# "Half Bridge" High Speed IGBT INT-A-PAK, 100 A

INT-A-PAK IGBT

## FEATURES

- Trench IGBT technology
- Gen 4 FRED Pt® technology anti-parallel diodes with ultra soft reverse recovery characteristics
- Very low switching losses
- $Al_2O_3$ DBC
- UL approved file E78996
- Designed for industrial level
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free

RoHS COMPLIANT

## BENEFITS

- Optimized for high current inverter stages
- Direct mounting to heatsink
- Very low junction to case thermal resistance
- Low EMI

| PRIMARY CHARACTERISTICS | |
|---|---|
| $V_{CES}$ | 650 V |
| $I_C$ DC, $T_C$ = 80 °C | 72 A |
| $V_{CE(on)}$ at 100 A, 25 °C | 1.82 V |
| Chip level $V_{CE(on)}$ at 100 A, 25 °C | 1.70 V |
| Speed | 8 kHz to 30 kHz |
| Package | INT-A-PAK |
| Circuit configuration | Half bridge |

## ABSOLUTE MAXIMUM RATINGS

| PARAMETER | SYMBOL | TEST CONDITIONS | MAX. | UNITS |
|---|---|---|---|---|
| Collector to emitter voltage | $V_{CES}$ | | 650 | V |
| Continuous collector current | $I_C$ | $T_C$ = 25 °C | 96 | A |
| | | $T_C$ = 80 °C | 72 | |
| Pulsed collector current | $I_{CM}$ | $T_C$ = 175 °C, $t_p$ = 6 ms, $V_{GE}$ = 15 V | 240 | |
| Peak switching current | $I_{LM}$ | | 140 | |
| Diode continuous forward current | $I_F$ | $T_C$ = 25 °C | 57 | |
| | | $T_C$ = 80 °C | 43 | |
| Maximum non-repetitive peak current | $I_{FSM}$ | 10 ms sine or 6 ms rectangular pulse, $T_J$ = 25 °C | 270 | |
| Gate to emitter voltage | $V_{GE}$ | | ± 20 | V |
| RMS isolation voltage | $V_{ISOL}$ | Any terminal to case, t = 1 min | 2500 | |
| Maximum power dissipation | $P_D$ | $T_C$ = 25 °C | 259 | W |
| | | $T_C$ = 80 °C | 164 | |
| Maximum power dissipation (Diode) | $P_D$ | $T_C$ = 25 °C | 150 | W |
| | | $T_C$ = 80 °C | 95 | |
| Operating junction temperature range | $T_J$ | | -40 to +175 | °C |
| Storage temperature range | $T_{Stg}$ | | -40 to +150 | |

## 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, $I_C$ = 200 µA | 650 | - | - | V |
| Collector to emitter voltage | $V_{CE(on)}$ | $V_{GE}$ = 15 V, $I_C$ = 50 A | - | 1.46 | - | |
| | | $V_{GE}$ = 15 V, $I_C$ = 100 A | - | 1.82 | 2.3 | |
| | | $V_{GE}$ = 15 V, $I_C$ = 100 A, $T_J$ = 125 °C | - | 2.12 | - | |
| Gate threshold voltage | $V_{GE(th)}$ | $V_{CE}$ = $V_{GE}$, $I_C$ = 1 mA | 3 | 4.0 | 5 | |
| 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) | - | -11 | - | mV/°C |
| Forward transconductance | $g_{fe}$ | $V_{CE}$ = 20 V, $I_C$ = 100 A | - | 132 | - | S |
| Transfer characteristics | $V_{GE}$ | $V_{CE}$ = 20 V, $I_C$ = 100 A | - | 6.46 | - | V |
| Collector to emitter leakage current | $I_{CES}$ | $V_{GE}$ = 0 V, $V_{CE}$ = 650 V | - | 0.5 | 50 | µA |
| | | $V_{GE}$ = 0 V, $V_{CE}$ = 650 V, $T_J$ = 125 °C | - | 7 | - | |
| Diode forward voltage drop | $V_{FM}$ | $I_C$ = 50 A, $V_{GE}$ = 0 V | - | 2.02 | 2.9 | V |
| | | $I_C$ = 50 A, $V_{GE}$ = 0 V, $T_J$ = 125 °C | - | 1.6 | - | |
| Gate to emitter leakage current | $I_{GES}$ | $V_{GE}$ = ± 20 V | - | - | ± 120 | nA |

## SWITCHING CHARACTERISTICS ($T_J$ = 25 °C unless otherwise specified)

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNITS |
|---|---|---|---|---|---|---|
| Total gate charge | $Q_g$ | $I_C$ = 75 A, $V_{CC}$ = 520 V, $V_{GE}$ = 15 V | - | 236 | - | nC |
| Gate to emitter charge | $Q_{ge}$ | | - | 31 | - | |
| Gate to collector charge | $Q_{gc}$ | | - | 65 | - | |
| Turn-on switching energy | $E_{on}$ | $I_C$ = 100 A, $V_{CC}$ = 325 V, $V_{GE}$ = 15 V, L = 500 µH, $R_g$ = 22 Ω, $T_J$ = 25 °C | - | 3.1 | - | mJ |
| Turn-off switching energy | $E_{off}$ | | - | 0.94 | - | |
| Total switching energy | $E_{ts}$ | | - | 4.04 | - | |
| Turn-on delay time | $t_{d(on)}$ | | - | 39 | - | ns |
| Rise time | $t_r$ | | - | 55 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 200 | - | |
| Fall time | $t_f$ | | - | 25 | - | |
| Turn-on switching energy | $E_{on}$ | $I_C$ = 100 A, $V_{CC}$ = 325 V, $V_{GE}$ = 15 V, L = 500 µH, $R_g$ = 22 Ω, $T_J$ = 125 °C | - | 3.2 | - | mJ |
| Turn-off switching energy | $E_{off}$ | | - | 1.0 | - | |
| Total switching energy | $E_{ts}$ | | - | 4.2 | - | |
| Turn-on delay time | $t_{d(on)}$ | | - | 36 | - | ns |
| Rise time | $t_r$ | | - | 58 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 210 | - | |
| Fall time | $t_f$ | | - | 23 | - | |
| Reverse bias safe operating area | RBSOA | $T_J$ = 175 °C, $I_C$ = 140 A, $V_{CC}$ = 325 V, $V_p$ = 650 V, $R_g$ = 22 Ω, $V_{GE}$ = 15 V to -5 V, L = 500 µH | Fullsquare | | | |
| Diode reverse recovery time | $t_{rr}$ | $I_F$ = 50 A, $dI_F/dt$ = 500 A/µs, $V_{rr}$ = 200 V | - | 79 | - | ns |
| Diode peak reverse current | $I_{rr}$ | | - | 10.5 | - | A |
| Diode recovery charge | $Q_{rr}$ | | - | 409 | - | nC |
| Diode reverse recovery time | $t_{rr}$ | $I_F$ = 50 A, $dI_F/dt$ = 500 A/µs, $V_{rr}$ = 200 V, $T_J$ = 125 °C | - | 141 | - | ns |
| Diode peak reverse current | $I_{rr}$ | | - | 19 | - | A |
| Diode recovery charge | $Q_{rr}$ | | - | 1336 | - | nC |

## THERMAL AND MECHANICAL SPECIFICATIONS

| PARAMETER | | SYMBOL | MIN. | TYP. | MAX. | UNITS |
|---|---|---|---|---|---|---|
| Operating junction temperature range | | $T_J$ | -40 | - | 175 | °C |
| Storage temperature range | | $T_{Stg}$ | -40 | - | 150 | |
| Junction to case | per switch | $R_{thJC}$ | - | - | 0.58 | °C/W |
| | per diode | | - | - | 1.0 | |
| Case to sink per module | | $R_{thCS}$ | - | 0.1 | - | |
| Mounting torque | case to heatsink | | - | - | 4 | Nm |
| | case to terminal 1, 2, 3 | | - | - | 3 | |
| Weight | | | - | 185 | - | g |

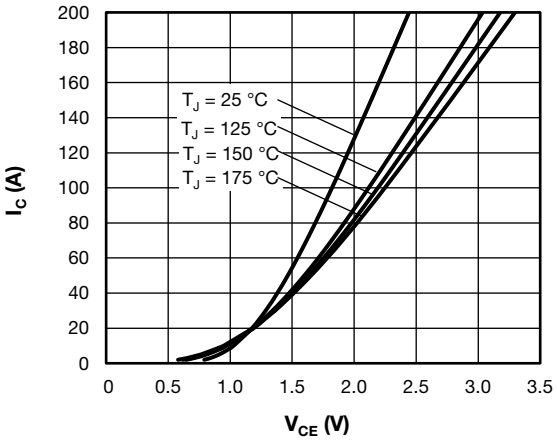



Fig. 1 - Typical Trench IGBT Output Characteristics, $V_{GE}$ = 15 V

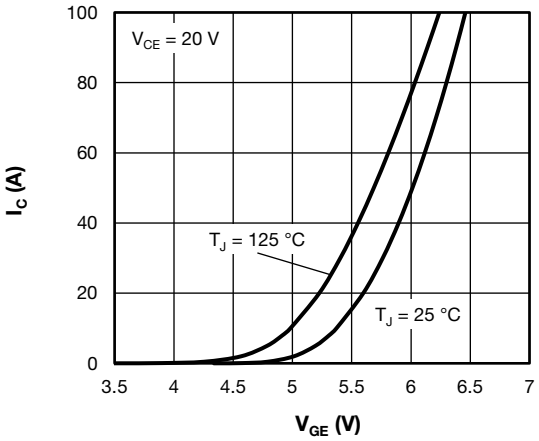



Fig. 4 - Typical Trench IGBT Transfer Characteristics

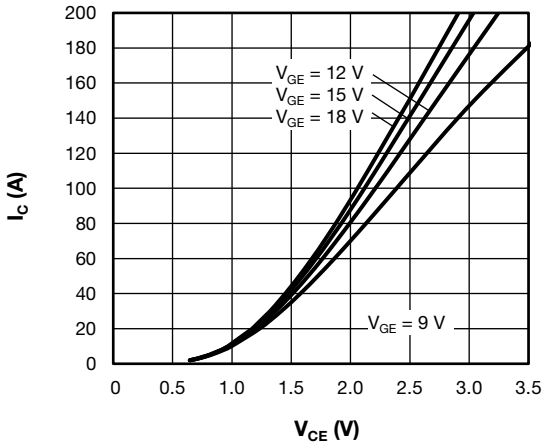



Fig. 2 - Typical Trench IGBT Output Characteristics, $T_J$ = 125 °C

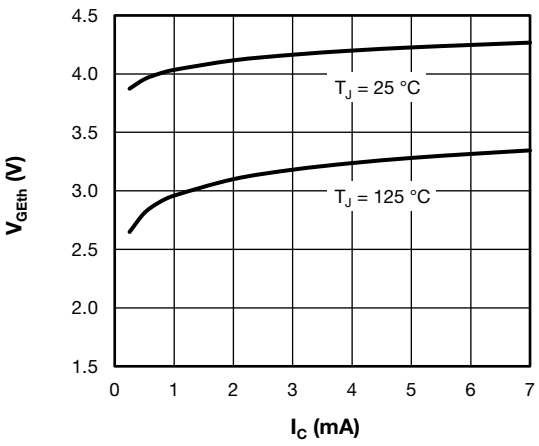



Fig. 5 - Typical Trench IGBT Gate Threshold Voltage

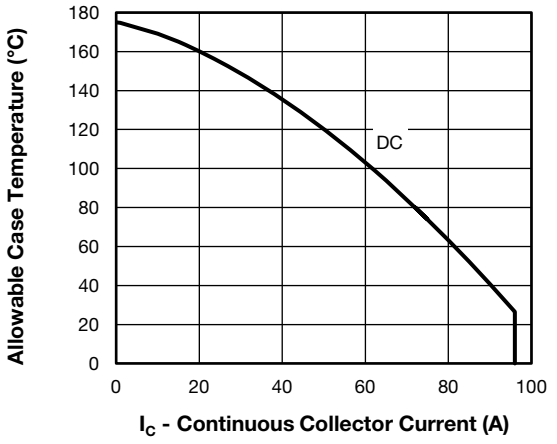



Fig. 3 - Maximum Trench IGBT Continuous Collector Current vs. Case Temperature

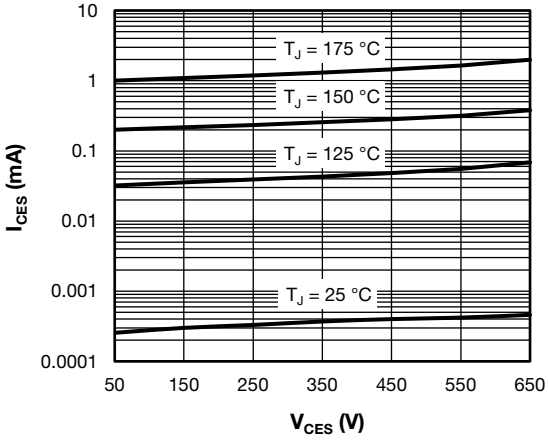



Fig. 6 - Typical Trench IGBT Zero Gate Voltage Collector Current

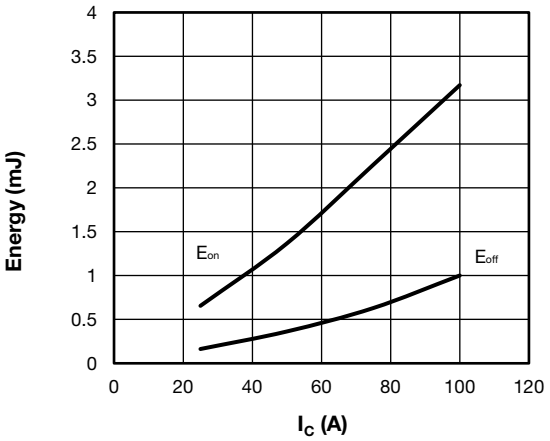



Fig. 7 - Typical Trench IGBT Energy Loss vs. $I_C$
(with Antiparallel Diode)
$T_J$ = 125 °C, $V_{CC}$ = 325 V, $R_g$ = 22 Ω, $V_{GE}$ = +15 V/-15 V, L = 500 µH

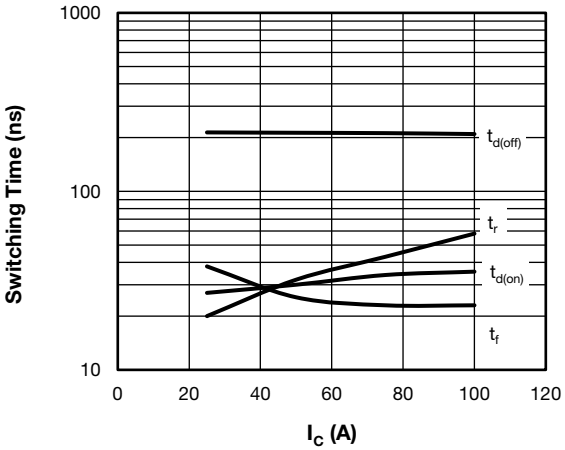



Fig. 8 - Typical Trench IGBT Switching Time vs. $I_C$
(with Antiparallel Diode)
$T_J$ = 125 °C, $V_{CC}$ = 325 V, $R_g$ = 22 Ω, $V_{GE}$ = +15 V/-15 V, L = 500 µH

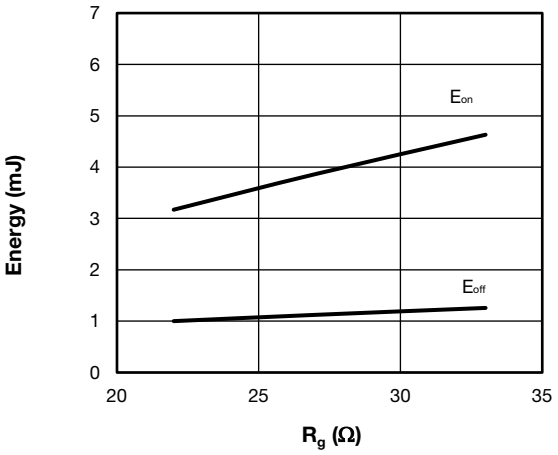



Fig. 9 - Typical Trench IGBT Energy Loss vs. $R_g$
(with Antiparallel Diode)
$T_J$ = 125 °C, $V_{CC}$ = 325 V, $I_C$ = 100 A, $V_{GE}$ = +15 V/-15 V, L = 500 µH

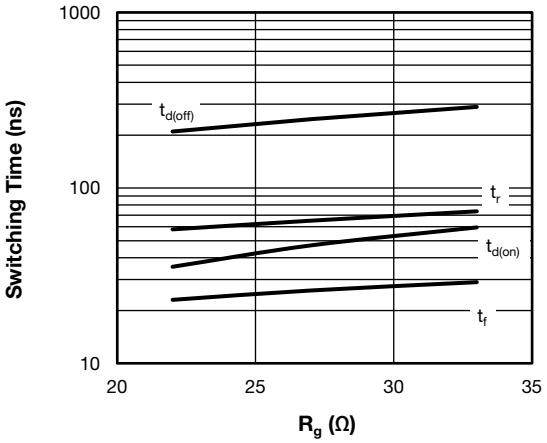



Fig. 10 - Typical Trench IGBT Switching Time vs. $R_g$
(with Antiparallel Diode)
$T_J$ = 125 °C, $V_{CC}$ = 325 V, $I_C$ = 100 A, $V_{GE}$ = +15 V/-15 V, L = 500 µH

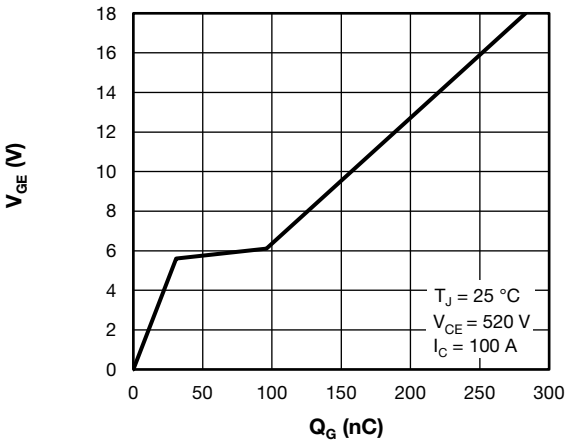



Fig. 11 - Typical Trench IGBT Gate Charge vs.
Gate to Collector Voltage

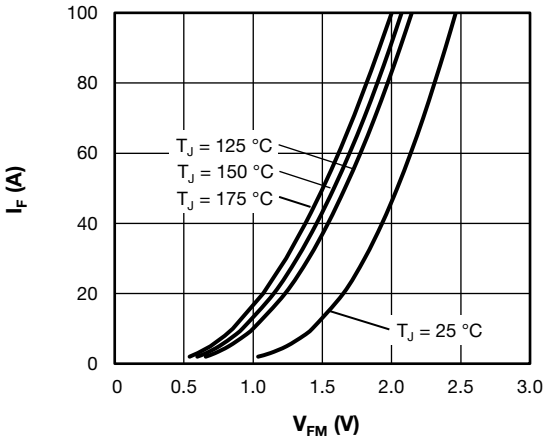



Fig. 12 - Typical Antiparallel Diode Forward Characteristics

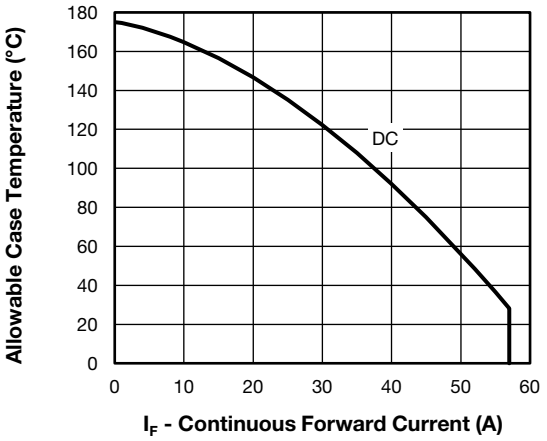



Fig. 13 - Maximum Antiparallel Diode Continuous Forward Current vs. Case Temperature

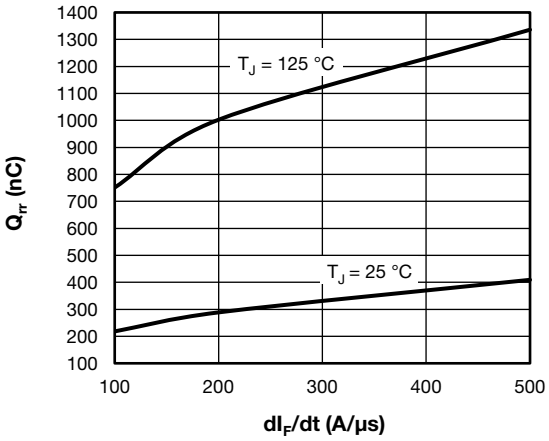



Fig. 16 - Typical Antiparallel Diode Reverse Recovery Charge vs. $dI_Fdt$
$I_F$ = 50 A, $V_{CC}$ = 200 V

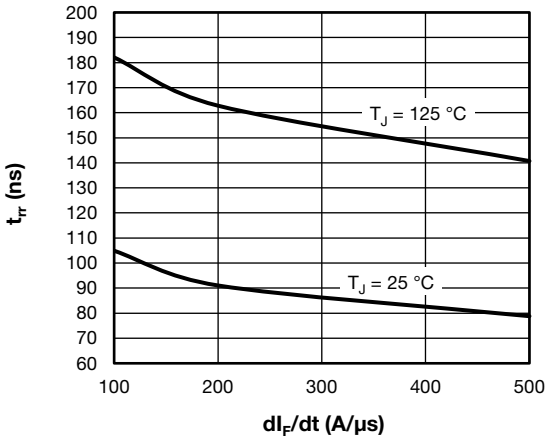



Fig. 14 - Typical Antiparallel Diode Reverse Recovery Time vs. $dI_Fdt$
$I_F$ = 50 A, $V_{CC}$ = 200 V

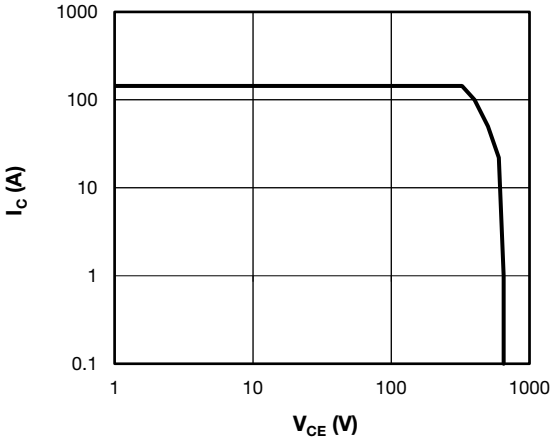



Fig. 17 - Trench IGBT Reverse BIAS SOA
$T_J$ = 175 °C, $I_C$ = 140 A, $R_g$ = 22 Ω, $V_{GE}$ = +15 V/-5 V, $V_{CC}$ = 325 V, $V_p$ = 650 V

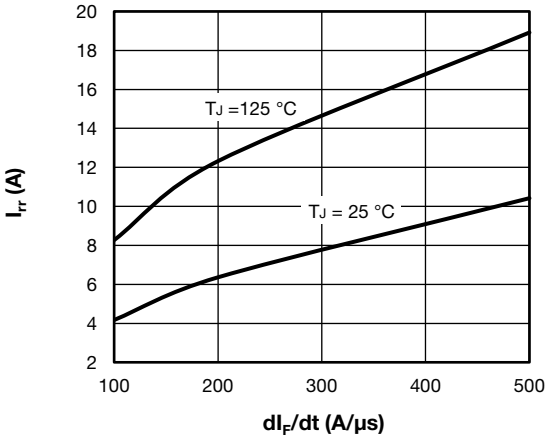



Fig. 15 - Typical Antiparallel Diode Reverse Recovery Current vs. $dI_Fdt$
$I_F$ = 50 A, $V_{CC}$ = 200 V

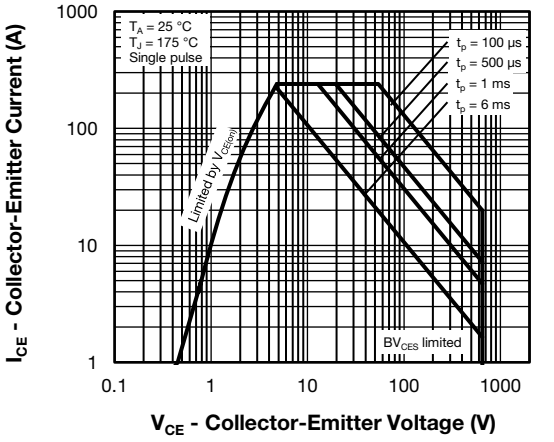



Fig. 18 - Trench IGBT Safe Operating Area

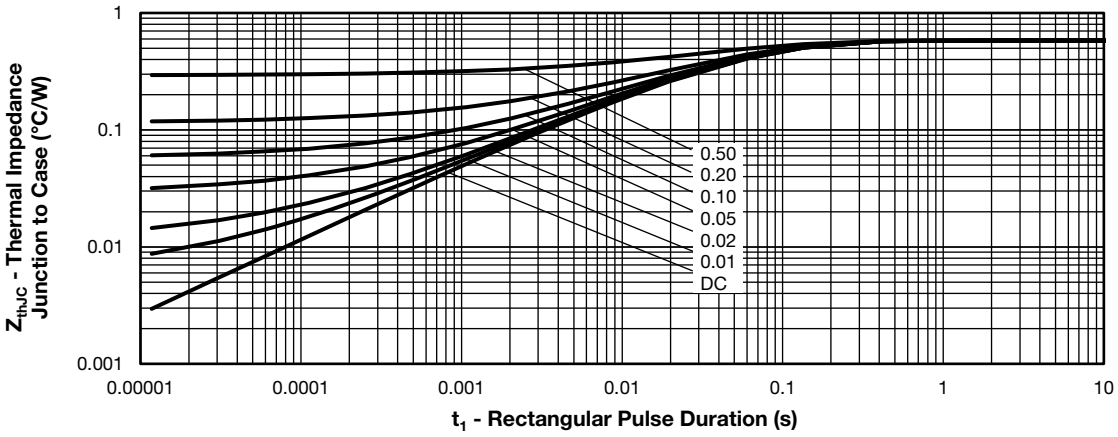



Fig. 19 - Maximum Trench IGBT Thermal Impedance $Z_{thJC}$ Characteristics

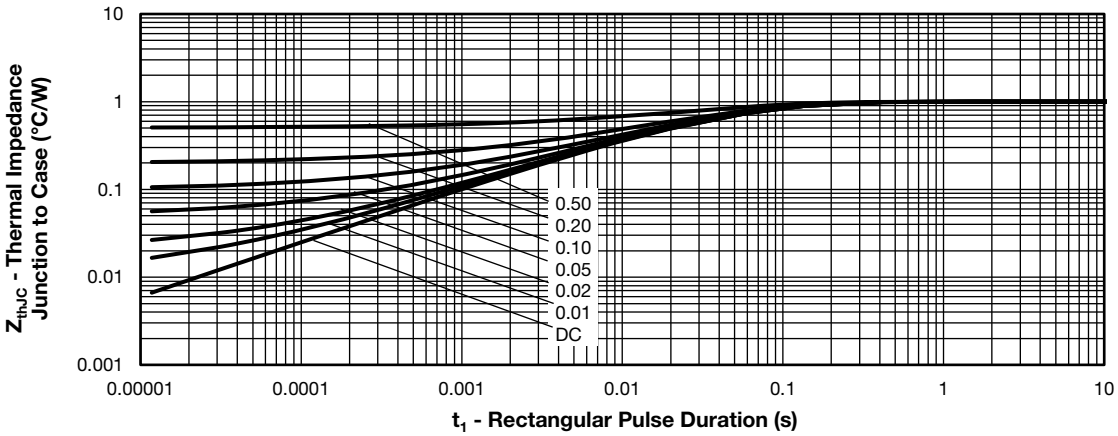



Fig. 20 - Maximum Antiparallel Diode Thermal Impedance $Z_{thJC}$ Characteristics

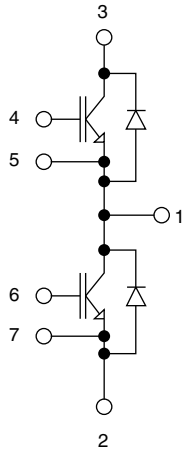
## ORDERING INFORMATION TABLE

Device code

| VS- | GT | 100 | T | S | 065 | N |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

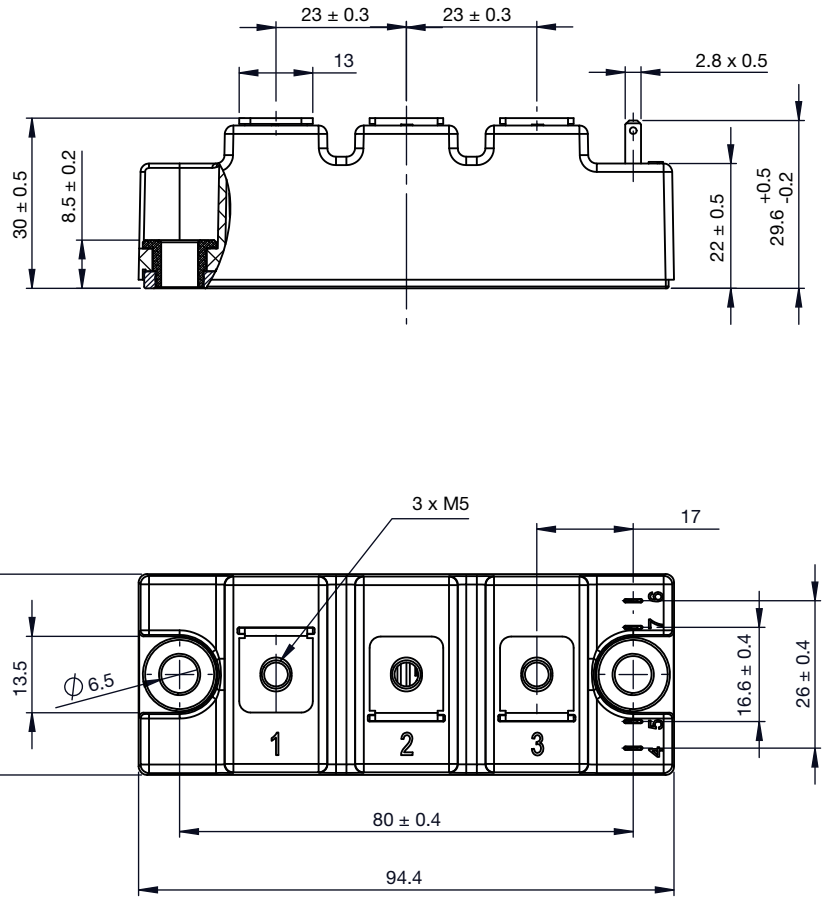
| | | |
|---|---|---|
| 1 | - | Vishay Semiconductors product |
| 2 | - | IGBT die technology (GT = trench) |
| 3 | - | Current rating (100 = 100 A) |
| 4 | - | Circuit configuration (T = half bridge) |
| 5 | - | Package indicator (S = INT-A-PAK) |
| 6 | - | Voltage code (065 = 650 V) |
| 7 | - | Speed/type (N = ultrafast IGBT) |

## CIRCUIT CONFIGURATION




| LINKS TO RELATED DOCUMENTS | |
|---|---|
| Dimensions | www.vishay.com/doc?95173 |

**DIMENSIONS** in millimeters (inches)




General tolerance ± 0.5 mm

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