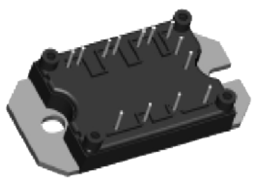
# Three Phase Inverter Module in MTP Package 1200 V NPT IGBT and HEXFRED® Diodes, 15 A



MTP

## PRODUCT SUMMARY

| | |
|---|---|
| $V_{CES}$ | 1200 V |
| $V_{CE(on)}$ typical at $V_{GE}$ = 15 V | 2.51 V |
| $I_C$ at $T_C$ = 100 °C | 15 A |
| $t_{sc}$ at $T_J$ = 150 °C | > 10 µs |

## FEATURES

- Generation 5 NPT 1200 V IGBT technology
- HEXFRED® diode with ultrasoft reverse recovery
- Very low conduction and switching losses
- Optional SMT thermistor (NTC)
- Aluminum oxide DBC
- Very low stray inductance design for high speed operation
- Short circuit 10 µs
- Square RBSOA
- Operating frequencies 8 kHz to 60 kHz
- UL approved file E78996
- Compliant to RoHS directive 2002/95/EC
- Designed and qualified for industrial level

Pb-free
RoHS
COMPLIANT

## BENEFITS

- Optimized for inverter motor drive applications
- Low EMI, requires less snubbing
- Direct mounting to heatsink
- PCB solderable terminals
- Very low junction to case thermal resistance

## 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 | 30 | A |
| | | $T_C$ = 100 °C | 15 | |
| Pulsed collector current | $I_{CM}$ | | 60 | |
| Peak switching current | $I_{LM}$ | | 60 | |
| Diode continuous forward current | $I_F$ | $T_C$ = 100 °C | 15 | |
| Peak diode forward current | $I_{FM}$ | | 30 | |
| Gate to emitter voltage | $V_{GE}$ | | ± 20 | V |
| RMS isolation voltage | $V_{ISOL}$ | Any terminal to case, t = 1 min | 2500 | |
| Maximum power dissipation (including diode and IGBT) | $P_D$ | $T_C$ = 25 °C | 187 | W |
| | | $T_C$ = 100 °C | 75 | |

| **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, $I_C$ = 250 μA | 1200 | - | - | V |
| Temperature coefficient of $V_{(BR)CES}$ | $\Delta V_{(BR)CES}/\Delta T_J$ | $V_{GE}$ = 0 V, $I_C$ = 1 mA | - | 1.11 | - | V/°C |
| Collector to emitter voltage | $V_{CE(on)}$ | $V_{GE}$ = 15 V, $I_C$ = 15 A | - | 2.51 | 2.70 | V |
| | | $V_{GE}$ = 15 V, $I_C$ = 30 A | - | 3.36 | 3.66 | |
| | | $V_{GE}$ = 15 V, $I_C$ = 15 A, $T_J$ = 125 °C | - | 2.94 | 3.16 | |
| | | $V_{GE}$ = 15 V, $I_C$ = 30 A, $T_J$ = 125 °C | - | 4.12 | 4.46 | |
| Gate threshold voltage | $V_{GE(th)}$ | $I_C$ = 250 μA | 4 | - | 6 | |
| Temperature coefficient of threshold voltage | $\Delta V_{GE(th)}/\Delta T_J$ | $V_{CE}$ = $V_{GE}$, $I_C$ = 1 mA | - | - 10 | - | mV/°C |
| Forward transconductance | $g_{fe}$ | $V_{CE}$ = 25 V, $I_C$ = 15 A | - | 12 | - | S |
| Collector to emitter leaking current | $I_{CES}$ | $V_{GE}$ = 0 V, $V_{CE}$ = 1200 V | - | - | 250 | μA |
| | | $V_{GE}$ = 0 V, $V_{CE}$ = 1200 V, $T_J$ = 125 °C | - | - | 1000 | |
| Diode forward voltage drop | $V_{FM}$ | $I_F$ = 15 A, $V_{GE}$ = 0 V | - | 2.13 | 2.58 | V |
| | | $I_F$ = 30 A, $V_{GE}$ = 0 V | - | 2.70 | 3.33 | |
| | | $I_F$ = 15 A, $V_{GE}$ = 0 V, $T_J$ = 125 °C | - | 2.27 | 2.75 | |
| | | $I_F$ = 30 A, $V_{GE}$ = 0 V, $T_J$ = 125 °C | - | 3.06 | 3.76 | |
| Gate to emitter leakage current | $I_{GES}$ | $V_{GE}$ = ± 20 V | - | - | ± 250 | nA |

| **SWITCHING CHARACTERISTICS** ($T_J$ = 25 °C unless otherwise specified) | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| Total gate charge (turn-on) | $Q_g$ | $I_C$ = 15 A<br>$V_{CC}$ = 600 V<br>$V_{GE}$ = 15 V | - | 98 | 146 | nC |
| Gate to emitter charge (turn-on) | $Q_{ge}$ | | - | 12 | 17 | |
| Gate to collector charge (turn-on) | $Q_{gc}$ | | - | 46 | 69 | |
| Turn-on switching loss | $E_{on}$ | $I_C$ = 15 A, $V_{CC}$ = 600 V, $V_{GE}$ = 15 V<br>$R_g$ = 10 Ω, L = 500 μH, $T_J$ = 25 °C<br>Energy losses include tail and diode reverse recovery | - | 0.990 | 1.485 | mJ |
| Turn-off switching loss | $E_{off}$ | | - | 0.827 | 1.241 | |
| Total switching loss | $E_{ts}$ | | - | 1.817 | 2.726 | |
| Turn-on switching loss | $E_{on}$ | $I_C$ = 15 A, $V_{CC}$ = 600 V, $V_{GE}$ = 15 V<br>$R_g$ = 10 Ω, L = 500 μH, $T_J$ = 125 °C<br>Energy losses include tail and diode reverse recovery | - | 1.352 | 2.028 | mJ |
| Turn-off switching loss | $E_{off}$ | | - | 1.138 | 1.707 | |
| Total switching loss | $E_{ts}$ | | - | 2.490 | 3.735 | |
| Turn-on delay time | $t_{d(on)}$ | $I_C$ = 15 A, $V_{CC}$ = 600 V, $V_{GE}$ = 15 V<br>L = 500 μH, $L_S$ = 100 nH<br>$R_g$ = 10 Ω, $T_J$ = 125 °C | - | 95 | 143 | ns |
| Rise time | $t_r$ | | - | 18 | 27 | |
| Turn-off delay time | $t_{d(off)}$ | | - | 134 | 200 | |
| Fall time | $t_f$ | | - | 227 | 341 | |
| Reverse BIAS safe operating area | RBSOA | $T_J$ = 150 °C, $I_C$ = 60 A<br>$R_g$ = 10 Ω, $V_{GE}$ = 15 V to 0 | Fullsquare | | | |
| Short circuit safe operating area | SCSOA | $V_{CC}$ = 600 V, $V_{GE}$ = + 15 V to 0<br>$T_J$ = 150 °C, $V_P$ = 1200 V, $R_g$ = 10 Ω | 10 | - | - | μs |
| Input capacitance | $C_{ies}$ | $V_{GE}$ = 0 V<br>$V_{CC}$ = 30 V<br>f = 1 MHz | - | 1302 | 1953 | pF |
| Output capacitance | $C_{oes}$ | | - | 717 | 1076 | |
| Reverse transfer capacitance | $C_{res}$ | | - | 38 | 57 | |
| Diode reverse recovery energy | $E_{rec}$ | $I_C$ = 15 A, $V_{CC}$ = 600 V, $V_{GE}$ = 15 V<br>L = 500 μH, $L_S$ = 100 nH<br>$R_g$ = 10 Ω, $T_J$ = 125 °C | - | 819 | - | μJ |
| Diode reverse recovery time | $t_{rr}$ | | - | 96 | - | ns |
| Diode peak reverse current | $I_{rr}$ | | - | 35 | - | A |

| THERMISTOR SPECIFICATIONS (T CODE ONLY) | | | | | | |
|---|---|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNITS |
| Resistance | $R_0$ (1) | $T_0$ = 25 °C | - | 30 | - | kΩ |
| Sensitivity index of the thermistor material | β (1)(2) | $T_0$ = 25 °C<br>$T_1$ = 85 °C | - | 4000 | - | K |

**Notes**

(1) $T_0$, $T_1$ are thermistor´s temperatures

(2) $\frac{R_0}{R_1} = \exp\left[\beta\left(\frac{1}{T_0} - \frac{1}{T_1}\right)\right]$

| THERMAL AND MECHANICAL SPECIFICATIONS | | | | | | | |
|---|---|---|---|---|---|---|---|
| PARAMETER | | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNITS |
| Operating junction temperature range | | $T_J$ | | - 40 | - | 150 | °C |
| Storage temperature range | | $T_{Stg}$ | | - 40 | - | 125 | °C |
| Junction to case | IGBT | $R_{thJC}$ | | - | - | 1.1 | °C/W |
| | Diode | | | - | - | 1.7 | |
| | Module | | | - | 0.50 | - | |
| Case to sink per module | | $R_{thCS}$ | Heatsink compound thermal conductivity = 1 W/mK | - | 0.1 | - | |
| Mounting torque | | | | - | - | 4 | Nm |
| Weight | | | | - | 65 | - | g |

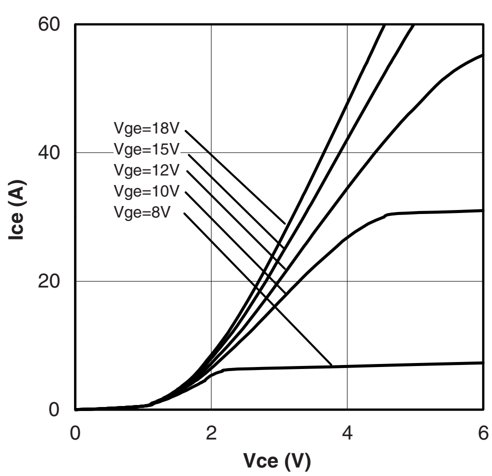



Fig. 1 - Typical Output Characteristics
$T_J$ = 25 °C

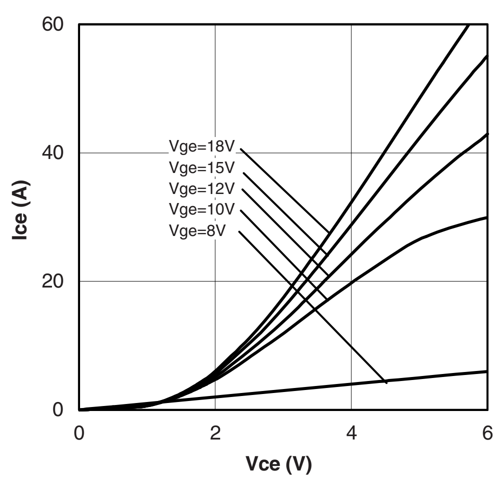



Fig. 2 - Typical Output Characteristics
$T_J$ = 125 °C

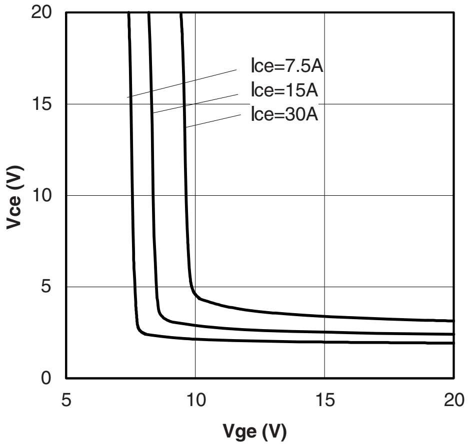



Fig. 3 - Typical $V_{CE}$ vs. $V_{GE}$
$T_J$ = 25 °C

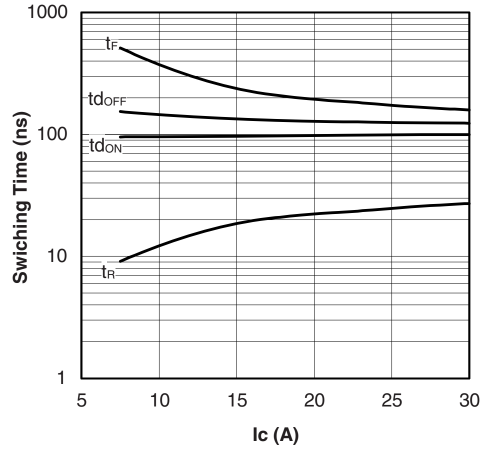



Fig. 6 - Typical Switching Time vs. $I_C$
$T_J$ = 125 °C, L = 500 µH, $V_{CE}$ = 600 V
$R_g$ = 10 Ω; $V_{GE}$ = 15 V

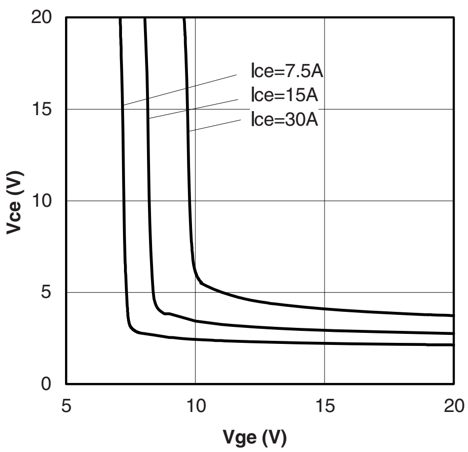



Fig. 4 - Typical $V_{CE}$ vs. $V_{GE}$
$T_J$ = 125 °C

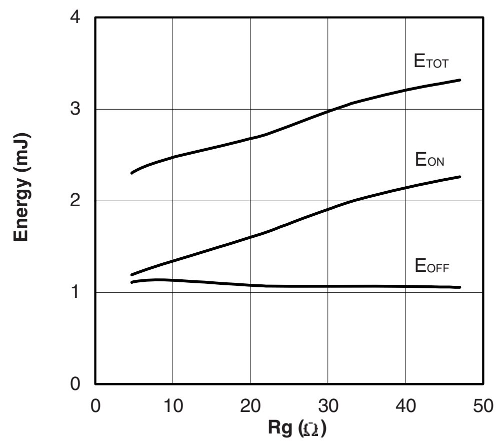



Fig. 7 - Typical Energy Loss vs. $R_g$
$T_J$ = 125 °C, L = 500 µH, $V_{CE}$ = 600 V
$I_C$ = 15 A; $V_{GE}$ = 15 V

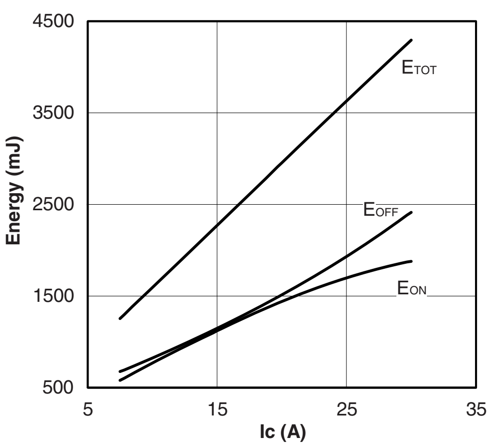



Fig. 5 - Typical Energy Loss vs. $I_C$
$T_J$ = 125 °C, L = 500 µH, $V_{CE}$ = 600 V
$R_g$ = 10 Ω; $V_{GE}$ = 15 V

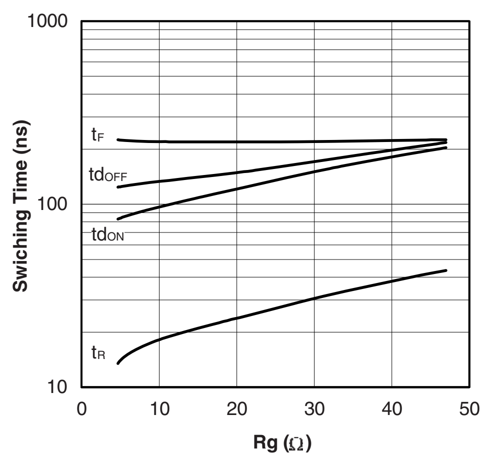



Fig. 8 - Typical Switching Time vs. $R_g$
$T_J$ = 125 °C, L = 500 µH, $V_{CE}$ = 600 V
$I_C$ = 15 A; $V_{GE}$ = 15 V

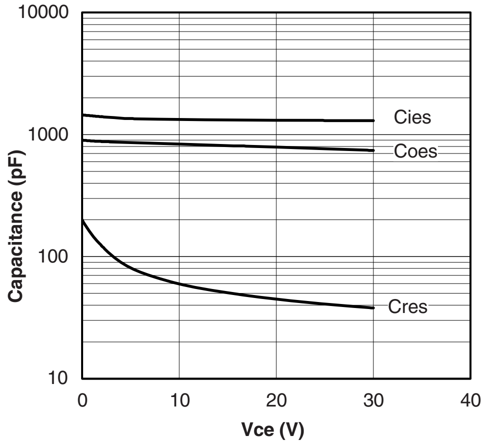



Fig. 9 - Typical Capacitance vs. $V_{CE}$
$V_{GE}$ = 0 V; f = 1 MHz

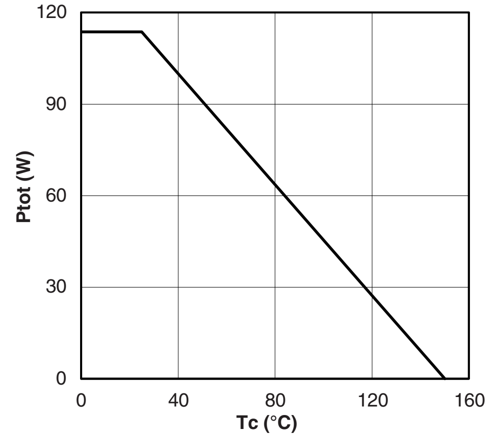



Fig. 12 - Power Dissipation vs. Case Temperature (IGBT only)

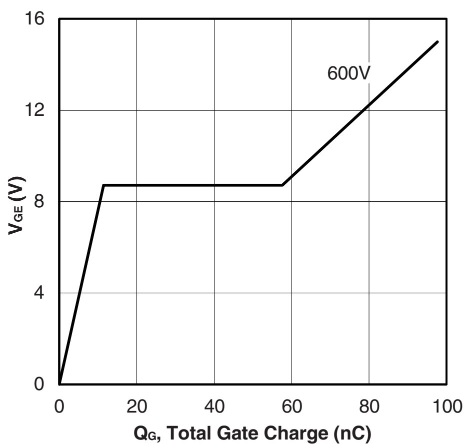



Fig. 10 - Typical Gate Charge vs. $V_{GE}$
$I_{CE}$ = 15 A

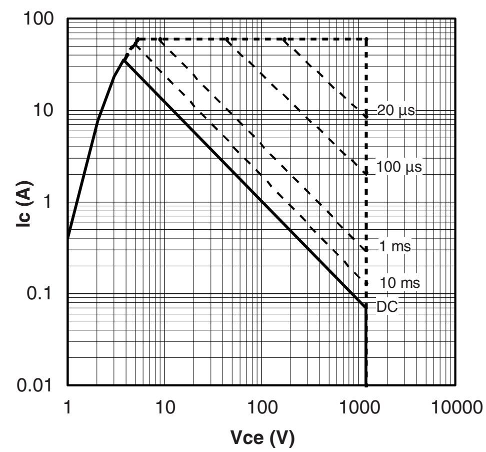



Fig. 13 - Forward SOA
$T_C$ = 25 °C, $T_J \leq$ 150 °C

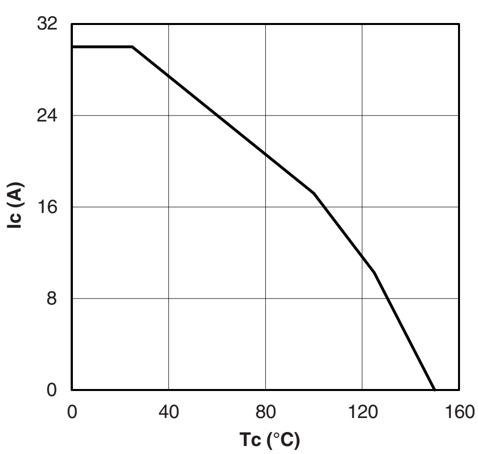



Fig. 11 - Maximum DC Collector Current vs. Case Temperature

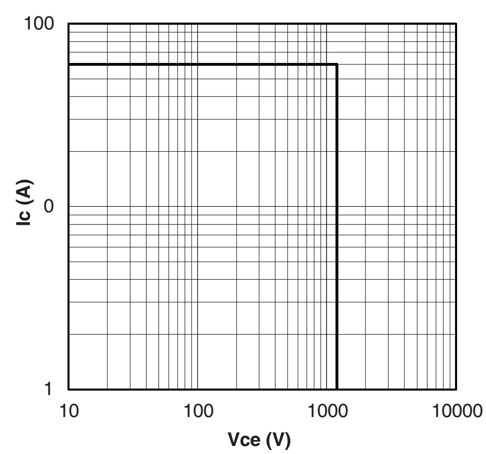



Fig. 14 - Reverse BIAS SOA
$T_J$ = 150 °C, $V_{GE}$ = 15 V

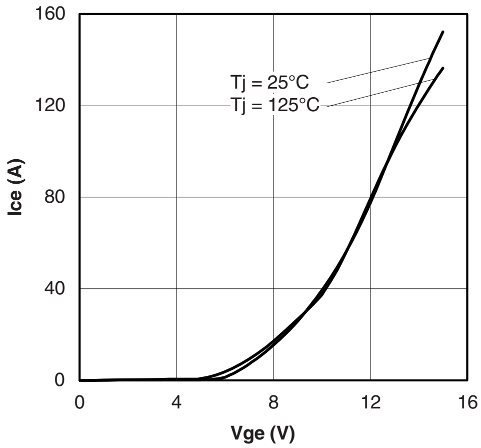



Fig. 15 - Typical Transfer Characteristics
$V_{CE}$ = 50 V; $t_p$ = 10 µs

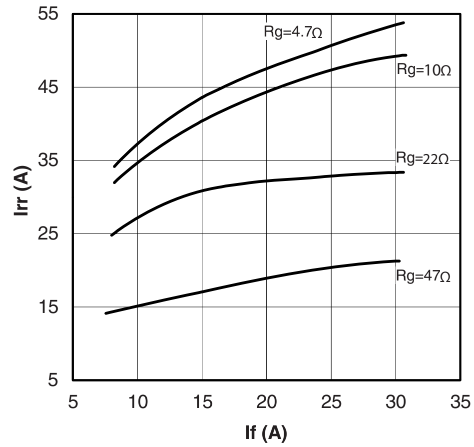



Fig. 17 - Typical Diode $I_{rr}$ vs. $I_F$
$T_J$ = 125 °C

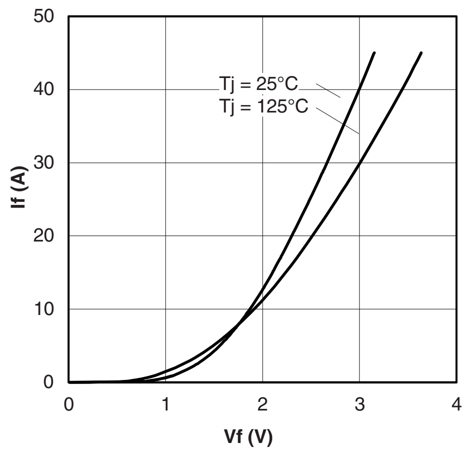



Fig. 16 - Typical Diode Forward Characteristics
$t_p$ = 80 µs

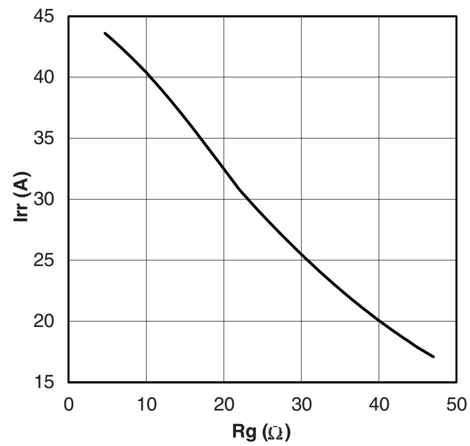



Fig. 18 - Typical Diode $I_{rr}$ vs. $R_g$
$T_J$ = 125 °C; $I_F$ = 10 A

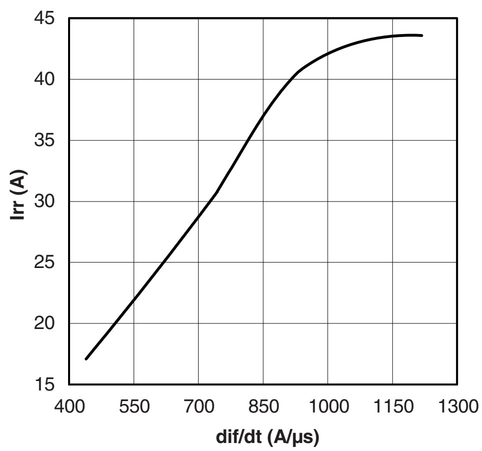



Fig. 19 - Typical Diode $I_{rr}$ vs. $dI_F/dt$; $V_{CC}$ = 600 V;
$V_{GE}$ = 15 V; $I_{CE}$ = 10 A, $T_J$ = 125 °C

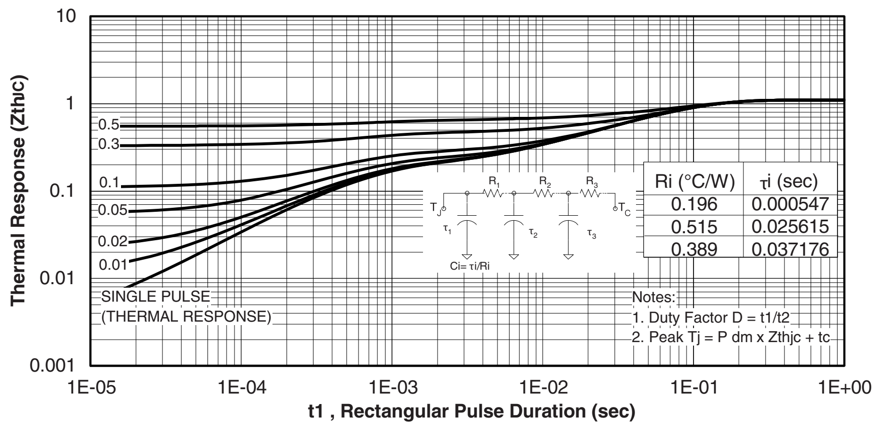



Fig. 20 - Maximum Transient Thermal Impedance, Junction to Case (IGBT)

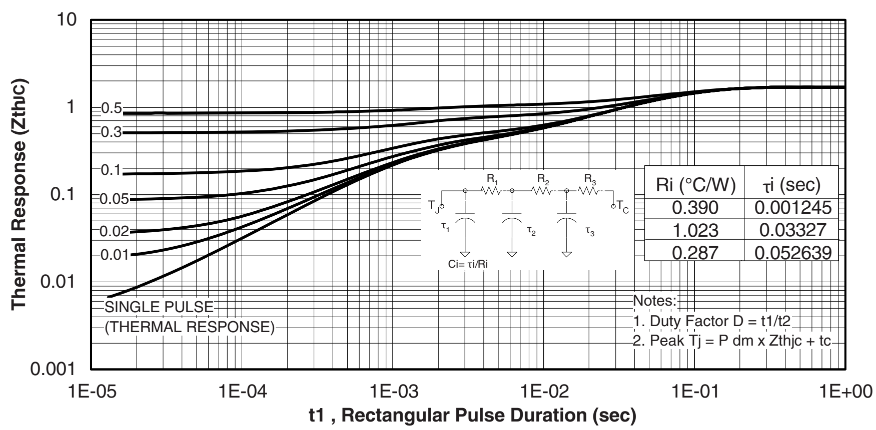



Fig. 21 - Maximum Transient Thermal Impedance, Junction to Case (Diode)

## ORDERING INFORMATION TABLE

**Device code**

| GB | 15 | XP | 120 | K | T | PbF |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

1 - IGBT module

2 - Nominal current rating (15 = 15 A)

3 - Circuit configuration (XP = Three phase inverter)

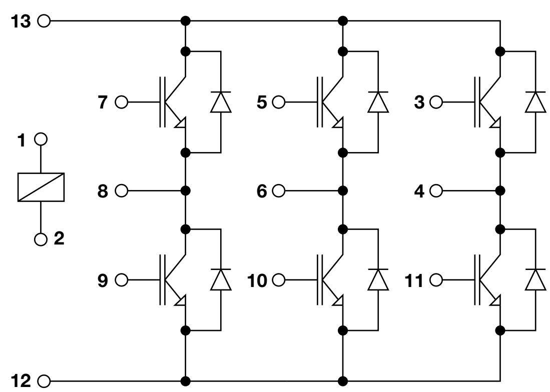
4 - Voltage code (120 = 1200 V)

5 - Speed/type (K = Ultrafast IGBT/inverter motor drive application)

6 - Special option:
- None = No special option
- T = Thermistor

7 - PbF = Lead (Pb)-free

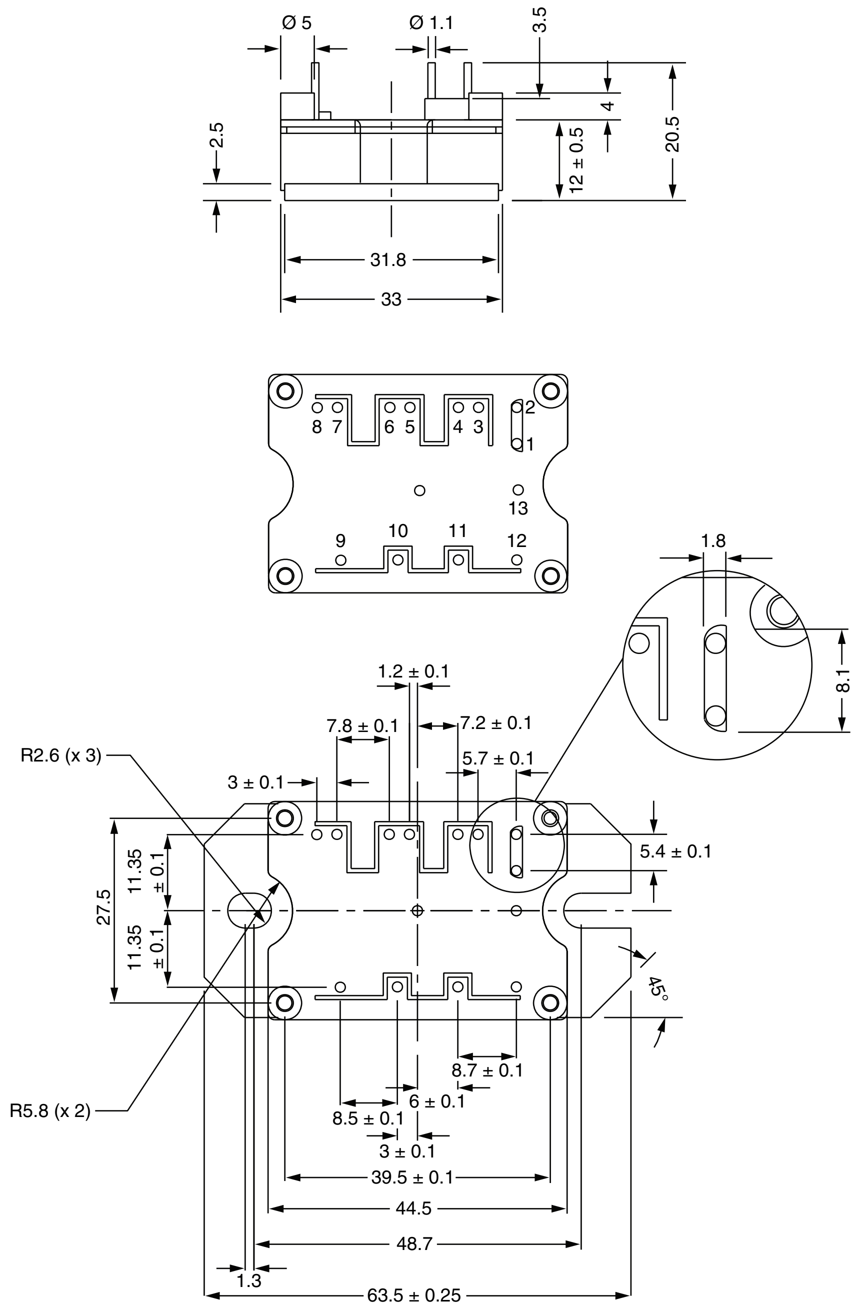
## CIRCUIT CONFIGURATION




| LINKS TO RELATED DOCUMENTS | |
|---|---|
| Dimensions | www.vishay.com/doc?95175 |

# MTP

**DIMENSIONS** in millimeters




**Note**

- Unused terminals are not assembled in the package

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