# "High Side Chopper" IGBT SOT-227 (Trench IGBT), 47 A

SOT-227

| PRIMARY CHARACTERISTICS | |
|---|---|
| $V_{CES}$ | 1200 V |
| $I_C$ DC | 50 A at 73 °C |
| $V_{CE(on)}$ typical at 50 A, 25 °C | 2.39 V |
| Package | SOT-227 |
| Circuit configuration | High side chopper |

## FEATURES

- Trench IGBT technology
- Square RBSOA
- HEXFRED® clamping diode
- Positive $V_{CE(on)}$ temperature coefficient
- Fully isolated package
- Speed 8 kHz to 60 kHz
- 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

**ABSOLUTE MAXIMUM RATINGS**

| PARAMETER | SYMBOL | TEST CONDITIONS | MAX. | UNITS |
|---|---|---|---|---|
| Collector to emitter voltage | $V_{CES}$ | | 1200 | V |
| Continuous collector current | $I_C$ | $T_C$ = 25 °C | 68 | A |
| | | $T_C$ = 80 °C | 47 | |
| Pulsed collector current | $I_{CM}$ | $T_C$ = 150 °C, $T_p$ = 6 ms, $V_{GE}$ = 15 V | 150 | |
| Clamped inductive load current | $I_{LM}$ | | 250 | |
| Diode continuous forward current | $I_F$ | $T_C$ = 25 °C | 87 | |
| | | $T_C$ = 80 °C | 59 | |
| Single pulse forward current | $I_{FSM}$ | 10 ms sine or 6 ms rectangular pulse, $T_J$ = 25 °C | 310 | |
| Gate to emitter voltage | $V_{GE}$ | | ± 20 | V |
| Power dissipation, IGBT | $P_D$ | $T_C$ = 25 °C | 291 | W |
| | | $T_C$ = 80 °C | 163 | |
| Power dissipation, diode | $P_D$ | $T_C$ = 25 °C | 338 | |
| | | $T_C$ = 80 °C | 190 | |
| RMS isolation voltage | $V_{ISOL}$ | Any terminal to case, t = 1 min | 2500 | V |


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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, $I_C$ = 2 mA | 1200 | - | - | V |
| Collector to emitter voltage | $V_{CE(on)}$ | $V_{GE}$ = 15 V, $I_C$ = 25 A | - | 1.95 | - | |
| | | $V_{GE}$ = 15 V, $I_C$ = 50 A | - | 2.39 | 2.8 | |
| | | $V_{GE}$ = 15 V, $I_C$ = 25 A, $T_J$ = 125 °C | - | 2.13 | - | |
| | | $V_{GE}$ = 15 V, $I_C$ = 50 A, $T_J$ = 125 °C | - | 2.76 | - | |
| Gate threshold voltage | $V_{GE(th)}$ | $V_{CE}$ = $V_{GE}$, $I_C$ = 2 mA | 4.6 | 5.8 | 7.6 | |
| Temperature coefficient of threshold voltage | $V_{GE(th)}/\Delta T_J$ | $V_{CE}$ = $V_{GE}$, $I_C$ = 2 mA (25 °C to 125 °C) | - | -13 | - | mV/°C |
| Collector to emitter leakage current | $I_{CES}$ | $V_{GE}$ = 0 V, $V_{CE}$ = 1200 V | - | 1.7 | 50 | μA |
| | | $V_{GE}$ = 0 V, $V_{CE}$ = 1200 V, $T_J$ = 125 °C | - | 26.2 | - | |
| Diode reverse breakdown voltage | $V_{BR}$ | $I_R$ = 1 mA | 1200 | - | - | V |
| Diode forward voltage drop | $V_{FM}$ | $I_F$ = 25 A, $V_{GE}$ = 0 V | - | 2.11 | 2.42 | V |
| | | $I_F$ = 50 A, $V_{GE}$ = 0 V | - | 2.72 | - | |
| | | $I_F$ = 25 A, $V_{GE}$ = 0 V, $T_J$ = 125 °C | - | 2.04 | - | |
| | | $I_F$ = 50 A, $V_{GE}$ = 0 V, $T_J$ = 125 °C | - | 2.83 | - | |
| Diode reverse leakage current | $I_{RM}$ | $V_R$ = 1200 V | - | 4 | 50 | μA |
| | | $T_J$ = 125 °C, $V_R$ = 1200 V | - | 0.8 | - | mA |
| Gate to emitter leakage current | $I_{GES}$ | $V_{GE}$ = ± 20 V | - | - | ± 200 | nA |

| **SWITCHING CHARACTERISTICS** ($T_J$ = 25 °C unless otherwise specified) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| Total gate charge (turn-on) | $Q_g$ | $I_C$ = 40 A, $V_{CC}$ = 960 V, $V_{GE}$ = 15 V | | - | 171 | - | nC |
| Gate to emitter charge (turn-on) | $Q_{ge}$ | | | - | 22 | - | |
| Gate to collector charge (turn-on) | $Q_{gc}$ | | | - | 86 | - | |
| Turn-on switching loss | $E_{on}$ | $I_C$ = 50 A, $V_{CC}$ = 600 V, $V_{GE}$ = 15 V, $R_g$ = 4.7 Ω, L = 500 μH, $T_J$ = 25 °C | Energy losses include tail and diode recovery | - | 2.7 | - | mJ |
| Turn-off switching loss | $E_{off}$ | | | - | 1.4 | - | |
| Total switching loss | $E_{tot}$ | | | - | 4.1 | - | |
| Turn-on switching loss | $E_{on}$ | $I_C$ = 50 A, $V_{CC}$ = 600 V, $V_{GE}$ = 15 V, $R_g$ = 4.7 Ω, L = 500 μH, $T_J$ = 125 °C | | - | 4.1 | - | |
| Turn-off switching loss | $E_{off}$ | | | - | 2.3 | - | |
| Total switching loss | $E_{tot}$ | | | - | 6.4 | - | |
| Turn-on delay time | $t_{d(on)}$ | | | - | 8 | - | ns |
| Rise time | $t_r$ | | | - | 11 | - | |
| Turn-off delay time | $t_{d(off)}$ | | | - | 81 | - | |
| Fall time | $t_f$ | | | - | 179 | - | |
| Reverse bias safe operating area | RBSOA | $T_J$ = 150 °C, $I_C$ = 250 A, $R_g$ = 4.7 Ω, $V_{GE}$ = 15 V to 0 V, $V_{CC}$ = 700 V, $V_P$ = 1200 V | | Fullsquare | | | |
| Diode reverse recovery time | $t_{rr}$ | $I_F$ = 50 A, $dI_F/dt$ = 200 A/μs, $V_R$ = 200 V | | - | 129 | - | ns |
| Diode peak reverse current | $I_{rr}$ | | | - | 11 | - | A |
| Diode recovery charge | $Q_{rr}$ | | | - | 710 | - | 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 | | - | 208 | - | ns |
| Diode peak reverse current | $I_{rr}$ | | | - | 17 | - | A |
| Diode recovery charge | $Q_{rr}$ | | | - | 1768 | - | 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 | $R_{thJC}$ | | - | - | 0.43 | °C/W |
| | Diode | | | - | - | 0.37 | |
| 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 | - | - | 1.8 (15.9) | Nm (lbf.in) |
| Case style | | SOT-227 | | | | | |

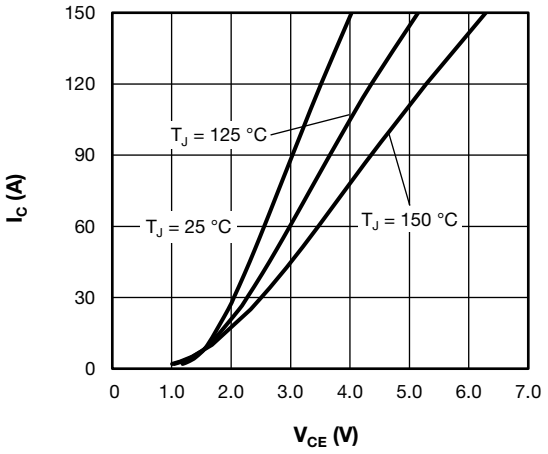


Fig. 1 - Typical Trench IGBT Output Characteristics, $V_{GE}$ = 15 V

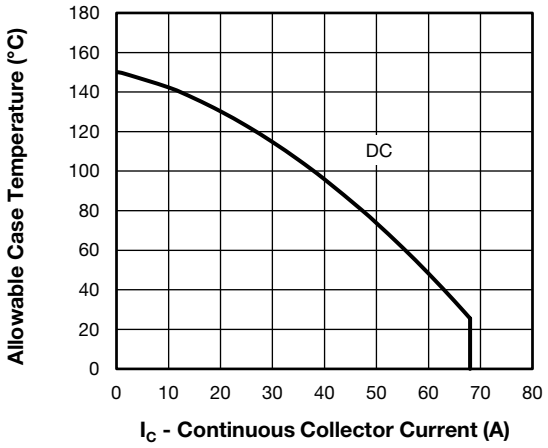


Fig. 3 - Maximum Trench IGBT Continuous Collector Current vs. Case Temperature

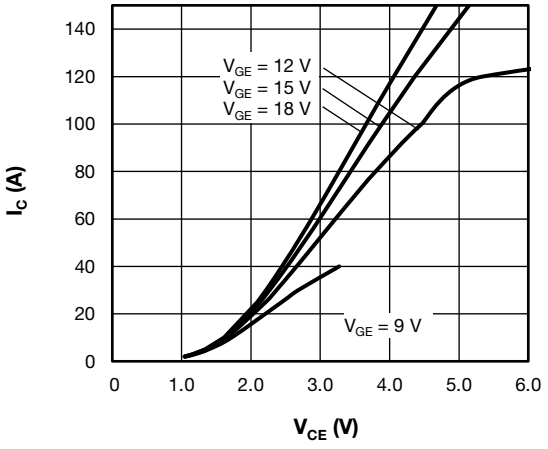


Fig. 2 - Typical Trench IGBT Output Characteristics, $T_J$ = 125 °C

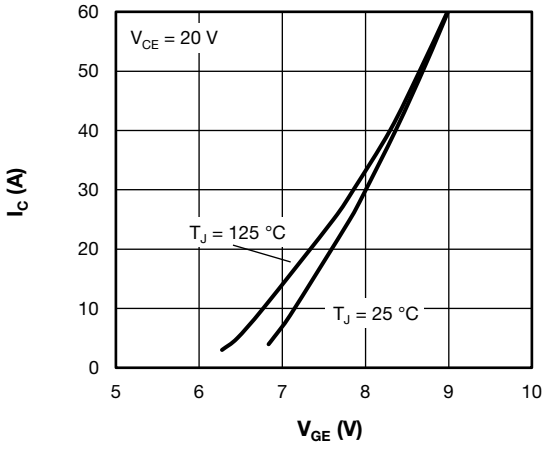


Fig. 4 - Typical Trench IGBT Transfer Characteristic


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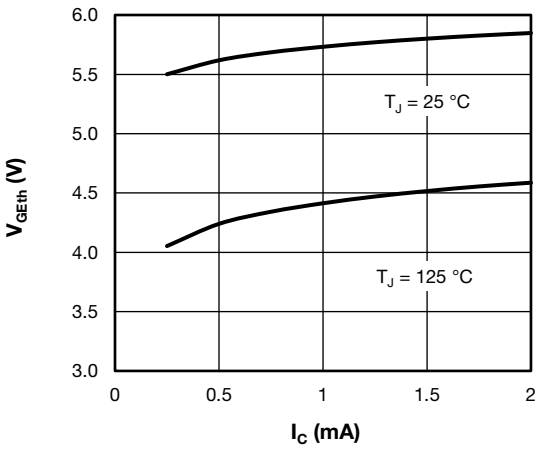


Fig. 5 - Typical Trench IGBT Gate Threshold Voltage

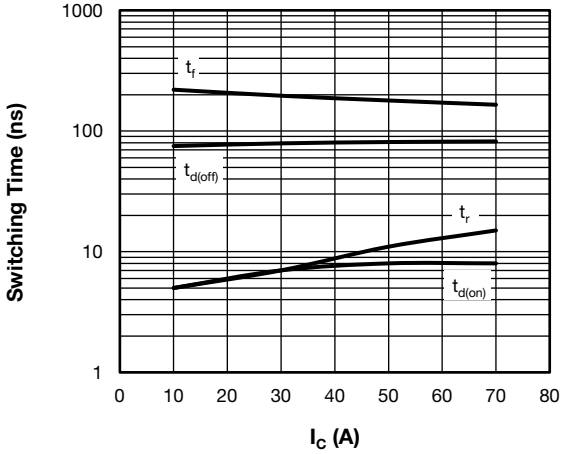


Fig. 8 - Typical Trench IGBT Switching Time vs. $I_C$
$T_J$ = 125 °C, $V_{CC}$ = 600 V, $R_g$ = 4.7 Ω, $V_{GE}$ = +15 V/-15 V, L = 500 μH

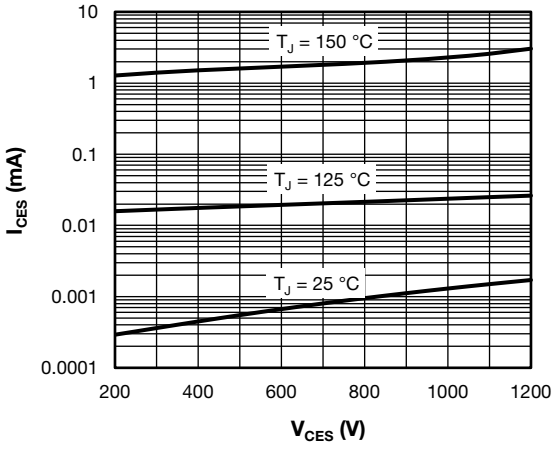


Fig. 6 - Typical Trench IGBT Zero Gate Voltage Collector Current

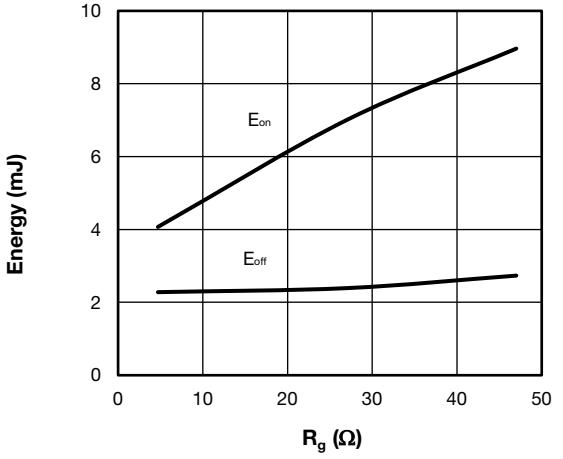


Fig. 9 - Typical Trench IGBT Energy Losses vs. $R_g$
$T_J$ = 125 °C, $V_{CC}$ = 600 V, $I_C$ = 50 A, $V_{GE}$ = +15 V/-15 V, L = 500 μH

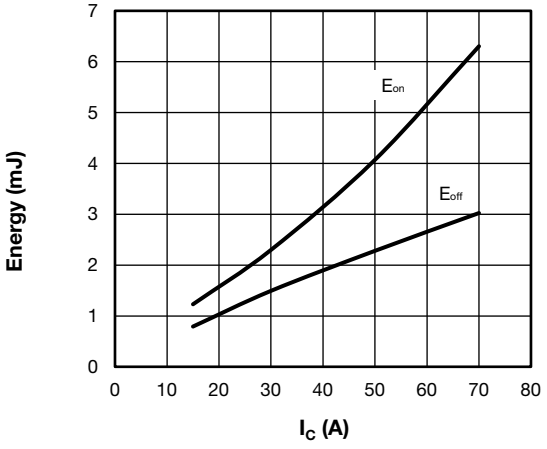


Fig. 7 - Typical Trench IGBT Energy Loss vs. $I_C$
$T_J$ = 125 °C, $V_{CC}$ = 600 V, $R_g$ = 4.7 Ω, $V_{GE}$ = +15 V/-15 V, L = 500 μH

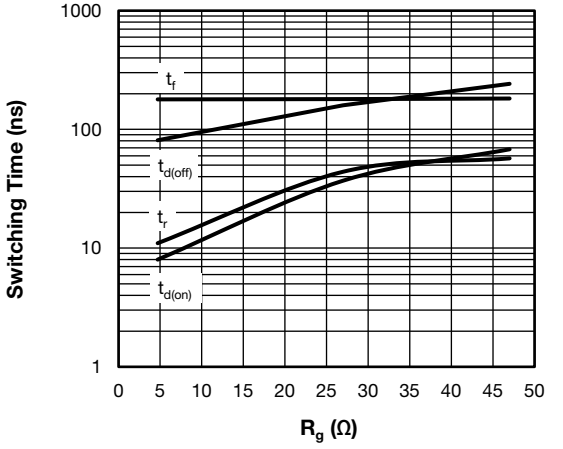


Fig. 10 - Typical Trench IGBT Switching Time vs. $R_g$
$T_J$ = 125 °C, $V_{CC}$ = 600 V, $I_C$ = 50 A, $V_{GE}$ = +15 V/-15 V, L = 500 μH


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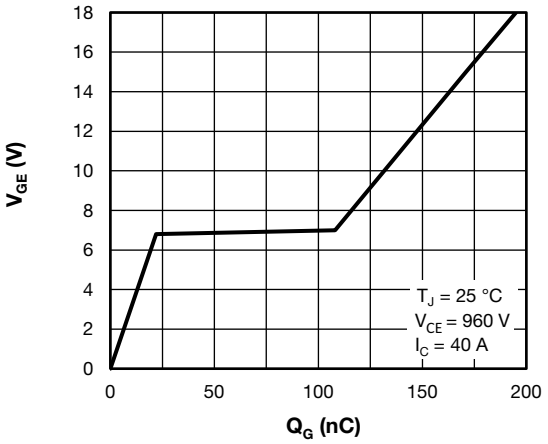


Fig. 11 - Typical Trench IGBT Gate Charge vs. Gate to Emitter Voltage

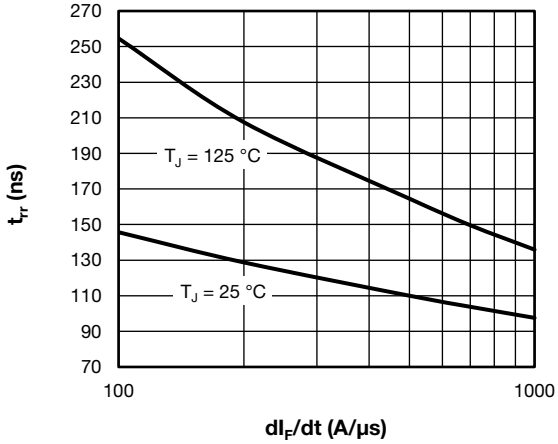


Fig. 14 - Typical Diode Reverse Recovery Time vs. $dI_F/dt$

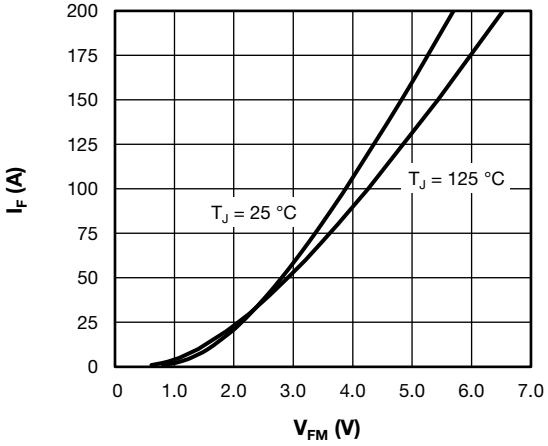


Fig. 12 - Typical Diode Forward Characteristic

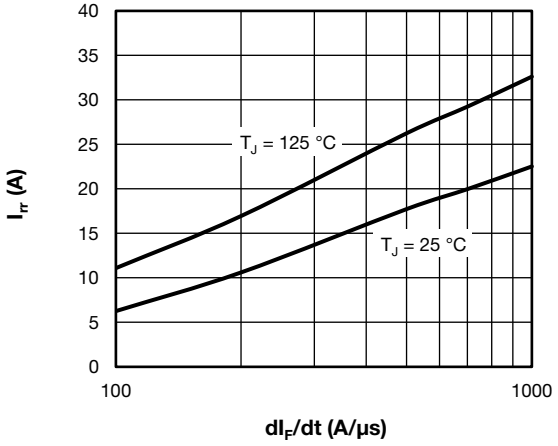


Fig. 15 - Typical Diode Reverse Recovery Current vs. $dI_F/dt$

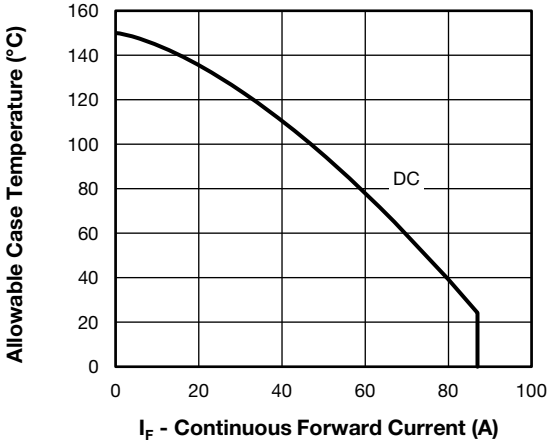


Fig. 13 - Maximum Diode Continuous Forward Current vs. Case Temperature

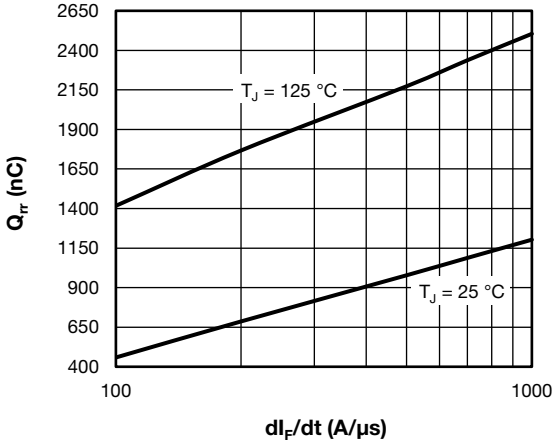


Fig. 16 - Typical Diode Reverse Recovery Charge vs. $dI_F/dt$


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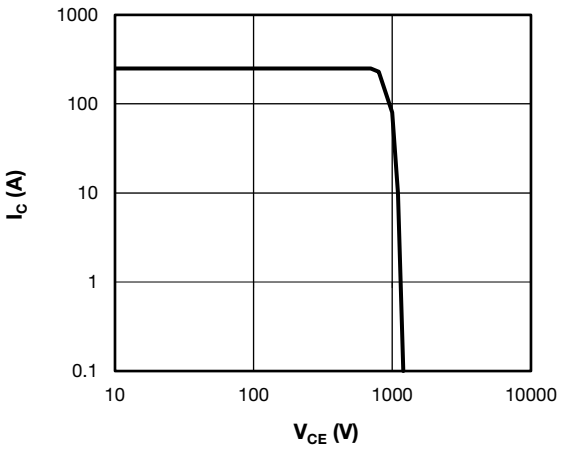


Fig. 17 - Trench IGBT Reverse BIAS SOA
$T_J$ = 150 °C, $I_C$ = 250 A, $R_g$ = 4.7 Ω, $V_{GE}$ = +15 V/ 0 V,
$V_{CC}$ = 700 V, $V_p$ = 1200 V

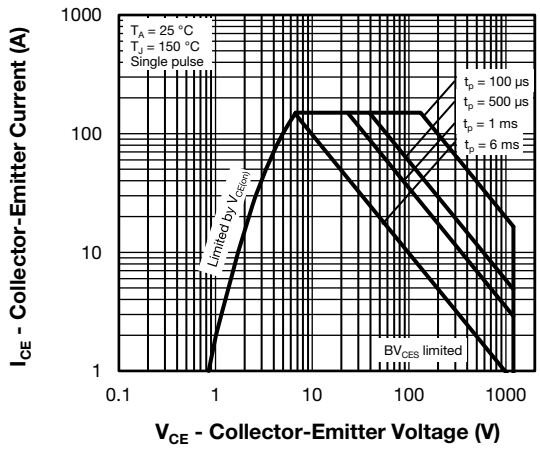


Fig. 18 - Trench IGBT Safe Operating Area

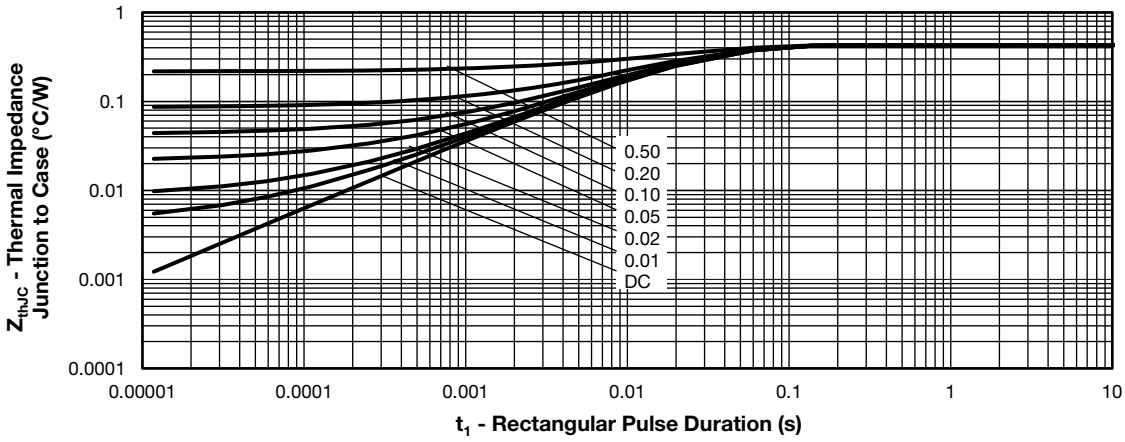


Fig. 19 - Maximum Trench IGBT Thermal Impedance $Z_{thJC}$ Characteristics

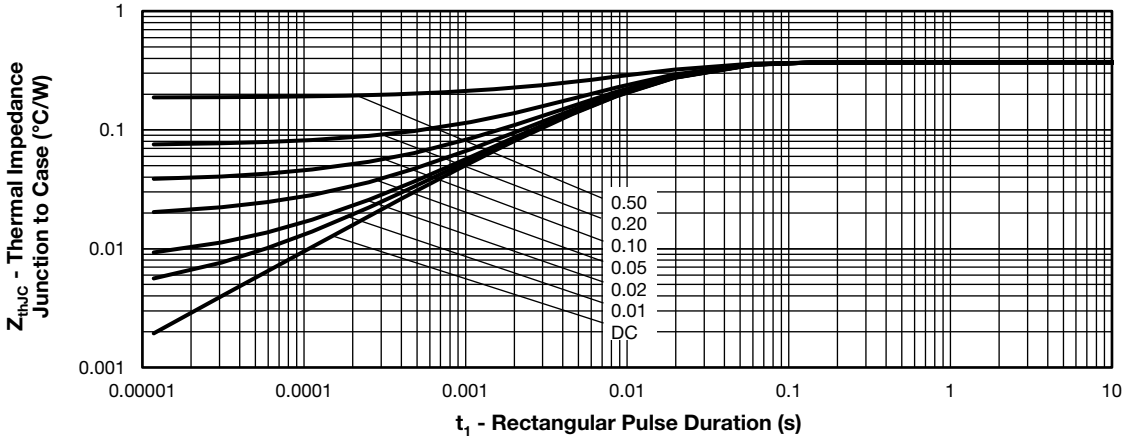


Fig. 20 - Maximum Diode Thermal Impedance $Z_{thJC}$ Characteristics


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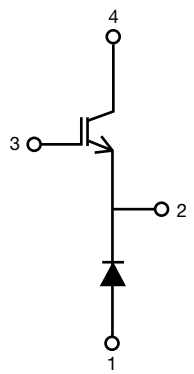
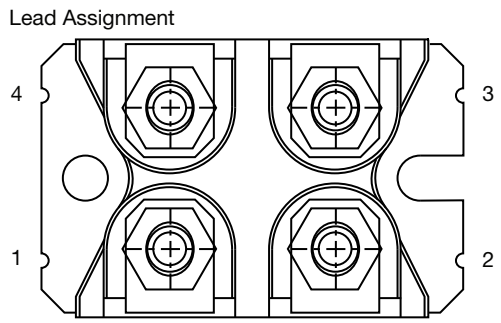
## ORDERING INFORMATION TABLE

| Device code | VS- | G | T | 55 | N | A | 120 | U | X |
|---|---|---|---|---|---|---|---|---|---|
| | 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 (55 = 55 A)
5 - Circuit configuration (N = high side chopper)
6 - Package indicator (A = SOT-227)
7 - Voltage rating (120 = 1200 V)
8 - Speed/type (U = ultrafast IGBT)
9 - Diode (X = HEXFRED® diode)

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

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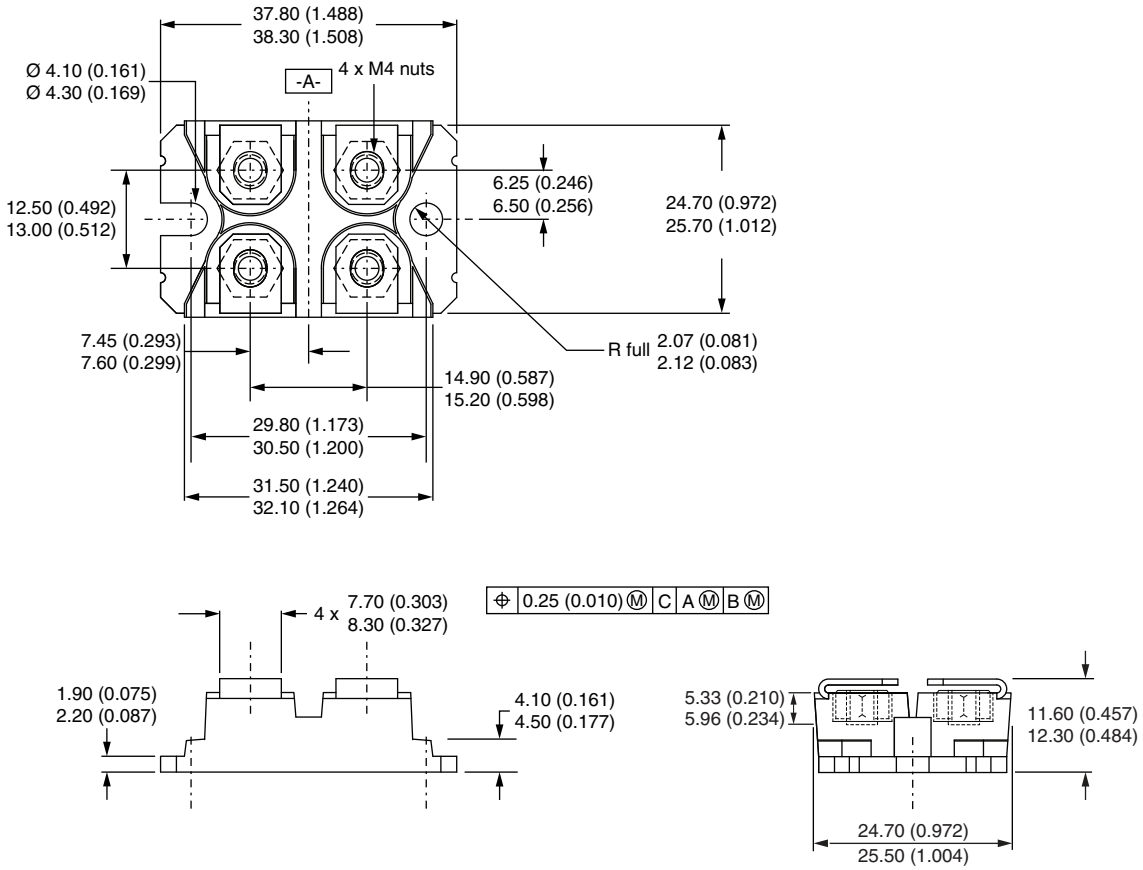
# SOT-227 Generation 2

**DIMENSIONS** in millimeters (inches)




**Note**

- Controlling dimension: millimeter



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