# STARPOWER

**SEMICONDUCTOR** **IGBT**

# GD650HFL170P1S

**1700V/650A 2 in one-package**

## General Description

STARPOWER IGBT Power Module provides ultra low conduction loss as well as short circuit ruggedness. They are designed for the applications such as wind and solar power.

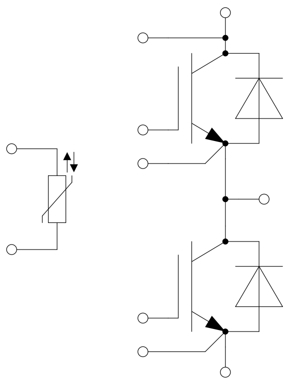
## Features

- Low $V_{CE(sat)}$ SPT+ IGBT technology
- 10μs short circuit capability
- $V_{CE(sat)}$ with positive temperature coefficient
- Maximum junction temperature 175$^{o}$C
- Enlarged Diode for regenerative operation
- Isolated copper baseplate using DBC technology
- High power and thermal cycling capability

## Typical Applications

- High Power Converter
- Wind and Solar Power
- Traction Drive

## Equivalent Circuit Schematic



# Absolute Maximum Ratings $T_C$=25°C unless otherwise noted

## IGBT

| Symbol | Description | Value | Unit |
|---|---|---|---|
| $V_{CES}$ | Collector-Emitter Voltage | 1700 | V |
| $V_{GES}$ | Gate-Emitter Voltage | ±20 | V |
| $I_C$ | Collector Current @ $T_C$=25°C<br>@ $T_C$=100°C | 1147<br>650 | A |
| $I_{CM}$ | Pulsed Collector Current $t_p$=1ms | 1300 | A |
| $P_D$ | Maximum Power Dissipation @ $T_j$=175°C | 4.3 | kW |

## Diode

| Symbol | Description | Value | Unit |
|---|---|---|---|
| $V_{RRM}$ | Repetitive Peak Reverse Voltage | 1700 | V |
| $I_F$ | Diode Continuous Forward Current | 650 | A |
| $I_{FM}$ | Diode Maximum Forward Current $t_p$=1ms | 1300 | A |

## Module

| Symbol | Description | Value | Unit |
|---|---|---|---|
| $T_{jmax}$ | Maximum Junction Temperature | 175 | °C |
| $T_{jop}$ | Operating Junction Temperature | -40 to +150 | °C |
| $T_{STG}$ | Storage Temperature Range | -40 to +150 | °C |
| $V_{ISO}$ | Isolation Voltage RMS,f=50Hz,t=1min | 4000 | V |

## IGBT Characteristics $T_C$=25$^o$C unless otherwise noted

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{CE(sat)}$ | Collector to Emitter Saturation Voltage | $I_C$=650A,$V_{GE}$=15V, $T_j$=25$^o$C | | 2.00 | 2.45 | V |
| | | $I_C$=650A,$V_{GE}$=15V, $T_j$=125$^o$C | | 2.40 | | |
| | | $I_C$=650A,$V_{GE}$=15V, $T_j$=150$^o$C | | 2.50 | | |
| $V_{GE(th)}$ | Gate-Emitter Threshold Voltage | $I_C$=24.0mA,$V_{CE}$=$V_{GE}$, $T_j$=25$^o$C | 5.4 | 6.2 | 7.4 | V |
| $I_{CES}$ | Collector Cut-Off Current | $V_{CE}$=$V_{CES}$,$V_{GE}$=0V, $T_j$=25$^o$C | | | 5.0 | mA |
| $I_{GES}$ | Gate-Emitter Leakage Current | $V_{GE}$=$V_{GES}$,$V_{CE}$=0V, $T_j$=25$^o$C | | | 400 | nA |
| $R_{Gint}$ | Internal Gate Resistance | | | 2.3 | | Ω |
| $C_{ies}$ | Input Capacitance | $V_{CE}$=25V,f=1MHz, $V_{GE}$=0V | | 40.5 | | nF |
| $C_{res}$ | Reverse Transfer Capacitance | | | 1.38 | | nF |
| $Q_G$ | Gate Charge | $V_{GE}$=-15…+15V | | 4.62 | | μC |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{CC}$=900V,$I_C$=650A, $R_{Gon}$=1.8Ω,$R_{Goff}$=2.7Ω, $V_{GE}$=±15V,$T_j$=25$^o$C | | 549 | | ns |
| $t_r$ | Rise Time | | | 91 | | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | | 1000 | | ns |
| $t_f$ | Fall Time | | | 290 | | ns |
| $E_{on}$ | Turn-On Switching Loss | | | 204 | | mJ |
| $E_{off}$ | Turn-Off Switching Loss | | | 141 | | mJ |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{CC}$=900V,$I_C$=650A, $R_{Gon}$=1.8Ω,$R_{Goff}$=2.7Ω, $V_{GE}$=±15V,$T_j$=125$^o$C | | 601 | | ns |
| $t_r$ | Rise Time | | | 109 | | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | | 1250 | | ns |
| $t_f$ | Fall Time | | | 490 | | ns |
| $E_{on}$ | Turn-On Switching Loss | | | 301 | | mJ |
| $E_{off}$ | Turn-Off Switching Loss | | | 204 | | mJ |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{CC}$=900V,$I_C$=650A, $R_{Gon}$=1.8Ω,$R_{Goff}$=2.7Ω, $V_{GE}$=±15V,$T_j$=150$^o$C | | 601 | | ns |
| $t_r$ | Rise Time | | | 119 | | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | | 1300 | | ns |
| $t_f$ | Fall Time | | | 570 | | ns |
| $E_{on}$ | Turn-On Switching Loss | | | 321 | | mJ |
| $E_{off}$ | Turn-Off Switching Loss | | | 229 | | mJ |
| $I_{SC}$ | SC Data | $t_P$≤10μs,$V_{GE}$=15V, $T_j$=150$^o$C,$V_{CC}$=1000V, $V_{CEM}$≤1700V | | 2700 | | A |

## Diode Characteristics $T_C$=25°C unless otherwise noted

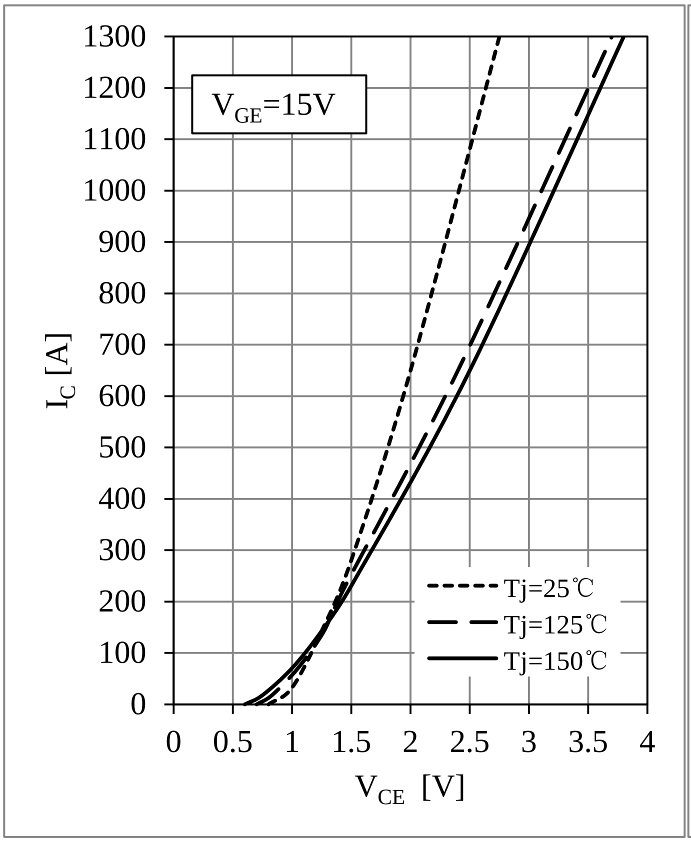
| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_F$ | Diode Forward Voltage | $I_F$=650A,$V_{GE}$=0V,$T_j$=25°C | | 1.80 | 2.25 | V |
| | | $I_F$=650A,$V_{GE}$=0V,$T_j$=125°C | | 1.95 | | |
| | | $I_F$=650A,$V_{GE}$=0V,$T_j$=150°C | | 1.90 | | |
| $Q_r$ | Recovered Charge | $V_R$=900V,$I_F$=650A, -di/dt=5200A/μs,$V_{GE}$=-15V $T_j$=25°C | | 160 | | μC |
| $I_{RM}$ | Peak Reverse Recovery Current | | | 695 | | A |
| $E_{rec}$ | Reverse Recovery Energy | | | 76.1 | | mJ |
| $Q_r$ | Recovered Charge | $V_R$=900V,$I_F$=650A, -di/dt=5200A/μs,$V_{GE}$=-15V $T_j$=125°C | | 265 | | μC |
| $I_{RM}$ | Peak Reverse Recovery Current | | | 760 | | A |
| $E_{rec}$ | Reverse Recovery Energy | | | 134 | | mJ |
| $Q_r$ | Recovered Charge | $V_R$=900V,$I_F$=650A, -di/dt=5200A/μs,$V_{GE}$=-15V $T_j$=150°C | | 310 | | μC |
| $I_{RM}$ | Peak Reverse Recovery Current | | | 805 | | A |
| $E_{rec}$ | Reverse Recovery Energy | | | 161 | | mJ |

## NTC Characteristics $T_C$=25°C unless otherwise noted

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $R_{25}$ | Rated Resistance | | | 5.0 | | kΩ |
| ΔR/R | Deviation of $R_{100}$ | $T_C$=100 °C,$R_{100}$=493.3Ω | -5 | | 5 | % |
| $P_{25}$ | Power Dissipation | | | | 20.0 | mW |
| $B_{25/50}$ | B-value | $R_2=R_{25}exp[B_{25/50}(1/T_2-1/(298.15K))]$ | | 3375 | | K |
| $B_{25/80}$ | B-value | $R_2=R_{25}exp[B_{25/80}(1/T_2-1/(298.15K))]$ | | 3411 | | K |
| $B_{25/100}$ | B-value | $R_2=R_{25}exp[B_{25/100}(1/T_2-1/(298.15K))]$ | | 3433 | | K |

## Module Characteristics $T_C$=25°C unless otherwise noted

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| $L_{CE}$ | Stray Inductance | | 18 | | nH |
| $R_{CC'+EE'}$ | Module Lead Resistance, Terminal to Chip | | 0.30 | | mΩ |
| $R_{thJC}$ | Junction-to-Case (per IGBT)<br>Junction-to-Case (per Diode) | | | 34.9<br>69.4 | K/kW |
| $R_{thCH}$ | Case-to-Heatsink (per IGBT)<br>Case-to-Heatsink (per Diode)<br>Case-to-Heatsink (per Module) | | 13.5<br>26.9<br>4.5 | | K/kW |
| M | Terminal Connection Torque, Screw M4<br>Terminal Connection Torque, Screw M8<br>Mounting Torque, Screw M5 | 1.8<br>8.0<br>3.0 | | 2.1<br>10.0<br>6.0 | N.m |
| G | Weight of Module | | 810 | | g |



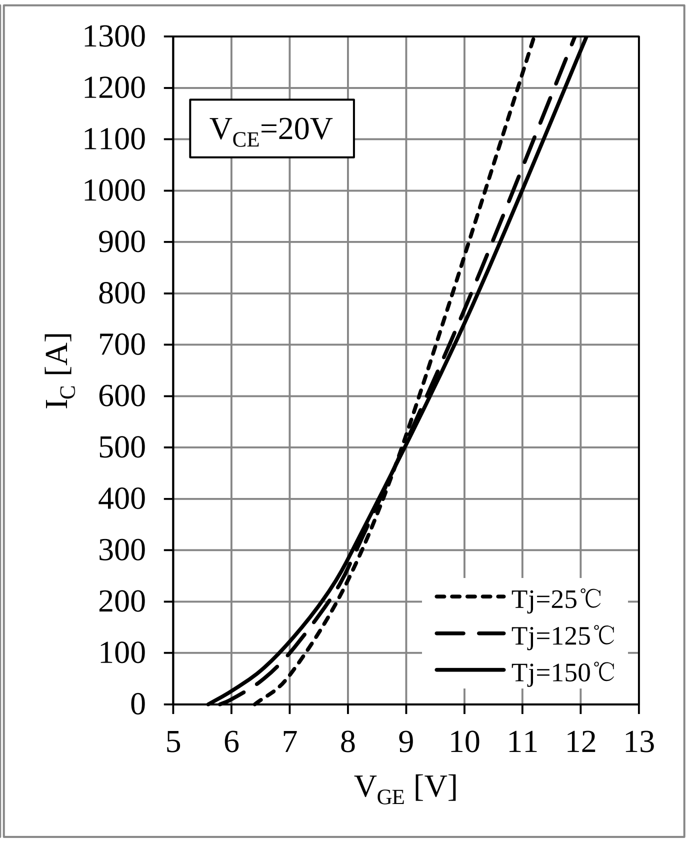
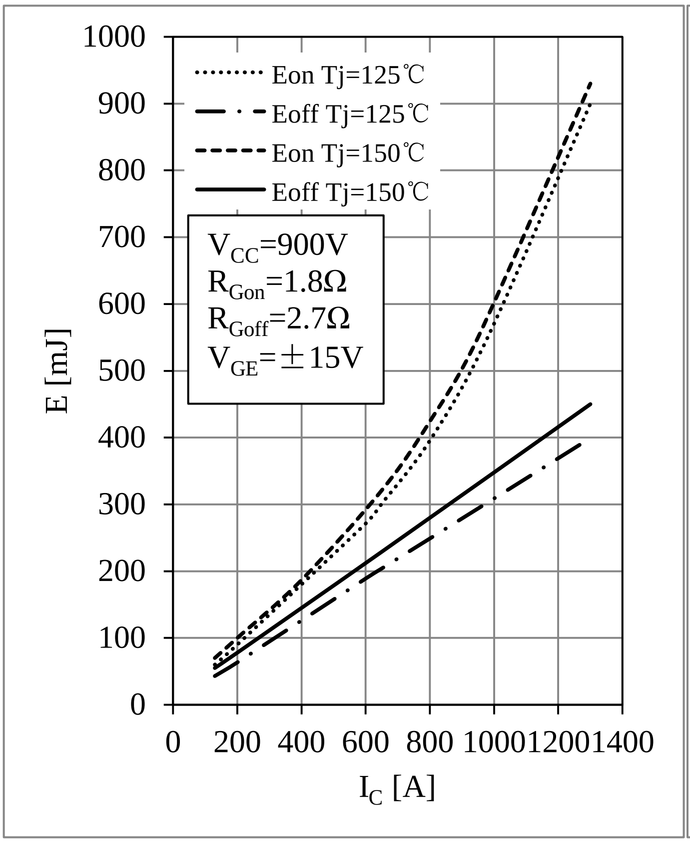




Fig 1. IGBT Output Characteristics

Fig 2. IGBT Transfer Characteristics



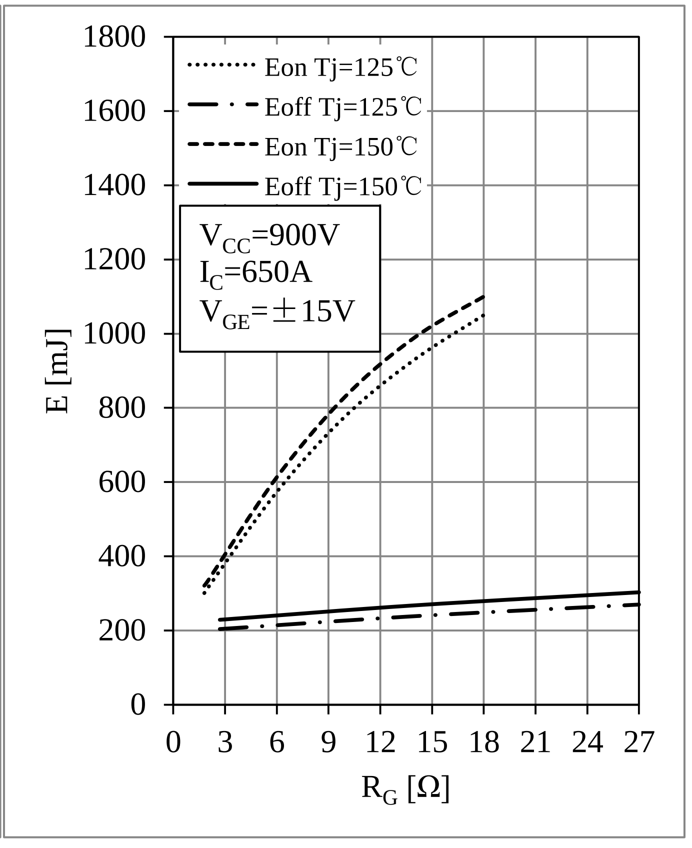




Fig 3. IGBT Switching Loss vs. $I_C$

Fig 4. IGBT Switching Loss vs. $R_G$

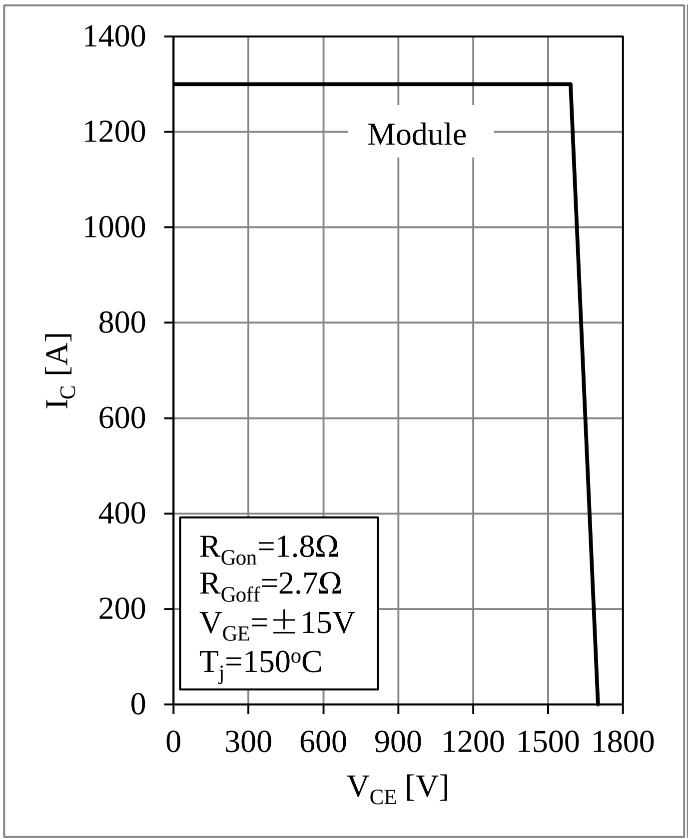



Fig 5. RBSOA

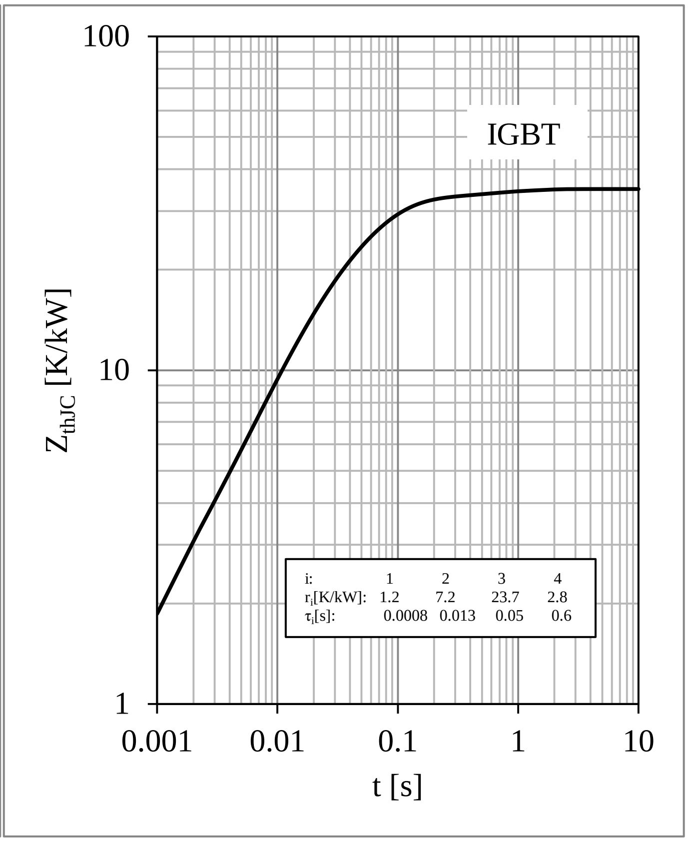



Fig 6. IGBT Transient Thermal Impedance

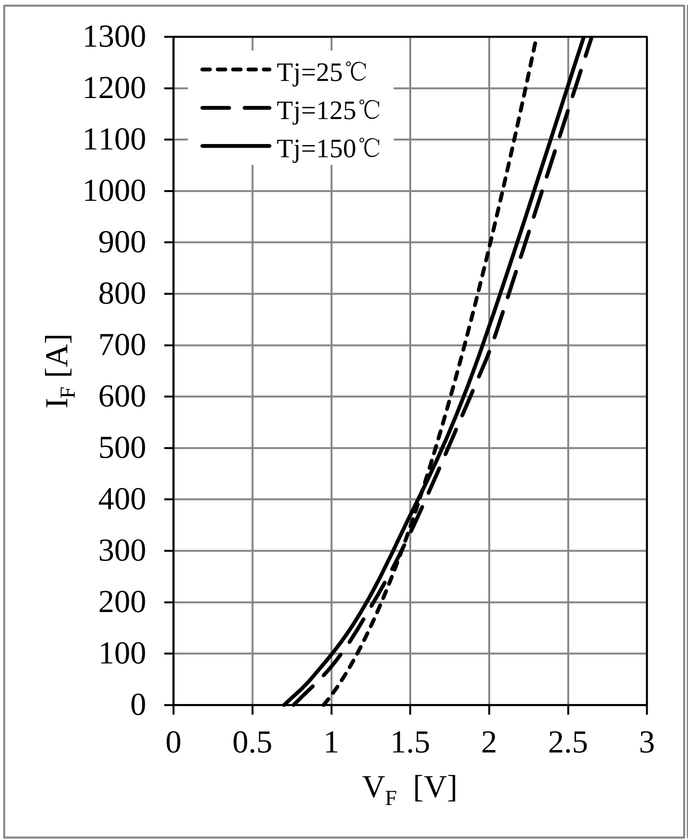



Fig 7. Diode Forward Characteristics

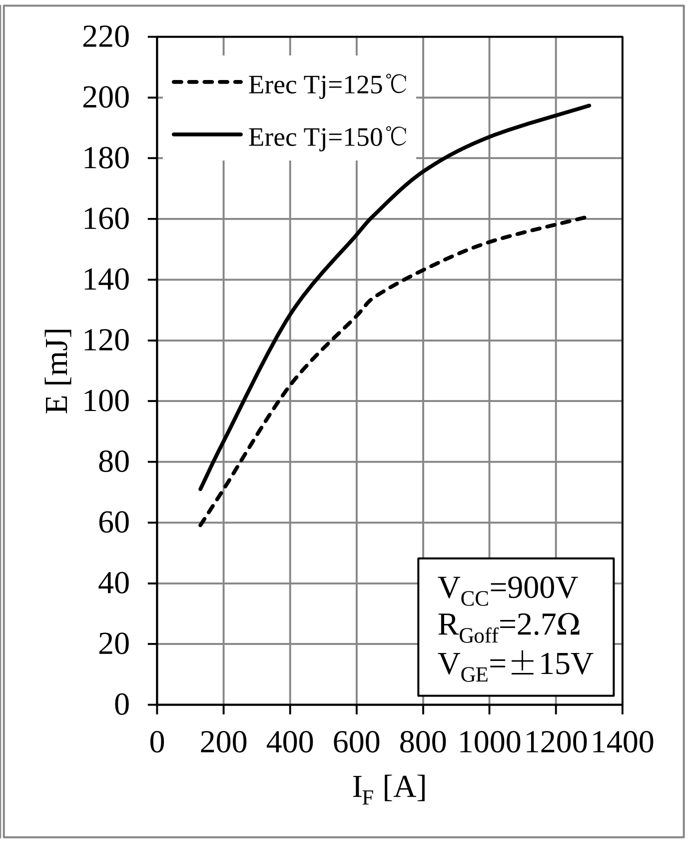



Fig 8. Diode Switching Loss vs. $I_F$

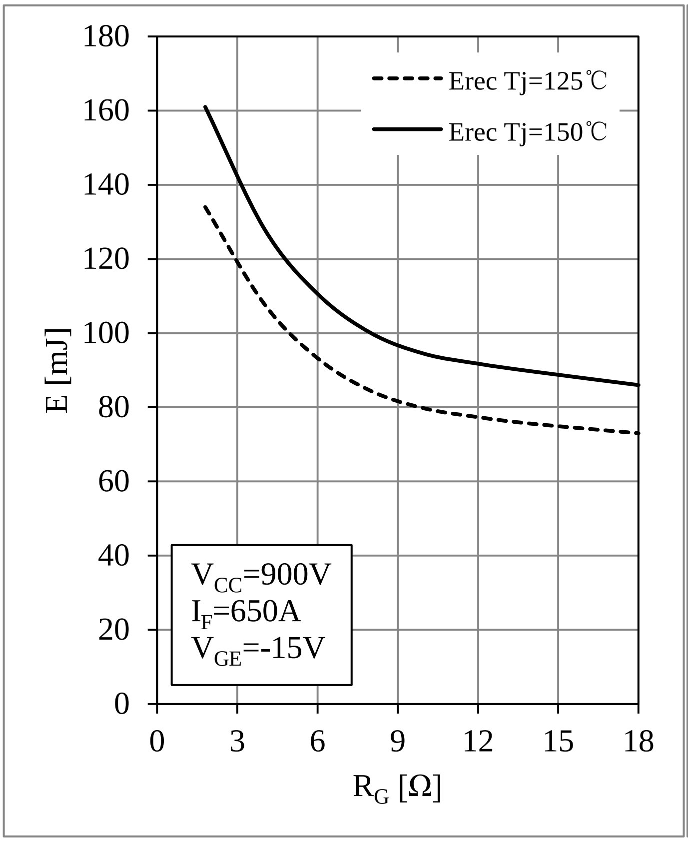



Fig 9. Diode Switching Loss vs. $R_G$

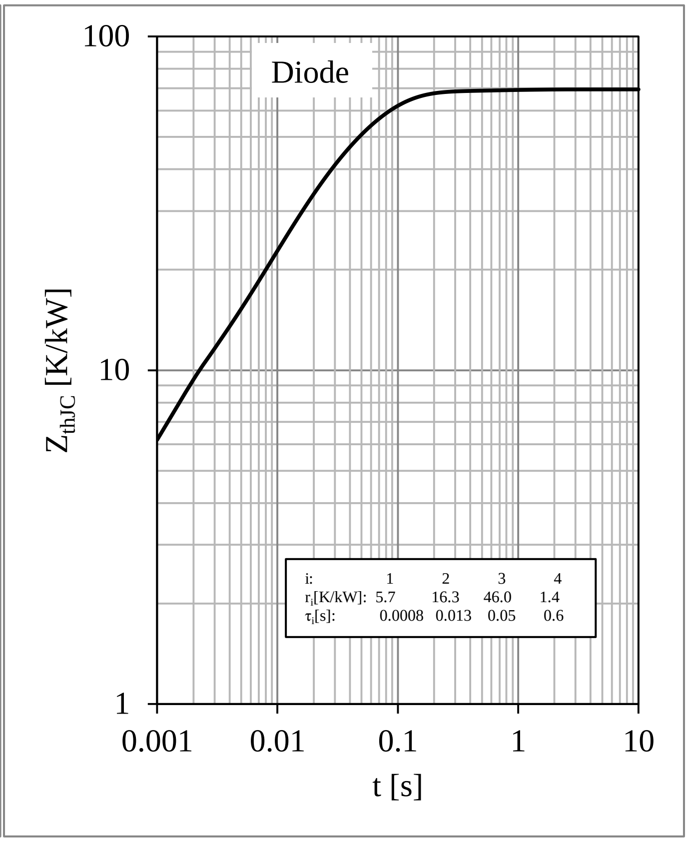



Fig 10. Diode Transient Thermal Impedance

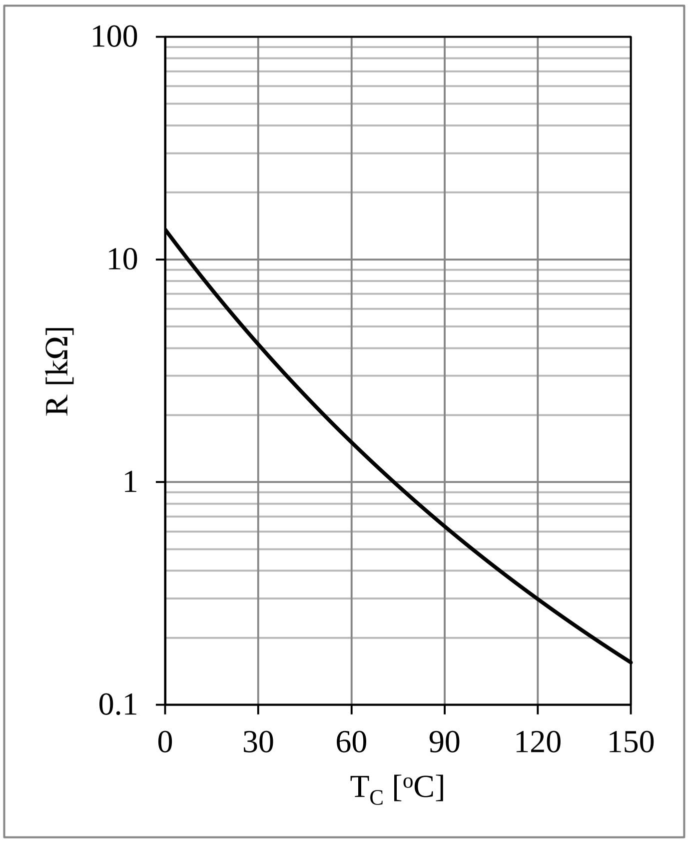
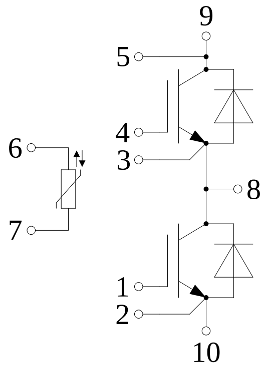


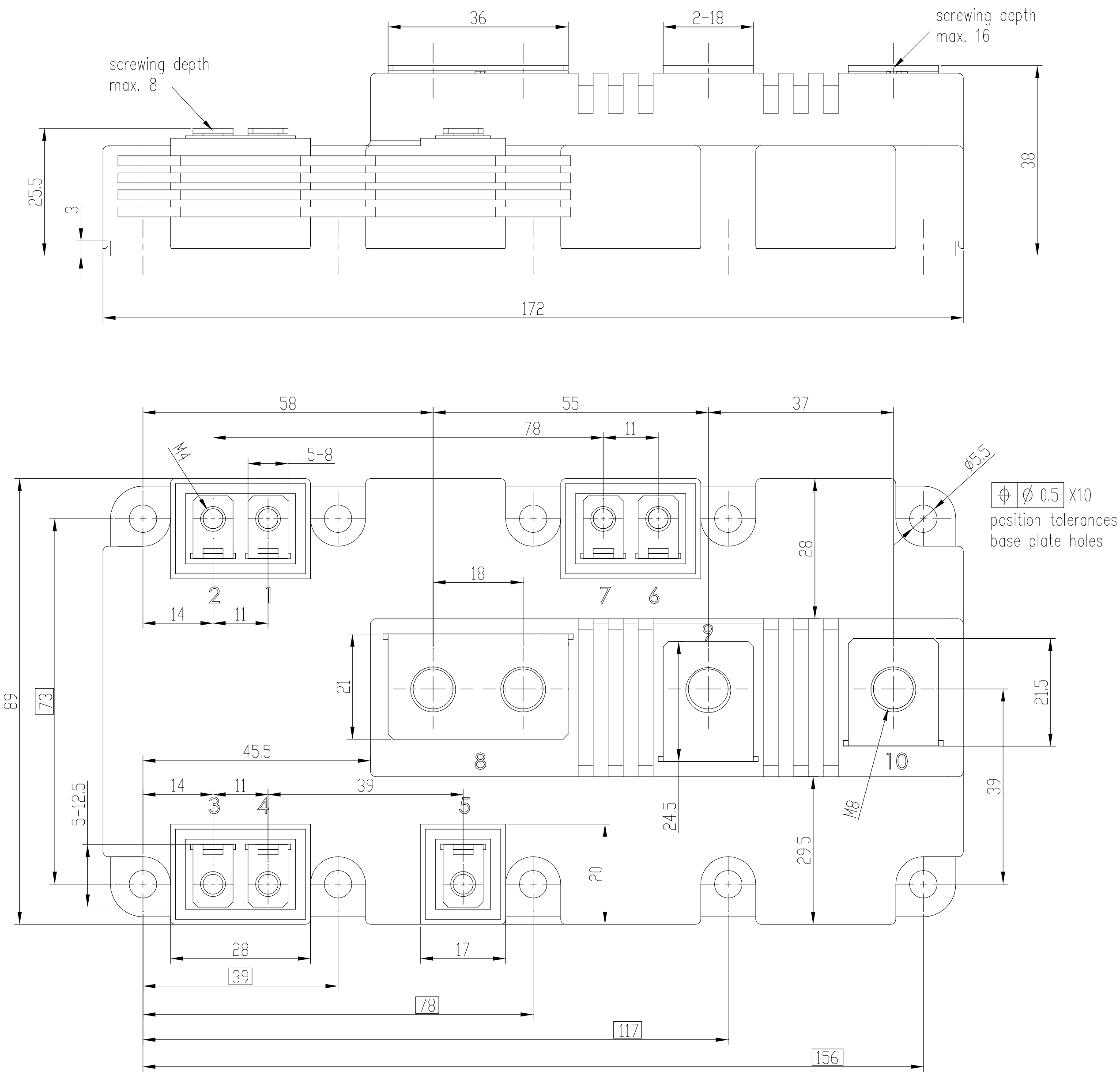

Fig 11. NTC Temperature Characteristic

## Circuit Schematic




## Package Dimensions

Dimensions in Millimeters



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