General Instrument Optoelectronic Products 1985

Catalog of Optoelectronic Products 1985

GENERAL INSTRUMENT

Catalog of Optoelectronic Products 1985

Optoelectronics Division
3400 Hillview Avenue
Palo Alto, California 94304
Tel: (415) 493-0400
TWX: (910) 373-1767
Telex: 348430
FAX (415) 493-0400, X-3401

GENERAL INSTRUMENT

ALL SPECIFICATIONS SUBJECT TO CHANGE

Printed in USA

About General Instrument Optoelectronics

Experience
For the last fifteen 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 optoisolators.

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 wafer 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. xii) 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 over 320 high performance optoelectronic devices in five major categories; optoisolators, emitters/detectors, displays, lamps and chips. 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 in the United States, Canada, Mexico, South America, Europe, Africa, Japan and Australia. In addition, six General Instrument Direct Sales Offices in the United States and eight 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 list on pages 547 and 550 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 six major product groups—optoisolators, IR emitters and detectors, optoswitches, displays, lamps and chips.

A selection guide will be found at the beginning 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 alpha-numeric listing appears on page ix which lists all products individually with the appropriate data sheet page number.

A cross-index at the end of the product section lists competitive products by part number, the manufacturer, and the equivalent General Instrument optoelectronic product. This compatibility guide is invaluable for design engineers.

Application notes starting on page 503, provide useful technical information to assist you in selecting and testing optoelectronic devices.

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 548 and 550.

Table of Contents

Alpha-Numeric Product Listing

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 controls 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.

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-883, Method 1011
  T_A = 0° C to 100° C (Air to Air)
  No. of cycles = 30
- Temperature Cycle per MIL-STD-883, Method 1010
  T_A = -55° C to 125° C
  No. of cycles = 30
- Thermal Intermittent Test
  T_A = 25° C to 100° C
  No. of cycles = 10
- Pressure Pot
  pressure = 15PSI
  time = 96 hours
  T_A = 121° C ±1° C

Reliability Test Facilities

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

- Automated Testing
- Life test equipment— Hi and Lo Temperature
- Temperature/humidity chambers
- Hi Temp. ovens
- T/S and T/C equipment

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

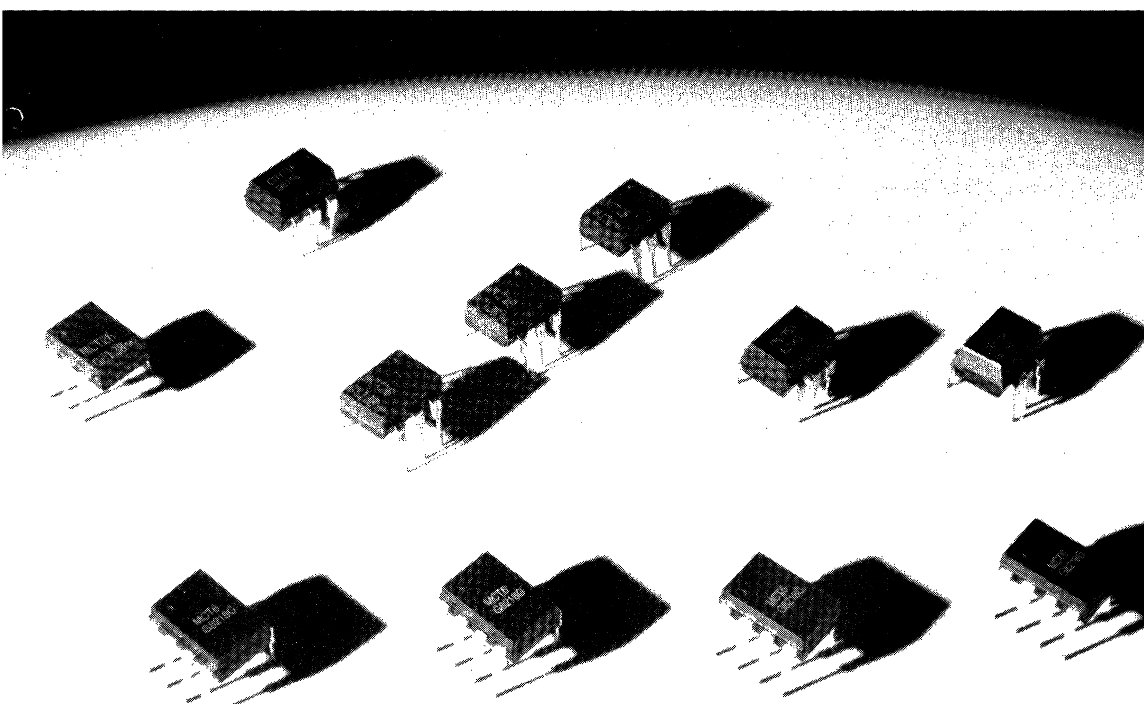
- Electrical testing and verification
- Pin to pin measurements
- Package dissection and cross-sectioning
- Chemical and plasma etching
- Optical photomicroscopy
- Micromanipulators
- Access to scanning electron microscope with X-ray spectrometry
- Access to Augur analysis

Failure Analysis and Qualitative Reliability

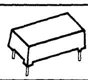
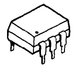
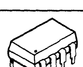
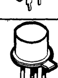
When a reliability failure does occur, a detailed analysis is performed to provide data for corrective action as well as guidelines for the design of future new products.

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

1 Optoisolators



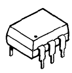
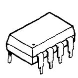
OPTOISOLATORS

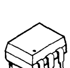
PACKAGE	DEVICE NO.	OUTPUT CONFIGURATION	MAX. EMITTER VOLTAGE	DETECTOR			
				MIN. OUTPUT VOLTAGE (BV_{CEO})	TYPICAL h_{fe}	MAX. $V_{CE}(SAT)$	MIN. CURRENT TRANSFER RATIO
TRANSISTORS							
	CNY65	Transistor	1.6 V @ 50 mA	32 V	—	0.3 V @ 1.0 mA	50-300%
	CNX35 CNX36	Transistor	1.5 V @ 10 mA	30V	—	0.4 V @ 4 mA	40-160% 80%
	CNY17-1 CNY17-2 CNY17-3 CNY17-4	Transistor	1.5 V @ 60 mA	70 V	—	0.3 V @ 2.5 mA	40-80% 63-125% 100-200% 160-320%
	H11A1 H11A2 H11A3	Transistor	1.5 V @ 10 mA	30 V	—	0.4 V @ 0.5 mA	50% 20% 20%
	H11D1 H11D2 H11D3 H11D4	High-Voltage Transistor	1.5 V @ 10 mA	300 V[2] 300 V[2] 200 V[2] 200 V[2]	—	0.4 V @ 0.5 mA	20% 20% 20% 10%
	MCT2200 MCT2201 MCT2202	Transistor	1.5 V @ 20 mA	30 V	—	0.3 V @ 2.5 mA	20% 100% 60-125%
	MCT2 MCT2E MCT26	Transistor	1.5 V @ 20 mA	30 V	250 250 150	0.4 V @ 2 mA 0.4 V @ 2 mA 0.5 V @ 1.6 mA	20% 20% 6%
	MCT210	Transistor	1.5 V @ 40 mA	30 V	400	0.4 V @ 16 mA	150%
	MCT270 MCT271 MCT272 MCT273 MCT274	Transistor	1.5 V @ 20 mA	30 V	500 420 500 280 360	0.4 V @ 2 mA	50% 45-90% 75-150% 125-250% 225-400%
	MCT275	Transistor	1.5 V @ 20 mA	80 V	170	0.4 V @ 2 mA	70-120%
	MCT276 MCT277	Transistor	1.5 V @ 20 mA	30 V	90 420	0.4 V @ 2 mA	15-60% 100%-up
	MCT5200 MCT5201	Transistor	1.5 V @ 5 mA	30 V	450	0.4 V @ 10 mA	100%
	MCT5210 MCT5211	Transistor	1.5 V @ 5 mA	30 V	550	0.4 V @ 6 mA	100%
	4N25 4N26 4N27 4N28	Transistor	1.5 V @ 50 mA	30 V	250	0.5 V @ 2 mA	20% 20% 10% 10%
	4N35 4N36 4N37	Transistor	1.5 V @ 10 mA	30 V	100	0.3 V @ 5 mA	100%
	MCT6 MCT66	Transistor Pair	1.5 V @ 20 mA	30 V	—	0.4 V @ 2 mA	20% 6%
	MCT4 MCT4R	Transistor	1.5 V @ 40 mA	30 V	—	0.5 V @ 2 mA	15%

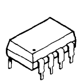
Note 1: Underwriter's Laboratory recognized product File E50151
Note 2: BV_{CER} @ I_C = 1 mA, R_{BE} = 1 megΩ

MIN. STEADY STATE ISOLATION VOLTAGE	TYPICAL OPERATING SPEED OR BANDWIDTH	PAGE NO.	APPLICATIONS
11600VDC/VDE [1]	5 μsec	9	VDE Approved, high isolation voltage for medical instrumentation, industrial controls, solid state relays, power supply monitor, AC line to digital isolation.
4400VDC [1]	2 μsec	13	Power supply regulators, digital logic inputs, microprocessor inputs, appliance sensor systems, power supply regulators, industrial controls.
7500V_{AC}PEAK [1]	6 μsec	17	
7500 V_{AC}PEAK [1]	2 μsec	21	
7500 V_{AC}PEAK [1]	5 μsec	25	
7500 V_{AC}PEAK [1]	6 μsec	29	
2500 V_{AC}RMS [1]	150 KHz 150 KHz 300 KHz	33 37 41	AC line/digital logic isolator, logic isolator, line receiver, cable receiver, relay monitor, power supply monitor.
2500 V_{AC}RMS [1]	150 KHz	43	Digital logic isolation, line receiver feedback control, monitoring circuits in high isolation environments.
2500 V_{AC}RMS [1]	10 μsec 7 μsec 10 μsec 20 μsec 25 μsec	47 51 55 59 63	Switching networks, power supply regulators, digital logic inputs, microcircuit inputs, appliance sensor systems, appliance controls
2500 V_{AC}RMS [1]	7 μsec	67	Telecommunications, high voltage industrial control, relay drive telephone.
2500 V_{AC}RMS [1]	3.5 μsec 15 μsec	71 75	Data processing, microprocessor input, high speed digital logic
7500 V_{AC}PEAK [1]	t_{PHL} = 5 μsec t_{PLH} = 13 μsec t_{PHL} = 12 μsec t_{PLH} = 8 μsec	79	LSTTL digital logic isolation, IEEE 488 isolated inputs, switching power supply, high speed industrial interface, isolated microprocessor inputs
7500 V_{AC}PEAK [1]	t_{PHL} = 10 μsec t_{PLH} = 10 μsec t_{PHL} = 20 μsec t_{PLH} = 20 μsec	85	CMOS to CMOS/LSTTL logic isolation, LSTTL to CMOS/LSTTL logic isolation, RS232 line receiver, telephone ring detector, AC line voltage sensing.
2500 V_{AC}RMS [1]	300 KHz	91	Low cost products for logic isolator, telecommunications, line/cable receiver, high frequency feedback & control system, monitoring circuits.
	150 KHz	95	Low current, low power products for industrial control and consumer, monitoring circuits, line receiver.
2500 V_{AC} RMS [1]	150 KHz	99	Data line isolation, telephone signal coupling, line/cable receiver mobile equipment.
1000 VDC [1]	300 KHz	103 105	Logic isolation, line or cable receiver for high hermeticity MCT4R-MIL-STD-883B preconditioning

OPTOISOLATORS

PACKAGE	DEVICE NO.	OUTPUT CONFIGURATION	MAX. EMITTER VOLTAGE	MIN. OUTPUT VOLTAGE (BV_{CEO})	DETECTOR		
					TYPICAL h_{fe}	MAX. $h_{CE}(SAT)$	MIN. CURRENT TRANSFER RATIO
DARLINGTONS							
	MCA2230 MCA2231 MCA2255	Darlington Transistor	1.5 V @ 20 mA	30 V 30 V 55 V	—	1.0 V @ 50 mA 1.2 V @ 50 mA 1.2 V @ 50 mA	100% 500% 500%
	MCA230 MCA231 MCA255	Darlington Transistor	1.5 V @ 20 mA	30 V 30 V 55 V	25,000 50,000 25,000	1.0 V @ 50 mA 1.2 V @ 50 mA 1.0 V @ 50 mA	100% 200% 100%
	H11B1 H11B2 H11B3	Darlington Transistor	1.5 V @ 10 mA	25 V	—	1.0 V @ 1 mA	500% 200% 100%
	4N29 4N30 4N31 4N32 4N33	Darlington Transistor	1.5 V @ 10 mA	30 V	5000	1.0 V @ 2 mA 1.0 V @ 2 mA 1.2 V @ 2 mA 1.0 V @ 2 mA 1.0 V @ 2 mA	100% 100% 50% 500% 500%
	MCA11G1 (H11G1) MCA11G2 (H11G2)	High Voltage Darlington Transistor	1.5 V @ 60 mA	100 V 80V	—	1.0 V @ 50 mA	1000%
	6N138 (MCC670) 6N139 (MCC671)	Split-darlington	1.7 V @ 1.6 mA	7 V 18 V	—	0.4 V @ I_F = 1.6 mA I_O = 4.8 mA V_{CC} = 4.5 V 0.4 V @ I_F = 5 mA I_O = 15 mA V_{CC} = 4.5 V	300% 400%

PACKAGE	DEVICE NO.	OUTPUT CONFIGURATION	MAX. EMITTER VOLTAGE	DETECTOR			
				V_{GT} (MAX.)	ON-VOLTAGE (MAX.)	HOLDING CURRENT (MAX.)	I_{FT} (MAX.)
SCR's							
	MCS2 MCS2400	SCR	1.5 V @ 20 mA	1 V	1.3 V @ 100 mA	0.5 mA	14 mA
	MCS21 MCS2401	SCR	1.5 V @ 20 mA	1 V	1.3 V @ 300 mA	0.5 mA	11 mA

PACKAGE	DEVICE NO.	OUTPUT CONFIGURATION	MAX. EMITTER VOLTAGE	DETECTOR			
				I_F (MIN.)	I_{OH} (MAX.)	V_{OL} (MAX.)	I_{CC} (TYP.)
HIGH SPEED LOGIC GATE							
	MCL2601 (HCPL2601) 6N137	Open-collector Logic gate	1.75 V @ 10 mA	5 mA	250 μA	0.6 V @ 13 mA	15 mA
	MCL2630 (HCPL2630)	Dual-channel Open-collector Logic gate	1.75 V @ 10 mA	5 mA	250 μA	0.6 V @ 13 mA	26 mA

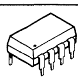
Note 1: Underwriter's Laboratory recognized product File E50151

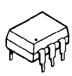
MIN. STEADY STATE ISOLATION VOLTAGE	TYPICAL OPERATING SPEED OR BANDWIDTH	PAGE NO.	APPLICATIONS
7500 V_{AC}PEAK UL[1]	10 KHz	107	High current, low capacitance and fast switching products for read relay, pulse transformer, multiple contact control applications, telecommunications, remote control logic isolation & alarm monitoring circuits, AC line/logic counting
2500 V_{AC}RMS UL[1]	10 KHz	111	
7500 V_{AC}PEAK UL[1]	10 KHz	115	
2500 V_{AC}RMS UL[1]	30 KHz	119	Low capacitance medium speed products for data isolation, logic conversion, line/cable receiver, monitoring circuits or mechanical feedback controls
2500 V_{AC}RMS UL[1]	100 μsec	123	High breakdown voltage with high current transfer ratio used in telecommunications, pulse transformer and other logic isolation.
3000 VDC UL[1]	t_{PHL} @ 10 μsec t_{PHL} @ 35 μsec t_{PHL} @ 1 μsec t_{PHL} @ 7 μsec	127	CMOS logic interface, telephone ring detector, low input TTL interface, power supply isolation.

BLOCKING VOLTAGE	MIN. STEADY STATE ISOLATION VOLTAGE	PAGE NO.	APPLICATIONS
200 V 400 V	2500 V_{AC}RMS UL[1]	131	Lower power IC's to AC line isolation, relay functions, latches for DC circuits, home appliances, consumer and industrial control logic.
200 V 400 V	2500 V_{AC}RMS UL[1]	131	Complete power isolation for integrated circuits and AC line voltage. High speed switching of relay functions.

MIN. TRANSIENT IMMUNITY CM	STEADY STATE ISOLATION VOLTAGE	OPERATING FREQUENCY (TYP.)	PAGE NO.	APPLICATIONS
-1000 V/μsec -150 V/μsec	3000 VDC UL[1]	10 MBits	135 139	Isolated line receiver, data transmission isolation, microprocessor system interface, pulse transformer replacement
-1000 V/μsec	3000 VDC UL[1]	10 MBits	145	

OPTOISOLATORS

PACKAGE	DEVICE NO.	OUTPUT CONFIGURATION	MAX. EMITTER VOLTAGE	DETECTOR			
				ON-STATE RMS INPUT CUR. (MIN.)	OFF-STATE RMS INPUT CUR. (MAX.)	V_{OL} (MAX.)	I_{OH} (MAX.)
AC LINE MONITOR							
	MID400	Open-collector Logic gate	1.5 V = 30 mA	4.0 mA	0.15 mA	0.4 @ 16 mA	100 μA

PACKAGE	DEVICE NO.	OUTPUT CONFIGURATION	MAX. EMITTER VOLTAGE	MAX. ON-STATE VOLTAGE	PEAK BLOCKING VOLTAGE	TYPICAL STATIC dv/dt	HOLDING CURRENT (TYP.)
TRIAC DRIVERS							
	MCP3009 MCP3010 MCP3011	TRIAC	1.5 V @ 30 mA	3.0 V @ 100 mA	250 V	10 V/μsec	200 μA
	MCP3011A MCP3012	TRIAC	1.5 V @ 10 mA	3.0 V @ 100 mA	250 V	10 V/μsec	200 μA
	MCP3020 MCP3021 MCP3022	TRIAC	1.5 V @ 30 mA	3.0 V @ 100 mA	400 V	15 V/μsec	200 μA
	MCP3022A MCP3023	TRIAC	1.5 V @ 10 mA	3.0 V @ 100 mA	400 V	15 V/μsec	200 μA
	MCP3030 MCP3031	TRIAC	1.5 V @ 30 mA	3.0 V @ 100 mA	250 V	100 V/μsec	100 μA
	MCP3032 MCP3033	TRIAC	1.5 V @ 10 mA	3.0 V @ 100 mA	250 V	100 V/μsec	100 μA
	MCP3040 MCP3041	TRIAC	1.5 V @ 30 mA	3.0 V @ 100 mA	400 V	100 V/μsec	100 μA
	MCP3042 MCP3043	TRIAC	1.5 V @ 10 mA	3.0 V @ 100 mA	400 V	100 V/μsec	100 μA

Note 1: Underwriter's Laboratory recognized product File E50151

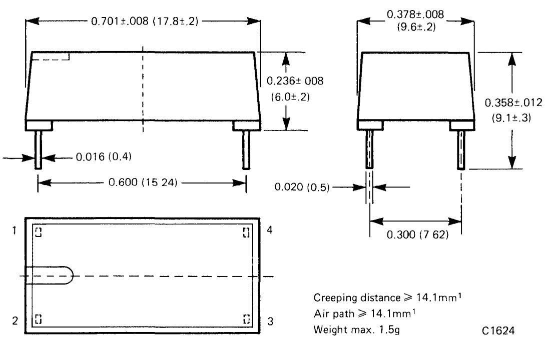
MIN. TRANSIENT STEADY STATE ISOLATION VOLTAGE	SWITCHING TIMES T_{ON}, T_{OFF}(TYP.)	PAGE NO.	APPLICATIONS
2500 V_{AC}RMS [1]	1.0 mS	149	Monitors AC "line-down" conditions; "closed loop" interface between electromechanical elements and microprocessors. Time delay isolation switch.

TRIGGER CURRENT (MAX. I_{FT})	MIN. STEADY STATE ISOLATION VOLTAGE	PAGE NO.	APPLICATIONS
30 mA 15 mA 10 mA	7500 V_{AC}PEAK [1]	155	Interface between electronic controls and power triacs to control resistive and inductive leads for 120 VAC or 240 VAC operations. Specific applications are used as triac driver, traffic light controls, motor controls and solid state relays
10 mA 5 mA	7500 V_{AC}PEAK [1]	159	
30 mA 15 mA 10 mA	7500 V_{AC}PEAK [1]	163	
10 mA 5 mA	7500 V_{AC}PEAK [1]	159	
30 mA 15 mA	7500 V_{AC}PEAK [1]	167	
10 mA 5 mA	7500 V_{AC}PEAK [1]	171	
30 mA 15 mA	7500 V_{AC}PEAK [1]	167	
10 mA 5 mA	7500 V_{AC}PEAK [1]	171	

GENERAL INSTRUMENT

CNY65

PACKAGE DIMENSIONS



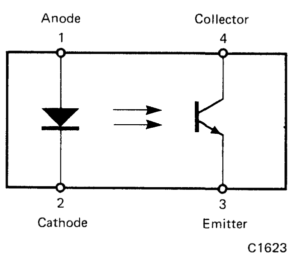


Fig. 1. Equivalent Circuit

DESCRIPTION

The CNY65 is an optoisolator which combines a GaAs LED with an NPN phototransistor. This device has very high isolation voltage of 11.6 kV DC and is VDE approved for continuous 1000 VAC operation.

FEATURES

- DC Isolation voltage 11.6 kV
- Nominal isolation operating voltage[2] 1000 VAC or 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%
- Underwriters Laboratory (UL) recognized File No. E76414

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	V_R = 0, f = 1mHz
OUTPUT DETECTOR						
Collector-Emitter Breakdown Voltage	BV_{CEO} *	32			V	I_C = 1mA
Emitter-Collector Breakdown Voltage	BV_{ECO} *	7			V	I_E = 100μA
Collector Leakage Current	I_{CEO} *		10	200	nA	V_{CE} = 20V
COUPLED CHARACTERISTICS						
Current Transfer Ratio	CTR*	50	100	300	%	I_F = 10mA, V_{CE} = 5V
Current Transfer Ratio	CTR*	60			%	I_F = 20mA, V_{CE} = 5V
Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$ *			0.3	V	I_F = 10mA, I_C = 1mA
DC Isolation Voltage[1]	V_{ISO} **	11.6			kV	t = 1 min.
Isolation Resistance	R_{ISO}		10^{12}		Ω	V_{ISO} ≐ 1000V, 40% R.H.
Isolation Capacitance	C_{ISO}		0.3		pF	f = 1mHz
Bandwidth	BW		110		kHz	I_F = 10mA, V_{CE} = 5V, R_L = 100Ω

* AQL = 0.65%
** AQL = 2.5%
1 Related to standard climate 23/50 DIN 50 014

SWITCHING CHARACTERISTICS

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

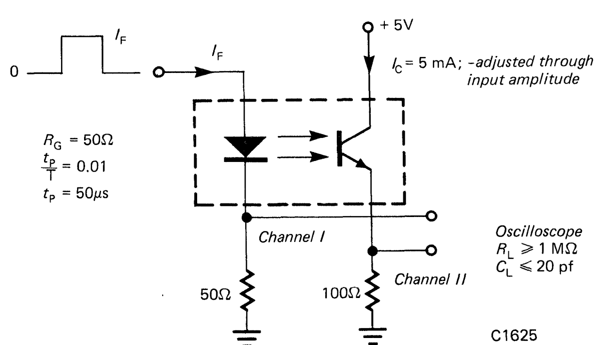


Fig. 2. Switching Time Test Circuit

TYPICAL ELECTRICAL CHARACTERISTICS CURVES (25°C Free air temperature unless otherwise specified)

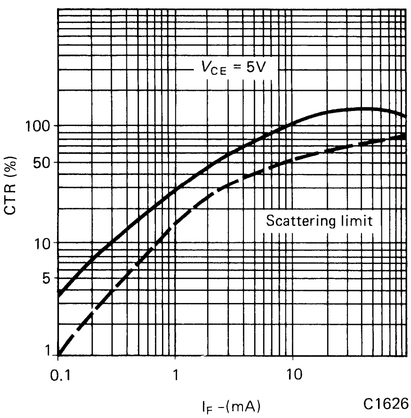


Fig. 3. Current Transfer Ratio vs. Forward Current

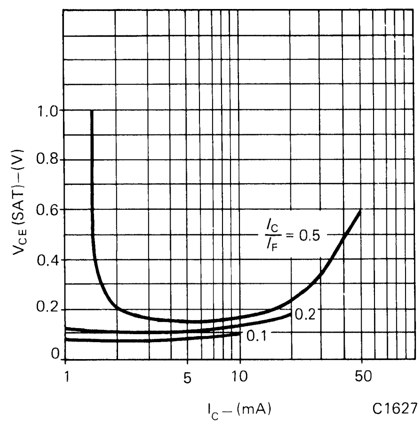


Fig. 4. V_{CE} (SAT) vs. Collector Current

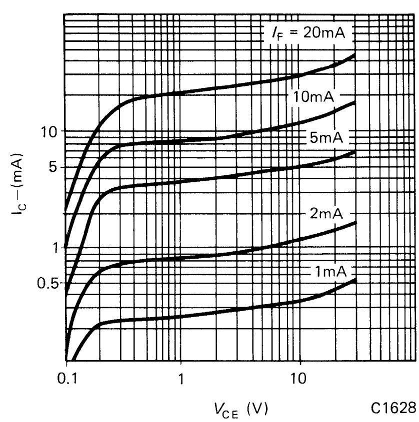


Fig. 5. Collector Current vs. Collector Voltage

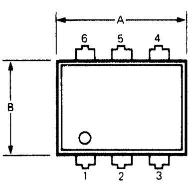
NOTES

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.*

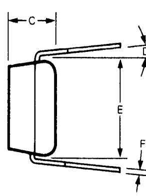
GENERAL INSTRUMENT

CNX 35
CNX 36

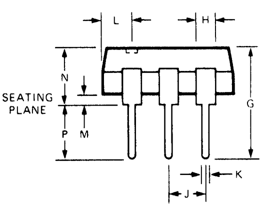
PACKAGE DIMENSIONS



C1240

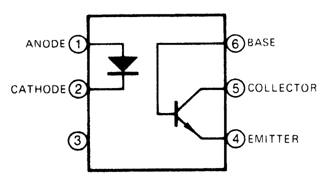


C1240



C1240

SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.355	9.02	
B	.270	6.86	
C	.160	4.06	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5



C1240

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0.100 INCH

C1339A

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% CNX 36—80%
- 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					I_F = 10 mA, V_{CE} = 0.4 V
	CNX 35		40		160	%	
	CNX 36		80			%	
	CNX 35, CNX 36	I_{CE1}	150			μA	T_A < 70° C, I_F = 2 mA, V_{CE} = 0.4 V
	CNX 35, CNX 36	I_{CE2}			15	μA	T_A < 70° C, V_F = 0.8 V, V_{CE} = 15 V
	Saturation voltage	$V_{CE\ (SAT)}$		0.1	.40	V	I_F = 10 mA; I_C = 4 mA
	Collector cut-off current (dark)	I_{CEW}			200	nA	Working voltage = 1500 V_{DC} V_{CC} = 10 V, I_F = 0, see Fig. 16
					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
	Turn-on	t_{on}		2		μs	
	Turn-off time	t_{off}		2		μs	
	Non-saturated						(V_{CB} = 10 V, I_{CB} = 50 μA, R_L = 100 Ω) See Fig. 18
	Turn-on	t_{on}		300		ns	
	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
		V_{ISO}	3734			V_{AC} RMS	Relative humidity ≤ 50% I_{I-O} ≤ 10 μA, 1 second
	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 temp coefficient			-1.8		mV/° C	
	Reverse voltage	V_R	3.0	25		V	I_R = 10μA
	Junction capacitance	C_J		50		pF	V_F = O 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 = 1.0 mA, I_F = 0
	Collector to base	BV_{CBO}	70	130		V	I_C = 10 μA
	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			2		pF	V_{CE} = 10, 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 (TA = 25° C Unless Otherwise Specified)

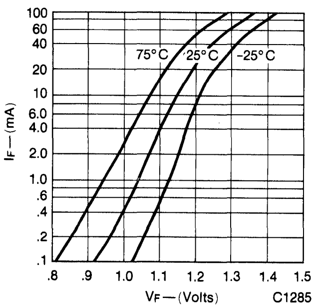


Fig. 1. Forward Voltage vs. Forward Current

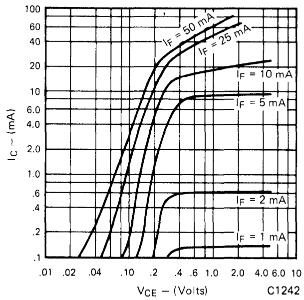


Fig. 2. Collector Current vs. Collector to Emitter Voltage

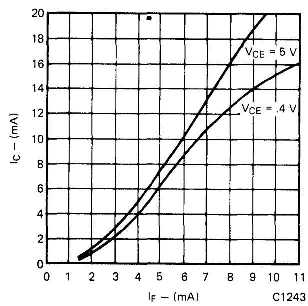


Fig. 3. Collector Current vs. Forward Current

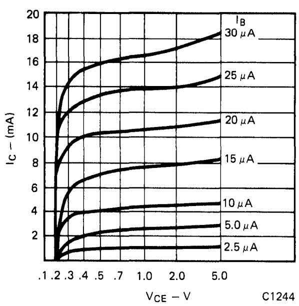


Fig. 4. Collector Current vs. Collector to Emitter Voltage

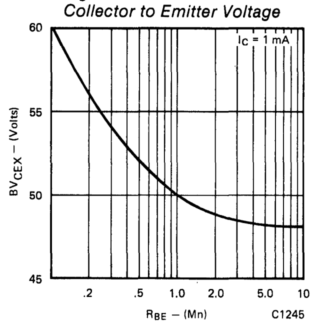


Fig. 5. Collector to Emitter Breakdown Voltage vs. Base to Emitter Resistance

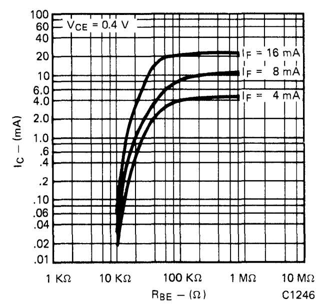


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

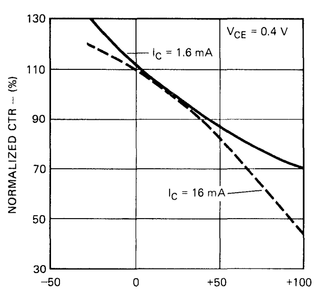


Fig. 7. Current Transfer Ratio (saturated) vs. Temperature

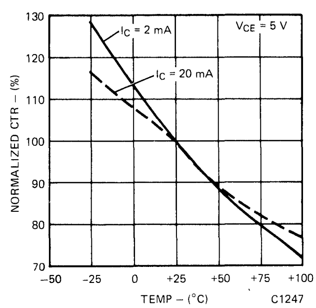


Fig. 8. Current Transfer Ratio (unsaturated) vs. Temperature

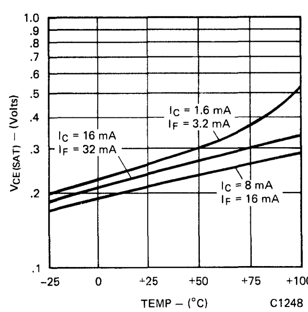


Fig. 9. Collector to Emitter Saturation Voltage vs. Temperature

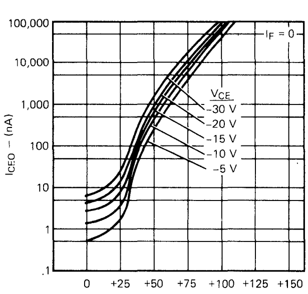


Fig. 10. Collector to Emitter Leakage Current vs. Temperature

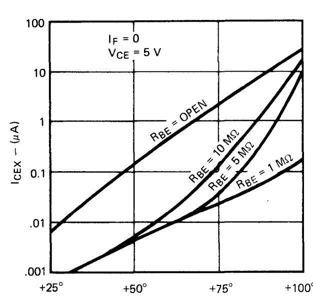


Fig. 11. Collector To Emitter Leakage Current vs. Temperature

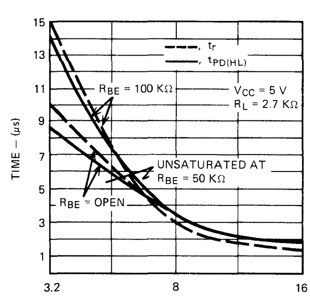


Fig. 12. Switch-on Time vs. I_F Drive (saturated)

SWITCHING CHARACTERISTICS

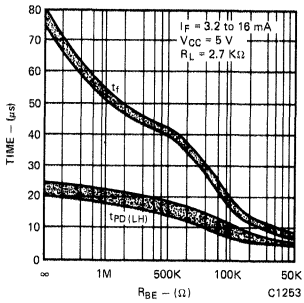


Fig. 13. Switch-off time vs. Base to Emitter Resistance (saturated)

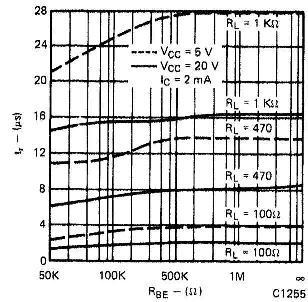


Fig. 14. Rise Time vs. Base to Emitter Resistance (non-saturated)

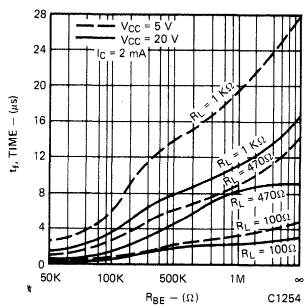


Fig. 15. Fall Time vs. Base to Emitter Resistance (non-saturated)

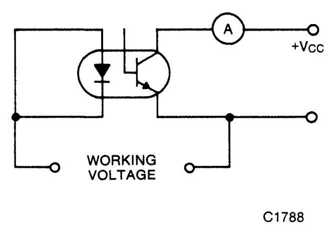


Fig. 16. I_{CEW} Test Circuit

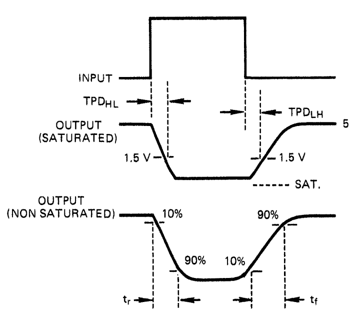


Fig. 17. Switching Time Waveforms

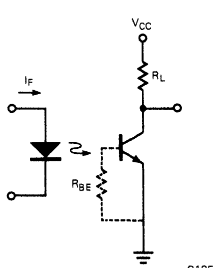


Fig. 18. Switching Time Test Circuits

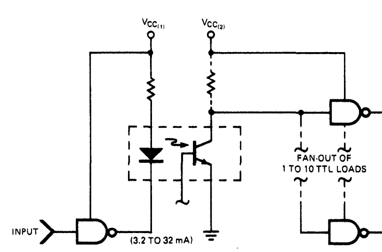
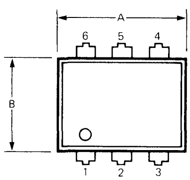


Fig. 19. Typical TTL interface at Operating Temperatures of 0° to 70° C

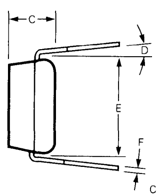
GENERAL INSTRUMENT

CNY17

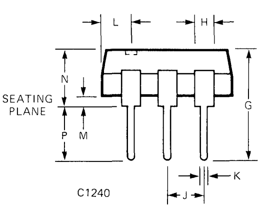
PACKAGE DIMENSIONS



C1240



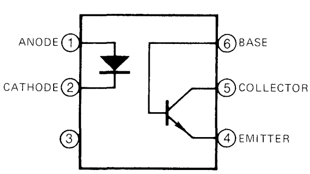
C1240



C1240

SYMBOL	INCHES MAX	mm MAX	NOTES
A	355	9 02	
B	270	6.86	
C	.160	4 06	
D	15°	15°	
E	300 Ref	7.62 Ref	1
F	014	0.36	
G	325	8 26	
H	070	1.78	
J	110	2 79	
K	022	0.56	
L	085	2 16	2
M			3
N	175	4 45	4
P			5

C1339A



C1240

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2 FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5 MINIMUM 0.100 INCH

Fig. 1. 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 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
- 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%, $I_{I\text{-}O}$ ≤ 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 = 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 specified)

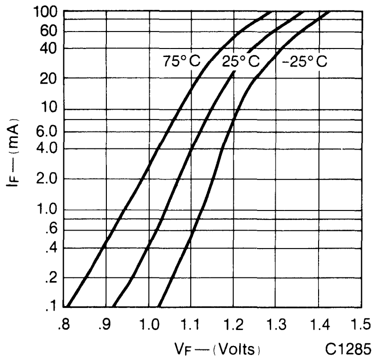


Fig. 2. Forward Voltage vs. Forward Current

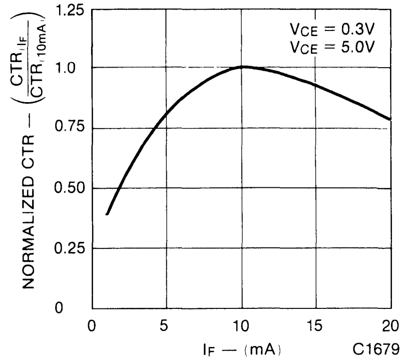


Fig. 3. Normalized Current Transfer Ratio vs. Forward Current

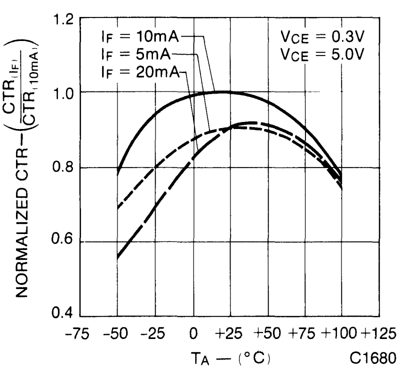


Fig. 4. Normalized Current Transfer Ratio vs. Ambient Temperature

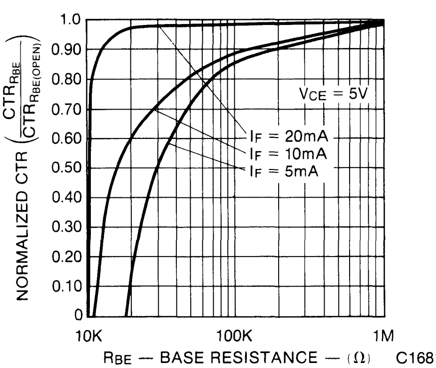


Fig. 5. C_{TR} vs. R_{BE}

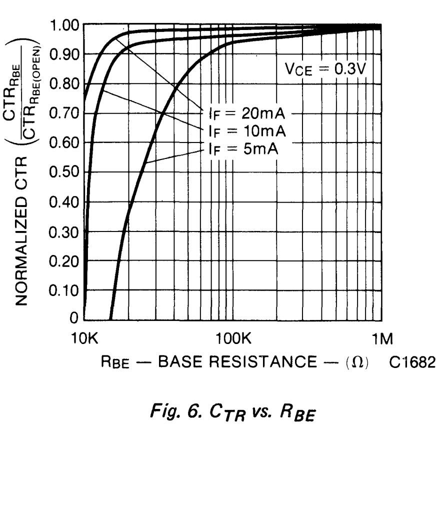


Fig. 6. C_{TR} vs. R_{BE}

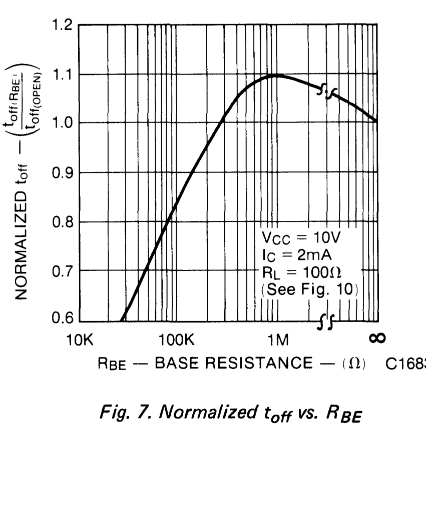


Fig. 7. Normalized t_{off} vs. R_{BE}

ELECTRICAL CHARACTERISTIC CURVES (25°C Free air temperature unless specified)

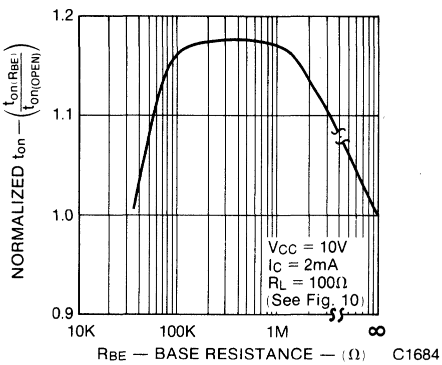


Fig. 8. Normalized t_{on} vs. R_{BE}

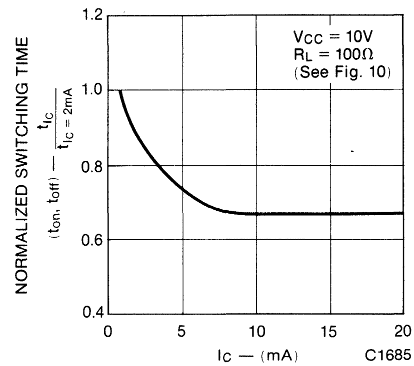


Fig. 9. Normalized Switching Time vs. Collector Current

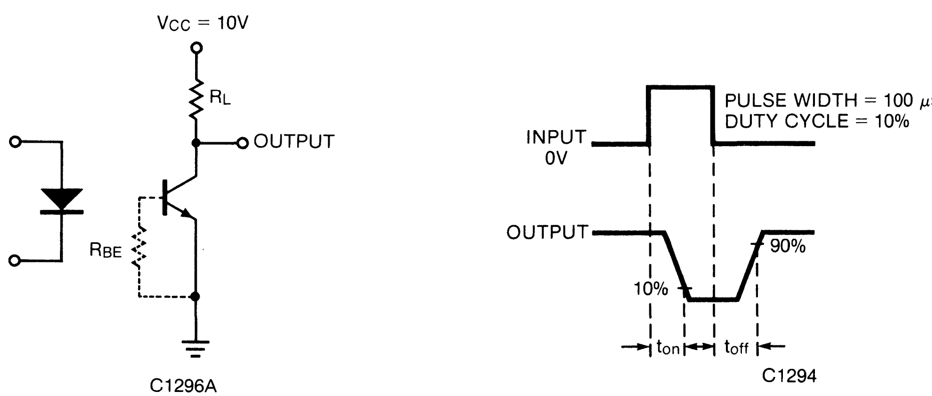
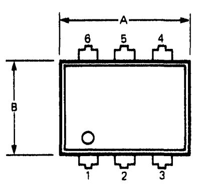


Fig. 10. Switching Time Test Circuit and Waveform

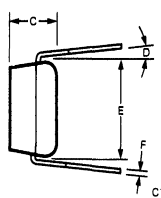
GENERAL INSTRUMENT

H11A1
H11A2
H11A3

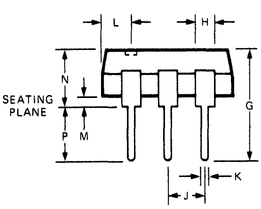
PACKAGE DIMENSIONS



C1240



C1240

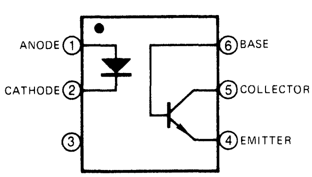


C1240

SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.355	9.02	
B	.270	6.86	
C	.160	4.06	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0.100 INCH

C1339



C1240

DESCRIPTION

The H11A1, H11A2, H11A3 are phototransistor-type optically coupled isolators. An infrared emitting diode manufactured from specially grown gallium arsenide is selectively coupled with an NPN silicon phototransistor. These devices are 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
- Minimum current transfer ratio of
  H11A1 50%
  H11A2, H11A3 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 .... 3.5 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					I_F = 10 mA, V_{CE} = 10 V
	H11A1		50			%	
	H11A2		20			%	
	H11A3		20			%	
	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 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 (TA = 25° C Unless Otherwise Specified)

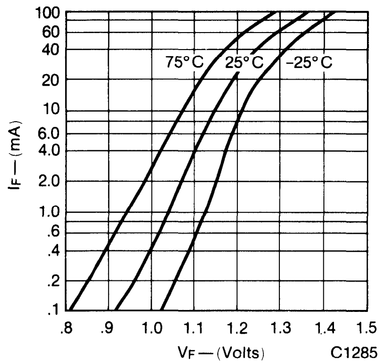


Fig. 1. Forward Voltage vs. Forward Current

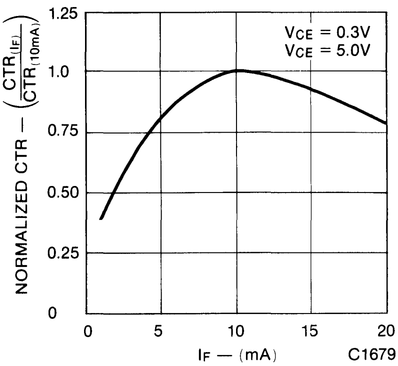


Fig. 2. Normalized Current Transfer Ratio vs. Forward Current

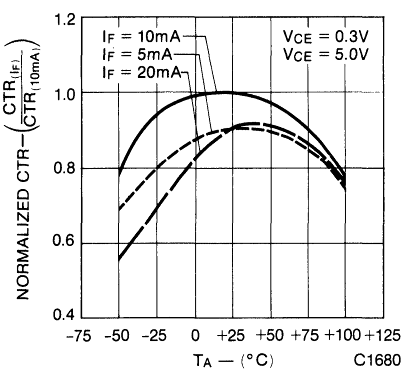


Fig. 3. Normalized Current Transfer Ratio vs. Ambient Temperature

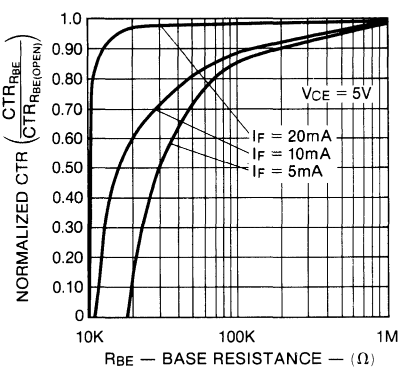


Fig. 4. C_{TR} vs. R_{BE}

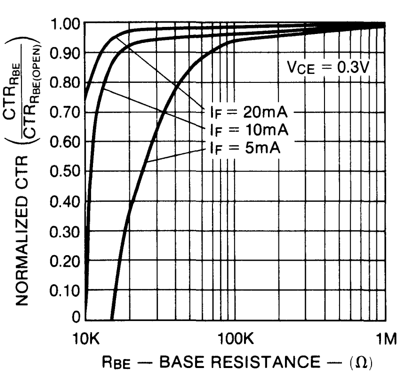


Fig. 5. C_{TR} vs. R_{BE}

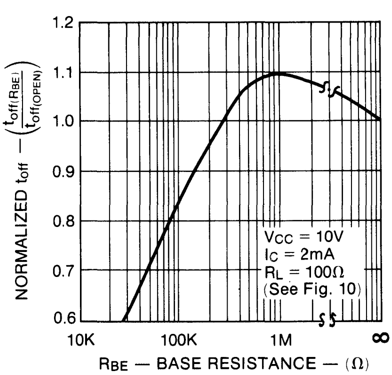


Fig. 6. Normalized t_{off} vs. R_{BE}

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

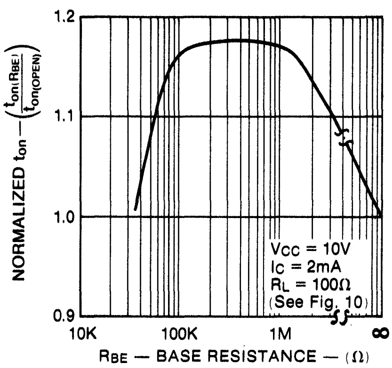


Fig. 7. Normalized t_{on} vs. R_{BE}

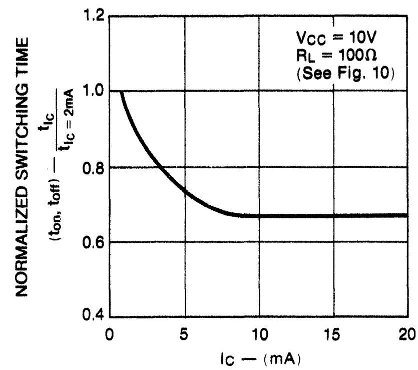


Fig. 8. Normalized Switching Time vs. Collector Current

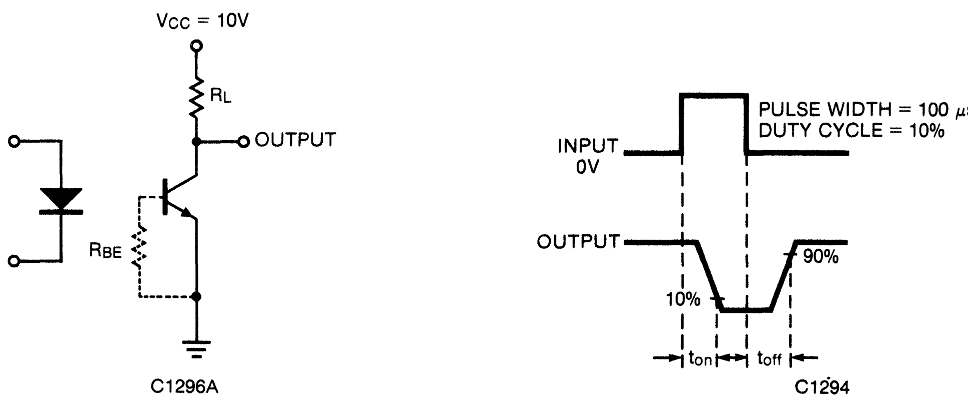
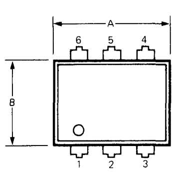


Fig. 9. Switching Time Test Circuit and Waveform

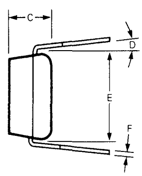
GENERAL INSTRUMENT

H11D1 H11D3
H11D2 H11D4

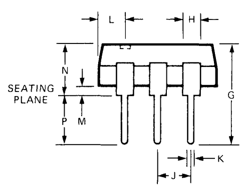
PACKAGE DIMENSIONS



C1240A



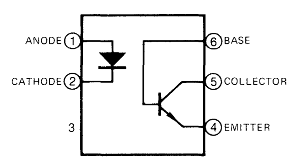
C1240A



C1240A

SYMBOL	INCHES MAX.	mm MAX	NOTES
A	355	9 02	
B	270	6 86	
C	.160	4 06	
D	15°	15°	
E	.300 Ref	7 62 Ref	1
F	014	0.36	
G	325	8.26	
H	070	1 78	
J	110	2.79	
K	022	0 56	
L	085	2.16	2
M			3
N	175	4 45	4
P			5

NOTES
1 INSTALLED POSITION OF LEAD CENTERS
2 FOUR PLACES
3 OVERALL INSTALLED POSITION
4 THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5 MINIMUM 0 100 INCH



C1109

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-D4, 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%
  H11D4—10%
- 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-D4
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
	H11D4		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

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 μ 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	Breakdown voltage						
	Collector to emitter	BV_{CER}					
	H11D1, H11D2,		300			V	I_C = 1 mA; I_F = 0,
	H11D3, H11D4		200			V	R_{BE} = 1 meg
	Collector to base	BV_{CBO}					
	H11D1, H11D2,		300			V	I_C = 100μA; I_F = 0
	H11D3, H11D4		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, H11D4	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

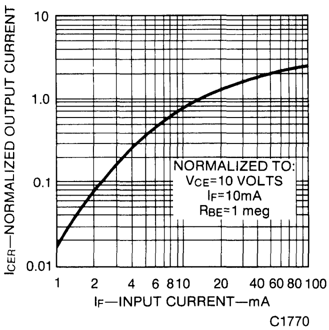


Fig. 1. Output Current vs. Input Current

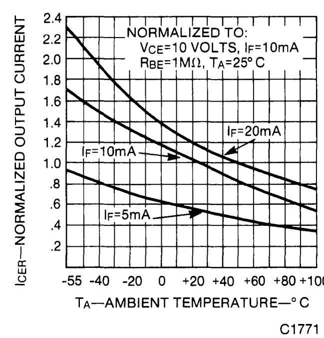


Fig. 2. Output Current vs. Temperature

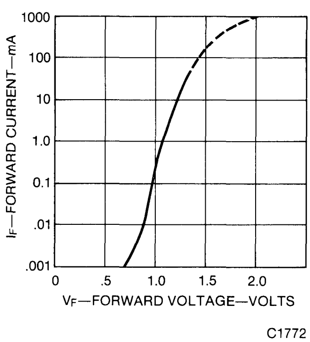


Fig. 3. Input Characteristics

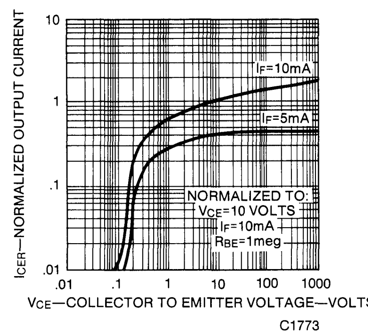


Fig. 4. Output Characteristics

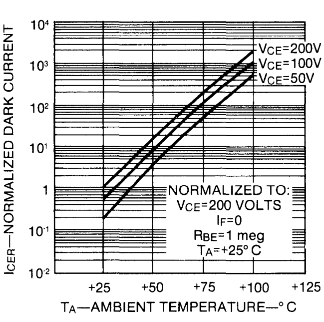


Fig. 5. Normalized Dark Current vs. Temperature

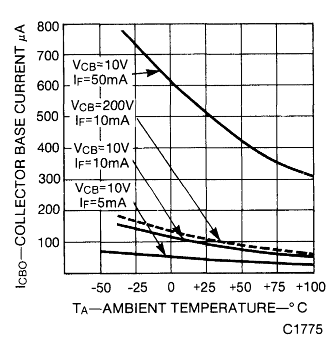
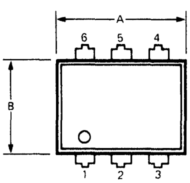
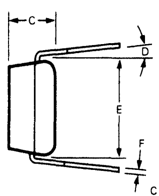


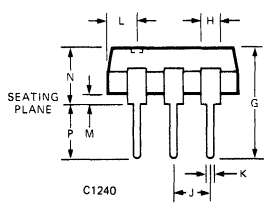
Fig. 6. Collector Base Current vs. Temperature

GENERAL INSTRUMENT

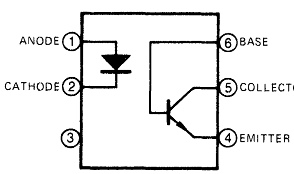
MCT2200
MCT2201
MCT2202







SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.355	9.02	
B	.270	6.86	
C	.160	4.06	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5



C1240

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0.100 INCH

DESCRIPTION

The MCT2200, MCT2201 and MCT2202 are optoisolators 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
  MCT2202—10 μs
- Underwriters Laboratory (UL) recognized File #E50151

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 soldering temperature (10 sec) .... 260°C
Total package power dissipation at 25°C ambient
(LED plus detector) .... 260 mW
Derate linearly from 25°C .... 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 dissipation 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 specified)

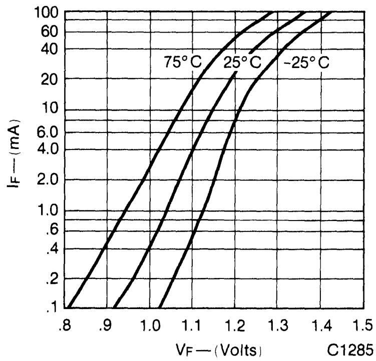


Fig. 2. Forward Voltage vs. Forward Current

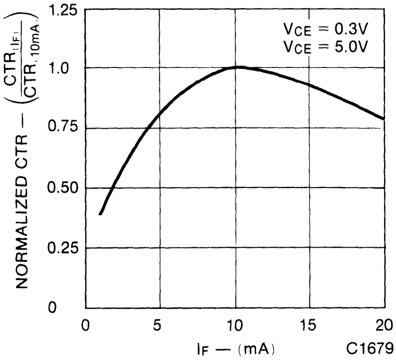


Fig. 3. Normalized Current Transfer Ratio vs. Forward Current

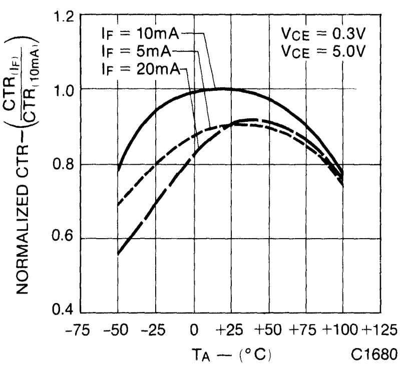


Fig. 4. Normalized Current Transfer Ratio vs. Ambient Temperature

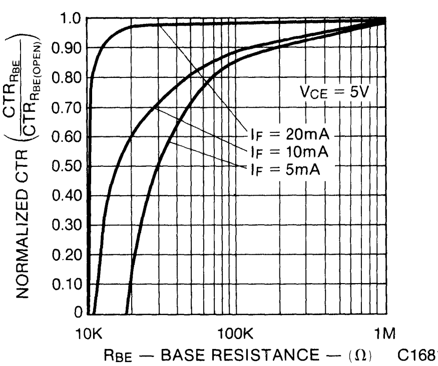


Fig. 5. C_{TR} vs. R_{BE}

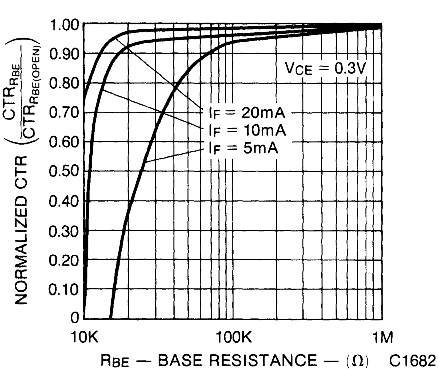


Fig. 6. C_{TR} vs. R_{BE}

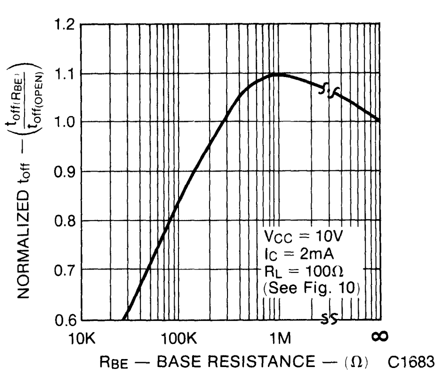


Fig. 7. Normalized t_{off} vs. R_{BE}

ELECTRICAL CHARACTERISTIC CURVES (25°C Free air temperature unless specified)

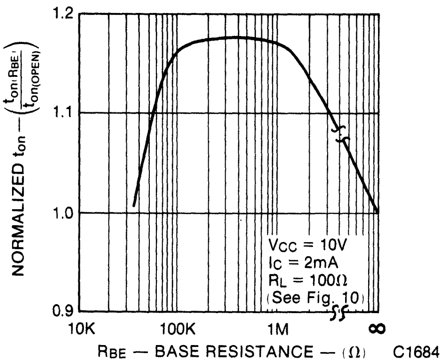


Fig. 8. Normalized t_{on} vs. R_{BE}

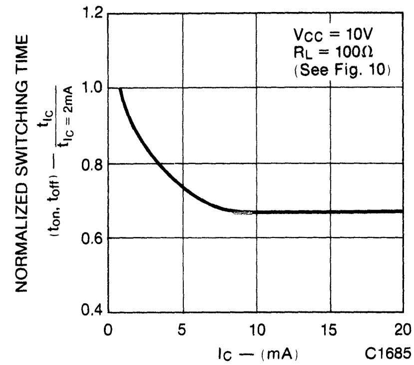
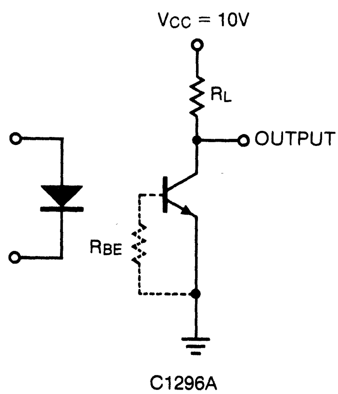


Fig. 9. Normalized Switching Time vs. Collector Current



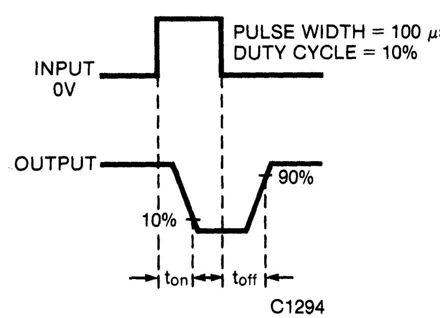
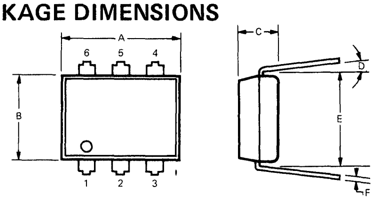


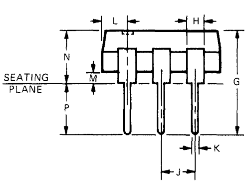
Fig. 10. Switching Time Test Circuit and Waveform

GENERAL INSTRUMENT

MCT2

PACKAGE DIMENSIONS





SYMBOL	INCHES MAX	mm MAX.	NOTES
A	355	9 02	
B	270	6 86	
C	130	3 30	
D	15°	15°	
E	.300 Ref.	7 62 Ref	1
F	014	0.36	
G	325	8 26	
H	070	1 78	
J	110	2 79	
K	022	0 56	
L	085	2 16	2
M			3
N	.175	4 45	4
P			5

NOTES
1 INSTALLED POSITION OF LEAD CENTERS
2 FOUR PLACES
3. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
4 MINIMUM 0 100 INCH

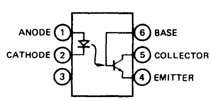
C1339C

DESCRIPTION

The MCT2 is a 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 feedback control
- Relay contact monitor
- Power supply monitor
- UL recognized — File E50151



C1339

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

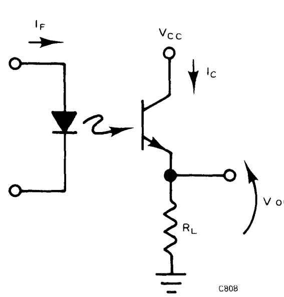
ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	MIN.		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)

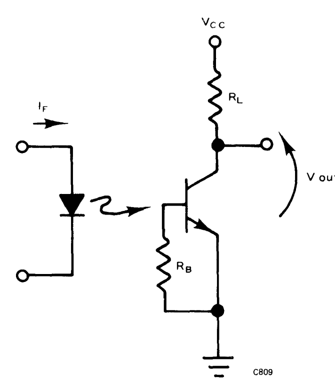
SWITCHING TIMES			TYP.	UNITS	TEST CONDITIONS
Saturated					
t on (from 5 V to 0.8 V)		t_{on} (SAT)	10	μs	$R_L=2$ KΩ, $I_F=15$ mA, $V_{CC}=5$ V
t off (from SAT to 2.0 V)		t_{off} (SAT)	30		R_B=open (Circuit No. 2)
Saturated					
t on (from 5 V to 0.8 V)		t_{on} (SAT)	10	μs	$R_L=2$ KΩ, $I_F=20$ mA, $V_{CC}=5$ 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

(25°C Free Air Temperature Unless Otherwise Specified)

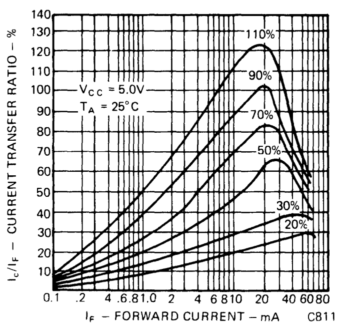


Fig. 1. Current Transfer Ratio vs., Forward Current

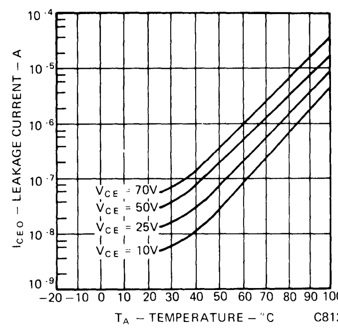


Fig. 2. Dark Current vs. Temperature

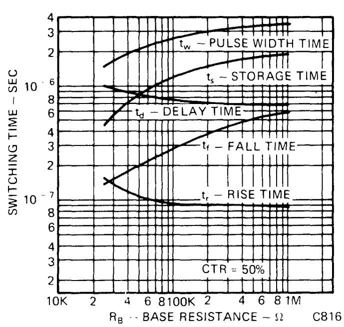


Fig. 3. Switching Time vs. Base Resistance

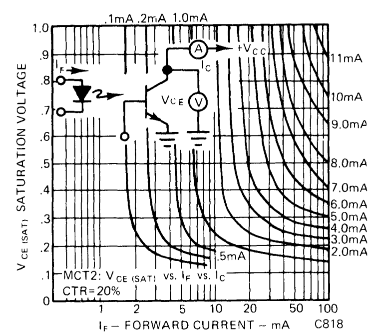


Fig. 4. Saturation Voltage vs. Forward Current

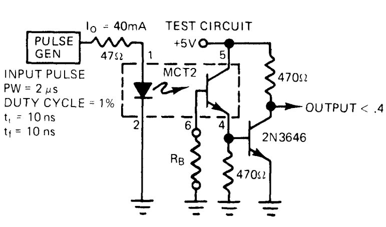


Fig. 5. Circuit for Figure 3

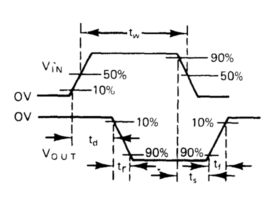


Fig. 6. Waveforms for Figure 3

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

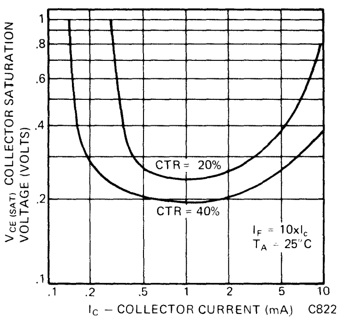


Fig. 7. Saturation Voltage vs. Collector Current

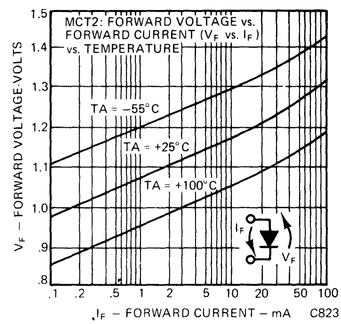


Fig. 8. Forward Voltage vs. Forward Current

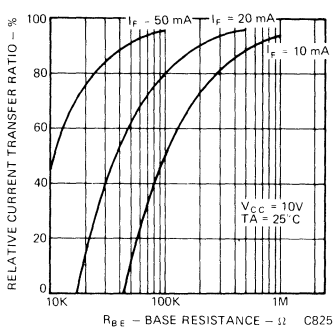


Fig. 9. Sensitivity vs. Base Resistance

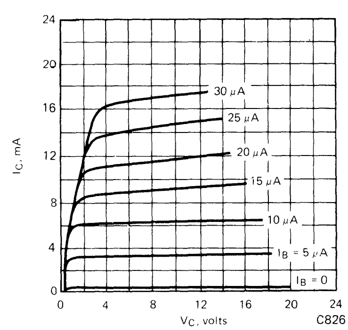


Fig. 10. Detector Typical h_{fe} Curves

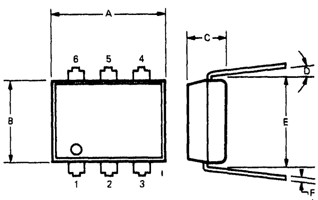
NOTES

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%.

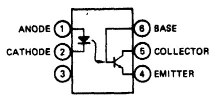
GENERAL INSTRUMENT

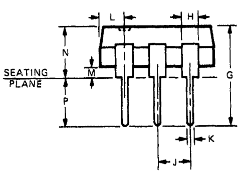
MCT2E

PACKAGE DIMENSIONS



C1339





SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.355	9.02	
B	.270	6.86	
C	130	3.30	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
4. MINIMUM 0 100 INCH

C1339C

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

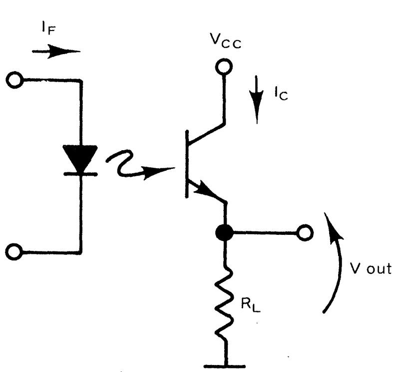
ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature Unless Otherwise Specified)

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)

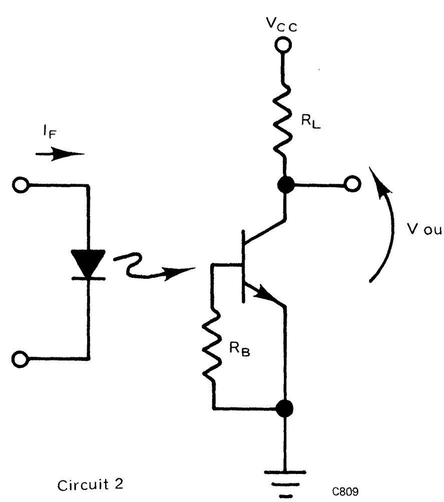
CHARACTERISTIC	SYMBOL	GUAR. MIN.	TYP.	GUAR. MAX.	UNITS	TEST CONDITIONS
Capacitance Collector To Emitter	C_{CEO}		8		pF	V_{CE}=0
Capacitance Collector To Base	C_{CBO}		20		pF	V_{CB}=10 V
Capacitance Emitter To Base	C_{EBO}		10		pF	V_{BE}=0
Coupled DC Collector Current Transfer Ratio	CTR_{CE}	20	60		%	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

C808



Circuit 2

C809

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

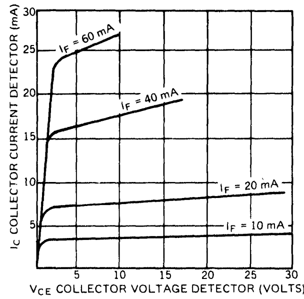


Fig. 1 Collector Current vs. Collector Voltage (for Typical CTR 30%)

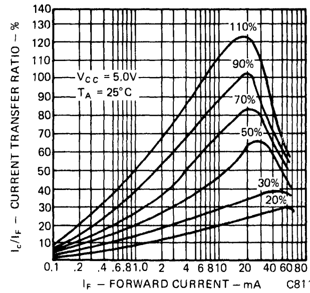


Fig. 2 Current Transfer Ratio vs. Forward Current

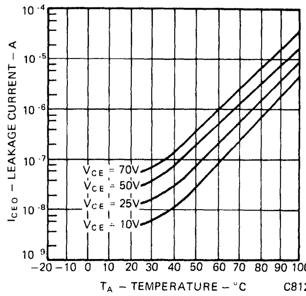


Fig. 3 Dark Current vs. Temperature

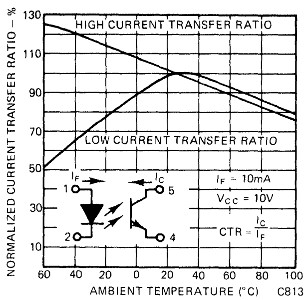


Fig. 4 Current Transfer Ratio vs. Temperature

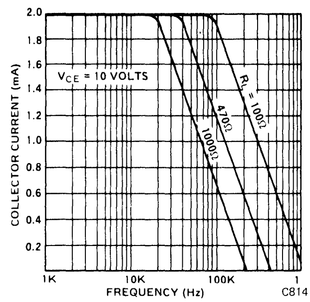


Fig. 5 Collector Current vs. Frequency

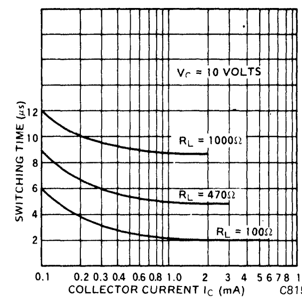


Fig. 6 Switching Time vs. Collector Current

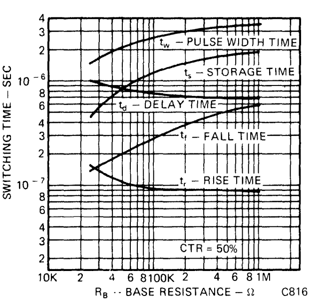


Fig. 7 Switching Time vs. Base Resistance

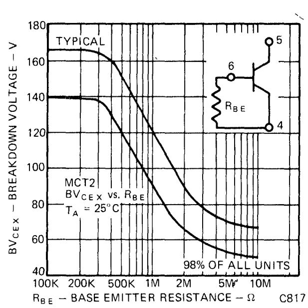


Fig. 8 Collector – Emitter Breakdown Voltage vs. Base Resistance

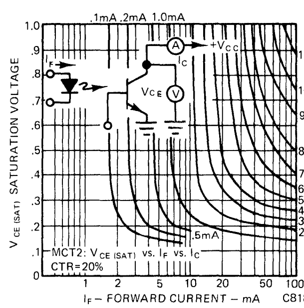


Fig. 9 Saturation Voltage vs. Forward Current

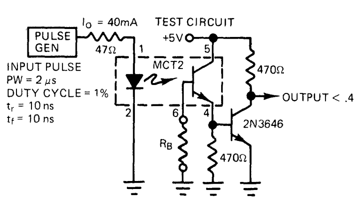


Fig. 10 Circuit for Figure 7

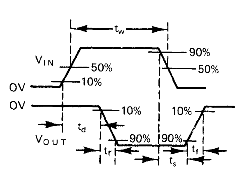


Fig. 11 Waveforms for Figure 7

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25° C Free Air Temperature Unless Otherwise Specified)

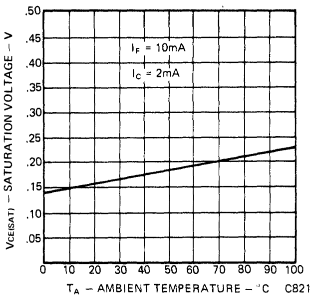


Fig. 12. Saturation Voltage vs. Temperature

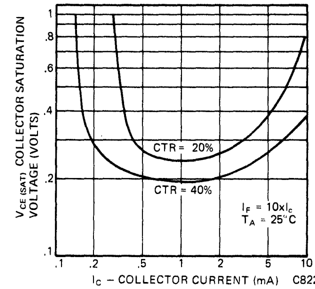


Fig. 13. Saturation Voltage vs. Collector Current

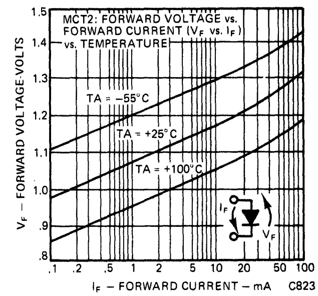


Fig. 14. Forward Voltage vs. Forward Current

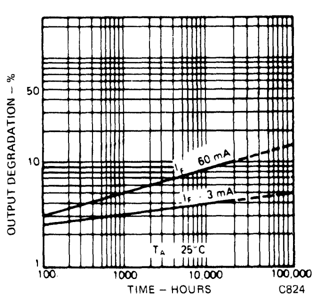


Fig. 15. Lifetime vs. Forward Current (Note 4)

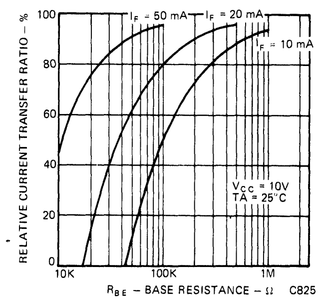


Fig. 16. Sensitivity vs. Base Resistance

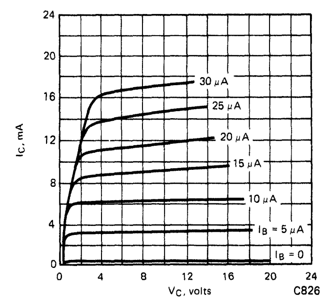
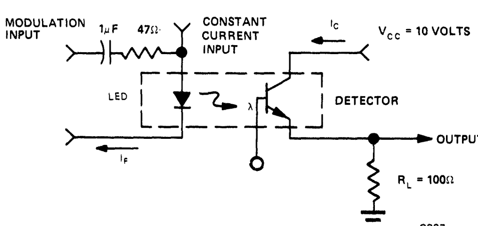
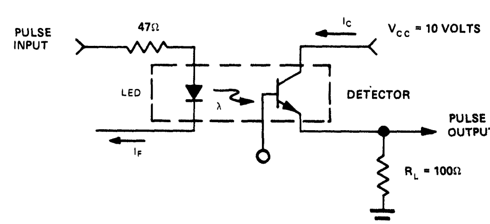


Fig. 17. Detector Typical h_{fe} Curves

OPERATING SCHEMATICS



Modulation Circuit Used to Obtain Output vs Frequency Plot



Circuit Used to Obtain Switching Time vs Collector Current Plot

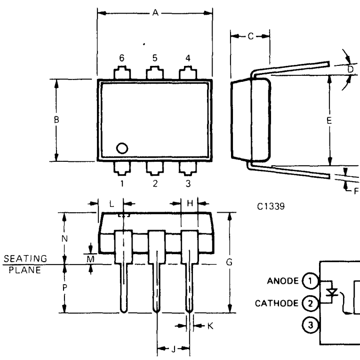
NOTES

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

MCT26

PACKAGE DIMENSIONS

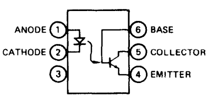


C1339

SYMBOL	INCHES MAX	mm MAX	NOTES
A	355	9 02	
B	270	6 86	
C	130	3 30	
D	15°	15°	
E	300 Ref	7 62 Ref	1
F	014	0 36	
G	325	8 26	
H	070	1 78	
J	110	2 79	
K	022	0 56	
L	085	2 16	2
M			3
N	175	4 45	4
P			5

NOTES
1 INSTALLED POSITION OF LEAD CENTERS
2 FOUR PLACES
3 OVERALL INSTALLED POSITION
4 THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5 MINIMUM 0 100 INCH

C1339C



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
- 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-O}	10^{11}	10^{12}		Ω	V_{E-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-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)

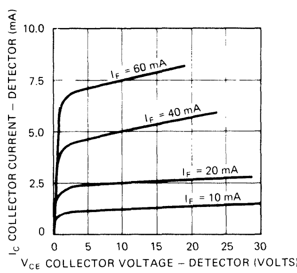


Fig. 1 Detector Output Characteristics

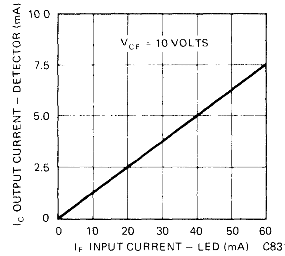


Fig. 2 Input Current vs. Output Current

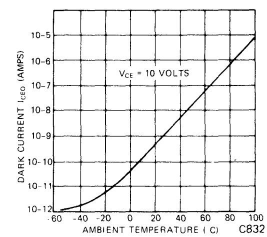


Fig. 3 Dark Current vs. Temperature (°C)

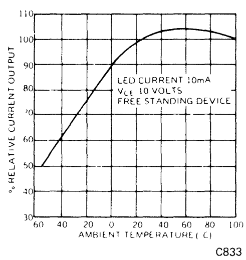


Fig. 4 Current Output vs. Temperature

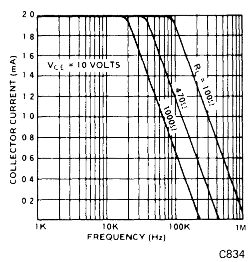


Fig. 5 Output vs. Frequency

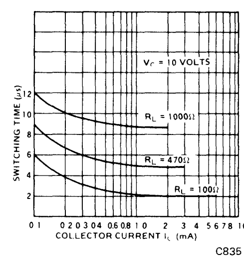
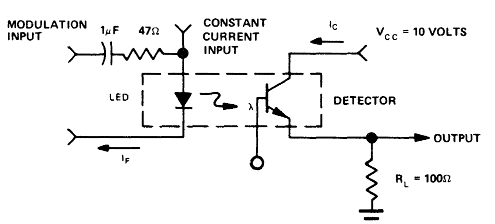


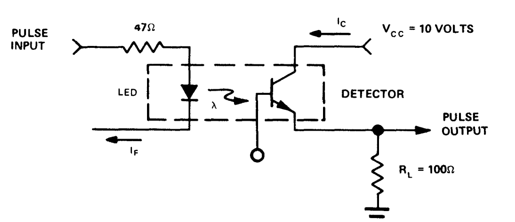
Fig. 6 Switching Time vs. Collector Current

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

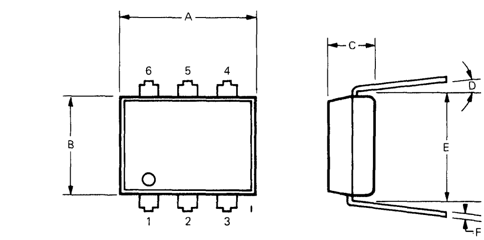
NOTES

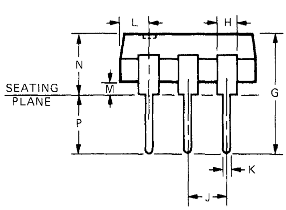
1. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.*
2. *The frequency at which i_C is 3 dB down from the 1 kHz value.*
3. *Rise time (t_r) is the time required for the collector current to increase from 10% of its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

MCT210

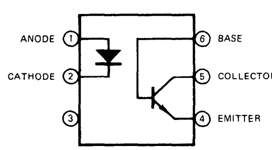
PACKAGE DIMENSIONS





SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.355	9.02	
B	.270	6.86	
C	.130	3.30	
D	15°	15°	
E	.300 Ref.	7 62 Ref	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0 56	
L	085	2 16	2
M			3
N	175	4.45	4
P			5

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0.100 INCH



C1339

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° 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-O} ≤ 10 μA
			3000			VAC-rms	1 second
	Steady state isolation	V_{iso}	3500			VDC	Relative humidity ≤ 50%, T_A = +25°C, I_{I-O} ≤ 10 μA
			2500			VAC-rms	1 minute
	Isolation resistance	R_{iso}	10^{11}	5×10^{12}		ohms	V_{I-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 specified)

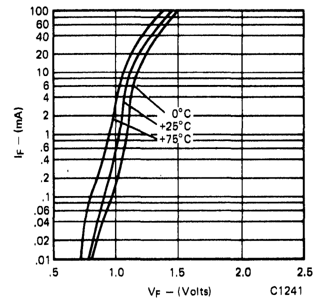


Fig. 1. Forward Voltage vs. Forward Current

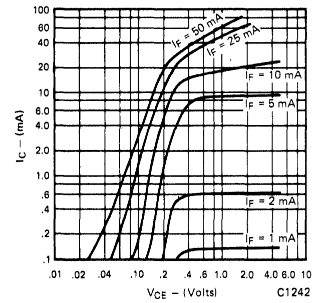


Fig. 2. Collector Current vs. Collector to Emitter Voltage

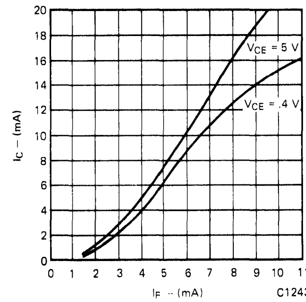


Fig. 3. Collector Current vs. Forward Current

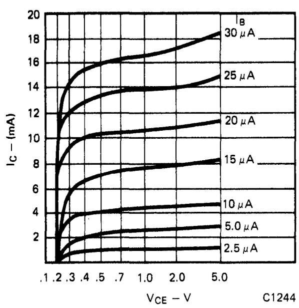


Fig. 4. Collector Current vs. Collector to Emitter Voltage

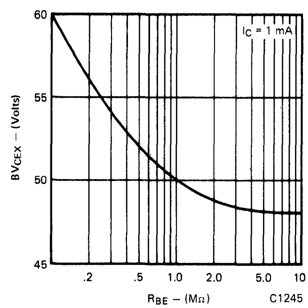


Fig. 5. Collector to Emitter Breakdown Voltage vs. Base to Emitter Resistance

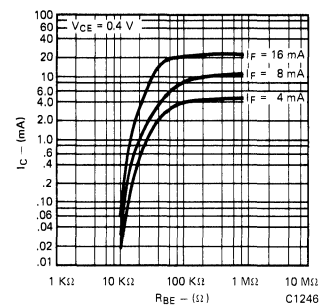


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

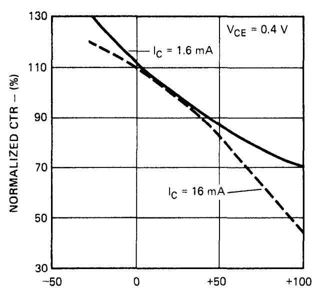


Fig. 7. Current Transfer Ratio (saturated) vs. Temperature

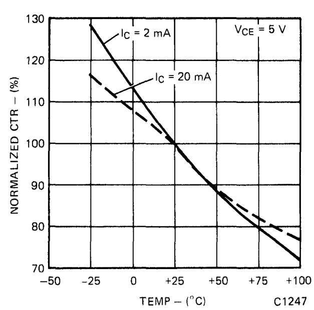


Fig. 8. Current Transfer Ratio (unsaturated) vs. Temperature

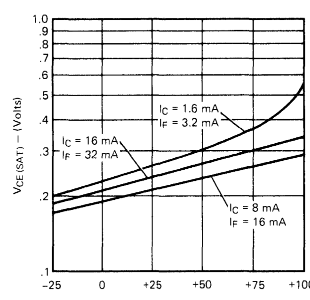


Fig. 9. Collector to Emitter Saturation Voltage vs. Temperature

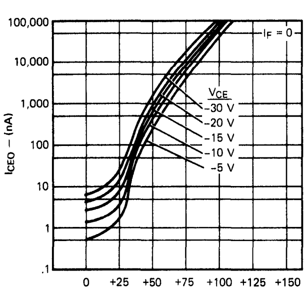


Fig. 10. Collector to Emitter Leakage Current vs. Temperature

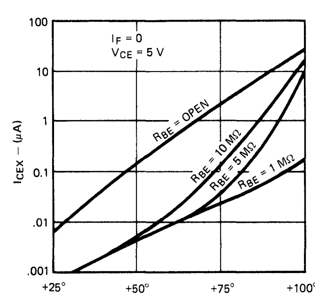


Fig. 11. Collector to Emitter Leakage Current vs. Temperature

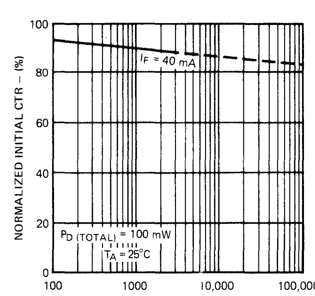


Fig. 12. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

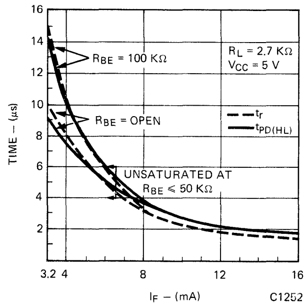


Fig. 13. Switch-on Time vs. I_F Drive (saturated)

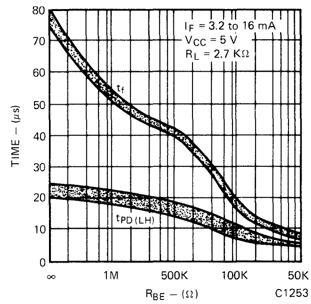


Fig. 14. Switch-off Time vs. Base to Emitter Resistance (saturated)

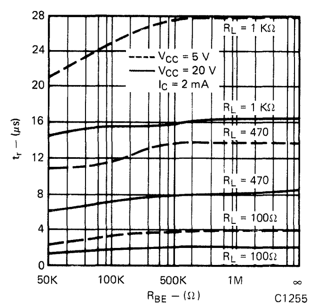


Fig. 15. Rise Time vs. Base to Emitter Resistance (non-saturated)

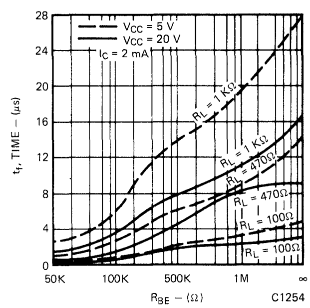


Fig. 16. Fall Time vs. Base to Emitter Resistance (non-saturated)

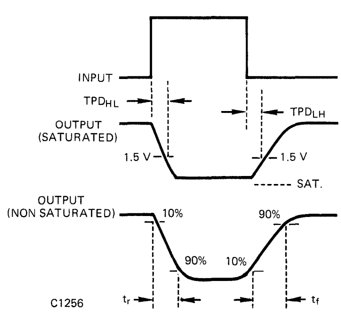


Fig. 17. Switching Time Waveforms

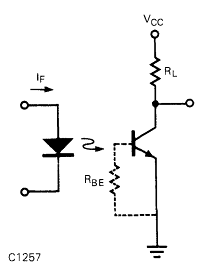


Fig. 18. Switching Time Test Circuits

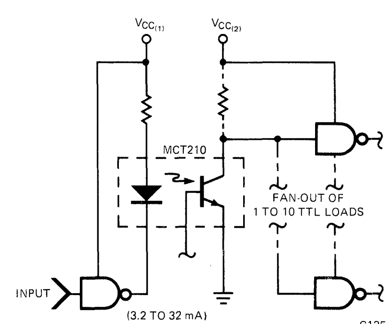
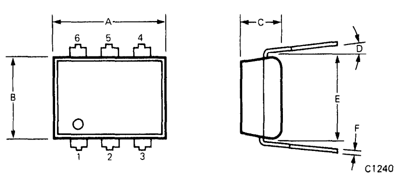


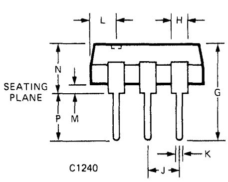
Fig. 19. Typical TTL Interface at Operating Temperatures of 0° to 70° C

GENERAL INSTRUMENT

MCT270

PACKAGE DIMENSIONS





SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.355	9.02	
B	.270	6.86	
C	.130	3.30	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0.100 INCH

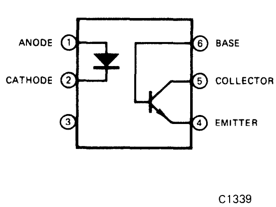


Fig. 1 Equivalent Circuit

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 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 Ω; 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} ≤ 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 = 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}	100	500			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
	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

TYPICAL ELECTRICAL CHARACTERISTIC CURVES (25°C Free air temperature unless specified)

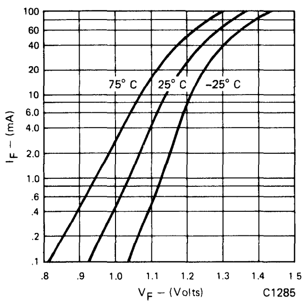


Fig. 1. Forward Voltage vs. Forward Current

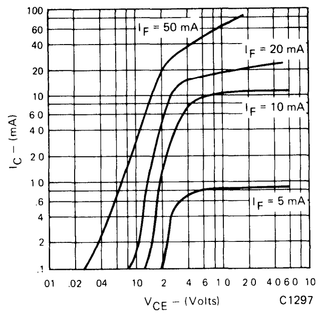


Fig. 2. Collector Current vs. Collector to Emitter Voltage

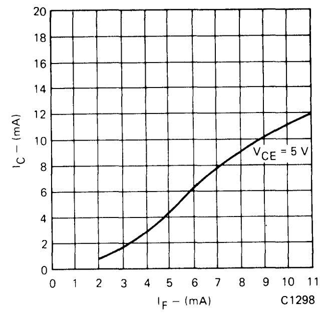


Fig. 3. Collector Current vs. Forward Current

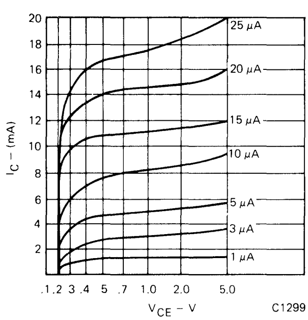


Fig. 4. Collector Current vs. Collector to Emitter Voltage

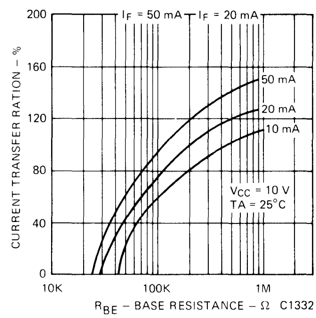


Fig. 5. Sensitivity vs. Base Resistance

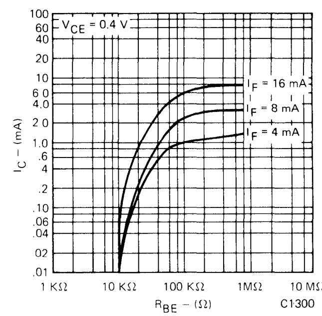


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

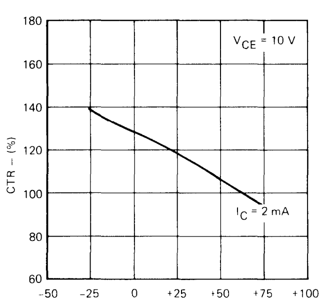


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

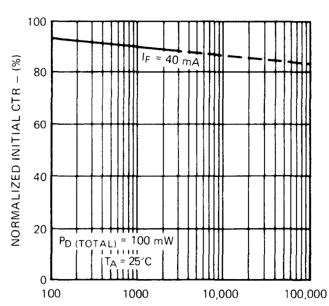


Fig. 8. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

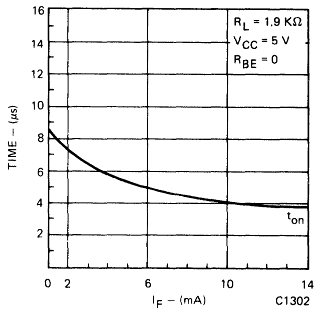


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

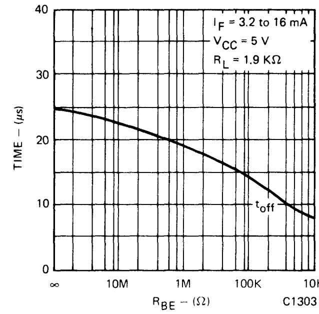


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

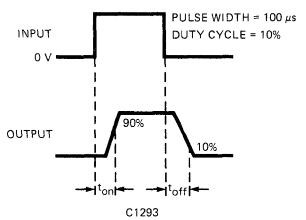


Fig. 11.

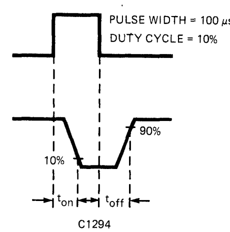


Fig. 12.

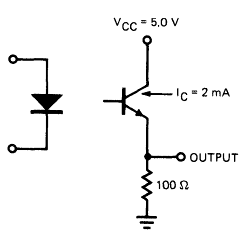


Fig. 13.

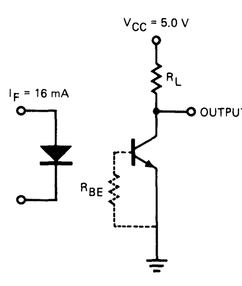
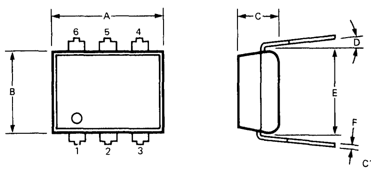


Fig. 14.

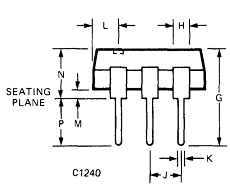
GENERAL INSTRUMENT

MCT271

PACKAGE DIMENSIONS



C1240

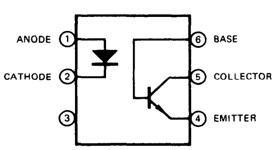


C1240

SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.355	9.02	
B	.270	6.86	
C	130	3.30	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0.100 INCH

C1339C



C1339

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%, $I_{I-O} \leq 10\ \mu A$
			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	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 specified)

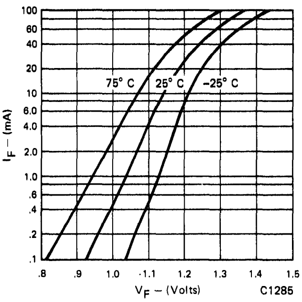


Fig. 1. Forward Voltage vs. Forward Current

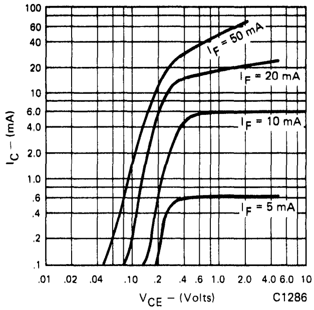


Fig. 2. Collector Current vs. Collector to Emitter Voltage

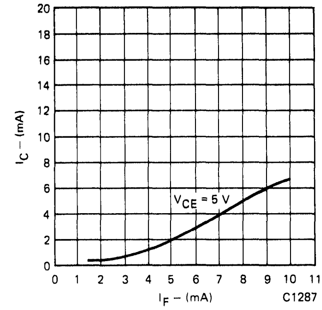


Fig. 3. Collector Current vs. Forward Current

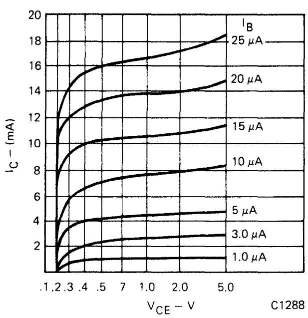


Fig. 4. Collector Current vs. Collector to Emitter Voltage

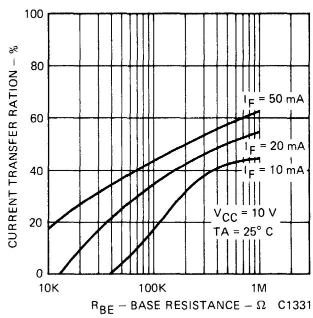


Fig. 5. Sensitivity vs. Base Resistance

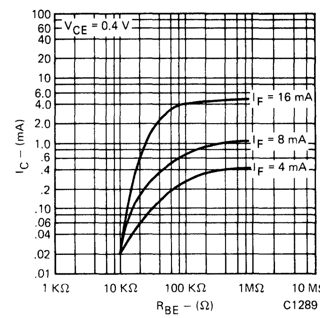


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

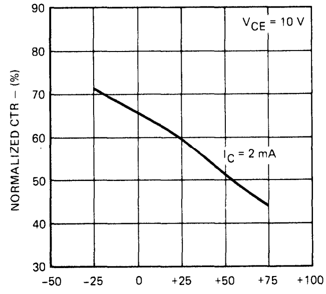


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

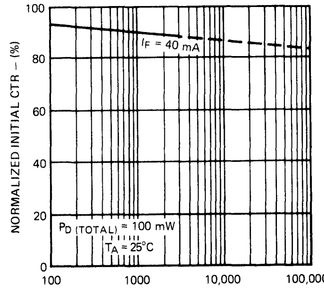


Fig. 8. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

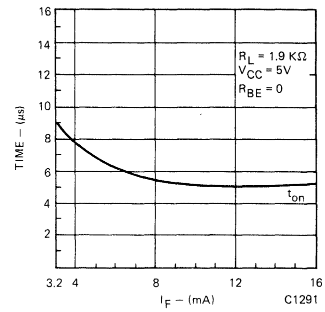


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

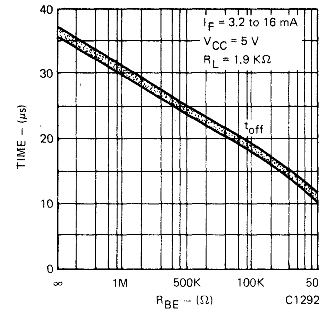


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

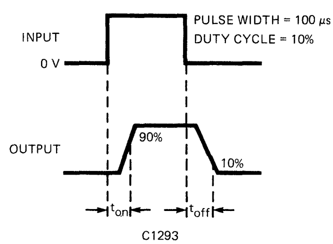


Fig. 11.

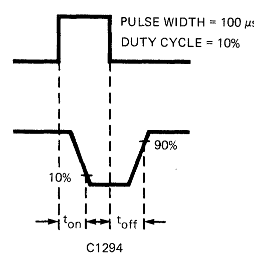


Fig. 12.

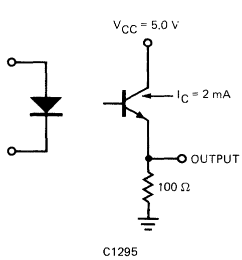


Fig. 13.

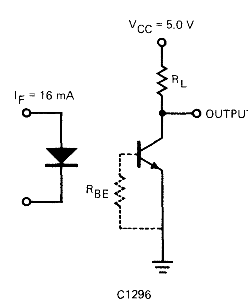
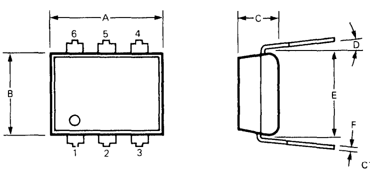


Fig. 14.

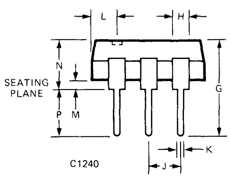
GENERAL INSTRUMENT

MCT272

PACKAGE DIMENSIONS



C1240

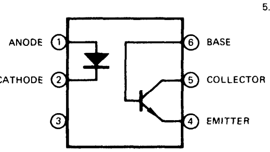


C1240

SYMBOL	INCHES MAX	mm MAX	NOTES
A	355	9.02	
B	.270	6.86	
C	130	3.30	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	325	8.26	
H	.070	1.78	
J	.110	2.79	
K	022	0 56	
L	085	2 16	2
M			3
N	175	4 45	4
P			5

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2 FOUR PLACES
3. OVERALL INSTALLED POSITION
4 THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0.100 INCH

C1339C



C1339

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; $R_L = 1.9\ K\Omega$
	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; $R_L = 4.7\ K\Omega$
	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 specified)

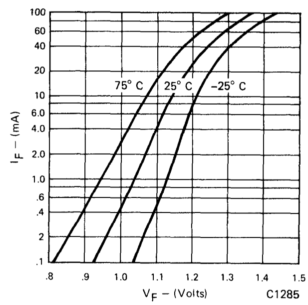


Fig. 1. Forward Voltage vs. Forward Current

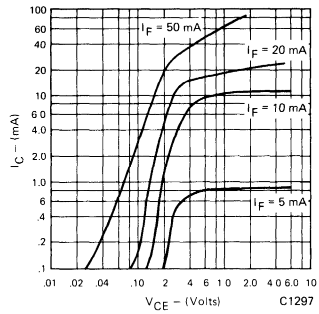


Fig. 2. Collector Current vs. Collector to Emitter Voltage

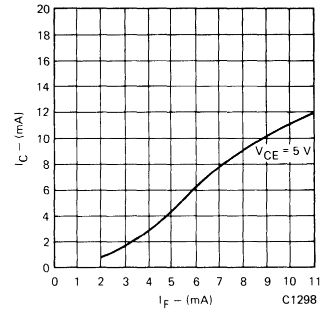


Fig. 3. Collector Current vs. Forward Current

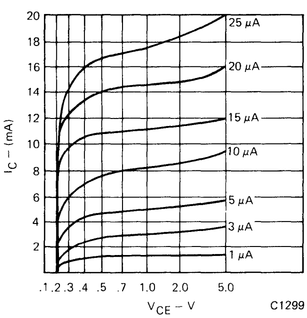


Fig. 4. Collector Current vs. Collector to Emitter Voltage

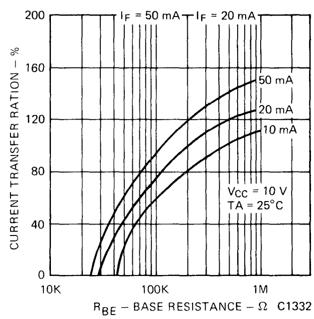


Fig. 5. Sensitivity vs. Base Resistance

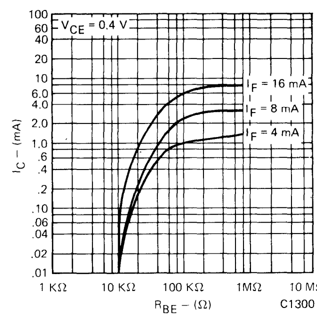


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

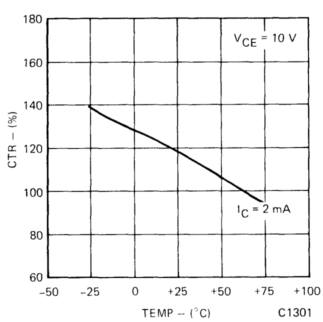


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

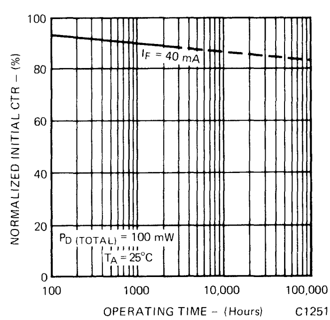


Fig. 8. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

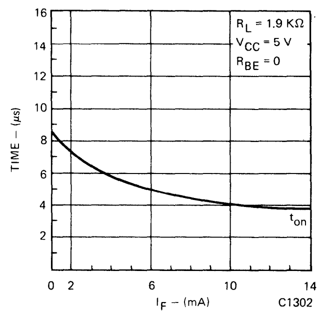


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

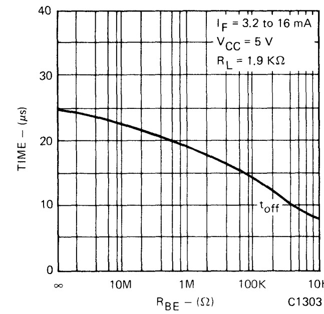


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

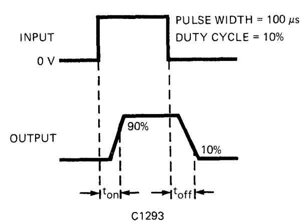


Fig. 11.

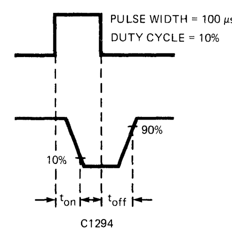


Fig. 12.

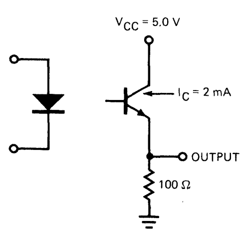


Fig. 13.

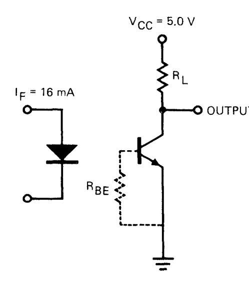


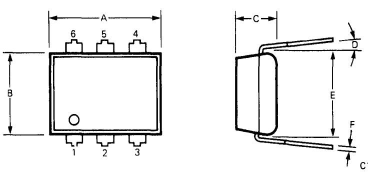
Fig. 14.

GENERAL INSTRUMENT

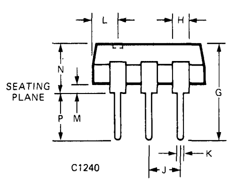
Optoisolators

MCT273

PACKAGE DIMENSIONS



C1240

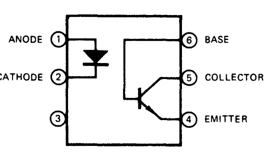


C1240

SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.355	9.02	
B	.270	6.86	
C	.130	3.30	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
4. MINIMUM 0.100 INCH

C1339C



C1339

DESCRIPTION

The MCT273 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 – 125% to 250% (specified conditions)
- Maximum Turn-on time – 20 μseconds (specified condition)
- Maximum Turn-off time – 20 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

- Microprocessor board, reversible input/output
- Sensors to logic
- Logic to controls
- Appliance controls
- Industrial process control 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}	125	200	250	%	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	$V_{CE(SAT)}$		0.20	.40	V	I_F = 16 mA; I_C = 2 mA
SWITCHING TIMES	Non-saturated						
	Turn-on time	t_{on}		7.6	20	μs	R_L = 100 Ω; I_C = 2 mA; V_{CC} = 5 V
	Turn-off time	t_{off}		6.6	20	μs	See figures 11, 13
	Saturated						
	Turn-on time	t_{on}		3.6		μs	I_F = 16 mA; R_L = 1.9 KΩ
	Turn-off time	t_{off}		75		μs	See figures 12, 14
	(Approximates a typical TTL interface)						
	Turn-on time	t_{on}		3.6		μs	I_F = 16 mA; R_L = 4.7 KΩ
	Turn-off time	t_{off}		155		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	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		1.20	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}		280			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 specified)

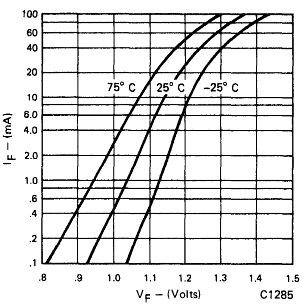


Fig. 1. Forward Voltage vs. Forward Current

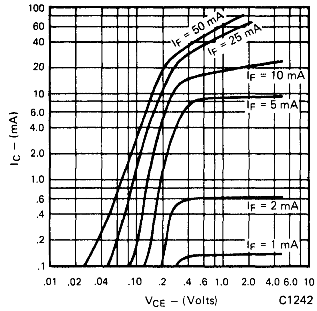


Fig. 2. Collector Current vs. Collector to Emitter Voltage

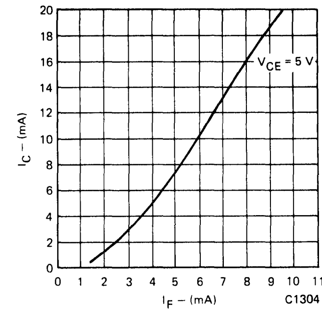


Fig. 3. Collector Current vs. Forward Current

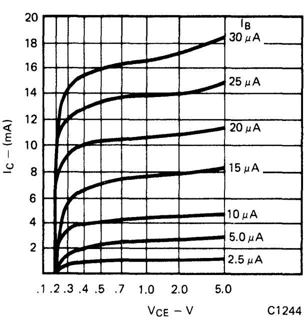


Fig. 4. Collector Current vs. Collector to Emitter Voltage

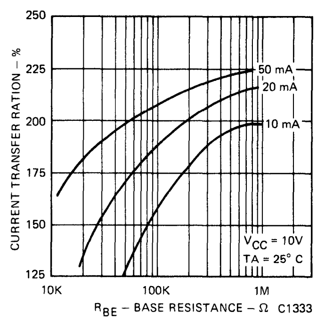


Fig. 5. Sensitivity vs. Base Resistance

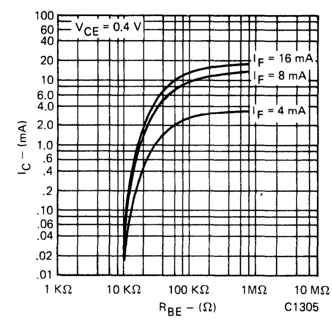


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

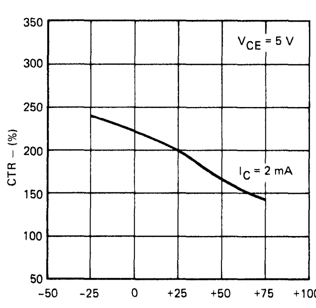


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

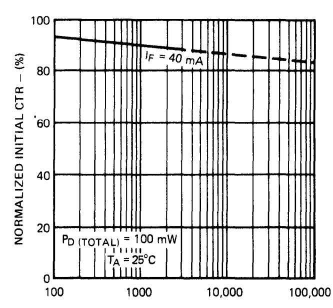


Fig. 8. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

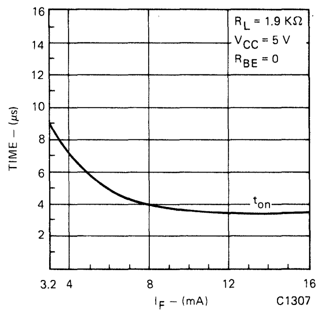


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

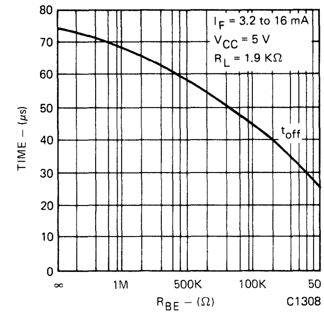


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

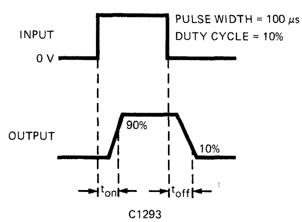


Fig. 11.

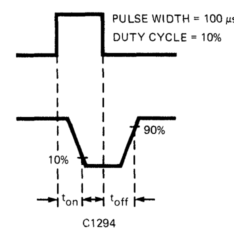


Fig. 12.

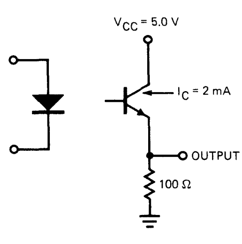


Fig. 13.

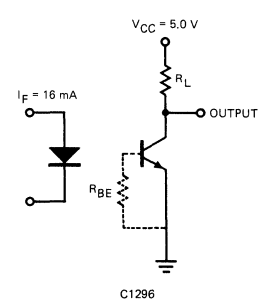
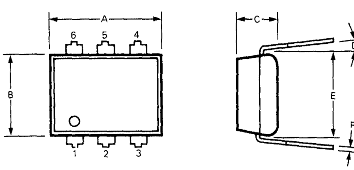


Fig. 14.

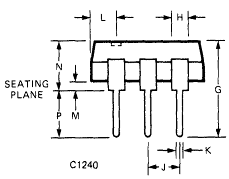
GENERAL INSTRUMENT

MCT274

PACKAGE DIMENSIONS



C1240

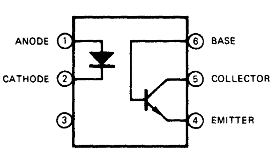


C1240

SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.355	9.02	
B	.270	6.86	
C	.130	3.30	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
4. MINIMUM 0.100 INCH

C1339C



C1339

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	$R_L = 100\ \Omega$; $I_C = 2$ 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%, $I_{I-O} \leq 10\ \mu A$
			3000			VAC-rms	t = 1 second
	Steady state isolation	V_{iso}	3500			VDC	Relative humidity ≤ 50%, $I_{I-O} \leq 10\ \mu A$
			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	$I_R = 10\ \mu A$
	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}		360			$V_{CE} = 5$ 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 specified)

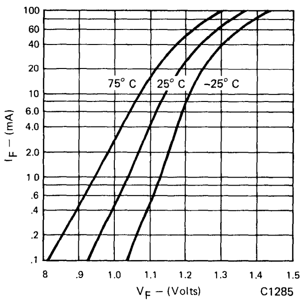


Fig. 1. Forward Voltage vs. Forward Current

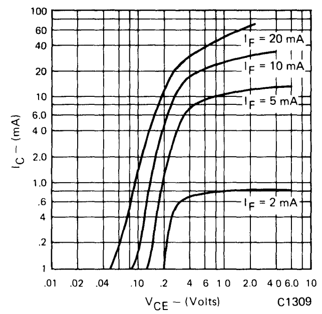


Fig. 2. Collector Current vs. Collector to Emitter Voltage

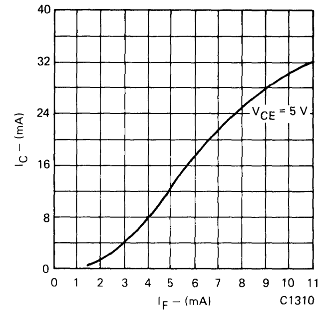


Fig. 3. Collector Current vs. Forward Current

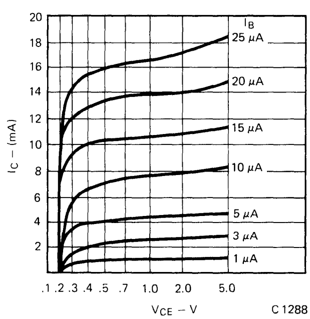


Fig. 4. Collector Current vs. Collector to Emitter Voltage

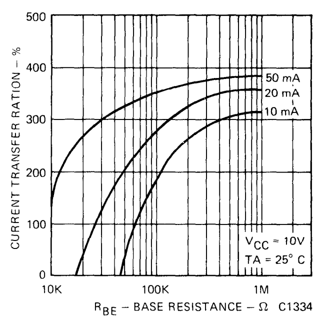


Fig. 5. Sensitivity vs. Base Resistance

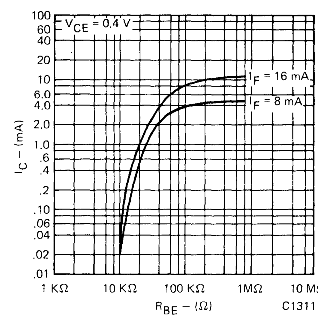


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

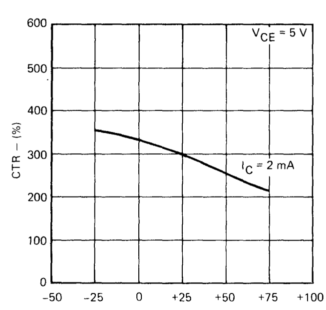


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

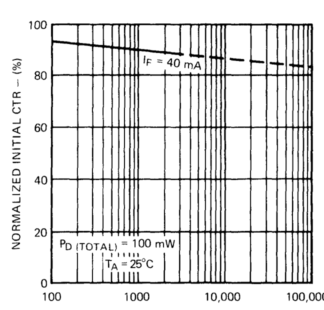


Fig. 8. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

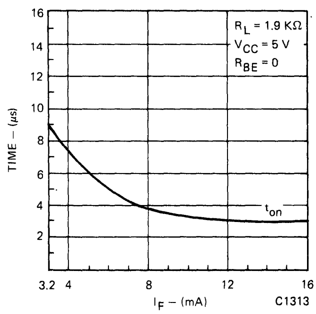


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

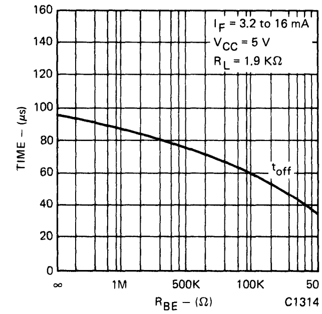


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

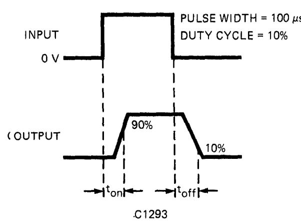


Fig. 11.

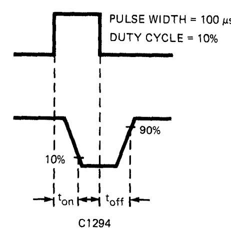


Fig. 12.

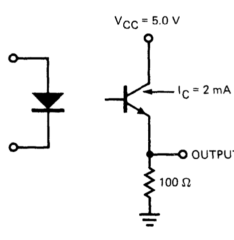


Fig. 13.

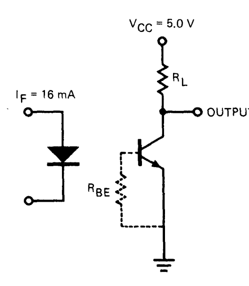
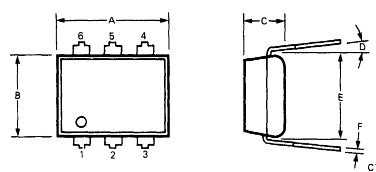


Fig. 14.

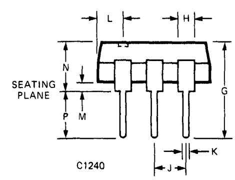
GENERAL INSTRUMENT

MCT275

PACKAGE DIMENSIONS



C1240

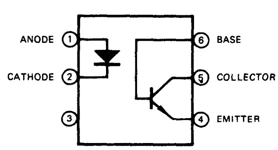


C1240

SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.355	9.02	
B	.270	6.86	
C	.130	3.30	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
4. MINIMUM 0.100 INCH

C1339C



C1339

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%, $I_{I-O} \leq 10\ \mu A$
			3000			VAC-rms	t = 1 second
	Steady state isolation	V_{iso}	3500			VDC	Relative humidity ≤ 50%, $I_{I-O} \leq 10\ \mu A$
			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	$I_R = 10\ \mu A$
	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}		170			$V_{CE} = 5$ V, $I_C = 100\ \mu A$
	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	$I_C = 10\ \mu A$
	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 specified)

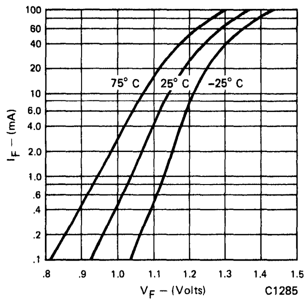


Fig. 1. Forward Voltage vs. Forward Current

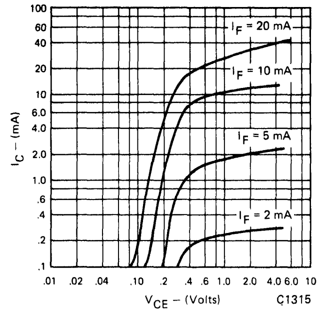


Fig. 2. Collector Current vs. Collector to Emitter Voltage

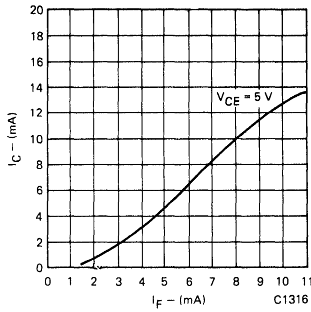


Fig. 3. Collector Current vs. Forward Current

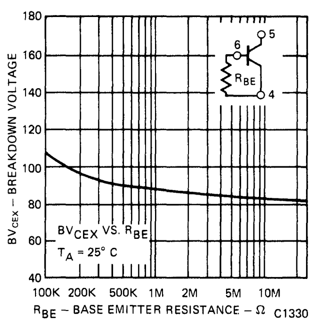


Fig. 4. Collector-Emitter Breakdown Voltage vs. Base Resistance

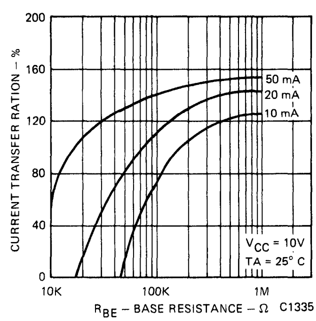


Fig. 5. Sensitivity vs. Base Resistance

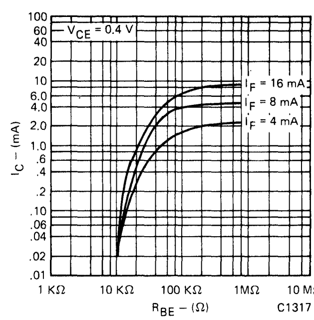


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

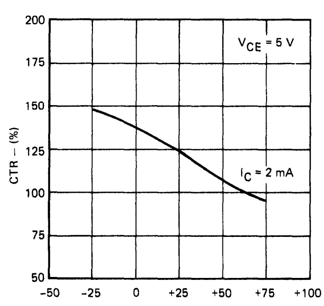


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

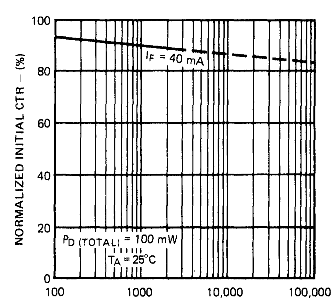


Fig. 8. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

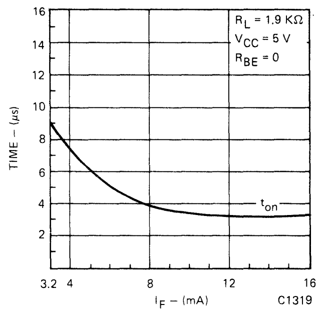


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

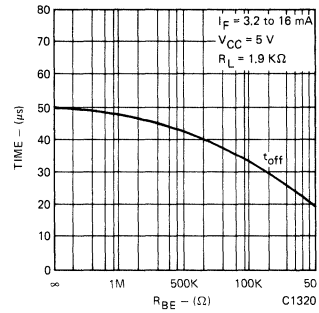


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

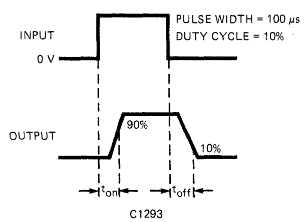


Fig. 11.

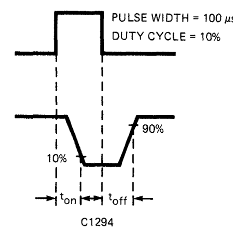


Fig. 12.

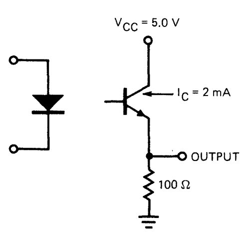


Fig. 13.

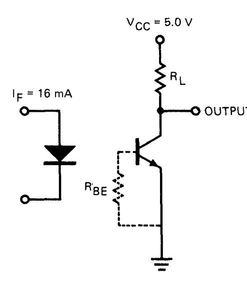
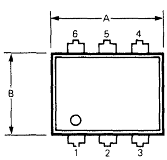


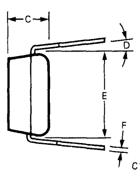
Fig. 14.

GENERAL INSTRUMENT

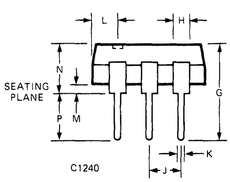
MCT276

PACKAGE DIMENSIONS





C1240

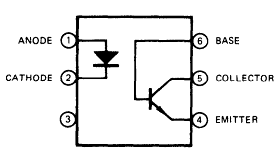


C1240

SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.355	9.02	
B	270	6.86	
C	130	3.30	
D	15°	15°	
E	.300 Ref.	7 62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	085	2.16	2
M			3
N	.175	4.45	4
P			5

NOTES
1 INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
4. MINIMUM 0.100 INCH

C1339C



C1339

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 specified)

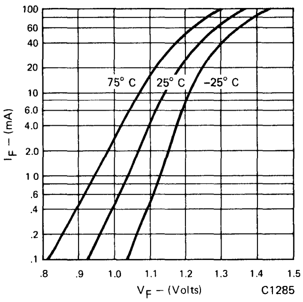


Fig. 1. Forward Voltage vs. Forward Current

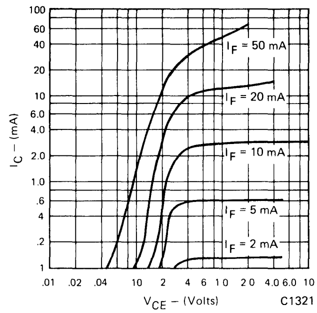


Fig. 2. Collector Current vs. Collector to Emitter Voltage

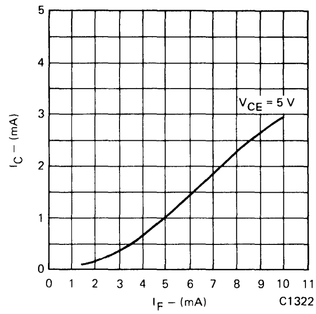


Fig. 3. Collector Current vs. Forward Current

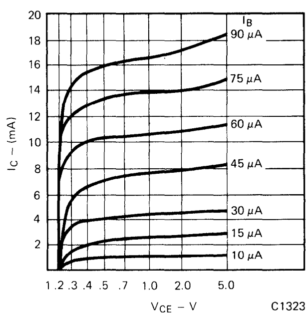


Fig. 4. Collector Current vs. Collector to Emitter Voltage

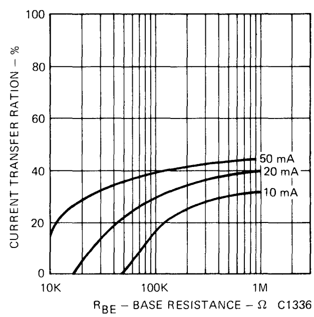


Fig. 5. Sensitivity vs. Base Resistance

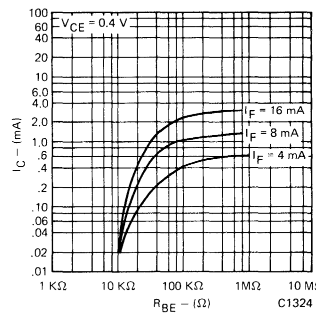


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

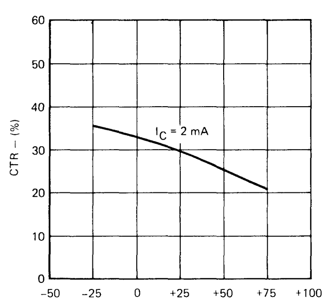


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

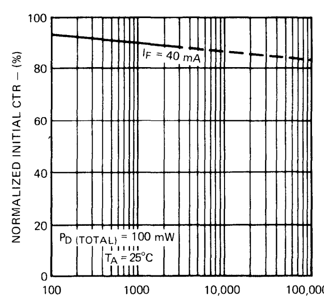


Fig. 8. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

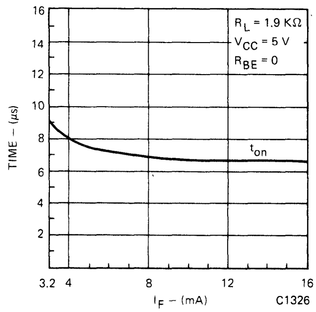


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

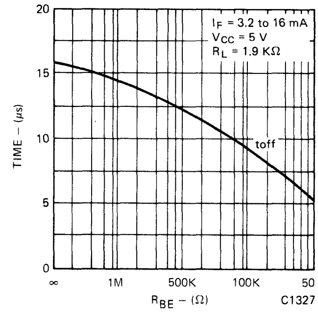


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

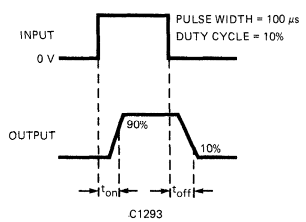


Fig. 11.

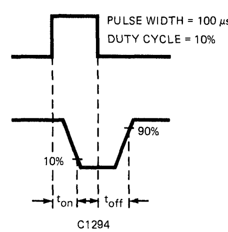


Fig. 12.

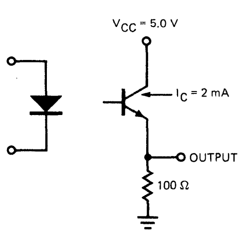


Fig. 13.

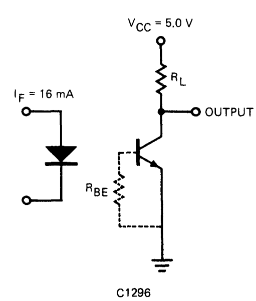
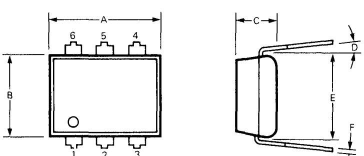


Fig. 14.

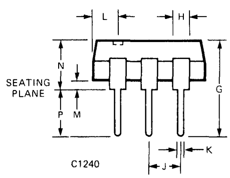
GENERAL INSTRUMENT

MCT277

PACKAGE DIMENSIONS



C1240

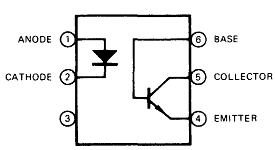


C1240

SYMBOL	INCHES MAX.	mm MAX	NOTES
A	355	9 02	
B	.270	6 86	
C	130	3 30	
D	15°	15°	
E	.300 Ref	7 62 Ref.	1
F	014	0 36	
G	325	8.26	
H	070	1 78	
J	110	2.79	
K	022	0 56	
L	085	2.16	2
M			3
N	.175	4 45	4
P			5

NOTES
1 INSTALLED POSITION OF LEAD CENTERS
2 FOUR PLACES
3 THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
4 MINIMUM 0 100 INCH

C1339C



C1339

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	$R_L = 100\ \Omega$; $I_C = 2$ 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; $R_L = 1.9\ K\Omega$
	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; $R_L = 4.7\ K\Omega$
	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%, $I_{I-O} \leq 10\ \mu A$
			3000			VAC-rms	t = 1 second
	Steady state isolation	V_{iso}	3500			VDC	Relative humidity ≤ 50%, $I_{I-O} \leq 10\ \mu A$
			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	$I_R = 10\ \mu A$
	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}		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 specified)

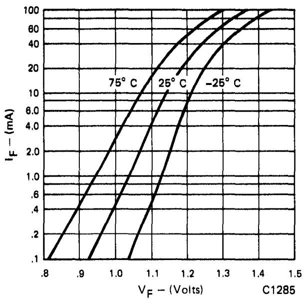


Fig. 1. Forward Voltage vs. Forward Current

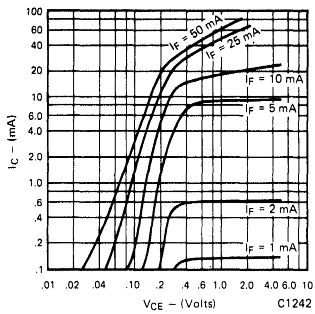


Fig. 2. Collector Current vs. Collector to Emitter Voltage

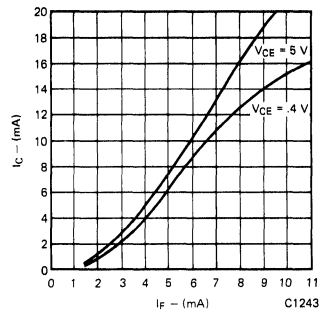


Fig. 3. Collector Current vs. Forward Current

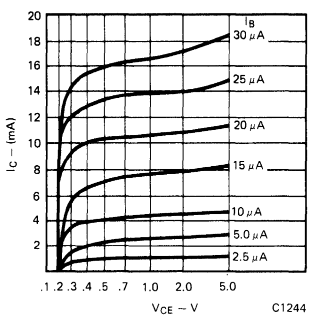


Fig. 4. Collector Current vs. Collector to Emitter Voltage

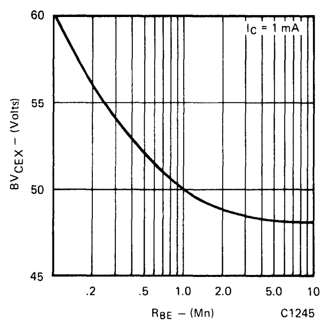


Fig. 5. Collector to Emitter Breakdown Voltage vs. Base to Emitter Resistance

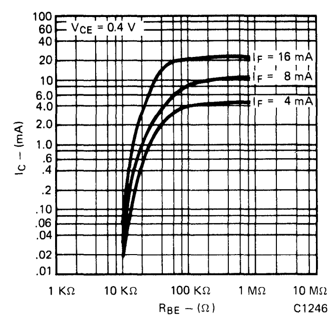


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

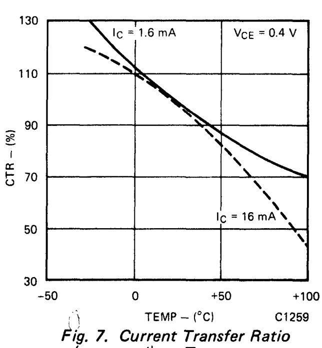


Fig. 7. Current Transfer Ratio (saturated) vs. Temperature

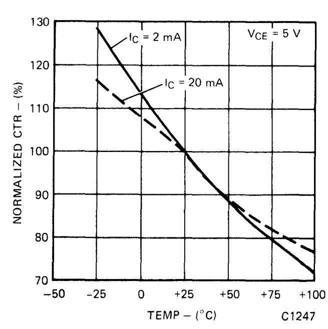


Fig. 8. Current Transfer Ratio (unsaturated) vs. Temperature

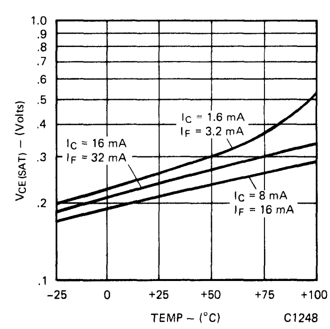


Fig. 9. Collector to Emitter Saturation Voltage vs. Temperature

TYPICAL ELECTRICAL CHARACTERISTIC CURVES (25°C Free air temperature unless specified)

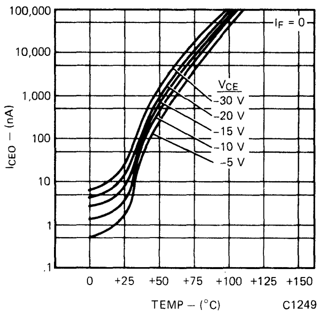


Fig. 10. Collector to Emitter Leakage Current vs. Temperature

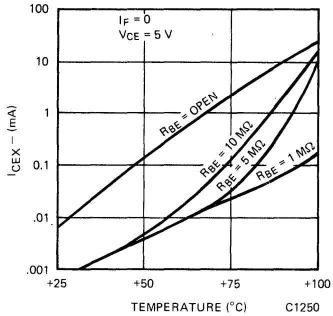


Fig. 11. Collector to Emitter Leakage Current vs. Temperature

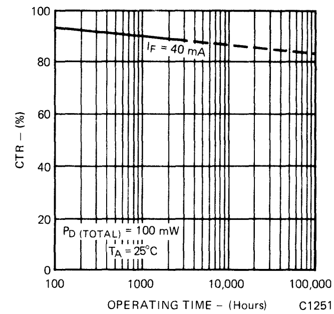


Fig. 12. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

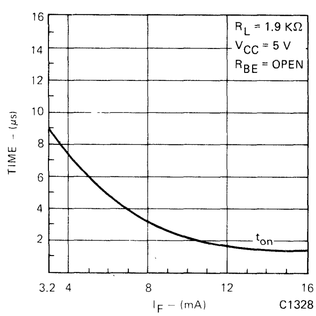


Fig. 13. Switch-on Time vs. I_F Drive (saturated)

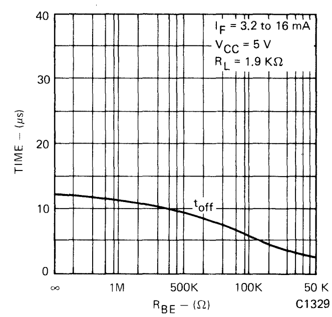


Fig. 14. Switch-off Time vs. Base to Emitter Resistance (saturated)

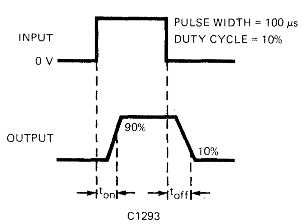


Fig. 15.

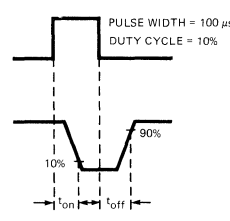


Fig. 16.

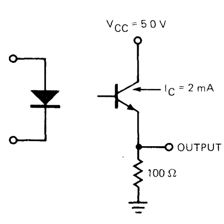


Fig. 17.

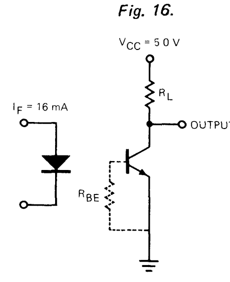
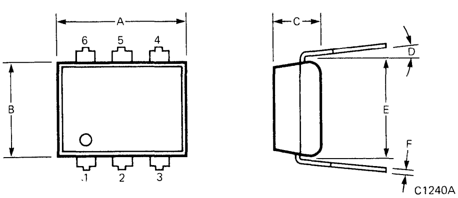


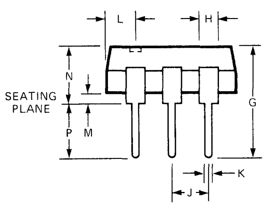
Fig. 18.

GENERAL INSTRUMENT

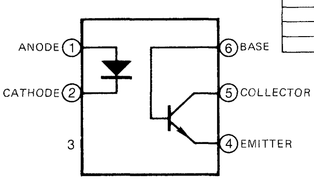
TTL/LSTTL COMPATIBLE PHOTOTRANSISTOR OPTOISOLATOR MCT5200 MCT5201

PACKAGE DIMENSIONS





SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	355	9.02	
B	.270	6.86	
C	.160	4.06	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5



NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0.100 INCH

C1109 A

DESCRIPTION

The MCT520X are high performance logic compatible phototransistor type optically coupled isolator products. They are constructed using a very 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 7500 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 100% for an input current of 10 mA.

FEATURES

- High CRT_{CE} (Sat)
  MCT5200 100% Min. at I_F = 10 mA
  MCT5201 120% Min. at I_F = 5 mA
- Guaranteed switching speed with LSTTL load
- Performance guaranteed over 0° C to 70° C temperature range
- High withstand test voltage
  5300 VAC RMS—5 seconds
  7500 VAC Peak—5 seconds
- High common mode rejection
- Data rates up to 150 Kbit/s
- 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 (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
(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	100	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	
			100	175			I_F = 10 mA, V_{CE} = 0.4 V		
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 emitter)	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		
			0.4	0.7			I_F = 10 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} = 10 mA		
		MCT-5201		0.2	0.4		I_F = 5 mA, I_{CE} = 6 mA		

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.*

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	MCT5200 & MCT5201		5000		v/μs	V_{CM} = 50 V_{p-p}, R_L = 1 KΩ, I_F = 5 mA	17	
Common mode coupling capacitor	C_{cm}	MCT5200 & MCT5201		0.2		pF			
Package capacitance input/output	C_{I-O}	MCT5200 & MCT5201		0.7		pF	V_{I-O} = 0, f = 1 MHz		
Withstand insulation test voltage	V_{ISO}	MCT5200 & MCT5201	5300			$V_{AC(RMS)}$	Relative humidity ≤ 50%		
	V_{ISO}	MCT5200 & MCT5201	7500			$V_{AC(Peak)}$	I_{I-O} ≤ 10 μA, 5 seconds		
Insulation resistance	R_{ISO}	MCT5200 & MCT5201	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	
INPUT DIODE	Forward voltage coefficient	$\Delta V_F/\Delta T_A$	MCT5200 & MCT5201		-1.9		mV/° C	I_F = 2 mA	1	
INPUT DIODE	Reverse voltage	V_R	MCT5200 & MCT5201	6			V	I_R = 10 μA		
INPUT DIODE	Junction capacitance	C_J	MCT5200 & MCT5201		18		pF	V_F = 0 V, f = 1 MHz		
INPUT DIODE					112		pF	V_F = 1 V, f = 1 MHz		
OUTPUT TRANSISTOR	DC forward current gain	h_{FE}	MCT5200		450	1000	—	V_{CE} = 5 V, I_{CE} = 2 mA	8, 9	
OUTPUT TRANSISTOR		$h_{FE(SAT)}$	MCT5200	250	400		—	V_{CE} = 0.4 V, I_{CE} = 6 mA	8, 9	
OUTPUT TRANSISTOR		h_{FE}	MCT5201		550	1000	—	V_{CE} = 5 V, I_{CE} = 2 mA	8, 9	
OUTPUT TRANSISTOR		$h_{FE(SAT)}$	MCT5201	400	450		—	V_{CE} = 0.4 V, I_{CE} = 6 mA	8, 9	
OUTPUT TRANSISTOR	Breakdown voltage									
OUTPUT TRANSISTOR	Collector to emitter	BV_{CEO}	MCT5200 & MCT5201	30	45		V	I_C = 1.0 mA, I_F = 0		
OUTPUT TRANSISTOR	Collector to base	BV_{CBO}	MCT5200 & MCT5201	30	70		V	I_C = 10 μA		
OUTPUT TRANSISTOR	Emitter to base	BV_{EBO}	MCT5200 & MCT5201	5	7		V	I_E = 10 μA		
OUTPUT TRANSISTOR	Leakage									
OUTPUT TRANSISTOR	Collector to emitter	I_{CER}	MCT5200 & MCT5201		5	100	nA	V_{CE} = 10 V, I_F = 0, R_{BE} = 1 MΩ	11	
OUTPUT TRANSISTOR	Capacitance									
OUTPUT TRANSISTOR	Collector to emitter				8		pF	V_{CE} = 0, f = 1 MHz	12	
OUTPUT TRANSISTOR	Collector to base				20		pF	V_{CB} = 5, f = 1 MHz	12	
OUTPUT TRANSISTOR	Emitter to base				7		pF	V_{EB} = 0, f = 1 MHz	12	

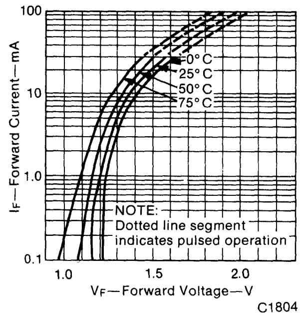


Fig. 1. Forward Voltage vs. Forward Current

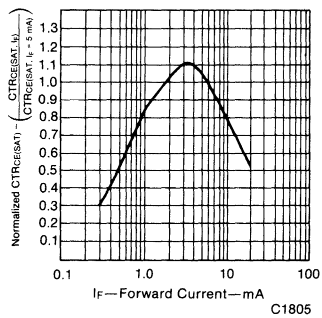


Fig. 2. Normalized Current Transfer Ratio vs. Forward Current

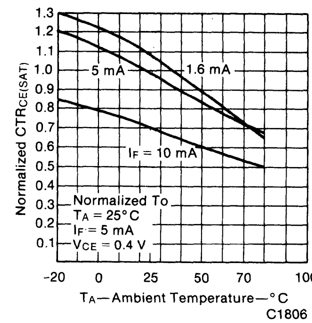


Fig. 3. Normalized CTR vs. Temperature

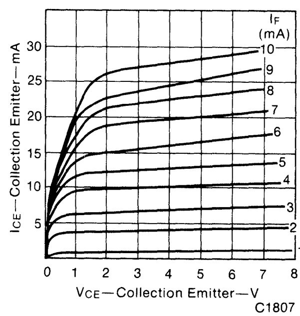


Fig. 4. MCT5200 Collector Current vs. Collector to Emitter Voltage

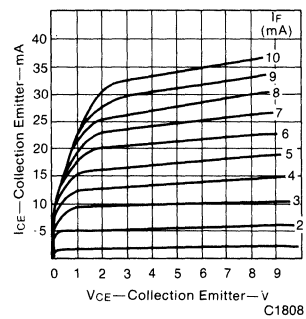


Fig. 5. MCT 5201 Collector Current vs. Collector to Emitter Voltage

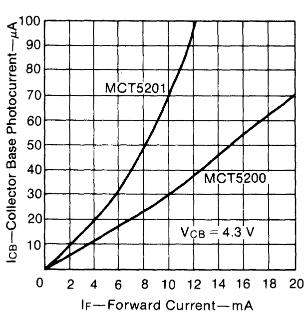


Fig. 6. Collector Base Photocurrent vs. Forward Current

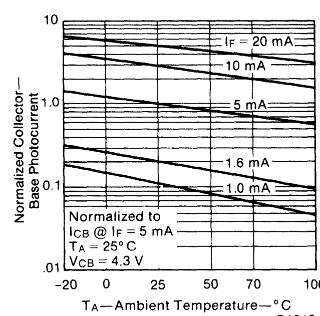


Fig. 7 Normalized Collector Base Photocurrent vs. Ambient Temperature

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

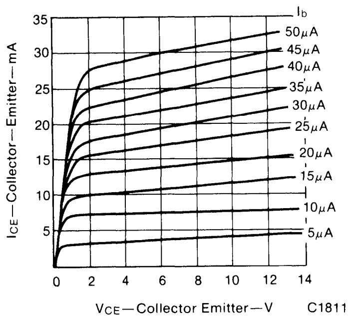


Fig. 8. Collector Current vs. Collector to Emitter Voltage

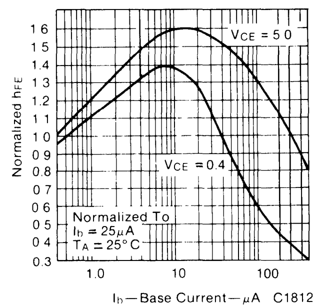


Fig. 9 Normalizec h_{FE} vs. Base Current

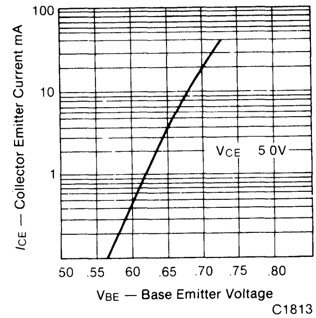


Fig. 10. Collector Current (I_{CE}) vs. Base Emitter Voltage (V_{BE})

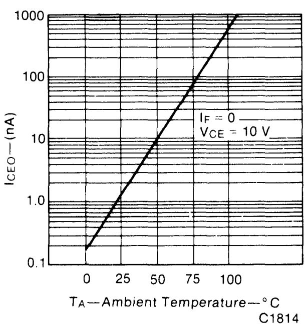


Fig. 11. Collector to Emitter Leakage Current vs. Temperature

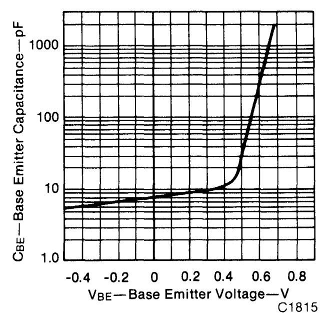


Fig. 12. Base Emitter Capacitance vs. Base Emitter Voltage

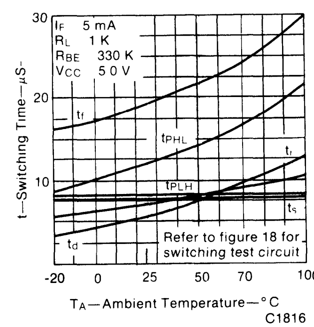


Fig. 13. Switching Time vs. Temperature
I_F=5 mA R_{BE}=330 K

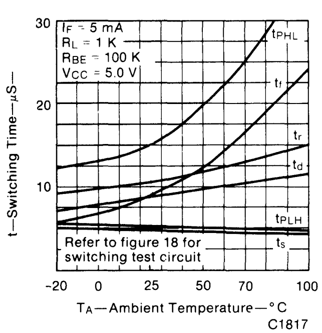


Fig. 14. Switching Speed vs. Temperature
I_F=5 mA R_{BE}=100 K

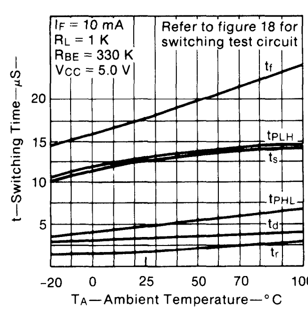


Fig. 15. Switching Speed vs. Temperature
I_F=5 mA R_{BE}=330 K

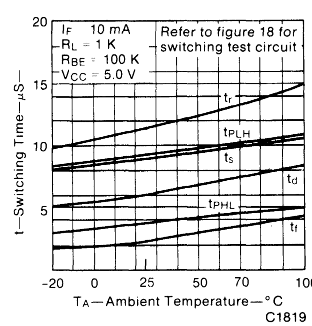


Fig. 16. Switching Speed vs. Temperature
I_F=5 mA R_{BE}=100 K

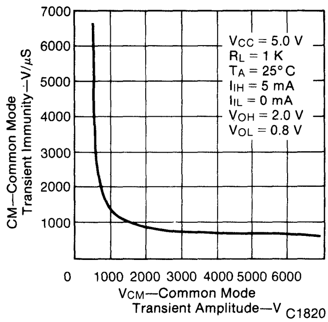


Fig. 17. Common Mode Transient Rejection vs. Common Mode Transient Voltage

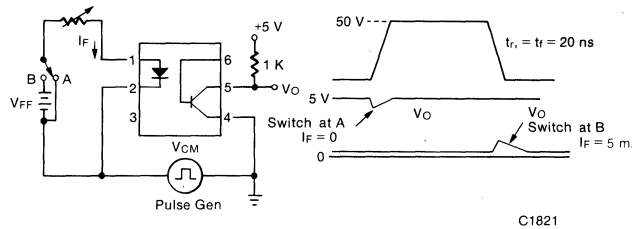
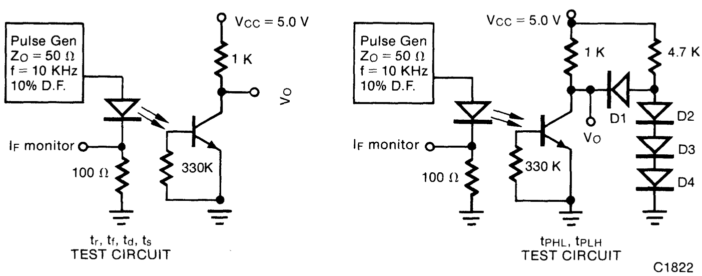


Fig. 17. Text Circuit for Transient Immunity and Typical Waveforms



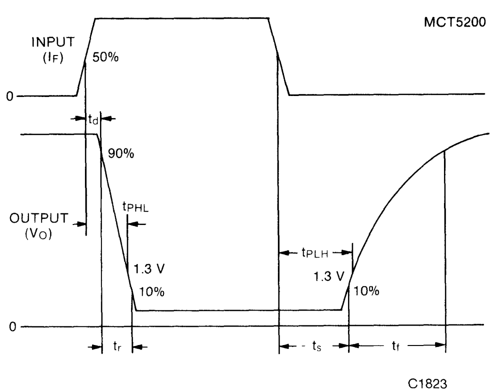
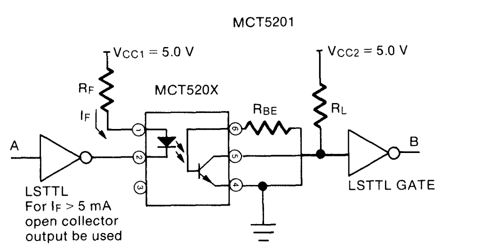


Fig. 18. Switching Circuit Waveforms



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

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

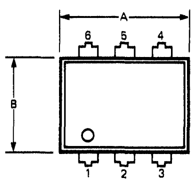
C1824

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

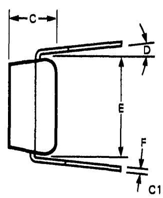
GENERAL INSTRUMENT

LOW INPUT CURRENT HIGH GAIN PHOTOTRANSISTOR OPTOISOLATOR MCT5210 MCT5211

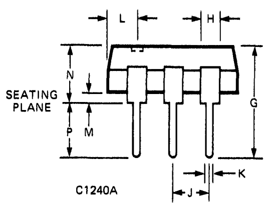
PACKAGE DIMENSIONS



C1240A

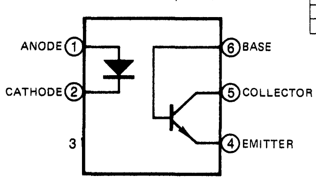


C1240A



C1240A

SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.355	9.02	
B	.270	6.86	
C	.160	4.06	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5



NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0.100 INCH

DESCRIPTION

The MCT-521X are high performance CMOS/LSTTL logic compatible phototransistor type optically coupled isolator products. They are constructed using a 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 7500 VAC 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 $CTR_{CE\ (SAT)}$
  - MCT5210—350% at I_F = 3 mA
  - MCT5211—250% at I_F = 1 mA
- CTR performance guaranteed over 0 to 70°C
- High withstand test voltage
  - 5300 VAC_{RMS}—5 seconds
  - 7500 VAC_{PEAK}—5 seconds
- High common mode transient rejection
- Data rates up to 100K bits/s
- Underwriters Laboratory (UL) recognized file #E5051

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 (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 . . . . 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

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}		5300			$V_{AC(RMS)}$	Relative humdity ≤ 50%, I_{I-O} ≤ 10 μA, 5 seconds		
	V_{ISO}		7500			$V_{AC(Peak)}$			
Insulation resistance	R_{ISO}		10''			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}			450	1000	—	V_{CE} = 5 V, I_{CE} = 2 mA	8	
		$h_{FE(SAT)}$	MCT5210	200	350			V_{CE} = 0.4 V, I_{CE} = 2 mA	9	
		h_{FE}			500	1000	—	V_{CE} = 5 V, I_{CE} = 2 mA	10	
		$h_{FE(SAT)}$	MCT5211	200	375			V_{CE} = 0.4 V, I_{CE} = 2 mA		
	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									
	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	

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-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-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-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-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		

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		

*All Typicals at T_A = 25° C

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-O} is the capacitance between the input (pins 1, 2, 3 connected) and the output, (pins 4, 5, 6 connected).*

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

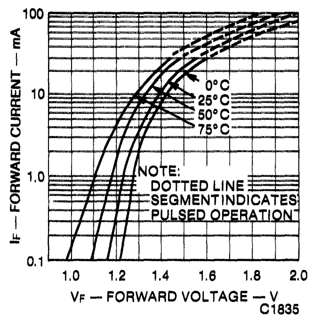


Fig. 1. Forward Voltage vs. Forward Current

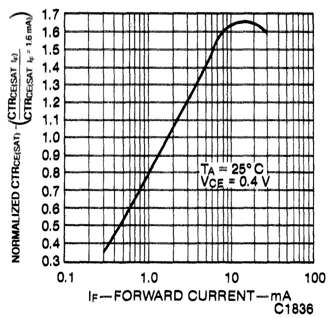


Fig. 2. Normalized Current Transfer Ratio vs. Forward Current

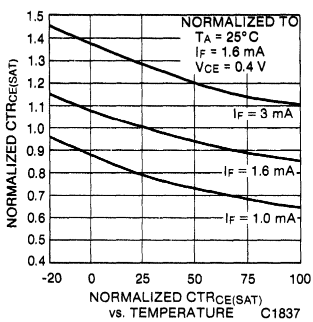


Fig. 3. Normalized CTR vs. Temperature

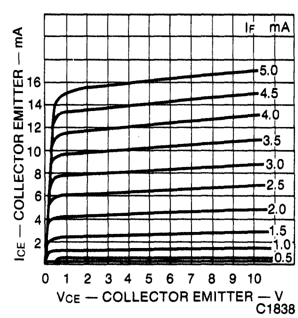


Fig. 4. DC Characteristics MCT5210

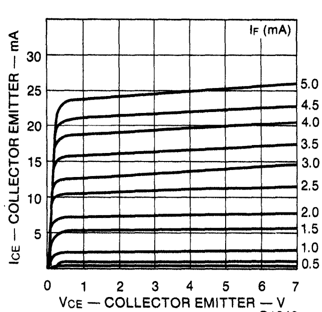


Fig. 5. DC Characteristics MCT5211

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

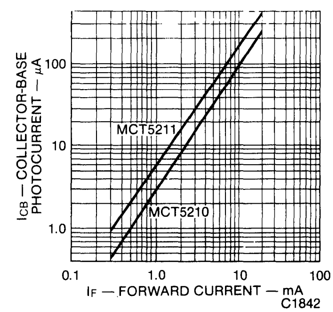


Fig. 6. Collector Base Photocurrent vs. Forward Current

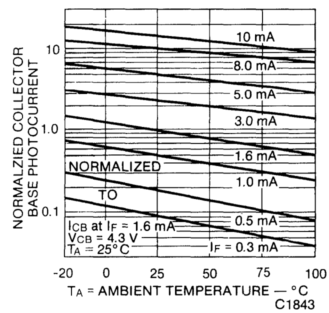


Fig. 7. Normalized Collector Base Photocurrent vs. Temperature

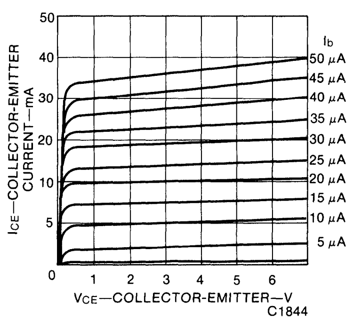


Fig. 8. Transistor DC Characteristics

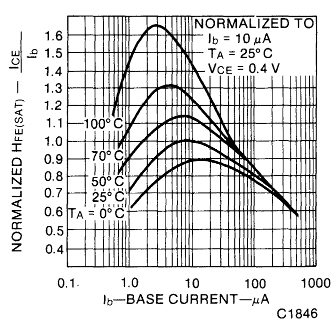


Fig. 9. $h_{FE(SAT)}$ vs. I_b vs. Temperature

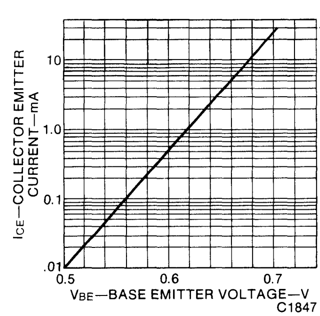


Fig. 10. Collector Current vs. Base Emitter Voltage

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

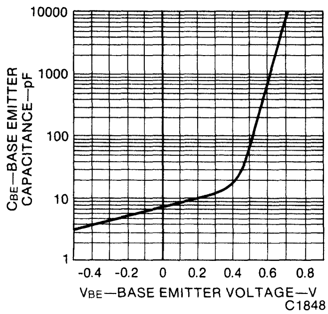


Fig. 11. C_{BE} vs. V_{BE}

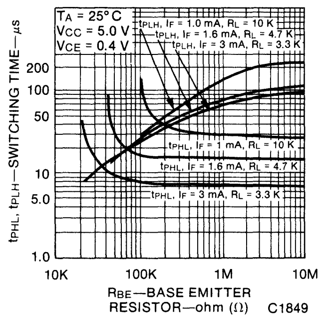
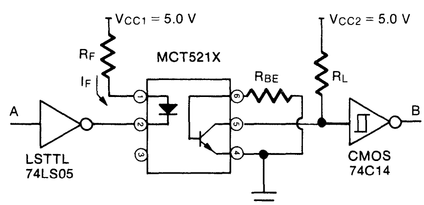
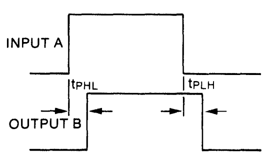


Fig. 12. Switching Time vs. R_{BE}



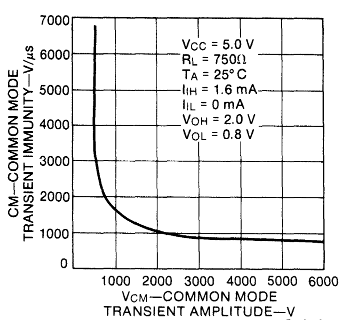


TYPICAL SWITCHING TIME T_A = 25°C

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



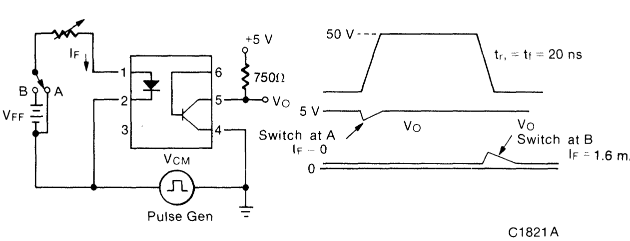
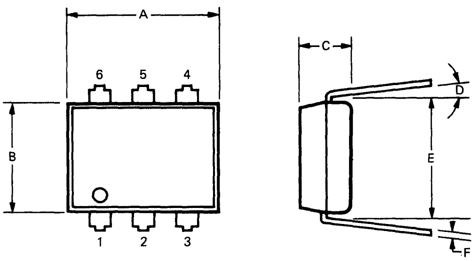


Fig. 14. Common Mode Transient Rejection & Test Circuit

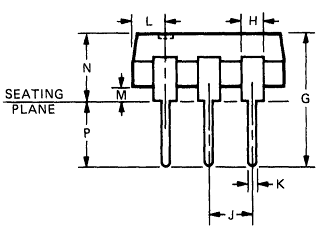
GENERAL INSTRUMENT

4N25 4N27
4N26 4N28

PACKAGE DIMENSIONS



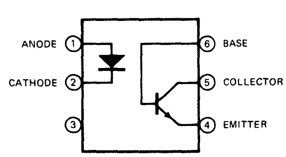
C1339



SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.355	9.02	
B	.270	6.86	
C	.160	4.06	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0.100 INCH

C1339A



DESCRIPTION

The 4N25, 4N26, 4N27, and 4N28 series of optoisolators 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)

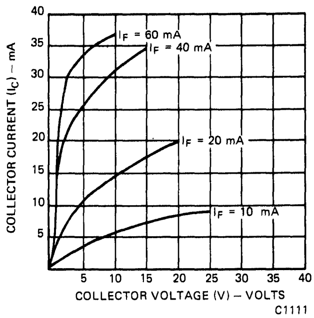


Fig. 1. Collector Current vs. Collector Voltage

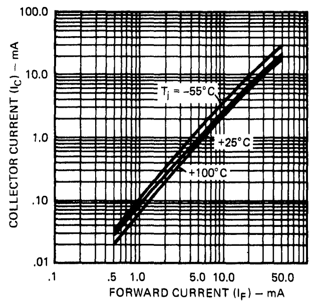


Fig. 2. Collector Current vs. Forward Current

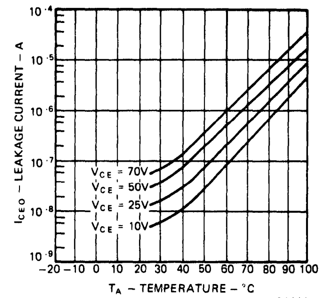


Fig. 3. Dark Current vs. Temperature

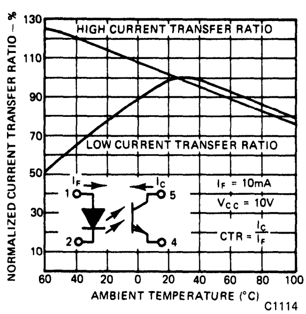


Fig. 4. Current Transfer Ratio vs. Temperature

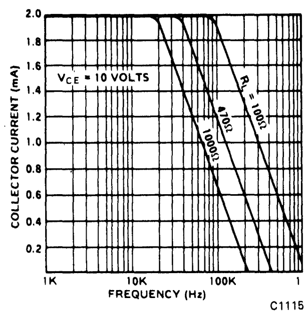


Fig. 5. Collector Current vs. Frequency (see Fig. 12 for circuit)

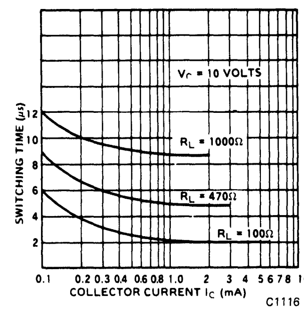
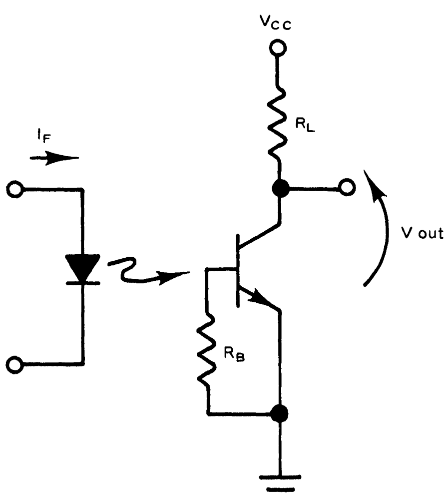


Fig. 6. Switching Time vs. Collector Current (see Fig. 13 for Circuit)



Circuit 1

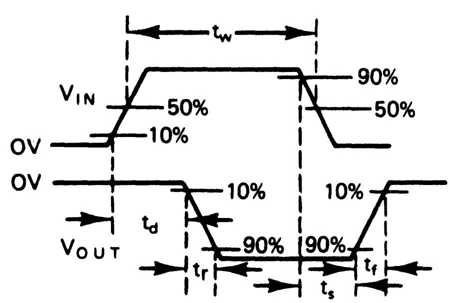


Fig. 7. Pulse Test Definition (Note 3)

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (Cont'd)

(25°C Free Air Temperature Unless Otherwise Specified)

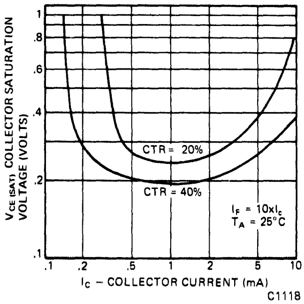


Fig. 8. Saturation Voltage vs. Collector Current

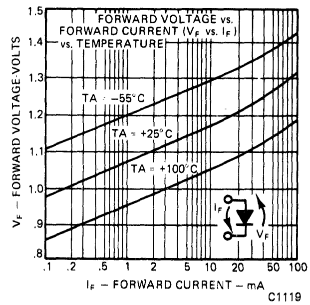


Fig. 9. Forward Voltage vs. Forward Current

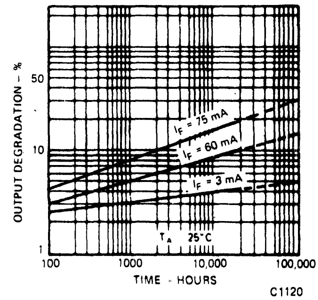


Fig. 10. Lifetime vs. Forward Current

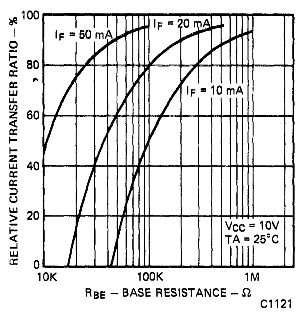


Fig. 11. Sensitivity vs. Base Resistance

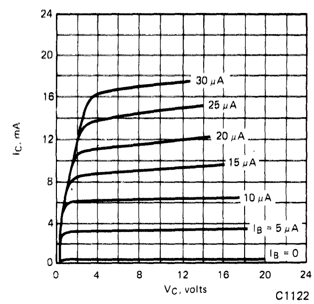


Fig. 12. Detector h_{fe} Curves

OPERATING SCHEMATICS

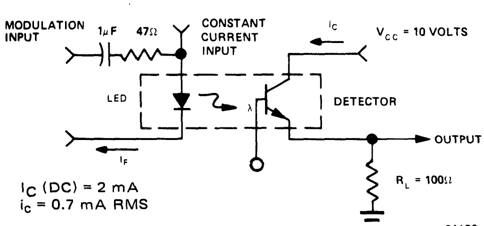


Fig. 13. Modulation Circuit Used to Obtain Output vs. Frequency Plot

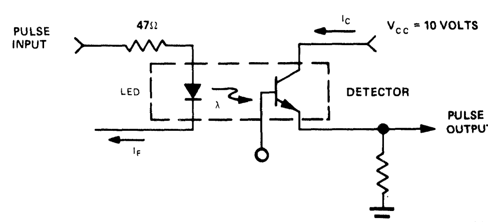


Fig. 14. Circuit Used to Obtain Switching Time vs. Collector Current Plot

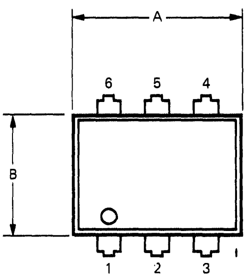
NOTES

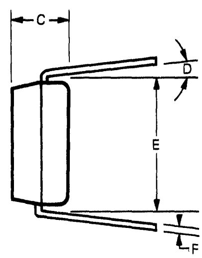
1. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.*
2. *The frequency at which i_c is 3dB down from the 10 kHz value.*
3. *Rise time (t_r) is the time required for the collector current to increase from 10% of its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

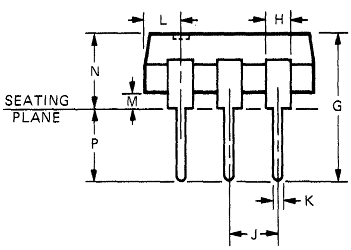
GENERAL INSTRUMENT

4N35
4N36
4N37

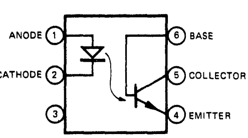
PACKAGE DIMENSIONS







SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.355	9.02	
B	.270	6.86	
C	.160	4.06	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5



C1339

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0.100 INCH

C1339A

DESCRIPTION

The 4N35, 4N36, and 4N37 series of opto-isolators have an NPN silicon planar photo-transistor 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			%	IF = 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	V_{ISO}	2500			volts	RMS, t = 1 minute
*Input to output isolation current (pulse width = 8 msec) (see Note 1)	$I_{I\text{-}O}$					
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	$R_{I\text{-}O}$	100			gigaohms	Input to output voltage = 500 V (see Note 1)
*Input to output capacitance	$C_{I\text{-}O}$			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)

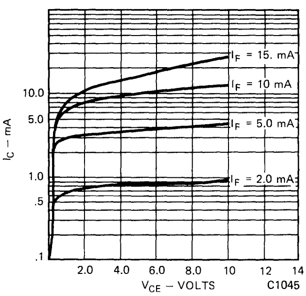


Fig. 1. Collector Current vs. Collector Voltage

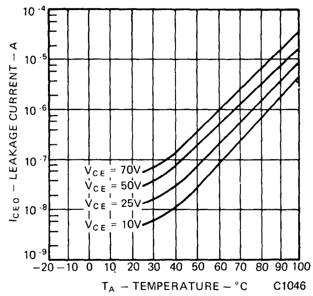


Fig. 2. Dark Current vs. Temperature

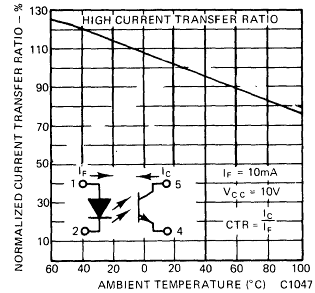


Fig. 3. Current Transfer Ratio vs. Temperature

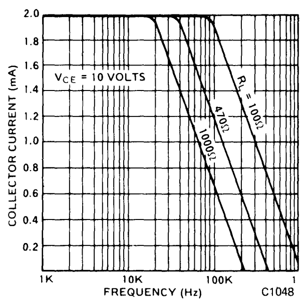


Fig. 4. Collector Current vs. Frequency

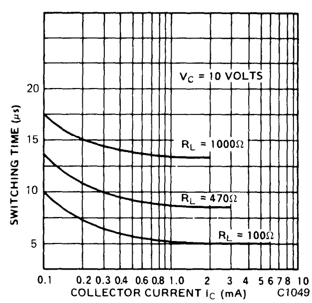


Fig. 5. Switching Time vs. Collector Current

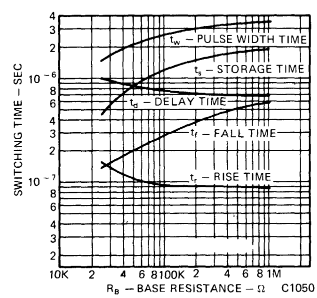


Fig. 6. Switching Time vs. Base Resistance

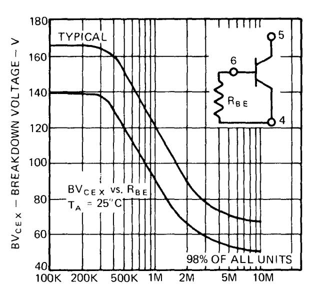


Fig. 7. Collector–Emitter Breakdown Voltage vs. Base Resistance

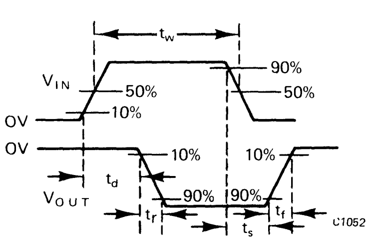


Fig. 8. Test Pulse Definition (Note 3)

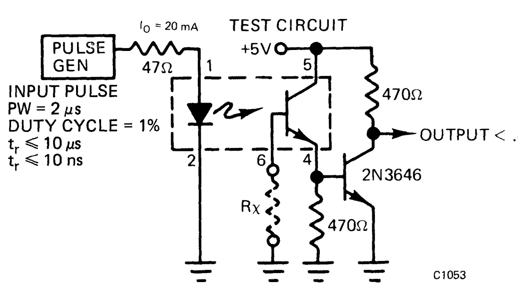


Fig. 9. Pulse Test Circuit for Fig. 7

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

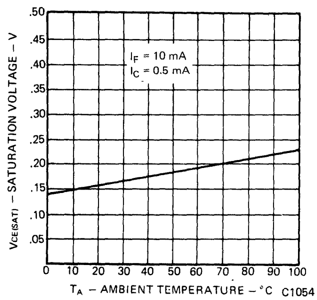


Fig. 10. Saturation Voltage vs. Temperature

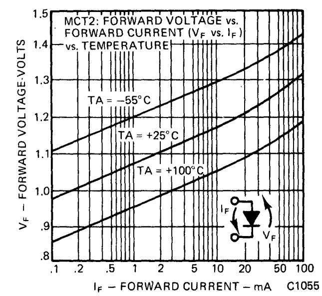


Fig. 11. Forward Voltage vs. Forward Current

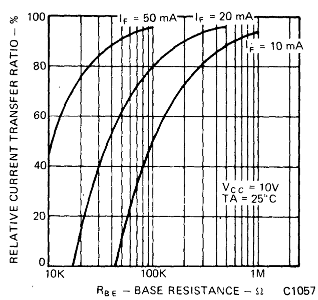


Fig. 12. Sensitivity vs. Base Resistance

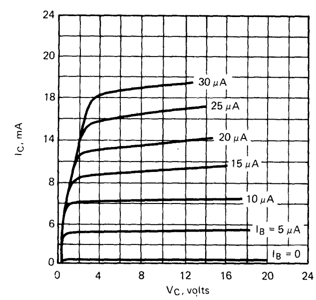


Fig. 13. Detector Standard Transfer Curves

OPERATING SCHEMATICS

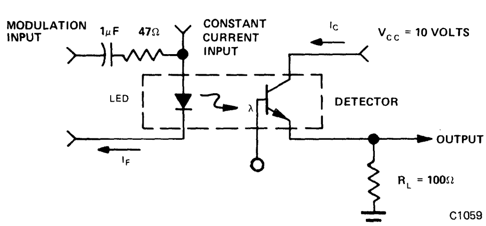


Fig. 14. Modulation Circuit Used to Obtain Output vs. Frequency Plot (Fig. 4)

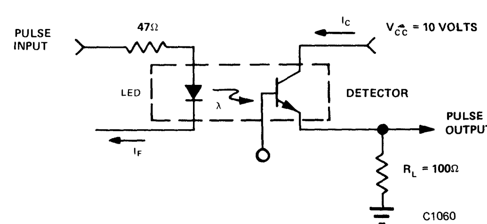


Fig. 15. Circuit Used to Obtain Switching Time vs. Collector Current Plot (Fig. 5)

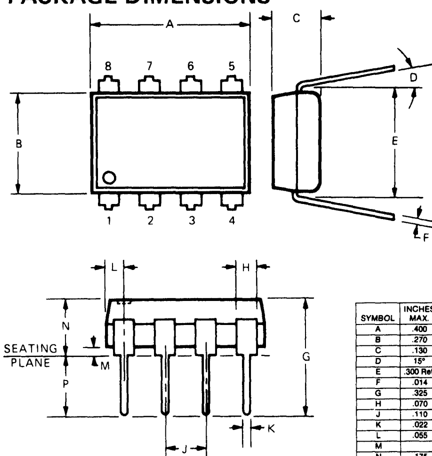
NOTES

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

MCT6
MCT66

PACKAGE DIMENSIONS

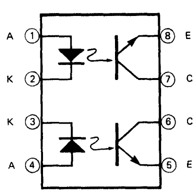


C1340

SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.400	10.16	
B	.270	6.86	
C	.130	3.30	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.055	1.40	2
M			3
N	.175	4.45	4
P			5

NOTES
1 INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0 100 INCH

C1339B



DESCRIPTION

The MCT6 and MCT66 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
- Same basic electrical characteristics as MCT2
- 1500 volt isolation
- 50% typical current transfer ratio
- 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 VACRMS
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	50		%	V_{CE} = 10V, I_F = 10mA
MCT66	6	15		%	V_{CE} = 10V, I_F = 10mA
Isolation voltage $BV_{(I-O)}$	2500			VACRMS	t = 1 second
Isolation resistance					
MCT6 — $R_{(I-O)}$	10^{11}	10^{12}		Ω	V_{I-O} = 500VDC
MCT66 — $R_{(I-O)}$	10^{11}	10^{12}		Ω	V_{I-O} = 500VDC
Breakdown voltage — channel-to-channel					
MCT6		500		VDC	Relative humidity = 40%
MCT66		500		VDC	Relative humidity = 40%
Capacitance between channels		0.4		pF	f = 1MHz
Saturation voltage — collector to emitter $V_{CE(SAT)}$					
MCT6		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)

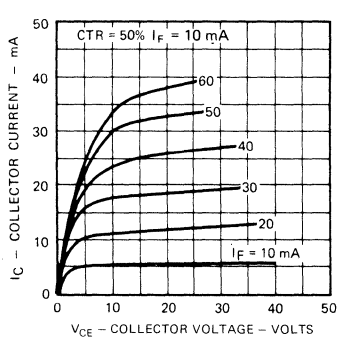


Fig. 1. I-V Curve of Phototransistor

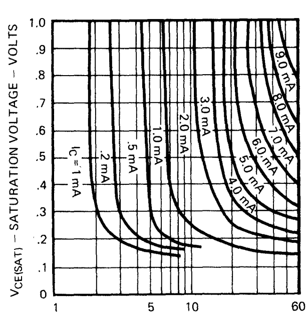


Fig. 2. I-V Curve in Saturation

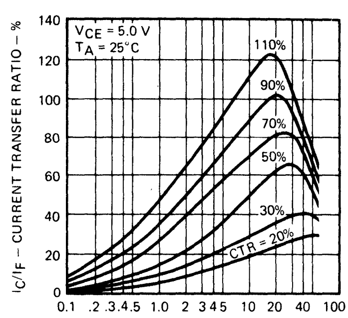


Fig. 3. CTR vs. Forward Current

MCT6 TYPICAL ELECTRO-OPTICAL CHARACTERTISTIC CURVES (Cont.)

(25°C Free Air Temperature Unless Otherwise Specified)

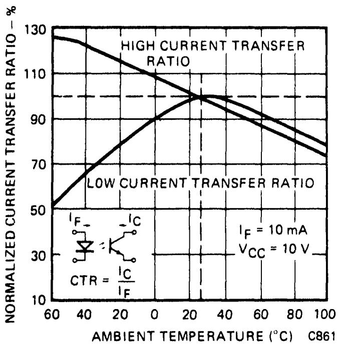


Fig. 4. Current Transfer Ratio vs. Temperature

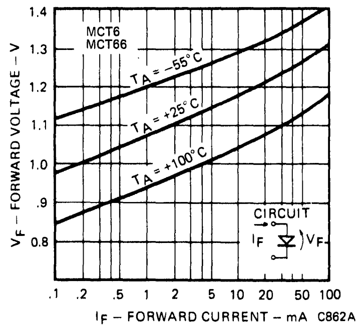


Fig. 5. I-V Curve of LED vs. Temperature

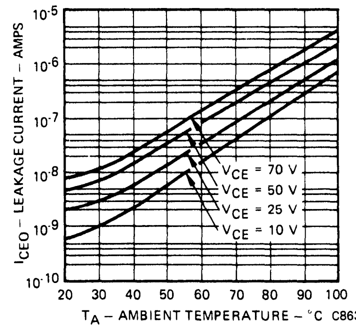


Fig. 6. Leakage Current vs. Temperature vs. Collector Voltage

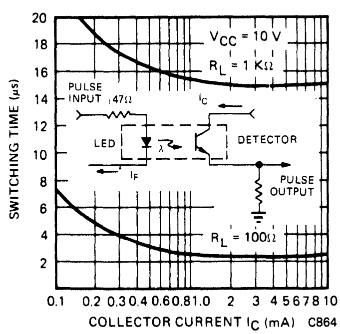


Fig. 7. Switching Time vs. Collector Current

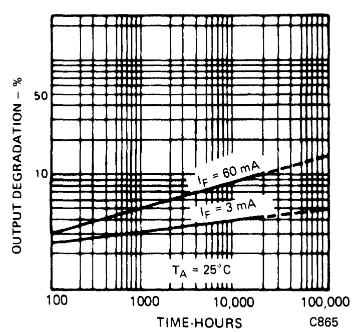


Fig. 8. Lifetime vs. Forward Current (Note 1)

MCT66 TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

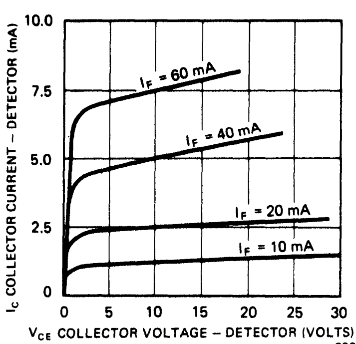


Fig. 1. Detector Output Characteristics

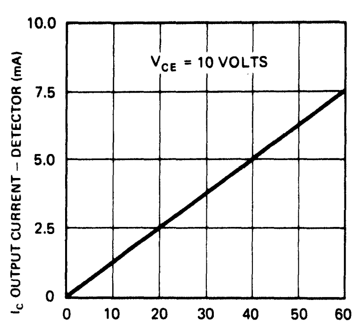


Fig. 2. Input Current vs. Output Current

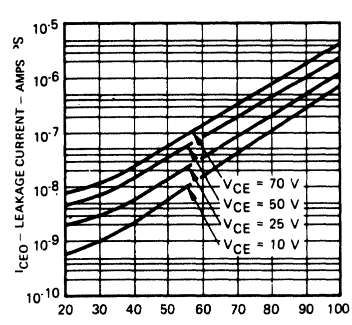


Fig. 3. Leakage Current vs. Temperature vs. Collector Voltage

MCT66 TYPICAL ELECTRO-OPTICAL CHARACTERTISTIC (Cont.)

(25°C Free Air Temperature Unless Otherwise Specified)

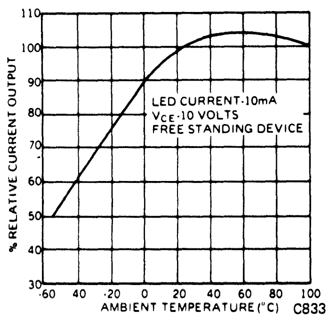


Fig. 4. Current Output vs. Temperature

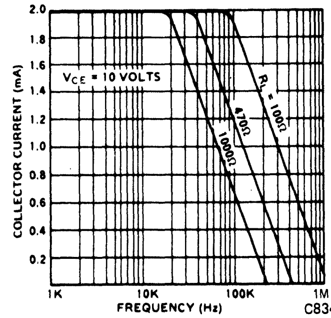


Fig. 5. Output vs. Frequency

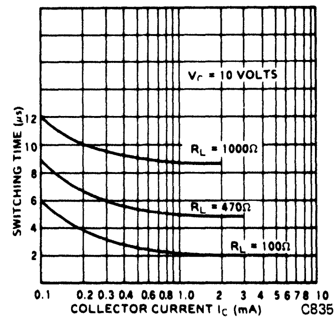


Fig. 6. Switching Time vs. Collector Current

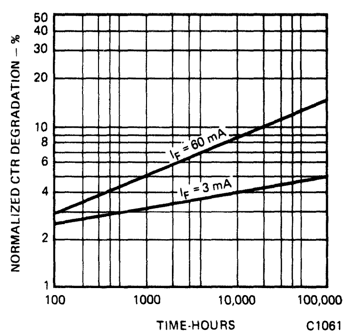
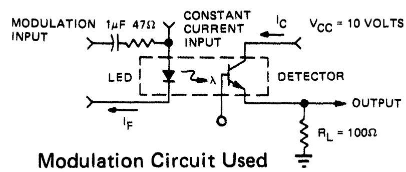
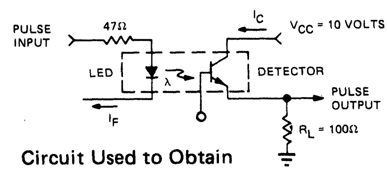


Fig. 7. Lifetime vs. Forward Current



Modulation Circuit Used to Obtain Figure 5

C837



Circuit Used to Obtain Figure 6

C838

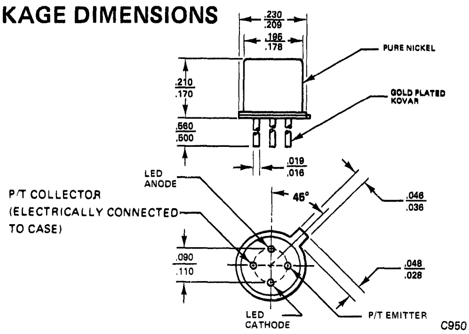
NOTES

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

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)

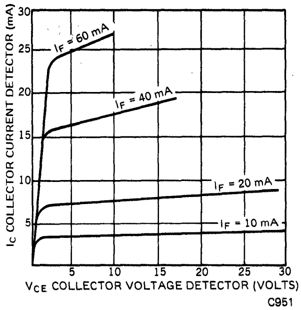


Figure 1 Detector Output Characteristics

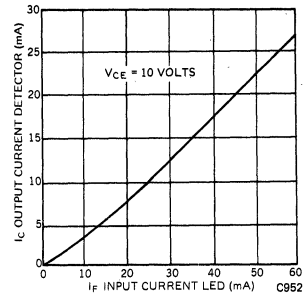


Figure 2 Input Current vs. Output Current

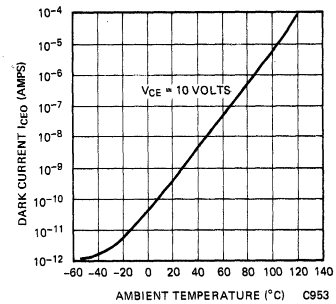


Figure 3 Dark Current vs. Temperature (°C)

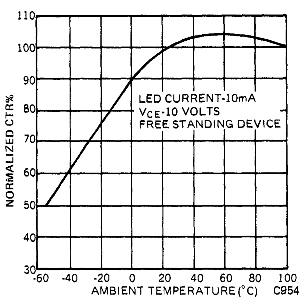


Figure 4 Current Output vs. Temperature

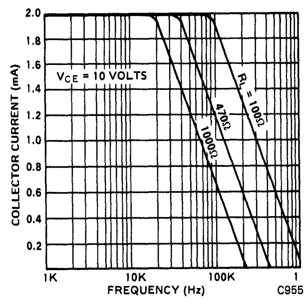


Figure 5 Output vs. Frequency

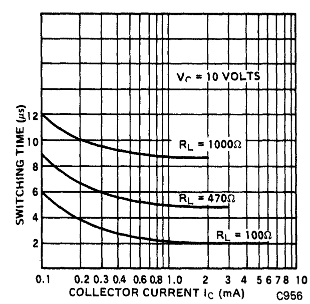
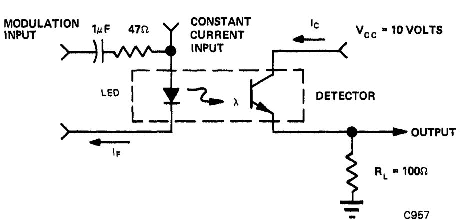


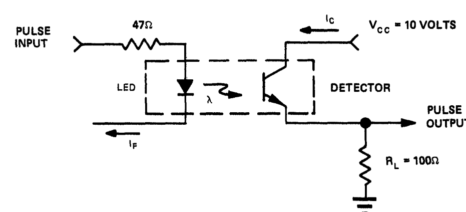
Figure 6 Switching Time vs. Collector Current

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

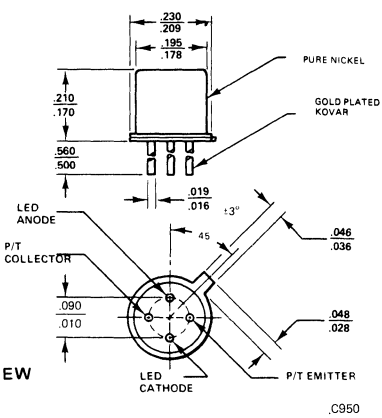
NOTES

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

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-883 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 – 168 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

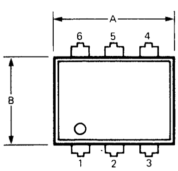
Characteristic	Method	LTPD
Subgroup VII		
High Temperature Storage	1008 – 150°C. for 1000 hours	7%
Critical Electrical	– Data Sheet	
Subgroup VIII		
Operating Life	1005 – Condition B	7%
Critical Electrical	– Data Sheets	
Subgroup IX		
Steady State Reverse Bias	1015 – Condition A; 72 hours at 150°C.	7%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

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

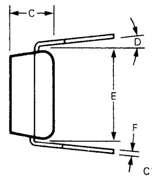
GENERAL INSTRUMENT

MCA2230
MCA2231
MCA2255

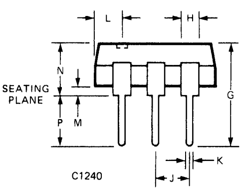
PACKAGE DIMENSIONS



C1240



C1240

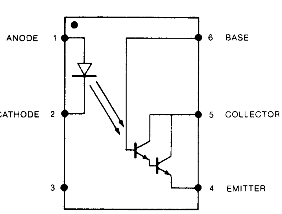


C1240

SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.355	9.02	
B	.270	6.86	
C	.160	4.06	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0.100 INCH

C1339



C1715

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			%	$I_F = 10$mA, $V_{CE} = 5$ V
			200			%	$I_F = 1$mA, $V_{CE} = 1$ V
	Saturation voltage						
	MCA2230	$V_{CE(SAT)}$			1.0	V	$I_C = I_F = 50$ mA
	MCA2231, MCA2255	$V_{CE(SAT)}$			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%, $I_{I\text{-}O} \leq 10$ μA, 5 seconds
		V_{iso}	7500			V_{AC}PEAK	Relative humidity ≤ 50%, $I_{I\text{-}O} \leq 10$ 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	$I_F = 20$ 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)

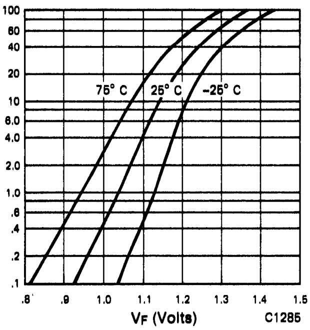


Fig. 1. Forward Voltage vs. Forward Current

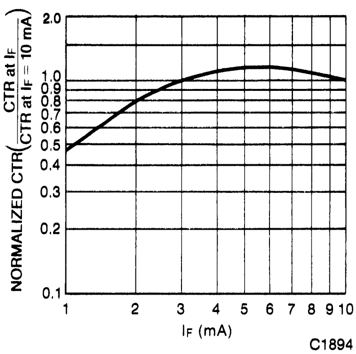


Fig. 2. Normalized CTR vs. I_F

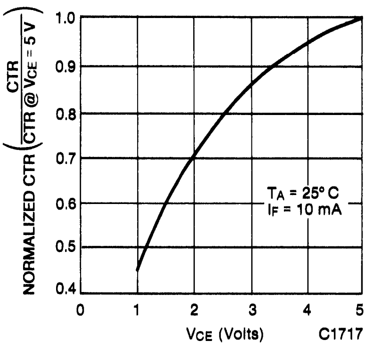


Fig. 3. Normalized CTR vs V_{CE}

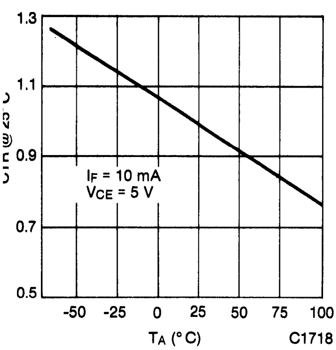


Fig. 4. Normalized CTR vs. Temperature

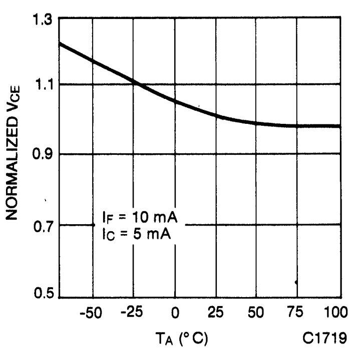


Fig. 5. Normalized V_{CE} *vs. Temperature*

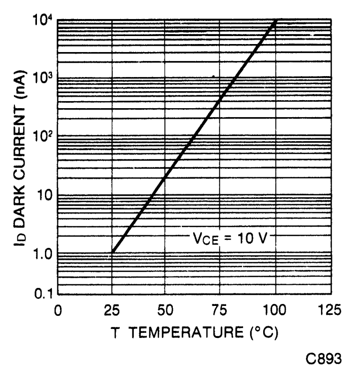


Fig. 6. Dark Current vs. Temperature

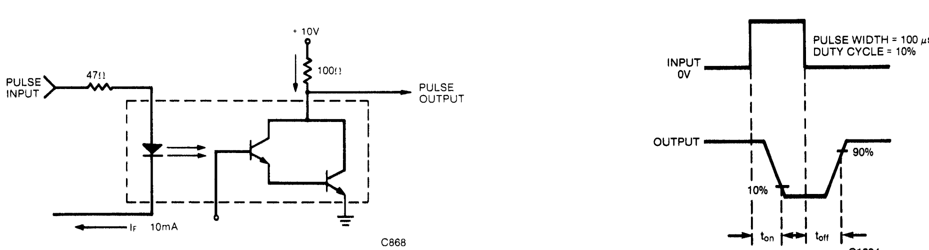
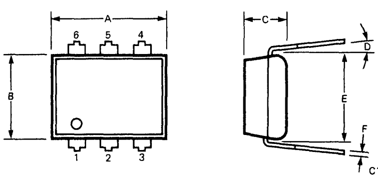


Fig. 7. Switching Time Test Circuit

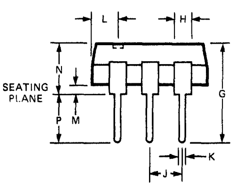
GENERAL INSTRUMENT

MCA230
MCA231
MCA255

PACKAGE DIMENSIONS



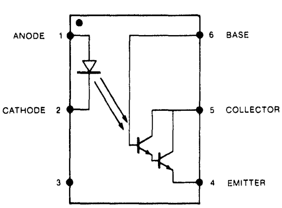
C1240A



SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.355	9.02	
B	.270	6.86	
C	.160	4.06	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0.100 INCH

C1339A



C1715

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)

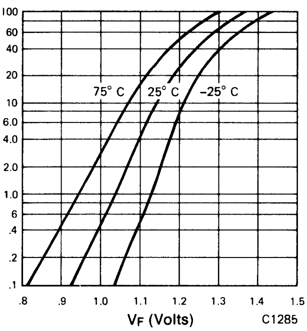


Fig. 1. Forward Voltage vs. Forward Current

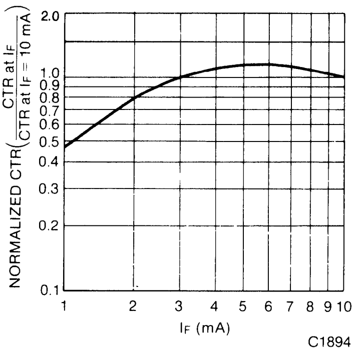


Fig. 2. Normalized CTR vs. I_F

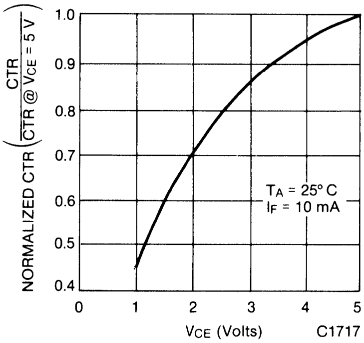


Fig. 3. Normalized CTR vs V_{CE}

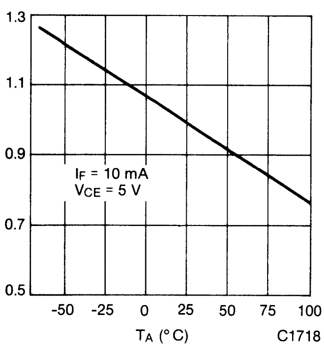


Fig. 4. Normalized CTR vs. Temperature

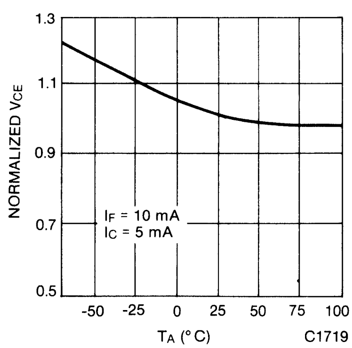


Fig. 5. Normalized V_{CE} vs. Temperature

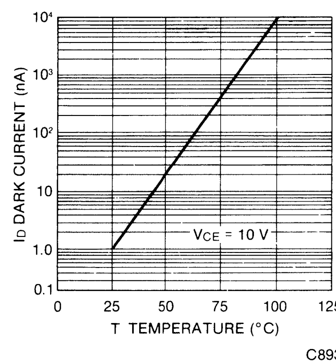


Fig. 6. Dark Current vs. Temperature

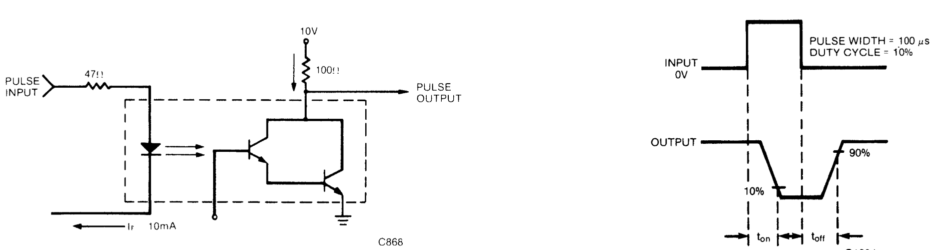
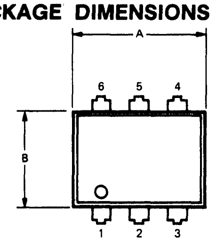


Fig. 7. Switching Time Test Circuit

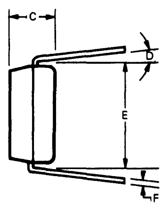
GENERAL INSTRUMENT

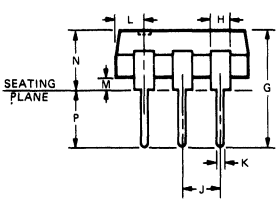
H11B1
H11B2
H11B3

PACKAGE DIMENSIONS



C1240

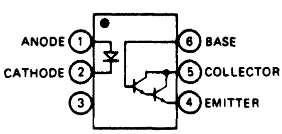




SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.355	9.02	
B	.270	6.86	
C	.160	4.06	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0.100 INCH

C1339



C1710

DESCRIPTION

The H11B1, H11B2, H11B3 are photodarlington-type optically coupled optoisolators. These devices have an infrared emitting diode manufactured from specially grown gallium arsenide, coupled with a silicon darlington-connected phototransistor. These devices are supplied in a standard plastic six-pin dual-in-line package.

FEATURES

- High sensitivity to low input current— Minimum 500 percent CTR at I_F = 1 mA
- High isolation voltage
  5300 V_{AC} RMS — 5 seconds
  7500 V_{AC} PEAK — 5 seconds
- Underwriters Laboratory (UL) recognized File #E50151

APPLICATIONS

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

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
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 at 25° C .... 150 mW
Derate linearly from 25° C .... 2.67 mW/° C
V_{CEO} .... 25 V
V_{CBO} .... 30 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					I_F = 1 mA, V_{CE} = 5 V
	H11B1		500			%	
	H11B2		200			%	
	H11B3		100			%	
	Saturation voltage	$V_{CE(SAT)}$		0.75	1.0	V	I_F = 1 mA, I_C = 1 mA
SWITCHING TIMES	Non-saturated						
	Turn-on time	t_{on}		125		μs	R_L = 100Ω, I_C = 10 mA
	Turn-off time	t_{off}		100		μs	V_{CE} = 10 V Pulse width ≤ 300 μsec, f ≤ 30 Hz See Figure 6
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 DARLINGTON	Breakdown voltage						
	Collector to emitter	BV_{CEO}	25			V	I_C = 10 mA, I_F = 0
	Collector to base	BV_{CBO}	30			V	I_C = 100 μA, I_F = 0
	Emitter to base	BV_{EBO}	5	7		V	I_E = 100 μA, I_F = 0
	Leakage current						
	Collector to emitter	I_{CEO}		5	100	nA	V_{CE} = 10 V, I_F = 0
	Capacitance	C_{CE}		6		pF	(V_{CE} = 10 V, f = 1 MHz

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

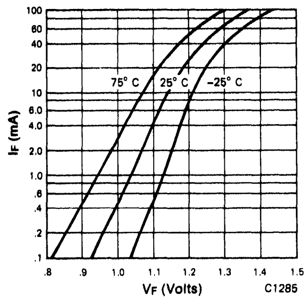


Fig. 1. Forward Voltage vs. Forward Current

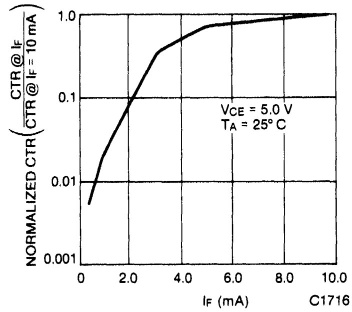


Fig. 2. Normalized CTR vs. I_F

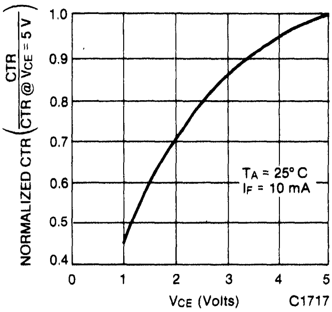


Fig. 3. Normalized CTR vs V_{CE}

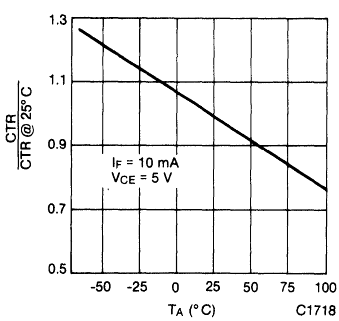


Fig. 4. Normalized CTR vs. Temperature

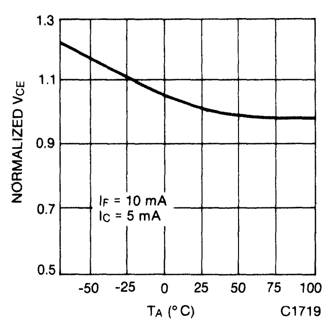


Fig. 5. Normalized V_{CE} vs. Temperature

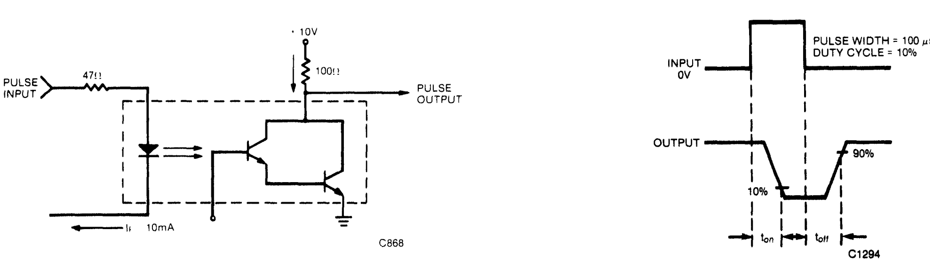
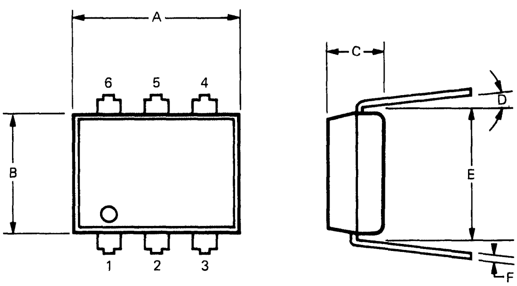


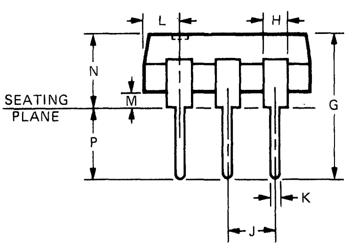
Fig. 6. Switching Time Test Circuit

GENERAL INSTRUMENT

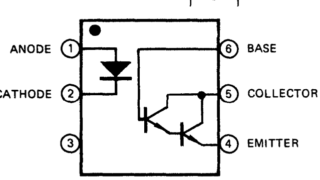
4N29 4N30 4N31 4N32 4N33

PACKAGE DIMENSIONS





SYMBOL	INCHES MAX.	mm MAX	NOTES
A	.355	9.02	
B	.270	6.86	
C	.160	4.06	
D	15°	15°	
E	300 Ref	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5



NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2 FOUR PLACES
3. OVERALL INSTALLED POSITION
4 THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0 100 INCH

C1339A

DESCRIPTION

The 4N29, 4N30, 4N31, 4N32 and 4N33 have a gallium arsenide infrared emitter optically coupled to a silicon planar photo-darlington.

FEATURES & APPLICATIONS

- Fast operate time — 10 μs
- 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

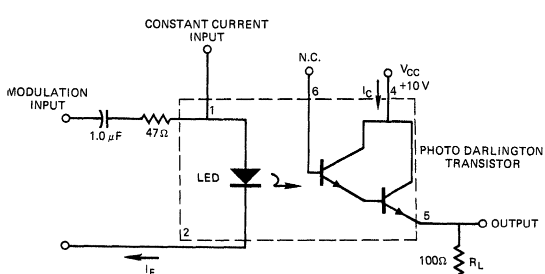
DETECTOR (Silicon Photo Darlington Transistor)
*Power dissipation @ 25°C ambient . . . . 150 mW
*Derate linearly from 25°C . . . . 2.0 mW/°C
*Collector-emitter breakdown voltage (BV_{CEO}) . . . . 30 V
*Collector-base breakdown voltage (BV_{CBO}) . . . . . . 50 V
Emitter-base breakdown voltage (BV_{EBO})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

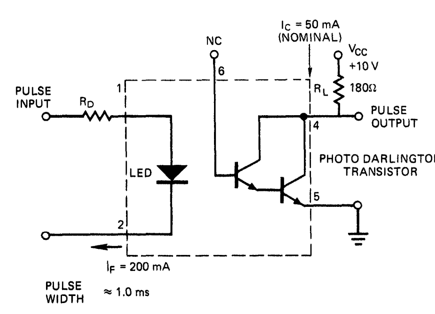
CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION
LED CHARACTERISTICS (T_A = 25°C unless otherwise noted)						
*Reverse leakage current	I_R		0.05	100	μA	V_R = 3.0 V
*Forward voltage	V_F		1.2	1.5	Volts	I_F = 10 mA
Capacitance	C		150		pF	V_R = 0 V, f = 1.0 MHz
PHOTOTRANSISTOR CHARACTERISTICS (T_A = 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
4N29, 4N30		10			mA	V_{CE} = 10 V, I_F = 10 mA, I_B = 0
4N31		5.0			mA	V_{CE} = 10 V, I_F = 10 mA, I_B = 0
Isolation voltage (Note 2)						
4N29, 4N30, 4N31, 4N32, 4N33	V_{ISO}	2500	—	—	V	V RMS, t = 1 minute
*(4N29, 4N32)		2500	—	—	V	VDC
*(4N30, 4N31, 4N33)		1500	—	—	V	VDC
Isolation capacitance (Note 2)	R_{ISO}		10^{11}		Ohms	V = 500 VDC
*Collector-emitter saturation voltage (1)	$V_{CE(SAT)}$					
4N31				1.2	Volts	I_C = 2.0 mA, I_F = 8.0 mA
4N29, 4N30, 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						
4N29, 4N30, 4N31	t_{OFF}		17	40	μs	I_C = 50 mA, I_F = 200 mA, V_{CC} = 10 V
4N32, 4N33			45	100		

*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.



I_C(DC) = 2.0 mA
I_C (AC SINE WAVE) = 0.7 mA RMS at lKHz
Note 2

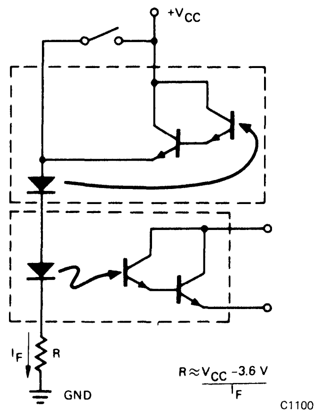
FREQUENCY RESPONSE TEST CIRCUIT #1



SWITCHING TIME TEST CIRCUIT #2

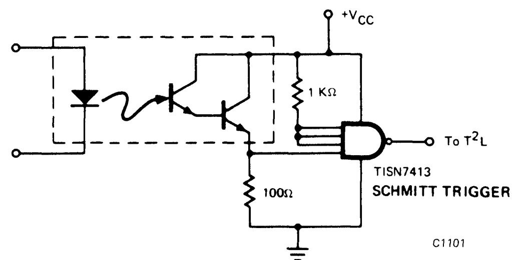
APPLICATION INFORMATION

LATCH

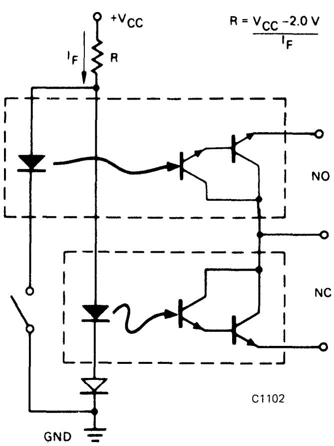


NOT APPLICABLE TO 4N31

T^2L LOGIC ISOLATION

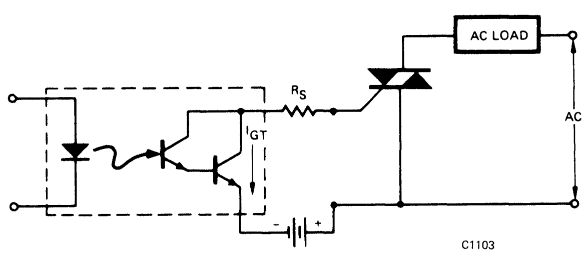


FORM C CONTACT

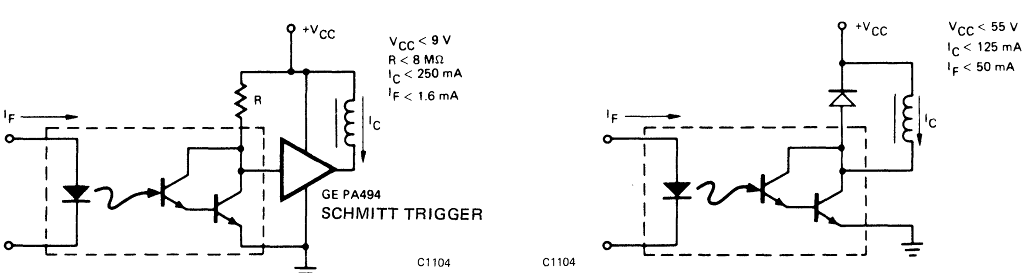


NOT APPLICABLE TO 4N31

TRIAC TRIGGER



OPERATING A RELAY COIL



TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

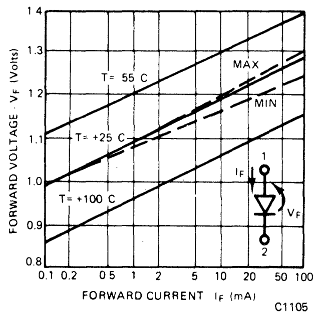


Fig. 1. Forward Voltage Drop vs. Forward Current

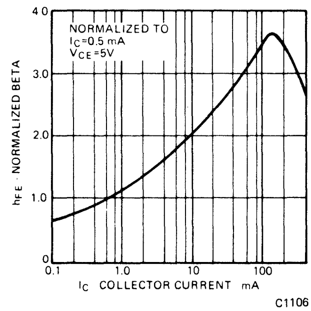


Fig. 2. Normalized Beta vs. Collector Current

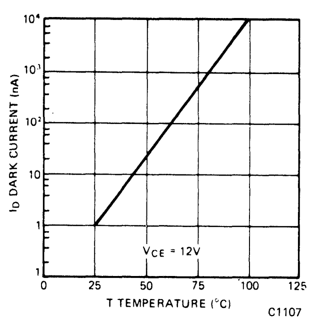


Fig. 3. Dark Current vs. Temperature

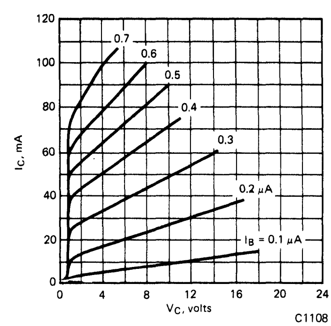


Fig. 4. Detector Standard Transfer Curves

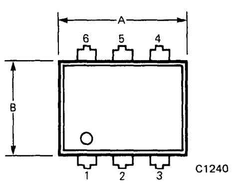
NOTES

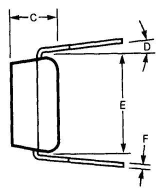
1. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.*
2. *The frequency at which i_C is 3dB down from the $1KH_Z$ value.*
3. *t_{ON} is measured from 10% of the leading edge of the input pulse to the 90% point on the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

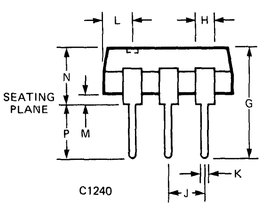
GENERAL INSTRUMENT

(H11G1) MCA11G1
(H11G2) MCA11G2

PACKAGE DIMENSIONS







SYMBOL	INCHES MAX.	mm MAX	NOTES
A	355	9 02	
B	.270	6.86	
C	.160	4.06	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0 36	
G	.325	8 26	
H	.070	1.78	
J	.110	2.79	
K	022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2 FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5 MINIMUM 0 100 INCH

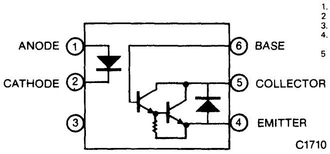


Fig. 1. Equivalent Circuit

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 phototransistor 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
- High sensitivity to low input curarent—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 60mA
Reverse voltage . . . . 6 V
Peak forward current
(1 μs pulse, 300 pps) . . . . 3.0 A
Power dissipation 25°C ambient 100mW
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

ELECTRO-OPTICAL CHARACTERISTICS (25° Temperature unless otherwise specified)

TRANSFER CHARACTERISTICS

	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Current Transfer Ratio collector to emitter	CTR					
			1000			%	I_F = 10 mA; V_{CE} = 1V
			500			%	I_F = 1 mA; V_{CE} = 5V
	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				
	Collector to base	BV_{CBO}					
	MCA11G1		100			V	I_C = 100 μA
	MCA11G2		80				
	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} = 80V, I_F = 0
	MCA11G2				100	nA	V_{CE} = 60V, I_F = 0
	MCA11G1				100	μA	V_{CE} = 80V, I_F = 0, T_A = 80°C
	MCA11G2				100	μA	V_{CE} = 60V, I_F = 0, T_A = 80°C

TYPICAL-ELECTRICAL CHARACTERISTIC CURVES

(25°C Free air temperature unless specified)

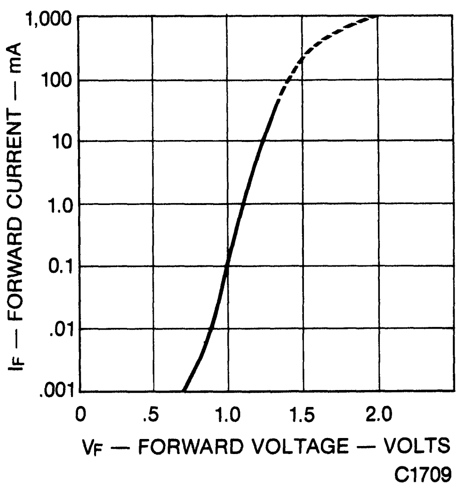


Fig. 2. Forward Voltage vs. Forward Current

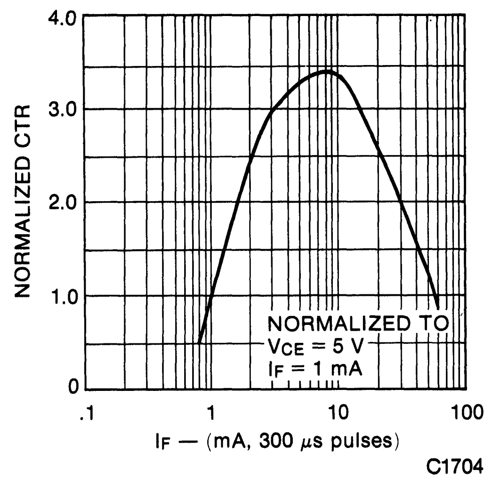


Fig. 3. Normalized CTR vs. Input Current

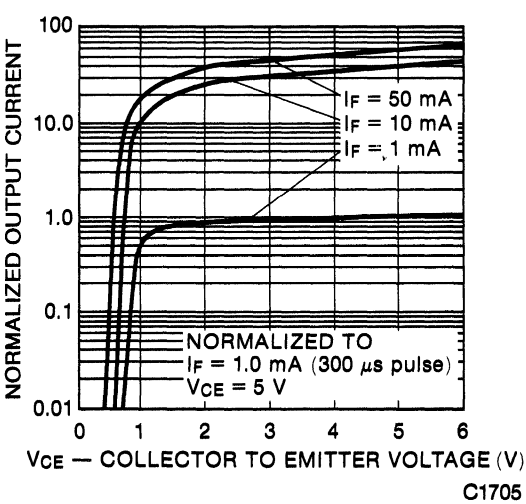


Fig. 4. Output Characteristics

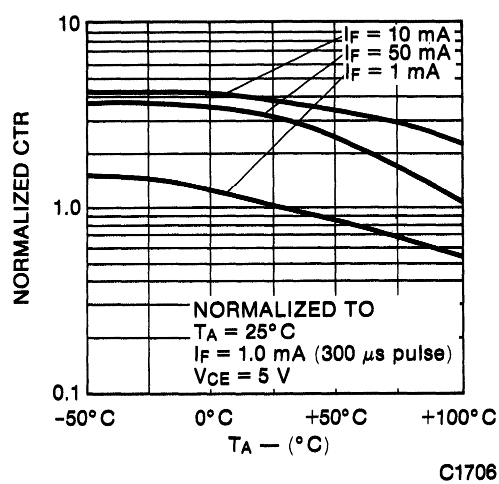


Fig. 5. Normalized CTR vs. Temperature

TYPICAL-ELECTRICAL CHARACTERISTIC CURVES (Cont.)

(25°C Free air temperature unless specified)

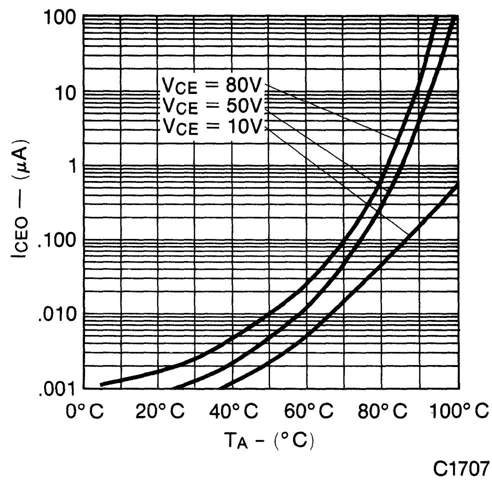


Fig. 6. Dark Current vs. Temperature

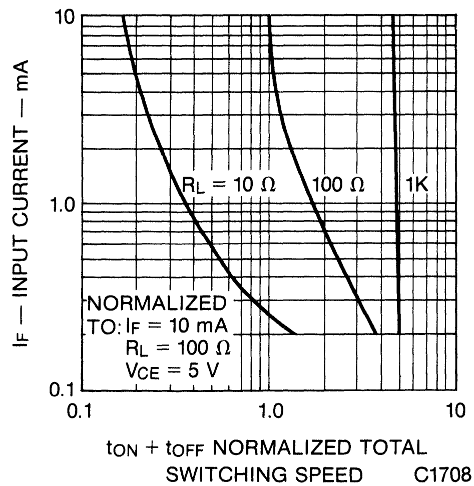
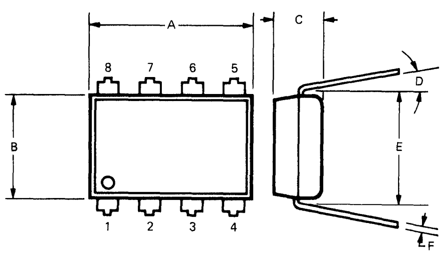


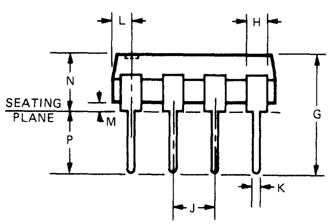
Fig. 7. Switching Speed

GENERAL INSTRUMENT

(MCC670) 6N138
(MCC671) 6N139

PACKAGE DIMENSIONS



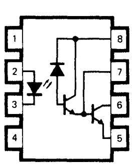


C1340

SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	0.400	10.16	
B	.270	6.86	
C	.130	3.30	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.055	1.40	2
M			3
N	175	4.45	4
P			5

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0.100 INCH

C1339B



PIN	
1	N/C
2	LED ANODE
3	LED CATHODE
4	N/C
5	GROUND
6	OUTPUT
7	OUTPUT BASE
8	V_{CC}

C1385

DESCRIPTION

The 6N138 and 6N139 are optically coupled isolators witha split-darlington output configuration. A red visible emitting diode manufactured from specially grown gallium arsenide is coupled to a photo sensitive circuit.

FEATURES

- High sensitivity to low input currents
  6N138—300% minimum CTR (I_F = 1.6 mA)
  6N139—400% minimum CTR (I_F = 0.5 mA)
- Fast switching capability at logic loads
  6N138—10 Microseconds (t_{on})
  35 Microseconds (t_{off})
  6N139— 1 Microseconds (t_{on})
  7 Microseconds (t_{off})
- UL Recognized (File #E51501)
- High input to output isolation = 3000V DC withstand test voltage

APPLICATIONS

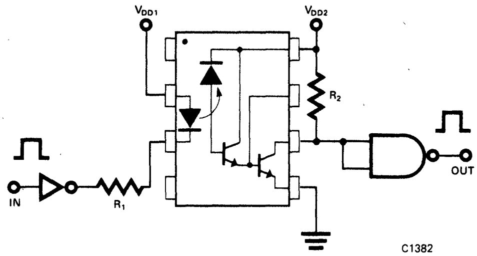
- CMOS logic interface
- Telephone ring detector
- Low input TTL interface
- Power supply isolation

ABSOLUTE MAXIMUM RATINGS*

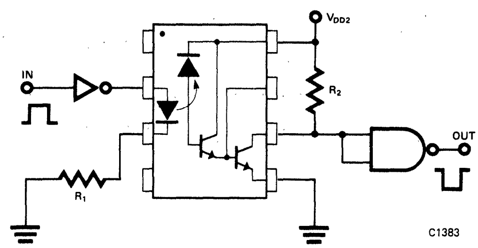
Storage Temperature . . . . -55°C to +125°C
Operating Temperature . . . . 0°C to +70°C
Lead Solder Temperature . . . . 260°C for 10 Sec
(1/16" below seating plane)
Average Input Current — I_F . . . . 20 mA
(See Note 1)
Peak Input Current — I_F . . . . 40 mA
(50% Duty Cycle, 1 ms Pulse Width)
Peak Transient Input Current — I_F . . . . 1.0 A
($\leq$ 1 μsec pulse width, 300 pps)
Reverse Input Voltage — V_R . . . . 5 V

Input Power Dissipation . . . . 35 mW
(See Note 2)
Output Current — I_O (Pin 6) . . . . 60 mA
(See Note 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
(See Note 4)

*JEDEC registered data



NON-INVERTING LOGIC INTERFACE



INVERTING LOGIC INTERFACE

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

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

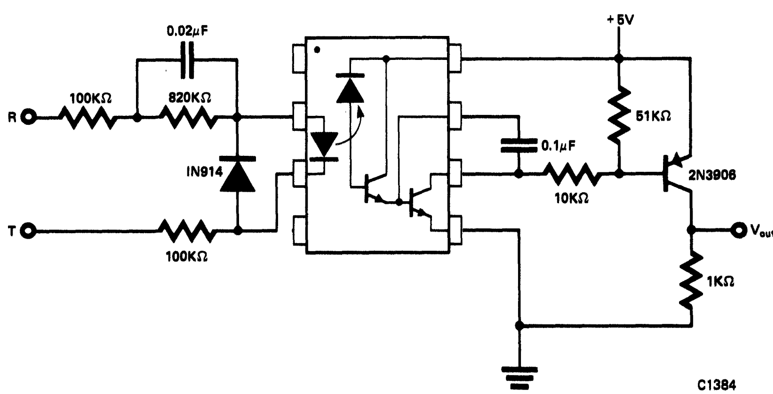
$$R_2 = \frac{V_{DD2} - V_{OLX} (@\ I_L + I_2)}{I_L}$$

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

<table>
<tr><th colspan="3"></th><th colspan="7">OUTPUT</th></tr>
<tr><th colspan="2" rowspan="2">INPUT</th><th></th><th>CMOS @ 5V</th><th>CMOS @ 10V</th><th>74XX</th><th>74LXX</th><th>74SXX</th><th>74LSXX</th><th>74HXX</th></tr>
<tr><th>R1 (Ω)</th><th>R2 (Ω)</th><th>R2 (Ω)</th><th>R2 (Ω)</th><th>R2 (Ω)</th><th>R2 (Ω)</th><th>R2 (Ω)</th><th>R2 (Ω)</th></tr>
<tr><td rowspan="2">CMOS @ 5V</td><td>NON-INV.</td><td>2000</td><td rowspan="14">1000</td><td rowspan="14">2200</td><td rowspan="14">750</td><td rowspan="14">1000</td><td rowspan="14">1000</td><td rowspan="14">1000</td><td rowspan="14">560</td></tr>
<tr><td>INV.</td><td>510</td></tr>
<tr><td rowspan="2">CMOS @ 10V</td><td>NON-INV.</td><td>5100</td></tr>
<tr><td>INV.</td><td>4700</td></tr>
<tr><td rowspan="2">74XX</td><td>NON-INV.</td><td>2200</td></tr>
<tr><td>INV.</td><td>180</td></tr>
<tr><td rowspan="2">74LXX</td><td>NON-INV.</td><td>1800</td></tr>
<tr><td>INV.</td><td>100</td></tr>
<tr><td rowspan="2">74SXX</td><td>NON-INV.</td><td>2000</td></tr>
<tr><td>INV.</td><td>360</td></tr>
<tr><td rowspan="2">74LSXX</td><td>NON-INV.</td><td>2000</td></tr>
<tr><td>INV.</td><td>180</td></tr>
<tr><td rowspan="2">74HXX</td><td>NON-INV.</td><td>2000</td></tr>
<tr><td>INV.</td><td>180</td></tr>
</table>

RESISTOR VALUES FOR LOGIC INTERFACE



TELEPHONE RINGING DETECTION USING OPTO-ISOLATOR

ELECTRICAL CHARACTERISTIC CURVES (25°C Free air temperature unless specified)

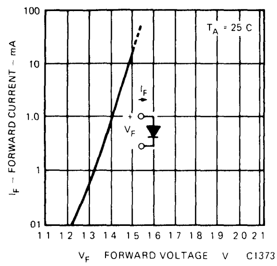


Fig. 1. Input Diode Forward Current vs. Forward Voltage

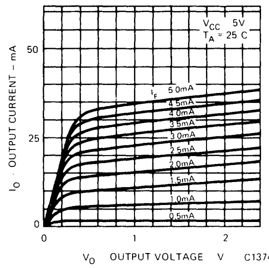


Fig. 2. 6N138 DC Transfer Characteristics

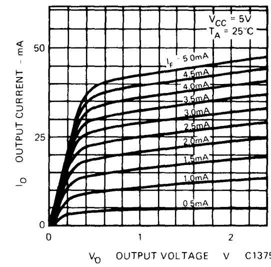


Fig. 3. 6N139 DC Transfer Characteristics

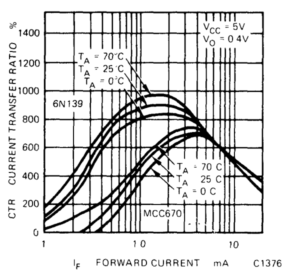


Fig. 4. Current Transfer Ratio vs. Forward Current

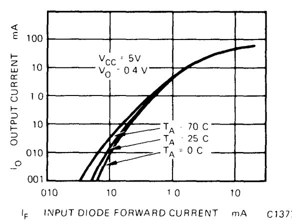


Fig. 5. 6N138 Output Current vs. Input Diode Forward Current

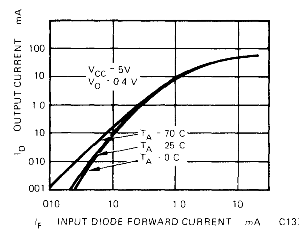


Fig. 6. 6N139 Output Current vs. Input Diode Forward Current

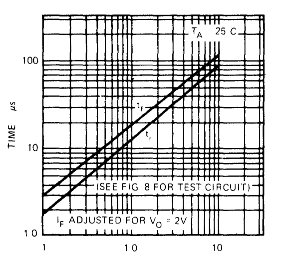


Fig. 7. Non-Saturated Rise and Fall Times vs. Load Resistance

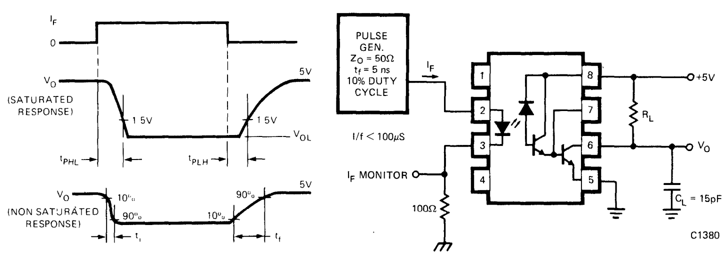


Fig. 8. Switching Test Circuit

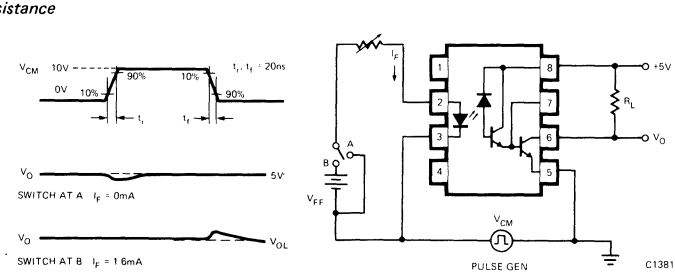


Fig. 9. Test Circuit for Transient Immunity and Typical Waveforms

ELECTRICAL SPECIFICATIONS (0° to +70°C Temperature unless otherwise specified)

CHARACTERISTIC	SYMBOL	DEVICE	MIN	TYP*	MAX	UNITS	TEST CONDITIONS
*Current Transfer Ratio (Notes 5, 6)		6N139	400	800		%	I_F = 0.5 mA, V_O = 0.4 V, V_{CC} = 4.5 V
			500	900			I_F = 1.6 mA, V_O = 0.4 V, V_{CC} = 4.5 V
		6N138	300	600		%	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}	6N138/6N139		0.20		mA	I_F = 1.6 mA, V_O = Open, V_{CC} = 5 V
Logic High Supply Current (Note 6)	I_{CCH}	6N138/6N139		10.0		nA	I_F = 0 mA, V_O = Open, V_{CC} = 5 V
*Input Forward Voltage	V_F	6N138/6N139		1.45	1.7	V	I_F = 1.6 mA, T_A = 25°C
Reverse Breakdown Voltage	BV_R	6N138/6N139	5			V	I_R = 10 µA, T_A = 25°C
Temperature Coefficient of Forward Voltage	$\frac{\Delta V_F}{\Delta T_A}$	6N138/6N139		−1.8		mV/°C	I_F = 1.6 mA
Input Capacitance	C_O	6N138/6N139		40		pF	f = 1 MHz, V_F = 0
*Isolation Leakage (Input-Output) (Note 7)	I_{I-O}	6N138/6N139			1.0	µA	45% Relative Humidity, T_A = 25°C V_{I-O} = 3000 V, t_d = 5 sec
Resistance (Input-Output) (Note 7)	R_{I-O}	6N138/6N139		10^{12}		Ω	V_{I-O} = 500 Vdc
Capacitance (Input-Output) (Note 7)	C_{I-O}	6N138/6N139		0.6		pF	f = 1 MHz

(All typicals at T_A = 25°C and V_{CC} = 5 V, unless otherwise noted.)

SWITCHING SPECIFICATIONS (T_A = 25°C)

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 kΩ
		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 kΩ
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 kΩ
		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 kΩ
Common Mode Transient Immunity at Logic High Level Output (See Fig. 9; Note 9)	CM_H			>500		V/µs	I_F = 0 mA, R_L = 2.2 kΩ $\|V_{cm}\|$ = 10 V_{p-p}
Common Mode Transient Immunity at Logic Low Level Output (See Fig. 9; Note 9)	CM_L			<−500		V/µs	I_F = 1.6 mA, R_L = 2.2 kΩ $\|V_{cm}\|$ = 10 V_{p-p}

NOTES

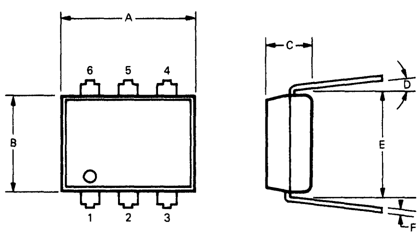
1. *Derate linearly above 50°C free-air temperature at a rate of 0.4 mA/°C.*
2. *Derate linearly above 50°C free-air temperature at a rate of 0.7 mW/°C.*
3. *Derate linearly above 25°C free-air temperature at a rate of 0.7 mA/°C.*
4. *Derate linearly above 25°C free-air temperature at a rate of 2.0 mW/°C.*
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).*

*JEDEC registered data

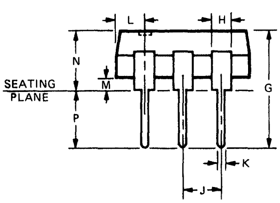
GENERAL INSTRUMENT

MCS2 MCS21 MCS2400 MCS2401

PACKAGE DIMENSIONS



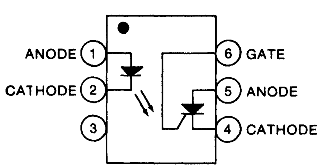
C1339



SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.365	9.27	
B	.270	6.86	
C	.160	4.06	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0.100 INCH

C1339A



C1339

DESCRIPTION

The MCS2, MCS21, MCS2400 and the MCS2401 devices consist of a photo SCR coupled to a gallium arsenide infrared diode in a six lead plastic DIP package. The MCS2 and the MCS21 have a blocking voltage rating of 200 volts while the MCS2400 and the MCS2401 have a 400 volt rating.

FEATURES

- Built-in memory
- AC switch (SPST)
- High current carrying capability (pulsed condition)
- Plastic dual-in-line package
- High isolation resistance — 10^{11} Ω
- Compact, rugged, light-weight
- Low coupling capacitance . . . 1.0 pF typical
- UL recognized (File #E50151)

APPLICATIONS

The Photo SCR coupled pair is intended for applications where complete electrical isolation is required between low power circuitry, such as integrated circuits, and AC line voltages. It provides high speed switching of relay functions. Because of its bistable characteristics, it lends itself for use as a latching relay in direct current circuits.

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 soldering temperature (10 sec.)	260° C
Insulation withstand voltage	2500 $V_{AC(RMS)}$
(1 minute duration)	3535 $V_{AC(PEAK)}$

INPUT DIODE

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

OUTPUT SCR

Peak forward voltage	
MCS2	200 V
MCS21	200 V
MCS2400	400 V
MCS2401	400 V
Forward RMS current	300 mA
Peak forward current (100 μs, 120 pps)	3.0 A
Reverse gate voltage	6 V
Power dissipation	400 mW
Derate linearly above 25° C	5.3 mW/° C

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

TRANSFER CHARACTERISTIC

	CHARACTERISTIC	SYMBOL	DEVICE	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Turn-on current (Threshold)	I_{FT}	MCS2 MCS2400	0.5	—	14	mA	V_{FX} = 100 V R_{GK} = 27 KΩ
			MCS21 MCS2401	0.5	—	11	mA	V_{FX} = 100 V R_{GK} = 27 KΩ
						20	mA	V_{FX} = 50 V R_{GK} = 10 KΩ
SWITCHING	Turn-on time	t_{on}		—	7	—	µs	I_F = 30 mA R_{GK} = 10 KΩ V_{AK} = 50 V
ISOLATION	Dielectric withstand test voltage	V_{ISO}		2500	—	—	VAC (RMS)	Relative humidity ≤ 50% I_{I-O} ≤ 10 µA, 1 minute
				3535	—	—	VAC (PEAK)	
	Isolation resistance	R_{ISO}		10^{11}	—	—	ohms	V_{I-O} = 500 V
	Package capacitance input-output	C_{IO}		—	0.7	—	pF	V_{I-O} = 0, f = 1 mHz
	Coupled dv/dt input-output	dv/dt		500	—	—	V/µs	See Fig. 11

INDIVIDUAL COMPONENT CHARACTERISTICS

	CHARACTERISTIC	SYMBOL	DEVICE	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		—	1.15	1.5	V	I_F = 10 µA
	Reverse voltage	V_R		3	—	—	V	I_R = 10 µA
	Junction capacitance	C_J		—	50	—	pF	V = 0
OUTPUT SCR	Forward blocking voltage	V_{DM}	MCS2 MCS21	200	—		V	R_{GK} = 10 KΩ I_D = 150 µA T_A = 100° C
			MCS2400 MCS2401	400	—	—	V	
	Reverse blocking voltage	V_{RM}	MCS2 MCS21	200	—	—	V	R_{GK} = 10 KΩ I_D = 150 µA T_A = 100° C
			MCS2400 MCS2401	400	—	—	V	
	On-state voltage	V_{TM}		—	1.1	1.3	V	I_{TM} = 300 mA
	Off-state voltage	I_{DM}	MCS2 MCS21		50	µA		V_{DM} = 200 mA R_{GK} = 10 KΩ T_A = 100° C
			MCS2400 MCS2401	—	—	150	µA	V_{DM} = 400 V R_{GK} = 10 KΩ T_A = 100° C
	Reverse current	I_{RM}	MCS2 MCS21	—	—	50	µA	V_{DM} = 200 V R_{GK} = 10 KΩ T_A = 100° C
			MCS2400 MCS2401	—	—	150	µA	V_{DM} = 400 V R_{GK} = 100 KΩ T_A = 100° C
	Capacitance anode-gate gate-cathode	C_J		—	20 350	—	pF pF	V = 0, f = 1 MHz

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

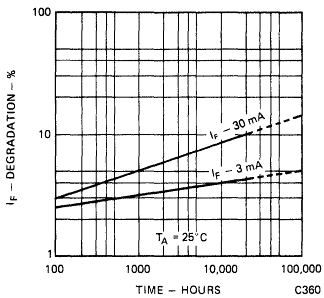


Fig. 1. LED Lifetime vs. Forward Current

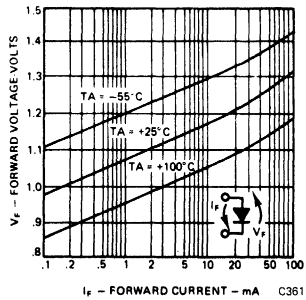


Fig. 2. Forward Voltage vs. Forward Current

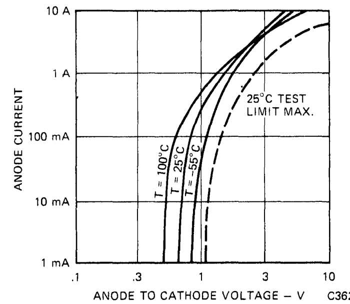


Fig. 3. Anode Current vs. Anode-Cathode Voltage

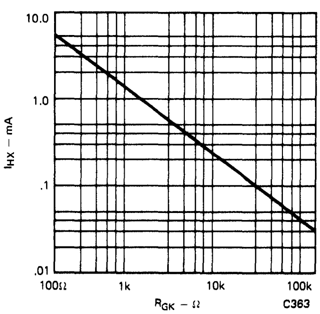


Fig. 4. Holding Current vs. Gate-Cathode Resistance

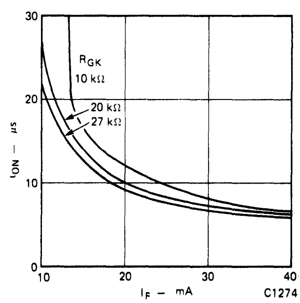


Fig. 5. Trigger Delay Time vs. Forward Current (note 1)

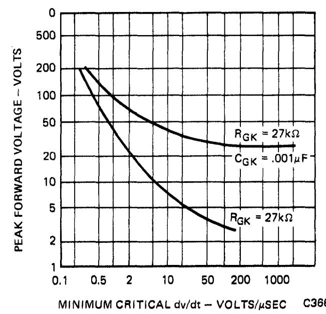


Fig. 6. Forward Blocking Voltage vs. Critical dV/dt

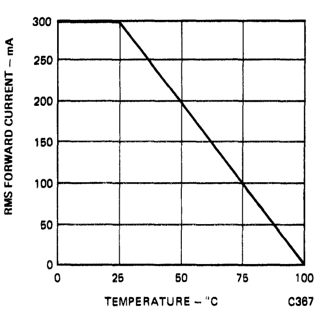


Fig. 7. Continuous Current Rating vs. Ambient Temperature

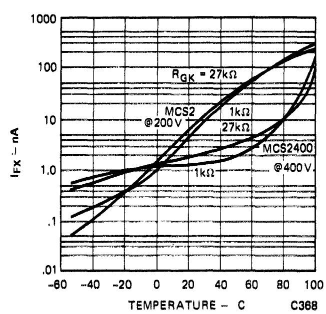


Fig. 8. Forward Leakage Current vs. Temperature

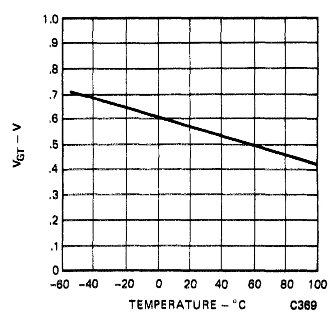


Fig. 9. Gate Trigger Voltage vs. Temperature

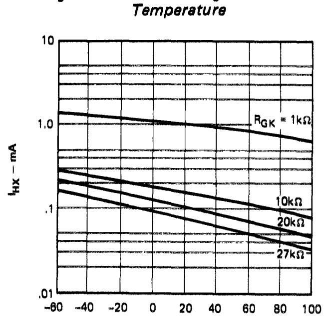


Fig. 10. Holding Current vs. Temperature

TYPICAL TEST CIRCUIT

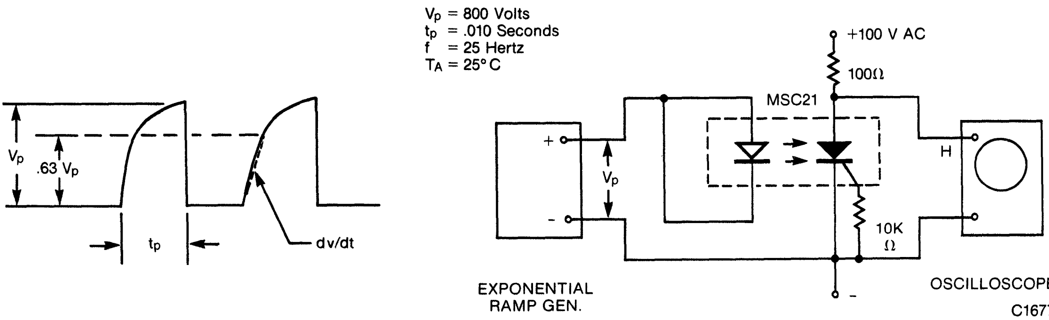
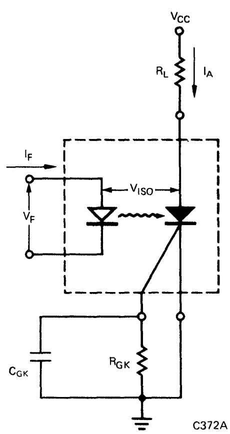
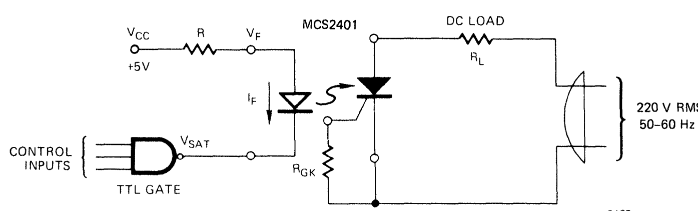


Fig. 11. Coupled dv/dt—Test Circuit

TYPICAL CIRCUIT APPLICATIONS



OPERATING SCHEMATICS



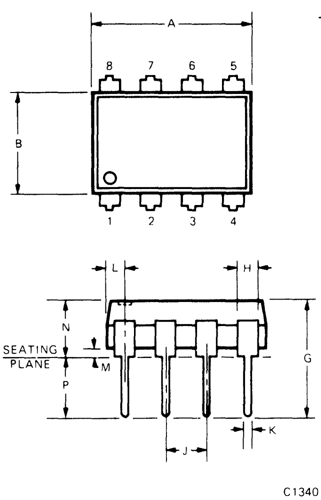
NOTES

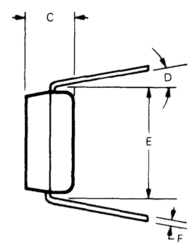
1. *The rise time of the SCR is typically less than 500 nanoseconds.*

GENERAL INSTRUMENT

HIGH CMR, HIGH SPEED MCL2601 (HCPL2601)

PACKAGE DIMENSIONS

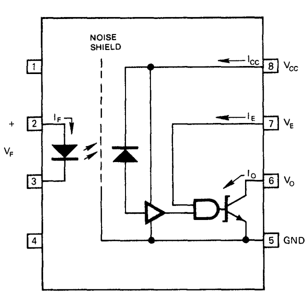




SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.400	10.16	
B	.270	6.86	
C	.130	3.30	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	022	0.56	
L	.055	1.40	2
M			3
N	.175	4.45	4
P			5

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0.100 INCH

C1339B



TRUTH TABLE
(Positive Logic)

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

A 0.01 to 0.1μF bypass capacitor must be connected between pins 8 and 5. (See note 1)

Fig. 1. Equivalent Circuit

DESCRIPTION

The MCL2601 is an optoisolator which combines a GaAsP LED as the emitter and an integrated high gain multi-stage high speed photo-detector. The output of the detector circuit is an open collector, Schottky clamped transistor capable of sinking 25mA (max.).

A Faraday shield integrated on the photodetector chip reduces the effects of capacitive coupling between the input LED emitter and the high gain stages of the detector. This provides an effective common mode transient immunity of 1000V/μS or equivalence of 300V P.P. sinusoid at 1MHz.

The circuit is packaged in a plastic 8-pin mini-DIP designed to provide for 3000V D.C. voltage isolation.

FEATURES

- High speed - 10 Mbs. typical
- Internal shielding - High common mode rejection
- High common mode transient immunity – 1000 V/μs minimum
- TTL compatible
- Low input current
- Specified characteristics over temperature: 0°C to 70°C
- Output - strobable
- UL recognized (File #50151)
- High input to output isolation: 3000 V dc withstand test voltage
- Pin for pin compatible to Hewlett Packard's HCPL-2601

APPLICATIONS

- Isolated line receiver
- Microprocessor system interface
- Data transmission isolation
- Digital isolation for A/D, D/A circuits.
- Ground loop elimination
- Instrument input/output isolation
- Replacement for pulse transformer

ABSOLUTE MAXIMUM RATING (between 0°C and 70°C)

Storage Temperature . . . . -55°C to +125°C
Operating Temperature . . . . 0°C to +70°C
Lead Solder Temperature . . . . 260°C for 10S
D-C/Average Forward Input Current 20mA
Enable Input Voltage, (V_E)
(Not To Exceed V_{CC} By More Than 500mV) . . . 5.5V

Reverse Input Voltage 5.0V
Reverse Supply Voltage (-V_{CC}) . . . . -500mV
Supply Voltage, (V_{CC}) . . . . 7.0V/1 Minute Maximum
Output Current, (I_O) 25mA
Output Voltage, (V_O) 7.0V
Collector Output Power Dissipation 40mW

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	

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

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

PARAMETER	SYMBOL	MIN.	*TYP.	MAX.	UNITS	TEST CONDITIONS
High Level Output Current	I_{OH}		.02nA	250	µA	V_{CC} = 5.5V, V_O = 5.5V I_F = 250µA, V_E = 2.0V
Low Level Output Voltage	V_{OL}		.34	0.6	V	V_{CC} = 5.5V, I_F = 5mA V_E = 2.0V, I_{OL} = 13mA
High Level Supply Current	I_{CCH}		10	15	mA	V_{CC} = 5.5V, I_F = 0mA V_E = 0.5V
Low Level Supply Current	I_{CCL}		15	18	mA	V_{CC} = 5.5V, I_F = 10mA V_E = 0.5V
Low Level Enable Current	I_{EL}		-1.5	-2.0	mA	V_{CC} = 5.5V, V_E = 0.5V
High Level Enable Current	I_{EH}		-1.0		mA	V_{CC} = 5.5V, V_E = 2.0V
High Level Enable Voltage	V_{EH}	2.0			V	V_{CC} = 5.5V, I_F = 10mA
Low Level Enable Voltage	V_{EL}			0.8	V	Note: 11
Input Forward Voltage	V_F		1.55	1.75	V	I_F = 10mA, T_A = 25°C
Input Reverse Breakdown Voltage	B_{VR}	5.0			V	I_R = 10µA, T_A =25°C
Input Capacitance	C_{IN}		30		pF	V_F = 0, f = 1MHz
Input Diode Temperature Coefficient	$\Delta V_F / \Delta T_A$		-1.4		mv/°C	I_F = 10mA
Input-Output Insulation Leakage Current	$I_{I\text{-}O}$			1.0	µA	Relative Humidity = 45% T_A = 25°C, t = 5s $V_{I\text{-}O}$ = 3000 VDC Note: 10
Resistance (Input to Output)	$R_{I\text{-}O}$		10^{12}		Ω	$V_{I\text{-}O}$ = 500V, Note: 10
Capacitance (Input to Output)	$C_{I\text{-}O}$		0.6		pF	f = 1MHz, Note: 10

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

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

PARAMETER	SYMBOL	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 = 350Ω C_L = 15pF
Output Rise Time (10-90%)	t_r		30		ns	I_F = 7.5mA
Output Fall Time (90-10%)	t_f		14		ns	Notes 2, 3, 4 & 5, Figure 8
Enable Propagation Delay Time (For Output High Level)	t_{ELH}		25		ns	I_F = 7.5mA V_{EH} = 3.0V V_{EL} = 0V
Enable Propagation Delay Time (For Output Low Level)	t_{EHL}		14		ns	R_L = 350Ω, C_L = 15pf Notes 6 & 7, Figure 9
Common Mode Transient Immunity (At Output High Level)	CM_H	1000	10,000		v/µs	V_{CM} = 50V (Peak) I_F = 0mA, V_{ON} (Min.) = 2.0V R_L = 350Ω, Note 9 Figure 13
Common Mode Transient Immunity (At Output Low Level)	CM_L	-1000	–10,000		v/µs	V_{CM} = 50V (Peak) I_F = 7.5mA, V_{OL} (Max.) = 0.8V R_L = 350Ω Note 8, Figure 13

TYPICAL CHARACTERISTIC CURVES (25°C Free Air temperature unless otherwise noted)

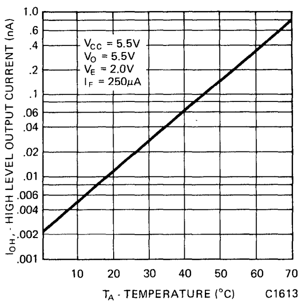


Fig. 2. High Level Output Current vs. Temperature

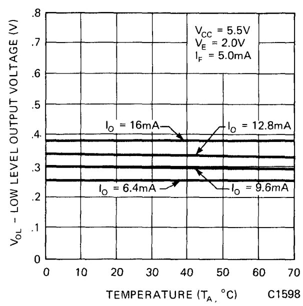


Fig. 3. Low Level Output Voltage vs. Temperature

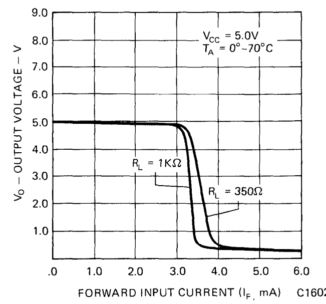


Fig. 4. Output Voltage vs. Forward Input Current

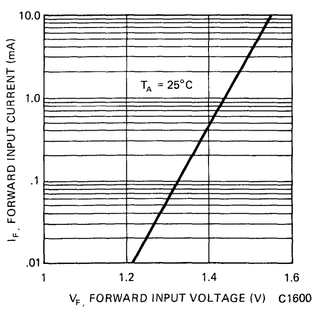


Fig. 5. Forward Input Current vs. Forward Input Voltage

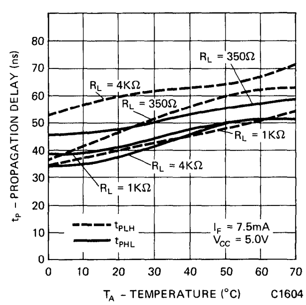


Fig. 6. Propagation Delay vs. Temperature

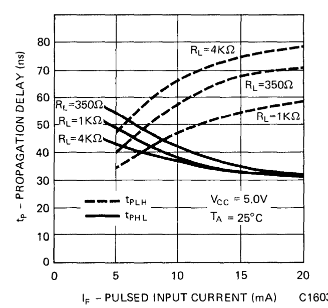


Fig. 7. Propagation Delay vs. Pulse Input Current

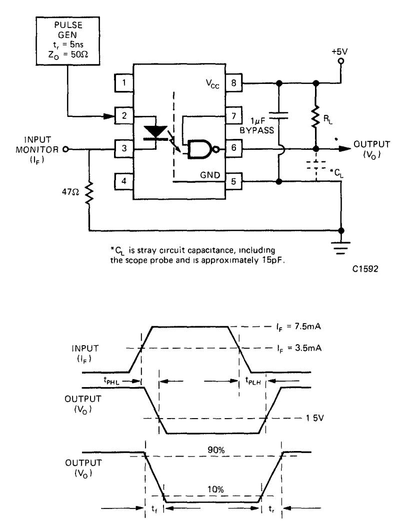


Fig. 8. Test Circuit t_{PHL}, t_{PLH}, t_r, and t_f

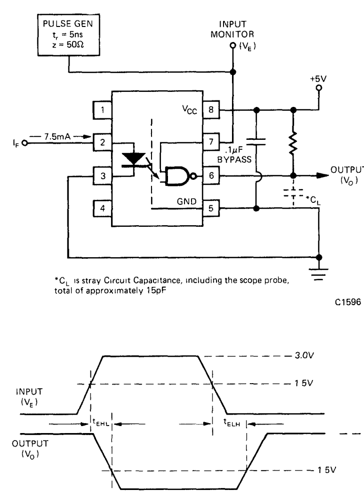


Fig. 9. Test Circuit t_{EHL} and t_{ELH}

TYPICAL CHARACTERISTIC CURVES (25°C Free Air temperature unless otherwise noted)

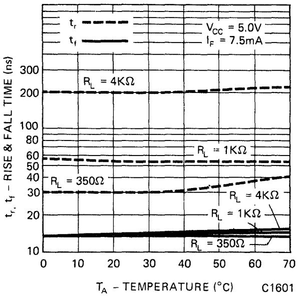


Fig. 10. Rise and Fall Time vs. Temperature

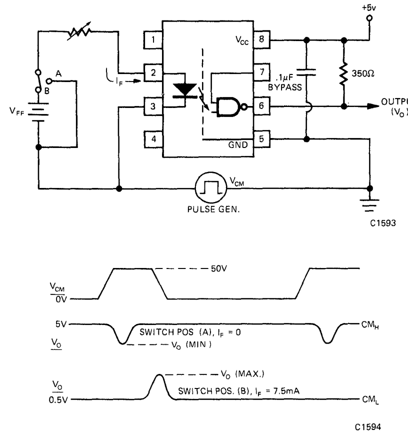


Fig. 13. Test Circuit Common Mode Transient Immunity

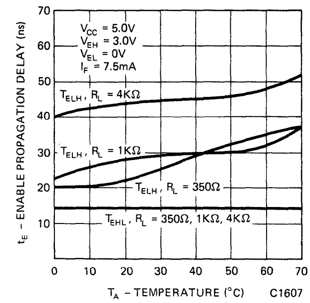


Fig. 11. Enable Propagation Delay vs. Temperature

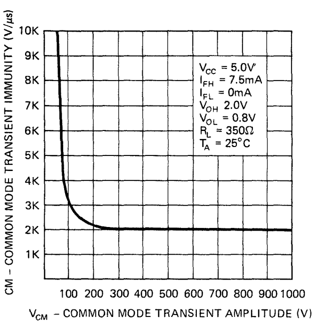


Fig. 12. Common Mode Transient Immunity vs. Common Mode Transient Amplitude C1590

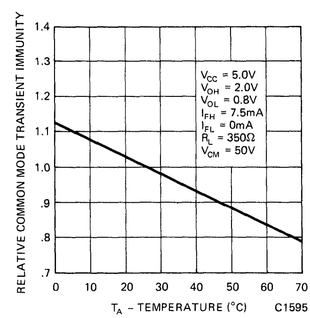


Fig. 14. Relative Common Mode Transient Immunity vs. Temperature

NOTES

1. *The V_{CC} supply voltage to each MCL2601 isolator must be bypassed by a 0.01µF 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 3.75mA level on the LOW to HIGH transition of the input current pulse to the 1.5V level on the HIGH to LOW transition of the output voltage pulse.*
3. *t_{PLH} - Propagation delay is measured from the 3.75mA level on the HIGH to LOW transition of the input current pulse to the 1.5V 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 10% levels of the LOW to HIGH transition on the output pulse.*
6. *t_{EHL} - Enable input propagation delay is measured from the 1.5V level on the LOW to HIGH transition of the input voltage pulse to the 1.5V level on the HIGH to LOW of the output voltage pulse.*
7. *t_{ELH} - Enable input propagation delay is measured from the 1.5V level on the HIGH to LOW transition of the input voltage pulse to the 1.5V 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., $V_{OUT} < 0.8V$). 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., $V_{OUT} > 2.0V$). Measured in volts per microsecond (V/µs).*

   Volts/microsecond can be translated to sinusoidial voltages:

   $$V/\mu s = \left(\frac{d\,V_{CM}}{dt}\right)_{Max.} = \pi f_{CM} V_{CM} \text{ (p.p.)}$$

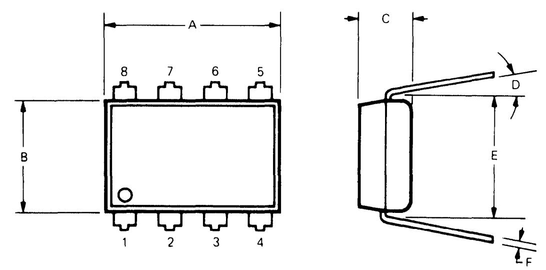
   Example:

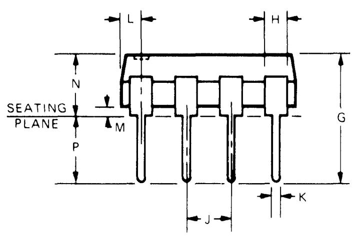
   $V_{CM} = 318 V_{PP}$ when f_{CM} = 1MHz using CM_L and CM_H = 1000V/µs data sheet specified minimum.
10. *- Device considered a two-terminal device: Pins 1, 2, 3 and 4 shorted together, and Pins 5, 6, 7 and 8 shorted together.*
11. *Enable Input - No pull up resistor required as the device has an internal pull up resistor.*

GENERAL INSTRUMENT

HIGH SPEED 6N137

PACKAGE DIMENSIONS*



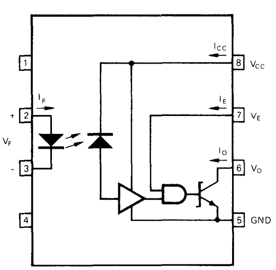


SYMBOL	INCHES MAX	mm MAX	NOTES
A	400	10 16	
B	270	6 86	
C	130	3 30	
D	15°	15°	
E	300 Ref	7 62 Ref	1
F	014	0 36	
G	325	8 26	
H	070	1 78	
J	110	2 79	
K	022	0 56	
L	055	1 40	2
M			3
N	175	4 45	4
P			5

NOTES
1 INSTALLED POSITION OF LEAD CENTERS
2 FOUR PLACES
3 OVERALL INSTALLED POSITION
4 THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5 MINIMUM 0 100 INCH

C1339B

DIMENSIONS IN INCHES AND (MILLIMETERS)



TRUTH TABLE
(POSITIVE LOGIC)

INPUT	ENABLE	OUTPUT
H	H	L
L	H	H
H	L	H
L	L	H

A 0.01 to 0.1μF BYPASS CAPACITOR MUST BE CONNECTED BETWEEN PINS 8 AND 5. (SEE NOTE 1)

Fig. 1. Equivalent Circuit

DESCRIPTION

The 6N137 is an optoisolator which combines a GaAsP LED as the emitter and an integrated high gain multi-stage high speed photodetector. The output of the detector circuit is an open collector, Schottky clamped transistor capable of sinking 50mA. The open collector output provides capability for bussing, OR'ing and strobing.

The circuit is packaged in a plastic 8-pin mini-DIP designed to provide for 3000V D.C. isolation withstand test voltage.

FEATURES

- High speed
- High common mode transient immunity
- TTL compatible
- Low input current
- Specified characteristics over temperature: 0°C to 70°C
- Output—Strobable
- UL recognized (File #50151)
- High input to output isolation: 3000V dc withstand test voltage

APPLICATIONS

- Isolated line receiver
- Microprocessor system interface
- Data transmission isolation
- Digital isolation for A/D, D/A circuits
- Ground loop elimination
- Instrument input/output isolation
- Replacement for pulse transformer

ABSOLUTE MAXIMUM RATINGS* (Between 0°C and 70°C)

Storage Temperature . . . . -55°C to +125°C
Operating Temperature . . . . 0°C to +70°C
Lead Solder Temperature
(1.6mm. Below seating plane) . . . . . . 260°C for 10S
D-C/Average Forward Input Current 20mA
Peak Forward Input Current
($t \leqslant 1.0$msec duration) 40mA

Enable Input Voltage, (V_E)
(Not to exceed V_{CC} by more than 500mV) 5.5V
Supply Voltage, (V_{CC}) . . . . 7.0V/1 minute maximum
Reverse Supply Voltage (V_{CC}) . . . . −500mV
Output Current, (I_O) 50mA
Output Voltage, (V_O) 7.0V
Collector Output Power Dissipation 85mW
Reverse Input Voltage 5V

*JEDEC Registered Data.

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	

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

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

PARAMETER	SYMBOL	MIN.	**TYP.	MAX.	UNITS	TEST CONDITIONS
High Level Output Current	I_{OH}*		.01 .02	250	μA nA	V_{CC} = 5.5V, V_O = 5.5V I_F = 250μA, V_E = 2.0V Figure 6
Low Level Output Voltage	V_{OL}*		.34	0.6	V	V_{CC} = 5.5V, I_F = 5mA V_E = 2.0V, I_{OL} = 13mA Figure 5
High Level Supply Current	I_{CCH}*		10	15	mA	V_{CC} = 5.5V, I_F = 0mA V_E = 0.5V
Low Level Supply Current	I_{CCL}*		15	18	mA	V_{CC} = 5.5V, I_F = 10mA V_E = 0.5V
Low Level Enable Current	I_{EL}*		-1.5	-2.0	mA	V_{CC} = 5.5V, V_E = 0.5V
High Level Enable Current	I_{EH}		-1.0		mA	V_{CC} = 5.5V, V_E = 2.0V
High Level Enable Voltage	V_{EH}	2.0			V	V_{CC} = 5.5V, I_F = 10mA
Low Level Enable Voltage	V_{EL}			0.8	V	Note: 11
Input Forward Voltage	V_F*		1.55	1.75	V	I_F = 10mA, T_A = 25°C Figure 4
Input Reverse Breakdown Voltage	B_{VR}*	5.0			V	I_R = 10μA, T_A = 25°C
Input Capacitance	C_{IN}		30		pF	V_F = 0, f = 1MHz
Input Diode Temperature Coefficient	$\Delta V_F/\Delta T_A$		-1.4		mV/°C	I_F = 10mA
Input-Output Insulation Leakage Current	$I_{I\text{-}O}$*			1.0	μA	Relative Humidity = 45% T_A = 25°C, t = 5s $V_{I\text{-}O}$ = 3000 VDC Note: 10
Resistance (Input to Output)	$R_{I\text{-}O}$		10^{12}		Ω	$V_{I\text{-}O}$ = 500V Note: 10
Capacitance (Input to Output)	$C_{I\text{-}O}$		0.6		pF	F = 1MHz Note: 10
Current Transfer Ratio	CTR		750		%	I_F = 5.0mA R_L = 100Ω Note: 12

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

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

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Propagation Delay Time (For Output High Level)	t_{PLH}*		48	75	ns	R_L = 350Ω, C_L = 15pF, I_F = 7.5mA, Notes 2,3,4 & 5, Figures 7 & 10
Propagation Delay Time (For Output Low Level)	t_{PHL}*		48	75	ns	
Output Rise Time (10-90%)	t_r		30		ns	
Output Fall Time (90-10%)	t_f		14		ns	
Enable Propagation Delay Time (For Output High Level)	t_{ELH}		25		ns	I_F = 7.5mA, V_{EH} = 3.0V, V_{EL} = OV, R_L = 350Ω, C_L = 15pF, Notes 6 & 7, Figure 11
Enable Propagation Delay Time (For Output Low Level)	t_{EHL}		14		ns	
Common Mode Transient Immunity (At Output High Level)	CM_H	50			v/μs	V_{CM} = 10V (Peak), I_F = 0mA, V_{ON} (Min.) = 2.0V, R_L = 350Ω, Note 9, Figure 13
Common Mode Transient Immunity (At Output Low Level)	CM_L	-150			v/μs	V_{CM} = 10V (Peak), I_F = 5mA, V_{OL} (Max.) = 0.8V, R_L = 350Ω, Note 8, Figure 13

**JEDEC Registered Data.*

TYPICAL CHARACTERISTIC CURVES (25°C Free Air Temperature unless otherwise noted)

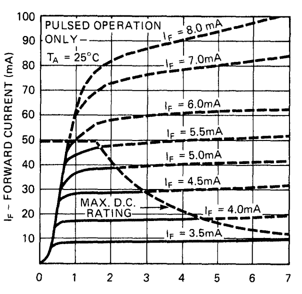


Fig. 2. Optoisolator Collector Characteristics

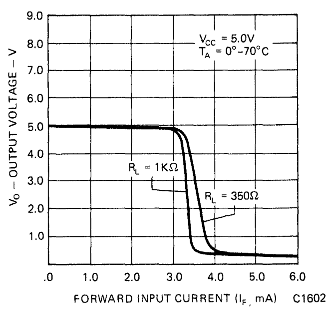


Fig. 3. Output Voltage vs. Forward Input Current

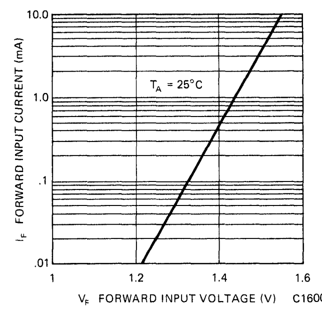


Fig. 4. Forward Input Current vs. Forward Input Voltage

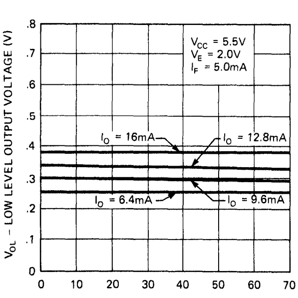


Fig. 5. Low Level Output Voltage vs. Temperature

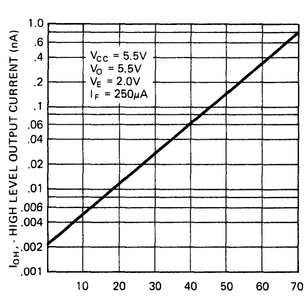


Fig. 6. High Level Output Current vs. Temperature

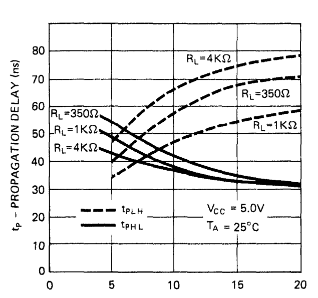


Fig. 7. Propagation Delay vs. Pulse Input Current

TYPICAL CHARACTERISTIC CURVES (25°C Free Air Temperature unless otherwise noted)

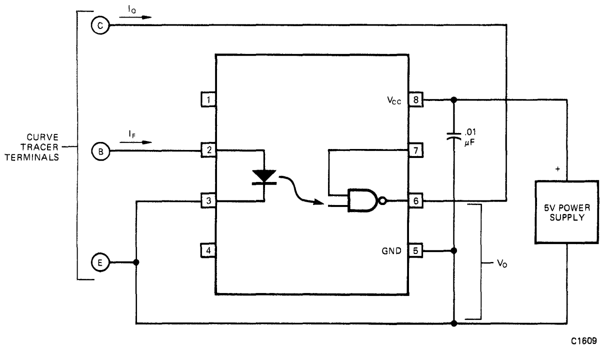


Fig. 8. Curve Tracer Connection to Obtain Collector Characteristics

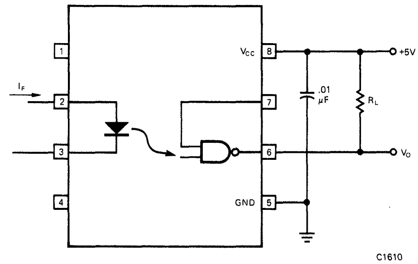


Fig. 9. Input-Output Schematic

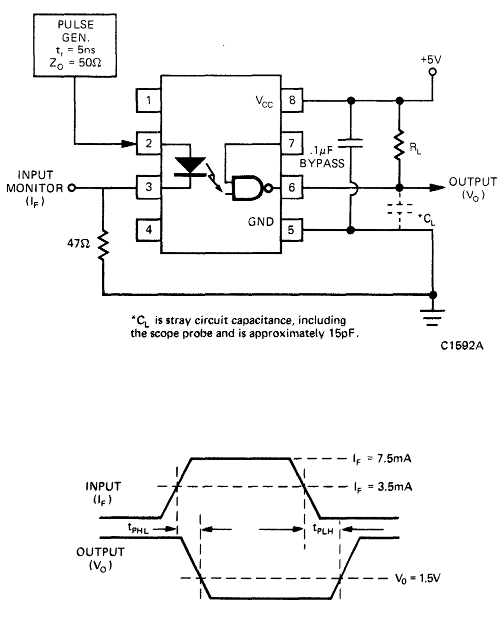


Fig. 10. Test Circuit t_{PHL} and t_{PLH}

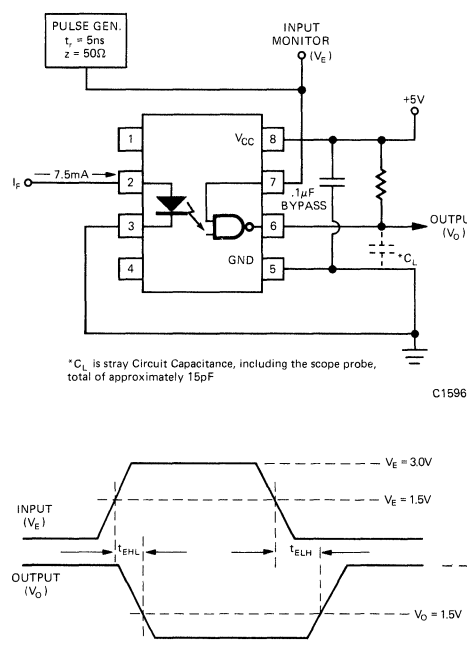


Fig. 11. Test Circuit t_{EHL} and t_{ELH}

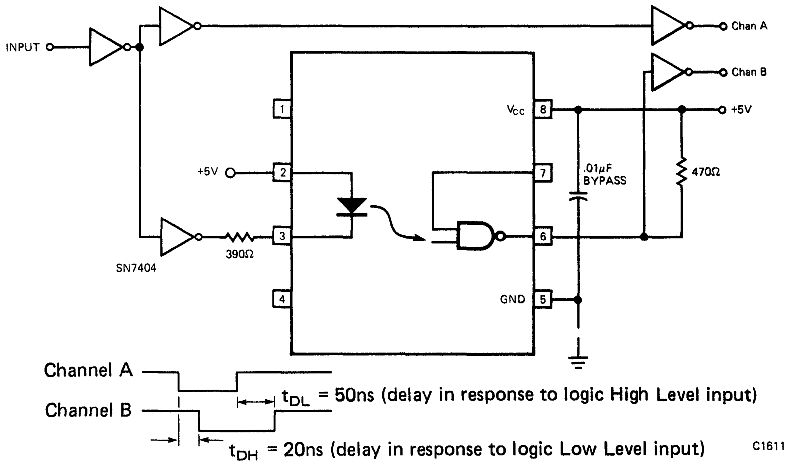


Fig. 12. Response Delay Between TTL Gates

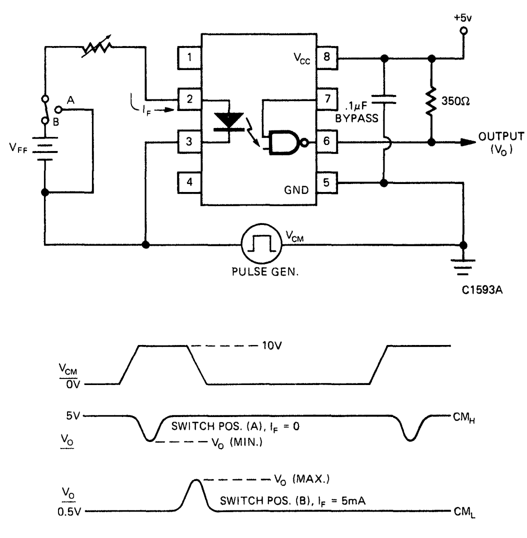


Fig. 13. Test Circuit for Transient Immunity and Typical Waveforms

NOTES

1. The V_{CC} supply voltage to each 6N137 isolator must be bypassed by a 0.01μF 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 3.75mA level on the LOW to HIGH transition of the input current pulse - to the 1.5V level on the HIGH to LOW transition of the output voltage pulse.

3. t_{PLH} - Propagation delay is measured from the 3.75mA level on the LOW to HIGH transition of the input current pulse - to the 1.5V 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 1.5V level on the LOW to HIGH transition of the input - voltage pulse to the 1.5V level on the HIGH to LOW of the output voltage pulse.

7. t_{ELH} - Enable input propagation delay is measured from the 1.5V level on the HIGH to LOW transition of the input - voltage pulse to the 1.5V 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., $V_{OUT} < 0.8V$). 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., $V_{OUT} > 2.0V$). Measured in volts per 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.

11. Enable Input - No pull up resistor required as the device has an internal pull up resistor.

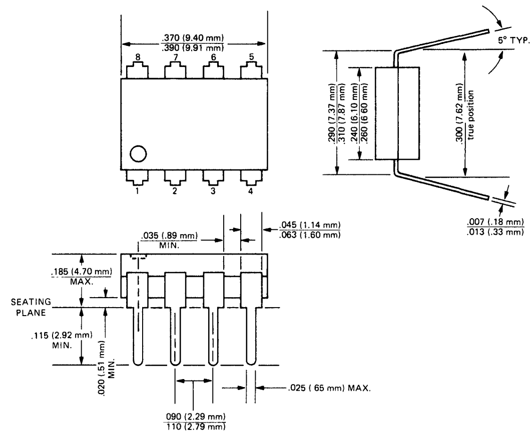
12. - DC current transfer ratio is defined as the ratio of the output collector current to the forward bias input current times 100%.

GENERAL INSTRUMENT

DUAL HIGH-SPEED TTL COMPATIBLE OPTOISOLATOR

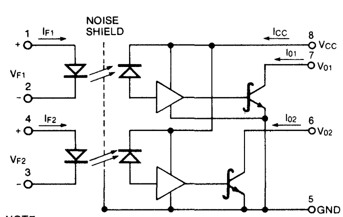
MCL2630 (HCPL2630)

PACKAGE DIMENSIONS



DIMENSIONS IN INCHES AND (MILLIMETERS)

C1589B



NOTE
A .01 TO 0.1μF BYPASS CAPACITOR MUST BE CONNECTED BETWEEN PINS 8 AND 5

Fig. 1. Equivalent Circuit

DESCRIPTION

The MCL2630 is a dual optoisolator which combines GaAsP LED as emitters and integrated high gain multi-stage high speed photo-detectors. The output of the detector circuits are open collector, Schottky clamped transistors.

The circuit is packaged in a plastic 8-pin mini-DIP designed to provide for 3000 V dc voltage isolation.

FEATURES

- High speed — 10 Mbs. typical
- High density packaging
- TTL compatible
- Low input current
- Specified characteristics over temperature: 0° C to 70° C
- UL recognized (File #50151)
- High input to output isolation: 3000 V dc withstand test voltage
- Pin-for-pin compatible to Hewlett-Packard's HCPL-2630
- Internal shield provides excellent common mode rejection

APPLICATIONS

- Isolated line receiver
- Microprocessor system interface
- Data transmission isolation
- Digital isolation for A/D, D/A circuits
- Ground loop elimination
- Instrument input/output isolation
- Replacement for pulse transformer

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

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 to 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}		30		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 = 5s, 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 = 5s V_{I-O} = 3000 V dc Note 10
Resistance (input to output)	R_{I-O}		10^{12}		Ω	V_{I-O} = 500 V, Note 10
Capacitance (input to output)	C_{I-O}		0.6		pF	f = 1 MHz, Note 10

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

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

PARAMETER	SYMBOL	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 = 350Ω 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	1,000	10,000		V/μs	V_{CM} = 50 V (peak) I_F =0 mA, V_{OL} (min) = 2.0 V R_L = 350Ω, Note 9, Fig. 12
Common mode transient immunity (At output low level)	CM_L	-1,000	-10,000		V/μs	V_{CM} = 50 V (peak) I_F = 7.5 mA, V_{OL} (max) = 0.8 V R_L = 350Ω, Note 8, Fig. 12

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

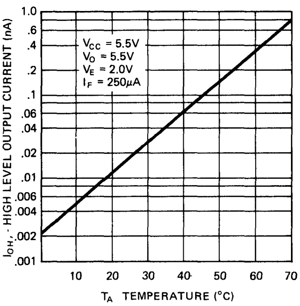


Fig. 2. High Level Output Current vs. Temperature

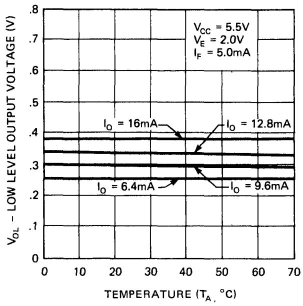


Fig. 3. Low level Output Voltage vs. Temperature

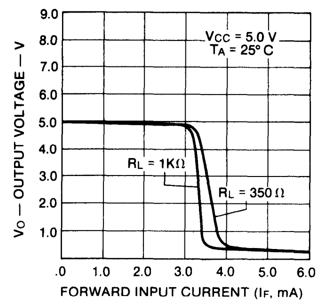


Fig. 4. Output Voltage vs. Forward Input Current

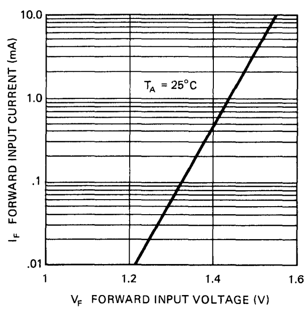


Fig. 5. Forward Input Current vs. Forward Input Voltage

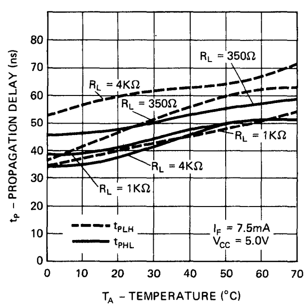


Fig. 6. Propagation Delay vs. Temperature

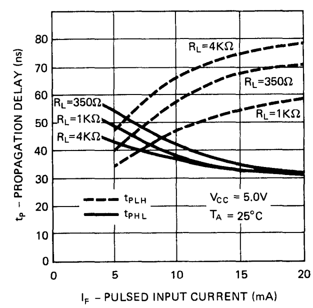


Fig. 7. Propagation Delay vs. Pulse Input Current

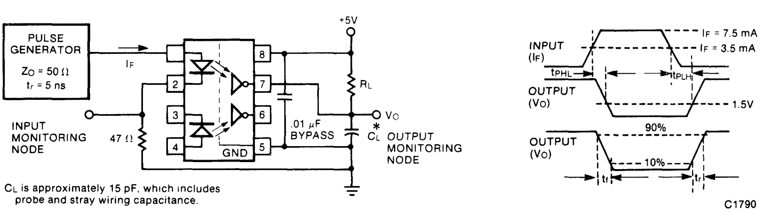
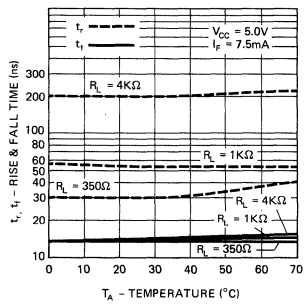


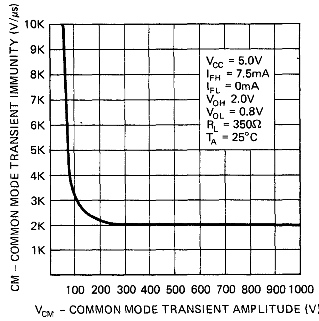
Fig. 8. Test Circuit t_{PHL}, t_{PLH}, t_r and t_f

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



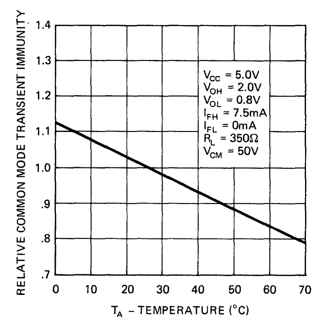
C1601

Fig. 9



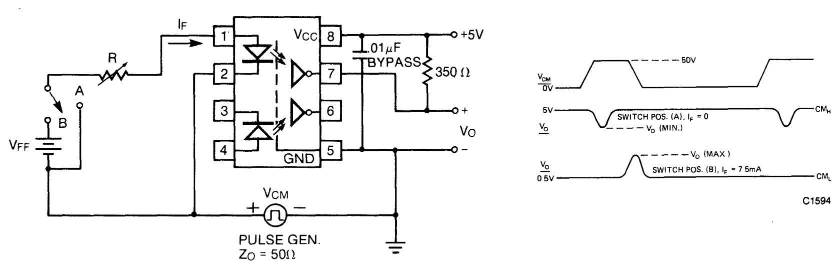
C1590

Fig. 10



C1595

Fig. 11



C1791

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 0.01µF 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 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/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).*

   Volts/microsecond can be translated to sinusoidial voltages:

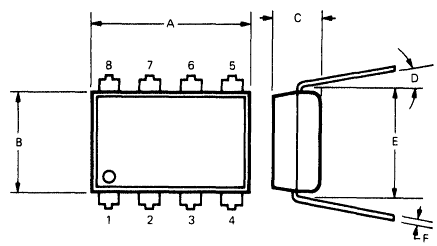
   $$V/\mu s = \left(\frac{d_{VCM}}{dt}\right)_{Max.} = \pi f_{CM} V_{CM} (p.p.)$$

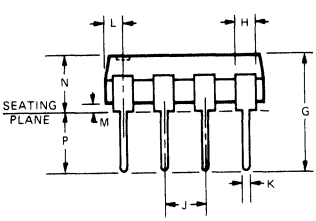
   Example: $V_{CM} = 318\ V_{pp}$ when $f_{CM} = 1$ MHz using CM_L and $CM_H = 1000$ V/µs.
10. *— Device considered a two-terminal device: Pins 1, 2, 3 and 4 shorted together, and Pins 5, 6, 7 and 8 shorted together.*

GENERAL INSTRUMENT

MID400

PACKAGE DIMENSIONS



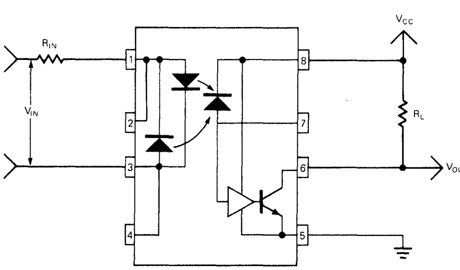


C1340

SYMBOL	INCHES MAX	mm MAX.	NOTES
A	.400	10.16	
B	.270	6.86	
C	.130	3.30	
D	15°	15°	
E	300 Ref.	7 62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	110	2.79	
K	.022	0.56	
L	.055	1.40	2
M			3
N	175	4 45	4
P			5

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2 FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0 100 INCH

C1339B



PIN	
1	V_{IN}
2	N/C
3	V_{IN}
4	N/C
5	GROUND
6	V_O
7	AUX.
8	V_{CC}

C1472

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 primarily 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 24 VAC to 240 VAC line 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 "line-down" condition
- "Closed-loop" interface between electromechanical 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)
Device Operation Input Voltage Range: 24 VAC to 240 VAC.

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 $\leq$ 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 $\geq$ 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 $\leq$ 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 $\geq$ 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 $\leq$ 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 $\geq$ 5.5 V
SWITCHING TIMES ($T_A = +25°C$)						
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%, $I_{I\text{-}O} \leq 10\mu A$
		2500			VACRMS	1 Second, 60 Hz
Steady State Isolation Voltage	V_{ISO}	3200			VDC	Relative Humidity $\leq$ 50%, $I_{I\text{-}O} \leq 10\mu A$
		2250			VACRMS	1 Minute, 60 Hz
Isolation Resistance	R_{ISO}	10^{11}			Ω	$V_{I\text{-}O} = 500$ 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 several 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:

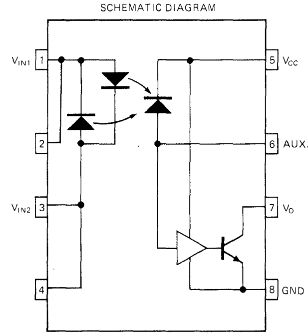
$$R_{IN} = \frac{V_{IN} - V_F}{I_{IN}}$$

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.

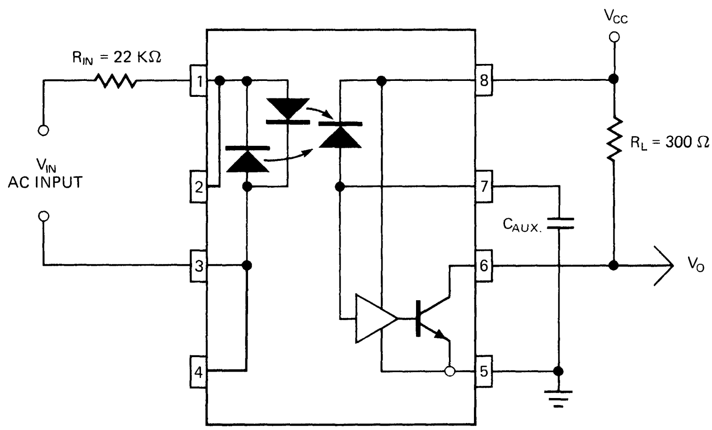
DYNAMIC CHARACTERISTICS

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.

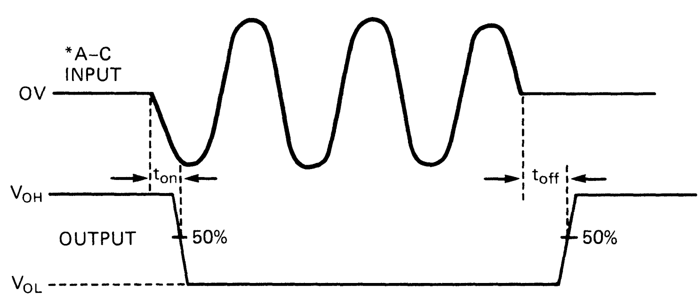
*Current flowing out of a terminal is a negative value.

OPERATING SCHEMATICS

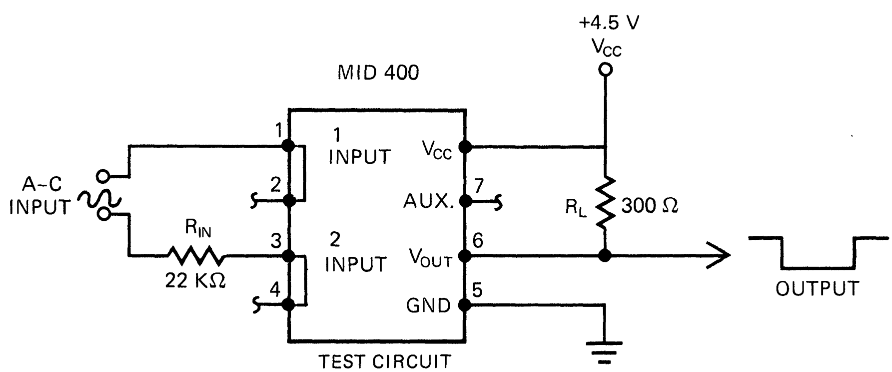


INPUT CURRENT VS. CAPACITANCE, $C_{AUX.}$ CIRCUIT
TEST CIRCUIT 1

C1478A



*INPUT TURNS ON AND OFF AT ZERO CROSSING.



TEST CIRCUIT 2

MID400 Switching Time

C1479A

TYPICAL CURVES

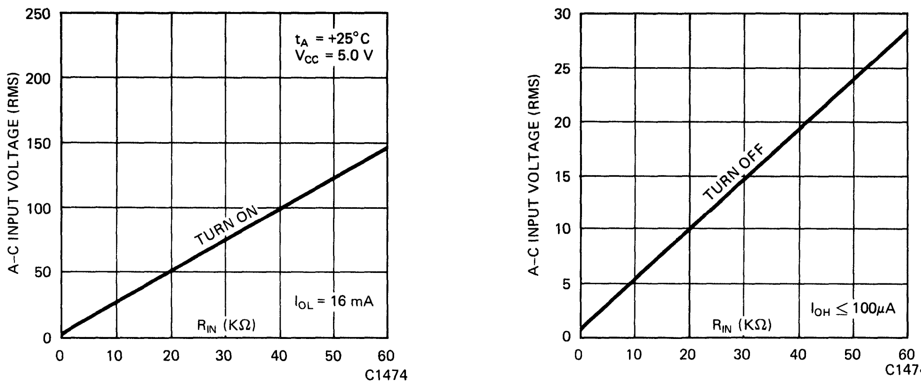


Fig. 2. Input Voltage vs. Input Resistance

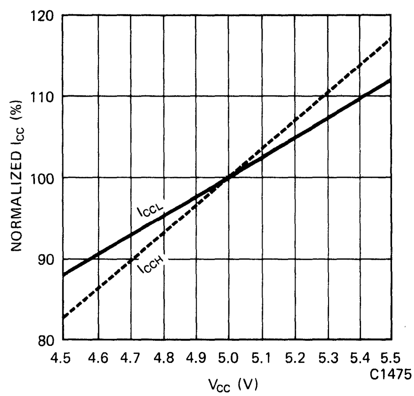


Fig. 3. Supply Current vs. Supply Voltage

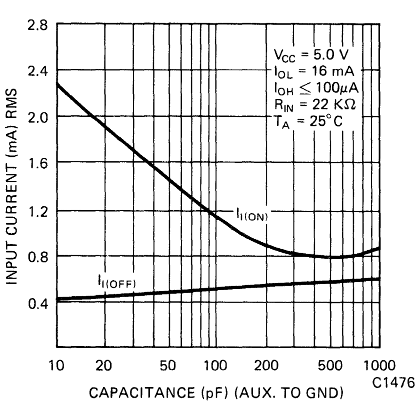


Fig. 4. Input Current vs. Capacitance (See test circuit 1)

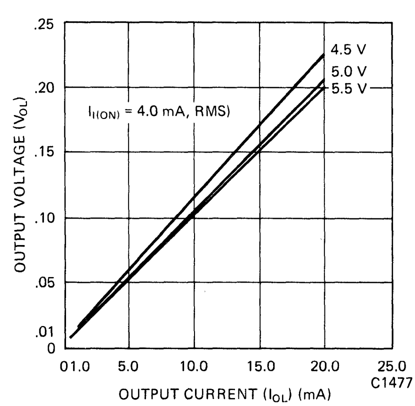
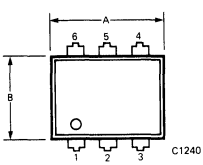


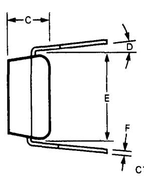
Fig. 5. Output Voltage vs. Output Current

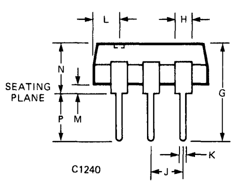
GENERAL INSTRUMENT

MCP3009
MCP3010
MCP3011

PACKAGE DIMENSIONS







SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.355	9.02	
B	.270	6.86	
C	.160	4.06	
D	15°	15°	
E	300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5

NOTES
1 INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5 MINIMUM 0.100 INCH

C1339A

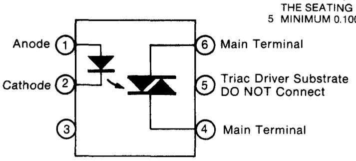


Fig. 1. Equivalent Circuit C1703

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

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 .... 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) 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%, $I_{I\text{-}O}$ ≤ 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 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° Free air temperature unless specified)

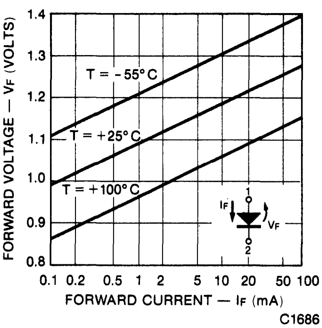


Fig. 2. Forward Voltage Drop vs. Forward Current

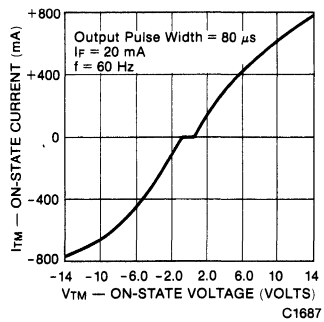


Fig. 3. On-State Characteristics

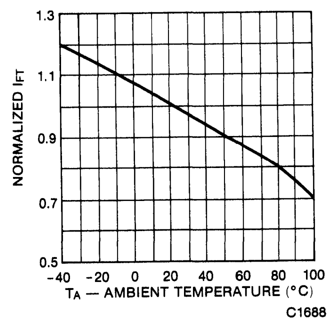


Fig. 4. Trigger Current vs. Temperature

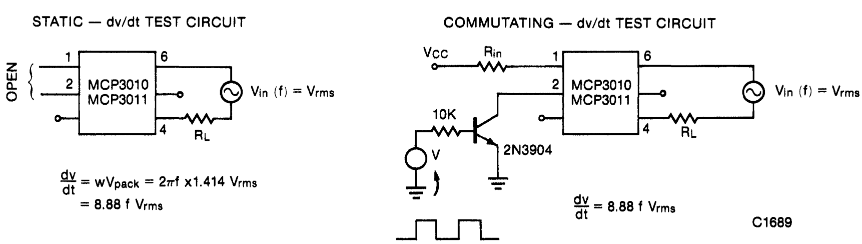


Fig. 5. dv/dt Test Circuits

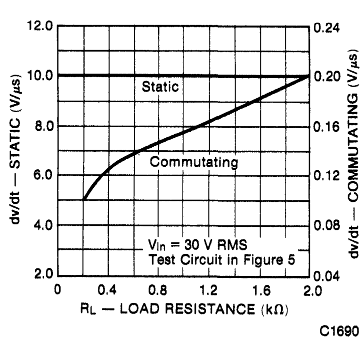


Fig. 6 dv/dt vs. Load Resistance

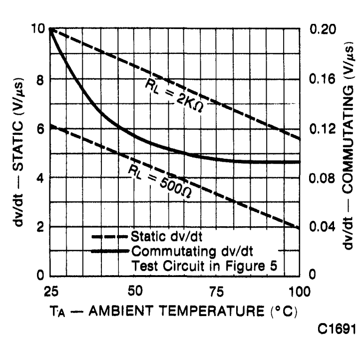


Fig. 7. dv/dt vs. Temperature

TYPICAL-ELECTRICAL CHARACTERISTIC CURVES

(25°C Temperature unless otherwise specified)

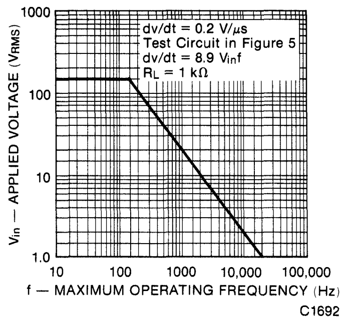


Fig. 8. Commutating dv/dt vs. Frequency

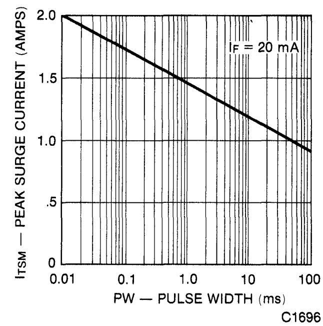


Fig. 9. Maximum Nonrepetitive Surge Current

TYPICAL APPLICATION CIRCUITS

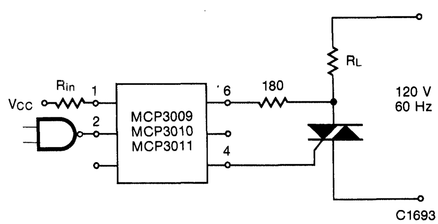


Fig. 10. Resistive Load

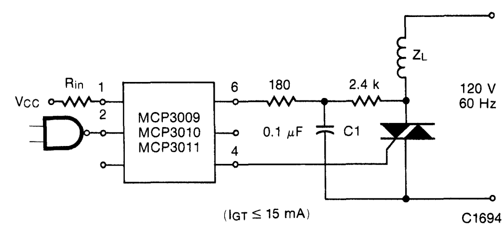


Fig. 11. Inductive Load With Sensitive Gate Triac

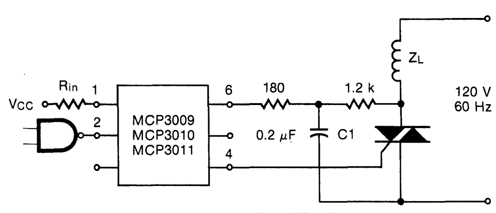


Fig. 12. Inductive Load With Non-Sensitive Gate Triac

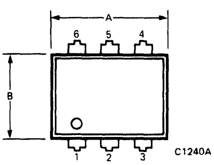
OPTICALLY ISOLATED
TRIAC DRIVER
250 VOLTS & 400 VOLTS

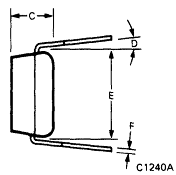
Optoisolators

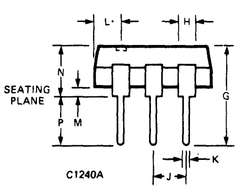
GENERAL INSTRUMENT

MCP3011A MCP3022A
MCP3012 MCP3023

PACKAGE DIMENSIONS







SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	355	9.02	
B	270	6.86	
C	.160	4.06	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0.100 INCH

C1339A

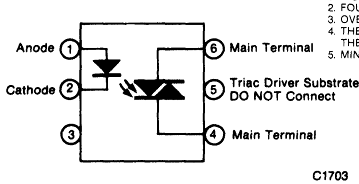


Fig. 1. Equivalent Circuit

DESCRIPTION

The MCP3011A, MCP3012, MCP3022A and MCP3023 are optically isolated triac driver devices These devices contain an 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 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	
MCP3011A, MCP3012	250 V
MCP3022A, 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)						
	MCP3011A, MCP3022A	I_{FT}			10	mA	Main terminal voltage = 3 V
	MCP3012, MCP3023				5		
	Holding current	I_H		200		μA	Either direction
dv/dt RATING	Critical rate of rise of off-state voltage						
	MCP3022A, MCP3023	dv/dt		15		V/μs	Static dv/dt, T_A = 85°C
	MCP3011A, 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						
	MCP3011A, MCP3012	I_{DRM}		10	100	nA	V_{DRM} = 250 V, Note 1
	MCP3022A, 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)

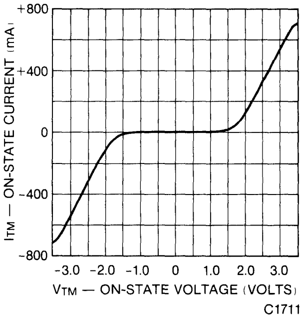


Fig. 2. On-State Characteristics

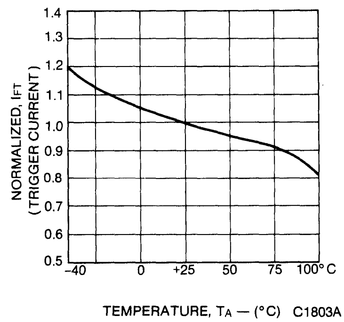


Fig. 3. Trigger Current vs. Temperature

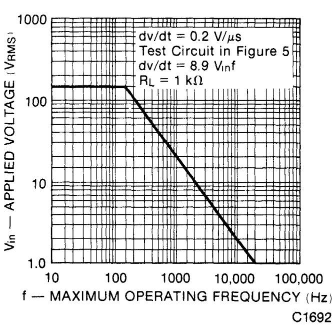


Fig. 4. Commutating dv/dt vs. Frequency

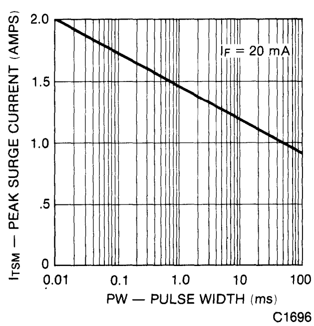


Fig. 5. Maximum Nonrepetitive Surge Current

Test Circuits for dv/dt measurements

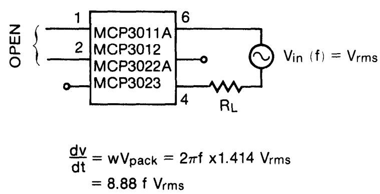


Fig. 6. Static dv/dt

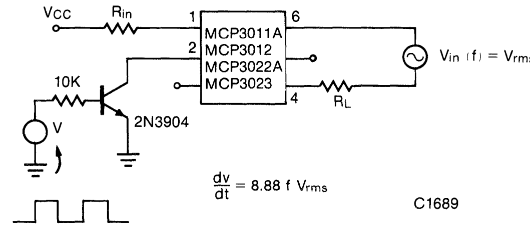


Fig. 7. Commutating dv/dt

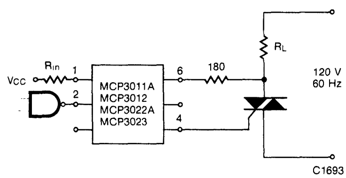


Fig. 8. Resistive Load

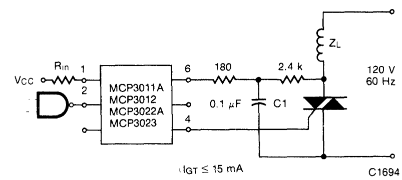


Fig. 9. Inductive Load With Sensitive Gate Triac

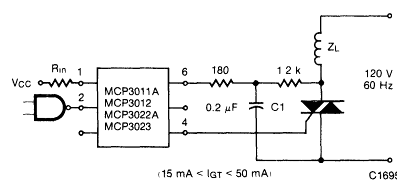


Fig. 10. Inductive Load With Non-Sensitive Gate Triac

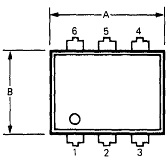
OPTICALLY ISOLATED
TRIAC DRIVER

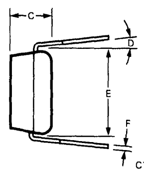
Optoisolators

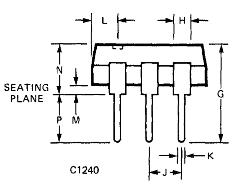
GENERAL INSTRUMENT

MCP3020
MCP3021
MCP3022

PACKAGE DIMENSIONS







SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.355	9.02	
B	.270	6.86	
C	.160	4.06	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0.100 INCH

C1339A

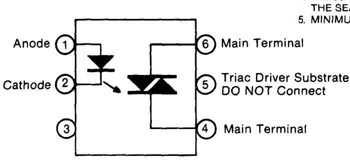


Fig. 1. Equivalent Circuit

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

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%, $I_{I\text{-}O}$ ≤ 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 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 Specified)

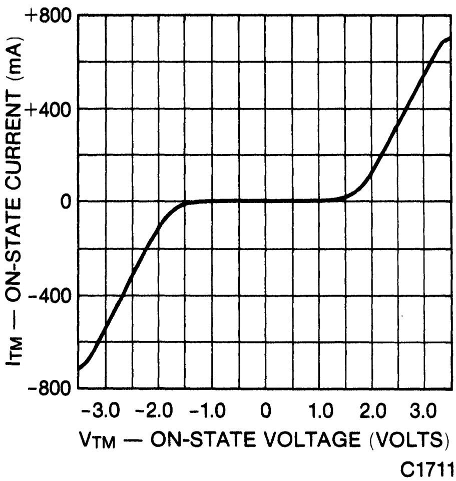


Fig. 2. On-State Characteristics

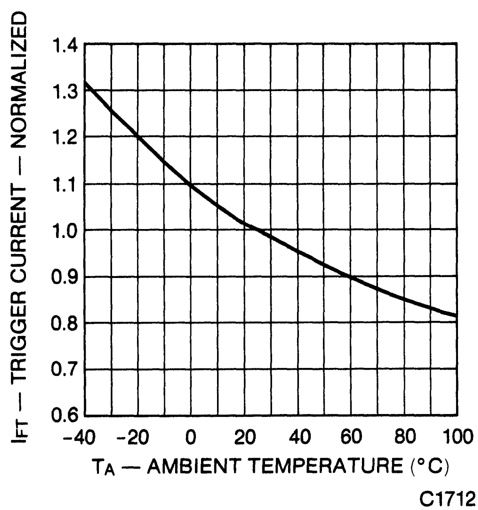
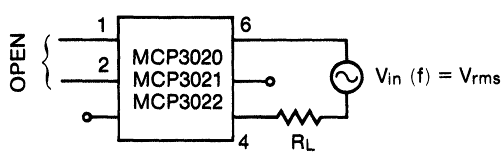


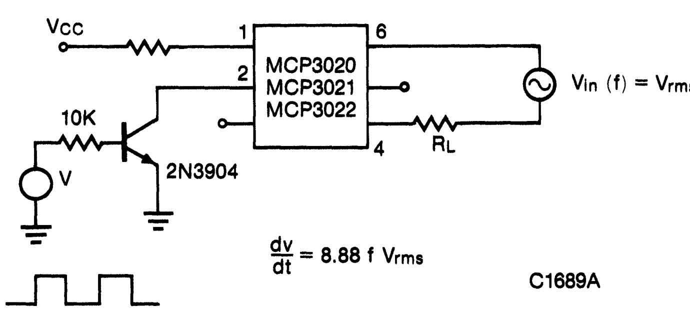
Fig. 3. Trigger Current vs. Temperature

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. 4. Static dv/dt



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

C1689A

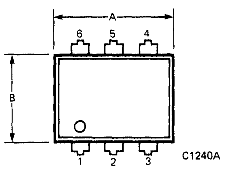
Fig. 5. Commutating dv/dt

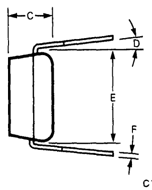
OPTICALLY ISOLATED ZERO-CROSSING TRIAC DRIVER 250 VOLTS & 400 VOLTS

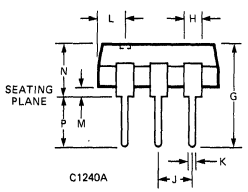
GENERAL INSTRUMENT

MCP3030 MCP3040 MCP3031 MCP3041

PACKAGE DIMENSIONS







SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.355	9.01	
B	.270	6.86	
C	.160	4.06	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5

NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0.100 INCH

C1339

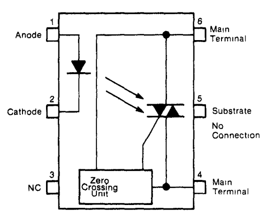


Fig. 1. Equivalent Circuit

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

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-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 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		100		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)

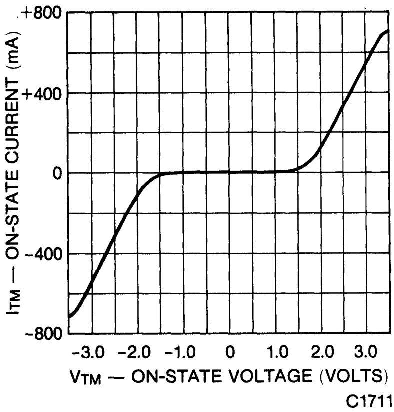


Fig. 2. On-State Characteristics

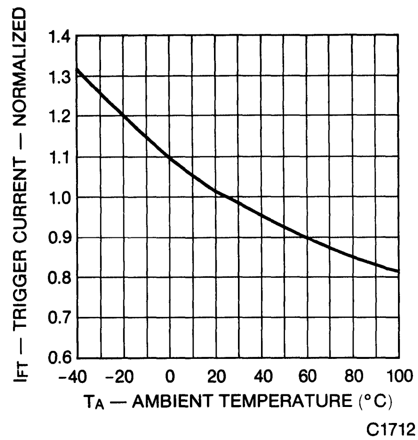


Fig. 3. Trigger Current vs. Temperature

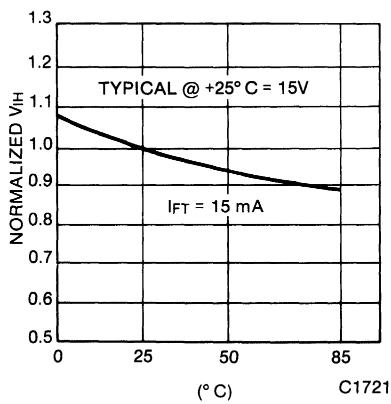


Fig. 4. Normalized Inhibit Voltage (V_{IH}) vs. Temperature

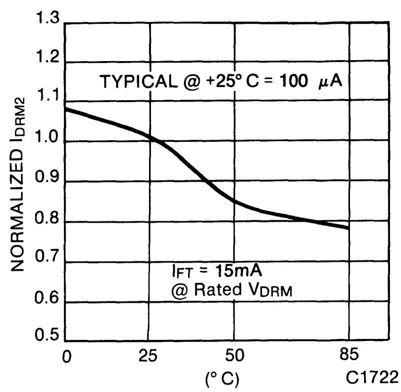


Fig. 5. Normalized I_{DRM2} vs. Temperature

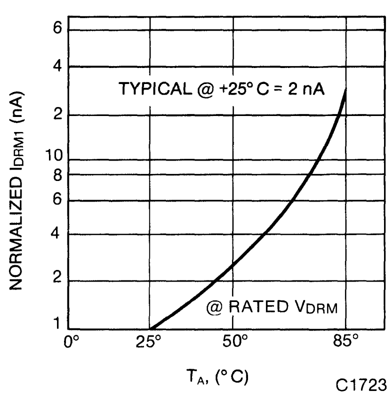


Fig. 6. Normalized I_{DRM1} vs. Temperature

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 @ $T_A \leq 70°C$

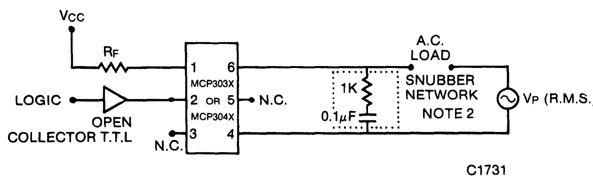


Figure 7 For Load Current $I_L \leq 50mA$ RMS → Direct Load Interface

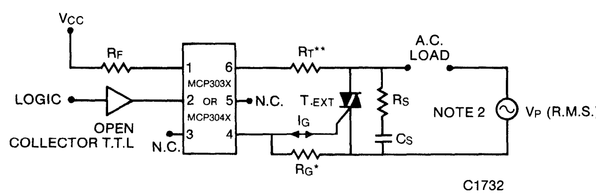


Figure 8 For Load Current $I_L > 50mA$ RMS → Interface Via External Triac (T_{EXT})

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

Typical Snubber Values — Fig. 8. Circuit Driving Inductive Load:

T_{EXT} dv/dt (v/μs)	RMS LOAD CURRENT I_L (A) — LEGEND: $R_S\Omega / C_S(\mu F)$						
	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:

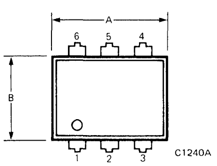
1. *MCP304X and T_{EXT} $V_{DRM} \geq 400$ V recommended for 120 V Inductive Loads - Fig. 8*
2. *Capacitor Working Voltage ≥ 2X RMS Line Voltage (V_P)*

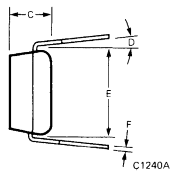
OPTICALLY ISOLATED ZERO-CROSSING TRIAC DRIVER 250 VOLTS & 400 VOLTS

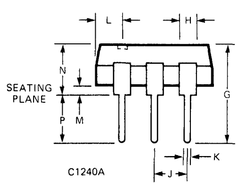
GENERAL INSTRUMENT

MCP3032 MCP3042
MCP3033 MCP3043

PACKAGE DIMENSIONS







SYMBOL	INCHES MAX	mm MAX	NOTES
A	355	9.02	
B	270	6.86	
C	.160	4 06	
D	15°	15°	
E	300 Ref	7.62 Ref	1
F	014	0 36	
G	.325	8.26	
H	.070	1.78	
J	110	2 79	
K	022	0 56	
L	085	2 16	2
M			3
N	175	4 45	4
P			5

NOTES
1 INSTALLED POSITION OF LEAD CENTERS
2 FOUR PLACES
3 OVERALL INSTALLED POSITION
4 THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5 MINIMUM 0 100 INCH

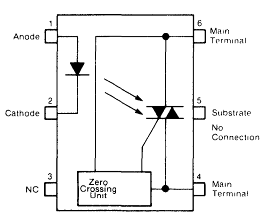


Fig. 1. Equivalent Circuit

DESCRIPTION

These devices are optically isolated zero-crossing triac drivers. They consist of an 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 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		100		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)

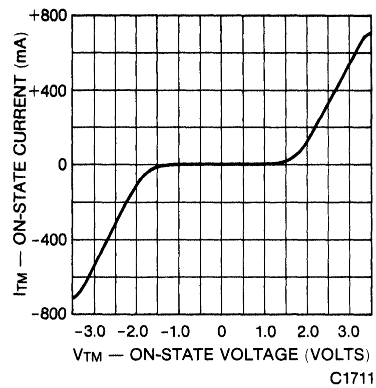


Fig. 2. On-State Characteristics

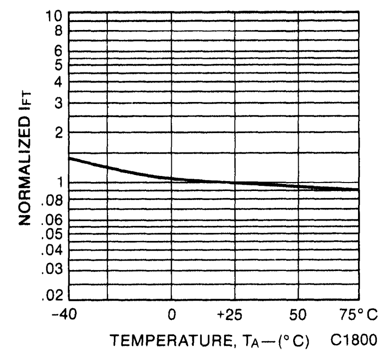


Fig. 3. Trigger Current vs. Temperature

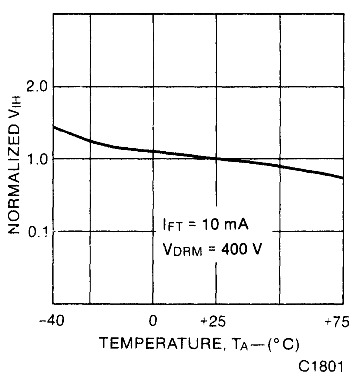


Fig. 4. Normalized Inhibit Voltage (V_{IH}) vs. Temperature

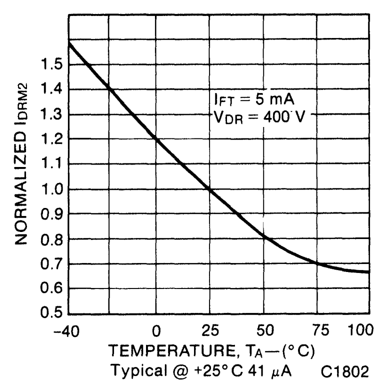


Fig. 5. Normalized I_{DRM2} vs. Temperature

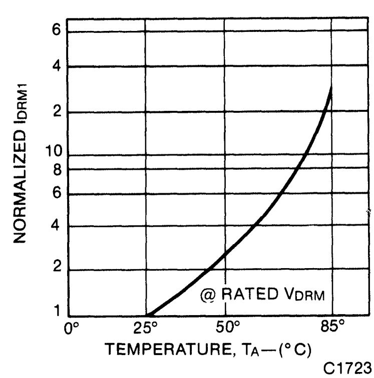


Fig. 6. Normalized I_{DRM1} vs. Temperature

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 @ $T_A \leq 70°C$

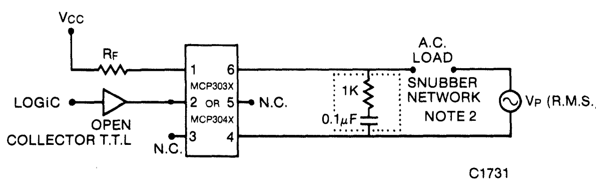


Figure 7 For Load Current $I_L \leq 50mA$ RMS → Direct Load Interface

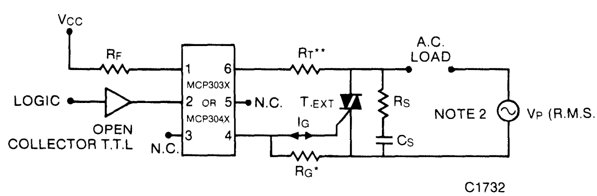


Figure 8 For Load Current $I_L > 50mA$ RMS → Interface Via External Triac (T_{EXT})

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

Typical Snubber Values — Fig. 8. Circuit Driving Inductive Load:

T_{EXT} dv/dt (v/μs)	RMS LOAD CURRENT I_L (A) — LEGEND: $R_S\Omega/C_S(\mu F)$						
	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. 8*
2. *Capacitor Working Voltage ≥ 2X RMS Line Voltage (V_P)*

GENERAL INSTRUMENT

OPTO PLUS

DESCRIPTION

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

- OPTO PLUS 1 offers 48 hour burn-in
- OPTO PLUS 2 offers 168 hour burn-in

ORDER INFORMATION

Any MCA2 or MCT2 type optoisolator may be purchased with the OPTO PLUS conditioning. The desired base-part with the PLUS 1 or PLUS 2 designation should be ordered. For example, MCT270 PLUS 2 is a standard General Instrument MCT270 which has been "reliability conditioned" for 168 hours.

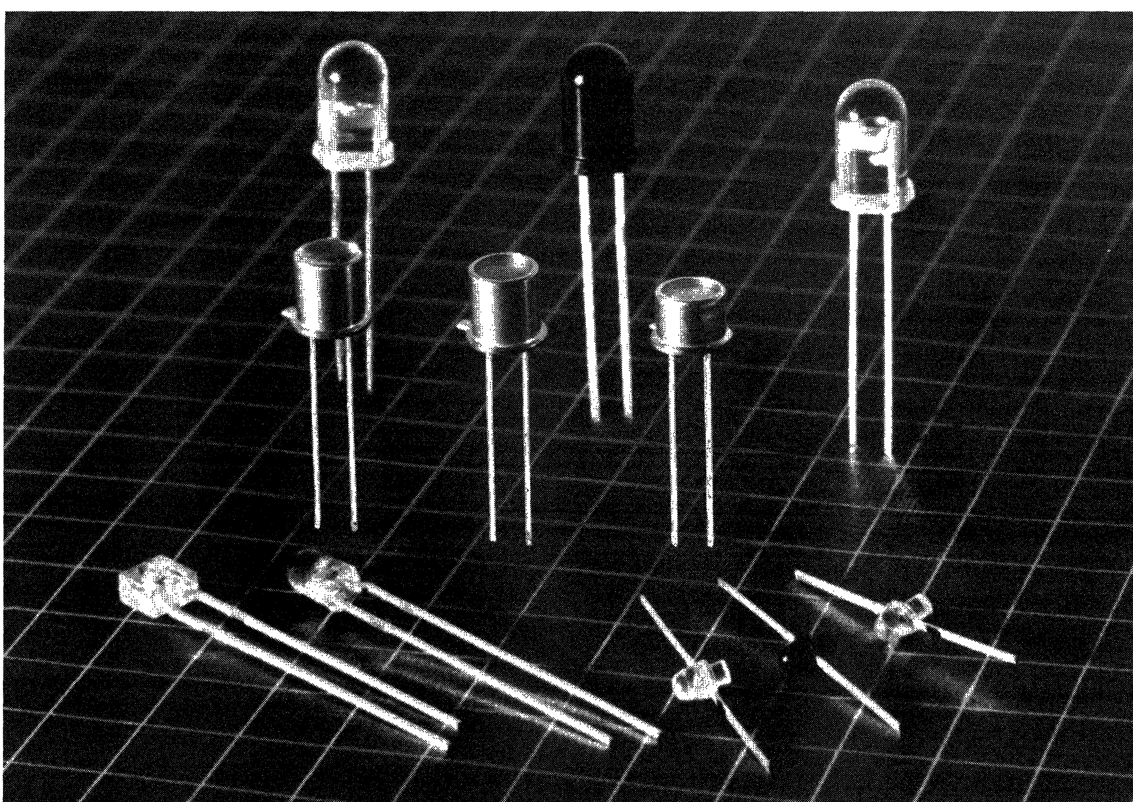
RELIABILITY CONDITIONING

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

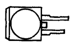
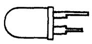
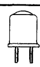
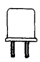
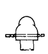
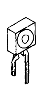
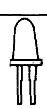
TEST PERFORMED	CONDITION
Stabilization Bake	MIL-STD-883 Method 1008.1 Condition C. 150° C, 24 hours.
Temperature Cycle	MIL-STD-883 Method 1010.2 Condition B. 5 Cycles -55° C to 125° C, 30 min. at extremes
Burn-in PLUS 1— 48 hrs. PLUS 2—168 hrs.	MIL-STD-883 Method 1015.2 Condition C. T_A = 25° C I_F = 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.	0.4% AQL

Infrared Emitters and Detectors

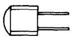
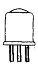
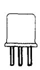
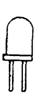
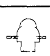
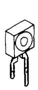
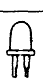
2



INFRARED EMITTERS

PACKAGE	DEVICE NO.	TOTAL OUTPUT POWER (TYP.)	AXIAL RADIANT INTENSITY (TYP.)	MAX. FORWARD VOLTAGE	INCLUDED ANGLE	MAX. POWER	RISE/FALL TIME (TYP.)	PAGE NO.	APPLICATIONS
	CQX47	25 mW	33 mW/sr	3.4 V @ 100 mA	50°	280 mW	450 nsec	181	
	CQY99	15 mW	14 mW/sr	1.7 V @ 100 mA	50°	210 mW	450 nsec	185	
	MEH520	10 mW	35 mW/sr	2.6 V @ 100 mA	20°	200 mW	800 nsec	189	
	MEH560	10 mW	4.5 mW/sr	2.6 V @ 100 mA	60°	200 mW	800 nsec	191	
	MEH580	10 mW	4.0 mW/sr	2.6 V @ 100 mA	80°	200 mW	800 nsec	193	
	MEK530	5 mW	13 mW/sr	1.8 V @ 20 mA	30°	150 mW	800 nsec	195	
	MEK560	5 mW	5 mW/sr	1.8 V @ 20 mA	60°	150 mW	800 nsec	195	Card readers, encoders, alarm and sector systems, level indicator, end of-tape detection.
	MEK730	12 mW	30 mW/sr	1.7 @ 100 mA	30°	150 mW	800 nsec	197	
	MEK760	12 mW	15 mW/sr	1.7 @ 100 mA	60°	150 mW	800 nsec	197	
	MEL560	5 mW	3 mW/sr	1.8 V @ 20 mA	60°	130 mW	800 nsec	199	
	MEL760	3 mW	2 mW/sr	1.6 V @ 20 mA	60°	150 mW	800 nsec	201	
	MEM540	5 mW	10 mW/sr	1.8 V @ 20 mA	40°	75 mW	800 nsec	203	
	MEM740	3 mW	6 mW/sr	1.6 V @ 20 mA	40°	75 mW	800 nsec	205	
	MES560	5 mW	2 mW/sr	1.8 V @ 20 mA	60°	130 mW	800 nsec	207	
	MES760	2.5 mW	1 mW/sr	1.6 @ 20 mA	60°	150 mW	800 nsec	209	
	ME7121 ME7124	3.0 mW	2 mW/sr 10 mW/sr	1.8 V @ 50 mA	34° 12°	150 mW	500 nsec	211	

ETECTORS

PACKAGE	DEVICE NO.	LIGHT CURRENT E_e = 5 mW/cm² (TYP.)	V_{CE} (SAT) (MAX.)	ACCEPTANCE ANGLE	MIN. BV_{CEO}	DARK CURRENT (MAX.)	RISE/FALL TIME BAND-WIDTH (TYP.)	PAGE NO.	APPLICATIONS
	BPW39A	1.0 mA	0.3 @ 1.0 mA	130°	32V	10 nA	170 KHz	215	
	MAH120	25 mA[1]	1.0 V @ 0.5 mA	20°	30 V	100 nA	35 μs	219	
	MTH320	7.5 mA	0.4 V @ 0.5 mA	20°	30 V	100 nA	4 μs	221	
	MTH321	20 mA	0.4 V @ 0.5 mA	20°	30 V	100 nA	4 μs	221	
	MTH420	35 mA	0.4 V @ 0.5 mA	20°	30 V	100 nA	4 μs	221	
	MTH421	60 mA	0.4 V @ 0.5 mA	20°	30 V	100 nA	4 μs	221	
	MTH360	1.0 mA	0.4 V @ 0.5 mA	60°	30 V	100 nA	4 μs	223	
	MTH361	5 mA	0.4 V @ 0.5 mA	60°	30 V	100 nA	4 μs	223	
	MTH460	3 mA	0.4 V @ 0.5 mA	60°	30 V	100 nA	4 μs	223	Optical switching, intrusion alarm, process control, tape and card reader, level controls, character recognition.
	MTH461	10 mA	0.4 V @ 0.5 mA	60°	30 V	100 nA	4 μs	223	
	MTK380	1.0 mA	0.4 V @ 0.5 mA	80°	30 V	100 nA	4 μs	225	
	MTK381	3 mA	0.4 V @ 0.5 mA	80°	30 V	100 nA	4 μs	225	
	MTK480	5 mA	0.4 V @ 0.5 mA	80°	30 V	100 nA	4 μs	225	
	MTK481	10 mA	0.4 V @ 0.5 mA	80°	30 V	100 nA	4 μs	225	
	MTM340	1.5 mA	0.4 V @ 0.5 mA	40°	30 V	100 nA	4 μs	227	
	MTS360	1.0 mA	0.4 V @ 0.5 mA	60°	30 V	100 nA	4 μs	229	
	MTS361	3 mA	0.4 V @ 0.5 mA	60°	30 V	100 nA	4 μs	229	
	MTS460	3 mA	0.4 V @ 0.5 mA	60°	30 V	100 nA	4 μs	229	
	MTS461	6 mA	0.4 V @ 0.5 mA	60°	30 V	100 nA	4 μs	229	
	MT8020		0.4 V @ 1.6 mA	90°	30 V	1.5 nA	300 KHz	231	

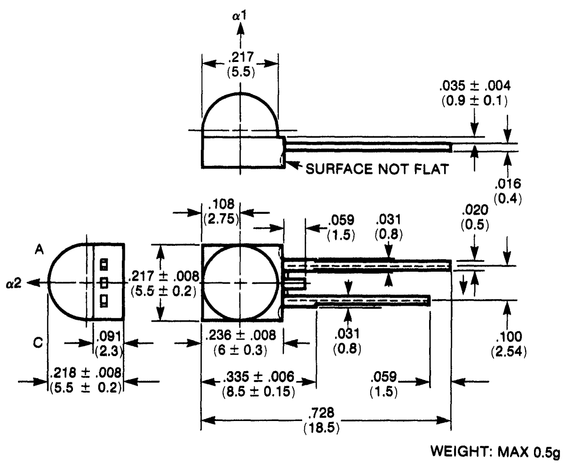
)TE 1: E_e = 0.5 mW/cm²

GENERAL INSTRUMENT

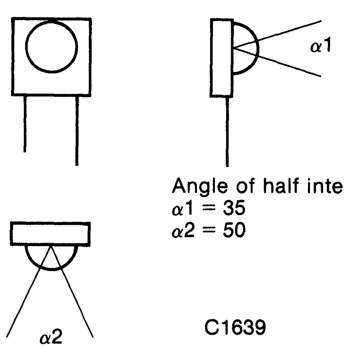
GaAs INFRARED EMITTING DIODE CQX47

PACKAGE DIMENSIONS

All dimensions are in inches (millimeters).



C1640



Angle of half intensity
α1 = 35
α2 = 50

C1639

DESCRIPTION

The CQX47 is a high power liquid phase epitaxial IR emitting diode. It is packaged in a plastic case in which the radiation direction is vertical to the mounting direction.

FEATURES

- Plastic case, blue clear
- High radiant intensity
- High radiant power
- Suitable for pulse operation
- Good spectral matching for silicon photo detectors

APPLICATIONS

- Remote control source
- Card and tape reader sources

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

Reverse Voltage 10V
Forward Current . . . . 100 mA
Forward Peak Current
(t_P/T = 0.5, $t_P \leq$ 10 ms) . . . . 200 mA
Forward Surge Current ($t_P \leq$ 10 µs) . . . . 2.5 A

Power Dissipation ($T_A \leq$ 25°C) . . . . 280 mW
Junction Temperature . . . . 100°C
Storage Temperature Range . . . . . −25°C to +100°C
Soldering Temperature (t ≤ 3 s) (See Note 1) . . 245°C

ELECTRICAL AND OPTICAL CHARACTERISTICS (T_A = 25°C Unless Otherwise Specified)

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Radiant intensity	I_e	25	33		mW/sr	I_F = 100 mA
	$I_e{}^1$		300		mW/sr	I_F = 1.5 A
Radiant power	ϕ_e		25		mW	I_F = 100 mA
Temperature coefficient of ϕ_e	$TK_{\phi e}$		−0.8		%/°C	I_F = 100 mA
Peak wavelength emission	λ_P		950		nm	I_F = 100 mA
Spectral half bandwidth	Δ_λ		50		nm	I_F = 100 mA
Forward voltage	V_F*		2.8	3.4	V	I_F = 100 mA
	$V_F{}^1$		5.4		V	I_F = 1.5 A
Breakdown voltage	V_R*	10			V	I_R = 100 μA
Junction capacitance	C_J		25		pF	V_R = 0, f = 1 MHz
Switching characteristics						
Rise time	t_r		400		ns	I_F peak = 1 A
Fall time	t_f		450		ns	t_P/T = 0.01, $t_P \leq$ 10 μs (See test circuit, Fig. 1)

*0.65 AQL
[1] t_P/T = 0.001, $t_P \leq$ 0.1 ms

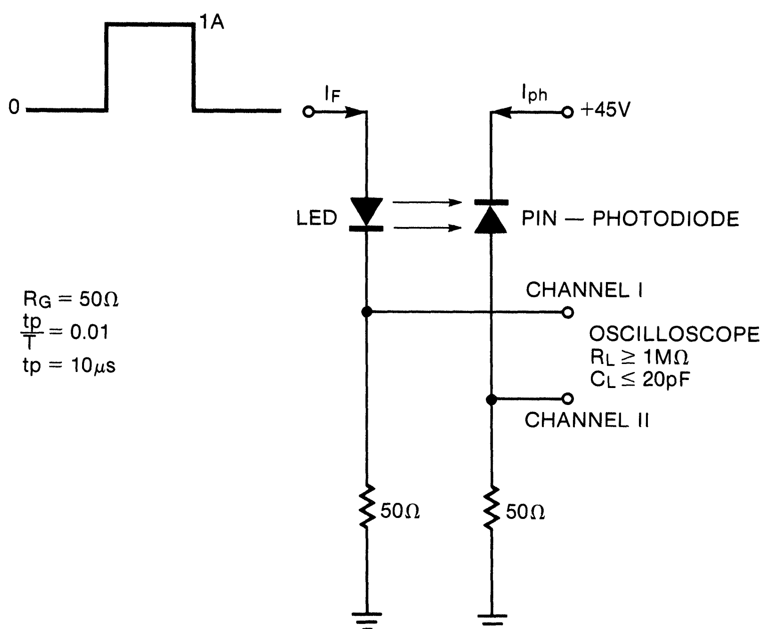


Fig. 1. Test Circuit For Switching Time

C1641

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (25°C Ambient Temperature Unless Otherwise Noted)

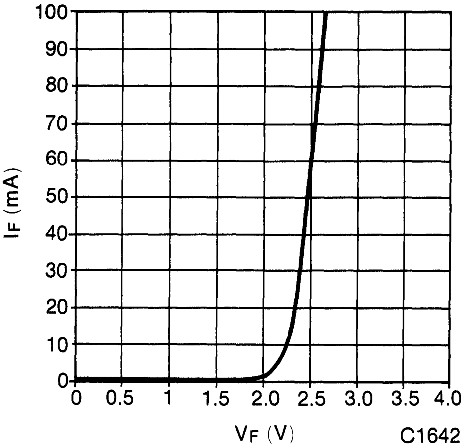


Fig. 2. Forward Current vs. Forward Voltage

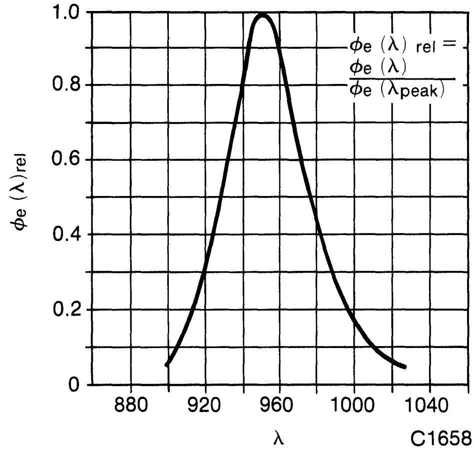


Fig. 3. Relative Radiated Power vs. Wavelength

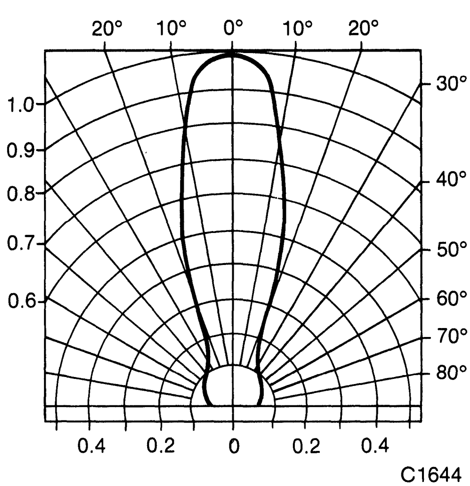


Fig. 4. α1 – Spatial Distribution For Vertical Plane

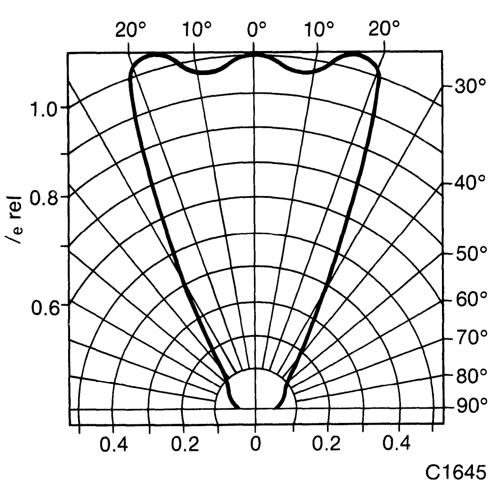


Fig. 5. α2 – Spatial Distribution For Horizontal Plane

Emitters Detectors

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

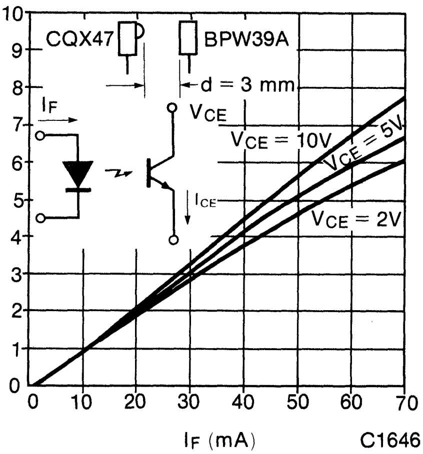


Fig. 6. Silicon Detector Output vs. Forward Current

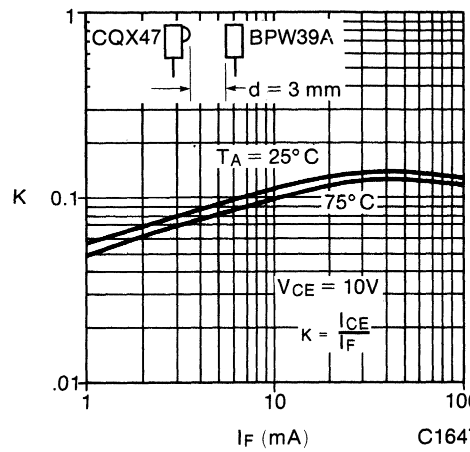


Fig. 7. Silicon Detector Current Transfer Ratio vs. Forward Current

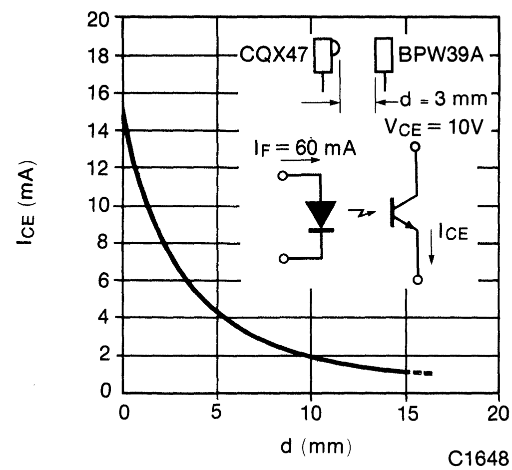


Fig. 8. On-axis Detector Response vs. Distance

NOTES

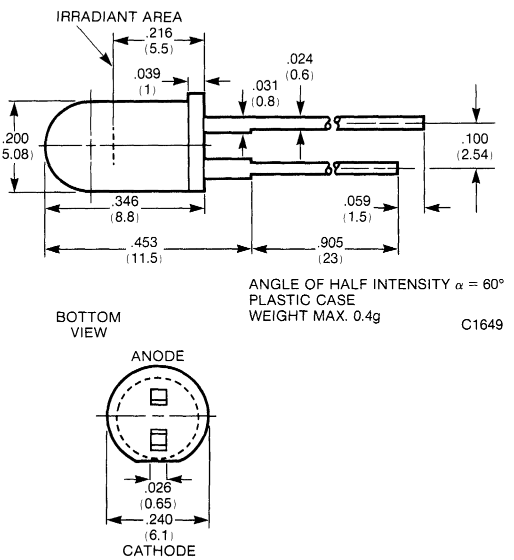
1. Distance from the touching border ≥1.5 mm with intermediate PC-board.

GENERAL INSTRUMENT

GaAs INFRARED EMITTING DIODE CQY99

PACKAGE DIMENSIONS

All dimensions are in inches (millimeters).



DESCRIPTION

The CQY99 high power infrared emitter is designed to accommodate all needs of the emitter detector relationship. This device is packaged in a clear blue plastic case.

FEATURES

- High radiant intensity
- High radiant power
- Suitable for pulse operation
- Good spectral matching for silicon photo detectors

APPLICATIONS

- Remote control source
- Card and tape reader sources

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

Reverse Voltage	5V
Forward Current	150 mA
Forward Peak Current (t_P/T = 0.5, $t_P \leq$ 10 ms)	300 mA
Forward Surge Current ($t_P \leq$ 10 μs)	2.5 A
Power Dissipation ($T_A \leq$ 25°C)	210 mW
Junction Temperature	100°C
Storage Temperature Range	−25°C to +100°C
Soldering Temperature ($t \leq$ 3 s) (See Note 1)	245°C

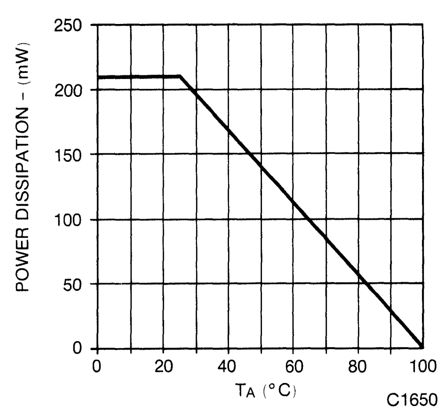


Fig. 1. Power Dissipation vs. Ambient Temperature

ELECTRICAL AND OPTICAL CHARACTERISTICS (T_A = 25°C Unless Otherwise Specified)

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Radiant power	ϕ_e*		15		mW	I_F = 100 mA
Temperature coefficient of ϕ_e	$\Delta\phi_e/\Delta T$		-0.8		%/°C	I_F = 100 mA
Radiant intensity	I_e	7	14		mW/sr	I_F = 100 mA
Peak wavelength emission	λ_P		950		nm	I_F = 100 mA
Spectral half bandwidth	Δ_λ		50		nm	I_F = 100 mA
Forward voltage	V_F*		1.4	1.7	V	I_F = 100 mA
Breakdown voltage	V_R*	5			V	I_R = 100 μA
Junction capacitance	C_J		50		pF	V_R = 0, f = 1 MHz
Thermal resistance (junction ambient)	R_{thJA}			350	°C/W	
Switching characteristics						
Rise time	t_r		400		ns	I_F = 1 A
Fall time	t_f		450		ns	t_P/T = 0.01, $t_P \leq 10\ \mu$s (See test circuit, Fig. 2)

*0.65 AQL

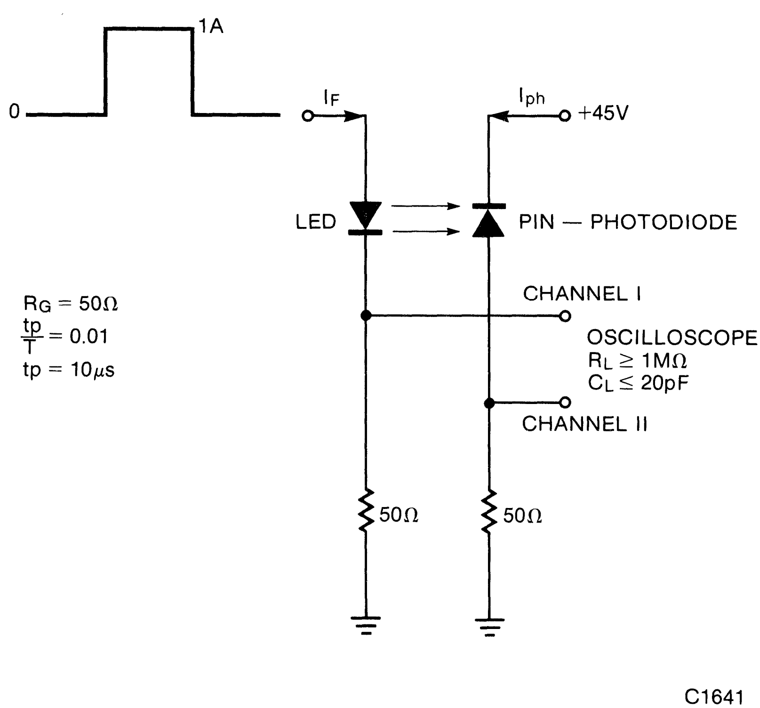


Fig. 2. Switching Time Test Circuit

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (25°C Ambient Temperature Unless Otherwise Noted)

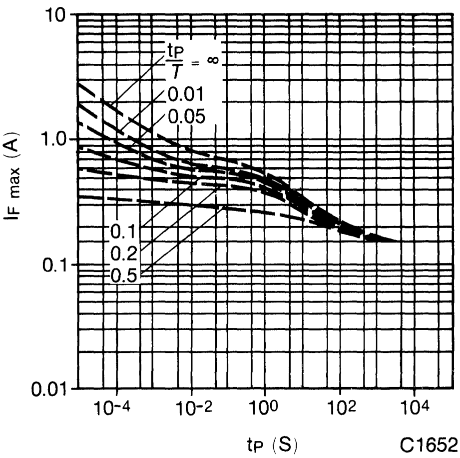


Fig. 3. Maximum Forward Current vs. Pulse Time

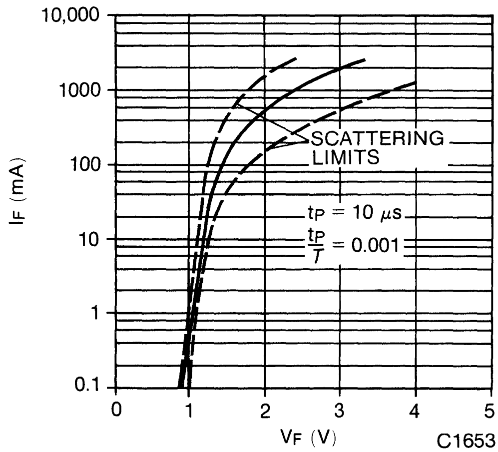


Fig. 4. Peak Forward Current vs. Peak Forward Voltage

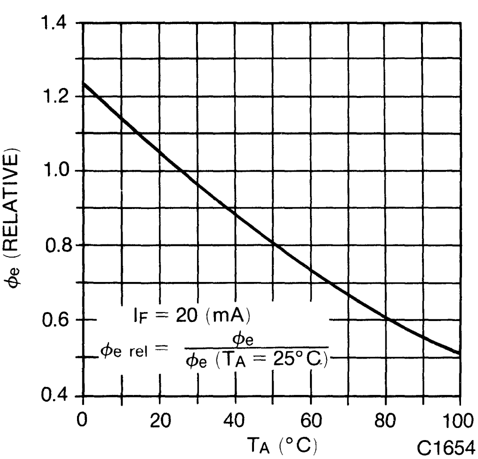


Fig. 5. Relative Radiant Power vs. Ambient Temperature

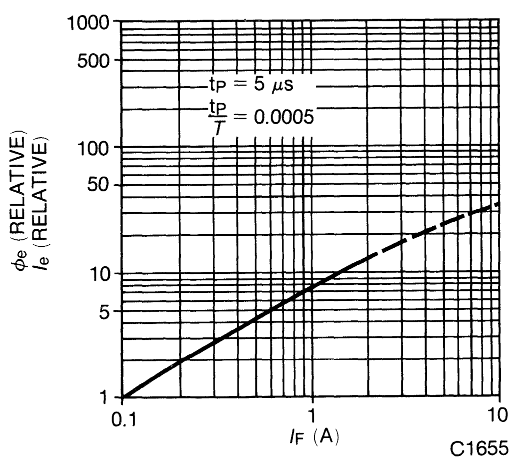


Fig. 6. Relative Radiant Power vs. Peak Forward Current

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (25°C Ambient Temperature Unless Otherwise Noted)

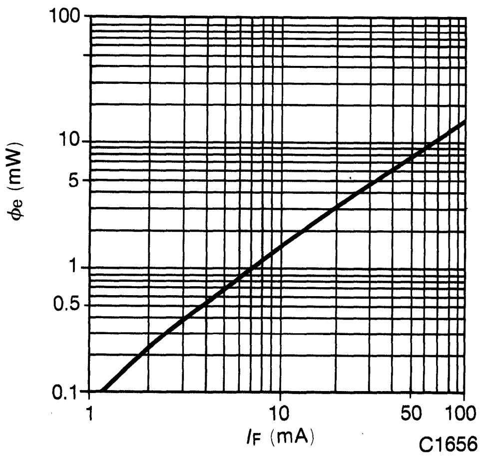


Fig. 7. Radiant Power vs. Forward Current

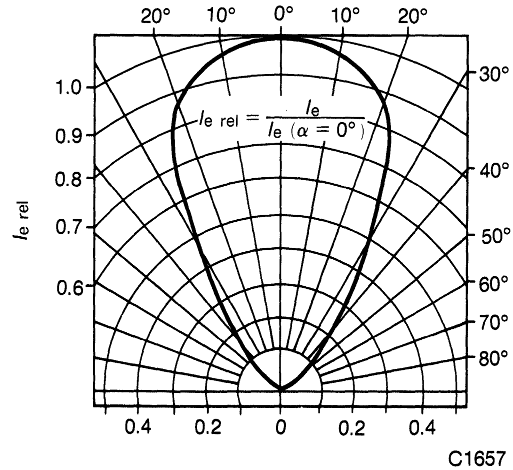


Fig. 8. Spatial Distribution

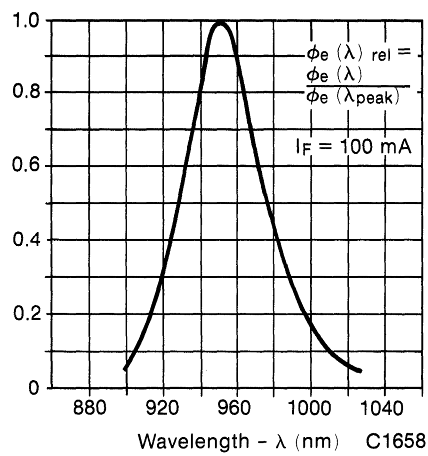


Fig. 9. Spectral Distribution

NOTES

1. Distance from the touching border ≥1.5 mm with intermediate PC-board.

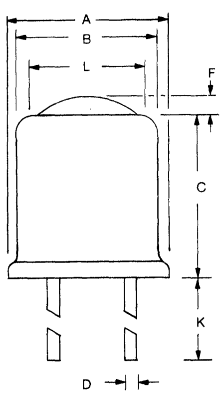
PRELIMINARY DATA SHEET

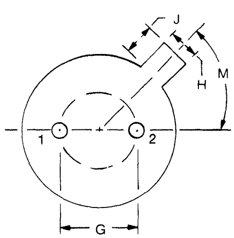
VERY HIGH INTENSITY AlGaAs HERMETIC INFRARED EMITTER

GENERAL INSTRUMENT

MEH520

PACKAGE DIMENSIONS





DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX
A	0.209	0.230	5.31	5.84
B	0.178	0.195	4.52	4.95
C	0.190	0.230	4.83	5.84
D	0.016	0.020	0.40	0.50
F	0.020	0.050	0.51	1.27
G	0.100		2.54	
H	0.036	0.046	0.91	1.17
J	0.030	0.048	0.76	1.22
K	1.000	———	25.40	———
L	0.140	0.165	3.56	4.19
M	45°		45°	

C1873A

PIN 1: ANODE (CASE)
PIN 2: CATHODE

FEATURES

- Very high intensity infrared emitter
- Aluminum gallium arsenide diode
- Hermetic TO-18 type package
- Narrow angle radiation beam
- Output flux of 10 mW at 100 mA
- Axial intensity of 35 mW/sr at 100 mA

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° C ambient . . . . 200 mW
Derate linearly at 1.6 mW/° C above 25° C ambient
Storage and operating temperatures . . -65° C to 150° C
Junction temperature . . . . 150° C
Lead solder time at 260° C (see Note 1) . . . . 5 sec.
Continuous forward current . . . . 100 mA
Reverse voltage . . . . 3 V
Peak forward current
(1 μsec pulse, 0.1% duty cycle) . . . . 10 A

NOTE: *Stresses listed under "Absolute Maximum Ratings" may be applied to a device without resulting in damage. Exposure to maximum rating conditions for extended periods may affect device reliability. Conditions listed under "Electro-Optical Characteristics" are specified for operation.*

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

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Axial radiant intensity (see Note 2)	I_e	20	35		mW/sr	I_F = 100 mADC
Total output power	Φ_e	6	10		mW	I_F = 100 mADC
Included angle Between half radiant intensity points	$2\theta_{1/2}(I_e)$		20		degrees	
Peak emission wavelength	λ_p		880		nm	I_F = 20 mA
Spectral line half width	$\Delta\lambda_{PHW}$		40		nm	I_F = 20 mA
Forward voltage	V_F		1.8	2.6	V	I_F = 100 mA
Reverse voltage	V_R	3	25		V	I_R = 10 μA
Rise/fall time (10%-90%)	t_r/t_f		800		ns	I_F = 50 mA, 50 Ω system

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

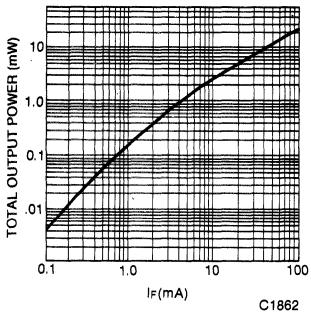


Fig. 1. Power Output vs. Input Current

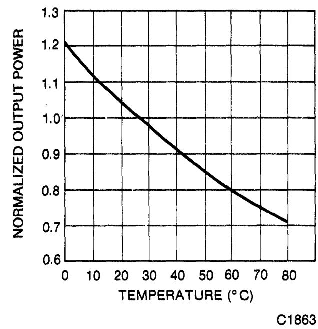


Fig. 2. Normalized Output Power vs. Temperature (Note 3)

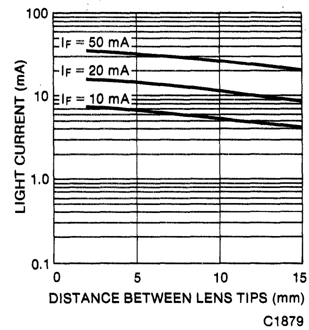


Fig. 3. Coupling Characteristics of MEH520 with MTH36X

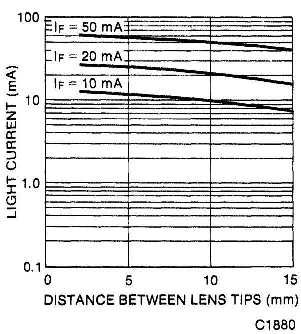


Fig. 3. Coupling Characteristics of MEH520 with MTH46X

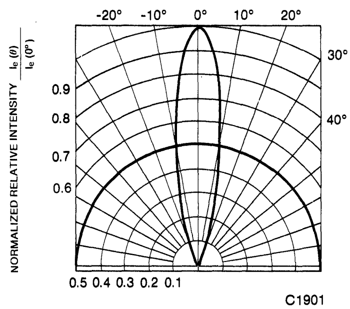


Fig. 5. Relative Angular Intensity Distribution

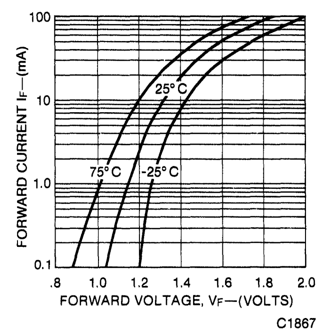


Fig. 6. Forward Current vs. Forward Voltage

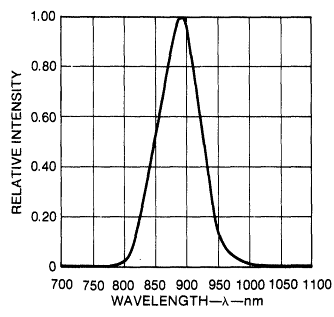


Fig. 7. Spectral Distribution

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 from the body of the device per MIL-S-750.*
2. *I_e measured with 1.0 cm diameter aperture at 14.7 cm on axis from tip of lens (ω = .0038 STERADIAN)*
3. *The curves in Fig. 2 are normalized to the power output at 25° C to indicate the relative efficiency over the operating temperature range.*

PRELIMINARY DATA SHEET

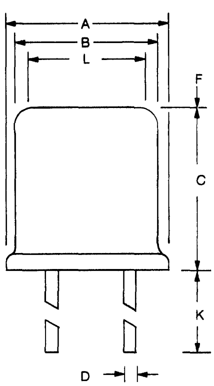
VERY HIGH POWER AlGaAs HERMETIC INFRARED EMITTER

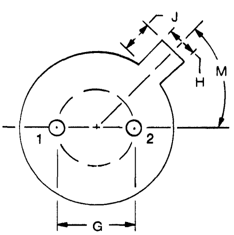
GENERAL INSTRUMENT

Emitters Detectors

MEH560

PACKAGE DIMENSIONS





DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX
A	0.209	0.230	5.31	5.84
B	0.178	0.195	4.52	4.95
C	0.190	0.230	4.83	5.84
D	0.016	0.020	0.40	0.50
F	———	0.010	———	0.25
G	0.100		2.54	
H	0.036	0.046	0.91	1.17
J	0.030	0.048	0.76	1.22
K	1.000	———	25.40	———
L	0.140	0.165	3.56	4.19
M	45°		45°	

PIN 1: ANODE (CASE)
PIN 2: CATHODE
DIM F: GLASS LENS FLUSH TO 0.010 INCH MAX

C1873

FEATURES

- Very high power infrared emitter
- Aluminum gallium arsenide diode
- Hermetic TO-18 type package
- Wide angle radiation beam
- Output flux of 10 mW at 100 mA

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° C ambient . . . . 200 mW
Derate linearly at 1.6 mW/° C above 25° C ambient
Storage and operating temperatures . . . -65° C to 150° C
Junction temperature . . . . 150° C
Lead solder time at 260° C (see Note 1) . . . . 5 sec.
Continuous forward current . . . . 100 mA
Reverse voltage . . . . 3 V
Peak forward current
(1 μsec, 0.1% duty cycle) . . . . 10 A

NOTE: *Stresses listed under "Absolute Maximum Ratings" may be applied to a device without resulting in damage. Exposure to maximum rating conditions for extended periods may affect device reliability. Conditions listed under "Electro-Optical Characteristics" are specified for operation.*

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

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Axial radiant intensity (see Note 2)	I_e	2	4.5		mW/sr	I_F = 100 mADC
Total Output Power	Φ_e	6	10		mW	I_F = 100 mADC
Included Angle Between half radiant intensity points	$2\theta_{1/2}(I_e)$		60		degrees	
Peak emission wavelength	λ_p		880		nm	I_F = 20 mA
Spectral line half width	$\Delta\lambda_{PHW}$		40		nm	I_F = 20 mA
Forward voltage	V_F		1.8	2.6	V	I_F = 100 mA
Reverse voltage	V_R	3	25		V	I_R = 10 μA
Rise/fall time (10%–90%)	t_r/t_f		800		ns	I_F = 50 mA, 50 Ω system

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

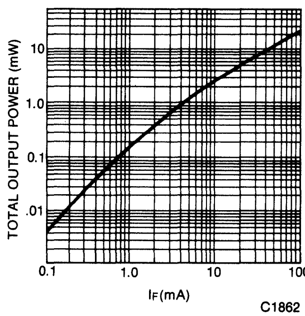


Fig. 1. Power Output vs. Input Current

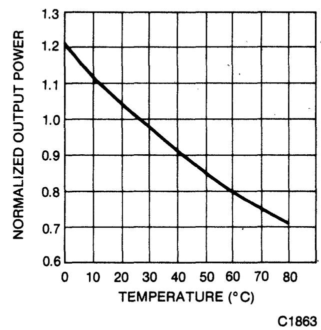


Fig. 2. Normalized Output Power vs. Temperature (Note 3)

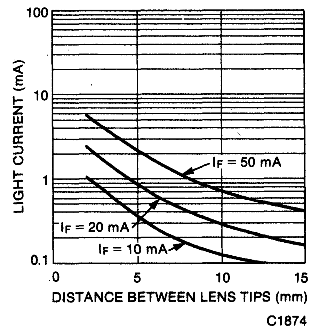


Fig. 3. Coupling Characteristics of MEH560 with MTH36X

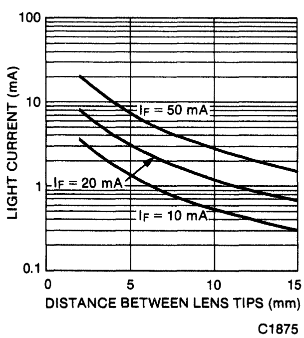


Fig. 3. Coupling Characteristics of MEH560 with MTH46X

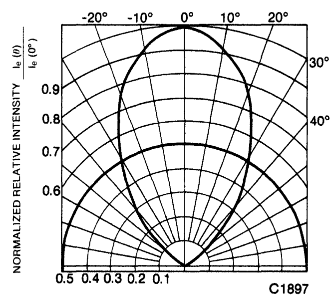


Fig. 5. Relative Angular Intensity Distribution

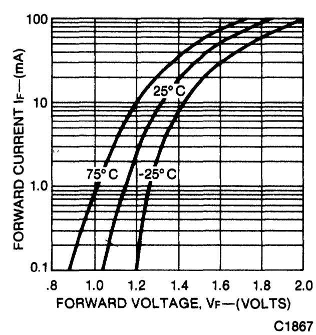


Fig. 6. Forward Current vs. Forward Voltage

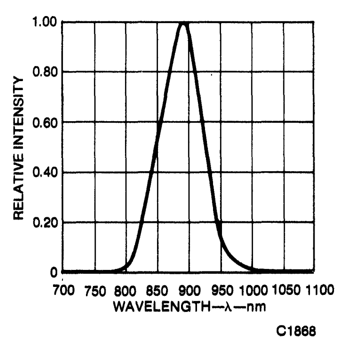


Fig. 7. Spectral Distribution

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 from the body of the device per MIL-S-750.***
2. ***I_e measured with 1.0 cm diameter aperture at 14.7 cm on axis from tip of lens (ω = .0038 STERADIAN).***
3. ***The curves in Fig. 2 are normalized to the power output at 25° C to indicate the relative efficiency over the operating temperature range.***

PRELIMINARY DATA SHEET

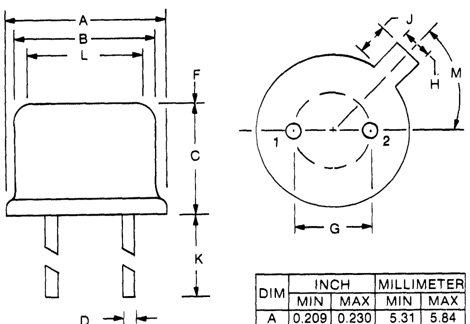
VERY HIGH POWER AlGaAs HERMETIC INFRARED EMITTER

GENERAL INSTRUMENT

MEH580

Emitters Detectors

PACKAGE DIMENSIONS



DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX
A	0.209	0.230	5.31	5.84
B	0.178	0.195	4.52	4.95
C	0.135	0.165	3.43	4.19
D	0.016	0.020	0.40	0.50
F	———	0.010	———	0.25
G	0.100		2.54	
H	0.036	0.046	0.91	1.17
J	0.030	0.048	0.76	1.22
K	1.000	———	25.40	———
L	0.140	0.165	3.56	4.19
M	45°		45°	

C1873D

PIN 1: ANODE (CASE)
PIN 2: CATHODE
DIM F: GLASS LENS FLUSH TO 0.010 INCH MAX

FEATURES

- Very high power infrared emitter
- Aluminum gallium arsenide diode
- Hermetic TO-18 type package
- Low profile package
- Extra wide angle radiation beam
- Output flux of 10 mW at 100 mA

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° C ambient . . . . 200 mW
Derate linearly at 1.6 mW/° C above 25° C ambient
Storage and operating temperatures . . -65° C to 150° C
Junction temperature . . . . 150° C
Lead solder time at 260° C (see Note 1) . . . . 5 sec.
Continuous forward current . . . . 100 mA
Reverse voltage . . . . 3 V
Peak forward current
(1 μsec pulse, 0.1% duty cycle) . . . . 10 A

NOTE: *Stresses listed under "Absolute Maximum Ratings" may be applied to a device without resulting in damage. Exposure to maximum rating conditions for extended periods may affect device reliability. Conditions listed under "Electro-Optical Characteristics" are specified for operation.*

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

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Axial radiant intensity	I_e	2	4		mW/sr	I_F = 100 mADC
Total Output Power	Φ_e	6	10		mW	I_F = 100 mADC
Included Angle Between half radiant intensity points	$2\theta_{1/2(Ie)}$		80		degrees	
Peak emission wavelength	λ_p		880		nm	I_F = 20 mA
Spectral line half width	$\Delta\lambda_{PHW}$		40		nm	I_F = 20 mA
Forward voltage	V_F		1.8	2.6	V	I_F = 100 mA
Reverse voltage	V_R	3	25		V	I_R = 10 μA
Rise/fall time (10%–90%)	t_r/t_f		800		ns	I_F = 50 mA, 50 Ω system

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

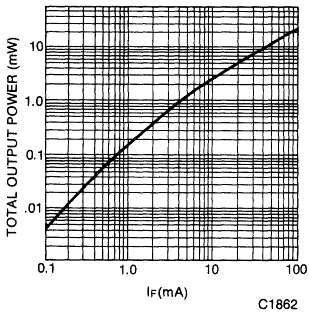


Fig. 1. Power Output vs. Input Current

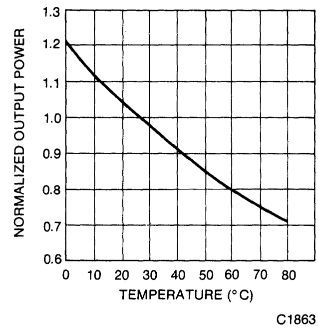


Fig. 2. Normalized Output Power vs. Temperature (Note 3)

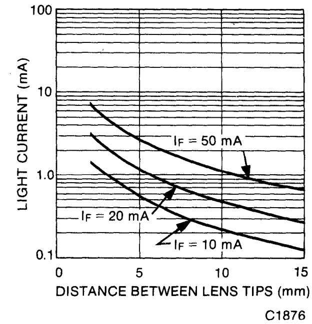


Fig. 3. Coupling Characteristics of MEH580 with MTH36X

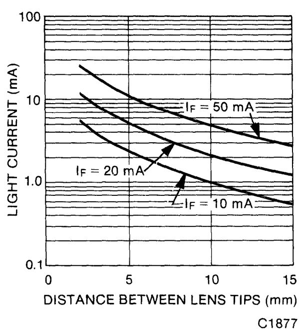


Fig. 4. Coupling Characteristics of MEH580 with MTH46X

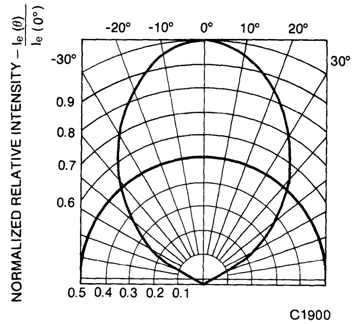


Fig. 5. Relative Angular Intensity Distribution

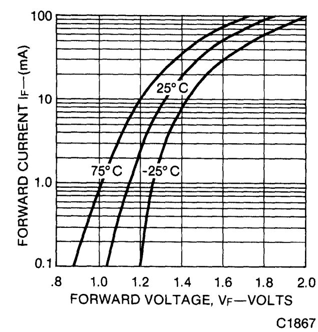


Fig. 6. Forward Current vs. Forward Voltage

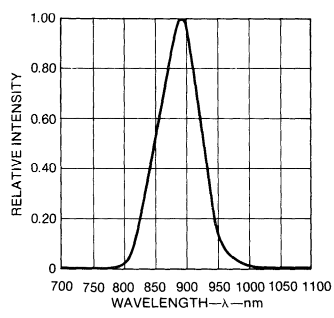


Fig. 7. Spectral Distribution

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 from the body of the device per MIL-S-750.*
2. *I_e measured with 1.0 cm diameter aperture at 14.7 cm on axis from tip of lens (ω = .0038 STERADIAN)*
3. *The curves in Fig. 2 are normalized to the power output at 25° C to indicate the relative efficiency over the operating temperature range.*

PRELIMINARY DATA SHEET

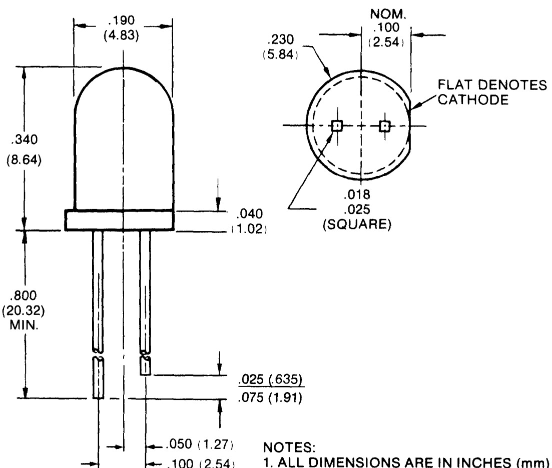
VERY HIGH EFFICIENCY AlGaAs INFRARED EMITTERS

GENERAL INSTRUMENT

MEK530
MEK560

Emitters Detectors

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

C1062J

FEATURES

- Very high efficiency infrared emitter
- Aluminum gallium arsenide diode
- Standard T-1¾ plastic package
- Red tinted lens color for identification
- Output flux of 5 mW at 20 mA
- Axial intensity of 13 mW/sr at 20 mA

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° C ambient . . . . 150 mW
Derate linearly at 2.4 mW/° C above 25° C ambient
Storage and operating temperatures . . -40° C to 100° C
Junction temperature . . . . 100° C
Lead solder time at 260° C (see Note 1) . . . . 5 sec.
Continuous forward current . . . . 50 mA
Reverse voltage . . . . 3 V
Peak forward current
(1μsec pulse, 0.3% duty cycle) . . . . 1 A

NOTE: *Stresses listed under "Absolute Maximum Ratings" may be applied to a device without resulting in damage. Exposure to maximum rating conditions for extended periods may affect device reliability. Conditions listed under "Electro-Optical Characteristics" are specified for operation.*

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

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Axial radiant intensity (see note 2)	I_e				mW/sr	I_F = 20 mADC
MEK530		7	13			
MEK560		2	5			
Total output power	Φ_e	3	5		mW	I_F = 20 mADC
Included angle Between half radiant intensity points	$2\theta_{1/2}(I_e)$				degrees	
MEK530			30			
MEK560			60			
Peak emission wavelength	λ_p		880		nm	I_F = 20 mA
Spectal line half width	$\Delta\lambda_{PHW}$		40		nm	I_F = 20 mA
Forward voltage	V_F		1.5	1.8	V	I_F = 20 mA
Reverse voltage	V_R	3	25		V	I_R = 10 μA
Rise/Fall time (10%-90%)	t_r/t_f		800		ns	I_F = 50 mA, 50 Ω system

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

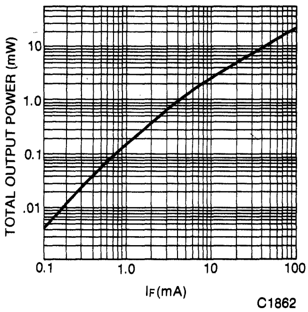


Fig. 1. Power Output vs. Input Current

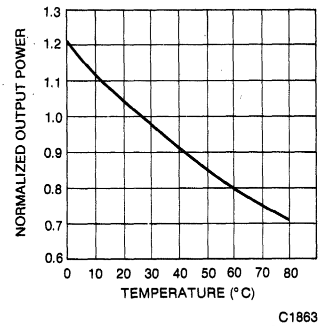


Fig. 2. Normalized Output Power vs. Temperature (Note 3)

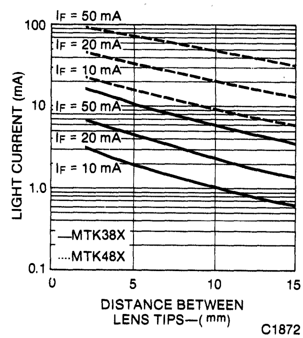


Fig. 3. Coupling Characteristics of MEK530 with MTK380/1 and MTK480/1

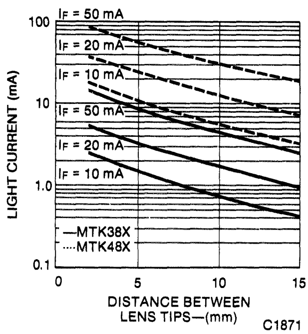


Fig. 4. Coupling Characteristics of MEK560 with MTK380/1 and MTK480/1

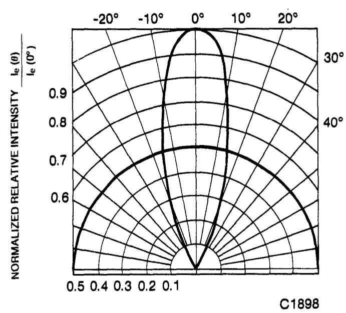


Fig. 5. Relative Angular Intensity Distribution of MEK530

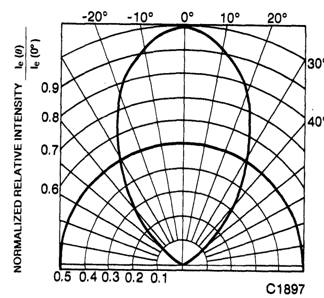


Fig. 6. Relative Angular Intensity Distribution of MEK560

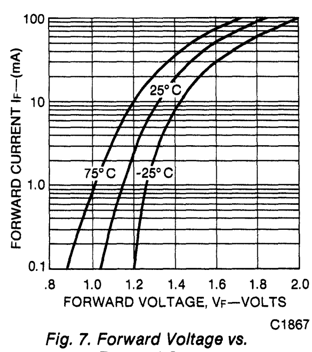


Fig. 7. Forward Voltage vs. Forward Current

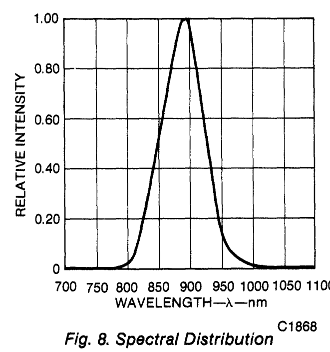


Fig. 8. Spectral Distribution

NOTES:

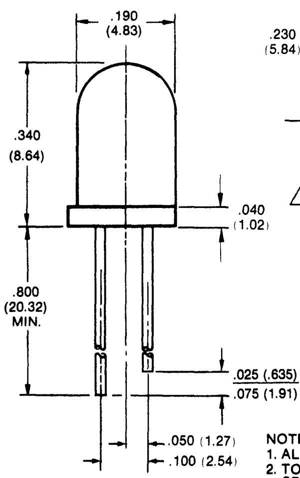
1. *The leads of the device were immersed in molten solder, heated to a temperature of 260°C, to a point 1/16 inch from the body of the device per MIL-S-750.*
2. *I_e measured with 1.0 cm diameter aperture at 14.7 cm on axis from tip of lens (ω = .0038 STERADIAN)*
3. *The curves in fig. 2 are normalized to the power output at 25°C to indicate the relative efficiency over the operating temperature range.*

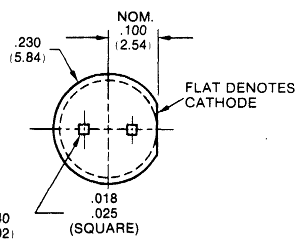
HIGH POWER GaAs INFRARED EMITTERS

GENERAL INSTRUMENT

MEK730
MEK760

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

C1062J

FEATURES

- High power infrared emitter
- Gallium arsenide diode
- Standard T-1¾ plastic package
- Clear lens
- Output flux of 12 mW at 100 mA
- Axial intensity of 30 mW/sr at 100 mA

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° C ambient . . . . 150 mW
Derate linearly at 2.0 mW/° C above 25° C ambient
Storage and operating temperatures . . -40° C to 100° C
Junction temperature . . . . 100° C
Lead solder time at 260° C (see Note 1) . . . . 5 sec.
Continuous forward current . . . . 100 mA
Reverse voltage . . . . 3 V
Peak forward current
(1 μsec pulse, 0.3% duty cycle) . . . . 1 A

NOTE: *Stresses listed under "Absolute Maximum Ratings" may be applied to a device without resulting in damage. Exposure to maximum rating conditions for extended periods may affect device reliability. Conditions listed under "Electro-Optical Characteristics" are specified for operation.*

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

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Axial radiant intensity (see note 2)	I_e				mW/sr	I_F = 100 mADC
MEK730		20	30			
MEK760		8	15			
Total output power	Φ_e	6	12		mW	I_F = 100 mADC
Included angle						
Between half radiant						
intensity points	$2\theta_{1/2}(I_e)$				degrees	
MEK720			30			
MEK730			60			
Peak emission wavelength	λ_p		940		nm	I_F = 20 mA
Spectal line half width	$\Delta\lambda_{PHW}$		30		nm	I_F = 20 mA
Forward voltage	V_F		1.2	1.7	V	I_F = 100 mA
Reverse voltage	V_R	3	20		V	I_R = 10 μA
Rise/Fall time (10%-90%)	t_r/t_f		800		ns	I_F = 50 mA, 50 Ω system

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

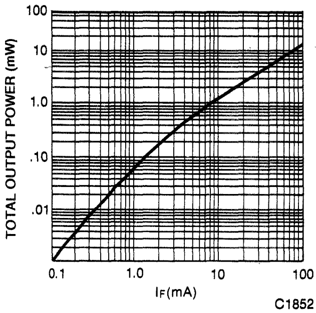


Fig. 1. Power Output vs. Input Current

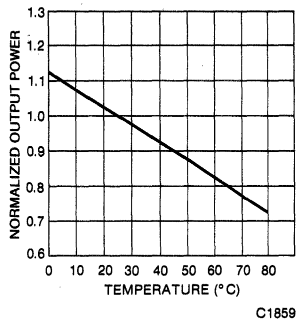


Fig. 2. Normalized Output Power vs. Temperature (Note 3)

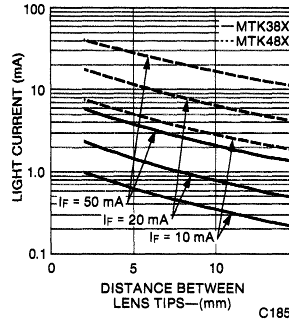


Fig. 3. Coupling Characteristics of MEK730 with MTK380/1 and MTK480/1

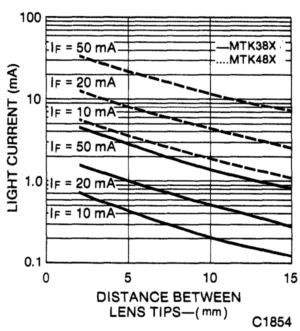


Fig. 4. Coupling Characteristics of MEK760 with MTK380/1 and MTK480/1

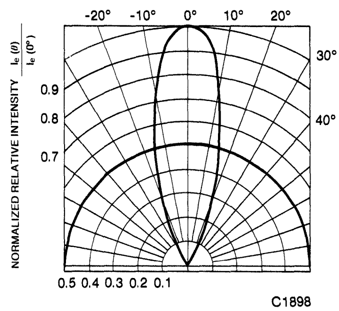


Fig. 5. Relative Angular Intensity Distribution of MEK730

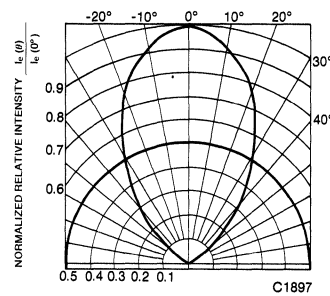


Fig. 6. Relative Angular Intensity Distribution of MEK760

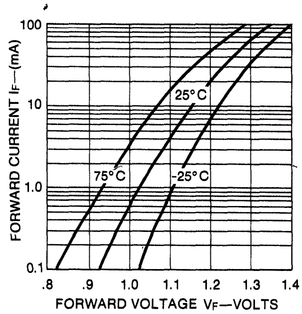


Fig. 7. Forward Current vs. Forward Voltage

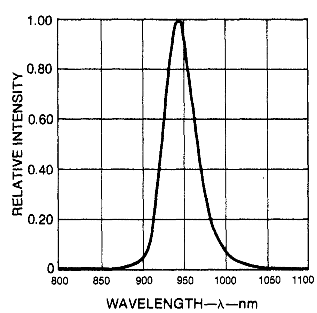


Fig. 8. Spectral Distribution

NOTES:

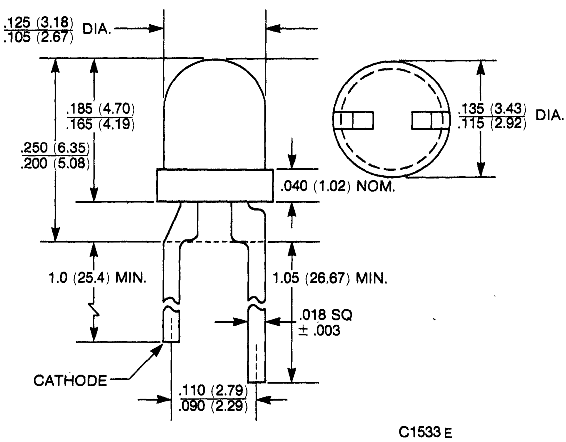
1. *The leads of the device were immersed in molten solder, heated to a temperature of 260° C, to a point 1/16 inch from the body of the device per MIL-S-750.*
2. *I_e measured with 1.0 cm diameter aperture at 14.7 cm on axis from tip of lens (ω = .0038 STERADIAN)*
3. *The curves in Fig. 2 are normalized to the power output at 25° C to indicate the relative efficiency over the operating temperature range.*

VERY HIGH EFFICIENCY AlGaAs INFRARED EMITTER

GENERAL INSTRUMENT

MEL560

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

FEATURES

- Very high efficiency infrared emitter
- Aluminum gallium arsenide diode
- Standard T-1 plastic package with 100 mil. lead spacing
- Red tinted lens color for identification
- Output flux of 5 mW at 20 mA

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° C ambient . . . . 130 mW
  Derate linearly at 1.7 mW/° C above 25° C ambient
Storage and operating temperatures . . -40° C to 100° C
Junction temperature . . . . 100° C
Lead solder time at 260° C (see Note 1) . . . . 5 sec.
Continuous forward current . . . . 50 mA
Reverse voltage . . . . 3 V
Peak forward current
  (1 µsec pulse, 0.3% duty cycle) . . . . 1 A

NOTE: *Stresses listed under "Absolute Maximum Ratings" may be applied to a device without resulting in damage. Exposure to maximum rating conditions for extended periods may affect device reliability. Conditions listed under "Electro-Optical Characteristics" are specified for operation.*

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

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Axial radiant intensity (see note 2)	I_e	2	3		mW/sr	I_F = 20 mADC
Total output power	Φ_e	3	5		mW	I_F = 20 mADC
Included angle Between half radiant intensity points	$2\theta_{½(I_e)}$		60		degrees	
Peak emission wavelength	λ_p		880		nm	I_F = 20 mA
Spectal line half width	$\Delta\lambda_{PHW}$		40		nm	I_F = 20 mA
Forward voltage	V_F		1.5	1.8	V	I_F = 20 mA
Reverse voltage	V_R	3	25		V	I_R = 10 µA
Rise/Fall time (10%-90%)	t_r/t_f		800		ns	I_F = 50 mA, 50 Ω system

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

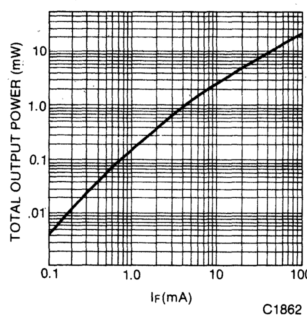


Fig. 1. Power Output vs. Input Current

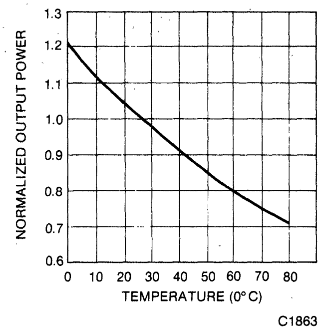


Fig. 2. Normalized Output Power vs. Temperature (Note 3)

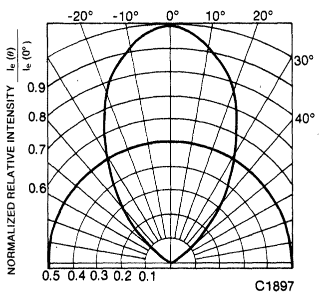


Fig. 3. Relative Angular Intensity Distribution

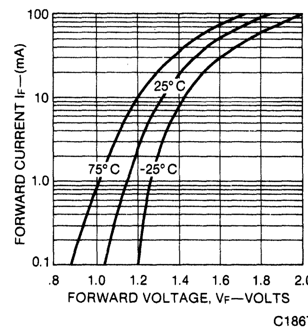


Fig. 4. Forward Current vs. Forward Voltage

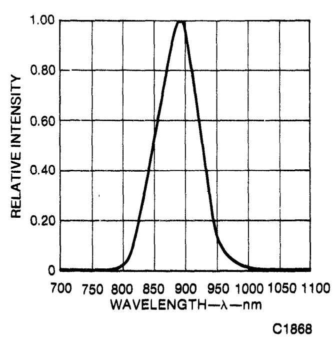


Fig. 5. Spectral Distribution

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 from the body of the devive per MIL-S-750.***
2. ***I_e measured with 1.0 cm diameter aperture at 14.7 cm on axis from tips of lens (ω = .0038 STERADIAN)***
3. ***The curves in Fig. 2 are normalized to the power output at 25° C to indicate the relative efficiency over the operating temperature range.***

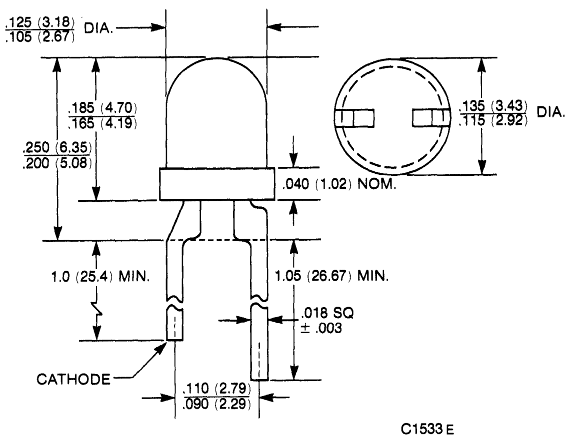
PRELIMINARY DATA SHEET

HIGH EFFICIENCY GaAs INFRARED EMITTER

GENERAL INSTRUMENT

MEL760

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

FEATURES

- High efficiency infrared emitter
- Gallium arsenide diode
- Standard T-1 plastic package with 100 mil. lead spacing
- Clear lens
- Output flux of 3 mW at 20 mA

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° C ambient . . . . 150 mW
Derate linearly at 2 mW/° C above 25° C ambient
Storage and operating temperatures . . -40° C to 100° C
Junction temperature . . . . 100° C
Lead solder time at 260° C (see Note 1) . . . . 5 sec.
Continuous forward current . . . . 100 mA
Reverse voltage . . . . 3 V
Peak forward current
(1 μsec pulse, 0.3% duty cycle) . . . . 1 A

NOTE: *Stresses listed under "Absolute Maximum Ratings" may be applied to a device without resulting in damage. Exposure to maximum rating conditions for extended periods may affect device reliability. Conditions listed under "Electro-Optical Characteristics" are specified for operation.*

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

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Axial radiant intensity (see note 2)	I_e	1	2		mW/sr	I_F = 20 mADC
Total output power	Φ_e	1.5	3		mW	I_F = 20 mADC
Included angle Between half radiant intensity points	$2\theta_{1/2}(I_e)$		60		degrees	
Peak emission wavelength	λp		940		nm	I_F = 20 mA
Spectal line half width	$\Delta\lambda_{PHW}$		30		nm	I_F = 20 mA
Forward voltage	V_F		1.2	1.6	V	I_F = 20 mA
Reverse voltage	V_R	3	20		V	I_R = 10 μA
Rise/Fall time (10%-90%)	t_r/t_f		800		ns	I_F = 50 mA, 50 Ω system

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

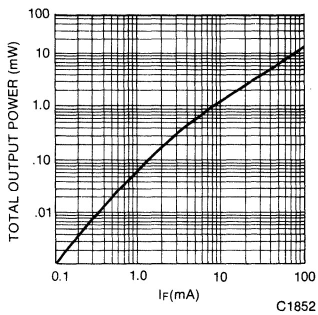


Fig. 1. Power Output vs. Input Current

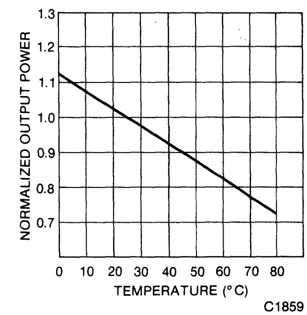


Fig. 2. Normalized Output Power vs. Temperature (Note 3)

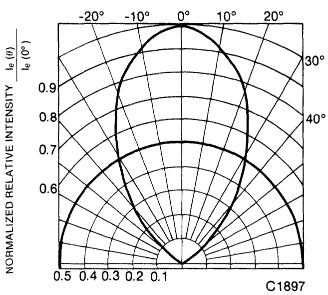


Fig. 3. Relative Angular Intensity Distribution

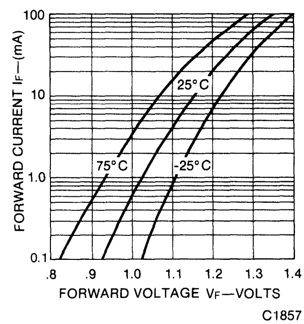


Fig. 4. Forward Current vs. Forward Voltage

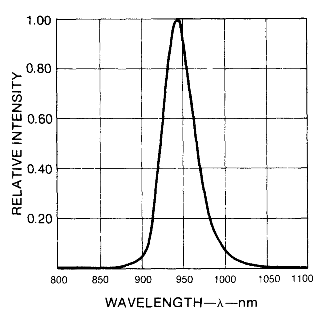


Fig. 5. Spectral Distribution

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 from the body of the devive per MIL-S-750.*
2. *I_e measured with 1.0 cm diameter aperture at 14.7 cm on axis from tips of lens (ω = .0038 STERADIAN)*
3. *The curves in Fig. 2 are normalized to the power output at 25° C to indicate the relative efficiency over the operating temperature range.*

PRELIMINARY DATA SHEET

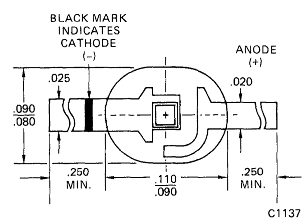
VERY HIGH EFFICIENCY AlGaAs INFRARED EMITTER

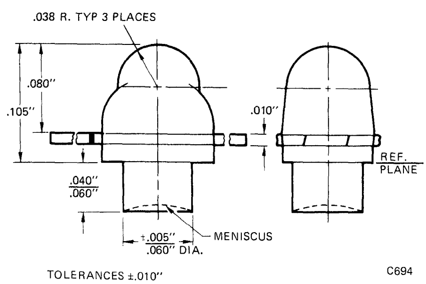
GENERAL INSTRUMENT

Emitters Detectors

MEM540

PACKAGE DIMENSIONS





FEATURES

- Very high efficiency infrared emitter
- Aluminum gallium arsenide diode
- Standard T-¾ plastic package
- Red tinted lens color for identification
- Output flux of 5 mW at 20 mA

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° C ambient . . . . 75 mW
Derate linearly at 1.0 mW/° C above 25° C ambient
Storage and operating temperatures . . . . -40° C to +100° C
Junction temperature . . . . 100° C
Lead solder time at 260° C (see note 1) . . . . 5 sec.
Continuous forward current . . . . 50 mA
Reverse voltage . . . . 3 V
Peak forward current (1 μsec pulse, 0.3% duty cycle) . . . . 1 A

NOTE: *Stresses listed under "Absolute Maximum Ratings" may be applied to a device without resulting in damage. Exposure to maximum rating conditions for extended periods may affect device reliability. Conditions listed under "Electro-Optical Characteristics" are specified for operation.*

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

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Axial radiant intensity	I_e	2	4		mW/sr	I_F = 20 mADC
Total output power	Φ_e	3	5		mW	I_F = 20 mADC
Included angle Between half radiant intensity points	$2\theta_{1/2}(I_e)$		40		degrees	
Peak emission wavelength	λ_p		880		nm	I_F = 20 mA
Spectal line half width	$\Delta\lambda_{PHW}$		50		nm	I_F = 20 mA
Forward voltage	V_F		1.5	1.8	V	I_F = 20 mA
Reverse voltage	V_R	3	25		V	I_R = 10 μA
Rise/Fall time (10%-90%)	t_r/t_f		800		ns	I_F = 50 mA

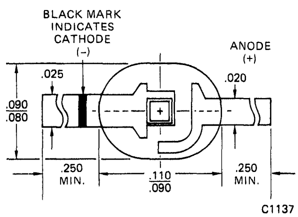
NOTES:
1. *The leads of the devices were immersed in molten solder heated to a temperature of 260° C, to a point 1/16 inch from the body of the device per MIL-S-750.*
2. *I_e measured with 1.0 cm diameter aperture at 14.7 cm on axis from tips of lens.*

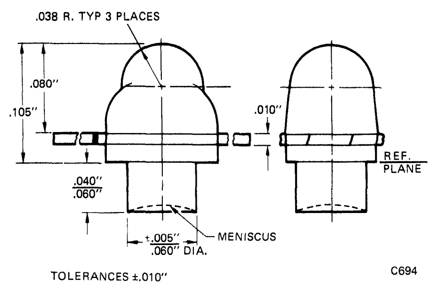
HIGH EFFICIENCY GaAs INFRARED EMITTER

GENERAL INSTRUMENT

MEM740

PACKAGE DIMENSIONS





FEATURES

- High efficiency infrared emitter
- Gallium arsenide diode
- Standard T-¾ plastic package
- Clear lens
- Output flux of 3 mW at 20 mA

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° C ambient . . . . 75 mW
Derate linearly at 1.0 mW/° C above 25° C ambient
Storage and operating
temperatures . . . . -40° C to +100° C
Junction temperature . . . . 100° C
Lead solder time at 260° C (see note 1) . . . . 5 sec.
Continuous forward current . . . . 50 mA
Reverse voltage . . . . 3 V
Peak forward current
(1 μsec pulse, 0.3% duty cycle) . . . . 1 A

NOTE: *Stresses listed under "Absolute Maximum Ratings" may be applied to a device without resulting in damage. Exposure to maximum rating conditions for extended periods may affect device reliability. Conditions listed under "Electro-Optical Characteristics" are specified for operation.*

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

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Axial radiant intensity	I_e	1	2		mW/sr	I_F = 20 mADC
Total output power	Φ_e	1.5	3		mW	I_F = 20 mADC
Included angle Between half radiant intensity points	$2\theta_{1/2}(I_e)$		40		degrees	
Peak emission wavelength	λ_p		940		nm	I_F = 20 mA
Spectal line half width	$\Delta\lambda_{PHW}$		50		nm	I_F = 20 mA
Forward voltage	V_F		1.2	1.6	V	I_F = 20 mA
Reverse voltage	V_R	3	25		V	I_R = 10 μA
Rise/Fall time (10%-90%)	t_r/t_f		800		ns	I_F = 50 mA

NOTES: 1. *The leads of the devices were immersed in molten solder heated to a temperature of 260° C, to a point 1/16 inch from the body of the device per MIL-S-750.*
2. *I_e measured with 1.0 cm diameter aperture at 14.7 cm on axis from tips of lens.*

PRELIMINARY DATA SHEET

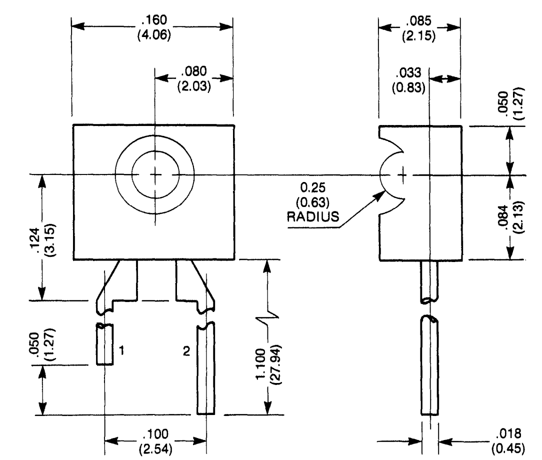
VERY HIGH EFFICIENCY AlGaAs SIDE VIEW INFRARED EMITTER

GENERAL INSTRUMENT

Emitters Detectors

MES560

PACKAGE DIMENSIONS



ALL DIMENSIONS IN INCHES (MILLIMETERS)
TOLERANCES ± .010 (±0.25)
PIN 1: ANODE PIN 2: CATHODE C1870

FEATURES

- Very high efficiency infrared emitter
- Aluminum gallium arsenide diode
- Side-view plastic package
- Recessed lens design
- Color coded RED on back surface
- Output flux of 5 mW at 20 mA
- Axial intensity of 2 mW/sr at 20 mA

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25°C ambient . . . . 130 mW
Derate linearly at 1.7 mW/°C above 25°C ambient
Storage and operating temperatures . . -40°C to 100°C
Junction temperature . . . . 100°C
Lead solder time at 260°C (see Note 1) . . . . 5 sec.
Continuous forward current . . . . 50 mA
Reverse voltage . . . . 3 V
Peak forward current
(1 μsec pulse, 0.3% duty cycle) . . . . 1 A

NOTE: *Stresses listed under "Absolute Maximum Ratings" may be applied to a device without resulting in damage. Exposure to maximum rating conditions for extended periods may affect device reliability. Conditions listed under "Electro-Optical Characteristics" are specified for operation.*

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

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Axial radiant intensity (see note 2)	I_e	1	2		mW/sr	I_F = 20 mADC
Total output power	Φ_e	3	5		mW	I_F = 20 mADC
Included angle Between half radiant intensity points	$2\theta_{1/2}(I_e)$		60		degrees	
Peak emission wavelength	λ_p		880		nm	I_F = 20 mA
Spectal line half width	$\Delta\lambda_{PHW}$		40		nm	I_F = 20 mA
Forward voltage	V_F		1.5	1.8	V	I_F = 20 mA
Reverse voltage	V_R	3	25		V	I_R = 10 μA
Rise/Fall time (10%-90%)	t_r/t_f		800		ns	I_F = 50 mA, 50 Ω system

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

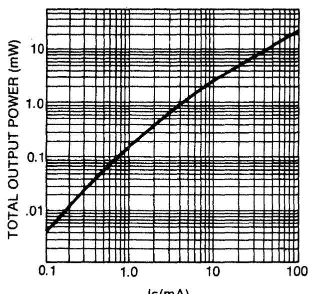


Fig. 1. Power Output vs. Input Current

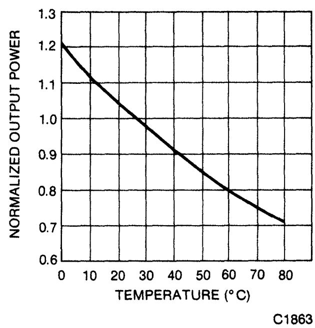


Fig. 2. Normalized Output Power vs. Temperature (see Note 3)

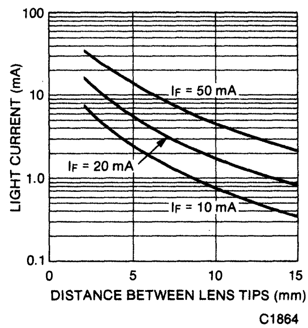


Fig. 3. Coupling Characteristics of MES560 with MTS360/1

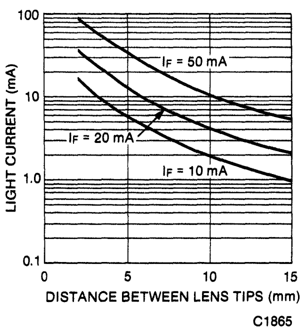


Fig. 4. Coupling Characteristics of MES560 with MTS460/1

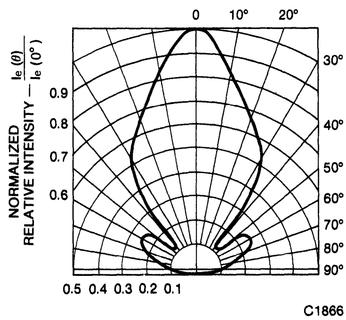


Fig. 5. Relative Angular Intensity Distribution

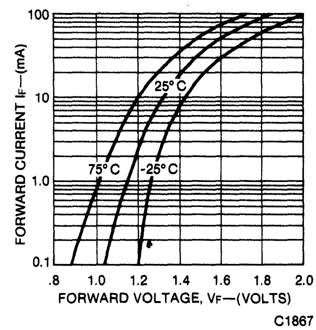


Fig. 6. Forward Current vs. Forward Voltage

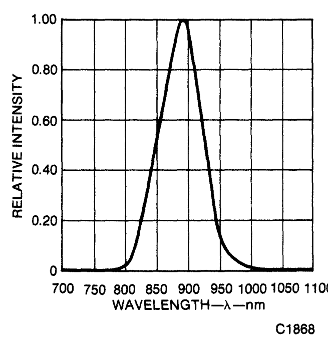


Fig. 7. Spectral Distribution

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 from the body of the devive per MIL-S-750.*
2. *I_e measured with 1.0 cm diameter aperture at 14.7 cm on axis from tip of lens (ω = .0038 STERADIAN)*
3. *The curves in Fig. 2 are normalized to the power output at 25°C to indicate the relative efficiency over the operating temperature range.*

PRELIMINARY DATA SHEET

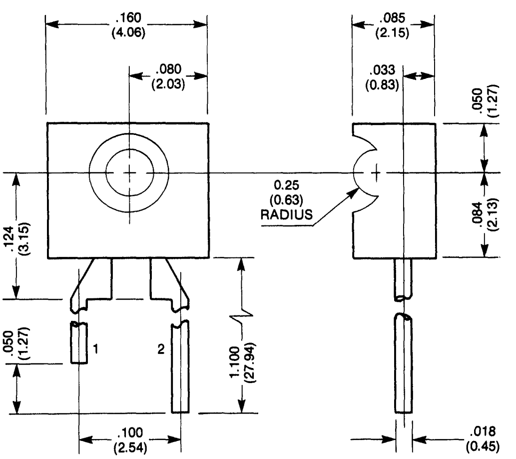
HIGH EFFICIENCY GaAs
SIDE VIEW INFRARED EMITTER

GENERAL INSTRUMENT

Emitters Detectors

MES760

PACKAGE DIMENSIONS



ALL DIMENSIONS IN INCHES (MILLIMETERS)
TOLERANCES ± .010 (±0.25)
PIN 1: CATHODE PIN 2: ANODE C1870

FEATURES

- High efficiency infrared emitter
- Gallium arsenide diode
- Side-view plastic package
- Recessed lens design
- Color coded WHITE on back surface
- Output flux of 2.5 mW at 20 mA
- Axial intensity of 1 mW/sr at 20 mA

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25°C ambient . . . . 150 mW
Derate linearly at 2.0 mW/°C above 25°C ambient
Storage and operating temperatures . . . -40°C to 100°C
Junction temperature . . . . 100°C
Lead solder time at 260°C (see Note 1) . . . . 5 sec.
Continuous forward current . . . . 100 mA
Reverse voltage . . . . 3 V
Peak forward current
(1 μsec pulse, 0.3% duty cycle) . . . . 1 A

NOTE: *Stresses listed under "Absolute Maximum Ratings" may be applied to a device without resulting in damage. Exposure to maximum rating conditions for extended periods may affect device reliability. Conditions listed under "Electro-Optical Characteristics" are specified for operation.*

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

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Axial radiant intensity (see note 2)	I_e	0.5	1		mW/sr	I_F = 20 mADC
Total output power	Φ_e	1.5	2.5		mW	I_F = 20 mADC
Included angle Between half radiant intensity points	$2\theta_{1/2}(I_e)$		60		degrees	
Peak emission wavelength	λ_p		940		nm	I_F = 20 mA
Spectal line half width	$\Delta\lambda_{PHW}$		30		nm	I_F = 20 mA
Forward voltage	V_F		1.2	1.6	V	I_F = 20 mA
Reverse voltage	V_R	3	20		V	I_R = 10 μA
Rise/Fall time (10%-90%)	t_r/t_f		800		ns	I_F = 50 mA, 50 Ω system

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (T$_A$ = 25°C Unless Otherwise Specified)

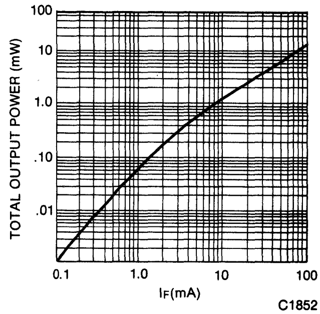


Fig. 1. Power Output vs. Input Current

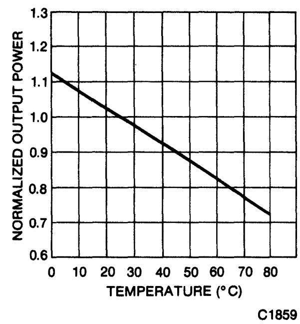


Fig. 2. Normalized Output Power vs. Temperature (Note 3)

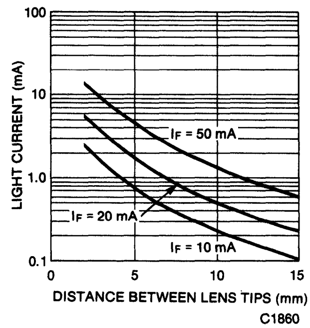


Fig. 3. Coupling Characteristics of MES760 with MTS360/1

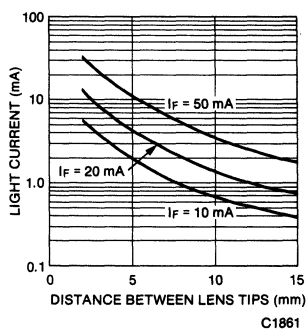


Fig. 4. Coupling Characteristics of MES760 with MTS460/1

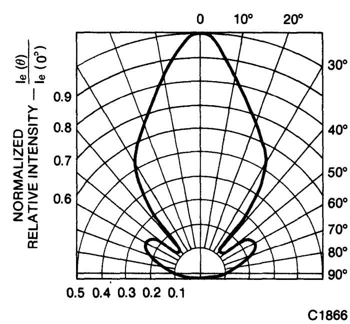


Fig. 5. Relative Angular Intensity Distribution

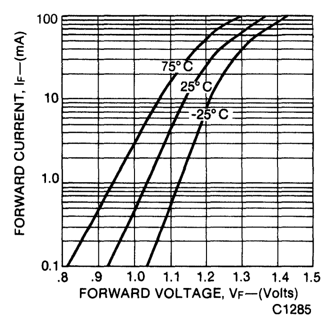


Fig. 6. Foward Current vs. Forward Voltage

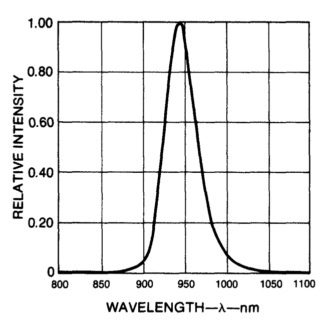


Fig. 7. Spectral Distribution

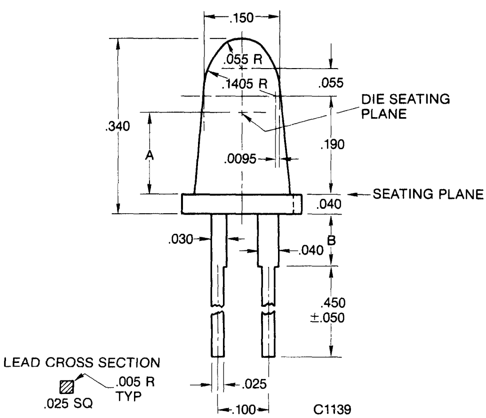
NOTES:

1. *The leads of the device were immersed in molten solder, heated to a temperature of 260° C, to a point 1/16 inch from the body of the devive per MIL-S-750.*
2. *I_e measured with 1.0 cm diameter aperture at 14.7 cm on axis from tip of lens (ω = .0038 STERADIAN)*
3. *The curves in fig. 2 are normalized to the power output at 25° C to indicate the relative efficiency over the operating temperature range.*

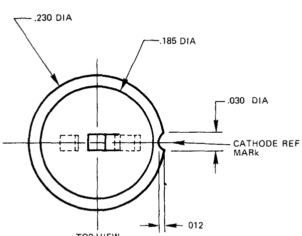
GENERAL INSTRUMENT

ME7121
ME7124

PACKAGE DIMENSIONS



C1139



C704

DIM	A	B
ME7121	.190	.100
ME7124	.145	.145

ALL DIMENSIONS IN INCHES
TOLERANCES = ±.010 UNLESS SPECIFIED

DESCRIPTION

This family of high power liquid phase epitaxial IR Emitters is designed to accommodate all needs of the emitter detector relationship. Products range from a wide angle power spread for non-critical detector location to sharp-angle concentration of power for detectors located a significant distance from the emitter. The devices can be mounted with a plastic pop-in, furnished upon request.

ABSOLUTE MAXIMUM RATINGS

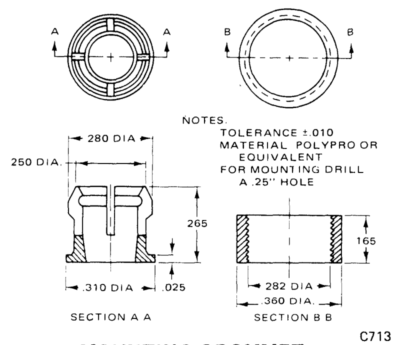
Power dissipation @ 25°C ambient . . . . 150 mW
Derate linearly from 50°C . . . . 2.8 mW/°C
Storage & operating temperature . . . . -55° to 100°C
Lead solder time @ 230°C (Note 3) . . . . 5 sec
Continuous forward current . . . . 100 mA
Reverse voltage . . . . 3.0 V
Peak forward current (PW = 1.0 μsec, Duty Cycle = 0.3%) . . . . 1.0 A

ELECTRO-OPTICAL CHARACTERISTICS

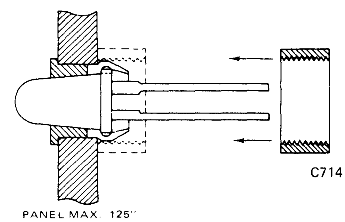
	TYPICAL HALF ANGLE (DEGREES)	TYPICAL ON AXIS INTENSITY (MW/STR.) @ 50 mA	
ME7121	17°	2.0	into cone @ 1/2 power points
ME7124	6°	10	@ I_F = 50 mA ROP = 3 mW

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Total External Output Power (Note 2)	1.0	3.0		mW	I_F = 50 mA
Peak Emission Wavelength		940		nm	I_F = 50 mA
Spectral Line Half Width		50		nm	I_F = 50 mA
Forward Voltage		1.4	1.8	V	I_F = 50 mA
Light Turn On & Turn Off Time		500		nsec	50 Ω Load
Reverse Current		10		μA	V_R = 3.0 V

PANEL MOUNTING TECHNIQUES



MOUNTING GROMMET



PANEL MOUNTING

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free air temperature unless otherwise specified.)

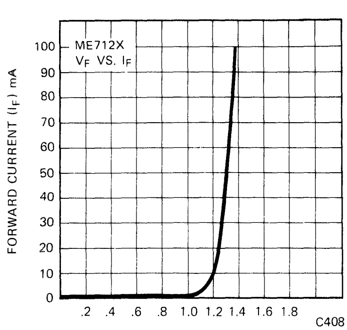


Fig. 1. I_F vs. V_F

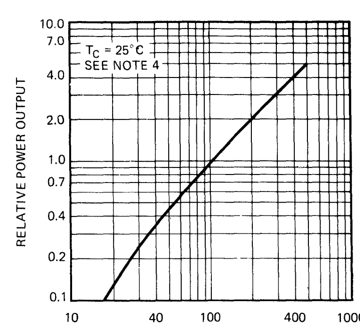


Fig. 2. ROP vs. I_F Peak

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (Cont.)

(25°C Free Air Temperature Unless Otherwise Specified)

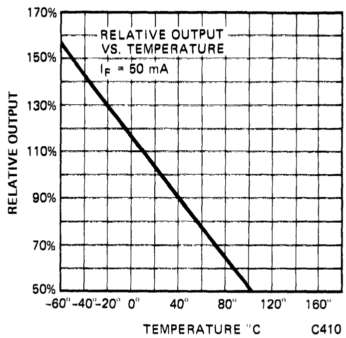


Fig. 3. ROP vs. Temperature (Note 1)

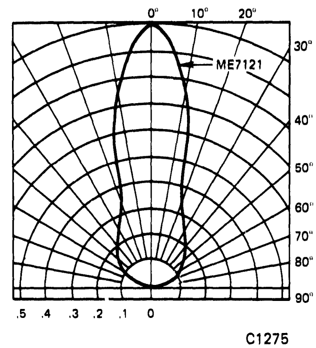


Fig. 4. Spatial Distribution (ME7121)

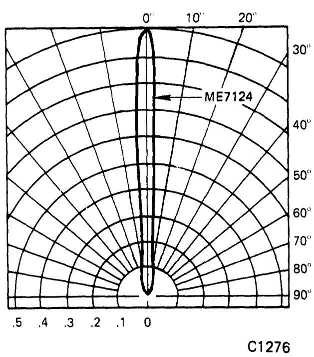


Fig. 5. Spatial Distribution (ME7124)

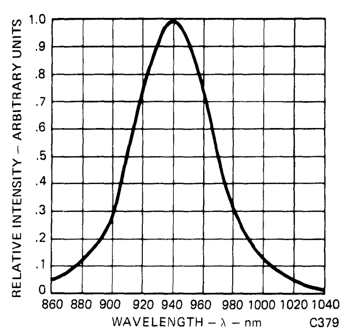


Fig. 6. Spectral Distribution

NOTES

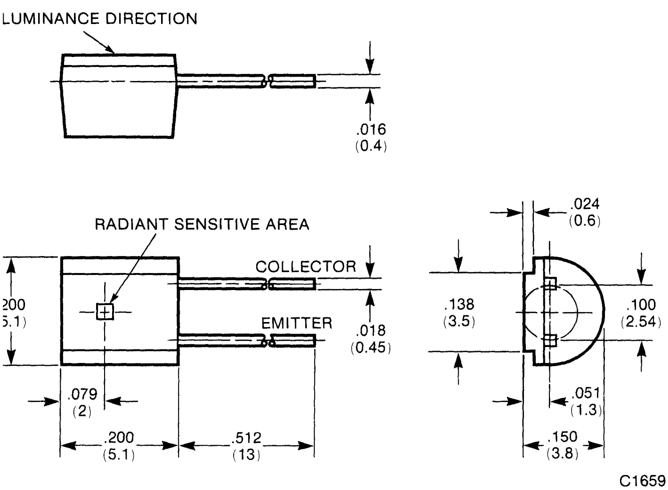
1. *The curves in figure 3 are normalized to the power output at 25°C to indicate the relative efficiency over the operating temperature range.*
2. *The total external radiated power output measurements are made with a Centralab 110C solar cell terminated into a 100Ω impedance.*
3. *The leads of the ME7121 and ME7124 were immersed in molten solder, heated to 230°C, to a point 1/16 inch from the body of the device, per MIL-S-750.*
4. *This parameter is measured using pulse techniques pw = 40 μsec duty cycle ≤10%.*

GENERAL INSTRUMENT

SILICON NPN EPITAXIAL PLANAR PHOTOTRANSISTOR BPW39A

PACKAGE DIMENSIONS

All dimensions are in inches (millimeters).



Angle of half sensitivity $\alpha = 130°$
Plastic case equivalent to:
JEDEC TO 92
10 B 3 DIN 41868
Weight = max 0.4 g.

DESCRIPTION

The BPW39A is an NPN silicon phototransistor packaged in a clear plastic case. This device has high sensitivity and is packaged in a TO-92 package.

FEATURES

- Plastic case, white clear
- Suitable for visible and near infrared radiation
- High sensitivity
- Wide angle of sensitivity
- Flat window
- Irradiation direction vertical to mounting direction
- Compatible with CQX47

APPLICATIONS

- Detector in electronic control and drive circuits
- Optical shaft position and velocity monitor using a digitally encoded disc mounted on a shaft
- Optical sensing of holes in paper, paper tape, IBM card or magnetic tape
- Optical sensing of marks on paper, paper tape, or IBM card
- End of tape sensor using a transparent section of tape, a reflective strip on the tape, or a hole in the tape
- End of film sensor for films not affected by infrared light
- Limit switch for mechanical travel such as cam switches, pressure switches, machine tool limit switches, foot pedal switches, safety interlock switches
- Edge sensor for sheet materials such as paper, plastic film, fabric, foil, newsprint, belt sanders, reproduction paper
- Fiber continuity monitor for fibers such as yarn, wire, thread
- Fluid volume monitor by sensing turbine vanes passing through the slot
- Liquid level detector of an opaque liquid

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

Collector-Emitter Voltage 32V
Emitter-Collector Voltage 5V
Collector Current .... 100 mA
Peak Collector Current
(t_P/T = 0.5, $t_P \leq$ 10 ms) .... 200 mA

Total Power Dissipation ($T_A \leq 25°C$) ...... 150 mW
Junction Temperature .... 85°C
Storage Temperature Range ...... −25°C to +85°C
Soldering Temperature (t ≤ 3 s) (See Note 1) . . 245°C

ELECTRICAL AND OPTICAL CHARACTERISTICS (T_A = 25°C Unless Otherwise Specified)

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Collector light current	I_{CE}*	0.5		1.6	mA	V_{CE} = 5V, Source = Tungsten[1]
Collector dark current	I_{CEO}*		10	100	nA	V_{CE} = 20V[2]
Sensitivity	s	100		320	μA/mW/cm²	V_{CE} = 5V[1]
Peak wavelength sensitivity	λ_P		780		nm	
Range of spectral bandwidth (50%)	$\lambda_{0.5}$		520-950		nm	
Collector-emitter breakdown voltage	BV_{CEO}*	32			V	I_C = 1 mA
Collector-emitter saturation voltage	$V_{CE(SAT)}$			0-3	V	I_C = 0.1 mA[1]
Bandwidth	Bw		170		kHz	I_C = 5 mA, V_{CC} = 5V, R_L = 100 Ω

*0.65 AQL
[1] Radiation source is unfiltered tungsten filament bulb at 2875°K color Temperature H = 5 mW/cm²
[2] Measured under dark conditions; H ≤ 1.0 μW/cm²

SWITCHING CHARACTERISTICS

CHARACTERISTICS	SYMBOL	TYP.	UNITS	CONDITIONS
Delay time	t_d	1.8	μs	V_{CC} = 5V, I_C = 5 mA, R_L = 100 Ω (See test circuit, Fig. 1)
Rise time	t_r	1.6	μs	
Turn-on time	t_{on}	3.4	μs	
Storage time	t_s	0.3	μs	
Fall time	t_f	1.7	μs	
Turn-off time	t_{off}	2.0	μs	

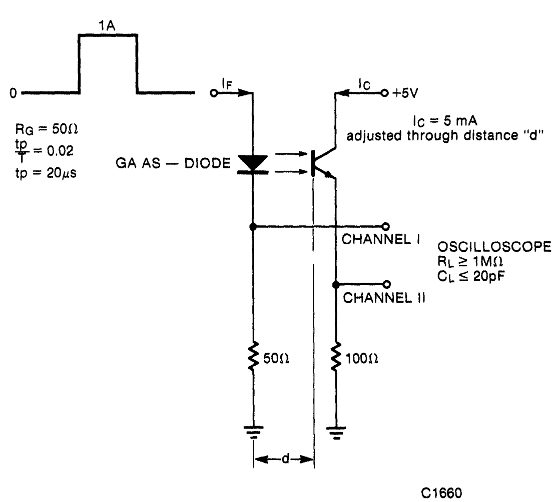


Fig. 1. Switching Time Test Circuit

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (25°C Ambient Temperature Unless Otherwise Noted)

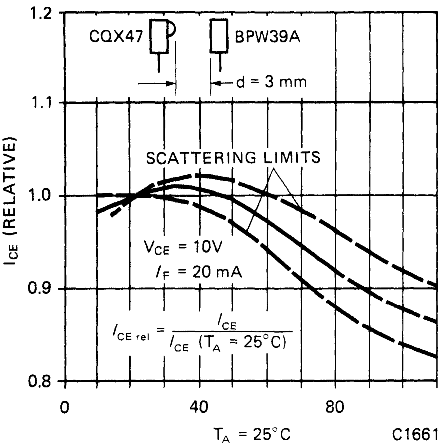


Fig. 2. Relative Collector Light Current vs. Ambient Temperature

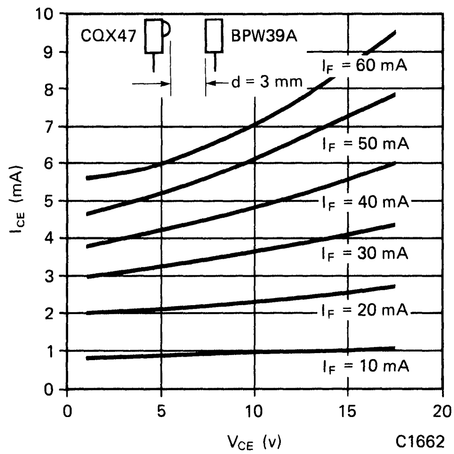


Fig. 3. Collector Light Current vs. Collector Emitter Voltage

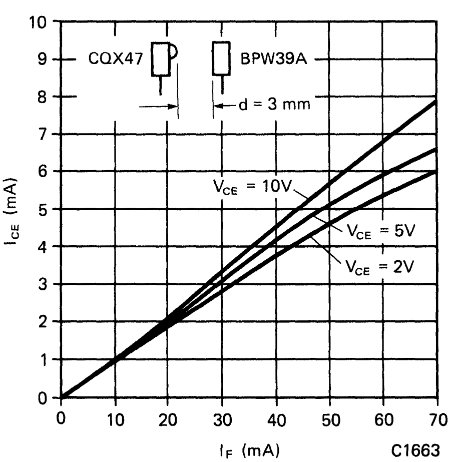


Fig. 4. Collector Light Current vs. GaAs LED Forward Current

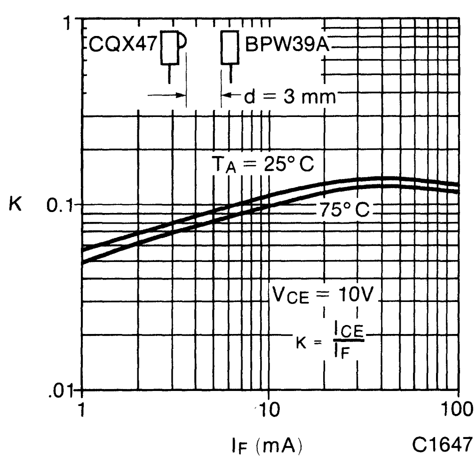


Fig. 5. Current Transfer Ratio vs. GaAs LED Forward Current

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

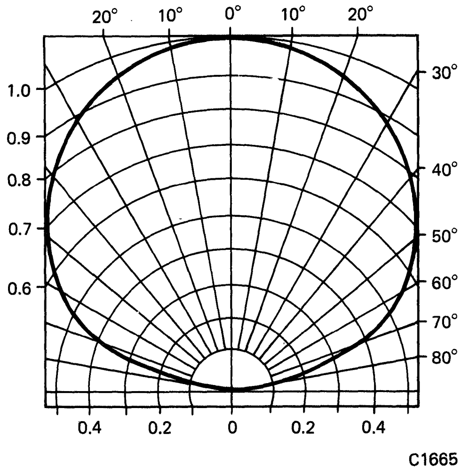


Fig. 6. Spatial Distribution

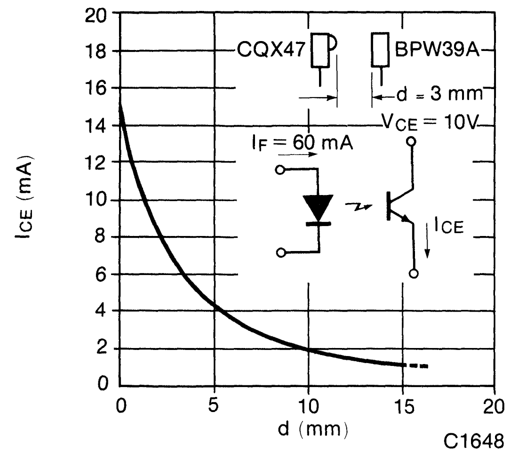


Fig. 7. Collector Light Current vs. Distance From GaAs LED Source

NOTES

1. Distance from the touching border ≥ 2 mm with intermediate PC-board.

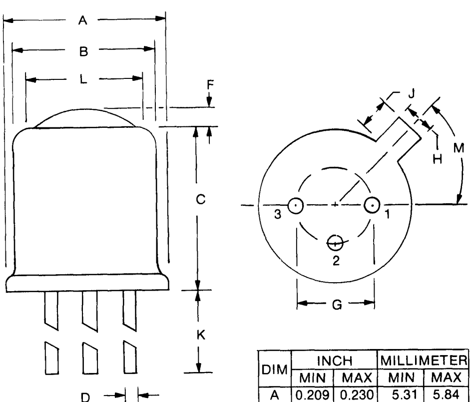
PRELIMINARY DATA SHEET

HIGH SENSITIVITY HERMETIC NPN PHOTODARLINGTON

GENERAL INSTRUMENT

MAH120

PACKAGE DIMENSIONS



PIN 1: EMITTER
PIN 2: BASE
PIN 3: COLLECTOR GROUNDED TO CASE

DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX
A	0.209	0.230	5.31	5.84
B	0.178	0.195	4.52	4.95
C	0.190	0.230	4.83	5.84
D	0.016	0.020	0.40	0.50
F	———	0.010	———	0.25
G	0.100		2.54	
H	0.036	0.046	0.91	1.17
J	0.030	0.048	0.76	1.22
K	1.000	———	25.40	———
L	0.140	0.165	3.56	4.19
M	45°		45°	

C1873B

FEATURES

- Hermetic TO-18 type package
- Lensed for narrow acceptance angle—20°
- High collector current

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° C ambient . . . . 300 mW
Derate linearly at 2.4 mW/° C above 25° C ambient
Storage and operating temperatures . . -65° C to 150° C
Junction temperature . . . . 150° C
Lead solder time at 260° C (see Note 1) . . . . 5 sec.
Collector emitter voltage . . . . 30 V
Emitter collector voltage . . . . 7 V
Collector base voltage . . . . 70 V

NOTE: *Stresses listed under "Absolute Maximum Ratings" may be applied to a device without resulting in damage. Exposure to maximum rating conditions for extended periods may affect device reliability. Conditions listed under "Electro-Optical Characteristics" are specified for operation.*

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

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Light current	I_L	25			mA	V_{CE} = 5 V E_e = 0.5 mW/cm²
Dark current	I_D			100	nA	V_{CE} = 10 V E_e = 0 mW/cm²
Collector-emitter breakdown voltage	BV_{CEO}	30			V	I_C = 100 μA
Collector-base breakdown voltage	BV_{CBO}	70			V	I_C = 10 μA
Emitter-collector breakdown voltage	BV_{ECO}	7			V	I_E = 100 μA
Collector-emitter saturation voltage	$V_{CE\,(SAT)}$		0.6	1.0	V	I_C = 500 μA E_e = 0.5 mW/cm
Rise time	t_r		5		μs	V_{CE} = 10 V R_L = 100 Ω I_C = 10 mA
Fall time	t_f		35		μs	V_{CE} = 10 V R_L = 100 Ω I_C = 10 mA

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

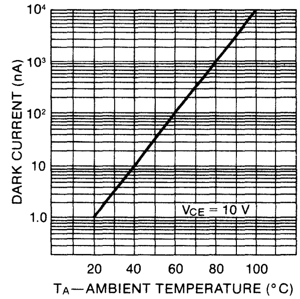


Fig. 1. Collector Dark Current vs. Ambient Temperature

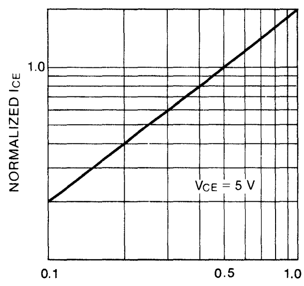


Fig. 2. Collector Current vs. Irradiance

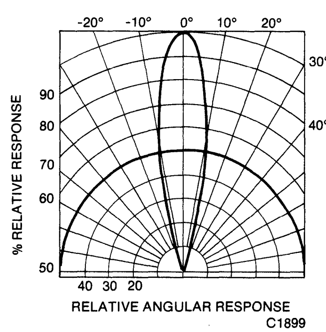


Fig. 3. Relative Angular Response

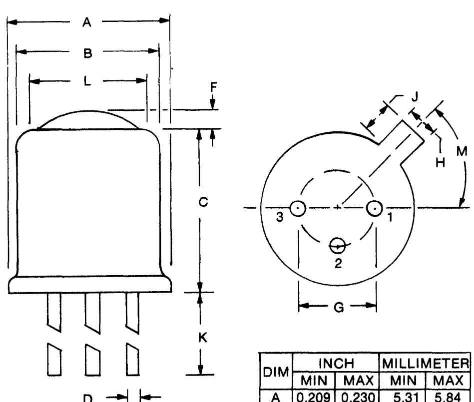
NOTES:

1. *The leads of the devices were immersed in molten solder heated to a temperature of 260° C, to a point 1/16 inch from the body of the device per MIL-S-750.*
2. *E_e = Radiant Incidance. Light source is an unfiltered Tungsten lamp at 2870° K color. A GaAs source of 1.7 mW/cm² approximately equivalent to a Tungsten source of 5 mW/cm² 2870° K.*

GENERAL INSTRUMENT

MTH320 MTH420 MTH321 MTH421

PACKAGE DIMENSIONS



PIN 1: EMITTER
PIN 2: BASE
PIN 3: COLLECTOR GROUNDED TO CASE

DIM	INCH		MILLIMETER	
	MIN	MAX	MIN	MAX
A	0.209	0.230	5.31	5.84
B	0.178	0.195	4.52	4.95
C	0.190	0.230	4.83	5.84
D	0.016	0.020	0.40	0.50
F	———	0.010	———	0.25
G	0.100		2.54	
H	0.036	0.046	0.91	1.17
J	0.030	0.048	0.76	1.22
K	1.000	———	25.40	———
L	0.140	0.165	3.56	4.19
M	45°		45°	

C1873B

FEATURES

- Silicon NPN epitaxial planar phototransistor
- Hermetic TO-18 type package
- Lensed for narrow acceptance angle—20°
- Wide range of collector currents

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° C ambient . . . . 300 mW
Derate linearly at 2.4 mW/° C above 25° C ambient
Storage and operating temperatures . . -65° C to 150° C
Junction temperature . . . . 150° C
Lead solder time at 260° C (see Note 1) . . . . 5 sec.
Collector emitter voltage . . . . 30 V
Emitter collector voltage . . . . 7 V
Collector base voltage . . . . 70 V

NOTE: *Stresses listed under "Absolute Maximum Ratings" may be applied to a device without resulting in damage. Exposure to maximum rating conditions for extended periods may affect device reliability. Conditions listed under "Electro-Optical Characteristics" are specified for operation.*

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

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Light current MTH320	I_L	7.5			mA	V_{CE} = 5 V, E_e = 5 mW/cm²
MTH321		20.0				
MTH420		35.0				
MTH421		60.0				
Dark current	I_D			100	nA	V_{CE} = 10 V, E_e = 0 mW/cm²
Collector-emitter breakdown voltage	BV_{CEO}	30			V	I_C = 100 μA
Collector-base breakdown voltage	BV_{CBO}	70			V	I_C = 10 μA
Emitter-collector breakdown voltage	BV_{ECO}	7			V	I_E = 100 μA
Collector-emitter saturation voltage	$V_{CE(SAT)}$			0.4	V	I_C = 500 μA, E_e = 5 mW/cm²
Rise/fall time	t_r/t_f		4		μs	V_{CE} = 10 V, R_L = 100 Ω, I_C = 2 mA

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

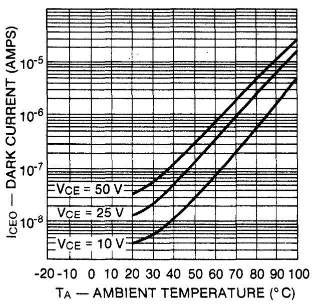


Fig. 1. Collector Dark Current vs. Ambient Temperature

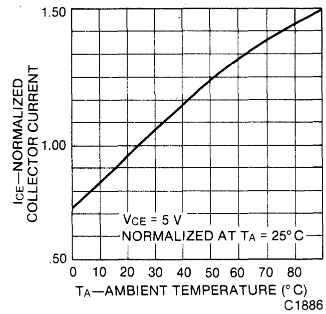


Fig. 2. Normalized Collector Current vs. Ambient Temperature

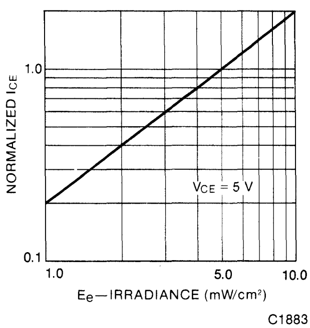


Fig. 3. Collector Current vs. Irradiance

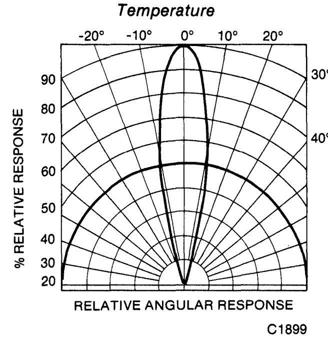


Fig. 4. Relative Angular Response

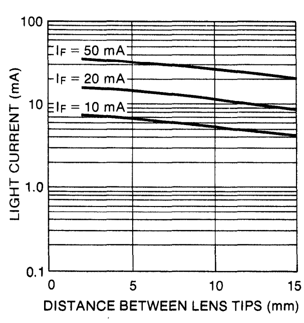


Fig. 5. Coupling Characteristics of MTH32X with MEH520

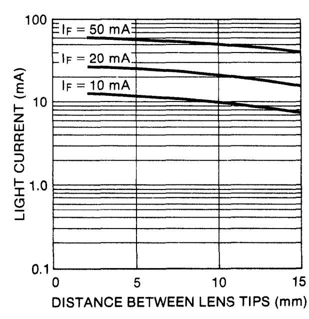


Fig. 6. Coupling Characteristic of MTH42X with MEH520

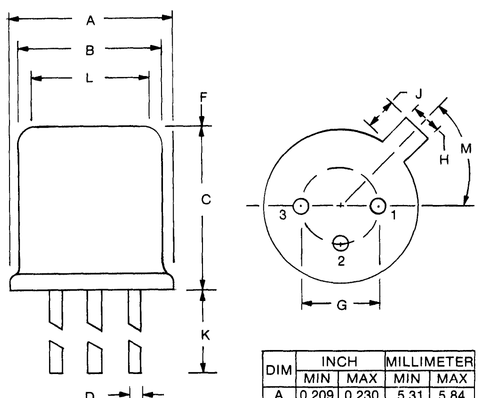
NOTES

1. *The leads of the devices were immersed in molten solder heated to a temperature of 260° C, to a point 1/16 inch from the body of the device per MIL-S-750.*
2. *E_e = Radiant Incidance. Light source is an unfiltered Tungsten lamp at 2870° K color. A GaAs source of 1.7 mW/cm² is approximately equivalent to a Tungsten source of 5 mW/cm² at 2870° K*

GENERAL INSTRUMENT

MTH360 MTH460 MTH361 MTH461

PACKAGE DIMENSIONS



PIN 1: EMITTER
PIN 2: BASE
PIN 3: COLLECTOR GROUNDED TO CASE
DIM F: GLASS LENS FLUSH TO 0.010 INCH MAX

DIM	INCH		MILLIMETER	
	MIN	MAX	MIN	MAX
A	0.209	0.230	5.31	5.84
B	0.178	0.195	4.52	4.95
C	0.190	0.230	4.83	5.84
D	0.016	0.020	0.40	0.50
F	———	0.010	———	0.25
G	0.100		2.54	
H	0.036	0.046	0.91	1.17
J	0.030	0.048	0.76	1.22
K	1.000	———	25.40	———
L	0.140	0.165	3.56	4.19
M	45°		45°	

C1873C

FEATURES

- Silicon NPN epitaxial planar phototransistor
- Hermetic TO-18 type package
- Flat lens for wide acceptance angle—60°
- Wide range of collector currents

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° C ambient . . . . 300 mW
Derate linearly at 2.4 mW/° C above 25° C ambient
Storage and operating temperatures . . . -65° C to 150° C
Junction temperature . . . . 150° C
Lead solder time at 260° C (see Note 1) . . . . 5 sec.
Collector emitter voltage . . . . 30 V
Emitter collector voltage . . . . .7 V
Collector base voltage . . . . 70 V

NOTE: *Stresses listed under "Absolute Maximum Ratings" may be applied to a device without resulting in damage. Exposure to maximum rating conditions for extended periods may affect device reliability. Conditions listed under "Electro-Optical Characteristics" are specified for operation.*

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

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Light current MTH360	I_L	1.0			mA	V_{CE} = 5 V, E_e = 5 mW/cm²
MTH361		5.0				
MTH460		3.0				
MTH461		10.0				
Dark current	I_D			100	nA	V_{CE} = 10 V, E_e = 0 mW/cm²
Collector-emitter breakdown voltage	BV_{CEO}	30			V	I_C = 100 μA
Collector-base breakdown voltage	BV_{CBO}	70			V	I_C = 10 μA
Emitter-collector breakdown voltage	BV_{ECO}	7			V	I_E = 100 μA
Collector-emitter saturation voltage	$V_{CE\ (SAT)}$			0.4	V	I_C = 500 μA, E_e = 5 mW/cm²
Rise/fall time	t_r/t_f		4		μs	V_{CE} = 10 V, R_L = 100 Ω, I_C = 2 mA

NOTES:

1. *The leads of the devices were immersed in molten solder heated to a temperature of 260° C, to a point 1/16 inch from the body of the device per MIL-S-750.*
2. *E_e = Radiant Incidance. Light source is an unfiltered Tungsten lamp at 2870° K color. A GaAs source of 1.7 mW/cm² is approximately equivalent to a Tungsten source of 5 mW/cm² at 2870° K.*

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

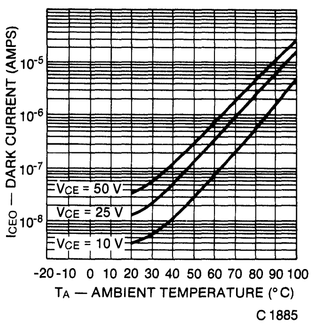


Fig. 1. Collector Dark Current vs. Ambient Temperature

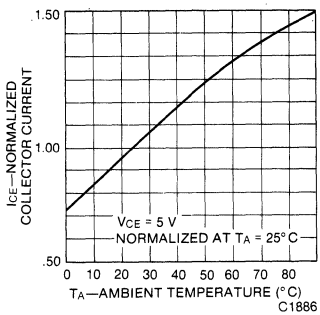


Fig. 2. Normalized Collector Current vs. Ambient Temperature

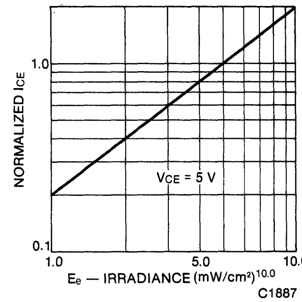


Fig. 3. Collector Current vs. Irradiance

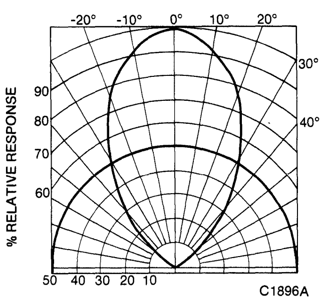


Fig. 4. Relative Angular Response

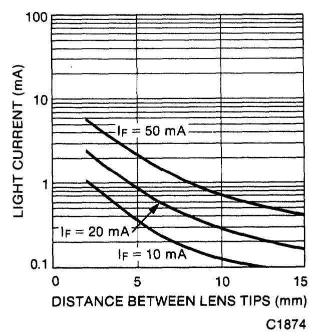


Fig. 5. Coupling Characteristics of MEH560 with MTH36X

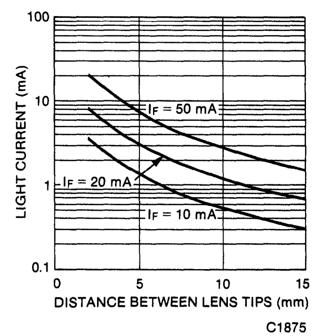


Fig. 6. Coupling Characteristics of MEH560 with MTH46X

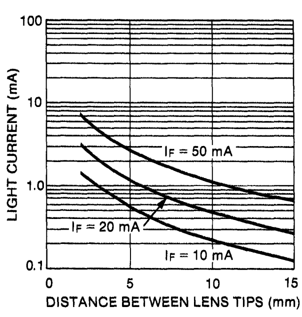


Fig. 7. Coupling Characteristics of MEH580 with MTH36X

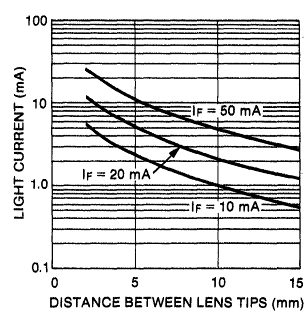


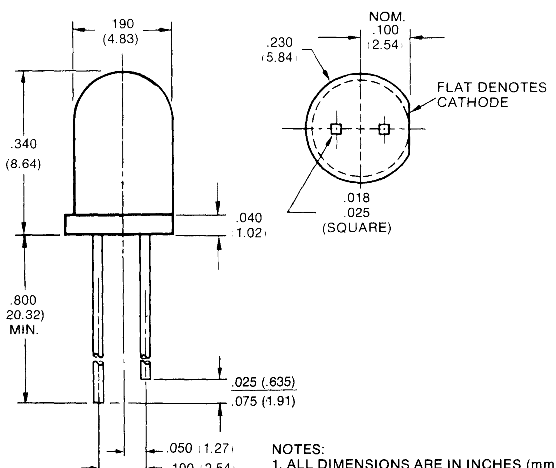
Fig. 8. Coupling Characteristics of MEH580 with MTH46X

GENERAL INSTRUMENT

MTK380 MTK480
MTK381 MTK481

PACKAGE DIMENSIONS

C1062J



C1062J

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

FEATURES

- Silicon NPN epitaxial planar phototransistor
- Standard T-1¾ plastic package
- Filtered lens for ambient light rejection
- Wide range of collector currents
- Wide acceptance angle 80° C

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° C ambient . . . . 200 mW
Derate linearly at 2.7 mW/° C above 25° C ambient
Storage and operating temperatures . . -40° C to 100° C
Lead solder time at 260° C (see Note 1) . . . . 5 sec.
Collector emitter voltage . . . . 30 V
Emitter collector voltage . . . . 7 V

NOTE: *Stresses listed under "Absolute Maximum Ratings" may be applied to a device without resulting in damage. Exposure to maximum rating conditions for extended periods may affect device reliability. Conditions listed under "Electro-Optical Characteristics" are specified for operation.*

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

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Light current	MTK380	I_L	1.0			mA	V_{CE} = 5 V
	MTK381		3.0				E_e = 5 mW/cm²
	MTK480		5.0				
	MTK481		10.0				
Dark current		I_D			100	nA	V_{CE} = 10 V E_e = 0 mW/cm²
Collector-emitter breakdown voltage		BV_{CEO}	30			V	I_C = 100 μA
Collector-base breakdown voltage		BV_{CBO}	70			V	I_C = 10 μA
Emitter-collector breakdown voltage		BV_{ECO}	7			V	I_E = 100 μA
Collector-emitter saturation voltage		$V_{CE(SAT)}$			0.4	V	I_C = 500 μA E_e = 5 mW/cm²
Rise/Fall time		t_r/t_f		4		μs	V_{CE} = 10 V R_L = 100 Ω I_C = 2 mA

MTK380 MTK381 MTK480 MTK481

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

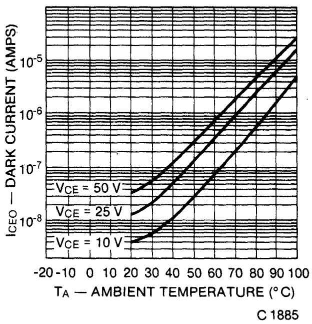


Fig. 1. Collector Dark Current vs. Ambient Temperature

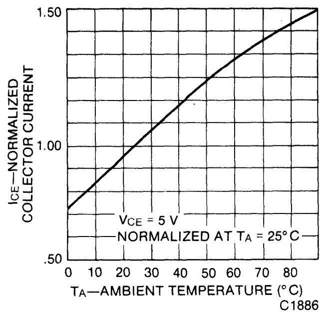


Fig. 2. Normalized Collector Current vs. Ambient Temperature

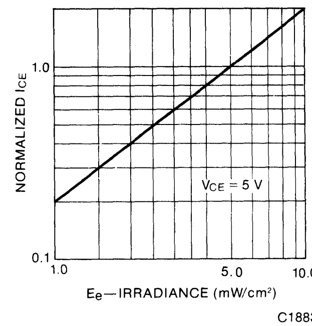


Fig. 3. Collector Current vs. Irradiance

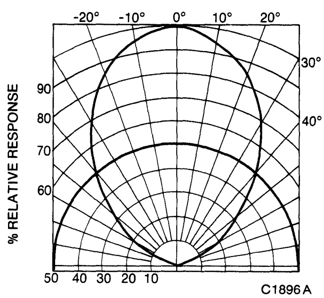


Fig. 4. Relative Angular Response

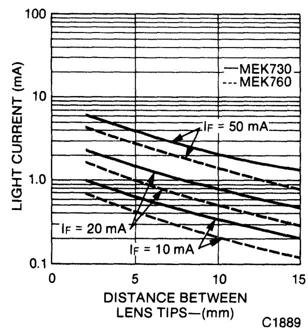


Fig. 5. Coupling Characteristics of MTK38X with MEK730 and MEK760

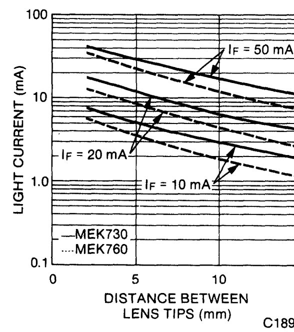


Fig. 6. Coupling Characteristics of MTK48X with MEK730 and MEK760

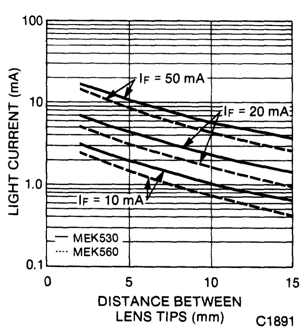


Fig. 7. Coupling Characteristics of MTK38X with MEK530 and MEK560

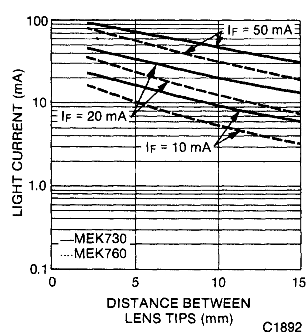


Fig. 8. Coupling Characteristics of MTK48X with MEK530 and MEK560

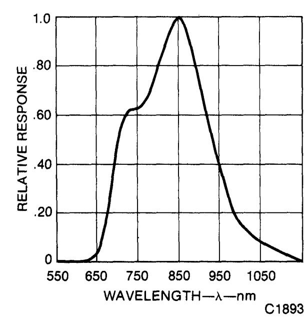


Fig. 9. Photosensor Spectral Response

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 from the body of the device per MIL-S-750.*
2. *E_e = Radiant Incidance. Light source is an unfiltered Tungsten lamp at 2870° K color. A GaAs source of 1.7 mW/cm² is approximately equivalent to a Tungsten source of 5 mW/cm² at 2870° K.*

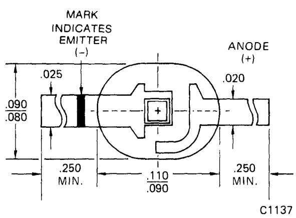
PRELIMINARY DATA SHEET **NPN SILICON PHOTOTRANSISTORS**

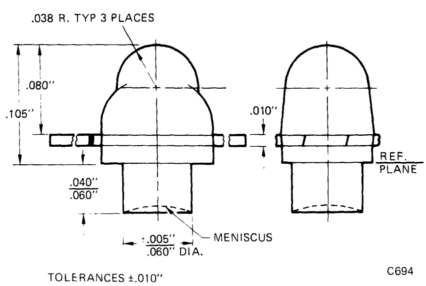
GENERAL INSTRUMENT

MTM340

Emitters Detectors

PACKAGE DIMENSIONS





FEATURES

- Silicon NPN epitaxial planar photoresistor
- Standard T-¾ plastic package
- Filtered lens for ambient light rejection
- Wide range of collector currents
- Acceptance angle of 40°

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° ambient . . . . 75 mW
Derate linearly at 1 mW/°C above 25°C
Storage and operating temperature . . . . -40°C to +100°C
Junction temperature . . . . 100°C
Lead solder time at 260°C (see Note 1) . . . . 5 sec.
Collector emitter voltage . . . . 30 V
Emitter collector voltage . . . . 7 V

NOTE: *Stresses listed under "Absolute Maximum Ratings" may be applied to a device without resulting in damage. Exposure to maximum rating conditions for extended periods may affect device reliability. Conditions listed under "Electro-Optical Characteristics" are specified for operation.*

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

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Light current	I_L	1.5			mA	V_{CE} = 5 V E_e = 5 mW/cm²
Dark current	I_D			100	nA	V_{CE} = 10 V E_e = 0 mW/cm²
Collector-emitter breakdown voltage	BV_{CEO}	30			V	I_C = 100 μA
Collector-base breakdown voltage	BV_{CBO}	70			V	I_C = 10 μA
Emitter-collector breakdown voltage	BV_{ECO}	7			V	I_E = 100 μA
Collector-emitter saturation voltage	$V_{CE(SAT)}$			0.4	V	I_C = 500 μA E_e = 5 mW/cm²
Rise/Fall time	t_r/t_f		4		μs	V_{CE} = 10 V R_L = 100 Ω I_C = 2 mA

NOTES:

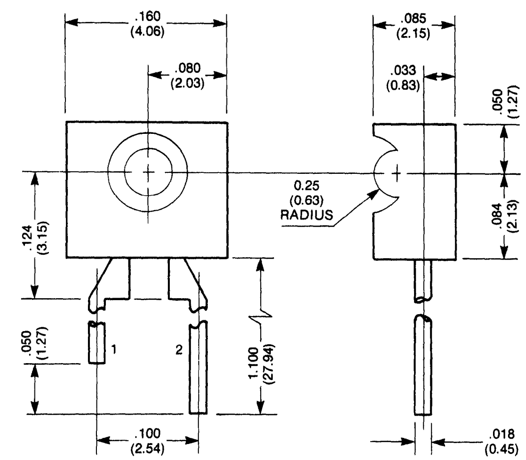
1. *The leads of the devices were immersed in molten solder heated to a temperature of 260°C, to a point 1/16 inch from the body of the device per MIL-S-750.*
2. *E_e = Radiant Incidance. Light source is an unfiltered Tungsten lamp at 2870° K color. A GaAs source of 1.7 mW/cm² is approximately equivalent to a Tungsten source of 5 mW/cm² at 2870° K*

GENERAL INSTRUMENT

MTS360 MTS460
MTS361 MTS461

Emitters Detectors

PACKAGE DIMENSIONS



ALL DIMENSIONS IN INCHES (MILLIMETERS)
TOLERANCES ± .010 (±0.25)

PIN 1: EMITTER PIN 2: COLLECTOR

C1870C

FEATURES

- Silicon NPN epitaxial planar phototransistor
- Side-view plastic package
- Recessed lens design
- Color coded BLACK on back surface

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25° C ambient . . . . 200 mW
Derate linearly at 2.7 mW/° C above 25° C ambient
Storage and operating temperatures . . -40° C to 100° C
Junction temperature . . . . 100° C
Lead solder time at 260° C (see Note 1) . . . . 5 sec.
Collector emitter voltage . . . . 30 V
Emitter collector voltage . . . . 7 V

NOTE: *Stresses listed under "Absolute Maximum Ratings" may be applied to a device without resulting in damage. Exposure to maximum rating conditions for extended periods may affect device reliability. Conditions listed under "Electro-Optical Characteristics" are specified for operation.*

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

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Light current	MTS360	I_L	1.0			mA	V_{CE} = 5 V E_e = 5 mW/cm²
	MTS361		3.0				
	MTS460		3.0				
	MTS461		6.0				
Dark current					100	nA	V_{CE} = 10 V E_e = 0 mW/cm²
Collector-emitter breakdown voltage		BV_{CEO}	30			V	I_C = 100 μA
Collector-base breakdown voltage		BV_{CBO}	70			V	I_C = 10 μA
Emitter-collector breakdown voltage		BV_{ECO}	7			V	I_E = 100 μA
Collector-emitter saturation voltage		$V_{CE(SAT)}$			0.4	V	I_C = 500 μA E_e = 5 mW/cm²
Rise/Fall time		t_r/t_f		4		μs	V_{CE} = 10 V R_L = 100 Ω I_C = 2 mA

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

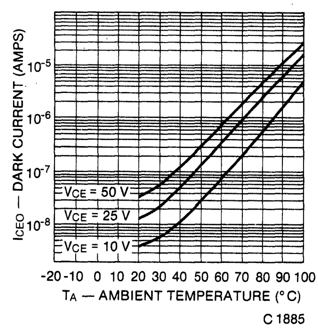


Fig. 1. Collector Dark Current vs. Ambient Temperature

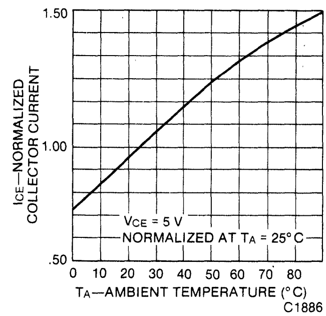


Fig. 2. Normalized Collector Current vs. Ambient Temperature

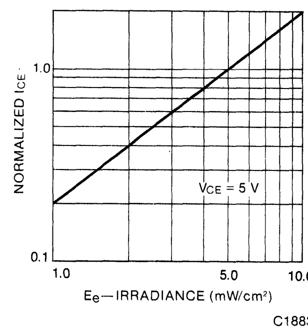


Fig. 3. Collector Current vs. Irradiance

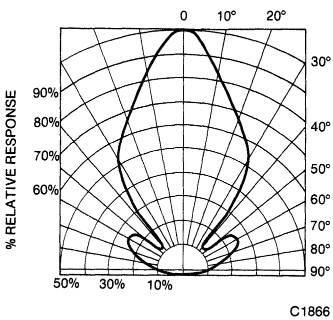


Fig. 4. Relative Angular Response

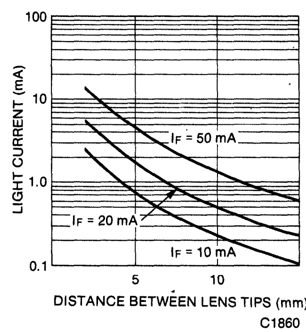


Fig. 5. Coupling Characteristics of MTS36X with MES760

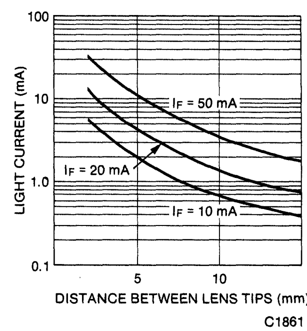


Fig. 6. Coupling Characteristics of MTS46X with MES760

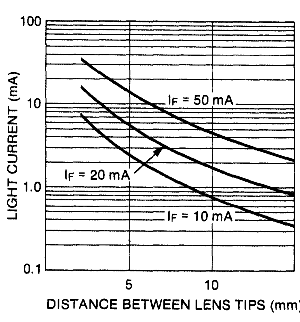


Fig. 7. Coupling Characteristics of MTS36X with MES560

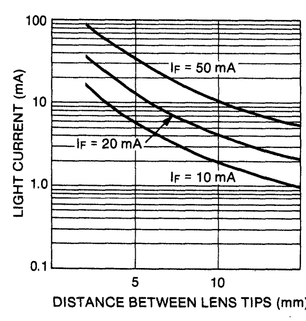


Fig. 8. Coupling Characteristics of MTS43X with MES560

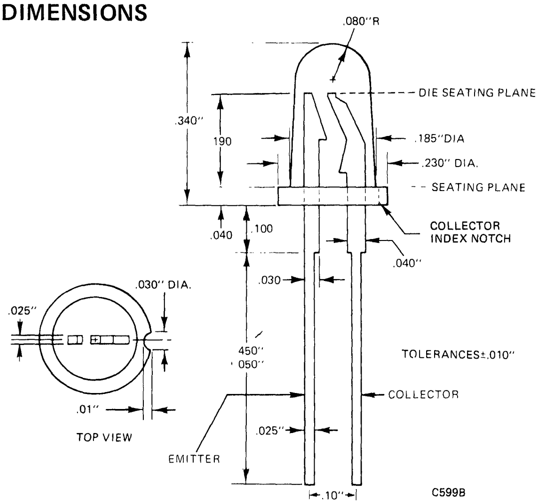
NOTES:

1. *The leads of the device were immersed in molten solder, heated to a temperature of 260° C, to a point 1/16 inch from the body of the device per MIL-S-750*
2. *E_e = Radiant Incidance. Light source is an unfiltered Tungsten lamp at 2870° K color. A GaAs source of 1.7 mW/cm² is approximately equivalent to a Tungsten source of 5 mW/cm² at 2870° K*

GENERAL INSTRUMENT

MT8020

PACKAGE DIMENSIONS



DESCRIPTION

The MT8020 is an NPN silicon planar phototransistor in a clear epoxy T-1 3/4 lamp package. The infrared emitter mates for the MT8020 are the ME7121 and the ME7124.

APPLICATIONS

When used as an emitter-detector pair the MT8020 and the ME7121 or ME7124 are suitable for the following applications:

- Optical shaft position and velocity monitor using a digitally encoded disc mounted on a shaft.
- Optical sensing of holes in paper, paper tape, IBM card or magnetic tape.
- Optical sensing of marks on paper, paper tape, or IBM card.
- End of tape sensor using a transparent section of tape, a reflective strip on the tape, or a hole in the tape.
- End of film sensor for films not affected by infrared light.
- Limit switch for mechanical travel such as cam switches, pressure switches, machine tool limit switches, foot pedal switches, safety interlock switches.
- Edge sensor for sheet materials such as paper, plastic film, fabric, foil, newsprint, belt sanders, reproduction paper.
- Fiber continuity monitor for fibers such as yarn, wire, thread.
- Fluid volume monitor by sensing turbine vanes passing through the slot.
- Liquid level detector of an opaque liquid.

ABSOLUTE MAXIMUM RATINGS

Storage and Operating Temperature –55°C to 100°C
Maximum Lead Solder Time @ 230°C (See Note 1) –5.0 sec

Power Dissipation @ 25°C Ambient	200 mW
Derate Linearly above 25°C Ambient	2.67 mW/°C
Collector-Emitter Breakdown Voltage (BV_{CEO})	30 V
Emitter-Collector Breakdown Voltage (BV_{ECO})	7.0 V
Collector Current (I_C)	40 mA

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

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Sensitivity (light current)	S_{ceo}	125	350	–	μA/mw/cm²	V_{ce} = 5V source = GaAs (note 4)
Sensitivity (light current)	S_{ceo}	50	140	–	μA/mw/cm²	V_{ce} = 5V source = tungsten (note 3)
Collector emitter breakdown voltage	BV_{ceo}	30	65	–	Volts	I_c = 100 μA (note 2)
Collector dark current	I_{ceo}	–	1.5	50	nA	V_{ce} = 10 V (note 2)
Emitter Collector breakdown voltage	BV_{eco}	7	12	–	Volts	I_e = 100μA
Collector emitter saturation voltage	V_{ce} (SAT)	–	0.2	0.4	Volts	I_c = 1.6mA H = 10mw/cm² source = GaAs (note 4)
Switching Speed	t_{on}	–	2.5	–	μsec	V_{cc} = 5.0 V I_c = 1.6 mA
	t_{off}	–	1.8	--	μsec	R_L = 100Ω (figure 7)
Current transfer ratio –ME7124	CTR	–	2.0	–	%	V_{ce} = 5V, when coupled to ME7124 at I_f = 20mA. MT8020 to ME7124 distance is .200"
Current transfer ratio –ME7121	CTR	–	0.5	–	%	V_{ce} = 5V, when coupled to ME7121 at I_f = 20mA. MT8020 to ME7121 distance is .200"

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

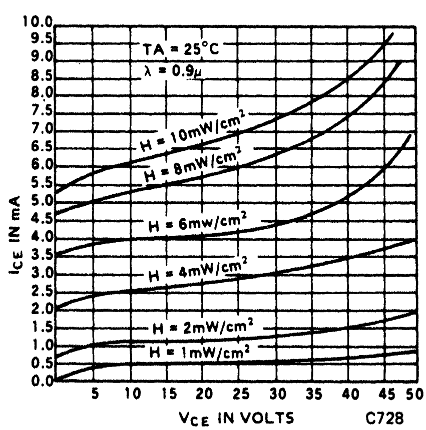


Fig. 1. Collector-Emitter Characteristics

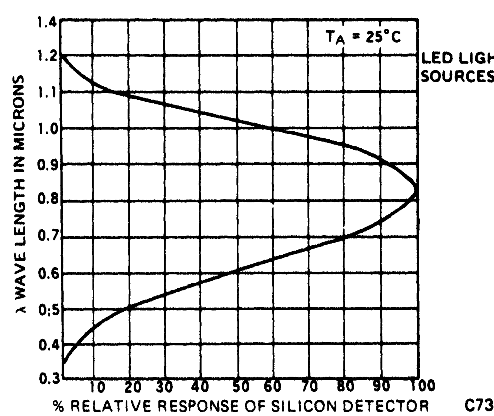


Fig. 2. Spectral Response

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

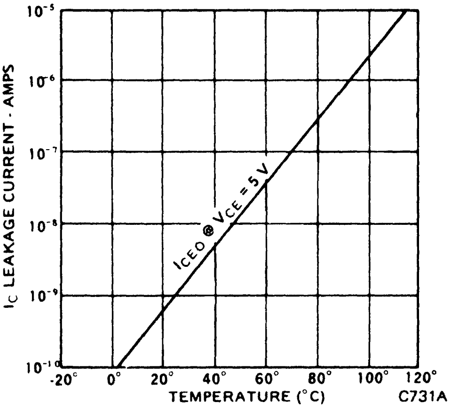


Fig. 3. Leakage Current vs. Temperature

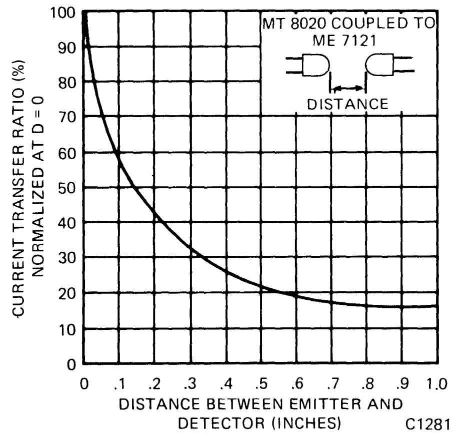


Fig. 4. Normalized Current Transfer Ratio vs. Distance Between Emitter and Detector MT8020 and ME7121.

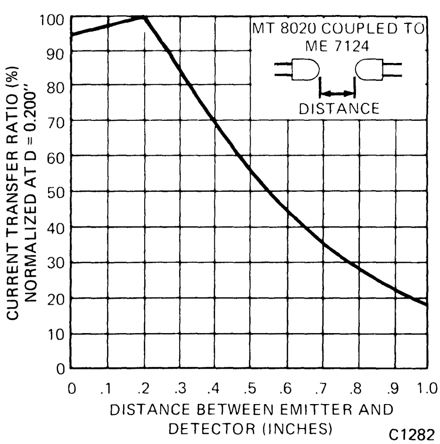


Fig. 5. Normalized Current Transfer Ratio vs. Distance Between Emitter and Detector MT8020 and ME7124.

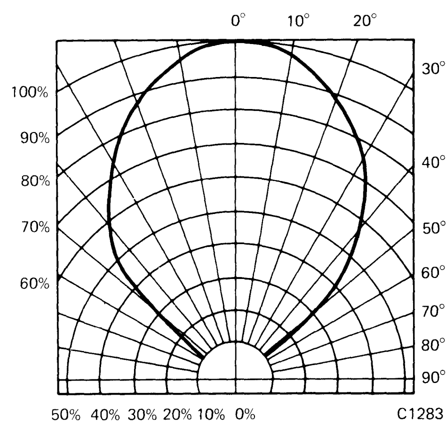


Fig. 6. Angular Response

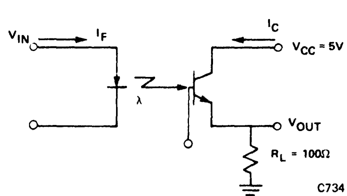


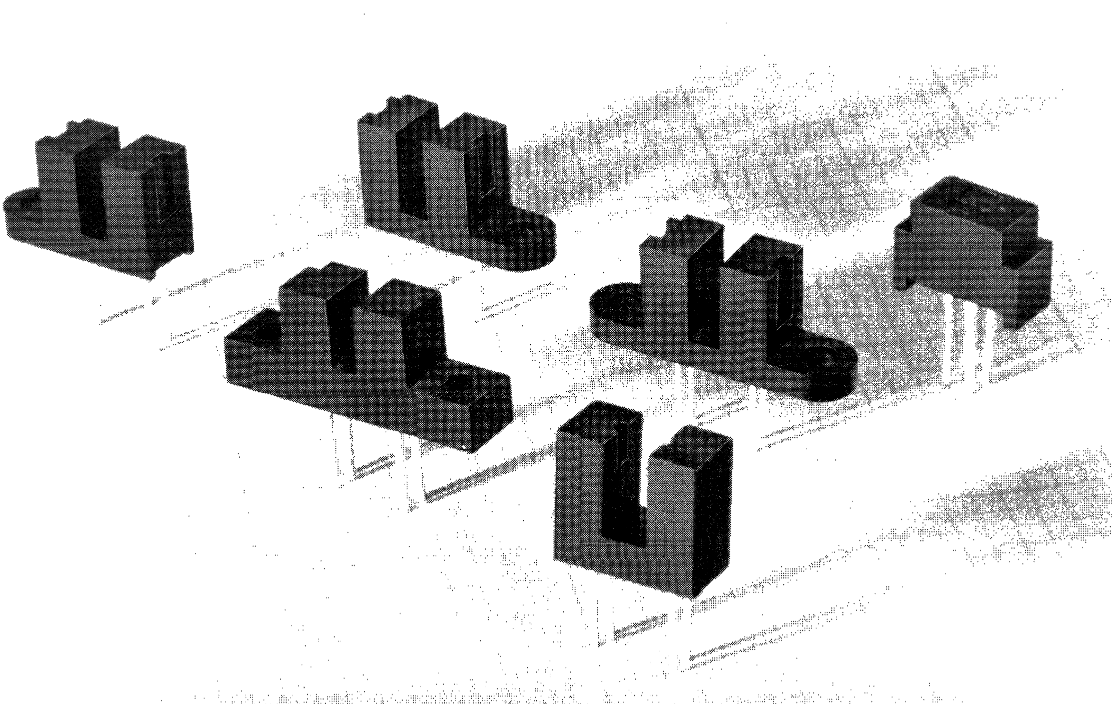
Fig. 7. Circuit Used to Obtain Switching Time Values Light Source is ME7121 or ME7124

Emitters Detectors

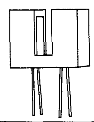
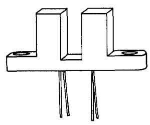
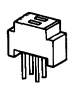
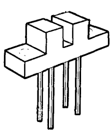
NOTES

1. The leads of the device were immersed in molten solder, heated to a temperature of 230°C, to a point 1/16-inch from the body of the device per MIL-S-750.
2. Measured under dark conditions $H \leq 1.0\ \mu w/cm^2$.
3. Radiation source is an unfiltered tungsten filament bulb at 2875°K color temperature. $H = 5\ mW/cm^2$.
4. Radiation source is a GaAs infrared emitting diode such as a ME7121 or ME7124 at $\lambda = 0.94$ microns. $H = 3\ mW/cm^2$.

Optoswitches 3



OPTO SWITCHES

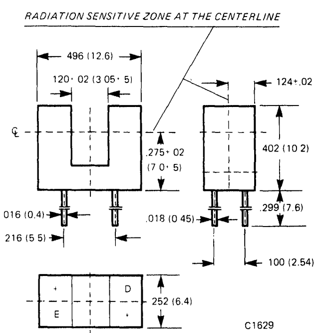
PACKAGE	DEVICE NO.	OUTPUT CONFIGURATION	MAX. EMITTER VOLTAGE	MIN. (BV_{CEO})	DETECTOR		
					TYPICAL DARK CURRENT	MAX. $V_{CE}(SAT)$	MIN. CURRENT TRANSFER RATIO
	CNY36	Slotted Limit Switch, Transistor	1.5 V @ 20 mA	32 V	5 nA @ 10 V	0.4 V @ 25 μA	1%
	CNY37	Slotted Limit Switch, Transistor	1.5 V @ 20 mA	32V	5 nA @ 10 V	0.4 V @ 25 μA	1%
	MSA7	Reflective Switch, Darlington	1.5 V @ 20 mA	30 V	5 nA @ 5 V	-	0.1%
	MSA8	Slotted Limit Switch, Darlington	1.5 V @ 20 mA	30 V	5 nA @ 5 V	1.0 V @ 2 mA	15%
	MSA81					1.0 V @ 1.6 mA	4%
	MST8	Slotted Limit Switch, Transistor			5 nA @ 10 V	0.4 V @ 50 μA	1%
	MST81					0.4 V @ 25 μA	0.25%

TYPICAL BANDWIDTH	PAGE NO.	APPLICATIONS
-	239	Tape reader, mark sensor, end-of-tape detector, end-of-film detector, metal processing equipment, length measurement, coded disk detection, edge sensor, textile processing equipment, fluid volume and velocity control, level detector, object sensor, strobing light control, stroboscope. Object sensing, end-of-tape detection, length measurement, industrial processing equipment.
-	239	
0.8 KHz	243	
0.8 KHz 1.5 KHz	247	
1.50 KHz 200 KHz	251	

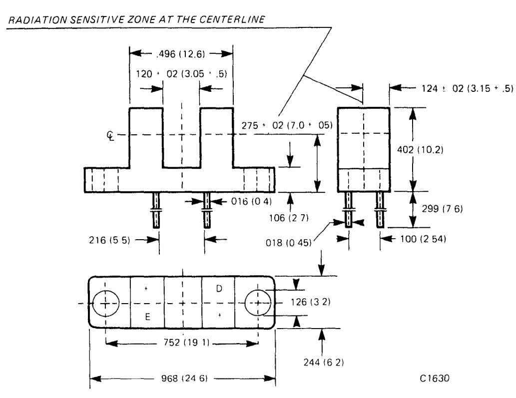
GENERAL INSTRUMENT

CNY36
CNY37

PACKAGE DIMENSIONS Dimensions in inches (mm)



CNY36



CNY37

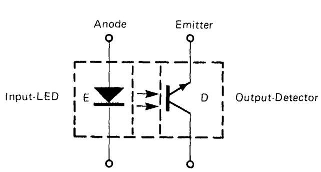


Fig. 1. Equivalent Circuit

DESCRIPTION

The CNY36 and CNY37 are both photon-coupled interrupter modules containing a GaAs LED and an NPN phototransistor. Both chips face each other across a 0.12 inch air gap. The CNY37 has mounting flanges on both sides, whereas the CNY36 comes without mounting flanges for applications where enough space may not be available.

FEATURES

- Compact construction
- CNY36 for printed circuit board construction
- CNY37 with mounting flange
- No contact switching, therefore high reliability.
- Plastic case.
- Transistor detector offers faster switching speeds than darlington detectors

APPLICATIONS

- Optical shaft position and velocity monitor using a digitally encoded disc mounted on a shaft.
- Optical sensing of holes in paper, paper tape, IBM card, or magnetic tape.
- Optical sensing of marks on paper, paper tape or IBM card.
- End of tape sensor using a transparent section of tape, a reflective strip on the tape, or a hole in the tape.
- End of film sensor for films not affected by infrared light.
- Limit switch for mechanical travel such as cam switches, pressure switches, machine tool limit switches, foot pedal switches, safety interlock switches.
- Edge sensor for sheet materials such as paper, plastic film, fabric, foil, newsprint, belt sanders, reproduction paper.
- Fiber continuity monitor for fibers such as yarn, wire, thread.
- Fluid volume monitor by sensing turbine vanes passing through the slot.
- Liquid level detector of an opaque liquid.

Optoswitches

ABSOLUTE MAXIMUM RATINGS

INPUT-LED CIRCUIT

Reverse Voltage 5V
Forward Current 60mA
Forward surge current ($tp/T = 0.01$, $tp \leqslant 0.1ms$) . . 1.0A
Power dissipation ($T_A \leqslant 25°C$) 100mW
Junction temperature . . . . 85°C

OUTPUT-DETECTOR CIRCUIT

Collector-emitter voltage 32V
Emitter-collector voltage 5V
Collector current 100mA
Power dissipation ($T_A \leqslant 25°C$) 150mW
Junction temperature . . . . 85°C

TOTAL PACKAGE

Storage temperature . . . . -25°C to + 85°C
Power dissipation ($T_A \leqslant 25°C$) 250mW
Soldering temperature ($t \leqslant 3s$) distance to the case $\geqslant$ 2mm . . . . 245°C

ELECTRICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	CONDITIONS
INPUT LED						
Forward Voltage	V_F*		1.2	1.5	V	$I_F = 20mA$
Reverse Breakdown Voltage	BV_R*	5			V	$I_R = 100\mu A$
OUTPUT DETECTOR						
Collector-Emitter Breakdown Voltage	BV_{CEO}*	32			V	$I_C = 1mA$
Collector Leakage Current	I_{CEO}*			100	nA	$V_{CE} = 10V$, $I_F = 0$
COUPLED CHARACTERISTICS						
Current Transfer Ratio	CTR*	1	4		%	$I_F = 20mA$, $V_{CE} = 10V$
Collector Dark Current	I_{CO}[1]		0.1		μA	$I_F = 20mA$, $V_{CE} = 10V$
Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$*			0.4	V	$I_F = 20mA$, $I_C = 25\mu A$

*AQL = 0.65%
[1] Closed aperture

SWITCHING CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Delay time	t_d		1.8		μs	$V_{CC} = 5V$, $I_C = 2mA$, $R_L = 100\Omega$ See test circuit.
Rise time	t_r		2.5		μs	
Turn-on time	t_{on}		4.3		μs	
Storage-time	t_s		0.3		μs	
Fall time	t_f		3.3		μs	
Turn-off time	t_{off}		3.6		μs	

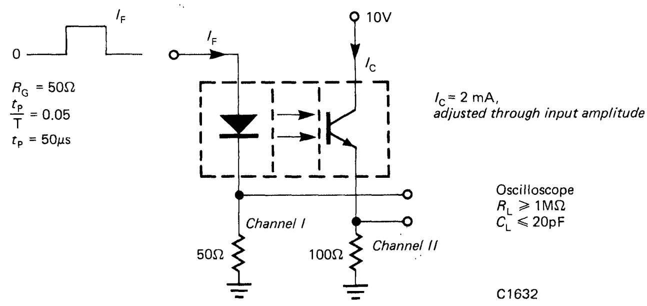


Fig. 2. Switching Time Test Circuit

TYPICAL ELECTRICAL CHARACTERISTICS CURVES (25°C Free air temperature unless otherwise specified)

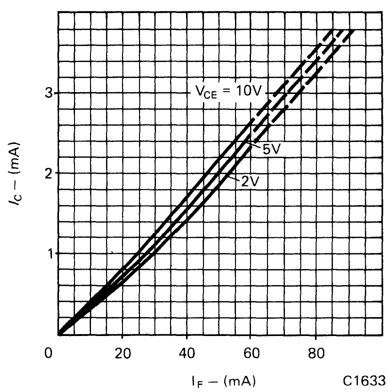


Fig. 3. Collector Current vs. Input LED Current

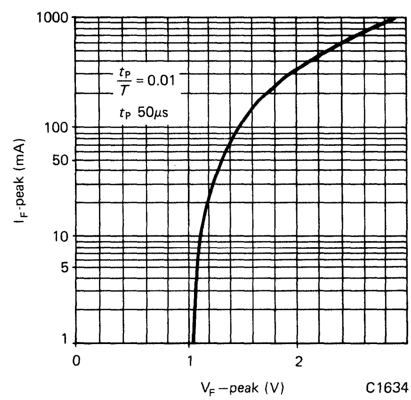


Fig. 4. Peak Input LED Current vs. Peak Input Voltage

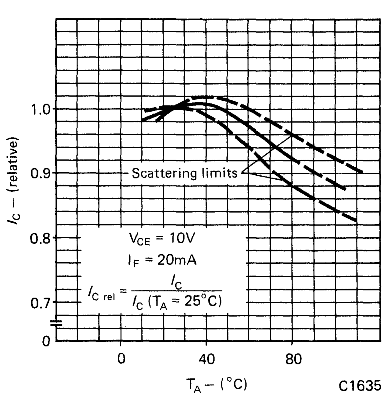


Fig. 5. Collector Current vs. Ambient Temperature

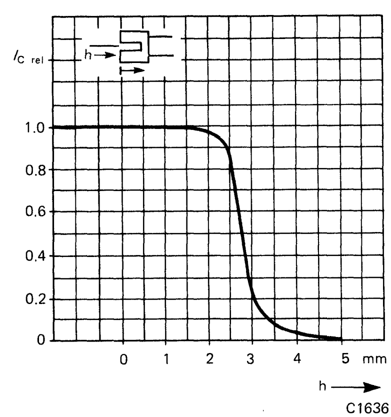


Fig. 6. Relative Collector Current vs. Object Distance

TYPICAL ELECTRICAL CHARACTERISTICS CURVES (25°C Free air temperature unless otherwise specified)

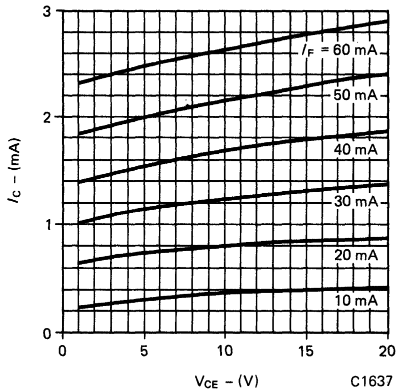


Fig. 7. Collector Current vs. Collector Emitter Voltage

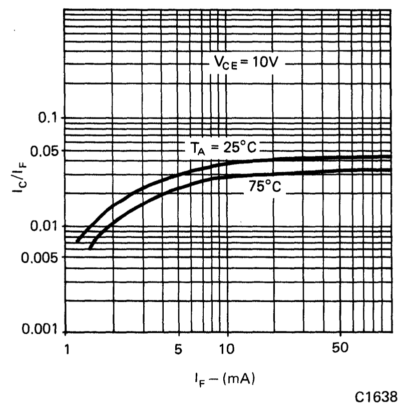
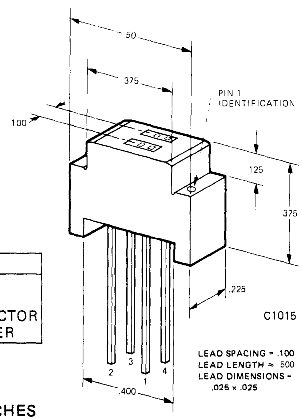


Fig. 8. $\frac{I_C}{I_F}$ vs. LED Forward Current

GENERAL INSTRUMENT

MSA7
(OLD PART NO.—MCA7)

PACKAGE DIMENSIONS



PIN	
1	LED ANODE
2	LED CATHODE
3	PHOTODARLINGTON COLLECTOR
4	PHOTODARLINGTON EMITTER

ALL DIMENSIONS ARE IN INCHES

DESCRIPTION

The MSA7 optoisolator consists of an infrared emitting diode and a silicon planar photodarlington. The on-axis radiation of the emitter and the on-axis response of the detector are both perpendicular to the face of the MSA7. The photodarlington responds to radiation emitted from the diode only when a reflective object or surface is in the field of view of the detector.

FEATURES

- High sensitivity
- Low cost
- High reliability

APPLICATIONS

- Object sensing
- End-of-tape sensing

ABSOLUTE MAXIMUM RATINGS

Storage Temperature .... −55°C to 100°C
Operating Temperature .... −55°C to 100°C
Lead Temperature (Soldering, 5 sec) .... 260°C
Total Power Dissipation
(25° Free Air Temp.) .... 250 mW
Derate linearly from 25°C .... 3.3 mW/°C

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

OUTPUT DARLINGTON
Power dissipation at 25°C Ambient..... 150 mW
Derate linearly from 25°C......... 2.0 mW/°C
Collector Current .... 25 mA
Collector to emitter voltage............ 30 V

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 Breakdown Voltage	BV_R	3.0	5.5		V	I_R = 10 μA
Junction Capacitance	C_j		50		pF	V_F = 0V
Reverse Leakage Current	I_R		.01	10	μA	V_R = 3.0V
OUTPUT DARLINGTON						
Breakdown Voltage	BV_{CEO}	30	55		V	I_C = 1.0 mA I_F = 0 (NOTE 2)
Reverse Breakdown Voltage	BV_{ECO}	5	7		V	I_C = 100 μA I_F = 0 (NOTE 2)
Leakage current	I_{CEO} (dark)		5	100	nA	V_{CE} = 5V (NOTE 2), I_F=0
Rise Time, Fall Time			0.6		mS	V_{CE} = 5V, R_L = 1KΩ
COUPLED						
DC Collector Current	I_C	.050	1		mA	I_F = 50 mA V_{CE} = 5.0V (NOTE 1 & 2) d = 1.0 CM

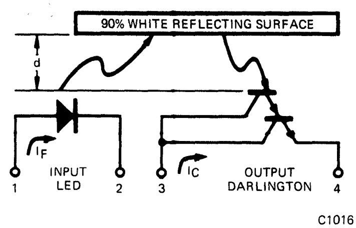


Figure 1 Parameter Symbols

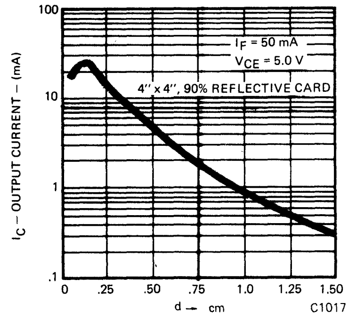


Figure 2 Output Current vs. Distance

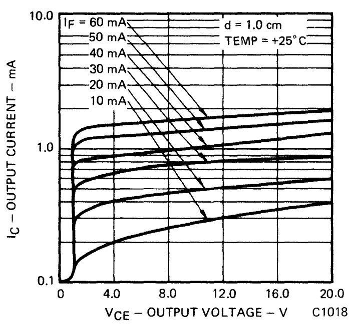


Figure 3 I_C vs. V_{CE}

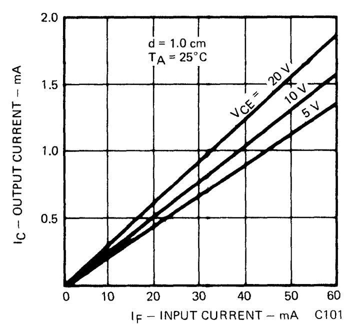


Figure 4 I_C vs. I_F

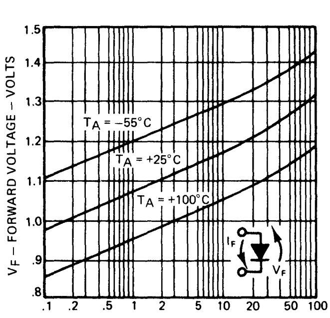


Figure 5 Forward Voltage vs. Forward Current

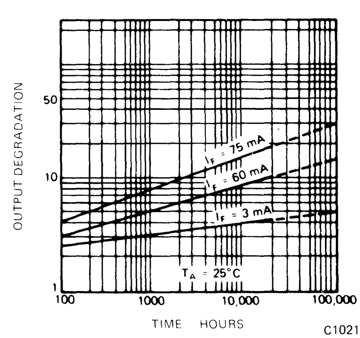


Figure 6 Lifetime vs. Forward Current

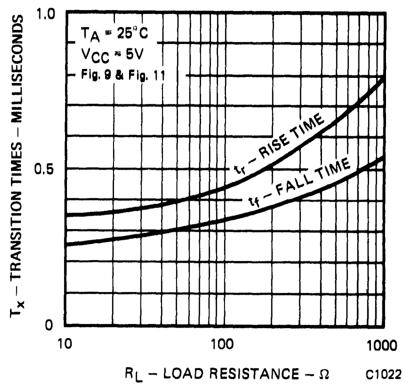


Figure 7. Non-Saturated Rise and Fall Times vs. Load Resistance

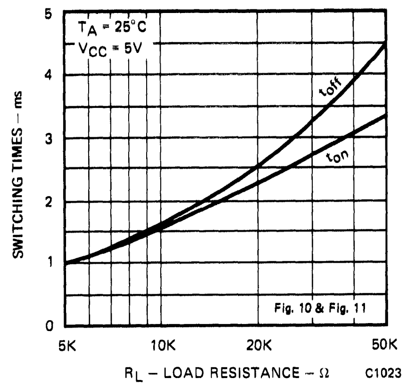


Figure 8. Saturated Switching Times vs. Load Resistance

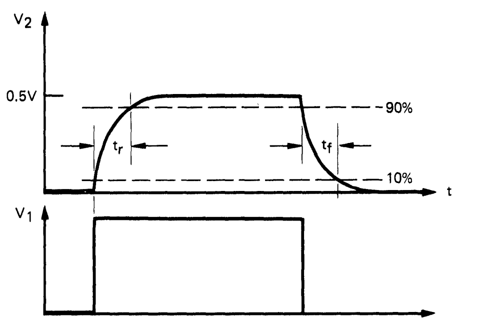


Figure 9. Non-Saturated Switching Waveforms

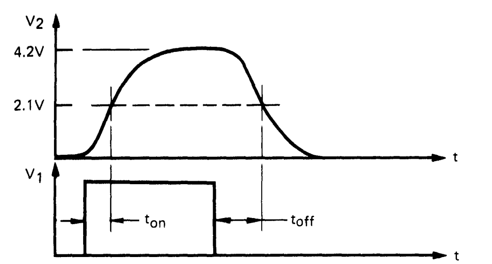


Figure 10. Saturated Switching Waveforms

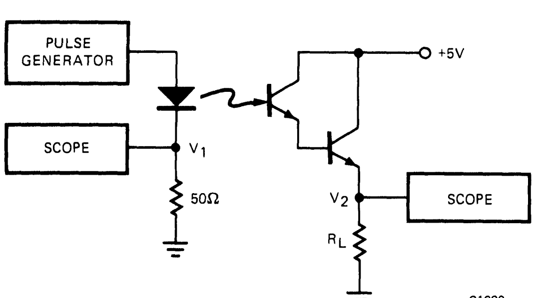


Figure 11. Circuit for Testing Switching Parameters

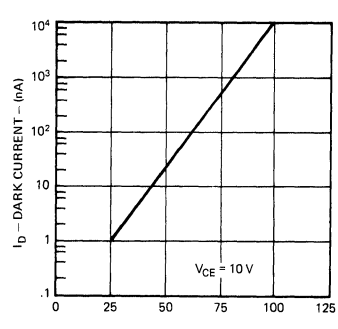
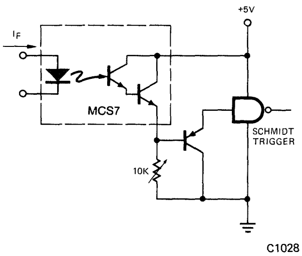


Figure 12. Dark Current vs. Temperature

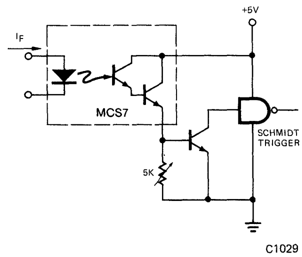
Optoswitches

CIRCUITS TO INTERFACE THE MCS7 WITH 5V LOGIC



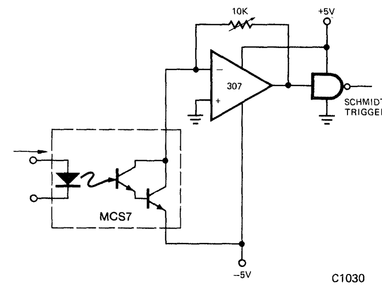
Circuit 1

Normally High Output



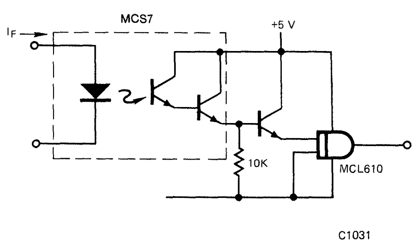
Circuit 2

Normally Low Output



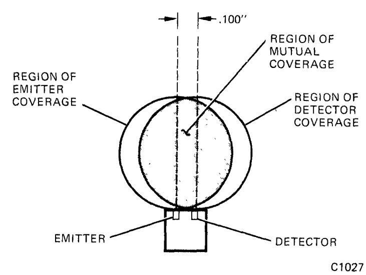
Circuit 3

Comparator Driver



Circuit 4

Booster Drive to Logic Isolator



Spatial Distribution of Maximum Sensitivity

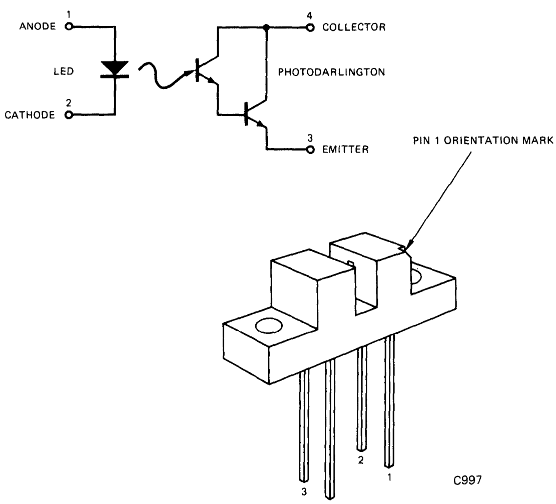
NOTES:

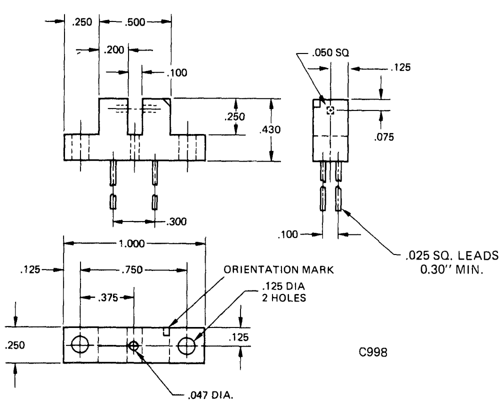
1. *Photo current is obtained from a 4.0″ x 4.0″, 90% white surface placed at a distance of 1.0 cm from the surface of the MCA7.*
2. *Measured with radiation flux intensity of less than 0.1 $\mu W/cm^2$ (dark condition) over the spectrum from 0.1 micron to 1.5 microns.*
3. *Measured at typical factory ambient of 150 foot-candles (150 lamberts per square foot).*

GENERAL INSTRUMENT

MSA8/MSA81
(OLD PART NO. MCA8/MCA81)

PACKAGE DIMENSIONS





All dimensions are in inches.
Active area of LED is .014 x .014
Active area of PhotoDarlington is .010 x .020
Dimensions ± .010 inches

DESCRIPTION

The MSA8 optical limit switch transmits light from a GaAs infrared emitting diode to a silicon photodarlington detector. Both semiconductor chips face each other across a .1-inch air gap. The MSA8 senses an object that interrupts the beam. Output current will directly operate a TTL Schmidt trigger.

FEATURES

- High sensitivity permits direct interface with TTL logic.
- Modular construction permits low cost package modification to suit any application.
- Recessed detector provides a high signal to noise ratio in ambient light.
- Plugs into standard DIP socket.
- Multiple flat reference surfaces allow precise mechanical alignment of the optical beam.
- Absence of lensing provides position sensitivity down to 0.020" between full on and full off.
- Solid copper lead-frame provides excellent heat sinking and highest reliability for the LED.
- One piece construction of the emitter and detector components provides excellent moisture resistance, immunity from thermal shocks, high and low temperature stability, and protection from shock and vibration.

APPLICATIONS

- Optical shaft position and velocity monitor using a digitally encoded disk mounted on a shaft.
- Optical sensing of holes in paper, paper tape, IBM card, or magnetic tape.
- Optical sensing of marks on paper, paper tape, or IBM card.
- End of tape sensor using a transparent section of tape, a reflective strip on the tape, or a hole in the tape.
- End of film sensor for films not affected by infrared light.
- Limit switch for mechanical travel such as cam switches, pressure switches, machine tool limit switches, foot pedal switches, safety interlock switches.
- Edge sensor for sheet materials such as paper, plastic film, fabric, foil, newsprint, belt sanders, reproduction paper.
- Fiber continuity monitor for fibers such as yarn, wire, thread.
- Fluid volume monitor by sensing turbine vanes passing through the slot.
- Liquid level detector of an opaque liquid.

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	1.5	V	I_F = 20 mA
Reverse Breakdown Voltage	BV_R	3.0	25		V	I_R = 10 μA
Reverse Leakage Current	I_R		.01	10	μA	V_R = 3 V
Junction Capacitance			50		pF	V_F = 0
OUTPUT DARLINGTON–MSA8						
Saturation Voltage	$V_{CE}(SAT)$		0.8	1.0	V	I_C = 2 mA, I_F = 16 mA (Note 1)
Collector Breakdown Voltage	BV_{CEO}	30	55		V	I_C = 1 mA, I_F = 0 (Note 1)
Emitter Breakdown Voltage	BV_{ECO}	5	7		V	I_C = 100 μA, I_F = 0
Dark Current–MCA8	I_{CEO}		5	100	nA	V_{CE} = 5.0 V, I_F = 0 (Note 1)
Rise Time	tr		2.3		ms	V_{CE} = 5 V, R_L = 1 KΩ
Fall Time	tf		1.7		ms	V_{CE} = 5 V, R_L = 1 KΩ
Turn-on Time	t_{ON}		.3		ms	I_F = 12 mA, FIG 12
Turn-off Time	t_{OFF}		1.0		ms	I_F = 12 mA, FIG 12
DC Current Transfer Ratio	CTR	15	30		%	I_F = 16 mA, V_{CE} = 5 V
OUTPUT DARLINGTON–MSA81						
Saturation Voltage	$V_{CE}(SAT)$		0.8	1.0	V	I_C = 1.6 mA, I_F = 50 mA (Note 1)
Collector Breakdown Voltage	BV_{CEO}	30	55		V	I_C = 1 mA, I_F = 0 (Note 1)
Emitter Breakdown Voltage	BV_{ECO}	5	7		V	I_C = 100 μA, I_F = 0
Dark Current	I_{CEO}		5	100	nA	V_{CE} = 5.0 V, I_F = 0 (Note 1)
Ambient Light Leakage Current			2		μA	V_{CE} = 5.0 V, I_F = 0
Rise Time	tr		.36		ms	V_{CE} = 5 V, R_L = 1 KΩ
Fall Time	tf		.3		ms	V_{CE} = 5 V, R_L = 1 KΩ
Turn-on Time	t_{ON}		.15		ms	I_F = 40 mA, FIG 12
Turn-off Time	t_{OFF}		.2		ms	I_F = 40 mA, FIG 12
DC Current Transfer Ratio	CTR	4	8		%	I_F = 16 mA, V_{CE} = 5 V

ABSOLUTE MAXIMUM RATINGS

Storage Temperature Range. . . . . . –65°C to +100°C
Operating Temperature Range. . . . –55°C to +100°C
Lead Temp. (Soldering, 10sec). . . . . 260°C
Total Power Diss. @ 25°C Free
  Air Temperature . . . . 275 mW
  Derate Linearly to 100°C (θ_{JA}) . . . . 1.65 mW/°C
Input to Output Isolation Voltage . . . . . 1500 VAC

Input Diode
  Power Dissipation @25°C Ambient . . . . . . 90 mW
  Derate Linearly from 25°C . . . . 1.2 mW/°C
  Forward Current. . . . . 60 mA
  Reverse Voltage . . . . 3 V
  Peak Forward Current
    (1 μs pulse, 300 pps) . . . . 3.0 A
Output Darlington
  Collector-Emitter Voltage (BV_{CEO}) . . . . . . 30 V
  Collector Current . . . . 100 mA

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

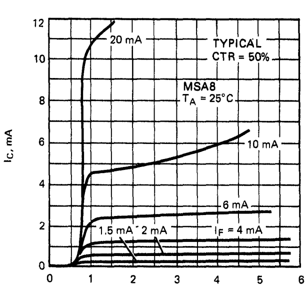


Figure 1 Collector Current vs. Collector Voltage

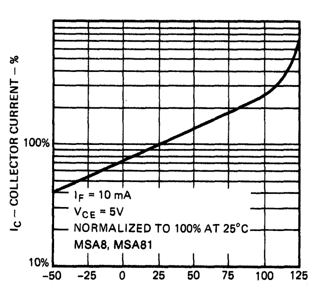


Figure 2 Collector Current vs. Ambient Temperature

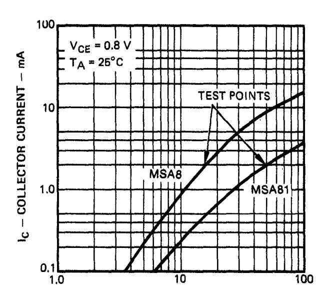


Figure 3 Collector Current vs. LED Current

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (Continued)

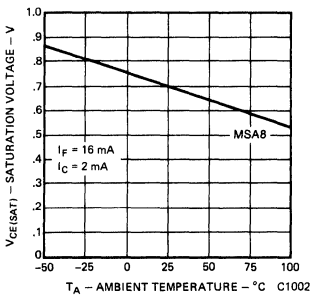


Figure 4 Saturation Voltage vs. Temperature

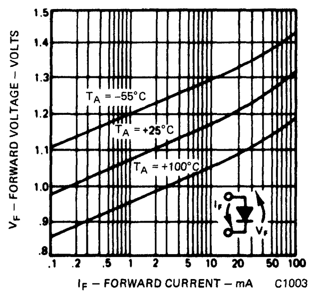


Figure 5 Forward Voltage vs. Forward Current

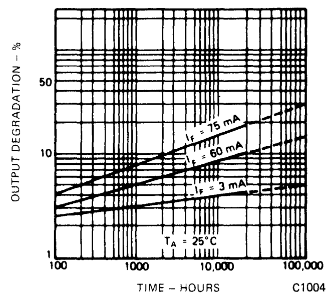


Figure 6 Lifetime vs. Forward Current

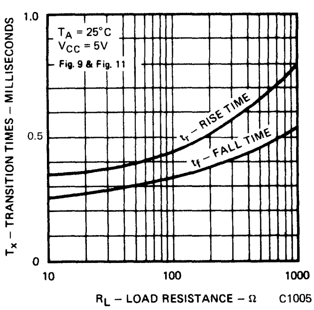


Figure 7 Non-Saturated Rise and Fall Times vs. Load Resistance

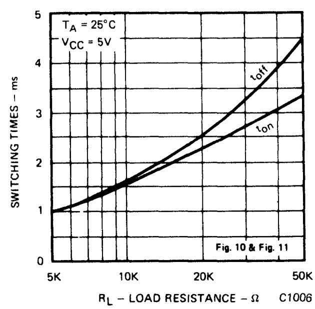


Figure 8 Saturated Switching Times vs. Load Resistance

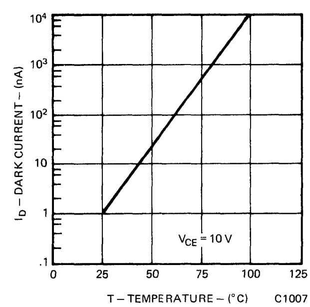


Figure 9. Dark Current vs. Temperature

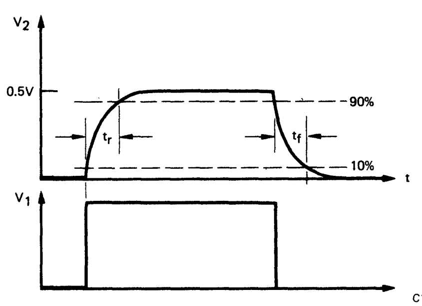


Figure 10 Non-Saturated Switching Waveforms

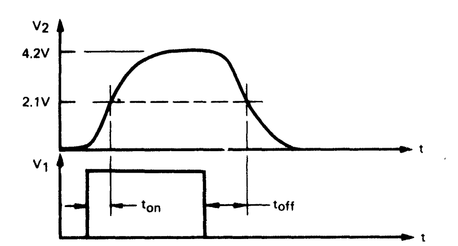


Figure 11 Saturated Switching Waveforms

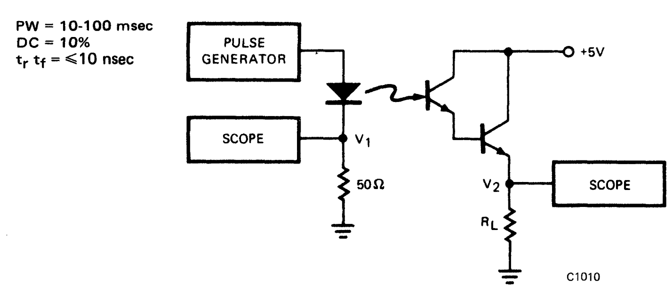


Figure 12 Circuit for Testing Switching Parameters

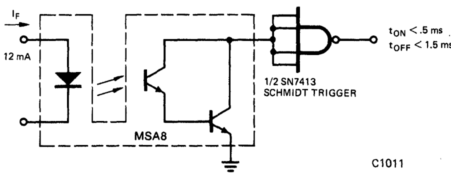


Figure 12 Driving a TTL Schmidt Trigger

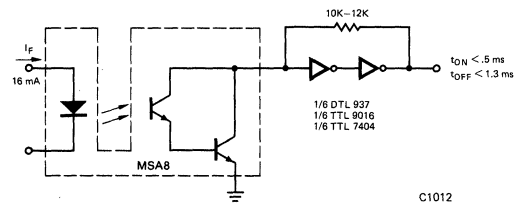


Figure 13 Driving Two Hex Inverters

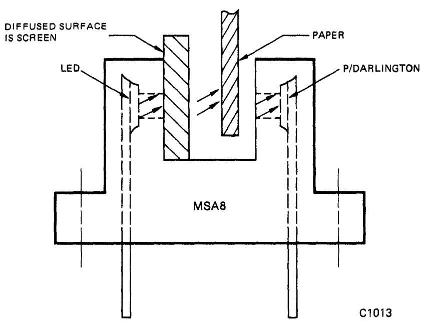


Figure 14 Detecting Paper by using a Lens Screen

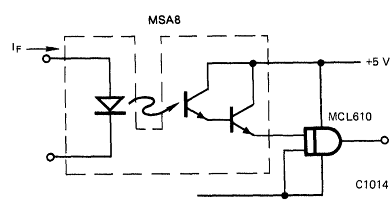


Figure 15 TTL Logic Interface

NOTES

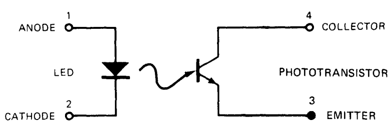
1. *Measured with radiation flux intensity of less than 0.1 μW/cm² (dark condition) over the spectrum from 0.1 micron to 1.5 microns.*

GENERAL INSTRUMENT

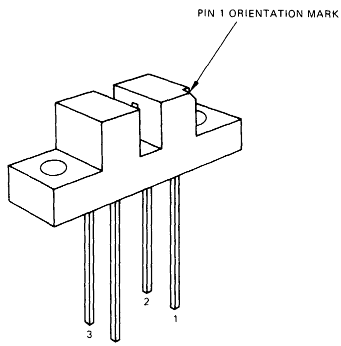
MST8/MST81
(OLD PART NO.—MCT8/MCT81)

Optoswitches

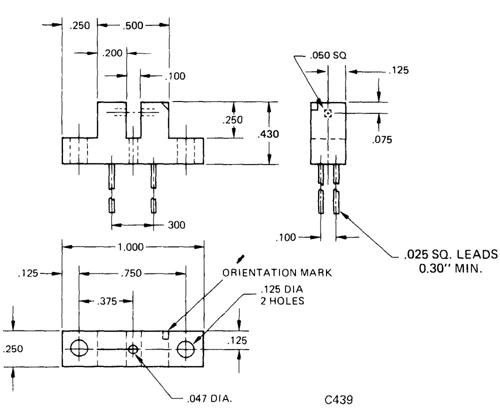
PACKAGE DIMENSIONS



C437



C438



C439

Dimensions ± .010 inches
All dimensions are in inches.

DESCRIPTION

The MST8 optical limit switch transmits light from a GaAs infrared emitting diode to a silicon phototransistor. Both semiconductor chips face each other across a .1-inch air gap. The MST8 senses an object in the air gap by the effect on light transmission.

FEATURES

- Transistor detector allows faster switching speeds than darlington detector.
- Modular package design permits low cost package modification to suit any application.
- Recessed detector and use of black plastic provide a high signal to noise ratio in ambient light.
- Plugs into standard DIP socket.
- Solid copper lead-frames provide excellent heat sinking.

APPLICATIONS

- Optical shaft position and velocity monitor using a digitally encoded disc mounted on a shaft.
- Optical sensing of holes in paper, paper tape, IBM card, or magnetic tape.
- Optical sensing of marks on paper, paper tape, or IBM card.
- End of tape sensor using a transparent section of tape, a reflective strip on the tape, or a hole in the tape.
- End of film sensor for films not affected by infrared light.
- Limit switch for mechanical travel such as cam switches, pressure switches, machine tool limit switches, foot pedal switches, safety interlock switches.
- Edge sensor for sheet materials such as paper, plastic film, fabric, foil, newsprint, belt sanders, reproduction paper.
- Fiber continuity monitor for fibers such as yarn, wire, thread.
- Fluid volume monitor by sensing turbine vanes passing through the slot.
- Liquid level detector of an opaque liquid.

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		1.30	1.50	V	$I_F = 20$ mA
Reverse Breakdown Voltage	BV_R	3.0	20		V	$I_R = 10\ \mu A$
Reverse Leakage Current	I_R		.01	10	μA	$V_R = 3$ V
OUTPUT TRANSISTOR—MST8						
DC Collector Current	I_C	.200	1.0		mA	$I_F = 20$ mA, $V_{CE} = 10$ V
Saturation Voltage	$V_{CE}(SAT)$		0.2	0.4	V	$I_C = 50\ \mu A$, $I_F = 20$ mA (Note 1)
Collector Breakdown Voltage	BV_{CEO}	30	55		V	$I_C = 1$ mA, $I_F = 0$ (Note 1)
Emitter Breakdown Voltage	BV_{ECO}	5	7		V	$I_C = 100\ \mu A$, $I_F = 0$
Dark Current	I_{CEO}		5	100	nA	$V_{CE} = 10.0$ V, $I_F = 0$ (Note 1)
Rise Time	tr		5		μsec	$V_{CC} = 10$ V, $I_C = 1$ mA $R_L = 100\ \Omega$ CIRCUIT 1
Fall Time	tf		4		μsec	$V_{CC} = 10$ V, $I_C = 1$ mA $R_L = 100\ \Omega$ CIRCUIT 1
Turn-on Time (from 5 V to 0.8 V)	t_{ON}		6		μsec	$I_F = 40$ mA CIRCUIT 2 $R_B = 1.2k\Omega$, $R_L = 2.4k\Omega$
Turn-off Time (from SAT. to 2 V)	t_{OFF}		4		μsec	$I_F = 40$ mA CIRCUIT 2 $R_B = 1.2k\Omega$, $R_L = 2.4k\Omega$
OUTPUT TRANSISTOR—MST81						
DC Collector Current	I_C	50	100		μA	$I_F = 20$ mA, $V_{CE} = 10$ V
Saturation Voltage	$V_{CE}(SAT)$		0.2	0.4	V	$I_C = 25\ \mu A$, $I_F = 20$ mA (Note 1)
Collector Breakdown Voltage	BV_{CEO}	30	55		V	$I_C = 1$ mA, $I_F = 0$ (Note 1)
Emitter Breakdown Voltage	BV_{ECO}	5	7		V	$I_C = 100\ \mu A$, $I_F = 0$
Dark Current	I_{CEO}		5	100	nA	$V_{CE} = 10.0$ V, $I_F = 0$ (Note 1)
Ambient Light Leakage Current			0.30		μA	$V_{CE} = 10.0$ V, $I_F = 0$
Rise Time	tr		3		μsec	$V_{CC} = 10$ V, $I_C = 1$ mA $R_L = 100\ \Omega$ CIRCUIT 1
Fall Time	tf		4		μsec	$V_{CC} = 10$ V, $I_C = 1$ mA $R_L = 100\ \Omega$ CIRCUIT 1
Turn-on Time (from 5 V to 0.8 V)	t_{ON}		6		μsec	$I_F = 40$ mA CIRCUIT 2 $R_B = 1.2k\Omega$, $R_L = 2.4k\Omega$
Turn-off Time (from SAT to 2 V)	t_{OFF}		3		μsec	$I_F = 40$ mA CIRCUIT 2 $R_B = 1.2k\Omega$, $R_L = 2.4k\Omega$

ABSOLUTE MAXIMUM RATINGS

Storage Temperature Range . . . . −65°C to +100°C
Operating Temperature Range . . . −55°C to +100°C
Lead Temp. (Soldering, 10 sec) . . . . 260°C
Total Power Diss. @ 25°C Free
Air Temperature . . . . 275 mW
Derate Linearly to 100°C (θ_{JA}). . . . . 3.7 mW/°C

Input Diode
Power Dissipation @ 25°C Ambient . . . . 90 mW
Derate Linearly Above 25°C . . . . 1.2 mW/°C
Forward Current . . . . 60 mA
Reverse Voltage . . . . 3 V
Peak Forward Current
(1 μs pulse, 300 pps) . . . . 3.0 A
Output Transistor
Collector-Emitter Voltage . . . . 30 V
Emitter-Collector Voltage . . . . 5 V

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

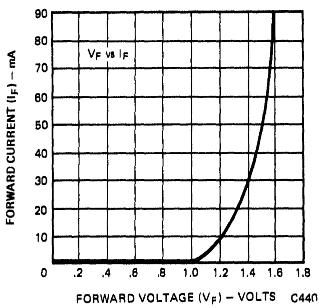


Fig. 1. Forward Voltage vs. Forward Current

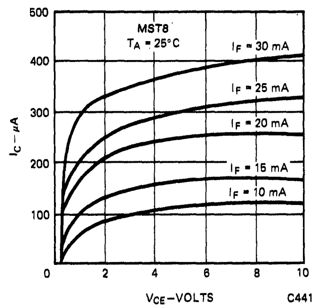


Fig. 2. Collector Current vs. Collector Voltage

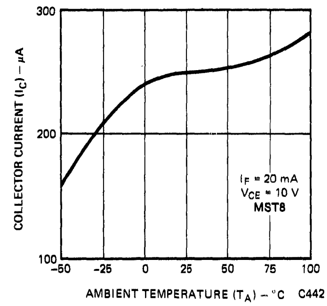


Fig. 3. Collector Current vs. Ambient Temperature

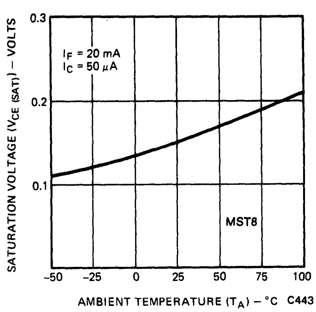


Fig. 4. Saturation Voltage vs. Temperature

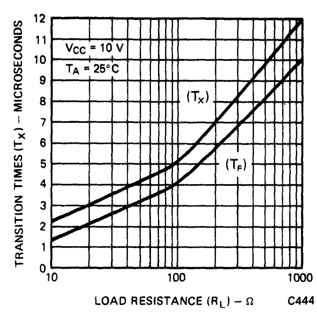
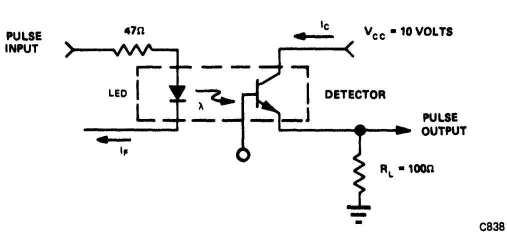


Fig. 5. Non-saturated Rise and Fall Times vs. Load Resistance

(See Circuit 1)



Circuit Used to Obtain Switching Time vs. Collector Current Plot

Fig. 6.

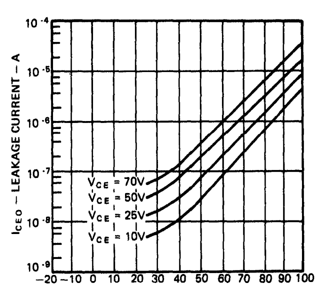


Fig. 7. Dark Current vs. Temperature

Optoswitches

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (CONT.)

PW = 10-100 μsec
DC = 10%
t_r t_f = ≤10 nsec

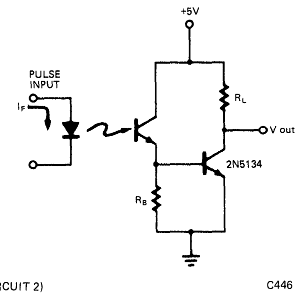


Fig. 8.

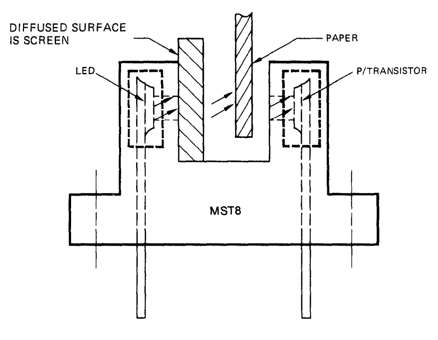


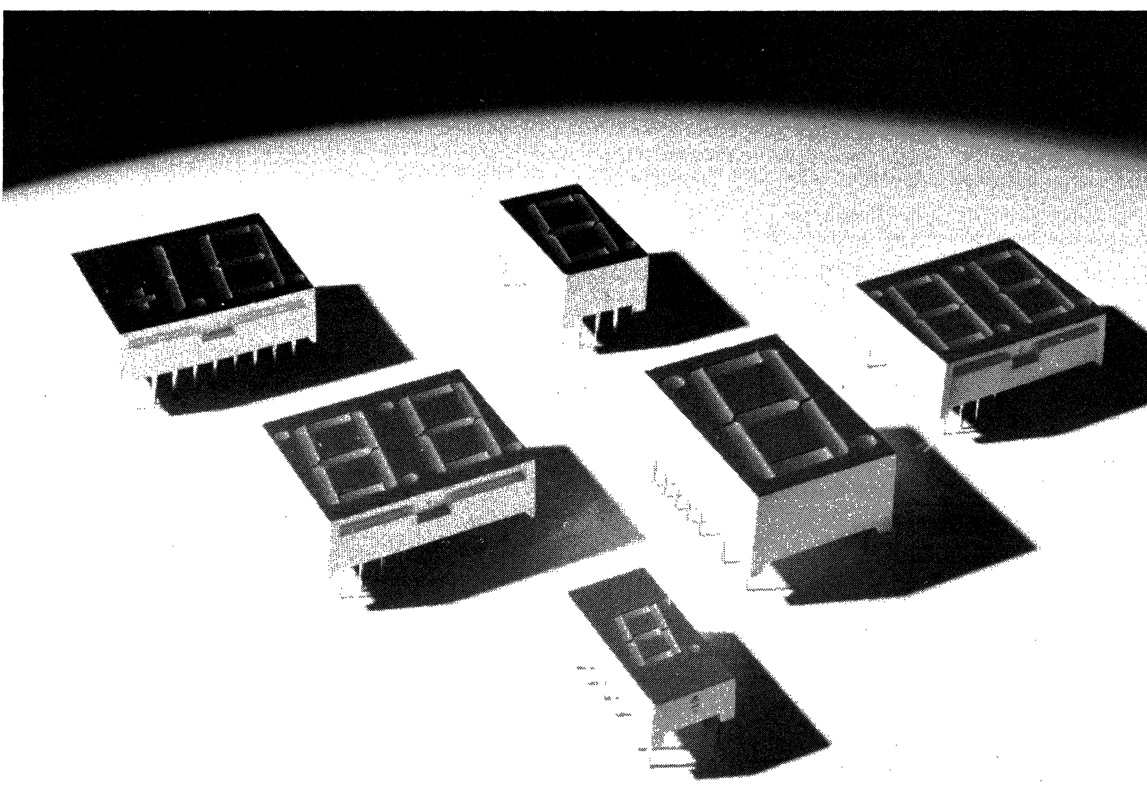
Fig. 9. Detecting Paper by Using a Lens Screen

NOTES:

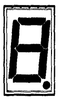
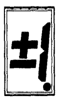
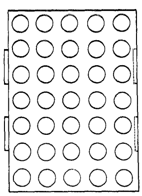
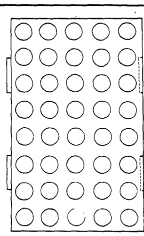
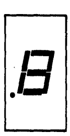
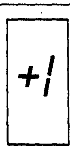
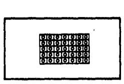
1. Measured with radiation flux intensity of less than 0.1 μW/cm² (dark condition) over the spectrum from 0.1 micron to 1.5 microns.

4

Displays

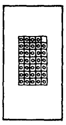
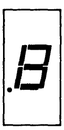
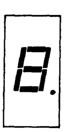
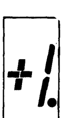


DISPLAYS

PACKAGE	DEVICE NO.	COLOR	DESCRIPTION	BRIGHTNESS OR LUMINOUS INTENSITY (PER SEG. MIN.)	PAGE NO.
	FND310	High Eff. Red		2800 μcd @ 20 mA	263
	FND350	Red	.362-Inch; Common Anode; RHDP	240 μcd @ 20 mA	267
	FND360	Hi-brite Red		590 μcd @ 20 mA	267
	FND317	High Eff. Red		2800 μcd @ 20 mA	263
	FND357	Red	.362-Inch; Common Cathode; RHDP	240 μcd @ 20 mA	267
	FND367	Hi-brite Red		590 μcd @ 20 mA	267
	FND318	High Eff. Red		2800 μcd @ 20 mA	263
	FND358	Red	.362-Inch; Common Cathode; RHDP; ±1 Overflow	240 μcd @ 20 mA	267
	FND368	Hi-brite Red		590 μcd @ 20 mA	267
	GMA2175	High Eff. Red	2.0-Inch; 5 by 7 Dot Matrix; Column Common Anode	4.0 mcd @ 20 mA	271
	GMA2475	High Eff. Green			271
	GMA2975	High Eff. Red			271
	GMC2175	High Eff. Red	2.0-Inch; 5 by 7 Dot Matrix; Column Common Cathode	4.0 mcd @ 20 mA	271
	GMC2475	High Eff. Green			271
	GMC2975	High Eff. Red			271
	GMA2185	High Eff. Red	2.4-Inch; 5 by 8 Dot Matrix; Column Common Anode		273
	GMA2485	High Eff. Green		4.0 mcd @ 20 mA	273
	GMA2985	High Eff. Red			273
	GMC2185	High Eff. Red	2.4-Inch; 5 x 8 Dot Matrix Column Common Cathode		273
	GMC2485	High Eff. Green		4.0 mcd @ 20 mA	273
	GMC2985	High Eff. Red			273
	MAN1A	Red	.270-Inch; Common Anode; LHDP; Direct View	74 μcd @ 20 mA	275
	MAN10A			74 μcd @ 10 mA	275
	MAN1001A	Red	.270-Inch; Common Anode; Polarity/ Overflow; Direct View	74 μcd @ 20 mA	277
	MAN101A			74 μcd @ 10 mA	277
	MAN2A	Red	.320-Inch; X-Y 35 Diode, Alpha-numeric; Direct View; Encapsulated	125 μcd @ 10 mA	279

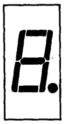
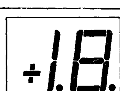
NOTE: PIN CONNECTION CODES: Ac (e.g.) First letter (capital) is segment, second letter (lower case) is cathode or anode.
E.g. Ac = Segment A cathode
Ac1 (e.g.) Final number refers to digit number in 2-Digit devices.

DISPLAYS

PACKAGE	DEVICE NO.	COLOR	DESCRIPTION	BRIGHTNESS OR LUMINOUS INTENSITY (PER SEG. MIN.)	PAGE NO.
	MAN24	High Eff. Green	.32-Inch; 5 by 7 Dot Matrix; LHDP	510 μcd @ 10 mA	281
	MAN27	Red		125 μcd @ 10 mA	281
	MAN28	Yellow		510 μcd @ 10 mA	281
	MAN29	High Eff. Red		320 μcd @ 10 mA	281
	MAN2815	Red	.135-Inch; Common Cathode; 14 Segment Alphanumeric; 8-Characters	60 μcd @ 2.5 mA (avge. curr.)	285
	MAN3410A	High Eff. Green	.3-Inch; Common Anode; RHDP	510 μcd @ 10 mA	289
	MAN3610A	Orange		510 μcd @ 10 mA	289
	MAN3810A	Yellow		320 μcd @ 10 mA	289
	MAN3910A	High Eff. Red		320 μcd @ 10 mA	301
	MAN71A	Red		125 μcd @ 10 mA	289
	MAN3420A	High Eff. Green	.3-Inch; Common Anode; LHDP	510 μcd @ 10 mA	289
	MAN3620A	Orange		510 μcd @ 10 mA	289
	MAN3820A	Yellow		320 μcd @ 10 mA	289
	MAN3920A	High Eff. Red		320 μcd @ 10 mA	301
	MAN72A	Red		125 μcd @ 10 mA	289
	MAN3430A	High Eff. Green	.3-Inch; Common Anode; Polarity & Overflow	510 μcd @ 10 mA	289
	MAN3630A	Orange		510 μcd @ 10 mA	289
	MAN3830A	Yellow		320 μcd @ 10 mA	289
	MAN3930A	High Eff. Red		320 μcd @ 10 mA	301
	MAN73A	Red		125 μcd @ 10 mA	289
	MAN3440A	High Eff. Green	.3-Inch; Common Cathode; RHDP	510 μcd @ 10 mA	289
	MAN3640A	Orange		510 μcd @ 10 mA	289
	MAN3840A	Yellow		320 μcd @ 10 mA	289
	MAN3940A	High Eff. Red		320 μcd @ 10 mA	301
	MAN74A	Red		125 μcd @ 10 mA	289
	MAN3480A	High Eff. Green	.3-Inch; Common Cathode; RHDP; 10-Pin	510 μcd @ 10 mA	295
	MAN3680A	Orange		510 μcd @ 10 mA	295
	MAN3880A	Yellow		320 μcd @ 10 mA	295
	MAN3980A	High Eff. Red		320 μcd @ 10 mA	301
	MAN78A	Red		125 μcd @ 10 mA	295
	MAN4405A	High Eff. Green	.4-Inch; Universal (CA/CC) Overflow ±1, RHDP	320 μcd @ 10 mA	305
	MAN4605A	Orange		510 μcd @ 10 mA	305
	MAN4705A	Red		200 μcd @ 10 mA	305
	MAN4805A	Yellow		510 μcd @ 10 mA	305
	MAN4905A	High Eff. Red		320 μcd @ 10 mA	317

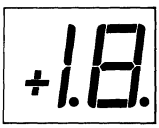
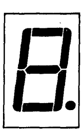
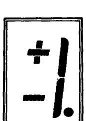
TE: PIN CONNECTION CODES: Ac (e.g.) First letter (capital) is segment, second letter (lower case) is cathode or anode.
E.g. Ac = Segment A cathode
Ac1 (e.g.) Final number refers to digit number in 2-Digit devices.

DISPLAYS

PACKAGE	DEVICE NO.	COLOR	DESCRIPTION	BRIGHTNESS OR LUMINOUS INTENSITY (PER SEG. MIN.)	PAGE NO.
	MAN4410A	High Eff. Green		320 µcd @ 10 mA	305
	MAN4610A	Orange		510 µcd @ 10 mA	305
	MAN4710A	Red	.4-Inch; Common Anode; RHDP	200 µcd @ 10 mA	305
	MAN4810A	Yellow		510 µcd @ 10 mA	305
	MAN4910A	High Eff. Red		320 µcd @ 10 mA	317
	MAN4440A	High Eff. Green		320 µcd @ 10 mA	305
	MAN4640A	Orange		510 µcd @ 10 mA	305
	MAN4740A	Red	.4-Inch; Common Cathode; RHDP	200 µcd @ 10 mA	305
	MAN4840A	Yellow		510 µcd @ 10 mA	305
	MAN4940A	High Eff. Red		320 µcd @ 10 mA	317
	MAN4480A	High Eff. Green		320 µcd @ 10 mA	311
	MAN4680A	Orange		510 µcd @ 10 mA	311
	MAN4780A	Red	4-Inch; Common Cathode; RHDP; 10-Pin	200 µcd @ 10 mA	311
	MAN4880A	Yellow		510 µcd @ 10 mA	311
	MAN4980A	High Eff. Red		320 µcd @ 10 mA	317
	MAN6110	High Eff. Red	0.56-Inch; Common Anode; RHDP; 2-Digit	200 µcd @ 2 mA	321
	MAN6140		0.56-Inch; Common Cathode; RHDP; 2-Digit		321
	MAN6410	High Eff. Green	0.56-Inch; Common Anode; RHDP; 2-Digit	510 µcd @ 10 mA	323
	MAN6440		0.56-Inch; Common Cathode; RHDP; 2-Digit		323
	MAN6610	Orange	0.56-Inch; Common Anode; RHDP; 2-Digit		327
	MAN6640		0.56-Inch; Common Cathode; RHDP 2-Digit		327
	MAN6710	Red	0.56-Inch; Common Anode; RHDP; 2-Digit	125 µcd @ 10 mA	331
	MAN6740		0.56-Inch; Common Cathode; RHDP; 2-Digit		331
	MAN6810	Yellow	0.56-Inch; Common Anode; RHDP; 2-Digit	510 µcd @ 10 mA	335
	MAN6840		0.56-Inch; Common Cathode; RHDP; 2-Digit		335
	MAN6910	High Eff. Red	0.56-Inch; Common Anode; RHDP; 2-Digit	320 µcd @ 10 mA	339
	MAN6940		0.56-Inch; Common Cathode; RHDP; 2-Digit		339
	MAN6130	High Eff. Red	0.56-Inch; Common Anode; RHDP; 1½-Digit	200 µcd @ 2 mA	321
	MAN6150		0.56-Inch; Common Cathode; RHDP; 1½-Digit		321

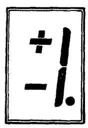
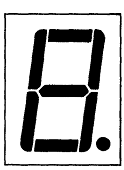
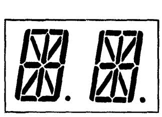
NOTE: PIN CONNECTION CODES: Ac (e.g.) First letter (capital) is segment, second letter (lower case) is cathode or anode.
E.g. Ac = Segment A cathode
Ac1 (e.g.) Final number refers to digit number in 2-Digit devices.

DISPLAYS

PACKAGE	DEVICE NO.	COLOR	DESCRIPTION	BRIGHTNESS OR LUMINOUS INTENSITY (PER SEG. MIN.)	PAGE NO.
	MAN6430	High Eff. Green	0.56-Inch; Common Anode; RHDP; 1½-Digit	510 μcd @ 10 mA	323
	MAN6450		0.56-Inch; Common Cathode; RHDP; 1½-Digit		323
	MAN6630	Orange	0.56-Inch; Common Anode; RHDP; 1½-Digit		327
	MAN6650		0.56-Inch; Common Cathode; RHDP 1½-Digit		327
	MAN6730	Red	0.56-Inch; Common Anode; RHDP 1½-Digit	125 μcd @ 10 mA	331
	MAN6750		0.56-Inch; Common Cathode; RHDP; 1½-Digit		331
	MAN6830	Yellow	0.56-Inch; Common Anode; RHDP; 1½-Digit	510 μcd @ 10 mA	335
	MAN6850		0.56-Inch; Common Cathode; RHDP; 1½-Digit		335
	MAN6930	High Eff. Red	0.56-Inch; Common Anode; RHDP 1½-Digit	320 μcd @ 10 mA	339
	MAN6950		0.56-Inch; Common Cathode; RHDP; 1½-Digit		339
	MAN6160	High Eff. Red	0.56-Inch; Common Anode; RHDP	200 μcd @ 2 mA	321
	MAN6180		0.56-Inch; Common Cathode; RHDP		321
	MAN6460	High Eff. Green	0.56-Inch; Common Anode; RHDP	510 μcd @ 10 mA	323
	MAN6480		0.56-Inch; Common Cathode; RHDP		323
	MAN6660	Orange	0.56-Inch; Common Anode; RHDP		327
	MAN6680		0.56-Inch; Common Cathode; RHDP		327
	MAN6760	Red	0.56-Inch; Common Anode; RHDP	125 μcd @ 10 mA	331
	MAN6780		0.56-Inch; Common Cathode; RHDP		331
	MAN6860	Yellow	0.56-Inch; Common Anode; RHDP	510 μcd @ 10 mA	335
	MAN6880		0.56-Inch; Common Cathode; RHDP		335
	MAN6960	High Eff. Red	0.56-Inch; Common Anode; RHDP	320 μcd @ 10 mA	339
	MAN6980		0.56-Inch; Common Cathode; RHDP		339
	MAN6175	High Eff. Red	0.56-Inch; Common Anode; RHDP; ±1 Overflow	200 μcd @ 2 mA	321
	MAN6195		0.56-Inch; Common Cathode; RHDP; ±1 Overflow		321
	MAN6475	High Eff. Green	0.56-Inch; Common Anode; RHDP; ±1 Overflow	510 μcd @ 10 mA	323
	MAN6495		0.56-Inch; Common Cathode; RHDP; ±1 Overflow		323

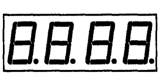
)TE: PIN CONNECTION CODES: Ac (e.g.) First letter (capital) is segment, second letter (lower case) is cathode or anode.
E.g. Ac = Segment A cathode
Ac1 (e.g.) Final number refers to digit number in 2-Digit devices.

DISPLAYS

PACKAGE	DEVICE NO.	COLOR	DESCRIPTION	BRIGHTNESS OR LUMINOUS INTENSITY (PER SEG. MIN.)	PAGE NO.
	MAN6675	Orange	0.56-Inch; Common Anode; RHDP; ±1 Overflow	510 μcd @ 10 mA	327
	MAN6695		0.56-Inch; Common Cathode; RHDP; ±1 Overflow		327
	MAN6775	Red	0.56-Inch; Common Anode; RHDP; ±1 Overflow	125 μcd @ 10 mA	331
	MAN6795		0.56-Inch; Common Cathode; RHDP; ±1 Overflow		331
	MAN6875	Yellow	0.56-Inch; Common Anode; RHDP; ±1 Overflow	510 μcd @ 10 mA	335
	MAN6895		0.56-Inch; Common Cathode; RHDP; ±1 Overflow		335
	MAN6975	High Eff. Red	0.56-Inch; Common Cathode; RHDP; ±1 Overflow	320 μcd @ 10 mA	339
	MAN6995		0.56-Inch; Common Cathode; RHDP; ±1 Overflow		339
	MAN8410	High Eff. Green	.800-Inch; Common Anode; RHDP	510 μcd @ 10 mA	343
	MAN8430		.800-Inch; Common Anode; RHDP; ±1 Overflow		343
	MAN8440		.800-Inch; Common Cathode; RHDP		343
	MAN8450		.800-Inch; Common Cathode; RHDP ±1 Overflow		343
	MAN8610	Orange	.800-Inch; Common Anode; RHDP	600 μcd @ 10 mA	347
	MAN8630		.800-Inch; Common Anode; RHDP; ±1 Overflow		347
	MAN8640		.800-Inch; Common Cathode; RHDP		347
	MAN8650		.800-Inch; Common Cathode; RHDP; ±1 Overflow		347
	MAN8810	Yellow	.800-Inch; Common Anode; RHDP	500 μcd @ 10 mA	351
	MAN8830		.800-Inch; Common Anode; RHDP; ±1 Overflow		351
	MAN8840		.800-Inch; Common Cathode; RHDP		351
	MAN8850		.800-Inch; Common Cathode; RHDP; ±1 Overflow		351
	MAN8910	High Eff. Red	.800-Inch; Common Anode; RHDP	320 μcd @ 10 mA	355
	MAN8930		.800-Inch; Common Anode; RHDP; ±1 Overflow		355
	MAN8940		.800-Inch; Common Cathode; RHDP		355
	MAN8950		.800-Inch; Common Cathode; RHDP; ±1 Overflow		355
	MMA54420	High Eff. Green	0.5-Inch, Two character 16 segment, Multiplex Common Cathode Display	510 μcd @ 10 mA	359
	MMA56420	Orange		510 μcd @ 10 mA	359
	MMA58420	Yellow		510 μcd @ 10 mA	359
	MMA59420	High Eff. Red		320 μcd @ 10 mA	359

NOTE: PIN CONNECTION CODES: Ac (e.g.) First letter (capital) is segment, second letter (lower case) is cathode or anode.
E.g. Ac = Segment A cathode
Ac1 (e.g.) Final number refers to digit number in 2-Digit devices.

DISPLAYS

PACKAGE	DEVICE NO.	COLOR	DESCRIPTION	BRIGHTNESS OR LUMINOUS INTENSITY (PER SEG. MIN.)	PAGE NO.
	MMN36220	Orange	0.3-Inch; Common Anode; 2-Digit Multiplexed	510 µcd @ 10 mA	363
	MMN38220	Yellow		510 µcd @ 10 mA	363
	MMN39220	High Eff. Red		350 µcd @ 10 mA	363
	MMN36420	Orange	0.3-Inch; Common Cathode; 2-Digit Multiplexed	510 µcd @ 10 mA	363
	MMN38420	Yellow		510 µcd @ 10 mA	363
	MMN39420	High Eff. Red		350 µcd @ 10 mA	363
	MMN36240	Orange	0.3-Inch; Common Anode; 4-Digit Multiplexed	510 µcd @ 10 mA	363
	MMN38240	Yellow		510 µcd @ 10 mA	363
	MMN39240	High Eff. Red		350 µcd @ 10 mA	363
	MMN36440	Orange	0.3-Inch; Common Cathode; 4-Digit Multiplexed	510 µcd @ 10 mA	363
	MMN38440	Yellow		510 µcd @ 10 mA	363
	MMN39440	High Eff. Red		350 µcd @ 10 mA	363
	MMN56120	Orange	0.5-Inch; Common Anode; 2-Digit Direct Drive	510 µcd @ 10 mA	367
	MMN58120	Yellow		510 µcd @ 10 mA	367
	MMN59120	High Eff. Red		350 µcd @ 10 mA	367
	MMN56320	Orange	0.5-Inch; Common Cathode; 2-Digit Direct Drive	510 µcd @ 10 mA	367
	MMN58320	Yellow		510 µcd @ 10 mA	367
	MMN59320	High Eff. Red		350 µcd @ 10 mA	367
	MMN56240	Orange	0.5-Inch; Common Anode; 4-Digit Multiplexed	510 µcd @ 10 mA	367
	MMN58240	Yellow		510 µcd @ 10 mA	367
	MMN59240	High Eff. Red		350 µcd @ 10 mA	367
	MMN56440	Orange	0.5-Inch; Common Cathode; 4-Digit Multiplexed	510 µcd @ 10 mA	367
	MMN58440	Yellow		510 µcd @ 10 mA	367
	MMN59440	High Eff. Red		350 µcd @ 10 mA	367

Displays

TE: PIN CONNECTION CODES: Ac (e.g.) First letter (capital) is segment, second letter (lower case) is cathode or anode.
E.g. Ac = Segment A cathode
Ac1 (e.g.) Final number refers to digit number in 2-Digit devices.

Preliminary Data Sheet

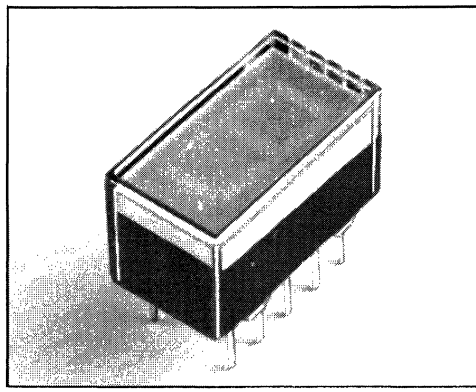
0.362-INCH SEVEN SEGMENT DISPLAY

GENERAL INSTRUMENT

HIGH EFFICIENCY RED FND310 FND317 FND318

FEATURES

- Exactly pin and package compatible with popular FND350 and FND360 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 gray 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

DESCRIPTION

The FND310, FND317, and FND318 are high efficiency red GaP seven segment LED displays with nominal 0.362 inch digit height. These displays are suitable for applications where the viewer is within fifteen feet and in high ambient light environments.

Displays

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION
FND310	Hi. Eff. Red	Common anode seven segment display
FND317	Hi. Eff. Red	Common cathode seven segment display
FND318	Hi. Eff. Red	Common cathode ±1 overflow display

ABSOLUTE MAXIMUM RATINGS

	FND310/317	FND318
Power dissipation at 25° C ambient	500 mW	320 mW
Derate linearly from 25° C	-9.8 mW/° C	-6 mW/° C
Storage and operating temperature	-25° C to +85° C	-25° C to +85° C
Continuous forward current		
Total	200 mA	125 mA
Per segment or decimal point	25 mA	25 mA
Reverse voltage		
Per segment or decimal point	6 V	6 V
Soldering time at 260° C (see note 1)	5.0 sec	5.0 sec

FND310 FND317 FND318

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) FND310, 317, 318	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			±33		%	I_F = 20 mA
Within one light category			±20		%	I_F = 20 mA
Viewing angle to half intensity	$\theta½$		±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

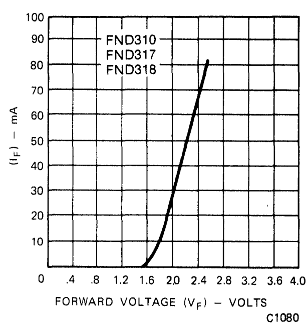


Fig. 1. Forward Current vs. Forward Voltage

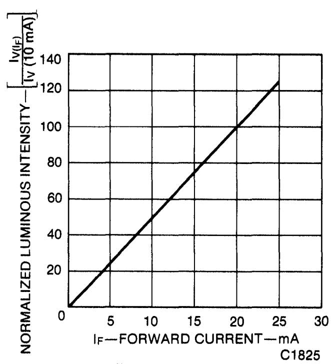


Fig. 2. Normalized Luminous Intensity vs. Forward Current

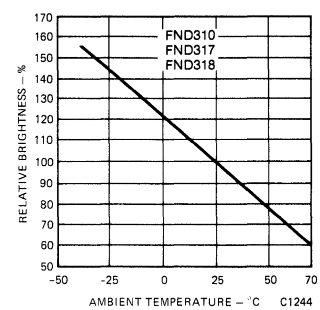


Fig. 3. Luminous Intensity vs. Temperature

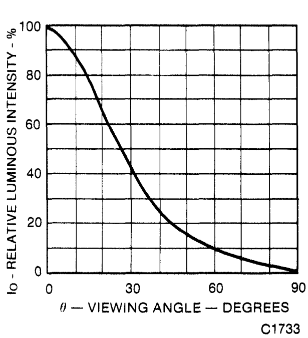


Fig. 4. Angular Distribution of Luminous Intensity

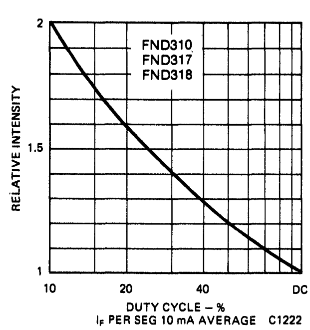


Fig. 5. Relative Luminous Efficiency (mcd per mA) vs. Peak Current per Segment

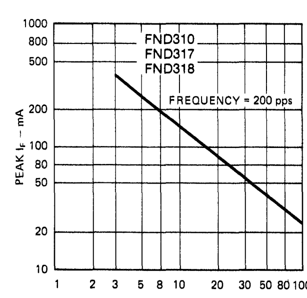


Fig. 6. Maximum Average Current Rating vs. Ambient Temperature

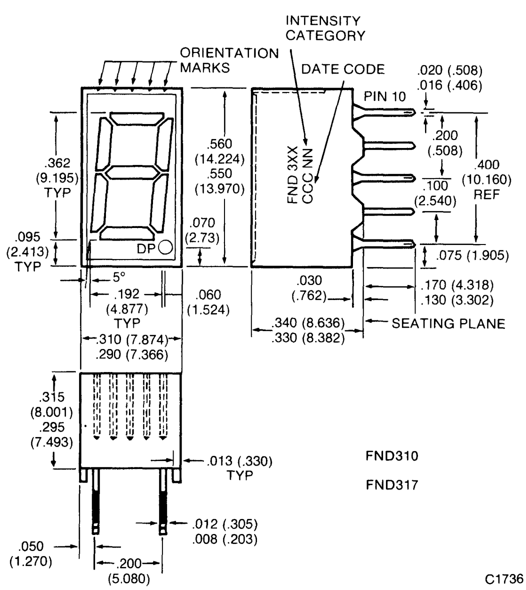
RECOMMENDED OPTICAL FILTER

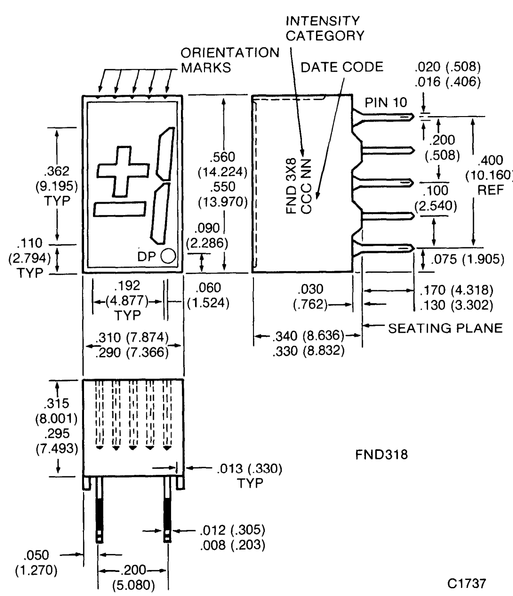
For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

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 Gray 18-23% transmission 630 nm SGL Homalite H100-1266 Chequers Engraving #105 3M Co. ND0220 Panelgraphics Gray #10 T=23% Gray #15 T=17% Rohm & Haas 2074

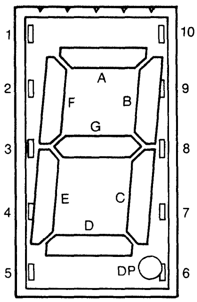
PACKAGE OUTLINES

Notes
All dimensions in inches and millimeters (parentheses)
Tolerance unless specified = ±.015 (±.381)



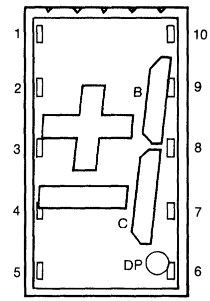


PIN CONNECTIONS



Pin	FND317	FND310
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

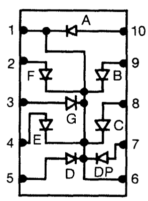
C1738



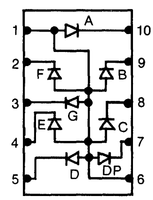
Pin	FND318
1	Common Cathode
2	Plus Sign
3	Minus Sign
4	NC
5	Omitted
6	Common Cathode
7	Decimal Point DP
8	Segment C
9	Segment B
10	NC

C1739

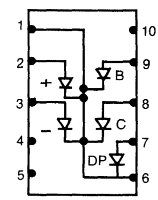
ELECTRICAL SCHEMATIC



FND317



FND310



FND318

NOTES:

1. *Leads of the device immersed to 1/16 in. from the body. Maximum device surface temperature 140° C.*
2. *Luminous Intensity measuraements are made under pulsed drive conditions (5 ms), and calibrated to DC via Gamma Scientific C-3 Spectral Scanning System.*

GENERAL INSTRUMENT

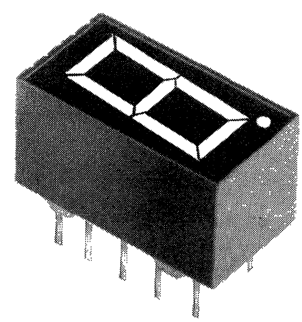
RED	**FND350**	**FND357**	**FND358**
HI-BRITE RED	**FND360**	**FND367**	**FND368**

FEATURES

- Exactly identical to displays with same part number formerly manufactured by Fairchild Optoelectronics Division.
- Compact - 10 digits in 3 in. 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, FND367 are RED GaAsP seven segment LED displays with a 0.362-inch digit height. The FND358, FND368 are RED GaAsP ±1 LED displays with nominal 0.362-inch digit height in common-cathode configuration. These displays are for applications where the viewer is within fifteen feet of the panel.

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION
FND350	RED	Common Anode Seven Segment Display
FND357	RED	Common Cathode Seven Segment Display
FND358	RED	Common Cathode ±1 Overflow Display
FND360	Hi-Brite RED	Common Anode Seven Segment Display
FND367	Hi-Brite RED	Common Cathode Seven Segment Display
FND368	Hi-Brite RED	Common Cathode ±1 Overflow Display

ABSOLUTE MAXIMUM RATINGS

	FND350/357 FND360/367	FND358 FND368
Power dissipation @ 25° C ambient	400mW	250mW
Derate linearly from 25° C	−6.5mW/° C	−4mW/° C
Storage and operating temperature	−25° C to +85° C	−25° C to +85° C
Continuous Forward Current		
Total	200mA	125mA
Per segment or decimal point	25mA	25mA
Reverse Voltage		
Per segment or decimal point	3.0 V	3.0 V
Soldering Time @ 260° C (see note 1)	5.0 sec	5.0 sec

FND350 FND357 FND358 FND360 FND367 FND368

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			±33		%	I_F = 20 mA
Within one Light Category			±20		%	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}
Wavelength temperature coefficient (case temp)	0.3 nm/° C	$\Delta\lambda/\Delta T$
Forward voltage temperature coefficient	−1.6mV/° C	$\Delta V_F/\Delta T$

TYPICAL CURVES

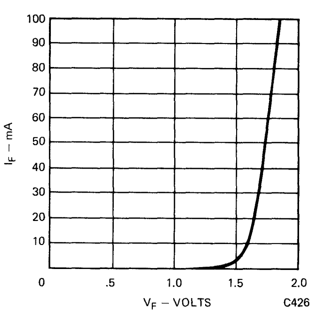


Fig. 1. - Forward Current vs. Forward Voltage

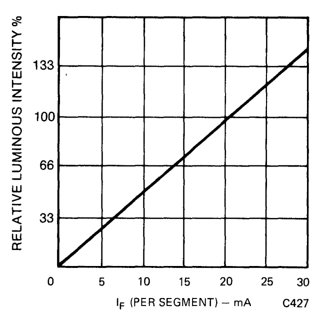


Fig. 2. - Luminous Intensity vs. Forward Current

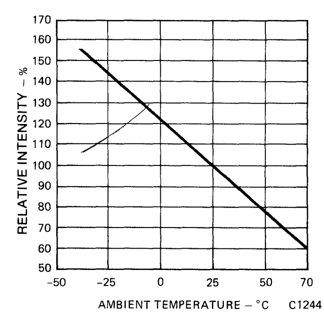


Fig. 3. - Luminous Intensity vs. Temperature

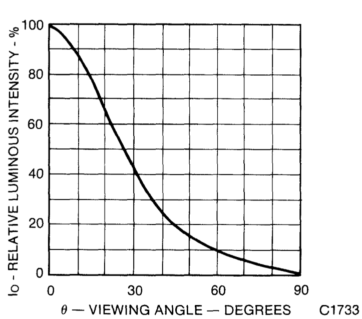


Fig. 4. - Angular Distribution of Luminous Intensity

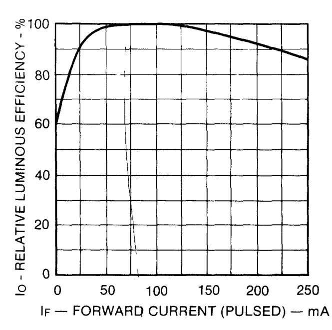


Fig. 5. - Relative Luminous Efficiency (mcd per mA) vs. Peak Current per Segment

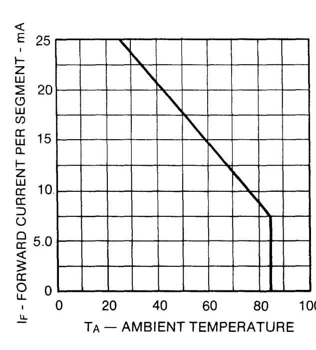


Fig. 6. - Maximum Average Current Rating vs. Ambient Temperature

RECOMMENDED OPTICAL FILTER

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

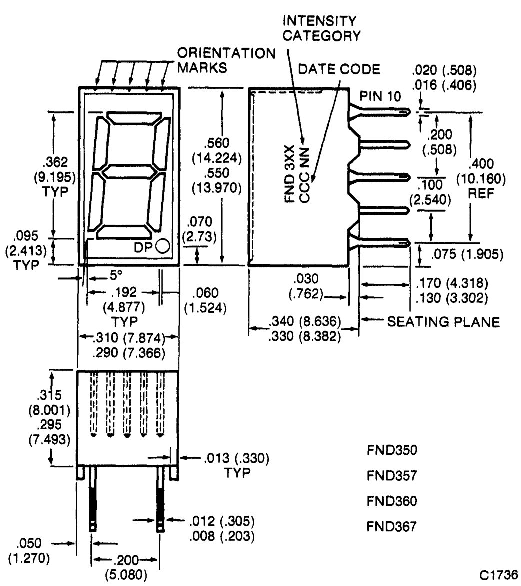
AMBIENT	OPTICAL FILTER
DIM 25 - 75 fc	Long Pass 70% transmission 655nm SGL Homalite H100 - 1650 LR-72 Rohm & Haas 2423 Panelgraphics Ruby RED #60 Chequers Engraving #118 3M Co. R6510
MODERATE 75 - 200 fc	RED Long Pass, 45% Transmission 655nm SGL Homalite H100-1650 LR-92 Chequers Engraving #112 Panelgraphics Dark RED #63 3M Co. Purple P7710
BRIGHT 200 - 1000 fc	Neutral Gray 18 - 26% transmission 655nm SGL Homalite H100 - 1266 Chequers Engraving #105 3M Co. ND0220 Panelgraphics Gray #10 T=23% Gray #15 T=17% Rohm & Haas 2074

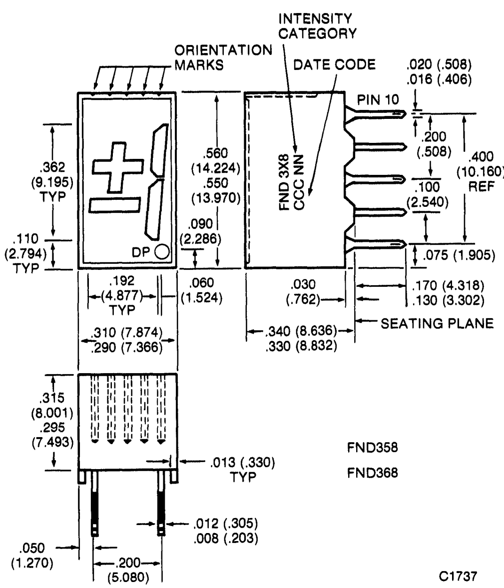
PACKAGE OUTLINES

Notes

All dimensions in inches and millimeters (parentheses)

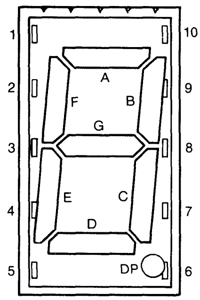
Tolerance unless specified =± .015 (±.381)





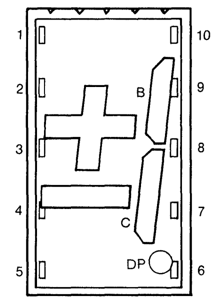
FND350 FND357 FND358 FND360 FND367 FND368

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

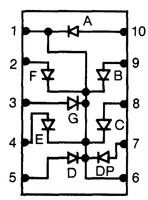
C1738



Pin	FND358/368
1	Common Cathode
2	Plus Sign
3	Minus Sign
4	NC
5	Omitted
6	Common Cathode
7	Decimal Point DP
8	Segment C
9	Segment B
10	NC

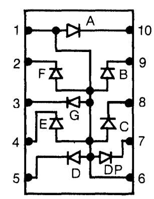
C1739

ELECTRICAL SCHEMATIC



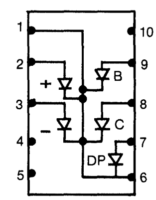
FND 357
FND 367

C1740



FND 350
FND 360

C1741



FND 358
FND 368

C1742

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.*

PREVIEW DATA SHEET

2.0" 5x7 ALPHANUMERIC
HIGH PERFORMANCE DISPLAY

GENERAL INSTRUMENT

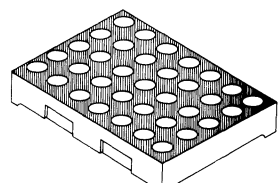
HIGH EFFICIENCY RED **GMA2175** **GMA2975**
GMC2175 **GMC2975**
HIGH EFFICIENCY GREEN **GMA2475**
GMC2475

FEATURES

- 2" Character height
- Row and column strobable
- Large emitting dot .2" diameter
- Low profile package
- Wide viewing angle 130°
- X-Y matrix addressable common anode/cathode column
- Display face colored for optimum contrast
- Low power/high brightness
- X-Y stackable package with integrated alignment keys

APPLICATIONS

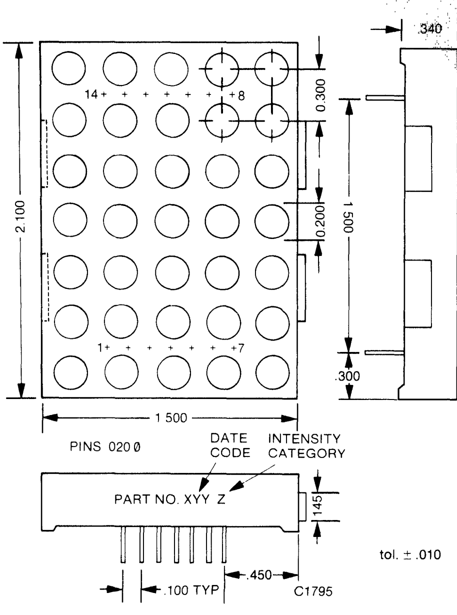
- Single/multi-line message display
- Large area graphics & signs
- Electronic games
- Industrial control system status



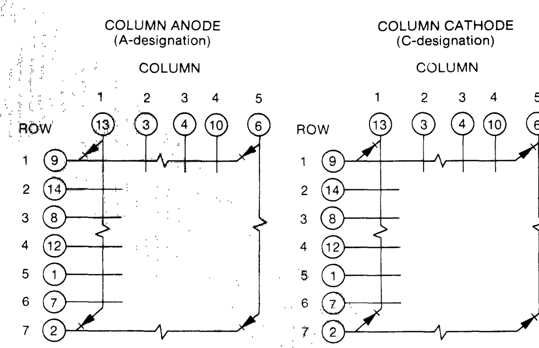
DESCRIPTION

The GMX2XXX family of displays are large emitting area (0.2" diameter) LED sources configured in a 35 dot 5x7 matrix array. They are available with Hi. Eff. Red and Green source color with either common anode or common cathode column electrical interconnection.

PACKAGE DIMENSIONS



ELECTRICAL CONNECTIONS



DEVICE PART NUMBER SELECTION

G M X 2 X X X

Mfg. — G
Matrix Array — M
Polarity — X
A=CA
C=CC
Dot size/emitting area — 2
LED/Face color** — X
Array confg* — X X

**1—HER/Gray Face
4—HEG/Gray Face
9—HER/Green Face

*75 = 5x7 Dot Matrix
85 = 5x8 Dot Matrix

C1796

Displays

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

Single Diode	
DC forward current	30 mA
Peak pulsed forward current 1/7 duty factor	150 mA
Reverse voltage	6 V
Diode Array	
Average power dissipation	1800 mW
Derate from 25° C	-20 mW/° C
DC current worst case	25 mA
Operating and storage	-40° C to 85° C
Junction temperature	90° C
Soldering temperature	260° C for 5 sec

As with all semiconductors, stresses listed under "Absolute Maximum Ratings" may be applied to devices (one at a time) without resulting in permanent damage. This is a stress rating only. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. The conditions listed under "Electrical Characteristics" are the only conditions recommended for satisfactory operation.

TYPICAL OPERATING CHARACTERISTICS AT 25° C

PARAMETER	SYMBOL	TYPICAL	UNITS	TEST CONDITIONS
Luminous intensity	I_V	4.0	mcd	I_F = 20 mA DC
Luminous intensity	I_V	6.0	mcd	I_F = 120 mA 1/7 DF
I_V matching		2:1		diode to diode
Viewing angle	$2\Theta_{1/2}$	140	deg	I_F = 20 mA
Forward voltage	V_F	2.0	V	I_F = 20 mA
Reverse current	I_R	100	μA	V_R = 5 V
Peak wavelength	λ_P	635	nm	I_F = 20 mA
Spectral halfwidth	λFWHM	40	nm	I_F = 20 mA
Capacitance	Cd	30	pF	V_F = 0 V, F = 1 MHz
Dynamic resistance	rd	20	ohms	$V_{F(TH)}$ = 1.8 V $I_{F(TH)}$ = 5 mA
Thermal resistance	Θ_{JL}	300	° C/W	

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.

GENERAL INSTRUMENT

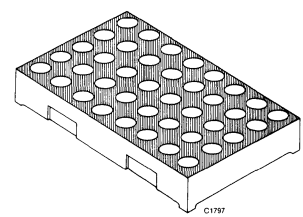
HIGH EFFICIENCY RED GMA2185 GMA2985 GMC2185 GMC2985
HIGH EFFICIENCY GREEN GMA2485 GMC2485

FEATURES

- 2.4" Character height
- Row and column strobable
- Large emitting dot .2" diameter
- Low profile package
- Wide viewing angle 130°
- X-Y matrix addressable common anode/cathode column
- Display face colored for optimum contrast
- Low power/high brightness
- X-Y stackable package with integrated alignment keys

APPLICATIONS

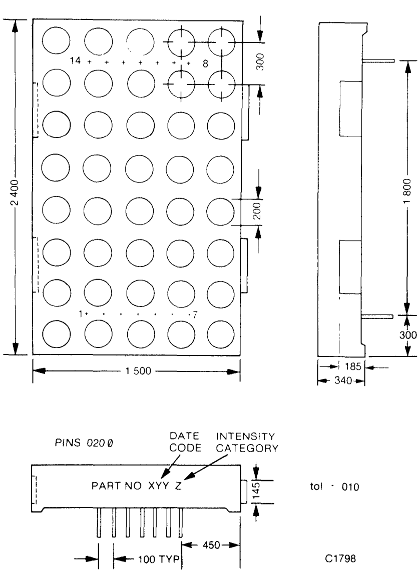
- Single/multi-line message display
- Large area graphics & signs
- Electronic games
- Industrial control system status


C1797

DESCRIPTION

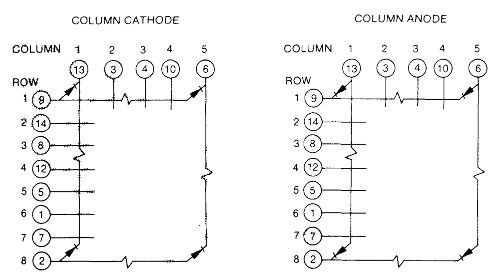
The GMX2XXX family of displays are large emitting area (0.2" diameter) LED sources configured in a 40 dot 5x8 matrix array. They are available with Hi. Eff. Red and Green source color with either common anode or common cathode column electrical interconnection.

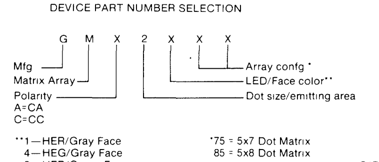
PACKAGE DIMENSIONS



C1798

ELECTRICAL CONNECTIONS





C1799

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

Single Diode
- DC forward current .... 30 mA
- Peak pulsed forward current 1/7 duty factor .... 150 mA
- Reverse voltage .... 6 V

Diode Array
- Average power dissipation .... 2000 mW
- Derate from 25°C .... -20 mW/°C
- DC current worst case .... 25 mA

Operating and storage .... -40°C to 85°C
Junction temperature .... 90°C
Soldering temperature .... 260°C for 5 sec

As with all semiconductors, stresses listed under "Absolute Maximum Ratings" may be applied to devices (one at a time) without resulting in permanent damage. This is a stress rating only. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. The conditions listed under "Electrical Characteristics" are the only conditions recommended for satisfactory operation.

TYPICAL OPERATING CHARACTERISTICS

PARAMETER	SYMBOL	TYPICAL	UNITS	TEST CONDITIONS
Luminous intensity	I_V	4.0	mcd	I_F = 20 mA DC
Luminous intensity	I_V	6.0	mcd	I_F = 120 mA 1/7 DF
I_V matching		2:1		diode to diode
Viewing angle	$2\Theta_{1/2}$	140	deg	I_F = 20 mA
Forward voltage	V_F	2.0	V	I_F = 20 mA
Reverse current	I_R	100	μA	V_R = 5 V
Peak wavelength	λ_P	635	nm	I_F = 20 mA
Spectral halfwidth	λFWHM	40	nm	I_F = 20 mA
Capacitance	Cd	30	pF	V_F = 0 V, F = 1 MHz
Dynamic resistance	rd	20	ohms	$V_{F(TH)}$ = 1.8 V $I_{F(TH)}$ = 5 mA
Thermal resistance	Θ_{JL}	300	°C/W	

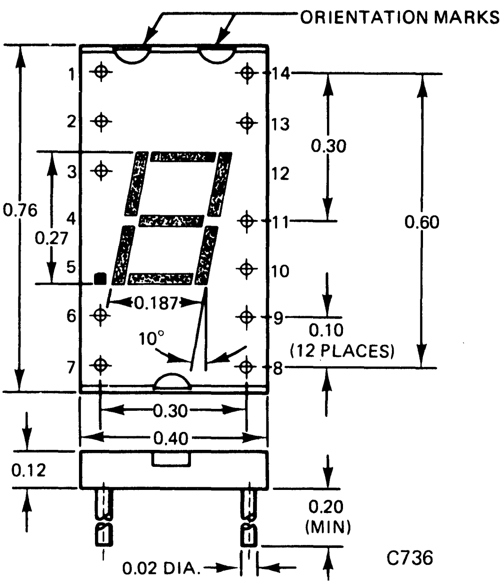
DATA SHEET CLASSIFICATIONS

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.

GENERAL INSTRUMENT

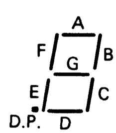
RED MAN1A
RED MAN10A

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 reliability
- 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 is for industrial and military applications such as:

- Digital readout displays
- Cockpit readout displays

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient . . . . . 750 mW
Derate linearly from 25°C . . . . 10 mW/°C
Storage and operating temp . . . . . . -55°C to 100°C
Continuous forward current
  Total . . . . 240 mA
  Per segment . . . . 30 mA
  Decimal point . . . . 30 mA
Reverse Voltage
  Per segment . . . . 10.0 volts
  Decimal point . . . . 5.0 volts
Solder time at 260°C (see note 5) . . . . 5 sec

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

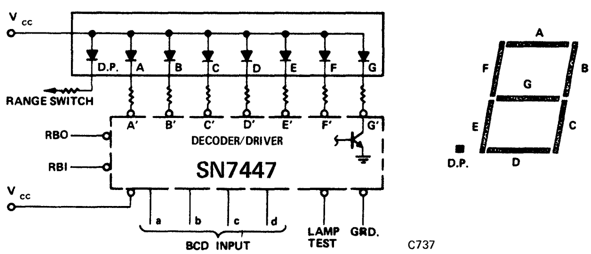
CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS MAN1A	TEST CONDITIONS MAN10A
Luminous Intensity (note 1 and 6)						
Segment	74			μcd	I_F=20 mA, λ=660 nm	I_F=10 mA, λ 660 nm
Decimal point	74			μcd	I_F=20 mA, λ=660 nm	I_F=10 mA, λ 660 nm
Peak emission wave length	630		700	nm		
Spectral line half width		20		nm		

ELECTRO-OPTICAL CHARACTERISTICS Cont.'d (25°C Ambient Temperature Unless Otherwise Specified)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS MAN1A	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 d	c	b	a	OUTPUT STATE A'	B'	C'	D'	E'	F'	G'	DISPLAY
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

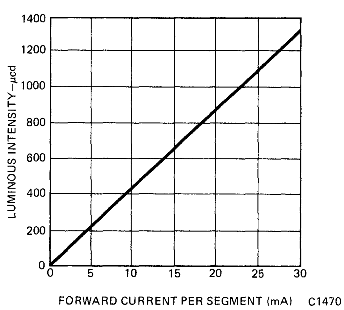


Figure 1 Luminous Intensity vs. Forward Current

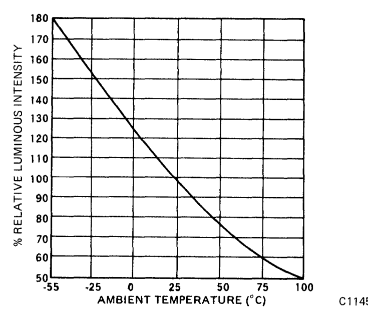


Figure 2 Luminous Intensity vs. Temperature

TYPICAL THERMAL CHARACTERISTICS

Thermal Resistance (note 4) Junction to free air Θ_{JA} . . . . 440°C/W
Wavelength Temperature Coefficient (case temp) . . . . 3.0 Å/°C
Forward Voltage Temperature Coefficient . . . . –3.0 mV/°C

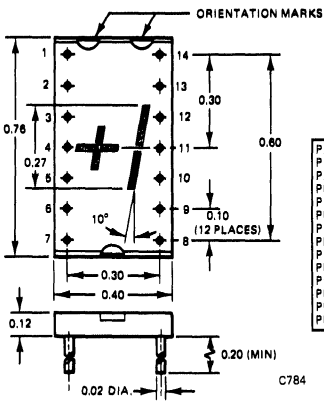
NOTES

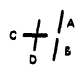
1. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ± 50% between all segments.*
2. *The curve in Figure 2 is normalized to the brightness at 25°C to indicate the relative efficiency over the operating temperature range.*
3. *For contrast 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 inches 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

RED MAN101A
RED MAN1001A

PACKAGE DIMENSIONS





PIN 1	ANODE COMMON CD
PIN 2	NO PIN
PIN 3	NO PIN
PIN 4	NO PIN
PIN 5	NO PIN
PIN 6	NO PIN
PIN 7	CATHODE D
PIN 8	CATHODE C
PIN 9	NO PIN
PIN 10	CATHODE B
PIN 11	CATHODE A
PIN 12	NO PIN
PIN 13	NO PIN
PIN 14	ANODE COMMON AB

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 reliability
- Shock resistant
- Operates with IC voltage requirements
- Small size; offering unique styling advantages
- Usable for high ambient applications
- Usable in vibrating environment, impervious to vibration

APPLICATIONS

The MAN101 and MAN1001 are for industrial and military applications such as:

- Digital readout displays
- Cockpit readout displays
- Battery operated equipment

Displays

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient . . . . 480 mW
Derate linearly from 25°C . . . . 6.4 mW/°C
Storage and operating temp . . . . -55°C to 100°C
Continuous forward current
  Total . . . . 120 mA
  Per segment . . . . 30 mA
Reverse Voltage
  Per segment . . . . 10.0 volts
Solder time at 260°C (see note 5) . . . . 5 sec

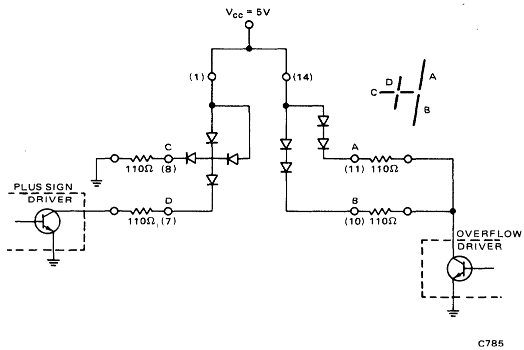
ELECTRO-OPTICAL CHARACTERISTICS (25°C Ambient Temperature Unless Otherwise Specified)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS MAN101A	MAN1001A
Luminous intensity (note 1 and 6)						
Segment	74			μcd	I_F = 10 mA, λ = 650 nm	I_F = 20 mA, λ 650 nm
Peak emission wave length	630		700	nm		
Spectral line half width		20		nm		
Forward voltage						
Segment		3.4	4.0	V	I_F = 10 mA	I_F = 20 mA
Dynamic resistance						
Segment		11		Ω	I_F = 20 mA	I_F = 20 mA
Capacitance						
Segment		80		pF	V = 0	V = 0
Reverse Current						
Segment			100	μA	V_R = 10.0 volts	V_R = 10.0 volts

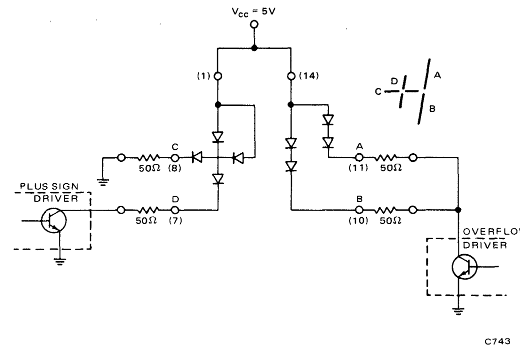
MAN101A MAN1001A

DRIVING CIRCUITRY

MAN101A



MAN1001A



NOTE:
1. *Parenthesis ( ) denote package pin numbers*
2. *Each segment requires 10 mA*

TYPICAL CURVES

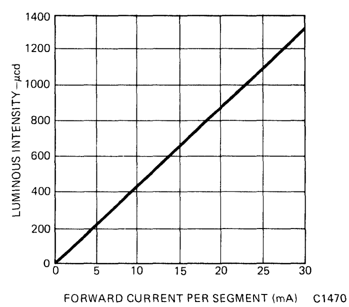


Figure 1 Luminous Intensity vs. Forward Current

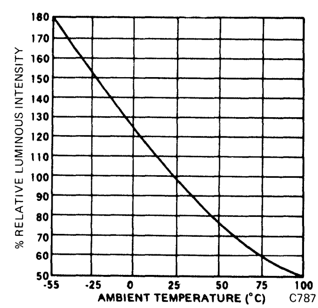


Figure 2 Luminous Intensity vs. Temperature

TYPICAL THERMAL CHARACTERISTICS

Thermal Resistance (note 4) Junction to free air θ_{JA} . . . . 440°C/W
Wavelength Temperature Coefficient (case temp) . . . . 3.0 Å/°C
Forward Voltage Temperature Coefficient . . . . –4.0 mV/°C

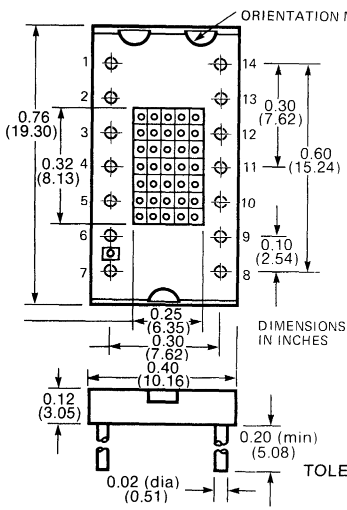
NOTES

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 inches from the body. Maximum device surface temperature is 140°C.*
6. *All displays are categorized for luminous intensity. The luminous category is marked on each part as a suffix letter to the part number.*

GENERAL INSTRUMENT

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

FEATURES & APPLICATIONS

- X-Y matrix drive
- Visible, bright red, high contrast display
- Categorized for luminous intensity (see note 5)
- 36 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 verifier
- Film annotation—2^{36} bits available
- Avionics display
- Computer peripheral displays

DESCRIPTION

The MAN2A is a 35 diode diffused planar GaAsP LED alpha-numeric 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.

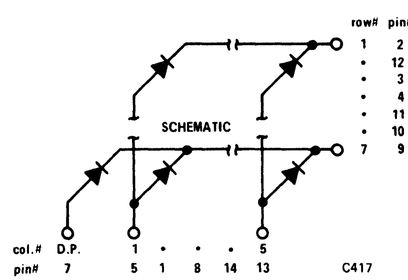
Displays

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 @ 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

Solder time at 260°C (notes 3, 4) .... 5 sec



C417

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

TYPICAL CURVES

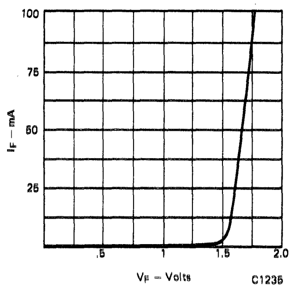


Fig. 1. Forward Current vs. Forward Voltage each LED

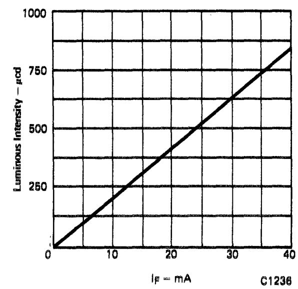


Fig. 2. Light Intensity vs. Forward Current each LED

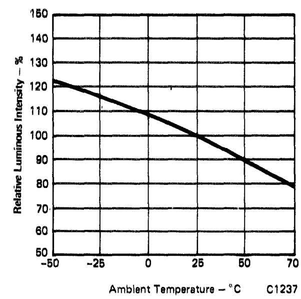


Fig. 3. Relative Luminous Intensity vs. Ambient Temperature

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 note 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 inches 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.*

PRELIMINARY DATA SHEET

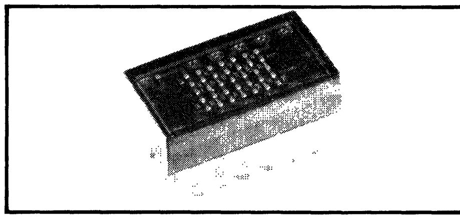
0.32 INCH DOT MATRIX DISPLAY

GENERAL INSTRUMENT

HIGH EFFICIENCY GREEN MAN24
RED MAN27
YELLOW MAN28
HIGH EFFICIENCY RED MAN29

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



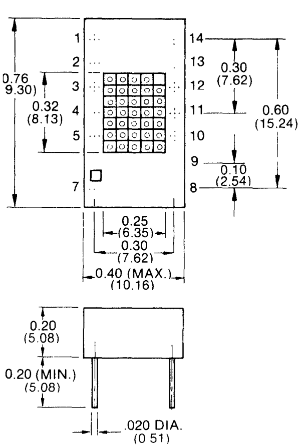
DESCRIPTION
The MAN20A series is a family of 5 x 7 LED dot matrix displays with nominal 0.32 inch character height. A wrap-around plastic cover provides an integral filter for direct viewing. Each unit is sealed by epoxy backfill.

Displays

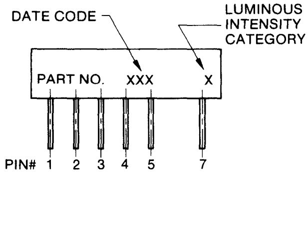
MODEL NUMBERS

Part Number	LED Color	Lens Color
MAN24	Hi. Eff. Green	Green
MAN27	Red	Red
MAN28	Yellow	Yellow
MAN29	Hi. Eff. Red	Red

PACKAGE DIMENSIONS



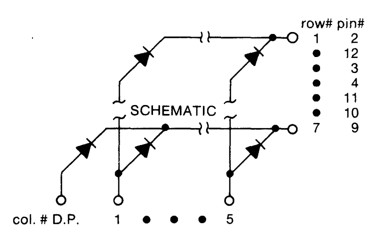
DIMENSIONS ARE IN INCHES (mm)
TOLERANCE ±.015" (0.38)



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 & 2)	20 mA
Solder time at 260°C (Notes 2, 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)

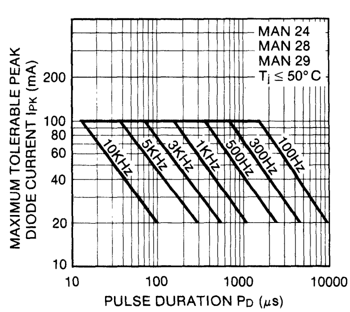


Fig. 1. Maximum Tolerable Peak Diode Current vs. Pulse Duration

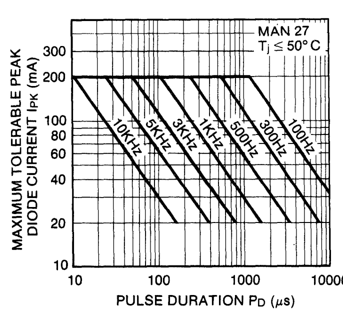


Fig. 2. Maximum Tolerable Peak Diode Current vs. Pulse Duration

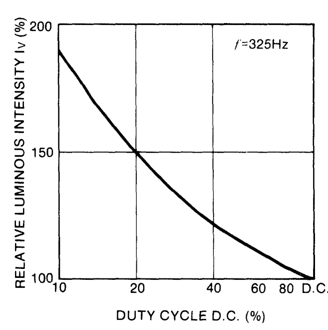


Fig. 3. Relative Luminous Intensity vs. Duty Cycle

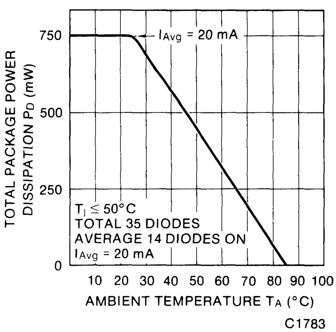


Fig. 4. Total Package Power Dissipation vs. Ambient Temp.

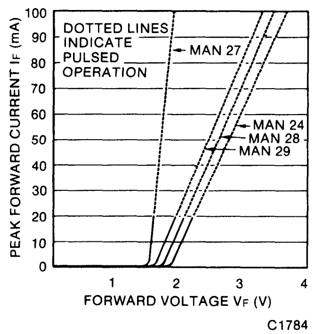


Fig. 5. Peak Forward Voltage vs. Peak Forward Current

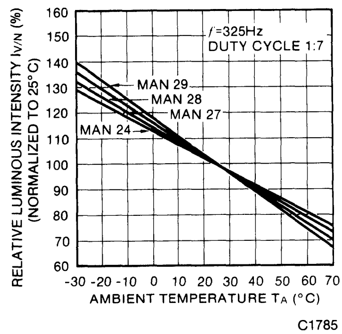


Fig. 6. Relative Luminous Intensity vs. Ambient Temperature

RECOMMENDED FILTERS FOR CONTRAST ENHANCEMENT

	AMBIENT		
COLOR	**DIM (Office) 25-75 FC**	**MODERATE (Test Floor) 75-200 FC**	**BRIGHT (Outdoors) 200-1000 FC**
HI.EFF. RED 635 nm STD RED 670 nm	Red Long Pass 65% H, H100-1650 C, 110 3M, R6310 POL, HNCP37; HTCP	Red Long Pass 40% H, F100-1650 C, 112 POL, HACP; HRCP (HT)	Gray 18-23% H, H100-1266 C, 105 3M, ND0220 HNCP 10, 22
YELLOW 583 nm	Yellow Band Pass 30% H, H100-1720 C, 106 P, Yellow 27 POL, HNCP37	Amber Long Pass 40% H, H100-1726 C, 106 P, Amber 23 3M, A5910 POL, HACP	Gray 18-23% H, H100-1266 C, 105 P, Gray 10 RH, 0538 POL, HACP
HI.EFF. GREEN 569 nm	Green Band Pass 30% H, H100-1440 C, 107 P, Green 48 POL, HNCP37	Gray 20-25% H, H100-1425 C, 107 P, Green 48 POL, HGCP	Gray 18-23% H, H100-1266 C, 105 P, Gray 10 POL, HGCP

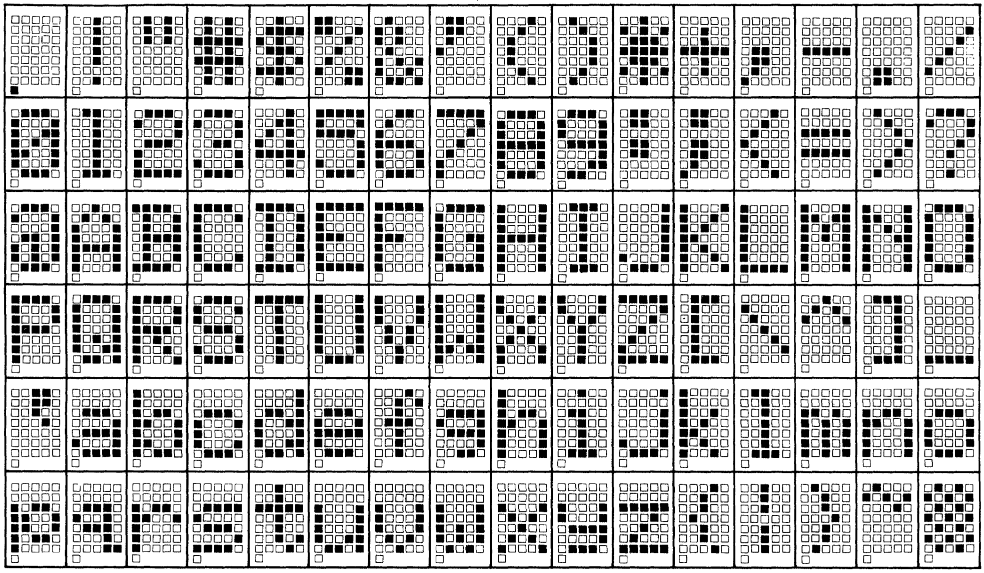
LEGEND:

C, 106 — Chequers #106
RH — Rohm & Haas
3M — 3M Company
POL — Polaroid Corporation
H — SGL Homalite
C — Chequers Engraving
P — Panelgraphics

NOTES:

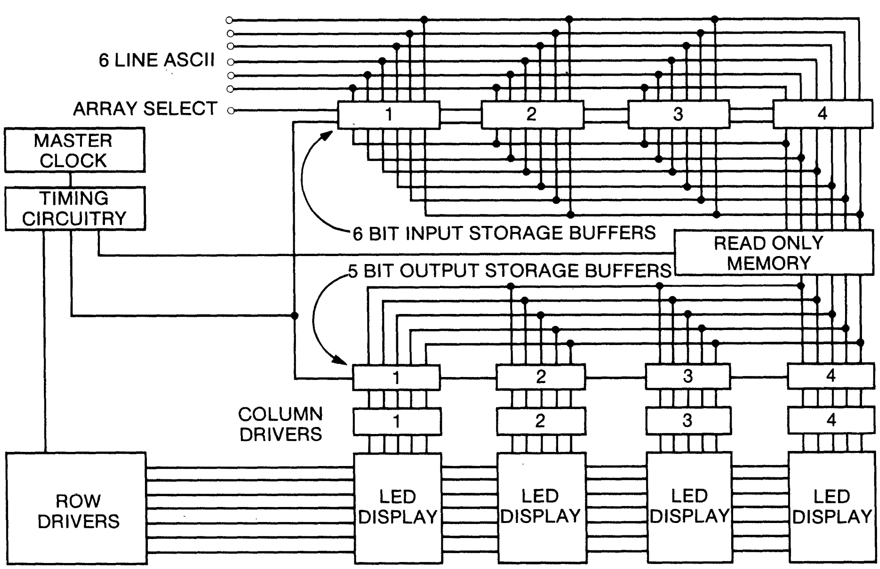
1. *The characteristic average luminous intensity is obtained by summing the luminous intensity of each diode and dividing by 35. Intensity will not vary more than ±33.3% between all diodes in a character.*
2. *Leads of the device immersed to 1/16 inches from the body. Maximum device surface temperature 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

.135-INCH 8-CHARACTER 14-SEGMENT ALPHA-NUMERIC DISPLAY

GENERAL INSTRUMENT

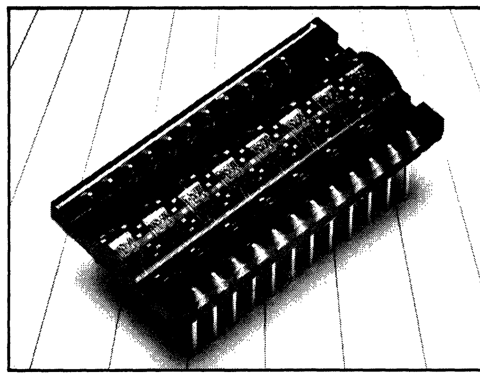
RED MAN2815

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 Alpha-numerics plus special characters.
- Voltage and current compatibility for interfacing ease with microprocessors and related circuitry.
- 0.135" character height
- 0.175" character spacing allowing as much as 32 characters in 5.6" linear panel space.
- Common Cathode
- Internally wired for multiplexing.

APPLICATIONS

- Computer terminals—lightweight, mobile, compact.
- Test & Measurement Equipment
- Desk Top Calculators
- Automotive Instrumentation
- Communications—message centers.
- Verification Systems



DESCRIPTION

The MAN2815 is an eight-character alpha-numeric 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 formated into a 14-segment font with a decimal point.

Displays

ABSOLUTE MAXIMUM RATINGS

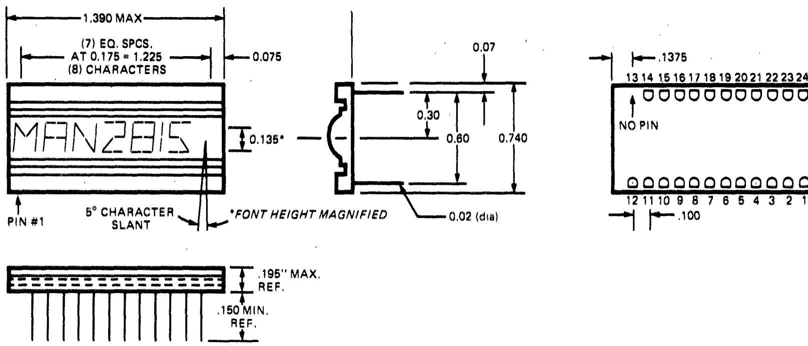
Average Forward Current per Segment	10 mA
Peak Forward Current per Segment (⩽ 200 μs, ⩽ 4% duty cycle)	250 mA
Reverse Voltage	5.0 volts
Storage & Operating Temperature	−40°C to 85°C
Solder Temperature (t ⩽ 5 sec) (See notes 2 & 3)	260°C
Average Power Dissipation (Total Package) @ T_A = 50°C	1200 mW
Derate 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

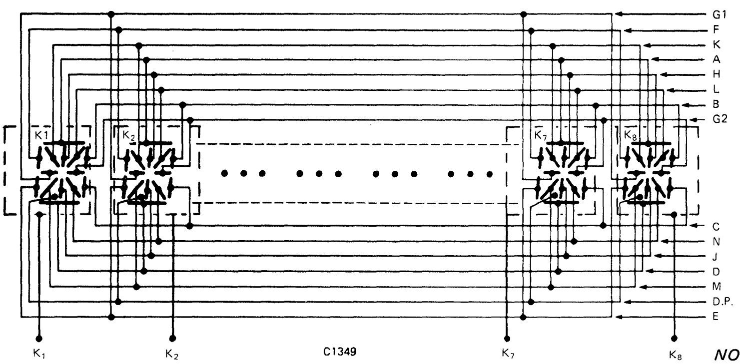


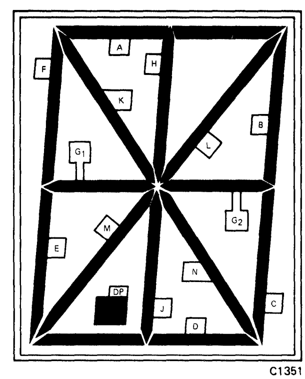
REFERENCE DESIGNATOR	
PIN NO.	DESCRIPTION
1	K1 CATHODE
2	K2 CATHODE
3	K3 CATHODE
4	(D) ANODE
5	K4 CATHODE
6	K5 CATHODE
7	(J) ANODE
8	K6 CATHODE
9	(DP) ANODE
10	K7 CATHODE
11	(M) ANODE
12	K8 CATHODE
13	NO PIN
14	(N) ANODE
15	(C) ANODE
16	(E) ANODE
17	(G2) ANODE
18	(G1) ANODE
19	(B) ANODE
20	(L) ANODE
21	(F) ANODE
22	(K) ANODE
23	(H) ANODE
24	(A) ANODE

TOLERANCES: ± .015

C1348

ELECTRICAL CONNECTIONS





NOTE: Segments A & D appear as 2 segments each, but both halves are driven together. (See wiring diagram.)

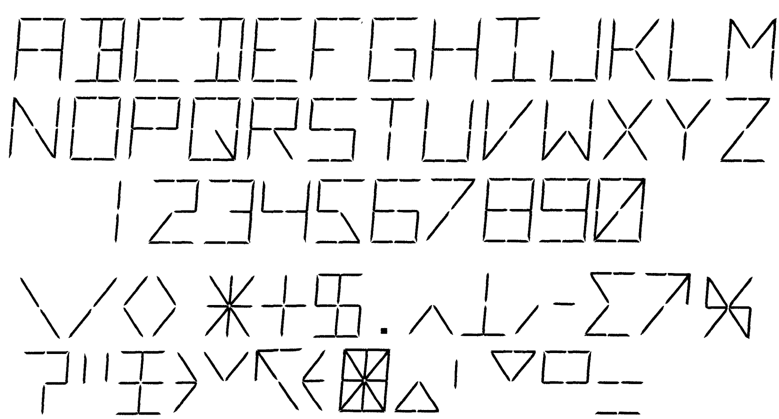


Fig. 8. 14 Segment Character Font

TYPICAL CURVES (unless otherwise noted)

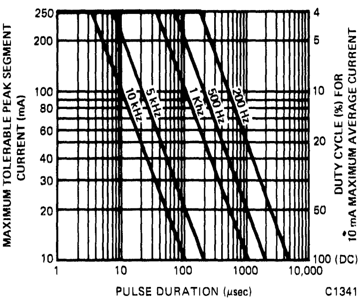


Fig. 1. Maximum Tolerable Peak Segment Current vs. Pulse Duration

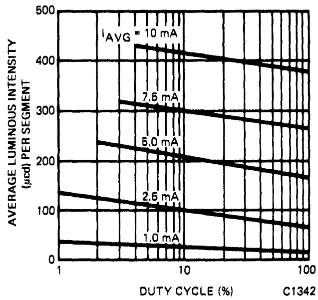


Fig. 2. Average Luminous Intensity/Segment vs. Duty Cycle

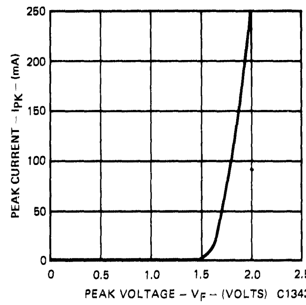


Fig. 3. Peak Current vs. Peak Voltage

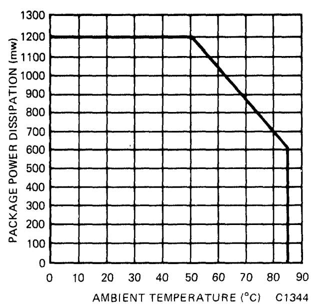


Fig. 4. Max. Tolerable Power Dissipation

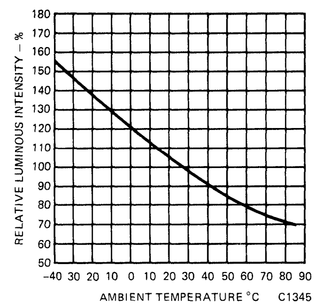


Fig. 5. Luminous Intensity vs. Temperature

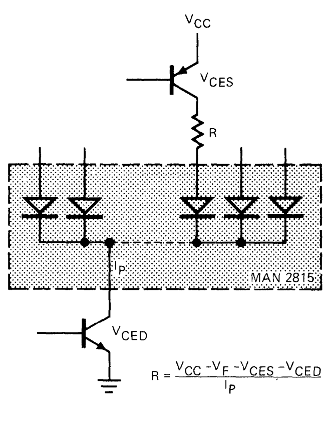


Fig. 6. Display Drive Consideration

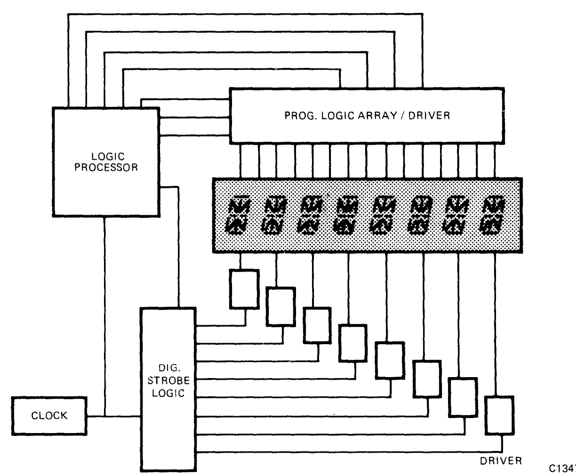


Fig. 7. MAN2815 in a Typical Application

Displays

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	volts	I_{pk} = 20 mA
Reverse Voltage	5.0			volts	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.

   $\therefore I_{PK} = \frac{2.5\ mA}{.03125}$ = 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" from the body of the device. Maximum unit 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

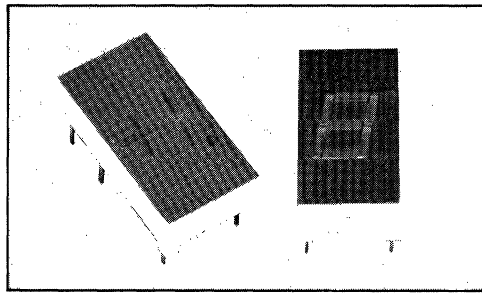
HIGH EFFICIENCY GREEN MAN3400A
ORANGE MAN3600A
RED MAN70A
YELLOW MAN3800A

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



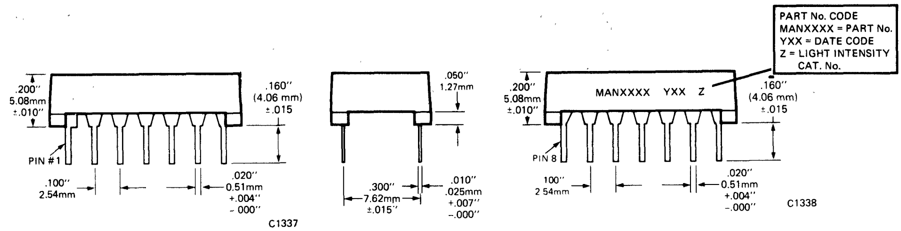
DESCRIPTION

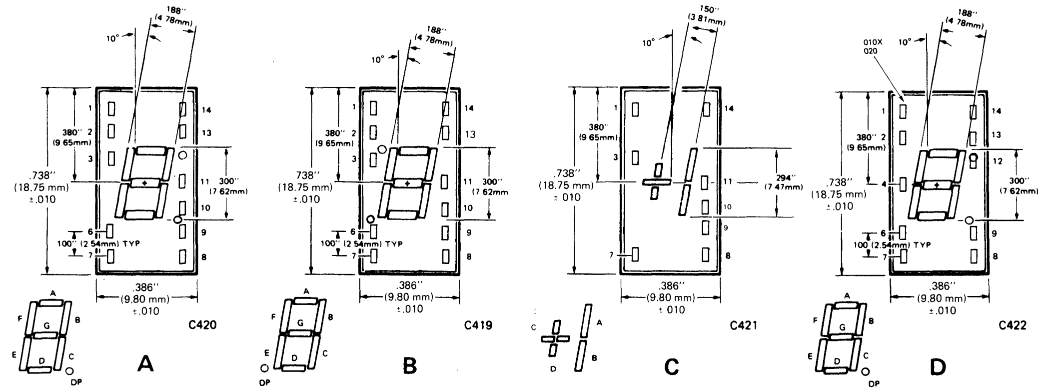
The MAN3400A, MAN3600A, MAN70A and MAN3800A Series provides a choice of color of LED displays. Standard units are available in red, green, orange and yellow, with common anode right hand decimal, common anode left hand decimal, common cathode right hand decimal, and common anode overflow (±1) with right hand decimal. 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.

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION
MAN3410A	High Efficiency Green	Common Anode; Right Hand Decimal
MAN3420A	High Efficiency Green	Common Anode; Left Hand Decimal
MAN3430A	High Efficiency Green	Common Anode; Overflow ±1
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
MAN3830A	Yellow	Common Anode; Overflow ±1
MAN3840A	Yellow	Common Cathode; Right Hand Decimal

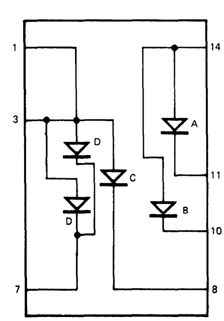
MAN3400A MAN3600A MAN70A MAN3800A SERIES





PIN NO.	ELECTRICAL CONNECTIONS			
	A	B	C	D
	MAN3410A, 3610A, 71A, 3810A	MAN3420A, 72A, 3620A, 3820A	MAN3430A, 3630A, 73A, 3830A	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	N.C.	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.	N.C.	N.C.	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



MAN3430A, 3630A, 73A, 3830A

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

Device	Parameter	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
MAN3410A, 3420A, 3430A, 3440A	Luminous intensity, Digit Average	510	2000		μcd	I_F = 10 mA
	(See Note 1, 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, 3830A, 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 MAN83A	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

Displays

TYPICAL CURVES

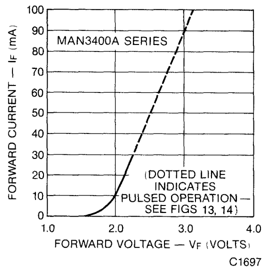


Fig. 1. Forward Current vs. Forward Voltage

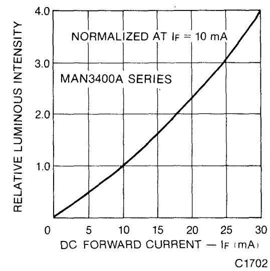


Fig. 2. Relative Luminous Intensity vs. DC Forward Current

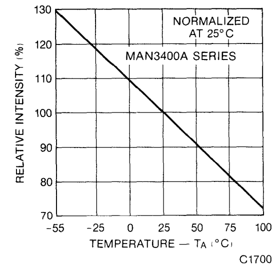


Fig. 3. Relative Luminous Intensity vs. Temperature

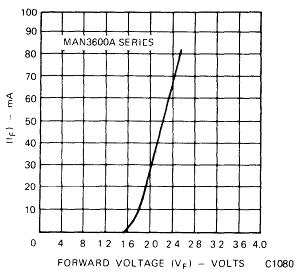


Fig. 4. Forward Current vs. Forward Voltage

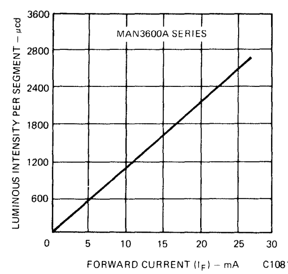


Fig. 5. Luminous Intensity vs. Forward Current

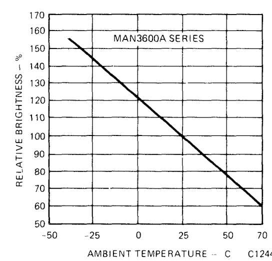


Fig. 6. Luminous Intensity vs. Temperature

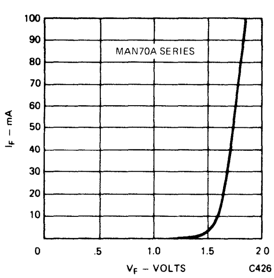


Fig. 7. Forward Current vs. Forward Voltage

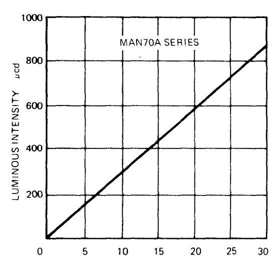


Fig. 8. Luminous Intensity vs. Forward Current

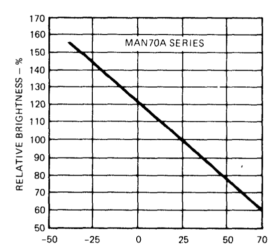


Fig. 9. Luminous Intensity vs. Temperature

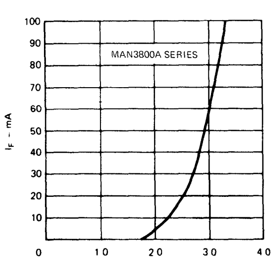


Fig. 10. Forward Current vs. Forward Voltage

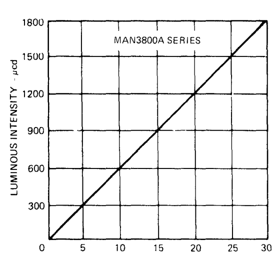


Fig. 11. Luminous Intensity vs. Forward Current

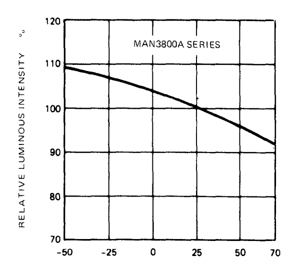


Fig. 12. Luminous Intensity vs. Temperature

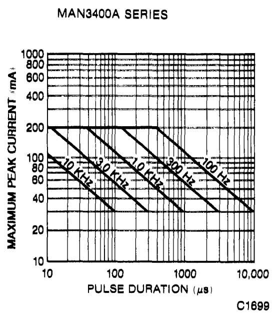


Fig. 13. Maximum Peak Current vs. Pulse Duration

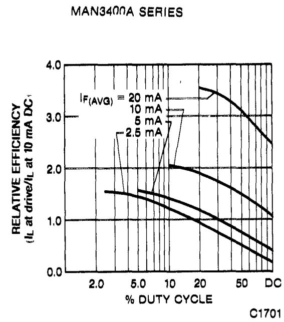


Fig. 14. Relative Efficiency vs. Duty Cycle

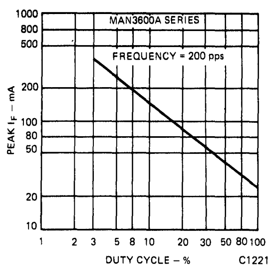


Fig. 15. Max Peak Current vs. Duty Cycle

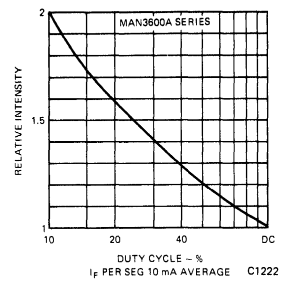


Fig. 16. Luminous Intensity vs. Duty Cycle

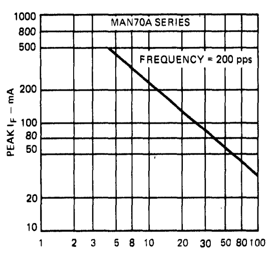


Fig. 17. Max Peak Current vs. Duty Cycle

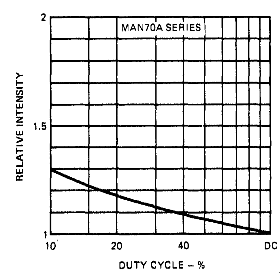


Fig. 18. Luminous Intensity vs. Duty Cycle

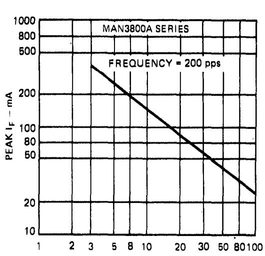


Fig. 19. Max Peak Current vs. Duty Cycle

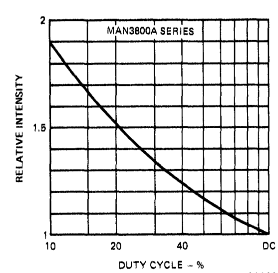


Fig. 20. Luminous Intensity vs. Duty Cycle

Displays

MAN3400A MAN3600A MAN70A MAN3800A SERIES

ABSOLUTE MAXIMUM RATINGS

	HIGH EFF. GREEN		RED	
	MAN3410A MAN3420A MAN3440A	MAN3430A	MAN71A MAN72A MAN74A	MAN73A
Power dissipation @ 25°C ambient	600 mW	300 mW	480 mW	300 mW
Derate linearly from 50°C	−12 mW/°C	−6.0 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	−40°C to +85°C
Continuous forward current				
Total	240 mA	100 mA	240 mA	150 mA
Per segment	30 mA	20 mA	30 mA	30 mA
Decimal point	30 mA	20 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
Solder time @ 260°C (Note 4 and 5)	5 sec.	5 sec.	5 sec.	5 sec.

	YELLOW		ORANGE	
	MAN3810A MAN3820A MAN3840A	MAN3830A	MAN3610A MAN3620A MAN3640A	MAN3630A
Power dissipation @ 25°C ambient	600 mW	375 mW	600 mW	375 mW
Derate linearly from 50°C	−10.3 mW/°C	−6.43 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	−40°C to +85°C
Continuous forward current				
Total	200 mA	125 mA	240 mA	150 mA
Per segment	25 mA	25 mA	30 mA	30 mA
Decimal point	25 mA	25 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
Solder time @ 260°C (Note 4 and 5)	5 sec.	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
MAN3410A MAN3420A MAN3430A MAN3440A	Panelgraphic Green 48 Homalite 100-1440 Green	MAN71A MAN72A MAN73A MAN74A	Panelgraphic Red 60 Homalite 100-1605
MAN3610A MAN3620A MAN3630A MAN3640A	Panelgraphic Scarlet 65 Homalite 100-1670	MAN3810A MAN3820A MAN3830A 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 temp)	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 temp)	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 Fig. 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-inches 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.*

0.300-INCH SEVEN SEGMENT DISPLAYS

GENERAL
INSTRUMENT

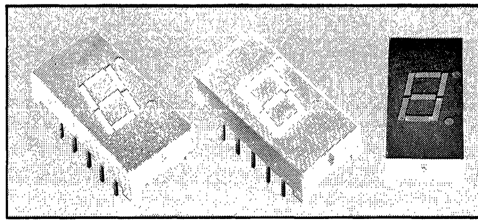
RED MAN78A
HIGH EFFICIENCY GREEN MAN3480A
YELLOW MAN3880A
ORANGE MAN3680A
HIGH EFFICIENCY RED MAN3980A

FEATURES

- H.P. 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



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 H.P. common cathode displays. This 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.

Displays

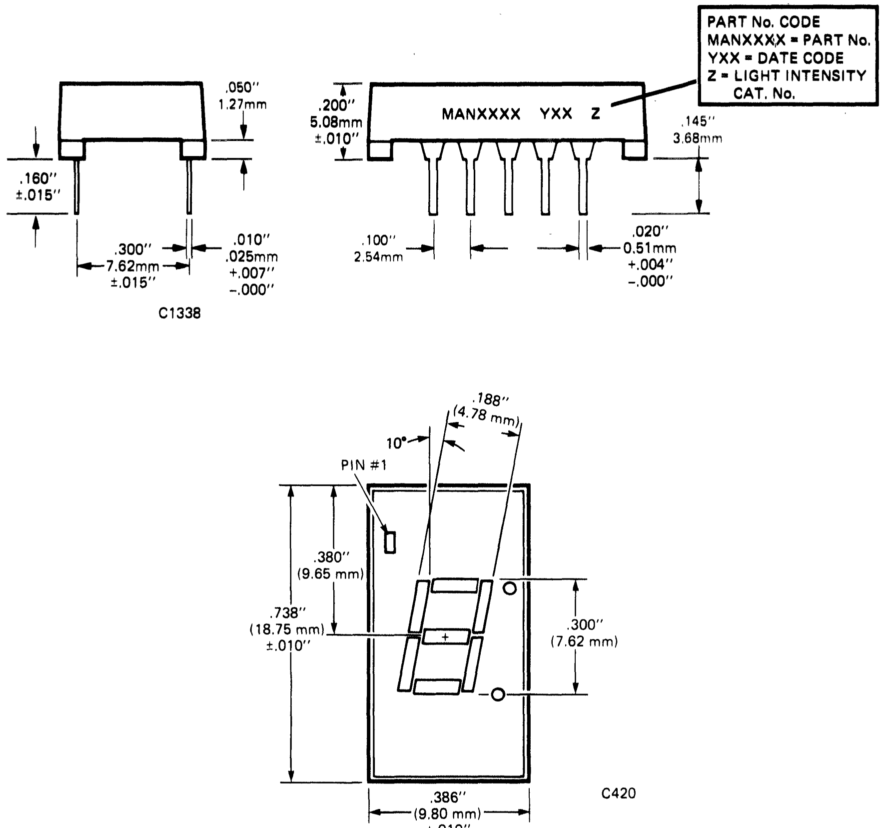
MODEL NUMBERS

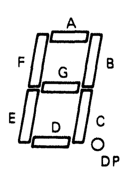
PART NO.	COLOR	DESCRIPTION
MAN3480A	High Efficiency Green	Common Cathode; Right Hand Decimal
MAN3680A	Orange	Common Cathode; Right Hand Decimal
MAN78A	Red	Common Cathode; Right Hand Decimal
MAN3880A	Yellow	Common Cathode; Right Hand Decimal
MAN3980A	High Efficiency Red	Common Cathode; Right Hand Decimal

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





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)

		MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
MAN3480A	Luminous intensity, Digit Average (See Note 1, 3)	510	2000		μcd	I_F = 10 mA
		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		V = 0
	Decimal point		35	80		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

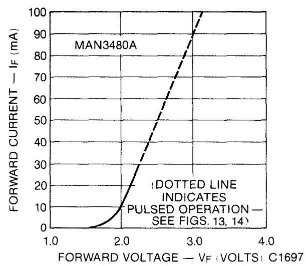


Fig. 1. Forward Current vs. Forward Voltage

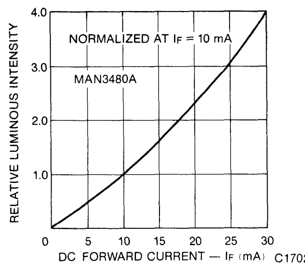


Fig. 2. Relative Luminous Intensity vs. DC Forward Current

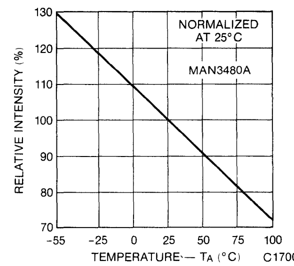


Fig. 3. Relative Luminous Intensity vs. Temperature

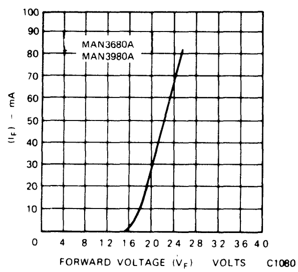


Fig. 4. Forward Current vs. Forward Voltage

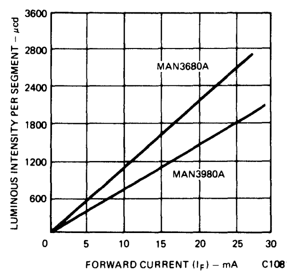


Fig. 5. Luminous Intensity vs. Forward Current

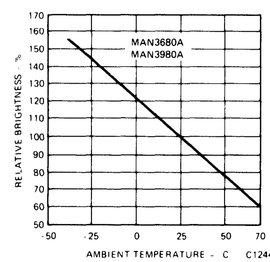


Fig. 6. Luminous Intensity vs. Temperature

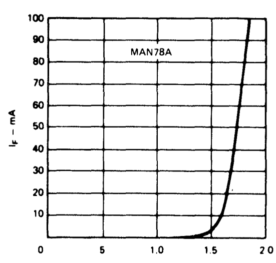


Fig. 7. Forward Current vs. Forward Voltage

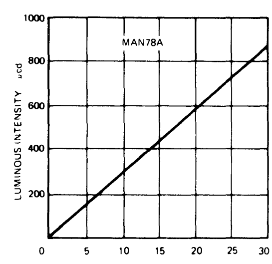


Fig. 8. Luminous Intensity vs. Forward Current

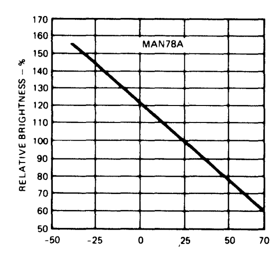


Fig. 9. Luminous Intensity vs. Temperature

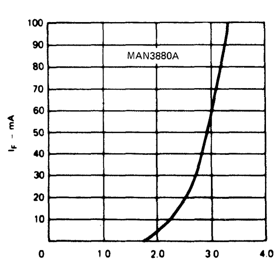


Fig. 10. Forward Current vs. Forward Voltage

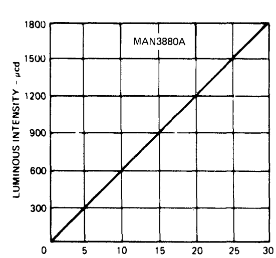


Fig. 11. Luminous Intensity vs. Forward Current

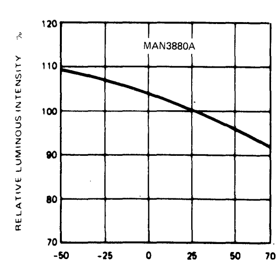


Fig. 12. Luminous Intensity vs. Temperature

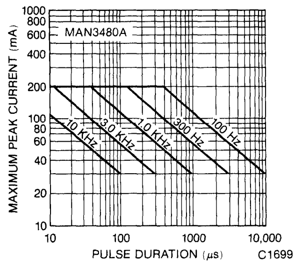


Fig. 13. Maximum Peak Current vs. Pulse Duration

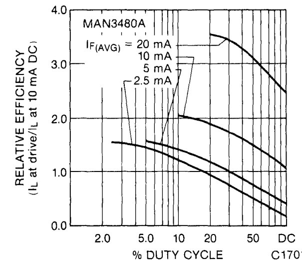


Fig. 14. Relative Efficiency vs. Duty Cycle

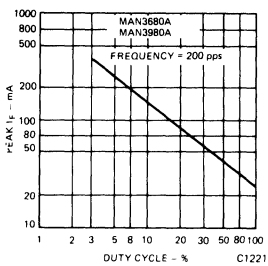


Fig. 15. Max Peak Current vs. Duty Cycle

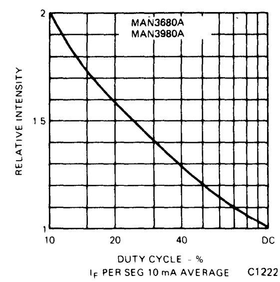


Fig. 16. Luminous Intensity vs. Duty Cycle

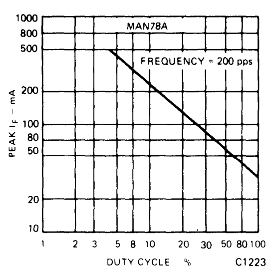


Fig. 17. Max Peak Current vs. Duty Cycle

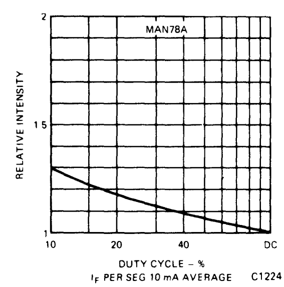


Fig. 18. Luminous Intensity vs. Duty Cycle

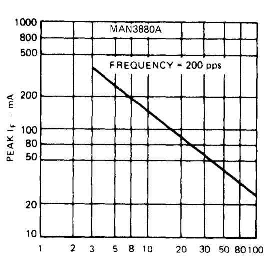


Fig. 19. Max Peak Current vs. Duty Cycle

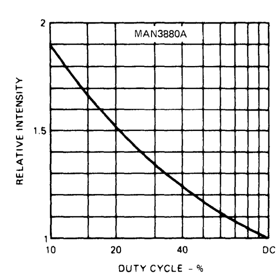


Fig. 20. Luminous Intensity vs. Duty Cycle

MAN3480A MAN3680A MAN78A MAN3880A MAN3980A

ABSOLUTE MAXIMUM RATINGS

	HIGH EFFICIENCY GREEN MAN3480A	RED MAN78A
Power dissipation @ 25°C ambient	600 mW	480 mW
Derate linearly from 50°C	-12 mW/°C	-6.9 mW/°C
Storage and operating temperature	-40°C to +85°C	-40°C to +85°C
Continuous forward current		
Total	240 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
Solder time @ 260°C (Note 4 and 5)	5 sec.	5 sec.

	ORANGE YELLOW HIGH EFFICIENCY RED MAN3680A MAN3880A MAN3980A
Power dissipation @ 25°C ambient	600 mW
Derate linearly from 50°C	-10.3 mW/°C
Storage and operating temperature	-40°C to +85°C
Continuous forward current	
Total	200 mA
Per segment	25 mA
Decimal point	25 mA
Reverse voltage	
Per segment	6.0 V
Decimal point	6.0 V
Solder time @ 260°C (Note 4 and 5)	5 sec.

TYPICAL THERMAL CHARACTERISTICS

GREEN/YELLOW	
Thermal resistance junction to free air Φ_{JA}	160°C/W
Wavelength temperature coefficient (case temp)	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 temp)	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 Fig. 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-inches from the body. Maximum device surface temperature is 140°C.*
5. *For flux removal, Freon TF, Freon TE, Isopropanal 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

HIGH EFFICIENCY RED MAN3900A SERIES

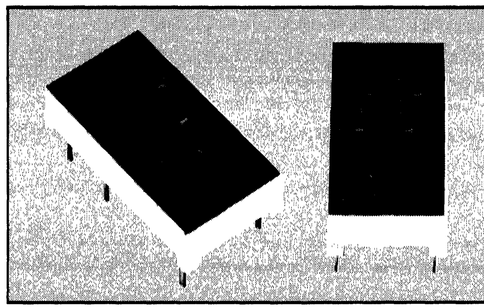
FEATURES

- 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



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, common cathode right hand decimal, and common anode overflow (±1) with 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.

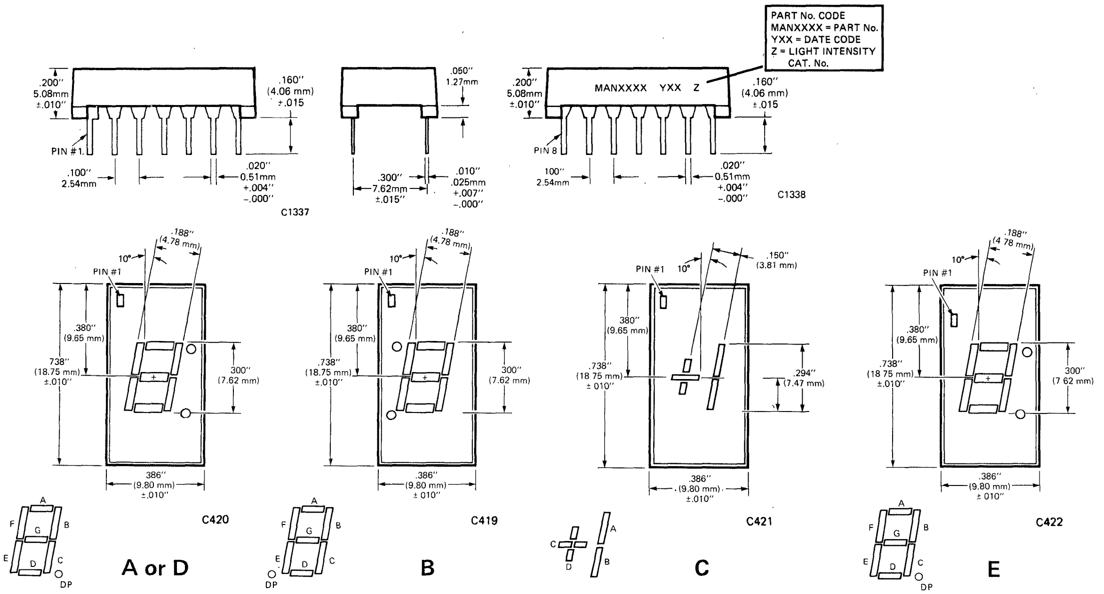
MODEL NUMBERS

PART NO.	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
MAN3930A	High Efficiency Red	C	Common Anode; Overflow ±1	C
MAN3940A	High Efficiency Red	D	Common Cathode; Right Hand Decimal	D
MAN3980A	High Efficiency Red	E	Common Cathode; Right Hand Decimal	E

RECOMMENDED FILTERS

For optimum on and off contrast, one of the following filters or equivalents should be used over the display:

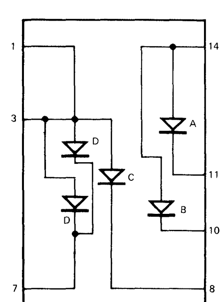
DEVICE TYPE	FILTER
MAN3910A MAN3920A MAN3930A MAN3940A MAN3980A	Panelgraphic Scarlet 65 Homalite 100-1670



PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS				
	A	B	C	D	E
	MAN3910A	MAN3920A	MAN3930A	MAN3940A	MAN3980A
1	Cathode A	Cathode A	Anode C,D	Anode F	Common cathode
2	Cathode F	Cathode F	No pin	Anode G	Anode F
3	Common anode	Common anode	Anode C, D	No pin	Anode G
4	No pin	No pin	No pin	Common cathode	Anode E
5	No pin	No pin	No pin	No pin	Anode D
6	No connection	Cathode D.P.	No pin	Anode E	Common cathode
7	Cathode E	Cathode E	Cathode D	Anode D	Anode D.P.
8	Cathode D	Cathode D	Cathode C	Anode C	Anode C
9	Cathode D.P.	No connection	No connection	Anode D.P.	Anode B
10	Cathode C	Cathode C	Cathode B	No pin	Anode A
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



MAN3930A

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

MAN3910A, 3920A, 3930A, 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

Displays

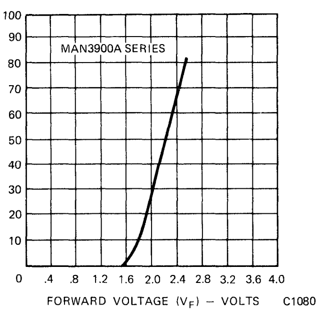


Fig. 1. Forward Current vs. Forward Voltage

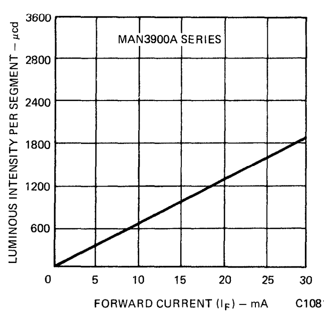


Fig. 2. Luminous Intensity vs. Forward Current

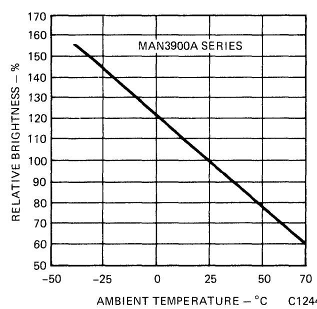


Fig. 3. Luminous Intensity vs. Temperature

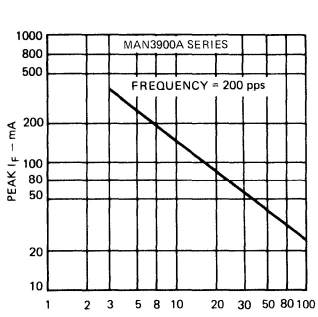


Fig.4. Max Peak Current vs. Duty Cycle

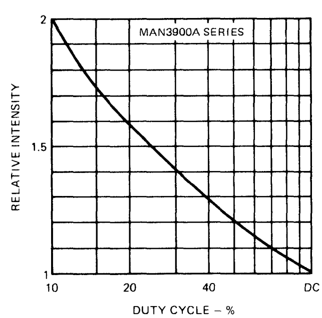


Fig. 5. Luminous Intensity vs. Duty Cycle

MAN3900A SERIES

ABSOLUTE MAXIMUM RATINGS

	MAN3910A MAN3920A MAN3940A MAN3980A	MAN3930A
Power dissipation @ 25°C ambient	600 mW	375 mW
Derate linearly from 50°C	−8.6 mW/°C	−5.36 mW/°C
Storage and operating temperature	−40°C to +85°C	−40°C to +85°C
Continuous forward current		
Total	240 mA	150 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
Solder time @ 260°C (Note 4 and 5)	5 sec.	5 sec.

TYPICAL THERMAL CHARACTERISTICS

HIGH EFFICIENCY RED

Thermal resistance junction to free air Φ_{JA}	160°C/W
Wavelength temperature coefficient (case temp)	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 Fig. 3 is normalized to the brightness at 25°C to indicate the relative luminous intensity over the operating termperature 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-inches 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

HIGH EFFICIENCY GREEN MAN4400A SERIES — RED MAN4700A SERIES
ORANGE MAN4600A SERIES — YELLOW MAN4800A SERIES

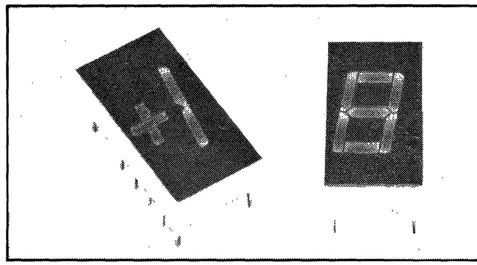
FEATURES

- 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°
- 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



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, orange and yellow, with common anode right hand decimal, common cathode right hand decimal, and universal (CA or CC) overflow (±1) with right hand decimal. They can be mounted in arrays with 0.400-inch (10.16 mm) center to center spacing. The green and yellow 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.

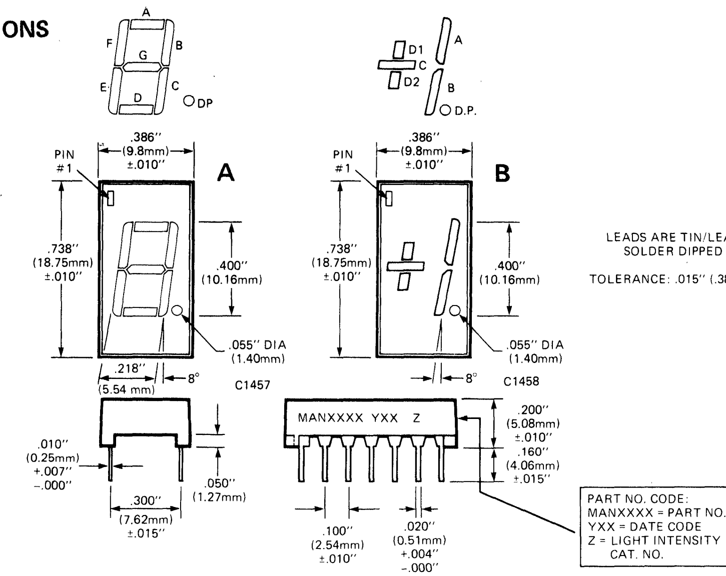
Displays

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN-OUT SPECIFICATION
MAN4405A	Green	Universal (CA or CC) Overflow ±1, Rt. Hand Dec.	B	D
MAN4410A	Green	Common Anode; Right Hand Decimal	A	A
MAN4440A	Green	Common Cathode; Right Hand Decimal	A	C
MAN4605A	Orange	Universal (CA or CC) Overflow ±1, Rt. Hand Dec.	B	D
MAN4610A	Orange	Common Anode; Right Hand Decimal	A	A
MAN4630A	Orange	Common Anode; Overflow ±1, Rt. Hand Dec.	B	B
MAN4640A	Orange	Common Cathode; Right Hand Decimal	A	C
MAN4705A	Red	Universal (CA or CC) Overflow ±1, Rt. Hand Dec.	B	D
MAN4710A	Red	Common Anode; Right Hand Decimal	A	A
MAN4740A	Red	Common Cathode; Right Hand Decimal	A	C
MAN4805A	Yellow	Universal (CA or CC) Overflow ±1, Rt. Hand Dec.	B	D
MAN4810A	Yellow	Common Anode; Right Hand Decimal	A	A
MAN4840A	Yellow	Common Cathode; Right Hand Decimal	A	C

MAN4400A MAN4600A MAN4700A MAN4800A SERIES

PACKAGE DIMENSIONS



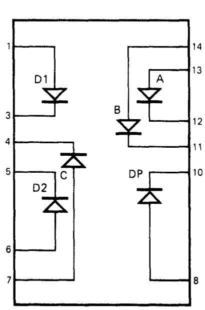
LEADS ARE TIN/LEAD SOLDER DIPPED

TOLERANCE: .015" (.381mm)

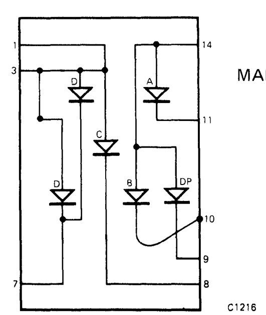
PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS A MAN4410/4610/4710/4810	B MAN4630*	C MAN4440/4640/4740/4840	D MAN4405/4605/4705/4805
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	NC	NC	Anode E	Anode D2
7	Cathode E	Cathode D	Anode D	Anode C
8	Cathode D	Cathode C	Anode C	Anode DP
9	Cathode DP	Cathode DP	Anode DP	No Pin
10	Cathode C	Cathode B	No Pin	Cathode DP
11	Cathode G	Cathode A	NC	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, & DP	Anode A	Anode B

ELECTRICAL SCHEMATIC



MAN4405/4605
4705/4805



MAN4630

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

Device	Parameter	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
MAN4405/4410/4440A	Luminous intensity, Digit Average (See Note 1)	510	2000		µcd	I_F = 10 mA
	Decimal point or Segment "C" or "D" of MAN4405 (See Note 3)	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
MAN4605/4610/4630*/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			
	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_{PK} = 100 mA
	Decimal point		2		Ω	I_{PK} = 100 mA
	Capacitance					
	Segment		35	80		V = 0
	Decimal point		35	80		V = 0
	Reverse current					
	Segment			100	µA	V = 5.0 V
	Decimal point			100	µA	V = 5.0 V
MAN4805/4810/4840A	Luminous intensity, Digit Average (See Note 1)	510	1200		µcd	I_F = 10 mA
	Decimal point (See Note 3)	250	600		µcd	I_F = 10 mA
	Segment "C" or "D" of MAN4805	250	600		nm	
	Peak emission wavelength		585			
	Forward voltage					
	Segment		2.5	3.0	V	I_F = 20 mA
	Decimal point		2.5	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

*The MAN4630 should be replaced by the MAN4605 for new design-ins.

TYPICAL CURVES

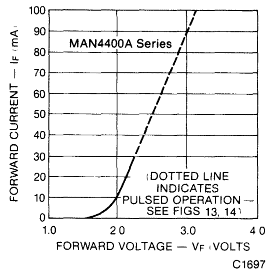


Fig. 1. Forward Current vs. Forward Voltage

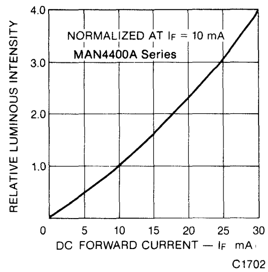


Fig. 2. Luminous Intensity vs. Forward Current

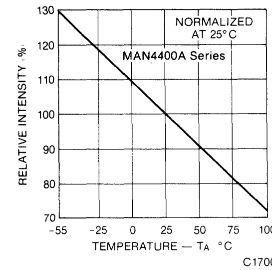


Fig. 3. Luminous Intensity vs. Temperature

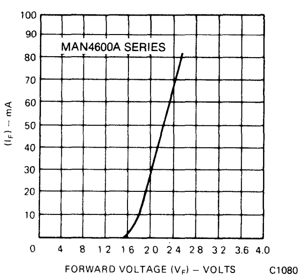


Fig. 4. Forward Current vs. Forward Voltage

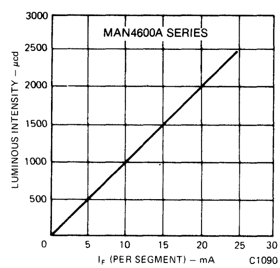


Fig. 5. Luminous Intensity vs. Forward Current

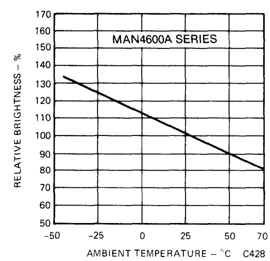


Fig. 6. Luminous Intensity vs. Temperature

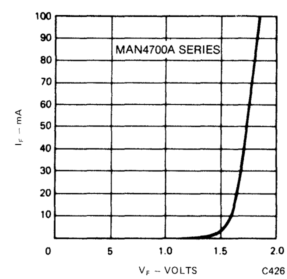


Fig. 7. Forward Current vs. Forward Voltage

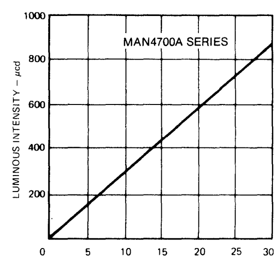


Fig. 8. Luminous Intensity vs. Forward Current

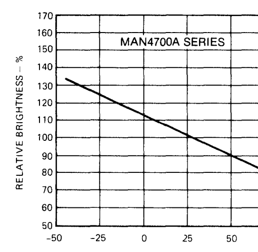


Fig. 9. Luminous Intensity vs. Temperature

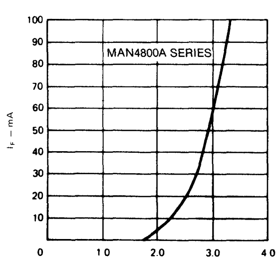


Fig. 10. Forward Current vs. Forward Voltage

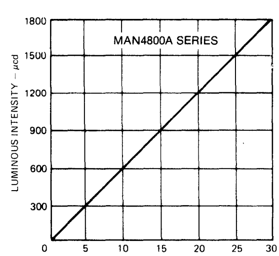


Fig. 11. Luminous Intensity vs. Forward Current

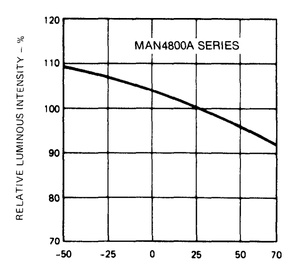


Fig. 12. Luminous Intensity vs. Temperature

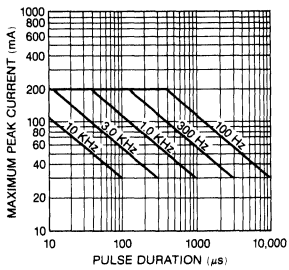


Fig. 13. Max Peak Current vs. Duty Cycle

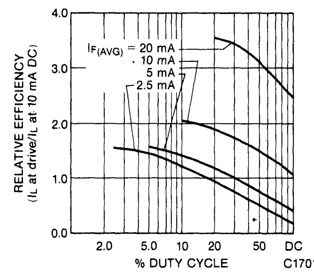


Fig. 14. Luminous Intensity vs. Duty Cycle

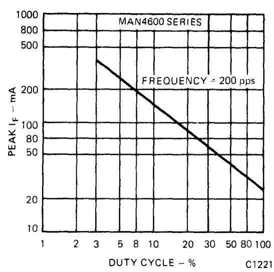


Fig. 15. Max Peak Current vs. Duty Cycle

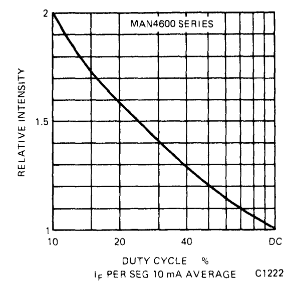


Fig. 16. Luminous Intensity vs. Duty Cycle

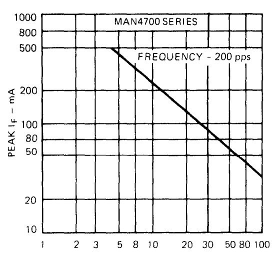


Fig. 17. Max Peak Current vs. Duty Cycle

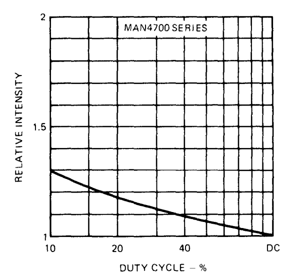


Fig. 18. Luminous Intensity vs. Duty Cycle

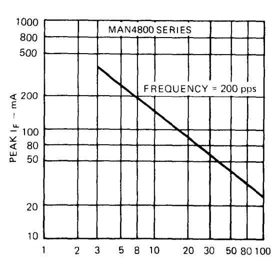


Fig. 19. Max Peak Current vs. Duty Cycle

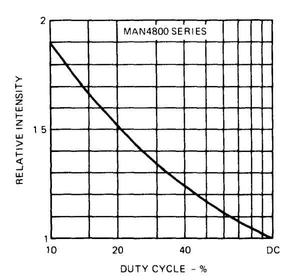


Fig. 20. Luminous Intensity vs. Duty Cycle

Displays

MAN4400A MAN4600A MAN4700A MAN4800A SERIES

ABSOLUTE MAXIMUM RATINGS

	MAN4405A	MAN4410A MAN4440A	MAN4705A	MAN4710A MAN4740A
Power dissipation @ 25°C ambient . . .	450 mW	600 mW	360 mW	480 mW
Derate linearly from 50°C.	-7.5 mW/°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	-40°C to +85°C
Continuous forward current				
Total.	180 mA	240 mA	180 mA	240 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
Solder time @ 260°C (Note 4 and 5)	5 sec.	5 sec.	5 sec.	5 sec.

	MAN4805A	MAN4810A MAN4840A	MAN4605A MAN4630A	MAN4610A MAN4640A
Power dissipation @ 25°C ambient . . .	450 mW	600 mW	450 mW	600 mW
Derate linearly from 50°C.	-7.7 mW/°C	-10.3 mW/°C	-6.4 mW/°C	-8.6 mW/°C
Storage and operating temperature . . .	-40° to +85°C	-40°C to +85°C	-40° to +85°C	-40° to +85°C
Continuous forward current				
Total.	150 mA	200 mA	180 mA	240 mA
Per segment	25 mA	25 mA	30 mA	30 mA
Decimal point.	25 mA	25 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
Solder time @ 260°C (Note 4 and 5)	5 sec.	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
MAN4405A, MAN4410A, MAN4440A	Panelgraphic Green 48	MAN4705A, MAN4710A, MAN4740A	Panelgraphic Red 60 Homalite 100-1605
MAN4605A, MAN4610A, MAN4630A, MAN4640A	Panelgraphic Scarlet 65 Homalite 100-1670	MAN4805A, MAN4810A, MAN4840A	Panelgraphic Yellow 25 or Amber 23 Homalite 100-1720 or 100-1726

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 temp) 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 temp) 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 Fig. 3, 6, 9, and 12 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 .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-inches 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 suffex letter to the part number.*

GENERAL INSTRUMENT

HIGH EFFICIENCY GREEN MAN4480A
ORANGE MAN4680A
RED MAN4780A
YELLOW MAN4880A
HIGH EFFICIENCY RED MAN4980A

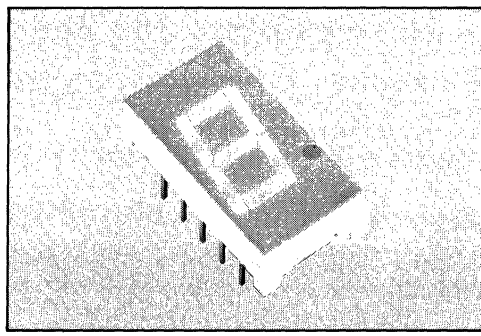
FEATURES

- H.P. 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°
- 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



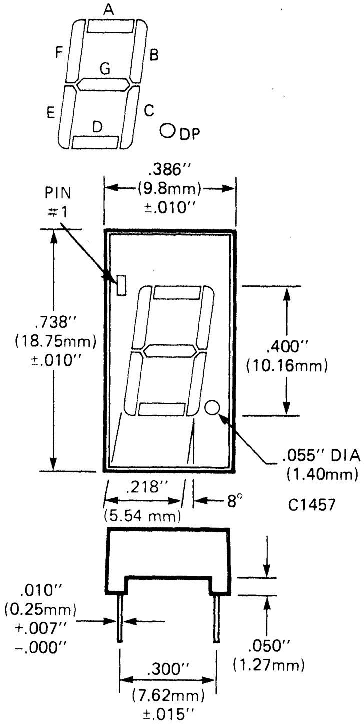
DESCRIPTION

The MAN4480A, MAN4680A, MAN4780A, MAN4880A and MAN4980A are common cathode displays which provide a choice of color of LED displays. They are pin and functional replacements for the 0.300 inch H.P. common cathode displays. This series is complementary to the MAN4400A, MAN4600A, MAN4700A and MAN4900A which are also available in red, yellow, green, orange and high efficiency red. They can be mounted in arrays with 0.400-inch (10.16 mm) center to center spacing. The green and yellow 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.

MODEL NUMBERS

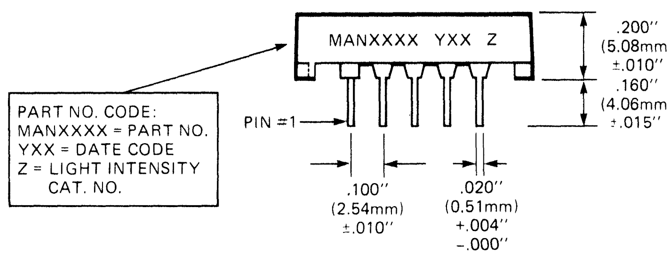
PART NO.	COLOR	DESCRIPTION
MAN4480A	Green	Common Cathode; Right Hand Decimal
MAN4680A	Orange	Common Cathode; Right Hand Decimal
MAN4780A	Red	Common Cathode; Right Hand Decimal
MAN4880A	Yellow	Common Cathode; Right Hand Decimal
MAN4980A	High Efficiency Red	Common Cathode; Right Hand Decimal

PACKAGE DIMENSIONS



LEADS ARE TIN/LEAD
SOLDER DIPPED

TOLERANCE: .015" (.381mm)



C1457

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
MAN4480A	Luminous intensity, Digit Average (See Note 1,3)	510	2000		μcd	I_F = 10 mA
	Decimal point (See Note 3)	710	2700		μcd	I_F = 10 mA
	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
MAN4680A	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
	Peak emission wavelength		630		nm	
	Spectral line half width		40		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
MAN4780A	Luminous intensity, Digit Average (See Note 1)	200	280		μcd	I_F = 10 mA
	Decimal point (See Note 3)	85	140		μcd	I_F = 10 mA
	Peak emission wavelength		660		nm	
	Spectral line half width		20		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_{PK} = 100 mA
	Decimal point		2		Ω	I_{PK} = 100 mA
	Capacitance					
	Segment		35	80		V = 0
	Decimal point		35	80		V = 0
	Reverse current					
	Segment			100	μA	V_R = 5.0 V
	Decimal point			100	μA	V_R = 5.0 V
MAN4880A	Luminous intensity, Digit Average (See Note 1)	510	1200		μcd	I_F = 10 mA
	Decimal point (See Note 3)	250	600		μcd	I_F = 10 mA
	Peak emission wavelength		585		nm	
	Spectral line half width		40		nm	
	Forward voltage					
	Segment		2.5	3.0	V	I_F = 20 mA
	Decimal point		2.5	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
MAN4980A	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

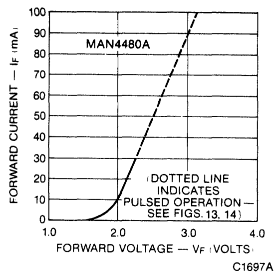


Fig. 1. Forward Current vs. Forward Voltage

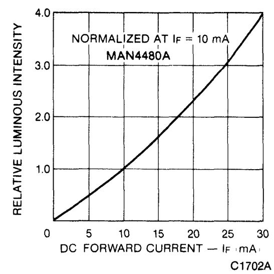


Fig. 2. Luminous Intensity vs. Forward Current

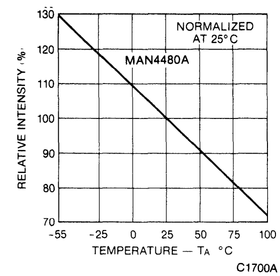


Fig. 3. Luminous Intensity vs. Temperature

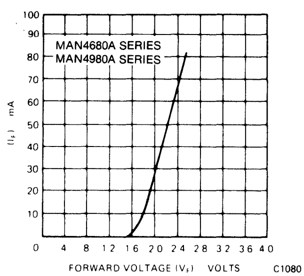


Fig. 4. Forward Current vs. Forward Voltage

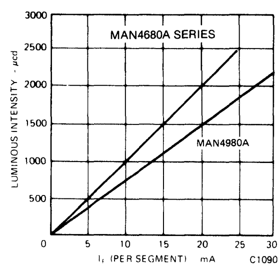


Fig. 5. Luminous Intensity vs. Forward Current

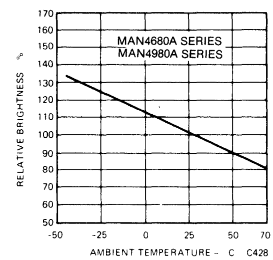


Fig. 6. Luminous Intensity vs. Temperature

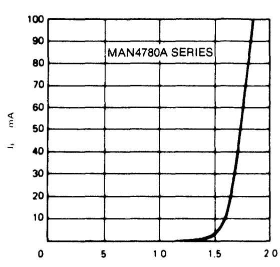


Fig. 7. Forward Current vs. Forward Voltage

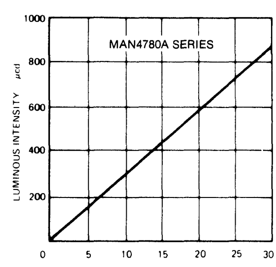


Fig. 8. Luminous Intensity vs. Forward Current

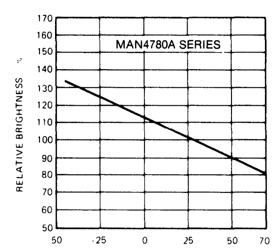


Fig. 9. Luminous Intensity vs. Temperature

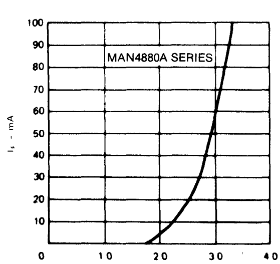


Fig. 10. Forward Current vs. Forward Voltage

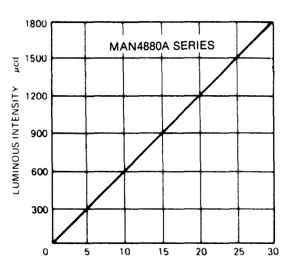


Fig. 11. Luminous Intensity vs. Forward Current

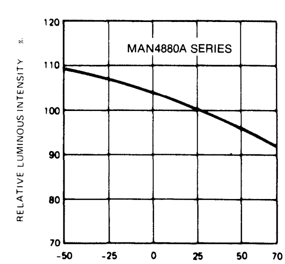


Fig. 12. Luminous Intensity vs. Temperature

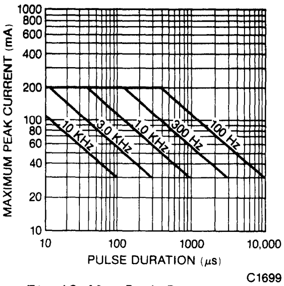


Fig. 13. Max Peak Current vs. Duty Cycle

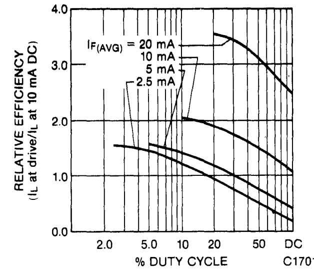


Fig. 14. Luminous Intensity vs. Duty Cycle

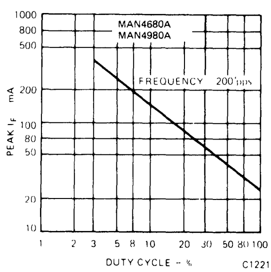


Fig. 15. Max Peak Current vs. Duty Cycle

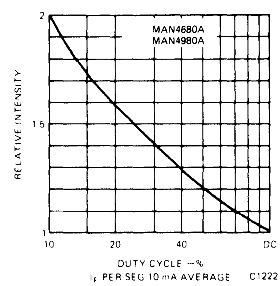


Fig. 16. Luminous Intensity vs. Duty Cycle

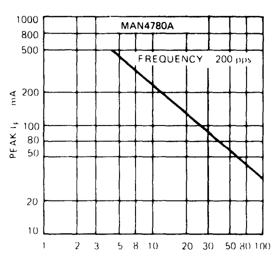


Fig. 17. Max Peak Current vs. Duty Cycle

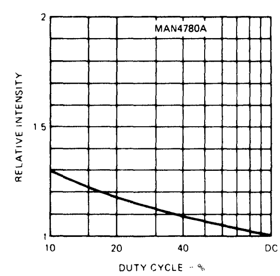


Fig. 18. Luminous Intensity vs. Duty Cycle

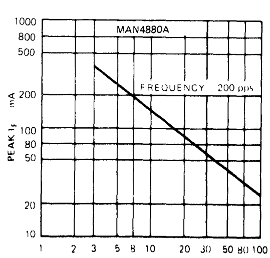


Fig. 19. Max Peak Current vs. Duty Cycle

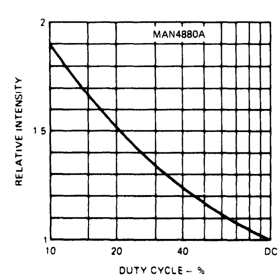


Fig. 20. Luminous Intensity vs. Duty Cycle

ABSOLUTE MAXIMUM RATINGS

	MAN4480A	MAN4680A	MAN4780A
Power dissipation @ 25°C ambient . . .	600 mW	600 mW	480 mW
Derate linearly from 50°C	-12 mW/°C	-8.6 mW/°C	-6.9 mW/°C
Storage and operating temperature . . .	-40°C to +85°C	-40° to +85°C	-40°C to +85°C
Continuous forward current			
Total	240 mA	240 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
Solder time @ 260°C (Note 4 and 5)	5 sec.	5 sec.	5 sec.

	MAN4880A	MAN4980A
Power dissipation @ 25°C ambient . . .	600 mW	600 mW
Derate linearly from 50°C	-10.3 mW/°C	-8.6 mW/°C
Storage and operating temperature . . .	-40°C to +85°C	-40° to +85°C
Continuous forward current		
Total	200 mA	240 mA
Per segment	25 mA	30 mA
Decimal point	25 mA	30 mA
Reverse voltage		
Per segment	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V
Solder time @ 260°C (Note 4 and 5)	5 sec.	5 sec.

TYPICAL THERMAL CHARACTERISTICS

GREEN/YELLOW

Thermal resistance junction to free air Φ_{JA} . . . 160°C/W
Wavelength temperature coefficient (case temp) 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 temp) 1.0 Å/°C
Forward voltage temperature coefficient . . . −2.0 mV/°C

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
MAN4480A	Panelgraphic Green 48	MAN4780A	Panelgraphic Red 60 Homalite 100-1605
MAN4680A	Panelgraphic Scarlet 65 Homalite 100-1670	MAN4880A	Panelgraphic Yellow 25 or Amber 23 Homalite 100-1720 or 100-1726
		MAN4980A	Panelgraphic Red 60

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.

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 Fig. 3, 6, 9, and 12 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 .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-inches 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 suffex letter to the part number.*

0.400-INCH SEVEN SEGMENT DISPLAY

GENERAL INSTRUMENT

HIGH EFFICIENCY RED MAN4900A SERIES

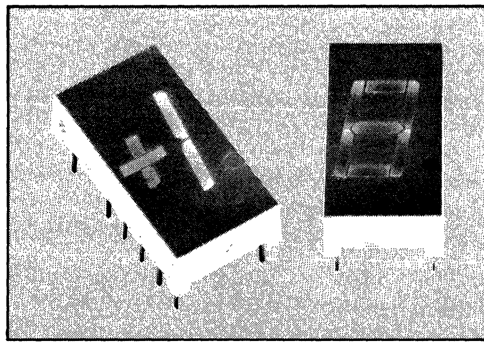
FEATURES

- 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



DESCRIPTION

The MAN4900A Series provides superior brightness high efficiency red LED display. Standard units are also available in red, green, orange and yellow, with common anode right hand decimal, common cathode right hand decimal, and universal (CA or CC) overflow (±1) with 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.

Displays

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN-OUT SPECIFICATION
MAN4905A	Hi. Eff. Red	Universal (CA or CC) Overflow ±1, Rt. Hand Dec.	B	D
MAN4910A	Hi. Eff. Red	Common Anode; Right Hand Decimal	A	A
MAN4940A	Hi. Eff. Red	Common Cathode; Right Hand Decimal	A	C
MAN4980A	Hi. Eff. Red	Common Cathode; Right Hand Decimal	C	E

RECOMMENDED FILTERS

For optimum on and off contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER
MAN4905A MAN4910A MAN4940A MAN4980A	Panelgraphic Scarlet 65 Homalite 100-1670

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

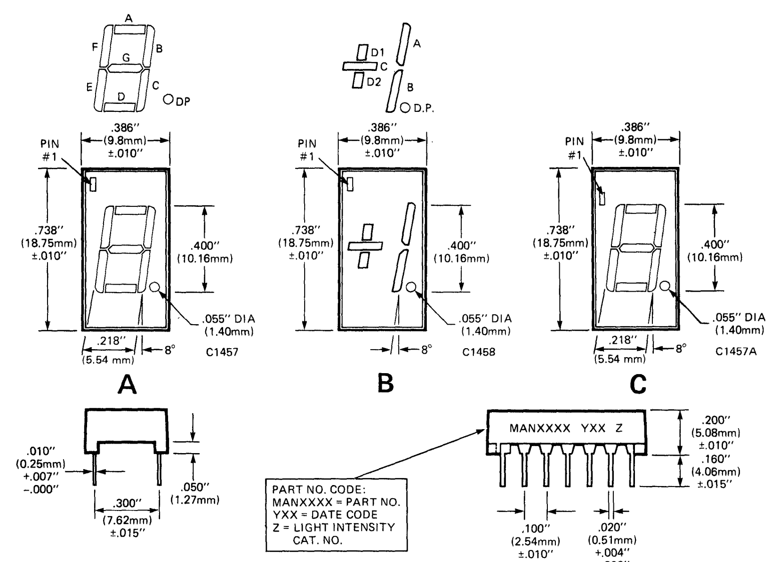
MAN4905A/4910A/4940A/4980A

	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)	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	C MAN4940A	D MAN4905A	E MAN4980A
1	Cathode A	Anode F	Anode D1	Common Cathode
2	Cathode F	Anode G	No Pin	Anode F
3	Common Anode	No Pin	Cathode D1	Anode G
4	No Pin	Common Cathode	Cathode C	Anode E
5	No Pin	No Pin	Cathode D2	Anode D
6	No Connection	Anode E	Anode D2	Common Cathode
7	Cathode E	Anode D	Anode C	Anode DP
8	Cathode D	Anode C	Anode DP	Anode C
9	Cathode DP	Anode DP	No Pin	Anode B
10	Cathode C	No Pin	Cathode DP	Anode A
11	Cathode G	No Connection	Cathode B	
12	No Pin	Common Cathode	Cathode A	
13	Cathode B	Anode B	Anode A	
14	Common Anode	Anode A	Anode B	

TYPICAL CURVES

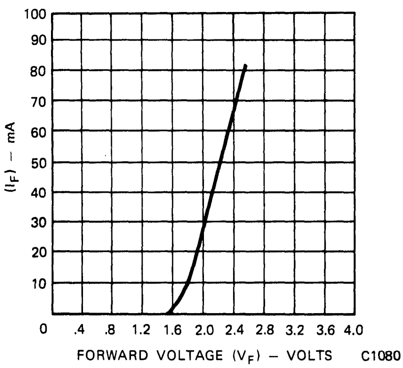


Fig. 1. Forward Current vs. Forward Voltage

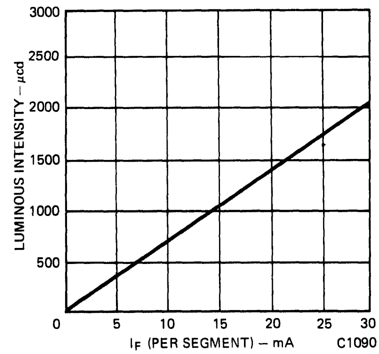


Fig. 2. Luminous Intensity vs. Forward Current

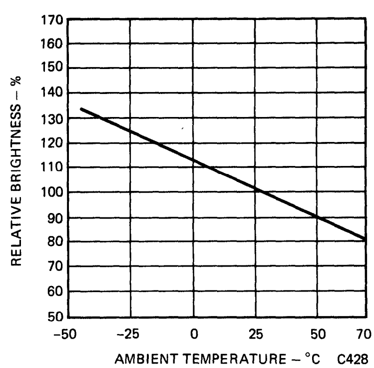


Fig. 3. Luminous Intensity vs. Temperature

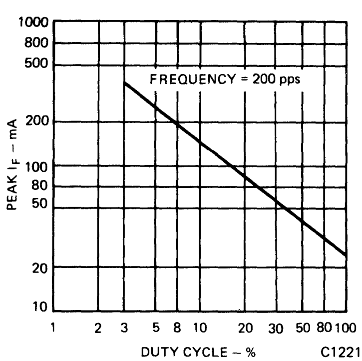


Fig. 4. Max Peak Current vs. Duty Cycle

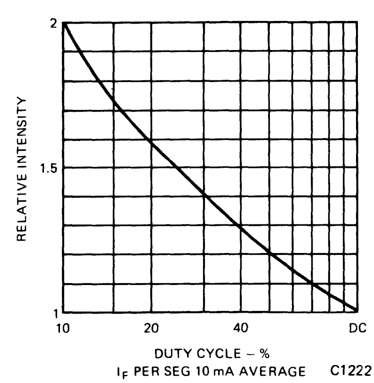
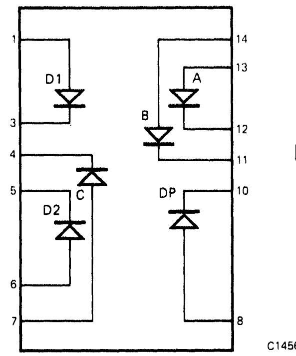


Fig. 5. Luminous Intensity vs. Duty Cycle

ELECTRICAL SCHEMATIC



MAN4905A

ABSOLUTE MAXIMUM RATINGS

	MAN4905A	MAN4910A MAN4940A MAN4980A
Power dissipation @ 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° to +85°C	-40° 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
Solder time @ 260°C (Note 4 and 5)	5 sec.	5 sec.

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Φ_{JA}	160°C/W
Wavelength temperature coefficient (case temp)	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 Fig. 3 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 .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-inches 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

LOW CURRENT HIGH EFFICIENCY RED

MAN 6100 SERIES

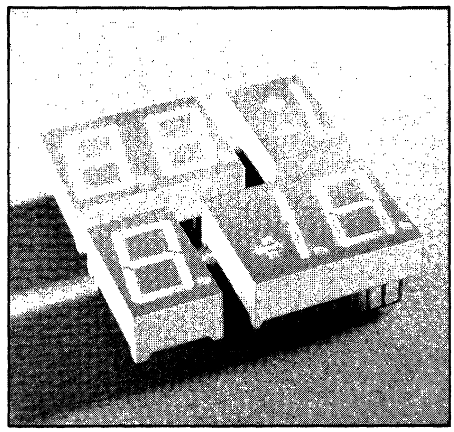
FEATURES

- 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



DESCRIPTION

The MAN 6100 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 point and are available in common anode or common cathode configuration. This device has a grey face and clear segments.

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN-OUT SPECIFICATION	FOR PACKAGE OUTLINE AND PINOUT CONFIGURATION, SEE SPECIFICATION
MAN6110	Hi. Eff. Red	2 Digit; Common Anode; Rt. Hand Decimal Point	A	A	MAN6910
MAN6130	Hi. Eff. Red	1½ Digit; Common Anode; Overflow ±1.8; Rt. Hand Decimal Point	B	B	MAN6930
MAN6140	Hi. Eff. Red	2 Digit; Common Cathode; Rt. Hand Decimal Point	A	C	MAN6940
MAN6150	Hi. Eff. Red	1½ Digit; Common Cathode; Overflow ±1.8; Rt. Hand Decimal Point	B	D	MAN6950
MAN6160	Hi. Eff. Red	Single Digit; Common Anode; Rt. Hand Decimal Point	C	E	MAN6960
MAN6175	Hi. Eff. Red	Single Digit; Common Anode; Overflow ±1.0; Rt. Hand Decimal	D	G	MAN6975
MAN6180	Hi. Eff. Red	Single Digit; Common Cathode; Rt. Hand Decimal Point	C	F	MAN6980
MAN6195	Hi. Eff. Red	Single Digit; Common Cathode; Overflow ±1.0; Rt. Hand Decimal Point	D	H	MAN6995

MAN 6100 SERIES

ABSOLUTE MAXIMUM RATINGS

	6110 6140	6130 6150	6160 6180	6175 6195
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
Solder time at 260° C (Notes 4 and 5)	5 sec.	5 sec.	5 sec.	5 sec.

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

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous intensity					
Digit average	200			μcd	$I_F = 2$ mA
Decimal point, "+", or "–"	100			μcd	$I_F = 2$ mA
Peak emission wavelength		635		nm	
Spectral line half width		40		nm	
Forward voltage					
Segment		1.8	2.2	V	$I_F = 2$ mA
Decimal point		1.8	2.2	V	$I_F = 2$ mA
Dynamic resistance					
Segment				Ω	$I_F = 2$ mA
Decimal point				Ω	$I_F = 2$ mA
Capacitance					
Segment				pF	$V = 0$
Decimal point				pF	$V = 0$
Reverse current					
Segment			100	μA	$V_R = 3$ V
Decimal point			100	μA	$V_R = 3$ V

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Θ_{JA} . . . . . 300° C/W
Wavelength temperature coefficient (case temp.) . . . . . 1.0 Å/C
Forward voltage temperature coefficient . . . . . -2.0 mV/° C

DATA SHEET CLASSIFICATIONS

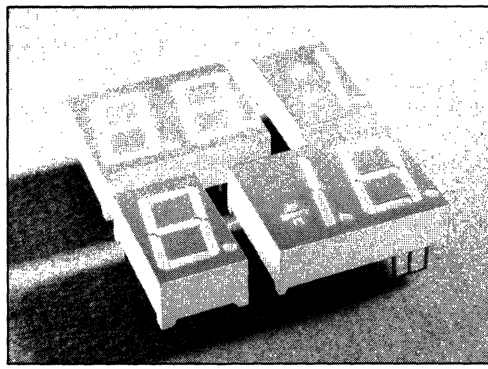
CLASSIFICATION	PRODUCT STAGE	DISCLAIMERS
Preview DATA SHEET	Formative or Design	This document contains the design specifications for product under development. Specifications may be changed in any manner without notice.
Advance Information DATA SHEET	Sampling or Pre-Production	This is advanced information,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

GENERAL INSTRUMENT

HIGH EFFICIENCY GREEN MAN6400 SERIES

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 & assembly

APPLICATIONS
For industrial and consumer applications such as:
- Digital readout displays
- Instrument panels
- Point-of-sale equipment
- Digital clocks
- TV and radios



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. 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 point and are available in common anode or common cathode configuration. This device has a grey face and clear segment to enhance on/off contrast.

MODEL NUMBERS

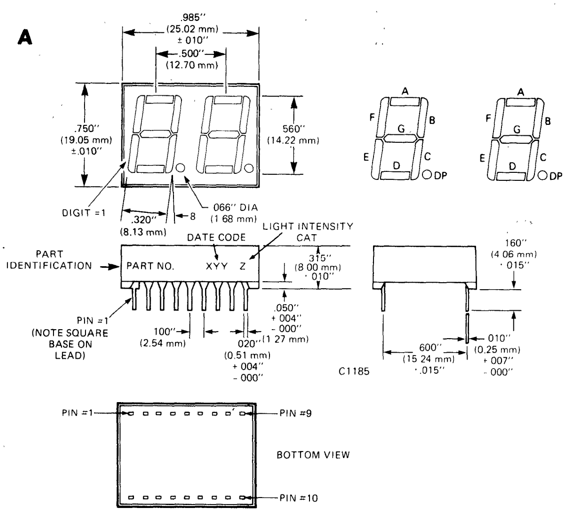
PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN-OUT SPECIFICATION
MAN6410	Hi. Eff. Green	2 Digit, Common Anode, Right Hand Decimal Point	A	A
MAN6430	Hi. Eff. Green	1½ Digit, Common Anode, Overflow ± 1.8, Right Hand Decimal Point	B	B
MAN6440	Hi. Eff. Green	2 Digit, Common Cathode, Right Hand Decimal Point	A	C
MAN6450	Hi. Eff. Green	1½ Digit, Common Cathode, Overflow ± 1.8, Right Hand Decimal Point	B	D
MAN6460	Hi. Eff. Green	Single Digit, Common Anode, Right Hand Decimal Point	C	E
MAN6475	Hi. Eff. Green	Single Digit, Common Anode, Overflow ± 1, Right Hand Decimal Point	D	G
MAN6480	Hi. Eff. Green	Single Digit, Common Cathode, Right Hand Decimal Point	C	F
MAN6495	Hi. Eff. Green	Single Digit, Common Cathode, Overflow ± 1, Right Hand Decimal Point	D	H

FILTER RECOMMENDATIONS
For optimum on and off contrast, one of the following filters or equivalents should be used over the display:

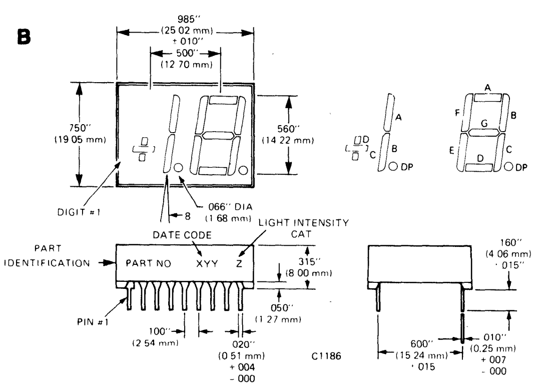
MAN6400 Series
- Panelgraphic Green 48
- Homalite 100-1440 Green
- Panelgraphic Grey 10
- Homalite 100-1266 Grey

PACKAGE DIMENSIONS

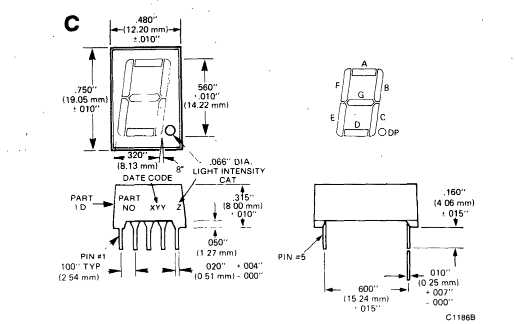
A

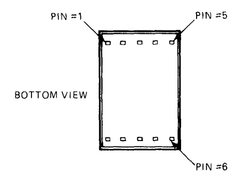


B



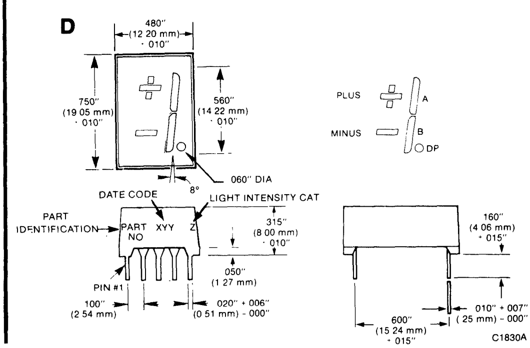
C





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.

D



PIN CONNECTIONS

PIN No.	ELECTRICAL CONNECTIONS							
	A MAN6410	B MAN6430	C MAN6440	D MAN6450	E MAN6460	F MAN6480	G MAN6475	H MAN6495
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

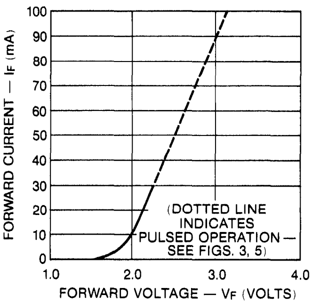


Fig. 1. Forward Current vs. Forward Voltage

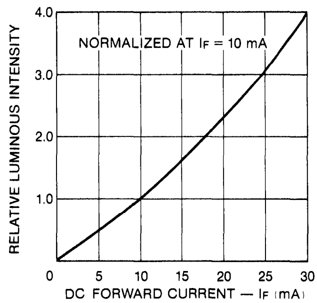


Fig. 2. Relative Luminous Intensity vs. DC Forward Current

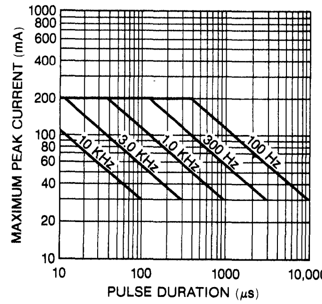


Fig. 3. Maximum Peak Current vs. Pulse Duration

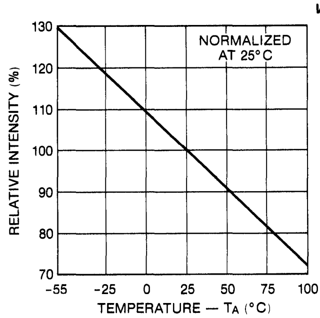


Fig. 4. Relative Luminous Intensity vs. Temperature

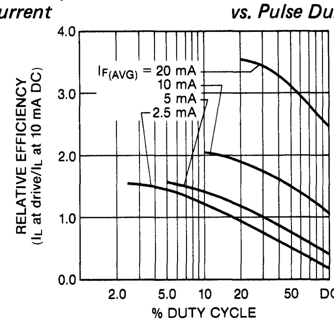
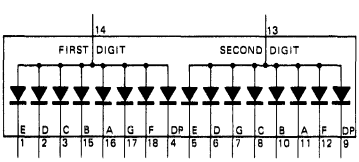
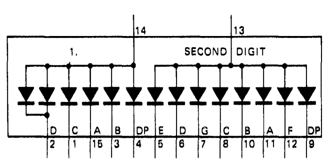


Fig. 5. Relative Efficiency vs. Duty Cycle

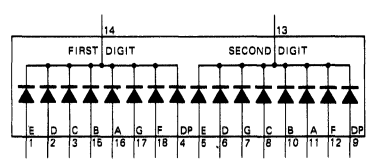
INTERNAL CONNECTIONS



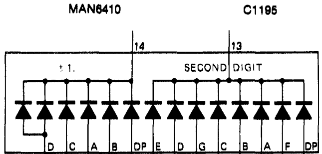
MAN6410 C1195



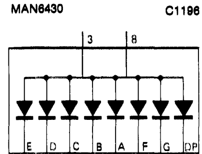
MAN6430 C1196



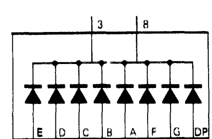
MAN6440 C1197



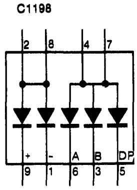
MAN6450 C1198



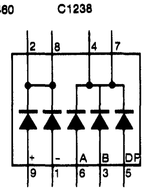
MAN6460 C1238



MAN6480 C1239



MAN6475 C1828



MAN6495 C1829

Displays

ABSOLUTE MAXIMUM RATINGS

	MAN6410 MAN6440	MAN6430 MAN6450	MAN6460 MAN6480	MAN6475 MAN6495
Power dissipation at 25° C ambient	1140 mW	1000 mW	570 mW	360 mW
Derate linearly from 50° C	-24 mW/° C	-21 mW/° C	-12 mW/° C	-8 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 diode	30 mA	30 mA	30 mA	30 mA
Reverse voltage				
Per diode	6.0 V	6.0 V	6.0 V	6.0 V
Solder time at 260° C (Notes 2 and 3)	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 Notes 1, 4)	510	2100		μcd	$I_F = 10$ mA
Plus or minus segment (6430/6450/6475/6495)	260	1100		μcd	$I_F = 10$ mA
Pulsed luminous intensity, digit average	710	2900		μcd	$I_F = 60$ mA peak, 1:6 DF
Plus or minus segment (6430/6450/6475/6495)	360	1450		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 Fig.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 Θ_{JA} .... 160° C/W
Wavelength temperature coefficient (case temperature) .... 1.0 Å/° C
Forward voltage temperature coefficient .... -1.4 mV/° C

NOTES

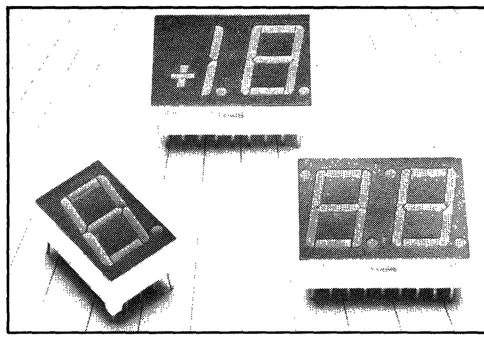
1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *Leads immersed to 1/16" from the body of the device. Maximum unit surface temperature is 140° C.*
3. *For flux removal, use Freon TF, Freon TE, Isoproponal, or water 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

ORANGE MAN6600 SERIES

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 & assembly



APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point-of-sale equipment
- Digital clocks
- TV and radios

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 point and are available in common anode or common cathode configuration. Units are constructed with orange face and segment color.

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN-OUT SPECIFICATION
MAN6610	Orange	2 Digit, Common Anode, Right Hand Decimal Point	A	A
MAN6630	Orange	1½ Digit, Common Anode, Overflow ± 1.8, Right Hand Decimal Point	B	B
MAN6640	Orange	2 Digit, Common Cathode, Right Hand Decimal Point	A	C
MAN6650	Orange	1½ Digit, Common Cathode, Overflow ± 1.8, Right Hand Decimal Point	B	D
MAN6660	Orange	Single Digit, Common Anode, Right Hand Decimal Point	C	E
MAN6675	Orange	Single Digit, Common Anode, Overflow ± 1, Right Hand Decimal Point	D	G
MAN6680	Orange	Single Digit, Common Cathode, Right Hand Decimal Point	C	F
MAN6695	Orange	Single Digit, Common Cathode, Overflow ± 1, Right Hand Decimal Point	D	H

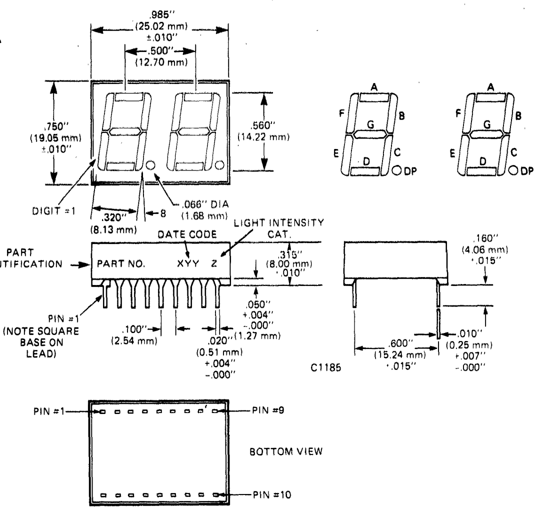
FILTER RECOMMENDATIONS

For optimum on and off contrast, one of the following filters or equivalents should be used over the display:

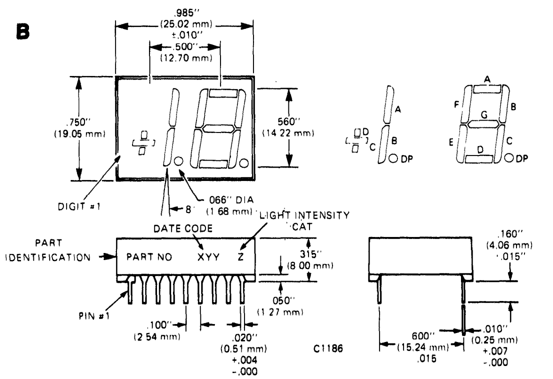
MAN6600 Series	Panelgraphic Scarlet 65
	Homalite 100-1670

PACKAGE DIMENSIONS

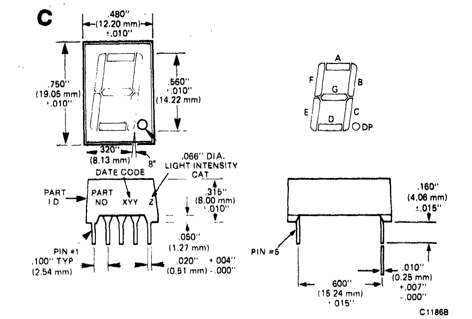
A

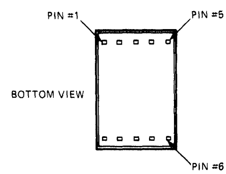


B



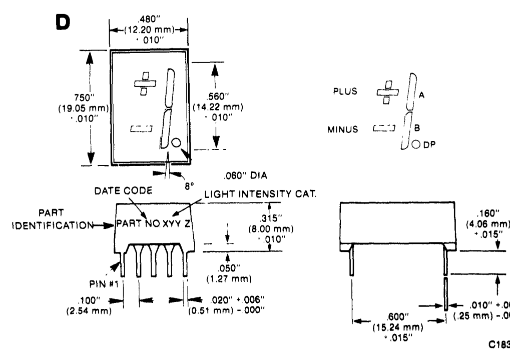
C





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.

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

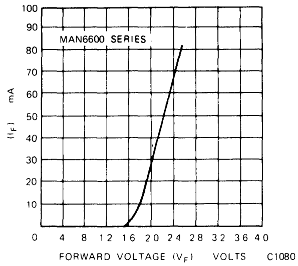


Fig. 1. Forward Current vs. Forward Voltage

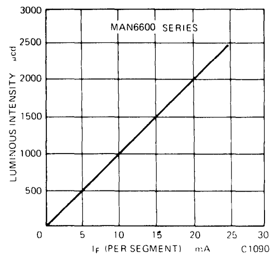


Fig. 2. Luminous Intensity vs. Forward Current

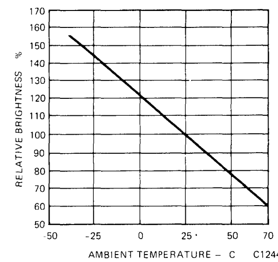


Fig. 3. Luminous Intensity vs. Temperature (see Note 2)

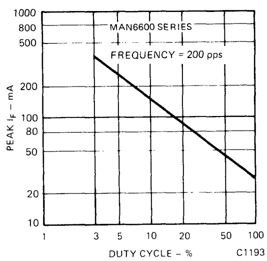


Fig. 4. Max Peak Current vs. Duty Cycle

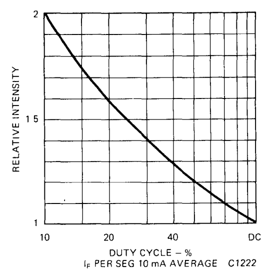
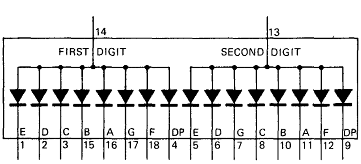


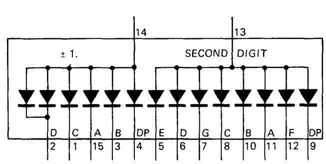
Fig. 5. Luminous Intensity vs. Duty Cycle

Displays

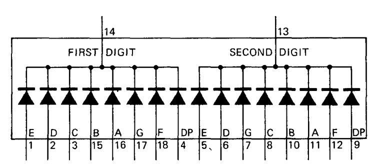
INTERNAL CONNECTIONS



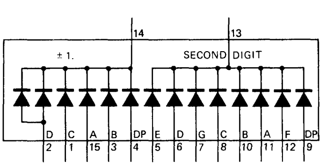
MAN6610 C1195



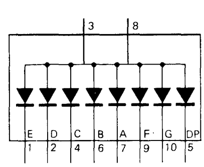
MAN6630 C1196



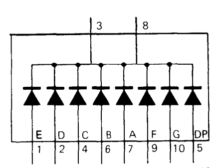
MAN6640 C1197



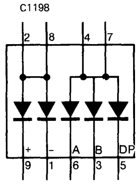
MAN6650 C1198



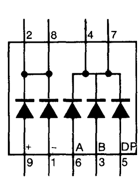
MAN6660 C1238



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
Solder time at 260° C (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	1300		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 Θ_{JA}	160° C/W
Wavelength temperature coefficient (case temperature)	1.0 Å/° C
Forward voltage temperature coefficient	-2.0 mV/° C

NOTES

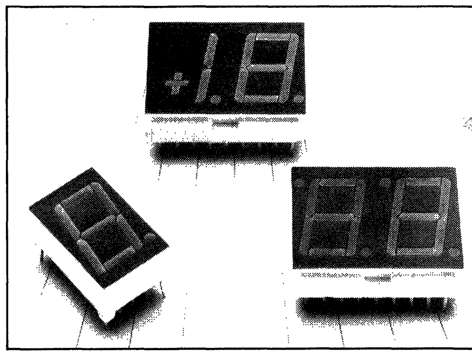
1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *The curve in Fig. 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" from the body of the device. Maximum unit surface temperature is 140° C.*
4. *For flux removal, use Freon TF, Freon TE, Isoproponal, or water 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

RED MAN6700 SERIES

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 & assembly



APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point-of-sale equipment
- Digital clocks
- TV and radios

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, single digits, and single polarity/overflow digits. All models have right hand decimal point and are available in common anode or common cathode configuration. Units are constructed with black face and red segment color.

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN-OUT SPECIFICATION
MAN6710	Red	2 Digit, Common Anode, Right Hand Decimal Point	A	A
MAN6730	Red	1½ Digit, Common Anode, Overflow ± 1.8, Right Hand Decimal Point	B	B
MAN6740	Red	2 Digit, Common Cathode, Right Hand Decimal Point	A	C
MAN6750	Red	1½ Digit, Common Cathode, Overflow ± 1.8, Right Hand Decimal Point	B	D
MAN6760	Red	Single Digit, Common Anode, Right Hand Decimal Point	C	E
MAN6775	Red	Single Digit, Common Anode, Overflow ± 1, Right Hand Decimal Point	D	G
MAN6780	Red	Single Digit, Common Cathode, Right Hand Decimal Point	C	F
MAN6795	Red	Single Digit, Common Cathode, Overflow ± 1, Right Hand Decimal Point	D	H

FILTER RECOMMENDATIONS

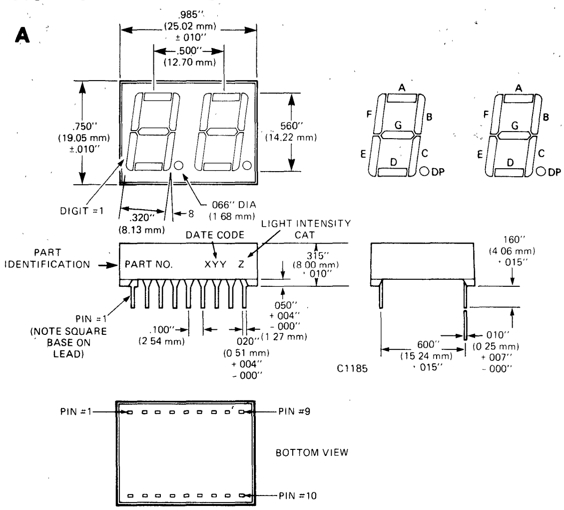
For optimum on and off contrast, one of the following filters or equivalents should be used over the display:

MAN6700 Series	Panelgraphic Red 60 Homalite 100-1605

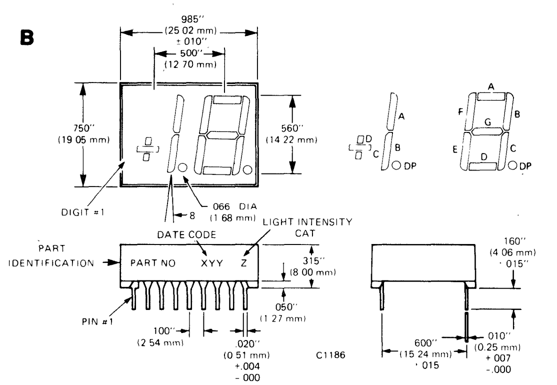
MAN6700 SERIES

PACKAGE DIMENSIONS

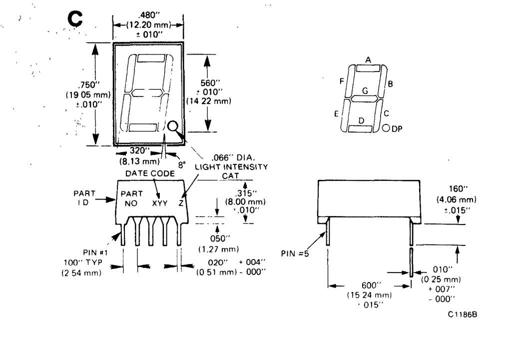
A

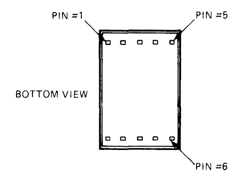


B



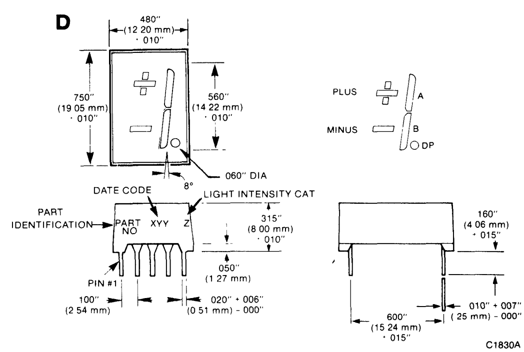
C





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.

D



PIN CONNECTIONS

PIN	ELECTRICAL CONNECTIONS							
No.	A MAN6710	B MAN6730	C MAN6740	D MAN6750	E MAN6760	F MAN6780	G MAN6775	H MAN6795
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

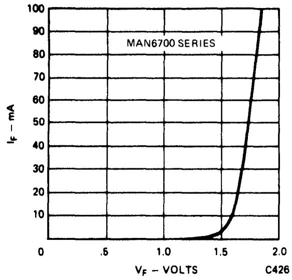


Fig. 1. Forward Current vs. Forward Voltage

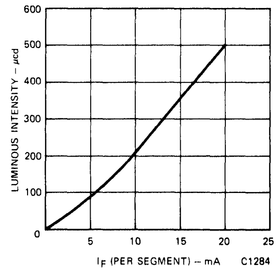


Fig. 2. Luminous Intensity vs. Forward Current

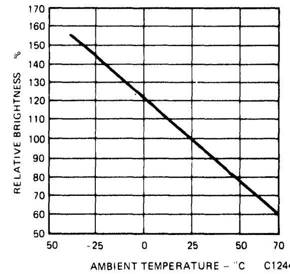


Fig. 3. Luminous Intensity vs. Temperature (See Note 2)

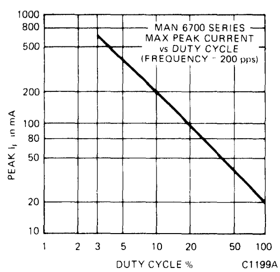


Fig. 4. Max Peak Current vs. Duty Cycle

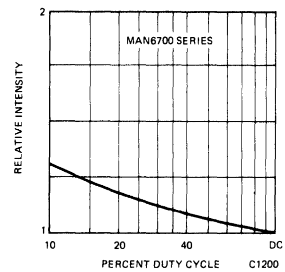
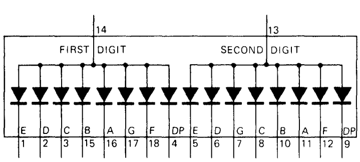
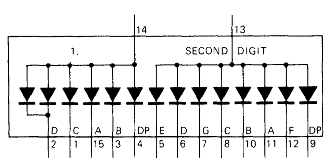


Fig. 5. Luminous Intensity vs. Duty Cycle

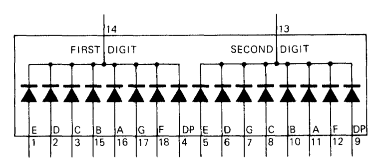
INTERNAL CONNECTIONS



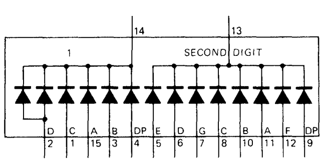
MAN6710 C1195



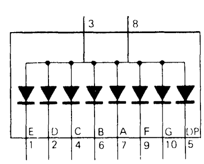
MAN6730 C1196



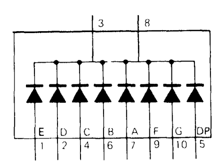
MAN6740 C1197



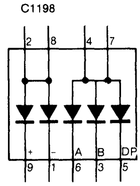
MAN6750 C1198



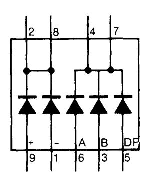
MAN6760 C1238



MAN6780 C1239



MAN6775
C1828



MAN6795
C1829

ABSOLUTE MAXIMUM RATINGS

	MAN6710 MAN6740	MAN6730 MAN6750	MAN6760 MAN6780	MAN6775 MAN6795
Power dissipation at 25° C ambient	960 mW	840 mW	480 mW	300 mW
Derate linearly from 50° C	-13.7 mW/° C	-12.0 mW/° C	-6.9 mW/° C	-4.3 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
Solder time at 260° C (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)	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_{PK} = 100 mA
Decimal point		2		Ω	I_{PK} = 100 mA
Capacitance					
Segment		35		pF	V = 0
Decimal point		35		pF	V = 0
Reverse current					
Segment			100	μA	V_R = 5.0V
Decimal point			100	μA	V_R = 5.0V
Segment C or D of "+" (6730/6750)			100	μA	V_R = 5.0V

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Θ_{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 Fig. 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" from the body of the device. Maximum unit surface temperature is 140° C.*
4. *For flux removal, use Freon TF, Freon TE, Isoproponal, or water 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

YELLOW MAN6800 SERIES

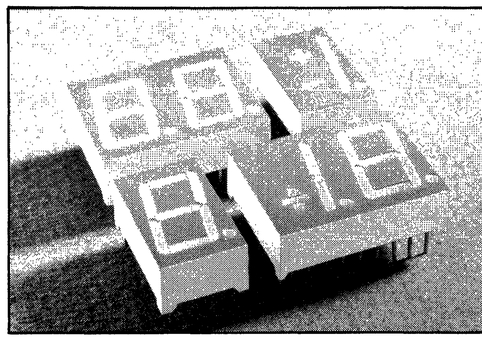
FEATURES

- Yellow 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
- Wide angle viewing . . . 150°
- High brightness maximized for high "on contrast
- Grey face for improved "off" contrast
- End stackable for multiple digit displays
- Categorized for luminous intensity (see Note 6)
- Two-digit package simplifies alignment & assembly
- Solid state reliability—long operation life
- Rugged encapsulated plastic construction
- Directly compatible with integrated circuits

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point-of-sale equipment
- Digital clocks
- TV and radios



DESCRIPTION

The MAN6800 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 point and are available in common anode or common cathode configuration. The display on-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 metal lead frame, plastic reflector cap with epoxy-filled segments and back.

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN-OUT SPECIFICATION
MAN6810	Yellow	2 Digit, Common Anode, Right Hand Decimal Point	A	A
MAN6830	Yellow	1½ Digit, Common Anode, Overflow ± 1.8, Right Hand Decimal Point	B	B
MAN6840	Yellow	2 Digit, Common Cathode, Right Hand Decimal Point	A	C
MAN6850	Yellow	1½ Digit, Common Cathode, Overflow ± 1.8, Right Hand Decimal Point	B	D
MAN6860	Yellow	Single Digit, Common Anode, Right Hand Decimal Point	C	E
MAN6875	Yellow	Single Digit, Common Anode, Overflow ± 1, Right Hand Decimal Point	D	G
MAN6880	Yellow	Single Digit, Common Cathode, Right Hand Decimal Point	C	F
MAN6895	Yellow	Single Digit, Common Cathode, Overflow ± 1, Right Hand Decimal Point	D	H

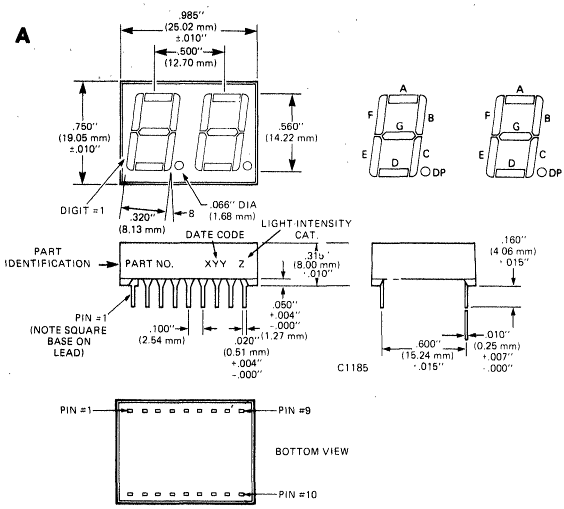
FILTER RECOMMENDATIONS

For optimum on and off contrast, one of the following filters or equivalents should be used over the display:

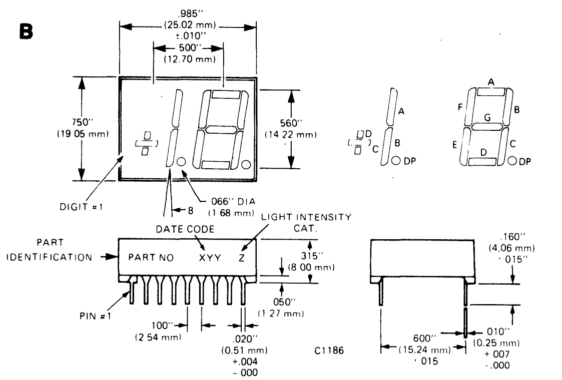
MAN6800 Series	Panelgraphic Yellow 25 or Amber 23 Panelgraphic Neutral Density Filter, Gray 10 Homalite 100-1720 or 1726

PACKAGE DIMENSIONS

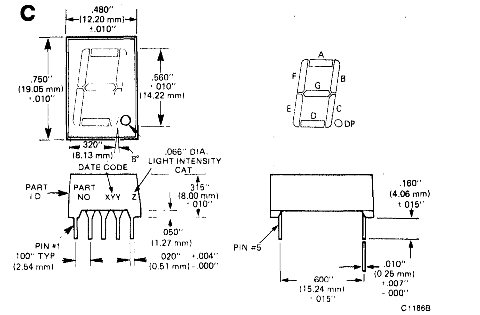
A

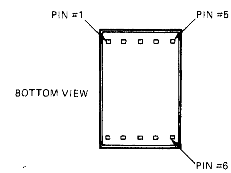


B



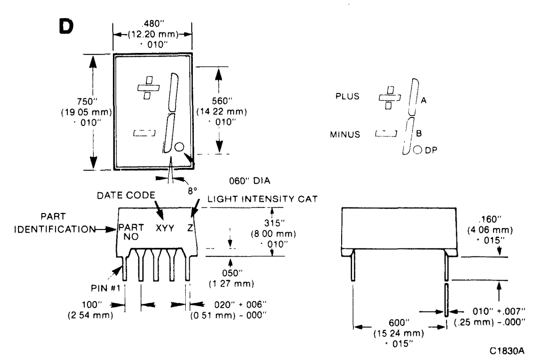
C





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.

D



PIN CONNECTIONS

PIN No.	ELECTRICAL CONNECTIONS							
	A MAN6810	B MAN6830	C MAN6840	D MAN6850	E MAN6860	F MAN6880	G MAN6875	H MAN6895
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

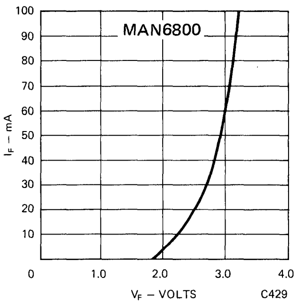


Fig. 1. Forward Current vs. Forward Voltage

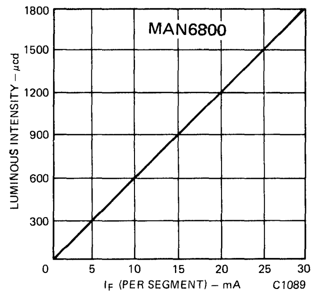


Fig. 2. Luminous Intensity vs. Forward Current

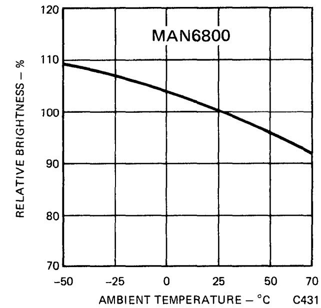


Fig. 3. Luminous Intensity vs. Temperature

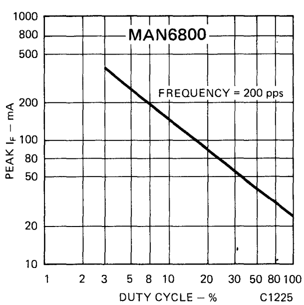


Fig. 4. Max Peak Current vs. Duty Cycle

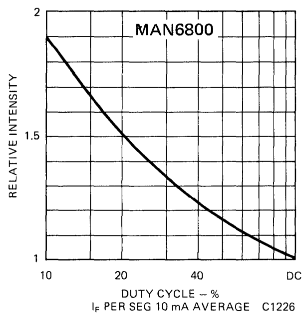


Fig. 5. Luminous Intensity vs. Duty Cycle

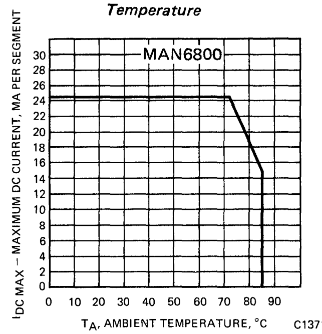
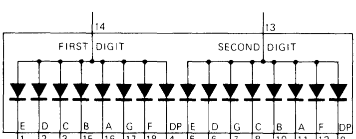
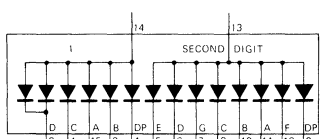


Fig. 6. Maximum DC Current vs. Temperature

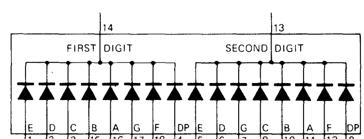
INTERNAL CONNECTIONS



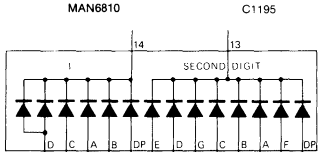
MAN6810 C1195



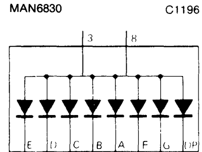
MAN6830 C1196



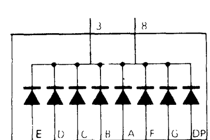
MAN6840 C1197



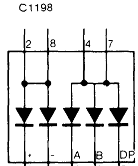
MAN6850 C1198



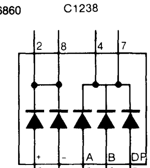
MAN6860 C1238



MAN6860 C1239



MAN6875 C1828



MAN6895 C1829

ABSOLUTE MAXIMUM RATINGS

	MAN6810 MAN6840	MAN6830 MAN6850	MAN6860 MAN6880	MAN6875 MAN6895
Power dissipation @ 25°C ambient	1200 mW	1050 mW	600 mW	375 mW
Derate linearly from 50°C	-20.5 mW/°C	-18.0 mW/°C	-10.3 mW/°C	-6.4 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	400 mA	350 mA	200 mA	125 mA
Per segment	25 mA	25 mA	25 mA	25 mA
Decimal point	25 mA	25 mA	25 mA	25 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
Solder time @ 260°C (Note 4)	5 sec.	5 sec.	5 sec.	5 sec.
Peak current per segment I_{max} (see Fig. 4)	—	—	—	—

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 6)	500			μcd	$I_F = 10$ mA
Decimal point (see Note 5)	200			μcd	$I_F = 10$ mA
Segment of "+" or "–" (6830/6850/6875/6895)	200			μcd	$I_F = 10$ mA
Peak emission wavelength		585		nm	
Spectral line half width		35		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	$V_R = 3.0$V
Decimal point			100	μA	$V_R = 3.0$V
Luminous intensity ratio I_L			2:1		$I_F = 10$ mA

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Θ_{JA}	160°C/W
Wavelength temperature coefficient (case temperature)	1.0 Å/°C
Forward voltage temperature coefficient	-1.5 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 Fig. 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" from the body of the device. Maximum unit surface temperature is 140° C.*
4. *For flux removal, use Freon TF, Freon TE, Isoproponal, or water 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

HIGH EFFICIENCY RED MAN6900 SERIES

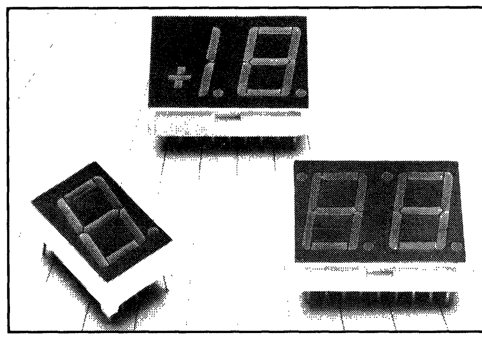
FEATURES

- 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 & assembly

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point-of-sale equipment
- Digital clocks
- TV and radios



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, single digits, and single polarity/overflow digits. All models have right hand decimal point and are available in common anode or common cathode configuration. This device has a red face and red segments.

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN-OUT SPECIFICATION
MAN6910	Hi. Eff. Red	2 Digit, Common Anode, Right Hand Decimal Point	A	A
MAN6930	Hi. Eff. Red	1½ Digit, Common Anode, Overflow ± 1.8, Right Hand Decimal Point	B	B
MAN6940	Hi. Eff. Red	2 Digit, Common Cathode, Right Hand Decimal Point	A	C
MAN6950	Hi. Eff. Red	1½ Digit, Common Cathode, Overflow ± 1.8, Right Hand Decimal Point	B	D
MAN6960	Hi. Eff. Red	Single Digit, Common Anode, Right Hand Decimal Point	C	E
MAN6975	Hi. Eff. Red	Single Digit, Common Anode, Overflow ± 1, Right Hand Decimal Point	D	G
MAN6980	Hi. Eff. Red	Single Digit, Common Cathode, Right Hand Decimal Point	C	F
MAN6995	Hi. Eff. Red	Single Digit, Common Cathode, Overflow ± 1, Right Hand Decimal Point	D	H

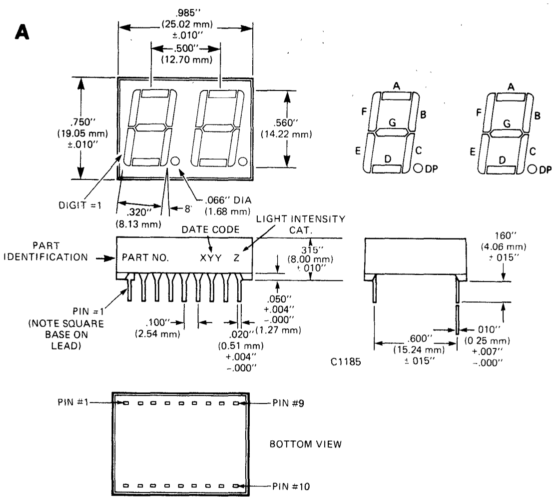
FILTER RECOMMENDATIONS

For optimum on and off contrast, one of the following filters or equivalents should be used over the display:

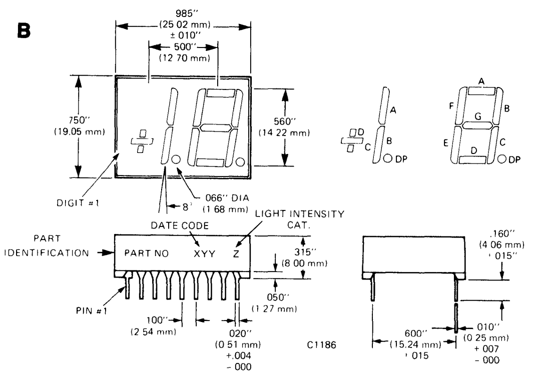
MAN6900 Series	Panelgraphic Scarlet 65 Homalite 100-1670

PACKAGE DIMENSIONS

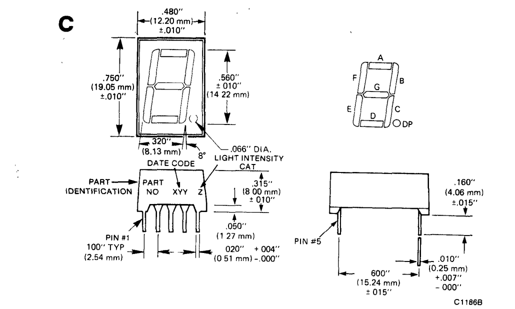
A

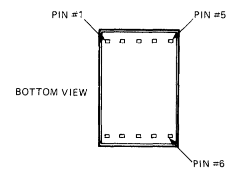


B



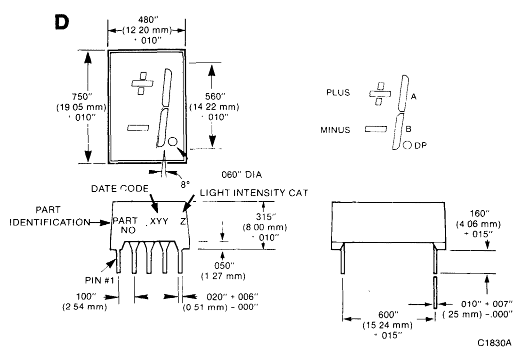
C





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.

D



PIN CONNECTIONS

PIN No.	ELECTRICAL CONNECTIONS							
	A MAN6910	B MAN6930	C MAN6940	D MAN6950	E MAN6960	F MAN6980	G MAN6975	H MAN6995
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

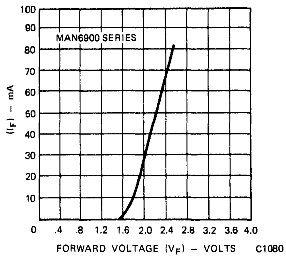


Fig. 1. Forward Current vs. Forward Voltage

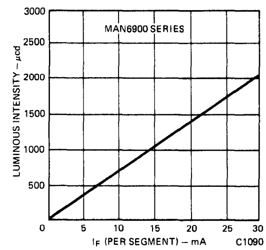


Fig. 2. Luminous Intensity vs. Forward Current

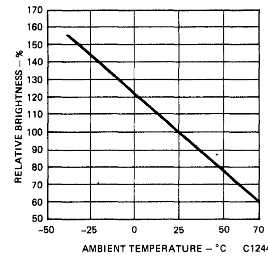


Fig. 3. Luminous Intensity vs. Temperature (see Note 2)

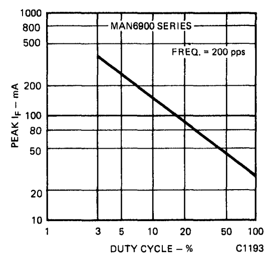


Fig. 4. Max Peak Current vs. Duty Cycle

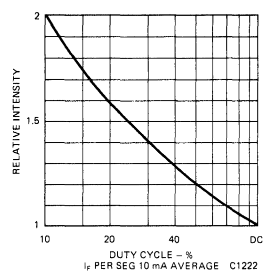
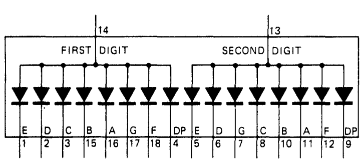
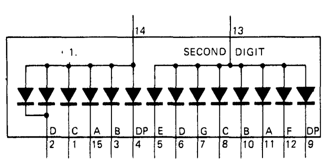


Fig. 5. Luminous Intensity vs. Duty Cycle

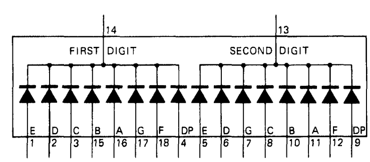
INTERNAL CONNECTIONS



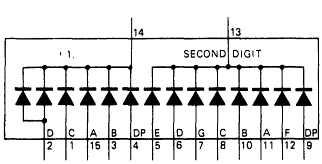
MAN6910 C1195



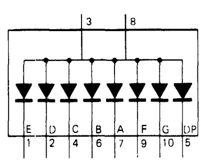
MAN6930 C1196



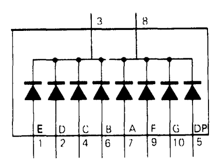
MAN6940 C1197



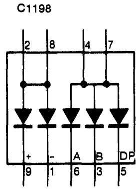
MAN6950 C1198



MAN6960 C1238

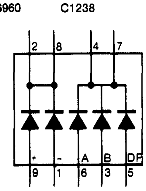


MAN6980 C1239



MAN6975

C1828



MAN6995

C1829

ABSOLUTE MAXIMUM RATINGS

	MAN6910 MAN6940	MAN6930 MAN6950	MAN6960 MAN6980	MAN6975 MAN6995
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
Solder time at 260°C (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)	320			μcd	$I_F = 10$ mA
Decimal point (see Note 5)	125			μcd	$I_F = 10$ mA
Segment of "+" or "–" (6930/6950/6975/6995)	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	$V_R = 3.0$V
Decimal point			100	μA	$V_R = 3.0$V

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Θ_{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 Fig. 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" from the body of the device. Maximum unit surface temperature is 140° C.*
4. *For flux removal, use Freon TF, Freon TE, Isoproponal, or water 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.*

0.800-INCH SEVEN SEGMENT
HIGH PERFORMANCE DISPLAY

GENERAL INSTRUMENT

HIGH EFFICIENCY GREEN # MAN8400 SERIES

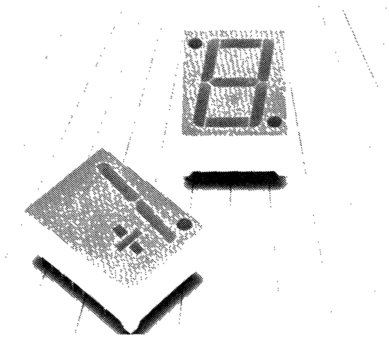
FEATURES

- High efficiency green nitrogen-doped GaP 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° C
- Low forward voltage
- Two-digit package simplifies alignment & assembly

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point-of-sale equipment
- Digital clocks
- TV and radios



DESCRIPTION

The MAN8400 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. The display on-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 lead frame, plastic reflector cap with epoxy-filled segments and back.

Displays

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING
MAN8410	Hi. Eff. Green	Common Anode, Right Hand Decimal Point	2
MAN8430	Hi. Eff. Green	Common Anode, ± 1 Overflow, Right Hand Decimal Point	1
MAN8440	Hi. Eff. Green	Common Cathode, Right Hand Decimal Point	2
MAN8450	Hi. Eff. Green	Common Cathode, ± 1 Overflow, Right Hand Decimal Point	1

FILTER RECOMMENDATIONS

For optimum on and off contrast, one of the following filters should be used over the display:

MAN8400 Series	Panelgraphic Green 48 Homalite 100-1440 Green Panelgraphic Grey 10 Homalite 100-1266 Grey

PACKAGE DIMENSIONS

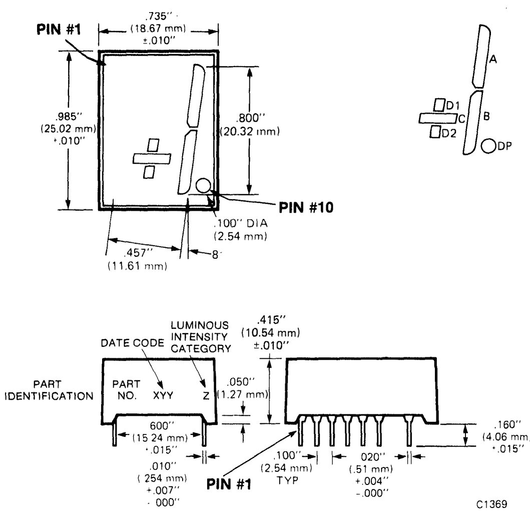


Fig. 1.

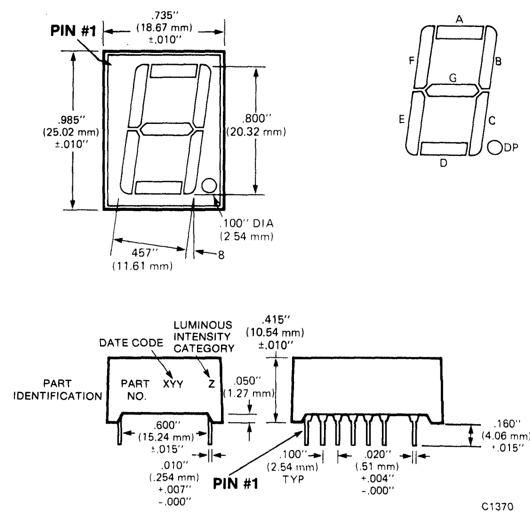


Fig. 2.

PIN CONNECTIONS

ELECTRICAL CONNECTIONS				
	MAN8410	**MAN8430**	**MAN8440**	**MAN8450**
	Digit	± Overflow	Digit	± Overflow
	Common Anode	Common Anode	Common Cathode	Common Cathode
PIN #	Package Dimensions 2	Package Dimensions 1	Package Dimensions 2	Package Dimensions 1
1	No Connection	No Connection	No Connection	No Connection
2	A Cathode	No Connection	A Anode	No Connection
3	F Cathode	No Connection	F Anode	No Connection
4	Common Anode	Common Anode	Common Cathode	Common Cathode
5	E Cathode	C Cathode	E Anode	C Anode
6	—	—	—	—
7	E Cathode	C Cathode	E Anode	C Anode
8	—	—	—	—
9	D Cathode	D2 Cathode	Common Cathode	Common Cathode
10	DP Cathode	DP Cathode	DP Anode	DP Anode
11	D Cathode	D2 Cathode	D Anode	D2 Anode
12	Common Anode	Common Anode	Common Cathode	Common Cathode
13	C Cathode	B Cathode	C Anode	B Anode
14	G Cathode	D1 Cathode	G Anode	D1 Anode
15	B Cathode	A Cathode	B Anode	A Anode
16	—	—	—	—
17	Common Anode	Common Anode	Common Cathode	Common Cathode
18	—	—	—	—

TYPICAL CURVES

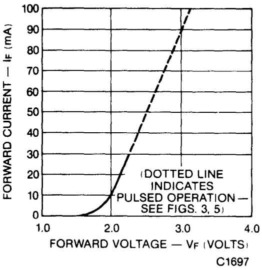


Fig. 3. Forward Current vs. Forward Voltage

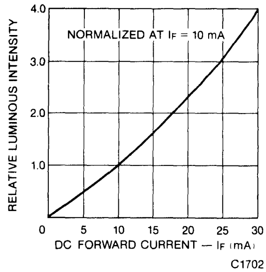


Fig. 4. Relative Luminous Intensity vs. DC Forward Current

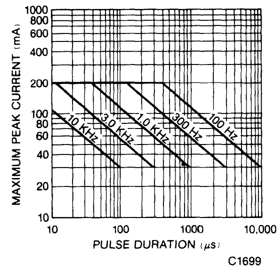


Fig. 5. Maximum Peak Current vs. Pulse Duration

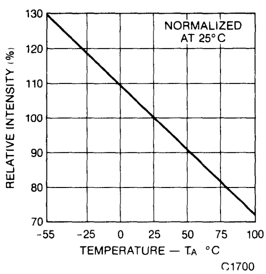


Fig. 6. Relative Luminous Intensity vs. Temperature

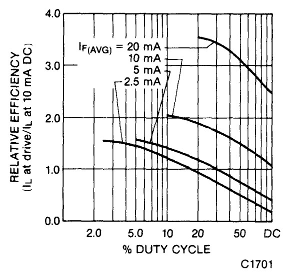
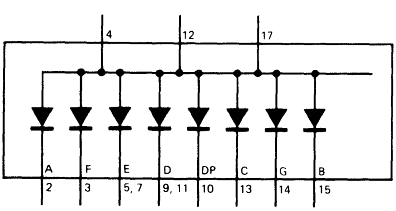
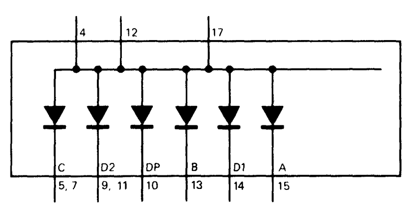


Fig. 7. Relative Efficiency vs. Duty Cycle

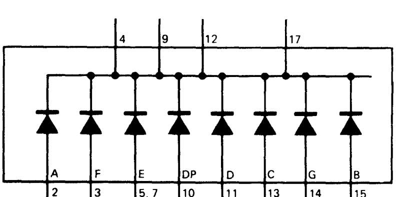
INTERNAL CONNECTIONS



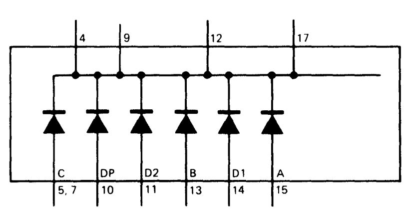
MAN8410



MAN8430



MAN8440



MAN8450

ABSOLUTE MAXIMUM RATINGS

	MAN8410 MAN8440	MAN8430 MAN8450
Power dissipation at 25°C ambient	600 mW	450 mW
Derate linearly from 50°C	-12 mW/°C	-7.5 mW/°C
Storage and operating temperature	-40°C to +85°C	-40°C to +85°C
Continuous forward current		
Total	240 mA	180 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
Solder time at 260°C (Notes 3 and 4)	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, 4)	510	2000		μcd	$I_F = 10$ mA
Segment C or D of "+"	260	1000		μcd	$I_F = 10$ mA
Pulsed luminous intensity, digit average	710	2700		μcd	$I_F = 60$ mA peak, 1:6 DF
Segment C or D of "+"	360	1350		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 Fig.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

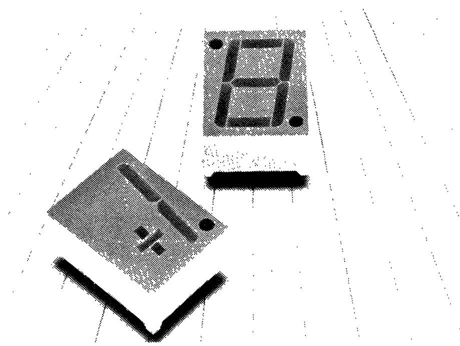
1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *Leads immersed to 1/16" from the body of the device. Maximum unit surface temperature is 140° C.*
3. *For flux removal, use Freon TF, Freon TE, Isoproponal, or water 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

HIGH EFFICIENCY RED (ORANGE) MAN8600 SERIES

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
- Gray 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

DESCRIPTION

The MAN8600 Series is a family of large digits 0.8 inches in height. This series combines high brightness, large size and 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 gray face and neutral segment color.

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING
MAN8610	Hi-Efficiency Red (Orange)	Common Anode, Right Hand Decimal Pt.	II
MAN8630	Hi-Efficiency Red (Orange)	Common Anode, ± 1 Overflow Right Hand Decimal Pt.	I
MAN8640	Hi-Efficiency Red (Orange)	Common Cathode, Right Hand Decimal Pt.	II
MAN8650	Hi-Efficiency Red (Orange)	Common Cathode, ± 1 Overflow Right Hand Decimal Pt.	I

FILTER RECOMMENDATIONS

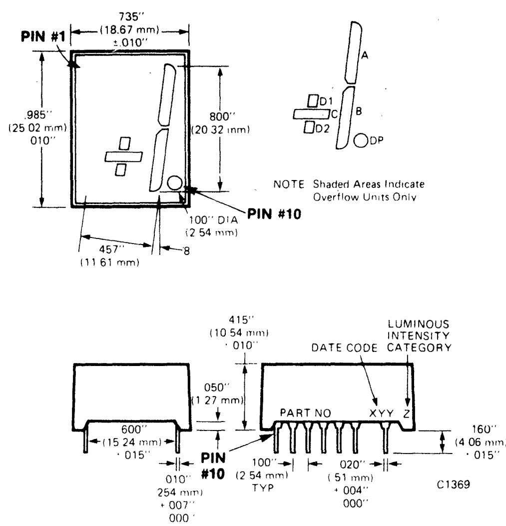
For optimum on and off contrast, one of the following filters should be used over the display:

PANELGRAPHIC SCARLET 65
HOMALITE 100-1670

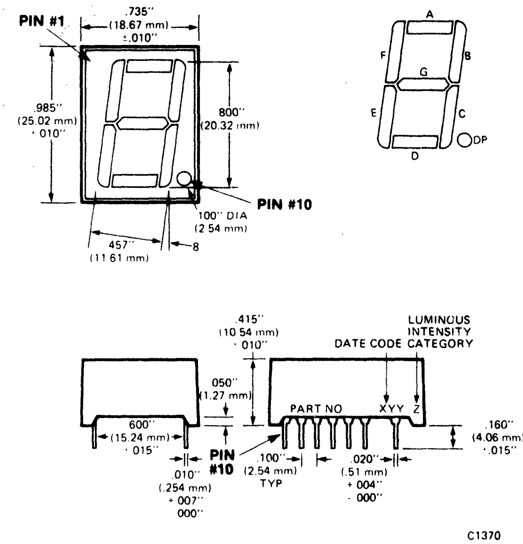
In situations of high ambient light, contrast with the gray face can be enhanced by using a neutral density filter. The following or an equivalent can be used:

PANELGRAPHIC GREY NO. 10

PACKAGE DIMENSIONS



II



PIN CONNECTIONS

ELECTRICAL CONNECTIONS				
	MAN8610	MAN8630	MAN8640	MAN8650
	Digit	± Overflow	Digit	± Overflow
	Common Anode	Common Anode	Common Cathode	Common Cathode
PIN #	Package Dimensions II	Package Dimensions I	Package Dimensions II	Package DimensionsI
1	No Connection	No Connection	No Connection	No Connection
2	A Cathode	No Connection	A Anode	No Connection
3	F Cathode	No Connection	F Anode	No Connection
4	Common Anode	Common Anode	Common Cathode	Common Cathode
5	E Cathode	C Cathode	E Anode	C Anode
6	—	—	—	—
7	E Cathode	C Cathode	E Anode	C Anode
8	—	—	—	—
9	D Cathode	D2 Cathode	Common Cathode	Common Cathode
10	DP Cathode	DP Cathode	DP Cathode	DP Cathode
11	D Cathode	D2 Cathode	D Anode	D2 Anode
12	Common Anode	Common Anode	Common Cathode	Common Cathode
13	C Cathode	B Cathode	C Anode	B Anode
14	G Cathode	D1 Cathode	G Anode	D1 Anode
15	B Cathode	A Cathode	B Anode	A Anode
16	—	—	—	—
17	Common Anode	Common Anode	Common Cathode	Common Cathode
18	—	—	—	—

TYPICAL CURVES

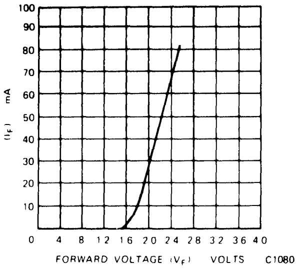


Fig. 1. Forward Current vs. Forward Voltage

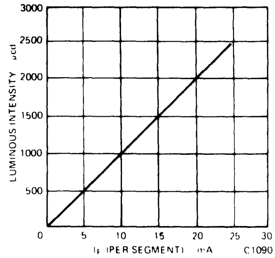


Fig. 2. Luminous Intensity vs. Forward Current

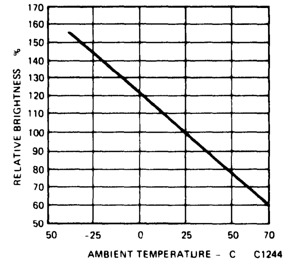


Fig. 3. Luminous Intensity vs. Temperature (see Note 2)

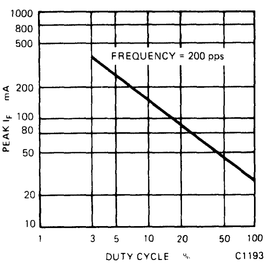


Fig. 4. Max Peak Current vs. Duty Cycle

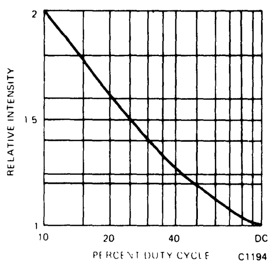


Fig. 5. Luminous Intensity vs. Duty Cycle

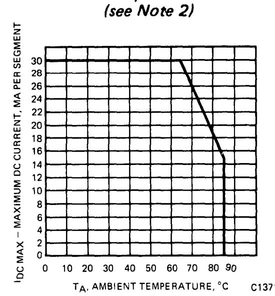
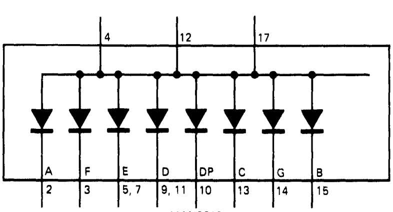
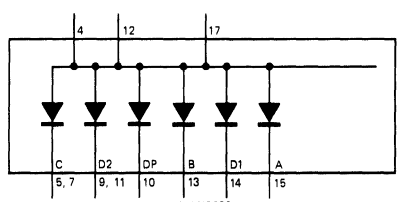


Fig. 6. Maximum DC Current vs. Temperature

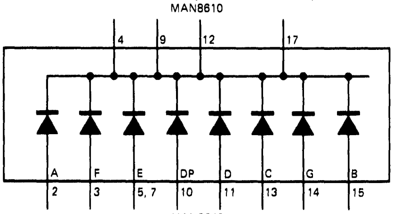
INTERNAL CONNECTIONS



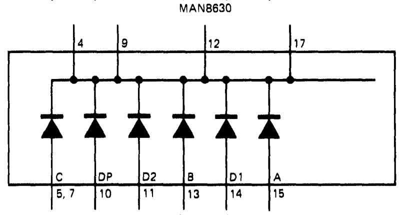
MAN8610



MAN8630



MAN8640



MAN8650

ABSOLUTE MAXIMUM RATINGS

MAN8600	MAN8610 MAN8640	MAN8630 MAN8650
Power dissipation @ 25°C ambient	600 mW	450 mW
Derate linearly from 50°C	-8.6 mW/°C	-6.4 mW/°C
Storage and operating temperature	-40°C to +85°C	-40°C to +85°C
Continuous forward current		
Total	240 mA	180 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
Solder time @ 260°C (Note 4)	5 sec.	5 sec.
Peak forward current per segment (I_{max}) (See Figure 4)	—	—

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

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity, Digit Average					
(See Note 1 and 6)	600	1000		μcd	$I_F = 10$ mA
Decimal point (see Note 5)	240	400		μcd	$I_F = 10$ mA
Segment C or D of "+" (8630/8650)	240	400		μcd	$I_F = 10$ mA
Peak emission wavelength		630			
Spectral line half width		40			
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 Θ_{JA} . . . . . 160°C/W
Wavelength temperature coefficient (case temp.) . . . . . 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 Fig. 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" from the body of the device. Maximum unit surface temperature is 140°C.*
4. *For flux removal, use Freon TF, Freon TE, Isoproponal, or water 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 as a suffix letter to the part number.*

GENERAL INSTRUMENT

YELLOW MAN8800 SERIES

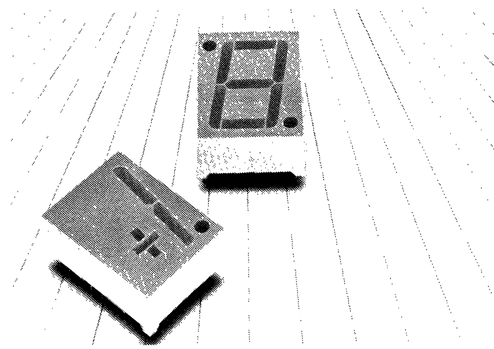
FEATURES

- Yellow 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
- Wide angle viewing . . . 150°
- High brightness maximized for high "on" contrast.
- Gray face for improved "off" contrast
- End stackable for multiple digit displays
- Categorized for luminous intensity (see note 6)
- Solid state reliability—long operation life
- Directly compatible with integrated circuits
- Rugged encapsulated plastic construction.

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point-of-sale equipment
- Digital clocks
- TV and radios



DESCRIPTION

The MAN8800 Series is a family of large digits 0.8 inches in height. This series combines high brightness large size and 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-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 lead frame, plastic reflector cap with epoxy-filled segments and back.

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING
MAN8810	Yellow	Common Anode, Right Hand Decimal Pt.	II
MAN8830	Yellow	Common Anode, ± 1 Overflow, Right Hand Decimal Pt.	I
MAN8840	Yellow	Common Cathode, Right Hand Decimal Pt.	II
MAN8850	Yellow	Common Cathode, ± 1 Overflow, Right Hand Decimal Pt.	I

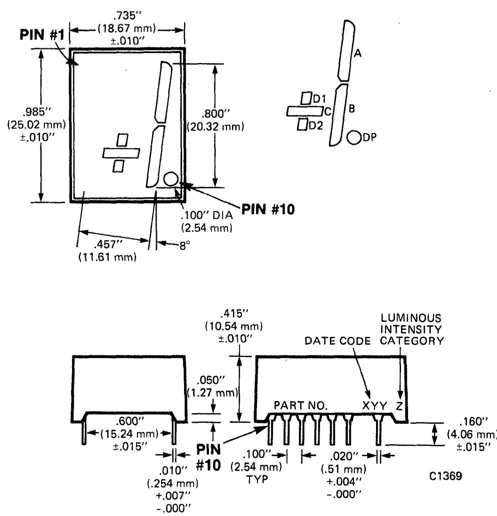
FILTER RECOMMENDATIONS

For optimum on and off contrast, one of the following filters should be used over the display:

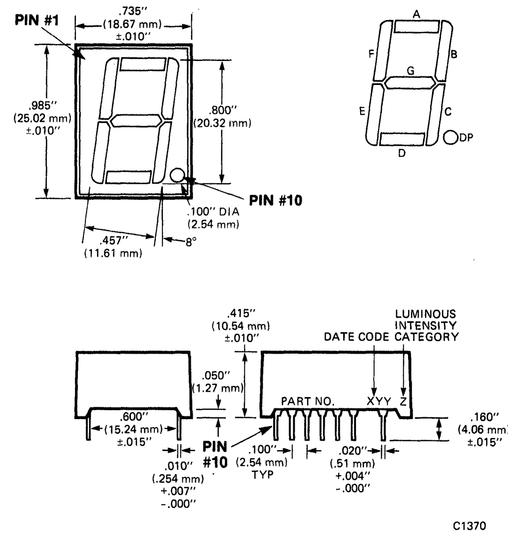
MAN8800 Series	Panelgraphic, Yellow 25 or Amber 23
	Panelgraphic, Neutral Density Filter, Gray 10
	Homalite, 100-1720 or 100-1726

PACKAGE DIMENSIONS

I



II



PIN CONNECTIONS

ELECTRICAL CONNECTIONS				
	MAN8810	MAN8830	MAN8840	MAN8850
	Digit	± Overflow	Digit	± Overflow
	Common Anode	Common Anode	Common Cathode	Common Cathode
PIN #	Package Dimensions II	Package Dimensions I	Package Dimensions II	Package Dimensions I
1	No Connection	No Connection	No Connection	No Connection
2	A Cathode	No Connection	A Anode	No Connection
3	F Cathode	No Connection	F Anode	No Connection
4	Common Anode	Common Anode	Common Cathode	Common Cathode
5	E Cathode	C Cathode	E Anode	C Anode
6	–	–	–	–
7	E Cathode	C Cathode	E Anode	C Anode
8	–	–	–	–
9	D Cathode	D2 Cathode	Common Cathode	Common Cathode
10	DP Cathode	DP Cathode	DP Anode	DP Anode
11	D Cathode	D2 Cathode	D Anode	D2 Anode
12	Common Anode	Common Anode	Common Cathode	Common Cathode
13	C Cathode	B Cathode	C Anode	B Anode
14	G Cathode	D1 Cathode	G Anode	D1 Anode
15	B Cathode	A Cathode	B Anode	A Anode
16	–	–	–	–
17	Common Anode	Common Anode	Common Cathode	Common Cathode
18	–	–	–	–

TYPICAL CURVES

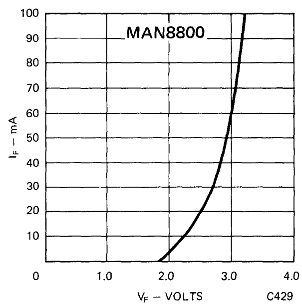


Fig. 1. Forward Current vs. Forward Voltage

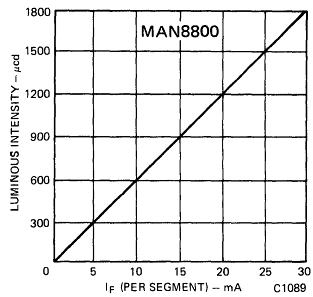


Fig. 2. Luminous Intensity vs. Forward Current

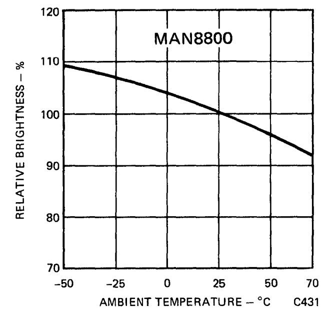


Fig. 3. Luminous Intensity vs. Temperature

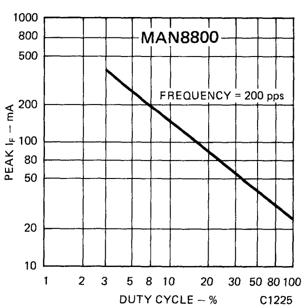


Fig. 4. Max Peak Current vs. Duty Cycle

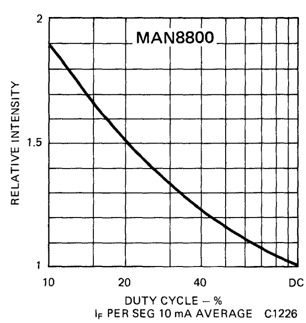


Fig. 5. Luminous Intensity vs. Duty Cycle

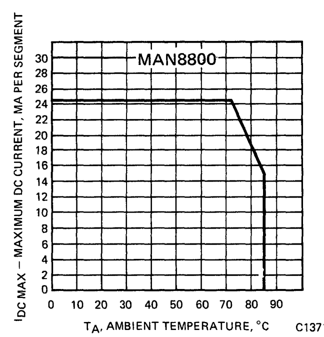
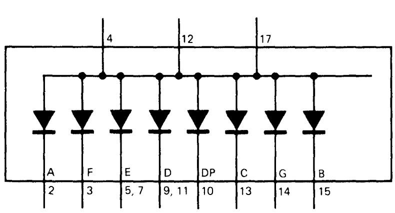
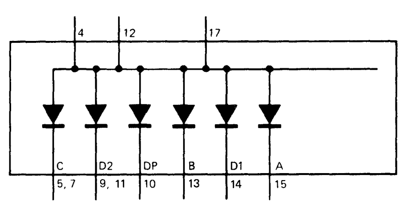


Fig. 6. Maximum DC Current vs. Temperature

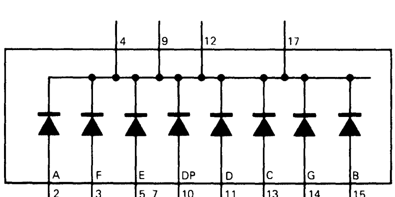
INTERNAL CONNECTIONS



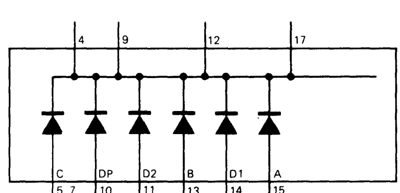
MAN8810



MAN8830



MAN8840



MAN8850

C1372

ABSOLUTE MAXIMUM RATINGS

	MAN8810 MAN8840	MAN8830 MAN8850
Power dissipation @ 25°C ambient	600mW	450mW
Derate linearly from 50° C	−10.3 mW/°C	−7.7 mW/°C
Storage and operating temperature	−40°C to +85°C	−40°C to +85°C
Continuous forward current		
Total	200 mA	150 mA
Per segment	25 mA	25 mA
Decimal point	25 mA	25 mA
Reverse voltage		
Per segment	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V
Solder time @ 260°C (Note 4)	5 sec.	5 sec.
Peak forward current per segment (I_{max}) (See Figure 4)	—	—

ELECTRICAL-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)	500	1100		μcd	I_F = 10 mA
Decimal point (see Note 5)	200	500		μcd	I_F = 10 mA
Segment C or D of "+" (8830/8850)	200	500		μcd	I_F = 10 mA
Peak emission wavelength		585		nm	
Spectral line half width		35		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 = 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 Θ_{JA} . . . 160°C/W
Wavelength temperature coefficient (case temp.) . . . 1.0 Å/°C
Forward voltage temperature coefficient . . . −1.5 mV/°C

NOTES

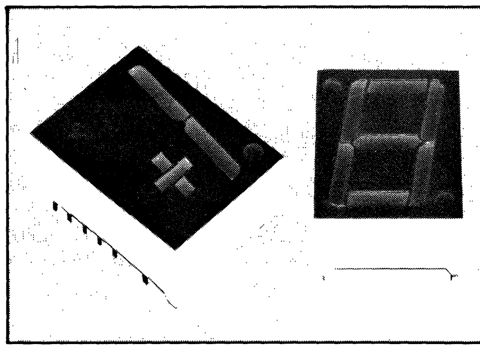
1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments as measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a digit.*
2. *The curve in Fig. 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" from the body of the device. Maximum unit surface temperature is 140°C.*
4. *For flux removal, use Freon TF, Freon TE, Isopropanal, or water 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 as a suffix letter to the part number.*

GENERAL INSTRUMENT

HIGH EFFICIENCY RED MAN8900 SERIES

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/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

DESCRIPTION

The MAN8900 Series is a family of large digits 0.8 inches in height. This series combines high brightness large size and 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.

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING
MAN8910	High Efficiency Red	Common Anode, Right Hand Decimal Pt.	II
MAN8930	High Efficiency Red	Common Anode, ± 1 Overflow, Right Hand Decimal Pt.	I
MAN8940	High Efficiency Red	Common Cathode, Right Hand Decimal Pt.	II
MAN8950	High Efficiency Red	Common Cathode, ± 1 Overflow, Right Hand Decimal Pt.	I

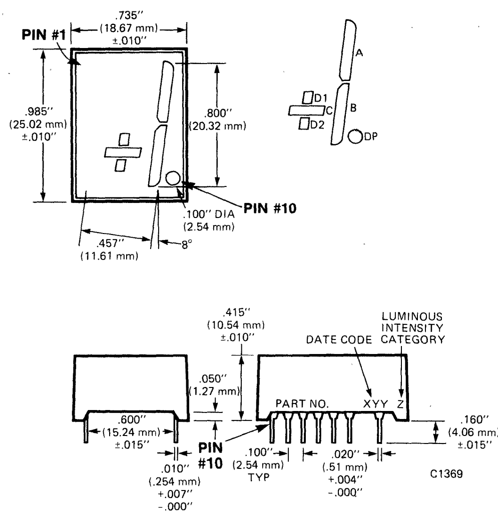
FILTER RECOMMENDATIONS

For optimum on and off contrast, one of the following filters should be used over the display:

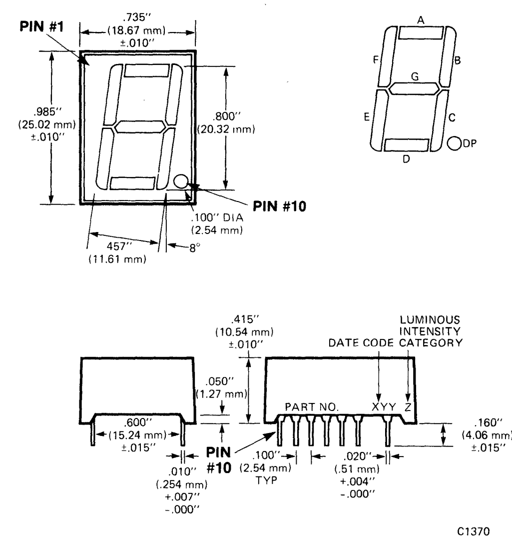
PANELGRAPHIC SCARLET 65
HOMALITE 100-1670

PACKAGE DIMENSIONS

I



II



PIN CONNECTIONS

ELECTRICAL CONNECTIONS				
	MAN8910	MAN8930	MAN8940	MAN8950
	Digit	± Overflow	Digit	± Overflow
	Common Anode	Common Anode	Common Cathode	Common Cathode
PIN #	Package Dimensions II	Package Dimensions I	Package Dimensions II	Package Dimensions I
1	No Connection	No Connection	No Connection	No Connection
2	A Cathode	No Connection	A Anode	No Connection
3	F Cathode	No Connection	F Anode	No Connection
4	Common Anode	Common Anode	Common Cathode	Common Cathode
5	E Cathode	C Cathode	E Anode	C Anode
6	—	—	—	—
7	E Cathode	C Cathode	E Anode	C Anode
8	—	—	—	—
9	D Cathode	D2 Cathode	Common Cathode	Common Cathode
10	DP Cathode	DP Cathode	DP Anode	DP Anode
11	D Cathode	D2 Cathode	D Anode	D2 Anode
12	Common Anode	Common Anode	Common Cathode	Common Cathode
13	C Cathode	B Cathode	C Anode	B Anode
14	G Cathode	D1 Cathode	G Anode	D1 Anode
15	B Cathode	A Cathode	B Anode	A Anode
16	—	—	—	—
17	Common Anode	Common Anode	Common Cathode	Common Cathode
18	—	—	—	—

TYPICAL CURVES

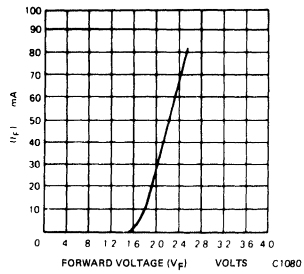


Fig. 1. Forward Current vs. Forward Voltage

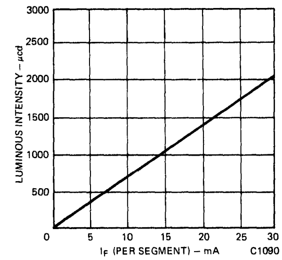


Fig. 2. Luminous Intensity vs. Forward Current

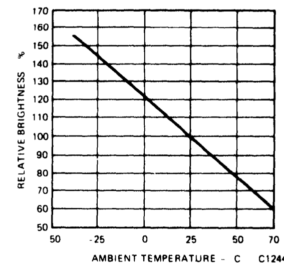


Fig. 3. Luminous Intensity vs. Temperature (see Note 2)

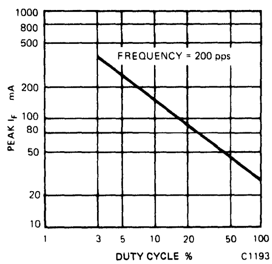


Fig. 4. Max Peak Current vs. Duty Cycle

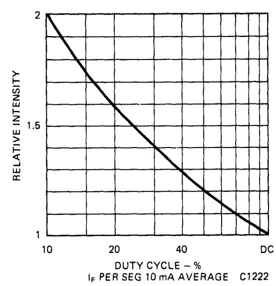


Fig. 5. Luminous Intensity vs. Duty Cycle

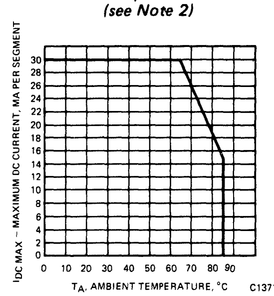
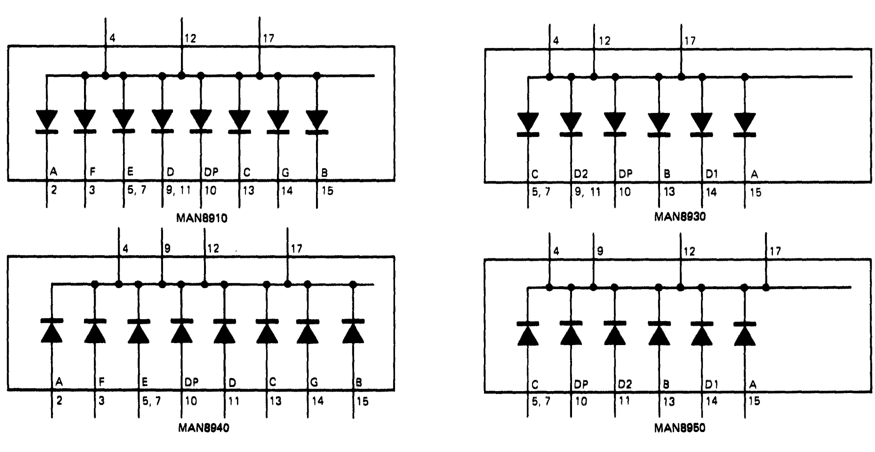


Fig. 6. Maximum DC Current vs. Temperature

NTERNAL CONNECTIONS



Displays

ABSOLUTE MAXIMUM RATINGS

	MAN8910 MAN8940	MAN8930 MAN8950
Power dissipation @ 25°C ambient	600 mW	450 mW
Derate linearly from 50°C	-8.6 mW/°C	-6.4 mW/°C
Storage and operating temperature	-40°C to +85°C	-40°C to +85°C
Continuous forward current		
Total	240 mA	180 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
Solder time @ 260°C (Note 4)	5 sec.	5 sec.
Peak forward current per segment (I_{max}) (See Figure 4)	—	—

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

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity, Digit Average (see Note 1)	320	1200		µcd	I_F = 10 mA
Decimal point (see Note 5)	130	500		µcd	I_F = 10 mA
Segment C or D of "+" (8930/8950)	130	500		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 Θ_{JA} . . . . . 160°C/W
Wavelength temperature coefficient (case temp.) . . . . . 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 Fig. 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" from the body of the device. Maximum unit surface temperature is 140°C.*
4. *For flux removal, use Freon TF, Freon TE, Isoproponal, or water 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 as a suffix letter to the part number.*

0.500-INCH HIGH PERFORMANCE 16 SEGMENT ALPHANUMERIC DISPLAYS

GENERAL INSTRUMENT

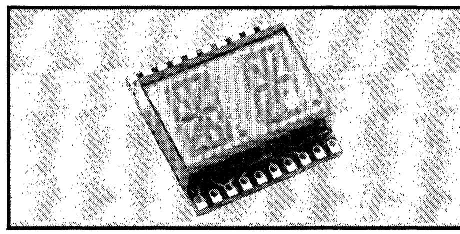
HIGH EFFICIENCY GREEN MMA54420 **YELLOW MMA58420**
ORANGE MMA56420 **HI EFF. RED MMA59420**

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-suppplied pins

APPLICATIONS

- Industrial Controls
- Test and Measurement Equipment
- Point of Sale
- Systems Status Indication
- Consumer Products
- Computer Terminals
- Automotive Instrumentation



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, dual edge tab connections.

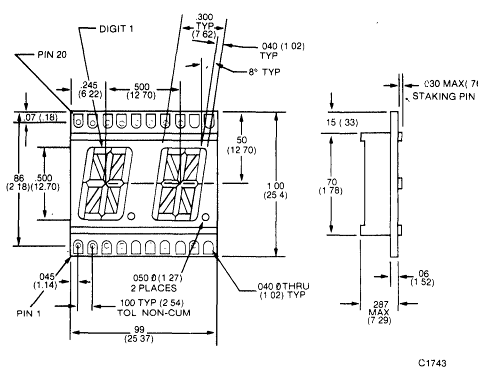
DESCRIPTION

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

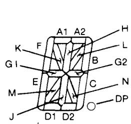


ELECTRICAL CONNECTION

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

C1744

ABSOLUTE MAXIMUM RATINGS

Power Dissipation @ 25°C ambient 2200mW
Derate Linearly from 45°C .... 50mW/°C
Storage and Operating Temp. .... -40°C to 85°C
D.C. Continuous Forward Current
  Total per character 425mA
  Per Segment or Decimal Point 25mA

Junction Temperature .... 90°C
Reverse Voltage
  Min. per Segment 5V
  Min. per Decimal Point 5V
Solder time at 260°C (Notes 4,5) .... 10 sec.
Peak Forward Current
  (See Figure 1) 0.5A

ELECTRICAL OPTICAL CHARACTERISTICS (T_A=25°C)

	MMA 54420	MMA 56420	MMA 58420	MMA 59420	UNITS	TEST CONDITIONS
Minimum Luminous Intensity Digit Average (See Notes 1,3)	510	510	510	320	μcd	I_F=10mA
Typical Luminous Intensity Digit Average (See Notes 1,3)	1,000	1000	900	730	μcd	I_F=10mA
Peak Emission Wavelength	562	630	585	630	nm	
Typical Forward Voltage Segment or Decimal Point	2.5	2.2	2.5	2.2	volts	I_F=20mA
Maximum Forward Voltage Segment or Decimal Point	3.0	2.6	3.0	2.6	volts	I_F=20mA
Dynamic Resistance Segment or Decimal Point	26	26	26	26	Ω	I_F=20mA
Capacitance Segment or Decimal Point	35	35	35	35	pF	V=0
Maximum Reverse Current	100	100	100	100	μA	V_R=5V

TYPICAL THERMAL CHARACTERISTICS

Thermal Resistance (Junction to Free Air) Θ_{JA} .... 200°C/W
Forward Voltage Temperature Coefficient .... —2.2mV/°C

TYPICAL CURVES (unless otherwise noted)

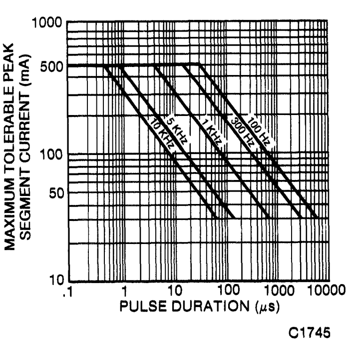


Fig. 1. Maximum Tolerable Peak Segment Current vs. Pulse Duration

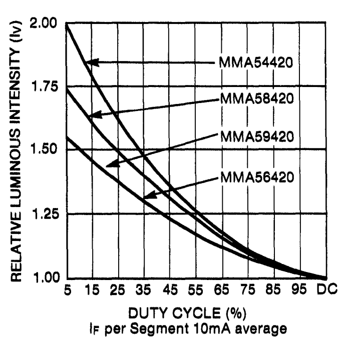


Fig. 2. Relative Luminous Intensity vs. Duty Cycle

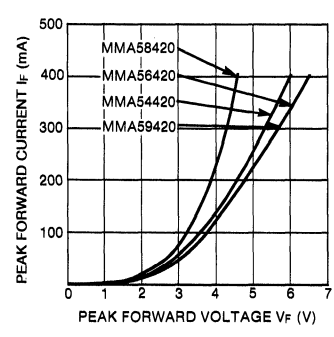


Fig. 3. Peak Forward Voltage vs. Peak Forward Current

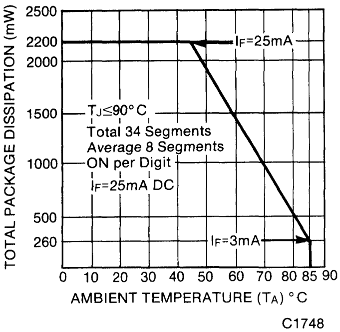


Fig. 4. Total Package Power Dissipation vs. Ambient Temp.

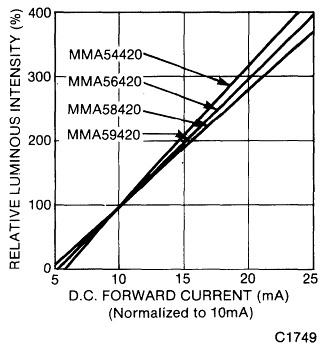


Fig. 5. Relative Luminous Intensity vs. Forward Current

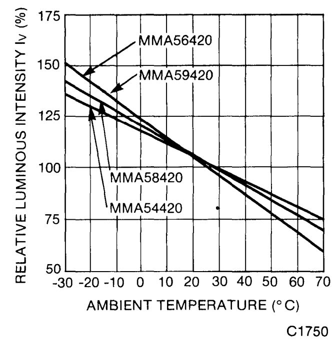


Fig. 6. Relative Luminous Intensity vs. Ambient Temperature

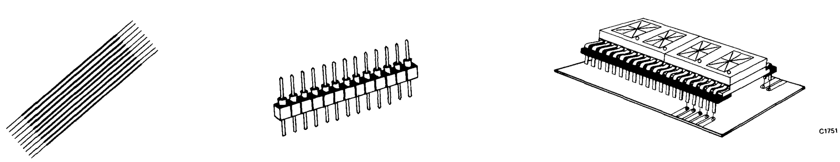
MMA5X420 Recommended Filters for Contrast Enhancement

COLOR	AMBIENT DIM (Office) 25-75 FC	MODERATE (Test Floor) 75-200 FC	BRIGHT (Outdoors) 200-1000 FC
HI EFF. RED ORANGE 635nm	Red Long Pass 65% H, H100-1650 C, 110 3M, R6310	Red Long Pass 40% H, H100-1650 C, 112	Gray 18-23% H, H100-1266 C, 105 3M, ND0220
YELLOW 583nm	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	Gray, 18-23% H, H100-1266 C, 105 P, Gray 10 RH2538
GREEN 569nm	Green Band Pass 30% H, H100-1440 C, 107 P, Green 48	Gray 20-25% H, H100-1425 C, 107 P, Green 48	Gray 18-23% H, H100-1266 C, 105 P, Grey 10 RH, 2538

LEGEND C, 106 = Cheques #106; RH = Rohm & Hass; 3M = 3M Company; 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	" " "
Cable Jumpers	CJ-20-C-12	" " "
Edge Card Connector	100 Series	Circuit Assembly Connectors
Strip Line Plugs	SP Series	" " "
Right Angle Strip Line Plugs	SP Series	" " "



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 Fig. 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, use Freon TF or Isoproponal at room temperature.*

Displays

TYPICAL DRIVE SCHEMES FOR MMA5X420 DISPLAYS

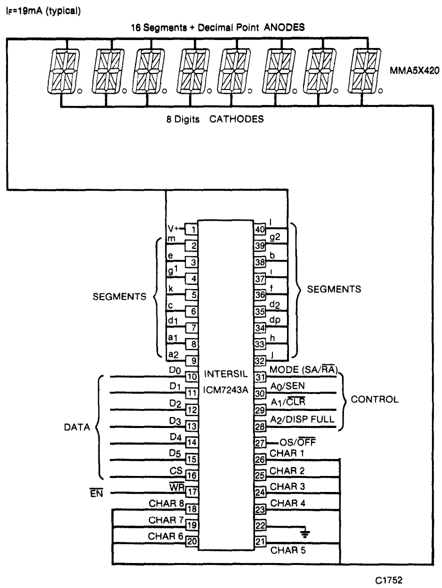


Figure 1. Direct Drive Method

$$I_F(PEAK) = \frac{V_{LED} - V_F - 1.4V}{R_L}$$

$$= I_{F(DC)} \times \text{Number of Digits}$$

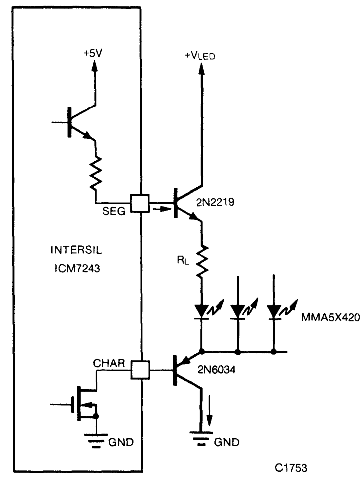
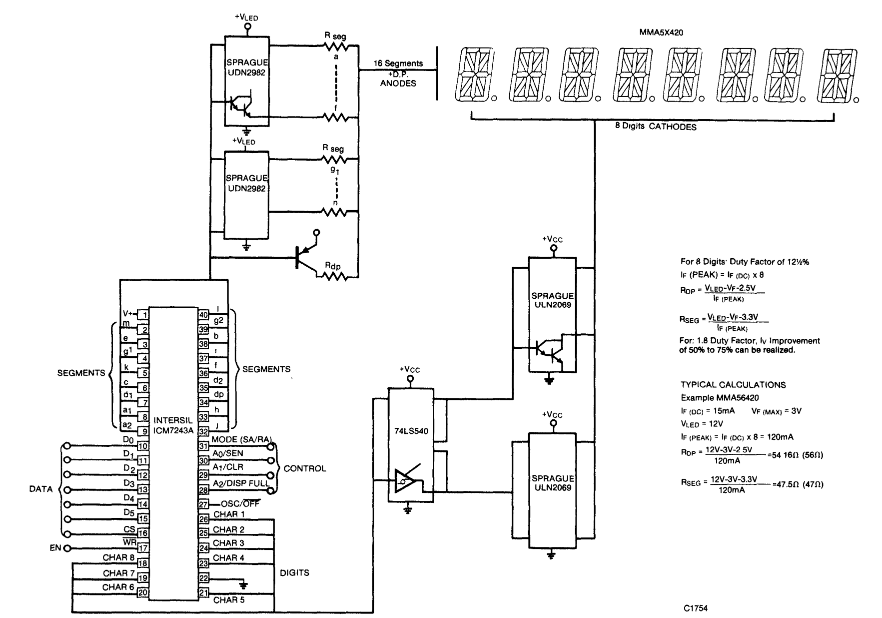


Figure 2. Discrete Buffering



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

GENERAL
INSTRUMENT

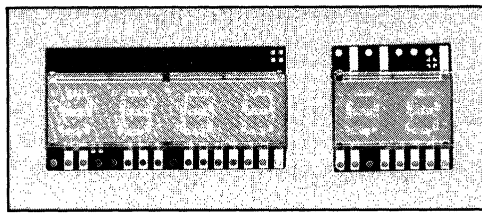
ORANGE MMN36000 SERIES
YELLOW MMN38000 SERIES
HIGH EFFICIENCY RED MMN39000 SERIES

FEATURES

- High performance GaAsP on GaP LED die for higher luminous intensity
- Multi-digit displays prematched for brightness and hue
- End-stackable two and four-digit packages
- Wide viewing angle
- High on/off contrast
- Special lens color options to tailor display to application
- Common anode or common cathode versions
- Replacement for National Semiconductor similar stick displays

APPLICATIONS

- Test and measurement
- Point-of-sale
- TV
- Industrial controls
- Consumer products
- Replacement for national semiconductor similar stick displays



DESCRIPTION

The MMN30000 Series is a family of multi-digit LED numeric displays featuring improved performance through the use of high efficiency GaAsP on GaP die. Construction is the non-encapsulated type using a P.C. board, air gap reflector cap, and a single piece lens cap. Terminals are standard P.C. board edge finger contacts on .100" centres. Additionally the contacts have a drilled plated through hole. Electrical connection can be made via edge card connectors or can be soldered to standard .100" terminal header strip. These displays offer a number of options for maximum design flexibility including various drive configurations, lens colors, and both two-digit and four-digit packages.

MODEL NUMBERS

PART NO.	LED COLOR	LENS COLOR	DESCRIPTION	PACKAGE DRAWING
2 DIGIT DISPLAYS				
MMN36220	Orange	Orange	Common anode, multiplexed	A
MMN36420	Orange	Orange	Common cathode, multiplexed	A
MMN38220	Yellow	Clear	Common anode, multiplexed	A
MMN38420	Yellow	Clear	Common cathode, multiplexed	A
MMN39220	High Efficiency Red	Red	Common anode, multiplexed	A
MMN39420	High Efficiency Red	Red	Common cathode, multiplexed	A
4 DIGIT DISPLAYS				
MMN36240	Orange	Orange	Common anode, multiplexed	B
MMN36440	Orange	Orange	Common cathode, multiplexed	B
MMN38240	Yellow	Clear	Common anode, multiplexed	B
MMN38440	Yellow	Clear	Common cathode, multiplexed	B
MMN39240	High Efficiency Red	Red	Common anode, multiplexed	B
MMN39440	High Efficiency Red	Red	Common cathode, multiplexed	B

MMN	W	X	Y	ZZ
Product Family Prefix	**Digit Size**	**Color**	**Drive Configuration**	**Number of Digits**
	3 = 0.3"	6 = orange	1 = common anode direct drive	
		8 = yellow	2 = common anode multiplexed	20 = 2
		9 = hi. eff. red	3 = common cathode direct drive	35 = 3½
			4 = common cathode multiplexed	40 = 4

ABSOLUTE MAXIMUM RATINGS

	4 DIGIT	2 DIGIT
Power Dissipation @ 25°C ambient	1600 mW/unit	800 mW/unit
Derate Linearly From 50°C	38 mW/°C	19 mW/°C
Storage and Operating Temperature	-40°C to +85°C	-40°C to +85°C
Continuous Forward Current DC		
Total Per Digit	160 mA	160 mA
Per Segment or DP	20 mA	20 mA

Reverse Voltage
- Min. Per Segment 5V
- Min. Decimal Point 5V

Solder Time @ 260°C . . . . 5 sec.
Pulse Current/Segment (See Figure 4) . . . . 0.5 AMP

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

Color	Series	Parameter	MIN	TYP.	MAX.	UNITS	TEST CONDITIONS
ORANGE	MMN36000 SERIES	Luminous intensity, Digit average (See Note 1)	510	1400		μcd	I_F = 10 mA
		Decimal point (See Note 3)	90	300		μcd	I_F = 10 mA
		Peak Emission wavelength		630		nm	
		Forward voltage					
		Segment		2.2	2.6	V	I_F = 20 mA
		Decimal point		2.2	2.6	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
YELLOW	MMN38000 SERIES	Luminous intensity, Digit average (See Note 1)	510	1200		μcd	I_F = 10 mA
		Decimal point (See Note 3)	90	260		μcd	I_F = 10 mA
		Peak Emission wavelength		585		nm	
		Forward voltage					
		Segment		2.5	3.0	V	I_F = 20 mA
		Decimal point		2.5	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
HIGH EFFICIENCY RED	MMN39000 SERIES	Luminous intensity, Digit average (See Note 1)	350	1200		μcd	I_F = 10 mA
		Decimal point (See Note 3)	65	260		μcd	I_F = 10 mA
		Peak Emission wavelength		630		nm	
		Forward voltage					
		Segment		2.2	2.6	V	I_F = 20 mA
		Decimal point		2.2	2.6	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 (at 25°C unless otherwise noted)

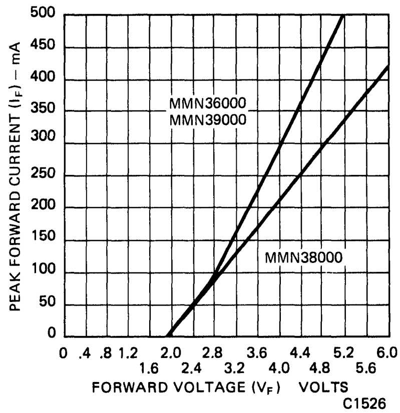


Fig. 1 Peak Forward Current vs. Forward Voltage

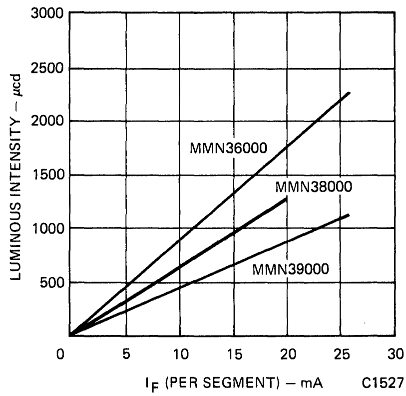


Fig. 2. Luminous Intensity vs. Forward Current

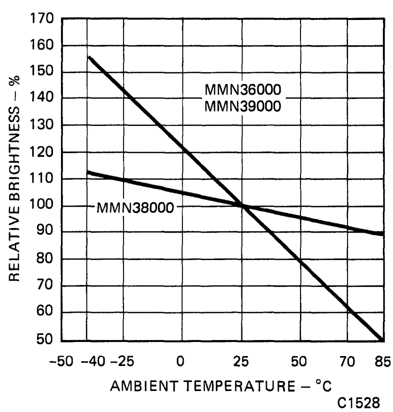


Fig. 3. Luminous Intensity vs. Temperature

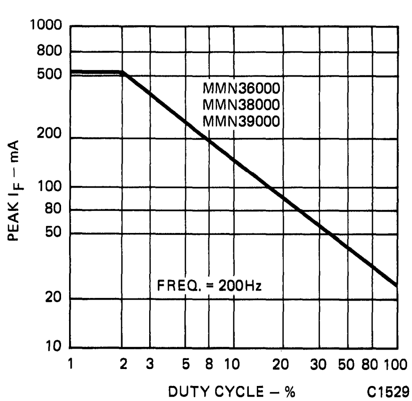


Fig. 4. Max Peak Current vs. Duty Cycle

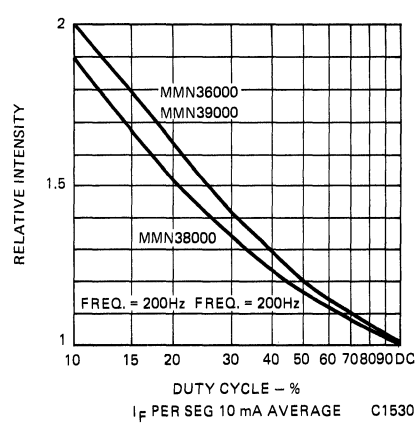
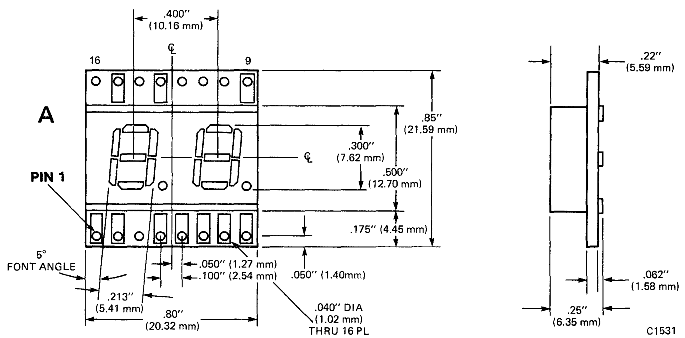
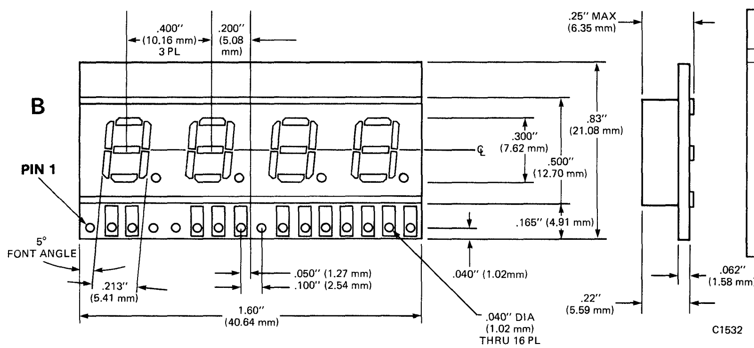


Fig. 5. Luminous Intensity vs. Duty Cycle

PACKAGE DIMENSIONS





PIN CONNECTIONS

MULTIPLEXED TWO-DIGIT DISPLAYS

Orange	MMN36220	MMN36420
Yellow	MMN38220	MMN38420
Red	MMN39220	MMN39420
PIN	COMMON ANODE	COMMON CATHODE
1	Cathode G	Anode G
2	Cathode E	Anode E
3	NC	NC
4	Dig. #1 C A	Dig. #1 C A
5	Cathode D	Anode D
6	Dig. #2 C A	Dig. #2 C A
7	Cathode DP	Anode DP
8	Cathode C	Anode C
9	Cathode B	Anode B
10	NC	NC
11	NC	NC
12	NC	NC
13	Cathode A	Anode A
14	NC	NC
15	Cathode F	Anode F
16	NC	NC

MULTIPLEXED FOUR-DIGIT DISPLAYS

Orange	MMN36240	MMN36440
Yellow	MMN38240	MMN38440
Red	MMN39240	MMN39440
PIN	COMMON ANODE	COMMON CATHODE
1	NC	NC
2	Cathode E	Anode E
3	Dig. #1 C A	Dig. #1 C C
4	NC	NC
5	NC	NC
6	Dig. #2 C A	Dig. #2 C C
7	Cathode D	Anode D
8	Cathode G	Anode G
9	NC	NC
10	#3 C A	#3 C C
11	Cathode B	Anode B
12	Cathode A	Anode A
13	Cathode F	Anode F
14	#4 C A	#4 C C
15	Cathode D P.	Anode D.P.
16	Cathode C	Anode C

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% between all segments within a digit or from digit to digit.*
2. *The curve in Fig. 3 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, use Freon TF or Isoproponal at room temperature.*

LIGHT FILTERS

A suitable light filter can considerably enhance the display aesthetics and increase the readability in high ambient light conditions.

Filters are available from:

Panelgraphic Corporation, New Jersey	201-227-1500	Rohm and Haas, Pennsylvania	215-592-3000
SGL Homalite, Delaware	302-652-3686		
3M Company, Minnesota	612-733-2023		
Polaroid Corporation, Massachusetts	617-769-6800		

GENERAL INSTRUMENT

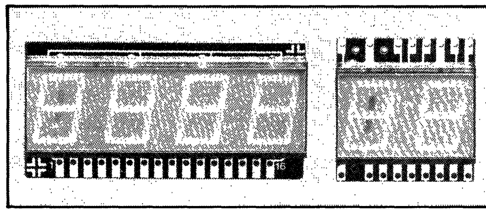
ORANGE MMN56000 SERIES
YELLOW MMN58000 SERIES
HIGH EFFICIENCY RED MMN59000 SERIES

FEATURES

- High performance GaAsP on GaP LED die for higher luminous intensity
- Multi-digit displays prematched for brightness and hue
- End-stackable two and four-digit packages
- General Instrument's distinctive sculptured font for an easy-to-read, pleasing appearance
- Special lens color options to tailor display to application

APPLICATIONS

- Test and measurement
- Point-of-sale
- TV
- Industrial controls
- Consumer products



DESCRIPTION

The MMN50000 Series is a family of multi-digit LED numeric displays featuring improved performance through the use of high efficiency GaAsP on GaP die. These displays offer a number of options for maximum design flexibility including various drive configurations, lens colors, and both two-digit and four-digit packages.

MODEL NUMBERS

PART NO.	LED COLOR	LENS COLOR	DESCRIPTION	PACKAGE DRAWING
2 DIGIT DISPLAYS				
MMN56120	Orange	Orange	Common anode, direct drive	A
MMN56320	Orange	Orange	Common cathode, direct drive	A
MMN58120	Yellow	Clear	Common anode, direct drive	A
MMN58320	Yellow	Clear	Common cathode, direct drive	A
MMN59120	High Efficiency Red	Red	Common anode, direct drive	A
MMN59320	High Efficiency Red	Red	Common cathode, direct drive	A
4 DIGIT DISPLAYS				
MMN56240	Orange	Orange	Common anode, multiplexed	B
MMN56440	Orange	Orange	Common cathode, multiplexed	B
MMN58240	Yellow	Clear	Common anode, multiplexed	B
MMN58440	Yellow	Clear	Common cathode, multiplexed	B
MMN59240	High Efficiency Red	Red	Common anode, multiplexed	B
MMN59440	High Efficiency Red	Red	Common cathode, multiplexed	B

MMN	W	X	Y	ZZ
Product Family Prefix	**Digit Size**	**Color**	**Drive Configuration**	**Number of Digits**
	5 = 0.5″	6 = orange 8 = yellow 9 = hi. eff. red	1 = common anode direct drive 2 = common anode multiplexed 3 = common cathode direct drive 4 = common cathode multiplexed	20 = 2 35 = 3½ 40 = 4

MMN56000 MMN58000 MMN59000 SERIES

ABSOLUTE MAXIMUM RATINGS

	4 DIGIT	2 DIGIT
Power Dissipation @ 25°C ambient	1600 mW	800 mW
Derate Linearly From 25°C	15 mW/°C	15 mW/°C
Storage and Operating Temperature	-40°C to +85°C	-40°C to +85°C
Continuous Forward Current DC		
Total Per Digit	160 mA	160 mA
Per Segment or DP	20 mA	20 mA

Reverse Voltage
- Min. Per Segment 5V
- Min. Decimal Point . . . . 5 V

Solder Time @ 260°C . . . . 10 sec.
Pulse Current (See Figure 4) . . . . 0.5 AMP

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

			MIN	TYP.	MAX.	UNITS	TEST CONDITIONS
ORANGE	MMN56000 SERIES	Luminous intensity, Digit average (See Note 1)	510	1200		μcd	I_F = 10 mA
		Decimal point (See Note 3)	90	260		μcd	I_F = 10 mA
		Peak Emission wavelength		630		nm	
		Forward voltage					
		Segment		2.2	2.6	V	I_F = 20 mA
		Decimal point		2.2	2.6	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
YELLOW	MMN58000 SERIES	Luminous intensity, Digit average (See Note 1)	510	1100		μcd	I_F = 10 mA
		Decimal point (See Note 3)	90	250		μcd	I_F = 10 mA
		Peak Emission wavelength		585		nm	
		Forward voltage					
		Segment		2.5	3.0	V	I_F = 20 mA
		Decimal point		2.5	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
HIGH EFFICIENCY RED	MMN59000 SERIES	Luminous intensity, Digit average (See Note 1)	350	1100		μcd	I_F = 10 mA
		Decimal point (See Note 3)	65	250		μcd	I_F = 10 mA
		Peak Emission wavelength		630		nm	
		Forward voltage					
		Segment		2.2	2.6	V	I_F = 20 mA
		Decimal point		2.2	2.6	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 (at 25°C unless otherwise noted)

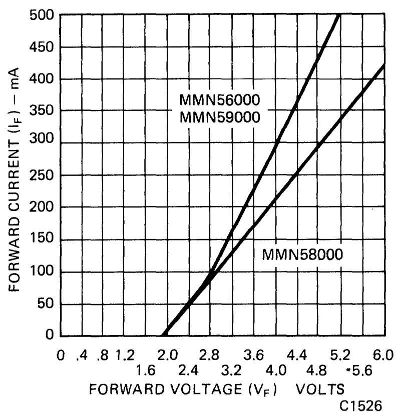


Fig. 1. Forward Current vs. Forward Voltage

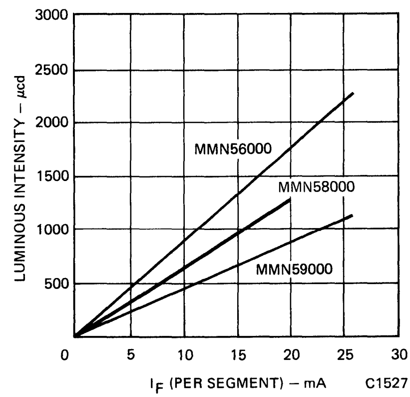


Fig. 2. Luminous Intensity vs. Forward Current

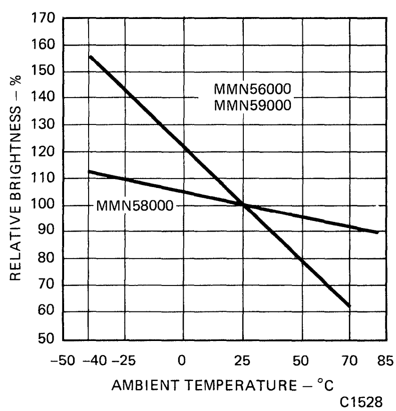


Fig. 3. Luminous Intensity vs. Temperature

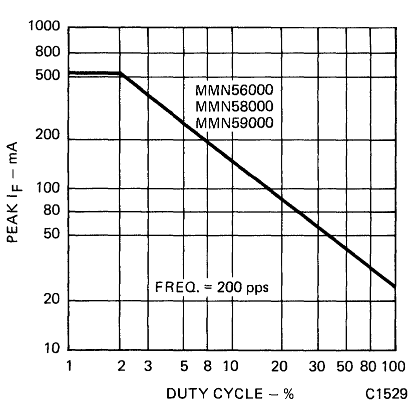


Fig. 4. Max Peak Current vs. Duty Cycle

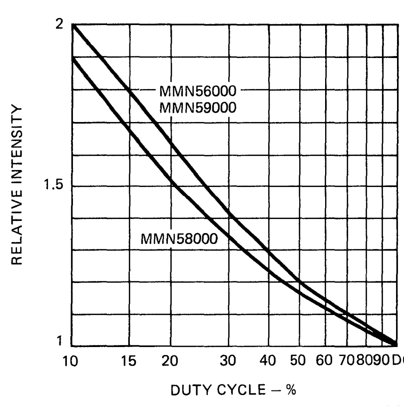
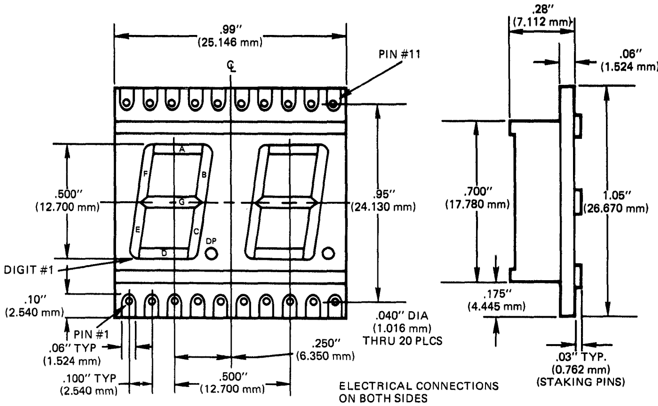


Fig. 5. Luminous Intensity vs. Duty Cycle

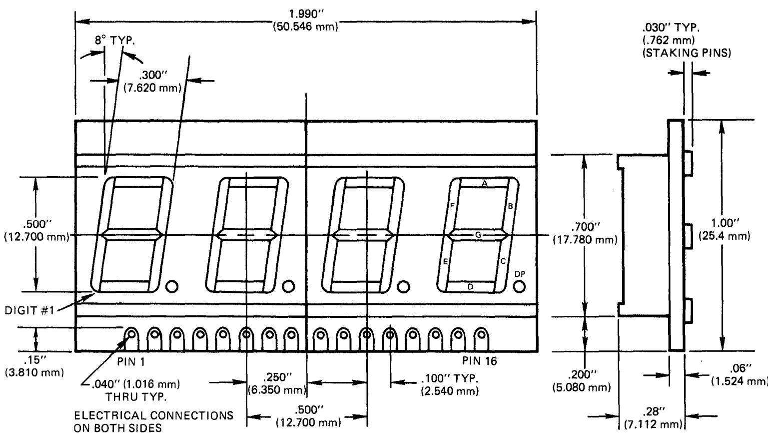
Displays

PACKAGE DIMENSIONS



A

C1501



B

C1500

PIN CONNECTIONS

TWO-DIGIT DISPLAYS

PIN	CONNECTION	PIN	CONNECTION
1	DIGIT 1 E SEGMENT	11	DIGIT 1 & 2 COMMON
2	NOT USED	12	DIGIT 2 B SEGMENT
3	DIGIT 1 D SEGMENT	13	DIGIT 2 A SEGMENT
4	DIGIT 1 DP SEGMENT	14	DIGIT 2 F SEGMENT
5	DIGIT 1 C SEGMENT	15	DIGIT 1 B SEGMENT
6	DIGIT 2 G SEGMENT	16	DIGIT 1 A SEGMENT
7	DIGIT 2 E SEGMENT	17	NOT USED
8	DIGIT 2 D SEGMENT	18	DIGIT 1 F SEGMENT
9	DIGIT 2 DP SEGMENT	19	NOT USED
10	DIGIT 2 C SEGMENT	20	DIGIT 1 G SEGMENT

MULTIPLEXED FOUR-DIGIT DISPLAYS

PIN	CONNECTION	PIN	CONNECTION
1	A SEGMENT	9	N.C.
2	N.C.	10	DIG. 3 and D.P. 3 COM.
3	D SEGMENT	11	B SEGMENT
4	DIG. 1 and D.P. 1 COM.	12	F SEGMENT
5	NO CONNECTION	13	E SEGMENT
6	NO CONNECTION	14	DIG. 4 and D.P. 4 COM.
7	DIG. 2 and D.P. 2 COM.	15	D.P.
8	C SEGMENT	16	G SEGMENT

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% between all segments within a digit or from digit to digit.*
2. *The curve in Fig. 3 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, use Freon TF or Isoproponal at room temperature.*

GENERAL INSTRUMENT

XDS2724P — XDS2724S — 24-character version
XDS2732P — XDS2732S — 32-character version

XDS SERIES

INTRODUCTION

The General Instrument XDS series is a complete, ready-to-use Alphanumeric Display System, using a combination of advanced LED display and microprocessor technology. These are available in 24 or 32 character versions. The series has been especially designed to provide the visual communication link in today's many microprocessor, data communications and instrumentation environments. The use of a microprocessor controller offers a wide variety of display features, and relieves the user's system from the normal display maintenance of refresh, update, addressing, etc.

In each version all characters of the display are uniquely addressable allowing the display to be selectively changed in accordance with system requirements. Also the displayed information may be "read from" by using addressing and the I/O lines. All display changes are instantaneous with no flicker or distracting movements.

Two input versions are offered — a "Parallel Version" and a "Serial Version". Both share similar design features, construction and common internal μP operating software.

The XDS series consists of 24 or 32 characters of 0.135" high 14 segment monolithic direct view red LED displays, a microprocessor, and all the necessary display drive electronics.

SPECIFICATIONS

Number of Characters 24, 32
Character Font . . . . . 14 Segment Plus Decimal Point
Character Size (Magnified) . . . . . . .135" (3.43 mm)
Character Line Length
  24 characters . . . . 4.135" (105.02 mm)
  32 characters . . . . 5.56" (141.23 mm)
Character Set (See Note 1) . . . Full ASCII Upper Case
Display Technology . . . LED Red GaAsP Monolithic
Display Type . . . . . . General Instrument's MAN2815
Display Cycle Time . . . . 11.6 mS
Display Duty Cycle
  Hi Brightness 1/32
  Lo Brightness 1/96

XDS2724
Dimensions (Overall) . . . . 6.8" W x 2.4" H x 1.35" D
(172.72 mm W x 60.96 mm H x 34.29 mm D)
XDS2732
Dimensions (Overall) . . . . 8.0" W x 2.6" H x 1.35" D
(203.2 mm W x 60.96 mm H x 34.29 mm D)
Weight . . . . Approximately 6 Ozs. Max
(168 Grams Max.)
Connectors . . . . 26 Pin Male Flat Ribbon
Serial Version . . . 3 Pin .100" Right Angle Header Strip

NOTE 1: Accepts full ASCII upper and lower case input data but displays all characters in upper case only. Data output retains the same upper and lower case format as the input.

FEATURES

- Completely solid state
- 24 or 32 characters .135" high; 14 segments per character plus decimal point displays with compact display line lengths
- Highly visible monolithic GaAsP red LED displays with wide viewing angle
- Aesthetically pleasing 0.175" character-to-character spacing
- Complete uisplay system with interfacing and display refresh electronics
- 8 bit μP controller
- Parallel and serial versions available
- Left/right display entry; Hardware/software control
- Multiple end-of-line modes, horizontal scroll, carriage return/line feed, no action
- Editing capability; Insert or delete characters
- Blinking on/off cursor; hardware/software control
- I/O accepts upper and lower case data but displays in upper case only; Data retains same ASCII format as input.
- End-of-line "bell" output
- Brightness control hardware/software
- A completely "Interactive Display System" with input and output capability
- Compact
- XDS2724 is mechanically similar to the HP HDSP-8716 unit with same mounting dimensions

NOTE: XDS SERIES DISPLAY SYSTEMS ARE INTENDED TO AID DESIGN AND PROTOTYPE WITH MAN 2815 DISPLAYS. USE IN PRODUCTION IS NOT RECOMMENDED.

XDS, PARALLEL VERSION

- Universal 8 bit bi-directional bus system
- Only 8 data plus 3 control interconnects between host μP and XDS display system plus 2 lines for power

XDS, SERIAL VERSION

- Serial RS232 input and output
- Selectable baud rates (50-9600)
- Full or half-duplex modes
- Selectable bit pattern, one or two stop bits, odd/even parity, or no parity
- Parallel ASCII data input option into UART transmitter section

ABSOLUTE MAXIMUM RATING

XDS2724P/2732P

Supply Voltage V_{CC} to ground .... 6.0 V
Voltage—Input and Output
Data and Options .... −0.5 V to V_{CC}
Storage Temperature .... −40°C to +85°C

Recommended Operating Conditions

Temperature .... 0°C to +70°C

Parameter	Symbol	Min.	Max.	Units
Supply Voltage	V_{CC}	4.75	5.25	V
Data Out (D_0-D_7)	I_{OL}		24	mA
	I_{OH}		2500	μA
Bell Output I_{OUT}	I_{OL}		24	mA
	I_{OH}		1000	μA

Figure 1A

XDS2724S/2732S

Supply Voltage V_{CC} to ground .... 6.0 V
Supply Voltage $+V_S$ to ground .... +15 V
Supply Voltage $-V_S$ to ground .... −15 V
Voltage—Input and Output Options . . . −0.5 V to V_{CC}
Storage Temperature .... −40°C to +85°C

Recommended Operating Conditions

Temperature .... 0°C to +70°C

Parameter	Symbol	Min.	Max.	Units
Supply Voltage	V_{CC}	4.75	5.25	V
	V_S^+	+10.8	+13.2	V
	V_S^-	−10.8	−13.2	V
RS232 Input V_{IN}	V_{IH}	+3	+15	V
	V_{IL}	-3	−15	V
RS232 Output V_{OUT}	V_{OH}	+3	+10.5V	V
	V_{OL}	-3	-10.5V	V
Bell Output I_{OUT}	I_{OL}		24	mA
	I_{OH}		1000	μA

Figure 1B

COMMON SPECIFICATIONS. *PARALLEL AND SERIAL VERSIONS*

ELECTRICAL CHARACTERISTICS (Over temperature range 0°C to +70°C)

All typical values specified V_{CC} = 5 V, V_S^+ = 12 V, V_S^- = −12 V and T_A = 25° unless otherwise specified.

XDS2724P/2724S/2732P/2732S

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	CONDITIONS
Average Luminous Intensity/Segment	I_V	30	50		μcd	See Note 2
Peak Wavelength	λp		660		nm	
Input Threshold—High All Inputs	V_{IH}	2.0			V	V_{CC} = 5 V ± 5%
Input Threshold—Low All Inputs	V_{IL}			0.8	V	V_{CC} = 5 V ± 5%
Input Current—Low $\overline{RST}$, $\overline{ST}$, BRT, SB, FNT, L/$\overline{R}$, PRI, $\overline{BLK}$	I_{IL}			1.6	mA	V_{CC} = 5.25 V
Output Current—High $\overline{BELL}$	I_{OH}			1000	μA	V_{CC} = 5.25 V @ V_{OH} = 2.4 V
Output Current—Low $\overline{BELL}$	I_{OL}			24	mA	V_{CC} = 5.25 V @ V_{OL} = 0.5 V

NOTE 2: Temperature 25°C, V_{CC} = 5 V, all characters with 8 segments on, High Brightness.

Figure 2

ELECTRICAL CHARACTERISTICS (Con't.)
Supply Current, Input/Output Specifications

PARALLEL VERSION
XDS2724P/2732P

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	CONDITIONS
V_{CC} Supply Current XDS2724P XDS2732P	 I_{CC} I_{CC}		 380 435	 450 520	 mA mA	 V_{CC} = 5.25 V all characters displaying 8 segments ON
Input Threshold—High All Inputs	V_{IH}	2.0			V	V_{CC} = 5 V
Input Threshold—Low All Inputs	V_{IL}			0.8	V	V_{CC} = 5 V
Input Current—High $D_0 \rightarrow D_7$	I_{IH}			40	μA	V_{CC} = 5.25 V V_{IN} = 2.7 V
Input Current Low $D_0 \rightarrow D_7$	I_{IL}			0.4	mA	V_{CC} = 5.25 V V_{IN} = .5 V
Input Current Low All inputs except D_0-D_7 (See Note 3)	I_{IL}			1.6	mA	V_{CC} = 5.25 V V_{IN} = .5 V
Data Out, D_0-D_7	V_{OH} V_{OL}	2.4		 0.5	V V	I_{OH} = −2.6 mA, V_{CC} = 4.75 V I_{OL} = 8 mA, V_{CC} = 4.75 V

Figure 3A

SERIAL VERSION
XDS2724S/2732S

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	CONDITIONS
$+V_{CC}$ Supply Current XDS2724S XDS2732S	 I_{CC} I_{CC}		 380 435	 450 520	 mA mA	V_S^+ = +13.2 V all characters V_S^- = −13.2 V displaying 8 V_{CC} = 5.25 V segments ON
V_S^+ Supply Current	I_S^+		+19.0	+25.0	mA	V_{CC} = 5.25 V V_S^+ = +13.2 V V_S^- = −13.2 V
V_S^- Supply Current	I_S^-		−32.0	−39.0	mA	V_{CC} = 5.25 V V_S^+ = +13.2 V V_S^- = −13.2 V
RS232C Output Voltage	V_{OL} V_{OH}	−9.0 +9.0	−10.5 +10.5		V	V_{CC} = 5.25 V, V_S^+ = +13.2 V, V_S^- = −13.2 V } R_L = 3K
RS232C Input Voltage	V_{IH} V_{IL}	+3.0 −3.0		+15.0 −15.0	V	V_{CC} = 5.25 V V_S^+ = +13.2 V V_S^- = −13.2 V

Figure 3B

NOTE 3: All inputs listed except D_0-D_7 have 4.7K pullup resistors. I_{IH} not specified due to pullup resistors.

Displays

BASIC INTERFACE DEFINITIONS

All statements are made with respect to the XDS display system from the host system as shown:

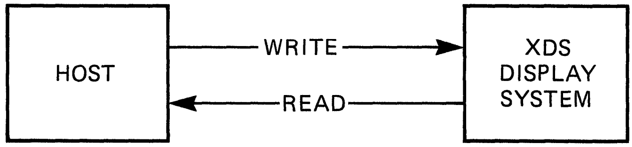


Figure 4. Data Flow Diagram

WRITE – Writes data from the host into the display.
READ – Display system outputs data to the host.

In both parallel and serial versions interfacing is straight forward requiring the minimum interconnects. The basic features and hardware/software display format remains the same for both systems.

XDS—PARALLEL SYSTEM DESCRIPTION

The XDS display system interface requires the minimum of control or "hand shaking" in a BUS oriented system, and is shown in Figure 5. Data/Control line functions are as follows:

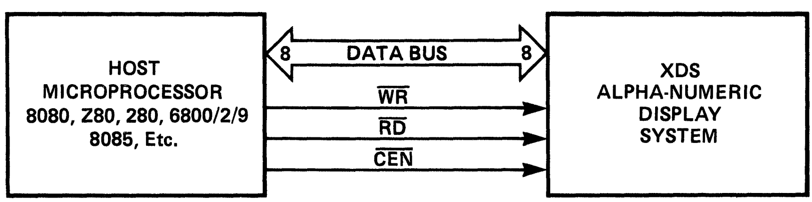


Figure 5

DATA BUS: 8 Bit standard μP bi-directional data BUS. This BUS in conjunction with 3 control inputs either accepts or sends data onto the 8 Bit BUS. When in the WRITE mode (with respect to display system) accepts data bytes, character display information, control codes and cursor locations. In the READ mode (output) it may be used to transmit "displayed information", status information and cursor location to the host system.

$\overline{C\ EN}$: CHIP ENABLE LINE: (ACTIVE LOW)
This is the master enable for any communications between host system and display subsystem.
When the $\overline{C\ EN}$ line is high, no communication exists between display and host microcomputer.
When the $\overline{C\ EN}$ line is low, the BUS READ, BUS WRITE and DATA BUS are recognized.

$\overline{RD}$: READ BUS: (ACTIVE LOW)
If $\overline{C\ EN}$ line is low and $\overline{RD}$ is low, it enables data to be read from the display system to the host system.

$\overline{WR}$: BUS WRITE: (ACTIVE LOW)
If $\overline{C\ EN}$ is low, a negative going pulse (high to low transition) on the $\overline{WR}$ line causes data on BUS to be latched into the display system and a service request is flagged.

TIMING DIAGRAMS:

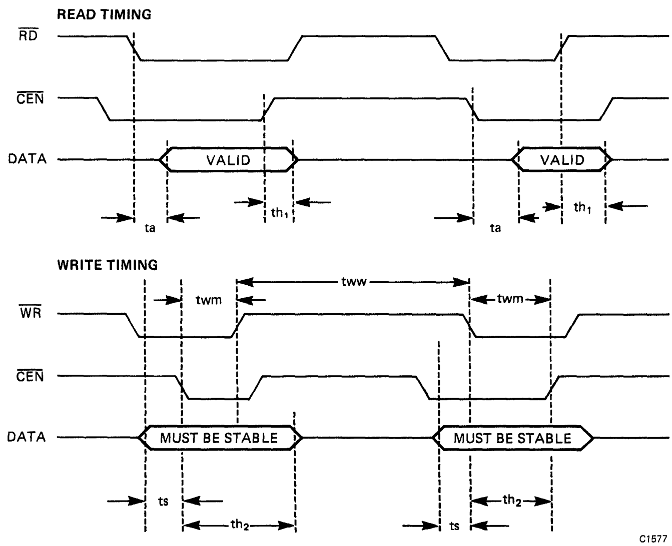


Figure 6

Figure 6 shows the timing relationships and specifications for the various control signals.

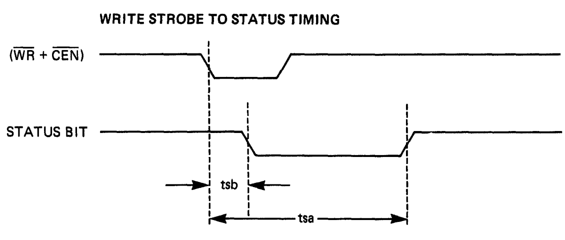


Figure 7

Read/Write Timing

Parameter	Symbol	Min.	Max.	Units
Read Timing Access Time	ta	–	28	nS
Data Hold Time	th_1	0	45	nS
Write Timing Set-up Time	ts	10	–	nS
Hold Time	th_2	3.0	–	nS
$\overline{WR}$ Pulse Width	twm	.015	35	μS

Write Strobe to Status Timing

Parameter	Symbol	Min.	Max.	Units
Time Between WRITES (See Note 4)	tww (Fig. 6)	220 μS	∞	–
Write Low to Status Low	tsb (Fig. 7)	–	50	μS
Write Low to Status High	tsa (Fig. 7)	–	5.0 mS	μS

Note 4: Write pulses should not be sent unless status bit is high; therefore, minimum time between write pulses is dependent on the status time-out, variable with last commanded operation.

CHARACTER-TO-CHARACTER ACCESS TIMES

Character-to-character access time is the amount of time required to enter a character to the next character into XDS Display System (entry to entry).

Left Entry Mode CR/LF
220μS = 4545 characters/second
The time increases in horizontal scroll mode when the display line has been filled to maximum of 803 μS which is equal to 1246 characters/second.

Right Entry Mode
803μS = 1246 characters/second

PARALLEL VERSION

$\overline{\text{C EN}}$	$\overline{\text{RD}}$	$\overline{\text{WR}}$	Data Bus Direction	Data Bus Content
H	X	X	High Impedance	—
L	L	H	Output	Data At Cursor Position
L	H	L	Input	Data From Host
L	L	L	—	Invalid Condition

Figure 8. Truth Table Control Inputs

BLOCK DIAGRAM—XDS2724P/2732P

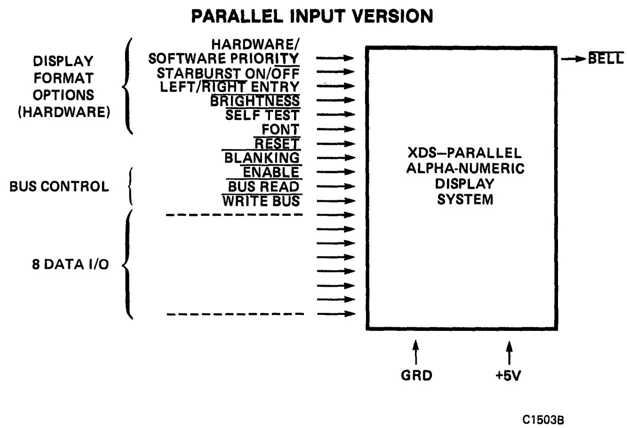


Figure 9.

XDS—SERIAL SYSTEM DESCRIPTION

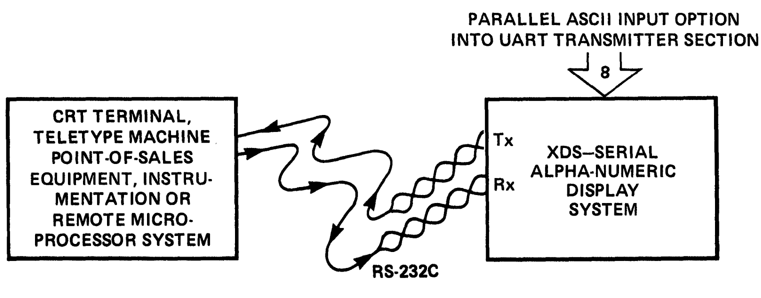


Figure 10

XDS SERIAL DISPLAY SYSTEM

Serial Version

The XDS Serial unit is designed to operate with RS232 serial input and output data. Jumper options provide for all commonly used Baud rates from 50 to 9600 Baud and for various bit patterns. A unique feature provides for a jumper option to allow ASCII parallel data to be loaded directly in the UART transmitter section, sent out to the host system RS232 serial. (See page 14)

The host's answer can then be returned RS232 serial for display on the XDS display system. The addition of the ASCII keyboard and a power supply makes for a complete terminal single line display sub-system. These features allow the system to be used in full or half duplex systems and provides a complete interactive display sub-system.

DATA BIT PATTERN–XDS–SERIAL

The data bit pattern starts with 1 START bit followed by 8 DATA BITS, least significant bit first (B_0) through to the most significant bit (B_7). Provision is made for jumper options for one or two STOP bits, odd or even PARITY, or NO PARITY.

Any data/command transmitted to the XDS display system is echoed back to the sender when the status bit goes high. If the command sent is a READ command, the data echoed back to the sender is that which was requested by the command, rather than echoing the command.

Above 300 Baud, NULLS must be sent to the XDS display system between characters to prevent display blanking.

BLOCK DIAGRAM–XDS2724S/2732S

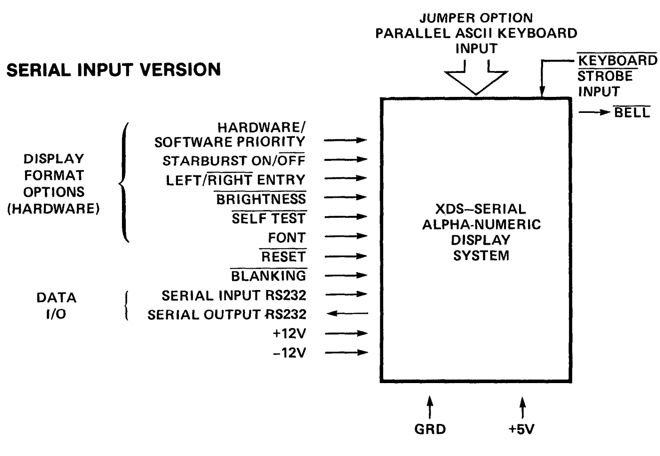


Figure 11.

DISPLAY FONT (14 segments plus decimal point)

The top and bottom segments are displayed split as shown, but are always shown as one since both halves are connected together.

The "decimal point" is used as a "period" and in the display of the "exclamation mark" and the "colon".

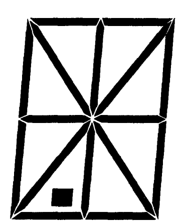


Figure 12. 14 Segments Plus Decimal Point

ASCII FONT CHART

STARBURST CURSOR FONT

Hex Character	ASCII	Font	Hex Character	ASCII	Font	Hex Character	ASCII	Font	Hex Character	ASCII	Font
00	NULL		20	SPACE		40	@		60	`	
01	SOH		21	!		41	A		61	a	
02	STX		22	"		42	B		62	b	
03	ETX		23	#		43	C		63	c	
04	EOT		24	$		44	D		64	d	
05	ENQ		25	%		45	E		65	e	
06	ACK		26	&		46	F		66	f	
07	BEL	*	27	'		47	G		67	g	
08	BS	*	28	(		48	H		68	h	
09	HT	*	29	)		49	I		69	i	
0A	LF	*	2A	*		4A	J		6A	j	
0B	VT		2B	+		4B	K		6B	k	
0C	FF		2C	,		4C	L		6C	l	
0D	CR	*	2D	—		4D	M		6D	m	
0E	SO		2E	.		4E	N		6E	n	
0F	SI		2F	/		4F	O		6F	o	
10	DLE		30	Ø		50	P		70	p	
11	DC1	*	31	1		51	Q		71	q	
12	DC2	*	32	2		52	R		72	r	
13	DC3	*	33	3		53	S		73	s	
14	DC4		34	4		54	T		74	t	
15	NAK		35	5		55	U		75	u	
16	SYN		36	6		56	V		76	v	
17	ETB		37	7		57	W		77	w	
18	CAN		38	8		58	X		78	x	
19	EM		39	9		59	Y		79	y	
1A	SUB		3A	:		5A	Z		7A	z	
1B	ESC	*	3B	;		5B	[		7B	{	
1C	FS		3C	<		5C	\		7C	|	
1D	GS		3D	=		5D	]		7D	}	
1E	RS		3E	>		5E	∧		7E	~	
1F	US		3F	?		5F	_		7F	DELETE	▲

▲ Deletes character under the cursor, and cursor moves to the right one position.

* Control characters used

Figure 13. ASCII Font Chart

BASIC DISPLAY MODES

(NOTE: The following illustrations are shown for a 24 character system. Operation for the 32 character system is similar.)

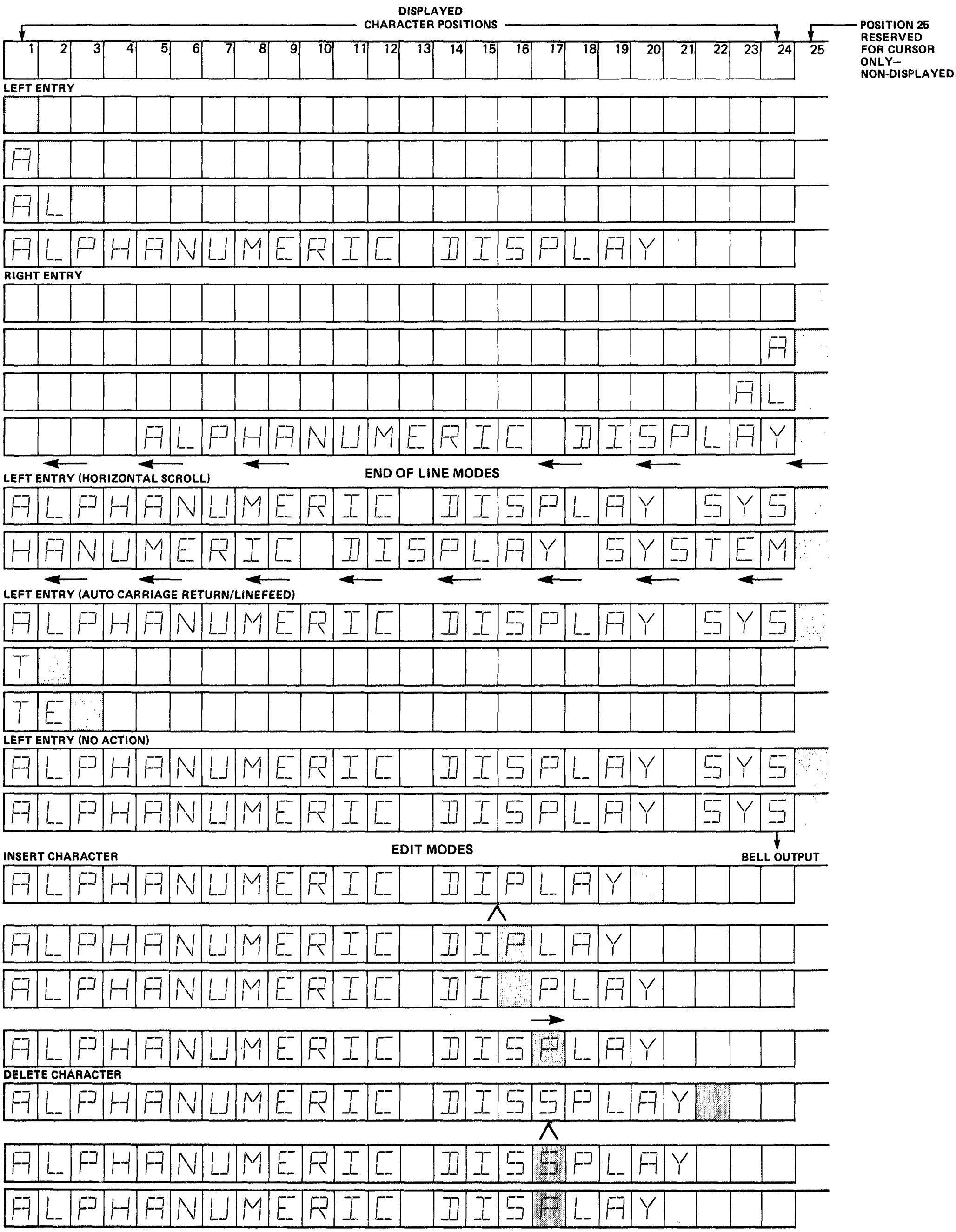


Figure 14.

Displays

DISPLAY MODES

The XDS2732 has 32 characters and operate similarly with the appropriate number of characters.

Display Length

The XDS2724 has 24 viewable character positions, 1 through 24. There is a non-displayed 25th position which is reserved for the cursor in RIGHT ENTRY DISPLAY, HORIZONTAL SCROLL NO-ACTION, modes, as shown in Figure 14.

DISPLAY ENTRY MODES

There are two character entry modes, left or right. Either can be selected by hardware or software commands. See Figure 14.

Left Entry

Characters when entered into an empty display enter on the left most position #1; subsequent characters fill the display left to right. In the "Left Entry" mode all "End-of-Line" mode commands, cursor control and editing features are functional as explained later.

Right Entry

Each new character entered is displayed in the right-most character position (last character) and the entire display is shifted left one position.

In the "Right Entry" mode the only display controls which function are the "Backspace" character which causes the entire display to be moved right one character position, and the "Line Feed" which clears the entire display. Cursor, "editing" modes, and "Bell output" are not functional.

The action taken by the display for new characters entered in "Right Entry" mode appear very similar to "Left Entry" with the "Horizontal Scroll End-of-Line" mode when the display has been filled; however, in horizontal scroll mode the cursor is operational. See "Horizontal Scroll Mode."

Internal Cursor

The display has an internal cursor which always points to where the next character entered will be displayed.

This may or may not be visible dependent upon whether a STARBURST has been selected by hardware/software and the display mode. If STARBURST is ON, the next character entered will be displayed at the current starburst location and the cursor will be moved one character to the right for left entry.

On POWER UP or on a RESET the entire display is blanked (refresh RAM filled with spaces). If "left display entry" mode is selected, the cursor will be at the left most position and the cursor value will be one. As each subsequent ASCII character (displayable only) is entered, it is displayed at the cursor position and the cursor will move right one position. Its value will have increased by one. The maximum cursor position is one position past the last displayable character and if further displayable characters are sent, the action taken by the display will depend upon the selected "end-of-line mode" (See Figure 14).

END-OF-LINE MODES

The "End-of-Line" modes determine what the display contents will do when all display character positions have been filled. All "End-of-Line" modes are selected or changed by software commands except the automatic default mode explained next.

Horizontal Scroll

The "Horizontal Scroll" mode is the automatic default. If no "End-of-Line" mode has been selected by software commands Horizontal Scroll Mode is assumed.

When all display character positions have been filled subsequent ASCII characters cause the entire display to be shifted left one position and a new character is entered in the right-most position. The starburst cursor, if selected, will not be visible since it will be in the position reserved for the cursor only. (See Figure 14.)

BACKSPACE and HORIZONTAL TAB allow the cursor to be moved throughout the display.

Carriage Return/Line Feed

When the entire display line has been filled, the next character entered clears the entire display and that character is placed in the left-most position #1. The starburst cursor, if selected, will be in position #2. (See Figure 14.)

No Action

When the display line has been filled further characters entered cause a negative pulse on the "BELL" output and the display remains unchanged.

The "Carriage Return" character clears the display and is ready to accept new data.

Power ON Default Mode

The display reverts to "Left Entry" display mode, "Horizontal Scroll" end-of-line mode. The "Starburst Cursor" is on when no hardware select inputs are connected.

CONTROL MODES AND COMMAND DEFINITIONS

Communication Input and Output
Communication with the XDS display system is made possible by the input and output ports. The "Parallel XDS" display communication is established by an 8-bit bi-directional I/O plus 3 command lines. The "Serial XDS" display communication is via a serial RS232C input port and a RS232C output port.

In both systems the data bit FORMAT remains the same. This is shown in Figure 15.

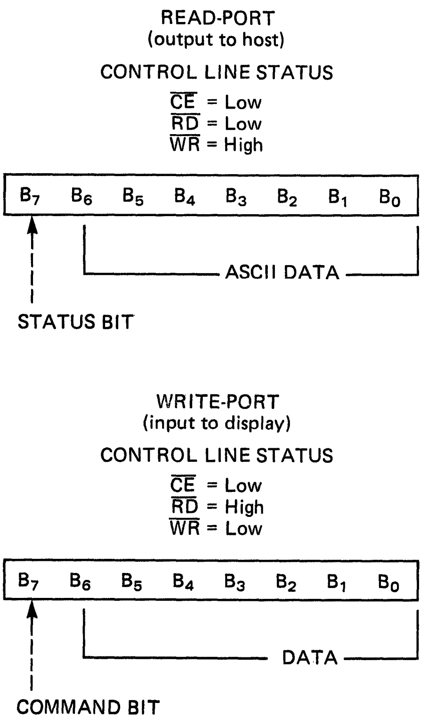


Figure 15

In the WRITE mode (to display) ASCII characters are transmitted to the display by sending bit B_7 = L with the ASCII DATA in bits $B_0 \rightarrow B_6$. All displayable ASCII characters will be stored in the display μP refresh RAM adjusted to be upper case. Some control characters will be recognized and will affect display operation. (See DATA WRITE.)

Commands are sent to the display by sending bit B_7 = H. The rest of the byte $B_0 \rightarrow B_6$ contains command information. (See COMMAND WRITE.)

In the READ mode bit B_7 is the STATUS BIT. If HIGH, the bits $B_0 \rightarrow B_6$ contain valid data. If bit B_7 is LOW, then bits $B_0 \rightarrow B_6$ contain invalid data.

Data Write
DATA WRITES are performed by sending an ASCII character in bits $B_0 \rightarrow B_6$ and bit B_7 = L. Some ASCII control characters will affect display operation as listed. All characters transmitted to the display will be echoed.

Control Characters Recognized:

L.F.	(HEX ØA)	Line feed: clears display without affecting the cursor position.
C.R.	(HEX ØD)	Carriage return: sets cursor to position one.
H.T.	(HEX Ø9)	Horizontal tab: moves cursor right one position.
B.S.	(HEX Ø8)	Backspace: In left entry, decrements cursor; in right entry, scrolls the display right one position, losing the last character.
ESC.	(HEX 1B)	The escape character plus a two key numeric entry positions the cursor to any of the 1 through 24 character positions. The first numeric entry represents the ten's digit, the second represents the unit's digit.
BELL	(HEX Ø7)	Bell: This character causes a negative pulse to be output on the "BELL" I/O line.

The following control characters set the mode of operation of the display when extra characters are typed beyond the end of the character line.

CTL Q.	(HEX 11)	Auto carriage return/line feed.
CTL R.	(HEX 12)	Display "No Action". Bell pulse only
CTL S.	(HEX 13)	Horizontal scroll (Auto Default Mode). All characters are shifted to the left one character position.

Command Write
The commands listed (Bit B_7 = H) affect the operation of the display system. Invalid commands will be ignored. Command characters can be sent but not checked at the output, due to bit B_7 being used as a status bit.

— continued on next page —

CONTROL MODES AND COMMAND DEFINITIONS (Continued)

Fixed Commands
These commands have to be generated by the host system.

Hex Value	Function
80	Carriage return, line feed
81	Read cursor position
82	Read data at cursor position
83	Read data at cursor, increment cursor
84	Insert space at cursor (left entry only)
85	Delete character at cursor position (left entry only)
86	Turn on starburst at cursor position (left entry only)
87	Turn off starburst
88	Select blinking of starburst, if displayed
89	Deselect blinking of starburst
8A	Go to left display entry mode
8B	Go to right display entry mode
8C	Go to high display brightness
8D	Go to low display brightness
8E	Enable hardware control of brightness (default)
8F	System reset, as power up, or hardware RESET

Inherent Address Commands
These commands contain the cursor address pointer.

Bit #	Command
Bit # 76543210	Command
Bit # 111XXXXX	Set cursor to position XXXXX (Binary)
Bit # 110XXXXX	Read data at position XXXXX (Binary)

HARDWARE/SOFTWARE CONTROL

At power up, or system reset, the display FORMAT option lines are read into the XDS processor. These option lines control:

(1) Hardware Priority, (2) Self-test, (3) Brightness, (4) Entry Mode—Left/Right, (5) Starburst Cursor On/Off, and (6) Font*.

The XDS controller board is designed so that the display format options can be controlled from an external system via input connections on the primary connector, P1.

Hardware Priority (PRI) pin #3
If the priority line is set HIGH, all software commands which could affect brightness or entry mode (left/right) are ignored.

Starburst (SB) pin #8
The starburst is merely a cursor location marker and it is displayed at position #1 at power up, if selected. (See Figure 14.) Software commands may be sent to turn on or turn off the starburst character and blinking may be selected or deselected. Selection of starburst ON/OFF does not change the blinking/not blinking state of the starburst stored command.

*Font input not used on XDS display system.

Brightness (BRT) pin #12
After power up, the state of the hardware brightness line is read during each display refresh cycle so that a light control system may be implemented to control the brightness of the display. If a "Hi" or "Lo" brightness software command is sent then the hardware "Brightness Line" is inoperative. Brightness stays "Hi" or "Lo" according to the software command. After receipt of a software "enable hardware brightness" command, sampling of the hardware line is resumed.

Blanking Input (BLK) pin #14
This line can be used to blank out the display or can be used to control the brightness levels of the display by varying the pulse frequency. Blanking occurs during the low state.

Left/Right Entry Mode (L/$\overline{R}$) pin #2
If the software priority has been selected (hardware PRIORITY line = L), then the entry mode may be modified with the "select left" (or right) entry mode software commands.

Self-Test ($\overline{ST}$) pin #18
If the SELF-TEST line is low at power up, the XDS μP sets the status bit low and executes the self-test sequence, the system will remain in SELF-TEST mode until the self-test line is taken high. Data or command inputs into the system will be ignored during a SELF-TEST sequence. The end of a SELF-TEST response is flagged by a cleared display and the status bit on the READ port being set high.

The self-test routine performs three functions: (1) performs a functional segment "lamp test" for each character (2) displays the entire available character set and (3) a functional self-test of the XDS controller.

The format of the self-test is simple: a non-blinking starburst character is displayed at the left-most location and the character is displayed at the right-most location. The starburst is then scrolled across the display moving rightwards as further characters, in sequence, are scrolled in from the right, moving left. When the entire character set has been displayed, spaces are scrolled in from the right until the display is cleared. At this point the status bit is set high and the XDS controller is ready to receive data/command inputs.

Font
This determines the type of display output from the μP control board for driving the display board, either 14 segment decoded information or an ASCII output. In the XDS systems 14 segment decode information is used and the FONT input must be left HIGH (PIN 6 of primary connector P1).

$\overline{\text{Bell}}$ Output pin #4
This is a negative pulse of 2 μs duration which can be used to trigger an audible device whenever a bell output occurs.

BLOCK DIAGRAMS

XDS Parallel Units

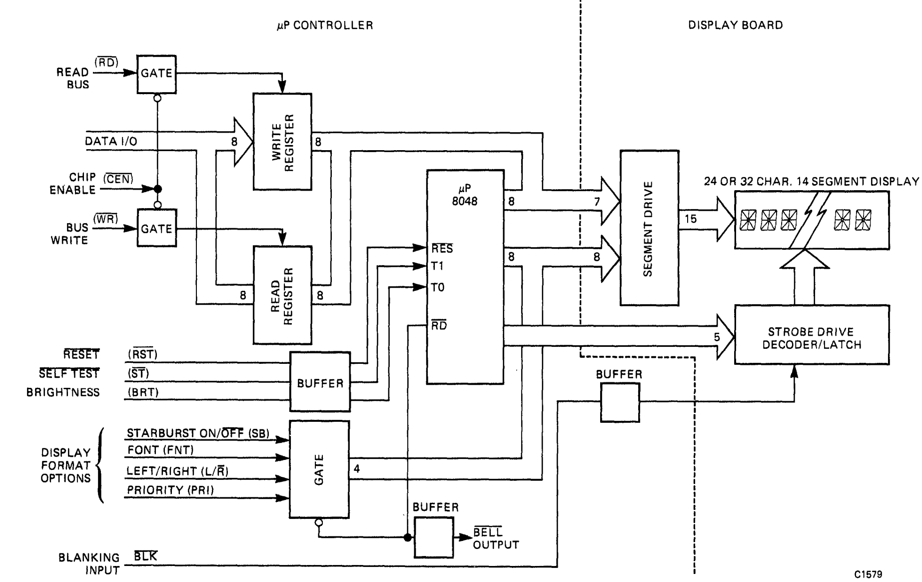


Figure 16. Block Diagram—XDS Parallel Unit

XDS Serial Units

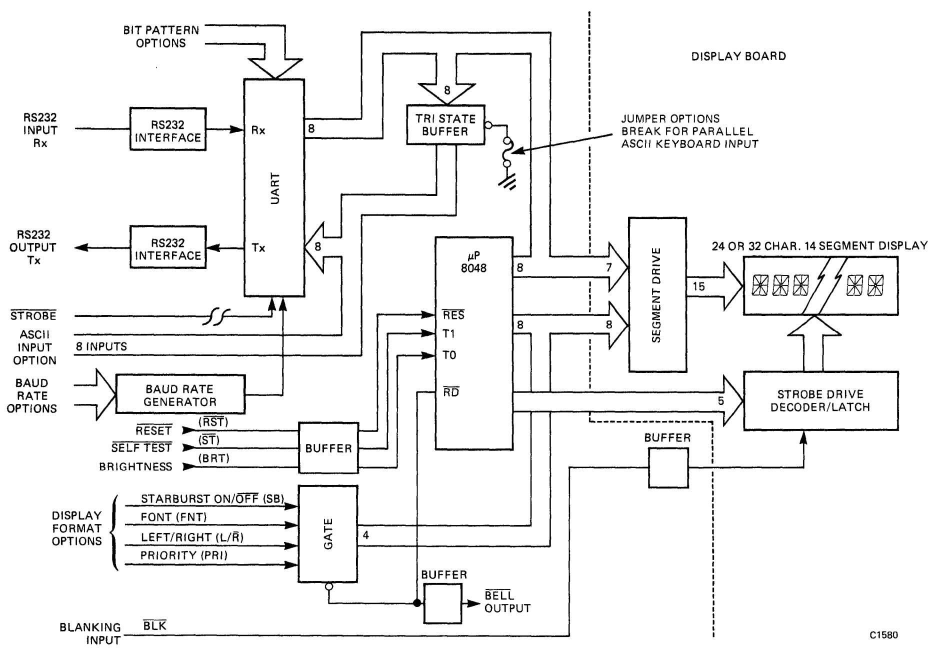


Figure 17. Block Diagram—XDS Serial Unit

Displays

CONNECTION TO COMMONLY USED MICROPROCESSORS

Intel 8080

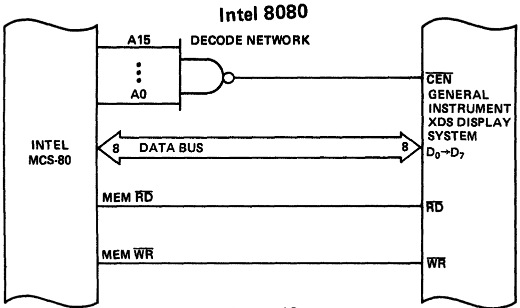


Figure 18

C1506B

Zilog Z-80

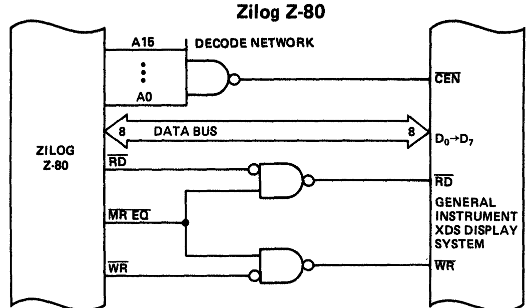


Figure 19

C1507B

Motorola MC68002/9

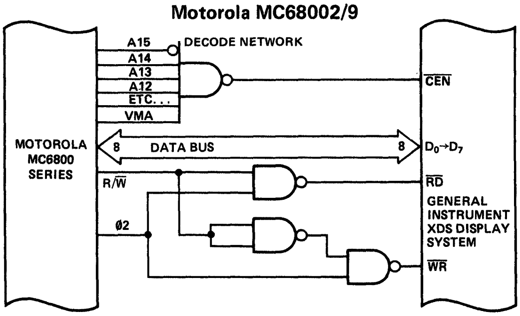


Figure 20

C1508B

Intel 8085

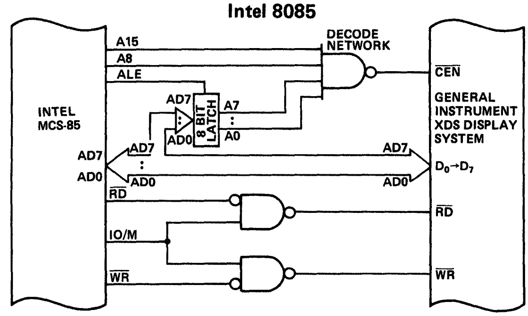


Figure 21

C1584

XDS SERIAL VERSION – JUMPER OPTIONS

As supplied, the units are set up for following

Operation Mode	"Full Duplex" (Echo Back after status bit (B7) goes high)
Baud Rate	110 Bits/Second
Bit Pattern	1 Start Bit
Bit Pattern	2 Stop Bits
Bit Pattern	8 Data Bits
Bit Pattern	No Parity

Baud Rate Table

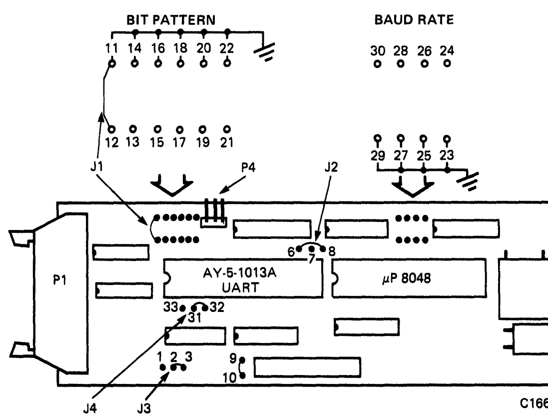
Pins Grounded	Baud Rate
E24, E28, E30	50
E28, E30	75
None	110
E24, E26, E30	134.5
E24	150
E26, E30	200
E26	300
E24, E30	600
E28	1200
E24, E28	1800
E30 or E24, E26	2400
E22, E28	4800
E24, E26, E28	9600

RS 232 Options

Jumpers	Pin Status	Action
E21	Open	No parity
E21	Grounded	Parity
E13	Open	Even parity
E13	Ground	Odd parity
E19	Open	2 Stop bits
E19	Ground	1 Stop bit
E15 E17	Selects number of data bits as per below	

E17	E15	Bits Per Character
0	0	5
0	1	6
1	0	7
1	1	8

0 = Ground 1 = Open



C1666

Figure 22. Serial Controller – Jumper Options

NOTE: All numbers shown for jumpers are prefixed with an "E" in the text.

"Half Duplex" (Parallel Keyboard Input)

1. Break jumper J3 (points 2 and 3) and connect points 1 and 2.
2. Break jumper J1 (points 11 and 12).
3. Break jumper J4 (points 31 and 32) and connect points 32 and 33.
4. Break jumper J2 (points 6 and 8) and connect points 6 and 7.

NOTE: 1. Key board strobe P1 Pin 5 active low.
2. Parallel/ serial interface not available simultaneously.

PACKAGE DIMENSIONS XDS2724P and 2724S

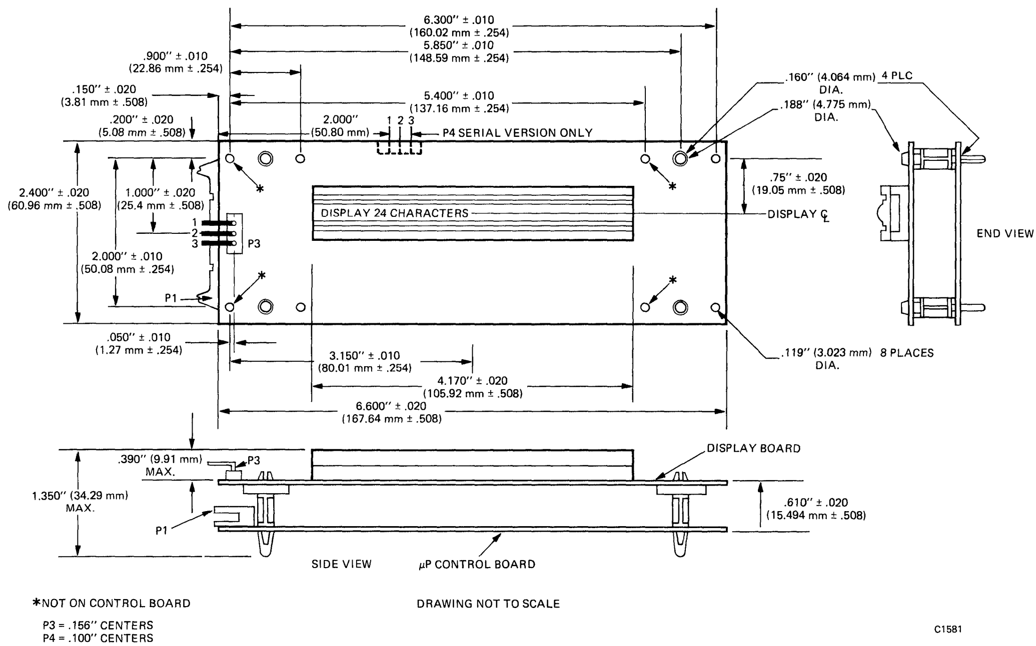


Figure 23

XDS2732P and 2732S

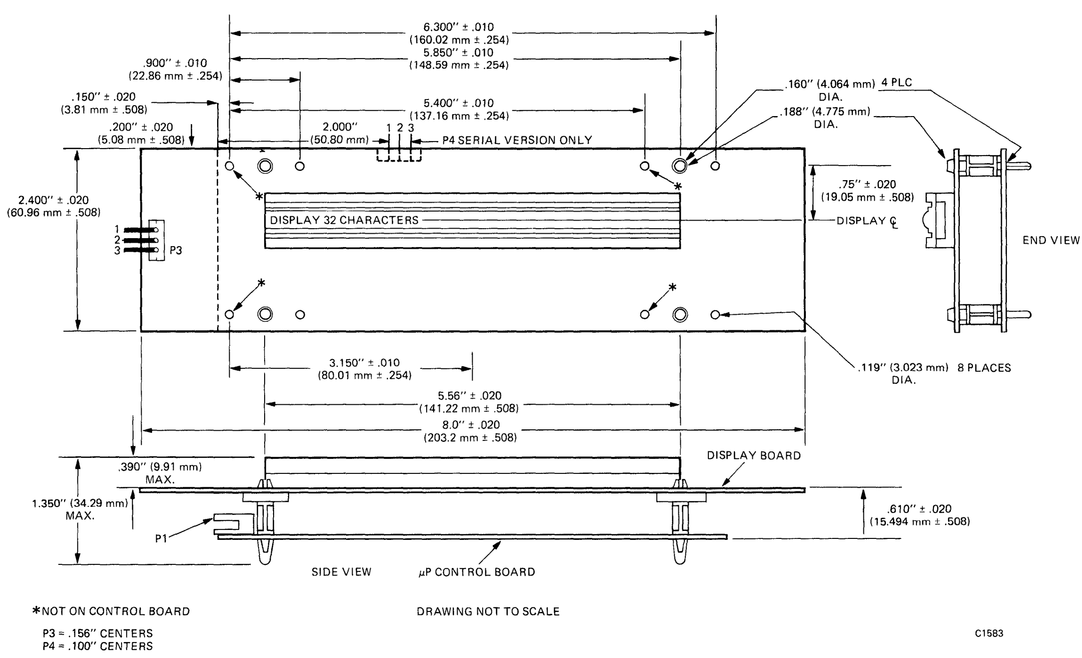
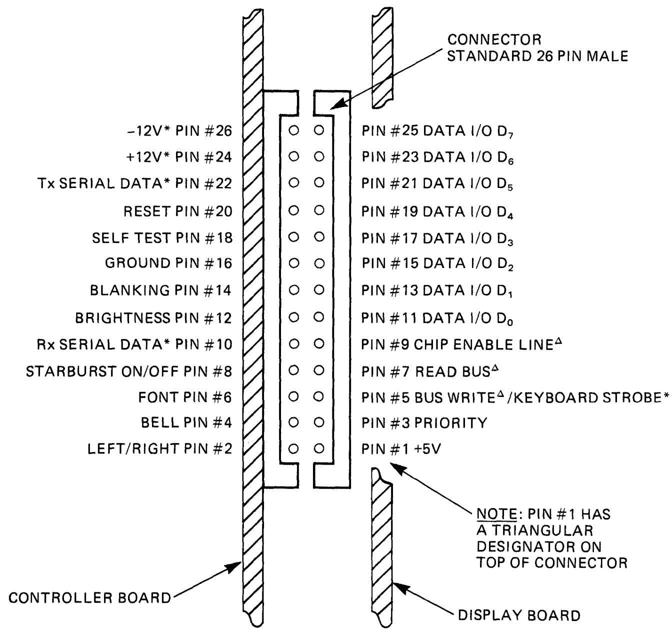


Figure 24

Displays

PRIMARY CONNECTOR



*SERIAL VERSION ONLY
^ΔPARALLEL VERSION ONLY

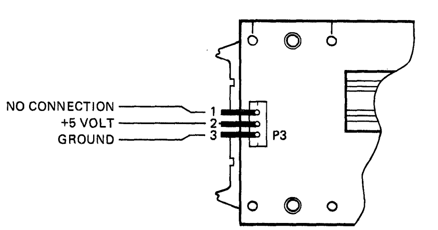
C1585

CONNECTION TO XDS DISPLAY SYSTEM REQUIRES 26 PIN STANDARD RIBBON CABLE WITH SOCKET CONNECTOR. A.P. PRODUCTS TYPE 924043-36-R OR SIMILAR.

Figure 25

P3 OPTIONAL: +5 V POWER CONNECTIONS

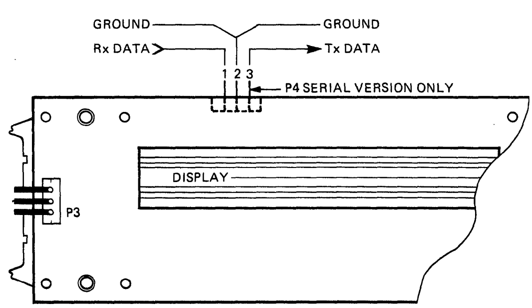
AN OPTIONAL 3 PIN MALE CONNECTOR MAY BE INSTALLED BY CUSTOMER FOR +5 VOLT SUPPLY IF REQUIRED.



C1586

MOUNTING CONNECTOR
MOLEX TYPE 26-17-1031 .156" CENTERS MALE OR SIMILAR.
MATING CONNECTOR
MOLEX TYPE 09-91-0300 .156" CENTERS FEMALE OR SIMILAR.

Figure 26



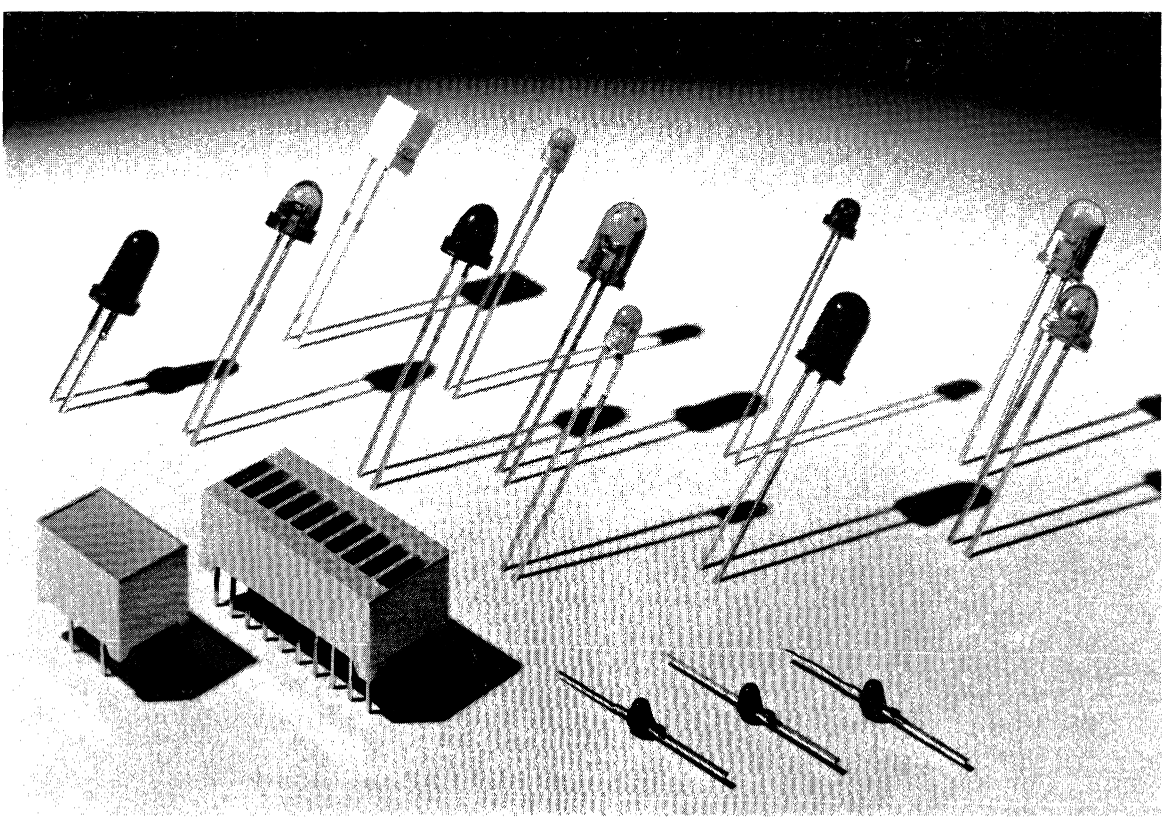
C1587

P4 SERIAL VERSION. OPTIONAL RS232 I/O

THIS CONNECTOR IS WIRED IN PARALLEL WITH CONNECTIONS IN P1. MATING CONNECTOR. FEMALE MOLEX 22-01-2036 .100" CENTERS.

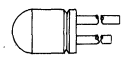
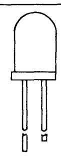
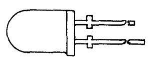
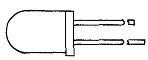
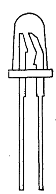
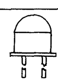
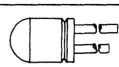
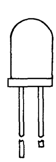
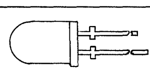
Figure 27

Lamps 5



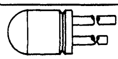
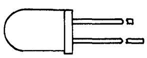
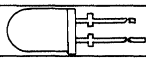
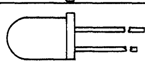
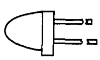
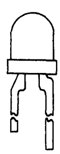
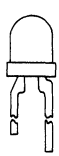
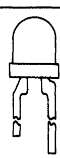
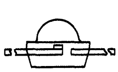
LED LAMPS

Non-Diffused (Backlighting)

PACKAGE	OUTLINE	PART NUMBER	SOURCE COLOR	LENS DESIGN	I_VTYP mcd/mA	2Θ½	PAGE
T-1¾		MK9150-1	High Eff. Red.	Water-clear	45/100	140	405
		MK9150-2			80/100	140	
		MK9160			100/100	75	401
		HLMP-3315		Tinted	18/10	35	415
		HLMP-3316			30/10	35	415
		MV6152			40/20	28	421
		MV6752			40/20	28	421
		HLMP-3750		Water-clear	150/20	24	399
		MV6052	Std. Red	Tinted	2.0/20	72	431
		MV6050		Water-clear	2.0/20	50	431
		MV5020			2.0/20	50	435
		MV5022		Tinted	1.6/20	50	435
		MV10B		Water-clear	.8/10	90	439
		MK9350-1	Yellow	Water-clear	45/100	140	405
		MK9350-2			80/100	140	405
		MK9360			100/100	75	401
		HLMP-3415		Amber Tint	18/10	35	415
		HLMP-3416			30/10	35	415
		MV6852			40/20	28	421
		MV6352		Yellow Tint	40/20	28	421
		HLMP-3850		Water-clear	150/20	24	399

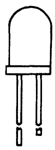
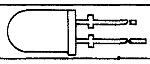
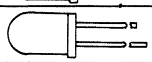
LED LAMPS

Non-Diffused (Backlighting)

PACKAGE	OUTLINE	PART NUMBER	SOURCE COLOR	LENS DESIGN	I_VTYP mcd/mA	2Θ½	PAGE
T-1¾		MK9450	High Eff. Green	Water-clear	45/100	140	413
		MK9460			50/100	75	
		HLMP-3517		Tinted	25/20	35	403
		HLMP-3519			50/20	35	415
		MV64520			25/20	35	415
		MV64521			60/20	35	421
		HLMP-3950		Water-clear	150/20	24	399
		FLV111	Std. Red	Water-clear	.8/20	70	425
		MV50152		Tinted	1.5/10	45	429
	Low Profile	MV57152	High Eff. Red		8.0/10	45	429
		MV53152	Yellow		5.0/10	45	429
		MV54152	High Eff. Green		5.0/10	45	429
T-1		MV5760	High Eff. Red	Water-clear	12/10	60	455
		HLMP-1320			12/10	45	451
		HLMP-1340			60/20	40	399
		MV57620		Tinted	2.0/10	60	455
		MV57621			4.0/10	60	455
		MV57622			12/10	60	455
		HLMP-1321			12/10	45	451
		MV5360	Yellow	Water-clear	12/10	60	455
		HLMP-1420			12/10	45	451
		HLMP-1440			60/20	40	399
		MV53620		Yellow Tint	2.0/1.0	60	455
		MV53621			4.0/1.0	60	455
		MV53622			8.0/1.0	60	455
		HLMP-1421		Amber Tint	12/10	45	451
		MV5460	High Eff. Green	Water-clear	12/20	60	455
		HLMP-1520			12/20	45	451
		HLMP-1540			60/20	40	399
		MV54623		Tinted	6/20	60	455
		MV54624			12/20	60	455
		HLMP-1521			12/20	45	451
T-¾		MV50	Std. Red	Water-clear	1.4/20	80	485
		MV54	Std. Red	Tinted	1.0/20	80	485
		MV53	Yellow		2.0/20	80	483
		MV57	High Eff. Red				
		MV64	High Eff. Green				
		MV55A	High Eff. Red		.5/5	30	487

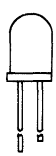
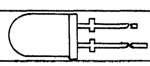
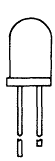
Lamps

White Diffused (Non-Tinted, Direct View)

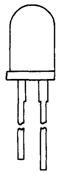
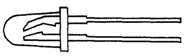
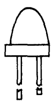
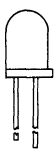
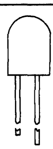
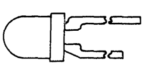
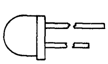
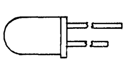
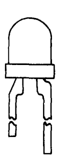
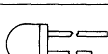
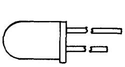
PACKAGE	OUTLINE	PART NUMBER	SOURCE COLOR	LENS DESIGN	I_VTYP mcd/mA	2Θ½	PAGE
T-1¾		MV6151	High Eff. Red	White Diffused	12/20	75	419
		MV6351	Yellow		12/20		
		MV6451	High Eff. Green		12/20		
		MV6651	Orange		12/20		
		MV6951	AlGaAs Red				
		MV5491A	A-Red/HEG		6.0/20	110	441
		MV6051	Std. Red		1.6/20	75	431
		MV5021*			1.6/20	50	435
	Low-profile	FLV112			.8/20	70	425

*with stand-off

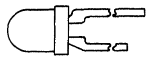
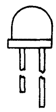
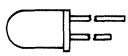
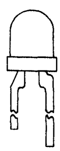
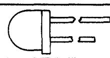
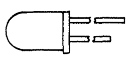
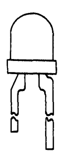
Tinted Diffused (Direct View)

PACKAGE	OUTLINE	PART NUMBER	SOURCE COLOR	LENS DESIGN	I_VTYP mcd/mA	2Θ½	PAGE
T-1¾		HLMP-4700	High Eff. Red	Tinted Diffused	2.0/2	50	397
		HLMP-3300			3.5/10	65	415
		HLMP-3301			7.0/10		
		HLMP-4600			4.0/10	32	
		HLMP-4601			8.0/10		
		MV6153		Amber Tinted Diffused	6.0/20	65	423
		MV6753		Tinted Diffused	9.0/20		
		MV6154A		Amber Tinted Diffused	20/20	24	
		MV6754A		Tinted Diffused			
		MV5094A	High Eff. Red/ A-Red		6.0/20	75	441
		HLMP-4719	Yellow	Yellow Tint Diffused	2.0/2	50	397
		HLMP-3400		Amber Tint Diffused	4.0/10	65	415
		HLMP-3401			8.0/10		
		MV6853			8.0/20		423
		MV6353		Yellow Tint Diffused	8.0/20		
		MV6354A			20/20	24	
		MV64530	High Eff. Green	Tinted	6.0/20	75	423
		HLMP-3502			6.0/20		415
		MV64531			14/20		423
		HLMP-3507			12/20		415
		MV6454A			20/20	24	423
		MV6055	Std. Red	Tinted Diffused	.6/20	150	431
		MV6056			.8/20	110	
		MV6053			1.6/20	80	
		MV6054A-1			2.0/10	40	
		MV6054A-2			3.0/10		
		MV6054A-3			4.0/10		

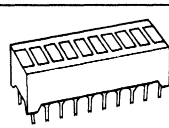
Tinted Diffused (Direct View)

PACKAGE	OUTLINE	PART NUMBER	SOURCE COLOR	LENS DESIGN	I_VTYP mcd/mA	2Θ½	PAGE
T-1¾		MV5054-1	Std. Red	Tinted Diffused	2.0/20	40	431
		MV5054-2			3.0/20	40	431
		MV5054-3			4.0/20	40	431
		MV5025			.4/20	50	435
		MV5026			.6/20	50	435
		MV5023			1.6/20	50	435
		MV5024			3.0/20	50	435
Low Profile T-1¾		MV50154	Std. Red	Tinted Diffused	1.5/10	50	429
		MV53154	Yellow		3.0/10		
		MV54154	High Eff. Green		3.0/10		
		MV57154	High Eff. Red		4.0/10		
		FLV110	Std. Red	Tinted Diffused	3.0/20	70	425
		FLV117	Std. Red		2.0/20		
		FLV310	High Eff. Green		15/20		
		FLV410	Yellow		15/20		
		FLV510	High Eff. Red		15/20		
		MV60538	Std. Red	Tinted Diffused	3.0/20	70	427
		MV63538	Yellow		16/20		
		MV64538	High Eff. Green		18/20		
		MV67538	High Eff. Red		14/20		
T-1		HLMP-1700	High Eff. Red	Tinted Diffused	2.0/2	50	397
		MV5777C			3.0/20	180	461
		MV5177C			3.0/20	180	461
		MV5174C		Amber Tint Diffused	5.0/20	90	457
		MV5774C		Tinted Diffused	5.0/20	90	457
		MV51640		Amber Tint Diffused	2.0/20	90	453
		MV51641			2.5/20		
		MV51642			3.5/20		
		MV57640		Tinted Diffused	2.0/10		
		MV57641			2.5/10		
		MV57642			4.0/10		
		HLMP-1300			2.0/10	60	451
		HLMP-1301			2.5/10		
		HLMP-1302			4.0/10		
		MV5077C	Std. Red	Tinted Diffused	1.75/20	110	463
		MV5075C			1.6/20	90	459
		MV5074C			2.5/20	70	459

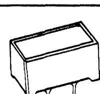
Tinted Diffused (Direct View)

PACKAGE	OUTLINE	PART NUMBER	SOURCE COLOR	LENS DESIGN	I_VTYP mcd/mA	$2\Theta_{1/2}$	PAGE
T-1		HLMP-1719	Yellow	Yellow Tint Diffused	2.0/2	50	397
		MV5377C			3.0/20	180	461
		MV5374C			3.0/20	90	457
		MV53640			2.0/10	90	453
		MV53641			3.0/10		453
		MV53642			4.5/10		453
		MV58640		Amber Tint Diffused	2.0/10		453
		MV58641			2.5/10		453
		MV58642			4.0/10		453
		HLMP-1400			2.0/10	60	451
		HLMP-1401			3.0/10		451
		HLMP-1402			4.0/10		451
		MV5477C	High Eff. Green	Tinted Diffused	3.0/20	180	461
		MV54774C			3.0/20	90	457
		MV54643			5.0/20		453
		MV54644			10/20		453
		MV55643		Green Tint Diffused	5.0/20		453
		MV55644			10/20		453
		HLMP-1503			5.0/20	60	451
		HLMP-1523			10/20		451

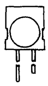
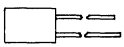
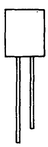
Bargraphs

PACKAGE	OUTLINE	PART NUMBER	SOURCE COLOR	SEGMENT/ FACE COLOR	I_VTYP mcd/mA	$2\Theta_{1/2}$	PAGE
10 element		MV53164	Yellow	Untinted Diffused/gray	1.0/10	130	477
		MV54164	High Eff. Green				
		MV57164	High Eff. Red	Red diffused/ gray			

Panel Indicators

PACKAGE	OUTLINE	PART NUMBER	SOURCE COLOR	ENCAPSULANT COLOR	I_VTYP mcd/mA	$2\Theta_{1/2}$	PAGE
.5-inch rectangular		MV53173	Yellow	Yellow Diffused	10.0/20	130	473
		MV54173	High Eff. Green	Untinted Diffused			
		MV57173	High Eff. Red	Red diffused			

Rectangulars

PACKAGE	OUTLINE	PART NUMBER	SOURCE COLOR	LENS DESIGN	IvTYP mcd/mA	2Θ½	PAGE
		MV53124	Yellow	Tinted Diffused	4.0/20	100	465
		MV54124	High Eff. Green				
		MV56124	Orange				
		MV57124	High Eff. Red				
		MV53123	Yellow		3.0/20	100	467
		MV54123	High Eff. Green				
		MV57123	High Eff. Red				
		HLMP-0300	High Eff. Red		2.5/20	100	469
		HLMP-0301			5.0/20		
		HLMP-0400	Yellow		2.5/20		
		HLMP-0401			5.0/20		
		HLMP-0503	High Eff. Green		3.0/20		
		HLMP-0504			5.0/20		

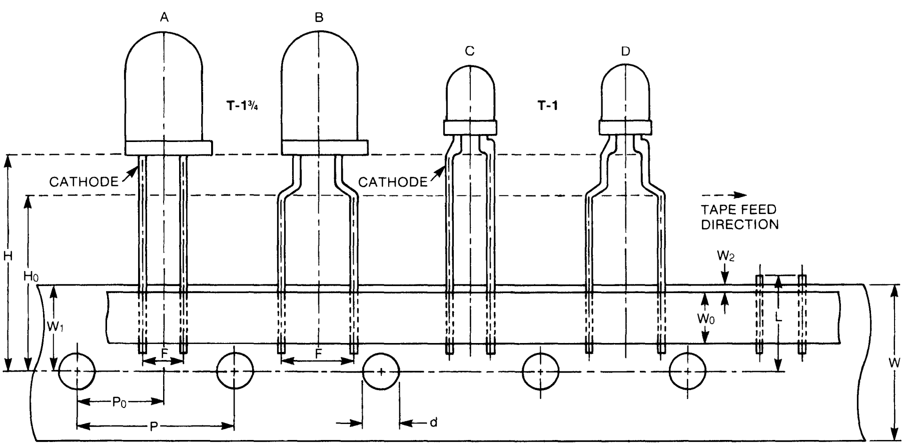
Special Functions

PACKAGE	OUTLINE	PART NUMBER	SOURCE COLOR	LENS DESIGN	IvTYP mcd/mA	2Θ½	PAGE
T-1¾	Bi-color	MV5491A	High Eff. Green & AlGaAs Red	White Diff.	6.0/20	100	441
		MV5491	Use MV5491A		1.0/20	45	445
		MV9471			5.0/20	45	443
		MV9475			5.0/20	45	443
	Ultra-Bright	MK9150	High Eff. Red	Water-clear	100/100	75	405
		MK9350	Yellow				405
		MK9450	High Eff. Green				413
		HLMP-3750	High Eff. Red		150/20	24	399
		HLMP-3850	Yellow				
		HLMP-3950	High Eff. Green				
T-1		HLMP-1340	High Eff. Red		60/20	40	399
		HLMP-1440	Yellow				
		HLMP-1540	High Eff. Green				
	2mA	HLMP-1700	High Eff. Red	Tinted Diffused	2.0/2	50	397
		HLMP-1719	Yellow				397
T-1¾		HLMP-4700	High Eff. Red				397
		HLMP-1719	Yellow				397
	Bipolar Red	MV5094A	High Eff. Red & AlGaAs Red	Red Diffused	6.0/20	75	441
		MV5094	Use MV5094A		.8/20	45	449
		MV9772			5.0/20	45	443
		MV9776			5.0/20	45	443

GENERAL INSTRUMENT

TAPE AND REEL

PACKAGE DIMENSIONS



C1834

	A	B	C	D
H	16.5	—	16.5	—
	18.5	18.5	18.5	—
	22.5	22.5	22.5	22.5
Ho	—	16	—	16
Wo	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			
Po	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	±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" lead spacing or preformed to .200"
- Choice of H = 16.5, 18.5 or 22.5 mm
- Standard reel or ammo box
- T-1¾; MV6X5X, MV5X9XA, MK9X60, GIOD HLMP-XXXX
- T-1; MV5X6XX, GIOD HLMP-XXXX

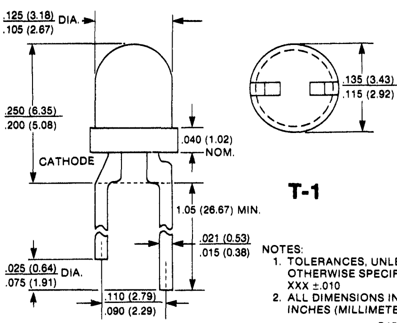
Lamps

GENERAL INSTRUMENT

2 mA

HIGH EFFICIENCY RED HLMP-4700 HLMP-1700
YELLOW HLMP-4719 HLMP-1719

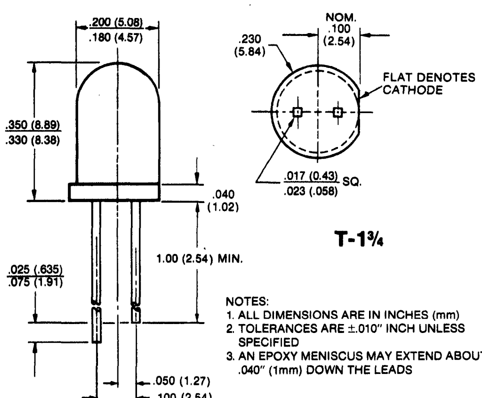
PACKAGE DIMENSIONS



T-1

NOTES:
1. TOLERANCES, UNLESS OTHERWISE SPECIFIED: XXX ±.010
2. ALL DIMENSIONS IN INCHES (MILLIMETERS)

C1533D



T-1¾

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

C1062F

FEATURES

- Very low power — 4 mW
- 2 mA drive from LSTTL or CMOS
- Yellow and Hi. Eff. Red
- Power savings in portable equipment
- Sturdier leads for easy assembly
- Both T-1¾ and T-1
- Use MP52 with HLMP-4700 and HLMP-4719

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 four 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.

PHYSICAL CHARACTERISTICS

SIZE	HLMP	SOURCE COLOR	LENS COLOR
T-1¾	4700	Hi Eff Red	Red Diffused
	4719	Yellow	Yellow Diffused
T-1	1700	Hi Eff Red	Red Diffused
	1719	Yellow	Yellow Diffused

HLMP-4700 HLMP-4719 HLMP-1700 HLMP-1719

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

PARAMETER	HI EFF RED	YELLOW	UNITS	NOTES
Power dissipation	27	24	mW	1
DC forward current	7.5	7.5	mA	
Peak forward current (PW ≤ 1 ms, DF ≤ 30%)	25	25	mA	
Lead soldering time at 260°C	5	5	seconds	2
Operating & storage temperatures	-55°C to +100°C			

1) Derate linearly from 92°C at 1 mA/°C
2) At 1/16 inch (1.6mm) from bottom of lamp.

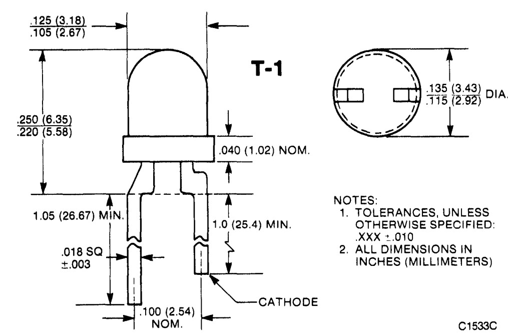
ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25°C Unless Otherwise Specified)

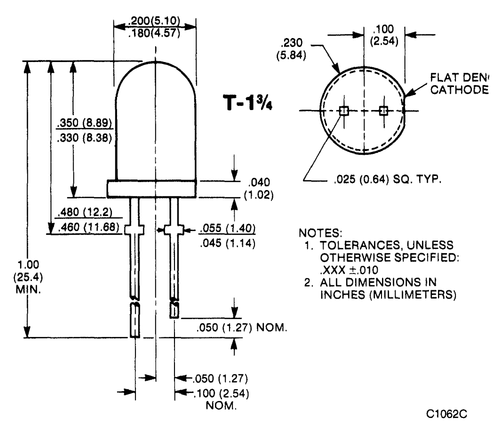
			T-1¾		T-1			
PARAMETER		SYMBOL	HI EFF RED (4700)	YELLOW (4719)	HI EFF RED (1700)	YELLOW (1719)	UNITS	TEST CONDITIONS
Luminous intensity	min	I_V	1.2	1.2	1.0	1.0	mcd	I_F = 2 mA
	typ		2.0	2.0	2.0	2.0	mcd	I_F = 2 mA
Forward voltage	max	V_F	2.2	2.7	2.2	2.7	V	I_F = 2 mA
	typ		1.8	1.9	1.8	1.9	V	I_F = 2 mA
Peak wavelength	typ	λ_P	635	585	635	585	nm	I_F = 2 mA
Reverse breakdown voltage	min	V_{BR}	5	5	5	5	V	I_R = 100 μA
Total viewing angle between half luminous intensity points	typ	$2\Theta_{1/2}$	50	50	50	50	degrees	

GENERAL INSTRUMENT

T-1 HLMP-1X40-Series
T-1¾ HLMP-3X50-Series

PACKAGE DIMENSIONS





FEATURES

- Minimum 80 mcd for T-1¾.
- Minimum 24 mcd for T-1.
- All three colors.
- Sturdy leads with stand-off
- Excellent for small area backlighting.

DESCRIPTION

The ultra-bright HLMP3X50 and HLMP1X40 series are direct, pin-for-pin replacements for the Hewlett-Packard devices with the same part numbers. HLMP3X50 in Hi. Eff. Red, Yellow and Hi. Eff. Green are very narrow viewing angle waterclear T-1¾ lamps. HLMP1X40 are medium viewing angle T-1 waterclear lamps in Hi. Eff. Red, Yellow and Hi. Eff. Green.

By using more efficient LED chips, these lamps are superior in luminous intensity compared to other lamps.

ULTRA BRIGHT FAMILY

LAMP SIZE	HLMP-	SOURCE COLOR
	3750	Hi. Eff. Red
T-1¾	3850	Yellow
	3950	Hi. Eff. Green
	1340	Hi. Eff. Red
T-1	1440	Yellow
	1540	Hi. Eff. Green

Lamps

ABSOLUTE MAXIMUM RATINGS (TA = 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 solder time at 260° C	5	5	5	seconds	3
Operating & Storage Temperature		-55 to +100° C			

1) For Hi. Eff. Red and Hi. Eff. Green, derate power linearly from 25° C at 1.8 mW/° C. For yellow derate power linearly from 50° C at 1.6 mW/° C.
2) For Hi. Eff. Red and Hi. Eff. Green derate linearly from 50° C at 0.5 mA/° C. For yellow derate linearly from 50° C at 0.2 mA/° C.
3) To a point of minimum 1/16 inch (1.6mm) from the bottom of the lamp.

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

PARAMETER		SYMBOL	HLMP T-1¾ HI. EFF. RED (3750)	HLMP T-1¾ YELLOW (3850)	HLMP T-1¾ HI. EFF. GREEN (3950)	HLMP T-1 HI. EFF. RED (1340)	HLMP T-1 YELLOW (1440)	HLMP T-1 HI. EFF. GREEN (1540)	UNITS	TEST CONDITIONS
Luminous intensity	min	I_V	80	80	80	24	24	24	mcd	I_F = 20 mA
	typ		150	150	150	60	60	60	mcd	I_F = 20 mA
Forward voltage	min	V_F	3.0	3.0	3.0	3.0	3.0	3.0	V	I_F = 20 mA
	typ		2.2	2.2	2.2	2.2	2.2	2.2	V	I_F = 20 mA
Peak wavelength	typ	λ_P	635	585	565	635	585	565	nm	I_F = 10 mA
Capacitance	typ	C	45	45	20	45	45	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	$2\theta_{1/2}$	24	24	24	40	40	40	degrees	

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25° C Free Air Temperature Unless Otherwise Specified)

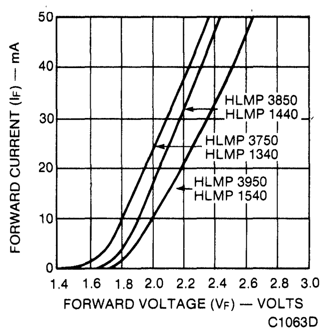


Fig. 1. Forward Voltage/ Forward Current

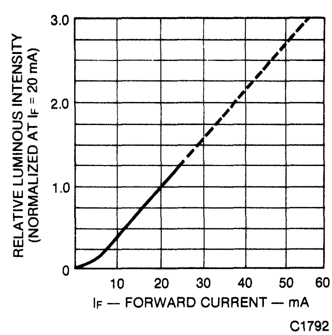


Fig. 2. Relative Luminous Intensity vs. DC Forward Current

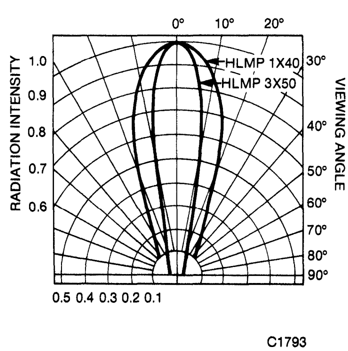


Fig. 3 Spatial Distribution

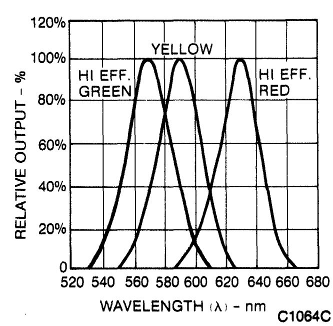
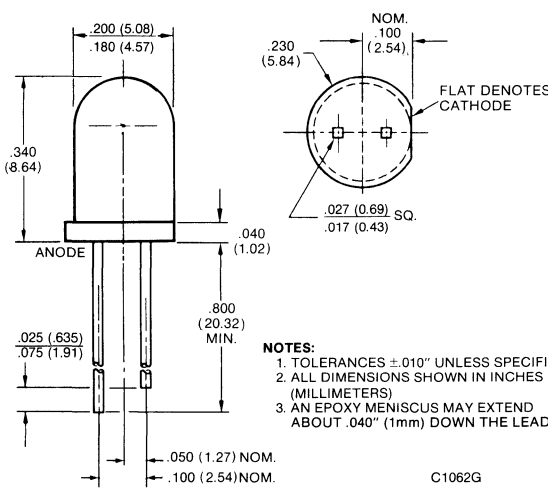


Fig. 4 Spectral Response

GENERAL INSTRUMENT

HIGH EFFICIENCY RED MK9160
YELLOW MK9360

PACKAGE DIMENSIONS

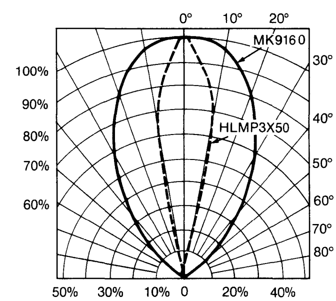


NOTES:
1. TOLERANCES ±.010" UNLESS SPECIFIED
2. ALL DIMENSIONS SHOWN IN INCHES (MILLIMETERS)
3. AN EPOXY MENISCUS MAY EXTEND ABOUT .040" (1mm) DOWN THE LEADS

C1062G

FEATURES

- Wide viewing angle
- 100 mcd typical
- All 3 colors (see MK9460 data sheet)
- Excellent for backlighting larger areas than ultra-bright lamp series HLMP3X50



C1066D

DESCRIPTION

These advanced light emitting diode lamps provide the combination of high on-axis luminous intensity and wide viewing angle from a single LED emitter chip. These lamps are capable of providing 200 mlm or 1400 μW with a forward current of 100 mA. The LED chip is a high efficiency GaAsP/GaP emitting a peak wavelength of 634 nm (MK9160) and 585 nm (MK9360). Clear lens. Anode long.

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

Power dissipation at 25°C lead temperature	300 mW
Storage temperature	-40°C to +85°C
Operating temperature	-40°C to +85°C
Lead solder time at 260°C	5 sec.
Continuous forward current at 25°C lead temperature	120 mA
Continuous forward current at 70°C lead temperature	30 mA
Peak forward current	1.0 A
Reverse voltage	6 V
Maximum diode junction temperature (T_J)	90°C

Lamps

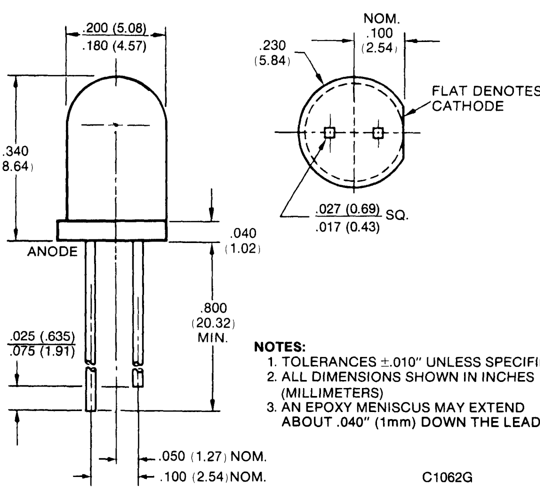
TYPICAL OPERATING CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

PARAMETER	SYMBOL	MV9160 TYPICAL	MV9360 TYPICAL	UNIT	TEST CONDITIONS
Axial luminous intensity	I_V	100	100	mcd	I_F = 100 mA
		50	50	mcd	I_F = 50 mA
Axial radiant intensity	I_e	540	540	μW	I_F = 100 mA
Total external luminous flux	ϕ_V	200	200	mlm	I_F = 100 mA
Total external radiant flux	ϕ_e	1400	1400	μW	I_F = 100 mA
Peak wavelength	λp	634	585	nm	I_F = 100 mA
Included angle Between half Intensity points	$2\Theta_{1/2}$	75	75	degrees	I_F = 100 mA
Dominant wavelength	λ_d	626	588	nm	I_F = 100 mA
Spectral line Half width	$\lambda_{p(FWHM)}$	40	40	nm	I_F = 100 mA
Forward voltage	V_F	2.3	2.4	V	I_F = 100 mA
Reverse voltage	V_R	6	6	V	I_F = 100 μA
Dynamic resistance	rd	5	5	Ω	$V_{F(TH)}$ = 1.8 V @ 20 mA I_F > 20 mA
Capacitance	C	30	30	pF	V_F = 0 V, f = 1 MHz
Rise Time	t_r	550	550	ns	I_F = 100 mA RL = 50 Ω
Fall time	t_f	250	250	ns	I_F = 100 mA RL = 50 Ω
Thermal Resistance	θ_{JC}	100	100	°C/W	

GENERAL INSTRUMENT

HIGH EFFICIENCY GREEN MK9460

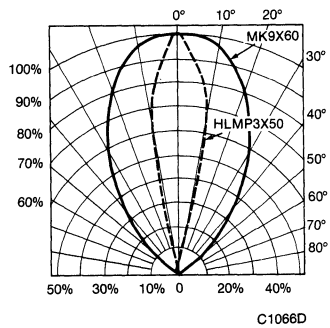
PACKAGE DIMENSIONS



NOTES:
1. TOLERANCES ±.010" UNLESS SPECIFIED
2. ALL DIMENSIONS SHOWN IN INCHES (MILLIMETERS)
3. AN EPOXY MENISCUS MAY EXTEND ABOUT .040" (1mm) DOWN THE LEADS

FEATURES

- Wide viewing angle
- 100 mcd typical
- All 3 colors (see MK9160, MK9360 data sheet)
- Excellent for backlighting larger areas than ultra-bright lamp series HLMP3X50



DESCRIPTION

These advanced light emitting diode lamps provide the combination of high on-axis luminous intensity and wide viewing angle from a single LED emitter chip. These lamps are capable of providing 200 mlm or 1400 μW with a forward current of 100 mA. Clear lens. Anode long.

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

Power dissipation at 25°C lead temperature	300 mW
Storage temperature	-40°C to +85°C
Operating temperature	-40°C to +85°C
Lead solder time at 260°C	5 sec.
Continuous forward current at 25°C lead temperature	120 mA
Continuous forward current at 70°C lead temperature	30 mA
Peak forward current	1.0 A
Reverse voltage	6 V
Maximum diode junction temperature (T_J)	90°C

Lamps

TYPICAL OPERATING CHARACTERISTICS (T_A = 25° C Unless Otherwise Specified)

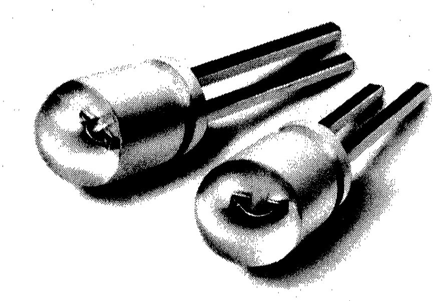
PARAMETER	SYMBOL	MK9460 TYPICAL	UNIT	TEST CONDITIONS
Axial luminous intensity	I_V	80	mcd	I_F = 100 mA
		30	mcd	I_F = 50 mA
Axial radiant intensity	I_e	540	μW	I_F = 100 mA
Total external luminous flux	ϕ_V	200	mlm	I_F = 100 mA
Total external radiant flux	ϕ_e	1400	μW	I_F = 100 mA
Peak wavelength	λ_p	565	nm	I_F = 100 mA
Included angle Between half Intensity points	$2\Theta_{1/2}$	75	degrees	I_F = 100 mA
Dominant wavelength	λ_d	558	nm	I_F = 100 mA
Spectral line Half width	$\lambda_{p(FWHM)}$	40	nm	I_F = 100 mA
Forward voltage	V_F	2.4	V	I_F = 100 mA
Reverse voltage	V_R	6	V	I_F = 100 μA
Dynamic resistance	rd	5	Ω	$V_{F(TH)}$ = 1.8 V @ 20 mA I_F > 20 mA
Capacitance	C	30	pF	V_F = 0 V, f = 1 MHz
Rise time	t_r	550	ns	I_F = 100 mA RL = 50 Ω
Fall time	t_f	250	ns	I_F = 100 mA RL = 50 Ω
Thermal resistance	θ_{JC}	100	°C/W	

GENERAL INSTRUMENT

HIGH EFFICIENCY RED MK9150-1, -2
YELLOW MK9350-1, -2

FEATURES

- Solid state equivalent of subminiature incandescent lamps in new design applications.
- Equal or more M.S.C.P. than a filtered half-watt incandescent lamp.
- Specially designed for back lighting applications of 1″×1″ panel message area or greater.
- Extremely wide viewing angle — 136°
- Long life, solid state reliability.
- Effective illuminator lifetime cost — several order of magnitude less than incandescent when including incandescent replacement labor and lamp costs.
- P.C. board mountable.
- Over 10 times more available light than standard GaP High Efficiency LED lamps.
- No IR radiation.



DESCRIPTION

These advanced light-emitting diode lamps provide true backlighting capability. These lamps are capable of producing up to 320 mlm of total luminous flux with electrical power requirements of less than 500 mW. The LED chips are high efficiency GaAsP/GaP. They are housed in a rugged T-1¾ package employing a built-in plastic reflector. Each lamp contains *two* LED chips internally wired in series.

APPLICATIONS

The illuminator series of LED lamps provides an attractive alternative design approach to subminiature incandescent lamps in backlighting applications. The long life and ruggedness of LED lamps can be applied to subminiature lamp applications that formally could not be done with indicator-type LED lamps. The luminous output of an orange (or red filtered) illuminator series LED lamp is comparable to a subminiature incandescent operated at the same input power and filtered orange (or red). The luminous output of a yellow illuminator series LED lamp is comparable to the luminous output of a subminiature incandescent operated at the same input power and filtered yellow.

ILLUMINATOR VS. INCANDESCENT

SHOCK/VIBRATION: LED lamps are highly shock resistant. Incandescent filaments can shatter when shocked or vibrated in the "on" position.

LONG LIFE: LED lamps operated at data sheet conditions have a life in excess of 100,000 hours. Incandescent lamps have a design life that ranges from 1,000 to 50,000 hours.

HEAT: LED lamps do not radiate heat; the non-photon (or heat) energy is dissipated through the lamp leads. Incandescent lamps radiate considerable heat through their lens.

STABLE: No surge current as experienced with incandescent lamps when cold.

PACKAGE: LED lamps are molded in shock resistant, high temperature plastic. Incandescents are glass with a high breakage hazard.

PERMANENCE: Due to the long life and superior environmental capability of the LED lamp, it can be mounted permanently. Incandescents are generally mounted in sockets which can be as expensive as the lamp itself.

MK9150-1, -2 MK9350-1, -2

ABSOLUTE MAXIMUM RATINGS

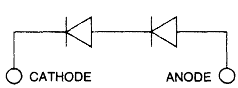
Power Dissipation @ 25°C lead temperature .... 625 mW
Derate linearly from 25°C lead temperature (see Figure 3) .... 10.4 mW/°C
Storage Temperature .... −40°C to +85°C
Operating Temperature .... −40°C to +85°C
Lead Solder Time @ 260°C .... 5 sec. with solder heat sink
Continuous Forward Current @ 25°C lead temperature .... 120 mA
Continuous Forward Current @ 70°C lead temperature .... 30 mA
Peak Forward Current (see Figure 6) .... 1.0 A
Reverse Voltage .... 12 volts
Maximum Diode Junction Temperature (T_J) .... 90°C

GUARANTEED ELECTRO/OPTICAL CHARACTERISTICS

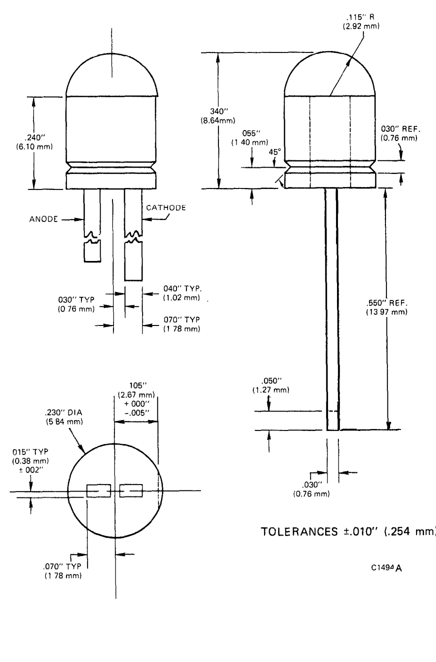
(25°C Lead Temperature, unless otherwise specified)

PARAMETER	SYMBOL	H.E. RED MK9150						YELLOW MK9350						UNIT	TEST CONDITIONS	FIG.	NOTES
		−1			−2			−1			−2						
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.				
Axial Luminous Intensity	I_V	25	45		50	80		25	45		50	80		mcd	I_F = 100 mA Test Duration <5 ms Thermal Resistance $\theta_{Lead\text{-}Ambient}$ <3°C/W	1	1
Forward Voltage	V_F	4.0	4.6	5.2	4.0	4.6	5.2	4.0	4.6	5.2	4.0	4.6	5.2	V	I_F = 100 mA	5	2
Reverse Voltage	V_R	12			12			12			12			V	$I_R = 100\ \mu A$		

SCHEMATIC



C1498



NOTES

1. Test duration ≦ 5ms, lamp supported in a socket with a thermal resistance less than 3°C/W.
2. Binning of forward voltage at 100 mA available upon special request.
3. Viewing angle is defined as the total included angle between the half intensity points.
4. Steady state axial luminous intensity is measured with an I_F = 100 mA DC, soak time = greater than 5 min. with the lamp mounted in a socket with a thermal resistance, θ_{LA}, less than 20°C/W.
5. The dominant wavelength, λ_d, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device.
6. The dynamic resistance represents the slope of the I_F/V_F curve (Figure 5) for 20 mA <I_F<125 mA.
7. The thermal resistance is measured for DC operation, soak time >1 min. in an infinite heat sink.
8. Radiant Intensity, I_e, in watts/steradian, may be found from the equation $I_e = I_v/\eta_v$, where I_v is the luminous intensity in candelas and η_v is the luminous efficacy in lumens/watt.

TYPICAL OPERATING CHARACTERISTICS AT 25°C

PARAMETER	SYMBOL	H.E. RED MK9150 TYPICAL -1	H.E. RED MK9150 TYPICAL -2	YELLOW MK9350 TYPICAL -1	YELLOW MK9350 TYPICAL -2	UNIT	TEST CONDITIONS	NOTES	FIGURE
Steady State Axial Luminous Intensity	I_V	28	51	28	51	mcd	I_F = 100 mA Test Duration >5 min Thermal Resistance $\theta_{Lead\text{-}Ambient}$ <20°C/W	1	2
Steady State Luminous Flux	ϕ_V	111	203	111	203	mlm	I_F = 100 mA Test Duration >5 min Thermal Resistance $\theta_{Lead\text{-}Ambient}$ <20°C/W Flux Integrated Over 2 π steradians	1	2
Included Angle Between Half Luminous Intensity Points	$2\theta_{1/2}(I_V)$	136		136		deg	I_F = 100 mA		2
Included Cone Angle Containing 50% of Luminous Flux	$2\theta_{1/2}(\phi_V)$	100		100		deg	I_F = 100 mA		2
Peak Wavelength	λ_{PEAK}	634		588		nm	I_F = 100 mA Test Duration 75 min Thermal Resistance $\theta_{Lead\text{-}Ambient}$ <20°C/W		7
Dominant Wavelength	λ_d	626		589		nm	I_F = 100 mA Test Duration >5 min Thermal Resistance $\theta_{Lead\text{-}Ambient}$ <20°C/W	5	7
Wavelength Temperature Coefficient	$\Delta\lambda(T)$	0.1				nm/°C	I_F = 100 mA		
Spectral Width at Half Peak	$\lambda_{P(FWHM)}$	40				nm	I_F = 100 mA		7
Dynamic Resistance	r_d	10				Ω	$V_{F(TH)}$ = 3.6 V @ 20 mA I_F > 20 mA	6	5
Capacitance	C	15				pF	V_F = 0 V, f = 1 MHz		
Rise Time	t_r	550				ns	I_F = 100 mA R_L = 50 Ω		
Fall Time	t_f	250				ns	I_F = 100 mA R_L = 50 Ω		
Thermal Resistance Junction to Lead	θ_{JL}	35				°C/W	I_F = 100 mA Measured in an Infinite Heatsink	7	20
Forward Voltage Temperature Coefficient	$\Delta V_{F(T)}$	−4.5		−4.0		mV/°C	I_F = 1mA		
Luminous Efficacy	η_V	147		570		lm/w		8	

Lamps

TYPICAL PERFORMANCE CURVES T_A=25°C

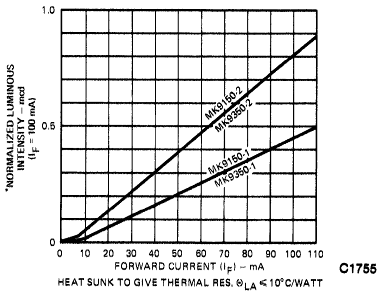


Fig. 1. Luminous Intensity vs. I_F

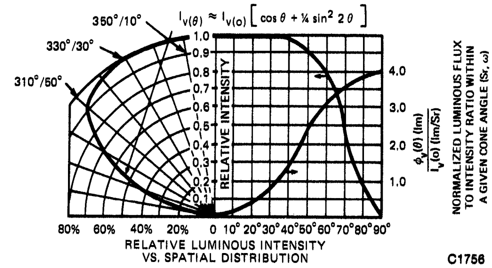


Fig. 2. Relative Luminous Intensity vs. Spatial Distribution

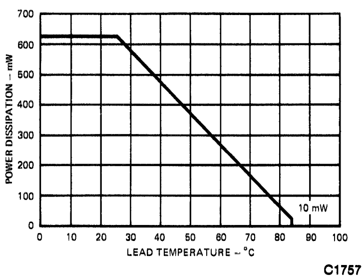


Fig. 3. Power Dissipation

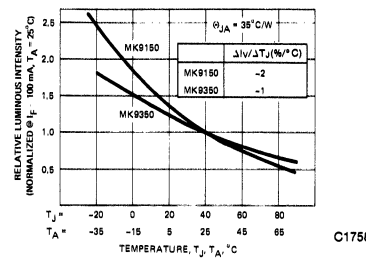


Fig. 4. Luminous Intensity vs. Junction Temperature and Ambient Temperature

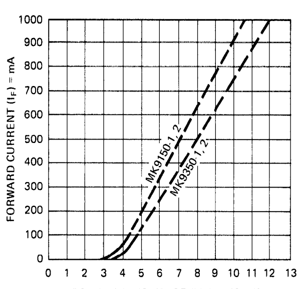


Fig. 5. Forward Voltage vs. Forward Current

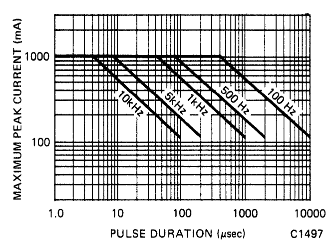


Fig. 6. Maximum Peak Current vs. Pulse Width and Repetition Rate

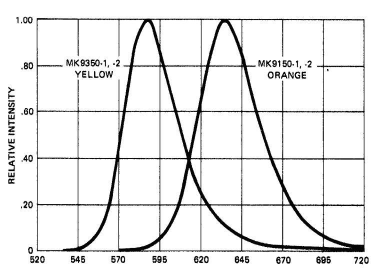


Fig. 7. Relative Intensity vs Wavelength

C1759

TYPICAL ELECTRICAL DRIVE CONSIDERATIONS

The Illuminator series of lamps are well suited to uniformly irradiate the rear surface of a backlight message area. Optimum illumination can be obtained when proper attention is payed to the electrical, optical, and thermal characteristics of these lamps.

Electrically the Illuminator consists of two GaAsP/GaP LED emitters internally connected in series. These two LED emitters are designed to operate at relatively high DC current levels. The typical forward voltage of 4.6V is specified at a forward current of 100mA. The variation of the dynamic resistance, r_d, cause the forward voltage to range from a minimum of 4.0V to a maximum of 5.2V when measured at 100mA. The I_F/V_F relationship shown in Figure 5 can be described as a piece-wise-linear model of a threshold voltage, V_{Fth}, plus the product of the dynamic resistance times the difference of the forward current minus the threshold current, I_{Fth}.

This relationship is shown mathematically below:

$$V_{F(I_F)} = V_{Fth} + (I_F - I_{Fth}) r_d \qquad (1)$$

The threshold voltage is typically 3.6V, when measured at a threshold current of 20mA. The dynamic resistance of the diode has the following range.

$r_{d(min)}$ = 5 ohms
$r_{d(typ)}$ = 10 ohms
$r_{d(max)}$ = 20 ohms

Using these resistor values and equation (1) it is possible to predict the Worst Case forward voltage at a given forward current.

DESIGN EXAMPLE

The highest level of optical flux output can be obtained at an input current below the absolute maximum DC level of 125mA, and at LED junction temperature of less than 90°C. The following series of equations will describe the Worst Case Design Analysis used to select the optimum current limiting resistor when the Illuminator is driven from a DC supply of 5V ± 5%, as shown in Figure 8.

1. Calculate the minimum resistor value given the minimum V_F at I_F (max).

$$R_{L(min)} = \frac{V_{CC(max)} - V_{F(min)}, I_{F(max)}}{I_{F(max)}} \qquad (2)$$

V_{CC} = 5V ± 5%

$$R_{L(min)} = \frac{5.25 - 4.1}{0.125}$$

$R_{L(min)}$ = 9.2 ohm

The nearest 5% resistor value greater than 9.2 ohm is 10 ohms.

2. Calculate the minimum forward current given the maximum dynamic resistance (20Ω), and lowest supply voltage (4.75V).

$$I_{F(min)} = \frac{V_{CC(min)} - V_{Fth} + I_{Fth} \cdot r_{d(max)}}{R_{L(max)} + r_{d(max)}} \qquad (3)$$

$$I_{F(min)} = \frac{4.75 - 3.6 + (0.02 \times 20)}{10.5 + 20}$$

$I_{F(min)}$ = 50.8mA

This current value will be used to determine the I_V variations given the difference between the $I_{F(max)}$ and $I_{F(min)}$.

The same equation can be used to calculate the typical forward current, $I_{F(typ)}$, the $I_{F(typ)}$ is equal to 80mA, for a V_{CC} of 5V, and an R_L = 10 ohms.

Thus with a 5V ± 5% power supply, a 10 ohm ± 5% current limiting resistor, and given the dynamic resistance range of 5-20 ohms the following current and voltages result.

	MIN	TYP	MAX	
I_F	50.8	80.0	121.0	mA
V_F	4.2	4.2	4.1	Volts

These voltage and current pairs are used to calculate the LED power dissipation, and the resulting LED junction temperature.

TYPICAL DRIVE CIRCUIT

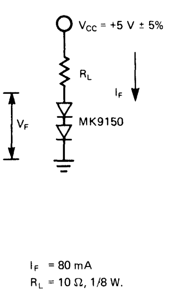


Fig. 8. 5-volt Operation

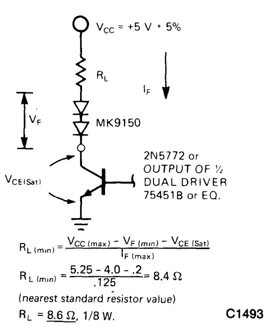


Fig. 9. 5-volt Operation

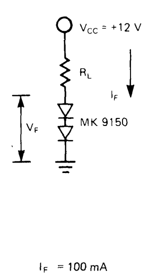


Fig. 10. 12-volt Operation

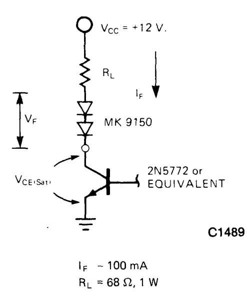


Fig. 11. 12-volt Operation

Lamps

ILLUMINANCE

The annunciation of messages or symbols on the front panel of electrical and electronic equipment can be accomplished by backlighting, as shown in Figures 16 and 17. The message, printed on transparent material, is illuminated from the rear with radiant energy from an LED lamp.

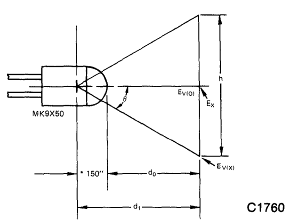
Illumination is measured in terms of illuminance, E_V, and is expressed in units of luminous flux per unit area (ϕ_V/A). Illuminance is expressed in lux (lx) for a message area given in square meters (m^2), and footcandles (fc) when square feet (ft^2) are used. Illuminance is visually perceived only by the brightness of the illuminated object.

The MK9150 and MK9350 are excellent choices for legend backlighting applications. Their construction, using two LED emitters, immersed in a spherical lens, offers the combination of high luminous flux and wide radiation pattern. High rear surface illumination insures a large message ON/OFF contrast ratio. The Illuminator's wide radiation pattern provides uniform brightness of the message area.

The illuminance provided by the MK9X50 series of lamps can be determined given the following information:

1. Edge of legend to center of legend illuminance ratio ($E_{V(x)}/E_{V(0)}$) (Figure 12.)
2. Legend height h (cm. or in.)
3. Solid angle (ω) subtended by the legend area (sr) (Figure 2).
4. Source axial luminous intensity ($I_{V(0)}$)

The edge of legend to center of legend illuminance ratio describes the illuminance uniformity. An illuminance uniformity of 0.5:1, or −3dB has proven acceptable due to the human eye's logarithmic response. Figure 13 presents a plot of the included angle (Θ) versus $E_{V(x)}/E_{V(0)}$ for the MK9X50 series lamps. This plot indicates that the edge of legend to center of legend ratio of 0.5 occurs when the included angle between the lamp and the edge of the legend (h/2) is 38.5 degrees.



C1760

Fig. 12. Lamp to Legend Mechanical Relationship

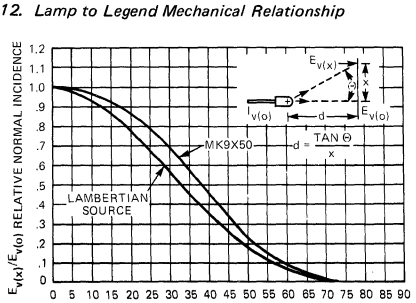


Fig. 13. Normalized Incidence on Diffuser C1762

Given the maximum height (h) dimension of the illuminated legend, and the angle ($E_{V(x)}/E_{V(0)}$), the mechanical spacing of the lamp to legend (d_0) can be determined by the following equations:

Metric (cm) — d_0 = lamp to legend distance

$$d_0 = \frac{0.5\ h}{\tan\Theta\ (E_{V(x)}/E_{V(0)})} - 0.35^* \quad (4)$$

English (in.)

$$d_0 = \frac{0.5\ h}{\tan\Theta\ (E_{V(x)}/E_{V(0)})} - 0.15^* \quad (5)$$

*These are the LED chip to front surface of lamp, distances, expressed in inches and centimeters.

The solutions to these two equations are given in Figures 14 and 15.

Given the $E_{V(x)}/E_{V(0)}$ ratio, the legend area (A_1) and the axial luminous intensity (I_V), the illuminance can be easily calculated.

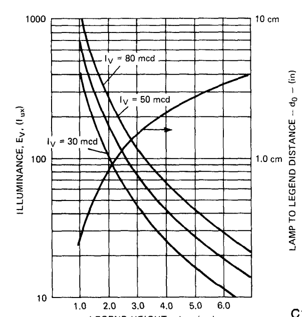
$$E_V = \frac{I_{V(0)} \cdot \omega}{A_1} \quad (6)$$

E_V = luminance
$I_{V(0)}$ = axial luminous intensity
A_1 = legend area
ω = solid angle (sr) subtended by legend area

From Figure 2 the solid angle (ω) is found to be 1.364 sr when the $E_{V(x)}/E_{V(0)}$ is 38.5 degrees. When a square legend whose height is given in either centimeters or inches, the following equations can be used.

Metric (lux, lx) English (footcandles, fc)

$$E_V = \frac{I_{V(0)} \cdot 1.364\ \text{sr}}{\left(\frac{h\ (cm)}{100}\right)^2} \quad (7) \qquad E_V = \frac{I_{V(0)} \cdot 1.364\ \text{sr}}{\left(\frac{h\ (in)}{12}\right)^2} \quad (8)$$



C1761

Fig. 14. Legend Height vs. Legend Illuminance (lux) and Lamp to Legend Distance

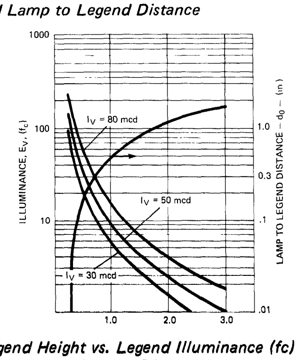


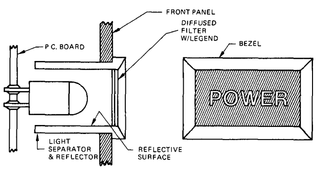
Fig. 15. Legend Height vs. Legend Illuminance (fc) and Lamp to Legend Distance C1763

Using the MK9150, mounted in a PinFin D-20, and operating from a 5V DC supply with a 10 ohm current limiting resistor (I_F = 80mA) the lamp will provide a typical $I_{V(0)}$ = 54 mcd.

1. From Figure 13, a $E_{V(x)}/E_{V(0)}$ of .5, Θ = 38.5
2. From Figure 2 the solid angle (ω) at 38.5 = 1.364 sr
3. Legend height = 0.75″
4. Axial luminous intensity = 54 mcd.

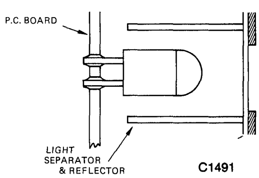
Using Figure 13, the lamp to legend distance, d_0, is determined to be 0.32 inch. The illuminance is calculated from Equation (8) to be 18.9 fc.

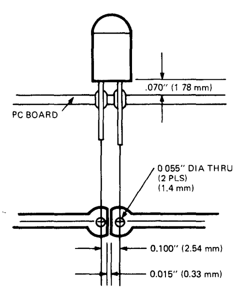
TYPICAL LAMP INSTALLATION



C1492

Fig. 16. Front Panel Mount





C1764

Fig. 17. Dead Front Panel *Fig. 18. PC Board Mounting*

CLEANING CONSIDERATIONS
!! CAUTION !!

The optical properties of the MK9X50 series lamps may be permanently impaired if the devices are cleaned with alcohol based solvents such as isopropyl or methanol alcohol.

SOLDERING CONSIDERATIONS

The lead material of the illuminator is copper which conducts ½ watt of heat to a heat sink during operation of the device.

Due to the size of the leads, the heat flow from a soldering iron or solder-wave into the device is also very efficient. The temperature at the plastic rises very quickly to the softening point. This allows the leads to move in the plastic when any force is applied which can damage the device.

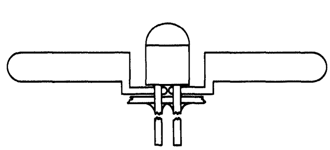


Fig. 19. Heat Sink for Soldering C1765

To prevent damage to the device during soldering, a heat sink tool must be used between the unit and the printed circuit board. We recommend that the plastic portion of the device be supported at least .070 inches from the board. The mass of the heat sink will be determined by the soldering temperature and times of exposure. The maximum temperature at the plastic lead interface must not exceed 150°C.

Small heat sink tools made by "X-acto" may be used by modifying the width of the jaw with a grinder. Two such clips should be used, one on each lead.

HEAT SINK CONSIDERATIONS

The axial luminous intensity, $I_{V(0)}$, and the total luminous flux, ϕ_V, are dependant upon the forward current, I_F, and the junction temperature, T_J. When the junction temperature is kept constant, the luminous intensity increases at a typical rate of 1%/mA over the range of 20mA to 125mA. As the junction temperature increases, the light output will decrease exponentially at a rate of $-0.015T_J$. The rise in junction temperature is caused by the change in ambient temperature and the electrical power being dissipated by the LED.

The Guaranteed Electro/Optical Characteristics section presents the axial luminous intensity, $I_{V(0)}$, under the test conditions of I_F = 100mA, and a test time of less than 5ms. Under this condition, the junction temperature is kept at or below 30°C (T_A = 25°C). This junction temperature is possible due to the short duration of the heating power when integrated with respect to the thermal time constant of the lamp. Within the range of 100μs to 50ms the pulsed thermal resistance of the illuminator can be described by the following equation:

$$\Theta_{JL(100\mu s<\tau<50ms)} = \frac{\Theta_{JL}}{5} \times \left(1 - \epsilon^{-\frac{t}{0.01s}}\right) \quad (9)$$

As the operation time is increased, the thermal impedance is dominated by the thermal resistance rather than the thermal capacitance. When the Illuminator is mounted in a PinFin Model D20 the typical thermal time constant is approximately one minute.

The following equation correlates the pulsed guaranteed luminous intensity to the steady state luminous intensity when given the DC forward current and the LED junction temperature.

$$I_{V(steady\ state)} = I_V \times \left[\frac{I_F - 12.5}{87.5}\right] \epsilon^{-0.015(T_J - 40°C)} \quad (10)$$

where I_F = mA, T_J = °C

The junction temperature can be kept at a minimum by providing a good thermal path from the lamp lead to ambient. The typical thermal resistance, Θ_{JL}, from the junction to the lead, is 35°C/W. The actual junction temperature is the sum of the ambient temperature, T_A, and the temperature rise caused by the electrical power input. This relationship is shown below.

$$T_J = T_A + P_{in}(\Theta_{JL} + \Theta_{LA}) \quad (11)$$

Recall that the power into the LED is the product of the forward current times the forward voltage. When the piece-wise-linear equation is substituted into the above equation the junction temperature can be described as follows:

$$T_J = T_A + (3.6 + (I_F - 0.02)r_d) \cdot (\Theta_{JL} + \Theta_{LA}) \quad (12)$$

where I_F = A, and r_d = ohm, Θ_{JL}, Θ_{LA} = °C/W.

Figure 20 represents the combination of the normalized luminous intensity as a function of forward current for different thermal resistances ($\Theta_{JL} + \Theta_{LA}$). Table I presents a number of common interconnection systems for the Illuminator and their thermal resistances. The thermal resistances, Θ_{JL}, range from 2°C/W for an infinite heat sink to 110°C/W for the device mounted with lightweight wire in free air. It is recommended that for optimal performance of the Illuminator, the mechanical interconnection offer a thermal resistance, Θ_{LA}, less than 35°C/W. This results in a Θ_{JA} of 70°C/W.

The following series of calculations illustrate the use of these equations to determine the luminous intensity, given the use of the PinFin heat sink (Θ_{LA} = 35°C/W) and the I_F caused by operation from a five volt supply and a ten ohm series resistor.

The first step is to determine the power being dissipated within the LED. When the lamp is operated from a current limited voltage supply, the maximum power will be dissipated when the forward voltage is at its minimum ($V_{F(min)}$). The minimum power will be dissipated under the condition of highest forward voltage. These two equations for the example are shown below.

$$P_{(max)} = V_{F(min)} \times I_{F(max)} \quad (13)$$
$$P_{(max)} = 4.1 \times 0.121$$
$$P_{(max)} = 496mW$$

$$P_{(min)} = (V_{Tth} + (I_{F(min)} - I_{Fth})\, r_{d(max)})\, I_{F(min)}$$
$$P_{(min)} = (3.6 + (0.051 - 0.02)\, 20)\, 0.051$$
$$P_{(min)} = 215mW$$

Given the electrical power dissipation, ambient temperature, and the thermal resistance junction to lead Θ_{JL}, and the thermal resistance lead to ambient, Θ_{LA}, it is possible to calculate the steady state luminous intensity for the lamp.

Given: MK9150-2

Θ_{JL} = 35°C/W — V_{CC} = 5V ± 5%

Θ_{LA} = 35°C/W — r_d = 5 ohm min, 10 ohm typ, 20 ohm max

T_A = 25°C — $P_{(typ)}$ = 336mW, $P_{(min)}$ 215mW

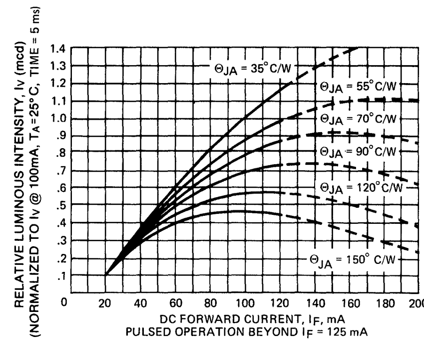
$P_{(max)}$ = 496mW

$I_{V(DS)}$ = 80mcd @ 100mA

Given these values for the variable for Equation 10, it is possible to calculate the steady state luminous intensity and luminous flux for the Illuminator with a typical luminous intensity of 80mcd at 100mA.

TABLE I. Table of Heat Sinks

Heat Sink Type	Typical (1 min.) Θ_{LA}
Large Cu Block 1″ × 2″ × 3″	2
Free Air #30 AWG Leads	110
PinFin Model D-20C, D-10C	35
Dual Pin Socket Molex 22-02-2021	50
PC Board Radiator Type — G10 2 oz Cu 1″ × 1″ Area Each Lead	30

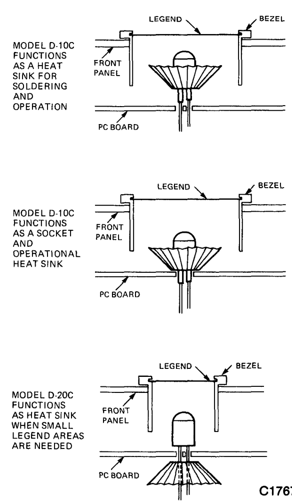


C1766

Fig. 20. Luminous Intensity vs Thermal Resistance

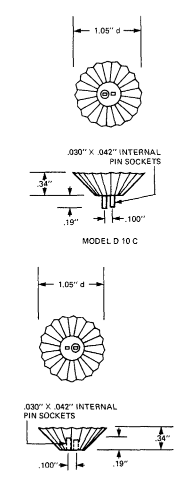
TABLE II. Electro/Optical Characteristics MK9150-2 5V 10 ohm Operation

$I_{v(ds)}$ @ 100 mA = 80 mcd typical				
PARAMETER	**MIN**	**TYP**	**MAX**	**UNITS**
Luminous Intensity I_V	35	54	73	mcd
Luminous Flux ϕ_V	138	213	288	mlm
Forward Current I_F	51	80	121	mA
Power Dissipation P	215	336	496	mW



C1767

Fig. 21. PinFin PC Board Mounting



C1768

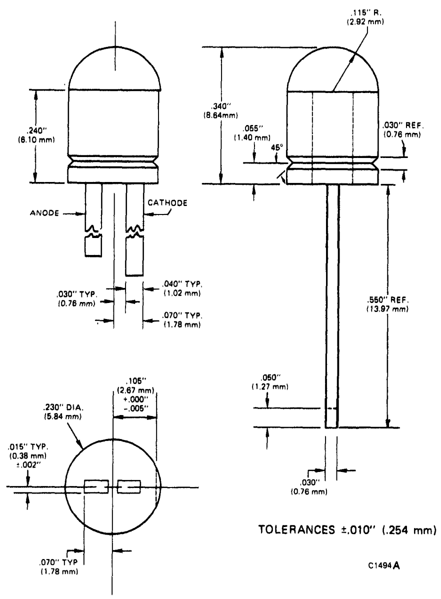
Fig. 22. PinFin Mechanical Drawing

PinFin Supplier
PinFin, Inc.
240 Griffin St.
Fall River, MA 02724

GENERAL INSTRUMENT

HIGH EFFICIENCY GREEN **MK9450**

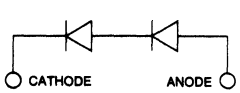
PACKAGE DIMENSIONS



TOLERANCES ±.010" (.254 mm)

C1494A

SCHEMATIC



C1498

FEATURES

- Solid state equivalent of subminiature incandescent lamps in new design applications.
- Equal or more M.S.C.P. than a filtered half-watt incandescent lamp.
- Specially designed for backlighting applications of 1"x1" panel message area or greater.
- Extremely wide viewing angle — 136°.
- Long life, solid state reliability.
- Effective illuminator lifetime cost — several order of magnitude less than incandescent when including incandescent replacement labor and lamp costs.
- P.C. board mountable.
- Over 10 times more available light than standard GaP High Efficiency LED lamps.
- No IR radiation.

DESCRIPTION

These advanced light-emitting diode lamps provide true backlighting capability. These lamps are capable of producing up to 320 mlm of total luminous flux with electrical power requirements of less than 500 mW. The LED chips are high efficiency GaAsP/GaP. They are housed in a rugged T-1¾ package employing a built-in plastic reflector. Each lamp contains *two* LED chips internally wired in series.

Lamps

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

Power dissipation at 25°C lead temperature	625 mW
Derate linearly from 25°C lead temperature	10.4 mW/°C
Storage temperature	-40°C to +85°C
Operating temperature	-40°C to +85°C
Lead solder time at 260°C	5 sec. with solder heat sink
Continuous forward current at 25°C lead temperature	120 mA
Continuous forward current at 70°C lead temperature	30 mA
Peak forward current	1.0 A
Reverse voltage	12 V
Maximum diode junction temperature (T_J)	90°C

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

PARAMETER	SYMBOL	HI EFF GREEN MK9450 MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS	FIG.	NOTES
Axial luminous intensity	I_V	25	45		mcd	I_F = 100 mA*	1	1
Forward voltage	V_F	4.0	5.0	6.8	V	I_F = 100 mA	5	2
Reverse voltage	V_R	12			V	I_R = 100 μA		

** Test duration < 5 ms, thermal resistance θlead-ambient < 3° C/W.*

TYPICAL OPERATING CHARACTERISTICS AT 25° C

PARAMETER	SYMBOL	HI EFF GREEN MK9450	UNIT	TEST CONDITIONS	NOTES
Steady state axial luminous intensity	I_V	30	mcd	I_F = 100 mA, test duration > 5 min, thermal resistance θlead-ambient < 20°C/W	1
Steady state luminous flux	ϕV	120	mlm	I_F = 100 mA, test duration > 5 min, thermal resistance θlead-ambient < 20°C/W flux integrated over 2 π steradians	1
Included angle between half luminous intensity points	$2\theta\frac{1}{2}(I_V)$	136	deg	I_F = 100 mA	
Included cone angle containing 50% of luminous flux	$2\theta\frac{1}{2}(\phi_V)$	100	deg	I_F = 100 mA	
Peak wavelength	λ_{PEAK}	562	nm	I_F = 100 mA, test duration 75 min, thermal resistance θlead-ambient < 10°C/W	
Dominant wavelength	λ_d	567	nm	I_F = 100 mA, test duration >5 min, thermal resistance θlead-ambient < 20°C/W	5
Wavelength temperature coefficient	$\Delta\lambda_{(T)}$	0.1	nm/°C	I_F = 100 mA	
Spectral width at half peak	$\lambda_{P(FWHM)}$	40	nm	I_F = 100 mA	
Dynamic resistance	r_d	10	Ω	$V_{F(TH)}$ = 3.6 V at 20 mA, I_F > 20 mA	6
Capacitance	C	15	pF	V_F = 0 V, f = 1 MHz	
Rise time/fall time	tr/tf	500	ns		
Thermal resistance junction to lead	θJL	35	°C/W	I_F = 100 mA, measured in an infinite heatsink	7
Forward voltage temperature coefficient	$\Delta V_{F(T)}$	-4.5	mV/°C	I_F = 1 mA	
Luminous efficacy	η_V	630	lm/w		8

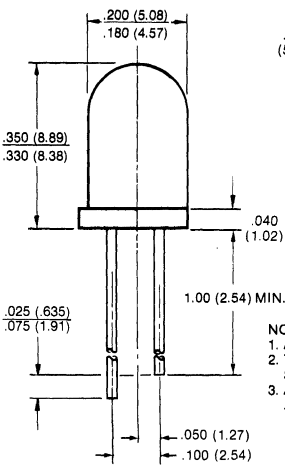
NOTES

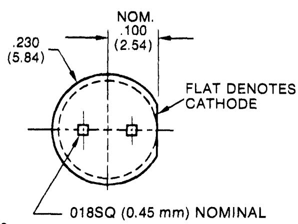
1. *Test duration ≤ 5ms, lamp supported in a socket with a thermal resistance less than 3° C/W.*
2. *Binning of forward voltage at 100 mA available upon special request.*
3. *Viewing angle is defined as the total included angle between the half intensity points.*
4. *Steady state axial luminous intensity is measured with an I_F = 100 mA DC, soak time = greater than 5 min. with the lamp mounted in a socket with a thermal resistance. θ_{LA}, less than 20° C/W.*
5. *The dominant wavelength, λ_d, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device.*
6. *The dynamic resistance represents the slope of the I_F/V_F curve for 20 mA < I_F < 125 mA.*
7. *The thermal resistance is measured for DC operation, soak time > 1 min. in an infinite heat sink.*
8. *Radiant intensity, I_e, in watts/steradian, may be found from the equation $I_e = I_v/\eta_v$, where I_v is the luminous intensity in candelas and η_v is the luminous efficacy in lumens/watt.*

GENERAL INSTRUMENT

HI EFF RED HLMP-3300 SERIES (5082-465X)
HI EFF RED HLMP-4600 SERIES
YELLOW HLMP-3400 SERIES (5082-455X)
HI EFF GREEN HLMP-3500 SERIES

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

C1062L

DESCRIPTION

The HLMP-3XXX and HLMP-460X lamps are drop-in replacements for Hewlett-Packard's lamps with the same part numbers. The MV6X5X series is very similar but differs in tint and leadlength.

These four general purpose T 1-¾ lamp families in three high-intensity colors offer three different lens effects. The HLMP-3X00 family gives a wide viewing angle tinted and diffused lamp, while the HLMP-3X15/16 are tinted non-diffused narrow viewing angle devices. The HLMP-4600 family are narrow viewing angle tinted and diffused lamps.

FEATURES

- Color matched equivalents to Hewlett-Packard devices.
- Popular, low-cost general purpose lamps.
- Wide and narrow viewing angle devices for direct view or backlighting.
- Solid state reliability.
- Can be panel mounted using MP52 grommet.
- Sturdy leads for easier assembly.

Lamps

PHYSICAL CHARACTERISTICS

HLMP-	(1) 5082-	Source Color	Lens Color (3)	Lens Effect	Application
3300	4650	Hi Eff Red	Red Diffused	Wide Beam	Direct view
3301	4655	Hi Eff Red	Red Diffused	Wide Beam	Hi-Bright direct view
3315	4657	Hi Eff Red	Clear Red	Narrow Beam	Backlighting
3316	4658	Hi Eff Red	Clear Red	Narrow Beam	Hi-Bright backlighting
4600 (2)	-	Hi Eff Red	Red Diffused	Narrow Beam	Direct view
4601	-	Hi Eff Red	Red Diffused	Narrow Beam	Hi-Bright direct view
3400	4550	Yellow	Amber Diffused	Wide Beam	Direct view
3401	4555	Yellow	Amber Diffused	Wide Beam	Hi-Bright direct view
3415	4557	Yellow	Clear Amber	Narrow Beam	Backlighting
3416	4558	Yellow	Clear Amber	Narrow Beam	Hi-Bright backlighting
3502	-	Hi Eff Green	Green Diffused	Wide Beam	Direct view
3507	-	Hi Eff Green	Green Diffused	Wide Beam	Hi-Bright direct view
3517	-	Hi Eff Green	Clear Green	Narrow Beam	Backlighting
3519	-	Hi Eff Green	Clear Green	Narrow Beam	Hi-Bright backlighting

1) Discontinued older Hewlett-Packard part numbers
2) For yellow and green versions, see MV6354A and MV6454A
3) The epoxy lens colors are all equivalent to Hewlett-Packard's lens colors

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

PARAMETER	HI EFF RED 3300/4600	YELLOW 3400	HI EFF GREEN 3500	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 foward current	30	20	30	mA	2
Lead solder time at 260° C	5	5	5	seconds	3
Storage and operating temperatures		-55° C to +100° C			

NOTES:
1. *For red and green derate power linearly from 25° C at 1.8 mW/° C. For yellow, derate power linearly from 50° C at 1.6mW/° C.*
2. *For red and green, derate linearly from 50° C at 0.5 mA/° 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 (25° C Ambient Temperature)

HI EFF RED

PARAMETER		SYMBOL	HLMP- 3300	3301	3315	3316	4600	4601	UNITS	TEST CONDITIONS
Luminous intensity	min	I_V	2.0	4.0	12	20	2.0	4.0	mcd	I_F = 10mA
	typ		3.5	7.0	18	30	4.0	8.0	mcd	I_F = 10mA
Forward voltage	max	V_F	3.0	3.0	3.0	3.0	3.0	3.0	V	I_F = 10mA
	typ		2.2	2.2	2.2	2.2	2.2	2.2	V	I_F = 10mA
Peak wavelength	typ	λ_p	635	635	635	635	635	635	nm	I_F = 10mA
Capacitance	typ	C	45	45	45	45	45	45	pF	V_F = 0, f = MHz
Reverse breakdown voltage	min	V_{BR}	5	5	5	5	5	5	V	I_R = 100μA
Total viewing angle between half luminous intensity points	typ	$2\Theta_{1/2}$	65	65	35	35	32	32	degrees	

YELLOW

PARAMETER		SYMBOL	HLMP- 3400	3401	3415	3416	UNITS	TEST CONDITIONS
Luminous intensity	min	I_V	2.0	4.0	10	20	mcd	I_F = 10mA
	typ		4.0	8.0	18	30	mcd	I_F = 10mA
Forward voltage	max	V_F	3.0	3.0	3.0	3.0	V	I_F = 10mA
	typ		2.2	2.2	2.2	2.2	V	I_F = 10mA
Peak wavelength	typ	λ_p	585	585	585	585	nm	I_F = 10mA
Capacitance	typ	C	45	45	45	45	pF	V_F = 0, f = 1MHz
Reverse breakdown voltage	min	V_{BR}	5	5	5	5	V	I_R = 100μA
Total viewing angle between half luminous intensity points	typ	$2\Theta_{1/2}$	65	65	35	35	degrees	

ELECTRO-OPTICAL CHARACTERISTICS (25° C Ambient Temperature)

HI EFF GREEN

PARAMETER		SYMBOL	HLMP- 3502	3507	3517	3519	UNITS	TEST CONDITIONS
Luminous intensity	min	I_V	3.0	7.0	12	30	mcd	I_F = 20 mA
	typ		6.0	12	25	50	mcd	I_F = 20 mA
Forward voltage	max	V_F	3.0	3.0	3.0	3.0	V	I_F = 20 mA
	typ		2.3	2.3	2.3	2.3	V	I_F = 20 mA
Peak wavelength	typ	λ_p	565	565	565	565	nm	I_F = 20 mA
Capacitance	typ	C	20	20	20	20	pF	V_F=0, f = 1 MHz
Reverse breakdown voltage	min	V_{BR}	5	5	5	5	V	I_R=100 μA
Total viewing angle between half luminous intensity points	typ	$2\Theta_{1/2}$	75	75	35	35	degrees	

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

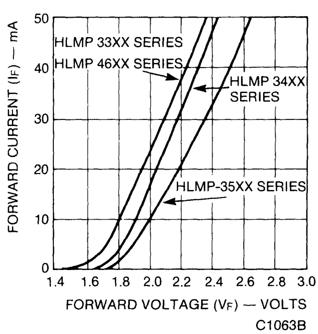


Fig. 1. Forward Voltage vs. Forward Current

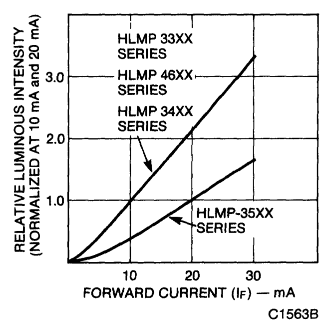


Fig. 2. Relative Luminous Intensity vs. Forward Current

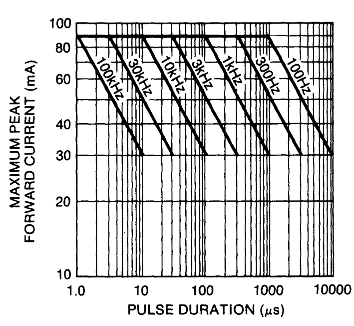


Fig. 3. Maximum Peak Forward Current vs. Pulse Duration

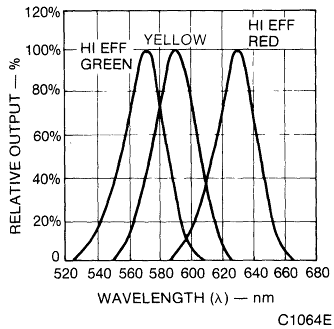


Fig. 4. Spectral Response

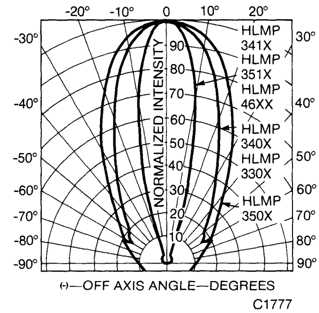
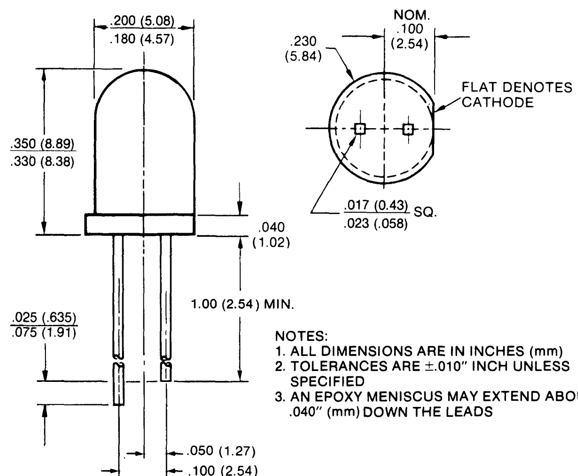


Fig. 5. Spatial Distribution

GENERAL INSTRUMENT

PINK (HIGH EFFICIENCY RED) MV6151
YELLOW MV6351
HIGH EFFICIENCY GREEN MV6451
ORANGE MV6651
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

C1062 F

DESCRIPTION

This white diffused and non-tinted family of T-1¾ lamps give maximum on/off contrast in high-ambient lighting levels. The family features orange, AlGaAs red (dark red), yellow and Hi. Eff. Green as well as Hi. Eff. Red which here is pink. The family exhibits wide viewing angle intended for direct view.

FEATURES

- Excellent on-off contrast
- Non-tinted, white diffused
- AlGaAs red plus 4 bright colors; orange, pink, 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	Hi. Eff. Red	White diff.	Pink diff.	Direct view
MV6351	Yellow	White diff.	Yellow diff.	Direct view
MV6451	Hi. Eff. Green	White diff.	Green diff.	Direct view
MV6651	Orange	White diff.	Orange diff.	Direct view
MV6951	AlGaAs Red	White diff.	Red diff.	Direct view

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

PARAMETER	PINK, YELLOW, RED*	GREEN, ORANGE	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 solder time at 260° C	5	5	seconds	2
Storage and operating temperatures	-55° C to +100° C			

NOTES

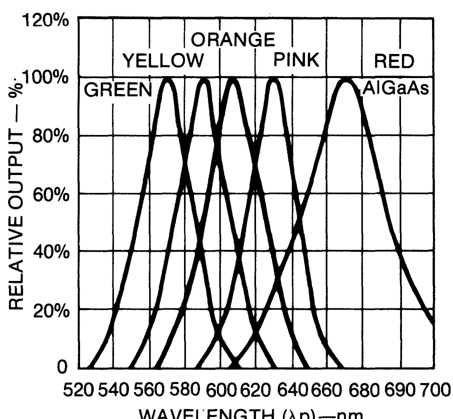
1. *Derate linearly from 25° C (MV6451 from 50° C) at 1.6mW/° C.*
2. *From a point minimum 1/16 inch (1.6mm) from the bottom of the lamp.*

MV6151 MV6351 MV6451 MV6651 MV6951

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

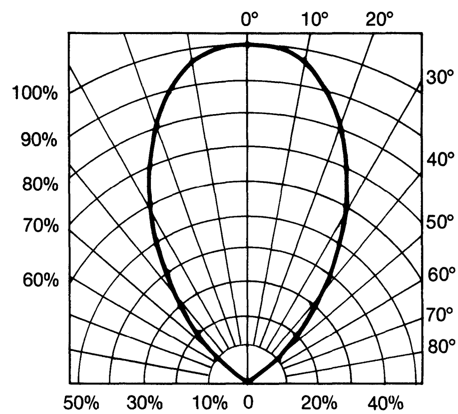
PARAMETER		SYMBOL	MV6151	MV6351	MV6451	MV6651	MV6951	UNITS	TEST CONDITIONS	NOTES
Luminous intensity	min	I_V	3.0	3.0	3.0	3.0	3.0	mcd	I_F = 20mA	1
	typ		12	12	12	12	12	mcd	I_F = 20mA	
Forward voltage	max	V_F	3.0	3.0	3.0	3.0	3.0	V	I_F = 20mA	
	typ		2.1	2.2	2.3	2.2	2.4	V	I_F = 20mA	
Peak wavelength	typ	λ_p	635	585	565	605	670	nm	I_F = 20mA	
Reverse breakdown voltage	min	V_{BR}	5	5	5	5	5	V	I_R = 100μA	
Total viewing angle between half luminous points	typ	$2\Theta_{1/2}$	70	70	70	70	70	degrees	I_F = 20mA	2

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



C1064E

Fig.1. Spectral Response



C1066C

Fig. 2. Spatial Distribution

NOTES

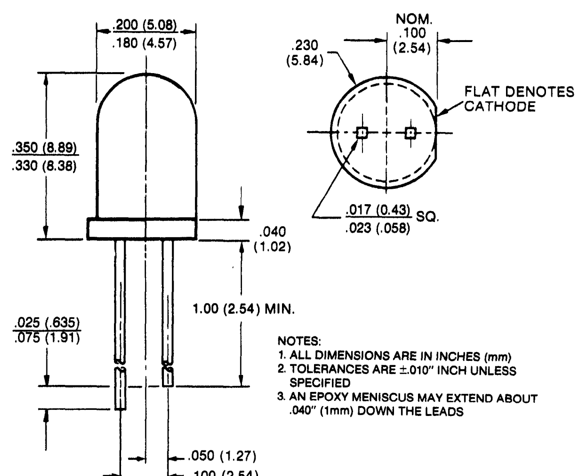
1. *As measured with a Photo Research Corp. "SPECTRA" Microandela Meter (Model IV-D).*
2. *The axes of spatial distribution are typically within a 10° C cone with reference to the central axis of the device.*

GENERAL INSTRUMENT

HIGH EFFICIENCY RED/PINK MV6152 MV5152
YELLOW MV6352 MV5352 MV6852
HIGH EFFICIENCY GREEN MV64520 MV64521 MV5452
HIGH EFFICIENCY RED MV6752 MV5752

PACKAGE DIMENSIONS

MV6X52X - LEAD CUT ANODE LONG MIN. 1.025"
MV5X52 - LEAD CUT CATHODE LONG MIN. 0.8"



C1062F

DESCRIPTION

These clear tinted solid state indicators offer high brightness and color availability. The high efficiency red, pink and yellow devices are made with gallium arsenide phosphide on gallium phosphide; the Hi. Eff. green units are made with gallium phosphide on gallium phosphide. All devices are available with anode long as MV6X5XX or with cathode long MV5X5X.

FEATURES

- High on-axis light output
- High efficiency GaP light sources
- Versatile mounting on P.C. 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)

	RED, YELLOW AND PINK	GREEN
Power dissipation	120 mW	120 mW
Derate linearly from 25°C (MVX452 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 solder 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

ANODE LONG	CATHODE LONG	SOURCE COLOR	LENS COLOR	LENS EFFECT	APPLICATION
MV6152	MV5152	Hi Eff. Red	Clear Pink	Narrow; Point Source	Backlighting
MV6352	MV5352	Yellow	Clear Yellow	Narrow; Point Source	Backlighting
MV6852 (HLMP-3415)	—	Yellow	Clear Amber	Narrow; Point Source	Backlighting
MV64520	MV5452	Hi Eff. Green	Clear Green	Narrow; Point Source	Backlighting
MV64521	—	Hi Eff. Green	Clear Green	Narrow; Point Source	Backlighting
MV6752 (HLMP-3315)	MV5752	Hi Eff. Red	Clear Red	Narrow; Point Source	Backlighting

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

PARAMETER	TEST COND.	UNITS	MV6152 MV5152	MV6352 MV5352 MV6852	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	60	40.0
Peak wave length	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)

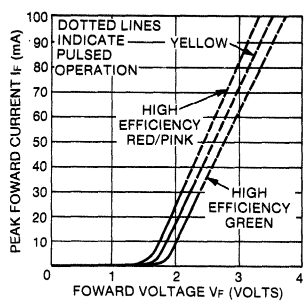


Fig. 1. Forward Current vs. Forward Voltage

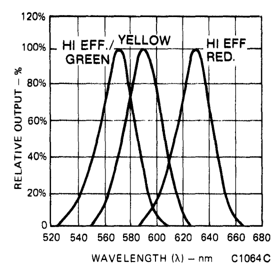


Fig. 2. Spectral Response

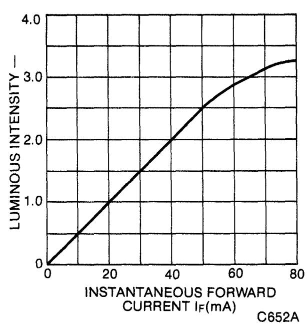


Fig. 3. Luminous Intensity vs. Forward Current

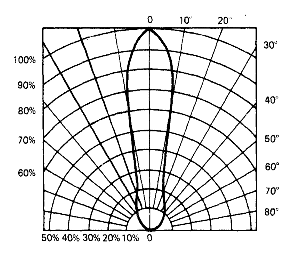


Fig. 4. Spatial Distribution (Note 2)

NOTES

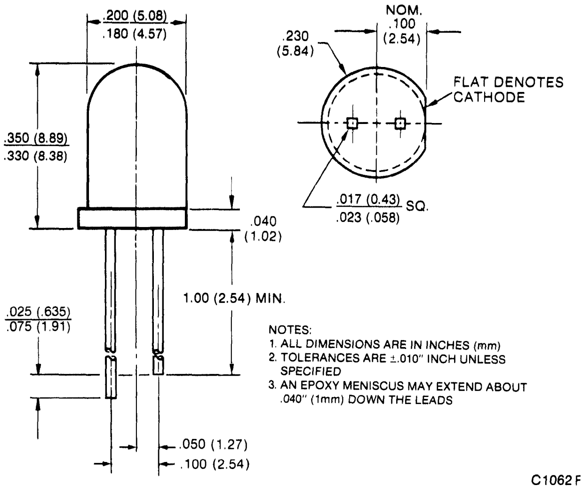
1. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The axes of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*
3. *The leads of the device were immersed in molten solder, at 260° C, to a point 1/16 inch (1.6mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

GENERAL INSTRUMENT

HIGH EFFICIENCY RED/PINK	**MV6153/4A**		**MV5153/4A**
YELLOW	**MV6353/4A**	**MV6853**	**MV5353/4A**
HIGH EFFICIENCY GREEN	**MV64530/1**	**MV6454A**	**MV5453/4A**
HIGH EFFICIENCY RED	**MV6753/4A**		**MV5753/4A**

PACKAGE DIMENSIONS

MV6X5XX - LEAD CUT ANODE LONG MIN. 1.025"
MV5X5X - LEAD CUT CATHODE LONG MIN 0.8"



DESCRIPTION

These solid state indicators offer a variety of diffused lens effects and color availability. The high efficiency red, pink 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 anode long as MV6X5XX, or with cathode long, MV5X5X.

FEATURES:

- High efficiency GaP light source with various lens effects
- Versatile mounting on P.C. board or panel
- Snap in grommet MP52 available as separate order item
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight
- Increased minimum brightness — MV5X54A/6X54A now 10 mcd at 20 mA

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

	RED, YELLOW AND PINK	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 solder 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

ANODE LONG	CATHODE LONG	SOURCE COLOR	LENS COLOR	LENS EFFECT	APPLICATION
MV6153	MV5153	Hi Eff. Red	Pink diffused	Wide beam	Direct view
MV6154A	MV5154A	Hi Eff. Red	Pink diffused	Narrow beam	Hi-brite direct view
MV6353	MV5353	Yellow	Yellow diffused	Wide beam	Direct view
MV6354A	MV5354A	Yellow	Yellow diffused	Narrow beam	Hi-brite direct view
MV6853 (HLMP3400)	—	Yellow	Amber diffused	Wide beam	Direct view
MV64530/1	MV5453	Hi Eff. Green	Green diffused	Wide beam	Direct view
MV6454A	MV5454A	Hi Eff. Green	Green diffused	Narrow beam	Hi-brite direct view
MV6753	MV5753	Hi Eff. Red	Red diffused	Wide beam	Direct view
MV6754A	MV5754A	Hi Eff. Red	Red diffused	Narrow beam	Hi-brite direct view

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

PARAMETER	TEST COND.	UNITS	6153 5153	6154A 5154A	6353 5353 6853	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 wave length	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											
Type.	V = 0	pF	45	45	45	45	20	20	20	45	45
Reverse voltage (V_R)	f = 1MHz										
Min.	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)

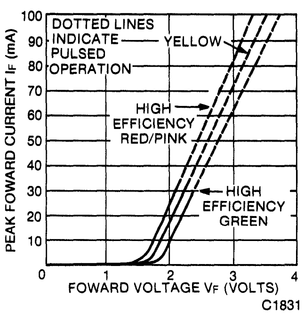


Fig. 1. Forward Current vs. Forward Voltage

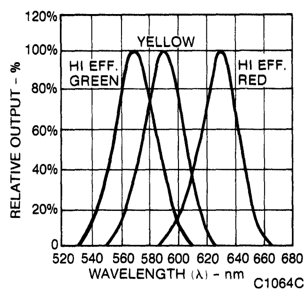


Fig. 2. Spectral Response

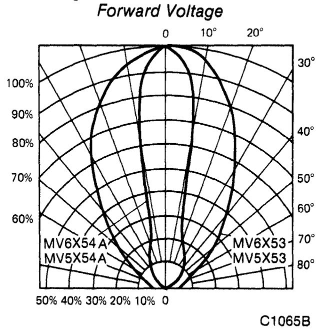


Fig. 3. Spatial Distribution (Note 2)

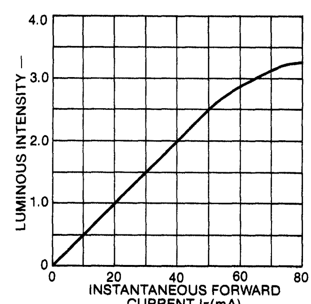


Fig. 4. Luminous Intensity vs. Forward Current

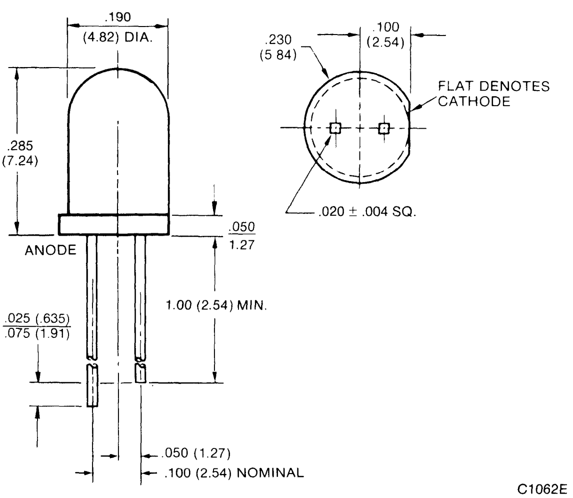
NOTES

1. *As measured with Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The axes of spatial distribution are typically with 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 (1.6mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

GENERAL INSTRUMENT

STANDARD RED FLV-110
STANDARD RED FLV-111
STANDARD RED FLV-112
STANDARD RED FLV-117
HI EFF. GREEN FLV-310
YELLOW FLV-410
HI EFF. RED FLV-510

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

DESCRIPTION

FLV-X1X are direct replacements for Fairchild's FLV-family with the same part numbers. The FLV-X1X has a .285 inch lens, .100 inch leadspacing and the anode lead is long. The family is also available without flange. See datasheet MV6X538.
Matching grommet FLS-010 is available as a separate order item.

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	FLANGELESS CROSS
FLV-110	Standard Red	Red Diffused	Wide angle	MV60538
FLV-111	Standard Red	Water-Clear	Point source narrow	
FLV-112	Standard Red	White-Diffused	Wide angle	
FLV-117	Standard Red	Red Diffused	Wide angle	MV60538
FLV-310	Hi Eff. Green	Green Diffused	Wide angle	MV64538
FLV-410	Yellow	Yellow Diffused	Wide angle	MV63538
FLV-510	Hi Eff. Red	Red Diffused	Wide angle	MV67538

Lamps

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

PARAMETER	TEST COND.	FLV-110	FLV-111	FLV-112	FLV-117	FLV-310	FLV-410	FLV-510	UNITS
Luminous intensity (I_V) minimum	I_F = 20 mA	.8	.8	.8	.2	1.6	1.6	3.0	mcd
Forward voltage (V_F) maximum	I_F = 20 mA	2.0	3.0	3.0	3.0	3.0	3.0	3.0	V
Peak wavelength	I_F = 20 mA	665	665	665	665	565	585	635	nm
Total viewing angle $2\frac{\theta}{2}$	I_F = 20 mA	70	40	70	70	70	70	70	degrees
Reverse Current (I_R)	V_R = 5.0 V	100	100	100	100	100	100	100	μA

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

	STD RED	RED AND YELLOW	GREEN	UNITS
Power dissipation	150	120	120	mW
Derate linearly from 25° C (FLV-310 from 50° C)	2.0	1.6	1.6	mW/° C
Continuous forward current	100	35	30	mA
Peak forward current (1μs PW, 300 pps)	1000	1000	90	mA
Lead solder time at 260° C	5	5	5	seconds
Storage and operating temperatures		-55° C to +100° C		

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25° C Free Air Temperature Unless Otherwise Specified)

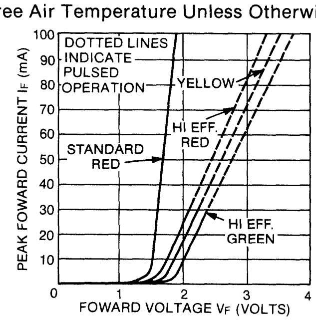


Fig. 1. Forward Current vs. Forward Voltage

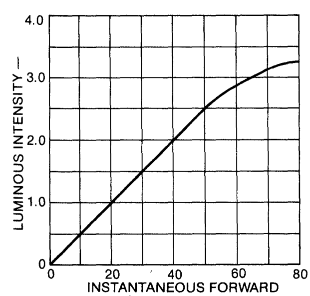


Fig. 2. Luminous Intensity vs. Forward Current

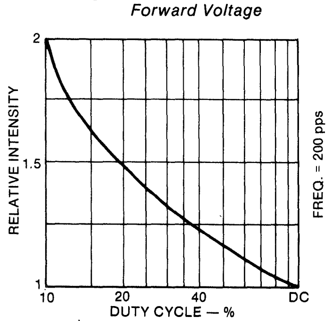


Fig. 3. Luminous Intensity vs. Duty Cycle

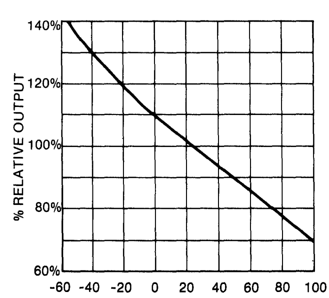
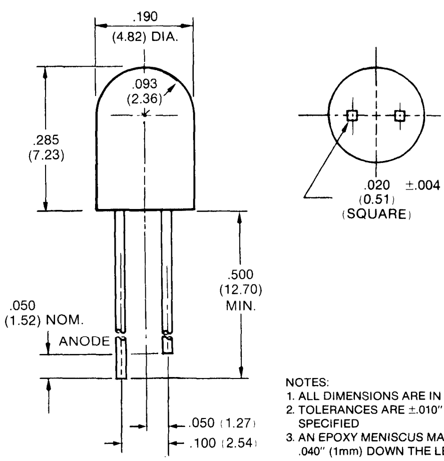


Fig. 4. Output vs. Temperature

GENERAL INSTRUMENT

RED MV60538 HI EFF. GREEN MV64538
YELLOW MV63538 HI EFF. RED MV67538

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

C1062A

DESCRIPTION

These are solid state indicators offering high brightness at low currents in a low profile flangeless T-1¾ with anode lead long.

FEATURES

- Flangeless T-1¾ low profile
- High intensity light source with diffused lens effects.
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight

Lamps

ABSOLUTE MAXIMUM RATING (TA = 25° C Unless Otherwise Specified)

Maximum power dissipation	105 mW
Derate linearly from 25° C (MV64538 from 50° C)	1.6 mW/° C
Maximum storage and operating temperatures	-55° C to 100° C
Maximum lead solder time @ 260° C	5 sec.
Maximum currents and voltages	
Continuous forward current	30 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle) (MV60538 1 amp)	90 mA
Reverse voltage	5.0 V

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	I_V MIN AT 20 mA	I_V TYP AT 20 mA	V_F MAX AT 20 mA
MV60538	Standard Red	Red diffused	Wide beam, 70 degrees	.5 mcd	3.0 mcd	2.2 V
MV63538	Yellow	Yellow diffused	Wide beam, 70 degrees	2.0 mcd	16 mcd	3.0 V
MV64538	Hi Eff. Green	Green diffused	Wide beam, 70 degrees	3.0 mcd	18 mcd	3.0 V
MV67538	Hi Eff. Red	Red diffused	Wide beam, 70 degrees	1.5 mcd	14 mcd	3.0 V

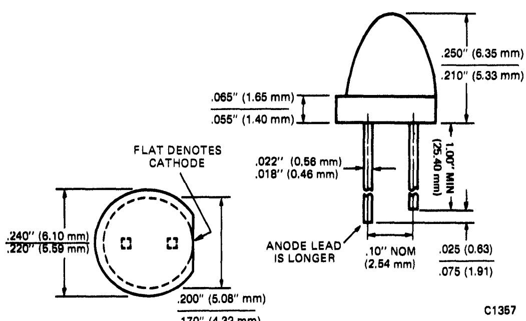
ELECTRO-OPTICAL CHARACTERISTICS

PARAMETER	TEST COND.	UNITS	MV60538	MV63538	MV64538	MV67538
Peak wave length	20 mA	nm	660	585	567	635
Capacitance						
Typ.	f = 1 MHz, V = 0	pF	25	45	20	45
Reverse voltage (V_R)						
Min.	I_R = 100 μA	V	5	5	5	5

GENERAL INSTRUMENT

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 Hi. Eff. red, Hi. Eff. green and yellow devices are made with gallium phosphide.

FEATURES

- High intensity light source with two lens effect
- Red, Hi. Eff. red, Hi. Eff. green and yellow colors available
- Versatile mounting on P.C. 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

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

Maximum power dissipation (MV5015X) .... 180 mW
Maximum power dissipation .... 105 mW
Derate linearly from 25° C .... 1.14 mW/° C
Derate linearly from 25° C (MV5015X) .... 2.0 mW/° C
Maximum storage and operating temperatures .... -55° C to +100° C

Maximum lead solder time at 260° C (see note 3) ...... 5 sec.
Continuous forward current .... 35 mA
Continuous forward current (MV5015X) .... 100 mA
Peak forward current (1 μs pulse 0.3% duty cycle) (MV5415X 90 mA) 1.0A
Reverse voltage .... 5.0 V

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT
MV50152	Red	Red clear	Point source
MV50154	Red	Red lightly diffused	Soft point source
MV53152	Yellow	Amber clear	Point Source
MV53154	Yellow	Amber lightly diffused	Soft point source
MV54152	Hi. Eff. Green	Green clear	Point source
MV54154	Hi. Eff. Green	Green lightly diffused	Soft point source
MV57152	Hi. Eff. Red	Red clear	Point source
MV57154	Hi. Eff. Red	Red lightly diffused	Soft point source

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

PARAMETER	SYMBOL	TEST COND.	UNITS	MV50152	MV50154	MV53152	MV53154	MV54152	MV54154	MV57152	MV57154
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 (see note 1) min.	I_V	10 mA	mcd	0.6	0.4	3.0	1.5	2.5	2.0	4.0	2.0
typ.		10 mA	mcd	2.0	1.5	5.0	3.0	5.0	3.0	8.0	4.0
Peak wave length	λ_P	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	5	5	5	5	5	5	5
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)	2Θ½		degrees	45	50	45	50	45	50	45	50

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

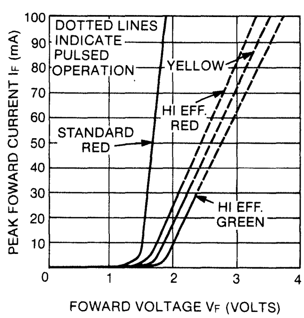


Fig. 1. Forward Current vs. Forward Voltage

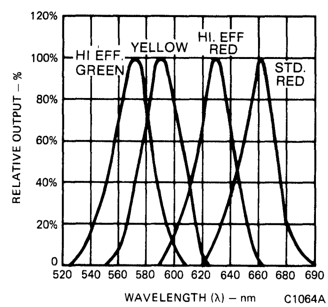


Fig. 2. Spectral Response

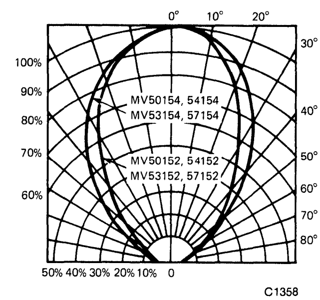


Fig. 3. Spatial Distribution (Note 2)

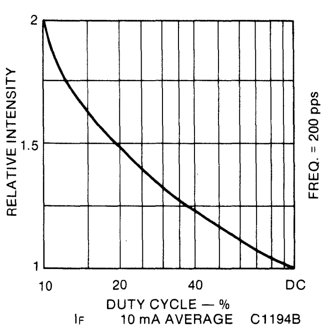


Fig. 4. Luminous Intensity vs. Duty Cycle

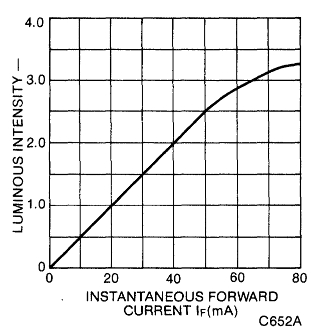


Fig. 5. Luminous Intensity vs. Foward Current

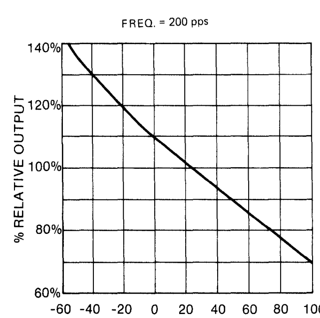


Fig. 6. Output vs. Temperature

NOTES

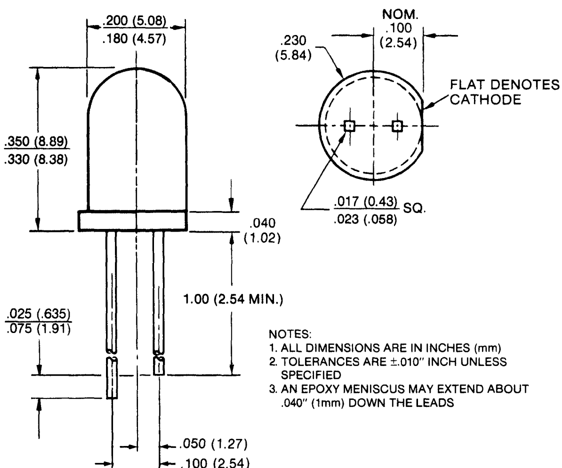
1. *As measured with a Photo Research Corp., "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*
3. *The leads of the device were immersed in molten solder at 260°C to a point 1/16 inch (1.6mm) from the body of of the device per MIL-S-750, with a dwell time of 5 seconds.*

GENERAL INSTRUMENT

MV6050/1/2/3 MV5050/1/2/3
MV6054A-1/2/3 MV5054A-1/2/3
MV6055/6 MV5055/6

PACKAGE DIMENSIONS

MV605X - LEAD CUT ANODE LONG MIN. 1.025"
MV505X - LEAD CUT CATHODE LONG MIN. 0.8"



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

C1062K

DESCRIPTION

The MV5050 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 P. C. board or panel
- Snap in mounting grommet MP52
- Long life — solid state reliability
- Low power requirements
- Compact, rugged, lightweight

Lamps

PHYSICAL CHARACTERISTICS

ANODE LONG	CATHODE LONG	SOURCE COLOR	LENS COLOR	LENS EFFECT	APPLICATION
MV6050	MV5050	Standard Red	Clear Non-tinted	Medium	Wide Beam Backlighting
MV6051*	MV5051	Standard Red	White Diffused	Wide Beam	Max Contrast in High Light Ambient*
MV6052	MV5052	Standard Red	Red Tint	Point Source	Backlighting
MV6053	MV5053	Standard Red	Red Diffused	Wide Beam	Direct View
MV6054A-1	MV5054A-1	Standard Red	Red Diffused	Narrow Beam	Direct View
MV6054A-2	MV5054A-2	Standard Red	Red Diffused	Narrow Beam	Direct View
MV6054A-3	MV5054A-3	Standard Red	Red Diffused	Narrow Beam	Direct View
MV6055	MV5055	Standard Red	Red Diffused	Very Wide Beam	Direct View
MV6056	MV5056	Standard Red	Dark Red Diffused	Very Wide Beam	Direct View

*For other colors see MV6X51 data sheet

ABSOLUTE MAXIMUM RATINGS (TA = 25° C Unless Otherwised Specified)

Power dissipation	180 mW
Derate linearly from 25° C	2.0 mW/° C
Storage and operating temperatures	-55° C to 100° C
Lead solder time @ 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 (TA = 25° C Unless Otherwise Specified)

PARAMETER	TEST COND	6050 5050	6051 5051	6052 5052	6053 5053	6054A-1 5054A-1	6054A-2 5054A-2	6054A-3 5054A-3	6055 5055	6056 5056	UNIT
Luminous Intensity	IF = 20mA	0.5	0.4	0.7	0.5				0.1	0.2	mcd
Iv min. (See note 1)	IF = 10mA					1.0	2.0	3.0			mcd
Forward Voltage	IF = 20mA	2.2	2.2	2.2	2.2				2.2	2.2	volt
VF mcd	IF = 10mA					2.2	2.2	2.2			volt
Peak Wave Length λ_p Typical	IF = 20mA	670	670	670	670	670	670	670	670	670	nm
Spectral Line Half Width Typical	IF = 20mA	20	20	20	20	20	20	20	20	20	nm
Capacitance Typical	V = 0 f = 1MHz	30	30	30	30	30	30	30	30	30	pF
Reverse Current IR Max.	VR = 5.0V	100	100	100	100	100	100	100	100	100	μA
Viewing angle Typical, See figures		50	72	72	80	40	40	40	150	110	degrees

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature)

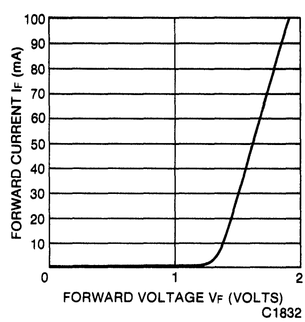


Fig. 1. Forward Current vs. Forward Voltage

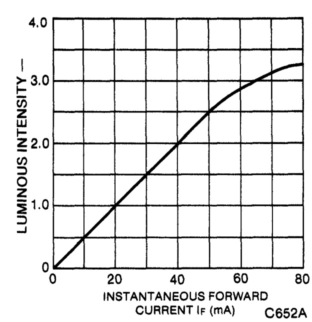


Fig. 2. Luminous Intensity vs. Forward Current

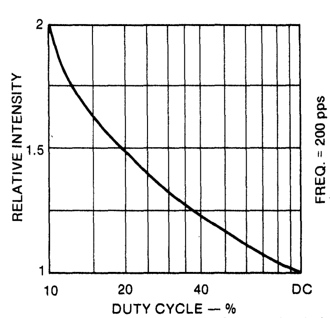


Fig. 3. Luminous Intensity vs. Duty Cycle

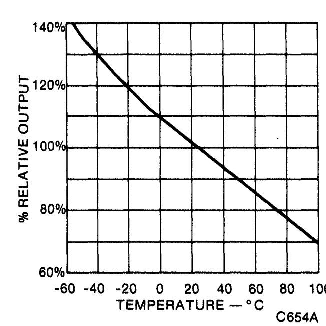


Fig. 4. Output vs. Temperature

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

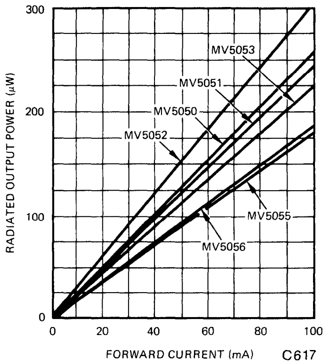


Fig. 5. ROP vs. Forward Current

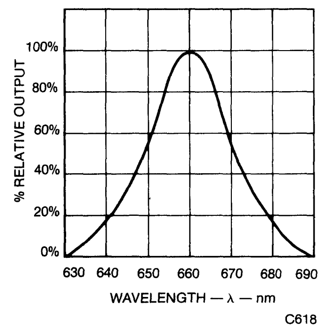


Fig. 6. Spectral Response

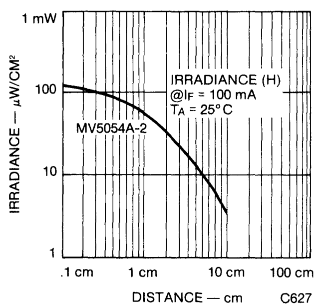


Fig. 7. Irradiance vs. Distance

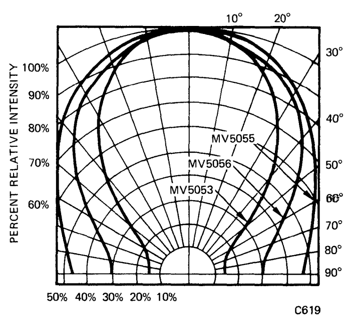


Fig. 8. Spatial Distribution (Note 2) (MV5053, MV5055, MV5056)

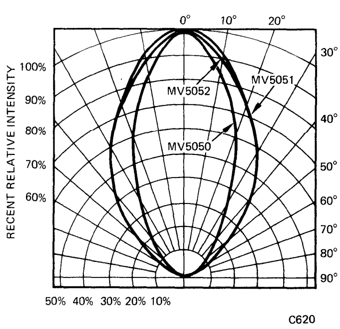


Fig. 9. Spatial Distribution (Note 2) (MV5050, MV5051, MV5052

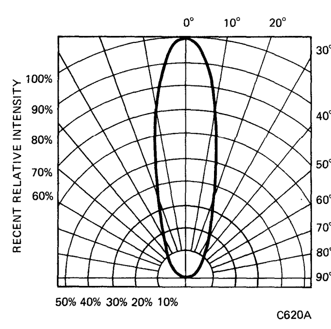


Fig. 10. Spatial Distribution (Note 2) (MV5054-A-1/2/3)

Lamps

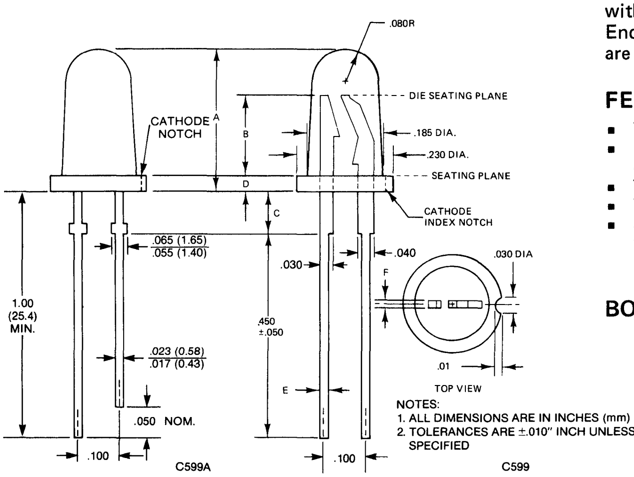
NOTES

1. *As measured with Photot 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 (1.6mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

GENERAL INSTRUMENT

STANDARD RED MV5020 SERIES

PACKAGE DIMENSIONS



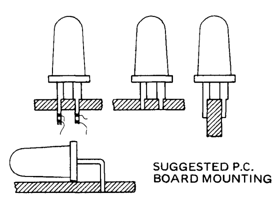
DESCRIPTION

The MV5020 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)

BOARD MOUNTING



ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25° C ambient	180 mW
Derate linearly from 25° C	2 mW/° C
Storage and operating temperatures	-55° C to 100° C
Lead solder time @ 260° C (note 2)	5 sec.
Continuous forward current @ 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
MV5020	.340	.190	.100	.040	.025	RED	CLEAR	POINT	X	X
MV5021	.340	.190	.100	.040	.025	RED	CLEAR DIFF.	SOFT	X	X
MV5022	.340	.190	.100	.040	.025	RED	TRANS. RED	POINT	X	X
MV5023	.340	.190	.100	.040	.025	RED	RED DIFF.	SOFT	X	X
MV5024	.340	.160	.130	.040	.025	RED	RED DIFF.	SOFT FLOODED	X	X
MV5025	.340	.160	.130	.040	.025	RED	RED DIFF.	FLOODED	X	X
MV5026	.340	.160	.130	.040	.025	RED	DK. RED DIFF.	FLOODED	X	X

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

PARAMETER		TEST COND.	UNITS	5020	5021	5022	5023	5024	5025	5026
Luminous Intensity—Min. (Note 1)		20 mA	mcd	0.6	0.5	0.6	0.4	0.9	0.1	0.1
Typ. (Note 1)		20 mA	mcd	2.0	1.6	1.6	1.6	3.0	.4	.6
Peak Wave Length		20 mA	nm	660	660	660	660	660	660	660
Spectral Line Half Width		20 mA	nm	20	20	20	20	20	20	20
Forward Voltage	Typ.	20 mA	V	1.65	1.65	1.65	1.65	1.65	1.65	1.65
VF	Max.	20 mA	V	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Reverse Current IR	Max.	V_R = 5.0 V	μA	100	100	100	100	100	100	100
Reverse Voltage VR	Min.	I_R = 100μA	V	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Capacitance	Typ.	V = 0	pF	35	35	35	35	35	35	35
View Angle		Between 50% Points	Degrees	90	90	90	90	60	180	90
Rise Time		10%-90% 50Ω system	nsec	50	50	50	50	50	50	50
& Fall Time	Typ.	90%-10% 50Ω system	nsec	50	50	50	50	50	50	50

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

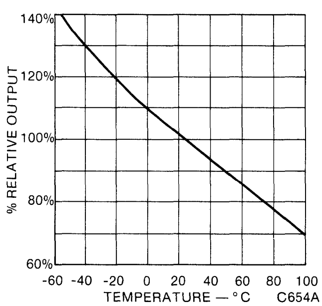


Fig. 1. Output vs. Temperature

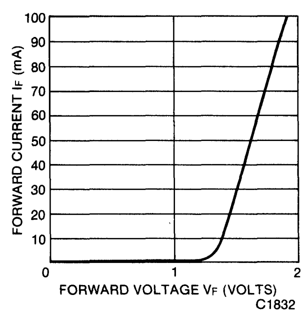


Fig. 2. Forward Current vs. Forward Voltage

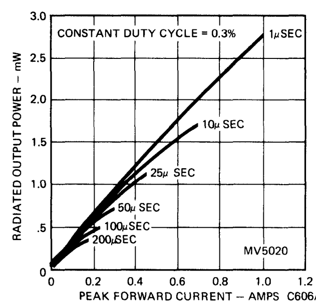


Fig. 3. Radiated Output Power vs. Peak Forward Current

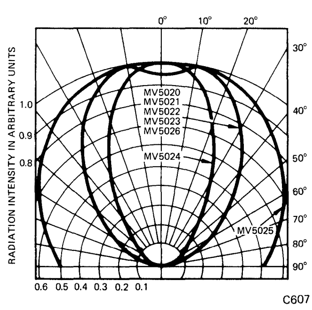


Fig. 4. Spatial Distribution

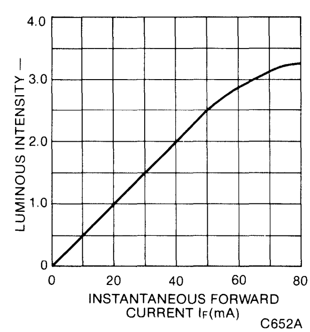


Fig. 5. Luminous Intensity vs. Forward Current

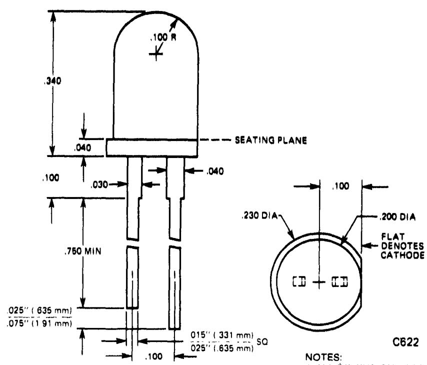
NOTES

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 (1.6mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

GENERAL INSTRUMENT

STANDARD RED MV5054-1
STANDARD RED MV5054-2
STANDARD RED MV5054-3

PACKAGE DIMENSIONS



C622

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 categories
- Illuminates a ¼" diameter circle
- Straight barrel T-1¾ with standoff
- Versatile mounting on PC board
- Mounting grommet MP52 available as separate order item

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 solder 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 (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

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

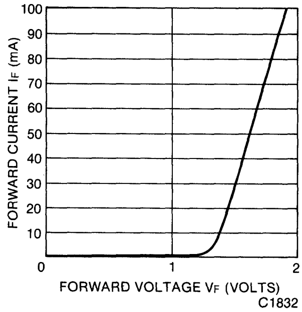


Fig. 1. Forward Current vs. Forward Voltage

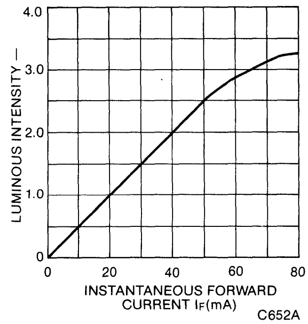


Fig. 2. Luminous Intensity Forward Current

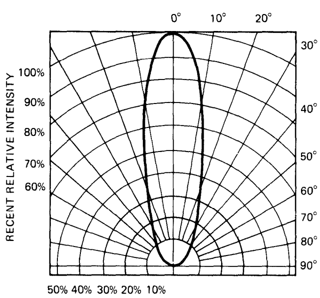


Fig. 3. Spatial Distribution (Note 2)

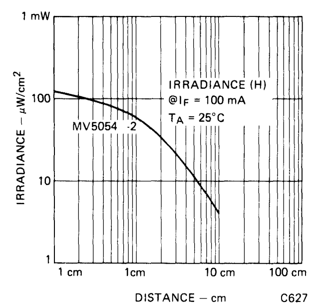


Fig. 4. Irradiance vs. Distance

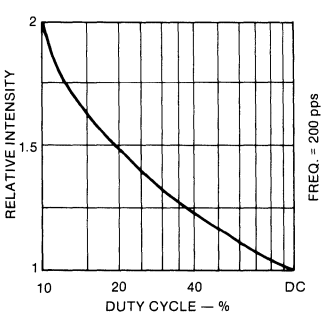


Fig. 5. Luminous Intensity vs. Duty Cycle

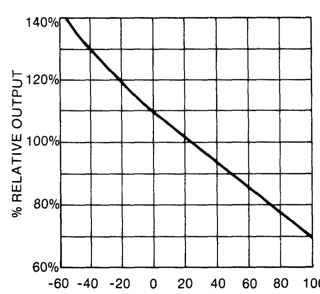
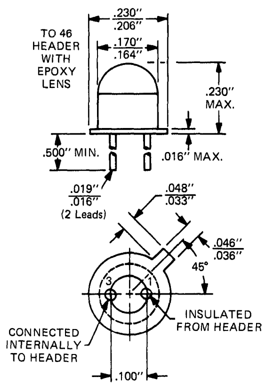


Fig. 6. Output vs. Temperature

GENERAL INSTRUMENT

STANDARD RED MV10B

PACKAGE DIMENSIONS



TOLERANCES ±.010"

C569

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.

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 temperature	-55°C to +100°C
Lead solder time at 260°C (see note 2)	7.0 s
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)

CHARACTERISTICS	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity (see note 1)	0.8		mcd	I_F = 10 mA
Peak emission wave length	660	700	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)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Light rise time and fall time		50		ns	50Ω system, I_F = 50 mA
Reverse current		50		nA	V_R = 3.0 V
Reverse breakdown voltage	3	15		V	I_R = 100 μA
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 (θ_{JA})	320° C/W
Thermal Resistance Junction to Case (θ_{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)

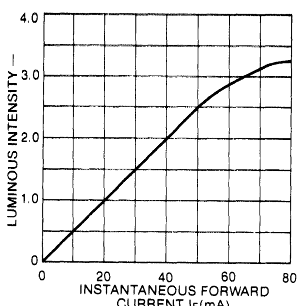


Fig. 1. Luminous Intensity vs. Forward Current

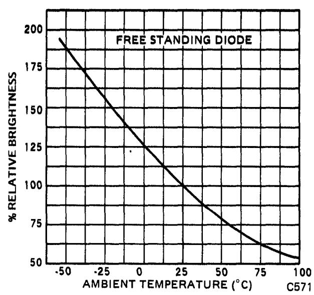


Fig. 2. Brightness vs. Temperature

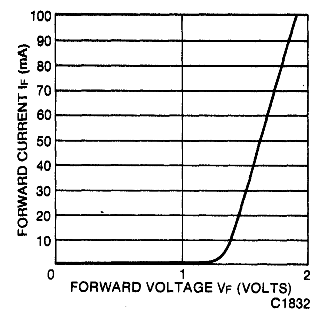


Fig. 3. Forward Current vs. Forward Voltage

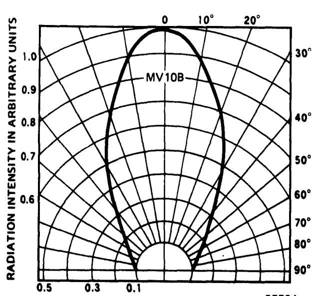


Fig. 4. Spatial Distribution (Note 3)

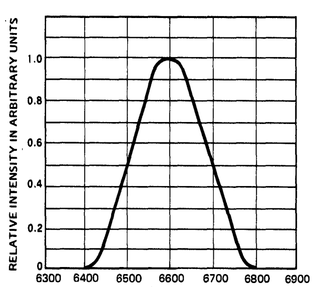


Fig. 5. Spectral Distribution

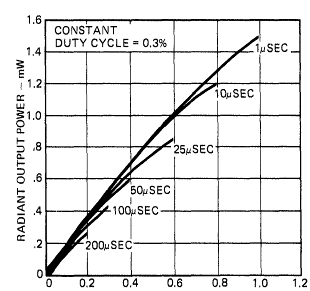


Fig. 6. Peak Power Output vs. Pulsed Forward Current

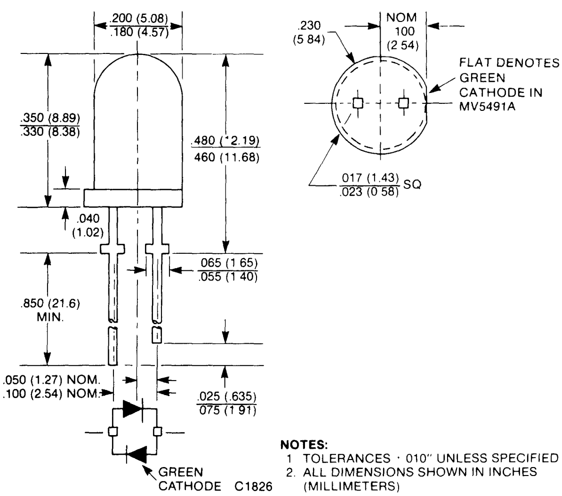
NOTES

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 (1.6mm) 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

HIGH EFFICIENCY GREEN/AlGaAs RED MV5491A*
HIGH EFFICIENCY RED/AlGaAs RED MV5094A*

PACKAGE DIMENSIONS



NOTES:
1. TOLERANCES ±.010" UNLESS SPECIFIED
2. ALL DIMENSIONS SHOWN IN INCHES (MILLIMETERS)

**A B-version is available on special order with tapered lens (as MV502X)*

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.

The A-versions have 1" leads with .060" wide stand-offs at the same position as the non-A versions and the MV9X7X in order to be fully interchangeable in existing PC-boards using .040"-.050" holes.

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
- Increased solder heat durability
- 4-state; green, red, orange, off (MV5491A)
- Same stand-off height as MV5491, MV5094 and MV9X7X
- 1" leads
- May be panel mounted—MP52 is separate order item

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

PARAMETER	RATING	UNITS	NOTES
Power dissipation	135	mW	1
Peak current	90	mA	
Average current	30	mA	2
Lead solder 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 current 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)

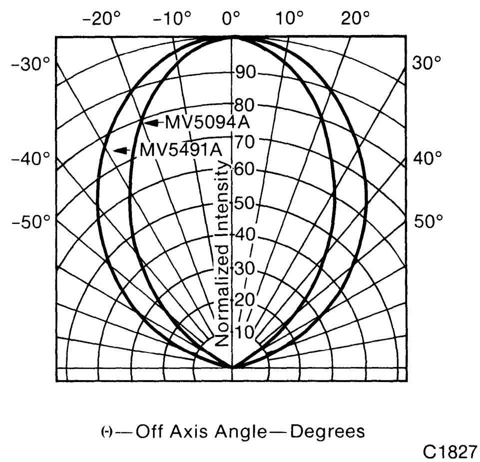


Fig. 1. Spatial Distribution

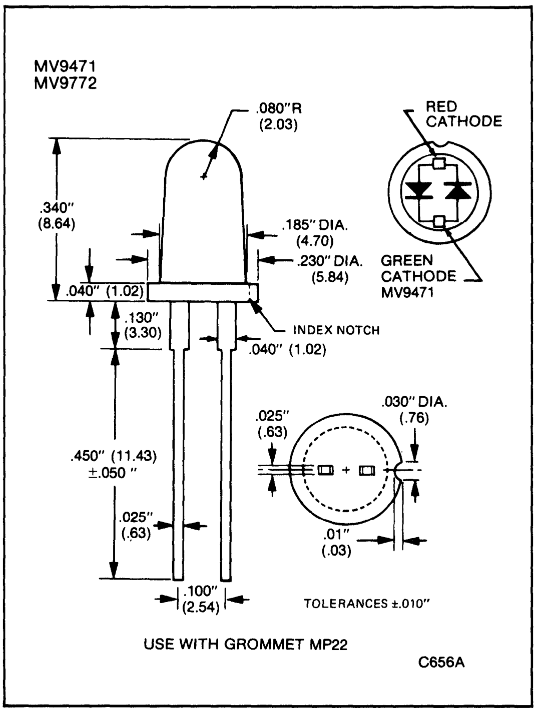
GENERAL INSTRUMENT

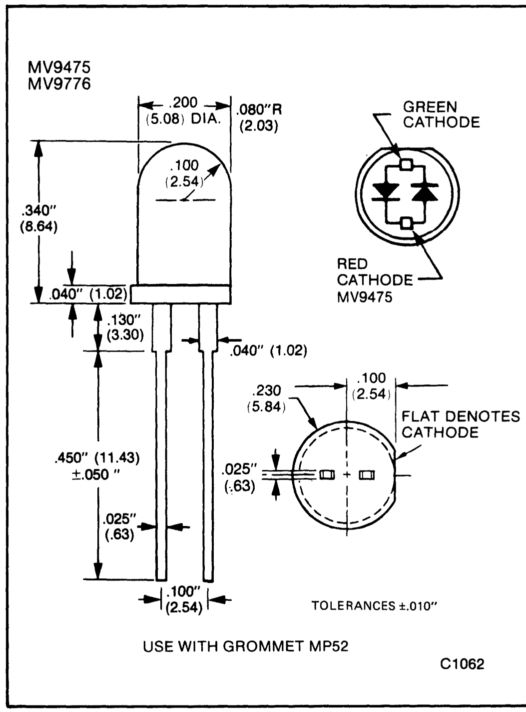
HI EFF. GREEN/HI EFF. RED MV9471/MV9475
BIPOLAR HI EFF. RED MV9772/MV9776
SEE MV5491A AND MV5094A FOR NEW DESIGNS

DESCRIPTION

The MV9X7X offers dual-chip high efficiency GaAsP on GaP in two industry standard lens shapes. They are all radical improvements of the well-known bipolar red MV5094 and bicolor green-red MV5491.

PACKAGE DIMENSIONS





PHYSICAL CHARACTERISTICS

DEVICE*	SOURCE COLOR	LENS COLOR	LENS EFFECT	I_V MIN @ 20 mA	λ_{PK}	V_F MAX @ 20 mA
MV9471	Hi Eff. Green/Red	White Diffused	Tapered	2.5 mcd	567/635 nm	3.0
MV9475	Hi Eff. Green/Red	White Diffused	Barrel	2.5 mcd	567/635 nm	3.0
MV9772	Hi Eff. Red/Red	Red Diffused	Tapered	2.5 mcd	635 nm	3.0
MV9776	Hi Eff. Red/Red	Red Diffused	Barrel	2.5 mcd	635 nm	3.0

See also MV5094 and MV5491
Other color combinations available on special order.

ABSOLUTE MAXIMUM RATINGS MV9772/6

Power Dissipation @ 25° C (Peak or continuous)	140 mW
Storage and Operating Temperature	-55° C to 100° C
A.C.$_{(RMS)}$/D.C. Forward Current 25° C	35 mA
A.C.$_{(RMS)}$/D.C. Forward Current 100° C	5 mA
I_{peak} (repetitive) (0.3% Duty Cycle, 1.0 μsec pulse width)	90 mA
Lead Solder time 260° C (See Note 3)	5 sec

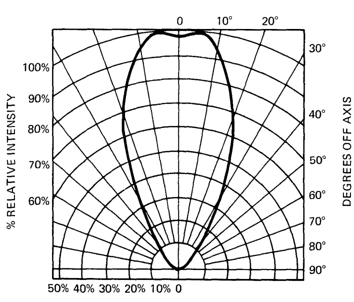
ABSOLUTE MAXIMUM RATINGS MV9471/6

Power Dissipation @ 25° C (Peak or Continuous)	200 mW
Storage & Operating Temp.	-55° C to 100° C
Currents	
Red ON (Peak or Continuous, 25° C)	35 mA
Green ON (Peak or Continuous, 25° C)	30 mA
Derate linearly from 25° C	
Red	-1.14 mW/° C
Green	-1.6 mW/° C
Lead solder time @ 260° C (See Note 3)	5 sec

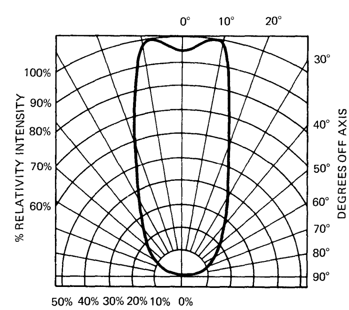
ELECTRO-OPTICAL CHARACTERISTICS (25° C Free Air Temperature)

	TYP.	UNITS	CONDITIONS
Spectral Half Width			
Red	20	nm	I_F = 20 mA
Green	30	nm	I_F = 20 mA
Dynamic Resistance (R_D)			
Red	5.5	Ω	
Green	50.0	Ω	

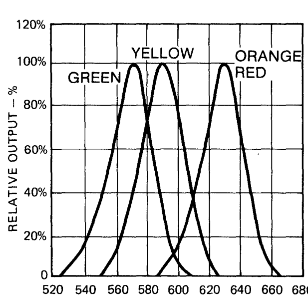
TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES
(25° C Free Air Temperature Unless Otherwise Specified)



MV9772/6
Spatial Distribution



MV9471/5
Spatial Distribution

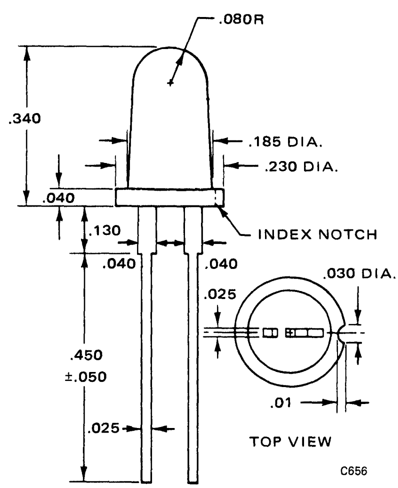


Spectral Response

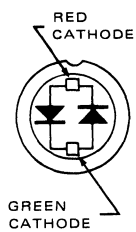
GENERAL INSTRUMENT

STANDARD RED/GREEN MV5491
SEE MV5491A FOR NEW DESIGNS

PACKAGE DIMENSIONS



NOTE: TOLERANCES ±.010 UNLESS SPECIFIED



DESCRIPTION

A green and red lamp made of GaAsP (Red) and GaP (Green) offering a changing color dependent on the direction the lamp is biased. These two light emitting diodes are mounted in the same convenient epoxy package.

FEATURES

- Bright
- Long life, rugged
- True polarity indicating
- 3 states: Green, Red, Off
- Solid state
- Integrated circuit compatible
- Convenient mounting clip available
- Versatile mounting on P.C. board or panel

ABSOLUTE MAXIMUM RATINGS

Power Dissipation @ 25°C (Peak or Continuous) . . . . . 200 mW
Storage & Operating Temp. . . . . . −55°C to 100°C
Currents
  Red ON (Peak or Continuous, 25°C) . . . . . 70 mA
  Green ON (Peak or Continuous, 25°C) . . . . . 35 mA
Derate linearly from 25°C
  Red . . . . . −1.66 mW/°C
  Green . . . . . −2.66 mW/°C
Lead solder time @ 260°C (See Note 3) . . . . . 5 sec

THERMAL CHARACTERISTICS

	TYP.	MAX.	UNITS	CONDITIONS
Forward Voltage Temp. Coefficient				
Red	−1.5		mV/°C	I_F = 20 mA
Green	−3.0		mV/°C	I_F = 20 mA

Lamps

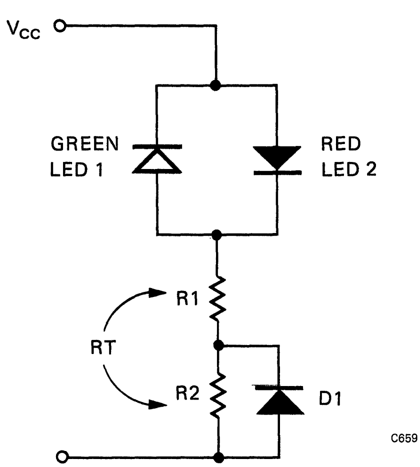
ELECTRO-OPTICAL CHARACTERISTICS (25°C Ambient Temperature)

	TYP.	MAX.	UNITS	CONDITIONS
Luminous Intensity (I) (note 2)				
Red	1.5		mcd	I_F = 20 mA
Green	.5		mcd	I_F = 20 mA
Wavelength (λpk)				
Red	660		nm	I_F = 20 mA
Green	560		nm	I_F = 20 mA
Spectral Half Width				
Red	20		nm	I_F = 20 mA
Green	30		nm	I_F = 20 mA
Forward Voltage (V_F)				
Red	1.65	2.0	volts	I_F = 20 mA
Green	2.2	3.0	volts	I_F = 20 mA
Dynamic Resistance (R_D)				
Red	5.5		Ω	
Green	50.0		Ω	

BIASING NETWORK

V_{CC} = 5V

D_1 = 1N914 (or equivalent)



$$R_T = \frac{V_{CC} - V_{LED2}}{I_{LED2}} \qquad R_1 = \frac{V_{CC} - (V_{LED1} + V_{D1})}{I_{LED1}}$$

Example: Match Intensities of both red and green units at 20 mA and 35 mA respectively.

FOR RED:

$$R_T = \frac{V_{CC} - V_{LED2}}{I_{LED2}} = \frac{5.0 - 1.63}{.020} = 168\Omega$$

FOR GREEN:

$$R_1 = \frac{V_{CC} - (V_{LED1} + V_{D1})}{I_{LED1}} = \frac{5.0 - (2.5 + 0.7)}{.035} = 51\Omega$$

$R_T - R_1 = R_2$

168 – 51 = 117Ω

SUGGESTED RESISTOR COMBINATIONS

GREEN →	10 mA			20 mA			30 mA		
RED	R_T	R_1	R_2	R_T	R_1	R_2	R_T	R_1	R_2
10 mA	344	230	114	344	102	242	344	63	281
20 mA	170	230	-60	170	102	68	170	63	107
30 mA	112	230	-118	112	102	10	112	63	49
40 mA	84	230	-146	84	102	-18	84	63	21
50 mA	67	230	-163	67	102	-35	67	63	4
60 mA	55	230	-175	55	102	-47	55	63	-8
70 mA	47	230	-183	47	102	-55	47	63	-16

NOTES: 1) All values are in ohms
2) V_{CC} = 5 volts D.C.
3) Current combinations in shaded area not possible with circuit shown

Note: Values computed are for maximum currents through each diode.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

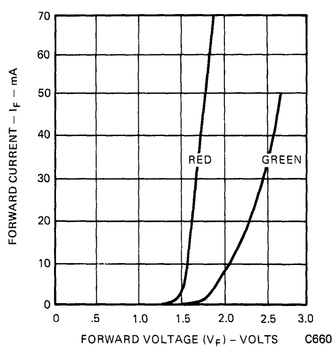


Fig. 1. Forward Current vs Forward Voltage

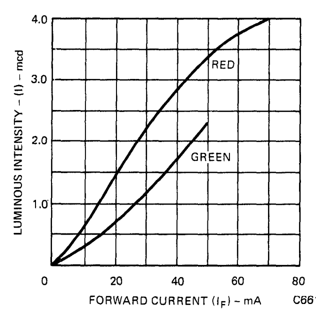


Fig. 2. Luminous Intensity vs Forward Current

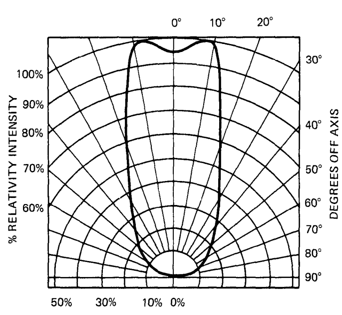


Fig. 3 Spatial Distribution (Note 1)

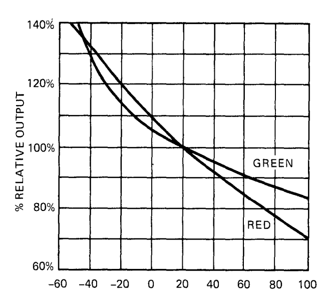


Fig. 4. Relative Output vs Temperature

Lamps

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

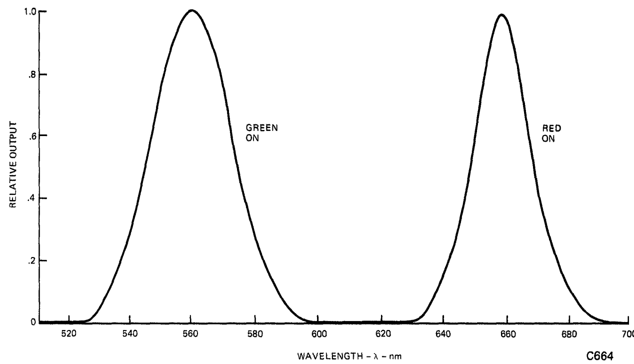


Fig. 5. Spectral Distribution

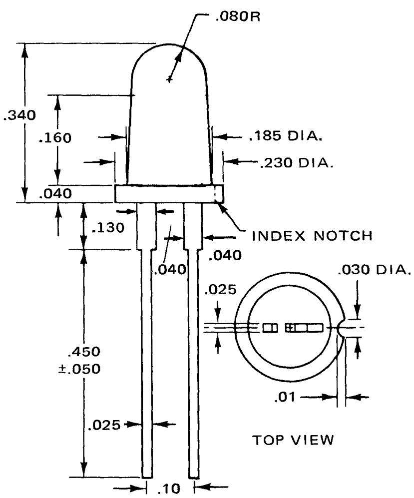
NOTES

1. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*
2. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
3. *The leads of the device were immersed in molten solder, heated to a temperature of 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.*

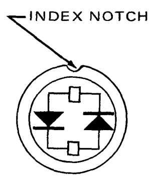
GENERAL INSTRUMENT

STANDARD RED MV5094
SEE MV5094A FOR NEW DESIGNS

PACKAGE DIMENSIONS



NOTE: TOLERANCES ±.010" UNLESS SPECIFIED C647



ELECTRICAL

DESCRIPTION

The MV5094 is the first commercially available solid state AC-DC lamp. Reliability, long life, plus a convenient panel mounting enable this red lamp to be run from A.C. voltages even as high as 110-115 V.

FEATURES

- Solid state
- A.C. lamp
- 110-115 VAC operation (see chart)
- Versatile mounting on P.C. board or panel
- Convenient mounting grommet available
- Cool operation
- Long life
- This lamp mounts in the MP21 or MP22 grommet.

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C (peak or continuous)	140 mW
Storage and operating temperature	-55°C to +100°C
A.C. (RMS)/D.C. forward current 25°C	70 mA
I^2T (0.1% duty cycle)	2.5×10^{-4} amps² sec.
I_{PEAK} (repetitive) (0.3% duty cycle, 1.0 μsec pulse width)	1.0 A
Lead solder time 260°C (see note 3)	5 sec.

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (25°C Ambient Temperature Unless Stated Otherwise)

	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Luminous Intensity (1) (Note 1)		.8		mcd	I_F = 20 mA
Forward Voltage (V_F)		1.6	2.0	volts	I_F = 20 mA

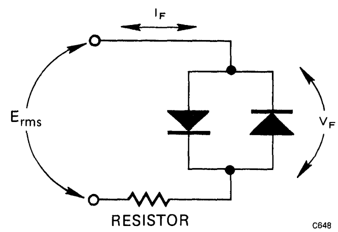
AC OPERATION

E_{RMS}	I_F = 10 mA, V_F = 1.56 RESISTOR	I_F = 25 mA, V_F = 1.62 RESISTOR	I_F = 50 mA, V_F = 1.66 RESISTOR	I_F = 70 mA, V_F = 1.70 RESISTOR
5.0	360 Ω, 1/8 W	130 Ω, 1/8 W	68 Ω, 1/4 W	51 Ω, 1/4 W
6.3	470 Ω, 1/8 W	180 Ω, 1/8 W	100 Ω, 1/4 W	68 Ω, 1/2 W
9.0	750 Ω, 1/8 W	300 Ω, 1/4 W	150 Ω, 1/2 W	110 Ω, 1 W
12.0	1.0 KΩ, 1/8 W	430 Ω, 1/2 W	200 Ω, 1/2 W	150 Ω, 1 W
15.0	1.3 KΩ, 1/4 W	560 Ω, 1/2 W	270 Ω, 1 W	200 Ω, 1 W
18.0	1.6 KΩ, 1/4 W	680 Ω, 1/2 W	330 Ω, 1 W	240 Ω, 2 W
24.0	2.2 KΩ, 1/4 W	910 Ω, 1 W	470 Ω, 2 W	330 Ω, 2 W
28.0	2.7 KΩ, 1/2 W	1.1 KΩ, 1 W	560 Ω, 2 W	390 Ω, 2 W
48.0	4.7 KΩ, 1/2 W	1.8 KΩ, 2 W	---------	---------
110.0	11.0 KΩ, 2 W	----------	---------	---------

Resistor values are nearest commercially available.

$$\text{Resistor Value} = \frac{E_{(RMS)} - V_F}{I_F}$$

where: I_F corresponds to a desired brightness level (from fig. 2).
V_F corresponds to the voltage across the device (from fig. 1).



TYPICAL ELECTRO-OPTICAL CHARACTERISTICS

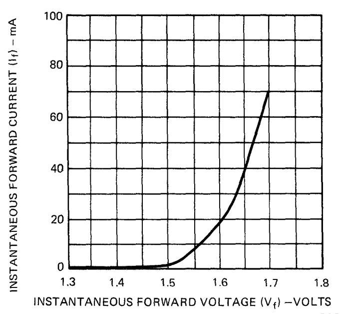


Fig. 1. Forward Current vs. Forward Voltage

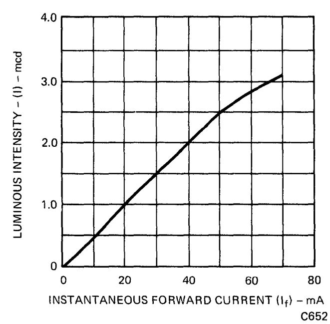


Fig. 2. Luminous Intensity vs. Forward Current

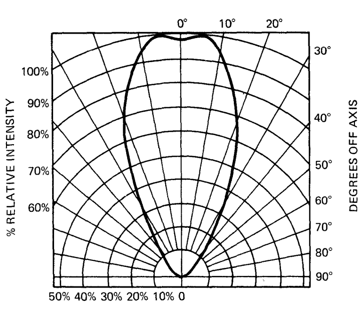


Fig. 3. Spatial Distribution

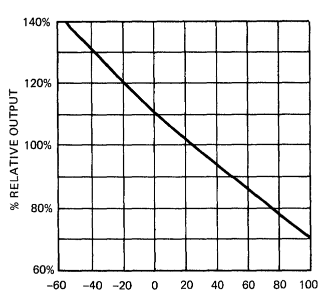


Fig. 4. Output vs. Temperature

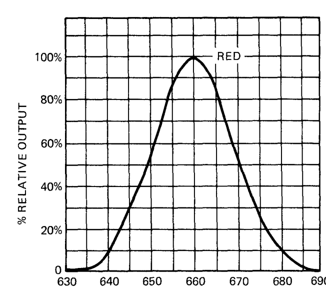


Fig. 5. Spectral Distribution

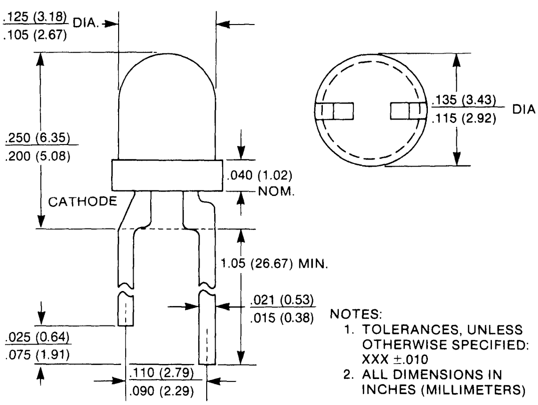
NOTES

1. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
2. *Values of Luminous Intensity may begin to decrease for operation above 25 KHz.*
3. *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

HIGH EFFICIENCY RED HLMP-1300 SERIES
YELLOW HLMP-1400 SERIES
HIGH EFFICIENCY GREEN HLMP-1500 SERIES

PACKAGE DIMENSIONS



NOTES:
1. TOLERANCES, UNLESS OTHERWISE SPECIFIED: XXX ±.010
2. ALL DIMENSIONS IN INCHES (MILLIMETERS)

C1533D

FEATURES

- Choice of waterclear, tinted and tinted diffused for backlighting applications or direct view.
- T-1 (3mm) diameter with 0.100 inch lead spacing.
- All 3 colors.
- Sturdy leads for easier assembly.

DESCRIPTION

The HLMP-1300/1400/1500 series of T-1 lamps are direct replacements for the Hewlett-Packard lamps with the same part numbers. These lamps are similar to the MV5X6XX except for the tint.

Lamps

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

LENS	SOURCE COLOR	HLMP-	LENS COLOR	I_V (mcd) MIN	I_V (mcd) TYP	at I_F (mA)	$2\theta_{1/2}$ TYP	λ_p (nm) TYP
Waterclear	Hi. Eff. Red	1320	None	6.0	12	10	45°	635
	Yellow	1420		6.0	12	10	45°	585
	Hi. Eff. Green	1520		6.0	12	20	45°	565
Tinted Non-Diffused	Hi. Eff. Red	1321	Red	6.0	12	10	45°	635
	Yellow	1421	Amber	6.0	12	10	45°	585
	Hi. Eff. Green	1521	Green	6.0	12	20	45°	565
Tinted Diffused	Hi. Eff. Red	1300	Red	1.0	2.0	10	60°	635
		1301		2.0	2.5	10	60°	635
		1302		3.0	4.0	10	60°	635
	Yellow	1400	Amber	1.0	2.0	10	60°	585
		1401		2.0	3.0	10	60°	585
		1402		3.0	4.0	10	60°	585
	Hi. Eff. Green	1503	Green	2.0	5.0	20	60°	565
		1523		5.0	10	20	60°	565

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

PARAMETER	HLMP-13XX HI. EFF. RED	HLMP-14XX YELLOW	HLMP-15XX 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	
DC forward current	30	20	30	mA	2
Operating and storage temperature		-55° C to +100° C			
Lead solder time at 260° C		5 seconds			3

1.) For Hi. Eff. Red and Hi. Eff. Green derate power linearly from 25° C at 1.8 mW/° C. For yellow derate linearly from 50° C at 1.6 mW/° C.
2.) For Hi. Eff. Red and Hi. Eff. Green derate linearly from 50° C at 0.5 mA/° C. For yellow derate linearly from 50° C at 0.2 mA/° C.
3.) At minimum 1/16 inch (1.6 mm) from lamp flange.

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

		HLMP-13XX HI. EFF. RED			HLMP-14XX YELLOW			HLMP-15XX HI. EFF. GREEN				
SYMBOL	PARAMETER	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
V_F	Forward voltage	1.5	2.2	3.0	1.5	2.2	3.0	-	-	-	V	I_F = 10 mA
V_F	Forward voltage	-	-	-	-	-	-	1.6	2.3	3.0	V	I_F = 20 mA
C	Capacitance		45			45			20		pF	V_F = 0, f = 1 MHz
BV_R	Reverse breakdown voltage	5			5			5			V	I_R = 100 μA

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

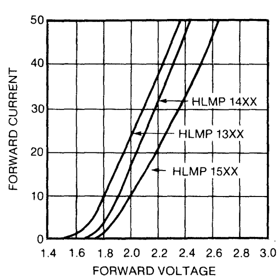


Fig. 1. Forward Voltage/ Forward Current

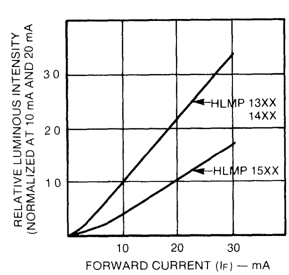


Fig. 2. Relative Luminous Intensity/ Forward Voltage

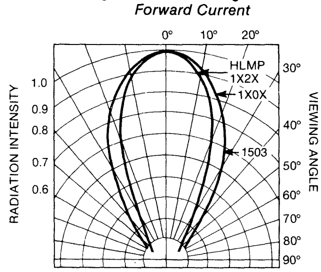


Fig. 3 Spatial Distribution

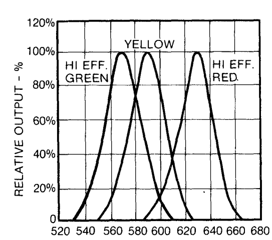
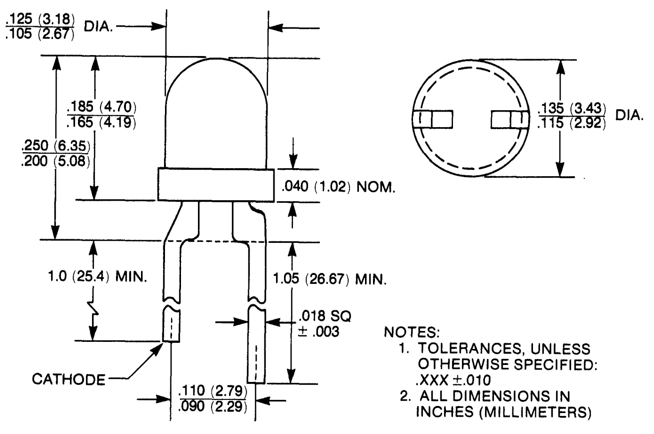


Fig. 4. Spectral Response

GENERAL INSTRUMENT

HIGH EFFICIENCY RED/PINK MV5164X
SOFT ORANGE MV5664X
YELLOW MV5364X
YELLOW (HLMP140X) MV5864X
HIGH EFFICIENCY GREEN MV5464X
HIGH EFFICIENCY GREEN (HLMP15X3) MV5564X
HIGH EFFICIENCY RED (HLMP130X) MV5764X

PACKAGE DIMENSIONS



NOTES:
1. TOLERANCES, UNLESS OTHERWISE SPECIFIED: .XXX ±.010
2. ALL DIMENSIONS IN INCHES (MILLIMETERS)

C1533D

DESCRIPTION

These solid state indicators offer a variety of color selection. The high efficiency red, pink, soft orange and yellow devices are made with gallium arsenide phosphide on gallium phosphide; the green units are made with gallium 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, 1400 and 1500 product series
- 100 mil lead spacing T-1
- High efficiency GaP light
- Versatile mounting on P.C. board or panel
- Wide viewing angle
- Diffused tinted lens
- All 4 colors including soft orange

Lamps

PHYSICAL CHARACTERISTICS

COLOR/DEVICE		SOURCE/COLOR	DIFFUSED LENS COLOR	LUMINOUS INTENSITY at 25°C (mcd) MIN.	TYP.	TEST CONDITIONS
PINK	MV51640			1.0	2.0	
	MV51641	Hi Eff. Red	Orange diff.	1.5	2.5	I_F = 10 mA
	MV51642			2.5	3.5	
SOFT ORANGE	MV56640	Orange	Orange diff.	1.0	2.0	I_F = 10 mA
YELLOW	MV53640			1.0	2.0	
	MV53641	Yellow	Yellow diff.	1.5	3.0	I_F = 10 mA
	MV53642			2.5	4.5	
YELLOW-AMBER	MV58640 (HLMP1400)			1.0	2.0	
	MV58641 (HLMP1401)	Yellow	Amber diff.	2.0	2.5	I_F = 10 mA
	MV58642 (HLMP1402)			3.0	4.0	
HI EFF. GREEN	MV54643	Hi Eff. Green	Green diff.	2.0	5.0	I_F = 20 mA
	MV54644			6.0	10.0	
	MV55643 (HLMP1503)	Hi Eff. Green	Green diff.	2.0	5.0	I_F = 20 mA
	MV55644 (HLMP1523)			5.0	10.0	
HI EFF. RED	MV57640 (HLMP1300)			1.0	2.0	
	MV57641 (HLMP1301)	Hi Eff. Red	Red diff.	2.0	2.5	I_F = 10 mA
	MV57642 (HLMP1302)			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 mW/°C	1.6 mW/°C
Storage and operating temperatures	-55°C to 100°C	-55°C to 100°
Lead solder 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)

PARAMETER		SYMBOL	TEST COND.	UNITS	MV5164X PINK	MV5664X SOFT ORANGE	MV5864X MV5364X YELLOW	MV5464X MV5564X GREEN	MV5764X RED
Forward voltage	typ.	V_F	I_F = 10 mA	V	2.0	2.2	2.1	2.2*	2.0
	max.				3.0	3.0	3.0	3.0*	3.0
Peak wave length		λp	I_F = 10 mA	nm	635	605	585	562	635
Spectral line Half width			I_F = 10 mA	nm	45	35	35	30	45
Capacitance	typ.	C	V = 0, f = 1 MHz	pF	45	45	45	20	45
Reverse voltage	min.	V_{BR}	I_F = 100 μA	V	5.0	5.0	5.0	5.0	5.0
Viewing angle (total)	typ.	2Θ½	See Fig. 3	degrees	90	90	90	90	90

*I_F = 20 mA

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

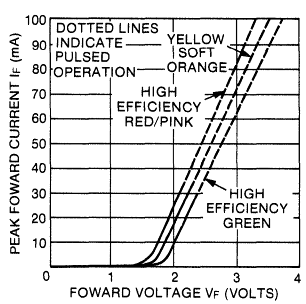


Fig. 1. Forward Current vs. Forward Voltage

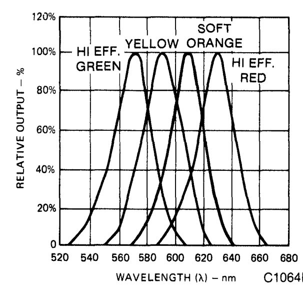


Fig. 2. Spectral Response

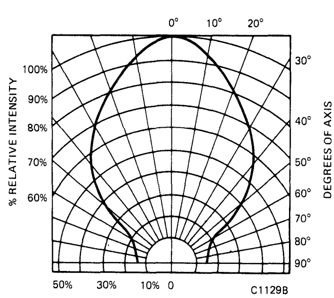


Fig. 3. Spatial Distribution

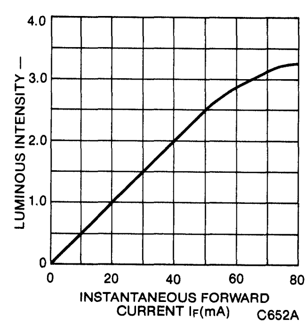
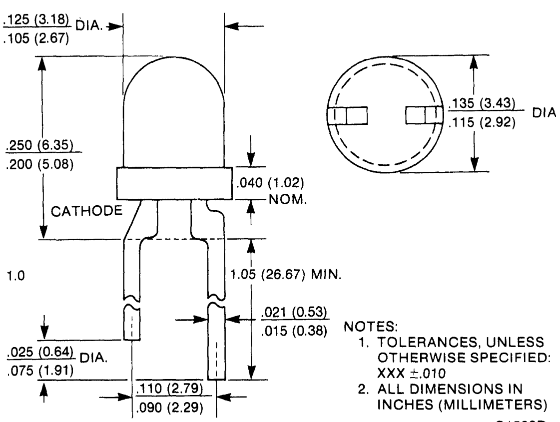


Fig. 4. Relative Luminous Intensity vs. Forward Current

GENERAL INSTRUMENT

YELLOW MV5362X TINTED, MV5360 WATER-CLEAR
HIGH EFFICIENCY GREEN MV5462X TINTED, MV5460 WATER-CLEAR
HIGH EFFICIENCY RED MV5762X TINTED, MV5760 WATER-CLEAR

PACKAGE DIMENSIONS



NOTES:
1. TOLERANCES, UNLESS OTHERWISE SPECIFIED: XXX ±.010
2. ALL DIMENSIONS IN INCHES (MILLIMETERS)

C1533D

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.

FEATURES

- Clear-tinted and water-clear 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 HLMP1X20/1 series
- Excellent for switch backlighting*

**See ultrabright T-1 series on data sheet HLMP1X40*

Lamps

PHYSICAL CHARACTERISTICS

COLOR/DEVICE		SOURCE COLOR	LENS COLOR	LUMINOUS INTENSITY IN mcd AT 25°C Min	Typ	TEST CONDITIONS
Yellow	MV53620	Yellow	Tinted	1.5	2.0	
	MV53621	Yellow	Tinted	3.0	4.0	I_F = 10 mA
	MV53622*	Yellow	Tinted	6.0	8.0	
	MV5360 (HLMP1420)	Yellow	Water-clear	6.0	12.0	
Green	MV54623	Hi. Eff. Hreen	Tinted	3.0	6.0	
	MV54624**	Hi. Eff. Green	Tinted	6.0	12.0	I_F = 20 mA
	MV5460 (HLMP1520)	Hi. Eff. Green	Water-clear	6.0	12.0	
Red	MV57620	Hi. Eff. Red	Tinted	1.5	2.0	
	MV57621	Hi. Eff. Red	Tinted	3.0	4.0	I_F = 10 mA
	MV57622 (HLMP1321)	Hi. Eff. Red	Tinted	6.0	12.0	
	MV5760 (HLMP1320)	Hi. Eff. Red	Water-clear	6.0	12.0	

**For exact color match to Hewlett-Packard, see data sheet HLMP1421*
***For exact color match to Hewlett-Packard, see data sheet HLMP1521*

MV5362X MV5462X MV5762X MV5X60

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

Power dissipation	120 mW
Derate linearly from 50°C	0.4 mA/°C
Storage and operating temperatures	-55°C to 100°C
Lead solder 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)

PARAMETER	TEST CONDITIONS	UNITS	MV53762X MV5360	MV5462X MV5460	MV5762X MV5760
Forward voltage (V_F)					
typ.	I_F = 10 mA	V	2.1	2.1*	2.0
max.			3.0	3.0*	3.0
Peak wave length	I_F = 10 mA	nm	585	567	635
Spectral line					
half width	I_F = 10 mA	nm	35	40	45
Capacitance					
typ.	f = 1 MHz, V = 0	pF	45	20	45
Reverse voltage (V_R)					
min.	I_R = 100 μA	V	5.0	5.0	5.0
Viewing angle (total)					
typ.	see Fig. 3	degrees	45	45	45

**I_F = 20 mA*

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

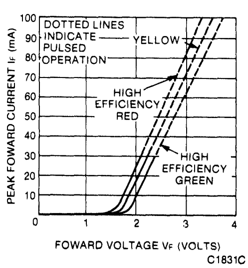


Fig. 1. Forward Current vs. Forward Voltage

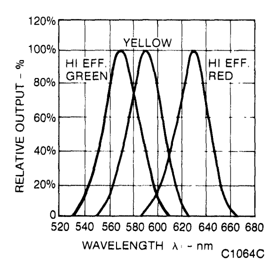


Fig. 2. Spectral Response

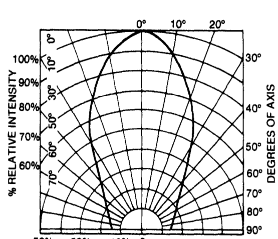


Fig. 3. Spatial Distribution

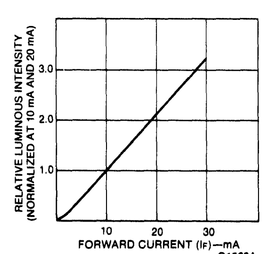
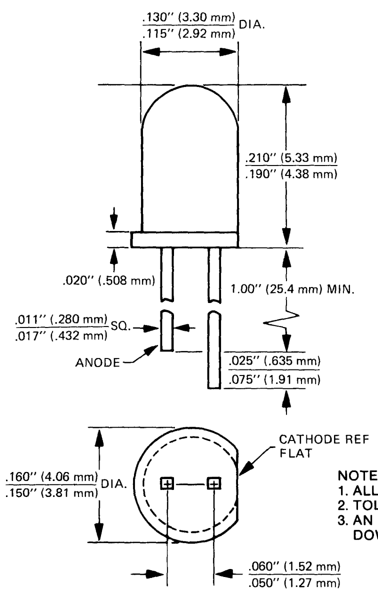


Fig. 4. Relative Luminous Intensity vs. Forward Current

GENERAL INSTRUMENT

HIGH EFFICIENCY RED/PINK MV5174C HIGH EFFICIENCY GREEN MV5474C YELLOW MV5374C 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

C1128A

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

- .005 inch lead spacing
- High efficiency GaP light source with various lens effects
- Versatile mounting on P.C. board or panel
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight
- Square leads (will fit into .020" [.508 mm] diameter holes)
- Upon request, also available with anode lead trimmed longer than cathode
- 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
Lead solder 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 PROFILE
MV5174C	Hi. Eff. Red	Pink diffused	Wide beam	High profile
MV5374C	Yellow	Yellow diffused	Wide beam	High profile
MV5474C	Hi. Eff. Green	Green diffused	Wide beam	High profile
MV5774C	Hi. Eff. Red	Red diffused	Wide beam	High profile

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

PARAMETER		SYMBOL	TEST COND.	UNITS	MV5174C	MV5374C	MV5474C	MV5774C
Forward voltage	typ.	V_F	I_F = 20 mA	V	2.0	2.1	2.2	2.0
	max.		I_F = 20 mA	V	3.0	3.0	3.0	3.0
Luminous intensity (see note 1)	min.	Iv	I_F = 20 mA	mcd	1.5	1.5	1.2	1.5
	typ.		I_F = 20 mA	mcd	5.0	4.0	4.0	5.0
Peak wave length		λ_p	I_F = 20 mA	nm	635	585	565	635
Spectral line Half width			I_F = 20 mA	nm	45	35	35	45
Capacitance	typ.	C	v = 0	pF	45	45	20	45
Reverse voltage	min.	V_{BR}	I_R = 100 μA	V	5	5	5	5
	typ.		I_R = 100 μA	V	25	25	25	25
Reverse current	typ	I_R	V_R = 5.0 V	nA	20	20	20	20
	max.		V_R = 5.0 V	μA	100	100	100	100
Viewing angle (total)		$2\Theta_{1/2}$	See Fig. 3	degrees	90	90	90	90

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

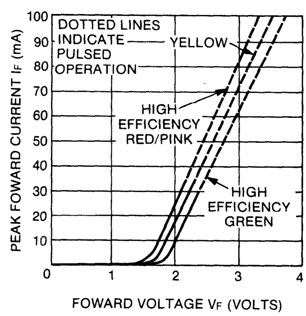


Fig. 1. Forward Current vs. Forward Voltage

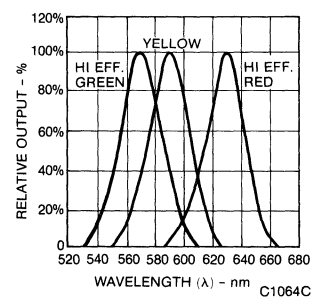


Fig. 2. Spectral Response

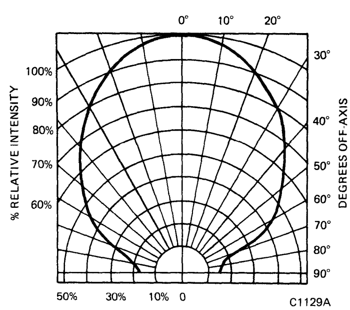


Fig. 3. Spatial Distribution

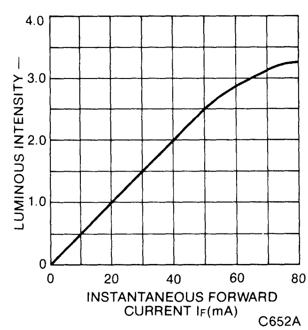


Fig. 4. Luminous Intensity vs. Forward Current

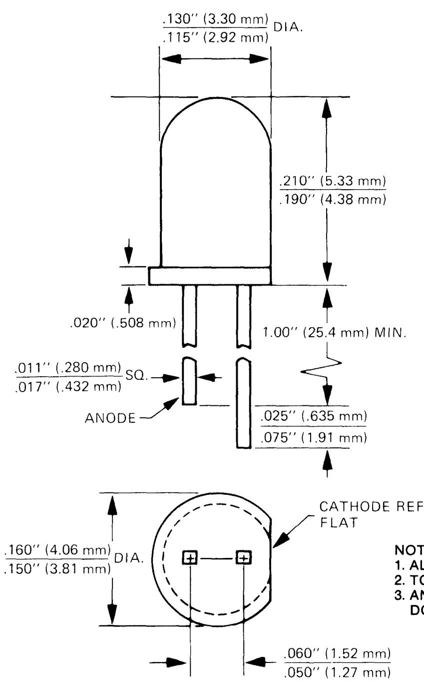
NOTES

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 (1.6mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

GENERAL INSTRUMENT

STANDARD RED **MV5074C**
STANDARD RED **MV5075C**

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

C1128A

DESCRIPTION

The MV5074C and MV5075C are red (GaAsP) light emitting diodes mounted in a red epoxy package. 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" (.508 mm) diameter hole)
- Compact size
- Bright (typically 2.0 mcd at 20 mA)
- Long life, rugged
- MV5074C and MV5075C have 1" (25.4 mm) minimum lead length
- Mount on approximately 3/16" (4.72 mm) centers
- Upon request, also available with anode lead trimmed longer than cathode
- Red tinted diffused

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

Power dissipation	100 mW
Derate linearly from 25°C	-1.27 mW/°C
Storage temperature	-55°C to +100°C
Operating temperature	-55°C to +100°C
Continuous forward current	50 mA
Peak forward current (μsec pulse 0.3% duty cycle)	1.0 A
Reverse voltage	5.0 V
Lead solder time at 260°C (see note 2)	5 sec.

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

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Optical					
Luminous Intensity (I) (Note 1)					
MV5074C	0.7	2.5		mcd	I_F = 20 mA
MV5075C	0.6	1.6		mcd	I_F = 20 mA
Wavelength (λpk)		660		nm	
Spectral Half Width		20		nm	
Viewing Angle					
MV5074C		70		degrees	Between 50% points
MV5075C		90		degrees	Between 50% points
Electrical					
Forward Voltage (V_F)		1.68	2.0	Volts	I_F = 20 mA
Reverse Voltage (V_R)	5.0	15.0		Volts	I_R = 100 μA
Dynamic Resistance (R_D)		7.0		Ω	
Capacitance		23		pF	V = 0

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

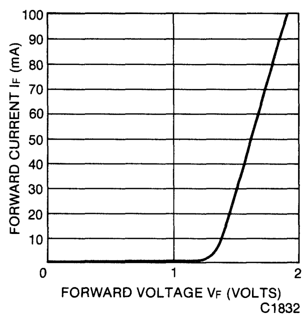


Fig. 1. Forward Current vs. Forward Voltage

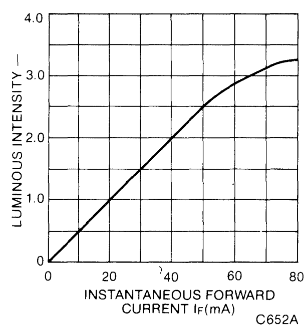


Fig. 2. Luminous Intensity vs. Forward Current

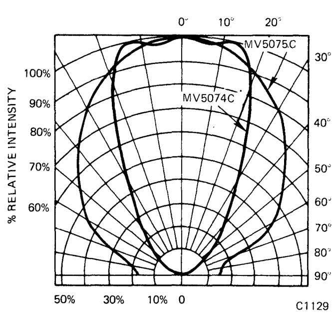


Fig. 3. Spatial Distribution

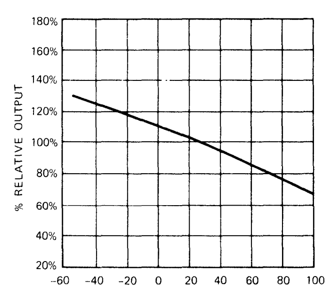


Fig. 4. Percent Relative Response vs. Temperature

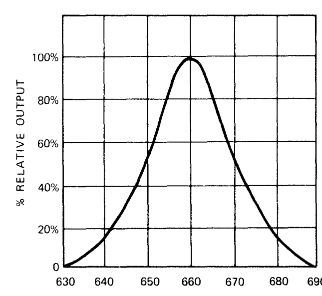


Fig. 5. Spectral Response

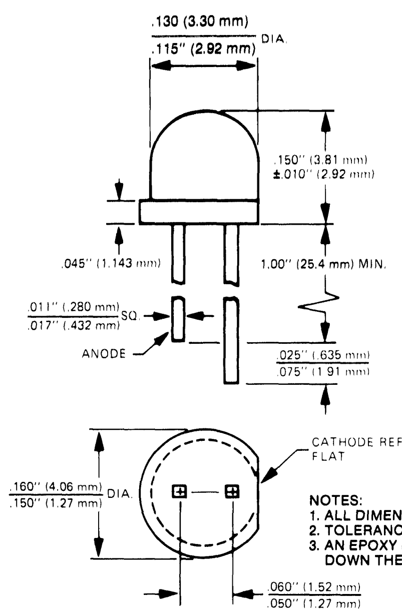
NOTES

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

HIGH EFFICIENCY RED/PINK MV5177C
YELLOW MV5377C
HIGH EFFICIENCY GREEN MV5477C
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

C1132

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" [.508 mm] diameter holes)
- Compact size
- Bright (up to 3.0 mcd at 20 mA)
- Long life, rugged
- Mount on approximately 3/16" (4.72 mm) centers
- See MV5077 series for other red sources
- Upon request, also available with anode lead trimmed longer than cathode
- Tinted diffused

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 (1 μsec pulse 0.3% duty cycle) (MV5477C 90 mA) .... 1.0 A
Reverse voltage .... 5.0 V
Lead solder time at 260° C (see note 2) .... 5 sec.

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	PACKAGE PROFILE
MV5177C	Hi. Eff. Red	Pink diffused	Wide beam	Low profile
MV5377C	Yellow	Yellow diffused	Wide beam	Low profile
MV5477C	Hi. Eff. 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	MV5177C	MV5377C	MV5477C	MV5774C
Forward voltage	typ.	V_F	I_F = 20 mA	V	2.0	2.1	2.2	2.0
	max.		I_F = 20 mA	V	3.0	3.0	3.0	3.0
Luminous intensity (see note 1)	min.	I_V	I_F = 20 mA	mcd	1.0	1.0	1.0	1.0
	typ.		I_F = 20 mA	mcd	3.0	2.0	2.5	3.0
Peak wave length		λ_p	I_F = 20 mA	nm	635	585	565	635
Spectral line Half width			I_F = 20 mA	nm	45	35	35	45
Capacitance	typ.	C	V = 0	pF	45	45	20	45
Reverse voltage	min.	V_R	I_R = 100 μA	V	5	5	5	5
	typ.		I_R = 100 μA	V	25	25	25	25
Viewing angle (total) (fig. 5)		$2\Theta_{1/2}$		degrees	180	180	180	180

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

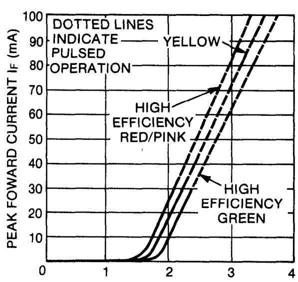


Fig. 1. Forward Current vs. Forward Voltage

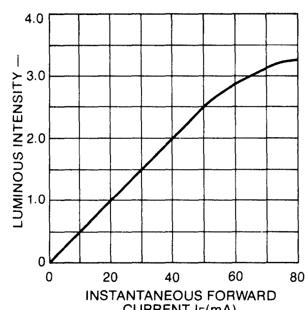


Fig. 2. Luminous Intensity vs. Forward Current

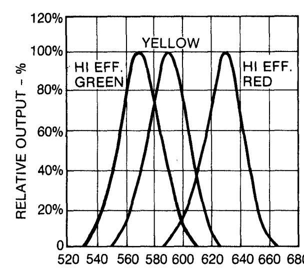


Fig. 3. Spectral Response

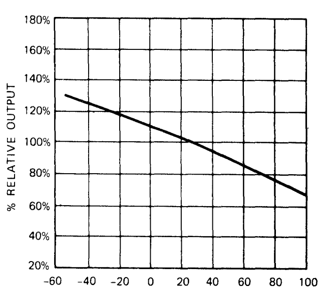


Fig. 4. Percent Relative Response vs. Temperature

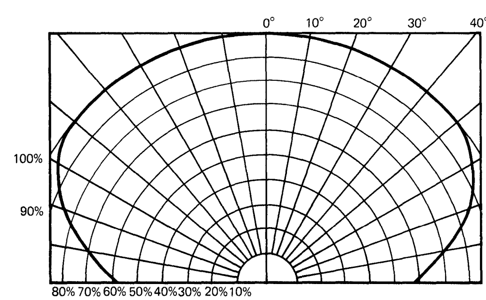


Fig. 5. Spatial Distribution

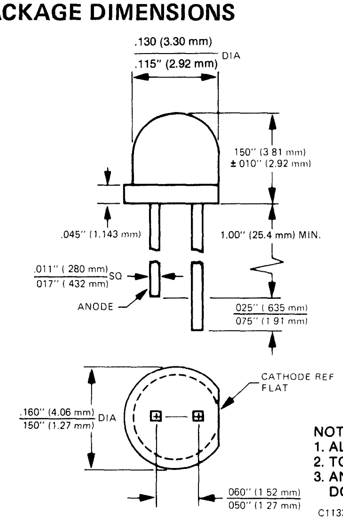
NOTES

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

STANDARD RED **MV5077C**

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

DESCRIPTION

MV5077C is a red (GaAsP) light emitting diode mounted in a red epoxy package. Its small size (approximately T-1 size), good viewing angle, and small square leads contribute to its versatility as an all purpose indicator.

FEATURES

- Square leads (will fit into .020" (.508 mm) diameter hole)
- Compact size
- Bright (typically 1.75 mcd at 20 mA)
- Long life, rugged
- MV5077C has 1" (25.4 mm) minimum lead length
- Mount on approximately 3/16" (4.72 mm) centers
- Upon request, also available with anode lead trimmed longer than cathode
- Red tinted diffused

Lamps

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

Power dissipation	100 mW
Derate linearly from 25°C	-1.27 mW/°C
Storage temperature	-55°C to +100°C
Operating temperature	-55°C to +100°C
Continuous forward current	50 mA
Peak forward current (μsec pulse 0.3% duty cycle)	1.0 A
Reverse voltage	5.0 V
Lead solder time at 260°C (see note 2)	5 sec.

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

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Optical					
Luminous Intensity (I) (Note 1)	0.3	1.75		mcd	I_F = 20 mA
Wavelength (λpk)		660		nm	I_F = 20 mA
Spectral Half Width		20		nm	I_F = 20 mA
Viewing Angle		110		degrees	Between 50% points
Electrical					
Forward Voltage (V_F)		1.68	2.0	Volts	I_F = 20 mA
Reverse Voltage (V_R)	5.0			Volts	I_R = 100 μA
Dynamic Resistance (R_D)		7.0		Ω	
Capacitance		23		pF	V = 0

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

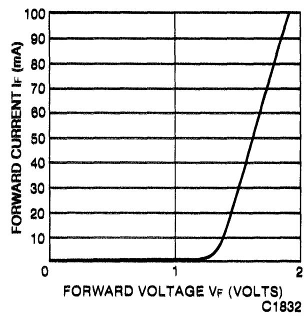


Fig. 1. Forward Current vs. Forward Voltage

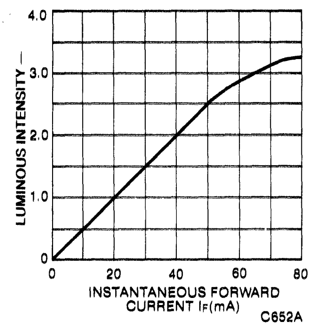


Fig. 2. Luminous Intensity vs. Forward Current

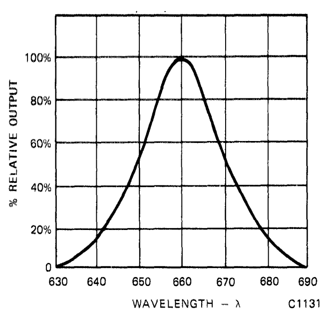


Fig. 3. Spectral Response

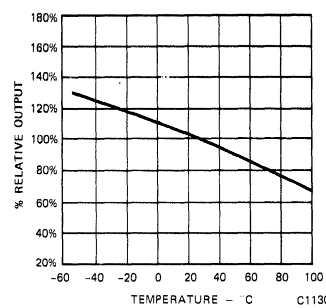


Fig. 4. Percent Relative Response vs. Temperature

NOTES

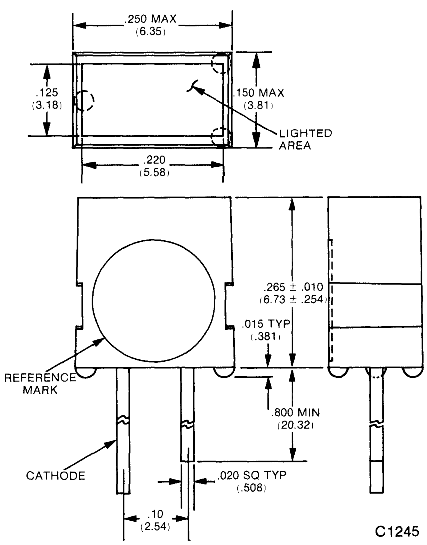
1. *As measured with a Photo Research Corp., "SPECTRA" Microcandela Meter (Model IV-D).*
2. *The leads of the device were immersed in molten solder at 260°C to a point 1/16 inch (1.6mm) from the device per MIL-S-750, with a dwell time of 5 seconds.*

GENERAL INSTRUMENT

YELLOW **MV53124**
HIGH EFFICIENCY GREEN **MV54124**

SOFT ORANGE **MV56124**
HIGH EFFICIENCY RED **MV57124**

PACKAGE DIMENSIONS



DESCRIPTION

This series of rectangular shaped solid state indicators is available in green yellow, red and orange. The rectangular lighted area is uniformly lit by a high performance LED chip.

FEATURES

- 4 bright colors
- .220" x .125" lighted area
- Stackable in X or Y direction without crosstalk
- High brightness—typically 4 mcd @ 20 mA
- Solid state reliability
- Compact, rugged, lightweight
- No light leakage from unit sides
- Mounting grommet available (see MP65) as separate order item

APPLICATIONS

- Legend backlighting
- Illuminated pushbutton
- Panel indicator
- Bargraph meter

Lamps

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C 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 AMP	90 mA
Forward current	35 mA	30 mA
Lead solder time at 260°C (See Note 1)	5 seconds	5 seconds
Reverse voltage	5.0 volts	5.0 volts

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	μA	V_R = 5.0 V
Capacitance		C	45	20	45	45	pF	V = 0, f = 1 MHz
Viewing angle (total)		$2\Theta½$	100	100	100	100	degrees	

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

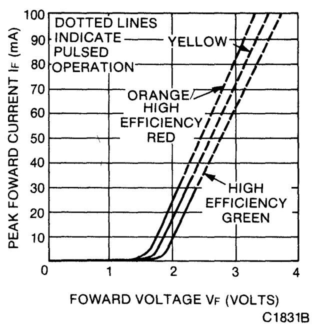


Fig. 1. Forward Current vs. Forward Voltage

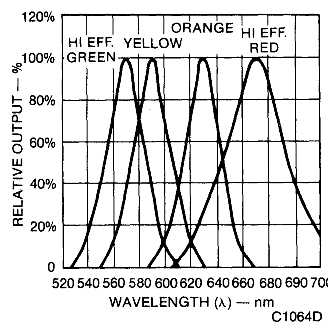


Fig. 2. Spectral Response

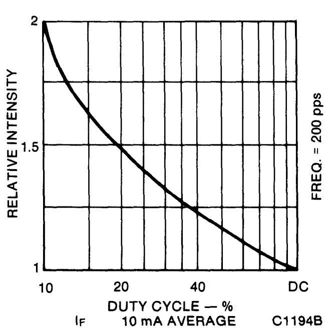


Fig. 3. Luminous Intensity vs. Duty Cycle

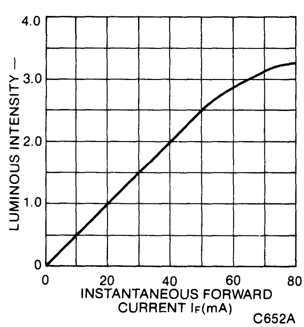


Fig. 4. Luminous Intensity vs. Forward Current

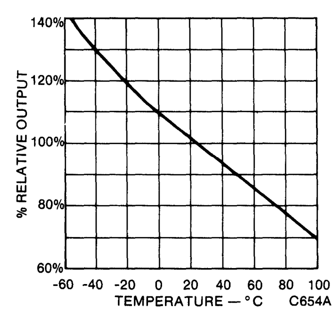


Fig. 5. Output vs. Temperature

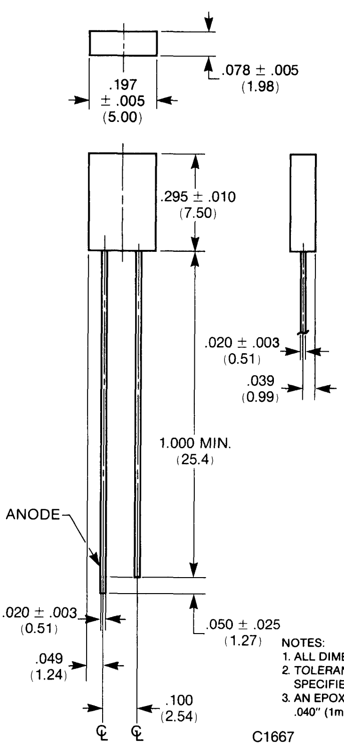
NOTES

1. *The leads of the device were immersed in molten solder, heated to a temperature of 260°C, to a point 1/16 inch (1.6mm) 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

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

C1667

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

Lamps

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 temperature	-55°C to 100°C	-55°C to 100°C
Operating temperature	-55°C to 100°C	-55°C to 100°C
Peak forward current (1 μsec pulse width 300 pps)	1 AMP	90 mA
Forward current	35 mA	30 mA
Lead solder time @ 260° C (see Note 1)	5 seconds	5 seconds
Reverse voltage	5.0 volts	5.0 volts

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

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 wave length		nm	585	562	635
Half width	I_F = 20 mA	nm	45	30	45
Capacitance					
Typ.	V = 0, f = 1MHz	pF	45	20	45
Reverse voltage (V_R)					
Min.	I_R = 100 μA	V	5.0	5.0	5.0
Viewing angle (total)		degrees	100	100	100

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS CURVES (25°C Free Air Temperature)

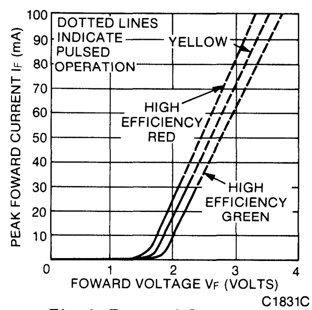


Fig. 1. Forward Current vs. Forward Voltage

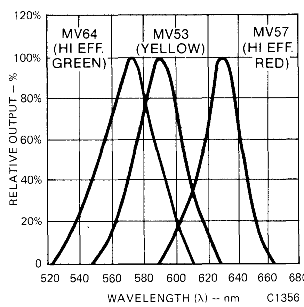


Fig. 2. Spectral Response

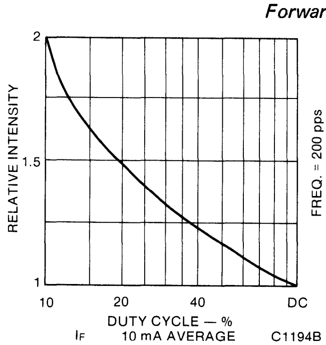


Fig. 3. Luminous Intensity vs. Duty Cycle

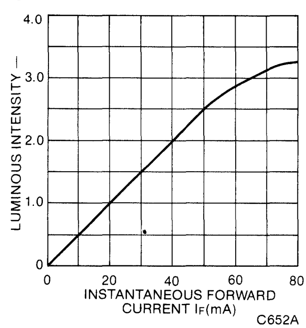


Fig. 4. Luminous Intensity vs. Forward Current

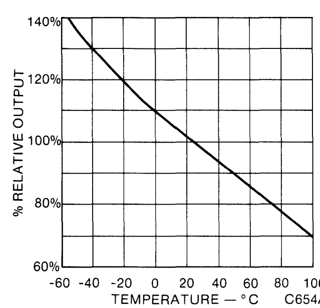


Fig. 5. Output vs. Temperature

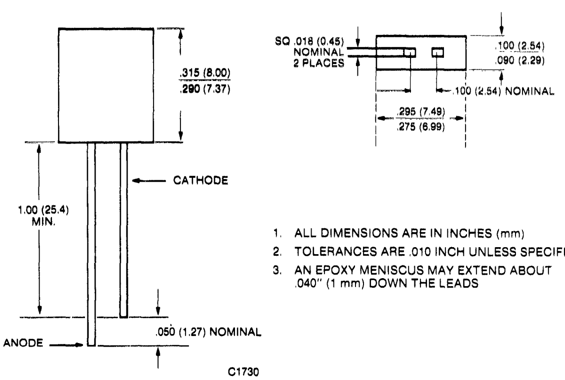
NOTES

1. *The leads of the device were immersed in molten solder, heated to a temperature of 260°C, to a point 1/16 inch (1.6mm) from the body of the device per MIL-S-750, with dwell time of 5 sec.*
2. *As measured with a Photo Research Spectra Corp. Microcandela Meter (Model IV D).*

GENERAL INSTRUMENT

HI EFF RED **HLMP-0300/1**
YELLOW **HLMP-0400/1**
HI EFF GREEN **HLMP-0503/4**

PACKAGE DIMENSIONS



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

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 Indicator

PHYSICAL CHARACTERISTICS

DEVICE	SOURCE COLOR	LENS COLOR	LENS EFFECT	Iv MIN. AT 20 mA
HLMP-0300	Hi Eff Red	Red Diffused	Very wide beam	1.0
HLMP-0301	Hi Eff 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	Hi Eff Green	Green Diffused	Very wide beam	1.5
HLMP-0504	Hi Eff 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 temperature	-55° C to +100° C
Lead solder time at 260° C	5 seconds
Continuous forward current at 25° C	30 mA
Peak forward current (1 μs pulse, 0.3% DF)	90 mA

Lamps

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	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	

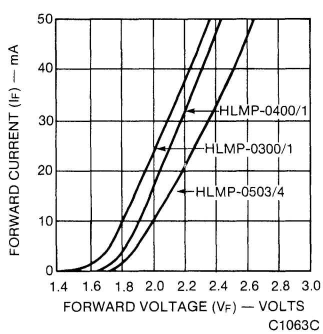


Fig. 1 Forward Current vs. Forward Voltage

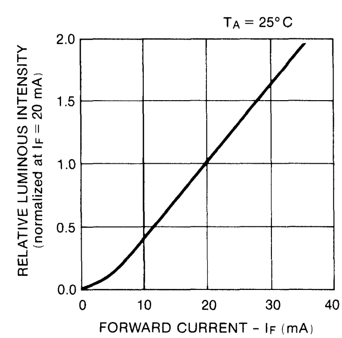


Fig. 2. Luminous Intensity vs. Forward Current

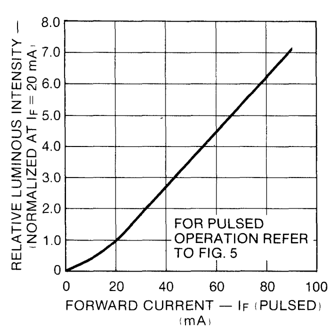


Fig. 3. Relative Luminous Intensity vs. Pulsed Forward Current

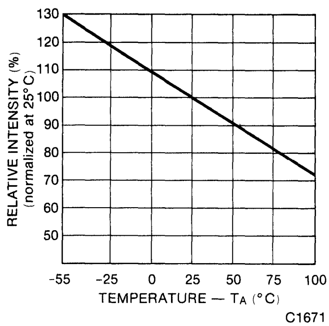


Fig. 4. Relative Luminous Intensity vs. Temperature

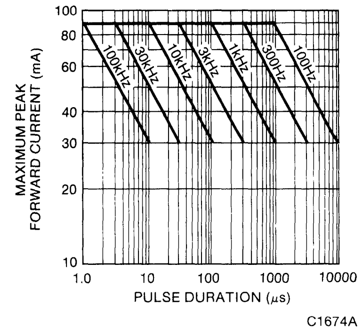


Fig. 5. Maximum Peak Forward Current vs. Pulse Duration

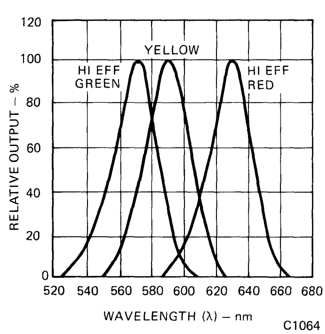


Fig. 6. Spectral Response

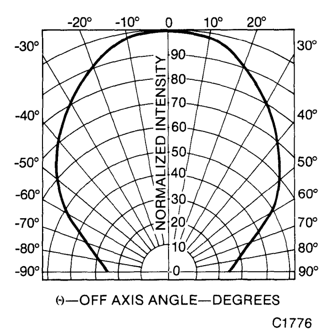


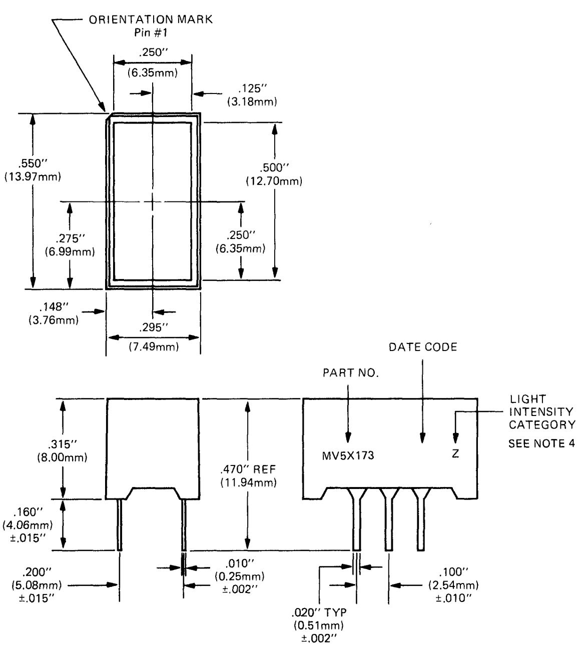
Fig. 7. Spatial Distribution

Lamps

GENERAL INSTRUMENT

YELLOW MV53173
HIGH EFFICIENCY GREEN MV54173
HIGH EFFICIENCY RED MV57173

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).

Separate mounting hardware is available. See MP73.

FEATURES

- .500" x .250" 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" 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
Solder 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 COND.	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					
(See Note 1) Min.	I_F = 20 mA	4.5	4.5	4.5	med
Peak wave length					
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 = 1MHz	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 Å/°C	1.0 Å/°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)

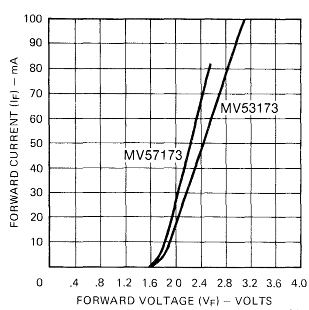


Fig. 1. Forward Current vs. Forward Voltage

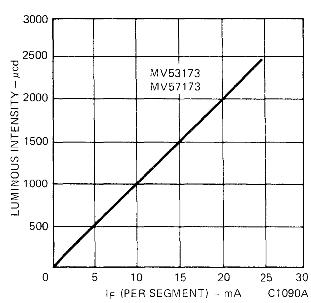


Fig. 2. Luminous Intensity vs. Forward Current (both LED chips on)

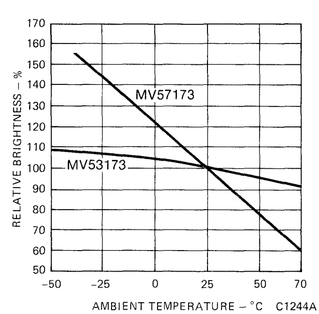


Fig. 3. Luminous Intensity vs. Temperature See Note 2

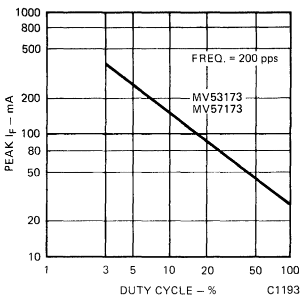


Fig. 4. Max Peak Current vs. Duty Cycle

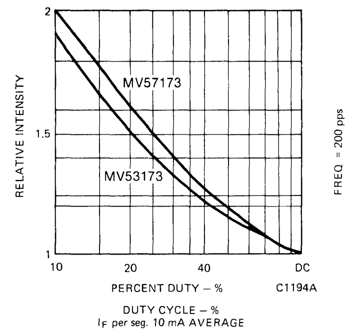


Fig. 5. Luminous Intensity vs. Duty Cycle

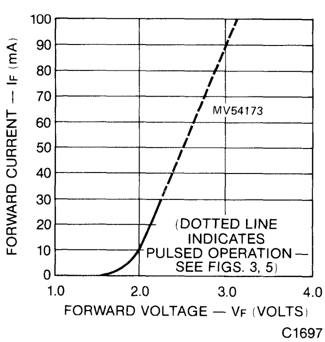


Fig 6. Forward Current vs. Forward Voltage

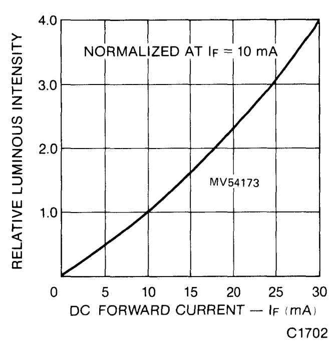


Fig. 7. Relative Luminous Intensity vs. DC Forward Current (Both LED chips on)

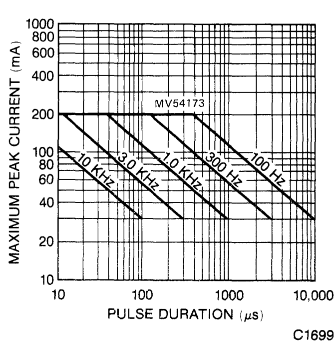


Fig. 8. Maximum Peak Current vs. Pulse Duration

Lamps

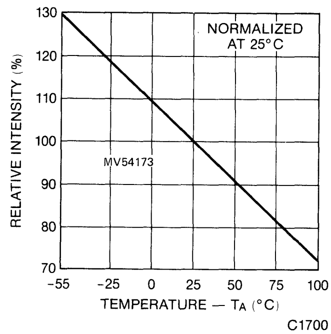


Fig. 9. Relative Luminous Intensity vs. Temperature

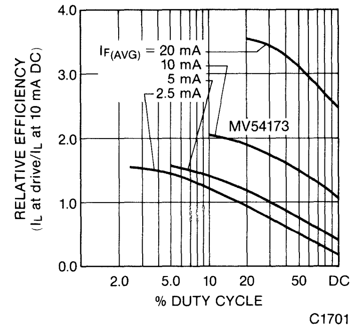
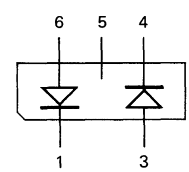


Fig. 10. Relative Efficiency vs. Duty Cycle

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

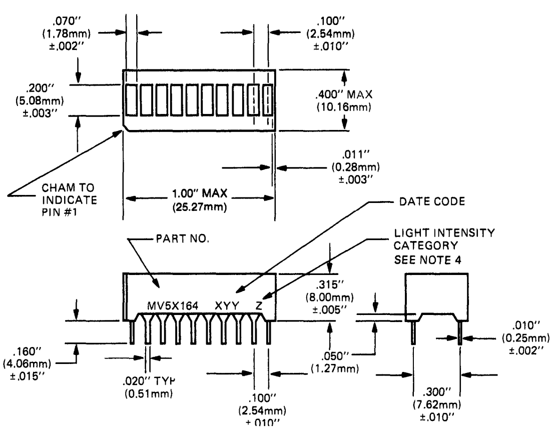
Panelgraphic Grey 10	Panelgraphic Grey 10	
	Homalite 100 — 1266 Grey	

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" (1.6mm) from the body of the device. Maximum unit surface temperature is 140°C.*
4. *All units are categorized for luminous intensity. The invensity 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

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 bar graph 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" DIP lead spacing
- Categorized for luminous intensity (see note 4)

ABSOLUTE MAXIMUM RATINGS

	MV53164	MV54164	MV57164
Power dissipation @ 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
Solder time @ 260°C (See Notes 3 and 5.)	5 sec.	5 sec.	5 sec.

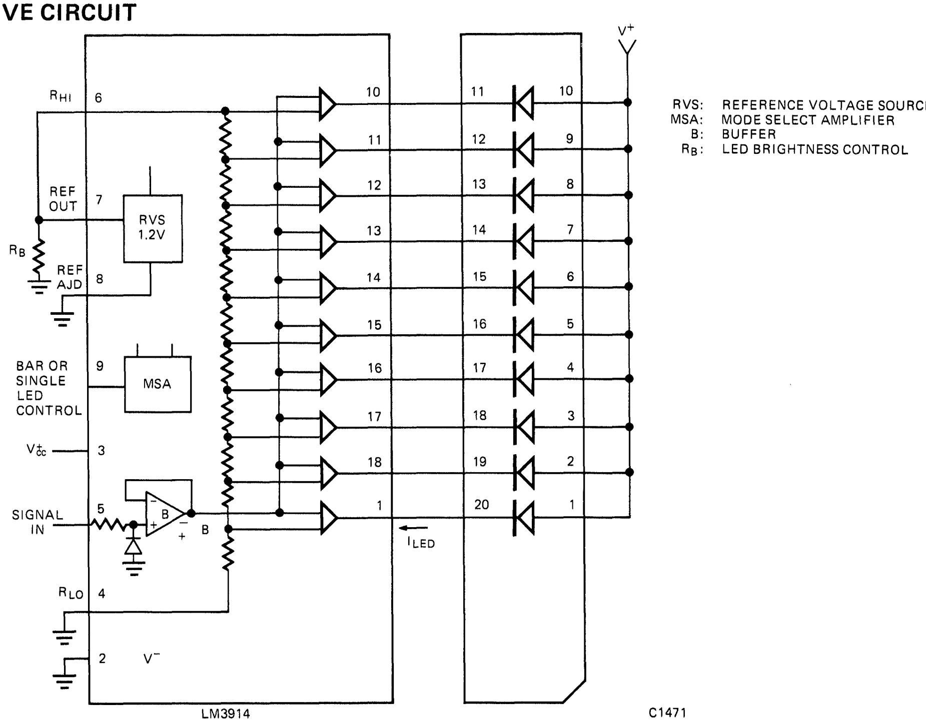
TYPICAL THERMAL CHARACTERISTICS

	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 Å/°C	1.0 Å/°C	1.0 Å/°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 avg.) (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 = 1MHz
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)

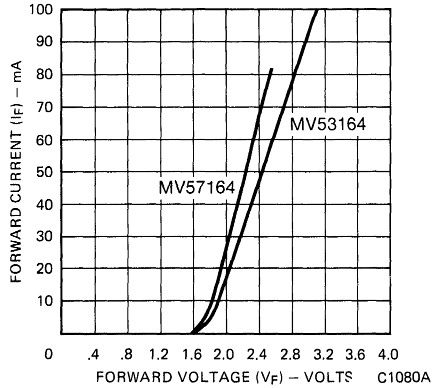


Fig. 1. Forward Current vs. Forward Voltage

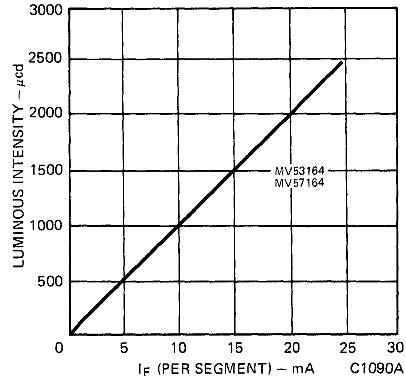


Fig. 2. Luminous Intensity vs. Forward Current

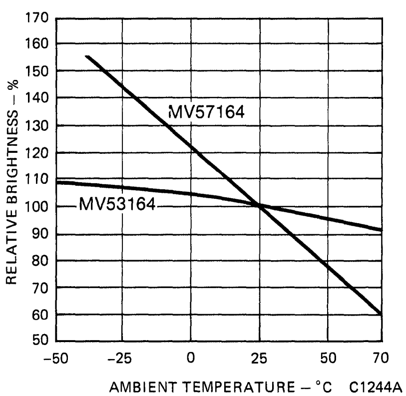


Fig. 3. Luminous Intensity vs. Temperature (See Note 2)

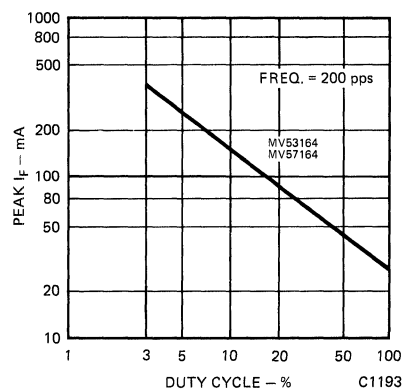


Fig. 4. Max Peak Current vs. Duty Cycle

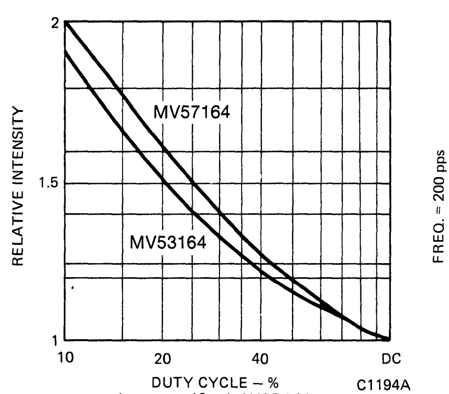
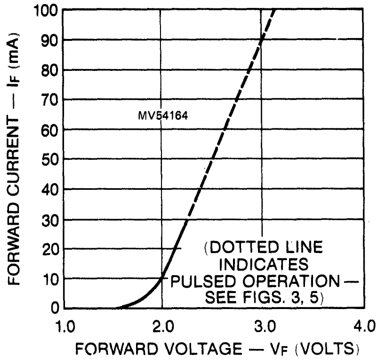


Fig. 5. Luminous Intensity vs. Duty Cycle

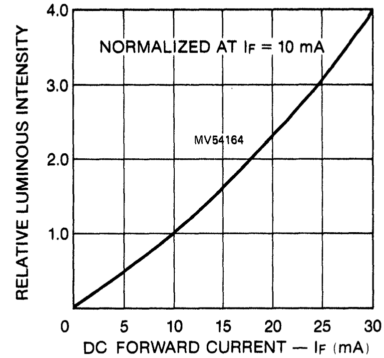
Lamps

TYPICAL CURVES MV54164 (PER SEGMENT) (25°C Free Air Temperature)



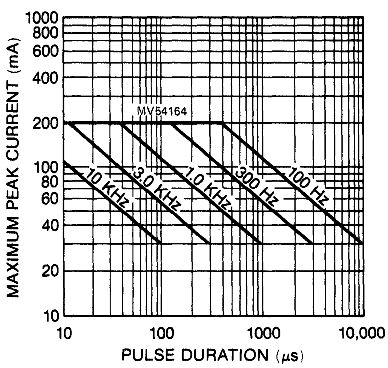
C1697

Fig. 6. Forward Current vs. Forward Voltage



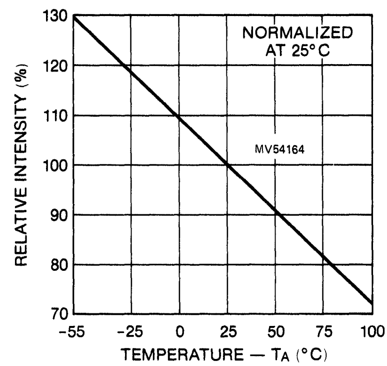
C1702

Fig. 7. Relative Luminous Intensity vs. DC Forward Current



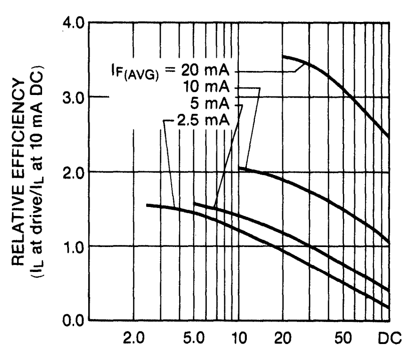
C1699

Fig. 8. Maximum Peak Current vs. Pulse Duration



C1700

Fig. 9. Relative Luminous Intensity vs. Temperature



C1701

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 Homalite 190 — 1720 or 100 — 1726	Panelgraphic Green 48 Homalite 100 — 1440 Green	Panelgraphic Red 60 Homalite 100 — 1605

In situations of high ambient light, a neutral density filter can be used to achieve greater contrast

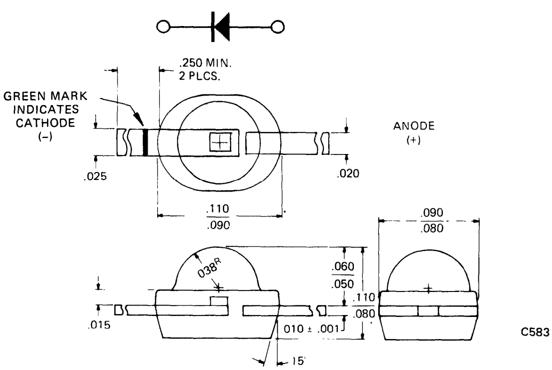
Panelgraphic Grey 10	Panelgraphic Grey 10 Homalite 100 — 1266 Grey	

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" (1.6mm) from the body of the device. Maximum unit surface temperature is 140°C.*
4. *All units are categorized for luminous intensity. The invensity 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

YELLOW MV53
HIGH EFFICIENCY RED MV57
HIGH EFFICIENCY GREEN MV64

PACKAGE DIMENSIONS



NOTES:
1. ALL DIMENSIONS IN INCHES
2. TOLERANCES ±.010" UNLESS SPECIFIED

DESCRIPTION

The MV64 Gallium Arsenide Phosphide Hi. Eff. diode mounted in a two lead green epoxy package. The MV53 is a Gallium Arsenide Phosphide diode mounted in a two lead yellow epoxy package, while MV57 is a Hi. Eff. Red LED in a red non-diffused package.

FEATURES

These miniature LED lamps are intended for high volume indicator light applications where high reliability and top performance are required. Major usage is in applications such as diagnostic lights on printed circuit boards and panel lights. The units can be used to displace subminiature lamps as small as T-¾ size.

- Multicolored versions of the popular MV50 package
- Low cost
- 3 bright colors
- Compatible with integrated circuits
- Long life, rugged
- Small size—T-¾
- Color tinted, non-diffused

Lamps

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

CHARACTERISTICS	MINIMUM	TYPICAL	MAXIMUM	UNITS	TEST CONDITIONS
Luminous intensity (note 1)	1.0	2.0		mcd	I_F = 20 mA
Peak wavelength, MV64		565		nm	I_F = 20 mA
Peak wavelength, MV53		589		nm	I_F = 20 mA
Peak wavelength, MV57		635		nm	I_F = 20 mA
Spectral line halfwidth		35		nm	I_F = 20 mA
Forward voltage MV64		2.2	3.0	V	I_F = 20 mA
MV53, MV57		2.1	3.0	V	I_F = 20 mA
Reverse breakdown voltage	5			V	I_R = 100 μA
Forward voltage temp. coefficient		-3.0		mV/°C	I_F = 20 mA
Viewing angle		80		degrees	between 50% points

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

Power dissipation	105 mW
Derate linearly from 25°C	1.3 mW/°C
Storage and operating temperature	-55°C to +100°C
Lead solder time at 230°C (see note 2)	5 sec.
Continuous forward current	35 mA
Reverse voltage	5.0 V

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

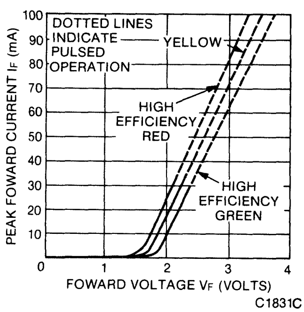


Fig. 1. Forward Current vs. Forward Voltage

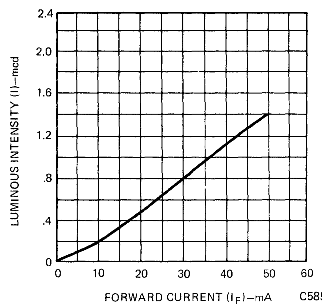


Fig. 2. Luminous Intensity vs. Forward Current

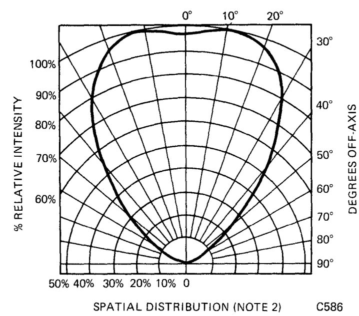
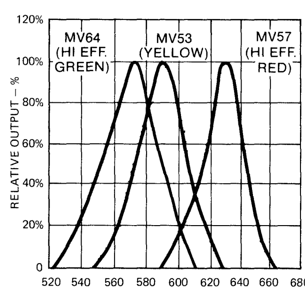


Fig. 3 Spatial Distribution (Note 2)



Spectral Response

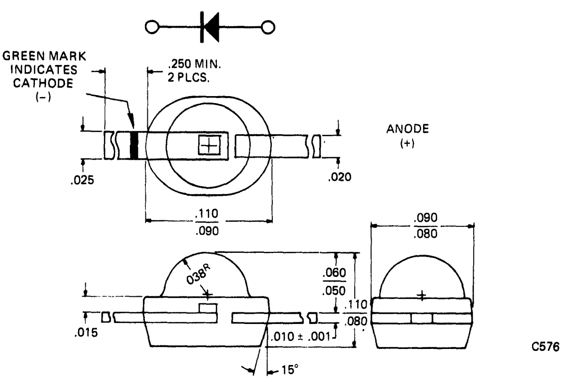
NOTES

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 a molten solder at 230°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

STANDARD RED MV50
STANDARD RED MV54

PACKAGE DIMENSIONS



NOTES:
1. ALL DIMENSIONS IN INCHES
2. TOLERANCES ±.010" UNLESS SPECIFIED

DESCRIPTION

The MV50 and MV54 are diffused Gallium Arsenide Phosphide diodes mounted in a two lead epoxy package; the MV50 has a clear lens; the MV54 is red diffused. On forward bias they emit a spectrally narrow band of visible light which peaks at 660 nm. (Also see MV55A.)

FEATURES

The MV50 and MV54 are intended for high volume indicator light applications where low cost, high reliability, and top performance are required. Major usage is in applications such as diagnostic lights on printed circuit boards and panel lights. They can be used to displace subminiature lamps as small as T3/4 size.

- Low cost
- Bright
- Compatible with integrated circuits
- Long life, rugged
- Small size - T3/4
- Easily assembled in arrays

TYPICAL THERMAL CHARACTERISTICS

Wavelength temperature coefficient (case temperature)	0.3 nm/°C
Forward voltage temperature coefficient	−2.0 mV/°C

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

Power dissipation	80 mW
Derate linearly from 25°C	1.6 mW/°C
Storage and operating temperture	-55°C to 100°C
Peak forward current (1μsec pulse width, 0.3% duty cycle)	1.0 A
Lead solder time @ 230°C (note 1)	5 sec.
Continuous forward current	40 mA
Reverse voltage	5.0 V

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

CHARACTERISTICS	MINIMUM MV50	MINIMUM MV54	TYPICAL MV50	TYPICAL MV54	MAXIMUM MV50/54	UNITS	TEST CONDITIONS
Luminous Intensity (note 2)	0.5	0.4	1.4	1.0		mcd	I_F = 20 mA
Peak emission wavelength			660	660		nm	I_F = 20 mA
Spectral line halfwidth			20	20		nm	I_F = 20 mA
Forward voltage			1.65	1.65	2.0	V	I_F = 20 mA
Capacitance			80	80		pF	V = 0, f = 1 MHz
Rise and fall time			50	50		ns	50Ω system, I_F = 20 mA
Reverse current					100	μA	V_R = 5.0 V
Reverse breakdown voltage	5		15	15		V	I_R = 100 μA
View angle			80	80		degrees	between 50% points

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

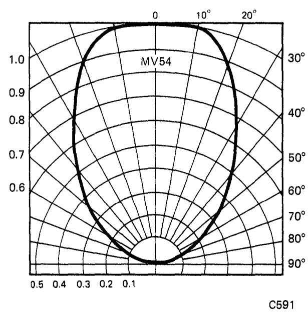


Fig. 1. Spatial Distribution (Note 3)

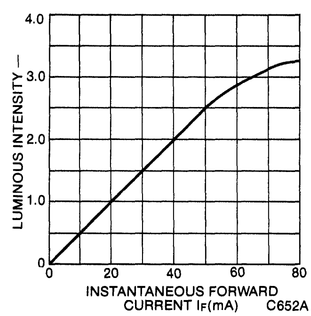


Fig. 2. Luminous Intensity vs. Forward Current

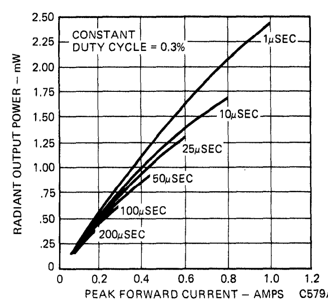


Fig. 3. Peak Power Output vs. Pulsed Forward Current

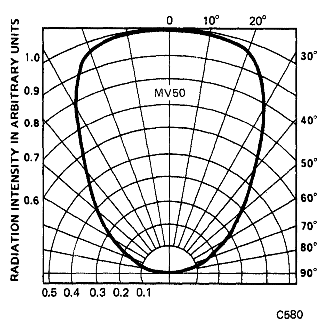


Fig. 4. Spatial Distribution (Note 3)

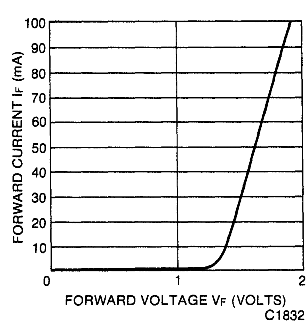


Fig. 5. Forward Current vs. Forward Voltage

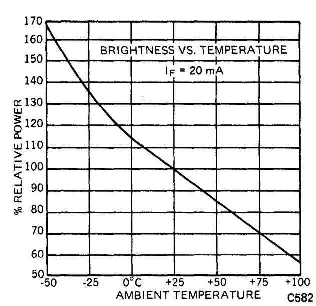


Fig. 6. Relative Power vs. Temperature

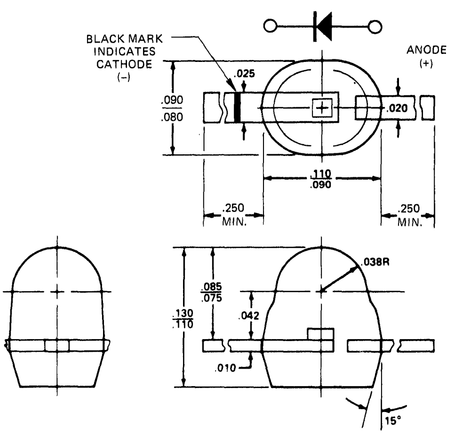
NOTES

1. *The leads of the device were immersed in molten solder at 230°C to a point 1/16 (1.6mm) inch from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*
2. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
3. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*

GENERAL INSTRUMENT

HIGH EFFICIENCY RED MV55A

PACKAGE DIMENSIONS



NOTE: TOLERANCE ±.010" UNLESS SPECIFIED

C593

DESCRIPTION

The MV55A is a Hi. Eff. red gallium arsenide phosphide device useful for low current drive (5 mA) applications, such as diagnostic functions or indicators. See also 2 mA lamp families.

FEATURES

MV55A is intended as a low cost, high reliability indicator lamp.

- Low cost
- Compatible with integrated circuits.
- Small size
- High on axis intensity.
- 2 Gate Load Bright Light
- MOS compatible

Lamps

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

Power dissipation	105 mW
Derate linearly from 25°C	1.3 mW/°C
Storage and operating temperature	-55°C to 100°C
Lead solder time @ 230°C (see note 1)	5 sec.
Continuous forward current	35 mA
Reverse voltage	5.0 V
Peak forward current (1μsec pulse, 0.1% duty cycle)	400 mA

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

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity (Note 3)	0.2	0.5		mcd	I_F = 5.0 mA
		2.0		mcd	I_F = 20 mA
Peak emission wave length		635		nm	
Spectral line half-width		45		nm	
Forward voltage		1.6	2.0	V	I_F = 5.0 mA
		2.2		V	I_F = 20 mA
Reverse current			100	μA	V_R = 5.0 V
Light turn-on and turn-off		1		ns	Z = 1Ω system
Capacitance		20		pF	V = 0
Reverse breakdown voltage	5			V	I_F = 100 μA

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(T_A = 25°C Unless Otherwise Specified)

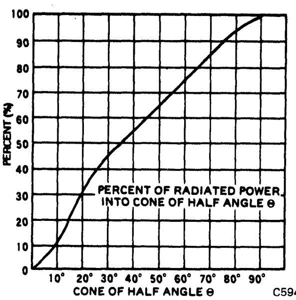


Figure 1

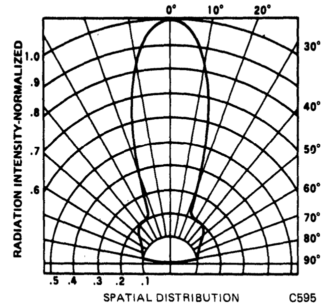


Fig. 2. (Note 2)

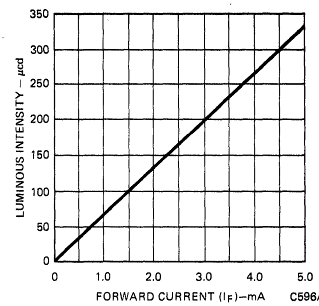


Fig. 3 Luminous Intensity vs. Forward Current

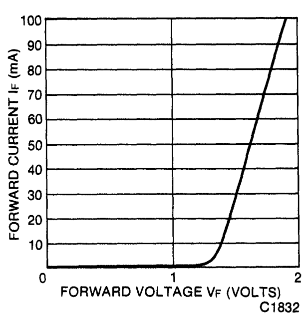


Fig. 4. Forward Current vs. Forward Voltage

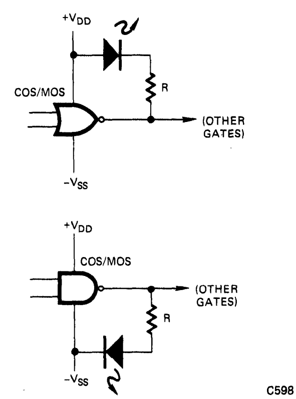


Fig. 5 MV55A Interfaced with COS/MOS

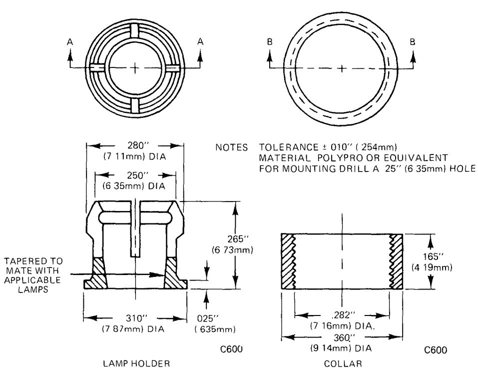
NOTES

1. *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.*
2. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*
3. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*

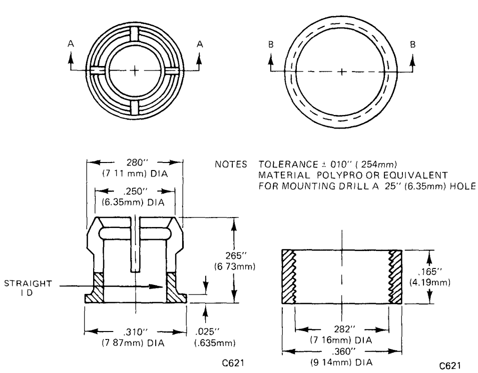
GENERAL INSTRUMENT

MP22 MP52

PACKAGE DIMENSIONS



MP22 TWO-PIECE POP-INS FOR MV5X2X



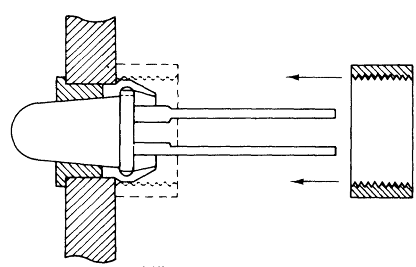
MP52 TWO-PIECE POP-INS FOR MV6X5X AND MV5X5X

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).

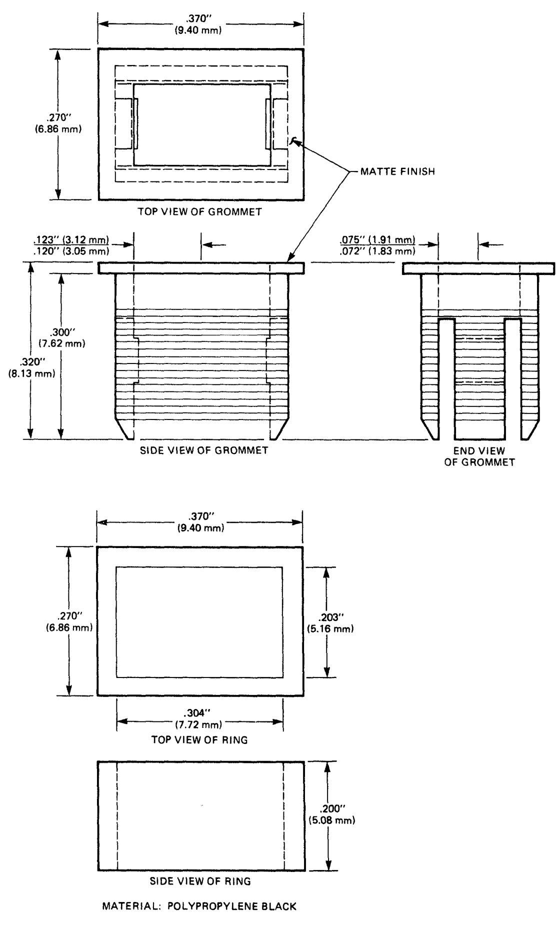
TYPICAL MOUNTING TECHNIQUE FOR EITHER TYPE



GENERAL INSTRUMENT

MP65

PACKAGE DIMENSIONS



MATERIAL: POLYPROPYLENE BLACK

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 following 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")

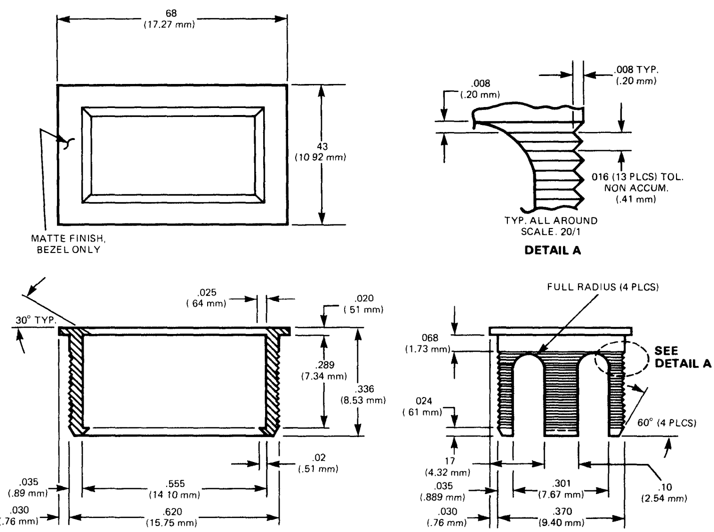
ROTEX PUNCH COMPANY, INC.
2350 Alvarado Street
San Leandro, CA 94577
(415) 357-3600
(Request a 3506 series punch with dimensions of 5/16" x 7/32")

PANEL MOUNTING GROMMET
FOR .5-INCH RECTANGULAR INDICATOR

GENERAL INSTRUMENT

MP73

PACKAGE DIMENSIONS:

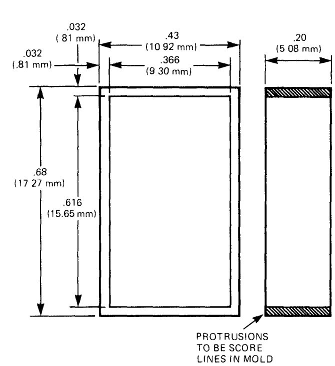


MATERIAL. POLYPROPYLENE – BLACK C 1480

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:

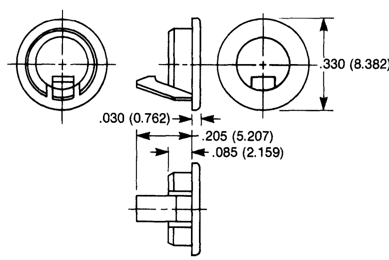
W. A. WHITNEY COMPANY
650 Race Street
Rockford, IL 61105
(815) 964-6771

ROTEX PUNCH COMPANY, INC.
2350 Alvarado Street
San Leandro, CA 94577
(415) 357-3600

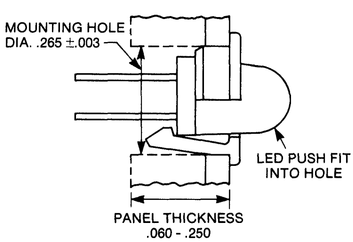
GENERAL INSTRUMENT

FLS-010

PACKAGE DIMENSIONS



Typical Mounting Technique



C1895

DESCRIPTION

The FLS010 is a black single-piece panel mount grommet exclusively designed for the .285" high low-profile FLV lamps.

FEATURES

- Single-piece grommet
- For .060" to .250" panels
- Lamp oriented to grommet-flat for polarity check

MOUNTING INSTRUCTIONS

1. The panel hole for the mounting clip should be 0.265-inch (±.002), and the hole edges should be deburred (this permits a 17/64-inch or H-sized drill to be used).
2. Insert the LED, lens first, with the flat flush against the tab, into the tab end of the clip. Press firmly until the tab snaps over the flat and locks the unit into the clip.
3. Insert the mounting clip and LED assembly into the panel hole, pins first, from the front side of the panel. Use a hollowed cylinder with an internal diameter greater than .200-inch and less than .24-inch (i.e., either a piece of 3/8-inch poly-flo tubing of 3/16-inch nut driver) to "press fit" the clip into the panel until the flange is seated snugly on the panel.

Chips 6

GENERAL INSTRUMENT

YELLOW Y-32
ORANGE O-32

DESCRIPTION

The Y, O-32 Series is a light emitting diode fabricating from state-of-the-art Nitrogen doped $GaAs_xP_{1-x}$ epitaxially grown on a GaP substrate. The device is a planar emitter whose luminous performance has been optimized by using the current best epitaxial growth and die fabrication procedures currently available. The dice are shipped in vials or expanded vinyl membranes for ease in handling and for maintenance of die adjacency which provides the user the best possible die-to-die hue and luminous intensity matching.

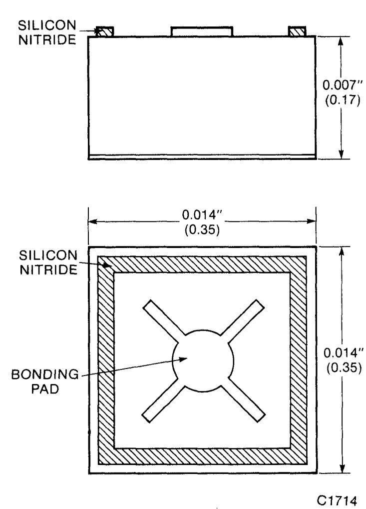
ELECTRICAL/OPTICAL CHARACTERIZATION (See Notes)

PARAMETER	PRODUCT	MIN	MAX
Forward Voltage @ I_f = 20mA	Y-32		2.6
	O-32		2.5
Reverse Voltage @ I_r = 100μA	Y-32	8	—
	O-32	8	—
Luminous Intensity at I_f = 20mA (unlensed)	Y-32	700	—
	O-32	700	—
Center Wavelength at I_f = 10mA	Y-32	5750	5950
	O-32	6250	6400

PHYSICAL CHARACTERISTICS

Viewed from the top, the nominal 32 Series die is square measuring 0.0140 inches. The nominal thickness of the die is 0.007 inches. In practice, the die dimensions do not deviate by more than 20% from the nominal values. The bottom of each die is metallized with a gold alloy which can be attached to conventional gold or silver plated substrates or lead frames by using a conductive epoxy.

The top of each die is selectively metallized and the bonding pad material is compatible with conventional gold thermocompression and aluminum wire bonding techniques.



PACKAGING AND LABELING

32 Series wafers are mounted on 5.75" x 5.75" expanded vinyl membranes and covered with a thin protective overlay. Each wafer is clearly labeled identifying the die type, lot number, control date, brightness minimum and the number of die which meet the specifications.

Notes:

1. Electrical and optical characteristics are determined by die attaching and wire bonding the LED chip to a TO-18, Au plated, Kovar header. No encapsulation is used.
2. Luminous intensity is measured with a Photo-Research Spectra microcandela meter, Model IV-D, fitted with a 4° probe. The center wavelength is determined with a 0.5 meter Jarrell-Ash grating monochromator and is defined as the average of the spectrum half power points.
3. Package code suffix: W = shipped in unscribed wafer form
   M = scribed and mounted on expanded vinyl membrane
   V = loose chips packed with cotton in a glass vial

LED Chips

GENERAL INSTRUMENT

RED MMH SERIES

DESCRIPTION

The MMH Series provides a 7 segment, digit and dot chip. They are specifically designed for hybrid assembly operations with automatic die attach and wire bonding operations in mind.

These chips are available in probed wafer form or mounted on expandable vinyl membranes for ease of handling and maintenance of dice adjacency, giving optimum digit-to-digit luminous intensity matching.

ELECTRICAL/OPTICAL CHARACTERISTICS

DESCRIPTION	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST COND	NOTES
Forward Voltage/Seg.	V_F	1.55	–	1.80	Volts	I_F=10mADC	A
Reverse Voltage/Seg.	V_R	5.0	–	–	Volts	I_R=100μADC	A
Luminous Intensity/Seg.	L.I.	67	–	–	μcd	I_F=5mADC	A,B,F
Luminous Intensity/Seg.	L.I.	160*	–	–	μcd	I_F=10mADC	A,B,F
Luminous Intensity Ratio (Segment to Segment)	R_{LI}–1	–	–	1.5	–	I_F=10mADC	A,B,C,F
Luminous Intensity Ratio (Adjacent Dice)	R_{LI}–2	–	–	1.5	–	I_F=10mADC	A,B,D,F,G
Luminous Intensity Ratio (Five Adjacent Dice)	R_{LI}–3	–	–	1.8	–	I_F=10mADC	A,B,E,F,G
Peak Wave Length	λp	–	655	–	ηm	I_F=10mADC	

*MMH322 = 250 μcd min.

MECHANICAL CHARACTERISTICS

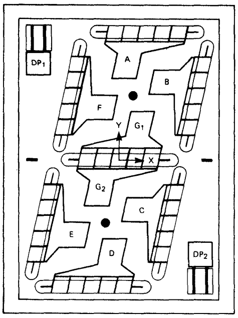
DIE TYPE	FONT	DIE SIZE (INCHES)	CHARACTER SIZE (INCHES)	CHARACTER SLANT	EMITTER WIDTH (IN)	NOMINAL BONDING PAD SIZE (IN)
MMH62M,W	7 seg.	0.048x0.036	0.042x0.022	12°	0.002	0.004x0.004
MMH321/2W,V	Dot	0.014x0.014	0.010x0.010	–	–	0.003 (DIA)

NOTE: See packaging note 3.

	MIN.	TYP.	MAX.	UNITS	NOTES
Cathode Metallization Au Alloy/Au – Thickness	3000	–	–	Å	
Anode Metallization Aluminum – Thickness	8000	–	–	Å	
Anode Bond Strength	3	–	–	Grams	H
Die Thickness – (Monolithic Digit)	–	0.007	–	Inches	
(Colon Dot)	–	0.0055	–	Inches	

LED Chips

MECHANICAL CRITERIA — (Origin of X-Y coordinate system is located at the geometric center of the chip with the coordinate axes parallel to the edges of the chip.)



C1360

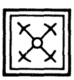
MMH62

DIE SIZE	0.048" X 0.036"
CHARACTER SIZE	0.040", Seg. A-Seg. D, ℄-℄
	0.01956", Seg. B-Seg. F, ℄-℄
CHARACTER SLANT	12°
EMITTER WIDTH	0.002"
NOMINAL BONDING PAD SIZE	0.004" X 0.004"

BONDING PAD LOCATIONS

X_A = 0.001"	Y_A = 0.0145"
X_B = 0.007"	Y_B = 0.012"
X_C = 0.0027"	Y_C = -0.008"
X_D = -0.001"	Y_D = -0.0145"
X_E = -0.007"	Y_E = -0.012"
X_F = -0.0027"	Y_F = 0.008"
X_{G_1} = 0.0032"	Y_{G_1} = 0.0055"
X_{G_2} = -0.0032"	Y_{G_2} = -0.0055"
X_{DP_1} = -0.0128"	Y_{DP_1} = 0.015"
X_{DP_2} = 0.0128"	Y_{DP_2} = -0.015"

MMH32



C1252

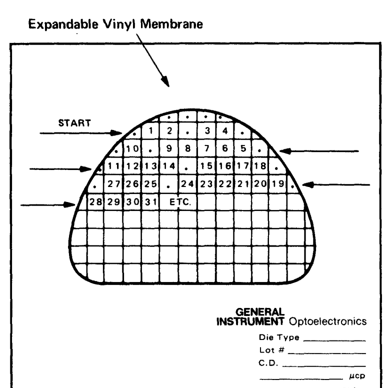
DIE SIZE	0.014" X 0.014"
CHARACTER SIZE	0.010" X 0.010"
BONDING PAD SIZE	0.003" (DIA)

VISUAL CHARACTERISTICS	LIMIT	NOTE
1. Chips	None in active area.	I, J
2. Cracks	None in active area.	K
3. Missing, extraneous, or occluded emitting area	Not detectable to the unaided eye under light-up @ I_F=10mADC.	A
4. Emitter isolation	No emitters electrically shorted.	
5. P-contact metallization defects	No defect producing visual non-uniformity in any emitting area detectable by the unaided eye under light-up @ I_F=10mADC.	A
6. Bonding pad defects	No defect prohibiting normally satisfactory wire bonding.	

NOTE: Supplemental visual characteristic drawings on request.

RECOMMENDED SEQUENCE FOR REMOVING DICE FROM EXPANDED MEMBRANE

In order to optimize digit to digit luminous intensity match, remove dice from expanded vinyl membrane in the sequence relative to wafer orientation on the membrane as shown in the drawing at right.



NOTES:

A. The device under test must be die attached and wire bonded to the display substrate of intended use or on an 8-Pin, TO-5, Au-plated, Kovar header.

B. Luminous intensity will be measured with a Photo-Research Spectra microcandela meter, Model IVD fitted with a 4° probe.

C. $R_{LI}-1$ is the ratio of brightest emitter divided by dimmest emitter within a die.

D. $R_{LI}-2$ is the ratio of brightest emitter divided by dimmest emitter between packaged horizontally adjacent dice.

E. $R_{LI}-3$ is the ratio of brightest emitter divided by the dimmest emitter between five packaged horizontally adjacent dice.

F. All correlation and reject verification must be done by electro-optic means such as monitoring the photo current from a silicon photodetector (C.I.E. corrected) or photomultiplier positioned such that the normal axis of the L.E.D. chip and the photodetector are coincident and that they be separated by at least two inches. The test must be conducted in a zero ambient light environment with device under test configuration as specified in Note A, above.

G. In order to optimize digit to digit luminous intensity matching die should be removed from the vinyl film as shown in figure 1.

H. The pull test shall be performed on a gold ball bond formed from 0.001 inch wire.

I. A chip is defined to be any missing material around the edges of the die when viewed from the emitter side of the die.

J. The active area consists of the areas defined by the emitters and p-contact metallization.

K. A crack is defined to be any mechanical discontinuity of the surface other than etched steps.

PACKAGING/LABELING/SHIPPING CHARACTERISTICS

1) Monolithic Numerics and Colons

Wafers are mounted on 5.75" x 5.75" expandable vinyl membranes. Each wafer is covered by a 0.001" thick mylar overlay and separated from adjacent wafers by anti-static, non-adhesive spacers. Each mounted wafer is marked with the following information:

Die Type
Lot Number
Number of Good Dice
Average Luminous Intensity
Control Date

Mounted wafers are packed in secondary cartons which ensure their integrity during shipment. Each secondary carton is marked with the following information:

Device Type/Part Number	Number of Good Dice
Lot Number	Date Code

2) Watch Set Colons

Standard packaging for discrete colons is a vial marked with the following information:

Die Type
Lot Number
Number of Good Dice
Luminous Intensity Category
Control Date

Colon dice are not visually sorted. The number of good dice supplied in a shipment corresponds to the ratio required for use with the monolithic digits. Colon dice are luminous intensity categorized for optimum match to the monolithic digits and are supplied in two standard categories to be used as follows:

3) Package Code Suffix

W = shipped in unscribed wafer form
M = scribed and mounted on expandable vinyl membrane
V = scribed and packaged in vials

7 Applications

AN301
discrete LED selecting made easier

Light Emitting Diodes, LED's, have come into widespread use on the electronics scene. This application note is intended to aid the designer in selecting a particular device from the many LED's offered today. The more important parameters as well as some little-known pitfalls are discussed.

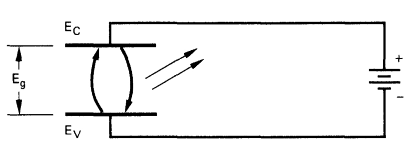
THEORY

Although light emission from a semiconductor junction had long been speculated, the first commercial devices did not become available until about 1963. This light emission phenomenon can be explained in terms of Semiconductor Energy-Band Theory. An external voltage applied to forward-bias a PN junction excites the majority carriers (electrons), causing them to move from the N-side Conduction Band to the P-side Valence Band. In making this transition the electrons cross the Energy Gap, E_g, that separates the two Bands, and so have to give up energy in the form of heat (phonons) and light (photons).

Each semiconductor material type has an E_g characteristic, and the wavelength (λ) of emitted light depends upon the magnitude of E_g, (see Figure 1). For example, Gallium Arsenide material, GaAs, has an E_g = 1.35 eV and a λ_{peak} = 9000 Å. The wavelength (i.e., color) emitted by some other materials made from Gallium compounds are listed in Table 1.

Material	Wavelength	Color
GaAs:Zn	9000Å	infrared
$GaAsP_{.4}$	6600Å	red
$GaAsP_{.5}$	6100Å	amber
$GaAsP_{.85}$:N	5900Å	yellow
GaP:N	5600Å	green

Table 1. Some Wavelentghs and Colors Emitted by Gallium Compounds



$$\text{Wavelength of Emission } (\lambda_{peak}) \cong \frac{12380}{E_g} \text{ (in Angstrom units)}$$

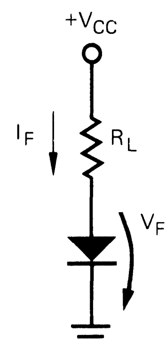
[Equation 1]

Fig. 1. Relationship Between Band-Gap Energy and Wavelength

ELECTRICAL CONSIDERATIONS

Most incandescents are rated in terms of voltage; LED's, on the other hand, are current-dependent devices since they are basically diodes. When operating from constant-voltage sources, protection should be provided by incorporating a current-limiting resistor with each LED.

Basic DC Circuit. For the simple circuit shown in Figure 2 the resistor value can be calculated from



$$R_L = \frac{V_{CC} - V_F}{I_F}$$

[Equation 2]

C1147

Figure 2.

where V_F and I_F are taken from an LED Data Sheet. The power rating required for the resistor should also be kept in mind.

Design Example #1: Suppose that a MV50 is to be used with Figure 2's circuit and a V_{CC} of +5 volts. Figure 3a shows the MV50's Brightness versus I_F curve, and Figure 3b shows I_F vs. V_F. (Note that Brightness varies directly with I_F). Further suppose that a Brightness of 800 foot-Lamberts is decided upon. From Figure 3a we see that I_F must be set at 13 mA, from Figure 3b we see that V_F will be 1.5 volts when I_F is 13 mA. Substituting these values in Equation 2, we obtain

$$R_L = \frac{V_{CC} - V_F}{I_F},\ R_L = \frac{5 - 1.5}{0.013},\ R_L = 269 \text{ ohm.}$$

Applications

From the expression, Power = $(I_F)^2 R_L$, we see that R_L's power rating can be 1/8 watt.

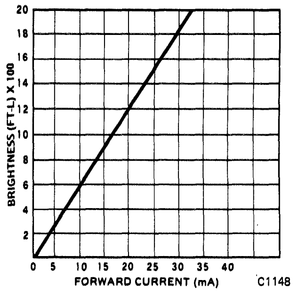


Figure 3a.

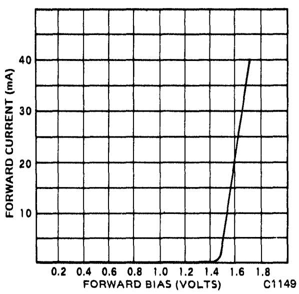


Figure 3b.

Active-Low Drive Circuit. Figure 4 shows a single-transistor drive circuit that lights the LED when the transistor is "low," i.e., conducting. The value for R_L can be calculated from

$$R_L = \frac{V_{CC} - V_F - V_{CE(sat)}}{I_F}$$

[Equation 3]

Active-High Drive Circuit. Figure 5 shows a single-transistor drive circuit that lights the LED when the transistor is "high," i.e., not conducting. Equation 2 can be used for calculating the value of R_L. The transistor should have a V_{CE} of approximately 0.4 volts when conducting.

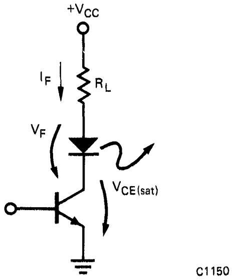


Figure 4.

Figure 6 shows a circuit that has an MOS IC output driving both an LED and a TTL logic input.

Design Example #2: Suppose that a given MOS ROM, operated with V_{SS} = +12 volts, V_{GG} = −12 volts, and V_{DD} = ground, is to drive an LED and a TTL logic input. Further suppose that the LED's brightness is to be adequate for use as a trouble-shooting indicator lamp.

From the data sheet for a MV55 we see that this low-cost, low-current LED typically delivers a usable 125 foot-Lamberts when I_F is 1 mA, and has an I_F maximum rating of 3 mA. A value of 6.8 Kohm should be used for R_L.

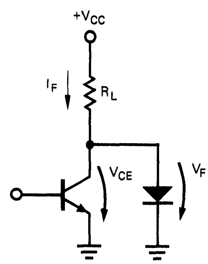


Figure 5.

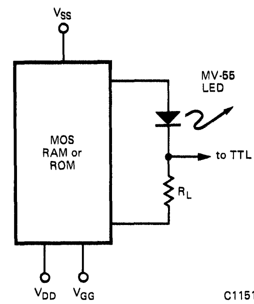


Figure 6.

AC Operation. LED's should be operated in the forward direction only. Therefore, the LED circuit must provide reverse-voltage protection if applied voltage is expected to exceed the V_R maximum rating of the LED. Figure 7a shows a circuit having an ordinary silicon diode (e.g., 1N914) placed "back-to-back" with the LED. Figure 7b shows an alternate and more novel approach that utilizes two LED's in parallel. If no current flows, neither LED lights. But as long as current does flow (in either direction), one of the LED's lights and one does not (because one LED will be conducting

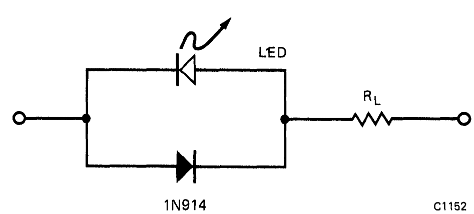


Fig. 7a. Bipolar Operation

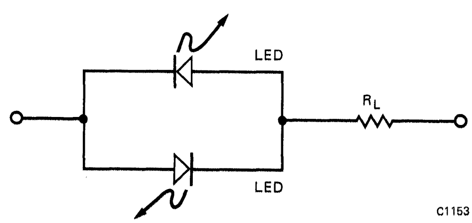


Fig. 7b. Bipolar Operation

and the other not conducting.) An extension of this back-to-back thinking led to the development of the bipolar devices, i.e., the MV5094 (Red/Red) and the MV5491 (Red/Green). These are actually two diodes in each package allowing either AC/DC or tri-state status indication.

If reverse operation (below breakdown) is expected for any length of time, then the designer should be aware of the fact that reverse leakage over temperature of LED materials (GaAs, GaAsP, etc.) is significantly less than that of silicon diode materials.

Pulsed Operation. Significantly higher peak LED light output can be obtained from ampere-level drive current pulses (of narrow width and at low duty cycle) than from steady-state driving. For example, total radiated power (expressed in milliwatts) from a ME7021, infra-red-emitting LED, operated steady-state (typically with I_F = 100 mA) is 2 mW. But this output increases to 50 mW when driven by a 6 amp, one microsecond-wide pulse at 0.1% Duty Cycle. It should be pointed out that this factor of 25 increase comes at the expense of a somewhat lower internal (quantum) efficiency.

Besides the increase in average power just described, pulsed operation of visible-emitting LED's also gives rise to a human perception phenomenon commonly known as Light Enhancement. This phenomenon is due in part to the eye's retention of high brightness levels (such as those produced by camera flash bulbs). A numerical Light Enhancement Factor (always greater than 1) can be defined by the following ratio:

$$\text{Light Enhancement Factor} = \frac{I_{DC\ (\text{steady-state operation})} \text{ to produce Brightness ``B''}}{I_{\text{average (pulsed operation)}} \text{ to produce Brightness ``B''}}$$

[Equation 6]

This Light Enhancement phenomenon is available only from GaAsP because this LED material will not saturate under high-current conditions.

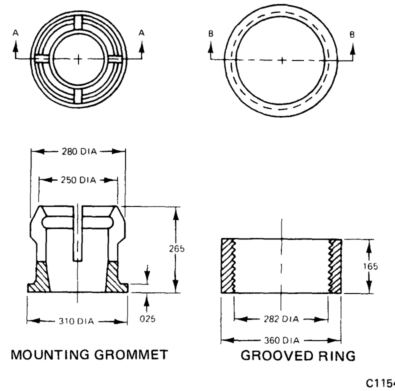
When the human eye is the detector of visible energy, lower average power is consumed by pulsed operation than by steady-state operation. This advantage of pulsed operation is especially important for battery-powered applications and for applications in which large LED arrays are being driven.

MOUNTING CONSIDERATIONS

Panel Mounting. In the "Pop-In" panel mounting method, (see Figure 8a), a black plastic mounting grommet is placed over the top of the lens and the LED is inserted—leads first—into the panel mounting hole until the grommet's flange butts against the panel. Next a grooved ring is placed against the inside-panel end of the grommet, and the ring is pushed on until the LED is securely held in place. The grommet's black color provides contrast improvement. This mounting method allows mounting of the MV5020-Series (T1¾ size) lamps in ¼ in. diameter holes on panels having thicknesses from 0.62 in. to 0.125 in.

A method for mounting LED types without using mounting hardware is to drill the panel holes and either epoxy the LED's into place or solder them to a back-panel printed circuit board, (see Figure 8b).

Printed Circuit Board Mounting. The most common techniques for mounting LED's on P.C. Boards are illustrated in Figure 9. The lead bending can be per-



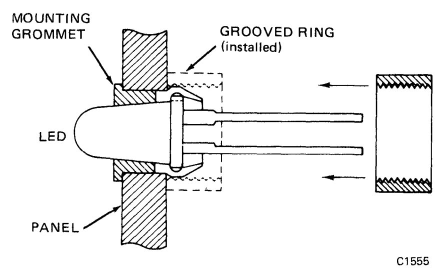


Figure 8a.

formed by the user, or arrangements can be made to have it done prior to shipment from the Factory.

OPTICAL CONSIDERATIONS

Lens Effects. Lenses of the earliest LED's were designed to pass maximum light in the forward direction, i.e., perpendicular to the mounting surface, (see Figure 10). Later LED's produced more light and their lenses were designed to spread light over a wider area, thus permitting broader observer viewing angles. Still later, as higher light output LED's became available, a variety of red-colored, epoxy lenses came into use. These lenses act to diffuse light into a broader apparent emitting area. LED lenses that produce a broad, evenly-diffused light

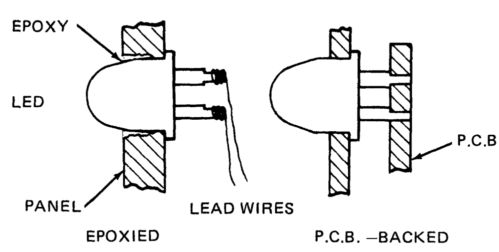
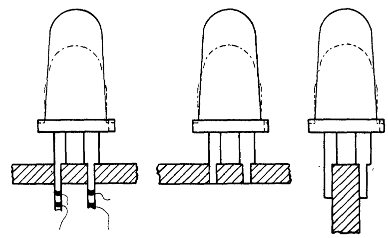
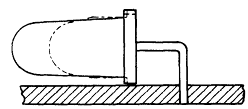


Fig. 8b. LED's Mounted Without Hardware



(a) LED's mounted
without leads being bent



(b) LED mounted
with leads bent

C1157

Fig. 9. Techniques for Mounting LED's on P.C. Boards

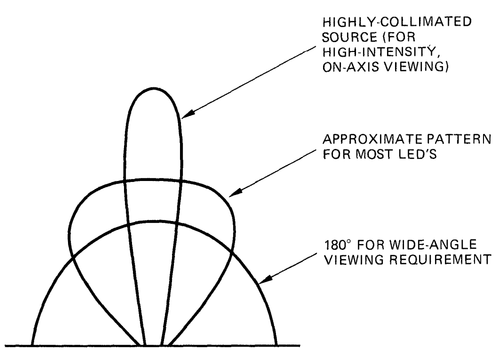
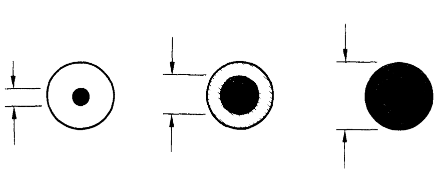


Fig. 10. Different Lens Effects (Used on the Same LED)

are generally assumed to be more pleasing to the eye than lenses that produce a highly-intense point of light. Figure 11 illustrates the effects of adding varying amounts of red diffusants to the epoxy lens material.



(a) Clear Lens (Point Source) (b) Partially Diffused (c) Fully Flooded (Area Source)

Fig. 11. Epoxy Lenses With Varying Amounts of Diffusants

Light Measurement. The manner by which the human eye "sees" is highly subjective and is affected by various factors such as "nature" of the light source (i.e., "point" or "area" source), viewing distance, color, and the observer's visual acuity. For example, it has been found that a "standard" observer with 20/20 vision can discern objects having dimensions that transcribe angles as small as two minutes. To such an observer a source having a 0.16-inch diameter and positioned farther away than 22 feet seems more "point" than "area" in nature.

Two photometric parameters which designers find useful for evaluating LED light output are Luminous Intensity, I, and Luminance (Brightness), B, (see Table 2). While an infinitely-small light source exists in theory only, the following expression can provide a means for determining the distance at which the eye loses its ability to discern an "area" and begins to see a "point."

$$\text{THRESHOLD DISTANCE} = \frac{\text{Diameter of Light Source}}{\text{TAN } 0^\circ\ 2'}$$

(At which sources "lose" their area) [Equation 7]

From this determination the designer can decide whether to use the I or B parameter for his evaluation of LED light output. The "diameter of the light source" in Equation 7 is the apparent emitting area of the LED. For a "clear" lens LED, (Figure 11a), multiply diode emitting area by the lens magnifying factor. (Unless stated otherwise, most clear lenses magnify by about 2X.) For a "flooded" lens LED, (Figure 11c), use the outside package diameter. For a partially-diffused lens LED, (Figure 11b), a good rule of thumb is one-half the outside package diameter.

Nature of Source	Photometric Parameter	Symbol	Units	Measurement of
Point	Luminous Intensity	I	candela	Luminous Flux/steradian
Area	Luminance (Brightness)	B	foot-Lambert	$\frac{\text{Luminous Flux/steradian}}{(\pi)(\text{Area of source in ft}^2)}$
			stilb	$\frac{\text{Luminous Flux/steradian}}{\text{Area of source in cm}^2}$

Table 2. I and B Photometric Parameters

Contrast Ratio. The degree by which an observer distinguishes an object or source is a function both of time spent looking and of Contrast Ratio. Contrast Ratio is defined as "the difference in Luminance between an object and its background," or

$$\text{CONTRAST RATIO} = \frac{L_s - L_b}{L_b}$$

where "L_s" is a Source Luminance and "L_b" is Background Luminance

[Equation 8]

After an observer has focused on an object for longer than about one second, the time factor becomes negligible and Contrast Ratio remains as the important factor.

Human Factors Studies have shown that a Contrast Ratio of 10 is the minimum design value. Knowing this, and knowing the background Luminance of some common materials under normal illumination levels, we can easily determine the minimum acceptable Luminance levels required from our LED light sources.

Design Example #3: Suppose that the illumination level produced by normal laboratory lighting is approximately 25 foot-candles, and that the reflection from a light-gray panel under this lighting produces a Background Luminance, L_b, of approximatley 10 foot-Lamberts. What is the minimum acceptable Luminance which must be produced by an LED mounted on this panel?

Substituting the above values into Equation 8, we have

$$10 = \frac{L_s - 10}{10}, \text{ or } L_s = 110.$$

Therefore, for an LED installed on a light-gray panel and used in this lighting environment, we see that the minimum acceptable level of Luminance is 110 foot-Lamberts.

Colors. LED's are now available in various colors. In some applications the designer may be called upon to develop circuits in which LED's of different colors are to produce equal Brightness. Since light output from an LED is basically a function of current flow through the PN junction, equal Brightness can be achieved by adjustments of current flow.

Design Example #4: Suppose that three LED's, one each of red, yellow, and green, are to each produce a luminous intensity of 2 mcd when installed in the circuit shown in Figure 12. Further suppose that V_{CC} is set at +5 volts and the LED types chosen are MV5053 (red), MV5353 (yellow), and MV5253 (green).

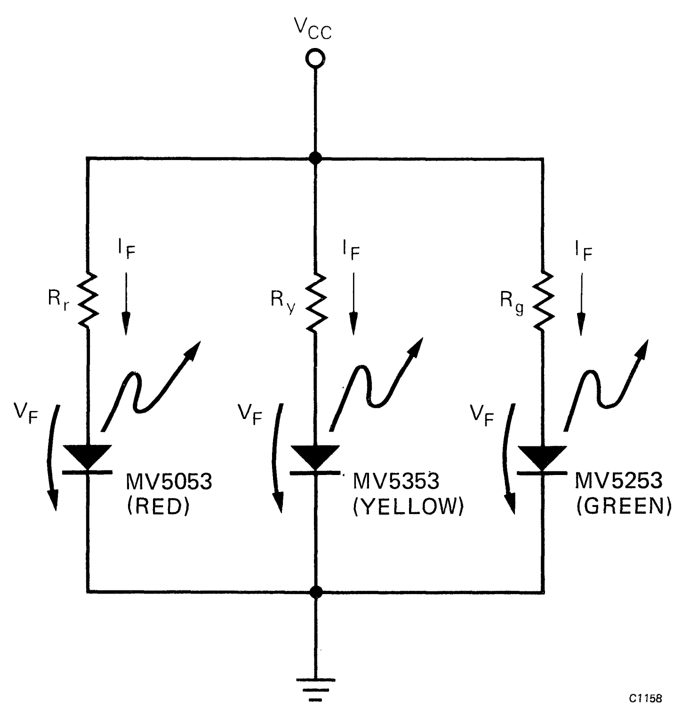


Fig. 12. Brightness Matching Different Colors

First the values of I_F needed to produce 2 mcd in each LED must be determined. From the data sheets we are given that the MV5053 typically produces 1.6 mcd when I_F is 20 mA; the MV5253 produces 1.5 mcd when I_F is 20 mA; and MV5353 produces 6.0 mcd when I_F is 20 mA. The brightness—I_F relationship for LED's can be assumed to be linear for I_F values within the maximum ratings. Therefore, knowing these points and that the luminous intensity is zero when I_F is zero, we can plot the straight-line relationship for each LED type (see Figure 13). From these plots we see that the MV5053 produces 2.0 mcd when I_F is 25 mA; the MV5253 when I_F is 26 mA; and the MV5353 when I_F is 7 mA.

Now the resistor values for R_r, R_y, and R_g can be calculated using Equation 2.

$$R_L = \frac{V_{CC} - V_F}{I_F}$$

with V_F taken as the "typical" values given on the data sheets. We then have:

$$R_r = \frac{5 - 1.65}{.025} \qquad R_y = \frac{5 - 2.1}{.007} \qquad R_g = \frac{5 - 2.2}{.026}$$

$$R_r = 134 \text{ ohms} \qquad R_y = 414 \text{ ohms} \qquad R_g = 108 \text{ ohms}$$

It should be noted that the foregoing analysis holds true only as long as spatial distribution (beam pattern) and apparent image size are very nearly the same for all LED's, regardless of color.

Infrared LED Sources. Visible-emitting LED's, the vital link in the man-machine interface, are characterized in terms of Photometric quantities. On the other hand, infrared-emitting LED's (whose invisible light is of wavelengths longer than 750 nanometers) are characterized in terms of Radiometric quantities. Also, applications requirements for infrared LED sources are different from those for visible-emitting LED's. Whereas for visible-emitting LED's a wide viewing angle is normally important, for infrared sources a narrow beam width and high on-axis intensity are normally important. Light output produced by infrared sources is defined by one or more of the following Radiometric parameters (see Table 3):

- Radiated Output Power (P) or (ROP)—Total output of the device in all directions (measured in Watts).
- Radiant Intensity (J)—Radiant flux per unit solid angle in a given direction (measured in Watts/steradian).
- Irradiance (H)—The density of radiant flux incident on a surface (measured in Watts/area).

Irradiance is a particularly useful parameter because it describes how much output power is available at a given

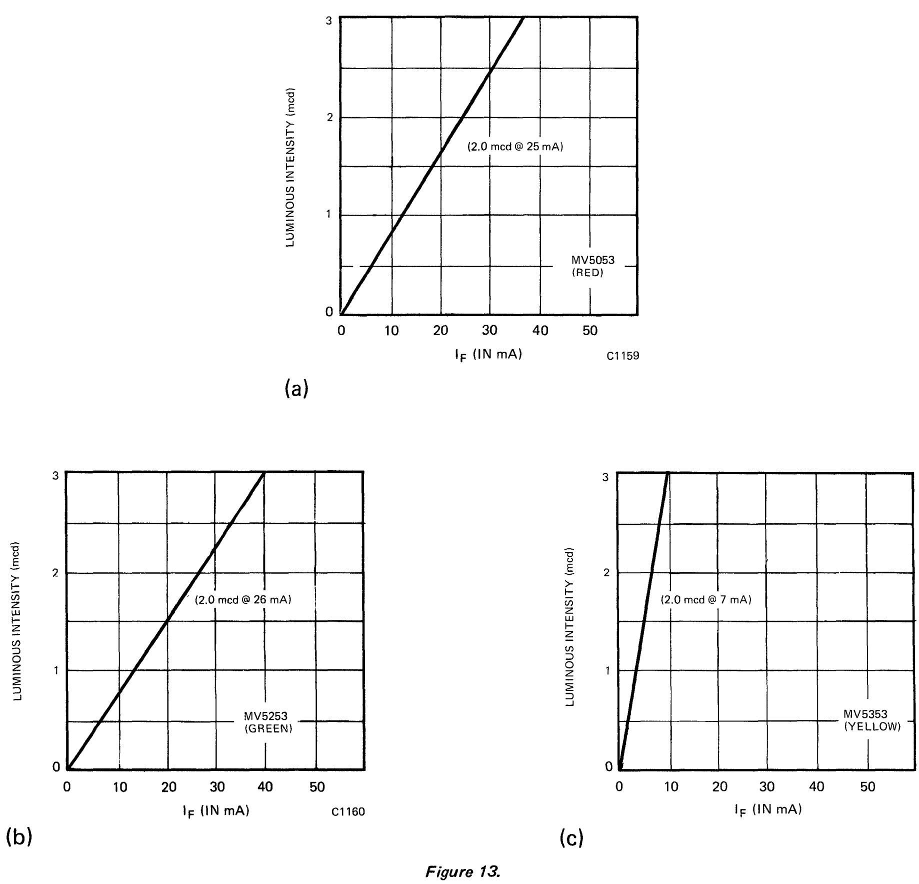


Figure 13.

Table 3.

	Parameter and Symbol		Definition	Units	Abbrev.
RADIOMETRIC	Radiant Energy	Q_e		erg joule calorie kilowatt-hour	 J cal kWh
	Radiant Flux	P	$P = \frac{dQ_e}{dt}$	erg per second watt	erg s^{-1} W
	Radiant Emittance (see Note 2)	W	$W = \frac{dP}{dA}$	watt per sq. cm, watt per sq. m, etc.	W cm^{-2} W m^{-2}
	Irradiance	H	$H = \frac{dP}{dA}$	watt per sq. cm, watt per sq. m, etc.	W cm^{-2} W m^{-2}
	Radiant Intensity (see Note 1)	J	$J = \frac{dP}{d\omega}$	watt per steradian	W sr^{-1}
	Radiance (see Note 1)	N	$N = \frac{d^2P}{d\omega(dA \cos \Theta)}$ $N = \frac{dJ}{(dA \cos \Theta)}$	watt per steradian and sq. cm watt per steradian and sq. m	W sr^{-1} cm^{-2} W sr^{-1} m^{-2}
PHOTOMETRIC	Luminous Efficacy	K	$K = \frac{F}{W}$	lumen per watt	lm W^{-1}
	Luminous Efficiency	V	$V = \frac{K}{K_{maximum}}$		
	Luminous Energy (quantity of light)	Q_v	$Q_v = \int_{380}^{760} K(\lambda) Q_e \lambda d\lambda$	lumen-hour lumen-second (talbot)	lm h lm s
	Luminous Flux	F	$F = \frac{dQ_v}{dt}$	lumen	lm
	Luminous Emittance (see Note 2)	L	$L = \frac{dF}{dA}$	lumen per sq. ft	lm ft^{-2}
	Illumination (illuminance)	E	$E = \frac{dF}{dA}$	footcandle (lumen per sq. ft.) lux (lumen per sq. m) phot (lumen per sq. cm)	fc lx ph
	Luminous Intensity (candlepower)	I	$I = \frac{dF}{d\omega}$	candela (lumen per steradian)	cd
	Luminance (brightness)	B	$B = \frac{d^2F}{d\omega(dA \cos \Theta)}$ $B = \frac{dI}{(dA \cos \Theta)}$	candela per unit area stilb (candela per sq. cm) nit (candela per sq. m) foot-Lambert (cd per πft^2) apostilb (cd per πm^2) Lambert (cd per πcm^2)	cd in^{-2}, etc. sb nt ft-L asb L

NOTES: 1. ω is a solid angle through which flux from point source is radiated

Θ is angle between line of sight and normal to surface considered

λ is wavelength

2. W and L refer to "emitted from" and H and E refer to "incident on"

distance away from the LED. Designers often make use of this parameter when choosing their infrared detectors. Silicon "solar cell" or "photovoltaic cell" detectors are the best detector choices because they generally have large active areas, good long-term stability, and near-perfect match in spectral response compared with infrared LED sources, (see Figure 14).

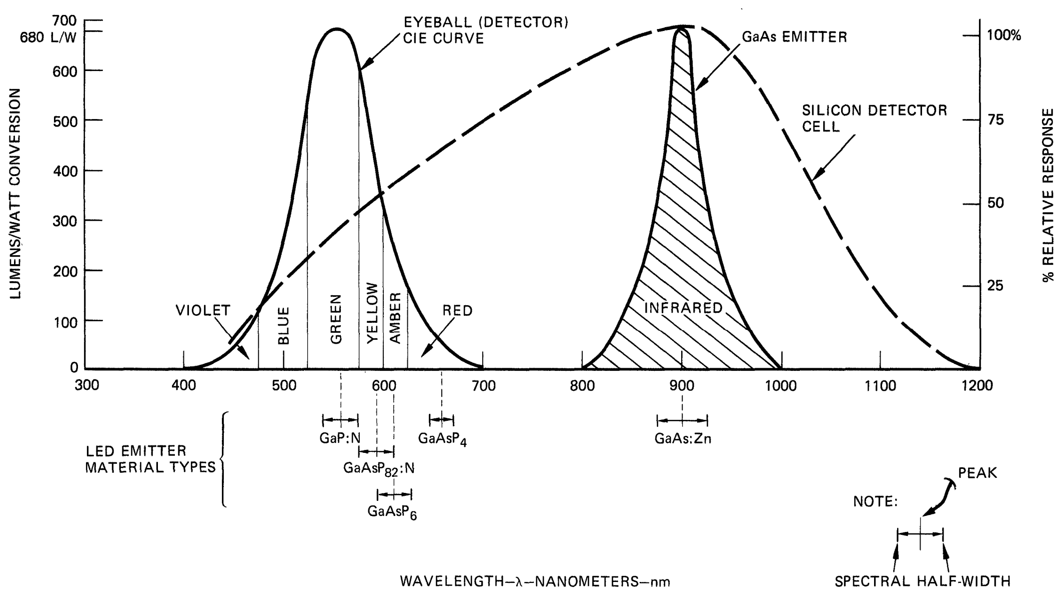


Fig. 14. Relationship Between LED and Detector Spectrums

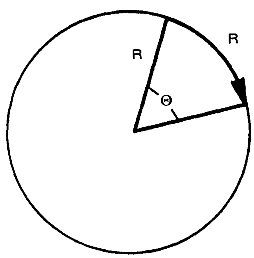
AN601
the photometry of LED's
a primer in photometry

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) $2\pi R = 360^\circ$. Radian $= 180^\circ/\pi = 57.27^\circ$ (approx.)

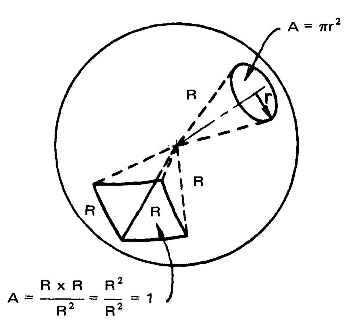


TWO DIMENSIONAL FIGURE

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.



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.

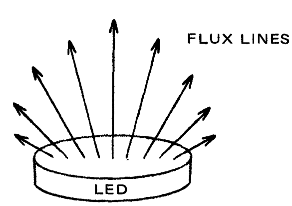


FIGURE 3

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.

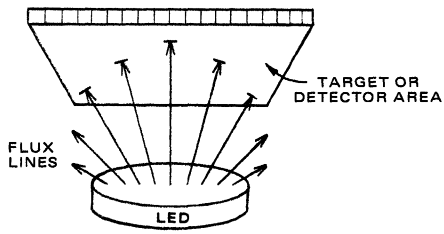


FIGURE 4

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).

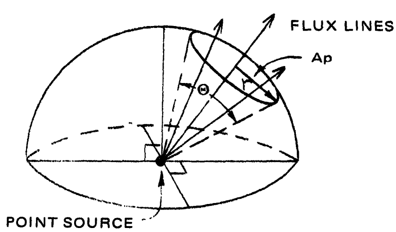


FIGURE 5

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.

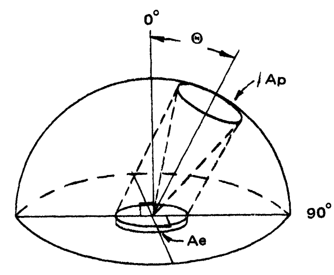


FIGURE 6

$$\frac{\text{LUMINOUS INTENSITY}}{\text{Ap}} = \frac{\frac{\text{LUMENS}}{\text{STERADIAN}}}{\text{Ae} \cos \Theta} = \frac{\text{CANDELAS}}{\text{(Sq. Unit)}}$$

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:

$1/\pi$ candela/cm^2 = LAMBERT
$1/\pi$ candela/m^2 = APOSTILB (or BLONDEL)
$1/\pi$ candela/in^2 = no designator available
$1/\pi$ candela/ft^2 = FOOT LAMBERT

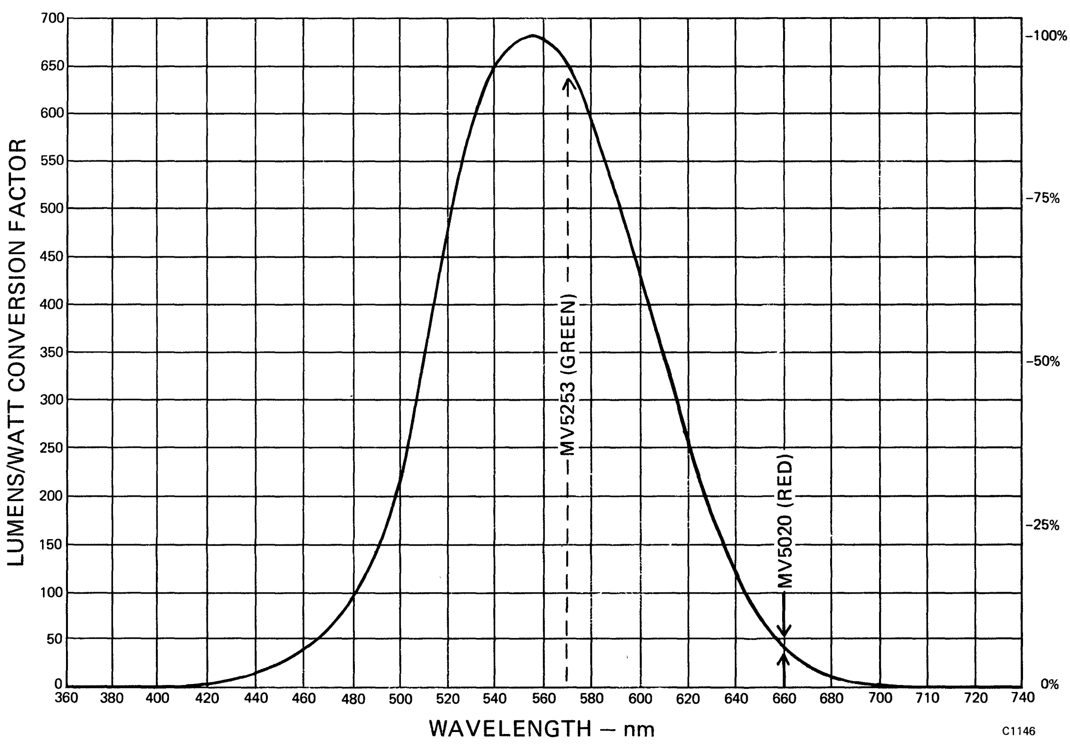
CIE CURVE

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 MV5253 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.

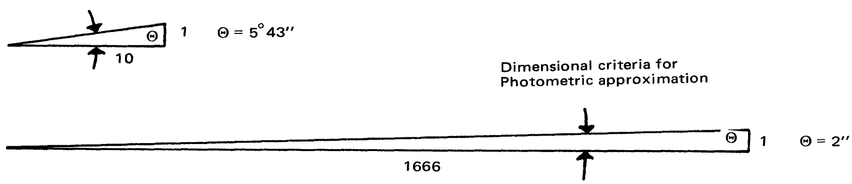


FIGURE 7

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.

Below are the products, their respective chip dimension, either diameter or diagonal, apparent size due to optical magnification and luminance/luminous intensity crossover distance. It should be stressed that this distance is not finite but represents a gradual threshold distance at which either parameter might be definitive.

Product	Active Chip Area	Optical Lens Factor	Apparent Size	Crossover Distance Feet
MV10B	.015"	x1.9	.028"	3.96
MV50	.017" diag.	x1.75	.030"	3.0
MV5020	.017" diag.	x1.5	.025"	2.5
MV5025	(.160")*	(x15.2)	.160"	22.2

*Entire lens is considered the apparent emitting area.

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

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

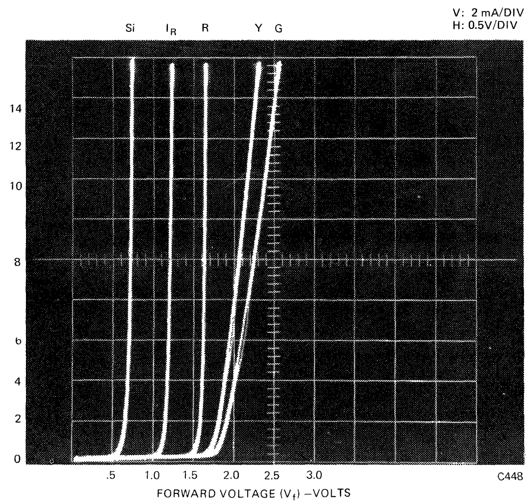


Fig. 1. Typical I_f/V_f Curves of Silicon, GaAs, and GaAsP, GaP (Silicon-IN914, IR-ME7024, Red-MV5053, Yellow-MV5353, Green-MV5253)

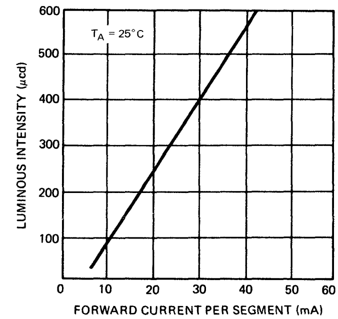


Fig. 2. Typical LED Curve Luminous Intensity vs. Forward Current for Constant Temperature

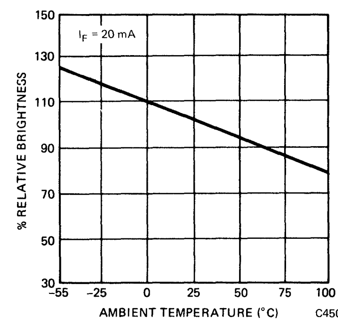


Fig. 3. Typical LED Curve Brightness vs. Temperature for Constant Current

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

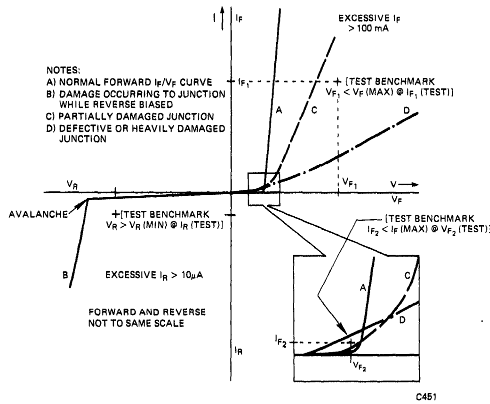


Fig. 4. Effects of Improper Testing Procedure

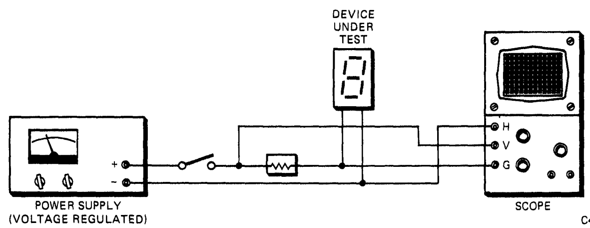


Fig. 5. Potentially Damaging Forward-Mode Test Setup

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.

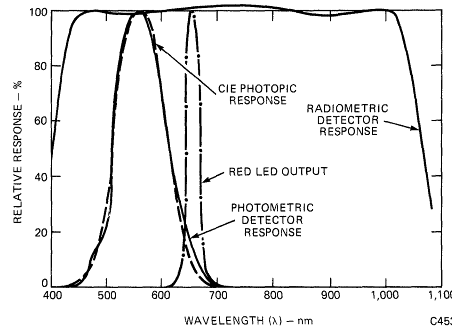


Fig. 6. Responses of Two Detectors to the Output of a Visible Red LED

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.

AN1071
Optoisolator input drive circuits
MCT270 SERIES

An optoisolator is a combination of a light source and a photo-sensitive detector. In the optoisolator, 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 optoisolators, 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 optoisolators is an 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 optoisolators 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.

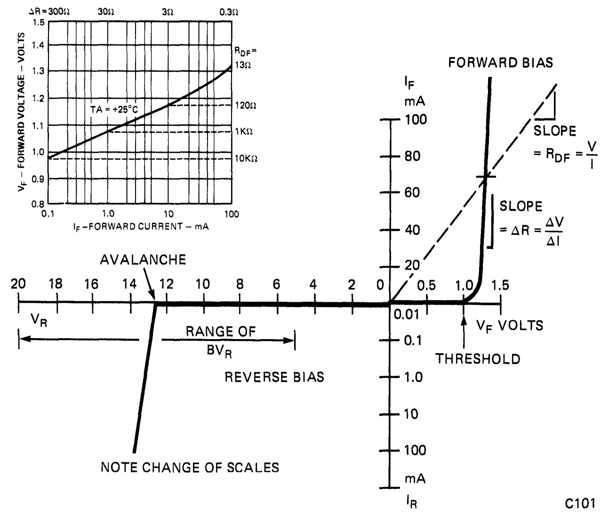
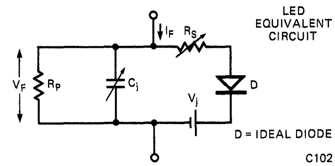


Fig. 1. Characteristics of IR LED



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

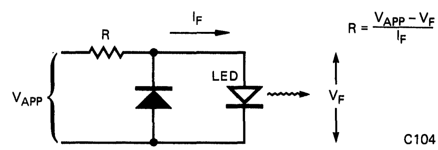


Fig. 4. Typical LED Drive Circuit

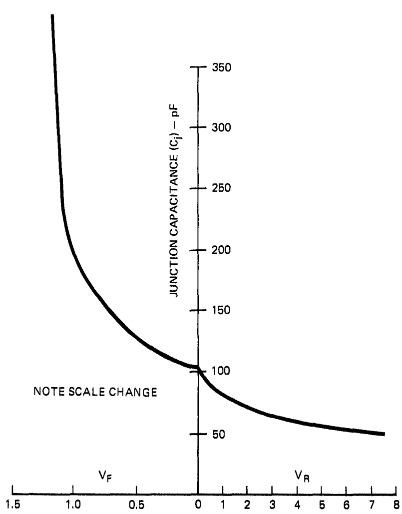


Fig. 3. Voltage Dependence of Junction Capacitance

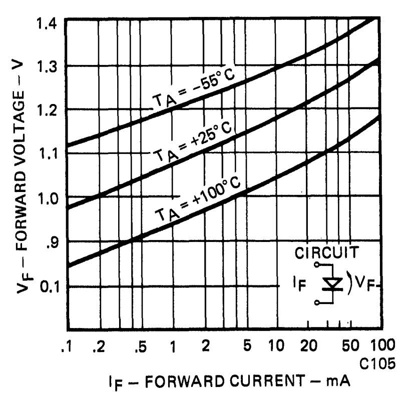


Fig. 5. IR Forward Voltage vs. Forward Current and Temperature

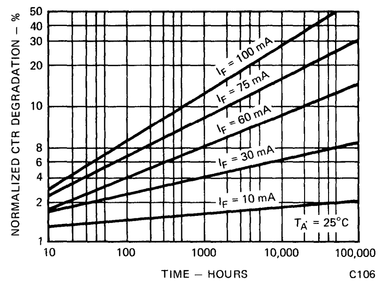


Fig. 6. Brightness Degradation vs. Forward Current and Time

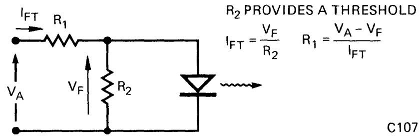


Fig. 7. LED Threshold Adjustment

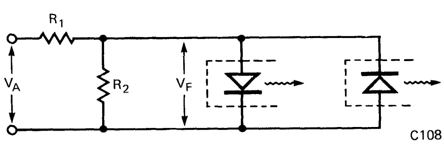


Fig. 8. Bipolar Input Selects LED

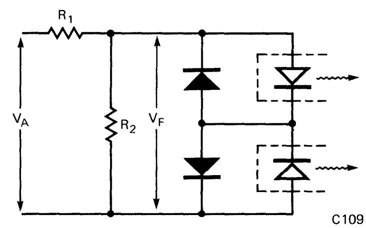


Fig. 9. High Threshold Bipolar Input

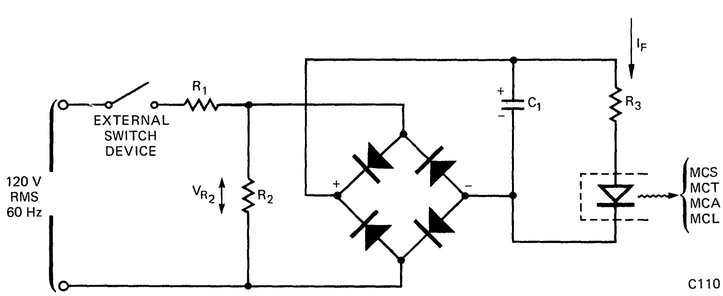


Fig. 10. AC Input to LED Drive Circuit

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 optoisolators 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 optoisolator 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 optoisolator, 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 opto-isolator, 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 optoisolator 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

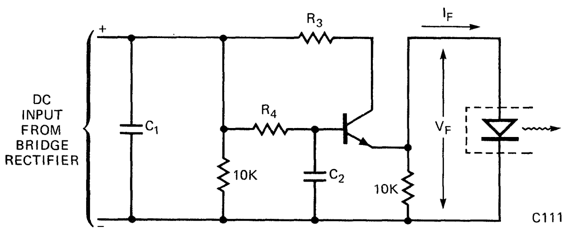


Fig. 11. R-C-Transistor Filter Circuit

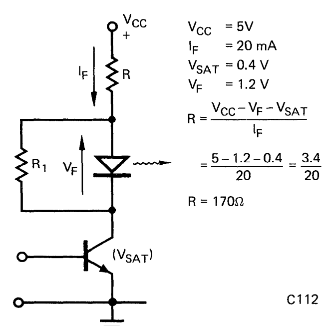


Fig. 12. Transistor Drive, Normally Off

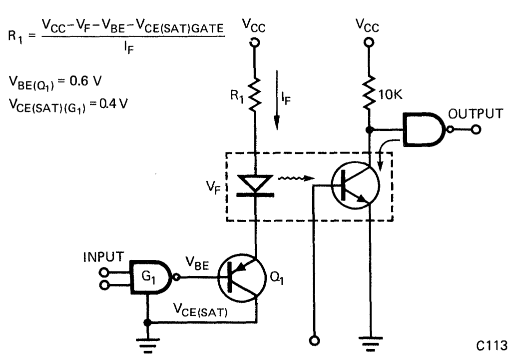


Fig. 13. Logic to LED Series Booster

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 optoisolator 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

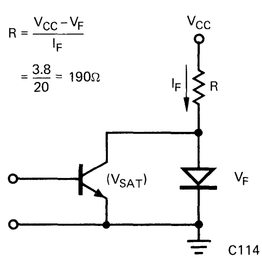


Fig. 14. Transistor Drive, Normally On

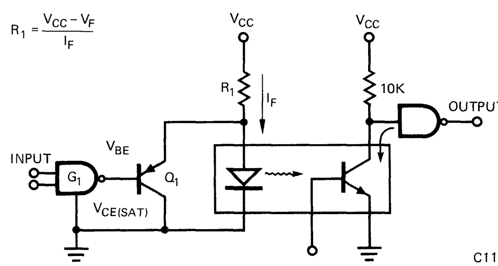


Fig. 15. Logic to LED Shunt Booster

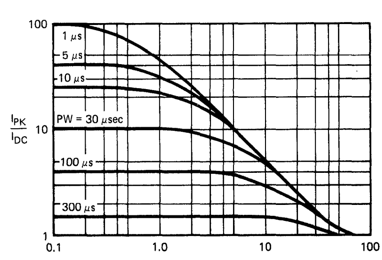


Fig. 16. Maximum Peak I_F Pulse Normalized to Max I_{DC} for Pulse Width (PW) and Duty Cycle (%)

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.

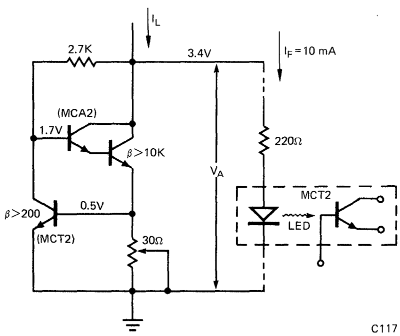


Fig. 17. Constant-Current Shunt Impedance

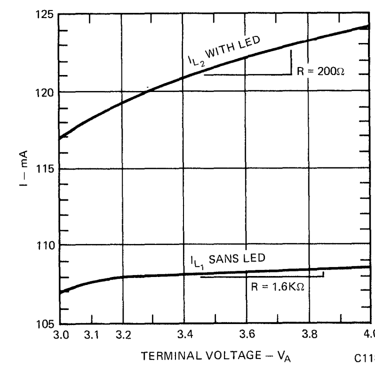


Fig. 18. Shunt Impedance Performance

AN1074
Low current input circuit ideas
6N139 (MCC671) 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 optoisolator, 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 MCC671 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 MCC671 as shown in the circuit of Figure 1.

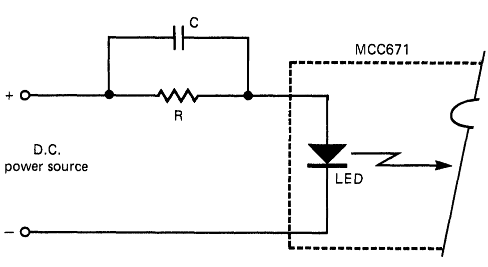


Figure 1. MCC671 Input Circuit For Signal Detection

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 MCC671

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.

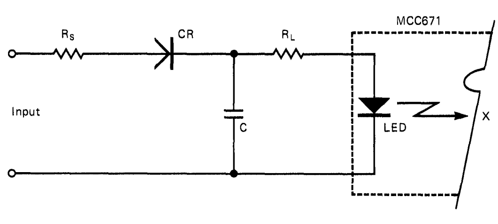


Figure 2. Pulse or Waveform Detection Circuit

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 MCC671

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.

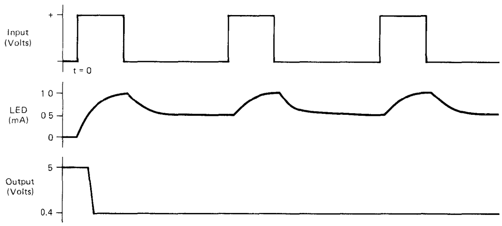


Figure 3. Pulse Train Waveforms

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.

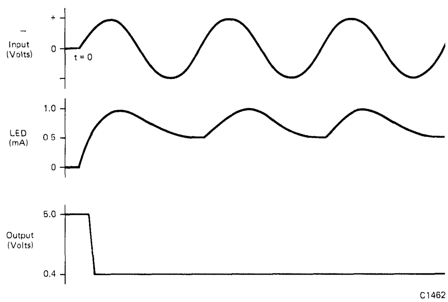


Figure 4. Sine Wave Waveforms

Matrices Opto-Coupling

With the low input LED current advantage of the MCC671, the ability to drive matrices with but one TTL output is now possible as shown in figure 5.

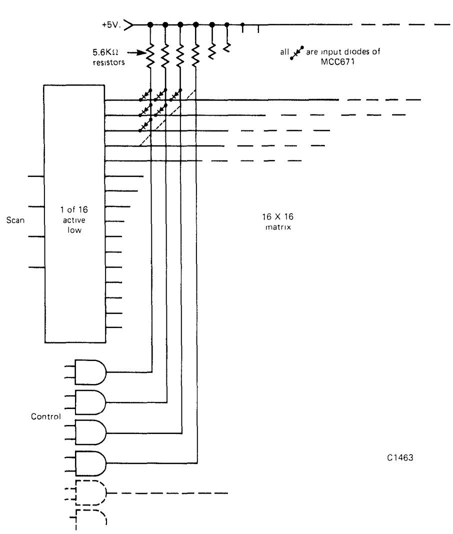


Figure 5. Opto-Coupling out of Matrices

Non-Loading Line Receiver

For virtual non-loading, the MCC671 is compatible with the differential amplifier circuit of Figure 6.

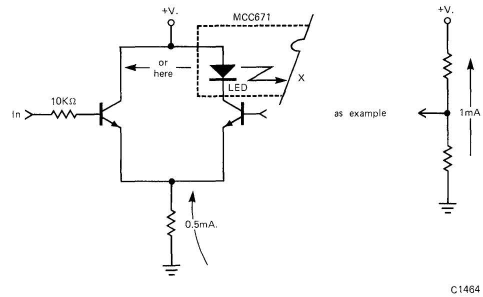


Figure 6. Differential Amplifier Drive

For a virtual no-load optosiolator circuit use:

X = Non-latching output circuitry to follow

LED = Input diode of MCC671

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".

MCC671 Output Circuitries

The following are two examples of MCC671 output circuitry. One latching (Figure 7); the other non-latching (Figure 8), but both capable of driving a TTL gate directly.

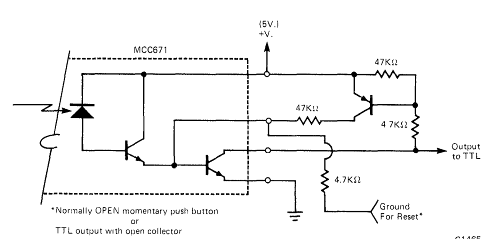


Figure 7. Latching Output Circuit For MCC671

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.

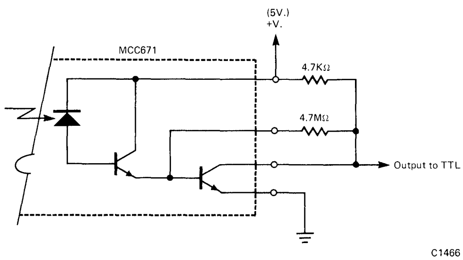


Figure 8. Non-Latching Output Circuit For MCC671

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 MCC671 specification sheet, you may not be totally aware of the current capabilities of Monsanto's optoisolators.

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 ($Q_1Q_3Q_5$) 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.

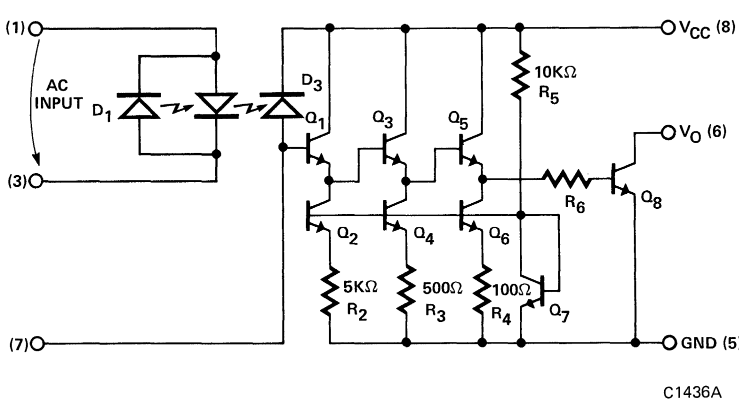


Fig. 1. Circuit Schematic of MID400 AC Line Monitor

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.

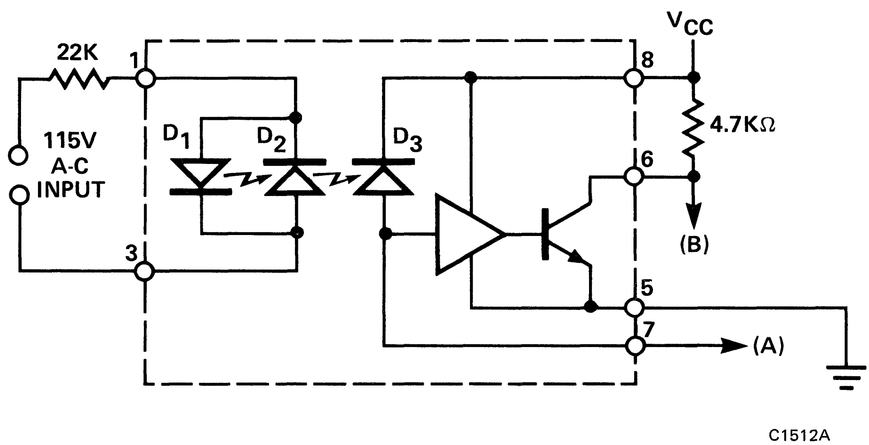


Fig. 2. Test Circuit

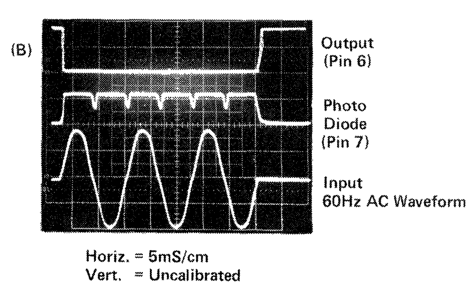


Fig. 3. Saturated Operation

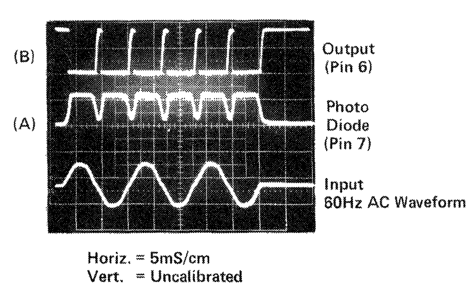


Fig. 4. Unsaturated Operation

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.

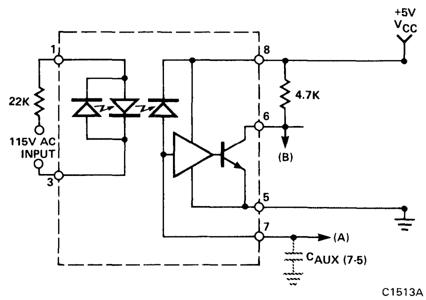


Fig. 5. Circuit With Addition of Capacitor at Pin 7

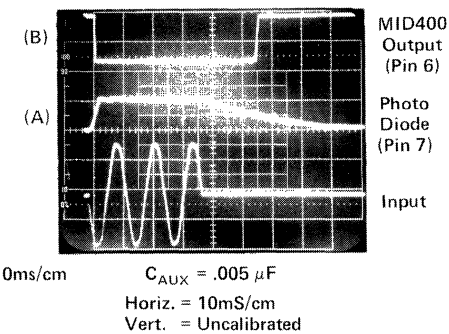


Fig. 6. Waveforms with Capacitor Added at Pin 7

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.

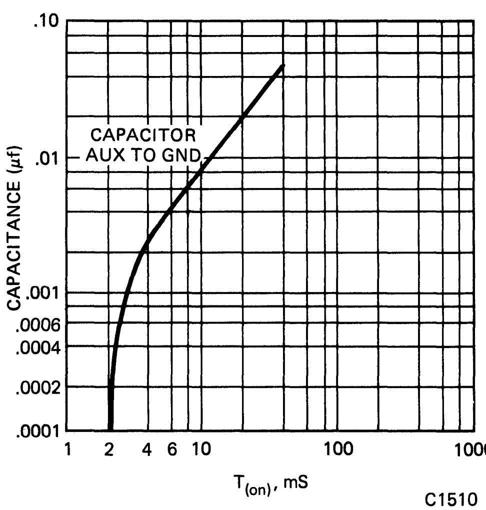


Fig. 7. Plot of Capacitance Versus Turn-on Time

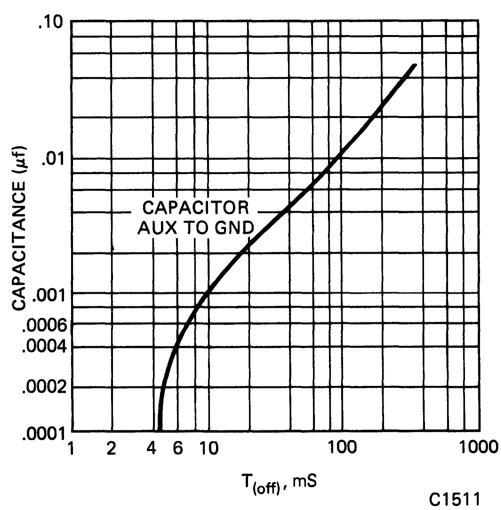


Fig. 8. Plot of Capacitance Versus Turn-off Time

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.

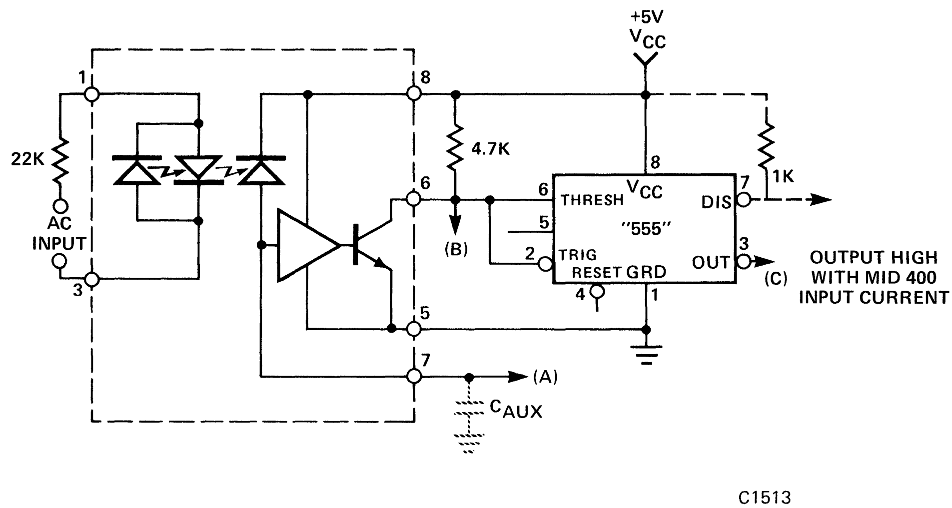


Fig. 9. Circuit with 555 Timer Added

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.

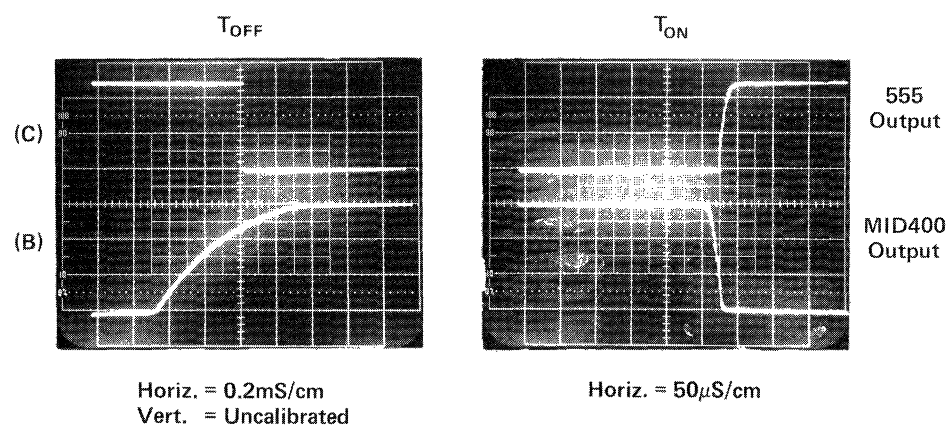


Fig. 10. Output Waveforms for $T_{ON}T_{OFF}$. Pin 7 Auxiliary Input Open Using the 555 Circuit (Fig. 9)

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).

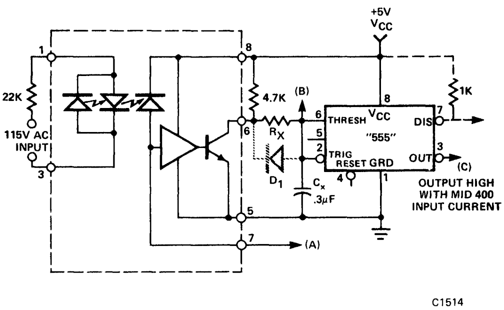
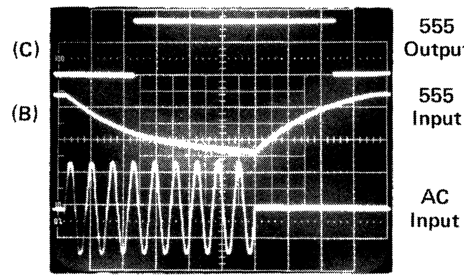


Fig. 11. Adjustable Delay Turn Off/On Circuit

Without D_1
Turn on and off Delay

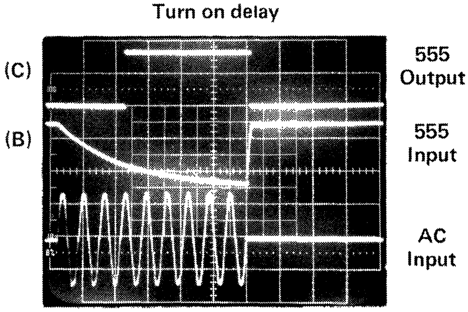


Horiz. = 20mS/cm
Vert. = Uncalibrated

$R_X = 200K\Omega$
$C_X = 0.3\mu F$

Fig. 12. Output Without D_1 Diode

With D_1
Turn on delay

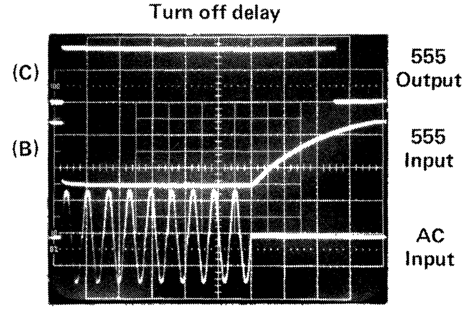


Horiz. = 20mS/cm
Vert. = Uncalibrated

$R_X = 200K\Omega$
$C_X = 0.3\mu F$

Fig. 13. Delayed Turn On. Diode D_1 Connected Opposite to Shown in Circuit Schematic

With D_1
Turn off delay



Horiz. = 20mS/cm
Vert. = Uncalibrated

$R_X = 200K\Omega$
$C_X = 0.3\mu F$

Fig. 14. Delayed Turn Off. Diode D_1 Connected As Shown in Circuit Schematic

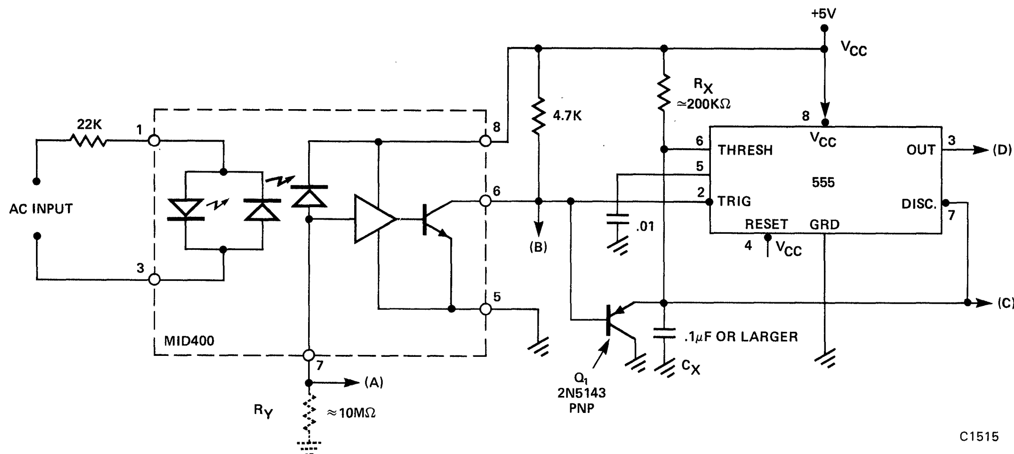


Fig. 15. Precision Delay Circuit

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.

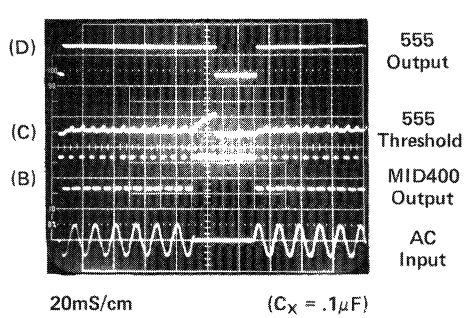


Fig. 16. Unsaturated Mode—Detects Missing AC Input Cycles (when more than one cycle is missing)

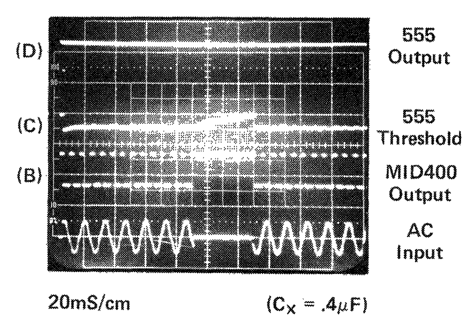


Fig. 17. Unsaturated Mode—Does NOT Detect Missing AC Input Cycles

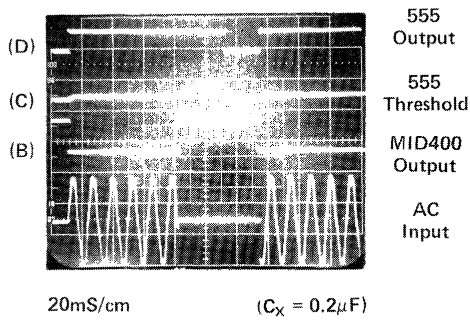


Fig. 18. Saturated Mode—Detects Missing AC Input Cycles

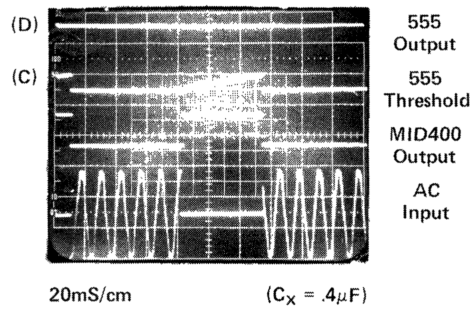


Fig. 19. Saturated Mode—Does NOT Detect Missing AC Input Cycles

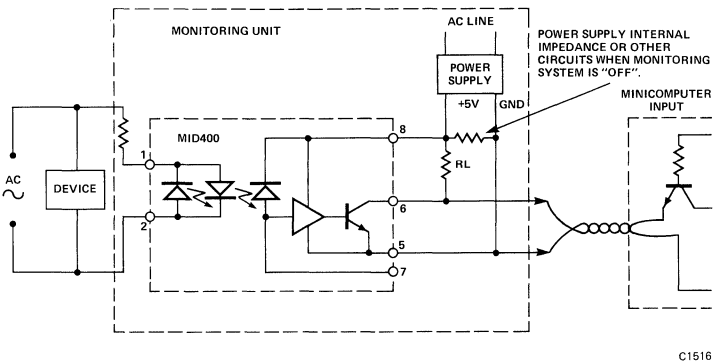


Fig. 20. Example For Fail-Safe Considerations

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

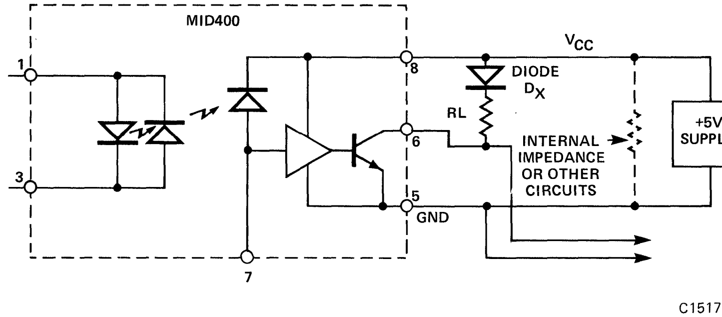


Fig. 21. Diode D_X Added to Stop Reverse Current When MID400 +5v V_{CC} Line is Off

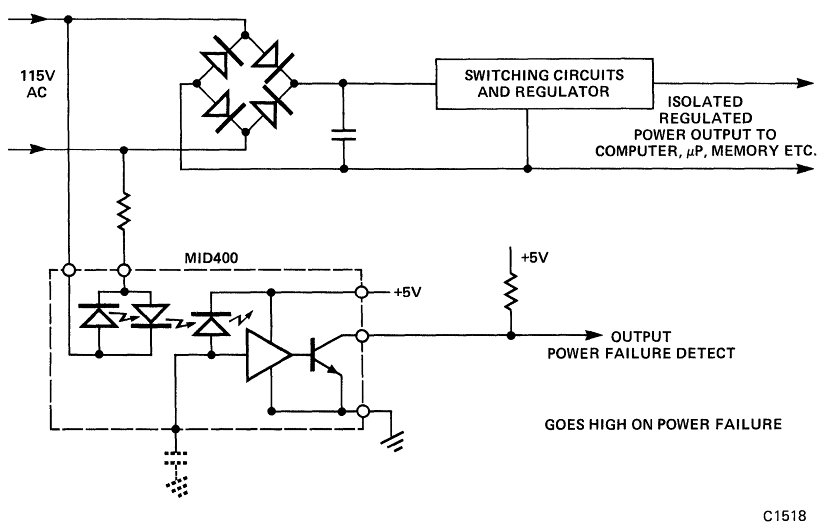


Fig. 22. Circuit for Switching Power Supply

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.

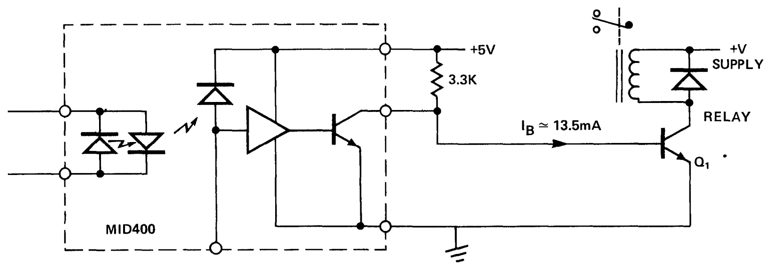
In this system it is quite feasible to get an erroneous apparent output from the MID400 if R_L is 1000 ohms, or less, and the 5V power supply in the monitor system presents a low impedance when OFF. The TTL input to the minicomputer might appear low due to current being forced through R_L and the low 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.

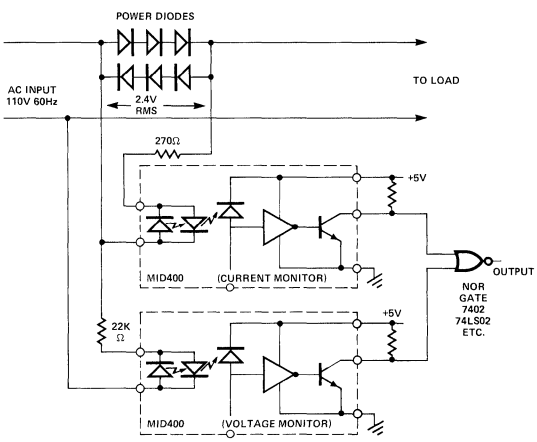
APPLICATION CIRCUITS

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.



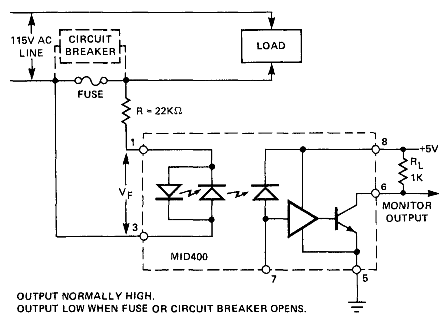
C1519

Fig. 23. Relay Interface Circuit



C1520

Fig. 24. AC Power Line Voltage and Current Monitor



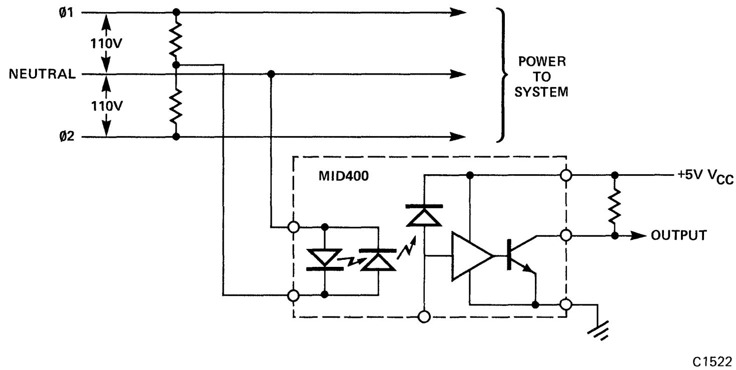
C1521

Fig. 25. Fuse or Circuit Breaker Monitor

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.

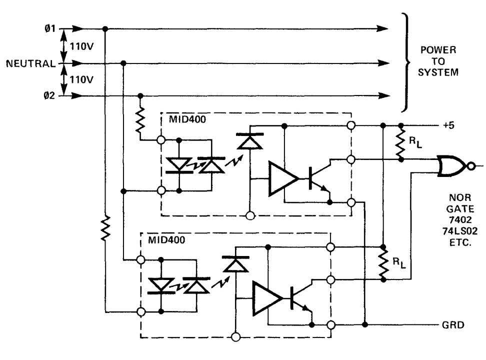
Figure 24 shows a circuit that uses two MID400s to monitor both voltage and current. When both voltage and current are being supplied to the load, the output of "NOR" gate is high. If load current drops due to either open circuit or failure, the output of "NOR" gate is low. If both voltage and current 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

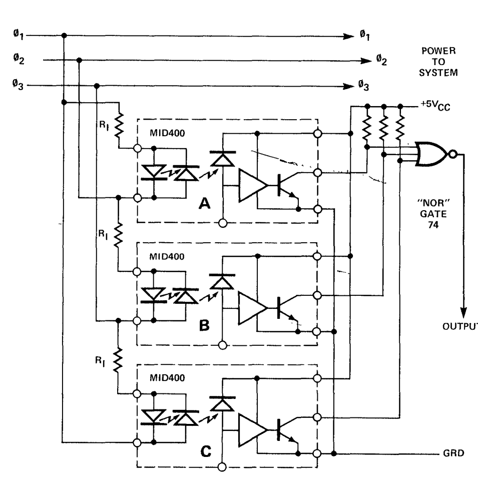


Fig. 28. Monitor Circuit for Three Phase Power Line

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.

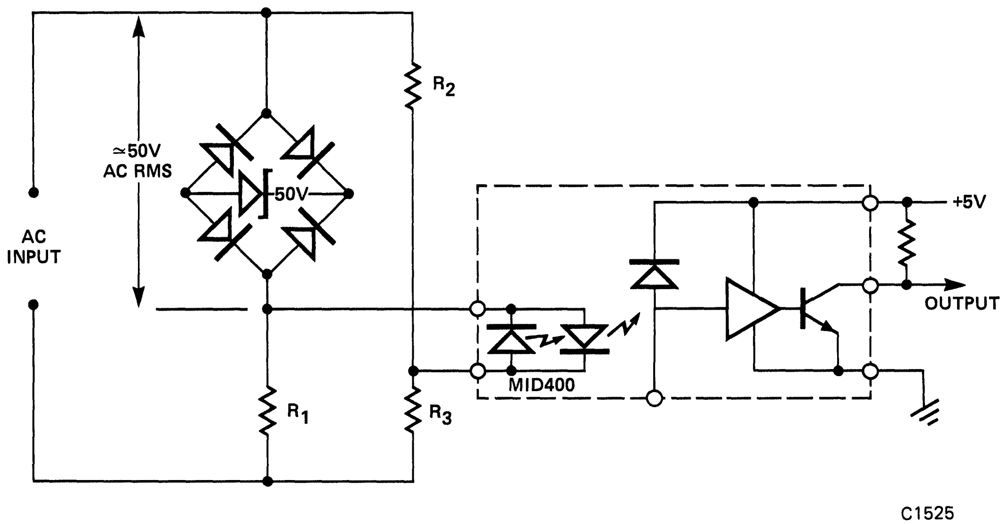


Fig. 29. AC Voltage Deviation Monitor

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.

Appendix 8

Cross Reference Index

Competitive Part Number	General Instrument Part Number
1351G	MAN3410A
1352G	MAN3420A
1353G	MAN3430A
1354G	MAN3440A
1361E	MAN3610A
1362E	MAN3620A
1363E	MAN3630A
1364E	MAN3640A
1371R	MAN71A
1372R	MAN72A
1373R	MAN73A
1374R	MAN74A
1381Y	MAN3810A
1382Y	MAN3820A
1383Y	MAN3830A
1384Y	MAN3840A
1451G	MAN4410A
1454G	MAN4440A
1455G	MAN4405A
1461E	MAN4610A
1464E	MAN4640A
1465E	MAN4605A
1471R	MAN4710A
1474R	MAN4740A
1475R	MAN4705A
1481Y	MAN4810A
1484Y	MAN4840A
1485Y	MAN4805A
1704R	MAN2A
1737R	MAN71A/72A
1738R	MAN74A
1787R	MAN6760
1788R	MAN6780
208G	MV5474C
209R	MV5075C
211G	MV5474C
212Y	MV5374C
216R	MV5774C
221RC	MV6053
222G	MV6050
224Y	MV6454A
228R	MV6353
229G	MV6753
229R	MV6454A
229Y	MV6754A
233G	MV6354A
233R	MV54643
233Y	MV57640
234G	MV53640
235R	MV64530
236R	MV6053
236RC	MV6050
237R	MV57640
2661E	MAN6610
2663E	MAN6630
2664E	MAN6640
2665E	MAN6650
2666E	MAN6660
2668E	MAN6680
2671R	MAN6710
2673R	MAN6730
2674R	MAN6740
2675R	MAN6750
2687R	MAN6760
2678R	MAN6780
3N243	MCT4
3N243R	MCT4R
4N25	4N25
4N26	4N26
4N27	4N27
4N28	4N28
4N29	4N29
4N30	4N30
4N31	4N31
4N32	4N32

Competitive Part Number	General Instrument Part Number
4N33	4N33
4N35	4N35
4N36	4N36
4N37	4N37
6N137	6N137
6N138	6N138
6N139	6N139
4300F-1	MV5075C
4300S1	MV57640
4301H1/5	MV5491
4303F1	MV5774C
4303F5	MV5474C
4303F7	MV5474C
4304H1	MV5374C
4304H5	MV6753
4304H-7	MV64530
430451	MV57152
430455	MV54152
430457	MV53152
4305H1	MV6752
4305H5	MV64520
4305H7	MV6352
5082-4100	MV54
5082-4101	MV54
5082-4150	MV53
5082-4160	MV55A
5082-4190	MV64
5082-4403	MV5054-1
5082-4415	MV5054-1
5082-4440	MV5054-1
5082-4444	MV5054-1
5082-4484	MV5075C
5082-4487	MV5077C
5082-4488	MV5077C
5082-4494	MV5075C
5082-4550	MV6353
5082-4555	MV6353
5082-4557	MV6352
5082-4558	MV6352
5082-4584	MV5374C
5082-4590	MV53154
5082-4592	MV53154
5082-4595	MV53152
5082-4597	MV53152
5082-4650	MV6753
5082-4655	MV6753
5082-4657	MV6752
5082-4658	MV6752
5082-4684	MV5774C
5082-4690	MV57154
5082-4692	MV57154
5082-4693	MV57154
5082-4694	MV57152
5082-4695	MV57152
5082-4790	MV50154
5082-4791	MV50154
5082-4850	MV5054-1
5082-4855	MV5054-1
5082-4880	MV5054-1
5082-4881	MV5054-1
5082-4882	MV5054-2
5082-4950	MV64530
5082-4957	MV6454A
5082-5958	MV6454A
5082-5990	MV54154
5082-7610	MAN3920A
5082-7611	MAN3910A
5082-7613	MAN3980A
5082-7620	MAN3820A
5082-7621	MAN3810A
5082-7623	MAN3880A
5082-7630	MAN3420A
5082-7631	MAN3410A
5082-7633	MAN3480A
5082-7730	MAN72A

Competitive Part Number	General Instrument Part Number
5082-7731	MAN71A
5082-7740	MAN78A
521-9175	MV64530
521-9176	MV5353
521-9179	MV5056
521-9185	MV50
521-9186	MV54
521-9189	MV5075C
521-9200	MV57154
521-9206	MV5474C
521-9207	MV5374C
521-9210	MV54643
521-9211	MV53641
521-9212	MV5054-1
521-9216	MV5075C
521-9217	MV6053
521-9224	MV64530
521-9225	MV6353
521-9240	MV6053
521-9242	MV5491
521-9246	MV6753
521-9247	MV6752
521-9248	MV6353
521-9249	MV6753
521-9250	MV64530
521-9251	MV64520
521-9253	MV54152
521-9254	MV53152
521-9256	MV6753
521-9257	MV6752
521-9258	MV6353
521-9259	MV6352
521-9260	MV64530
521-9261	MV6352
745-0005	MAN2A
745-0014	MAN71A
745-0014	MAN72A
745-0016	MAN74A
7610R	MAN3620A
7611R	MAN3810A
7620Y	MAN3820A
7621Y	MAN3810A
7630G	MAN3420A
7631G	MAN3410A
7730R	MAN72A
7731R	MAN71A
BPW13A	MTH360
BPW13B	MTH360
BPW13C	MTH360
BPW14A	MTH320
BPW14B	MTH320
BPW14C	MTH320
BPW40	MTK380
BPX38-1	MTH360
BPX38-2	MTH360
BPX38-3	MTH360
BPX38-4	MTH360
BPX43-1	MTH320
BPX43-2	MTH320
BPX43-3	MTH320
BPX43-4	MTH320
BPX99	MAH120
BPY62-1	MTH320
BPY62-2	MTH320
BPY62-3	MTH320
BP103-1	MTH360
BP103-2	MTH360
BP103-3	MTH360
BP103-4	MTH360
CL13	4N37
CL1510	4N37
CL1511	4N37
CMD50	MV50
CMD50152	MV50152
CMD50154	MV50154

Competitive Part Number	General Instrument Part Number
CMD5021	MV5021
CMD5022	MV5022
CMD5023	MV5023
CMD5024	MV5024
CMD5025	MV5025
CMD5026	MV5026
CMD5050	MV6050
CMD5051	MV6051
CMD5052	MV6052
CMD5053	MV6053
CMD5054A-1	MV6054A-1
CMD5054A-2	MV6054A-2
CMD5054A-3	MV6054A-3
CMD5055	MV6055
CMD5056	MV6056
CMD5074-C	MC5074C
CMD5075-C	MV5075C
CMD5077-C	MV5077C
CMD5094	MV5094
CD5152	MV6152
CMD5153	MV6153
CMD5154	MV6154A
CMD51640	MV51640
CMD51641	MV51641
CMD51642	MV51642
CMD5174-C	MV5174C
CMD5177-C	MV5177C
CMD52	MV64
CMD52124	MV54124
CMD52152	MV54152
CMD52154	MV54154
CMD52164	MV54164
CMD5254	MV6454A
CMD52640	MV54643
CMD52641	MV54643
CMD52642	MV54643
CMD52643	MV54643
CMD52644	MV54644
CMD5274-C	MV5474C
CMD5277-C	MV5477C
CMD53	MV53
CMD53124	MV53124
CMD53152	MV53152
CMD53154	MV53154
CMD53164	MV53164
CMD53173	MV53173
CMD5352	MV6352
CMD5353	MV6353
CMD5354	MV6354A
CMD53640	MV53640
CMD53641	MV53641
CMD53642	MV53642
CMD5374-C	MV5374C
CMD5377-C	MV5377C
CMD54	MV54
CMD5491	MV5491
CMD55-A	MV55A
CMD57124	MV57124
CMD57154	MV57154
CMD57164	MV57164
CMD57173	MV57173
CMD5752	MV6752
CMD5753	MV6753
CMD5754	MV6454A
CMD57640	MV57640
CMD57641	MV57641
CMD57642	MV57642
CMD5774-C	MV5774C
CMD5777-C	MV5777C
CMD64520	MV64520
CMD64530	MV64530
CMD64531	MV64531
CMD9150-1	MK9150-1
CMD9150-2	MK9150-2
CMD9350-1	MK9350-1

*Selected

Appendix

Competitive Part Number	General Instrument Part Number
CMD9350-2	MK9350-2
CNX35	CNX35
CNX36	CNX36
CNY17-1	CNY17-1
CNY17-2	CNY17-2
CNY17-3	CNY17-3
CNY17-4	CNY17-4
CNY17I	CNY17-1
CNY17II	CNY17-2
CNY17III	CNY17-3
CNY17IV	CNY17-4
CNY28	CNY37
CNY51	CNY17-3
CNY75A	CNY17-2
CNY75B	CNY17-3
CNY75C	CNY17-4
CQV11	MV57642
CQV13	MV53641
CQV13	MV53642
CQV15	MV54643
CQV15	MV54643
CQV15-6	MV54644
CQV20-3	MV6053
CQV20-4	MV6053
CQV21	MV6753
CQV23	MV6353
CQV25-3	MV64530
CQV25-6	MV64531
CQV51	MV6752
CQV51-H	MV6752
CQV53	MV6352
CQV55	MV64521
CQX13-1, 2	MV54154
CQX23-1, 2	MV57154
CQX33-2	MV53154
CQY99	MEK760
DL-10, A	MAN10A
DL-101, A	MAN1001A
DL-500	MAN6680
DL-507	MAN6760
DL-57	MAN2A
DL-524	MAN6750
DL-527	MAN6710
DL-528	MAN6740
DLO-524	MAN6950
DLO-527	MAN6910
DLO-528	MAN6940
DL-701	MAN73A
DL-704	MAN74A
DL-707	MAN72A
DL-707R	MAN71A
DL-727	MAN6710
DL-728	MAN6740
DL7651	MAN4610A
DL7751-S	MAN4710A
FLV110	FLV110
FLV111	FLV111
FLV112	FLV112
FLV113	FLV113
FLV150	MV6053
FLV160	MV6053
FLV251	MV6752
FLV252	MV6752
FLV310	FLV310
FLV340	MV54154
FLV350	MV64530
FLV360	MV64530
FLV410	FLV410
FLV440	MV53154
FLV450	MV64530
FLV460	MV64530
FLV510	FLV510
FLV540	MV57154
FLV550	MV6753
FLV560	MV6753

*Selected

Competitive Part Number	General Instrument Part Number
FND330	FND330
FND337	FND337
FND338	FND338
FND350	FND350
FND357	FND357
FND358	FND358
FND360	FND360
FND367	FND367
FND368	FND368
FND500	MAN6780
FND507	MAN6760
FND560	MAN6980
FND5-7	MAN6960
FND800	MAN8940
FND807	MAN8910
FND847	MAN8910
FND850	MAN8940
FPT500	MT2*
FSC825B	MCT270
F5E1	MEH580
F5E2	MEH580
F5E3	MEH580
F5F1	MES760
GBG1000	MV54164
GE3009	MCP3009
GE3010	MCP3010
GE3011	MCP3011/3011A
GE3012	MCP3012
GE3020	MCP3020
GE3021	MCP3021
GE3022	MCP3022/3022A
GE3023	MCP3023
GFH600I	CNY17-2
GFH600II	CNY17-3
GFH600III	CNY17-4
GL4484	MV5474C
GL4850	MV64530
GL4950	MV64530
GL56	MV64
H11A1	H11A1
H11A2	H11A2
H11A3	H11A3
H11A4	MCT2
H11A5	MCT2
H11A520	MCT2250
H11A550	MCT2201
H11A5100	MCT2201
H11B1	H11B1
H11B2	H11B2
H11B255	MCA255
H11B3	H11B3
H11C1	MCS21
H11C2	MCS21
H11C3	MCS2
H11C4	MCS2401
H11C5	MCS2401
H11C6	MCS2400
H11D1	H11D1
H11D2	H11D2
H11D3	H11D3
H11D4	H11D4
H11G1	MCA11G1
H11G2	MCA11G2
H11J1	MCP3011
H11J2	MCP3010
H11J3	MCP3011
H11J4	MCP3010
H11J5	MCP3009
H13A1	MST8/CNY37
H13A2	MST81/CNY37
H13B1	MSA8
H13B2	MSA81
H20A1	MSA81
H20A1	CNY36
H20A2	CNY36

Competitive Part Number	General Instrument Part Number
HCPL2601	MCL2601
HCPL2630	HCPL2630
HCPL2630	MCL2630
HCPL2631	MCL2630
HD1131G	MAN6460
HD1133G	MAN6480
HD1131O	MAN6960
HD1133O	MAN6980
HD1131R	MAN6760
HD1133R	MAN6780
HD1131Y	MAN6860
HD1133Y	MAN6880
HDSP-3401	MAN8910
HDSP-3403	MAN8940
HDSP-3530	MAN3920A
HDSP-3531	MAN3910A
HDSP-3533	MAN3980A
HDSP-3600	MAN3420A
HDSP-3601	MAN3410A
HDSP-3603	MAN3480A
HDSP-3901	MAN8910
HDSP-3903	MAN8940
HDSP-4030	MAN3810A
HDSP-4031	MAN3810A
HDSP-4033	MAN3880A
HDSP-4201	MAN8810
HDSP-4203	MAN8840
HDSP-4830	MV57164
HDSP-4840	MV53164
HDSP-4850	MV54164
HDSP-5301	MAN6760
HDSP-5303	MAN6780
HDSP-5321	MAN6710
HDSP-5323	MAN6740
HDSP-5501	MAN6960
HDSP-5503	MAN6980
HDSP-5521	MAN6910
HDSP-5523	MAN6940
HDSP-5531	MAN6960
HDSP-5533	MAN6980
HDSP-5601	MAN6460
HDSP-5603	MAN6480
HDSP-5621	MAN6410
HDSP-5623	MAN6440
HDSP-5701	MAN6860
HDSP-5703	MAN6880
HDSP-5721	MAN6810
HDSP-5723	MAN6840
HDSP-5731	MAN6860
HDSP-5733	MAN6880
HDSP-5801	MAN6460
HDSP-5803	MAN6480
HLMP-0101	MV5054-1
HLMP-0102	MV5054-1
HLMP-0140	MV5054-1
HLMP-0200	MV5054-1
HLMP-0202	MV5054-2
HLMP-0222	MV6050
HLMP-0222	MV6052
HLMP-0242	MV6051
HLMP-1002	MV5075C
HLMP-1200	MV5077C
HLMP-1201	MV5077C
HLMP-1300	HLMP-1300
HLMP-1300	MV57640
HLMP-1301	HLMP-1301
HLMP-1301	MV57641
HLMP-1302	HLMP-1302
HLMP-1302	MV57642
HLMP-1320	HLMP-1320
HLMP-1320	MV5760
HLMP-1321	HLMP-1321
HLMP-1340	HLMP-1340
HLMP-1321	MV57622
HLMP-1400	HLMP-1400

Competitive Part Number	General Instrument Part Number
HLMP-1400	MV58640
HLMP-1401	HLMP-1401
HLMP-1401	MV58641
HLMP-1402	HLMP-1402
HLMP-1402	MV58642
HLMP-1403	HLMP-1403
HLMP-1420	HLMP-1420
HLMP-1420	MV5360
HLMP-1421	HLMP-1421
HLMP-1440	HLMP-1440
HLMP-1500	MV54643
HLMP-1501	MV54643
HLMP-1503	HLMP-1503
HLMP-1503	MV55643
HLMP-1520	HLMP-1520
HLMP-1520	MV5460
HLMP-1521	HLMP-1521
HLMP-1523	HLMP-1523
HLMP-1523	MV54644
HLMP-1540	HLMP-1540
HLMP-1700	HLMP-1700
HLMP-1719	HLMP-1719
HLMP-3000	MV5053
HLMP-3001	MV5054A-1
HLMP-3200	MV50154
HLMP-3201	MV50154
HLMP-3300	HLMP-3300
HLMP-3301	HLMP-3301
HLMP-3315	HLMP-3315
HLMP-3316	HLMP-3316
HLMP-3350	MV57154
HLMP-3351	MV57154
HLMP-3365	MV57152
HLMP-3366	MV57152
HLMP-3400	HLMP3400
HLMP-3401	HLMP3401
HLMP-3415	HLMP3415
HLMP-3416	HLMP3416
HLMP-3465	MV53152
HLMP-3466	MV53152
HLMP-3502	HLMP3502
HLMP-3507	HLMP3507
HLMP-3517	HLMP3517
HLMP-3519	HLMP3519
HLMP-3750	HLMP-3750
HLMP-3850	HLMP-3850
HLMP-3950	HLMP-3950
HLMP-4600	HLMP4600
HLMP-4601	HLMP4601
HLMP-4700	HLMP-4700
HLMP-4719	HLMP-4719
HLMP-6000	MV54
HLMP-6001	MV54
HLMP-6300	MV55A
HLMP-6400	MV53
HLMP-6500	MV64
IL1	MCT2
IL1	MCT2E
IL5	MCT270
IL12	MCT2
IL15	MCT26
IL100	MCL2601*
IL101	MCL2601*
IL201	MCT272
IL202	MCT273
IL203	MCT274
IL501	MCT2200
IL505	MCT2201
IL512	MCT2200
IL530	MCA2230
IL555	MCA2255
ILA30	MCA230
ILA50	MCA255
ILA55	MCA255
ILA230	MCA230

Competitive Part Number	General Instrument Part Number
ILA255	MCA255
ILCA2-30	MCA230
ILCA2-55	MCA255
ILCT6	MCT6
ILD-1	MCT6
ILD74	MCT66
IRL60	MEM740
K5200	MTH360
K5201	MTH360
K5202	MTH360
K5203	MTH361
K5210	MTH360
K5211	MTH361
K5250	MTH320
K5251	MTH320
K5253	MTH320
K5255	MTH320
K5256	MTH320
K5257	MTH321
K5258	MTH321
K5551	MTS461
K5552	MTS461
K5553	MTS361
K5554	MTS361
K6300	MEH560
K6301	MEH560
K6302	MEH560
K6304	MEH560
K6350	MEH520
K6351	MEH520
K6352	MEH520
K6354	MEH520
K6500	MEK730
K6501	MEK730
K6502	MEK730
K6503	MEK730
K6504	MEK730
K6505	MEK730
K6550	MES760
K6551	MES760
K6552	MES760
K6553	MES760
K6554	MES760
K6555	MES760
L14F1	MAH120
L14F2	MAH120
L14G1	MTH320
L14G2	MTH320
L14G3	MTH320
L14Q1	MTS360
LD271	MEK760*
LD271H	MEK760*
LD271A	MEK760
LD30-A	MV57640
LD30-1	MV5075B
LD30-2	MV57642
LD30-3	MV57642
LD32-1	MV57641
LD32-2	MV57642
LD36-A	MV53640
LD36-1	MV53640
LD36-2	MV53641
LD36-C	MV53642
LD37-A	MV54643
LD37-1	MV54643
LD37-2	MV54644
LD41-A	MV6053
LD41-1	MV6053
LD50-A	MV5054-1
LD50-1	MV5054-2
LD50-2	MV6054-3
LD52-C	MV6752
LD52-CA	MV6752
LD52-1	MV6753
LD52-2	MV6753

*Selected

Competitive Part Number	General Instrument Part Number
LD56-A	MV6353
LD56-C	MV6353
LD56-CA	MV6352
LD56-1	MV6353
LD56-2	MV6353
LD56-C	MV6752
LD56-CA	MV6352
LD57-A	MV64530
LD57-CA	MV64521
LD57-1	MV64530
LD57-2	MV64530
LD57-C	MV6752
LD57-CA	MV64520
LSL 3L-50	MV6055
LSL 6L	MV6053
LSL 6L-A	MV6753
LSL 6L-50	MV6053
LSL 8L	MV6752
LSL 16L	MV64530
LSL 18L	MV64520
LSL 26L	MV6353
LSL 28L	MV6352
LSM 3L	MV6055
LSM 6L	MV6053
LSM 6L-A	MV6753
LSM 8L	MV6752
LSM 16L	MV64530
LSM 18L	MV64520
LSM 26L	MV6353
LSM 28L	MV6352
MLED71	MES760
MOC1005	MCT2200
MOC1006	MCT2200
MOC3002	MCS2400
MOC3003	MCS21
MOC3009	MCP3009
MOC3010	MCP3010
MOC3011	MCP3011
MOC3020	MCP3020
MOC3021	MCP3021
MOC3022	MCP3022
MOC3030	MCP3030
MOC3031	MCP3031
MOC3040	MCP3040
MOC3041	MCP3041
MOC8020	MCA11G2
MOC8050	MCA11G2
MRD701	MTS360
MRD3050	MTH320
MRD3051	MTH320
MRD3054	MTH320
MRD3055	MTH320
MRD3056	MTH320
NSB373	MAN74A
NSB374	MAN72A
NSB381	MAN74A
NSB382	MAN72A
NSB3881	MMN39440
NSB3882	MMN39240
NSL5020	MV5020
NSL5022	MV5022
NSL5023	MV5023
NSL5024	MV5024
NSL5026	MV5026
NSL5027	MV6054A-2
NSL5027	MV5024
NSL5050	MV5024
NSL5052	MV6052
NSL5053	MV6053
NSL5056	MV6056
NSL5057	MV5054-1
NSL5058	MV6753
NSL5076	MV5177C
NSL5076A	MV5074C
NSL5080	MV5074C

Competitive Part Number	General Instrument Part Number
NSL5086	MV5774C
NSL5252	MV64520
NSL5253	MV64530
NSL5274	MV5377C
NSL5352	MV6352
NSL5353	MV6353
NSN61L	MAN8610
NSN64R	MAN8640
NSN71L	MAN72A
NSN71R	MAN71A
NSN74R	MAN74A
NSN583	MMN59320
OBG1000	MV57164
OP130	MEH520
OP131	MEH520
OP132	MEH520
OP133	MEH520
OP130W	MEH580
OP131W	MEH580
OP132W	MEH580
OP133W	MEH580
OP140SL	MES760
OP140SLA	MES760*
OP140SLB	MES760*
OP140SLC	MES760
OP140SLD	MES760
OP161SL	MEL760*
OP161SLA	MEL760*
OP161SLB	MEL760*
OP161SLC	MEL760
OP161SLD	MEL760
OP211	MV5474C
OP230W	MEH560
OP231W	MEH560
OP232W	MEH560
OP233W	MEH560
OP240	MES560
OP240SLA	MES560
OP240SLB	MES560
OP240SLC	MES560
OP508F	MTS360
OP550	MTS360
OP550SLA	MTS461
OP550SLB	MTS461
OP550SLC	MTS461
OP550SLD	MTS461
OP800	MTH320
OP801	MTH320
OP802	MTH320
OP803	MTH320
OP804	MTH320
OP805	MTH321
OP841	MTH320
OP842	MTH320
OP845	MTH320
OP800W	MTH360
OP801W	MTH360
OP802W	MTH460
OP841W	MTH360
OP842W	MTH360
OP843W	MTH460
OP844W	MTH460
OP845W	MTH460
OPB711	MSA7
OPB77	MSA7
OPB819S3	CNY37
OPB819S10	CNY37
OPI-140	MCT4
OP12100	MCT210
OPI2150	MCT26
OPI2151	MCT2
OPI2152	MCT2
OPI2153	MCT272
OPI2154	MCT5210
OPI2155	MCT5210

Competitive Part Number	General Instrument Part Number
OPI2250	MCT2
OPI2251	MCT2
OPI2252	MCT2
OPI2253	MCT272
OPI2254	MCT5210
OPI2555	MCT5210
OPI3009	MCP3004
OPI3010	MCP3010
OPI3011	MCP3011
OPI3012	MCP3012
OPI3020	MCP3020
OPI3021	MCP3021
OPI3022	MCP3022
OPI3023	MCP3023
OPI3032	MCP3032
OPI3033	MCP3033
OPI3042	MCP3042
OPI3043	MCP3043
OPI3150	MCA231
OPI3151	MCA231
OPI3152	MCA231
OPI3153	MCA231*
OPI3250	MCA2231
OPI3251	MCA2231
OPI3252	MCA2231
OPI3253	MCA2231*
OPI6100	H11D1
OPL209A	MV5075C
OPL212	MV5374C
OPL260	MV5174C
RLT-1	MV5075C
RL2	MV6056
RL20	MV6053
RL20-02	MV6052
RL20-03	MV6051
RL20-04	MV6050
RL20-04	MV5020
RL2000	MV5054-1
RL209	MV5075C
RL21	MV5024
RL21	MV5025
RL21	MV5026
RL4403	MV5054-1
RL4415	MV5054-1
RL4480	MV57640
RL4480-1	MV57640
RL4480-2	MV57641
RL4480-5	MV57640
RL4484	MV5074C
RL4850	MV5054-1
RL50	MV50
RL5053	MV6053
RL5053-1	MV6053
RL5053-2	MV6053
RL5053-3	MV6753
RL5054-1	MV5054-1
RL5054-2	MV5054-2
RL54	MV54
RL55	MV55A
RL55-5	MV55A
SD3440-1	MTH360
SD3440-2	MTH360
SD3440-3	MTH460
SD3440-4	MTH460
SD3440-5	MTH460
SD3443-1	MTH360
SD3443-2	MTH360
SD3443-3	MTH361
SD5443-1	MTH320
SD5443-2	MTH320
SD5443-3	MTH321
SD5443-4	MTH321
SD8403-1	MTK380
SD8403-2	MTK381
SD8403-3	MTK381

Competitive Part Number	General Instrument Part Number
SD8403-4	MTK480
SD8406-1	MTS360
SD8406-2	MTS361
SD8406-3	MTH460
SD8406-4	MTH461
SE3470-1	MEH580*
SE3470-2	MEH580*
SE3470-3	MEH580*
SE3470-4	MEH580*
SE5470-1	MEH520*
SE5470-2	MEH520*
SE5470-3	MEH520*
SE5470-4	MEH520*
SEP8503-1	MEK760
SEP8503-2	MEK760
SEP8503-3	MEK760
SEP8503-4	MEK760
SEP8505-1	MEL760
SEP8505-2	MEL760
SEP8505-3	MEL760*
SEP8505-4	MEL760*
SEP8506-1	MES760
SEP8506-2	MES760
SEP8506-3	MES760
SEP8506-4	MES760
SEP8703-1	MEK560
SEP8703-2	MEK560
SEP8703-3	MEK560*
SEP8703-4	MEK560*
SFH409	MEL760
SFH600-0	CNY17-1
SFH600-1	CNY17-2
SFH600-2	CNY17-3
SFH600-3	CNY17-4
SFH601-1	CNY17-1
SFH601-2	CNY17-2
SFH601-3	CNY17-3
SFH601-4	CNY17-4
SPT1873	MCT8
TIL38	MEK760
TIL40	MES760
TIL81	MTH320
TIL99	MTH360
TIL111	TIL111
TIL112	TIL112
TIL113	TIL113
TIL114	TIL114
TIL115	TIL115
TIL116	TIL116
TIL117	TIL117
TIL118	TIL118
TIL119	TIL119
TIL120	MCT4
TIL124	MCT276
TIL126	MCT271
TIL126	MCT272
TIL143	MST8
TIL144	MST8
TIL145	MSA8
TIL146	MSA8
TIL149	MSA7
TIL155	MCT270
TIL209A	MV5075C
TIL211	MV5474C
TIL211	MV54643
TIL212-1	MV5174C
TIL212-1	MV5374C
TIL212-2	MV5374C
TIL213	MV53640
TIL216-1	MV5774C
TIL216-2	MV5774C
TIL220	MV6054A-1
TIL221	MV6050
TIL224	MV6354A
TIL228	MV6754A
TIL231-1	MV6052
TIL232	MV5474C
TIL234	MV6454A
TIL240	MV6353
TIL241	MV6753
TIL242	MV64530
TIL242-1	MV64530
TIL242-2	MV64531
TIL303	MAN10A
TIL304	MAN1001A
TIL305	MAN2A
TIL312	MAN71A
TIL312	MAN72A
TIL314	MAN3410A
TIL314	MAN3420A
TIL316	MAN3810A
TIL316	MAN3820A
TIL317	MAN3840A
TIL321	MAN6760
TIL322	MAN6780
TIL325	MAN6860
TIL326	MAN6880
TIL392	MAN10A
TIL411	MTS360
TIL415	MTS360
TIL903-1	MEH520
TIL903-2	MEH520
TIL904-1	MEH520
TIL904-2	MEH520
TIL905-1	MEH560
TIL905-2	MEH560
TIL906-1	MEH530
TIL906-2	MEH530
TLN101	MEH520
TLN104	MEM740
TLN105A	MEK760
TLN107	MES760
TLN108	MEH520
TLN109	MEL760
TLN110	MEK730
TLR303	MAN72A
TPS604	MTH320
TPS606	MTM340
TPS607	MTS360
VTT1010	MTH360
VTT1011	MTH360
VTT1012	MTH360
VTT1013	MTH460
VTT1020	MTH360
VTT1021	MTH360
VTT1022	MTH360
VTT1023	MTH360
VTT1031	MTH360
VTT1032	MTH461
VTT1033	MTH461
VTT1110	MTH320
VTT1111	MTH320
VTT1112	MTH320
VTT1120	MTH320
VTT1121	MTH320
VTT1122	MTH320
VTT1123	MTH320
VTT1131	MTH320
VTT1132	MTH320
XC209	MV5075C
XC209A	MV5174C
XC209G	MV5474C
XC209Y	MV5374C
XC209-02	MV5074C
XC446G-2	MV6454A
XC446Y-2	MV6354A
XC554A-2	MV6154A
XC554G-2	MV6454A
XC554Y-2	MV6354
XC554-6	MV6752
XC554A-6	MV6152
XC554G-6	MV64530
XC554Y-6	MV6352
XC554-9	MV6752
XC556	MV5054-1
XC556-2	MV5054-2
XC556-3	MV5054-3
XC556A-2	MV6154A
XC800W	MTH360
XC801W	MTH360
XC802W	MTH460
XC5025	MV5025
XC5053	MV6053
XC5053A	MV6153
XC5053G	MV64530
XC5055	MV6055
XL56	MV5054-3
XL56	MV5374C
YBG1000	MV53164
YL212	MV5374C
YL56	MV53
YL4484	MV53640
YL4484	MV5374C
YL4550	MV6353
YL4850	MV6353

*Selected

North American Technical Representatives

ARKANSAS
Beacon Electronic Associates
Little Rock (501) 224-5449

ALABAMA
Beacon Electronic Associates
Huntsville (205) 881-5031

ARIZONA
Thom Luke Sales, Inc.
Scottsdale (602) 941-1901

CALIFORNIA
Ewing-Foley, Inc.
Los Altos (415) 941-4525

Landa/Minyard, Inc.
Los Angeles (213) 879-0770

Harvey King, Inc.
San Diego (619) 587-9300

COLORADO
D/Z Associates, Inc.
Denver (303) 443-4388

CONNECTICUT
Scientific Components, Inc.
Cheshire (203) 272-2963

DELAWARE
Beacon North, Inc.
(800) 336-3747

FLORIDA
Beacon Electronic Associates
Clearwater (813) 796-2378

Beacon Electronic Associates
Boca Raton (305) 392-3500

Beacon Electronic Associates
Maitland (305) 647-3498

Beacon Electronic Associates
Melbourne (305) 724-8010

GEORGIA
Beacon Electronic Associates
Atlanta (404) 256-9640

ILLINOIS
Sumer, Inc.
Rolling Meadows (312) 991-8500

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

LOUISIANA
Beacon Electronics Associates
Huntsville (205) 881-5031

MARYLAND
Beacon North, Inc.
Randallstown (800) 336-3747

MASSACHUSETTS
Kanan Associates
Needham Heights (617) 449-7400

MICHIGAN
Rathsburg Associates, Inc.
Detroit (313) 882-1717

MINNESOTA
Mel Foster Technical Sales, Inc.
Edina (612) 941-9790

MISSISSIPPI
Beacon Electronics Associates
Huntsville (205) 881-5031

MISSOURI
Lorenz Sales
Bridgeton (314) 298-8585

NEBRASKA
Lorenz Sales
Lincoln (402) 475-4660

NEW MEXICO
SynTech
Albuquerque (505) 266-7951

NEW YORK
Bob Dean, Inc.
Ithaca (607) 257-1111

Comtronic Associates
Melville (516) 249-0505

NORTH CAROLINA
Beacon Electronic Associates
Raleigh (919) 787-0330

OHIO
Midwest Marketing
Chagrin Falls (216) 247-6655

Midwest Marketing
Dayton (513) 433-2511

OKLAHOMA
Southern States Marketing, Inc.
Richardson (214) 238-7500

OREGON
Western Technical Sales
Hillsboro (503) 640-4621

PENNSYLVANIA
CMS Marketing
Glenside (215) 885-5106

Russell F. Clark Co., Inc.
Pittsburgh (412) 242-9500

PUERTO RICO
Beacon Electronics Associates
San Turce (809) 728-5040

SOUTH CAROLINA
Beacon Electronics Associates
Raleigh (919) 787-0330

TENNESSEE
Beacon Electronics Associates
Atlanta (404) 256-9640

TEXAS
Southern States Marketing, Inc.
Austin (512) 452-9459

Southern States Marketing, Inc.
Houston (713) 558-4900

Southern States Marketing, Inc.
Richardson (214) 238-7500

UTAH
D/Z Associates, Inc.
Salt Lake City (801) 483-1025

VIRGINIA
Beacon North, Inc.
Fairfax (703) 591-1300

WASHINGTON
Western Technical Sales
Bellevue (206) 641-3900

Western Technical Sales
Spokane (509) 922-7600

WEST VIRGINIA
Beacon North, Inc.
(800) 336-3747

WISCONSIN
Sumer, Inc.
Brookfield (414) 784-6641

CANADA
DaveTek Marketing
Vancouver, B.C. (604) 430-3680

Vitel Electronics
Toronto, Ont. (416) 676-9720

Vitel Electronics
Ottawa, Ont. (613) 592-0090

Vitel Electronics
Montreal, Que. (514) 331-7393

North American Franchised Distributors

ALABAMA
Arrow Electronics
Huntsville (205) 837-6955
Hamilton/Avnet
Huntsville (205) 837-7210
Kierulff Electronics
Huntsville (205) 883-6070
Schweber Electronics
Huntsville (205) 882-2200

ARIZONA
Arrow Electronics
Tempe (602) 968-4800
Hamilton/Avnet
Tempe (602) 231-5100
Kierulff Electronics
Phoenix (602) 243-4101
Wyle Laboratories Electronics Marketing Group
Phoenix (602) 866-2888

CALIFORNIA
Arrow Electronics
Chatsworth (818) 701-7500
Hayward (415) 487-4600
Sunnyvale (408) 745-6600
San Diego (619) 565-4800
Tustin (714) 838-5422
Avnet Electronics
Costa Mesa (714) 754-6111
Chatsworth (818) 700-2600
Hamilton/Avnet
Ontario (714) 989-4602
Sacramento (916) 925-2216
San Diego (619) 571-7510
Sunnyvale (408) 743-3355
Hamilton Electro-Sales
Chatsworth (818) 700-6500
Costa Mesa (714) 641-4100
Culver City (213) 558-2121
Kierulff Electronics
Los Angeles (213) 725-2325
San Jose (408) 971-2600
San Diego (619) 278-2112
Tustin (714) 731-5711
Wyle Laboratories Electronics Marketing Group
Calabassas (818) 880-9001
El Segundo (213) 322-8100
Irvine (714) 863-9953
San Diego (619) 565-9171
Santa Clara (408) 727-2500

COLORADO
Arrow Electronics
Denver (303) 696-1111
Hamilton/Avnet
Denver (303) 740-1000
Kierulff Electronics
Englewood (303) 790-4444
Wyle Laboratories Electronics Marketing Group
Denver (303) 457-9953

CONNECTICUT
Arrow Electronics
Wallingford (203) 265-7741
Hamilton/Avnet
Danbury (203) 797-2800
J.V. Electronics
East Haven (203) 469-2321
Kierulff Electronics
Wallingford (203) 265-1115
Schweber Electronics
Danbury (203) 748-7080

FLORIDA
Arrow Electronics
Ft. Lauderdale (305) 776-7790
Palm Bay (305) 725-1480
Hamilton/Avnet
Ft. Lauderdale (305) 971-2900
St. Petersburg (813) 576-3930
Orlando (305) 628-3888
Hammond Electronics, Inc.
Ft. Lauderdale (305) 973-7103
Orlando (305) 849-6060
Kierulff Electronics
Ft. Lauderdale (305) 486-4004
St. Petersburg (813) 576-1966
Schweber Electronics
Hollywood (305) 927-0511

GEORGIA
Arrow Electronics
Atlanta (404) 449-8252
Hamilton/Avnet
Atlanta (404) 447-7507
Kierulff Electronics
Atlanta (404) 447-5252
Schweber Electronics
Atlanta (404) 449-9170

ILLINOIS
Arrow Electronics
Schaumburg (312) 397-3440
Hamilton/Avnet
Chicago (312) 860-7780
Kierulff Electronics
Itasca (312) 250-0500
Newark Electronics
Chicago (312) 784-5100
Schweber Electronics
Elk Grove (312) 364-3750

INDIANA
Arrow Electronics
Indianapolis (317) 243-9353
Graham Electronics
Ft. Wayne (219) 423-3422
Indianapolis (317) 634-8202
Hamilton/Avnet
Indianapolis (317) 844-9333

IOWA
Arrow Electronics
Cedar Rapids (319) 395-7230
Schweber Electronics
Cedar Rapids (319) 373-1417

KANSAS
Hamilton/Avnet
Kansas City (913) 888-8900

MARYLAND
Arrow Electronics
Baltimore (301) 995-0003
Hamilton/Avnet
Baltimore (301) 995-3500
Kierulff Electronics
Baltimore (301) 636-5800
Schweber Electronics
Gaithersburg (301) 840-5900

MASSACHUSETTS
Arrow Electronics
Woburn (617) 933-8130
Hamilton/Avnet
Peabody (617) 532-3701
Kierulff Electronics
Billerica (617) 667-8331
Schweber Electronics
Bedford (617) 275-5100

MICHIGAN
Arrow Electronics
Detroit (313) 971-8220
Hamilton/Avnet
Detroit (313) 522-4700
Grand Rapids (616) 243-8805
Schweber Electronics
Livonia (313) 525-8100

MINNESOTA
Arrow Electronics
Edina (612) 830-1800
Hamilton/Avnet
Minneapolis (612) 932-0600
Kierulff Electronics
Edina (612) 941-7500
Schweber Electronics
Edina (612) 941-5280

MISSOURI
Arrow Electronics
St. Louis (314) 567-6888
Hamilton/Avnet
St. Louis (314) 344-1200
Kierulff Electronics
Maryland Heights (314) 739-0855

NEW HAMPSHIRE
Arrow Electronics
Manchester (603) 668-6968

NEW JERSEY
Arrow Electronics
Fairfield (201) 575-5300
Marlton (609) 596-8000
Hamilton/Avnet
Cherry Hill (609) 424-0100
Fairfield (201) 575-3490
Kierulff Electronics
Fairfield (201) 575-6750
Schweber Electronics
Fairfield (201) 227-7880

NEW MEXICO
Arrow Electronics
Albuquerque (505) 243-4566
Hamilton/Avnet
Albuquerque (505) 765-1500

NEW YORK
Arrow Electronics
Hauppauge (516) 231-1000
Rochester (716) 427-0300
Syracuse (315) 652-1000
Hamilton/Avnet
Hauppage (516) 231-9800
Rochester (716) 475-9130
Syracuse (315) 437-6602
Milgray Electronics, Inc.
Farmingdale (516) 420-9800
Schweber Electronics
Rochester (716) 424-2222
Westbury (516) 334-7474
Summit Distributors, Inc.
Buffalo (716) 884-3450

NORTH CAROLINA
Arrow Electronics
Raleigh (919) 876-3132
Winston-Salem (919) 725-8711
Hamilton/Avnet
Raleigh (919) 878-0819
Hammond Electronics, Inc.
Greensboro (919) 275-6391
Kierulff Electronics
Raleigh (919) 872-8410
Schweber Electronics
Raleigh (919) 876-0000

OHIO
Arrow Electronics
Cleveland (216) 248-3990
Dayton (513) 435-5563
CAM/RPC Electronics
Cleveland (216) 461-4700
Hamilton/Avnet
Cleveland (216) 831-3500
Columbus (614) 436-5851
Dayton (513) 433-0610
Kierulff Electronics
Cleveland (216) 587-6558
Schweber Electronics
Beachwood (216) 464-2970

OKLAHOMA
Arrow Electronics
Tulsa (918) 665-7700
Kierulff Electronics
Tulsa (918) 252-7537
Schweber Electronics
Tulsa (205) 882-2200

OREGON
Arrow Electronics
Portland (503) 684-1690
Hamilton/Avnet
Lake Oswego (503) 635-7850
Kierulff Electronics
Portland (503) 641-9150
Wyle Laboratories
Electronics Marketing Group
Portland (503) 640-6000

PENNSYLVANIA
Arrow Electronics
Philadelphia (215) 928-1800
Pittsburgh (412) 856-7000
CAM/RPC Electronics
Pittsburgh (412) 782-3770
Hamilton/Avnet
Pittsburgh (800) 258-3848
Schweber Electronics
Horsham (215) 441-0600
Pittsburgh (412) 782-1600

SOUTH CAROLINA
Hammond Electronics, Inc.
Greenville (803) 233-4121

TENNESSEE
Hammond Electronics
(800) 334-0267

TEXAS
Arrow Electronics
Austin (512) 835-4180
Dallas (214) 386-7500
Houston (713) 530-4700
Hamilton/Avnet
Austin (512) 837-8911
Dallas (214) 659-4111
Houston (713) 780-1771
Harrison Equip. Co., Inc.
Stafford (713) 879-2600
Kierulff Electronics
Austin (512) 835-2090
Dallas (214) 343-2400
Houston (713) 530-7030
Schweber Electronics
Austin (512) 458-8253
Dallas (214) 661-5010
Houston (713) 784-3600
Wyle Labratories
Austin (512) 834-9957
Dallas (214) 235-9953
Houston (713) 879-9953

UTAH
Arrow Electronics
Salt Lake City (801) 972-0404
Hamilton/Avnet
Salt Lake City (801) 972-2800
Kierulff Electronics
Salt Lake City (801) 973-6913
Wyle Laboratories
Electronics Marketing Group
Salt Lake City (801) 974-9953

WASHINGTON
Arrow Electronics
Bellevue (206) 643-4800
Hamilton/Avnet
Seattle (206) 643-3950
Kierulff Electronics
Tukwila (206) 575-4420
Wyle Laboratories
Electronics Marketing Group
Seattle (206) 453-8300

WISCONSIN
Arrow Electronics
Brookfield (414) 792-0150
Hamilton/Avnet
New Berlin (414) 784-4510
Kierulff Electronics
Waukesha (414) 784-8160
Schweber Electronics
Brookfield (414) 784-9020

CANADA
Arrow Electronics
Calgary (403) 246-1980
Montreal (514) 735-5511
Ottawa (613) 226-6903
Quebec (418) 687-4231
Toronto (416) 661-0220
Cardinal Electronics
Edmonton (403) 483-6266
Future Electronics, Inc.
Calgary (403) 259-6408
Montreal (514) 694-7710
Ottawa (613) 820-9471
Toronto (416) 638-4771
Vancouver (604) 438-5545
Hamilton/Avnet
Calgary (403) 230-3586
Montreal (514) 331-6443
Ottawa (613) 226-1700
Toronto (416) 677-7432
R.A.E. Electronics
Vancouver (604) 291-8866
Edmonton (403) 451-4001

International Stocking Distributors and Technical Representatives

EUROPE

AUSTRIA
Storchengasse 1/1/1
1150 Wien
Tel. 85.86.46
TELEX - 0135701

Omni Ray GesmbH
Vertriebsbuero Wien
Prinz Eugen-Strasse 36
1040 Wien
Tel. 0222/65.64.31
TELEX - 132712

BELGIUM-LUXEMBOURG
N.V. Telerex
Kouwenbergdreef 6
2230 Schilde
Tel. 03/383/33.50
TELEX - 33511

DENMARK
Nordisk Elektronik AS
Transformervej 17
2730 Herlev
Tel. 02/842000
TELEX - 35200

FINLAND
Oy Fintronic AB
Melkonkatu 24A
00210 Helsinki 21
Tel. 0-692 6022
TELEX - 124224

FRANCE
Direct
151/153 Rue de Constantine
76201 Rouen
Tel. 35/98.40.48
TELEX - 770842

Groupement Electronique de Distribution
352 Avenue Georges Clemenceau
92000 Nanterre
Tel. 01/204.04.04
TELEX - 615051

Mercure C - Z.I. D'Aix en Provence
13763 Les Milles
Tel. 42/60 01 77
TELEX - 420683

1 Avenue de Danemark
37100 Tours
Tel. 47/41 76 46
TELEX - 750765

R.T.F
9 Rue d'Arcueil
94250 Gentilly
Tel. 664.11.01
TELEX - 201069

S.C.T
37 Avenue Emile Dewoitine
31200 Toulouse
Tel. 61/81.51.57
TELEX - 520927

80/83 Quai de Queyries
33072 Bordeaux
Tel. 56/86.50.31
TELEX - 550988

Scientech
11 Avenue Ferdinand Buisson
75016 Paris
Tel. 609.91.36
TELEX - 260042

Selfco
31 Rue du Fosse des treize
67000 Strasbourg
Tel. 88/22.08.88
TELEX - 890.706

GERMANY
Indeg GmbH
Emil Kommerlingstrasse 5
Postfach 1563
6780 Pirmasens
Tel. 06331/94065
TELEX - 452269

A Neye-Enatechnik GmbH
2085 Quickborn-Hamburg
Schillerstrasse 14
Postfach 1240
Tel. 04106/6121
TELEX - 213590

Semitron GmbH
Im Gut 1
7891 Kuessaberg
Tel. 07742/7011
TELEX - 7921472

Servitronic GmbH
Berliner Strasse 140
1000 Berlin 31
Tel. 030/87 04 06
TELEX - 183557

Spoerle Electronic KG
Max Planckstrasse 1-3
Postfach 10 21 40
6072 Dreieich/Frankfurt
Tel. 06103/304304
TELEX - 417903

GREECE
General Electronics Ltd.
209 Thivon Street
GR-184 54 Nikaia
Piraeus
Tel. 1/4922068
TELEX - 212949

IRELAND
Bloomer Electronics Ltd.
9-10 Carn Industrial Estate
Portadown-Co. Armagh BT63 5RH
Northern Ireland
Tel. 0762/339818
TELEX - 748054

ISRAEL
A. Schneider Ltd.
44 Petach Tikva Road
P.O. Box 18055
Tel Aviv 61180
Tel. 3/372089
TELEX - 33613

ITALY
Idac Elettronica s.p.a.
Via Verona 8
35010 Busa di Vigonza (PD)
Tel. 049/725 699
TELEX - 430353

Kontron s.p.a.
Via G. Fantoli 16/15
20138 Milano
Tel. 02/50721
TELEX - 312288

Lasl Elettronica s.p.a.
Viale Lombardia 1
20092 Cinisello Balsamo (Milano)
Tel. 02/6120441/2-3-4-5
TELEX - 331612

Silverstar Ltd.
20 Via dei Gracchi
20146 Milano
Tel. 02/4996
TELEX - 332189

NETHERLANDS
Techmation Electronics B.V.
P.O. Box 9
4175 ZG Haaften
Bernhardstraat II
4175 Ed Haaften
Tel. 04189/2222
TELEX - 50423

NORWAY
Nordisk Elektronik A/S
Smedsvingen 4
P.O. Box 130
1364 Hvalstad
Tel. 02/846210
TELEX - 77546

SOUTH AFRICA
Electrolink Ltd.
P.O. Box 1020
Martin Hammerschlag Way
Cape Town 8000
Tel. 21/5350/1/2
TELEX - 527320

SPAIN
Kontron Electronica
Salvatierra, 4
28034 Madrid
Tel. 729 11 55
TELEX - 23382

Sutelco
Pilar de Zaragoza 23
Madrid 2
Tel. 1/245.86.03
TELEX - 43852

SWEDEN
Nordisk Elektronik A/B
Box 1409
Huvudstagatan 1
171 27 Solna
Tel. 8/734.97.70
TELEX - 10547

SWITZERLAND
Omni Ray AG
Industriestrasse 31
8305 Dietlikon
Tel. 01/835.21.11
TELEX - 53239

TURKEY
Turkelek Elektronik Ltd.
Hatay Sok. 8
Ankara
Tel. (41) 25.21.09/18.94.83
TELEX - 42120

UNITED KINGDOM
B.A. Electronics Ltd.
Hitchin Road
Arlesey
Bedfordshire SE15 6SU
Tel. 0462/834744
TELEX - 826257

Polar Electronics Ltd.
Europa House, West Street
Leighton Buzzard
Beds. LU7 7ND
Tel. 0525/377093
TELEX - 825238

Semtor Electonics Ltd.
Brooklyn House
22 The Green
West Drayton Middlexsex UB7 7PQ
Tel. 08954/45832
TELEX - 8814938

STC Electronic Services
Edinburgh Way
Harlow Essex CM20 2DE
Tel. 0279/26777
TELEX - 81525

Semiconductor Specialists (U.K.) Ltd.
Carroll House
159 High Street, Yiewsley
West Drayton
Middlesex UB7 7XB
Tel. 08954/46415
TELEX 21958

YUGOSLAVIA
Belram S.A.
83 Avenue des Mimosas
1150 Brussels/Belgium
Tel. 02/734.33.32
TELEX - 21790

JAPAN

Dainichi Electronics Inc.
Koraku Bldg.
1-1-8, Koraku
Bunkyo-Ku, Tokyo 112
Tel. (03) 815-4711

Japan Electronics Research Corp.
Omori Mitsubishi Bldg.
2-3-10 Sanno
Ohta-Ku, Tokyo 143
Tel. (03) 777-4111

Kokuel Tsusho Co., Ltd.
Hoei Bldg.
3-10 Kanda-Jimbo-Cho
Chiyoda-Ku, Tokyo 101
Tel. (03) 230-0190

Nagoya Dengensha
9-27 Furuwatari-Cho
Naka-Ku, Nagoya 460
Tel. (052) 322-3511

New Metals and Chemicals Co., Ltd.
Shin Daiichi Bldg.
3-4-13 Nihonbachi
Chuo-Ku, Tokyo 103
Tel. (03) 201-6585

Takachiho Koheki Co., Ltd.
Nakamura Bldg.
1-2-8 Yotsuya
Shinjuku-Ku, Tokyo 160
Tel. (03) 355-1111

SOUTH AMERICA

ARGENTINA
Reycom Electronica SRL
Uruguay 485 - 7th Floor C
1015 - Buenos Aires
Tel. 40-2199/45-8092
TELEX - 17591

BRAZIL
Cosele
Comercio e Servicos
Electornicos Ltda.
Rua da Consolacao, 867 Cj. 22-01301
Sao Paulo
Tel. (011) 255-1733
TELEX - (011) 30869 CSEL BR

CHILE
Victronics Ltda.
Casilla 283-V, Correo 21
Santiago 01, Chile
Tel. 36440 or 30237
TELEX - 3520001

MEXICO
Mexel
Mexicana de Elect Ind. S.S.
Tlacoquemecatl 139-401
Mexico 12 DF
Tel. 575-78-68
TELEX - 1771823 MXELME

SOUTHEAST ASIA

AUSTRALIA
Allied Capacitors Pty. Ltd.
214 Harbord Road
P.O. Box 198
Brookvale 2100 NSW
Tel. 02/938-2422
TELEX - 790-25400

Rifa Pty. Ltd.
202 Bell Street
Preston, Victoria
3072, Australia
Tel. (03) 480-1211
TELEX - AA31001

HONG KONG
Astec Agencies Ltd.
RM 706-710, Austin Tower
22-26A, Austin Avenue
Tsimshatsui, Kowloon
Tel. 3/7210346-9
TELEX - 37528 ASAG HX

INDIA
A.T.E. Pvt. Ltd.
36, SDF-2, SEEPZ
Andheri (E), Bombay-400 096
Tel. 604 9032/630 0195
TELEX - 011-71513 DIP IN

Zenith Electro Systems Pvt. Ltd.
106, Mittal Chambers
Nariman Point
Bombay-400021
Tel. 2027887
TELEX - 011-3152 ZENTRONICS

KOREA
Won IL Commercial Corp.
402, Won IL Building
San 127-1, Seocho-Dong
Kangnam-Ku, Seoul
Tel. 2/5834321-3
TELEX - K27860 WONIL

NEW ZEALAND
Channel Master
Roma Road
Mt. Roskill, Auckland
Tel. 599-003
TELEX - NZ21033

SINGAPORE
Astec Components Pte Ltd.
116 Lavender Street No. 04-02
Singapore 1233
Tel. 2920826
TELEX - RS 35709 ASTEC

THAILAND
Choakchai Elect. Ltd.
128/22 Thanon Atsadang,
Bangkok, 10200 Thailand
Tel. 221-0432, 221-5384
TELEX - 84809 CESLP TH

International Sales Offices

EUROPE
GENERAL INSTRUMENT
Optoelectronics Division
Moutstraat 104/106
B 9000 Gent, Belgium
Tel. 091/22.57.91
TELEX—12 686
FAX—091/21.23.50

FRANCE
GENERAL INSTRUMENT
FRANCE
5-7 Rue Amiral Courbet
94160 Saint-Mande
Tel. 01/43.74.25.75
TELEX—213.073

GERMANY
GENERAL INSTRUMENT
DEUTSCHL AND GmbH
Optoelectronics Division
Freischuetzstr, 96
8000 Muenchen 81
Tel. 089/95.99.70
TELEX—05/24523
FAX—089/9570489

ITALY
GENERAL INSTRUMENT
EUROPE DIV.
C.P. Clare Elettronica SRL
Via Quintiliano 27
20138 Milano
Tel. 02/5062584/504605
TELEX—314233
FAX—02/5063930

UNITED KINGDOM
GENERAL INSTRUMENT
U.K. LTD
Times House
Station Approach
Ruislip, Middlesex HA4 8LE
Tel. 08956/36522
TELEX—23272
FAX—08956.39304

SOUTH AMERICA
GENERAL INSTRUMENT
Optoelectronics Division
3400 Hillview Avenue
Palo Alto, CA 94304
Tel. (415) 493-0400

SOUTHEAST ASIA
GENERAL INSTRUMENT
MALAYSIA
Optoelectronics Division
5 Jalan SS 8/2
Sungei Way Free Trade Zone
Kuala Lumpur, Malaysia
Tel. 761211
TELEX—GIMAL 37517

HONG KONG
GENERAL INSTRUMENT
HONG KONG LTD.
Room 1104-1107, Tower B.
Mandarin Plaza
14, Science Museum Road
Tsimshatsui East, Kowloon
Hong Kong
Tel. (03) 7226577
TELEX—54608 GIHK HX

JAPAN
GENERAL INSTRUMENT
INTERNATIONAL CORP.
Fukido Bldg.
1-13 Toronomon 4-Chome
Minato-Ku, Tokyo 105
Tel. (03) 437-0281
TELEX—720-2423413

TAIWAN
GENERAL INSTRUMENT
S.E.A. LTD
Discrete Semiconductor &
Optoelectronics Division
233, Pao Chiao Road,
Hsin Tien, Taipei, Taiwan
R.O.C.
Tel. (02) 9114804
TELEX—34297 GITSEAMK

North American Direct Sales Offices

HEADQUARTERS
GENERAL INSTRUMENT
Optoelectronics Division
3400 Hillview Avenue
Palo Alto, CA 94304
(415) 493-0400
TWX/TLX: 470208
FAX: (415) 493-7055

NORTHWEST REGION
GENERAL INSTRUMENT
Optoelectronics Division
3400 Hillview Avenue
Palo Alto, CA 94304
(415) 493-0400

SOUTHWEST REGION
GENERAL INSTRUMENT
Optoelectronics Division
25301 Cabot Road, Suite 204
Laguna Hills, CA 92653
(714) 581-5817

CENTRAL REGION
GENERAL INSTRUMENT
Optoelectronics Division
2355 S. Arlington Hts. Rd.
Suite 303
Arlington Heights, IL 60005
(312) 364-9410

EASTERN REGION
GENERAL INSTRUMENT
Optoelectronics Division
758 Highway 18, Suite 104
East Brunswick, NJ 08816
(201) 254-1588

NORTHEAST REGION
GENERAL INSTRUMENT
Optoelectronics Division
36 Commerce Way
Woburn, MA 01801
(617) 938-1444

SOUTHEAST REGION
GENERAL INSTRUMENT
Optoelectronics Division
3030 Holcomb Bridge Road,
Suite F
Norcross, GA 30071
(404) 446-2939

Address update
September 1985

Optoelectronics Division
3400 Hillview Avenue
Palo Alto, California 94304

GENERAL INSTRUMENT