Displays

Discrete LED Lamps

Optoisolators

Solid State Optoelectronics

1977 Catalog of Optoelectronic Products

Monsanto
the science company.

1977
Catalog
of
Optoelectronic
Products

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Customer Information

About This Catalog

This catalog of Monsanto light emitting diode products provides detailed information on the key devices in our extensive line. It illustrates the broadest line of LED products available anywhere from any one manufacturer . . .

- discrete lamps
- solid state displays
- optoisolators (optical couplers)

It also shows you how to find and obtain the product that best fills your design needs or to get additional assistance if required.

Monsanto

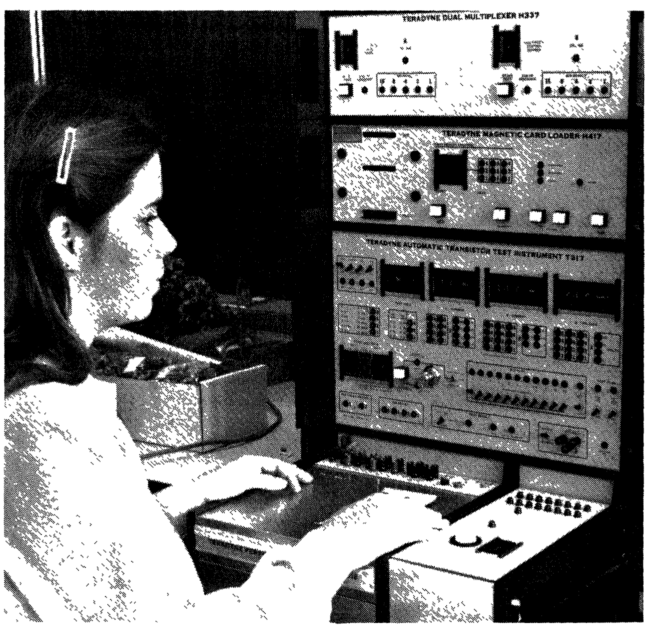
Cost/Value: the Key to Leadership

Monsanto has always applied high technological capability to product development and research activity. The results are shown in our experience in the areas of material development and available optoelectronic products.

QUALITY has always been a prime concern in any product development at Monsanto. Today, Monsanto light emitting diodes are considered to be of the highest quality available, primarily due to an extensive, well-planned quality assurance program and complementary engineering capabilities. High standards are set, and quality control checks throughout the assembly processes ensure products of quality.

This quality plus original design expertise, product assistance, customer order processing, shipment control and after-sale service demonstrates Monsanto's ability to satisfy customer requirements.

These characteristics combine to make Monsanto light emitting diodes the *best cost/value* available in the world.



High Performance Products

Monsanto's experience in processing, packaging, and materials technology has developed a broad line of high performance LED products:

- Numeric and alphanumeric displays
- Discrete LED Lamps
- Infrared emitters
- Optoisolators

Each of these product areas is stocked in depth with many variations of size, packaging, function, appearance, performance and color. In addition, constant research and development provide a steady influx of creative new products and continuous improvements in product performance.

Customer Service

Monsanto offers a complete sales network that is specifically organized to service the customer.

DISTRIBUTORS Stocking distributors are located throughout the world–

United States, Europe, Canada, Japan, Australia, Africa–

to provide the customer with immediate availability of product quantities of most standard products.

SALES ENGINEERS/REPRESENTATIVES A large organization of highly qualified technical sales engineers is immediately available in all areas to offer assistance in design, concept, and product selection.

PRODUCT MARKETING An internal staff of product marketing personnel is available to provide further factory assistance. Organized by product area, they offer the customer broad experience and knowledge at the factory level.

APPLICATIONS ENGINEERING Providing complete backup for applications assistance or discussion of specific problems, Monsanto engineers ensure that the customer has all information sources available to him.

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Monsanto

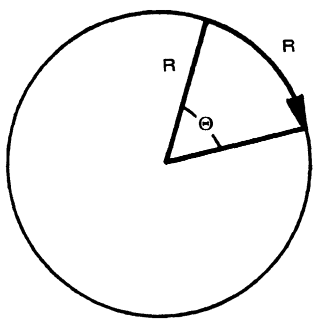
AN601
the photometry of LED's
a primer in photometry

REVIEW OF GEOMETRIC PRINCIPLES

Any short discourse on the subject of photometry requires a brief review of geometric principles utilized.

RADIAN

In plane geometry the angle whose arc is equal to the radius generating it is called a radian. Therefore, if $C = 2\pi R$ (Circumference of a circle) $2\pi R = 360^\circ$. Radian $= 180^\circ/\pi = 57.27^\circ$ (approx.)

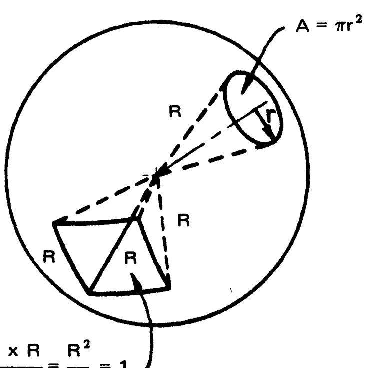


TWO DIMENSIONAL FIGURE

FIGURE 1

STERADIAN

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



$$A = \frac{R \times R}{R^2} = \frac{R^2}{R^2} = 1$$

THREE DIMENSIONAL FIGURE

FIGURE 2

Other abbreviations of immediate concern are:

- Ae = Area of emitting (or reflecting) surface.
- Ap = Apparent area of an emitting source whose image is protected 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.

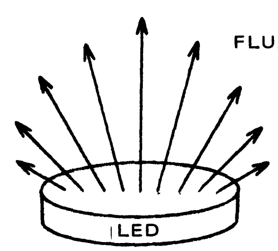


FIGURE 3

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.

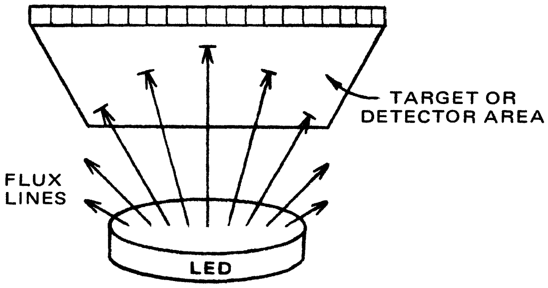


FIGURE 4

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).

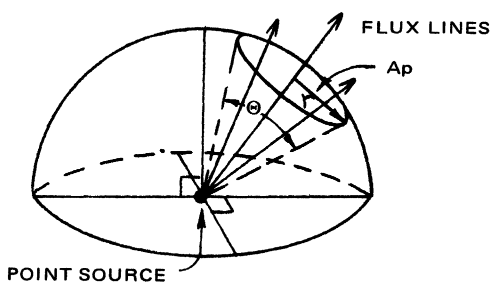


FIGURE 5

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.

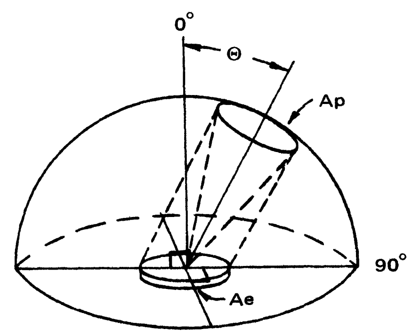


FIGURE 6

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

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

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 Monsanto's MV5025 this computes to approximately 22 feet (1666 x .16" diameter, approximately 22 feet) well within the expected normal viewing distance of an observer.

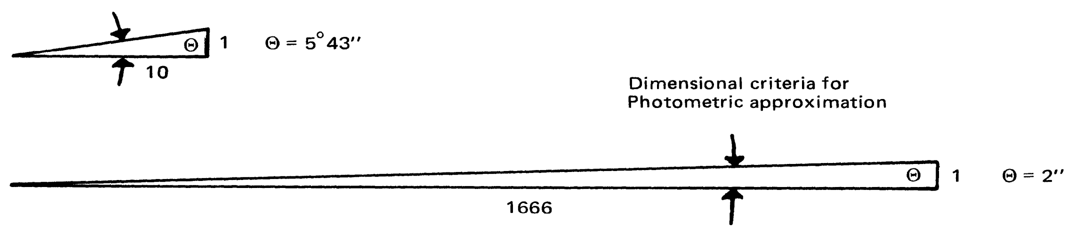


FIGURE 7

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 Monsanto 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

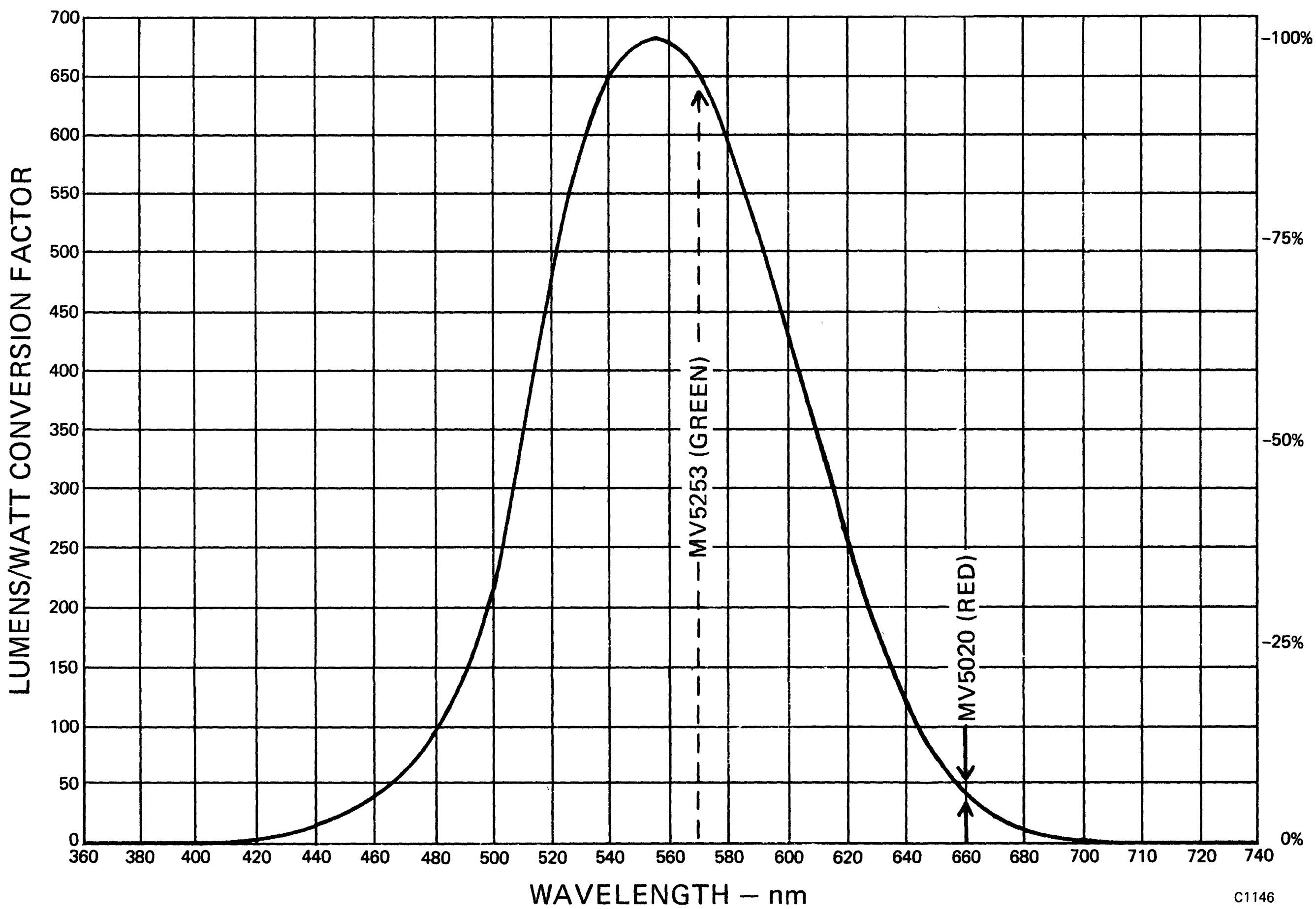
CIE CURVE

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.

Monsanto

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.

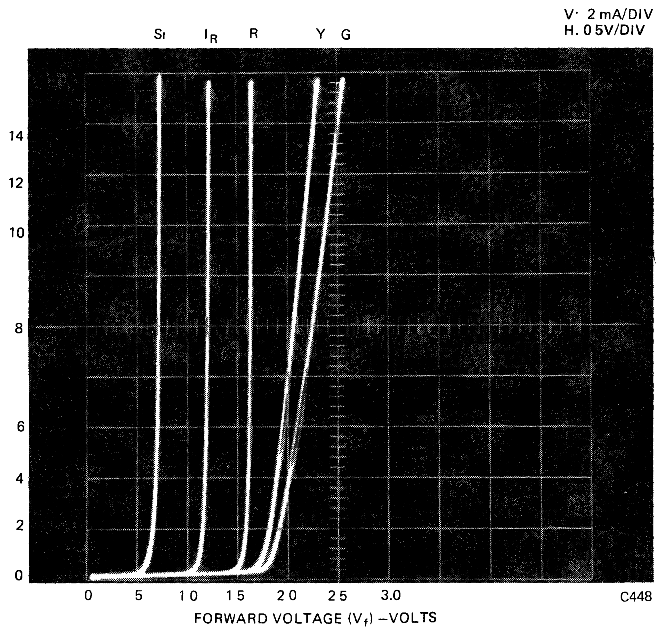


Fig. 1. Typical I_f/V_f Curves of Silicon, GaAs, and GaAsP, GaP (Silicon-IN914, IR-ME7024, Red-MV5053, Yellow-MV5353, Green-MV5253)

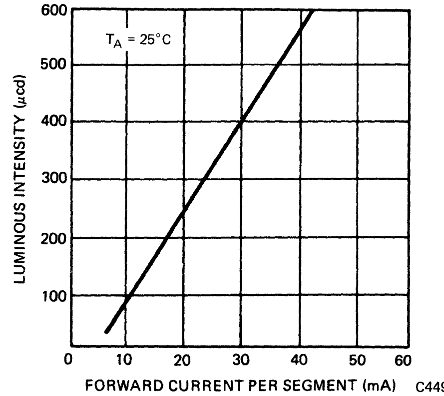


Fig. 2. Typical LED Curve Luminous Intensity vs. Forward Current for Constant Temperature

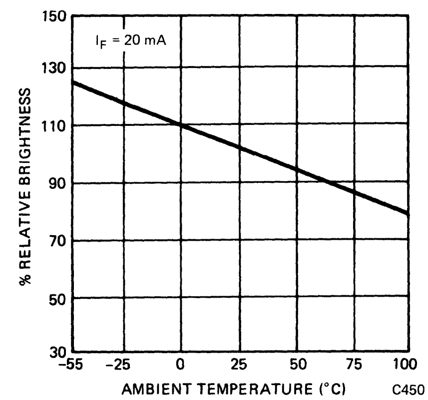


Fig. 3. Typical LED Curve Brightness vs. Temperature for Constant Current

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 Monsanto 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 3 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

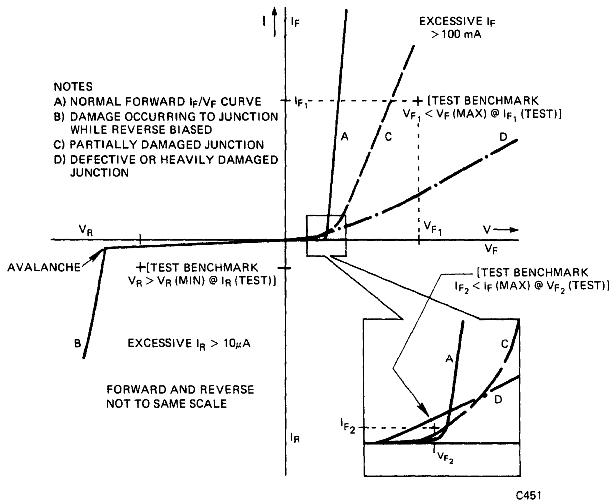


Fig. 4. Effects of Improper Testing Procedure

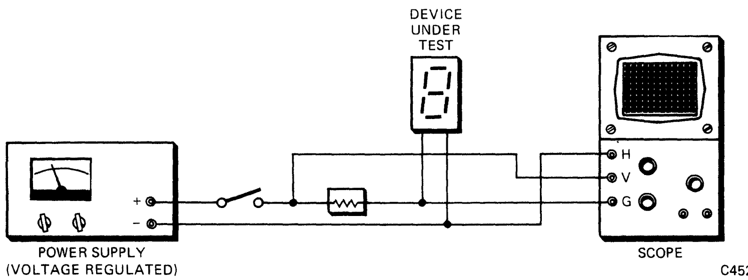


Fig. 5. Potentially Damaging Forward-Mode Test Setup

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 Monsanto quality assurance engineers, is to use a power supply which is both full voltage regulated and current limited.

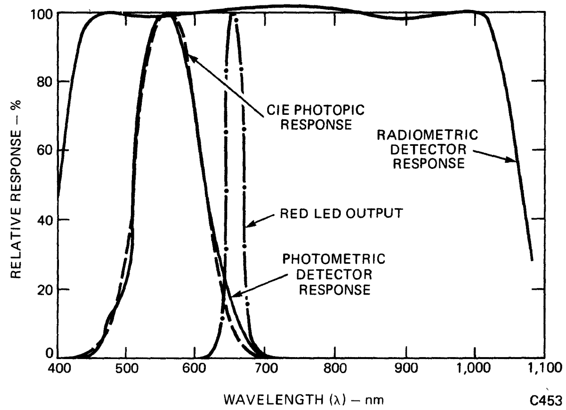


Fig. 6. Responses of Two Detectors to the Output of a Visible Red LED

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. For a detailed discussion of various LED measurement techniques and procedures, and of various methods for avoiding potential problem areas, refer to Monsanto Application Note, AN602.

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.

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[2] Michael A. Zaha, "Shedding Some Needed Light on Optical Measurements," *Electronics*, November 6, 1972, pp. 94-96.

Monsanto

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.

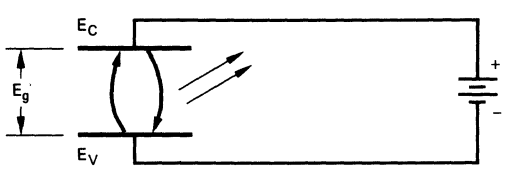
THEORY

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



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

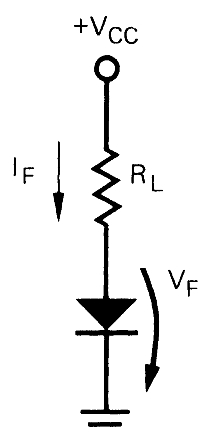
[Equation 1]

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 Monsanto 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.

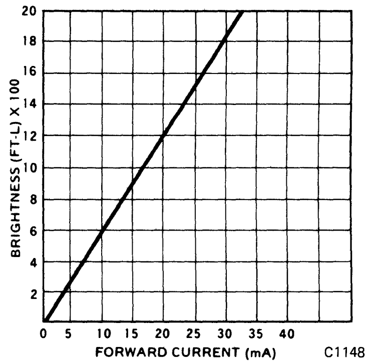


Figure 3a.

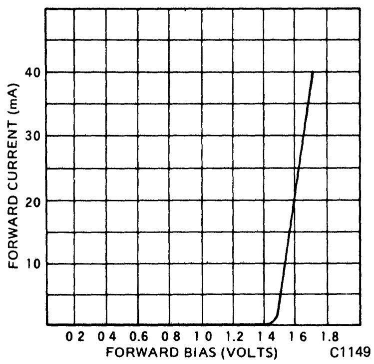


Figure 3b.

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.

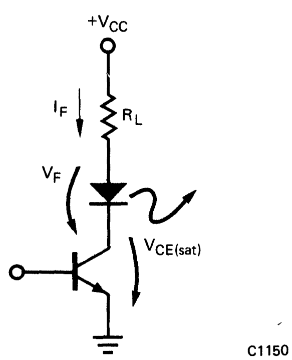


Figure 4.

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 Monsanto 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.

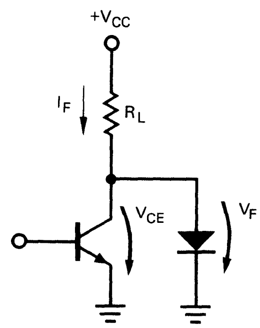


Figure 5.

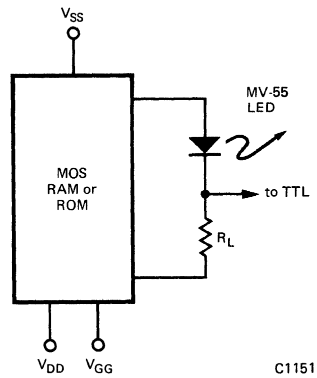


Figure 6.

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

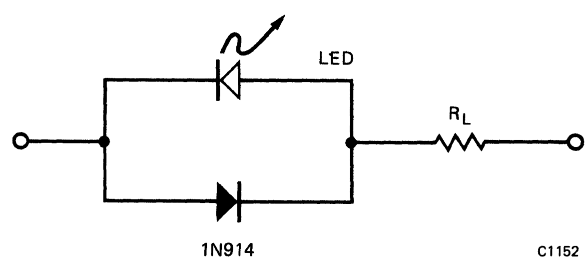


Fig. 7a. Bipolar Operation

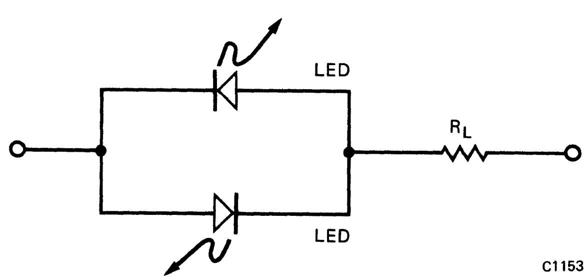


Fig. 7b. Bipolar Operation

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 Monsanto ME7021, infrared-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.

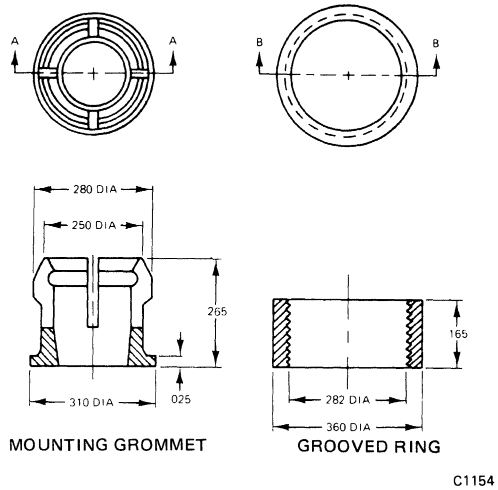
When the human eye is the detector of visible energy, lower average power is consumed by pulsed operation than by steady-state operation. This advantage of pulsed operation is especially important for battery-powered applications and for applications in which large LED arrays are being driven.

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 Monsanto 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 performed by the user, or arrangements can be made to have it done prior to shipment from the Factory.



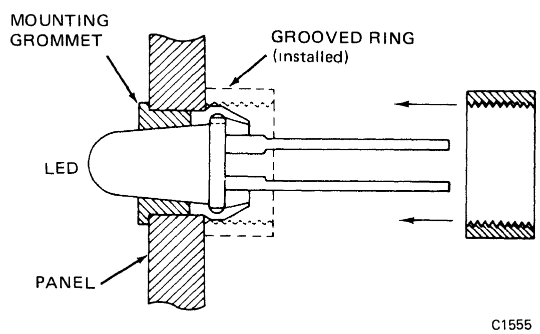


Figure 8a.

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

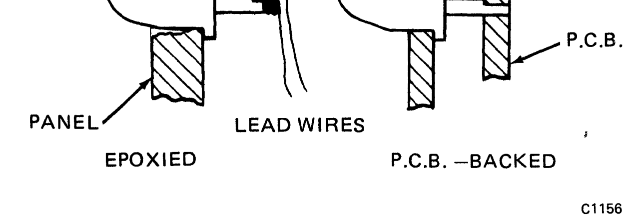
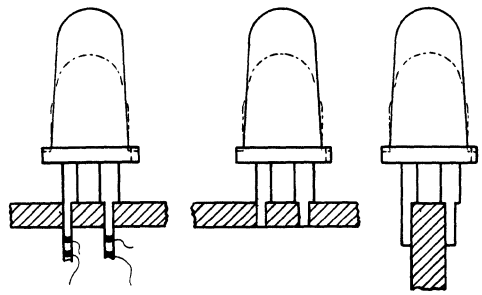
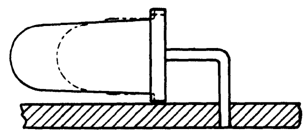


Fig. 8b. LED's Mounted Without Hardware



(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

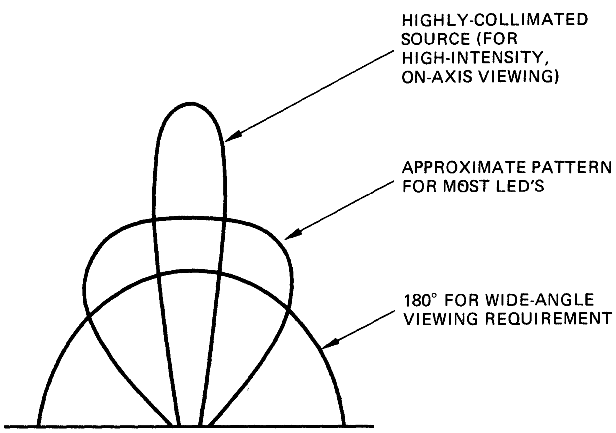
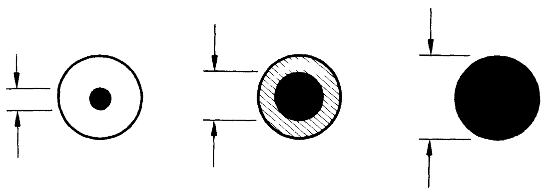


Fig. 10. Different Lens Effects (Used on the Same LED)

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 Monsanto's MV5053 (red), MV5353 (yellow), and MV5253 (green).

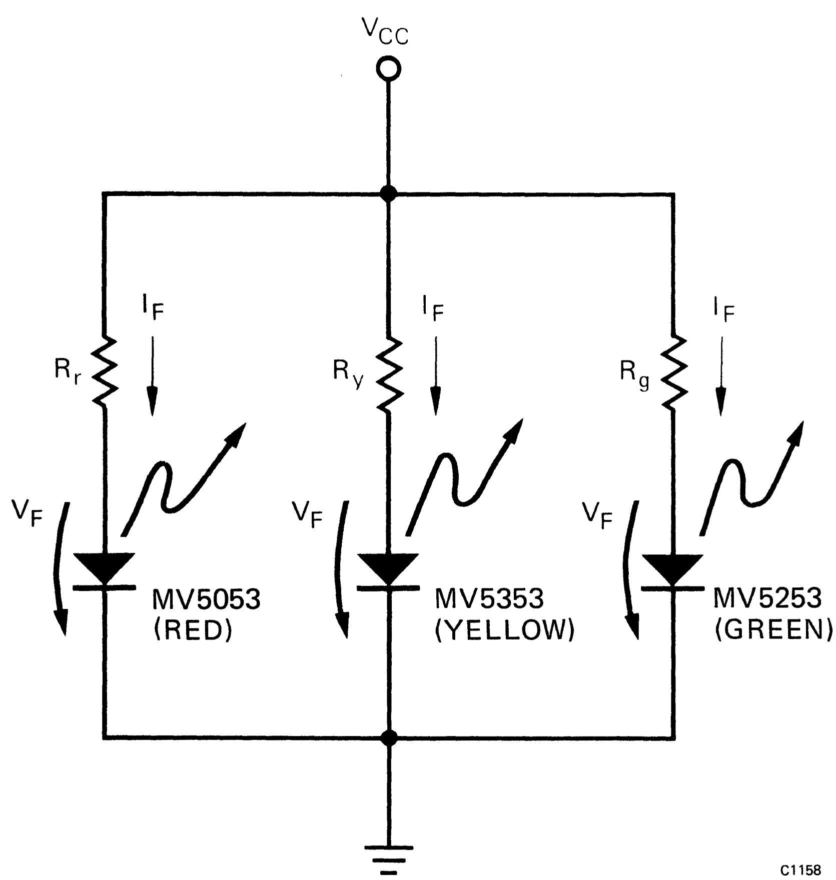


Fig. 12. Brightness Matching Different Colors

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

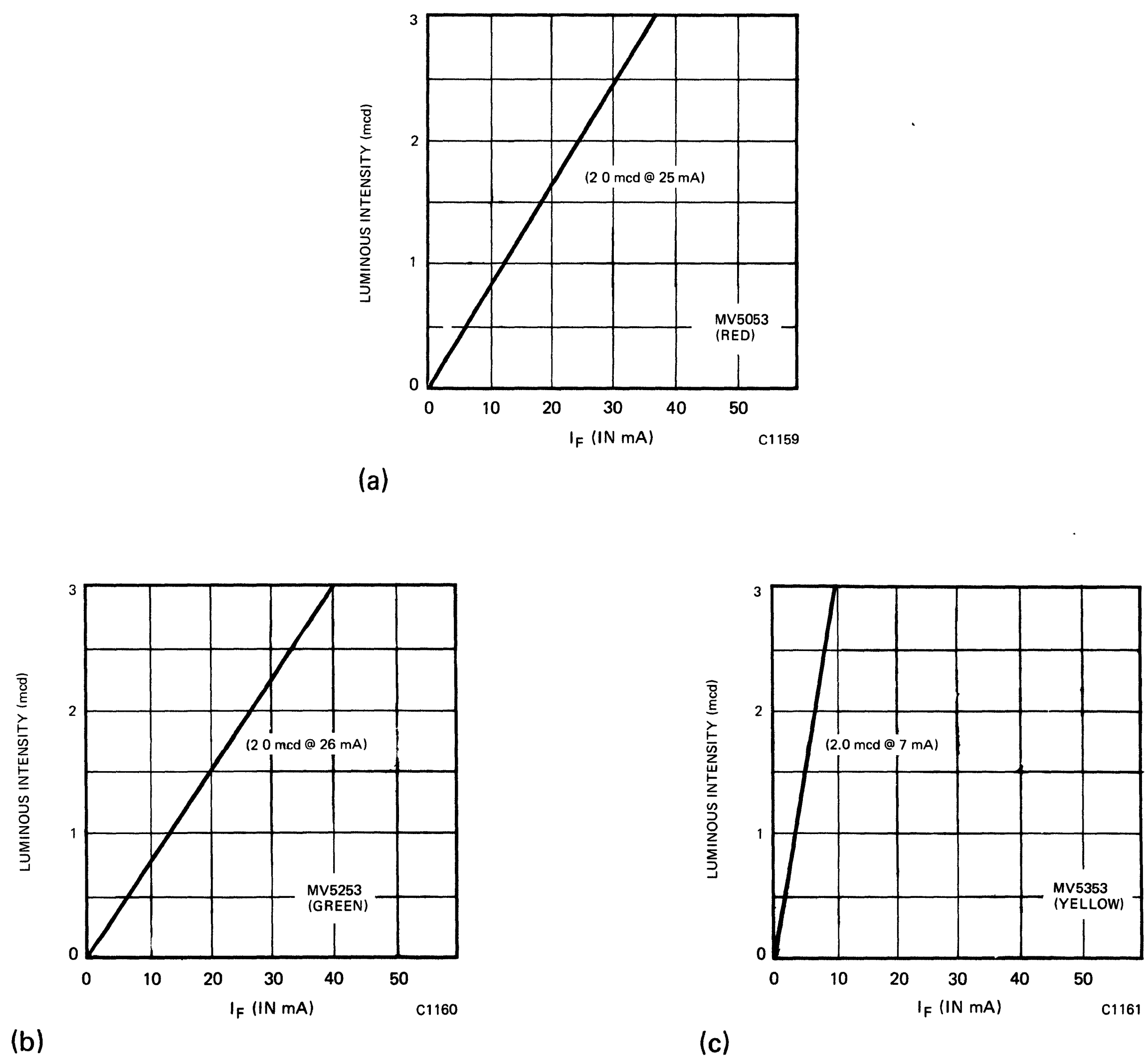


Figure 13.

Table 3.

	Parameter and Symbol		Definition	Units	Abbrev.
RADIOMETRIC	Radiant Energy	Q_e		erg joule calorie kilowatt-hour	 J cal kWh
RADIOMETRIC	Radiant Flux	P	$P = \frac{dQ_e}{dt}$	erg per second watt	erg s^{-1} W
RADIOMETRIC	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}
RADIOMETRIC	Radiant Intensity (see Note 1)	J	$J = \frac{dP}{d\omega}$	watt per steradian	W sr^{-1}
RADIOMETRIC	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}
PHOTOMETRIC	Luminous Efficiency	V	$V = \frac{K}{K_{maximum}}$		
PHOTOMETRIC	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
PHOTOMETRIC	Luminous Flux	F	$F = \frac{dQ_v}{dt}$	lumen	lm
PHOTOMETRIC	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
PHOTOMETRIC	Luminous Intensity (candlepower)	I	$I = \frac{dF}{d\omega}$	candela (lumen per steradian)	cd
PHOTOMETRIC	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).

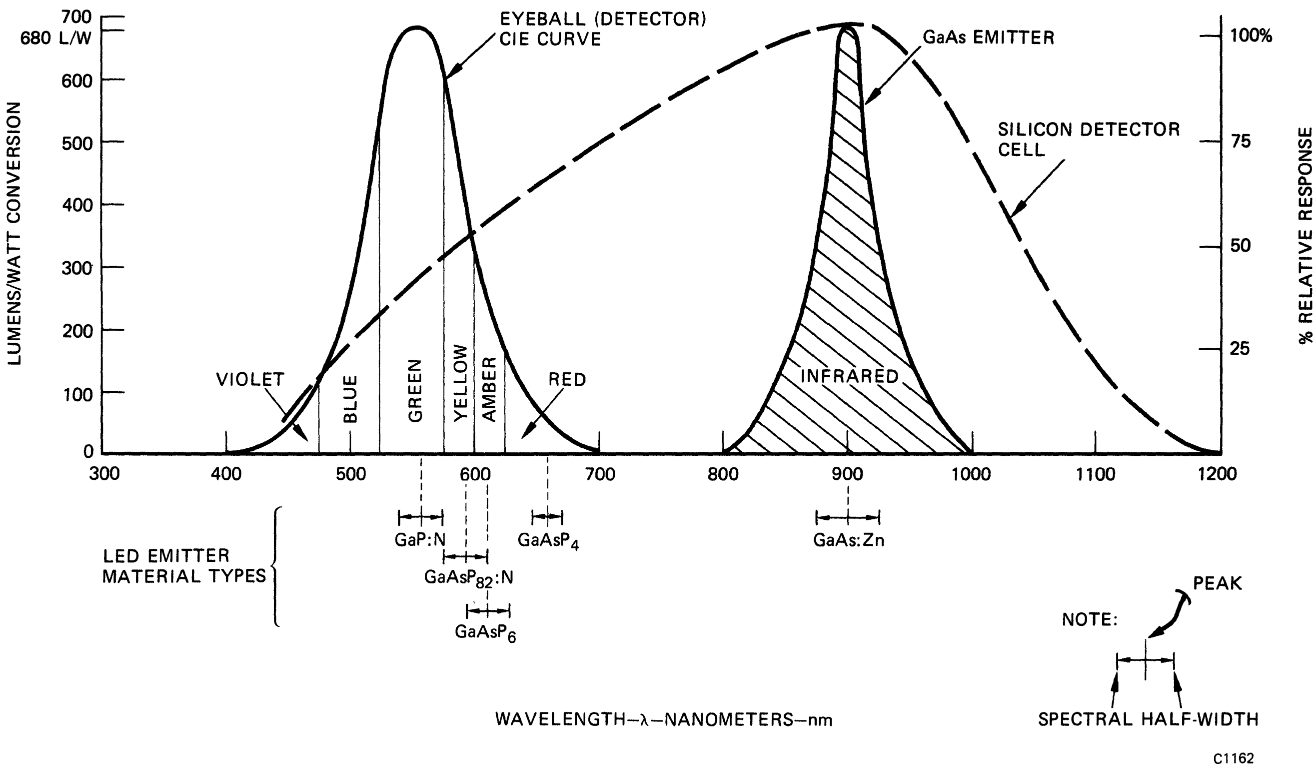


Fig. 14. Relationship Between LED and Detector Spectrums

Monsanto

AN602 measuring LED output

This Application Note serves to acquaint the reader with methods used by Monsanto to measure the emission produced by LED's. This Note defines the main LED parameters, explains measurement techniques and procedures, identifies instrumentation used, and describes test jigging. Also, it evaluates sources of measurement errors, points out approximations that are made, and discusses some practical limitations.

While methods described in this Application Note represent the best developed to date (September 1972), further improvements and refinements can be expected as LED technology continues to advance.

RADIATED POWER

Definition of Parameters. The term "flux" refers to the total amount of energy radiated in all directions per unit time from an electromagnetic source. The parameter "Total Radiated Output Power," (symbol "ROP" or "P"), refers to flux from an infrared-emitting LED. The measurement unit is the "watt." The parameter "Luminous Flux," (symbol "F"), refers to flux from a visible-emitting LED; the measurement unit is the "lumen."

Measurement Techniques and Procedures. When placed within a jig with reflective walls, as shown in Figure 1, virtually the entire output of the LED falls upon the silicon solar cell. The light generates a photoelectric current within the solar cell, and this current flows through a termination resistor. A meter monitors the voltage drop across the resistor and the meter scale is calibrated directly in "watts."

Output peak wavelength, λ_{peak}, of the LED under test must be known. This value of wavelength is needed for calculating a "sensitivity correction factor," which is applied to the meter reading. This procedure is necessary because solar cells do not respond uniformly for all wavelengths of light, (see Figure 2). For example, an LED producing 10 microwatts at λ_{peak} of 900 nanometers might cause the solar cell to generate more current than does an LED producing 10 microwatts at λ_{peak} equal to 800 nanometers.

For LED's that produce emission at visible wavelengths, the readings in "watts" units must be converted into "lumens" units. The conversion is based upon wavelength and has been derived from empirical evaluations of the human eye's spectral response. The data generally accepted within the industry is known as the "CIE Curve" or "standard eyeball," and was established by Commission Internationale de l' Eclair. (For more details on CIE Curve, see AN601.) The formula used for this conversion is as follows:

Luminous Flux (in lumens) = ROP (in watts) x CIE lumens-per-watt Conversion Factor.

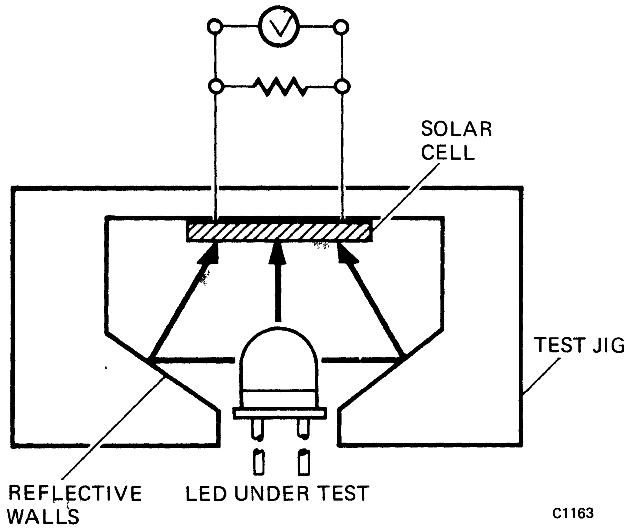


Fig. 1. Diagram of Jigging for P and F Measurements

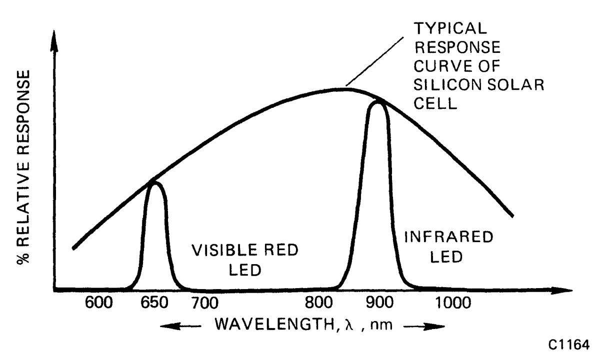


Fig. 2. Typical Spectral Response of Solar Cell Detector

Approximations and Sources of Error. In the above procedure the emission from the LED is assumed to be monochromatic, i.e., occurring at a single wavelength. In actuality, the emission does have a narrow spectral width and the "monochromatic" assumption can lead to measurement errors on the order of 10%, or greater.

A second source of error arises because some flux is lost within the jig, due to reflectance, absorption, and excessive angles of incidence for light reflected back into the LED lens.

LUMINOUS INTENSITY

Definition of Parameter. The term "intensity" refers to amount of energy radiated in a given direction per unit time from an electromagnetic source. The parameter "Luminous Intensity," (symbol "I"), refers to the intensity from a visible-emitting LED. The measurement unit is called "candela" (or "candle"), and one candela is equal to one lumen per unit solid angle (steradian).

Measurement Techniques and Procedures. Luminous Intensity measurements are quickly and easily made using a SPECTRA Model IV Microcandela Meter. The meter consists of a long tube (having non-reflecting interior walls) positioned in front of an electronic detector (photo-multiplier tube) (see Figure 3). The LED is placed in the end of the tube and a reading is obtained from the readout indicator. Because the distance from the LED to the detector—one foot—is sixty times the average diameter (0.2 inch) of an LED, the LED can be assumed (mathematically) to act as a "point" source, i.e., a source whose dimensions are negligable. The Luminous Intensity can be calculated from the formula,

Luminous Intensity (in candelas) = Correction Factor (in lumens-per-steradian) x Detector Output

The λ_{peak} of the LED must be known, and used to determine the magnitude of a Correction Factor.

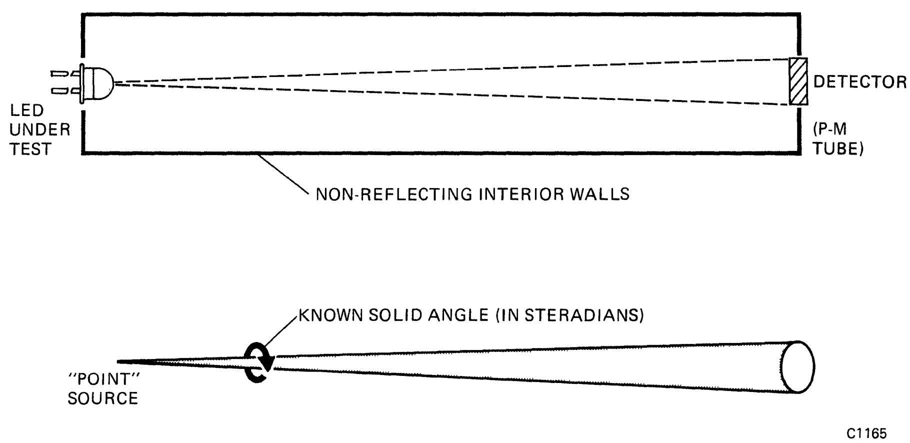


Fig. 3. Jigging for "I" Measurement

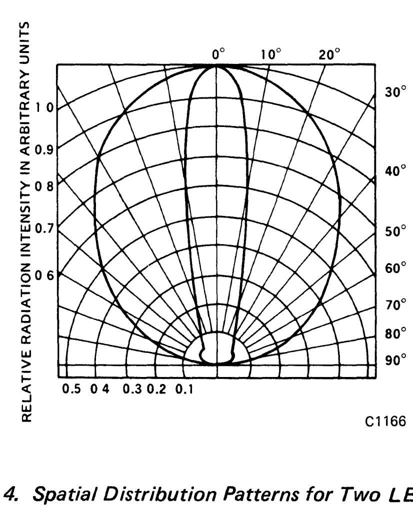


Fig. 4. Spatial Distribution Patterns for Two LED's

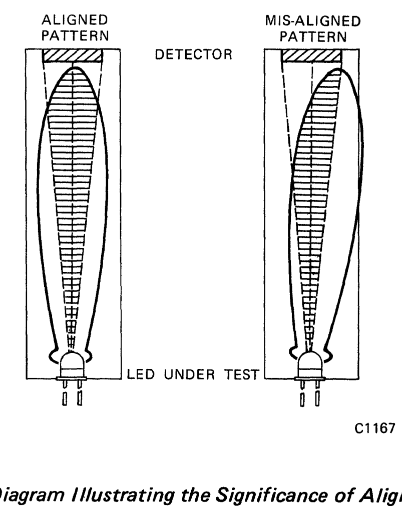


Fig. 5. Diagram Illustrating the Significance of Alignment

Approximations and Sources of Error. The repeatability of readings taken using this measurement technique can be dependent upon the positioning of the LED in the test socket. Because light emitted from each LED is spread over a given spatial distribution, (see Figure 4), the orientation of the LED determines the extent to which the distribution pattern aligns with the main axis of the test instrument, (see Figure 5). It can be seen that LED positioning is most critical for devices having a very narrow spatial distribution.

LUMINANCE

Definition of Parameter. The parameter "Luminance," (also sometimes called "Photometric Brightness"), refers to the ratio of Luminous Intensity contribution in a given direction to the area of the light source, (see Figure 6). Measurement units are given in "candelas per square unit" and many different-named units are in use, (see Table 1). An area light source whose spatial distribution pattern is spherical is called a "Lambertian Source," (see Figure 6a). Note that, because both Luminous Intensity readings and projected area vary with cosine θ, (see Figure 6b), "off-axis" Luminance readings are equal to "on-axis" readings for such a source.

Luminance is a practical parameter choice because source area—which in many instances the eye is able to detect—is introduced into the defining expression. In practice the "foot-Lambert" is the most-used unit of Luminance, but it is also the most abused, since it implies an assumption of a Lambertian distribution pattern (which does not hold for most LED's). Another Luminance measurement unit which does not assume a Lambertian distribution pattern is called "stilb," and is defined as follows:

$$\text{stilb} = \frac{\text{candelas}}{\text{area in cm}^2}$$

This measurement unit can be used for LED's having differing spatial distribution patterns.

Measurement Techniques and Procedures. A Photo Research "Spot Brightness Meter" is used in conjunction with an L175 lens, (see Figure 7). The importance of the lens is that it determines the area to be measured. The L175 samples a circular area that is 0.008 inch in diameter. This dimension was chosen because most LED chips have active areas of this size or greater. The meter's indicator provides a direct Luminance reading in "foot-Lambert" units. (Luminance readings in "stilb" units can be derived from Luminous Intensity readings divided by Apparent Area, Ap.)

Approximations and Sources of Error. This method provides a good measurement of Luminance on devices having a clear lens (i.e., LED chip visible), but is less satisfactory on devices having lenses into which diffusants have been introduced. The repeatability of readings on devices having diffused lenses can be dependent upon positioning of the LED in the test socket (in the same manner as was described under Luminous Intensity measurements). Another source of error arises on LED's whose diffused lenses increase the apparent image size, say to 0.160 inch diameter. Then, it is often difficult (if not impossible) to repeatably pick up the same 0.008 inch diameter segment.

Care must be taken in definition of area. For clear lens devices use the active emitting area times lens magnification factor. For fully-flooded lens devices merely use the outside dimensions of the package. But devices with partially-diffused lenses present a different problem. An arbitrary solution is to define the size as one-half the outside package dimensions.

WAVELENGTH

Definition of Parameters. Wavelength, (symbol "λ"), is the name given to the basic characteristic of electromagnetic waves that describes distance that a wave travels during one complete cycle. Units most frequently used in light measurements are Angstroms, Å

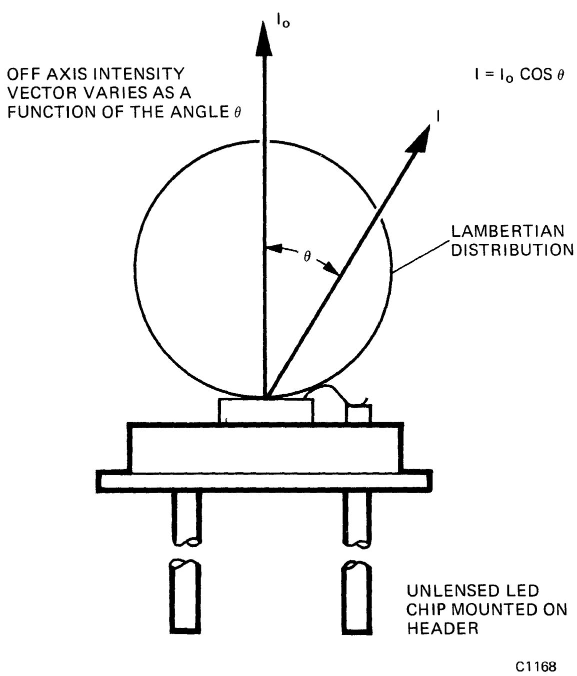


Fig. 6a. Lambertian Distribution

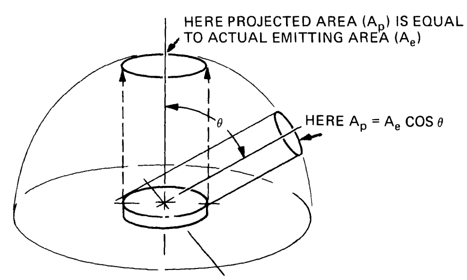


Figure 6b.

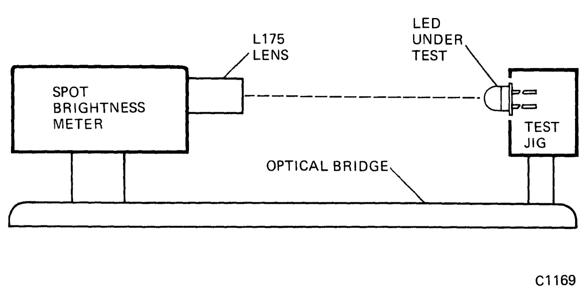


Fig. 7. Diagram of Luminance Measurement Method

(10^{-10} meters), and nanometer, nm, (10^{-9} meters). The parameter "Peak Emission Wavelength," (symbol "λ_{peak}"), refers to that value of wavelength in an LED emission spectrum which has the greatest energy content. The parameter "Spectral Line Half-Width" refers to the numerical difference between the value of shorter wavelength and the value of longer wavelength for which energy content is 50% of λ_{peak}, (see Figure 8).

Measurement Techniques and Procedures. Wavelength parameters can be measured using a Warner and Swasey Model 501 "Rapid Scanning Spectrometer" (or equivalent), together with an oscilloscope that displays the spectral wavelength information with wavelength linear in time, (see Figure 9). An internally calibrated radiation source permits the Model 501 to make absolute measurements of wavelength. It can also generate a display of change in wavelength distribution of energy as a function of time, i.e., energy spectrum. These capabilities are accomplished by means of various filters, gratings, and detectors. Wavelengths ranging from ultraviolet (at 2500 Angstroms) to infrared (at 14.5 microns) can be measured.

In addition to the analog oscilloscope display, a digital readout of wavelength can be obtained by using a type 2A63 Differential Comparator plug-in, calibrated for direct readout, in a Tektronix 565 Dual Beam oscilloscope (or equivalent). The "Delayed Sweep" feature of the oscilloscope is used to provide an intensity--modulated "bright spot" on the analog display. The Test Operator causes this "bright spot" to move along the displayed waveform by turning a front panel dial. A digital display continuously shows the numerical value of wavelength corresponding to the position of the "bright spot." In this way the Test Operator can obtain direct readouts of "λ_{peak}," and λ_1 and λ_2 measurements for calculating "Spectral Line Half-Width."

Approximations and Sources of Error. Excellent correlation of readings between devices, and with wavelength standards, is possible. The positioning of the LED and dimensions of the jigging are not critical.

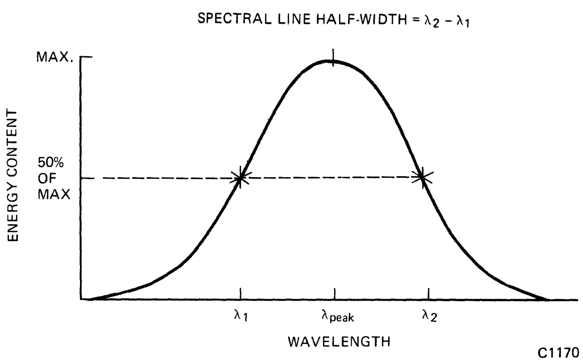


Fig. 8. "λ_{peak}" and "Spectral Line Half-Width" of an LED Emission Spectrum

PRACTICAL LIMITATIONS

This Application Note has described measurement methods by which a user can obtain parameter data on LED devices. However, human visual perception is a phenomenon having complex physiological-psychological aspects, and such engineering-type data alone are not adequate for completely predicting human performance. Also important, but at the same time impossible to quantify by conventional measurement methods, are such subjective factors as texture, color, sparkle, and even the viewer's emotional state (for example, performance during emergency, panic situations compared to that during routine, ordinary situations).

Therefore, while these measurement methods leave some room for further improvements and refinements, it would be too much to expect that they could ever provide perfect correlation with human performance.

$$\text{LUMINANCE} = \frac{\text{Luminous Intensity}}{\text{Ap}} = \frac{\text{lumens/steradian}}{\text{Ae cos }\Theta} = \frac{\text{candelas}}{\text{(square unit)}}$$

Name of Unit	Definition
1 stilb	1 candela per cm^2
1 nit	1 candela per m^2
(no designator available)	1 candela per in^2
(no designator available)	1 candela per ft^2
Lambert	$(1/\pi)$ candela per cm^2
apostilb (or blondel)	$(1/\pi)$ candela per m^2
(no designator available)	$(1/\pi)$ candela per in^2
Foot-Lambert	$(1/\pi)$ candela per ft^2

Table 1. Names of Luminance Units

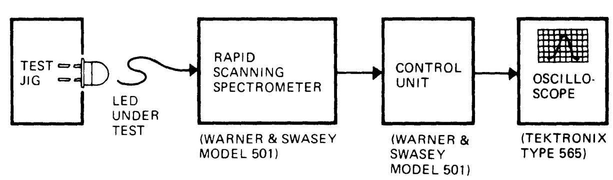


Fig. 9. Block Diagram of Wavelength Measuring Equipment

Monsanto

AN302
using LED's
to replace incandescent lamps

High-density configurations of high-intensity incandescent lamps can generate considerable heat. For example, a 10-by-10 bank of miniature 50-volt lamps can dissipate 200 watts. The resulting heat can cause catastrophic damage to mounting sockets, shorten life of insulation material, weaken structural material, and make lamp replacement almost hazardous. LED's, on the other hand, not only run cooler but also use less power and have longer life. This Application Note points out some important electrical design considerations when using LED's as indicator lamps. Circuits that assure low power dissipation and protection for the LED's will be shown.

Note from the Editor: The author of this Note wrote from a point of view which subscribed to socketing off-the-shelf LED's. He realizes that various methods can be used to prohibit the inverse insertion of a polarized device into a symmetric socket, but chose to ignore these means for exemplification.

DEVICE MAXIMUM RATINGS

As in any circuit design, care must be taken not to exceed the maximum ratings of the components. In the case of LED's used as indicator lamps, the main absolute maximum parameters to be considered are Continuous Forward Current, I_F, and Reverse Voltage, V_R. Well-engineered circuit designs should protect the LED's from the consequences of being plugged into a socket in the reverse polarity, damage arising from voltage transients on the power supply, and inductive kicks of solenoids or relay coils. Table I lists some of the absolute maximum ratings for a typical LED solid-state indicator lamp, Monsanto's MV5054-2.

MONSANTO MV5054-2

Absolute Maximum Ratings at 100°C		Units
Reverse Voltage, V_R	5.0	V
Continuous Forward Current, I_F	15.0	mA
Peak Forward Current, I_P	6.0	A

Table I. Absolute Maximum Ratings of a Typical LED

SUPPLY VOLTAGE LESS THAN LED'S V_R MAX. RATING

The simple circuit shown in Figure 1 can be used in applications that have a DC supply voltage equal to or less than the V_R maximum rating of the LED. The resistance value of R1 can be calculated from the expression R = 100 (V_{CC} – 2) when the I_F of the LED is to be 10mA. If the LED is plugged in so as to effect reverse polarity, no prohibitively high current flows since V_{CC} does not exceed the V_R max. of the LED.

Now consider what happens in Figure 1 if transient voltage spikes appear on the power supply line. Positive-going spikes cause I_F to increase, but cause no device problems since LED's can withstand very large positive-going spikes of short duration as they have extremely high Peak Forward Current, I_P, ratings. As long as the amplitude is less than V_{CC}, negative-going spikes merely reduce I_F; if greater than V_{CC} + V_R), LED Reverse Current, I_R, can become very large and device damage can result. Those applications in which negative-going spikes of amplitude greater than (V_R + V_{CC}) can occur should have a silicon diode added, either in series (Figure 2) or in parallel (Figure 3) with the LED.

The "+V_{CC}" of Figures 1, 2, and 3 just described can, of course, be half-wave or full-wave rectification as well as DC (provided that the peak does not exceed +5 volts).

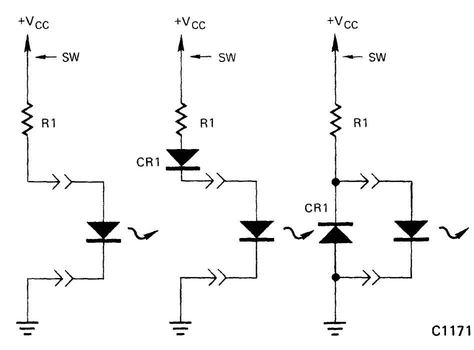


Figure 1 *Figure 2* *Figure 3*

NOTES

R1 is 1/4w, ±5%, composition resistor
CR1 is 1N914 or equivalent silicon diode

"SW" idicates recommended location of series switch or relay contact
"⏚" indicates ground return of +V_{CC} or output of NAND/NOR logic gate

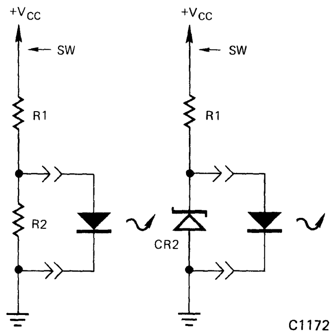


Figure 4 *Figure 5*

NOTES
R1 is 1/4 to 1 w, ±5%, composition resistor
R2 is 1/4 w, ±5%, composition resistor
CR2 is 5 volt, ±20%, 250 mw, low-cost zener

"SW" indicates recommended location of series switch or relay contact
"⏚" indicates ground return of $+V_{CC}$ or output of NAND/NOR logic gate

SUPPLY VOLTAGE GREATER THAN LED'S V_R MAX. RATING

An LED plugged in the inverse polarity in Figure 1, 2, or 3 can be damaged by high I_R if the supply voltage is greater than the V_R maximum rating of the LED. To protect against possible damage, an additional component must be added. Figure 4 shows a circuit having an additional resistor, R2, whose function is to limit the voltage drop to the V_R max. of the LED when no LED is plugged in.

DESIGN EXAMPLE: Suppose that an MV5054-2 LED is to be used in an application having a V_{CC} of 50 volts and an I_F of 10mA. When no LED is plugged in, R2's voltage drop is to be less than 5 volts (the V_R maximum rating listed in Table I for a MV5054-2).

Standard values of 3300 ohms for R1 and 360 ohms for R2 are obtained from a simple Thevenin's Theorem equivalent circuit, as:

$$\frac{V_{R\,max.} - V_{F\,(typ.)}}{I_F} = \frac{R1\,R2}{R1 + R2}, \text{ where } R1 = 9\,R2$$

$$\frac{5 - 1.8}{.01} = \frac{R1\,R2}{R1 + R2} = \frac{9\,R2}{10}, \text{ etc.}$$

Note that Figure 4's circuit also provides protection against damage from negative-going voltage spikes of amplitudes greater than $V_R + V_{CC}$).

The circuit shown in Figure 5 can protect the LED against incorrect socketing as well as against voltage spikes of virtually any amplitude. The value of the zener diode's breakdown voltage is chosen to be less than the V_R maximum but greater than V_F maximum of the LED. When no LED is plugged in, the zener conducts with a breakdown voltage less than V_R. An LED plugged in with the wrong polarity is not stressed because the voltage applied across its terminals is less than its V_R maximum rating. Figure 5's circuit provides protection against negative-going voltage spikes since a spike of amplitude greater than V_{CC} put the zener into forward conduction, holding the reverse voltage across the terminals of the LED to no more than one volt.

Notice that the "$+V_{CC}$" of Figures 4 and 5 can be half-wave or full-wave rectification (or for that matter just plain AC) so long as the peak voltage does not exceed 50 volts. Figure 4, if driven by AC, gives an effect that the LED is non-polarized and will operate no matter how inserted in the socket.

HIGH-DENSITY LAMP CONFIGURATIONS

At the beginning of this Application Note it was pointed out that a 10-by-10 bank of miniature 50-volt incandescent lamps can dissipate 200 watts. Besides running cooler than incandescents, LED indicator lamps can be used in circuit designs that reduce power dissipated at the socket. Consider the circuit shown in Figure 6 for a 20-lamp bank operating from a 50-volt, ±5% power source. Here the Q1, CR3 portion of the circuit acts as an equivalent 40-volt zener, and can be located easily on a heat sink remote from the lamp sockets. The amount of power dissipated at each socket—LED plus resistors—is less than one-fifth watt, rather than the incandescent lamp's two watts.

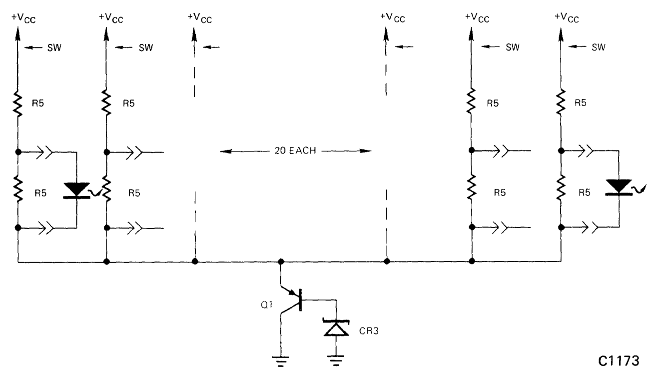


Figure 6

NOTES
R5 is 680 ohm, 1/2 w, ±5%, composition resistor
Q1 is 10 w, PNP transistor

CR3 is 39 volt, ±5%, 1 w zener
"SW" indicates recommended location location of series switch or relay contact

Although a Monsanto MV5054-2 LED has been used in all circuits shown in this Application Note, the same design considerations apply to other LED types as well.

Monsanto

AN303
MOS logic level indicator

Monsanto has developed a very low current LED capable of being driven directly from MOS and COS integrated circuits. Designated the MV55, this visible red LED incorporates a new chip, specially designed for operation at low current levels. The MV55 typically produces a Brightness of more than 100 ft-Lamberts from a Forward Current of only 1 mA. This Brightness is adequate for indicating binary logic level, especially in the subdued ambient lighting environment commonly found within cabinet- or chassis-mounted equipment.

ELECTRICAL CHARACTERISTICS

The Brightness versus Continuous Forward Current relationship for a typical MV55 is shown in Figure 1. In steady-state operation the MV55 has an absolute maximum Continuous Forward Current rating of 4 mA, and in pulsed operation (with one microsecond pulse width and 0.1% duty cycle) an absolute maximum Peak Forward Current rating of 400 mA. For Reverse Voltage the MV55 has a 3.0 volt absolute maximum rating, and "turn-on" and "turn-off" times (with a one-ohm load impedance) are typically one nanosecond, (10^{-9} seconds).

MECHANICAL CHARACTERISTICS

The MV55's package has an axial-lead form factor (see Figure 2). Its very small size minimizes space requirements, permitting high-density P.C. Board layouts. The MV55 is simple to install, since mounting sockets or other hardware are not required. The ribbon-type leads can be either soldered or welded. The low profile of the package enables edge-board or flat-board mounting. (Arrangements can be made to have leads custom prebent prior to shipment from the factory.)

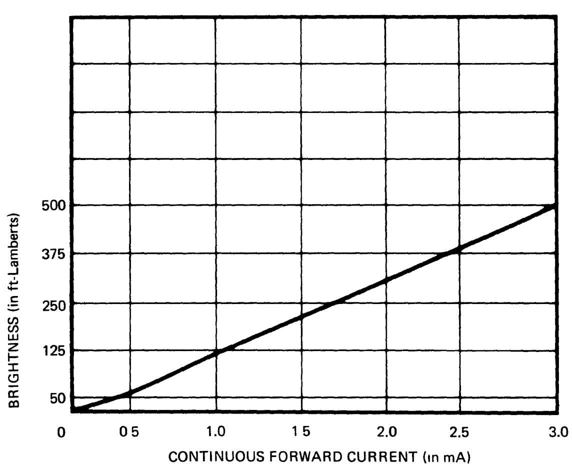


Fig. 1. Brightness versus Continuous Forward Current for typical MV55

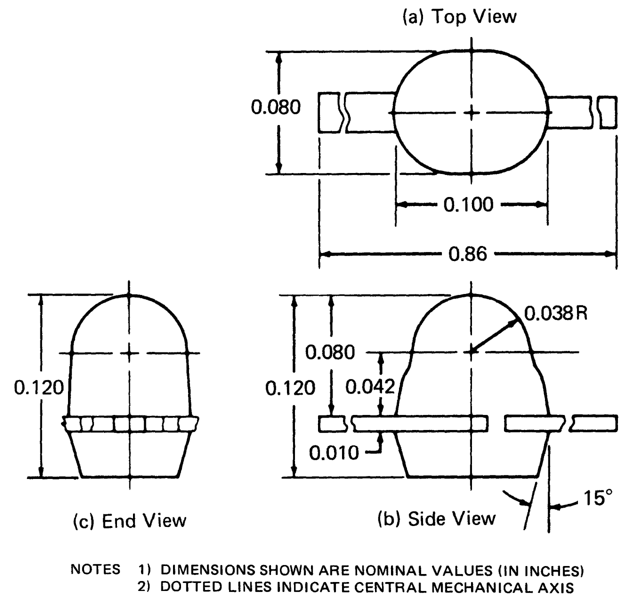


Fig. 2. MV55 Package

LENS CHARACTERISTICS

The MV55 has a red, fully-diffused plastic lens which collects the LED output into a narrow spatial distribution pattern (see Figure 3). For MV55 devices the axis of spatial distribution is typically within a 10° cone with reference to the central mechanical axis of the package. This lens assures high Luminous Intensity along the axis of spatial distribution.

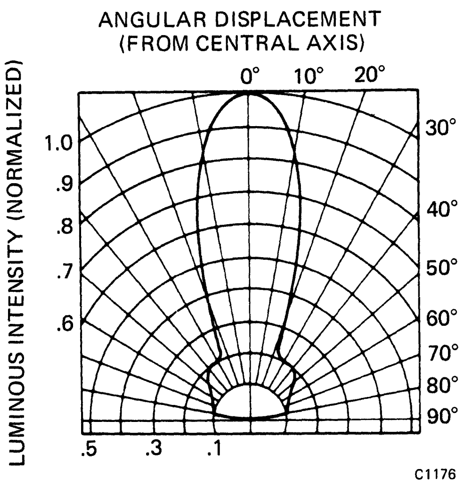


Fig. 3. Spatial Distribution Pattern for MV55

BASIC CIRCUITS

Some basic circuits for the MV55 are shown in Figure 4. Note that this LED does not require buffering or interface stages, but merely connects directly to the IC output. The choice between the circuits shown in Figure 4a and 4b is made according to whether the LED is to light when the IC output state is at logical "1," or at logical "0." In Figure 4c's circuit the MV55 not only performs as an indicator, but also presents a high impedance to the TTL gate when the MOS output is at logical "0."

CONCLUSION

This Application Note has briefly pointed out the main features of the MV55 and has shown circuits in which it can be used. The MV55 not only offers the high reliability and long lifetime inherent in solid state devices, but also has low unit cost.

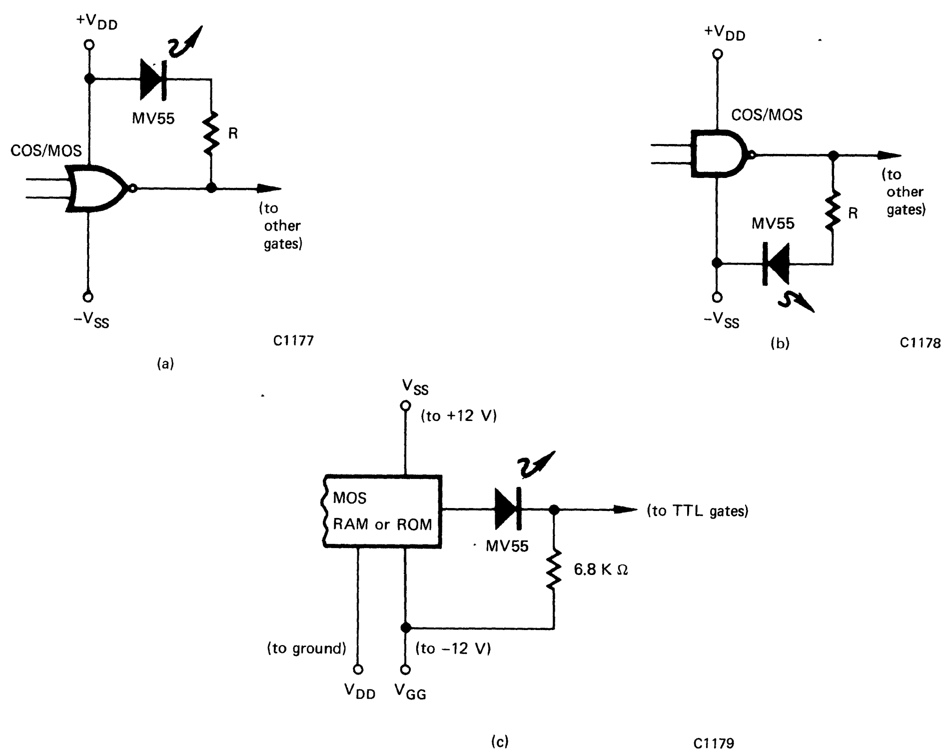


Fig. 4. Basic Circuits for MV55

3 VISIBLE LIGHT EMITTING DIODES

Discrete LED Lamps

Monsanto offers a broad line of discrete light emitting diode products to provide the customer with a wide selection of off-the-shelf products that will meet his particular requirements. A broad selection of packages, lens effects, color power, and brightness is available from standard distribution channels in virtually all quantities. These lines are being updated continually to provide modern, functional devices for customer use.

QUICK REFERENCE CHART

MODEL NO.	VIEWED COLOR	SOURCE WAVE-LENGTH	FORWARD VOLTAGE	BRIGHTNESS NO. AND UNITS	TEST @ CURR. (I_F)	REVERSE CURRENT	MAX. FORWARD* CURRENT @ 25°C	MAX. POWER	PACKAGE KEY
MV10B	Red	(660) nm	1.65 V	0.8 mcd	10 mA	50 nA	70 mA	175 mW	C
MV50	Red	(660) nm	1.65 V	1.4 mcd	20 mA	5.0 nA	40 mA	80 mW	A
MV52	Green	(565) nm	2.2 V	1.5 mcd	50 mA	100 μA max.	35 mA	105 mW	A
MV53	Yellow	(589) nm	2.1 V	1.5 mcd	50 mA	100 μA max.	35 mA	105 mW	A
MV54	Red	(660) nm	1.65 V	1.0 mcd	20 mA	5.0 nA	40 mA	80 mW	A
MV55	Red	(660) nm	1.6 V	0.5 mcd	3 mA	150 nA	4 mA	6 mW	B
MV5020	Red	(660) nm	1.65 V	2.0 mcd	20 mA	15 nA	100 mA	180 mW	G
MV5021	Red	(660) nm	1.65 V	1.6 mcd	20 mA	15 nA	100 mA	180 mW	G
MV5022	Red	(660) nm	1.65 V	1.6 mcd	20 mA	15 nA	100 mA	180 mW	G
MV5023	Red	(660) nm	1.65 V	1.6 mcd	20 mA	15 nA	100 mA	180 mW	G
MV5024	Red	(660) nm	1.65 V	3.0 mcd	20 mA	15 nA	100 mA	180 mW	G
MV5025	Red	(660) nm	1.65 V	0.4 mcd	20 mA	15 nA	100 mA	180 mW	G
MV5026	Red	(660) nm	1.65 V	0.6 mcd	20 mA	15 nA	100 mA	180 mW	G
MV5050	Red	(660) nm	1.7 V	2.0 mcd	20 mA	20 nA	100 mA	180 mW	I
MV5051	Red	(660) nm	1.7 V	1.6 mcd	20 mA	15 nA	100 mA	180 mW	I
MV5052	Red	(660) nm	1.7 V	2.0 mcd	20 mA	5 nA	100 mA	180 mW	I
MV5053	Red	(660) nm	1.7 V	1.6 mcd	20 mA	5 nA	100 mA	180 mW	I
MV5054-1	Red	(660) nm	1.8 V	2.0 mcd	10 mA	100 nA	100 mA	180 mW	H
MV5054-2	Red	(660) nm	1.8 V	3.0 mcd	10 mA	100 nA	100 mA	180 mW	H
MV5054-3	Red	(660) nm	1.8 V	4.0 mcd	10 mA	100 nA	100 mA	180 mW	H
MV5055	Red	(660) nm	1.7 V	0.6 mcd	20 mA	5 nA	100 mA	180 mW	I
MV5056	Red	(660) nm	1.7 V	0.8 mcd	20 mA	5 nA	100 mA	180 mW	I
MV5074B/C	Red	(660) nm	1.68 V	2.4 mcd	20 mA	15 nA	50 mA	100 mW	E
MV5075B/C	Red	(660) nm	1.68 V	1.5 mcd	20 mA	15 nA	50 mA	100 mW	E
MV5077B/C	Red	(660) nm	1.6 V	1.7 mcd	20 mA	15 nA	50 mA	100 mW	D
MV5152	Orange	(635) nm	2.0 V	40 mcd	20 mA	20 nA	35 mA	105 mW	I
MV5153	Orange	(635) nm	2.0 V	9.0 mcd	20 mA	20 nA	35 mA	105 mW	I
MV5154	Orange	(635) nm	2.0 V	10.0 mcd	20 mA	20 nA	35 mA	105 mW	I
MV5252	Green	(565) nm	2.2 V	11 mcd	20 mA	20 nA	35 mA	105 mW	I
MV5253	Green	(565) nm	2.2 V	3.5 mcd	20 mA	20 nA	35 mA	105 mW	I
MV5254	Green	(565) nm	2.2 V	3.0 mcd	20 mA	20 nA	35 mA	105 mW	I
MV5352	Yellow	(585) nm	2.1 V	40 mcd	20 mA	20 nA	35 mA	105 mW	I
MV5353	Yellow	(585) nm	2.1 V	8.0 mcd	20 mA	20 nA	35 mA	105 mW	I
MV5354	Yellow	(585) nm	2.1 V	10.0 mcd	20 mA	20 nA	35 mA	105 mW	I
MV5752	Orange	(635) nm	2.0 V	40 mcd	20 mA	20 nA	35 mA	105 mW	I
MV5753	Orange	(635) nm	2.0 V	9.0 mcd	20 mA	20 nA	35 mA	105 mW	I
MV5754	Orange	(635) nm	2.0 V	10.0 mcd	20 mA	20 nA	35 mA	105 mW	I
MV5174B/C	Orange	(635) nm	2.0 V	3.5 mcd	20 mA	20 nA	35 mA	105 mW	E
MV5177B/C	Orange	(635) nm	2.0 V	2.4 mcd	20 mA	20 nA	35 mA	105 mW	D
MV5274B/C	Green	(565) nm	2.2 V	1.8 mcd	20 mA	20 nA	35 mA	105 mW	E
MV5277B/C	Green	(565) nm	2.2 V	0.9 mcd	20 mA	20 nA	35 mA	105 mW	D
MV5374B/C	Yellow	(585) nm	2.1 V	2.5 mcd	20 mA	20 nA	35 mA	105 mW	E
MV5377B/C	Yellow	(585) nm	2.1 V	2.0 mcd	20 mA	20 nA	35 mA	105 mW	D
MV5774B/C	Orange	(635) nm	2.0 V	3.5 mcd	20 mA	20 nA	35 mA	105 mW	E
MV5777B/C	Orange	(635) nm	2.0 V	2.4 mcd	20 mA	20 nA	35 mA	105 mW	D
MV5094	Red/Red (Note a)		1.6 V	0.8 mcd	20 mA	15 nA	70 mA	140 mW	F
MV5491	Red/Green (Note b)								
	Red Diode		1.65 V	1.5 mcd	20 mA	15 nA	70 mA	200 mW	F
	Green Diode		3.0 V	0.5 mcd	20 mA	100 μA max.	35 mA	200 mW	F

NOTES:

(a) The MV5094 contains two red diodes connected inversely parallel. Therefore the unit operates on either polarity DC current or AC current. Wavelength is 660 nm. For this unit, I^2T (0.1% duty cycle . . . 2.5×10^{-4} amps² sec).

(b) The MV5491 contains one red and one green diode connected inversely parallel. Therefore the unit emits green light (570 nm) with one DC polarity and red light (660 nm) with the opposite DC polarity.

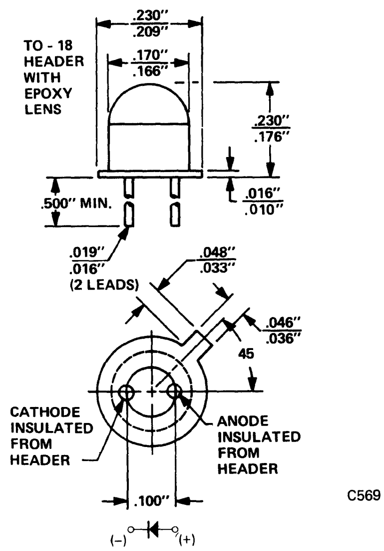
All specifications are typical unless otherwise specified.

Monsanto — RED LED — MV10B

PRODUCT DESCRIPTION

The MV10B is a GaAsP light emitting diode mounted on a TO18 header with a clear epoxy lens. On forward bias, it emits a spectrally narrow band of radiation which peaks at 660 nm.

PACKAGE DIMENSIONS



FEATURES

- High Efficiency
- Ultra High Brightness
- Long Life — Solid State Reliability
- Low Power Requirements
- Compatible with Integrated Circuits — DTL, RTL, T^2L.
- 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 4)	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 (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Brightness (see note 1) (B)		600		ft-L	I_F = 50 mA
Luminous-Intensity (I)		0.8		mcd	I_F = 10 mA
Total external radiated power (see note 2)		90		µW	I_F = 50 mA
Peak emission wave length	630	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_{JA} . . . . 155° C/W
Wavelength Temperature Coefficient (case temperature) . . . . 0.3 nm/°C
Forward Voltage Temperature Coefficient . . . . −2.0 mV/°C

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

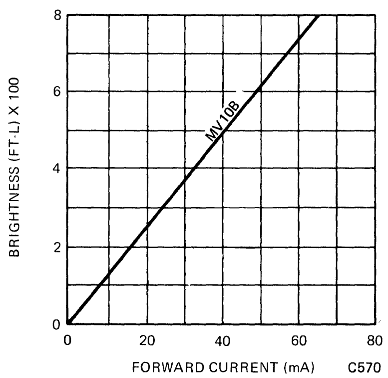


Figure 1 Brightness vs. Forward Current

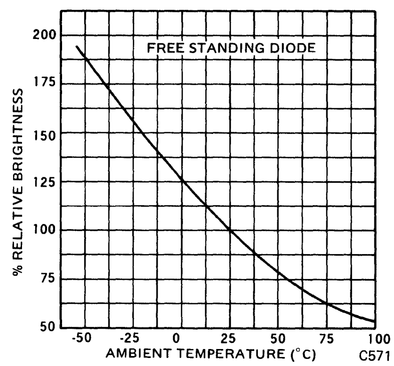


Figure 2 Brightness vs. Temperature

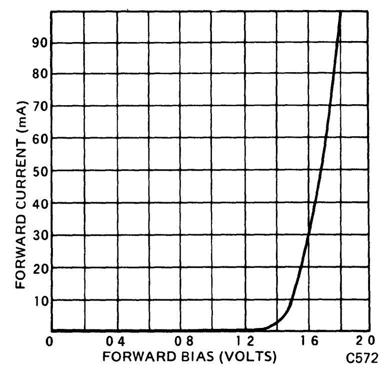


Figure 3 Forward Current vs. Forward Voltage

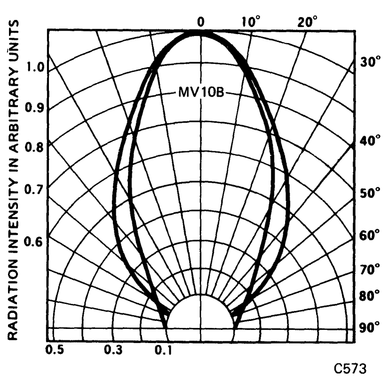


Figure 4 Spatial Distribution (Note 5)

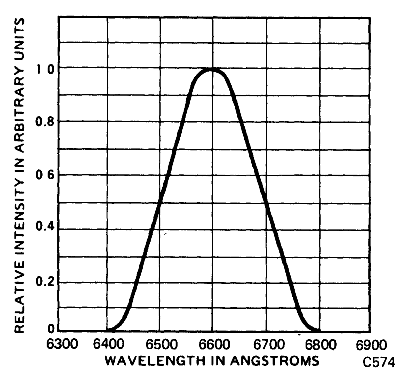


Figure 5 Spectral Distribution

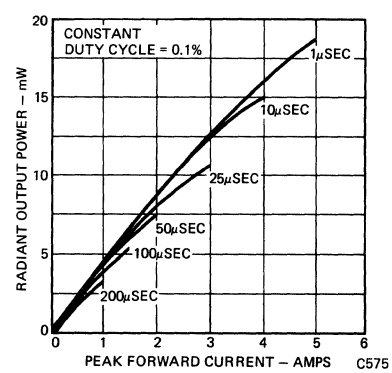


Figure 6 Peak Power Output vs. Pulsed Forward Current

NOTES

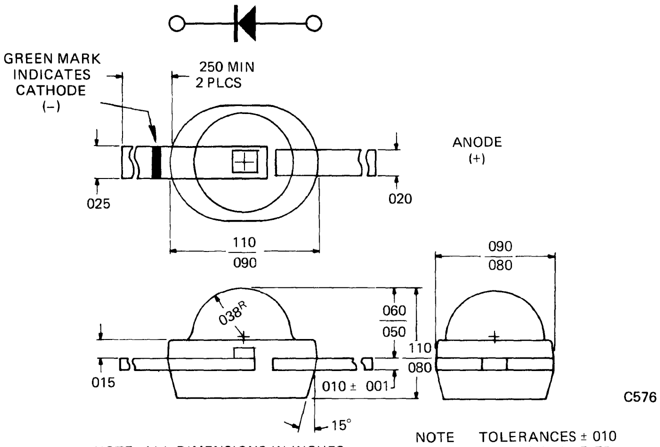
1. *As measured with a Photo Research Spectra Spot Brightness Meter with "Spectar" L-175 lens in the brightest region of the emitting surface.*
2. *The total external power output measurements are made with a Centralab 100C solar cell terminated into a 100 ohm impedance.*
3. *The apparent spot size diameter for the MV10B is 0.028-inch.*
4. *The leads of the MV10B were immersed in molten solder, heated to 260°C, to a point 1/16-inch from the body of the device per MIL-S-750.*
5. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*

Monsanto RED LED MV50

PRODUCT DESCRIPTION

The MV50 is a diffused Gallium Arsenide Phosphide diode mounted in a two lead epoxy package. On forward bias it emits a spectrally narrow band of visible light which peaks at 660 nm.

PACKAGE DIMENSIONS



FEATURES

The MV50 is intended for high volume indicator light applications where low cost, high reliability, and top performance are required. Major usage is expected in applications such as diagnostic lights on printed circuit boards and panel lights. The MV50 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

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient	80 mW
Derate linearly from 25°C	1.0 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

CHARACTERISTICS	MINIMUM	TYPICAL	MAXIMUM	UNITS	TEST CONDITIONS
Luminous Intensity (I) (note 3)*	0.5	1.4		mcd	I_F = 20 mA
Total external radiated power		60		µW	I_F = 20 mA
Peak emission wavelength	630	660		nm	I_F = 20 mA
Spectral line halfwidth		20		nm	I_F = 20 mA
Forward voltage		1.65	2.0	V	I_F = 20 mA
Capacitance		80		pF	V = 0
Light rise and fall time		50		ns	50Ω system, I_F = 20 mA
Reverse current		5.0		nA	V_R = 3.0 V
Reverse breakdown voltage	5	15		V	I_R = 100 µA
Luminous flux		1.6		mL	I_F = 20 mA
View angle		80		degrees	50% points

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

TYPICAL THERMAL CHARACTERISTICS

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 Unless Otherwise Specified)

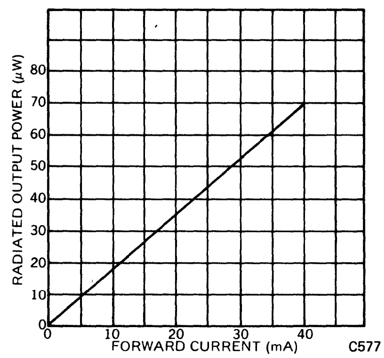


Figure 1 ROP vs. Forward Current

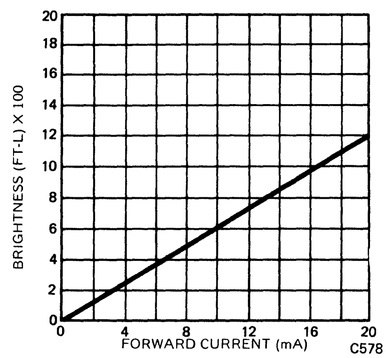


Figure 2 Brightness vs. Forward Current

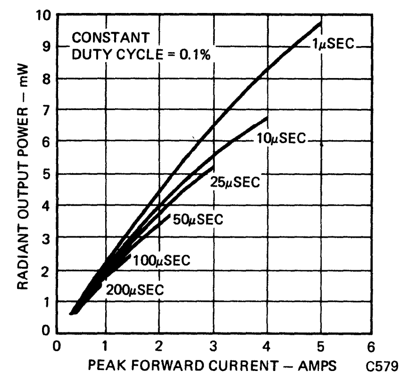


Figure 3 Peak Power Output vs. Pulsed Forward Current

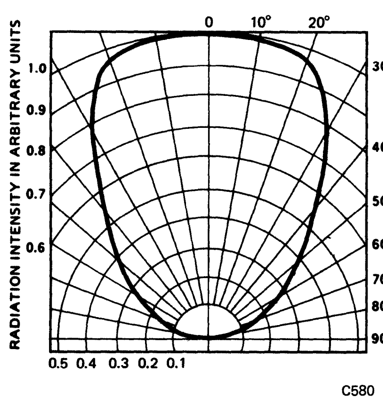


Figure 4 Spatial Distribution (Note 4)

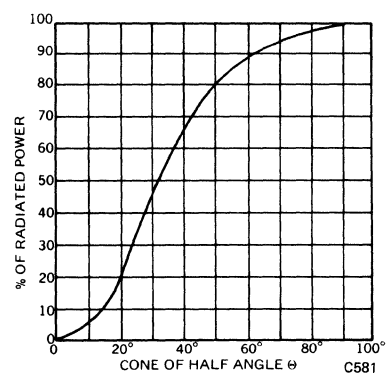


Figure 5 Percent Radiated Power Into Cone of Half Angle

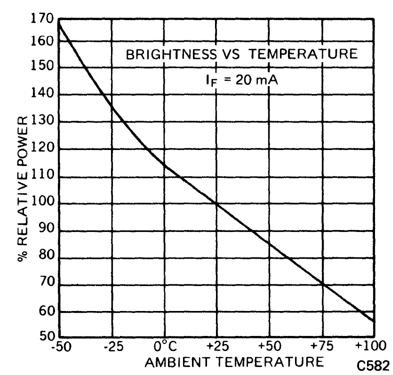


Figure 6 Relative Power vs. Temperature

NOTES

1. *The leads of the device were immersed in molten solder at 260°C to a point 1/16 inch from the body of the device per MIL-S-750.*
2. *As measured with a photo Research Spectra Spot Brightness Meter with "Spectar" L-175 lens in the brightest region of the emitting surface.*
3. *As measured with a Photo Research Corp. Microcandela Meter (Model IV D).*
4. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*

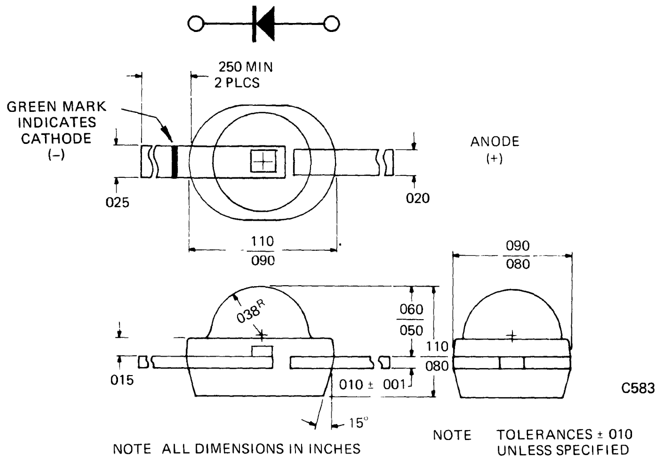
Monsanto

GREEN AND YELLOW LIGHT EMITTING DIODES — MV52 MV53

PRODUCT 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.

PACKAGE DIMENSIONS



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 expected 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 T3/4 size.

- MULTICOLORED VERSIONS OF THE POPULAR MV50 PACKAGE
- Low cost
- Bright
- Compatible with integrated circuits
- Long life, rugged
- Small size — T3/4

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 . . . . 5 sec
Continuous forward current . . . . 35 mA
Reverse Voltage . . . . 5.0 V

ELECTRO-OPTICAL CHARACTERISTICS

CHARACTERISTICS	MINIMUM	TYPICAL	MAXIMUM	UNITS	TEST CONDITIONS
Luminous Intensity (I) (Note 1)*	0.2	1.0		mcd	I_F = 20 mA
Peak emission wavelength, MV52	550	565	575	nm	I_F = 20 mA
Peak emission wavelength, MV53	580	589	600	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

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

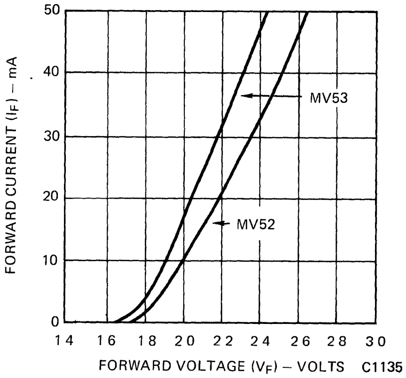


Fig. 1. Forward Current vs. Forward Voltage

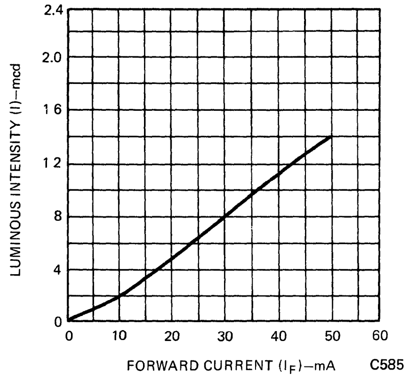


Fig. 2. Luminous Intensity vs. Forward Current

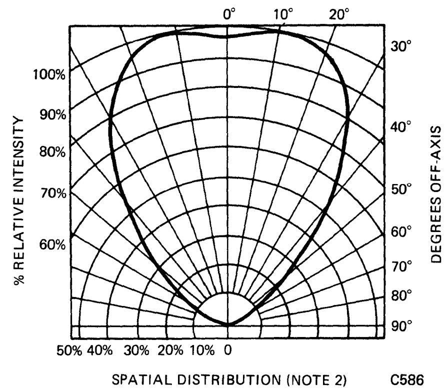


Fig. 3. Spatial Distribution (Note 2)

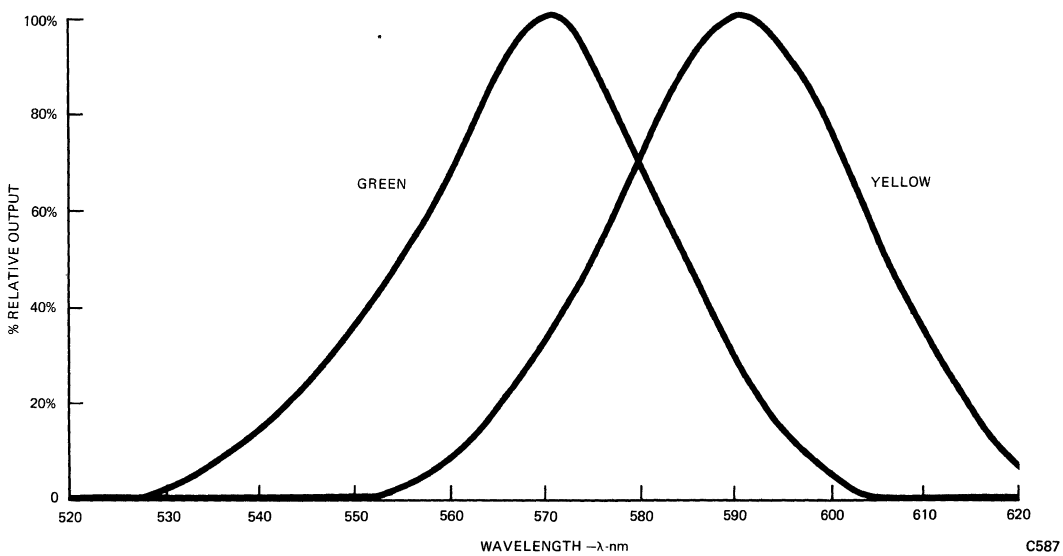


Fig. 4. MV52-MV53 Spectral Response

NOTES

1. *As measured with a Photo Research Corp. 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.*

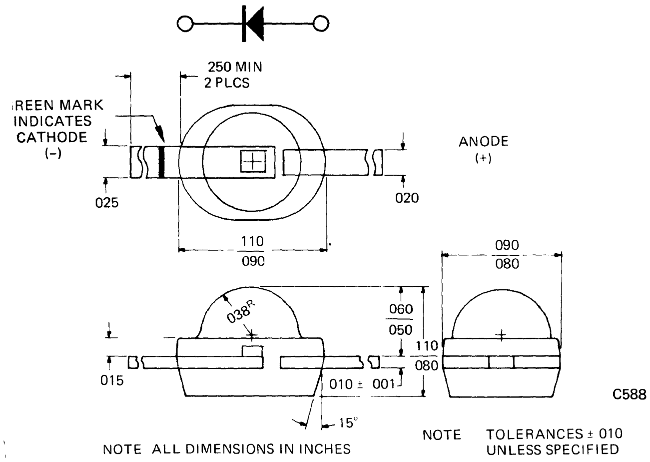
Monsanto

RED LED | MV54

PRODUCT DESCRIPTION

The MV54 is a diffused Gallium Arsenide Phosphide diode mounted in a two lead epoxy package. The lens is red diffused epoxy, and the outline is identical to the MV50.

PACKAGE DIMENSIONS



FEATURES

The MV54 is intended for high volume indicator light applications where low cost, high reliability, and top performance are required. Major usage is expected in applications such as diagnostic lights on printed circuit boards and panel lights. The MV54 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

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient	80 mW
Derate linearly from 50°C	1.6 mW/°C
Storage temperature	-55°C to 100°C
Operating temperature	-55°C to 100°C
Lead solder time @ 230°C (note 1)	5 sec
Continuous forward current	40 mA
Reverse voltage	5.0 V

ELECTRO-OPTICAL CHARACTERISTICS

	MINIMUM	TYPICAL	MAXIMUM	UNITS	TEST CONDITIONS
Brightness (Note 2)*	0.4	1.0		mcd	I_F=20 mA
Total external radiated power		38		μW	I_F=20 mA
Peak emission wavelength	630	660		nm	I_F=20 mA
Spectral line halfwidth		20		nm	I_F=20 mA
Forward voltage		1.65	2.0	V	I_F=20 mA
Capacitance		80		pF	V=0
Light rise and fall time		50		ns	Z = 50Ω system I_F=50 mA
Reverse current		5.0		nA	V_R=3.0 V
Reverse breakdown voltage	5	15		V	I_R=100 μA

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

Typical Thermal Characteristics

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 Unless Otherwise Specified)

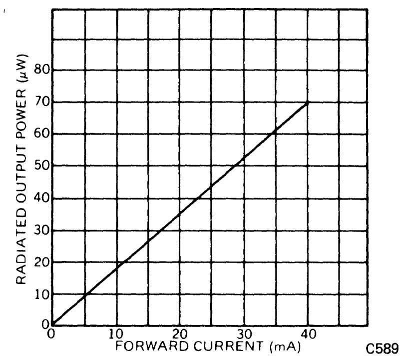


Figure 1 ROP vs. Forward Current

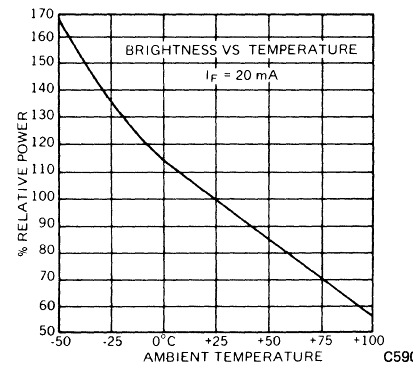


Figure 2 Power vs. Temperature

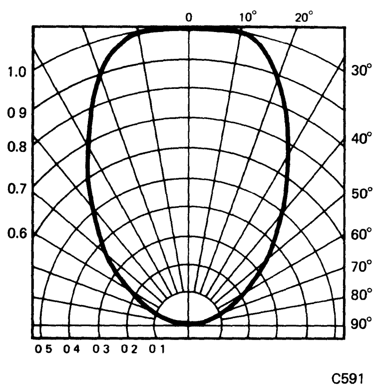


Figure 3 Spatial Distribution (Note 3)

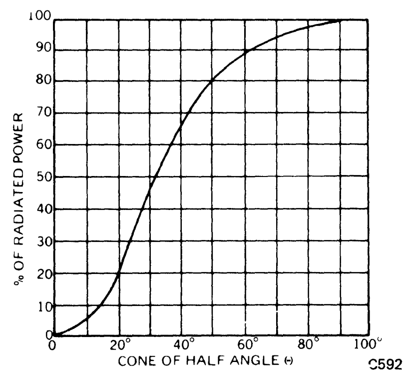


Figure 4 Percent Radiated Power Into Cone of Half Angle

Notes

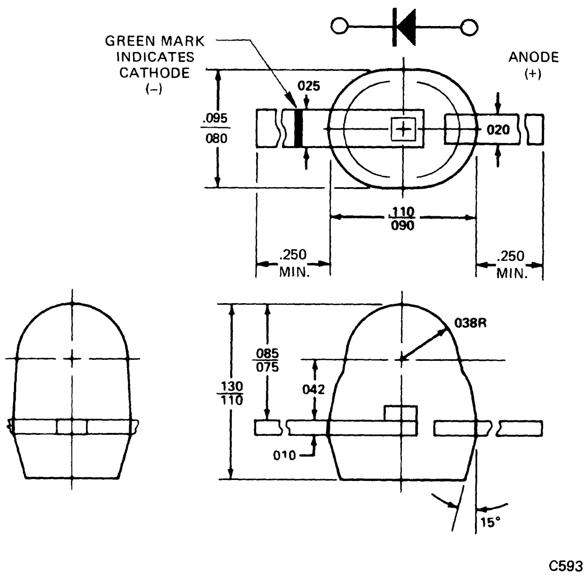
1. *The leads of the device were immersed in molten solder at 260°C to a point 1/16 inch from the body of the device per MIL-S-750.*
2. *As measured with a Photo Research Spectra Corp. Microcandela Meter (Model IV D).*
3. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*

Monsanto VISIBLE RED LED MV55

PRODUCT DESCRIPTION:

The MV-55 is a gallium arsenide phosphide device useful for low current drive (3 mA) applications, such as diagnostic functions or indicators.

PACKAGE DIMENSIONS



MV-55

FEATURES

MV55 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	6 mW
Derate linearly from 25°C	-.08 mW/°C
Storage & operating temperature	-55°C to 100°C
Lead solder time @ 230°C (See Note 1)	5 sec
Continuous forward current	5 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 Unless Otherwise Specified)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Brightness (Note 3)*	0.2	0.5		mcd	I_F = 5.0 mA
Peak emission wave length	630	660		nm	
Spectral line half-width		20		nm	
Forward voltage		1.6	2.0	V	I_F = 3.0 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

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

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

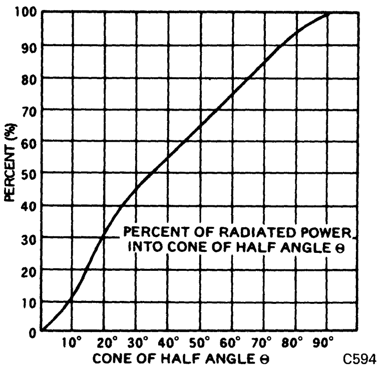


Figure 1

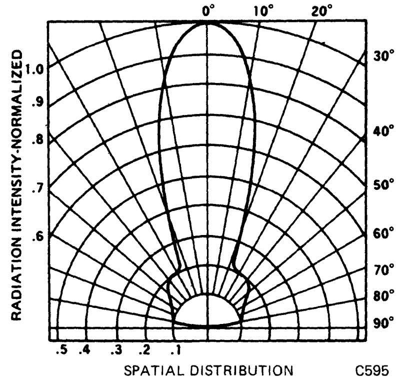


Figure 2 (Note 2)

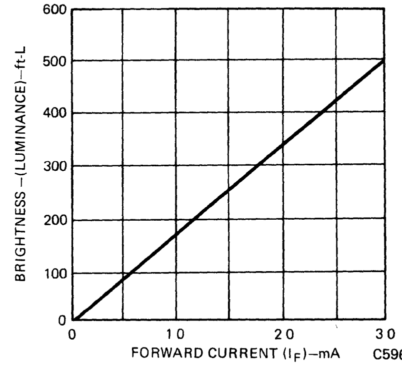


Fig. 3 Brightness vs. Forward Current

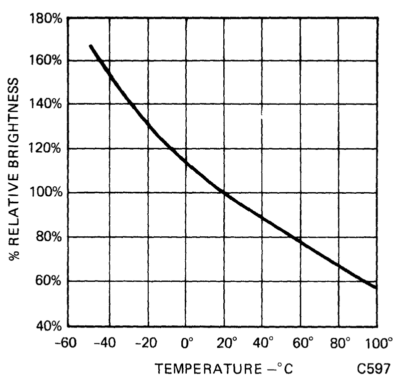


Fig. 4 Relative Output vs. Temperature

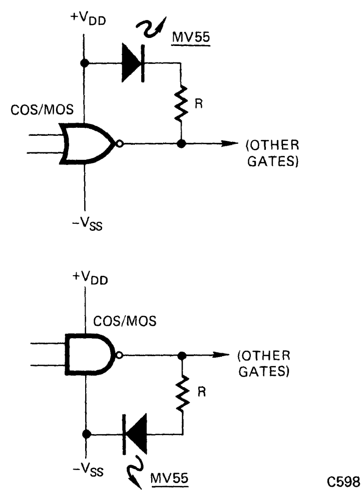


Fig. 5 MV55 Interfaced with COS/MOS

NOTES

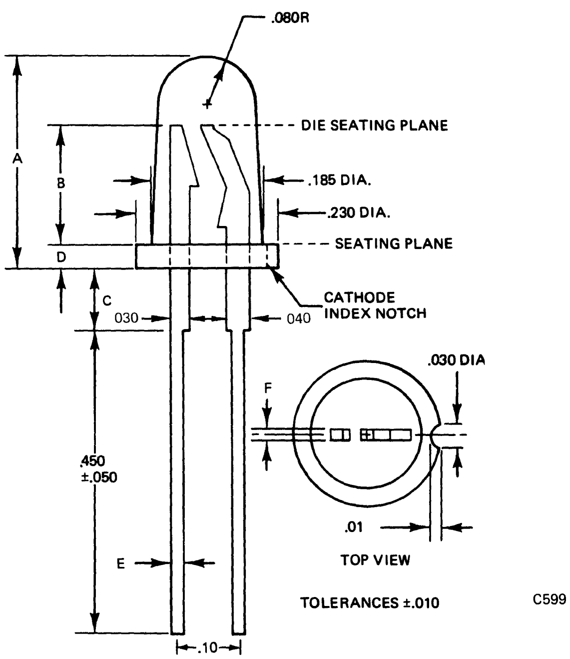
1. *The leads of the device were immersed in molten solder, heated to a temperature of 230°C, to a point 1/16 inch from the body of the device per MIL-S-750.*
2. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*
3. *As measured with a Photo Research Spectra Corp. Microcandela Meter (Model IV D).*

Monsanto RED SOLID STATE LAMPS MV5020 SERIES

PRODUCT 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.

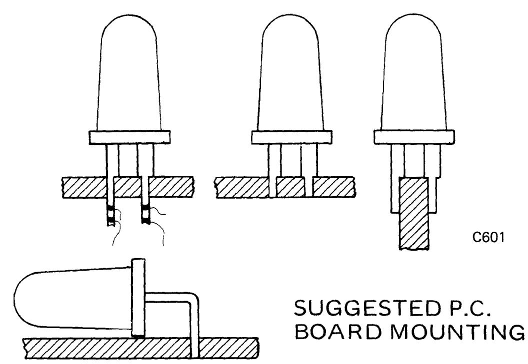
PACKAGE DIMENSIONS



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



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 @ 230°C	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	DIFF.	SOFT	X	X
MV5022	.340	.190	.100	.040	.025	RED	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	RED DIFF.	FLOODED	X	X

ELECTRO-OPTICAL CHARACTERISTICS

PARAMETER		TEST COND.	UNITS	5020	5021	5022	5023	5024	5025	5026
Luminous Intensity (Min.) (Note 2)*		20 mA	mcd	0.6	0.5	0.6	0.4	0.9	0.1	0.1
Luminous Intensity I (Typ.) (Note 2)		20 mA	mcd	2.0	1.6	1.6	1.6	3.0	.4	.6
Peak Wave Length +30 −20		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.			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.		μA	100	100	100	100	100	100	100
Reverse Voltage VR	Min.	I_R = 100μA	volts	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	Typ.			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
Light Rise Time		10%-90% 50Ω system	nse	50	50	50	50	50	50	50
& Fall Time	Typ.	90%-10% 50Ω system	nsec	50	50	50	50	50	50	50
Apparent Area (Circular)		———	cm^2 ($x10^{-3}$)	.828	32.5	.828	32.5	130	130	130

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS

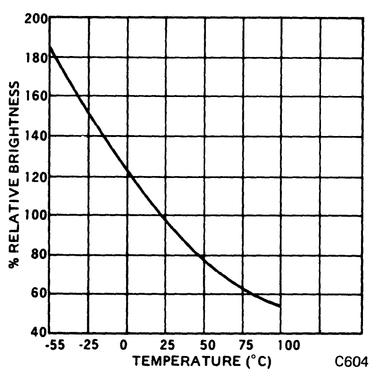


Fig. 1. Brightness vs. Temperature

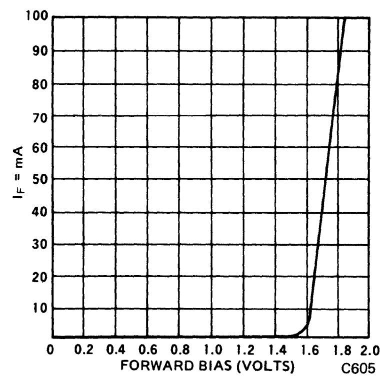


Fig. 2. Forward Current vs. Forward Voltage

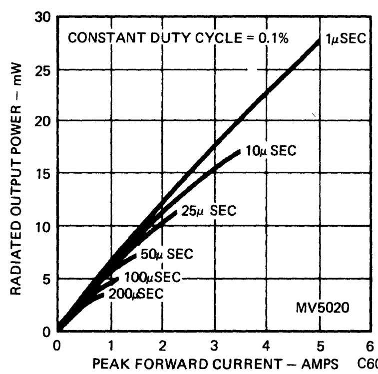


Fig. 3. Radiated Output Power vs. Peak Forward Current

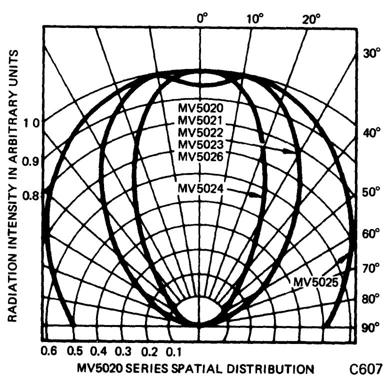


Fig. 4. Spatial Distribution

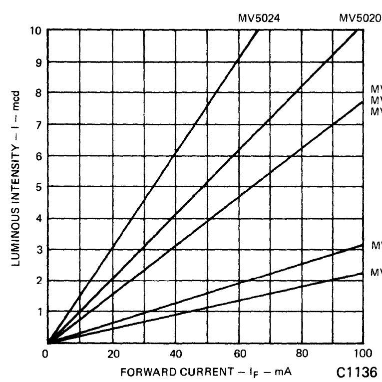


Fig. 5. Luminous Intensity vs. Forward Current

NOTES

1. *As measured with a Photo Research Spectra Brightness Spot Meter with "SPECTAR" L-175 lens in the center of the emitting surface.*
2. *As measured with a Photo Research Spectra Corp. 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.*

Monsanto

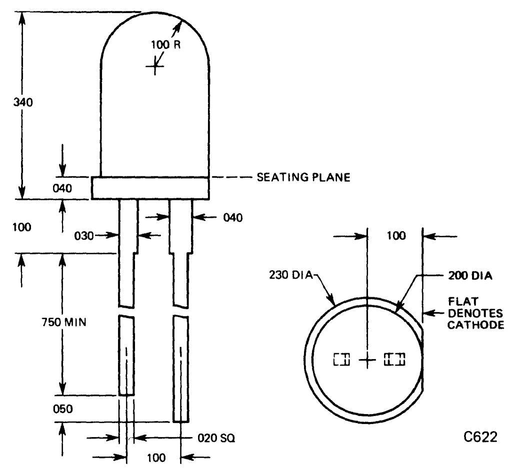
RED SOLID STATE LAMP

MV5054-1 MV5054-2 MV5054-3

PRODUCT DESCRIPTION

The MV5054 series lamps are made with gallium arsenide phosphide diodes mounted in a red epoxy package.

PACKAGE DIMENSIONS



TOLERANCE ±.010

FEATURES

- GaP performance
- Illuminates a ¼" dia circle
- Low cost
- High intensity red light source for back lighting a panel
- Versatile mounting on PC board
- Transparent mounting clip available
- Three intensity categories

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) e 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 Unless Otherwise Specified)

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	
MV5054-3	3.0	4.0		mcd	
Forward voltage		1.8	2.2	V	I_F = 10 mA
Capacitance		35		pF	V = 0
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
Apparent area		.203		cm^2	

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

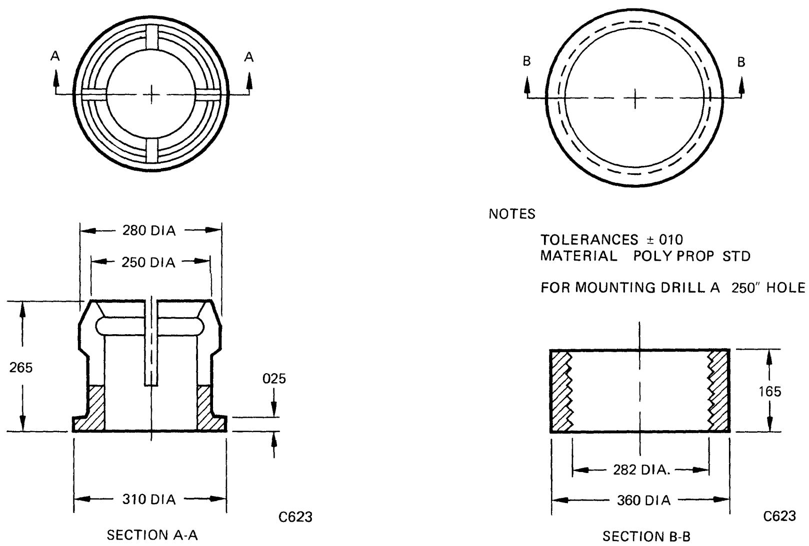


Fig. 1. Mounting Grommet (supplied only on request)

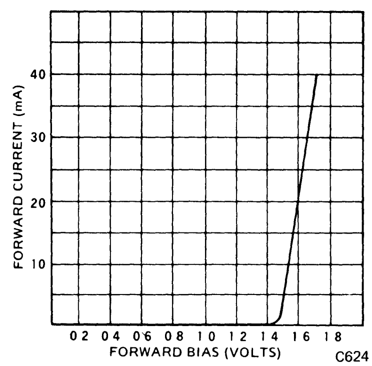


Fig. 2. Forward Current vs. Forward Voltage

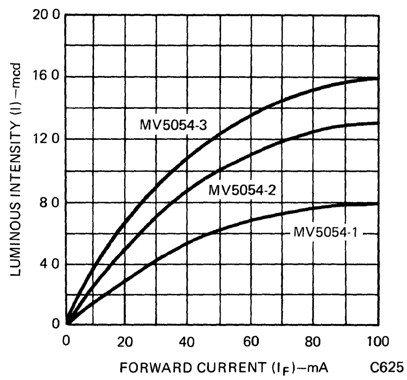


Fig. 3. Luminous Intensity vs. Forward Current

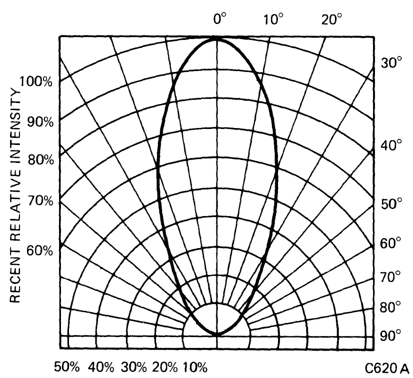


Fig. 4. Spatial Distribution (Note 2)

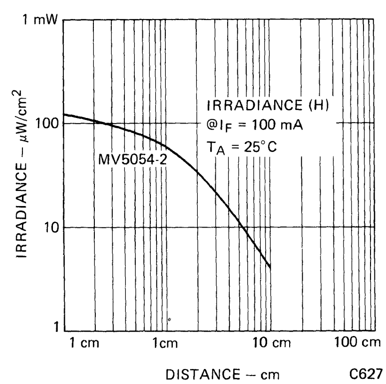


Fig. 5. Irradiance vs. Distance

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 molton solder, at 260°C, to a point 1/16 inch from the body of the device per MIL-S-750.*

Monsanto

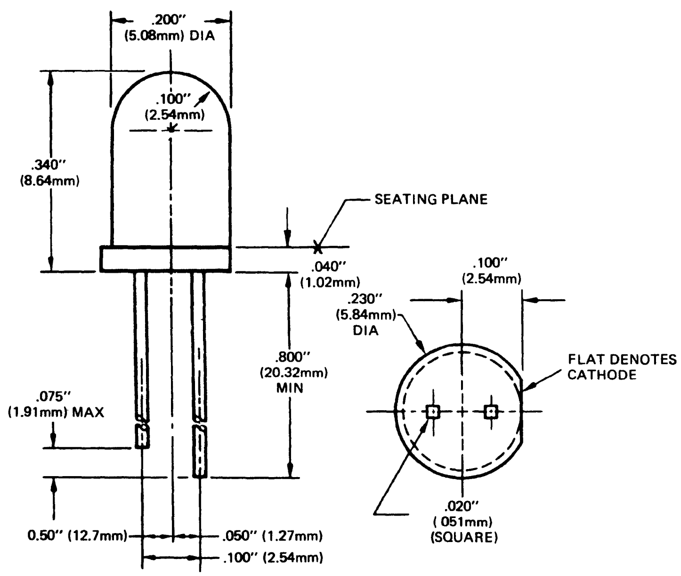
RED SOLID STATE LAMPS

MV5050 MV5053 MV5051 MV5055 MV5052 MV5056

PRODUCT 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.

PACKAGE DIMENSIONS



TOLERANCES ±.010" (.254 mm) C1062

FEATURES

- Low cost
- High intensity red light source with various lens colors and effects
- Versatile mounting on P.C. board or panel
- Snap in clip available on request
- Long life—solid state reliability
- Low power requirements
- Compacts, rugged, lightweight
- High efficiency
- Ultra high brightness

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	Red	Point	X	X
MV5053	Red	Red Diffused	Flooded	X	X
MV5055	Red	Red Diffused	Flooded	X	X
MV5056	Red	Red Diffused	Flooded	X	X

ELECTRO-OPTICAL CHARACTERISTICS

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

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

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

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

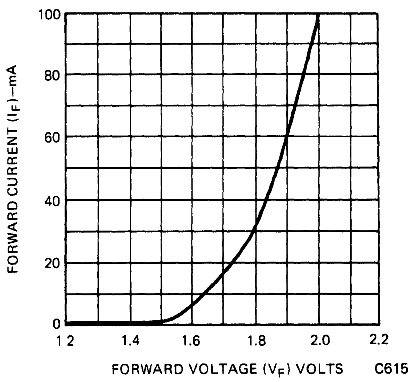


Fig. 1. Forward Current vs. Forward Voltage

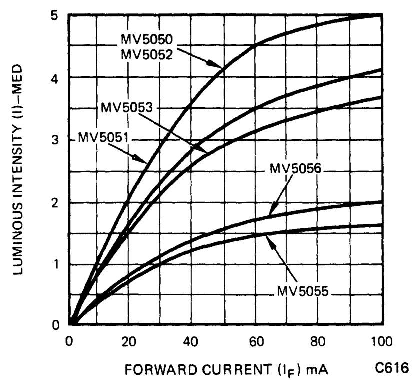


Fig. 2. Luminous Intensity vs. Forward Current

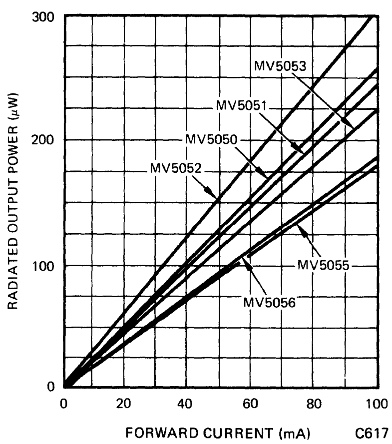


Fig. 3. ROP vs. Forward Current

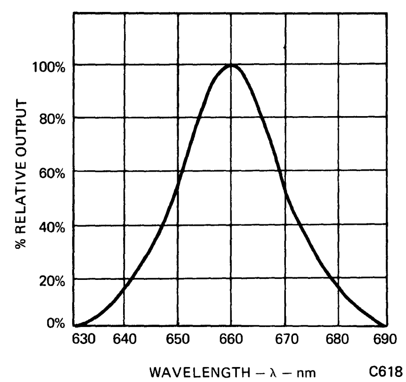


Fig. 4. Spectral Response

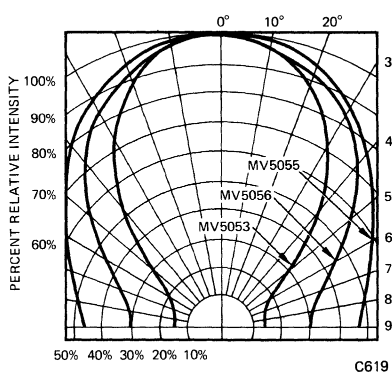


Fig. 5. Spatial Distribution (Note 2)
(MV5053, MV5055, MV5056)

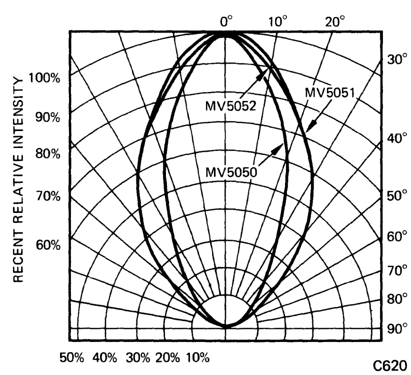


Fig. 6. Spatial Distribution (Note 2)
(MV5050, MV5051, MV5052)

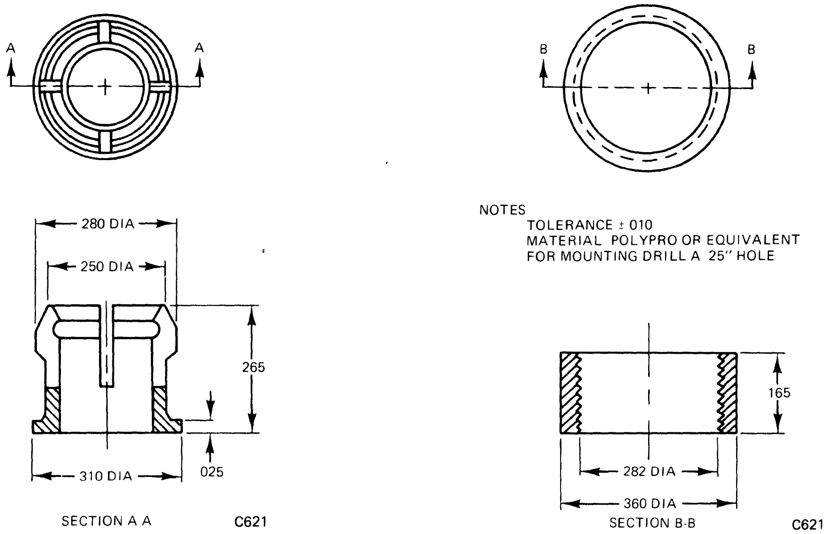


Fig. 7. Mounting Grommet (supplied on request only)

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 from the body of the device per MIL-S-750.*

Monsanto

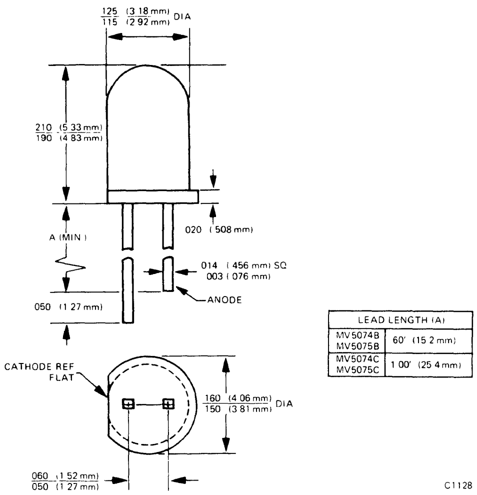
RED SOLID STATE LAMP

MV5074B/C MV5075B/C

PRODUCT DESCRIPTION

The MV5074B/C and MV5075B/C 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.

PACKAGE DIMENSIONS



FEATURES

- Square leads (will fit into .020" (.508 mm) diameter hole)
- Compact size
- Bright (typically 2.0 mcd at 20 mA)
- Long life, rugged
- MV5074B and MV5075B have .6" (15.2 mm) minimum lead length
- MV5074C and MV5075C have 1" (25.4 mm) minimum lead length
- Mount on approximately 3/16" (4.72 mm) centers
- Direct replacement for Texas Instruments TIL-209A (MV5074B)

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 (230°C, 1/16" from body)	5 sec

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Optical					
Luminous Intensity (I) (Note 1)*					
MV5074B/C	0.7	2.5		mcd	I_F = 20 mA
MV5075B/C	0.6	1.6		mcd	I_F = 20 mA
Wavelength (λpk)	640	660	700	nm	
Spectral Half Width		20		nm	
Viewing Angle					
MV5074B/C		70		degrees	Between 50% points
MV5075B/C		90		degrees	Between 50% points
Radiated Output Power (ROP)		30		µW	I_F = 20 mA
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

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

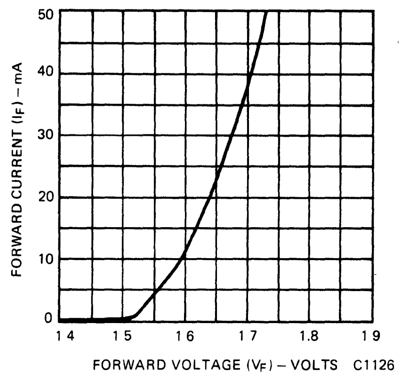


Fig. 1. Forward Current vs. Forward Voltage

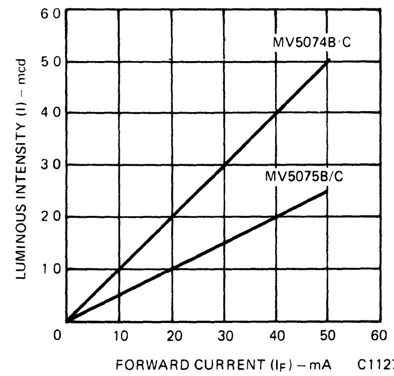


Fig. 2. Luminous Intensity vs. Forward Current

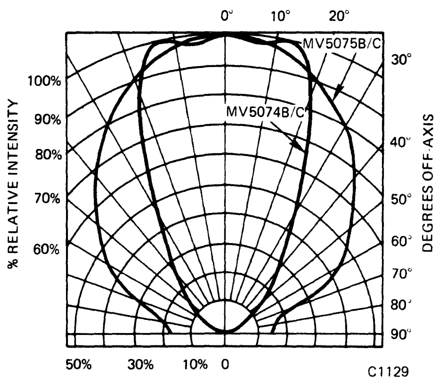


Fig. 3. Spatial Distribution

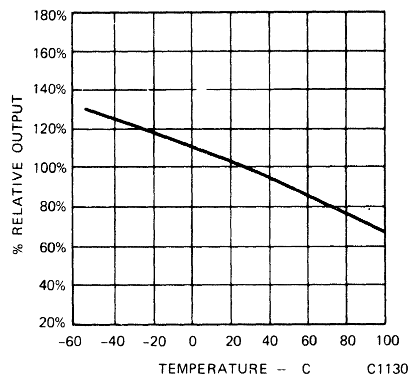


Fig. 4. Percent Relative Response vs. Temperature

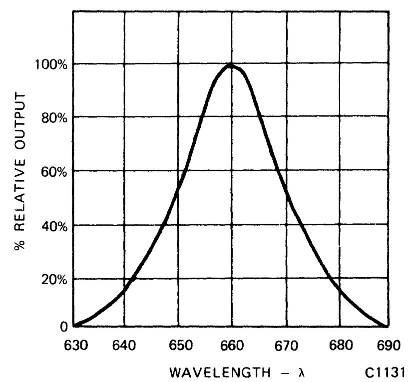


Fig. 5. Spectral Response

NOTES

1. *Luminous Intensity measurements are taken with a Photo Research Corp., "SPECTRA" Microcandela Meter (Model IV D).*

Monsanto

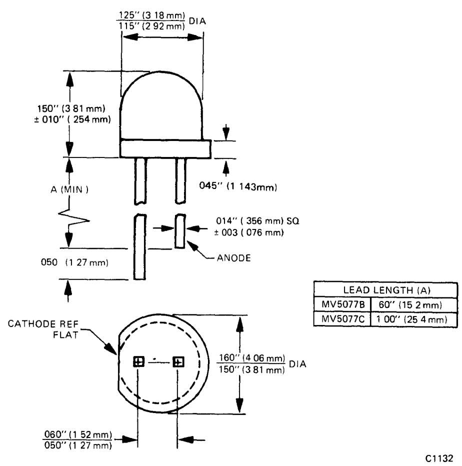
RED SOLID STATE LAMP

MV5077B MV5077C

PRODUCT DESCRIPTION

The MV5077B and MV5077C 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.

PACKAGE DIMENSIONS



FEATURES

- Square leads (will fit into .020" (.508 mm) diameter hole)
- Compact size
- Bright (typically 1.75 mcd at 20 mA)
- Long life, rugged
- MV5077B have .6" (15.2 mm) minimum lead length
- MV5077C have 1" (25.4 mm) minimum lead length
- Mount on approximately 3/16" (4.72 mm) centers

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 (230°C, 1/16" from body) . . . . . 5 sec

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Optical					
Luminous Intensity (I) (Note 1)*	0.3	1.75		mcd	I_F = 20 mA
Wavelength (λpk)	640	660	700	nm	
Spectral Half Width		20		nm	
Viewing Angle		110		degrees	Between 50% points
Radiated Output Power (ROP)		30		μW	I_F = 20 mA
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

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

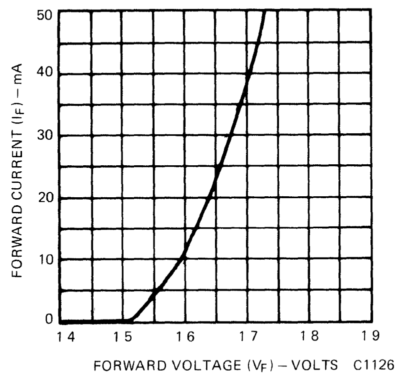


Fig. 1. Forward Current vs. Forward Voltage

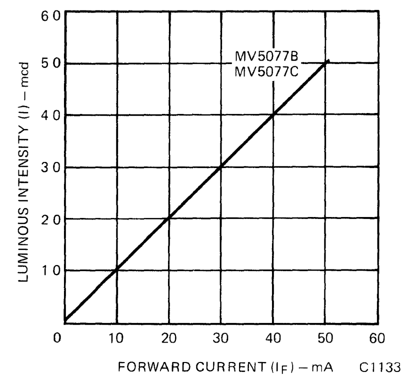


Fig. 2. Luminous Intensity vs. Forward Current

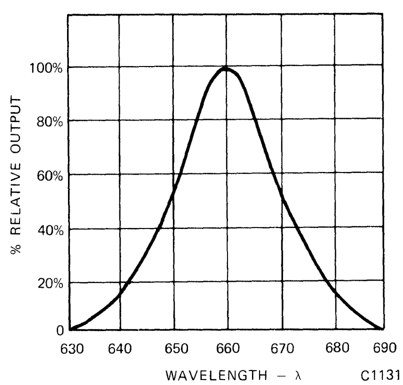


Fig. 3. Spectral Response

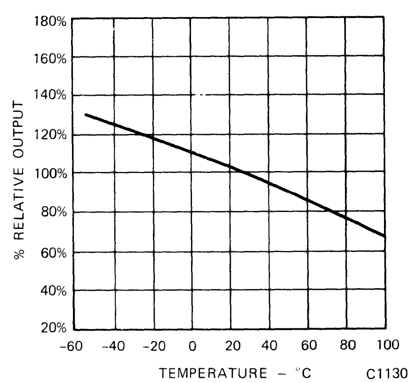


Fig. 4. Percent Relative Response vs. Temperature

NOTES

1. *Luminous Intensity measurements are taken with a Photo Research Corp., "SPECTRA" Microcandela Meter (Model IV D).*

Monsanto

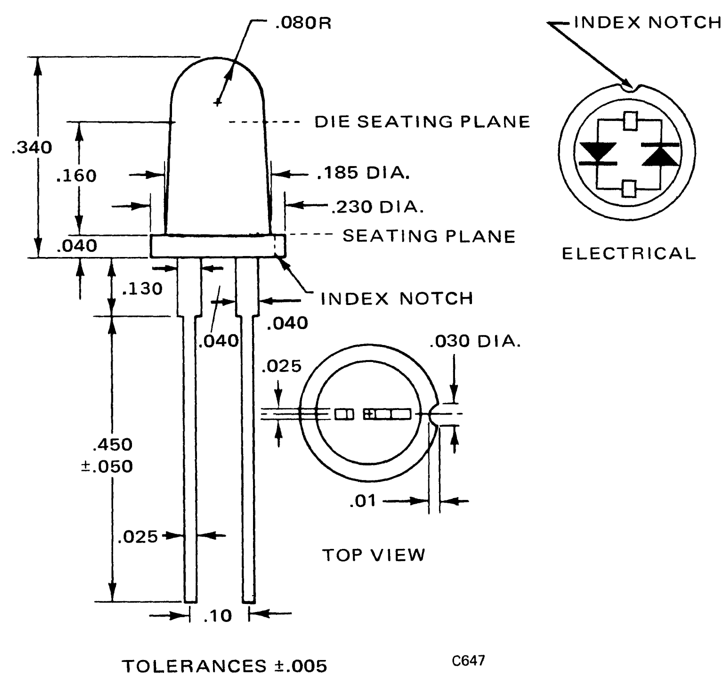
RED BIPOLAR SOLID STATE LAMP

MV5094

PRODUCT 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.

PACKAGE DIMENSIONS



FEATURES

- Bright
- Solid state
- A.C. lamp
- 110-115 VAC operation (see chart)
- Versatile mounting on P.C. board or panel
- Convenient mounting clip available
- Cool operation—no hot bulb
- Long life
- This lamp mounts in the MP21 or MP22 grommet.

ABSOLUTE MAXIMUM RATINGS

Power Dissipation @ 25°C (Peak or continuous)	140 mW
Storage Temperature	−65°C to +125°C
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 230°C	5 sec

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

	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Luminous Intensity (I) (note 1)		.8		mcd	I_f = 20 mA
Forward Voltage (V_f)		1.6	2.0	volts	I_f = 20 mA

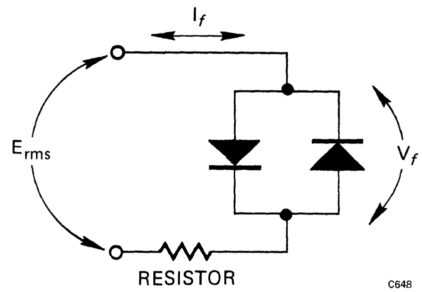
AC OPERATION

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.

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

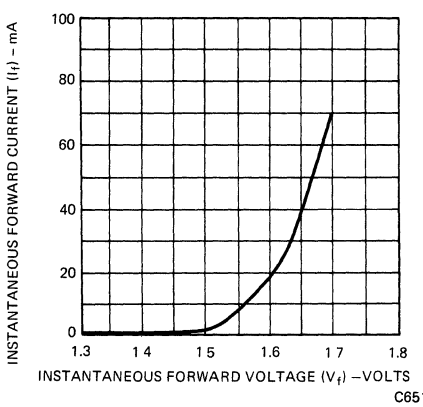


Fig. 1. Forward Current vs. Forward Voltage

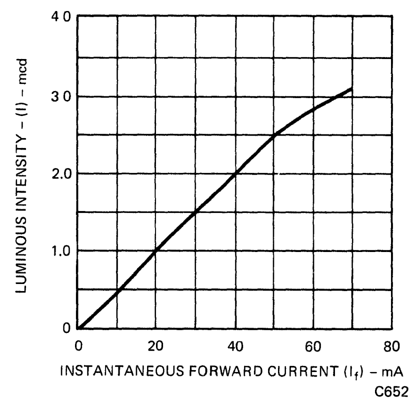


Fig. 2. Luminous Intensity vs. Forward Current

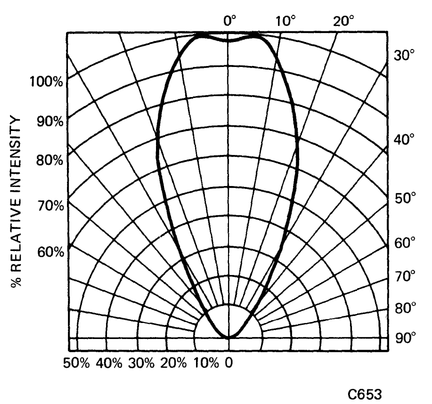


Fig. 3. Spatial Distribution

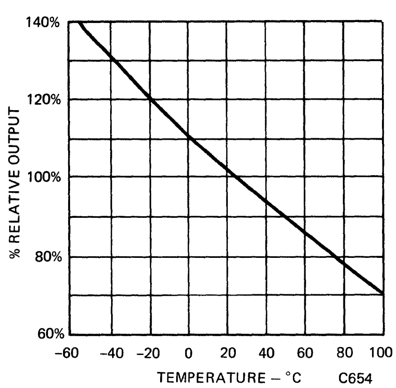


Fig. 4. Output vs. Temperature

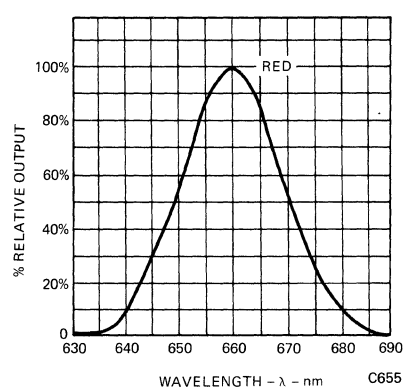


Fig. 5. Spectral Distribution

NOTES:

1. *Luminous Intensity figures are the typical values per phase of operation and measured with a Photo Research Corp. Microcandela Meter (Model IV D).*
2. *Values of Luminous Intensity may begin to decrease for operation above 25 KHz.*

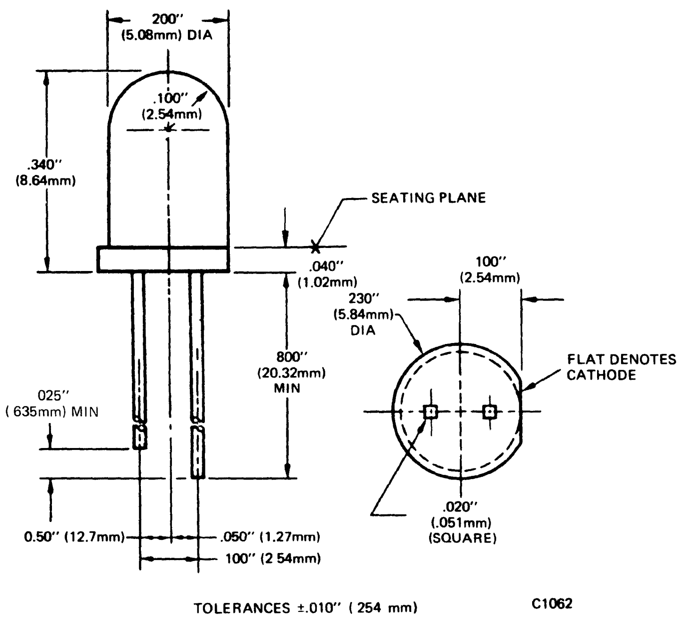
Monsanto SOLID STATE LAMPS

ORANGE	MV5152
GREEN	MV5252
YELLOW	MV5352
IMPROVED RED	MV5752

PRODUCT DESCRIPTION

These solid state indicators offer high brightness and color availability. The orange, red, and yellow devices are made with gallium arsenide phosphide, and the green units are made with gallium phosphide. All are encapsulated in epoxy lenses.

PACKAGE DIMENSIONS



FEATURES

- Low cost
- Ultra high intensity light sources
- Orange, green, yellow, and red colors available. (See MV5050 series for other red sources.)
- Versatile mounting on P.C. board or panel
- Snap in clip available on request
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight
- High efficiency

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient	105 mW
Derate linearly from 25°C	1.14 mW/°C
Storage temperature	–55°C to 100°C
Operating temperature	–55°C to 100°C
Lead solder time @ 230°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	POP-IN MOUNTING	CIRCUIT BOARD MOUNTING
MV5152	Orange	Clear orange	Narrow beam; point source	X	X
MV5252	Green	Clear green	Narrow beam; point source	X	X
MV5352	Yellow	Clear yellow	Narrow beam; point source	X	X
MV5752	Orange	Clear red	Narrow beam; point source	X	X

ELECTRO-OPTICAL CHARACTERISTICS

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

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

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

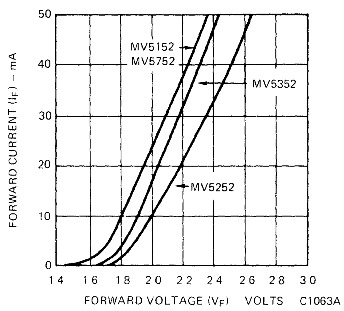


Fig. 1. Forward Current vs. Forward Voltage

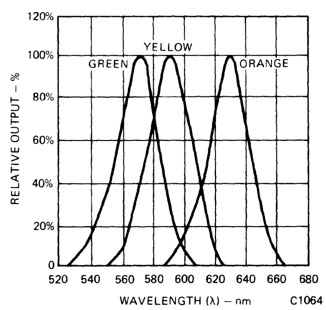


Fig. 2. Spectral Response

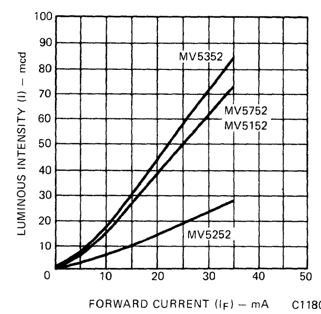


Fig. 3. Brightness vs. Forward Current

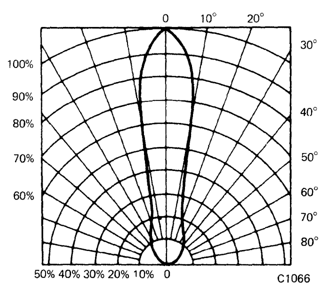


Fig. 4. Spatial Distribution (Note 2) (MV5352, MV5252, MV5152, MV5752)

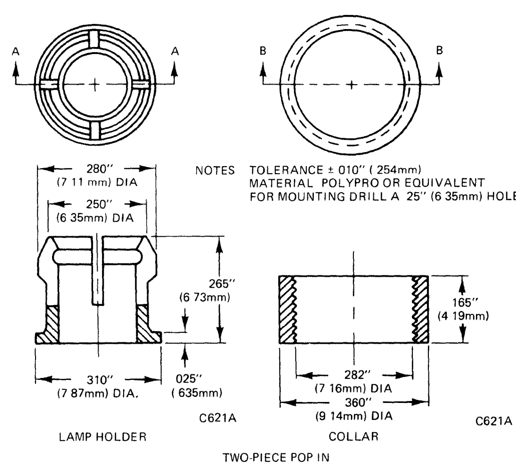


Fig. 5. Mounting Grommet (supplied on request only)

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 230°C, to a point 1/16 inch from the body of the device per MIL-S-750.*

Monsanto

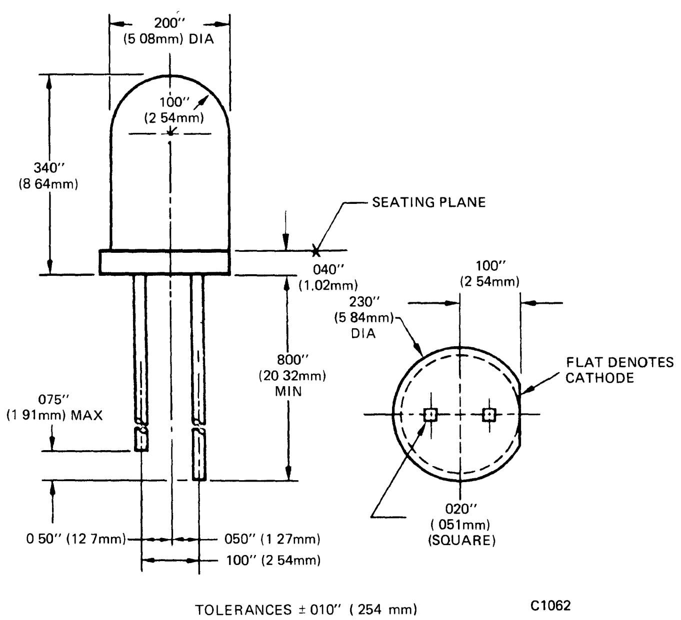
SOLID STATE LAMPS

ORANGE MV5153 MV5154
GREEN MV5253 MV5254
YELLOW MV5353 MV5354

PRODUCT DESCRIPTION

These solid state indicators offer a variety of lens effects and color availability. The 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.

PACKAGE DIMENSIONS



FEATURES

- Low cost
- High intensity light source with various lens effects.
- Orange, green, and yellow colors available. (See MV5050 series for red sources.)
- Versatile mounting on P.C. board or panel
- Snap in clip available on request
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight
- High efficiency
- Ultra high brightness

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 @ 230°C (see Note 3)	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	POP-IN MOUNTING	CIRCUIT BOARD MOUNTING
MV5153	Orange	Orange diffused	Wide beam	X	X
MV5154	Orange	Orange diffused	Narrow beam	X	X
MV5253	Green	Green diffused	Wide beam	X	X
MV5254	Green	Green diffused	Narrow beam	X	X
MV5353	Yellow	Yellow diffused	Wide beam	X	X
MV5354	Yellow	Yellow diffused	Narrow beam	X	X

ELECTRO-OPTICAL CHARACTERISTICS

PARAMETER	TEST COND.	UNITS	MV5153	MV5154	MV5253	MV5254	MV5353	MV5354
Forward voltage (V_F)	20 mA	V						
Typ.			2.0	2.0	2.2	2.2	2.1	2.1
Max.			3.0	3.0	3.0	3.0	3.0	3.0
Luminous intensity (see Note 1)*								
Min.	20 mA	mcd	3.0	3.0	0.8	0.9	2.5	3.0
Typ.	20 mA	mcd	6.0	8.0	1.5	3.0	6.0	10.0
Peak wave length	20 mA	nm	635	635	565	565	585	585
Spectral line Half width	20 mA	nm	45	45	35	35	35	35
Capacitance								
Typ.	V = 0	pF	45	45	45	45	45	45
Reverse voltage (V_R)	I_R = 100 μA							
Min.		V	5	5	5	5	5	5
Typ.		V	25	25	25	25	25	25
Reverse current (I_R)	V_R = 5.0 V							
Max.		μA	100	100	100	100	100	100
Typ.		nA	20	20	20	20	20	20
Viewing angle (total)	See Fig. 3 & 4	degrees	65	24	65	24	65	24

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

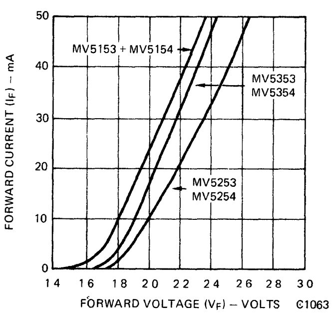


Fig. 1. Forward Current vs. Forward Voltage

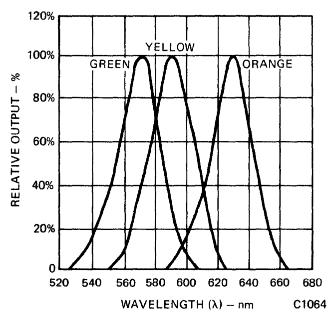


Fig. 2. Spectral Response

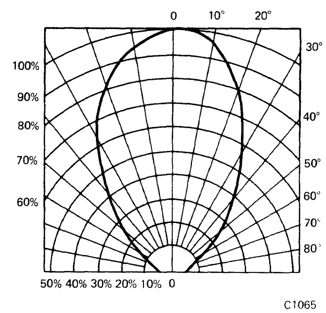


Fig. 3. Spatial Distribution (Note 2) (MV5353, MV5253, MV5153)

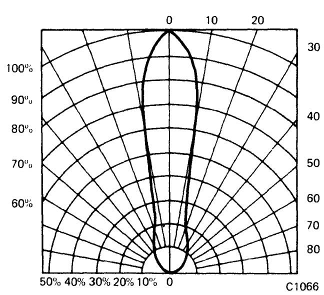


Fig. 4. Spatial Distribution (Note 2) (MV5354, MV5254, MV5154)

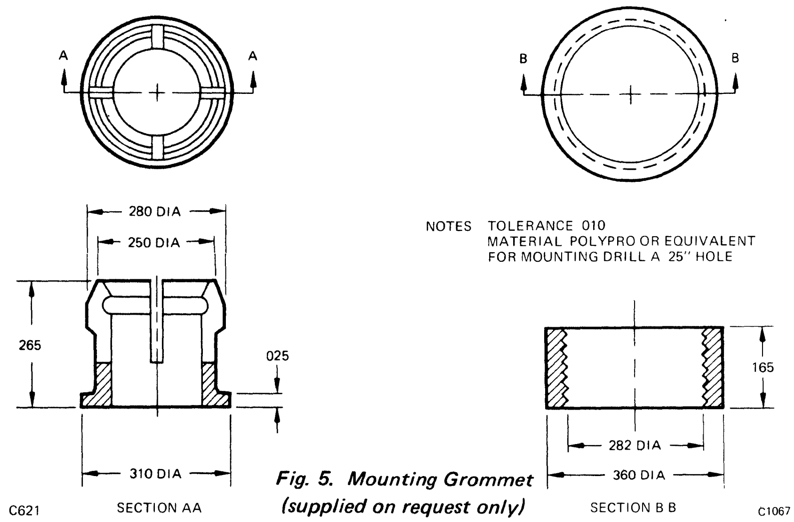


Fig. 5. Mounting Grommet (supplied on request only)

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 230°C, to a point 1/16 inch from the body of the device per MIL-S-750.*

Monsanto

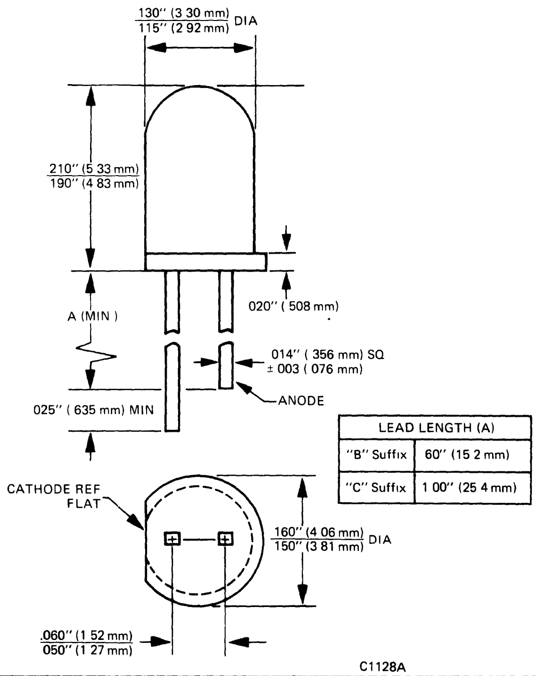
SOLID STATE LAMPS

ORANGE	MV5174B/C
GREEN	MV5274B/C
YELLOW	MV5374B/C
IMPROVED RED	MV5774B/C

PRODUCT DESCRIPTION

These solid state indicators offer a variety of color selection. The orange, red, and yellow devices are made with gallium arsenide phosphide, and the green units are made with 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.

PACKAGE DIMENSIONS



LEAD LENGTH (A)	
"B" Suffix	.60" (15.2 mm)
"C" Suffix	1.00" (25.4 mm)

FEATURES

- Low Cost
- High intensity light source with various lens effects
- Orange, green, yellow and red colors available. (See MV5074 series for additional red sources.)
- Versatile mounting on P.C. board or panel
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight
- High efficiency
- Ultra high brightness
- "B"—designated products have 0.6" (15.2 mm) minimum lead length
- "C"—designated products have 1" (25.4 mm) minimum lead length
- Square leads (will fit into .020" [.508 mm] diameter holes)

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C ambient	105 mW
Derate linearly from 25°C	1.14 mW/°C
Storage temperature	–55°C to 100°C
Operating temperature	–55°C to 100°C
Lead solder time @ 230°C (see Note 3)	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
MV5174B/C	Orange	Orange diffused	Wide beam	High profile
MV5274B/C	Green	Green diffused	Wide beam	High profile
MV5374B/C	Yellow	Yellow diffused	Wide beam	High profile
MV5774B/C	Orange	Red diffused	Wide beam	High profile

ELECTRO-OPTICAL CHARACTERISTICS

PARAMETER	TEST COND.	UNITS	MV5174B/C	MV5274B/C	MV5374B/C	MV5774B/C
Forward voltage (V_F)	20 mA	V				
Typ.			2.0	2.2	2.1	2.0
Max.			3.0	3.0	3.0	3.0
Luminous intensity (see Note 1)*						
Min.			1.5	.4	1.5	1.5
Typ.	20 mA	mcd	5.0	1.0	4.0	5.0
Peak wave length	20 mA	nm	635	565	585	635
Spectral line Half width	20 mA	nm	45	35	35	45
Capacitance						
Typ.	V = 0	pF	45	45	45	45
Reverse voltage (V_R)	I_R = 100 μA					
Min.		V	5	5	5	5
Typ.		V	25	25	25	25
Reverse current (I_R)	V_R = 5.0 V					
Max.		μA	100	100	100	100
Typ.		nA	20	20	20	20
Viewing angle (total)	See Fig. 3 & 4	degrees	90	90	90	90

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

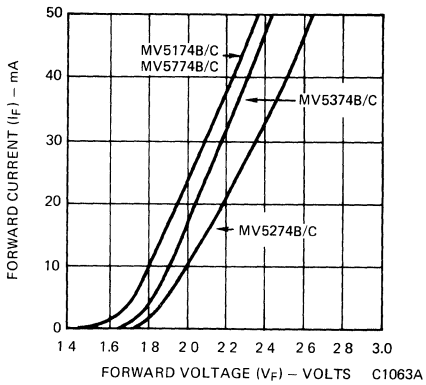


Fig. 1. Forward Current vs. Forward Voltage

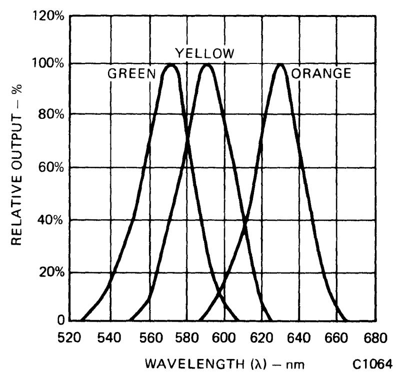


Fig. 2. Spectral Response

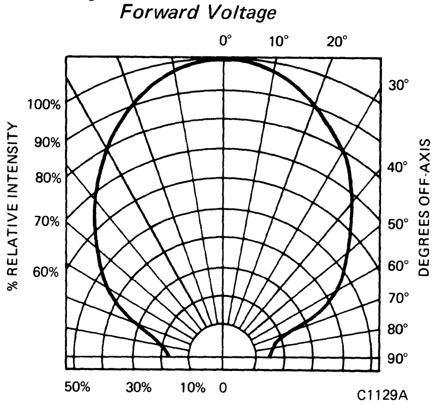


Fig. 3. Spatial Distribution

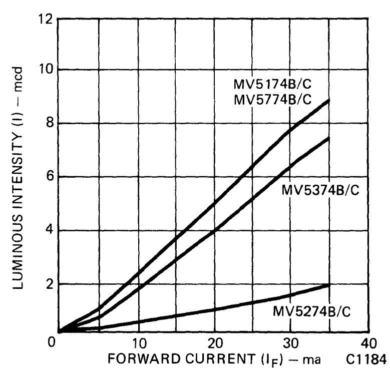


Fig. 4. Luminous Intensity vs. Forward Current

NOTES

1. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter, Model IVD.*
2. *The leads of the device were immersed in molten solder, at 230°C, to a point 1/16 inch from the body of the device per MIL-S-750.*

Monsanto

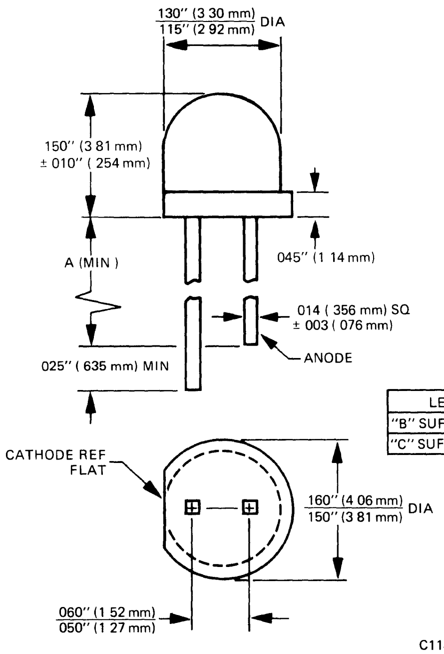
SOLID STATE LAMPS

ORANGE	MV5177B/C
GREEN	MV5277B/C
YELLOW	MV5377B/C
IMPROVED RED	MV5777B/C

PRODUCT DESCRIPTION

These solid state indicators offer a variety of color selection. The orange, red, and yellow devices are made with gallium arsenide phosphide, and the green units are made with 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.

PACKAGE DIMENSIONS



LEAD LENGTH (A)	
"B" SUFFIX	60" (15.2 mm)
"C" SUFFIX	1.00" (25.4 mm)

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
- "B"—designated products have .6" (15.2 mm) minimum lead length
- "C"—designated products have 1" (25.4 mm) minimum lead length
- Mount on approximately 3/16" (4.72 mm) centers
- Orange, green, yellow, and red colors available (see MV5077 series for other red sources.)

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C	105 mW
Derate linearly from 25°C	1.14 mW/°C
Storage temperature	–55°C to +100°C
Operating temperature	–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 (230°C, 1/16" from body)	5 sec

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	PACKAGE PROFILE
MV5177B/C	Orange	Orange diffused	Wide beam	Low profile
MV5277B/C	Green	Green diffused	Wide beam	Low profile
MV5377B/C	Yellow	Yellow diffused	Wide beam	Low profile
MV5777B/C	Orange	Red diffused	Wide beam	Low profile

MV5177B/C, MV5277B/C, MV5377B/C, MV5777B/C

ELECTRO-OPTICAL CHARACTERISTICS

PARAMETER	TEST COND.	UNITS	MV5177B/C	MV5277B/C	MV5377B/C	MV5777B/C
Forward voltage (V_F)	20 mA	V				
Typ.			2.0	2.2	2.1	2.0
Max.			3.0	3.0	3.0	3.0
Luminous intensity (see Note 1)*						
Min.			1.0	.2	1.0	1.0
Typ.	20 mA	mcd	3.0	0.6	2.0	3.0
Peak wave length	20 mA	nm	635	565	585	635
Spectral line Half width	20 mA	nm	45	35	35	45
Capacitance						
Typ.	V = 0	pF	45	45	45	45
Reverse voltage (V_R)	I_R = 100 μA					
Min.		V	5	5	5	5
Typ.		V	25	25	25	25
Viewing angle (total)		degrees	180	180	180	180
Dynamic resistance (R_D)		Ω	7.0	7.0	7.0	7.0

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

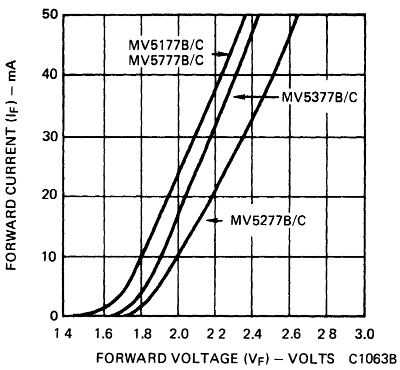


Fig. 1. Forward Current vs. Forward Voltage

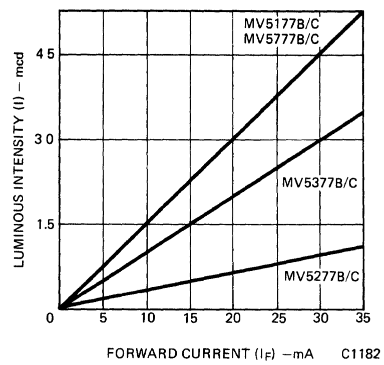


Fig. 2. Luminous Intensity vs. Forward Current

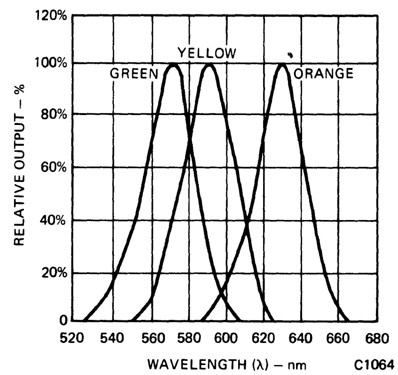


Fig. 3. Spectral Response

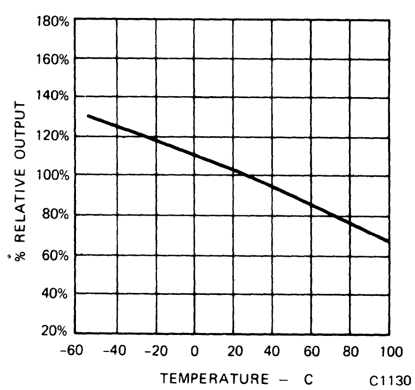


Fig. 4. Percent Relative Response vs. Temperature

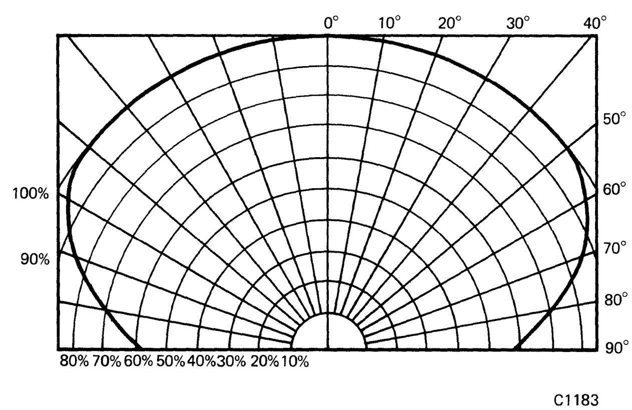


Fig. 5. Spatial Distribution

NOTES

1. *Luminous intensity measurements are taken with a Photo Research Corp., "SPECTRA" Microcandela Meter Model IVD.*

Monsanto

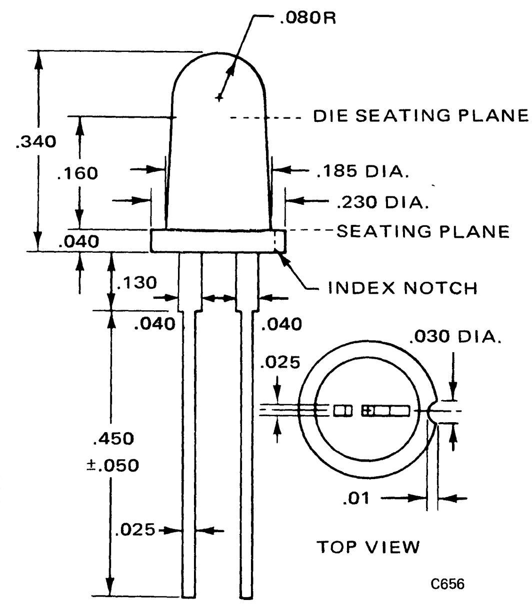
RED/GREEN TRI-STATE LAMP

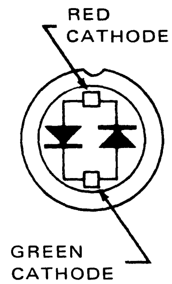
MV5491

PRODUCT 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.

PACKAGE DIMENSIONS



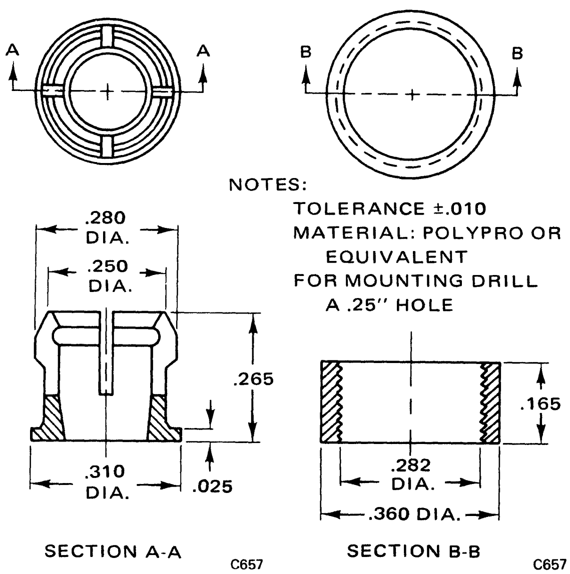


TOLERANCES ±.010

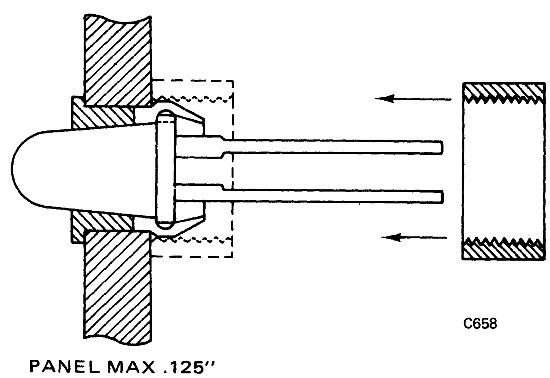
FEATURES

- 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

MOUNTING TECHNIQUES



POP IN CLIP



PANEL MOUNTING

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 @ 230°C	5 sec

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

OPTICAL

	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Luminous Intensity (I) (note 2)					
Red		1.5		mcd	I_F = 20 mA
Green		.5		mcd	I_F = 20 mA
Apparent Area (A_P)		32		cm^2	($X10^{-3}$)
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

ELECTRICAL

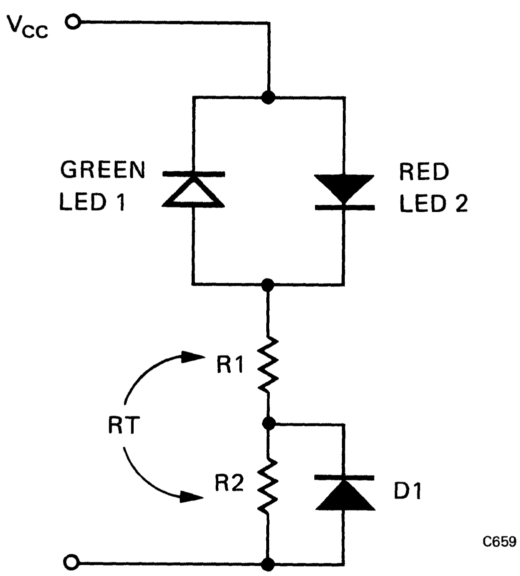
	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Forward Voltage (V_F)					
Red		1.65	2.0	volts	I_F = 20 mA
Green		2.2	3.0	volts	I_F = 30 mA
Dynamic Resistance (R_D)					
Red		5.5		Ω	
Green		50.0		Ω	

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

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 30 mA and 50 mA respectively.

FOR RED:

$$R_T = \frac{V_{CC} - V_{LED2}}{I_{LED2}} = \frac{5.0 - 1.63}{0.3} = 112\Omega$$

$$R_T - R_1 = R_2$$

$$112 - 34 = 78\Omega$$

FOR GREEN:

$$R_1 = \frac{V_{CC} - (V_{LED1} + V_{D1})}{I_{LED1}} = \frac{5.0 - (2.6 + 0.7)}{.05} = 34\Omega$$

SUGGESTED RESISTOR COMBINATIONS:

GREEN →	10 mA			20 mA			30 mA			40 mA			50 mA		
RED	R_T	R_1	R_2	R_T	R_1	R_2	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	344	44	300	344	34	310
20 mA	170	230	-60	170	102	68	170	63	107	170	44	126	170	34	136
30 mA	112	230	-118	112	102	10	112	63	49	112	44	68	112	34	78
40 mA	84	230	-146	84	102	-18	84	63	21	84	44	40	84	34	50
50 mA	67	230	-163	67	102	-35	67	63	4	67	44	23	67	34	33
60 mA	55	230	-175	55	102	-47	55	63	-8	55	44	11	55	34	21
70 mA	47	230	-183	47	102	-55	47	63	-16	47	44	3	47	34	13

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 CHARACTERISTICS

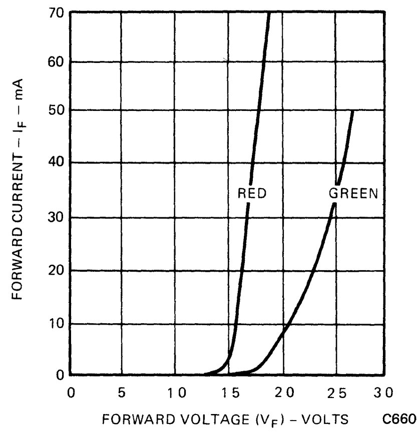


Fig. 1. Forward Current vs Forward Voltage

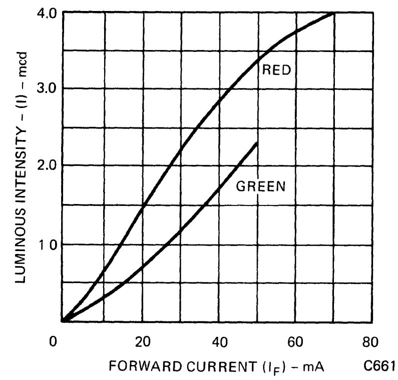


Fig. 2. Luminous Intensity vs Forward Current

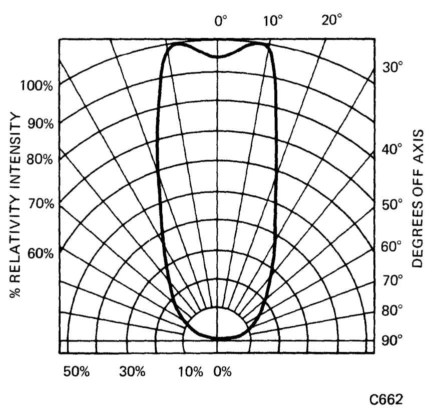


Fig. 3 Spatial Distribution (Note 1)

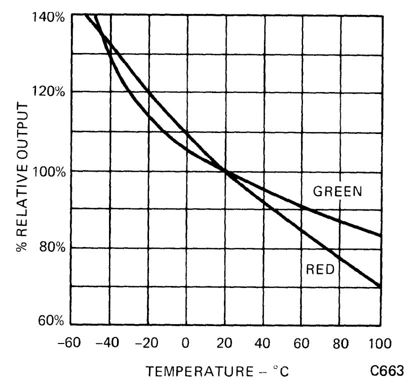


Fig. 4. Relative Output vs Temperature

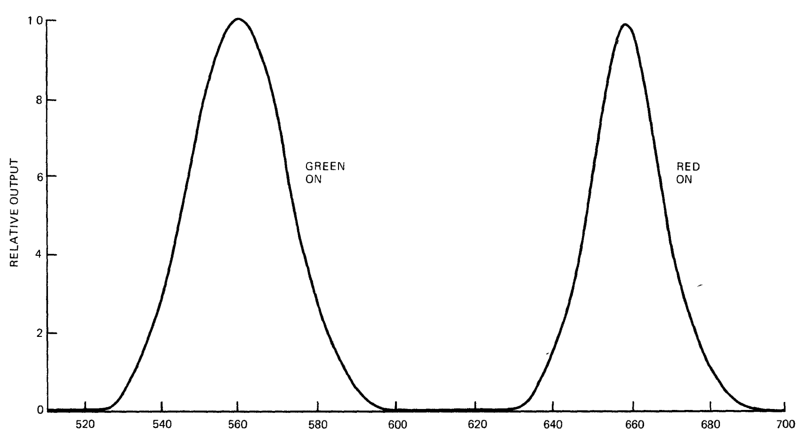


Fig. 5. Spectral Distribution

NOTES

1. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*
2. *Luminous Intensity figures are measured with a Photo Research Corp. Microcandela Meter (Model IV D).*

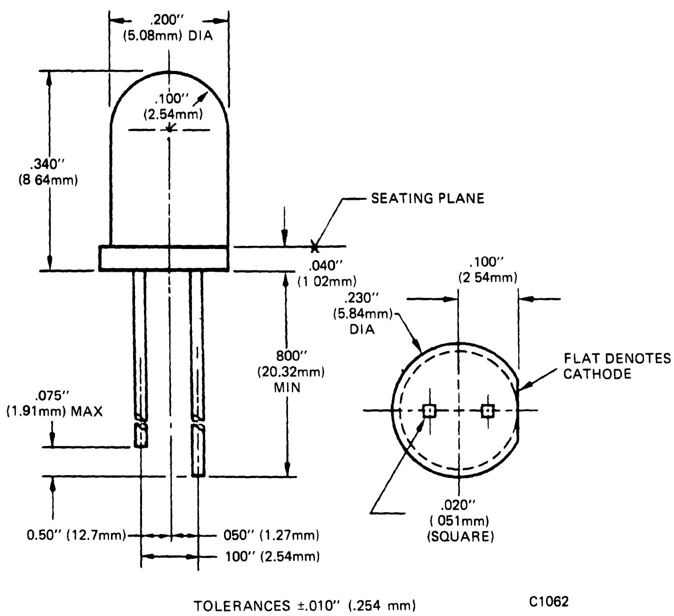
Monsanto

SOLID STATE LAMPS | MV5753 MV5754

PRODUCT DESCRIPTION

These are solid state indicators offering high brightness at low currents. The MV5753 and MV5754 are made with gallium arsenide phosphide chips and are encapsulated in epoxy lenses.

PACKAGE DIMENSIONS



FEATURES

- High intensity light source with various lens effects.
- Versatile mounting on P.C. board or panel
- Snap in clip available on request
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight
- High efficiency
- Ultra high brightness

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 @ 230°C (see Note 3)	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	POP-IN MOUNTING	CIRCUIT BOARD MOUNTING
MV5753	Red	Red diffused	Wide beam	X	X
MV5754	Red	Red diffused	Narrow beam	X	X

ELECTRO-OPTICAL CHARACTERISTICS

PARAMETER	TEST COND.	UNITS	MV5753	MV5754
Forward voltage (V_F)	20 mA	V		
Typ.			2.0	2.0
Max.			3.0	3.0
Luminous intensity (see Note 1)*				
Min.	20 mA	mcd	3.0	3.0
Typ.	20 mA	mcd	6.0	8.0
Peak wave length	20 mA	nm	635	635
Spectral line Half width	20 mA	nm	45	45
Capacitance				
Typ.	V = 0	pF	45	45
Reverse voltage (V_R)	I_R = 100 μA			
Min.		V	5	5
Typ.		V	25	25
Reverse current (I_R)	V_R = 5.0 V			
Max.		μA	100	100
Typ.		nA	20	20
Viewing angle (total)	See Fig. 3 & 4	degrees	65	24

*Luminous intensity guaranteed to a 2.5% AQL inspection plan per MIL-STD-105D.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

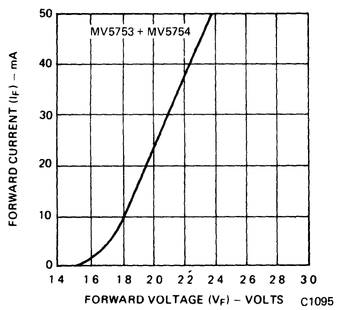


Fig. 1. Forward Current vs. Forward Voltage

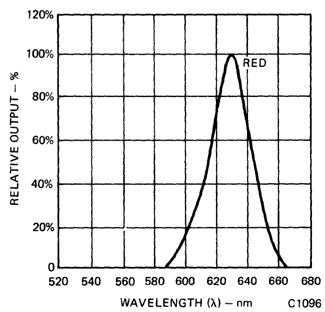


Fig. 2. Spectral Response

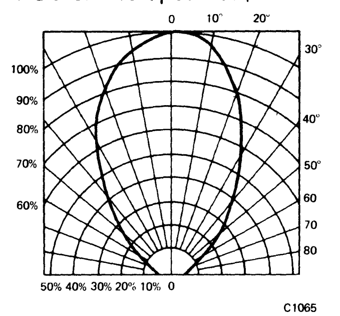


Fig. 3. Spatial Distribution (Note 2) for MV5753

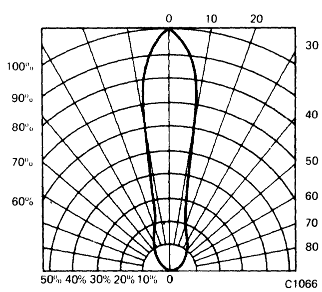


Fig. 4. Spatial Distribution (Note 2) for MV5754

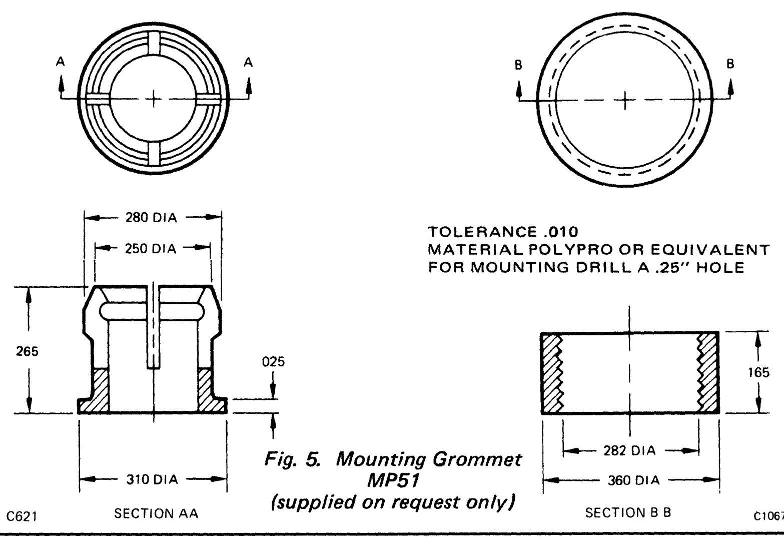


Fig. 5. Mounting Grommet MP51 (supplied on request only)

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 from the body of the device per MIL-S-750.*

Monsanto

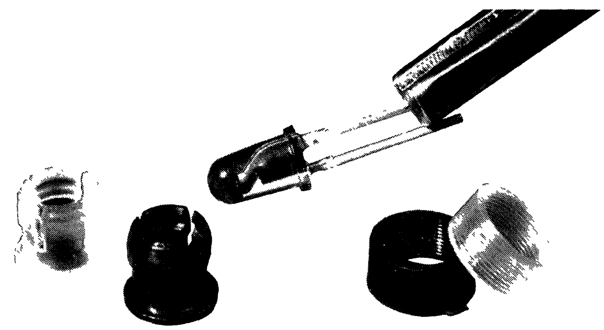
PANEL MOUNTING GROMMETS (FOR LED PANEL INDICATORS)

MP21 MP22 MP51 MP52

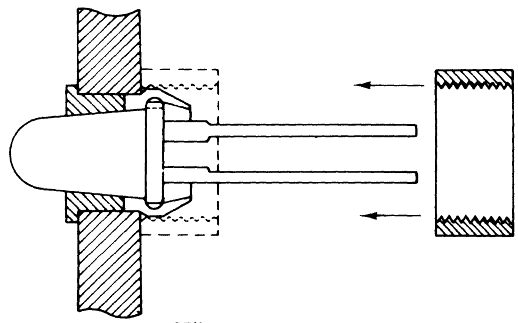
DESCRIPTION

The MP Series of mounting grommets is intended for panel mounting of many standard Monsanto 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 (3.18mm).

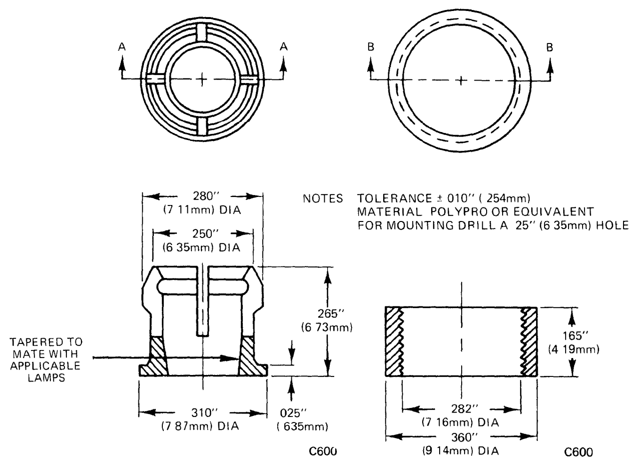


TYPICAL MOUNTING TECHNIQUE

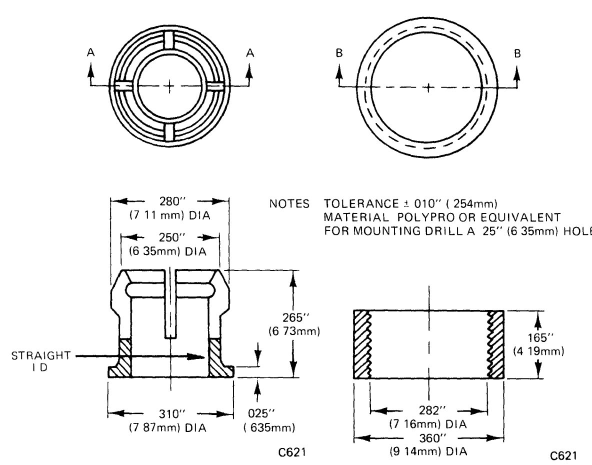


PART NUMBER	COLOR	AVAILABILITY	APPLICABLE LAMPS
MP21	CLEAR	Special order only	MV5020 thru MV5026; ME7120 thru ME7124
MP22	BLACK	Standard	
MP51	CLEAR	Special order only	MV5050 thru MV5056; MV5153; MV5154; MV5253, MV5254; MV5353, MV5354
MP52	BLACK	Standard	

DIMENSIONAL DATA



MP21 OR MP22
TWO-PIECE POP-INS



MP51 OR MP52
TWO-PIECE POP-INS

4 INFRARED LIGHT EMITTING DIODES

Infrared Emitters and Photodetectors

Infrared emitters are available from Monsanto in a number of package configurations, sizes, output power ratings, and radiation angles. In addition, silicon phototransistors are available in two sensitivity categories.

QUICK REFERENCE CHART

MODEL NO.	FORWARD VOLTAGE (V_F)	POWER OUT (P_O)	TEST CURRENT	MAXIMUM POWER	PACKAGE KEY
ME60	1.3 V	550 μW	50 mA	75 mW	C
ME61	1.3 V	550 μW	50 mA	75 mW	D
ME7021 (Note a)	1.3 V	1000 μW	50 mA	150 mW	E
ME7121 (Note a)	1.4 V	3 mW	50 mA	150 mW	E
ME7161	1.3 V	3 mW	50 mA	75 mW	D

MODEL NO.	SENSITIVITY (μA/mW/cm²)	COLLECTOR DARK CURRENT	COLLECTOR-EMITTER BREAKDOWN	MAXIMUM POWER	PACKAGE KEY
MT1	560	1 nA	65 V	200 mW	A
MT2	1400	1 nA	65 V	200 mW	B

NOTE:
(a) The ME7021 and ME7121 have a 15° half-angle; the ME7024 and ME7124 have a 4° half-angle .

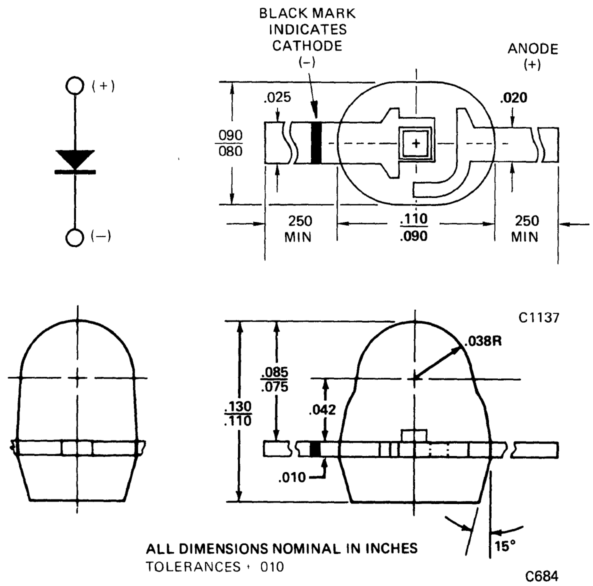
Monsanto

INFRARED EMITTER — ME60

PRODUCT DESCRIPTION

The ME60 is a diffused planar gallium arsenide infrared diode. The lead-frame construction is encapsulated in an epoxy case and lens.

PACKAGE DIMENSIONS



FEATURES

The ME60 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	1.0mW/°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
Reverse current	10 μA

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)	400	550		μW	I_F = 50 mA
On-axis irradiance		250		μW/cm2	I_F = 50 mA, d = 1 cm
Peak emission wave length		900		nm	
Spectral line half-width		50		nm	
Forward voltage		1.3	1.5	V	I_F = 50 mA
Reverse current		5		nA	V_R = 3.0 volts
Light turn-on and turn-off		10		ns	
Capacitance		80		pF	V=0
Reverse breakdown voltage	3	5		V	I_R=10μA
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)

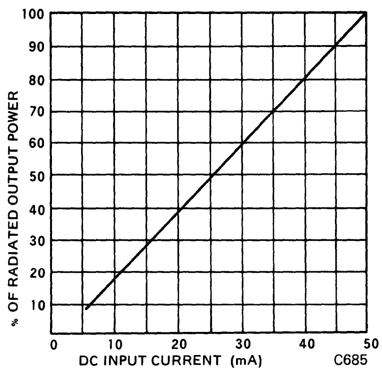


Fig. 1. Input Current vs. Output Power

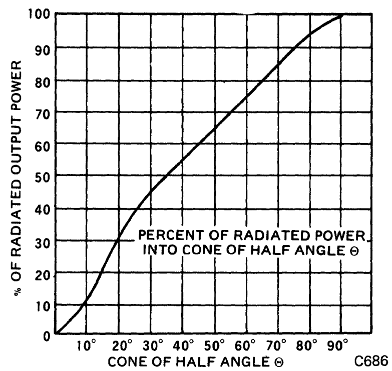


Fig. 2. Percent of Radiated Power into Cone of Half Angle

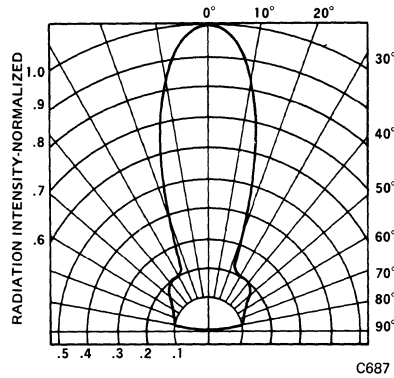


Fig. 3. Spatial Distribution (Note 3)

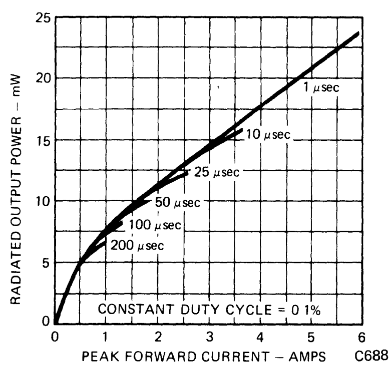


Fig. 4. Radiated Output Power vs. Peak Forward Current

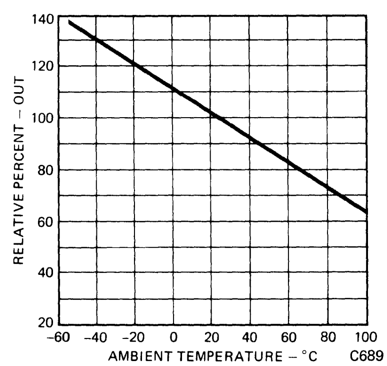


Fig. 5. % Relative Output vs. Temperature

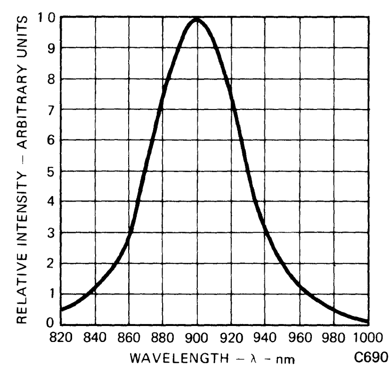


Fig. 6. Spectral Distribution

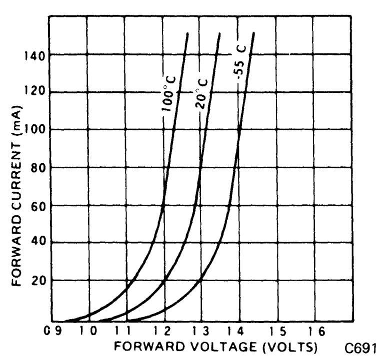


Fig. 7 Forward Current vs. Forward Voltage

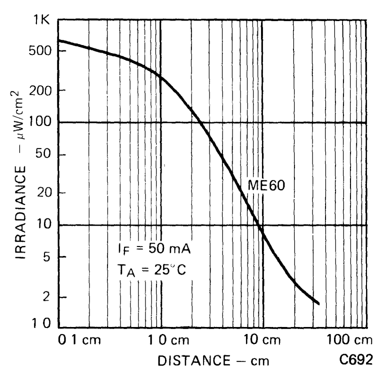


Fig. 8. On-Axis Irradiance vs. Distance (Note 4)

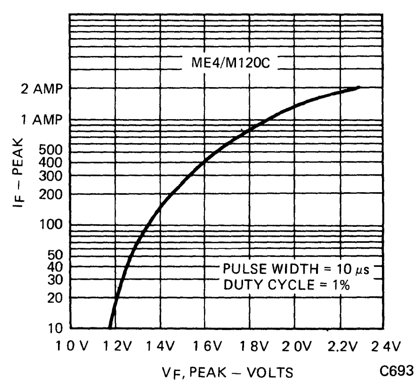


Fig. 9. V_F vs. I_F (to 4 A) Pulsed

NOTES

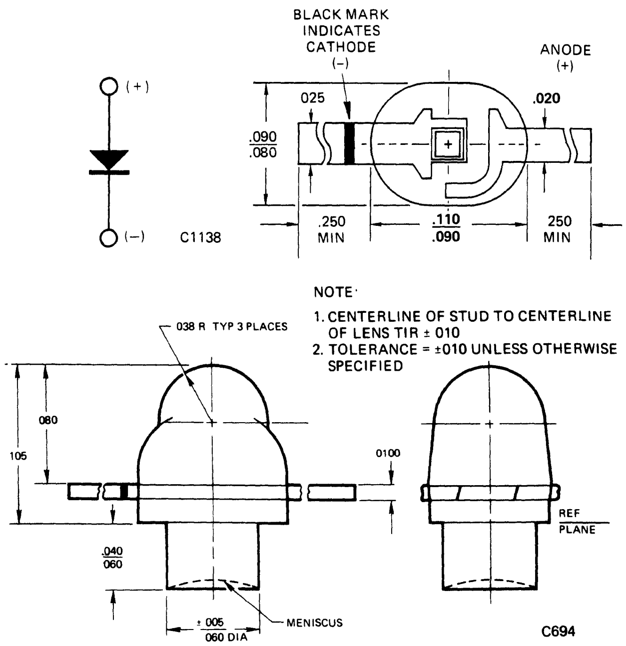
1. *The leads of the device were immersed in molten solder, heated to a temperature of 230°C, to a point 1/16 inch from the body of the device per MIL-S-750.*
2. *The total external radiated power output measurements are made with a Centralab 110C solar cell terminated into a 100Ω impedance.*
3. *The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.*
4. *Distance measurements taken from top of lens.*

Monsanto | INFRARED EMITTER | ME61

PRODUCT DESCRIPTION

The ME61 is a diffused planar gallium arsenide infrared diode. The lead-frame construction is encapsulated in an epoxy case and lens and provides an alignment stud as an integral part of the package.

PACKAGE DIMENSIONS



FEATURES

The ME61 is intended for high volume infrared source application where low cost, high reliability and high density packaging are required.

- Stud base for precise alignment
- 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	1.0mW/°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
Reverse current	10 μA

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

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CHARACTERISTICS
Total external radiated power (see note 2)	400	550		μW	I_F = 50 mA
On-axis irradiance		250		μW/cm2	I_F = 50 mA, d = 1 cm
Zone 1 power (see Fig. 7)	45			μW	I_F = 50 mA
Peak emission wavelength		900		nm	
Spectral line half-width		50		nm	
Forward voltage		1.3	1.5	V	I_F = 50 mA
Reverse current		5		nA	V_R = 3.0 volts
Light turn-on and turn-off		10		ns	
Capacitance		80		pF	V = 0
Reverse breakdown voltage	3	5		V	I_R = 10 μA
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)

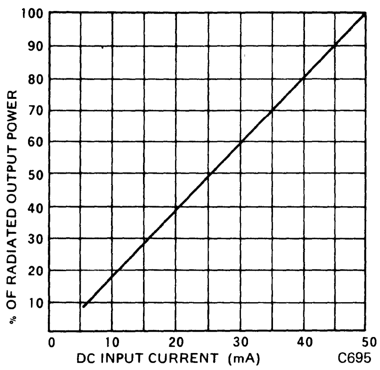


Fig. 1. Input Current vs. Output Power

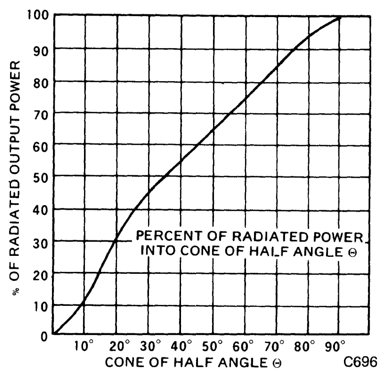


Fig. 2. Percent of Radiated Power into Cone of Half Angle

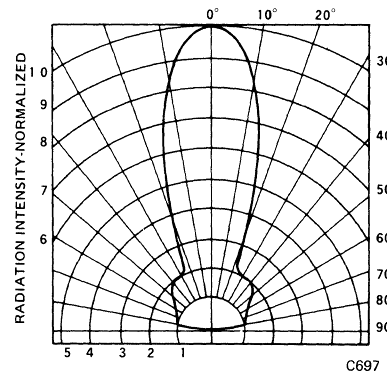


Fig. 3. Spatial Distribution (Note 3)

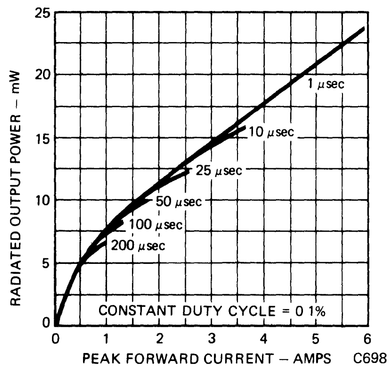


Fig. 4. Radiated Output Power vs. Peak Forward Current

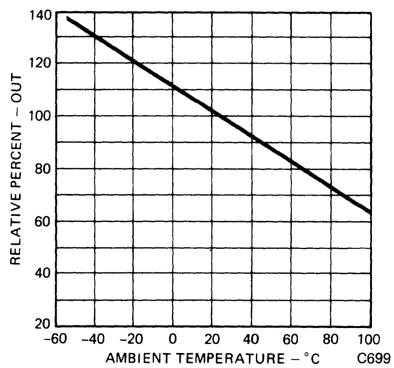


Fig. 5. % Relative Output vs. Temperature

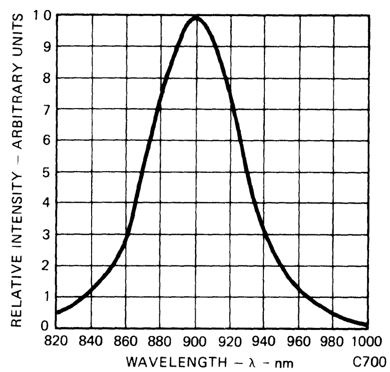


Fig. 6. Spectral Distribution

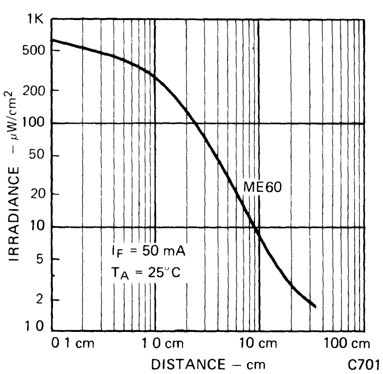


Fig. 7. On-Axis Irradiance vs. Distance

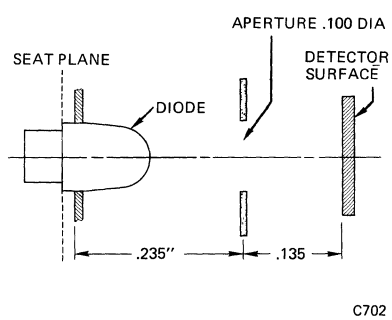


Fig. 8. Zone 1 Measurement

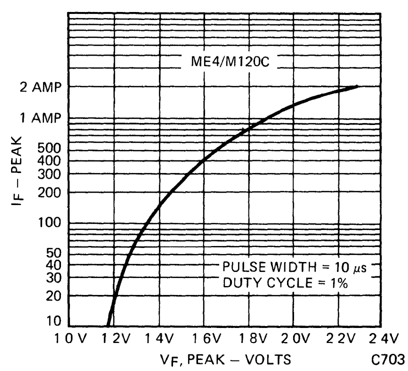


Fig. 9. V_F vs. I_F (to 4A) Pulsed

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.*

Monsanto

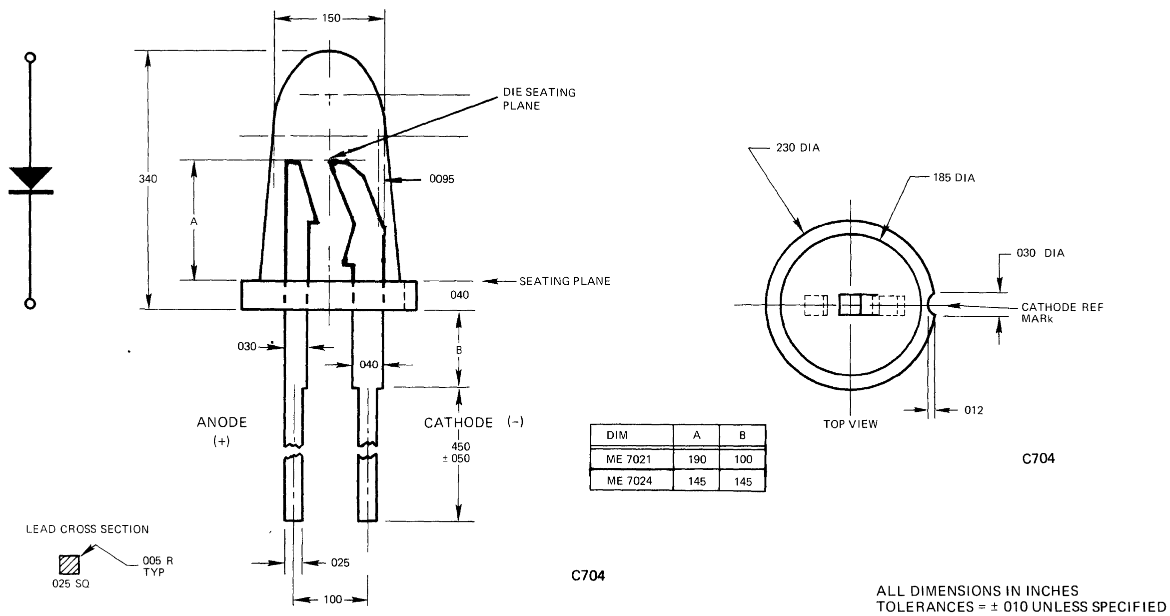
INFRARED EMITTERS

ME7021 ME7024

PRODUCT DESCRIPTION

This family of IR Emitters is designed to accomodate 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.

PACKAGE DIMENSIONS



DIM	A	B
ME 7021	190	100
ME 7024	145	145

ALL DIMENSIONS IN INCHES
TOLERANCES = ± 010 UNLESS SPECIFIED

ELECTRO-OPTICAL CHARACTERISTICS

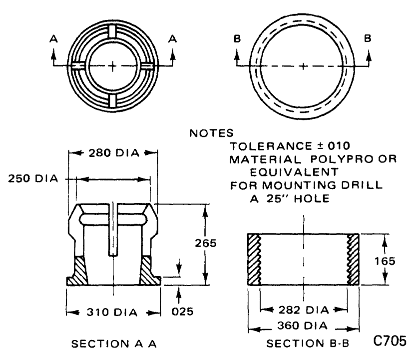
	TYPICAL HALF ANGLE (DEGREES)	TYPICAL ON AXIS INTENSITY (MW/STR.) @ 50 mA	
ME7021	15°	3.6	into cone @ 1/2 power points @ I_F = 50 mA ROP = 1 mW
ME7024	4°	81.2	

	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Total External Output Power (Note 2)	.5	1.0		mW	I_F = 50 mA
Peak Emission Wave Length		900		nm	I_F = 50 mA
Spectral Line Half Width		50		nm	I_F = 50 mA
Forward Voltage		1.3	1.5	V	I_F = 50 mA
Reverse Breakdown Voltage	5.0	8.0		V	I_R = 100 μA
Capacitance		105		pF	V=0, f=1 MHz
Light Turn On & Turn Off Time		100		nsec	50 Ω Load
Dynamic Resistance (R_D)		1.6		Ω	T_F = 100 mA

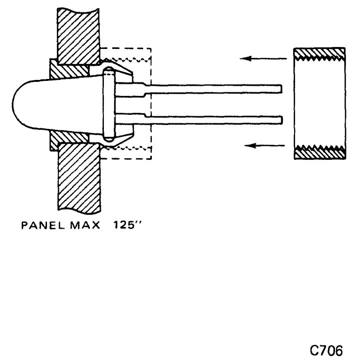
ABSOLUTE MAXIMUM RATINGS

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	5.0 V
Peak forward current (PW - 1.0 μsec, Duty Cycle = 0.3%)	1.0 A

PANEL MOUNTING TECHNIQUES



MOUNTING GROMMET



PANEL MOUNTING

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free air temperature unless otherwise specified)

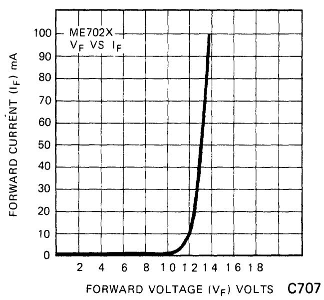


Fig. 1. I_F vs. V_F

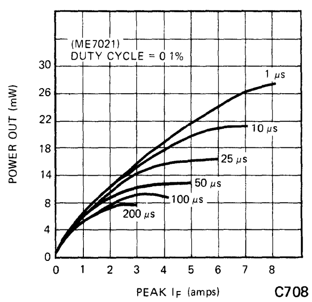


Fig. 2. ROP vs I_F Peak

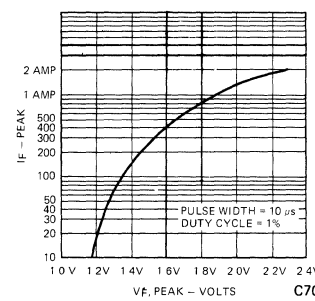


Fig. 3. I_F Peak Pulse Mode Characteristics

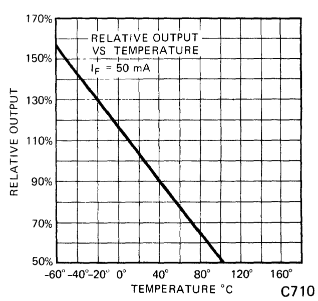


Fig. 4. ROP vs. Temperature (Note 1)

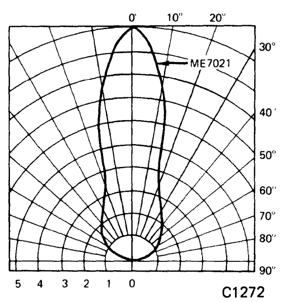


Fig. 5. Spatial Distribution (ME7021)

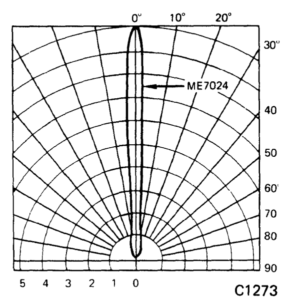


Fig. 6. Spatial Distribution (ME7024)

NOTES

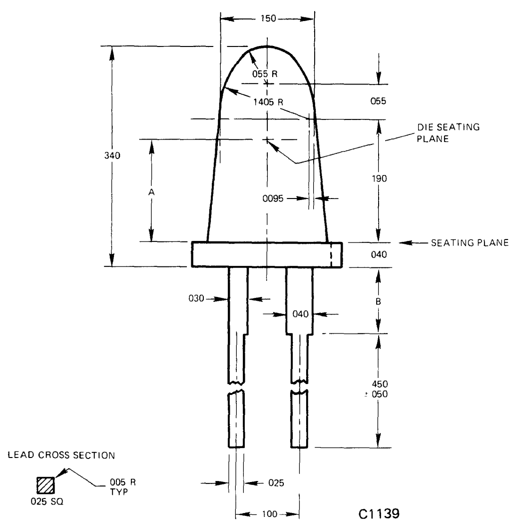
1. *The curves in figure 3 are normalized to the power output at 25°C to indicate the relative efficiency over the operating temperature range.*
2. *The total external radiated power output measurements are made with a Centralab 110C solar cell terminated into a 100Ω impedance.*
3. *The leads of the ME7021 and ME7024 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.*

Monsanto HIGH POWER INFRARED EMITTERS ME7121, ME7124

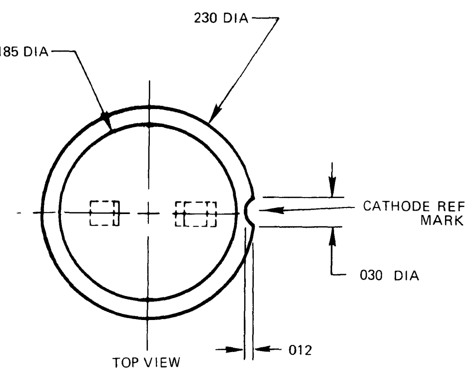
PRODUCT DESCRIPTION

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.

PACKAGE DIMENSIONS



C1139



DIM	A	B
ME7121	190	100
ME7124	145	145

C1140

ALL DIMENSIONS IN INCHES
TOLERANCES = ± 010 UNLESS SPECIFIED

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

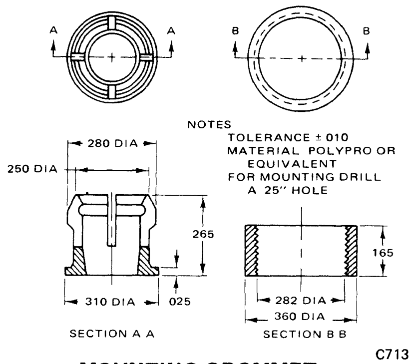
ELECTRO-OPTICAL CHARACTERISTICS

	TYPICAL HALF ANGLE (DEGREES)	TYPICAL ON AXIS INTENSITY (MW/STR.) @ 50 mA
ME7121	17°	10.8
ME7124	6°	243.6

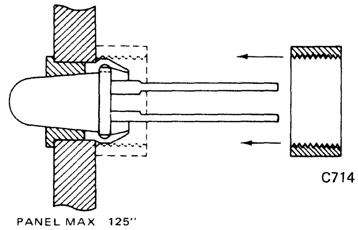
{ into cone @ 1/2 power points, @ I_F = 50 mA, ROP = 3 mW }

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

PANEL MOUNTING TECHNIQUES



MOUNTING GROMMET



PANEL MOUNTING

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

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

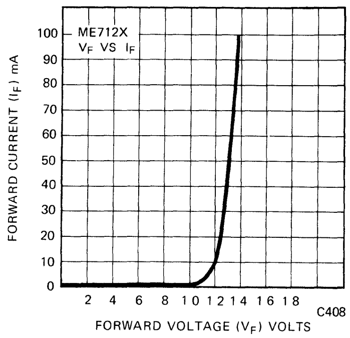


Fig. 1. I_F vs. V_F

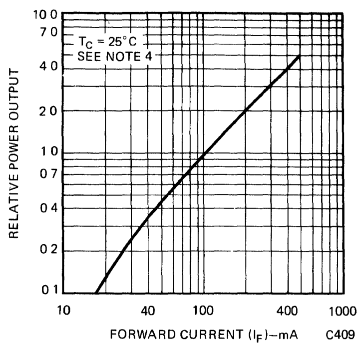


Fig. 2. ROP vs. I_F Peak

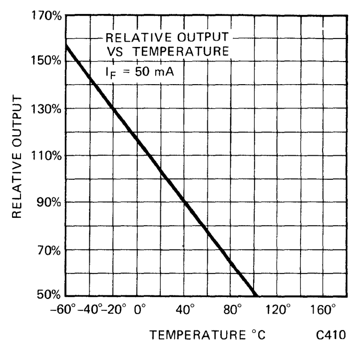


Fig. 3. ROP vs. Temperature (Note 1)

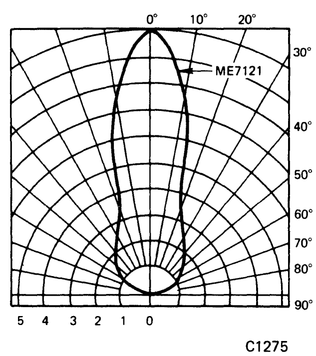


Fig. 4. Spatial Distribution (ME7121)

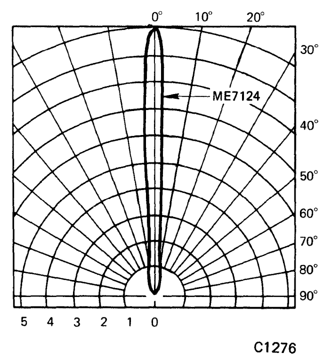


Fig. 5. Spatial Distribution (ME7124)

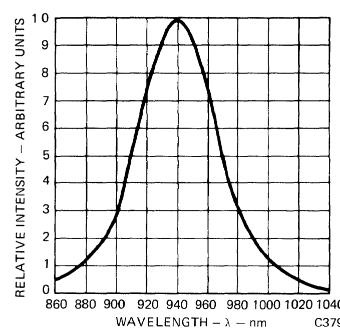


Fig. 6. Spectral Distribution

NOTES

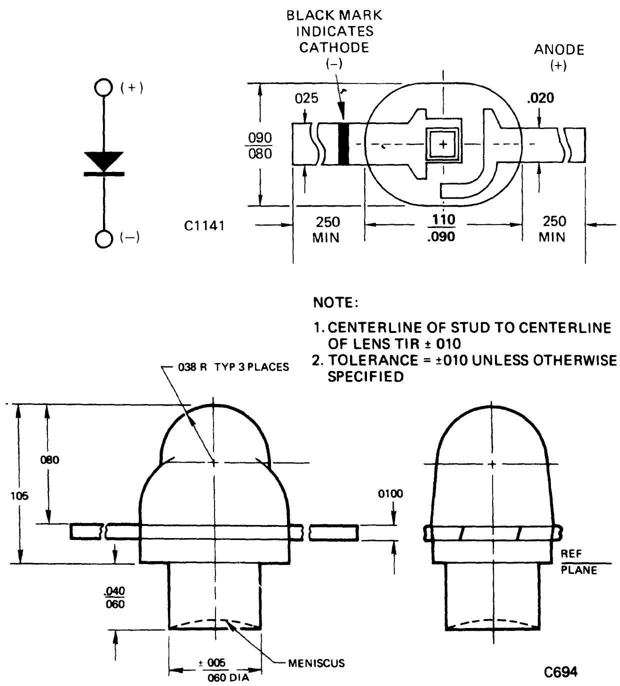
1. *The curves in figure 3 are normalized to the power output at 25°C to indicate the relative efficiency over the operating temperature range.*
2. *The total external radiated power output measurements are made with a Centralab 110C solar cell terminated into a 100Ω impedance.*
3. *The leads of the 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 tw = 40 µsec duty cycle ⩽10%.*

Monsanto INFRARED EMITTER ME7161

PRODUCT DESCRIPTION

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

PACKAGE DIMENSIONS



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	
Spectral line half-width		50		nm	
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	
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)

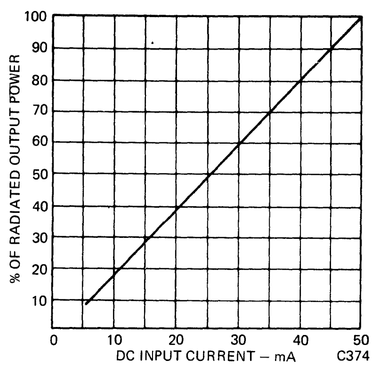


Fig. 1. Input Current vs. Output Power

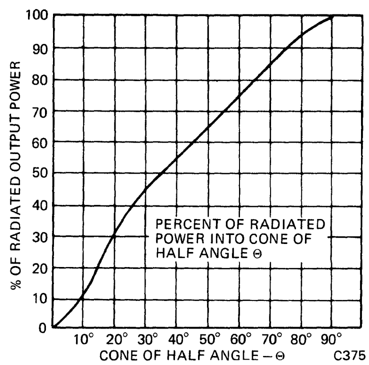


Fig. 2. Percent of Radiated Power Into Cone of Half Angle

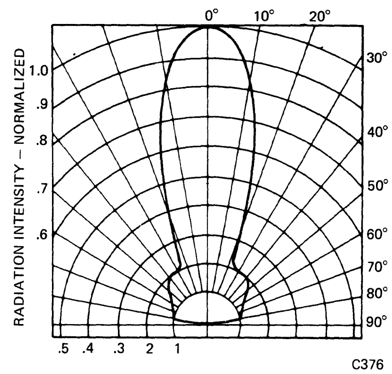


Fig. 3. Spatial Distribution (Note 3)

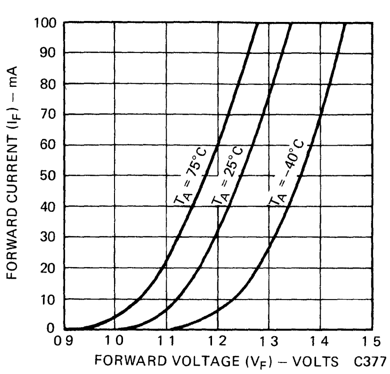


Fig. 4. Forward Current vs. Forward Voltage

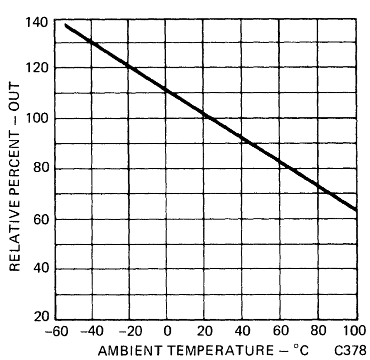


Fig. 5. % Relative Output vs. Temperature

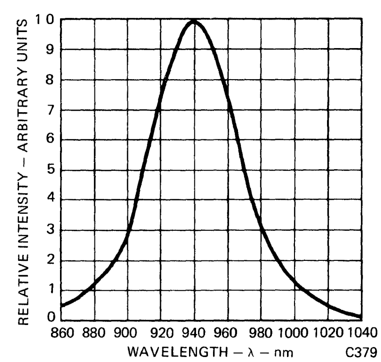


Fig. 6. Spectral Distribution

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.*

5 VISIBLE DISPLAYS

Displays

Monsanto offers a variety of standard solid state digital display devices with choices of font style, size, package type, and color. This table is representative of the many types available.

Applications include . . .

- calculators
- instruments
- consumer products
- automobiles
- clocks
- communications equipmen
- computers
- POS terminals

QUICK REFERENCE CHART

PRODUCT	DIGIT HEIGHT	COLOR	PEAK WAVE-LENGTH	BRIGHTNESS (ft.-L) OR LUMINOUS INTENSITY (μcd) (per SEG. MIN.)	VOLTS-MAX. (V_F/SEG.)	TEST CONDITION (I_F)	PRODUCT FEATURES	PACKAGE
MAN1A	.270 in.	Red	660 nm	100 ft.-L	4.0 V	20 mA	Low Brightness 7 Segment	A
MAN10A	.270 in.	Red	660 nm	100 ft.-L	4.0 V	10 mA	High Brightness Low Current	A
MAN1001A	.270 in.	Red	660 nm	100 ft.-L	4.0 V	20 mA	Polarity/Overflow for MAN1A	B
MAN101A	.270 in.	Red	660 nm	100 ft.-L	4.0 V	10 mA	Polarity/Overflow for MAN10A	B
MAN2A	.320 in.	Red	650 nm	125 μcd	2.0 V	10 mA	35 Diode Alpha-Numeric	G
MAN3610	.300 in.	Orange	630 nm	510 μcd	2.5 V	10 mA	Common Anode; RHDP	C,N
MAN3620	.300 in.	Orange	630 nm	510 μcd	2.5 V	10 mA	Common Anode; LHDP	D,N
MAN3630	.294 in.	Orange	630 nm	510 μcd	2.5 V	10 mA	Common Anode; RHDP Overflow (±1)	E,N
MAN3640	.300 in.	Orange	630 nm	510 μcd	2.5 V	10 mA	Common Cathode; RHDP	F,N
MAN51	.300 in.	Green	565 nm	125 μcd	3.5 V	10 mA	Common Anode; RHDP	C,N
MAN52	.300 in.	Green	565 nm	125 μcd	3.5 V	10 mA	Common Anode; LHDP	D,N
MAN53	.294 in.	Green	565 nm	125 μcd	3.5 V	10 mA	Common Anode; RHDP Overflow (±1)	E,N
MAN54	.300 in.	Green	565 nm	125 μcd	3.5 V	10 mA	Common Cathode; RHDP	F,N
MAN71	.300 in.	Red	650 nm	125 μcd	2.0 V	10 mA	Common Anode; RHDP	C,N
MAN72	.300 in.	Red	650 nm	125 μcd	2.0 V	10 mA	Common Anode; LHDP	D,N
MAN73	.294 in.	Red	650 nm	125 μcd	2.0 V	10 mA	Common Anode; RHDP Overflow (±1)	E,N
MAN74	.300 in.	Red	650 nm	125 μcd	2.0 V	10 mA	Common Cathode; RHDP	F,N
MAN81	.300 in.	Yellow	590 nm	320 μcd	3.5 V	10 mA	Common Anode; RHDP	C,N
MAN82	.300 in.	Yellow	590 nm	320 μcd	3.5 V	10 mA	Common Anode; LHDP	D,N
MAN83	.294 in.	Yellow	590 nm	320 μcd	3.5 V	10 mA	Common Anode; RHDP (Overflow (±1)	E,N
MAN84	.300 in.	Yellow	590 nm	320 μcd	3.5 V	10 mA	Common Cathode; RHDP	F,N
MAN4610	.400 in.	Orange	630 nm	510 μcd	2.5 V	10 mA	Common Anode; RHDP	H,N
MAN4630	.400 in.	Orange	630 nm	510 μcd	2.5 V	10 mA	Common Anode; RHDP Overflow (±1)	I,N
MAN4640	.400 in.	Orange	630 nm	510 μcd	2.5 V	10 mA	Common Cathode; RHDP	J,N
MAN6610	.560 in.	Orange	630 nm	510 μcd	2.5 V	10 mA	2 Digit; Common Anode; RHDP	K
MAN6630	.560 in.	Orange	630 nm	510 μcd	2.5 V	10 mA	1½ Digit; Common Anode; Overflow (±1.8); RHDP	L
MAN6640	.560 in.	Orange	630 nm	510 μcd	2.5 V	10 mA	2 Digit; Common Cathode; RHDP	K
MAN6650	.560 in.	Orange	630 nm	510 μcd	2.5 V	10 mA	1½ Digit; Common Cathode; Overflow (±1.8); RHDP	L
MAN6660	.560 in.	Orange	630 nm	510 μcd	2.5 V	10 mA	Single digit; Common Anode; RHDP	M
MAN6680	.560 in.	Orange	630 nm	510 μcd	2.5 V	10 mA	Single digit; Common Cathode; RHDP	M
MAN6710	.560 in.	Red	650 nm	125 μcd	2.0 V	10 mA	2 Digit; Common Anode; RHDP	K
MAN6730	.560 in.	Red	650 nm	125 μcd	2.0 V	10 mA	1½ Digit; Common Anode; Overflow (±1.8); RHDP	L
MAN6740	.560 in.	Red	650 nm	125 μcd	2.0 V	10 mA	2 Digit; Common Cathode; RHDP	K
MAN6750	.560 in.	Red	650 nm	125 μcd	2.0 V	10 mA	1½ Digit; Common Cathode; Overflow (±1.8); RHDP	L

Models shown in bold type are industry standard products.

Monsanto

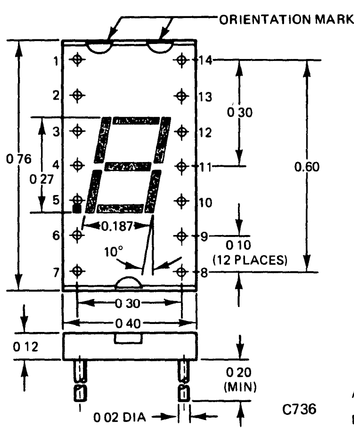
.27" RED SEVEN SEGMENT DISPLAY

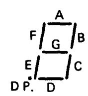
MAN1 MAN1A

PRODUCT DESCRIPTION

The MAN1 is a seven segment diffused planar GaAsP light emitting diode array. It is mounted on a dual in-line 14 pin substrate and then encapsulated in clear epoxy for protection. It is capable of displaying all digits and nine distinct letters. The MAN1A has identical specifications, but is encapsulated in high contrast red epoxy.

PACKAGE DIMENSIONS





PIN 1	CATHODE A
PIN 2	CATHODE F
PIN 3	ANODE-COMMON
PIN 4	NC
PIN 5	NC
PIN 6	DECIMAL POINT CATHODE
PIN 7	CATHODE E
PIN 8	CATHODE D
PIN 9	ANODE-COMMON
PIN 10	CATHODE C
PIN 11	CATHODE G
PIN 12	NC
PIN 13	CATHODE B
PIN 14	ANODE-COMMON

JUMPER PINS 3, 9, AND 14 ON CIRCUIT BOARD

ALL DIMENSIONS NOMINAL IN INCHES

DUAL, IN-LIINE CONFIGURATION

FEATURES

- High brightness . . . Typically 350 ft-L @ 20 mA
- 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

The MAN1 is for industrial and military applications such as:

- Digital readout displays
- Cockpit readout displays

ABSOLUTE MAXIMUM RATINGS

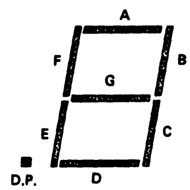
Power dissipation @ 25°C ambient	750 mW
Derate linearly from 25°C	10 mW/°C
Storage and operating temp	-55°C to 100°C
Continuous forward current	
Total	240 mA
Per segment	30 mA
Decimal point	30 mA
Reverse Voltage	
Per segment	6.0 volts
Decimal point	3.0 volts

ELECTRO-OPTICAL CHARACTERISTICS

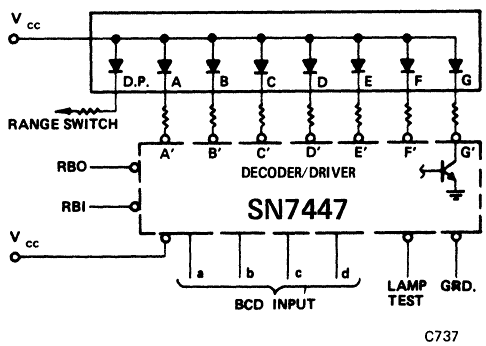
(25°C Ambient Temperature Unless Otherwise Specified)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Brightness (note 1)					
Segment	100	350		ft-L	I_F=20 mA, λ=650 nm
Decimal point	100	350		ft-L	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=20 mA
Decimal point		1.6	2.0	V	I_F=20 mA
Dynamic resistance					
Segment		11		Ω	I_F=20 mA
Decimal point		5.5		Ω	I_F=20 mA
Capacitance					
Segment		80		pF	V=0
Decimal point		135		pF	V=0
Reverse Current					
Segment			100	μA	V_R=6.0 volts
Decimal point			100	μA	V_R=3.0 volts

Decoder/Driver Functional Diagram



Monsanto MAN1, MAN1A



Typical Truth Table

INPUT CODE				OUTPUT STATE							DISPLAY
d	c	b	a	A'	B'	C'	D'	E'	F'	G'	
0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	1	1	0	0	1	1	1	1	1
0	0	1	0	0	0	1	0	0	1	0	2
0	0	1	1	0	0	0	0	1	1	0	3
0	1	0	0	1	0	0	1	1	0	0	4
0	1	0	1	0	1	0	0	1	0	0	5
0	1	1	0	1	1	0	0	0	0	0	6
0	1	1	1	0	0	0	1	1	1	1	7
1	0	0	0	0	0	0	0	0	0	0	8
1	0	0	1	0	0	0	1	1	0	0	9

Typical Curves

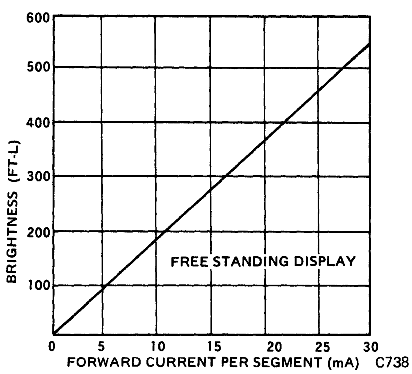


Figure 1 Brightness vs. Forward Current

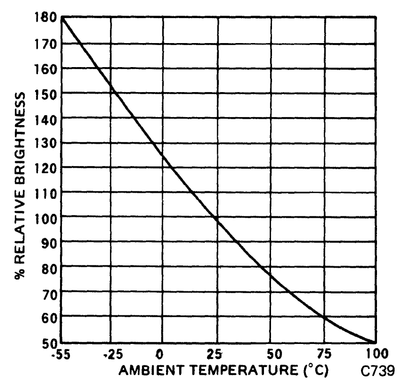


Figure 2 Brightness vs. Temperature

Typical Thermal Characteristics

Thermal Resistance (note 4) Junction to free air Θ_{JA} . . . . .440°C/W
Wavelength Temperature Coefficient (case temp) . . . . 0.3 nm/°C
Forward Voltage Temperature Coefficient . . . . - 4.0 mV/°C

Notes

1. *As measured with a Photo Research Corp. Spot Brightness Meter with "SPECTAR" L175 lens in the brightest region of the emitting surface. Brightness cannot 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.*

Monsanto

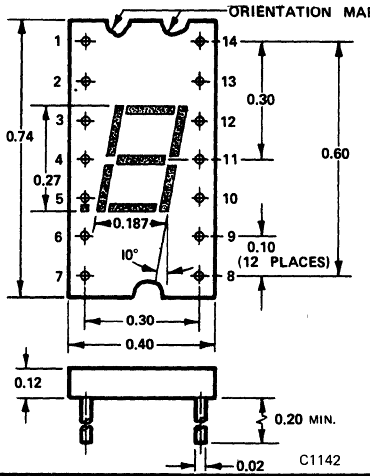
.27" ALPHA-NUMERIC DISPLAY

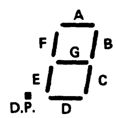
MAN10 MAN10A

PRODUCT DESCRIPTION

The MAN10 is a seven segment diffused planar GaAsP light emitting diode array. It is mounted on a dual in-line 14 pin substrate and then encapsulated in clear epoxy for protection. It is capable of displaying all digits and nine distinct letters. The MAN-10A has identical specifications but is encapsulated in high contrast red epoxy.

PACKAGE DIMENSIONS





PIN 1 CATHODE A
PIN 2 CATHODE F
PIN 3 ANODE-COMMON
PIN 4 NO PIN
PIN 5 NO PIN
PIN 6 DECIMAL POINT CATHODE
PIN 7 CATHODE E
PIN 8 CATHODE D
PIN 9 ANODE-COMMON
PIN 10 CATHODE C
PIN 11 CATHODE G
PIN 12 NO PIN
PIN 13 CATHODE B
PIN 14 ANODE-COMMON
PIN 15
JUMPER PINS 3,9, and 14 ON CIRCUIT BOARD

FEATURES

- High brightness . . . Typically 350 ft-L @ 10 mA
- 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 high ambient applications
- Usable in vibrating environment, impervious to vibration

The MAN10 is for industrial and military applications such as:

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

ABSOLUTE MAXIMUM RATINGS

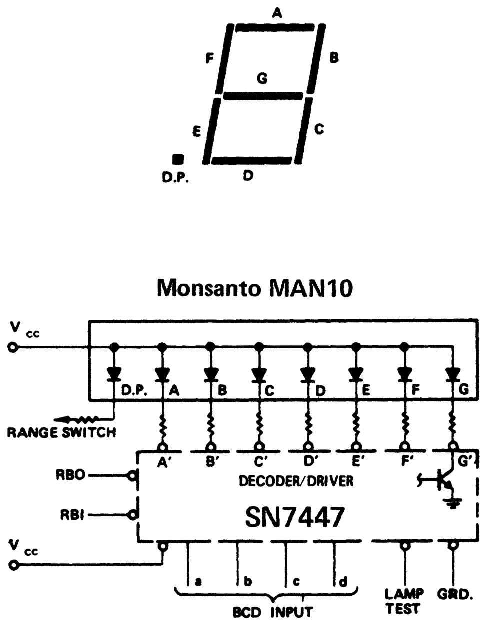
Power dissipation @ 25°C ambient	750 mW
Derate linearly from 25°C	10 mW/°C
Storage and operating temp	-55°C to 100°C
Continuous forward current	
Total	240 mA
Per segment	30 mA
Decimal point	30 mA
Reverse Voltage	
Per segment	6.0 volts
Decimal point	3.0 volts

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Ambient Temperature Unless Otherwise Specified)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Brightness (note 1)					
Segment	100	350		ft-L	I_F=10 mA, λ=660 nm
Decimal point	100	350		ft-L	I_F=10 mA, λ=660 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
Decimal point		1.6	2.0	V	I_F = 10 mA
Dynamic resistance					
Segment		11		Ω	I_F=20 mA
Decimal point		5.5		Ω	I_F=20 mA
Capacitance					
Segment		80		pF	V=0
Decimal point		135		pF	V=0
Reverse Current					
Segment			100	μA	V_R=6.0 volts
Decimal point			100	μA	V_R=3.0 volts

DECODER/DRIVER FUNCTIONAL DIAGRAM

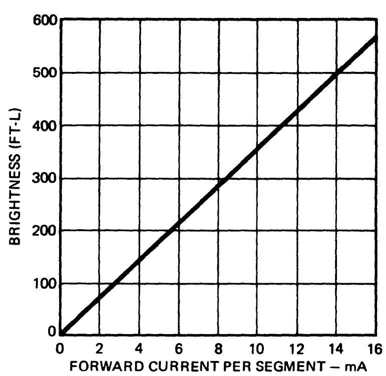


C1143

TYPICAL TRUTH TABLE

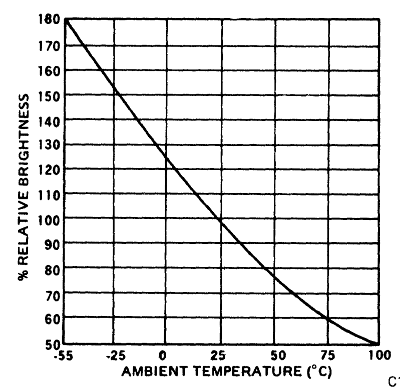
INPUT CODE				OUTPUT STATE							DISPLA
d	c	b	a	A'	B'	C'	D'	E'	F'	G'	
0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	1	1	0	0	1	1	1	1	1
0	0	1	0	0	0	1	0	0	1	0	2
0	0	1	1	0	0	0	0	1	1	0	3
0	1	0	0	1	0	0	1	1	0	0	4
0	1	0	1	0	1	0	0	1	0	0	5
0	1	1	0	1	1	0	0	0	0	0	6
0	1	1	1	0	0	0	1	1	1	1	7
1	0	0	0	0	0	0	0	0	0	0	8
1	0	0	1	0	0	0	1	1	0	0	9

TYPICAL CURVES



C1144

Figure 1 Brightness vs. Forward Current



C1145

Figure 2 Brightness 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. Spot Brightness Meter with "SPECTAR" L175 lens in the brightest region of the emitting surface. Brightness cannot 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.*

Monsanto

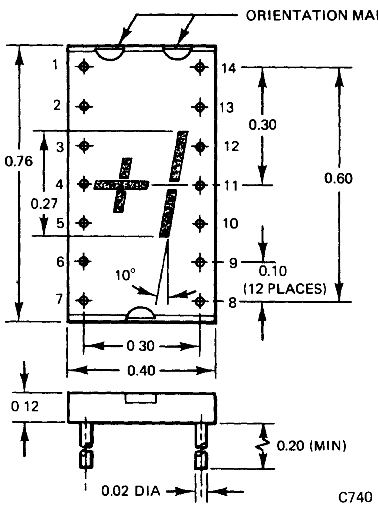
.27" RED POLARITY & OVERFLOW DISPLAY

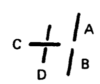
MAN1001 MAN1001A

PRODUCT DESCRIPTION

The MAN1001 is a four segment, diffused planar GaAsP LED array. It is mounted on a dual-in-line 14 pin substrate and then encapsulated in clear epoxy for protection. It provides polarity and overflow display capability. The MAN1001A has identical specifications but is encapsulated in red epoxy.

PACKAGE DIMENSIONS





PIN 1	ANODE COMMON CD
PIN 2	NC
PIN 3	NC
PIN 4	NC
PIN 5	NC
PIN 6	NC
PIN 7	CATHODE D
PIN 8	CATHODE C
PIN 9	NC
PIN 10	CATHODE B
PIN 11	CATHODE A
PIN 12	NC
PIN 13	NC
PIN 14	ANODE COMMON AB

C740

ALL DIMENSIONS NOMINAL IN INCHES

DUAL, IN-LINE CONFIGURATION

FEATURES & APPLICATIONS

- High brightness - typically 350 ft-L @ 20 mA
- 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
- Directly compatible with integrated circuits
- Usable for wide viewing angle requirements
- Usable in vibrating environment, impervious to vibration

It is ideal for industrial and military applications such as:

- Digital readout displays
- Cockpit readout displays

ABSOLUTE MAXIMUM RATINGS

Power dissipation @ 25°C . . . . 480 mW
Derate linearly from 25°C . . . . 6.4 mW/°C
Storage and operating temperature . . . . -55°C to 100°C
Continuous forward current
  Total . . . . 120 mA
  Per segment . . . . 30 mA
Reverse voltage
  Per segment . . . . 6,0 volts

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Ambient Temperature Unless Otherwise Specified)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Brightness (note 1) segment	100	350		ft-L	I_F=20 mA, λ= 655 nm
Peak emission wave length	630		700	nm	
Spectral line half width		20		nm	
Forward voltage segment		3.4	4.0	V	I_F=20 mA
Dynamic resistance		11		Ω	I_F=20 mA
Capacitance segment		80		pF	V=0
Reverse current segment			100	μA	V_R=6.0 V

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance (note 4) junction to free air Θ_{JA} . . . . 440°C/W
Wavelength temperature coefficient (case temperature) . . . . 0.3 nm/°C
Forward voltage temperature coefficient . . . . - 4.0 mV/°C

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

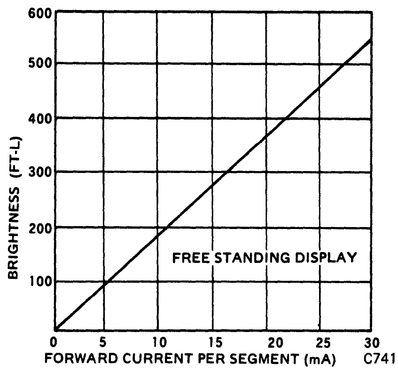


Figure 1 Brightness vs. Forward Current

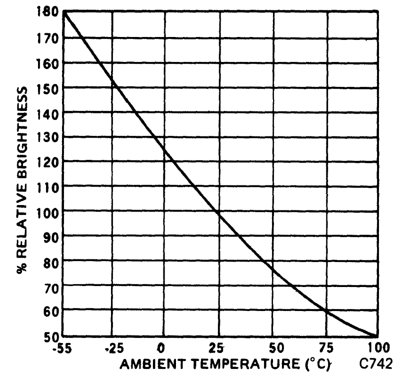
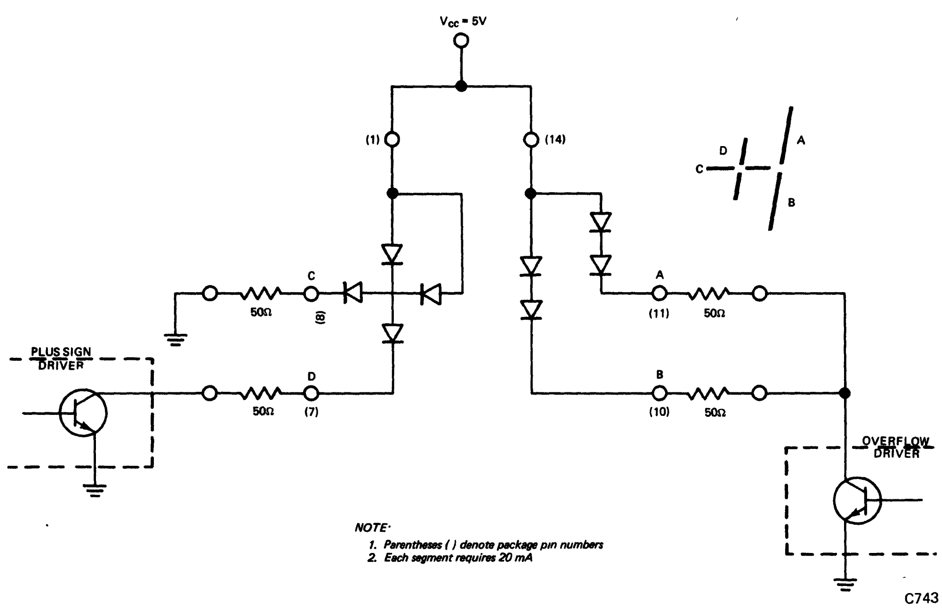


Figure 2 Brightness vs. Temperature

DRIVING CIRCUITRY FOR THE MAN1001, MAN1001A



NOTES

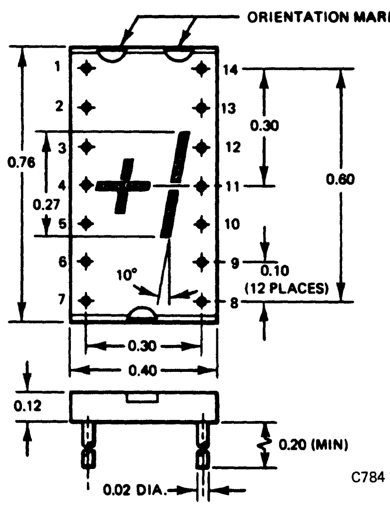
1. *As measured with a Photo Research Corp. Spot Brightness Meter with "SPECTAR" L175 lens in the brightest region of the emitting surface. Brightness cannot vary more than ±50% between all segments.*
2. *The curve in Figure 2 is normalized to the brightness at 25°C to indicate the relative efficiency over the operating temperature range.*
3. *For contrast improvement Polaroid HRCO7 circular polarizer filter can be used. Non-glare circular polarizer filter will provide further enhancement is display visibility.*
4. *Thermal resistance (junction to ambient) value of any one segment with all segments in operation.*

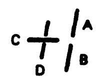
Monsanto .27" RED POLARITY AND OVERFLOW DISPLAY — MAN101 MAN101A

PRODUCT DESCRIPTION

The MAN101 is a diffused planar GaAsP light emitting diode array. It is mounted on a dual in-line 14 pin substrate and then encapsulated in clear epoxy for protection. It is designed to present polarity and overflow information when used with the MAN10 seven segment display. The MAN101A has identical specifications but is encapsulated in high contrast red epoxy.

PACKAGE DIMENSIONS





PIN 1	ANODE COMMON CD
PIN 2	NC
PIN 3	NC
PIN 4	NC
PIN 5	NC
PIN 6	NC
PIN 7	CATHODE D
PIN 8	CATHODE C
PIN 9	NC
PIN 10	CATHODE B
PIN 11	CATHODE A
PIN 12	NC
PIN 13	NC
PIN 14	ANODE COMMON AB

ALL DIMENSIONS NOMINAL IN INCHES

DUAL, IN-LINE CONFIGURATION

FEATURES

- High brightness . . . Typically 350 ft-L @ 10 mA
- 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

The MAN101 is for industrial and military applications such as:

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

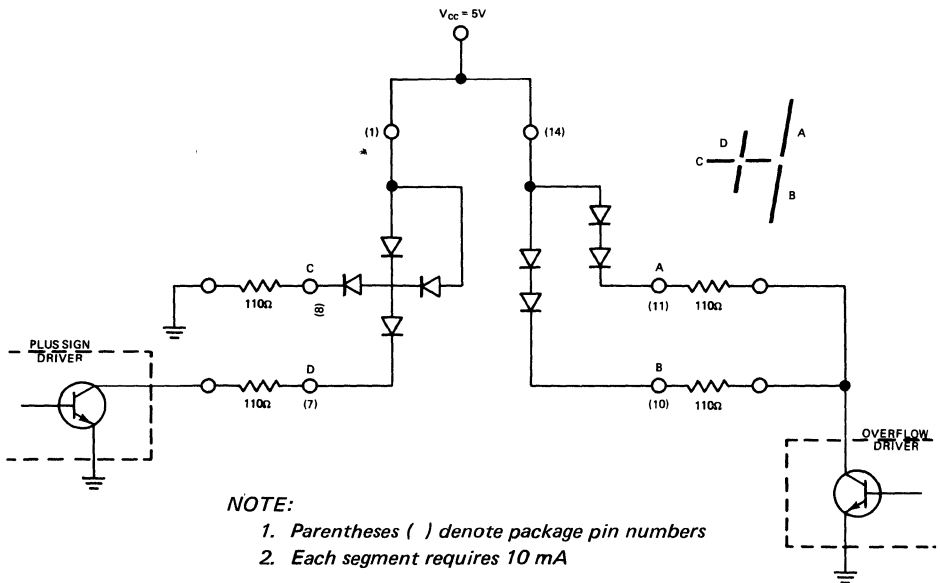
ABSOLUTE MAXIMUM RATINGS

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 . . . . 6.0 volts

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

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Brightness (note 1)					
Segment	100	350		ft-L	I_F = 10 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
Dynamic resistance					
Segment		11		Ω	I_F = 20 mA
Capacitance					
Segment		80		pF	V = 0
Reverse Current					
Segment			100	μA	V_R = 6.0 volts

DRIVING CIRCUITRY FOR THE MAN101, MAN101A



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

TYPICAL CURVES

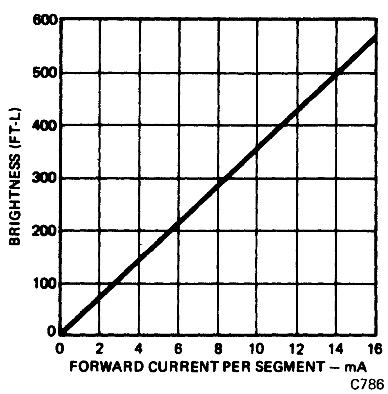


Figure 1 Brightness vs. Forward Current

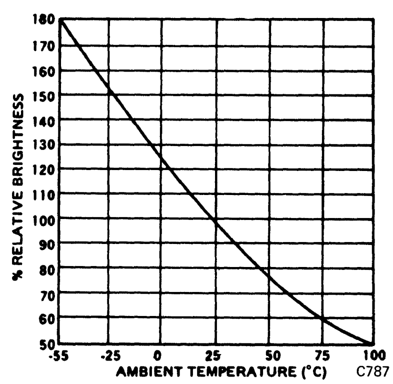


Figure 2 Brightness vs. Temperature

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. Spot Brightness Meter with "SPECTAR" L175 lens in the brightest region of the emitting surface. Brightness cannot 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.*

Monsanto

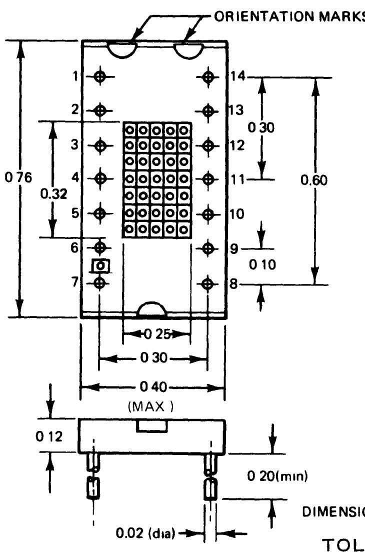
.32" RED ALPHA-NUMERIC DISPLAY

MAN2A

'RODUCT 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 64 character ASCII code.

'ACKAGE 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 C416

TOLERANCE ±.015"

FEATURES & APPLICATIONS

- Visible, bright red, high contrast display
- 36 light emitting diodes including decimal point
- Capable of displaying 64 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

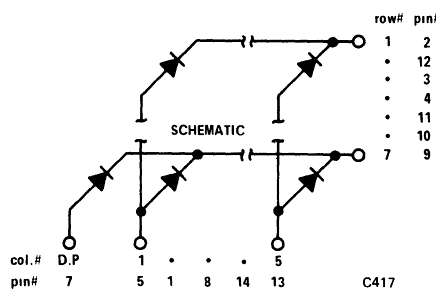
ABSOLUTE MAXIMUM RATINGS

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



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)	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

TYPICAL CURVES

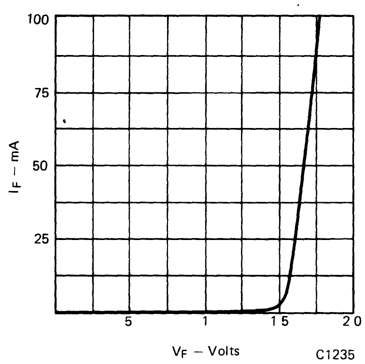


Fig. 1. Forward Current vs. Forward Voltage each LED

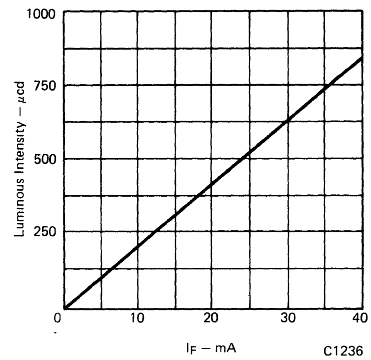


Fig. 2. Light Intensity vs. Forward Current each LED

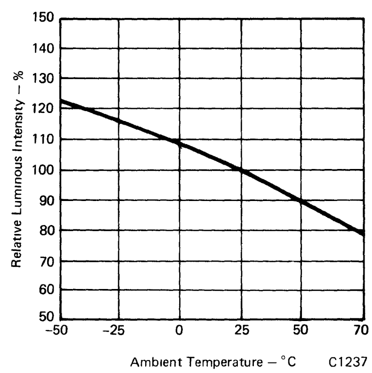


Fig. 3. Relative Luminous Intensity vs. Ambient Temperature

NOTES

1. *The characteristic average luminous intensity is obtained by summing the luminous intensity of each diode and dividing by 35. The standard of measurement is the Photo Research Spectra Microcandela Meter corrected for wavelength error. 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.*

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

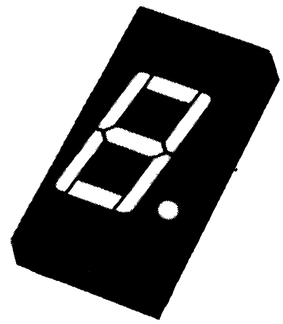
Monsanto

0.400-INCH ORANGE SEVEN SEGMENT DISPLAY

MAN4600A SERIES

FEATURES

- 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 operating life
- Impact resistant plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Standard 14 pin dual in-line package configuration
- Wide angle viewing . . . 150°
- Package size and lead configuration is the same as MAN 50A, 70A, 80A and MAN3600A



DESCRIPTION

The MAN4600A Series is available with common anode right 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.

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN-OUT SPECIFICATION
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	C	C

RECOMMENDED FILTERS

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

Panelgraphic Scarlet 65
Homalite 100-1670

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

		MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
MAN4610A/4630A/4640A	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 MAN4630A	250			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

ABSOLUTE MAXIMUM RATINGS

	MAN4610A/4640A	MAN4630A
Power dissipation @ 25°C ambient	400 mW	250 mW
Derate linearly from 25°C	–6.7 mW/°C	–4.2 mW/°C
Storage and operating temperature	–40°C to 85°C	–40°C to 85°C
Continuous forward current		
Total	160 mA	100 mA
Per segment	20 mA	20 mA
Decimal point	20 mA	20 mA
Reverse voltage		
Per segment	3.0 V	3.0 V
Decimal point	3.0 V	3.0 V
Solder time @ 260°C (Note 4)	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

TYPICAL CURVES

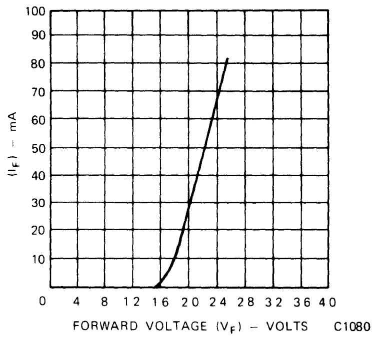


Fig. 1. Forward Current vs. Forward Voltage

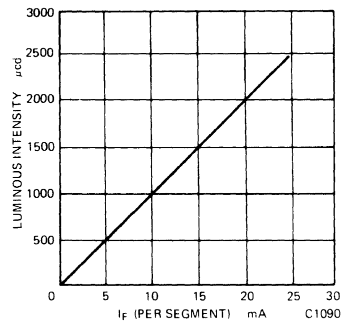


Fig. 2. Luminous Intensity vs. Forward Current

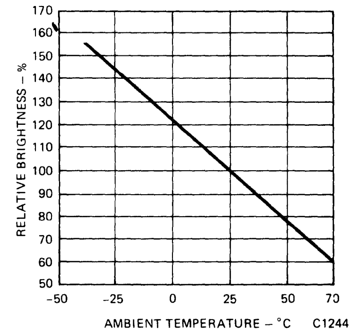


Fig. 3. Luminous Intensity vs. Temperature

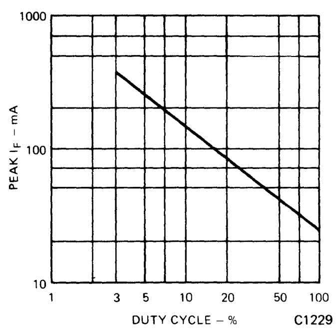


Fig. 4. Max Peak Current vs. Duty Cycle

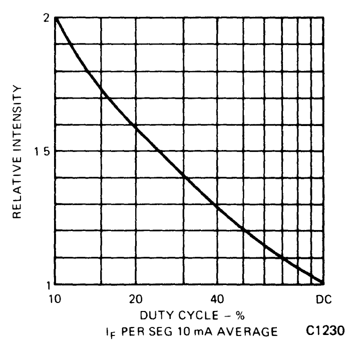
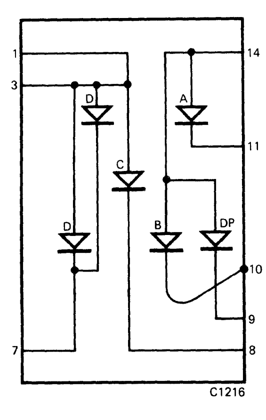


Fig. 5. Luminous Intensity vs. Duty Cycle

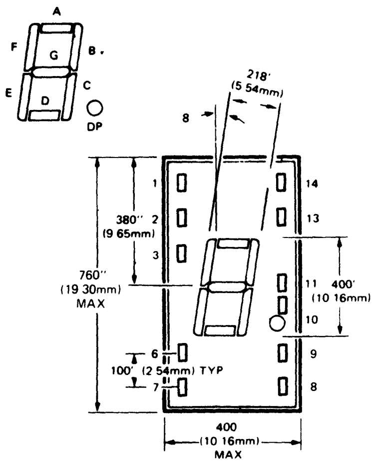
NOTES:

1. *The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing the total number of segments. The standard of measurement is the Photo Research Spectra Microcandela Meter corrected for wave length. 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.*

ELECTRICAL SCHEMATIC—MAN4630

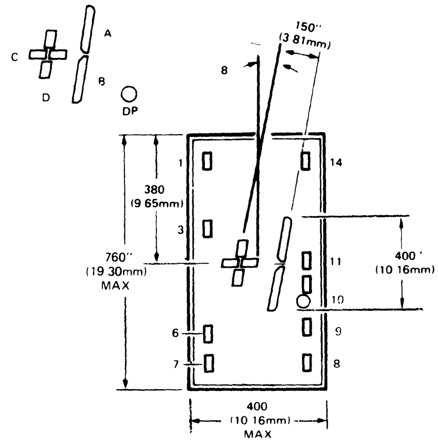


PACKAGE DIMENSIONS



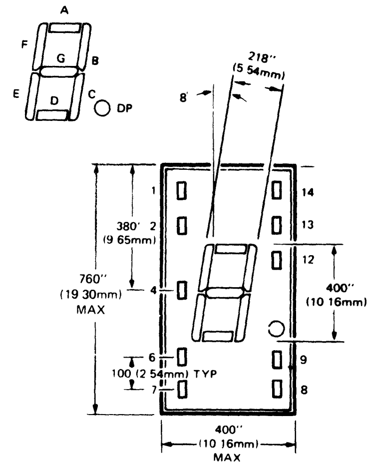
C1091

A



C1092

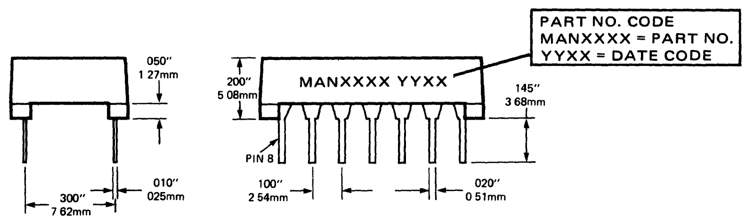
B



C1094

C

TOLERANCE: .015" (.381mm)



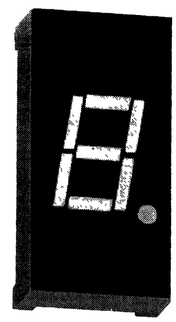
LEADS ARE TIN/LEAD SOLDER DIPPED

PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS		
	A MAN4610A	B MAN4630A	C MAN4640A
1	Cathode A	Anode C, D	Anode F
2	Cathode F	No Pin	Anode G
3	Common Anode	Anode C, D	No Pin
4	No Pin	No Pin	Common Cathode
5	No Pin	No Pin	No Pin
6	NC	NC	Anode E
7	Cathode E	Cathode D	Anode D
8	Cathode D	Cathode C	Anode C
9	Cathode DP	Cathode DP	Anode DP
10	Cathode C	Cathode B	No Pin
11	Cathode G	Cathode A	No Pin
12	No Pin	No Pin	Common Cathode
13	Cathode B	No Pin	Anode B
14	Common Anode	Anode A, B, & DP	Anode A

Monsanto

GREEN ORANGE RED YELLOW 0.300-INCH SEVEN SEGMENT DISPLAY MAN50A MAN3600A MAN70A MAN80A



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
- Standard 14 pin dual in-line package configuration
- Wide angle viewing . . . 150°

For industrial and consumer applications such as:
- Digital readout displays
- Instrument panels
- Point of sale equipment
- Calculators
- Digital clocks

DESCRIPTION

The MAN50A, MAN3600A, MAN70A and MAN80A 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.

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION
MAN51A	Green	Common Anode; Right Hand Decimal
MAN52A	Green	Common Anode; Left Hand Decimal
MAN53A	Green	Common Anode; Overflow ±1
MAN54A	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
MAN81A	Yellow	Common Anode; Right Hand Decimal
MAN82A	Yellow	Common Anode; Left Hand Decimal
MAN83A	Yellow	Common Anode; Overflow ±1
MAN84A	Yellow	Common Cathode; Right Hand Decimal

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

		MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
MAN51A, 52A, 53A, 54A	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 MAN53A	60			µcd	$I_F = 10$ mA
	Peak emission wavelength		565		nm	
	Spectral line half width		40		nm	
	Forward voltage					
	Segment			3.5	V	$I_F = 20$ mA
	Decimal point			3.5	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	$V_R = 3.0$ V
	Decimal point			100	µA	$V_R = 3.0$ 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	$V_R = 3.0$ V
	Decimal point			100	µA	$V_R = 3.0$ 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		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
MAN81A, 82A, 83A, 84A	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			3.5	V	$I_F = 20$ mA
	Decimal point			3.5	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 CURVES

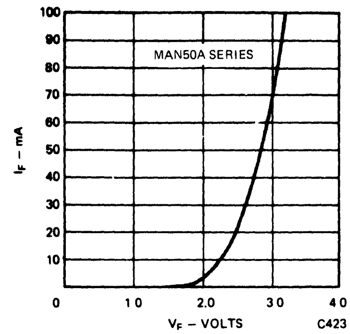


Fig. 1. Forward Current vs. Forward Voltage

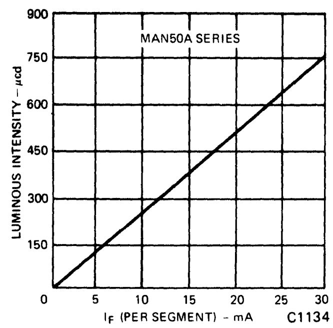


Fig. 2. Luminous Intensity vs. Forward Current

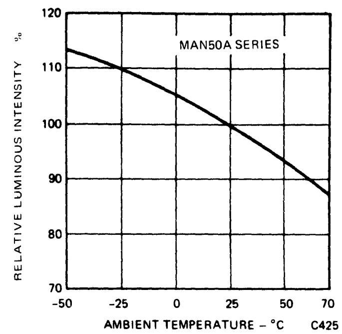


Fig. 3. Luminous Intensity vs. Temperature

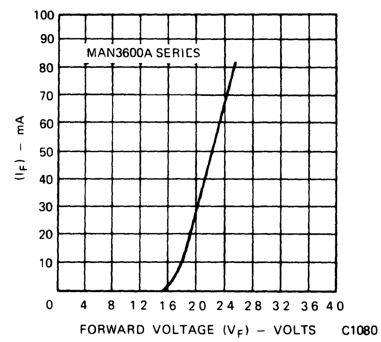


Fig. 4. Forward Current vs. Forward Voltage

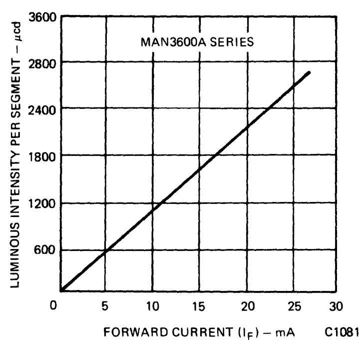


Fig. 5. Luminous Intensity vs. Forward Current

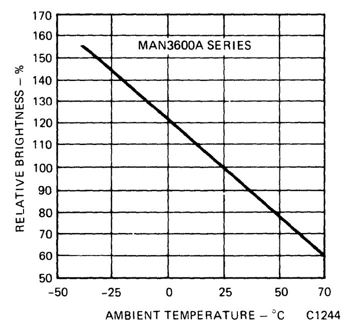


Fig. 6. Luminous Intensity vs. Temperature

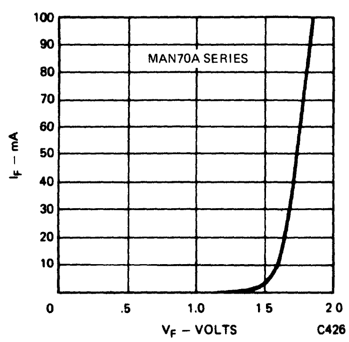


Fig. 7. Forward Current vs. Forward Voltage

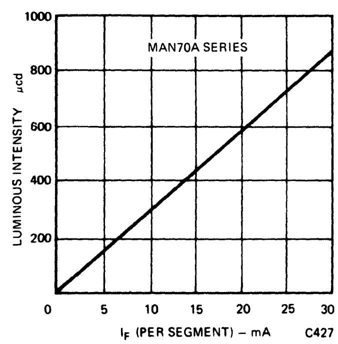


Fig. 8. Luminous Intensity vs. Forward Current

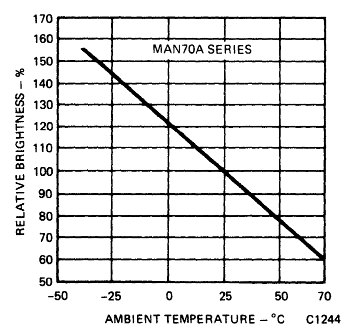


Fig. 9. Luminous Intensity vs. Temperature

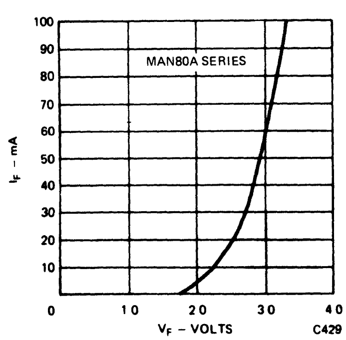


Fig. 10. Forward Current vs. Forward Voltage

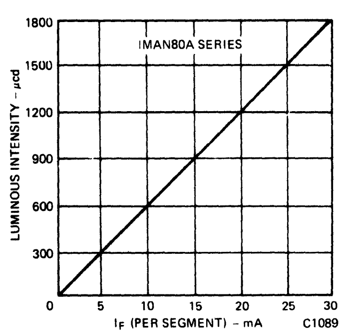


Fig. 11. Luminous Intensity vs. Forward Current

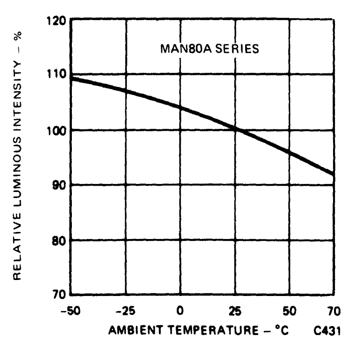


Fig. 12. Luminous Intensity vs. Temperature

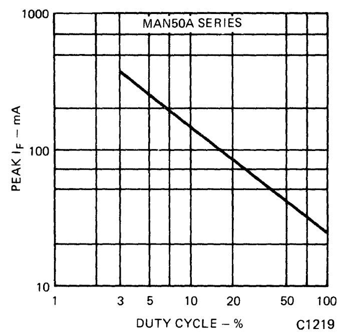


Fig. 13. Max Peak Current vs. Duty Cycle

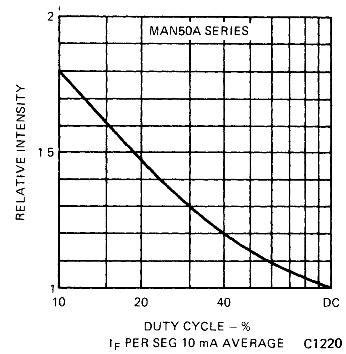


Fig. 14. Luminous Intensity vs. Duty Cycle

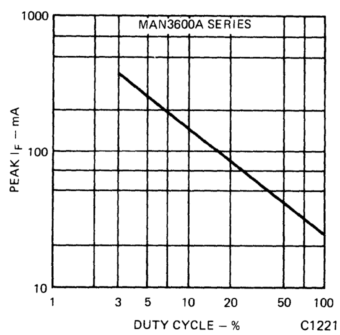


Fig. 15. Max Peak Current vs. Duty Cycle

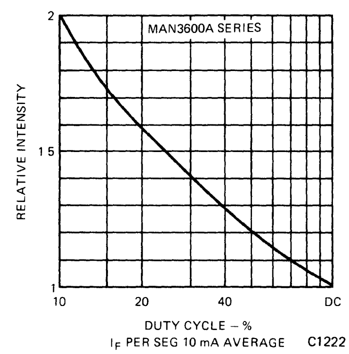


Fig. 16. Luminous Intensity vs. Duty Cycle

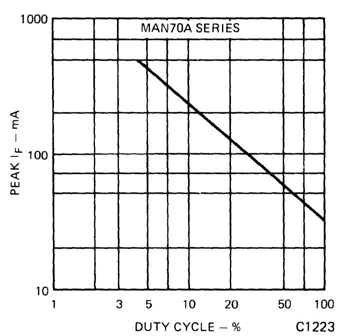


Fig. 17. Max Peak Current vs. Duty Cycle

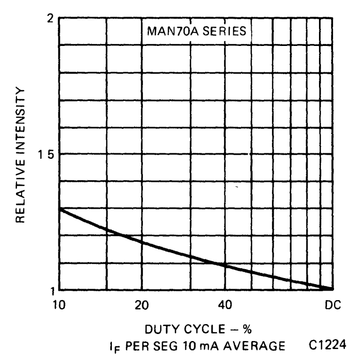


Fig. 18. Luminous Intensity vs. Duty Cycle

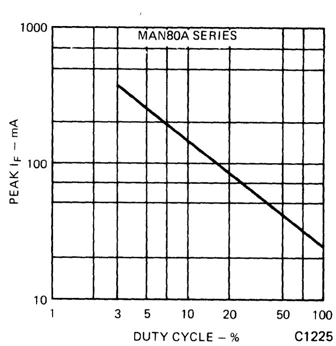


Fig. 19. Max Peak Current vs. Duty Cycle

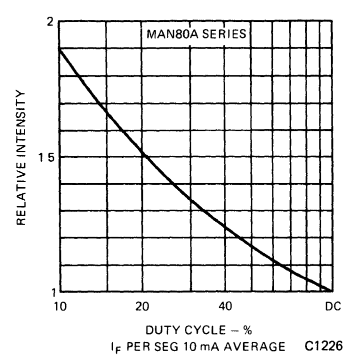
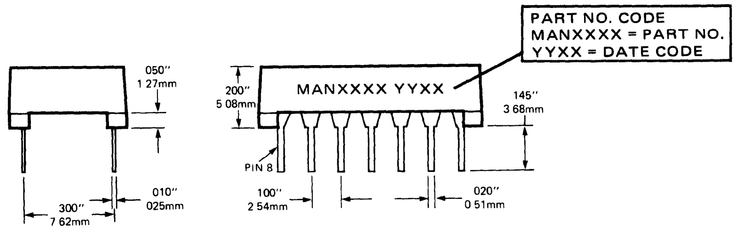
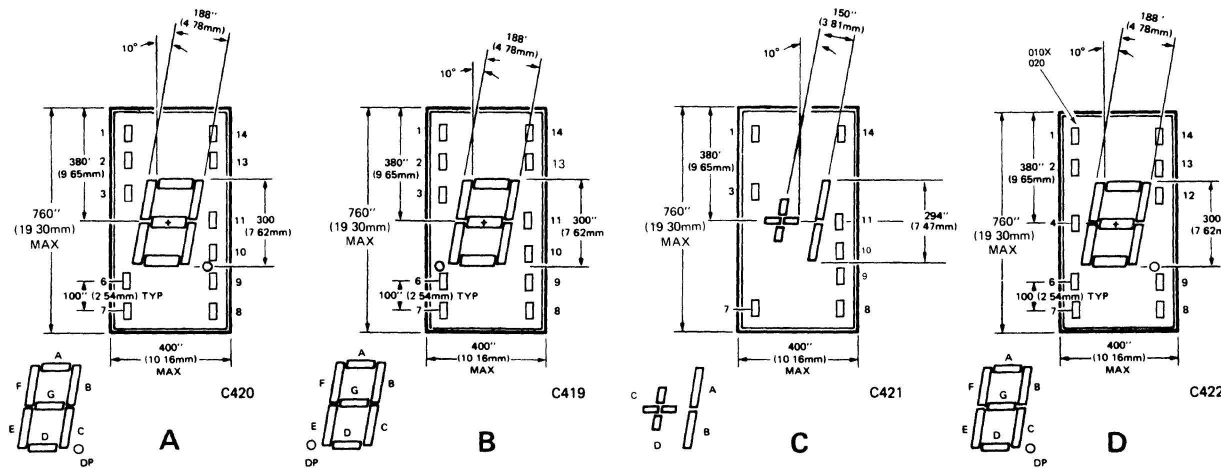


Fig. 20. Luminous Intensity vs. Duty Cycle

MAN50A MAN3600A MAN70A MAN80A SERIES

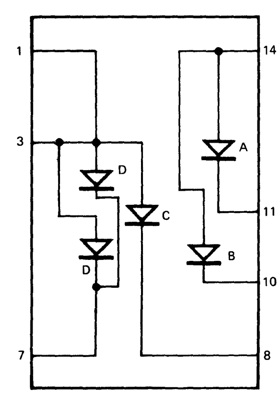




PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS			
	A	B	C	D
	MAN51A, 3610A, 71A, 81A	MAN52A, 72A, 3620A, 82A	MAN53A, 3630A, 73A, 83A	MAN54A, 3640A, 74A, 84A
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



MAN53A, 3630A, 73A, 83A

MAN50A MAN3600A MAN70A MAN80A SERIES

ABSOLUTE MAXIMUM RATINGS

	MAN51A, 52A, 54A, 3610A, 3620A, 3640A, 81A, 82A, 84A	MAN53A, 3630A, 83A	MAN71A, 72A, 74A	MAN73A
Power dissipation @ 25°C ambient	400 mW	250 mW	700 mW	350 mW
Derate linearly from 25°C	-6.7 mW/°C	-4.2 mW/°C	-11.7 mW/°C	-5.8 mW/°C
Storage and operating temperature	-40°C to 85°C	-40°C to 85°C	-40°C to 85°C	-40°C to 85°C
Continuous forward current				
Total	160 mA	100 mA	240 mA	150 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	3.0 V	3.0 V	5.0 V	5.0 V
Decimal point	3.0 V	3.0 V	5.0 V	5.0 V
Solder time @ 260°C (Note 4)	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
MAN51A, MAN52A, MAN53A, MAN54A	Panelgraphic Green 48
MAN3610A, MAN3620A, MAN3630A, MAN3640A	Panelgraphic Scarlet 65 Homalite 100-1670
MAN71A, MAN72A, MAN73A, MAN74A	Panelgraphic Red 60 Homalite 100-1605
MAN81A, MAN82A, MAN83A, MAN84A	Panelgraphic Yellow 25 or Amber 23 Homalite 100-1720 or 100-1726·

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. 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.*
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.*

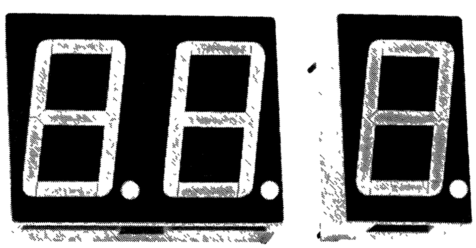
Monsanto

0.560-INCH ORANGE HIGH PERFORMANCE DISPLAY

MAN6600 SERIES

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.



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
- Wide angle viewing . . . 150°
- Low forward voltage
- Two-digit package simplifies alignment & assembly

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point-of-sale equipment
- Digital clocks
- TV and radios

MODEL NUMBERS

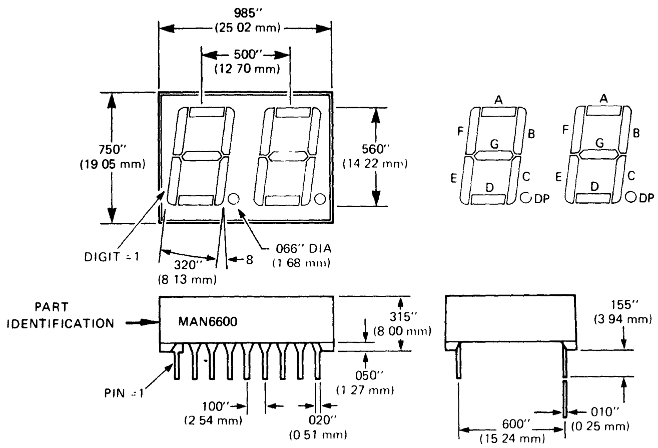
PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN-OUT SPECIFICATION
MAN6610	Orange	2 Digit; Common Anode; Rt. Hand Decimal	A	A
MAN6630	Orange	1½ Digit; Common Anode; Overflow ±1.8. Rt. Hand Decimal	B	B
MAN6640	Orange	2 Digit; Common Cathode; Rt. Hand Decimal	A	C
MAN6650	Orange	1½ Digit; Common Cathode; 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

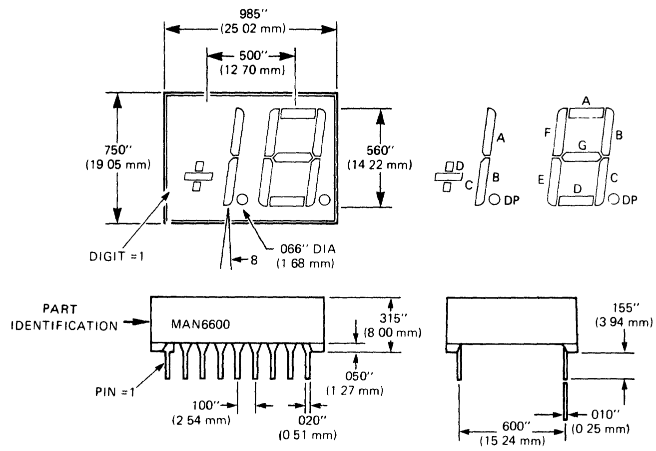
For optimum on and off contrast, one of the following filters or equivalents should be used over the display:

MAN6600 Series	Panelgraphic Scarlet 65 Homalite 100-1670

PACKAGE DIMENSIONS



A



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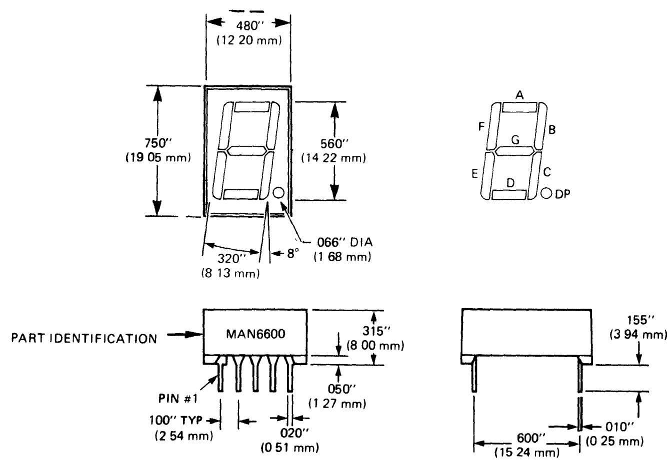


C

TOLERANCE
±.015"

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		

ABSOLUTE MAXIMUM RATINGS

	MAN6610/6640	MAN6630/6650	MAN6660/6680
Power dissipation @ 25°C ambient	800 mW	650 mW	400 mW
Derate linearly from 25°C	−13 mW/°C	−11 mW/°C	−6.7 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	320 mA	260 mA	160 mA
Per segment	20 mA	20 mA	20 mA
Decimal point	20 mA	20 mA	20 mA
Reverse voltage			
Per segment	3.0 V	3.0 V	3.0 V
Decimal point	3.0 V	3.0 V	3.0 V
Solder time @ 260°C (see Note 3 & 4)	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 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.*
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.*

TYPICAL CURVES

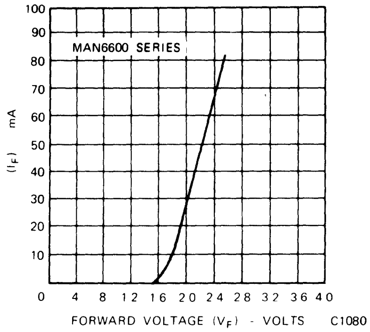


Fig. 1. Forward Current vs. Forward Voltage

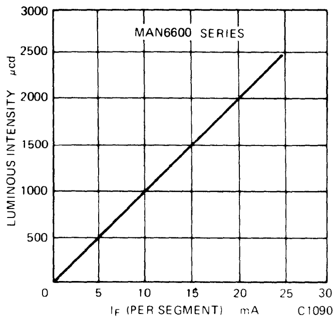


Fig. 2. Luminous Intensity vs. Forward Current

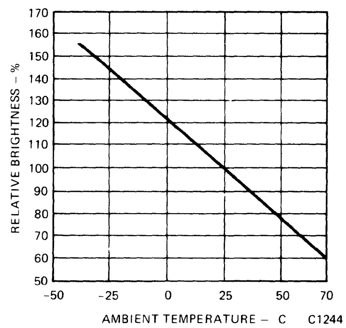


Fig. 3. Luminous Intensity vs. Temperature (see Note 2)

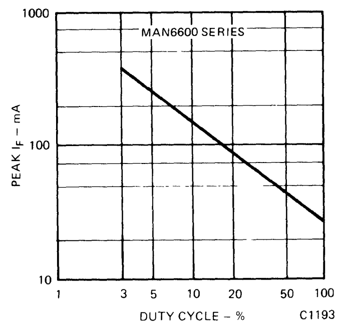


Fig. 4. Max Peak Current vs. Duty Cycle

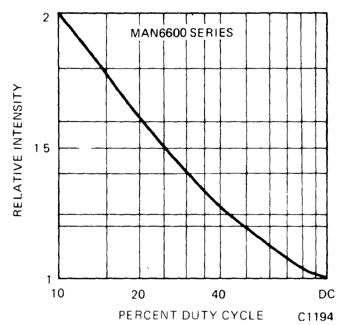
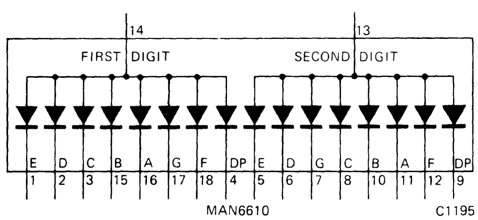
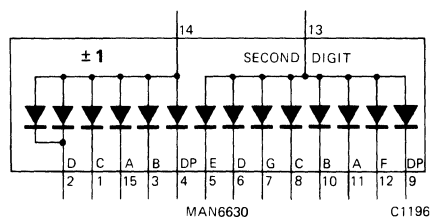
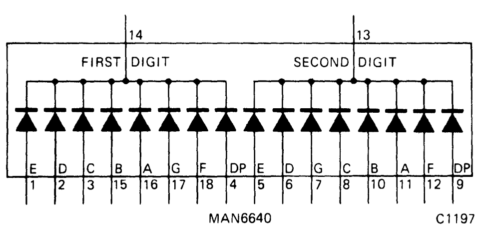


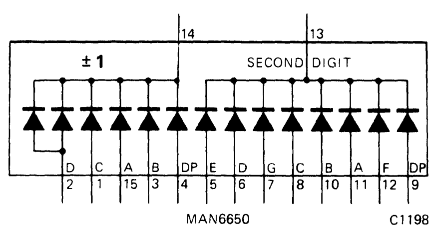
Fig. 5. Luminous Intensity vs. Duty Cycle

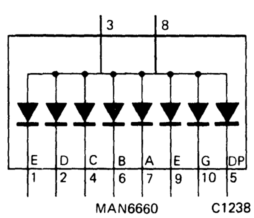
INTERNAL CONNECTIONS

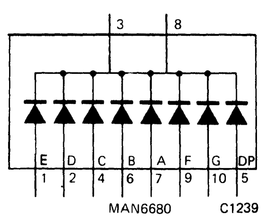












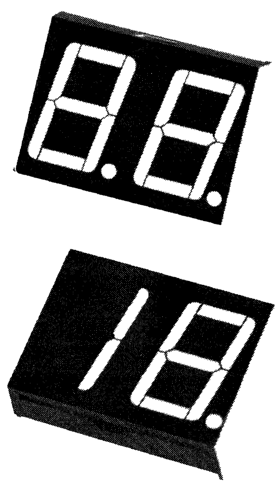
Monsanto

0.560-INCH RED HIGH PERFORMANCE DISPLAY

MAN6700 SERIES

DESCRIPTION

The MAN6700 Series is a family of large digits which can be mounted on 0.5-inch centers. The series features the sculptured font which minimizes "gappiness" at the segment intersections. The models available are two-digit, with right-hand decimal points and one and one-half digit, with polarity sign and right-hand decimal points. Both models are available in a common anode or common cathode configuration.



FEATURES

- High performance GaAsP
- Large, easy to read, digits
- Common anode or common cathode models
- Also available in orange
- 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
- Wide angle viewing . . . 150°
- Standard double-dip lead configuration
- Low forward voltage
- Two-digit package simplifies alignment & assembly

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point-of-sale equipment
- Digital clocks
- TV and radios

MODEL NUMBERS

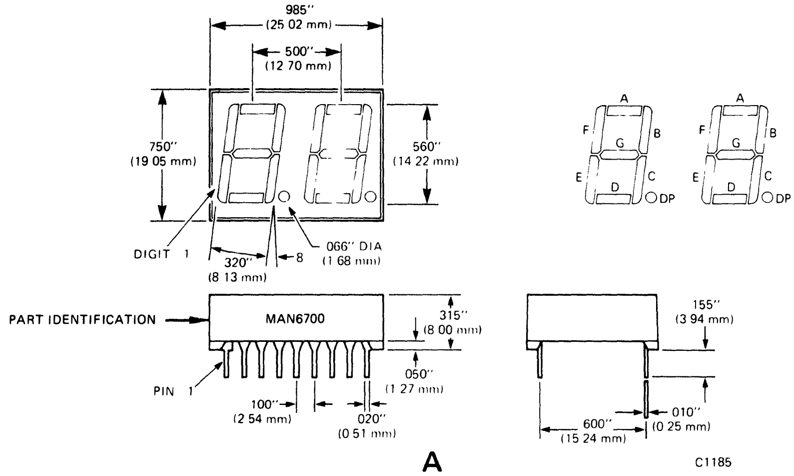
PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN-OUT SPECIFICATION
MAN6710	Red	2 Digit; Common Anode; Rt. Hand Decimal	A	A
MAN6730	Red	1½ Digit; Common Anode; Overflow ±1.8. Rt. Hand Decimal	B	B
MAN6740	Red	2 Digit; Common Cathode; Rt. Hand Decimal	A	C
MAN6750	Red	1½ Digit; Common Cathode; Overflow ±1.8. Rt. Hand Decimal	B	D

FILTER RECOMMENDATIONS

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

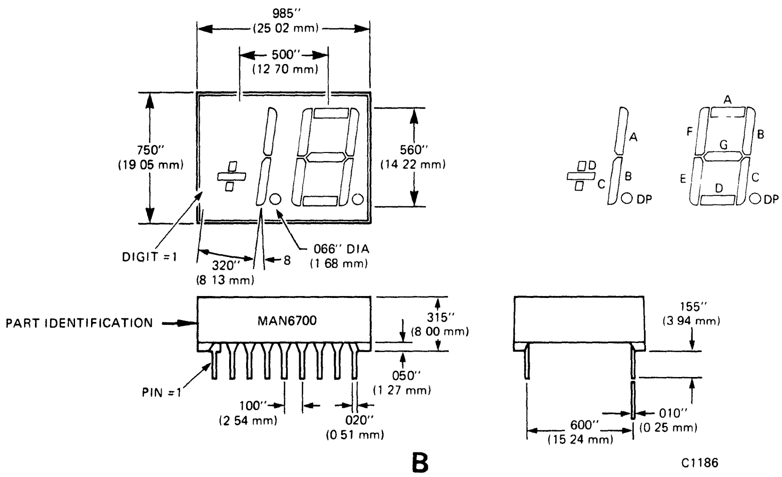
MAN6700 Series	Panelgraphic Red 60 Homalite 100 - 1605

PACKAGE DIMENSIONS



A

TOLERANCE
±.015"



B

PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS			
	A MAN6710	**B MAN6730**	**C MAN6740**	**D MAN6750**
1	E cathode (No. 1)	C cathode (No. 1)	E anode (No. 1)	C anode (No. 1)
2	D cathode (No. 1)	D cathode (No. 1)	D anode (No. 1)	D anode (No. 1)
3	C cathode (No. 1)	B cathode (No. 1)	C anode (No. 1)	B anode (No. 1)
4	DP cathode (No. 1)	DP cathode (No. 1)	DP anode (No. 1)	DP anode (No. 1)
5	E cathode (No. 2)	E cathode (No. 2)	E anode (No. 2)	E anode (No. 2)
6	D cathode (No. 2)	D cathode (No. 2)	D anode (No. 2)	D anode (No. 2)
7	G cathode (No. 2)	G cathode (No. 2)	G anode (No. 2)	G anode (No. 2)
8	C cathode (No. 2)	C cathode (No. 2)	C anode (No. 2)	C anode (No. 2)
9	DP cathode (No. 2)	DP cathode (No. 2)	DP anode (No. 2)	DP anode (No. 2)
10	B cathode (No. 2)	B cathode (No. 2)	B anode (No. 2)	B anode (No. 2)
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

ABSOLUTE MAXIMUM RATINGS

	MAN6710/6740	MAN6730/6750
Power dissipation @ 25°C ambient	800 mW	650 mW
Derate linearly from 25°C	−13 mW/°C	−10.5 mW/°C
Storage and operating temperature	−40°C to 85°C	−40°C to 85°C
Continuous forward current		
Total	320 mA	260 mA
Per segment	20 mA	20 mA
Decimal point	20 mA	20 mA
Reverse voltage		
Per segment	5.0 V	5.0 V
Decimal point	5.0 V	5.0 V
Solder time @ 260°C (see Note 3 and 4)	5 sec	5 sec

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

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous intensity, Digit Average (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) (Notes)	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. 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.*
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.*

TYPICAL CURVES

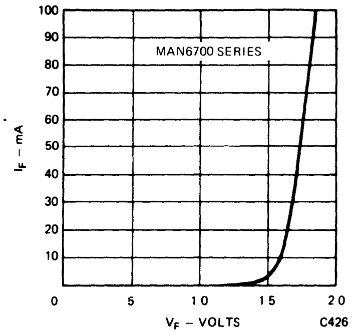


Fig. 1. Forward Current vs. Forward Voltage

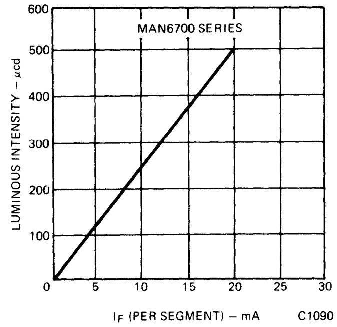


Fig. 2. Luminous Intensity vs. Forward Current

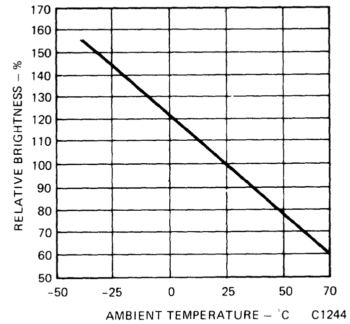


Fig. 3. Luminous Intensity vs. Temperature (See Note 2)

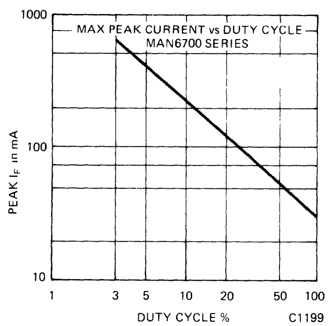


Fig. 4. Max Peak Current vs. Duty Cycle

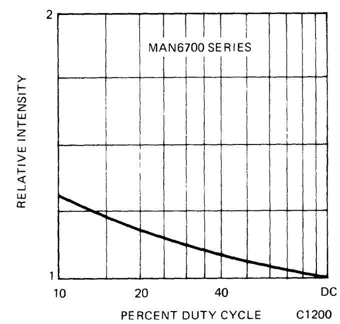
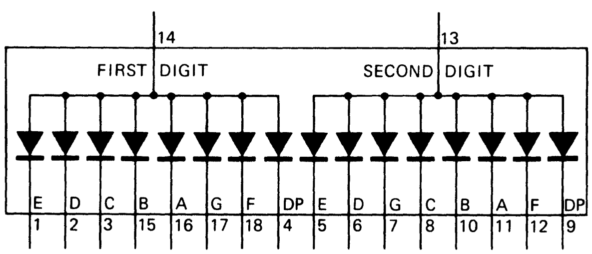
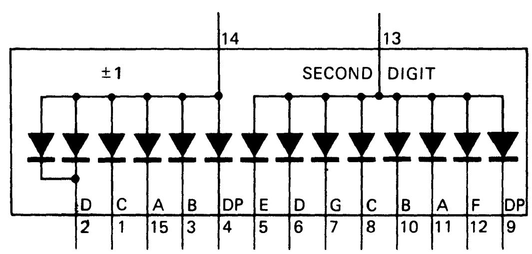


Fig. 5. Luminous Intensity vs. Duty Cycle

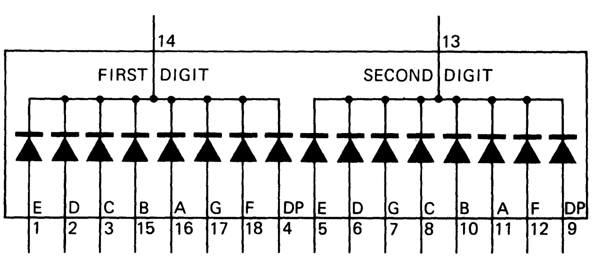
INTERNAL CONNECTIONS



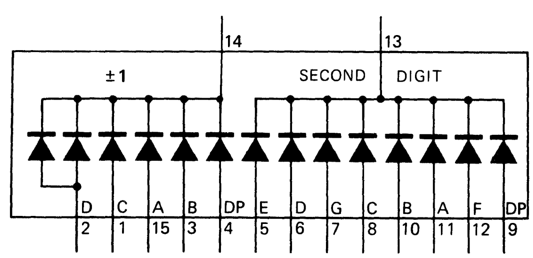
MAN6710 C1195



MAN6730 C1196



MAN6740 C1197



MAN6750 C1198

6 OPTO-ISOLATORS

Optoisolators

QUICK REFERENCE CHART

OUTPUT FORMAT	PRODUCT	PACKAGE KEY	PACKAGE TYPE	MIN. CURRENT TRANSFER RATIO	MIN. DC ISOLATION VOLTAGE	MIN. OUTPUT VOLTAGE RATING (BV_{CEO})	TYPICAL BANDWIDTH $R_L = 100\Omega$
TRANSISTOR	MCT2	A	6 LEAD PLASTIC DIP	20%	1500 V	30 V	150 kHz
TRANSISTOR	MCT2E	A	6 LEAD PLASTIC DIP	20%	2500 V	30 V	150 kHz
TRANSISTOR	MCT210	A	6 LEAD PLASTIC DIP	150%	4000 V	30 V	150 kHz
TRANSISTOR	MCT26	A	6 LEAD PLASTIC DIP	6%	1500 V	30 V	150 kHz
TRANSISTOR	MCT4	C	TO-46 METAL CAN	15%	1000 V	30 V	150 kHz
TRANSISTOR	MCT4R*	C	TO-46 METAL CAN	15%	1000 V	30 V	150 kHz
TRANSISTOR	MCT6	B	8 LEAD PLASTIC DIP DUAL CHANNEL	20%	1500 V	30 V	150 kHz
TRANSISTOR	MCT66	B	8 LEAD PLASTIC DIP DUAL CHANNEL	6%	1500 V	30 V	150 kHz
TRANSISTOR	4N25	F	6 LEAD PLASTIC DIP	20%	2500 V	30 V	300 kHz
TRANSISTOR	4N26	F	6 LEAD PLASTIC DIP	20%	1500 V	30 V	300 kHz
TRANSISTOR	4N27	F	6 LEAD PLASTIC DIP	10%	1500 V	30 V	300 kHz
TRANSISTOR	4N28	F	6 LEAD PLASTIC DIP	10%	500 V	30 V	300 kHz
TRANSISTOR	4N35	F	6 LEAD PLASTIC DIP	100%	3550 V	30 V	150 kHz
TRANSISTOR	4N36	F	6 LEAD PLASTIC DIP	100%	2500 V	30 V	150 kHz
TRANSISTOR	4N37	F	6 LEAD PLASTIC DIP	100%	1500 V	30 V	150 kHz
DARLINGTON TRANS.	MCA230	A	6 LEAD PLASTIC DIP	100%	1500 V	30 V	10 kHz
DARLINGTON TRANS.	MCA231	A	6 LEAD PLASTIC DIP	200%	1500 V	30 V	10 kHz
DARLINGTON TRANS.	MCA255	A	6 LEAD PLASTIC DIP	100%	1500 V	55 V	10 kHz
DARLINGTON TRANS.	4N29	F	6 LEAD PLASTIC DIP	100%	2500 V	30 V	30 kHz
DARLINGTON TRANS.	4N30	F	6 LEAD PLASTIC DIP	100%	1500 V	30 V	30 kHz
DARLINGTON TRANS.	4N31	F	6 LEAD PLASTIC DIP	50%	1500 V	30 V	30 kHz
DARLINGTON TRANS.	4N32	F	6 LEAD PLASTIC DIP	500%	2500 V	30 V	30 kHz
DARLINGTON TRANS.	4N33	F	6 LEAD PLASTIC DIP	500%	1500 V	30 V	30 kHz

*Reliability conditioned to MIL-STD-883, Method 5005/B, 100% pre-conditioning.

OUTPUT FORMAT	PRODUCT	PACKAGE KEY	PACKAGE TYPE	DC ISOLATION VOLTAGE	FORWARD BLOCKING VOLTAGE (V_{DRRM})	MAX. TURN-ON CURRENT (I_F)
SCR	MCS2	A	6 LEAD PLASTIC DIP	1500 V	200 V	14.0 mA
SCR	MCS2400	A	6 LEAD PLASTIC DIP	1500 V	400 V	14.0 mA
2 SCR's (CONNECTED ANODE TO CATHODE)	MCS6200	B	8 LEAD PLASTIC DIP	1500 V	200 V	14.0 mA
2 SCR's (CONNECTED ANODE TO CATHODE)	MCS6201	B	8 LEAD PLASTIC DIP	2500 V	200 V	14.0 mA

OUTPUT FORMAT	PRODUCT	PACKAGE KEY	PACKAGE TYPE	MIN. DC ISOLATION VOLTAGE	MIN. BINARY DATA RATE (BDR)	MAX. TRIGGER (I_F)	TYP. HYSTERESIS (ΔI_F)
LOGIC GATE OPEN COLLECTOR	MCL601	B	8 LEAD PLASTIC DIP	2000 V	0.10 MHz	5.0 mA	1.0 mA
LOGIC GATE OPEN COLLECTOR	MCL611	B	8 LEAD PLASTIC DIP	2000 V	1.0 MHz	15.0 mA	5.0 mA

(TOTEM POLE OUTPUT – MCL600 & MCL610 available February, 1977.)

OUTPUT FORMAT	PRODUCT	PACKAGE KEY	PACKAGE TYPE	COLLECTOR CURRENT (I_C)	TYPICAL BANDWIDTH	MAX. DARK CURRENT (I_{CEO})
TRANSISTOR	MCT8	E	SLOTTED LIMIT SWITCH	200 μA @ I_F = 20 mA, V_{CE} = 10 V	150 kHz	100 nA
TRANSISTOR	MCT81	E	SLOTTED LIMIT SWITCH	50 μA @ I_F = 20 mA, V_{CE} = 10 V	200 kHz	100 nA
DARLINGTON	MCA7	D	REFLECTIVE SENSOR SWITCH	50 μA @ I_F = 50 mA, V_{CE} = 5 V	0.8 kHz	100 nA
DARLINGTON	MCA8	E	SLOTTED LIMIT SWITCH	2 mA @ I_F = 16 mA, V_{CE} = 1 V	0.8 kHz	100 nA
DARLINGTON	MCA81	E	SLOTTED LIMIT SWITCH	1.6 mA @ I_F = 50 mA, V_{CE} = 1 V	1.5 kHz	100 nA

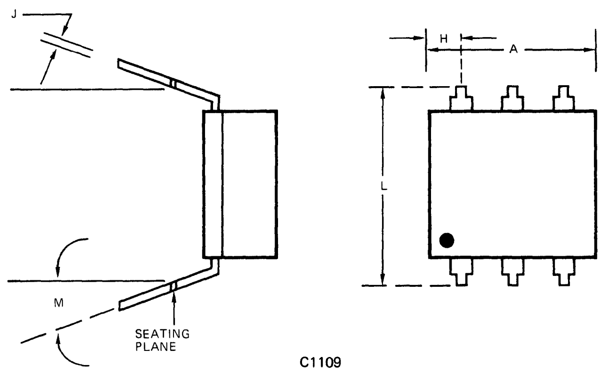
Monsanto

PHOTOTRANSISTOR OPTO-ISOLATORS | 4N25 4N26 4N27 4N28

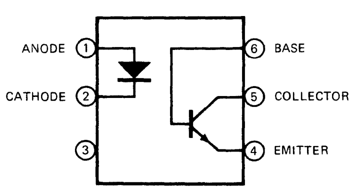
PRODUCT DESCRIPTION

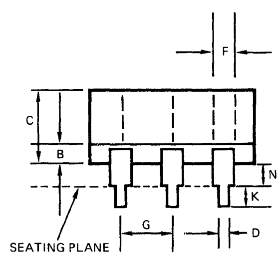
The 4N25, 4N26, 4N27 and 4N28 series of optoisolators have a NPN silicon planar phototransistor optically coupled to a gallium arsenide diode. Each is mounted in a six-lead plastic DIP package.

PACKAGE DIMENSIONS



C1109





C1109

DIM.	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.
A	8.38	8.89	0.330	0.350
B	1.40	1.65	0.055	0.065
C	2.92	3.18	0.115	0.125
D	0.41	0.51	0.016	0.020
F	1.14	1.40	0.045	0.055
G	2.29	2.79	.090	.110
H	1.57	1.83	0.062	0.072
J	0.23	0.28	0.009	0.011
K	2.54	3.30	0.100	0.130
L	7.37	7.87	0.290	0.310
M	—	5°	—	5°
N	—	1.27	—	0.050

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

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
(1 μs pulse, 300 pps) . . . . 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 = 50 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)	V_{ISO}	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 12)

*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. 14)
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. 14)
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)

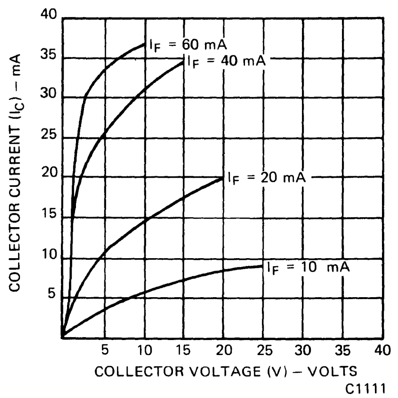


Fig. 1. Collector Current vs. Collector Voltage

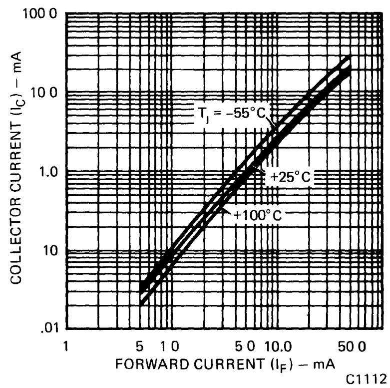


Fig. 2. Collector Current vs. Forward Current

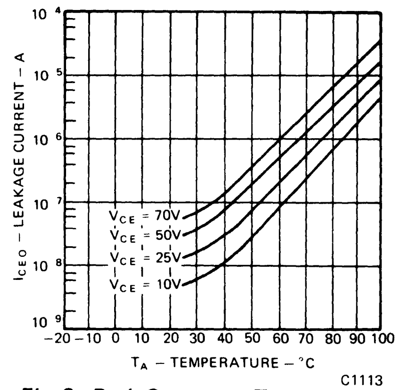


Fig. 3. Dark Current vs. Temperature

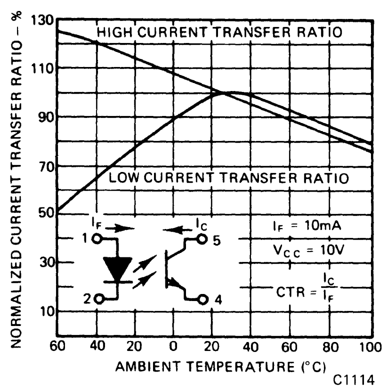


Fig. 4. Current Transfer Ratio vs. Temperature

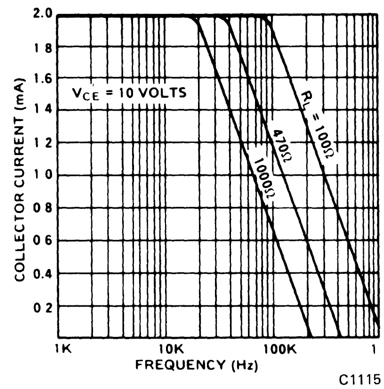


Fig. 5. Collector Current vs. Frequency (see Fig. 12 for circuit)

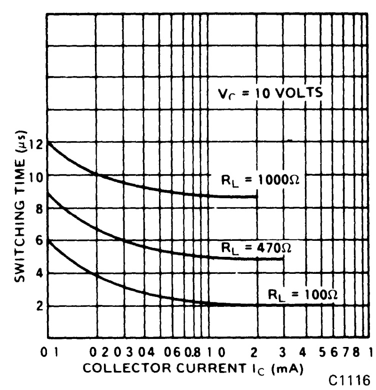
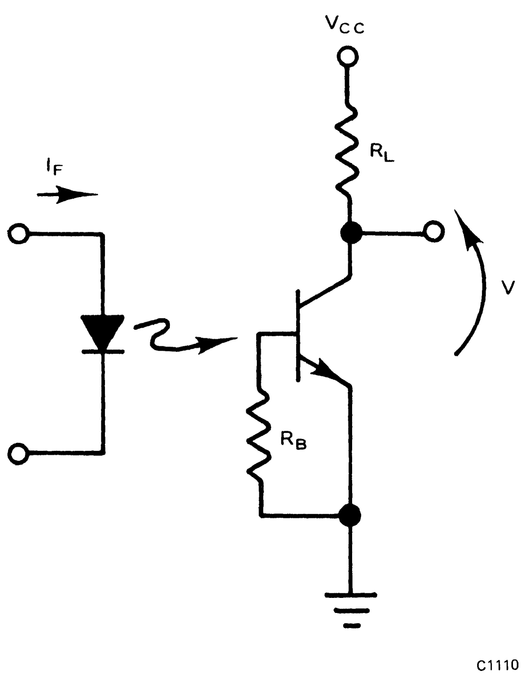


Fig. 6. Switching Time vs. Collector Current (see Fig. 13 for Circuit)



Circuit 1

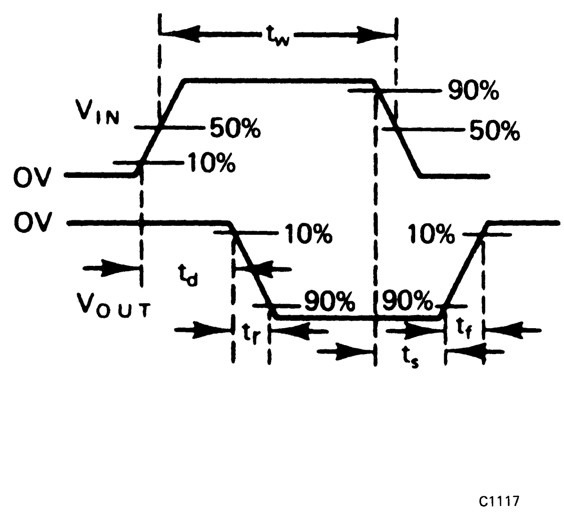


Fig: 7. Pulse Test Definition (Note 3)

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (Cont'd)

(25°C Free Air Temperature Unless Otherwise Specified)

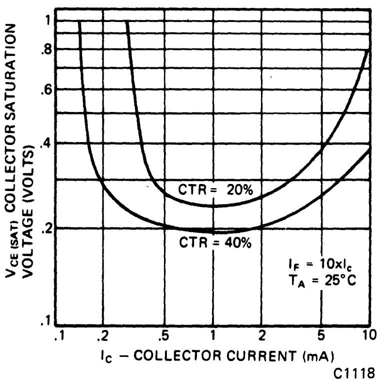


Fig. 8. Saturation Voltage vs. Collector Current

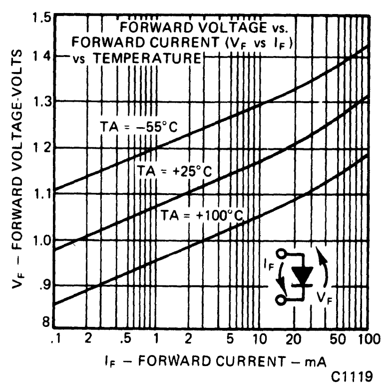


Fig. 9. Forward Voltage vs. Forward Current

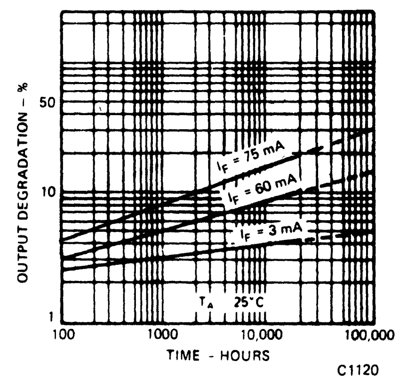


Fig. 10. Lifetime vs. Forward Current

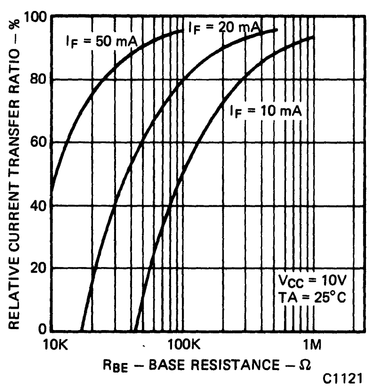


Fig. 10. Sensitivity vs. Base Resistance

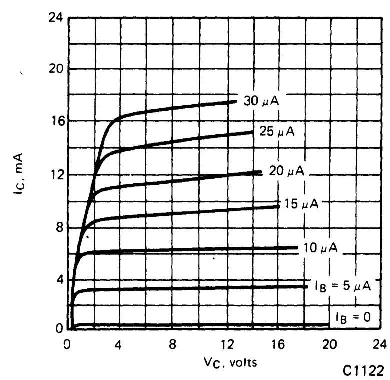


Fig. 11. Detector h_{fe} Curves

OPERATING SCHEMATICS

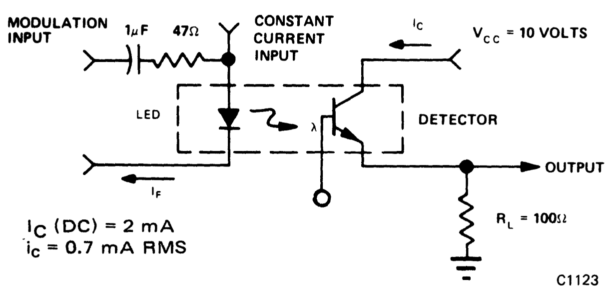


Fig. 12. Modulation Circuit Used to Obtain Output vs. Frequency Plot

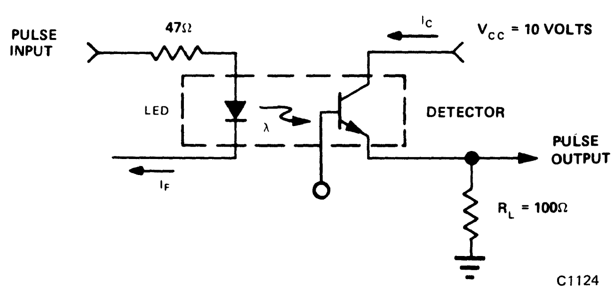


Fig. 13. Circuit Used to Obtain Switching Time vs. Collector Current Plot

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%.*

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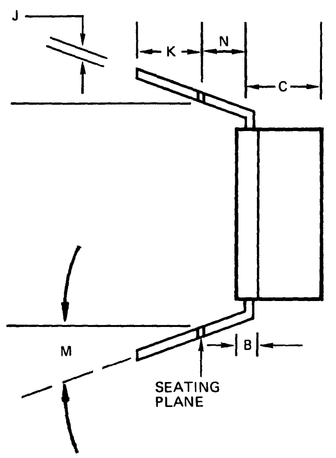
PHOTO-DARLINGTON OPTO-ISOLATOR

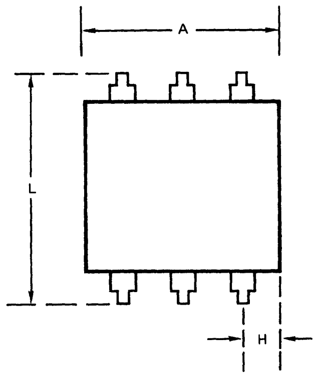
4N29 4N32 4N30 4N33 4N31

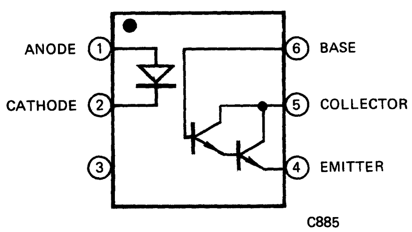
PRODUCT DESCRIPTION

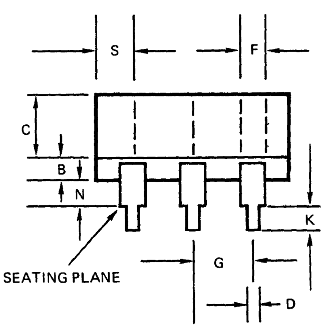
The 4N29, 4N30, 4N31, 4N32 and 4N33 have a gallium arsenide infrared emitter optically coupled to a silicon planar photo-darlington. Each unit is sealed in a 6-lead plastic DIP package.

PACKAGE DIMENSIONS









DIM.	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.
A	8.38	8.89	0.330	0.385
B	1.40	1.65	0.055	0.065
C	2.92	3.18	0.115	0.125
D	0.41	0.51	0.016	0.020
F	1.14	1.40	0.045	0.055
G	2.54 Basic		0.100 Basic	
H	1.57	1.83	0.062	0.072
J	0.23	0.28	0.009	0.011
K	2.54	3.30	0.100	0.130
L	7.37	7.87	0.290	0.310
M	—	5°	—	5°
N	—	1.27	—	0.050

FEATURES & APPLICATIONS

- Fast operate time — 10 μs
- High isolation resistance — $10^{11}\ \Omega$
- High dielectric strength, input to output — 2500 V min. 4N29, 4N32; 1500 V min. 4N30, 4N31, 4N33
- Low coupling capacitance — 1.0 pF
- Convenient package — plastic dual-in-line
- Long lifetime, solid state reliability
- Low weight — 0.4 grams

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 pulse, 330 pps) . . 3.0 A

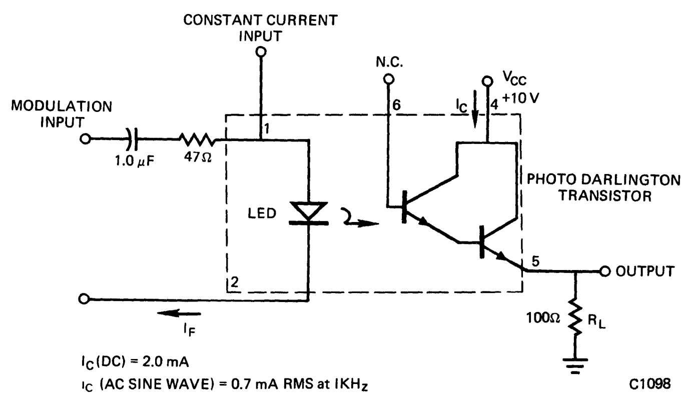
DETECTOR (Silicon Photo Darlington Transistor)
*Power dissipation @ 25°C ambient . . . . 150 mW
*Derate linearly from 25°C . . . . 2.0 mW/°C
*Collector-emitter breakdown voltage (BV_{CEO}) . . . . 30 V
*Collector-base breakdown voltage (BV_{CBO}) . . . . . . 50 V
Emitter-base breakdown voltage (BV_{EBO})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

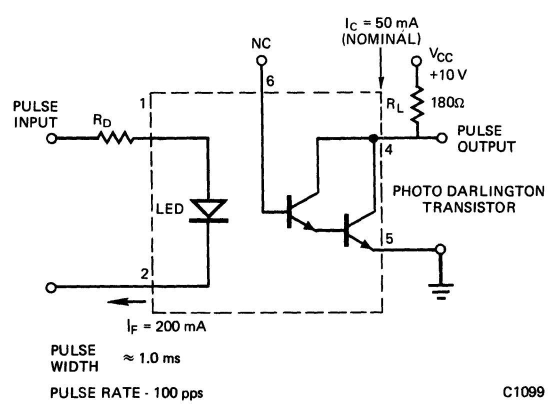
CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION
LED CHARACTERISTICS (T_A = 25°C unless otherwise noted)						
*Reverse leakage current	I_R		0.05	100	μA	V_R = 3.0 V
*Forward voltage	V_F		1.2	1.5	Volts	I_F = 50 mA
Capacitance	C		150		pF	V_R = 0 V, f = 1.0 MHz
PHOTOTRANSISTOR CHARACTERISTICS (T_A = 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 (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 (2)						
4N29, 4N32	V_{ISO}	2500			VDC	
4N30, 4N31, 4N33		1500			VDC	
Isolation Resistance (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 (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 (Note 3)	t_{ON}		0.6	5.0	μs	I_C = 50 mA, I_F = 200 mA, V_{CC} = 10 V
Turn-off time (Note 3)						
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

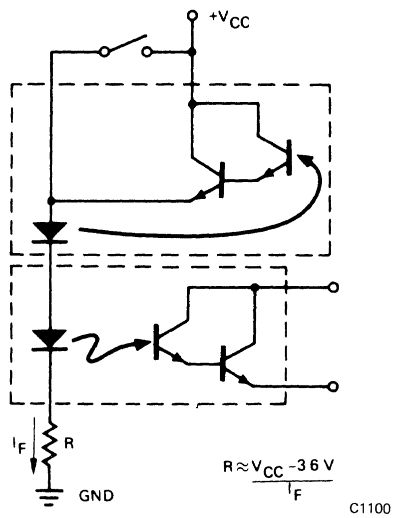
FREQUENCY RESPONSE TEST CIRCUIT #1



SWITCHING TIME TEST CIRCUIT #2

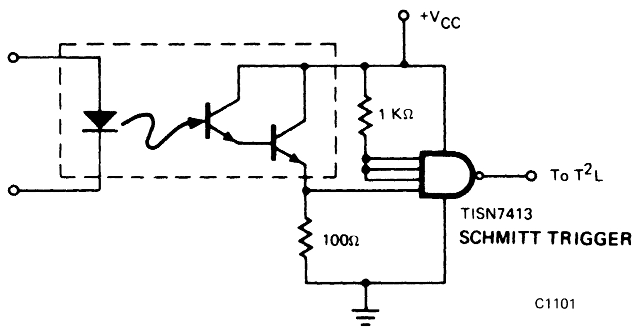
APPLICATION INFORMATION

LATCH

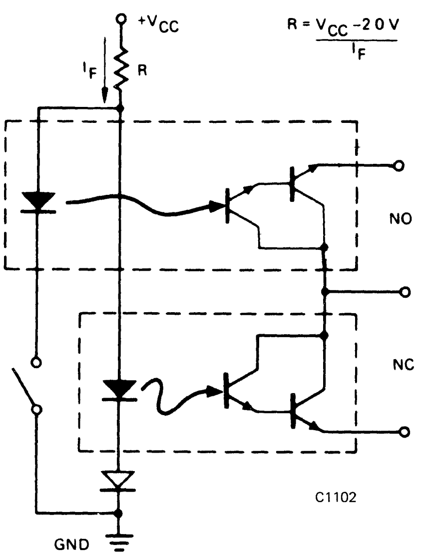


NOT APPLICABLE TO 4N31

T²L LOGIC ISOLATION

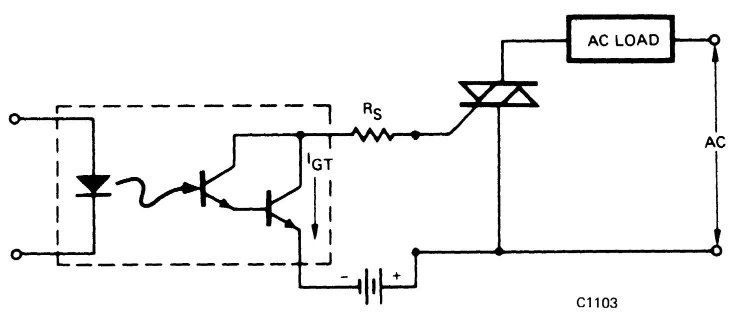


FORM C CONTACT

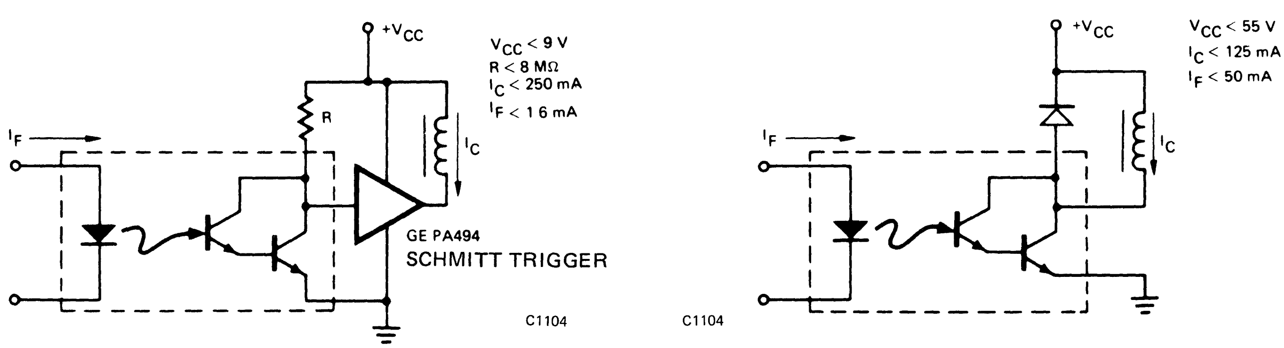


NOT APPLICABLE TO 4N31

TRIAC TRIGGER



OPERATING A RELAY COIL



TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

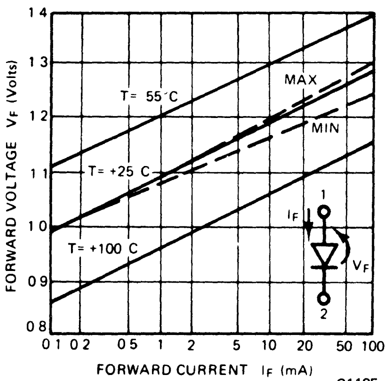


Fig. 1. Forward Voltage Drop vs. Forward Current

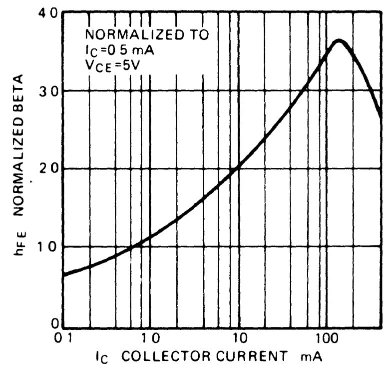


Fig. 2. Normalized Beta vs. Collector Current

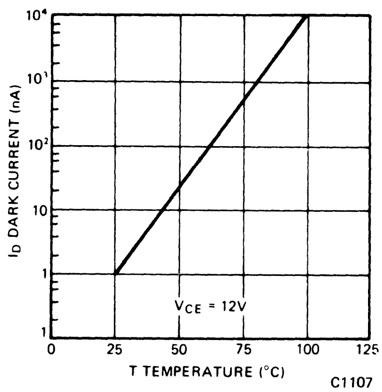


Fig. 3. Dark Current vs. Temperature

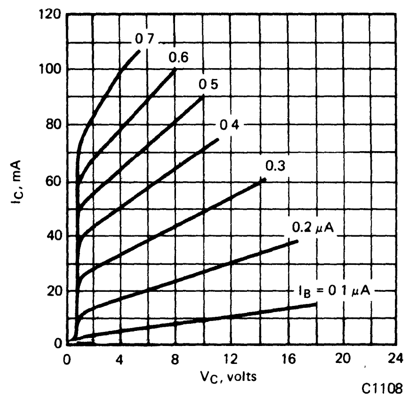


Fig. 4. Detector Standard Transfer Curves

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.*

Monsanto

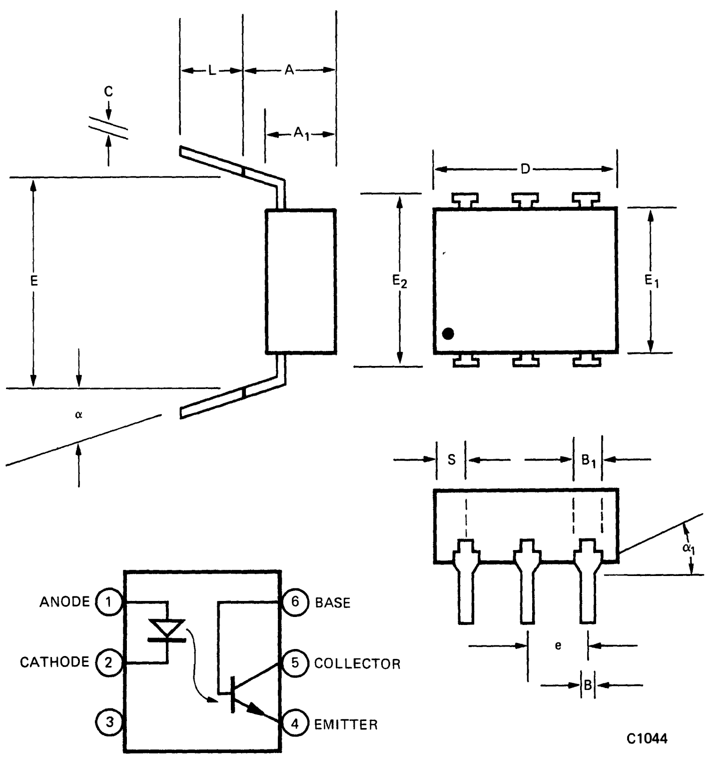
PHOTOTRANSISTOR OPTO-ISOLATORS

4N35 4N36 4N37

PRODUCT DESCRIPTION

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

PACKAGE DIMENSIONS



NOTES
1 INSTALLED POSITION OF LEAD CENTERS.
2 OVERALL INSTALLED DIMENSIONS
3. BASED ON A 035" DIA MOUNTING HOLE
4 APPLIES TO LEADS PRIOR TO INSTALLATION

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
- Industrial controls
- Covered under UL component recognition program, reference File No. E50151
- High DC current transfer ratio
- High isolation voltage

SYMBOL	INCH MIN.	INCH MAX.	MILLIMETER MIN.	MILLIMETER MAX.	NOTES
A		.160		4.06	3
A_1	.020		.51		
B	.015	.021	.381	.533	
B_1	.050	.070	1.27	1.77	
C	.008	.015	.204	.381	
D	.330	.385	8.39	.977	
E	.290	.310	7.37	7.87	1
E_1	.260	.280	6.61	7.11	
E_2		.325		8.25	2
e	.090	.110	2.29	2.79	
L	.100		2.54		
S	.065	.090	1.66	2.28	
α	0°	15°	0°	15°	4
$α_1$	45° ref		45° ref		

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.	−2σ	TYP.	+2σ	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}	100	125	250	430			V_{CE} = 5 V, I_C = 100 μA
*Collector to emitter breakdown voltage	BV_{CEO}	30	50	65	90		V	I_C = 10 mA, I_F = 0
*Collector to base breakdown voltage	BV_{CBO}	70	140	165	200		V	I_C = 100 μA
*Emitter to collector breakdown voltage	BV_{ECO}	7	13	14	15		V	I_C = 100 μA, I_F = 0
Collector to emitter, leakage current	I_{CEO}		0.1	5	50	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	C_{CEO}			8			pF	V_{CE} = 0
Capacitance collector to base	C_{CBO}			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
*Input to output isolation current (pulse width = 8 msec) (see Note 1)	I_{I-O}							
Input to output voltage = 3550 V (peak)		4N35				100	μA	
Input to output voltage = 2500 V (peak)		4N36				100	μA	
Input to output voltage = 1500 V (peak)		4N37				100	μA	
*Input to output resistance	R_{I-O}	100					gigaohms	Input to output voltage = 500 V (see Note 1)
*Input to output capacitance	C_{I-O}					2.5	picofarads	Input to output voltage = 0 V, f = 1 MHz (see Note 1)
*Turn on time—t_{on}	t_{ON}			5		10	μsec	V_{CC} = 10 V, I_C = 2 mA, R_L = 100Ω, (see Fig. 15)
*Turn off time—t_{off}	t_{OFF}			5		10	μsec	V_{CC} = 10 V, I_C = 2 mA, R_L = 100Ω, (see Fig. 15)

*Indicates JEDEC registered values

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

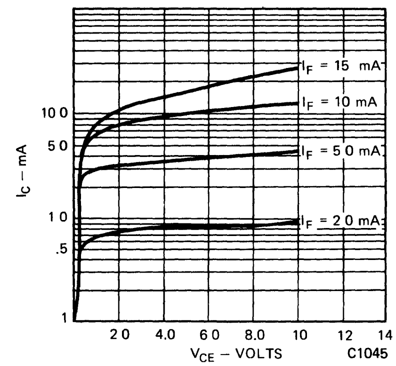


Fig. 1. Collector Current vs. Collector Voltage

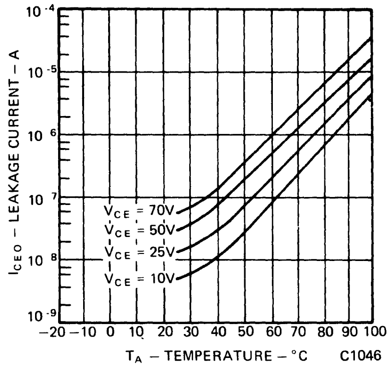


Fig. 2. Dark Current vs. Temperature

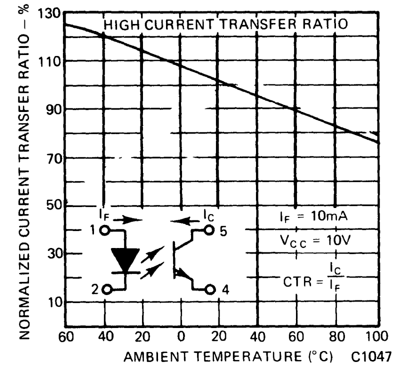


Fig. 3. Current Transfer Ratio vs. Temperature

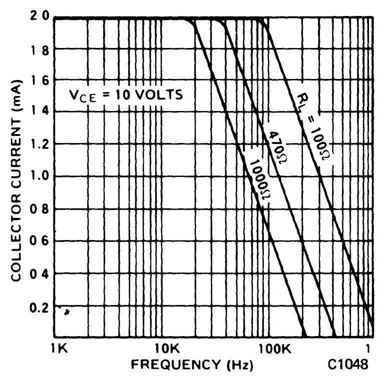


Fig. 4. Collector Current vs. Frequency

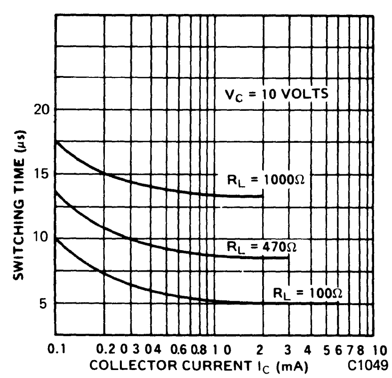


Fig. 5. Switching Time vs. Collector Current

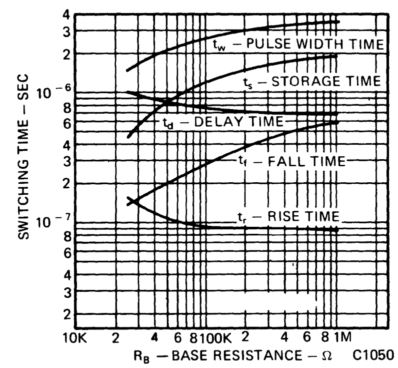


Fig. 6. Switching Time vs. Base Resistance

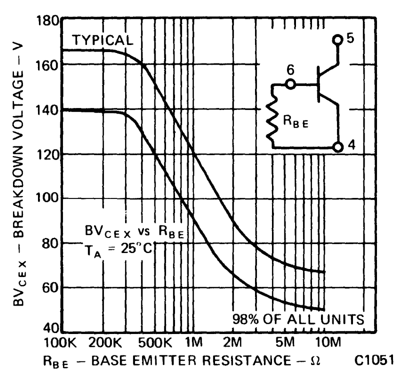


Fig. 7. Collector–Emitter Breakdown Voltage vs. Base Resistance

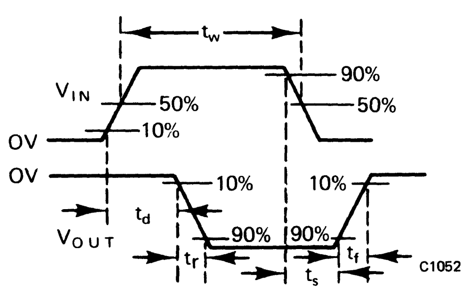


Fig. 8. Pulse Test Definition (Note 3)

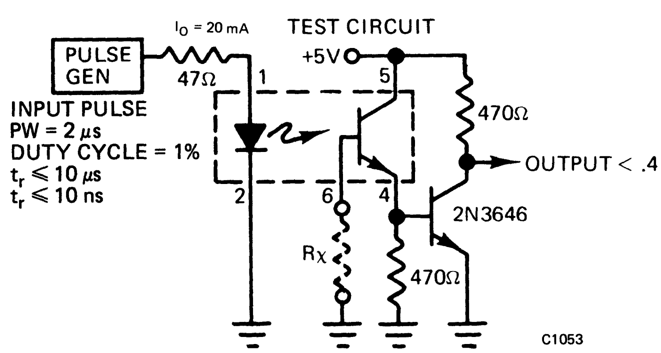


Fig. 9. Pulse Test Circuit for Fig. 7

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

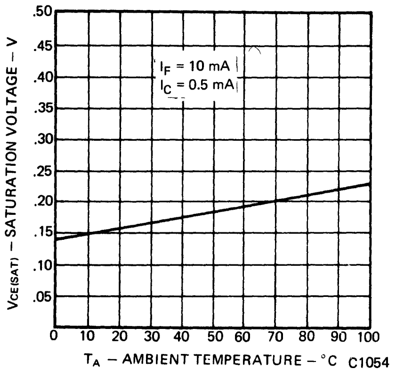


Fig. 10. Saturation Voltage vs. Temperature

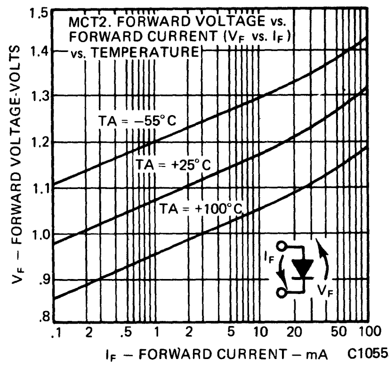


Fig. 11. Forward Voltage vs. Forward Current

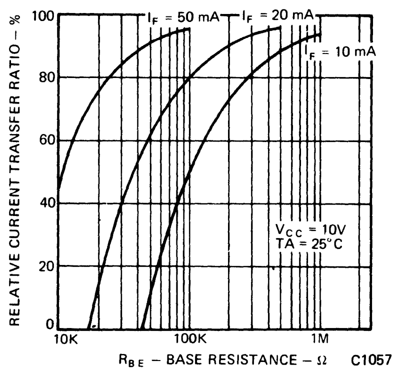


Fig. 12. Sensitivity vs. Base Resistance

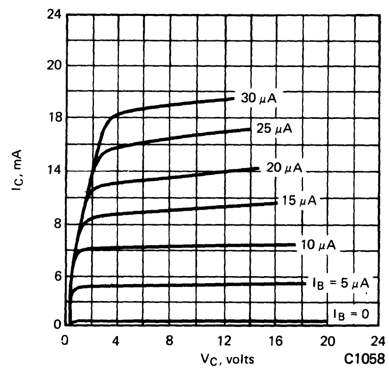


Fig. 13. Detector Standard Transfer Curves

OPERATING SCHEMATICS

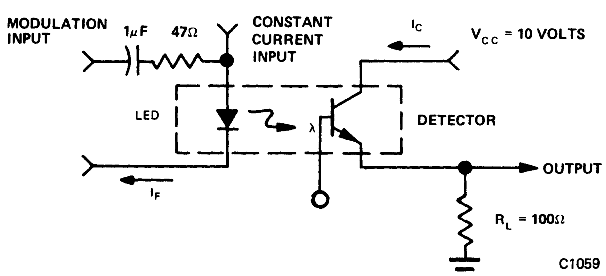


Fig. 14. Modulation Circuit Used to Obtain Output vs. Frequency Plot (Fig. 4)

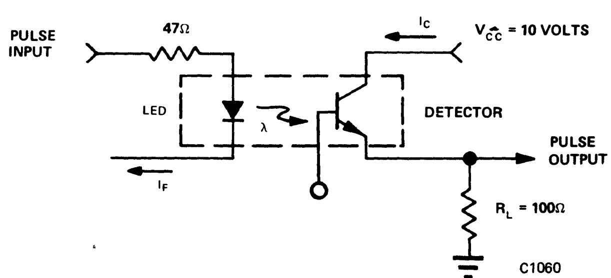


Fig. 15. Circuit Used to Obtain Switching Time vs. Collector Current Plot (Fig. 5)

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%.*

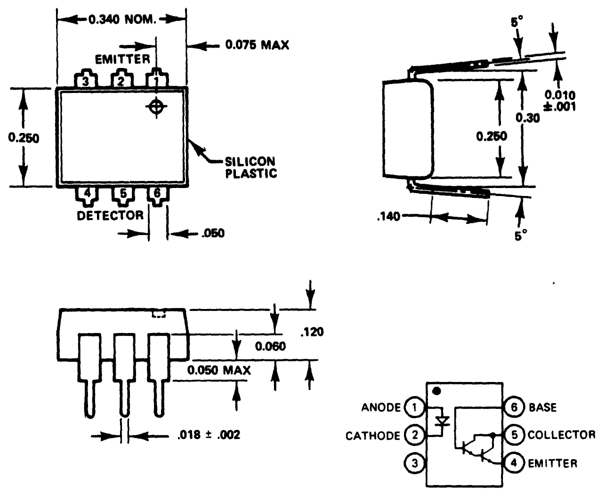
Monsanto

PHOTO-DARLINGTON OPTO-ISOLATOR

MCA230 MCA255

PRODUCT DESCRIPTION

The MCA230 and MCA255 optoisolators contain a gallium arsenide infrared emitting diode optically coupled to a silicon planar photo-darlington 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.



NOTE: ALL DIMENSIONS IN INCHES AND ARE TYPICAL EXCEPT AS NOTED

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—3550 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.

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	300 mW
Derate linearly from 25°C	4.0 mW/°C

LED (GaAs Diode)

Power dissipation @ 25°C ambient	90 mW
Derate linearly from 25°C	2 mW/°C
Continuous forward current	60 mA
Reverse current	10 μA
Peak forward current (1 μsec pulse, 300 pps)	3.0 A

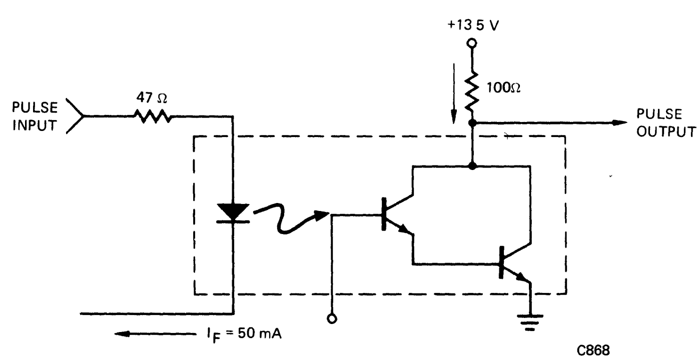
DETECTOR

(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

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_C = 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	400		%	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
Rise time	t_r		5		μsec	Note 3
ISOLATION						
DC Voltage Breakdown	V_{ISO}	3550	5500			
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}	

SWITCHING TIME TEST CIRCUIT



Pulse Width = 1 ms
Pulse Rep Rate = 100 Hz

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

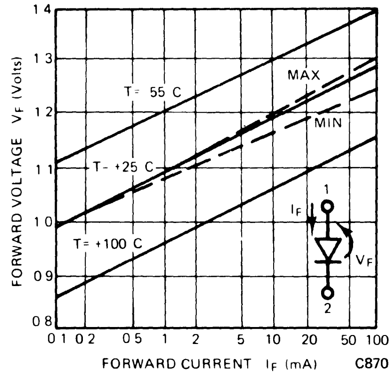


Fig. 1. Forward Voltage Drop vs. Forward Current

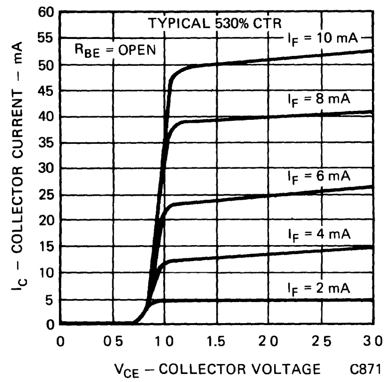


Fig. 2. Collector Current vs. Collector Voltage

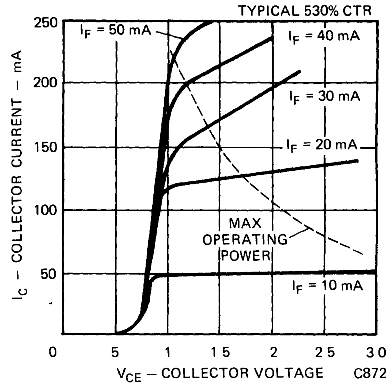


Fig. 3. Collector Current vs. Collector Voltage

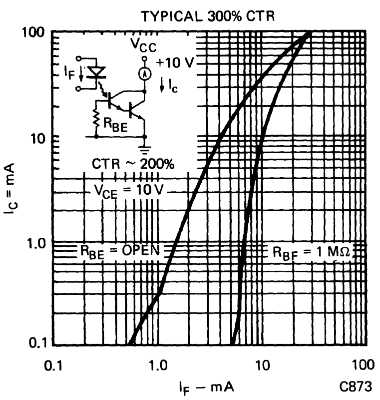


Fig. 4. Current Transfer Characteristic

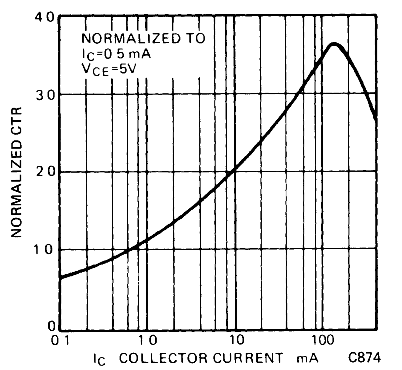


Fig. 5. Normalized CTR vs. Collector Current

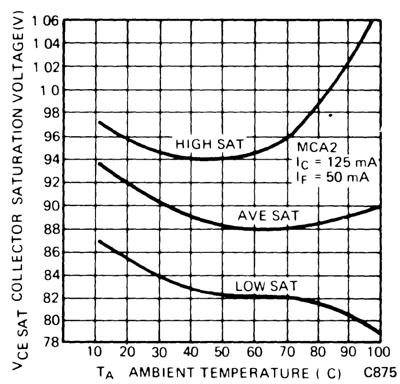


Fig. 6. $V_{CE\text{-}SAT}$ vs. Temperature

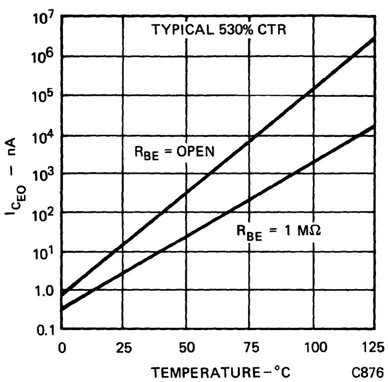


Fig. 7. I_{CEO} vs. Temperature

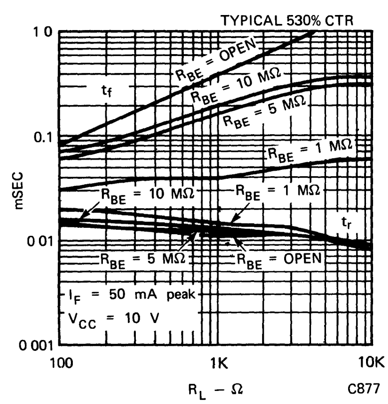


Fig. 8. Switching Times

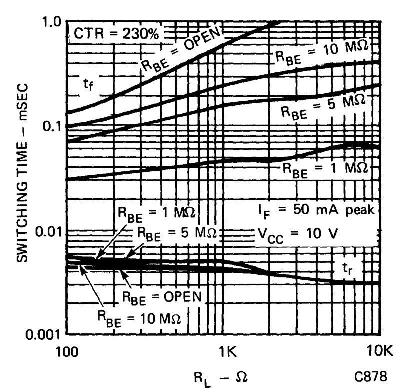


Fig. 9. Switching Times

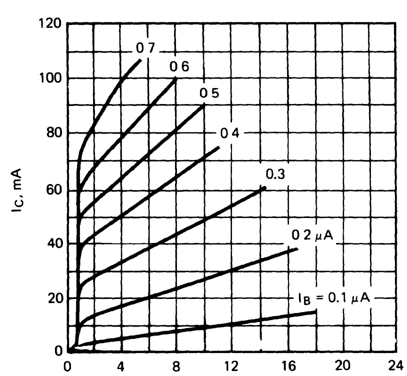


Fig. 10 Detector Standard Transfer Curves

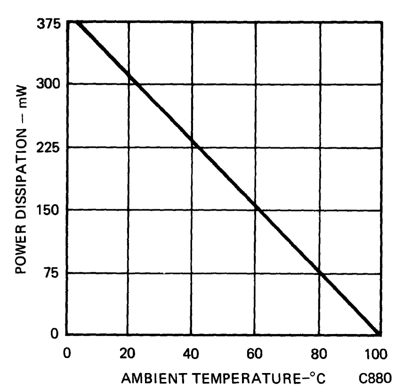


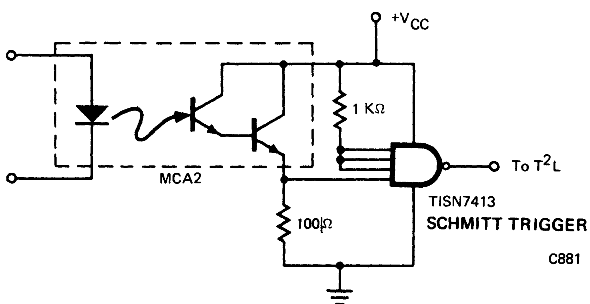
Fig. 11. Package Power Derating

DC RELAY CHARACTERISTICS (TYPICAL)

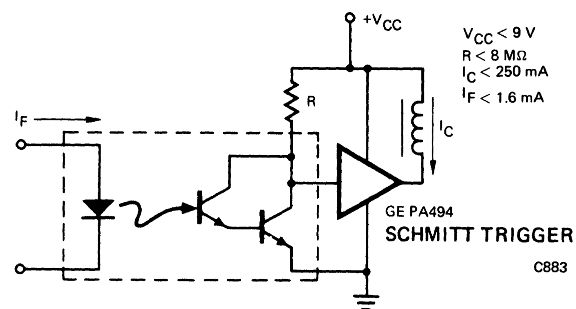
CONTACTS		
Contact configuration		SPST-NO
Contact load rating		125 mA DC
Contact withstand voltage	MCA230	30 V DC
	MCA255	55 V DC
Closed contact voltage		1.0 V
Operate time with 100 Ω load		10 μseconds
Release time with 100 Ω load		35 μseconds
COIL		
Turn on voltage		1.3 V
Turn on current at rated contact load		50 mA
ISOLATION		
Dielectric strength, contacts to coil		3550 VDC minimum
Isolation resistance, contact to coil		10^{11} Ohms
Capacitance, contacts to coil		1.0 pF
WEIGHT		0.4 grams

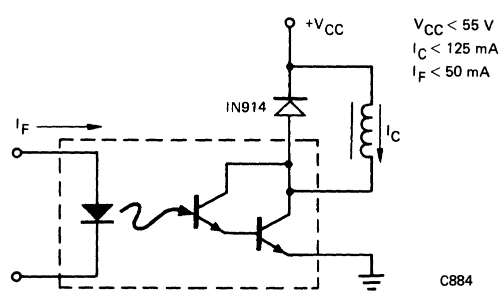
APPLICATION CIRCUITS

ISOLATE T^2L LOGIC WITH MCA2



OPERATING A RELAY COIL WITH MCA2





NOTES

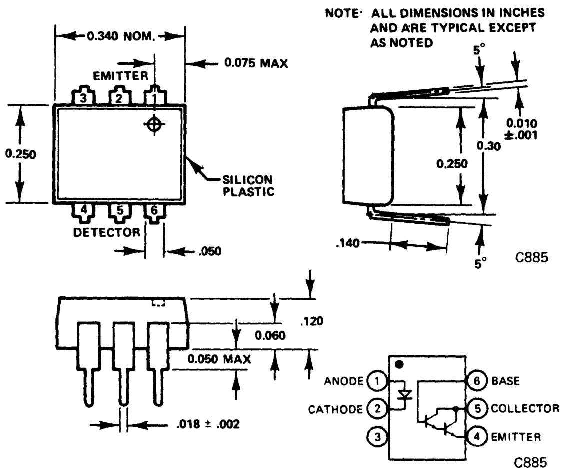
1. *The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 5 volts.*
2. *The frequency at which i_C is 3 dB down from the 1 kHz value.*
3. *Rise time (t_r) is the time required for the collector current to increase from 10% of its final 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%.*

Monsanto PHOTO-DARLINGTON OPTO-ISOLATOR MCA231

PRODUCT DESCRIPTION

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

PACKAGE DIMENSIONS



FEATURES:

- High sensitivity—1 mA on the input will sink a TTL gate.
- High isolation—3550 VDC, 10^{12} Ω, 0.5 pF

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.
- See Application Note 511—Interfacing a Darlington to TTL Logic.

ABSOLUTE MAXIMUM RATINGS

Storage Temperature Range	−65°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	275 mW
Derate Linearly to 100°C (θ_{JA})	3.7 mW/°C
Input to Output Isolation Voltage	3550 VDC
Input Diode	
Forward DC Current	60 mA
Reverse DC Current	4 mA
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}	3550	5500		VDC	t = 1 minute
		850			VRMS	60 Hz
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 I_C = 50 mA,	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 (CTR = 200%)
Saturation Voltage	$V_{CE(sat)}$		0.8	1.0	V	I_C = 10 mA, I_F = 5 mA (CTR = 200%)
Saturation Voltage	$V_{CE(sat)}$		0.9	1.2	V	I_C = 50 mA, I_F = 10 mA(CTR = 500%)
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)

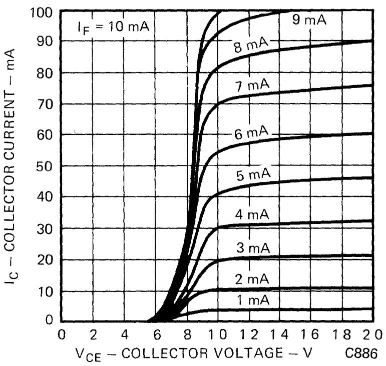


Figure 1. Collector Current vs. Collector Voltage

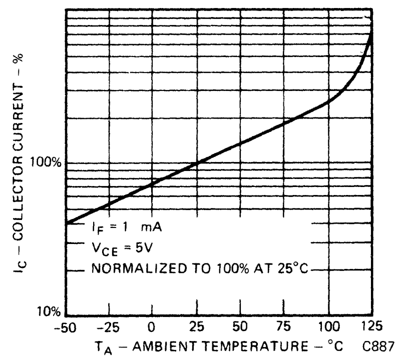


Figure 2. Collector Current vs. Ambient Temperature

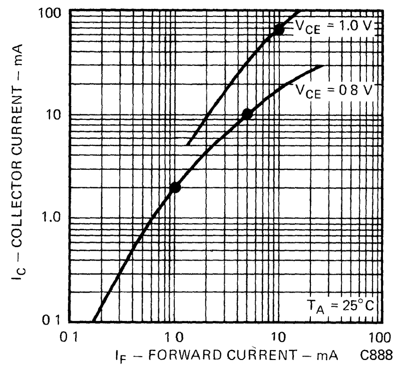


Figure 3. Collector Current vs. LED Current

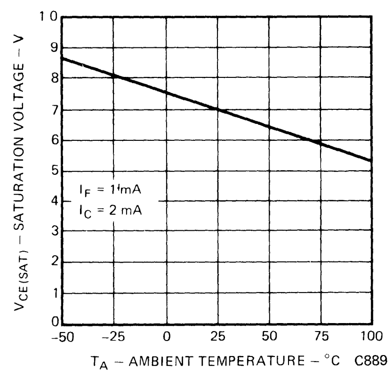


Figure 4. Saturation Voltage vs. Temperature

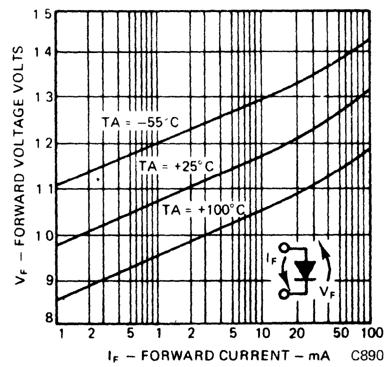


Figure 5. Forward Voltage vs. Forward Current

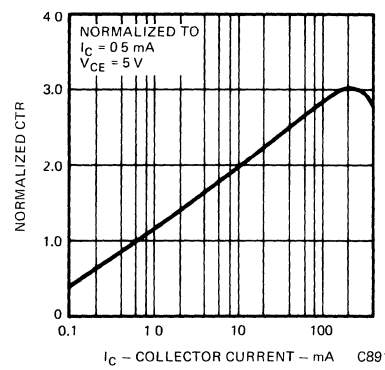


Figure 6. Normalized CTR vs. Collector Current

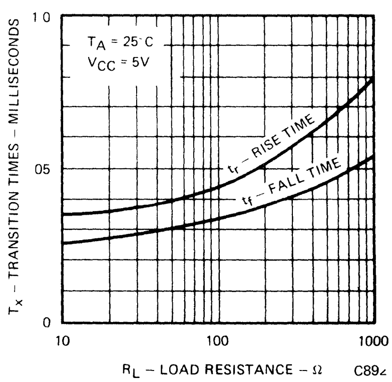


Figure 7. Non-Saturated Rise and Fall Times vs. Load Resistance

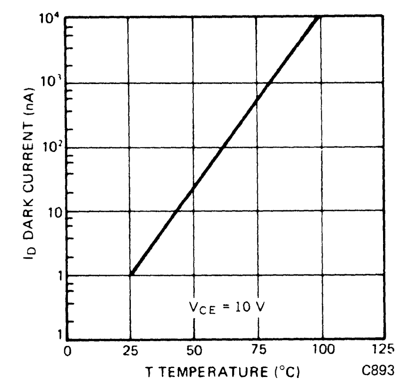


Figure 8. Dark Current vs. Temperature

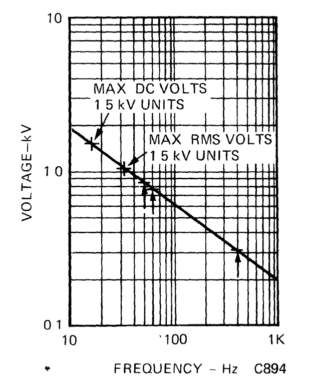


Figure 9. Steady-State AC Voltage Limit of Isolation Dielectric

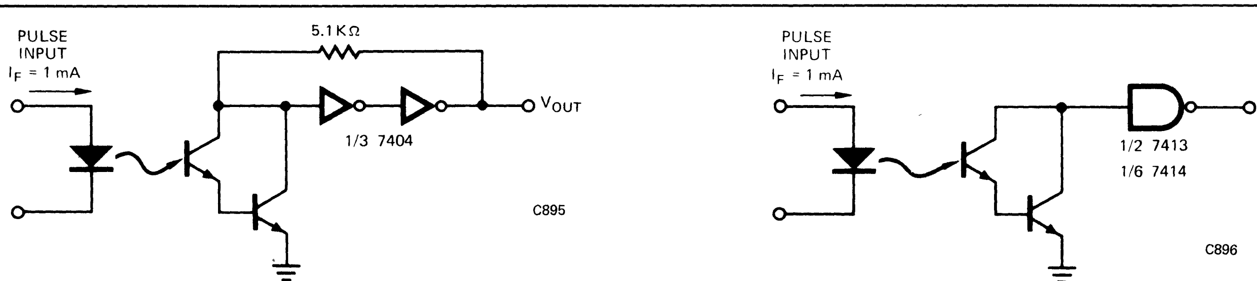


Figure 10. Logic Interface

NOTES

See MCA230 for circuits

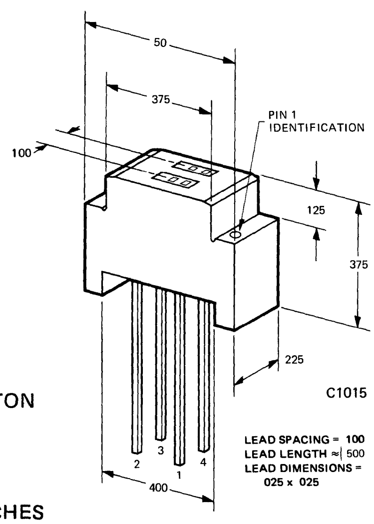
Monsanto

REFLECTIVE OBJECT SENSOR — MCA7

PRODUCT DESCRIPTION

The MCA7 opto-isolator consists of a GaAsLITE emitting diode that generates infrared light and a silicon planar photo darlington. 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.

PACKAGE DIMENSIONS



PIN 1 ANODE } LED
2 CATHODE
3 COLLECTOR } PHOTO-DARLINGTON
4 EMITTER

ALL DIMENSIONS ARE IN INCHES

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 . . . . 150 mW
Derate Linearly from 25°C . . . . 2.0 mW/°C
Forward DC current . . . . 75 mA
Reverse current . . . . 10 mA
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
Leakage Current	I_{CEO} (ambient)		6.8		mA	V_{CE} = 5V (NOTE 3), I_F=0
Rise Time, Fall Time			0.6		mS	V_{CE} = 5V, R_L = 1KΩ
COUPLED						
DC Current Transfer Ratio	(CTR)	.050	1		mA	I_F = 50 mA V_{CE} = 5.0V (NOTE 1 & 2) d = 1.0 CM

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

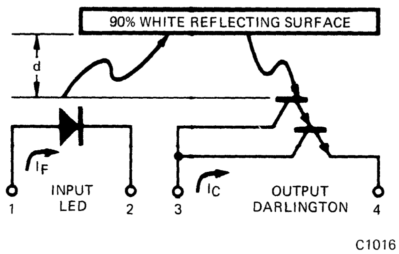


Figure 1 Parameter Symbols

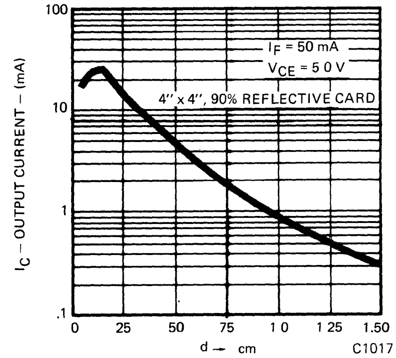


Figure 2 Output Current vs. Distance

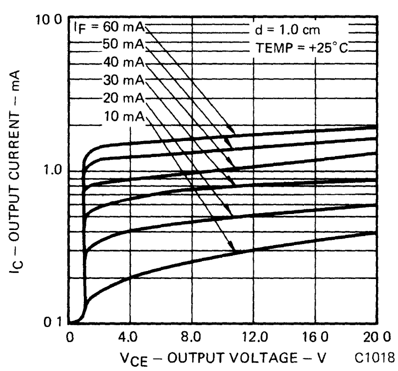


Figure 3 I_C vs. V_{CE}

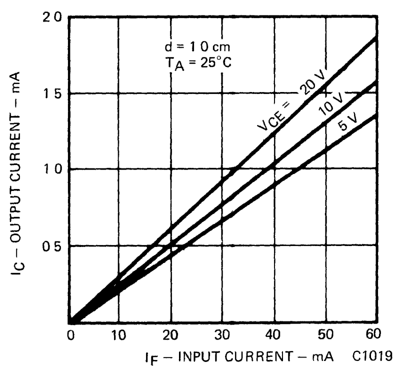


Figure 4 I_C vs. I_F

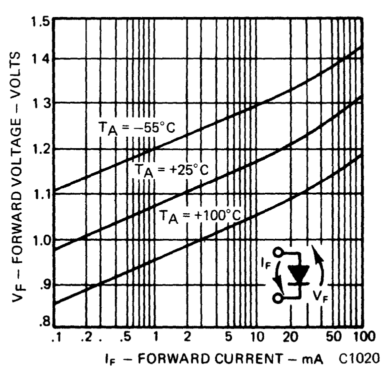


Figure 5 Forward Voltage vs. Forward Current

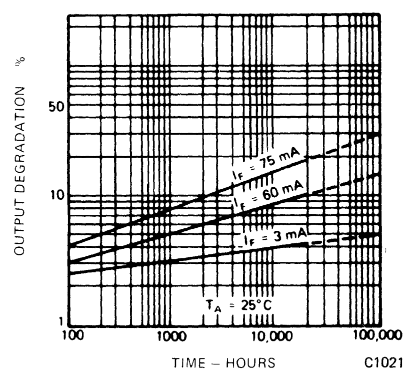


Figure 6 Lifetime vs. Forward Current

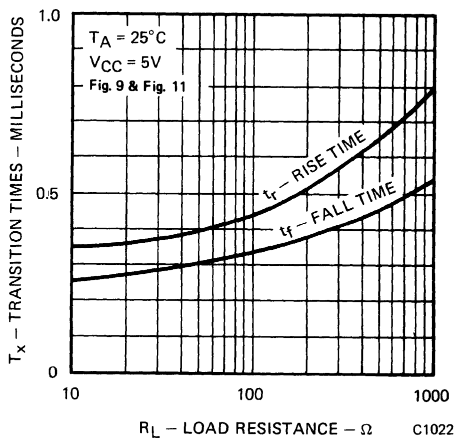


Figure 7. Non-Saturated Rise and Fall Times vs. Load Resistance

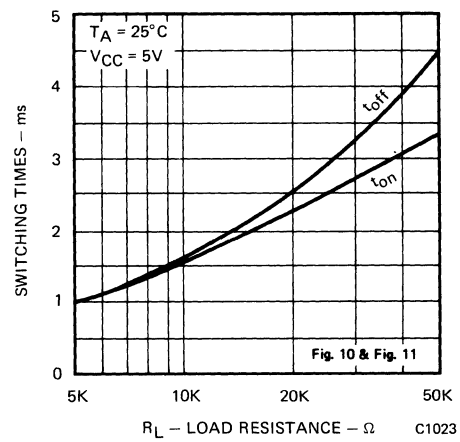


Figure 8. Saturated Switching Times vs. Load Resistance

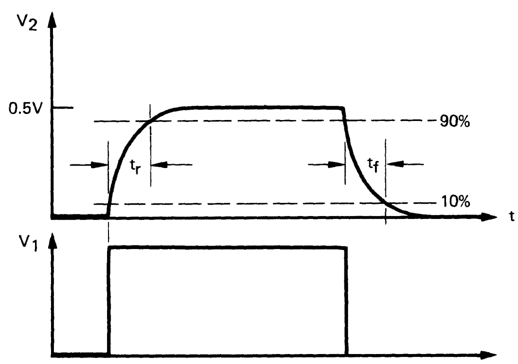


Figure 9. Non-Saturated Switching Waveforms

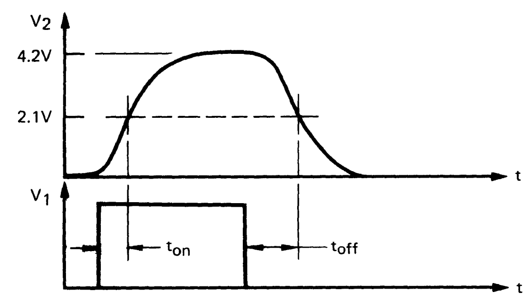


Figure 10. Saturated Switching Waveforms

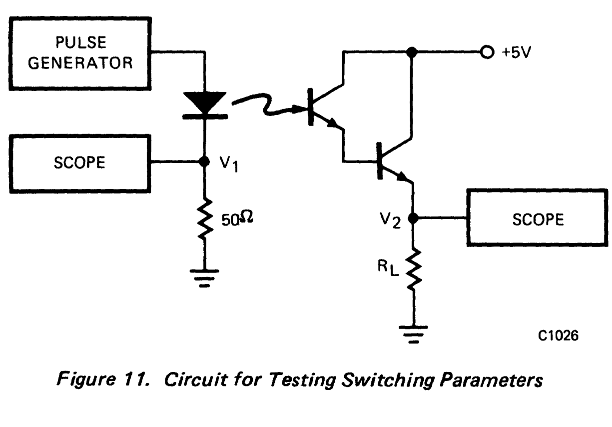


Figure 11. Circuit for Testing Switching Parameters

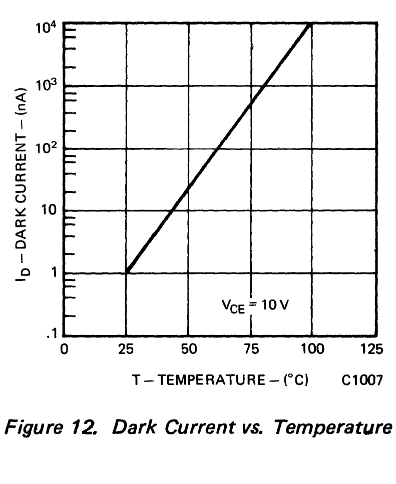
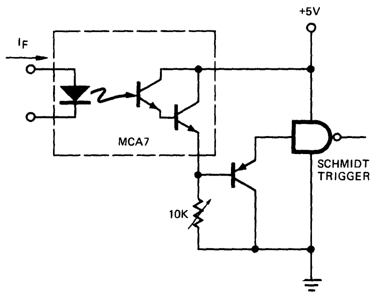


Figure 12. Dark Current vs. Temperature

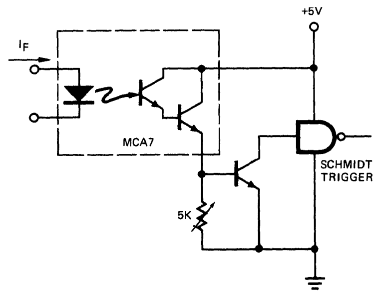
CIRCUITS TO INTERFACE THE MCA7 WITH 5V LOGIC



C1028

Circuit 1

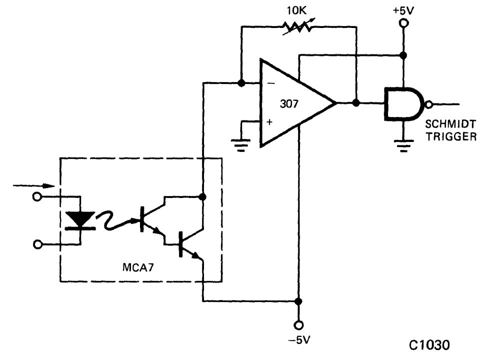
Normally High Output



C1029

Circuit 2

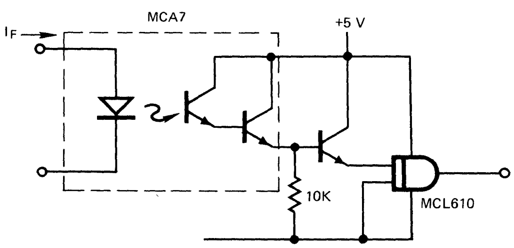
Normally Low Output



C1030

Circuit 3

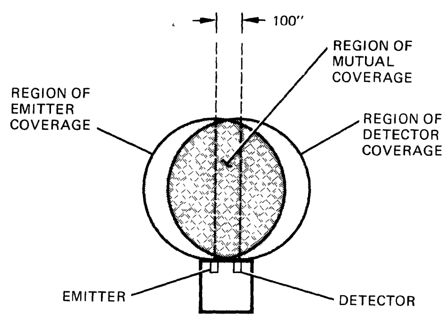
Comparator Driver



C1031

Circuit 4

Booster Drive to Logic Isolator



C1027

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).*

Monsanto

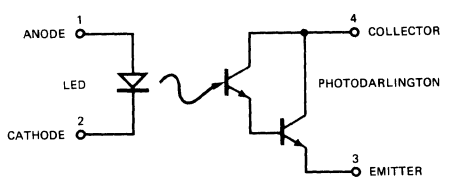
SLOTTED OPTICAL LIMIT SWITCH

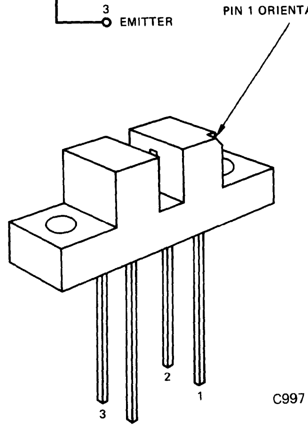
MCA8 MCA81

PRODUCT DESCRIPTION

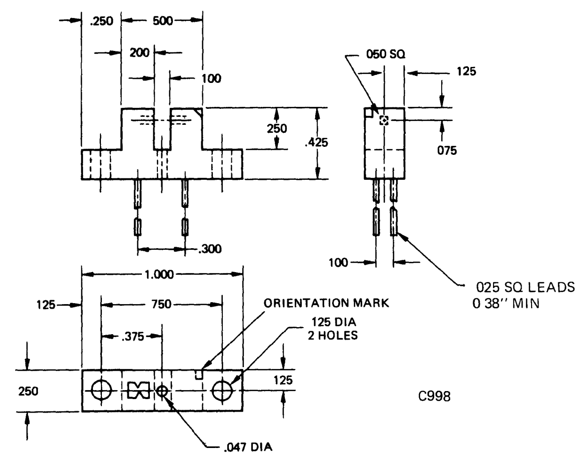
The MCA8 optical limit switch transmits light from a GaAs infrared emitting diode onto a silicon photodarlington detector. Both semiconductor chips face each other across an .01 inch air gap. The MCA8 senses a moving object that passes through the air gap. Output current will directly operate a TTL Schmidt trigger.

PACKAGE DIMENSIONS





C997



C998

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

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 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.

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 (Note 2)
Dark Current–MCA8	I_{CEO}		5	100	nA	V_{CE} = 5.0 V, I_F = 0 (Note 1)
Ambient Leakage Current			20		μA	V_{CE} = 5.0 V, I_F = 0 (Note 2)
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 (Note 2)
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 (Note 2)
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}). . . . .3.7 mW/°C
Input to Output Isolation Voltage . . . . . 1500 VAC

Input Diode
  Forward DC Current . . . . .60 mA
  Reverse DC Current . . . . 4 mA
  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)

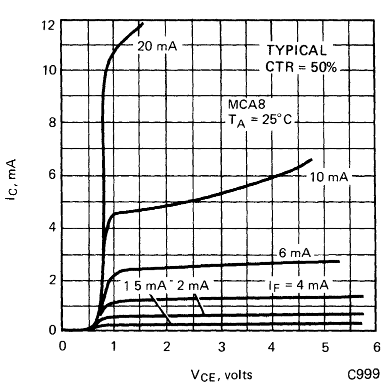


Figure 1 Collector Current vs. Collector Voltage

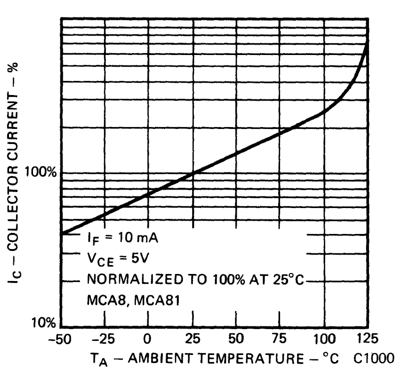


Figure 2 Collector Current vs. Ambient Temperature

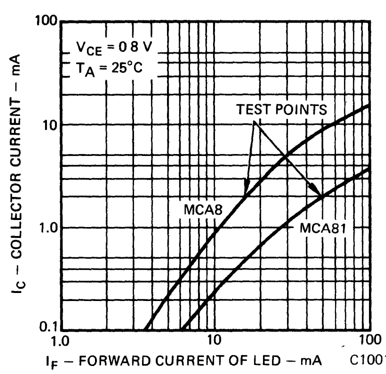


Figure 3 Collector Current vs. LED Current

Typical Electro-Optical Characteristic Curves (Cont.)

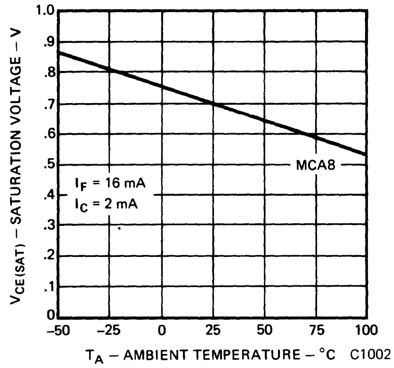


Figure 4 Saturation Voltage vs. Temperature

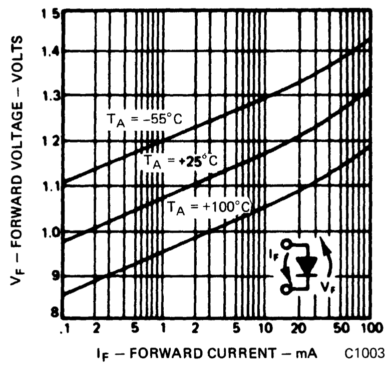


Figure 5 Forward Voltage vs. Forward Current

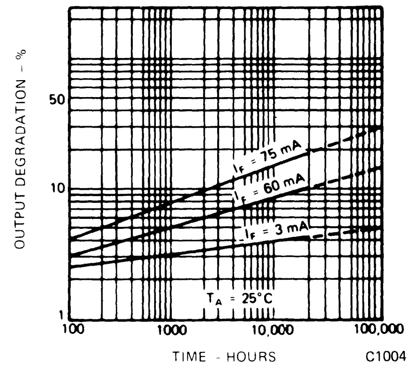


Figure 6 Lifetime vs. Forward Current

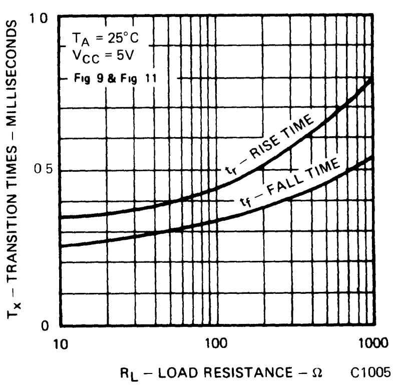


Figure 7 Non-Saturated Rise and Fall Times vs. Load Resistance

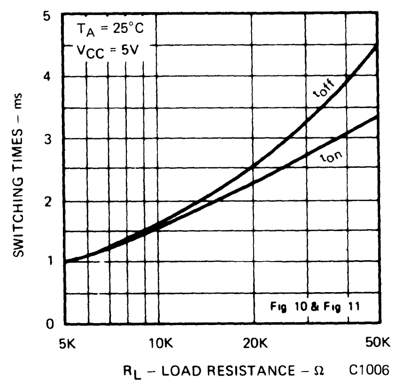


Figure 8 Saturated Switching Times vs. Load Resistance

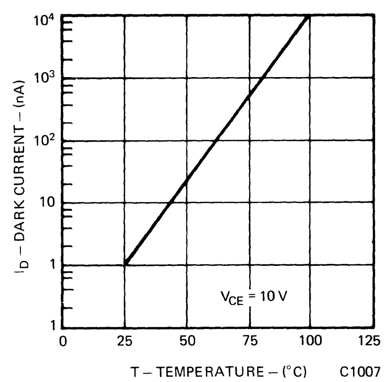


Figure 9. Dark Current vs. Temperature

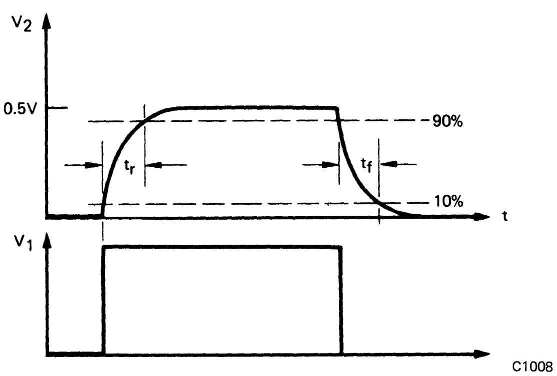


Figure 10 Non-Saturated Switching Waveforms

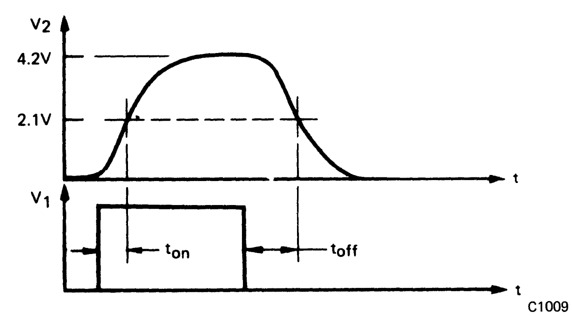


Figure 11 Saturated Switching Waveforms

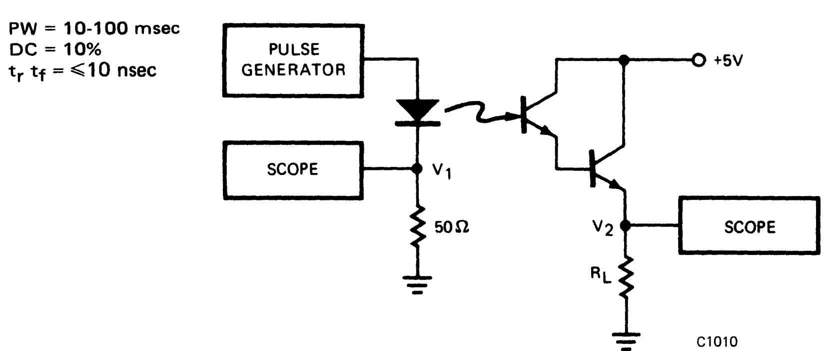


Figure 12 Circuit for Testing Switching Parameters

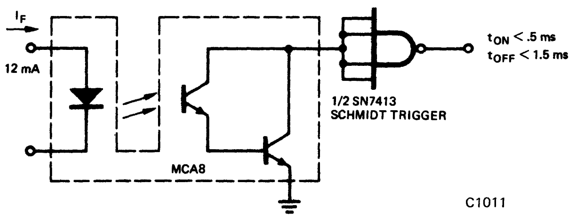


Figure 12 Driving a TTL Schmidt Trigger

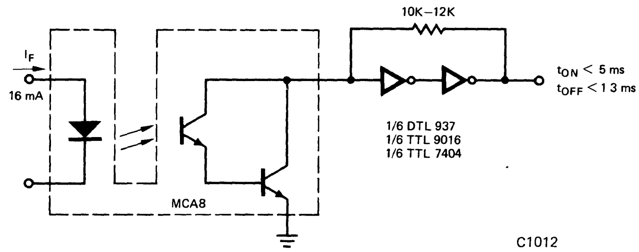


Figure 13 Driving Two Hex Inverters

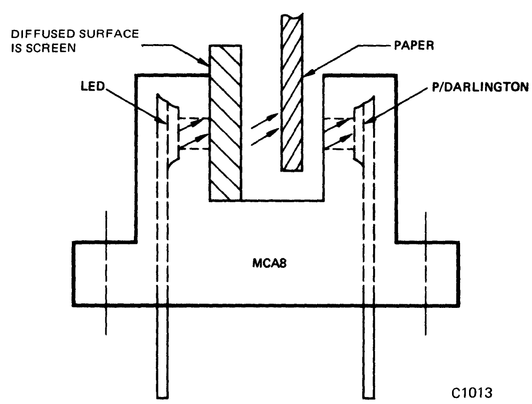


Figure 14 Detecting Paper by using a Lens Screen

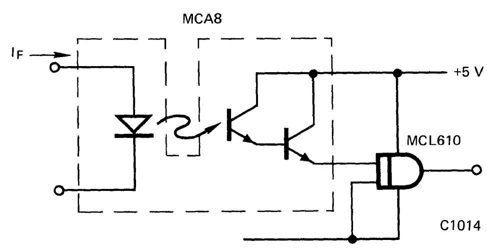


Figure 15 TTL Logic Interface

Detecting Paper by Using a Lens Screen

Infrared light tends to go right through paper, making detection very difficult. For instance, one sheet of white 20# bond paper has an ON/OFF ratio of 1.5 to 1. This ratio can be greatly increased by diffusing the light from the LED prior to striking the paper. A piece of paper used as a diffusant increases the ON/OFF ratio to 5:1. For best results, use a plexiglas lens screen, No. LS85PL 1/16, made by Polacoat, 9750 Conklin Road, Cincinnati, Ohio 45242. This screen transmits 90% of the original light, yet increases the ON/OFF ratio to 16:1 for 20# bond paper, and 60:1 for a manila card.

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.*
2. *Measured at typical factory ambient of 150 foot-candles (150 lamberts per square foot).*

Monsanto

OPTICALLY ISOLATED LOGIC GATE

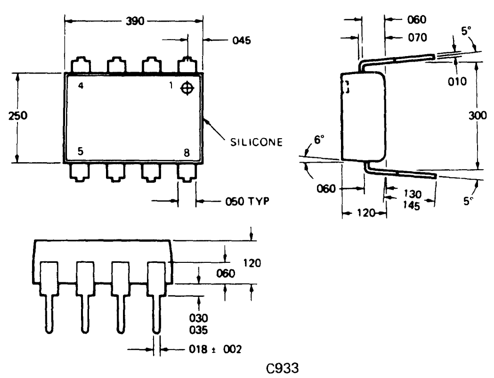
MCL601 MCL611

PRODUCT DESCRIPTION

The MCL601 and MCL611, are optically isolated logic gates in an 8-lead DIP package. A GaAs LED radiates infrared light onto a high speed photodiode detector, thus providing electrical isolation of ±2000 V between input and output. A differential comparator amplifies the photodiode signal, and a Schmitt trigger improves noise immunity by providing threshold and hysteresis. A standard open collector circuit on the output offers normal current sinking capability. The LED drive current requirement matches either mode of logic loading. The output is compatible to most logic systems. The MCL601 has a 0.1 MHz data rate; the MCL 611 has a 1 MHz data rate.

PACKAGE DIMENSIONS

ALL DIMENSIONS IN INCHES



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

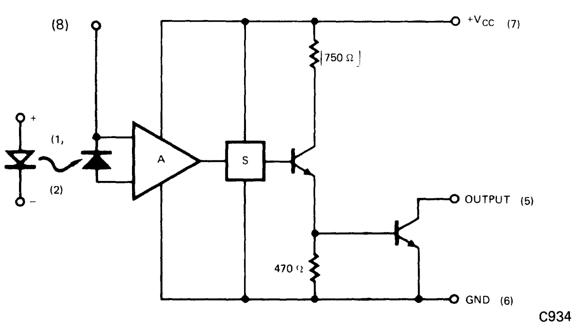
FEATURES

- Compatible TTL input drive load
- Output compatible to TTL, DTL, RTL, CTL, HiNIL
- Single +5 V_{CC} supply required
- High toggle speed, high data rate
- Short transmission delay
- Small 8 pin DIP, two packages fit 16 pin socket
- High isolation between input-output
- High CMRR (Common Mode Rejection Ratio)
- Built-in hysteresis for noise immunity
- Output ORing capability

APPLICATIONS

- Digital logic to digital logic isolator—eliminates spurious grounds
- DC input level sensor—Schmitt trigger toggle
- AC to TTL conversion—square wave shaping
- Line receiver—eliminates CMN and ground loop transients
- Logic level shifter, input-output independent ground systems

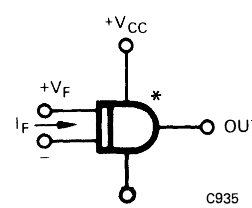
SCHEMATIC DIAGRAM



A = Differential amp, comparator
S = Schmitt trigger, threshold hysteresis

Typical Values Shown

SYMBOL



* OPEN COLLECTOR

ABSOLUTE MAXIMUM RATINGS

Storage temperature . . . . −55°C to +150°C
Operating temperature . . . . 0°C to +70°C
Lead temperature (Soldering, 10 sec.) . . . . 260°C

Input Diode
- Forward DC current . . . . 20 mA
- Reverse Voltage 3V
- Peak forward current (1 μs pulse, 300 pps) . . . . 3.0 A
- Power dissipation at 25°C ambient . . . . . . 100 mW
- Derate linearly from 25°C . . . . 1.33 mW/°C

Output Gate
- Power dissipation at 25°C ambient . . . . . . 100 mW
- Derate linearly from 25°C . . . . 1.33 mW/°C
- DC supply current I_{CC} . . . . 30 mA
- Output collector voltage V_{SS} 15V
- V_{CC} 8V
- Output current low—I_{OL} . . . . 16 mA

Input to output voltage . . . . ±2000 V DC

Note: The input is not specified as "HI" or "LOW" as with normal gate units. The input is "ON" or "OFF," set by the current flow through the input LED. Thus the input may be "ON" for logic drive "HI" (pull up load system, Figure 1A) or logic drive "LOW" (pull down load systems, Figure 1B, as in open collector output devices.) See Z plot.

As a convenience of notation, reference will be made to a pull down type load input connected as in Figure 1B. A logical "LOW" is "ON", and a logical "HI" is "OFF".

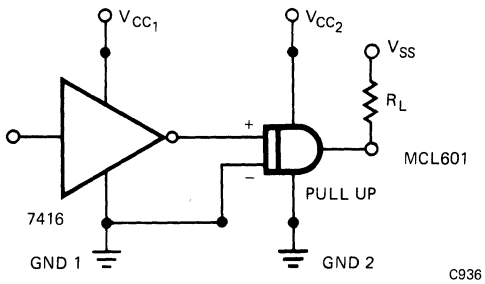


Figure 1A

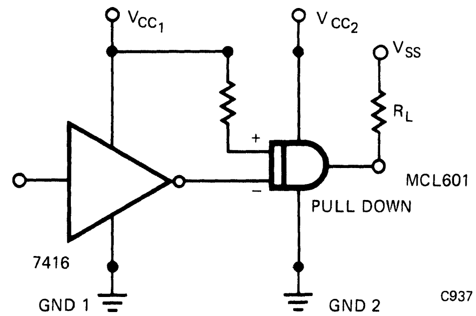


Figure 1B

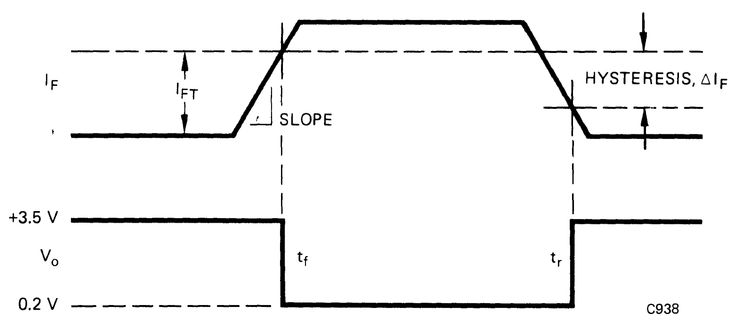


Figure 2A

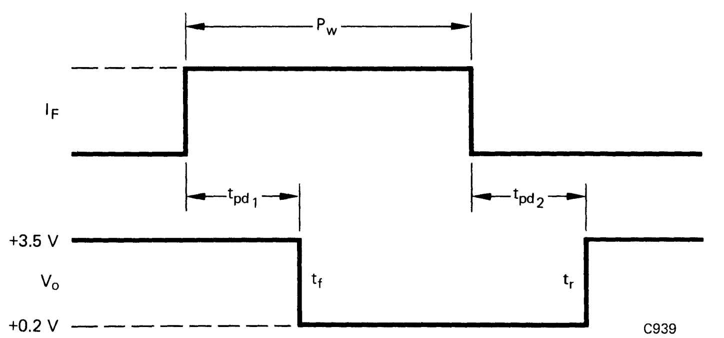


Figure 2B

The MCL input may be driven in series or in parallel with other MCL units, and/or in parallel with other logic units. The input of the MCL has an equivalent unit load (U.L.) rating related to current requirements.

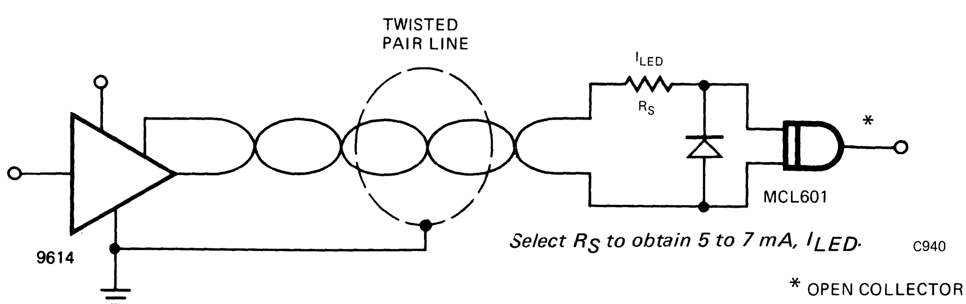


Fig. 3. Line Receiver

RECOMMENDED OPERATING CONDITIONS

PARAMETER		MIN.	TYP.	MAX.	UNITS
Supply Voltage V_{CC}		4.5	5.0	5.5	Volts
Operating Free Air Temperature Range		0	25	70	°C
Normalized Fan Out	Logic HIGH			20	U.L.
	Logic LOW			10	U.L.
Maximum Input Rise and Fall Time	Slope		No Restriction		
Minimum Input Rise and Fall Time	Slope		See Fig. 2A		
Minimum Pulse Width			least t_{pd}		

ELECTRICAL CHARACTERISTICS (25°C)

PARAMETER	SYMBOL	MIN.	TYP. (Note 2)	MAX.	UNITS	TEST CONDITIONS (Note 1)
Input Diode						
Forward Voltage	V_F		1.25	1.50	V	I_F = 20 mA
Forward Voltage Temp Coefficient			-1.8		mV/°C	
Reverse Breakdown Voltage	BV_R	3.0	5.5		V	I_R = 10 μA
Reverse Leakage Current			.001	10	μA	V_R = 3.0 V
Junction Capacitance	C_J		50		pF	V_F = 0
Rise Time	tr		20		ns	I_F = 50 mA, 50Ω system
Fall Time	tf		20		ns	I_F = 50 mA, 50Ω system
Output						
Output Current HIGH (collector leakage)	I_{OHL}			200	μA	V_{CC} = 4.5 V, I_F = 0 mA V_{OH} = 15 V
Output Voltage LOW	V_{OL}		0.2	0.4	Volts	V_{CC} = 4.5 V, I_F = (ON)MAX I_{OL} = 16 mA
Supply Current HIGH	I_{CCH}		6	15	mA	V_{CC} = 5.5V, I_F = 0 mA
Supply Current LOW	I_{CCL}		10	25	mA	V_{CC} = 5.5V, I_F = MAX
MCL601, 5 mA DRIVE (V_{CC} = 5 V)						
Switching Characteristics (Fig. 2B)						
t_{pd} (On)			2	4	μs	I_F = 3.0 mA
t_{pd} (Off)			2	4	μs	I_F = 3.0 mA
tr, tf			10		ns	C_L = 25 pF, R_L = 280Ω
Binary data rate		0.1	0.2		MHz	I_F = 3.0 mA, R_L = 280 Ω
Input Diode						
I_F (On)			3.0	5.0	mA	
I_F (Off)		0.5	2.0		mA	
ΔI_F (hysteresis)			1.0		mA	
V_F (On)			1.15		V	I_F = 5.0 mA
V_F (Off)			0.95		V	I_F = 1.0 mA
Input load equivalent			2		U.L.	
MCL611, 15 mA DRIVE (V_{CC} = 5 V)						
Switching Characteristics (Fig. 2B)						
t_{pd} (On) (Fig. 9)			.3	.6	μs	I_F = 10 mA
t_{pd} (Off)					μs	I_F = 10 mA
tr, tf			10		ns	C_L = 25 pF, R_L = 280Ω
Binary data rate		1.0	1.2		MHz	I_F = 3.0 mA, R_L = 280 Ω
Input Diode (Fig. 11)						
I_F (On)			10	15	mA	
I_F (Off)		2.0	5		mA	
ΔI_F (hysteresis)			5		mA	
V_F (On)			1.1	1.30	V	I_F = 10 mA
V_F (Off)		1.00	1.1		V	I_F = 2.5 mA
Input load equivalent			6		U.L.	

ISOLATION

PARAMETER	MIN.	TYP.	UNITS
DC Voltage Breakdown	2000		VDC
AC Voltage Limit @ 60 Hz	800		VRMS
Capacitance		1.0	pF
Resistance		10^{12}	Ω

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

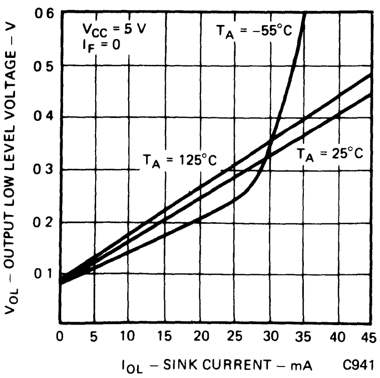


Fig. 4. Low Level Output Voltage vs. Sink Current

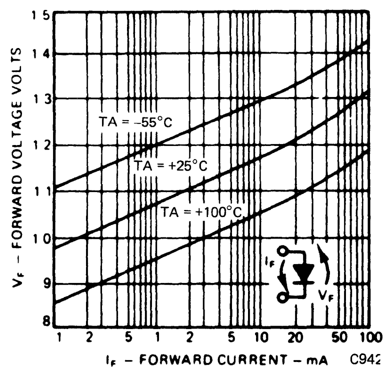


Fig. 5. Forward Voltage vs. Forward Current

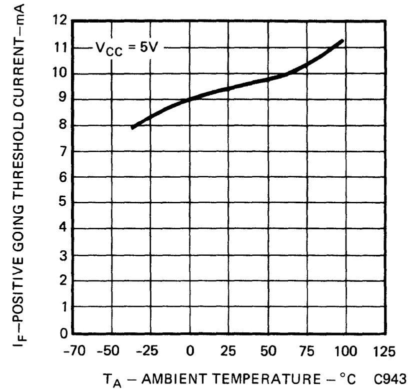


Fig. 6. MCL 611—Positive Going Threshold Current vs. Ambient Temperature

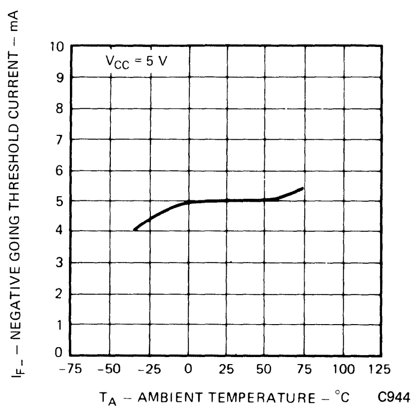


Fig. 7. MCL611—Negative-Going Threshold Current vs. Ambient Temperature

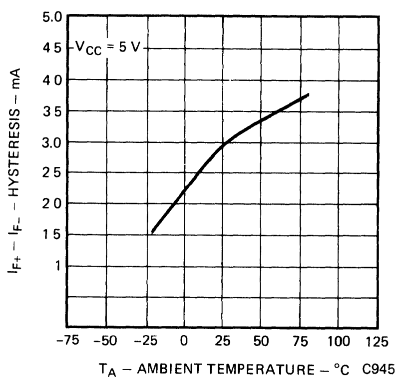


Fig. 8. MCL611—Hysteresis vs. Ambient Temperature

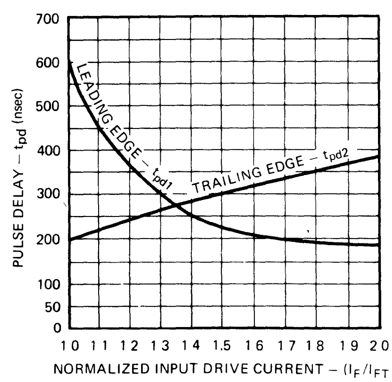


*Fig. 9. MCL611—Normalized Input *Drive Current vs. Pulse Delay*

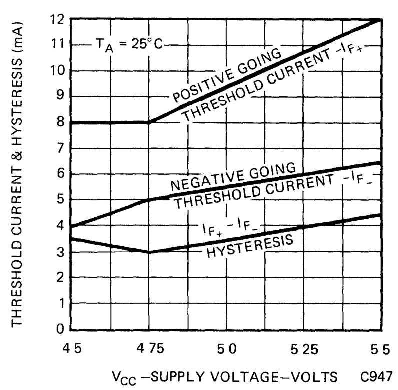


Fig. 10. MCL611—Threshold Current & Hysteresis vs. Supply Voltage

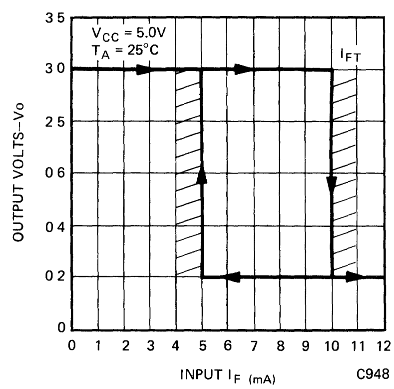


Fig. 11. MCL611—Threshold & Hysteresis of Input/Output

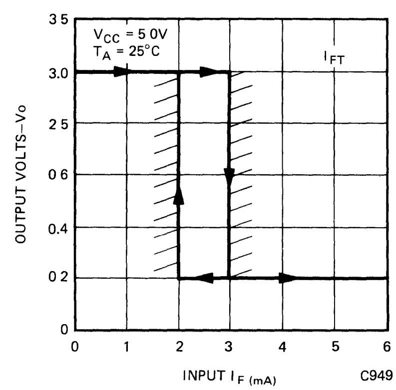


Fig. 12. MCL601—Threshold & Hysteresis of Input/Output

NOTES:

1. *For conditions shown as MIN. or MAX., use the appropriate value specified under recommended operating conditions for the applicable device type.*
2. *Typical limits are at V_{CC} = 5.0 V, 25°C.*

Monsanto

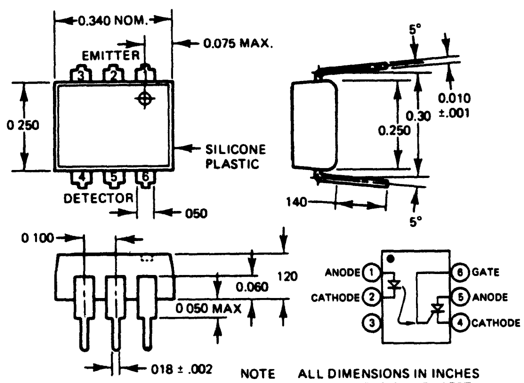
PHOTO SCR OPTO-ISOLATOR

MCS2 MCS2400

PRODUCT 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.

PACKAGE DIMENSIONS



NOTE ALL DIMENSIONS IN INCHES AND ARE TYPICAL EXCEPT AS NOTED

C359

FEATURES & APPLICATIONS

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

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.

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} = 27kΩ @ 100°C
Reverse blocking voltage (V_{ROM})	200	—	—	400	—	—	V	R_{GK} = 27kΩ @ 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
Isolation breakdown voltage (V_{ISO})	3550	5500	—	3550	5500	—	VDC	t = 1 min.
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
Dielectric dissipation limit (D)	—	50,000	—	—	50,000	—	V-Hz	t = 15 minutes
AC voltage limit	—	800	—	—	800	—	V_{RMS}	f = 60 Hz

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 . . . . 60 mW
Derate linearly from 25°C . . . . 0.8 mW/°C
Continuous forward current . . . . 40 mA
Reverse current . . . . 10 μA
Peak forward current . . . . 0.5 A
(50 μs pulse, 120 pps)

COUPLED
Isolation voltage . . . . 3550 VDC
Total package power dissipation . . . . 250 mW

DETECTOR (Photo SCR)
Power dissipation @ 25°C ambient . . . . 200 mW
Derate linearly from 25°C . . . . 2.67 mW/°C
DC anode current . . . . 150 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 CHARACTERISTIC CURVES (25°C Free Air Unless Otherwise Specified)

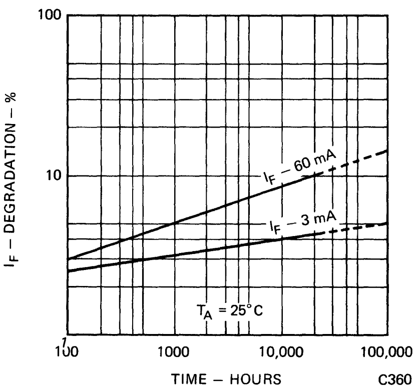


Fig. 1. LED Lifetime vs. Forward Current

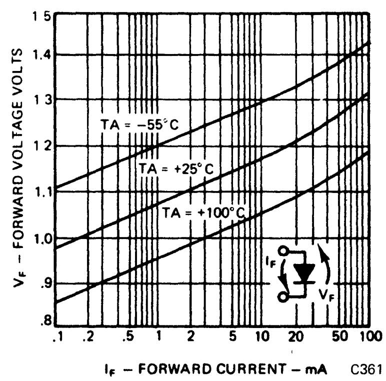


Fig. 2. Forward Voltage vs. Forward Current

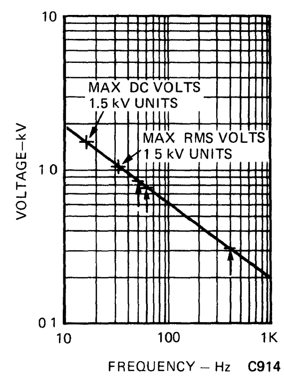


Fig. 3. Steady-State AC Voltage Limit of Isolation Dielectric vs. Line Frequency

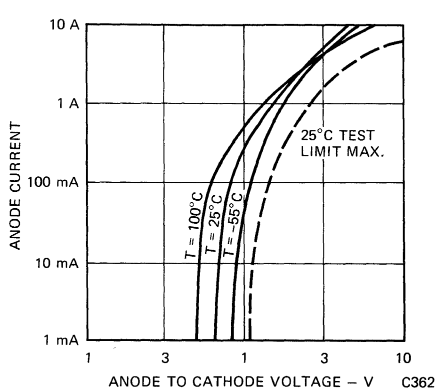


Fig. 4. Anode Current vs. Anode-Cathode Voltage

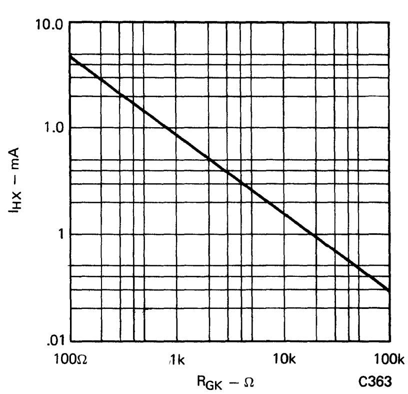


Fig. 5. Holding Current vs. Gate-Cathode Resistance

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

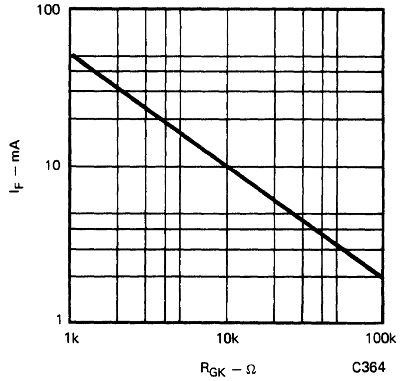


Fig. 6. Forward Current vs. Gate-Cathode Resistance

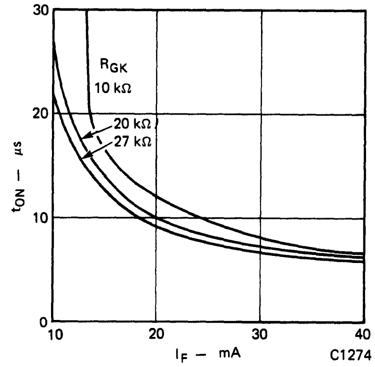


Fig. 7. Trigger Delay Time vs. Foward Current (note 1)

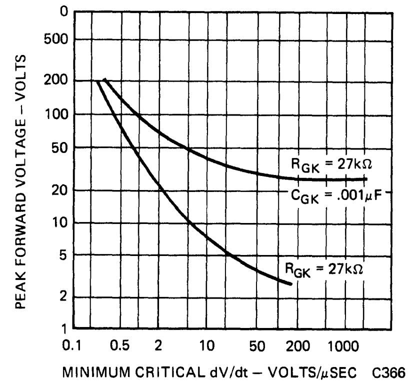


Fig. 8. Forward Blocking Voltage vs. Critical dV/dt

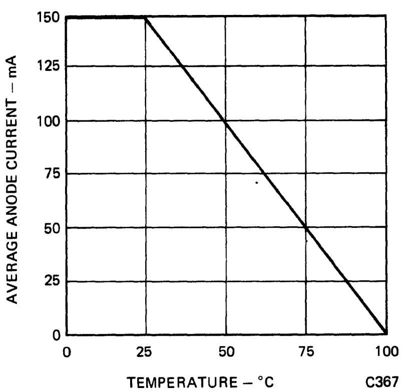


Fig. 9. Continuous Current Rating vs. Ambient Temperature

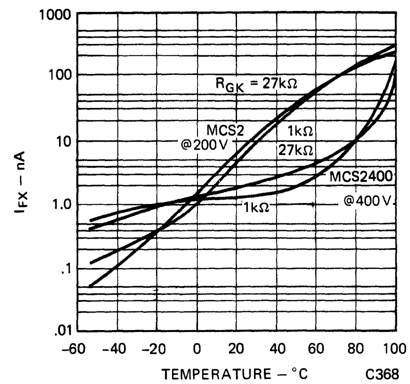


Fig. 10 Forward Leakage Current vs. Temperature

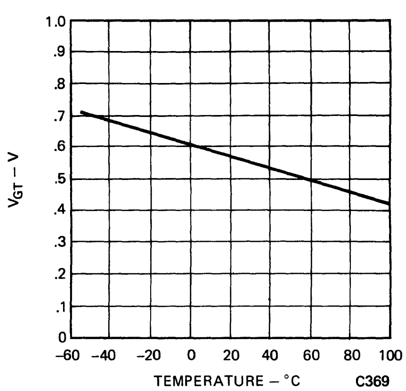


Fig. 11. Gate Trigger Voltage vs. Temperature

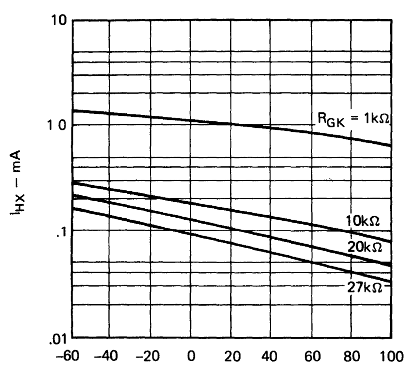


Fig. 12. Holding Current vs. Temperature

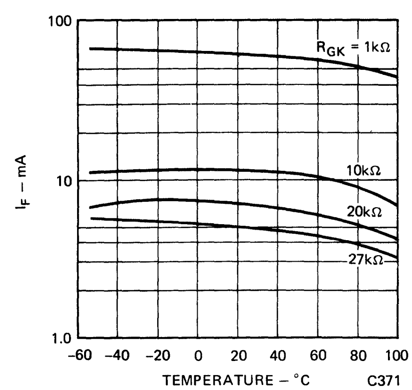
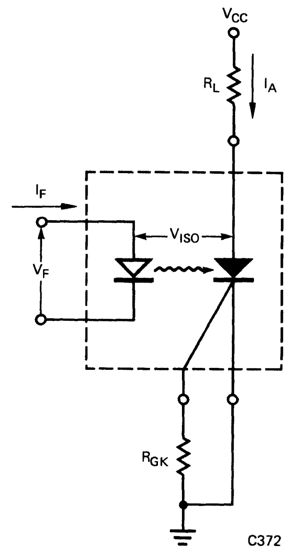
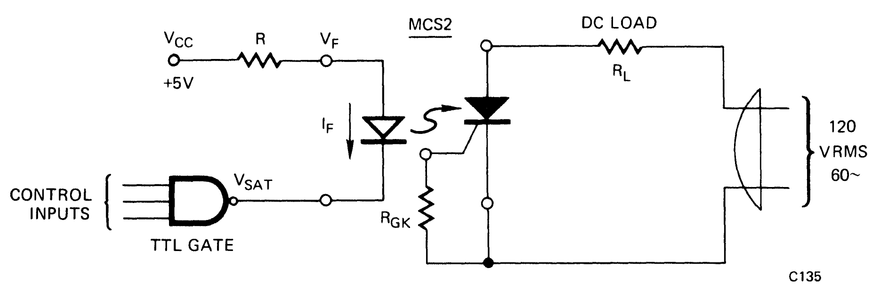


Fig. 13. Forward Current vs. Temperature

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.*

Monsanto

OPTICALLY ISOLATED SOLID STATE AC DIP RELAY

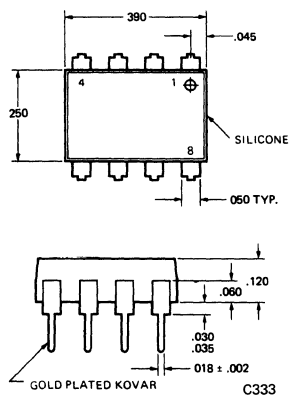
MCS6200 MCS6201

PRODUCT DESCRIPTION

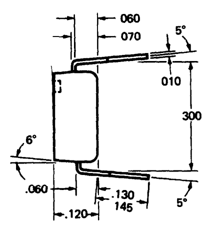
The MCS6200 series are optically-isolated solid state relays with two photo-SCR's connected Anode-to-Cathode (see circuit diagram). Two Light Emitting Diodes, coupled to the photo-SCR's, provide independent SCR control. The MCS6200 features an input to output minimum breakdown voltage of 1500 VDC, while the MCS6201 features 2500 VDC.

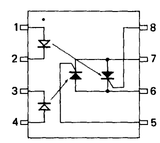
PACKAGE DIMENSIONS, PIN DESIGNATION, CIRCUIT CONFIGURATION

ALL DIMENSIONS IN INCHES



C333





C326

FEATURES

- Fast switching
- Independent direction control
- Low input control power
- High pulse current capability
- High voltage isolation between input and output
- Compact plastic DIP package

APPLICATIONS

- AC power control
- Triac triggering
- Bi-directional motor control
- DC power supply polarity control

ABSOLUTE MAXIMUM RATINGS

Storage temperature –55° 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	60 mW
Derate linearly from 25°C	0.8 mW/°C
Continuous forward current	40 mA
Reverse voltage	3.0 volts
Peak forward current (50 µs pulse, non-repetitive)	0.5 A

COUPLED

Total package power dissipation at 25°	400 mW
Derate linearly from 25°C	5.3 mW/°C
Input to output breakdown voltage	
MCS6200	1500 VDC
MCS6201	2500 VDC

DETECTOR (Photo SCR) each direction

Power dissipation @ 25°C ambient	200 mW
Derate linearly from 25°C	2.67 mW/°C
Continuous forward current	150 mA
Peak pulse current (100 µsec @ 120 pps)	0.5 A
Average gate current	25 mA
Reverse gate current	1.0 mA

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

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
LED (each)						
Forward voltage	V_F		1.25	1.5	V	I_F = 20 mA
Reverse voltage	V_R	3.0	—	—	V	I_R = 10 µA
Reverse current	I_R	—	.001	10	µA	V_R = 3.0 V
Junction capacitance	C_J	—	50	—	pF	V_F = 0 V

ELECTRO-OPTICAL CHARACTERISTICS (Con't)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DETECTOR (each)						
Forward leakage current	I_{FX}	—	.02	2.0	μA	V_{FX} = Rated F_{FXM}, R_{GK} = 27 Ω
Reverse leakage current	I_{RX}	—	.02	2.0	μA	V_{RX} = Rated V_{RDM}, R_{GK} = 27 Ω
Max. forward and reverse blocking voltage (Note 1)	V_{FXM}, V_{ROM}	200	—	—	V	R_{GK} = 27 kΩ
On voltage	V_{TM}	—	1.0	1.3	V	I_T = 100 mA
Holding current	I_{HX}	.01	.15	2.0	mA	R_{GK} = 27 kΩ
Gate trigger voltage	V_{GT}	—	.5	1.0	V	V_{FX} = 100 V
Gate trigger current	I_{GT}	—	15	100	μA	V_{FX} = 100 V, R_L = 10 kΩ, R_{GK} = 27 kΩ
(direct drive)	I_{GT}	—	45	500	μA	V_{FX} = 100 V, R_L = 10 kΩ, R_{GK} = 10 kΩ
	I_{GT}	—	0.5	2.0	mA	V_{FX} = 100 V, R_L = 10 kΩ, R_{GK} = 1 kΩ
COUPLED						
Turn on current	I_F	2	8	14	mA	V_{FX} = 100 V, R_{GK} = 27 kΩ
Trigger time	$t_{on} = t_r + t_d$	—	7.0	—	μsec	R_{GK} = 27 kΩ, I_F = 30 mA, V_{CC} = 20 V
AC turn on current (Note 2)	I_F	20	—	—	mA	V_{CC} = 120 VAC, I_T = 100 mA, R_{GK} = 27 kΩ
ISOLATION						
Isolation breakdown voltage	V_{ISO}					t = 1 minute
MCS6200		1500	—	—	VDC	
MCS6201		2500	—	—	VDC	
Isolation resistance	R_{ISO}	—	10^{11}	—	Ω	V = Rated V_{ISO}
Capacitance	C_{ISO}	—	1.0	—	pf	f = 1 MHz
Dielectric dissipation limit			50,000		V-Hz	15 minutes
AC voltage limit @ 60 Hz			800		V_{RMS}	15 minutes

Note 1. Due to the asymmetry of the devices, the reverse avalanche breakdown of one channel may not be protected by the forward break-down of the other channel, when a 200 volt level is exceeded.

Note 2. To ensure conduction in both directions, see "TRIAC CONNECTION" schematic.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

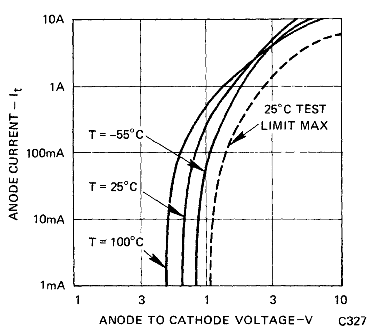


Fig. 1. I_T vs. V_{TM}

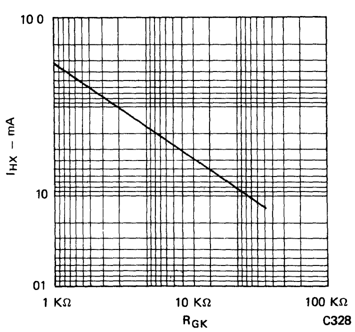


Fig. 2. Holding Current (I_{HX} vs. R_{GK})

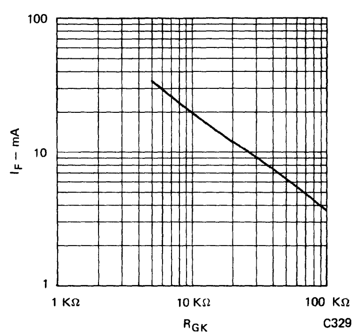


Fig. 3. Turn On vs. R_{GK}

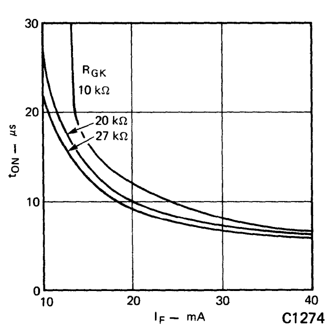


Fig. 4. Trigger Delay Time vs. Forward Current (note 1)

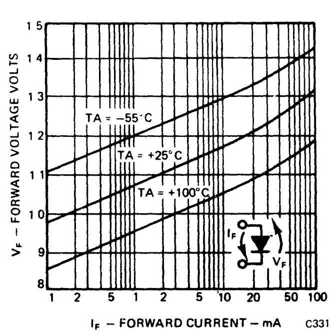


Fig. 5. Forward Voltage vs. Forward Current

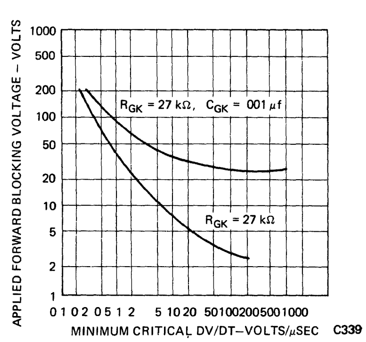


Fig. 6. dV/dt @ 25°C

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (Con't)

(25°C Free Air Temperature Unless Otherwise Specified

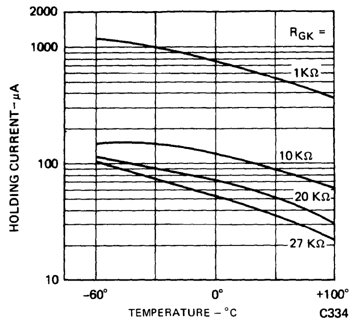


Fig. 7. I_{HX} *vs. Temp. °C*

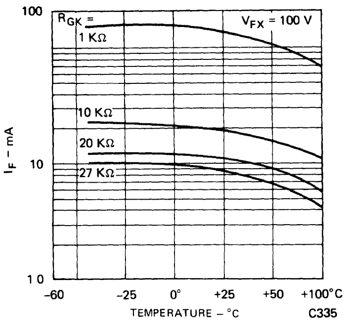


Fig. 8. I_F *vs. Temp.*

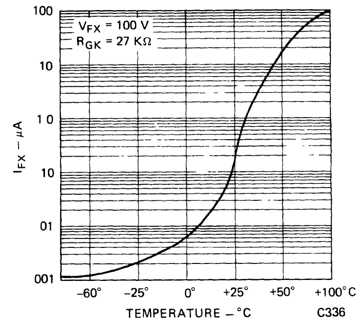


Fig. 9. I_{FX} *vs. Temp.*

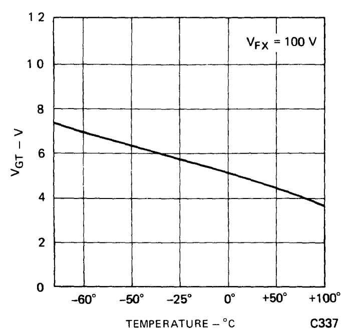


Fig. 10. Gate Trigger Voltage V_{GT} *vs. T*

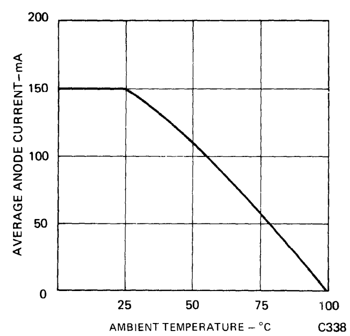
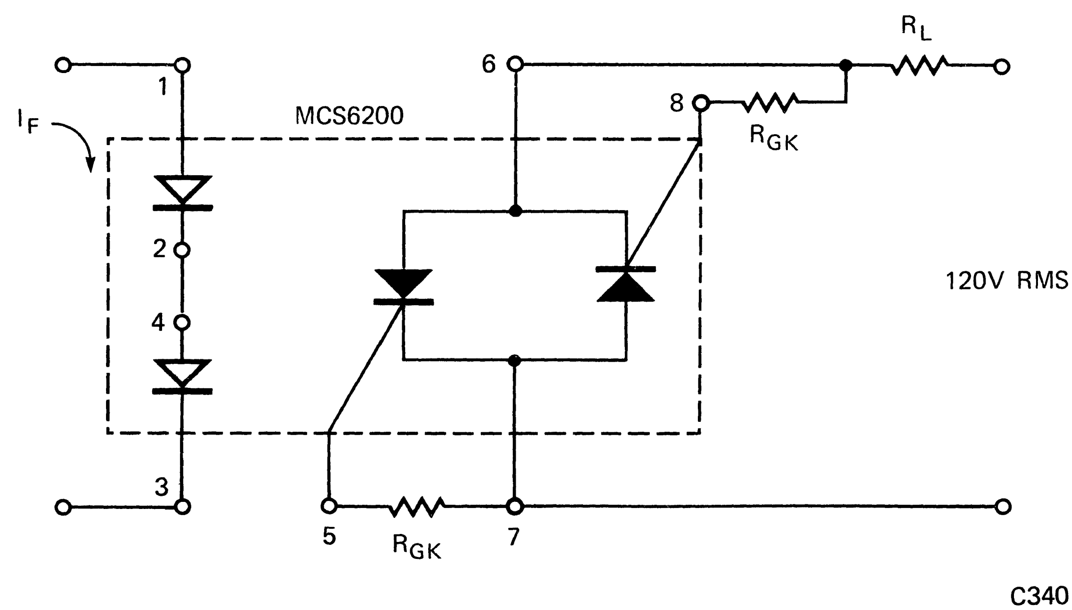


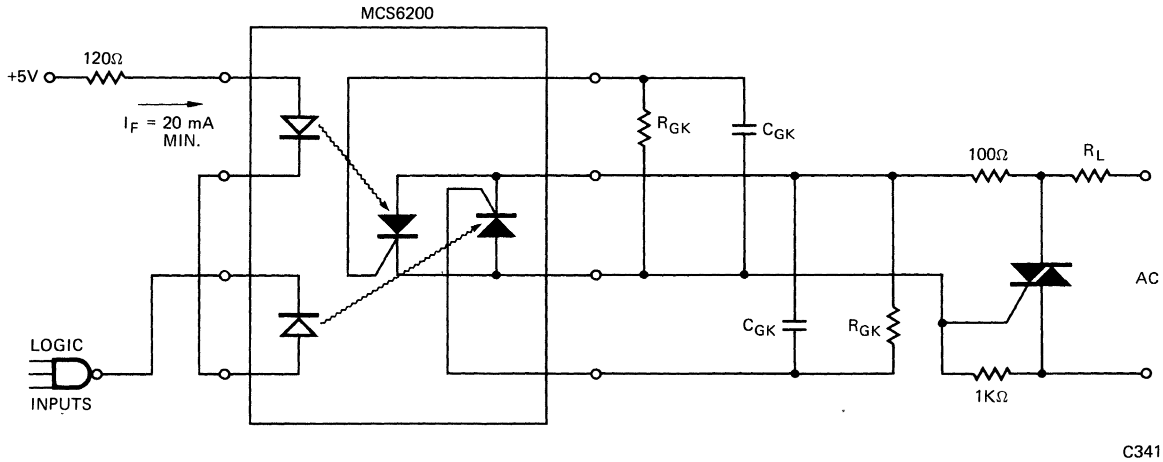
Fig. 11. Anode Current Derating

TYPICAL CIRCUIT APPLICATIONS

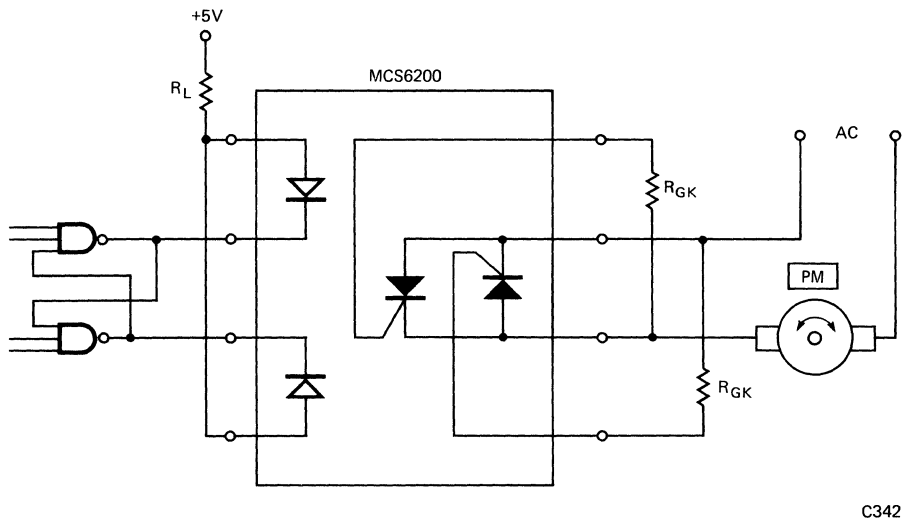


A. TRIAC CONNECTION

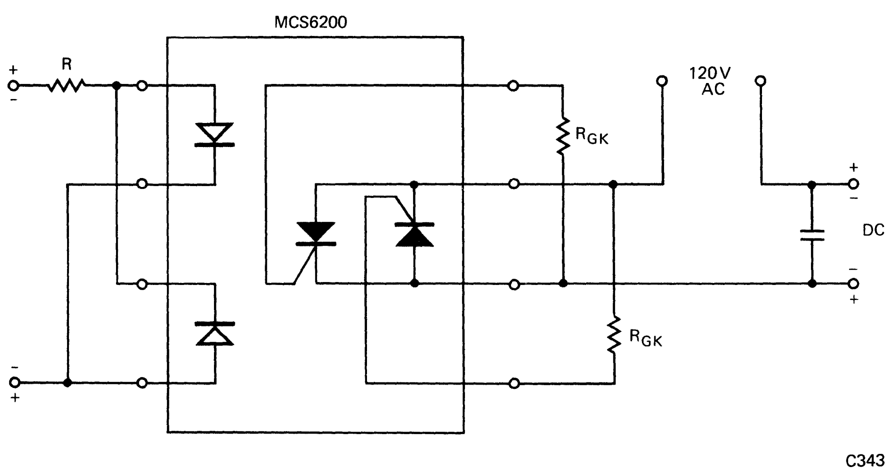
TYPICAL CIRCUIT APPLICATIONS (Cont'd)



B. TRIAC TRIGGER



C. BI-DIRECTIONAL MOTOR CONTROL



D. DC POWER SUPPLY POLARITY CONTROL

Monsanto

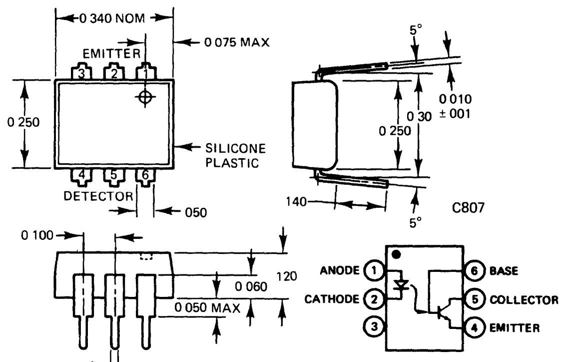
PHOTOTRANSISTOR OPTO-ISOLATOR

MCT2 MCT2E

PRODUCT 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.

PACKAGE DIMENSIONS



NOTE ALL DIMENSIONS IN INCHES AND ARE TYPICAL EXCEPT AS NOTED

C807

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 Approved Product File E50151

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 DC current . . . . 60 mA
- Reverse current . . . . 10 μA
- 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 MCT2 1500 volts DC
Input to output voltage isolation MCT2E 2500 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

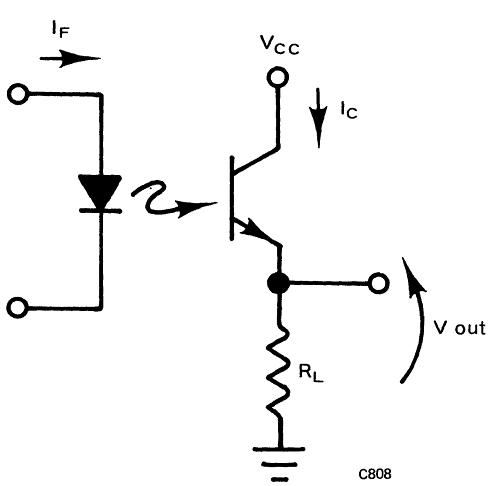
ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	GUAR. MIN.	TYP.	GUAR. 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=0V
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_C=100 μA, I_F=0
Collector To Emitter, Leakage Current	I_{CEO}		5	50	nA	V_{CE}=10 V, I_F=0, Note 5
Collector To Base Leakage Current	I_{CBO}		0.1	20	nA	V_{CB}=10 V, I_F=0

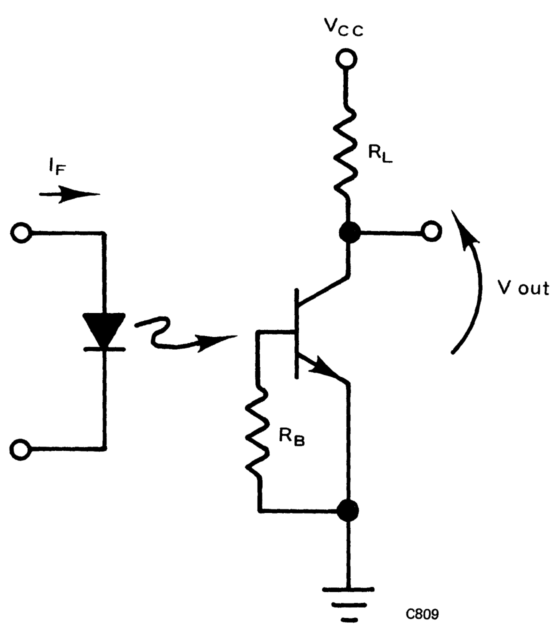
ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

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
Isolation Voltage MCT2		1500	2300		VDC	
		800			VRMS	f=60 Hz
Isolation Voltage MCT2E	B_V(I-O)	3550			VDC	
Isolation Resistance		10^{11}	10^{12}		Ω	V_{I-O}=500 V
Isolation Capacitance			.5		pF	f=1MHz
Collector-Emitter, Saturation Voltage	V_{CE}(sat)		0.24	0.4	V	I_C = 2.0 mA, I_F = 16 mA
Bandwidth (see note 2)	B_W		150		KHz	I_C=2 mA, V_{CE}=10 V, R_L=100 Ω (Circuit No. 1)

SWITCHING TIMES			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)

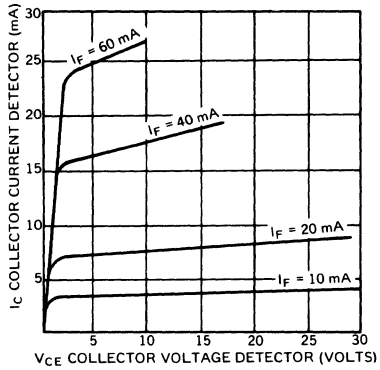


Fig. 1 Collector Current vs. Collector Voltage (for Typical CTR 30%)

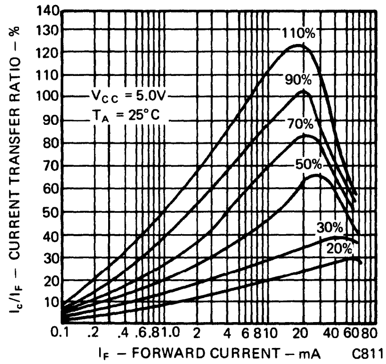


Fig. 2 Current Transfer Ratio vs. Forward Current

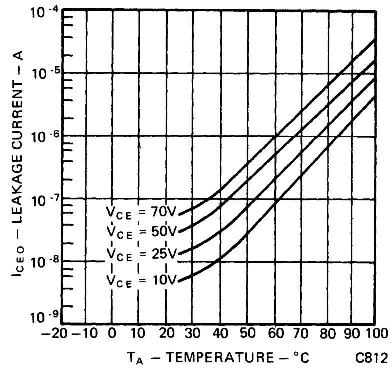


Fig. 3 Dark Current vs. Temperature

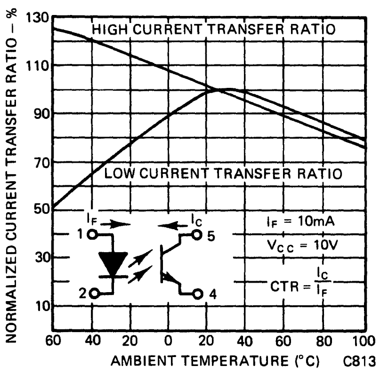


Fig. 4 Current Transfer Ratio vs. Temperature

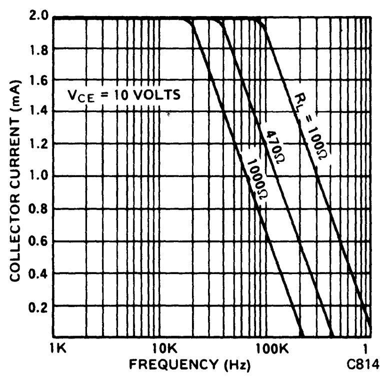


Fig. 5 Collector Current vs. Frequency

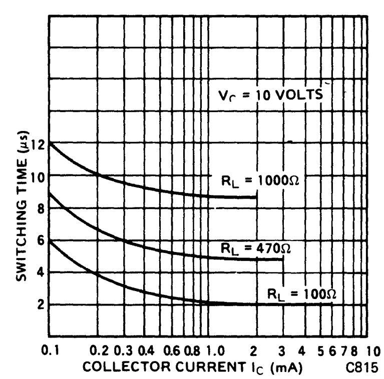


Fig. 6 Switching Time vs. Collector Current

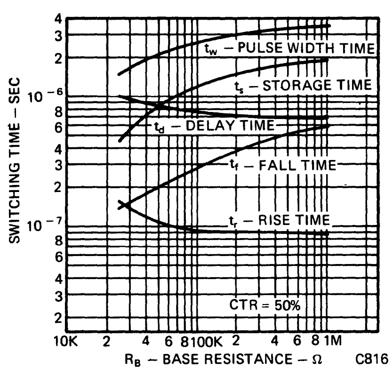


Fig. 7 Switching Time vs. Base Resistance

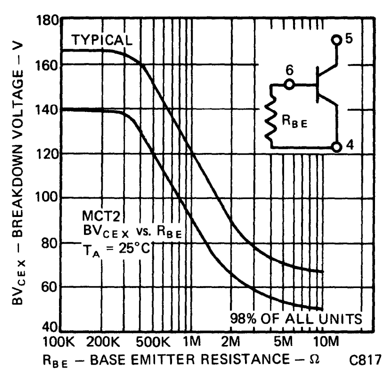


Fig. 8 Collector — Emitter Breakdown Voltage vs. Base Resistance

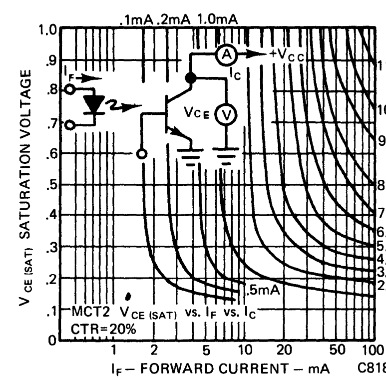


Fig. 9 Saturation Voltage vs. Forward Current

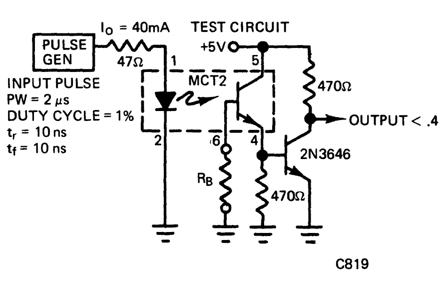


Fig. 10 Circuit for Figure 7

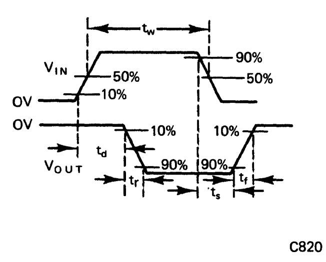


Fig. 11 Waveforms for Figure 7

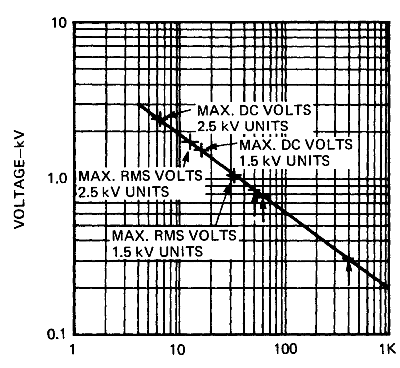


Fig. 12 Steady-State AC Voltage Limit of Isolation Dielectric

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

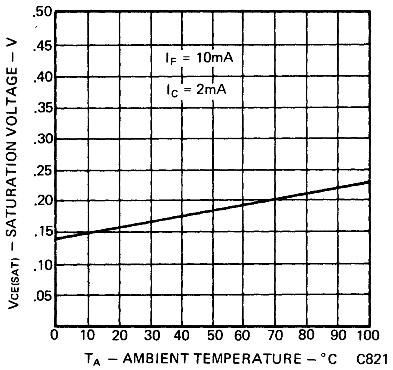


Fig. 13 Saturation Voltage vs. Temperature

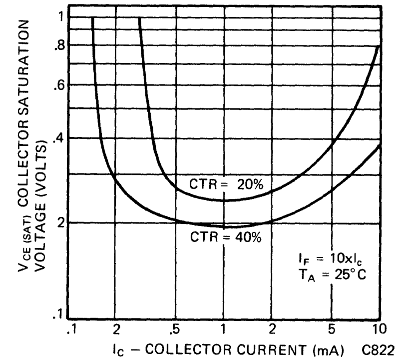


Fig. 14 Saturation Voltage vs. Collector Current

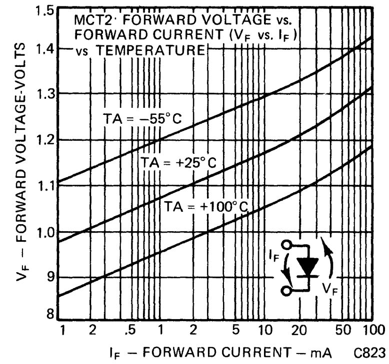


Fig. 15 Forward Voltage vs. Forward Current

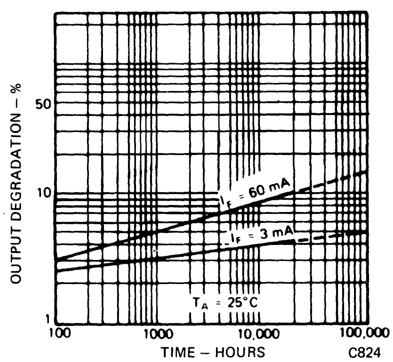


Fig. 16 Lifetime vs. Forward Current

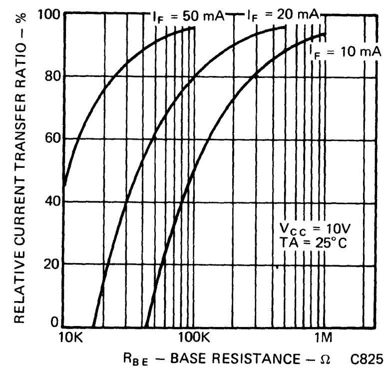


Fig. 17 Sensitivity vs. Base Resistance

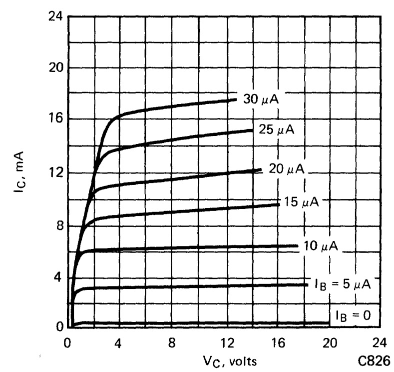
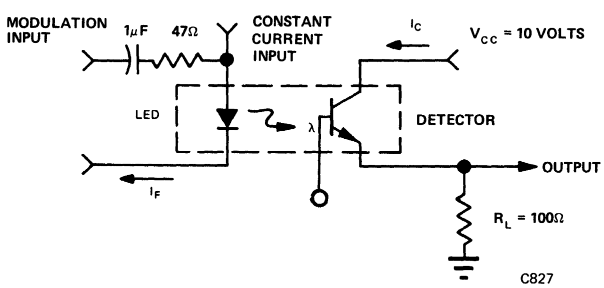
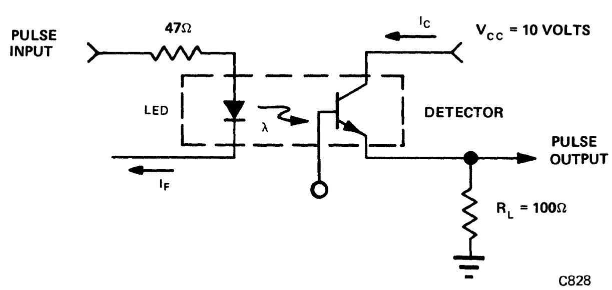


Fig. 18 Detector Typical h_{fe} Curves

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%.*
4. *For design information send for Application Notes Handbook.*
5. *Use a 100 MΩ resistor R_{BE} for test stability.*
6. *Normalized CTR degradation =* $\frac{CTR_O - CTR}{CTR_O}$

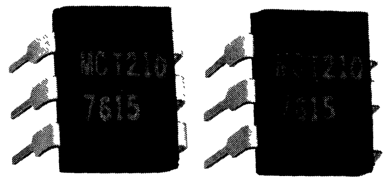
Monsanto

PHOTOTRANSISTOR OPTO-ISOLATOR

MCT210

FEATURES

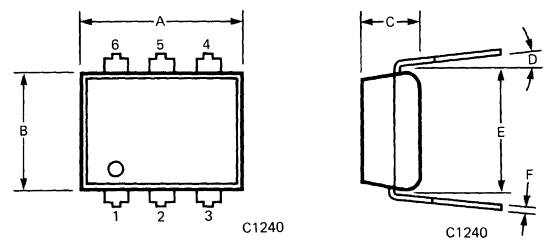
- TTL compatible 1-10 gate loads
- High CTR with transistor output MCT210—150% min.
- Specified CTR over temperature range
- Good logic load characteristics
  V_{OL} = 0.4 V @ 1.6 mA to 16 mA output sinking (I_{OL})
- 4 KV minimum isolation voltage



APPLICATIONS

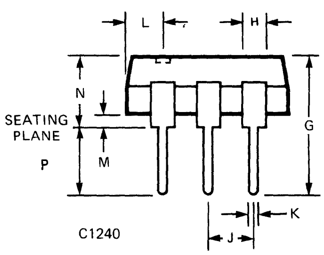
- Digital logic isolation
- Line receivers
- Feedback control circuits
- Monitoring circuits

PACKAGE DIMENSIONS

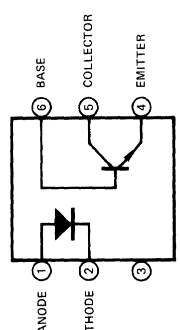


C1240

C1240



C1240



C1109

PRODUCT 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.

SYMBOL	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	345	365	8 76	9 27
B	245	265	6 22	6 73
C	115	125	2 92	3 18
D	0°	15°	0°	15°
E	300 REF		7 62 REF	
F	010	014	0 25	0 36
G		325		8 26
H	045	070	1 14	1 78
J	090	.110	2 29	2 79
K	018	022	0 46	0 56
L	075	085	1 91	2 16
M	025		0 64	
N		175		4 45
P	100		2 54	

PACKAGE MATERIALS
LEADS—TINNED WITH 60/40 TIN LEAD

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature . . . . −55°C to 150°C
Operating temperature . . . . −55°C to 100°C
Lead temperature
(Soldering, 10 sec) . . . . 260°C
Input to output voltage at 25°C . . . . 4000 V
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 . . . . 40 mA
Reverse current . . . . 10 μA
Peak forward current
(1 μs pulse, 300 pps) . . . . 3.0 A
Power dissipation 25°C to 70°C ambient . . . 60 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}	100	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	50		V	I_C = 10 μA
	Emitter to collector	BV_{ECO}	6	8		V	I_C = 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		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	Isolation voltage		4000			VDC	Relative humidity ⩽ 50%, T_A = +25°c, $I_{I\text{-}O}$ ⩽ 10 μA
	Isolation resistance		10^{11}	5×10^{12}		Ω	$V_{I\text{-}O}$ = 500 VDC, T_A = +25°C
	Isolation capacitance			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

All Typ. readings @ +25°C

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

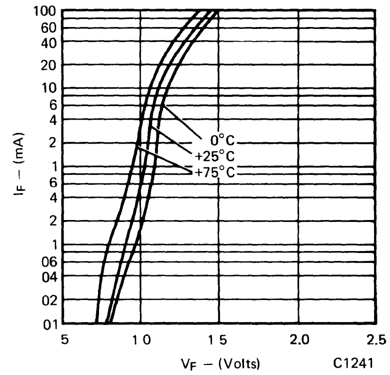


Fig. 1. Forward Voltage vs. Forward Current

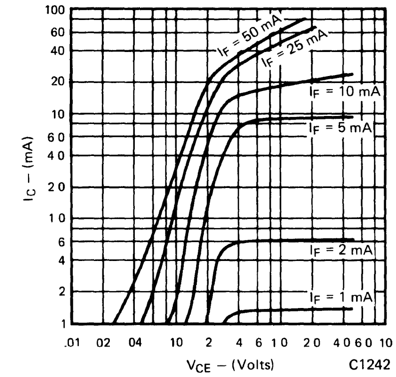


Fig. 2. Collector Current vs. Collector to Emitter Voltage

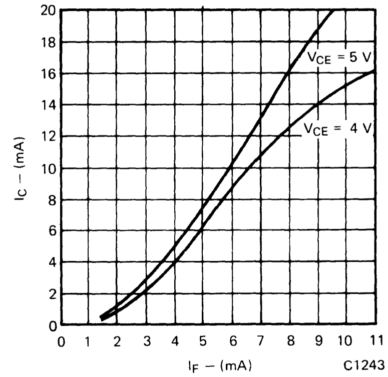


Fig. 3. Collector Current vs. Forward Current

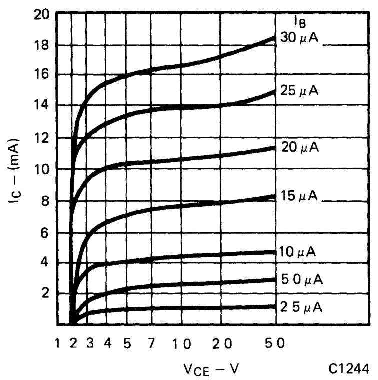


Fig. 4. Collector Current vs. Collector to Emitter Voltage

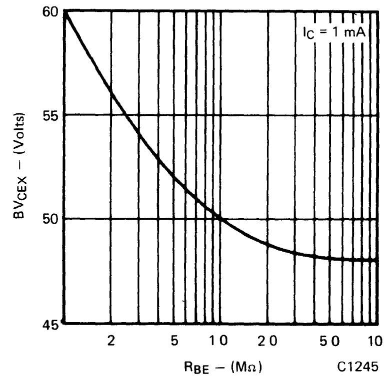


Fig. 5. Collector to Emitter Breakdown Voltage vs. Base to Emitter Resistance

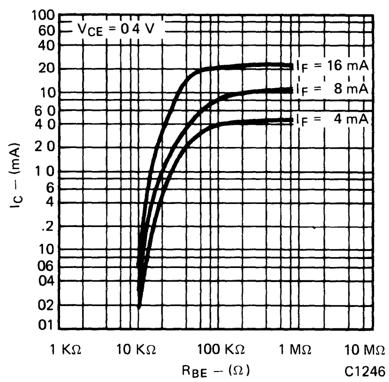


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

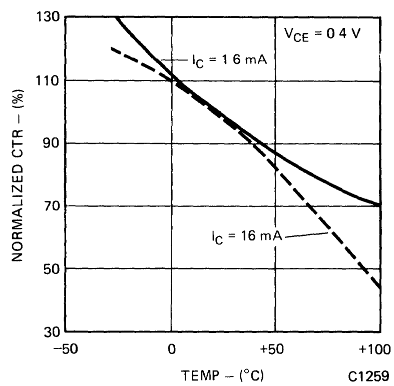


Fig. 7. Current Transfer Ratio (saturated) vs. Temperature

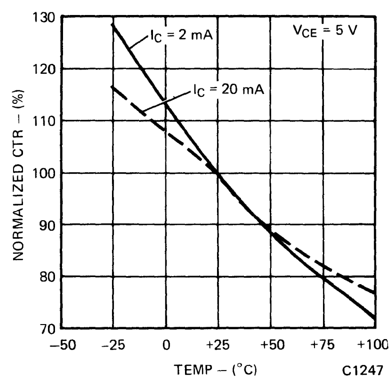


Fig. 8. Current Transfer Ratio (unsaturated) vs. Temperature

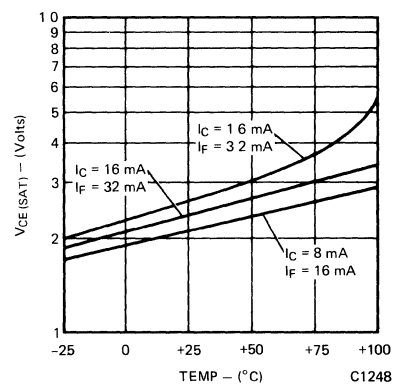


Fig. 9. Collector to Emitter Saturation Voltage vs. Temperature

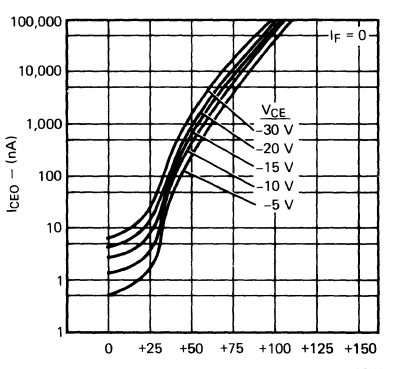


Fig. 10. Collector to Emitter Leakage Current vs. Temperature

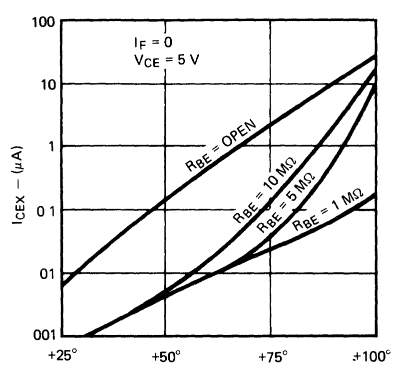


Fig. 11. Collector to Emitter Leakage Current vs. Temperature

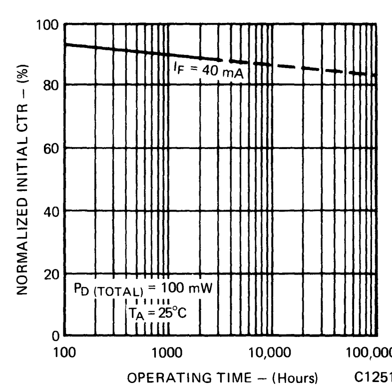


Fig. 12. Current Transfer Ratio vs. Operating Time

SWITCHING CHARACTERISTICS

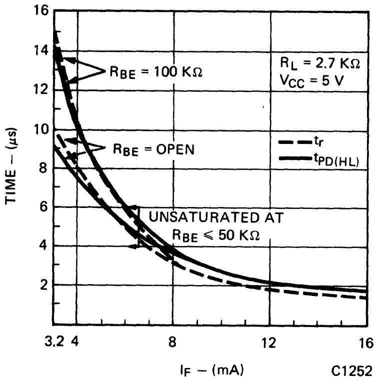


Fig. 13. Switch-on Time vs. I_F Drive (saturated)

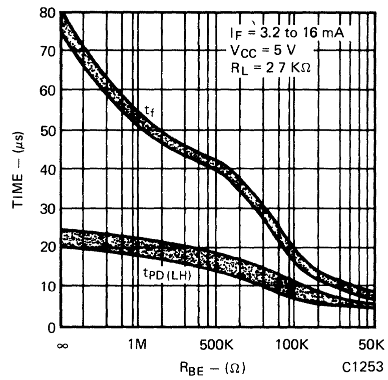


Fig. 14. Switch-off Time vs. Base to Emitter Resistance (saturated)

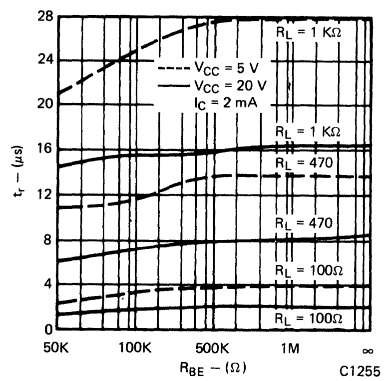


Fig. 15. Rise Time vs. Base to Emitter Resistance (non-saturated)

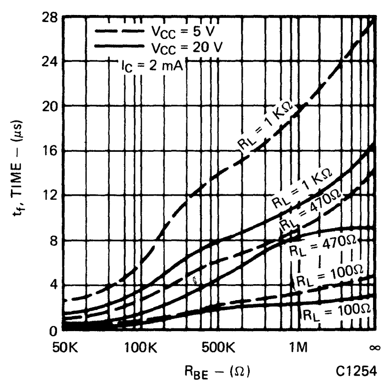


Fig. 16. Fall Time vs. Base to Emitter Resistance (non-saturated)

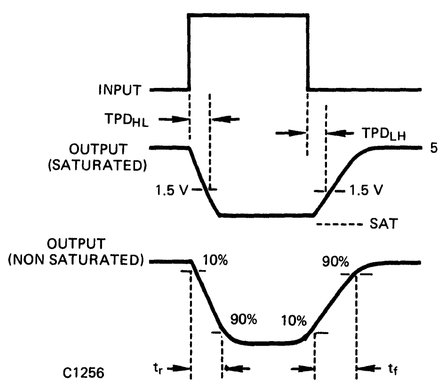


Fig. 17. Switching Time Waveforms

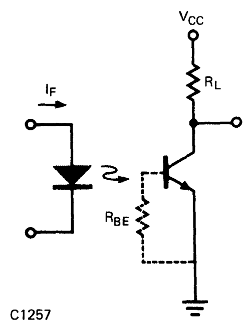


Fig. 18. Switching Time Test Circuits

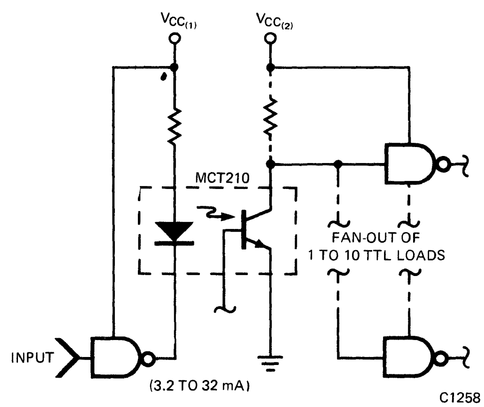


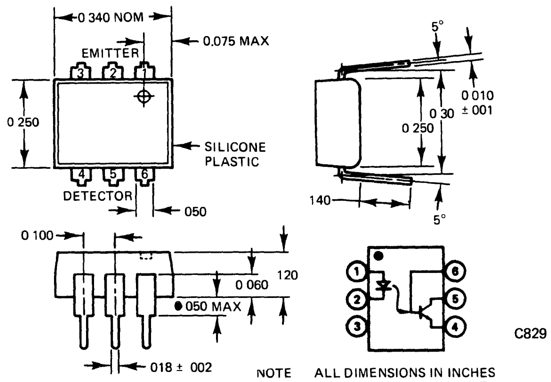
Fig. 19. Typical TTL Interface at Operating Temperatures of 0° to 70° C

Monsanto PHOTOTRANSISTOR OPTO-ISOLATOR | MCT26

PRODUCT DESCRIPTION

The MCT26 is a NPN silicon planar phototransistor optically coupled to a gallium arsenide diode. It is mounted in a six lead plastic DIP.

PACKAGE DIMENSIONS



NOTE ALL DIMENSIONS IN INCHES AND ARE TYPICAL EXCEPT AS NOTED

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

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 DC current . . . . 60 mA
- Reverse current . . . . 10 μA
- 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 . . . . 1500 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_C = 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	1500	2500	—	VDC	
	800	—	—		VAC, RMS @ f = 60 Hz
Resistance emitter-detector $R_{I\text{-}O}$	10^{11}	10^{12}		Ω	$V_{E\text{-}D}$ = 500 VDC
V_{CE} (SAT)	—	0.2	0.3	V	I_C = 250 μA, I_F = 20 mA
	—	0.2	0.5	V	I_C = 1.6 mA, I_F = 60 mA
Capacitance LED to detector $C_{I\text{-}O}$	—	0.5	—	pF	f = 1 MHz
Bandwidth (see figure 5) B_W	—	300	—	kHz	I_C = 2 mA, note 2
Rise time + fall time (see oper. schematics) t_r I_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)

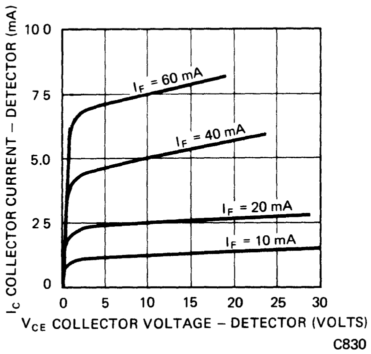


Fig. 1 Detector Output Characteristics

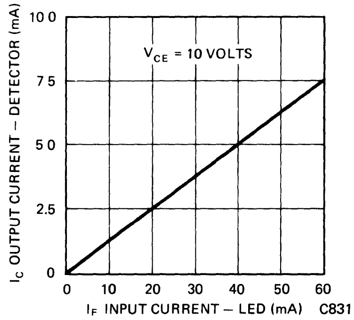


Fig. 2 Input Current vs. Output Current

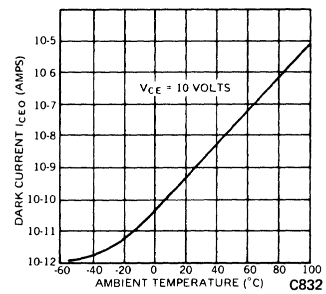


Fig. 3 Dark Current vs. Temperature (°C)

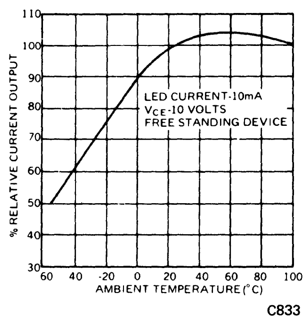


Fig. 4 Current Output vs. Temperature

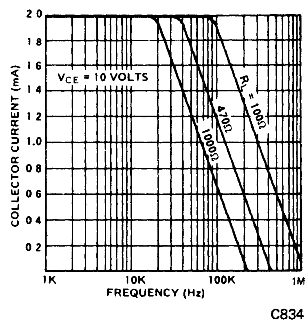


Fig. 5 Output vs. Frequency

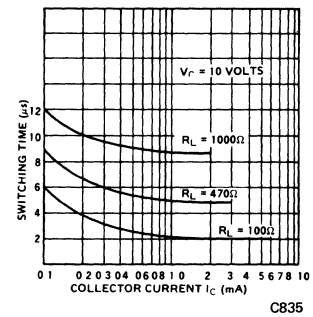


Fig. 6 Switching Time vs. Collector Current

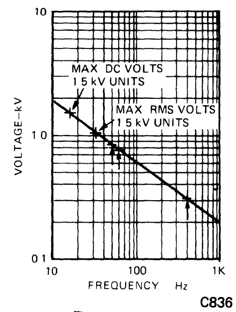
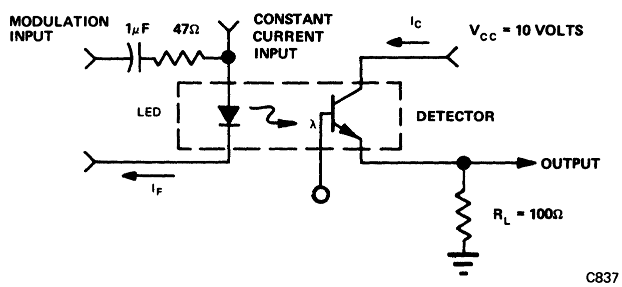


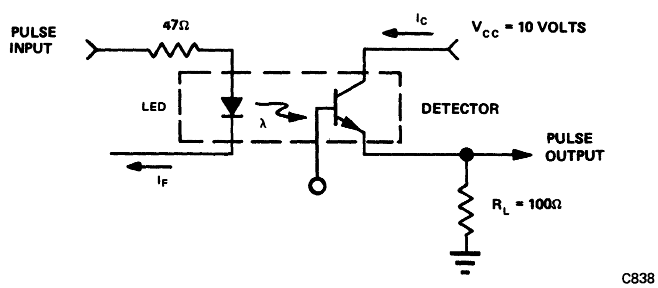
Fig. 7 Steady-State AC Voltage Limit of Isolation Dielectric

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%.*

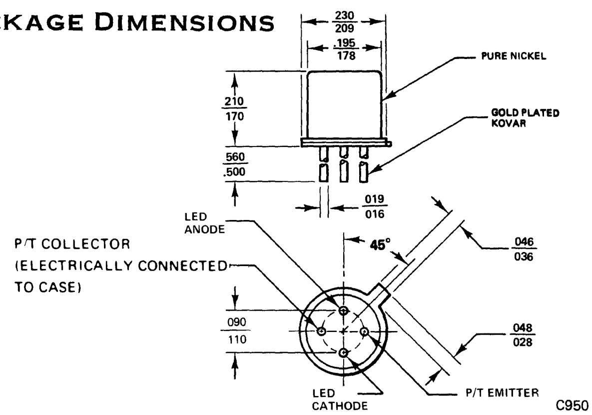
Monsanto

PHOTOTRANSISTOR OPTO-ISOLATOR | MCT4

PRODUCT 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.

PACKAGE DIMENSIONS



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 . . . . . . 60 mW
- Derate linearly from 25°C . . . . 0.6 mW/°C
- Continuous forward current . . . . 40 mA
- Reverse voltage . . . . 3.0 volts
- Peak forward current . . . . 3.0 A (1 μs pulse, 300 pps)

DETECTOR (Silicon phototransistor)

- Power dissipation @ 25°C ambient . . . . 190 mW
- Derate linearly from 25°C . . . . 1.9 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_C=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	
Resistance emitter-detector	10^{11}	10^{12}		ohms	V_{E-D}=500 V
$V_{CE(SAT)}$		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)

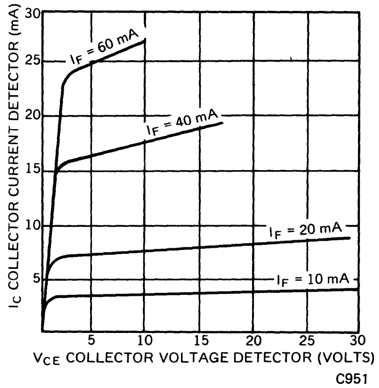


Figure 1 Detector Output Characteristics

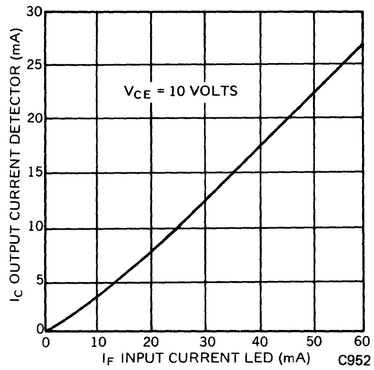


Figure 2 Input Current vs. Output Current

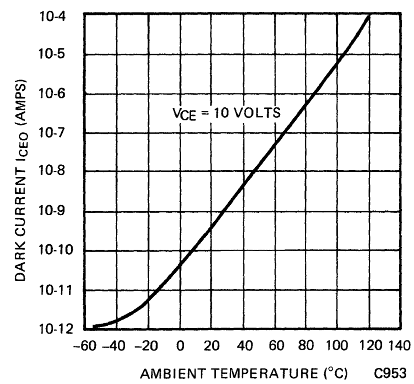


Figure 3 Dark Current vs. Temperature (°C)

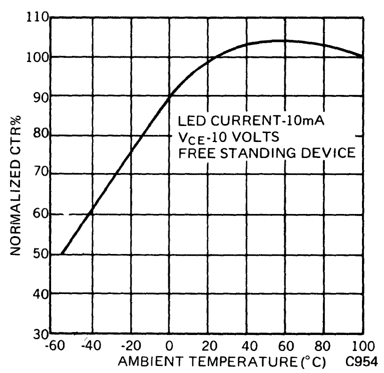


Figure 4 Current Output vs. Temperature

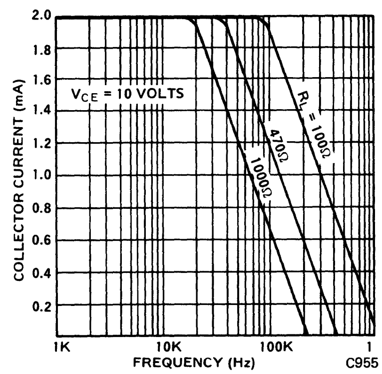


Figure 5 Output vs. Frequency

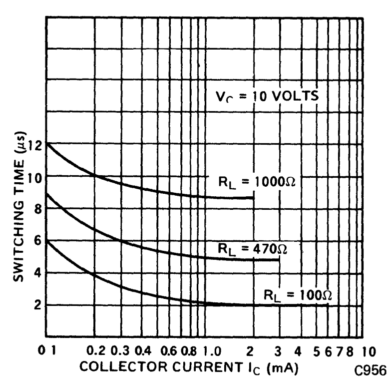
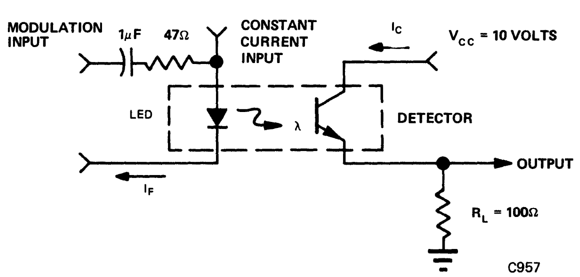


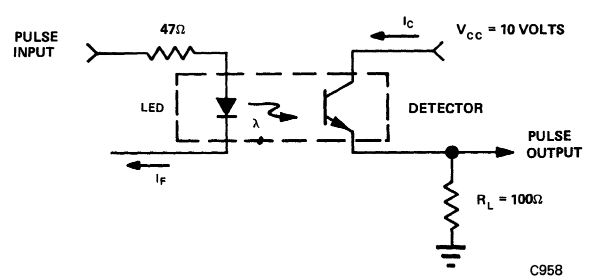
Figure 6 Switching Time vs. Collector Current

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%.*

Monsanto

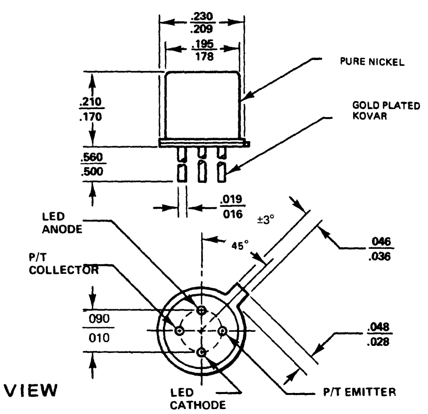
PHOTOTRANSISTOR OPTO-ISOLATOR

MCT4-R
RELIABILITY CONDITIONED

PRODUCT DESCRIPTION

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

PACKAGE DIMENSIONS



BOTTOM VIEW

FEATURES

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

The Monsanto MCT 4R is designed and manufactured to conform to the requirements of military systems. Reliability testing has proven the product capable of conforming to the screening and quality conformance requirements of MIL-STD-883 Class B devices.

SCREEN – 100%

Characteristic	Method
Internal Visual	2010 – Characteristics applicable to device
Stabilization Bake	1008 – 150°C. for 48 hours
Temperature Cycle	1010 – 10 cycles; –55°C., 25°C., 150°., 25°C.
Centrifuge	2001 – Test Condition E
Hermeticity	1014 – Fine and Gross
Critical Electrical	– Data Sheet
Burn In*	1015 – 168 hours @ 125°C.
Final Electrical	– Data Sheet
Group A Sample Inspection	5005 Table I Subgroups
External Visual	2009

LOT QUALIFICATION TESTS

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

LIFE TESTING 7% LTPD

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

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

Monsanto

DUAL PHOTOTRANSISTOR OPTO-ISOLATOR | MCT6

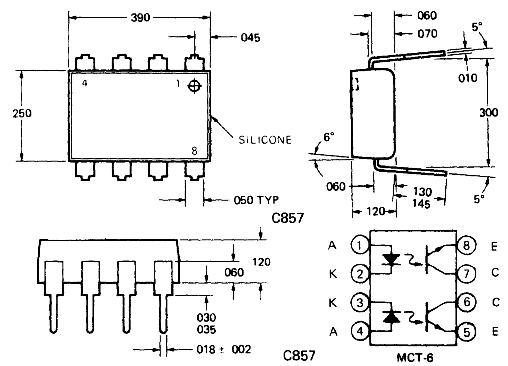
PRODUCT DESCRIPTION

The MCT6 opto-isolator has two channels for high density applications. For four channel applications, two-packages fit into a standard 16-pin DIP socket.

At the input, a GaAsLITE emitting diode generates infrared light proportional to current passing through the diode in the forward direction. At the output, a silicon phototransistor detects and amplifies the photocurrent generated in its photosensitive base region. Light coupling electrically isolates the input from the output.

PACKAGE DIMENSIONS

ALL DIMENSIONS IN INCHES



NOTE CHIPS ARE LOCATED ON PINS 2, 3, 6 AND 7

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

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)
Rated forward current, DC . . . . 60 mA
Peak reverse current . . . . 10 μA
Peak forward current (1μs pulse, 300 pps) . . . . 3 A
Power dissipation at 25°C ambient . . . . 100 mW
Derate linearly from 50°C . . . . 2 mW/°C

OUTPUT TRANSISTOR (each channel)
Power dissipation @ 25°C ambient . . . . 150 mW
Derate linearly from 25°C . . . . 2 mW/°C
Collector Current . . . . 30 mA

COUPLED
Input to output breakdown voltage . . . . . . 1500 volts DC
Total package power dissipation @ 25°C ambient . . 400 mW
Derate linearly from 25°C . . . . 5.33 mW/°C

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

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE					
Rated forward voltage V_F		1.25	1.50	V	$I_F = 20$ mA
Reverse voltage V_R	3.0	25		V	$I_R = 10\ \mu A$
Reverse current I_R		.01	10	μA	$V_R = 3.0$ V
Junction capacitance C_J		50		pF	$V_F = 0$ V
OUTPUT TRANSISTOR ($I_F = 0$)					
Breakdown voltage, collector to emitter BV_{CEO}	30	85		V	$I_C = 1.0$ mA
Breakdown voltage, emitter to collector BV_{ECO}	6	13		V	$I_C = 100\ \mu A$
Leakage current, collector to emitter I_{CEO}		5	100	nA	$V_{CE} = 10$ V
Capacitance collector to emitter C_{CE}		8		pF	$V_{CE} = 0$ V
COUPLED					
DC current transfer ratio (I_C/I_F) CTR	20	50		%	$V_{CE} = 10$ V, $I_F = 10$ mA
Isolation voltage $BV_{(I-O)}$	1500	2500		VDC	
Isolation resistance $R_{(IU)}$	10^{11}	10^{12}		Ω	$V_{I-O} = 500$ VDC
Isolation capacitance $C_{(I-O)}$		0.5		pF	f = 1 MHz
Breakdown voltage — channel-to-channel		1500		V	Relative humidity = 40%
Capacitance between channels		0.4		pF	f = 1 MHz
Saturation voltage — collector to emitter $V_{CE(SAT)}$		.20	.40	V	$I_C = 2$ mA, $I_F = 16$ mA
Bandwidth B_W		150		kHz	$I_C = 2$ mA, $V_{CC} = 10$ V, $R_L = 100\ \Omega$

ELECTRO-OPTICAL CHARACTERISTICS (Con't)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SWITCHING TIMES, OUTPUT TRANSISTOR					
Non-saturated rise time, fall time		2.4		μs	I_C = 2 mA, V_{CE} = 10 V, R_L = 100Ω
Non-saturated rise time, fall time		15		μs	I_C = 2 mA, V_{CE} = 10 V, R_L = 1 KΩ
Saturated turn-on time (from 5.0 V to 0.8 V)		5		μs	R_L = 2 KΩ, I_F = 15 mA
Saturated turn-off time (from saturation to 2.0 V)		25		μs	R_L = 2 KΩ, I_F = 15 mA

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

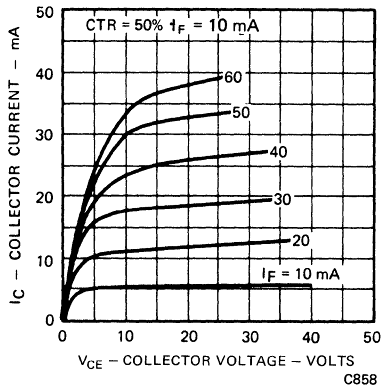


Figure 1 I-V Curve of Phototransistor

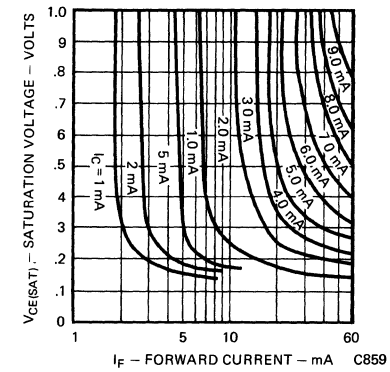


Figure 2 I-V Curve in Saturation

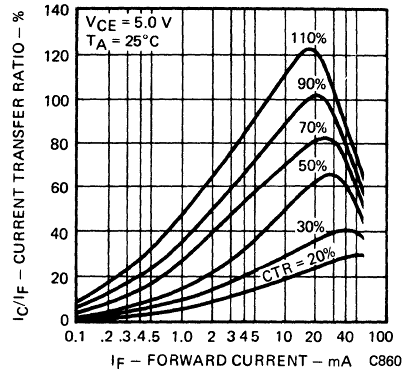


Figure 3 CTR vs. Forward Current

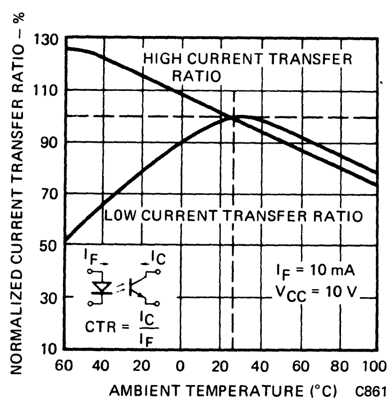


Figure 4 Current Transfer Ratio vs. Temperature

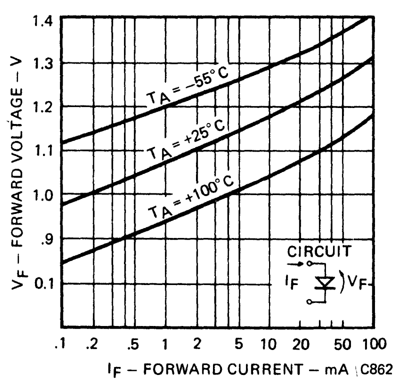


Figure 5 I-V Curve of LED vs. Temperature

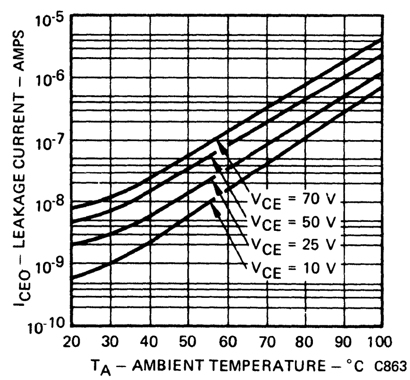


Figure 6 Leakage Current vs. Temperature vs. Collector Voltage

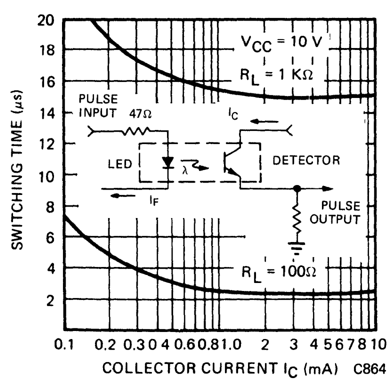


Figure 7 Switching Time vs. Collector Current

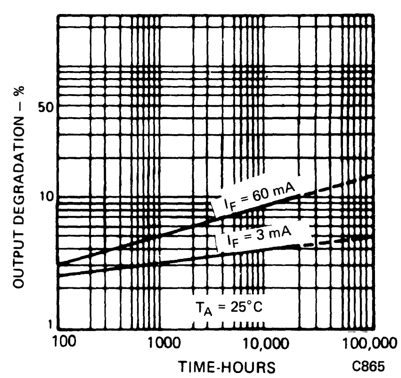


Figure 8 Lifetime vs. Forward Current (Note 1)

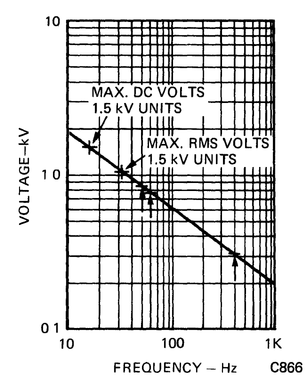


Fig. 9. Steady-State AC Voltage Limit of Isolation Dielectric

NOTES

1. Normalized CTR degradation = $\frac{CTR_o - CTR}{CTR_o}$

Monsanto

DUAL PHOTOTRANSISTOR OPTO-ISOLATOR

MCT66

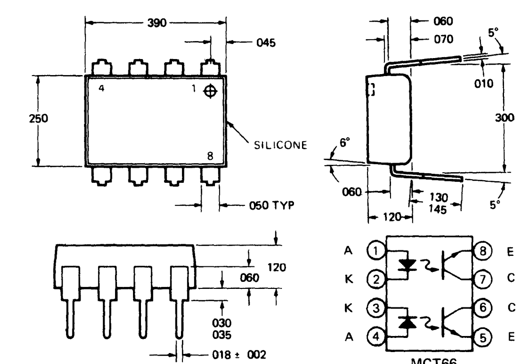
PRODUCT DESCRIPTION

The MCT66 opto-isolator has two channels for high density applications. For four channel applications, two-packages fit into a standard 16-pin DIP socket.

At the input, a GaAsLITE emitting diode generates infrared light proportional to current passing through the diode in the forward direction. At the output, a silicon phototransistor detects and amplifies the photocurrent generated in its photosensitive base region. Light coupling electrically isolates the input from the output.

PACKAGE DIMENSIONS

ALL DIMENSIONS IN INCHES



C857

NOTE CHIPS ARE LOCATED ON PINS 2, 3, 6 AND 7

FEATURES

- Two isolated channels per package
- Two packages fit into a 16 lead DIP socket
- Same basic electrical characteristics as MCT26
- 1500 volt isolation from non-repetitive surges
- 15% typical current transfer ratio

APPLICATIONS

- AC Line/Digital Logic . . . . Isolate high voltage transients
- Digital Logic/Digital Logic . . . . Eliminate spurious ground loops
- Digital Logic/AC Triac Control . . . . Isolate high voltage transients
- Twisted pair line receiver . . . . Eliminate ground loop pick-up
- Telephone/Telegraph line receiver. . . Isolate high voltage transients
- High Frequency Power Supply Feedback Control . . . . Maintain floating ground
- Relay contact monitor . . . . Isolate floating grounds and transients
- Power Supply Monitor . . . . Isolate transients and ground systems

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)

- Rated forward current, DC . . . . 60 mA
- Peak reverse current . . . . 10 μA
- Reverse voltage . . . . 3.0 V
- Peak forward current (1 μs pulse, 300 pps) . . . . 3 A
- Power dissipation at 25°C ambient . . . . 100 mW
- Derate linearly from 50°C . . . . 2 mW/°C

OUTPUT TRANSISTOR (each channel)

- Power dissipation @ 25°C ambient . . . . 150 mW
- Derate linearly from 25°C . . . . 2 mW/°C
- Collector Current . . . . 30 mA

COUPLED

- Input to output breakdown voltage . . . . . . 1500 volts DC
- Total package power dissipation @ 25°C ambient . . 400 mW
- Derate linearly from 25°C . . . . 5.33 mW/°C

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

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE					
Rated forward voltage V_F	—	1.25	1.50	V	I_F = 20 mA
Reverse voltage V_R	3.0	25	—	V	I_R = 10 μA
Reverse current I_R	—	.001	10	μA	V_R = 3.0 V
Junction capacitance C_J	—	50	—	pF	V_F = 0 V
OUTPUT TRANSISTOR (I_F = 0)					
Breakdown voltage, collector to emitter BV_{CEO}	30	85	—	V	I_C = 1.0 mA
Breakdown voltage, emitter to collector BV_{ECO}	6	13	—	V	I_C = 100 μA
Leakage current, collector to emitter I_{CEO}	—	5	100	nA	V_{CE} = 10 V
Capacitance collector to emitter C_{CE}		8		pF	V_{CE} = 0 V
COUPLED					
DC current transfer ratio (I_C/I_F) = CTR	6	15	—	%	V_{CE} = 10 V, I_F = 10 mA
Isolation voltage $BV_{(I-O)}$	1500	2500	—	VDC	Peak from non-repetitive surges
Isolation resistance $R_{(I-O)}$	10^{11}	10^{12}	—	Ω	V_{I-O} = 500 VDC
Isolation capacitance $C_{(I-O)}$	—	0.5	—	pF	f = 1 MHz
Breakdown voltage — channel-to-channel	—	1500	—	VDC	Relative humidity = 40%
Capacitance between channels	—	0.4	—	pF	f = 1 MHz
Saturation voltage — collector to emitter V_{CE} (SAT)	—	0.2	0.4	V	I_C = 2 mA, I_F = 40 mA
Bandwidth B_W	—	150	—	kHz	I_C = 2 mA, V_{CC} = 10 V, R_L = 100 Ω

ELECTRO-OPTICAL CHARACTERISTICS (Con't)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SWITCHING TIMES, OUTPUT TRANSISTOR					
Non-saturated rise time, fall time (Note 3)		2.4		μs	I_C = 2 mA, V_{CE} = 10 V, R_L = 100 Ω
Non-saturated rise time, fall time (Note 3)		15		μs	I_C = 2 mA, V_{CE} = 10 V, R_L = 1 kΩ
Saturated turn-on time (from 5.0 V to 0.8 V)		5		μs	R_L = 2 KΩ, I_F = 40 mA
Saturated turn-off time (from saturation to 2.0 V)		25		μs	R_L = 2 KΩ, I_F = 40 mA

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

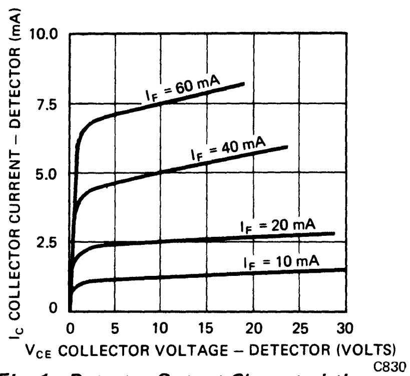


Fig. 1. Detector Output Characteristics

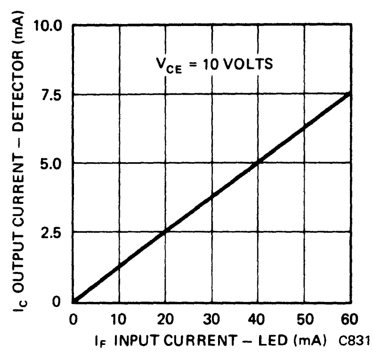


Fig. 2. Input Current vs. Output Current

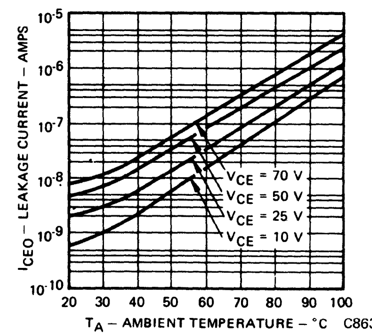


Fig. 3. Leakage Current vs. Temperature vs. Collector Voltage

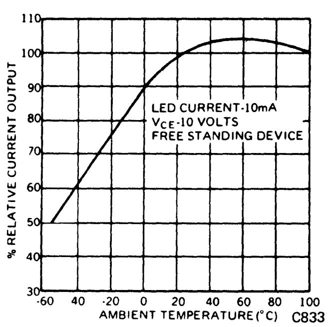


Fig. 4. Current Output vs. Temperature

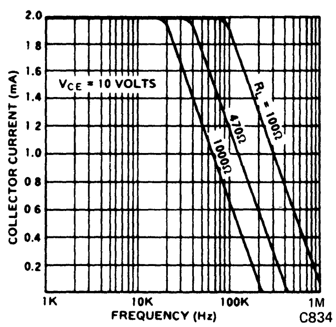


Fig. 5. Output vs. Frequency

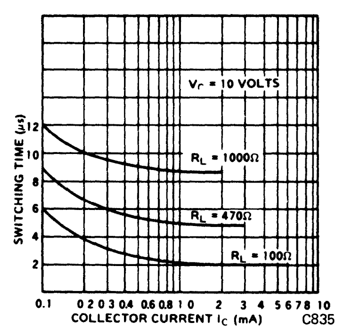


Fig. 6. Switching Time vs. Collector Current

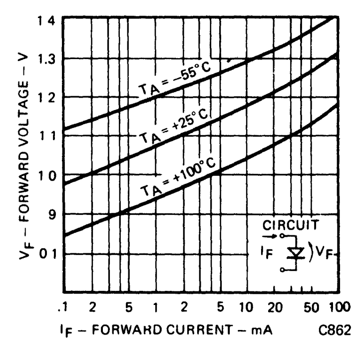


Fig. 7. I-V Curve of LED vs. Temperature

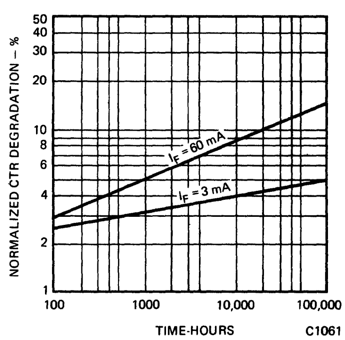
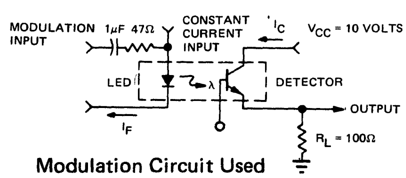
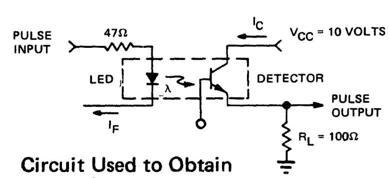


Fig. 8. Lifetime vs. Forward Current



Modulation Circuit Used to Obtain Figure 5 C837



Circuit Used to Obtain Figure 6 C838

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%.

Monsanto

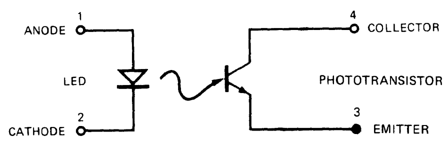
SLOTTED OPTICAL LIMIT SWITCH

MCT8 MCT81

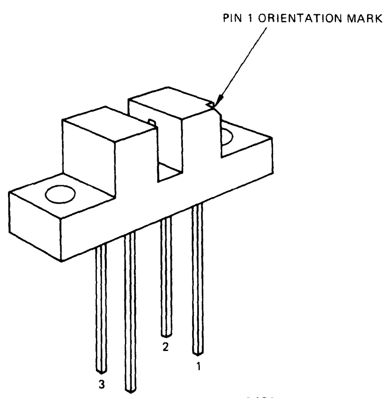
PRODUCT DESCRIPTION

The MCT8 optical limit switch transmits light from a GaAs infrared emitting diode onto a silicon phototransistor. Both semiconductor chips face each other across an .01 inch air gap. The MCT8 senses an object in the air gap by the effect on light transmission.

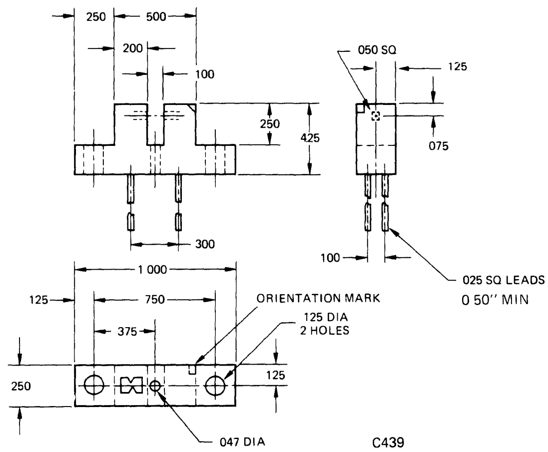
PACKAGE DIMENSIONS



C437



C438



C439

Dimensions ± .010 inches
All dimensions are in inches.

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 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.

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

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F		1.30	1.50	V	$I_F = 20$ mA
Reverse Breakdown Voltage	BV_R	3.0	20		V	$I_R = 10\ \mu A$
Reverse Leakage Current	I_R		.01	10	μA	$V_R = 3$ V
OUTPUT TRANSISTOR—MCT8						
DC Current Transfer Ratio	CTR	.200	1.0		mA	$I_F = 20$ mA, $V_{CE} = 10$ V
Saturation Voltage	V_{CE}(SAT)		0.2	0.4	V	$I_C = 50\ \mu A$, $I_F = 20$ mA (Note 1)
Collector Breakdown Voltage	BV_{CEO}	30	55		V	$I_C = 1$ mA, $I_F = 0$ (Note 1)
Emitter Breakdown Voltage	BV_{ECO}	5	7		V	$I_C = 100\ \mu A$, $I_F = 0$ (Note 2)
Dark Current	I_{CEO}		5	100	nA	$V_{CE} = 10.0$ V, $I_F = 0$ (Note 1)
Ambient Leakage Current			0.35		μA	$V_{CE} = 10.0$ V, $I_F = 0$ (Note 2)
Rise Time	tr		5		μsec	$V_{CC} = 10$ V, $I_C = 1$ mA $R_L = 100\ \Omega$ CIRCUIT 1
Fall Time	tf		4		μsec	$V_{CC} = 10$ V, $I_C = 1$ mA, $R_L = 100\ \Omega$ CIRCUIT 1
Turn-on Time (from 5 V to 0.8 V)	t_{ON}		6		μsec	$I_F = 40$ mA CIRCUIT 2 $R_B = 1.2k\Omega$, $R_L = 2.4k\Omega$
Turn-off Time (from SAT. to 2 V)	t_{OFF}		4		μsec	$I_F = 40$ mA CIRCUIT 2 $R_B = 1.2k\Omega$, $R_L = 2.4k\Omega$
OUTPUT TRANSISTOR—MCT81						
DC Current Transfer Ratio	CTR	50	100		μA	$I_F = 20$ mA, $V_{CE} = 10$ V
Saturation Voltage	V_{CE}(SAT)		0.2	0.4	V	$I_C = 25\ \mu A$, $I_F = 20$ mA (Note 1)
Collector Breakdown Voltage	BV_{CEO}	30	55		V	$I_C = 1$ mA, $I_F = 0$ (Note 1)
Emitter Breakdown Voltage	BV_{ECO}	5	7		V	$I_C = 100\ \mu A$, $I_F = 0$ (Note 2)
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, $I_F = 0$ (Note 2)
Rise Time	tr		3		μsec	$V_{CC} = 10$ V, $I_C = 1$ mA $R_L = 100\ \Omega$ CIRCUIT 1
Fall Time	tf		4		μsec	$V_{CC} = 10$ V, $I_C = 1$ mA $R_L = 100\ \Omega$ CIRCUIT 1
Turn-on Time (from 5 V to 0.8 V)	t_{ON}		6		μsec	$I_F = 40$ mA CIRCUIT 2 $R_B = 1.2k\Omega$, $R_L = 2.4k\Omega$
Turn-off Time (from SAT to 2 V)	t_{OFF}		3		μsec	$I_F = 40$ mA CIRCUIT 2 $R_B = 1.2k\Omega$, $R_L = 2.4k\Omega$

ABSOLUTE MAXIMUM RATINGS

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

Input Diode
Forward DC Current .... 50 mA
Reverse DC Current .... 4 mA
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)

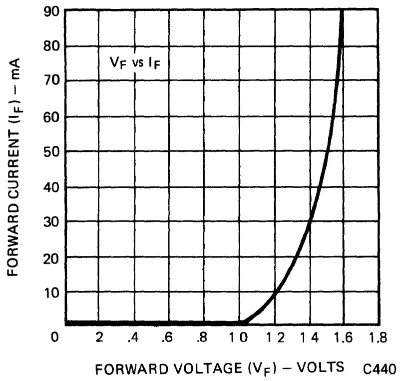


Fig. 1. Forward Voltage vs. Forward Current

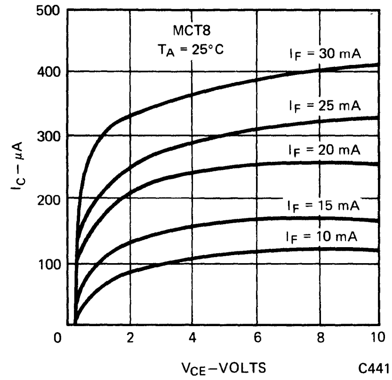


Fig. 2. Collector Current vs. Collector Voltage

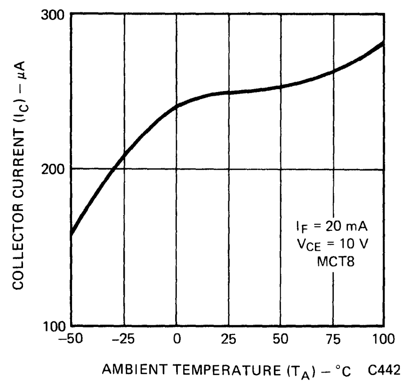


Fig. 3. Collector Current vs. Ambient Temperature

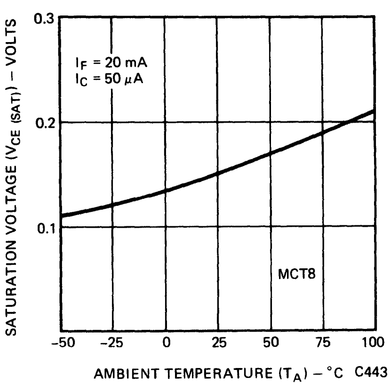


Fig. 4. Saturation Voltage vs. Temperature

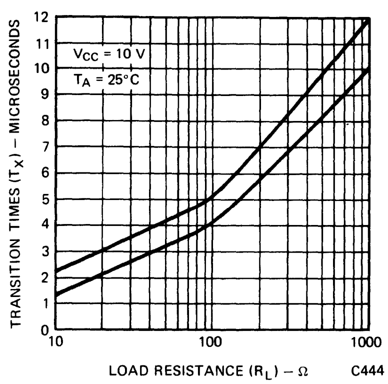


Fig. 5. Non-saturated Rise and Fall Times vs. Load Resistance

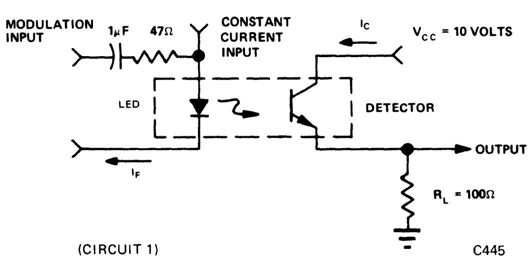


Figure 6.

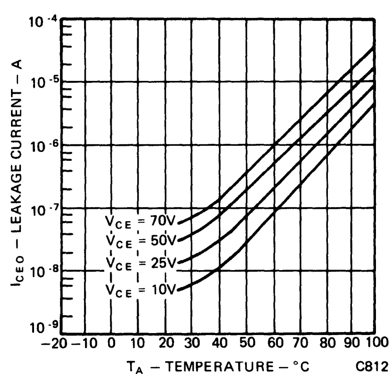


Fig. 7. Dark Current vs. Temperature

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (CONT.)

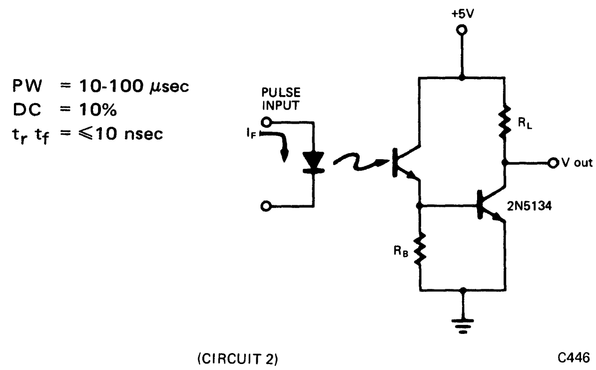


Figure 7.

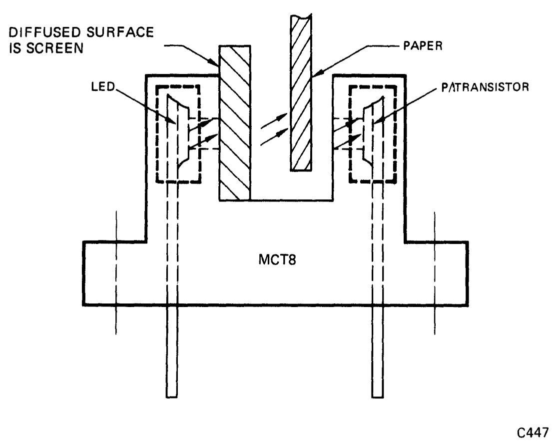


Fig. 8. Detecting Paper by Using a Lens Screen

DETECTING PAPER BY USING A LENS SCREEN

Infrared light tends to go right through paper, making detection very difficult. For instance, one sheet of white 20# bond paper has an ON/OFF ratio of 1.5 to 1. This ratio can be greatly increased by diffusing the light from the LED prior to striking the paper. A piece of paper used as a diffusant increases the ON/OFF ratio to 5:1. For best results, use a plexiglas lens screen, No. LS85PL 1/16, made by Polacoat, 9750 Conklin Road, Cincinnati, Ohio 45242. This screen transmits 90% of the original light, yet increases the ON/OFF ratio to 16:1 for 20# bond paper, and 60:1 for a manila card.

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.*
2. *Measured at typical factory ambient of 150 foot-candles (150 lamberts per square foot).*
3. *Rise time is the time required for the collector current to increase from 10% of its final value to 90%.*
   Fall time is the time required for the collector current to decrease from 90% of its initial value to 10%.

7 PHOTO-DETECTORS

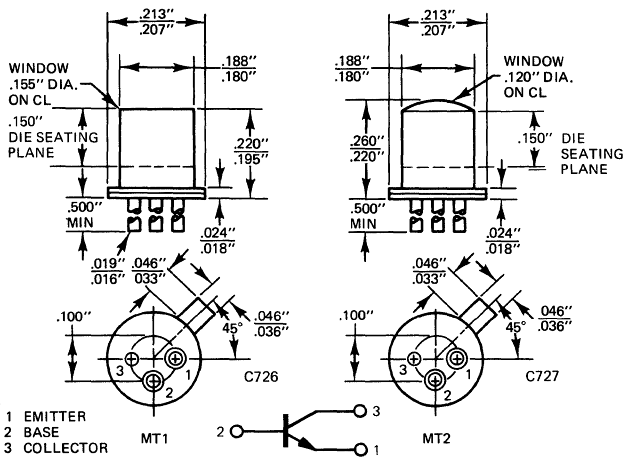
Monsanto

SILICON PHOTOTRANSISTOR — MT1 MT2

PRODUCT 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 optical gain of 4.

PACKAGE DIMENSIONS



NOTE
LEAD 1 EMITTER
LEAD 2 BASE
LEAD 3 COLLECTOR

NOTE Active Area = .032" x .032"

FEATURES & APPLICATIONS

- 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}=5.0 V, I_C=2.0 mA, R_L=100Ω
Light current fall time (see figure 8) (t_r)		2.0		µs	V_{CC}=5.0 V, I_C=2.0 mA, R_L=100Ω
Delay time (see figure 8) (t_d)		1.2		µs	V_{CC}=5.0 V, I_C=2.0 mA, R_L=100Ω
Frequency response		300		kHz	V_{CC}=5.0 V, I_C=2.0 mA, R_L=100Ω

ELECTRICAL 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)

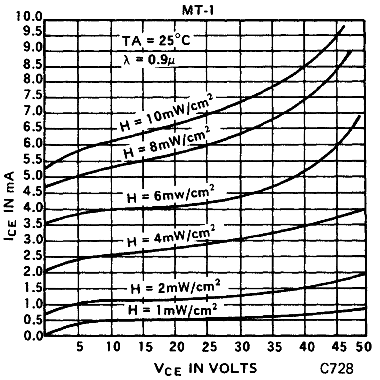


Figure 1 Collector-Emitter Characteristics

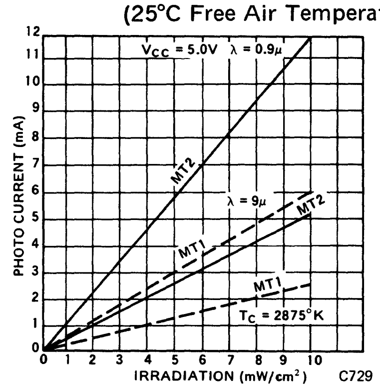


Figure 2 Photo Current vs. Irradiation

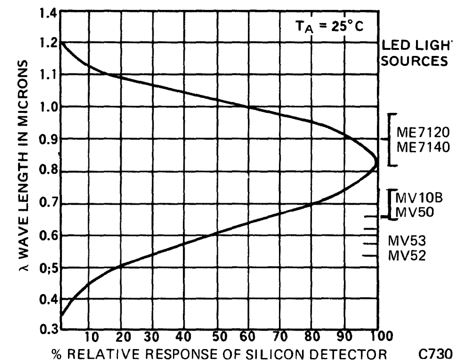


Figure 3 Spectral Response

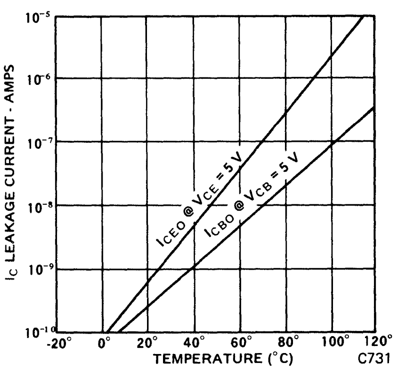


Figure 4 Leakage Current vs. Temperature

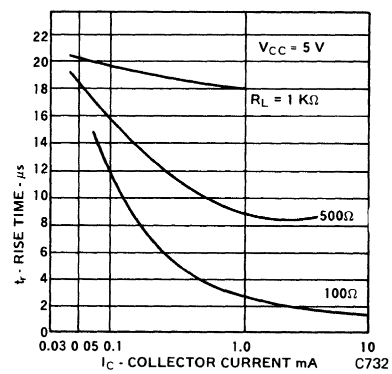


Figure 5 Rise Time vs. Collector Current

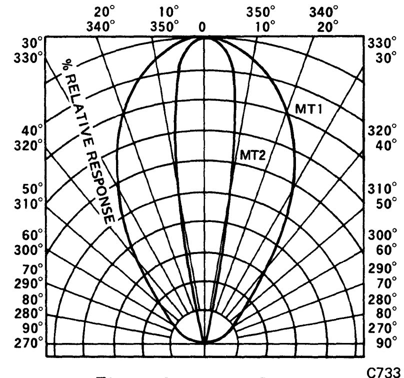


Figure 6 Angular Response

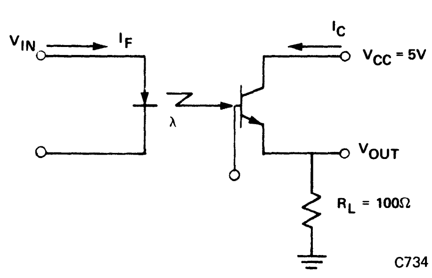


Fig. 7 Circuit Used to Obtain Switching Time vs. Collector Current Plot

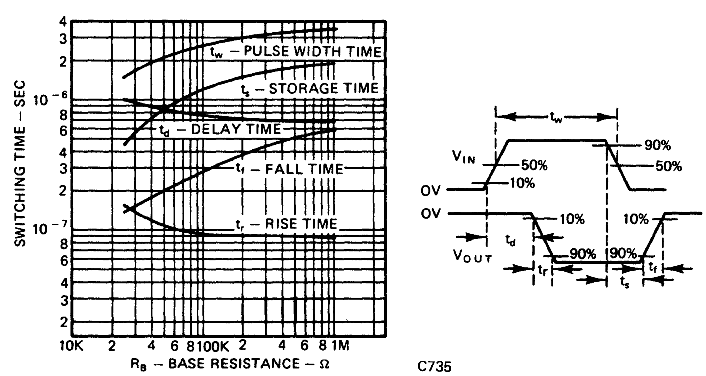


Fig. 8 Switching Time vs. Base Resistance

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.*

Monsanto

DUAL PHOTOTRANSISTOR OPTO-ISOLATOR

MCT6

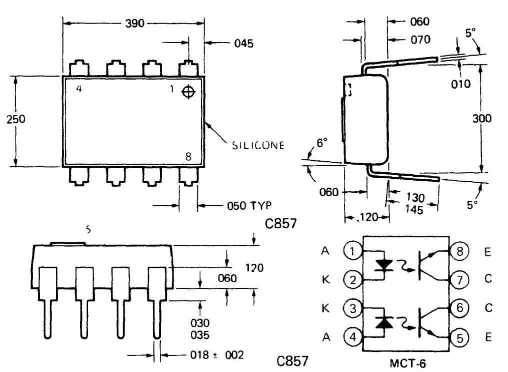
PRODUCT DESCRIPTION

The MCT6 opto-isolator has two channels for high density applications. For four channel applications, two-packages fit into a standard 16-pin DIP socket.

At the input, a GaAsLITE emitting diode generates infrared light proportional to current passing through the diode in the forward direction. At the output, a silicon phototransistor detects and amplifies the photocurrent generated in its photosensitive base region. Light coupling electrically isolates the input from the output.

PACKAGE DIMENSIONS

ALL DIMENSIONS IN INCHES



NOTE CHIPS ARE LOCATED ON PINS 2, 3, 6 AND 7

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

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)

Rated forward current, DC	60 mA
Peak reverse current	10 μA
Peak forward current (1μs pulse, 300 pps)	3 A
Power dissipation at 25°C ambient	100 mW
Derate linearly from 50°C	2 mW/°C

OUTPUT TRANSISTOR (each channel)

Power dissipation @ 25°C ambient	150 mW
Derate linearly from 25°C	2 mW/°C
Collector Current	30 mA

COUPLED

Input to output breakdown voltage	1500 volts DC
Total package power dissipation @ 25°C ambient	400 mW
Derate linearly from 25°C	5.33 mW/°C

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

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE					
Rated forward voltage		1.25	1.50	V	I_F = 20 mA
Reverse voltage	3.0	5		V	I_R = 10 μA
Reverse current		.001	10	μA	V_R = 3.0 V
Junction capacitance		100		pF	V_F = 0 V
		300		pF	V_F = 1 V
OUTPUT TRANSISTOR (I_F = 0)					
Breakdown voltage, collector to emitter	30	65		V	I_C = 1.0 mA
Breakdown voltage, emitter to collector	6	13		V	I_C = 100 μA
Leakage current, collector to emitter		1	100	nA	V_{CE} = 10 V
Capacitance collector to emitter		8		pF	V_{CE} = 0 V
COUPLED					
DC current transfer ratio (I_C/I_F)	20	50		%	V_{CE} = 10 V, I_F = 10 mA
Isolation voltage	1500	2500		V	
Isolation resistance	10^{11}	10^{12}		Ω	V_{I-O} = 500 V
Isolation capacitance		0.5		pF	f = 1 MHz
Breakdown voltage — channel-to-channel		1500		V	Relative humidity = 40%
Capacitance between channels		0.4		pF	f = 1 MHz
Saturation voltage — collector to emitter			.40	V	I_C = 2 mA, I_F = 16 mA
Bandwidth		150		KHz	I_C = 2 mA, V_{CC} = 10 V, R_L = 100 Ω

ELECTRO-OPTICAL CHARACTERISTICS (Con't)

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SWITCHING TIMES, OUTPUT TRANSISTOR					
Non-saturated rise time, fall time		2.4		μs	I_C = 2 mA, V_{CE} = 10 V, R_L = 100Ω
Non-saturated rise time, fall time		15		μs	I_C = 2 mA, V_{CE} = 10 V, R_L = 1 KΩ
Saturated turn-on time (from 5.0 V to 0.8 V)		5		μs	R_L = 2 KΩ, I_F = 15 mA
Saturated turn-off time (from saturation to 2.0 V)		25		μs	R_L = 2 KΩ, I_F = 15 mA

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

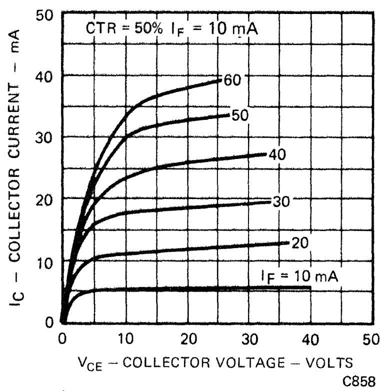


Figure 1 I-V Curve of Phototransistor

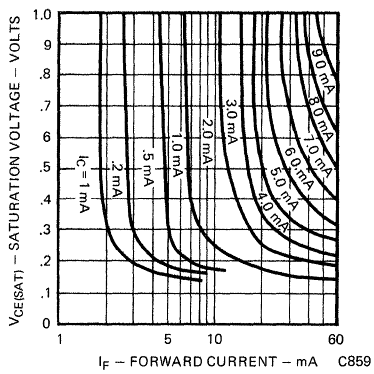


Figure 2 I-V Curve in Saturation

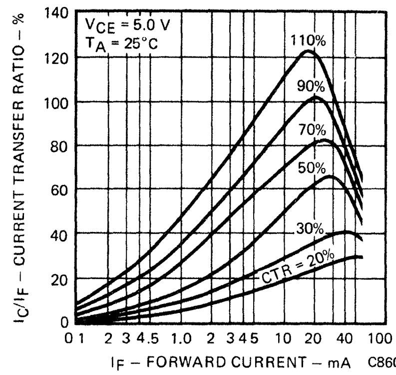


Figure 3 CTR vs. Forward Current

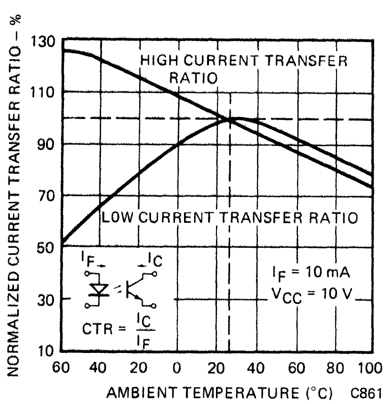


Figure 4 Current Transfer Ratio vs. Temperature

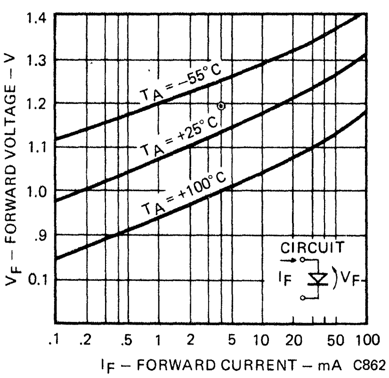


Figure 5 I-V Curve of LED vs. Temperature

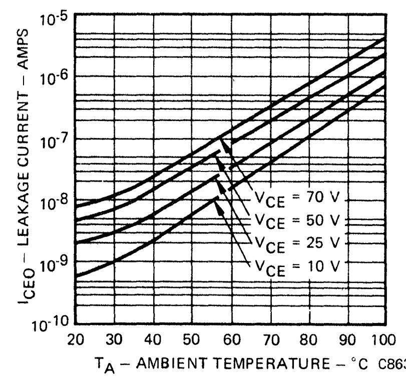


Figure 6 Leakage Current vs. Temperature vs. Collector Voltage

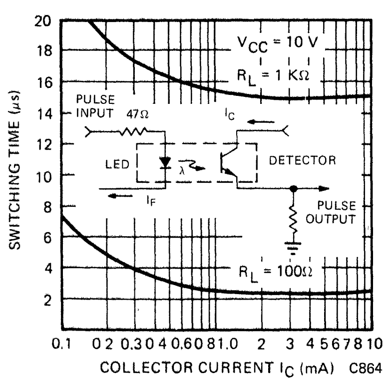


Figure 7 Switching Time vs. Collector Current

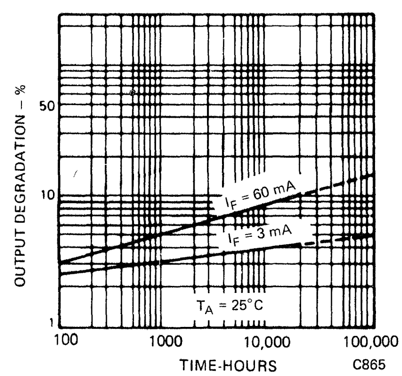


Figure 8 Lifetime vs. Forward Current (Note 1)

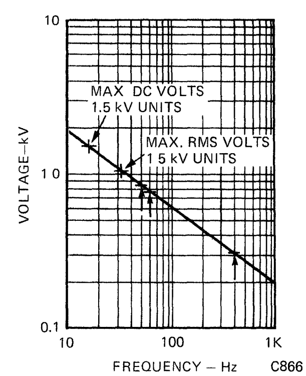


Fig. 9. Steady-State AC Voltage Limit of Isolation Dielectric

NOTES

1. Normalized CTR degradation = $\frac{CTR_o - CTR}{CTR_o}$
2. For more applications detail, see Application Notes Handbook.

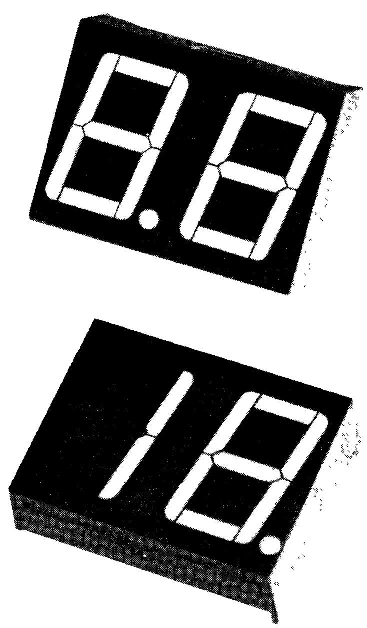
Monsanto

0.560-INCH RED HIGH PERFORMANCE DISPLAY

MAN6700 SERIES

DESCRIPTION

The MAN6700 Series is a family of large digits which can be mounted on 0.5-inch centers. The series features the sculptured font which minimizes "gappiness" at the segment intersections. The models available are two-digit, with right-hand decimal points and one and one-half digit, with polarity sign and right-hand decimal points. Both models are available in a common anode or common cathode configuration.



FEATURES

- High performance GaAsP
- Large, easy to read, digits
- Common anode or common cathode models
- Also available in orange
- 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
- Wide angle viewing . . . 150°
- Standard double-dip lead configuration
- Low forward voltage
- Two-digit package simplifies alignment & assembly

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point-of-sale equipment
- Digital clocks
- TV and radios

MODEL NUMBERS

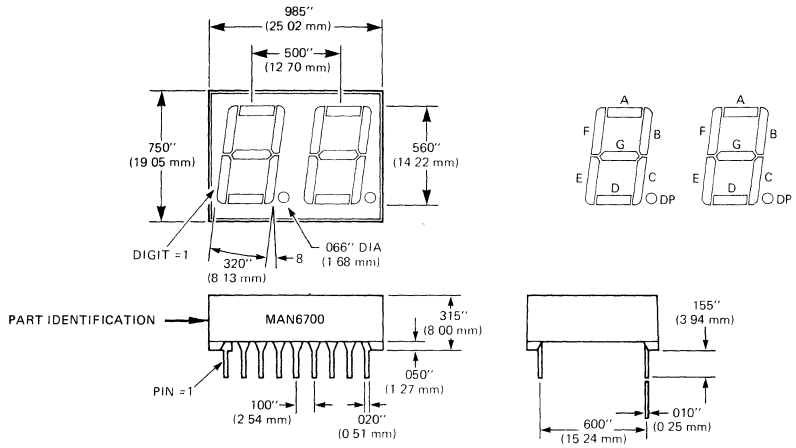
PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN-OUT SPECIFICATION
MAN6710	Red	2 Digit; Common Anode; Rt. Hand Decimal	A	A
MAN6730	Red	1½ Digit; Common Anode; Overflow ±1.8. Rt. Hand Decimal	B	B
MAN6740	Red	2 Digit; Common Cathode; Rt. Hand Decimal	A	C
MAN6750	Red	1½ Digit; Common Cathode; Overflow ±1.8. Rt. Hand Decimal	B	D

FILTER RECOMMENDATIONS

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

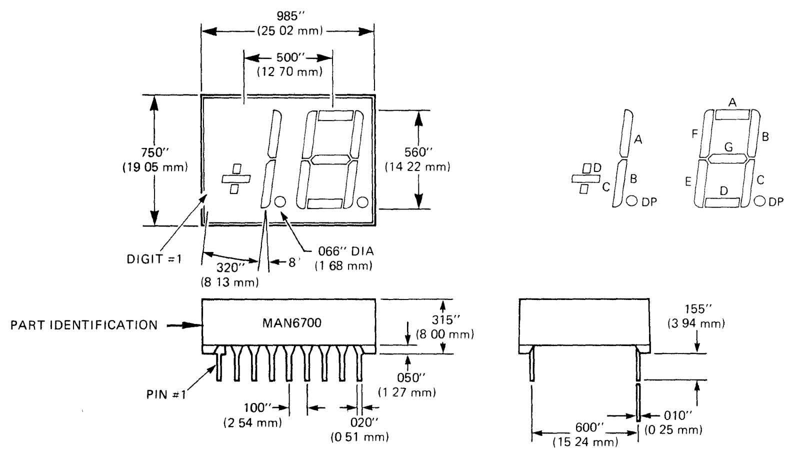
MAN6700 Series	Panelgraphic Red 60 Homalite 100 - 1605

PACKAGE DIMENSIONS



A

C1185



B

C1186

PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS			
	A MAN6710	B MAN6730	C MAN6740	D MAN6750
1	E cathode (No. 1)	C cathode (No. 1)	E anode (No. 1)	C anode (No. 1)
2	D cathode (No. 1)	D cathode (No. 1)	D anode (No. 1)	D anode (No. 1)
3	C cathode (No. 1)	B cathode (No. 1)	C anode (No. 1)	B anode (No. 1)
4	DP cathode (No. 1)	DP cathode (No. 1)	DP anode (No. 1)	DP anode (No. 1)
5	E cathode (No. 2)	E cathode (No. 2)	E anode (No. 2)	E anode (No. 2)
6	D cathode (No. 2)	D cathode (No. 2)	D anode (No. 2)	D anode (No. 2)
7	G cathode (No. 2)	G cathode (No. 2)	G anode (No. 2)	G anode (No. 2)
8	C cathode (No. 2)	C cathode (No. 2)	C anode (No. 2)	C anode (No. 2)
9	DP cathode (No. 2)	DP cathode (No. 2)	DP anode (No. 2)	DP anode (No. 2)
10	B cathode (No. 2)	B cathode (No. 2)	B anode (No. 2)	B anode (No. 2)
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

ABSOLUTE MAXIMUM RATINGS

	MAN6710/6740	MAN6730/6750
Power dissipation @ 25°C ambient	800 mW	650 mW
Derate linearly from 25°C	−13 mW/°C	−10.5 mW/°C
Storage and operating temperature	−40°C to 85°C	−40°C to 85°C
Continuous forward current		
Total	320 mA	260 mA
Per segment	20 mA	20 mA
Decimal point	20 mA	20 mA
Reverse voltage		
Per segment	5.0 V	5.0 V
Decimal point	5.0 V	5.0 V
Solder time @ 260°C (see Note 3 and 4)	5 sec	5 sec

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

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous intensity, Digit Average (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)	55			μcd	I_F = 10 mA
Peak emission wavelength		650		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		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
Decimal point			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. 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.*
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.*

TYPICAL CURVES

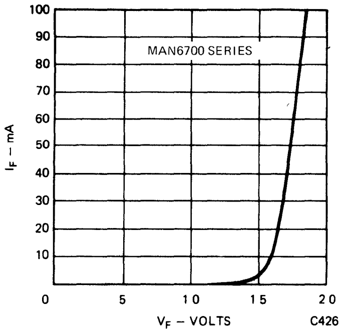


Fig. 1. Forward Current vs. Forward Voltage

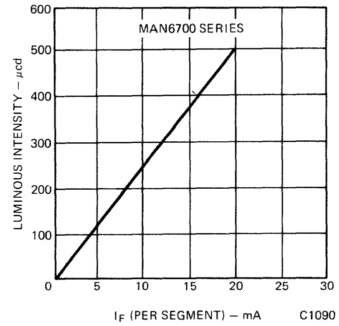


Fig. 2. Luminous Intensity vs. Forward Current

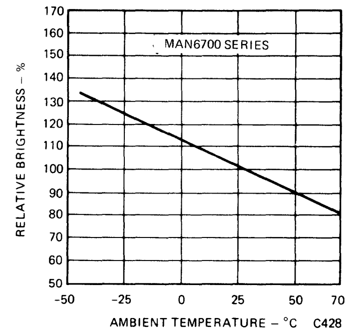


Fig. 3. Luminous Intensity vs. Temperature (See Note 2)

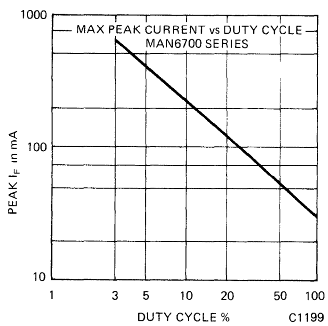


Fig. 4. Max Peak Current vs. Duty Cycle

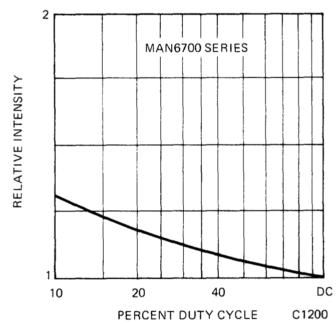
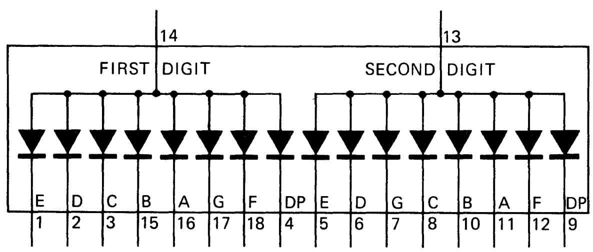
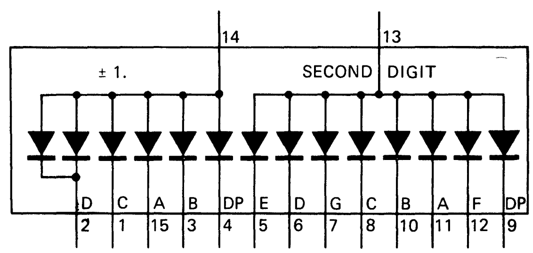


Fig. 5. Luminous Intensity vs. Duty Cycle

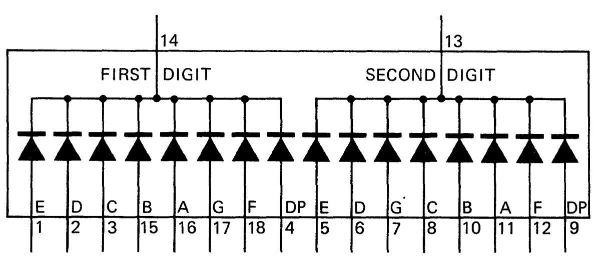
INTERNAL CONNECTIONS



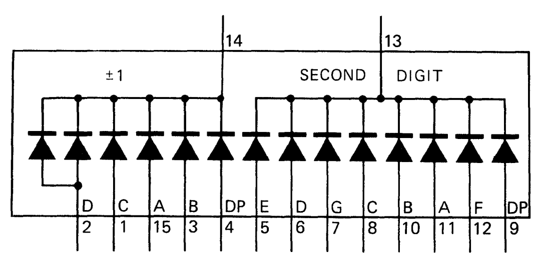
MAN6710 C1195



MAN6730 C1196



MAN6740 C1197



MAN6750 C1198

Monsanto / Electronics Division
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(415) 493-3300–TWX (910) 373-1767

Monsanto

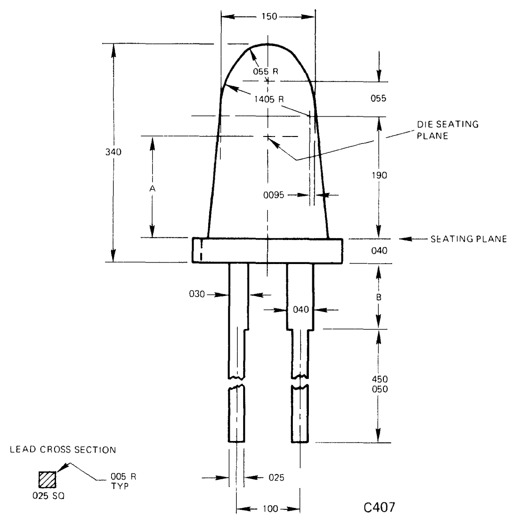
HIGH POWER INFRARED EMITTERS

ME7121, ME7122, ME7123, ME7124

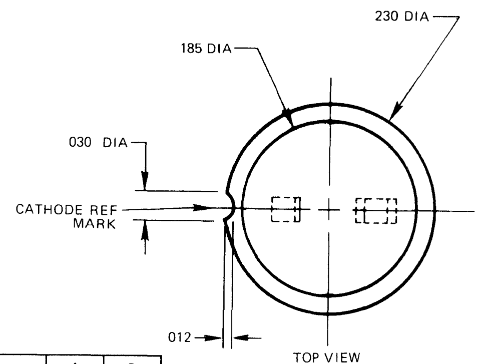
PRODUCT DESCRIPTION

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.

PACKAGE DIMENSIONS



C407



DIM	A	B
ME7121	190	100
ME7122	175	115
ME7123	160	130
ME7124	145	145

C407

ABSOLUTE MAXIMUM RATINGS

Maximum power dissipation @ 25°C ambient	150 mW
Derate linearly from 50°C	2.8 mW/°C
Maximum storage & operating temperature	−55° to 100°C
Maximum lead solder time @ 260°C (Note 3)	5 sec
Maximum continuous forward current	100 mA
Maximum reverse voltage	3.0 V
Peak forward current (PW - 1.0 μsec, Duty Cycle = 0.1%)	6.0 A

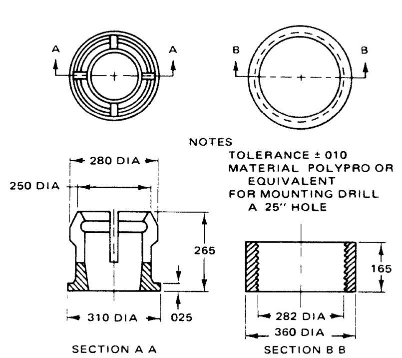
ELECTRO-OPTICAL CHARACTERISTICS

	TYPICAL HALF ANGLE (DEGREES)	TYPICAL ON AXIS INTENSITY (MW/STR.) @ 50 mA
ME7121	15°	10.8
ME7122	10°	26.4
ME7123	6°	105.6
ME7124	4°	243.6

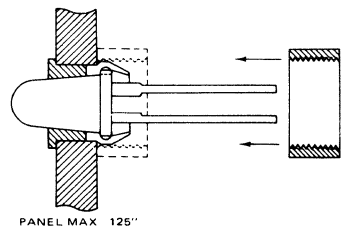
into cone @ 1/2 power points @ I_F = 50 mA ROP = 3 mW

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

PANEL MOUNTING TECHNIQUES



MOUNTING GROMMET



PANEL MOUNTING

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

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

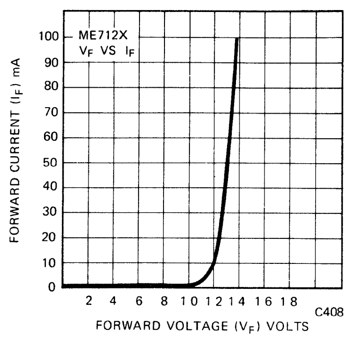


Fig. 1. I_F vs. V_F

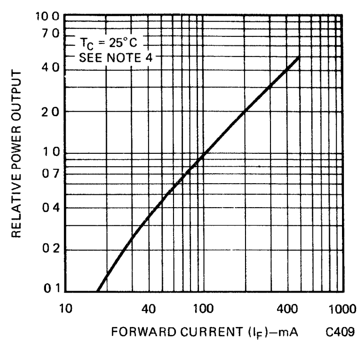


Fig. 2. ROP vs. I_F Peak

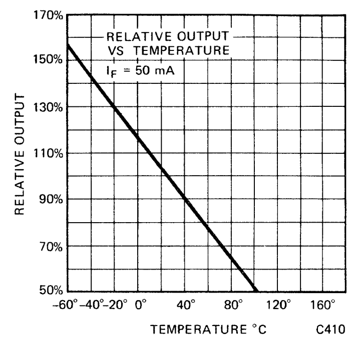


Fig. 3. ROP vs. Temperature (Note 1)

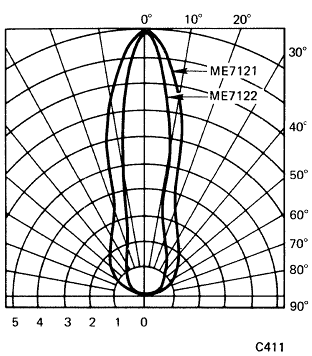


Fig. 4. Spatial Distribution (ME7121 and ME7122)

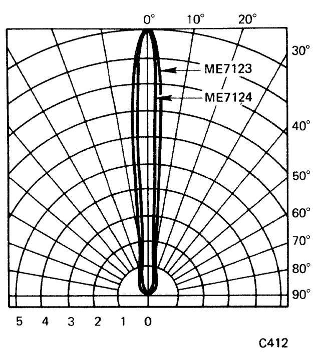


Fig. 5. Spatial Distribution (ME7123 and ME7124)

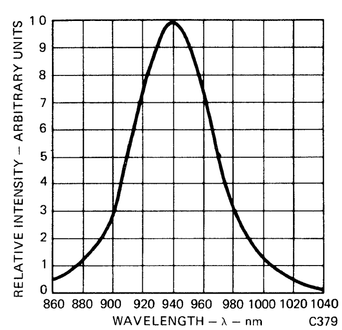


Fig. 6. Spectral Distribution

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, ME7122, ME7123, and ME7124 were immersed in molten solder, heated to 260°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 tw = 40 µsec duty cycle ⩽10%.*

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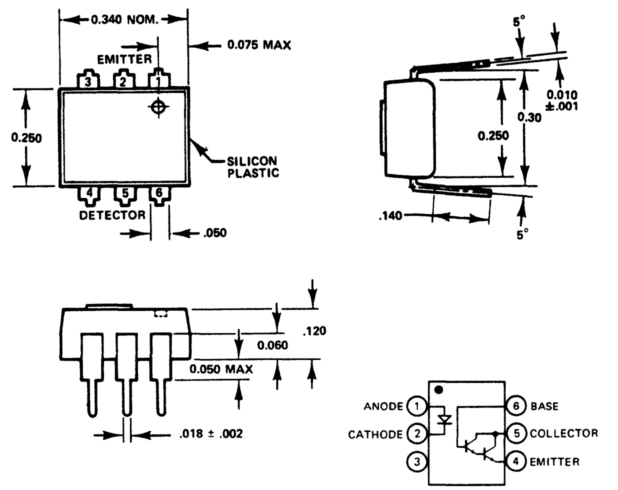
Monsanto

PHOTO-DARLINGTON OPTO-ISOLATOR

MCA230 MCA255

PRODUCT DESCRIPTION

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



NOTE ALL DIMENSIONS IN INCHES AND ARE TYPICAL EXCEPT AS NOTED

C867

FEATURES & APPLICATIONS

- High collector current rating—50 mA
- Fast operate time—10 μs
- Fast release time—35 μs
- High isolation resistance—10^{11} Ω
- High dielectric strength, input to output—1500 V
- Low coupling capacitance—1.0 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.

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	300 mW
Derate linearly from 25°C	4.0 mW/°C

LED (GaAs Diode)

Power dissipation @ 25°C ambient	90 mW
Derate linearly from 55°C	2 mW/°C
Continuous forward current	60 mA
Reverse current	10 μA
Peak forward current (1 μsec pulse, 300 pps)	3.0 A

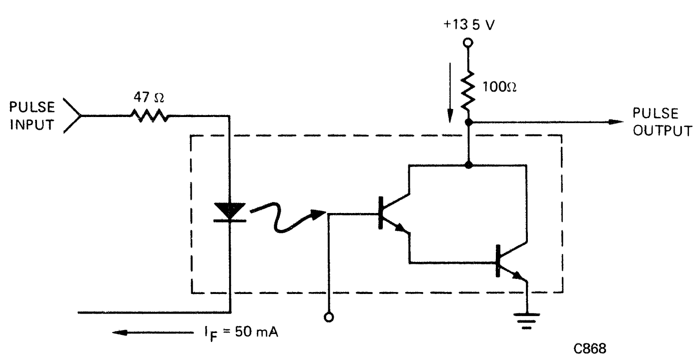
DETECTOR

(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

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	5		V	I_R = 10 μA
Capacitance	C_J		100		pF	V = 0
DETECTOR						
Gain (second stage)	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_C = 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			0.04		%	I_F = 50 mA, V_{CB} = 10 V
DC Collector Current Transfer Ratio		100	400		%	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
Turn-off time	t_{OFF}		35		μsec	See switching time test circuit
Turn-on time	t_{ON}		10		μsec	Note 3
ISOLATION						
DC Voltage Breakdown	V_{ISO}	1500	2000			
Resistance	R_{ISO}		10^{12}			
Leakage Current	I_{ISO}		10		μA	V_{ISO} = 1500 VDC.
Capacitance	C_{ISO}		1.0		pF	
Dielectric Dissipation Limit		50,000			VHz	RMS
AC Voltage Limit @ 60 Hz		800			V_{RMS}	

SWITCHING TIME TEST CIRCUIT



TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

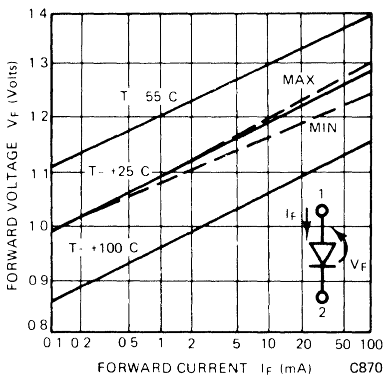


Fig. 1. Forward Voltage Drop vs. Forward Current

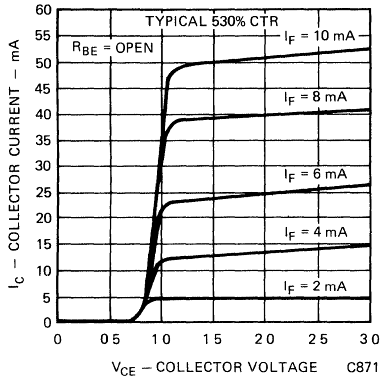


Fig. 2. Collector Current vs. Collector Voltage

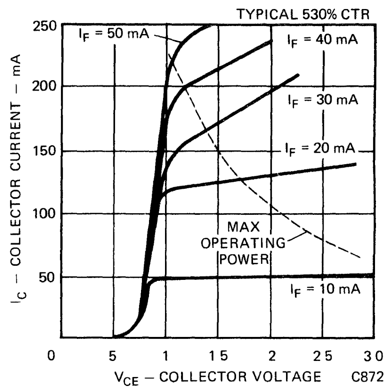


Fig. 3. Collector Current vs. Collector Voltage

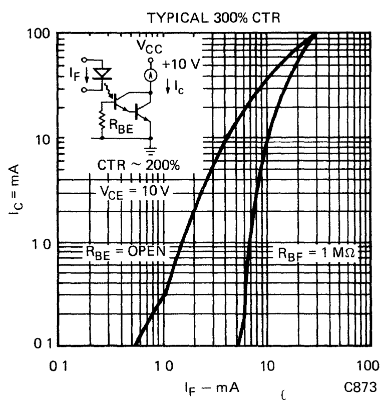


Fig. 4. Current Transfer Characteristic

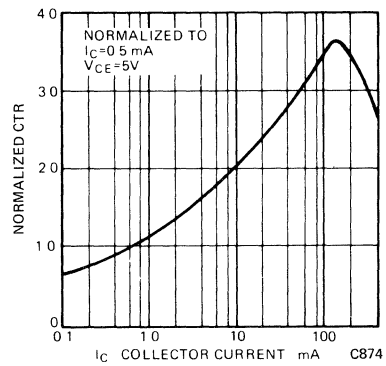


Fig. 5. Normalized CTR vs. Collector Current

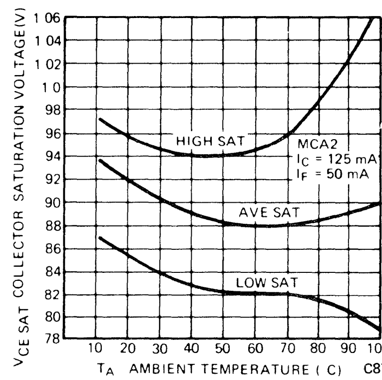


Fig. 6. $V_{CE\text{-}SAT}$ vs. Temperature

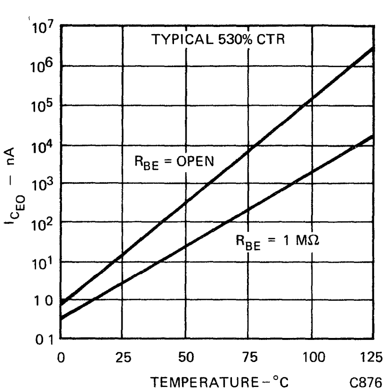


Fig. 7. I_{CEO} vs. Temperature

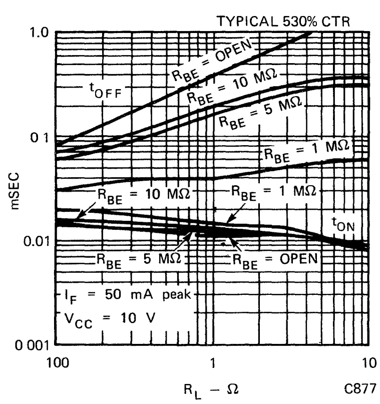


Fig. 8. Switching Times

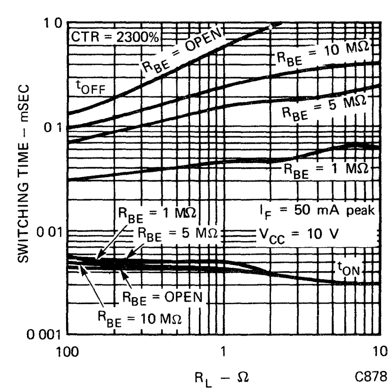


Fig. 9. Switching Times

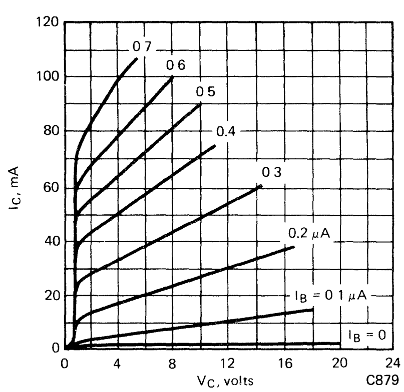


Fig. 10 Detector Standard Transfer Curves

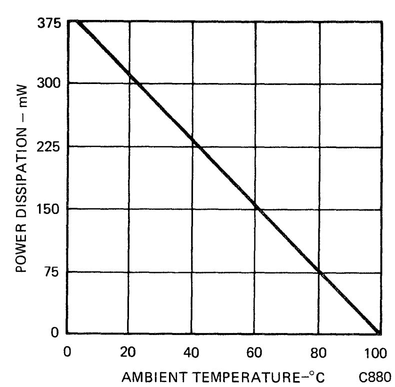


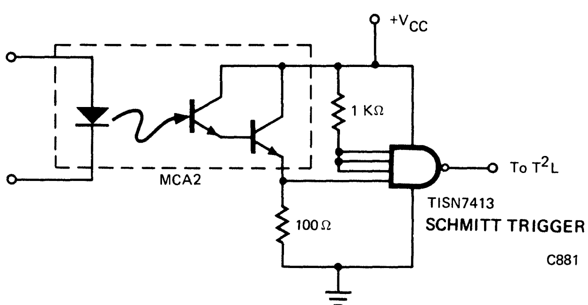
Fig. 11. Package Power Derating

DC RELAY CHARACTERISTICS

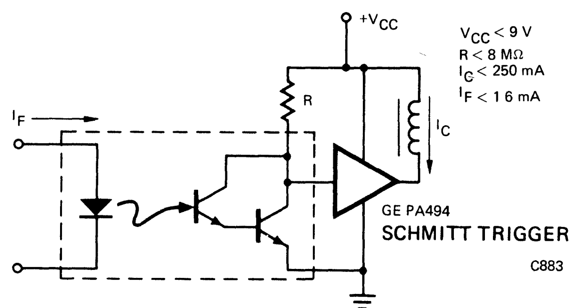
CONTACTS		
Contact configuration		SPST-NO
Contact load rating		125 mA DC
Contact withstand voltage	MCA230	30 V DC
	MCA255	55 V DC
Closed contact voltage		1.0 V
Operate time with 100 Ωload		10 μseconds
Release time with 100 Ωload		35 μseconds
COIL		
Turn on voltage		1.3 V
Turn on current at rated contact load		50 mA
ISOLATION		
Dielectric strength, contacts to coil		1500 V minimum
Isolation resistance, contact to coil		10^{11} Ohms
Capacitance, contacts to coil		1.0 pF
WEIGHT		0.4 grams

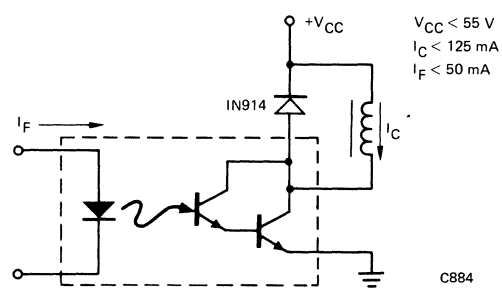
APPLICATION CIRCUITS

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 to increase from 10% of its final value, to 90%. Fall time (t_f) is the time required for the collector to decrease from 90% of its initial value to 10%.*
4. *See Application Note AN501A.*

Electronics Division
3400 Hillview Avenue—Palo Alto, California 94304 (415) 493-3300—TWX (910) 373-1767
Monsanto

Monsanto

DESIGNER SERIES

MCT276

PHOTOTRANSISTOR OPTOISOLATORS

FEATURE SPECIFICATIONS

- **Highest speed discrete phototransistor optoisolator**
- **Controlled Current Transfer Ratio — 15% to 60% (specified conditions)**
- **Maximum Turn-on time — 2.5 μseconds (specified condition)**
- **Maximum Turn-off time — 2.5 μseconds (specified condition)**
- **Surge Isolation Rating — 3550 volts DC 2500 volts AC, rms**
- **Steady-state Isolation Rating — 3150 volts DC 2250 volts AC, rms**
- **Underwriters Laboratory (U.L.) recognized — File E50151**

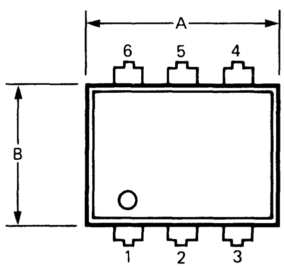
DESCRIPTION

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.

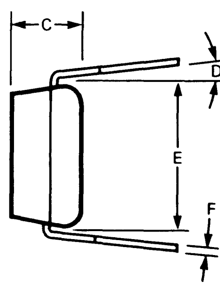
APPLICATIONS

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

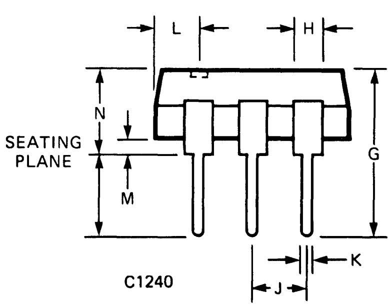
PACKAGE DIMENSIONS



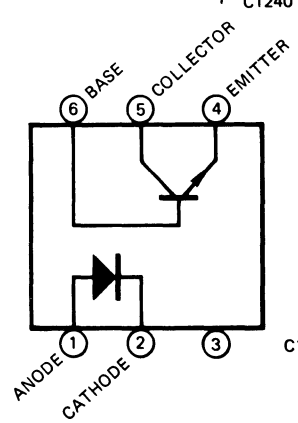
C1240



C1240



C1240



C1109

SYMBOL	INCHES MAX.	mm MAX.	NOTES
A	.365	9.27	
B	.270	6.73	
C	.130	3.18	
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			3

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

ELECTRO-OPTICAL CHARACTERISTICS (0° to +70°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	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	2.5	μs	R_L = 100 Ω; I_C = 2 mA; V_{CC} = 5 V
	Turn-off time	t_{off}		2.2	2.5	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}	3550			VDC	Relative humidity ≤ 50%, T_A = +25°C, $I_{I\text{-}O}$ ≤ 10 μA
			2500			VAC-rms	1 second
	Steady state isolation	V_{iso}	3150			VDC	Relative humidity ≤ 50%, T_A = +25°C, $I_{I\text{-}O}$ ≤ 10 μA
			2250			VAC-rms	1 minute
	Isolation resistance	R_{iso}	10^{11}			ohms	$V_{I\text{-}O}$ = 500 VDC, T_A = +25°C
	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_C = 100 μA, I_F = 0
	Leakage current						
	Collector to emitter	I_{CEO}		5	50	nA	V_{CE} = 10 V, I_F = 0, T_A = +25°C
	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

ALL TYP. READINGS @ +25°C

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

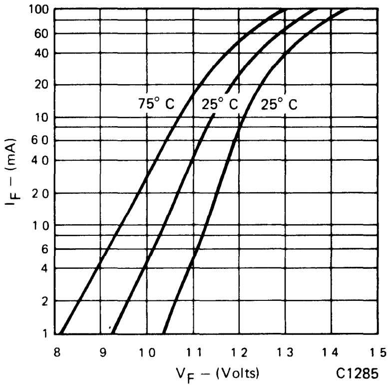


Fig. 1. Forward Voltage vs. Forward Current

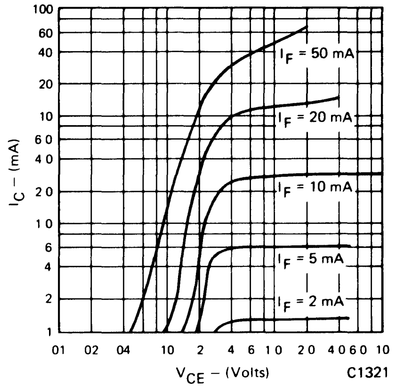


Fig. 2. Collector Current vs. Collector to Emitter Voltage

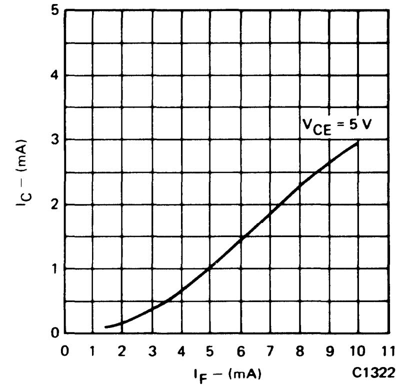


Fig. 3. Collector Current vs. Forward Current

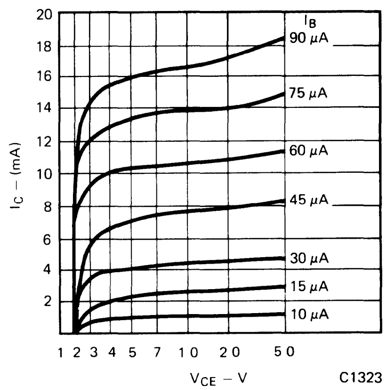


Fig. 4. Collector Current vs. Collector to Emitter Voltage

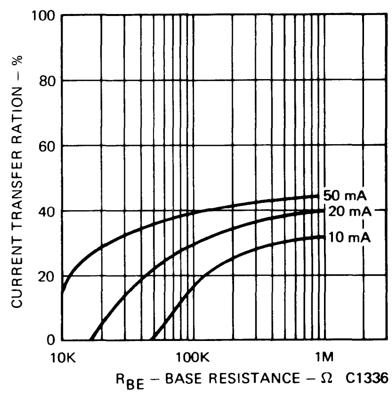


Fig. 5. Sensitivity vs. Base Resistance

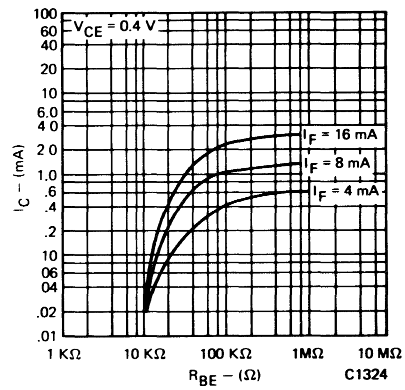


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

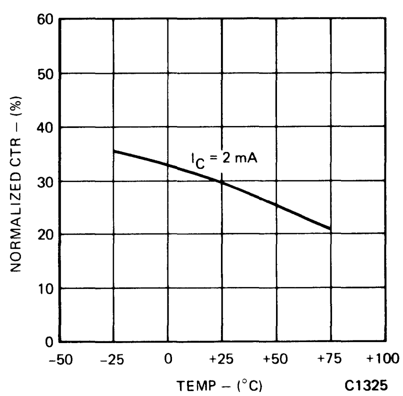


Fig. 7. Current Transfer Ratio (unsaturated) vs. Temperature

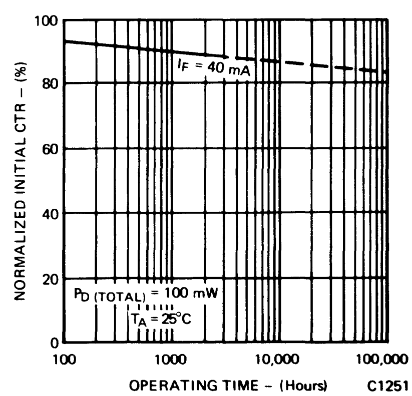


Fig. 8. Current Transfer Ratio vs. Operating Time

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 .... 200 mW
Derate linearly from 25°C .... 2.6 mW/°C

OUTPUT TRANSISTOR

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

SWITCHING CHARACTERISTICS

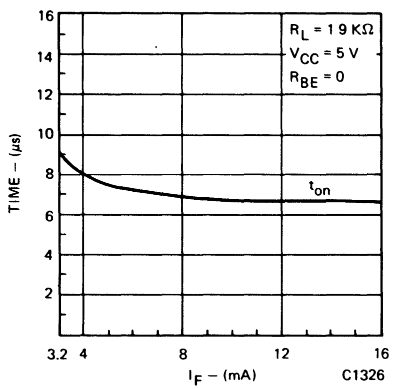


Fig. 9. Switch-on Time vs. I_F Drive (saturated)

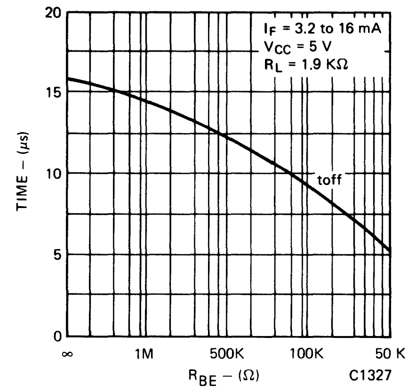


Fig. 10. Switch-off Time vs. Base to Emitter Resistance (saturated)

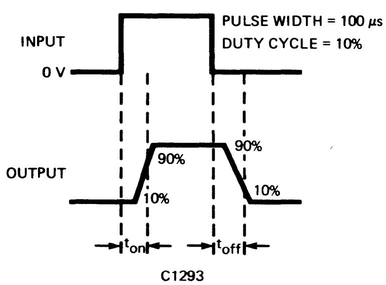


Fig. 11.

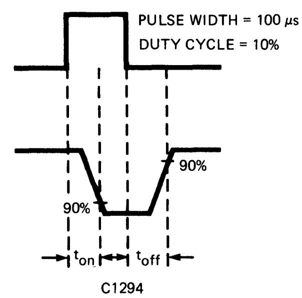


Fig. 12.

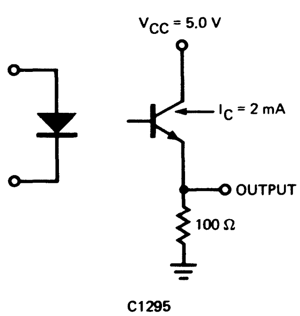


Fig. 13.

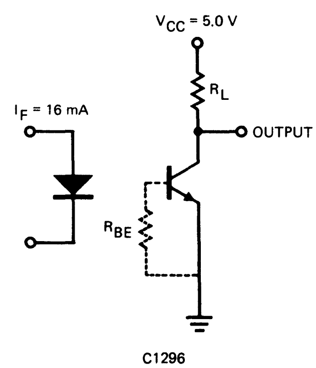


Fig. 14.

Monsanto

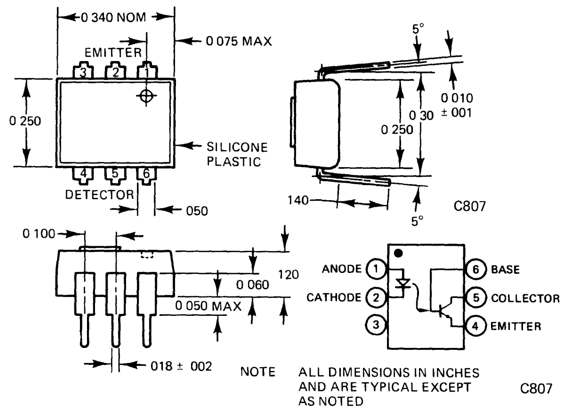
PHOTOTRANSISTOR OPTO-ISOLATOR

MCT2 MCT2E

PRODUCT DESCRIPTION

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

PACKAGE DIMENSIONS



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

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 DC current . . . . 60 mA
- Reverse current . . . . 10 μA
- 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 MCT2 . . 1500 volts
Input to output voltage isolation MCT2E . 2500 volts
Total package power dissipation at 25°C ambient (LED plus detector) . . . . .250 mW
Derate linearly from 25°C . . . . .3.3 mW/°C

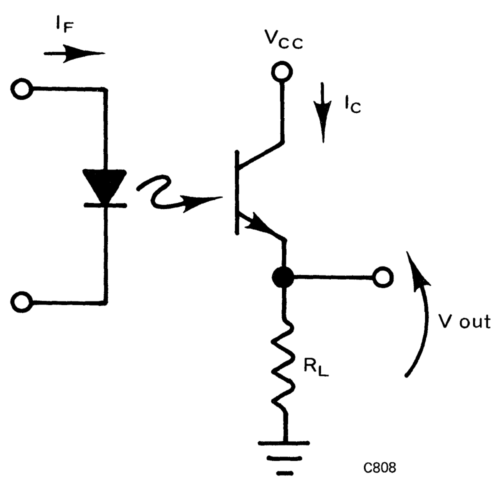
ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	GUAR. MIN.	TYP.	GUAR. MAX.	UNITS	TEST CONDITIONS
Input Diode						
Forward Voltage	V_F		1.25	1.50	V	I_F = 20 mA
Forward Voltage Temp. Coefficient			-1.8		mV/°C	
Reverse Breakdown Voltage	BV_R	3.0	5.5		V	I_R=10 μA
Junction Capacitance	C_J		105		pF	V_F=0 V
			300		pF	V_F=1 V
Reverse Leakage Current			.01	10	μA	V_R=3.0 V
Rise Time	t_r		20		ns	I_F=50 mA, 50 Ω System
Fall Time	t_f		20		ns	I_F=50 mA, 50 Ω System
Output Transistor						
DC Forward Current Gain	h_{FE}	100	250			V_{CE}=5 V, I_C=100 μA
Collector To Emitter Break-down Volt.	BV_{CEO}	30	65		V	I_C=1.0 mA, I_F=0
Collector To Base Break-down Voltage	BV_{CBO}	70	165		V	I_C=10 μA
Emitter to Collector Break-down Voltage	BV_{ECO}	7	14		V	I_C=100 μA, I_F=0
Collector To Emitter, Leak-age Current	I_{CEO}		5	50	nA	V_{CE}=10 V, I_F=0, Note 5
Collector To Base Leak-age Current	I_{CBO}		0.1	20	nA	V_{CB}=10 V, I_F=0

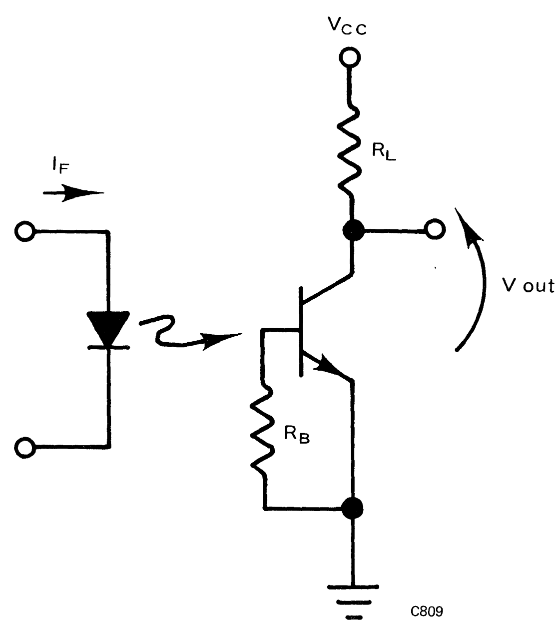
ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	GUAR. MIN.	TYP.	GUAR. MAX.	UNITS	TEST CONDITIONS
Capacitance Collector To Emitter			8		pF	$V_{CE}=0$
Capacitance Collector To Base			20		pF	$V_{CB}=10$ V
Capacitance Emitter To Base			10		pF	$V_{BE}=0$
Coupled						
DC Collector Current Transfer Ratio	I_C/I_F	20	50		%	$V_{CE}=10$ V, $I_F=10$ mA, Note 1
DC Base Current Transfer Ratio	I_B/I_F		.20		%	$V_{CB}=10$ V, I_F-10 mA
Isolation Voltage MCT2		1500	2300		VDC	
		800			VRMS	f=60 Hz
Isolation Voltage MCT2E		2500			VDC	
Isolation Resistance			10^{11}		Ω	$V_{I-O}=500$ V
Isolation Capacitance			1.0		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)			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	0.5	μs	$R_L=100$ Ω, $I_C=2$ mA, $V_{CC}=10$ V (Circuit No. 1)
	Rise Time	2.5		
	Storage Time	0.0		
	Fall Time	2.6		
Non-Saturated Collector	Delay Time	2.0	μs	$R_L=1$ KΩ, $I_C=2$ mA, $V_{CC}=10$V (Circuit No. 1)
	Rise Time	15		
	Storage Time	0.0		
	Fall Time	15		
Saturated	t on (from 5 V to 0.8 V)	5	μs	$R_L=2$ KΩ, $I_F=15$ mA, $V_{CC}=5$ V
	t off (from SAT to 2.0 V)	25		R_B=open (Circuit No. 2)
Saturated	t on (from 5 V to 0.8 V)	5	μs	$R_L=2$ KΩ, $I_F=20$ mA, $V_{CC}=5$ V
	t off (from SAT to 2.0 V)	18		$R_B=100$ KΩ (Circuit No. 2)
Non-Saturated Base	Rise Time	175	ns	$R_L=1$ KΩ, $V_{CB}=10$ V
	Fall Time	175	ns	



Circuit 1



Circuit 2

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

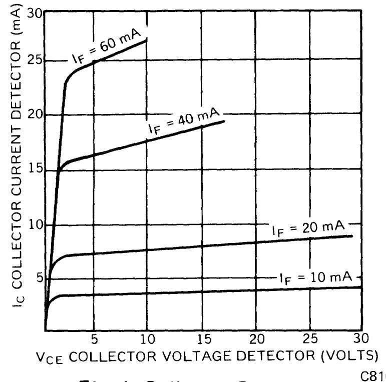


Fig. 1 Collector Current vs. Collector Voltage (for Typical CTR 30%)

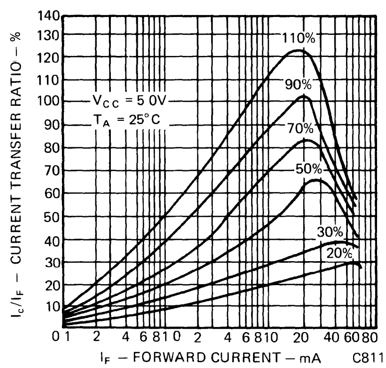


Fig. 2 Current Transfer Ratio vs. Forward Current

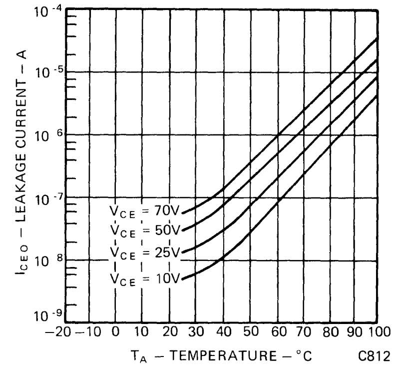


Fig. 3 Dark Current vs. Temperature

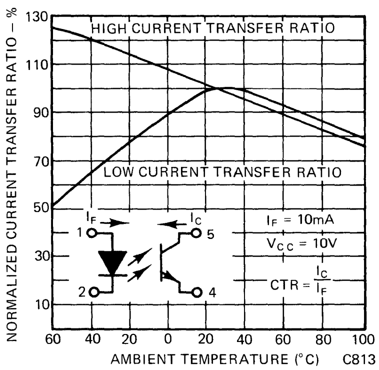


Fig. 4 Current Transfer Ratio vs. Temperature

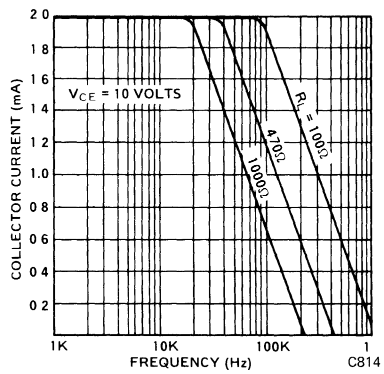


Fig. 5 Collector Current vs. Frequency

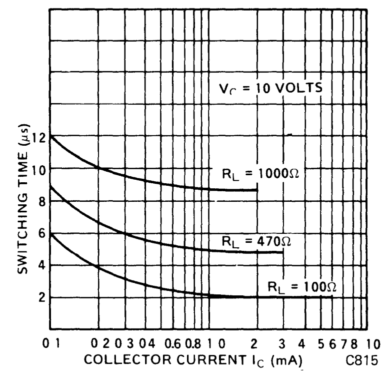


Fig. 6 Switching Time vs. Collector Current

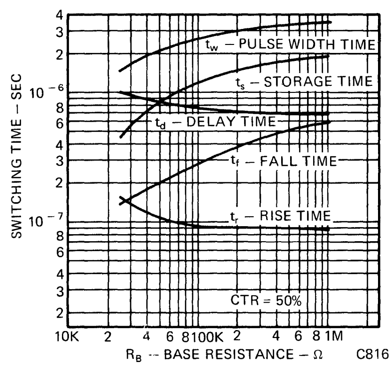


Fig. 7 Switching Time vs. Base Resistance

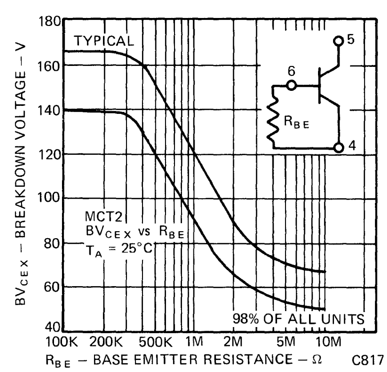


Fig. 8 Collector — Emitter Breakdown Voltage vs. Base Resistance

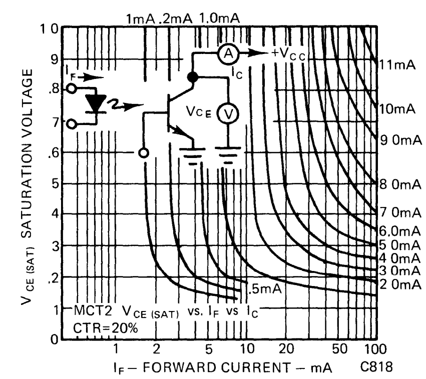


Fig. 9 Saturation Voltage vs. Forward Current

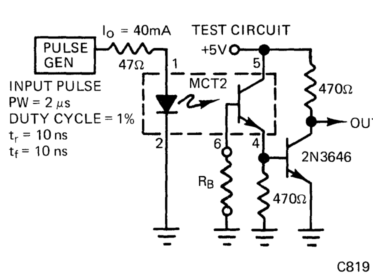


Fig. 10 Circuit for Figure 7

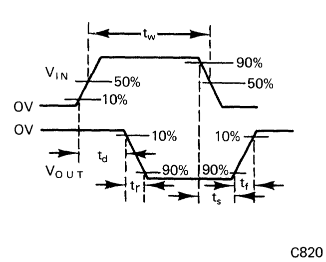


Fig. 11 Waveforms for Figure 7

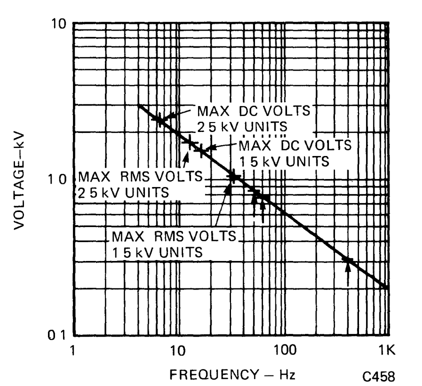


Fig. 12 Steady-State AC Voltage Limit of Isolation Dielectric

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

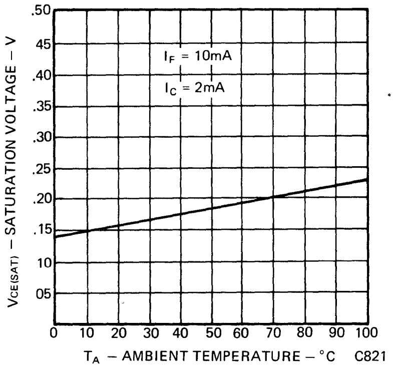


Fig. 13 Saturation Voltage vs. Temperature

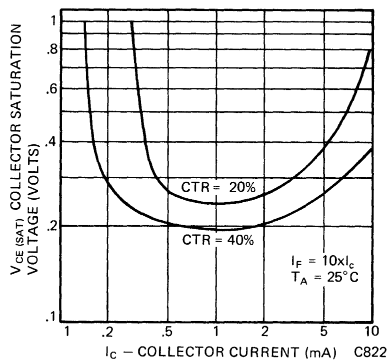


Fig. 14 Saturation Voltage vs. Collector Current

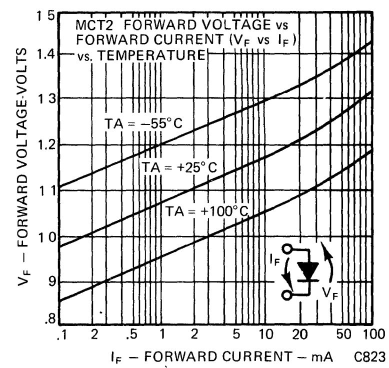


Fig. 15 Forward Voltage vs. Forward Current

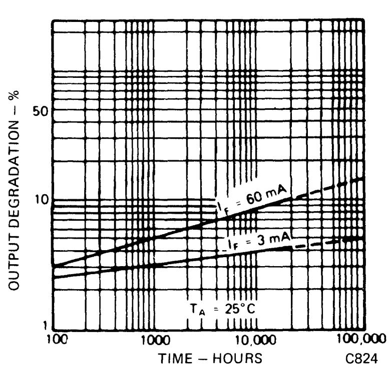


Fig. 16 Lifetime vs. Forward Current

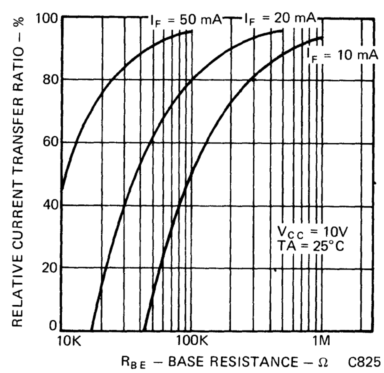


Fig. 17 Sensitivity vs. Base Resistance

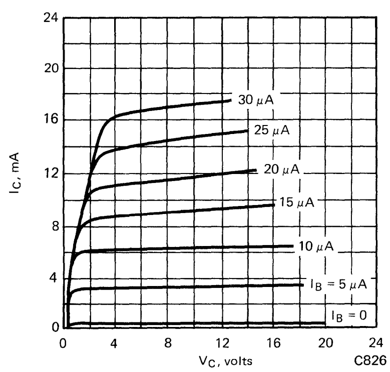
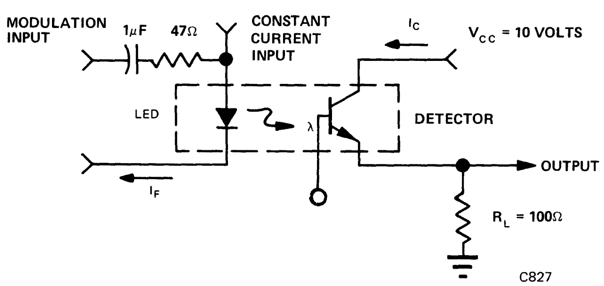
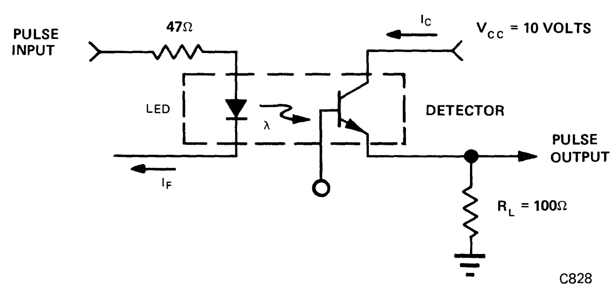


Fig. 18 Detector Typical h_{fe} Curves

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%.*
4. *For design information send for Application Notes Handbook.*
5. *Use a 100 M Ω resistor R_{BE} for test stability.*
6. *Normalized CTR degradation =* $\frac{CTR_O - CTR}{CTR_O}$

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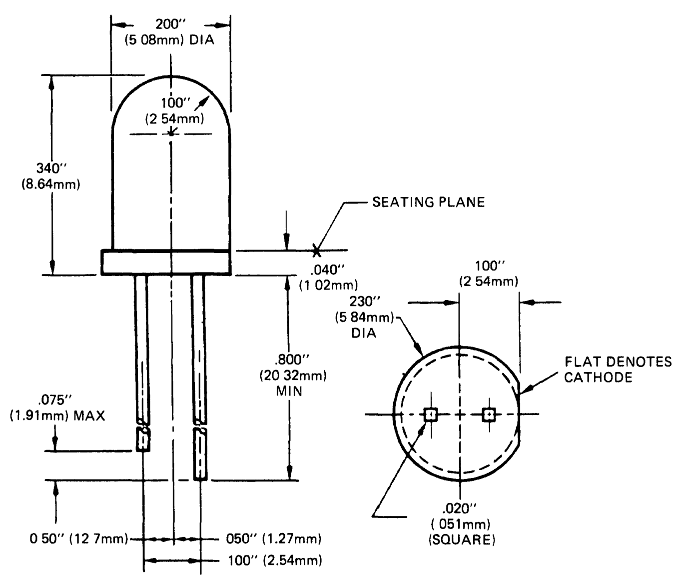
Monsanto

Monsanto SOLID STATE LAMPS | MV5753 MV5754

PRODUCT DESCRIPTION

These are solid state indicators offering high brightness at low currents. The MV5753 and MV5754 are made with gallium arsenide phosphide chips and are encapsulated in epoxy lenses.

PACKAGE DIMENSIONS



TOLERANCES ± .010" (.254 mm) C1062

FEATURES

- High intensity light source with various lens effects.
- Versatile mounting on P.C. board or panel
- Snap in clip available on request
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight
- High efficiency
- Ultra high brightness

ABSOLUTE MAXIMUM RATINGS

Maximum power dissipation @ 25°C ambient	105 mW
Derate linearly from 25°C	1.14 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	35 mA
Continuous forward current @ 100°C	10 mA
Peak forward current (1 μsec pulse, 0.1% duty cycle)	5.0 A
Reverse voltage	5.0 V

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	POP-IN MOUNTING	CIRCUIT BOARD MOUNTING
MV5753	Red	Red diffused	Wide beam	X	X
MV5754	Red	Red diffused	Narrow beam	X	X

ELECTRO-OPTICAL CHARACTERISTICS

PARAMETER	TEST COND.	UNITS	MV5753	MV5754
Forward voltage (V_F)	20 mA	V		
Typ.			2.0	2.0
Max.			3.0	3.0
Luminous intensity (see Note 1)				
Typ.	20 mA	mcd	4.0	8.0
Peak wave length	20 mA	nm	635	635
Spectral line Half width	20 mA	nm	45	45
Capacitance				
Typ.	V = 0	pF	45	45
Reverse voltage (V_R)	I_R = 100 μA			
Min.		V	5	5
Typ.		V	25	25
Reverse current (I_R)	V_R = 5.0 V			
Max.		μA	100	100
Typ.		nA	20	20
Viewing angle (total)	See Fig. 3 & 4	degrees	65	24

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

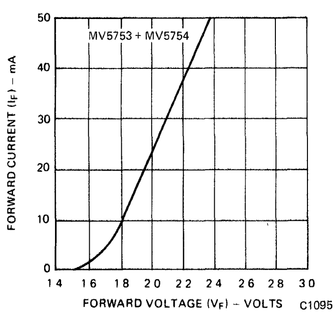


Fig. 1. Forward Current vs. Forward Voltage

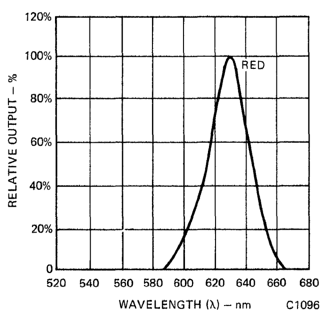


Fig. 2. Spectral Response

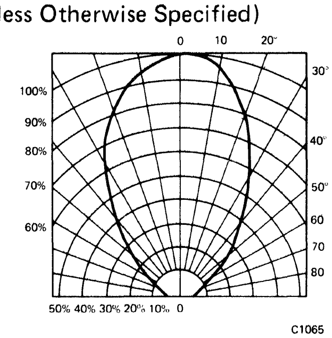


Fig. 3. Spatial Distribution (Note 2) for MV5753

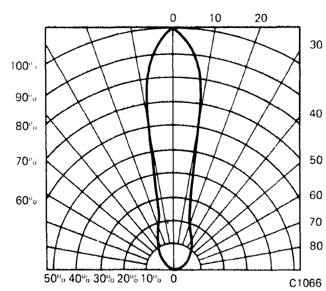


Fig. 4. Spatial Distribution (Note 2) for MV5754

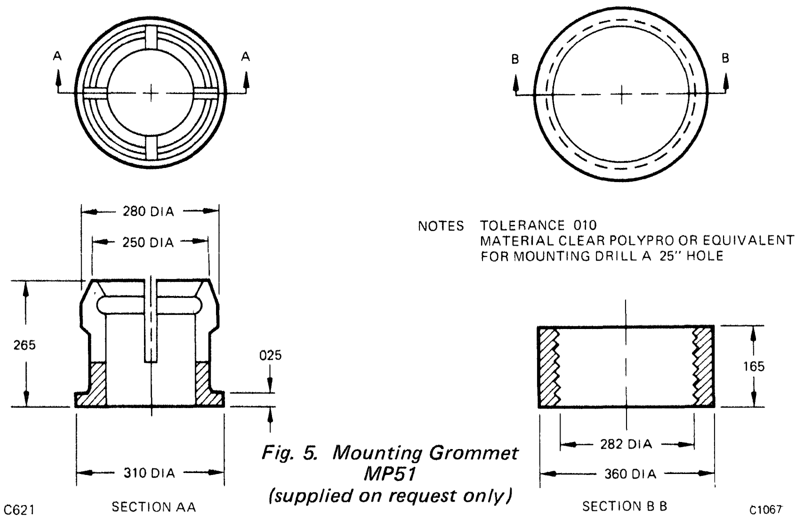


Fig. 5. Mounting Grommet MP51 (supplied on request only)

NOTES

1. *As measured with a Photo Research Corp. "SPECTRA" Microcandela Meter (S/N 1015).*
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 from the body of the device per MIL-S-750.*

Monsanto

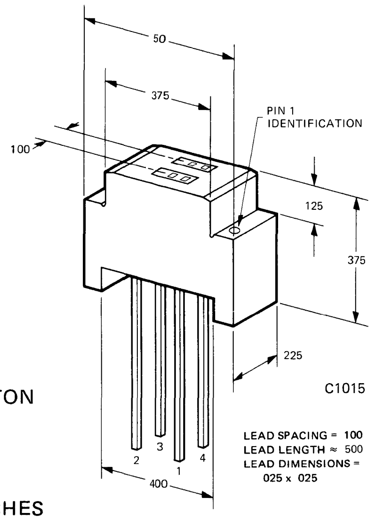
REFLECTIVE OBJECT SENSOR

MCA7

PRODUCT DESCRIPTION

The MCA7 opto-isolator consists of a GaAsLITE emitting diode that generates infrared light and a silicon planar photo darlington. 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.

PACKAGE DIMENSIONS



PIN 1 ANODE } LED
2 CATHODE
3 COLLECTOR } PHOTO-DARLINGTON
4 EMITTER

ALL DIMENSIONS ARE IN INCHES

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

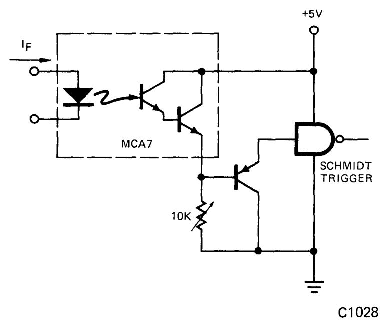
INPUT DIODE
Power dissipation at 25°C ambient . . . . 150 mW
Derate Linearly from 25°C . . . . 2.0 mW/°C
Forward DC current . . . . 75 mA
Reverse current . . . . 10 mA
Peak forward current (1 μs pulse, 300 pps) . . 3.0 A

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)

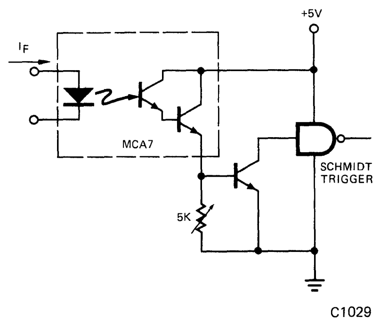
CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F		1.25	1.50	V	I_F = 20 mA
Forward Voltage Temp. Coefficient			−1.8		mV/°C	
Reverse Breakdown Voltage	BV_R	3.0	5.5		V	I_R = 10 μA
Junction Capacitance	C_j		105		pF	V_F = 0V
Reverse Leakage Current			.01	10	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
Leakage Current	I_{CEO} (ambient)		6.8		mA	V_{CE} = 5V (NOTE 3), I_F=0
Rise Time, Fall Time			0.6		mS	V_{CE} = 5V, R_L = 1KΩ
COUPLED						
Photo Current	IC (λ)	50	400		μA	I_F = 50 mA V_{CE} = 5.0V (NOTE 1 & 2) d = 1.0 CM

CIRCUITS TO INTERFACE THE MCA7 WITH 5V LOGIC



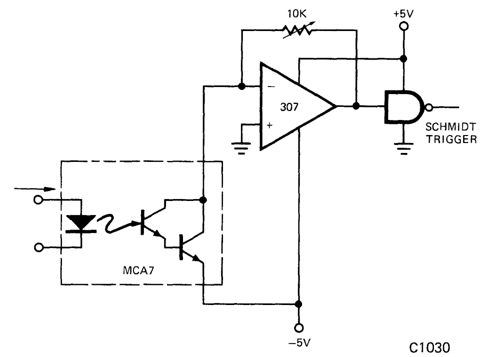
Circuit 1

Normally High Output



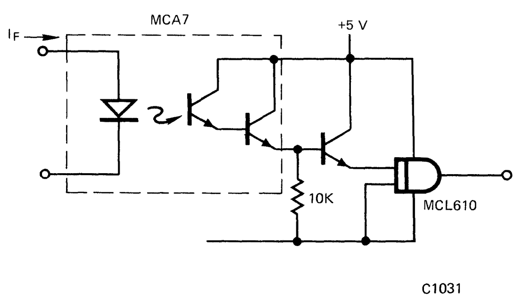
Circuit 2

Normally Low Output



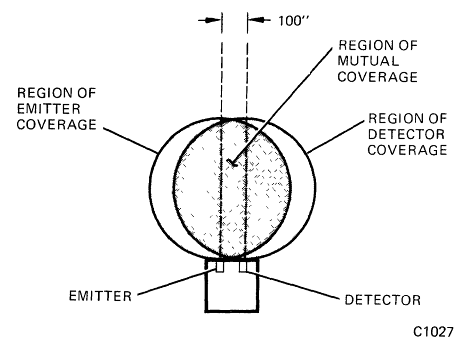
Circuit 3

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).*
4. *See Application Note AN507*

Electronics Division
3400 Hillview Avenue—Palo Alto, California 94304 (415) 493-3300—TWX (910) 373-1767
Monsanto

Monsanto

MAN8600 SERIES

0.800 INCH HI-EFFICIENCY RED (ORANGE) HIGH PERFORMANCE DISPLAY

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
- Wide angle viewing . . . 150°
- Low forward voltage
- Gray face for use in high ambient light conditions

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.

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN-OUT SPECIFICATION
MAN8610	Hi-Efficiency Red (Orange)	Common Anode, Right Hand Decimal Pt.	B	A
MAN8630	Hi-Efficiency Red (Orange)	Common Anode, ± 1 Overflow, Right Hand Decimal Pt.	A	B
MAN8640	Hi-Efficiency Red (Orange)	Common Cathode, Right Hand Decimal Pt.	B	C
MAN8650	Hi-Efficiency Red (Orange)	Common Cathode, ± 1 Overflow, Right Hand Decimal Pt.	A	D

FILTER RECOMMENDATIONS

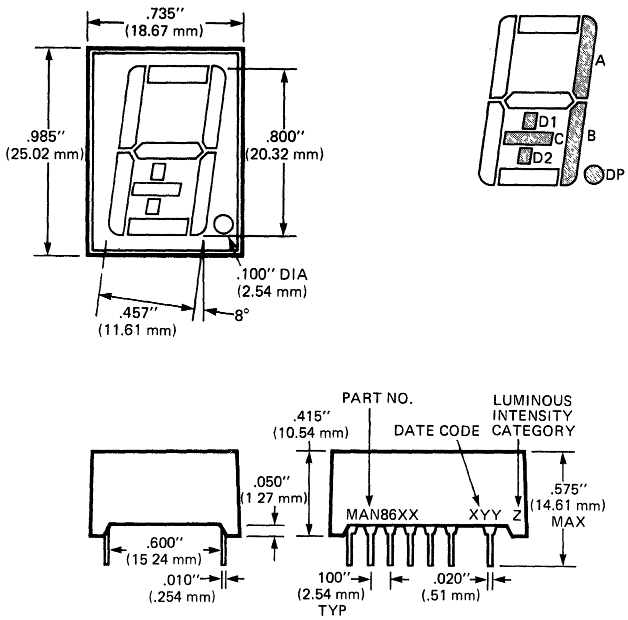
For optimum on and off contrast, one of the following filters should be used over the display:

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:

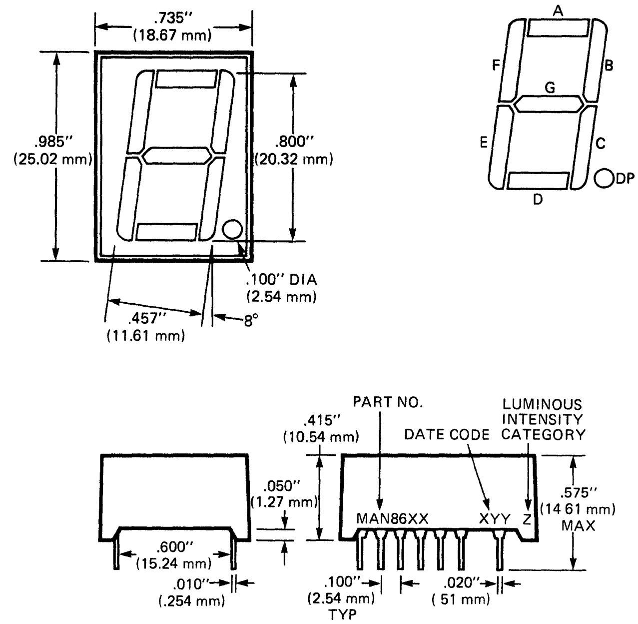
PANELGRAPHIC GREY NO. 10

PACKAGE DIMENSIONS



C1369

A



C1370

B

PIN CONNECTIONS

ELECTRICAL CONNECTIONS				
PIN #	A MAN8610	B MAN8630	C MAN8640	D MAN8650
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	D1 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	D2 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

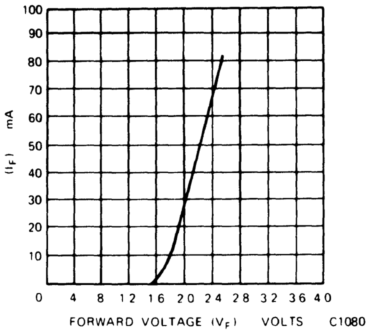


Fig. 1. Forward Current vs. Forward Voltage

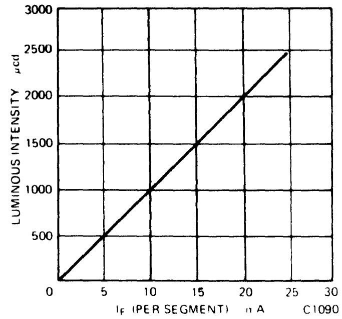


Fig. 2. Luminous Intensity vs. Forward Current

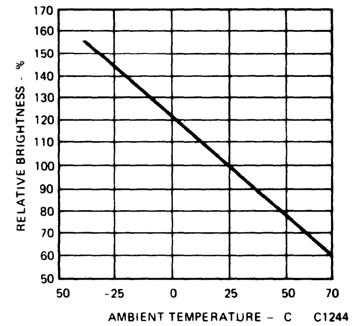


Fig. 3. Luminous Intensity vs. Temperature (see Note 2)

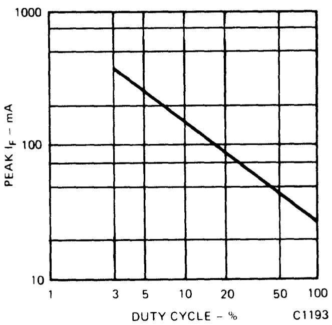


Fig. 4. Max Peak Current vs. Duty Cycle

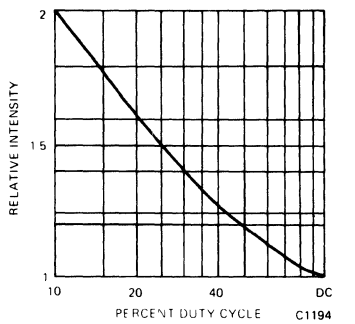


Fig. 5. Luminous Intensity vs. Duty Cycle

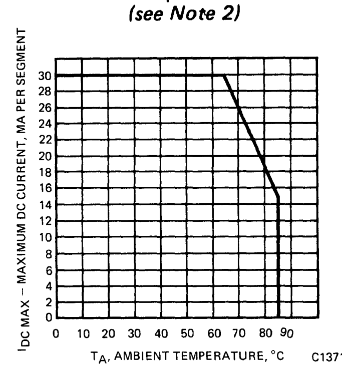
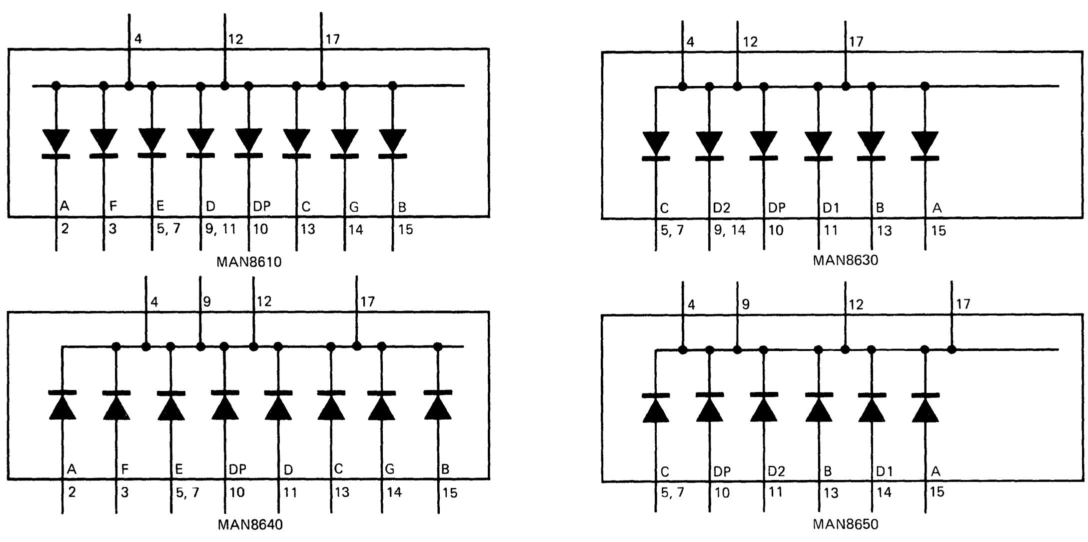


Fig. 6. Maximum DC Current vs. Temperature

INTERNAL CONNECTIONS



C1372

MAN8600 SERIES

ABSOLUTE MAXIMUM RATINGS

	MAN8610/8640	MAN8630/8650
Power dissipation — 25°C ambient	800 mW	650 mW
Derate linearly from 25°C	−13 mW/°C	−11 mW/°C
Storage and operating temperature	−40°C to +100°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 (see Note 3 & 4)	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)	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
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 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.*
2. *The curve in Fig. 3 is normalized to the brightness at 25°C to indicate the relative efficiency over the operating temperature range.*
3. *Leads immersed to 1/16" from the body of the device. Maximum unit surface temperature is 140°C.*
4. *For flux removal, use Freon TF, Freon TE, Isopropanal, or water up to their boiling points.*
5. *Intensity adjusted for smaller areas of the "+" and decimal points.*

Electronics Division
3400 Hillview Avenue—Palo Alto, California 94304 (415) 493-3300—TWX (910) 373-1767
Monsanto

Monsanto

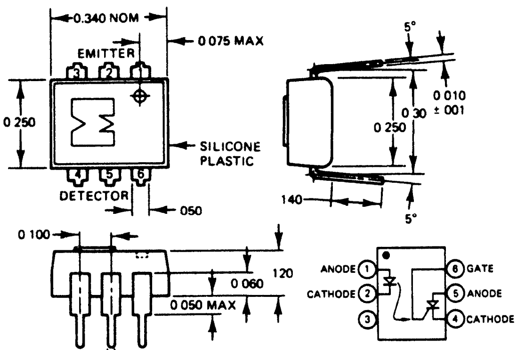
PHOTO SCR OPTO-ISOLATOR

MCS2 MCS2400

PRODUCT DESCRIPTION

The MCS2 and the MCS2400 devices are made with a PNPN planar photo SCR coupled to a diffused planar gallium arsenide infrared diode. They mount in a six lead plastic DIP package. The MCS2 has an anode voltage rating of 200 volts while the MCS2400 has a 400 volt rating.

PACKAGE DIMENSIONS



NOTE ALL DIMENSIONS IN INCHES AND ARE TYPICAL EXCEPT AS NOTED

NOTE TWO PACKAGES PER MATCHED SET C359

FEATURES & APPLICATIONS

- Built-in memory
- AC switch (SPST)
- High current carrying capability (pulsed condition)
- Plastic dual-in-line package
- High isolation resistance—10^{11} Ω
- 1500 volt isolation, emitter to detector
- Compact, rugged, light-weight
- Low coupling capacitance . . . 1.0 pF typical

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 providing high speed switching or relay functions. Its bistable characteristics lends itself for use as a latching relay in direct current circuits. (See note 2).

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

	MCS2			MCS2400				
CHARACTERISTICS	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE								
Forward voltage (V_F)	1.1	1.25	1.5	1.1	1.25	1.5	V	I_F = 40 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)	—	100	—	—	100	—	pF	V = 0
Rise and fall time (t_r, t_f)	—	20	—	—	20	—	ns	I_F = 40 mA, R_L = 50 Ω
DETECTOR								
Forward leakage current (I_{FX})	—	.006	2.0	—	.001	2.0	μA	V_{FX} = Rated V_{FX}, R_{GK} = 27kΩ
Reverse leakage current (I_{RX})	—	.006	2.0	—	.001	2.0	μA	V_{RX} = Rated V_{RX}, R_{GK} = 27kΩ
Forward blocking voltage (V_{FXM})	200	—	—	400	—	—	V	R_{GK} = 27kΩ @ 100°C
Reverse blocking voltage (V_{ROM})	200	—	—	400	—	—	V	R_{GK} = 27kΩ @ 100°C
On voltage (V_{TM})	—	.98	1.3	—	.98	1.3	V	I_T = 100 mA
Holding current (I_{HX})	.01	.06	.20	.01	.06	.20	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
Rate of rise of forward blocking voltage (see Fig. 7) (dV_A/dt)	—	0.45	—	—	0.45	—	V/μs	V_{FX} = 100 V, R_{GK} = 27kΩ
	—	0.90	—	—	0.90	—	V/μs	V_{FX} = 100 V, R_{GK} = 27kΩ, C_{GK} = .001 μF
COUPLED								
Turn on current (threshold) (I_F)	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})	—	2	—	—	4	—	μs	I_F = 30 mA, R_{GK} = 27kΩ, V_{CC} = 100 V
Isolation breakdown voltage (V_{ISO})	1500	—	—	1500	—	—	VDC	t = 1 min.
Isolation resistance (R_{ISO})	—	10^{11}	—	—	10^{11}	—	Ω	V = Rated
Isolation capacitance (C_{ISO})	—	1.0	—	—	1.0	—	pF	f = 1 MHz
Leakage current (I_L)	—	10	—	—	10	—	nA	V = Rated V_{ISO}
Dielectric dissipation limit (D)	—	50,000	—	—	50,000	—	V-Hz	t = 15 minutes
AC voltage limit	—	800	—	—	800	—	V_{RMS}	f = 60 Hz

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	60 mW
Derate linearly from 25°C	0.8 mW/°C
Continuous forward current	40 mA
Reverse current	10 µA
Peak forward current (50 µs pulse, 120 pps)	0.5 A

COUPLED

Isolation voltage	1500 VDC
Total package power dissipation	250 mW

DETECTOR (Photo SCR)

Power dissipation @ 25°C ambient	200 mW
Derate linearly from 25°C	2.67 mW/°C
DC anode current	150 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 CHARACTERISTIC CURVES (25°C Free Air Unless Otherwise Specified)

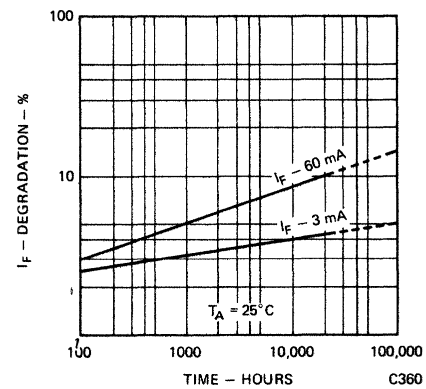


Fig. 1. LED Lifetime vs. Forward Current

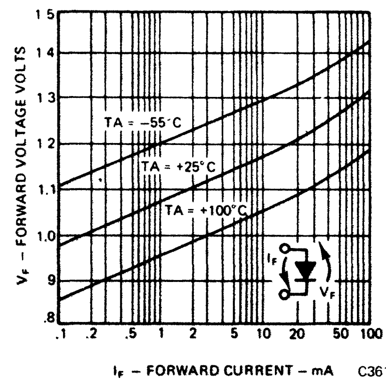


Fig. 2. Forward Voltage vs. Forward Current

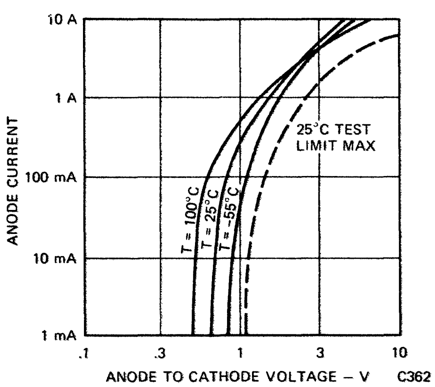


Fig. 3. Anode-Cathode Voltage vs. Anode Current

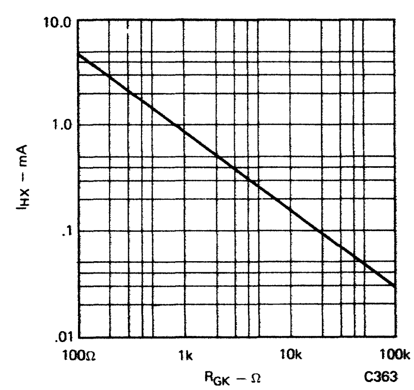


Fig. 4. Gate-Cathode Resistance vs. Holding Current

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

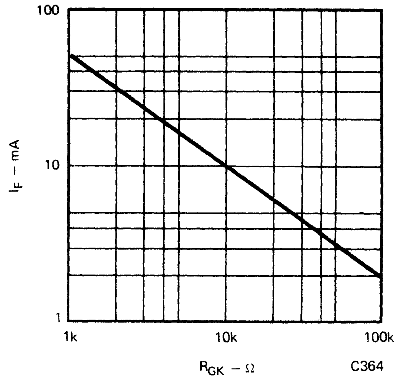


Fig. 5. Gate-Cathode Resistance vs. Forward Current

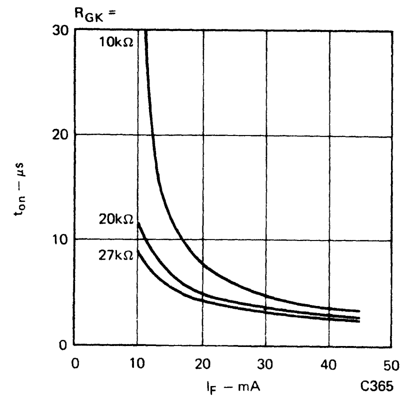


Fig. 6. Rise Time vs. Forward Current

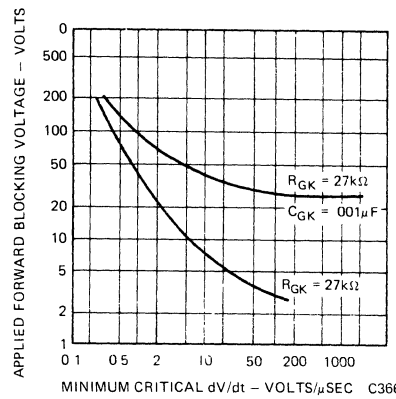


Fig. 7. Critical dV/dt vs. Forward Blocking Voltage

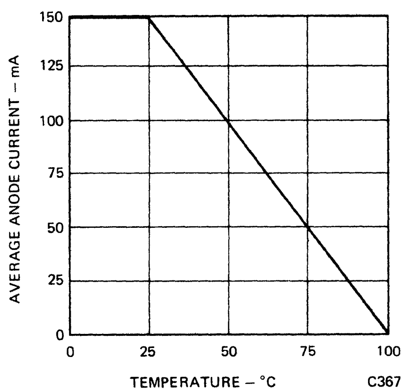


Fig. 8. Continuous Current Rating

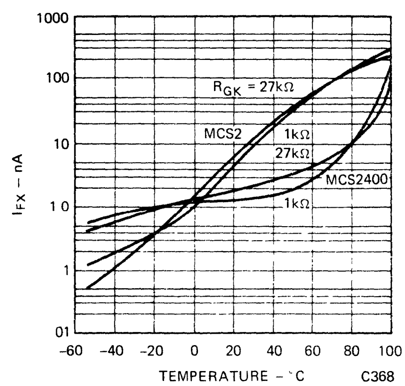


Fig. 9. Temperature vs. Forward Leakage Current

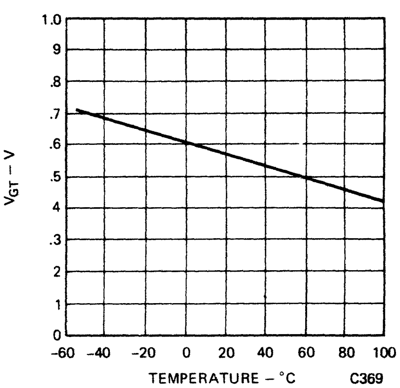


Fig. 10. Temperature vs. Gate Trigger Voltage

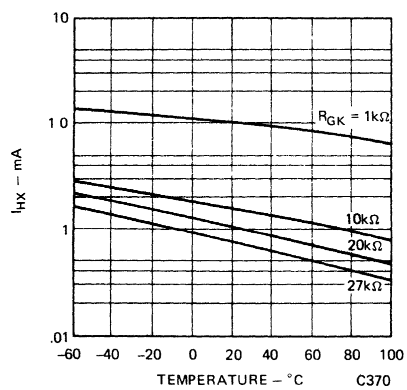


Fig. 11. Temperature vs. Holding Current

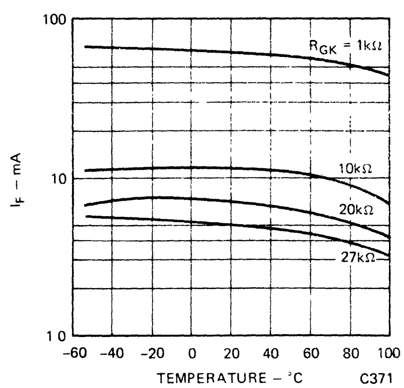
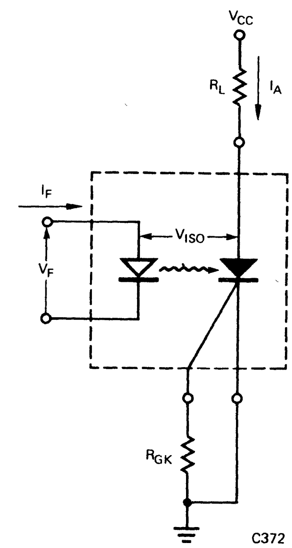
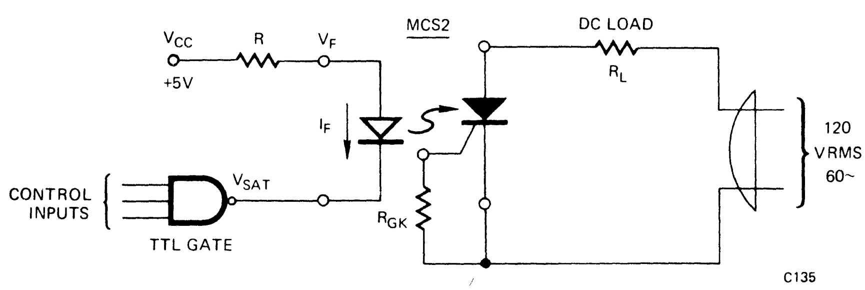


Fig. 12. Temperature vs. Forward Current

TYPICAL CIRCUIT APPLICATIONS



OPERATING SCHEMATICS



RELAY CIRCUIT FOR HALF WAVE A.C. CONDUCTION

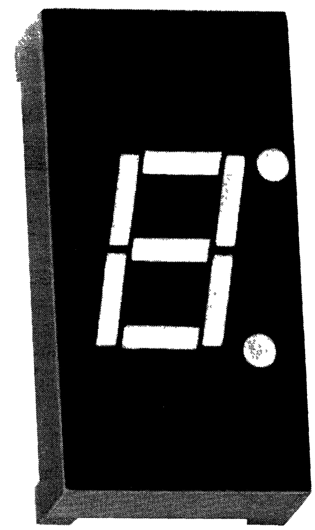
NOTES

1. *The rise time of the SCR is less than 500 nanoseconds.*
2. *For design information send for AN502A.*

Monsanto / Electronic Special Products
3400 Hillview Avenue—Palo Alto, California 94304
(415) 493-3300—TWX (910) 373-1767

Monsanto

GREEN MAN50 SERIES
ORANGE MAN3600 SERIES
RED MAN70 SERIES
YELLOW MAN80 SERIES
0.300-INCH SEVEN SEGMENT DISPLAY



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
- Standard 14 pin dual in-line package configuration
- Wide angle viewing . . . 150°

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Calculators
- Digital clocks

DESCRIPTION

The MAN50, MAN3600, MAN70 and MAN80 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.

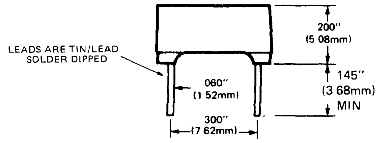
MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION
MAN51	Green	Common Anode; Right Hand Decimal
MAN52	Green	Common Anode; Left Hand Decimal
MAN53	Green	Common Anode; Overflow ±1
MAN54	Green	Common Cathode; Right Hand Decimal
MAN3610	Orange	Common Anode; Right Hand Decimal
MAN3620	Orange	Common Anode; Left Hand Decimal
MAN3630	Orange	Common Anode; Overflow ±1
MAN3640	Orange	Common Cathode; Right Hand Decimal
MAN71	Red	Common Anode; Right Hand Decimal
MAN72	Red	Common Anode; Left Hand Decimal
MAN73	Red	Common Anode; Overflow ±1
MAN74	Red	Common Cathode; Right Hand Decimal
MAN81	Yellow	Common Anode; Right Hand Decimal
MAN82	Yellow	Common Anode; Left Hand Decimal
MAN83	Yellow	Common Anode; Overflow ±1
MAN84	Yellow	Common Cathode; Right Hand Decimal

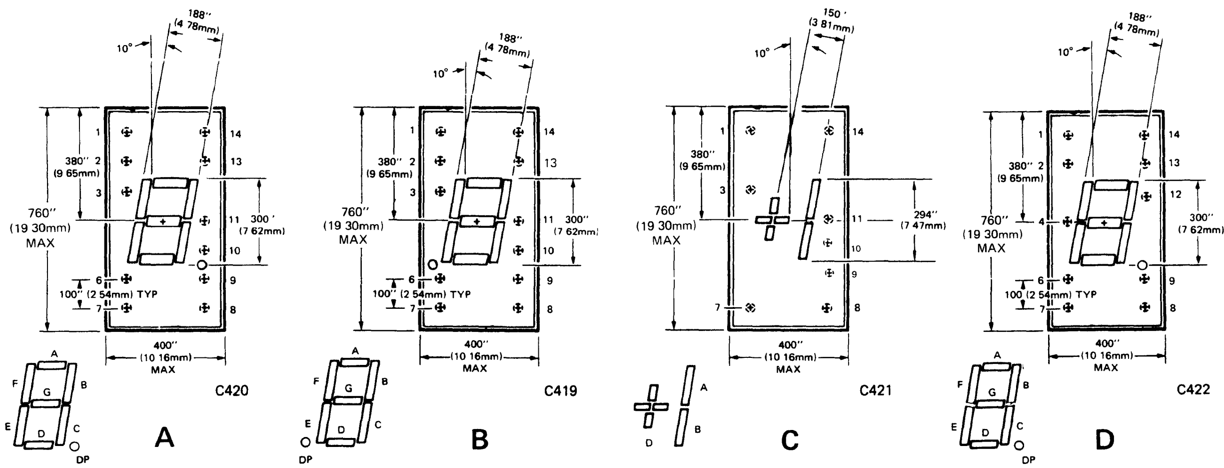
MAN50 MAN3600 MAN70 MAN80 SERIES

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

Device	Parameter	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
MAN51, 52, 53, 54	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 MAN53	60			µcd	I_F = 10 mA
	Peak emission wavelength		565		nm	
	Spectral line half width		40		nm	
	Forward voltage					
	Segment		2.5	3.5	V	I_F = 20 mA
	Decimal point		2.5	3.5	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 = 3.0 V
	Decimal point			100	µA	V_R = 3.0 V
MAN3610, 3620, 3630, 3640	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 MAN3630	265			µcd	I_F = 10 mA
	Peak emission wavelength		630		nm	
	Spectral line half width		40		nm	
	Forward voltage					
	Segment		2.0	2.5	V	I_F = 20 mA
	Decimal point		2.0	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
MAN71, 72, 73, 74	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 MAN73	60			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 = 5.0 V
	Decimal point			100	µA	V = 5.0 V
MAN81, 82, 83, 84	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 MAN83	160			µcd	I_F = 10 mA
	Peak emission wavelength		585		nm	
	Spectral line half width		40		nm	
	Forward voltage					
	Segment		2.5	3.5	V	I_F = 20 mA
	Decimal point		2.5	3.5	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



TOLERANCE = 015" (381mm)

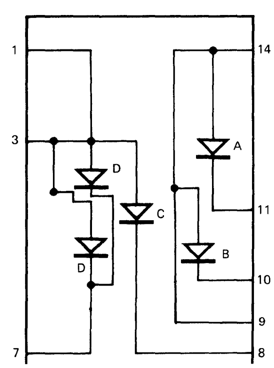


PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS			
	A MAN51, 3610, 71, 81	B MAN52, 72, 3620, 82	C MAN53, 3630, 73, 83	D MAN54, 3640, 74, 84
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	Cathode D.P. or 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

*Check with Factory Regarding Change Over.

ELECTRICAL SCHEMATIC



MAN53, 3630, 73 and 83

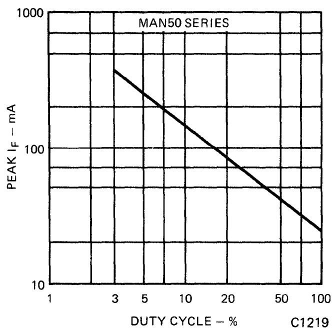


Fig. 13. Max Peak Current vs. Duty Cycle

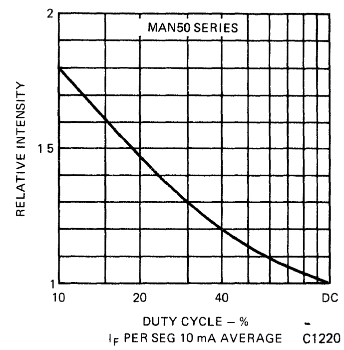


Fig. 14. Luminous Intensity vs. Duty Cycle

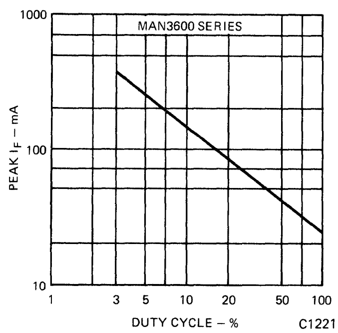


Fig. 15. Max Peak Current vs. Duty Cycle

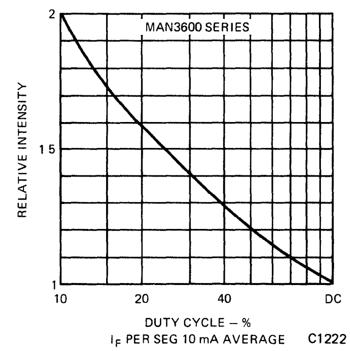


Fig. 16. Luminous Intensity vs. Duty Cycle

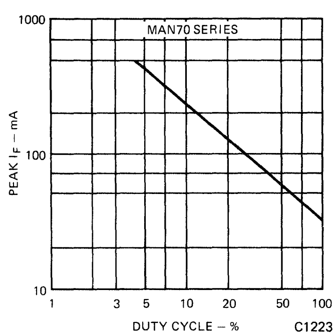


Fig. 17. Max Peak Current vs. Duty Cycle

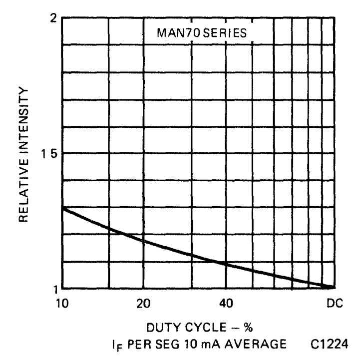


Fig. 18. Luminous Intensity vs. Duty Cycle

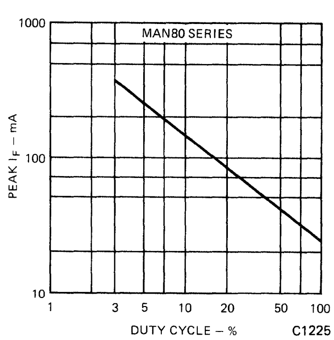


Fig. 19. Max Peak Current vs. Duty Cycle

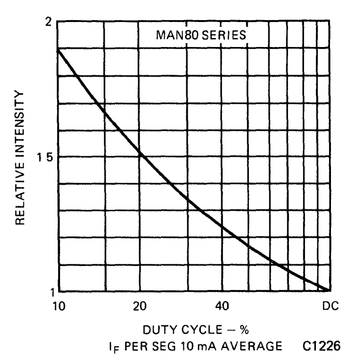


Fig. 20. Luminous Intensity vs. Duty Cycle

TYPICAL CURVES

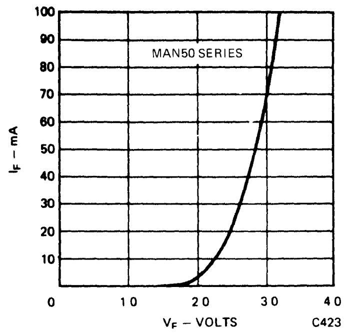


Fig. 1. Forward Current vs. Forward Voltage

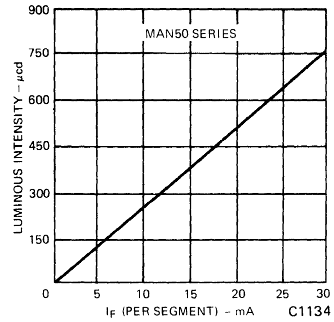


Fig. 2. Luminous Intensity vs. Forward Current

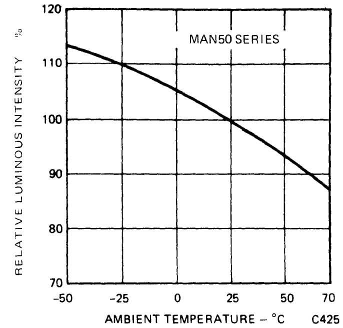


Fig. 3. Luminous Intensity vs. Temperature

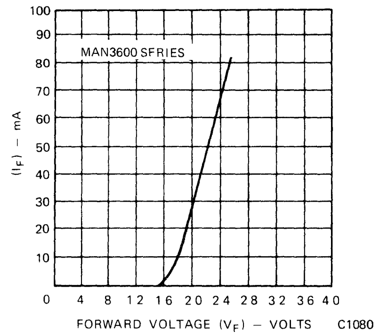


Fig. 4. Forward Current vs. Forward Voltage

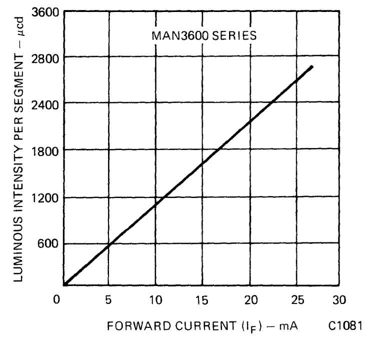


Fig. 5. Luminous Intensity vs. Forward Current

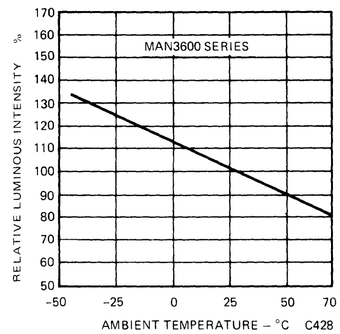


Fig. 6. Luminous Intensity vs. Temperature

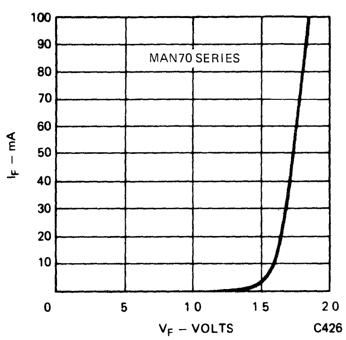


Fig. 7. Forward Current vs. Forward Voltage

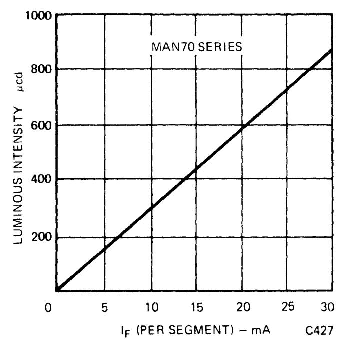


Fig. 8. Luminous Intensity vs. Forward Current

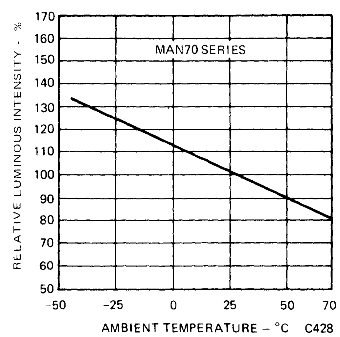


Fig. 9. Luminous Intensity vs. Temperature

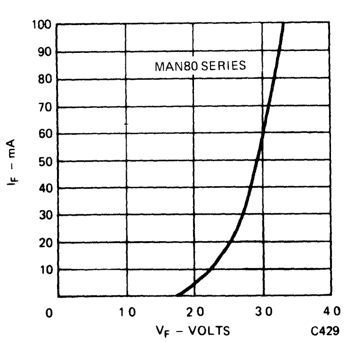


Fig. 10. Forward Current vs. Forward Voltage

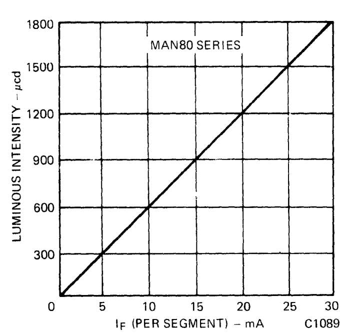


Fig. 11. Luminous Intensity vs. Forward Current

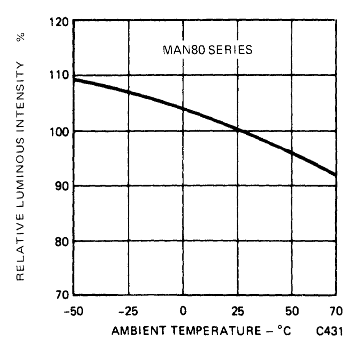


Fig. 12. Luminous Intensity vs. Temperature

ABSOLUTE MAXIMUM RATINGS

	MAN51, 52, 54, 3610, 3620, 3640, 81, 82, 84	MAN53, 3630, 83	MAN71, 72, 74	MAN73
Power dissipation @ 25°C ambient	400 mW	250 mW	700 mW	350 mW
Derate linearly from 25°C	−6.7 mW/°C	−4.2 mW/°C	−11.7 mW/°C	−5.8 mW/°C
Storage and operating temperature	−40°C to 85°C	−40°C to 85°C	−40°C to 85°C	−40°C to 85°C
Continuous forward current				
Total	160 mA	100 mA	240 mA	150 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	3.0 V	3.0 V	5.0 V	5.0 V
Decimal point	3.0 V	3.0 V	5.0 V	5.0 V
Solder time @ 260°C (Note 4)	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
MAN51 MAN52 MAN53 MAN54	Panelgraphic Green 48
MAN3610 MAN3620 MAN3630 MAN3640	Panelgraphic Scarlet 65 Homalite 100-1670
MAN71 MAN72 MAN73 MAN74	Panelgraphic Red 60 Homalite 100-1605
MAN81 MAN82 MAN83 MAN84	Panelgraphic Yellow 25 or Amber 23 Homalite 100-1720 or 100-1726

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/W
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. 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.*
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.*

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Monsanto

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MCC670
MCC671

HIGH GAIN SPLIT-DARLINGTON OPTOISOLATORS

FEATURES

- High sensitivity to low input currents
  - MCC670 – 300% minimum CTR (I_F = 1.6 mA)
  - MCC671 – 400% minimum CTR (I_F = .5 mA)
- Fast switching capability at logic loads
  - MCC670 – 10 Microseconds (t_{on})
    35 Microseconds (t_{off})
  - MCC671 – 1 Microseconds (t_{on})
    7 Microseconds (t_{off})
- UL Recognized

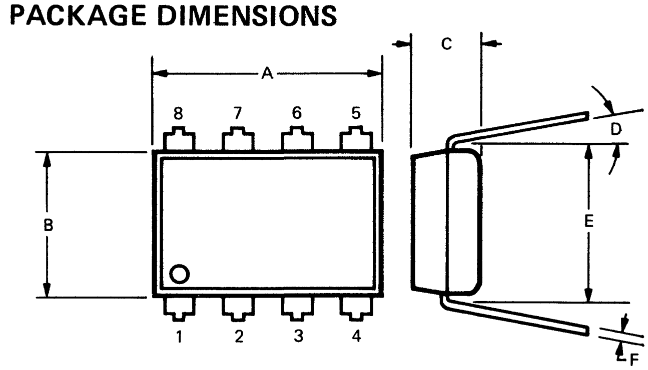
DESCRIPTION

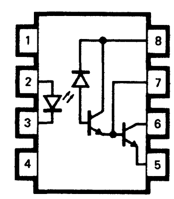
The MCC670 and MCC671 are optically coupled isolators with a split-darlington output configuration. A red visible emitting diode manufactured from specially grown gallium arsenide is coupled to a photo sensitive circuit.

APPLICATIONS

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

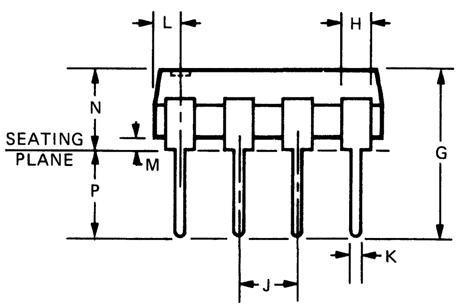
PACKAGE DIMENSIONS





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

C1385



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			3

PACKAGE MATERIALS:
Leads – Tinned with 60/40 tin lead
Body – Silicone plastic

NOTES
1. Installed position of lead centers
2. Four places
3. Overall installed position
4. These measurements are made from the seating plane

C1340

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)
MCC670 . . . . –0.5 to 7 V
MCC671 . . . . –0.5 to 18 V
Output Power Dissipation . . . . 100 mW
(See Note 4)

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)	CTR	MCC671	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
		MCC670	300	600		%	I_F = 1.6 mA, V_O = 0.4 V, V_{CC} = 4.5 V
Logic Low Output Voltage (Note 6)	V_{CL}	MCC671		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
		MCC670		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}	MCC671		0.1	100	μA	I_F = 0 mA, V_O = V_{CC} = 18 V
		MCC670		0.001	250	μA	I_F = 0 mA, V_O = V_{CC} = 7 V
Logic Low Supply Current (Note 6)	I_{CCL}	MCC670/671		0.20		mA	I_F = 1.6 mA, V_O = Open, V_{CC} = 5 V
Logic High Supply Current (Note 6)	I_{CCH}	MCC670/671		10.0		nA	I_F = 0 mA, V_O = Open, V_{CC} = 5 V
Input Forward Voltage	V_F	MCC670/671		1.45	1.7	V	I_F = 1.6 mA, T_A = 25°C
Reverse Breakdown Voltage	BV_R	MCC670/671	5			V	I_R = 10 mA, T_A = 25°C
Temperature Coefficient of Forward Voltage	$\frac{\Delta V_F}{\Delta T_A}$	MCC670/671		−1.8		mV/°C	I_F = 1.6 mA
Input Capacitance	C_O	MCC670/671		40		pF	f = 1 MHz, V_F = 0
Isolation Leakage (Input-Output) (Note 7)	$I_{I\text{-}O}$	MCC670/671			1.0	μA	45% Relative Humidity, T_A = 25°C $V_{I\text{-}O}$ = 3000 V, t_d = 5 sec
Resistance (Input-Output) (Note 7)	$R_{I\text{-}O}$	MCC670/671		10^{12}		Ω	$V_{I\text{-}O}$ = 500 Vdc
Capacitance (Input-Output) (Note 7)	$C_{I\text{-}O}$	MCC670/671		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}	MCC671		5.0	25	μs	I_F = 0.5 mA, R_L = 4.7 kΩ
		MCC671		0.2	1	μs	I_F = 12 mA, R_L = 270 Ω
		MCC670		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}	MCC671		1 0	60	μs	I_F = 0.5 mA, R_L = 4.7 kΩ
		MCC671		1.0	7	μs	I_F = 12 mA, R_L = 270 Ω
		MCC670		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 $V_{p\text{-}p}$
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 $V_{p\text{-}p}$

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).*

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

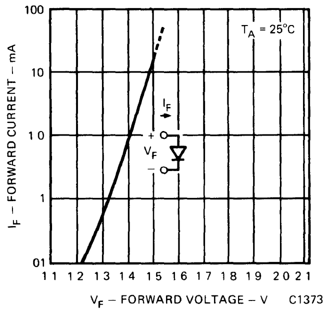


Fig. 1. Input Diode Forward Current vs. Forward Voltage

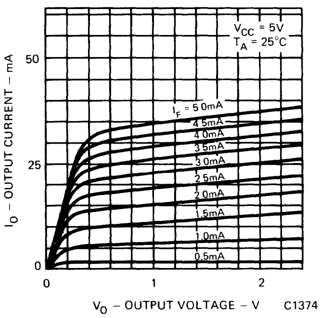


Fig. 2. MCC670 DC Transfer Characteristics

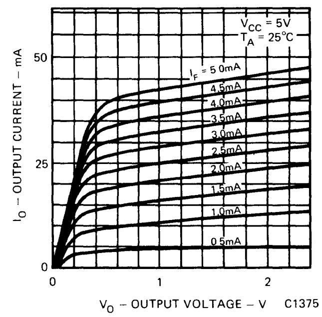


Fig. 3. MCC671 DC Transfer Characteristics

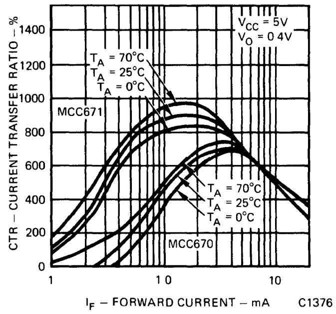


Fig. 4. Current Transfer Ratio vs. Forward Current

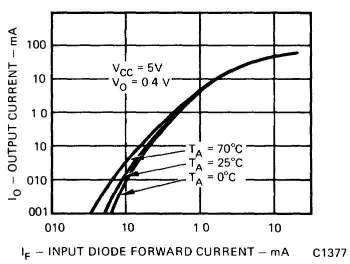


Fig. 5. MCC670 Output Current vs. Input Diode Forward Current

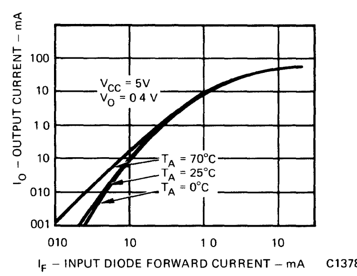


Fig. 6. MCC671 Output Current vs. Input Diode Forward Current

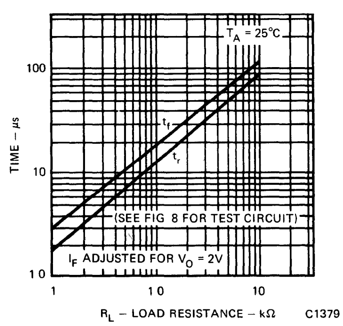


Fig. 7. Non-Saturated Rise and Fall Times vs. Load Resistance

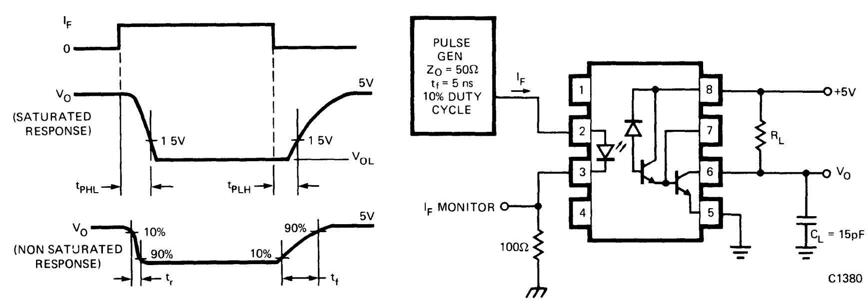


Fig. 8. Switching Test Circuit

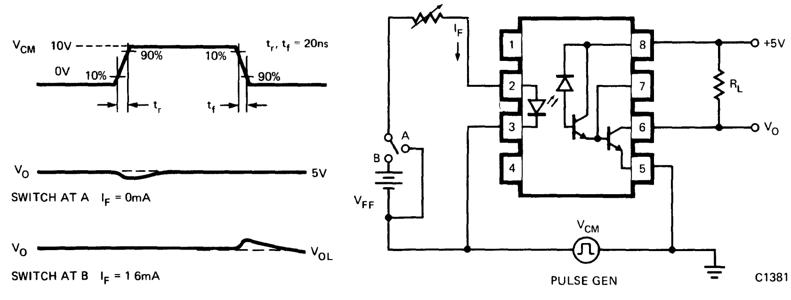
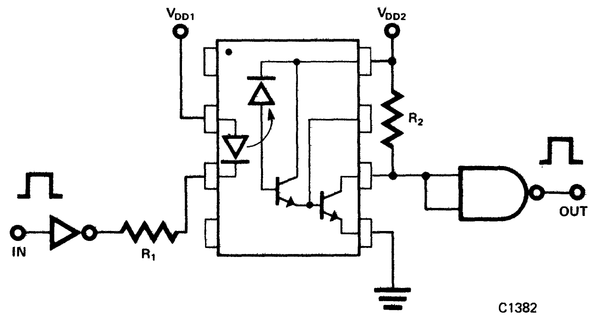
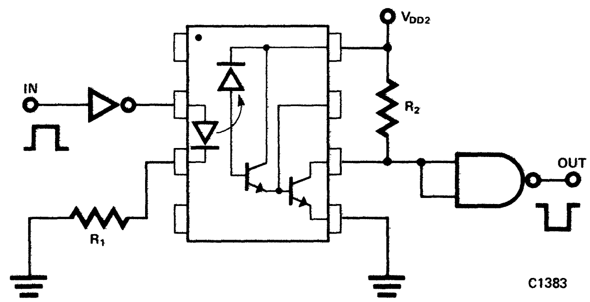


Fig. 9. Test Circuit for Transient Immunity and Typical Waveforms



NON-INVERTING LOGIC INTERFACE



INVERTING LOGIC INTERFACE

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

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

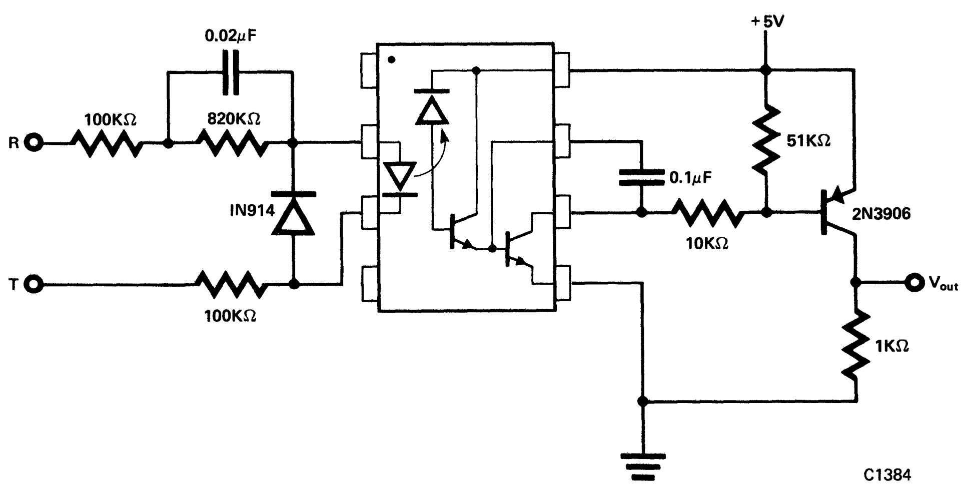
$$R_2 = \frac{V_{DD2} - V_{OLX}(@\ I_L + I_2)}{I_L}$$

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.

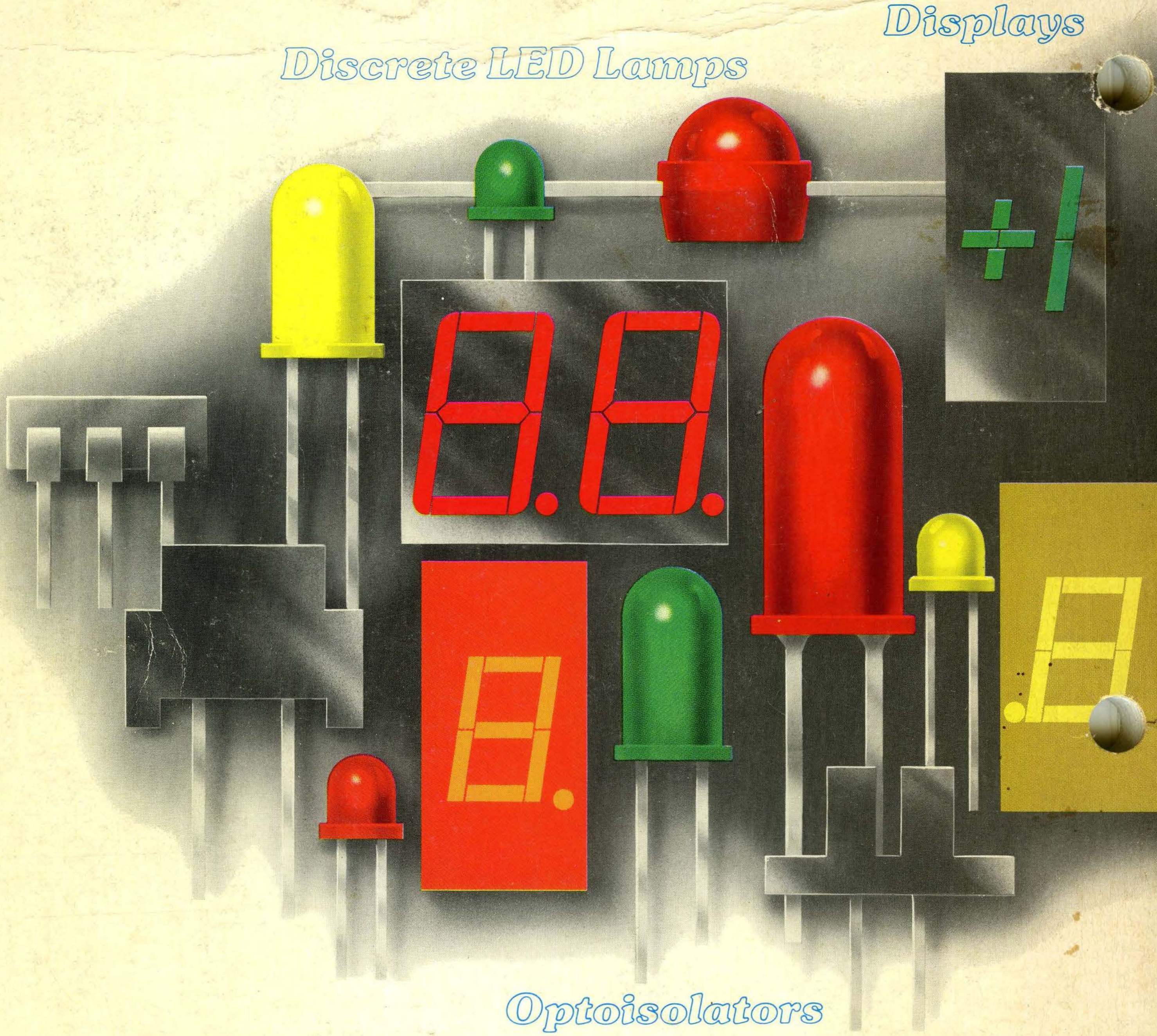
CURRENT LIMITING
RESISTOR CALCULATION

			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



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