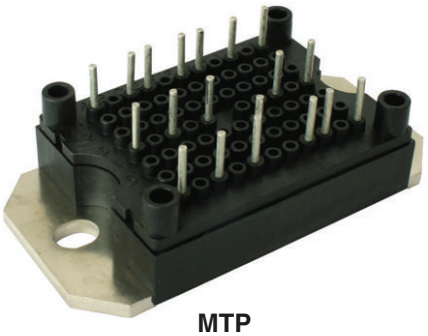
# "Full Bridge" IGBT MTP (TrenchStop IGBT), 57 A



MTP
(Package example)

## FEATURES

- Trench and Field Stop IGBT technology
- Positive $V_{CE(on)}$ temperature coefficient
- 10 µs short circuit capability
- HEXFRED® antiparallel diodes with ultrasoft reverse recovery
- Low diode $V_F$
- Square RBSOA
- Aluminum nitride DBC
- Very low stray inductance design for high speed operation
- UL approved file E78996
- Designed and qualified for industrial level
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free

RoHS COMPLIANT

## BENEFITS

- Optimized for welding, UPS and SMPS applications
- Rugged with ultrafast performance
- Outstanding ZVS and hard switching operation
- Low EMI, requires less snubbing
- Excellent current sharing in parallel operation
- Direct mounting to heatsink
- PCB solderable terminals
- Very low junction to case thermal resistance

| PRIMARY CHARACTERISTICS | |
|---|---|
| $V_{CES}$ | 1200 V |
| $I_C$ at $T_C$ = 25 °C | 57 A |
| $V_{CE(on)}$ | 1.84 V |
| Speed | 8 kHz to 30 kHz |
| Package | MTP |
| Circuit configuration | Full bridge |

| ABSOLUTE MAXIMUM RATINGS | | | | |
|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS | MAX. | UNITS |
| Collector to emitter breakdown voltage | $V_{CES}$ | | 1200 | V |
| Continuous collector current | $I_C$ | $T_C$ = 25 °C | 57 | A |
| | | $T_C$ = 80 °C | 42 | |
| Pulsed collector current | $I_{CM}$ | $T_J$ = 150 °C, $t_p$ = 6 ms, $V_{GE}$ = 15 V | 50 | |
| Clamped inductive load current | $I_{LM}$ | | 75 | |
| Diode continuous forward current | $I_F$ | $T_C$ = 106 °C | 25 | |
| Diode maximum forward current | $I_{FM}$ | | 100 | |
| Gate to emitter voltage | $V_{GE}$ | | ± 20 | V |
| RMS isolation voltage | $V_{ISOL}$ | Any terminal to case, t = 1 min | 2500 | |
| Maximum power dissipation (only IGBT) | $P_D$ | $T_C$ = 25 °C | 240 | W |
| | | $T_C$ = 80 °C | 134 | |



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| ELECTRICAL SPECIFICATIONS ($T_J$ = 25 °C unless otherwise noted) | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| Collector to emitter breakdown voltage | $V_{(BR)CES}$ | $V_{GE}$ = 0 V, $I_C$ = 850 µA | 1200 | - | - | V |
| Collector to emitter saturation voltage | $V_{CE(on)}$ | $V_{GE}$ = 15 V, $I_C$ = 20 A | - | 1.84 | 2.16 | V |
| | | $V_{GE}$ = 15 V, $I_C$ = 40 A | - | 2.60 | - | |
| | | $V_{GE}$ = 15 V, $I_C$ = 20 A, $T_J$ = 125 °C | - | 2.06 | - | |
| | | $V_{GE}$ = 15 V, $I_C$ = 40 A, $T_J$ = 125 °C | - | 3.19 | - | |
| | | $V_{GE}$ = 15 V, $I_C$ = 20 A, $T_J$ = 150 °C | - | 2.12 | - | |
| Gate threshold voltage | $V_{GE(th)}$ | $V_{CE}$ = $V_{GE}$, $I_C$ = 850 µA | 4.7 | 5.8 | 6.8 | |
| Temperature coefficient of threshold voltage | $V_{GE(th)}/\Delta T_J$ | $V_{CE}$ = $V_{GE}$, $I_C$ = 0.85 mA (25 °C to 125 °C) | - | -12.1 | - | mV/°C |
| Transconductance | $g_{fe}$ | $V_{CE}$ = 20 V, $I_C$ = 20 A | - | 13 | - | S |
| Zero gate voltage collector current | $I_{CES}$ (1) | $V_{GE}$ = 0 V, $V_{CE}$ = 1200 V, $T_J$ = 25 °C | - | 1.0 | 200 | µA |
| | | $V_{GE}$ = 0 V, $V_{CE}$ = 1200 V, $T_J$ = 125 °C | - | 0.52 | - | mA |
| | | $V_{GE}$ = 0 V, $V_{CE}$ = 1200 V, $T_J$ = 150 °C | - | 2.1 | - | |
| Gate to emitter leakage current | $I_{GES}$ | $V_{GE}$ = ± 20 V | - | - | ± 250 | nA |

**Note**

(1) $I_{CES}$ includes also opposite leg overall leakage

| SWITCHING CHARACTERISTICS ($T_J$ = 25 °C unless otherwise specified) | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| Total gate charge (turn-on) | $Q_g$ | $I_C$ = 20 A<br>$V_{CC}$ = 960 V<br>$V_{GE}$ = 15 V | - | 119 | - | nC |
| Gate to emitter charge (turn-on) | $Q_{ge}$ | | - | 20 | - | |
| Gate to collector charge (turn-on) | $Q_{gc}$ | | - | 57 | - | |
| Turn-on switching loss | $E_{on}$ | $V_{CC}$ = 600 V, $I_C$ = 20 A, $V_{GE}$ = 15 V,<br>$R_g$ = 5 Ω, L = 1 mH, $T_J$ = 25 °C,<br>energy losses include tail and<br>diode reverse recovery | - | 0.75 | - | mJ |
| Turn-off switching loss | $E_{off}$ | | - | 0.66 | - | |
| Total switching loss | $E_{tot}$ | | - | 1.41 | - | |
| Turn-on switching loss | $E_{on}$ | $V_{CC}$ = 600 V, $I_C$ = 20 A, $V_{GE}$ = 15 V,<br>$R_g$ = 5 Ω, L = 1 mH, $T_J$ = 125 °C,<br>energy losses include tail and<br>diode reverse recovery | - | 1.08 | - | |
| Turn-off switching loss | $E_{off}$ | | - | 1.18 | - | |
| Total switching loss | $E_{tot}$ | | - | 2.26 | - | |
| Input capacitance | $C_{ies}$ | $V_{GE}$ = 0 V<br>$V_{CC}$ = 30 V<br>f = 1.0 MHz | - | 1430 | - | pF |
| Output capacitance | $C_{oes}$ | | - | 115 | - | |
| Reverse transfer capacitance | $C_{res}$ | | - | 75 | - | |
| Reverse bias safe operating area | RBSOA | $T_J$ = 150 °C,<br>$I_C$ = 75 A, $V_{CC}$ = 900 V, $V_p$ = 1200 V,<br>$R_g$ = 4.7 Ω, $V_{GE}$ = + 15 V to 0 V,<br>L = 500 µH | Fullsquare | | | |
| Short circuit safe operating area | SCSOA | $T_J$ = 150 °C,<br>$V_{CC}$ = 800 V, $V_p$ = 1200 V,<br>$R_g$ = 5 Ω, $V_{GE}$ = +15 V to 0 V | - | - | 10 | µs |

| DIODE SPECIFICATIONS ($T_J$ = 25 °C unless otherwise specified) | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| Diode forward voltage drop | $V_{FM}$ | $I_C$ = 20 A | - | 2.48 | 2.94 | V |
| | | $I_C$ = 40 A | - | 3.28 | - | |
| | | $I_C$ = 20 A, $T_J$ = 125 °C | - | 2.44 | - | |
| | | $I_C$ = 40 A, $T_J$ = 125 °C | - | 3.45 | - | |
| | | $I_C$ = 20 A, $T_J$ = 150 °C | - | 2.21 | - | |
| Reverse recovery energy of the diode | $E_{rec}$ | $V_{GE}$ = 15 V, $R_g$ = 5 Ω, L = 200 µH<br>$V_{CC}$ = 600 V, $I_C$ = 20 A<br>$T_J$ = 125 °C | - | 420 | - | µJ |
| Diode reverse recovery time | $t_{rr}$ | | - | 98 | - | ns |
| Peak reverse recovery current | $I_{rr}$ | | - | 33 | - | A |


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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 | $R_{thJC}$ | | - | - | 0.52 | °C/W |
| | Diode | | | - | - | 0.61 | |
| Case to sink per module | | $R_{thCS}$ | | - | 0.06 | - | |
| Clearance | | | External shortest distance in air between 2 terminals | 5.5 | - | - | mm |
| Creepage | | | Shortest distance along external surface of the insulating material between 2 terminals | 8 | - | - | |
| Mounting torque | | | A mounting compound is recommended and the torque should be checked after 3 hours to allow for the spread of the compound. Lubricated threads. | 3 ± 10 % | | | Nm |
| Weight | | | | 66 | | | g |

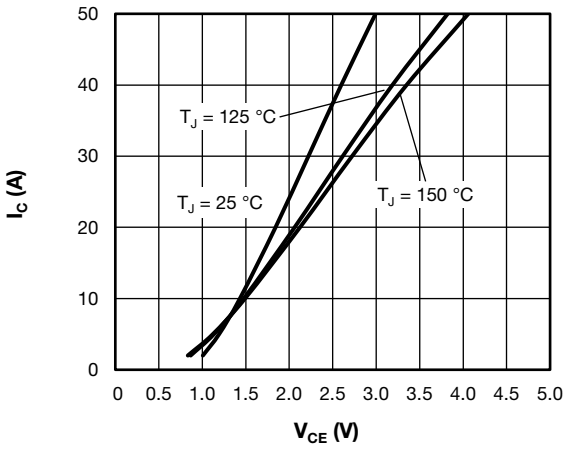



Fig. 1 - Typical Trench IGBT Output Characteristics, $V_{GE}$ = 15 V

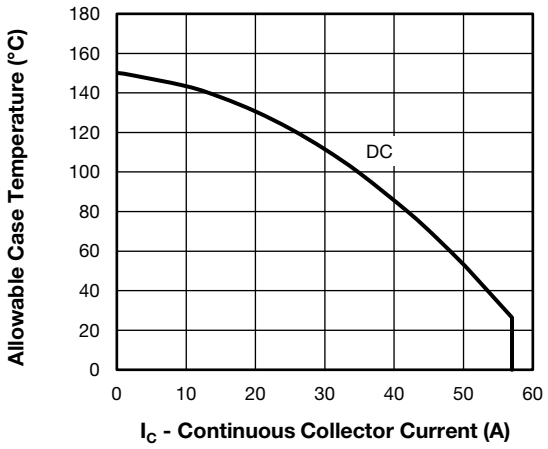



Fig. 3 - Maximum Trench IGBT Continuous Collector Current vs. Case Temperature

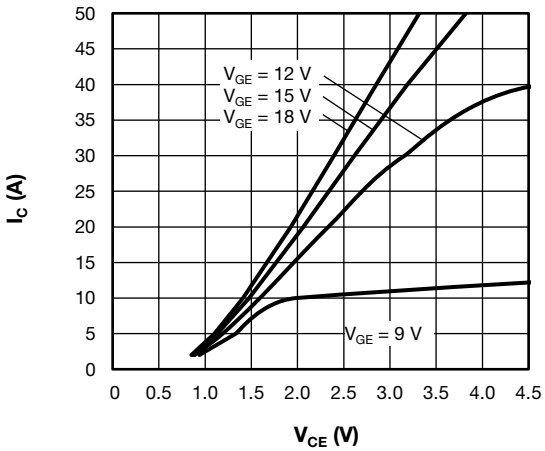



Fig. 2 - Typical Trench IGBT Output Characteristics, $T_J$ = 125 °C

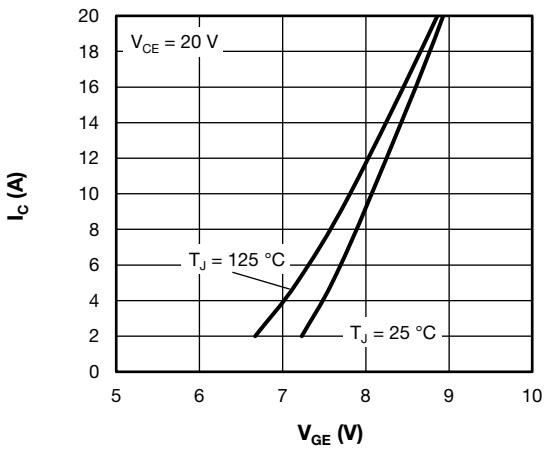



Fig. 4 - Typical Trench IGBT Transfer Characteristics


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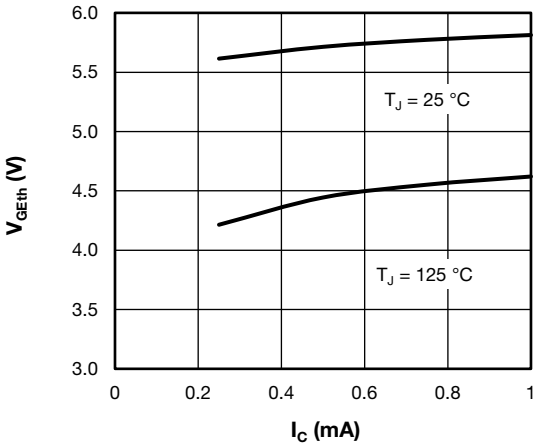



Fig. 5 - Typical Trench IGBT Gate Threshold Voltage

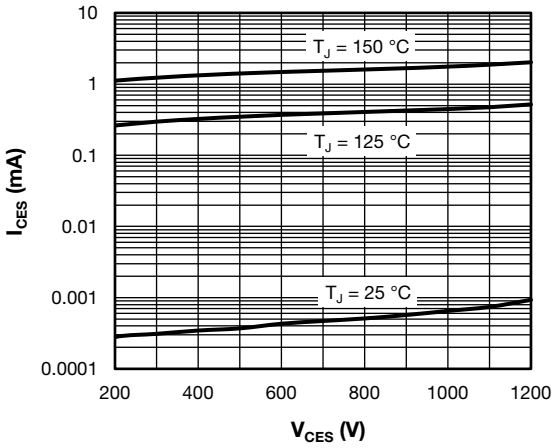



Fig. 6 - Typical Trench IGBT Zero Gate Voltage Collector Current

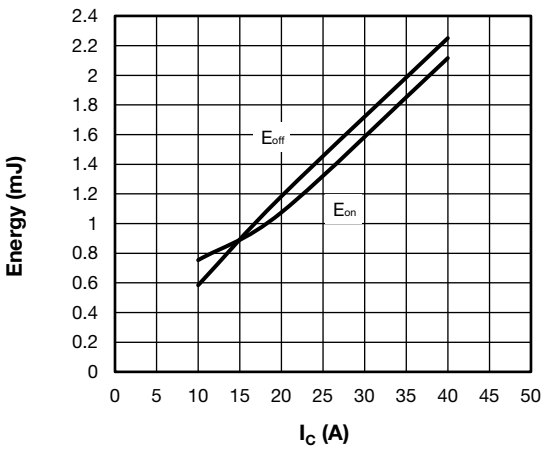



Fig. 7 - Typical Trench IGBT Energy Loss vs. $I_C$
(with Antiparallel Diode)
$T_J$ = 125 °C, $V_{CC}$ = 600 V, $R_g$ = 4.7 Ω, $V_{GE}$ = +15V/-15V, L = 500 µH

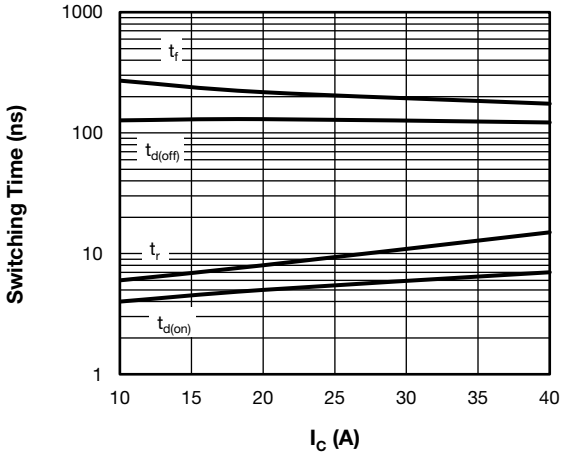



Fig. 8 - Typical Trench IGBT Switching Time vs. $I_C$
(with Antiparallel Diode)
$T_J$ = 125 °C, $V_{CC}$ = 600 V, $R_g$ = 4.7 Ω, $V_{GE}$ = +15V/-15V, L = 500 µH

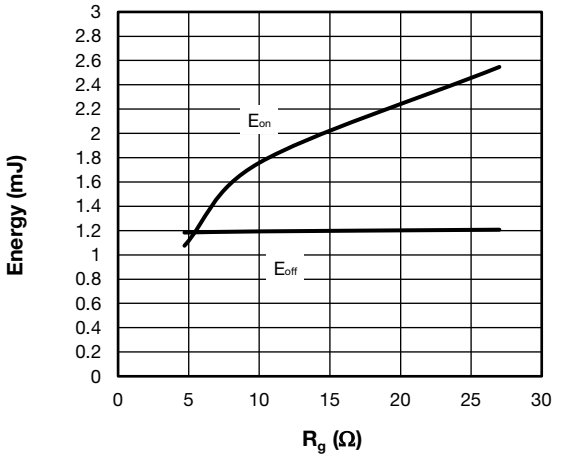



Fig. 9 - Typical Trench IGBT Energy Loss vs. $R_g$
(with Antiparallel Diode)
$T_J$ = 125 °C, $V_{CC}$ = 600 V, $I_C$ = 20 A, $V_{GE}$ = +15V/-15V, L = 500 µH

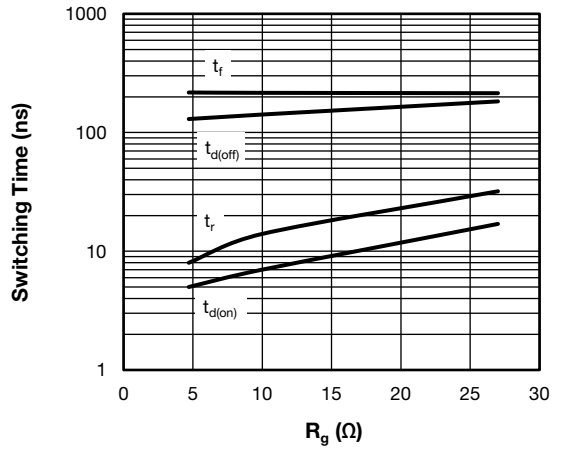



Fig. 10 - Typical Trench IGBT Switching Time vs. $R_g$
(with Antiparallel Diode)
$T_J$ = 125 °C, $V_{CC}$ = 600 V, $I_C$ = 20 A, $V_{GE}$ = +15V/-15V, L = 500 µH


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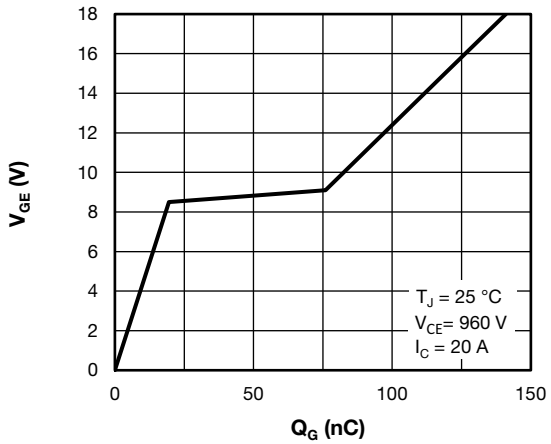



Fig. 11 - Typical Trench IGBT Gate charge vs. Gate to Emitter Voltage

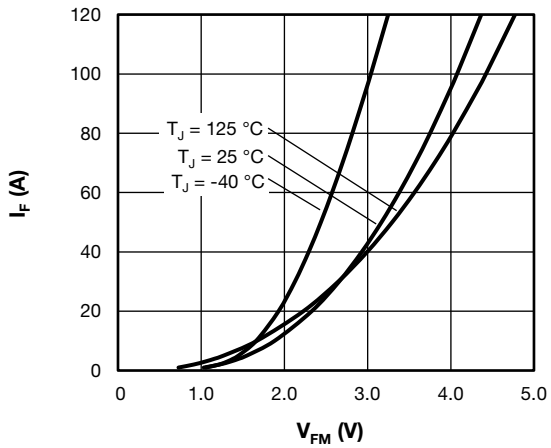



Fig. 12 - Typical Diode Forward Characteristics
$t_p$ = 80 µs

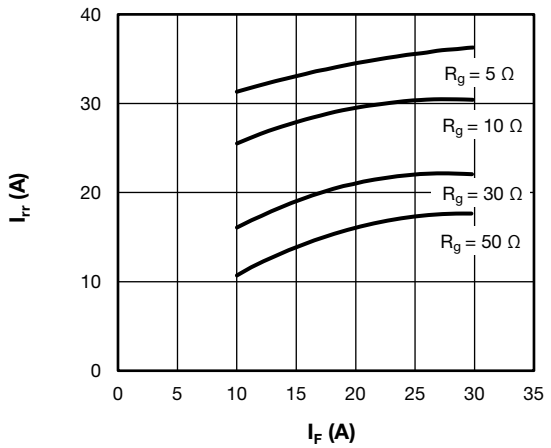



Fig. 13 - Typical Diode $I_{rr}$ vs. $I_F$,
$T_J$ = 150 °C

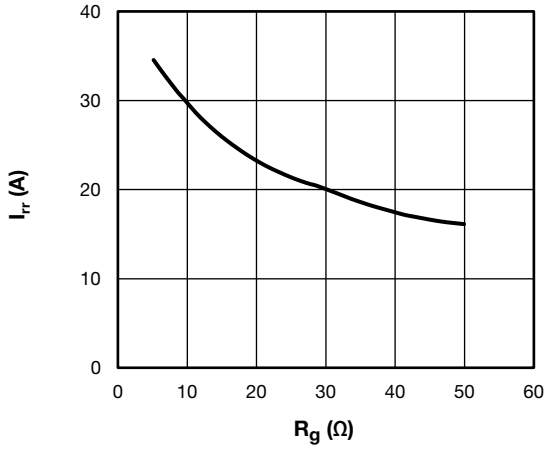



Fig. 14 - Typical Diode $I_{rr}$ vs. $R_g$
$T_J$ = 150 °C; $I_F$ = 5.0 A

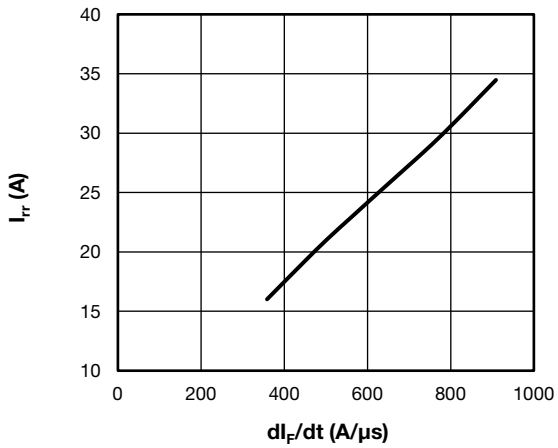



Fig. 15 - Typical Diode $I_{rr}$ vs. $dI_F/dt$
$V_{CC}$ = 400 V; $V_{GE}$ = 15 V; $I_{CE}$ = 5.0 A; $T_J$ = 150 °C

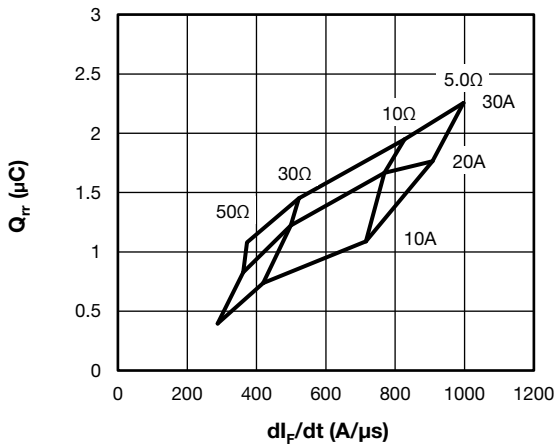



Fig. 16 - Typical Diode $Q_{rr}$ vs. $dI_F/dt$
$V_{CC}$ = 400 V; $V_{GE}$ = 15 V; $T_J$ = 150 °C


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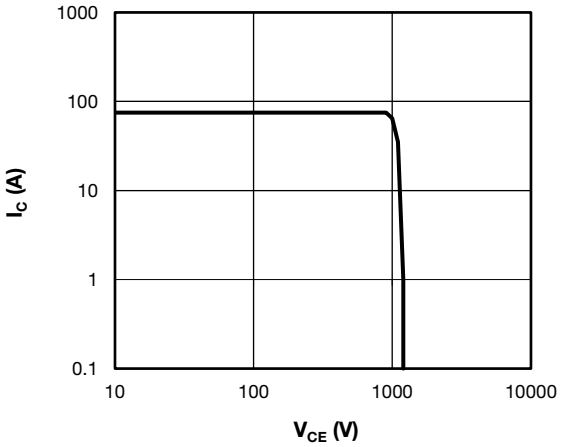



Fig. 17 - Trench IGBT Reverse BIAS SOA
$T_J$ = 150 °C, $I_C$ = 75 A, $R_g$ = 4.7 Ω, $V_{GE}$ = +15V/0 V, $V_{CC}$ = 700 V, $V_p$ = 1200 V

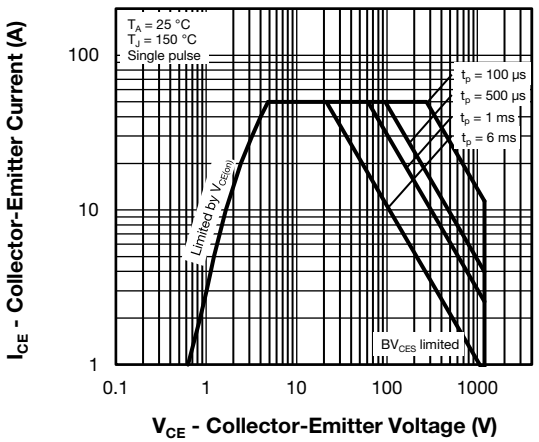



Fig. 18 - Trench IGBT Safe Operating Area

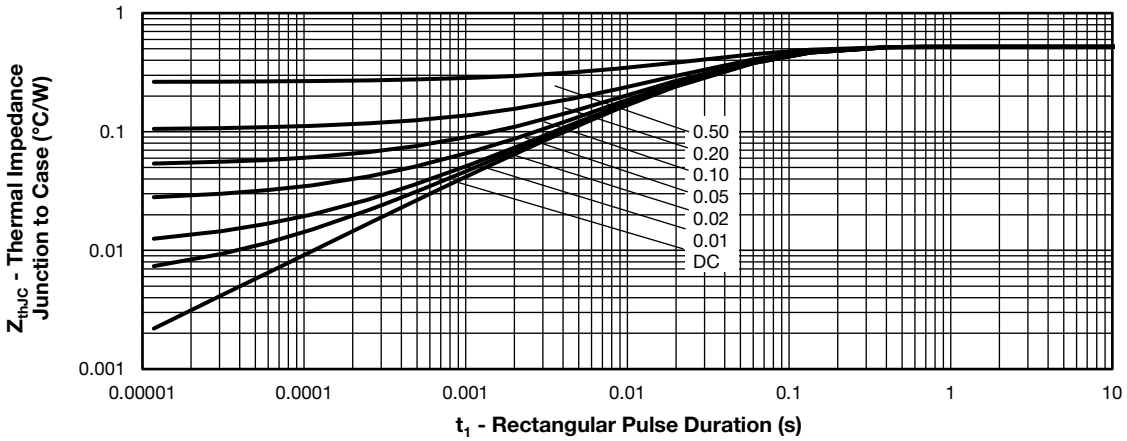



Fig. 19 - Maximum Trench IGBT Thermal Impedance $Z_{thJC}$ Characteristics

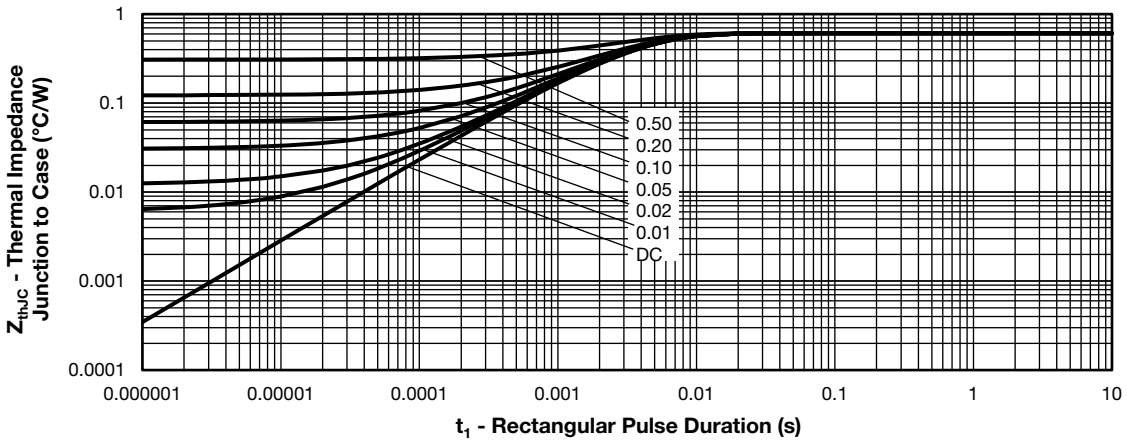



Fig. 20 - Maximum Diode Thermal Impedance $Z_{thJC}$ Characteristics


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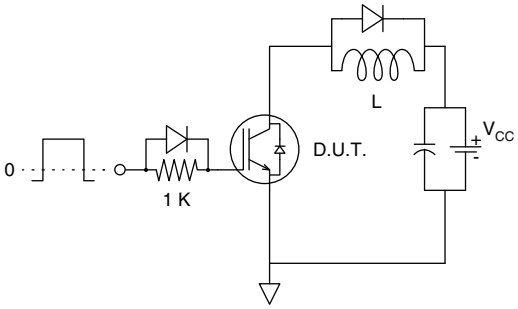



Fig. 21 - Gate Charge Circuit (Turn-Off)

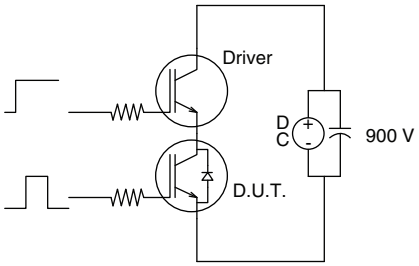



Fig. 23 - S.C. SOA Circuit

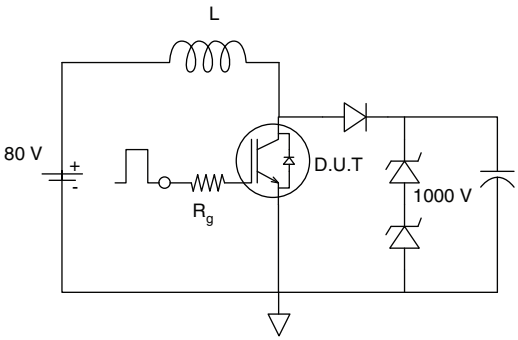



Fig. 22 - RBSOA Circuit

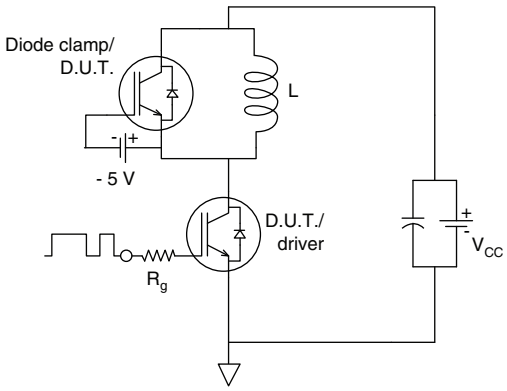



Fig. 24 - Switching Loss Circuit

## ORDERING INFORMATION TABLE

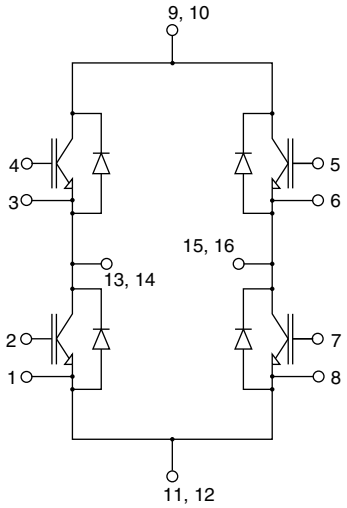
**Device code**

| VS- | 20 | MT | 120 | P | F | P |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

| | | |
|---|---|---|
| 1 | - | Vishay Semiconductors product |
| 2 | - | Current rating (20 = 20 A) |
| 3 | - | Essential part number |
| 4 | - | Voltage code (120 = 1200 V) |
| 5 | - | Speed / type (P = Trench IGBT) |
| 6 | - | Circuit configuration (F = full bridge) |
| 7 | - | P = lead (Pb)-free |


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## CIRCUIT CONFIGURATION

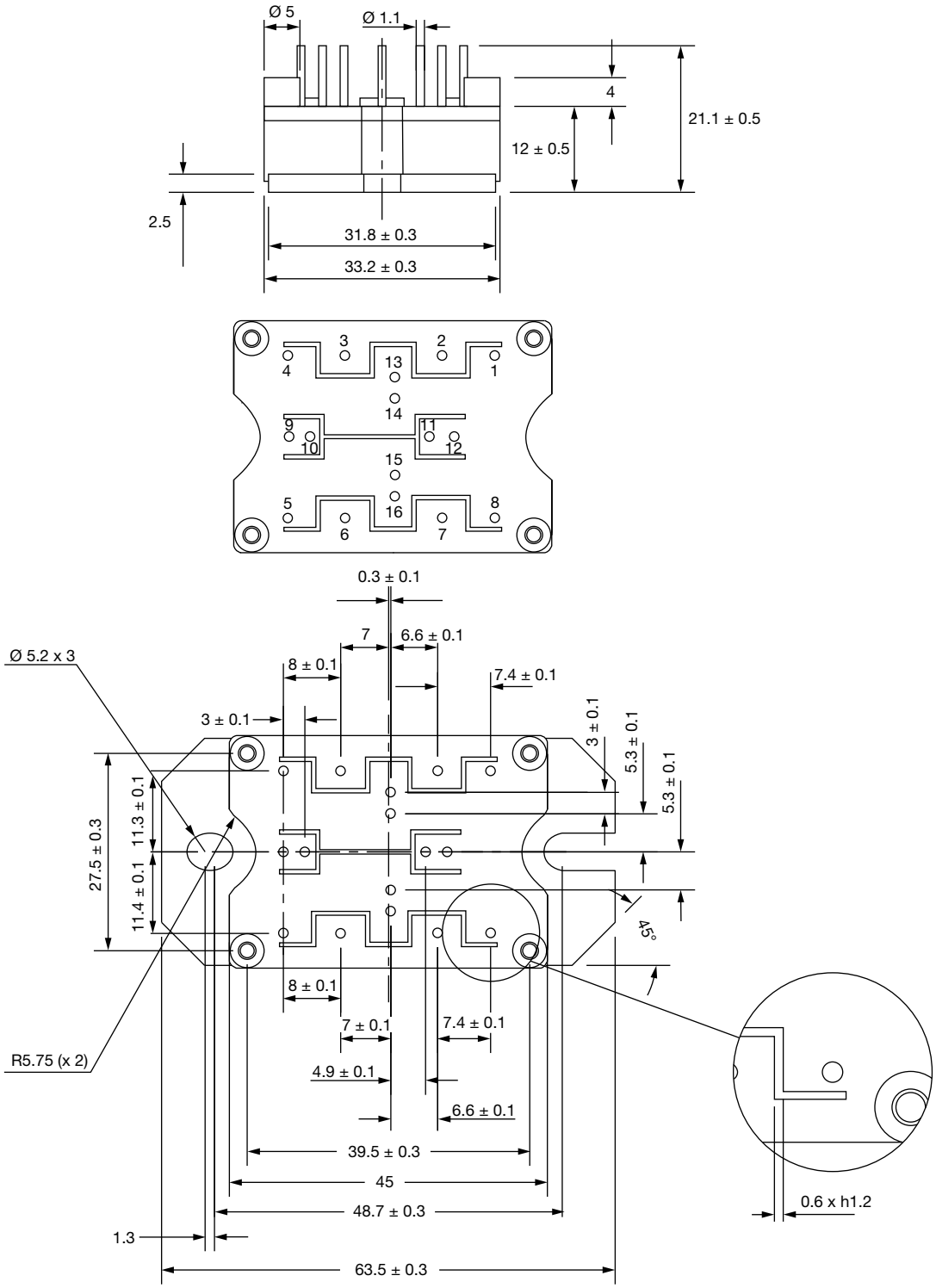



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# MTP MOSFET / IGBT Full-Bridge

**DIMENSIONS** in millimeters




Tolerance (unless other stated):
X = ± 0.3
X.X = ± 0.1
X.XX = ± 0.03



For technical questions within your region: DiodesAmericas@vishay.com, DiodesAsia@vishay.com, DiodesEurope@vishay.com

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