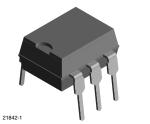
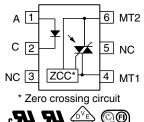


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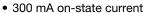
# Optocoupler, Phototriac Output, Zero Crossing, High dV/dt, Low Input Current





## **FEATURES**

- High static dV/dt 5 kV/µs
- High input sensitivity I<sub>FT</sub> = 1.6 mA, 2 mA, and 3 mA



- · Zero voltage crossing detector
- 800 V blocking voltage
- Isolation rated voltage 4420 V<sub>RMS</sub>
- Material categorization: for definitions of compliance please see <a href="https://www.vishay.com/doc?99912"><u>www.vishay.com/doc?99912</u></a>

### **APPLICATIONS**

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

#### **AGENCY APPROVALS**

- UL
- cUL
- DIN EN 60747-5-5 (VDE 0884-5), available with option 1
- FIMKO

### **LINKS TO ADDITIONAL RESOURCES**













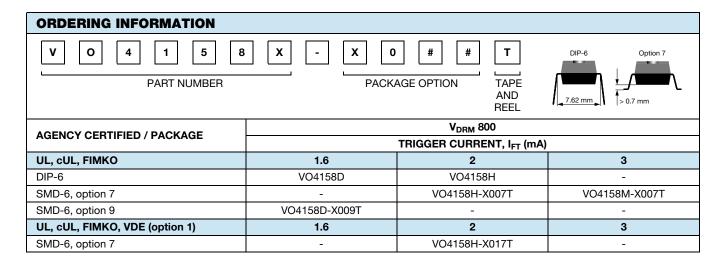
#### **DESCRIPTION**

The 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  $kV/\mu s$ .

The 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.





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| <b>ABSOLUTE MAXIMUM RATINGS</b> (T <sub>amb</sub> = 25 °C, unless otherwise specified) |   |             |                  |             |       |  |  |
|--|---|-------------|------------------|-------------|-------|--|--|
| PARAMETER  | TEST CONDITION                                      | PART        | SYMBOL           | VALUE       | UNIT  |  |  |
| INPUT  |   |             |                  |             |       |  |  |
| Reverse voltage  |   |             | $V_{R}$          | 6           | V     |  |  |
| Forward current  |   |             | I <sub>F</sub>   | 60          | mA    |  |  |
| Surge current  |   |             | I <sub>FSM</sub> | 2.5         | Α     |  |  |
| Derate from 25 °C  |   |             |                  | 1.33        | mW/°C |  |  |
| OUTPUT   |   |             |                  |             |       |  |  |
| Peak off-state voltage   |   | VO4158D/H/M | $V_{DRM}$        | 800         | V     |  |  |
| RMS on-state current   |   |             | I <sub>TM</sub>  | 300         | mA    |  |  |
| Derate from 25 °C  |   |             |                  | 6.6         | mW/°C |  |  |
| COUPLER  |   |             |                  |             |       |  |  |
| Storage temperature range  |   |             | T <sub>stg</sub> | -55 to +150 | °C    |  |  |
| Ambient temperature range  |   |             | T <sub>amb</sub> | -55 to +100 | °C    |  |  |
| Soldering temperature  | Max. ≤ 10 s dip soldering ≥ 0.5 mm from case bottom |             | T <sub>sld</sub> | 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.

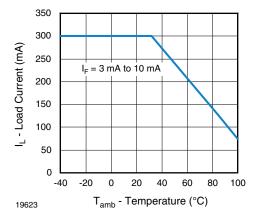


Fig. 1 - Recommended Operating Condition



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| THERMAL CHARACTERISTICS                                   |                    |       |      |
|---|--------------------|-------|------|
| PARAMETER   | SYMBOL             | VALUE | UNIT |
| LED power dissipation                                     | P <sub>diss</sub>  | 100   | mW   |
| Output power dissipation                                  | P <sub>diss</sub>  | 500   | mW   |
| Total power dissipation                                   | P <sub>tot</sub>   | 600   | mW   |
| Maximum LED junction temperature                          | T <sub>jmax.</sub> | 125   | °C   |
| Maximum output die junction temperature                   | T <sub>jmax.</sub> | 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.

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

#### 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.



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| SAFETY AND INSULATION RATINGS                |  |                   |                    |                   |  |  |
|--|--|-------------------|--------------------|-------------------|--|--|
| PARAMETER                                    | TEST CONDITION                                     | SYMBOL            | VALUE              | UNIT              |  |  |
| Climatic classification                      | According to IEC 68 part 1                         |                   | 55 / 100 / 21      |                   |  |  |
| Comparative tracking index                   |  | CTI               | 175                |                   |  |  |
| Maximum rated withstanding isolation voltage | t = 1 min  | V <sub>ISO</sub>  | 4420               | V <sub>RMS</sub>  |  |  |
| Maximum transient isolation voltage          |  | V <sub>IOTM</sub> | 8000               | V <sub>peak</sub> |  |  |
| Maximum repetitive peak isolation voltage    |  | V <sub>IORM</sub> | 890                | V <sub>peak</sub> |  |  |
| Isolation resistance                         | V <sub>IO</sub> = 500 V, T <sub>amb</sub> = 25 °C  | R <sub>IO</sub>   | ≥ 10 <sup>12</sup> | Ω                 |  |  |
|  | V <sub>IO</sub> = 500 V, T <sub>amb</sub> = 100 °C | R <sub>IO</sub>   | ≥ 10 <sup>11</sup> | Ω                 |  |  |
| Output safety power                          |  | P <sub>SO</sub>   | 500                | mW                |  |  |
| Input safety current                         |  | I <sub>SI</sub>   | 250                | mA                |  |  |
| Safety temperature                           |  | T <sub>S</sub>    | 175                | °C                |  |  |
| Creepage distance                            | Standard DIP-4                                     |                   | ≥ 7                | mm                |  |  |
| Clearance distance                           | Standard DIP-4                                     |                   | ≥ 7                | mm                |  |  |
| Insulation thickness                         |  | DTI               | ≥ 0.4              | mm                |  |  |

#### Note

### TYPICAL CHARACTERISTICS (T<sub>amb</sub> = 25 °C, unless otherwise specified)

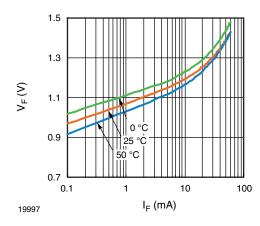


Fig. 2 - Diode Forward Voltage vs. Forward Current

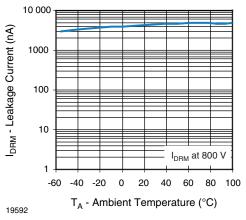


Fig. 4 - Leakage Current vs. Ambient Temperature

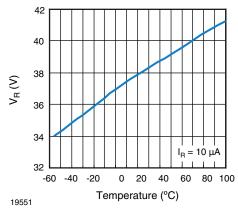


Fig. 3 - Diode Reverse Voltage vs. Temperature

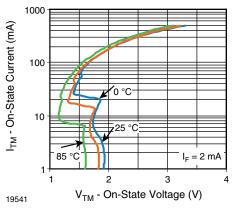


Fig. 5 - On State Current vs. On State Voltage

<sup>•</sup> As per IEC 60747-5-5, § 7.4.3.8.2, this optocoupler is suitable for "safe electrical insulation" only within the safety ratings. Compliance with the safety ratings shall be ensured by means of protective circuits.





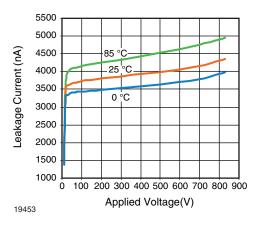


Fig. 6 - Output Off Current (Leakage) vs. Voltage

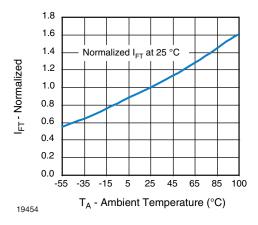


Fig. 7 - Normalized Trigger Input Current vs. Temperature

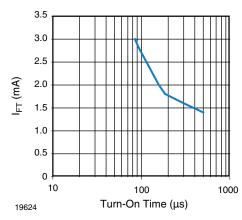


Fig. 8 - Trigger Current vs. Turn-On Time

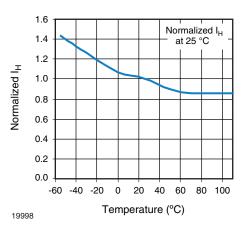


Fig. 9 - Normalized Holding Current vs. Temperature

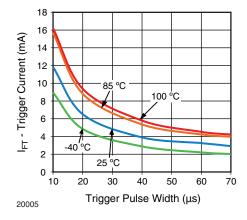


Fig. 10 - I<sub>FT</sub> vs. LED Pulse Width

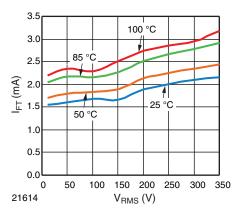


Fig. 11 - I<sub>FT</sub> vs. V<sub>RMS</sub> and Temperature



21609-1

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# Control 220/240 VAC zc IJ1

Fig. 12 - Basic Power Triac Driver Circuit

Inductive load

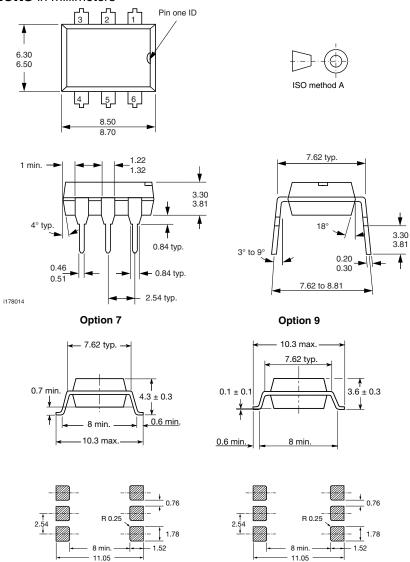
Nutral

### **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 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





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### **PACKAGE MARKING** (example)



#### Notes

- XXXX = LMC (lot marking code)
- 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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