

# STARPOWER

SEMICONDUCTOR

**IGBT**

## GD650HFX170P1S

**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.

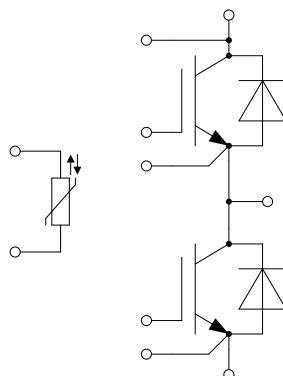
### Features

- Low  $V_{CE(sat)}$  Trench IGBT technology
- 10 $\mu$ s short circuit capability
- $V_{CE(sat)}$  with positive temperature coefficient
- Maximum junction temperature 175°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**  $T_C=25^{\circ}\text{C}$  unless otherwise noted**IGBT**

Symbol	Description	Value	Unit
$V_{CES}$	Collector-Emitter Voltage	1700	V
$V_{GES}$	Gate-Emitter Voltage	$\pm 20$	V
$I_C$	Collector Current @ $T_C=25^{\circ}\text{C}$	1073	A
	@ $T_C=100^{\circ}\text{C}$	650	A
$I_{CM}$	Pulsed Collector Current $t_p=1\text{ms}$	1300	A
$P_D$	Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$	4.2	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 $t_p=1\text{ms}$	1300	A

**Module**

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

**IGBT Characteristics**  $T_C=25^\circ\text{C}$  unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C=650\text{A}, V_{GE}=15\text{V}, T_j=25^\circ\text{C}$		1.90	2.35	V
		$I_C=650\text{A}, V_{GE}=15\text{V}, T_j=125^\circ\text{C}$		2.35		
		$I_C=650\text{A}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}$		2.45		
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$I_C=24.0\text{mA}, V_{CE}=V_{GE}, T_j=25^\circ\text{C}$	5.6	6.2	6.8	V
$I_{CES}$	Collector Cut-Off Current	$V_{CE}=V_{CES}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$			5.0	mA
$I_{GES}$	Gate-Emitter Leakage Current	$V_{GE}=V_{GES}, V_{CE}=0\text{V}, T_j=25^\circ\text{C}$			400	nA
$R_{Gint}$	Internal Gate Resistance			2.3		$\Omega$
$C_{ies}$	Input Capacitance	$V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$		72.3		nF
$C_{res}$	Reverse Transfer Capacitance			1.75		nF
$Q_G$	Gate Charge	$V_{GE}=-15\dots+15\text{V}$		5.66		$\mu\text{C}$
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=900\text{V}, I_C=650\text{A}, R_{Gon}=1.8\Omega, R_{Goff}=2.7\Omega, V_{GE}=\pm 15\text{V}, T_j=25^\circ\text{C}$		468		ns
$t_r$	Rise Time			86		ns
$t_{d(off)}$	Turn-Off Delay Time			850		ns
$t_f$	Fall Time			363		ns
$E_{on}$	Turn-On Switching Loss			226		mJ
$E_{off}$	Turn-Off Switching Loss			161		mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=900\text{V}, I_C=650\text{A}, R_{Gon}=1.8\Omega, R_{Goff}=2.7\Omega, V_{GE}=\pm 15\text{V}, T_j=125^\circ\text{C}$		480		ns
$t_r$	Rise Time			110		ns
$t_{d(off)}$	Turn-Off Delay Time			1031		ns
$t_f$	Fall Time			600		ns
$E_{on}$	Turn-On Switching Loss			338		mJ
$E_{off}$	Turn-Off Switching Loss			226		mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=900\text{V}, I_C=650\text{A}, R_{Gon}=1.8\Omega, R_{Goff}=2.7\Omega, V_{GE}=\pm 15\text{V}, T_j=150^\circ\text{C}$		480		ns
$t_r$	Rise Time			120		ns
$t_{d(off)}$	Turn-Off Delay Time			1040		ns
$t_f$	Fall Time			684		ns
$E_{on}$	Turn-On Switching Loss			368		mJ
$E_{off}$	Turn-Off Switching Loss			242		mJ
$I_{SC}$	SC Data	$t_p \leq 10\mu\text{s}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}, V_{CC}=1000\text{V}, V_{CEM} \leq 1700\text{V}$		2600		A

**Diode Characteristics**  $T_C=25^\circ\text{C}$  unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_F$	Diode Forward Voltage	$I_F=650\text{A}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$		1.85	2.30	V
		$I_F=650\text{A}, V_{GE}=0\text{V}, T_j=125^\circ\text{C}$		1.98		
		$I_F=650\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$		2.02		
$Q_r$	Recovered Charge	$V_R=900\text{V}, I_F=650\text{A},$ $-di/dt=5980\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=25^\circ\text{C}$		176		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			765		A
$E_{rec}$	Reverse Recovery Energy			87.4		mJ
$Q_r$	Recovered Charge	$V_R=900\text{V}, I_F=650\text{A},$ $-di/dt=5980\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=125^\circ\text{C}$		292		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			798		A
$E_{rec}$	Reverse Recovery Energy			159		mJ
$Q_r$	Recovered Charge	$V_R=900\text{V}, I_F=650\text{A},$ $-di/dt=5980\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=150^\circ\text{C}$		341		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			805		A
$E_{rec}$	Reverse Recovery Energy			192		mJ

**NTC Characteristics**  $T_C=25^\circ\text{C}$  unless otherwise noted

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

**Module Characteristics**  $T_c=25^\circ\text{C}$  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		m $\Omega$
$R_{thJC}$	Junction-to-Case (per IGBT)			35.8	K/kW
	Junction-to-Case (per Diode)			71.3	
$R_{thCH}$	Case-to-Heatsink (per IGBT)		13.5		K/kW
	Case-to-Heatsink (per Diode)		26.9		
	Case-to-Heatsink (per Module)		4.5		
M	Terminal Connection Torque, Screw M4	1.8		2.1	N.m
	Terminal Connection Torque, Screw M8	8.0		10.0	
	Mounting Torque, Screw M5	3.0		6.0	
G	Weight of Module		810		g

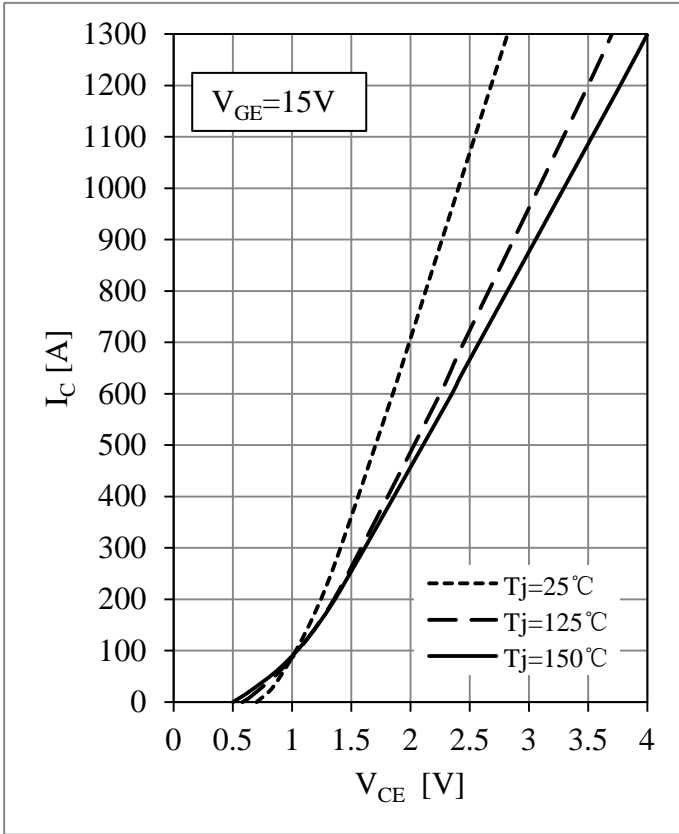


Fig 1. IGBT Output Characteristics

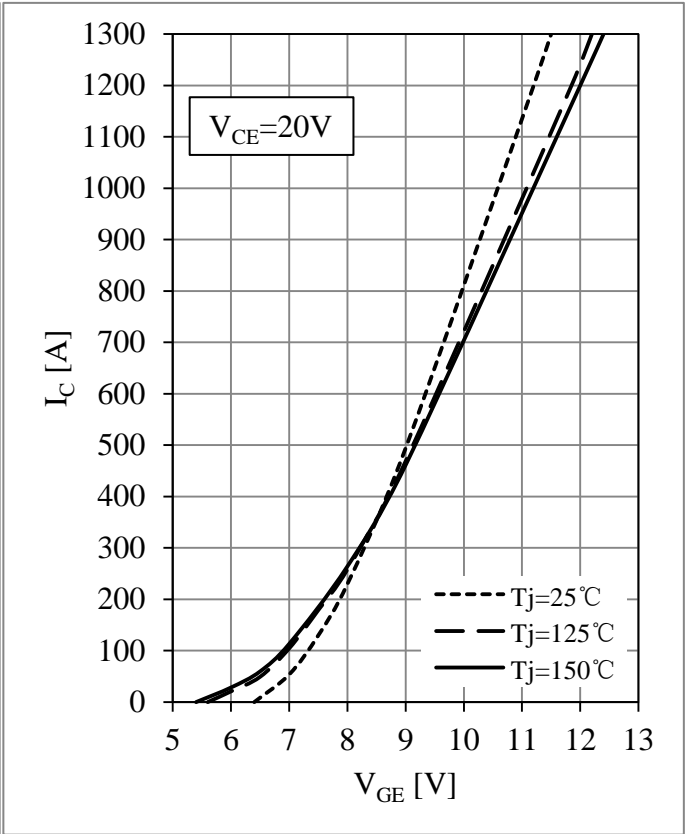


Fig 2. IGBT Transfer Characteristics

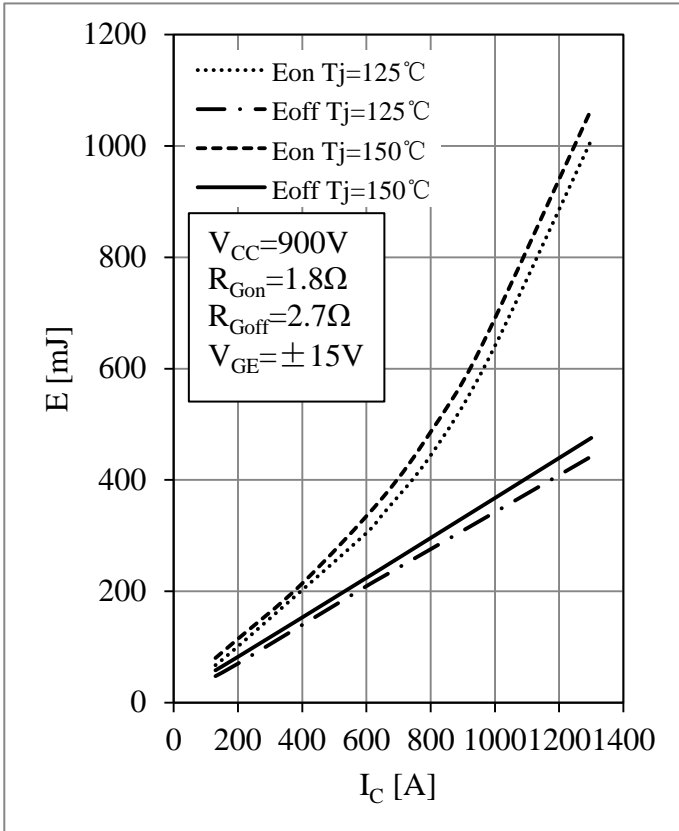


Fig 3. IGBT Switching Loss vs.  $I_c$

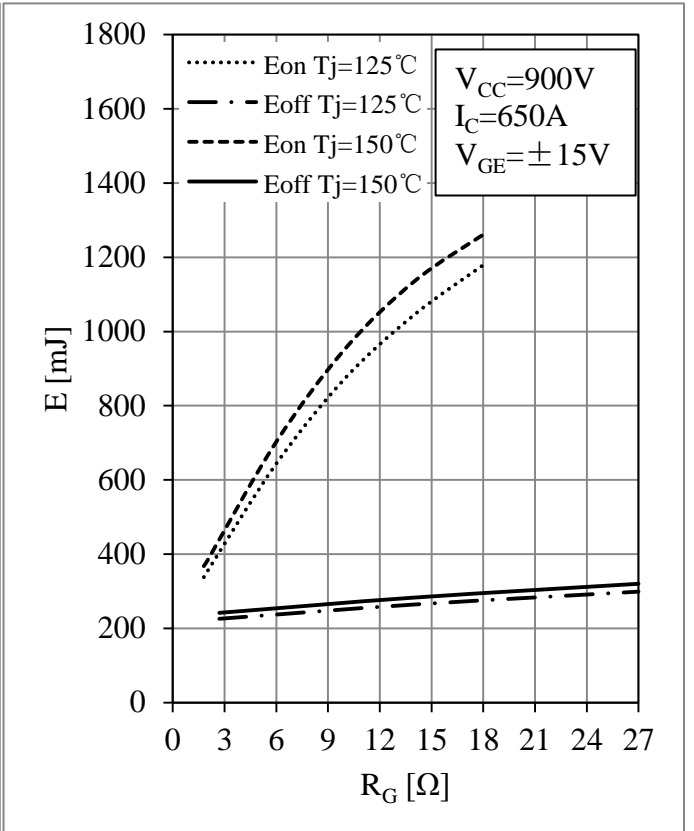


Fig 4. IGBT Switching Loss vs.  $R_G$

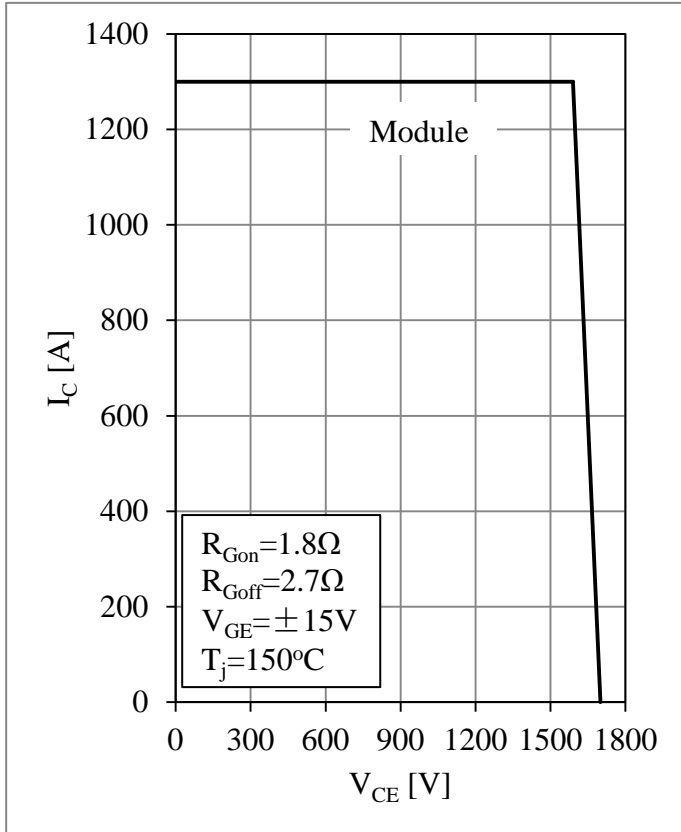


Fig 5. RBSOA

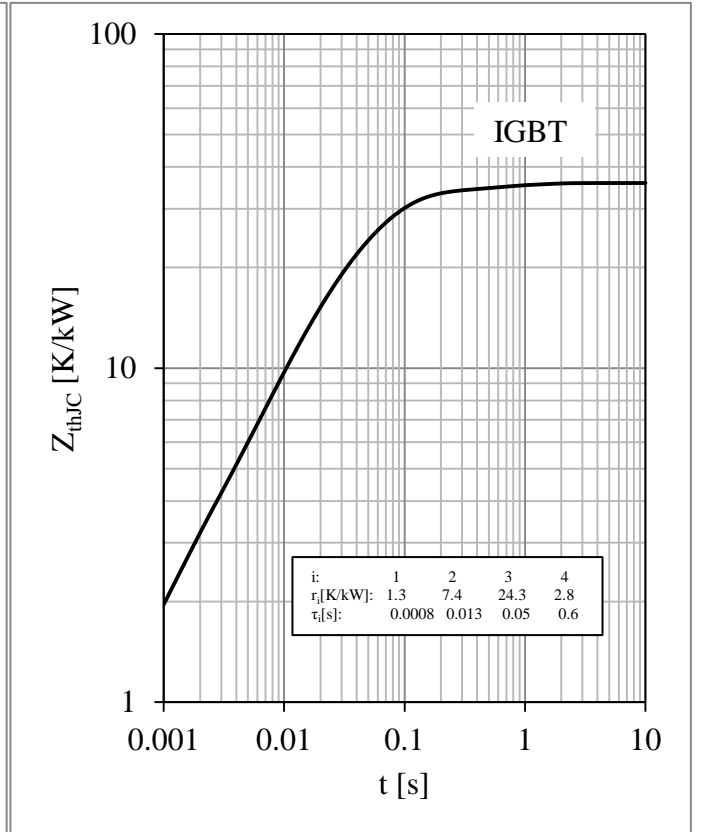


Fig 6. IGBT Transient Thermal Impedance

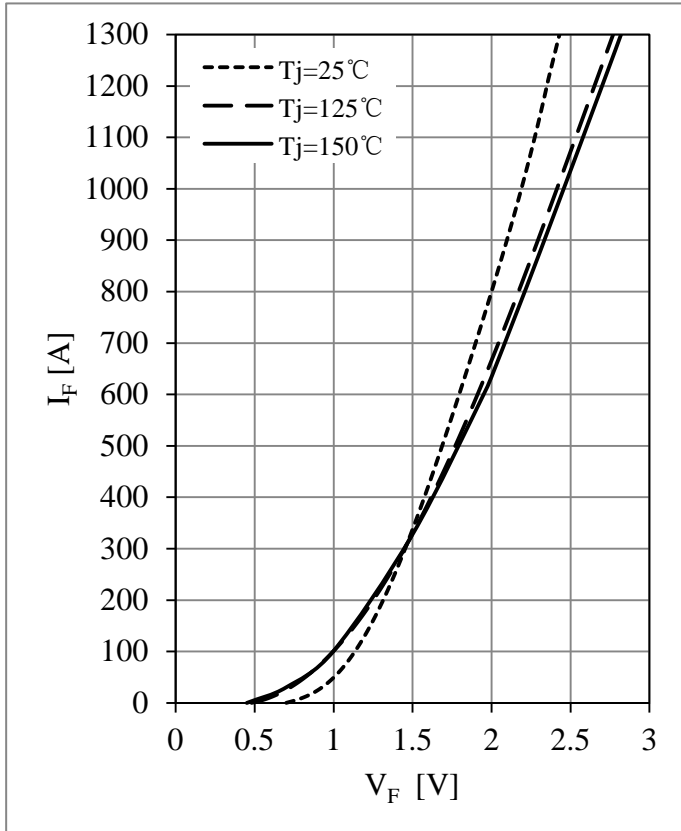


Fig 7. Diode Forward Characteristics

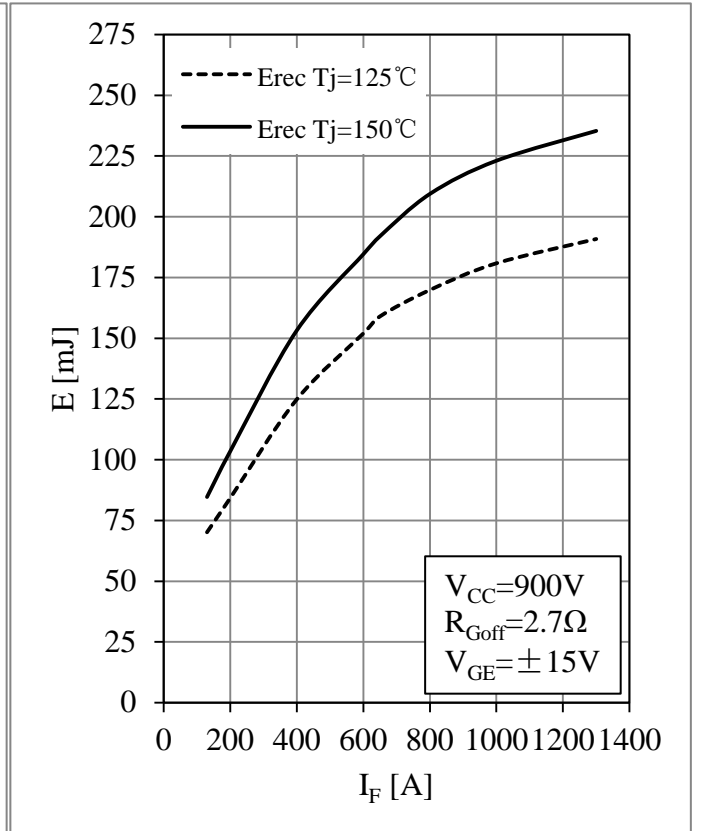


Fig 8. Diode Switching Loss vs.  $I_F$

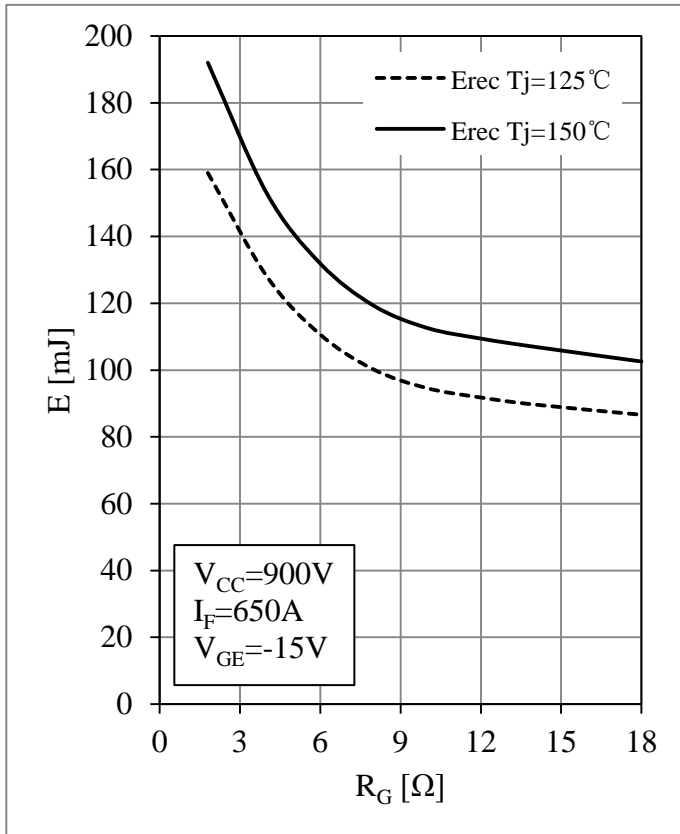


Fig 9. Diode Switching Loss vs.  $R_G$

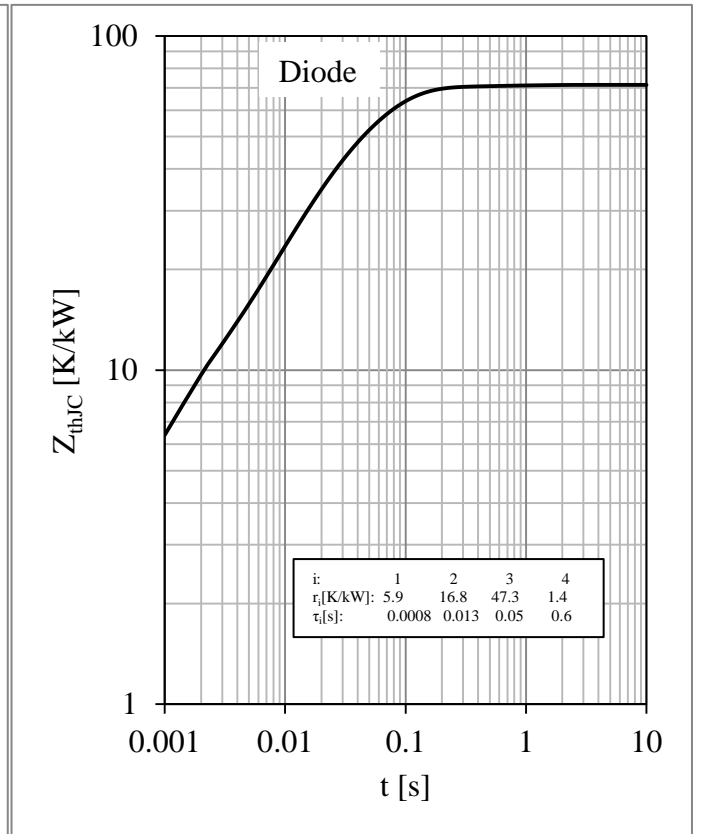


Fig 10. Diode Transient Thermal Impedance

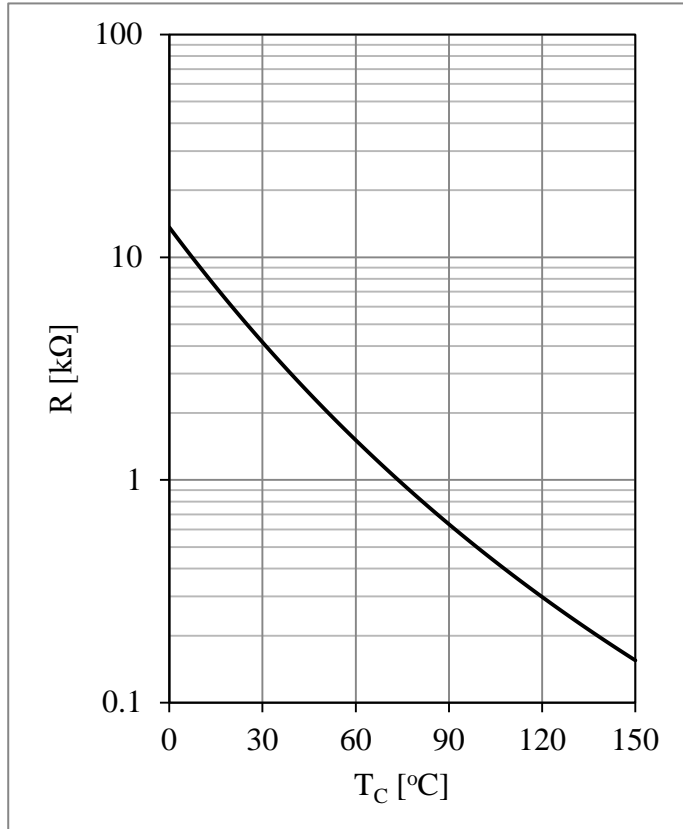
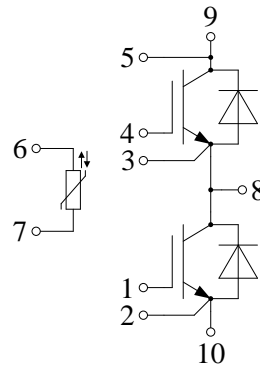


Fig 11. NTC Temperature Characteristic

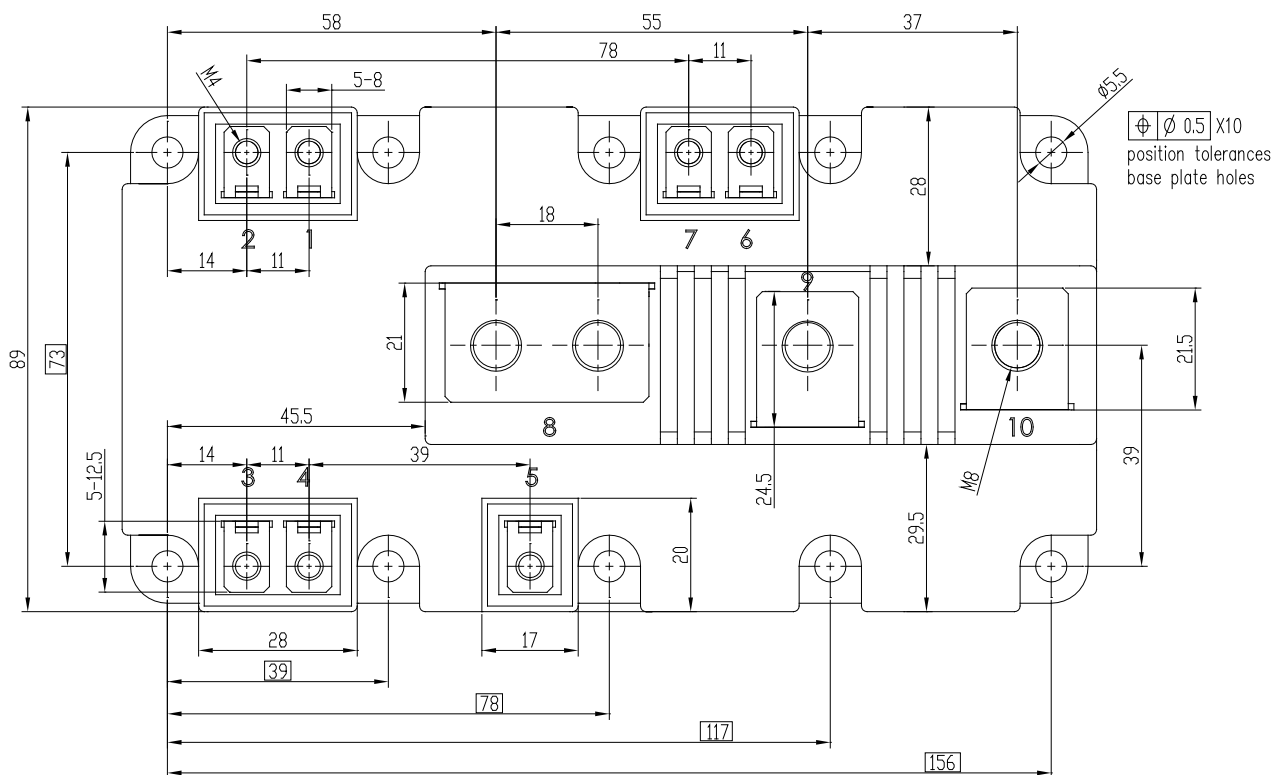
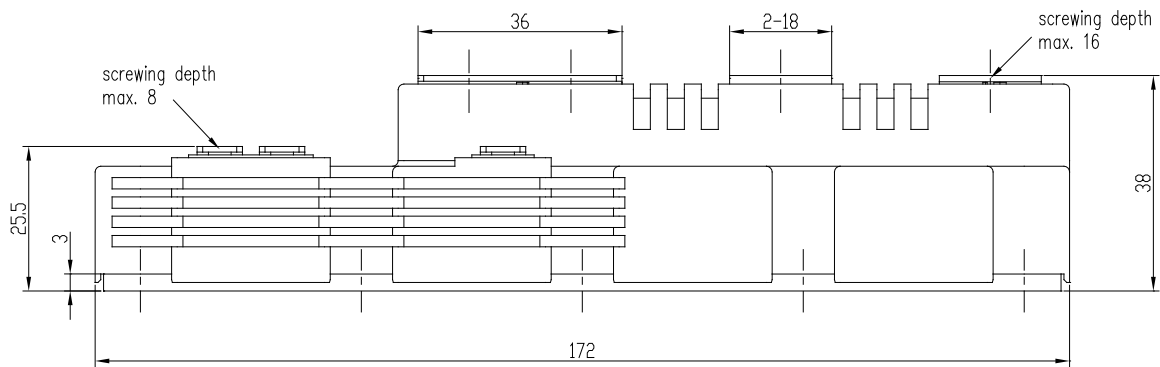


**Circuit Schematic**



**Package Dimensions**

Dimensions in Millimeters



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