

STARPOWER

SEMICONDUCTOR

IGBT

GD400HTX120P4SA

1200V/400A 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.

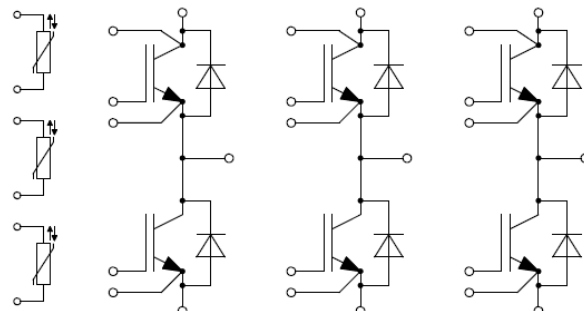
Features

- Low $V_{CE(sat)}$ Trench IGBT technology
- Low switching losses
- 10 μ 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 DBC technology

Typical Applications

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

Equivalent Circuit Schematic



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

Symbol	Description	Value	Unit
V_{CES}	Collector-Emitter Voltage	1200	V
V_{GES}	Gate-Emitter Voltage	± 20	V
I_{CN}	Implemented Collector Current	400	A
I_C	Collector Current @ $T_F=25^{\circ}\text{C}$	400	A
	@ $T_F=75^{\circ}\text{C}$	300	A
I_{CM}	Pulsed Collector Current $t_p=1\text{ms}$	800	A
P_D	Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$	1500	W

Diode

Symbol	Description	Value	Unit
V_{RRM}	Repetitive Peak Reverse Voltage	1200	V
I_{FN}	Implemented Forward Current	400	A
I_F	Diode Continuous Forward Current	300	A
I_{FM}	Diode Maximum Forward Current $t_p=1\text{ms}$	800	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 $T_F=25^{\circ}\text{C}$ unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C=300\text{A}, V_{GE}=15\text{V}, T_j=25^{\circ}\text{C}$		1.50	1.95	V
		$I_C=300\text{A}, V_{GE}=15\text{V}, T_j=125^{\circ}\text{C}$		1.60		
		$I_C=300\text{A}, V_{GE}=15\text{V}, T_j=150^{\circ}\text{C}$		1.65		
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$I_C=16.0\text{mA}, V_{CE}=V_{GE}, T_j=25^{\circ}\text{C}$	5.3	5.8	6.3	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			0.5		Ω
C_{ies}	Input Capacitance	$V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$		41.4		nF
C_{res}	Reverse Transfer Capacitance			1.16		nF
Q_G	Gate Charge	$V_{GE}=15\text{V}$		3.11		μC
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=500\text{V}, I_C=300\text{A}, R_G=1.5\Omega, V_{GE}=\pm 15\text{V}, L_s=25\text{nH}, T_j=25^{\circ}\text{C}$		74		ns
t_r	Rise Time			31		ns
$t_{d(off)}$	Turn-Off Delay Time			352		ns
t_f	Fall Time			255		ns
E_{on}	Turn-On Switching Loss			4.01		mJ
E_{off}	Turn-Off Switching Loss			22.9		mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=500\text{V}, I_C=300\text{A}, R_G=1.5\Omega, V_{GE}=\pm 15\text{V}, L_s=25\text{nH}, T_j=125^{\circ}\text{C}$		81		ns
t_r	Rise Time			34		ns
$t_{d(off)}$	Turn-Off Delay Time			411		ns
t_f	Fall Time			397		ns
E_{on}	Turn-On Switching Loss			7.40		mJ
E_{off}	Turn-Off Switching Loss			32.2		mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=500\text{V}, I_C=300\text{A}, R_G=1.5\Omega, V_{GE}=\pm 15\text{V}, L_s=25\text{nH}, T_j=150^{\circ}\text{C}$		82		ns
t_r	Rise Time			36		ns
$t_{d(off)}$	Turn-Off Delay Time			425		ns
t_f	Fall Time			434		ns
E_{on}	Turn-On Switching Loss			8.90		mJ
E_{off}	Turn-Off Switching Loss			35.2		mJ
I_{SC}	SC Data	$t_p \leq 10\mu\text{s}, V_{GE}=15\text{V}, T_j=150^{\circ}\text{C}, V_{CC}=900\text{V}, V_{CEM} \leq 1200\text{V}$		1600		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	$I_F=300\text{A}, V_{GE}=0\text{V}, T_j=25^{\circ}\text{C}$		1.70	2.15	V
		$I_F=300\text{A}, V_{GE}=0\text{V}, T_j=125^{\circ}\text{C}$		1.70		
		$I_F=300\text{A}, V_{GE}=0\text{V}, T_j=150^{\circ}\text{C}$		1.70		
Q_r	Recovered Charge	$V_R=500\text{V}, I_F=300\text{A},$ $-di/dt=10600\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $L_s=25\text{nH}, T_j=25^{\circ}\text{C}$		15.0		μC
I_{RM}	Peak Reverse Recovery Current			391		A
E_{rec}	Reverse Recovery Energy			9.40		mJ
Q_r	Recovered Charge	$V_R=500\text{V}, I_F=300\text{A},$ $-di/dt=9600\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $L_s=25\text{nH}, T_j=125^{\circ}\text{C}$		24.0		μC
I_{RM}	Peak Reverse Recovery Current			457		A
E_{rec}	Reverse Recovery Energy			18.4		mJ
Q_r	Recovered Charge	$V_R=500\text{V}, I_F=300\text{A},$ $-di/dt=9500\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $L_s=25\text{nH}, T_j=150^{\circ}\text{C}$		29.0		μC
I_{RM}	Peak Reverse Recovery Current			488		A
E_{rec}	Reverse Recovery Energy			23.2		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
Δp	Pressure Drop Cooling Circuit $\Delta V/\Delta t=10.0\text{dm}^3/\text{min}; T_F=25^{\circ}\text{C}; \text{Cooling Fluid}=50\% \text{ Water}/50\% \text{ Ethylene Glycol}$		100		mbar
p	Maximum Pressure In Cooling Circuit			2.5	bar
L_{CE}	Stray Inductance		14		nH
$R_{CC'+EE'}$	Module Lead Resistance, Terminal to Chip		0.80		m Ω
R_{thJF}	Junction-to-Cooling Fluid (per IGBT) Junction-to-Cooling Fluid (per Diode)			0.100 0.125	K/W
M	Terminal Connection Torque, Screw M6 Mounting Torque, Screw M6	2.5 3.0		5.0 6.0	N.m
G	Weight of Module		1250		g

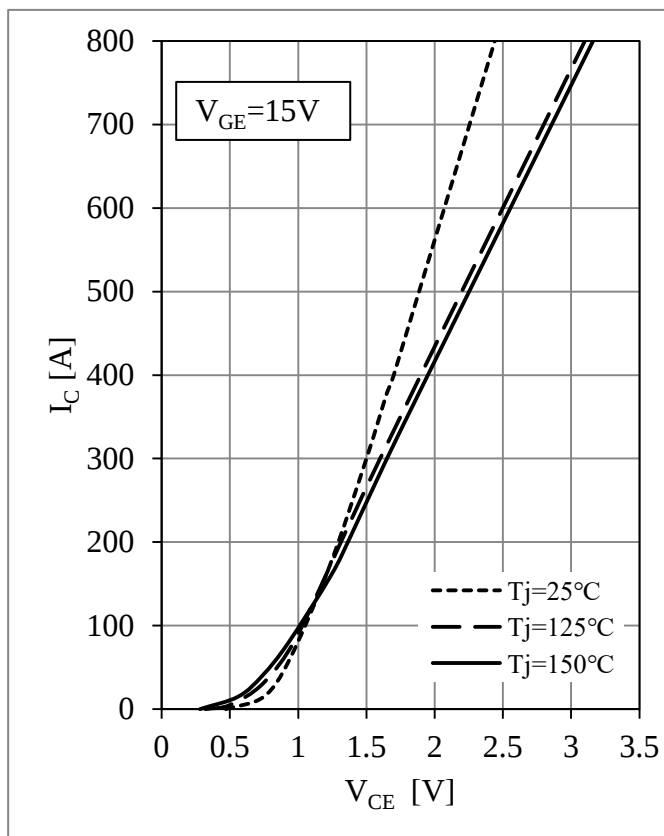


Fig 1. IGBT Output Characteristics

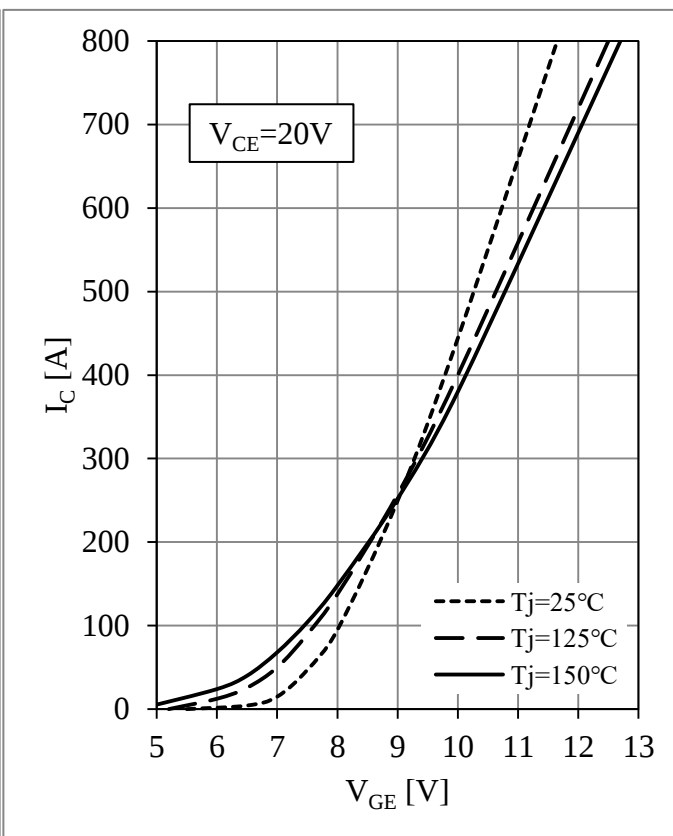
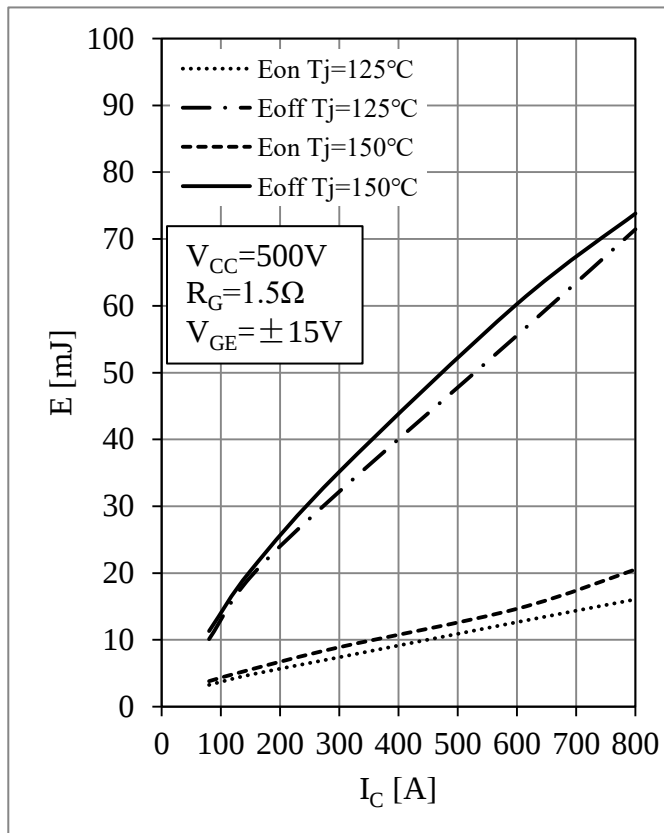
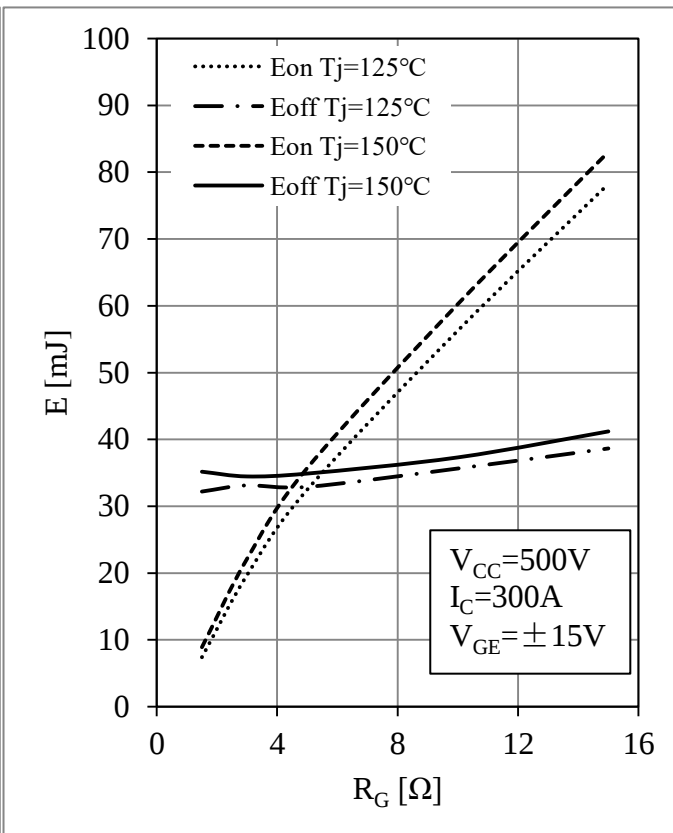


Fig 2. IGBT Transfer Characteristics

Fig 3. IGBT Switching Loss vs. I_C Fig 4. IGBT Switching Loss vs. R_G

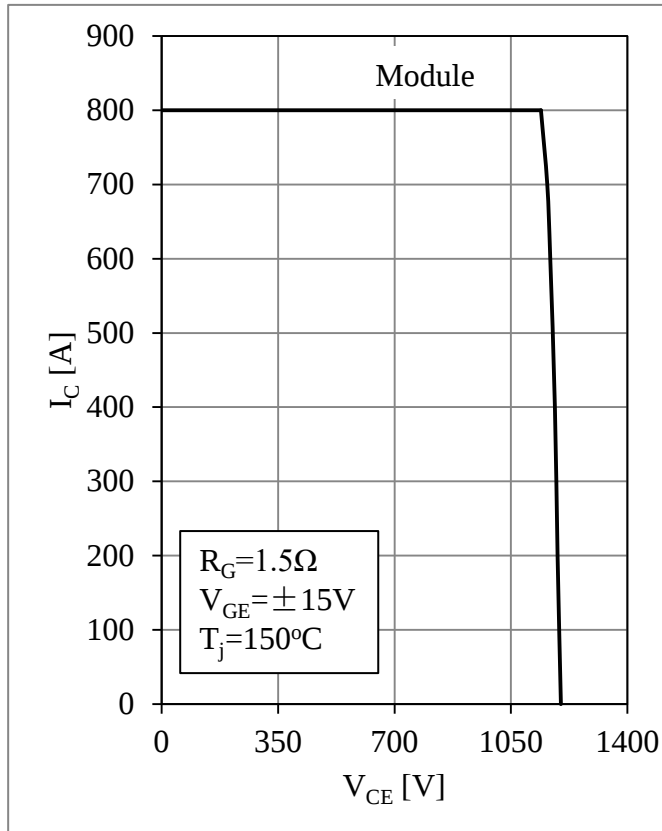


Fig 5. RBSOA

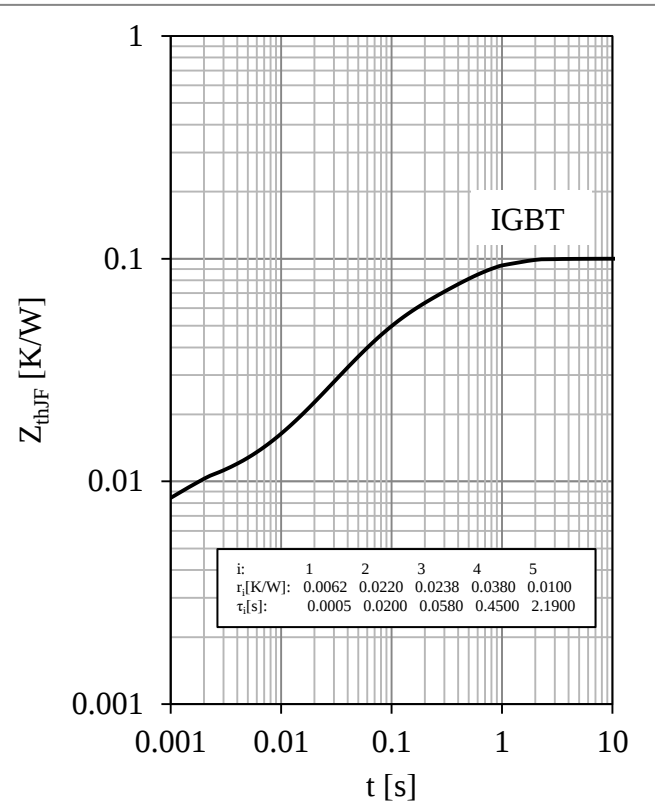


Fig 6. IGBT Transient Thermal Impedance

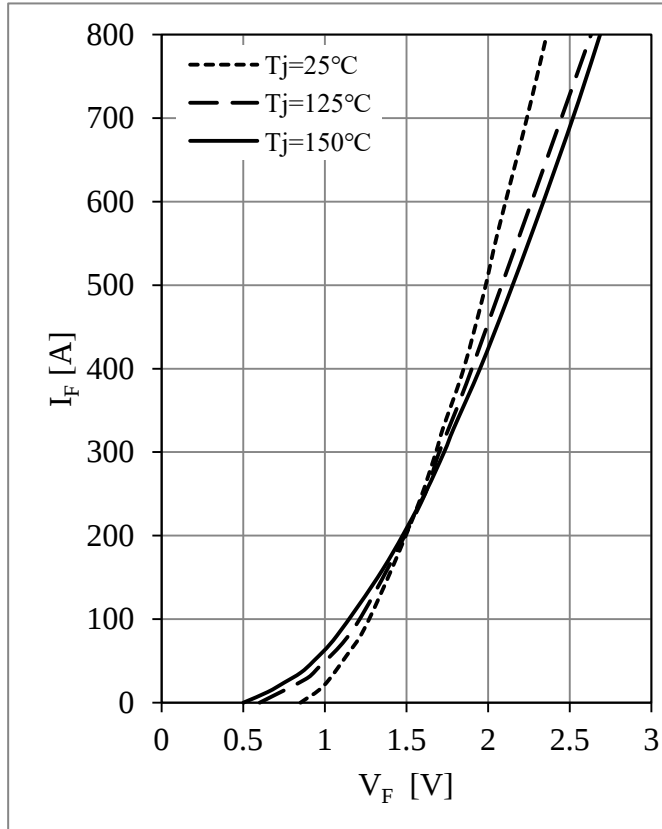
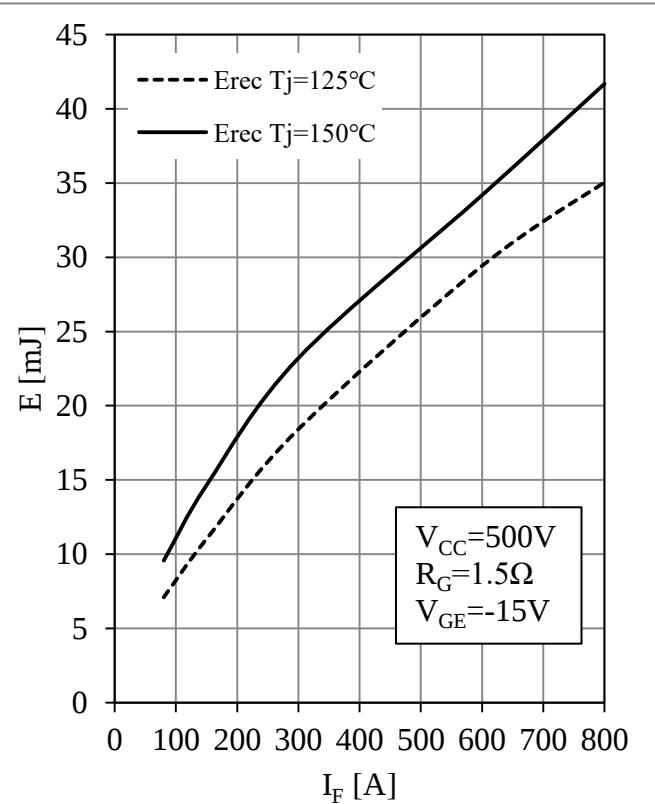


Fig 7. Diode Forward Characteristics

Fig 8. Diode Switching Loss vs. I_F

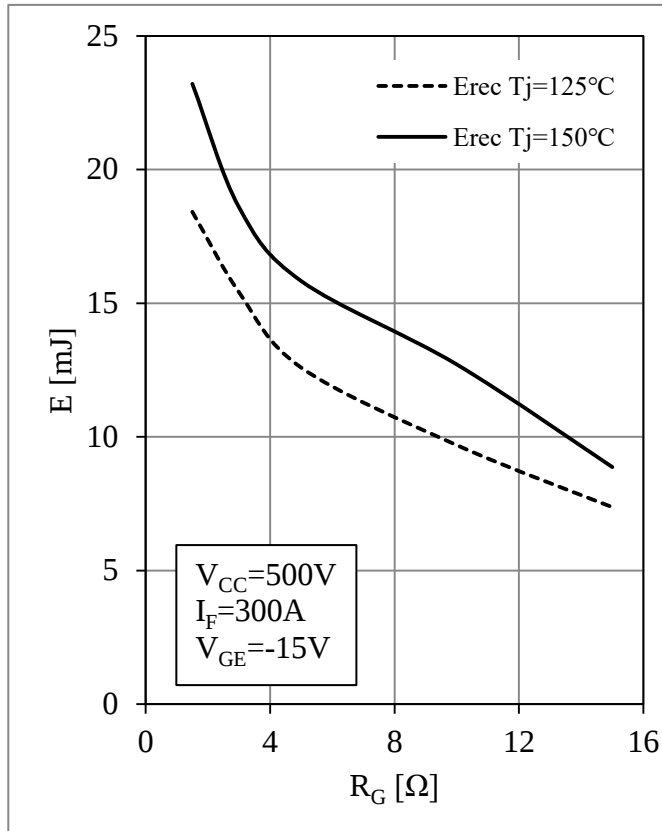
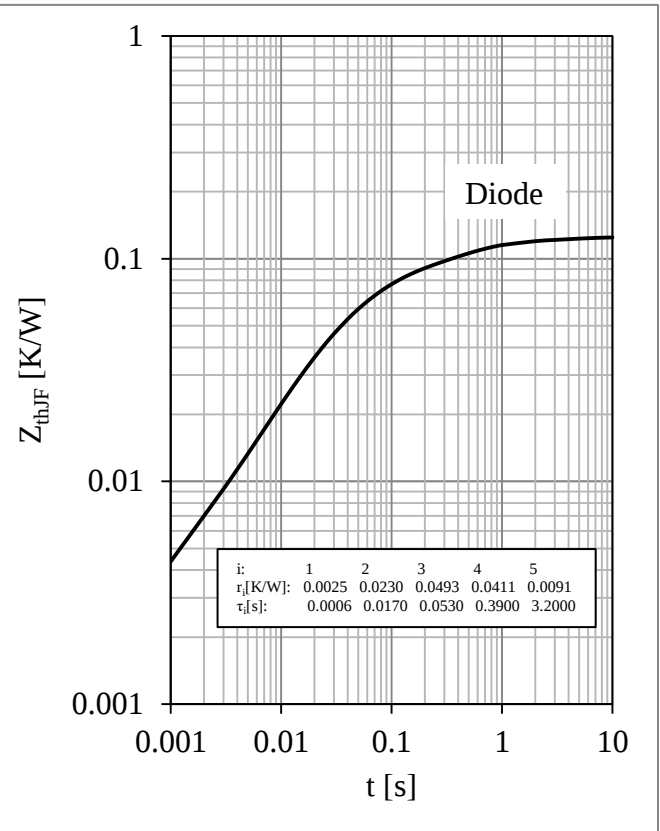
Fig 9. Diode Switching Loss vs. R_G 

Fig 10. Diode Transient Thermal Impedance

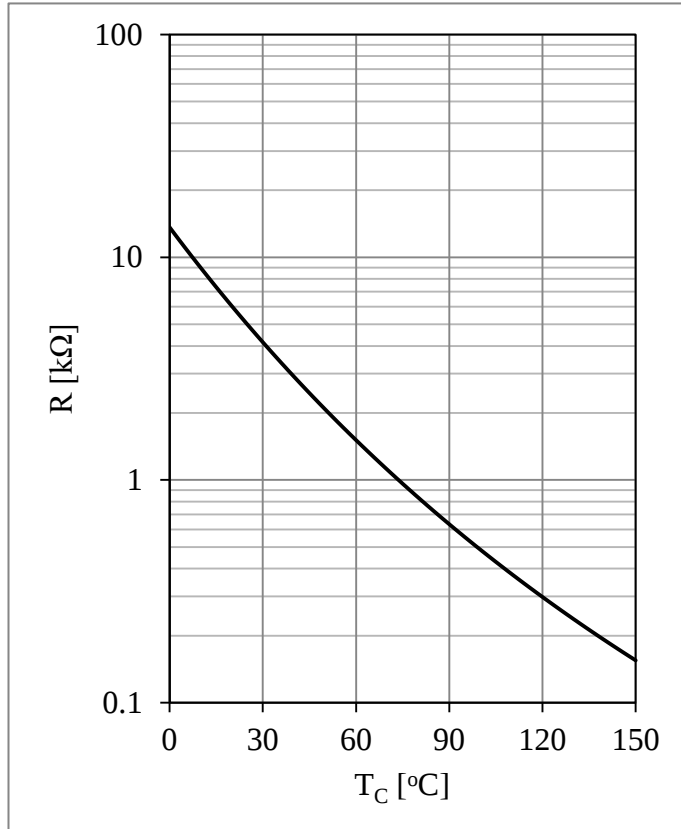
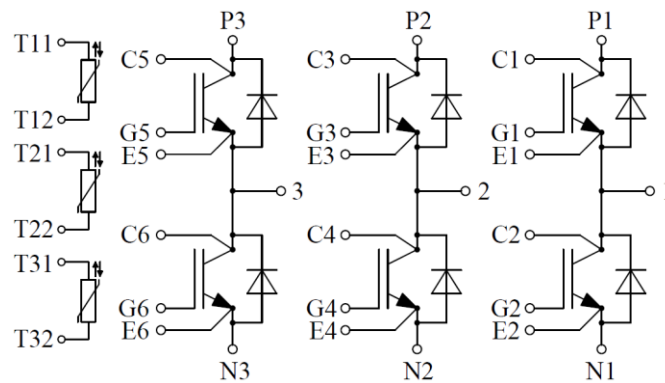


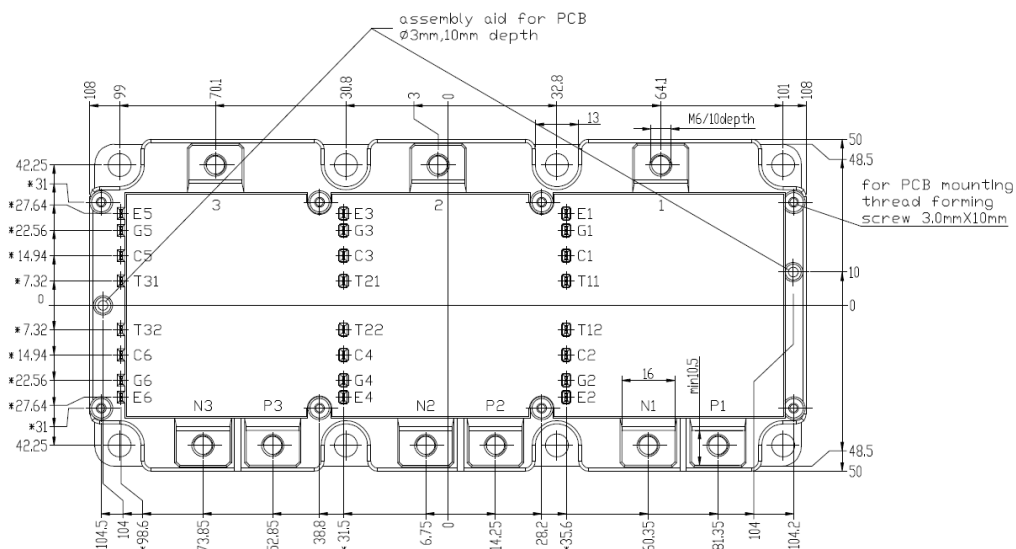
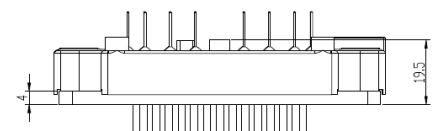
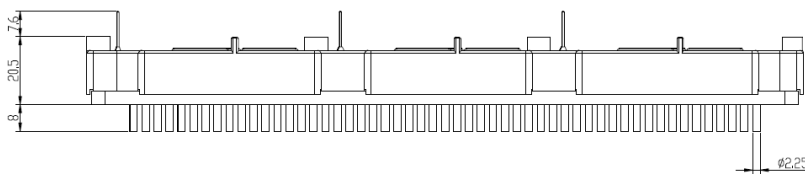
Fig 11. NTC Temperature Characteristic

Circuit Schematic



Package Dimensions

Dimensions in Millimeters



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