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September 2015

# MOC3061M, MOC3062M, MOC3063M, MOC3162M, MOC3163M 6-Pin DIP Zero-Cross Triac Driver Optocoupler (600 Volt Peak)

## Features

- Simplifies Logic Control of 115/240 VAC Power
- Zero Voltage Crossing to Minimize Conducted and Radiated Line Noise
- 600 V Peak Blocking Voltage
- Superior Static  $dv/dt$ 
  - 600 V/ $\mu$ s (MOC306xM)
  - 1000 V/ $\mu$ s (MOC316xM)
- Safety and Regulatory Approvals
  - UL1577, 4,170 VAC<sub>RMS</sub> for 1 Minute
  - DIN EN/IEC60747-5-5

## Description

The MOC306XM and MOC316XM 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 115/240 VAC lines, such as solid-state relays, industrial controls, motors, solenoids and consumer appliances, etc.

## Applications

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

## Schematic

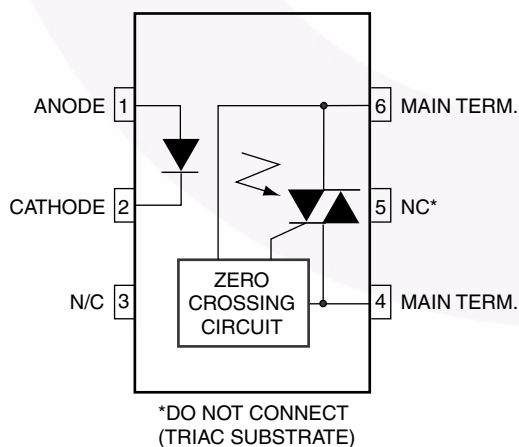


Figure 1. Schematic

## Package Outlines

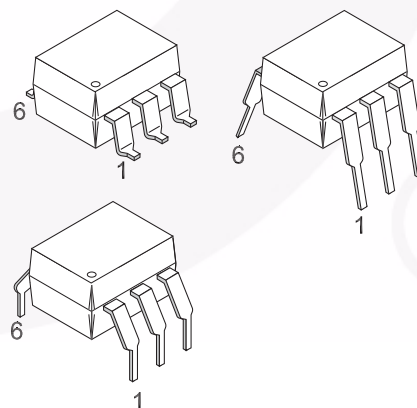


Figure 2. Package Outlines

MOC306XM, MOC316XM — 6-Pin DIP Zero-Cross Triac Driver Optocoupler (600 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  | 1360              | 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                                   | All    | 600                   | V                    |
| $I_{TSM}$           | Peak Non-Repetitive Surge Current<br>(Single Cycle 60 Hz Sine Wave) | 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                  |             | 1.3   | 1.5        | V                |
| $I_R$             | Reverse Leakage Current                    | $V_R = 6\text{ V}$                             | All                  |             | 0.005 | 100        | $\mu\text{A}$    |
| <b>DETECTOR</b>   |  |  |                      |             |       |            |                  |
| $I_{\text{DRM1}}$ | Peak Blocking Current, Either Direction    | $V_{\text{DRM}} = 600\text{ V}, I_F = 0^{(1)}$ | MOC306XM<br>MOC316XM |             | 10    | 500<br>100 | nA               |
| dv/dt             | Critical Rate of Rise of Off-State Voltage | $I_F = 0$ (Figure 11) <sup>(2)</sup>           | MOC306XM<br>MOC316XM | 600<br>1000 | 1500  |            | V/ $\mu\text{s}$ |

### Transfer Characteristics

| Symbol          | DC Characteristics                           | Test Conditions   | Device   | Min. | Typ. | Max.          | Unit          |
|-----------------|--|---|--|------|------|---------------|---------------|
| $I_{\text{FT}}$ | LED Trigger Current (Rated $I_{\text{FT}}$ ) | Main Terminal Voltage = 3 V <sup>(3)</sup>                              | MOC3061M<br>MOC3062M<br>MOC3162M<br>MOC3063M<br>MOC3163M |      |      | 15<br>10<br>5 | mA            |
| $V_{\text{TM}}$ | Peak On-State Voltage, Either Direction      | $I_{\text{TM}} = 100\text{ mA peak}, I_F = \text{rated } I_{\text{FT}}$ | All  |      | 1.8  | 3.0           | V             |
| $I_{\text{H}}$  | Holding Current, Either Direction            |   | All  |      | 500  |               | $\mu\text{A}$ |

### Zero Crossing Characteristics

| Symbol            | Characteristics   | Test Conditions  | Device   | Min. | Typ. | Max.     | Unit |
|-------------------|---|--|--|------|------|----------|------|
| $V_{\text{INH}}$  | Inhibit Voltage (MT1-MT2 voltage above which device will not trigger) | $I_F = \text{rated } I_{\text{FT}}$  | MOC3061M<br>MOC3062M<br>MOC3063M<br>MOC3162M<br>MOC3163M |      | 12   | 20<br>15 | V    |
| $I_{\text{DRM2}}$ | Leakage in Inhibited State  | $I_F = \text{rated } I_{\text{FT}}, \text{ DRM} = 600\text{ V}, \text{ off-state}$ | All  |      |      | 2        | mA   |

### Isolation Characteristics

| Symbol           | Parameter                        | Test Conditions                             | Min. | Typ.      | Max. | Unit               |
|------------------|----------------------------------|---|------|-----------|------|--------------------|
| $V_{\text{ISO}}$ | Isolation Voltage <sup>(4)</sup> | $f = 60\text{ Hz}, t = 1\text{ Minute}$     | 4170 |           |      | $V_{\text{ACRMS}}$ |
| $R_{\text{ISO}}$ | Isolation Resistance             | $V_{\text{I-O}} = 500\text{ V}_{\text{DC}}$ |      | $10^{11}$ |      | $\Omega$           |
| $C_{\text{ISO}}$ | Isolation Capacitance            | $V = 0\text{ V}, f = 1\text{ MHz}$          |      | 0.2       |      | pF                 |

#### 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  $I_{\text{FT}}$ . Therefore, recommended operating  $I_F$  lies between max  $I_{\text{FT}}$  (15 mA for MOC3061M, 10 mA for MOC3062M and MOC3162M, 5 mA for MOC3063M and MOC3163M) and absolute maximum  $I_F$  (60 mA).
- Isolation voltage,  $V_{\text{ISO}}$ , 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



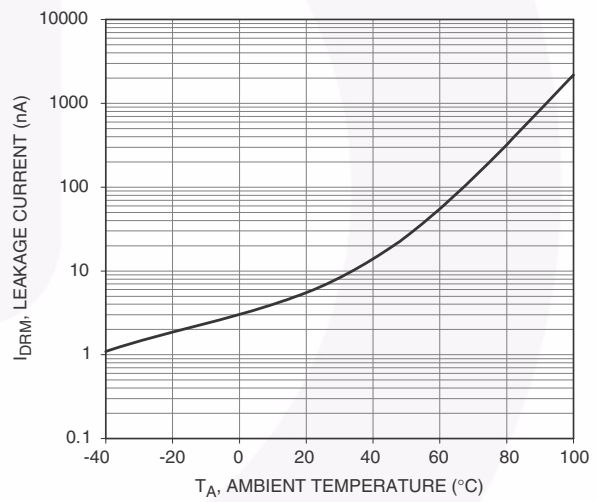
**Figure 3. LED Forward Voltage vs. Forward Current**



**Figure 4. Trigger Current vs. Temperature**



**Figure 5. LED Current Required to Trigger vs. LED Pulse Width**



**Figure 6. Leakage Current, I<sub>DRM</sub> vs. Temperature**

**Typical Performance Curves** (Continued)



**Figure 7.  $I_{DRM2}$ , Leakage in Inhibit State vs. Temperature**



**Figure 8. On-State Characteristics**

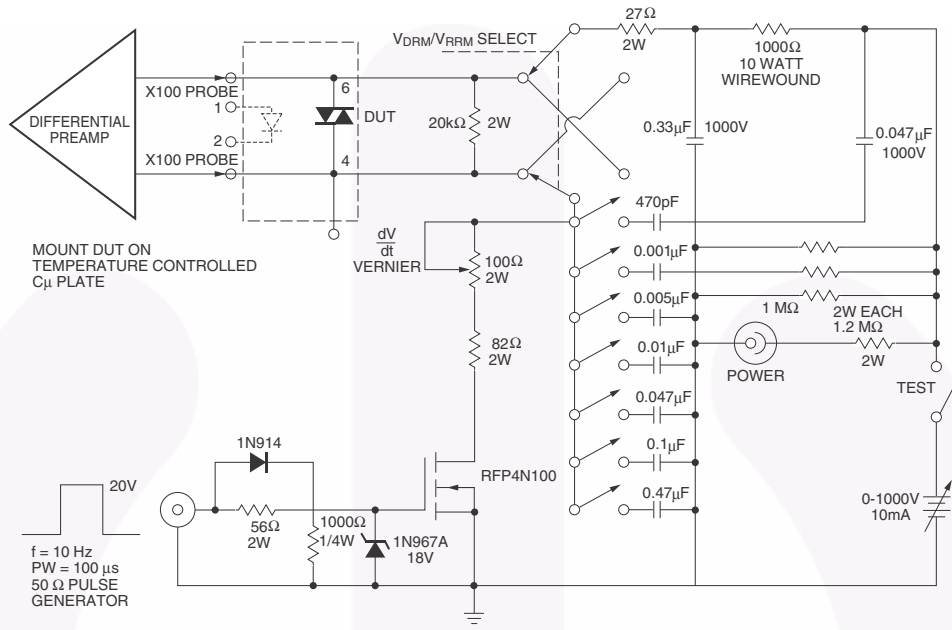


**Figure 9.  $I_H$ , Holding Current vs. Temperature**



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

1. 100x scope probes are used, to allow high speeds and voltages.
2. 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 vernier resistor combined with various capacitor combinations 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.  $t_{RC}$  is measured at this point and recorded.



ALL COMPONENTS ARE NON-INDUCTIVE UNLESS SHOWN  
**Figure 11. Circuit for Static  $\frac{dv}{dt}$  Measurement of Power Thyristors**

## Basic Applications

Typical circuit 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, 15mA for the MOC3061M, 10mA for the MOC3062M, or 5mA for the MOC3063M. The 39Ω resistor and 0.01μF capacitor are for snubbing of the triac and is often, but not always, necessary depending upon the particular triac and load used.



**Figure 12. Hot-Line Switching Application Circuit**

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 330Ω.

### Note:

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



**Figure 13. Inverse-Parallel SCR Driver Circuit**



## Reflow Profile



| Profile Feature   | Pb-Free Assembly Profile  |
|---|---------------------------|
| Temperature Minimum (T <sub>smin</sub> )                              | 150°C                     |
| Temperature Maximum (T <sub>smax</sub> )                              | 200°C                     |
| Time (t <sub>s</sub> ) from (T <sub>smin</sub> to T <sub>smax</sub> ) | 60 seconds to 120 seconds |
| Ramp-up Rate (T <sub>L</sub> to T <sub>P</sub> )                      | 3°C/second maximum        |
| Liquidous Temperature (T <sub>L</sub> )                               | 217°C                     |
| Time (t <sub>L</sub> ) Maintained Above (T <sub>L</sub> )             | 60 seconds to 150 seconds |
| Peak Body Package Temperature   | 260°C +0°C / -5°C         |
| Time (t <sub>p</sub> ) within 5°C of 260°C                            | 30 seconds                |
| Ramp-down Rate (T <sub>P</sub> to T <sub>L</sub> )                    | 6°C/second maximum        |
| Time 25°C to Peak Temperature   | 8 minutes maximum         |

Figure 14. Reflow Profile

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

| Part Number  | Package  | Packing Method             |
|--------------|--|----------------------------|
| MOC3061M     | DIP 6-Pin  | Tube (50 Units)            |
| MOC3061SM    | SMT 6-Pin (Lead Bend)                                    | Tube (50 Units)            |
| MOC3061SR2M  | SMT 6-Pin (Lead Bend)                                    | Tape and Reel (1000 Units) |
| MOC3061VM    | DIP 6-Pin, DIN EN/IEC60747-5-5 Option                    | Tube (50 Units)            |
| MOC3061SVM   | SMT 6-Pin (Lead Bend), DIN EN/IEC60747-5-5 Option        | Tube (50 Units)            |
| MOC3061SR2VM | SMT 6-Pin (Lead Bend), DIN EN/IEC60747-5-5 Option        | Tape and Reel (1000 Units) |
| MOC3061TVM   | 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 MOC3062M, MOC3063M, MOC3162M, and MOC3163M product families.

## Marking Information

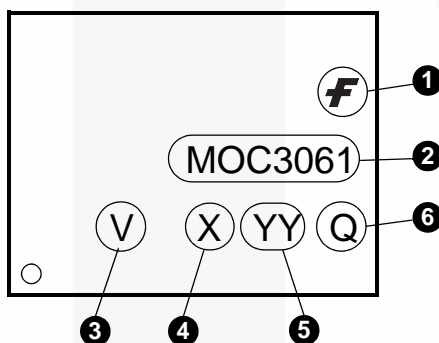


Figure 15. Top Mark

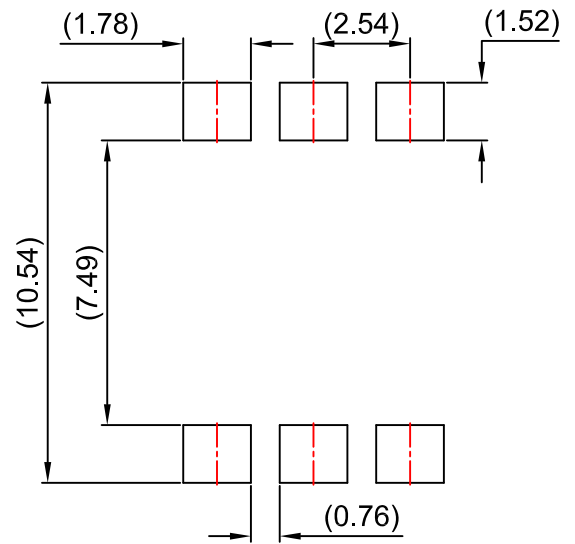
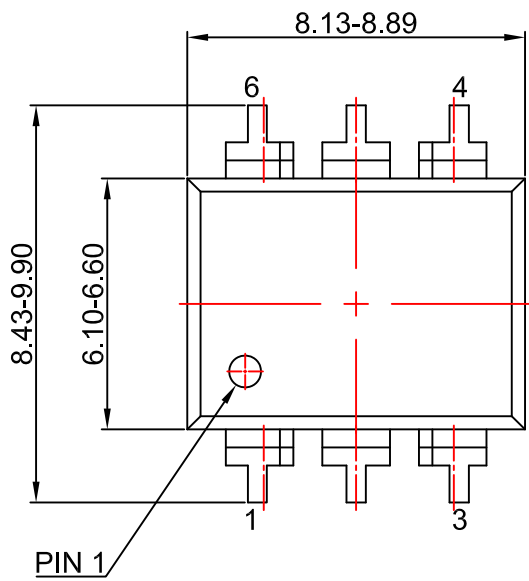
| Top Mark Definitions |   |
|----------------------|---|
| 1                    | Fairchild Logo  |
| 2                    | Device Number   |
| 3                    | DIN EN/IEC60747-5-5 Option (only appears on component ordered with this option) |
| 4                    | One-Digit Year Code, e.g.,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



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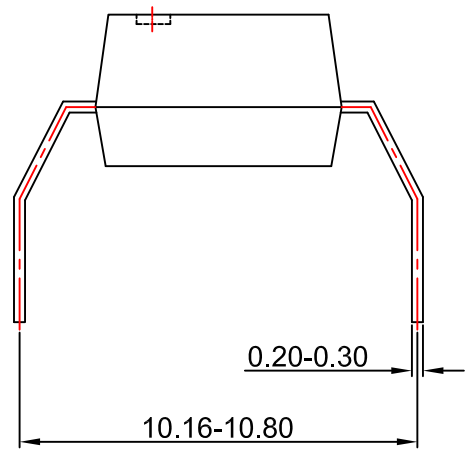
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