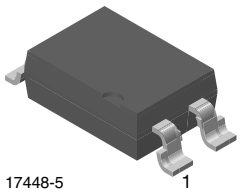
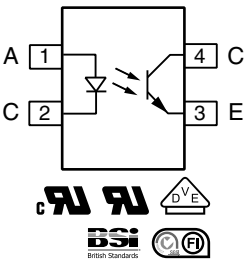
# Optocoupler, Phototransistor Output, High Reliability, 5300 $V_{RMS}$




## FEATURES

- Excellent CTR linearity depending on forward current
- Isolation test voltage, 5300 $V_{RMS}$
- Fast switching times
- Low CTR degradation
- Low coupling capacitance
- Material categorization: For definitions of compliance please see www.vishay.com/doc?99912

Pb-free

e3

RoHS COMPLIANT

## DESCRIPTION

The SFH6156 features a variety of transfer ratios, low coupling capacitance and high isolation voltage. This coupler has a GaAs infrared diode emitter, which is optically coupled to a silicon planar phototransistor detector, and is incorporated in a plastic SMD package.

The coupling devices are designed for signal transmission between two electrically separated circuits.

## APPLICATIONS

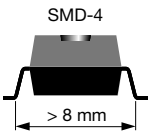
- Switchmode power supply
- Telecom
- Battery powered equipment

## AGENCY APPROVALS

- UL1577, file no. E52744 system code H or J, double protection
- DIN EN 60747-5-5 (VDE 0884-5) available with option 1
- cUL tested to CSA 22.2 bulletin 5A
- BSI IEC 60950, IEC 60065
- FIMKO EN6005, EN60950-1

## ORDERING INFORMATION

| S | F | H | 6 | 1 | 5 | 6 | - | # | X | 0 | 0 | 1 | T |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PART NUMBER | | | | | | | | CTR BIN | PACKAGE OPTION | | | | TAPE AND REEL |




| AGENCY CERTIFIED/PACKAGE | CTR (%) | | | |
|---|---|---|---|---|
| | 10 mA | | | |
| **UL, cUL, BSI, FIMKO** | **40 to 80** | **63 to 125** | **100 to 200** | **160 to 320** |
| SMD-4, 100 mil, pitch | SFH6156-1 | SFH6156-2 | SFH6156-3 | SFH6156-4 |
| | SFH6156-1T | SFH6156-2T | SFH6156-3T | SFH6156-4T |
| **VDE, UL, cUL, BSI, FIMKO** | **40 to 80** | **63 to 125** | **100 to 200** | **160 to 320** |
| SMD-4, 100 mil, pitch | SFH6156-1X001 | SFH6156-2X001 | - | SFH6156-4X001 |
| | SFH6156-1X001T | SFH6156-2X001T | - | SFH6156-4X001T |

| ABSOLUTE MAXIMUM RATINGS ($T_{amb}$ = 25 °C, unless otherwise specified) | | | | |
|---|---|---|---|---|
| **PARAMETER** | **TEST CONDITION** | **SYMBOL** | **VALUE** | **UNIT** |
| **INPUT** | | | | |
| Reverse voltage | | $V_R$ | 6 | V |
| DC forward current | | $I_F$ | 60 | mA |
| Surge forward current | $t_p \leq 10$ µs | $I_{FSM}$ | 2.5 | A |
| **OUTPUT** | | | | |
| Collector emitter voltage | | $V_{CEO}$ | 70 | V |
| Emitter collector voltage | | $V_{ECO}$ | 7 | V |
| Collector current | | $I_C$ | 50 | mA |
| | $t_p \leq 1$ ms | $I_C$ | 100 | mA |
| **COUPLER** | | | | |
| Isolation test voltage between emitter and detector | t = 1 s | $V_{ISO}$ | 5300 | $V_{RMS}$ |
| Creepage distance | | | ≥ 7 | mm |
| Clearance distance | | | ≥ 7 | mm |
| Insulation thickness between emitter and detector | | | ≥ 0.4 | mm |
| Comparative tracking index per DIN IEC112/VDE0303 part 1 | | CTI | ≥ 175 | |
| Isolation resistance | $V_{IO}$ = 500 V, $T_{amb}$ = 25 °C | $R_{IO}$ | ≥ $10^{12}$ | Ω |
| | $V_{IO}$ = 500 V, $T_{amb}$ = 100 °C | $R_{IO}$ | ≥ $10^{11}$ | Ω |
| Storage temperature range | | $T_{stg}$ | - 55 to + 150 | °C |
| Ambient temperature range | | $T_{amb}$ | - 55 to +100 | °C |
| Soldering temperature (1) | max. 10 s | $T_{sld}$ | 260 | °C |

**Notes**

- 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.

(1) Refer to reflow profile for soldering conditions for surface mounted devices (SMD).

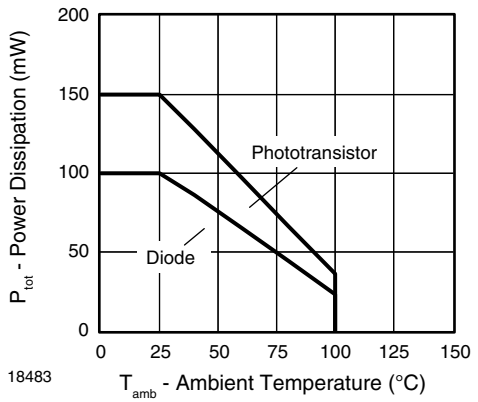
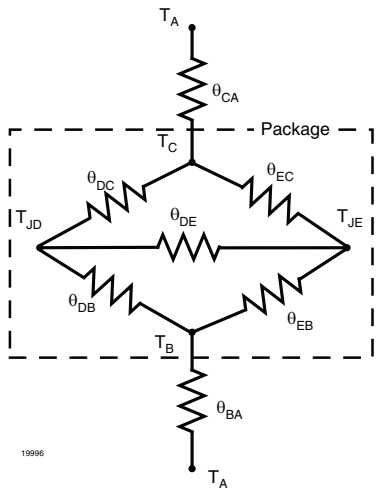



Fig. 1 - Permissible Power Dissipation vs. Ambient Temperature

## THERMAL CHARACTERISTICS

| PARAMETER | SYMBOL | VALUE | UNIT |
|---|---|---|---|
| LED power dissipation | $P_{diss}$ | 100 | mW |
| Output power dissipation | $P_{diss}$ | 150 | mW |
| Maximum LED junction temperature | $T_{jmax.}$ | 125 | °C |
| Maximum output die junction temperature | $T_{jmax.}$ | 125 | °C |
| Thermal resistance, junction emitter to board | $\theta_{EB}$ | 173 | °C/W |
| Thermal resistance, junction emitter to case | $\theta_{EC}$ | 149 | °C/W |
| Thermal resistance, junction detector to board | $\theta_{DB}$ | 111 | °C/W |
| Thermal resistance, junction detector to case | $\theta_{DC}$ | 127 | °C/W |
| Thermal resistance, junction emitter to junction detector | $\theta_{ED}$ | 95 | °C/W |
| Thermal resistance, board to ambient (1) | $\theta_{BA}$ | 195 | °C/W |
| Thermal resistance, case to ambient (1) | $\theta_{CA}$ | 3573 | °C/W |




**Notes**

- 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.

(1) For 2 layer FR4 board (4" x 3" x 0.062")

## ELECTRICAL CHARACTERISTICS ($T_{amb}$ = 25 °C, unless otherwise specified)

| PARAMETER | TEST CONDITION | PART | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|---|
| **INPUT** | | | | | | | |
| Forward voltage | $I_F$ = 60 mA | | $V_F$ | | 1.25 | 1.65 | V |
| Reverse current | $V_R$ = 6 V | | $I_R$ | | 0.01 | 10 | µA |
| Capacitance | $V_R$ = 0 V, f = 1 MHz | | $C_O$ | | 13 | | pF |
| **OUTPUT** | | | | | | | |
| Collector emitter capacitance | $V_{CE}$ = 5 V, f = 1 MHz | | $C_{CE}$ | | 5.2 | | pF |
| Collector emitter leakage current | $V_{CE}$ = 10 V | SFH6156-1 | $I_{CEO}$ | | 2 | 50 | nA |
| | | SFH6156-2 | $I_{CEO}$ | | 2 | 50 | nA |
| | | SFH6156-3 | $I_{CEO}$ | | 5 | 100 | nA |
| | | SFH6156-4 | $I_{CEO}$ | | 5 | 100 | nA |
| **COUPLER** | | | | | | | |
| Collector emitter saturation voltage | $I_F$ = 10 mA, $I_C$ = 2.5 mA | | $V_{CEsat}$ | | 0.25 | 0.4 | V |
| Coupling capacitance | | | $C_C$ | | 0.4 | | pF |

**Note**

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

## CURRENT TRANSFER RATIO

| PARAMETER | TEST CONDITION | PART | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|---|
| $I_C/I_F$ | $I_F$ = 10 mA, $V_{CE}$ = 5 V | SFH6156-1 | CTR | 40 | | 80 | % |
| | | SFH6156-2 | CTR | 63 | | 125 | % |
| | | SFH6156-3 | CTR | 100 | | 200 | % |
| | | SFH6156-4 | CTR | 160 | | 320 | % |
| | $I_F$ = 1 mA, $V_{CE}$ = 5 V | SFH6156-1 | CTR | 13 | 30 | | % |
| | | SFH6156-2 | CTR | 22 | 45 | | % |
| | | SFH6156-3 | CTR | 34 | 70 | | % |

| SWITCHING CHARACTERISTICS | | | | | | | |
|---|---|---|---|---|---|---|---|
| **PARAMETER** | **TEST CONDITION** | **PART** | **SYMBOL** | **MIN.** | **TYP.** | **MAX.** | **UNIT** |
| **NON-SATURATED** | | | | | | | |
| Rise time | $I_F$ = 10 mA, $V_{CC}$ = 5 V, $T_A$ = 25 °C, $R_L$ = 75 Ω | | $t_r$ | | 2 | | µs |
| Fall time | $I_F$ = 10 mA, $V_{CC}$ = 5 V, $T_A$ = 25 °C, $R_L$ = 75 Ω | | $t_f$ | | 2 | | µs |
| Turn-on time | $I_F$ = 10 mA, $V_{CC}$ = 5 V, $T_A$ = 25 °C, $R_L$ = 75 Ω | | $t_{on}$ | | 3 | | µs |
| Turn-off time | $I_F$ = 10 mA, $V_{CC}$ = 5 V, $T_A$ = 25 °C, $R_L$ = 75 Ω | | $t_{off}$ | | 2.3 | | µs |
| Cut-off frequency | $I_F$ = 10 mA, $V_{CC}$ = 5 V, $T_A$ = 25 °C, $R_L$ = 75 Ω | | $f_{ctr}$ | | 250 | | kHz |
| **SATURATED** | | | | | | | |
| Rise time | $V_{CC}$ = 5 V, $T_A$ = 25 °C, $R_L$ = 1 kΩ, $I_F$ = 20 mA | SFH6156-1 | $t_r$ | | 2 | | µs |
| | $V_{CC}$ = 5 V, $T_A$ = 25 °C, $R_L$ = 1 kΩ, $I_F$ = 10 mA | SFH6156-2 | $t_r$ | | 3 | | µs |
| | | SFH6156-3 | $t_r$ | | 3 | | µs |
| Fall time | $V_{CC}$ = 5 V, $T_A$ = 25 °C, $R_L$ = 1 kΩ, $I_F$ = 20 mA | SFH6156-1 | $t_f$ | | 11 | | µs |
| | $V_{CC}$ = 5 V, $T_A$ = 25 °C, $R_L$ = 1 kΩ, $I_F$ = 10 mA | SFH6156-2 | $t_f$ | | 14 | | µs |
| | | SFH6156-3 | $t_f$ | | 14 | | µs |
| Turn-on time | $V_{CC}$ = 5 V, $T_A$ = 25 °C, $R_L$ = 1 kΩ, $I_F$ = 20 mA | SFH6156-1 | $t_{on}$ | | 3 | | µs |
| | $V_{CC}$ = 5 V, $T_A$ = 25 °C, $R_L$ = 1 kΩ, $I_F$ = 10 mA | SFH6156-2 | $t_{on}$ | | 4.2 | | µs |
| | | SFH6156-3 | $t_{on}$ | | 4.2 | | µs |
| Turn-off time | $V_{CC}$ = 5 V, $T_A$ = 25 °C, $R_L$ = 1 kΩ, $I_F$ = 20 mA | SFH6156-1 | $t_{off}$ | | 18 | | µs |
| | $V_{CC}$ = 5 V, $T_A$ = 25 °C, $R_L$ = 1 kΩ, $I_F$ = 10 mA | SFH6156-2 | $t_{off}$ | | 23 | | µs |
| | | SFH6156-3 | $t_{off}$ | | 23 | | µs |

| SAFETY AND INSULATION RATINGS | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **TEST CONDITION** | **SYMBOL** | **MIN.** | **TYP.** | **MAX.** | **UNIT** |
| Climatic classification (according to IEC 68 part 1) | | | | 55/100/21 | | |
| Comparative tracking index | | CTI | 175 | | 399 | |
| $V_{IOTM}$ | | $V_{IOTM}$ | 10 000 | | | $V_{peak}$ |
| $V_{IORM}$ | | $V_{IORM}$ | 890 | | | $V_{peak}$ |
| $P_{SO}$ | | $P_{SO}$ | | | 400 | mW |
| $I_{SI}$ | | $I_{SI}$ | | | 275 | mA |
| $T_{SI}$ | | $T_{SI}$ | | | 175 | °C |
| Creepage distance | | | 7 | | | mm |
| Clearance distance | | | 7 | | | mm |
| Insulation thickness, reinforced rated | per IEC 60950 2.10.5.1 | | 0.4 | | | mm |

**Note**

- 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.

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

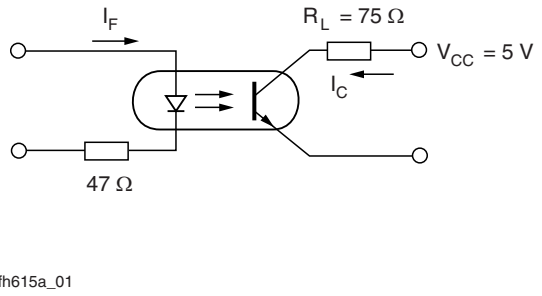



Fig. 2 - Linear Operation (without Saturation)

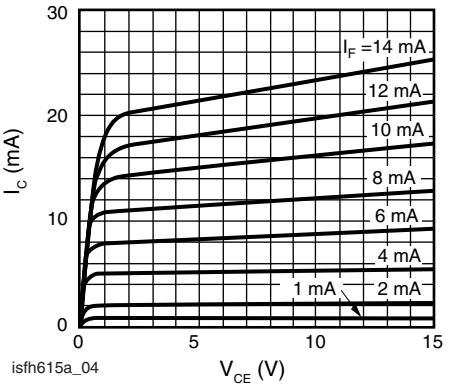



Fig. 5 - Output Characteristics (Typ.) Collector Current vs. Collector Emitter Voltage

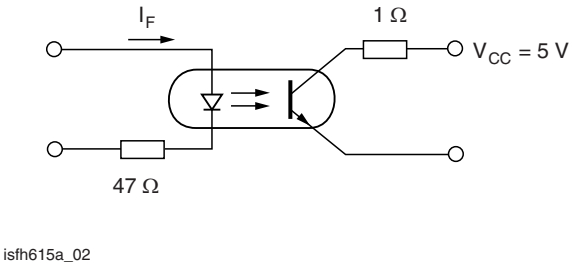



Fig. 3 - Switching Operation (with Saturation)

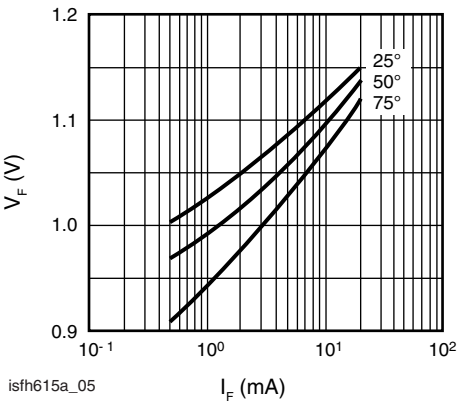



Fig. 6 - Diode Forward Voltage (Typ.) vs. Forward Current

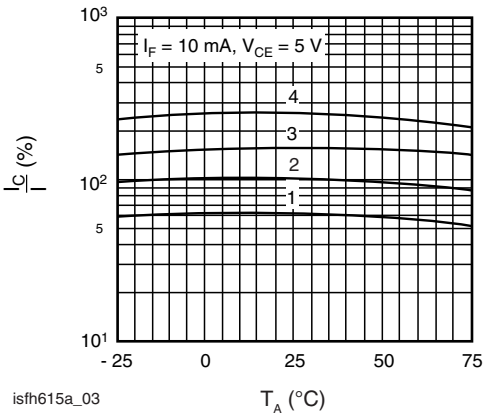



Fig. 4 - Current Transfer Ratio (Typ.) vs. Temperature

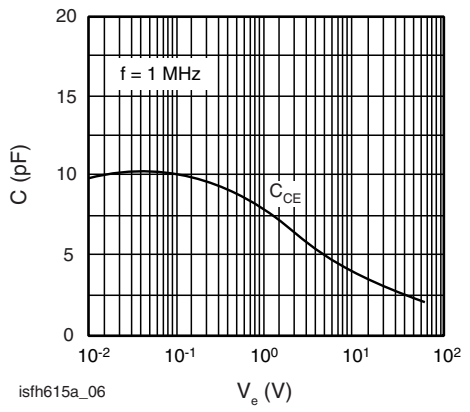



Fig. 7 - Transistor Capacitance (Typ.) vs. Collector Emitter Voltage

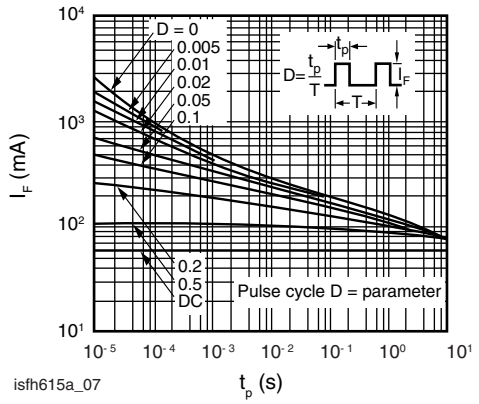
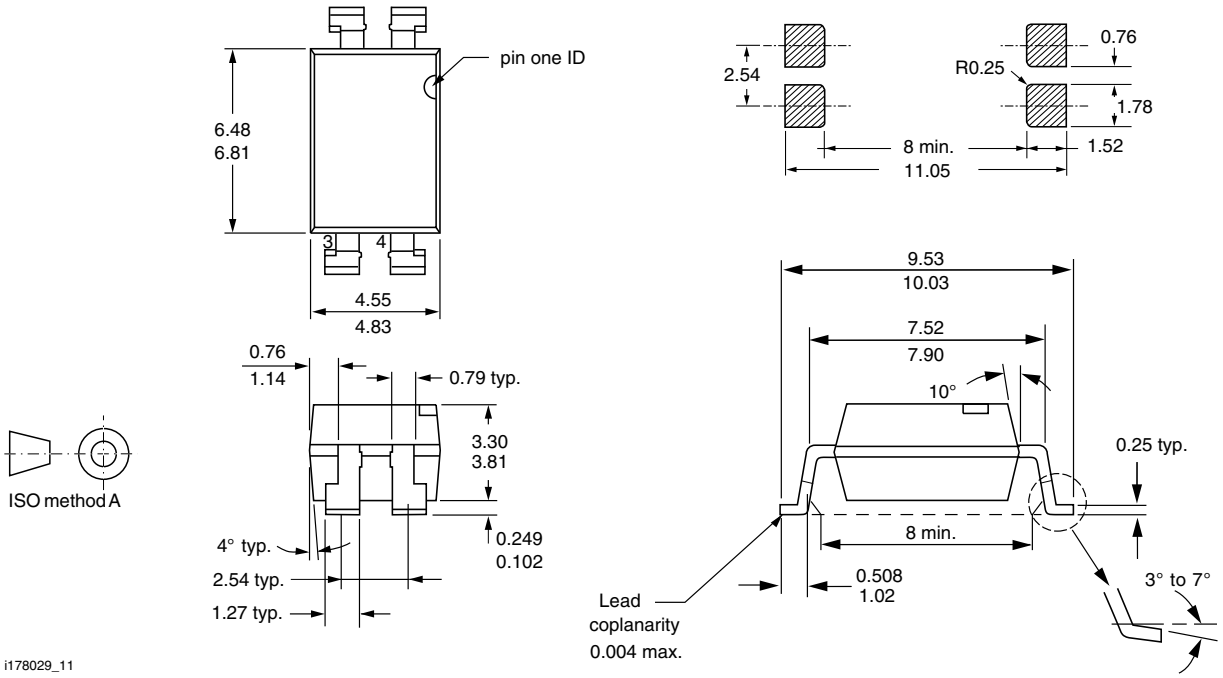
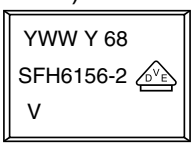



Fig. 8 - Permissible Pulse Handling Capability Forward Current vs. Pulse Width

## **PACKAGE DIMENSIONS** millimeters




## **PACKAGE MARKING** (example of SFH6156-2X001T)




**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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