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# Insulated Gate Bipolar Transistor
# Trench PT IGBT, 600 V, 250 A

Proprietary Vishay IGBT Silicon “L Series”

SOT-227

## FEATURES

- Standard speed Trench PT IGBT
- Fully isolated package
- Very low internal inductance (≤ 5 nH typical)
- Industry standard outline
- UL approved file E78996
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free

RoHS COMPLIANT

## BENEFITS

- Optimized for high current inverter stages (AC TIG welding machine)
- Direct mounting to heatsink
- Plug-in compatible with other SOT-227 packages
- Lower conduction losses
- Low EMI, requires less snubbing

| PRODUCT SUMMARY | |
|---|---|
| $V_{CES}$ | 600 V |
| $I_C$ DC (1) | 239 A at 90 °C |
| $V_{CE(on)}$ typical at 100 A, 25 °C | 1.10 V |
| Speed | DC to 1 kHz |
| Package | SOT-227 |
| Circuit | Single switch no diode |

**Note**

(1) Maximum continuous collector current 100 A to do not exceed the maximum temperature of terminals

| ABSOLUTE MAXIMUM RATINGS | | | | |
|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MAX.** | **UNITS** |
| Collector to emitter voltage | $V_{CES}$ | | 600 | V |
| Continuous collector current | $I_C$ | $T_C$ = 25 °C | 380 | A |
| | | $T_C$ = 90 °C | 239 | |
| Pulsed collector current | $I_{CM}$ | | 600 | |
| Clamped inductive load current | $I_{LM}$ | | 400 | |
| Gate-to-emitter voltage | $V_{GE}$ | | ± 20 | V |
| Power dissipation, IGBT | $P_D$ | $T_C$ = 25 °C | 893 | W |
| | | $T_C$ = 90 °C | 429 | |
| Isolation voltage | $V_{ISOL}$ | Any terminal to case, t = 1 min | 2500 | V |

| ELECTRICAL SPECIFICATIONS ($T_J$ = 25 °C unless otherwise specified) | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| Collector to emitter breakdown voltage | $V_{BR(CES)}$ | $V_{GE}$ = 0 V, $I_C$ = 250 µA | 600 | - | - | V |
| Collector to emitter voltage | $V_{CE(on)}$ | $V_{GE}$ = 15 V, $I_C$ = 100 A | - | 1.10 | 1.30 | |
| | | $V_{GE}$ = 15 V, $I_C$ = 100 A, $T_J$ = 125 °C | - | 1.03 | - | |
| | | $V_{GE}$ = 15 V, $I_C$ = 100 A, $T_J$ = 150 °C | - | 1.0 | - | |
| Gate threshold voltage | $V_{GE(th)}$ | $V_{CE}$ = $V_{GE}$, $I_C$ = 3.2 mA | 4.1 | 6.1 | 8.1 | |
| | | $V_{CE}$ = $V_{GE}$, $I_C$ = 3.2 mA, $T_J$ = 125 °C | - | 3.5 | - | |
| Temperature coefficient of threshold voltage | $\Delta V_{GE(th)}/\Delta T_J$ | $V_{CE}$ = $V_{GE}$, $I_C$ = 3.2 mA, (25 °C to 125 °C) | - | -26 | - | mV/°C |
| Collector to emitter leakage current | $I_{CES}$ | $V_{GE}$ = 0 V, $V_{CE}$ = 600 V | - | 1.0 | 100 | µA |
| | | $V_{GE}$ = 0 V, $V_{CE}$ = 600 V, $T_J$ = 125 °C | - | 350 | - | |
| | | $V_{GE}$ = 0 V, $V_{CE}$ = 600 V, $T_J$ = 150 °C | - | 700 | - | |
| Gate to emitter leakage current | $I_{GES}$ | $V_{GE}$ = ± 20 V | - | - | ± 350 | nA |

| SWITCHING CHARACTERISTICS ($T_J$ = 25 °C unless otherwise specified) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| Total gate charge (turn-on) | $Q_g$ | $I_C$ = 100 A, $V_{CC}$ = 400 V, $V_{GE}$ = 15 V | | - | 942 | - | nC |
| Gate to emitter charge (turn-on) | $Q_{ge}$ | | | - | 295 | - | |
| Gate to collector charge (turn-on) | $Q_{gc}$ | | | - | 802 | - | |
| Turn-on switching loss | $E_{on}$ | $I_C$ = 100 A, $V_{CC}$ = 480 V, $V_{GE}$ = 15 V, $R_g$ = 5 Ω, L = 500 µH, $T_J$ = 25 °C | Energy losses include tail and diode recovery. diode used 60APH06 | - | 2.2 | - | mJ |
| Turn-off switching loss | $E_{off}$ | | | - | 11 | - | |
| Total switching loss | $E_{tot}$ | | | - | 13.2 | - | |
| Turn-on delay time | $t_{d(on)}$ | | | - | 300 | - | ns |
| Rise time | $t_r$ | | | - | 85 | - | |
| Turn-off delay time | $t_{d(off)}$ | | | - | 515 | - | |
| Fall time | $t_f$ | | | - | 450 | - | |
| Turn-on switching loss | $E_{on}$ | $I_C$ = 100 A, $V_{CC}$ = 480 V, $V_{GE}$ = 15 V, $R_g$ = 5 Ω, L = 500 µH, $T_J$ = 125 °C | | - | 2.6 | - | mJ |
| Turn-off switching loss | $E_{off}$ | | | - | 21.5 | - | |
| Total switching loss | $E_{tot}$ | | | - | 24.1 | - | |
| Turn-on delay time | $t_{d(on)}$ | | | - | 285 | - | ns |
| Rise time | $t_r$ | | | - | 85 | - | |
| Turn-off delay time | $t_{d(off)}$ | | | - | 785 | - | |
| Fall time | $t_f$ | | | - | 790 | - | |
| Reverse bias safe operating area | RBSOA | $T_J$ = 150 °C, $I_C$ = 400, $R_g$ = 5 Ω, $V_{GE}$ = 15 V to 0 V, $V_{CC}$ = 480 V, $V_P$ = 600 V, L = 500 µH | | Fullsquare | | | |

| THERMAL AND MECHANICAL SPECIFICATIONS | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| Junction and storage temperature range | $T_J$, $T_{Stg}$ | | -40 | - | 150 | °C |
| Junction to case | $R_{thJC}$ | | - | - | 0.14 | °C/W |
| Case to heatsink | $R_{thCS}$ | Flat, greased surface | - | 0.1 | - | |
| Weight | | | - | 30 | - | g |
| Mounting torque | | Torque to terminal | - | - | 1.1 (9.7) | Nm (lbf.in) |
| | | Torque to heatsink | - | - | 1.3 (11.5) | Nm (lbf.in) |
| Case style | | SOT-227 | | | | |

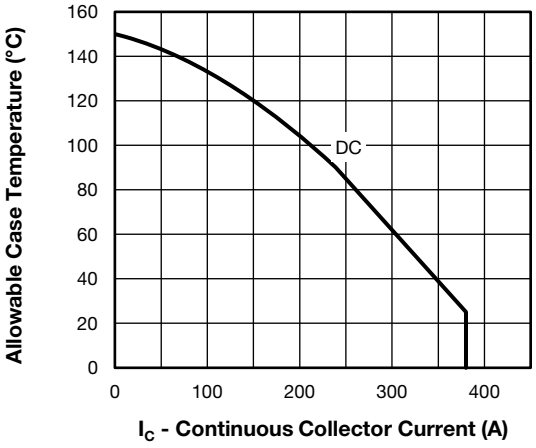



Fig. 1 - Maximum DC IGBT Collector Current vs. Case Temperature

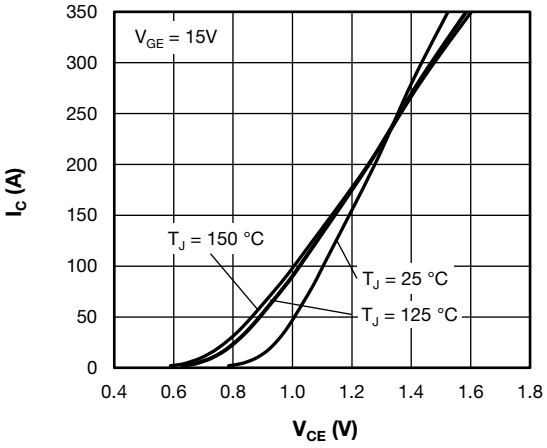



Fig. 2 - Typical IGBT Output Characteristics vs. $V_{GE}$ = 15 V

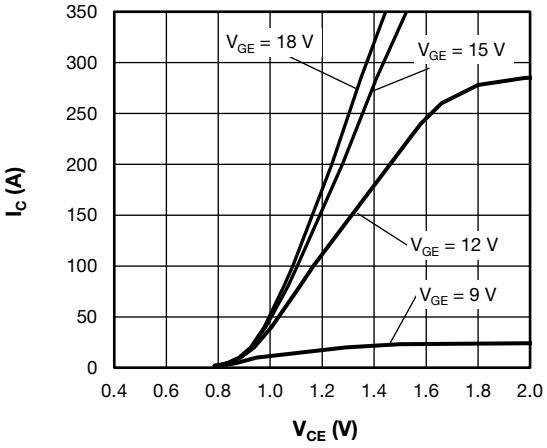



Fig. 3 - Typical Output Characteristics vs. $V_{GE}$ at 25 °C

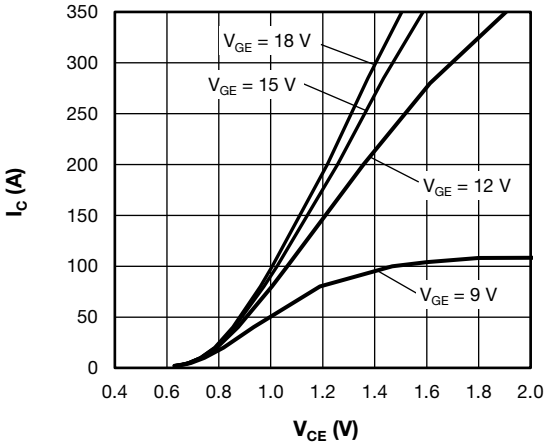



Fig. 4 - Typical Output Characteristics vs. $V_{GE}$ at 125 °C

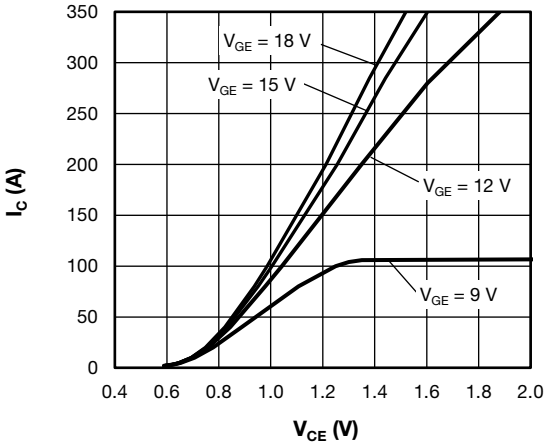



Fig. 5 - Typical Output Characteristics vs. $V_{GE}$ at 150 °C

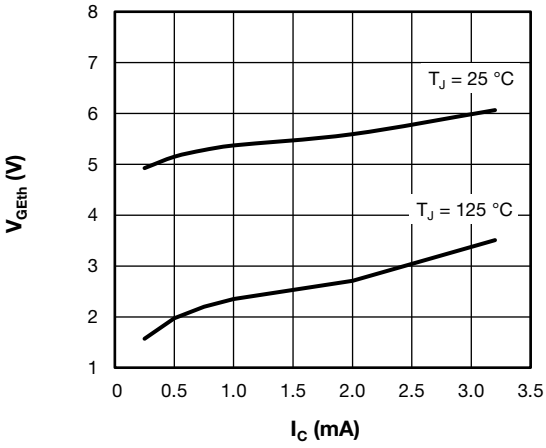



Fig. 6 - Typical Gate Threshold Voltage Characteristics

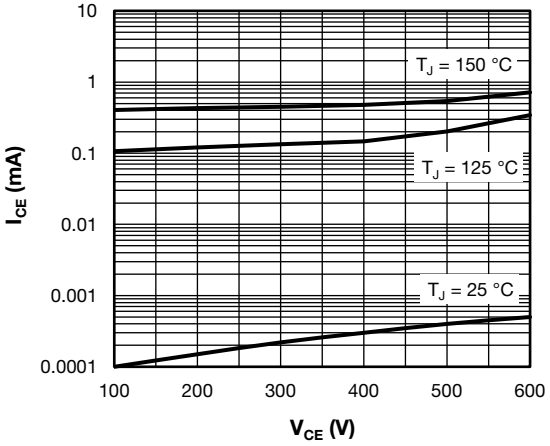



Fig. 7 - Typical Zero Voltage Collector Current

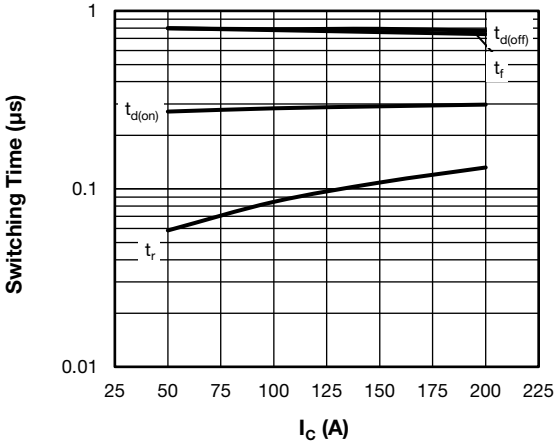



Fig. 10 - Typical IGBT Switching Time vs. $I_C$
$T_J$ = 125 °C, $V_{CC}$ = 480 V, $V_{GE}$ = 15 V, L = 500 µH, $R_g$ = 5 Ω
Diode used: 60APH06

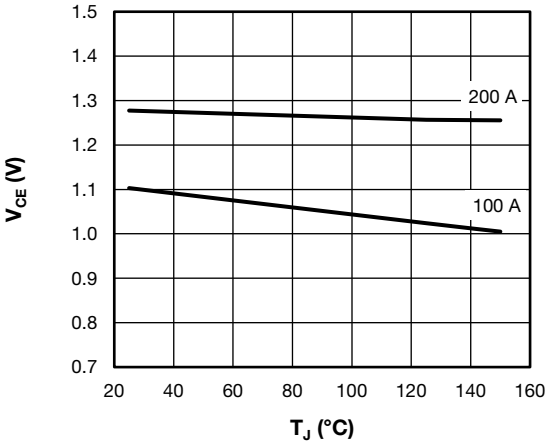



Fig. 8 - Typical $V_{CE}$ vs. Junction Temperature

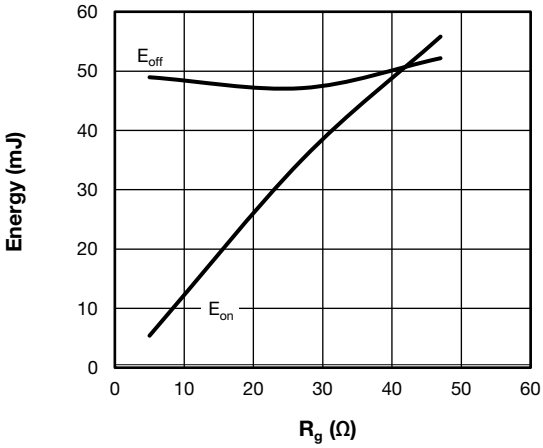



Fig. 11 - Typical IGBT Energy Losses vs. $R_g$
$T_J$ = 125 °C, $I_C$ = 200 A, $V_{CC}$ = 480 V, $V_{GE}$ = 15 V, L = 500 µH,
$R_g$ = 5 Ω, Diode used: 60APH06

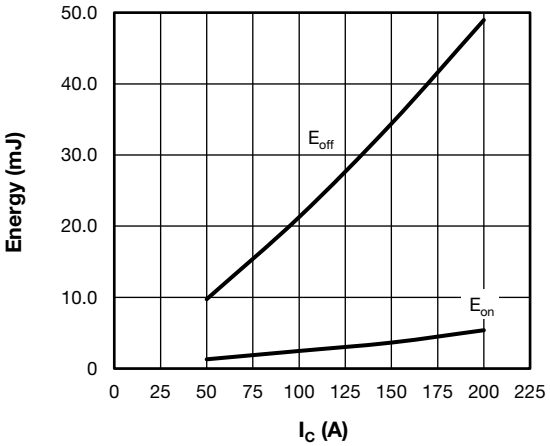



Fig. 9 - Typical IGBT Energy Losses vs. $I_C$
$T_J$ = 125 °C, $V_{CC}$ = 480 V, $V_{GE}$ = 15 V, L = 500 µH, $R_g$ = 5 Ω
Diode used: 60APH06

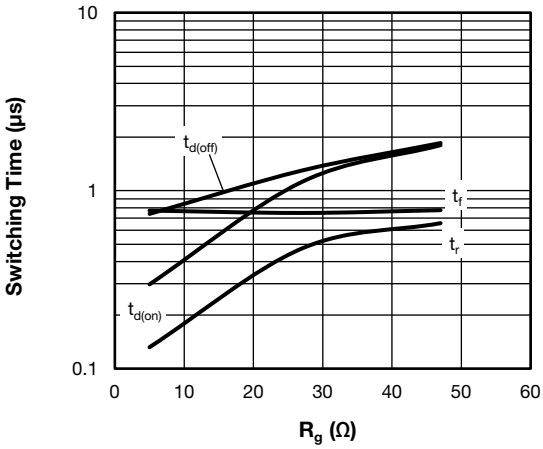



Fig. 12 - Typical IGBT Switching Time vs. $R_g$
$T_J$ = 125 °C, $I_C$ = 200 A, $V_{CC}$ = 480 V, $V_{GE}$ = 15 V, L = 500 µH,
$R_g$ = 5 Ω, Diode used: 60APH06

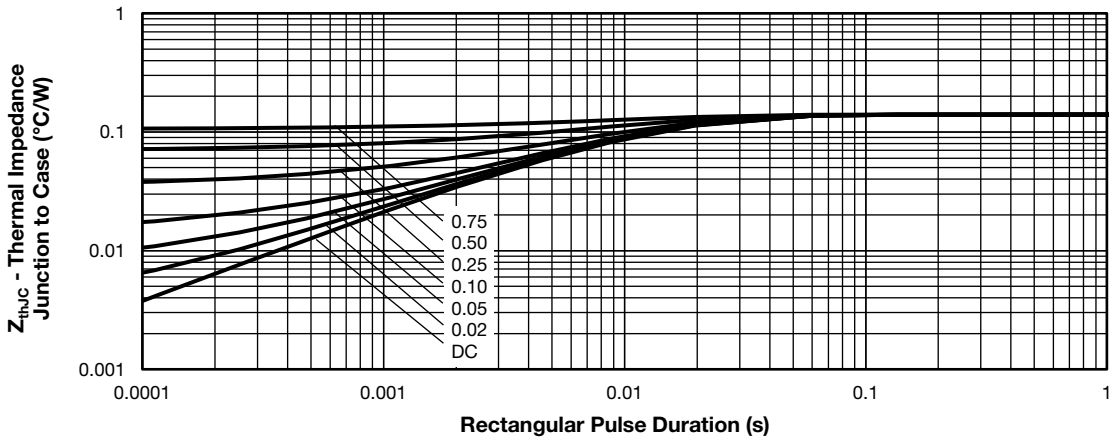



Fig. 13 - Maximum Thermal Impedance Characteristics

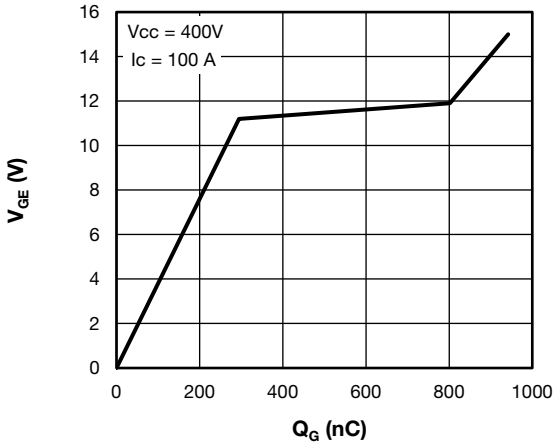
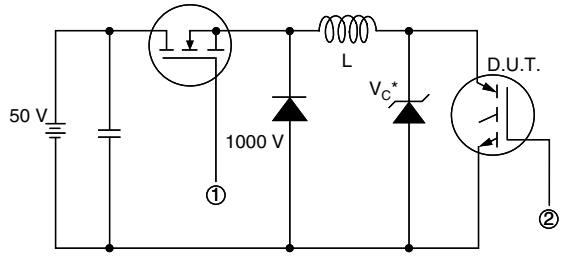



Fig. 14 - Typical Gate Charge vs. Gate Emitter Voltage




* Driver same type as D.U.T.; $V_C$ = 80 % of $V_{CE}$ (max)

**Note:** Due to the 50 V power supply, pulse width and inductor will increase to obtain rated $I_d$

Fig. 16a - Clamped Inductive Load Test Circuit

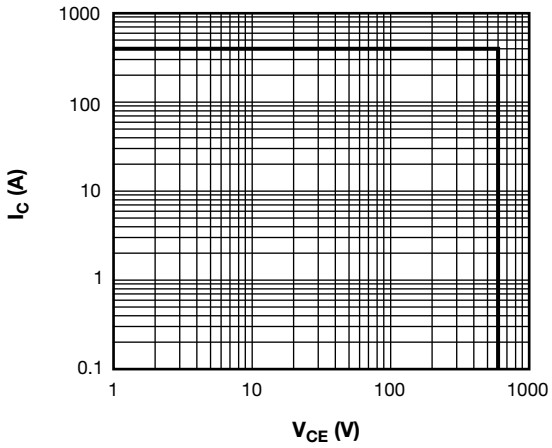



Fig. 15 - Reverse BIAS SOA, $T_J$ = 150 °C, $V_{GE}$ = 15 V

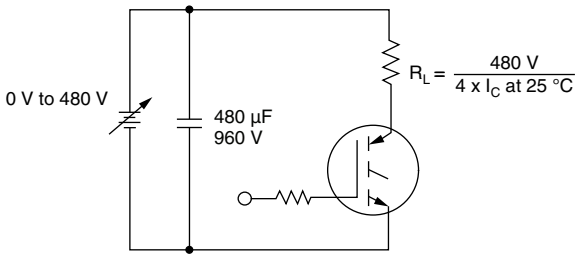
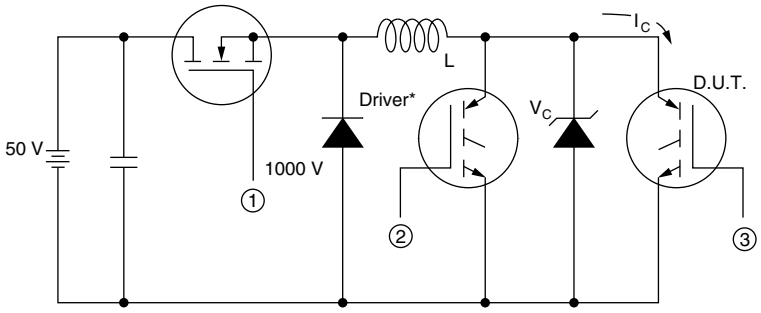
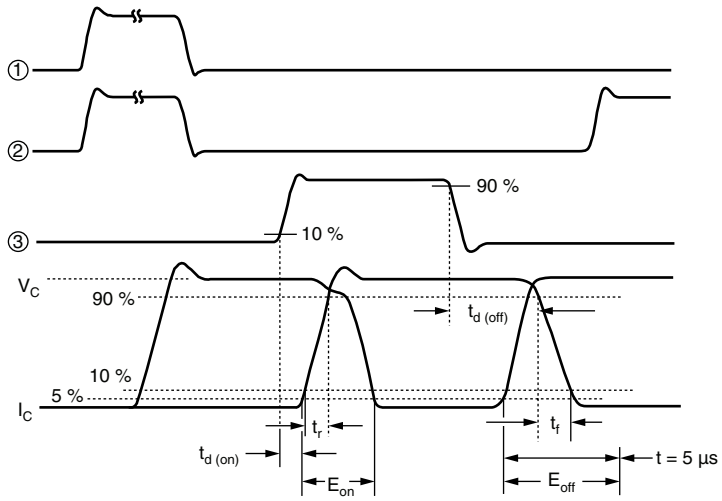



Fig. 16b - Pulsed Collector Current Test Circuit




* Driver same type as D.U.T., $V_C$ = 480 V

Fig. 17a - Switching Lost Test Circuit




$E_{ts} = (E_{on} + E_{off})$

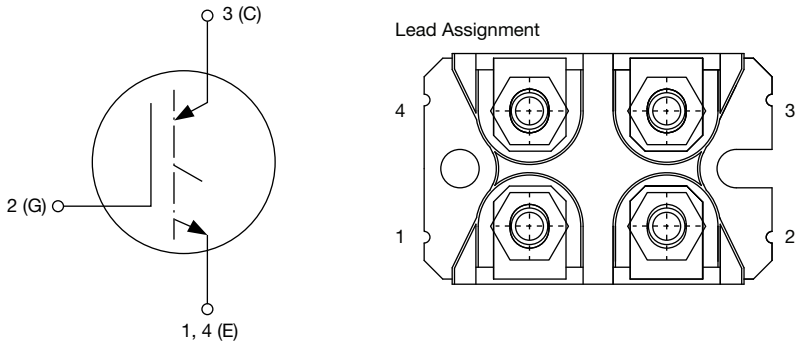
Fig. 17b - Switching Loss Waveforms

## ORDERING INFORMATION TABLE

**Device code**

| VS- | G | P | 250 | S | A | 60 | S |
|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

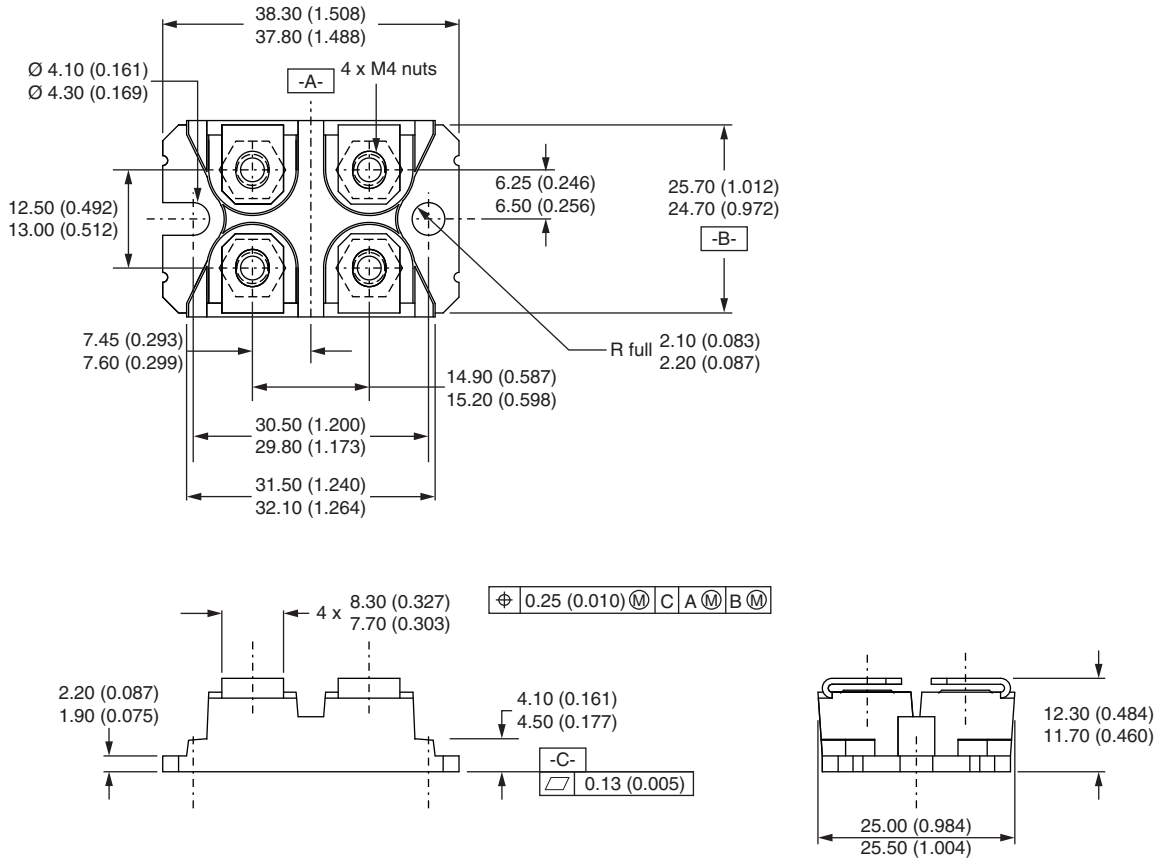
| | | |
|---|---|---|
| 1 | - | Vishay Semiconductors product |
| 2 | - | Insulated Gate Bipolar Transistor (IGBT) |
| 3 | - | P = Trench PT IGBT |
| 4 | - | Current rating (250 = 250 A) |
| 5 | - | Circuit configuration (S = single switch, no diode) |
| 6 | - | Package indicator (A = SOT-227) |
| 7 | - | Voltage rating (60 = 600 V) |
| 8 | - | Speed/type (S = standard speed) |

| CIRCUIT CONFIGURATION | | |
|---|---|---|
| **CIRCUIT** | **CIRCUIT CONFIGURATION CODE** | **CIRCUIT DRAWING** |
| Single switch, no diode | S |   |

| LINKS TO RELATED DOCUMENTS | |
|---|---|
| Dimensions | www.vishay.com/doc?95423 |
| Packaging information | www.vishay.com/doc?95425 |

# SOT-227 Generation II

**DIMENSIONS** in millimeters (inches)




**Note**

- Controlling dimension: millimeter

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