range of -40°C to 85°C. This consistency is shown in Figures 10 and 11.

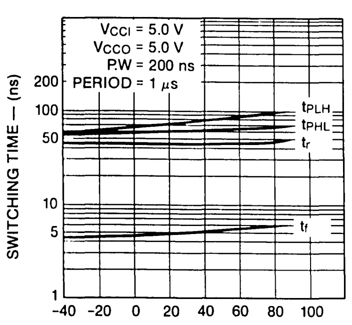


*Fig. 10. 74**OL**6000/01 Switching Times vs. Ambient Temperature*

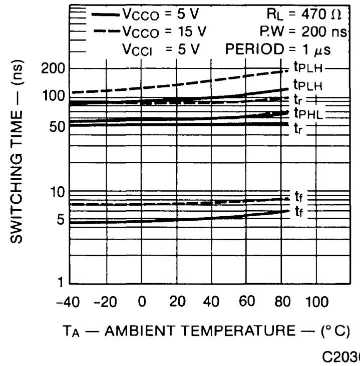


*Fig. 11. 74**OL**6010/11 Switching Times vs. Ambient Temperature*

OPERATIONAL CONSIDERATIONS

The Optologic gates have eliminated the need to perform a worst case analysis for logic family compatability and switching speed. Operational performance degradation is greatly minimized through the optimal selection of the LED emitter and output amplifier. These features make the Optologic gates the easiest optocouplers to use for logic-to-logic interfacing.

The consistent performance of the Optologic gates will be obtained if the designer ensures that package power dissipation and operational supply voltage does not exceed their absolute maximum ratings. The 74**OL**6000/01 were designed to operate from standard 4.5 to 5.5 volt supplies and, under these conditions, the devices will operate successfully over a -40° C to 85° C range. The 74**OL**6010/11 output amplifier will operate from a 15V supply over a temperature range of -40° C to 55° C, however, the output amplifier power supply voltage must be derated at a rate of -0.27V/° C above an operational temperature of 55° C. This function is shown graphically in Figure 12.

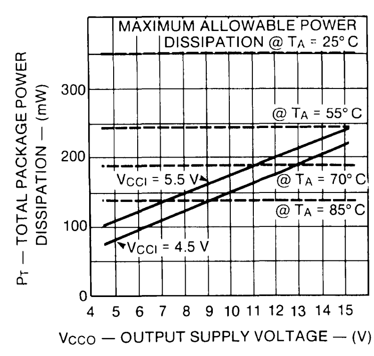


Fig. 12. Power Dissipation vs. Ambient Temperature

Operational stability is optimized when low impedance V_{CC} and V_{DD} supplies are used to power the Optologic gates. This can be ensured by the common practice of including 0.1 µF bypass capacitors for the input and output amplifier supplies. These capacitors are placed immediately next to the V_{CC}

and ground connections of the input and output amplifier. These capacitors minimize output ringing and improve the power supply noise rejection. A suggested printed circuit board layout is shown in Figure 13.

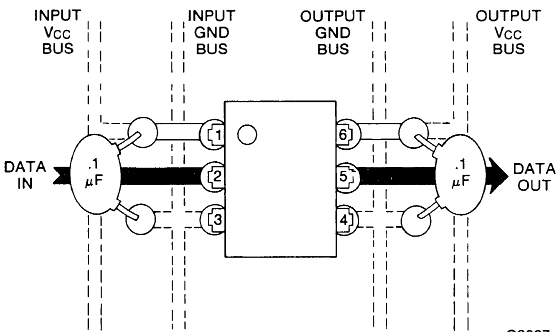


Fig. 13. Suggested PCB Lay-out

DATA COMMUNICATIONS INTERFACING

The common LED input/phototransistor output and high speed logic compatible output have found their way into point-to-point (simplex) data communications applications. When used as a line receiver the designer was required to design a matching network to provide the minimum reflection caused by the non-linear input impedance of the light emitting diode. These matching networks were commonly designed for a specific cable distance between the receiver and the transmitter. Therefore, if the cable distance were to be changed, a new matching network would be required in order to effect proper operation.

This need of designing matching networks and allowing only point-to-point communications is a thing of the past with the introduction of the Optologic gates. The Optologic gate, when used as a line receiver, does not require a matching network. Its input amplifier offers a 22Kohm input resistance which permits it to bridge the transmission. When it is used as the only receiver connected to the end of the transmission line, optimum speed performance will be obtained when the transmission line is terminated in its characteristic impedance (Zo).

When multiple data taps are required, all the designer need do is bridge the Optologic gate across the tranmission line at the desired cable length. Figure 14 illustrates a simplex multi-drop (tap) data communications system that has incorporated four 74**OL**6001 gates as receivers, evenly spaced along a 1000 foot, 75 ohms co-axial transmission line. The cable used in this example is a Times Fiber & Cable Model RG59/U Series 2000. This cable includes a third insulated conductor that is used as the V_{CC} supply source for the input amplifier of the Optologic gates connected to the transmission line. This third conductor permits one simple isolated supply to power all the Optologic gates connected to the communications cable.

The common mode rejection and insulation of the communications system can be greatly improved by incorporating an Optologic gate as a line driver. When driving low impedance transmission lines such as the 75 ohm coax shown in Figure 14, a buffer is required to drive the line. This buffer is shown in Figure 15.

The signal quality "Eye Pattern" for the communications system shown in Figure 14 is provided in Figures 16 through 18 with a 10 MBaud NRZ Psuedo-Random Sequence (PRS). Traces 1-3 in Figure 16 describe the transmitter section. Traces 4-7 of Figure 17 show the output of the four Optologic bridged terminations. Traces 8-11 in Figure 18 illustrate the "Eye Pattern", as seen at the output of the 74**LS**04 logic gate. The data quality is well persorved, in that only a 30% eye closure is seen at the receiver located 1000 feet from the transmitter.

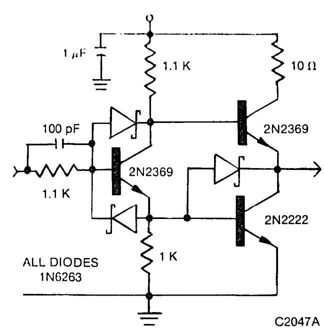
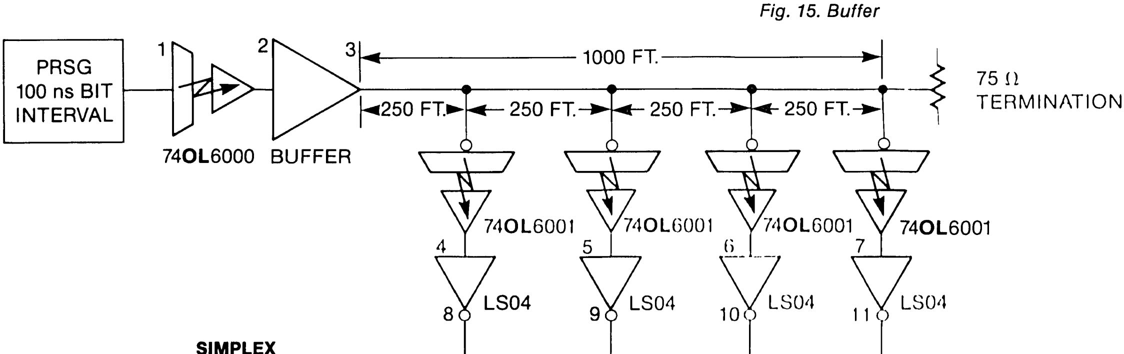


Fig. 15. Buffer



SIMPLEX
NOTES
— *All Optologic Gate Input and Output Amplifiers Bypassed With 0.1 µF Capacitors*
— *PRSG = Pseudo Random Sequence Generator*
— *1 to 11 Refer to Testpoints; See Waveforms on Figs. 16, 17 and 18*

Fig. 14. Simplex Multi-drop Data Communications System

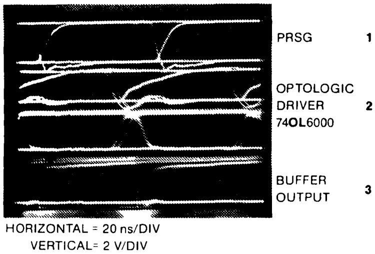


Fig. 16.

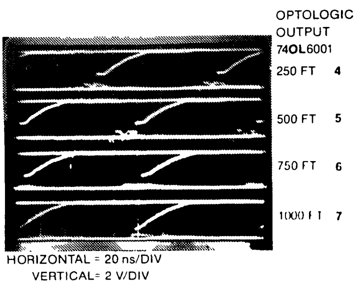


Fig. 17.

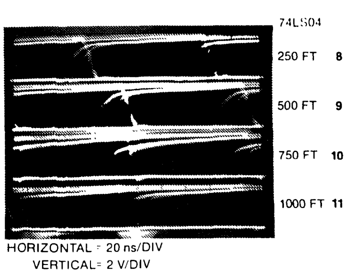


Fig. 18.

Through the use of the tri-state line driver, shown in Figure 19, a half duplex multi-drop communications system can be configured. This is done by adding this driver at each of the tap positions shown in Figure 14. This system provides the most common data communications configuration of high speed bi-directional communications, with the added features of vastly improved common mode transient rejection and insulation when compared to a common integrated line receiver.

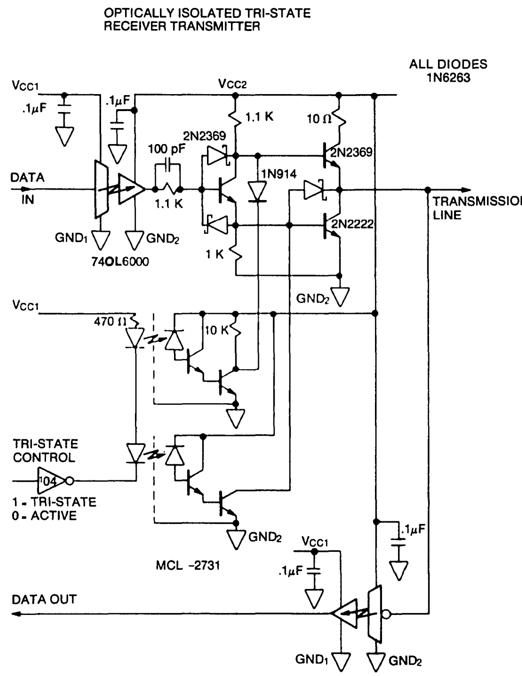


Fig. 19.

When high differential and common mode rejection are required, the differentially driven and received communications topology is considered. Figure 20 shows a full duplex point-to-point communications system that is implemented with twisted pair shielded cable. Given the higher impedance of this type of cable, it is possible for the Optologic gates to drive the line directly. Here, a 74**OL**6000 and 74**OL**6001 are used in a push-pull mode to differentially drive the line. The receiving end of the line is simply terminated in Zo. Bridging this termination is a DM8820 differential line receiver that is connected to the 74**OL**6000 Optologic gate. Power for the line receiver and the Optologic gates is derived from two insulated shields of the twisted pair cable. This system offers a data rate in excess of 1 MBaud NRZ at a distance of 600 feet.

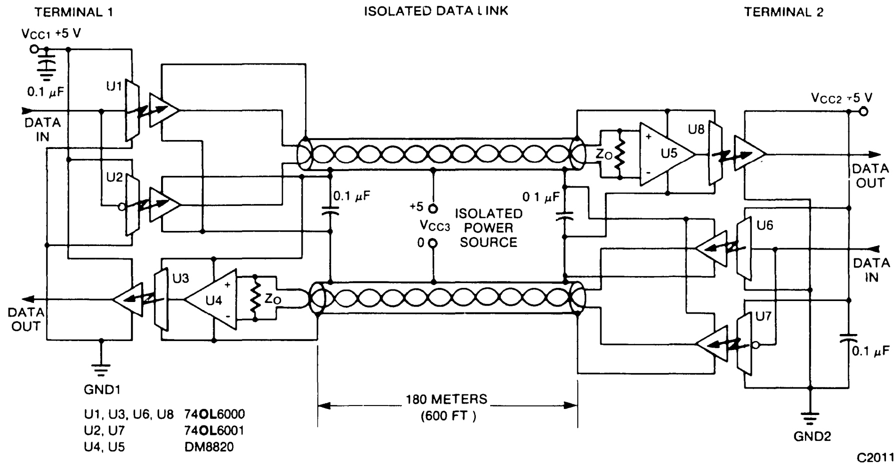


Fig. 20. 1 MBaud Full Duplex Differential Optically Isolated Transmit and Receive Data Transmission System with Shielded Twisted Pair.

AC VOLTAGE LEVEL MONITOR

The machine and process control industry has used optocouplers as voltage sensing devices for a number of years. They have proven very versatile when the presence or absence of power is to be determined. The monitoring of specific voltage levels has required the designer to commonly use selected couplers that have guaranteed gain at a specific LED drive current. Once armed with this specification, a resistor divider network is designed that will support 1 to 10 mA required by the LED. As the line voltage threshold increases, the power dissipation in the passive divider network can approach 2 watts.

Using the Optologic gate, a fixed AC or DC level monitor can easily be designed. Recall the Optologic gate has a fixed reference source built into the input amplifier. The stability and consistency of this reference source allows the designer to construct a level detector using standard product that will offer an accuracy of ±15%. If higher accuracy is needed, the factory can provide devices with tighter reference voltage tolerance. Not only is high accuracy possible, but power required from the line is typically less than 0.2 W.

Applications

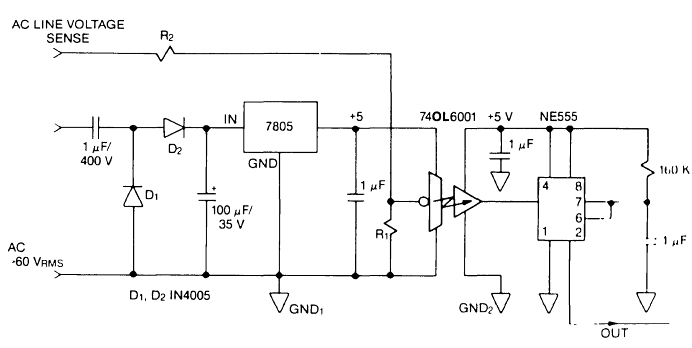


Fig. 21. Optologic Voltage Line Monitor and Power Supply

The most significant feature of the Optologic, in this application, is the small amount of current that is required to flow in the voltage divider. Under worst case design considerations, this sensing current will not exceed 500 μA. This low current permits the use of .25 W or smaller precision resistors, thus allowing even greater monitor accuracy.

For example, when sensing a voltage of 110 VAC, the power dissipated in the divider network is only 45mW.

Figure 21 shows a typical AC Line Monitor circuit. The threshold is determined by selecting the value of R1 and R2. Best accuracy is achieved when R1 is equal to or less than 2.2Kohm. Once R1 is selected, the value of R2 can be determined with the following equation.

$$R2 = \frac{R1\ R_N\ (Vth - Vref)}{Vref(R_N + R1) - R1V}$$

Where

Vth = Selected AC or DC switching level
$Vref$ = 1.34V
R_N = 22Kohm
V = 4.3V

This equation has been solved graphically in Figure 22.

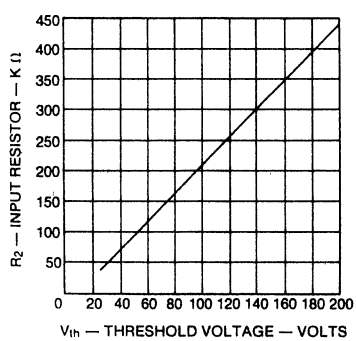


Fig. 22. Input Resistor vs. Threshold Voltage

The monitor circuit shown in Figure 21 consists of three elements. The first is an Optologic power supply, the second is the voltage divider, and the third is the retriggerable one-shot.

The power supply consists of a capacitor voltage divider and 5V regulator. A capacitor divider was used to minimize the power consumption from the AC line. This power supply will provide over 15 mA when the line voltage exceeds 60V RMS.

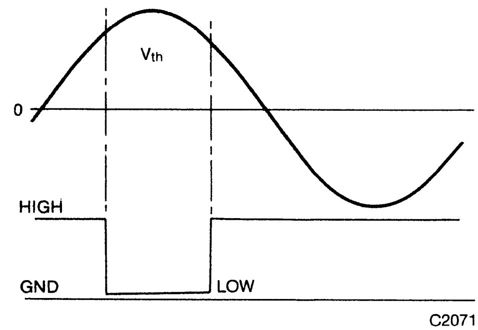


Fig. 23. 74OL0001 AC Level Detection Waveform

The voltage divider (R1, R2) sets the monitor threshold point of the sensor. R1 is used as an Optologic input pull-down, thus, as the input voltage rises, it forces current through R1 which raises its voltage up to the Vref of the Optologic input. Once the reference voltage is exceeded, the output of the Optologic will change state. Figure 23 illustrates the relationship of the input voltage to the 74OL6001 output. It can be seen that the output is a series of pulses, whose width is determined by the duration that the input waveform exceeds the voltage threshold.

The final section of the sensor consists of a retriggerable one-shot, constructed with an NE555 timer. This one-shot is included to convert the pulse train into a constant logic level. For best stability, a time constant of 1 1/4 cycles was selected. When a 60Hz power main is to be monitored, this becomes a time constant of 18ms. Thus, as the input voltage exceeds the monitor threshold, the output of the 74OL6001 changes from high to low, thus triggering the NE555 timer. Once triggered, the NE555 outputs a logic high and will stay high as long as it is triggered every 16ms.

CONCLUSION

The Optologic family of TTL and CMOS compatible devices is a new and easy-to-use optically coupled logic circuit element. This Application Note has provided but few of many new uses for this versatile device. Not only does this device provide high noise immunity and level shifting for logic-to-logic interfaces, it also has numerous applications in data communications and industrial control systems.

Appendix 6

North American Technical Representatives

ARKANSAS
Ammon & Rizos
Tulsa (918) 663-8788

ALABAMA
(404) 446-2939

ARIZONA
Thom Luke Sales, Inc.
Scottsdale (602) 941-1901

CALIFORNIA
Brooks Technical Group
Mt. View (415) 960-3880
Harvey King, Inc.
San Diego (619) 587-9300
Varigon, Inc.
El Toro (714) 855-0233

COLORADO
Elcom, Inc.
Denver (303) 337-2300

CONNECTICUT
Scientific Components, Inc.
Cheshire (203) 272-2963

DELAWARE
Beacon North, Inc.
(800) 336-3747

FLORIDA
(404) 446-2939

GEORGIA
(404) 446-2939

NORTH ILLINOIS
Sumer, Inc.
Rolling Meadows (312) 991-8500

SOUTH ILLINOIS
Lorenz Sales
University City (314) 997-4558

INDIANA
Leslie M. Devoe Company
Indianapolis (317) 842-3245

IOWA
Lorenz Sales
Cedar Rapids (319) 377-4666

KANSAS
Lorenz Sales
Overland Park (913) 649-5556

MARYLAND
Beacon North, Inc.
(800) 336-3747

MASSACHUSETTS
Kanan Associates
Needham Heights (617) 449-7400

MICHIGAN
Rathsburg Associates, Inc.
(313) 559-9700

MINNESOTA
Mel Foster Technical Sales, Inc.
Edina (612) 941-9790

MISSOURI
Lorenz Sales
University City (314) 997-4558

NEBRASKA
Lorenz Sales
Lincoln (402) 475-4660

NEW JERSEY
TAI Corporation
Bellmawr (609) 933-2600

NEW MEXICO
SynTech
Albuquerque (505) 266-7951

NEW YORK
Bob Dean, Inc.
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