


Insulated Gate Bipolar Transistor (Warp 2 Speed IGBT), 90 A



SOT-227

| PRIMARY CHARACTERISTICS | |
|--------------------------------------|-----------------------------|
| V_{CES} | 600 V |
| I_C DC | 90 A at 90 °C |
| $V_{CE(on)}$ typical at 100 A, 25 °C | 2.40 V |
| I_F DC | 108 A at 90 °C |
| Speed | 8 kHz to 30 kHz |
| Package | SOT-227 |
| Circuit configuration | Single switch with AP diode |

FEATURES

- NPT warp 2 speed IGBT technology with positive temperature coefficient
- Square RBSOA
- HEXFRED® anti-parallel diodes with ultrasoft reverse recovery
- 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


**RoHS
COMPLIANT**
BENEFITS

- Designed for increased operating efficiency in power conversion: UPS, SMPS, welding, induction heating
- Easy to assemble and parallel
- Direct mounting to heatsink
- Plug-in compatible with other SOT-227 packages
- Lower conduction losses and switching losses
- Low EMI, requires less snubbing

| ABSOLUTE MAXIMUM RATINGS | | | | |
|----------------------------------|------------|-----------------------------------|----------|-------|
| PARAMETER | SYMBOL | TEST CONDITIONS | MAX. | UNITS |
| Collector to emitter voltage | V_{CES} | | 600 | V |
| Continuous collector current | I_C | $T_C = 25\text{ °C}$ | 147 | A |
| | | $T_C = 90\text{ °C}$ | 90 | |
| Pulsed collector current | I_{CM} | | 300 | |
| Clamped inductive load current | I_{LM} | | 300 | |
| Diode continuous forward current | I_F | $T_C = 25\text{ °C}$ | 180 | |
| | | $T_C = 90\text{ °C}$ | 108 | |
| Gate-to-emitter voltage | V_{GE} | | ± 20 | V |
| Power dissipation, IGBT | P_D | $T_C = 25\text{ °C}$ | 625 | W |
| | | $T_C = 90\text{ °C}$ | 300 | |
| Power dissipation, diode | P_D | $T_C = 25\text{ °C}$ | 379 | |
| | | $T_C = 90\text{ °C}$ | 182 | |
| Isolation voltage | V_{ISOL} | Any terminal to case, $t = 1$ min | 2500 | V |



| ELECTRICAL SPECIFICATIONS ($T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified) | | | | | | |
|---|--------------------------------|--|------|------|-----------|----------------------|
| PARAMETER | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNITS |
| Collector to emitter breakdown voltage | $V_{BR(CES)}$ | $V_{GE} = 0\text{ V}, I_C = 250\text{ }\mu\text{A}$ | 600 | - | - | V |
| Collector to emitter voltage | $V_{CE(on)}$ | $V_{GE} = 15\text{ V}, I_C = 100\text{ A}$ | - | 2.4 | 2.8 | |
| | | $V_{GE} = 15\text{ V}, I_C = 100\text{ A}, T_J = 125\text{ }^\circ\text{C}$ | - | 3 | 3.4 | |
| | | $V_{GE} = 15\text{ V}, I_C = 100\text{ A}, T_J = 150\text{ }^\circ\text{C}$ | - | 3.3 | - | |
| Gate threshold voltage | $V_{GE(th)}$ | $V_{CE} = V_{GE}, I_C = 250\text{ }\mu\text{A}$ | 3 | 3.9 | 5.0 | |
| | | $V_{CE} = V_{GE}, I_C = 250\text{ }\mu\text{A}, T_J = 125\text{ }^\circ\text{C}$ | - | 2.5 | - | |
| Temperature coefficient of threshold voltage | $\Delta V_{GE(th)}/\Delta T_J$ | $V_{CE} = V_{GE}, I_C = 1\text{ mA}$ ($25\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$) | - | -10 | - | mV/ $^\circ\text{C}$ |
| Collector to emitter leakage current | I_{CES} | $V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}$ | - | 7 | 100 | μA |
| | | $V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}, T_J = 125\text{ }^\circ\text{C}$ | - | 1.5 | 6.0 | mA |
| | | $V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}, T_J = 150\text{ }^\circ\text{C}$ | - | 6 | 10 | |
| Forward voltage drop, diode | V_{FM} | $I_C = 100\text{ A}, V_{GE} = 0\text{ V}$ | - | 1.6 | 2.1 | V |
| | | $I_C = 100\text{ A}, V_{GE} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$ | - | 1.56 | 2.0 | |
| | | $I_C = 100\text{ A}, V_{GE} = 0\text{ V}, T_J = 150\text{ }^\circ\text{C}$ | - | 1.53 | - | |
| Gate to emitter leakage current | I_{GES} | $V_{GE} = \pm 20\text{ V}$ | - | - | ± 200 | nA |

| SWITCHING CHARACTERISTICS ($T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified) | | | | | | | | |
|---|--------------|---|---|------|------|-------|----|----|
| PARAMETER | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNITS | | |
| Total gate charge (turn-on) | Q_g | $I_C = 100\text{ A}, V_{CC} = 480\text{ V}, V_{GE} = 15\text{ V}$ | - | 460 | 690 | nC | | |
| Gate to emitter charge (turn-on) | Q_{ge} | | - | 160 | 250 | | | |
| Gate to collector charge (turn-on) | Q_{gc} | | - | 70 | 130 | | | |
| Turn-on switching loss | E_{on} | $I_C = 100\text{ A}, V_{CC} = 360\text{ V}, V_{GE} = 15\text{ V}, R_g = 5\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 25\text{ }^\circ\text{C}$ | - | 0.39 | - | mJ | | |
| Turn-off switching loss | E_{off} | | - | 1.10 | - | | | |
| Total switching loss | E_{tot} | | - | 1.49 | - | | | |
| Turn-on delay time | $t_{d(on)}$ | | Energy losses include tail and diode recovery. Diode used 60APH06 | - | 245 | - | ns | |
| Rise time | t_r | | | - | 53 | - | | |
| Turn-off delay time | $t_{d(off)}$ | | | - | 240 | - | | |
| Fall time | t_f | | | - | 63 | - | | |
| Turn-on switching loss | E_{on} | | | - | 0.52 | - | | mJ |
| Turn-off switching loss | E_{off} | | | - | 1.24 | - | | |
| Total switching loss | E_{tot} | | | - | 1.76 | - | | |
| Turn-on delay time | $t_{d(on)}$ | $I_C = 100\text{ A}, V_{CC} = 360\text{ V}, V_{GE} = 15\text{ V}, R_g = 5\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 125\text{ }^\circ\text{C}$ | - | 240 | - | ns | | |
| Rise time | t_r | | - | 54 | - | | | |
| Turn-off delay time | $t_{d(off)}$ | | - | 250 | - | | | |
| Fall time | t_f | | - | 80 | - | | | |
| Reverse bias safe operating area | RBSOA | $T_J = 150\text{ }^\circ\text{C}, I_C = 300\text{ A}, R_g = 22\text{ }\Omega, V_{GE} = 15\text{ V to } 0\text{ V}, V_{CC} = 400\text{ V}, V_P = 600\text{ V}, L = 500\text{ }\mu\text{H}$ | Fullsquare | | | | | |
| Diode reverse recovery time | t_{rr} | $I_F = 50\text{ A}, di_F/dt = 200\text{ A}/\mu\text{s}, V_R = 200\text{ V}$ | - | 95 | - | ns | | |
| Diode peak reverse current | I_{rr} | | - | 10 | - | A | | |
| Diode recovery charge | Q_{rr} | | - | 480 | - | nC | | |
| Diode reverse recovery time | t_{rr} | $I_F = 50\text{ A}, di_F/dt = 200\text{ A}/\mu\text{s}, V_R = 200\text{ V}, T_J = 125\text{ }^\circ\text{C}$ | - | 144 | - | ns | | |
| Diode peak reverse current | I_{rr} | | - | 16 | - | A | | |
| Diode recovery charge | Q_{rr} | | - | 1136 | - | nC | | |



| 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 | IGBT | R_{thJC} | - | - | 0.20 | °C/W |
| | Diode | | - | - | 0.33 | |
| 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 | - | - | 1.8 (15.9) | Nm (lbf.in) |
| Case style | | | SOT-227 | | | |

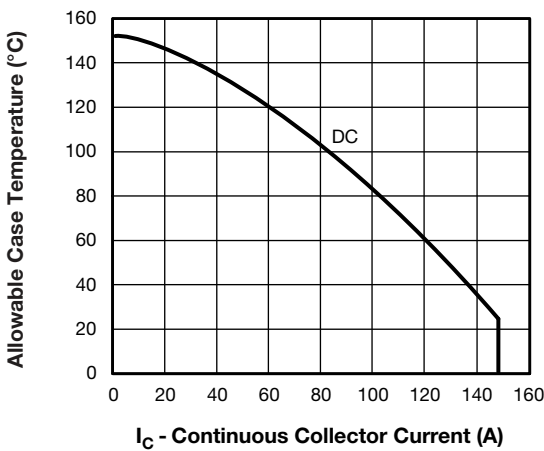


Fig. 1 - Maximum DC IGBT Collector Current vs. Case Temperature

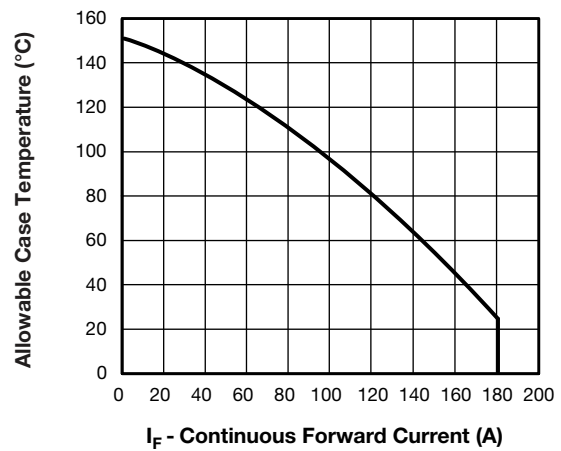


Fig. 3 - Maximum Allowable Forward Current vs. Case Temperature, Diode Leg

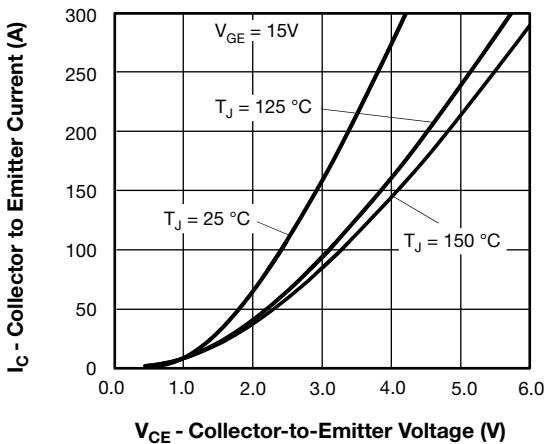


Fig. 2 - Typical Collector to Emitter Voltage (V)

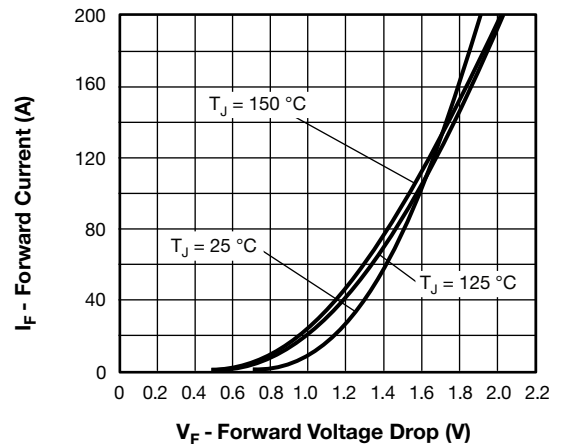


Fig. 4 - Typical Forward Voltage Drop Characteristics

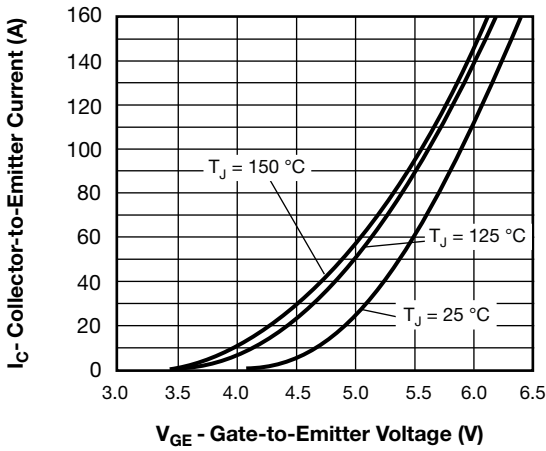


Fig. 5 - Typical IGBT Transfer Characteristics

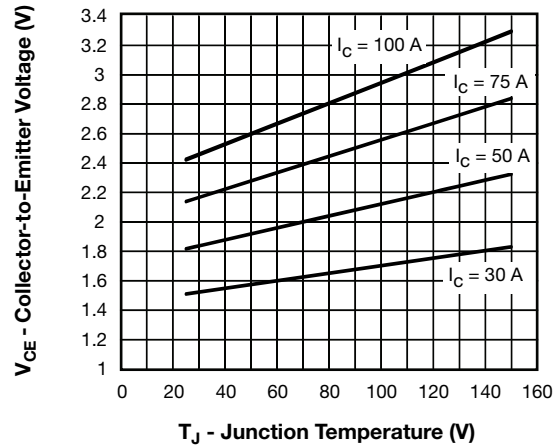


Fig. 8 - Typical IGBT Collector to Emitter Voltage vs. Junction Temperature, $V_{GE} = 15\text{ V}$

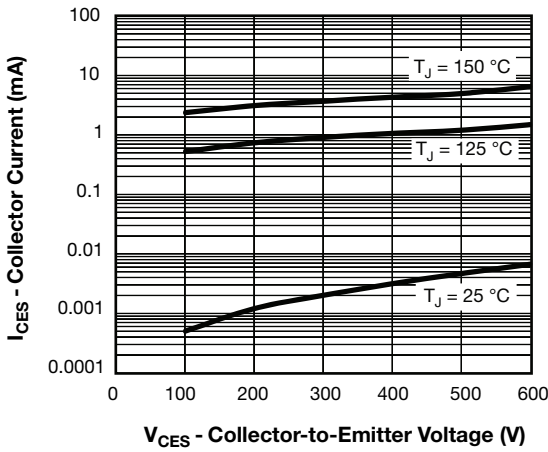


Fig. 6 - Typical IGBT Zero Gate Voltage Collector Current

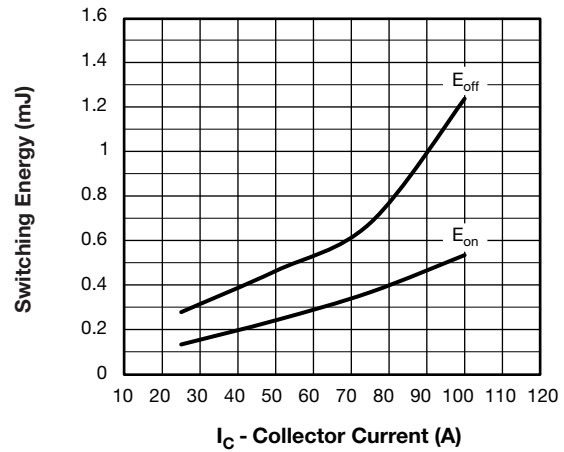


Fig. 9 - Typical IGBT Energy Losses vs. I_C
 $T_J = 125\text{ }^\circ\text{C}$, $L = 500\text{ }\mu\text{H}$, $V_{CC} = 360\text{ V}$,
 $R_g = 5\text{ }\Omega$, $V_{GE} = 15\text{ V}$, Diode used: 60APH06

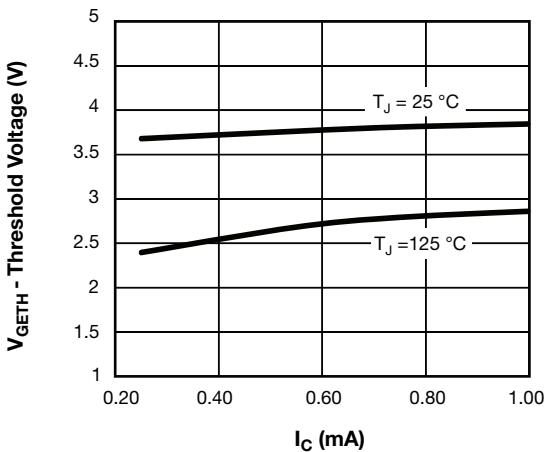


Fig. 7 - Typical IGBT Threshold Voltage

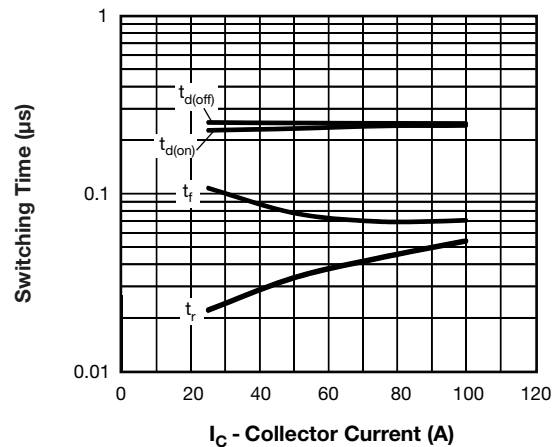


Fig. 10 - Typical IGBT Switching Time vs. I_C
 $T_J = 125\text{ }^\circ\text{C}$, $L = 500\text{ }\mu\text{H}$, $V_{CC} = 360\text{ V}$,
 $R_g = 5\text{ }\Omega$, $V_{GE} = 15\text{ V}$, Diode used: 60APH06

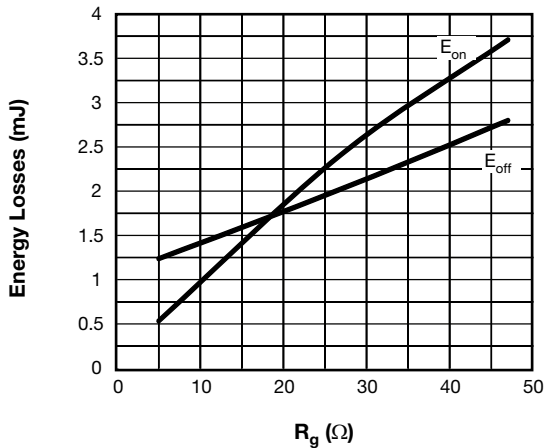


Fig. 11 - Typical IGBT Energy Loss vs. R_g
 $T_J = 125\text{ }^\circ\text{C}$, $I_C = 100\text{ A}$, $L = 500\text{ }\mu\text{H}$,
 $V_{CC} = 360\text{ V}$, $V_{GE} = 15\text{ V}$, Diode used: 60APH06

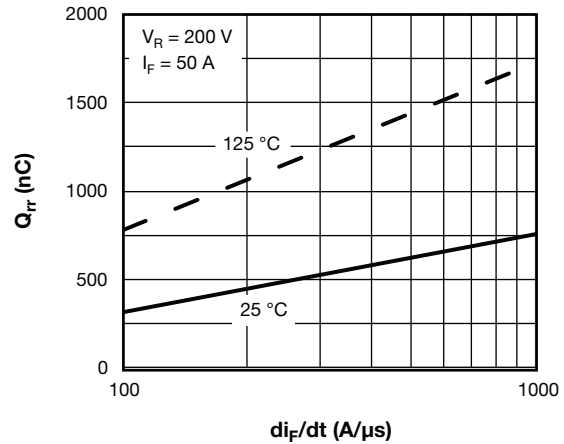


Fig. 14 - Typical Stored Charge vs. di_F/dt of Diode

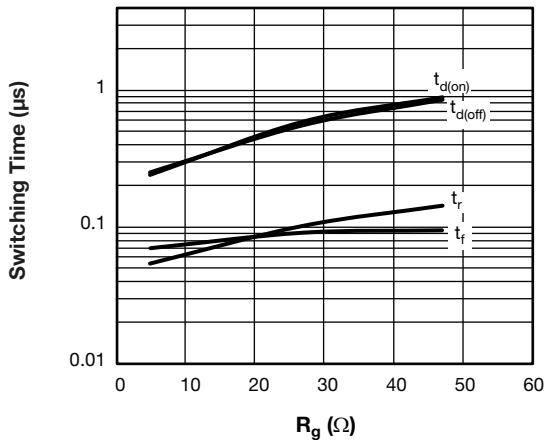


Fig. 12 - Typical IGBT Switching Time vs. R_g
 $T_J = 125\text{ }^\circ\text{C}$, $L = 500\text{ }\mu\text{H}$, $V_{CC} = 360\text{ V}$,
 $I_C = 100\text{ A}$, $V_{GE} = 15\text{ V}$, Diode used: 60APH06

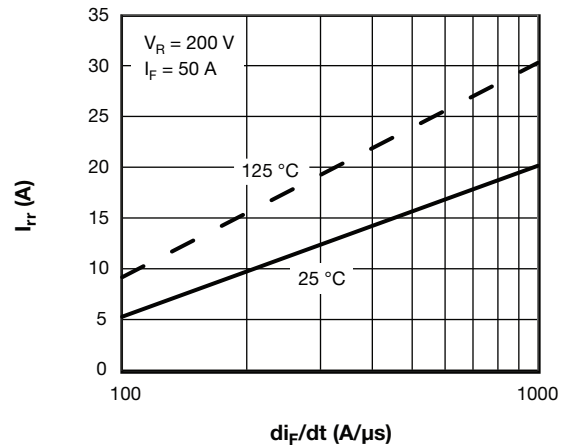


Fig. 15 - Typical Reverse Recovery Current vs. di_F/dt of Diode

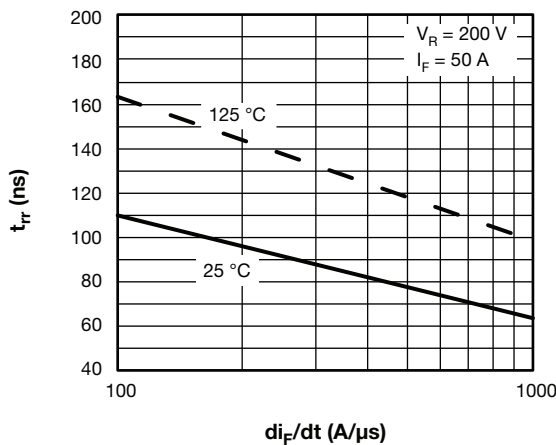


Fig. 13 - Typical Reverse Recovery Time vs. di_F/dt , of Diode

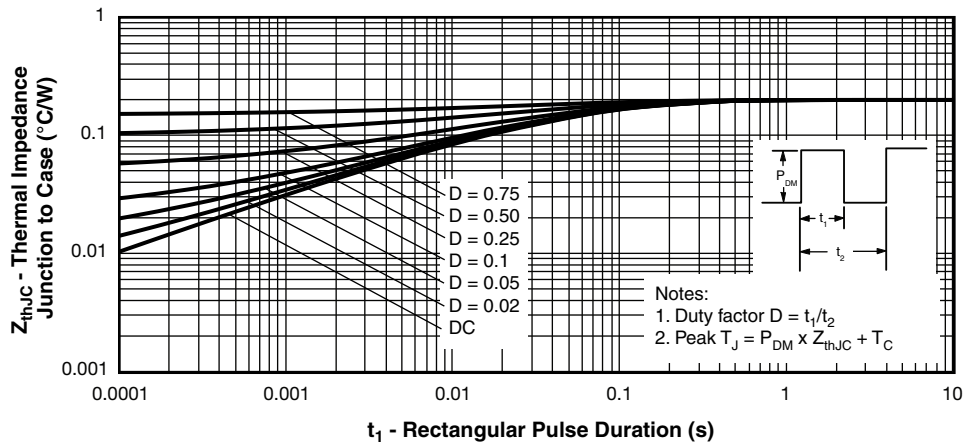


Fig. 16 - Maximum Thermal Impedance Z_{thJC} Characteristics, IGBT

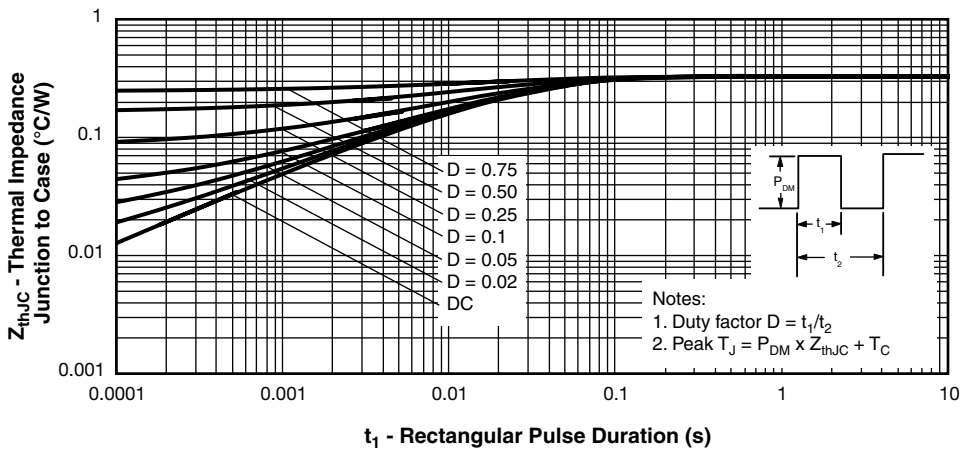


Fig. 17 - Maximum Thermal Impedance Z_{thJC} Characteristics, Diode

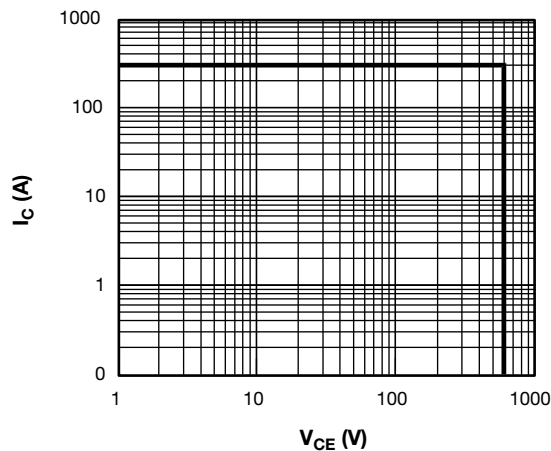
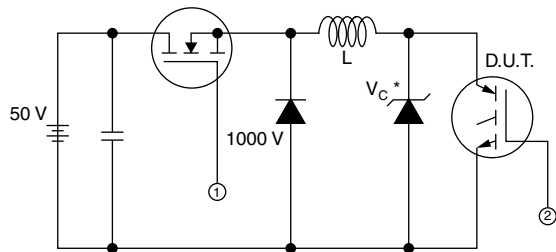
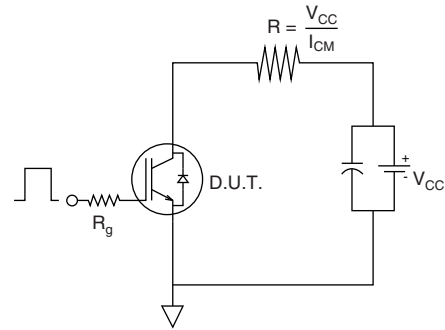


Fig. 18 - IGBT Reverse BIAS SOA, $T_J = 150\text{ }^\circ\text{C}$, $V_{GE} = 15\text{ V}$

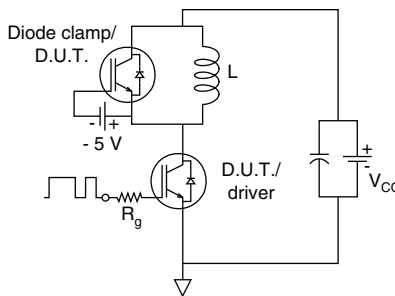


* Driver same type as D.U.T.; $V_C = 80\%$ of $V_{ce(max)}$
 * Note: Due to the 50 V power supply, pulse width and inductor will increase to obtain I_d

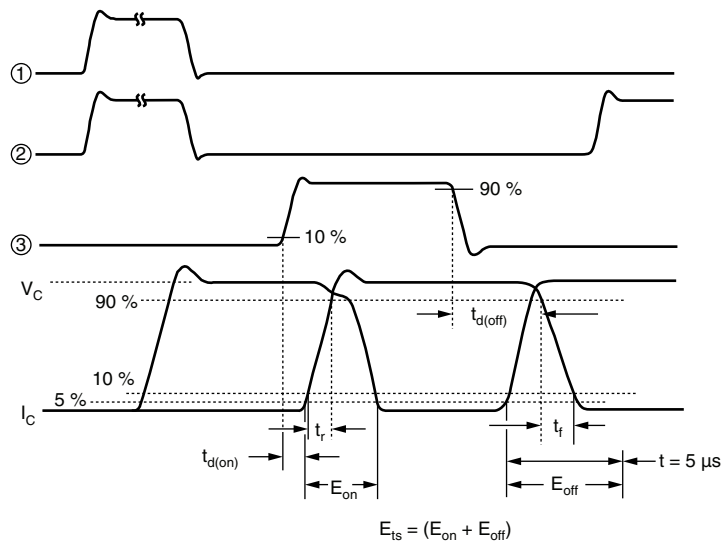
19a - Clamped Inductive Load Test Circuit



19b - Pulsed Collector Current Test Circuit



20a - Switching Loss Test Circuit



20b - Switching Loss Waveforms Test Circuit

ORDERING INFORMATION TABLE

| | | | | | | | | |
|-------------|------------|----------|----------|-----------|----------|----------|-----------|----------|
| Device code | VS- | G | B | 90 | D | A | 60 | U |
| | ① | ② | ③ | ④ | ⑤ | ⑥ | ⑦ | ⑧ |

- 1** - Vishay Semiconductors product
- 2** - Insulated gate bipolar transistor (IGBT)
- 3** - B = IGBT Gen 5
- 4** - Current rating (90 = 90 A)
- 5** - Circuit configuration (D = single switch with AP diode)
- 6** - Package indicator (A = SOT-227)
- 7** - Voltage rating (60 = 600 V)
- 8** - Speed/type (U = ultrafast IGBT)

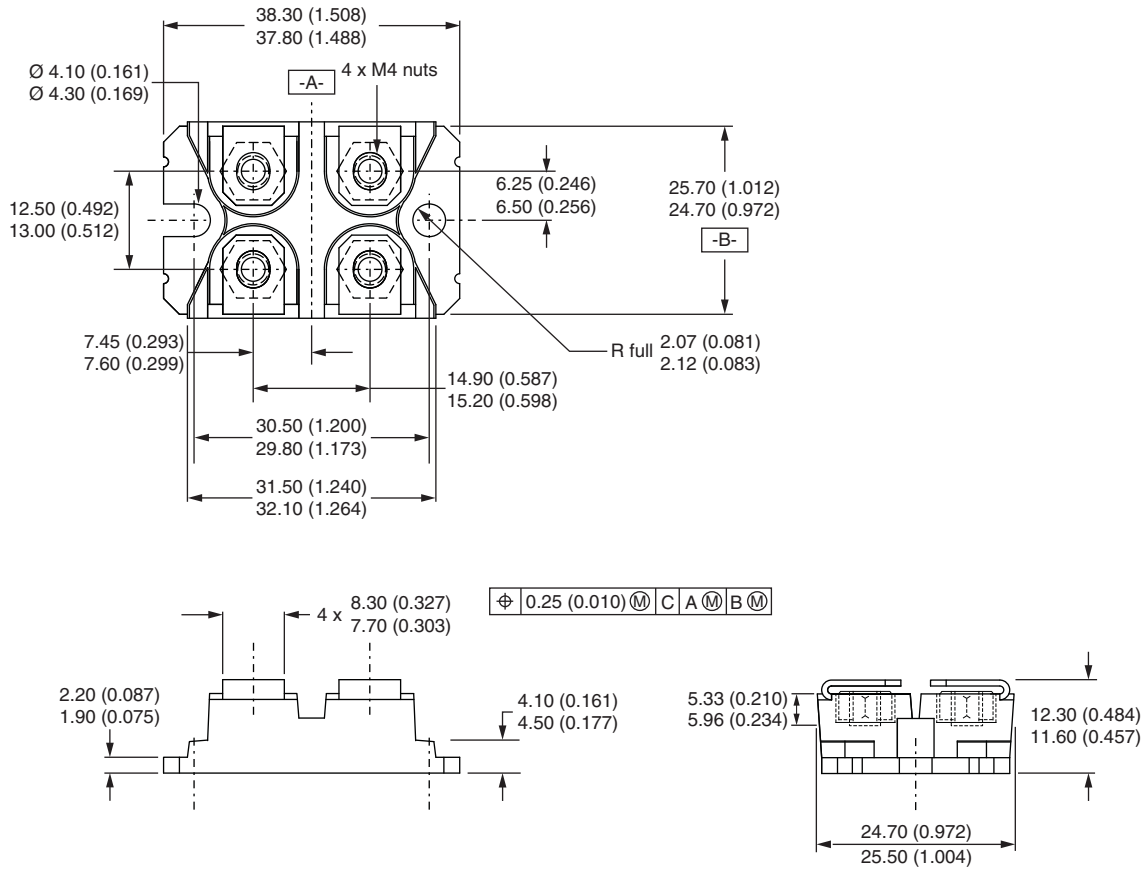
| CIRCUIT CONFIGURATION | | |
|-----------------------------|----------------------------|-----------------|
| CIRCUIT | CIRCUIT CONFIGURATION CODE | CIRCUIT DRAWING |
| Single switch with AP diode | D | |

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



SOT-227 Generation 2

DIMENSIONS in millimeters (inches)



Note

- Controlling dimension: millimeter



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