

## Optocoupler, Phototriac Output, Zero Crossing, High dV/dt, Low Input Current



21842-1



i179030\_4



### FEATURES

- High static dV/dt 5 kV/μs
- High input sensitivity  $I_{FT} = 1.6$  mA, 2 mA, and 3 mA
- 300 mA on-state current
- Zero voltage crossing detector
- 700 V and 800 V blocking voltage
- Isolation test voltage 5300  $V_{RMS}$
- Compliant to RoHS Directive 2011/65/EU



**RoHS**  
COMPLIANT

### DESCRIPTION

The VO4157 and VO4158 consists of a GaAs IRLED optically coupled to a photosensitive zero crossing TRIAC packaged in a DIP-6 package.

High input sensitivity is achieved by using an emitter follower phototransistor and a cascaded SCR predriver resulting in an LED trigger current of 1.6 mA for bin D, 2 mA for bin H, and 3 mA for bin M.

The new phototriac zero crossing family uses a proprietary dV/dt clamp resulting in a static dV/dt of greater than 5 kV/μs.

The VO4157 and VO4158 isolates low-voltage logic from 120  $V_{AC}$ , 240  $V_{AC}$ , and 380  $V_{AC}$  lines to control resistive, inductive, or capacitive loads including motors, solenoids, high current thyristors or TRIAC and relays.

### APPLICATIONS

- Solid-state relays
- Industrial controls
- Office equipment
- Consumer appliances

### AGENCY APPROVALS

- UL1577, file no. E52744 system code H or J, double protection
- cUL - file no. E52744, equivalent to CSA bulletin 5A
- DIN EN 60747-5-2 (VDE 0884) available with option 1
- FIMKO

| ORDERING INFORMATION     |                                |               |                |               |               |               |
|--------------------------|--------------------------------|---------------|----------------|---------------|---------------|---------------|
|                          |                                |               |                |               |               |               |
| PART NUMBER              |                                |               | PACKAGE OPTION |               | TAPE AND REEL |               |
|                          |                                |               |                |               |               |               |
|                          |                                |               |                |               |               |               |
| AGENCY CERTIFIED/PACKAGE | $V_{DRM}$ 700                  |               |                | $V_{DRM}$ 800 |               |               |
|                          | TRIGGER CURRENT, $I_{FT}$ (mA) |               |                |               |               |               |
| UL, cUL                  | 1.6                            | 2             | 3              | 1.6           | 2             | 3             |
| DIP-6                    | VO4157D                        | VO4157H       | VO4157M        | VO4158D       | VO4158H       | VO4158M       |
| DIP-6, 400 mil, option 6 | VO4157D-X006                   | VO4157H-X006  | VO4157M-X006   | VO4158D-X006  | VO4158H-X006  | VO4158M-X006  |
| SMD-6, option 7          | VO4157D-X007T                  | VO4157H-X007T | VO4157M-X007T  | VO4158D-X007T | VO4158H-X007T | VO4158M-X007T |
| VDE, UL, cUL             | 1.6                            | 2             | 3              | 1.6           | 2             | 3             |
| DIP-6                    | -                              | -             | VO4157M-X001   | -             | -             | -             |
| DIP-6, 400 mil, option 6 | -                              | -             | -              | -             | -             | VO4158M-X016  |
| SMD-6, option 7          | VO4157D-X017T                  | VO4157H-X017T | VO4157M-X017T  | -             | VO4158H-X017T | -             |
| SMD-6, option 8          | -                              | -             | -              | -             | -             | VO4158M-X018T |



| <b>ABSOLUTE MAXIMUM RATINGS</b> ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified) |  |             |           |               |           |
|--|--|-------------|-----------|---------------|-----------|
| PARAMETER  | TEST CONDITION   | PART        | SYMBOL    | VALUE         | UNIT      |
| <b>INPUT</b>   |  |             |           |               |           |
| Reverse voltage  |  |             | $V_R$     | 6             | V         |
| Forward current  |  |             | $I_F$     | 60            | mA        |
| Surge current  |  |             | $I_{FSM}$ | 2.5           | A         |
| Derate from 25 °C  |  |             |           | 1.33          | mW/°C     |
| <b>OUTPUT</b>  |  |             |           |               |           |
| Peak off-state voltage   |  | VO4157D/H/M | $V_{DRM}$ | 700           | V         |
|  |  | VO4158D/H/M | $V_{DRM}$ | 800           | V         |
| RMS on-state current   |  |             | $I_{TM}$  | 300           | mA        |
| Derate from 25 °C  |  |             |           | 6.6           | mW/°C     |
| <b>COUPLER</b>   |  |             |           |               |           |
| Isolation test voltage (between emitter and detector, climate per DIN 500414, part 2, Nov. 74)         | $t = 1\text{ min}$   |             | $V_{ISO}$ | 5300          | $V_{RMS}$ |
| Storage temperature range  |  |             | $T_{stg}$ | - 55 to + 150 | °C        |
| Ambient temperature range  |  |             | $T_{amb}$ | - 55 to + 100 | °C        |
| Soldering temperature  | max. $\leq 10\text{ s}$ dip soldering<br>$\geq 0.5\text{ mm}$ from case bottom |             | $T_{sld}$ | 260           | °C        |

**Note**

- Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of this document. Exposure to absolute maximum ratings for extended periods of the time can adversely affect reliability. This phototriac should not be used to drive a load directly. It is intended to be a trigger device only.



Fig. 1 - Recommended Operating Condition

| THERMAL CHARACTERISTICS                                   |                |       |      |
|---|----------------|-------|------|
| PARAMETER   | SYMBOL         | VALUE | UNIT |
| LED power dissipation                                     | $P_{diss}$     | 100   | mW   |
| Output power dissipation                                  | $P_{diss}$     | 500   | mW   |
| Total power dissipation                                   | $P_{tot}$      | 600   | mW   |
| Maximum LED junction temperature                          | $T_{jmax.}$    | 125   | °C   |
| Maximum output die junction temperature                   | $T_{jmax.}$    | 125   | °C   |
| Thermal resistance, junction emitter to board             | $\theta_{JEB}$ | 150   | °C/W |
| Thermal resistance, junction emitter to case              | $\theta_{JEC}$ | 139   | °C/W |
| Thermal resistance, junction detector to board            | $\theta_{JDB}$ | 78    | °C/W |
| Thermal resistance, junction detector to case             | $\theta_{JDC}$ | 103   | °C/W |
| Thermal resistance, junction emitter to junction detector | $\theta_{JED}$ | 496   | °C/W |
| Thermal resistance, case to ambient                       | $\theta_{CA}$  | 3563  | °C/W |


**Note**

- The thermal characteristics table above were measured at 25 °C and the thermal model is represented in the thermal network below. Each resistance value given in this model can be used to calculate the temperatures at each node for a given operating condition. The thermal resistance from board to ambient will be dependent on the type of PCB, layout and thickness of copper traces. For a detailed explanation of the thermal model, please reference Vishay's Thermal Characteristics of Optocouplers application note.

| ELECTRICAL CHARACTERISTICS ( $T_{amb} = 25\text{ °C}$ , unless otherwise specified) |   |             |              |      |      |      |                  |
|---|---|-------------|--------------|------|------|------|------------------|
| PARAMETER   | TEST CONDITION                              | PART        | SYMBOL       | MIN. | TYP. | MAX. | UNIT             |
| <b>INPUT</b>  |   |             |              |      |      |      |                  |
| Forward voltage   | $I_F = 10\text{ mA}$                        |             | $V_F$        |      | 1.2  | 1.4  | V                |
| Reverse current   | $V_R = 6\text{ V}$                          |             | $I_R$        |      | 0.1  | 10   | $\mu\text{A}$    |
| Input capacitance   | $V_F = 0\text{ V}$ , $f = 1\text{ MHz}$     |             | $C_i$        |      | 25   |      | pF               |
| <b>OUTPUT</b>   |   |             |              |      |      |      |                  |
| Repetitive peak off-state voltage   | $I_{DRM} = 100\text{ }\mu\text{A}$          | VO4157D/H/M | $V_{DRM}$    | 700  |      |      | V                |
|   |   | VO4158D/H/M | $V_{DRM}$    | 800  |      |      | V                |
| Off-state current   | $V_D = V_{DRM}$ , $I_F = 0$                 |             | $I_{DRM}$    |      |      | 100  | $\mu\text{A}$    |
| On-state voltage  | $I_T = 300\text{ mA}$                       |             | $V_{TM}$     |      |      | 3    | V                |
| On-state current  | $PF = 1$ , $V_{T(RMS)} = 1.7\text{ V}$      |             | $I_{TM}$     |      |      | 300  | mA               |
| Off-state current in inhibit state  | $I_F = 2\text{ mA}$ , $V_{DRM}$             |             | $I_{DINH}$   |      |      | 200  | $\mu\text{A}$    |
| Holding current   |   |             | $I_H$        |      |      | 500  | $\mu\text{A}$    |
| Zero cross inhibit voltage  | $I_F = \text{rated } I_{FT}$                |             | $V_{IH}$     |      |      | 20   | V                |
| Critical rate of rise of off-state voltage  | $V_D = 0.67 V_{DRM}$ , $T_J = 25\text{ °C}$ |             | $dV/dt_{cr}$ | 5000 |      |      | V/ $\mu\text{s}$ |
| <b>COUPLER</b>  |   |             |              |      |      |      |                  |
| LED trigger current, current required to latch output                               | $V_D = 3\text{ V}$                          | VO4157D     | $I_{FT}$     |      |      | 1.6  | mA               |
|   |   | VO4157H     | $I_{FT}$     |      |      | 2    | mA               |
|   |   | VO4157M     | $I_{FT}$     |      |      | 3    | mA               |
|   |   | VO4158D     | $I_{FT}$     |      |      | 1.6  | mA               |
|   |   | VO4158H     | $I_{FT}$     |      |      | 2    | mA               |
|   |   | VO4158M     | $I_{FT}$     |      |      | 3    | mA               |
| Common mode coupling capacitance  |   |             | $C_{CM}$     |      | 0.01 |      | pF               |
| Capacitance (input to output)   | $f = 1\text{ MHz}$ , $V_{IO} = 0\text{ V}$  |             | $C_{IO}$     |      | 0.8  |      | pF               |

**Note**

- Minimum and maximum values were tested requirements. Typical values are characteristics of the device and are the result of engineering evaluations. Typical values are for information only and are not part of the testing requirements.



| SAFETY AND INSULATION RATINGS  |                |            |      |           |      |      |
|--|----------------|------------|------|-----------|------|------|
| PARAMETER  | TEST CONDITION | SYMBOL     | MIN. | TYP.      | MAX. | UNIT |
| Climatic classification (according to IEC68 part 1)  |                |            |      | 55/100/21 |      |      |
| Pollution degree (DIN VDE 0109)  |                |            |      | 2         |      |      |
| Comparative tracking index per DIN IEC112/VDE 0303 part 1, group IIIa per DIN VDE 6110 175 399 |                |            | 175  |           | 399  |      |
| $V_{IOTM}$   |                | $V_{IOTM}$ | 8000 |           |      | V    |
| $V_{IORM}$   |                | $V_{IORM}$ | 890  |           |      | V    |
| $P_{SO}$   |                | $P_{SO}$   |      |           | 500  | mW   |
| $I_{SI}$   |                | $I_{SI}$   |      |           | 250  | mA   |
| $T_{SI}$   |                | $T_{SI}$   |      |           | 175  | °C   |
| Creepage distance  |                |            | 7    |           |      | mm   |

**TYPICAL CHARACTERISTICS** ( $T_{amb} = 25\text{ °C}$ , unless otherwise specified)

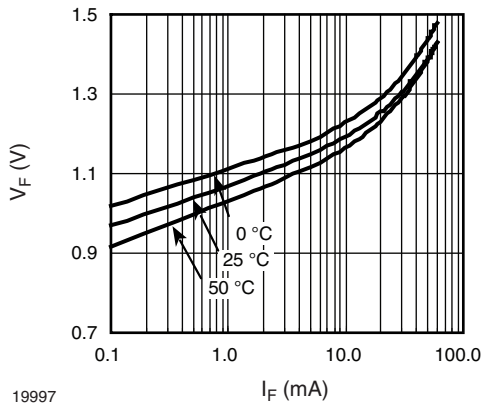


Fig. 2 - Diode Forward Voltage vs. Forward Current

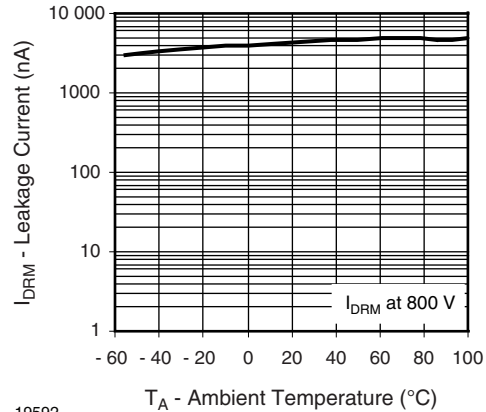


Fig. 4 - Leakage Current vs. Ambient Temperature

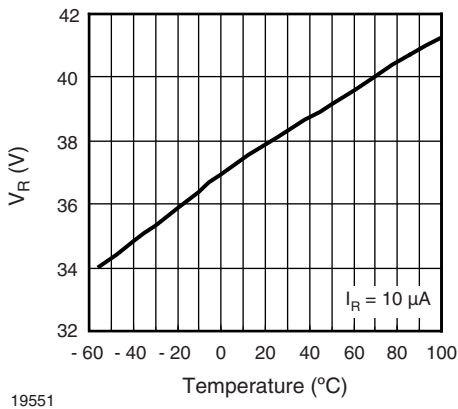


Fig. 3 - Diode Reverse Voltage vs. Temperature



Fig. 5 - On State Current vs. On State Voltage



19453

Fig. 6 - Output Off Current (Leakage) vs. Voltage



19998

Fig. 9 - Normalized Holding Current vs. Temperature



19454

Fig. 7 - Normalized Trigger Input Current vs. Temperature



20005

Fig. 10 -  $I_{FT}$  vs. LED Pulse Width



19624

Fig. 8 - Trigger Current vs. Turn-On Time



21614

Fig. 11 -  $I_{FT}$  vs.  $V_{RMS}$  and Temperature

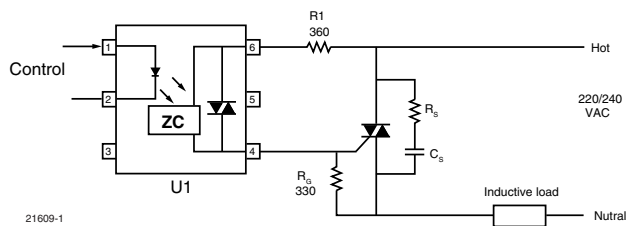


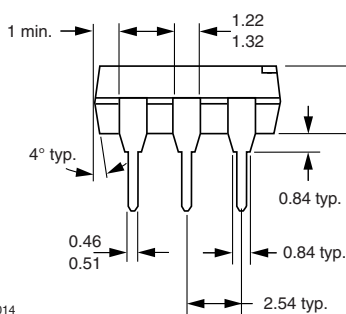
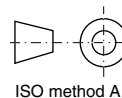
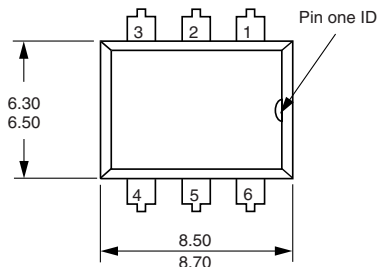
Fig. 12 - Basic Power Triac Driver Circuit

**POWER FACTOR CONSIDERATIONS**

As a zero voltage crossing optotriac, the commutating dV/dt spikes can inhibit one half of the TRIAC from turning on. If the spike potential exceeds the inhibit voltage of the zero-cross detection circuit, half of the TRIAC will be held-off and not turn-on. This hold-off condition can be eliminated by using a capacitor or RC snubber placed directly across the power triac as shown in fig. 11. Note that the value of the capacitor increases as a function of the load current.

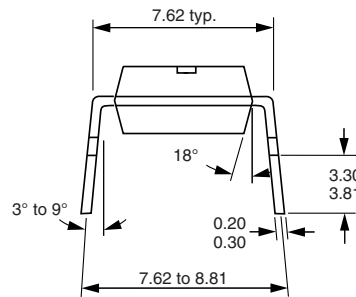
The hold-off condition also can be eliminated by providing a higher level of LED drive current. The higher LED drive current provides a larger photocurrent which causes the phototransistor to turn-on before the commutating spike has activated the zero-cross detection circuit. For example, if a device requires 1.5 mA for a resistive load, then 2.7 mA (1.8 times) may be required to control an inductive load whose power factor is less than 0.3.

**PACKAGE DIMENSIONS** in millimeters



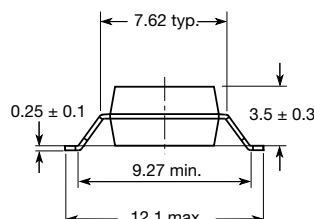
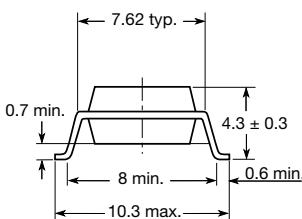
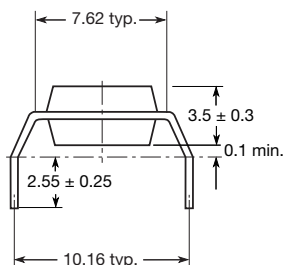
i178014

**Option 6**

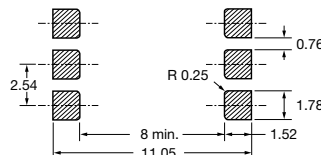
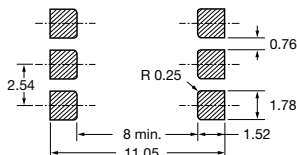


**Option 7**

**Option 8**



20802-41





**PACKAGE MARKING** (example)



**Notes**

- VDE logo is only marked on option 1 parts. Tape and reel suffix (T) is not part of the package marking.



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