# Insulated Gate Bipolar Transistor
# Ultralow $V_{CE(on)}$, 250 A

SOT-227

## FEATURES

- Standard: optimized for minimum saturation voltage and low speed
- Lowest conduction losses available
- Fully isolated package (2500 $V_{AC}$)
- Very low internal inductance (5 nH typical)
- Industry standard outline
- Designed and qualified for industrial level
- UL approved file E78996
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free

RoHS COMPLIANT

## BENEFITS

- Designed for increased operating efficiency in power conversion: UPS, SMPS, TIG welding, induction heating
- Easy to assemble and parallel
- Direct mounting to heatsink
- Plug-in compatible with other SOT-227 packages

| PRODUCT SUMMARY | |
|---|---|
| $V_{CES}$ | 600 V |
| $V_{CE(on)}$ (typical) at 200 A, 25 °C | 1.33 V |
| $I_C$ at $T_C$ = 90 °C (1) | 250 A |
| Speed | DC to 1 kHz |
| Package | SOT-227 |
| Circuit | Single switch no diode |

**Note**

(1) Maximum collector current admitted 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 | $I_C$ (1) | $T_C$ = 25 °C | 400 | A |
| | | $T_C$ = 90 °C | 250 | |
| Pulsed collector current | $I_{CM}$ | Repetitive rating; $V_{GE}$ = 20 V, pulse width limited by maximum junction temperature | 400 | |
| Clamped Inductive load current | $I_{LM}$ | $V_{CC}$ = 80 % ($V_{CES}$), $V_{GE}$ = 20 V, L = 10 µH, $R_g$ = 2.0 Ω | 400 | |
| Gate to emitter voltage | $V_{GE}$ | | ± 20 | V |
| Power dissipation | $P_D$ | $T_C$ = 25 °C | 961 | W |
| | | $T_C$ = 90 °C | 462 | |
| Isolation voltage | $V_{ISOL}$ | Any terminal to case, t = 1 min | 2500 | V |

**Note**

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

| THERMAL AND MECHANICAL SPECIFICATIONS | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| Junction and storage temperature range | $T_J$, $T_{Stg}$ | | -40 | - | 150 | °C |
| Thermal resistance junction to case | $R_{thJC}$ | | - | - | 0.13 | °C/W |
| Thermal resistance case to heatsink | $R_{thCS}$ | Flat, greased surface | - | 0.05 | - | |
| 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 | | | | | |

| **ELECTRICAL SPECIFICATIONS** ($T_J$ = 25 °C unless otherwise noted) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| Collector to emitter breakdown voltage | $V_{(BR)CES}$ | $V_{GE}$ = 0 V, $I_C$ = 1 mA | | 600 | - | - | V |
| Emitter to collector breakdown voltage | $V_{(BR)ECS}$ (1) | $V_{GE}$ = 0 V, $I_C$ = 1.0 A | | 18 | - | - | |
| Collector to emitter voltage | $V_{CE(on)}$ | $I_C$ = 100 A | $V_{GE}$ = 15 V | - | 1.10 | 1.3 | |
| | | $I_C$ = 200 A | | - | 1.33 | 1.66 | |
| | | $I_C$ = 100 A, $T_J$ = 125 °C | | - | 1.02 | - | |
| | | $I_C$ = 200 A, $T_J$ = 125 °C | | - | 1.32 | - | |
| | | $I_C$ = 100 A, $T_J$ = 150 °C | | - | 1.02 | - | |
| | | $I_C$ = 200 A, $T_J$ = 150 °C | | - | 1.33 | - | |
| Gate threshold voltage | $V_{GE(th)}$ | $V_{CE}$ = $V_{GE}$, $I_C$ = 250 µA | | 3.0 | 4.5 | 6.0 | |
| | | $V_{CE}$ = $V_{GE}$, $I_C$ = 250 µA, $T_J$ = 125 °C | | - | 3.1 | - | |
| Temperature coefficient of threshold voltage | $\Delta V_{GE(th)}/\Delta T_J$ | $V_{CE}$ = $V_{GE}$, $I_C$ = 1 mA, 25 °C to 125 °C | | - | -12 | - | mV/°C |
| Collector to emitter leakage current | $I_{CES}$ | $V_{GE}$ = 0 V, $V_{CE}$ = 600 V | | - | 20 | 1000 | µA |
| | | $V_{GE}$ = 0 V, $V_{CE}$ = 600 V, $T_J$ = 125 °C | | - | 0.2 | - | mA |
| | | $V_{GE}$ = 0 V, $V_{CE}$ = 600 V, $T_J$ = 150 °C | | - | 0.6 | 10 | |
| Gate to emitter leakage current | $I_{GES}$ | $V_{GE}$ = ± 20 V | | - | - | ± 250 | nA |

**Notes**

(1) Pulse width ≤ 80 µs; duty factor ≤ 0.1 %

| **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, $V_{CC}$ = 600 V, $V_{GE}$ = 15 V | | - | 770 | 1200 | nC |
| Gate-to-emitter charge (turn-on) | $Q_{ge}$ | | | - | 100 | 150 | |
| Gate-to-collector charge (turn-on) | $Q_{gc}$ | | | - | 260 | 380 | |
| Turn-on switching loss | $E_{on}$ | $T_J$ = 25 °C<br>$I_C$ = 100 A<br>$V_{CC}$ = 480 V<br>$V_{GE}$ = 15 V<br>$R_g$ = 5.0 Ω<br>L = 500 µH | Energy losses include tail and diode recovery. Diode used 60APH06 | - | 0.55 | - | mJ |
| Turn-off switching loss | $E_{off}$ | | | - | 25 | - | |
| Total switching loss | $E_{tot}$ | | | - | 25.5 | - | |
| Turn-on delay time | $t_{d(on)}$ | | | - | 267 | - | ns |
| Rise time | $t_r$ | | | - | 42 | - | |
| Turn-off delay time | $t_{d(off)}$ | | | - | 310 | - | |
| Fall time | $t_f$ | | | - | 450 | - | |
| Turn-on switching loss | $E_{on}$ | $T_J$ = 125 °C<br>$I_C$ = 100 A<br>$V_{CC}$ = 480 V<br>$V_{GE}$ = 15 V<br>$R_g$ = 5.0 Ω<br>L = 500 µH | | - | 0.67 | - | mJ |
| Turn-off switching loss | $E_{off}$ | | | - | 43.0 | - | |
| Total switching loss | $E_{tot}$ | | | - | 43.7 | - | |
| Turn-on delay time | $t_{d(on)}$ | | | - | 275 | - | ns |
| Rise time | $t_r$ | | | - | 50 | - | |
| Turn-off delay time | $t_{d(off)}$ | | | - | 350 | - | |
| Fall time | $t_f$ | | | - | 700 | - | |
| Internal emitter inductance | $L_E$ | Between lead and center of die contact | | - | 5.0 | - | nH |
| Input capacitance | $C_{ies}$ | $V_{GE}$ = 0 V , $V_{CC}$ = 30 V, f = 1.0 MHz | | - | 16 250 | - | pF |
| Output capacitance | $C_{oes}$ | | | - | 1040 | - | |
| Reverse transfer capacitance | $C_{res}$ | | | - | 190 | - | |

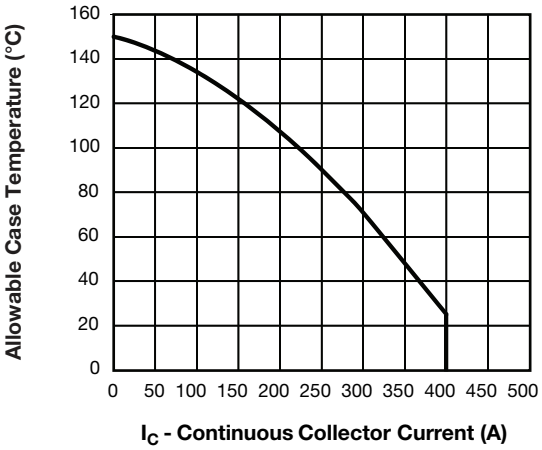



Fig. 1 - Maximum DC IGBT Collector Current vs. Case Temperature

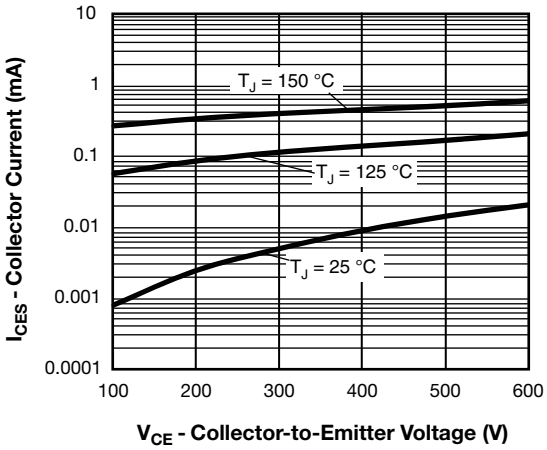



Fig. 4 - Typical IGBT Zero Gate Voltage Collector Current

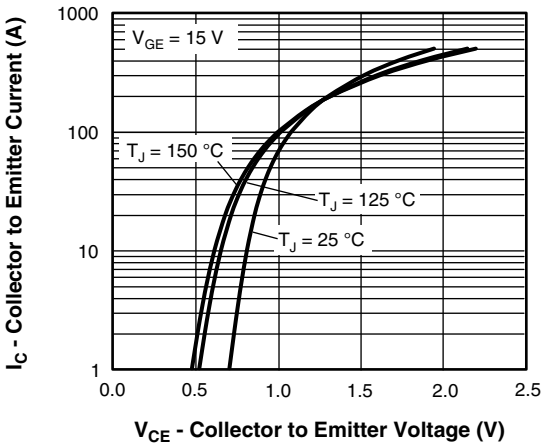



Fig. 2 - Typical Collector to Emitter Current Output Characteristics

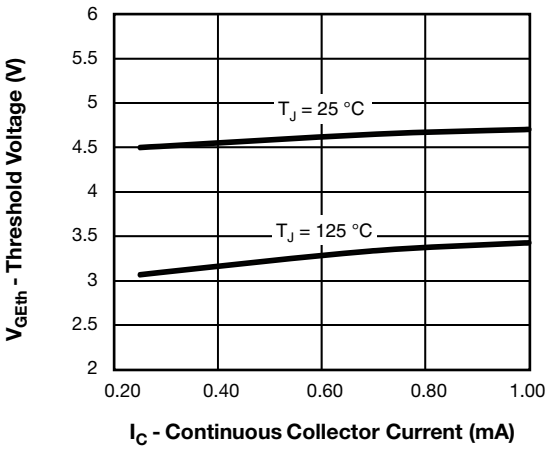



Fig. 5 - Typical IGBT Threshold Voltage

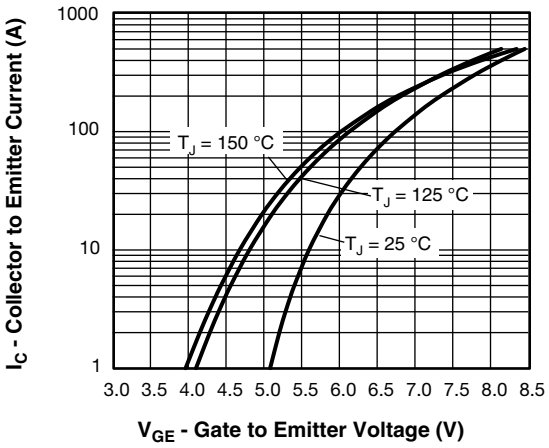



Fig. 3 - Typical IGBT Transfer Characteristics

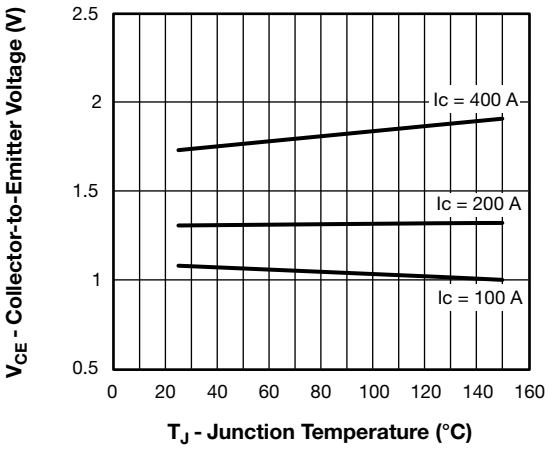



Fig. 6 - Typical IGBT Collector to Emitter Voltage vs. Junction Temperature, $V_{GE}$ = 15 V

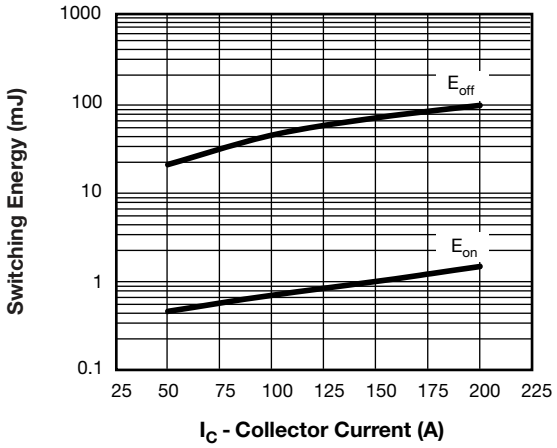



Fig. 7 - Typical IGBT Energy Losses vs. $I_C$, $T_J$ = 125 °C,
$V_{CC}$ = 480 V, $V_{GE}$ = 15 V, L = 500 µH, $R_g$ = 5 Ω,
Diode used: 60APH06

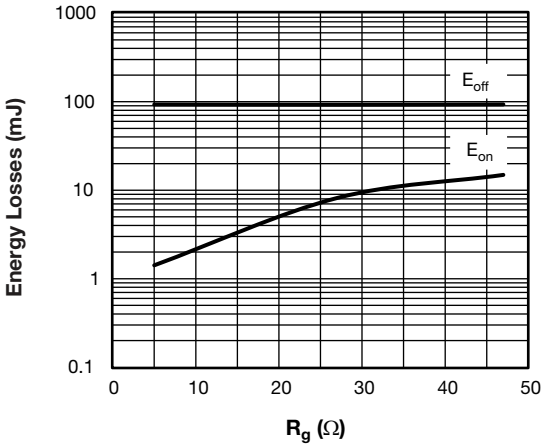



Fig. 9 - Typical IGBT Energy Losses vs. $R_g$,
$T_J$ = 125 °C, $I_C$ = 200 A, $V_{CC}$ = 480 V, $V_{GE}$ = 15 V, L = 500 µH,
Diode used: 60APH06

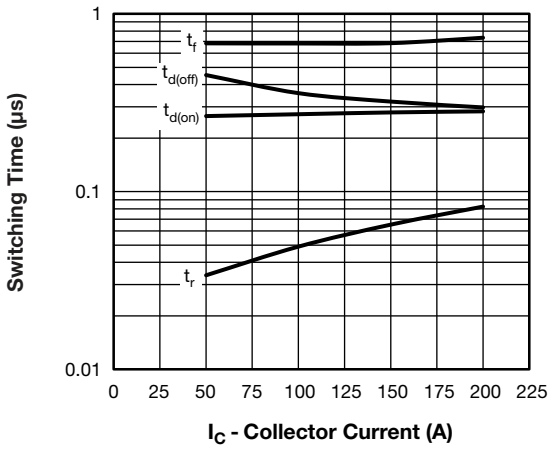



Fig. 8 - Typical IGBT Switching Time vs. $I_C$,
$T_J$ = 125 °C, $V_{CC}$ = 480 V, $V_{GE}$ = 15 V, L = 500 µH, $R_g$ = 5 Ω,
Diode used: 60APH06

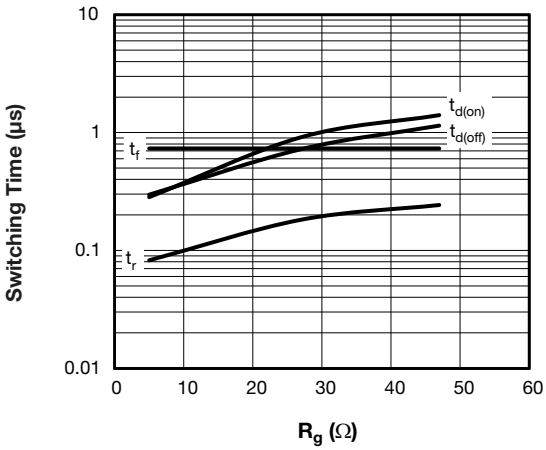



Fig. 10 - Typical IGBT Switching Time vs. $R_g$,
$T_J$ = 125 °C, $I_C$ = 200 A, $V_{CC}$ = 480 V, $V_{GE}$ = 15 V, L = 500 µH,
Diode used: 60APH06

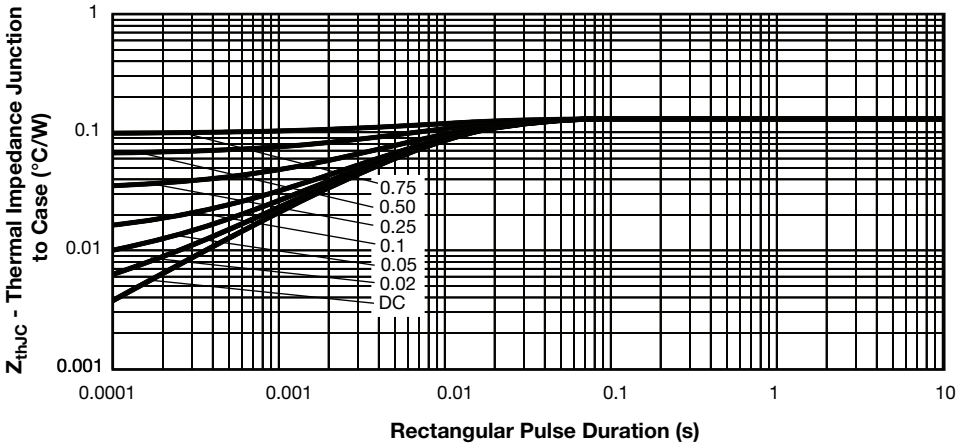



Fig. 11 - Maximum Thermal Impedance $Z_{thJC}$ Characteristics

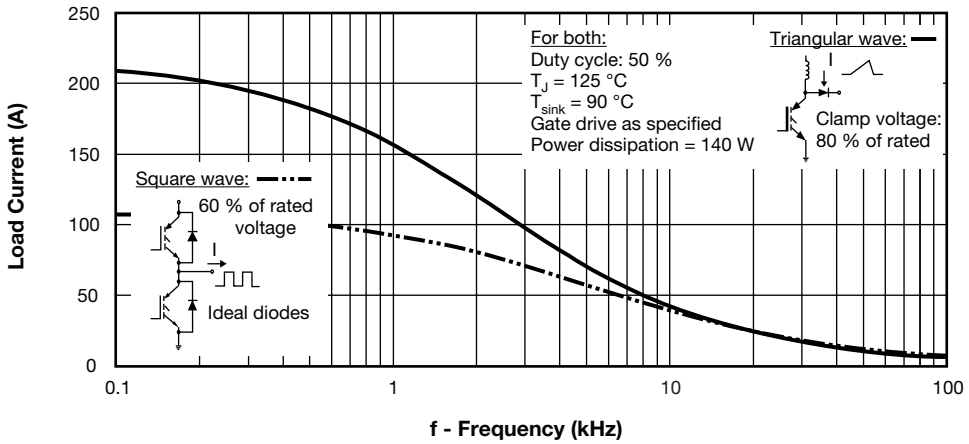



Fig. 12 - Typical Load Current vs. Frequency (Load Current = $I_{RMS}$ of Fundamental)

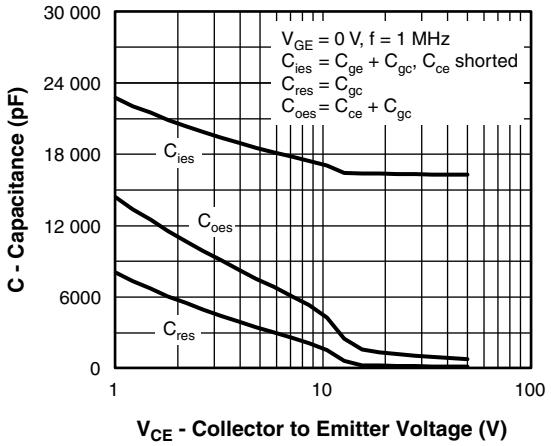



Fig. 13 - Typical Capacitance vs. Collector to Emitter Voltage

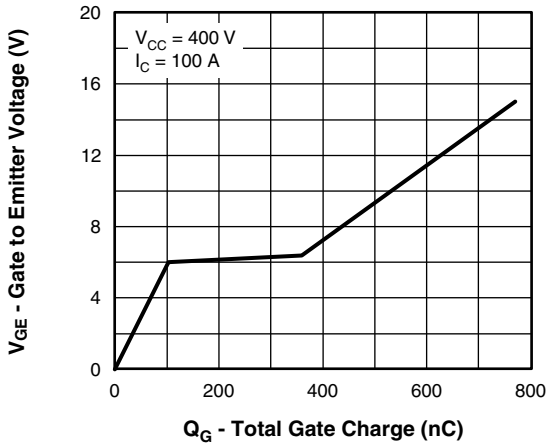



Fig. 14 - Typical Gate Charge vs. Gate to Emitter Voltage

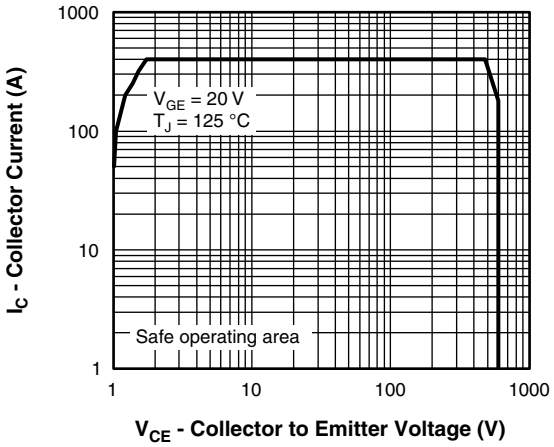
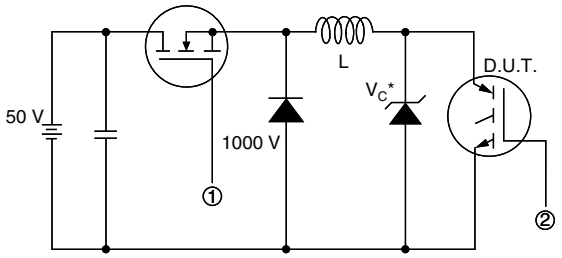



Fig. 15 - Turn-Off SOA




* 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

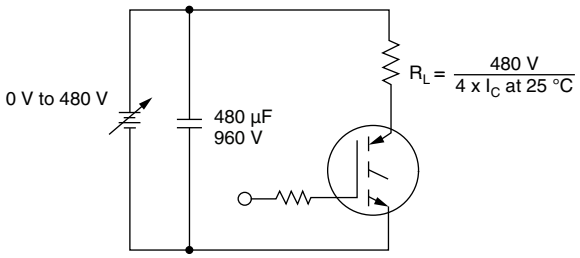
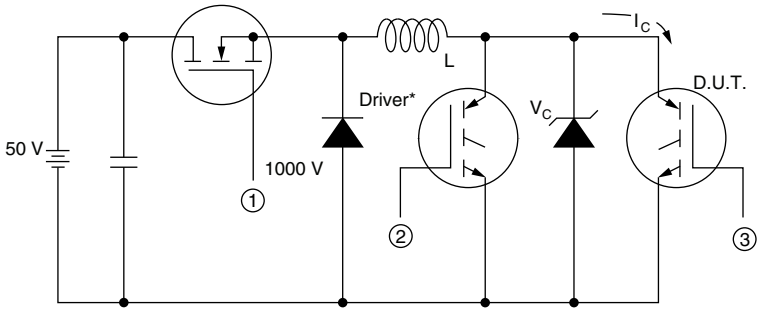
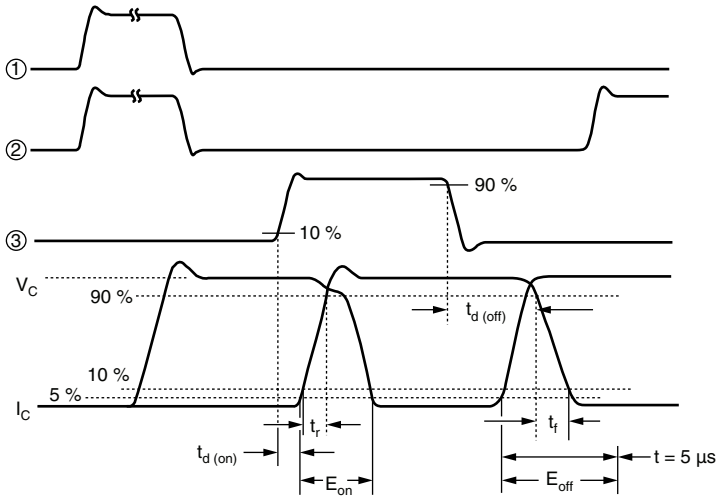



Fig. 16b - Pulsed Collector Current Test Circuit




* 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

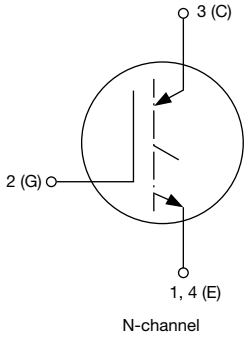
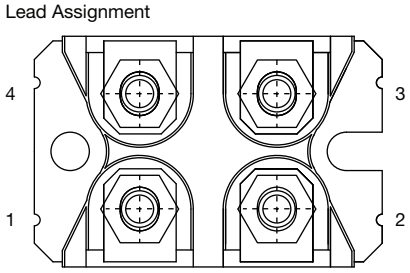
## ORDERING INFORMATION TABLE

Device code

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

- 1 - Vishay Semiconductors product
- 2 - Insulated Gate Bipolar Transistor (IGBT)
- 3 - Gen 4, IGBT silicon
- 4 - Current rating (250 = 250 A)
- 5 - Circuit configuration (S = single switch, without antiparallel diode)
- 6 - Package indicator (A = SOT-227)
- 7 - Voltage rating (60 = 600 V)
- 8 - Speed/type (S = standard speed)

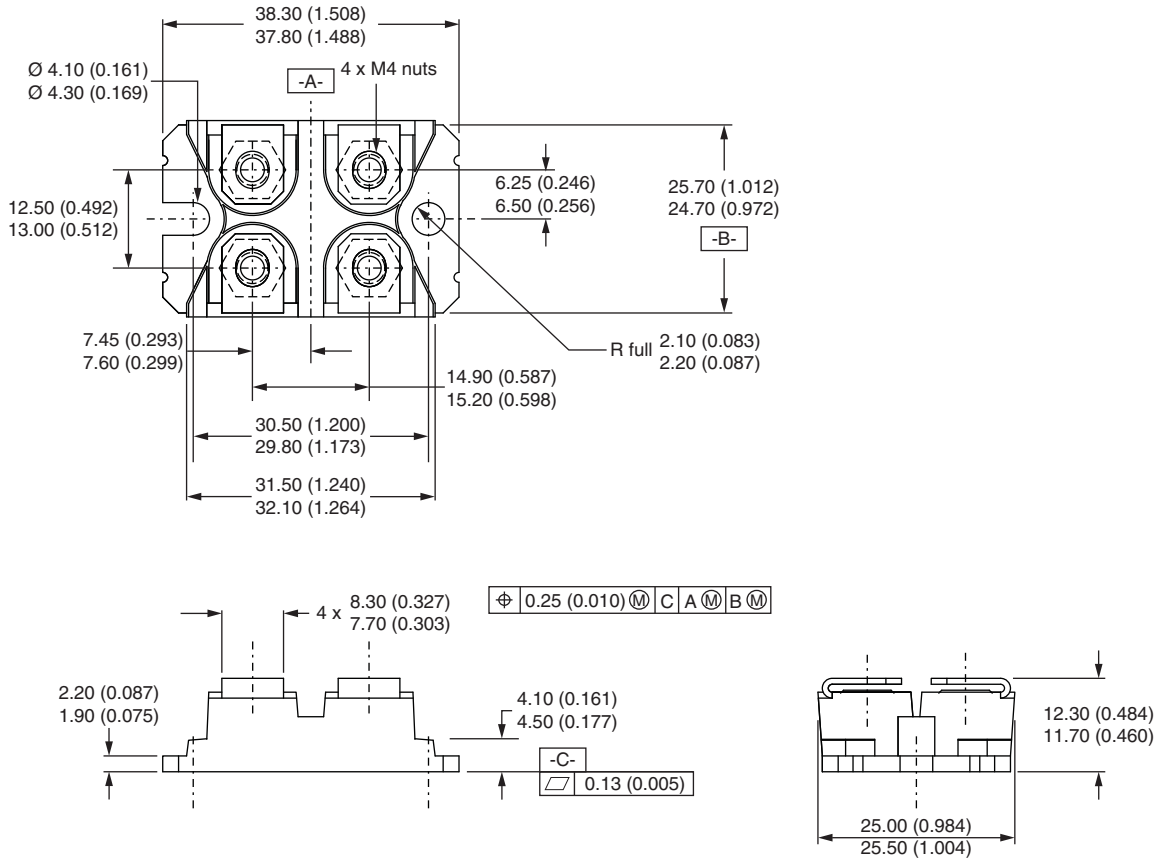
## CIRCUIT CONFIGURATION

| CIRCUIT | CIRCUIT CONFIGURATION CODE | CIRCUIT DRAWING |
|---|---|---|
| Single switch, no antiparallel diode | S |   N-channel   |

| 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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