Advance Information

POWER OPTO™ Isolator

2 Amp Random-Phase Triac Output

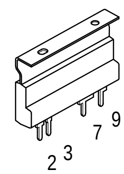
MOC2R60-10*
MOC2R60-15

*Motorola Preferred Devices

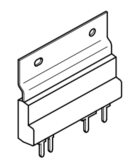
OPTOISOLATOR
2 AMPS
RANDOM–PHASE
TRIAC OUTPUT
600 VOLTS

This device consists of a gallium arsenide infrared emitting diode optically coupled to a random phase triac driver circuit and a power triac. It is capable of driving a load of up to 2 amps (rms) directly, on line voltages from 20 to 280 volts AC (rms).

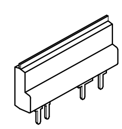
- Provides Normally Open Solid State AC Output with 2 Amp Rating
- 70 Amp Single Cycle Surge Capability
- Phase Controllable
- High Input-Output Isolation of 3750 vac (rms)
- Static dv/dt Rating of 400 Volts/µs Guaranteed
- 2 Amp Pilot Duty Rating Per UL508 ¶117 (Overload Test) and ¶118 (Endurance Test) [File No. 129224]
- CSA Approved [File No. CA77170-1]. VDE Approval in Process.
- Exceeds NEMA 2-230 and IEEE472 Noise Immunity Test Requirements (See Figure 17)



CASE 417-02
Style 2
PLASTIC PACKAGE



CASE 417A-02
Style 1
PLASTIC PACKAGE



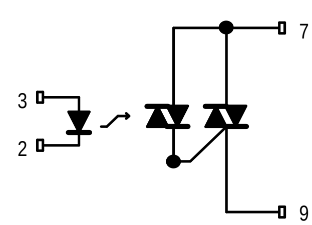
CASE 417B-01
Style 1
PLASTIC PACKAGE

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

Rating	Symbol	Value	Unit
INPUT LED			
Forward Current — Maximum Continuous	I_F	50	mA
Forward Current — Maximum Peak (PW = 100µs, 120 pps)	I_F(pk)	1.0	A
Reverse Voltage — Maximum	V_R	6.0	V
OUTPUT TRIAC			
Output Terminal Voltage — Maximum Transient (1)	V_{DRM}	600	V(pk)
Operating Voltage Range — Maximum Continuous (f = 47 – 63 Hz)	V_T	20 to 280	Vac(rms)
On-State Current Range (Free Air, Power Factor ≥ 0.3)	I_T(rms)	0.03 to 2.0	A
Non-Repetitive Single Cycle Surge Current — Maximum Peak (t = 16.7 ms)	I_{TSM}	70	A
Main Terminal Fusing Current (t = 8.3 ms)	I^2T	26	A^2sec
Load Power Factor Range	PF	0.3 to 1.0	—
Junction Temperature Range	T_J	– 40 to 125	°C
TOTAL DEVICE			
Input-Output Isolation Voltage — Maximum (2) 47 – 63 Hz, 1 sec Duration	V_{ISO}	3750	Vac(rms)
Thermal Resistance — Power Triac Junction to Case (See Figure 18)	$R_{\theta JC}$	8.0	°C/W
Ambient Operating Temperature Range	T_{oper}	– 40 to +100	°C
Storage Temperature Range	T_{stg}	– 40 to +150	°C
Lead Soldering Temperature — Maximum (1/16″ From Case, 10 sec Duration)	T_L	260	°C

1. Test voltages must be applied within dv/dt rating.
2. Input-Output isolation voltage, V_{ISO}, is an internal device dielectric breakdown rating. For this test, pins 2, 3 and the heat tab are common, and pins 7 and 9 are common.

DEVICE SCHEMATIC



1, 4, 5, 6, 8. NO PIN
2. LED CATHODE
3. LED ANODE
7. MAIN TERMINAL 2
9. MAIN TERMINAL 1

POWER OPTO is a trademark of Motorola, Inc.

This document contains information on a new product. Specifications and information herein are subject to change without notice.

Preferred devices are Motorola recommended choices for future use and best overall value.

REV 1

MOTOROLA

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

Characteristic	Symbol	Min	Typ	Max	Unit
INPUT LED					
Forward Voltage (I_F = 10 mA)	V_F	1.00	1.17	1.50	V
Reverse Leakage Current (V_R = 6.0 V)	I_R	—	1.0	100	μA
Capacitance	C	—	18	—	pF
OUTPUT TRIAC					
Off-State Leakage, Either Direction (I_F = 0, V_{DRM} = 400 V)	I_{DRM}(1)	—	0.25	100	μA
Critical Rate of Rise of Off-State Voltage (Static) (V_{in} = 400 vac(pk)) (1) (2)	dv/dt(s)	400	—	—	V/μs
Holding Current, Either Direction (I_F = 0, V_D = 12 V, I_T = 200 mA)	I_H	—	10	—	mA
COUPLED					
LED Trigger Current Required to Latch Output Either Direction (Main Terminal Voltage = 2.0 V) (3) (4) MOC2R60-10 / MOC2R60-15	I_{FT}(on)	—	7.0 12	10 15	mA
On-State Voltage, Either Direction (I_F = Rated I_{FT}(on), I_{TM} = 2.0 A)	V_{TM}	—	0.96	1.3	V
Commutating dv/dt (Rated V_{DRM}, I_T = 30 mA – 2.0 A(rms), T_A = – 40 + 100°C, f = 60 Hz) (2)	dv/dt (c)	5.0	—	—	V/μS
Common-mode Input-Output dv/dt (2)	dv/dt(cm)	—	40,000	—	V/μS
Input-Output Capacitance (V = 0, f = 1.0 MHz)	C_{ISO}	—	1.3	—	pF
Isolation Resistance (V_{I-O} = 500 V)	R_{ISO}	10^{12}	10^{14}	—	Ω

1. Per EIA/NARM standard RS–443, with V_P = 200 V, which is the instantaneous peak of the maximum operating voltage.
2. Additional dv/dt information, including test methods, can be found in Motorola applications note AN1048/D.
3. All devices are guaranteed to trigger at an I_F value less than or equal to the max I_{FT}. Therefore, the recommended operating I_F lies between the device's maximum I_{FT}(on) limit and the Maximum Rating of 50 mA.
4. Current–limiting resistor required in series with LED.

TYPICAL CHARACTERISTICS

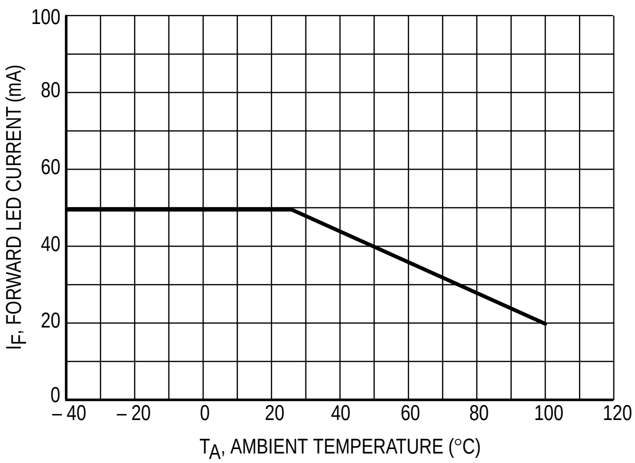


Figure 1. Maximum Allowable Forward LED Current versus Ambient Temperature

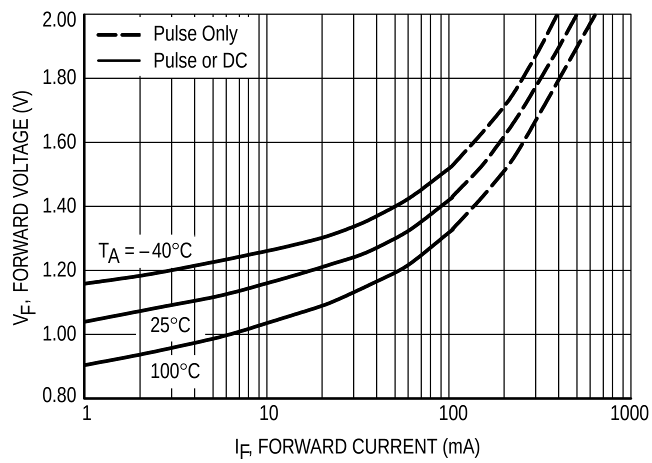


Figure 2. LED Forward Voltage versus LED Forward Current

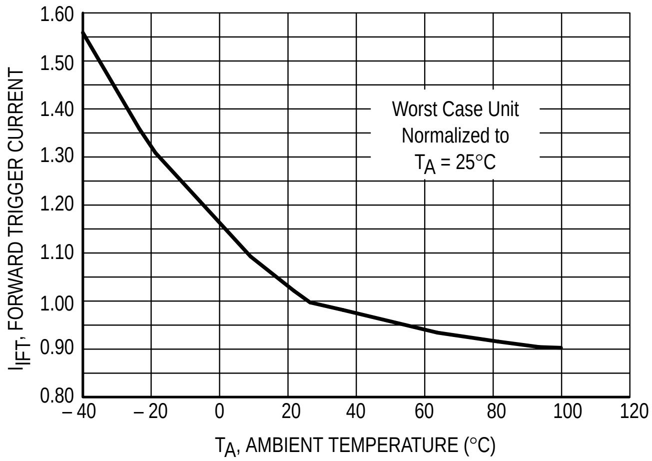


Figure 3. Forward LED Trigger Current versus Ambient Temperature

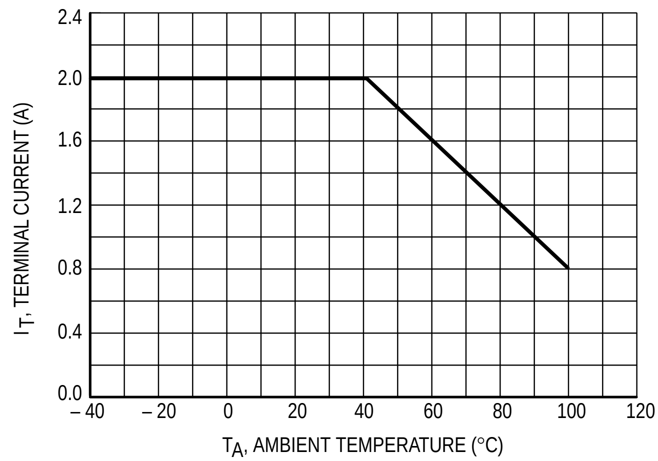


Figure 4. Maximum Allowable On-State RMS Output Current (Free Air) versus Ambient Temperature

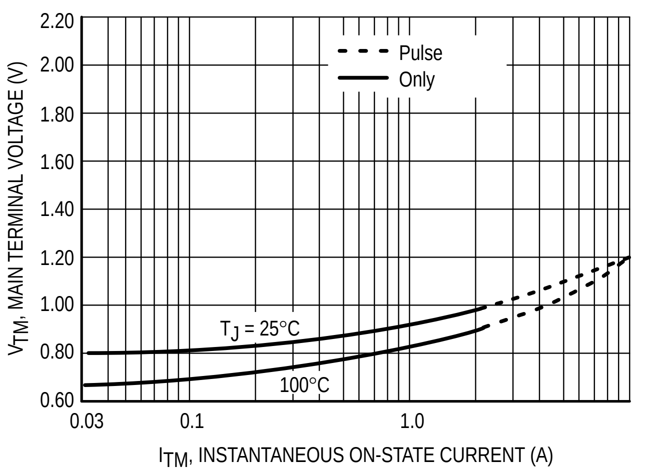


Figure 5. On-State Voltage Drop versus Output Terminal Current

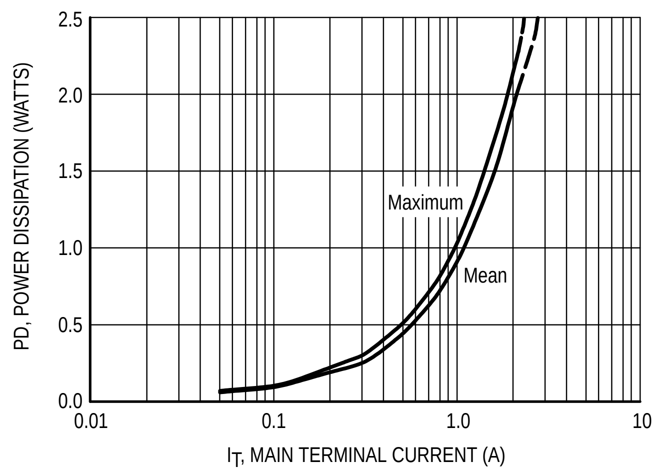


Figure 6. Power Dissipation versus Main Terminal Current

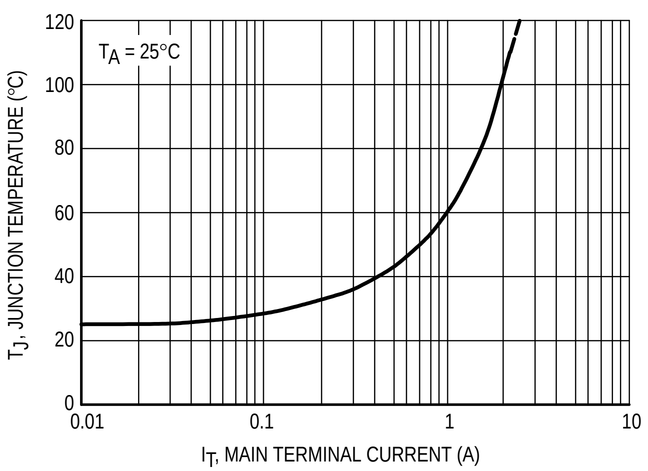


Figure 7. Junction Temperature versus Main Terminal RMS Current (Free Air)

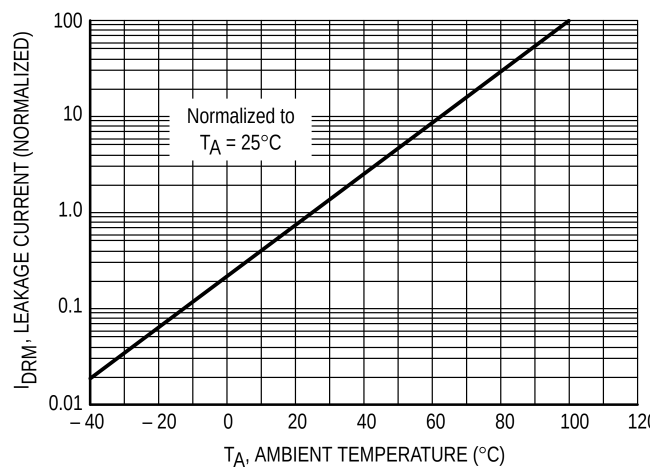


Figure 8. Leakage with LED Off versus Ambient Temperature

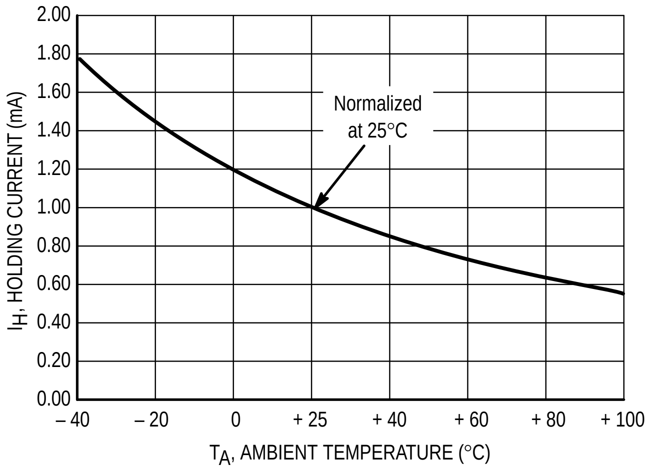


Figure 9. Holding Current versus Ambient Temperature

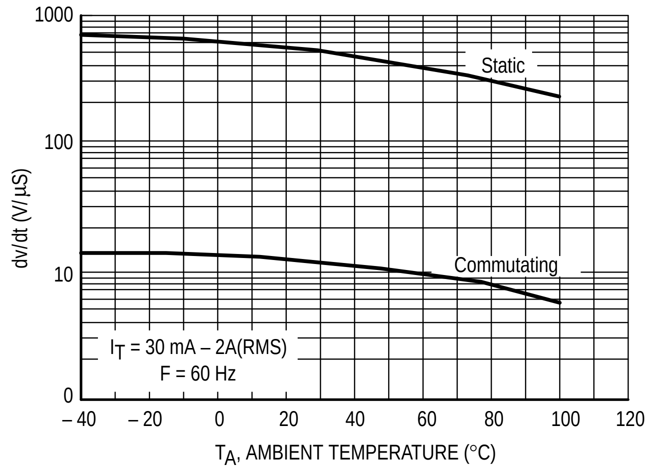


Figure 10. dv/dt versus Ambient Temperature

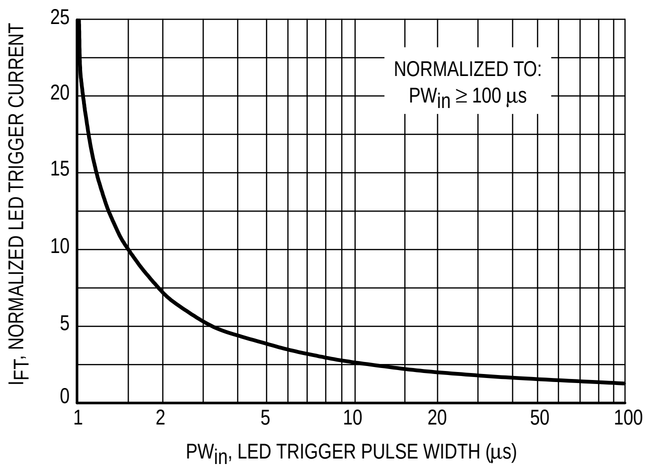


Figure 11. LED Current Required to Trigger versus LED Pulse Width

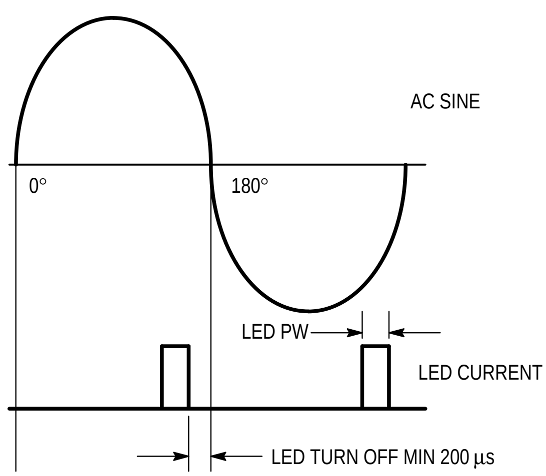


Figure 12. Minimum Time for LED Turn-Off to Zero Cross of AC Trailing Edge

Phase Control Considerations

LED Trigger Current versus PW (normalized)

The Random Phase POWER OPTO Isolators 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 11. 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 degrees 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 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 12. This assures that the device has time to switch off. Shorter times may cause loss off control at the following half cycle.

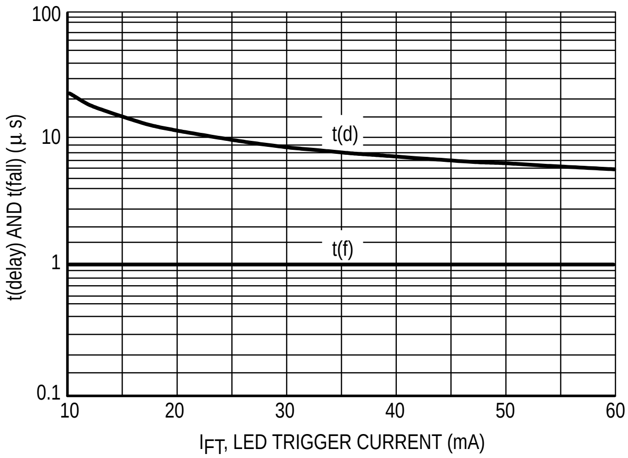


Figure 13. Delay Time, t(d), and Fall Time, t(f), versus LED Trigger Current

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

The POWER OPTO Isolators turn on switching speed consists of a turn on delay time t(d) and a fall time t(f). Figure 13 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 triacs turn on time is important to the power dissipation of this device.

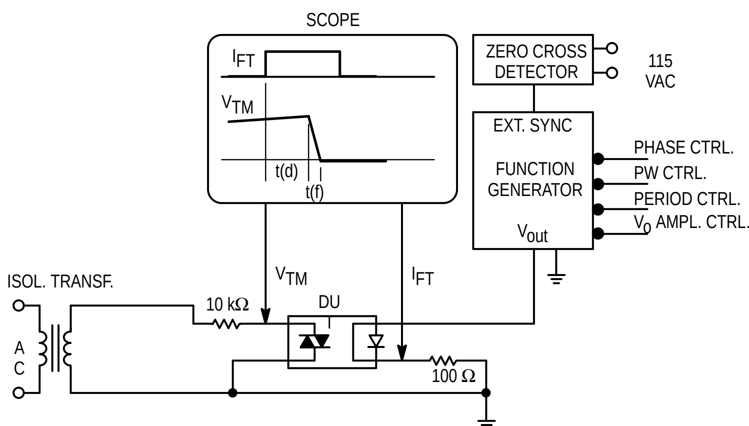


Figure 14. Switching Time Test Circuit

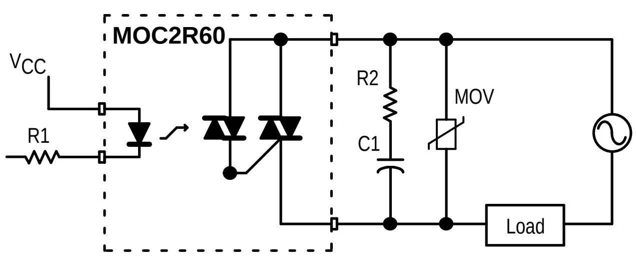


Figure 15. Typical Application Circuit

Select the value of R1 according to the following formulas:

(1) $R1 = (V_{CC} - V_F)$ / Max. I_{FT} (on) per spec.

(2) $R1 = (V_{CC} - V_F) / 0.050$

Typical values for C1 and R2 are 0.01 µF and 39 Ω, respectively. You may adjust these values for specific applications. The maximum recommended value of C1 is 0.022 µF. See application note AN1048 for additional information on component values.

The MOV may or may not be needed depending upon the characteristics of the applied AC line voltage. For applications where line spikes may exceed the 600 volts rating of the MOC2R60, an MOV is required.

Use care to maintain the minimum spacings as shown. Safety and regulatory requirements dictate a minimum of 8.0 mm between the closest points between input and output conducting paths, Pins 3 and 7. Also, 0.070 inches distance is required between the two output Pins, 7 and 9.

Keep pad sizes on Pins 7 and 9 as large as possible for optimal performance.

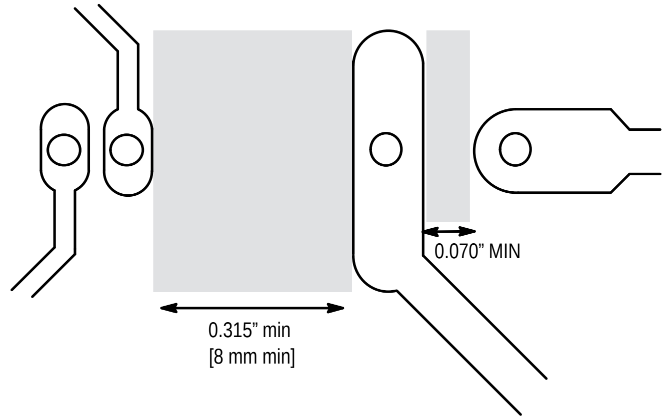


Figure 16. PC Board Layout Recommendations

Each device, when installed in the circuit shown in Figure 17, shall be capable of passing the following conducted noise tests:

- IEEE 472 (2.5 KV)
- Lamp Dimmer (NEMA Part DC33, § 3.4.2.1)
- NEMA ICS 2-230.45 Showering Arc
- MIL-STD-461A CS01, CS02 and CS06

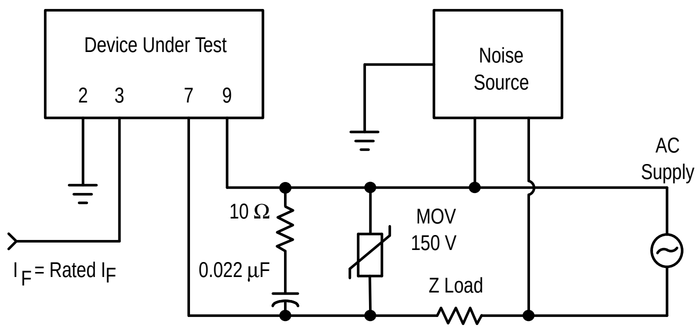
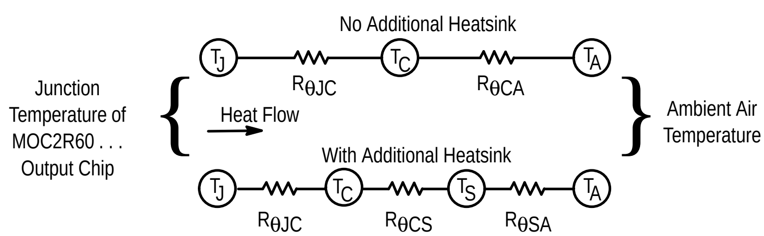
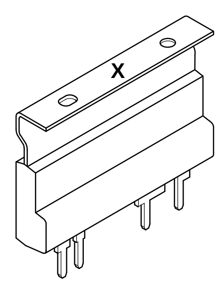


Figure 17. Test Circuit for Conducted Noise Tests





Terms in the model signify:

T_A = Ambient temperature
T_S = Optional additional heat sink temperature
T_C = Case temperature
T_J = Junction temperature
P_D = Power dissipation

$R_{\theta SA}$ = Thermal resistance, heat sink to ambient
$R_{\theta CA}$ = Thermal resistance, case to ambient
$R_{\theta CS}$ = Thermal resistance, heat sink to case
$R_{\theta JC}$ = Thermal resistance, junction to case

Values for thermal resistance components are: $R_{\theta CA}$ = 36°C/W/in maximum
$R_{\theta JC}$ = 8.0°C/W maximum

The design of any additional heatsink will determine the values of $R_{\theta SA}$ and $R_{\theta CS}$.

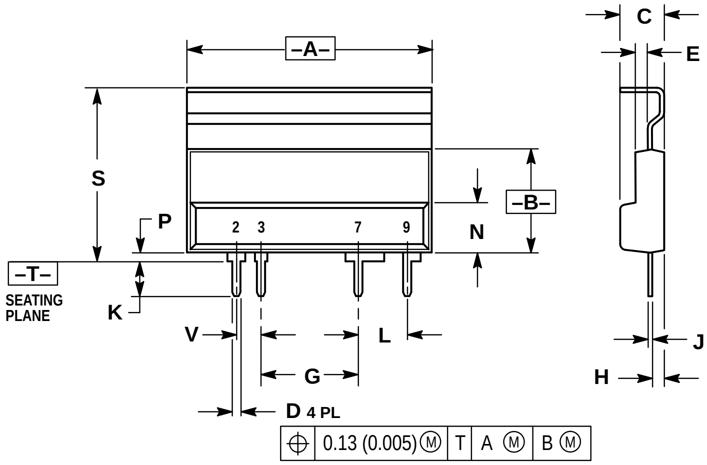
$T_C - T_A = P_D\ (R_{\theta CA})$

$= P_D\ (R_{\theta JC}) + R_{\theta SA})$, where P_D = Power Dissipation in Watts.

Thermal measurements of $R_{\theta JC}$ are referenced to the point on the heat tab indicated with an 'X'. Measurements should be taken with device orientated along its vertical axis.

Figure 18. Approximate Thermal Circuit Model

PACKAGE DIMENSIONS



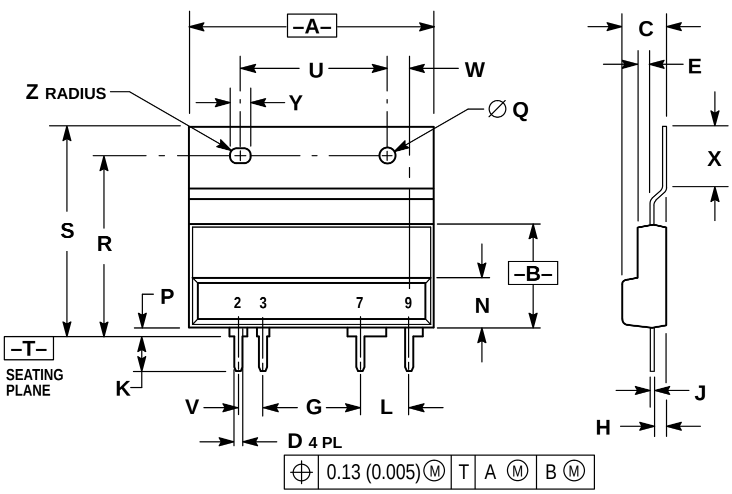
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.965	1.005	24.51	25.53
B	0.416	0.436	10.57	11.07
C	0.170	0.190	4.32	4.83
D	0.025	0.035	0.64	0.89
E	0.040	0.060	1.02	1.52
G	0.400 BSC		10.16 BSC	
H	0.040	0.060	1.02	1.52
J	0.012	0.018	0.30	0.46
K	0.134	0.154	3.40	3.91
L	0.200 BSC		5.08 BSC	
N	0.190	0.210	4.83	5.33
P	0.023	0.043	0.58	1.09
S	0.695	0.715	17.65	18.16
V	0.100 BSC		2.54 BSC	

STYLE 2:
PIN 2. LED CATHODE
3. LED ANODE
7. TRIAC MT
9. TRIAC MT

CASE 417–02
PLASTIC
STANDARD HEAT TAB
ISSUE C

ORDER "F" SUFFIX
HEAT TAB OPTION
(EX: MOC2R60–10F)



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

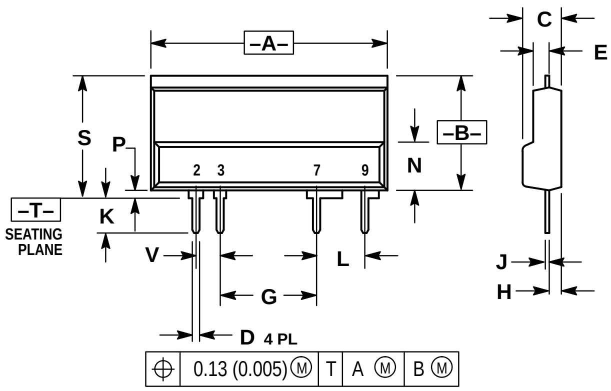
DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.965	1.005	24.51	25.53
B	0.416	0.436	10.57	11.07
C	0.170	0.190	4.32	4.83
D	0.025	0.035	0.64	0.89
E	0.040	0.060	1.02	1.52
G	0.400 BSC		10.16 BSC	
H	0.040	0.060	1.02	1.52
J	0.012	0.018	0.30	0.46
K	0.134	0.154	3.40	3.91
L	0.200 BSC		5.08 BSC	
N	0.190	0.210	4.83	5.33
P	0.023	0.043	0.58	1.09
Q	0.057	0.067	1.45	1.70
R	0.734	0.754	18.64	19.15
S	0.840	0.870	21.34	22.10
U	0.593	0.613	15.06	15.57
V	0.100 BSC		2.54 BSC	
W	0.074	0.094	1.88	2.39
X	0.265	0.295	6.73	7.49
Y	0.079	0.089	2.01	2.26
Z	0.026	0.036	0.66	0.91

STYLE 1:
PIN 2. LED CATHODE
3. LED ANODE
7. TRIAC MT
9. TRIAC MT

CASE 417A–02
PLASTIC
FLUSH MOUNT HEAT TAB
ISSUE A

PACKAGE DIMENSIONS — CONTINUED

ORDER "C" SUFFIX
HEAT TAB OPTION
(EX: MOC2R60–10C)



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.965	1.005	24.51	25.53
B	0.416	0.436	10.57	11.07
C	0.170	0.190	4.32	4.83
D	0.025	0.035	0.64	0.89
E	0.040	0.060	1.02	1.52
G	0.400 BSC		10.16 BSC	
H	0.040	0.060	1.02	1.52
J	0.012	0.060	0.30	0.46
K	0.134	0.154	3.40	3.91
L	0.200 BSC		5.08 BSC	
N	0.190	0.210	4.83	5.33
P	0.023	0.043	0.58	1.09
S	0.439	0.529	11.15	13.44
V	0.100 BSC		2.54 BSC	

STYLE 1:
PIN 2. LED CATHODE
3. LED ANODE
7. TRIAC MT
9. TRIAC MT

CASE 417B–01
PLASTIC
CUT HEAT TAB
ISSUE O

How to reach us:
USA / EUROPE: Motorola Literature Distribution;
P.O. Box 20912; Phoenix, Arizona 85036. 1–800–441–2447

MFAX: RMFAX0@email.sps.mot.com – TOUCHTONE (602) 244–6609
INTERNET: http://Design–NET.com

JAPAN: Nippon Motorola Ltd.; Tatsumi–SPD–JLDC, Toshikatsu Otsuki,
6F Seibu–Butsuryu–Center, 3–14–2 Tatsumi Koto–Ku, Tokyo 135, Japan. 03–3521–8315

HONG KONG: Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park,
51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852–26629298