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August 2015

# MOC3031M, MOC3032M, MOC3033M, MOC3041M, MOC3042M, MOC3043M 6-Pin DIP Zero-Cross Triac Driver Output Optocoupler (250/400 Volt Peak)

## Features

- Simplifies Logic Control of 115 VAC Power
- Zero Voltage Crossing
- $dv/dt$  of 2000 V/ $\mu$ s Typical, 1000 V/ $\mu$ s Guaranteed
- Peak Blocking Voltage
  - 250 V, MOC303XM
  - 400 V, MOC304XM
- Safety and Regulatory Approvals
  - UL1577, 4,170 VAC<sub>RMS</sub> for 1 Minute
  - DIN EN/IEC60747-5-5

## Applications

- Solenoid/Valve Controls
- Lighting Controls
- Static Power Switches
- AC Motor Drives
- Temperature Controls
- E.M. Contactors
- AC Motor Starters
- Solid State Relays

## Description

The MOC303XM and MOC304XM devices consist of a GaAs infrared emitting diode optically coupled to a monolithic silicon detector performing the function of a zero voltage crossing bilateral triac driver.

They are designed for use with a triac in the interface of logic systems to equipment powered from 115 VAC lines, such as teletypewriters, CRTs, solid-state relays, industrial controls, printers, motors, solenoids and consumer appliances, etc.

## Schematic

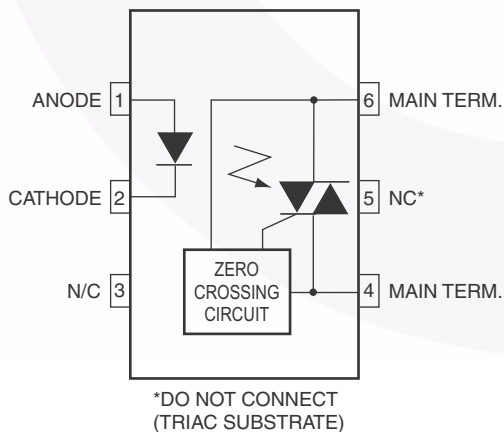


Figure 1. Schematic

## Package Outlines

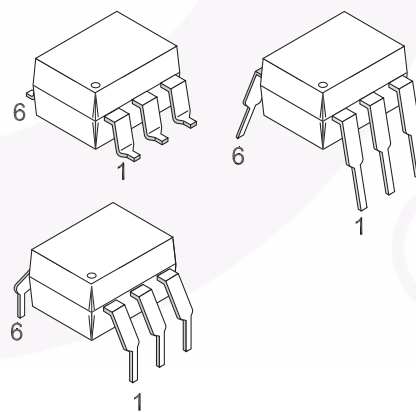


Figure 2. Package Outlines

MOC303XM, MOC304XM — 6-Pin DIP Zero-Cross Triac Driver Output Optocoupler (250/400 Volt Peak)

## Safety and Insulation Ratings

As per DIN EN/IEC 60747-5-5, this optocoupler is suitable for "safe electrical insulation" only within the safety limit data. Compliance with the safety ratings shall be ensured by means of protective circuits.

| Parameter   |                        | Characteristics |
|---|------------------------|-----------------|
| Installation Classifications per DIN VDE 0110/1.89 Table 1, For Rated Mains Voltage | < 150 V <sub>RMS</sub> | I-IV            |
|   | < 300 V <sub>RMS</sub> | I-IV            |
| Climatic Classification   |                        | 40/85/21        |
| Pollution Degree (DIN VDE 0110/1.89)  |                        | 2               |
| Comparative Tracking Index  |                        | 175             |

| Symbol            | Parameter  | Value             | Unit              |
|-------------------|--|-------------------|-------------------|
| V <sub>PR</sub>   | Input-to-Output Test Voltage, Method A, V <sub>IORM</sub> × 1.6 = V <sub>PR</sub> , Type and Sample Test with t <sub>m</sub> = 10 s, Partial Discharge < 5 pC  | 1275              | V <sub>peak</sub> |
|                   | Input-to-Output Test Voltage, Method B, V <sub>IORM</sub> × 1.875 = V <sub>PR</sub> , 100% Production Test with t <sub>m</sub> = 1 s, Partial Discharge < 5 pC | 1594              | V <sub>peak</sub> |
| V <sub>IORM</sub> | Maximum Working Insulation Voltage   | 850               | V <sub>peak</sub> |
| V <sub>IOTM</sub> | Highest Allowable Over-Voltage   | 6000              | V <sub>peak</sub> |
|                   | External Creepage  | ≥ 7               | mm                |
|                   | External Clearance   | ≥ 7               | mm                |
|                   | External Clearance (for Option TV, 0.4" Lead Spacing)  | ≥ 10              | mm                |
| DTI               | Distance Through Insulation (Insulation Thickness)   | ≥ 0.5             | mm                |
| R <sub>IO</sub>   | Insulation Resistance at T <sub>S</sub> , V <sub>IO</sub> = 500 V  | > 10 <sup>9</sup> | Ω                 |

## Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.  $T_A = 25^\circ\text{C}$  unless otherwise specified.

| Symbol              | Parameters  | Device                           | Value                 | Unit                 |
|---------------------|---|----------------------------------|-----------------------|----------------------|
| <b>TOTAL DEVICE</b> |   |                                  |                       |                      |
| $T_{STG}$           | Storage Temperature   | All                              | -40 to +150           | $^\circ\text{C}$     |
| $T_{OPR}$           | Operating Temperature   | All                              | -40 to +85            | $^\circ\text{C}$     |
| $T_J$               | Junction Temperature Range  | All                              | -40 to +100           | $^\circ\text{C}$     |
| $T_{SOL}$           | Lead Solder Temperature   | All                              | 260 for<br>10 seconds | $^\circ\text{C}$     |
| $P_D$               | Total Device Power Dissipation at $25^\circ\text{C}$ Ambient        | All                              | 250                   | mW                   |
|                     | Derate Above $25^\circ\text{C}$                                     |                                  | 2.94                  | mW/ $^\circ\text{C}$ |
| <b>EMITTER</b>      |   |                                  |                       |                      |
| $I_F$               | Continuous Forward Current  | All                              | 60                    | mA                   |
| $V_R$               | Reverse Voltage   | All                              | 6                     | V                    |
| $P_D$               | Total Power Dissipation at $25^\circ\text{C}$ Ambient               | All                              | 120                   | mW                   |
|                     | Derate Above $25^\circ\text{C}$                                     |                                  | 1.41                  | mW/ $^\circ\text{C}$ |
| <b>DETECTOR</b>     |   |                                  |                       |                      |
| $V_{DRM}$           | Off-State Output Terminal Voltage                                   | MOC3031M<br>MOC3032M<br>MOC3033M | 250                   | V                    |
|                     |   | MOC3041M<br>MOC3042M<br>MOC3043M | 400                   |                      |
| $I_{TSM}$           | Peak Repetitive Surge Current<br>(PW = 100 $\mu\text{s}$ , 120 pps) | All                              | 1                     | A                    |
| $P_D$               | Total Power Dissipation at $25^\circ\text{C}$ Ambient               | All                              | 150                   | mW                   |
|                     | Derate Above $25^\circ\text{C}$                                     |                                  | 1.76                  | mW/ $^\circ\text{C}$ |

## Electrical Characteristics

$T_A = 25^\circ\text{C}$  unless otherwise specified.

### Individual Component Characteristics

| Symbol          | Parameters                                 | Test Conditions                           | Device | Min. | Typ. | Max. | Unit             |
|-----------------|--|---|--------|------|------|------|------------------|
| <b>EMITTER</b>  |  |   |        |      |      |      |                  |
| $V_F$           | Input Forward Voltage                      | $I_F = 30\text{ mA}$                      | All    |      | 1.25 | 1.50 | V                |
| $I_R$           | Reverse Leakage Current                    | $V_R = 6\text{ V}$                        | All    |      | 0.01 | 100  | $\mu\text{A}$    |
| <b>DETECTOR</b> |  |   |        |      |      |      |                  |
| $I_{DRM1}$      | Peak Blocking Current, Either Direction    | Rated $V_{DRM}$ , $I_F = 0^{(1)}$         | All    |      |      | 100  | nA               |
| $V_{TM}$        | Peak On-State Voltage, Either Direction    | $I_{TM} = 100\text{ mA peak}$ , $I_F = 0$ | All    |      | 1.8  | 3.0  | V                |
| dv/dt           | Critical Rate of Rise of Off-State Voltage | $I_F = 0$ (Figure 11) <sup>(2)</sup>      | All    | 1000 | 2000 |      | V/ $\mu\text{s}$ |

### Transfer Characteristics

| Symbol   | DC Characteristics                | Test Conditions                            | Device   | Min. | Typ. | Max. | Unit          |
|----------|-----------------------------------|--|----------|------|------|------|---------------|
| $I_{FT}$ | LED Trigger Current               | Main Terminal Voltage = $3\text{ V}^{(3)}$ | MOC3031M |      |      | 15   | mA            |
|          |                                   |  | MOC3041M |      |      |      |               |
|          |                                   |  | MOC3032M |      |      | 10   |               |
|          |                                   |  | MOC3042M |      |      |      |               |
| $I_H$    | Holding Current, Either Direction |  | MOC3033M |      |      | 5    | $\mu\text{A}$ |
|          |                                   |  | MOC3043M |      |      |      |               |
|          |                                   |  | All      |      | 400  |      | $\mu\text{A}$ |

### Zero Crossing Characteristics

| Symbol     | Characteristics            | Test Conditions  | Device | Min. | Typ. | Max. | Unit |
|------------|----------------------------|--|--------|------|------|------|------|
| $V_{IH}$   | Inhibit Voltage            | $I_F = \text{rated } I_{FT}$ , MT1-MT2 voltage above which device will not trigger off-state | All    |      |      | 20   | V    |
| $I_{DRM2}$ | Leakage in Inhibited State | $I_F = \text{rated } I_{FT}$ , rated $V_{DRM}$ off-state                                     | All    |      |      | 2    | mA   |

### Isolation Characteristics

| Symbol    | Parameter                        | Test Conditions       | Device | Min. | Typ. | Max. | Unit           |
|-----------|----------------------------------|-----------------------|--------|------|------|------|----------------|
| $V_{ISO}$ | Isolation Voltage <sup>(4)</sup> | $t = 1\text{ Minute}$ | All    | 4170 |      |      | $V_{AC_{RMS}}$ |

#### Notes:

- Test voltage must be applied within dv/dt rating.
- This is static dv/dt. See Figure 11 for test circuit. Commutating dv/dt is a function of the load-driving thyristor(s) only.
- 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  $I_{FT}$  (15 mA for MOC3031M and MOC3041M, 10 mA for MOC3032M and MOC3042M, 5 mA for MOC3033M and MOC3043M) and absolute maximum  $I_F$  (60 mA).
- Isolation voltage,  $V_{ISO}$ , is an internal device dielectric breakdown rating. For this test, pins 1 and 2 are common, and pins 4, 5 and 6 are common.

## Typical Performance Curves

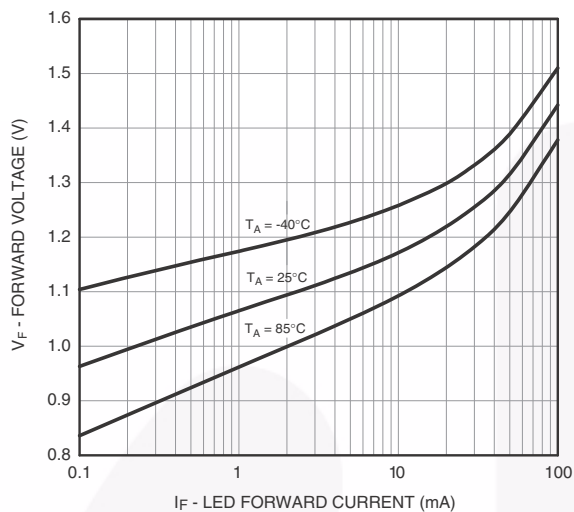


Figure 3. LED Forward Voltage vs. Forward Current

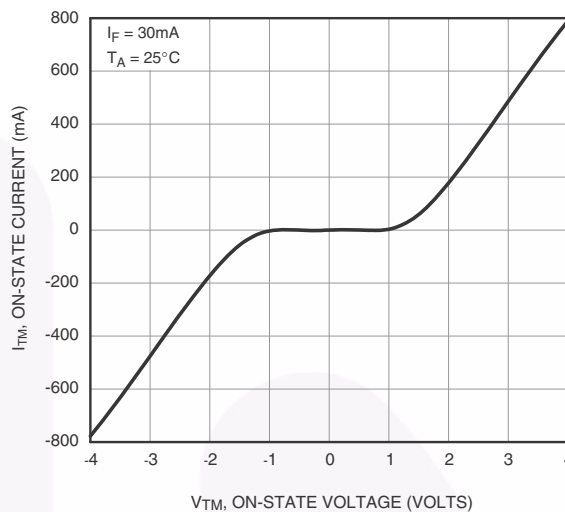


Figure 4. On-State Characteristics

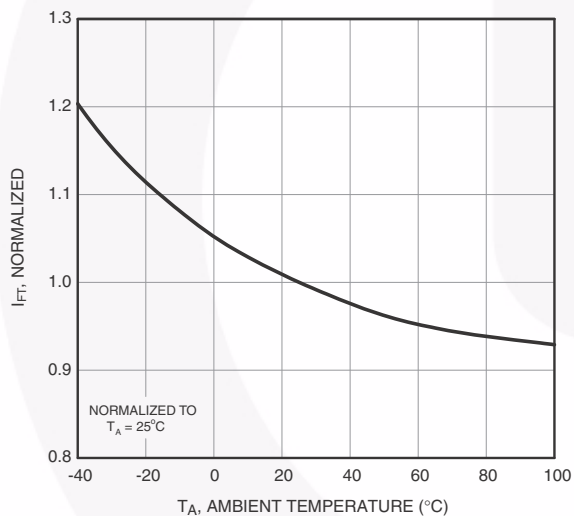


Figure 5. Trigger Current vs. Temperature

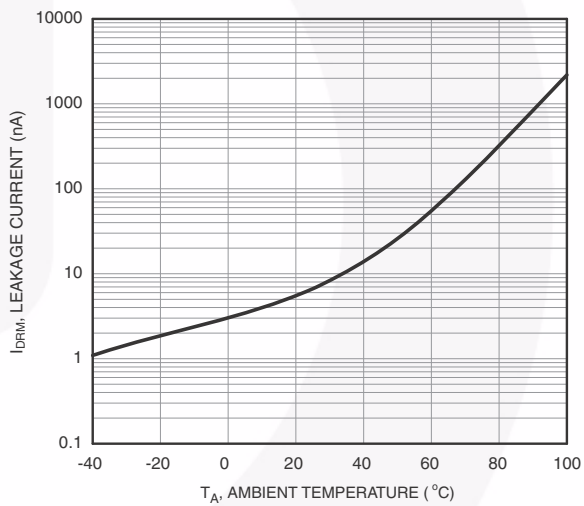
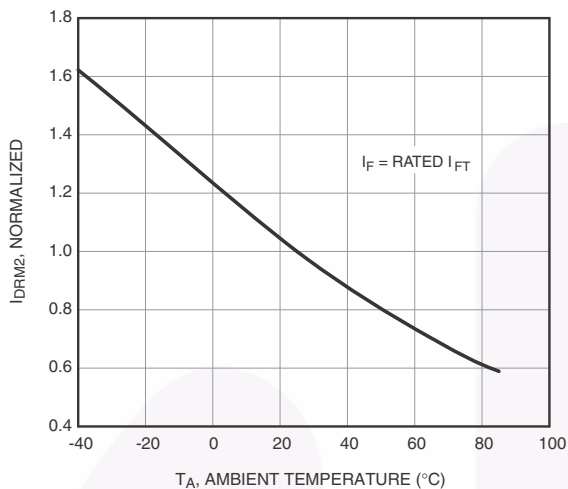
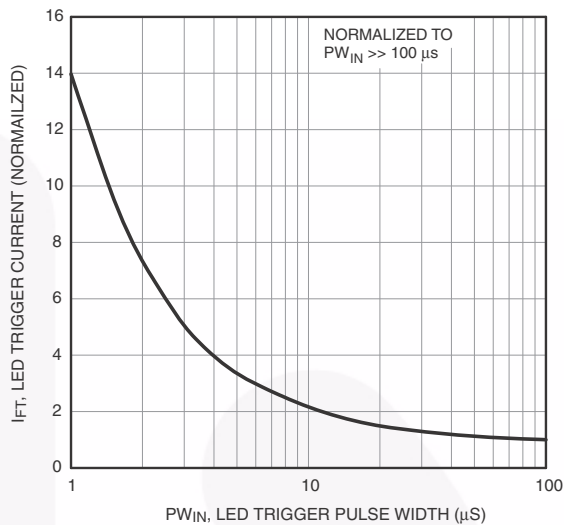


Figure 6. Leakage Current,  $I_{DRM}$  vs. Temperature

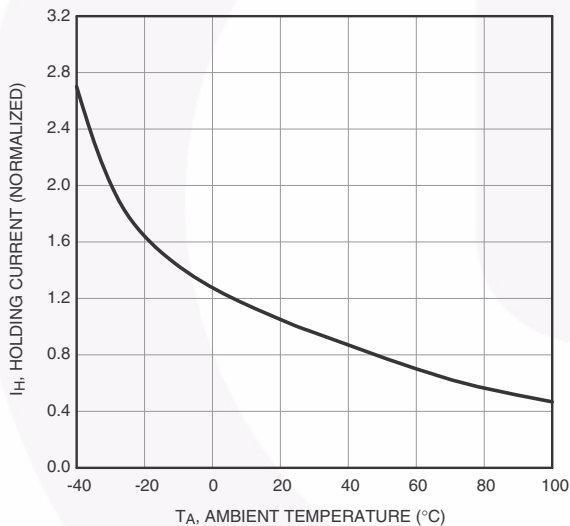
**Typical Performance Curves** (Continued)



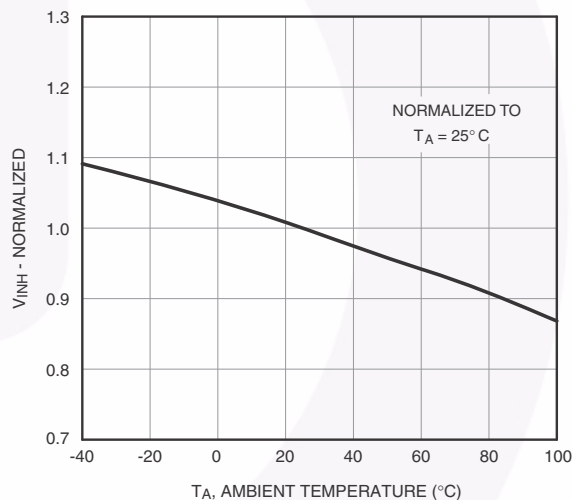
**Figure 7.** I<sub>DRM2</sub> - Leakage in Inhibit State vs. Temperature



**Figure 8.** LED Current Required to Trigger vs. LED Pulse Width



**Figure 9.** Holding Current, I<sub>H</sub> vs. Temperature



**Figure 10.** Inhibit Voltage vs. Temperature

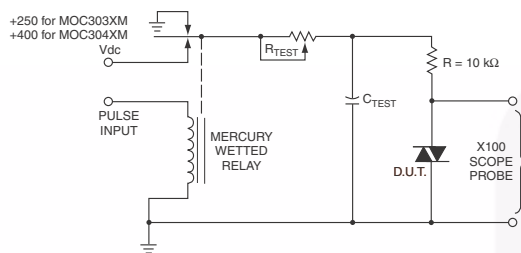


Figure 11. Static dv/dt Test Circuit

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.  $\tau_{RC}$  is measured at this point and recorded.



Figure 12. Static dv/dt Test Waveform (MOC3031M, MOC3032M, MOC3033M)

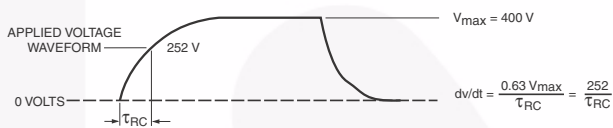
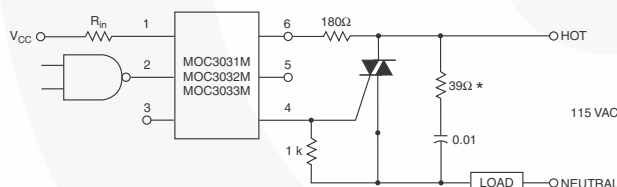


Figure 13. Static dv/dt Test Waveform (MOC3041M, MOC3042M, MOC3043M)

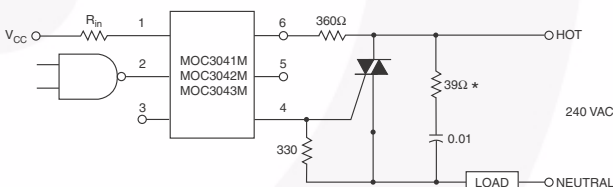
Typical circuit (Fig 14, 15) for use when hot line switching is required. In this circuit the “hot” side of the line is switched and the load connected to the cold or neutral side. The load may be connected to either the neutral or hot line.

$R_{in}$  is calculated so that  $I_F$  is equal to the rated  $I_{FT}$  of the part, 5mA for the MOC3033M and MOC3043M, 10mA for the MOC3032M and MOC3042M, or 15mA for the MOC3031M and MOC3041M. The 39 ohm resistor and 0.01 $\mu$ F capacitor are for snubbing of the triac and may or may not be necessary depending upon the particular triac and load used.



\*For highly inductive loads (power factor < 0.5), change this value to 360 ohms.

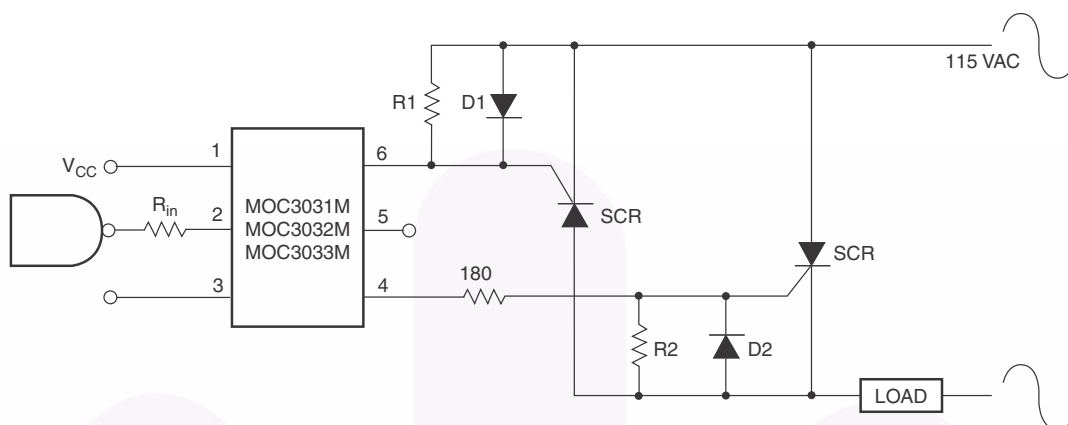
Figure 14. Hot-Line Switching Application Circuit (MOC3031M, MOC3032M, MOC3033M)



\*For highly inductive loads (power factor < 0.5), change this value to 360 ohms.

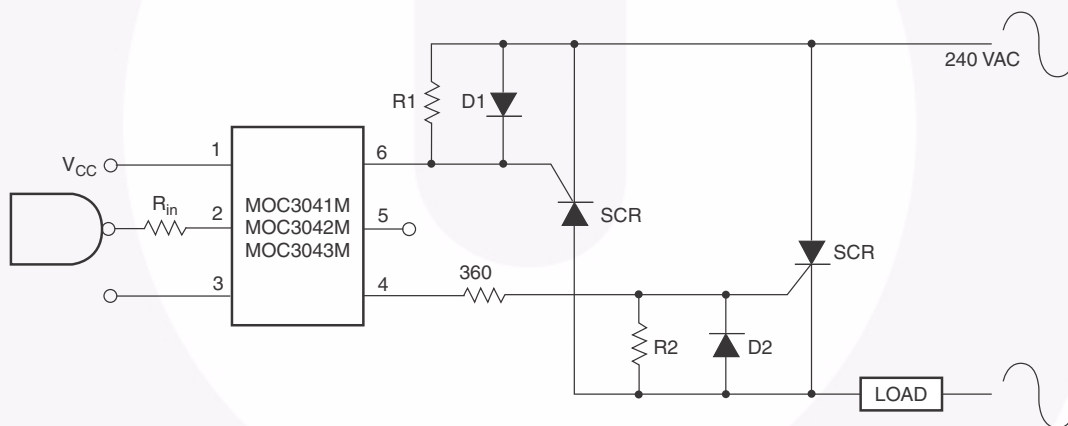
Figure 15. Hot-Line Switching Application Circuit (MOC3041M, MOC3042M, MOC3043M)





**Figure 16. Inverse-Parallel SCR Driver Circuit  
(MOC3031M, MOC3032M, MOC3033M)**

Suggested method of firing two, back-to-back SCR's with a Fairchild triac driver. Diodes can be 1N4001; resistors, R1 and R2, are optional 1k $\Omega$ .



**Figure 17. Inverse-Parallel SCR Driver Circuit  
(MOC3041M, MOC3042M, MOC3043M)**

Suggested method of firing two, back-to-back SCR's with a Fairchild triac driver. Diodes can be 1N4001; resistors, R1 and R2, are optional 330 $\Omega$ .

**Note:**

This optoisolator should not be used to drive a load directly. It is intended to be a trigger device only.

### Reflow Profile

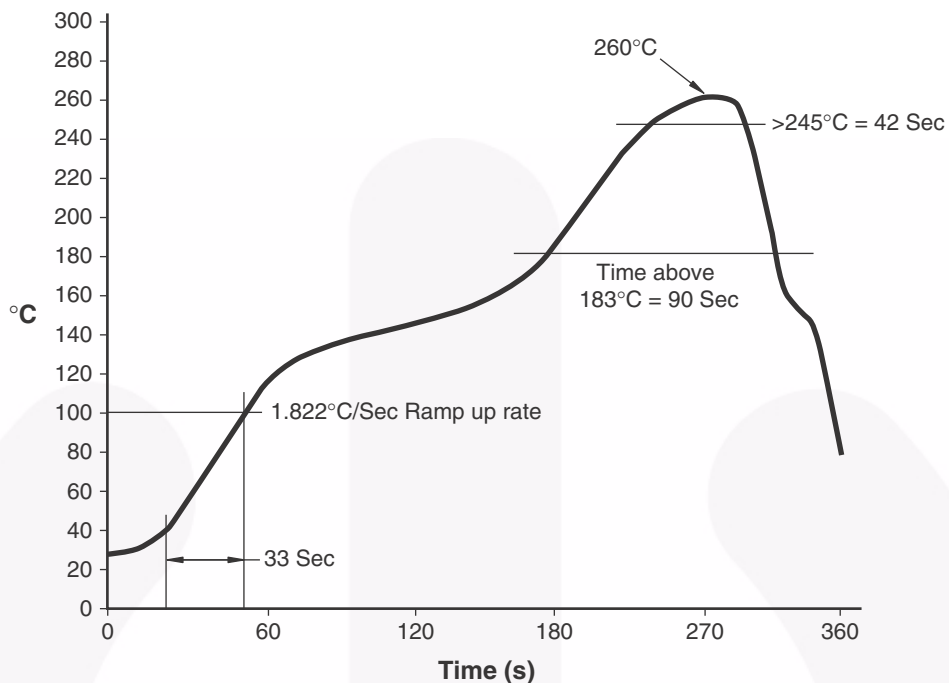


Figure 18. Reflow Profile

## Ordering Information<sup>(5)</sup>

| Part Number  | Package  | Packing Method             |
|--------------|--|----------------------------|
| MOC3031M     | DIP 6-Pin  | Tube (50 Units)            |
| MOC3031SM    | SMT 6-Pin (Lead Bend)                                    | Tube (50 Units)            |
| MOC3031SR2M  | SMT 6-Pin (Lead Bend)                                    | Tape and Reel (1000 Units) |
| MOC3031VM    | DIP 6-Pin, DIN EN/IEC60747-5-5 Option                    | Tube (50 Units)            |
| MOC3031SVM   | SMT 6-Pin (Lead Bend), DIN EN/IEC60747-5-5 Option        | Tube (50 Units)            |
| MOC3031SR2VM | SMT 6-Pin (Lead Bend), DIN EN/IEC60747-5-5 Option        | Tape and Reel (1000 Units) |
| MOC3031TVM   | DIP 6-Pin, 0.4" Lead Spacing, DIN EN/IEC60747-5-5 Option | Tube (50 Units)            |

**Note:**

5. The product orderable part number system listed in this table also applies to the MOC3032M, MOC3033M, MOC3041M, MOC3042M, and MOC3043M product families.

## Marking Information

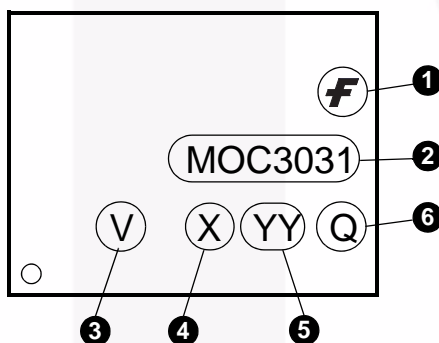
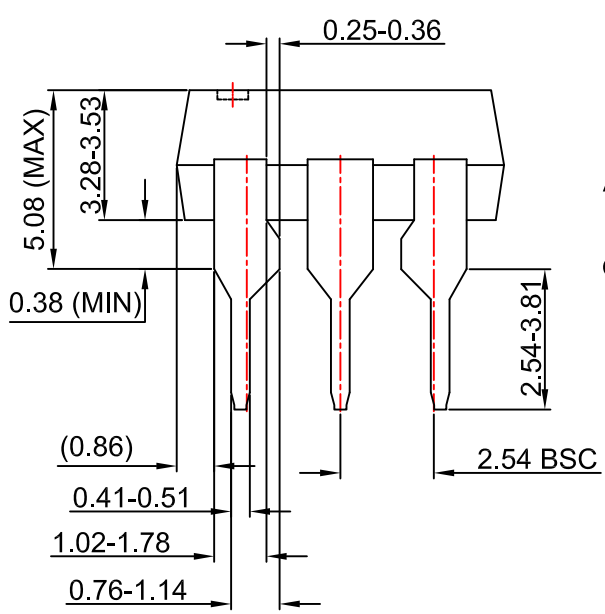
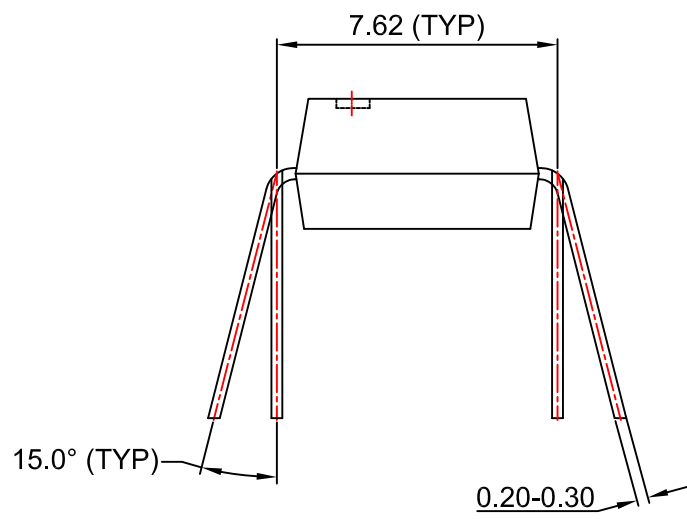
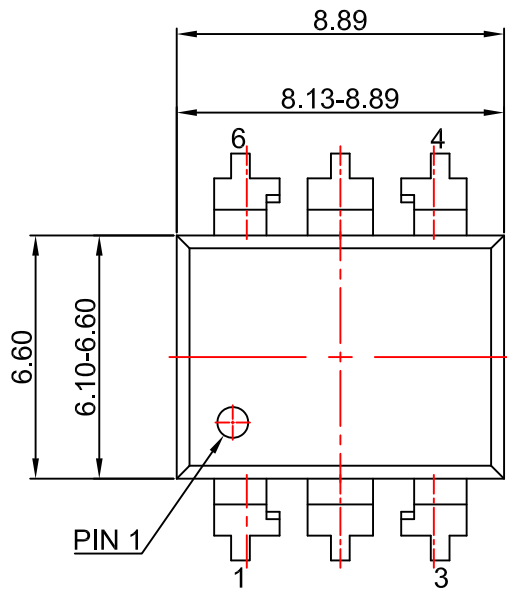


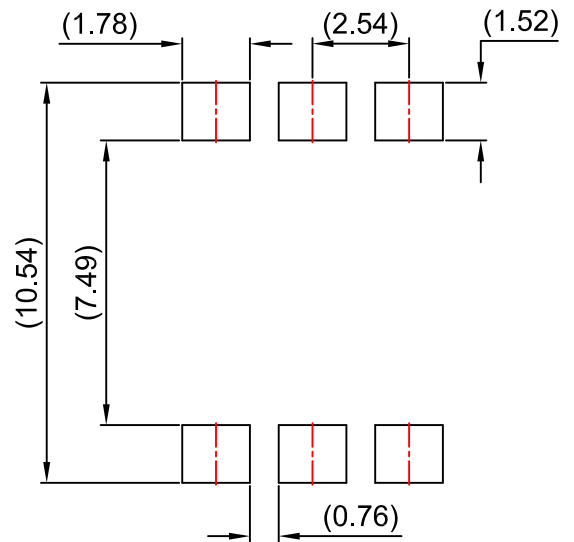
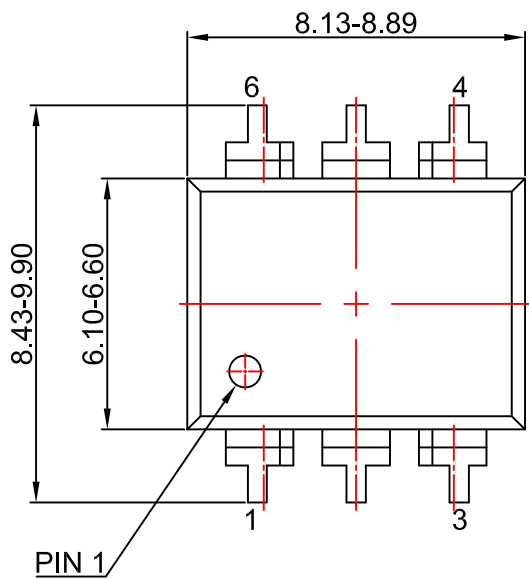
Figure 19. Top Mark

| Top Mark Definitions |   |
|----------------------|---|
| 1                    | Fairchild Logo  |
| 2                    | Device Number   |
| 3                    | DIN EN/IEC60747-5-5 Option (only appears on component ordered with this option) |
| 4                    | One-Digit Year Code, e.g., '5'  |
| 5                    | Two-Digit Work Week, Ranging from '01' to '53'                                  |
| 6                    | Assembly Package Code   |

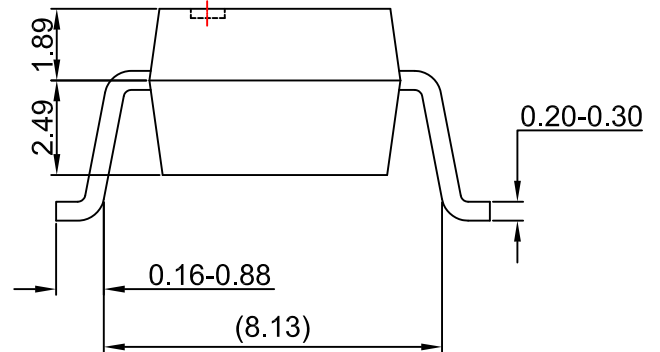
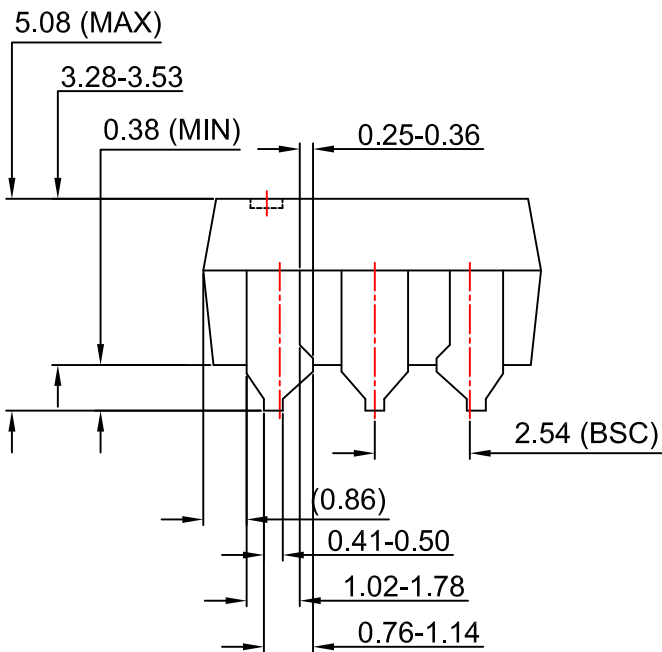


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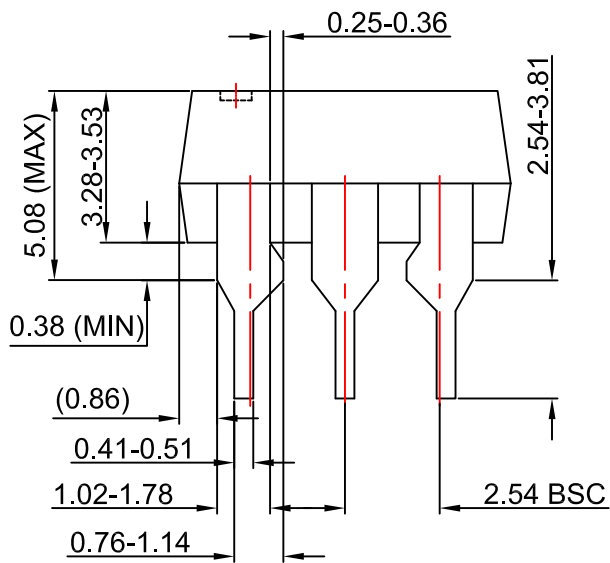
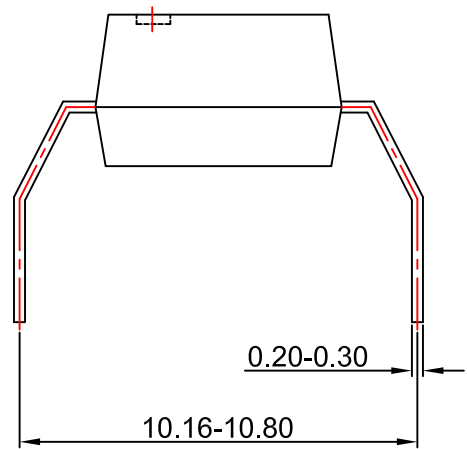
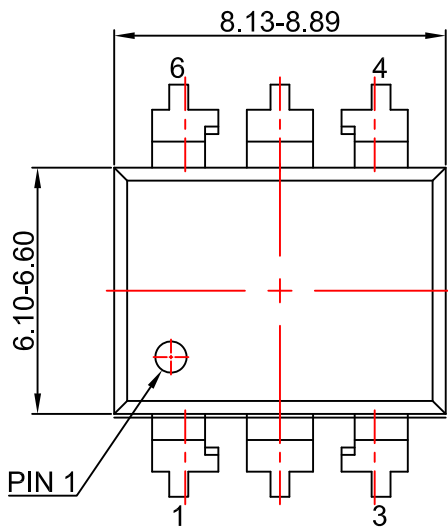
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