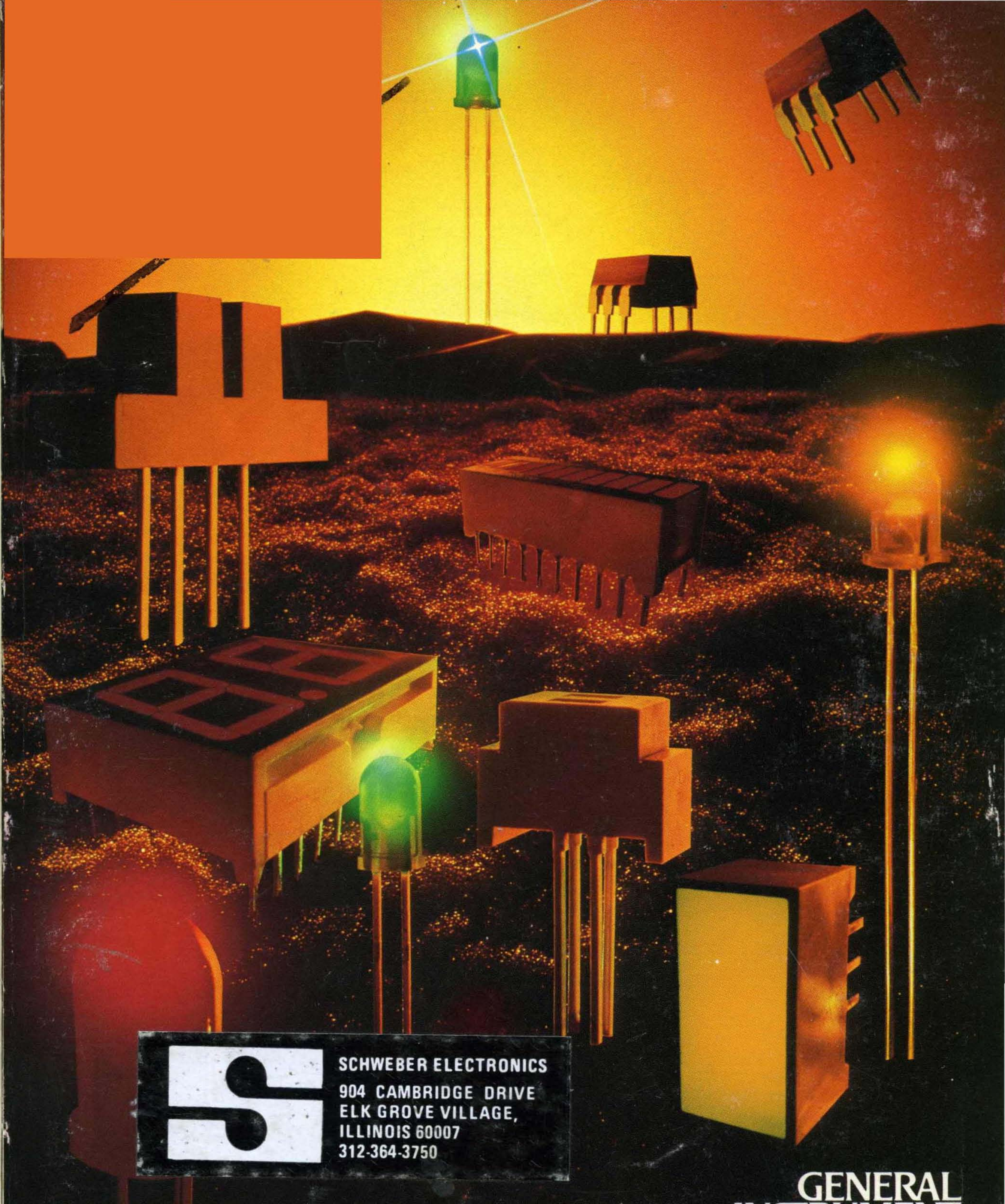
General Instrument Optoelectronic Products 1983



Catalog of Optoelectronic Products 1983

GENERAL INSTRUMENT

Catalog of Optoelectronic Products 1983

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GENERAL INSTRUMENT

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About General Instrument Optoelectronics

Experience

For the last thirteen 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 and advanced manufacturing techniques ensure the highest standards of production (see page iii for detailed reliability information). We are committed to the concept of providing state-of-the-art dependable products at competitive prices.

Broad Product Range

We offer over 300 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 421 and 424 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 five major product groups—optoisolators, IR emitters and detectors, 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 *vi* 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 373, 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 422 and 424.

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Alpha-Numeric Product Listing

General Instrument Reliability

At General Instrument, product dependability is assured through an active reliability 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 type.

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

Quality Control

Quality control is considered 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
  $T_A = 25°C$
  time = 1000 hours
  I_F = max. rated
- High Temperature Storage
  $T_A = 150°C$
  time = 1000 hr.
- Low Temperature Storage
  $T_A = -55°C$
  time = 1000 hr.
- 85/85 No Bias
  $T_A = 85°C$
  RH = 85%
  time = 1000 hrs.
- HTRB
  $T_A = 100°C$
  voltage = 80% max. rated
  time = 1000 hrs.
- Thermal Shock per MIL-STD-883, Method 1011
  T_A = 0°C to 100°C
  No. of cycles = 30
- Temperature Cycle per MIL-STD-883, Method 1010
  T_A = −55°C to 125°C
  No. of cycles = 100
- Thermal Intermittent Test
  T_A = 25°C to 100°C
  No. of cycles = 10
- Moisture Resistance per MIL-STD-833 Method 1004 (omit initial conditioning and Step 7)
- Pressure Pot
  pressure = 15PSI
  time = 96 hours

Reliability Test Facilities

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

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

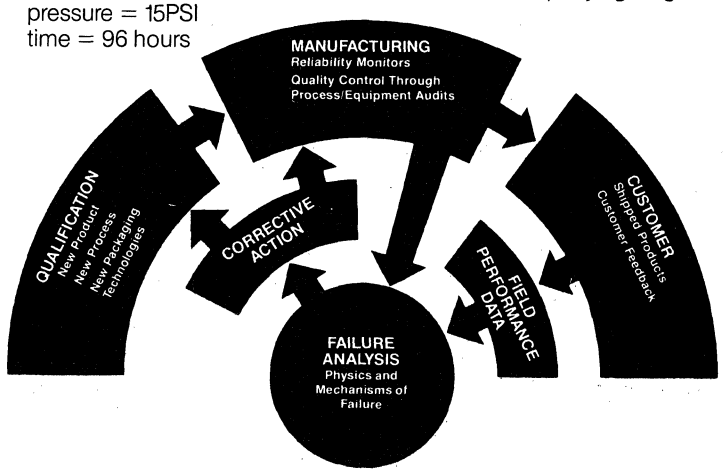
In addition, the failure analysis lab facilities in Palo Alto and Kuala Lumpur also have the following capabilities:

- 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 Auger analysis

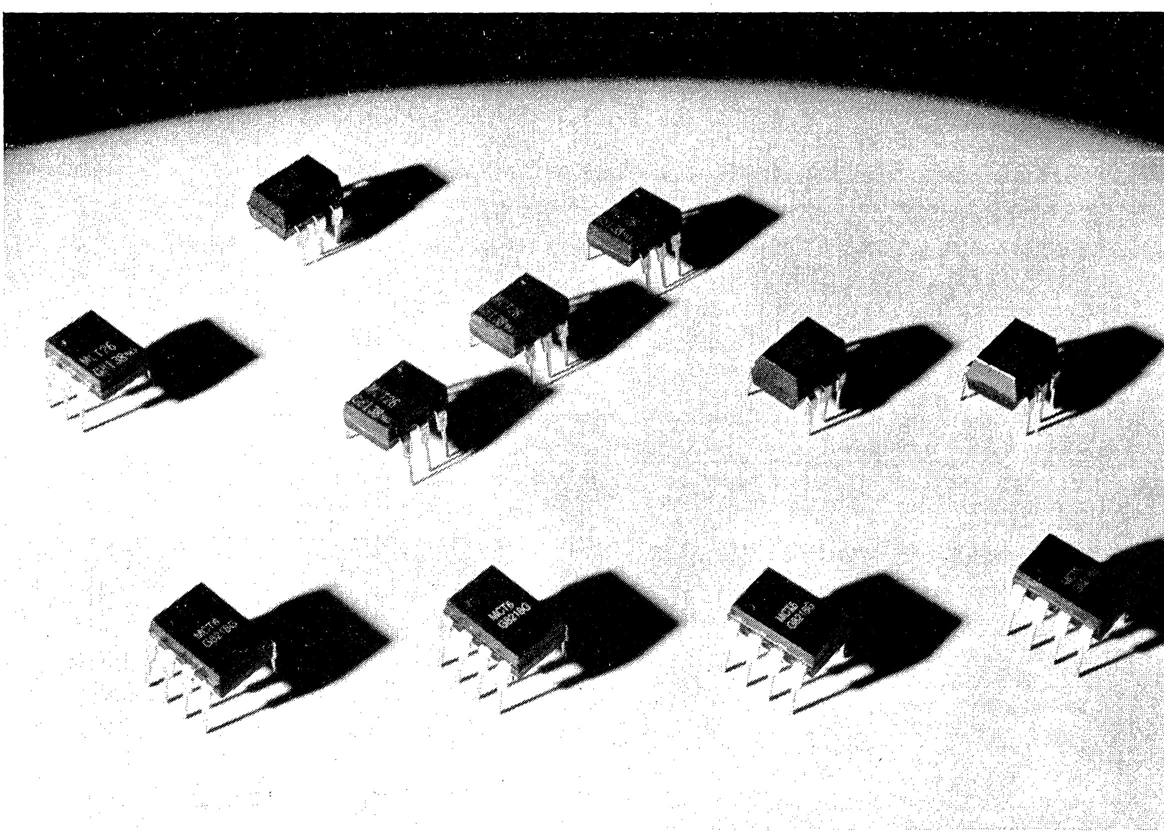
Failure Analysis and Qualitative Reliability

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.

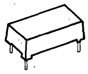
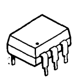
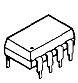
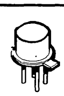
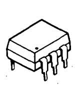
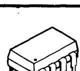
This on-going activity and the resulting feedback and action is illustrated in the accompanying diagram.



1 Optoisolators



OPTOISOLATORS

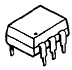
PACKAGE	DEVICE NO.	OUTPUT CONFIGURATION	MAX. EMITTER VOLTAGE	DETECTOR			
				MIN. OUTPUT VOLTAGE (BV_{CEO})	TYPICAL h_{FE}	MAX. $V_{CE}(SAT)$	MIN. CURRENT TRANSFER RATIO
TRANSISTORS							
	CNY65	TRANSISTOR	1.6V @ 50mA	32V	–	.3V @ 1mA	50-300%
	CNY17A CNY17B CNY17C CNY17D	TRANSISTOR	1.65V @ 60mA	70V	–	.3V @ 2.5mA	40-80% 63-125% 100-200% 160-320%
	CNY75A CNY75B CNY75C	TRANSISTOR	1.6V @ 50mA	70V	–	.3V @ 2.5mA	63-123% 100-200% 160-320%
	MCT2200 MCT2201 MCT2202	TRANSISTOR	1.5V @ 20mA	30V	–	.3V @ 2.5mA	20% 100% 60-125%
	MCT2 MCT2E MCT26	TRANSISTOR	1.5V @ 20mA	30V	250 250 150	.4V @ 2mA .4V @ 2mA .5V @ 1.6mA	20% 20% 6%
	MCT210	TRANSISTOR	1.5V @ 40mA	30V	400	.4V @ 16mA	150%
	MCT270 MCT271 MCT272 MCT273 MCT274	TRANSISTOR	1.5V @ 20mA	30V	500 420 500 280 360	.4V @ 2mA	50% 45-90% 75-150% 125-250% 225-400%
	MCT275	TRANSISTOR	1.5V @ 20mA	80V	170	.4V @ 2mA	70-210%
	MCT276 MCT277	TRANSISTOR	1.5V @ 20mA	30V	90 420	.4V @ 2mA	15-60% 100%-up
	4N25 4N26 4N27 4N28	TRANSISTOR	1.5V @ 50mA	30V	250	.5V @ 2mA	20% 20% 10% 10%
	4N35 4N36 4N37	TRANSISTOR	1.5V @ 10mA	30V	100	.3V @ 5mA	100%
	MCT6 MCT66	TRANSISTOR PAIR	1.5V @ 20mA	30V	–	.4V @ 2mA	20% 6%
	MCT4 MCT4R	TRANSISTOR	1.5V @ 40mA	30V	–	.5V @ 2mA	15%
DARLINGTONS							
	MCA230 MCA231 MCA255	DARLINGTON TRANSISTOR	1.5V @ 20mA	30V 30V 55V	25,000 50,000 25,000	1.0V @ 50mA 1.2V @ 50mA 1.0V @ 50mA	100% 200% 100%
	4N29 4N30 4N31 4N32 4N33	DARLINGTON TRANSISTOR	1.5V @ 50mA	30V	5000	1.0V @ 2mA 1.0V @ 2mA 1.2V @ 2mA 1.0V @ 2mA 1.0V @ 2mA	100% 100% 50% 500% 500%
	MCA11G1 MCA11G2	HIGH VOLTAGE DARLINGTON TRANSISTOR	1.5V @ 60mA	100V 80V	–	1.0V @ 50mA	1000%
	6N138 (MCC670) 6N139 (MCC671)	SPLIT-DARLINGTON	1.7V @ 1.6mA	7V 18V	–	0.4V @ I_f = 1.6mA, I_O = 4.8mA V_{CC} = 4.5V 0.4V @ I_f = 5mA, I_O = 15mA V_{CC} = 4.5V	300% 400%

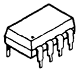
NOTE 1: Underwriter's Laboratory recognized product File E50151.

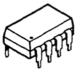
MIN. STEADY STATE ISOLATION VOLTAGE	TYPICAL OPERATING SPEED OR BANDWIDTH	PAGE NO.	APPLICATIONS
11600VDC/VDE (UL)[1]	5μsec	33	VDE Approved, high isolation voltage for medical instrumentation, industrial controls, solid state relays, power supply monitor, AC line to digital logic isolation.
7500VDC (UL)[1]	5μsec	29	Power supply regulators, digital logic inputs, microprocessor inputs, appliance sensor systems, power supply regulators, industrial controls.
5300VDC/VDE (UL)[1]	5μsec	37	Telephone circuits, industrial control systems, power supply regulators, appliance sensor systems, microprocessor controls.
7500VDC (UL)[1]	10μsec	83 87 91	Power supply regulators, digital logic inputs, microprocessor inputs, appliance sensor systems, industrial controls.
2500VAC (UL)[1]	150KHz 150KHz 300KHz	71 75 95	AC line/digital logic isolator, logic isolator, line receiver, cable receiver, relay monitor, power supply monitor.
2500VAC (UL)[1]	150KHz	79	Digital logic isolation, line receiver feedback control, monitoring circuits in high isolation environments.
2500VAC (UL)[1]	10μsec 7μsec 10μsec 20μsec 25μsec	97 101 105 109 113	Switching networks, power supply regulators, digital logic inputs, microcircuit inputs, appliance sensor systems, appliance controls.
2500VAC (UL)[1]	7μsec	117	Telecommunications, high voltage industrial control, relay driver, telephone.
2500VAC (UL)[1]	3.5μsec 15μsec	121 125	Data processing, microprocessor input, high speed digital logic.
2500VAC (UL)[1]	300KHz	7	Low cost products for logic isolator, telecommunications, line/cable receiver, high frequency feedback & control system, monitoring circuits.
	150KHz	15	Low current, low power products for industrial control and consumer, monitoring circuits, line receiver.
3000VDC (UL)[1]	150KHz	133	Data line isolation, telephone signal coupling, line/cable receiver, mobile equipment.
1000VDC	300KHz	129 131	Logic isolation, line or cable receiver for high hermeticity. MCT4R–MIL–STD.–883B preconditioning.

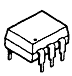
2500VAC (UL)[1]	10KHz	45 49 45	High current, low capacitance and fast switching products for read relay, pulse transformer, multiple contact control applications. Telecommunication, remote control logic isolation & alarm monitoring circuits, AC line/logic coupling.
2500VAC (UL)[1]	30KHz	11	Low capacitance medium speed products for data isolation, logic conversion, line/cable receiver, monitoring circuits or mechanical feedback controls.
2500VAC (UL)[1]	100μsec	41	High breakdown voltage with high current transfer ratio used in telecommunications, pulse transformer and other logic isolation.
3000VDC (UL)[1]	t_{PHL} @ 10μsec t_{PLH} @ 35μsec t_{PHL} @ 1μsec t_{PLH} @ 7μsec	25	CMOS logic interface, telephone ring detector, low input TTL interface, power supply isolation.

OPTOISOLATORS

PACKAGE	DEVICE NO.	OUTPUT CONFIGURATION	MAX. EMITTER VOLTAGE	DETECTOR V_{GT} (MAX.)	DETECTOR ON-VOLTAGE (MAX.)	DETECTOR HOLDING CURRENT (MAX.)	DETECTOR I_{FT} (MAX.)
SCR's							
	MCS2 MCS2400	SCR	1.5V @ 20mA	1V	1.3V @ 100mA	.5mA	14mA
	MCS21 MCS2401	SCR	1.5V @ 20mA	1V	1.3V @ 300mA	.5mA	11mA

PACKAGE	DEVICE NO.	OUTPUT CONFIGURATION	MAX. EMITTER VOLTAGE	DETECTOR ΔI_f (TYP.)	DETECTOR I_{OHL} (MAX.)	DETECTOR V_{OL} (MAX.)	DETECTOR I_{CC} (TYP.)
HIGH SPEED LOGIC GATE							
	MCL2601 6N137	OPEN-COLLECTOR LOGIC GATE	1.75V @ 10mA	3mA	250μA	.6V @ 13mA	15mA

PACKAGE	DEVICE NO.	OUTPUT CONFIGURATION	MAX. EMITTER VOLTAGE	DETECTOR ON-STATE RMS INPUT CUR. (MIN.)	DETECTOR OFF-STATE RMS INPUT CUR. (MAX.)	DETECTOR V_{OL} (MAX.)	DETECTOR I_{OH} (MAX.)
AC LINE MONITOR							
	MID400	OPEN-COLLECTOR LOGIC GATE	1.5V = 30mA	4.0mA	.15mA	0.4%	100μA

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	1.5V @ 60mA	3.0V @ 100mA	250V	10V/μsec	200μA
	MCP3020 MCP3021 MCP3022	TRIAC	1.5V @ 60mA	3.0V @ 100mA	400V	15V/μsec	200μA

NOTE 1: Underwriter's Laboratory recognized product file E50151.

BLOCKING VOLTAGE	MIN. STEADY STATE ISOLATION VOLTAGE	PAGE NO.	APPLICATIONS
200V 400V	2500VAC (UL)[1]	63	Lower power IC's to AC line isolation, relay functions, latches for DC circuits, home appliances, consumer and industrial control logic.
200V 400V	2500VAC (UL)[1]	67	Complete power isolation for integrated circuits and AC line voltage. High speed switching of relay functions.

MIN. TRANSIENT IMMUNITY CM	MIN. STEADY STATE ISOLATION VOLTAGE	OPERATING FREQUENCY (TYP.)	PAGE NO.	APPLICATIONS
−1000V/μsec −150V/μsec	3000V (UL)[1]	10Mbits	51 19	Isolated line receiver, data transmission isolation, microprocessor system interface, pulse transformer replacement.

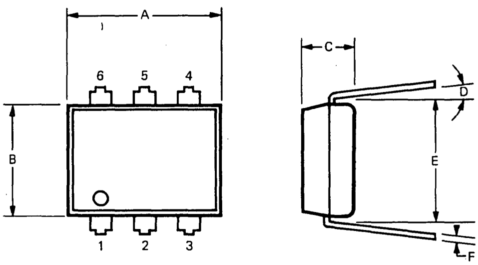
MIN. STEADY STATE ISOLATION VOLTAGE	SWITCHING TIMES T_{ON}, T_{OFF} (TYP.)	PAGE NO.	APPLICATIONS
3550V (UL)[1]	1.0 mS	137	Monitors AC "line-down" conditions; "closed loop" interface between electromechanical elements and microprocessors. Time delay isolation switch.

TRIGGER CURRENT (MAX. I_{FT})	MIN. STEADY STATE ISOLATION VOLTAGE	PAGE NO.	APPLICATIONS
30mA 15mA 10mA	7500VAC (UL)[1]	55	Interface between electronic controls and power triacs to control resistive and inductive leads for 120VAC or 240VAC operations. Specific applications are used as triac driver, traffic light control, motor control and solid state relays.
30mA 15mA 10mA	7500VAC (UL)[1]	59	

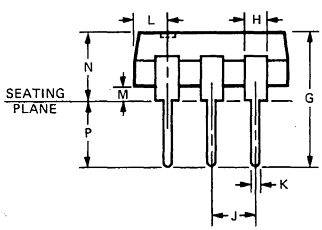
GENERAL INSTRUMENT

4N25 4N27
4N26 4N28

PACKAGE DIMENSIONS

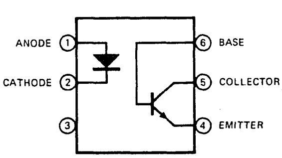


C1339



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



DESCRIPTION

The 4N25, 4N26, 4N27, and 4N28 series of optoisolators have an NPN silicon planar phototransistor optically coupled to a gallium arsenide diode. Each is mounted in a six-lead plastic DIP package.

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
- High isolation voltage
- Excellent frequency response
- UL recognized — File E50151
- High isolation voltage V_{ISO} = 2500 V RMS — 1 minute
- VDE approval applied for

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)

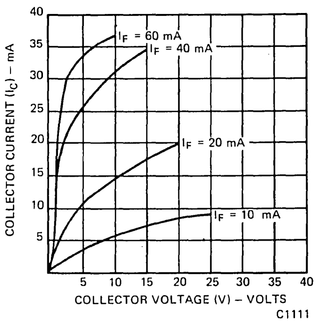


Fig. 1. Collector Current vs. Collector Voltage

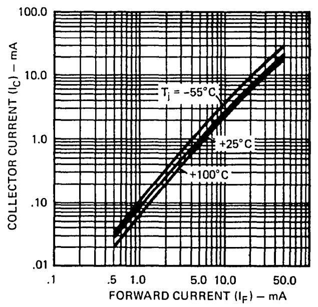


Fig. 2. Collector Current vs. Forward Current

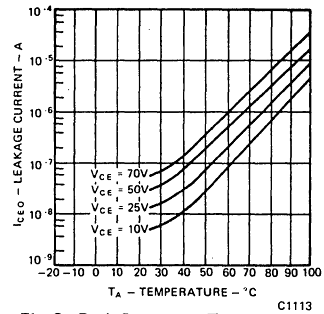


Fig. 3. Dark Current vs. Temperature

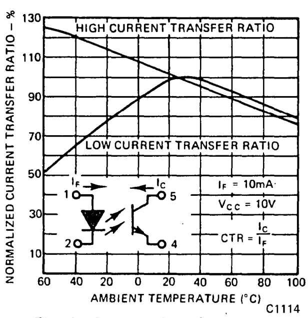


Fig. 4. Current Transfer Ratio vs. Temperature

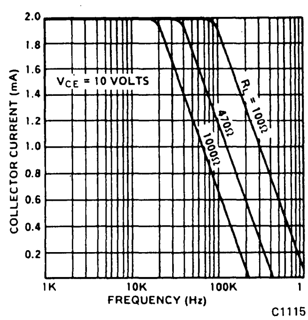


Fig. 5. Collector Current vs. Frequency (see Fig. 12 for circuit)

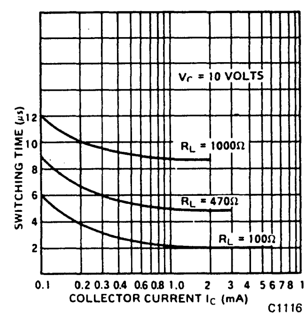
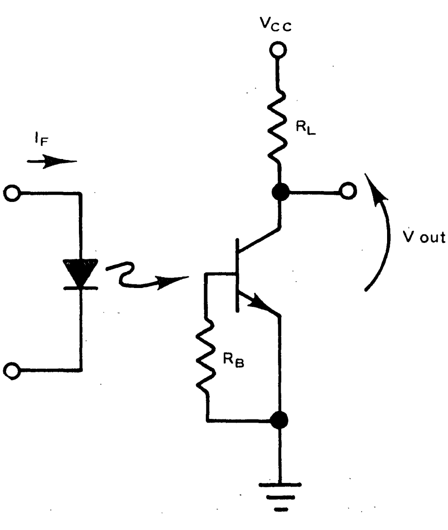


Fig. 6. Switching Time vs. Collector Current (see Fig. 13 for Circuit)



Circuit 1

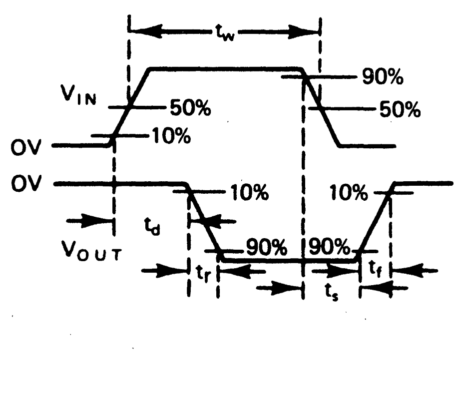


Fig. 7. Pulse Test Definition (Note 3)

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

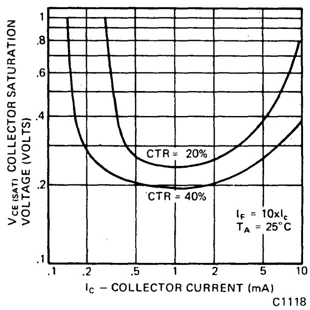


Fig. 8. Saturation Voltage vs. Collector Current

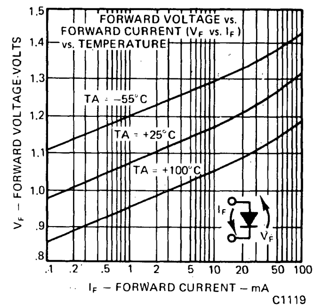


Fig. 9. Forward Voltage vs. Forward Current

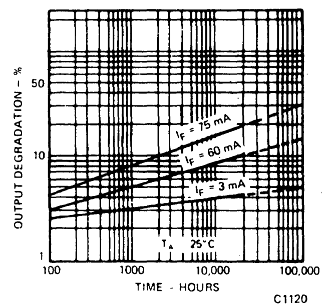


Fig. 10. Lifetime vs. Forward Current

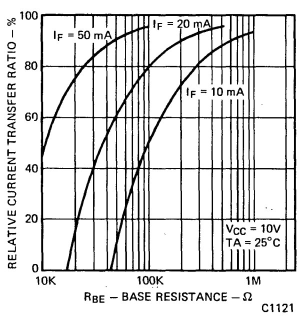


Fig. 11. Sensitivity vs. Base Resistance

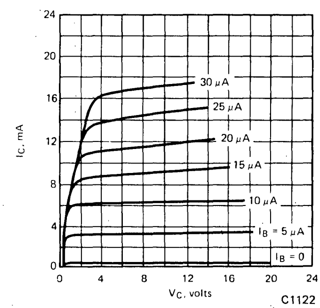


Fig. 12. Detector h_{fe} Curves

OPERATING SCHEMATICS

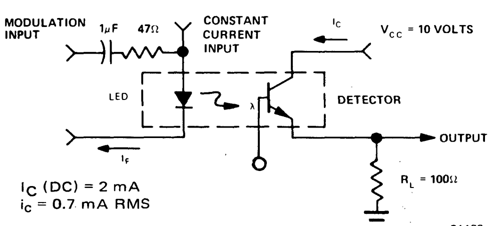


Fig. 13. Modulation Circuit Used to Obtain Output vs. Frequency Plot

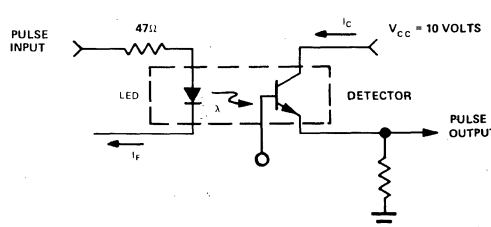


Fig. 14. Circuit Used to Obtain Switching Time vs. Collector Current Plot

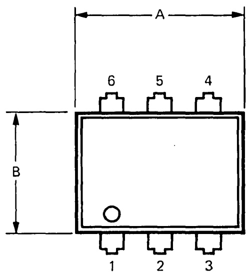
NOTES

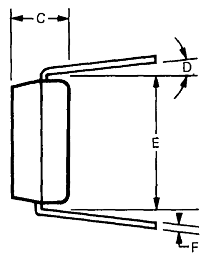
1. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.*
2. *The frequency at which i_C is 3dB down from the 10 kHz value.*
3. *Rise time (t_r) is the time required for the collector current to increase from 10% of its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

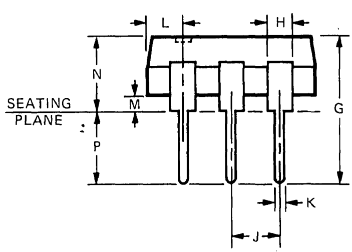
GENERAL INSTRUMENT

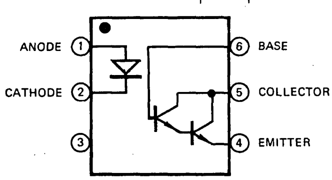
4N29 4N30 4N31 4N32 4N33

PACKAGE DIMENSIONS









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

DESCRIPTION

The 4N29, 4N30, 4N31, 4N32 and 4N33 have a gallium arsenide infrared emitter optically coupled to a silicon planar photo-darlington. Each unit is sealed in a 6-lead plastic DIP package.

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
- VDE approval applied for

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

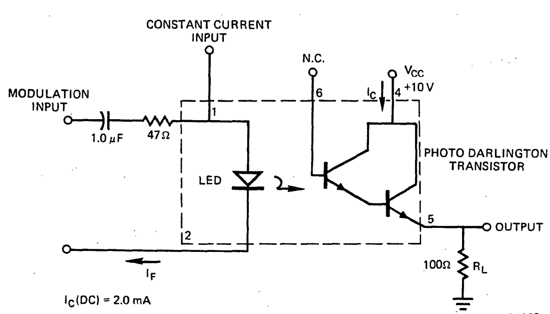
DETECTOR (Silicon Photo Darlington Transistor)
*Power dissipation @ 25°C ambient . . . . 150 mW
*Derate linearly from 25°C . . . . 2.0 mW/°C
*Collector-emitter breakdown voltage (BV_{CEO}) . . . . 30 V
*Collector-base breakdown voltage (BV_{CBO}) . . . . . . 50 V
Emitter-base breakdown voltage (BV_{EBO})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

*Indicated JEDEC Registered data.

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

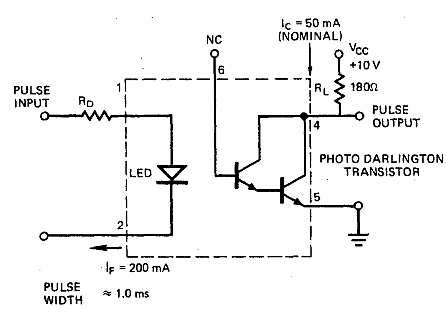
CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION
LED CHARACTERISTICS (T_A = 25°C unless otherwise noted)						
*Reverse leakage current	I_R		0.05	100	μA	V_R = 3.0 V
*Forward voltage	V_F		1.2	1.5	Volts	I_F = 10 mA
Capacitance	C		150		pF	V_R = 0 V, f = 1.0 MHz
PHOTOTRANSISTOR CHARACTERISTICS (T_A = 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.



Note 2

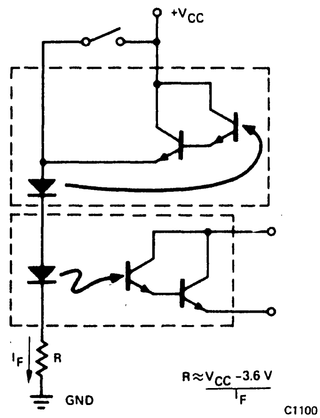
FREQUENCY RESPONSE TEST CIRCUIT #1



SWITCHING TIME TEST CIRCUIT #2

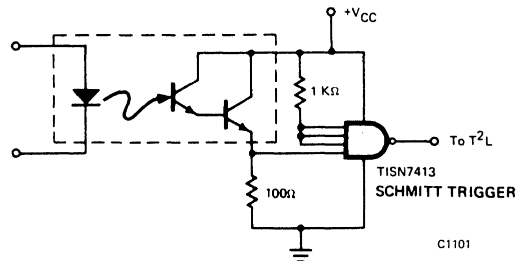
APPLICATION INFORMATION

LATCH

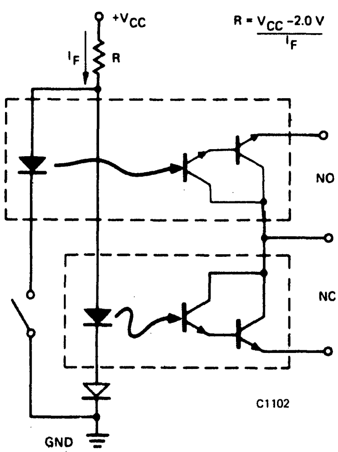


NOT APPLICABLE TO 4N31

T²L LOGIC ISOLATION

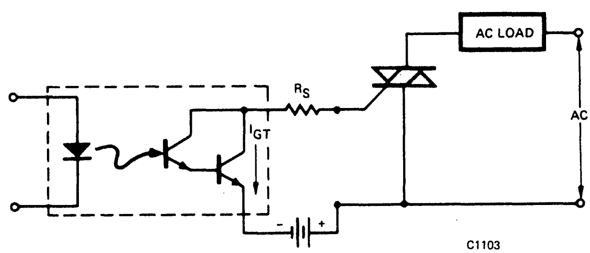


FORM C CONTACT

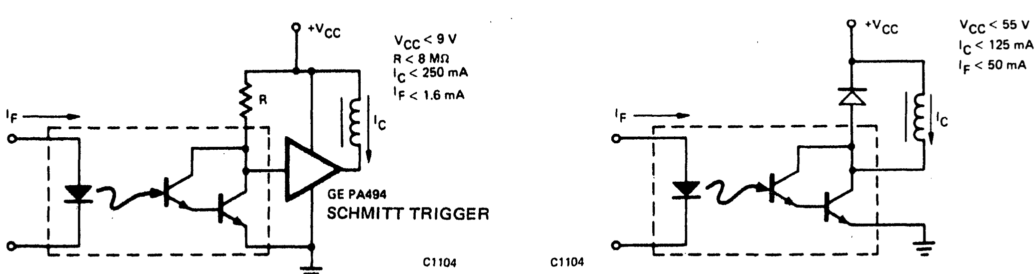


NOT APPLICABLE TO 4N31

TRIAC TRIGGER



OPERATING A RELAY COIL



TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

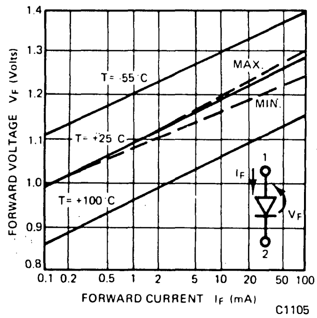


Fig. 1. Forward Voltage Drop vs. Forward Current

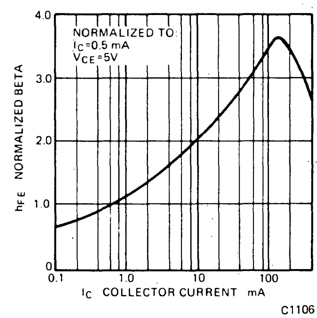


Fig. 2. Normalized Beta vs. Collector Current

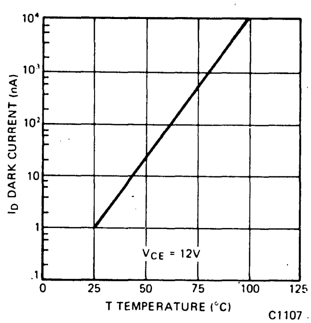


Fig. 3. Dark Current vs. Temperature

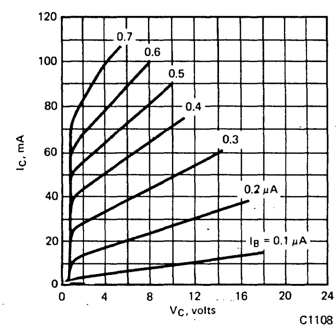


Fig. 4. Detector Standard Transfer Curves

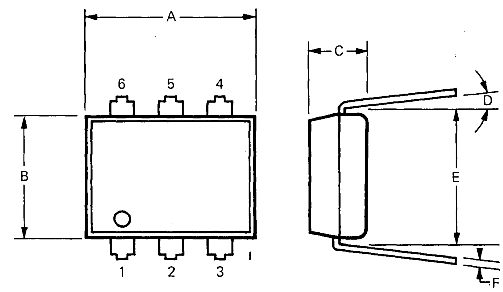
NOTES

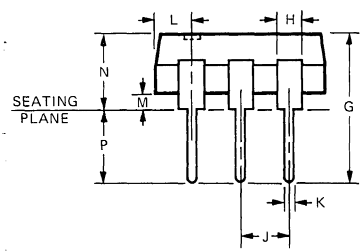
1. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.*
2. *The frequency at which i_C is 3dB down from the IKH_Z value.*
3. *t_{ON} is measured from 10% of the leading edge of the input pulse to the 90% point on the leading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

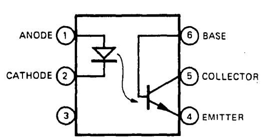
4N35
4N36
4N37

PACKAGE DIMENSIONS





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



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

DESCRIPTION

The 4N35, 4N36, and 4N37 series of opto-isolators have an NPN silicon planar photo-transistor optically coupled to a diffused planar gallium arsenide diode. Each is mounted in a six-lead plastic DIP package.

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
- VDE approval applied for

ABSOLUTE MAXIMUM RATINGS

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

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

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

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

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

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

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Input Diode						
*Forward voltage	V_F	.8		1.50	V	I_F = 10 mA
*Forward voltage temp. coefficient	V_F	.9		1.7	V	I_F = 10 mA, T_A = −55°C
*Forward voltage	V_F	.7		1.4	V	I_F = 10 mA, T_A = +100°C
*Junction capacitance	C_J			100	pF	V_F = 0 V, f = 1 mHz
*Reverse leakage current			.01	10	μA	V_R = 6.0 V
Output Transistor						
DC forward current gain	h_{FE}		250			V_{CE} = 5 V, I_C = 100 μA
*Collector to emitter breakdown voltage	BV_{CEO}	30	65		V	I_C = 10 mA, I_F = 0
*Collector to base breakdown voltage	BV_{CBO}	70	165		V	I_C = 100 μA
*Emitter to collector breakdown voltage	BV_{ECO}	7	14		V	T_E = 100 μA, I_F = 0
Collector to emitter, leakage current	I_{CEO}		5	50	nA	V_{CE} = 10 V, I_F = 0
*Collector to emitter leakage current (dark)	I_{CEO}			500	μA	V_{CE} = 30 V, I_F = 0, T_A = 100°C
Capacitance collector to emitter			8		pF	V_{CE} = 0
Capacitance collector to base			20		pF	V_{CB} = 10 V
Capacitance base to emitter	C_{BEO}		10		pF	V_{BE} = 0
Coupled						
†*DC current transfer ratio	CTR	100			%	I_F = 10 mA, V_{CE} = 10 V
†*DC current transfer ratio	CTR	40			%	I_F = 10 mA, V_{CE} = 10 V, T_A = −55°C
†*DC current transfer ratio	CTR	40			%	I_F = 10 mA, V_{CE} = 10 V, T_A = +100°C
*Saturation voltage—collector to emitter	$V_{CE(SAT)}$			.3	volts	I_F = 10 mA, I_C = 0.5 mA
Isolation voltage	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)

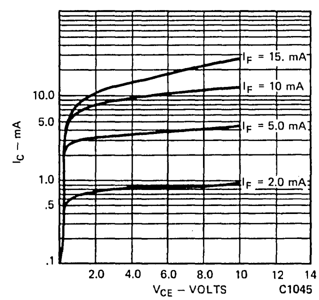


Fig. 1. Collector Current vs. Collector Voltage

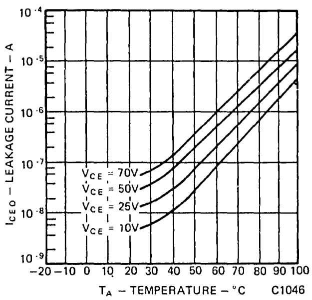


Fig. 2. Dark Current vs. Temperature

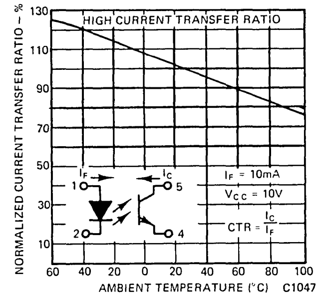


Fig. 3. Current Transfer Ratio vs. Temperature

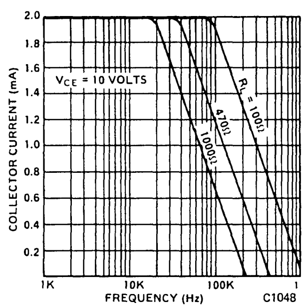


Fig. 4. Collector Current vs. Frequency

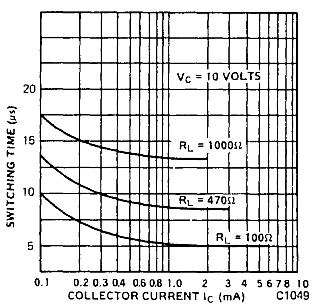


Fig. 5. Switching Time vs. Collector Current

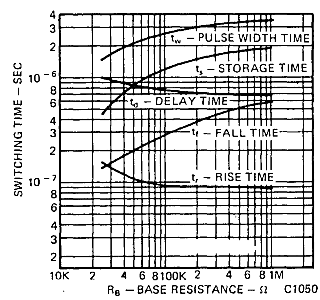


Fig. 6. Switching Time vs. Base Resistance

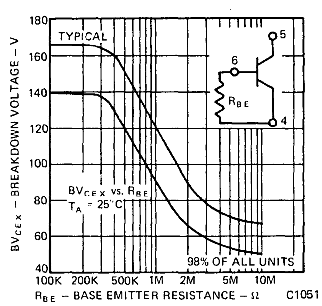


Fig. 7. Collector–Emitter Breakdown Voltage vs. Base Resistance

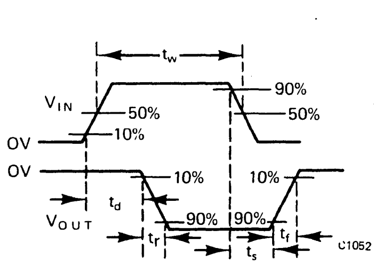


Fig. 8. Test Pulse Definition (Note 3)

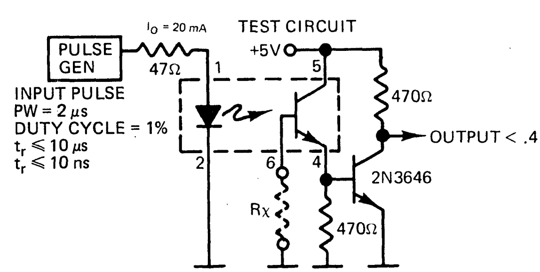


Fig. 9. Pulse Test Circuit for Fig. 7

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

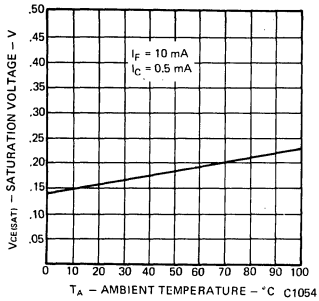


Fig. 10. Saturation Voltage vs. Temperature

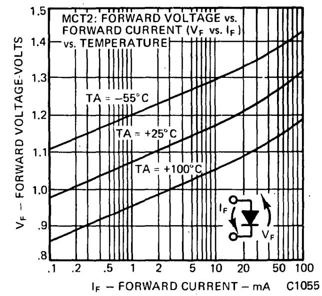


Fig. 11. Forward Voltage vs. Forward Current

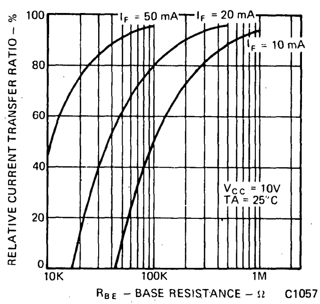


Fig. 12. Sensitivity vs. Base Resistance

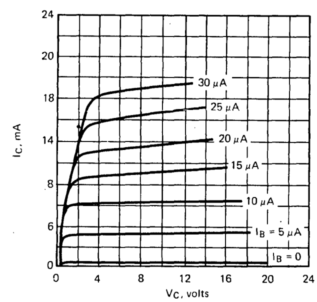


Fig. 13. Detector Standard Transfer Curves

OPERATING SCHEMATICS

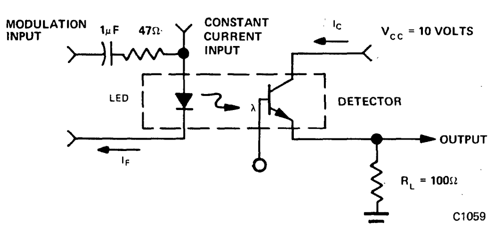


Fig. 14. Modulation Circuit Used to Obtain Output vs. Frequency Plot (Fig. 4)

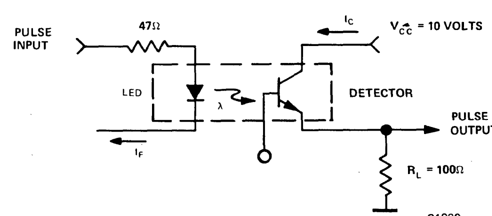


Fig. 15. Circuit Used to Obtain Switching Time vs. Collector Current Plot (Fig. 5)

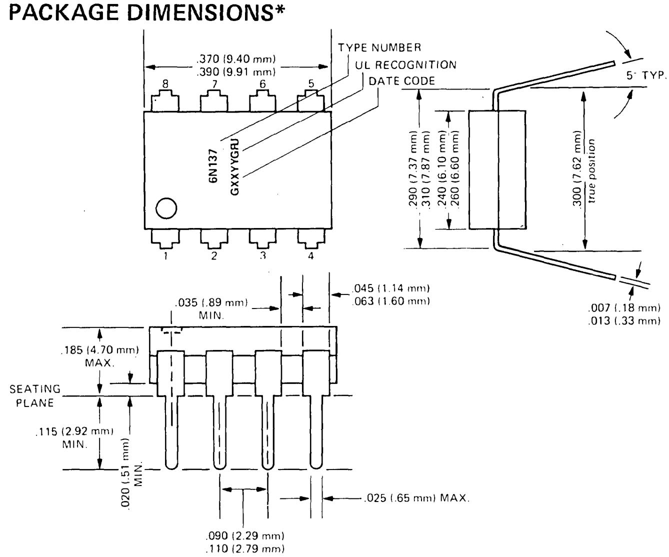
NOTES

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

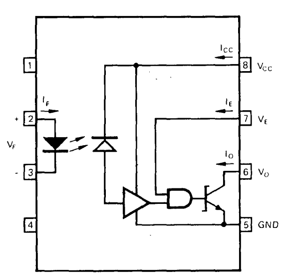
HIGH SPEED 6N137

PACKAGE DIMENSIONS*



DIMENSIONS IN INCHES AND (MILLIMETERS)

C1589A



C1605A

Fig. 1. Equivalent Circuit

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)

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
- VDE approval applied for

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 ≤ 1.0msec 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	$I_{I\text{-}0}$*			1.0	μA	Relative Humidity = 45% T_A = 25°C, t = 5s $V_{I\text{-}0}$ = 3000 VDC Note: 10
Resistance (Input to Output)	$R_{I\text{-}0}$		10^{12}		Ω	$V_{I\text{-}0}$ = 500V Note: 10
Capacitance (Input to Output)	$C_{I\text{-}0}$		0.6		pF	F = 1MHz Note: 10
Current Transfer Ratio	CTR		750		%	I_F = 5.0mA R_L = 100Ω Note: 12

** JEDEC Registered Data.*

** 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} = 0V, 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)

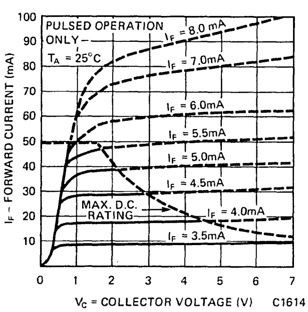


Fig. 2. Optoisolator Collector Characteristics

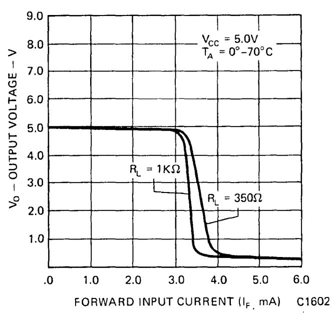


Fig. 3. Output Voltage vs. Forward Input Current

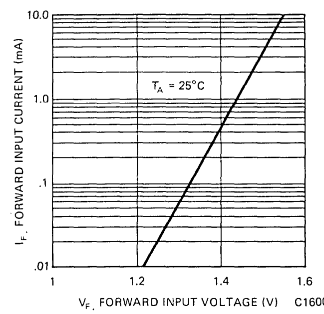


Fig. 4. Forward Input Current vs. Forward Input Voltage

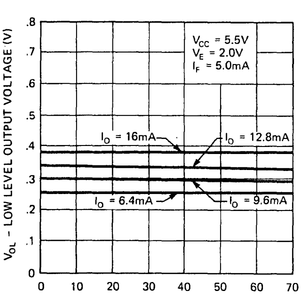


Fig. 5. Low Level Output Voltage vs. Temperature

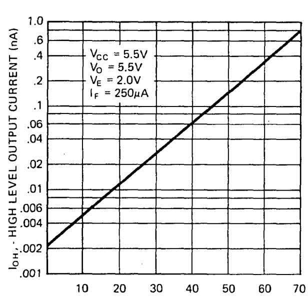


Fig. 6. High Level Output Current vs. Temperature

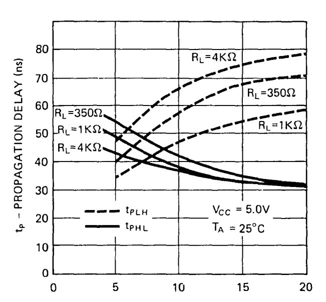


Fig. 7. Propagation Delay vs. Pulse Input Current

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

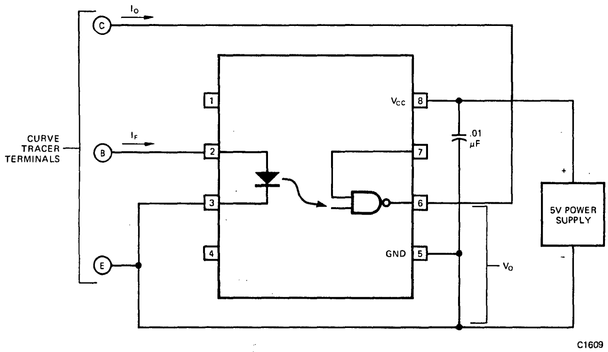


Fig. 8. Curve Tracer Connection to Obtain Collector Characteristics

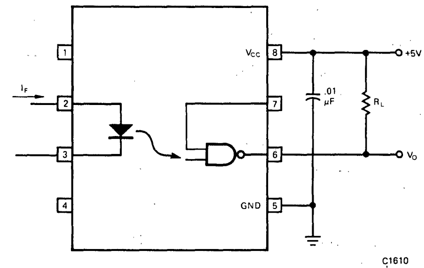


Fig. 9. Input-Output Schematic

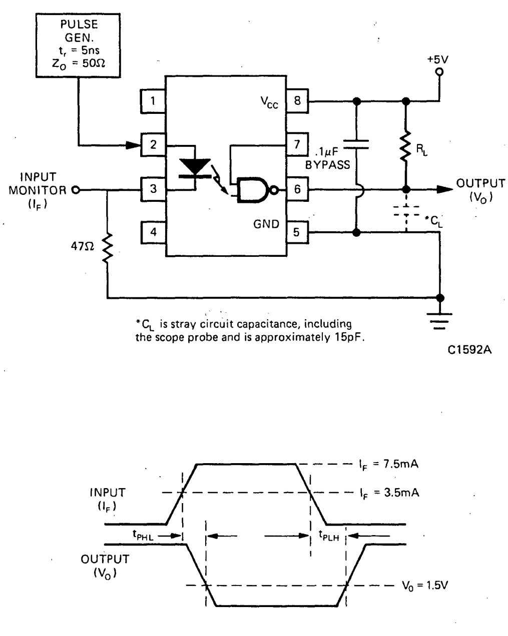


Fig. 10. Test Circuit t_{PHL} and t_{PLH}

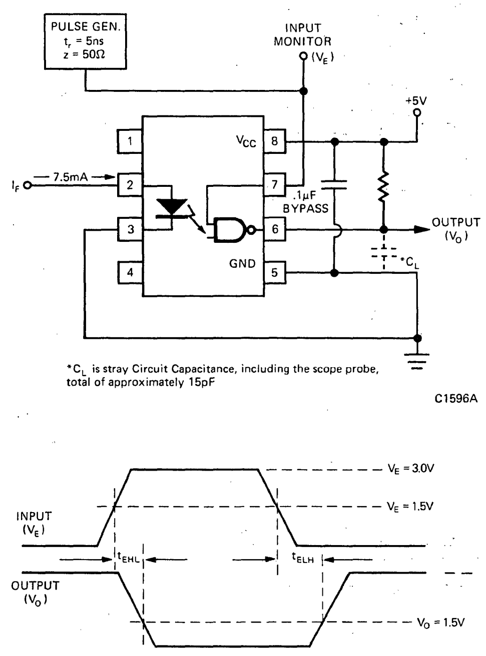


Fig. 11. Test Circuit t_{EHL} and t_{ELH}

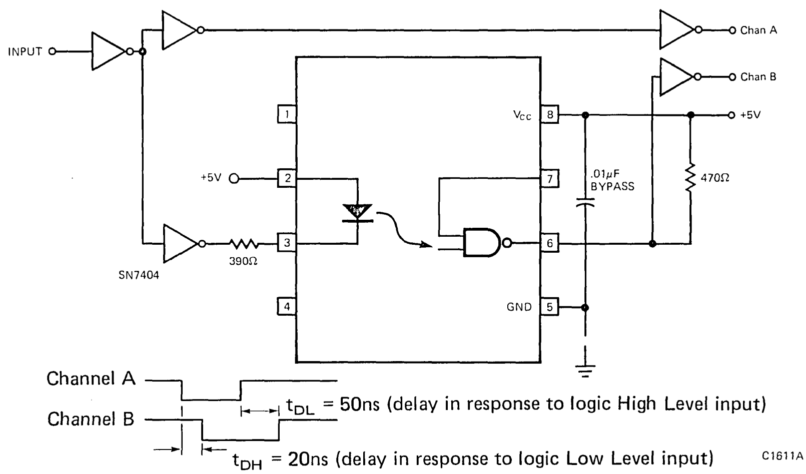


Fig. 12. Response Delay Between TTL Gates

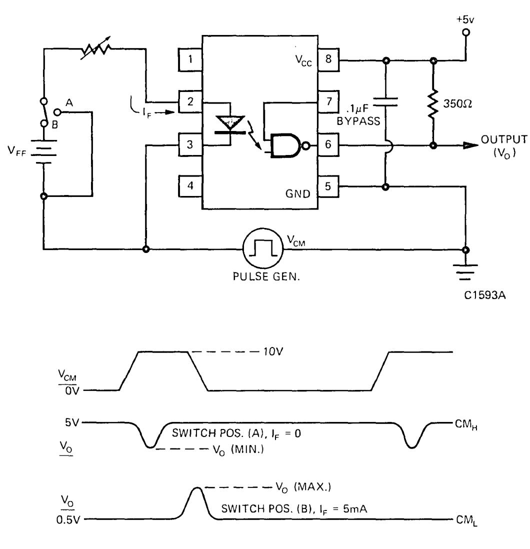


Fig. 13. Test Circuit for Transient Immunity and Typical Waveforms

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.

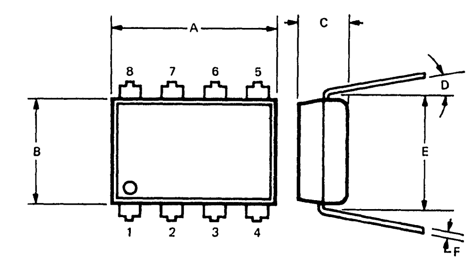
11. Enable Input - No pull up resistor required as the device has an internal pull up resistor.

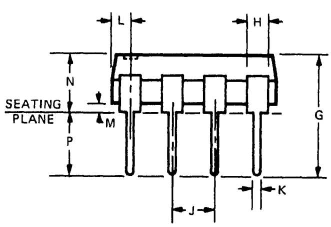
12. - DC current transfer ratio is defined as the ratio of the output collector current to the forward bias input current times 100%.

GENERAL INSTRUMENT

(MCC670) 6N138
(MCC671) 6N139

PACKAGE DIMENSIONS

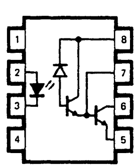




C1340

SYMBOL	INCH MAX.	mm. MAX.	NOTES
A	.410	10.29	
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



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 = .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 #E50151)
- High input to output isolation = 3000V DC withstand test voltage
- VDE approval applied for

APPLICATIONS

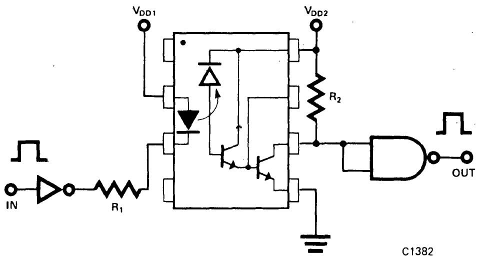
- CMOS logic interface
- Telephone ring detector
- Low input TTL interface
- Power supply isolation

ABSOLUTE MAXIMUM RATINGS*

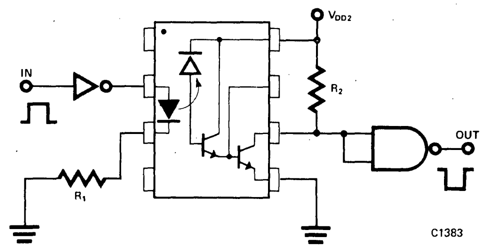
Storage Temperature .... -55°C to +125°C
Operating Temperature .... 0°C to +70°C
Lead Solder Temperature .... 260°C for 10 Sec (1/16" below seating plane)
Average Input Current — I_F .... 20 mA (See Note 1)
Peak Input Current — I_F .... 40 mA (50% Duty Cycle, 1 ms Pulse Width)
Peak Transient Input Current — 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

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

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

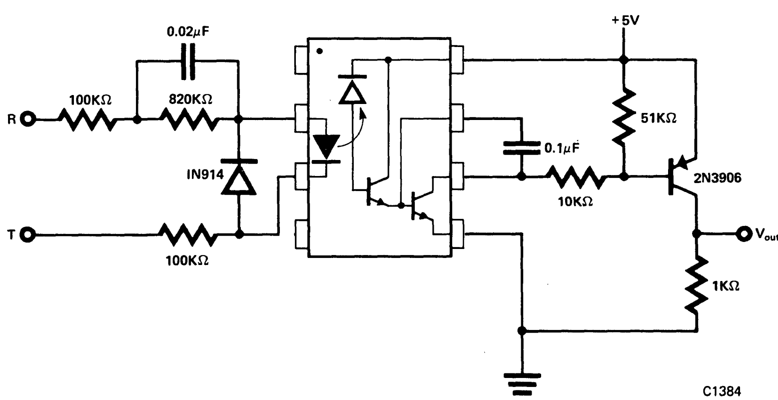
$$R_2 = \frac{V_{DD2} - V_{OLX} (@ I_L + I_2)}{I_L}$$

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

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

RESISTOR VALUES FOR LOGIC INTERFACE



TELEPHONE RINGING DETECTION USING OPTO-ISOLATOR

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

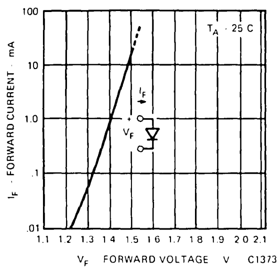


Fig. 1. Input Diode Forward Current vs. Forward Voltage

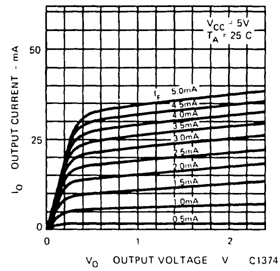


Fig. 2. 6N138 DC Transfer Characteristics

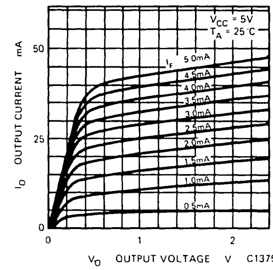


Fig. 3. 6N139 DC Transfer Characteristics

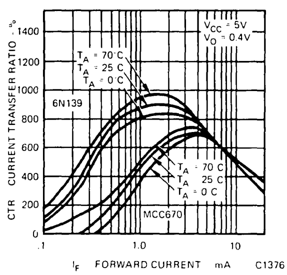


Fig. 4. Current Transfer Ratio vs. Forward Current

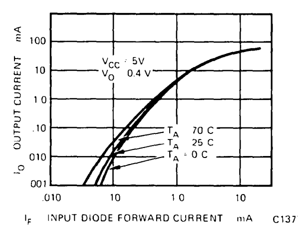


Fig. 5. 6N138 Output Current vs. Input Diode Forward Current

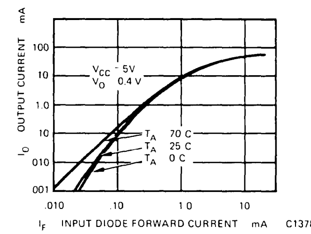


Fig. 6. 6N139 Output Current vs. Input Diode Forward Current

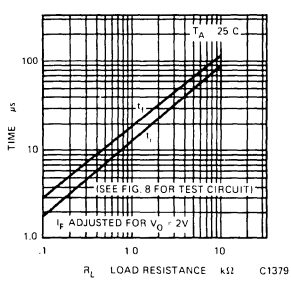


Fig. 7. Non-Saturated Rise and Fall Times vs. Load Resistance

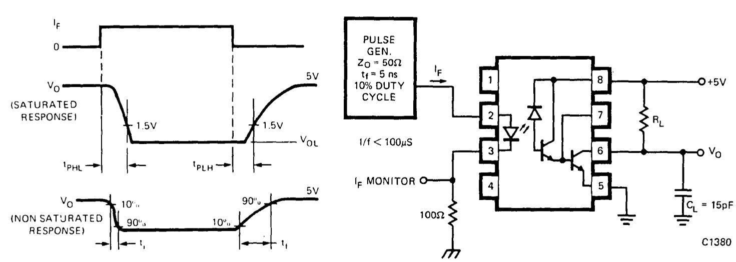


Fig. 8. Switching Test Circuit

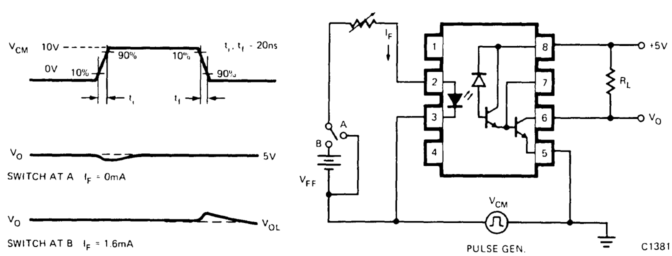


Fig. 9. Test Circuit for Transient Immunity and Typical Waveforms

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, $\lvert V_{cm} \rvert$ = 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, $\lvert V_{cm} \rvert$ = 10 V_{p-p}

NOTES

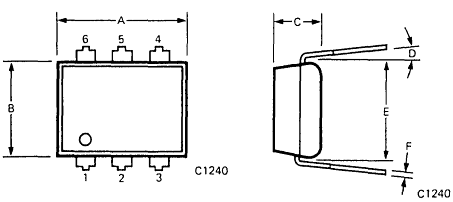
1. *Derate linearly above 50°C free-air temperature at a rate of 0.4 mA/°C.*
2. *Derate linearly above 50°C free-air temperature at a rate of 0.7 mW/°C.*
3. *Derate linearly above 25°C free-air temperature at a rate of 0.7 mA/°C.*
4. *Derate linearly above 25°C free-air temperature at a rate of 2.0 mW/°C.*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

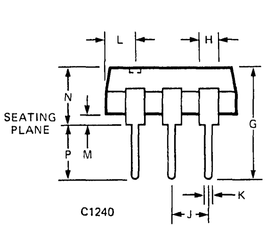
*JEDEC registered data

GENERAL INSTRUMENT

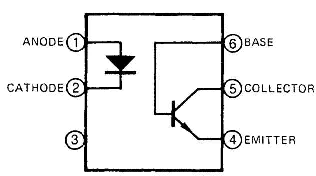
CNY17

PACKAGE DIMENSIONS





SYMBOL	INCHES MAX.	MIL. 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

Fig. 1. Equivalent Circuit

DESCRIPTION

The CNY17 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
  5300 VAC RMS – 5 seconds
  7500 VAC PEAK – 5 seconds
- High BV_{CEO} minimum 70 volts
- Current transfer ratio in selected groups:
  CNY17A: 40%- 80%
  CNY17B: 63%-125%
  CNY17C: 100%-200%
  CNY17D: 160%-320%
- Maximum turn-on, turn-off time 10μ seconds specified
- Underwriters Laboratory (UL) recognized File #E50151
- VDE approval applied for

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
	CNY17A		40		80		
	CNY17B		63		125		
	CNY17C		100		200		
	CNY17D		160		320		
	Saturation voltage	$V_{CE(SAT)}$		.27	.40	V	I_F = 10 mA; I_C = 2.5 mA
SWITCHING TIMES	Non-saturated						R_L = 100 Ω; I_C = 2 mA; V_{CC} = 10 V See figure 10.
	Turn-on time	t_{on}		6.0	10	μs	
	Turn-off time	t_{off}		5.5	10	μs	
ISOLATION	Isolation Voltage	V_{iso}	5300			V_{AC} RMS	Relative humidity ⩽ 50%, I_{I-O} ⩽ 10 μA, 5 seconds
		V_{iso}	7500			V_{AC} PEAK	Relative humidity ⩽ 50%, I_{I-O} ⩽ 10 μA, 5 seconds
	Isolation resistance	R_{iso}	10^{11}			ohms	V_{I-O} = 500 VDC
	Isolation capacitance	C_{iso}		.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 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 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)

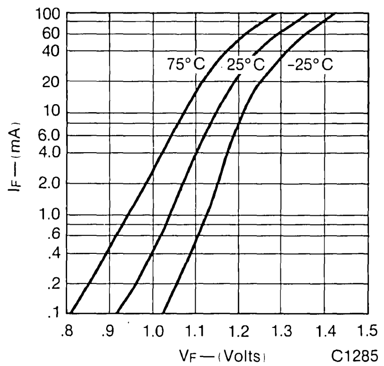


Fig. 2. Forward Voltage vs. Forward Current

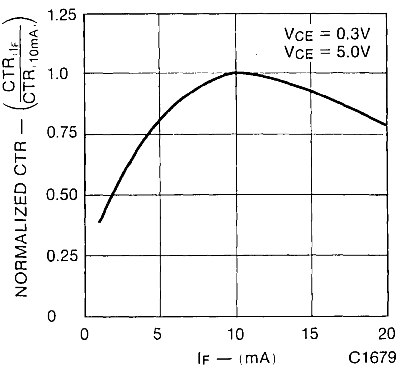


Fig. 3. Normalized Current Transfer Ratio vs. Forward Current

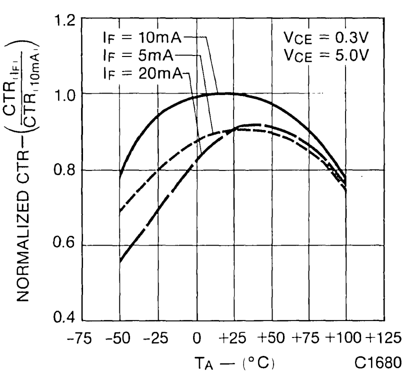


Fig. 4. Normalized Current Transfer Ratio vs. Ambient Temperature

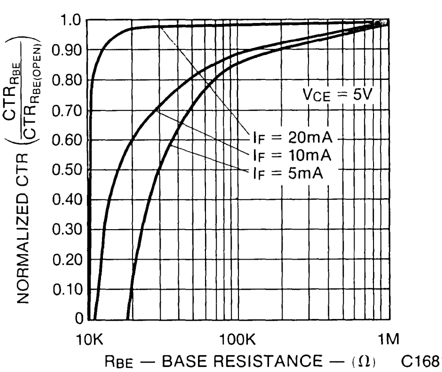


Fig. 5. C_{TR} vs. R_{BE}

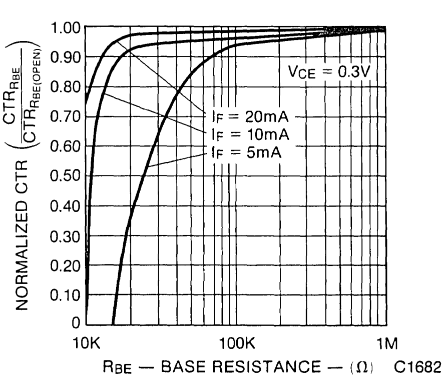


Fig. 6. C_{TR} vs. R_{BE}

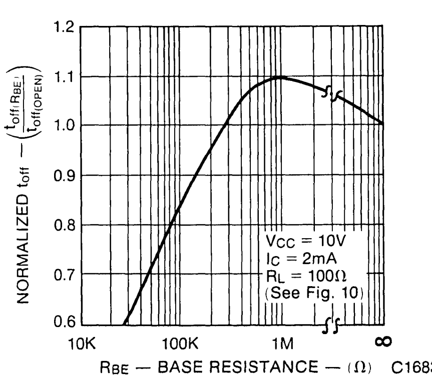


Fig. 7. Normalized t_{off} vs. R_{BE}

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

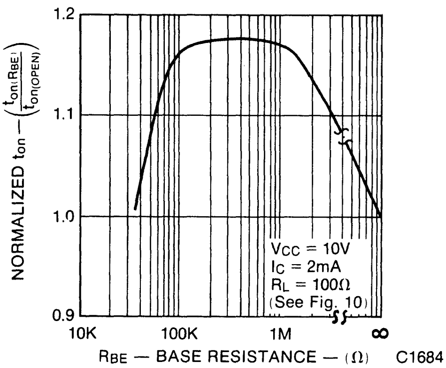


Fig. 8. Normalized t_{on} vs. R_{BE}

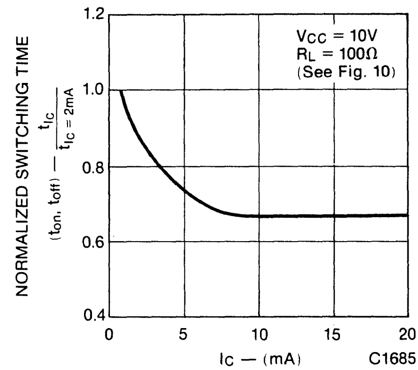
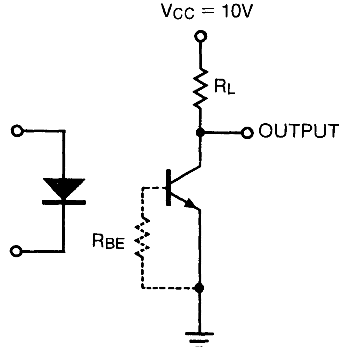


Fig. 9. Normalized Switching Time vs. Collector Current



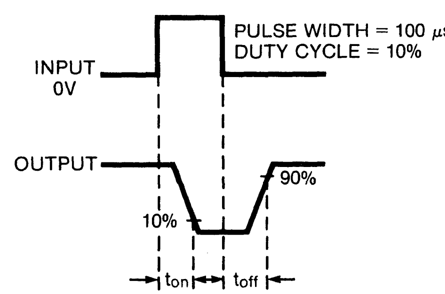


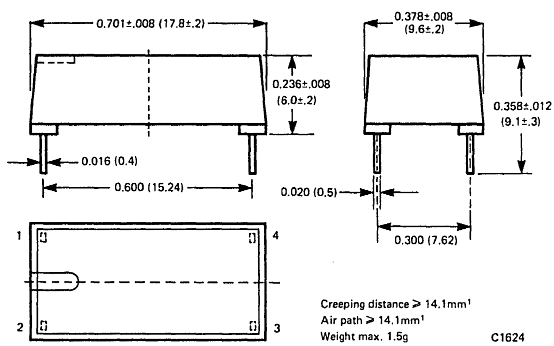
Fig. 10. Switching Time Test Circuit and Waveform

VDE APPROVED, HIGH-VOLTAGE OPTOISOLATOR

GENERAL INSTRUMENT

CNY65

PACKAGE DIMENSIONS



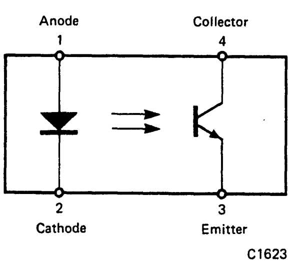


Fig. 1. Equivalent Circuit

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. The circuit is packaged in a plastic dual-in-line package.

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 ($T_A \leq 25°C$) 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 ($T_A \leq 25°C$) 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 ($T_A \leq 25°C$) 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	

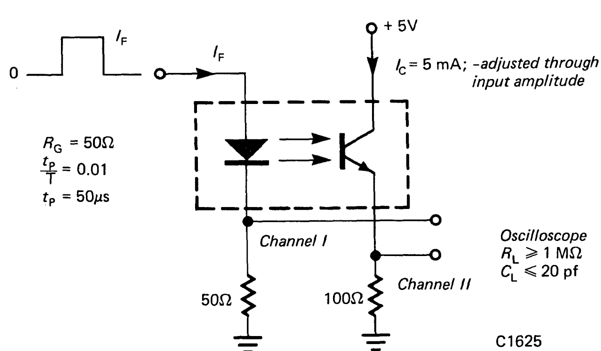


Fig. 2. Switching Time Test Circuit

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

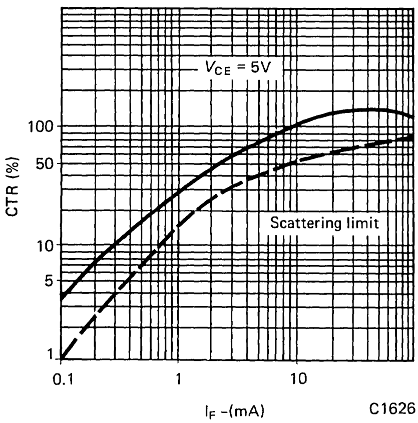


Fig. 3. Current Transfer Ratio vs. Forward Current

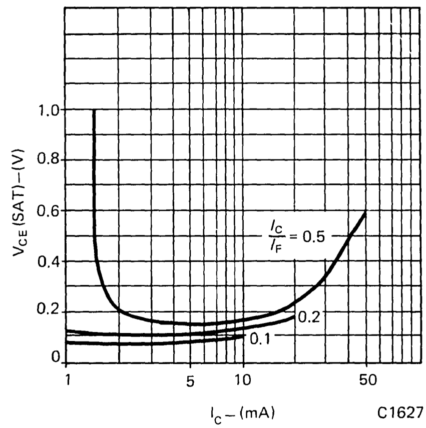


Fig. 4. V_{CE} (SAT) vs. Collector Current

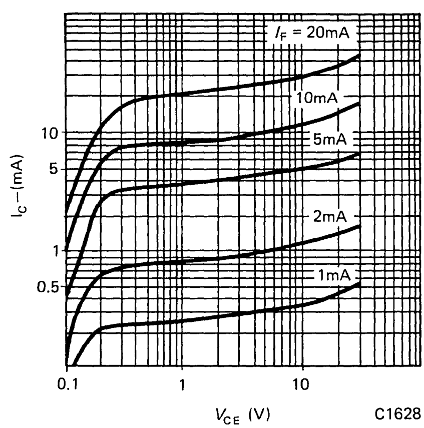


Fig. 5. Collector Current vs. Collector Voltage

NOTES

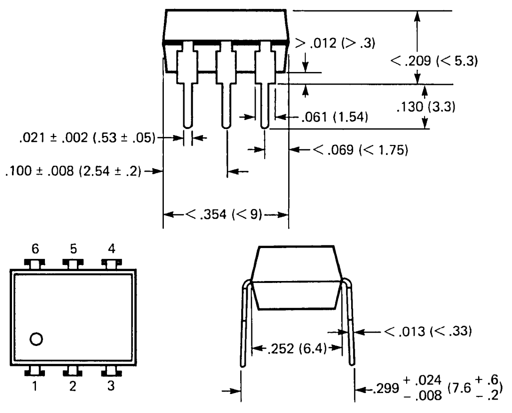
1. *Creeping current resistance: Group III (KB>600–KC>600) according to VDE 0110b/2.79 table 3 and DIN 53 480/VDE 0303 part 1/10.76.*
2. *According to VDE test certificate dated 3/19/82.*
3. *Related to standard climate 23/50 DIN 50 014.*

GENERAL INSTRUMENT

CNY75A
CNY75B
CNY75C

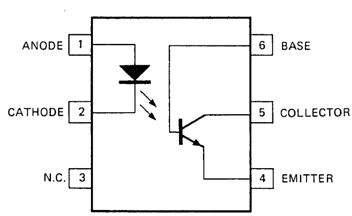
PACKAGE DIMENSIONS

Dimensions in inches (millimeters)



Airpath ⩾ 7.4 mm^2
Creeping Distance ⩾ 8.6 mm^2
Weight = approximately 0.7 g

C1614



C1615

Fig. 1. Equivalent Circuit

DESCRIPTION

The CNY75 Series is an optoisolator which combines a GaAs emitter with a silicon NPN phototransistor. This device offers high isolation voltage (5.3 kV min.) as well as high BV_{CEO} (70 V min.). The CNY 75 is packaged in a plastic six-pin dual-in-line package. VDE approval is pending.

FEATURES

- Isolation voltage 5.3kV[1]
- Nominal isolation operating voltage[1] — 500V AC or 600V DC for isolation group C according to VDE 0110/b/02.79
- VDE test class 25/100/21 DIN 40 045
- Low coupling capacity typ. 0.3 pF
- Current transfer ratio in selected groups:
  - CNY75A: 63%-125%
  - CNY75B: 100%-200%
  - CNY75C: 160%-320%
- Underwriters Laboratory (UL) recognized File No. E76414

APPLICATIONS

- Telephone circuits
- Digital input to telecommunications
- Industrial control systems
- Power supply regulators
- Appliance sensor systems
- Microprocessor controls

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature range	-55°C to +100°C
DC isolation voltage (t = 1 min)[3]	5.3kV
Total power dissipation (T_A ⩽ 25°C)	250mW
Solder lead temperature (t ⩽ 3s)[4]	260°C

EMITTER

Reverse voltage	5V
Forward current	60mA
Forward surge current (tp ⩽ 10μs)	3A
Power dissipation (T_A ⩽ 25°C)	100mW
Junction temperature	100°C

DETECTOR

Collector-base voltage	80V
Collector-emitter voltage	70V
Emitter-collector voltage	7V
Collector current	50mA
Collector peak current (tp/T = 0.5, tp ⩽ 10ms)	100mA
Power dissipation (⩽ 25°C)	150mW
Junction temperature	100°C

ELECTRICAL CHARACTERISTICS (25°C Ambient Temperature Unless Otherwise Specified)

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	CONDITIONS
INPUT DIODE						
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 TRANSISTOR						
Collector-base Breakdown Voltage	BV_{CBO} *	80			V	I_C = 100μA
Collector-emitter Breakdown Voltage	BV_{CEO} *	70			V	I_C = 1mA
Emitter-Collector Breakdown Voltage	BV_{ECO} *	7			V	I_E = 100μA
Collector-emitter leakage current	I_{CEO} *		30	150	nA	V_{CE} = 30V, I_F = 0
COUPLED DEVICE						
Current Transfer Ratio	I_C/I_F *					I_F = 10mA, V_{CE} = 5V
Group A		63		125	%	
Group B		100		200	%	
Group C		160		320	%	
Collector-emitter Saturation Voltage	$V_{CE(SAT)}$ *			0.3	V	I_F = 10mA, I_C = 1mA
DC Isolation Voltage[5]	V_{ISO} **	5.3			kV	t = 1 min.
Isolation Resistance[5]	R_{ISO}		10^{12}		Ω	V_{ISO} = 1000V, 40% R.H.
Isolation Capacitance	C_{ISO}		0.3		pF	f = 1 mHz
Bandwidth	BW		110		kHz	I_F = 10mA, V_{CE} = 5V, R_L = 100Ω

* AQL = 0.65%
** AQL = 2.5%

SWITCHING CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Delay time	t_d		2.5		µs	
Rise time	t_r		3.5		µs	V_{CC} = 5V,
Turn-on time	t_{on}		6.0		µs	I_C = 10mA,
Storage-time	t_s		0.3		µs	R_L = 100Ω
Fall time	t_f		3.2		µs	See Figure 2
Turn-off time	t_{off}		3.5		µs	

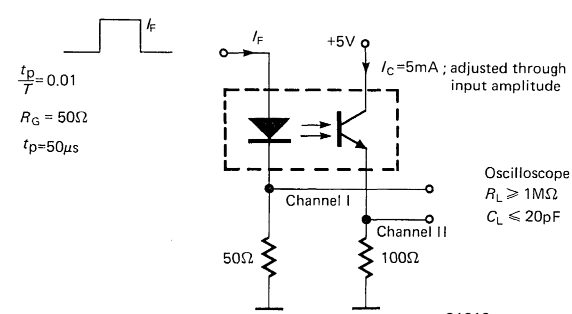


Fig. 2. Test Circuit for Switching Characteristics

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

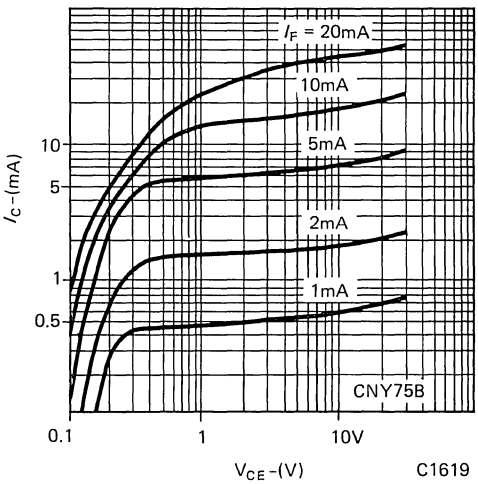


Fig. 3. Collector Current vs. Collector Voltage

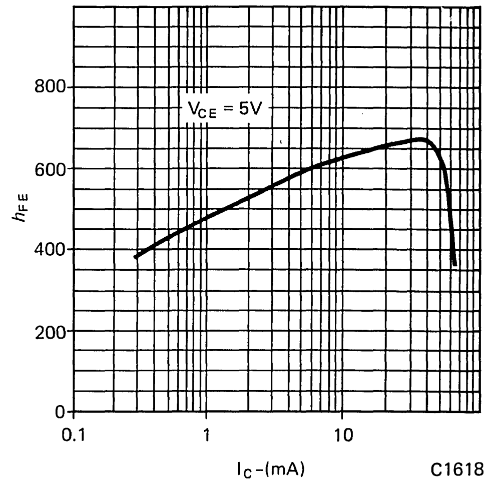


Fig. 4. h_{FE} vs. Collector Current

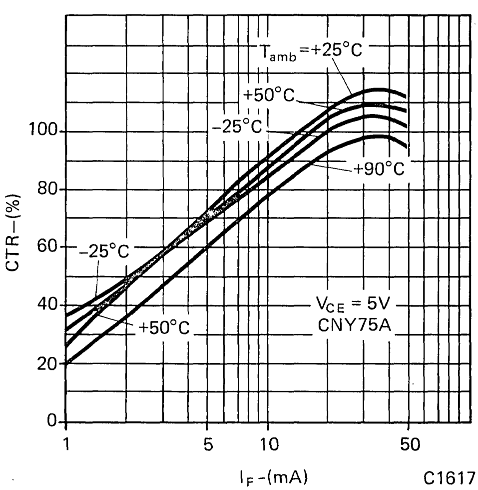


Fig. 5. Current Transfer Ratio vs. Forward Current

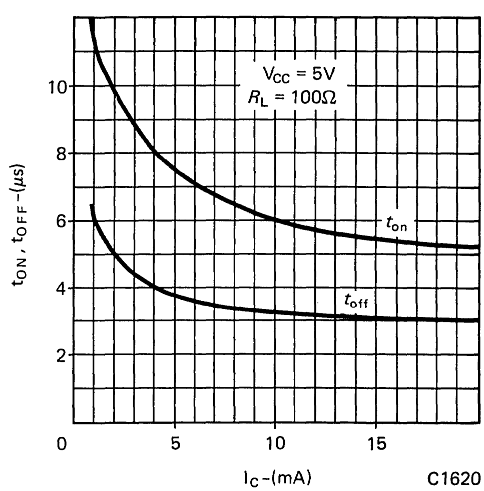


Fig. 6. Switching Time vs. Collector Current (See Fig. 2 for Test Circuit)

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

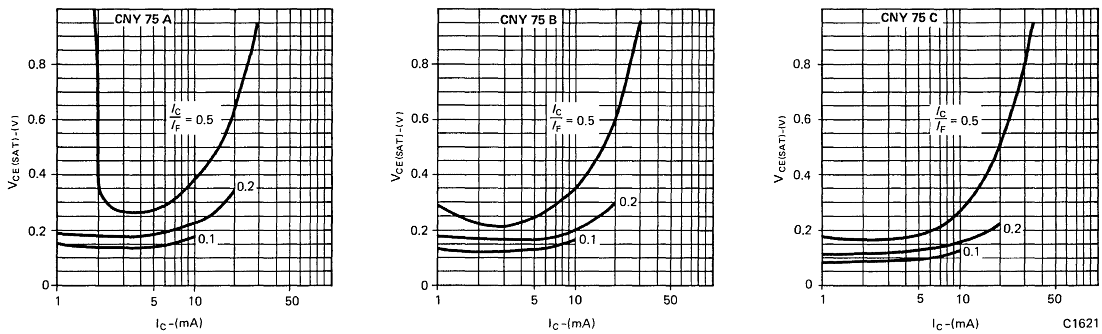


Fig. 7. Saturated Collector Emitter Voltage vs. Collector Current

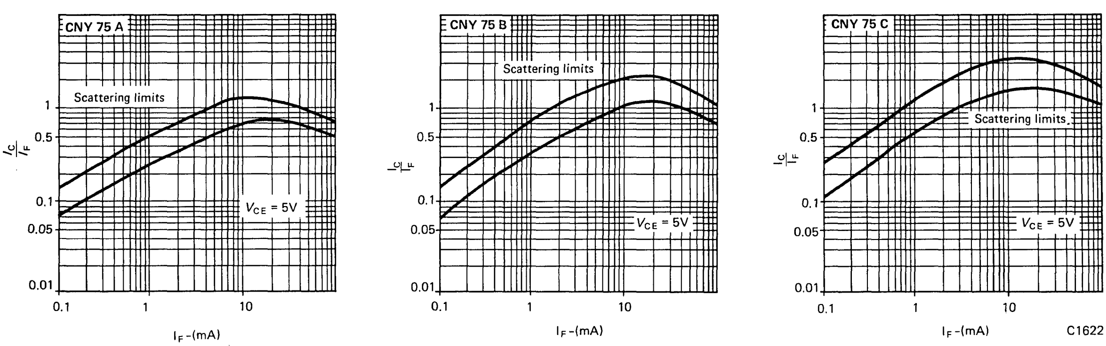


Fig. 8. Current Transfer Ratio vs. Forward Current

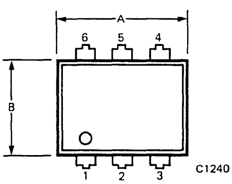
NOTES

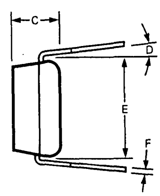
1. *According to VDE 0883/6.80. VDE-certificate has been applied.*
2. *Creeping current resistance: Group I according to VDE 0110 & 6 table 3 and DIN 53 480/VDE 0303 part 1.*
3. *Related to standard climate 23/50 DIN 50 014.*
4. *Distance from the touching border ⩾ 2 mm.*
5. *Related to standard climate 23/50 DIN 50 014.*

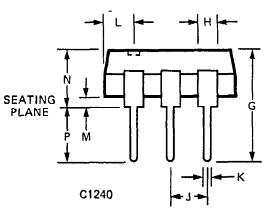
GENERAL INSTRUMENT

MCA11G1
MCA11G2

PACKAGE DIMENSIONS







SYMBOL	INCHES MAX.	MIL. 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

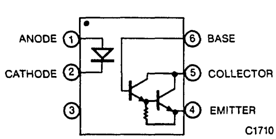


Fig. 1. Equivalent Circuit

DESCRIPTION

The MCA11G1 and MCA11G2 are photodarlington-type optically coupled optoisolators. Both devices have an infrared light emitting diode manufactured from specially grown gallium arsenide, coupled with a silicon, darlington connected phototransistor which has an integral base-emitter resistor to optimize elevated temperature characteristics. These devices are supplied in a standard plastic six-pin dual-in-line package.

FEATURES

- High BV_{CEO}
  Minimum 100V for MCA11G1
  Minimum 80V for MCA11G2
- High sensitivity to low input current — Minimum 500 percent CTR at $I_F = 1$ mA
- High isolation voltage
  2500 VAC RMS — Steady State Rating
- Low leakage current at elevated temperature (maximum 100μA at 80°C).
- Underwriters Laboratory (UL) recognized File #E50151
- VDE approval applied for

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	$V_{CE(SAT)}$					
				.85	1.0	V	I_F = 16 mA; I_C = 50 mA
				.75	1.0	V	I_F = 1 mA; I_C = 1 mA
SWITCHING TIMES	Turn-on time	t_{on}		5		μs	$R_L = 100\Omega$; 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 1 second
			3000			VAC-rms	
	Steady state isolation	V_{iso}	3500			VDC	Relative humidity ⩽ 50%, I_{I-O} ⩽ 10 μA 1 minute
			2500			VAC-rms	
	Isolation resistance	R_{iso}	10^{11}			ohms	V_{I-O} = 500 VDC
	Isolation capacitance	C_{iso}		.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 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 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 collector	BV_{ECO}	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)

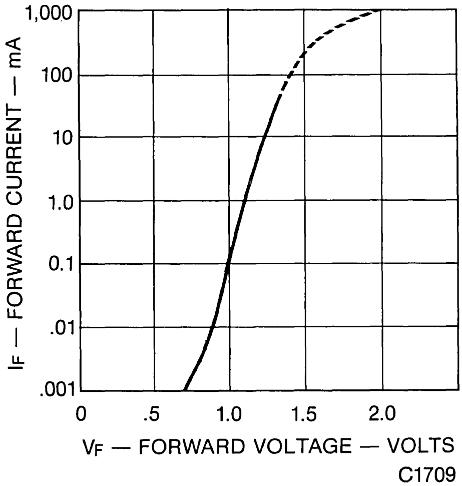


Fig. 2. Forward Voltage vs. Forward Current

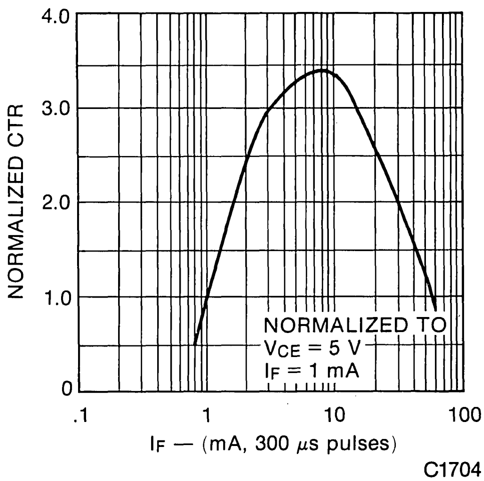


Fig. 3. Normalized CTR vs. Input Current

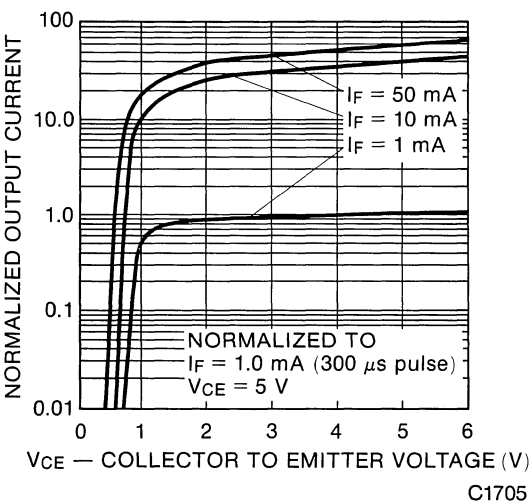


Fig. 4. Output Characteristics

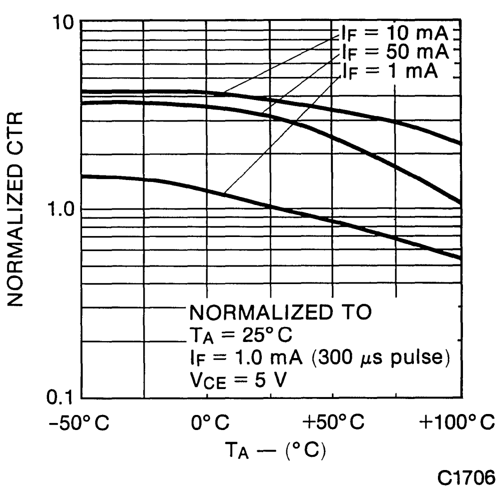


Fig. 5. Normalized CTR vs. Temperature

TYPICAL-ELECTRICAL CHARACTERISTIC CURVES (Cont.)

(25°C Free air temperature unless specified)

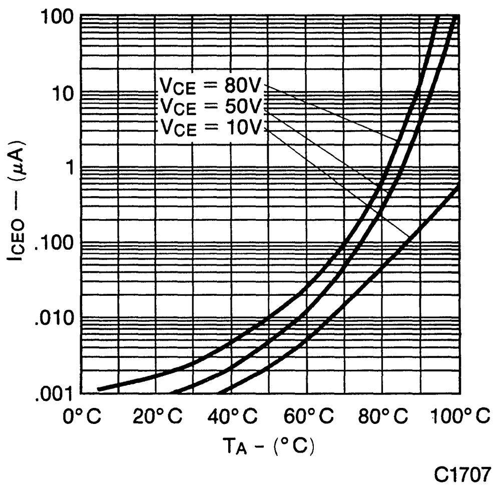


Fig. 6. Dark Current vs. Temperature

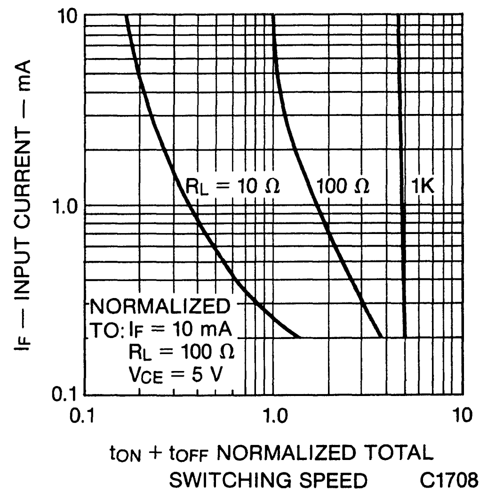
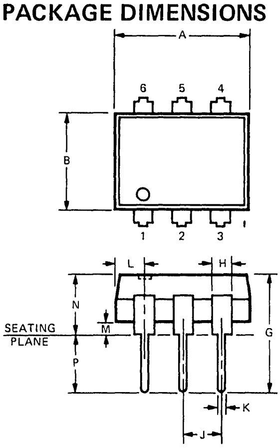


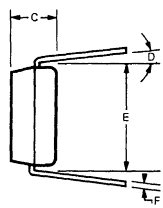
Fig. 7. Switching Speed

GENERAL INSTRUMENT

MCA230
MCA255

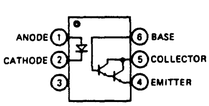
PACKAGE DIMENSIONS





C867

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

DESCRIPTION

The MCA230 and MCA255 optoisolators contain a gallium arsenide infrared emitting diode optically coupled to a silicon planar photodarlington transistor. Both units are sealed in a 6-lead plastic DIP package. Electrical isolation compares favorably with that of a relay—without the relay's inherent magnetic field. The MCA230 has a minimum collector-emitter breakdown voltage of 30 volts and the MCA255, 55 volts.

FEATURES & APPLICATIONS

- High collector current rating – 125 mA
- Fast operate time – 10 μs
- Fast release time – 35 μs
- High isolation resistance – 10^{11} Ω
- High dielectric strength, input to output – 4000 VDC
- Low coupling capacitance – 0.5 pF
- Convenient package – plastic dual-in-line
- Long lifetime, solid state reliability
- Low weight – 0.4 grams
- Replace reed relays for 50 mA, 55 V DC loads
- Replace pulse transformers
- Form multiple contact, NO/NC relays
- Useful for telephone lines, telegraph lines, SCR triggers, hospital monitoring systems, airborne systems, remote data gathering systems and remote control systems.
- Use as a low-current alarm monitor for battery powered supplies
- UL recognized – File E50151
- VDE approval applied for

ABSOLUTE MAXIMUM RATINGS

Storage Temperature . . . . –55°C to 150°C
Operating Temperature . . . . –55°C to 100°C
Lead Soldering time @ 260°C . . . . .7.0 sec
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 . . . . 90 mW
Derate linearly from 25°C . . . . 1.2 mW/°C
Continuous forward current . . . . 60 mA
Reverse voltage . . . . 3.0 V
Peak forward current (1 μsec pulse, 300 pps) . . 3.0 A

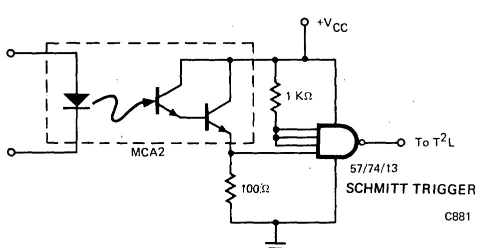
DETECTOR
(Silicon Photo Transistor) **MCA230** **MCA255**
Power dissipation
@ 25°C ambient . . . . .210 mW . . .210 mW
Derate linearly from 25°C . . 2.8 mW/°C . 2.8 mW/°C
Collector-emitter breakdown
voltage (BV_{CEO}) . . . . 30 V . . . . . 55 V
Collector-base breakdown
voltage (BV_{CBO}) . . . . 30 V . . . . . 55 V
Emitter-base breakdown
voltage (BV_{EBO}) . . . . 8.0 V . . . . 8.0 V
Collector-emitter
current (I_{CE}) . . . . .125.0 mA 125.0mA

DC RELAY CHARACTERISTICS (TYPICAL)

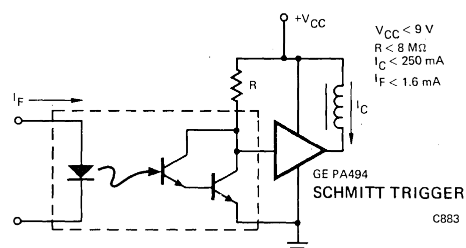
CONTACTS		
Contact configuration		SPST-NO
Contact load rating		50 mA DC
Contact withstand voltage	MCA230	30 V DC
	MCA255	55 V DC
Closed contact voltage		1.0 V
Operate time with 100 Ωload		10 μseconds
Release time with 100 Ωload		35 μseconds
COIL		
Turn on voltage		1.3 V
Turn on current at rated contact load		50 mA
ISOLATION		
Dielectric strength, contacts to coil		4000 VDC minimum
Isolation resistance, contact to coil		10^{11} Ohms
Capacitance, contacts to coil		1.0 pF
WEIGHT		0.4 grams

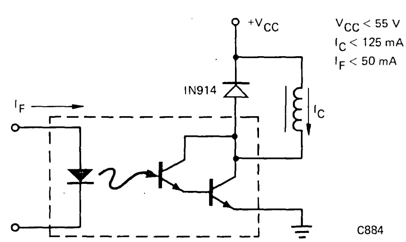
APPLICATION CIRCUITS

ISOLATE T²L LOGIC WITH MCA2



OPERATING A RELAY COIL WITH MCA2





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 5 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%.*

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

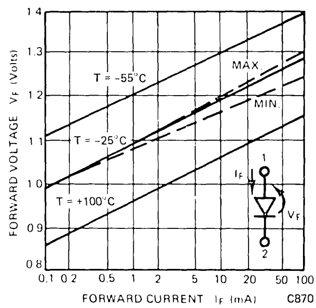


Fig. 1. Forward Voltage Drop vs. Forward Current

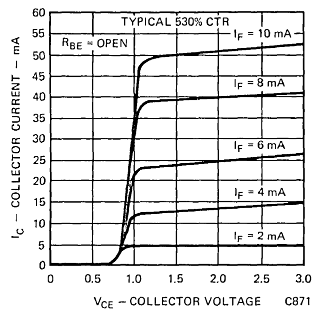


Fig. 2. Collector Current vs. Collector Voltage

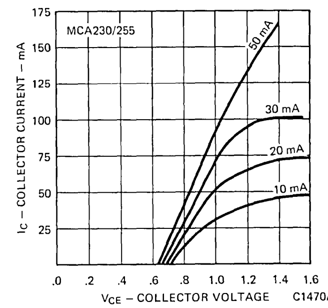


Fig. 3. Collector Current vs. Collector Voltage

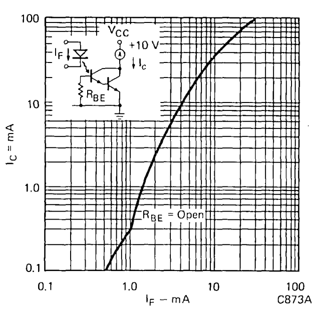


Fig. 4. Current Transfer Characteristic

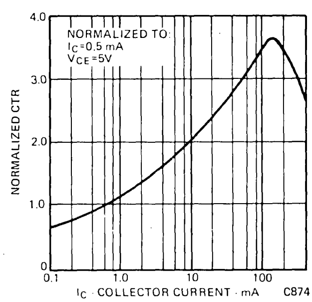


Fig. 5. Normalized CTR vs. Collector Current

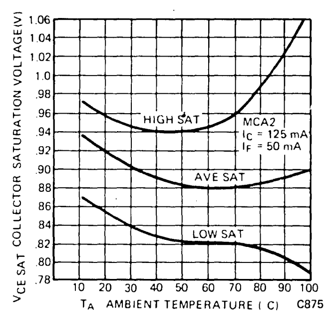


Fig. 6. $V_{CE\text{-}SAT}$ vs. Temperature

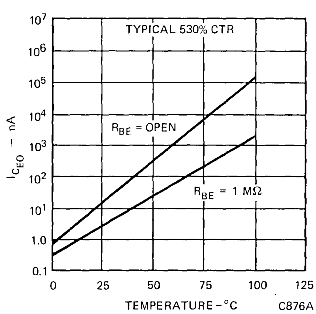


Fig. 7. I_{CEO} vs. Temperature

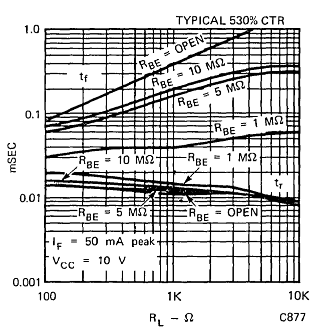


Fig. 8. Switching Times

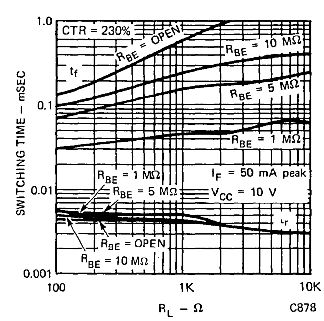


Fig. 9. Switching Times

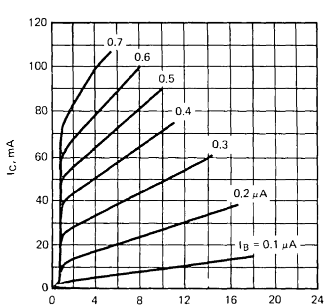


Fig. 10 Detector Standard Transfer Curves

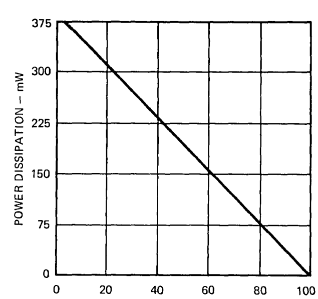
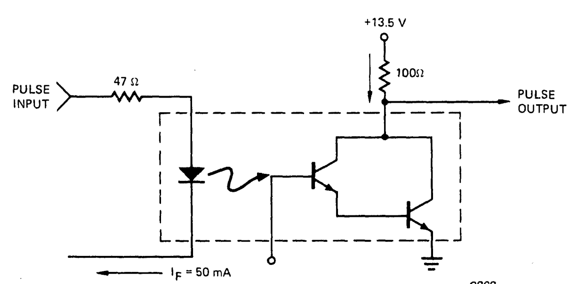


Fig. 11. Package Power Derating

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

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
EMITTER						
Forward Voltage	V_F		1.25	1.5	V	I_F = 20 mA
Reverse Voltage	V_R	3	25		V	I_R = 10 µA
Capacitance	C_J		50		pF	V = 0
DETECTOR						
Gain	H_{FE}		25,000			V_{CE} = 5 V, I_C = 0.5 mA
Collector Breakdown Voltage	BV_{CEO}	30/55			V	I_C = 100 µA, I_F = 0
Base Breakdown Voltage	BV_{CBO}	30/55			V	I_C = 10 µA, I_F = 0
Emitter Breakdown Voltage	BV_{EBO}	8			V	I_E = 1 µA, I_F = 0
Collector Leakage Current	I_{CEO} (DARK)		1.0	100	nA	V_{CE} = 10 V, I_F = 0
Capacitance						
Collector-Emitter			3.4		pF	V_{CE} = 10 V
Collector-Base			10		pF	V_{CB} = 10 V
Emitter-Base			10		pF	V_{EB} = 0.5 V
COUPLED						
DC Base Current Transfer Ratio			0.1		%	I_F = 50 mA, V_{CB} = 10 V
DC Collector Current Transfer Ratio		100	530		%	I_F = 10 mA, V_{CE} = 5 V, Note 1
Saturation Voltage	V_{CE} (SAT)			1.0	V	I_C = 50 mA, I_F = 50 mA
Bandwidth (50% Δ CTR)			10		kHz	I_C = 10 mA, Note 2, R_L = 100 Ω, V_{CE} = 10 V
Fall time	t_f		35		µsec	See switching time test circuit Note 3
Rise time	t_r		5		µsec	
ISOLATION						
DC Voltage Breakdown	V_{ISO}	4000			V	t = 1 second
Resistance	R_{ISO}	10^{11}	10^{12}		Ω	V = 500 VDC
Leakage Current	I_{ISO}		10		µA	V_{ISO} = 1500 VDC.
Capacitance	C_{ISO}		0.5		pF	
Dielectric Dissipation Limit		50,000			VHz	RMS
AC Voltage Limit @ 60 Hz		2500			V_{RMS}	t = 1 minute

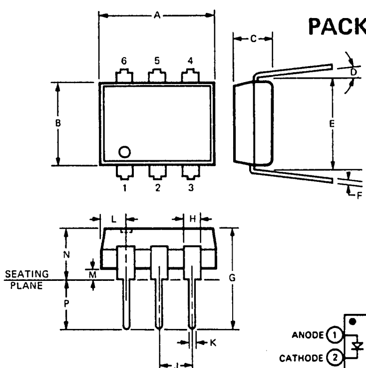
SWITCHING TIME TEST CIRCUIT



Pulse Width = 1 ms
Pulse Rep Rate = 100 Hz

GENERAL INSTRUMENT

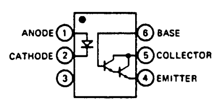
MCA231



PACKAGE DIMENSIONS

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



C1339

DESCRIPTION

The MCA231 contains a gallium arsenide infrared emitter optically coupled to a silicon planar photodarlington. Both units are sealed in a 6-lead plastic DIP package.

FEATURES

- High sensitivity — 1 mA on the input will sink a TTL gate
- High isolation — 4000 VDC, 10^{12} Ω, 0.5 pF
- UL recognized — File E50151
- VDE approval applied for

TYPICAL APPLICATIONS

- Isolate logic from 110/220 VAC.
- Eliminate troublesome ground loop problems by coupling directly to twisted pair lines in digital systems. Particularly useful for telephone lines, telegraph lines, SCR triggers, hospital monitoring systems, airborne systems, remote data gathering systems, and remote control systems.

ABSOLUTE MAXIMUM RATINGS

Storage Temperature Range . . . . −55°C to +150°C
Operating Temperature Range . . . . −55°C to +100°C
Lead Temp. (Soldering, 10 sec) . . . . 260°C
Total Power Diss. @ 25°C Free
Air Temperature . . . . 250 mW
Derate Linearly to 100°C (θ_{JA}) . . . . 3.3 mW/°C
Input to Output Isolation Voltage . . . . 3550 VDC
(1 second)

Input Diode
Forward Current . . . . 60 mA
Reverse Voltage . . . . 3.0 V
Peak Forward Current (1 μs pulse, 300 pps) . . . . . . 3.0 A
Output Darlington
Collector-Emitter Voltage . . . . 30 V
Collector-Base Voltage . . . . 30 V
Emitter-Base Voltage . . . . 6 V
Collector Current . . . . 125 mA

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

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Isolation between emitter and detector						
Capacitance	C_{iso}		0.5		pF	f = 1 MHz
Resistance	R_{iso}	10^{11}	10^{12}		Ω	V = 500 VDC
Voltage Breakdown	V_{iso}	4000			VDC	t = 1 second
		2500			VRMS	t = 1 minute
Emitter (GaAs LED)						
Forward Voltage	V_F		1.15	1.5	V	I_F = 20 mA
Reverse Voltage	V_R	3.0	25		V	I_R = 10 μA
Junction Capacitance	C_J		50		pF	V_R = 0 V
Detector (Silicon Photo-Darlington)						
Collector Breakdown Voltage	V(BR)CEO	30	60		V	I_C = 1 mA
Base Breakdown Voltage	V(BR)CBO	30	60		V	I_C = 10 μA
Emitter Breakdown Voltage	V(BR)EBO	6	8		V	I_E = 10 μA
Collector Leakage Current	I_{CEO}		1	100	nA	V_{CE} = 10 V
Saturation Voltage	$V_{CE(sat)}$		0.8	1.0	V	I_C = 2 mA, I_F = 1 mA
Saturation Voltage	$V_{CE(sat)}$		0.8	1.0	V	I_C = 10 mA, I_F = 5 mA
Saturation Voltage	$V_{CE(sat)}$		0.9	1.2	V	I_C = 50 mA, I_F = 10 mA
Base photo-current	I_B		2		μA	V_{CB} = 5 V, I_F = 10 mA
Darlington gain	h_{FE}		50 k			I_B = 1 μA, V_{CE} = 1 V
Collector-emitter capacitance	C_{CE}		6		pF	V_{CE} = 10 V
Switching Times, Coupled						
Rise time, fall time	t_r, t_f		80		μs	V_{CC} = 10 V, I_C = 10 mA, R_L = 100Ω
TTL gate turn-on time	t_{ON}		200		μs	I_F = 1 mA, Fig. 10
TTL gate turn-off time	t_{OFF}		400		μs	I_F = 1 mA, Fig. 10
DC Collector Current Transfer Ratio	CTR	200	400		%	I_F = 10 mA, V_{CE} = 5 V

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

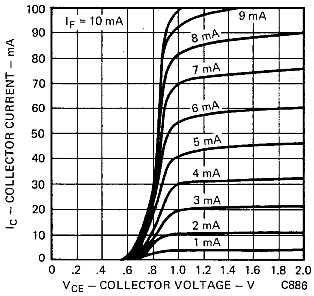


Figure 1. Collector Current vs. Collector Voltage

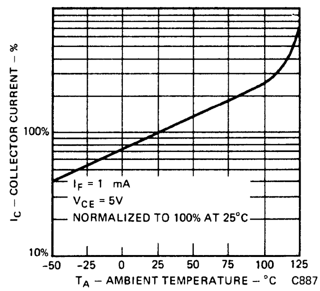


Figure 2. Collector Current vs. Ambient Temperature

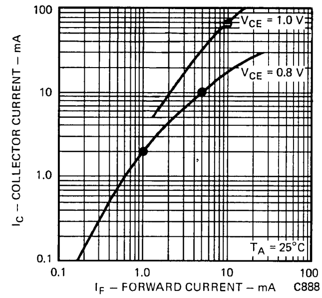


Figure 3. Collector Current vs. LED Current

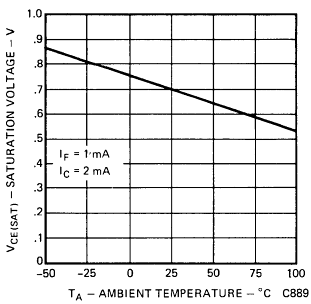


Figure 4. Saturation Voltage vs. Temperature

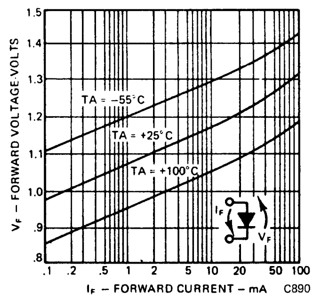


Figure 5. Forward Voltage vs. Forward Current

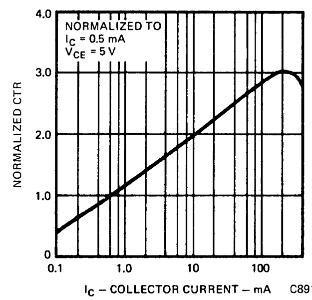


Figure 6. Normalized CTR vs. Collector Current

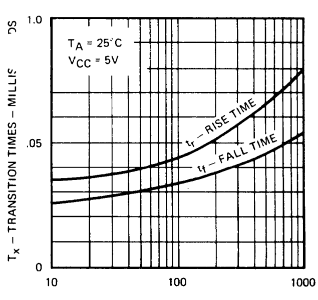


Figure 7. Non-Saturated Rise and Fall Times vs. Load Resistance

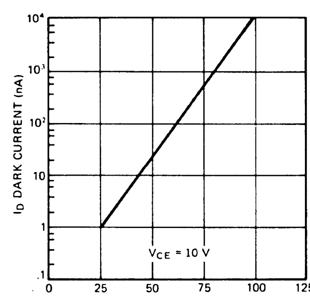


Figure 8. Dark Current vs. Temperature

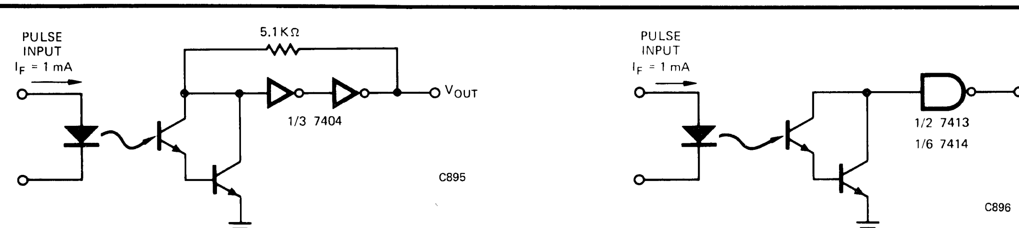


Figure 10. Logic Interface

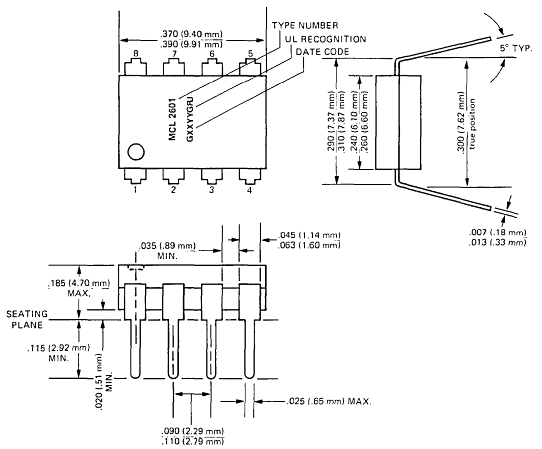
NOTES

See MCA230 for circuits

GENERAL INSTRUMENT

HIGH CMR, HIGH SPEED MCL2601

PACKAGE DIMENSIONS



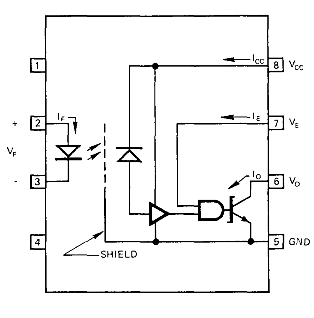


Fig. 1. Equivalent Circuit

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)

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 with-stand test voltage
- Pin for pin compatible to Hewlett Packard's HCPL-2601
- VDE approval applied for

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-O}			1.0	μA	Relative Humidity = 45% T_A = 25°C, t = 5s V_{I-O} = 3000 VDC Note: 10
Resistance (Input to Output)	R_{I-O}		10^{12}		Ω	V_{I-O} = 500V, Note: 10
Capacitance (Input to Output)	C_{I-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
Enable Propagation Delay Time (For Output Low Level)	t_{EHL}		14		ns	V_{EL} = 0V 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)

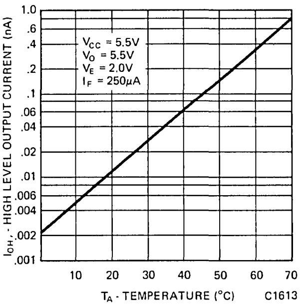


Fig. 2. High Level Output Current vs. Temperature

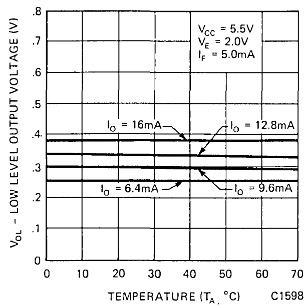


Fig. 3. Low Level Output Voltage vs. Temperature

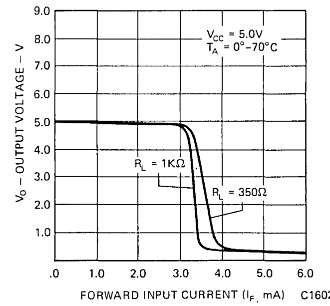


Fig. 4. Output Voltage vs. Forward Input Current

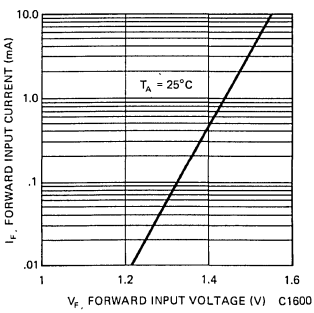


Fig. 5. Forward Input Current vs. Forward Input Voltage

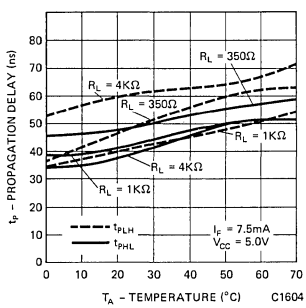


Fig. 6. Propagation Delay vs. Temperature

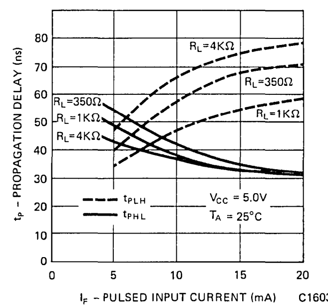


Fig. 7. Propagation Delay vs. Pulse Input Current

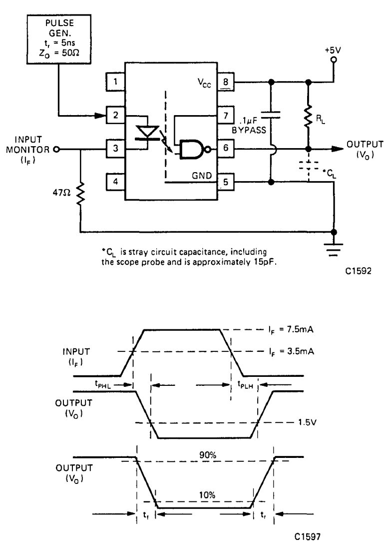


Fig. 8. Test Circuit t_{PHL}, t_{PLH}, t_r, and t_f

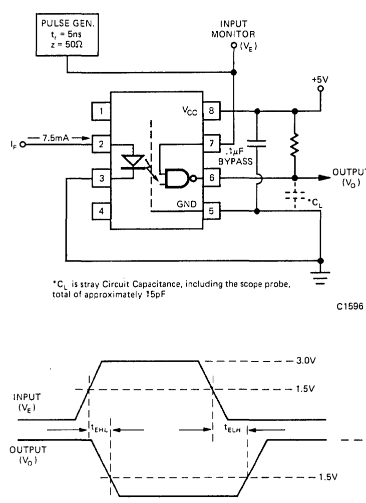


Fig. 9. Test Circuit t_{EHL} and t_{ELH}

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

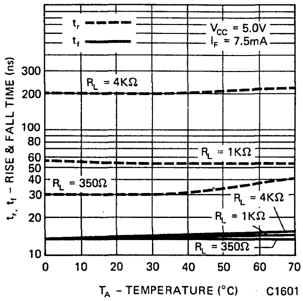


Fig. 10. Rise and Fall Time vs. Temperature

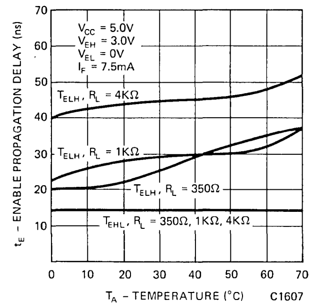


Fig. 11. Enable Propagation Delay vs. Temperature

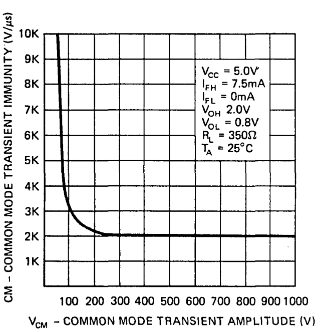


Fig. 12. Common Mode Transient Immunity vs. Common Mode Transient Amplitude C1590

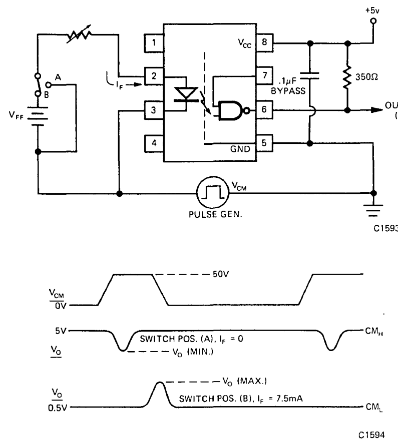


Fig. 13. Test Circuit Common Mode Transient Immunity

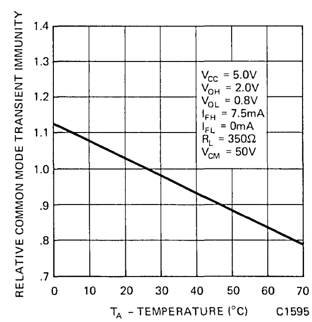


Fig. 14. Relative Common Mode Transient Immunity vs. Temperature

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:

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

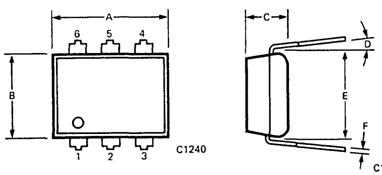
   Example:

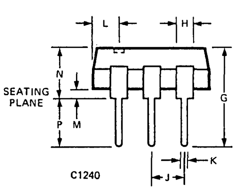
   $V_{CM} = 318 V_{PP}$ when $f_{CM} = 1MHz$ using CM_L and $CM_H = 1000V/\mu s$ data sheet specified minimum.
10. *- Device considered a two-terminal device: Pins 1, 2, 3 and 4 shorted together, and Pins 5, 6, 7 and 8 shorted together.*
11. *Enable Input - No pull up resistor required as the device has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

GENERAL INSTRUMENT

MCP3009
MCP3010
MCP3011

PACKAGE DIMENSIONS





SYMBOL	INCHES MAX.	MIL. 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

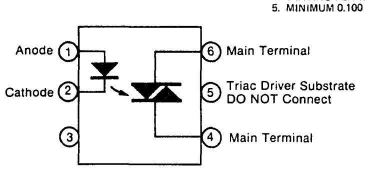


Fig. 1. Equivalent Circuit

DESCRIPTION

The MCP3009, MCP3010 and MCP3011 are optically isolated triac driver devices. These devices contain a GaAs infrared LED 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
- VDE approval applied for

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
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 . . . . . 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}		.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 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)

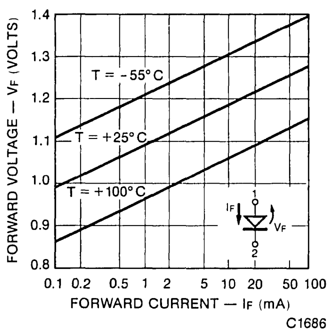


Fig. 2. Forward Voltage Drop vs. Forward Current

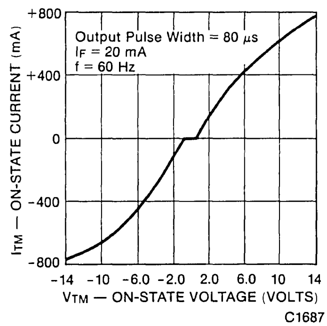


Fig. 3. On-State Characteristics

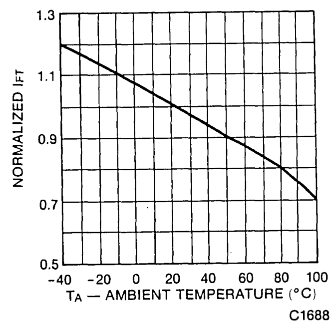


Fig. 4. Trigger Current vs. Temperature

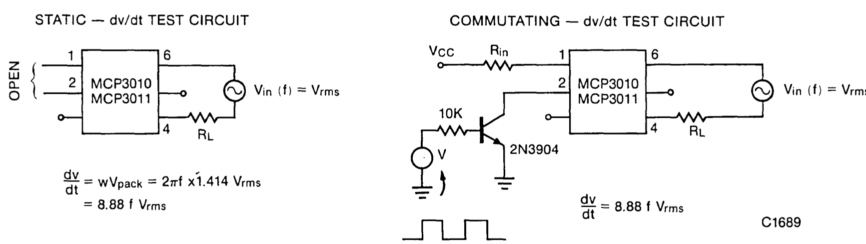


Fig. 5. dv/dt Test Circuits

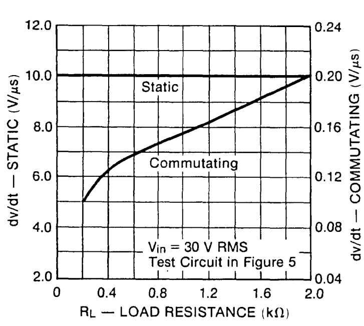


Fig. 6 dv/dt vs. Load Resistance

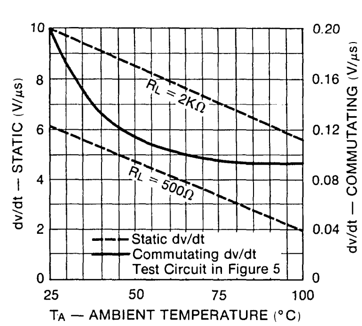


Fig. 7. dv/dt vs. Temperature

TYPICAL-ELECTRICAL CHARACTERISTIC CURVES

(25°C Temperature unless otherwise specified)

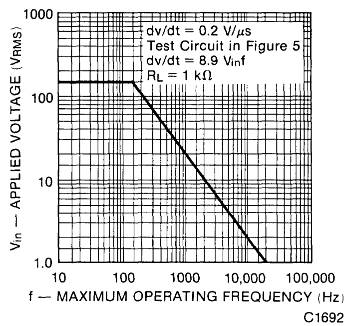


Fig. 8. Commutating dv/dt vs. Frequency

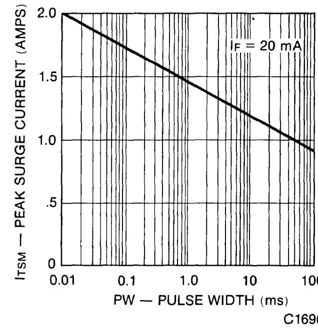


Fig. 9. Maximum Nonrepetitive Surge Current

TYPICAL APPLICATION CIRCUITS

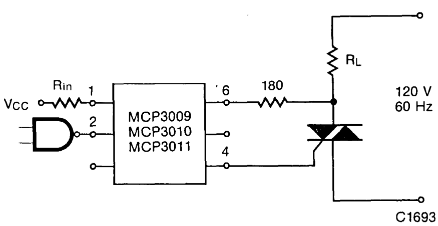


Fig. 10. Resistive Load

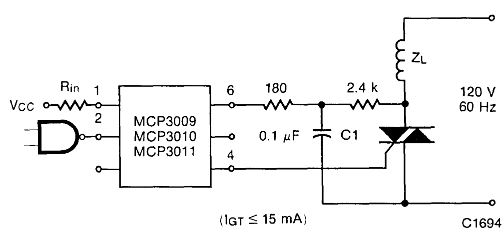


Fig. 11. Inductive Load With Sensitive Gate Triac

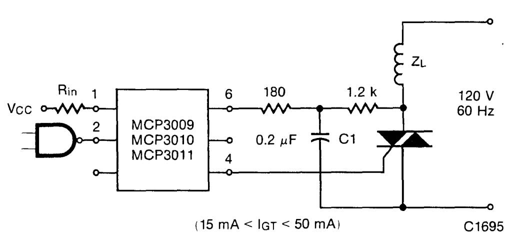


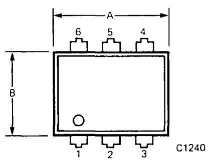
Fig. 12. Inductive Load With Non-Sensitive Gate Triac

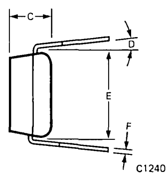
OPTICALLY ISOLATED
TRIAC DRIVER

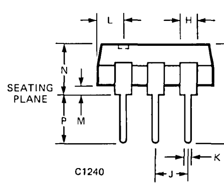
GENERAL INSTRUMENT

MCP3020
MCP3021
MCP3022

PACKAGE DIMENSIONS







SYMBOL	INCHES MAX.	MIL. 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

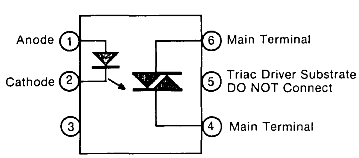


Fig. 1. Equivalent Circuit

DESCRIPTION

The MCP3020, MCP3021 and MCP3022 are optically isolated triac driver devices. These devices contain a GaAs infrared LED 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

- Low input current required (typically 5 mA — MCP3022)
- Minimum commutating dv/dt is specified at 0.1 V/μsec
- Pin for pin replacement for the MOC3020 and MOC3021
- High isolation voltage — minimum 7500 VAC peak
- Underwriters Laboratory (UL) recognized — File E50151
- VDE approval applied for

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}		.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 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)

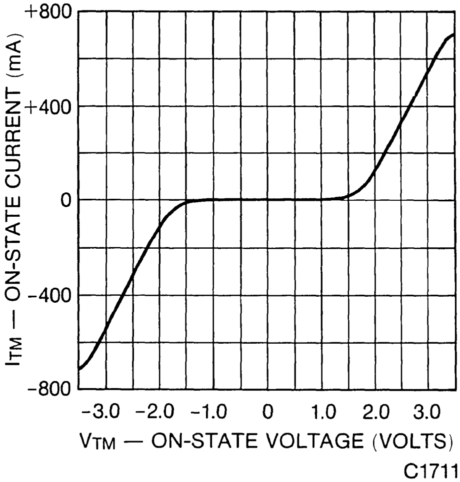


Fig. 2.
On-State Characteristics

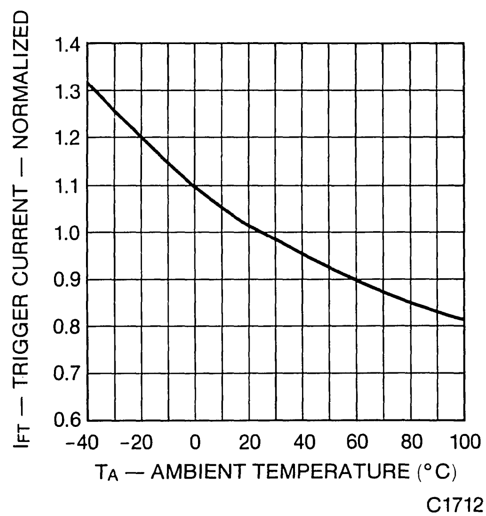
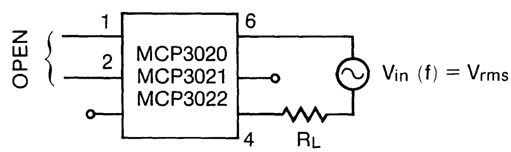


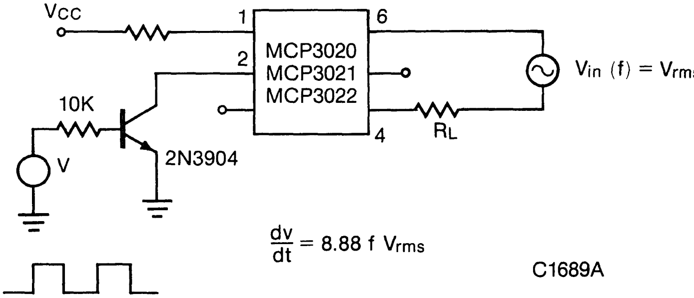
Fig. 3. Trigger Current vs.
Temperature

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



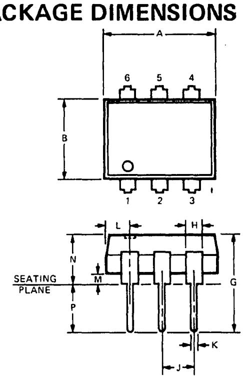
$$\frac{dv}{dt} = 8.88\ f\ V_{rms}$$

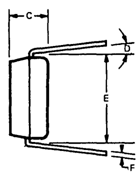
Fig. 5. Commutating dv/dt

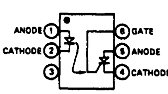
GENERAL INSTRUMENT

MCS2
MCS2400

PACKAGE DIMENSIONS







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

C1339

DESCRIPTION

The MCS2 and the MCS2400 devices consist of a photo SCR coupled to a gallium arsenide infrared diode in a six lead plastic DIP package. The MCS2 has a blocking voltage rating of 200 volts while the MCS2400 has 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 — $10^{11}\ \Omega$
- Compact, rugged, light-weight
- Low coupling capacitance — 1.0 pF typical
- MCS2400, UL recognized (File E50151)
- High isolation voltage V_{ISO} = 2500 V RMS, 1 minute
- VDE approval applied for

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

Storage temperature –55°C to 150°C
Operating temperature –55°C to 100°C
Lead soldering time @ 260°C 7.0 seconds

LED (GaAs Diode)
Power dissipation @ 25°C ambient . . . . 90 mW
Derate linearly from 25°C . . . . 1.2 mW/°C
Continuous forward current . . . . 60 mA
Reverse voltage . . . . 3.0 V
Peak forward current . . . . 0.5 A
(50 μs pulse, 120 pps)

COUPLED
Isolation voltage . . . . 3550 VDC
Total package power dissipation . . . . 250 mW
Derate linearly from 25°C . . . . 3.3 mW/°C

DETECTOR (Photo SCR)
Power dissipation @ 25°C ambient . . . . 200 mW
Derate linearly from 25°C . . . . 2.67 mW/°C
MCS2 DC anode current . . . . 150 mA
MCS2400 DC anode current . . . . 100 mA
Peak pulse current (100 μs, 120 pps) . . . . 1.0 A
Average gate current . . . . 25 mA
Reverse gate current . . . . 1.0 mA
MCS2 anode voltage (DC or peak AC) . . . . 200 V
MCS2400 anode voltage (DC or peak AC) . . . . . 400 V

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

CHARACTERISTICS	MCS2 MIN.	MCS2 TYP.	MCS2 MAX.	MCS2400 MIN.	MCS2400 TYP.	MCS2400 MAX.	UNITS	TEST CONDITIONS
INPUT DIODE								
Forward voltage (V_F)		1.25	1.5		1.25	1.5	V	I_F = 20mA
Reverse voltage (V_R)	3.0	—	—	3.0	—	—	V	I_R = 10 μA
Reverse current (I_R)	—	.001	10	—	.001	10	μA	V_R = 3.0 V
Junction capacitance (C_J)	—	50	—	—	50	—	pF	V = 0
DETECTOR								
Forward leakage current (I_{FX})	—	.02	2.0	—	.02	2.0	μA	V_{FX} = Rated V_{FX}, R_{GK} = 27kΩ
Reverse leakage current (I_{RX})	—	.02	2.0	—	.02	2.0	μA	V_{RX} = Rated V_{RX}, R_{GK} = 27kΩ
Forward blocking voltage (V_{FXM}, V_{DM})	200	—	—	400	—	—	V	R_{GK} = 10kΩ @ 100°C
Reverse blocking voltage (V_{ROM})	200	—	—	400	—	—	V	R_{GK} = 10kΩ @ 100°C
On voltage (V_{TM})	—	.98	1.3	—	.98	1.3	V	I_T = 100 mA
Holding current (I_{HX})	.01	.16	.50	.01	.16	.50	mA	R_{GK} = 27kΩ
Gate trigger voltage (V_{GT})	—	0.5	1.0	—	0.6	1.0	V	V_{FX} = 100 V
Gate trigger current (I_{GT})	—	19	100	—	23	100	μA	V_{FX} = 100 V, R_L = 10kΩ, R_{GK} = 27kΩ
COUPLED								
Turn on current (threshold), (I_{FT})	0.5	5.0	14	0.5	5.0	14	mA	V_{FX} = 100 V, R_{GK} = 27kΩ
$t_r + t_d$ (See note 1) = (t_{on})	—	7	—	—	7	—	μs	I_F = 30 mA, R_{GK} = 27kΩ, V_{CC} = 20 V
Steady state voltage (V_{ISO})	3500	—	—	3500	—	—	VDC	t = 1 min.
	2500	—	—	2500	—	—	V_{RMS}	t = 1 min.
Surge isolation rating	4000	—	—	4000	—	—	VDC	t = 1 sec.
	3000	—	—	3000	—	—	V_{RMS}	t = 1 sec.
Isolation resistance (R_{ISO})	10^{11}	10^{12}	—	10^{11}	10^{12}	—	Ω	V = 500 VDC
Isolation capacitance (C_{ISO})	—	1.0	2	—	1.0	2	pF	f = 1 MHz

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

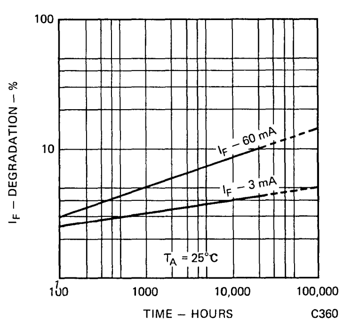


Fig. 1. LED Lifetime vs. Forward Current

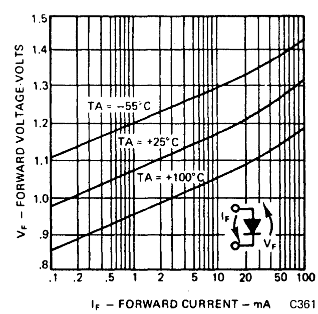


Fig. 2. Forward Voltage vs. Forward Current

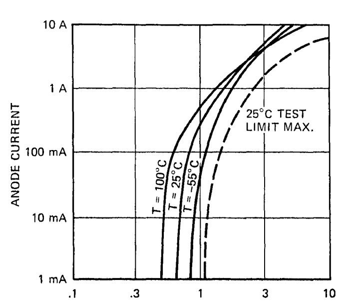


Fig. 3. Anode Current vs. Anode-Cathode Voltage

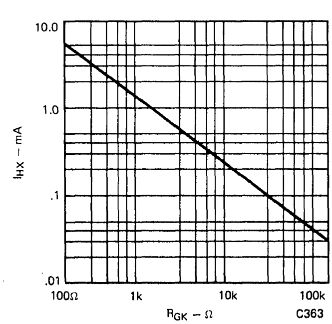


Fig. 4. Holding Current vs. Gate-Cathode Resistance

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (Cont'd)

(25°C Free Air Unless Otherwise Specified)

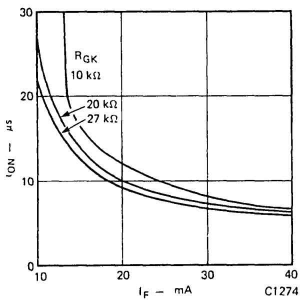


Fig. 5. Trigger Delay Time vs. Forward Current (note 1)

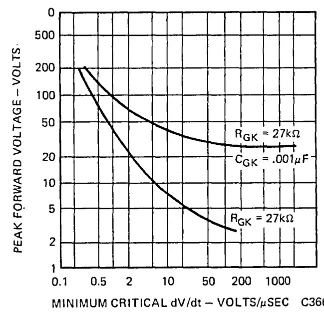


Fig. 6. Forward Blocking Voltage vs. Critical dV/dt

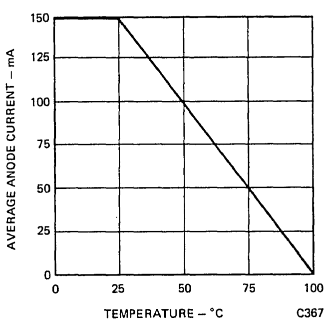


Fig. 7. Continuous Current Rating vs. Ambient Temperature

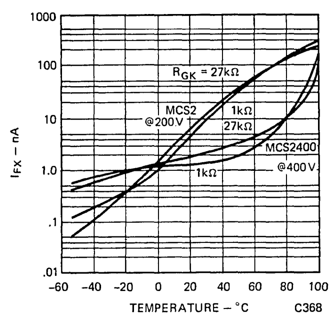


Fig. 8. Forward Leakage Current vs. Temperature

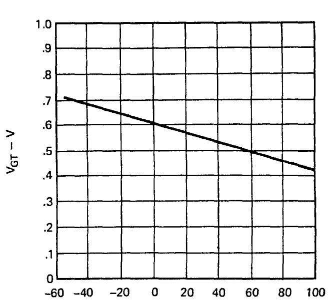


Fig. 9. Gate Trigger Voltage vs. Temperature

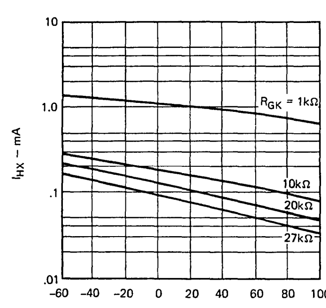
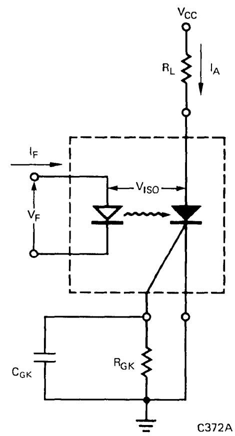
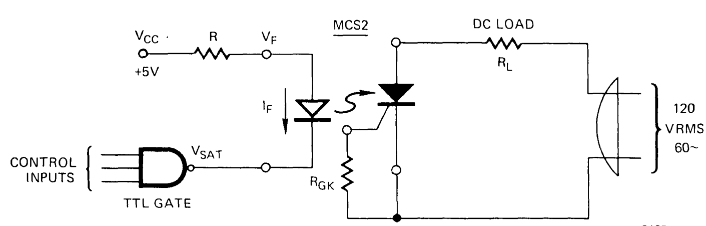


Fig. 10. Holding Current vs. Temperature

TYPICAL CIRCUIT APPLICATIONS



OPERATING SCHEMATICS



RELAY CIRCUIT FOR HALF WAVE A.C. CONDUCTION

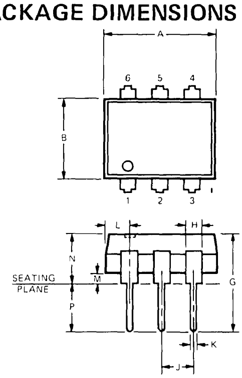
NOTES

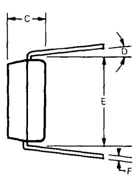
1. *The rise time of the SCR is typically less than 500 nanoseconds.*

GENERAL INSTRUMENT

MCS21
MCS2401

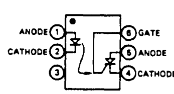
PACKAGE DIMENSIONS





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



C1339

DESCRIPTION

The MCS21 and the MCS2401 devices consist of a photo SCR coupled to a gallium arsenide infrared diode in a six lead plastic DIP package. The MCS21 has a blocking voltage rating of 200 volts while the MCS2401 has 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
- MCS21, MCS2401, UL recognized (File #E50151)
- VDE approval applied for

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

Storage temperature -55°C to 150°C
Operating temperature -55°C to 100°C
Lead soldering time @ 260°C 7.0 seconds

LED (GaAs Diode)
Power dissipation @ 25°C ambient . . . . 100 mW
Derate linearly from 25°C . . . . 1.3 mW/°C
Continuous forward current . . . . 60 mA
Reverse voltage . . . . 6.0 V
Peak forward current (1 μs, 300 pps) . . . . 3.0 A

COUPLED
Isolation voltage . . . . 4000 VDC

DETECTOR (Photo SCR)
Power dissipation @ 25°C ambient . . . . 400 mW
Derate linearly from 25°C . . . . 5.3 mW/°C
RMS forward current . . . . 300 mA
Peak pulse current (100 μs, 120 pps) . . . . 1.0 A
Average gate current . . . . 25 mA
Reverse gate current . . . . 1.0 mA
Peak forward voltage MCS21 . . . . 200 V
MCS2401 . . . . 400 V

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

CHARACTERISTICS	MCS21 MIN.	MCS21 TYP.	MCS21 MAX.	MCS2401 MIN.	MCS2401 TYP.	MCS2401 MAX.	UNITS	TEST CONDITIONS
INPUT DIODE								
Forward voltage (V_F)		1.15	1.5		1.15	1.5	V	I_F = 20 mA
Reverse voltage (V_R)	3.0	—	—	3.0	—	—	V	I_R = 10 μA
Reverse current (I_R)	—	.001	10	—	.001	10	μA	V_R = 3.0 V
Junction capacitance (C_J)	—	50	—	—	50	—	pF	V = 0
DETECTOR								
Off state current (I_{DM})	—	—	50	—	—	150	μA	V_{DM} = rated, T_A = 100°C, R_{GK} = 10 kΩ
Reverse current (I_{RM})	—	—	50	—	—	150	μA	V_{RM} = rated, T_A = 100°C, R_{GK} = 10 kΩ
Forward blocking voltage (V_{DM})	200	—	—	400	—	—	V	R_{GK} = 10kΩ @ 100°C
Reverse blocking voltage (V_{RM})	200	—	—	400	—	—	V	R_{GK} = 10kΩ @ 100°C
On voltage (V_{TM})	—	1.1	1.3	—	1.1	1.3	V	I_T = 300 mA
Holding current (I_{HX})	.01	.16	.50	.01	.16	.50	mA	R_{GK} = 27kΩ
Gate trigger voltage (V_{GT})	—	0.5	1.0	—	0.6	1.0	V	V_{FX} = 100 V
Gate trigger current (I_{GT})	—	19	100	—	23	100	μA	V_{FX} = 100 V, R_L = 110kΩ, R_{GK} = 27kΩ
COUPLED								
Turn on current (threshold), (I_{FT})	0.5	—	11	0.5	—	11	mA	V_{FX} = 100 V, R_{GK} = 27kΩ
Turn on current (threshold) (I_{FT})	—	—	20	—	—	20	mA	V_{FX} = 50 V, R_{GK} = 10kΩ
$t_r + t_d$ (See note 1) = (t_{on})	—	7	—	—	7	—	μs	I_F = 30 mA, R_{GK} = 27kΩ, V_{CC} = 20 V
Steady state voltage (V_{ISO})	3500	—	—	3500	—	—	VDC	t = 1 min. Relative humidity 50%
	2500	—	—	2500	—	—	V_{RMS}	t = 1 min. Relative humidity 50%
Surge isolation rating	4000	—	—	4000	—	—	VDC	t = 1 sec. Relative humidity 50%
	3000	—	—	3000	—	—	V_{RMS}	t = 1 sec. Relative humidity 50%
Coupled dv/dt, (input to output)	500	—	—	500	—	—	V/μs	See figure 11.

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

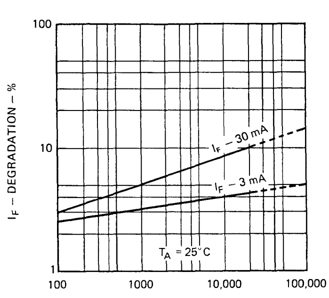


Fig. 1. LED Lifetime vs. Forward Current

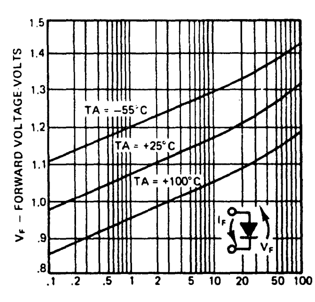


Fig. 2. Forward Voltage vs. Forward Current

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

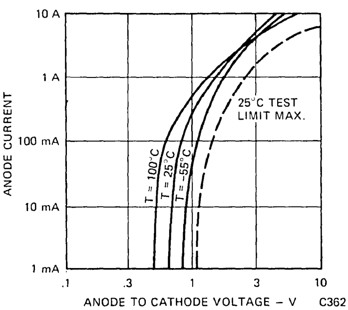


Fig. 3. Anode Current vs. Anode-Cathode Voltage

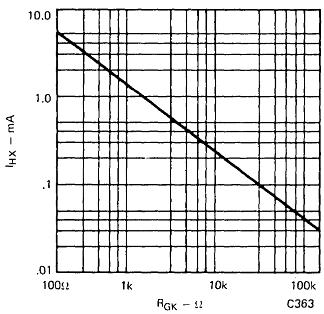


Fig. 4. Holding Current vs. Gate-Cathode Resistance

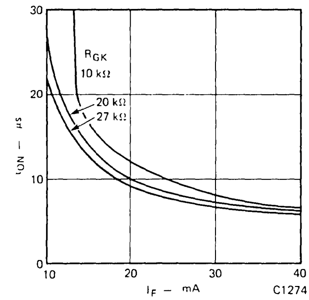


Fig. 5. Trigger Delay Time vs. Forward Current (note 1)

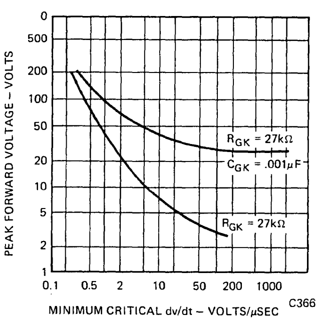


Fig. 6. Forward Blocking Voltage vs. Critical dV/dt

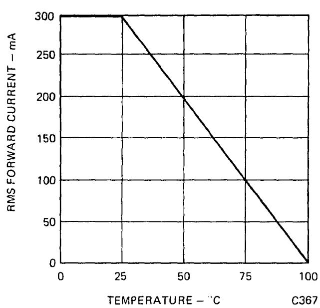


Fig. 7. Continuous Current Rating vs. Ambient Temperature

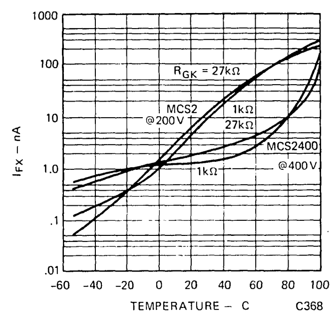


Fig. 8. Forward Leakage Current vs. Temperature

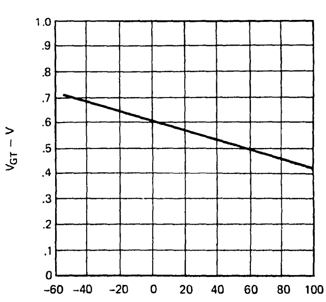


Fig. 9. Gate Trigger Voltage vs. Temperature

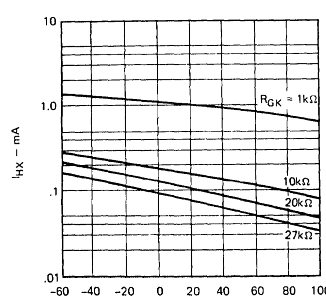
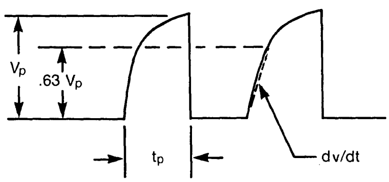


Fig. 10. Holding Current vs. Temperature

TYPICAL TEST CIRCUIT



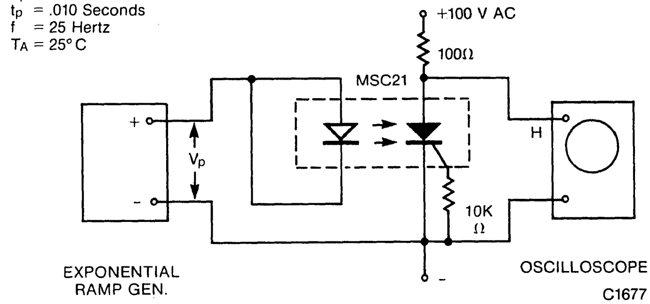
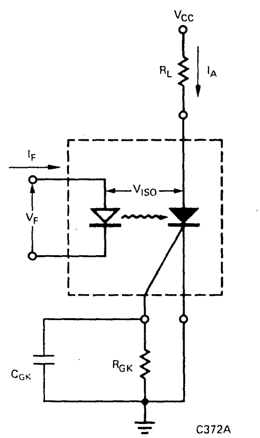
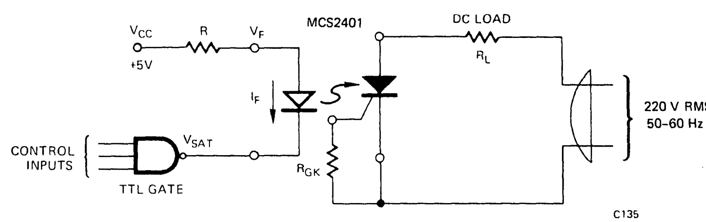


Fig. 11
Coupled dv/dt — Test Circuit

TYPICAL CIRCUIT APPLICATIONS



OPERATING SCHEMATICS



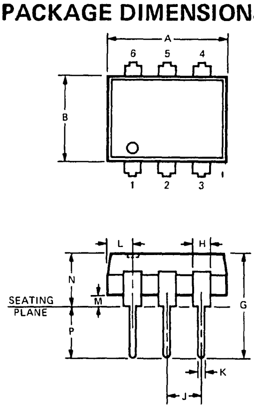
NOTES

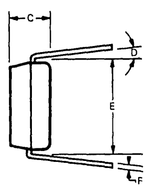
1. *The rise time of the SCR is typically less than 500 nanoseconds.*

GENERAL INSTRUMENT

MCT2

PACKAGE DIMENSIONS





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

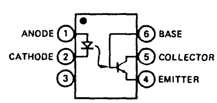
NOTES
1. INSTALLED POSITION OF LEAD CENTERS
2. FOUR PLACES
3. OVERALL INSTALLED POSITION
4. THESE MEASUREMENTS ARE MADE FROM THE SEATING PLANE
5. MINIMUM 0.100 INCH

DESCRIPTION

The MCT2 is a NPN silicon planar phototransistor optically coupled to a gallium arsenide diode. It is mounted in a six-lead plastic DIP package.

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
- VDE approval applied for



C1339

ABSOLUTE MAXIMUM RATINGS

Storage temperature −55°C to 150°C
Operating temperature −55°C to 100°C
Lead temperature (Soldering, 10 sec) 260°C

Input Diode
- Forward current . . . . 60 mA
- 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 volts DC
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 Breakdown Voltage	BV_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

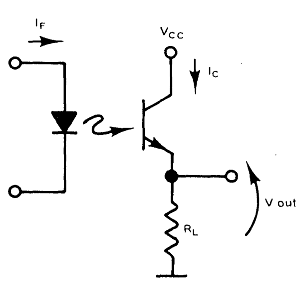
ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

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	I_C/I_F	20	60		%	$V_{CE}=10$ V, $I_F=10$ mA, Note 1
DC Base Current Transfer Ratio	I_B/I_F		.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)

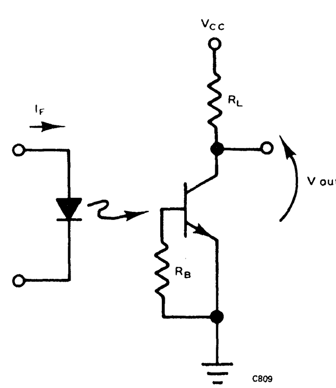
SWITCHING TIMES			TYP	UNITS	TEST CONDITIONS
Saturated					
t on (from 5 V to 0.8 V)		t_{on} (SAT)	10	μs	$R_L=2$ KΩ, $I_F=15$ mA, $V_{CC}=5$ V
t off (from SAT to 2.0 V)		t_{off} (SAT)	30		R_B=open (Circuit No. 2)
Saturated					
t on (from 5 V to 0.8 V)		t_{on} (SAT)	10	μs	$R_L=2$ KΩ, $I_F=20$ mA, $V_{CC}=5$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

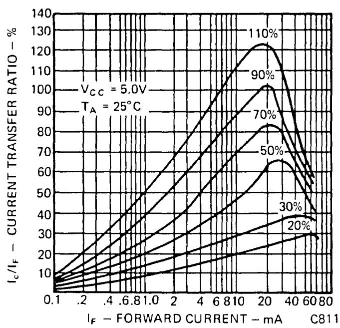


Fig. 1. Current Transfer Ratio vs. Forward Current

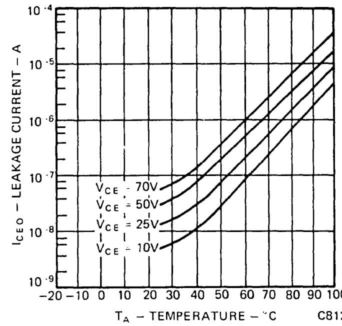


Fig. 2. Dark Current vs. Temperature

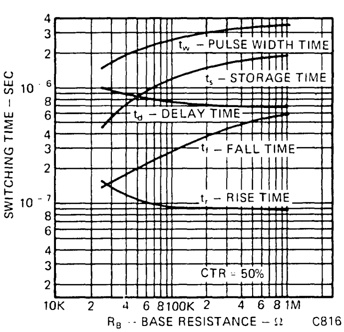


Fig. 3. Switching Time vs. Base Resistance

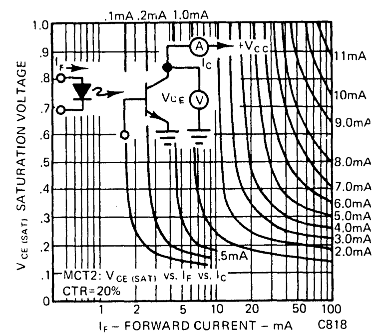


Fig. 4. Saturation Voltage vs. Forward Current

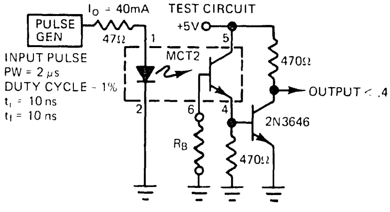


Fig. 5. Circuit for Figure 3

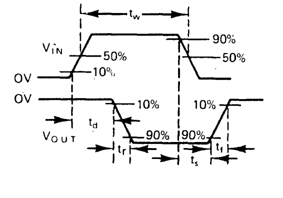


Fig. 6. Waveforms for Figure 3

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

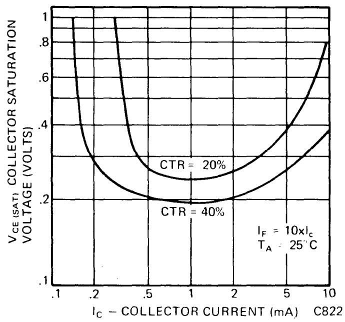


Fig. 7. Saturation Voltage vs. Collector Current

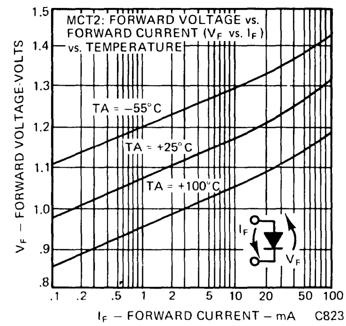


Fig. 8. Forward Voltage vs. Forward Current

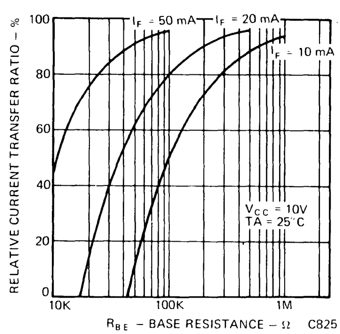


Fig. 9. Sensitivity vs. Base Resistance

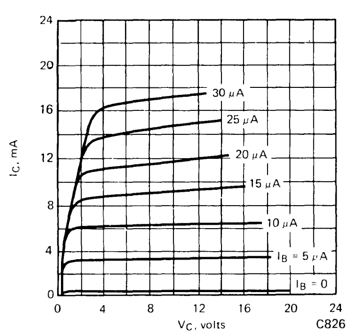


Fig. 10. Detector Typical h_{fe} Curves

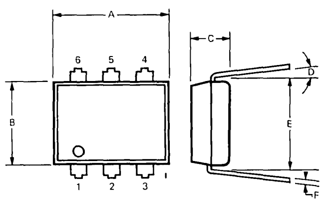
NOTES

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%.

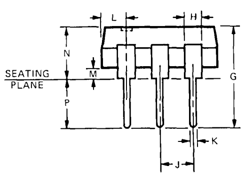
GENERAL INSTRUMENT

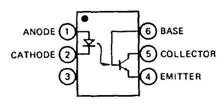
MCT2E

PACKAGE DIMENSIONS



C1339





SYMBOL	INCHES MAX	mm MAX	NOTES
A	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

DESCRIPTION

The MCT2E is a NPN silicon planar phototransistor optically coupled to a gallium arsenide diode. It is mounted in a six-lead plastic DIP package.

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
- VDE approval applied for

ABSOLUTE MAXIMUM RATINGS

Storage temperature −55°C to 150°C
Operating temperature −55°C to 100°C
Lead temperature (Soldering, 10 sec) 260°C

Input Diode
- Forward current . . . . 60 mA
- 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

Isolation rating . . . . 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

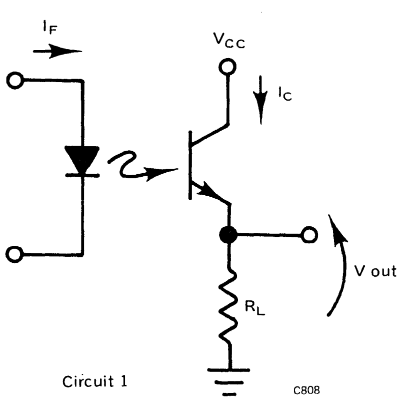
ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Input Diode						
Forward Voltage	V_F		1.25	1.50	V	I_F = 20 mA
Reverse Breakdown Voltage	BV_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

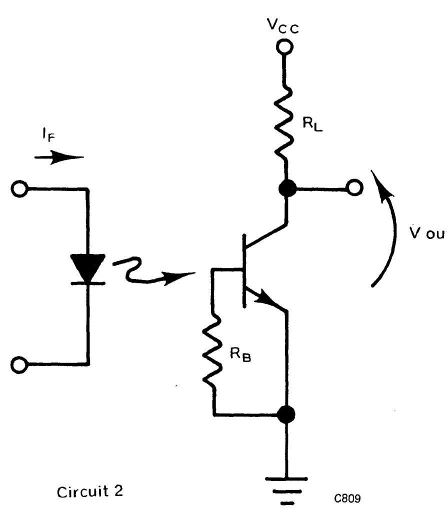
ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

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	I_C/I_F	20	60		%	$V_{CE}=10$ V, $I_F=10$ mA, Note 1
DC Base Current Transfer Ratio	I_B/I_F		.35		%	$V_{CB}=10$ V, I_F-10 mA
Surge isolation voltage	V_{iso}	4000			VDC	Relative humidity ≤ 50% T_A = +25°C, $I_{I\text{-}O} \leq 10\ \mu A$
		3000			VAC-rms	1 second
Steady state isolation voltage	V_{iso}	3500			VDC	Relative humidity ≤ 50%, T_A = +25°C, $I_{I\text{-}O} \leq 10\ \mu A$
		2500			VAC-rms	1 minute
	B_V(I-O)	3500			VDC	
Isolation Resistance		10^{11}	10^{12}		Ω	$V_{I\text{-}O}=500$ 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
Non-Saturated Collector	Delay Time	t_d	0.5	μs	R_L=100 Ω, I_C=2 mA, V_{CC}=10 V (Circuit No. 1)
	Rise Time	t_r	2.5		
	Storage Time	t_s	0.1		
	Fall Time	t_f	2.6		
Non-Saturated Collector	Delay Time	t_d	2.0	μs	R_L=1 KΩ, I_C=2 mA, V_{CC}=10V (Circuit No. 1)
	Rise Time	t_r	15		
	Storage Time	t_s	0.1		
	Fall Time	t_f	15		
Saturated					
t on (from 5 V to 0.8 V)		t_{on} (SAT)	5	μs	R_L=2 KΩ, I_F=15 mA, V_{CC}=5 V
t off (from SAT to 2.0 V)		t_{off} (SAT)	25		R_B=open (Circuit No. 2)
Saturated					
t on (from 5 V to 0.8 V)		t_{on} (SAT)	5	μs	R_L=2 KΩ, I_F=20 mA, V_{CC}=5 V
t off (from SAT to 2.0 V)		t_{off} (SAT)	18		R_B=100 KΩ (Circuit No. 2)
Non-Saturated Base	Rise Time	t_r	175	ns	R_L=1 KΩ, V_{CB}=10 V
	Fall Time	t_f	175	ns	



Circuit 1



Circuit 2

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

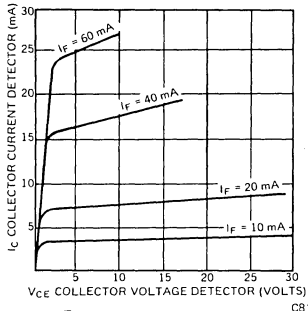


Fig. 1 Collector Current vs. Collector Voltage (for Typical CTR 30%)

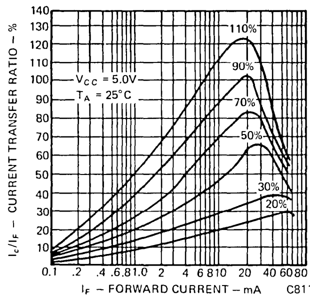


Fig. 2 Current Transfer Ratio vs. Forward Current

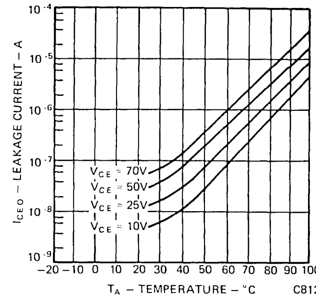


Fig. 3 Dark Current vs. Temperature

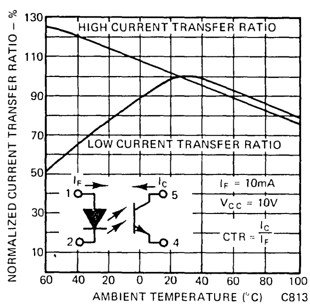


Fig. 4 Current Transfer Ratio vs. Temperature

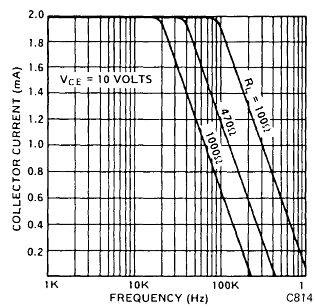


Fig. 5 Collector Current vs. Frequency

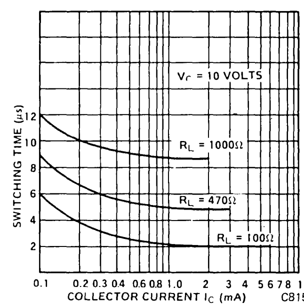


Fig. 6 Switching Time vs. Collector Current

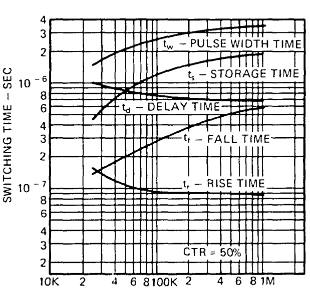


Fig. 7 Switching Time vs. Base Resistance

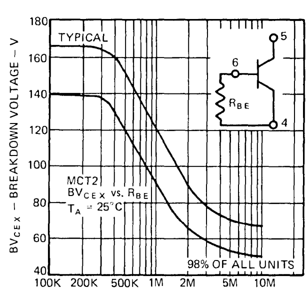


Fig. 8 Collector – Emitter Breakdown Voltage vs. Base Resistance

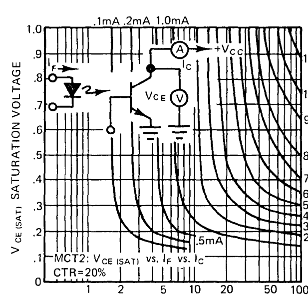


Fig. 9 Saturation Voltage vs. Forward Current

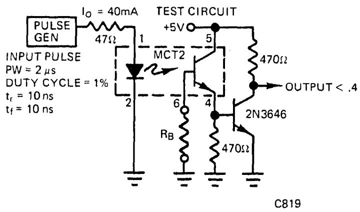


Fig. 10 Circuit for Figure 7

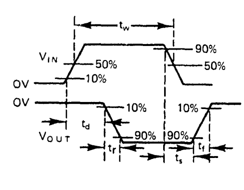


Fig. 11 Waveforms for Figure 7

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25° C Free Air Temperature Unless Otherwise Specified)

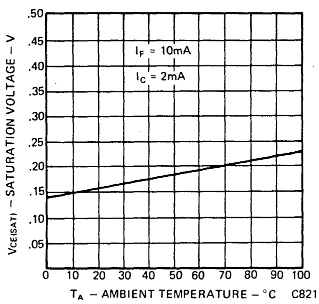


Fig. 12. Saturation Voltage vs. Temperature

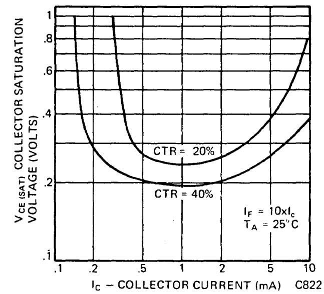


Fig. 13. Saturation Voltage vs. Collector Current

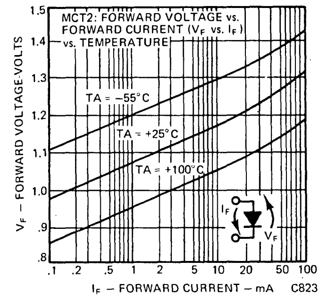


Fig. 14. Forward Voltage vs. Forward Current

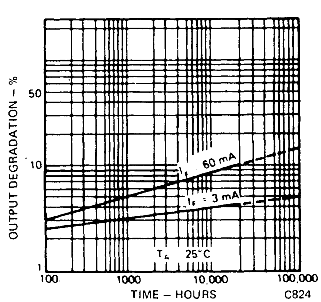


Fig. 15. Lifetime vs. Forward Current (Note 4)

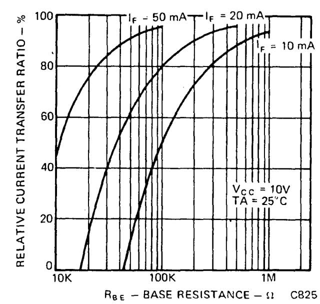


Fig. 16. Sensitivity vs. Base Resistance

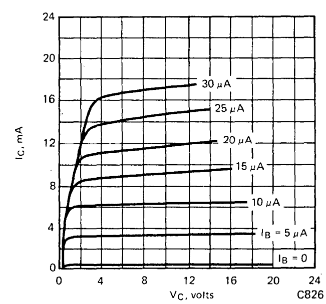
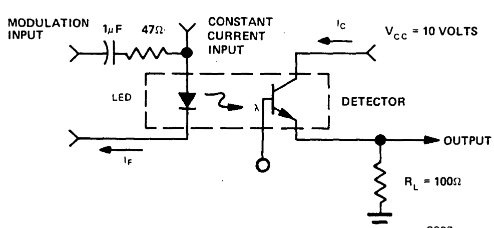
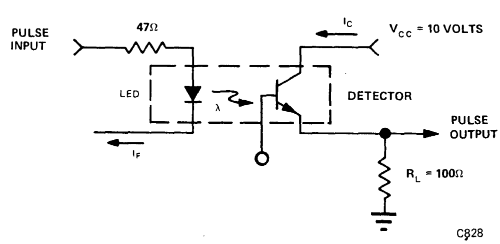


Fig. 17. Detector Typical h_{fe} Curves

OPERATING SCHEMATICS



Modulation Circuit Used to Obtain Output vs Frequency Plot



Circuit Used to Obtain Switching Time vs Collector Current Plot

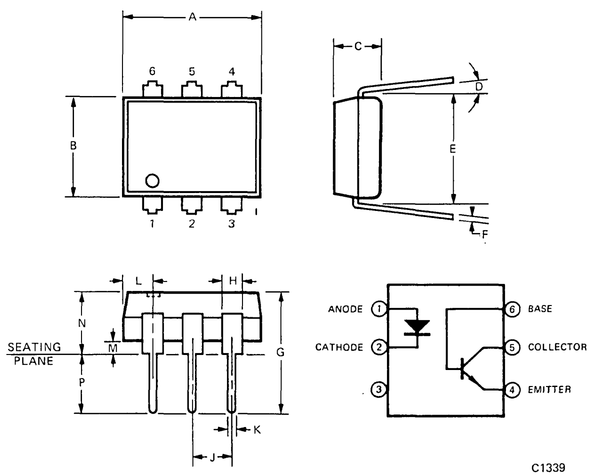
NOTES

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

MCT210

PACKAGE DIMENSIONS



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

DESCRIPTION

The MCT210 incorporates a NPN silicon planar phototransistor optically coupled to a gallium arsenide diode emitter. The MCT210 has a specified minimum CTR of 50%, saturated, and 150%, unsaturated. This unit is mounted in a six-lead plastic DIP socket.

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)
- VDE approval applied for

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

COUPLED 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)

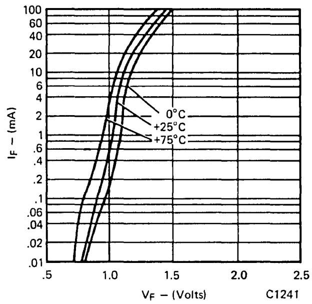


Fig. 1. Forward Voltage vs. Forward Current

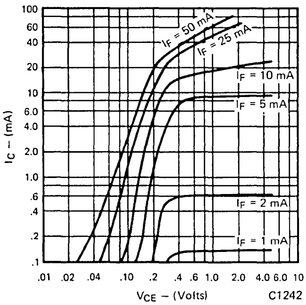


Fig. 2. Collector Current vs. Collector to Emitter Voltage

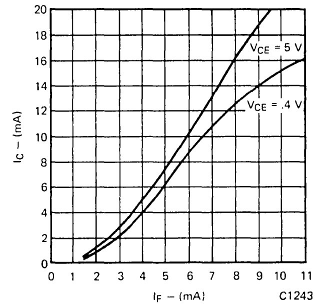


Fig. 3. Collector Current vs. Forward Current

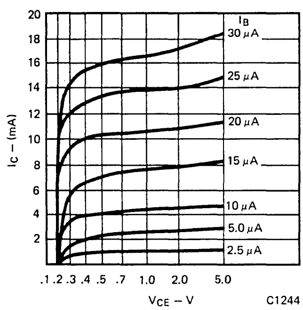


Fig. 4. Collector Current vs. Collector to Emitter Voltage

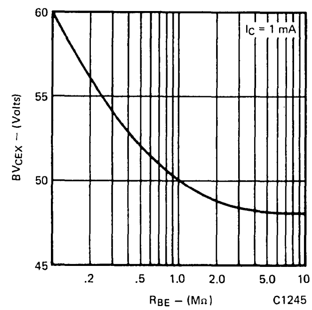


Fig. 5. Collector to Emitter Breakdown Voltage vs. Base to Emitter Resistance

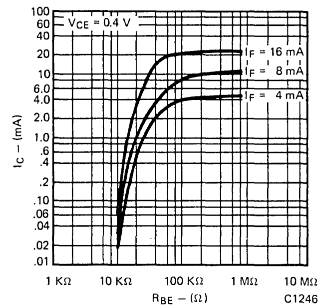


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

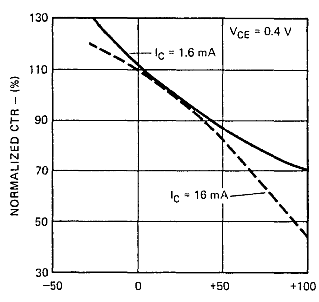


Fig. 7. Current Transfer Ratio (saturated) vs. Temperature

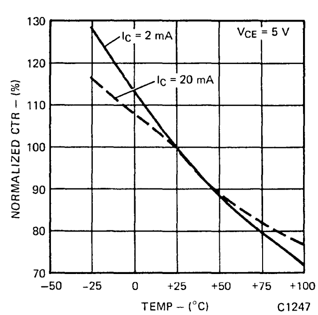


Fig. 8. Current Transfer Ratio (unsaturated) vs. Temperature

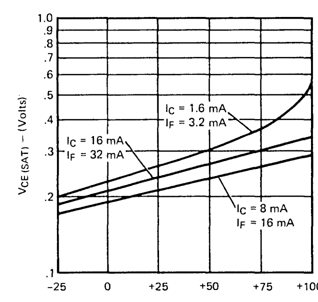


Fig. 9. Collector to Emitter Saturation Voltage vs. Temperature

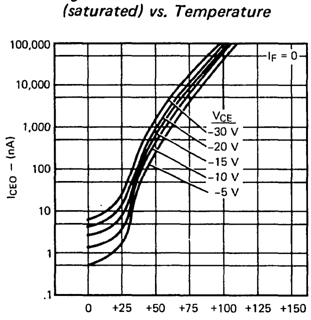


Fig. 10. Collector to Emitter Leakage Current vs. Temperature

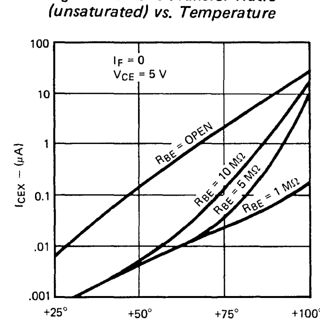


Fig. 11. Collector to Emitter Leakage Current vs. Temperature

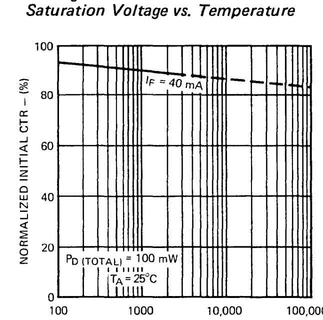


Fig. 12. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

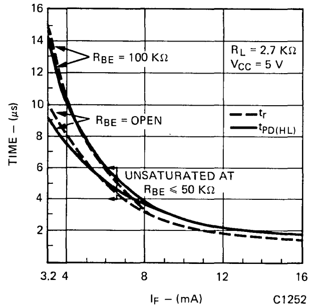


Fig. 13. Switch-on Time vs. I_F Drive (saturated)

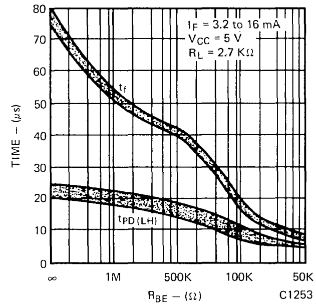


Fig. 14. Switch-off Time vs. Base to Emitter Resistance (saturated)

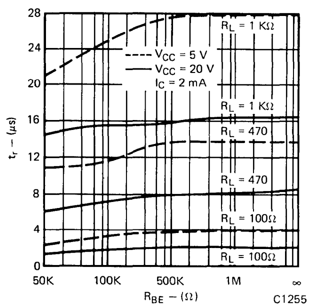


Fig. 15. Rise Time vs. Base to Emitter Resistance (non-saturated)

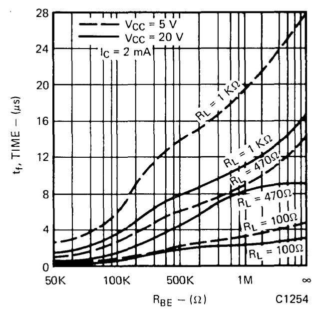


Fig. 16. Fall Time vs. Base to Emitter Resistance (non-saturated)

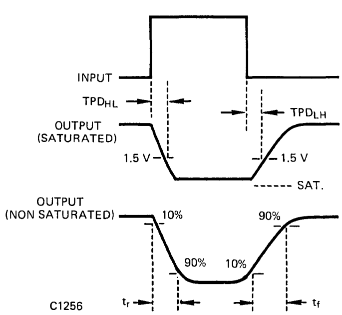


Fig. 17. Switching Time Waveforms

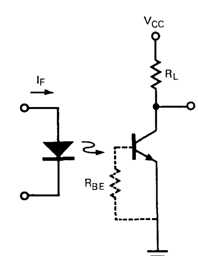


Fig. 18. Switching Time Test Circuits

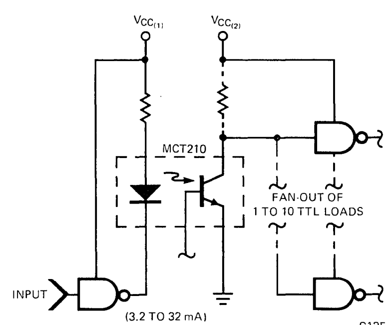
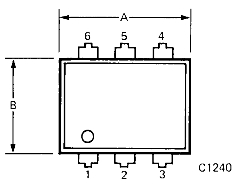


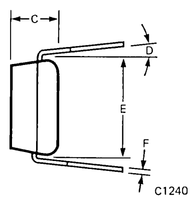
Fig. 19. Typical TTL Interface at Operating Temperatures of 0° to 70° C

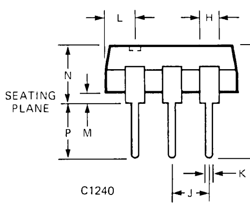
GENERAL INSTRUMENT

MCT2200

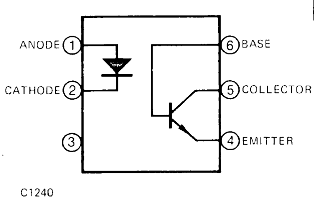
PACKAGE DIMENSIONS







SYMBOL	INCHES MAX.	MIL. 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

Fig. 1. Equivalent Circuit

DESCRIPTION

The MCT2200 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
  5300 VAC RMS — 5 seconds
  7500 VAC PEAK — 5 seconds
- Minimum current transfer ratio of 20%
- Maximum turn-on, turn-off time 20μ seconds specified
- Underwriters Laboratory (UL) recognized File #E50151
- VDE approval applied for

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	20	60		%	I_F = 10 mA; V_{CE} = 5 V
	Saturation voltage	$V_{CE(SAT)}$		.21	.40	V	I_F = 10 mA; I_C = 2.5 mA
SWITCHING TIMES	Non-saturated						
	Turn-on time	t_{on}		6.0	20	μs	R_L = 100 Ω; I_C = 2 mA; V_{CC} = 10 V See figure 10.
	Turn-off time	t_{off}		5.5	20	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}		.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 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 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			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)

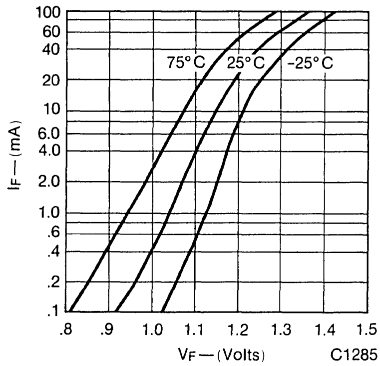


Fig. 2. Forward Voltage vs. Forward Current

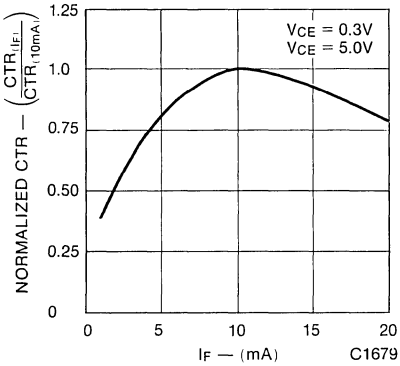


Fig. 3. Normalized Current Transfer Ratio vs. Forward Current

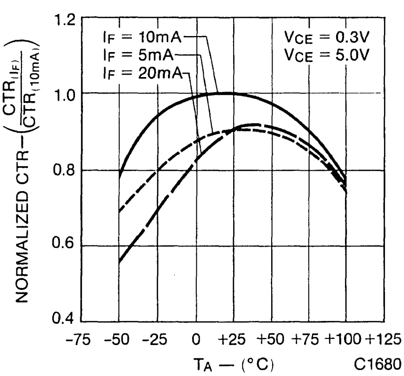


Fig. 4. Normalized Current Transfer Ratio vs. Ambient Temperature

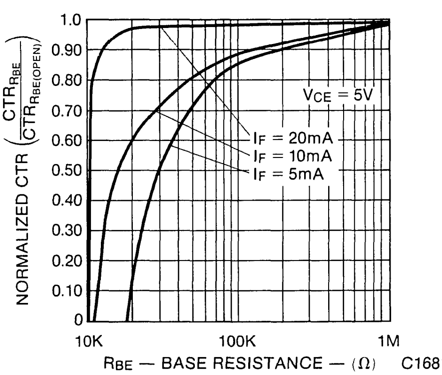


Fig. 5. C_{TR} vs. R_{BE}

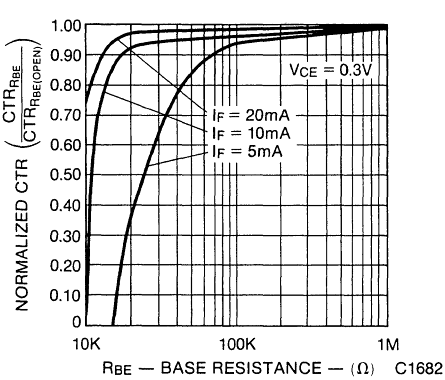


Fig. 6. C_{TR} vs. R_{BE}

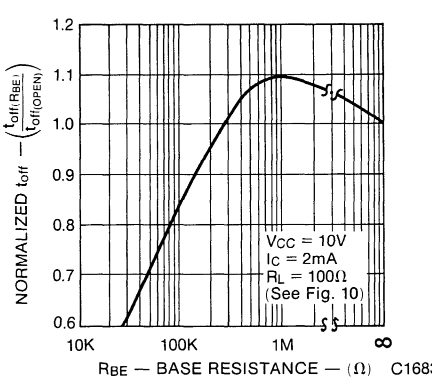


Fig. 7. Normalized t_{off} vs. R_{BE}

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

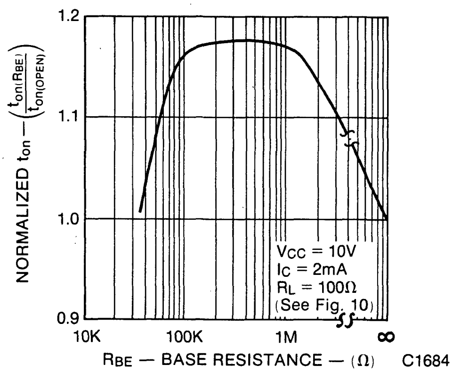


Fig. 8. Normalized t_{on} vs. R_{BE}

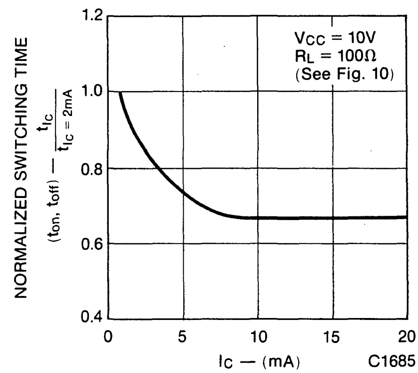
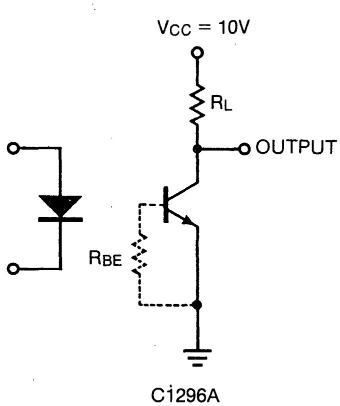


Fig. 9. Normalized Switching Time vs. Collector Current



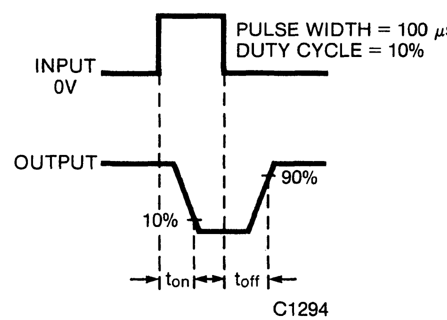
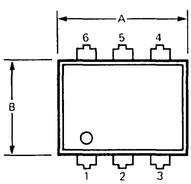


Fig. 10. Switching Time Test Circuit and Waveform

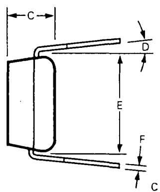
GENERAL INSTRUMENT

MCT2201

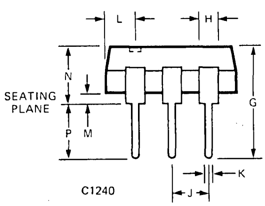
PACKAGE DIMENSIONS



C1240

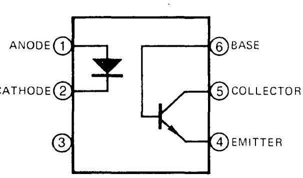


C1240



C1240

SYMBOL	INCHES MAX.	MIL. 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



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 MCT2201 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
  5300 VAC RMS — 5 seconds
  7500 VAC PEAK — 5 seconds
- Minimum current transfer ratio of 100%
- Maximum turn-on, turn-off time 10μ seconds specified
- Underwriters Laboratory (UL) recognized File #E50151
- VDE approval applied for

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	100	200		%	I_F = 10 mA; V_{CE} = 5 V
DC	Saturation voltage	$V_{CE(SAT)}$		.21	.40	V	I_F = 10 mA; I_C = 2.5 mA
SWITCHING TIMES	Non-saturated						
SWITCHING TIMES	Turn-on time	t_{on}		6.0	10	μs	R_L = 100 Ω; I_C = 2 mA; V_{CC} = 10 V See figure 10.
SWITCHING TIMES	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
ISOLATION		V_{iso}	7500			V_{AC} PEAK	Relative humidity ⩽ 50%, $I_{I\text{-}O}$ ⩽ 10 μA, 5 seconds
ISOLATION	Isolation resistance	R_{iso}	10^{11}			ohms	$V_{I\text{-}O}$ = 500 VDC
ISOLATION	Isolation capacitance	C_{iso}		.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
INPUT DIODE	Forward voltage temp. coefficient			-1.8		mV/°C	
INPUT DIODE	Reverse breakdown voltage	BV_R	3.0	25		V	I_R = 10 μA
INPUT DIODE	Junction capacitance	C_J		50		pF	V_F = 0 V, f = 1 MHz
INPUT DIODE				65		pF	V_F = 1 V, f = 1 MHz
INPUT DIODE	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
OUTPUT TRANSISTOR	Breakdown voltage						
OUTPUT TRANSISTOR	Collector to emitter	BV_{CEO}	30	45		V	I_C = 1.0 mA, I_F = 0
OUTPUT TRANSISTOR	Collector to base	BV_{CBO}	70	130		V	I_C = 10 μA
OUTPUT TRANSISTOR	Emitter to collector	BV_{ECO}	7	10		V	I_E = 100 μA, I_F = 0
OUTPUT TRANSISTOR	Leakage current						
OUTPUT TRANSISTOR	Collector to emitter	I_{CEO}		5	50	nA	V_{CE} = 10 V, I_F = 0
OUTPUT TRANSISTOR	Collector to base	I_{CBO}			20	nA	V_{CB} = 10 V, I_F = 0
OUTPUT TRANSISTOR	Capacitance						
OUTPUT TRANSISTOR	Collector to emitter			8		pF	V_{CE} = 0, f = 1 MHz
OUTPUT TRANSISTOR	Collector to base			20		pF	V_{CB} = 5, f = 1 MHz
OUTPUT TRANSISTOR	Emitter to base			10		pF	V_{EB} = 0, f = 1 MHz

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

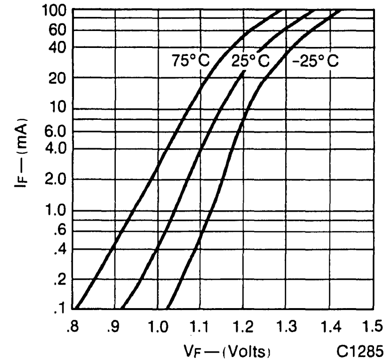


Fig. 2. Forward Voltage vs. Forward Current

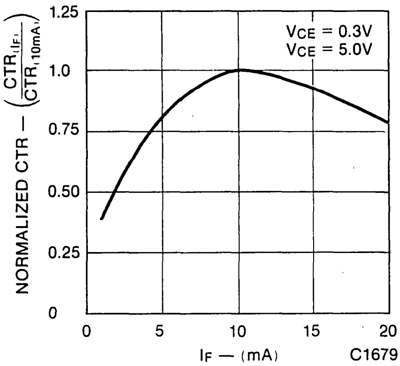


Fig. 3. Normalized Current Transfer Ratio vs. Forward Current

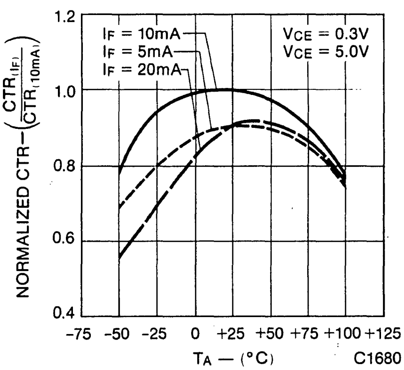


Fig. 4. Normalized Current Transfer Ratio vs. Ambient Temperature

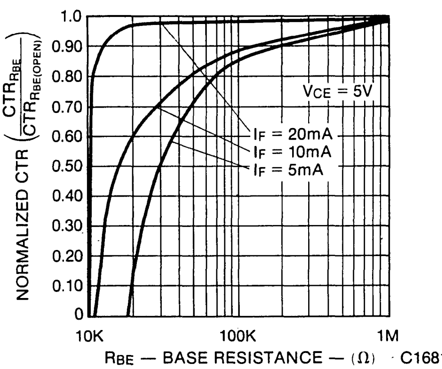


Fig. 5. C_{TR} vs. R_{BE}

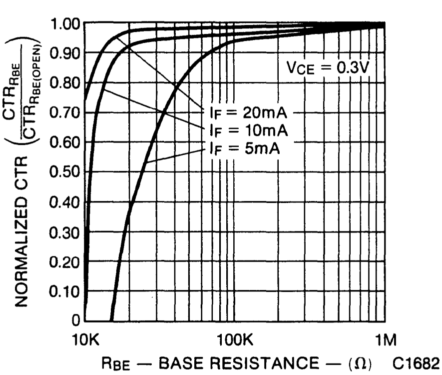


Fig. 6. C_{TR} vs. R_{BE}

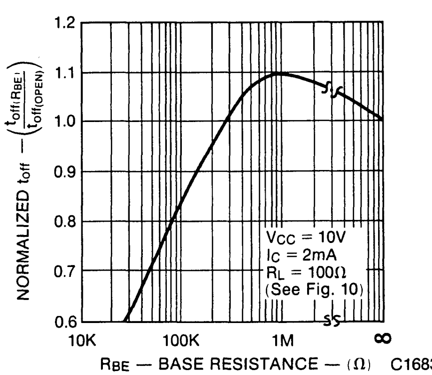


Fig. 7. Normalized t_{off} vs. R_{BE}

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

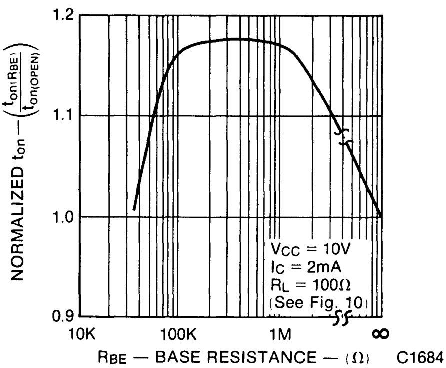


Fig. 8. Normalized t_{on} vs. R_{BE}

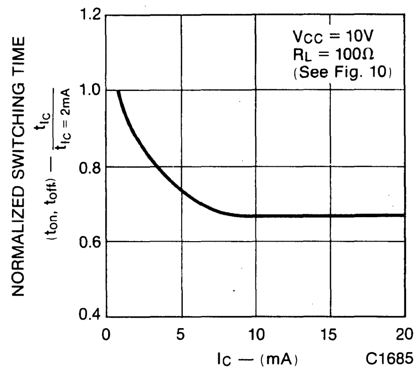


Fig. 9. Normalized Switching Time vs. Collector Current

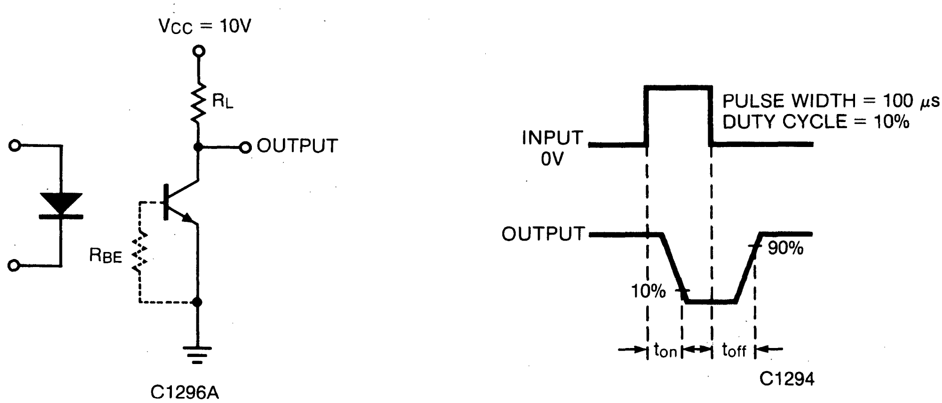
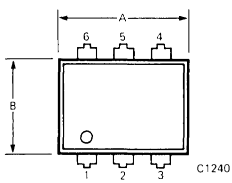


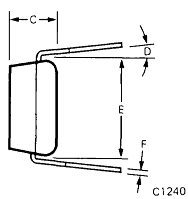
Fig. 10. Switching Time Test Circuit and Waveform

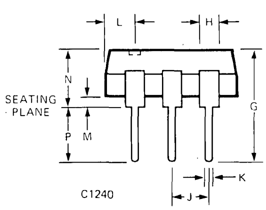
GENERAL INSTRUMENT

MCT2202

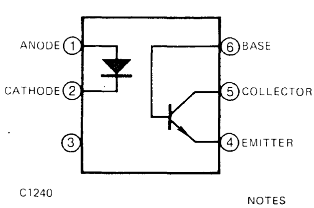
PACKAGE DIMENSIONS







SYMBOL	INCHES MAX.	MIL. 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

Fig. 1. Equivalent Circuit

DESCRIPTION

The MCT2202 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
  5300 VAC RMS – 5 seconds
  7500 VAC PEAK – 5 seconds
- Controlled current transfer ratio of 63% to 125%
- Maximum turn-on, turn-off time 10μ seconds specified
- Underwriters Laboratory (UL) recognized File #E50151
- VDE approval applied for

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	63	95	125	%	I_F = 10 mA; V_{CE} = 5 V
	Saturation voltage	$V_{CE(SAT)}$		.21	.40	V	I_F = 10 mA; I_C = 2.5 mA
SWITCHING TIMES	Non-saturated						
	Turn-on time	t_{on}		6.0	10	μs	R_L = 100 Ω; I_C = 2 mA; V_{CC} = 10 V; See figure 10.
	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}		.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 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 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 collector	BV_{ECO}	7	10		V	I_E = 100 μA, I_F = 0
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	V_{CE} = 10 V, I_F = 0
	Collector to base	I_{CBO}			20	nA	V_{CB} = 10 V, I_F = 0
	Capacitance						
	Collector to emitter			8		pF	V_{CE} = 0, f = 1 MHz
	Collector to base			20		pF	V_{CB} = 5, f = 1 MHz
	Emitter to base			10		pF	V_{EB} = 0, f = 1 MHz

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

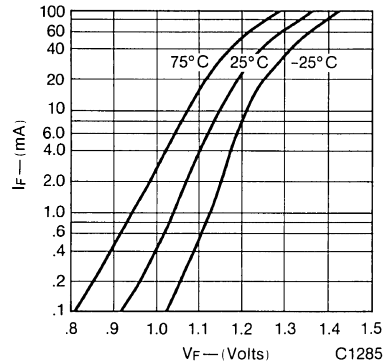


Fig. 2. Forward Voltage vs. Forward Current

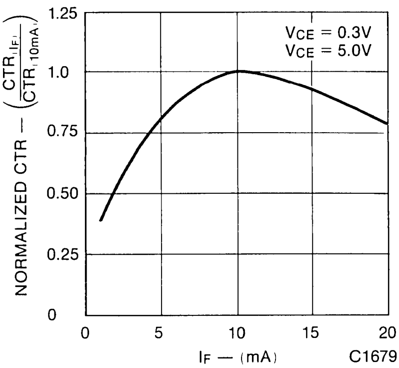


Fig. 3. Normalized Current Transfer Ratio vs. Forward Current

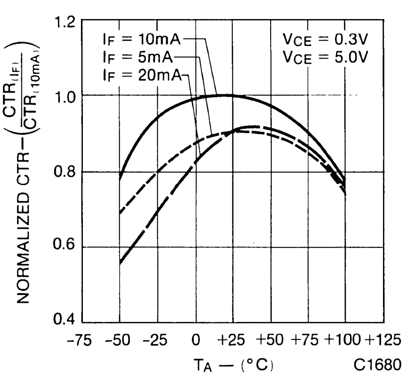


Fig. 4. Normalized Current Transfer Ratio vs. Ambient Temperature

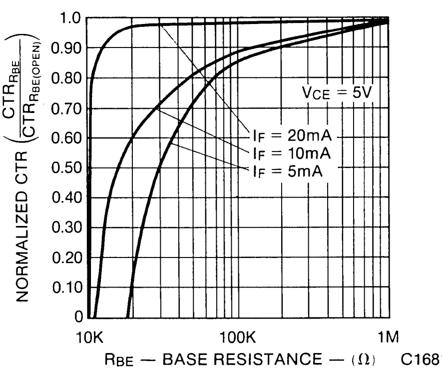


Fig. 5. C_{TR} vs. R_{BE}

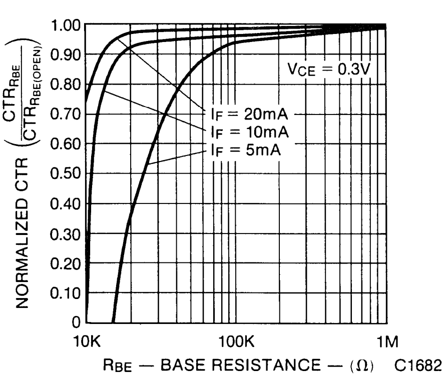


Fig. 6. C_{TR} vs. R_{BE}

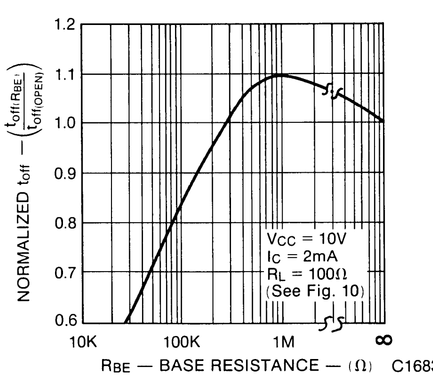


Fig. 7. Normalized t_{off} vs. R_{BE}

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

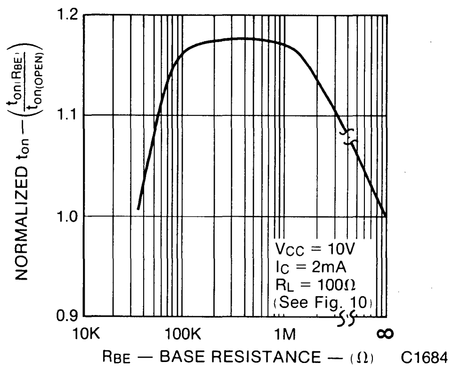


Fig. 8. Normalized t_{on} vs. R_{BE}

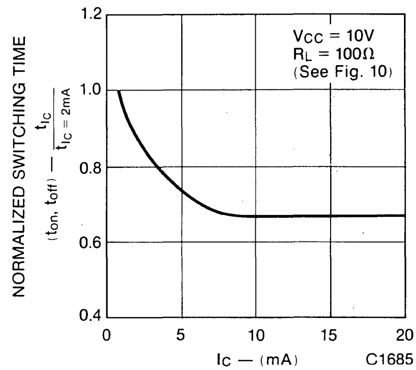
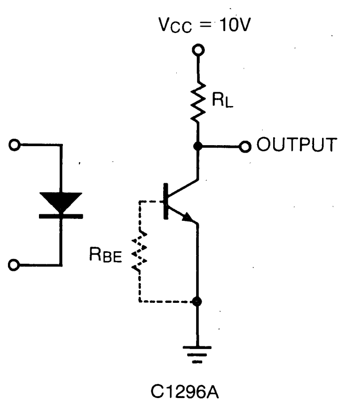


Fig. 9. Normalized Switching Time vs. Collector Current



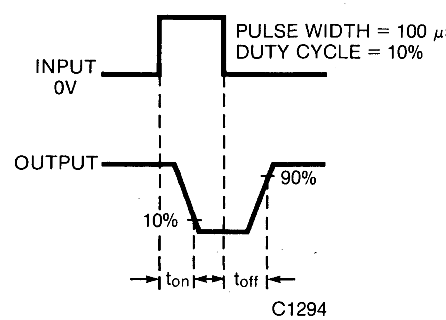
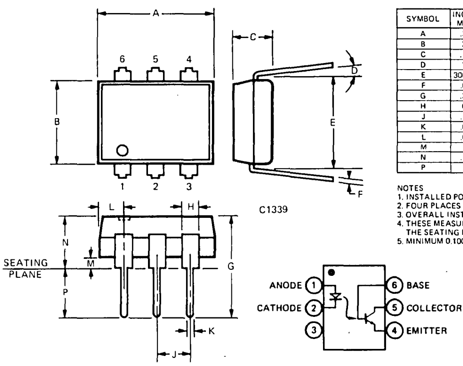


Fig. 10. Switching Time Test Circuit and Waveform

GENERAL INSTRUMENT

MCT26

PACKAGE DIMENSIONS



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

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
- VDE approval applied for

ABSOLUTE MAXIMUM RATINGS

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

Input Diode
- Forward current . . . . 60 mA
- 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. . . . . 2500 volts
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)

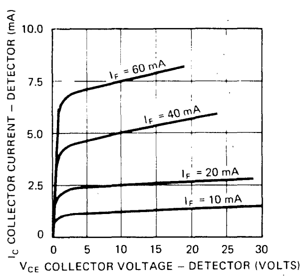


Fig. 1 Detector Output Characteristics

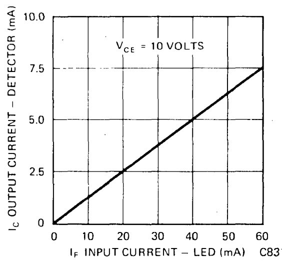


Fig. 2 Input Current vs. Output Current

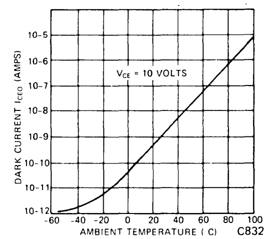


Fig. 3 Dark Current vs. Temperature (°C)

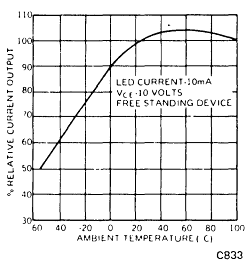


Fig. 4 Current Output vs. Temperature

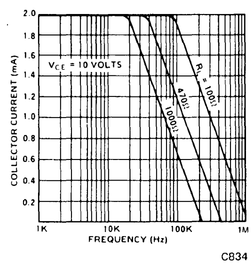


Fig. 5 Output vs. Frequency

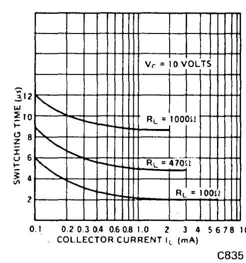
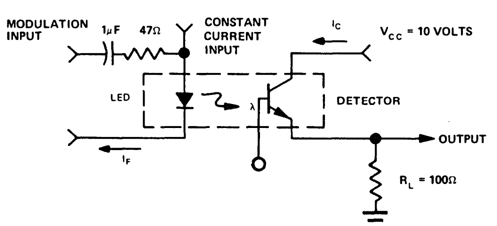


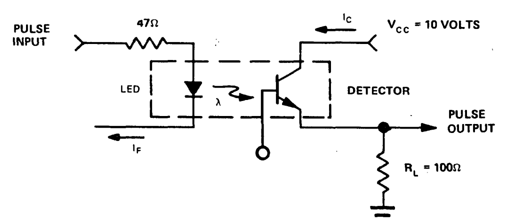
Fig. 6 Switching Time vs. Collector Current

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

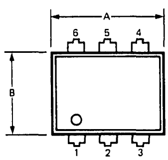
NOTES

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%.*

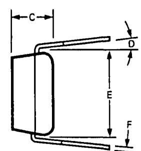
GENERAL INSTRUMENT

MCT270

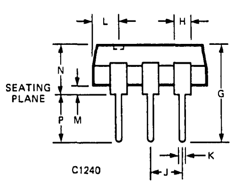
PACKAGE DIMENSIONS



C1240



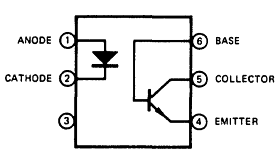
C1240



C1240

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



C1339

Fig. 1 Equivalent Circuit

DESCRIPTION

The MCT270 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

- 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
- VDE approval applied for

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	I_{CE}/I_F	50	115		%	I_F = 10 mA; V_{CE} = 10 V
	Current Transfer Ratio, collector to base	I_{CB}/I_F	.045	.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}		.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 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 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 collector	BV_{ECO}	7	10		V	I_E = 100 μA, I_F = 0
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	V_{CE} = 10 V, I_F = 0
	Collector to base	I_{CBO}			20	nA	V_{CB} = 10 V, I_F = 0
	Capacitance						
	Collector to emitter			8		pF	V_{CE} = 0, f = 1 MHz
	Collector to base			20		pF	V_{CB} = 5, f = 1 MHz
	Emitter to base			10		pF	V_{EB} = 0, f = 1 MHz

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

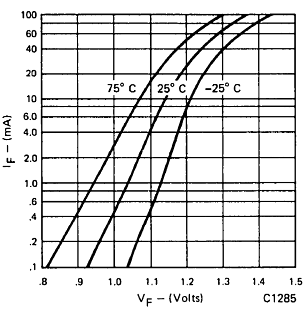


Fig. 1. Forward Voltage vs. Forward Current

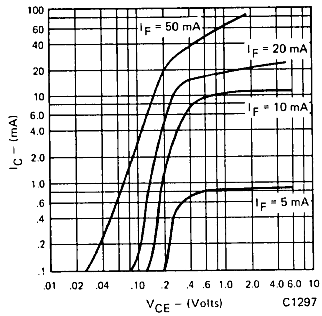


Fig. 2. Collector Current vs. Collector to Emitter Voltage

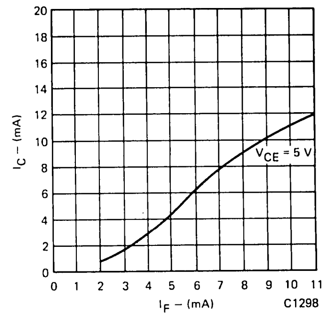


Fig. 3. Collector Current vs. Forward Current

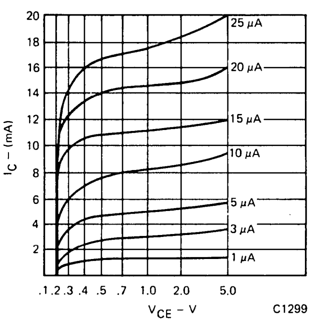


Fig. 4. Collector Current vs. Collector to Emitter Voltage

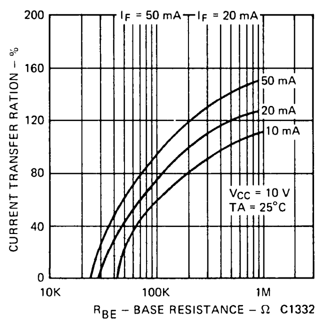


Fig. 5. Sensitivity vs. Base Resistance

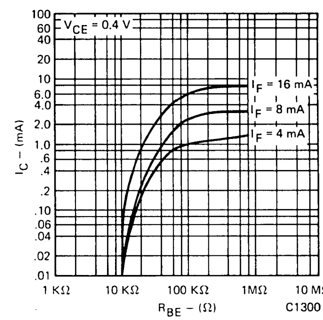


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

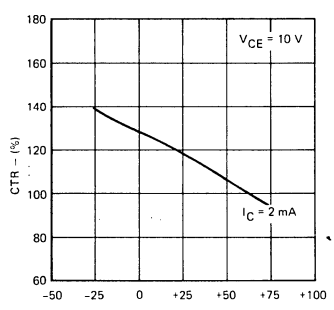


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

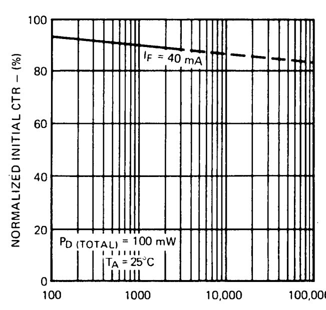


Fig. 8. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

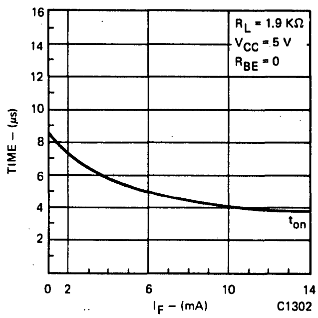


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

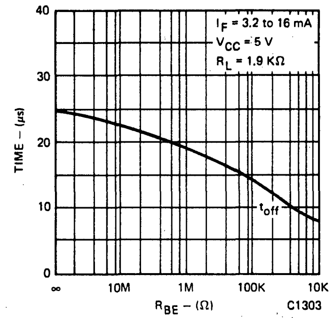


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

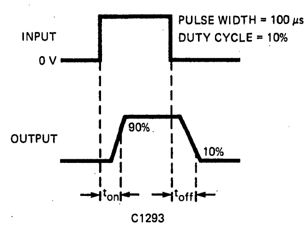


Fig. 11.

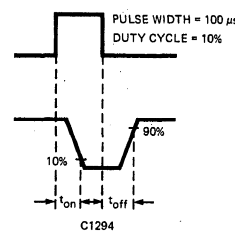


Fig. 12.

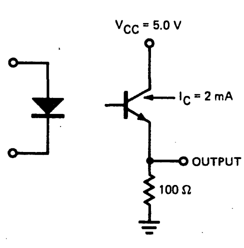


Fig. 13.

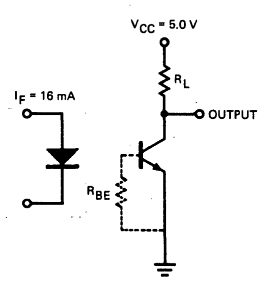
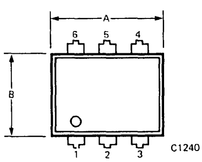


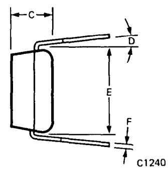
Fig. 14.

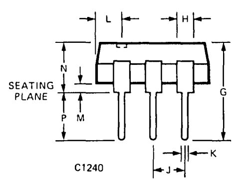
GENERAL
INSTRUMENT

MCT271

PACKAGE DIMENSIONS

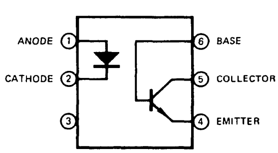






SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.365	9.27	
B	.270	6.86	
C	.160	4.06	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5

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



C1339

DESCRIPTION

The MCT271 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

- 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
- VDE approval applied for

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)	I_{CE}/I_F	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	I_{CB}/I_F		.15		%	I_F = 10 mA; V_{CB} = 10 V
	Saturation voltage	$V_{CE(SAT)}$		.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 Ω; 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} ⩽ 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}		.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 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 TRANSISTOR	DC forward current gain	h_{FE}	100	420			V_{CE} = 5 V, I_C = 100 μA
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	30	45		V	I_C = 1.0 mA, I_F = 0
	Collector to base	BV_{CBO}	70	130		V	I_C = 10 μA
	Emitter to 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
	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)

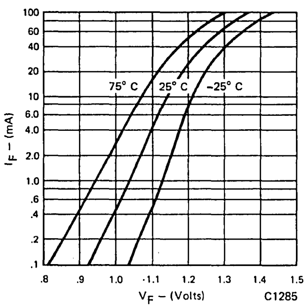


Fig. 1. Forward Voltage vs. Forward Current

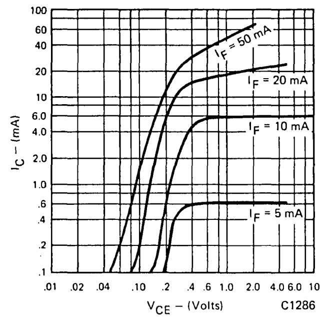


Fig. 2. Collector Current vs. Collector to Emitter Voltage

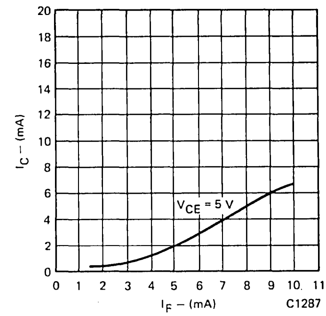


Fig. 3. Collector Current vs. Forward Current

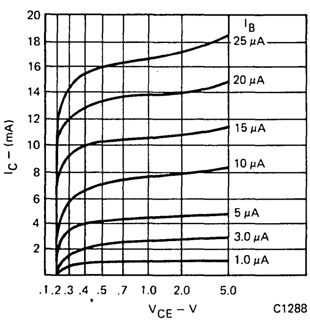


Fig. 4. Collector Current vs. Collector to Emitter Voltage

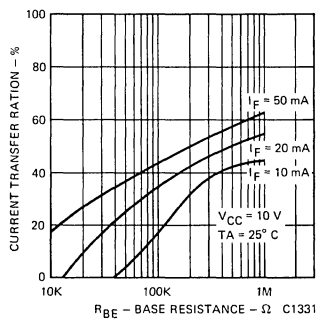


Fig. 5. Sensitivity vs. Base Resistance

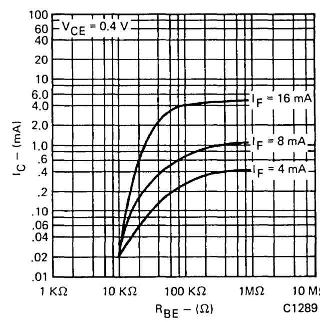


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

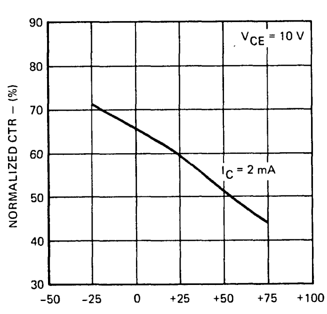


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

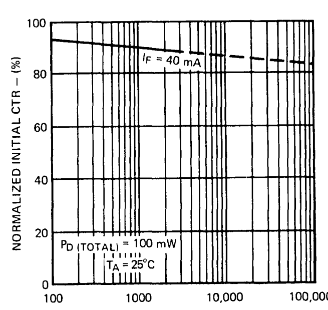


Fig. 8. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

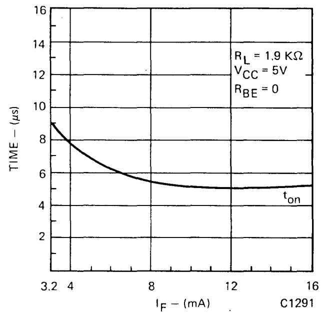


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

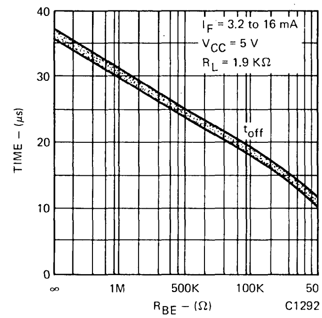


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

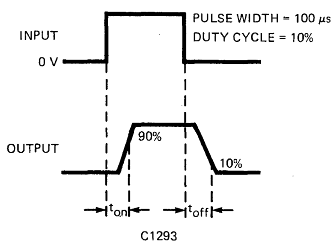


Fig. 11.

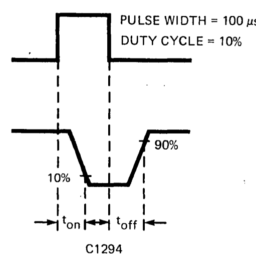


Fig. 12.

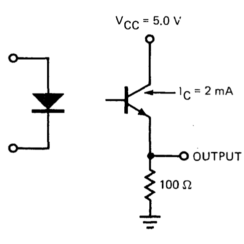


Fig. 13.

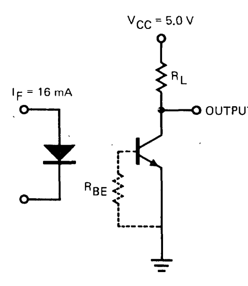
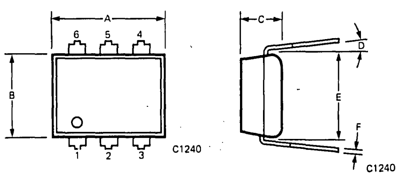


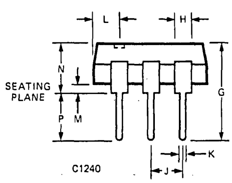
Fig. 14.

GENERAL INSTRUMENT

MCT272

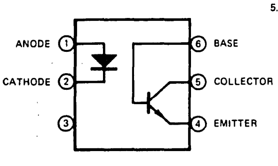
PACKAGE DIMENSIONS





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



C1339

DESCRIPTION

The MCT272 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

- 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
- VDE approval applied for

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)	I_{CE}/I_F	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	I_{CB}/I_F		.15		%	I_F = 10 mA; V_{CB} = 10 V
	Saturation voltage	$V_{CE(SAT)}$		.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 Ω; I_C = 2 mA; V_{CC} = 5 V
	Turn-off time	t_{off}		5.5	10	μs	See figures 11, 13
	Saturated						
	Turn-on time	t_{on}		3.9		μs	I_F = 16 mA; R_L = 1.9 KΩ
	Turn-off time	t_{off}		48		μs	See figures 12, 14
	(Approximates a typical TTL interface)						
	Turn-on time	t_{on}		3.9		μs	I_F = 16 mA; R_L = 4.7 KΩ
	Turn-off time	t_{off}		110		μs	See figures 12, 14
	(Approximates a typical low power TTL interface)						
ISOLATION	Surge isolation	V_{iso}	4000			VDC	Relative humidity ⩽ 50%, I_{I-O} ⩽ 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}		.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 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 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 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
	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)

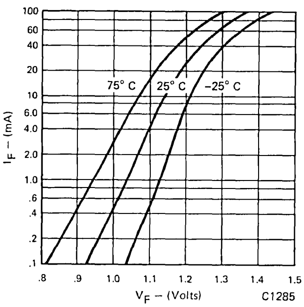


Fig. 1. Forward Voltage vs. Forward Current

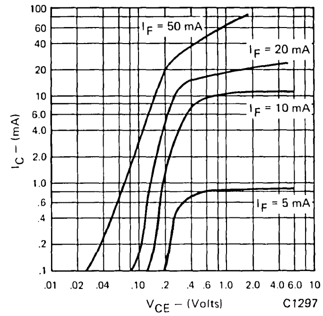


Fig. 2. Collector Current vs. Collector to Emitter Voltage

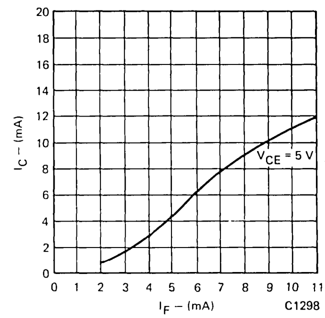


Fig. 3. Collector Current vs. Forward Current

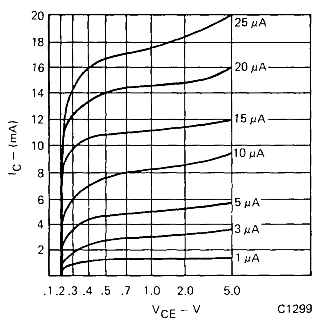


Fig. 4. Collector Current vs. Collector to Emitter Voltage

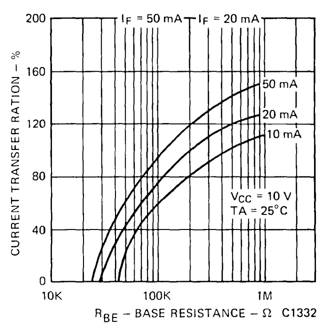


Fig. 5. Sensitivity vs. Base Resistance

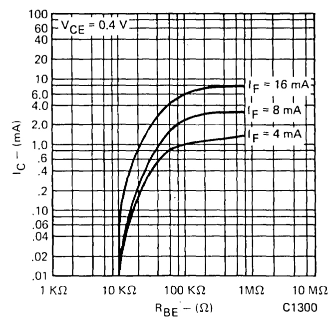


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

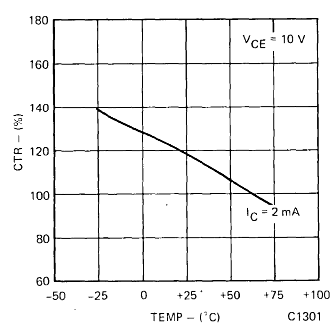


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

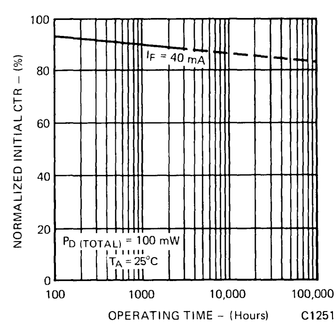


Fig. 8. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

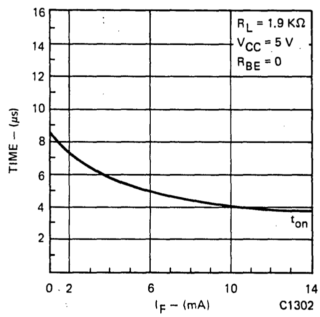


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

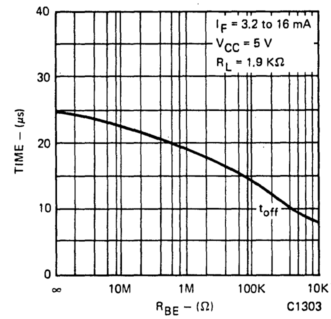


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

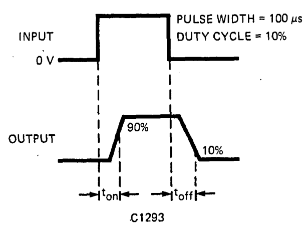


Fig. 11.

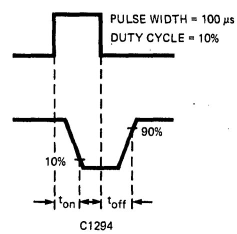


Fig. 12.

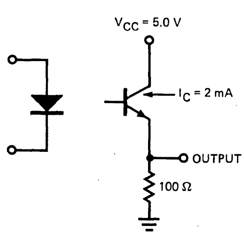


Fig. 13.

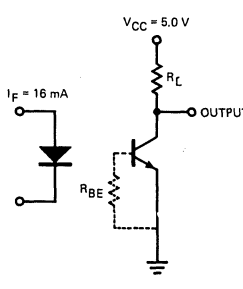


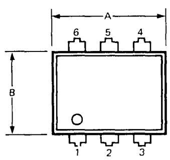
Fig. 14.

DESIGNER SERIES
PHOTOTRANSISTOR OPTOISOLATOR

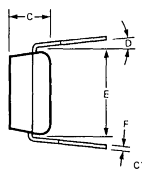
GENERAL INSTRUMENT

MCT273

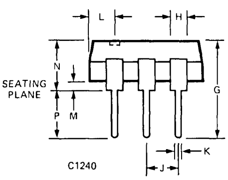
PACKAGE DIMENSIONS



C1240



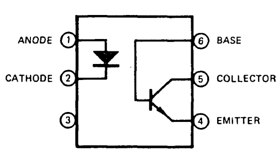
C1240



C1240

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



C1339

DESCRIPTION

The MCT273 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

- 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
- VDE approval applied for

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)	I_{CE}/I_F	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	I_{CB}/I_F		.15		%	I_F = 10 mA; V_{CB} = 10 V
	Saturation voltage	$V_{CE(SAT)}$		.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}		.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 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 TRANSISTOR	DC forward current gain	h_{FE}		280			V_{CE} = 5 V, I_C = 100 μA
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	30	70		V	I_C = 1.0 mA, I_F = 0
	Collector to base	BV_{CBO}	70	170		V	I_C = 10 μA
	Emitter to collector	BV_{ECO}	7	12		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)

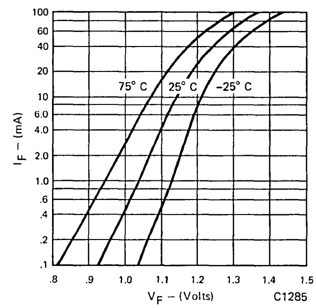


Fig. 1. Forward Voltage vs. Forward Current

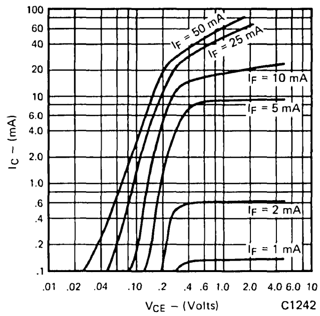


Fig. 2. Collector Current vs. Collector to Emitter Voltage

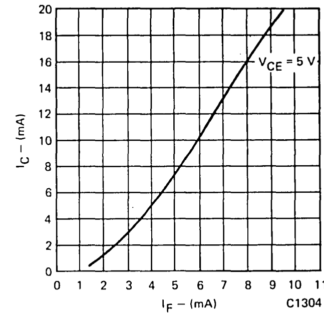


Fig. 3. Collector Current vs. Forward Current

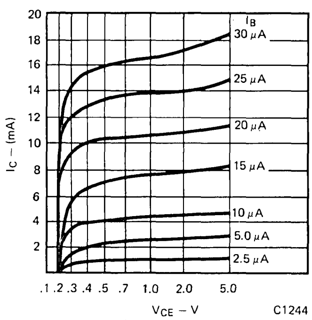


Fig. 4. Collector Current vs. Collector to Emitter Voltage

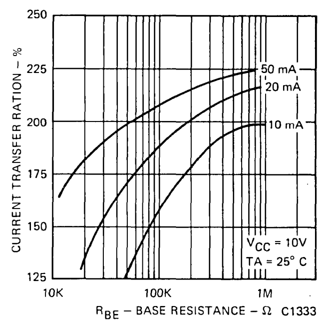


Fig. 5. Sensitivity vs. Base Resistance

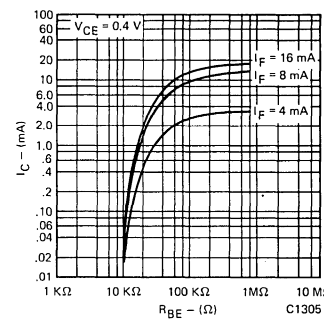


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

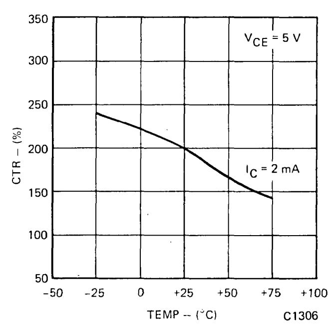


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

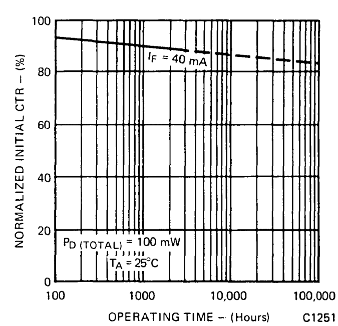


Fig. 8. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

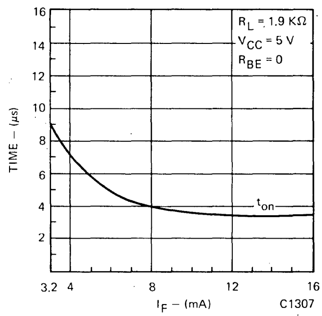


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

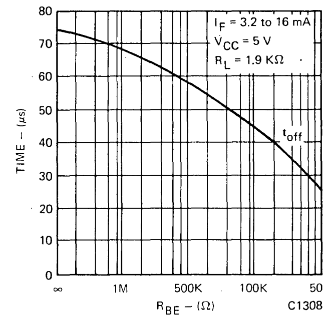


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

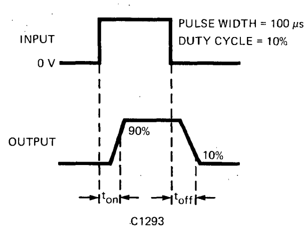


Fig. 11.

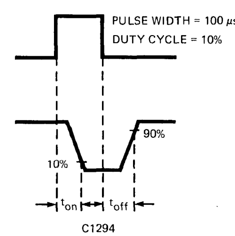


Fig. 12.

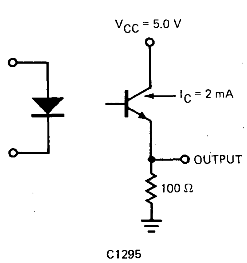


Fig. 13.

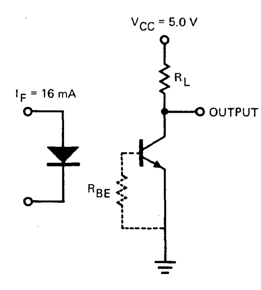
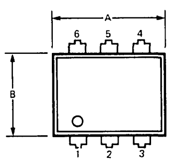


Fig. 14.

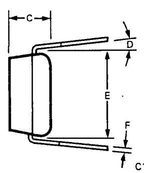
GENERAL INSTRUMENT

MCT274

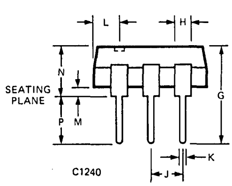
PACKAGE DIMENSIONS



C1240



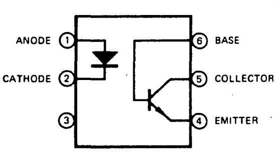
C1240



C1240

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



C1339

DESCRIPTION

The MCT274 is a phototransistor-type optically coupled isolator. An infrared emitting diode manufactured from specially grown gallium arsenide is selectively coupled with an NPN high-gain silicon phototransistor. The device is supplied in a standard plastic six-pin dual-in-line package.

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
- VDE approval applied for

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)	I_{CE}/I_F	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	I_{CB}/I_F		.15		%	I_F = 10 mA; V_{CB} = 10 V
	Saturation voltage	$V_{CE(SAT)}$		.16	.40	V	I_F = 16 mA; I_C = 2 mA
SWITCHING TIMES	Non-saturated						
	Turn-on time	t_{on}		9.1	25	μs	R_L = 100 Ω; I_C = 2 mA; V_{CC} = 5 V
	Turn-off time	t_{off}		7.9	25	μs	See figures 11, 13
	Saturated						
	Turn-on time	t_{on}		3.0		μs	I_F = 16 mA; R_L = 1.9 KΩ
	Turn-off time	t_{off}		95		μs	See figures 12, 14
	(Approximates a typical TTL interface)						
	Turn-on time	t_{on}		3.0		μs	I_F = 16 mA; R_L = 4.7 KΩ
	Turn-off time	t_{off}		185		μs	See figures 12, 14
	(Approximates a typical low power TTL interface)						
ISOLATION	Surge isolation	V_{iso}	4000			VDC	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA
			3000			VAC-rms	t = 1 second
	Steady state isolation	V_{iso}	3500			VDC	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA
			2500			VAC-rms	t = 1 minute
	Isolation resistance	R_{iso}	10^{11}			ohms	V_{I-O} = 500 VDC
	Isolation capacitance	C_{iso}		.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 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 TRANSISTOR	DC forward current gain	h_{FE}		360			V_{CE} = 5 V, I_C = 100 μA
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	30	70		V	I_C = 1.0 mA, I_F = 0
	Collector to base	BV_{CBO}	70	170		V	I_C = 10 μA
	Emitter to collector	BV_{ECO}	7	12		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)

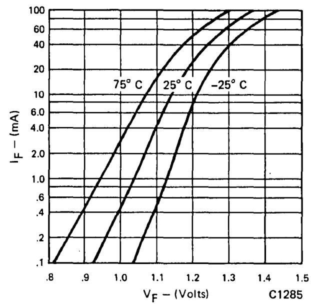


Fig. 1. Forward Voltage vs. Forward Current

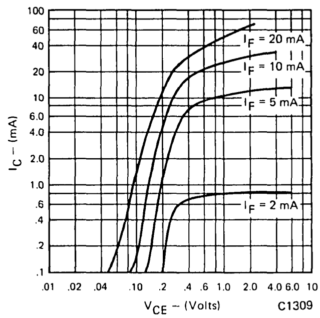


Fig. 2. Collector Current vs. Collector to Emitter Voltage

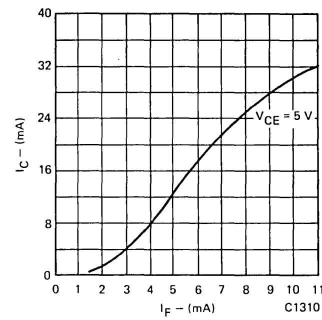


Fig. 3. Collector Current vs. Forward Current

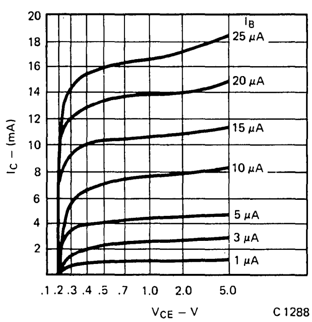


Fig. 4. Collector Current vs. Collector to Emitter Voltage

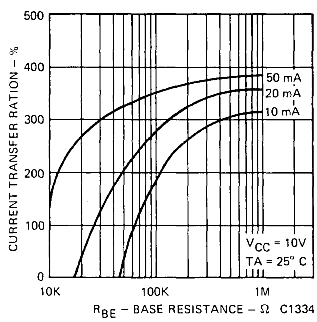


Fig. 5. Sensitivity vs. Base Resistance

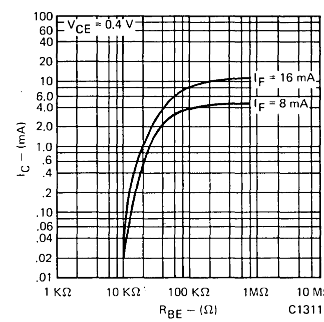


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

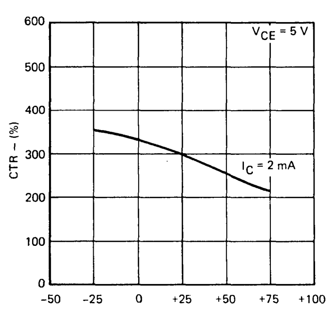


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

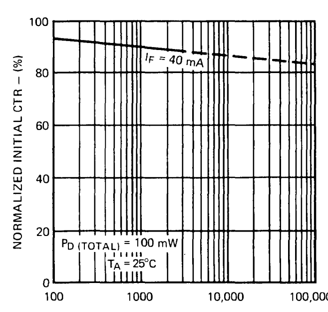


Fig. 8. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

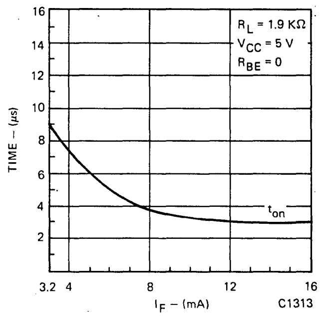


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

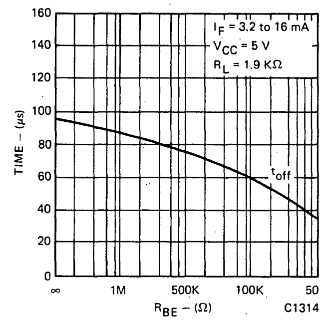


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

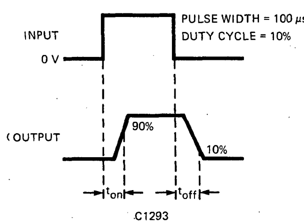


Fig. 11.

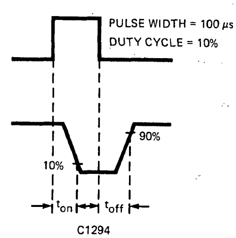


Fig. 12.

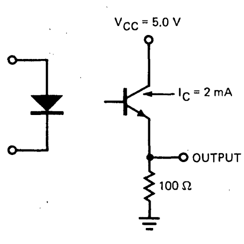


Fig. 13.

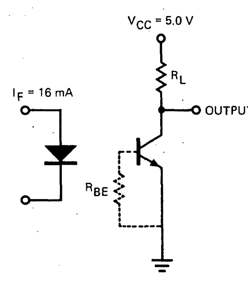
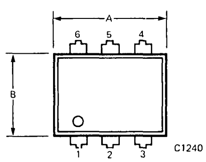


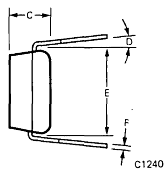
Fig. 14.

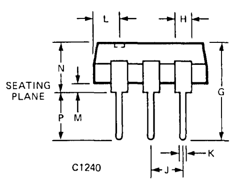
GENERAL INSTRUMENT

MCT275

PACKAGE DIMENSIONS

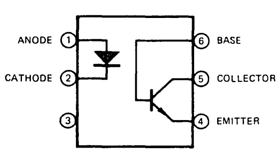






SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.365	9.27	
B	.270	6.86	
C	.160	4.06	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5

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



C1339

DESCRIPTION

The MCT275 is a phototransistor-type optically coupled isolator. An infrared emitting diode manufactured from specially grown gallium arsenide is selectively coupled with a high voltage NPN silicon phototransistor. The device is supplied in a standard plastic six-pin dual-in-line package.

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
- VDE approval applied for

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)	I_{CE}/I_F	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	I_{CB}/I_F		.15		%	I_F = 10 mA; V_{CB} = 10 V
	Saturation voltage	$V_{CE(SAT)}$		.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 Ω; 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} ≤ 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}		.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 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 TRANSISTOR	DC forward current gain	h_{FE}		170			V_{CE} = 5 V, I_C = 100 μA
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	80	85		V	I_C = 1.0 mA, I_F = 0
	Collector to base	BV_{CBO}	70	180		V	I_C = 10 μA
	Emitter to collector	BV_{ECO}	7	11		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)

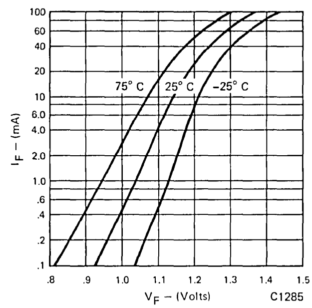


Fig. 1. Forward Voltage vs. Forward Current

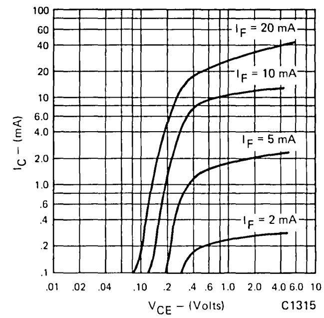


Fig. 2. Collector Current vs. Collector to Emitter Voltage

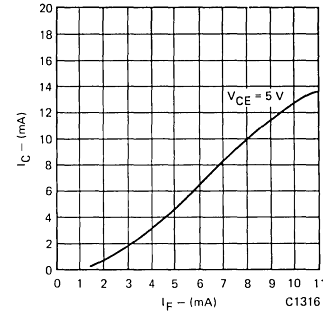


Fig. 3. Collector Current vs. Forward Current

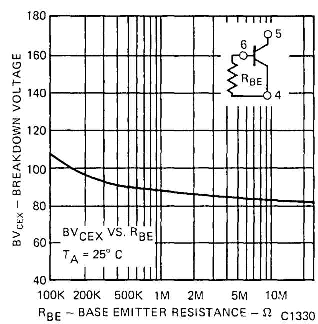


Fig. 4. Collector-Emitter Breakdown Voltage vs. Base Resistance

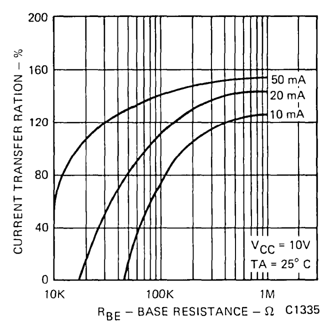


Fig. 5. Sensitivity vs. Base Resistance

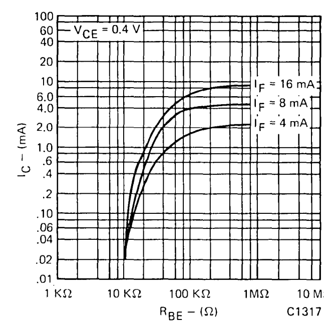


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

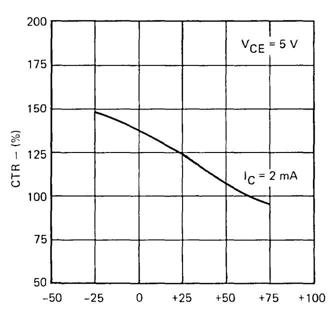


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

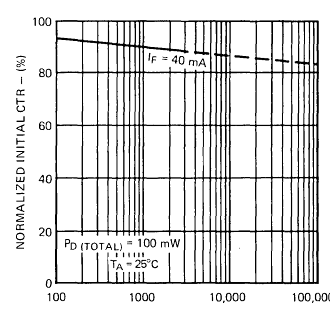


Fig. 8. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

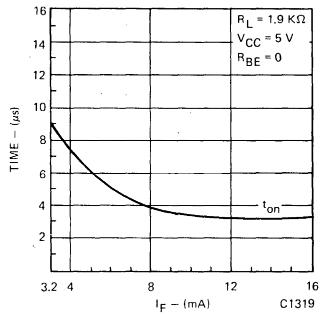


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

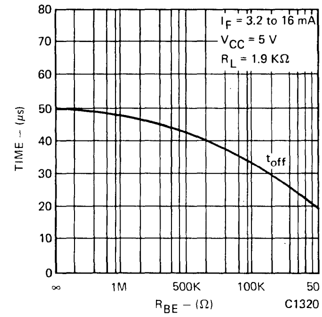


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

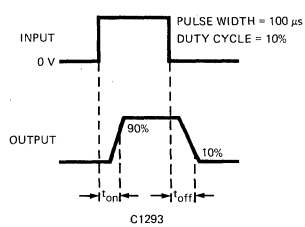


Fig. 11.

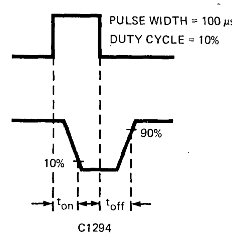


Fig. 12.

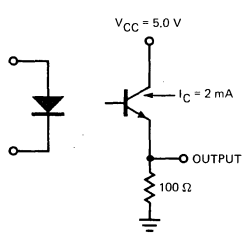


Fig. 13.

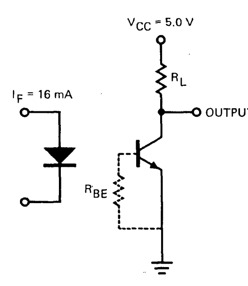
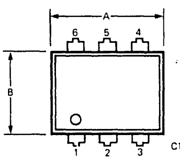


Fig. 14.

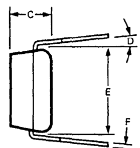
GENERAL INSTRUMENT

MCT276

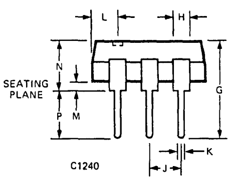
PACKAGE DIMENSIONS



C1240



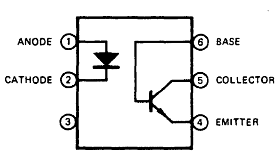
C1240



C1240

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



C1339

DESCRIPTION

The MCT276 is a phototransistor-type optically coupled isolator. An infrared emitting diode manufactured from specially grown gallium arsenide is selectively coupled with a high speed NPN silicon phototransistor. The device is supplied in a standard plastic six-pin dual-in-line package.

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
- VDE approval applied for

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)	I_{CE}/I_F	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	I_{CB}/I_F		.15		%	I_F = 10 mA; V_{CB} = 10 V
	Saturation voltage	$V_{CE(SAT)}$		.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}		.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 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 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 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
	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)

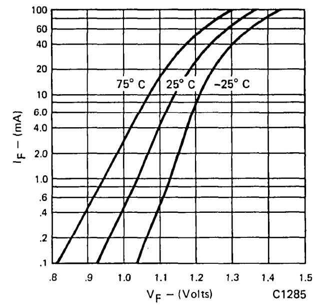


Fig. 1. Forward Voltage vs. Forward Current

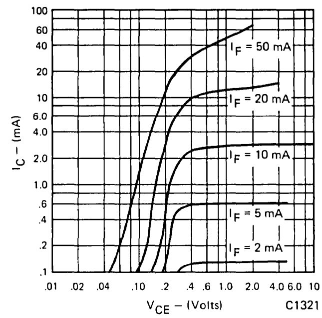


Fig. 2. Collector Current vs. Collector to Emitter Voltage

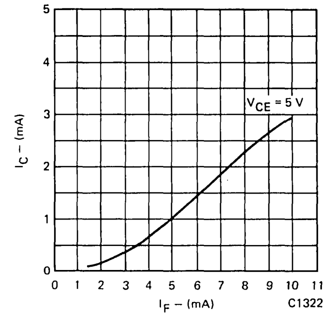


Fig. 3. Collector Current vs. Forward Current

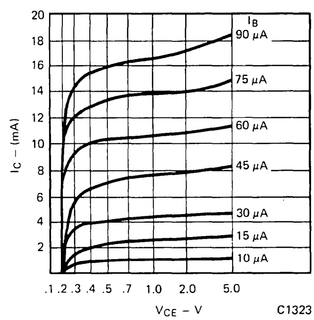


Fig. 4. Collector Current vs. Collector to Emitter Voltage

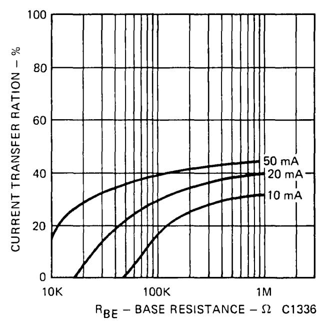


Fig. 5. Sensitivity vs. Base Resistance

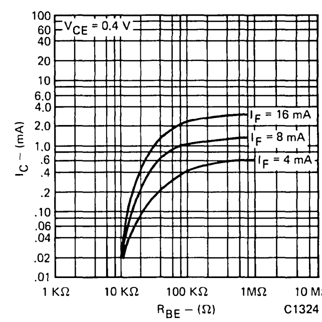


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

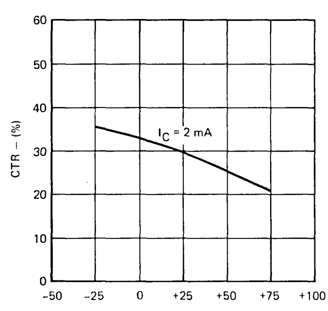


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

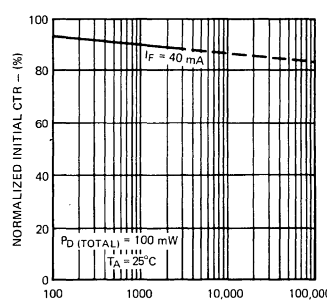


Fig. 8. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

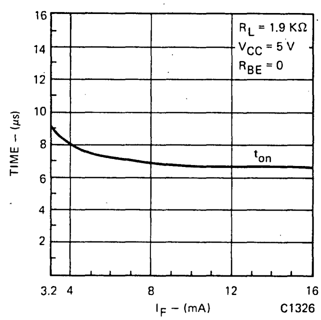


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

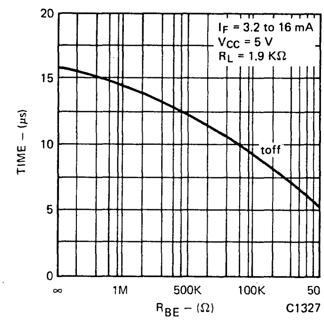


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

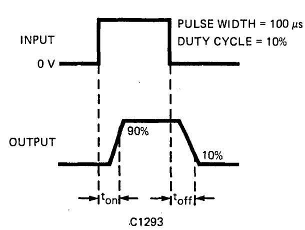


Fig. 11.

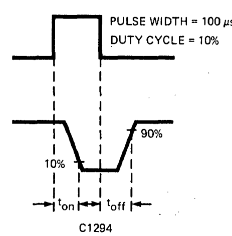


Fig. 12.

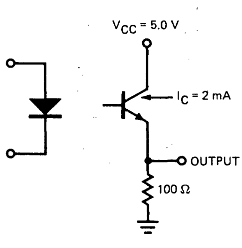


Fig. 13.

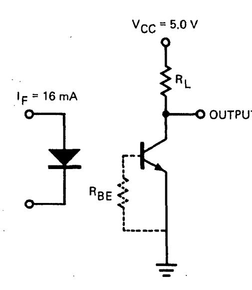
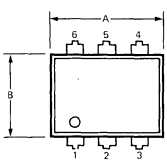


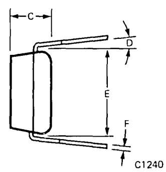
Fig. 14.

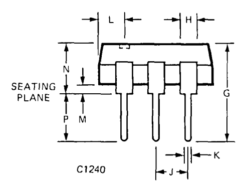
GENERAL INSTRUMENT

MCT277

PACKAGE DIMENSIONS

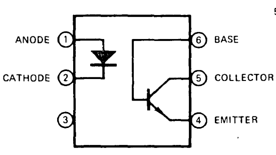






SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.365	9.27	
B	.270	6.86	
C	.160	4.06	
D	15°	15°	
E	.300 Ref.	7.62 Ref.	1
F	.014	0.36	
G	.325	8.26	
H	.070	1.78	
J	.110	2.79	
K	.022	0.56	
L	.085	2.16	2
M			3
N	.175	4.45	4
P			5

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



C1339

DESCRIPTION

The MCT277 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

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
- VDE approval applied for

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)	I_{CE}/I_F	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	I_{CB}/I_F		.4		%	I_F = 10 mA; V_{CB} = 10 V
SWITCHING TIMES	Non-saturated						
	Turn-on time	t_{on}			15	μs	R_L = 100 Ω; I_C = 2 mA; V_{CC} = 5 V
	Turn-off time	t_{off}			15	μs	See figures 15, 17
	Saturated						
	Turn-on time	t_{on}		3.8		μs	I_F = 16 mA; R_L = 1.9 KΩ
	Turn-off time	t_{off}		90		μs	See figures 16, 18
	(Approximates a typical TTL interface)						
	Turn-on time	t_{on}		3.7		μs	I_F = 16 mA; R_L = 4.7 KΩ
	Turn-off time	t_{off}		190		μs	See figures 16, 18
	(Approximates a typical low power TTL interface)						
ISOLATION	Surge isolation	V_{iso}	4000			VDC	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA
			3000			VAC-rms	t = 1 second
	Steady state isolation	V_{iso}	3500			VDC	Relative humidity ≤ 50%, I_{I-O} ≤ 10 μA
			2500			VAC-rms	t = 1 minute
	Isolation resistance	R_{iso}	10^{11}			ohms	V_{I-O} = 500 VDC
	Isolation capacitance	C_{iso}		1.0		pF	f = 1 MHz

INDIVIDUAL COMPONENT CHARACTERISTICS

	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE	Forward voltage	V_F		1.20	1.50	V	I_F = 20 mA
	Forward voltage temp. coefficient			-1.8		mV/°C	
	Reverse 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 TRANSISTOR	DC forward current gain	h_{FE}		420			V_{CE} = 5 V, I_C = 100 μA
	Breakdown voltage						
	Collector to emitter	BV_{CEO}	30	45		V	I_C = 1.0 mA, I_F = 0
	Collector to base	BV_{CBO}	30	30		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
	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)

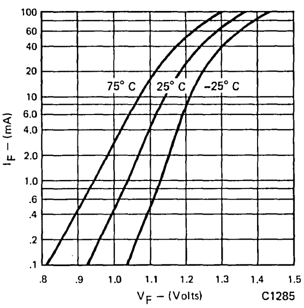


Fig. 1. Forward Voltage vs. Forward Current

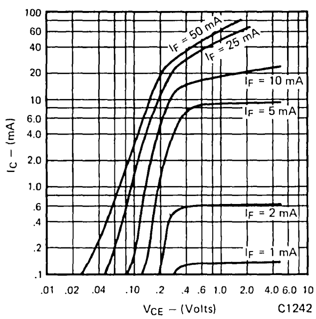


Fig. 2. Collector Current vs. Collector to Emitter Voltage

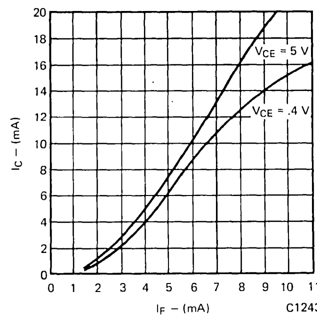


Fig. 3. Collector Current vs. Forward Current

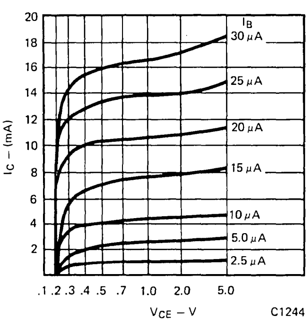


Fig. 4. Collector Current vs. Collector to Emitter Voltage

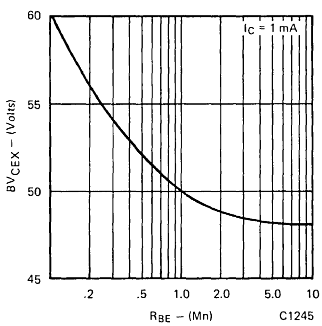


Fig. 5. Collector to Emitter Breakdown Voltage vs. Base to Emitter Resistance

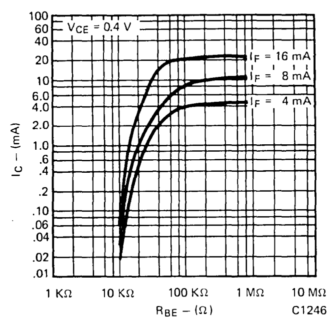


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

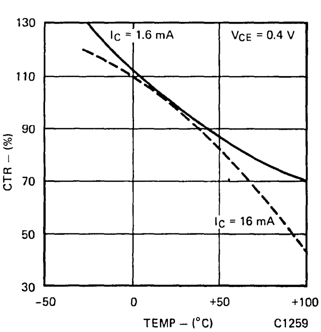


Fig. 7. Current Transfer Ratio (saturated) vs. Temperature

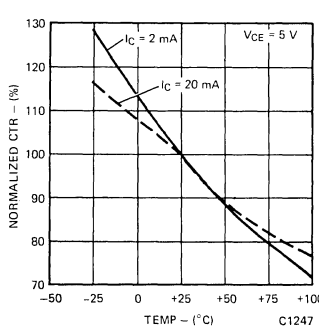


Fig. 8. Current Transfer Ratio (unsaturated) vs. Temperature

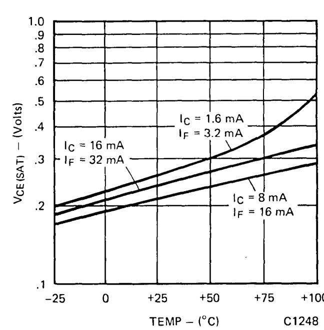


Fig. 9. Collector to Emitter Saturation Voltage vs. Temperature

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

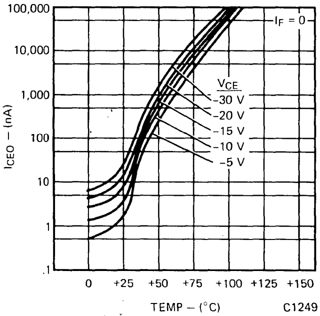


Fig. 10. Collector to Emitter Leakage Current vs. Temperature

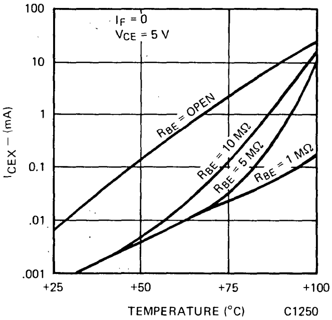


Fig. 11. Collector to Emitter Leakage Current vs. Temperature

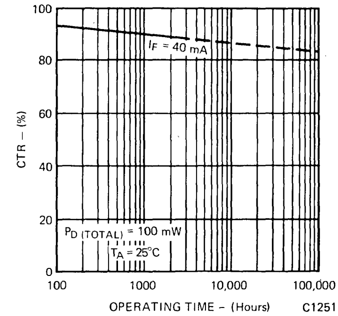


Fig. 12. Current Transfer Ratio vs. Operating Time

TYPICAL SWITCHING CHARACTERISTICS

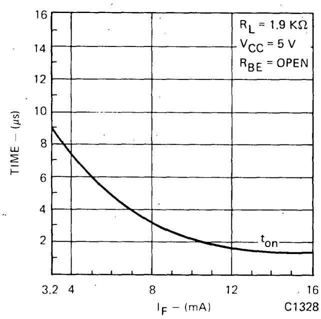


Fig. 13. Switch-on Time vs. I_F Drive (saturated)

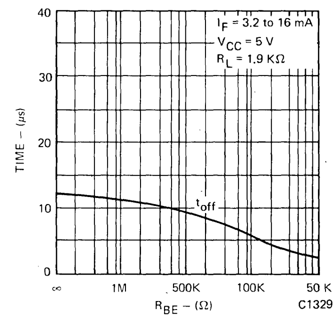


Fig. 14. Switch-off Time vs. Base to Emitter Resistance (saturated)

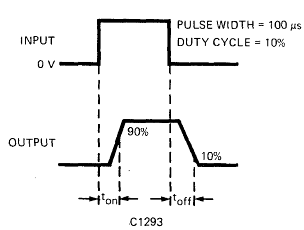


Fig. 15.

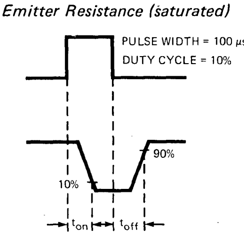


Fig. 16.

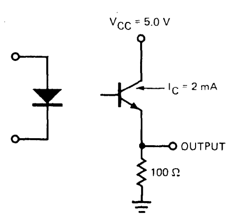


Fig. 17.

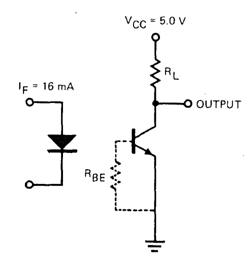
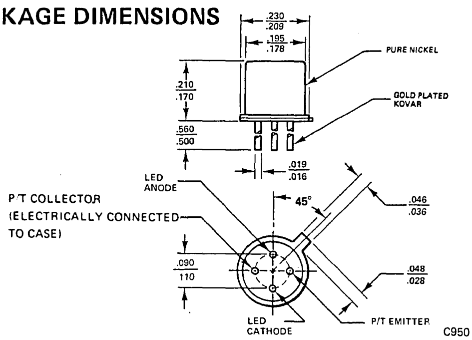


Fig. 18.

GENERAL INSTRUMENT

MCT4

PACKAGE DIMENSIONS



DESCRIPTION

The MCT4 is a standard four-lead, TO-18 package containing a GaAs light 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 time @ 260°C - 10.0 seconds

LED(GaAs Diode)
Power dissipation @ 25°C ambient . . . . . . 90 mW
Derate linearly from 25°C . . . . 1.2 mW/°C
Continuous forward current . . . . 40 mA
Reverse voltage . . . . 3.0 volts
Peak forward current . . . . 3.0 A
(1 μs pulse, 300 pps)
Total power dissipation . . . . 250 mW
Derate linearly from 25°C . . . . 3.3 mW/°C

DETECTOR (Silicon phototransistor)
Power dissipation @ 25°C ambient . . . . . 200 mW
Derate linearly from 25°C . . . . 2.67 mW/°C
Collector-emitter breakdown voltage
(BV_{CEO}) . . . . 30 volts
Emitter-collector breakdown voltage
(BV_{ECO}) . . . . 7.0 volts
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)

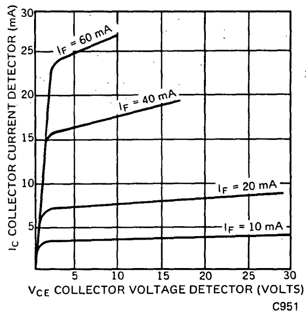


Figure 1 Detector Output Characteristics

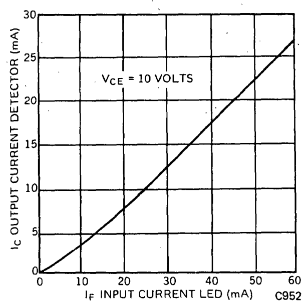


Figure 2 Input Current vs. Output Current

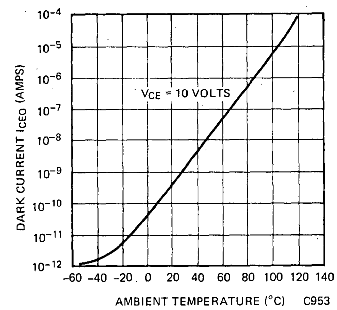


Figure 3 Dark Current vs. Temperature (°C)

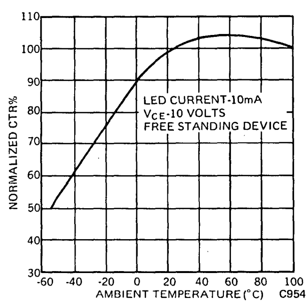


Figure 4 Current Output vs. Temperature

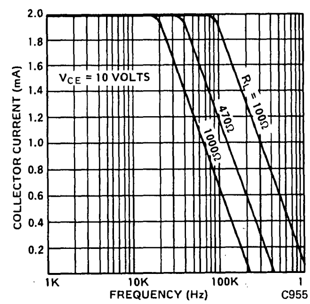


Figure 5 Output vs. Frequency

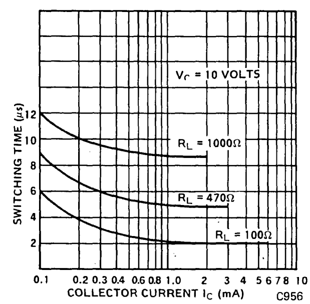
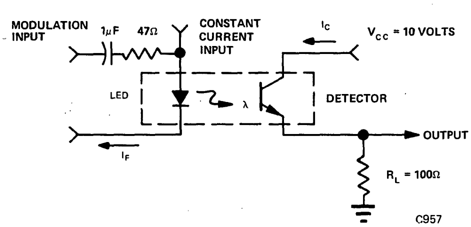


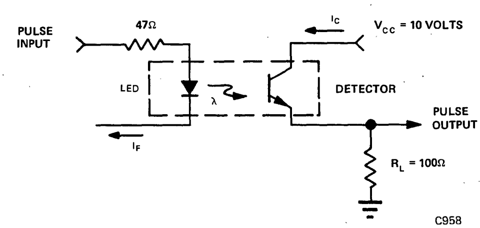
Figure 6 Switching Time vs. Collector Current

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

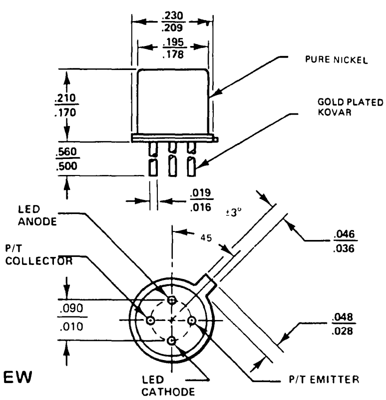
1. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.*
2. *The frequency at which i_C is 3 dB down from the 1 kHz value.*
3. *Rise time (t_r) is the time required for the collector current to increase from 10% of its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

RELIABILITY CONDITIONED PHOTOTRANSISTOR OPTOISOLATOR

GENERAL INSTRUMENT

MCT4R

PACKAGE DIMENSIONS



BOTTOM VIEW

.C950

DESCRIPTION

The MCT4 is a standard four-lead, TO-18 package containing a GaAs light 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

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

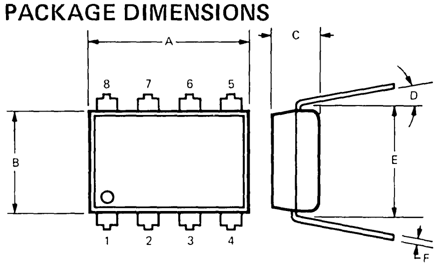
Subgroup VII		
High Temperature Storage	1008 – 150°C. for 1000 hours	7%
Critical Electrical	– Data Sheet	
Subgroup VIII		
Operating Life	1005 – Condition B	7%
Critical Electrical	– Data Sheets	
Subgroup IX		
Steady State Reverse Bias	1015 – Condition A; 72 hours at 150°C.	7%
Subgroup X		
Bond Strength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

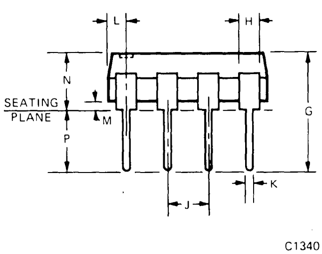
Reference: MIL-STD-883, Test Methods and Procedures for Microelectronics.

GENERAL INSTRUMENT

MCT6
MCT66

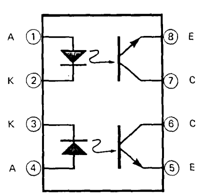
PACKAGE DIMENSIONS





SYMBOL	INCH MAX.	mm. MAX.	NOTES
A	.410	10.29	
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



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 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
- VDE approval applied for

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 . . . 1500 volts DC
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 $BV_{(I-O)}$	1500	2500		VDC	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)

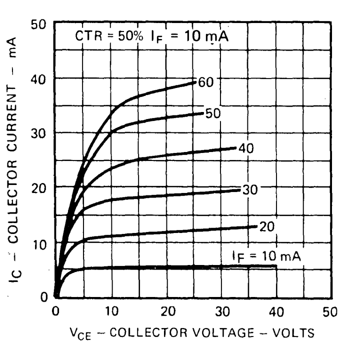


Fig. 1. I-V Curve of Phototransistor

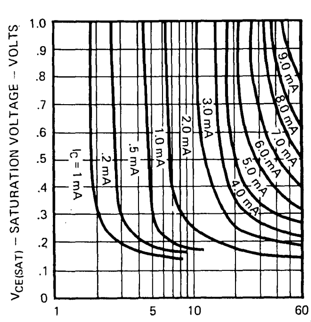


Fig. 2. I-V Curve in Saturation

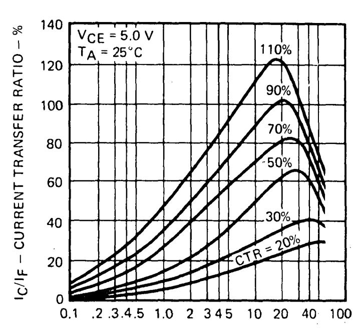


Fig. 3. CTR vs. Forward Current

MCT6 TYPICAL ELECTRO-OPTICAL CHARACTERTISTIC CURVES (Cont.)

(25°C Free Air Temperature Unless Otherwise Specified)

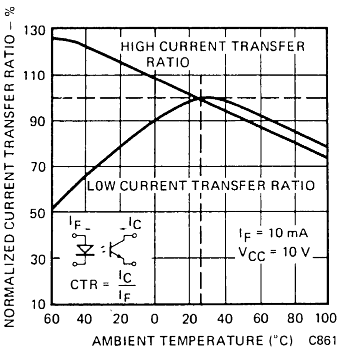


Fig. 4. Current Transfer Ratio vs. Temperature

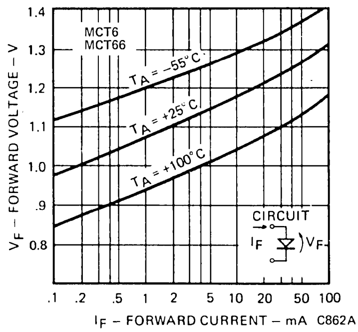


Fig. 5. I-V Curve of LED vs. Temperature

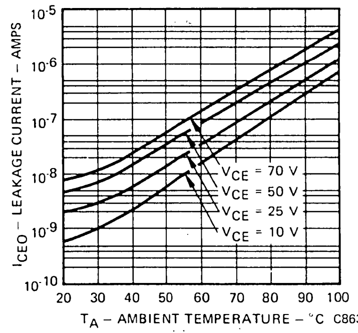


Fig. 6. Leakage Current vs. Temperature vs. Collector Voltage

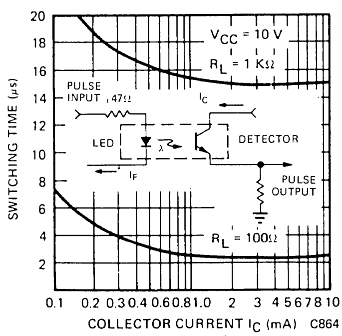


Fig. 7. Switching Time vs. Collector Current

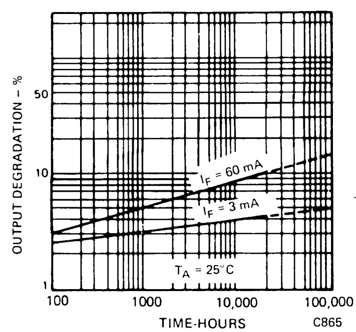


Fig. 8. Lifetime vs. Forward Current (Note 1)

MCT66 TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

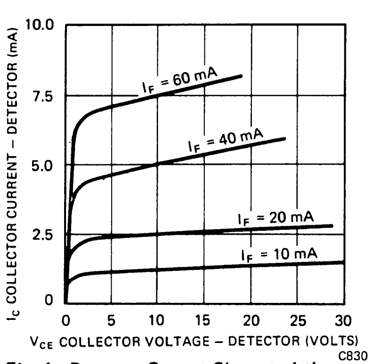


Fig. 1. Detector Output Characteristics

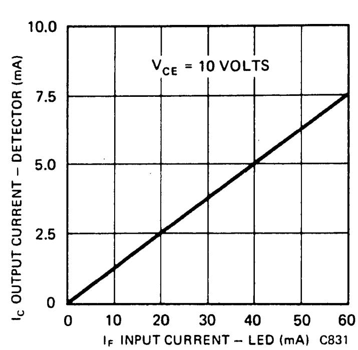


Fig. 2. Input Current vs. Output Current

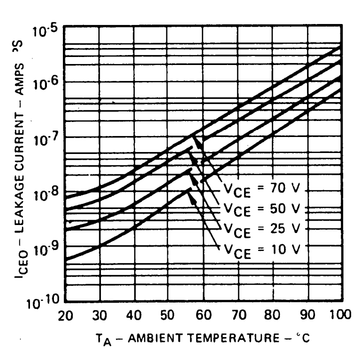


Fig. 3. Leakage Current vs. Temperature vs. Collector Voltage

MCT66 TYPICAL ELECTRO-OPTICAL CHARACTERTISTIC (Cont.)

(25°C Free Air Temperature Unless Otherwise Specified)

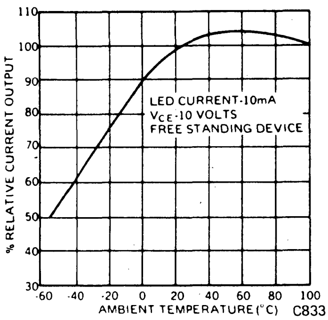


Fig. 4. Current Output vs. Temperature

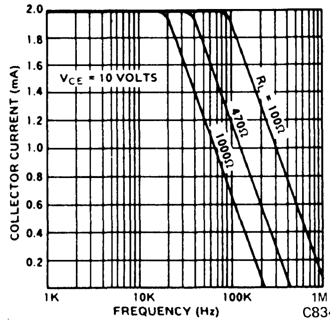


Fig. 5. Output vs. Frequency

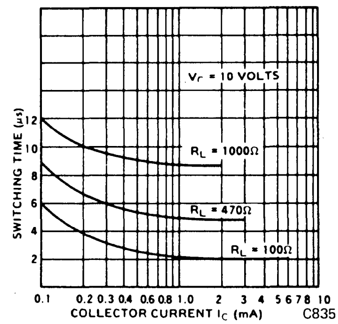


Fig. 6. Switching Time vs. Collector Current

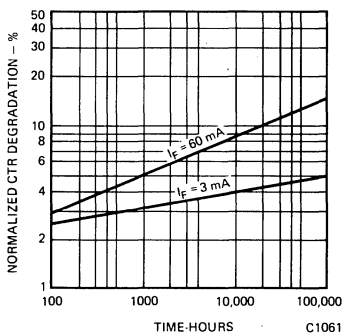
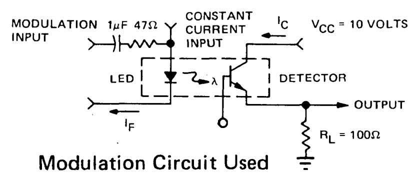
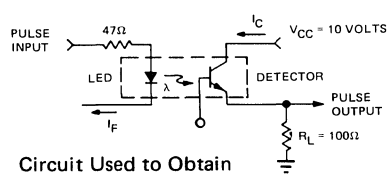


Fig. 7. Lifetime vs. Forward Current



Modulation Circuit Used to Obtain Figure 5

C837



Circuit Used to Obtain Figure 6

C838

NOTES

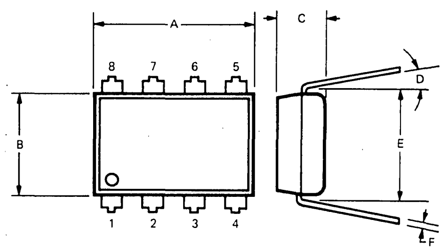
1. *Normalized CTR degradation* $= \dfrac{CTR_O - CTR}{CTR_O}$
2. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.*
3. *The frequency at which i_C is 3 dB down from the 1 kHz value.*
4. *Rise time (t_r) is the time 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%.

AC LINE MONITOR
OPTICALLY ISOLATED INTERFACE DEVICE

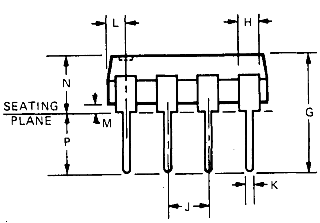
GENERAL INSTRUMENT

MID400

PACKAGE DIMENSIONS



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



C1340

SYMBOL	INCH MAX.	mm. MAX.	NOTES
A	.410	10.29	
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

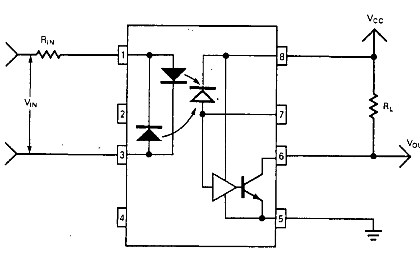


Fig. 1. MID400 Interfacing Circuit

DESCRIPTION

The MID400 is an optically isolated AC line-to-logic interface device. It is packaged in an 8-lead plastic DIP. The AC line voltage is monitored by two back-to-back GaAs LED diodes in series with an external resistor. A high gain detector circuit senses the LED current and drives the output gate to a logic low condition.

The MID400 has been designed 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)
- VDE approval applied for

APPLICATIONS

- Monitoring of the AC "line-down" condition
- "Closed-loop" interface between electro-mechanical elements such as solenoids, relay contacts, small motors, and micro-processors
- 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 $\leq$ 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:

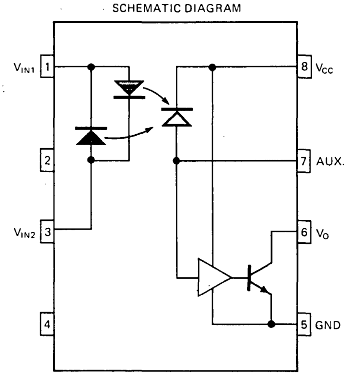
$$R_{IN} = \frac{V_{IN} - V_F}{I_{IN}}$$

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.

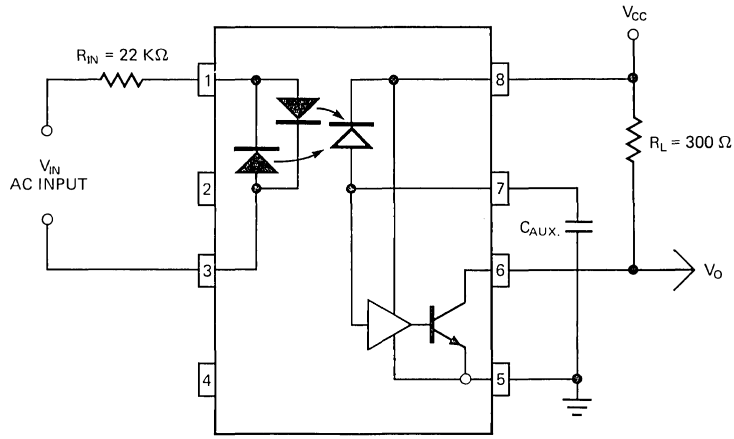
DYNAMIC CHARACTERISTICS

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.

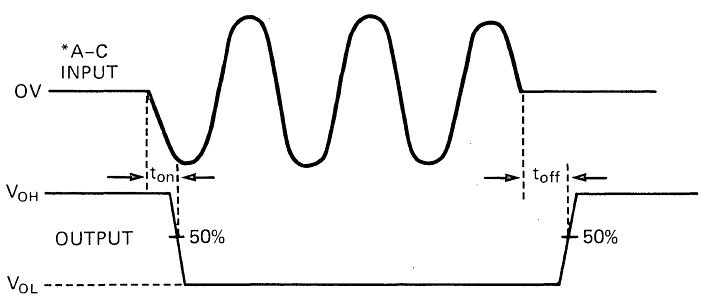
OPERATING SCHEMATICS



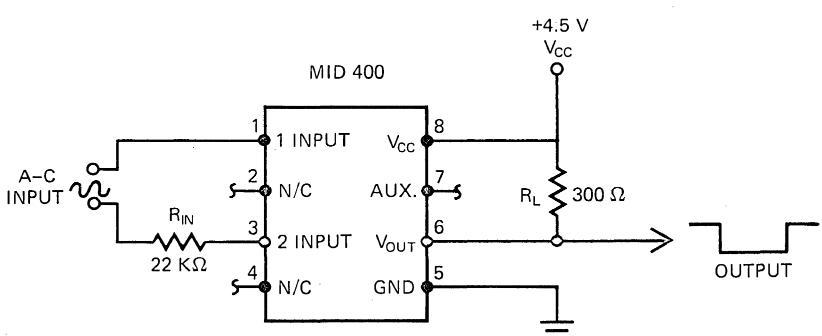
TEST CIRCUIT 1

Input Current vs. Capacitance, $C_{AUX.}$ Circuit

C1478



*INPUT TURNS ON AND OFF AT ZERO CROSSING.



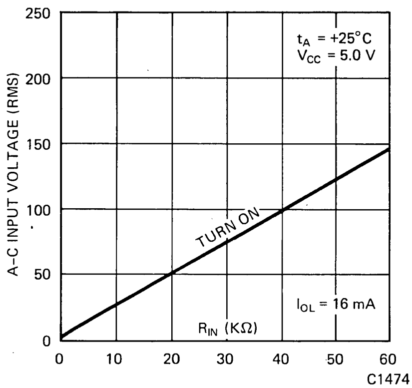
TEST CIRCUIT

TEST CIRCUIT 2

MID400 Switching Time

C1479

TYPICAL CURVES



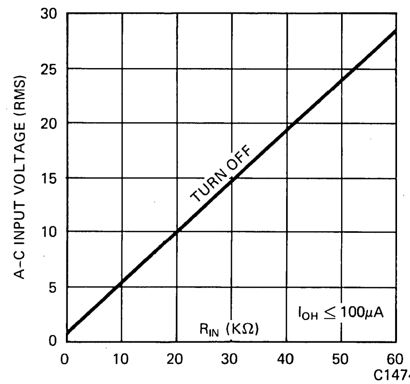


Fig. 2. Input Voltage vs. Input Resistance

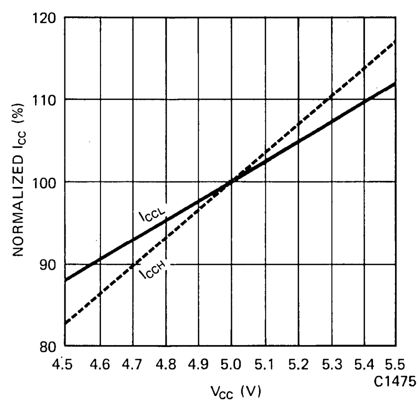


Fig. 3. Supply Current vs. Supply Voltage

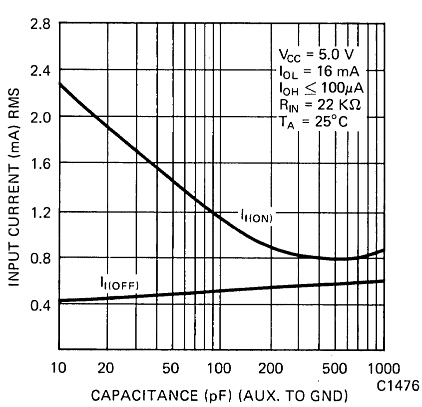


Fig. 4. Input Current vs. Capacitance (See test circuit 1)

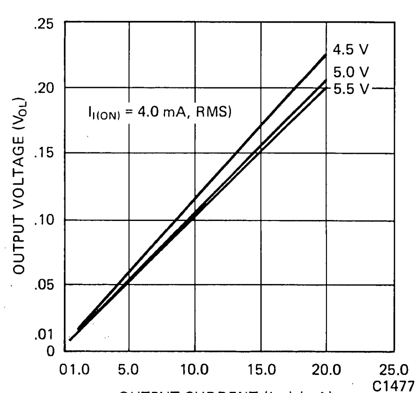
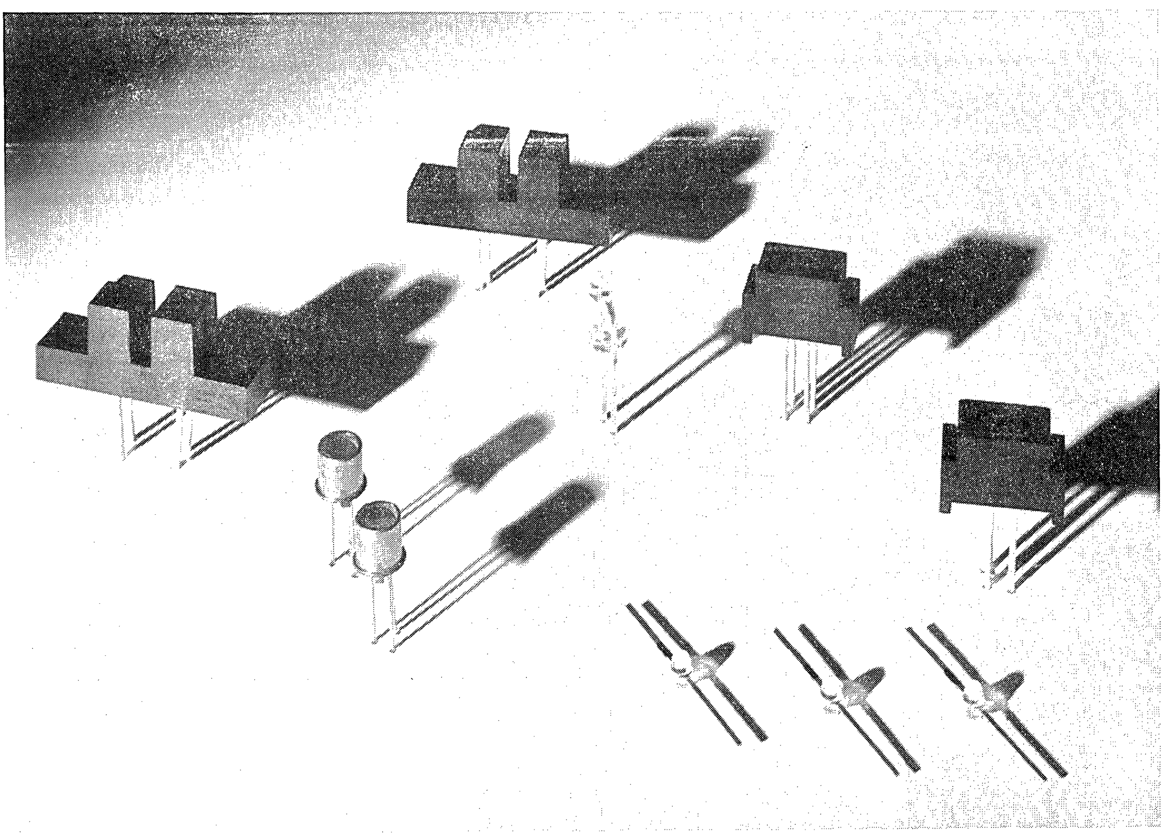


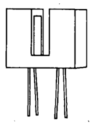
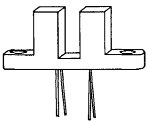
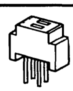
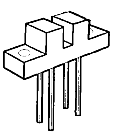
Fig. 5. Output Voltage vs. Output Current

Optoswitches Emitters Detectors

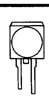
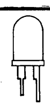
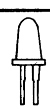
2



OPTO SWITCHES

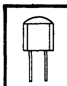
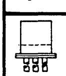
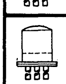
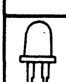
PACKAGE	DEVICE NO.	OUTPUT CONFIGURATION	MAX. EMITTER VOLTAGE	DETECTOR MIN. BV_{CEO}	DETECTOR TYPICAL DARK CURRENT	DETECTOR MAX. $V_{CE}(SAT)$	DETECTOR MIN. CURRENT TRANSFER RATIO
	CNY36	SLOTTED LIMIT SWITCH, TRANSISTOR	1.5V @ 20mA	32V	5nA @ 10V	.4V @ 25μA	1%
	CNY37	SLOTTED LIMIT SWITCH, TRANSISTOR	1.5V @ 20mA	32V	5nA @ 10V	.4V @ 25μA	1%
	MCA7	REFLECTIVE SENSOR, DARLINGTON	1.5V @ 20mA	30V	5nA @ 5V	–	0.1%
	MCA8	SLOTTED LIMIT SWITCH, DARLINGTON	1.5V @ 20mA	30V	5nA @ 5V	1.0V @ 2mA	15%
	MCA81					1.0V @ 1.6mA	4%
	MCT8	SLOTTED LIMIT SWITCH, TRANSISTOR	1.5V @ 20mA	30V	5nA @ 10V	.4V @ 50μA	1%
	MCT81					.4V @ 25μA	0.25%

INFRARED EMITTERS

PACKAGE	DEVICE NO.	RADIATED POWER (TYP.)	ON-AXIS IRRADIANCE OR INTENSITY (TYP.)	MAX. FORWARD VOLTAGE	MAX. DC CURRENT	MAX. POWER	ON/OFF DELAY (TYP.)	PAGE NO.	APPLICATIONS
	CQX47	25mW	33mW/Str.	3.4V @ 100mA	100mA	280mW	450nsec	155	Card readers, encoders, alarm and sector systems, level indicator, end-of-tape detection.
	CQY99	15mW	14mW/Str.	1.7V @ 100mA	150mA	210mW	450nsec	159	
	ME7121	3.0mW	10.8mW/Str.	1.8V @ 50mA	100mA	150mW	500nsec	175	
	ME7124	3.0mW	243.6mW/Str.	1.8V @ 50mA	100mA	150mW	500nsec	175	
	ME7161	3.0mW		1.8V @ 50mA	50mA	75mW	500nsec	179	

TYPICAL BANDWIDTH	PAGE NO.	APPLICATIONS
–	151	
–	151	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.
0.8KHz	163	Object sensing, end-of-tape detection, length measurement, industrial processing equipment.
0.8KHz 1.5KHz	167 167	
150KHz 200KHz	171 171	

SILICON DETECTORS

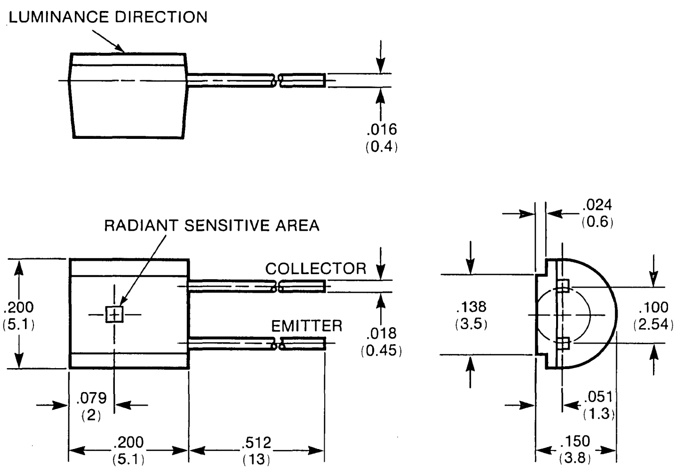
PACKAGE	DEVICE NO.	SENSITIVITY $\mu A/mW/cm^2$ (TYPICAL)	V_{CE} (SAT) (MAX.	MAX. DC CURRENT	MIN. BV_{CEO}	DARK CURRENT (TYPICAL)	BAND-WIDTH (TYP.)	PAGE NO.	APPLICATIONS
	BPW39A	400	0.3V @ 1mA	100mA	32V	10nA	500KHz	147	
	MT1	560	.5V @ 2mA	40mA	30V	1nA	300KHz	181	Optical switching, intrusion alarm, process control, tape and card reader, level controls, character recognition.
	MT2	1400						181	
	MT8020	350	0.4V @ 1.6 mA	40mA	30V	1.5nA	300KHz	183	

GENERAL INSTRUMENT

SILICON NPN EPITAXIAL PLANAR PHOTOTRANSISTOR BPW39A

PACKAGE DIMENSIONS

All dimensions are in inches (millimeters).



C1659

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 th 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

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 ($t \leq 3$ s) (See Note 1) . . 245°C

ELECTRICAL AND OPTICAL CHARACTERISTICS (25°C Ambient Temperature 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	

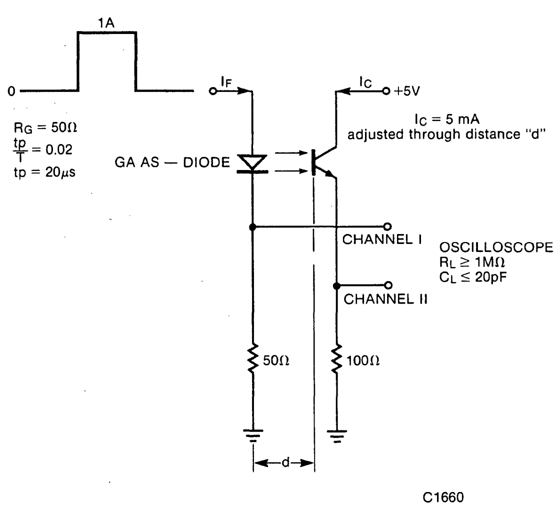


Fig. 1. Switching Time Test Circuit

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

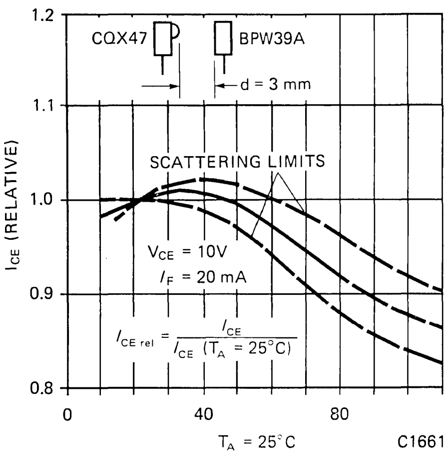


Fig. 2. Relative Collector Light Current vs. Ambient Temperature

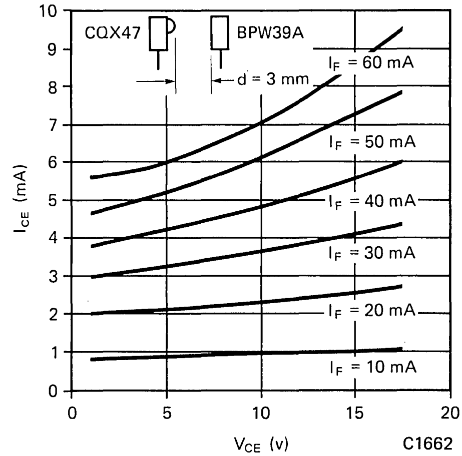


Fig. 3. Collector Light Current vs. Collector Emitter Voltage

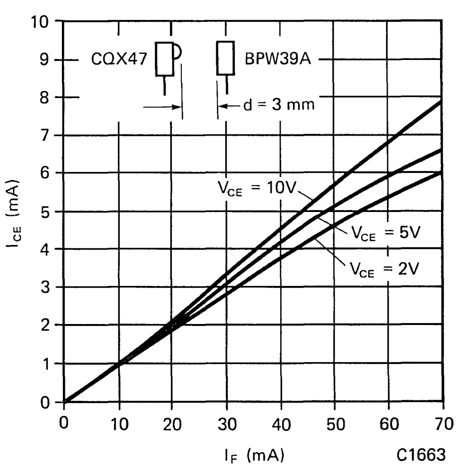


Fig. 4. Collector Light Current vs. GaAs LED Forward Current

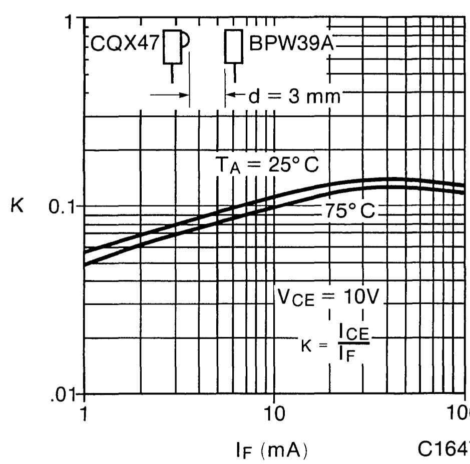


Fig. 5. Current Transfer Ratio vs. GaAs LED Forward Current

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

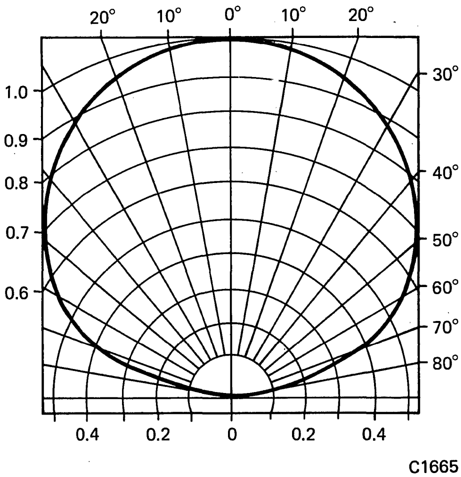


Fig. 6. Spatial Distribution

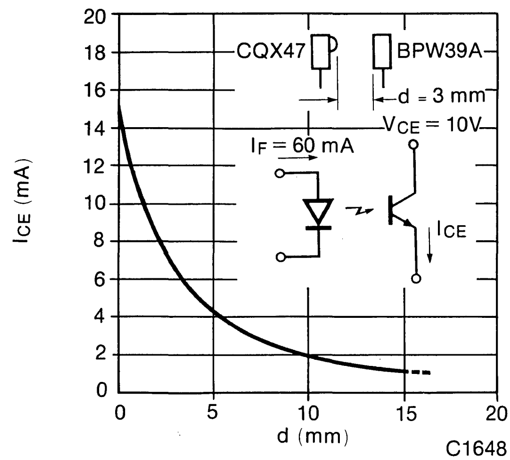


Fig. 7. Collector Light Current vs. Distance From GaAs LED Source

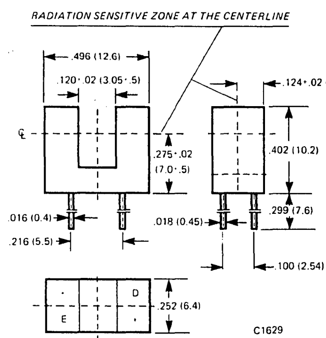
NOTES

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

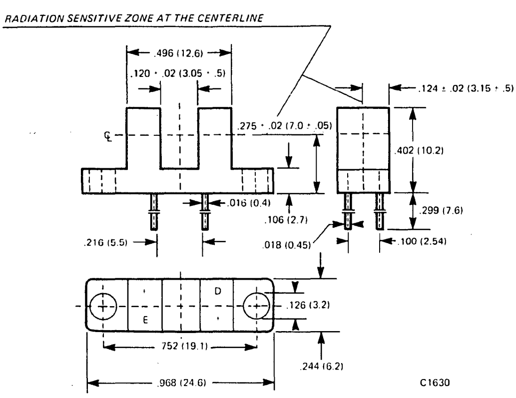
GENERAL INSTRUMENT

CNY36
CNY37

PACKAGE DIMENSIONS Dimensions in inches (mm)



CNY36



CNY37

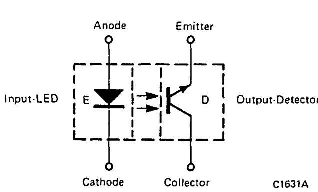


Fig. 1. Equivalent Circuit

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.

CNY36 CNY37

ABSOLUTE MAXIMUM RATINGS

INPUT-LED CIRCUIT

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

OUTPUT-DETECTOR CIRCUIT

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

TOTAL PACKAGE

Storage temperature .... −25°C to + 85°C
Power dissipation ($T_A \leq 25°C$) 250mW
Soldering temperature (t ≤ 3s) distance to the case ≥ 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	

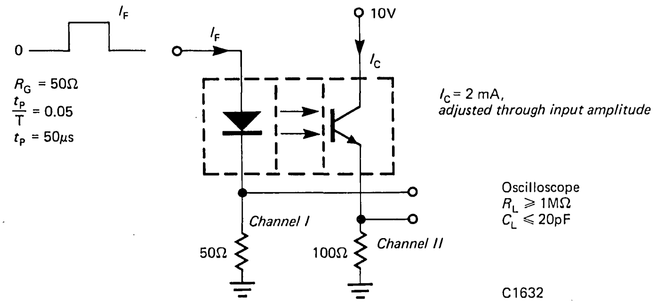


Fig. 2. Switching Time Test Circuit

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

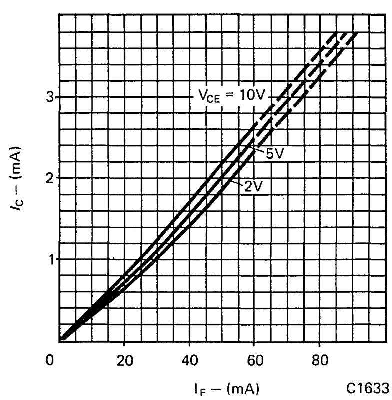


Fig. 3. Collector Current vs. Input LED Current

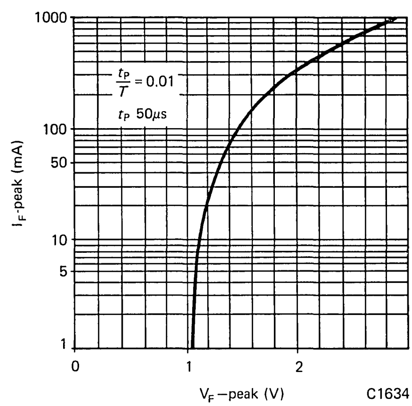


Fig. 4. Peak Input LED Current vs. Peak Input Voltage

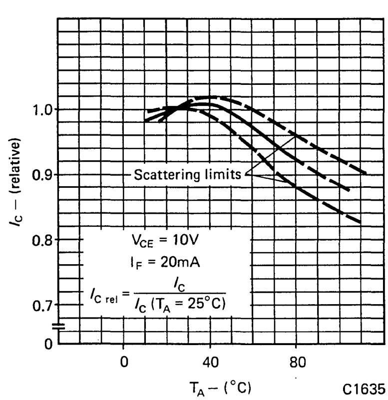


Fig. 5. Collector Current vs. Ambient Temperature

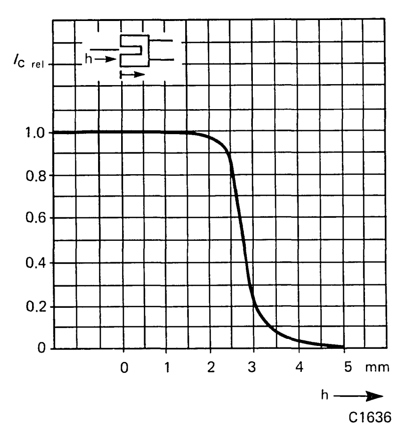


Fig. 6. Relative Collector Current vs. Object Distance

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

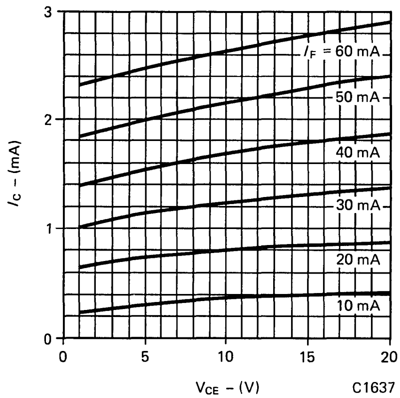


Fig. 7. Collector Current vs. Collector Emitter Voltage

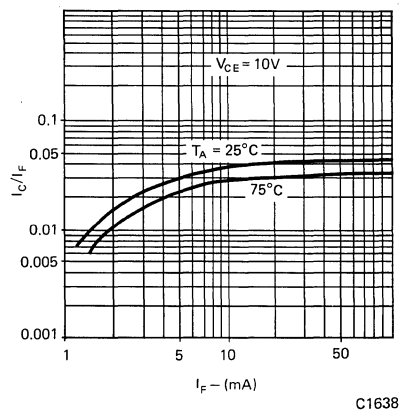


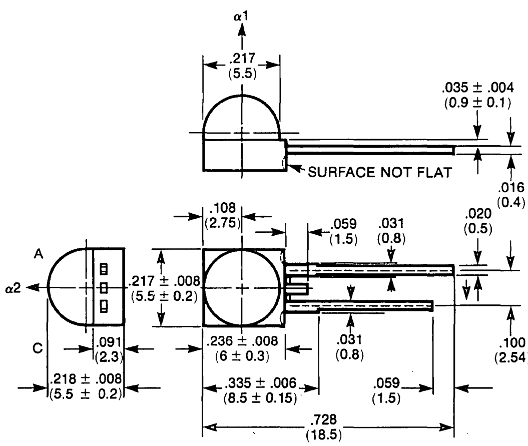
Fig. 8. $\frac{I_C}{I_F}$ vs. LED Forward Current

GENERAL INSTRUMENT

GaAs INFRARED LIGHT EMITTING DIODE CQX47

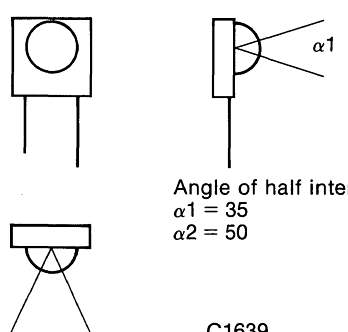
PACKAGE DIMENSIONS

All dimensions are in inches (millimeters).



WEIGHT: MAX 0.5g

C1640



Angle of half intensity
$\alpha 1 = 35$
$\alpha 2 = 50$

C1639

DESCRIPTION

The CQX47 is a high power liquid phase epitaxial IR emitter device. 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

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 ($t_P \leq 10\ \mu s$) .... 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 ($t \leq 3$ s) (See Note 1) .. 245°C

ELECTRICAL AND OPTICAL CHARACTERISTICS (25°C Ambient Temperature 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, $t_P \leq 10\ \mu s$ (See test circuit, Fig. 1)

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

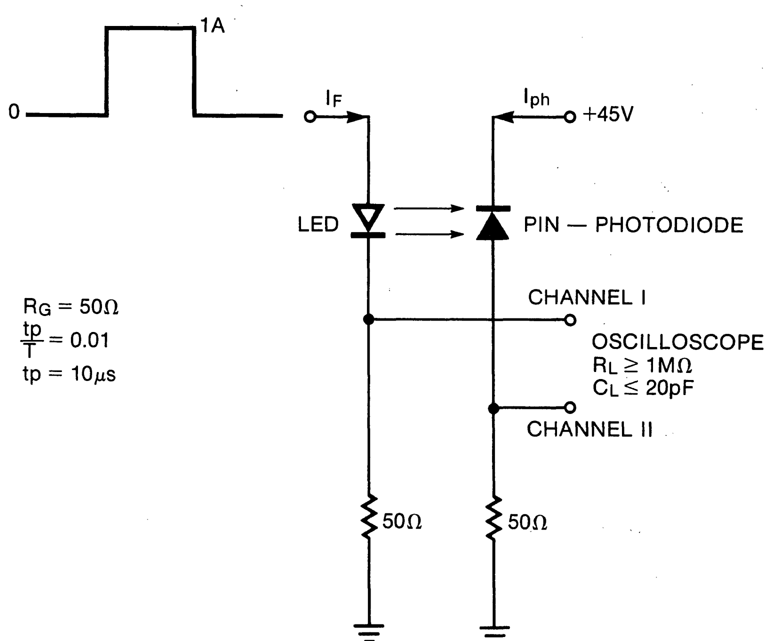


Fig. 1. Test Circuit For Switching Time

C1641

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

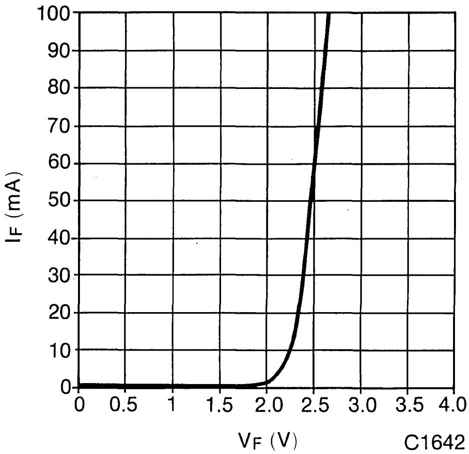


Fig. 2. Forward Current vs. Forward Voltage

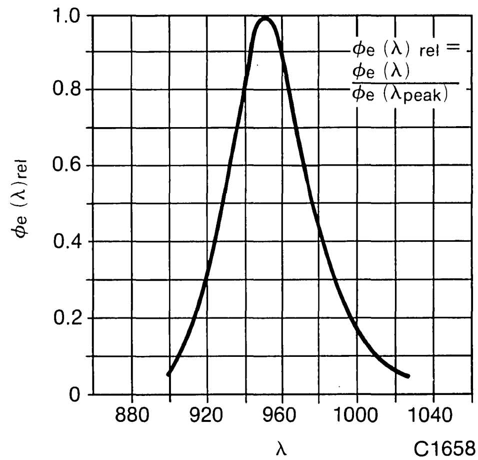


Fig. 3. Relative Radiated Power vs. Wavelength

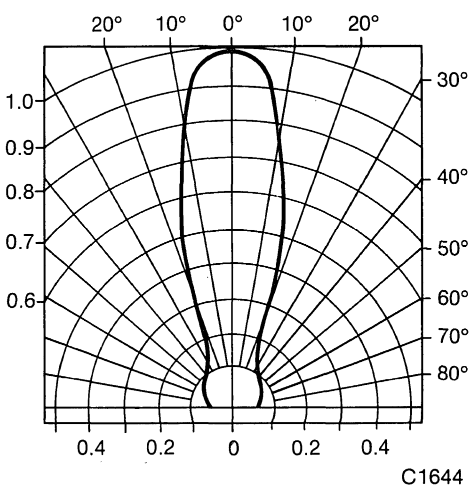


Fig. 4. α1 – Spatial Distribution For Vertical Plane

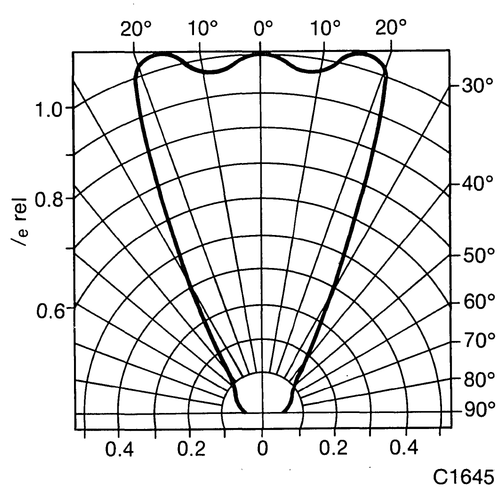


Fig. 5. α2 – Spatial Distribution For Horizontal Plane

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

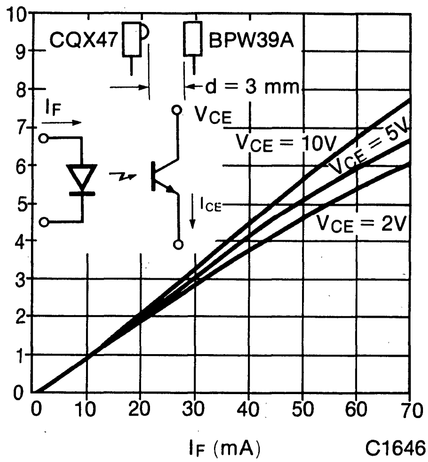


Fig. 6. Silicon Detector Output vs. Forward Current

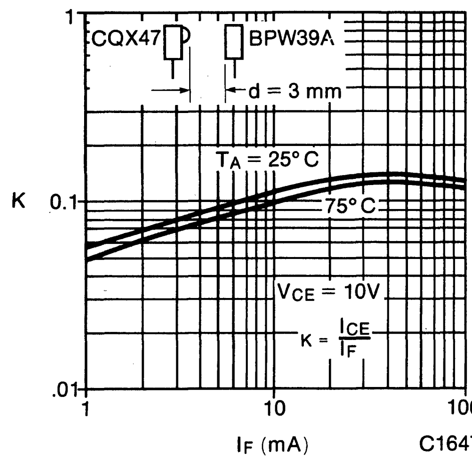


Fig. 7. Silicon Detector Current Transfer Ratio vs. Forward Current

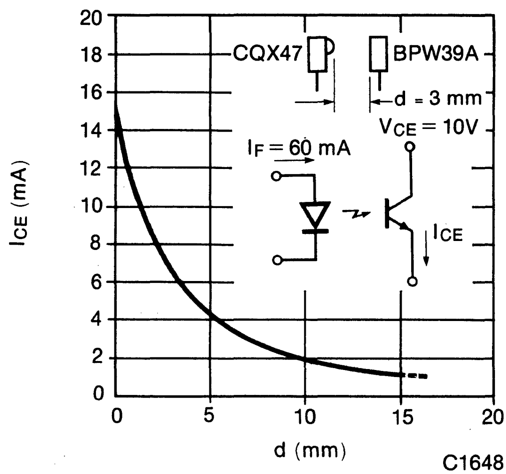


Fig. 8. On-axis Detector Response vs. Distance

NOTES

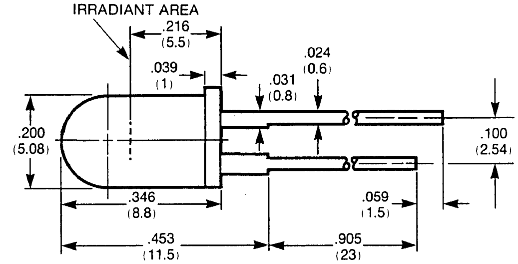
1. *Distance from the touching border ≥1.5 mm with intermediate PC-board.*

GENERAL INSTRUMENT

GaAs INFRARED LIGHT EMITTING DIODE CQY99

PACKAGE DIMENSIONS

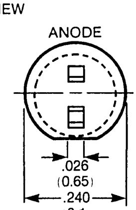
All dimensions are in inches (millimeters).



ANGLE OF HALF INTENSITY α = 60°
PLASTIC CASE
WEIGHT MAX. 0.4g

C1649

BOTTOM VIEW



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

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 ≤ 3 s) (See Note 1) . . 245°C

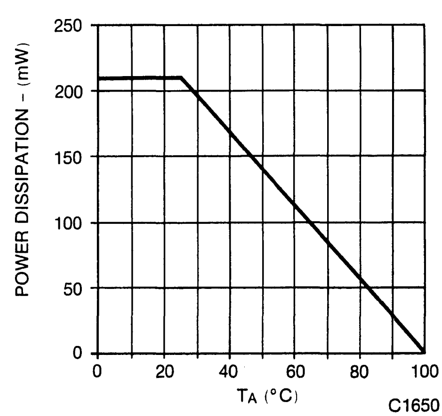


Fig. 1. Power Dissipation vs. Ambient Temperature

ELECTRICAL AND OPTICAL CHARACTERISTICS (25°C Ambient Temperature 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 μs (See test circuit, Fig. 2)

*0.65 AQL

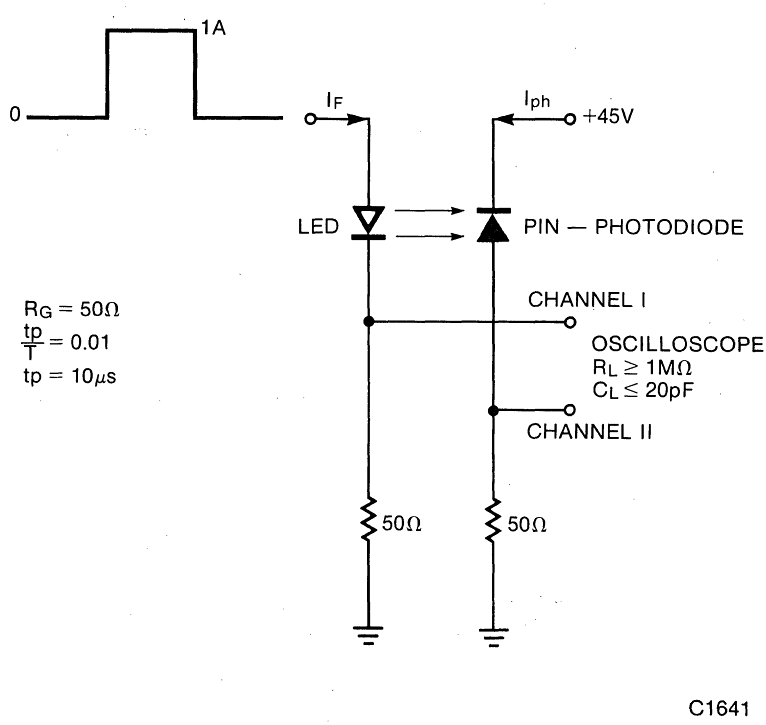


Fig. 2. Switching Time Test Circuit

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

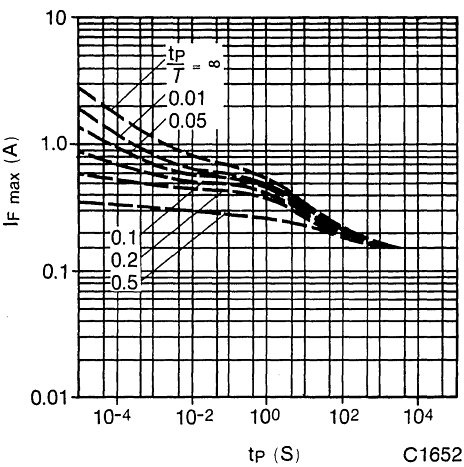


Fig. 3. Maximum Forward Current vs. Pulse Time

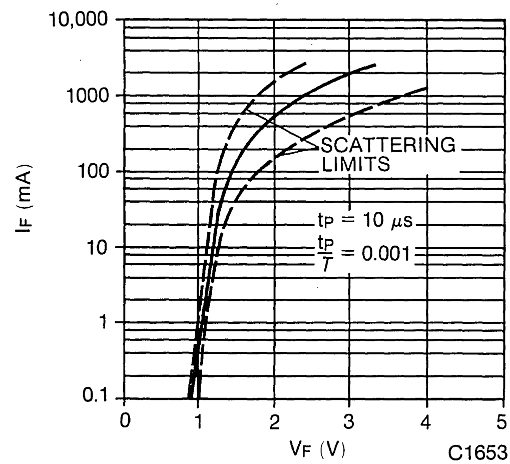


Fig. 4. Peak Forward Current vs. Peak Forward Voltage

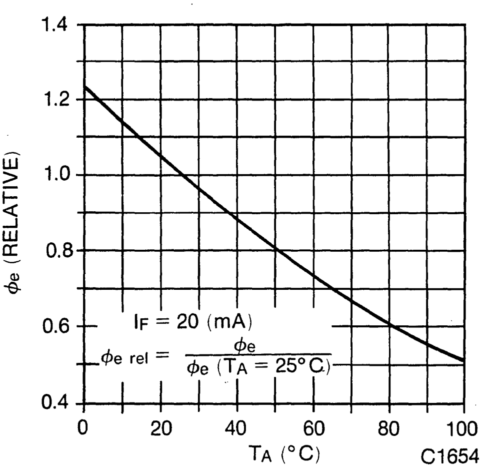


Fig. 5. Relative Radiant Power vs. Ambient Temperature

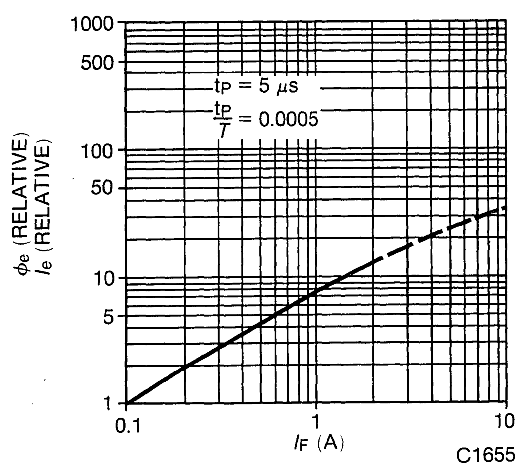


Fig. 6. Relative Radiant Power vs. Peak Forward Current

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

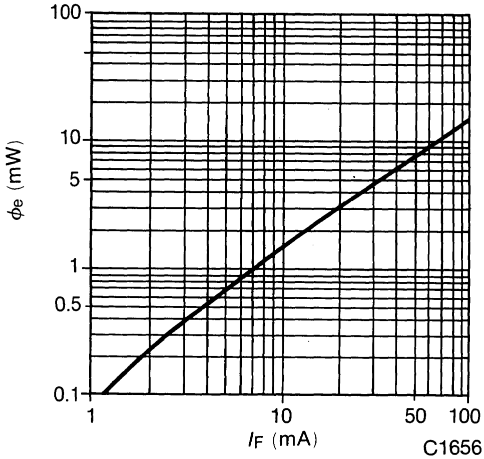


Fig. 7. Radiant Power vs. Forward Current

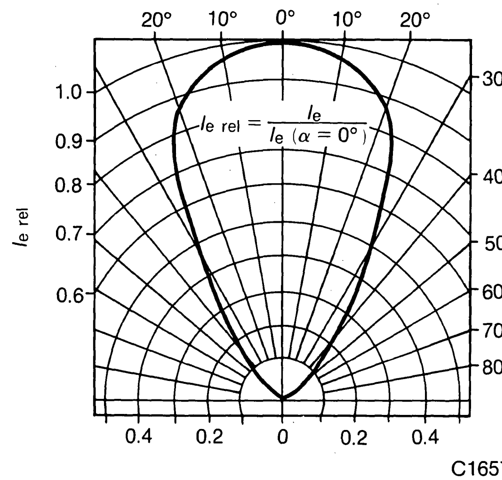


Fig. 8. Spatial Distribution

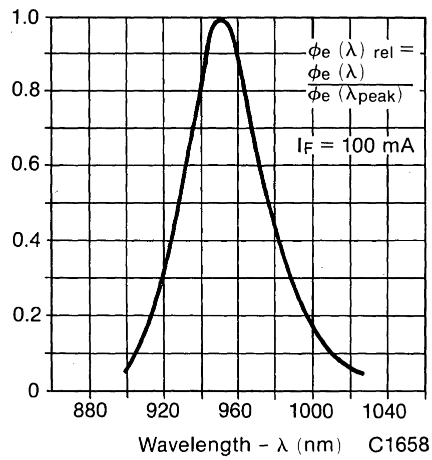


Fig. 9. Spectral Distribution

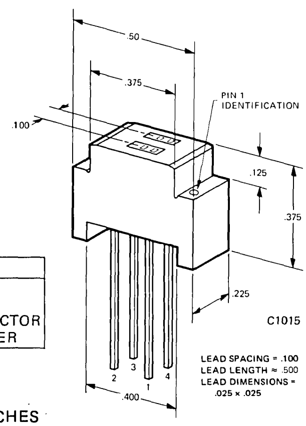
NOTES

1. *Distance from the touching border $\geq$1.5 mm with intermediate PC-board.*

GENERAL INSTRUMENT

MCA7

PACKAGE DIMENSIONS



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

ALL DIMENSIONS ARE IN INCHES

DESCRIPTION

The MCA7 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 MCA7. 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

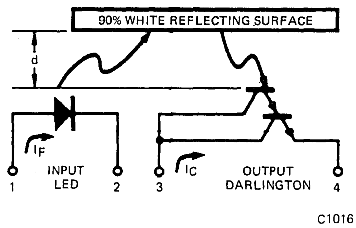


Figure 1 Parameter Symbols

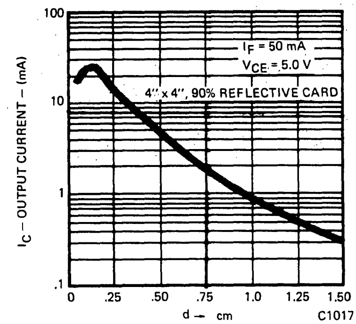


Figure 2 Output Current vs. Distance

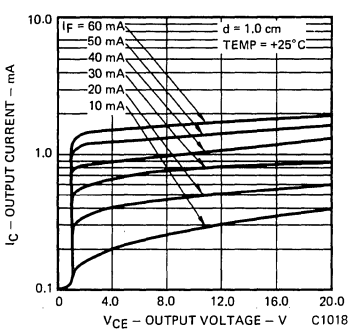


Figure 3 I_C vs. V_{CE}

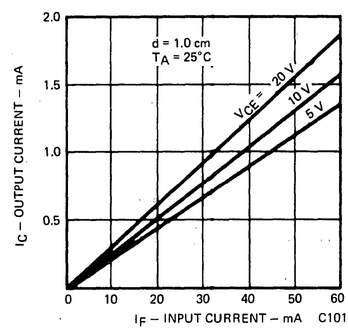


Figure 4 I_C vs. I_F

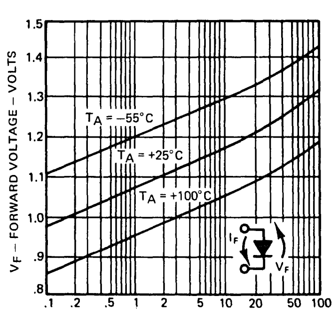


Figure 5 Forward Voltage vs. Forward Current

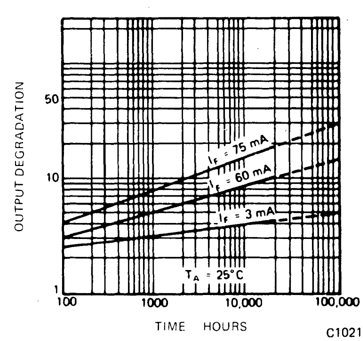


Figure 6 Lifetime vs. Forward Current

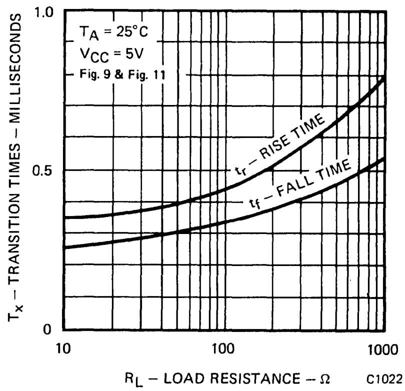


Figure 7. Non-Saturated Rise and Fall Times vs. Load Resistance

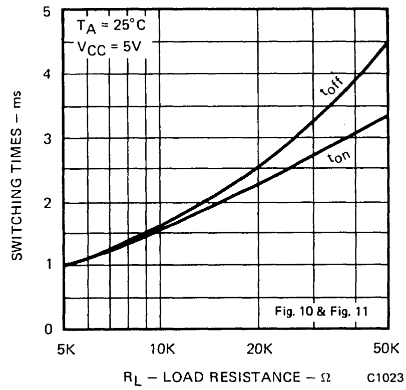


Figure 8. Saturated Switching Times vs. Load Resistance

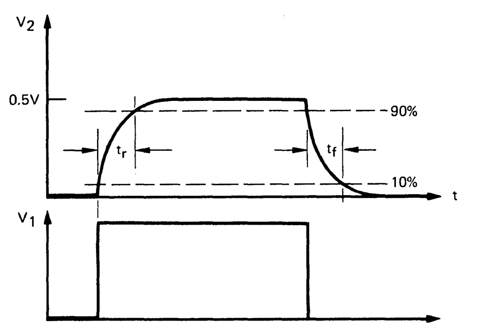


Figure 9. Non-Saturated Switching Waveforms

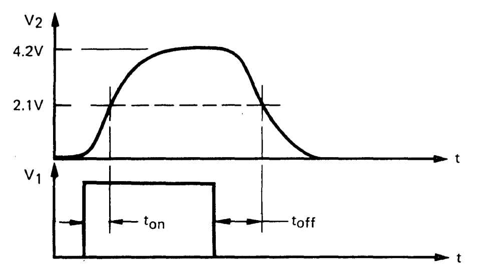


Figure 10. Saturated Switching Waveforms

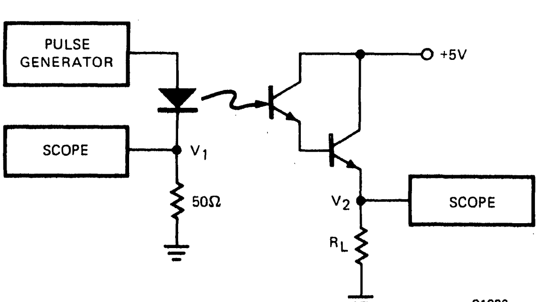


Figure 11. Circuit for Testing Switching Parameters

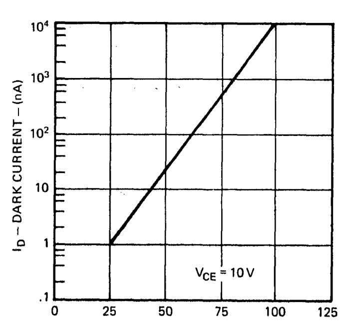
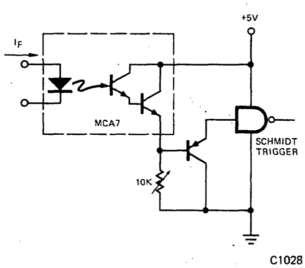


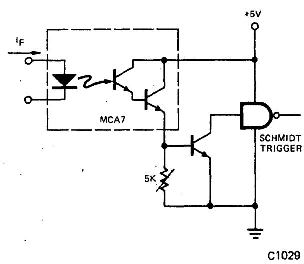
Figure 12. Dark Current vs. Temperature

CIRCUITS TO INTERFACE THE MCA7 WITH 5V LOGIC



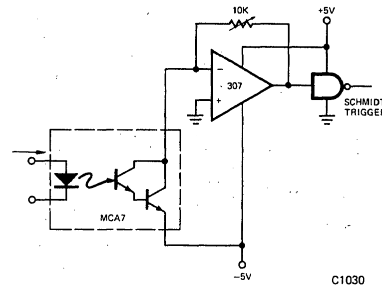
Circuit 1

Normally High Output



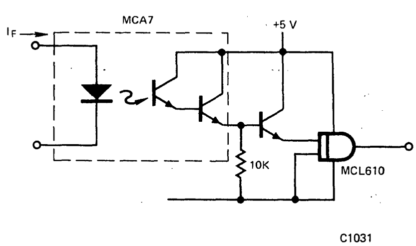
Circuit 2

Normally Low Output



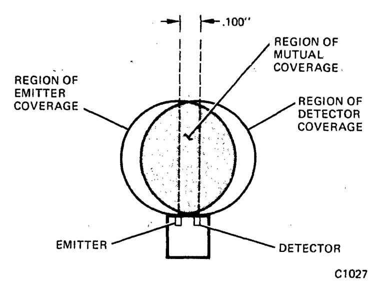
Circuit 3

Comparator Driver



Circuit 4

Booster Drive to Logic Isolator



Spatial Distribution of Maximum Sensitivity

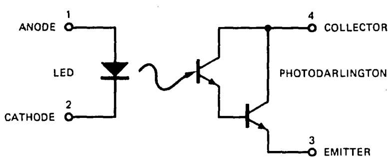
NOTES:

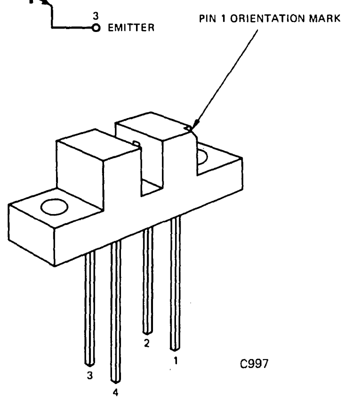
1. *Photo current is obtained from a 4.0" x 4.0", 90% white surface placed at a distance of 1.0 cm from the surface of the MCA7.*
2. *Measured with radiation flux intensity of less than 0.1 μW/cm² (dark condition) over the spectrum from 0.1 micron to 1.5 microns.*
3. *Measured at typical factory ambient of 150 foot-candles (150 lamberts per square foot).*

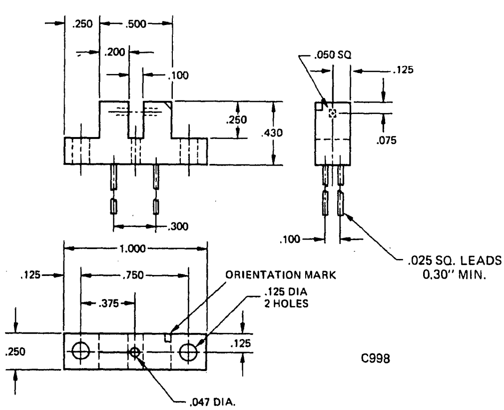
GENERAL INSTRUMENT

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 MCA8 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 MCA8 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.

MCA8 MCA81

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—MCA8						
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—MCA81						
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)

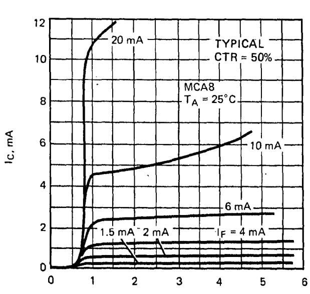


Figure 1 Collector Current vs. Collector Voltage

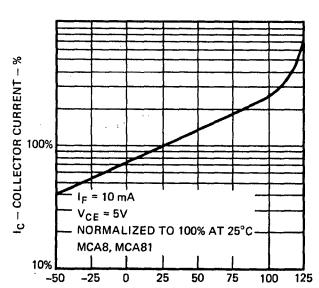


Figure 2 Collector Current vs. Ambient Temperature

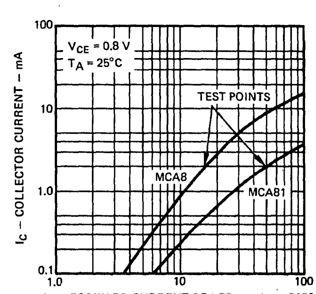


Figure 3 Collector Current vs. LED Current

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (Continued)

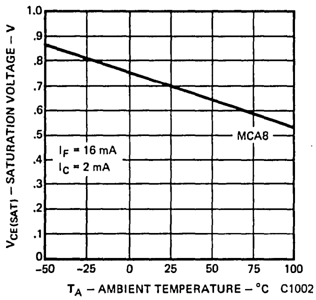


Figure 4 Saturation Voltage vs. Temperature

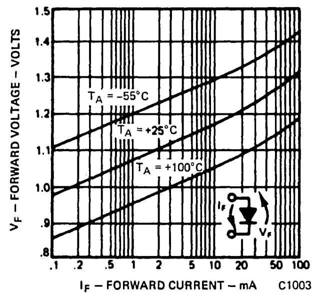


Figure 5 Forward Voltage vs. Forward Current

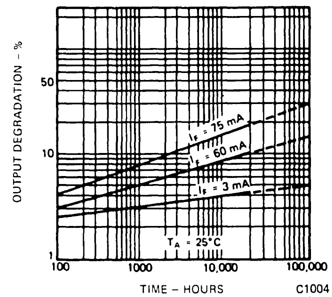


Figure 6 Lifetime vs. Forward Current

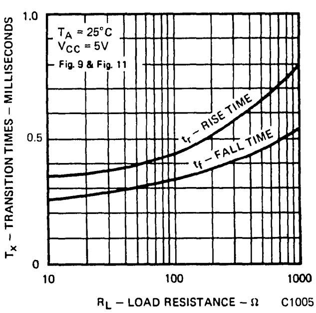


Figure 7 Non-Saturated Rise and Fall Times vs. Load Resistance

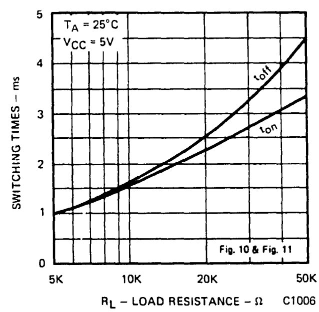


Figure 8 Saturated Switching Times vs. Load Resistance

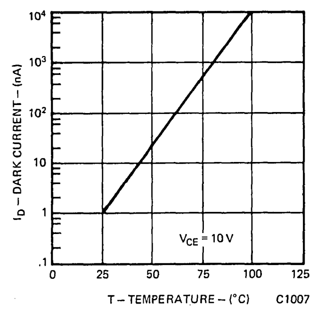


Figure 9. Dark Current vs. Temperature

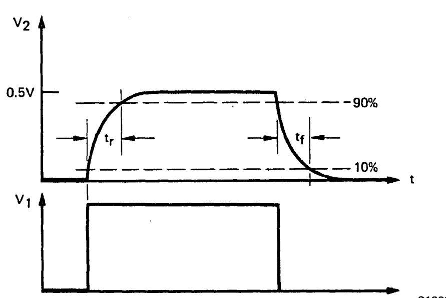


Figure 10 Non-Saturated Switching Waveforms

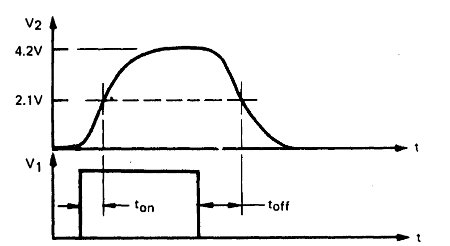


Figure 11 Saturated Switching Waveforms

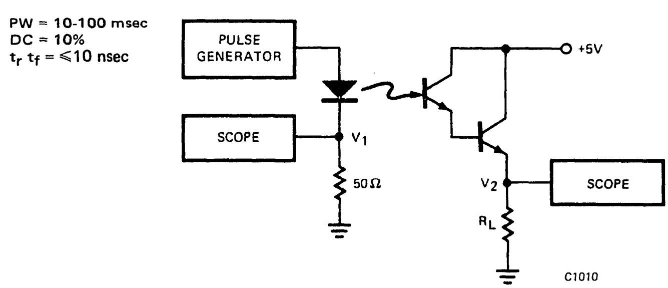


Figure 12 Circuit for Testing Switching Parameters

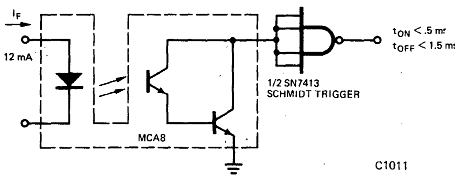


Figure 12 Driving a TTL Schmidt Trigger

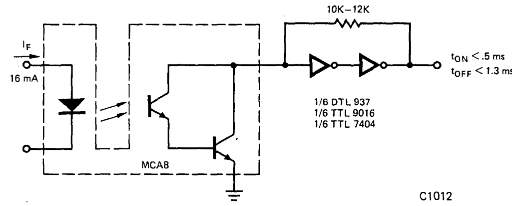


Figure 13 Driving Two Hex Inverters

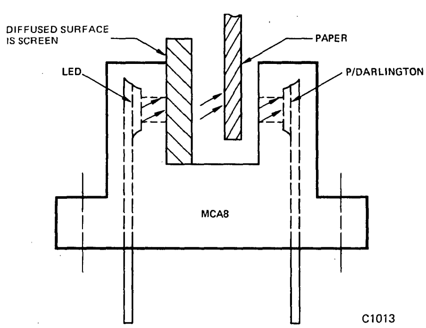


Figure 14 Detecting Paper by using a Lens Screen

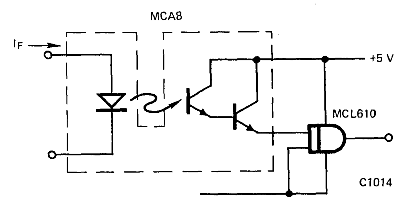


Figure 15 TTL Logic Interface

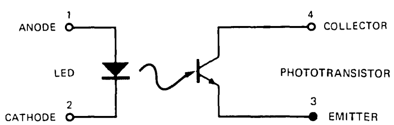
NOTES

1. *Measured with radiation flux intensity of less than 0.1 $\mu W/cm^2$ (dark condition) over the spectrum from 0.1 micron to 1.5 microns.*

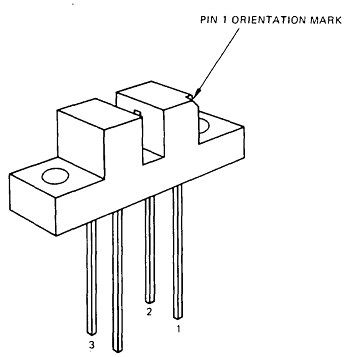
GENERAL INSTRUMENT

MCT8
MCT81

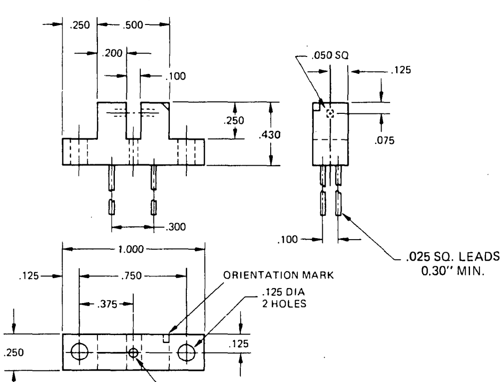
PACKAGE DIMENSIONS



C437



C438



C439

Dimensions ± .010 inches
All dimensions are in inches.

DESCRIPTION

The MCT8 optical limit switch transmits light from a GaAs infrared emitting diode to a silicon phototransistor. Both semiconductor chips face each other across an .1-inch air gap. The MCT8 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 μA
Reverse Leakage Current	I_R		.01	10	μA	V_R = 3 V
OUTPUT TRANSISTOR—MCT8						
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 μA, 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 μA, 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 Ω CIRCUIT 1
Fall Time	tf		4		μsec	V_{CC} = 10 V, I_C = 1 mA R_L = 100 Ω CIRCUIT 1
Turn-on Time (from 5 V to 0.8 V)	t_{ON}		6		μsec	I_F = 40 mA CIRCUIT 2 R_B = 1.2kΩ, R_L = 2.4kΩ
Turn-off Time (from SAT. to 2 V)	t_{OFF}		4		μsec	I_F = 40 mA CIRCUIT 2 R_B = 1.2kΩ, R_L = 2.4kΩ
OUTPUT TRANSISTOR—MCT81						
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 μA, 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 μA, 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 Ω CIRCUIT 1
Fall Time	tf		4		μsec	V_{CC} = 10 V, I_C = 1 mA R_L = 100 Ω CIRCUIT 1
Turn-on Time (from 5 V to 0.8 V)	t_{ON}		6		μsec	I_F = 40 mA CIRCUIT 2 R_B = 1.2kΩ, R_L = 2.4kΩ
Turn-off Time (from SAT to 2 V)	t_{OFF}		3		μsec	I_F = 40 mA CIRCUIT 2 R_B = 1.2kΩ, R_L = 2.4kΩ

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)

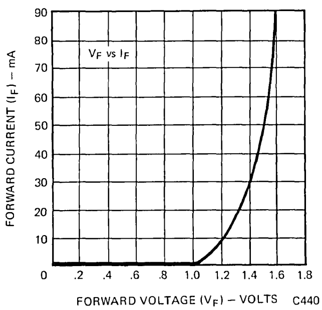


Fig. 1. Forward Voltage vs. Forward Current

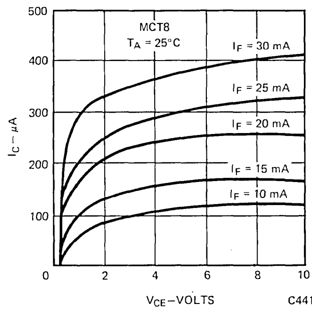


Fig. 2. Collector Current vs. Collector Voltage

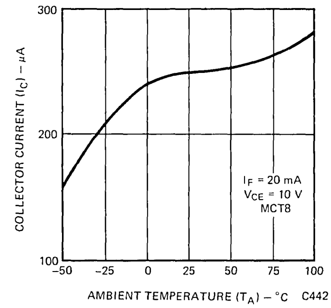


Fig. 3. Collector Current vs. Ambient Temperature

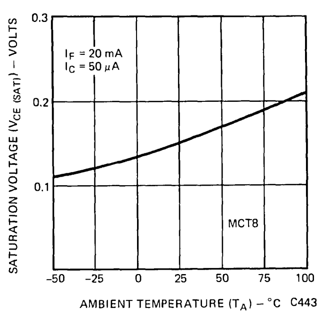


Fig. 4. Saturation Voltage vs. Temperature

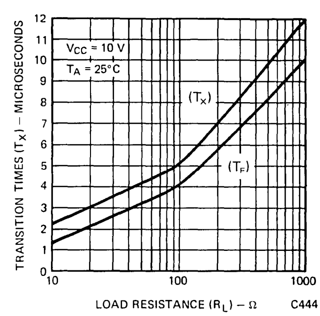
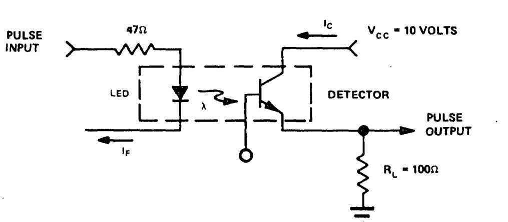


Fig. 5. Non-saturated Rise and Fall Times vs. Load Resistance

(See Circuit 1)



Circuit Used to Obtain Switching Time vs. Collector Current Plot

Fig. 6.

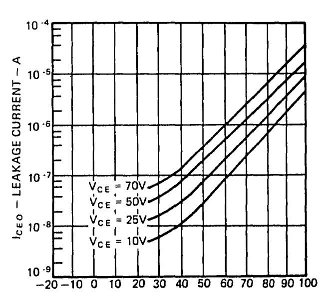


Fig. 7. Dark Current vs. Temperature

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (CONT.)

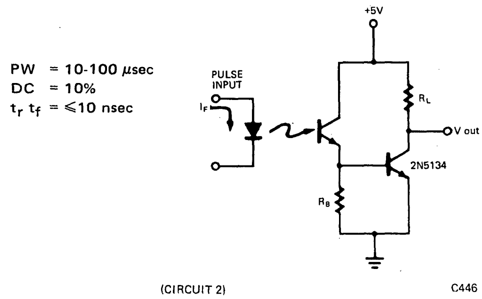


Fig. 8.

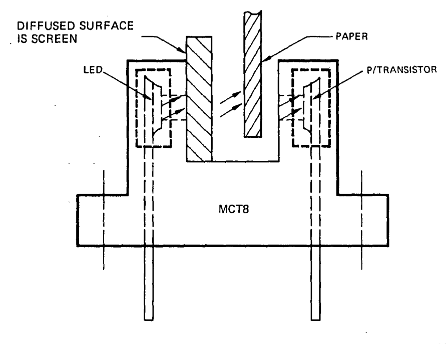


Fig. 9. Detecting Paper by Using a Lens Screen

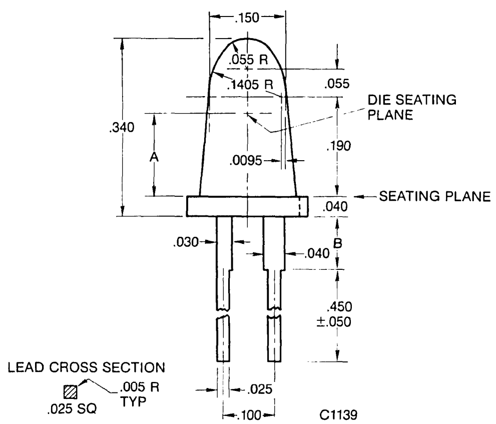
NOTES:

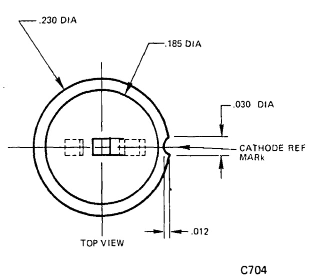
1. *Measured with radiation flux intensity of less than 0.1 μW/cm^2 (dark condition) over the spectrum from 0.1 micron to 1.5 microns.*

GENERAL INSTRUMENT

ME7121
ME7124

PACKAGE DIMENSIONS





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

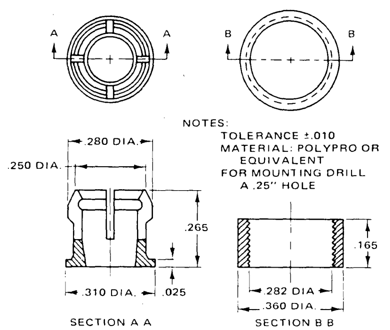
Power dissipation @ 25°C ambient . . . . 150 mW
Derate linearly from 50°C. . . . . 2.8 mW/°C
Storage & operating temperature . . . . -55° to 100°C
Lead solder time @ 230°C (Note 3) . . . . 5 sec
Continuous forward current . . . . 100 mA
Reverse voltage. . . . . 3.0 V
Peak forward current (PW = 1.0 μsec,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

ELECTRO-OPTICAL CHARACTERISTICS

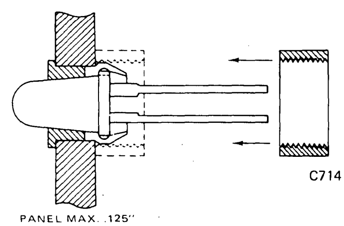
	TYPICAL HALF ANGLE (DEGREES)	TYPICAL ON AXIS INTENSITY (MW/STR.) @ 50 mA	
ME7121	17°	2.0	into cone @ 1/2 power points @ I_F = 50 mA ROP = 3 mW
ME7124	6°	10	

	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.)

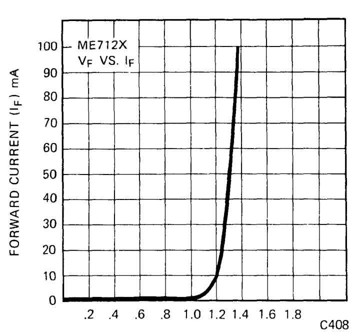


Fig. 1. I_F vs. V_F

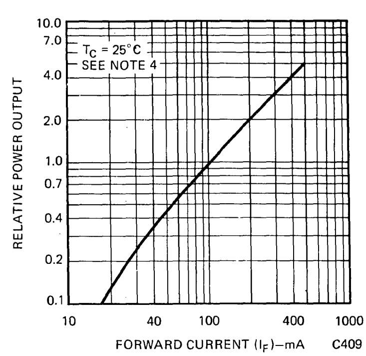


Fig. 2. ROP vs. I_F Peak

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (Cont.)

(25°C Free Air Temperature Unless Otherwise Specified)

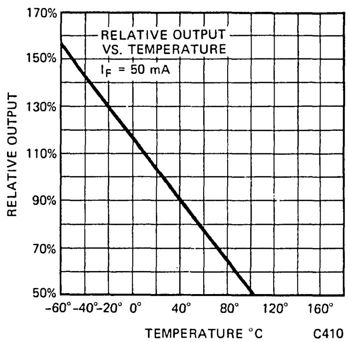


Fig. 3. ROP vs. Temperature (Note 1)

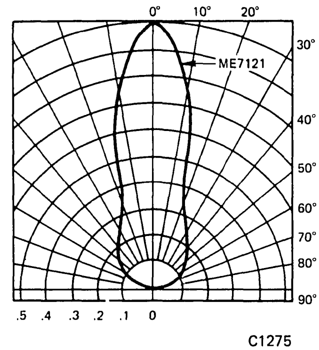


Fig. 4. Spatial Distribution (ME7121)

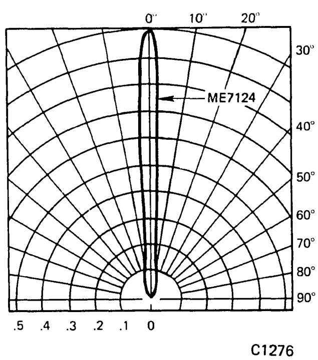


Fig. 5. Spatial Distribution (ME7124)

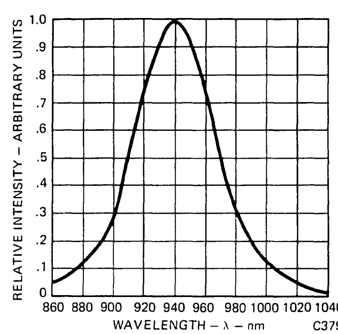


Fig. 6. Spectral Distribution

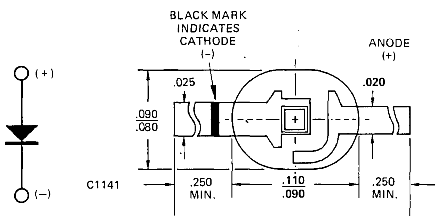
NOTES

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%.*

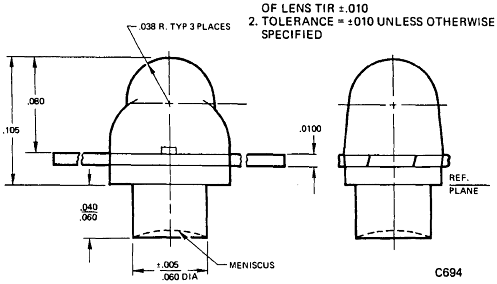
GENERAL INSTRUMENT

ME7161

PACKAGE DIMENSIONS



NOTE:
1. CENTERLINE OF STUD TO CENTERLINE OF LENS TIR ±.010
2. TOLERANCE = ±010 UNLESS OTHERWISE SPECIFIED



DESCRIPTION

The ME7161 is a liquid phase epitaxial gallium arsenide infrared diode. The lead-frame construction is encapsulated in an epoxy case and lens.

FEATURES

The ME7161 is intended for high volume infrared source application where low cost, high reliability and high density packaging are required.

- Low cost
- Compatible with integrated circuits
- Long life, rugged
- Small size
- Easily assembled in linear arrays
- Card & tape reader sources
- High on-axis power

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient	75 mW
Derate linearly from 25°C	1.0 mW/°C
Storage & operating temperature	−55°C to 100°C
Lead solder time @ 230°C (See Note 1)	5 sec
Continuous forward current	50 mA
Peak forward current (1 μsec pulse width, 0.3% duty cycle)	1.0 A
Reverse voltage	3.0 V

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

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Total external radiated power (see Note 2)	0.8	3.0		mW	I_F = 50 mA
Peak emission wave length		940		nm	I_F = 50 mA
Spectral line half-width		50		nm	I_F = 50 mA
Forward voltage		1.3	1.8	V	I_F = 50 mA
Reverse current		10		μA	V_R = 3.0 V
Light turn-on and turn-off		500		ns	50Ω Load
Capacitance		80		pF	V = 0
Forward voltage temperature coefficient		−1.05		mV/°C	I_F = 10 mA

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

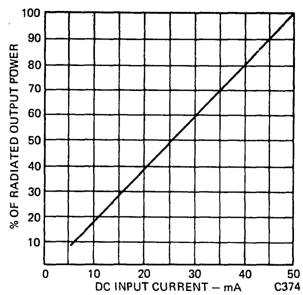


Fig. 1. Input Current vs. Output Power

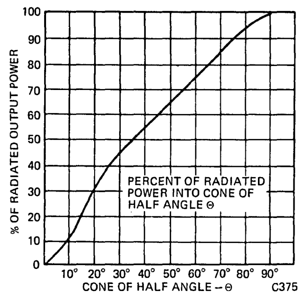


Fig. 2. Percent of Radiated Power Into Cone of Half Angle

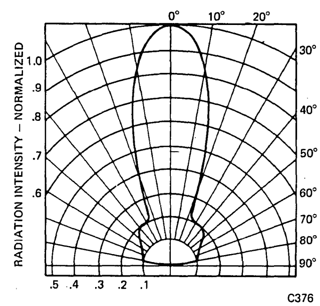


Fig. 3. Spatial Distribution (Note 3)

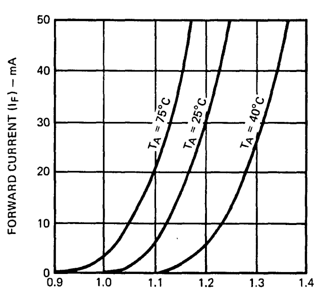


Fig. 4. Forward Current vs. Forward Voltage

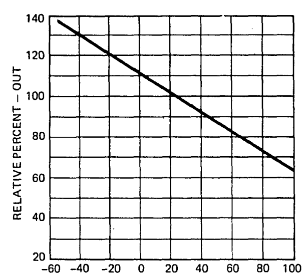


Fig. 5. % Relative Output vs. Temperature

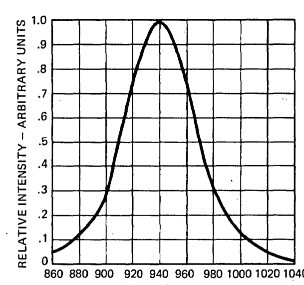


Fig. 6. Spectral Distribution

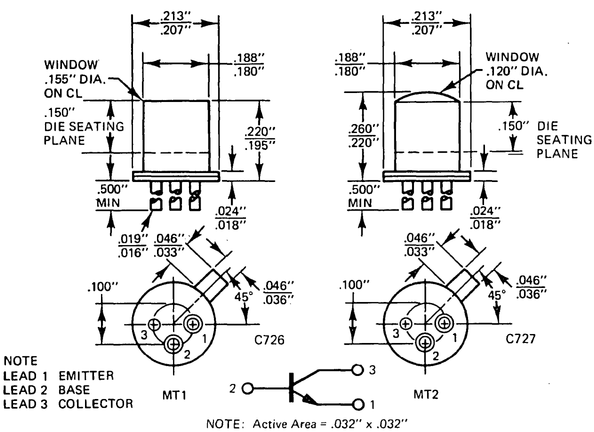
NOTES

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. *The total external radiated power output measurements are made with a Centralab 110C solar cell terminated into a 100Ω impedance.*
3. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*

GENERAL INSTRUMENT

MT1
MT2

PACKAGE DIMENSIONS



DESCRIPTION

The MT1 and MT2 silicon phototransistors are mounted on a standard TO46 header. The MT1 features a flat window mounted at the top of a protective metal can. The MT2 has a lens in the same position for an optical gain of 4.

FEATURES

- Low leakage current - 1 nA
- Wide Spectral Response
- Responsive to GaAs - 1.40 mA/mW/cm^2
- Optional flat lens (MT1) or built-in optics (MT2)
- Standard Transistor (Hermetic Seal) package for easy handling and mounting

- Optical switching & encoding
- Intrusion Alarm
- Process Control
- Tape and Card Reader
- Level & Industrial Control
- Optical Character Recognition

ABSOLUTE MAXIMUM RATINGS

Storage and Operating Temperature -55°C to 125°C
Maximum Lead Solder Time @ 260°C (See Note 1) - 7.0 sec

Power Dissipation @ 25°C Ambient	200 mW
Derate Linearly from 25°C	2.0 mW/°C
Collector-Emitter Breakdown Voltage (BV_{CEO})	30 V
Emitter-Collector Breakdown Voltage (BV_{ECO})	7.0 V
Collector-Base Breakdown Voltage (BV_{CBO})	80 V
Collector Current (I_C)	40 mA

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

CHARACTERISTICS & SYMBOLS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Sensitivity MT1 (see note 3) (S_{CEO})	200	560		µA/mW/cm²	λ=0.9 microns, V_{CE}=5.0 V
Sensitivity MT2 (see note 3) (S_{CEO})	500	1400		µA/mW/cm²	λ=0.9 microns, V_{CE}=5.0 V
Sensitivity MT1 (see note 4) (S_{CEO})	80	260		µA/mW/cm²	2875°K, V_{CE}=5.0 V
Sensitivity MT2 (see note 4) (S_{CEO})	200	650		µA/mW/cm²	2875°K, V_{CE}=5.0 V
Sensitivity MT1 (see note 3) (S_{CBO})	1.4	2.5		µA/mW/cm²	λ=0.9 microns, V_{CE}=5.0 V
Sensitivity MT2 (see note 3) (S_{CBO})	3.5	6.2		µA/mW/cm²	λ=0.9 microns, V_{CB}=5.0 V
Sensitivity MT1 (see note 4) (S_{CBO})	0.6	1.0		µA/mW/cm²	2875°K, V_{CB}=5.0 V
Sensitivity MT2 (see note 4) (S_{CBO})	1.5	2.5		µA/mW/cm²	2875°K, V_{CB}=5.0 V
Collector-emitter saturation voltage ($V_{CE(sat)}$)		0.2	0.5	V	I_C=2.0 mA, H=10mW/cm²
Light current rise time (see figure 8) (t_r)		2.0		µs	V_{CC}=5.0V, I_C=2.0mA, R_L=100Ω
Light current fall time (see figure 8) (t_r)		2.0		µs	V_{CC}=5.0V, I_C=2.0mA, R_L=100Ω
Delay time (see figure 8) (t_d)		1.2		µs	V_{CC}=5.0V, I_C=2.0mA, R_L=100Ω
Frequency response		300		kHz	V_{CC}=5.0V, I_C=2.0mA, R_L=100Ω

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

CHARACTERISTICS	SYMBOLS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Collector dark current (see note 2)	I_{CEO}		1	20	nA	V_{CE}=5.0 V
Collector dark current (see note 2)	I_{CBO}		0.15	10	nA	V_{CB}=5.0 V
Collector base breakdown voltage (see note 2)	BV_{CBO}	80	140		V	I_C=100 μA
Collector emitter breakdown voltage (see note 2)	BV_{CEO}	30	65		V	I_C=100 μA
Emitter collector breakdown voltage (see note 2)	BV_{ECO}	7	12		V	I_E=100 μA

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

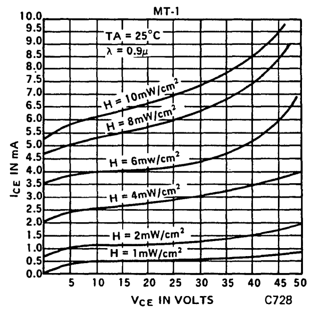


Figure 1 Collector-Emitter Characteristics

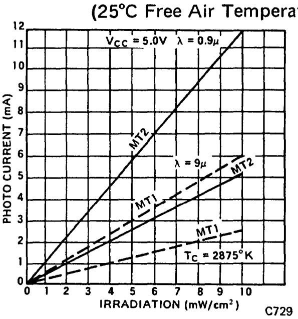


Figure 2 Photo Current vs. Irradiation

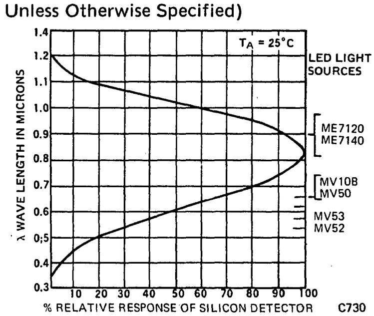


Figure 3 Spectral Response

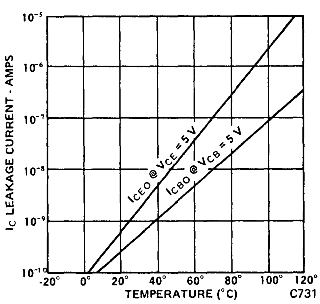


Figure 4 Leakage Current vs. Temperature

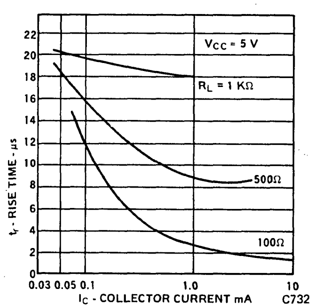


Figure 5 Rise Time vs. Collector Current

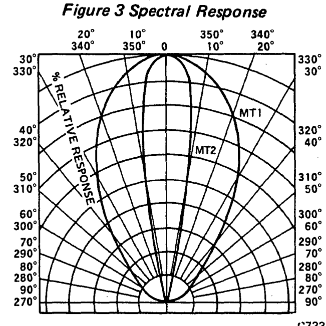


Figure 6 Angular Response

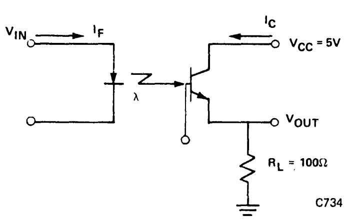


Fig. 7 Circuit Used to Obtain Switching Time vs. Collector Current Plot

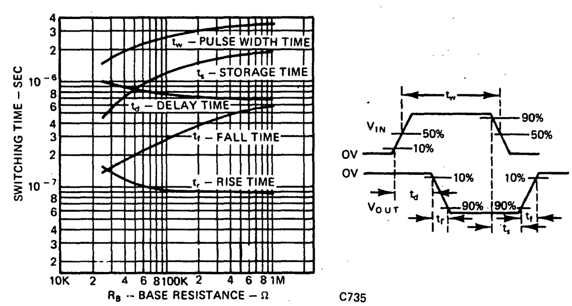


Fig. 8 Switching Time vs. Base Resistance

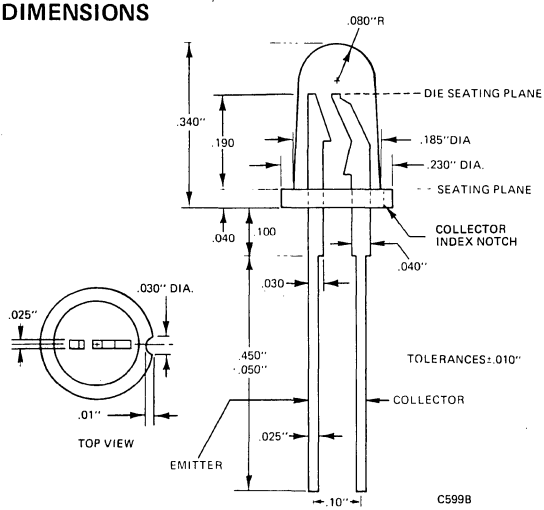
NOTES

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. *Measured under dark conditions H≤1.0μW/cm².*
3. *Measured with a GaAs light source at 0.9 microns with a radiation flux density of 3 mW/cm².*
4. *Measured with a tungsten filament lamp operated at a color temperature of 2875°K with a radiation flux density of 5 mW/cm².*

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 infra-red 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

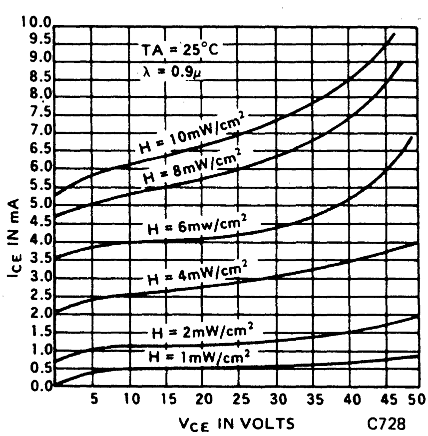


Fig. 1. Collector-Emitter Characteristics

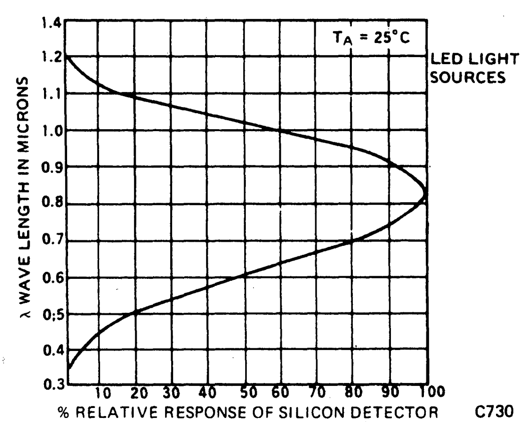


Fig. 2. Spectral Response

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

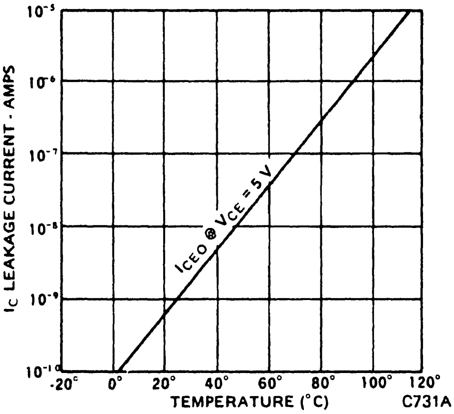


Fig. 3. Leakage Current vs. Temperature

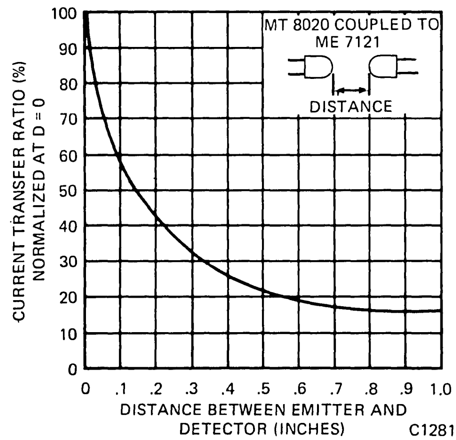


Fig. 4. Normalized Current Transfer Ratio vs. Distance Between Emitter and Detector MT8020 and ME7121.

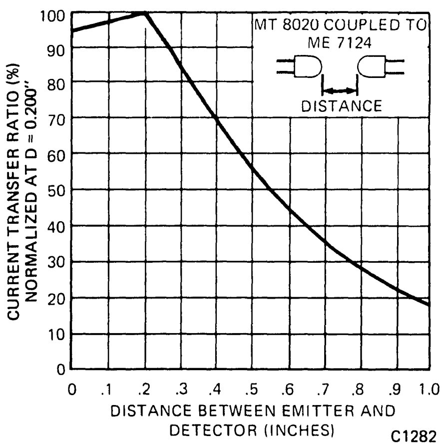


Fig. 5. Normalized Current Transfer Ratio vs. Distance Between Emitter and Detector MT8020 and ME7124.

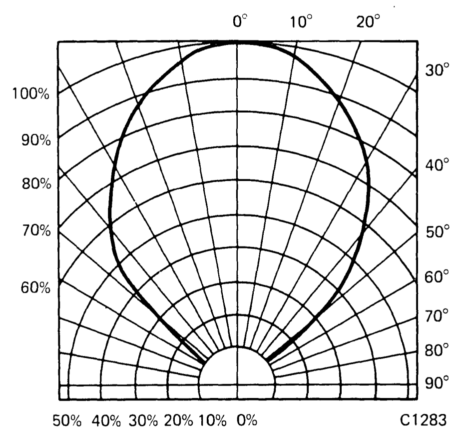


Fig. 6. Angular Response

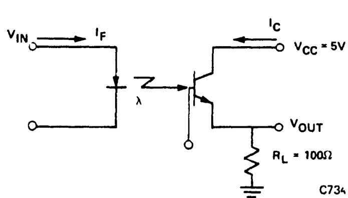
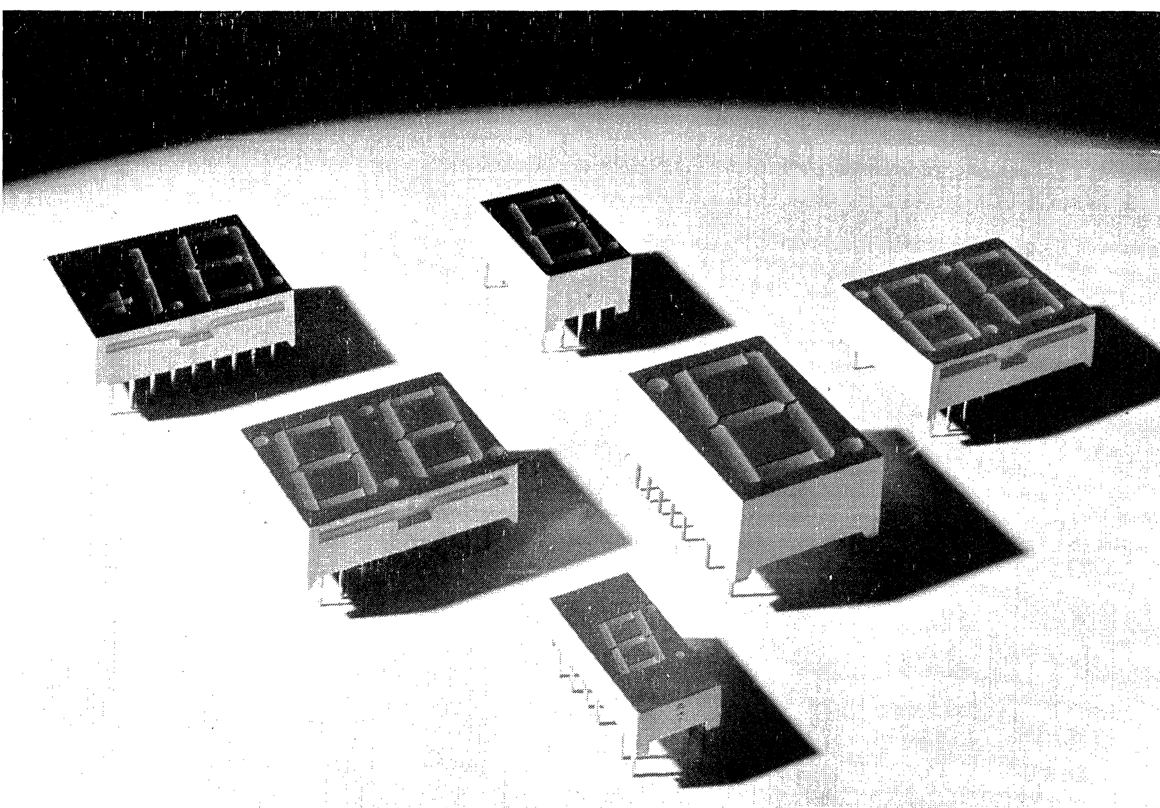


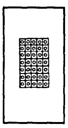
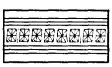
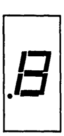
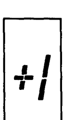
Fig. 7. Circuit Used to Obtain Switching Time Values Light Source is ME7121 or ME7124

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≤1.0 μw/cm².*
3. *Radiation source is an unfiltered tungsten filament bulb at 2875°K color temperature. H = 5 mW/cm².*
4. *Radiation source is a GaAs infrared emitting diode such as a ME7121 or ME7124 at λ = 0.94 microns. H = 3 mW/cm².*

Displays 3



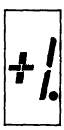
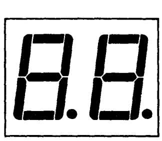
PACKAGE	DEVICE NO.	COLOR	DESCRIPTION	BRIGHTNESS OR LUMINOUS INTENSITY (PER SEG. MIN.)	PAGE NO.
	MAN1A	Red	.270-Inch; Common Anode; LHDP; Direct View	74µcd @ 20mA	197
	MAN10A			74µcd @ 10mA	
	MAN1001A	Red	.270-Inch; Common Anode; Polarity/Overflow; Direct View	74µcd @ 20mA	199
	MAN101A			74µcd @ 10mA	
	MAN2A	Red	.320-Inch; X-Y 35 Diode, Alphanumeric; Direct View	125µcd @ 10mA	201
	MAN2815	Red	.135-Inch; Common Cathode; 14 Segment Alphanumeric; 8-Characters	60µcd @ 2.5mA (avge. curr.)	203
	MAN3610A	Orange	.3-Inch; Common Anode; RHDP	510µcd @ 10mA	207
	MAN3910A	High Eff. Red		320µcd @ 10mA	219
	MAN3410A	High Eff. Green		510µcd @ 10mA	207
	MAN71A	Red		125µcd @ 10mA	207
	MAN3810A	Yellow		320µcd @ 10mA	207
	MAN3640A	Orange	.3-Inch; Common Cathode; RHDP	510µcd @ 10mA	207
	MAN3940A	High Eff. Red		320µcd @ 10mA	219
	MAN3440A	High Eff. Green		510µcd @ 10mA	207
	MAN74A	Red		125µcd @ 10mA	207
	MAN3840A	Yellow		320µcd @ 10mA	207
	MAN3620A	Orange	.3-Inch; Common Anode; LHDP	510µcd @ 10mA	207
	MAN3920A	High Eff. Red		320µcd @ 10mA	219
	MAN3420A	High Eff. Green		510µcd @ 10mA	207
	MAN72A	Red		125µcd @ 10mA	207
	MAN3820A	Yellow		320µcd @ 10mA	207
	MAN3630A	Orange	.3-Inch; Common Anode; Polarity & Overflow	510µcd @ 10mA	207
	MAN3930A	High Eff. Red		320µcd @ 10mA	219
	MAN3430A	High Eff. Green		510µcd @ 10mA	207
	MAN73A	Red		125µcd @ 10mA	207
	MAN3830A	Yellow		320µcd @ 10mA	207

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.

PIN CONNECTIONS (See note)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	APPLICATIONS
Ac	Fc	ca	NC	NC	DPc	Ec	Dc	ca	Cc	Gc	NC	Bc	ca	Instruments Test Equipment Office Machine Computer
C/D com-mon	NC	NC	NC	NC	NC	Dc	Cc	NC	Bc	Ac	NC	NC	A/B com-mon	
Col. 2 (+)	Row 1 (–)	Row 3 (–)	Row 4 (–)	Col. 1 (+)	NC	DP (+)	Col. 3 (+)	Row 7 (–)	Row 6 (–)	Row 5 (–)	Row 2 (–)	Col. 5 (+)	Col. 4 (+)	Business Machines Calculators Computers Indus. Control Equ.
For pin connections, see Package Drawing on Page 204.														Compact Computers Test Equipment Desk Top Calculators Commun. Equip. Verification Sys.
Ac	Fc	ca	NP	NP	NC	Ec	Dc	DPc	Cc	Gc	NP	Bc	ca	Instruments Test Equipment Office Machines Computers Automobiles Clocks/Radios Communication Equipment Calculators CB Radios
Fa	Ga	NP	cc	NP	Ea	Da	Ca	DPa	NP	NP	cc	Ba	Aa	
Ac	Fc	ca	NP	NP	DPc	Ec	Dc	NC	Cc	Gc	NP	Bc	ca	
Ca Da	NP	Ca Da	NP	NP	NP	Dc	Cc	NC	Bc	Ac	NP	NP	Aa Ba	

ca = common anode
cc = common cathode
DP = decimal point
NC = no connection
NP = no pin

DISPLAYS

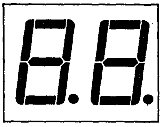
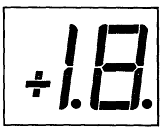
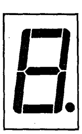
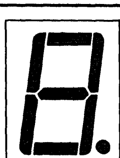
PACKAGE	DEVICE NO.	COLOR	DESCRIPTION	BRIGHTNESS OR LUMINOUS INTENSITY (PER SEG. MIN.)	PAGE NO.
	MAN3680A	Orange	.3-Inch; Common Cathode; RHDP; 10-Pin	510μcd @ 10mA	213
	MAN3980A	High Eff. Red		320μcd @ 10mA	219
	MAN3480A	High Eff. Green		510μcd @ 10mA	213
	MAN78A	Red		125μcd @ 10mA	213
	MAN3880A	Yellow		320μcd @ 10mA	213
	MAN4510A	Green	.4-Inch; Common Anode; RHDP	320μcd @ 10mA	223
	MAN4610A	Orange		510μcd @ 10mA	223
	MAN4710A	Red		200μcd @ 10mA	223
	MAN4810A	Yellow		510μcd @ 10mA	223
	MAN4910A	High Eff. Red		320μcd @ 10mA	235
	MAN4505A	Green	.4-Inch; Universal (CA/CC) Overflow ±1, RHDP	320μcd @ 10mA	223
	MAN4605A	Orange		510μcd @ 10mA	223
	MAN4705A	Red		200μcd @ 10mA	223
	MAN4805A	Yellow		510μcd @ 10mA	223
	MAN4905A	High Eff. Red		320μcd @ 10mA	235
	MAN4540A	Green	.4-Inch; Common Cathode; RHDP	320μcd @ 10mA	223
	MAN4640A	Orange		510μcd @ 10mA	223
	MAN4740A	Red		200μcd @ 10mA	223
	MAN4840A	Yellow		510μcd @ 10mA	223
	MAN4940A	High Eff. Red		320μcd @ 10mA	235
	MAN4580A	Green	.4-Inch; Common Cathode; RHDP; 10-Pin	200μcd @ 10mA	229
	MAN4680A	Orange		510μcd @ 10mA	229
	MAN4780A	Red		200μcd @ 10mA	229
	MAN4880A	Yellow		510μcd @ 10mA	229
	MAN4980A	High Eff. Red		320μcd @ 10mA	229, 235
	MAN6410	High Eff. Green	0.56-Inch; Common Anode; RHDP; 2-Digit	510μcd @ 10mA	239
	MAN6440		0.56-Inch; Common Cathode; RHDP; 2-Digit		
	MAN6610	Orange	0.56-Inch; Common Anode; RHDP; 2-Digit		243
	MAN6640		0.56-Inch; Common Cathode; RHDP; 2-Digit		
	MAN6710	Red	0.56-Inch; Common Anode; RHDP; 2-Digit	125μcd @ 10mA	247
	MAN6740		0.56-Inch; Common Cathode; RHDP; 2-Digit		

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.

PIN CONNECTIONS (See note)																		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	APPLICATIONS
Cc	Fa	Ga	Ea	Da	Cc	DPa	Ca	Ba	Aa									
Ac	Fc	ca	NP	NP	NC	Ec	Dc	DPc	Cc	Gc	NP	Bc	ca	–	–	–	–	
Da1	NP	Dc1	Cc	Dc2	Da2	Ca	DPa	NP	DPc	Bc	Ac	Aa	Ba	–	–	–	–	Instruments Test Equipment Office Machines Computers Automobiles Clocks/Radios Communication Equipment Calculators CB Radios
Fa	Ga	NP	cc	NP	Ea	Da	Ca	DPa	NP	NP	cc	Ba	Aa	–	–	–	–	
Cc	Fa	Ga	Ea	Da	Cc	DPa	Ca	Ba	Aa	–	–	–	–	–	–	–	–	
Ec1 Ea1	Dc1 Da1	Cc1 Ca1	DPc1 DPa1	Ec2 Ea2	Dc2 Da2	Gc2 Ga2	Cc2 Ca2	DPc2 DPa2	Bc2 Ba2	Ac2 Aa2	Fc2 Fa2	ca2 cc2	ca1 cc1	Bc1 Ba1	Ac1 Aa1	Gc1 Ga1	Fc1 Fa1	
Ec1 Ea1	Dc1 Da1	Cc1 Ca1	DPc1 DPa1	Ec2 Ea2	Dc2 Da2	Gc2 Ga2	Cc2 Ca2	DPc2 DPa2	Bc2 Ba2	Ac2 Aa2	Fc2 Fa2	ca2 cc2	ca1 cc1	Bc1 Ba1	Ac1 Aa1	Gc1 Ga1	Fc1 Fa1	POS Terminals Computers Instruments Test Equipment Clocks/Radios TV Channel Indicators
Ec1 Ea1	Dc1 Da1	Cc1 Ca1	DPc1 DPa1	Ec2 Ea2	Dc2 Da2	Gc2 Ga2	Cc2 Ca2	DPc2 DPa2	Bc2 Ba2	Ac2 Aa2	Fc2 Fa2	ca2 cc2	ca1 cc1	Bc1 Ba1	Ac1 Aa1	Gc1 Ga1	Fc1 Fa1	

ca = common anode
cc = common cathode
DP = decimal point

NC = no connection
NP = no pin

PACKAGE	DEVICE NO.	COLOR	DESCRIPTION	BRIGHTNESS OR LUMINOUS INTENSITY (PER SEG. MIN.)	PAGE NO.
	MAN6810	Yellow	0.56-Inch; Common Anode; RHDP; 2-Digit	510μcd @ 10mA	251
	MAN6840		0.56-Inch; Common Cathode; RHDP; 2-Digit		
	MAN6910	High Eff. Red	0.56-Inch; Common Anode; RHDP; 2-Digit	320μcd @ 10mA	255
	MAN6940		0.56-Inch; Common Cathode; RHDP; 2-Digit		
	MAN6430	High Eff. Green	0.56-Inch; Common Anode; RHDP; 1½-Digit	510μcd @ 10mA	239
	MAN6450		0.56-Inch; Common Cathode; RHDP; 1½-Digit		
	MAN6630	Orange	0.56-Inch; Common Anode; RHDP; 1½-Digit		243
	MAN6650		0.56-Inch; Common Cathode; RHDP; 1½-Digit		
	MAN6730	Red	0.56-Inch; Common Anode; RHDP; 1½-Digit	125μcd @ 10mA	247
	MAN6750		0.56-Inch; Common Cathode; RHDP; 1½-Digit		
	MAN6830	Yellow	0.56-Inch; Common Anode; RHDP; 1½-Digit	510μcd @ 10mA	251
	MAN6850		0.56-Inch; Common Cathode; RHDP; 1½-Digit		
	MAN6930	High Eff. Red	0.56-Inch; Common Anode; RHDP; 1½-Digit	320μcd @ 10mA	255
	MAN6950		0.56-Inch; Common Cathode; RHDP; 1½-Digit		
	MAN6460	High Eff. Green	0.56-Inch; Common Anode; RHDP	510μcd @ 10mA	239
	MAN6480		0.56-Inch; Common Cathode; RHDP		
	MAN6660	Orange	0.56-Inch; Common Anode; RHDP		243
	MAN6680		0.56-Inch; Common Cathode; RHDP		
	MAN6760	Red	0.56-Inch; Common Anode; RHDP	125μcd @ 10mA	247
	MAN6780		0.56-Inch; Common Cathode; RHDP		
	MAN6860	Yellow	0.56-Inch; Common Anode; RHDP	510μcd @ 10mA	251
	MAN6880		0.56-Inch; Common Cathode; RHDP		
	MAN6960	High Eff. Red	0.56-Inch; Common Anode; RHDP	320μcd @ 10mA	255
	MAN6980		0.56-Inch; Common Cathode; RHDP		
	MAN8610	Orange	.800-Inch; Common Anode; RHDP	600μcd @ 10mA	259
	MAN8630		.800-Inch; Common Anode; RHDP; ±1 Overflow		
	MAN8640		.800-Inch; Common Cathode; RHDP		
	MAN8650		.800-Inch; Common Cathode; RHDP; ±1 Overflow		

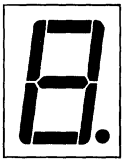
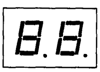
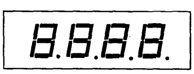
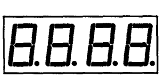
NOTE: PIN CONNECTION CODES: Ac (e.g.) First letter (capital) is segment, second letter (lower case) is cathode or anode.
E.g. Ac = Segment A cathode
Ac1 (e.g.) Final number refers to digit number in 2-Digit devices.

PIN CONNECTIONS (See note)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	APPLICATIONS
Ec1	Dc1	Cc1	DPc1	Ec2	Dc2	Gc2	Cc2	DPc2	Bc2	Ac2	Fc2	ca2	ca1	Bc1	Ac1	Gc1	Fc1	
Ea1	Da1	Ca1	DPa1	Ea2	Da2	Ga2	Ca2	DPa2	Ba2	Aa2	Fa2	cc2	cc1	Ba1	Aa1	Ga1	Fa1	
Ec1	Dc1	Cc1	DPc1	Ec2	Dc2	Gc2	Cc2	DPc2	Bc2	Ac2	Fc2	ca2	ca1	Bc1	Ac1	Gc1	Fc1	
Ea1	Da1	Ca1	DPa1	Ea2	Da2	Ga2	Ca2	DPa2	Ba2	Aa2	Fa2	cc2	cc1	Ba1	Aa1	Ga1	Fa1	
Cc1	Dc1	Bc1	DPc1	Ec2	Dc2	Gc2	Cc2	DPc2	Bc2	Ac2	Fc2	ca2	ca1	Ac1	NC	NC	NC	
Ca1	Da1	Ba1	DPa1	Ea2	Da2	Ga2	Ca2	DPa2	Ba2	Aa2	Fa2	cc2	cc1	Aa1	NC	NC	NC	
	Dc1	Bc1	DPc1	Ec2	Dc2	Gc2	Cc2	DPc2	Bc2	Ac2	Fc2	ca2	ca1	Ac1	NC	NC	NC	
Ca1	Da1	Ba1	DPa1	Ea2	Da2	Ga2	Ca2	DPa2	Ba2	Aa2	Fa2	cc2	cc1	Aa1	NC	NC	NC	
Cc1	Dc1	Bc1	DPc1	Ec2	Dc2	Gc2	Cc2	DPc2	Bc2	Ac2	Fc2	ca2	ca1	Ac1	NC	NC	NC	
Ca1	Da1	Ba1	DPa1	Ea2	Da2	Ga2	Ca2	DPa2	Ba2	Aa2	Fa2	cc2	cc1	Aa1	NC	NC	NC	
Cc1	Dc1	Bc1	DPc1	Ec2	Dc2	Gc2	Cc2	DPc2	Bc2	Ac2	Fc2	ca2	ca1	Ac1	NC	NC	NC	
Ca1	Da1	Ba1	DPa1	Ea2	Da2	Ga2	Ca2	DPa2	Ba2	Aa2	Fa2	cc2	cc1	Aa1	NC	NC	NC	
Cc1	Dc1	Bc1	DPc1	Ec2	Dc2	Gc2	Cc2	DPc2	Bc2	Ac2	Fc2	ca2	ca1	Ac1	NC	NC	NC	POS Terminals Computers Instruments Test Equipment Clocks/Radios TV Channel Indicators
Ca1	Da1	Ba1	DPa1	Ea2	Da2	Ga2	Ca2	DPa2	Ba2	Aa2	Fa2	cc2	cc1	Aa1	NC	NC	NC	
Ec	Dc	ca	Cc	DPc	Bc	Ac	ca	Fc	Gc	–	–	–	–	–	–	–	–	
Ea	Da	cc	Ca	DPa	Ba	Aa	cc	Fa	Ga	–	–	–	–	–	–	–	–	
Ec	Dc	ca	Cc	DPc	Bc	Ac	ca	Fc	Gc	–	–	–	–	–	–	–	–	
Ea	Da	cc	Ca	DPa	Ba	Aa	cc	Fa	Ga	–	–	–	–	–	–	–	–	
Ec	Dc	ca	Cc	DPc	Bc	Ac	ca	Fc	Gc	–	–	–	–	–	–	–	–	
Ea	Da	cc	Ca	DPa	Ba	Aa	cc	Fa	Ga	–	–	–	–	–	–	–	–	
Ec	Dc	ca	Cc	DPc	Bc	Ac	ca	Fc	Gc	–	–	–	–	–	–	–	–	
Ea	Da	cc	Ca	DPa	Ba	Aa	cc	Fa	Ga	–	–	–	–	–	–	–	–	
Ec	Dc	ca	Cc	DPc	Bc	Ac	ca	Fc	Gc	–	–	–	–	–	–	–	–	
Ea	Da	cc	Ca	DPa	Ba	Aa	cc	Fa	Ga	–	–	–	–	–	–	–	–	
NC	Ac	Fc	ca	Ec	NP	Ec	NP	Dc	DPc	Dc	ca	Cc	Gc	Bc	NP	ca	NP	
NC	NC	NC	ca	Cc	NP	Cc	NP	D2c	DPc	D2c	ca	Bc	D1c	Ac	NP	ca	NP	
NC	Aa	Fa	cc	Ea	NP	Ea	NP	cc	DPa	Da	cc	Ca	Ga	Ba	NP	cc	NP	
NC	NC	NC	cc	Ca	NP	Ca	NP	cc	DPa	D2a	cc	Ba	D1a	Aa	NP	cc	NP	

ca = common anode
cc = common cathode
DP = decimal point

NC = no connection
NP = no pin

PACKAGE	DEVICE NO.	COLOR	DESCRIPTION	BRIGHTNESS OR LUMINOUS INTENSITY (PER SEG. MIN.)	PAGE NO.
	MAN8810	Yellow	.800-Inch; Common Anode; RHDP	500μcd @ 10mA	263
	MAN8830		.800-Inch; Common Anode; RHDP; ±1 Overflow		
	MAN8840		.800-Inch; Common Cathode; RHDP		
	MAN8850		.800-Inch; Common Cathode; RHDP; ±1 Overflow		
	MAN8910	High Eff. Red	.800-Inch; Common Anode; RHDP	320μcd @ 10mA	267
	MAN8930		.800-Inch; Common Anode; RHDP; ±1 Overflow		
	MAN8940		.800-Inch; Common Cathode; RHDP		
	MAN8950		.800-Inch; Common Cathode; RHDP; ±1 Overflow		
	MMN36220	Orange	0.3-Inch; Common Anode; 2-Digit Multiplexed	510μcd @ 10mA	271
	MMN38220	Yellow		510μcd @ 10mA	
	MMN39220	High Eff. Red		350μcd @ 10mA	
	MMN36420	Orange	0.3-Inch; Common Cathode; 2-Digit Multiplexed	510μcd @ 10mA	271
	MMN38420	Yellow		510μcd @ 10mA	
	MMN39420	High Eff. Red		350μcd @ 10mA	
	MMN36240	Orange	0.3-Inch; Common Anode; 4-Digit Multiplexed	510μcd @ 10mA	271
	MMN38240	Yellow		510μcd @ 10mA	
	MMN39240	High Eff. Red		350μcd @ 10mA	
	MMN36440	Orange	0.3-Inch; Common Cathode; 4-Digit Multiplexed	510μcd @ 10mA	271
	MMN38440	Yellow		510μcd @ 10mA	
	MMN39440	High Eff. Red		350μcd @ 10mA	
	MMN56120	Orange	0.5-Inch; Common Anode; 2-Digit Direct Drive	510μcd @ 10mA	275
	MMN58120	Yellow		510μcd @ 10mA	
	MMN59120	High Eff. Red		350μcd @ 10mA	
	MMN56320	Orange	0.5-Inch; Common Cathode; 2-Digit Direct Drive	510μcd @ 10mA	275
	MMN58320	Yellow		510μcd @ 10mA	
	MMN59320	High Eff. Red		350μcd @ 10mA	
	MMN56240	Orange	0.5-Inch; Common Anode; 4-Digit Multiplexed	510μcd @ 10mA	275
	MMN58240	Yellow		510μcd @ 10mA	
	MMN59240	High Eff. Red		350μcd @ 10mA	
	MMN56440	Orange	0.5-Inch; Common Cathode; 4-Digit Multiplexed	510μcd @ 10mA	275
	MMN58440	Yellow		510μcd @ 10mA	
	MMN59440	High Eff. Red		350μcd @ 10mA	

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.

PIN CONNECTIONS (See note)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	APPLICATIONS
NC	Ac	Fc	ca	Ec	NP	Ec	NP	Dc	DPc	Dc	ca	Cc	Gc	Bc	NP	ca	NP	–	–	POS Terminals Computers Instruments Test Equipment Clocks/Radios TV Channel Indicators
NC	NC	NC	ca	Cc	NP	Cc	NP	D2c	DPc	D2c	ca	Bc	D1c	Ac	NP	ca	NP	–	–	
NC	Aa	Fa	cc	Ea	NP	Ea	NP	cc	DPa	Da	cc	Ca	Ga	Ba	NP	cc	NP	–	–	
NC	NC	NC	cc	Ca	NP	Ca	NP	cc	DPa	D2a	cc	Ba	D1a	Aa	NP	cc	NP	–	–	
NC	Ac	Fc	ca	Ec	NP	Ec	NP	Dc	DPc	Dc	ca	Cc	Gc	Bc	NP	ca	NP	–	–	
NC	NC	NC	ca	Cc	NP	Cc	NP	D2c	DPc	D2c	ca	Bc	D1c	Ac	NP	ca	NP	–	–	
NC	Aa	Fa	cc	Ea	NP	Ea	NP	cc	DPa	Da	cc	Ca	Ga	Ba	NP	cc	NP	–	–	
NC	NC	NC	cc	Ca	NP	Ca	NP	cc	DPa	D2a	cc	Ba	D1a	Aa	NP	cc	NP	–	–	
Gc	Ec	NC	1a	Dc	2a	DPc	Cc	Bc	NC	NC	NC	Ac	NC	Fc	NC	–	–	–	–	Test and Measurement Point-of-Sale Industrial Control Consumer Products TV
Ga	Ea	NC	1c	Da	2c	DPa	Ca	Ba	NC	NC	NC	Aa	NC	Fa	NC	–	–	–	–	
NC	Ec	1a	NC	NC	2a	Dc	Gc	NC	3a	Bc	Ac	Fc	4a	DPc	Cc	–	–	–	–	
NC	Ea	1c	NC	NC	2c	Da	Ga	NC	3c	Ba	Aa	Fa	4c	DPa	Ca	–	–	–	–	
Ec1	NC	Dc1	DPc1	Cc1	Gc2	Ec2	Dc2	DPc2	Cc2	ca	Bc2	Ac2	Fc2	Bc1	Ac1	NC	Fc1	NC	Gc1	
Ea1	NC	Da1	DPa1	Ca1	Ga2	Ea2	Da2	DPa2	Ca2	cc	Ba2	Aa2	Fa2	Ba1	Aa1	NC	Fa1	NC	Ga1	
Ac	NC	Dc	ca1	NC	NC	ca2	Cc	NC	ca3	Bc	Fc	Ec	ca4	DPc	Gc	–	–	–	–	
Aa	NC	Da	cc1	NC	NC	cc2	Ca	NC	cc3	Ba	Fa	Ea	cc4	DPa	Ga	–	–	–	–	

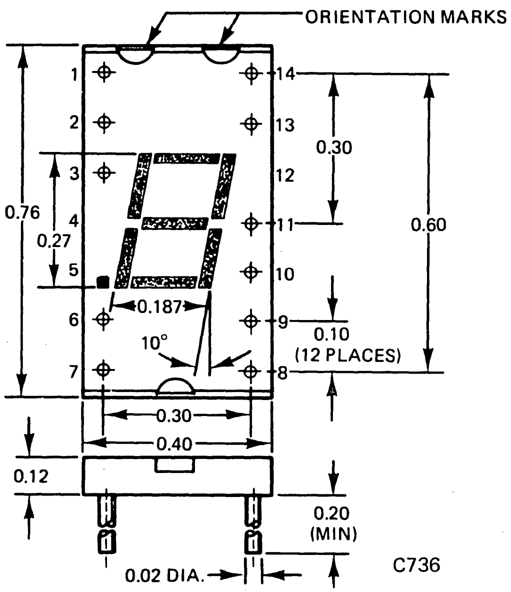
ca = common anode
cc = common cathode
DP = decimal point

NC = no connection
NP = no pin

GENERAL INSTRUMENT

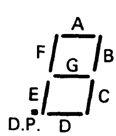
RED MAN1A
RED MAN10A

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 ON CIRCUIT BOARD	
PIN 8	CATHODE D		

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)

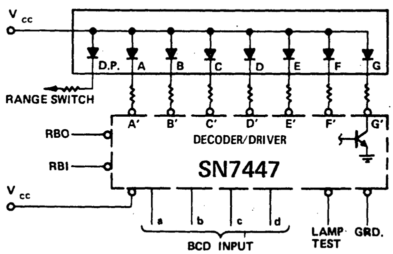
CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS MAN1A	TEST CONDITIONS MAN10A
Luminous Intensity (note 1 and 6)						
Segment	74			μcd	I_F=20 mA, λ=660 nm	I_F=10 mA, λ 660 nm
Decimal point	74			μcd	I_F=20 mA, λ=660 nm	I_F=10 mA, λ 660 nm
Peak emission wave length	630		700	nm		
Spectral line half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

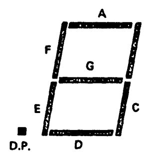
ELECTRO-OPTICAL CHARACTERISTICS Cont.'d (25°C Ambient Temperature Unless Otherwise Specified)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS MAN1A	TEST CONDITIONS MAN10A
Forward voltage						
Segment		3.4	4.0	V	I_F=20 mA	I_F=10 mA
Decimal point		1.6	2.0	V	I_F=20 mA	I_F=10 mA
Dynamic resistance						
Segment		11		Ω	I_F=20 mA	I_F=20 mA
Decimal point		5.5		Ω	I_F=20 mA	I_F=20 mA
Capacitance						
Segment		80		pF	V=0	V=0
Decimal point		135		pF	V=0	V=0
Reverse Current						
Segment			100	μA	V_R=10.0 volts	V_R=10.0 volts
Decimal point			100	μA	V_R= 5.0 volts	V_R= 5.0 volts

DECODER/DRIVER FUNCTIONAL DIAGRAM

General Instrument MAN1A/MAN10A





C737

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

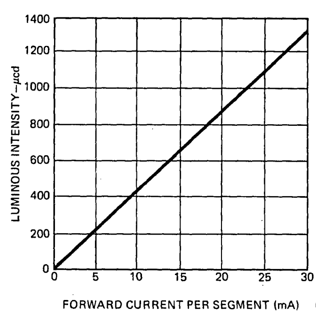
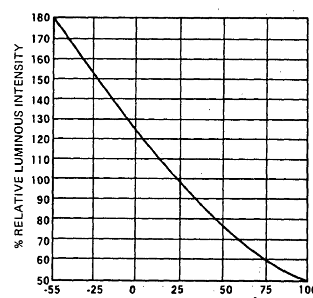


Figure 1 Luminous Intensity vs. Forward Current



C1145

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

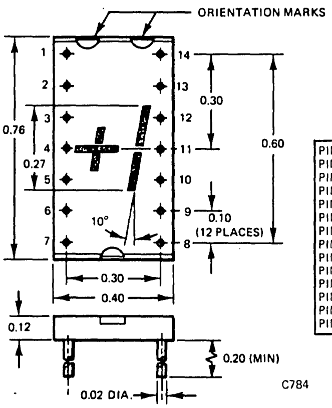
NOTES

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

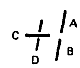
RED MAN101A
RED MAN1001A

PACKAGE DIMENSIONS



ALL DIMENSIONS NOMINAL IN INCHES

DUAL, IN-LINE CONFIGURATION



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

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

ABSOLUTE MAXIMUM RATINGS

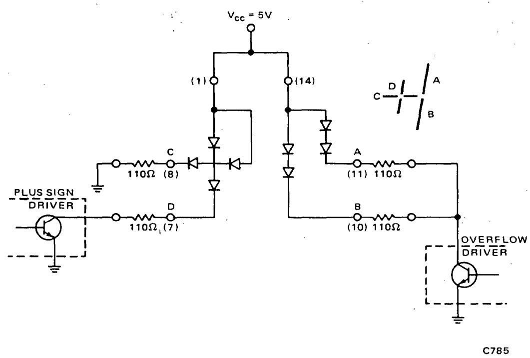
Power dissipation @ 25°C ambient	480 mW
Derate linearly from 25°C	6.4 mW/°C
Storage and operating temp	-55°C to 100°C
Continuous forward current	
Total	120 mA
Per segment	30 mA
Reverse Voltage	
Per segment	10.0 volts
Solder time at 260°C (see note 5)	5 sec

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

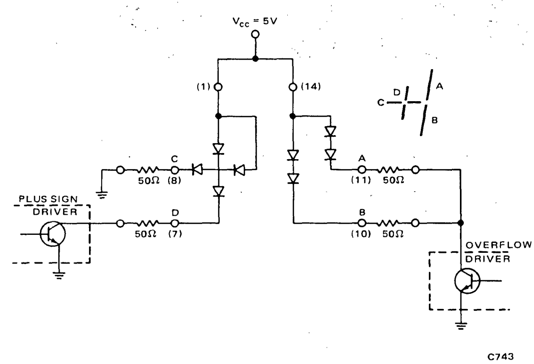
CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS MAN101A	MAN1001A
Luminous intensity (note 1 and 6)						
Segment	74			μcd	I_F = 10 mA, λ = 650 nm	I_F = 20 mA, λ 650 nm
Peak emission wave length	630		700	nm		
Spectral line half width		20		nm		
Forward voltage						
Segment		3.4	4.0	V	I_F = 10 mA	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

DRIVING CIRCUITRY

MAN101A



MAN1001A



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

TYPICAL CURVES

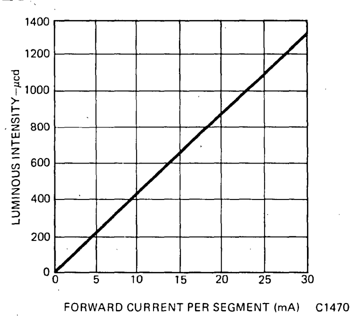


Figure 1 Luminous Intensity vs. Forward Current

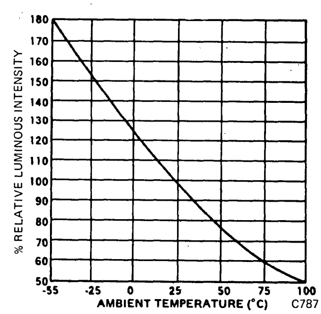


Figure 2 Luminous Intensity vs. Temperature

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

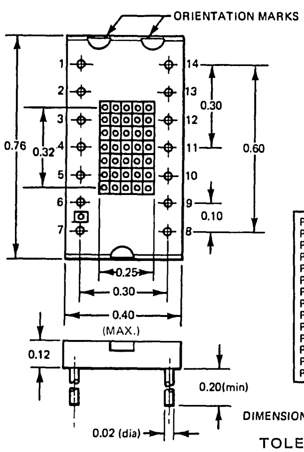
NOTES

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,	+

DIMENSIONS IN INCHES

TOLERANCE ±.015"

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

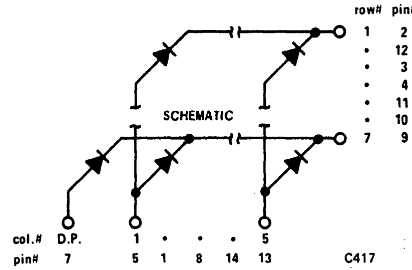
The MAN2A is a 35 diode diffused planar GaAsP LED alpha-numeric array with a decimal point. It is mounted on a dual in-line, 14-pin substrate with a high contrast red epoxy lens. It is capable of displaying the full character ASCII code.

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

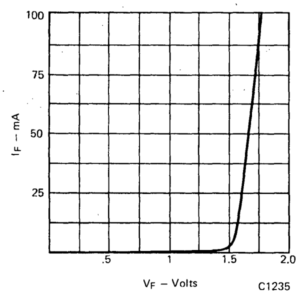


Fig. 1. Forward Current vs. Forward Voltage each LED

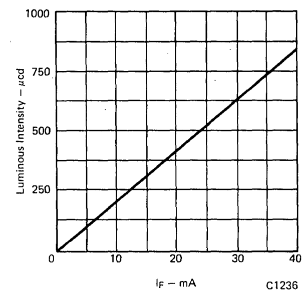


Fig. 2. Light Intensity vs. Forward Current each LED

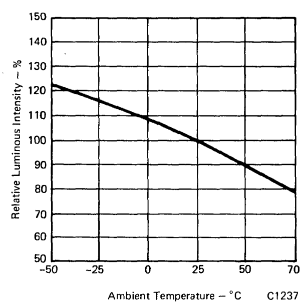


Fig. 3. Relative Luminous Intensity vs. Ambient Temperature

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			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.*

GENERAL INSTRUMENT

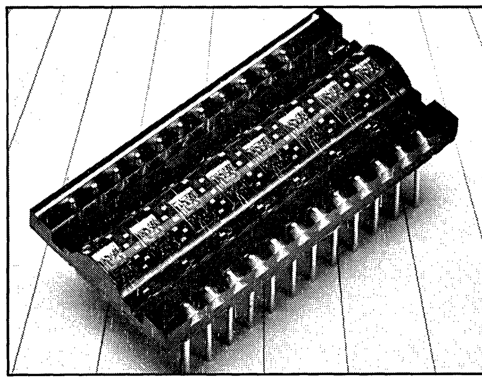
RED **MAN2815**

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.

ABSOLUTE MAXIMUM RATINGS

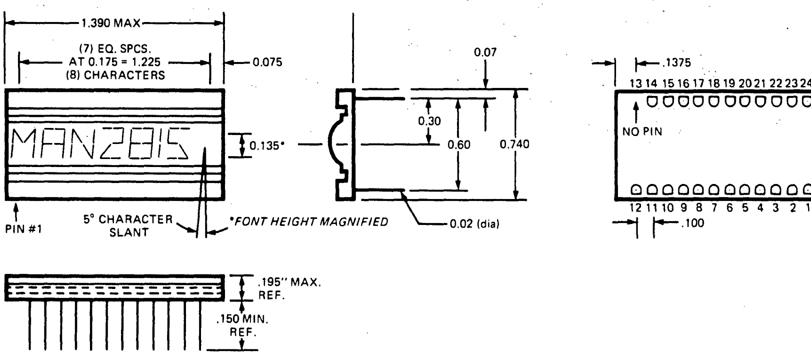
Average Forward Current per Segment	10 mA
Peak Forward Current per Segment ($\leqslant$ 200 μs, $\leqslant$ 4% duty cycle)	250 mA
Reverse Voltage	5.0 volts
Storage & Operating Temperature	–40°C to 85°C
Solder Temperature (t $\leqslant$ 5 sec) (See notes 2 & 3)	260°C
Average Power Dissipation (Total Package) @ 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

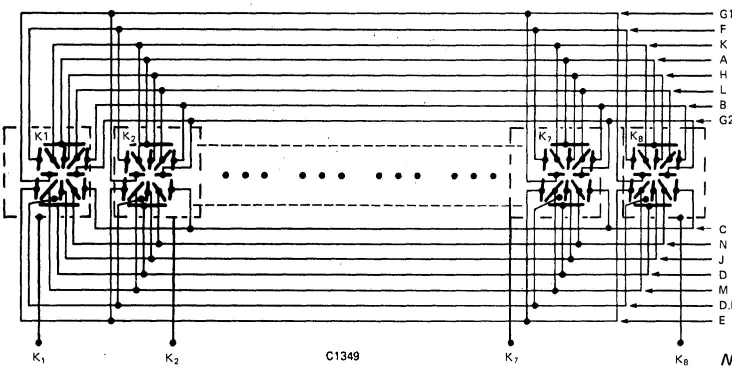


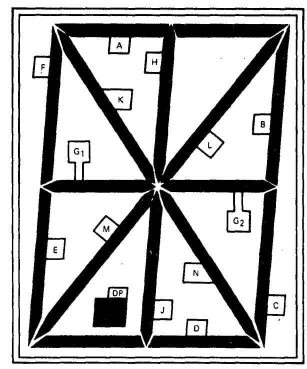
REFERENCE DESIGNATOR	
PIN NO.	DESCRIPTION
1	K1 CATHODE
2	K2 CATHODE
3	K3 CATHODE
4	(D) ANODE
5	K4 CATHODE
6	K5 CATHODE
7	(J) ANODE
8	K6 CATHODE
9	(DP) ANODE
10	K7 CATHODE
11	(M) ANODE
12	K8 CATHODE
13	NO PIN
14	(N) ANODE
15	(C) ANODE
16	(E) ANODE
17	(G2) ANODE
18	(G1) ANODE
19	(B) ANODE
20	(L) ANODE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

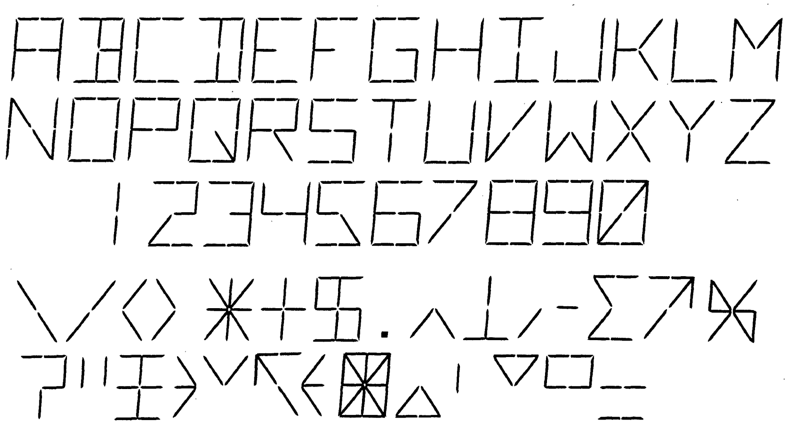


Fig. 8. 14 Segment Character Font

TYPICAL CURVES (unless otherwise noted)

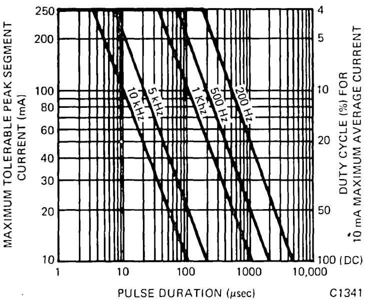


Fig. 1. Maximum Tolerable Peak Segment Current vs. Pulse Duration

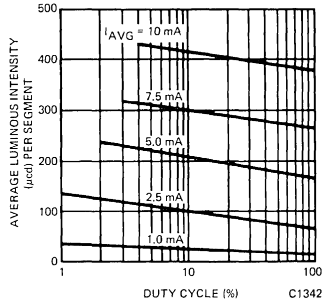


Fig. 2. Average Luminous Intensity/Segment vs. Duty Cycle

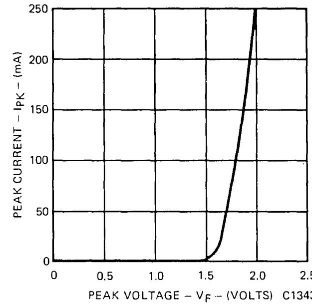


Fig. 3. Peak Current vs. Peak Voltage

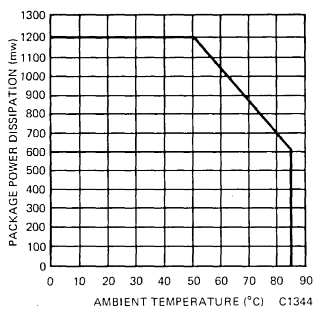


Fig. 4. Max. Tolerable Power Dissipation

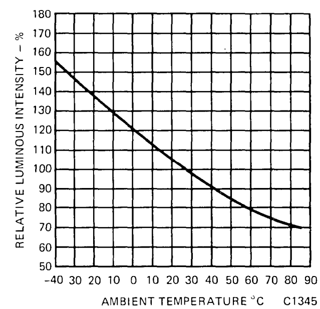


Fig. 5. Luminous Intensity vs. Temperature

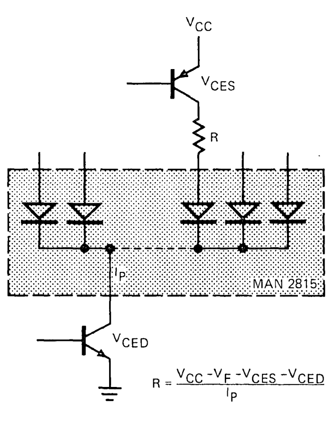


Fig. 6. Display Drive Consideration

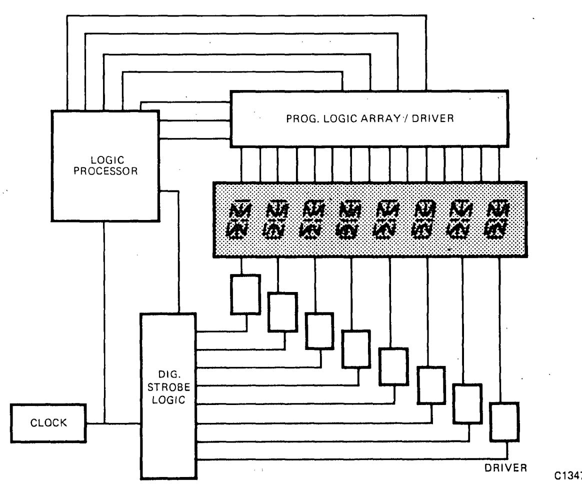


Fig. 7. MAN2815 in a Typical Application

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.
   $\therefore I_{PK} = \frac{2.5 \text{ mA}}{.03125}$ = 80 mA/seg.

NOTES

1. *The average Luminous Intensity per segment is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments as measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D).*
2. *Leads immersed to 1/16" 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

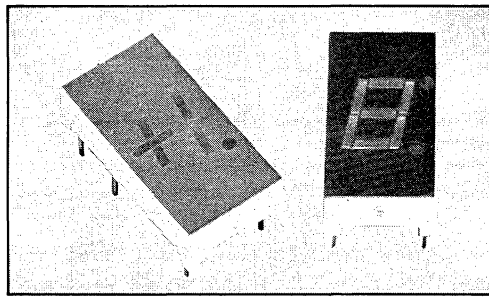
HIGH EFFICIENCY GREEN MAN3400A
ORANGE MAN3600A
RED MAN70A
YELLOW MAN3800A

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



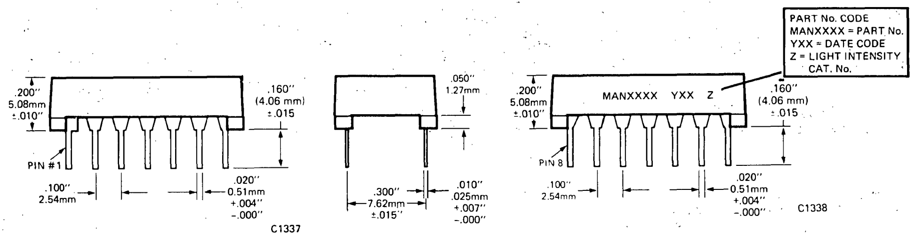
DESCRIPTION

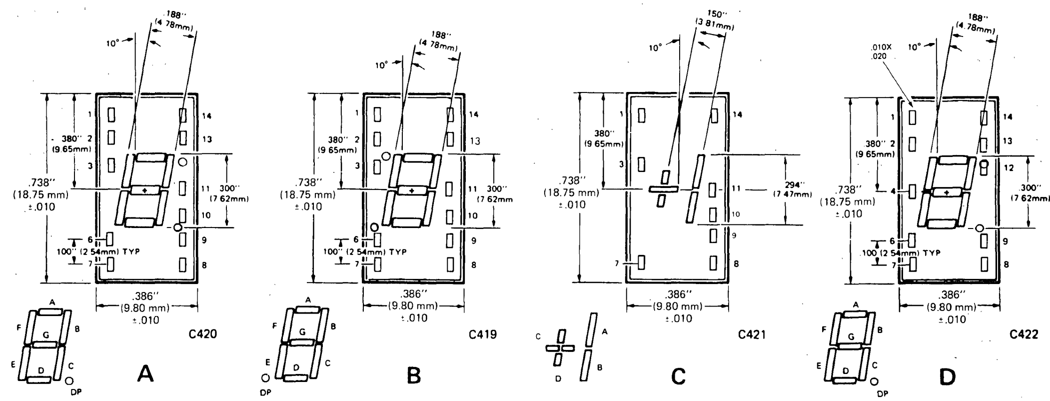
The MAN3400A, MAN3600A, MAN70A and MAN3800A Series provides a choice of color of LED displays. Standard units are available in red, green, orange and yellow, with common anode right hand decimal, common anode left hand decimal, common cathode right hand decimal, and common anode overflow (±1) with right 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

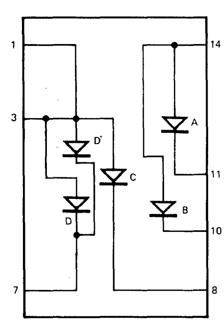
MAN3400A MAN3600A MAN70A MAN3800A SERIES





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			μcd	I_F = 10 mA
	(See Note 1, 3)	710			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			μcd	I_F = 10 mA
	Decimal point (See Note 3)	265			μcd	I_F = 10 mA
	Segment "C" or "D" of MAN3630A	265			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			μcd	I_F = 10 mA
	Decimal point (See Note 3)	60			μcd	I_F = 10 mA
	Segment "C" or "D" of MAN73A	60			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			μcd	I_F = 10 mA
	Decimal point (See Note 3)	160			μcd	I_F = 10 mA
	Segment "C" or "D" of MAN83A	160			μcd	I_F = 10 mA
	Peak emission wavelength		585		nm	
	Spectral line half width		40		nm	
	Forward voltage					
	Segment			3.0	V	I_F = 20 mA
	Decimal point			3.0	V	I_F = 20 mA
	Dynamic resistance					
	Segment		26		Ω	I_F = 20 mA
	Decimal point		26		Ω	I_F = 20 mA
	Capacitance					
	Segment		35		pF	V = 0
	Decimal point		35		pF	V = 0
	Reverse current					
	Segment			100	μA	V_R = 5.0 V
	Decimal point			100	μA	V_R = 5.0 V

TYPICAL CURVES

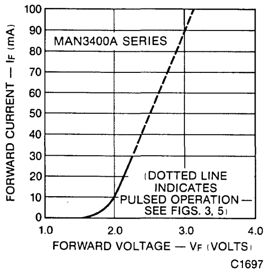


Fig. 1. Forward Current vs. Forward Voltage

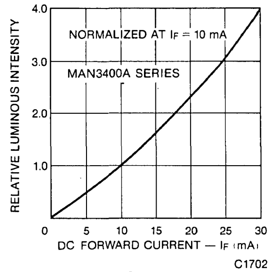


Fig. 2. Relative Luminous Intensity vs. DC Forward Current

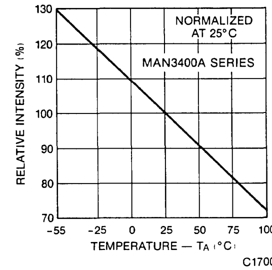


Fig. 3. Relative Luminous Intensity vs. Temperature

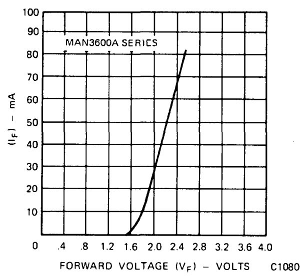


Fig. 4. Forward Current vs. Forward Voltage

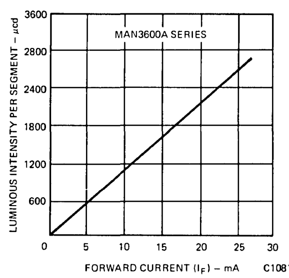


Fig. 5. Luminous Intensity vs. Forward Current

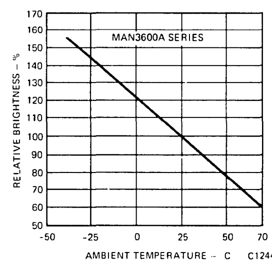


Fig. 6. Luminous Intensity vs. Temperature

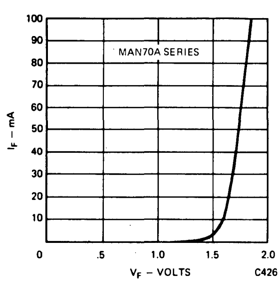


Fig. 7. Forward Current vs. Forward Voltage

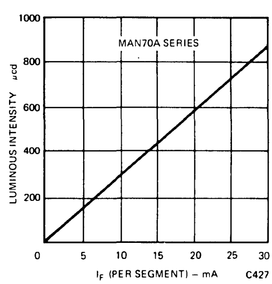


Fig. 8. Luminous Intensity vs. Forward Current

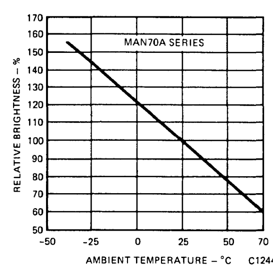


Fig. 9. Luminous Intensity vs. Temperature

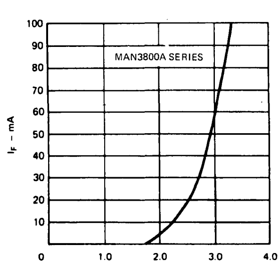


Fig. 10. Forward Current vs. Forward Voltage

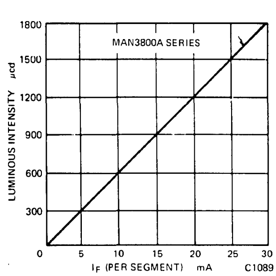


Fig. 11. Luminous Intensity vs. Forward Current

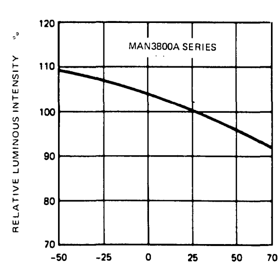


Fig. 12. Luminous Intensity vs. Temperature

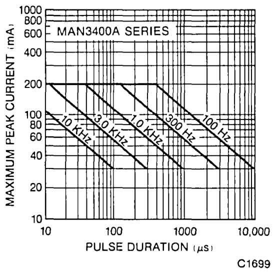


Fig. 13. Maximum Peak Current vs. Pulse Duration

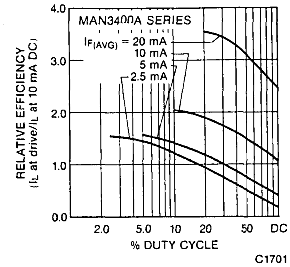


Fig. 14. Relative Efficiency vs. Duty Cycle

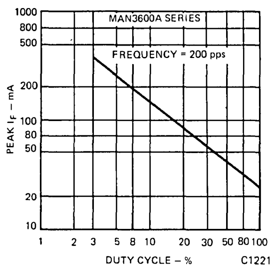


Fig. 15. Max Peak Current vs. Duty Cycle

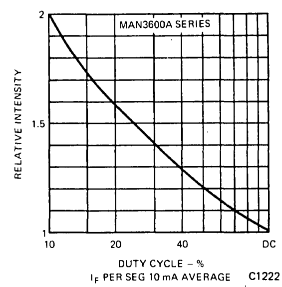


Fig. 16. Luminous Intensity vs. Duty Cycle

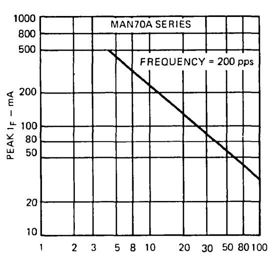


Fig. 17. Max Peak Current vs. Duty Cycle

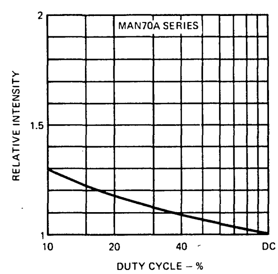


Fig. 18. Luminous Intensity vs. Duty Cycle

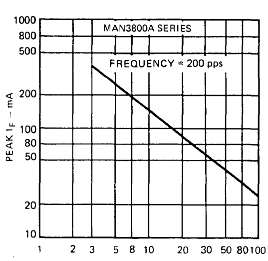


Fig. 19. Max Peak Current vs. Duty Cycle

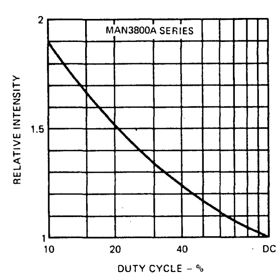


Fig. 20. Luminous Intensity vs. Duty Cycle

ABSOLUTE MAXIMUM RATINGS

	HIGH EFF. GREEN		RED	
	MAN3410A MAN3420A MAN3440A	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.*

GENERAL INSTRUMENT

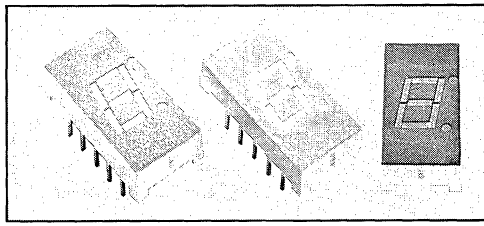
HIGH EFFICIENCY GREEN MAN3480A
ORANGE MAN3680A
RED MAN78A
YELLOW MAN3880A
HIGH EFFICIENCY RED MAN3980A

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.

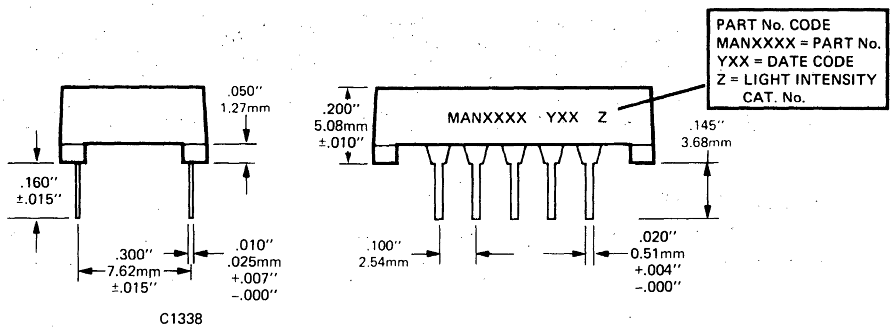
MODEL NUMBERS

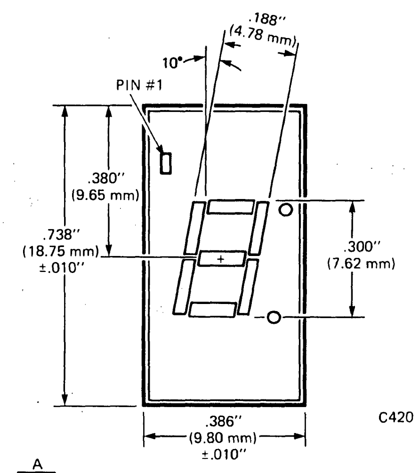
PART NO.	COLOR	DESCRIPTION
MAN3480A	High Efficiency Green	Common Cathode; Right Hand Decimal
MAN3680A	Orange	Common Cathode; Right Hand Decimal
MAN78A	Red	Common Cathode; Right Hand Decimal
MAN3880A	Yellow	Common Cathode; Right Hand Decimal
MAN3980A	High Efficiency Red	Common Cathode; Right Hand Decimal

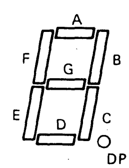
RECOMMENDED FILTERS

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			μcd	I_F = 10 mA
		710			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			μcd	I_F = 10 mA
	Decimal point (See Note 3)	265			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			μcd	I_F = 10 mA
	Decimal point (See Note 3)	60			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			μcd	I_F = 10 mA
	Decimal point (See Note 3)	160			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			μcd	I_F = 10 mA
	Decimal point (See Note 3)	165			μcd	I_F = 10 mA
	Peak emission wavelength		635		nm	
	Spectral line half width		40		nm	
	Forward voltage					
	Segment			2.5	V	I_F = 20 mA
	Decimal point			2.5	V	I_F = 20 mA
	Dynamic resistance					
	Segment		26		Ω	I_F = 20 mA
	Decimal point		26		Ω	I_F = 20 mA
	Capacitance					
	Segment		35		pF	V = 0
	Decimal point		35		pF	V = 0
	Reverse current					
	Segment			100	μA	V_R = 5.0 V
	Decimal point			100	μA	V_R = 5.0 V

TYPICAL CURVES

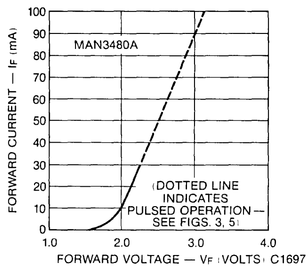


Fig. 1. Forward Current vs. Forward Voltage

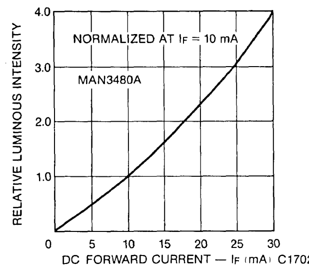


Fig. 2. Relative Luminous Intensity vs. DC Forward Current

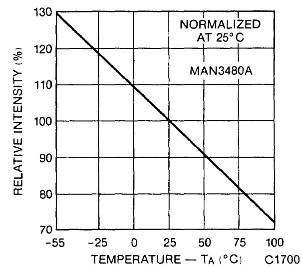


Fig. 3. Relative Luminous Intensity vs. Temperature

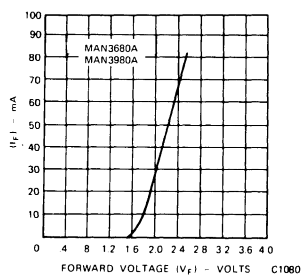


Fig. 4. Forward Current vs. Forward Voltage

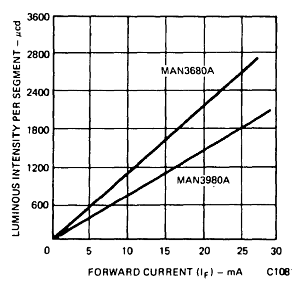


Fig. 5. Luminous Intensity vs. Forward Current

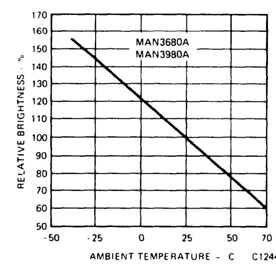


Fig. 6. Luminous Intensity vs. Temperature

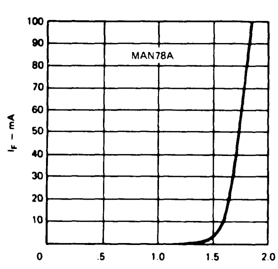


Fig. 7. Forward Current vs. Forward Voltage

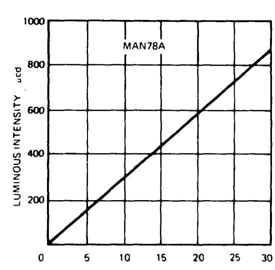


Fig. 8. Luminous Intensity vs. Forward Current

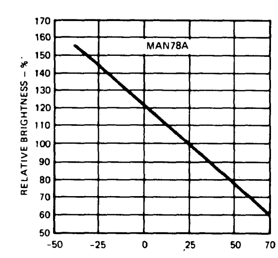


Fig. 9. Luminous Intensity vs. Temperature

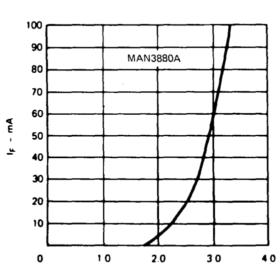


Fig. 10. Forward Current vs. Forward Voltage

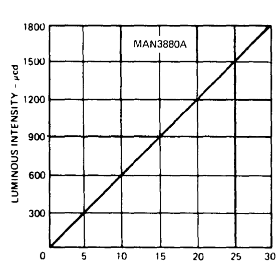


Fig. 11. Luminous Intensity vs. Forward Current

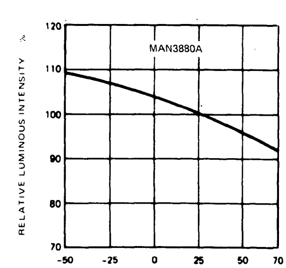


Fig. 12. Luminous Intensity vs. Temperature

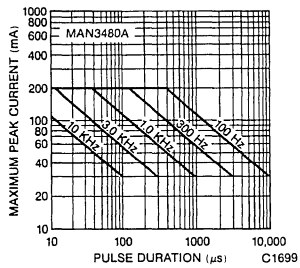


Fig. 13. Maximum Peak Current vs. Pulse Duration

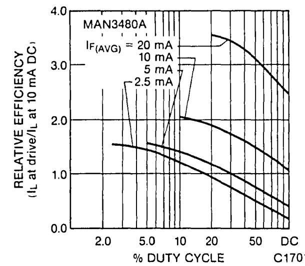


Fig. 14. Relative Efficiency vs. Duty Cycle

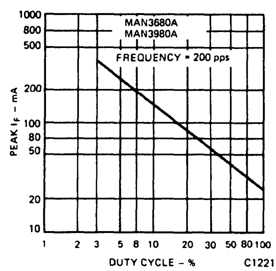


Fig. 15. Max Peak Current vs. Duty Cycle

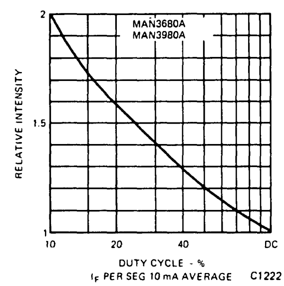


Fig. 16. Luminous Intensity vs. Duty Cycle

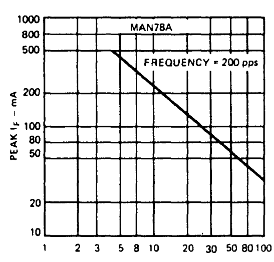


Fig. 17. Max Peak Current vs. Duty Cycle

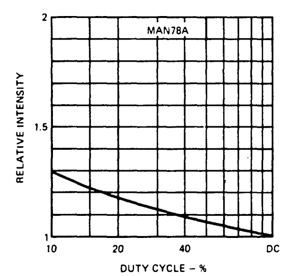


Fig. 18. Luminous Intensity vs. Duty Cycle

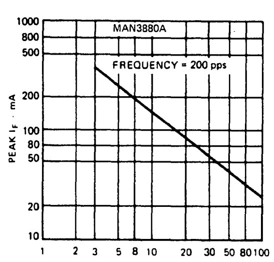


Fig. 19. Max Peak Current vs. Duty Cycle

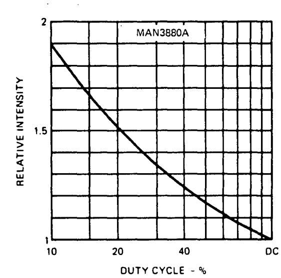


Fig. 20. Luminous Intensity vs. Duty Cycle

ABSOLUTE MAXIMUM RATINGS

	HIGH 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, 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 RED MAN3900A SERIES

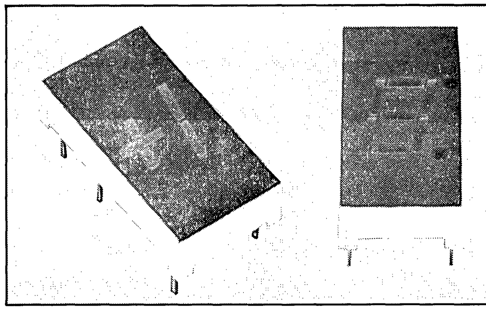
FEATURES

- 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.

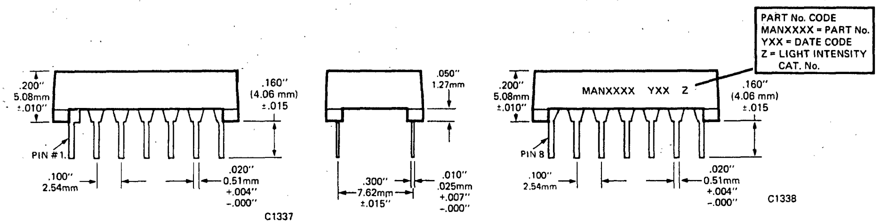
MODEL NUMBERS

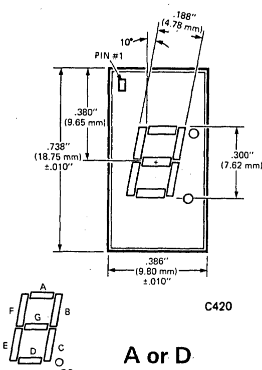
PART NO.	COLOR	PACKAGE	DESCRIPTION	PIN OUT SPECIFICATION
MAN3910A	High Efficiency Red	A	Common Anode; Right Hand Decimal	A
MAN3920A	High Efficiency Red	B	Common Anode; Left Hand Decimal	B
MAN3930A	High Efficiency Red	C	Common Anode; Overflow ±1	C
MAN3940A	High Efficiency Red	D	Common Cathode; Right Hand Decimal	D
MAN3980A	High Efficiency Red	E	Common Cathode; Right Hand Decimal	E

RECOMMENDED FILTERS

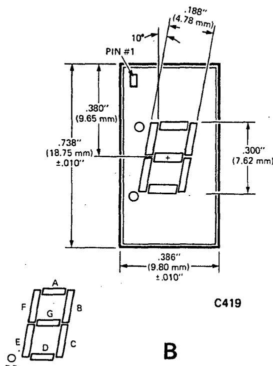
For optimum on and off contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER
MAN3910A MAN3920A MAN3930A MAN3940A MAN3980A	Panelgraphic Scarlet 65 Homalite 100-1670

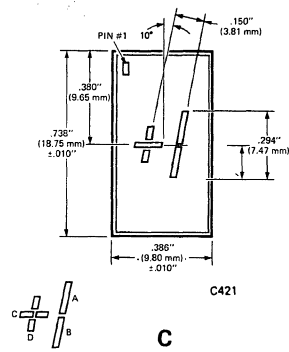




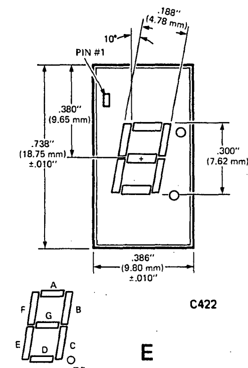
A or D



B



C

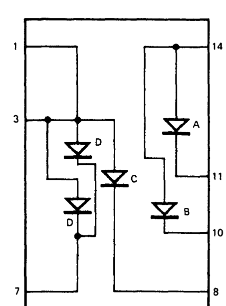


E

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			μcd	I_F = 10 mA
Decimal point (See Note 3)	165			μcd	I_F = 10 mA
Segment "C" or "D" of MAN3630A	165			μcd	I_F = 10 mA
Peak emission wavelength		635		nm	
Spectral line half width		40		nm	
Forward voltage					
Segment			2.5	V	I_F = 20 mA
Decimal point			2.5	V	I_F = 20 mA
Dynamic resistance					
Segment		26		Ω	I_F = 20 mA
Decimal point		26		Ω	I_F = 20 mA
Capacitance					
Segment		35		pF	V = 0
Decimal point		35		pF	V = 0
Reverse current					
Segment			100	μA	V_R = 5.0 V
Decimal point			100	μA	V_R = 5.0 V

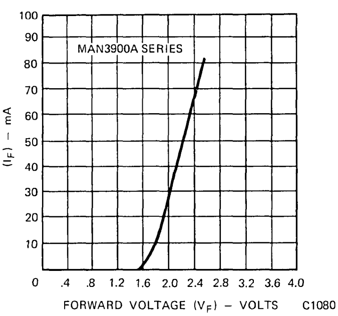


Fig. 1. Forward Current vs. Forward Voltage

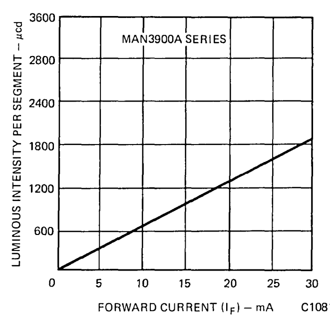


Fig. 2. Luminous Intensity vs. Forward Current

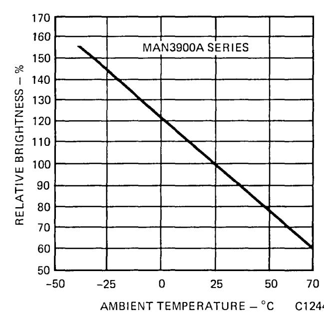


Fig. 3. Luminous Intensity vs. Temperature

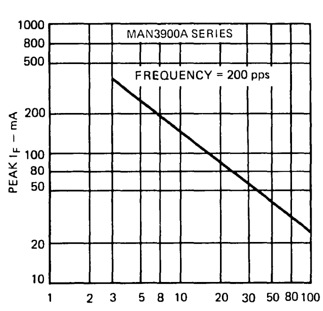


Fig.4. Max Peak Current vs. Duty Cycle

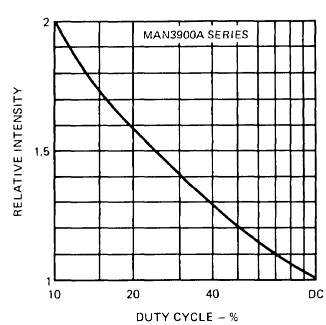


Fig. 5. Luminous Intensity vs. Duty Cycle

ABSOLUTE MAXIMUM RATINGS

	MAN3910A MAN3920A MAN3940A MAN3980A	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

GREEN MAN4500A SERIES ORANGE MAN4600A SERIES RED MAN4700A SERIES YELLOW MAN4800A SERIES

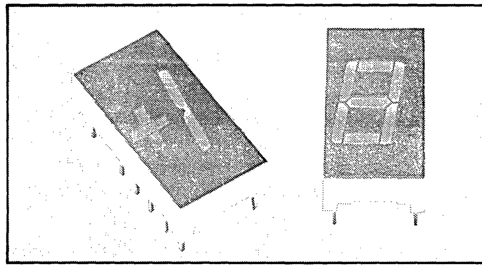
FEATURES

- 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

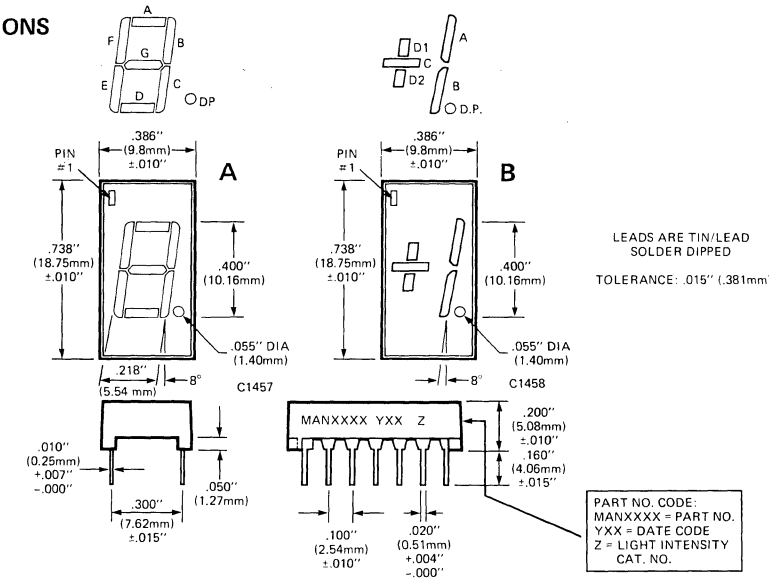
The MAN4500, MAN4600, MAN4700 and MAN4800 Series provides superior brightness in a choice of color LED displays. Standard units are available in red, green, orange and yellow, with common anode right hand decimal, common cathode right hand decimal, and universal (CA or CC) overflow (±1) with right hand 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.

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN-OUT SPECIFICATION
MAN4505A	Green	Universal (CA or CC) Overflow ±1, Rt. Hand Dec.	B	D
MAN4510A	Green	Common Anode; Right Hand Decimal	A	A
MAN4540A	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

MAN4500A MAN4600A MAN4700A MAN4800A SERIES

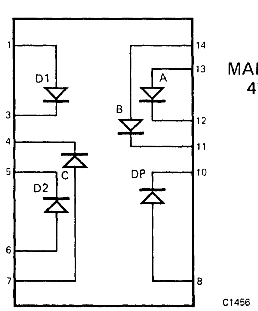
PACKAGE DIMENSIONS



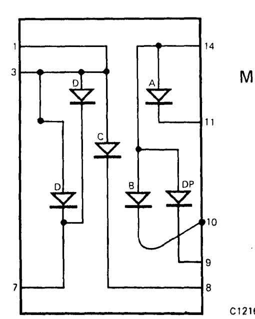
PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS A MAN4510/4610/4710/4810	B MAN4630*	C MAN4540/4640/4740/4840	D MAN4505/4605/4705/4805
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



MAN4505/4605
4705/4805



MAN4630

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

Device	Parameter	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
MAN4505/4510/4540	Luminous intensity, Digit Average (See Note 1)	320			μcd	I_F = 10 mA
	Decimal point (See Note 3)	150			μcd	I_F = 10 mA
	Segment "C" or "D" of MAN4505	150			nm	
	Peak emission wavelength		565			
	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		17		Ω	I_F = 20 mA
	Decimal point		17		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
MAN4605/4610/4630*/4640	Luminous intensity, Digit Average (See Note 1)	510			μcd	I_F = 10 mA
	Decimal point (See Note 3)	250			μcd	I_F = 10 mA
	Segment "C" or "D" of MAN4630 or 4605	250			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
MAN4705/4710/4740	Luminous intensity, Digit Average (See Note 1)	200			μcd	I_F = 10 mA
	Decimal point (See Note 3)	85			μcd	I_F = 10 mA
	Segment "C" or "D" of MAN4705	85			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
MAN4805/4810/4840	Luminous intensity, Digit Average (See Note 1)	510			μcd	I_F = 10 mA
	Decimal point (See Note 3)	250			μcd	I_F = 10 mA
	Segment "C" or "D" of MAN4805	250			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

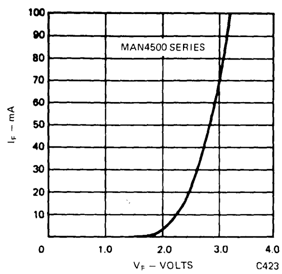


Fig. 1. Forward Current vs. Forward Voltage

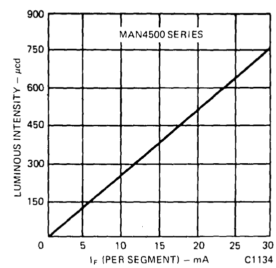


Fig. 2. Luminous Intensity vs. Forward Current

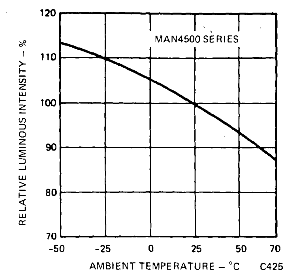


Fig. 3. Luminous Intensity vs. Temperature

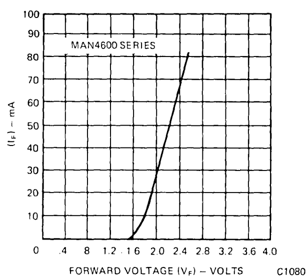


Fig. 4. Forward Current vs. Forward Voltage

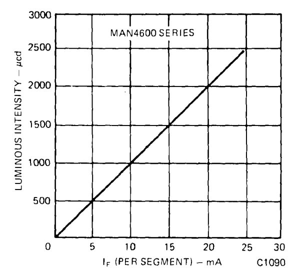


Fig. 5. Luminous Intensity vs. Forward Current

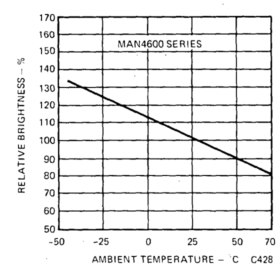


Fig. 6. Luminous Intensity vs. Temperature

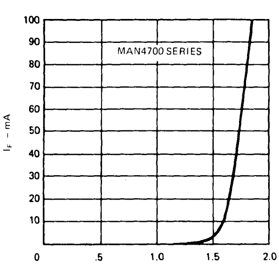


Fig. 7. Forward Current vs. Forward Voltage

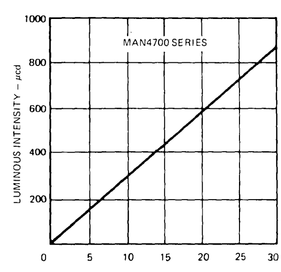


Fig. 8. Luminous Intensity vs. Forward Current

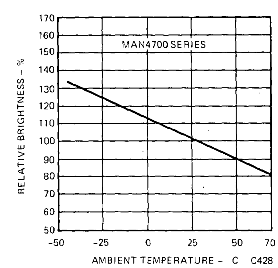


Fig. 9. Luminous Intensity vs. Temperature

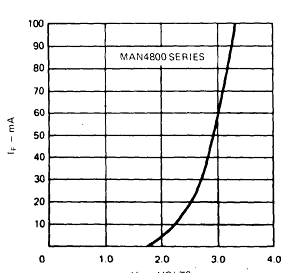


Fig. 10. Forward Current vs. Forward Voltage

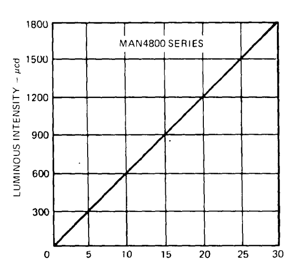


Fig. 11. Luminous Intensity vs. Forward Current

Fig. 12. Luminous Intensity vs. Temperature

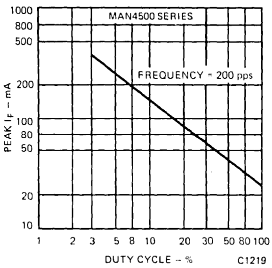


Fig. 13. Max Peak Current vs. Duty Cycle

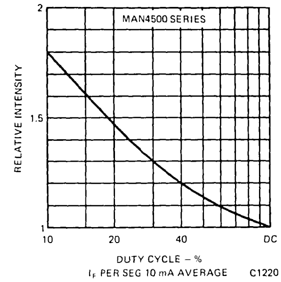


Fig. 14. Luminous Intensity vs. Duty Cycle

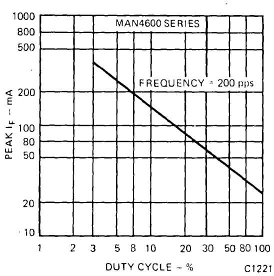


Fig. 15. Max Peak Current vs. Duty Cycle

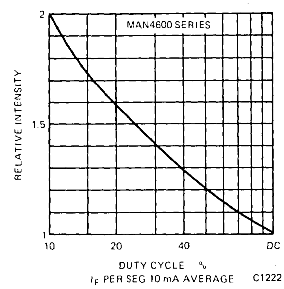


Fig. 16. Luminous Intensity vs. Duty Cycle

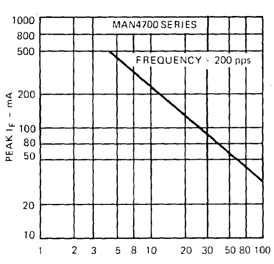


Fig. 17. Max Peak Current vs. Duty Cycle

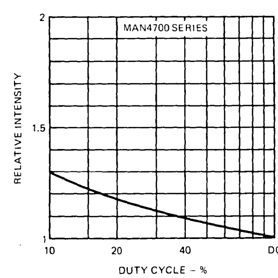


Fig. 18. Luminous Intensity vs. Duty Cycle

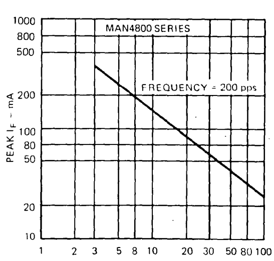


Fig. 19. Max Peak Current vs. Duty Cycle

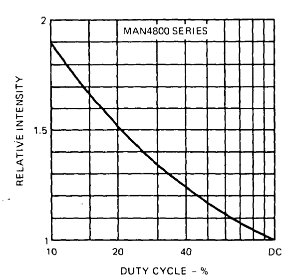


Fig. 20. Luminous Intensity vs. Duty Cycle

MAN4500A MAN4600A MAN4700A MAN4800A SERIES

ABSOLUTE MAXIMUM RATINGS

	MAN4505	MAN4510 MAN4540	MAN4705	MAN4710 MAN4740
Power dissipation @ 25°C ambient . . .	360 mW	480 mW	360 mW	480 mW
Derate linearly from 50°C.	−7.2 mW/°C	−9.6 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.	120 mA	160 mA	180 mA	240 mA
Per segment	20 mA	20 mA	30 mA	30 mA
Decimal point.	20 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.

	MAN4805	MAN4810 MAN4840	MAN4605 MAN4630	MAN4610 MAN4640
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
MAN4505, MAN4510, MAN4540	Panelgraphic Green 48	MAN4705, MAN4710, MAN4740	Panelgraphic Red 60 Homalite 100-1605
MAN4605, MAN4610, MAN4630, MAN4640	Panelgraphic Scarlet 65 Homalite 100-1670	MAN4805, MAN4810, MAN4840	Panelgraphic Yellow 25 or Amber 23 Homalite 100-1720 or 100-1726

NOTE: When using the grey face MAN4500 or MAN4800 series 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

GREEN MAN4580A
ORANGE MAN4680A
RED MAN4780A
YELLOW MAN4880A
HIGH EFFICIENCY RED MAN4980A

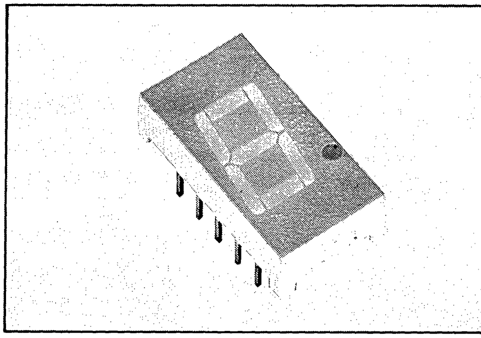
FEATURES

- 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



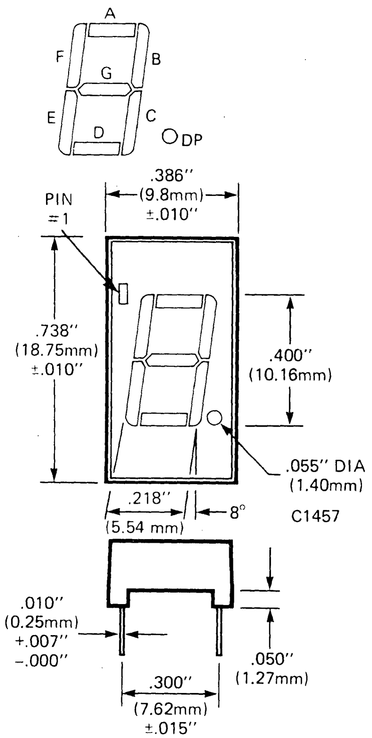
DESCRIPTION

The MAN4580A, 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 MAN4500A, 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

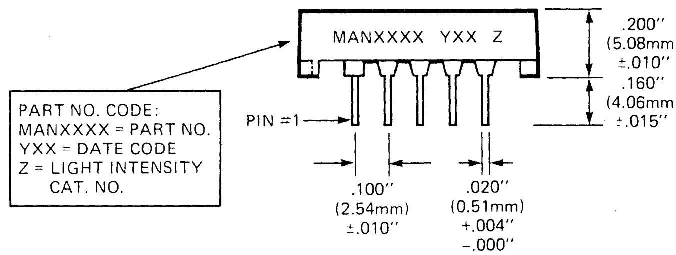
PART NO.	COLOR	DESCRIPTION
MAN4580A	Green	Common Cathode; Right Hand Decimal
MAN4680A	Orange	Common Cathode; Right Hand Decimal
MAN4780A	Red	Common Cathode; Right Hand Decimal
MAN4880A	Yellow	Common Cathode; Right Hand Decimal
MAN4980A	High Efficiency Red	Common Cathode; Right Hand Decimal

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
MAN4580	Luminous intensity, Digit Average (See Note 1)	320			µcd	I_F = 10 mA
	Decimal point (See Note 3)	150			µcd	I_F = 10 mA
	Peak emission wavelength		565		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		17		Ω	I_F = 20 mA
	Decimal point		17		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
MAN4680	Luminous intensity, Digit Average (See Note 1)	510			µcd	I_F = 10 mA
	Decimal point (See Note 3)	250			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
MAN4780	Luminous intensity, Digit Average (See Note 1)	200			µcd	I_F = 10 mA
	Decimal point (See Note 3)	85			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
MAN4880	Luminous intensity, Digit Average (See Note 1)	510			µcd	I_F = 10 mA
	Decimal point (See Note 3)	250			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
MAN4980	Luminous intensity, Digit Average (See Note 1)	320			µcd	I_F = 10 mA
	Decimal point (See Note 3)	165			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

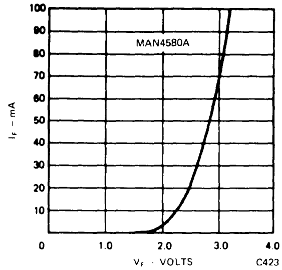


Fig. 1. Forward Current vs. Forward Voltage

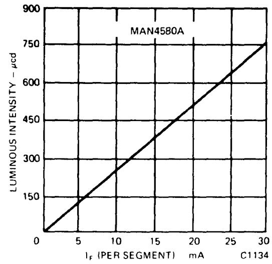


Fig. 2. Luminous Intensity vs. Forward Current

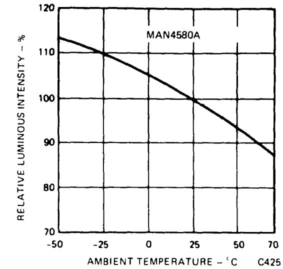


Fig. 3. Luminous Intensity vs. Temperature

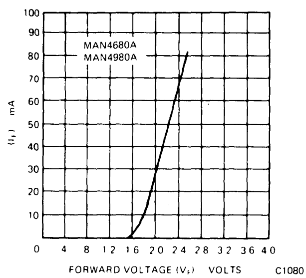


Fig. 4. Forward Current vs. Forward Voltage

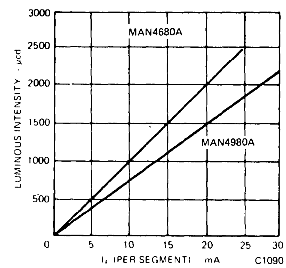


Fig. 5. Luminous Intensity vs. Forward Current

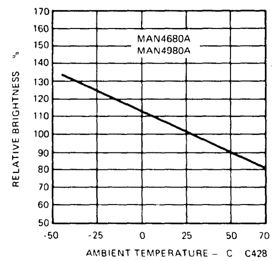


Fig. 6. Luminous Intensity vs. Temperature

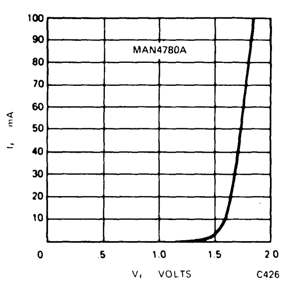


Fig. 7. Forward Current vs. Forward Voltage

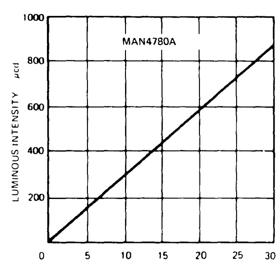


Fig. 8. Luminous Intensity vs. Forward Current

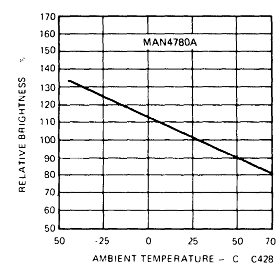


Fig. 9. Luminous Intensity vs. Temperature

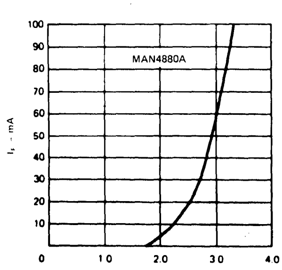


Fig. 10. Forward Current vs. Forward Voltage

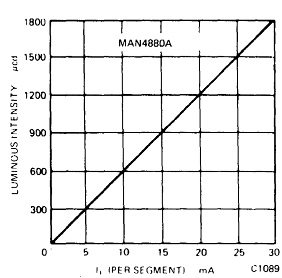


Fig. 11. Luminous Intensity vs. Forward Current

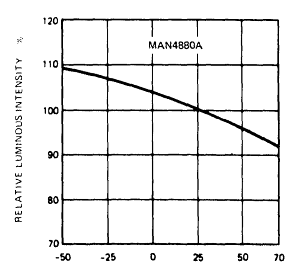


Fig. 12. Luminous Intensity vs. Temperature

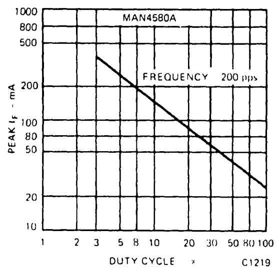


Fig. 13. Max Peak Current vs. Duty Cycle

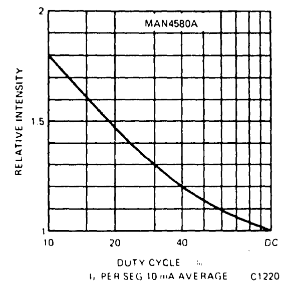


Fig. 14. Luminous Intensity vs. Duty Cycle

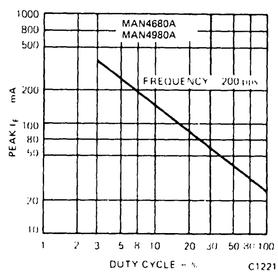


Fig. 15. Max Peak Current vs. Duty Cycle

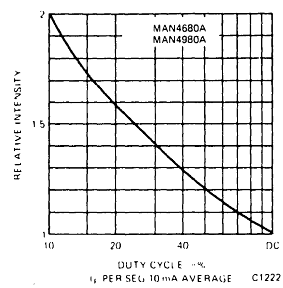


Fig. 16. Luminous Intensity vs. Duty Cycle

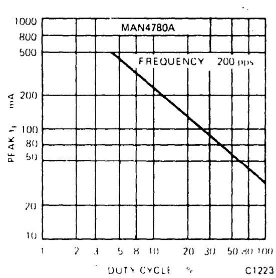


Fig. 17. Max Peak Current vs. Duty Cycle

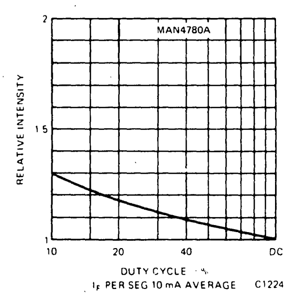


Fig. 18. Luminous Intensity vs. Duty Cycle

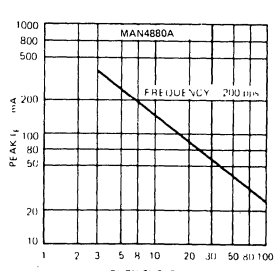


Fig. 19. Max Peak Current vs. Duty Cycle

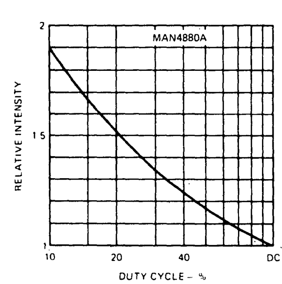


Fig. 20. Luminous Intensity vs. Duty Cycle

ABSOLUTE MAXIMUM RATINGS

	MAN4580A	MAN4680A	MAN4780A
Power dissipation @ 25°C ambient	480 mW	600 mW	480 mW
Derate linearly from 50°C	−9.6 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	160 mA	240 mA	240 mA
Per segment	20 mA	30 mA	30 mA
Decimal point	20 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
MAN4580A	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 MAN4580 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.*

GENERAL
INSTRUMENT

HIGH EFFICIENCY RED MAN4900A SERIES

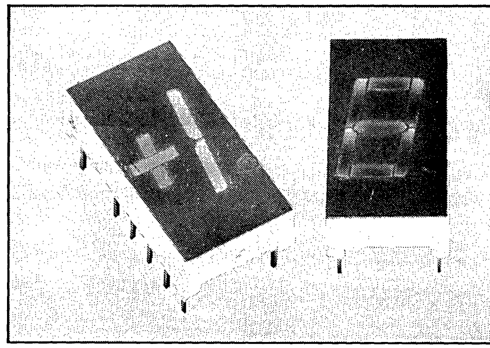
FEATURES

- 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.

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)

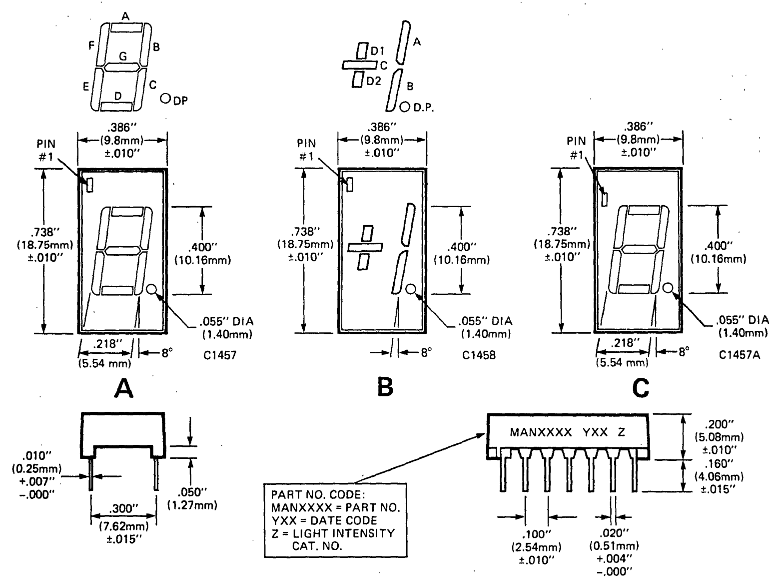
MAN4905A/4910A/4940A/4980A

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous intensity, Digit Average (See Note 1)	320			μcd	I_F = 10 mA
Decimal point (See Note 3)	160			μcd	I_F = 10 mA
Segment "C" or "D" of MAN4930A or 4905A	160			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

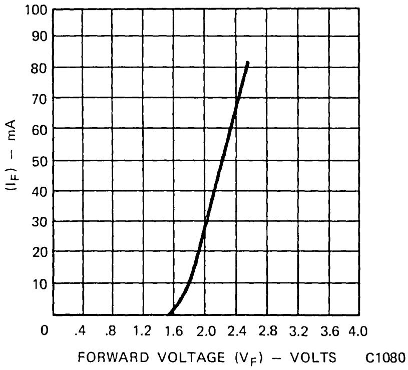


Fig. 1. Forward Current vs. Forward Voltage

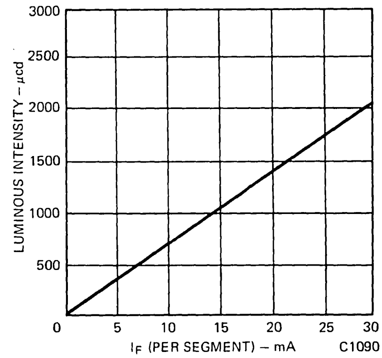


Fig. 2. Luminous Intensity vs. Forward Current

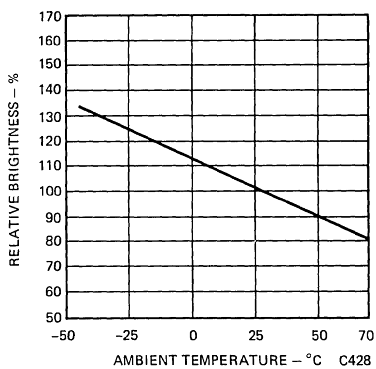


Fig. 3. Luminous Intensity vs. Temperature

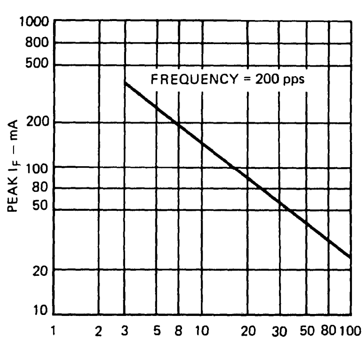


Fig. 4. Max Peak Current vs. Duty Cycle

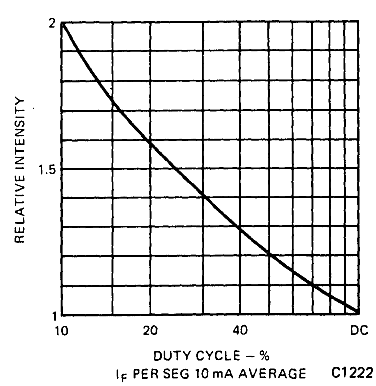
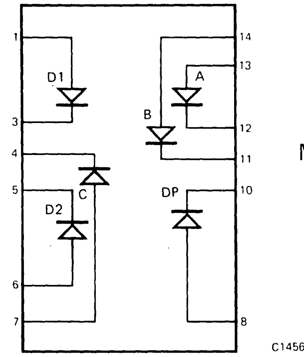


Fig. 5. Luminous Intensity vs. Duty Cycle

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

HIGH EFFICIENCY GREEN **MAN6400 SERIES**

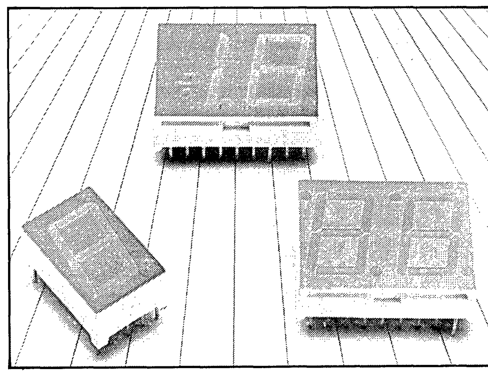
FEATURES

- High efficiency green nitrogen-doped Gallium Phosphide.
- 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, and single 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 neutral segment color to enhance on/off contrast.

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION	DRAWING	PIN-OUT SPECIFICATION
MAN6410	Hi. Eff. Green	2 Digit; Common Anode; Rt. Hand Decimal	A	A
MAN6430	Hi. Eff. Green	1½ Digit; Common Anode; Overflow ± 1.8. Rt. Hand Decimal	B	B
MAN6440	Hi. Eff. Green	2 Digit; Common Cathode; Rt. Hand Decimal	A	C
MAN6450	Hi. Eff. Green	1½ Digit; Common Cathode; Overflow ± 1.8. Rt. Hand Decimal	B	D
MAN6460	Hi. Eff. Green	Single Digit; Common Anode; Rt. Hand Decimal	C	E
MAN6480	Hi. Eff. Green	Single Digit; Common Cathode; Rt. Hand Decimal	C	F

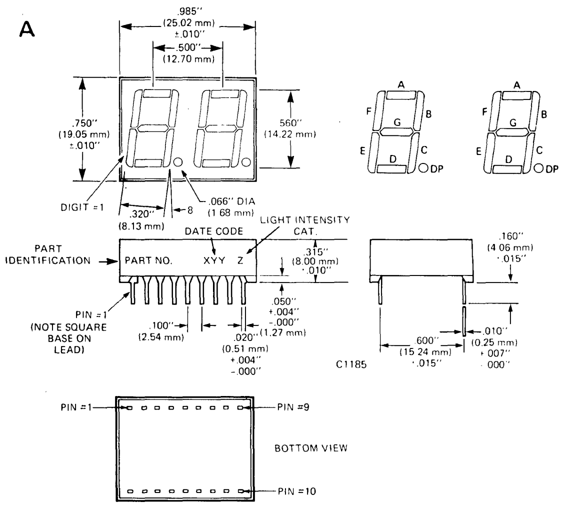
FILTER RECOMMENDATIONS

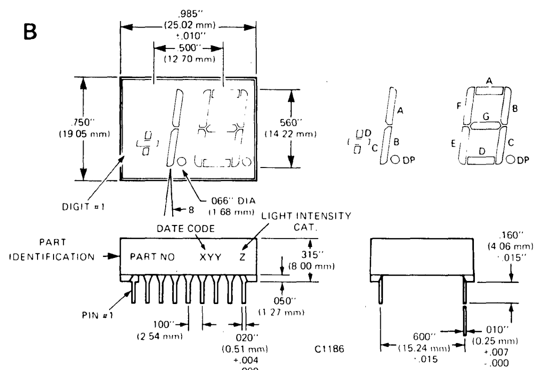
For optimum on and off contrast, one of the following filters or equivalents should be used over the display:

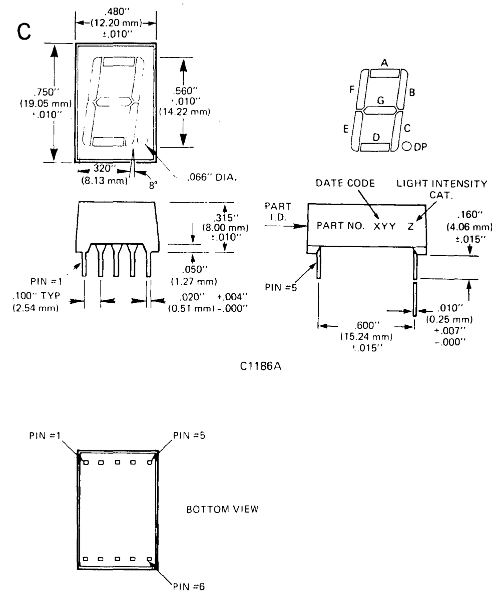
MAN6400 Series	Panelgraphic Green 48
	Homalite 100-1440 Green
	Panelgraphic Grey 10
	Homalite 100-1266 Grey

MAN6400 SERIES

PACKAGE DIMENSIONS







NOTE: When placing double digits and single digits together on a board, allowance should be made for .150" spacing between the end leads of the double digit and the end leads of the single digit.

PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS					
	A MAN6410	B MAN6430	C MAN6440	D MAN6450	E MAN6460	F MAN6480
1	E cathode (No. 1)	C cathode (No. 1)	E anode (No. 1)	C anode (No. 1)	E cathode	E anode
2	D cathode (No. 1)	D cathode (No. 1)	D anode (No. 1)	D anode (No. 1)	D cathode	D anode
3	C cathode (No. 1)	B cathode (No. 1)	C anode (No. 1)	B anode (No. 1)	Common anode	Common cathode
4	DP cathode (No. 1)	DP cathode (No. 1)	DP anode (No. 1)	DP anode (No. 1)	C cathode	C anode
5	E cathode (No. 2)	E cathode (No. 2)	E anode (No. 2)	E anode (No. 2)	DP cathode	DP anode
6	D cathode (No. 2)	D cathode (No. 2)	D anode (No. 2)	D anode (No. 2)	B cathode	B anode
7	G cathode (No. 2)	G cathode (No. 2)	G anode (No. 2)	G anode (No. 2)	A cathode	A anode
8	C cathode (No. 2)	C cathode (No. 2)	C anode (No. 2)	C anode (No. 2)	Common anode	Common cathode
9	DP cathode (No. 2)	DP cathode (No. 2)	DP anode (No. 2)	DP anode (No. 2)	F cathode	F anode
10	B cathode (No. 2)	B cathode (No. 2)	B anode (No. 2)	B anode (No. 2)	G cathode	G anode
11	A cathode (No. 2)	A cathode (No. 2)	A anode (No. 2)	A anode (No. 2)		
12	F cathode (No. 2)	F cathode (No. 2)	F anode (No. 2)	F anode (No. 2)		
13	Digit No. 2 anode	Digit No. 2 anode	Digit No. 2 cathode	Digit No. 2 cathode		
14	Digit No. 1 anode	Digit No. 1 anode	Digit No. 1 cathode	Digit No. 1 cathode		
15	B cathode (No. 1)	A cathode (No. 1)	B anode (No. 1)	A anode (No. 1)		
16	A cathode (No. 1)	No connection	A anode (No. 1)	No connection		
17	G cathode (No. 1)	No connection	G anode (No. 1)	No connection		
18	F cathode (No. 1)	No connection	F anode (No. 1)	No connection		

TYPICAL CURVES

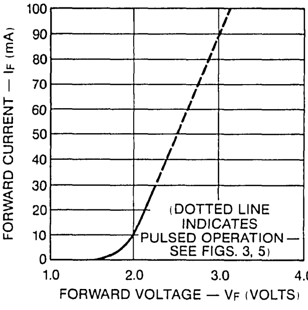


Fig. 1. Forward Current vs. Forward Voltage

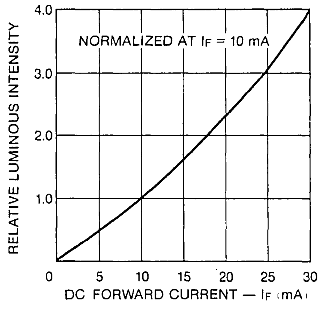


Fig. 2. Relative Luminous Intensity vs. DC Forward Current

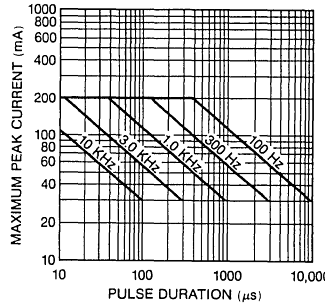


Fig. 3. Maximum Peak Current vs. Pulse Duration

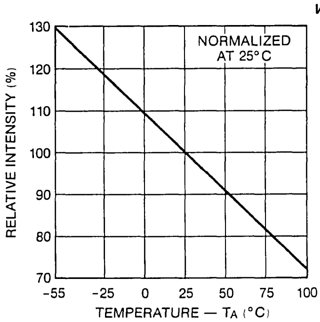


Fig. 4. Relative Luminous Intensity vs. Temperature

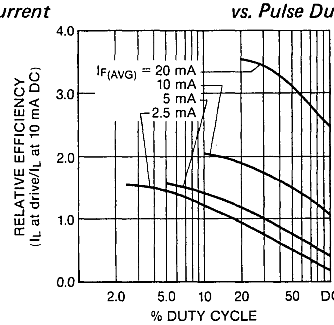
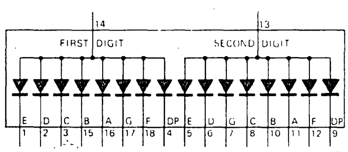
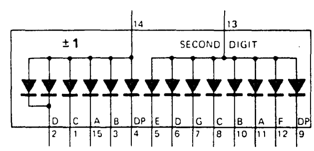
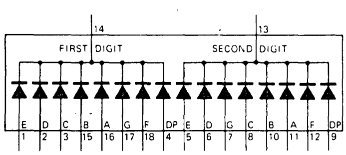


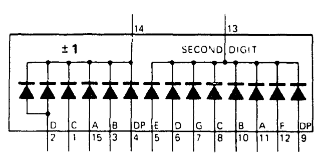
Fig. 5. Relative Efficiency vs. Duty Cycle

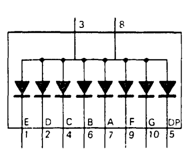
INTERNAL CONNECTIONS

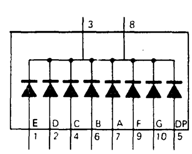












ABSOLUTE MAXIMUM RATINGS

	MAN6410 MAN6440	MAN6430 MAN6450	MAN6460 MAN6480
Power dissipation @ 25°C ambient	1140 mW	1000 mW	570 mW
Derate linearly from 50°C	–24 mW/°C	–21 mW/°C	–12 mW/°C
Storage and operating temperature	–40°C to +85°C	–40°C to +85°C	–40°C to +85°C
Continuous forward current			
Total	480 mA	420 mA	240 mA
Per diode	30 mA	30 mA	30 mA
Reverse voltage			
Per diode	6.0 V	6.0 V	6.0 V
Solder time @ 260°C (Note 2 and 3)	5 sec.	5 sec.	5 sec.

ELECTRICAL-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, 4)	510			µcd	I_F = 10 mA
Segment C or D of "+" (6430/6450)	260			µcd	I_F = 10 mA
Pulsed Luminous Intensity, Digit Average	710			µcd	I_F = 60 mA peak, 1:6 DF
Segment C or D of "+" (6430/6450)	360			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 temp.) . . . . . 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.*

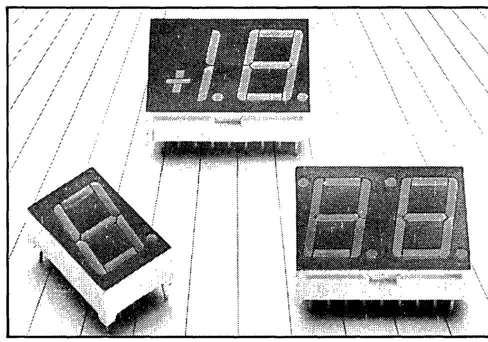
0.560-INCH HIGH PERFORMANCE DISPLAY

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, and single 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; Rt. Hand Decimal	A	A
MAN6630	Orange	1½ Digit; Common Anode; Overflow ±1.8. Rt. Hand Decimal	B	B
MAN6640	Orange	2 Digit; Common Cathode; Rt. Hand Decimal	A	C
MAN6650	Orange	1½ Digit; Common Cathode; Overflow ±1.8. Rt. Hand Decimal	B	D
MAN6660	Orange	Single Digit; Common Anode; Rt. Hand Decimal	C	E
MAN6680	Orange	Single Digit; Common Cathode; Rt. Hand Decimal	C	F

FILTER RECOMMENDATIONS

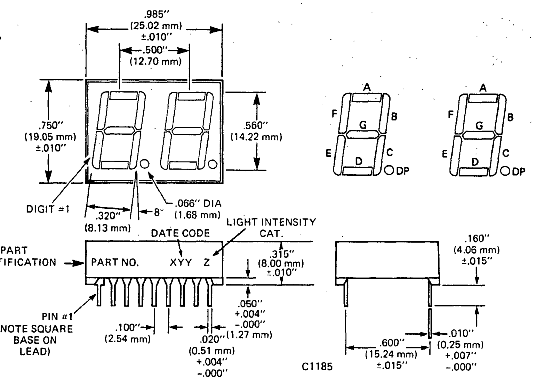
For optimum on and off contrast, one of the following filters or equivalents should be used over the display:

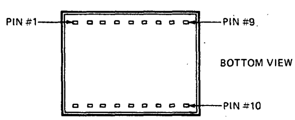
MAN6600 Series	Panelgraphic Scarlet 65 Homalite 100-1670

MAN6600 SERIES

PACKAGE DIMENSIONS

A





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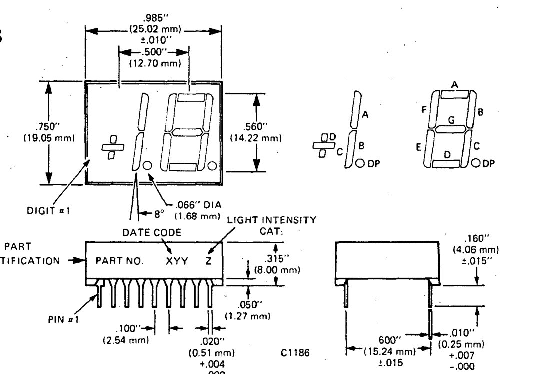

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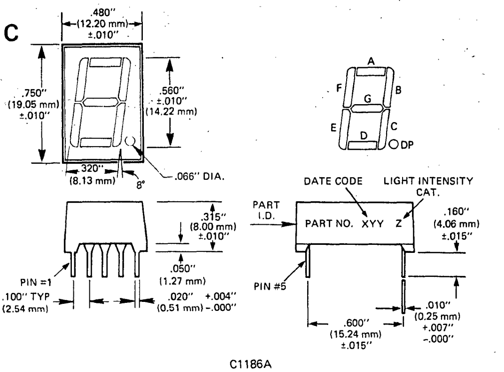
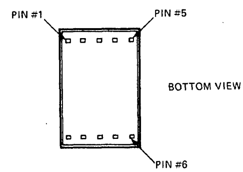




NOTE: When placing double digits and single digits together on a board, allowance should be made for .150" spacing between the end leads of the double digit and the end leads of the single digit.

PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS					
	A MAN6610	B MAN6630	C MAN6640	D MAN6650	E MAN6660	F MAN6680
1	E cathode (No. 1)	C cathode (No. 1)	E anode (No. 1)	C anode (No. 1)	E cathode	E anode
2	D cathode (No. 1)	D cathode (No. 1)	D anode (No. 1)	D anode (No. 1)	D cathode	D anode
3	C cathode (No. 1)	B cathode (No. 1)	C anode (No. 1)	B anode (No. 1)	Common anode	Common cathode
4	DP cathode (No. 1)	DP cathode (No. 1)	DP anode (No. 1)	DP anode (No. 1)	C cathode	C anode
5	E cathode (No. 2)	E cathode (No. 2)	E anode (No. 2)	E anode (No. 2)	DP cathode	DP anode
6	D cathode (No. 2)	D cathode (No. 2)	D anode (No. 2)	D anode (No. 2)	B cathode	B anode
7	G cathode (No. 2)	G cathode (No. 2)	G anode (No. 2)	G anode (No. 2)	A cathode	A anode
8	C cathode (No. 2)	C cathode (No. 2)	C anode (No. 2)	C anode (No. 2)	Common anode	Common cathode
9	DP cathode (No. 2)	DP cathode (No. 2)	DP anode (No. 2)	DP anode (No. 2)	F cathode	F anode
10	B cathode (No. 2)	B cathode (No. 2)	B anode (No. 2)	B anode (No. 2)	G cathode	G anode
11	A cathode (No. 2)	A cathode (No. 2)	A anode (No. 2)	A anode (No. 2)		
12	F cathode (No. 2)	F cathode (No. 2)	F anode (No. 2)	F anode (No. 2)		
13	Digit No. 2 anode	Digit No. 2 anode	Digit No. 2 cathode	Digit No. 2 cathode		
14	Digit No. 1 anode	Digit No. 1 anode	Digit No. 1 cathode	Digit No. 1 cathode		
15	B cathode (No. 1)	A cathode (No. 1)	B anode (No. 1)	A anode (No. 1)		
16	A cathode (No. 1)	No connection	A anode (No. 1)	No connection		
17	G cathode (No. 1)	No connection	G anode (No. 1)	No connection		
18	F cathode (No. 1)	No connection	F anode (No. 1)	No connection		

TYPICAL CURVES

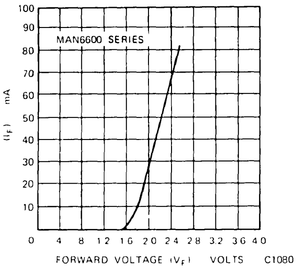


Fig. 1. Forward Current vs. Forward Voltage

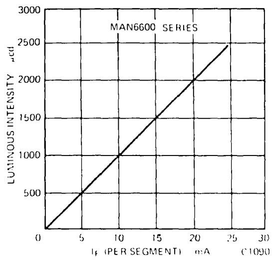


Fig. 2. Luminous Intensity vs. Forward Current

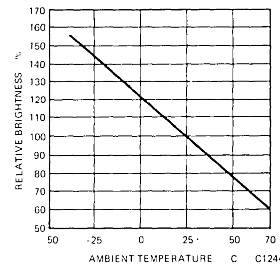


Fig. 3. Luminous Intensity vs. Temperature (see Note 2)

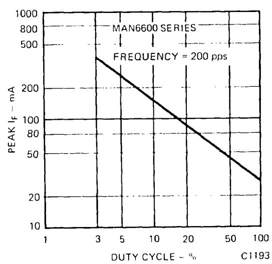


Fig. 4. Max Peak Current vs. Duty Cycle

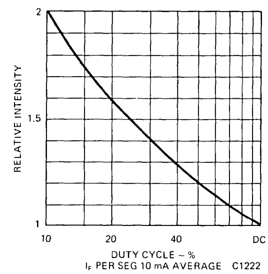
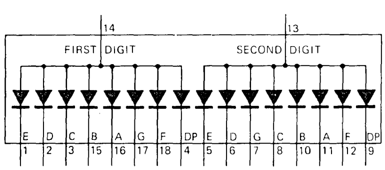
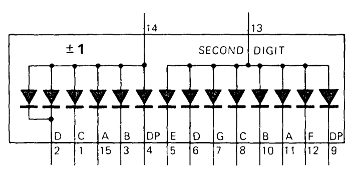
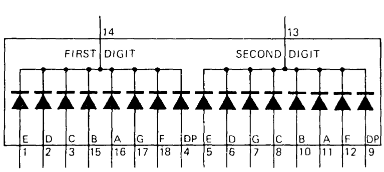


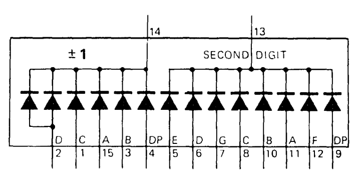
Fig. 5. Luminous Intensity vs. Duty Cycle

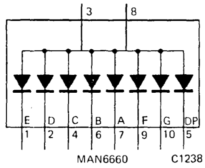
INTERNAL CONNECTIONS

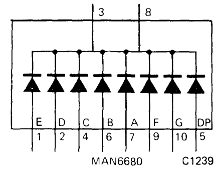












ABSOLUTE MAXIMUM RATINGS

	MAN6610 MAN6640	MAN6630 MAN6650	MAN6660 MAN6680
Power dissipation @ 25°C ambient . . .	1200 mW	1050 mW	600 mW
Derate linearly from 50°C.	−17.1 mW/°C	−15.0 mW/°C	−8.6 mW/°C
Storage and operating temperature . . .	−40°C to +85°C	−40°C to +85°C	−40°C to +85°C
Continuous forward current			
Total.	480 mA	420 mA	240 mA
Per segment	30 mA	30 mA	30 mA
Decimal point.	30 mA	30 mA	30 mA
Reverse voltage			
Per segment	6.0 V	6.0 V	6.0 V
Decimal point.	6.0 V	6.0 V	6.0 V
Solder time @ 260°C (Note 4 and 5)	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					
(see Note 1)	510			μcd	I_F = 10 mA
Decimal point (see Note 5)	200			μcd	I_F = 10 mA
Segment C or D of "+" (6630/6650)	200			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
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 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 on each part as a suffix letter to the part number.*

GENERAL INSTRUMENT

RED MAN6700 SERIES

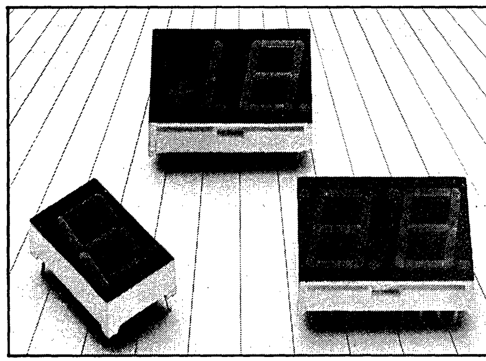
FEATURES

- 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-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; Rt. Hand Decimal	A	A
MAN6730	Red	1½ Digit; Common Anode; Overflow ±1.8 Rt. Hand Decimal	B	B
MAN6740	Red	2 Digit; Common Cathode; Rt. Hand Decimal	A	C
MAN6750	Red	1½ Digit; Common Cathode; Overflow ±1.8 Rt. Hand Decimal	B	D
MAN6760	Red	Single Digit; Common Anode; Rt. Hand Decimal	C	E
MAN6780	Red	Single Digit; Common Cathode; Rt. Hand Decimal	C	F

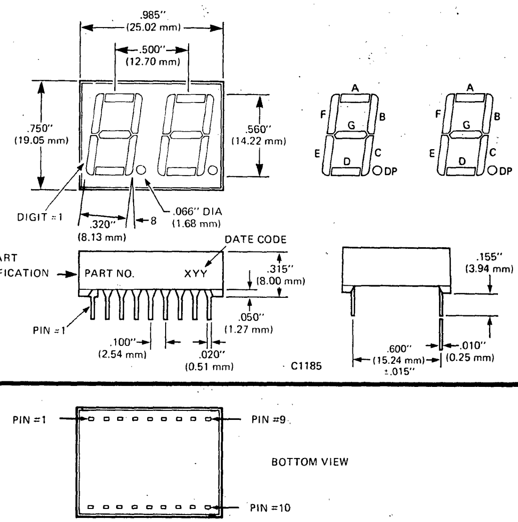
FILTER RECOMMENDATIONS

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

PACKAGE DIMENSIONS

A



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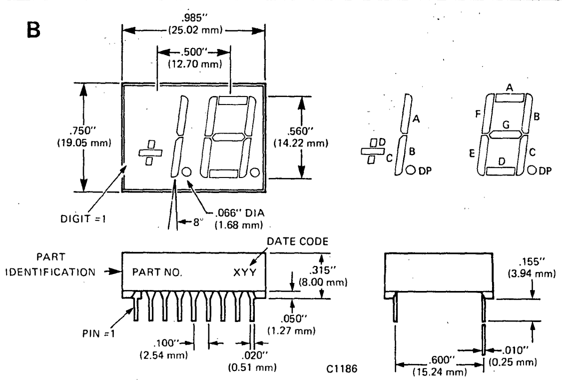

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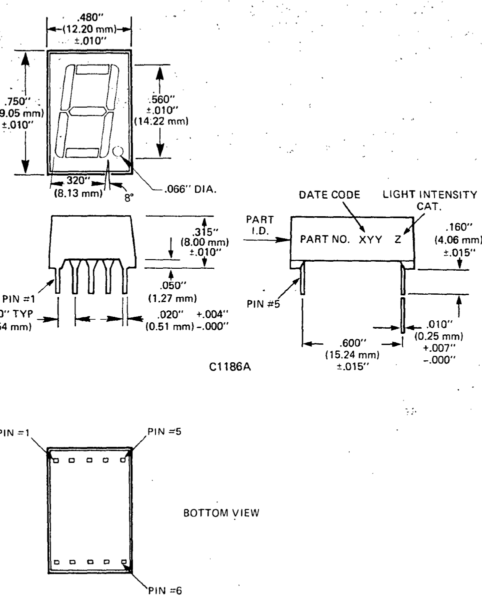


Note: When placing double digits and single digits together on a board, allowance should be made for .150" spacing between the end leads of the double digit and the end leads of the single digit.

PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS					
	A MAN6710	B MAN6730	C MAN6740	D MAN6750	E MAN6760	F MAN6780
1	E cathode (No. 1)	C cathode (No. 1)	E anode (No. 1)	C anode (No. 1)	E cathode	E anode
2	D cathode (No. 1)	D cathode (No. 1)	D anode (No. 1)	D anode (No. 1)	D cathode	D anode
3	C cathode (No. 1)	B cathode (No. 1)	C anode (No. 1)	B anode (No. 1)	Common anode	Common cathode
4	DP cathode (No. 1)	DP cathode (No. 1)	DP anode (No. 1)	DP anode (No. 1)	C cathode	C anode
5	E cathode (No. 2)	E cathode (No. 2)	E anode (No. 2)	E anode (No. 2)	DP cathode	DP anode
6	D cathode (No. 2)	D cathode (No. 2)	D anode (No. 2)	D anode (No. 2)	B cathode	B anode
7	G cathode (No. 2)	G cathode (No. 2)	G anode (No. 2)	G anode (No. 2)	A cathode	A anode
8	C cathode (No. 2)	C cathode (No. 2)	C anode (No. 2)	C anode (No. 2)	Common anode	Common cathode
9	DP cathode (No. 2)	DP cathode (No. 2)	DP anode (No. 2)	DP anode (No. 2)	F cathode	F anode
10	B cathode (No. 2)	B cathode (No. 2)	B anode (No. 2)	B anode (No. 2)	G cathode	G anode
11	A cathode (No. 2)	A cathode (No. 2)	A anode (No. 2)	A anode (No. 2)		
12	F cathode (No. 2)	F cathode (No. 2)	F anode (No. 2)	F anode (No. 2)		
13	Digit No. 2 anode	Digit No. 2 anode	Digit No. 2 cathode	Digit No. 2 cathode		
14	Digit No. 1 anode	Digit No. 1 anode	Digit No. 1 cathode	Digit No. 1 cathode		
15	B cathode (No. 1)	A cathode (No. 1)	B anode (No. 1)	A anode (No. 1)		
16	A cathode (No. 1)	No connection	A anode (No. 1)	No connection		
17	G cathode (No. 1)	No connection	G anode (No. 1)	No connection		
18	F cathode (No. 1)	No connection	F anode (No. 1)	No connection		

TYPICAL CURVES

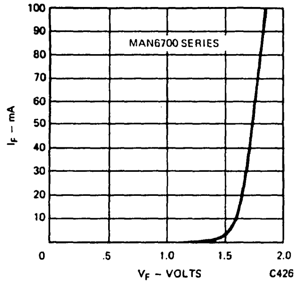


Fig. 1. Forward Current vs. Forward Voltage

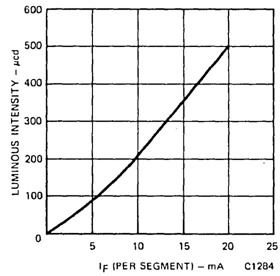


Fig. 2. Luminous Intensity vs. Forward Current

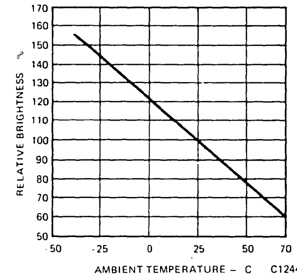


Fig. 3. Luminous Intensity vs. Temperature (See Note 2)

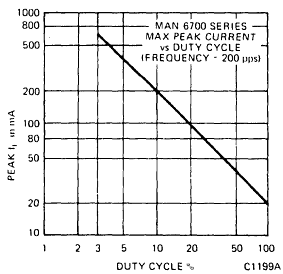


Fig. 4. Max Peak Current vs. Duty Cycle

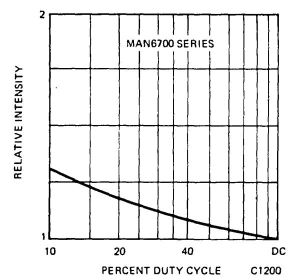
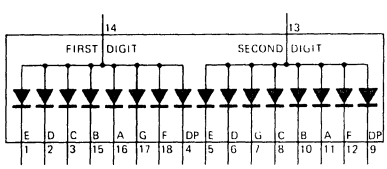
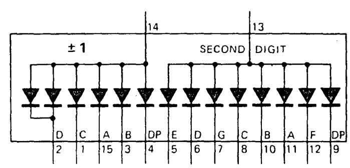


Fig. 5. Luminous Intensity vs. Duty Cycle

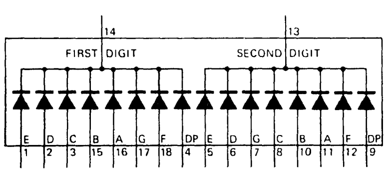
INTERNAL CONNECTIONS



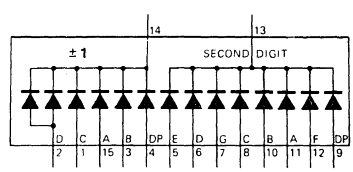
MAN6710 C1195



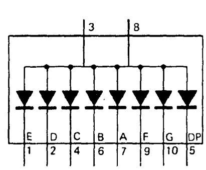
MAN6730 C1196



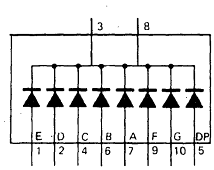
MAN6740 C1197



MAN6750 C1198



MAN6760 C1238



MAN6780 C1239

ABSOLUTE MAXIMUM RATINGS

MAN6700	MAN6710 MAN6740	MAN6730 MAN6750	MAN6760 MAN6780
Power dissipation @ 25°C ambient . . .	960 mW	840 mW	480 mW
Derate linearly from 50°C.	−13.7 mW/°C	−12.0 mW/°C	−6.9 mW/°C
Storage and operating temperature . . .	−40°C to +85°C	−40°C to +85°C	−40°C to +85°C
Continuous forward current			
Total.	480 mA	420 mA	240 mA
Per segment	30 mA	30 mA	30 mA
Decimal point.	30 mA	30 mA	30 mA
Reverse voltage			
Per segment	6.0 V	6.0 V	6.0 V
Decimal point.	6.0 V	6.0 V	6.0 V
Solder time @ 260°C (Note 4 and 5)	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 (see Note 1)	125			μcd	I_F = 10 mA
Decimal point (see Note 5)	55			μcd	I_F = 10 mA
Segment C or D of "+" (6730/6750) (note 5)	35			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 = 5.0 V
Decimal point			100	μA	V_R = 5.0 V
Segment C or D of "+" (6730/6750)			100	μA	V_R = 5.0 V

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Θ_{JA} . . . . 160°C/W
Wavelength temperature coefficient (case temp.) . . . . 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 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

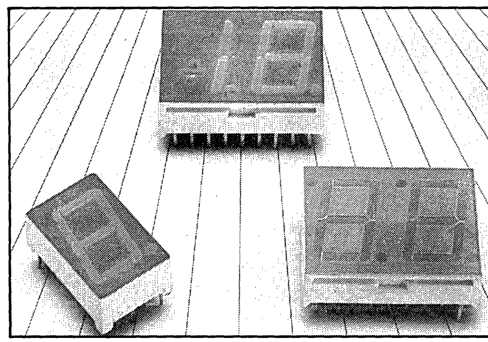
FEATURES

- 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
- Gray 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, and single 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
MAN6810	Yellow	2 Digit; Common Anode; Rt. Hand Decimal	I
MAN6830	Yellow	1½ Digit; Common Anode; Overflow ±1.8. Rt. Hand Decimal	II
MAN6840	Yellow	2 Digit; Common Cathode; Rt. Hand Decimal	I
MAN6850	Yellow	1½ Digit; Common Cathode; Overflow ±1.8. Rt. Hand Decimal	II
MAN6860	Yellow	Single Digit; Common Anode; Rt. Hand Decimal	III
MAN6880	Yellow	Single Digit; Common Cathode; Rt. Hand Decimal	III

FILTER RECOMMENDATIONS

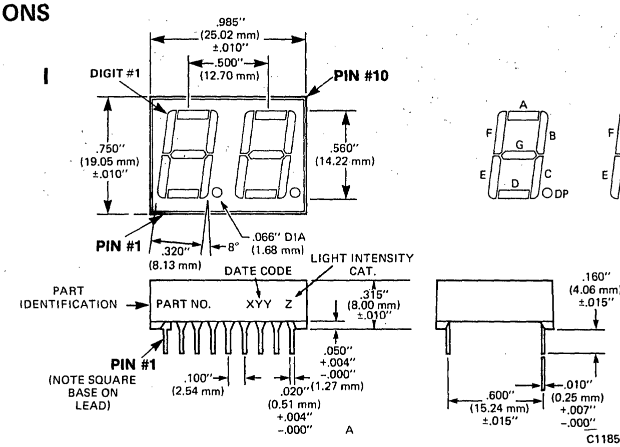
For optimum on and off contrast, one of the following filters or equivalents should be used over the display:

MAN6800 Series	Panelgraphic, Yellow 25 or Amber 23 Panelgraphic, Neutral Density Filter, Gray 10 Homalite, 100-1720 or 100-1726

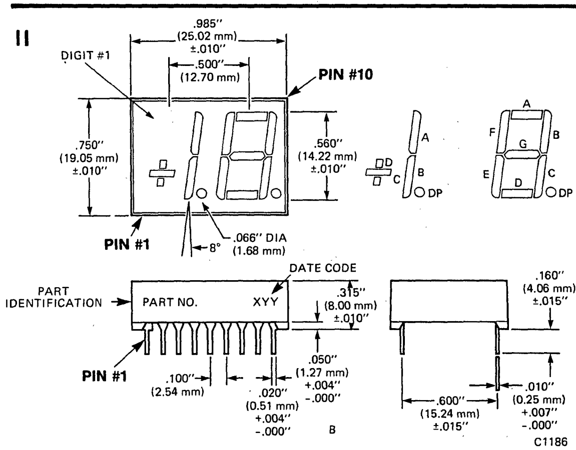
MAN6800 SERIES

PACKAGE DIMENSIONS

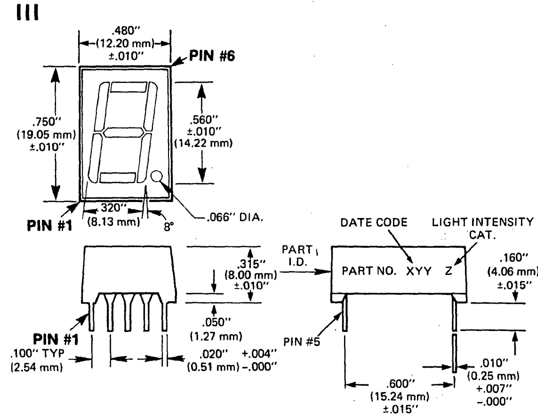
I



II



III



PIN CONNECTIONS

	ELECTRICAL CONNECTIONS					
	MAN6810	MAN6830	MAN6840	MAN6850	MAN6860	MAN6880
	2 Digit	1½ Digit	2 Digit	1½ Digit	1 Digit	1 Digit
	C.A.	C.A.	C.C.	C.C.	C.A.	C.C.
PIN NO.	PACKAGE DIMENSIONS I	PACKAGE DIMENSIONS II	PACKAGE DIMENSIONS I	PACKAGE DIMENSIONS II	PACKAGE DIMENSIONS III	PACKAGE DIMENSIONS III
1	E cathode (No. 1)	C cathode (No. 1)	E anode (No. 1)	C anode (No. 1)	E cathode	E anode
2	D cathode (No. 1)	D cathode (No. 1)	D anode (No. 1)	D anode (No. 1)	D cathode	D anode
3	C cathode (No. 1)	B cathode (No. 1)	C anode (No. 1)	B anode (No. 1)	Common anode	Common cathode
4	DP cathode (No. 1)	DP cathode (No. 1)	DP anode (No. 1)	DP anode (No. 1)	C cathode	C anode
5	E cathode (No. 2)	E cathode (No. 2)	E anode (No. 2)	E anode (No. 2)	DP cathode	DP anode
6	D cathode (No. 2)	D cathode (No. 2)	D anode (No. 2)	D anode (No. 2)	B cathode	B anode
7	G cathode (No. 2)	G cathode (No. 2)	G anode (No. 2)	G anode (No. 2)	A cathode	A anode
8	C cathode (No. 2)	C cathode (No. 2)	C anode (No. 2)	C anode (No. 2)	Common anode	Common cathode
9	DP cathode (No. 2)	DP cathode (No. 2)	DP anode (No. 2)	DP anode (No. 2)	F cathode	F anode
10	B cathode (No. 2)	B cathode (No. 2)	B anode (No. 2)	B anode (No. 2)	G cathode	G anode
11	A cathode (No. 2)	A cathode (No. 2)	A anode (No. 2)	A anode (No. 2)		
12	F cathode (No. 2)	F cathode (No. 2)	F anode (No. 2)	F anode (No. 2)		
13	Digit No. 2 anode	Digit No. 2 anode	Digit No. 2 cathode	Digit No. 2 cathode		
14	Digit No. 1 anode	Digit No. 1 anode	Digit No. 1 cathode	Digit No. 1 cathode		
15	B cathode (No. 1)	A cathode (No. 1)	B anode (No. 1)	A anode (No. 1)		
16	A cathode (No. 1)	No connection	A anode (No. 1)	No connection		
17	G cathode (No. 1)	No connection	G anode (No. 1)	No connection		
18	F cathode (No. 1)	No connection	F anode (No. 1)	No connection		

TYPICAL CURVES

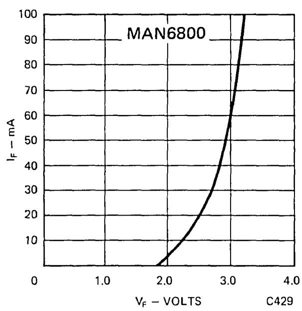


Fig. 1. Forward Current vs. Forward Voltage

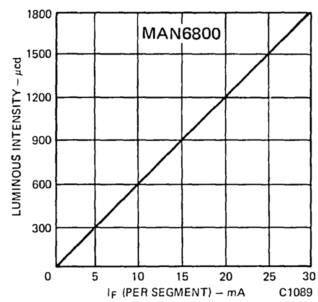


Fig. 2. Luminous Intensity vs. Forward Current

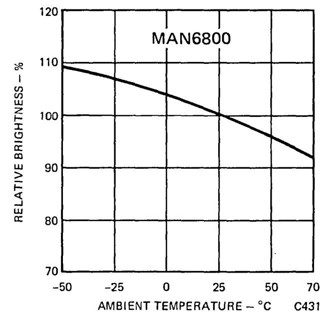


Fig. 3. Luminous Intensity vs. Temperature

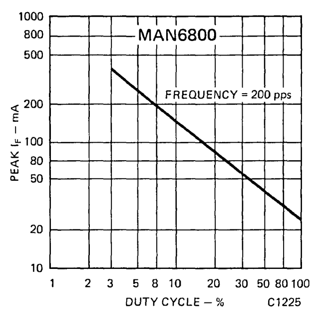


Fig. 4. Max Peak Current vs. Duty Cycle

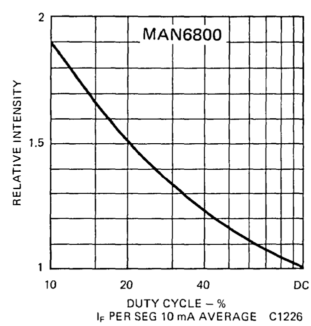


Fig. 5. Luminous Intensity vs. Duty Cycle

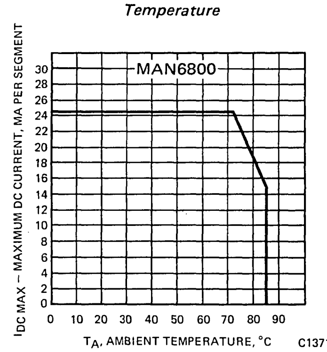
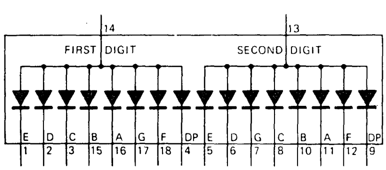
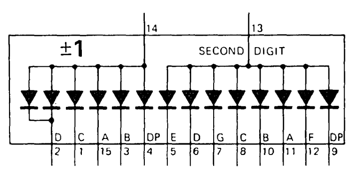


Fig. 6. Maximum DC Current vs. Temperature

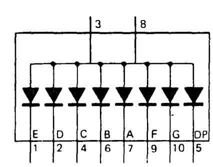
INTERNAL CONNECTIONS



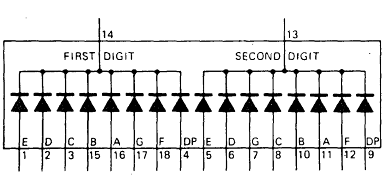
MAN6810



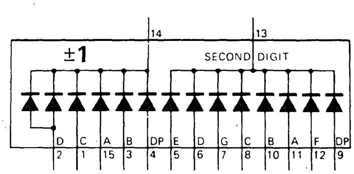
MAN6830



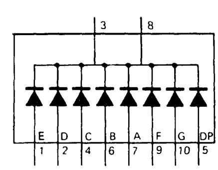
MAN6860



MAN6840



MAN6850



MAN6880

ABSOLUTE MAXIMUM RATINGS

	MAN6810 MAN6840	MAN6830 MAN6850	MAN6860 MAN6880
Power dissipation @ 25°C ambient	1200 mW	1050 mW	600 mW
Derate linearly from 50°C	−20.5 mW/°C	−18.0 mW/°C	−10.3 mW/°C
Storage and operating temperature	−40°C to +85°C	−40°C to +85°C	−40°C to +85°C
Continuous forward current			
Total	400 mA	350 mA	200 mA
Per segment	25 mA	25 mA	25 mA
Decimal point	25 mA	25 mA	25 mA
Reverse voltage			
Per segment	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V
Solder time @ 260°C (Note 4)	5 sec.	5 sec.	5 sec.
Peak current per segment Imax (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			μcd	I_F = 10 mA
Decimal point (See Note 5)	200			μcd	I_F = 10 mA
Segment C or D of "+" (6830/6850)	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 (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

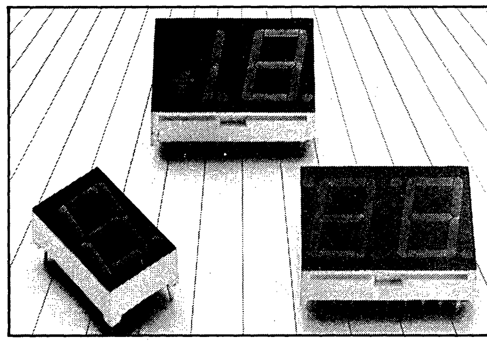
1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within 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, Isopropanol, 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, and single digits. All models have right hand decimal point and are available in common anode or common cathode configuration. This device is constructed with red face and segment color.

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN-OUT SPECIFICATION
MAN6910	Hi. Eff. Red	2 Digit; Common Anode; Rt. Hand Decimal	A	A
MAN6930	Hi. Eff. Red	1½ Digit; Common Anode; Overflow ±1.8. Rt. Hand Decimal	B	B
MAN6940	Hi. Eff. Red	2 Digit; Common Cathode; Rt. Hand Decimal	A	C
MAN6950	Hi. Eff. Red	1½ Digit; Common Cathode; Overflow ±1.8. Rt. Hand Decimal	B	D
MAN6960	Hi. Eff. Red	Single Digit; Common Anode; Rt. Hand Decimal	C	E
MAN6980	Hi. Eff. Red	Single Digit; Common Cathode; Rt. Hand Decimal	C	F

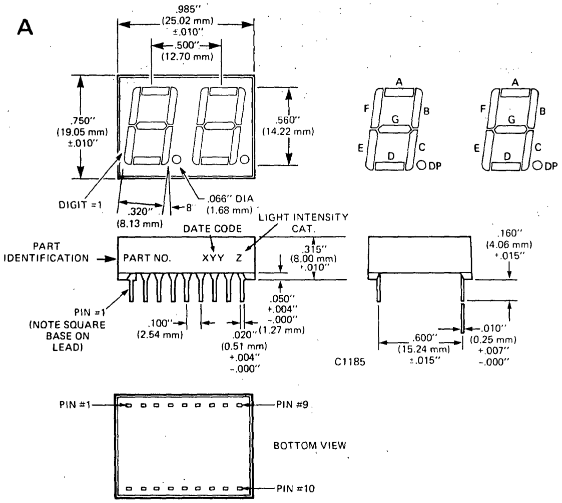
FILTER RECOMMENDATIONS

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

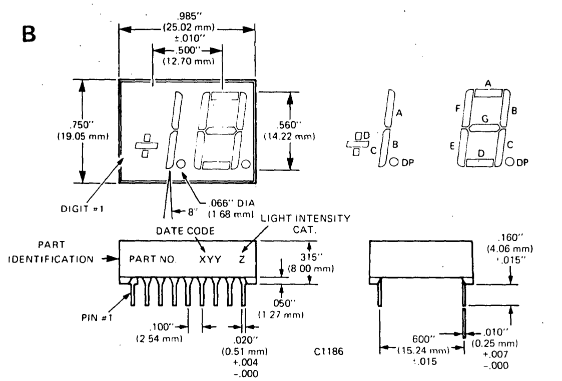
MAN6900 Series	Panegraphic Scarlet 65 Homalite 100-1670

PACKAGE DIMENSIONS

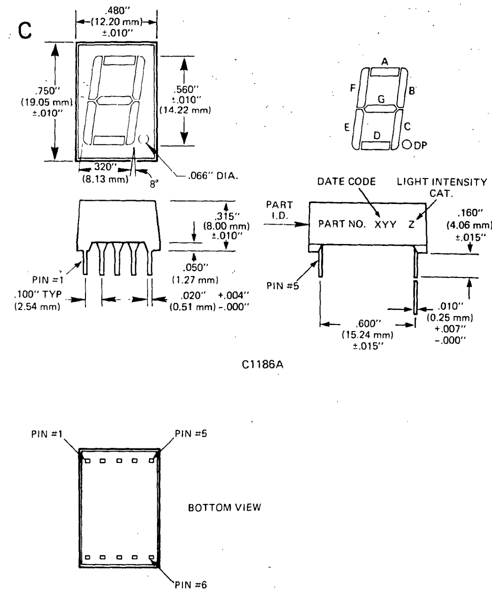
A



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.

PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS					
	A MAN6910	B MAN6930	C MAN6940	D MAN6950	E MAN6960	F MAN6980
1	E cathode (No. 1)	C cathode (No. 1)	E anode (No. 1)	C anode (No. 1)	E cathode	E anode
2	D cathode (No. 1)	D cathode (No. 1)	D anode (No. 1)	D anode (No. 1)	D cathode	D anode
3	C cathode (No. 1)	B cathode (No. 1)	C anode (No. 1)	B anode (No. 1)	Common anode	Common cathode
4	DP cathode (No. 1)	DP cathode (No. 1)	DP anode (No. 1)	DP anode (No. 1)	C cathode	C anode
5	E cathode (No. 2)	E cathode (No. 2)	E anode (No. 2)	E anode (No. 2)	DP cathode	DP anode
6	D cathode (No. 2)	D cathode (No. 2)	D anode (No. 2)	D anode (No. 2)	B cathode	B anode
7	G cathode (No. 2)	G cathode (No. 2)	G anode (No. 2)	G anode (No. 2)	A cathode	A anode
8	C cathode (No. 2)	C cathode (No. 2)	C anode (No. 2)	C anode (No. 2)	Common anode	Common cathode
9	DP cathode (No. 2)	DP cathode (No. 2)	DP anode (No. 2)	DP anode (No. 2)	F cathode	F anode
10	B cathode (No. 2)	B cathode (No. 2)	B anode (No. 2)	B anode (No. 2)	G cathode	G anode
11	A cathode (No. 2)	A cathode (No. 2)	A anode (No. 2)	A anode (No. 2)		
12	F cathode (No. 2)	F cathode (No. 2)	F anode (No. 2)	F anode (No. 2)		
13	Digit No. 2 anode	Digit No. 2 anode	Digit No. 2 cathode	Digit No. 2 cathode		
14	Digit No. 1 anode	Digit No. 1 anode	Digit No. 1 cathode	Digit No. 1 cathode		
15	B cathode (No. 1)	A cathode (No. 1)	B anode (No. 1)	A anode (No. 1)		
16	A cathode (No. 1)	No connection	A anode (No. 1)	No connection		
17	G cathode (No. 1)	No connection	G anode (No. 1)	No connection		
18	F cathode (No. 1)	No connection	F anode (No. 1)	No connection		

TYPICAL CURVES

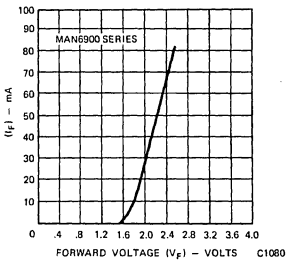


Fig. 1. Forward Current vs. Forward Voltage

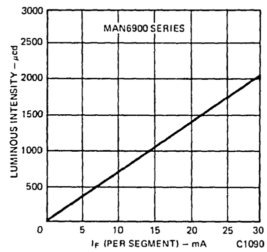


Fig. 2. Luminous Intensity vs. Forward Current

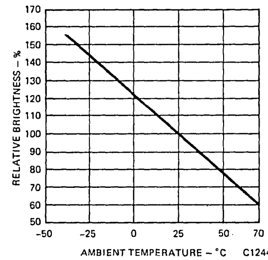


Fig. 3. Luminous Intensity vs. Temperature (see Note 2)

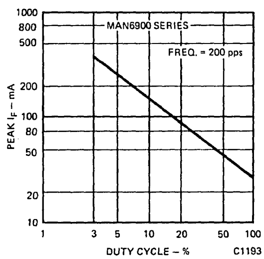


Fig. 4. Max Peak Current vs. Duty Cycle

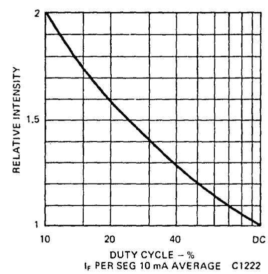
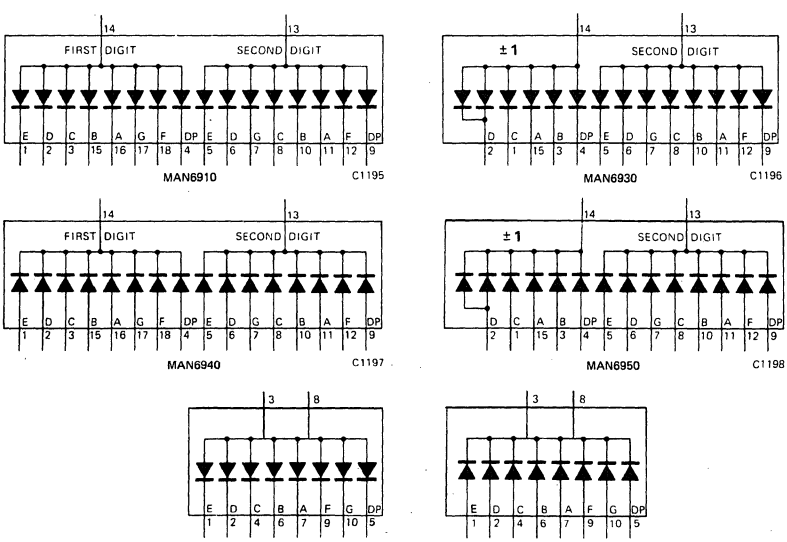


Fig. 5. Luminous Intensity vs. Duty Cycle

INTERNAL CONNECTIONS



ABSOLUTE MAXIMUM RATINGS

	MAN6910 MAN6940	MAN6930 MAN6950	MAN6960 MAN6980
Power dissipation @ 25°C ambient	1200 mW	1050 mW	600 mW
Derate linearly from 50°C	−17.1 mW/°C	−15.0 mW/°C	−8.6 mW/°C
Storage and operating temperature	−40°C to +85°C	−40°C to +85°C	−40°C to +85°C
Continuous forward current			
Total	480 mA	420 mA	240 mA
Per segment	30 mA	30 mA	30 mA
Decimal point	30 mA	30 mA	30 mA
Reverse voltage			
Per segment	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V
Solder time @ 260°C (Note 4 and 5)	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					
(See Note 1)	320			μcd	I_F = 10 mA
Decimal point (See Note 5)	125			μcd	I_F = 10 mA
Segment C or D of "+" (6930/6950)	125			μcd	I_F = 10 mA
Peak emission wavelength		635		nm	
Spectral line half width		40		nm	
Forward voltage					
Segment			2.5	V	I_F = 20 mA
Decimal point			2.5	V	I_F = 20 mA
Dynamic resistance					
Segment		26		Ω	I_F = 20 mA
Decimal point		26		Ω	I_F = 20 mA
Capacitance					
Segment		35		pF	V = 0
Decimal point		35		pF	V = 0
Reverse current					
Segment			100	μA	V_R = 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 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 on each part as a suffix letter to the part number.*

GENERAL INSTRUMENT

HIGH EFFICIENCY RED (ORANGE) MAN8600 SERIES

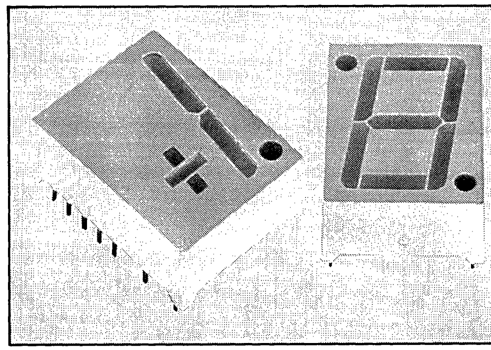
FEATURES

- 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 grey 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:

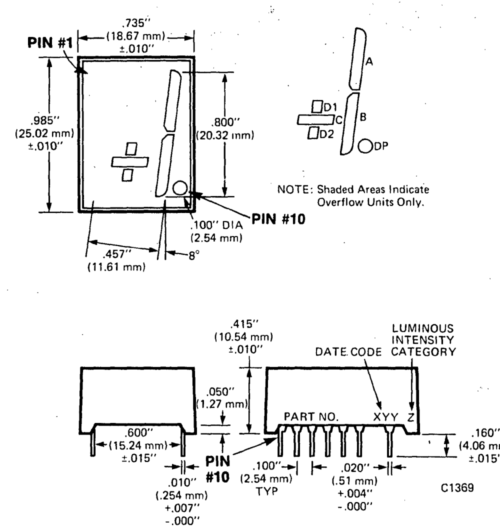
PANELGRAPHIC SCARLET 65
HOMALITE 100-1670

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:

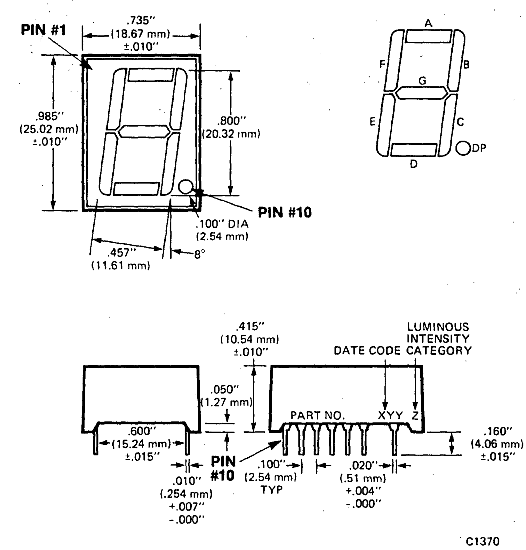
PANELGRAPHIC GREY NO. 10

PACKAGE DIMENSIONS

I



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 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

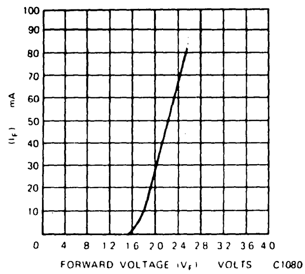


Fig. 1. Forward Current vs. Forward Voltage

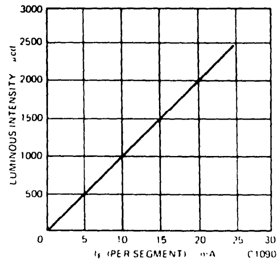


Fig. 2. Luminous Intensity vs. Forward Current

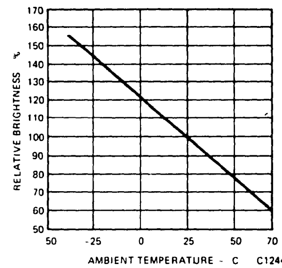


Fig. 3. Luminous Intensity vs. Temperature (see Note 2)

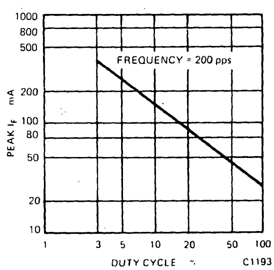


Fig. 4. Max Peak Current vs. Duty Cycle

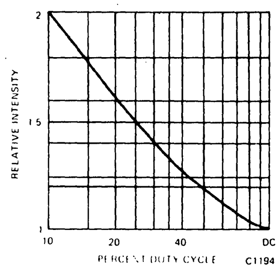


Fig. 5. Luminous Intensity vs. Duty Cycle

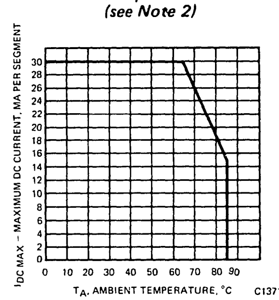
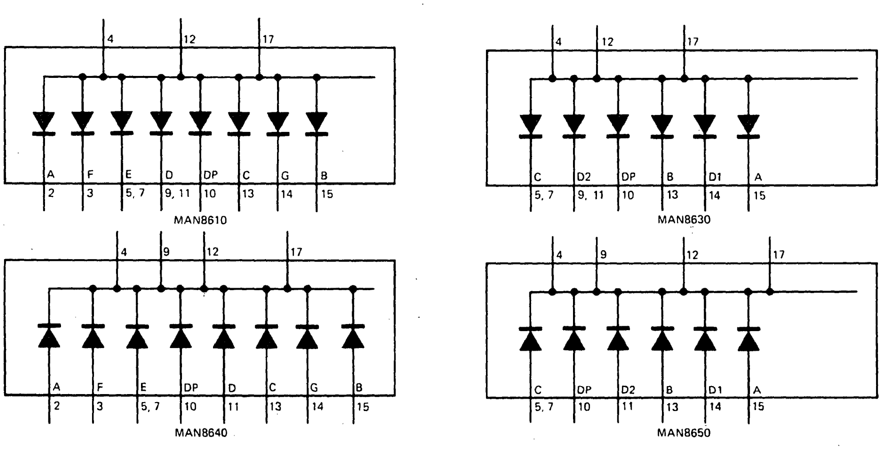


Fig. 6. Maximum DC Current vs. Temperature

INTERNAL CONNECTIONS



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

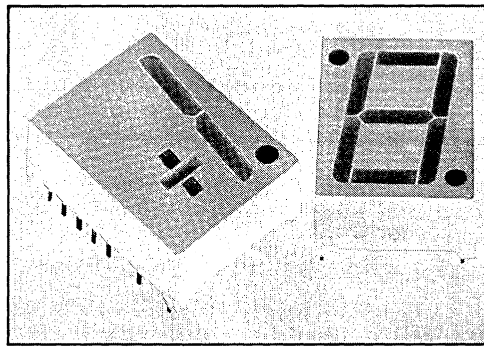
FEATURES

- 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

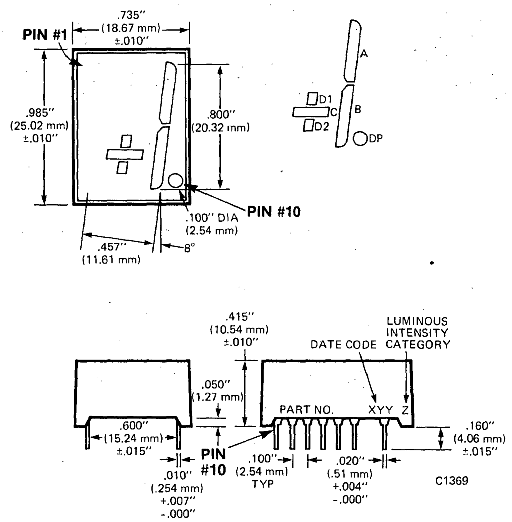
FILTER RECOMMENDATIONS

For optimum on and off contrast, one of the following filters should be used over the display:

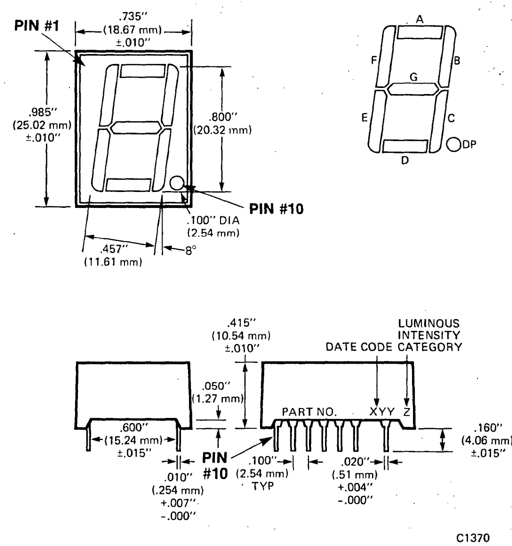
MAN8800 Series	Panelgraphic, Yellow 25 or Amber 23 Panelgraphic, Neutral Density Filter, Gray 10 Homalite, 100-1720 or 100-1726

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

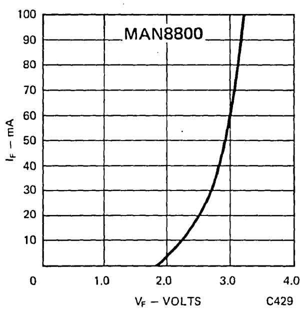


Fig. 1. Forward Current vs. Forward Voltage

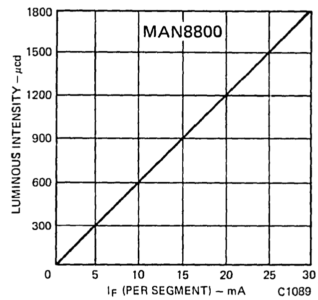


Fig. 2. Luminous Intensity vs. Forward Current

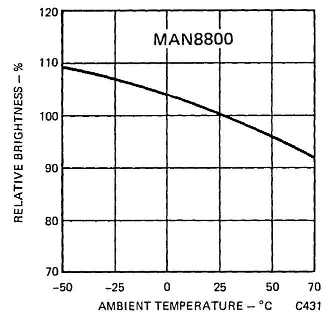


Fig. 3. Luminous Intensity vs. Temperature

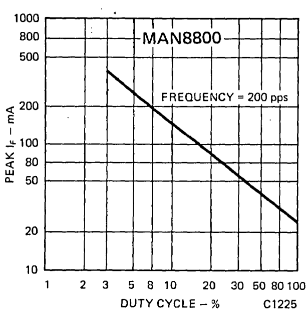


Fig. 4. Max Peak Current vs. Duty Cycle

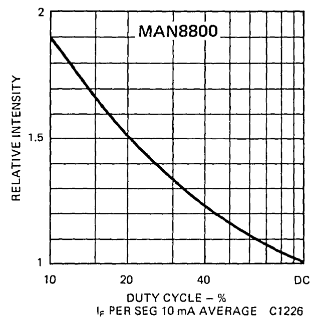


Fig. 5. Luminous Intensity vs. Duty Cycle

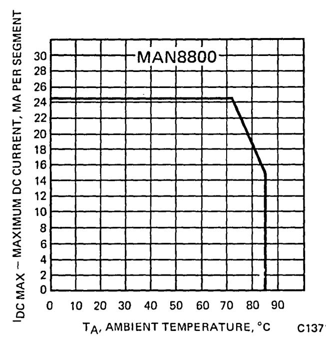
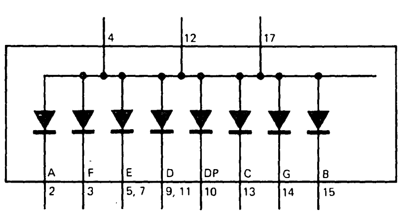
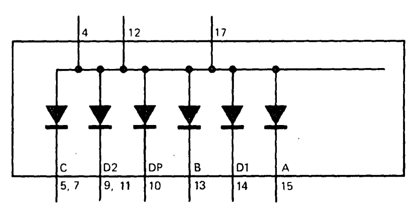


Fig. 6. Maximum DC Current vs. Temperature

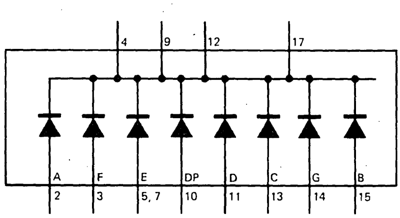
INTERNAL CONNECTIONS



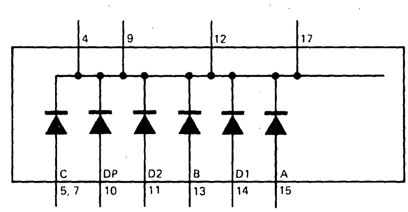
MAN8810



MAN8830



MAN8840



MAN8850

C1372

MAN8800 SERIES

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			µcd	I_F = 10 mA
Decimal point (see Note 5)	200			µcd	I_F = 10 mA
Segment C or D of "+" (8830/8850)	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 (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

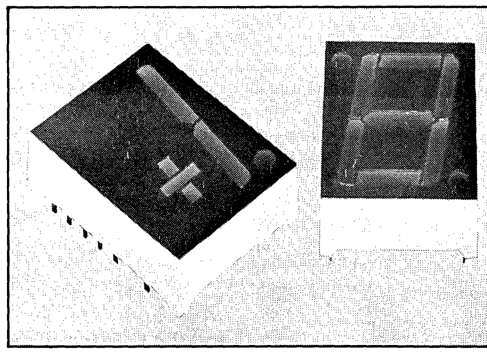
1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments as measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (Model IV-D). Intensity will not vary more than ±33.3% between all segments within a 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, 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

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

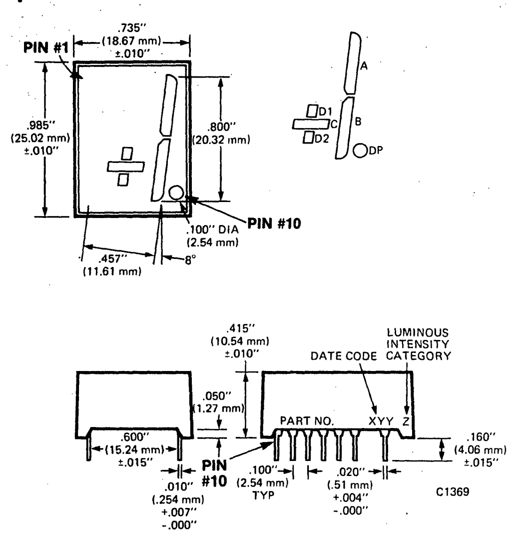
FILTER RECOMMENDATIONS

For optimum on and off contrast, one of the following filters should be used over the display:

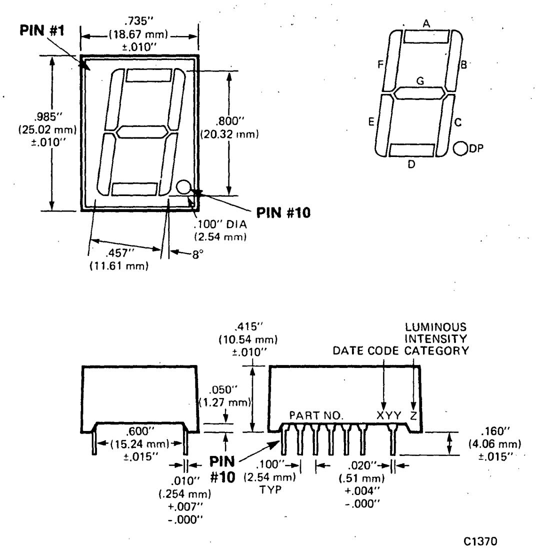
PANELGRAPHIC SCARLET 65
HOMALITE 100-1670

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

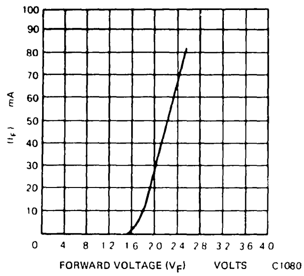


Fig. 1. Forward Current vs. Forward Voltage

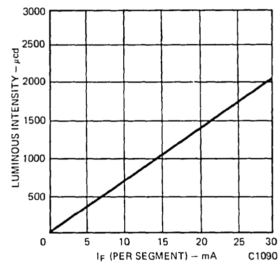


Fig. 2. Luminous Intensity vs. Forward Current

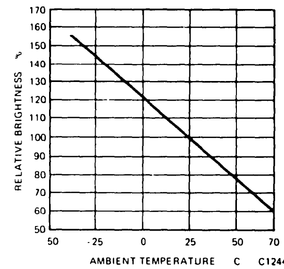


Fig. 3. Luminous Intensity vs. Temperature (see Note 2)

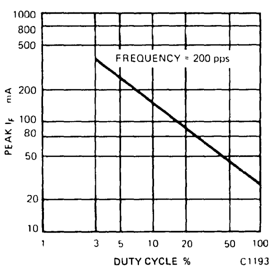


Fig. 4. Max Peak Current vs. Duty Cycle

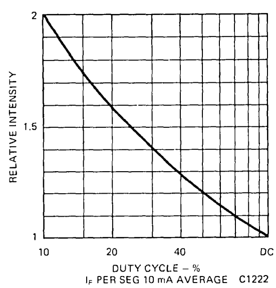


Fig. 5. Luminous Intensity vs. Duty Cycle

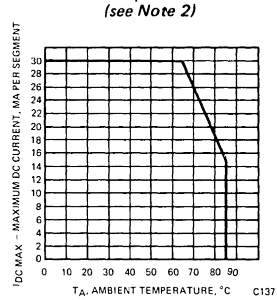
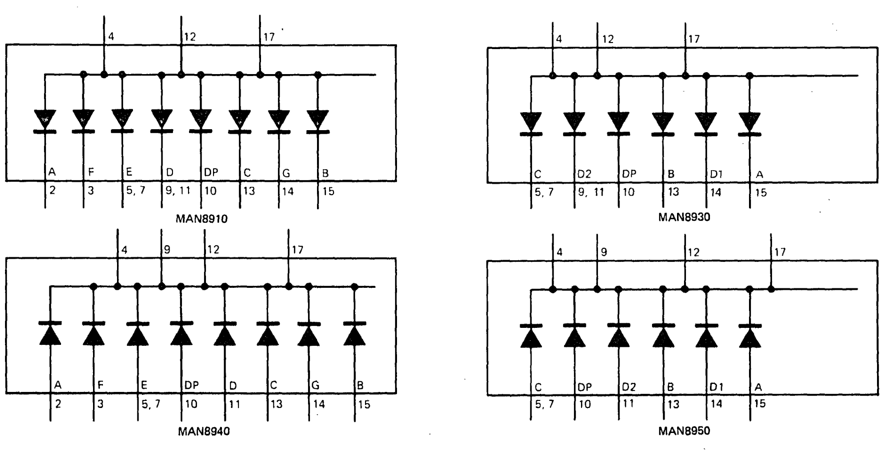


Fig. 6. Maximum DC Current vs. Temperature

INTERNAL CONNECTIONS



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			μcd	I_F = 10 mA
Decimal point (see Note 5)	130			μcd	I_F = 10 mA
Segment C or D of "+" (8930/8950)	130			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.*

0.300-INCH HIGH PERFORMANCE 7 SEGMENT MULTIDIGIT DISPLAYS

GENERAL INSTRUMENT

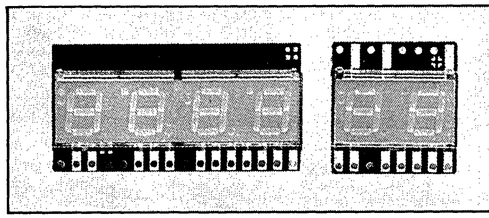
ORANGE MMN36000 SERIES
YELLOW MMN38000 SERIES
HIGH EFFICIENCY RED MMN39000 SERIES

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)

			MIN	TYP.	MAX.	UNITS	TEST CONDITIONS
ORANGE	MMN36000 SERIES	Luminous intensity, Digit average (See Note 1)	510			μcd	I_F = 10 mA
		Decimal point (See Note 3)	90			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			μcd	I_F = 10 mA
		Decimal point (See Note 3)	90			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			μcd	I_F = 10 mA
		Decimal point (See Note 3)	65			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)

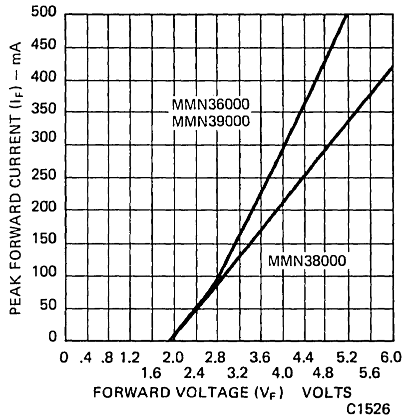


Fig. 1 Peak Forward Current vs. Forward Voltage

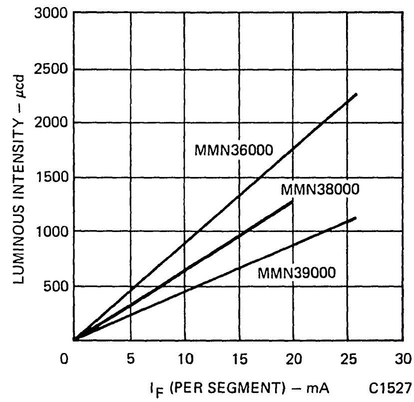


Fig. 2. Luminous Intensity vs. Forward Current

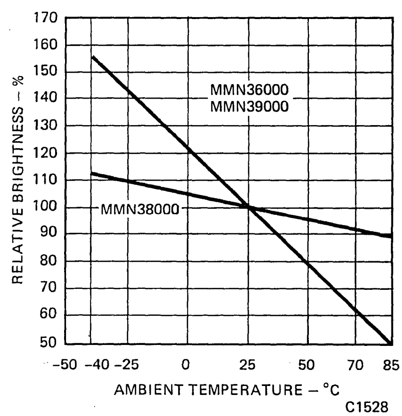


Fig. 3. Luminous Intensity vs. Temperature

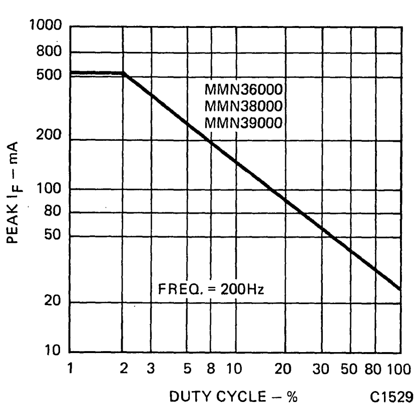


Fig. 4. Max Peak Current vs. Duty Cycle

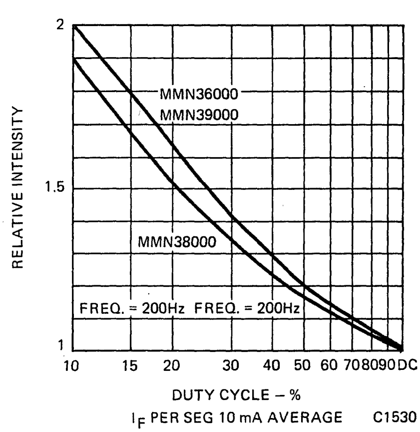
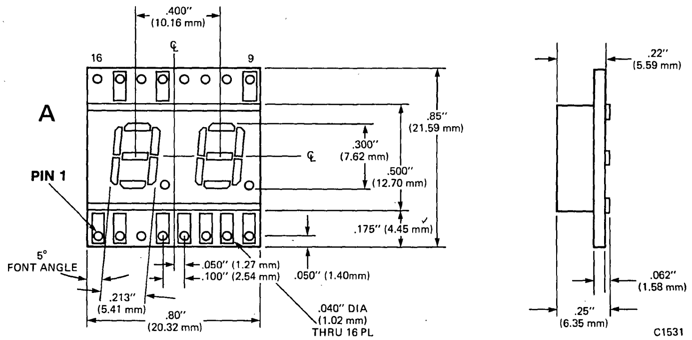
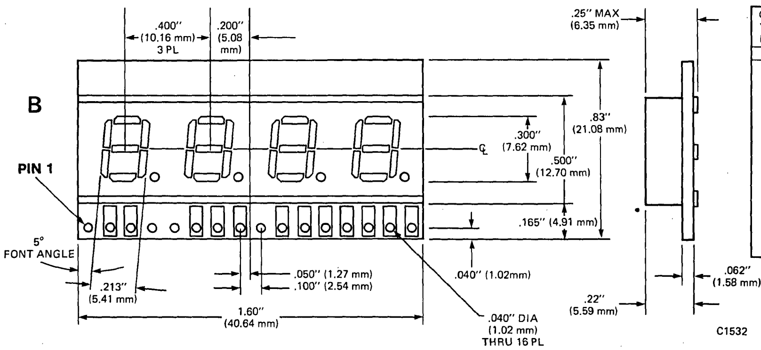


Fig. 5. Luminous Intensity vs. Duty Cycle

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

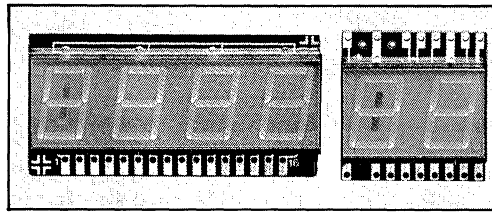
ORANGE MMN56000 SERIES
YELLOW MMN58000 SERIES
HIGH EFFICIENCY RED MMN59000 SERIES

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

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			μcd	$I_F = 10$ mA
		Decimal point (See Note 3)	90			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			μcd	$I_F = 10$ mA
		Decimal point (See Note 3)	90			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			μcd	$I_F = 10$ mA
		Decimal point (See Note 3)	65			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)

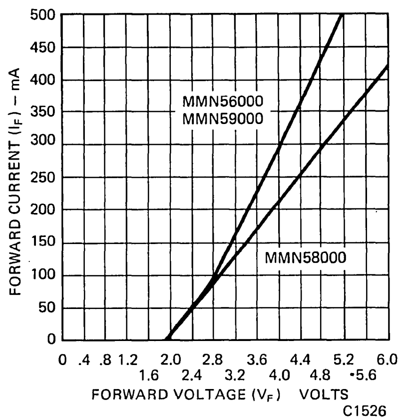


Fig. 1. Forward Current vs. Forward Voltage

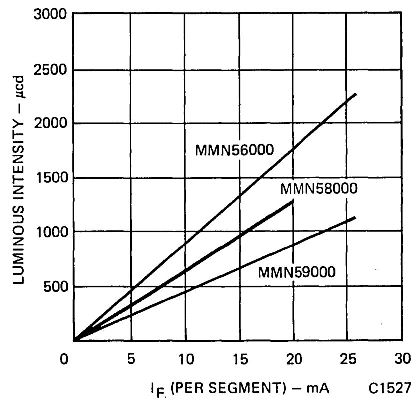


Fig. 2. Luminous Intensity vs. Forward Current

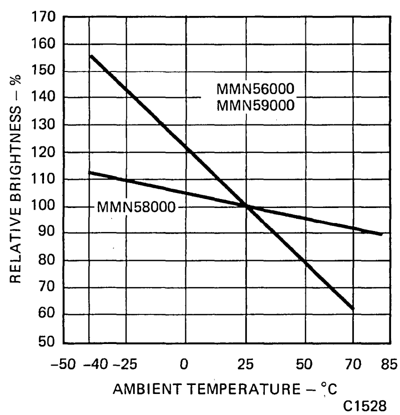


Fig. 3. Luminous Intensity vs. Temperature

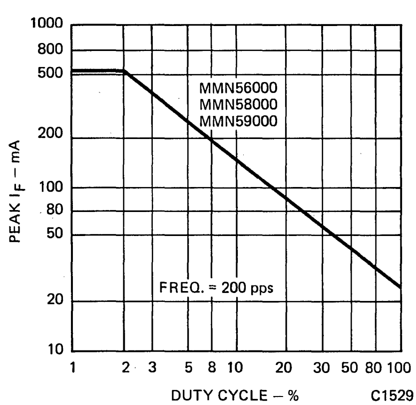


Fig. 4. Max Peak Current vs. Duty Cycle

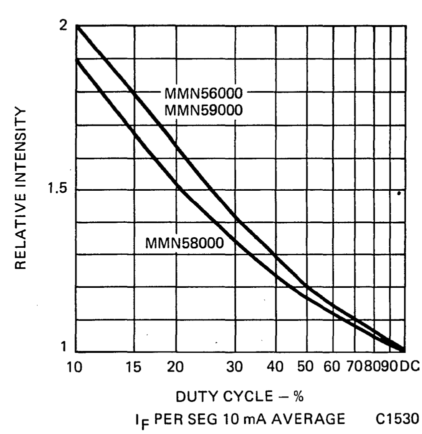
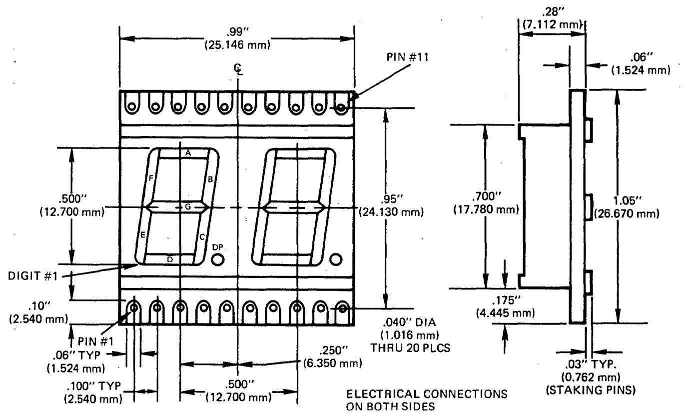
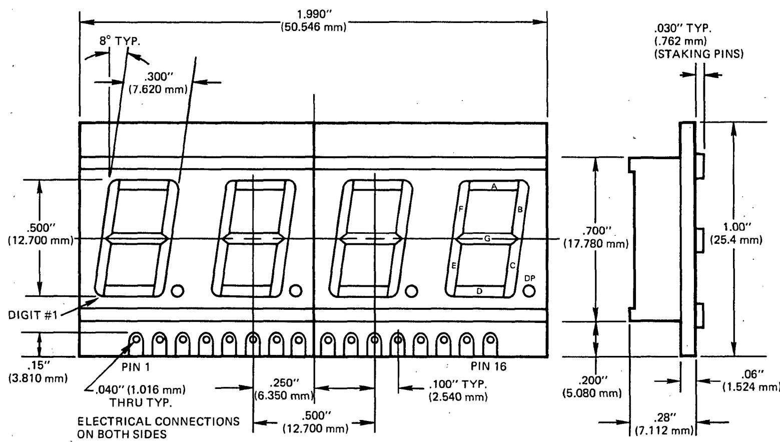


Fig. 5. Luminous Intensity vs. Duty Cycle

PACKAGE DIMENSIONS



A



B

PIN CONNECTIONS

MULTIPLEXED 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.

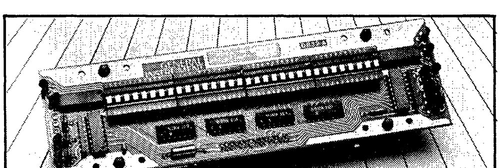
The XDS series consists of 24 or 32 characters of 0.135" high 14 segment monolithic direct view red LED displays, a microprocessor, and all the necessary display drive electronics.

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 display 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

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_{OL}		24	mA
I_{OUT}	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_{OL}		24	mA
I_{OUT}	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 $D_0 \to D_7$	I_{IH}			40	µA	V_{CC} = 5.25 V V_{IN} = 2.7 V
Input Current Low $D_0 \to D_7$	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.

BASIC INTERFACE DEFINITIONS

All statements are made with respect to the XDS display system from the host system as shown:

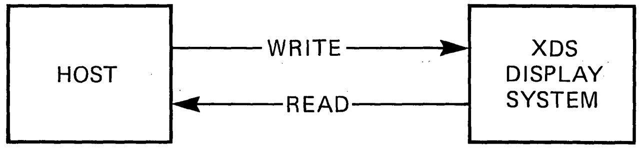


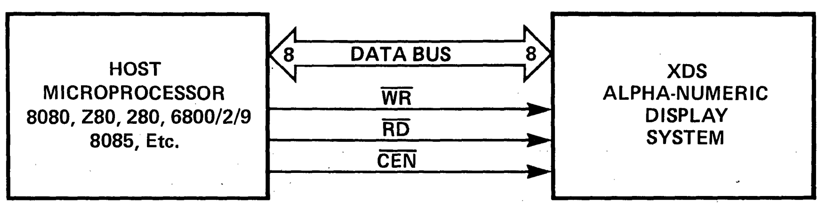
Figure 4. Data Flow Diagram

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:



C1502A

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.

$\overline{\text{C EN}}$: CHIP ENABLE LINE: (ACTIVE LOW)
This is the master enable for any communications between host system and display subsystem.
When the $\overline{\text{C EN}}$ line is high, no communication exists between display and host microcomputer.
When the $\overline{\text{C EN}}$ line is low, the BUS READ, BUS WRITE and DATA BUS are recognized.

$\overline{\text{RD}}$: READ BUS: (ACTIVE LOW)
If $\overline{\text{C EN}}$ line is low and $\overline{\text{RD}}$ is low, it enables data to be read from the display system to the host system.

$\overline{\text{WR}}$: BUS WRITE: (ACTIVE LOW)
If $\overline{\text{C EN}}$ is low, a negative going pulse (high to low transition) on the $\overline{\text{WR}}$ line causes data on BUS to be latched into the display system and a service request is flagged.

TIMING DIAGRAMS:

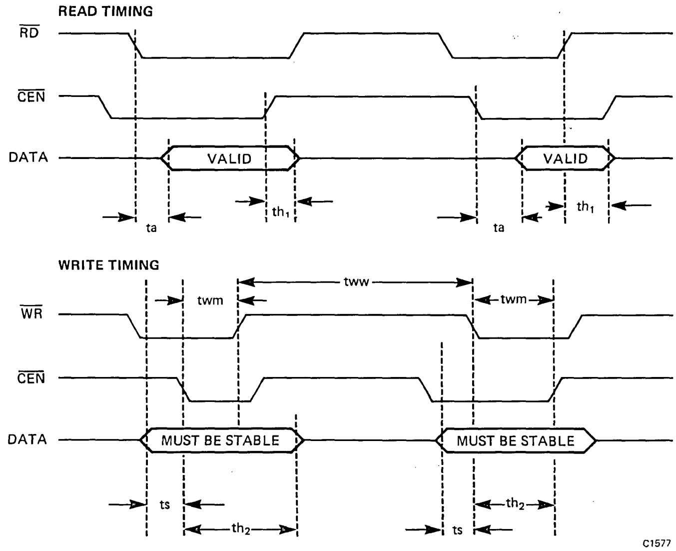


Figure 6

Figure 6 shows the timing relationships and specifications for the various control signals.

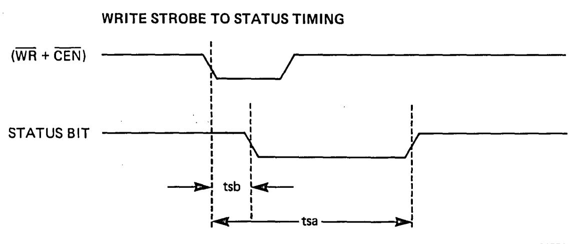


Figure 7

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

$\overline{C\ EN}$	$\overline{RD}$	$\overline{WR}$	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

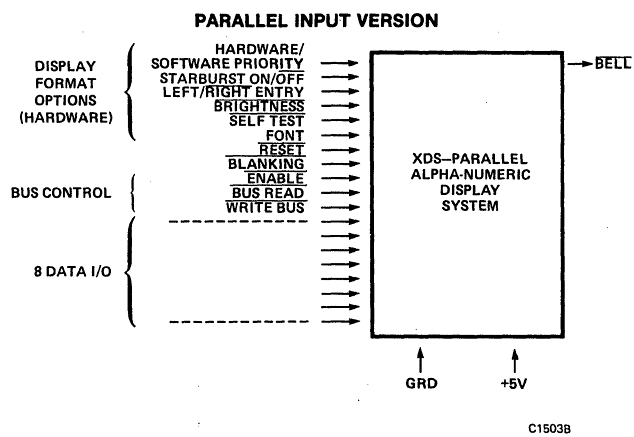


Figure 9.

XDS—SERIAL SYSTEM DESCRIPTION

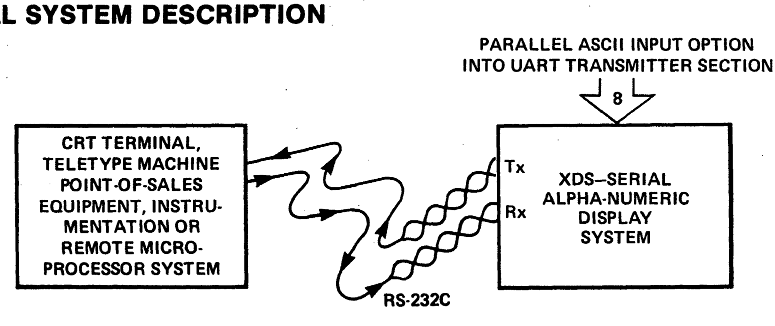


Figure 10

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

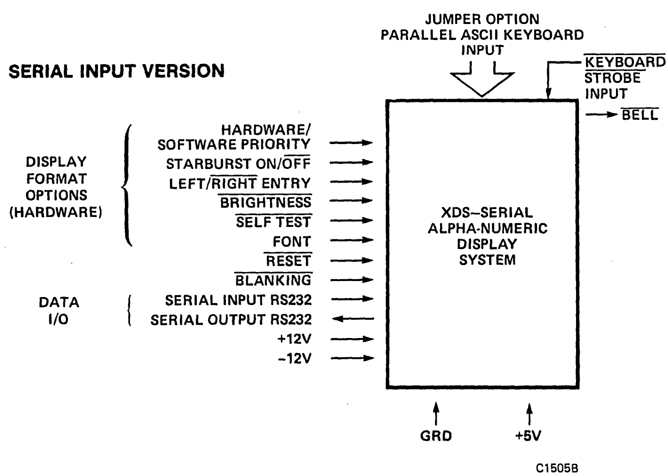


Figure 11.

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".

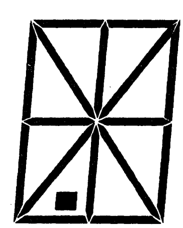


Figure 12. 14 Segments Plus Decimal Point

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	A	61	a	A
02	STX		22	"	"	42	B	B	62	b	B
03	ETX		23	#	#	43	C	C	63	c	C
04	EOT		24	$	$	44	D	D	64	d	D
05	ENQ		25	%	%	45	E	E	65	e	E
06	ACK		26	&	&	46	F	F	66	f	F
07	BEL	*	27	'	/	47	G	G	67	g	G
08	BS	*	28	(	(	48	H	H	68	h	H
09	HT	*	29	)	)	49	I	I	69	i	I
0A	LF	*	2A	*	*	4A	J	J	6A	j	J
0B	VT		2B	+	+	4B	K	K	6B	k	K
0C	FF		2C	,	,	4C	L	L	6C	l	L
0D	CR	*	2D	–	--	4D	M	M	6D	m	M
0E	SO		2E	.	.	4E	N	N	6E	n	N
0F	SI		2F	/	/	4F	O	O	6F	o	O
10	DLE		30	Ø	Ø	50	P	P	70	p	P
11	DC1	*	31	1	1	51	Q	Q	71	q	Q
12	DC2	*	32	2	2	52	R	R	72	r	R
13	DC3	*	33	3	3	53	S	S	73	s	S
14	DC4		34	4	4	54	T	T	74	t	T
15	NAK		35	5	5	55	U	U	75	u	U
16	SYN		36	6	6	56	V	V	76	v	V
17	ETB		37	7	7	57	W	W	77	w	W
18	CAN		38	8	8	58	X	X	78	x	X
19	EM		39	9	9	59	Y	Y	79	y	Y
1A	SUB		3A	:	:	5A	Z	Z	7A	z	Z
1B	ESC	*	3B	;	;	5B	[	[	7B	{	⊣
1C	FS		3C	<	<	5C	\	\	7C	ǀ	ǀ
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.)

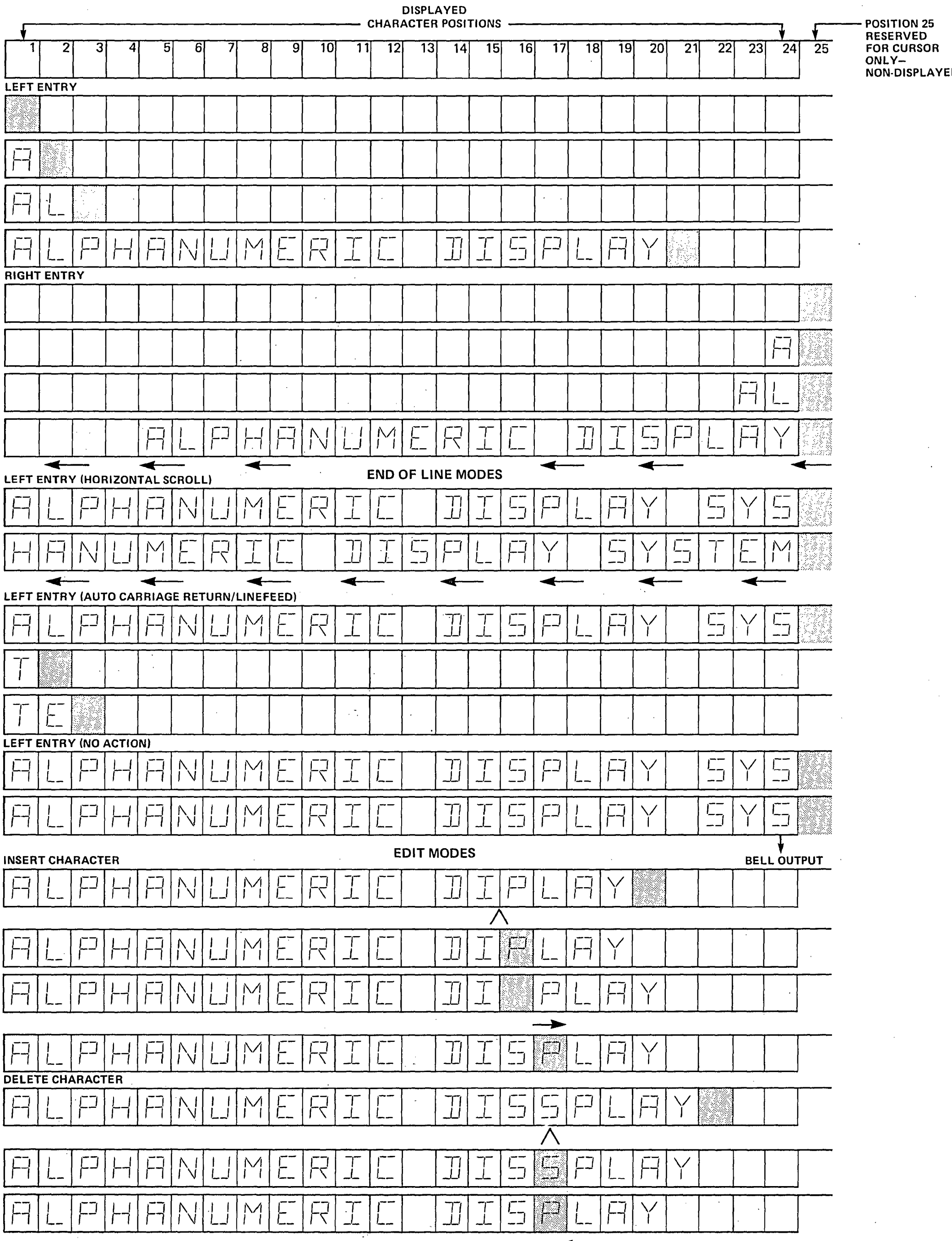


Figure 14.

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

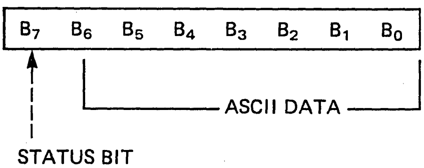
Communication Input and Output
Communication with the XDS display system is made possible by the input and output ports. The "Parallel XDS" display communication is established by an 8-bit bi-directional I/O plus 3 command lines. The "Serial XDS" display communication is via a serial RS232C input port and a RS232C output port.

In both systems the data bit FORMAT remains the same. This is shown in Figure 15.

READ-PORT
(output to host)

CONTROL LINE STATUS

$\overline{CE}$ = Low
$\overline{RD}$ = Low
$\overline{WR}$ = High



WRITE-PORT
(input to display)

CONTROL LINE STATUS

$\overline{CE}$ = Low
$\overline{RD}$ = High
$\overline{WR}$ = Low

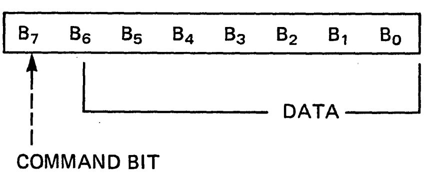


Figure 15

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
8Ø	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 # 7654321Ø	Command
Bit # 111XXXXX	Set cursor to position XXXXX (Binary)
Bit # 11ØXXXXX	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

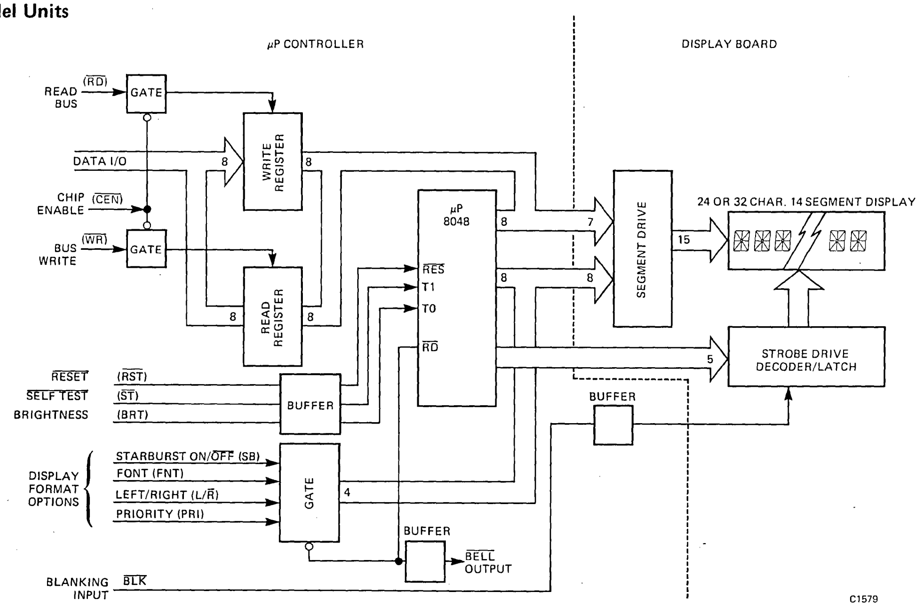


Figure 16. Block Diagram—XDS Parallel Unit

XDS Serial Units

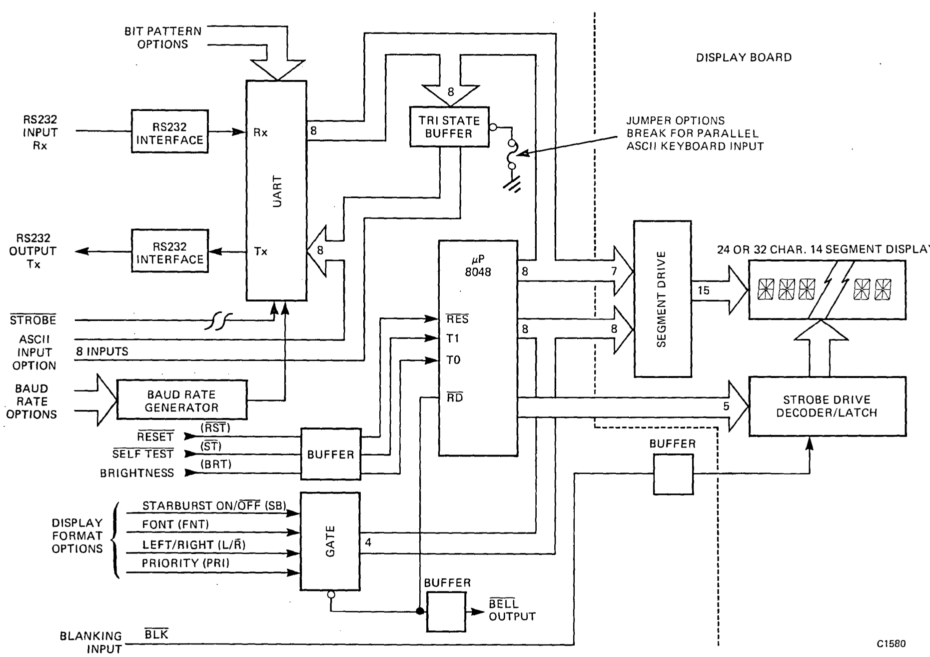


Figure 17. Block Diagram—XDS Serial Unit

CONNECTION TO COMMONLY USED MICROPROCESSORS

Intel 8080

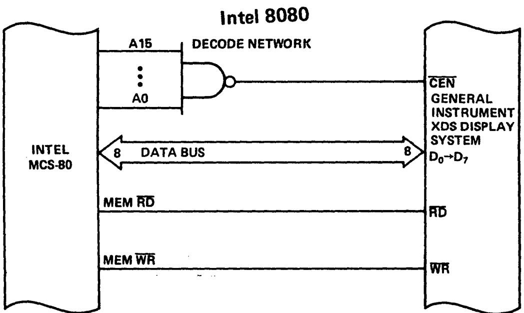


Figure 18

C1506B

Zilog Z-80

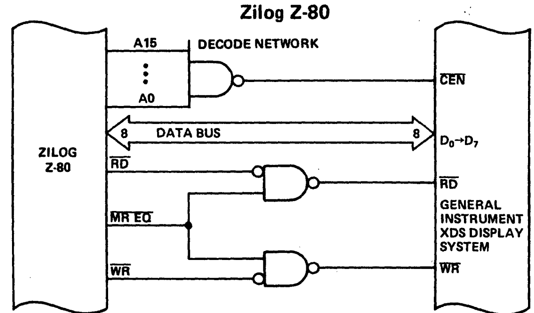


Figure 19

C1507B

Motorola MC68002/9

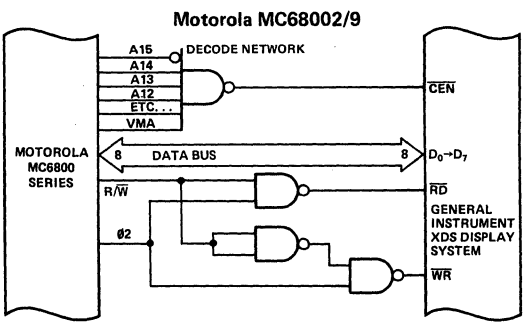


Figure 20

C1508B

Intel 8085

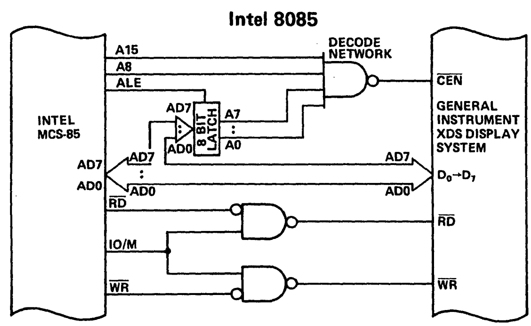


Figure 21

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
E22	Open	No parity
E22	Grounded	Parity
E14	Open	Even parity
E14	Ground	Odd parity
E20	Open	2 Stop bits
E20	Ground	1 Stop bit
E15 E17	Selects number of data bits as per below	
E15 E17	Bits Per Character	
0 0	5	
0 1	6	
1 0	7	
1 1	8	

0 = Ground 1 = Open

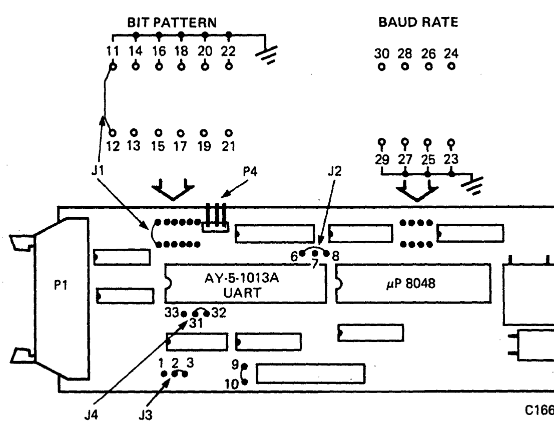


Figure 22. Serial Controller – Jumper Options

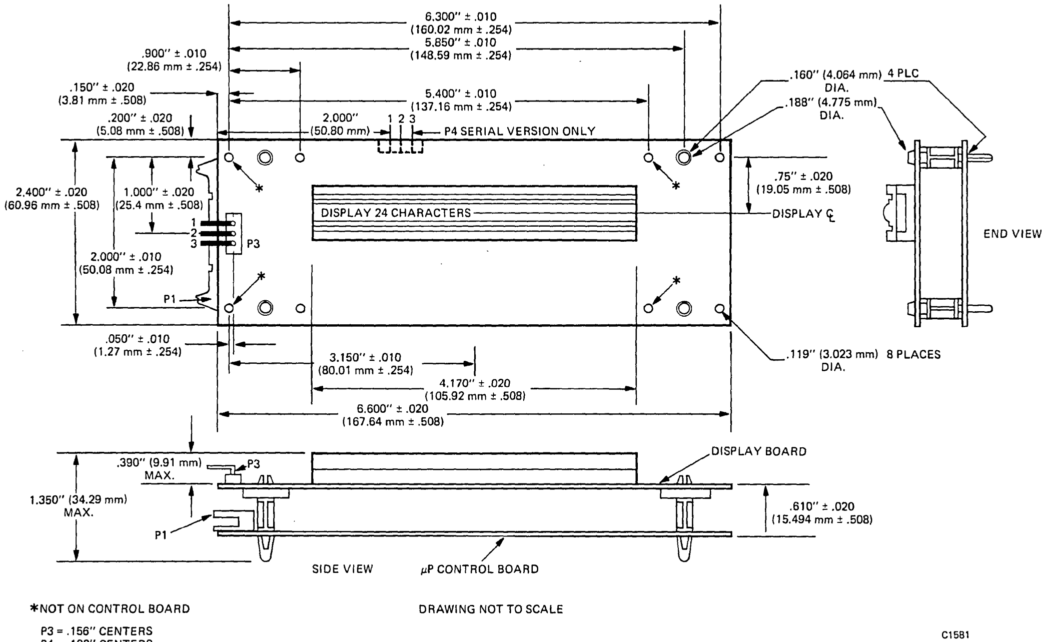
NOTE: All numbers shown for jumpers are prefixed with an "E" in the text.

"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



*NOT ON CONTROL BOARD

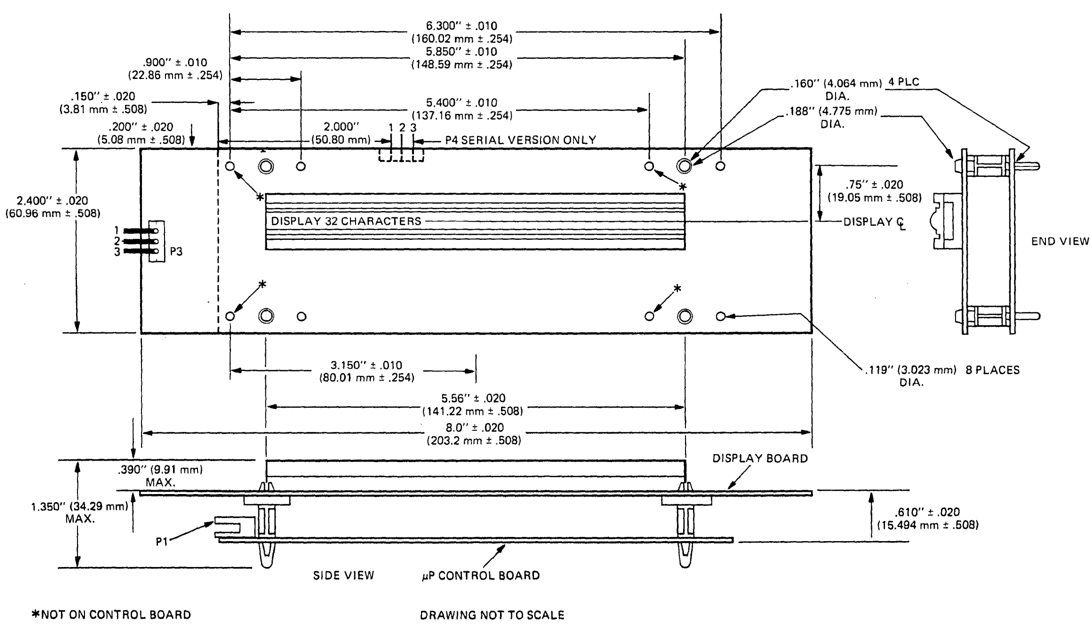
DRAWING NOT TO SCALE

P3 = .156" CENTERS
P4 = .100" CENTERS

NOTE: P3 OPTIONAL. NOT INSTALLED.

Figure 23

XDS2732P and 2732S



*NOT ON CONTROL BOARD

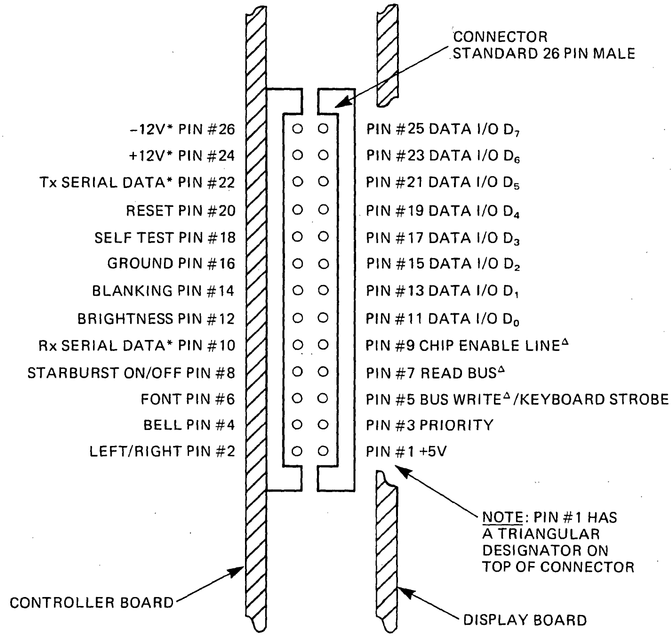
DRAWING NOT TO SCALE

P3 = .156" CENTERS
P4 = .100" CENTERS

NOTE: P3 OPTIONAL. NOT INSTALLED.

Figure 24

PRIMARY CONNECTOR



*SERIAL VERSION ONLY
△PARALLEL VERSION ONLY

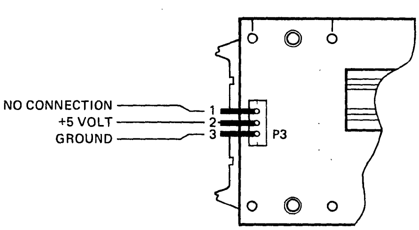
C1585

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

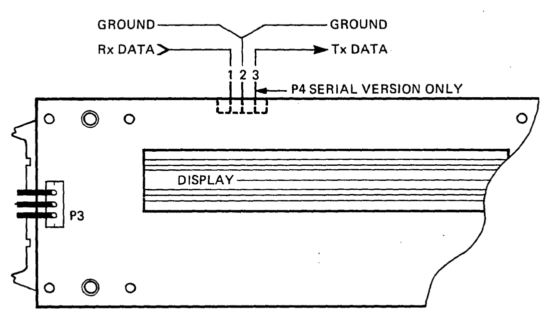
AN OPTIONAL 3 PIN MALE CONNECTOR MAY BE INSTALLED BY CUSTOMER FOR +5 VOLT SUPPLY IF REQUIRED.



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

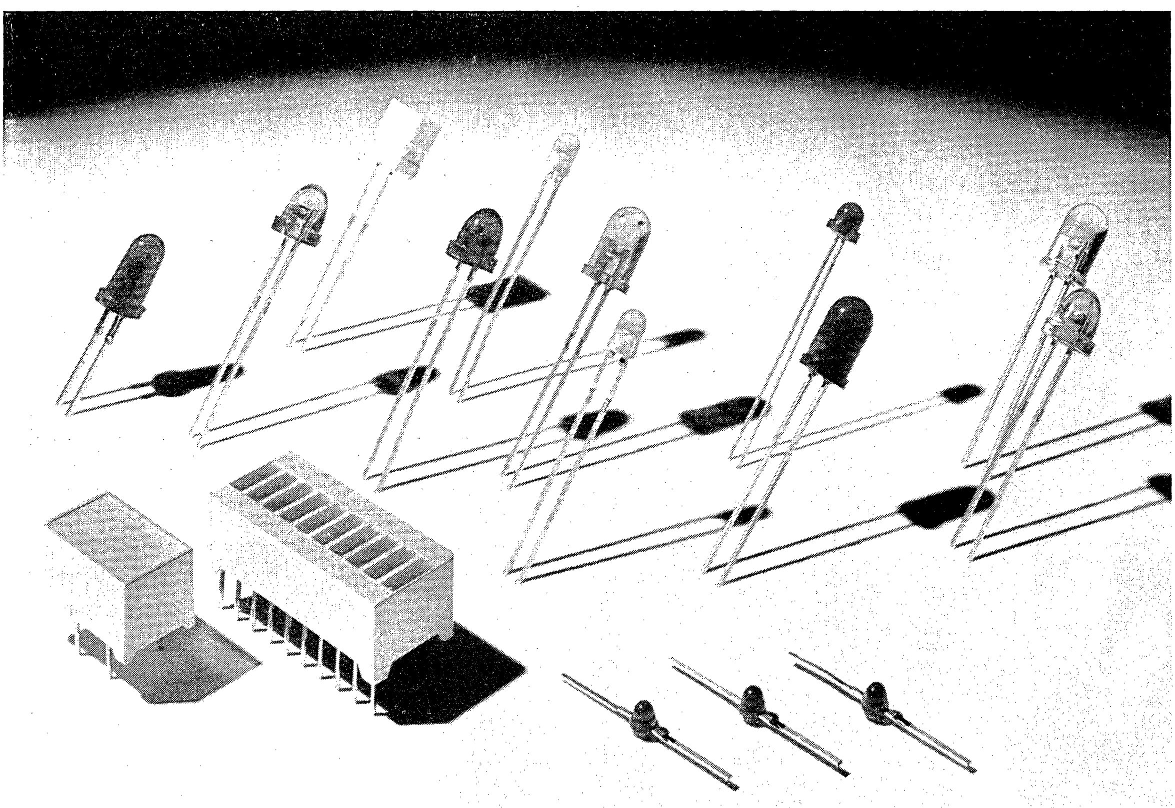
P4 SERIAL VERSION. OPTIONAL RS232 I/O

THIS CONNECTOR IS WIRED IN PARALLEL WITH CONNECTIONS IN P1. MATING CONNECTOR. FEMALE MOLEX 22-01-2036 .100" CENTERS.

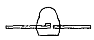
Figure 27

4

Lamps



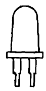
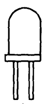
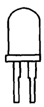
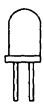
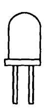
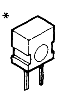
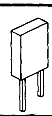
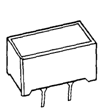
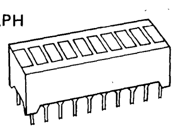
LED LAMPS

PACKAGE	DEVICE NO.	VIEWED COLOR/ LENS COLOR or EFFECT	LUMINOUS INTENSITY (TYP) @ FORWARD CURRENT	TYPICAL VIEWING ANGLE
TO-18 	MV10B	Red/Clear	0.8mcd @ 10mA	
T-3/4 	MV50 MV52 MV53 MV54	Red/Clear Green/Clear Yellow/Clear Red/Flooded	1.4 mcd @ 20mA 1.5 mcd @ 20mA 1.5 mcd @ 20mA 1.0 mcd @ 20mA	80°
T-3/4 	MV55A	High Eff. Red	0.5 mcd @ 3mA	40°
T-1, .055" LEAD SPACING (a)  (b) 	(a) MV5074C (a) MV5075C	Red	2.5 mcd @ 20mA 1.6 mcd @ 20mA	70° 90°
	(b) MV5077C		1.7 mcd @ 20mA	110°
	(a) MV5174C (b) MV5177C	Orange	5.0 mcd @ 20mA 3.0 mcd @ 20mA	90° 180°
	(a) MV5274C (b) MV5277C	Green	1.8 mcd @ 20mA 0.9 mcd @ 20mA	90° 180°
	(a) MV5374C (b) MV5377C	Yellow	4.0 mcd @ 20mA 2.0 mcd @ 20mA	90° 180°
	(a) MV5774C (b) MV5777C	High Eff. Red	5.0 mcd @ 20mA 3.0 mcd @ 20mA	90° 180°
T-1, .100" LEAD SPACING 	MV51640 MV51641 MV51642	Orange	2.0 mcd @ 10mA 2.5 mcd @ 10mA 3.5 mcd @ 10mA	90° 90° 90°
	MV52640 MV52641 MV52642	Green	1.5 mcd @ 20mA 3.0 mcd @ 20mA 4.0 mcd @ 20mA	90° 90° 90°
	MV53620 MV53640 MV53641 MV53642	Yellow	2.0 mcd @ 10mA 2.0 mcd @ 10mA 3.0 mcd @ 10mA 4.5 mcd @ 10mA	60° 90° 90° 90°
	MV54643 MV54644	High Eff. Green	5.0 mcd @ 20mA 10.0 mcd @ 20mA	90° 90°
	MV57620 MV57640 MV57641 MV57642	High Eff. Red	2.0 mcd @ 10mA 2.0 mcd @ 10mA 2.5 mcd @ 10mA 3.5 mcd @ 10mA	60° 90° 90° 90°
T-1-3/4* LOW PROFILE 	MV50152 MV50154	Red	2.0 mcd @ 10mA 1.5 mcd @ 10mA	45° 50°
	MV52152 MV52154	Green	2.0 mcd @ 10mA 1.5 mcd @ 10mA	45° 50°
	MV53152 MV53154	Yellow/Orange	5.0 mcd @ 10mA 3.0 mcd @ 10mA	45° 50°
	MV57152 MV57154	Orange/Amber	8.0 mcd @ 10mA 4.0 mcd @ 10mA	45° 50°
T-1-3/4* BI-DIRECTIONAL 	MV5094	Red	0.8 mcd @ 20mA	50°
TWO COLOR LED* 	MV5491	Green/ Red	0.5 mcd @ 20mA 1.5 mcd @ 20mA	50°

*MOUNTING HARDWARE AVAILABLE

MAX. POWER	MAX. DC CURRENT	FORWARD VOLTAGE (TYPICAL)	PAGE NO.	APPLICATIONS
175mW	70mA	1.65V	305	General purpose indicator lights compatible with Bipolar IC's.
80mW	40mA	1.65V	307	Indicator lights, diagnostic and panel displays, printed circuit board indicators, miniature low profile package.
105mW	35mA	2.20V	309	
105mW	35mA	2.10V	309	
80mW	40mA	1.65V	307	
6mW	4mA	1.60V	311	Diagnostic or indicator lights in low-power/low current environments, MOS compatible
100mW	50mA	1.68V	311	General purpose indicators, developmental projects, breadboards.
			315	Miniature indicators, breadboards, test jigs. Low profile.
105mW	35mA	2.00V	317 319	Portable equipment, general purpose indicators and matrix panel displays, test equipment and systems, sorting machines, vending machines. High intensity indicators in four colors.
		2.20V	317 319	
		2.10V	317 319	
		2.00V	317 319	
120mW	30mA	2.00V	321	Computers, general purpose indicators, instruments, test systems, mini- and micro-processors, process controlled industrial systems, sorting machines, assembly equipment, vending machines, telephone equipment, backlight panels. High intensity indicators in four colors.
		2.20V	321	
		2.10V	323 321 321 321	
		2.20V	301, 321	
		2.00V	323 321 321 321	
	100mA	1.60V	325	
180mW	35mA	2.20V	325	
		2.10V	325	
		2.00V	325	
140mW	70mA	1.60V	337	High voltage bi-directional AC indicators, power supplies, transformers.
200mW	35mA 70mA	2.20V 1.65V	343	Polarity indication tri-state indicator, flow direction display, instruments, tester displays, educational aids.

LED LAMPS

PACKAGE	DEVICE NO.	VIEWED COLOR/ LENS COLOR or EFFECT	LUMINOUS INTENSITY (TYP) @ FORWARD CURRENT	TYPICAL VIEWING ANGLE
T-1-3/4* 	MV5020 MV5021 MV5022 MV5023 MV5024 MV5025 MV5026	Red/Clear Red/Soft Red/Point Red/Soft Red/Soft Red/Flooded Red/Flooded	2.0 mcd @ 20mA 1.6 mcd @ 20mA 1.6 mcd @ 20mA 1.6 mcd @ 20mA 3.0 mcd @ 20mA 0.4 mcd @ 20mA 0.6 mcd @ 20mA	90° 90° 90° 90° 60° 180° 90°
T-1-3/4* 	MV5050 MV5051 MV5052 MV5053 MV5055 MV5056	Red/Clear Red/Soft Red/Point Red/Flooded Red/Flooded Red/Flooded	2.0 mcd @ 20mA 1.6 mcd @ 20mA 2.0 mcd @ 20mA 1.6 mcd @ 20mA 0.6 mcd @ 20mA 0.8 mcd @ 20mA	50° 72° 72° 80° 150° 110°
T-1-3/4* 	MV5054-1 MV5054-2 MV5054-3	Red	2.0 mcd @ 10mA 3.0 mcd @ 10mA 4.0 mcd @ 10mA	50°
T-1-3/4* 	MV5054A-1 MV5054A-2 MV5054A-3		2.0 mcd @ 10mA 3.0 mcd @ 10mA 4.0 mcd @ 10mA	
T-1-3/4* 	MV5152 MV5153 MV5154	Orange	40.0 mcd @ 20mA 6.0 mcd @ 20mA 10.0 mcd @ 20mA	28° 65° 24°
	MV5252 MV5253 MV5254	Green	15.0 mcd @ 20mA 3.5 mcd @ 20mA 3.0 mcd @ 20mA	28° 65° 24°
	MV5352 MV5353 MV5354	Yellow	45.0 mcd @ 20mA 8.0 mcd @ 20mA 10.0 mcd @ 20mA	28° 65° 24°
	MV5752 MV5753 MV5754	High Eff. Red	40.0 mcd @ 20mA 9.0 mcd @ 20mA 10.0 mcd @ 20mA	28° 65° 24°
	MV64520 MV64521 MV64530 MV64531	High Eff. Green	25.0 mcd @ 20mA 60.0 mcd @ 20mA 6.0 mcd @ 20mA 14.0 mcd @ 20mA	35° 35° 75° 77°
RECTANGULAR* 	MV52124 MV53124 MV54124 MV57124	Green Yellow High Eff. Green High Eff. Red	3.0 mcd @ 20mA 4.0 mcd @ 20mA 4.0 mcd @ 20mA 4.0 mcd @ 20mA	100°
RECTANGULAR 	MV53123 MV54123 MV57123	Yellow High Eff. Green High Eff. Red	4.0 mcd @ 20mA	100°
.5" RECTANGULAR* 	MV53173 MV54173 MV57173	Yellow High Eff. Green High Eff. Red	10 mcd @ 20mA	Wide Angle
BAR GRAPH 	MV53164 MV54164 MV57164	Yellow High Eff. Green High Eff. Red	1.0 mcd @ 10mA (per segment)	Wide Angle

*MOUNTING HARDWARE AVAILABLE

MAX. POWER	MAX. DC CURRENT	FORWARD VOLTAGE (TYPICAL)	PAGE NO.	APPLICATIONS
180mW	100mA	1.65V	327	Instruments, printed circuit board indicators, board-mounted panel display, different lens effect and viewing angles. MV5020 series offers leads with standoffs for assembly ease. General purpose indicators.
		1.70V	329	
		1.80V	333	
			335	
120mW	35mA	2.00V	339 341 341	Computers, general purpose indicators, instruments, test systems, mini- and micro-processors, process controlled industrial systems, sorting machines, assembly equipment, vending machines, telephone equipment, backlight panels. High intensity indicators in four colors.
		2.20V	339 341 341	
		2.10V	339 341 341	
		2.00V	339 341 341	
120mW	30mA	2.20V	301, 339 301, 339 301, 341 301, 341	
120mW	35mA 35mA 30mA 35mA	2.00V 2.00V 2.20V 2.00V	349 349 301, 349 349	Legend backlight, panel indicator, bar graph, display button. Mounting hardware available.
120mW	35mA	2.00V	347 301, 347 347	Legend backlight, illuminates pushbutton, panel indicator, bar graph meter.
200mW	25mA 30mA 35mA	2.00V 2.00V 2.20V	351	Panel indicators, backlight legends, light arrays.
750mW	300mA (30mA per segment)	2.50V	355	Analog measurement, audio instruments, meters, gauges.

GENERAL INSTRUMENT

HIGH EFFICIENCY GREEN

RECTANGULAR **MV54123**
RECTANGULAR **MV54124**
T-1 DIFFUSED **MV54643**
T-1 DIFFUSED **MV54644**
T-1¾ NON-DIFFUSED **MV64520**
T-1¾ NON-DIFFUSED **MV64521**
T-1¾ DIFFUSED **MV64530**
T-1¾ DIFFUSED **MV64531**

DESCRIPTION

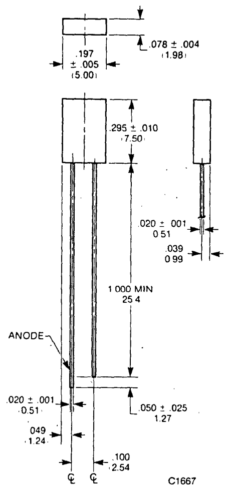
General Instrument introduces a new family of solid state lamps utilizing an improved gallium phosphide green light emitting diode.

FEATURES

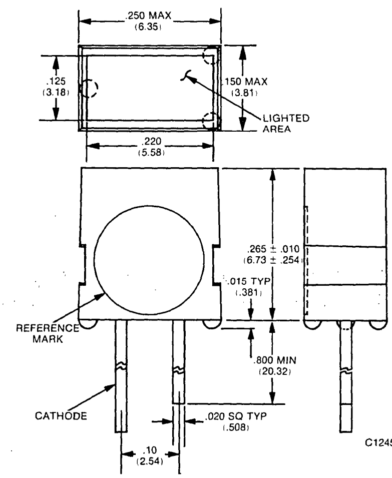
- Typically 2-3 times brighter than the first generation green lamps.
- Comparable in brightness to high-efficiency red, yellow and orange.
- Pin-for-pin replacements for first generation lamps.

PACKAGE DIMENSIONS

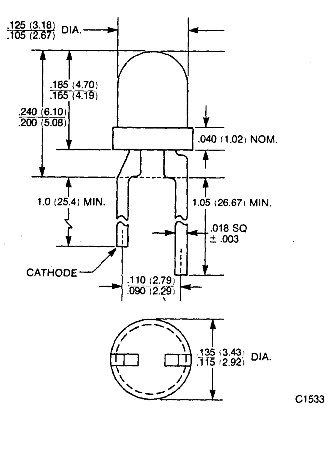
MV54123



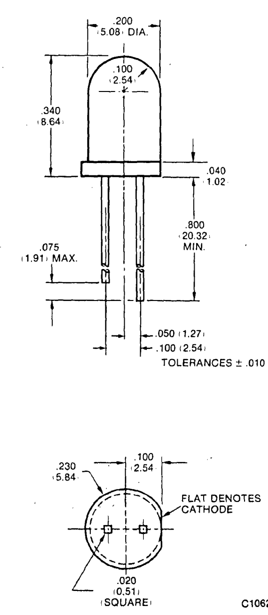
MV54124



MV54643
MV54644



MV64520 MV64530
MV64521 MV64531



NOTES:
1. ALL DIMENSIONS IN INCHES (MILLIMETERS)
2. AN EPOXY MINISCUS MAY EXTEND ABOUT .040" (1 mm) DOWN THE LEADS.
3. TOLERANCES ±.010" UNLESS SPECIFIED.

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient	120 mW
Derate linearly from 50°C	1.6 mW/°C
Storage and operating temperatures	−55°C to 100°C
Lead solder time @ 260°C (1/16 inch from body)	5 sec
Continuous forward current @ 25°C	30 mA
Continuous forward current @ 100°C	10 mA
Peak forward current (see figure 3)	90 mA
Reverse voltage	5.0 V

LUMINOUS INTENSITY AND VIEWING ANGLE (AT 25°C AMBIENT)

PART NUMBER	PACKAGE DESCRIPTION	LUMINOUS INTENSITY (mcd) AT 20 mA DC MIN.	TYP.	VIEWING ANGLE
MV54123	Rectangular	1.0	4.0	100°
MV54124	Rectangular	2.0	4.0	100°
MV54643	T-1 Diffused	2.0	5.0	90°
MV54644	T-1 Diffused	6.0	10.0	90°
MV64520	T-1¾ Non-Diffused	12.0	25.0	35°
MV64521	T-1¾ Non-Diffused	30.0	60.0	35°
MV64530	T-1¾ Diffused	3.0	6.0	75°
MV64531	T-1¾ Diffused	7.0	14.0	75°

ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25°C)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward Voltage	V_F		2.2	3.0	V	I_F = 20 mA
Peak Wavelength	λp		562		nm	I_F = 20 mA
Dominant Wavelength	λd		567		nm	I_F = 20 mA
Spectral Line Half Width	$\Delta\lambda/2$		30		nm	I_F = 20 mA
Light Rise Time	t_r		500		ns	I_F = 20 mA
Capacitance	C		20		pF	V_F = 0, f = 1 MHz
Reverse Breakdown Voltage	V_R	5.0	50		V	I_R = 100 μA
Temperature Coefficient of V_F	$\Delta V_F/\Delta T$		−1.35		mV/°C	I_F = 20 mA

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS CURVES (T_A = 25°C)

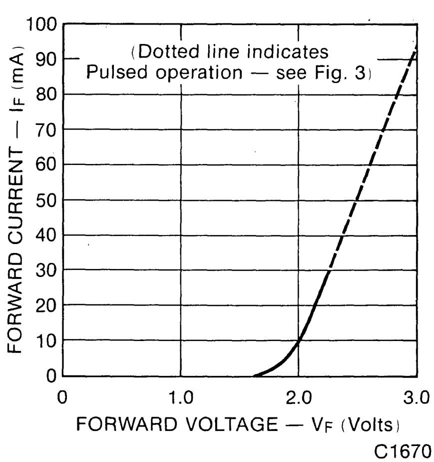


Fig. 1. Forward Current vs. Forward Voltage

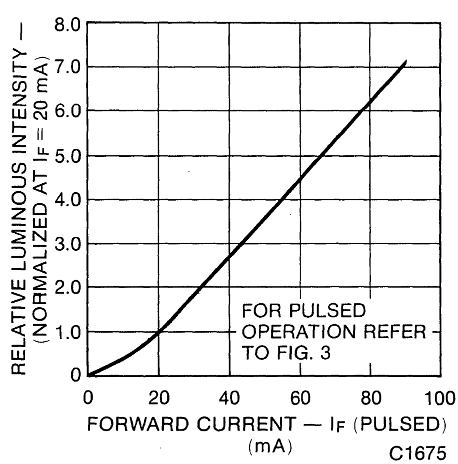


Fig. 2. Relative Luminous Intensity vs. Pulsed Forward Current

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS CURVES (T_A = 25°C)

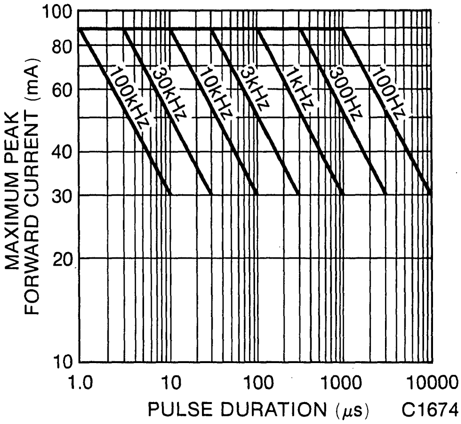


Fig. 3. Maximum Peak Forward Current vs. Pulse Duration

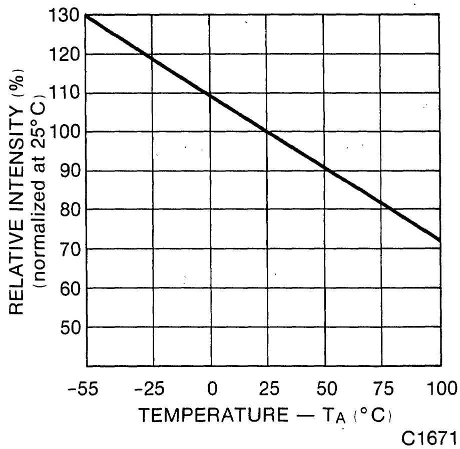


Fig. 4. Relative Luminous Intensity vs. Temperature

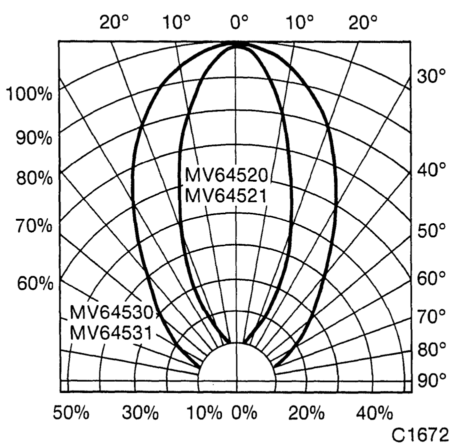


Fig. 5. Spatial Distribution

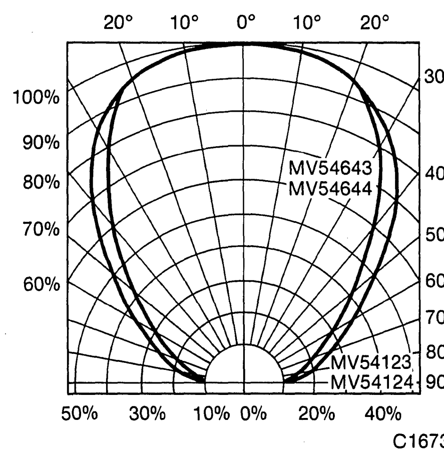
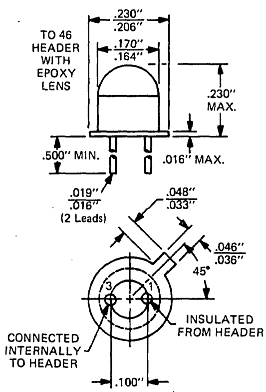


Fig. 6. Spatial Distribution

GENERAL INSTRUMENT

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

- Ultra High Brightness
- Long Life — Solid State Reliability
- Low Power Requirements
- Compatible with Integrated Circuits
- Compact, Rugged, Lightweight.

ABSOLUTE MAXIMUM RATINGS

Power Dissipation @ 25°C Ambient Temperature	175mW
Derate Linearly from 25°C	2.33mW/°C
Storage & Operating Temperature	-55°C to +100°C
Lead Solder Time @ 260°C (See note 2)	7.0 s
Continuous Forward Current	70mA
Peak Forward Current (1 μsec pulse, 0.3% duty cycle)	1.0A
Reverse Voltage	5.0V

ELECTRO-OPTICAL CHARACTERISTICS

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)

CHARACTERISTICS	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

(25°C Free Air Temperature)

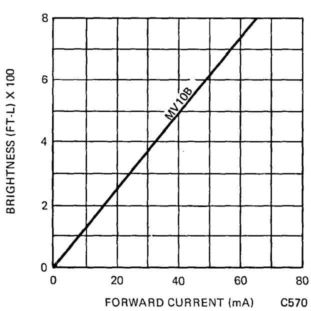


Figure 1 Brightness vs. Forward Current

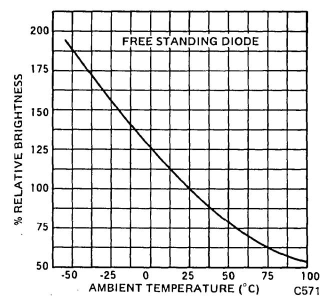


Figure 2 Brightness vs. Temperature

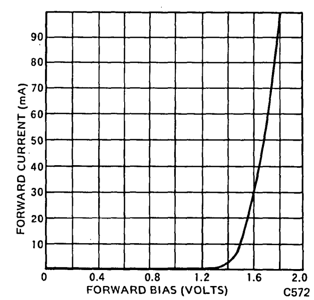


Figure 3 Forward Current vs. Forward Voltage

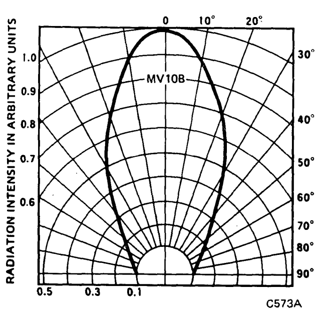


Figure 4 Spatial Distribution (Note 3)

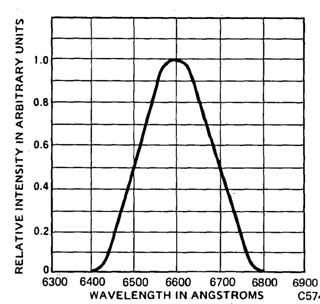


Figure 5 Spectral Distribution

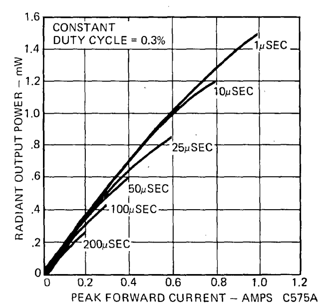


Figure 6 Peak Power Output vs. Pulsed Forward Current

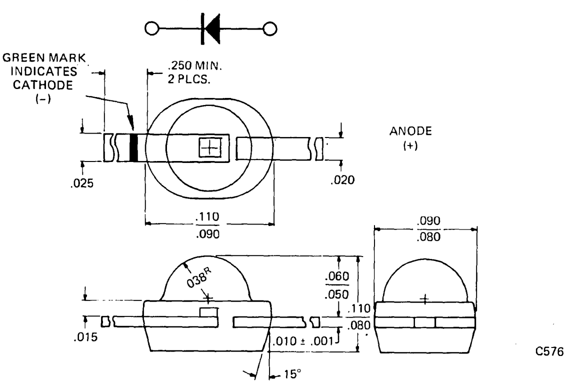
NOTES

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

RED MV50
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

Power dissipation @ 25°C ambient	80 mW
Derate linearly from 25°C	1.6 mW/°C
Storage and operating temperature	–55°C to 100°C
Peak forward current (1 μsec pulse width, 0.3% duty cycle)	1.0A
Lead solder time @ 230° (note 1)	5 sec
Continuous forward current	40 mA
Reverse Voltage	5.0 V

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

CHARACTERISTICS	MINIMUM		TYPICAL		MAXIMUM	UNITS	TEST CONDITIONS
	MV50	MV54	MV50	MV54	MV50/54		
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
Rise and fall time			50	50		ns	50Ω system, I_F = 20 mA
Reverse current			5.0	5.0		nA	V_R = 3.0 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 (25°C Free Air Temperature)

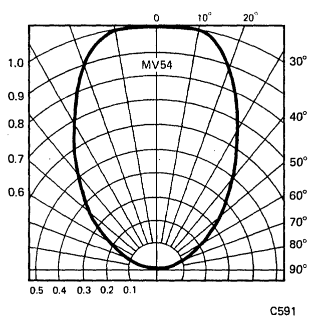


Figure 1 Spatial Distribution (Note 3)

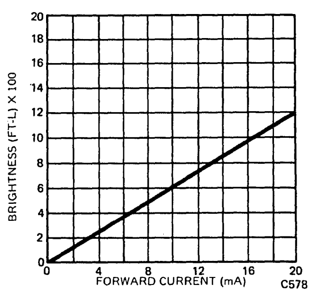


Figure 2 Brightness vs. Forward Current

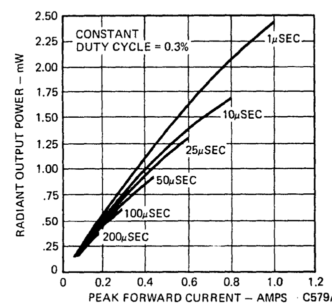


Figure 3 Peak Power Output vs. Pulsed Forward Current

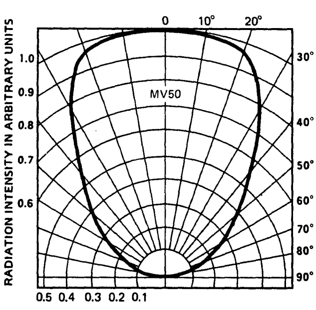


Figure 4 Spatial Distribution (Note 3)

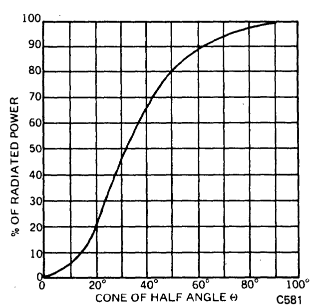


Figure 5 Percent Radiated Power Into Cone of Half Angle

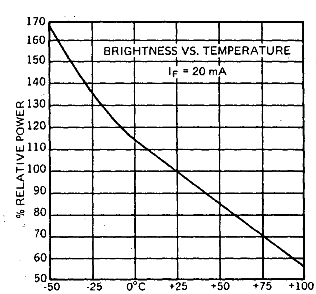


Figure 6 Relative Power vs. Temperature

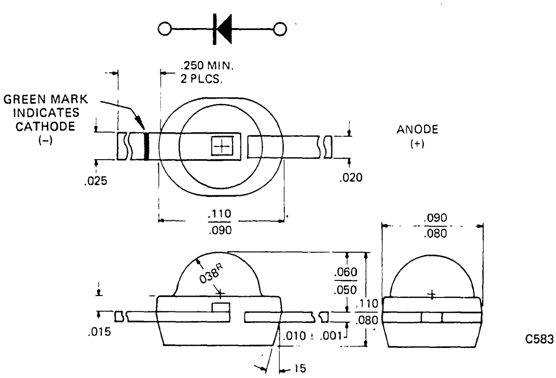
NOTES

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

GREEN MV52
YELLOW MV53

PACKAGE DIMENSIONS



NOTES:
1. ALL DIMENSIONS IN INCHES
2. TOLERANCES ±.010" UNLESS SPECIFIED

DESCRIPTION

The MV52 is a Gallium Phosphide 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. The identical mechanical configuration is also available in a red lamp, part number MV50 or MV54.

FEATURES

The MV52 and MV53 units 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-3/4 size.

- Multicolored versions of the popular MV50 package
- Low cost
- Bright
- Compatible with integrated circuits
- Long life, rugged
- Small size—T-3/4

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

CHARACTERISTICS	MINIMUM	TYPICAL	MAXIMUM	UNITS	TEST CONDITIONS
Luminous Intensity (Note 1)	0.2	1.0		mcd	I_F = 20 mA
Peak emission wavelength, MV52		565		nm	I_F = 20 mA
Peak emission wavelength, MV53		589		nm	I_F = 20 mA
Spectral line halfwidth MV52, MV53		35		nm	I_F = 20 mA
Forward voltage MV52		2.2	3.0	V	I_F = 20 mA
MV53		2.1	3.0	V	I_F = 20 mA
Reverse breakdown voltage	5	15		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

Power dissipation @ 25°C ambient	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 3)	5 sec
Continuous forward current	35 mA
Reverse Voltage	5.0 V

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature)

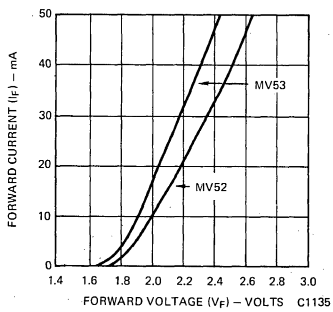


Fig. 1. Forward Current vs. Forward Voltage

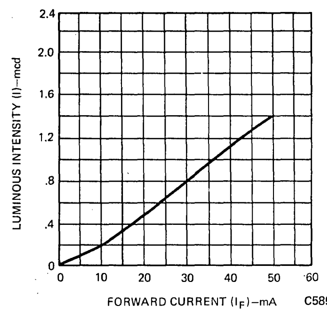


Fig. 2. Luminous Intensity vs. Forward Current

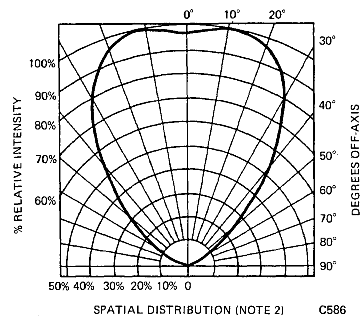
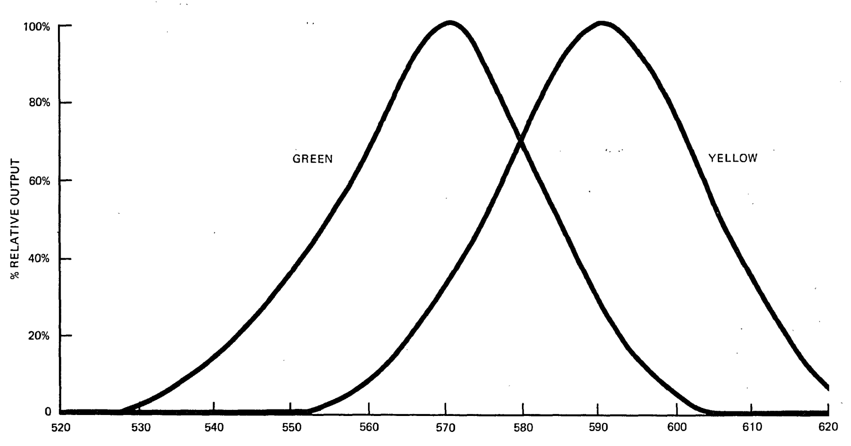


Fig. 3 Spatial Distribution (Note 2)



MV52-MV53 Spectral Response

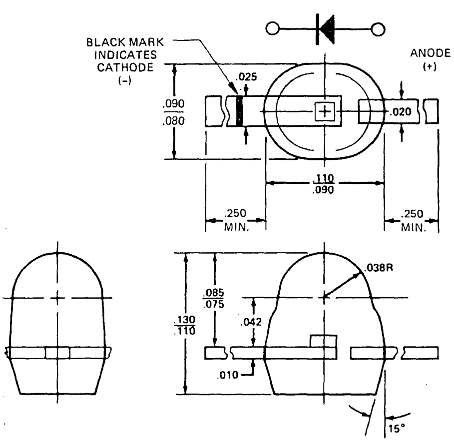
NOTES

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 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

RED MV55A

PACKAGE DIMENSIONS



NOTE: TOLERANCE ±.010″ UNLESS SPECIFIED

C593

DESCRIPTION

The MV55A is a gallium arsenide phosphide device useful for low current drive (5 mA) applications, such as diagnostic functions or indicators.

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

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient	105 mW
Derate linearly from 25°C	1.3 mW/°C
Storage & 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 (1 μsec pulse, 0.1% duty cycle)	400 mA

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

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		.15	10	μA	V_R = 3.0 volts
Light turn-on and turn-off		1		ns	Z = 1Ω system
Capacitance		20		pF	V = 0
Reverse breakdown voltage	3			V	I_F = 10 μA

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature)

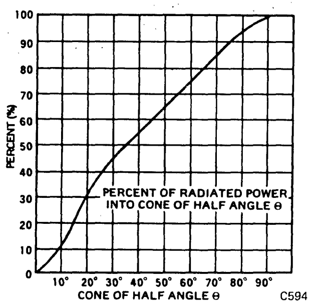


Figure 1

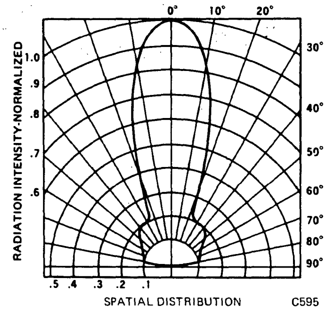


Figure 2 (Note 2)

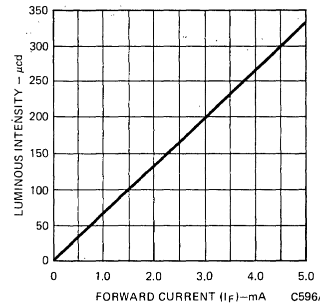


Fig. 3 Luminous Intensity vs. Forward Current

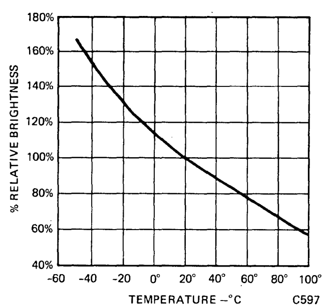


Fig. 4 Relative Output vs. Temperature

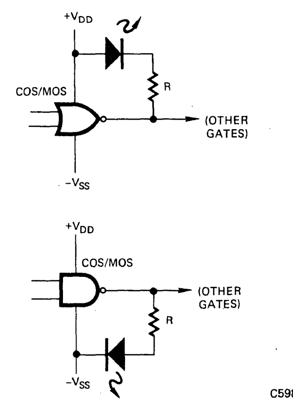


Fig. 5 MV55A Interfaced with COS/MOS

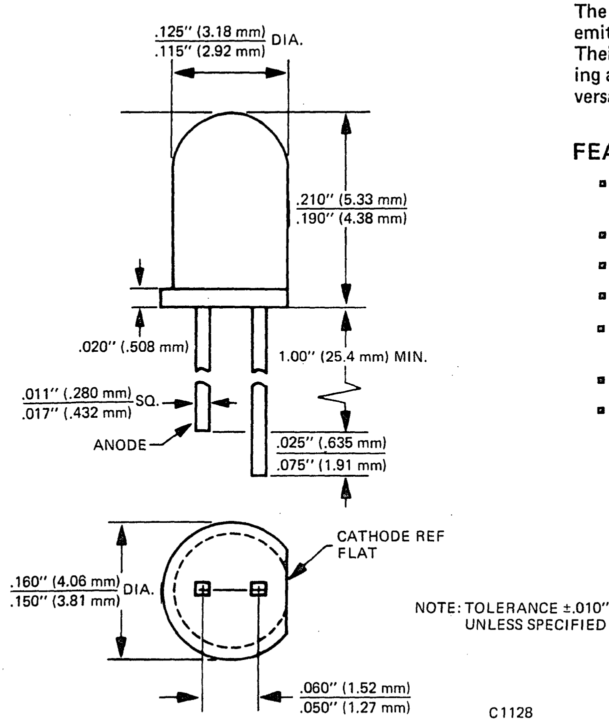
NOTES

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

RED MV5074C
RED MV5075C

PACKAGE DIMENSIONS



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.

ABSOLUTE MAXIMUM RATINGS

Power Dissipation @ 25°C	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 (25°C)	50 mA
Peak Forward Current (1 μsec Pulse Width, 0.3% Duty Cycle)	1.0 A
Reverse Voltage	5.0 Volts
Lead Solder Time 260°C (See Note 2)	5 sec

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

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

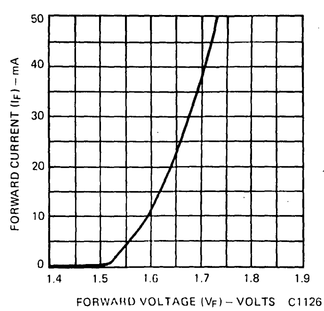


Fig. 1. Forward Current vs. Forward Voltage

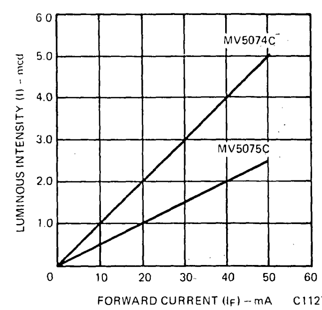


Fig. 2. Luminous Intensity vs. Forward Current

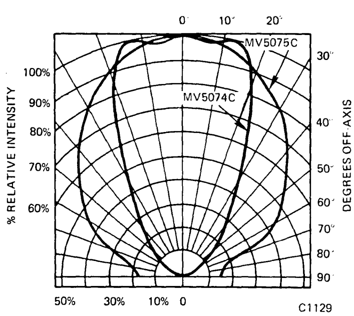


Fig. 3. Spatial Distribution

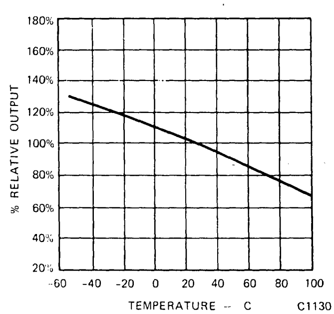


Fig. 4. Percent Relative Response vs. Temperature

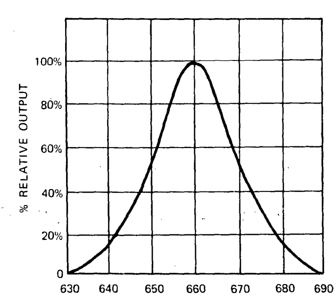


Fig. 5. Spectral Response

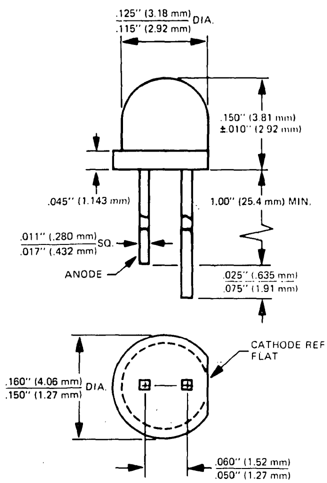
NOTES

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

RED **MV5077C**

PACKAGE DIMENSIONS



NOTE: TOLERANCE ±.010" UNLESS SPECIFIED

C1132

DESCRIPTION

MV5077C is a red (GaAsP) light emitting diode mounted in a red epoxy package. Its small size (approxim*tely 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 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

ABSOLUTE MAXIMUM RATINGS

Power Dissipation @ 25°C	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 (25°C)	50 mA
Peak Forward Current (1 μsec Pulse Width, 0.3% Duty Cycle)	1.0 A
Reverse Voltage	5.0 Volts
Lead Solder Time 260°C (See Note 2)	5 sec

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

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	15.0		Volts	I_R = 100 μA
Dynamic Resistance (R_D)		7.0		Ω	
Capacitance		23		pF	V = 0

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

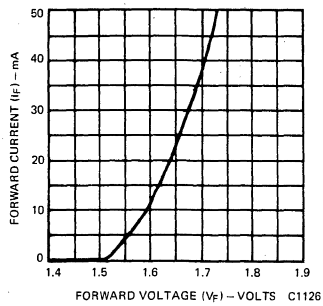


Fig. 1. Forward Current vs. Forward Voltage

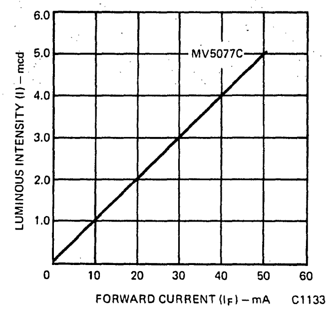


Fig. 2. Luminous Intensity vs. Forward Current

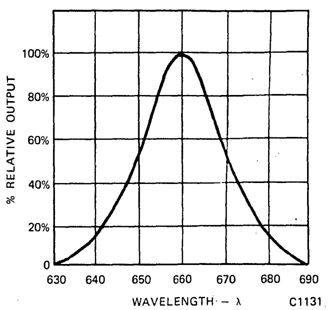


Fig. 3. Spectral Response

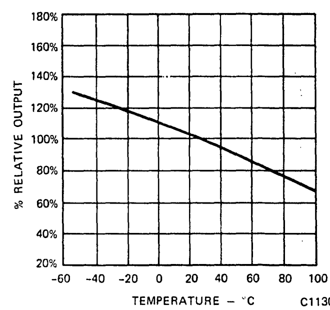


Fig. 4. Percent Relative Response vs. Temperature

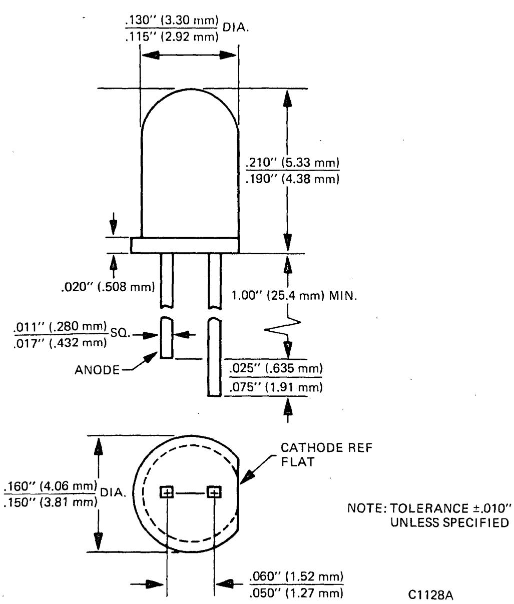
NOTES

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

ORANGE MV5174C GREEN MV5274C YELLOW MV5374C HIGH EFFICIENCY RED MV5774C

PACKAGE DIMENSIONS



DESCRIPTION

These solid state indicators offer a variety of color selection. The high-efficiency red, orange and yellow devices are made with a gallium arsenide phosphide on gallium phosphide; the green units are made with gallium phosphide on gallium phosphide. All are encapsulated in epoxy packages. Their small size (approximately T-1 size), good viewing angle, and small square leads contributes to their versatility as all purpose indicators.

FEATURES

- 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

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient	105 mW
Derate linearly from 25°C	1.14 mW/°C
Storage and operating temperatures	−55°C to 100°C
Lead solder time @ 260°C (See Note 2)	5 sec
Continuous forward current @ 25°C	35 mA
Continuous forward current @ 100°C	10 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle)	1.0 A
Reverse voltage	5.0 V

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	PACKAGE PROFILE
MV5174C	Orange	Orange diffused	Wide beam	High profile
MV5274C	Green	Green diffused	Wide beam	High profile
MV5374C	Yellow	Yellow diffused	Wide beam	High profile
MV5774C	Red	Red diffused	Wide beam	High profile

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

PARAMETER	TEST COND.	UNITS	MV5174C	MV5274C	MV5374C	MV5774C
Forward voltage (V_F)						
Typ.	I_F = 20 mA	V	2.0	2.2	2.1	2.0
Max.	I_F = 20 mA	V	3.0	3.0	3.0	3.0
Luminous intensity (see Note 1)						
Min.	I_F = 20 mA	mcd	1.5	.4	1.5	1.5
Typ.	I_F = 20 mA	mcd	5.0	1.0	4.0	5.0
Peak wave length	I_F = 20 mA	nm	635	565	585	635
Spectral line Half width	I_F = 20 mA	nm	45	35	35	45
Capacitance						
Typ.	V = 0	pF	45	45	45	45
Reverse voltage (V_R)						
Min.	I_R = 100 μA	V	5	5	5	5
Typ.	I_R = 100 μA	V	25	25	25	25
Reverse current (I_R)						
Typ.	V_R = 5.0 V	nA	20	20	20	20
Max.	V_R = 5.0 V	μA	100	100	100	100
Viewing angle (total)	See Fig. 3 & 4	degrees	90	90	90	90

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

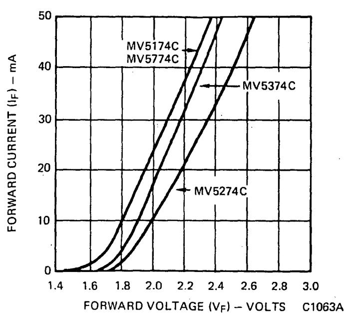


Fig. 1. Forward Current vs. Forward Voltage

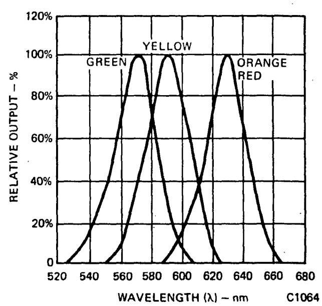


Fig. 2. Spectral Response

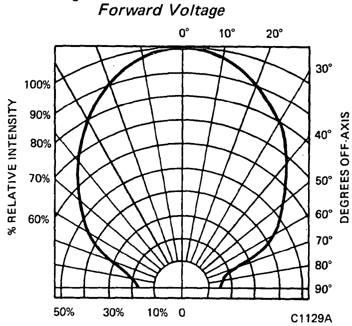


Fig. 3. Spatial Distribution

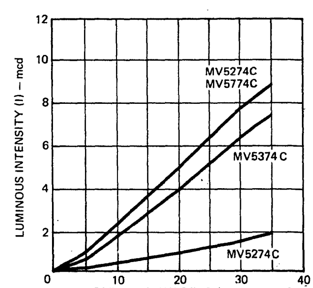


Fig. 4. Luminous Intensity vs. Forward Current

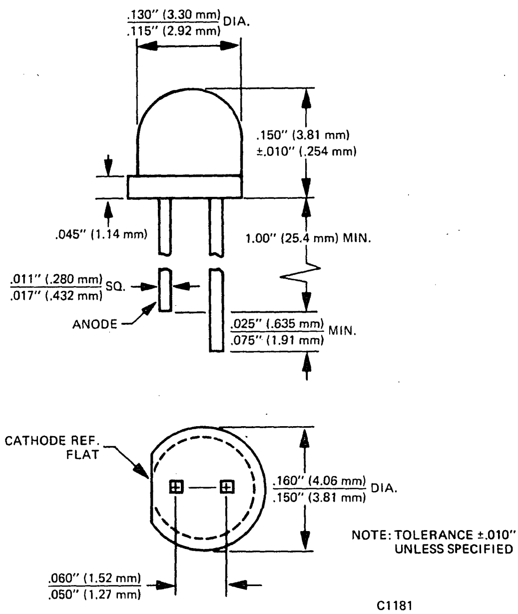
NOTES

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

ORANGE MV5177C GREEN MV5277C YELLOW MV5377C HIGH EFFICIENCY RED MV5777C

PACKAGE DIMENSIONS



DESCRIPTION

These solid state indicators offer a low profile T-1 package. The high-efficiency red, orange and yellow devices are made with gallium arsenide phosphide on gallium phosphide; the green units are made with gallium 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 hole)
- 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

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient	105 mW
Derate linearly from 25°C	1.14 mW/°C
Storage and operating temperatures	−55°C to +100°C
Continuous forward current @ 25°C	35 mA
Peak forward current (1 μsec pulse width, 0.3% duty cycle)	1.0 A
Reverse voltage	5.0 V
Lead solder time @ 260°C (See Note 2)	5 sec

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	PACKAGE PROFILE
MV5177C	Orange	Orange diffused	Wide beam	Low profile
MV5277C	Green	Green diffused	Wide beam	Low profile
MV5377C	Yellow	Yellow diffused	Wide beam	Low profile
MV5777C	Red	Red diffused	Wide beam	Low profile

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

PARAMETER	TEST COND.	UNITS	MV5177C	MV5277C	MV5377C	MV5777C
Forward voltage (V_F)						
Typ.	I_F = 20 mA	V	2.0	2.2	2.1	2.0
Max.	I_F = 20 mA	V	3.0	3.0	3.0	3.0
Luminous intensity (see Note 1)						
Min.	I_F = 20 mA	mcd	1.0	.2	1.0	1.0
Typ.	I_F = 20 mA	mcd	3.0	0.6	2.0	3.0
Peak wave length	I_F = 20 mA	nm	635	565	585	635
Spectral line Half width	I_F = 20 mA	nm	45	35	35	45
Capacitance						
Typ.	V = 0	pF	45	45	45	45
Reverse voltage (V_R)						
Min.	I_R = 100 μA	V	5	5	5	5
Typ.	I_R = 100 μA	V	25	25	25	25
Viewing angle (total) (Fig. 5)		degrees	180	180	180	180
Dynamic resistance (R_D)		Ω	7.0	7.0	7.0	7.0

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

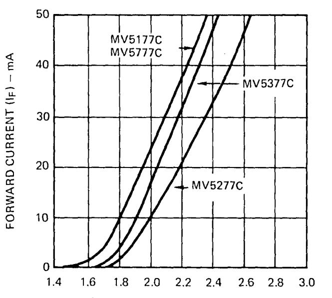


Fig. 1. Forward Current vs. Forward Voltage

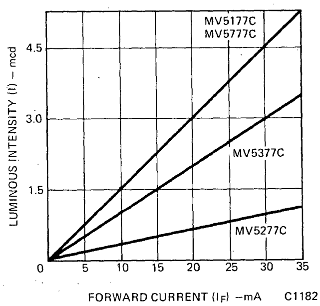


Fig. 2. Luminous Intensity vs. Forward Current

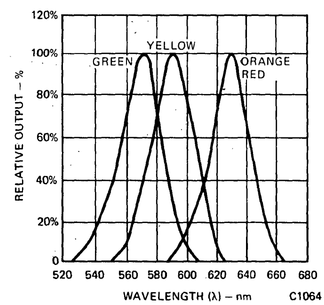


Fig. 3. Spectral Response

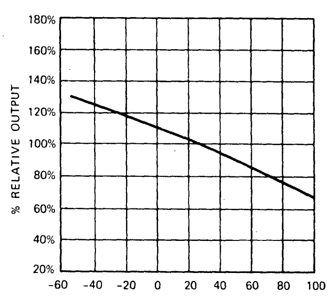


Fig. 4. Percent Relative Response vs. Temperature

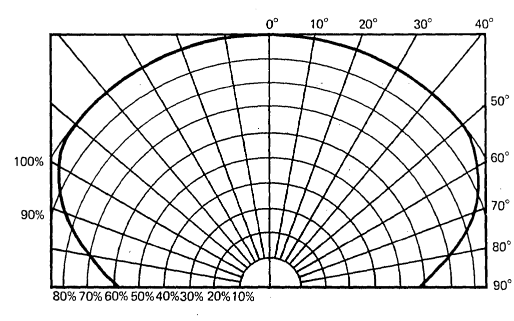


Fig. 5. Spatial Distribution

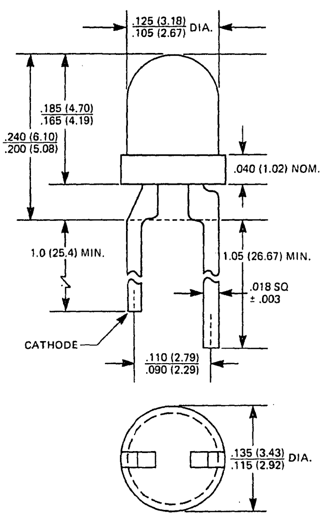
NOTES

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

ORANGE MV5164X
GREEN (HLMP 150X) MV5264X
YELLOW (HLMP 140X) MV5364X
HIGH EFF. GREEN MV5464X
HIGH EFF. RED (HLMP 130X) MV5764X

PACKAGE DIMENSIONS



NOTES:
1. ALL DIMENSIONS IN INCHES (MILLIMETERS)
2. AN EPOXY MINISCUS MAY EXTEND ABOUT 040" (1 mm) DOWN THE LEADS.
3. TOLERANCES ±.010" UNLESS SPECIFIED

C1533

FEATURES

- Replacement for the HLMP 1300, 1400 and 1500 product series.
- 100 mil lead spacing
- High efficiency GaP light
- Versatile mounting on P.C. board or panel
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight
- T-1 diameter
- Wide viewing angle
- Diffused lens

DESCRIPTION

These solid state indicators offer a variety of color selection. The high efficiency red, 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.

LUMINOUS INTENSITY AT 25°C (mcd)

	MIN	TYP	TEST CONDITIONS
ORANGE			
MV51640	1.0	2.0	
MV51641	1.5	2.5	$I_F = 10$ mA
MV51642	2.5	3.5	
GREEN			
MV52640 (HLMP 1500)	.8	1.5	
MV52641 (HLMP 1501)	1.5	3.0	$I_F = 20$ mA
MV52642 (HLMP 1502)	2.5	4.0	
YELLOW			
MV53640 (HLMP 1400)	1.0	2.0	
MV53641 (HLMP 1401)	1.5	3.0	$I_F = 10$ mA
MV53642 (HLMP 1402)	2.5	4.5	
HIGH EFFICIENCY GREEN*			
MV54643	2.0	5.0	$I_F = 20$ mA
MV54644	6.0	10.0	
HIGH EFFICIENCY RED			
MV57640 (HLMP 1300)	1.0	2.0	
MV57641 (HLMP 1301)	1.5	2.5	$I_F = 10$ mA
MV57642 (HLMP 1302)	2.5	3.5	

**see also High Efficiency Green Data Sheet.*

ABSOLUTE MAXIMUM RATINGS

	MV5164X-5364X MV5264X-5764X	MV5464X Series
Power dissipation @ 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°C
Lead solder time @ 260°C (1/16 inch from body)	5 sec	5 sec
Continuous forward current @ 25°C	30 mA	30 mA
Continuous forward current @ 100°C	10 mA	10 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	TEST COND.	UNITS	MV5164X ORANGE	MV5264X GREEN	MV5364X YELLOW	MV5464X HI EFF GREEN	MV5764X RED
Forward voltage (V_F)							
Typ.	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	I_F = 10 mA	nm	635	565	585	562	635
Spectral line							
Half width	I_F = 10 mA	nm	45	35	35	30	45
Capacitance							
Typ.	V = 0, f = 1MHz	pF	45	45	45	20	45
Reverse voltage (V_R)							
Min.	I_F = 100 μA	V	5.0	5.0	5.0	5	5.0
Typ.			25	25	25	50	25
Viewing angle (total)	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)

For MV5464X See High Efficiency Green Data Sheet see page no. 301

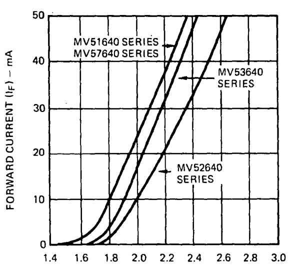


Fig. 1. Forward Current vs. Forward Voltage

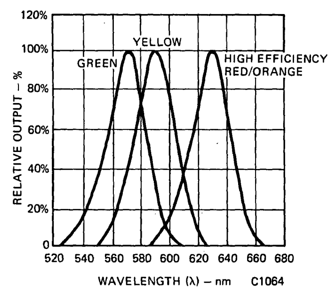


Fig. 2. Spectral Response

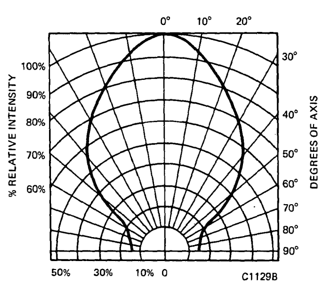


Fig. 3. Spatial Distribution

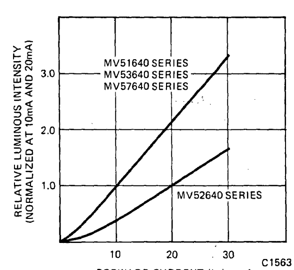
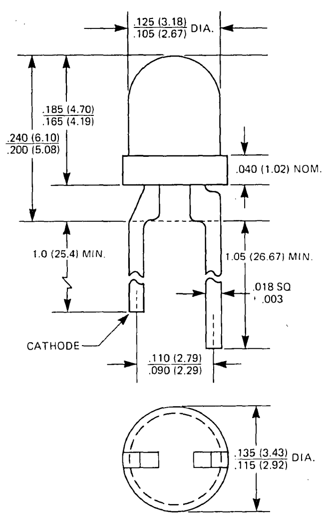


Fig. 4. Relative Luminous Intensity vs. Forward Current

GENERAL INSTRUMENT

YELLOW MV53620 SERIES
HIGH EFFICIENCY RED MV57620 SERIES

PACKAGE DIMENSIONS



NOTES:
1. ALL DIMENSIONS IN INCHES (MILLIMETERS)
2. AN EPOXY MINISCUS MAY EXTEND ABOUT 040" (1 mm) DOWN THE LEADS.
3. TOLERANCES ±.010" UNLESS SPECIFIED

C1533

FEATURES

- Clear-colored, non-diffused lens
- 100 mil lead spacing
- High efficiency GaP light
- Versatile mounting on P.C. board or panel
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight
- T-1 diameter
- Wide viewing angle
- Clear lens

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.

LUMINOUS INTENSITY AT 25°C (mcd)

	MIN	TYP	TEST CONDITIONS
HIGH EFFICIENCY RED			
MV57620	1.5	2.0	
MV57621	3.0	4.0	I_F = 10 mA
MV57622	6.0	8.0	
YELLOW			
MV53620	1.5	2.0	
MV53621	3.0	4.0	I_F = 10 mA
MV53622	6.0	8.0	

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient . . . . 120 mW
Derate linearly from 50°C . . . . 0.4 mA/°C
Storage and operating temperatures . . . . -55°C to 100°C
Lead solder time @ 260°C (1/16 inch from body) . . . . 5 sec
Continuous forward current @ 25°C . . . . 30 mA
Continuous forward current @ 100°C . . . . 10 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle) . . . . 1.0 A
Reverse voltage . . . . 5.0 V

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

PARAMETER	TEST COND.	UNITS	MV53620 SERIES	MV57620 SERIES
Forward voltage (V_F)				
Typ.	I_F = 10 mA	V	2.1	2.0
Max.			3.0	3.0
Peak wave length	I_F = 10 mA	nm	585	635
Spectral line				
Half width	I_F = 10 mA	nm	35	45
Capacitance				
Typ.	V = 0	pF	45	45
Reverse voltage (V_R)				
Min.	I_R = 100 μA	V	5.0	5.0
Typ.			25	25
Viewing angle (total)	See Fig. 3	degrees	60	60

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

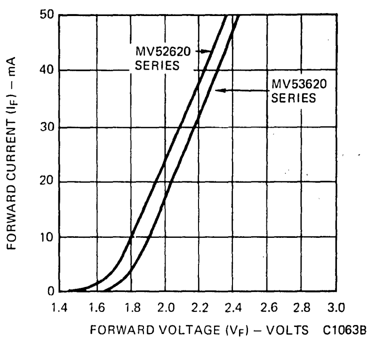


Fig. 1. Forward Current vs. Forward Voltage

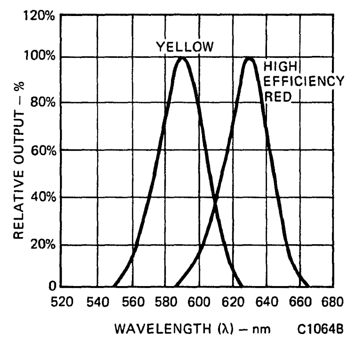


Fig. 2. Spectral Response

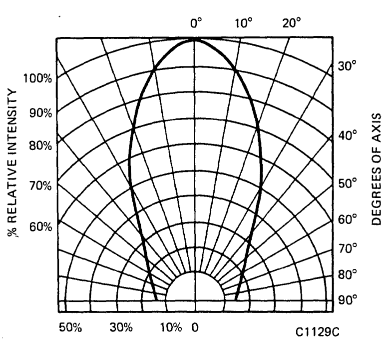


Fig. 3. Spatial Distribution

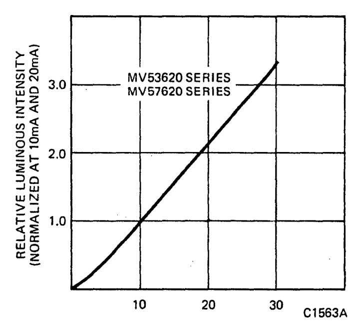
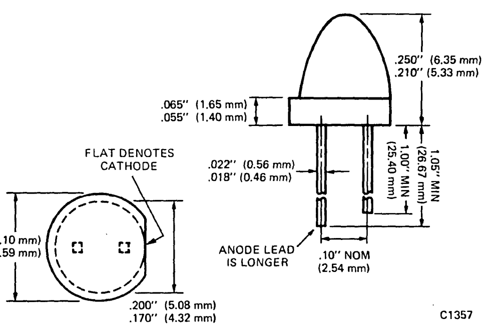


Fig. 4. Relative Luminous Intensity vs. Forward Current

GENERAL INSTRUMENT

MV50152 MV50154 MV52152 MV52154 MV53152 MV53154 MV57152 MV57154

PACKAGE DIMENSIONS



DESCRIPTION

These solid state indicators offer a variety of lens effects and color availability in a short barrel T-1¾ package. The red, orange and yellow devices are made with gallium arsenide phosphide, and the green units are made with gallium phosphide. All are encapsulated in epoxy lenses.

FEATURES

- High intensity light source with two lens effects.
- Red, orange, 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
- Ultra high brightness
- Short T-1 3/4 size

ABSOLUTE MAXIMUM RATINGS

Maximum power dissipation @ 25°C ambient (red) . . . . 180 mW
Maximum power dissipation @ 25°C ambient (Orange, yellow, green) . . . . 105 mW
Derate linearly from 25°C (GYO) . . . . 1.14 mW/°C
Derate linearly from 25°C (Red) . . . . 2.0 mW/°C
Maximum storage and operating temperatures . . . . −55°C to 100°C

Maximum lead solder time @ 260°C (See Note 3) . . . 5 Sec
Maximum currents and voltages
Continuous forward current @ 25°C . . . . Red = 100 mA GYO = 35 mA
Continuous forward current @ 100°C . . . . . . 10 mA
Peak forward current (1 μS pulse, 0.3% duty cycle) . . . . 1.0 A
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
MV52152	Green	Green clear	Point source
MV52154	Green	Green lightly diffused	Soft point source
MV53152	Yellow	Orange clear	Point source
MV53154	Yellow	Orange lightly diffused	Soft point source
MV57152	Orange	Amber clear	Point source
MV57154	Orange	Amber lightly diffused	Soft point source

MV50152/4 MV52152/4 MV53152/4 MV57152/4

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

PARAMETER	TEST COND.	UNITS	MV50152	MV50154	MV52152	MV52154	MV53152	MV53154	MV57152	MV57154
Fwd. Voltage (V_F)	10 mA	V	1.6	1.6	2.2	2.2	2.1	2.1	2.0	2.0
Typ			1.6	1.6	2.2	2.2	2.1	2.1	2.0	2.0
Max			2.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0
Luminous Intensity										
(see Note 1) Min	10 mA	mcd	.6	.4	.75	.5	3.0	1.5	4.0	2.0
Typ	10 mA	mcd	2.0	1.5	2.0	1.5	5.0	3.0	8.0	4.0
Peak wave length	10 mA	nm	660	660	565	565	585	585	630	630
Spectral line Half width	10 mA	nm	20	20	35	35	35	35	45	45
Capacitance										
Typ	V = 0	pF	30	30	45	45	45	45	45	45
Reverse volt. (V_R)	I_R = 100 μA	V								
Min			5	5	5	5	5	5	5	5
Typ			25	25	25	25	25	25	25	25
Reverse current (I_R)	V_R = 5.0 V	μA								
Max			100	100	100	100	100	100	100	100
Typ			20	20	20	20	20	20	20	20
Viewing angle (see fig. 3)			45	50	45	50	45	50	45	50

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

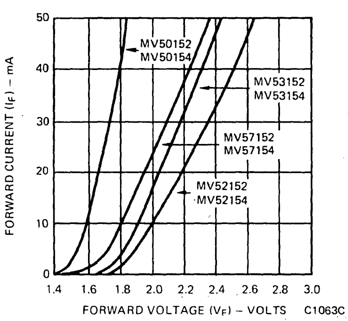


Fig. 1. Forward Current vs. Forward Voltage

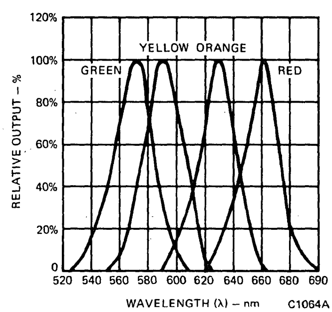


Fig. 2. Spectral Response

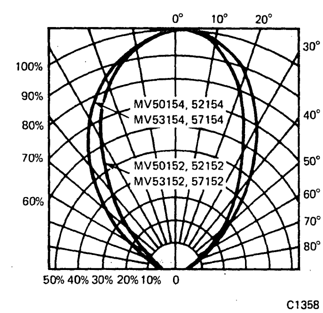


Fig. 3. Spatial Distribution (Note 2)

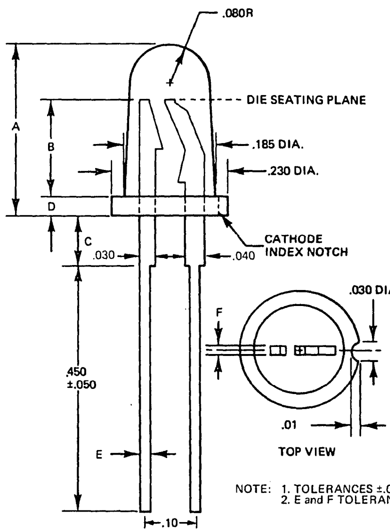
NOTES

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

RED MV5020 SERIES

PACKAGE DIMENSIONS



NOTE: 1. TOLERANCES ±.010" UNLESS SPECIFIED
2. E and F TOLERANCES ±.002"

C599

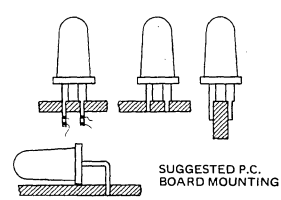
DESCRIPTION

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

- Low cost
- High intensity red light source with various lens colors and effects
- Versatile mounting on PC board or panel
- Snap in panel mounting clip available (See MP21 and MP22 for clip detail)

BOARD MOUNTING



SUGGESTED P.C. BOARD MOUNTING

C601

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
Continuous forward current @ 100°C	20 mA
Peak forward current (1 µsec 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	Typ.	$V_R = 5.0$ V	nA	15	15	15	15	15	15	15
	Max.	$V_R = 5.0$ V	μA	100	100	100	100	100	100	100
Reverse Voltage VR	Min.	$I_R = 100\mu A$	V	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	Typ.	$I_R = 100\mu A$	V	10.0	10.0	10.0	10.0	10.0	10.0	10.0
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

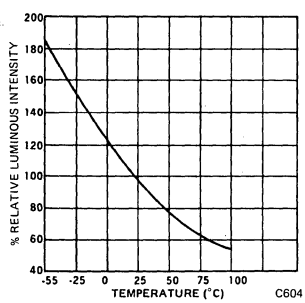


Fig. 1. Luminous Intensity vs. Temperature

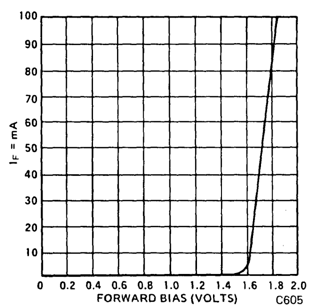


Fig. 2. Forward Current vs. Forward Voltage

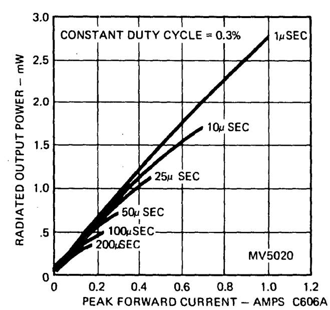


Fig. 3. Radiated Output Power vs. Peak Forward Current

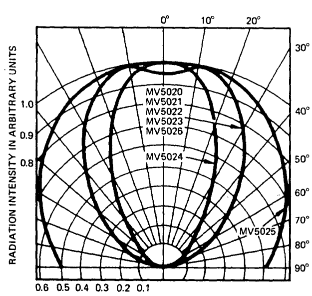


Fig. 4. Spatial Distribution

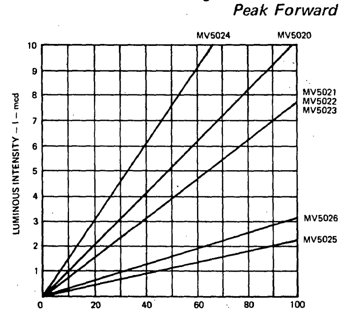


Fig. 5. Luminous Intensity vs. Forward Current

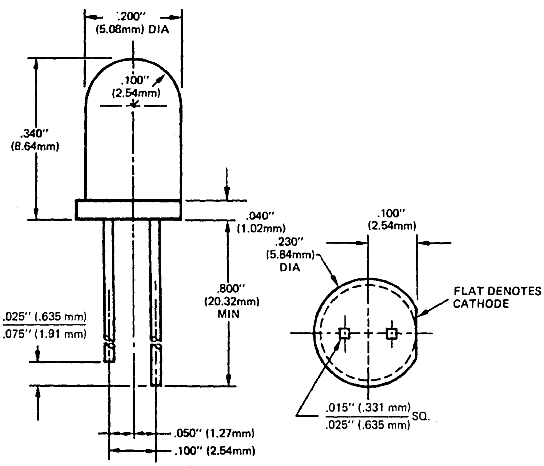
NOTES

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

RED MV5050 MV5053
RED MV5051 MV5055
RED MV5052 MV5056

PACKAGE DIMENSIONS



NOTE: TOLERANCES ±.010" UNLESS SPECIFIED C1062

DESCRIPTION

The MV5050 series of solid state indicators is made with Gallium Arsenide Phosphide light emitting diodes encapsulated in epoxy lenses. Various lens effects are pleasing in different design settings.

FEATURES

- High intensity red light source with various lens colors and effects
- Versatile mounting on P.C. board or panel
- Snap in mounting grommet available on request
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight
- Upon request, also available with anode lead trimmed longer than cathode.

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	POP-IN MOUNTING	CIRCUIT BOARD MOUNTING
MV5050	Red	Clear	Point	X	X
MV5051	Red	Diffused	Soft	X	X
MV5052	Red	Trans. Red	Point	X	X
MV5053	Red	Red Diffused	Flooded	X	X
MV5055	Red	Red Diffused	Flooded	X	X
MV5056	Red	Dark Red Diffused	Flooded	X	X

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 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 @ 260°C (See Note 3)	5 sec
Continuous forward current @ 25°C	100 mA
Continuous forward current @ 100°C	15 mA
Peak forward current (1 µsec pulse, 0.3% duty cycle)	1.0 A
Reverse voltage	5.0 V

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

PARAMETER	TEST COND.	UNITS	5050	5051	5052	5053	5055	5056
Forward Voltage (V_F)								
Typ.	I_F = 20 mA	V	1.7	1.7	1.7	1.7	1.7	1.7
Max.	I_F = 20 mA	V	2.2	2.2	2.2	2.2	2.2	2.2
Luminous Intensity (See note 1)								
Min.	I_F = 20 mA	mcd	0.5	0.4	0.7	0.5	0.1	0.2
Typ.	I_F = 20 mA	mcd	2.0	1.6	2.0	1.6	.6	.8
Peak Wave Length	I_F = 20 mA	nm	670	670	670	670	670	670
Spectral Line Half Width	I_F = 20 mA	nm	20	20	20	20	20	20
Capacitance								
Typ.	V = 0	pF	30	30	30	30	30	30
Reverse Voltage (V_R)								
Min.	I_R = 100µA	V	5	5	5	5	5	5
Typ.	I_R = 100µA	V	25	25	25	25	25	25
Reverse Current (I_R)								
Max.	V_R = 5.0V	µA	100	100	100	100	100	100
Typ.	V_R = 5.0V	nA	20	15	5	5	5	5
Rise Time	10%-90% 50Ω system	nsec	50	50	50	50	50	50
Fall Time	90%-10% 50Ω system	nsec	50	50	50	50	50	50
Viewing Angle	See Fig. 5 & 6	degrees	50	72	72	80	150	110

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

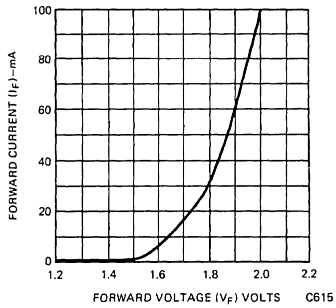


Fig. 1. Forward Current vs. Forward Voltage

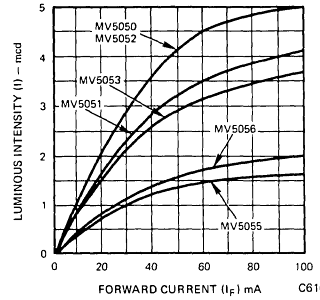


Fig. 2. Luminous Intensity vs. Forward Current

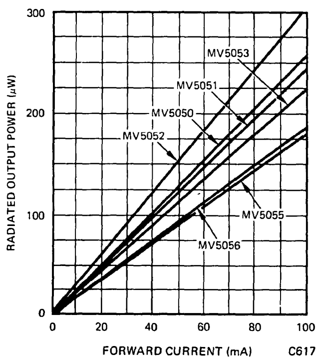


Fig. 3. ROP vs. Forward Current

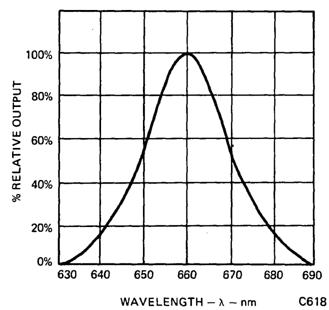


Fig. 4. Spectral Response

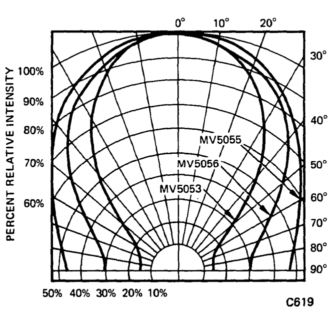


Fig. 5. Spatial Distribution (Note 2)
(MV5053, MV5055, MV5056)

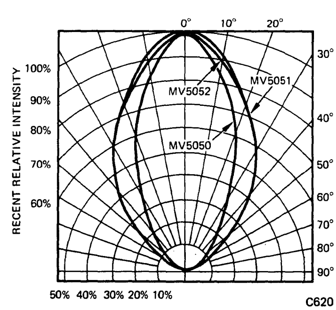


Fig. 6. Spatial Distribution (Note 2)
(MV5050, MV5051, MV5052)

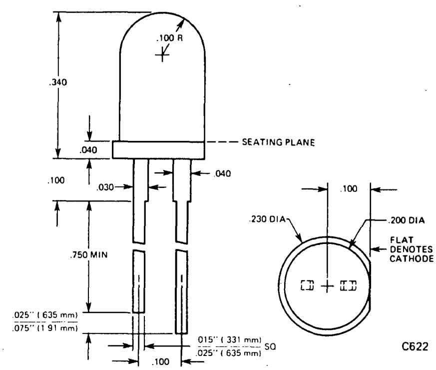
NOTES

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 (1.6mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

GENERAL INSTRUMENT

RED MV5054-1
RED MV5054-2
RED MV5054-3

PACKAGE DIMENSIONS



NOTE 1: TOLERANCES ±.010" 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" dia. circle
- High intensity red light source for back lighting a panel
- Versatile mounting on PC board
- Mounting grommet available.

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 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 @ 230°C (See Note 3)	5 sec
Continuous forward current @ 25°C	100 mA
Continuous forward current @ 100°C	15 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle)	1.0 A
Reverse voltage	5.0 V
Reverse current	10 μA

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

($25^{\circ}C$ Free-Air Temperature Unless Otherwise Specified)

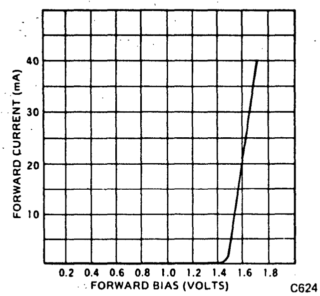


Fig. 2. Forward Current vs. Forward Voltage

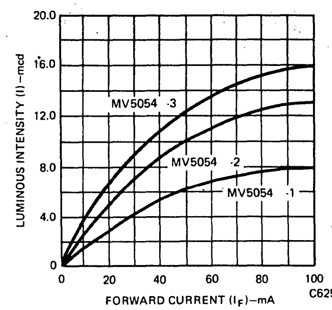


Fig. 3. Luminous Intensity vs. Forward Current

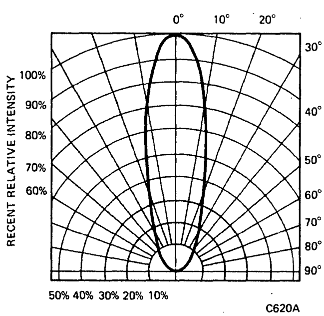


Fig. 4. Spatial Distribution (Note 2)

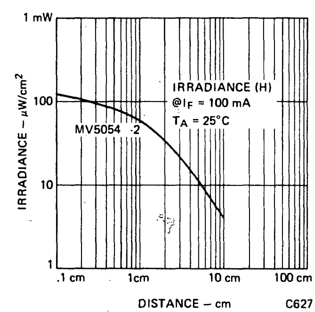


Fig. 5. Irradiance vs. Distance

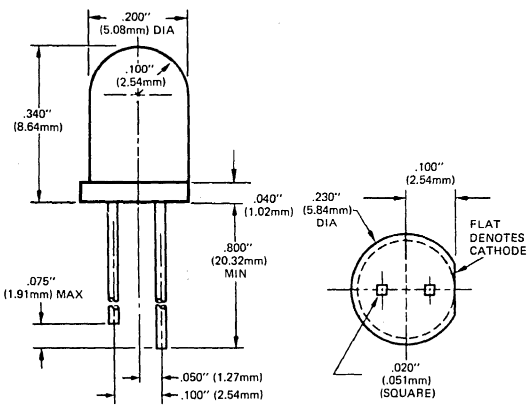
NOTES

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 $260^{\circ}C$ 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

RED MV5054A-1
RED MV5054A-2
RED MV5054A-3

PACKAGE DIMENSIONS



NOTE: 1. TOLERANCES ±.010" UNLESS SPECIFIED

C1062

DESCRIPTION

The MV5054A lamp series is made with gallium arsenide phosphide diodes mounted in a red epoxy package.

FEATURES

- Three light intensity categories
- Illuminates a ¼" dia. circle
- High intensity red light source for back lighting a panel
- Versatile mounting on PC board
- Mounting grommet available
- Improved performance in multiple unit applications

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 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 @ 260°C (See Note 3)	5 sec
Continuous forward current @ 25°C	100 mA
Continuous forward current @ 100°C	15 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle)	1.0 A
Reverse voltage	5.0 V
Reverse current	10 μA

ELECTRO-OPTICAL CHARACTERISTICS (25°C Ambient Temperature)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous intensity (Note 1)					
MV5054A-1	1.0	2.0		mcd	I_F = 10 mA
MV5054A-2	2.0	3.0		mcd	I_F = 10 mA
MV5054A-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)

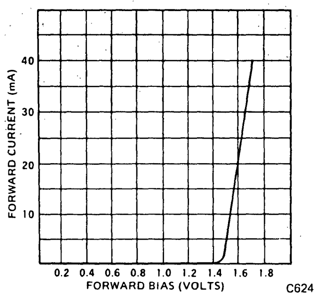


Fig. 2. Forward Current vs. Forward Voltage

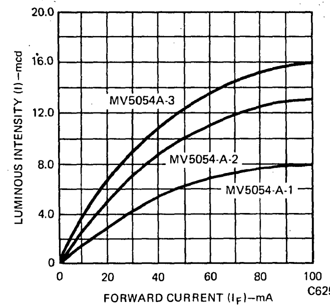


Fig. 3. Luminous Intensity vs. Forward Current

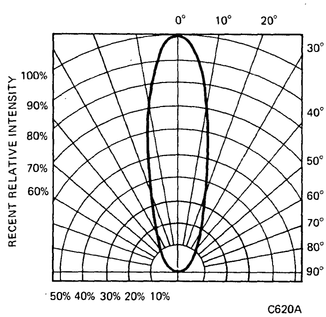


Fig. 4. Spatial Distribution (Note 2)

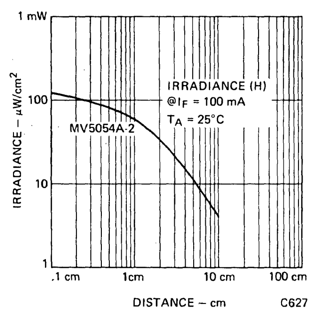


Fig. 5. Irradiance vs. Distance

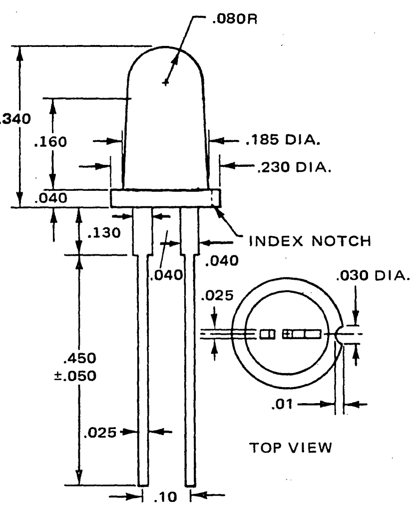
NOTES

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 (1.6mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.*

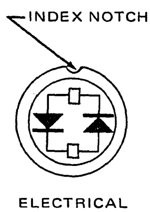
GENERAL INSTRUMENT

RED MV5094

PACKAGE DIMENSIONS



NOTE: TOLERANCES ±.010" UNLESS SPECIFIED   C647



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
A.C.$_{(RMS)}$/D.C. Forward Current 100°C	5 mA
I^2T (0.1% Duty Cycle)	2.5×10^{-4} amps^2 sec
I_{peak} (repetitive) (0.3% Duty Cycle, 1.0 μsec pulse width)	1.0A
Lead Solder time 260°C (See Note 3)	5 sec

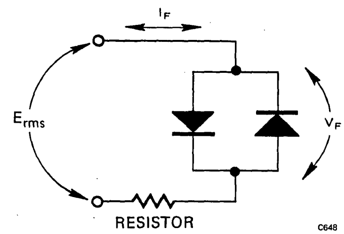
TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (25°C Ambient Temperature Unless Stated Otherwise)

	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

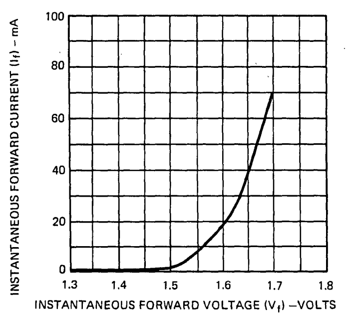


Fig. 1. Forward Current vs. Forward Voltage

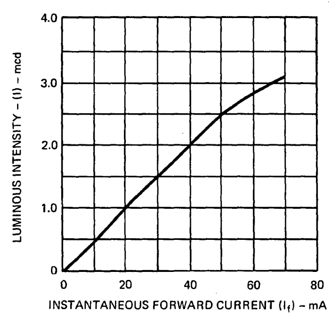


Fig. 2. Luminous Intensity vs. Forward Current

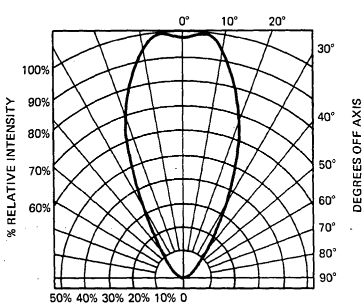


Fig. 3. Spatial Distribution

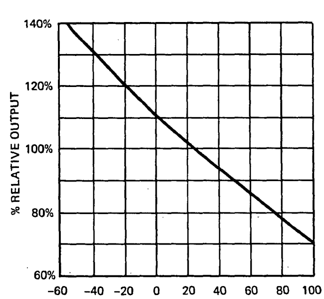


Fig. 4. Output vs. Temperature

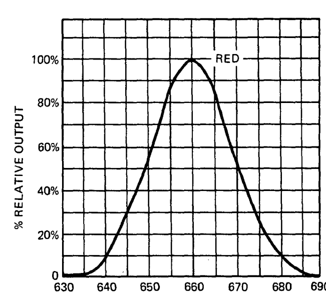


Fig. 5. Spectral Distribution

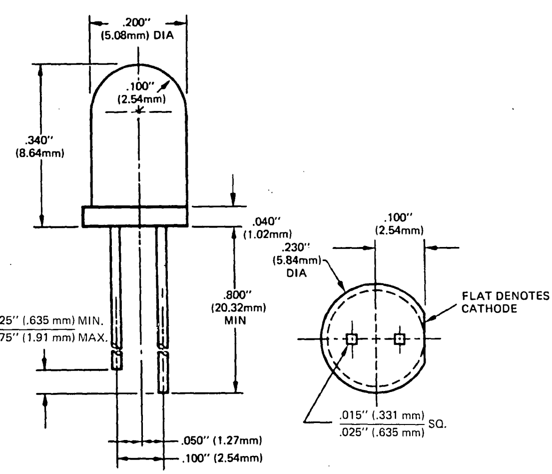
NOTES

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

ORANGE MV5152 · GREEN MV5252 · YELLOW MV5352 · HIGH EFFICIENCY RED MV5752 · HIGH EFFICIENCY GREEN MV64520 · HIGH EFFICIENCY GREEN MV64521

PACKAGE DIMENSIONS



NOTE: 1. TOLERANCES ±.010 UNLESS SPECIFIED
2. DRAWING SHOWS CATHODE LONG

C1062

DESCRIPTION

These solid state indicators offer high brightness and color availability. The high-efficiency red, orange and yellow devices are made with gallium arsenide phosphide on gallium phosphide; the green units are made with gallium phosphide on gallium phosphide.

FEATURES

- High on-axis light output
- High efficiency GaP light sources
- Versatile mounting on P.C. board or panel
- Snap in grommet available on request
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight
- Upon request, also available with anode lead trimmed longer than cathode.

ABSOLUTE MAXIMUM RATINGS

	MV5X52	MV6452X
Power dissipation @ 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°C
Lead solder time @ 260°C (See Note 3)	5 sec	5 sec
Continuous forward current @ 25°C	35 mA	30 mA
Continuous forward current @ 100°C	10 mA	10 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

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	POLARITY
MV5152	Orange	Clear orange	Narrow beam; point source	Cathode long
MV5252	Green	Clear green	Narrow beam; point source	Cathode long
MV5352	Yellow	Clear yellow	Narrow beam; point source	Cathode long
MV5752	High Eff. Red	Clear red	Narrow beam; point source	Cathode long
MV64520	High Eff. Green	Clear green	Narrow beam; point source	Cathode short
MV64521	High Eff. Green	Clear green	Narrow beam; point source	Cathode short

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature

PARAMETER	TEST COND.	UNITS	MV5152	MV5252	MV5352	MV64520	MV64521	MV5752
Forward voltage (V_F)								
Typ.	I_F = 20 mA	V	2.0	2.2	2.1	2.2	2.2	2.0
Max.	I_F = 20 mA	V	3.0	3.0	3.0	3.0	3.0	3.0
Luminous Intensity								
(See Note 1) Min.	I_F = 20 mA	mcd	17.0	2.0	10.0	12.0	30.0	17.0
Typ.	I_F = 20 mA	mcd	40.0	15.0	45.0	25	60	40.0
Peak wave length	20 mA	nm	635	565	585	562	562	635
Spectral line Half width	20 mA	nm	45	35	35	30	30	45
Capacitance								
Typ.	V = 0, f = 1 MHz	pF	45	45	45	20	20	45
Reverse voltage (V_R)								
Min.	I_R = 100 μA	V	5	5	5	5	5	5
Typ.	I_R = 100 μA	V	25	25	25	50	50	25
Reverse current (I_R)								
Max.	V_R = 5.0 V	μA	100	100	100	100	100	100
Typ.	V_R = 5.0 V	nA	20	20	20	20	20	20
Viewing angle (total)	See Fig. 3 & 4	degrees	28	28	28	35	35	28

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) **For MV6452X see High Efficiency Data Sheet page no. 301**

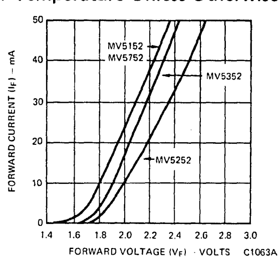


Fig. 1. Forward Current vs. Forward Voltage

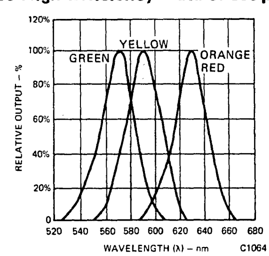


Fig. 2. Spectral Response

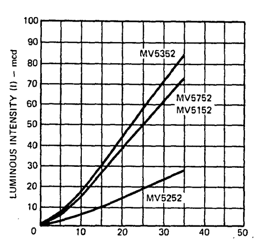


Fig. 3. Luminous Intensity vs. Forward Current

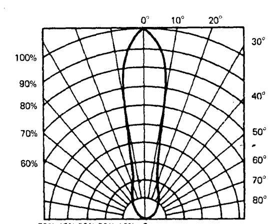


Fig. 4. Spatial Distribution (Note 2) (MV5352, MV5252, MV5152, MV5752)

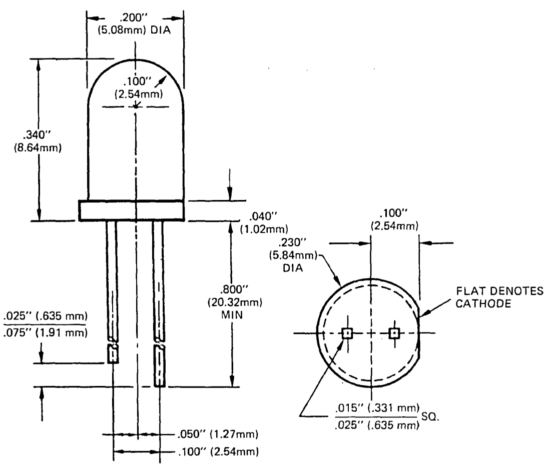
NOTES

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

ORANGE MV5153/4
GREEN MV5253/4
YELLOW MV5353/4
HIGH EFFICIENCY RED MV5753/4
HIGH EFFICIENCY GREEN MV64530/1

PACKAGE DIMENSIONS



NOTE 1: TOLERANCES ±.010" UNLESS SPECIFIED
2: DRAWING SHOWS CATHODE LONG

C1062

DESCRIPTION

These solid state indicators offer a variety of lens effects and color availability. The high efficiency red, orange and yellow devices are made with gallium arsenide phosphide on gallium phosphide; the green units are made with gallium phosphide on gallium phosphide.

FEATURES

- High efficiency GaP light source with various lens effects
- Versatile mounting on P.C. board or panel
- Snap in grommet available on request
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight
- Upon request, also available with anode lead trimmed longer than cathode.

ABSOLUTE MAXIMUM RATINGS

	MV5X5X	MV6453X
Power dissipation @ 25°C ambient	120 mW	120 mW
Derate linearly from 25°C (MV6453X from 50°C)	1.14 mW/°C	1.6 mW/°C
Storage and operating temperatures	-55°C to 100°C	-55°C to 100°C
Lead solder time @ 260°C (See Note 3)	5 sec	5 sec
Continuous forward current @ 25°C	35 mW	30 mA
Continuous forward current @ 100°C	10 mA	10 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

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	POLARITY
MV5153	Orange	Orange diffused	Wide beam	Cathode long
MV5154	Orange	Orange diffused	Narrow beam	Cathode long
MV5253	Green	Green diffused	Wide beam	Cathode long
MV5254	Green	Green diffused	Narrow beam	Cathode long
MV5353	Yellow	Yellow diffused	Wide beam	Cathode long
MV5354	Yellow	Yellow diffused	Narrow beam	Cathode long
MV5753	High Eff. Red	Red diffused	Wide beam	Cathode long
MV5754	High Eff. Red	Red diffused	Narrow beam	Cathode long
MV64530	High Eff. Green	Green diffused	Wide beam	Cathode short
MV64531	High Eff. Green	Green diffused	Wide beam	Cathode short

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

PARAMETER	TEST COND.	UNITS	5153	5154	5253	5254	5353	5354	64530	64531	5753	5754
Forward voltage (V_F)												
Typ.	I_F = 20 mA	V	2.0	2.0	2.2	2.2	2.1	2.1	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	3.0
Luminous intensity												
(See Note 1) Min.	I_F = 20 mA	mcd	3.0	3.0	0.8	0.9	2.5	3.0	3.0	7.0	3.0	3.0
Typ.	I_F = 20 mA	mcd	6.0	10.0	3.5	3.0	8.0	10.0	6.0	14.0	9.0	10.0
Peak wave length	I_F = 20 mA	nm	635	635	565	565	585	585	562	562	635	635
Spectral line Half width	I_F = 20 mA	nm	45	45	35	35	35	35	30	30	45	45
Capacitance												
Typ.	V = 0	pF	45	45	45	45	45	45	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	5
Typ.	I_R = 100 μA	V	25	25	25	25	25	25	50	50	25	25
Reverse current (I_R)												
Max.	V_R = 5.0 V	μA	100	100	100	100	100	100	100	100	100	100
Typ.	V_R = 5.0 V	nA	20	20	20	20	20	20	20	20	20	20
Viewing angle (total)	See Fig. 3 & 4	degrees	65	24	65	24	65	24	75	75	65	24

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

For MV64530/-1 see High Efficiency Green Data Sheet see page no. 301

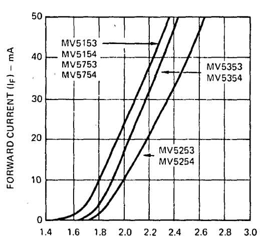


Fig. 1. Forward Current vs. Forward Voltage

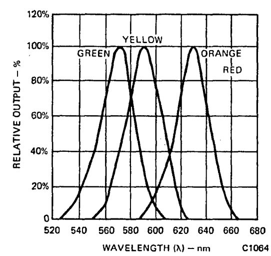


Fig. 2. Spectral Response

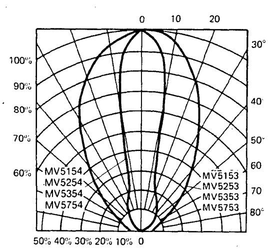


Fig. 3. Spatial Distribution (Note 2)

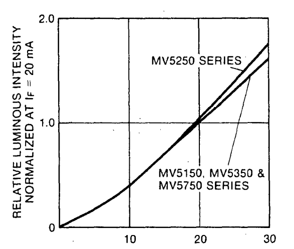


Fig. 4. Relative Luminous Intensity vs. Forward Current

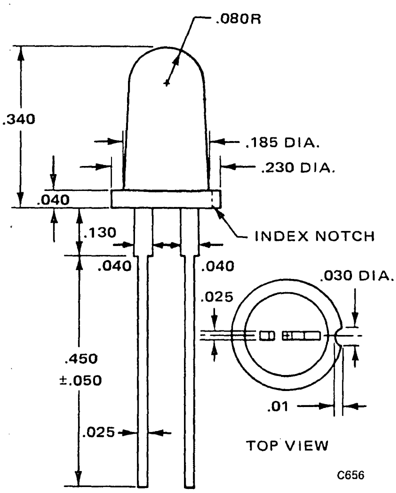
NOTES

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.*

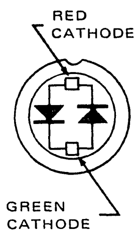
GENERAL INSTRUMENT

RED/GREEN MV5491

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

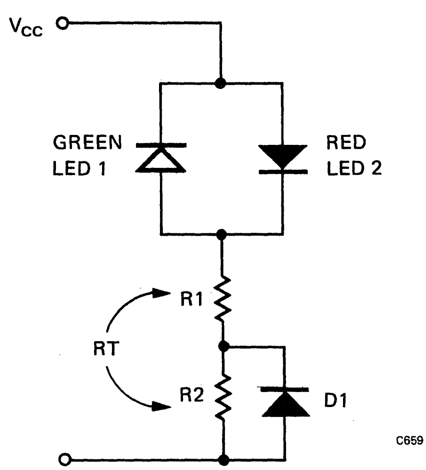
	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Forward Voltage Temp. Coefficient					
Red		−1.5		mV/°C	I_F = 20 mA
Green		−3.0		mV/°C	I_F = 20 mA

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:

$$R_1 = \frac{V_{CC} - (V_{LED1} + V_{D1})}{I_{LED1}} = \frac{5.0 - (2.5 + 0.7)}{.035} = 51\Omega$$

$R_T - R_1 = R_2$

$168 - 51 = 117\Omega$

SUGGESTED RESISTOR COMBINATIONS

RED \ GREEN →	10 mA			20 mA			30 mA		
	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)

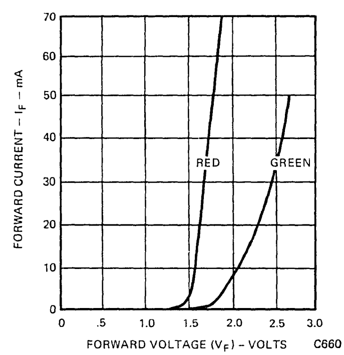


Fig. 1. Forward Current vs Forward Voltage

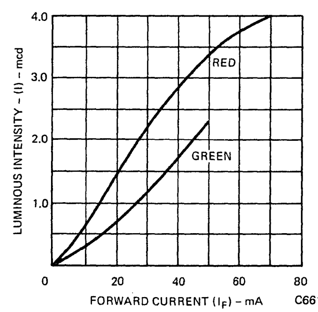


Fig. 2. Luminous Intensity vs Forward Current

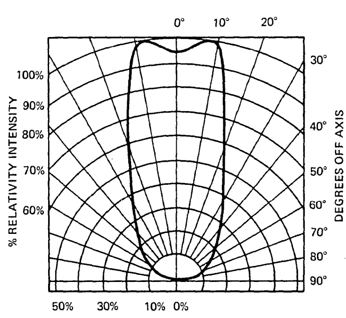


Fig. 3 Spatial Distribution (Note 1)

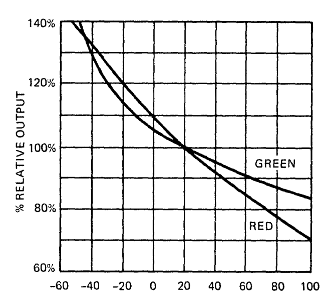


Fig. 4. Relative Output vs Temperature

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

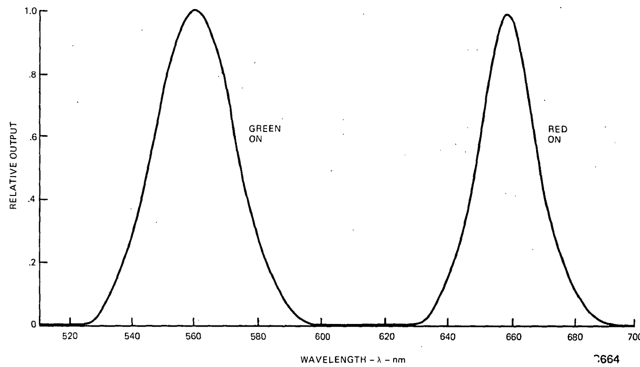


Fig. 5. Spectral Distribution

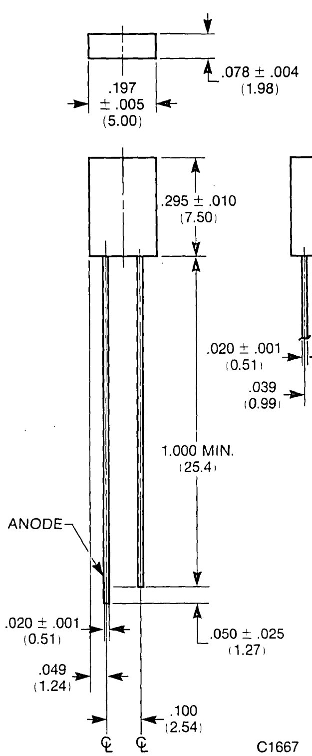
NOTES

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

YELLOW MV53123
HIGH EFFICIENCY GREEN MV54123
HIGH EFFICIENCY RED MV57123

PACKAGE DIMENSIONS



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 @ 20 mA
- Solid state reliability
- Compact, rugged, lightweight

APPLICATIONS

- Legend backlighting
- Illuminated pushbutton
- Panel indicator
- Bargraph meter

NOTE 1: ALL DIMENSIONS SHOWN IN INCHES (MILLIMETERS)
2: TOLERANCES ±.010" UNLESS SPECIFIED

ABSOLUTE MAXIMUM RATINGS

	MV53123 MV57123	MV54123
Power dissipation @ 25°C	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 @ 25°C	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	5.0
Typ.	I_R = 100 μA	V	25	50	25
Viewing angle (total)		degrees	100	100	100

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS CURVES (25°C Free Air Temperature)

For MV54123 see High Efficiency Green Data Sheet curves page no. 304

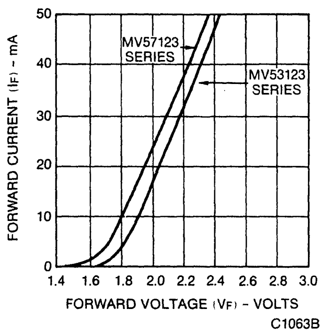


Fig. 1. Forward Current vs. Forward Voltage

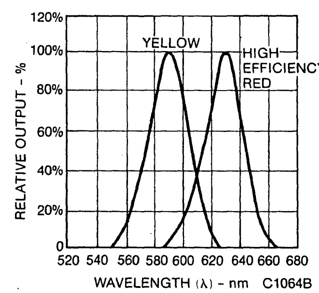


Fig. 2. Spectral Response

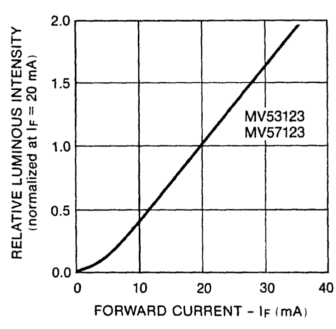


Fig. 3. Luminous Intensity vs. Forward Current (See note 2)

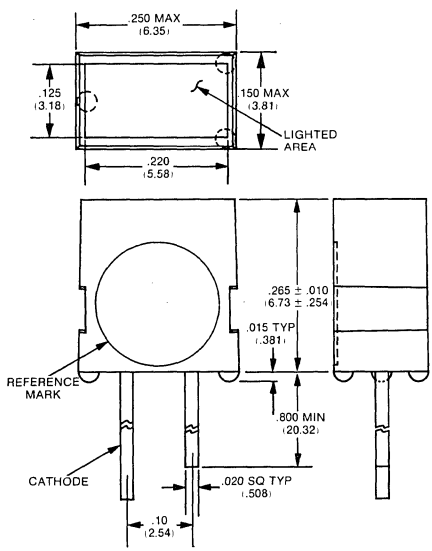
NOTES

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

GREEN MV52124 **HIGH EFFICIENCY GREEN MV54124**
YELLOW MV53124 **HIGH EFFICIENCY RED MV57124**

PACKAGE DIMENSIONS



DESCRIPTION

This series of rectangularly shaped solid state indicators is available in green, yellow, and red. The rectangular lighted area is uniformly lit by a high performance LED chip.

FEATURES

- .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)

APPLICATIONS

- Legend backlighting
- Illuminated pushbutton
- Panel indicator
- Bargraph meter

ABSOLUTE MAXIMUM RATINGS

	MV52124 MV53124 MV57124	MV54124
Power dissipation @ 25°C	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 @ 25°C	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	SYM	MV52124	MV53124	MV54124	MV57124	UNITS	TEST CONDITIONS
Forward voltage, TYP.	V_F	2.0	2.0	2.2	2.0	V	I_F = 20 mA
MAX.		3.0	3.0	3.0	3.0	V	
Luminous intensity, MIN.	(See note 2)	1.0	1.0	2.0	1.0	mcd	I_F = 20 mA
TYP.		3.0	4.0	4.0	4.0	mcd	
Peak wavelength		565	585	562	635	nm	I_F = 20 mA
Spectral line half width		45	45	30	45	nm	I_F = 20 mA
Reverse voltage, MIN.	V_R	5	5	5	5	V	I_R = 100 μA
TYP.		25	25	50	25	V	
Reverse current, TYP.	I_R	20	20	20	20	nA	V_R = 5.0 V
MAX.		100	100	100	100	μA	
Capacitance		45	45	20	45	pF	V = 0
Viewing angle (total)		100	100	100	100	degrees	V = 0, f = 1MHz

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) **For MV54124 see High Efficiency Green Data Sheet page no. 304**

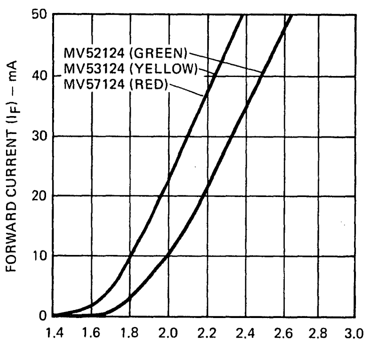


Fig. 1. Forward Current vs. Forward Voltage

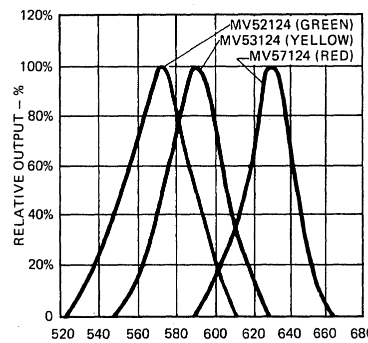


Fig. 2. Spectral Response

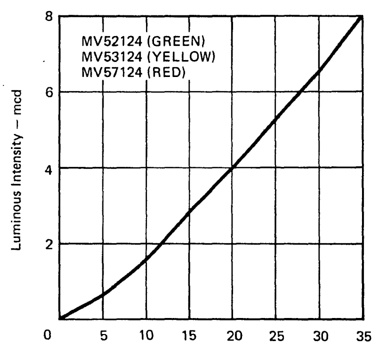


Fig. 3. Luminous Intensity vs. Forward Current

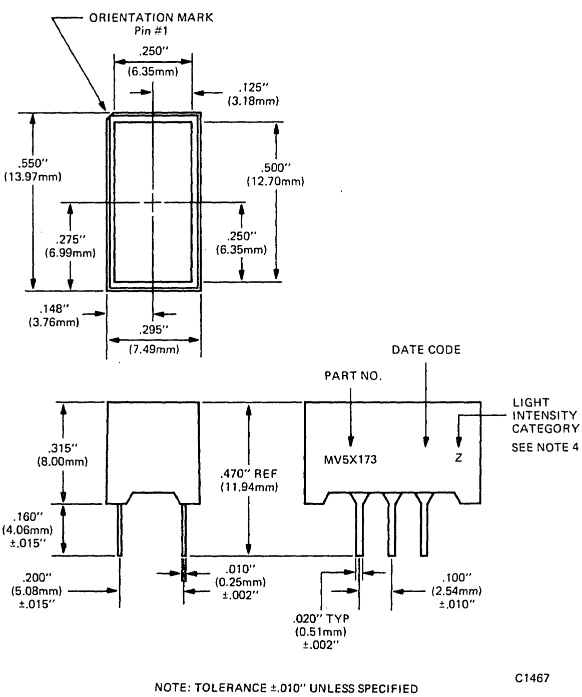
NOTES

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 MV53173
HIGH EFFICIENCY GREEN MV54173
HIGH EFFICIENCY RED MV57173

PACKAGE DIMENSIONS



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.

MV53173 MV54173 MV57173

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)

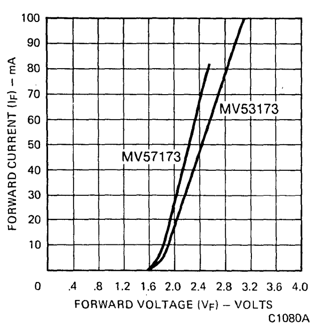


Fig. 1. Forward Current vs. Forward Voltage

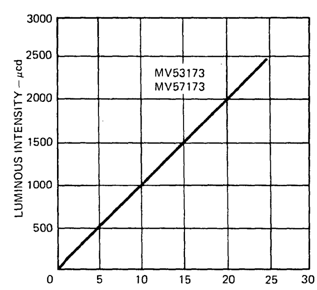


Fig. 2. Luminous Intensity vs. Forward Current (both LED chips on)

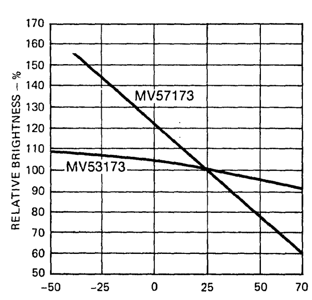


Fig. 3. Luminous Intensity vs. Temperature See Note 2

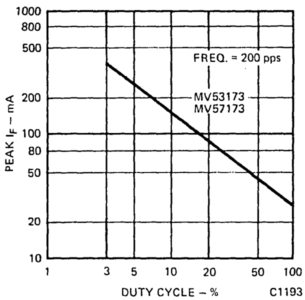


Fig. 4. Max Peak Current vs. Duty Cycle

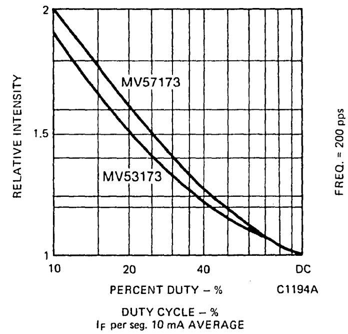


Fig. 5. Luminous Intensity vs. Duty Cycle

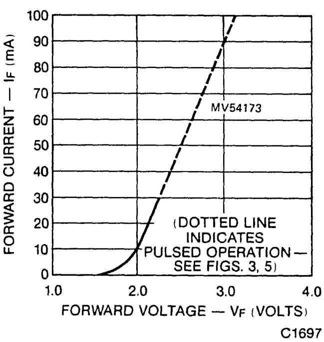


Fig 6. Forward Current vs. Forward Voltage

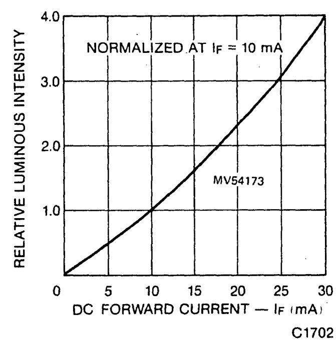


Fig. 7. Relative Luminous Intensity vs. DC Forward Current (Both LED chips on)

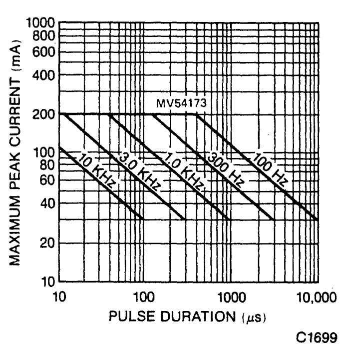


Fig. 8. Maximum Peak Current vs. Pulse Duration

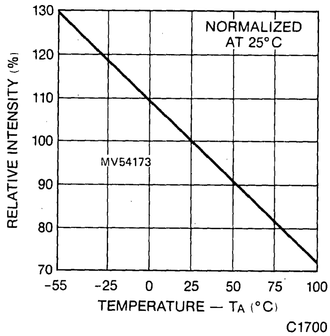


Fig. 9. Relative Luminous Intensity vs. Temperature

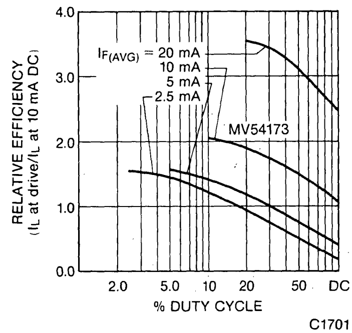
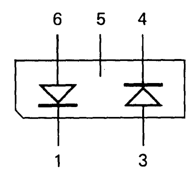


Fig. 10. Relative Efficiency vs. Duty Cycle

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 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

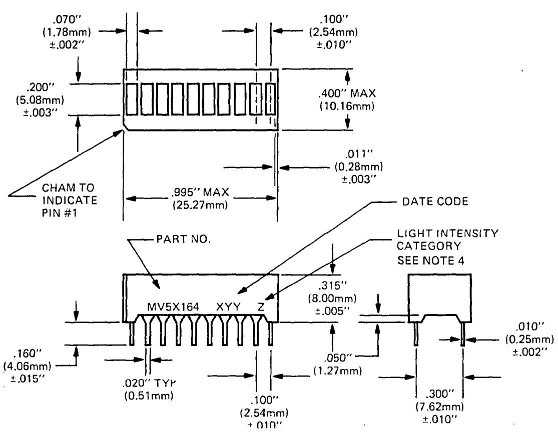
Panelgraphic Grey 10	Panelgraphic Grey 10 Homalite 100 — 1266 Grey	

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 MV53164
HIGH EFFICIENCY GREEN MV54164
HIGH EFFICIENCY RED MV57164

PACKAGE DIMENSIONS



NOTE: TOLERANCES ±.010" UNLESS SPECIFIED

C1468

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.

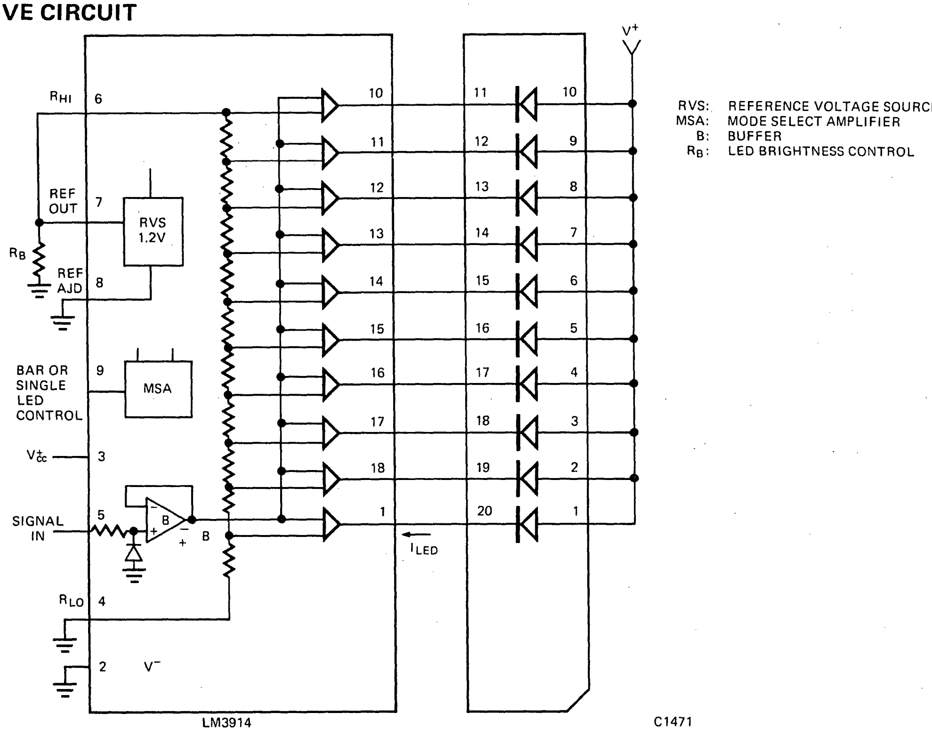
TYPICAL THERMAL CHARACTERISTICS

	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			µcd	I_F = 10 mA
Pulsed luminous intensity (MV54164)	710			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)

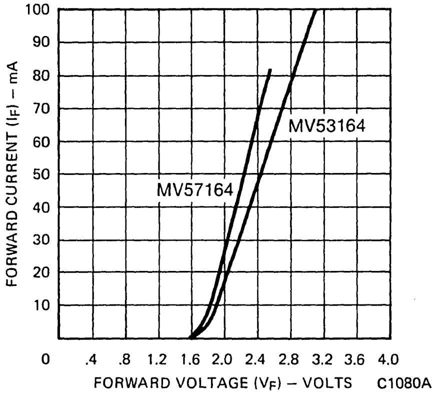


Fig. 1. Forward Current vs. Forward Voltage

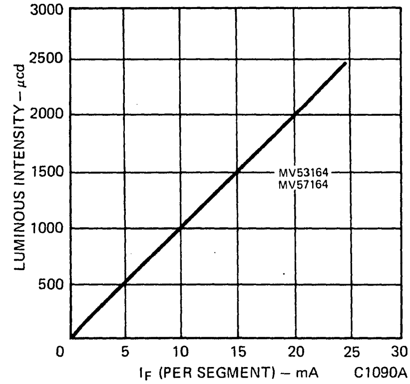


Fig. 2. Luminous Intensity vs. Forward Current

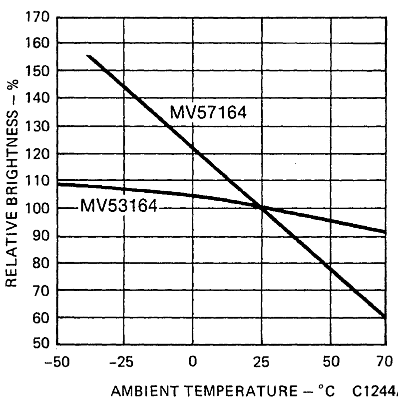


Fig. 3. Luminous Intensity vs. Temperature (See Note 2)

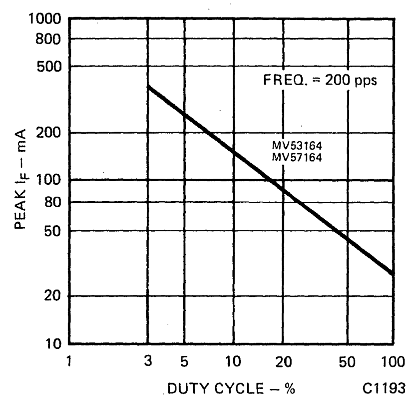


Fig. 4. Max Peak Current vs. Duty Cycle

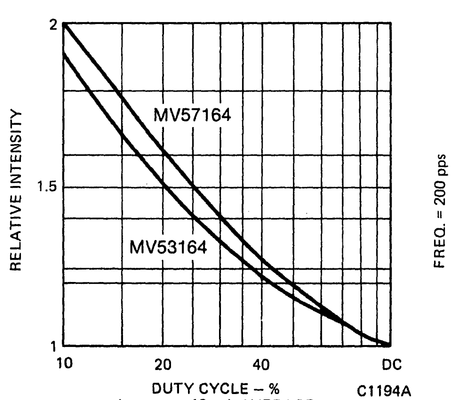


Fig. 5. Luminous Intensity vs. Duty Cycle

TYPICAL CURVES MV54164 (PER SEGMENT) (25°C Free Air Temperature)

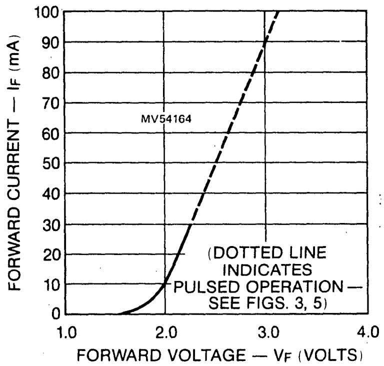


Fig. 6. Forward Current vs. Forward Voltage

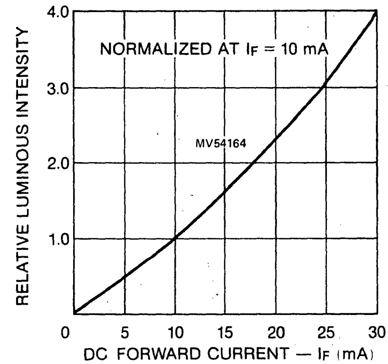


Fig. 7. Relative Luminous Intensity vs. DC Forward Current

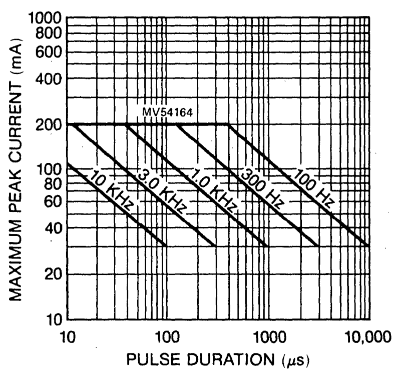


Fig. 8. Maximum Peak Current vs. Pulse Duration

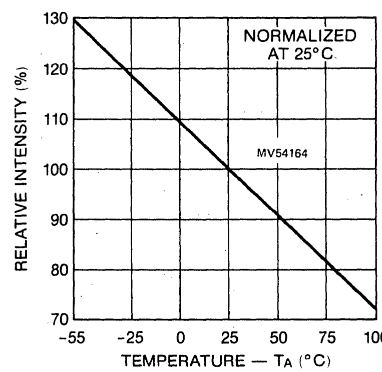


Fig. 9. Relative Luminous Intensity vs. Temperature

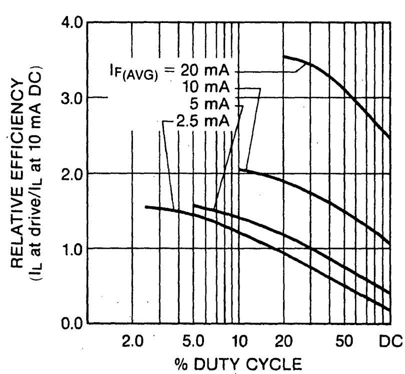


Fig. 10. Relative Efficiency vs. Duty Cycle

FILTER RECOMMENDATIONS

For optimum on and off contrast, one of the following filters or equivalents may be used over the lamp

MV53164	MV54164	MV57164
Panelgraphic Yellow 25 or Amber 23 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

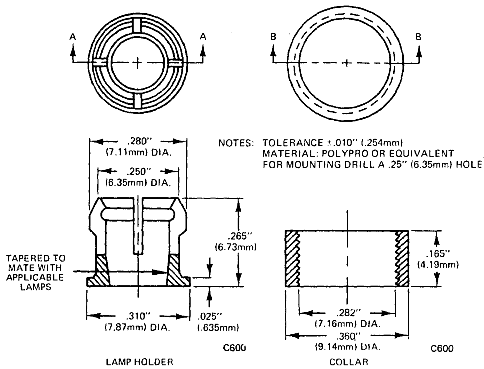
MV53164	MV54164	MV57164
Panelgraphic Grey 10	Panelgraphic Grey 10 Homalite 100 – 1266 Grey	

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.*

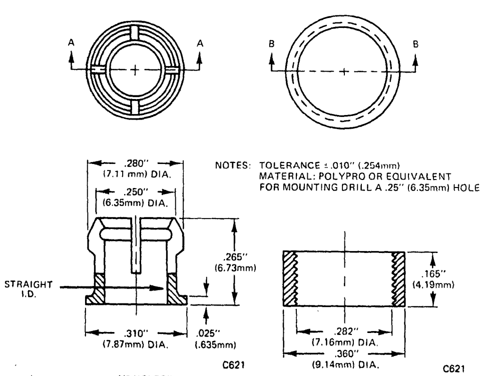
GENERAL INSTRUMENT

MP21 MP51
MP22 MP52

PACKAGE DIMENSIONS



MP21/MP22
TWO-PIECE POP-INS



MP51/MP52
TWO-PIECE POP-INS

DESCRIPTION

The MP Series of mounting grommets is intended for panel mounting of many standard General Instrument light emitting diode indicators. The grommets are made of plastic and are available in clear and black.

The MP Series will easily mount the applicable lamps on any panel thickness up to .125 inch (3.18 mm).

APPLICATION

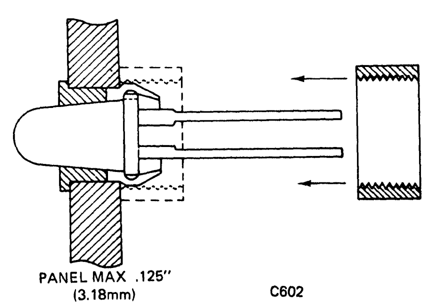
PART NO.	AVAILABILITY
MP21 (CLEAR)	Special Order Only
MP22 (BLACK)	Standard

Applicable Lamps:
ME7021 thru ME7124;
MV5020 thru MV5056

PART NO.	AVAILABILITY
MP51 (CLEAR)	Special Order Only
MP52 (BLACK)	Standard

Applicable Lamps:
MV5050 thru MV5056
MV5054A-1-2-3
MV5152 thru MV5752
MV5153 thru MV5753
MV5154 thru MV5754
MV5174C thru MV5774C

TYPICAL MOUNTING TECHNIQUE

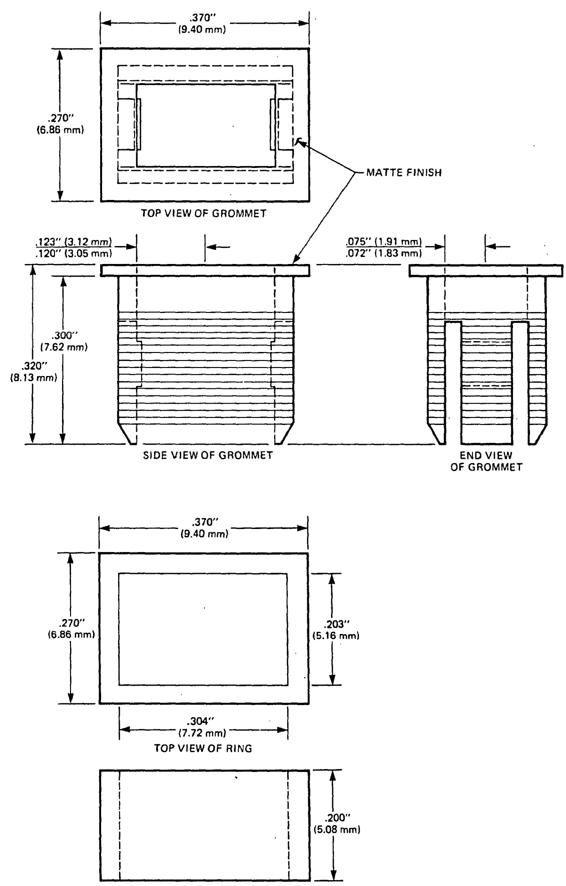


C602

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")

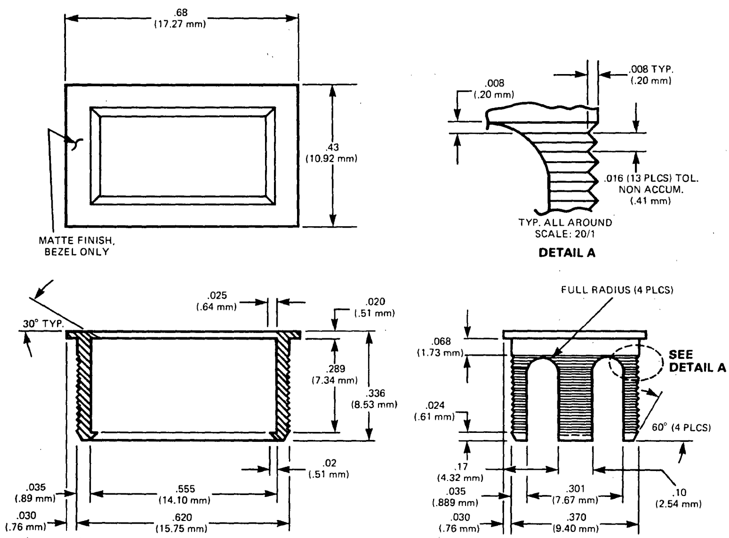
ROTEX PUNCH COMPANY, INC.
2350 Alvarado Street
San Leandro, CA 94577
(415) 357-3600
(Request a 3506 series punch with dimensions of 5/16" x 7/32")

PANEL MOUNTING GROMMET FOR .5-INCH RECTANGULAR INDICATOR

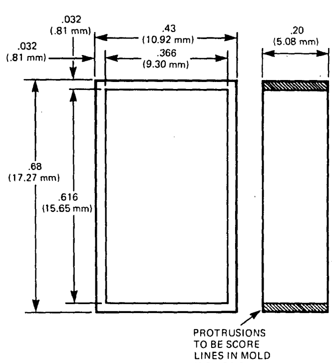
GENERAL INSTRUMENT

MP73

PACKAGE DIMENSIONS:



MATERIAL: POLYPROPYLENE – BLACK C 1480



MATERIAL: POLYPROPYLENE – BLACK C 1481

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).

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

5 Chips

GENERAL INSTRUMENT

GREEN G-32
YELLOW Y-32
ORANGE O-32

DESCRIPTION

The G, Y, O-32 Series is a light emitting diode fabricated from state-of-the-art Nitrogen doped $GaAs_X P_{1-X}$ 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.

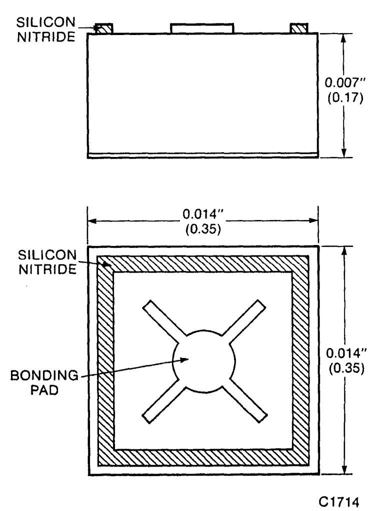
ELECTRICAL/OPTICAL CHARACTERIZATION (See Notes)

PARAMETER	PRODUCT	MIN	MAX	UNITS
Forward Voltage @ I_f = 20mA	G-32		2.6	Volts
	Y-32		2.6	
	O-32		2.5	
Reverse Voltage @ I_r = 100μA	G-32	8	–	Volts
	Y-32	8	–	
	O-32	8	–	
Luminous Intensity at I_f = 20mA (unlensed)	G-32	200	–	μcd
	Y-32	700	–	
	O-32	700	–	
Center Wavelength at I_f = 10mA	G-32	5600	5750	Angstroms
	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

GENERAL INSTRUMENT

RED MMH SERIES

DESCRIPTION

The MMH Series provides a selection of 7 segment, and 9 segment fonts, with digit slants from 0 degrees to 12 degrees, as well as a bar chip and dot chip. These products offer high performance gallium arsenide phosphide red monolithic numeric, bar, and dot LED's and are particularly suited for watch, clock, toy and game displays. They are specifically designed for hybrid assembly operations with automatic die attach and wire bonding operations in mind.
Monolithic numeric products 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.

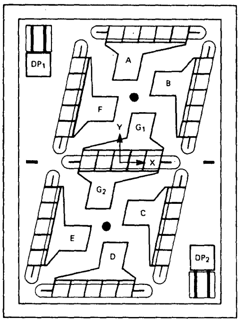
MECHANICAL CHARACTERISTICS

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
MMH75M	9 seg.	0.106x0.066	0.100x0.060	0°	0.005	Universal
MMH78M	9 seg.	0.082x0.052	0.075x0.045	0°	0.0055	Universal
MMH80W	1 seg.	0.040x0.010	0.005x0.035	0°	0.005	0.004x0.0040
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) (Colon Dot)	– –	0.007 0.0055	– –	Inches Inches	

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.)



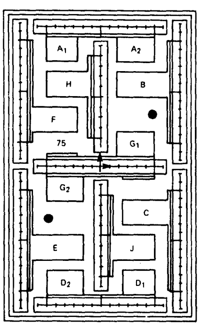
C1360

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"



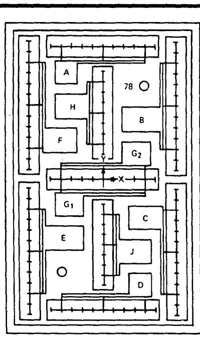
C1363

MMH75

DIE SIZE	0.106" X 0.066"
CHARACTER SIZE	0.095", Seg. A-Seg. D, ℄-℄ 0.055", Seg. F-Seg. B, ℄-℄
CHARACTER SLANT	0°
EMITTER WIDTH	0.005"
EMITTER LENGTH	0.049", Seg. B, C, E, F 0.046", Seg. A, D, G 0.038", Seg. H, J
NOMINAL BONDING PAD SIZE	Universal Chip

BONDING PAD LOCATIONS

X_{A_1} = −0.0132" ± 0.003"	X_{G_1} = −0.0122" ± 0.004"	Y_{D_1} = −0.0392" ± 0.001"
X_{A_2} = 0.0122" ± 0.004"	X_{G_2} = 0.0122" ± 0.004"	Y_{D_2} = −0.0392" ± 0.001"
X_B = 0.0143" ± 0.006"	X_H = −0.0117" ± 0.005"	Y_E = −0.0278" ± 0.002"
X_C = 0.0153" ± 0.005"	X_J = 0.0117" ± 0.005"	Y_F = 0.0158" ± 0.002"
X_{D_1} = −0.0122" ± 0.003"	Y_{A_1} = 0.0392" ± 0.001"	Y_{G_1} = −0.0084" ± 0.001"
X_{D_2} = 0.0132" ± 0.003"	Y_{A_2} = 0.0392" ± 0.001"	Y_{G_2} = 0.0084" ± 0.001"
X_E = −0.0143" ± 0.006"	Y_B = 0.0278" ± 0.002"	Y_H = 0.0278" ± 0.002"
X_F = −0.0153" ± 0.005"	Y_C = −0.0158" ± 0.002"	Y_J = −0.0278" ± 0.002"



C1364

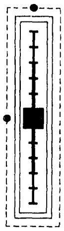
MMH78

DIE SIZE	0.082" X 0.052"
CHARACTER SIZE	0.0695", Seg. A-Seg. D, ℄-℄ 0.0395", Seg. F-Seg. B, ℄-℄
CHARACTER SLANT	0°
EMITTER WIDTH	0.0055"
EMITTER LENGTH	0.0365", Seg. B, C, E, F 0.030", Seg. A, D, G 0.024", Seg. H, J
NOMINAL BONDING PAD SIZE	Universal Chip

BONDING PAD LOCATIONS

X_A = −0.0099" ± 0.001"	X_{G_2} = 0.009" ± 0.002"	Y_D = −0.0275" ± 0.001"
X_B = 0.0102" ± 0.003"	X_H = −0.0087" ± 0.002"	Y_E = −0.0157" ± 0.001"
X_C = 0.011" ± 0.002"	X_J = 0.0087" ± 0.002"	Y_F = 0.0101" ± 0.001"
X_D = 0.0099" ± 0.001"	Y_A = 0.0275" ± 0.001"	Y_{G_1} = −0.0725" ± 0.001"
X_E = −0.0102" ± 0.003"	Y_B = 0.0157" ± 0.001"	Y_{G_2} = 0.0725" ± 0.001"
X_F = −0.011" ± 0.002"	Y_C = −0.0101" ± 0.001"	Y_H = 0.019" ± 0.001"
X_{G_1} = −0.009" ± 0.002"		Y_J = −0.019" ± 0.001"

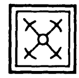
MMH80



C1365

DIE SIZE	0.040" X 0.010"
CHARACTER SIZE	0.005" X 0.035"
CHARACTER SLANT	0°
EMITTER WIDTH	0.005"
EMITTER LENGTH	0.035"
BONDING PAD SIZE	0.004" X 0.004"
PAD LOCATION	0.000" X 0.000"

MMH32



C1252

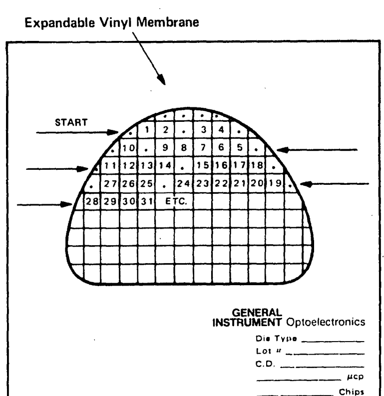
DIE SIZE	0.014" X 0.014"
CHARACTER SIZE	0.010" X 0.010"
BONDING PAD SIZE	0.003" (DIA)

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

Applications 6

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.

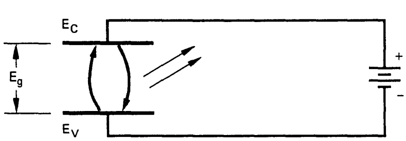
THEORY

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



$$\text{Wavelength of Emission } (\lambda_{peak}) \cong \frac{12380}{E_g} \text{ (in Angstrom units)}$$

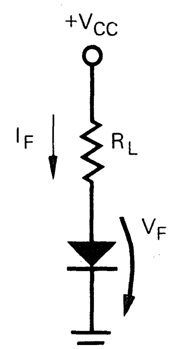
[Equation 1]

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]

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

$$R_L = \frac{V_{CC} - V_F}{I_F},\ R_L = \frac{5 - 1.5}{0.013},\ R_L = 269 \text{ ohm.}$$

From the expression, Power = $(I_F)^2 R_L$, we see that R_L's power rating can be 1/8 watt.

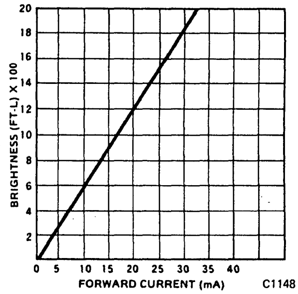


Figure 3a.

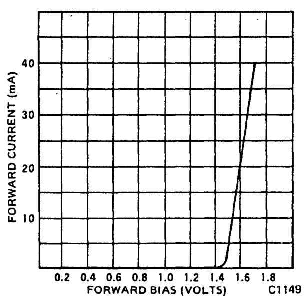


Figure 3b.

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.

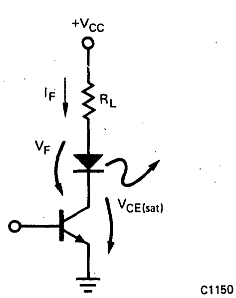


Figure 4.

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.

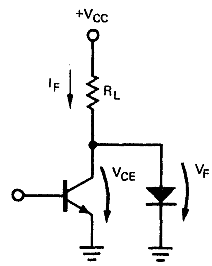


Figure 5.

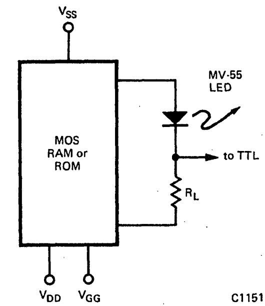


Figure 6.

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

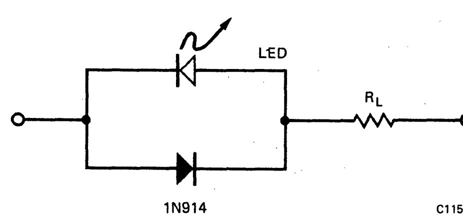


Fig. 7a. Bipolar Operation

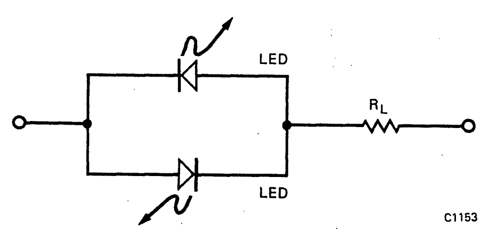


Fig. 7b. Bipolar Operation

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.

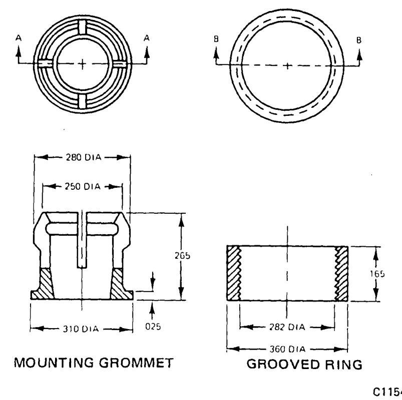
When the human eye is the detector of visible energy, lower average power is consumed by pulsed operation than by steady-state operation. This advantage of pulsed operation is especially important for battery-powered applications and for applications in which large LED arrays are being driven.

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-



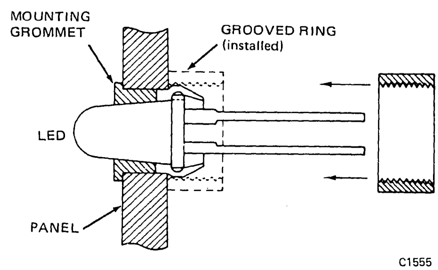


Figure 8a.

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

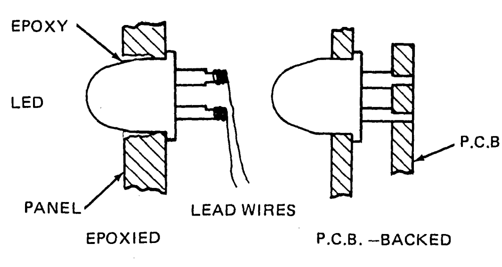
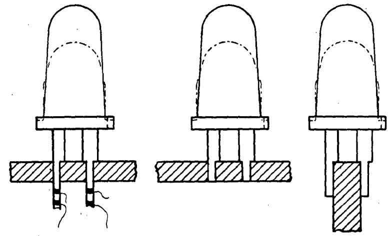
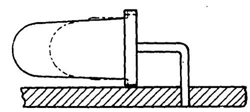


Fig. 8b. LED's Mounted Without Hardware



(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

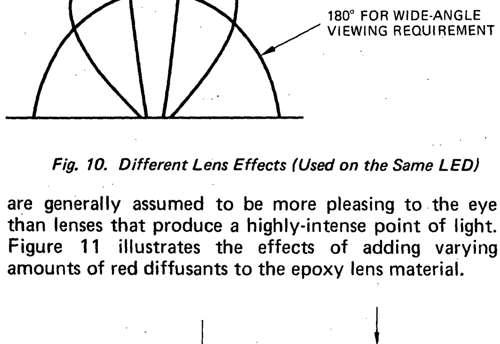
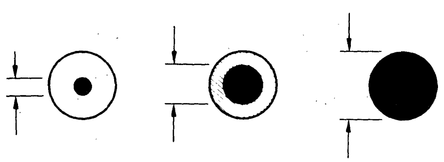


Fig. 10. Different Lens Effects (Used on the Same LED)

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).

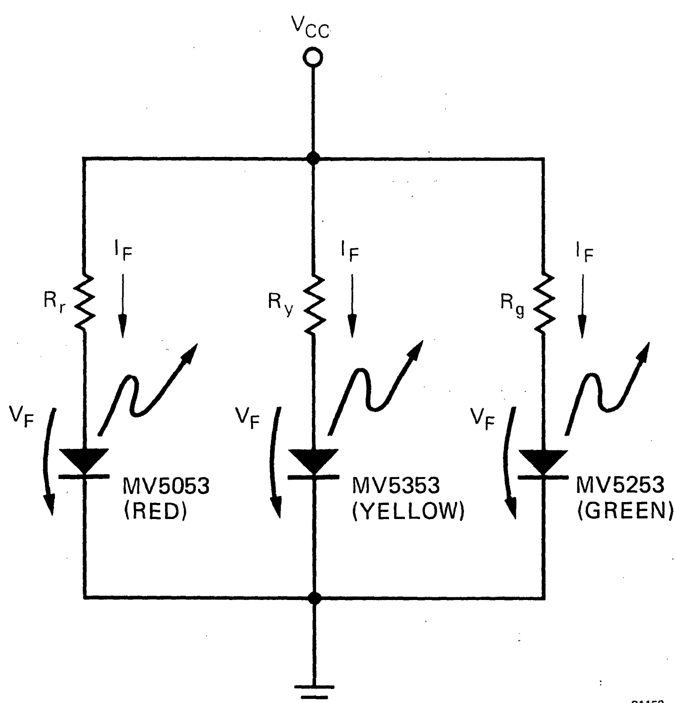


Fig. 12. Brightness Matching Different Colors

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

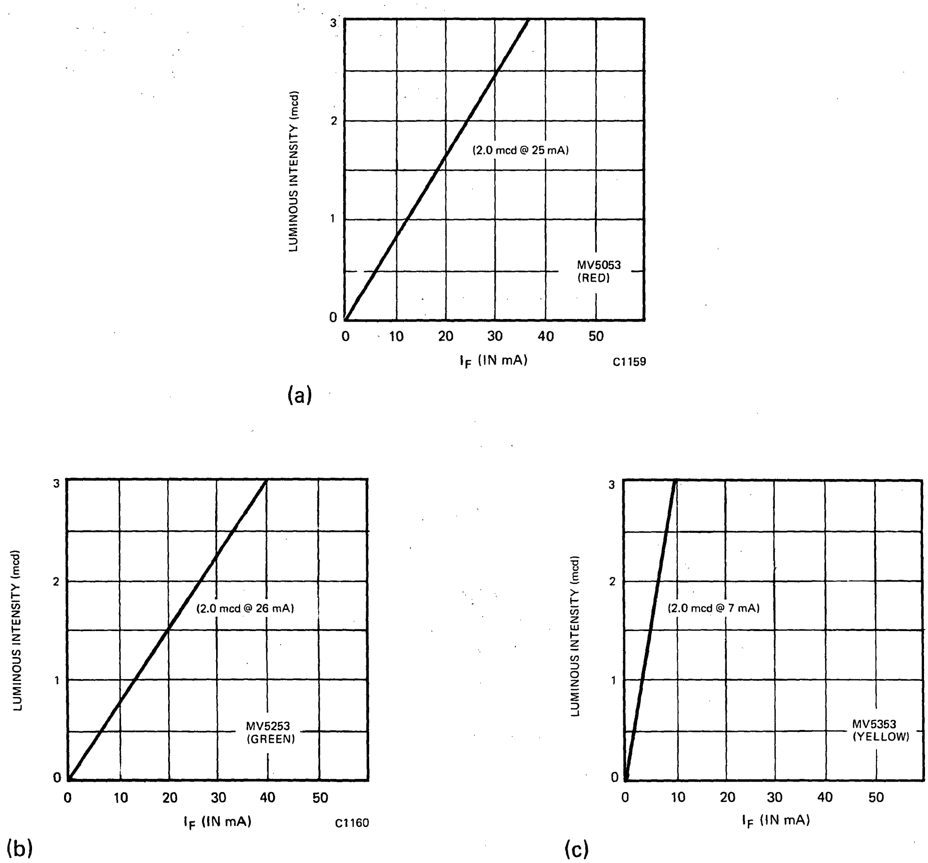


Figure 13.

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) Irradiance	W H	$W = \frac{dP}{dA}$ $H = \frac{dP}{dA}$	watt per sq. cm, watt per sq. m, etc. watt per sq. cm, watt per sq. m, etc.	W cm^{-2} W m^{-2} 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) Illumination (illuminance)	L E	$L = \frac{dF}{dA}$ $E = \frac{dF}{dA}$	lumen per sq. ft footcandle (lumen per sq. ft.) lux (lumen per sq. m) phot (lumen per sq. cm)	lm ft^{-2} 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).

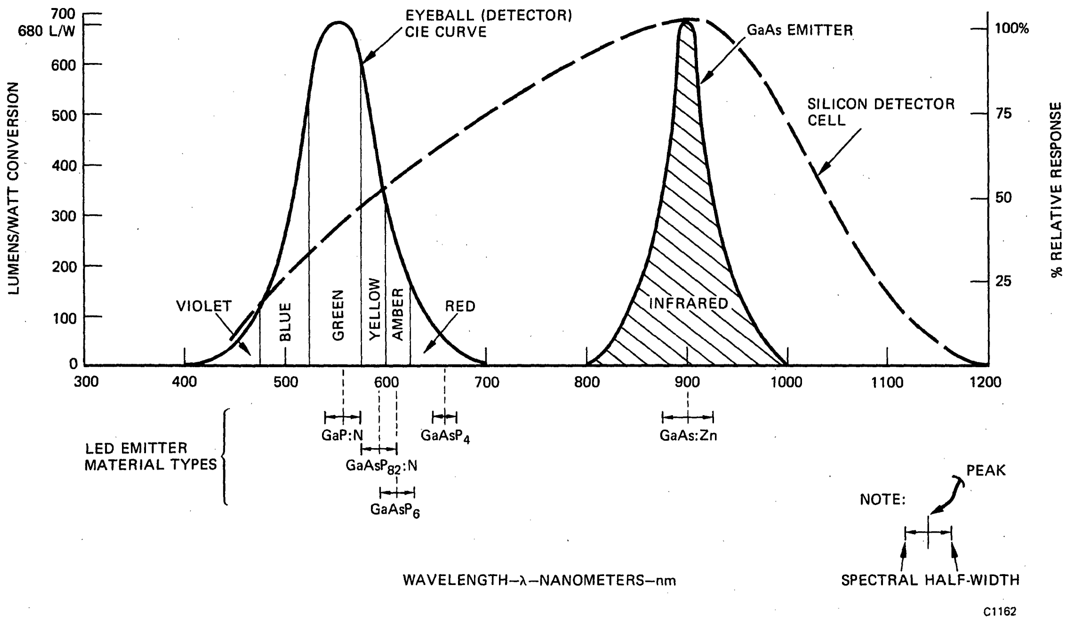


Fig. 14. Relationship Between LED and Detector Spectrums

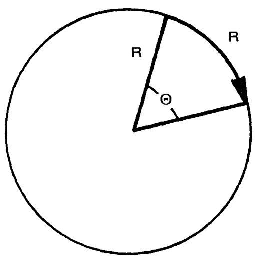
AN601
the photometry of LED's
a primer in photometry

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) $2\pi R = 360°$. Radian $= 180°/\pi = 57.27°$ (approx.)

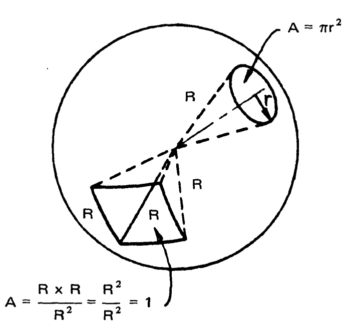


TWO DIMENSIONAL FIGURE

FIGURE 1

STERADIAN

In solid geometry one steradian is the solid angle subtended at the center of a sphere by a portion of the surface area equal to the square of the radius of the sphere. Therefore, if $AREA/R^2 = 1 = 1$ steradian and the area on the surface of a sphere equals $4\pi R^2$, then $4\pi R^2/R^2$ or 4π steradians of solid angle ω about the center of a sphere. The steradian is usually abbreviated as STER.



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.

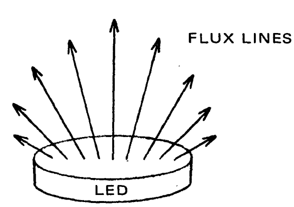


FIGURE 3

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.

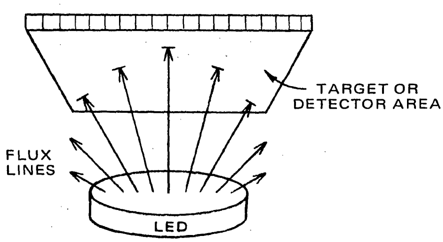


FIGURE 4

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).

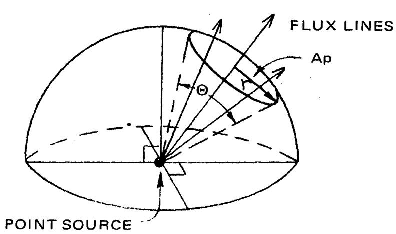


FIGURE 5

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.

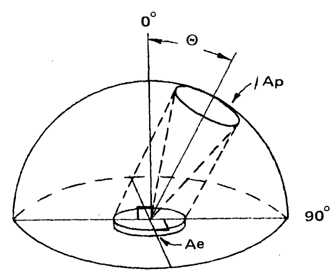


FIGURE 6

$$\frac{\text{LUMINOUS INTENSITY}}{Ap} = \frac{\frac{\text{LUMENS}}{\text{STERADIAN}}}{Ae \cos \Theta} = \frac{\text{CANDELAS}}{\text{(Sq. Unit)}}$$

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

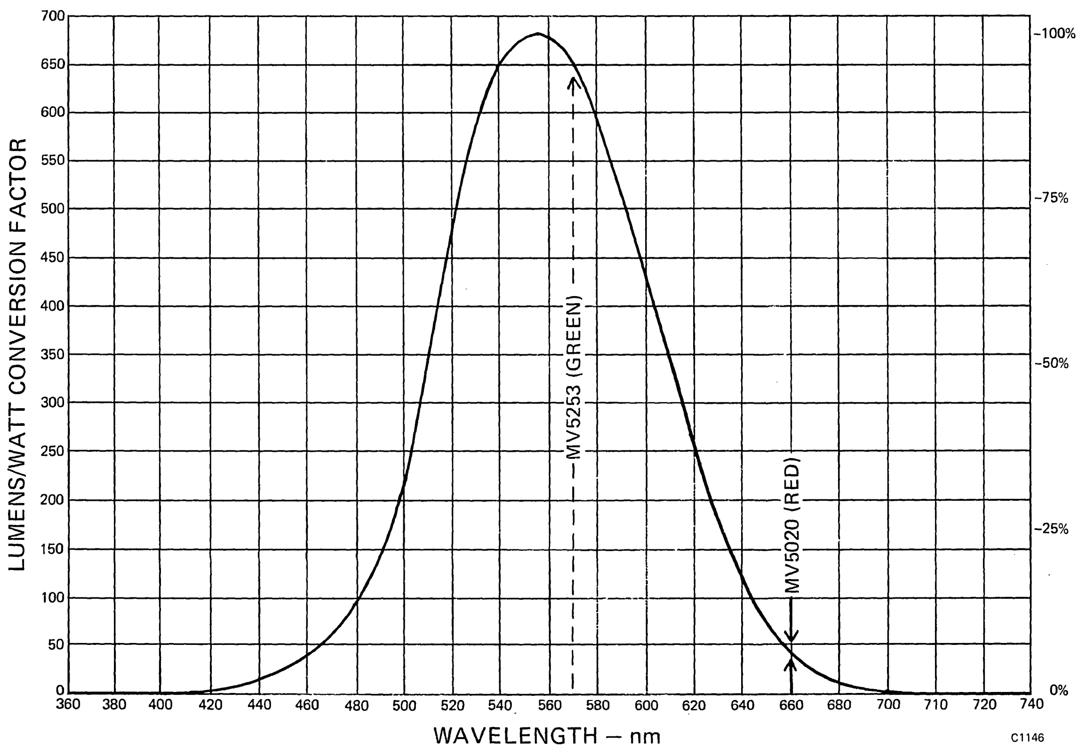
CIE CURVE

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.

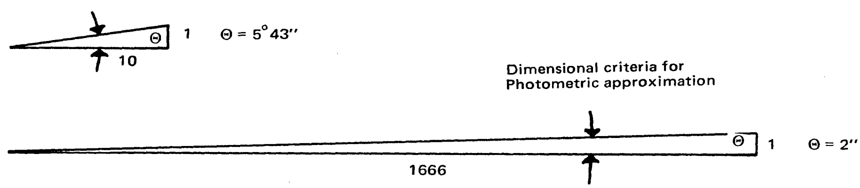


FIGURE 7

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.

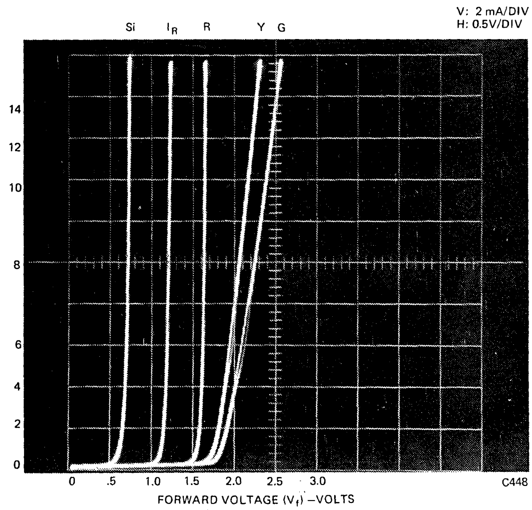


Fig. 1. Typical I_f/V_f Curves of Silicon, GaAs, and GaAsP, GaP (Silicon-IN914, IR-ME7024, Red-MV5053, Yellow-MV5353, Green-MV5253)

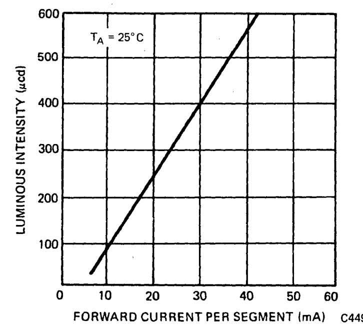


Fig. 2. Typical LED Curve Luminous Intensity vs. Forward Current for Constant Temperature

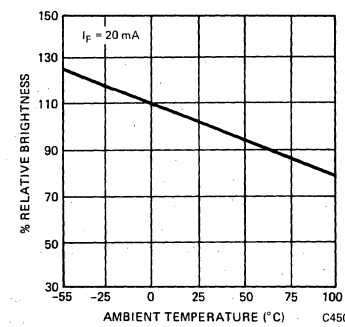


Fig. 3. Typical LED Curve Brightness vs. Temperature for Constant Current

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

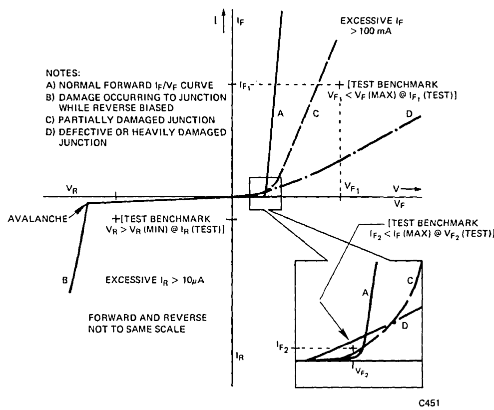


Fig. 4. Effects of Improper Testing Procedure

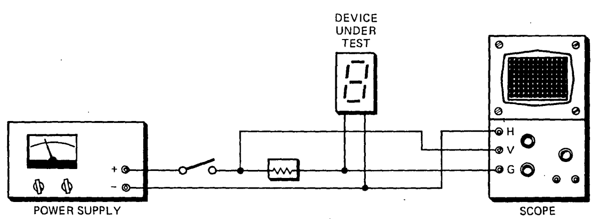


Fig. 5. Potentially Damaging Forward-Mode Test Setup

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.

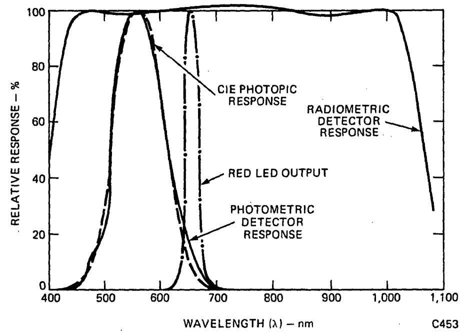


Fig. 6. Responses of Two Detectors to the Output of a Visible Red LED

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.

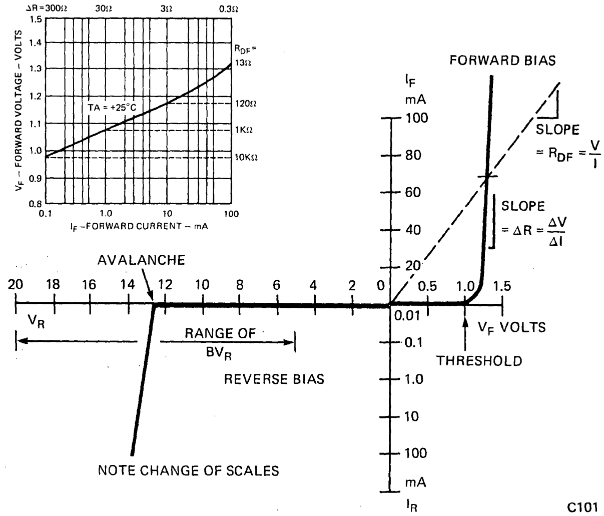
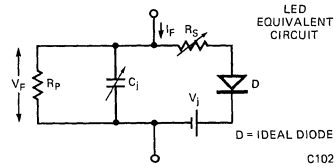


Fig. 1. Characteristics of IR LED



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

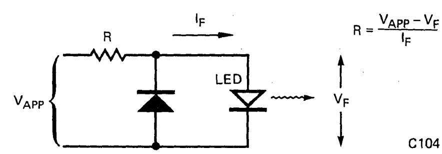


Fig. 4. Typical LED Drive Circuit

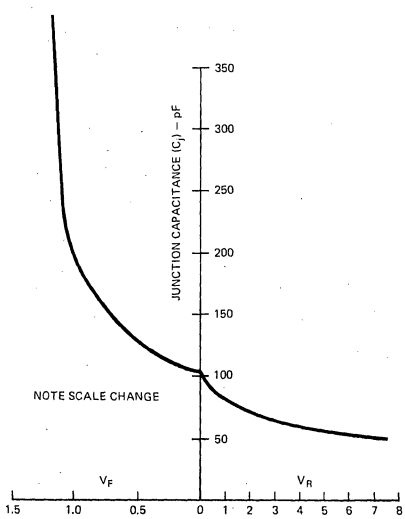


Fig. 3. Voltage Dependence of Junction Capacitance

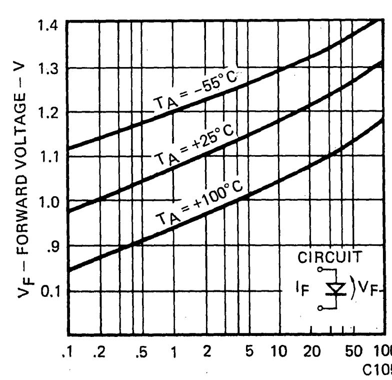


Fig. 5. IR Forward Voltage vs. Forward Current and Temperature

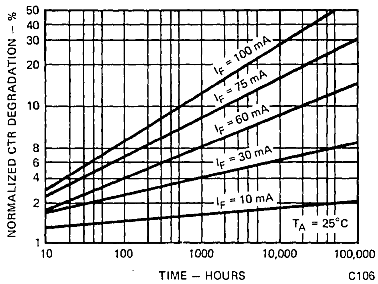


Fig. 6. Brightness Degradation vs. Forward Current and Time

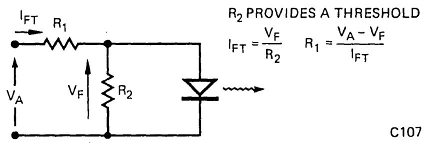


Fig. 7. LED Threshold Adjustment

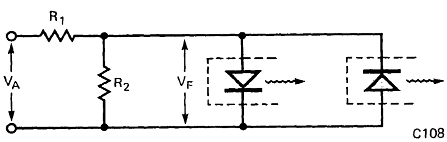


Fig. 8. Bipolar Input Selects LED

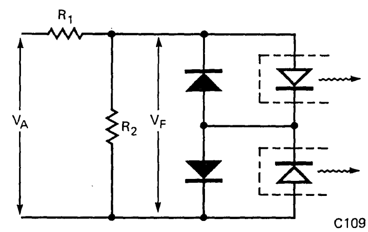


Fig. 9. High Threshold Bipolar Input

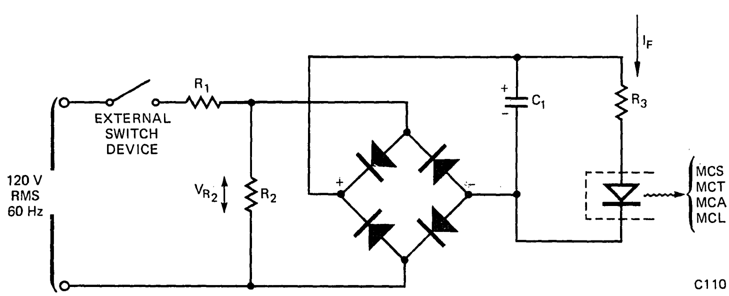


Fig. 10. AC Input to LED Drive Circuit

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

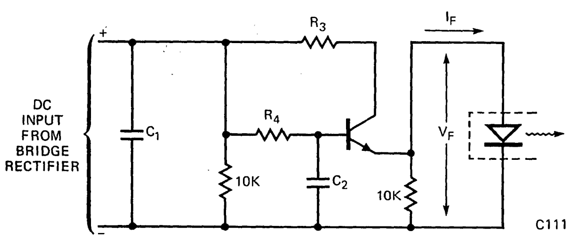


Fig. 11. R-C-Transistor Filter Circuit

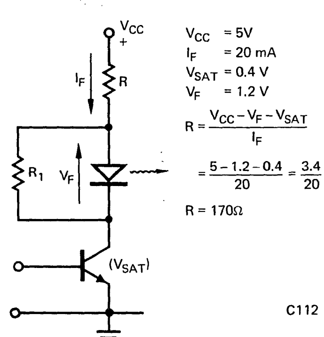


Fig. 12. Transistor Drive, Normally Off

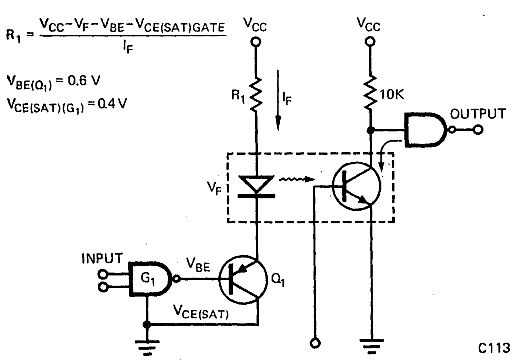


Fig. 13. Logic to LED Series Booster

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

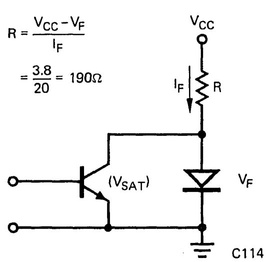


Fig. 14. Transistor Drive, Normally On

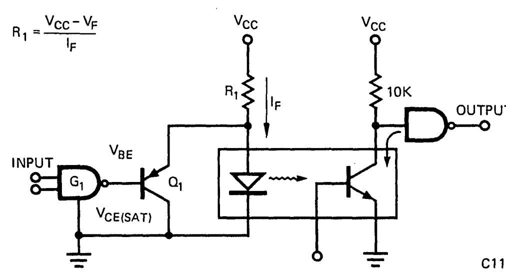


Fig. 15. Logic to LED Shunt Booster

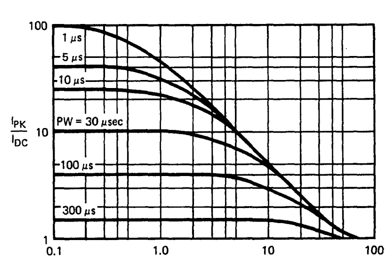


Fig. 16. Maximum Peak I_F Pulse Normalized to Max I_{DC} for Pulse Width (PW) and Duty Cycle (%)

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.

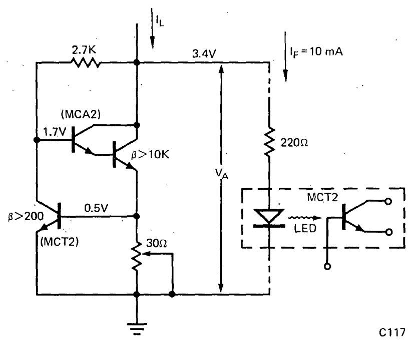


Fig. 17. Constant-Current Shunt Impedance

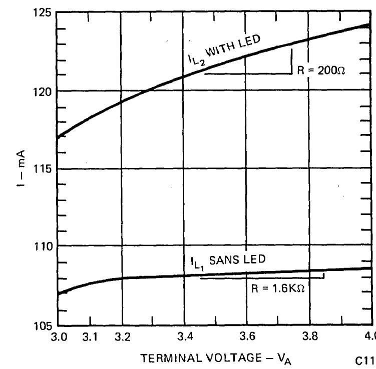


Fig. 18. Shunt Impedance Performance

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.

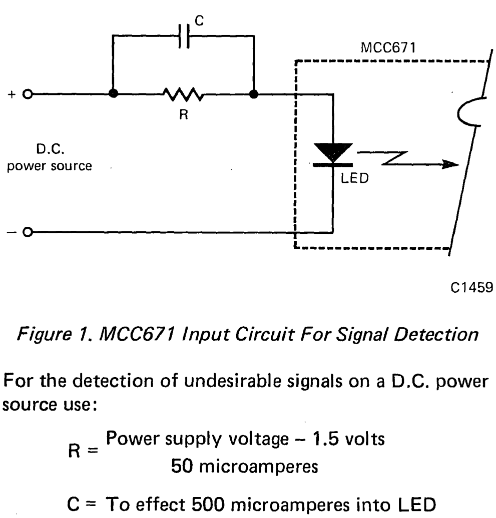


Figure 1. MCC671 Input Circuit For Signal Detection

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.

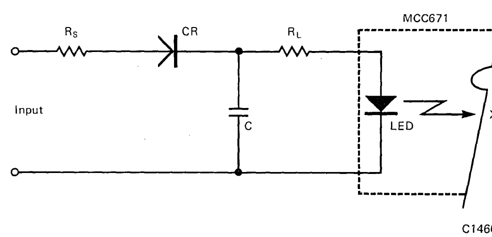


Figure 2. Pulse or Waveform Detection Circuit

For the detection of the presence of a desired signal, pulse or waveform use:

CR = Silicon diode

$$R_L = \frac{(\text{Positive Vpk. of input}) - 2.5\text{ volts}}{1\text{ milliampere}}$$

$$C\text{min} = \frac{\text{Pulse interval of } 1/_F}{R_L}$$

$$R_S\text{max} = \frac{\text{Pulse width or } 1/4F}{5C}$$

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.

The resulting LED forward current that will keep the output circuitry conducting is shown as the result of proper design.

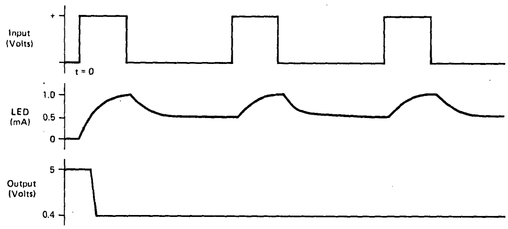


Figure 3. Pulse Train Waveforms

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.

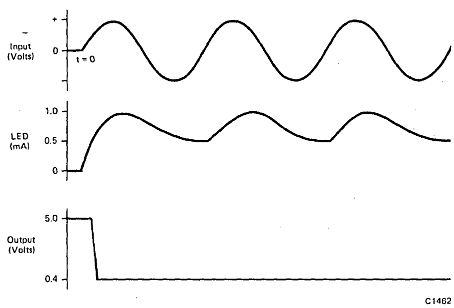


Figure 4. Sine Wave Waveforms

Matrices Opto-Coupling

With the low input LED current advantage of the MCC671, the ability to drive matrices with but one TTL

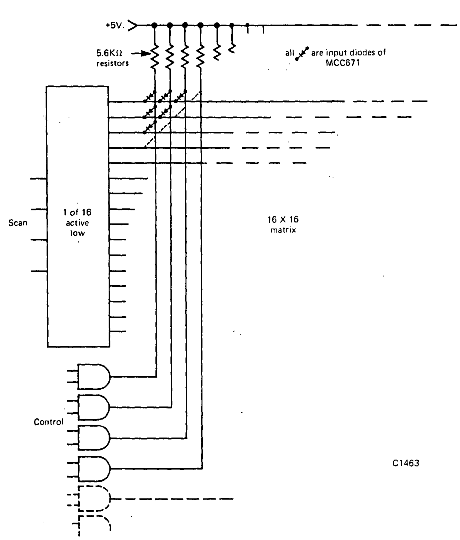


Figure 5. Opto-Coupling out of Matrices

output is now possible as shown in figure 5.

Non-Loading Line Receiver

For virtual non-loading, the MCC671 is compatible with the differential amplifier circuit of Figure 6.

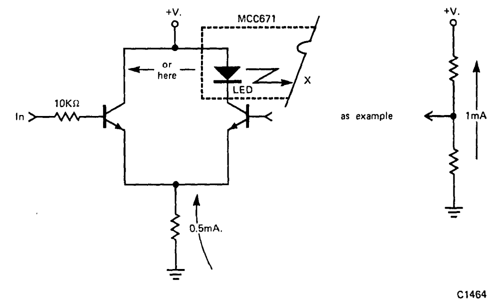


Figure 6. Differential Amplifier Drive

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.

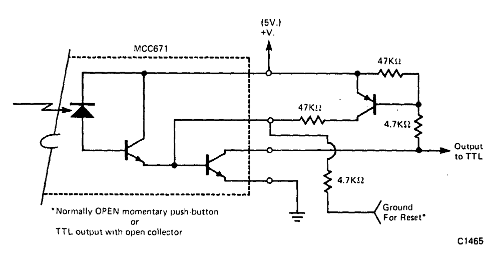


Figure 7. Latching Output Circuit For MCC671

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.

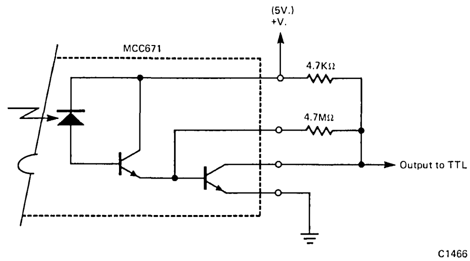


Figure 8. Non-Latching Output Circuit For MCC671

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.

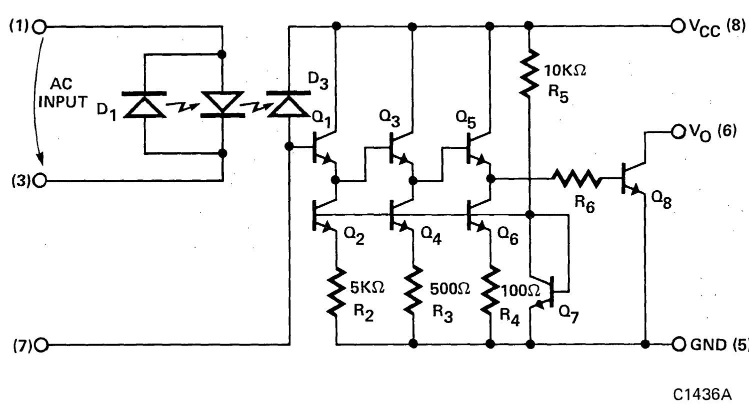


Fig. 1. Circuit Schematic of MID400 AC Line Monitor

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.

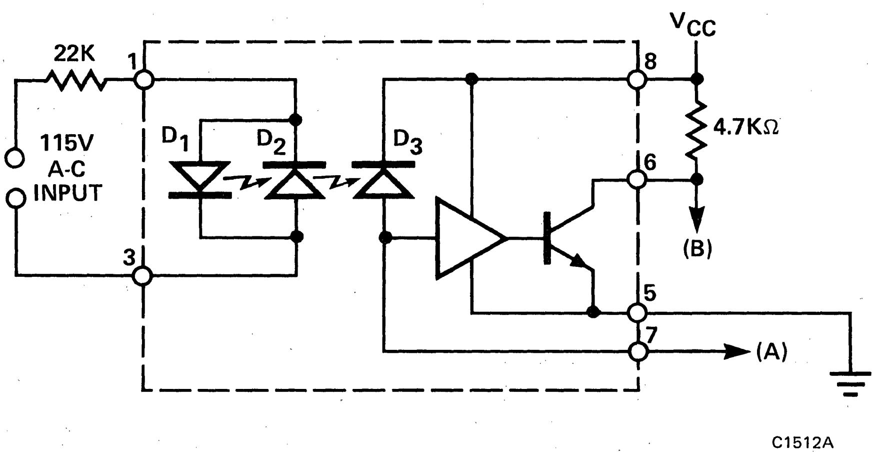
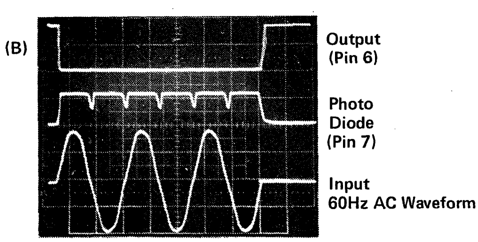


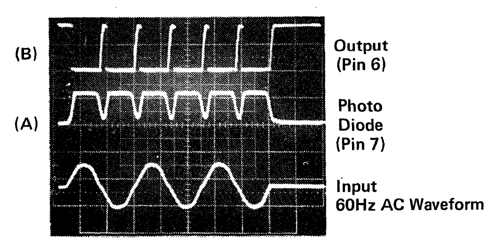
Fig. 2. Test Circuit



Horiz. = 5mS/cm
Vert. = Uncalibrated

Fig. 3. Saturated 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.



Horiz. = 5mS/cm
Vert. = Uncalibrated

Fig. 4. Unsaturated Operation

NOTE: Below normal specified 4mA RMS input I_F current. The level of 120Hz pulses from the photodiode are now below the input threshold of the amplifier and the pulses appear on the output. The output pulse width depends on the AC input drive level.

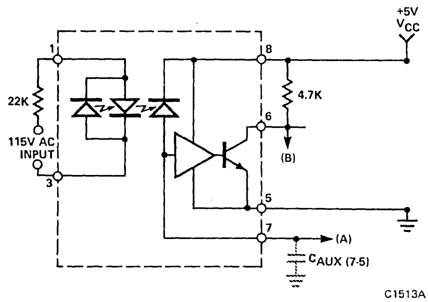


Fig. 5. Circuit With Addition of Capacitor at Pin 7

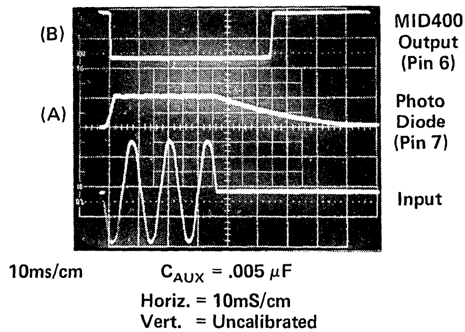


Fig. 6. Waveforms with Capacitor Added at Pin 7

OPERATION WITH AN EXTERNAL CAPACITOR

Figure 5 shows a basic delay circuit obtained by addition of an integrating capacitor C_X to the photodiode/amplifier input point pin 7. Delay at POWER ON is short, as the photodiode, when conducting, has a low impedance providing a fast charge to the capacitor. The delay when AC is removed is long, because the capacitor discharges through various leakages of the amplifier and the photodiode. The waveforms in Figure 6 shows the capacitance on both TURN-ON and TURN-OFF delays. Figures 7 and 8 show plots of capacitance versus turn-on and turn-off time.

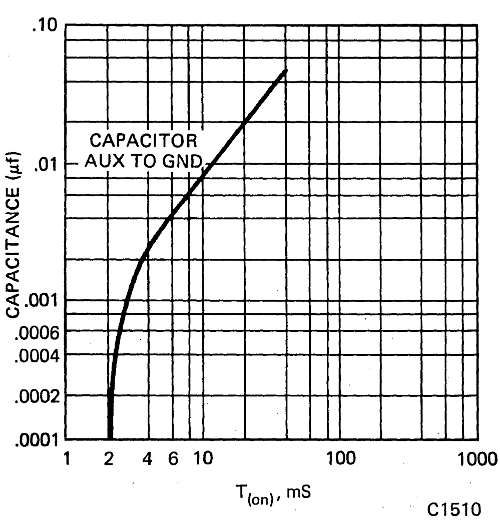


Fig. 7. Plot of Capacitance Versus Turn-on Time

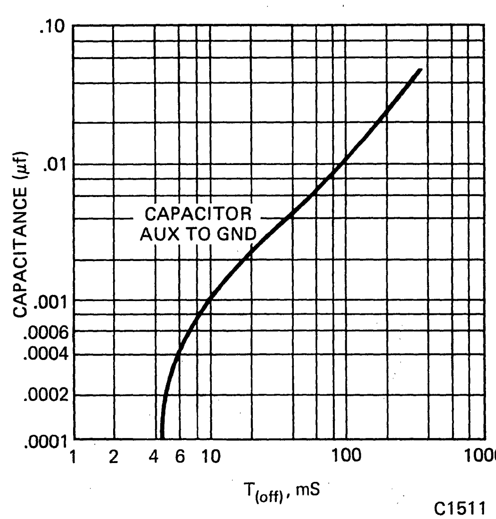


Fig. 8. Plot of Capacitance Versus Turn-off Time

MID400 INTERFACE CIRCUITS USING A 555 TIMER

Addition of a 555 Timer at the MID400 output, as shown in Figure 9, produces an interface circuit with improved drive capability and output switching times, and better noise immunity. Figure 10 illustrates these switching time improvements.

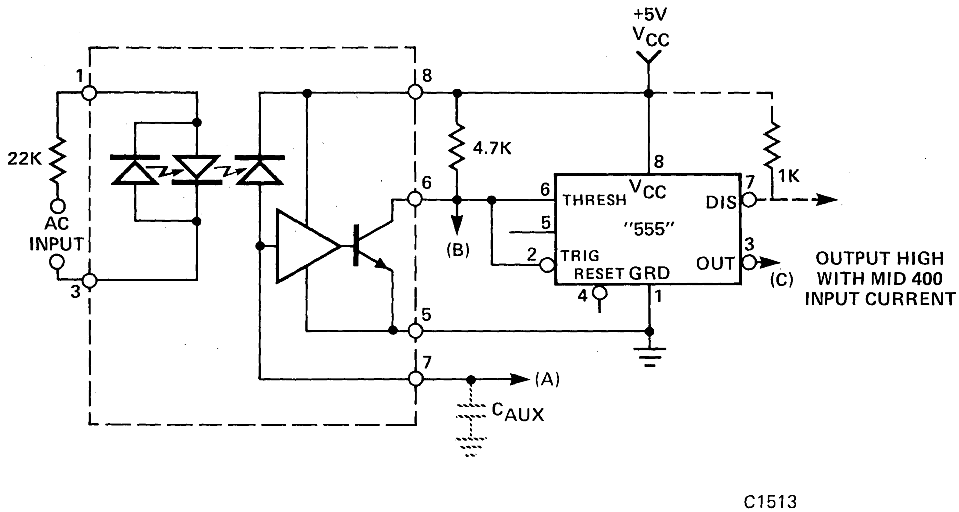


Fig. 9. Circuit with 555 Timer Added

The 555 Timer is basically being used as a SCHMITT trigger circuit with well defined input thresholds. The input HIGH state is 2/3 V_{CC}, (+5 volts in this case), and its LOW state is 1/3 V_{CC}.

The output may be taken from either 555 pin 3 or from pin 7 discharge point with a pullup resistor. Both these pins are high when AC current is applied to the MID400. The 555 output is capable of supplying both sink and source currents up to 200mA. One advantage of using the 555 discharge output pin is that it can be tied to another similar unit to provide the "AND" function. That is both AC inputs to both units must be present before the 555 outputs can be high.

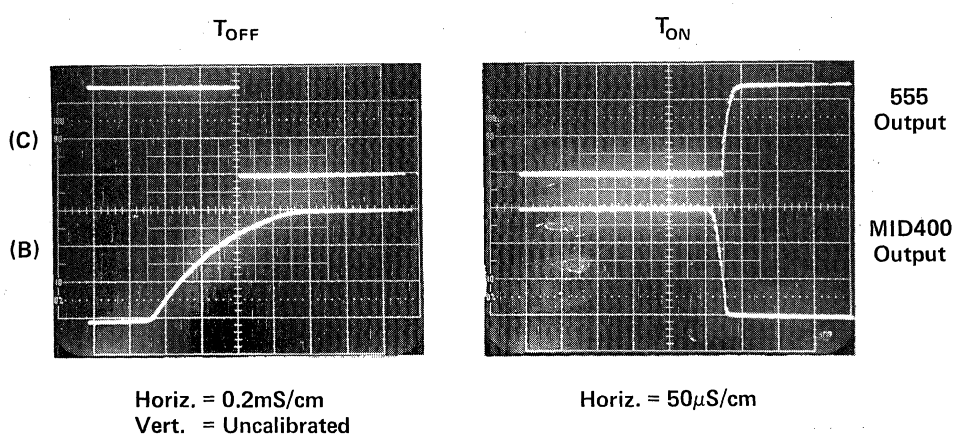


Fig. 10. Output Waveforms for T_{ON} T_{OFF}. Pin 7 Auxiliary Input Open Using the 555 Circuit (Fig. 9)

Figure 11 shows a circuit which includes a 555 Timer for shaping of waveforms. This circuit can provide an adjustable delay either at power on or power off. Delay is adjusted by the time constant of R_X and C_X. Insertion of diode D_1 across R_X provides either a fast charge and slow discharge of C_X, or a slow charge and fast discharge when diode polarity is reversed. See waveforms in Figures 12 through 14. Because charge on capacitor is established by the output of MID400, the delay will vary according to whether MID400 is operated in saturated mode or unsaturated mode. In the unsaturated mode delay will depend upon the ratio of the pulse ON to OFF time (Duty Factor).

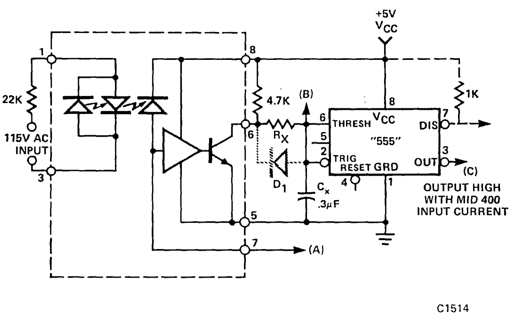


Fig. 11. Adjustable Delay Turn Off/On Circuit

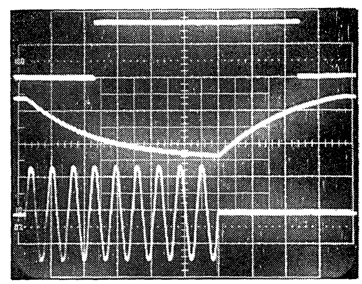
Without D_1

Turn on and off Delay

(C) 555 Output

(B) 555 Input

AC Input



Horiz. = 20mS/cm
Vert. = Uncalibrated

R_X = 200KΩ
C_X = 0.3µF

Fig. 12. Output Without D_1 Diode

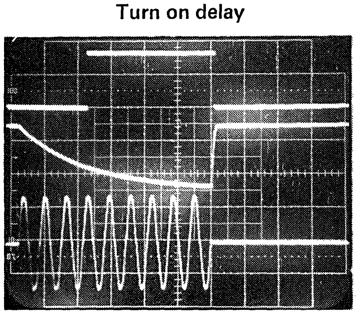
With D_1

Turn on delay

(C) 555 Output

(B) 555 Input

AC Input



Horiz. = 20mS/cm
Vert. = Uncalibrated

R_X = 200KΩ
C_X = 0.3µF

Fig. 13. Delayed Turn On. Diode D_1 Connected Opposite to Shown in Circuit Schematic

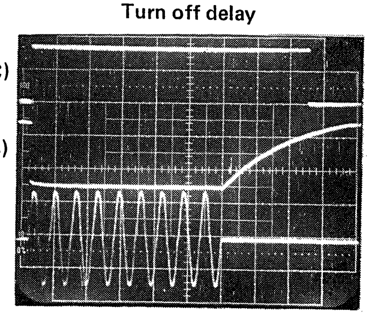
With D_1

Turn off delay

(C) 555 Output

(B) 555 Input

AC Input



Horiz. = 20mS/cm
Vert. = Uncalibrated

R_X = 200KΩ
C_X = 0.3µF

Fig. 14. Delayed Turn Off. Diode D_1 Connected As Shown in Circuit Schematic

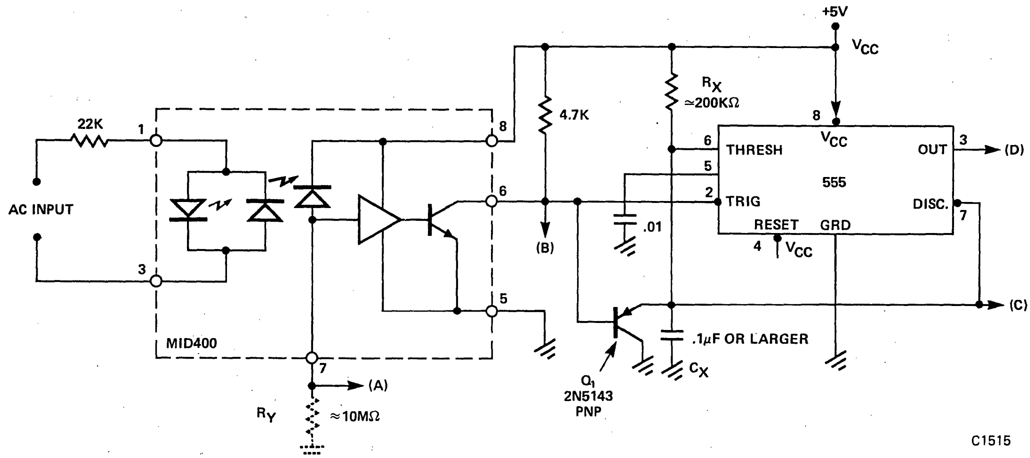


Fig. 15. Precision Delay Circuit

Figure 15 shows a precision delay circuit. Here delay is provided by using the 555 Timer as a missing pulse detector or one-shot. The time out is independent of whether the MID400 is operated in saturated or unsaturated mode. In unsaturated mode the Timer is continuously being reset by the 120Hz pulses from the MID400 and output of the 555 is high. When an AC line fails, there are no 120 Hz pulses, the 555 times out and the output then goes low. Refer to waveforms in Figure 16.

A larger capacitor at C_X will increase the time-out period of the 555 causing it not to detect the missing input cycles as shown in Figure 17.

With the MID400 operated in the saturated mode, output of MID400 is low, which turns on the PNP transistor Q_1, stopping C_X from charging, and the 555 output is high.

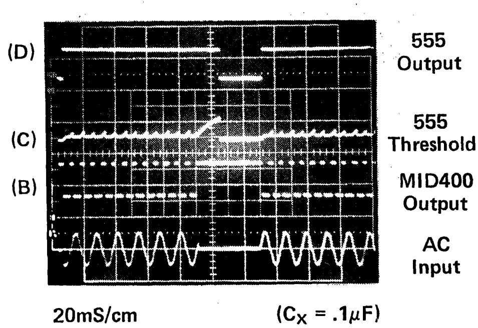


Fig. 16. Unsaturated Mode—Detects Missing AC Input Cycles (when more than one cycle is missing)

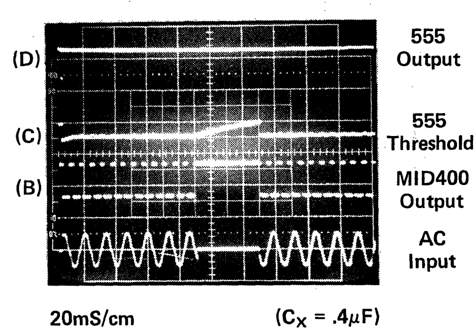


Fig. 17. Unsaturated Mode—Does NOT Detect Missing AC Input Cycles

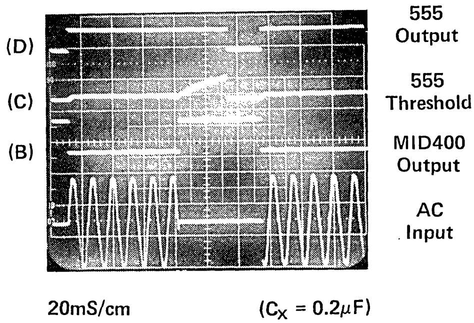


Fig. 18. Saturated Mode—Detects Missing AC Input Cycles

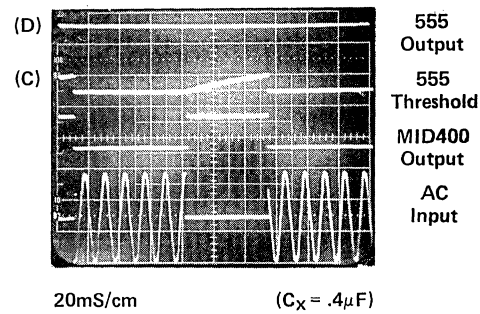


Fig. 19. Saturated Mode—Does NOT Detect Missing AC Input Cycles

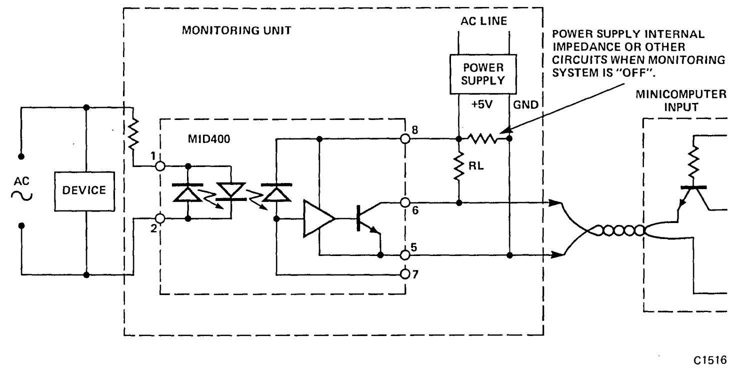


Fig. 20. Example For Fail-Safe Considerations

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 $R_X C_X$ 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

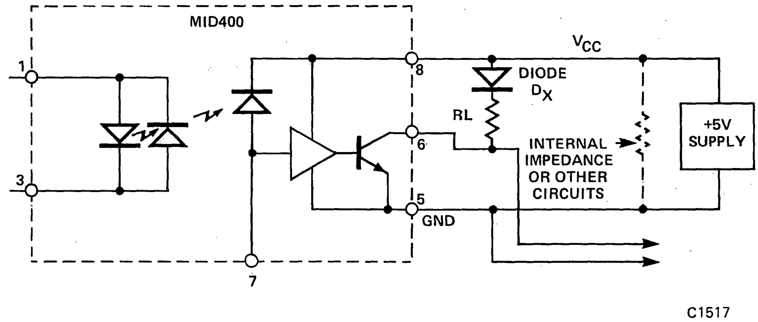


Fig. 21. Diode D_X Added to Stop Reverse Current When MID400 +5v V_{CC} Line is Off

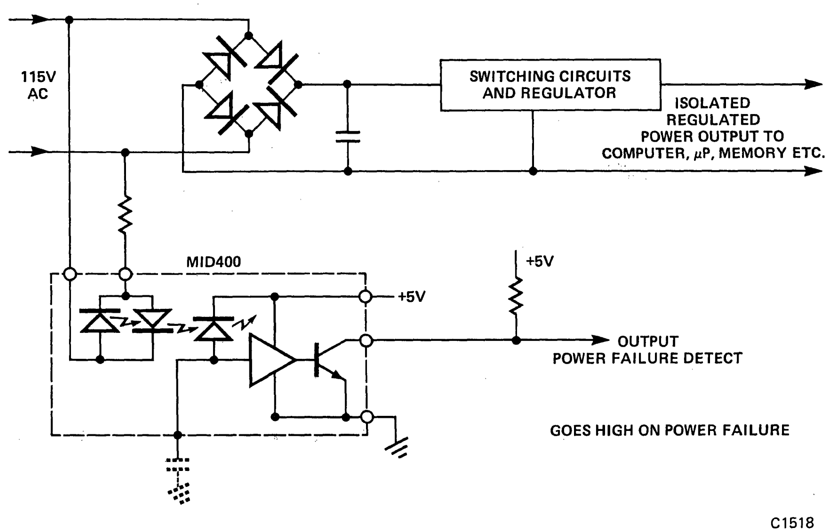


Fig. 22. Circuit for Switching Power Supply

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.

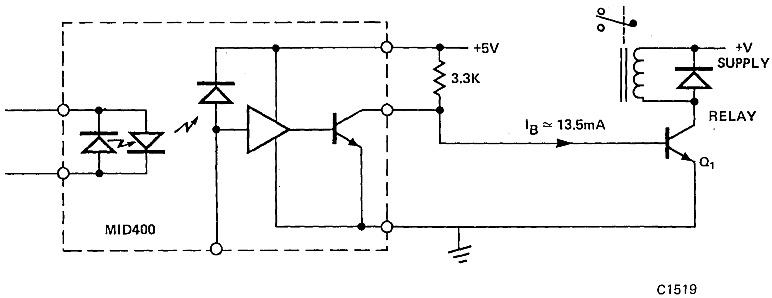


Fig. 23. Relay Interface Circuit

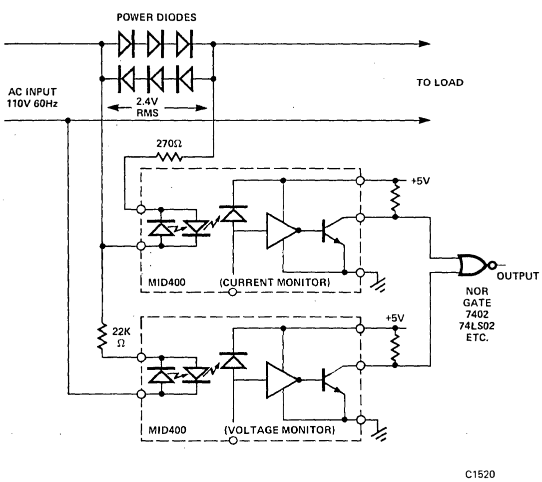


Fig. 24. AC Power Line Voltage and Current Monitor

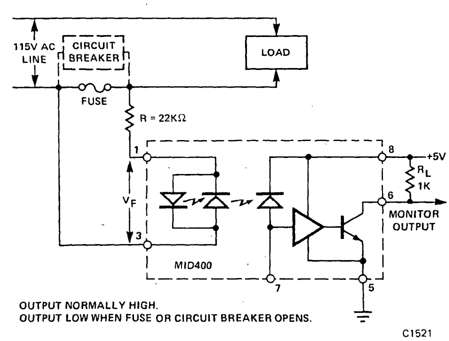
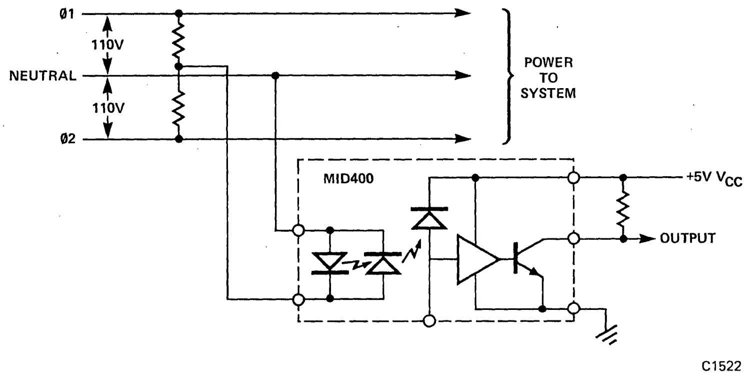


Fig. 25. Fuse or Circuit Breaker Monitor

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.

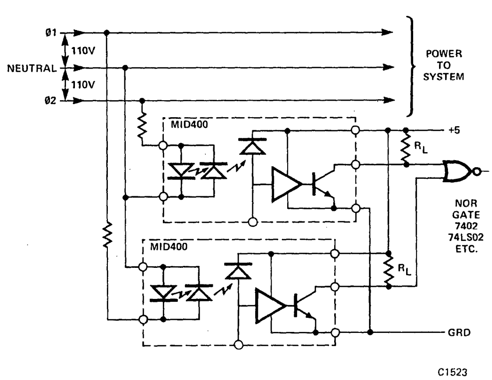
Figure 24 shows a circuit that uses two MID400s to monitor both voltage and current. When both voltage and current are being supplied to the load, the output of "NOR" gate is high. If load current drops due to either open circuit or failure, the output of "NOR" gate is low. If both voltage and current 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

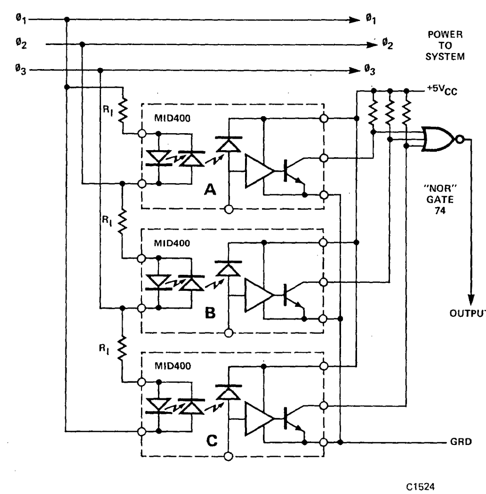


Fig. 28. Monitor Circuit for Three Phase Power Line

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.

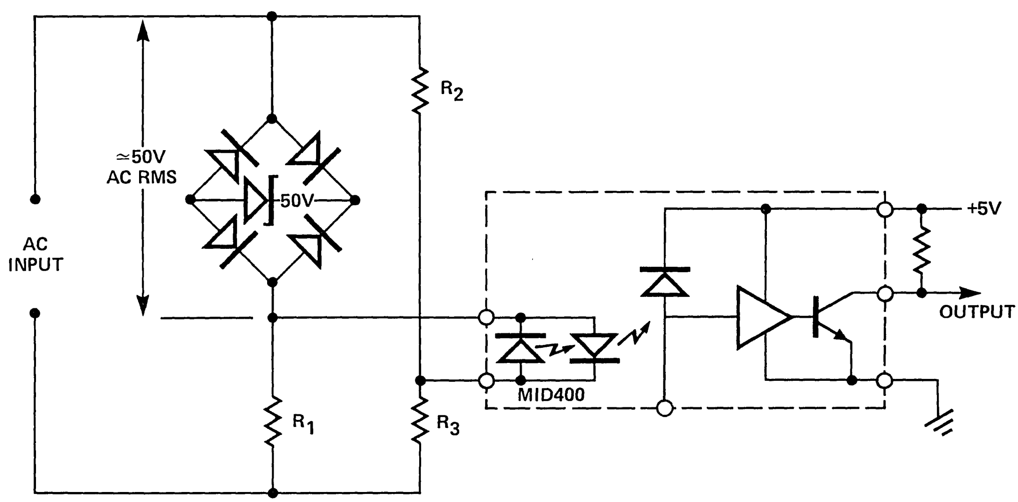


Fig. 29. AC Voltage Deviation Monitor

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 7

Cross Reference Index

Competitive Type Number	Manufacturer	General Instrument Part Number
1351G	1EE	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	"	MAN4510A
1454G	"	MAN4540A
1455G	"	MAN4505A
1461E	"	MAN4610A
1464E	"	MAN4640A
1465E	"	MAN4605A
1471R	"	MAN4710A
1474R	"	MAN4740A
1475R	"	MAN4705A
1481Y	"	MAN4810A
1484Y	"	MAN4840A
1485Y	"	MAN4805A
1704R	"	MAN2A
1737R	"	MAN71A or 72A
1738R	"	MAN74A
1787R	"	MAN6760
1788R	"	MAN6780
2661E	"	MAN6610
2663E	"	MAN6630
2664E	"	MAN6640
2665E	"	MAN6650
2666E	"	MAN6660
2668E	"	MAN6680
2671R	"	MAN6710
1673R	"	MAN6730
2674R	"	MAN6740
2675R	"	MAN6750
2687R	"	MAN6760
2678R	"	MAN6780
3N243	OPTRON	MCT4
3N243R	"	MCT4R
4N25	FSC/GE/LIT/ MOT/OPT	4N25
4N26	FSC/GE/MOT	4N26

Competitive Type Number	Manufacturer	General Instrument Part Number
4N27	FSC/GE/MOT	4N27
4N28	"	4N28
4N29	"	4N29
4N29	OPTRON	MCT277
4N30	"	4N30
4N31	"	4N31
4N32	"	4N32
4N33	"	4N33
4N35	"	4N35
4N36	"	4N36
4N37	FSC/GE/ MOT/OPTRON	4N37
6N137	"	6N137
6N138	HP/ SPECTRONICS	MCC670/ 6N138
6N139	"	MCC671/ 6N139
5082-4101	HP	MV54
5082-4150	"	MV53
5082-4160	"	MV55A
5082-4360	"	6N137
5082-4361	"	MCL2601
5082-4370	"	MCC670/ 6N138
5082-4371	"	MCC671/ 6N139
5082-4494	"	MV5075B
5082-4550	"	MV5353
5082-4555	"	MV5353
5082-4557	"	MV5352
5082-4558	"	MV5352
5082-4584	"	MV5374B
5082-4590	"	MV53154
5082-4592	"	MV53154
5082-4595	"	MV53152
5082-4597	"	MV53152
5082-4650	"	MV5753
5082-4655	"	MV5753
5082-4657	"	MV5752
5082-4658	"	MV5752
5082-4684	"	MV5774B
5082-4690	"	MV57154
5082-4692	"	MV57154
5082-4693	"	MV57152
5082-4694	"	MV57152
5082-4695	"	MV57152
5082-4790	"	MV50154
5082-4792	"	MV50154
5082-4850	"	MV5053
5082-4855	"	MV5054A-1

Competitive Type Number	Manufacturer	General Instrument Part Number	Competitive Type Number	Manufacturer	General Instrument Part Number
5082-4855	HP	MV5054A-2	521-9259	DIALIGHT	MV5352
5082-4855	"	MV5054A-3	521-9260	"	MV5253
5082-4880	"	MV5054A-1	521-9261	"	MV5352
5082-4881	"	MV5054A-2	745-0005	"	MAN2A
5082-4885	"	MV5050	745-0014	DIALIGHT	MAN71A
5082-4885	"	MV5052	745-0014	"	MAN72A
5082-4888	"	MV5051	745-0016	"	MAN74A
5082-4950	"	MV5253	7610R	1EE	MAN3620A
5082-4955	"	MV5253	7611R	"	MAN3810A
5082-4957	"	MV5252	7620Y	"	MAN3820A
5082-4958	"	MV5252	7621Y	"	MAN3810A
5082-4990	"	MV52154	7630G	"	MAN3420A
5082-4992	"	MV52154	7631G	"	MAN3410A
5082-4995	"	MV52152	7730R	"	MAN72A
5082-4997	"	MV52152	7731R	"	MAN71A
5082-7610	"	MAN3920A	8503-1	SPECTRONICS	CQY99
5082-7610	"	MAN3620A	BPX38-3, -4	SIEMENS/LIT	MT1
5082-7611	"	MAN3910A	BPX43-2, -3	"	MT2
5082-7611	"	MAN3610A	BPX62	"	MT2
5082-7613	"	MAN3980A	BP103B-2, -3	"	MT8020
5082-7620	"	MAN3820A	CL13	CLAIREX	4N37
5082-7621	"	MAN3810A	CLI510	"	4N37
5082-7623	"	MAN3880A	CLI511	"	4N37
5082-7630	"	MAN3400A	CMN3620A	CML	MAN3620A
5082-7631	"	MAN3410A	CMN3640A	"	MAN3640A
5082-7633	"	MAN3480A	CMN3680A	"	MAN3680A
5082-7651	"	MAN4610A	CMN3910A	"	MAN3910A
5082-7730	"	MAN72A	CMN3920A	"	MAN3920A
5082-7731	"	MAN71A	CMN3930A	"	MAN3930A
5082-7740	"	MAN78A	CMN3940A	"	MAN3940A
521-9179	DIALIGHT	MV5056	CMN3980A	"	MAN3980A
521-9185	"	MV50	CMN4580A	"	MAN4580A
521-9186	"	MV54	CMN4610A	"	MAN4610A
521-9189	"	MV5075B	CMN4640A	"	MAN4640A
521-9195	"	MV54	CMN4680A	"	MAN4680A
521-9206	"	MV5274B	CMN4705A	"	MAN4705A
521-9207	"	MV5374B	CMN4710A	"	MAN4710A
521-9216	"	MV5075C	CMN4780A	"	MAN4780A
521-9217	"	MV5053	CMN4880A	"	MAN4880A
521-9224	"	MV5253	CMN4905A	"	MAN4905A
521-9225	"	MV5353	CMN4910A	"	MAN4910A
521-9246	"	MV5753	CMN4940A	"	MAN4940A
521-9247	"	MV5752	CMN4980A	"	MAN4980A
521-9248	"	MV5353	CMN58A	"	MAN3480A
521-9249	"	MV5753	CMN6640	"	MAN6640
521-9250	"	MV5253	CMN6680	"	MAN6680
521-9251	"	MV5257	CMN6710	"	MAN6710
521-9256	"	MV5753	CMN6730	"	MAN6730
521-9257	"	MV5752	CMN6740	"	MAN6740
521-9258	"	MV5353	CMN6780	"	MAN6780

Competitive Type Number	Manufacturer	General Instrument Part Number
CMN6910	CML	MAN6910
CMN6930	"	MAN6930
CMN6940	"	MAN6940
CMN6950	"	MAN6950
CMN6960	"	MAN6960
CMN6980	"	MAN6980
CMN72A	"	MAN72A
CMN73A	"	MAN73A
CMN74A	"	MAN74A
CMN78A	"	MAN78A
CMN88A	"	MAN3880A
CMN8910	"	MAN8910
CMN8930	"	MAN8930
CMN8940	"	MAN8940
CMN8950	"	MAN8950
CMN56120	"	MMN56120
CMN56240	"	MMN56240
CMN56320	"	MMN56320
CMN56440	"	MMN56440
CMN58120	"	MMN58120
CMN58240	"	MMN58240
CMN58320	"	MMN58320
CMN58440	"	MMN58440
CMN59120	"	MMN59120
CMN59240	"	MMN59240
CMN59320	"	MMN59320
CMN59440	"	MMN59440
CM4-5B	"	MP22
CM4-6B	"	MP52
CM4-8B	"	MP65
CM4-9B	"	MP73
CM4-20	"	MV5020
CM4-21	"	MV5021
CM4-22	"	MV5022
CM4-23	"	MV5025
CM4-24	"	MV5024
CM4-25	"	MV5023
CM4-43A	"	MV5075B
CM4-43B	"	MV5075C
CM4-73A	"	MV5052/ MV50152
CM4-80B	"	MV5050
CM4-81B	"	MV5051
CM4-82B	"	MV5052
CM4-83	"	MV5054-1
CM4-83-1	"	MV5054-1
CM4-83-2	"	MV5054-2
CM4-83-3	"	MV5054-3
CM4-84B	"	MV5053
CM4-84B-0	"	MV5053
CM4-84B-1	"	MV5053

Competitive Type Number	Manufacturer	General Instrument Part Number
CM4-84B-2	CML	MV5053
CM4-85B	"	MV5056
CM4-86B	"	MV5055
CM4-244A	"	MV5774B
CM4-244B	"	MV5774C
CM4-264	"	MV57124
CM4-265	"	MV57173
CM4-282B	"	MV5752
CM4-382B-2	"	MV5752
CM4-283B	"	MV5754
CM4-284B	"	MV5753
CMR-284B-2	"	MV5753
CM4-293B	"	MV50152
CM4-294B	"	MV5-154
CM4-344A	"	MV5274B
CM4-344B	"	MV5274C
CM4-364	"	MV52124
CM4-382B	"	MV5252
CM4-382B-2	"	MV5252
CM4-383B	"	MV5254
CM4-384B	"	MV5253
CM4-384B-2	"	MV5253
CM4-393B	"	MV52152
CM4-394B	"	MV52154
CM4-444A	"	MV5174B
CM4-470-1-9150-1	"	MK9150-1
CM4-470-2-9150-2	"	MK9150-2
CM4-482B	"	MV5152
CM4-482B-2	"	MV5152
CM4-483B	"	MV5154
CM4-484B	"	MV5153
CM4-484B-2	"	MV5153
CM4-493B	"	MV57152
CM4-494B	"	MV57154
CM4-544A	"	MV5374B
CM4-544B	"	MV5374C
CM4-564	"	MV53124
CM4-570-1-9350-1	"	MK9350-1
CM4-570-2-9350-2	"	MK9350-2
CM4-582B	"	MV5352
CM4-582B-2	"	MV5352
CM4-583B	"	MV5354
CM4-584B	"	MV5353
CM4-584B-2	"	MV5353
CM4-593B	"	MV53152

Competitive Type Number	Manufacturer	General Instrument Part Number
CM4-594B	CML	MV53154
CNY17-I	SIEMENS/LIT	CNY17-1
CNY17-II	"	CNY17-2/75A
CNY17-III	"	CNY17-3/75B
CNY17-IV	"	CNY17-4/75C
CNY28	"	CNY37
CNY51	GE/SIEMENS	CNY75B
CQX13-1	"	MV52154
CQX23-1	"	MV50154
CQX33-2	"	MV53154
DL-10	SIEMENS/LIT	MAN10A
DL-10A	"	MAN10A
DL-101	"	MAN1001A
DL-101A	"	MAN1001A
DL-500	"	MAN6680
DL-507	"	MAN6760
DL-57	"	MAN2A
DL-701	"	MAN73A
DL-704	"	MAN74A
DL-707	"	MAN72A
DL-707R	"	MAN71A
DL-727	"	MAN6710
DL-728	"	MAN6740
DL7651	"	MAN4610A
DL7751-S	"	MAN4710A
FCD810	FAIRCHILD	MCT26
FCD810C/D	"	MCT2200
FCD820	"	MCT2
FCD820B	"	MCT2E
FCD820C/D	"	MCT2200
FCD825C/D	"	MCT2201
FCD830C/D	"	MCT2200
FCD831C/D	"	MCT2200
FCD836C/D	"	MCT2200
FCD850	"	MCA230
FCD860	"	MCA231
FCD880	"	MCT6
FCD885	"	MCT66
FLV251	"	MV5752
FLV252	"	MV5752
FLV310	"	MV5254
FLV315	"	MV5253
FLV341	"	MV5252
FLV350	"	MV5253
FLV351	"	MV5252
FLV355	"	MV5253
FLV360	"	MV5253
FLV365	"	MV5253
FLV440	"	MV5353
FLV450	"	MV5353

Competitive Type Number	Manufacturer	General Instrument Part Number
FLV460	FAIRCHILD	MV5353
FND500	"	MAN6780
FND507	"	MAN6760
FND560	"	MAN6680
FND567	"	MAN6660
FND800	"	MAN8640
FND807	"	MAN8610
FND847	"	MAN8610
FND850	"	MAN8640
FPT500	"	MT2*
FSC825B	"	MCT270
GBG1000	"	MV54164
GL4484	SIEMENS/LIT	MV5274B
GL4850	"	MV5253
GL4950	"	MV5253
GL56	"	MV52
H11A1	GE	MCT270/ MCT272
H11A2	"	MCT2
H11A3	"	MCT2E
H11A4	"	MCT2
H11A5	"	MCT26
H11B2	"	MCA231
H11B255	"	MCA255
H11B3	"	MCA230
H11C1	"	MCS21
H11C2	"	MCS21
H11C3	"	MCS2
H11C4	"	MCS2401
H11C5	"	MCS2401
H11C6	"	MCS2400
H11G1	"	MCA11G1
H11G2	"	MCA11G2
H11J1	"	MCP3011
H11J2	"	MCP3010
H11J3	"	MCP3011
H11J4	"	MCP3010
H11J5	"	MCP3009
H13A1	"	MCT8- CNY37
H13A2	"	MCT81- CNY37
H13B1	"	MCA8
H13B2	"	MCA81
H20A1	"	CNY36
H20A2	"	CNY36
HCPL-2601	HP	MCL2601
HD1131-0	SIEMENS/LIT	MAN6660

*Minor mechanical or electrical differences

Competitive Type Number	Manufacturer	General Instrument Part Number
HD1133-0	SIEMENS/LIT	MAN6680
HD1131-R	"	MAN6760
HD1133-R	"	MAN6780
HD1131-0	"	MAN6960
HD1133-0	"	MAN6980
HDSP-3401	HP	MAN8910
HDSP-3403	"	MAN8940
HDSP-3530	"	MAN3920A
HDSP-3530	"	MAN3620A
HDSP-3531	"	MAN3910A
HDSP-3531	"	MAN3610A
HDSP-3533	"	MAN3980A
HDSP-3533	"	MAN4980A
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-5301	"	MAN6760
HDSP-5303	"	MAN6780
HDSP-5501	"	MAN6960
HDSP-5503	"	MAN6980
HDSP-5701	"	MAN6860
HDSP-5703	"	MAN6880
HDSP-5801	"	MAN6460
HDSP-5803	"	MAN6480
HLMP-1300	"	MV57640
HLMP-1301	"	MV57641
HLMP-1302	"	MV57642
HLMP-1400	"	MV53640
HLMP-1401	"	MV53641
HLMP-1402	"	MV53642
HLMP-1500	"	MV52640
HLMP-1501	"	MV52641
HLMP-1502	"	MV52642
HLMP-1503	"	MV54643
HLMP-1523	"	MV54644
HLMP-3300	"	MV5753
HLMP-3301	"	MV5753
HLMP-3400	"	MV5353
HLMP-3401	"	MV5353
HLMP-3500	"	MV5253
HLMP-3501	"	MV5253
HLMP-3502	"	MV64530
HLMP-3507	"	MV64531
HLMP-3517	"	MV64520

Competitive Type Number	Manufacturer	General Instrument Part Number
HLMP-3519	HP	MV64521
IL1	SIEMENS/LIT	MCT2E/MCT2/ MCT276
IL5	"	MCT270
IL12	"	MCT2
IL15	"	MCT26
ILA30	"	MCA230
ILA50	"	MCA255
ILA55	"	MCA256
ILCA2-30	"	MCA230
ILCA2-55	"	MCA255
ILCT6	"	MCT6
ILD74	"	MCT66
LD261-4	"	ME7161*
LD271	"	ME7121*
LD271A	"	COY99
LD30-1	"	MV5075B
LD32-1	"	MV57641
LD32-2	"	MV57642
LD36-C	"	MV53642
LD37-1	"	MV52642
LD52-1	"	MV5753
LD52-2	"	MV5753
LD52-C	"	MV5752
LD52-CA	"	MV5752
LD56-1	"	MV5353
LD56-2	"	MV5353
LD56-C	"	MV5752
LD56-CA	"	MV5352
LD57-1	"	MV5253
LD57-2	"	MV5253
LD57-C	"	MV5252
LD57-CA	"	MV5252
MCA230	FAIRCHILD	MCA230
MCA231	"	MCA231
MCA255	"	MCA255
MCT2	"	MCT2
MCT2E	"	MCT2E
MCT6	"	MCT6
MCT26	"	MCT26
MCT66	"	MCT66
MOC119	MOTOROLA	MCA231
MOC1000	"	MCT2
MOC1001	"	MCT2E
MOC1002	"	4N27
MOC1003	"	4N28
MOC1005	"	MCT2200
MOC1006	"	MCT2200
MOC1200	"	MCA230
MOC3000	"	MCS2
MOC3001	"	MMCS2401

Competitive Type Number	Manufacturer	General Instrument Part Number
MOC3002	MOTOROLA	MCS2400
MOC3003	"	MCS21
MOC3009	"	MCP3009
MOC3010	"	MCP3010
MOC3011	"	MCP3011
MV5050	FAIRCHILD	MV5050
MV5051	"	MV5051
MV5052	"	MV5052
MV5053	"	MV5053
MV5054-1	"	MV5054-1
MV5054-2	"	MV5054-2
MV5054-3	"	MV5054-3
MV5055	"	MV5055
MV5056	"	MV5056
MV5152	"	MV5152
MV5153	"	MV5153
MV5154	"	MV5154
MV5252	"	MV5252
MV5253	"	MV5253
MV5254	"	MV5254
MV5352	"	MV5352
MV5353	"	MV5353
MV5354	"	MV5354
MV5752	"	MV5752
MV5754	"	MV5754
NSB373	NATIONAL	MAN74A
NSB374	"	MAN72A
NSB381	"	MAN74A
NSB382	"	MAN72A
NSB3881	"	MMN39440
NSB3882	"	MMN39240
NSB581	"	MAN6740
NSB583	"	MAN6740
NSB5881	"	MMN59440
NSB5882	"	MMN59240
NSL5020	"	MV5020
NSL5022	"	MV5022
NSL5023	"	MV5023
NSL5024	"	MV5024
NSL5026	"	MV5026
NSL5027	"	MV5054A-2
NSL5053	"	MV5053
NSL5057	"	MV5054A-1
NSL5076	"	MV5177C
NSL5076A	"	MV5074C
NSL5080	"	MV5074C
NSL5274	"	MV5377C
NSN61L	"	MAN8710
NSN64R	"	MAN8640
NSN71L	"	MAN72A

Competitive Type Number	Manufacturer	General Instrument Part Number
NSN71R	NATIONAL	MAN71A
NSN74R	"	MAN74A
NSN373	"	MMN39320
NSN374	"	MMN39120
NSN583	"	MMN59320
OPB711	OPTRON	MCA7
OPB77	"	MCA7
OP800W	"	MT1
OP804	"	MT2
OPB813S3	"	CNY37
OPB819S10	"	CNY37
OP160	"	CQY99
OPI-140	"	MCT4
OPI-2100	"	MCT210
OPI-2150	"	MCT26
OPI-2151	"	MCT2
OPI-2152	"	MCT2
OPI-2153	"	MCT272
OPI-2250	"	MCT2
OPI-2251	"	MCT2
OPI2252	"	MCT2
OPI2253	"	MCT272
RL-20	SIEMENS/ LITRONIX	MV5053
RL20-02	"	MV5052
RL20-03	"	MV5051
RL20-03	"	MV5021
RL20-04	"	MV5050
RL20-04	"	MV5020
RL-2000	"	MV5054-1
RL-209	"	MV5075C
RL21	"	MV5024
RL21	"	MV5025
RL21	"	MV5026
RL-21	"	MV5054-1
RL-4403	"	MV5054-1
RL-4415	"	MV5054-1
RL-4484	"	MV5074B
RL-4850	"	MV5054-1
RL-50	"	MV50
RL-5054-1	"	MV5054-1
RL-5054-2	"	MV5054-2
RL-54	"	MV54
RL-55	"	MV55
RL-55-5	"	MV55
SCD11B2	SPECTRONIX	MCA231
SCD11B3	"	MCA230
SCD255	"	MCA255
SCS11C1	"	MCS2400
SCS11C3	"	MCS2400
SCS11C6	"	MCS2400

Competitive Type Number	Manufacturer	General Instrument Part Number
SCS11C9	SPECTRONIX	MCS2400
SFH600 I	SPEC/ SIEMENS/LIT.	CNY75A
SFH600 II	"	CNY75B
SFH600-Z	"	MCT210
SFH600 III	"	CNY75C/ MCT271
SFH601 I	"	CNY75A/ MCT272
SFH 601 II	"	CNY75B/ MCT273/ MCT275
SFH601 III	"	CNY75C
SFH601-4	"	MCT274
SPT1873	"	MCT8
SPX2*	"	4N35
SPX2E*	"	4N35
SPX26	"	MCT26
SPX28*	"	4N27
SPX33	"	MCT271
SPX35*	"	4N35
SPX36*	"	4N35
SPX37*	"	4N35
SPX4*	"	4N35
SPX5*	"	4N35
SPX53	"	MCT272
SPX6*	"	4N35
SPX103	"	MCT273
SPX1872-1*	"	CNY36
SPX1874-1*	"	CNY37
SPX2862-1*	"	CNY36
TIL111	TI	MCT2
TIL112	"	MCT26
TIL113	"	MCA230
TIL114	"	MCT2E
TIL115	"	MCT2E
TIL116	"	MCT2E
TIL117	"	MCT272/ MCT270
TIL118	"	MCT271
TIL119	"	MCA231
TIL120	"	MCT4
TIL124	"	MCT276
TIL126	"	MCT271
TIL126	"	MCT272
TIL138	"	MCT8
TIL143	"	MCA8
TIL143	"	MCT8
TIL144	"	MCA81
TIL144	"	MCT81
TIL145	"	MCA8

Competitive Type Number	Manufacturer	General Instrument Part Number
TIL146	TI	MCA8
TIL149	"	MCA7
TIL155	"	MCT270
TIL209A	"	MV5075C
TIL211	"	MV5274C
TIL211	"	MV52640
TIL212-1	"	MV5174B
TIL212-1	"	MV5374C
TIL212-2	"	MV5374C
TIL213	"	MV53640
TIL220	"	MV5054A-1
TIL220	"	MV5054A-2
TIL220	"	MV5054A-3
TIL216-1	"	MV5774C
TIL216-2	"	MV5774C
TIL228-1	"	MV5754
TIL228-2	"	MV5754
TIL228-3	"	MV5754
TIL231-1	"	MV5052
TIL232-1	"	MV5274B
TIL234-1	"	MV5254
TIL234-2	"	MV5254
TIL234-3	"	MV5254
TIL240-1	"	MV5353
TIL240-2	"	MV5353
TIL241-1	"	MV5753
TIL241-2	"	MV5753
TIL242-1	"	MV5253
TIL242-2	"	MV5253
TIL302	"	MAN10A
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
TLR303	"	MAN72
XC209	XCITON	MV5075B
XC209A	"	MV5174B
XC209G	"	MV5274B
XC209Y	"	MV5374B
XC209-02	"	MV5074B

Competitive Type Number	Manufacturer	General Instrument Part Number
XC5025	XCITON	MV5025
XC5053	"	MV5053
XC5053A	"	MV5153
XC5053G	"	MV5253
XC5053Y	"	MV5353
XC5055	"	MV5055
XC554A-2	"	MV5154
XC554G-2	"	MV5254
XC554Y-2	"	MV5354
XC554-3	"	MV5754
XC554A-4	"	MV5154
XC554G-4	"	MV5754
XC554Y-4	"	MV5354
XC554-6	"	MV5752
XC554A-6	"	MV5152
XC554G-6	"	MV5252
XC554Y-6	"	MV5352
XC554-9	"	MV5752
XC556	"	MV5054-1
XC556A	"	MV5154
XC556G	"	MV5254
XC556Y	"	MV5354
XC556-2	"	MV5054-2
XC556A-2	"	MV5154
XC556A	"	MV5154
XC556G	"	MV5254
XC556Y	"	MV5354
XC556-2	"	MV5054-2
XC556A-2	"	MV5154
XC556G-2	"	MV5254
XC556Y-2	"	MV5354
XC556-3	"	MV5054-3
YL212	"	MV5374C
YL56	SIEMENS/LIT	MV5374B
YL4484	"	MV5374B
YL4484	"	MV53640
YL4550	"	MV5353
YL4850	"	MV5353

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