

# STARPOWER

SEMICONDUCTOR

**IGBT**

## GD450HFX120C6SA

**1200V/450A 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 hybrid and electric vehicle.

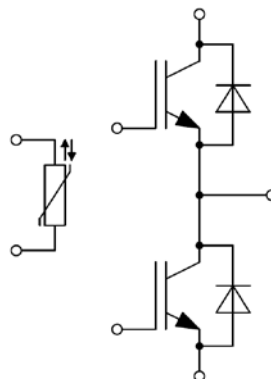
### Features

- 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
- Low inductance case
- Fast & soft reverse recovery anti-parallel FWD
- Isolated copper baseplate using DBC technology

### Typical Applications

- Hybrid and electric vehicle
- Inverter for motor drive
- Uninterruptible power supply

### 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	1200	V
$V_{GES}$	Gate-Emitter Voltage	$\pm 20$	V
$I_C$	Collector Current @ $T_C=25^{\circ}\text{C}$	680	A
	@ $T_C=100^{\circ}\text{C}$	450	A
$I_{CM}$	Pulsed Collector Current $t_p=1\text{ms}$	900	A
$P_D$	Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$	2173	W

**Diode**

Symbol	Description	Value	Unit
$V_{RRM}$	Repetitive Peak Reverse Voltage	1200	V
$I_F$	Diode Continuous Forward Current	450	A
$I_{FM}$	Diode Maximum Forward Current $t_p=1\text{ms}$	900	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 +125	$^{\circ}\text{C}$
$V_{ISO}$	Isolation Voltage RMS, $f=50\text{Hz}$ , $t=1\text{min}$	2500	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	$I_C=450\text{A}, V_{GE}=15\text{V}, T_j=25^\circ\text{C}$		1.70	2.15	V	
		$I_C=450\text{A}, V_{GE}=15\text{V}, T_j=125^\circ\text{C}$		1.95			
		$I_C=450\text{A}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}$		2.00			
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$I_C=11.3\text{mA}, V_{CE}=V_{GE}, T_j=25^\circ\text{C}$	5.2	5.8	6.4	V	
$I_{CES}$	Collector Cut-Off Current	$V_{CE}=V_{CES}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$			1.0	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			0.7		$\Omega$	
$C_{ies}$	Input Capacitance	$V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$		46.6		nF	
$C_{res}$	Reverse Transfer Capacitance				1.31		nF
$Q_G$	Gate Charge	$V_{GE}=-15\dots+15\text{V}$		3.50		$\mu\text{C}$	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=600\text{V}, I_C=450\text{A}, R_G=1.3\Omega, V_{GE}=\pm 15\text{V}, T_j=25^\circ\text{C}$		203		ns	
$t_r$	Rise Time			64		ns	
$t_{d(off)}$	Turn-Off Delay Time			491		ns	
$t_f$	Fall Time			79		ns	
$E_{on}$	Turn-On Switching Loss			16.1		mJ	
$E_{off}$	Turn-Off Switching Loss			38.0		mJ	
$t_{d(on)}$	Turn-On Delay Time		$V_{CC}=600\text{V}, I_C=450\text{A}, R_G=1.3\Omega, V_{GE}=\pm 15\text{V}, T_j=125^\circ\text{C}$		235		ns
$t_r$	Rise Time				75		ns
$t_{d(off)}$	Turn-Off Delay Time			581		ns	
$t_f$	Fall Time			109		ns	
$E_{on}$	Turn-On Switching Loss			27.8		mJ	
$E_{off}$	Turn-Off Switching Loss			55.5		mJ	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=600\text{V}, I_C=450\text{A}, R_G=1.3\Omega, V_{GE}=\pm 15\text{V}, T_j=150^\circ\text{C}$			235		ns
$t_r$	Rise Time				75		ns
$t_{d(off)}$	Turn-Off Delay Time			621		ns	
$t_f$	Fall Time			119		ns	
$E_{on}$	Turn-On Switching Loss			30.5		mJ	
$E_{off}$	Turn-Off Switching Loss			61.5		mJ	
$I_{SC}$	SC Data		$t_p \leq 10\mu\text{s}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}, V_{CC}=800\text{V}, V_{CEM} \leq 1200\text{V}$		1800		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	$I_F=450\text{A}, V_{GE}=0\text{V}, T_j=25^{\circ}\text{C}$		1.85	2.30	V	
		$I_F=450\text{A}, V_{GE}=0\text{V}, T_j=125^{\circ}\text{C}$		1.90			
		$I_F=450\text{A}, V_{GE}=0\text{V}, T_j=150^{\circ}\text{C}$		1.95			
$Q_r$	Recovered Charge	$V_{CC}=600\text{V}, I_F=450\text{A},$ $-di/dt=6600\text{A}/\mu\text{s}, V_{GE}=-15\text{V},$ $T_j=25^{\circ}\text{C}$		55.2		$\mu\text{C}$	
$I_{RM}$	Peak Reverse Recovery Current			518		A	
$E_{rec}$	Reverse Recovery Energy			26.0		mJ	
$Q_r$	Recovered Charge			106		$\mu\text{C}$	
$I_{RM}$	Peak Reverse Recovery Current		$V_{CC}=600\text{V}, I_F=450\text{A},$ $-di/dt=6600\text{A}/\mu\text{s}, V_{GE}=-15\text{V},$ $T_j=125^{\circ}\text{C}$		633		A
$E_{rec}$	Reverse Recovery Energy			47.5		mJ	
$Q_r$	Recovered Charge			121		$\mu\text{C}$	
$I_{RM}$	Peak Reverse Recovery Current		$V_{CC}=600\text{V}, I_F=450\text{A},$ $-di/dt=6600\text{A}/\mu\text{s}, V_{GE}=-15\text{V},$ $T_j=150^{\circ}\text{C}$		661		A
$E_{rec}$	Reverse Recovery Energy			53.9		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		20		nH
$R_{CC'+EE'}$	Module Lead Resistance, Terminal to Chip		1.10		m $\Omega$
$R_{thJC}$	Junction-to-Case (per IGBT)			0.069	K/W
	Junction-to-Case (per Diode)			0.108	
$R_{thCH}$	Case-to-Heatsink (per IGBT)		0.030		K/W
	Case-to-Heatsink (per Diode)		0.046		
	Case-to-Heatsink (per Module)		0.009		
M	Terminal Connection Torque, Screw M6	3.0		6.0	N.m
	Mounting Torque, Screw M5	3.0		6.0	
G	Weight of Module		350		g

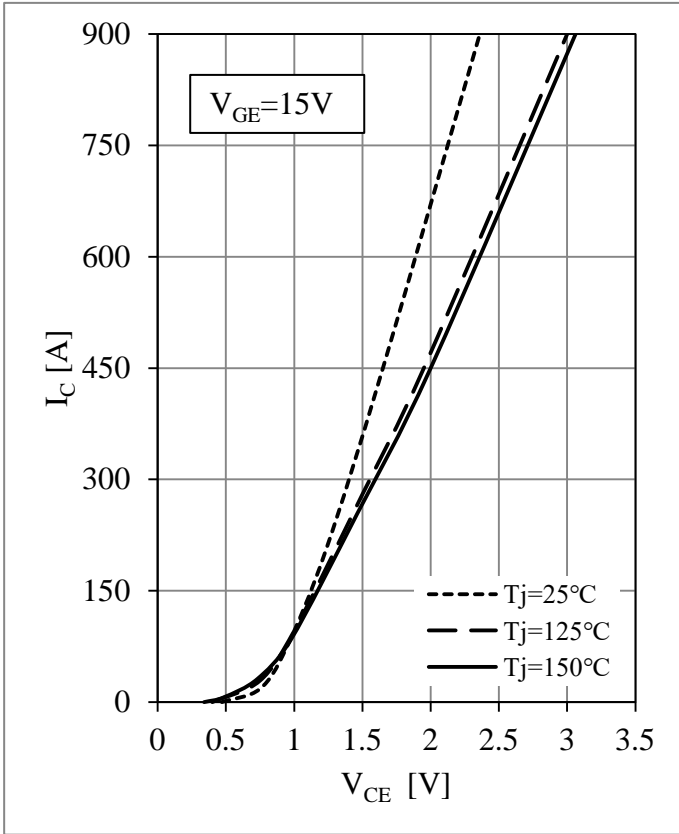


Fig 1. IGBT Output Characteristics

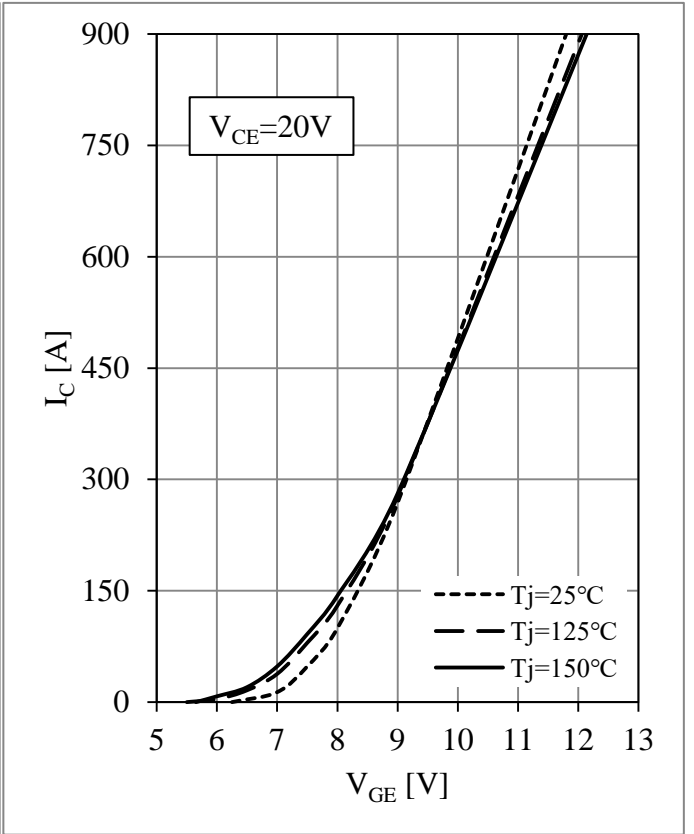


Fig 2. IGBT Transfer Characteristics

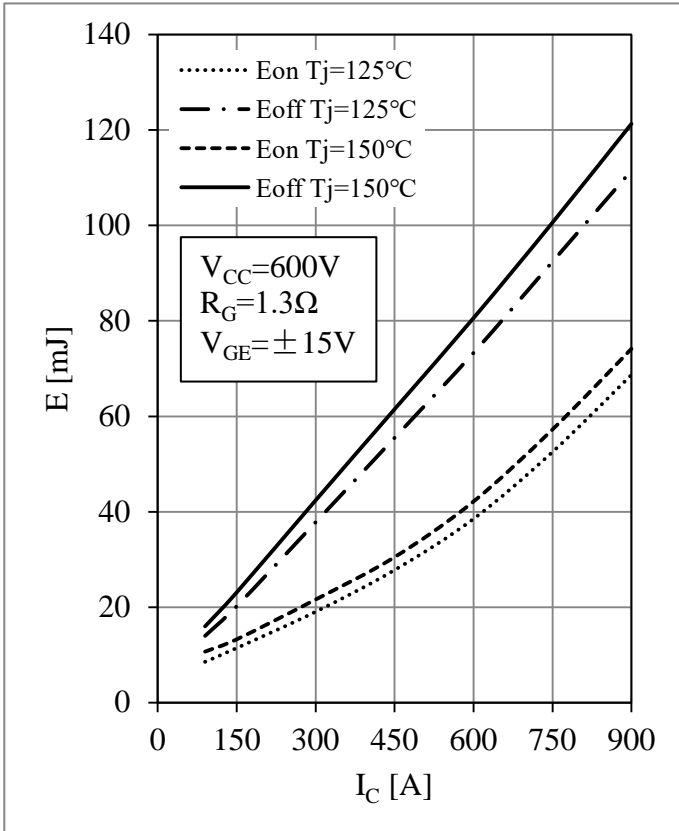


Fig 3. IGBT Switching Loss vs.  $I_c$

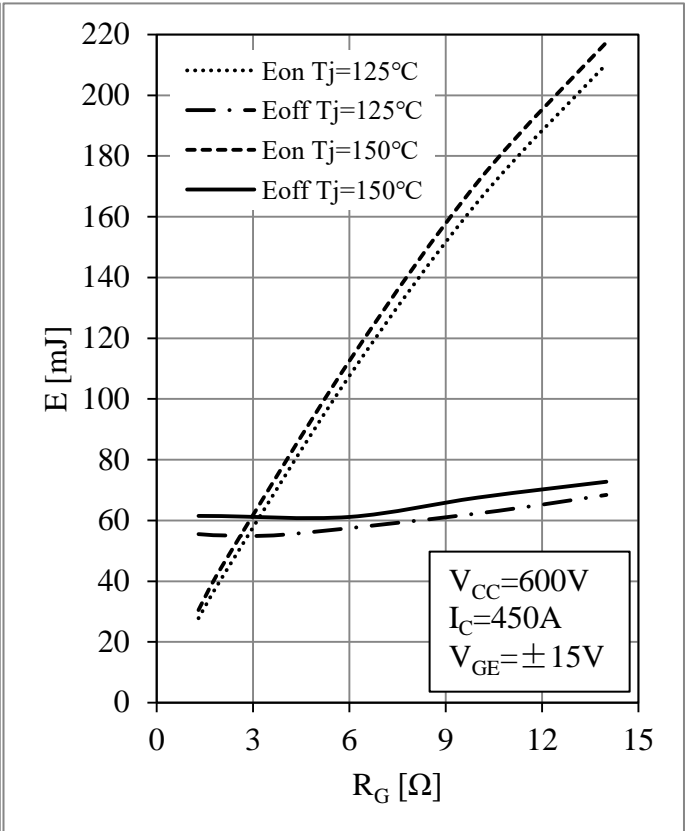


Fig 4. IGBT Switching Loss vs.  $R_G$

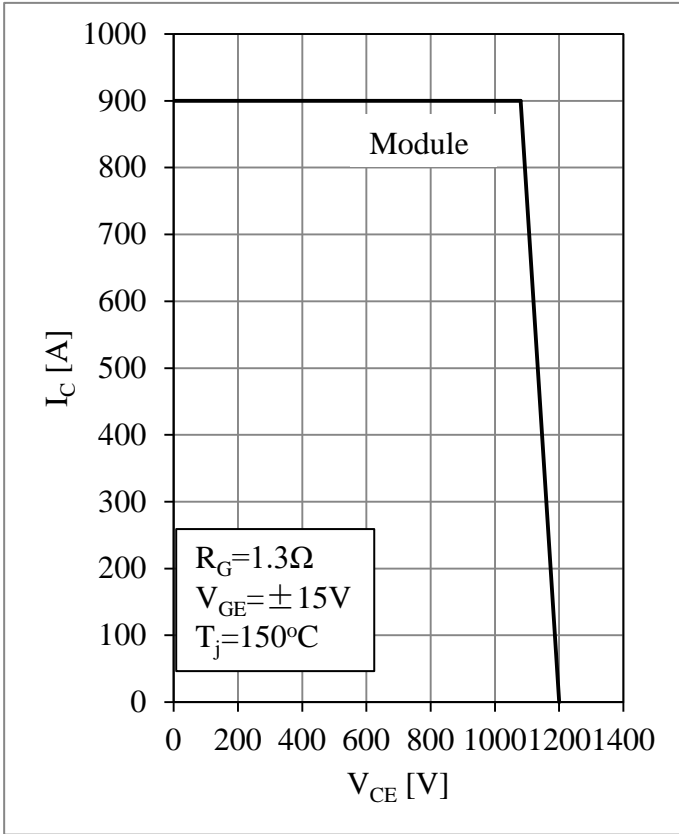


Fig 5. RBSOA

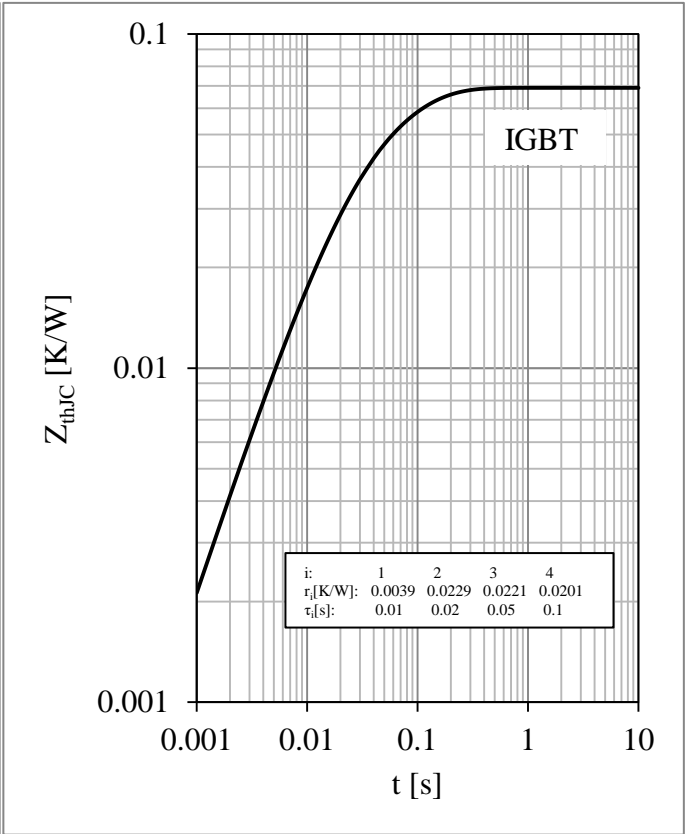


Fig 6. IGBT Transient Thermal Impedance

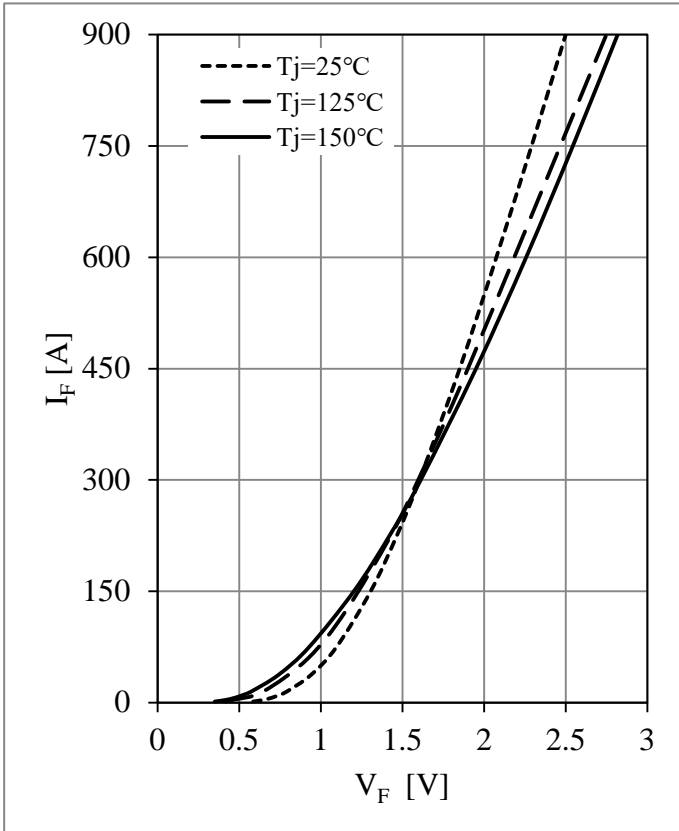


Fig 7. Diode Forward Characteristics

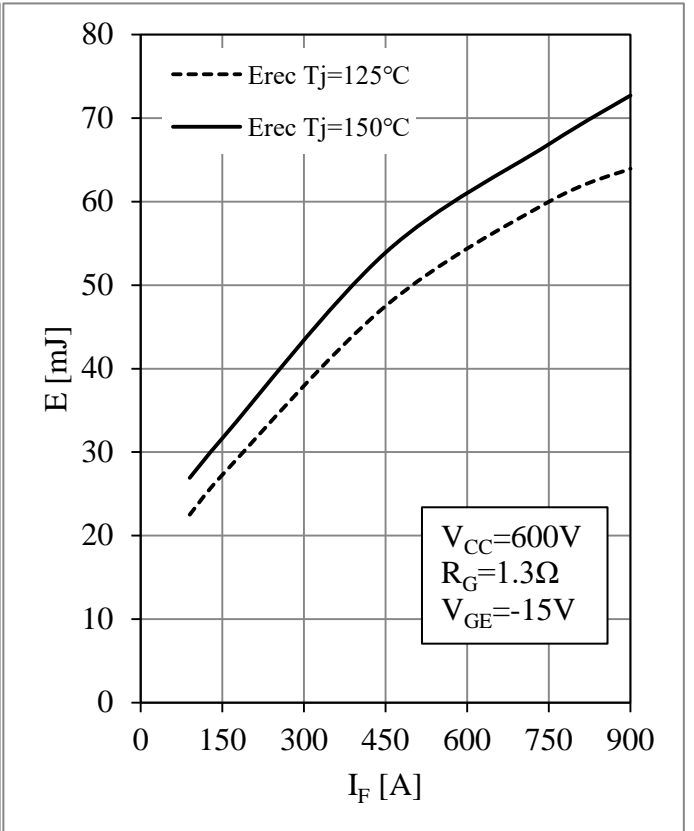


Fig 8. Diode Switching Loss vs.  $I_F$

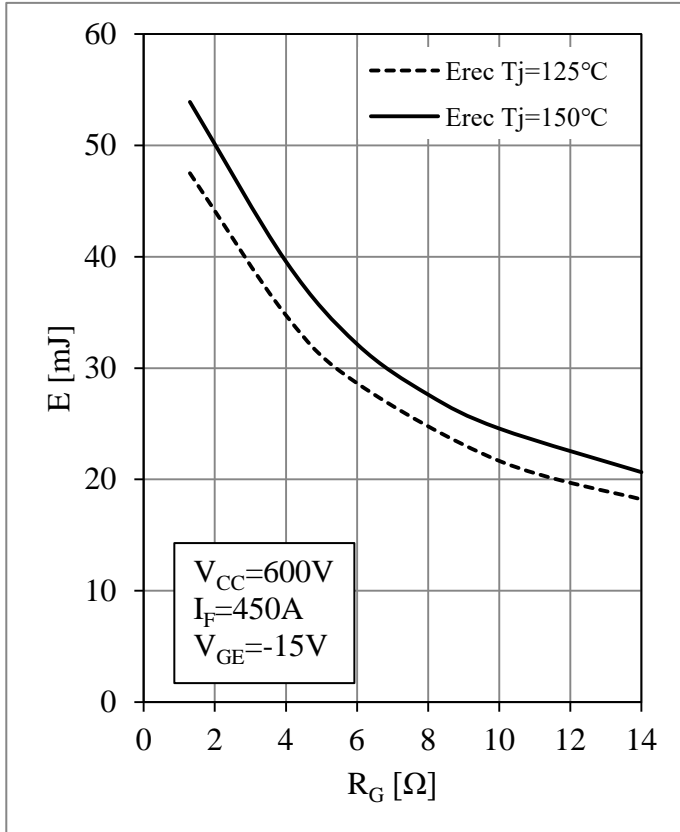


Fig 9. Diode Switching Loss vs.  $R_G$

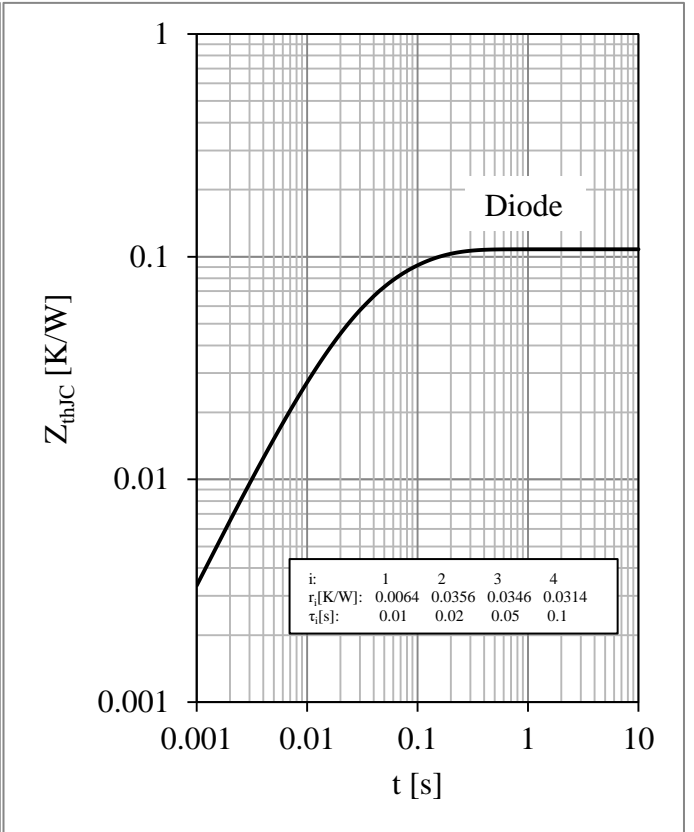


Fig 10. Diode Transient Thermal Impedance

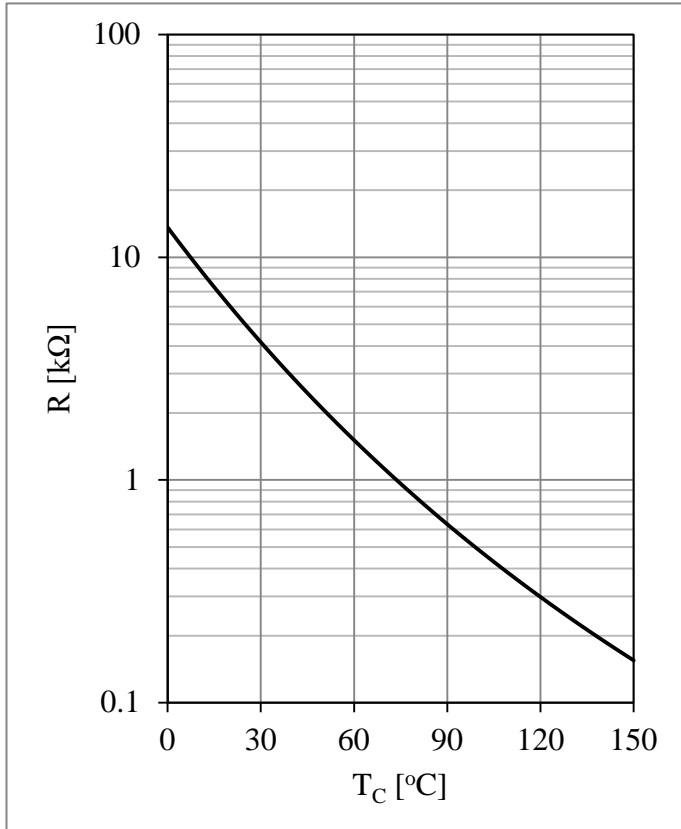
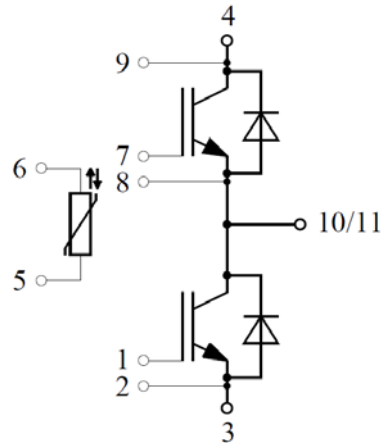


Fig 11. NTC Temperature Characteristic

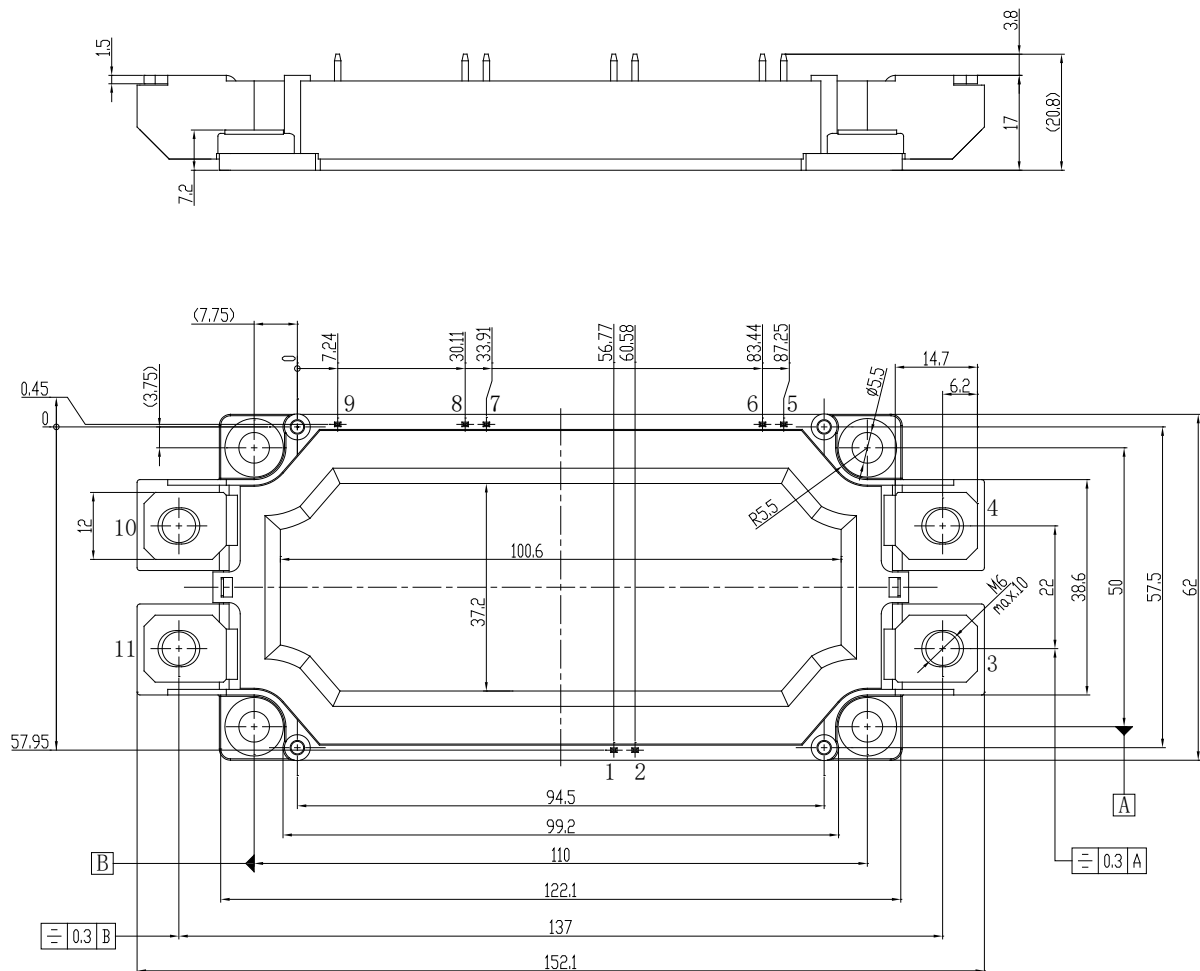


**Circuit Schematic**



**Package Dimensions**

Dimensions in Millimeters



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