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July 2015

# MOC3010M, MOC3011M, MOC3012M, MOC3020M, MOC3021M, MOC3022M, MOC3023M 6-Pin DIP Random-Phase Triac Driver Output Optocoupler (250/400 Volt Peak)

## Features

- Excellent  $I_{FT}$  Stability—IR Emitting Diode Has Low Degradation
- Peak Blocking Voltage
  - 250 V, MOC301XM
  - 400 V, MOC302XM
- Safety and Regulatory Approvals
  - UL1577, 4,170 VAC<sub>RMS</sub> for 1 Minute
  - DIN EN/IEC60747-5-5

## Applications

- Industrial Controls
- Solenoid/Valve Controls
- Traffic Lights
- Static AC Power Switch
- Vending Machines
- Incandescent Lamp Dimmers
- Solid State Relay
- Motor Control
- Lamp Ballasts

## Description

The MOC301XM and MOC302XM series are optically isolated triac driver devices. These devices contain a GaAs infrared emitting diode and a light activated silicon bilateral switch, which functions like a triac. They are designed for interfacing between electronic controls and power triacs to control resistive and inductive loads for 115 V<sub>AC</sub> operations.

## Schematic



\*DO NOT CONNECT  
(TRIAC SUBSTRATE)

Figure 1. Schematic

## Package Outlines

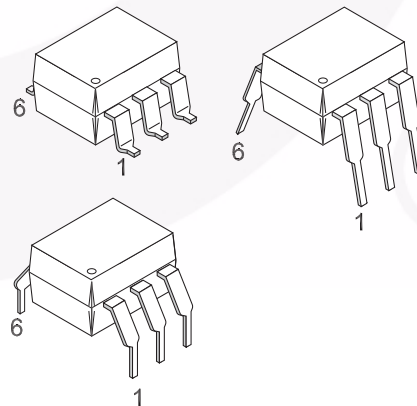


Figure 2. Package Outlines

MOC301XM, MOC302XM — 6-Pin DIP Random-Phase 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  | 330                   | mW                   |
|                     | Derate Above $25^\circ\text{C}$                                     |  | 4.4                   | mW/ $^\circ\text{C}$ |
| <b>EMITTER</b>      |   |  |                       |                      |
| $I_F$               | Continuous Forward Current  | All  | 60                    | mA                   |
| $V_R$               | Reverse Voltage   | All  | 3                     | V                    |
| $P_D$               | Total Power Dissipation at $25^\circ\text{C}$ Ambient               | All  | 100                   | mW                   |
|                     | Derate Above $25^\circ\text{C}$                                     |  | 1.33                  | mW/ $^\circ\text{C}$ |
| <b>DETECTOR</b>     |   |  |                       |                      |
| $V_{DRM}$           | Off-State Output Terminal Voltage                                   | MOC3010M<br>MOC3011M<br>MOC3012M             | 250                   | V                    |
|                     |   | MOC3020M<br>MOC3021M<br>MOC3022M<br>MOC3023M | 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  | 300                   | mW                   |
|                     | Derate Above $25^\circ\text{C}$                                     |  | 4                     | 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                   | $I_F = 10\text{ mA}$                          | All    |      | 1.15 | 1.50 | V             |
| $I_R$            | Reverse Leakage Current                 | $V_R = 3\text{ V}, T_A = 25^\circ\text{C}$    | All    |      | 0.01 | 100  | $\mu\text{A}$ |
| <b>DETECTOR</b>  |   |   |        |      |      |      |               |
| $I_{\text{DRM}}$ | Peak Blocking Current, Either Direction | Rated $V_{\text{DRM}}, I_F = 0^{(1)}$         | All    |      | 10   | 100  | nA            |
| $V_{\text{TM}}$  | Peak On-State Voltage, Either Direction | $I_{\text{TM}} = 100\text{ mA peak}, I_F = 0$ | All    |      | 1.8  | 3.0  | V             |

### Transfer Characteristics

| Symbol          | DC Characteristics                | Test Conditions              | Device   | Min. | Typ. | Max. | Unit          |
|-----------------|-----------------------------------|------------------------------|----------|------|------|------|---------------|
| $I_{\text{FT}}$ | LED Trigger Current               | Voltage = $3\text{ V}^{(2)}$ | MOC3020M |      |      | 30   | mA            |
|                 |                                   |                              | MOC3010M |      |      | 15   |               |
|                 |                                   |                              | MOC3021M |      |      |      |               |
|                 |                                   |                              | MOC3011M |      |      | 10   |               |
|                 |                                   |                              | MOC3022M |      |      |      |               |
|                 |                                   |                              | MOC3012M |      |      | 5    |               |
|                 |                                   |                              | MOC3023M |      |      |      |               |
| $I_{\text{H}}$  | Holding Current, Either Direction |                              | All      |      | 100  |      | $\mu\text{A}$ |

### Isolation Characteristics

| Symbol           | Parameter                        | Test Conditions       | Device | Min. | Typ. | Max. | Unit               |
|------------------|----------------------------------|-----------------------|--------|------|------|------|--------------------|
| $V_{\text{ISO}}$ | Isolation Voltage <sup>(3)</sup> | $t = 1\text{ Minute}$ | All    | 4170 |      |      | $V_{\text{ACRMS}}$ |

#### Notes:

- Test voltage must be applied within dv/dt rating.
- 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  $I_{\text{FT}}$  (30 mA for MOC3020M, 15 mA for MOC3010M and MOC3021M, 10 mA for MOC3011M and MOC3022M, 5 mA for MOC3012M and MOC3023M) 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

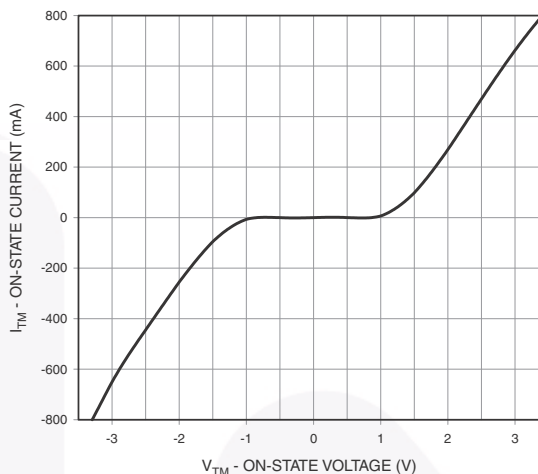


Figure 4. On-State Characteristics

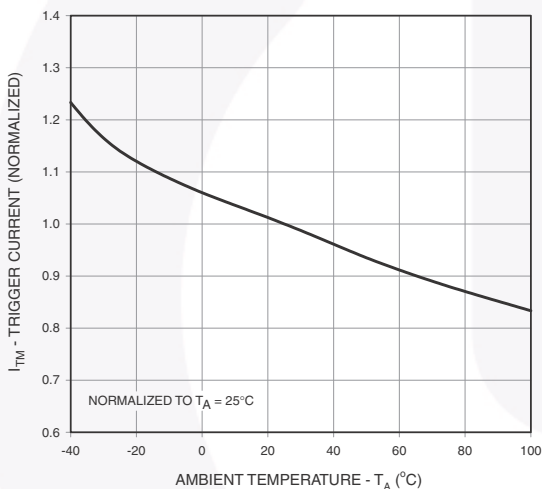


Figure 5. Trigger Current vs. Ambient Temperature

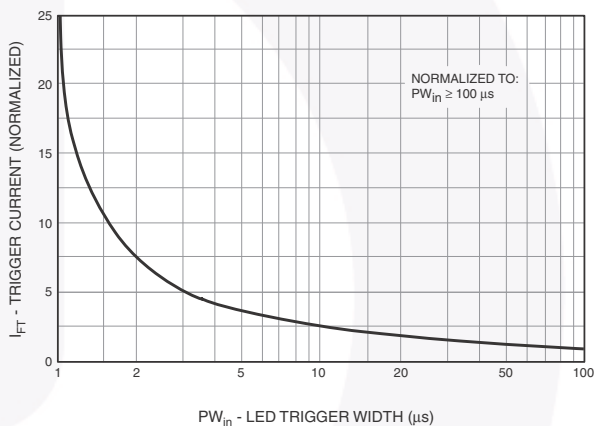


Figure 6. LED Current Required to Trigger vs. LED Pulse Width



Figure 7. dv/dt vs. Temperature

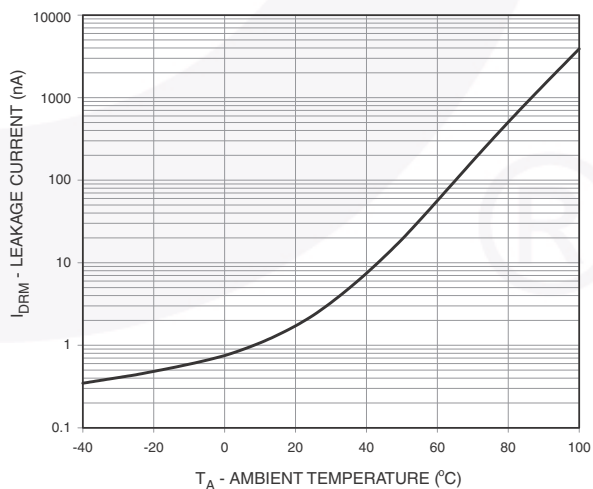
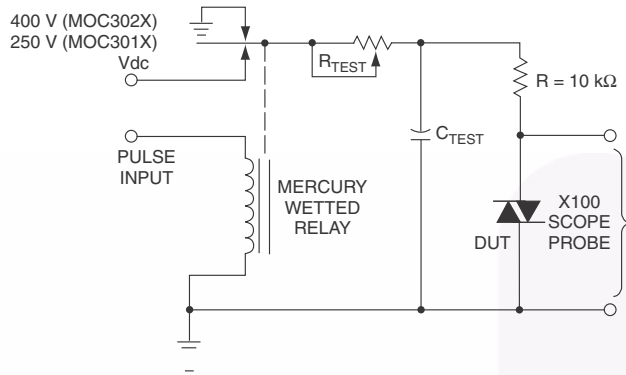
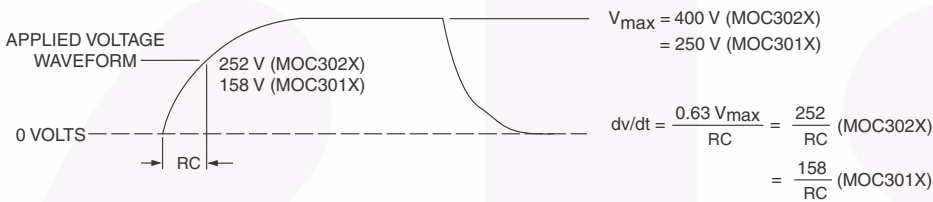


Figure 8. Leakage Current,  $I_{DRM}$  vs. Temperature



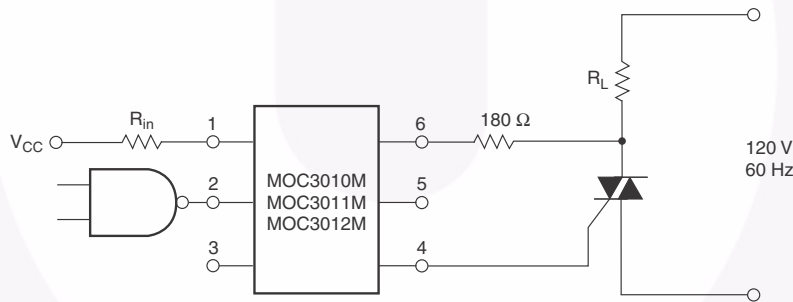
1. The mercury wetted relay provides a high speed repeated pulse to the D.U.T.
2. 100x scope probes are used, to allow high speeds and voltages.
3. The worst-case condition for static dv/dt is established by triggering the DUT with a normal LED input current, then removing the current. The variable  $R_{TEST}$  allows the dv/dt to be gradually increased until the DUT 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 DUT stops triggering.  $\tau_{RC}$  is measured at this point and recorded.



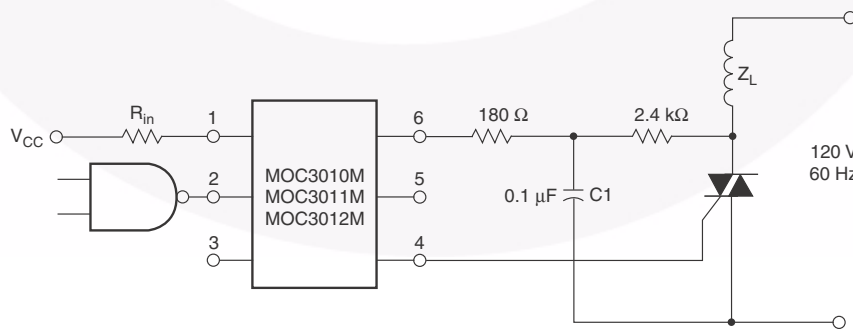
**Note:**

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

**Figure 9. Static dv/dt Test Circuit**



**Figure 10. Resistive Load**



**Figure 11. Inductive Load with Sensitive Gate Triac ( $I_{GT} \leq 15 \text{ mA}$ )**

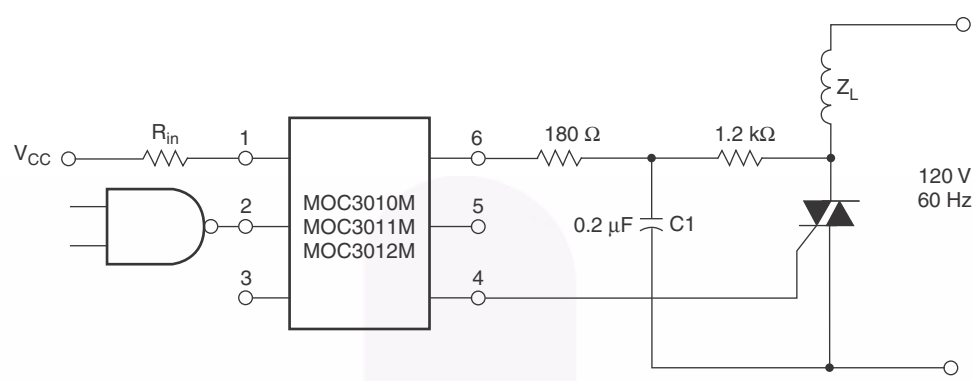
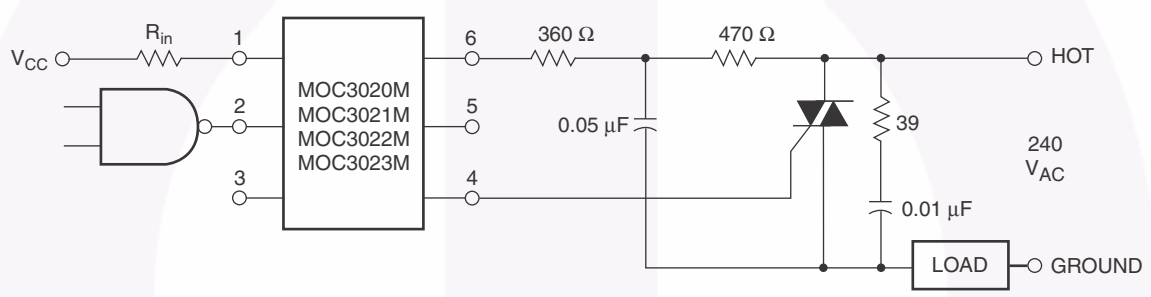


Figure 12. Inductive Load with sensitive Gate Triac ( $I_{GT} \leq 15 \text{ mA}$ )



In this circuit the "hot" side of the line is switched and the load connected to the cold or ground side. The 39  $\Omega$  resistor and 0.01  $\mu\text{F}$  capacitor are for snubbing of the triac, and the 470  $\Omega$  resistor and 0.05  $\mu\text{F}$  capacitor are for snubbing the coupler. These components may or may not be necessary depending upon the particular and load used.

Figure 13. Typical Application Circuit



### Reflow Profile

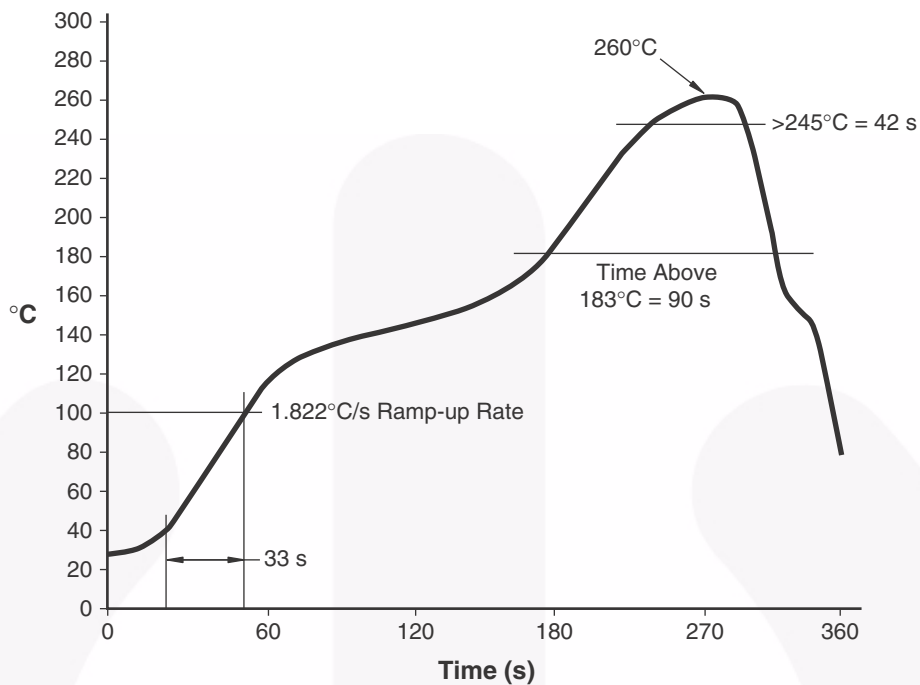


Figure 14. Reflow Profile

### Ordering Information<sup>(4)</sup>

| Part Number  | Package  | Packing Method             |
|--------------|--|----------------------------|
| MOC3010M     | DIP 6-Pin  | Tube (50 Units)            |
| MOC3010SM    | SMT 6-Pin (Lead Bend)                                    | Tube (50 Units)            |
| MOC3010SR2M  | SMT 6-Pin (Lead Bend)                                    | Tape and Reel (1000 Units) |
| MOC3010VM    | DIP 6-Pin, DIN EN/IEC60747-5-5 Option                    | Tube (50 Units)            |
| MOC3010SVM   | SMT 6-Pin (Lead Bend), DIN EN/IEC60747-5-5 Option        | Tube (50 Units)            |
| MOC3010SR2VM | SMT 6-Pin (Lead Bend), DIN EN/IEC60747-5-5 Option        | Tape and Reel (1000 Units) |
| MOC3010TVM   | DIP 6-Pin, 0.4" Lead Spacing, DIN EN/IEC60747-5-5 Option | Tube (50 Units)            |

**Note:**

4. The product orderable part number system listed in this table also applies to the MOC3011M, MOC3012M, MOC3020M, MOC3021M, MOC3022M, and MOC3023M 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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