FAIRCHILD
SEMICONDUCTOR™

GlobalOptoisolator™

VDE | UL | CSA | SETI | SEMKO | DEMKO | NEMKO | BABT

MOC3051
MOC3052

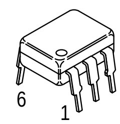
6-Pin DIP Random-Phase Optoisolators Triac Drivers
(600 Volts Peak)

The MOC3051 Series consists of a GaAs infrared LED optically coupled to a non–Zero–crossing silicon bilateral AC switch (triac). The MOC3051 Series isolates low voltage logic from 115 and 240 Vac lines to provide random phase control of high current triacs or thyristors. The MOC3051 Series features greatly enhanced static dv/dt capability to ensure stable switching performance of inductive loads.

- ***To order devices that are tested and marked per VDE 0884 requirements, the suffix "V" must be included at end of part number. VDE 0884 is a test option.***

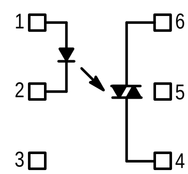
Recommended for 115/240 Vac(rms) Applications:

- Solenoid/Valve Controls
- Lamp Ballasts
- Static AC Power Switch
- Interfacing Microprocessors to 115 and 240 Vac Peripherals
- Solid State Relays
- Incandescent Lamp Dimmers
- Temperature Controls
- Motor Controls



STANDARD THRU HOLE

COUPLER SCHEMATIC



1. ANODE
2. CATHODE
3. NC
4. MAIN TERMINAL
5. SUBSTRATE DO NOT CONNECT
6. MAIN TERMINAL

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
INFRARED EMITTING DIODE			
Reverse Voltage	V_R	3	Volts
Forward Current — Continuous	I_F	60	mA
Total Power Dissipation @ T_A = 25°C Negligible Power in Triac Driver Derate above 25°C	P_D	100 1.33	mW mW/°C
OUTPUT DRIVER			
Off–State Output Terminal Voltage	V_{DRM}	600	Volts
Peak Repetitive Surge Current (PW = 100 µs, 120 pps)	I_{TSM}	1	A
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	300 4	mW mW/°C
TOTAL DEVICE			
Isolation Surge Voltage (1) (Peak ac Voltage, 60 Hz, 1 Second Duration)	V_{ISO}	7500	Vac(pk)
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	330 4.4	mW mW/°C
Junction Temperature Range	T_J	–40 to +100	°C
Ambient Operating Temperature Range	T_A	–40 to +85	°C
Storage Temperature Range	T_{stg}	–40 to +150	°C
Soldering Temperature (10 s)	T_L	260	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
INPUT LED					
Reverse Leakage Current (V_R = 3 V)	I_R	—	0.05	100	µA
Forward Voltage (I_F = 10 mA)	V_F	—	1.15	1.5	Volts
OUTPUT DETECTOR (I_F = 0 unless otherwise noted)					
Peak Blocking Current, Either Direction (Rated V_{DRM}, Note 1) @ I_{FT} per device	I_{DRM}	—	10	100	nA
Peak On–State Voltage, Either Direction (I_{TM} = 100 mA Peak)	V_{TM}	—	1.7	2.5	Volts
Critical Rate of Rise of Off–State Voltage @ 400 V (Refer to test circuit, Figure 10)	dv/dt static	1000	—	—	V/µs
COUPLED					
LED Trigger Current, Either Direction, Current Required to Latch Output (Main Terminal Voltage = 3 V, Note 2)	I_{FT}				mA
MOC3051		—	—	15	
MOC3052		—	—	10	
Holding Current, Either Direction	I_H	—	280	—	µA

1. Test voltage must be applied within dv/dt rating.
2. All devices are guaranteed to trigger at an I_F value less than or equal to max I_{FT}. Therefore, recommended operating I_F lies between max 15 mA for MOC3051, 10 mA for 3052 and absolute max I_F (60 mA).

TYPICAL ELECTRICAL CHARACTERISTICS
T_A = 25°C

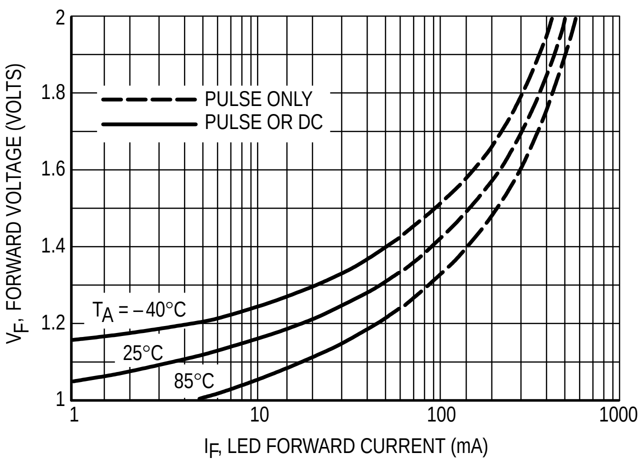


Figure 1. LED Forward Voltage versus Forward Current

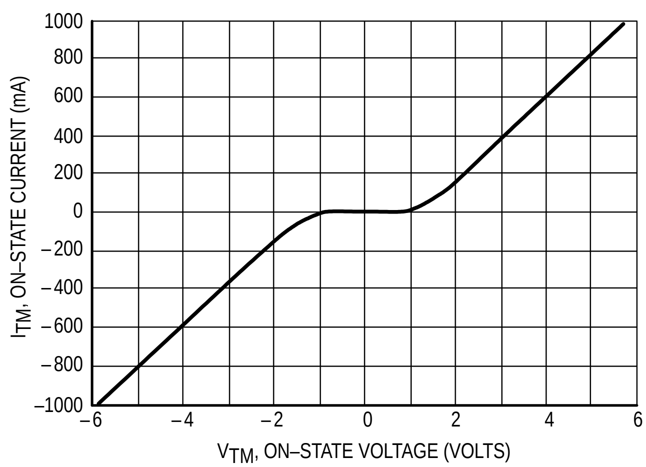


Figure 2. On–State Characteristics

TYPICAL ELECTRICAL CHARACTERISTICS

T_A = 25°C

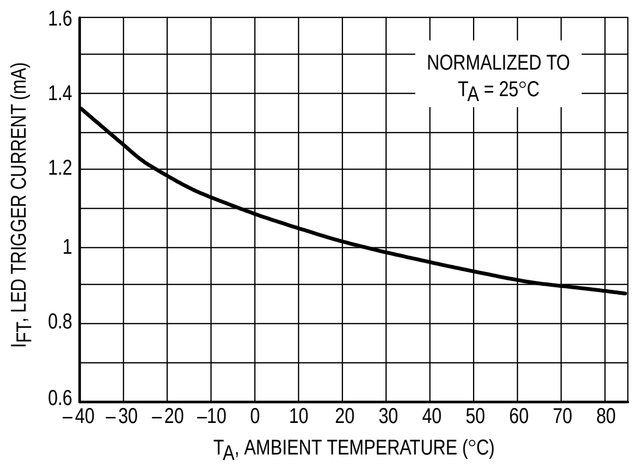


Figure 3. Trigger Current versus Temperature

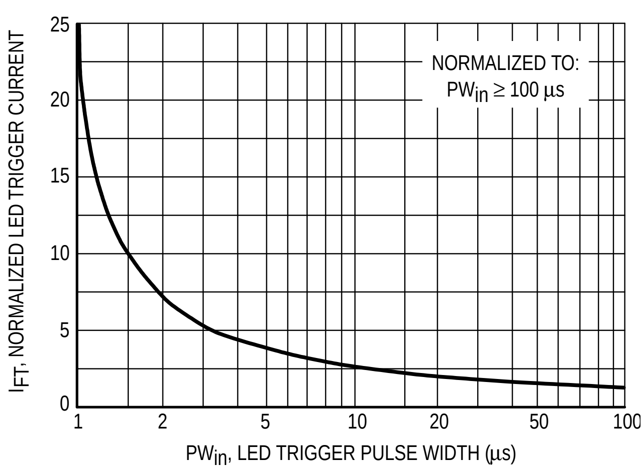


Figure 4. LED Current Required to Trigger versus LED Pulse Width

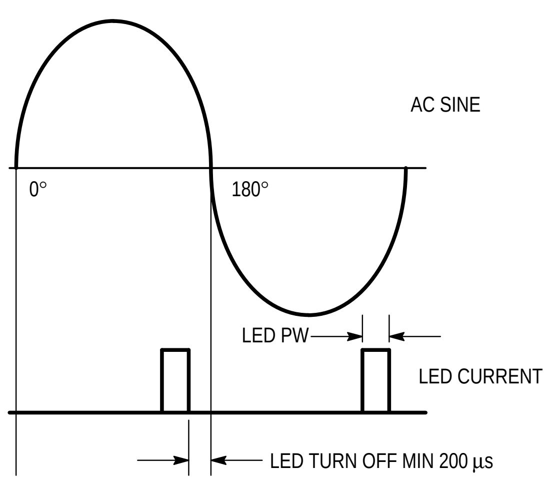


Figure 5. Minimum Time for LED Turn–Off to Zero Cross of AC Trailing Edge

I_{FT} versus Temperature (normalized)

This graph shows the increase of the trigger current when the device is expected to operate at an ambient temperature below 25°C. Multiply the normalized I_{FT} shown on this graph with the data sheet guaranteed I_{FT}.

Example:
T_A = –40°C, I_{FT} = 10 mA
I_{FT} @ –40°C = 10 mA x 1.4 = 14 mA

Phase Control Considerations

LED Trigger Current versus PW (normalized)

Random Phase Triac drivers are designed to be phase controllable. They may be triggered at any phase angle within the AC sine wave. Phase control may be accomplished by an AC line zero cross detector and a variable pulse delay generator which is synchronized to the zero cross detector. The same task can be accomplished by a microprocessor which is synchronized to the AC zero crossing. The phase controlled trigger current may be a very short pulse which saves energy delivered to the input LED. LED trigger pulse currents shorter than 100 µs must have an increased amplitude as shown on Figure 4. This graph shows the dependency of the trigger current I_{FT} versus the pulse width t (PW). The reason for the I_{FT} dependency on the pulse width can be seen on the chart delay t(d) versus the LED trigger current.

I_{FT} in the graph I_{FT} versus (PW) is normalized in respect to the minimum specified I_{FT} for static condition, which is specified in the device characteristic. The normalized I_{FT} has to be multiplied with the devices guaranteed static trigger current.

Example:
Guaranteed I_{FT} = 10 mA, Trigger pulse width PW = 3 µs
I_{FT} (pulsed) = 10 mA x 5 = 50 mA

Minimum LED Off Time in Phase Control Applications

In Phase control applications one intends to be able to control each AC sine half wave from 0 to 180 degrees. Turn on at zero degrees means full power and turn on at 180 degree means zero power. This is not quite possible in reality because triac driver and triac have a fixed turn on time when activated at zero degrees. At a phase control angle close to 180 degrees the driver's turn on pulse at the trailing edge of the AC sine wave must be limited to end 200 µs before AC zero cross as shown in Figure 5. This assures that the triac driver has time to switch off. Shorter times may cause loss of control at the following half cycle.

TYPICAL ELECTRICAL CHARACTERISTICS

T_A = 25°C

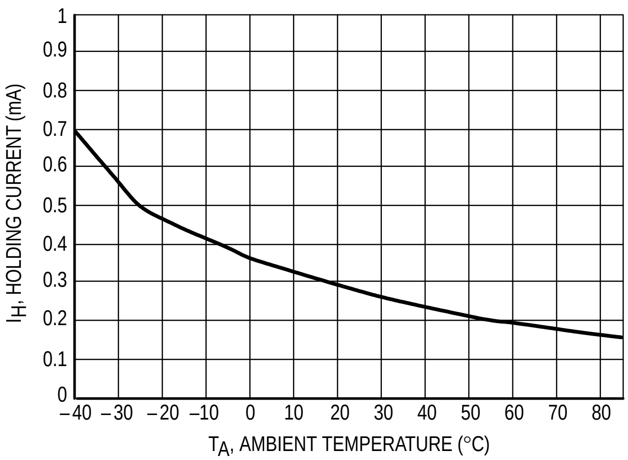


Figure 6. Holding Current, I_H versus Temperature

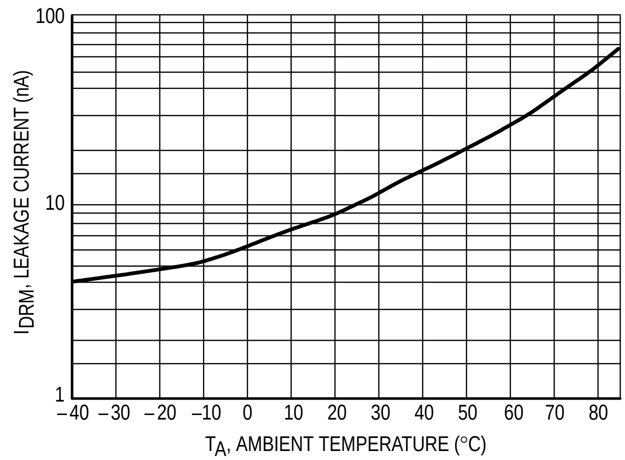


Figure 7. Leakage Current, I_{DRM} versus Temperature

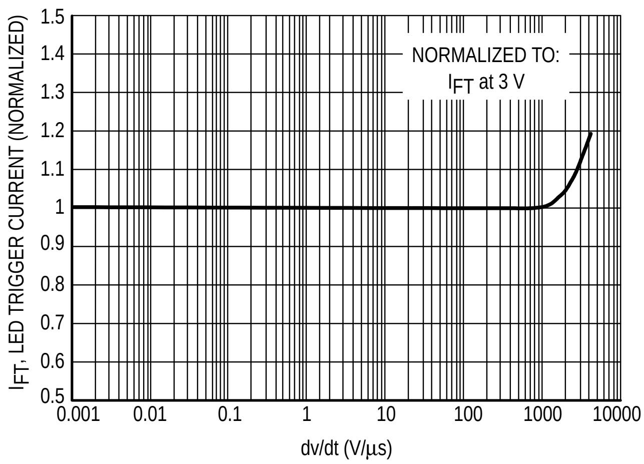


Figure 8. ED Trigger Current, I_{FT}, versus dv/dt

I_{FT} versus dv/dt

Triac drivers with good noise immunity (dv/dt static) have internal noise rejection circuits which prevent false triggering of the device in the event of fast raising line voltage transients. Inductive loads generate a commutating dv/dt that may activate the triac drivers noise suppression circuits. This prevents the device from turning on at its specified trigger current. It will in this case go into the mode of “half waving” of the load. Half waving of the load may destroy the power triac and the load.

Figure 8 shows the dependency of the triac drivers I_{FT} versus the reapplied voltage rise with a Vp of 400 V. This dv/dt condition simulates a worst case commutating dv/dt amplitude.

It can be seen that the I_{FT} does not change until a commutating dv/dt reaches 1000 V/µs. Practical loads generate a commutating dv/dt of less than 50 V/µs. The data sheet specified I_{FT} is therefore applicable for all practical inductive loads and load factors.

TYPICAL ELECTRICAL CHARACTERISTICS

$T_A = 25°C$

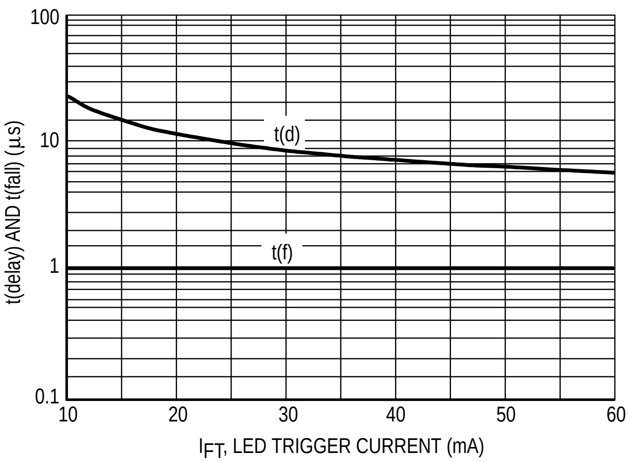


Figure 9. Delay Time, t(d), and Fall Time, t(f), versus LED Trigger Current

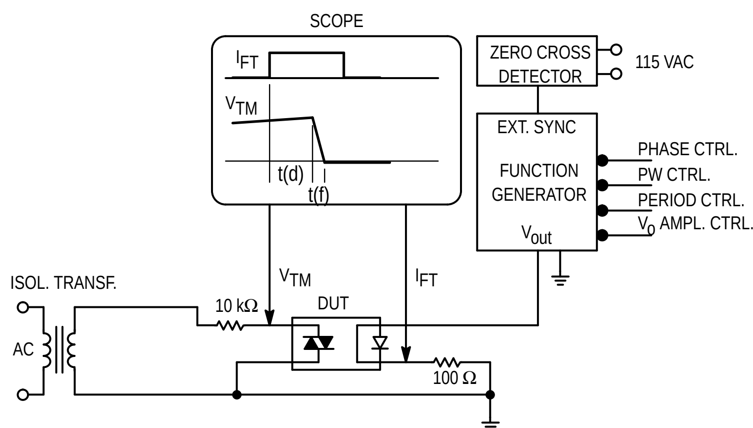
t(delay), t(f) versus I_{FT}

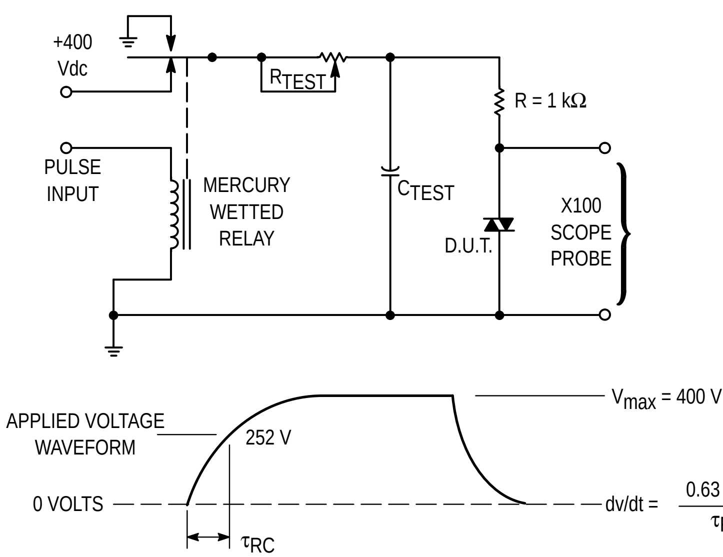
The triac driver's turn on switching speed consists of a turn on delay time t(d) and a fall time t(f). Figure 9 shows that the delay time depends on the LED trigger current, while the actual trigger transition time t(f) stays constant with about one micro second.

The delay time is important in very short pulsed operation because it demands a higher trigger current at very short trigger pulses. This dependency is shown in the graph I_{FT} versus LED PW.

The turn on transition time t(f) combined with the power triac's turn on time is important to the power dissipation of this device.

Switching Time Test Circuit





$$dv/dt = \frac{0.63\ V_{max}}{\tau_{RC}} = \frac{252}{\tau_{RC}}$$

1. The mercury wetted relay provides a high speed repeated pulse to the D.U.T.
2. 100x scope probes are used, to allow high speeds and voltages.
3. The worst–case condition for static dv/dt is established by triggering the D.U.T. with a normal LED input current, then removing the current. The variable R_{TEST} allows the dv/dt to be gradually increased until the D.U.T. continues to trigger in response to the applied voltage pulse, even after the LED current has been removed. The dv/dt is then decreased until the D.U.T. stops triggering. τ_{RC} is measured at this point and recorded.

Figure 10. Static dv/dt Test Circuit

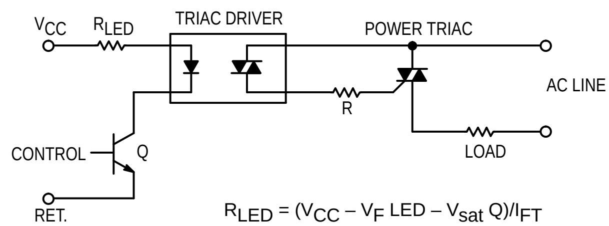
APPLICATIONS GUIDE

Basic Triac Driver Circuit

The new random phase triac driver family MOC3052 and MOC3051 are very immune to static dv/dt which allows snubberless operations in all applications where external generated noise in the AC line is below its guaranteed dv/dt withstand capability. For these applications a snubber circuit is not necessary when a noise insensitive power triac is used. Figure 11 shows the circuit diagram. The triac driver is directly connected to the triac main terminal 2 and a series Resistor R which limits the current to the triac driver. Current limiting resistor R must have a minimum value which restricts the current into the driver to maximum 1A.

$R = Vp\ AC/I_{TM}$ max rep. = Vp AC/1A

The power dissipation of this current limiting resistor and the triac driver is very small because the power triac carries the load current as soon as the current through driver and current limiting resistor reaches the trigger current of the power triac. The switching transition times for the driver is only one micro second and for power triacs typical four micro seconds.

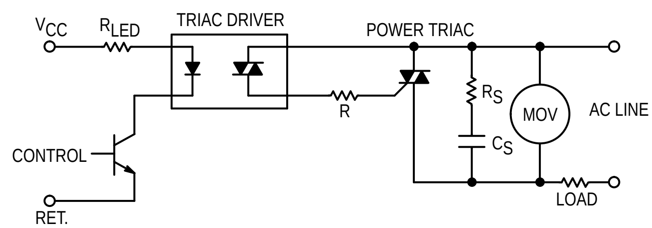


$R_{LED} = (V_{CC} - V_F\ LED - V_{sat}\ Q)/I_{FT}$
$R = V_p\ AC\ line/I_{TSM}$

Figure 11. Basic Driver Circuit

Triac Driver Circuit for Noisy Environments

When the transient rate of rise and amplitude are expected to exceed the power triacs and triac drivers maximum ratings a snubber circuit as shown in Figure 12 is recommended. Fast transients are slowed by the R–C snubber and excessive amplitudes are clipped by the Metal Oxide Varistor MOV.

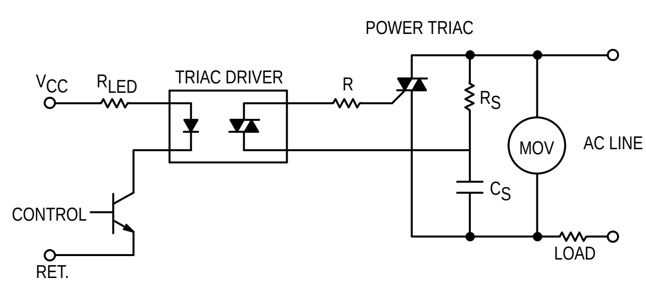


Typical Snubber values R_S = 33 Ω, C_S = 0.01 µF
MOV (Metal Oxide Varistor) protects triac and driver from transient overvoltages >V_{DRM} max.

Figure 12. Triac Driver Circuit for Noisy Environments

Triac Driver Circuit for Extremely Noisy Environments, as specified in the noise standards IEEE472 and IEC255–4.

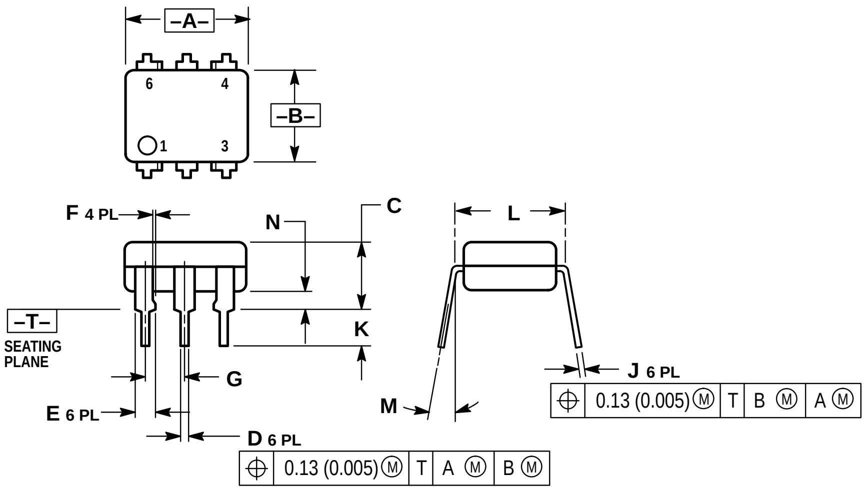
Industrial control applications do specify a maximum transient noise dv/dt and peak voltage which is superimposed onto the AC line voltage. In order to pass this environment noise test a modified snubber network as shown in Figure 13 is recommended.



Recommended snubber to pass IEEE472 and IEC255–4 noise tests
R_S = 47 W, C_S = 0.01 mF

Figure 13. Triac Driver Circuit for Extremely Noisy Environments

PACKAGE DIMENSIONS

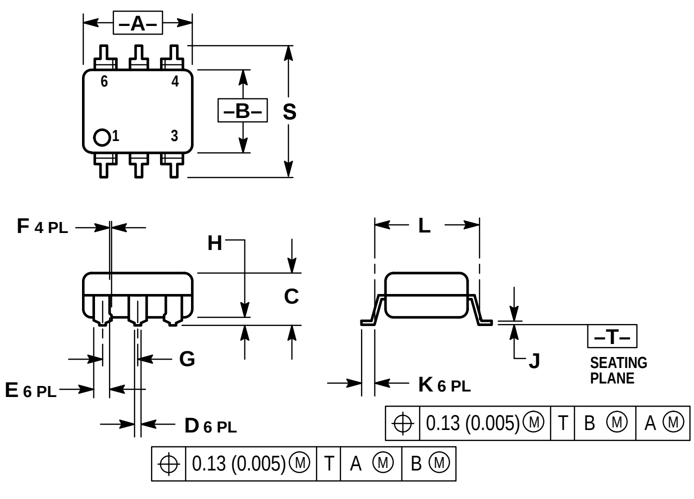


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.320	0.350	8.13	8.89
B	0.240	0.260	6.10	6.60
C	0.115	0.200	2.93	5.08
D	0.016	0.020	0.41	0.50
E	0.040	0.070	1.02	1.77
F	0.010	0.014	0.25	0.36
G	0.100 BSC		2.54 BSC	
J	0.008	0.012	0.21	0.30
K	0.100	0.150	2.54	3.81
L	0.300 BSC		7.62 BSC	
M	0°	15°	0°	15°
N	0.015	0.100	0.38	2.54

STYLE 6:
PIN 1. ANODE
2. CATHODE
3. NC
4. MAIN TERMINAL
5. SUBSTRATE
6. MAIN TERMINAL

THRU HOLE



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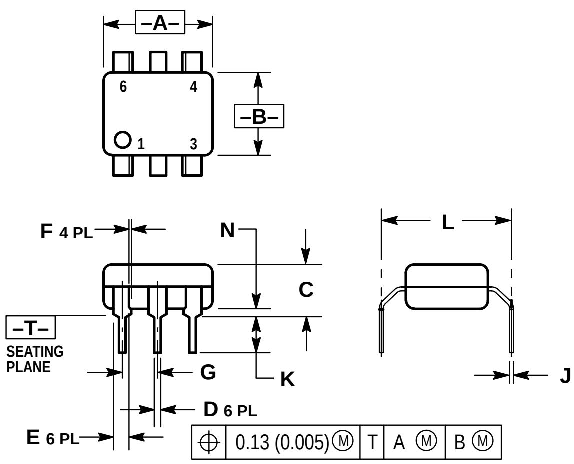
C	0.115	0.200	2.93	5.08
D	0.016	0.020	0.41	0.50
E	0.040	0.070	1.02	1.77
F	0.010	0.014	0.25	0.36
G	0.100 BSC		2.54 BSC	
H	0.020	0.025	0.51	0.63
J	0.008	0.012	0.20	0.30
K	0.006	0.035	0.16	0.88
L	0.320 BSC		8.13 BSC	
S	0.332	0.390	8.43	9.90

SURFACE MOUNT



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F	0.010	0.014	0.25	0.36
G	0.100 BSC		2.54 BSC	
J	0.008	0.012	0.21	0.30
K	0.100	0.150	2.54	3.81
L	0.400	0.425	10.16	10.80
N	0.015	0.040	0.38	1.02

0.4" LEAD SPACING

DISCLAIMER

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2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.