

# STARPOWER

SEMICONDUCTOR

**IGBT**

## GD720HTA120P6HT

**1200V/720A 6 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.

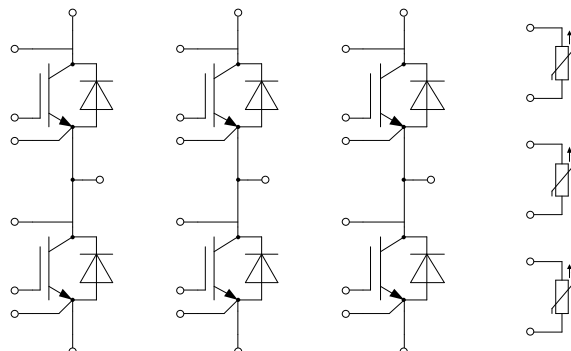
### Features

- Low  $V_{CE(sat)}$  Trench IGBT technology
- Low switching losses
- 4 $\mu$ 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 pinfin baseplate using Si<sub>3</sub>N<sub>4</sub>AMB technology

### Typical Applications

- Automotive application
- Hybrid and electric vehicle
- Inverter for motor drive

### Equivalent Circuit Schematic



**Absolute Maximum Ratings**  $T_F=25^{\circ}\text{C}$  unless otherwise noted**IGBT**

Symbol	Description	Values	Unit
$V_{CES}$	Collector-Emitter Voltage	1200	V
$V_{GES}$	Gate-Emitter Voltage	$\pm 20$	V
$I_{CN}$	Implemented Collector Current	720	A
$I_C$	Collector Current @ $T_F=65^{\circ}\text{C}$	600	A
$I_{CM}$	Pulsed Collector Current $t_p=1\text{ms}$	1440	A
$P_D$	Maximum Power Dissipation @ $T_F=75^{\circ}\text{C}$ $T_{vj}=175^{\circ}\text{C}$	1204	W

**Diode**

Symbol	Description	Values	Unit
$V_{RRM}$	Repetitive Peak Reverse Voltage	1200	V
$I_{FN}$	Implemented Collector Current	720	A
$I_F$	Diode Continuous Forward Current	600	A
$I_{FM}$	Diode Maximum Forward Current $t_p=1\text{ms}$	1440	A

**Module**

Symbol	Description	Value	Unit
$T_{vjmax}$	Maximum Junction Temperature	175	$^{\circ}\text{C}$
$T_{vjop}$	Operating Junction Temperature continuous For 10s within a period of 30s, occurrence maximum 3000 times over lifetime	-40 to +150 +150 to +175	$^{\circ}\text{C}$
$T_{STG}$	Storage Temperature Range	-40 to +125	$^{\circ}\text{C}$
$V_{ISO}$	Isolation Voltage RMS, $f=50\text{Hz}$ , $t=1\text{min}$	3000	V

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit	
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C=600\text{A}, V_{GE}=15\text{V}, T_{vj}=25^\circ\text{C}$		1.50		V	
		$I_C=600\text{A}, V_{GE}=15\text{V}, T_{vj}=150^\circ\text{C}$		1.80			
		$I_C=600\text{A}, V_{GE}=15\text{V}, T_{vj}=175^\circ\text{C}$		1.85			
		$I_C=720\text{A}, V_{GE}=15\text{V}, T_{vj}=25^\circ\text{C}$		1.60			
		$I_C=720\text{A}, V_{GE}=15\text{V}, T_{vj}=175^\circ\text{C}$		2.05			
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$I_C=15.6\text{mA}, V_{CE}=V_{GE}, T_{vj}=25^\circ\text{C}$		6.0		V	
$I_{CES}$	Collector Cut-Off Current	$V_{CE}=V_{CES}, V_{GE}=0\text{V}, T_{vj}=25^\circ\text{C}$			1.0	mA	
$I_{GES}$	Gate-Emitter Leakage Current	$V_{GE}=V_{GES}, V_{CE}=0\text{V}, T_{vj}=25^\circ\text{C}$			400	nA	
$R_{Gint}$	Internal Gate Resistance			1.67		$\Omega$	
$C_{ies}$	Input Capacitance			48.7		nF	
$C_{oes}$	Output Capacitance	$V_{CE}=25\text{V}, f=100\text{kHz}, V_{GE}=0\text{V}$		1.55		nF	
$C_{res}$	Reverse Transfer Capacitance			0.26		nF	
$Q_G$	Gate Charge	$V_{CE}=800\text{V}, I_C=600\text{A}, V_{GE}=-8\dots+15\text{V}$		3.52		$\mu\text{C}$	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=800\text{V}, I_C=600\text{A}, R_{Gon}=3.0\Omega, R_{Goff}=1.0\Omega, L_S=24\text{nH}, V_{GE}=-8\text{V}/+15\text{V}, T_{vj}=25^\circ\text{C}$		208		ns	
$t_r$	Rise Time			65		ns	
$t_{d(off)}$	Turn-Off Delay Time			505		ns	
$t_f$	Fall Time			104		ns	
$E_{on}$	Turn-On Switching Loss			77.7		mJ	
$E_{off}$	Turn-Off Switching Loss			62.2		mJ	
$t_{d(on)}$	Turn-On Delay Time		$V_{CC}=800\text{V}, I_C=600\text{A}, R_{Gon}=3.0\Omega, R_{Goff}=1.0\Omega, L_S=24\text{nH}, V_{GE}=-8\text{V}/+15\text{V}, T_{vj}=150^\circ\text{C}$		225		ns
$t_r$	Rise Time				75		ns
$t_{d(off)}$	Turn-Off Delay Time			567		ns	
$t_f$	Fall Time			191		ns	
$E_{on}$	Turn-On Switching Loss			110		mJ	
$E_{off}$	Turn-Off Switching Loss			83.4		mJ	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=800\text{V}, I_C=600\text{A}, R_{Gon}=3.0\Omega, R_{Goff}=1.0\Omega, L_S=24\text{nH}, V_{GE}=-8\text{V}/+15\text{V}, T_{vj}=175^\circ\text{C}$			226		ns
$t_r$	Rise Time				77		ns
$t_{d(off)}$	Turn-Off Delay Time			583		ns	
$t_f$	Fall Time			203		ns	
$E_{on}$	Turn-On Switching Loss			118		mJ	
$E_{off}$	Turn-Off Switching Loss			85.9		mJ	
$I_{SC}$	SC Data		$t_p \leq 4\mu\text{s}, V_{GE}=15\text{V}, T_{vj}=175^\circ\text{C}, V_{CC}=800\text{V}, V_{CEM} \leq 1200\text{V}$		2600		A

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_F$	Diode Forward Voltage	$I_F=600\text{A}, V_{GE}=0\text{V}, T_{vj}=25^{\circ}\text{C}$		1.95		V
		$I_F=600\text{A}, V_{GE}=0\text{V}, T_{vj}=150^{\circ}\text{C}$		1.95		
		$I_F=600\text{A}, V_{GE}=0\text{V}, T_{vj}=175^{\circ}\text{C}$		1.90		
		$I_F=720\text{A}, V_{GE}=0\text{V}, T_{vj}=25^{\circ}\text{C}$		2.05		
		$I_F=720\text{A}, V_{GE}=0\text{V}, T_{vj}=175^{\circ}\text{C}$		2.05		
$Q_r$	Recovered Charge			44.3		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current	$V_R=800\text{V}, I_F=600\text{A},$ $-di/dt=8281\text{A}/\mu\text{s}, L_S=24\text{nH},$ $V_{GE}=-8\text{V}, T_{vj}=25^{\circ}\text{C}$		346		A
$E_{rec}$	Reverse Recovery Energy			16.2		mJ
$Q_r$	Recovered Charge			73.4		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current	$V_R=800\text{V}, I_F=600\text{A},$ $-di/dt=6954\text{A}/\mu\text{s}, L_S=24\text{nH},$ $V_{GE}=-8\text{V}, T_{vj}=150^{\circ}\text{C}$		385		A
$E_{rec}$	Reverse Recovery Energy			27.8		mJ
$Q_r$	Recovered Charge			80.7		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current	$V_R=800\text{V}, I_F=600\text{A},$ $-di/dt=6679\text{A}/\mu\text{s}, L_S=24\text{nH},$ $V_{GE}=-8\text{V}, T_{vj}=175^{\circ}\text{C}$		392		A
$E_{rec}$	Reverse Recovery Energy			30.7		mJ

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

Symbol	Parameter	Min.	Typ.	Max.	Unit
$L_{CE}$	Stray Inductance		8		nH
$R_{CC'+EE'}$	Module Lead Resistance, Terminal to Chip		0.75		m $\Omega$
p	Maximum Pressure In Cooling Circuit $T_{\text{baseplate}} < 40^{\circ}\text{C}$ $T_{\text{baseplate}} > 40^{\circ}\text{C}$ (relative pressure)			2.5 2.0	bar
$R_{thJF}$	Junction-to-Cooling Fluid (per IGBT) Junction-to-Cooling Fluid (per Diode) $\Delta V/\Delta t=10.0\text{dm}^3/\text{min}, T_F=75^{\circ}\text{C}$		0.072 0.104	0.083 0.120	K/W
M	Terminal Connection Torque, Screw M5 Mounting Torque, Screw M4	3.6 1.8		4.4 2.2	N.m
G	Weight of Module		750		g

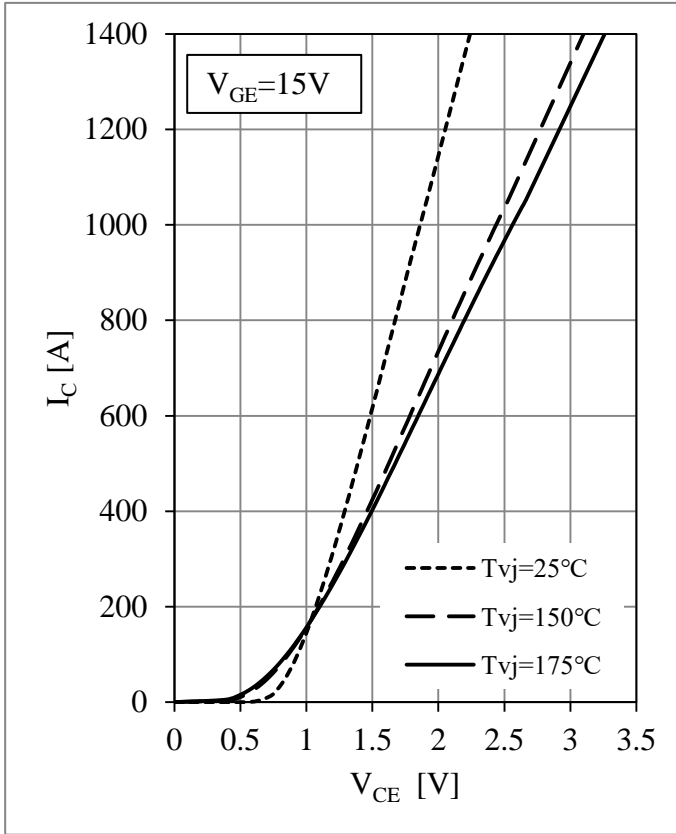


Fig 1. IGBT Output Characteristics

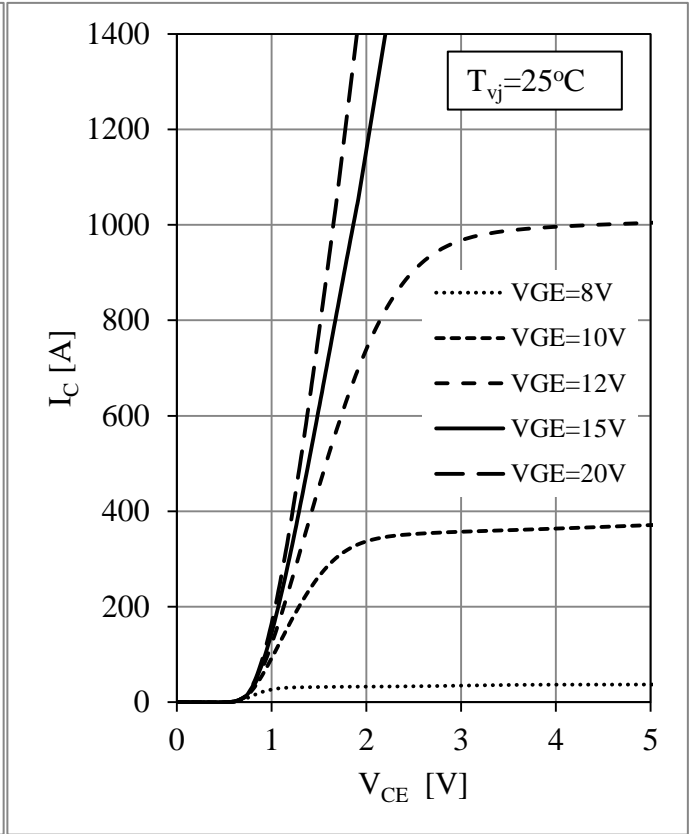


Fig 2. IGBT Output Characteristics

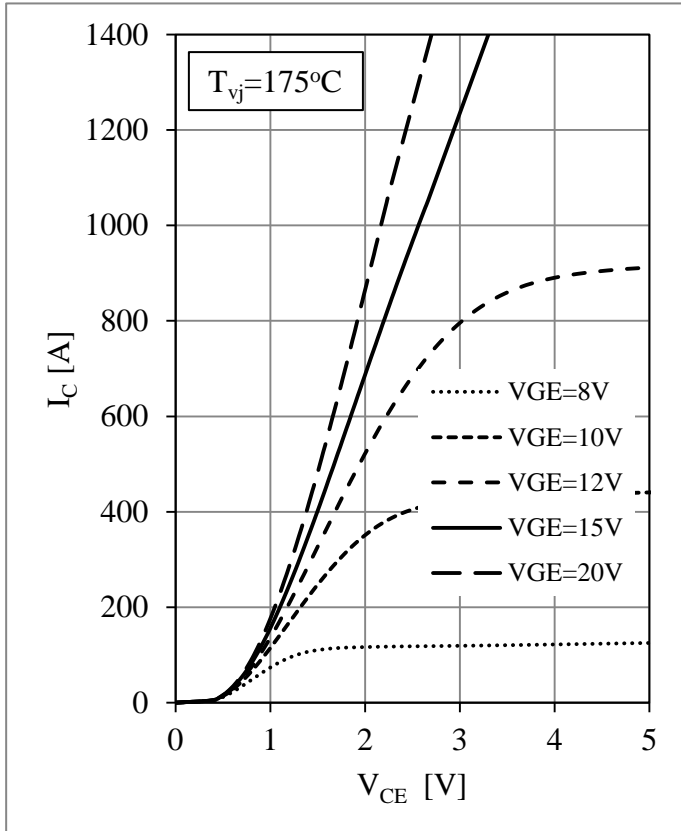


Fig 3. IGBT Output Characteristics

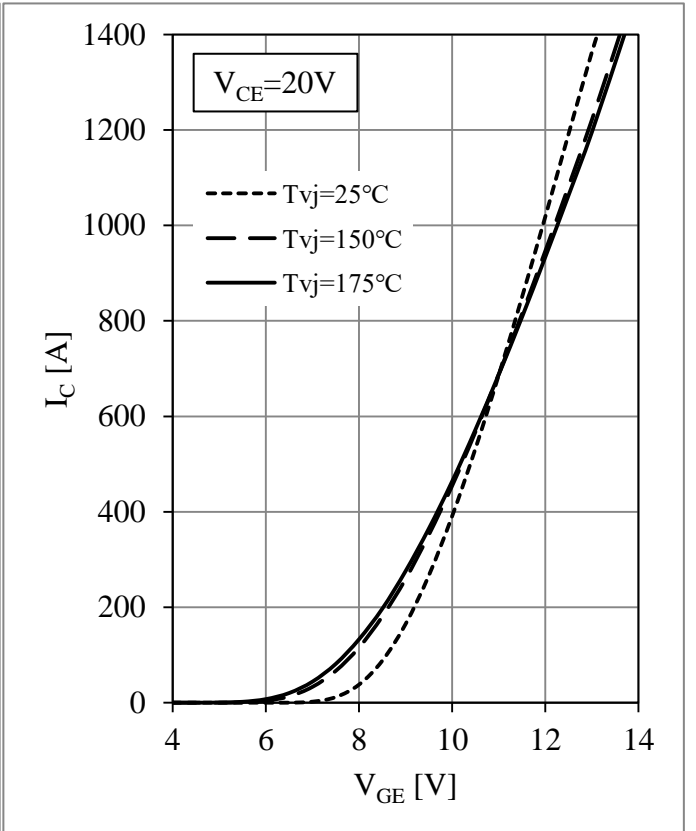


Fig 4. IGBT Transfer Characteristics

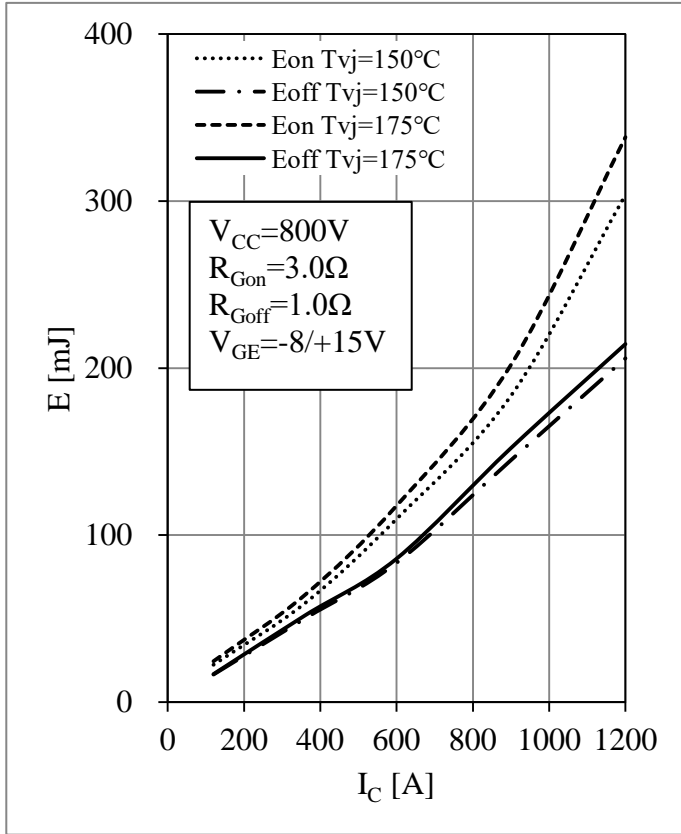


Fig 5. IGBT Switching Loss vs.  $I_C$

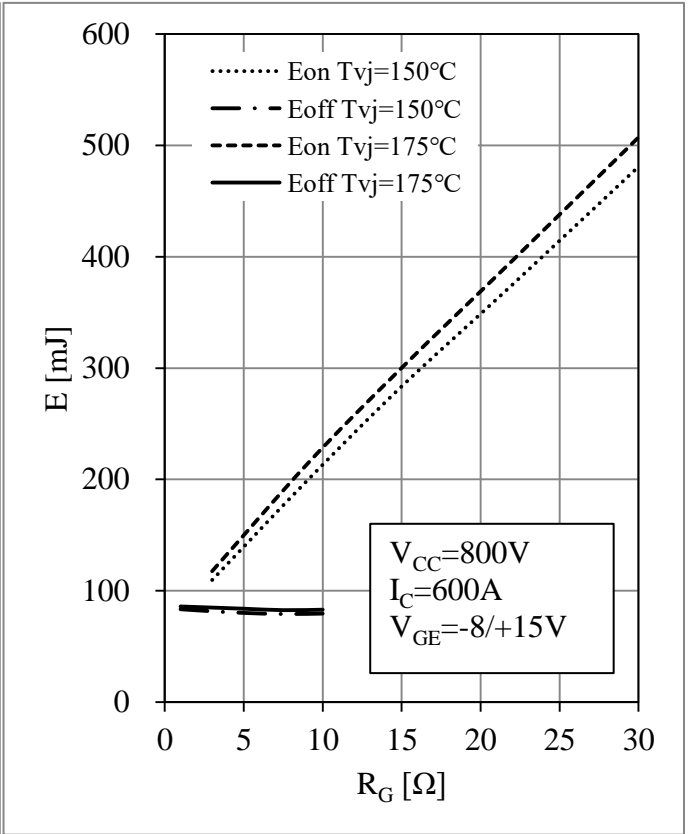


Fig 6. IGBT Switching Loss vs.  $R_G$

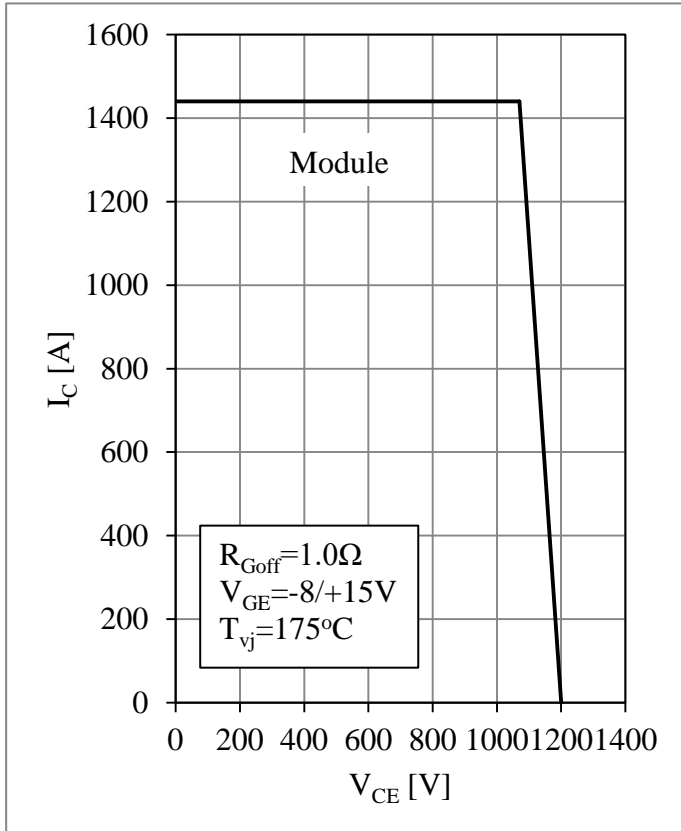


Fig 7. RBSOA

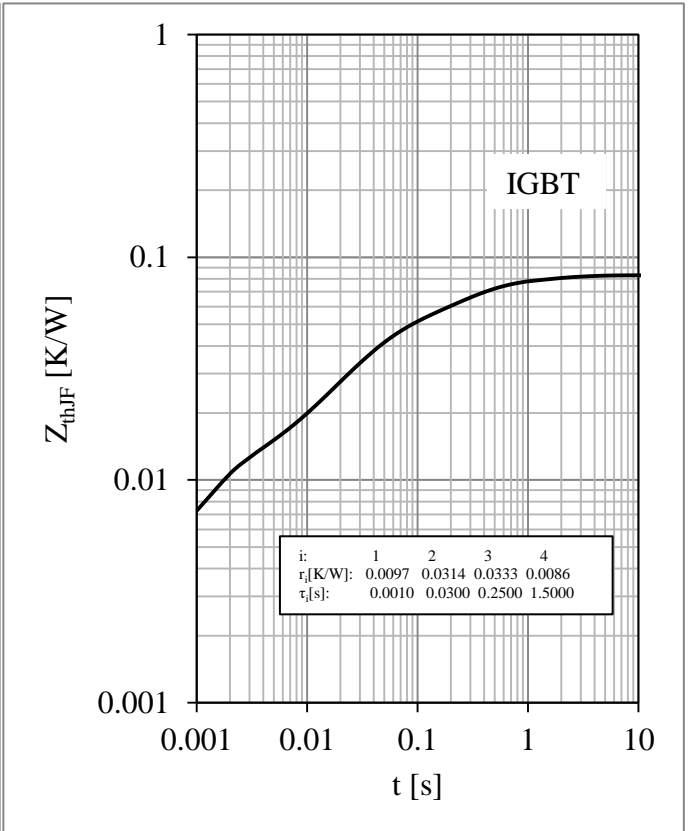


Fig 8. IGBT Transient Thermal Impedance

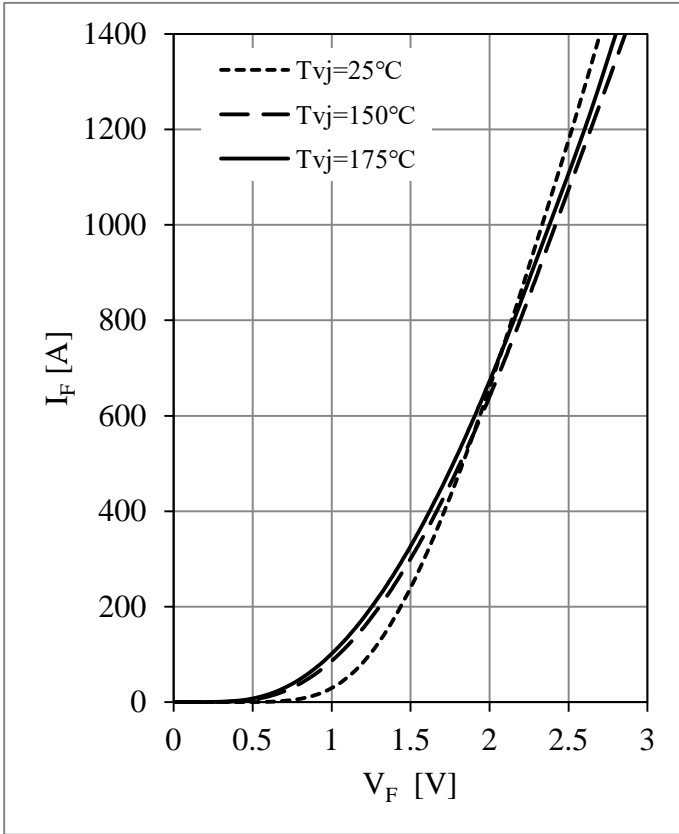


Fig 9. Diode Forward Characteristics

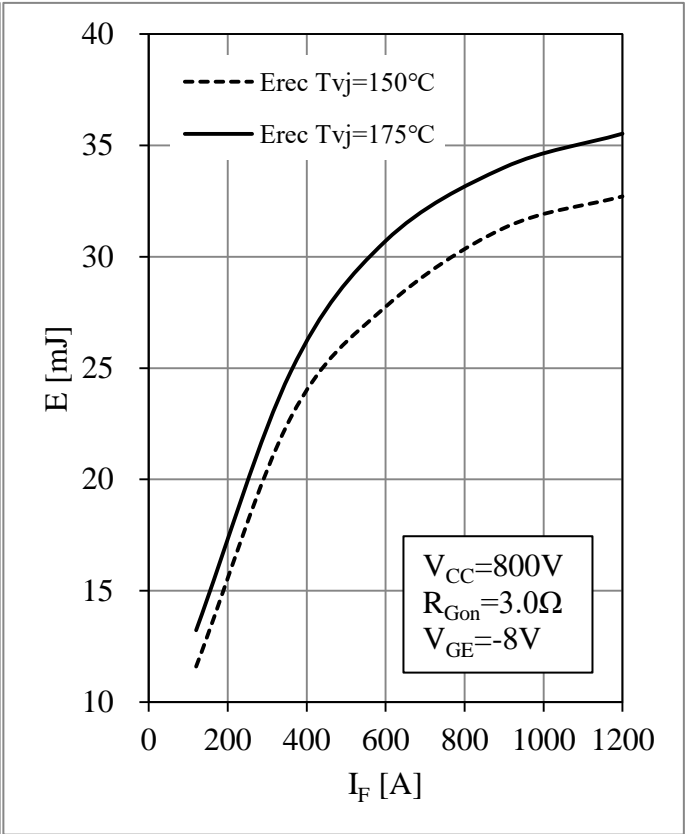


Fig 10. Diode Switching Loss vs.  $I_F$

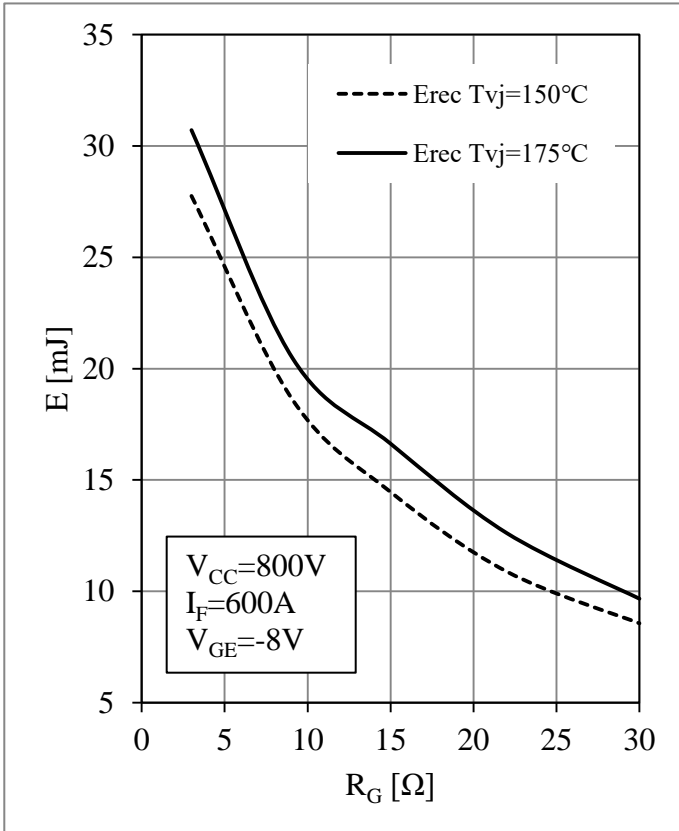


Fig 11. Diode Switching Loss vs.  $R_G$

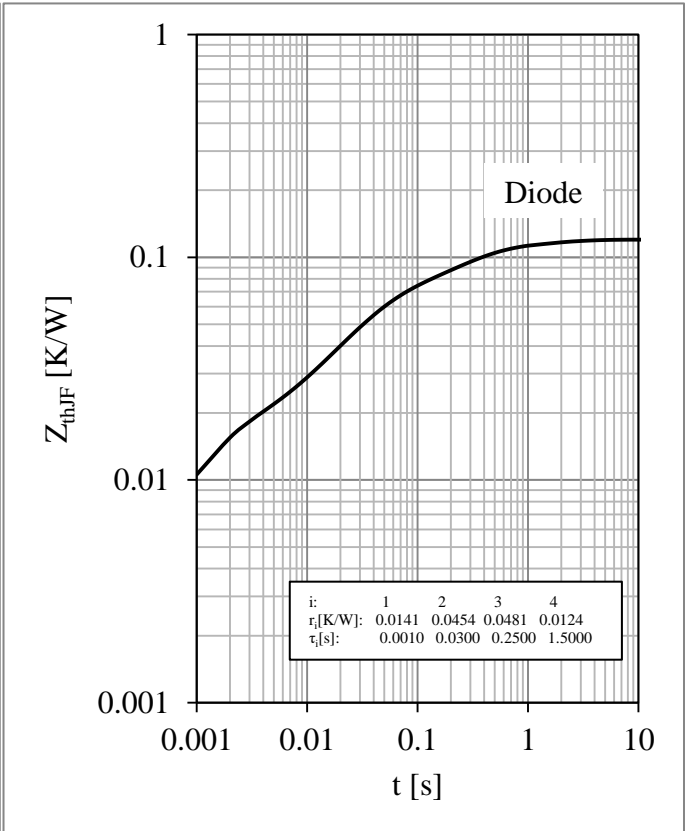


Fig 12. Diode Transient Thermal Impedance



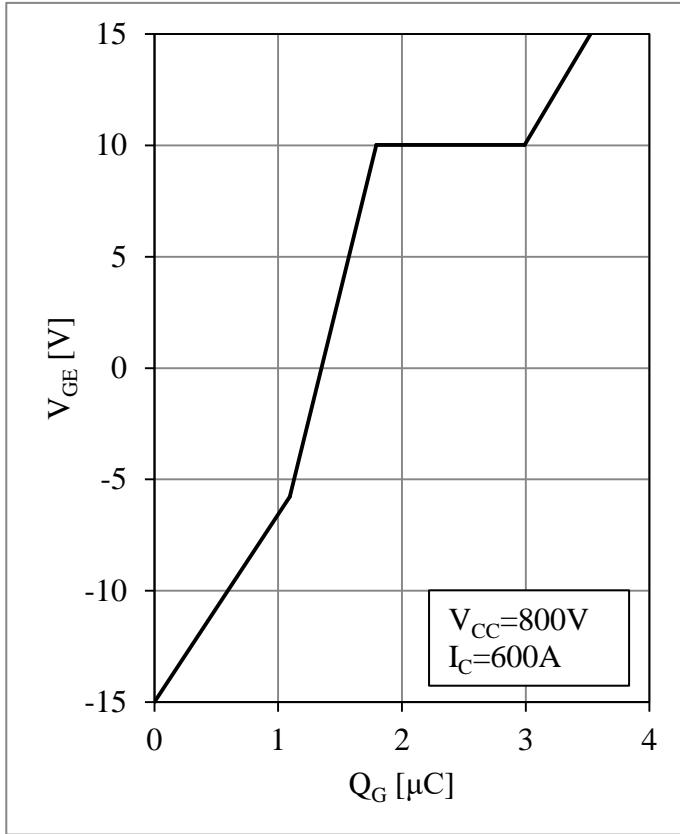


Fig 13. IGBT Gate Charge Characteristic

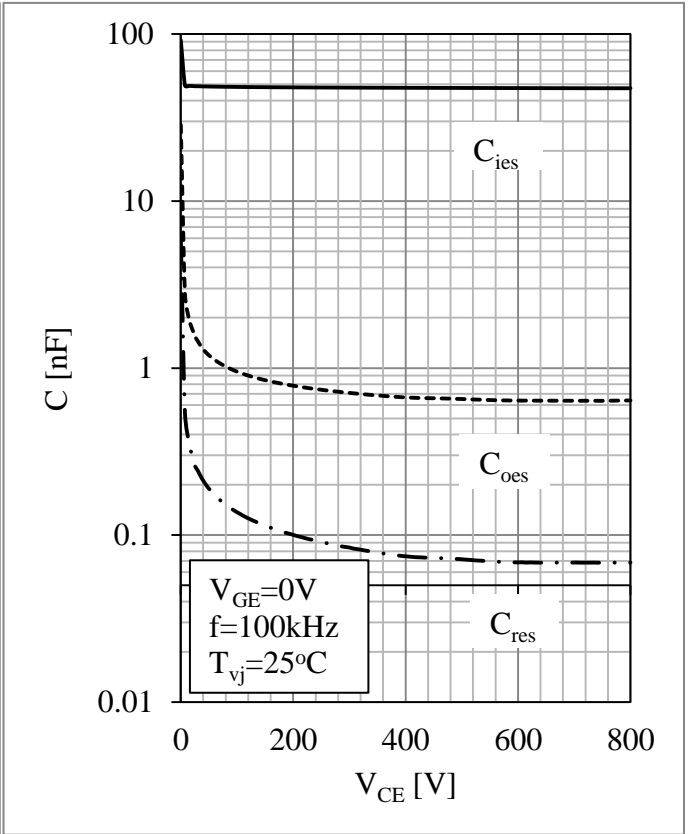


Fig 14. IGBT Capacity Characteristic

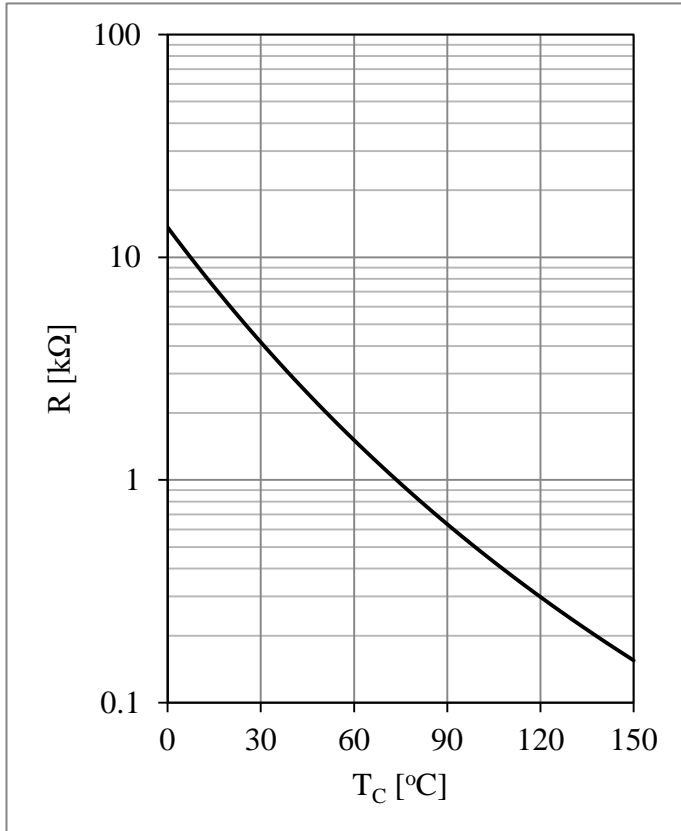
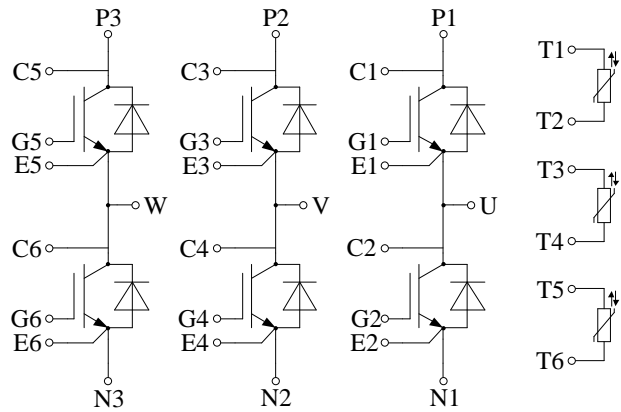


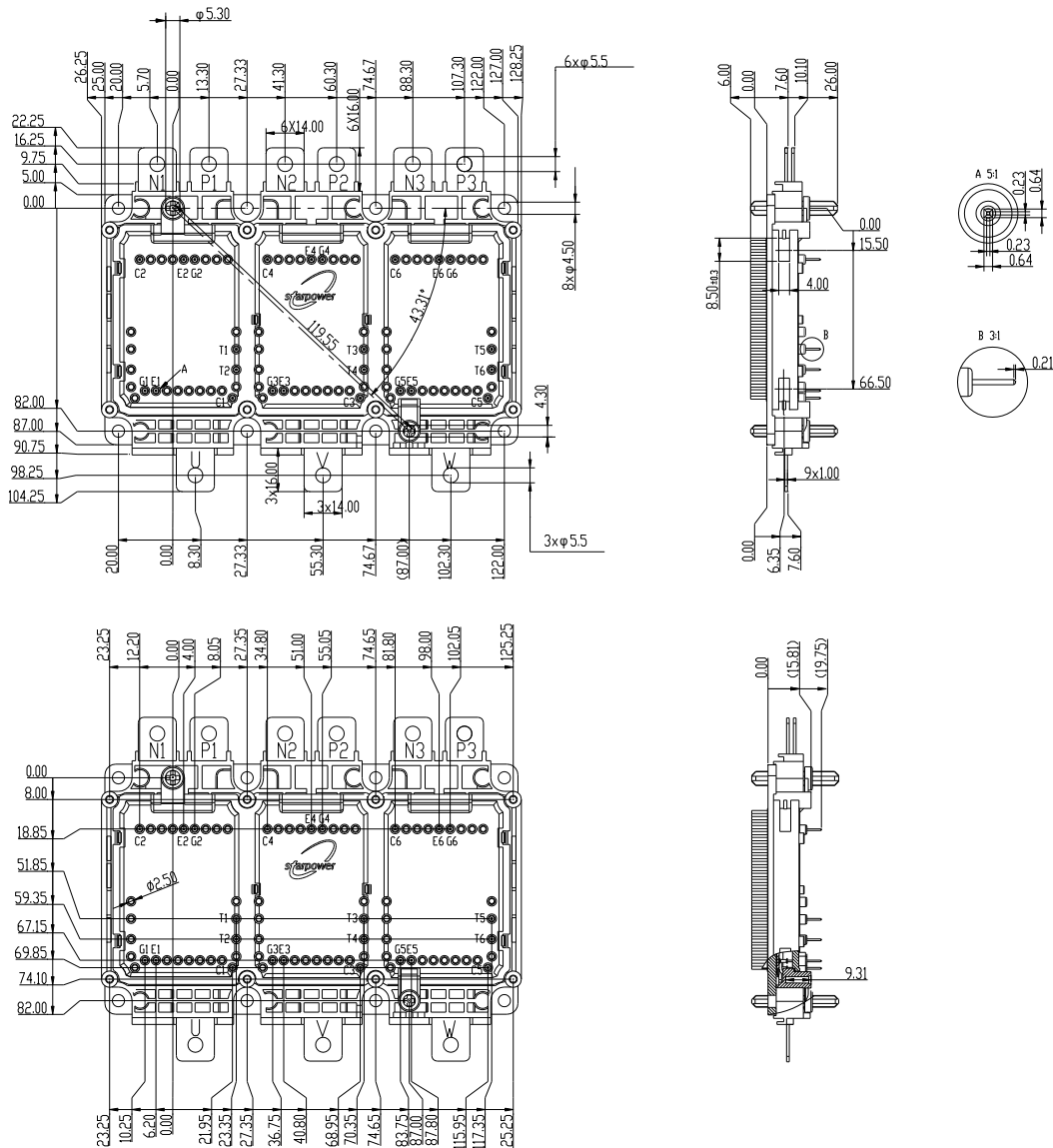
Fig 15. NTC Temperature Characteristic

Circuit Schematic



Package Dimensions

Dimensions in Millimeters



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