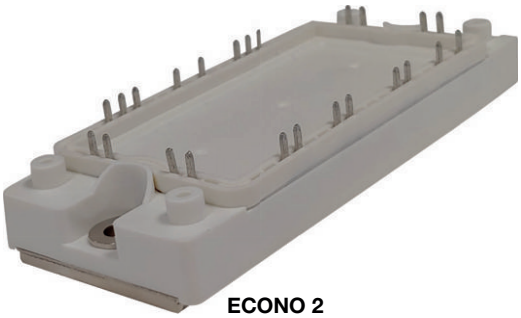
# IGBT Fourpack Module, 50 A



**ECONO 2**
**(Package example)**

## FEATURES

- Trench gate field stop IGBT
- Square RBSOA
- HEXFRED® low $Q_{rr}$, low switching energy
- Positive $V_{CE(on)}$ temperature coefficient
- Copper baseplate
- Low stray inductance design
- Designed and qualified for industrial market
- UL approved file E78996
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free
RoHS COMPLIANT

## BENEFITS

- Benchmark efficiency for SMPS appreciation in particular HF welding
- Rugged transient performance
- Low EMI, requires less snubbing
- Direct mounting to heatsink space saving
- PCB solderable terminals
- Low junction to case thermal resistance

| PRIMARY CHARACTERISTICS | |
|---|---|
| $V_{CES}$ | 1200 V |
| $I_C$ at $T_C$ = 66 °C | 50 A |
| $V_{CE(on)}$ (typical) | 2.34 V |
| Speed | 8 kHz to 30 kHz |
| Package | ECONO 2 |
| Circuit configuration | 4 pack |

**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 | 64 | A |
| | | $T_C$ = 80 °C | 44 | |
| Pulsed collector current, see fig. C.T.5 | $I_{CM}$ | $T_J$ = 150 °C, $t_p$ = 6 ms, $V_{GE}$ = 15 V | 180 | |
| Clamped inductive load current | $I_{LM}$ | | 150 | |
| Diode continuous forward current | $I_F$ | $T_C$ = 25 °C | 40 | |
| | | $T_C$ = 80 °C | 25 | |
| Diode maximum forward current | $I_{FM}$ | | 150 | |
| Gate to emitter voltage | $V_{GE}$ | | ± 20 | V |
| Maximum power dissipation (IGBT) | $P_D$ | $T_C$ = 25 °C | 231 | W |
| | | $T_C$ = 80 °C | 130 | |
| Isolation voltage | $V_{ISOL}$ | | AC 2500 (min) | 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 | $BV_{(CES)}$ | $V_{GE}$ = 0 V, $I_C$ = 2 mA | 1200 | - | - | V |
| Collector to emitter voltage | $V_{CE(ON)}$ | $I_C$ = 50 A, $V_{GE}$ = 15 V | - | 2.34 | 2.80 | |
| | | $I_C$ = 50 A, $V_{GE}$ = 15 V, $T_J$ = 125 °C | - | 2.66 | - | |
| Gate threshold voltage | $V_{GE(th)}$ | $V_{CE}$ = $V_{GE}$, $I_C$ = 2 mA | 4.6 | 5.9 | 7.6 | |
| Threshold voltage temperature coefficient | $\Delta V_{GE(th)}/\Delta T_J$ | $V_{CE}$ = $V_{GE}$, $I_C$ = 2 mA (25 °C to 125 °C) | - | -13 | - | mV/°C |
| Zero gate voltage collector current | $I_{CES}$ | $V_{GE}$ = 0 V, $V_{CE}$ = 1200 V | - | 1 | 50 | µA |
| | | $V_{GE}$ = 0 V, $V_{CE}$ = 1200 V, $T_J$ = 125 °C | - | 670 | - | |
| Diode forward voltage drop | $V_{FM}$ | $I_F$ = 50 A | - | 3.30 | 4.5 | V |
| | | $I_F$ = 50 A, $T_J$ = 125 °C | - | 3.60 | - | |
| Gate to emitter leakage current | $I_{GES}$ | $V_{GE}$ = ± 20 V | - | - | ± 200 | nA |

| **SWITCHING CHARACTERISTICS** ($T_J$ = 25 °C unless otherwise noted) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| Total gate charge (turn-on) | $Q_G$ | $I_C$ = 50 A<br>$V_{CC}$ = 960 V<br>$V_{GE}$ = 15 V | | - | 154 | - | nC |
| Gate to emitter charge (turn-on) | $Q_{GE}$ | | | - | 17 | - | |
| Gate to collector charge (turn-on) | $Q_{GC}$ | | | - | 79 | - | |
| Turn-on switching loss | $E_{on}$ | $I_C$ = 50 A, $V_{CC}$ = 600 V<br>$V_{GE}$ = 15 V, $R_G$ = 4.7 Ω, L = 500 µH<br>$T_J$ = 25 °C (1) | | - | 1.17 | - | mJ |
| Turn-off switching loss | $E_{off}$ | | | - | 1.50 | - | |
| Total switching loss | $E_{tot}$ | | | - | 2.67 | - | |
| Turn-on switching loss | $E_{on}$ | $I_C$ = 50 A, $V_{CC}$ = 600 V<br>$V_{GE}$ = 15 V, $R_G$ = 4.7 Ω, L = 500 µH<br>$T_J$ = 125 °C (1) | | - | 1.58 | - | |
| Turn-off switching loss | $E_{off}$ | | | - | 2.52 | - | |
| Total switching loss | $E_{tot}$ | | | - | 4.10 | - | |
| Turn-on delay time | $t_{d(on)}$ | $I_C$ = 50 A, $V_{CC}$ = 600 V<br>$V_{GE}$ = 15 V, $R_G$ = 4.7 Ω, L = 500 µH<br>$T_J$ = 125 °C | | - | 44 | - | ns |
| Rise time | $t_r$ | | | - | 11 | - | |
| Turn-off delay time | $t_{d(off)}$ | | | - | 96 | - | |
| Fall time | $t_f$ | | | - | 187 | - | |
| Reverse bias safe operating area | RBSOA | $T_J$ = 150 °C, $I_C$ = 150 A, $V_{CC}$ = 800 V,<br>$V_P$ = 1200 V, $R_g$ = 4.7 Ω,<br>$V_{GE}$ = 15 V to 0 V | | Fullsquare | | | |
| Short circuit safe operating area | SCSOA | $T_J$ = 150 °C<br>$V_{CC}$ = 600 V, $V_P$ = 1200 V<br>$R_G$ = 10 Ω, $V_{GE}$ = 15 V to 0 V | | 5 | - | - | µs |
| Diode peak reverse recovery current | $I_{rr}$ | $T_J$ = 25 °C | $V_{CC}$ = 600 V<br>$I_F$ = 50 A<br>dI/dt = 7 A/µs | - | 1.3 | - | A |
| | | $T_J$ = 125 °C | | - | 2.0 | - | |
| Diode reverse recovery time | $t_{rr}$ | $T_J$ = 25 °C | | - | 0.453 | - | µs |
| | | $T_J$ = 125 °C | | - | 0.74 | - | |
| Total reverse recovery charge | $Q_{rr}$ | $T_J$ = 25 °C | | - | 0.12 | - | µC |
| | | $T_J$ = 125 °C | | - | 0.4 | - | |

**Note**

(1) Energy losses include “tail” and diode reverse recovery

| **INTERNAL NTC - THERMISTOR SPECIFICATIONS** | | | | |
|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **TYP.** | **UNITS** |
| Resistance | $R_{25}$ | $T_C$= 25 °C | 5000 | Ω |
| | $R_{100}$ | $T_C$= 100 °C | 493 ± 5 % | |
| B-value | $B_{25/50}$ | $R_2 = R_{25}$ exp. [$B_{25/50}$ (1/$T_2$ - 1/(298.15K))] | 3375 ± 5 % | K |
| Maximum operating temperature | | | 220 | °C |
| Dissipation constant | | | 2 | mW/°C |
| Thermal time constant | | | 8 | s |


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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 | $R_{thJC}$ | | - | - | 0.54 | °C/W |
| Junction to case DIODE | $R_{thJC}$ | | - | - | 1 | |
| Case to sink per module | $R_{thCS}$ | | - | 0.05 | - | |
| Mounting torque (M5) | | | 2.7 | - | 3.3 | Nm |
| Weight | | | - | 170 | - | g |

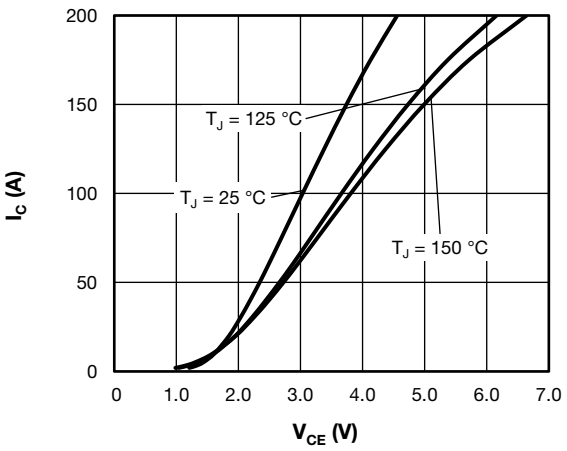


Fig. 1 - Typical Trench IGBT Output Characteristics, $V_{GE}$ = 15 V

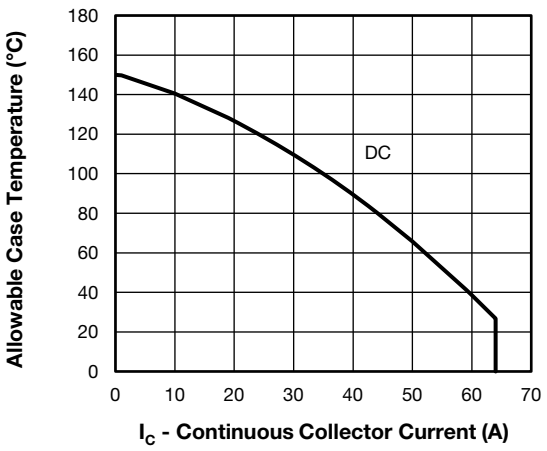


Fig. 3 - Maximum Trench IGBT Continuous Collector Current vs. Case Temperature

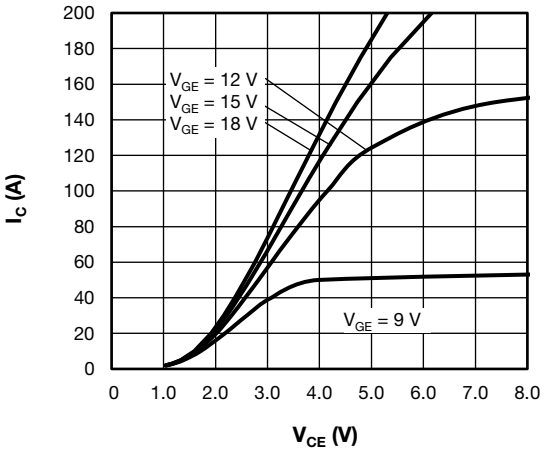


Fig. 2 - Typical Trench IGBT Output Characteristics, $T_J$ = 125 °C

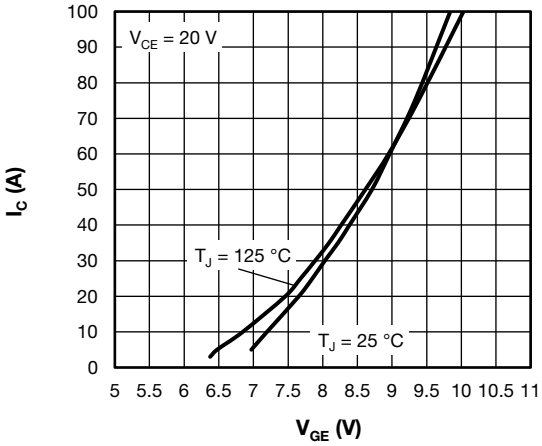


Fig. 4 - Typical Trench IGBT Transfer Characteristics


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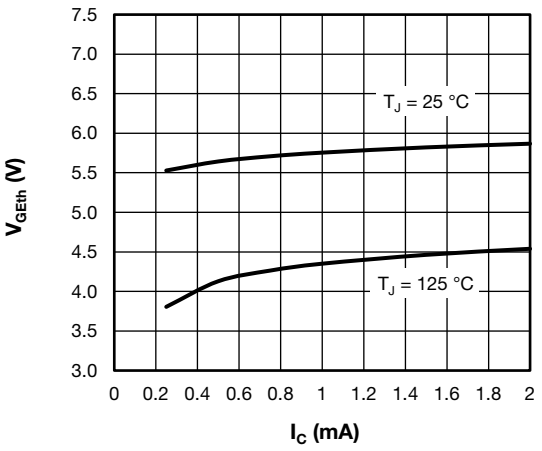


Fig. 5 - Typical Trench IGBT Gate Threshold Voltage

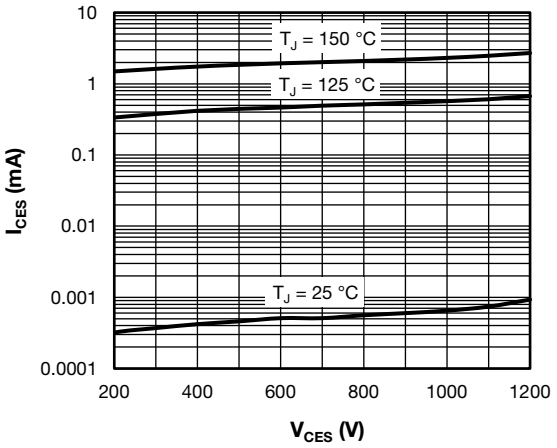


Fig. 6 - Typical Trench IGBT Zero Gate Voltage Collector Current

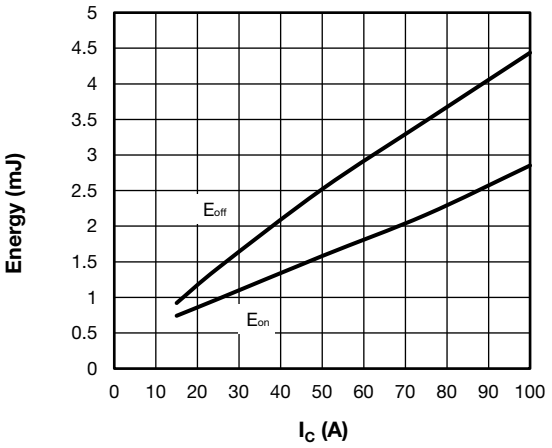


Fig. 7 - Typical Trench IGBT Energy Loss vs. $I_C$
(with Antiparallel Diode)
$T_J$ = 125 °C, $V_{CC}$ = 600 V, $R_g$ = 4.7 Ω, $V_{GE}$ = +15 V/-15 V, L = 500 μH

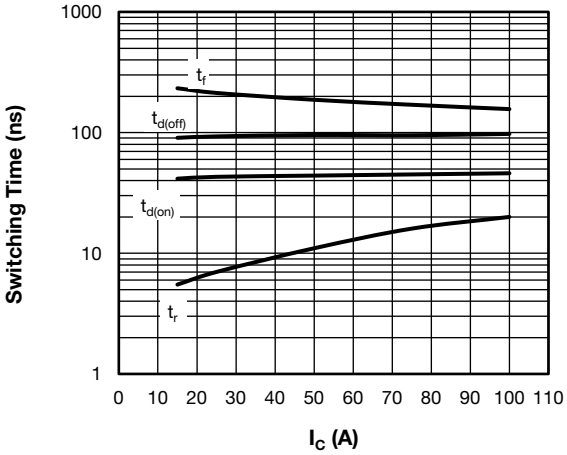


Fig. 8 - Typical Trench IGBT Switching Time vs. $I_C$
(with Antiparallel Diode)
$T_J$ = 125 °C, $V_{CC}$ = 600 V, $R_g$ = 4.7 Ω, $V_{GE}$ = +15 V/-15 V, L = 500 μH

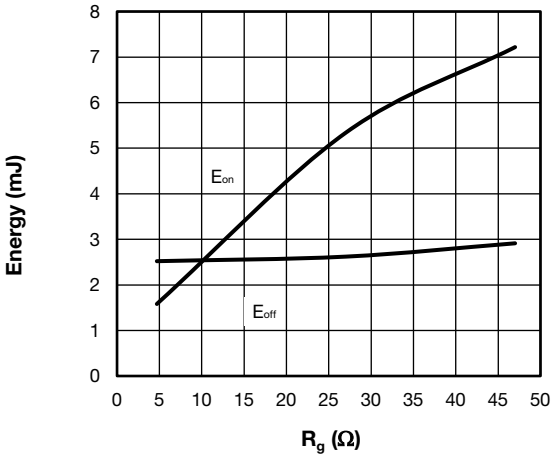


Fig. 9 - Typical Trench IGBT Energy Loss vs. $R_g$
(with Antiparallel Diode)
$T_J$ = 125 °C, $V_{CC}$ = 600 V, $I_C$ = 40 A, $V_{GE}$ = +15 V/-15 V, L = 500 μH

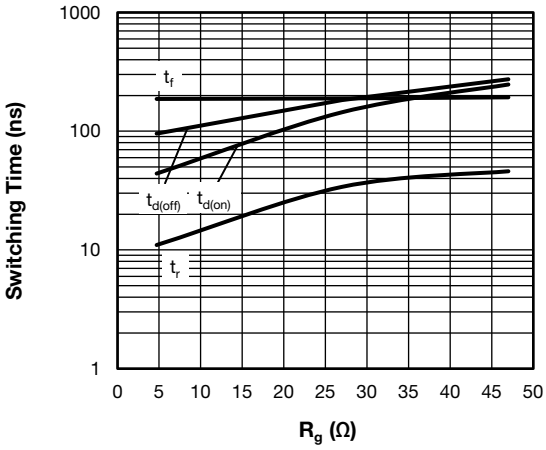


Fig. 10 - Typical Trench IGBT Switching Time vs. $R_g$
(with Antiparallel Diode)
$T_J$ = 125 °C, $V_{CC}$ = 600 V, $I_C$ = 50 A, $V_{GE}$ = +15 V/-15 V, L = 500 μH


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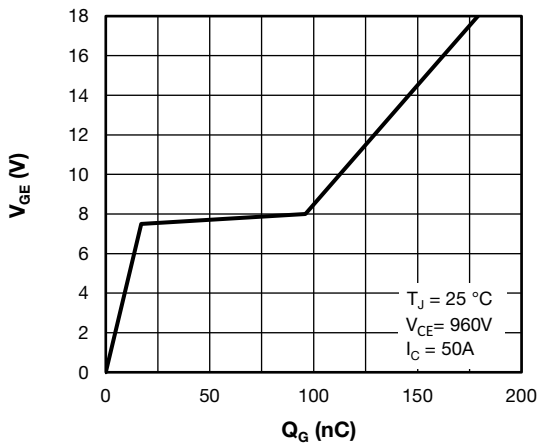


Fig. 11 - Typical Trench IGBT Gate Charge vs. Gate to Emitter Voltage

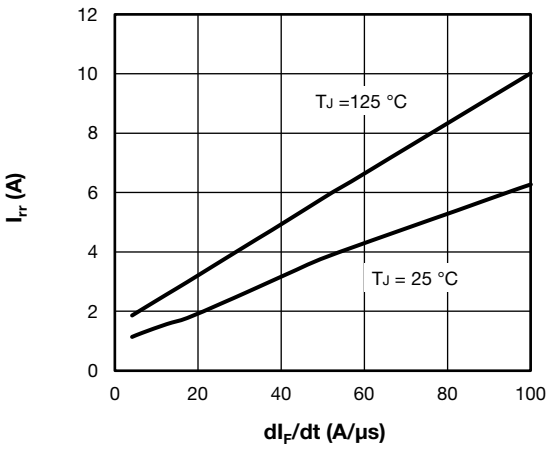


Fig. 14 - Typical Diode Reverse Recovery Current vs. $dI_F/dt$

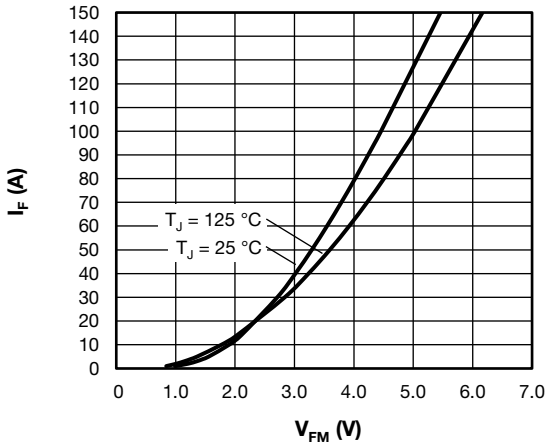


Fig. 12 - Typical Diode Forward Characteristics

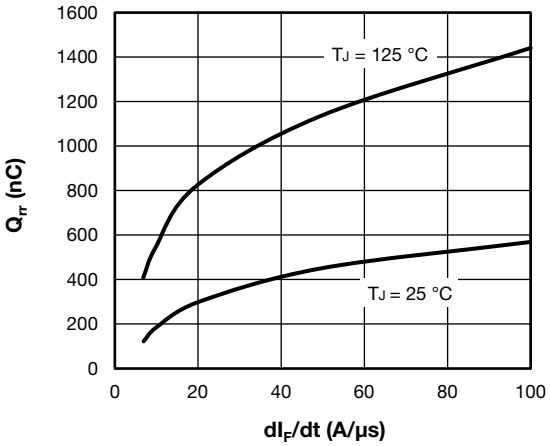


Fig. 15 - Typical Diode Reverse Recovery Charge vs. $dI_F/dt$

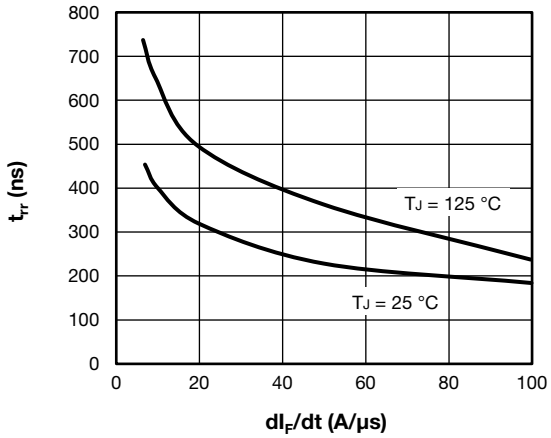


Fig. 13 - Typical Diode Reverse Recovery Time vs. $dI_F/dt$

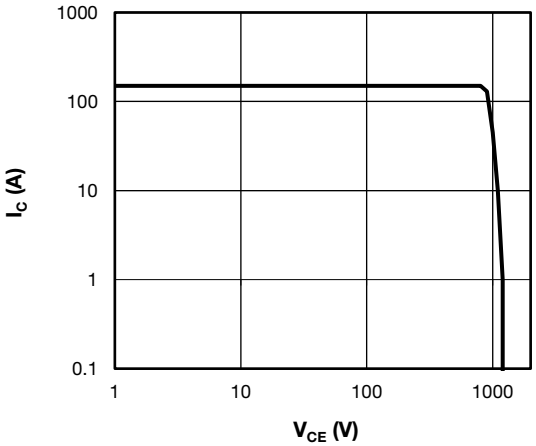


Fig. 16 - Trench IGBT Reverse BIAS SOA
$T_J$ = 150 °C, $I_C$ = 150 A, $R_g$ = 4.7 Ω, $V_{GE}$ = +15 V / 0 V, $V_{CC}$ = 800 V, $V_p$ = 1200 V


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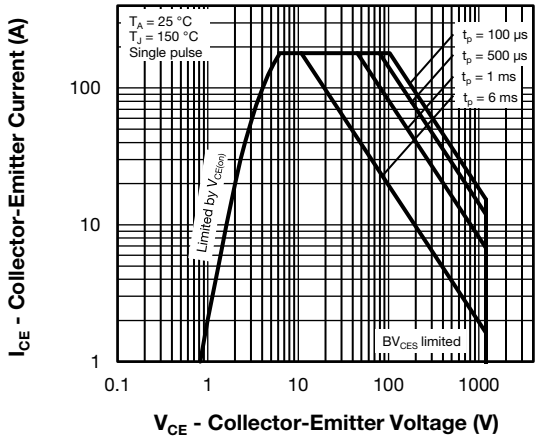


Fig. 17 - Trench IGBT Safe Operating Area

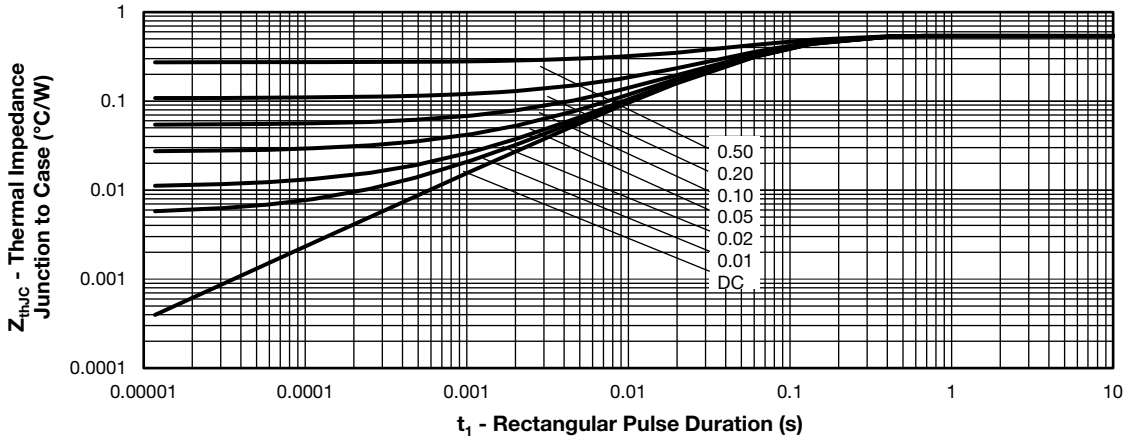


Fig. 18 - Maximum Trench IGBT Thermal Impedance $Z_{thJC}$ Characteristics

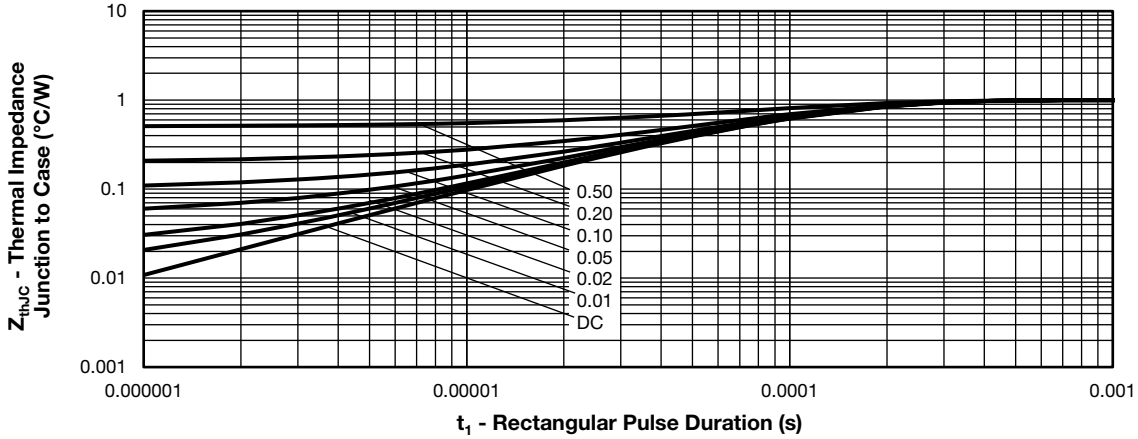


Fig. 19 - Maximum Diode Thermal Impedance $Z_{thJC}$ Characteristics


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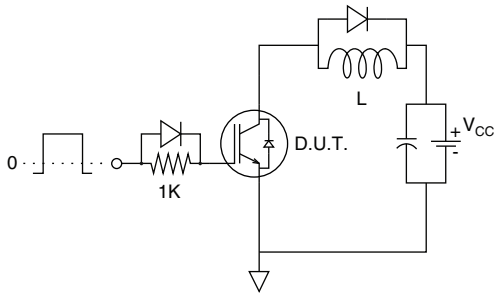


Fig. 20 - Gate Charge Circuit (Turn-Off)

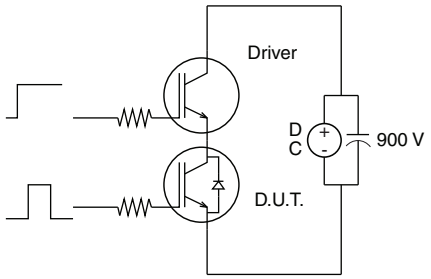


Fig. 22 - S.C. SOA Circuit

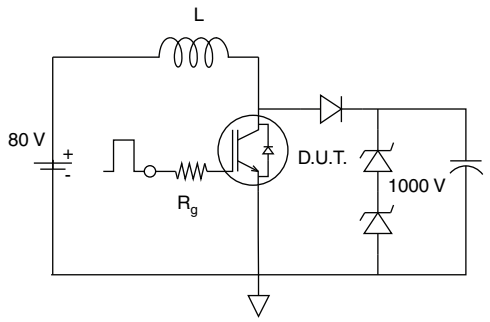


Fig. 21 - RBSOA Circuit

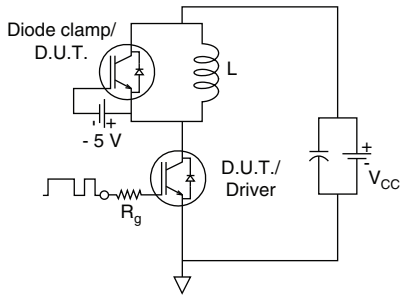


Fig. 23 - Switching Loss Circuit

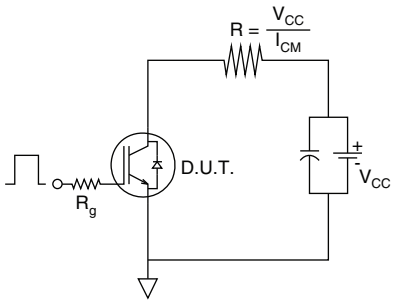


Fig. 24 - Resistive Load Circuit


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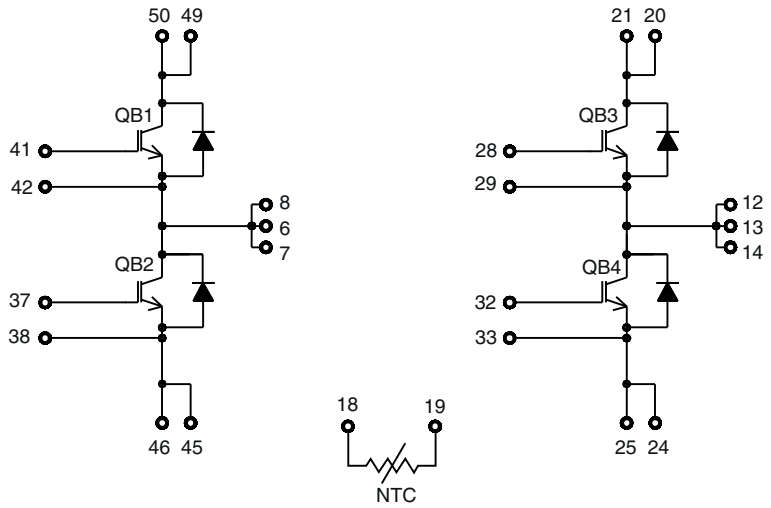
## ORDERING INFORMATION TABLE

| Device code | VS- | G | T | 50 | Y | F | 120 | N | T |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

| | | |
|---|---|---|
| 1 | - | Vishay Semiconductors product |
| 2 | - | Insulated gate bipolar transistor (IGBT) |
| 3 | - | T = Trench gate field stop IGBT |
| 4 | - | Current rating (50 = 50 A) |
| 5 | - | Circuit configuration (Y = 4 pack) |
| 6 | - | Package indicator (F = ECONO 2) |
| 7 | - | Voltage rating (120 = 1200 V) |
| 8 | - | Speed/type (N = ultrafast with reduced diode, speed 8 kHz to 60 kHz) |
| 9 | - | NTC Thermistor |

## CIRCUIT CONFIGURATION





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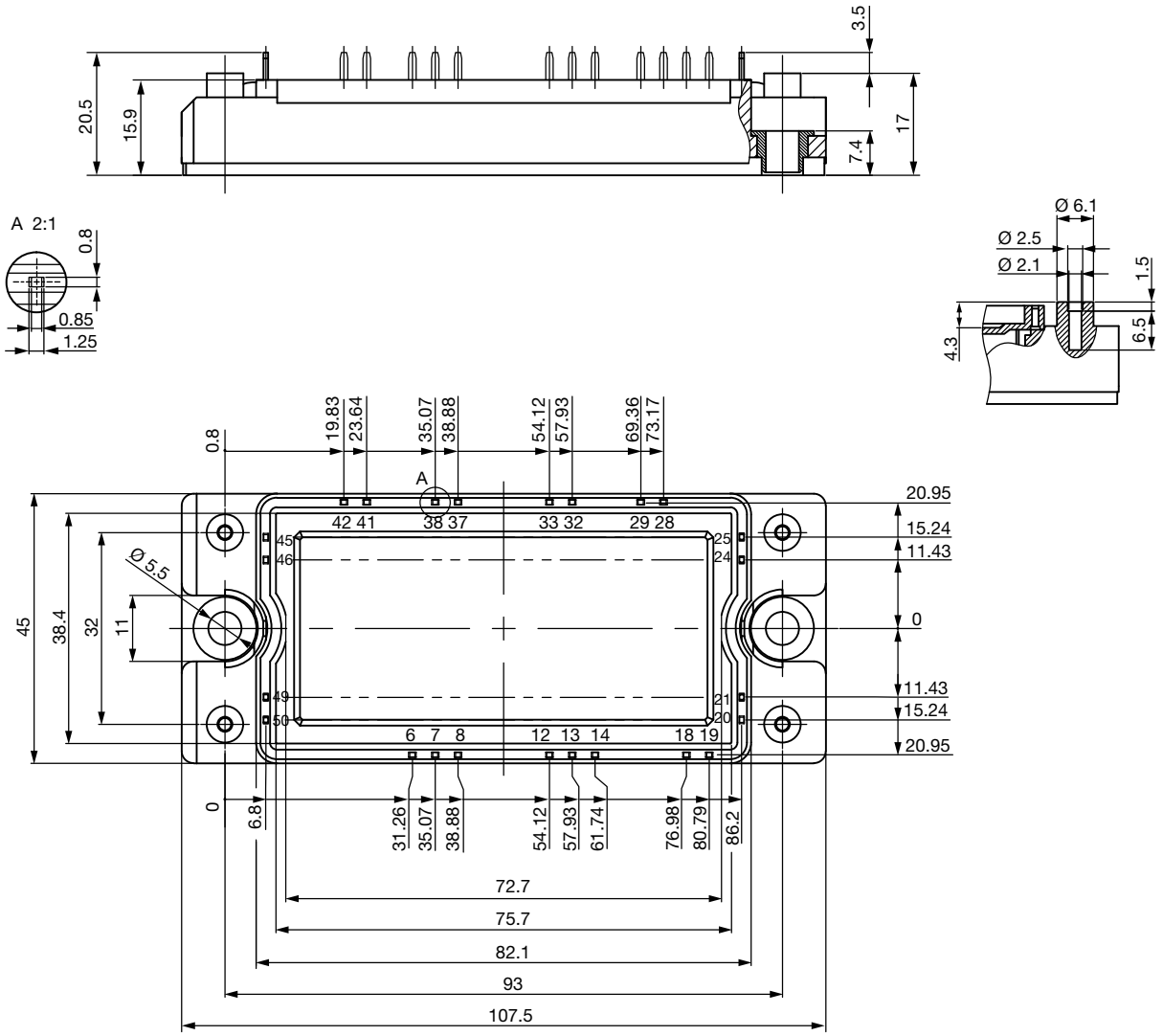
**DIMENSIONS** in millimeters





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