


“High Side Chopper” IGBT SOT-227, 70 A



SOT-227

FEATURES

- Trench IGBT technology
- Higher switching frequency up to 150 kHz
- Square RBSOA
- Low $V_{CE(on)}$
- FRED Pt[®] hyperfast rectifier
- 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

PRIMARY CHARACTERISTICS

| | |
|-------------------------------------|-------------------|
| V_{CES} | 600 V |
| I_C DC | 70 A at 57 °C |
| $V_{CE(on)}$ typical at 70 A, 25 °C | 1.79 V |
| I_F DC | 70 A at 86 °C |
| Package | SOT-227 |
| Circuit configuration | High side chopper |

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 | $T_C = 25\text{ °C}$ | 81 | A |
| | | $T_C = 80\text{ °C}$ | 61 | |
| Pulsed collector current | I_{CM} | | 170 | |
| Clamped inductive load current | I_{LM} | | 250 | |
| Diode continuous forward current | I_F | $T_C = 25\text{ °C}$ | 113 | |
| | | $T_C = 80\text{ °C}$ | 75 | |
| Single pulse forward current | I_{FSM} | 10 ms sine or 6 ms rectangular pulse, $T_J = 25\text{ °C}$ | 390 | |
| Gate to emitter voltage | V_{GE} | | ± 20 | V |
| Power dissipation, IGBT | P_D | $T_C = 25\text{ °C}$ | 231 | W |
| | | $T_C = 80\text{ °C}$ | 146 | |
| Power dissipation, diode | P_D | $T_C = 25\text{ °C}$ | 330 | |
| | | $T_C = 80\text{ °C}$ | 179 | |
| RMS 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 | $V_{BR(CES)}$ | $V_{GE} = 0\text{ V}, I_C = 0.4\text{ mA}$ | 600 | - | - | V |
| Collector to emitter voltage | $V_{CE(on)}$ | $V_{GE} = 15\text{ V}, I_C = 35\text{ A}$ | - | 1.44 | - | |
| | | $V_{GE} = 15\text{ V}, I_C = 70\text{ A}$ | - | 1.79 | 2.26 | |
| | | $V_{GE} = 15\text{ V}, I_C = 35\text{ A}, T_J = 125\text{ }^\circ\text{C}$ | - | 1.60 | - | |
| | | $V_{GE} = 15\text{ V}, I_C = 70\text{ A}, T_J = 125\text{ }^\circ\text{C}$ | - | 2.02 | - | |
| Gate threshold voltage | $V_{GE(th)}$ | $V_{CE} = V_{GE}, I_C = 0.6\text{ mA}$ | 2.9 | 3.9 | 5.1 | |
| Temperature coefficient of threshold voltage | $\Delta V_{GE(th)}/\Delta T_J$ | $V_{CE} = V_{GE}, I_C = 0.6\text{ mA}$ (25 °C to 125 °C) | - | -10.0 | - | mV/°C |
| Collector to emitter leakage current | I_{CES} | $V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}$ | - | 0.2 | 100 | μA |
| | | $V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}, T_J = 125\text{ }^\circ\text{C}$ | - | 19 | - | |
| Diode reverse breakdown voltage | V_{BR} | $I_R = 1\text{ mA}$ | 600 | - | - | V |
| Diode forward voltage drop | V_{FM} | $I_F = 35\text{ A}, V_{GE} = 0\text{ V}$ | - | 1.67 | 2.33 | V |
| | | $I_F = 70\text{ A}, V_{GE} = 0\text{ V}$ | - | 1.96 | - | |
| | | $I_F = 35\text{ A}, V_{GE} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$ | - | 1.23 | - | |
| | | $I_F = 70\text{ A}, V_{GE} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$ | - | 1.55 | - | |
| Diode reverse leakage current | I_{RM} | $V_R = 600\text{ V}$ | - | 0.1 | 50 | μA |
| | | $T_J = 125\text{ }^\circ\text{C}, V_R = 600\text{ V}$ | - | 0.04 | - | mA |
| 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 | $I_C = 70\text{ A}, V_{CC} = 520\text{ V}, V_{GE} = 15\text{ V}$ | - | 193 | - | nC | |
| Gate to emitter charge (turn-on) | Q_{ge} | | - | 29 | - | | |
| Gate to collector charge (turn-on) | Q_{gc} | | - | 56 | - | | |
| Turn-on switching loss | E_{on} | $I_C = 35\text{ A}, V_{CC} = 300\text{ V}, V_{GE} = 15\text{ V}, R_g = 4.7\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 25\text{ }^\circ\text{C}$ | - | 0.35 | - | mJ | |
| Turn-off switching loss | E_{off} | | - | 0.15 | - | | |
| Total switching loss | E_{tot} | | - | 0.5 | - | | |
| Turn-on switching loss | E_{on} | $I_C = 70\text{ A}, V_{CC} = 300\text{ V}, V_{GE} = 15\text{ V}, R_g = 4.7\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 25\text{ }^\circ\text{C}$ | - | 0.8 | - | | |
| Turn-off switching loss | E_{off} | | - | 0.34 | - | | |
| Total switching loss | E_{tot} | | - | 1.14 | - | | |
| Turn-on switching loss | E_{on} | $I_C = 35\text{ A}, V_{CC} = 300\text{ V}, V_{GE} = 15\text{ V}, R_g = 4.7\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 125\text{ }^\circ\text{C}$ | - | 0.56 | - | | ns |
| Turn-off switching loss | E_{off} | | - | 0.25 | - | | |
| Total switching loss | E_{tot} | | - | 0.81 | - | | |
| Turn-on delay time | $t_{d(on)}$ | Energy losses include tail and diode recovery | - | 24 | - | | |
| Rise time | t_r | | - | 9 | - | | |
| Turn-off delay time | $t_{d(off)}$ | | - | 105 | - | | |
| Fall time | t_f | - | 31 | - | | | |
| Turn-on switching loss | E_{on} | $I_C = 70\text{ A}, V_{CC} = 300\text{ V}, V_{GE} = 15\text{ V}, R_g = 4.7\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 125\text{ }^\circ\text{C}$ | - | 0.95 | - | mJ | |
| Turn-off switching loss | E_{off} | | - | 0.53 | - | | |
| Total switching loss | E_{tot} | | - | 1.48 | - | | |
| Turn-on delay time | $t_{d(on)}$ | Energy losses include tail and diode recovery | - | 26 | - | ns | |
| Rise time | t_r | | - | 23 | - | | |
| Turn-off delay time | $t_{d(off)}$ | | - | 101 | - | | |
| Fall time | t_f | - | 24 | - | | | |
| Reverse bias safe operating area | RBSOA | $T_J = 175\text{ }^\circ\text{C}, I_C = 250\text{ A}, R_g = 4.7\text{ }\Omega, V_{GE} = 15\text{ V to } 0\text{ V}, V_{CC} = 300\text{ V}, V_P = 600\text{ V}$ | Fullsquare | | | | |
| Diode reverse recovery time | t_{rr} | $I_F = 50\text{ A}, dI_F/dt = 200\text{ A}/\mu\text{s}, V_R = 200\text{ V}$ | - | 64 | - | ns | |
| Diode peak reverse current | I_{rr} | | - | 4.5 | - | A | |
| Diode recovery charge | Q_{rr} | | - | 144 | - | nC | |
| Diode reverse recovery time | t_{rr} | $I_F = 50\text{ A}, dI_F/dt = 200\text{ A}/\mu\text{s}, V_R = 200\text{ V}, T_J = 125\text{ }^\circ\text{C}$ | - | 136 | - | ns | |
| Diode peak reverse current | I_{rr} | | - | 12 | - | A | |
| Diode recovery charge | Q_{rr} | | - | 807 | - | nC | |



| THERMAL AND MECHANICAL SPECIFICATIONS | | | | | | |
|--|----------------|-----------------------|------|------|------------|-------------|
| PARAMETER | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNITS |
| Junction and storage temperature range | T_J, T_{Stg} | | -40 | - | 175 | °C |
| Junction to case | IGBT | | - | - | 0.65 | °C/W |
| | Diode | | - | - | 0.53 | |
| 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 | | | | |

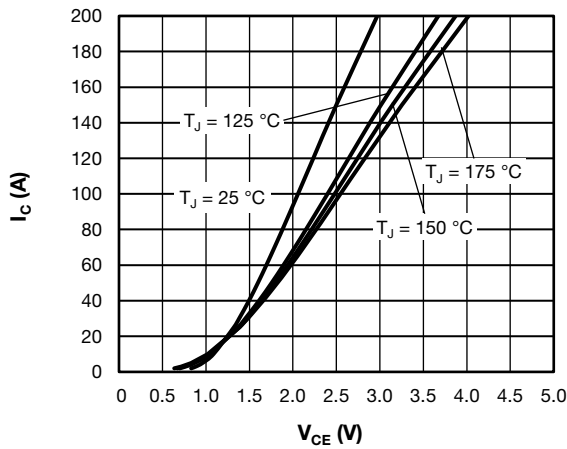


Fig. 1 - Typical Trench IGBT Output Characteristics, $V_{GE} = 15\text{ V}$

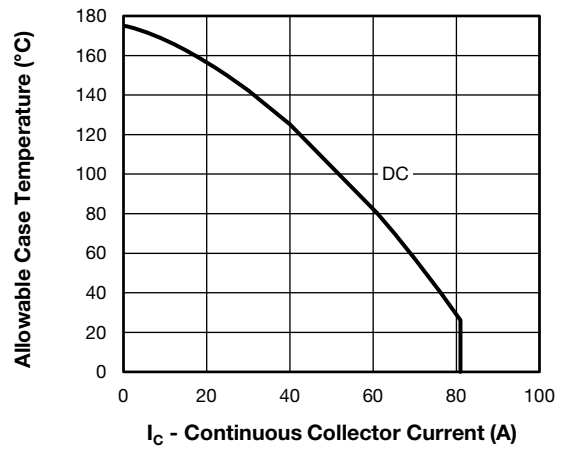


Fig. 3 - Maximum Trench IGBT Continuous Collector Current vs. Case Temperature

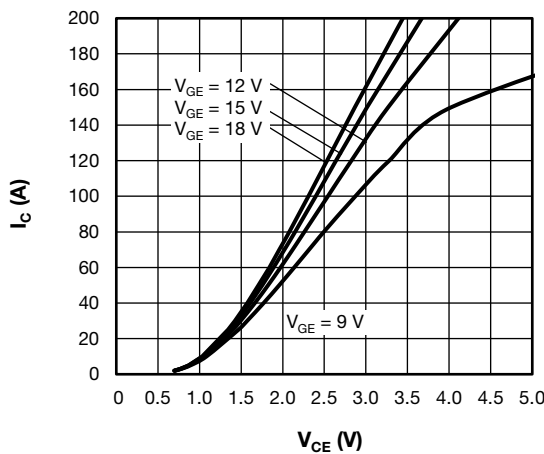


Fig. 2 - Typical Trench IGBT Output Characteristics, $T_J = 125\text{ °C}$

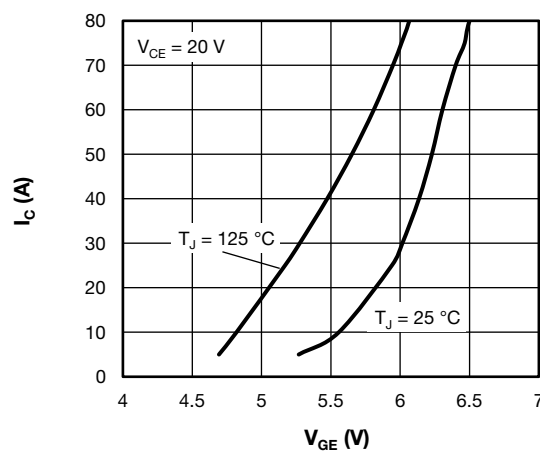


Fig. 4 - Typical Trench IGBT Transfer Characteristics

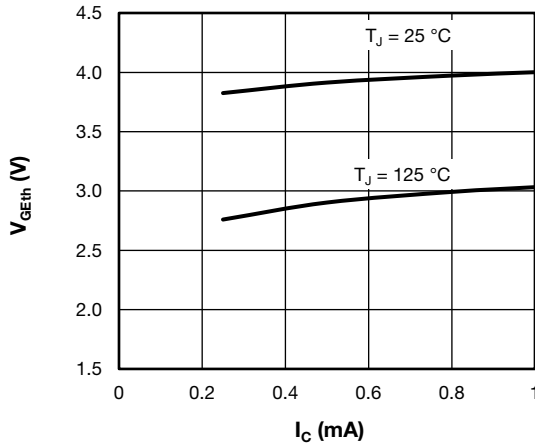


Fig. 5 - Typical Trench IGBT Gate Threshold Voltage

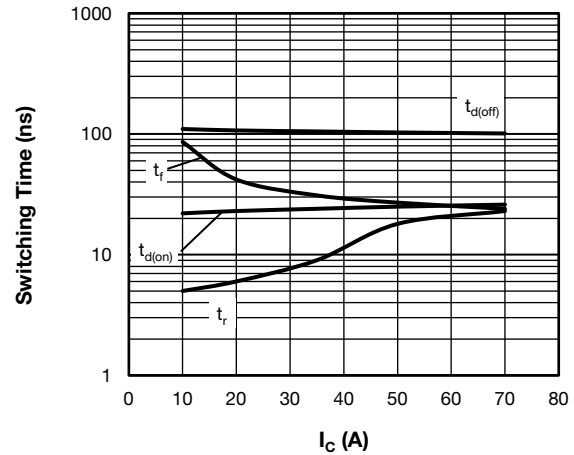


Fig. 8 - Typical Trench IGBT Switching Time vs. I_c (with Antiparallel Diode)

$T_J = 125\text{ °C}$, $V_{CC} = 300\text{ V}$, $R_g = 4.7\ \Omega$, $V_{GE} = +15\text{ V}/-15\text{ V}$, $L = 500\ \mu\text{H}$

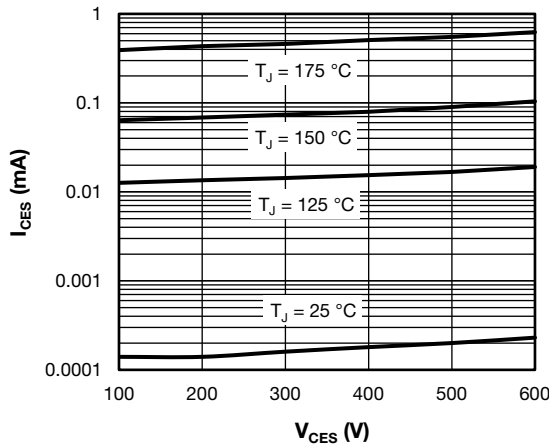


Fig. 6 - Typical Trench IGBT Zero Gate Voltage Collector Current

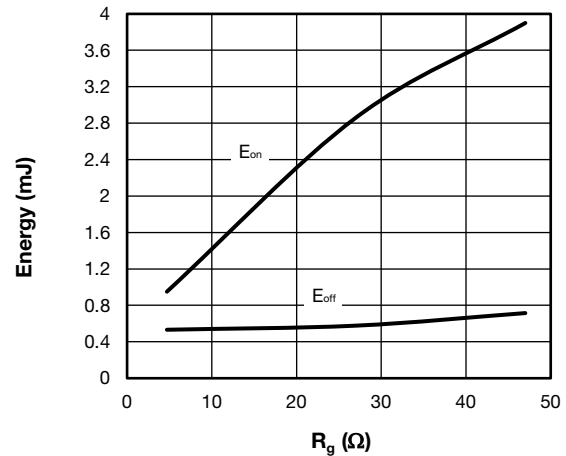


Fig. 9 - Typical Trench IGBT Energy Loss vs. R_g (with Antiparallel Diode)

$T_J = 125\text{ °C}$, $V_{CC} = 300\text{ V}$, $I_c = 70\text{ A}$, $V_{GE} = +15\text{ V}/-15\text{ V}$, $L = 500\ \mu\text{H}$

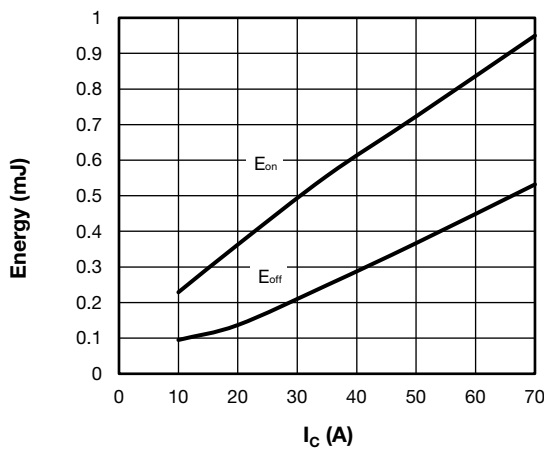


Fig. 7 - Typical Trench IGBT Energy Loss vs. I_c (with Antiparallel Diode)

$T_J = 125\text{ °C}$, $V_{CC} = 300\text{ V}$, $R_g = 4.7\ \Omega$, $V_{GE} = +15\text{ V}/-15\text{ V}$, $L = 500\ \mu\text{H}$

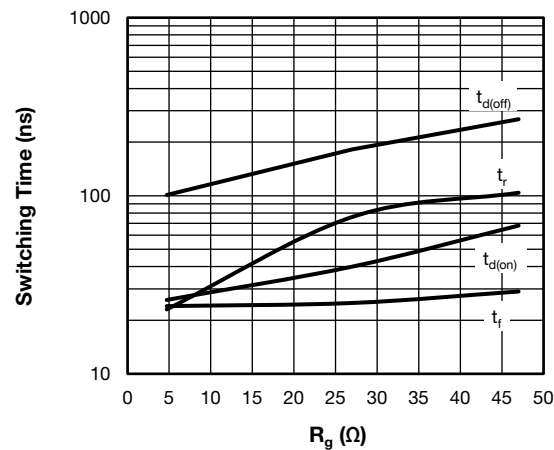


Fig. 10 - Typical Trench IGBT Switching Time vs. R_g (with Antiparallel Diode)

$T_J = 125\text{ °C}$, $V_{CC} = 300\text{ V}$, $I_c = 70\text{ A}$, $V_{GE} = +15\text{ V}/-15\text{ V}$, $L = 500\ \mu\text{H}$

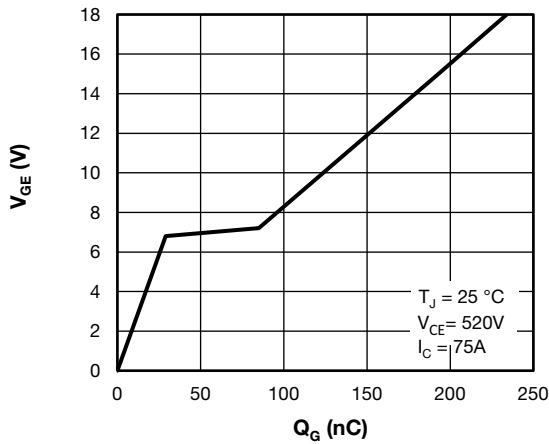


Fig. 11 - Typical Trench IGBT Gate Charge vs. Gate to Emitter Voltage

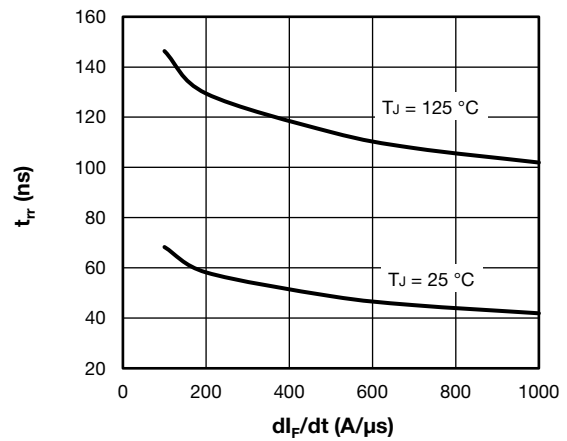


Fig. 14 - Typical Diode Reverse Recovery Time vs. dI_F/dt
 $I_F = 50 \text{ A}$, $V_{CC} = 200 \text{ V}$

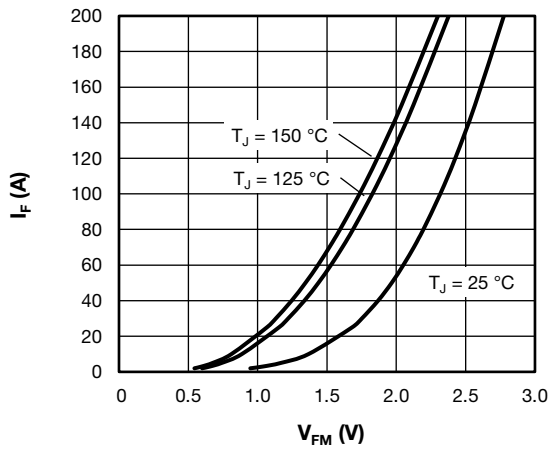


Fig. 12 - Typical Diode Forward Characteristics

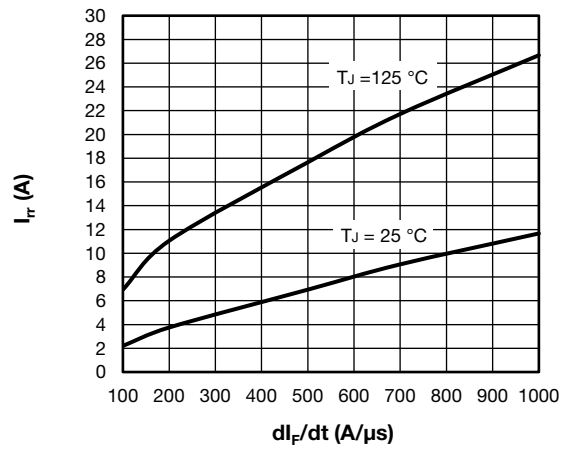


Fig. 15 - Typical Diode Reverse Recovery Current vs. dI_F/dt
 $I_F = 50 \text{ A}$, $V_{CC} = 200 \text{ V}$

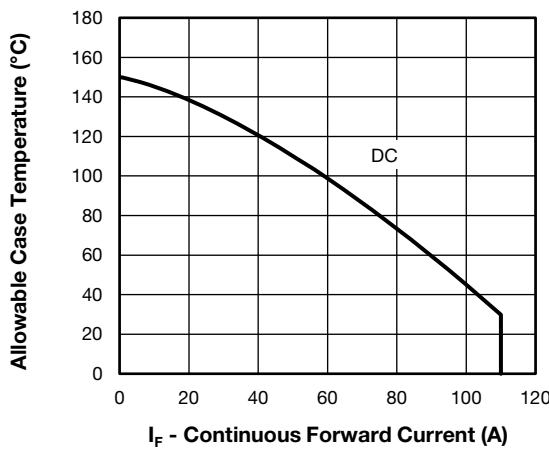


Fig. 13 - Maximum Diode Continuous Forward Current vs. Case Temperature

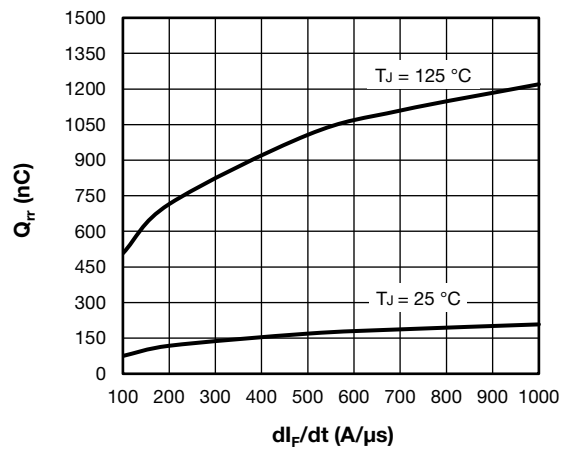


Fig. 16 - Typical Diode Reverse Recovery Charge vs. dI_F/dt
 $I_F = 50 \text{ A}$, $V_{CC} = 200 \text{ V}$

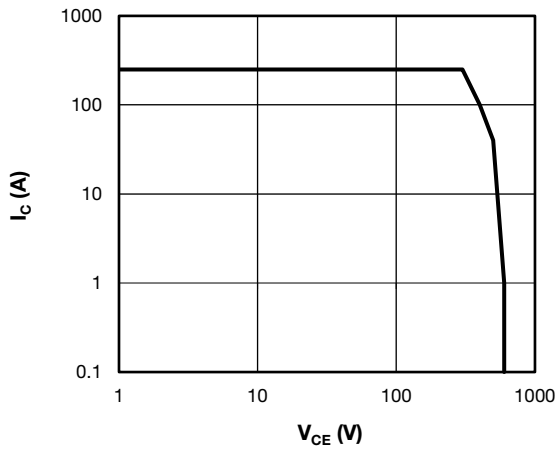


Fig. 17 - Trench IGBT Reverse BIAS SOA
 $T_J = 175\text{ }^\circ\text{C}$, $I_C = 250\text{ A}$, $R_g = 4.7\ \Omega$, $V_{GE} = +15\text{ V/0 V}$,
 $V_{CC} = 300\text{ V}$, $V_p = 600\text{ V}$

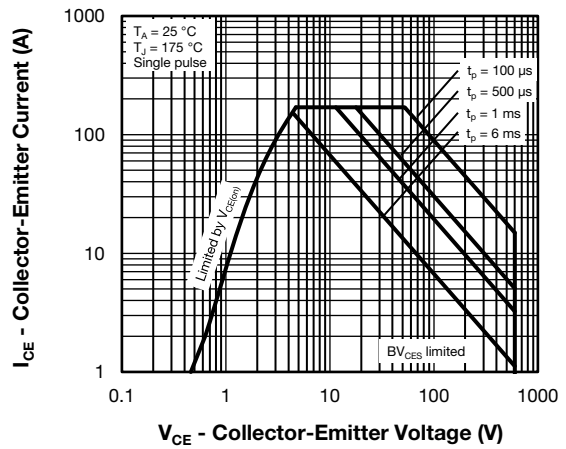


Fig. 18 - Trench IGBT Safe Operating Area

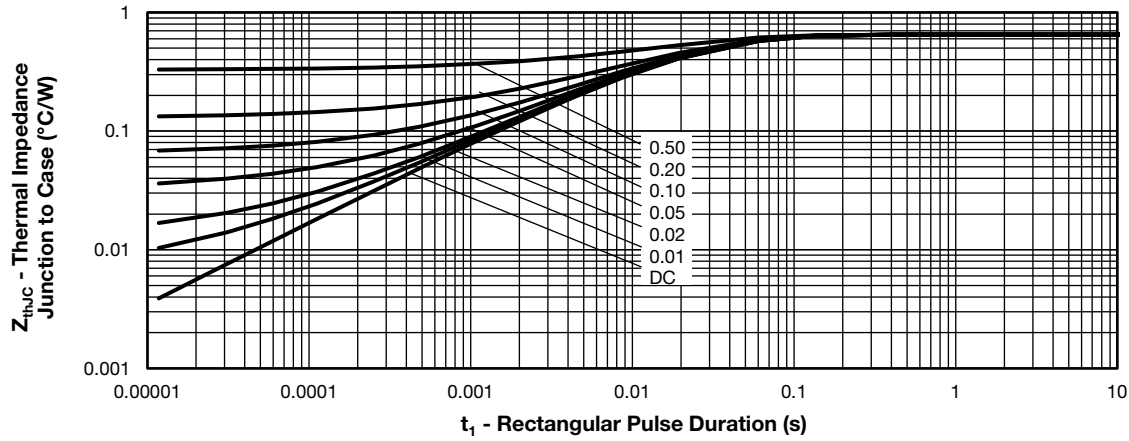


Fig. 19 - Maximum Trench IGBT Thermal Impedance Z_{thJC} Characteristics

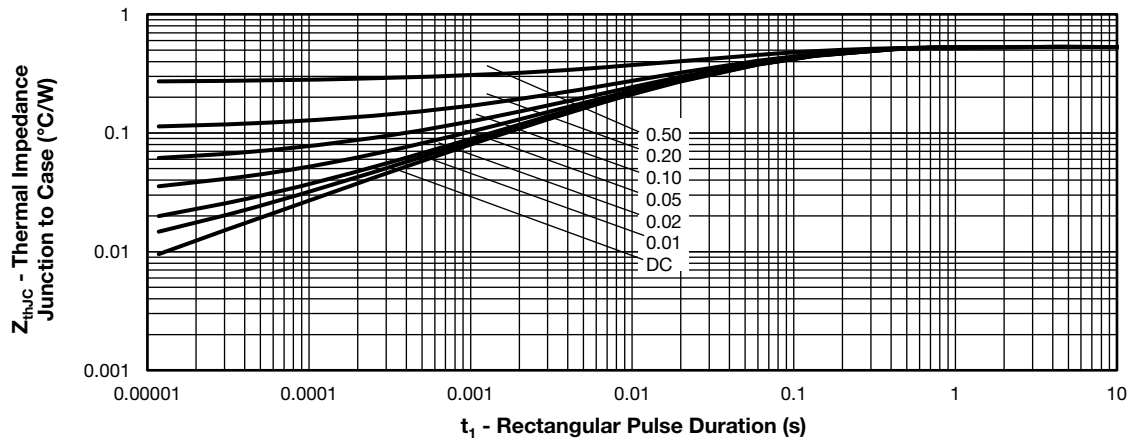


Fig. 20 - Maximum Diode Thermal Impedance Z_{thJC} Characteristics

ORDERING INFORMATION TABLE

| | | | | | | | | | |
|-------------|------------|----------|----------|-----------|----------|----------|-----------|----------|----------|
| Device code | VS- | G | T | 75 | N | A | 60 | U | F |
| | ① | ② | ③ | ④ | ⑤ | ⑥ | ⑦ | ⑧ | ⑨ |

- 1** - Vishay Semiconductors product
- 2** - Insulated gate bipolar transistor (IGBT)
- 3** - T = Trench IGBT
- 4** - Current rating (75 = 75 A)
- 5** - Circuit configuration (N = high side chopper)
- 6** - Package indicator (A = SOT-227)
- 7** - Voltage rating (60 = 600 V)
- 8** - Speed / type (U = ultrafast IGBT)
- 9** - Diode (F = FRED Pt[®] diode)

| CIRCUIT CONFIGURATION | | |
|-----------------------|----------------------------|-----------------|
| CIRCUIT | CIRCUIT CONFIGURATION CODE | CIRCUIT DRAWING |
| High side chopper | N | |

| 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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