# Insulated Gate Bipolar Transistor (Ultrafast IGBT), 90 A



SOT-227

## FEATURES

- NPT Gen 5 IGBT technology
- Square RBSOA
- HEXFRED® low $Q_{rr}$, low switching energy
- Positive $V_{CE(on)}$ temperature coefficient
- 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

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

| PRODUCT SUMMARY | |
|---|---|
| $V_{CES}$ | 1200 V |
| $I_C$ DC | 90 A at 90 °C |
| $V_{CE(on)}$ typical at 75 A, 25 °C | 3.3 V |
| Speed | 8 kHz to 30 kHz |
| Package | SOT-227 |
| Circuit | Single switch diode |

| ABSOLUTE MAXIMUM RATINGS | | | | |
|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS | MAX. | UNITS |
| Collector to emitter voltage | $V_{CES}$ | | 1200 | V |
| Continuous collector current | $I_C$ (1) | $T_C$ = 25 °C | 149 | A |
| | | $T_C$ = 90 °C | 90 | |
| Pulsed collector current | $I_{CM}$ | | 200 | |
| Clamped inductive load current | $I_{LM}$ | | 200 | |
| Diode continuous forward current | $I_F$ | $T_C$ = 25 °C | 76 | |
| | | $T_C$ = 90 °C | 46 | |
| Gate to emitter voltage | $V_{GE}$ | | ± 20 | V |
| Power dissipation, IGBT | $P_D$ | $T_C$ = 25 °C | 862 | W |
| | | $T_C$ = 90 °C | 414 | |
| Power dissipation, diode | $P_D$ | $T_C$ = 25 °C | 357 | |
| | | $T_C$ = 90 °C | 171 | |
| Isolation voltage | $V_{ISOL}$ | Any terminal to case, t = 1 min | 2500 | V |

**Note**

(1) Maximum collector current admitted is 100 A, to do exceed the maximum temperature of terminals



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| 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 | 1200 | - | - | V |
| Collector to emitter voltage | $V_{CE(on)}$ | $V_{GE}$ = 15 V, $I_C$ = 75 A | - | 3.3 | 3.8 | V |
| | | $V_{GE}$ = 15 V, $I_C$ = 75 A, $T_J$ = 125 °C | - | 3.6 | 3.9 | |
| | | $V_{GE}$ = 15 V, $I_C$ = 75 A, $T_J$ = 150 °C | - | 3.7 | - | |
| Gate threshold voltage | $V_{GE(th)}$ | $V_{CE}$ = $V_{GE}$, $I_C$ = 250 µA | 4 | 5 | 6 | |
| | | $V_{CE}$ = $V_{GE}$, $I_C$ = 250 µA, $T_J$ = 125 °C | - | 3.2 | - | |
| Temperature coefficient of threshold voltage | $V_{GE(th)}/\Delta T_J$ | $V_{CE}$ = $V_{GE}$, $I_C$ = 1 mA (25 °C to 125 °C) | - | -12 | - | mV/°C |
| Collector to emitter leakage current | $I_{CES}$ | $V_{GE}$ = 0 V, $V_{CE}$ = 1200 V | - | 7 | 250 | µA |
| | | $V_{GE}$ = 0 V, $V_{CE}$ = 1200 V, $T_J$ = 125 °C | - | 1.4 | 10 | mA |
| | | $V_{GE}$ = 0 V, $V_{CE}$ = 1200 V, $T_J$ = 150 °C | - | 6.5 | 20 | |
| Forward voltage drop, diode | $V_{FM}$ | $V_{GE}$ = 0 V, $I_F$ = 75 A | - | 3.4 | 5.0 | V |
| | | $V_{GE}$ = 0 V, $I_F$ = 75 A, $T_J$ = 125 °C | - | 3.2 | 5.2 | |
| | | $V_{GE}$ = 0 V, $I_F$ = 75 A, $T_J$ = 150 °C | - | 3.05 | - | |
| Gate to emitter leakage current | $I_{GES}$ | $V_{GE}$ = ± 20 V | - | - | ± 250 | nA |

| SWITCHING CHARACTERISTICS ($T_J$ = 25 °C unless otherwise specified) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| Total gate charge (turn-on) | $Q_g$ | $I_C$ = 50 A, $V_{CC}$ = 600 V, $V_{GE}$ = 15 V | | - | 690 | - | nC |
| Gate to emitter charge (turn-on) | $Q_{ge}$ | | | - | 65 | - | |
| Gate to collector charge (turn-on) | $Q_{gc}$ | | | - | 250 | - | |
| Turn-on switching loss | $E_{on}$ | $I_C$ = 75 A, $V_{CC}$ = 600 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 HFA16PB120 | - | 1.2 | - | mJ |
| Turn-off switching loss | $E_{off}$ | | | - | 2.1 | - | |
| Total switching loss | $E_{tot}$ | | | - | 3.3 | - | |
| Turn-on delay time | $t_{d(on)}$ | | | - | 250 | - | ns |
| Rise time | $t_r$ | | | - | 38 | - | |
| Turn-off delay time | $t_{d(off)}$ | | | - | 280 | - | |
| Fall time | $t_f$ | | | - | 90 | - | |
| Turn-on switching loss | $E_{on}$ | $I_C$ = 75 A, $V_{CC}$ = 600 V, $V_{GE}$ = 15 V, $R_g$ = 5 Ω, L = 500 µH, $T_J$ = 125 °C | | - | 1.7 | - | mJ |
| Turn-off switching loss | $E_{off}$ | | | - | 4.08 | - | |
| Total switching loss | $E_{tot}$ | | | - | 5.78 | - | |
| Turn-on delay time | $t_{d(on)}$ | | | - | 245 | - | ns |
| Rise time | $t_r$ | | | - | 48 | - | |
| Turn-off delay time | $t_{d(off)}$ | | | - | 280 | - | |
| Fall time | $t_f$ | | | - | 140 | - | |
| Reverse bias safe operating area | RBSOA | $T_J$ = 150 °C, $I_C$ = 200 A, $R_g$ = 22 Ω, $V_{GE}$ = 15 V to 0 V, $V_{CC}$ = 900 V, $V_P$ = 1200 V, L = 500 µH | | Fullsquare | | | |
| Diode reverse recovery time | $t_{rr}$ | $I_F$ = 50 A, $dI_F/dt$ = 200 A/µs, $V_R$ = 200 V | | - | 140 | - | ns |
| Diode peak reverse current | $I_{rr}$ | | | - | 13 | - | A |
| Diode recovery charge | $Q_{rr}$ | | | - | 860 | - | nC |
| Diode reverse recovery time | $t_{rr}$ | $I_F$ = 50 A, $dI_F/dt$ = 200 A/µs, $V_R$ = 200 V, $T_J$ = 125 °C | | - | 210 | - | ns |
| Diode peak reverse current | $I_{rr}$ | | | - | 19 | - | A |
| Diode recovery charge | $Q_{rr}$ | | | - | 1880 | - | nC |


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| 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 | $R_{thJC}$ | | - | - | 0.145 | °C/W |
| | Diode | | | - | - | 0.35 | |
| 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 | | | | | |

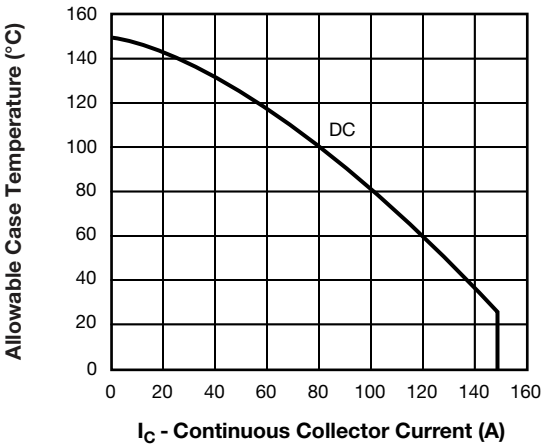



Fig. 1 - Maximum DC IGBT Collector Current vs. Case Temperature

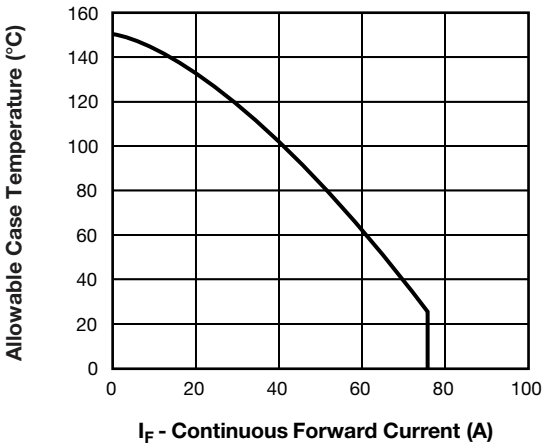



Fig. 3 - Allowable Forward Current vs. Case Temperature Diode Leg

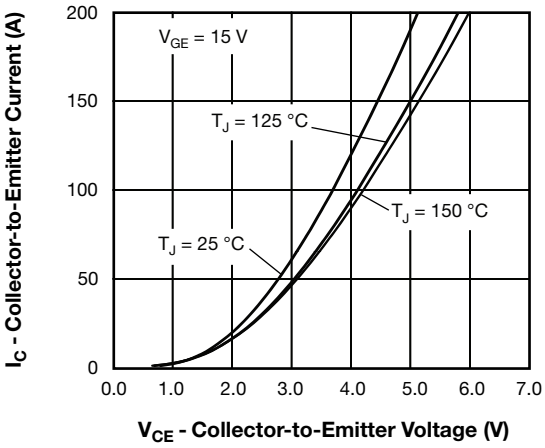



Fig. 2 - Typical Collector to Emitter Current Output Characteristics of IGBT

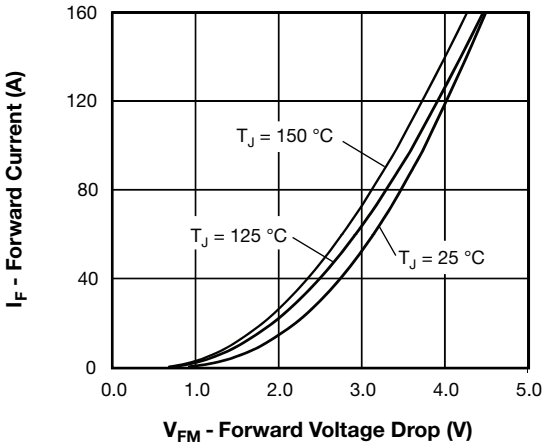



Fig. 4 - Typical Diode Forward Voltage Drop Characteristics


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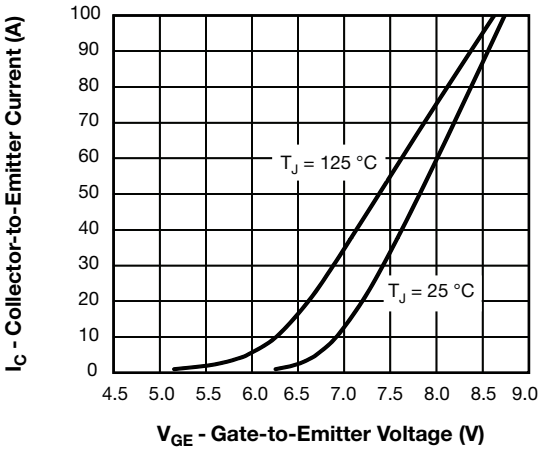



Fig. 5 - Typical IGBT Transfer Characteristics

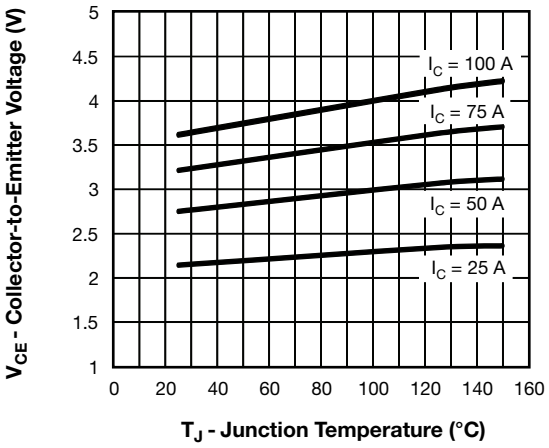



Fig. 8 - Typical IGBT Collector to Emitter Voltage vs. Junction Temperature, $V_{GE}$ = 15 V

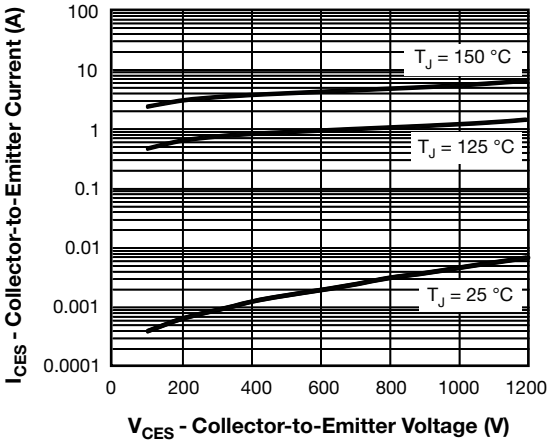



Fig. 6 - Typical IGBT Zero Gate Voltage Collector Current

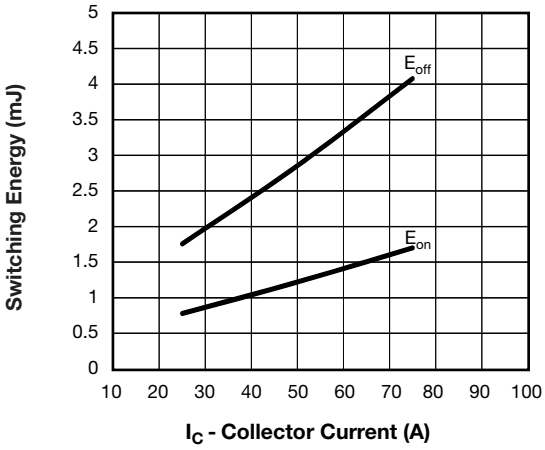



Fig. 9 - Typical IGBT Energy Losses vs. $I_C$
$T_J$ = 125 °C, L = 500 µH, $V_{CC}$ = 600 V,
$R_g$ = 5 Ω, $V_{GE}$ = 15 V, Diode used HFA16PB120

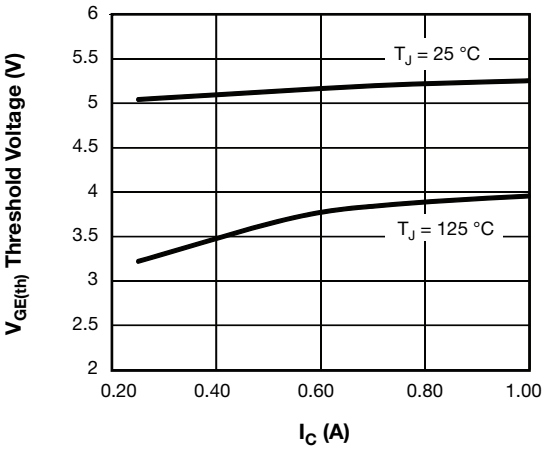



Fig. 7 - Typical IGBT Threshold Voltage

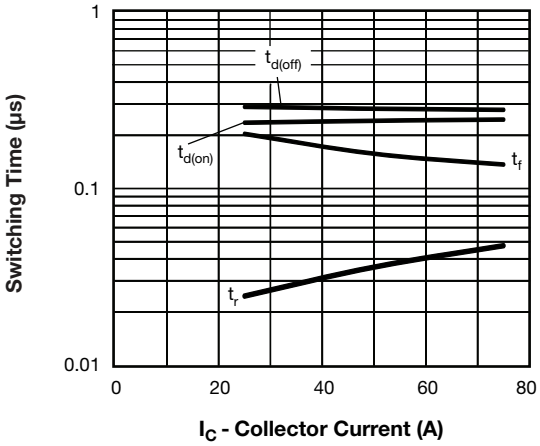



Fig. 10 - Typical IGBT Switching Time vs. $I_C$
$T_J$ = 125 °C, L = 500 µH, $V_{CC}$ = 600 V,
$R_g$ = 5 Ω, $V_{GE}$ = 15 V, Diode used HFA16PB120


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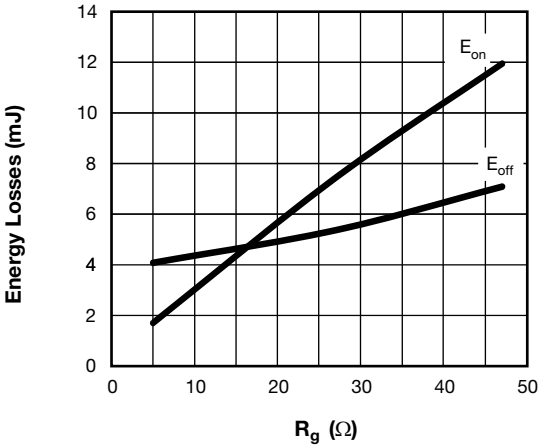



Fig. 11 - Typical IGBT Energy Loss vs. $R_g$,
$T_J$ = 125 °C, $I_C$ = 75 A, L = 500 µH,
$V_{CC}$ = 600 V, $V_{GE}$ = 15 V, Diode used HFA16PB120

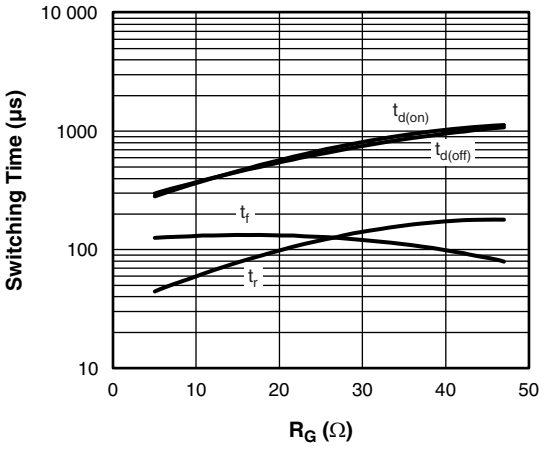



Fig. 12 - Typical IGBT Switching Time vs. $R_g$
$T_J$ = 125 °C, L = 500 µH, $V_{CC}$ = 600 V,
$R_g$ = 5 Ω, $V_{GE}$ = 15 V

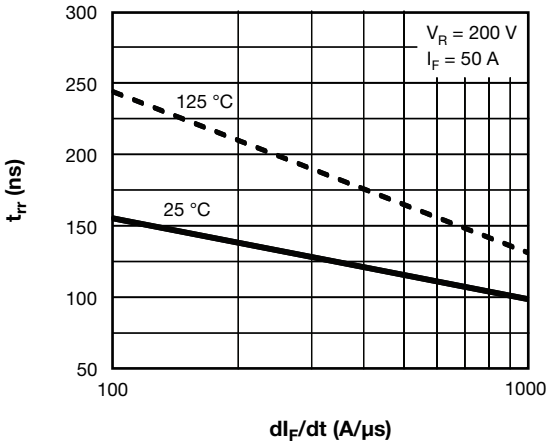



Fig. 13 - Typical $t_{rr}$ Diode vs. $dI_F/dt$
$V_{RR}$ = 200 V, $I_F$ = 50 A

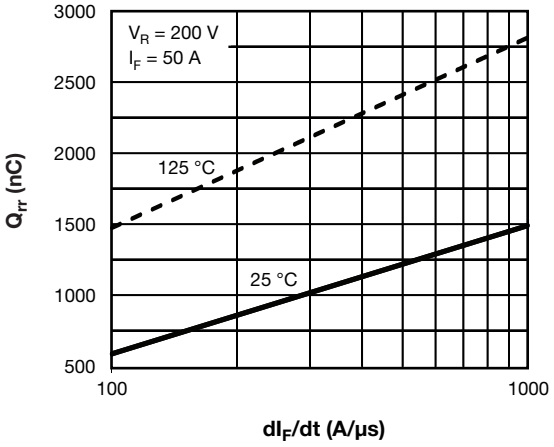



Fig. 14 - Stored Charge vs. $dI_F/dt$ of Diode

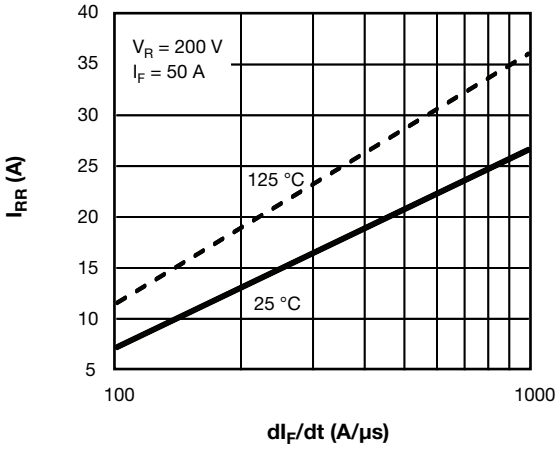



Fig. 15 - Typical Reverse Recovery Current vs. $dI_F/dt$ of Diode


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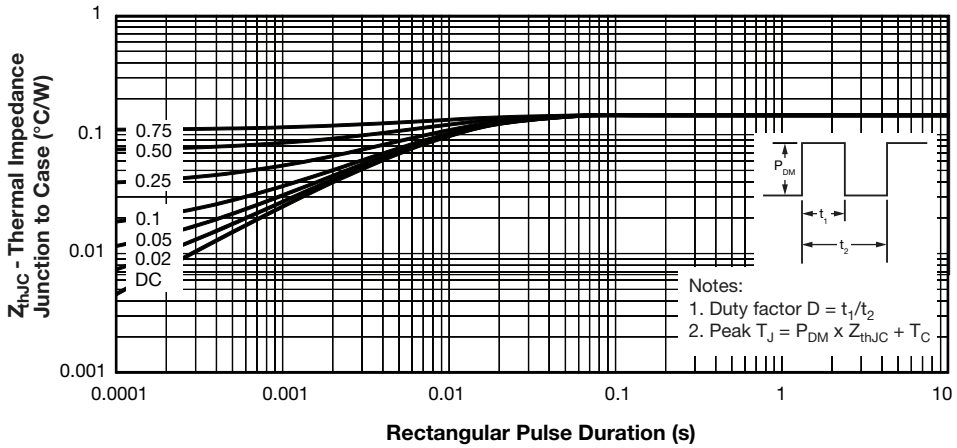



Fig. 16 - Maximum Thermal Impedance $Z_{thJC}$ Characteristics (IGBT)

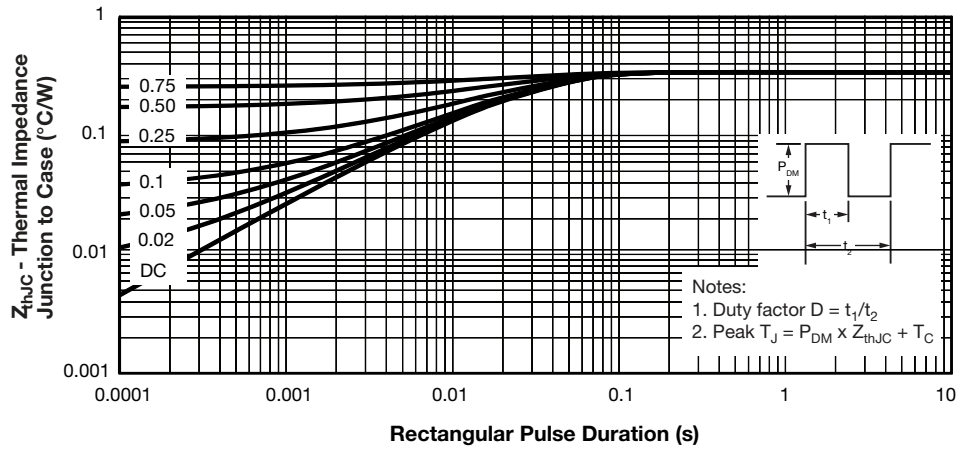



Fig. 17 - Maximum Thermal Impedance $Z_{thJC}$ Characteristics (Diode)

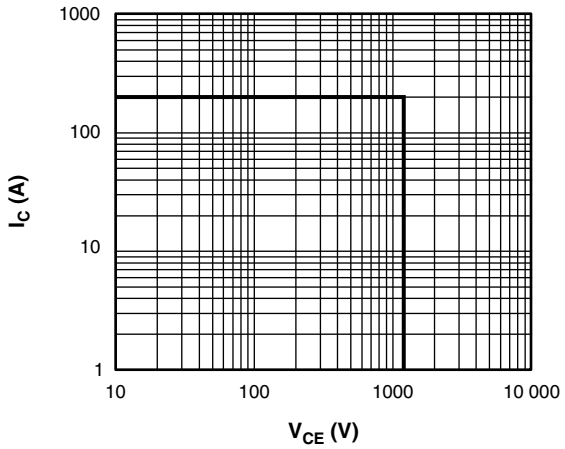
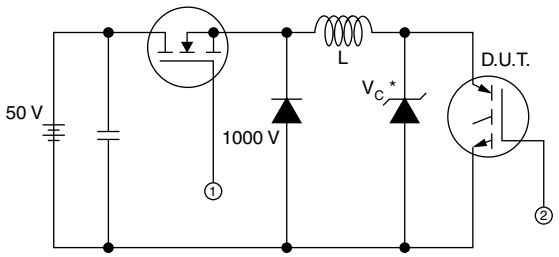



Fig. 18 - IGBT Reverse Bias SOA, TJ = 150 °C, $V_{GE}$ = 15 V,


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* 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 Id

Fig. 19a - Clamped Inductive Load Test Circuit

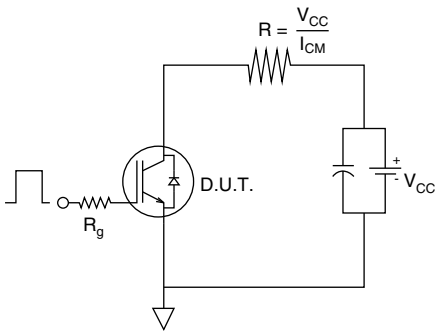



Fig. 19b - Pulsed Collector Current Test Circuit

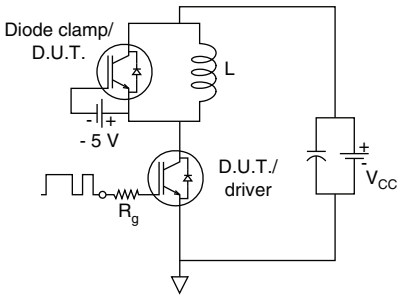
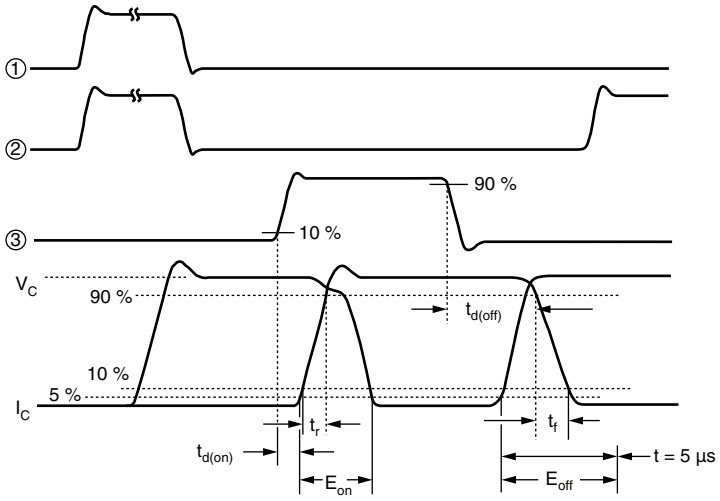



Fig. 20a - Switching Loss Test Circuit




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

Fig. 20b - Switching Loss Waveforms Test Circuit


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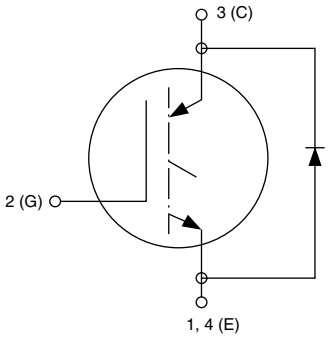
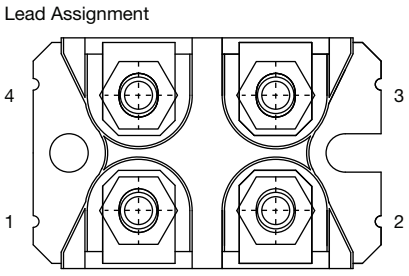
## ORDERING INFORMATION TABLE

Device code

| VS- | G | B | 90 | D | A | 120 | U |
|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

1 - Vishay Semiconductors product
2 - Insulated Gate Bipolar Transistor (IGBT)
3 - B = IGBT Generation 5
4 - Current rating (90 = 90 A)
5 - Circuit configuration (D = Single switch with antiparallel diode)
6 - Package indicator (A = SOT-227)
7 - Voltage rating (120 = 1200 V)
8 - Speed/type (U = Ultrafast IGBT)

## CIRCUIT CONFIGURATION

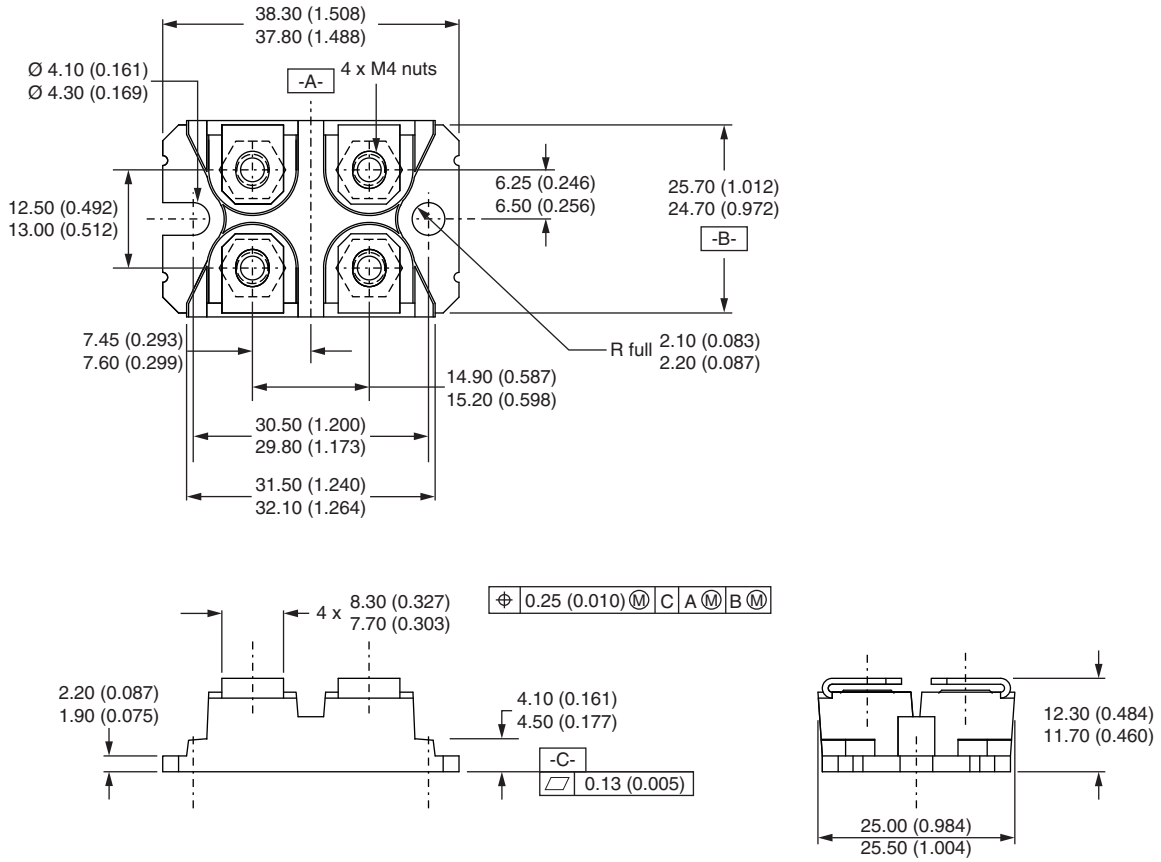
| CIRCUIT | CIRCUIT CONFIGURATION CODE | CIRCUIT DRAWING |
|---|---|---|
| Single switch with antiparallel diode | D |     |

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


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# SOT-227 Generation II

**DIMENSIONS** in millimeters (inches)




**Note**

- Controlling dimension: millimeter



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