

# STARPOWER

SEMICONDUCTOR

**IGBT**

## GD950HTX75P6HB

**750V/950A 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.

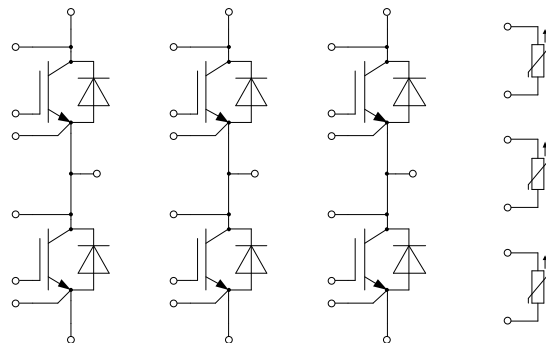
### Features

- Low  $V_{CE(sat)}$  Trench IGBT technology
- Low switching losses
- 6 $\mu$ 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	750	V
$V_{GES}$	Gate-Emitter Voltage	$\pm 20$	V
$I_{CN}$	Implemented Collector Current	950	A
$I_C$	Collector Current @ $T_F=90^{\circ}\text{C}$	450	A
$I_{CM}$	Pulsed Collector Current $t_p=1\text{ms}$	1900	A
$P_D$	Maximum Power Dissipation @ $T_F=75^{\circ}\text{C}$ $T_j=175^{\circ}\text{C}$	877	W

**Diode**

Symbol	Description	Values	Unit
$V_{RRM}$	Repetitive Peak Reverse Voltage	750	V
$I_{FN}$	Implemented Collector Current	950	A
$I_F$	Diode Continuous Forward Current	450	A
$I_{FM}$	Diode Maximum Forward Current $t_p=1\text{ms}$	1900	A

**Module**

Symbol	Description	Value	Unit
$T_{jmax}$	Maximum Junction Temperature	175	$^{\circ}\text{C}$
$T_{jop}$	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, $f=50\text{Hz}$ , $t=1\text{min}$	2500	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	$I_C=450\text{A}, V_{GE}=15\text{V}, T_j=25^{\circ}\text{C}$		1.25	1.50	V	
		$I_C=450\text{A}, V_{GE}=15\text{V}, T_j=150^{\circ}\text{C}$		1.35			
		$I_C=450\text{A}, V_{GE}=15\text{V}, T_j=175^{\circ}\text{C}$		1.40			
		$I_C=950\text{A}, V_{GE}=15\text{V}, T_j=25^{\circ}\text{C}$		1.60			
		$I_C=950\text{A}, V_{GE}=15\text{V}, T_j=175^{\circ}\text{C}$		2.05			
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$I_C=9.60\text{mA}, V_{CE}=V_{GE}, T_j=25^{\circ}\text{C}$	5.0	5.7	7.0	V	
		$I_C=9.60\text{mA}, V_{CE}=V_{GE}, T_j=175^{\circ}\text{C}$		3.5			
$I_{CES}$	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			42.1		nF	
$C_{oes}$	Output Capacitance	$V_{CE}=50\text{V}, f=100\text{kHz}, V_{GE}=0\text{V}$		1.80		nF	
$C_{res}$	Reverse Transfer Capacitance			1.18		nF	
$Q_G$	Gate Charge	$V_{CE}=400\text{V}, I_C=450\text{A}, V_{GE}=-8\dots+15\text{V}$		3.01		$\mu\text{C}$	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=400\text{V}, I_C=450\text{A}, R_G=2.4\Omega, L_S=24\text{nH}, V_{GE}=-8\text{V}/+15\text{V}, T_j=25^{\circ}\text{C}$		171		ns	
$t_r$	Rise Time			68		ns	
$t_{d(off)}$	Turn-Off Delay Time			605		ns	
$t_f$	Fall Time			68		ns	
$E_{on}$	Turn-On Switching Loss			20.2		mJ	
$E_{off}$	Turn-Off Switching Loss			22.3		mJ	
$t_{d(on)}$	Turn-On Delay Time		$V_{CC}=400\text{V}, I_C=450\text{A}, R_G=2.4\Omega, L_S=24\text{nH}, V_{GE}=-8\text{V}/+15\text{V}, T_j=150^{\circ}\text{C}$		172		ns
$t_r$	Rise Time				74		ns
$t_{d(off)}$	Turn-Off Delay Time				685		ns
$t_f$	Fall Time				77		ns
$E_{on}$	Turn-On Switching Loss			27.5		mJ	
$E_{off}$	Turn-Off Switching Loss			28.4		mJ	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=400\text{V}, I_C=450\text{A}, R_G=2.4\Omega, L_S=24\text{nH}, V_{GE}=-8\text{V}/+15\text{V}, T_j=175^{\circ}\text{C}$			174		ns
$t_r$	Rise Time				76		ns
$t_{d(off)}$	Turn-Off Delay Time				697		ns
$t_f$	Fall Time				79		ns
$E_{on}$	Turn-On Switching Loss			29.1		mJ	
$E_{off}$	Turn-Off Switching Loss			29.6		mJ	
$I_{SC}$	SC Data		$t_p \leq 6\mu\text{s}, V_{GE}=15\text{V}$		5100		A

		$T_j=25^{\circ}\text{C}, V_{CC}=400\text{V},$ $V_{CEM}\leq 750\text{V}$				
		$t_p\leq 3\mu\text{s}, V_{GE}=15\text{V},$ $T_j=175^{\circ}\text{C}, V_{CC}=400\text{V},$ $V_{CEM}\leq 750\text{V}$		3800		

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_F$	Diode Forward Voltage	$I_F=450\text{A}, V_{GE}=0\text{V}, T_j=25^{\circ}\text{C}$		1.35	1.60	V
		$I_F=450\text{A}, V_{GE}=0\text{V}, T_j=150^{\circ}\text{C}$		1.30		
		$I_F=450\text{A}, V_{GE}=0\text{V}, T_j=175^{\circ}\text{C}$		1.25		
		$I_F=950\text{A}, V_{GE}=0\text{V}, T_j=25^{\circ}\text{C}$		1.65		
		$I_F=950\text{A}, V_{GE}=0\text{V}, T_j=175^{\circ}\text{C}$		1.65		
$Q_r$	Recovered Charge			17.6		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current	$V_R=400\text{V}, I_F=450\text{A},$ $-di/dt=5540\text{A}/\mu\text{s}, V_{GE}=-8\text{V}$		198		A
$E_{rec}$	Reverse Recovery Energy	$L_S=24\text{nH}, T_j=25^{\circ}\text{C}$		3.68		mJ
$Q_r$	Recovered Charge			34.3		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current	$V_R=400\text{V}, I_F=450\text{A},$ $-di/dt=5010\text{A}/\mu\text{s}, V_{GE}=-8\text{V}$		258		A
$E_{rec}$	Reverse Recovery Energy	$L_S=24\text{nH}, T_j=150^{\circ}\text{C}$		7.35		mJ
$Q_r$	Recovered Charge			39.9		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current	$V_R=400\text{V}, I_F=450\text{A},$ $-di/dt=4920\text{A}/\mu\text{s}, V_{GE}=-8\text{V}$		276		A
$E_{rec}$	Reverse Recovery Energy	$L_S=24\text{nH}, T_j=175^{\circ}\text{C}$		8.56		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 $\Omega$
$\Delta p$	$\Delta V/\Delta t=10.0\text{dm}^3/\text{min}, T_F=75^{\circ}\text{C}$		64		mbar
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) $\Delta V/\Delta t=10.0\text{dm}^3/\text{min}, T_F=75^{\circ}\text{C}$		0.098 0.128	0.114 0.147	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

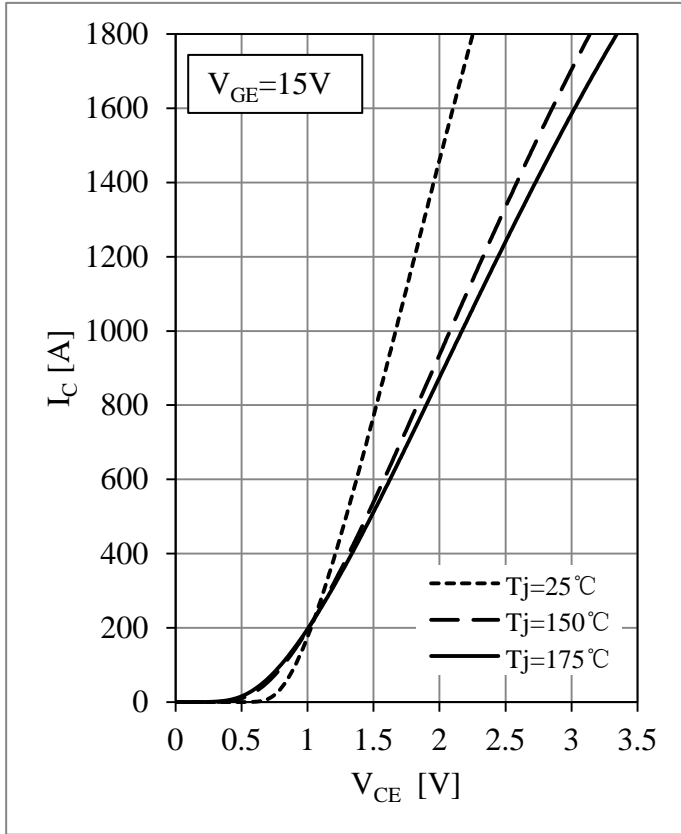


Fig 1. IGBT Output Characteristics

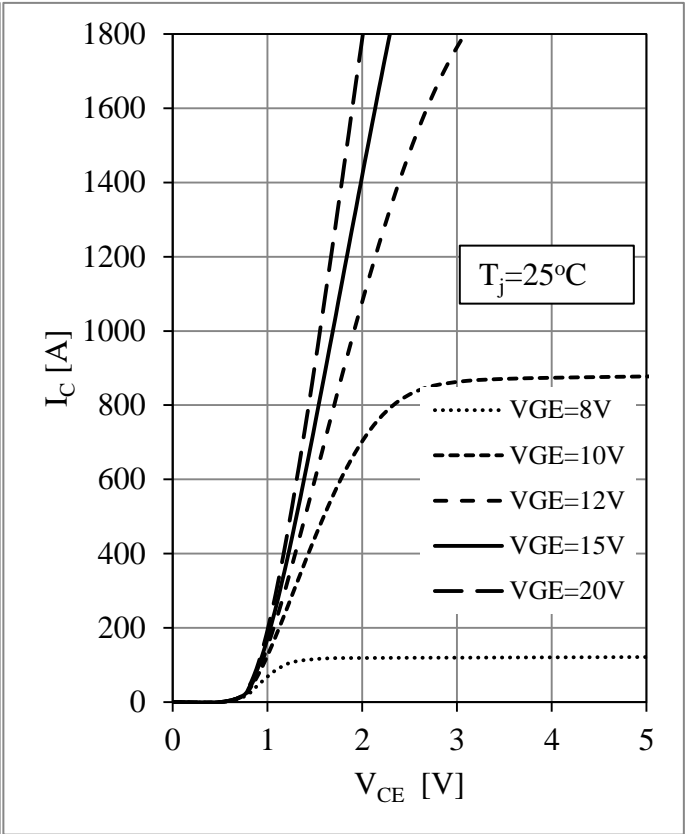


Fig 2. IGBT Output Characteristics

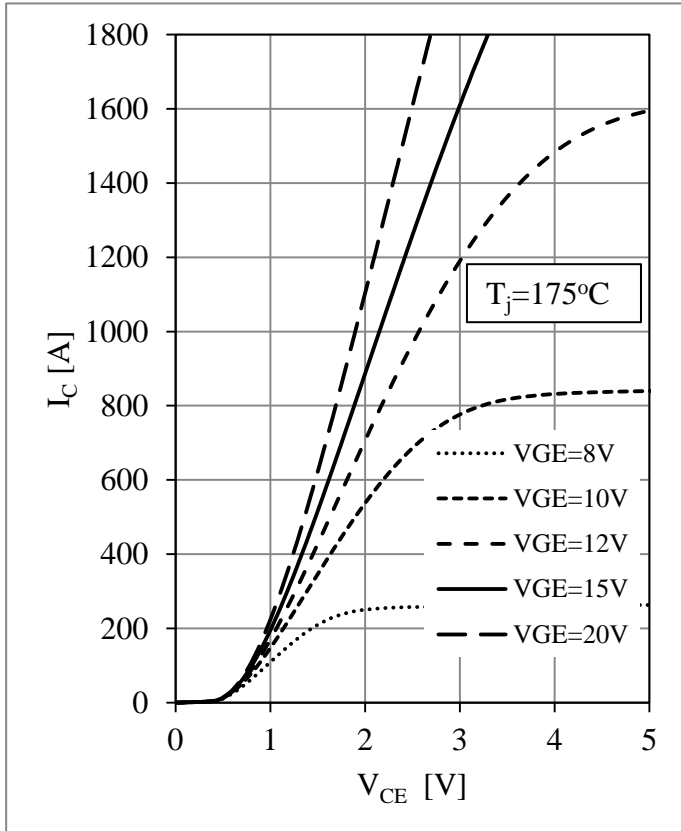


Fig 3. IGBT Output Characteristics

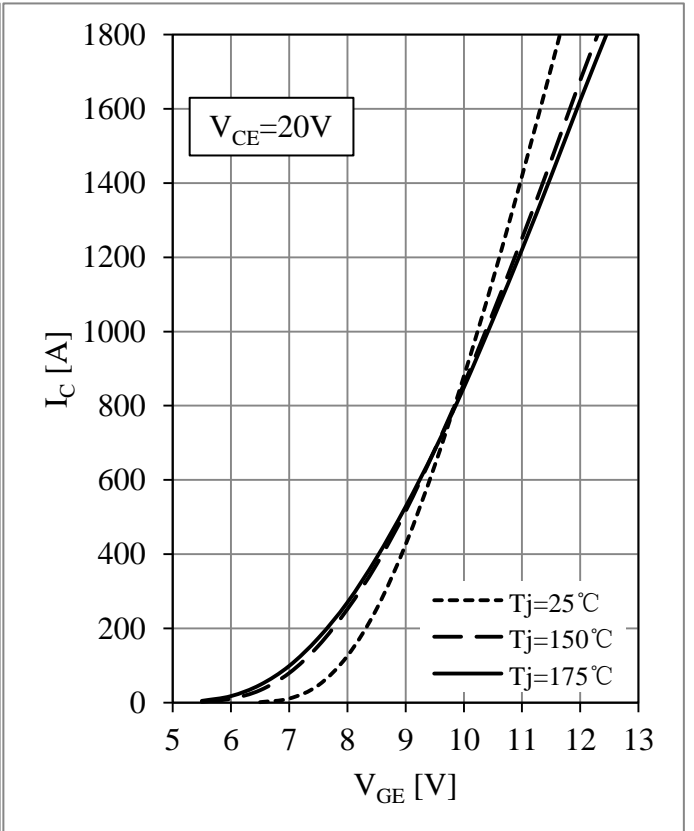


Fig 4. IGBT Transfer Characteristics

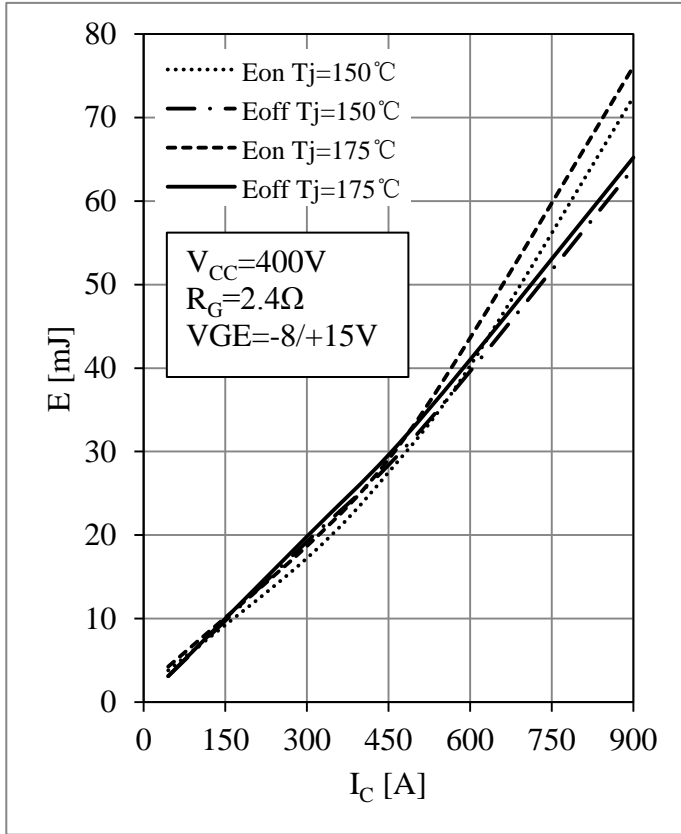


Fig 5. IGBT Switching Loss vs.  $I_C$

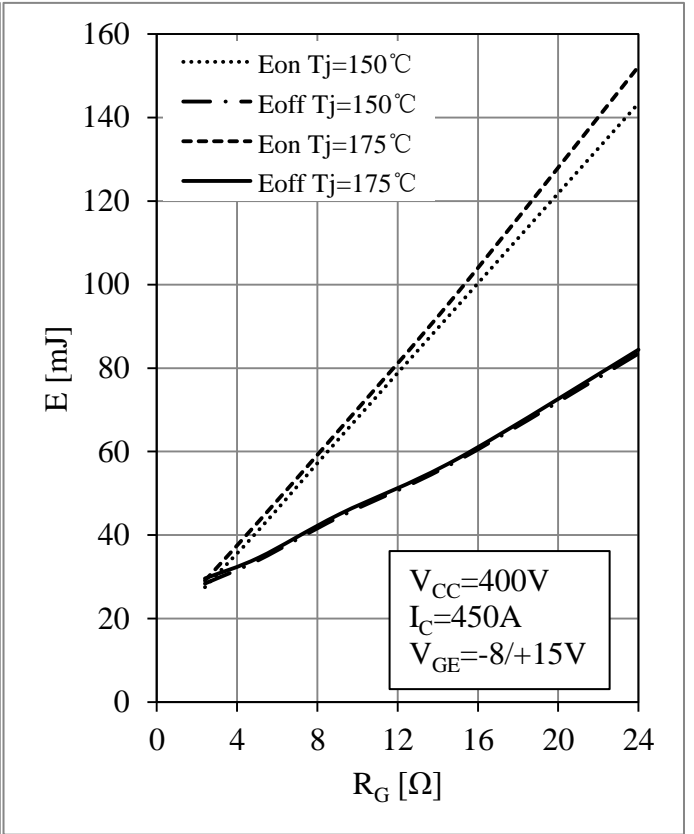


Fig 6. IGBT Switching Loss vs.  $R_G$

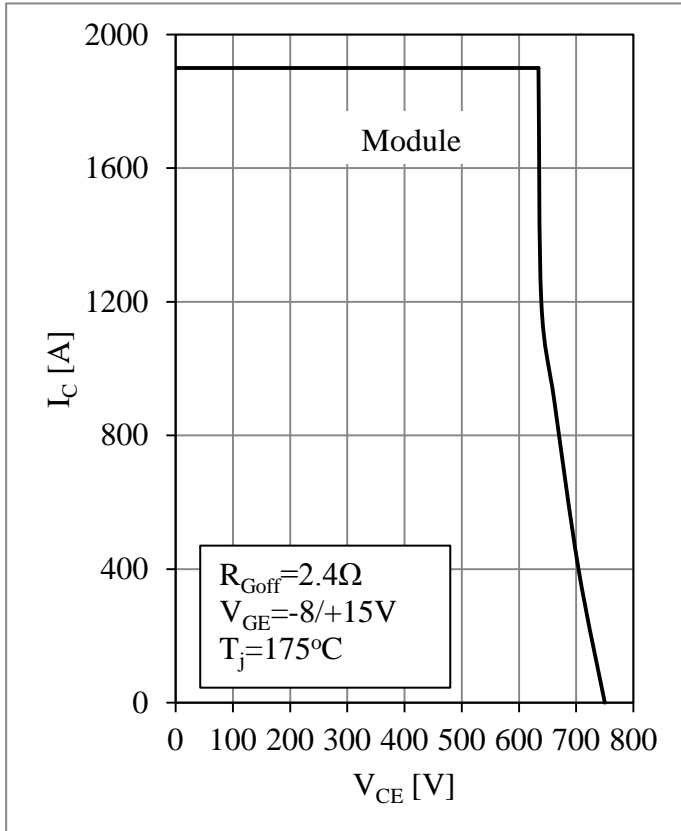


Fig 7. RBSOA

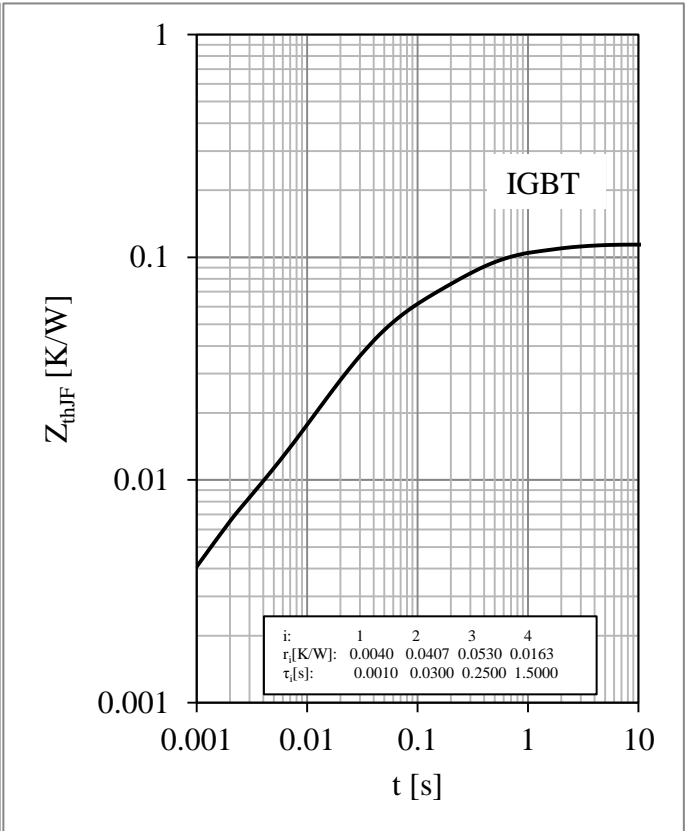


Fig 8. IGBT Transient Thermal Impedance

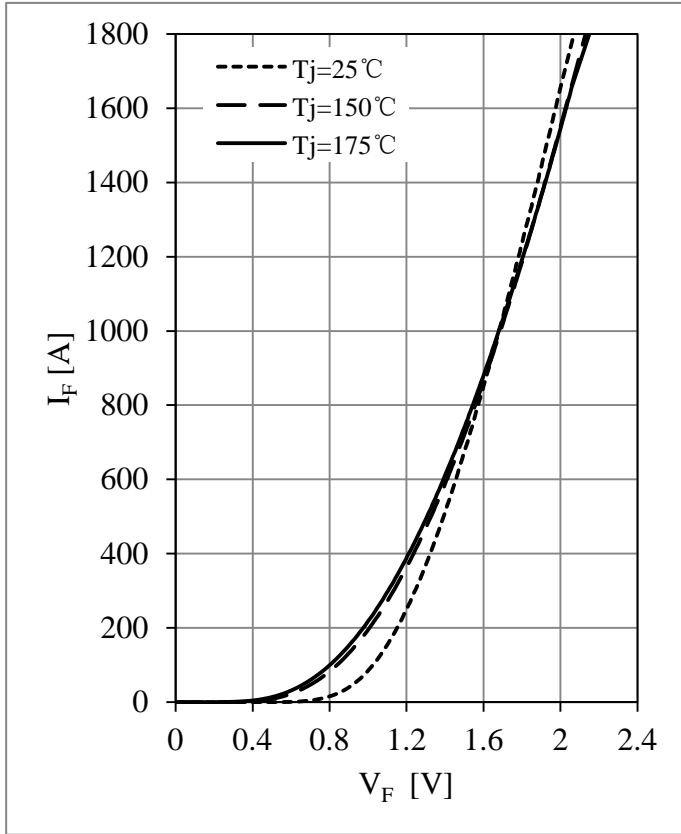


Fig 9. Diode Forward Characteristics

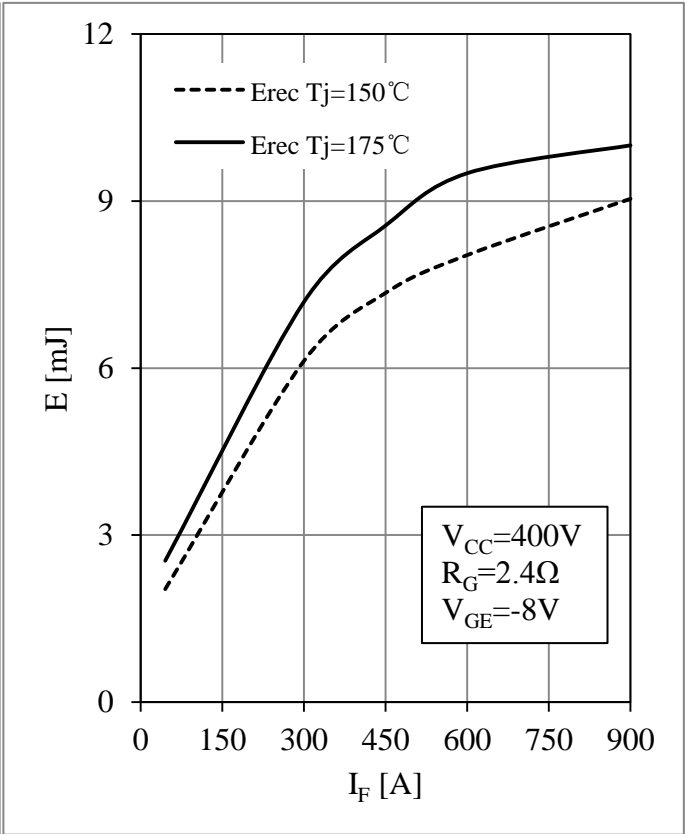


Fig 10. Diode Switching Loss vs.  $I_F$

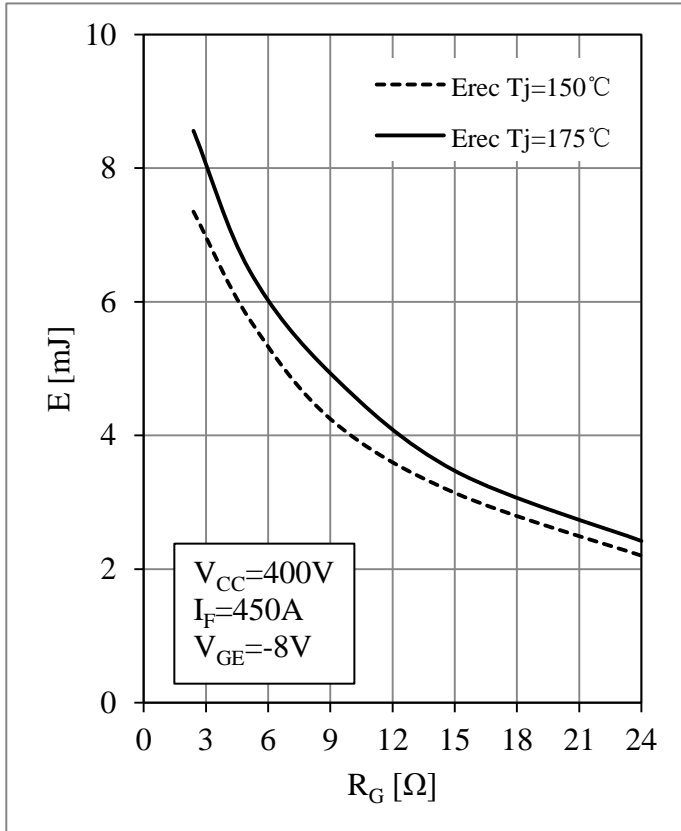


Fig 11. Diode Switching Loss vs.  $R_G$

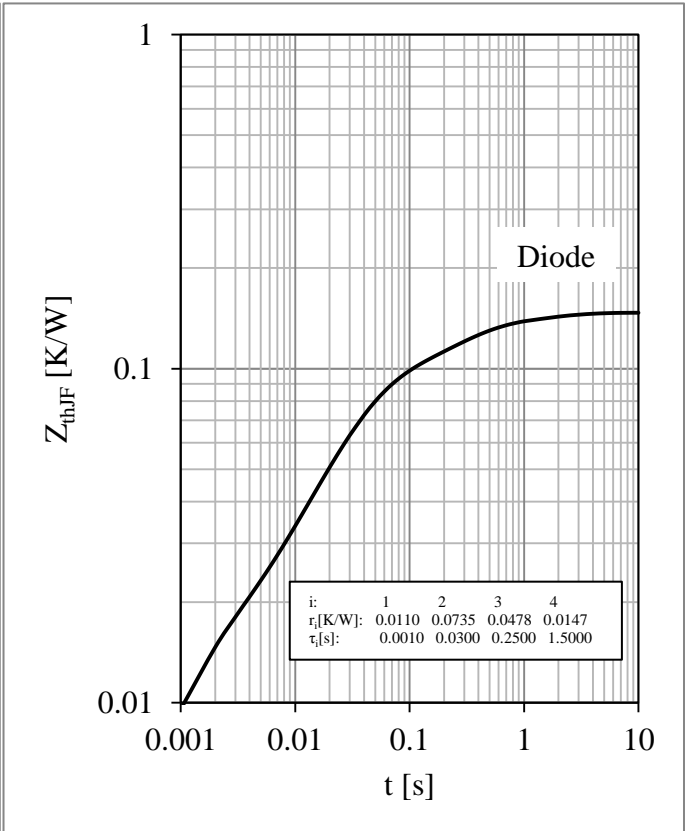


Fig 12. Diode Transient Thermal Impedance



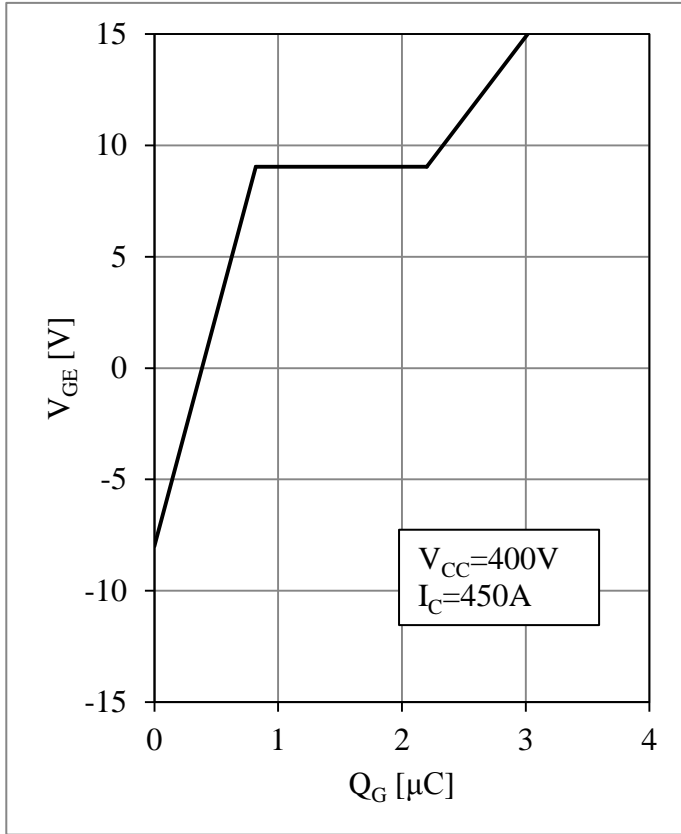


Fig 13. IGBT Gate Charge Characteristic

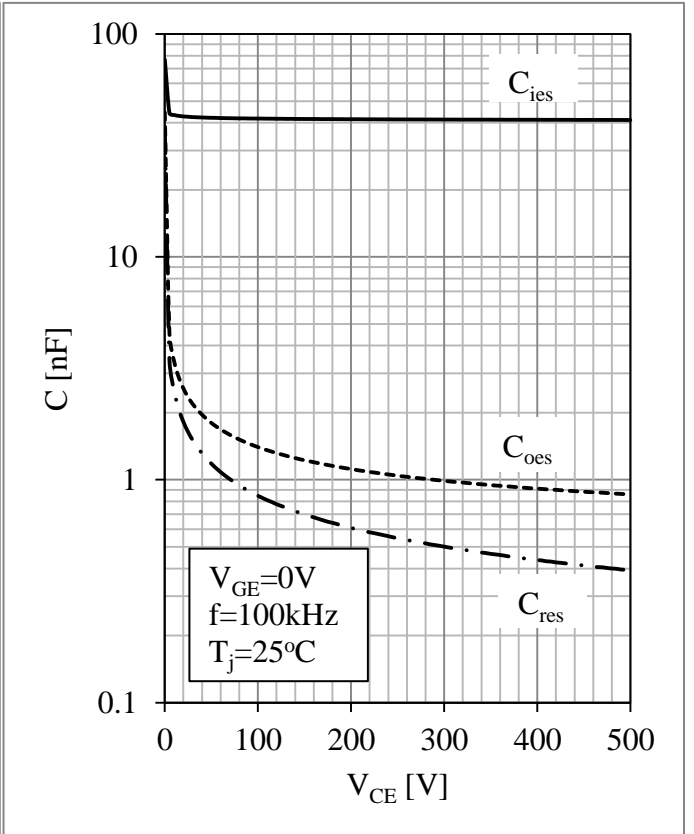


Fig 14. IGBT Capacity Characteristic

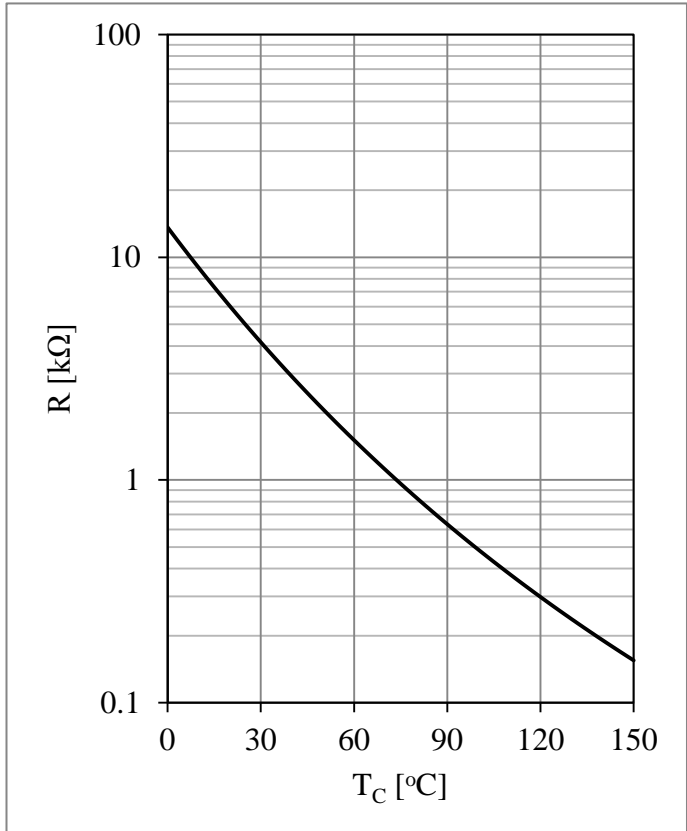


Fig 15. NTC Temperature Characteristic

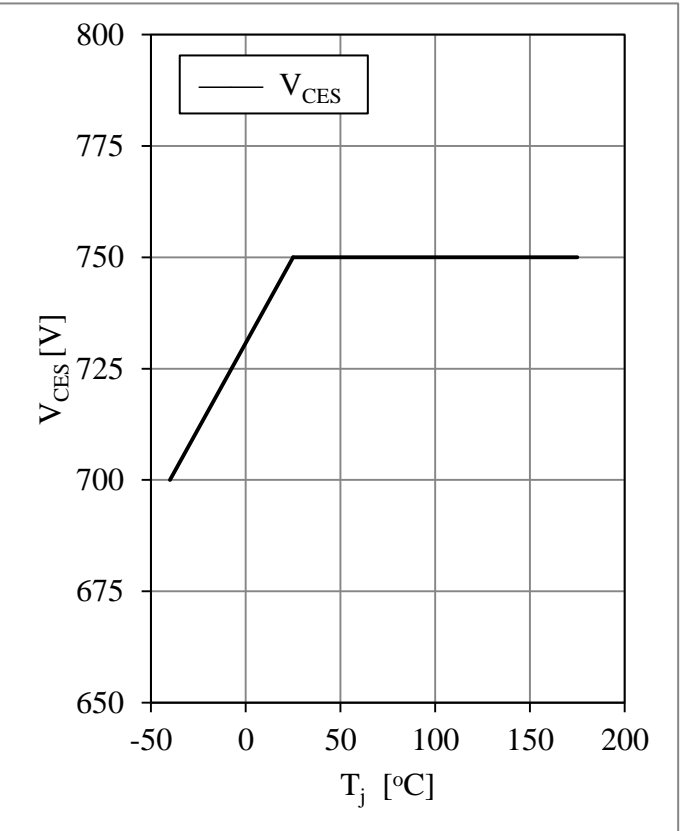
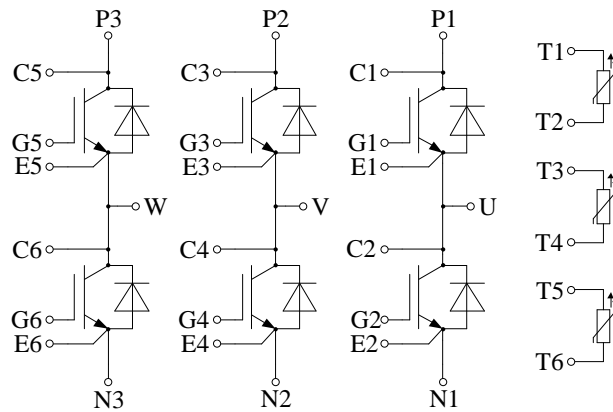


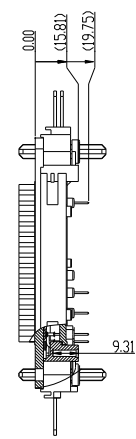
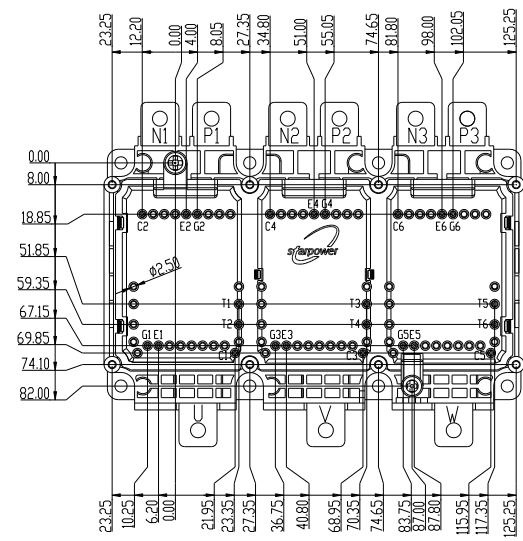
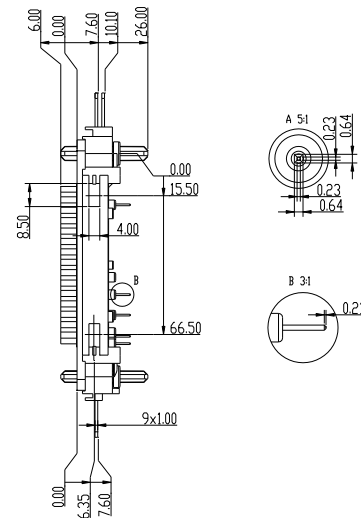
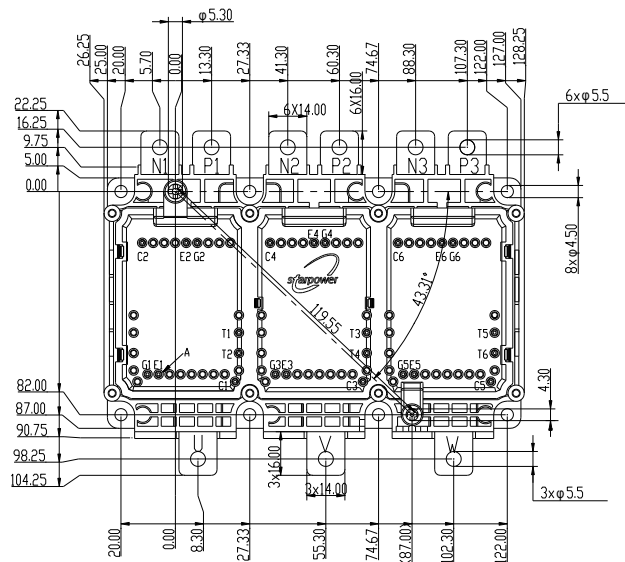
Fig 16. Maximum Allowed Collector-Emitter Voltage

**Circuit Schematic**



**Package Dimensions**

Dimensions in Millimeters



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