

STARPOWER

SEMICONDUCTOR

IGBT

GD150PIX65C6SGF

650V/150A PIM 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 general inverters and UPS.

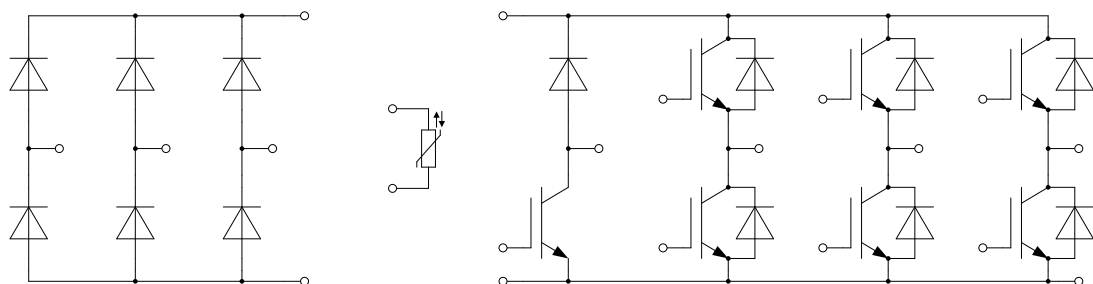
Features

- Low $V_{CE(sat)}$ Trench IGBT technology
- 6 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 baseplate using DBC technology

Typical Applications

- Inverter for motor drive
- AC and DC servo drive amplifier
- Uninterruptible power supply

Equivalent Circuit Schematic



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

Symbol	Description	Value	Unit
V_{CES}	Collector-Emitter Voltage	650	V
V_{GES}	Gate-Emitter Voltage	± 20	V
I_C	Collector Current @ $T_C=25^{\circ}\text{C}$ @ $T_C=70^{\circ}\text{C}$	195	A
		150	
I_{CRM}	Repetitive Peak Collector Current tp limited by T_{vjop}	300	A
P_D	Maximum Power Dissipation @ $T_{vj}=175^{\circ}\text{C}$	491	W

Diode-inverter

Symbol	Description	Value	Unit
V_{RRM}	Repetitive Peak Reverse Voltage	650	V
I_F	Diode Continuous Forward Current	150	A
I_{FRM}	Repetitive Peak Forward Current tp limited by T_{vjop}	300	A

Diode-rectifier

Symbol	Description	Value	Unit
V_{RRM}	Repetitive Peak Reverse Voltage	1600	V
I_O	Average Output Current 50Hz/60Hz,sine wave	150	A
I_{FSM}	Surge Forward Current $t_p=10\text{ms}$ @ $T_{vj}=25^{\circ}\text{C}$ @ $T_{vj}=150^{\circ}\text{C}$	1600	A
		1400	
I^2t	I^2t -value, $t_p=10\text{ms}$ @ $T_{vj}=25^{\circ}\text{C}$ @ $T_{vj}=150^{\circ}\text{C}$	13000 9800	A^2s

IGBT-brake

Symbol	Description	Value	Unit
V_{CES}	Collector-Emitter Voltage	650	V
V_{GES}	Gate-Emitter Voltage	± 20	V
I_C	Collector Current @ $T_C=25^{\circ}\text{C}$ @ $T_C=85^{\circ}\text{C}$	143	A
		100	
I_{CRM}	Repetitive Peak Collector Current tp limited by T_{vjop}	200	A
P_D	Maximum Power Dissipation @ $T_{vj}=175^{\circ}\text{C}$	380	W

Diode-brake

Symbol	Description	Value	Unit
V_{RRM}	Repetitive Peak Reverse Voltage	650	V
I_F	Diode Continuous Forward Current	50	A
I_{FRM}	Repetitive Peak Forward Current tp limited by T_{vjop}	100	A

Module

Symbol	Description	Value	Unit
T_{vjmax}	Maximum Junction Temperature(inverter,brake)	175	$^{\circ}\text{C}$
	Maximum Junction Temperature (rectifier)	150	
T_{vjop}	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-inverter 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	$I_C=150\text{A}, V_{GE}=15\text{V}, T_{vj}=25^{\circ}\text{C}$		1.45	1.90	V
		$I_C=150\text{A}, V_{GE}=15\text{V}, T_{vj}=125^{\circ}\text{C}$		1.60		
		$I_C=150\text{A}, V_{GE}=15\text{V}, T_{vj}=150^{\circ}\text{C}$		1.70		
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$I_C=2.40\text{mA}, V_{CE}=V_{GE}, T_{vj}=25^{\circ}\text{C}$	5.1	5.8	6.5	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			2.0		Ω
C_{ies}	Input Capacitance	$V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$		17.4		nF
C_{res}	Reverse Transfer Capacitance			0.34		nF
Q_G	Gate Charge	$V_{GE}=-15\dots+15\text{V}$		1.04		μC
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=300\text{V}, I_C=150\text{A}, R_G=3.3\Omega, L_S=35\text{nH}, V_{GE}=\pm 15\text{V}, T_{vj}=25^{\circ}\text{C}$		114		ns
t_r	Rise Time			90		ns
$t_{d(off)}$	Turn-Off Delay Time			170		ns
t_f	Fall Time			77		ns
E_{on}	Turn-On Switching Loss			5.53		mJ
E_{off}	Turn-Off Switching Loss			2.65		mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=300\text{V}, I_C=150\text{A}, R_G=3.3\Omega, L_S=35\text{nH}, V_{GE}=\pm 15\text{V}, T_{vj}=125^{\circ}\text{C}$		136		ns
t_r	Rise Time			98		ns
$t_{d(off)}$	Turn-Off Delay Time			191		ns
t_f	Fall Time			120		ns
E_{on}	Turn-On Switching Loss			7.21		mJ
E_{off}	Turn-Off Switching Loss			3.33		mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=300\text{V}, I_C=150\text{A}, R_G=3.3\Omega, L_S=35\text{nH}, V_{GE}=\pm 15\text{V}, T_{vj}=150^{\circ}\text{C}$		139		ns
t_r	Rise Time			99		ns
$t_{d(off)}$	Turn-Off Delay Time			195		ns
t_f	Fall Time			131		ns
E_{on}	Turn-On Switching Loss			7.56		mJ
E_{off}	Turn-Off Switching Loss			3.54		mJ
I_{SC}	SC Data	$t_p \leq 6\mu\text{s}, V_{GE}=15\text{V}, T_{vj}=150^{\circ}\text{C}, V_{CC}=360\text{V}, V_{CEM} \leq 650\text{V}$		700		A

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
V_F	Diode Forward Voltage	$I_F=150\text{A}, V_{GE}=0\text{V}, T_{vj}=25^{\circ}\text{C}$		1.55	1.80	V
		$I_F=150\text{A}, V_{GE}=0\text{V}, T_{vj}=125^{\circ}\text{C}$		1.55		
		$I_F=150\text{A}, V_{GE}=0\text{V}, T_{vj}=150^{\circ}\text{C}$		1.50		
Q_r	Recovered Charge	$V_R=300\text{V}, I_F=150\text{A},$ $-di/dt=1611\text{A}/\mu\text{s}, L_S=35\text{nH},$ $V_{GE}=-15\text{V}, T_{vj}=25^{\circ}\text{C}$		4.35		μC
I_{RM}	Peak Reverse Recovery Current			54		A
E_{rec}	Reverse Recovery Energy			0.71		mJ
Q_r	Recovered Charge	$V_R=300\text{V}, I_F=150\text{A},$ $-di/dt=1366\text{A}/\mu\text{s}, L_S=35\text{nH},$ $V_{GE}=-15\text{V}, T_{vj}=125^{\circ}\text{C}$		8.03		μC
I_{RM}	Peak Reverse Recovery Current			62		A
E_{rec}	Reverse Recovery Energy			1.38		mJ
Q_r	Recovered Charge	$V_R=300\text{V}, I_F=150\text{A},$ $-di/dt=1342\text{A}/\mu\text{s}, L_S=35\text{nH},$ $V_{GE}=-15\text{V}, T_{vj}=150^{\circ}\text{C}$		9.08		μC
I_{RM}	Peak Reverse Recovery Current			65		A
E_{rec}	Reverse Recovery Energy			1.55		mJ

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_F	Diode Forward Voltage	$I_C=150\text{A}, T_{vj}=150^{\circ}\text{C}$		1.00		V
I_R	Reverse Current	$T_{vj}=150^{\circ}\text{C}, V_R=1600\text{V}$			3.0	mA

IGBT-brake 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	$I_C=100\text{A}, V_{GE}=15\text{V}, T_{vj}=25^{\circ}\text{C}$		1.45	1.90	V
		$I_C=100\text{A}, V_{GE}=15\text{V}, T_{vj}=125^{\circ}\text{C}$		1.60		
		$I_C=100\text{A}, V_{GE}=15\text{V}, T_{vj}=150^{\circ}\text{C}$		1.70		
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$I_C=1.60\text{mA}, V_{CE}=V_{GE}, T_{vj}=25^{\circ}\text{C}$	5.1	5.8	6.5	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			2.0		Ω
C_{ies}	Input Capacitance	$V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$		11.6		nF
C_{res}	Reverse Transfer Capacitance			0.23		nF
Q_G	Gate Charge	$V_{GE}=-15\dots+15\text{V}$		0.69		μC
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=300\text{V}, I_C=100\text{A}, R_G=3.3\Omega, L_S=35\text{nH}, V_{GE}=\pm 15\text{V}, T_{vj}=25^{\circ}\text{C}$		69		ns
t_r	Rise Time			39		ns
$t_{d(off)}$	Turn-Off Delay Time			137		ns
t_f	Fall Time			97		ns
E_{on}	Turn-On Switching Loss			3.59		mJ
E_{off}	Turn-Off Switching Loss			1.73		mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=300\text{V}, I_C=100\text{A}, R_G=3.3\Omega, L_S=35\text{nH}, V_{GE}=\pm 15\text{V}, T_{vj}=125^{\circ}\text{C}$		79		ns
t_r	Rise Time			88		ns
$t_{d(off)}$	Turn-Off Delay Time			151		ns
t_f	Fall Time			123		ns
E_{on}	Turn-On Switching Loss			4.20		mJ
E_{off}	Turn-Off Switching Loss			2.24		mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=300\text{V}, I_C=100\text{A}, R_G=3.3\Omega, L_S=35\text{nH}, V_{GE}=\pm 15\text{V}, T_{vj}=150^{\circ}\text{C}$		82		ns
t_r	Rise Time			88		ns
$t_{d(off)}$	Turn-Off Delay Time			155		ns
t_f	Fall Time			125		ns
E_{on}	Turn-On Switching Loss			4.33		mJ
E_{off}	Turn-Off Switching Loss			2.30		mJ
I_{SC}	SC Data	$t_p \leq 6\mu\text{s}, V_{GE}=15\text{V}, T_{vj}=150^{\circ}\text{C}, V_{CC}=360\text{V}, V_{CEM} \leq 650\text{V}$		400		A

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_F	Diode Forward Voltage	$I_F=50\text{A}, V_{GE}=0\text{V}, T_{vj}=25^{\circ}\text{C}$		1.60	2.05	V
		$I_F=50\text{A}, V_{GE}=0\text{V}, T_{vj}=125^{\circ}\text{C}$		1.65		
		$I_F=50\text{A}, V_{GE}=0\text{V}, T_{vj}=150^{\circ}\text{C}$		1.65		
Q_r	Recovered Charge	$V_R=300\text{V}, I_F=50\text{A},$ $-di/dt=2486\text{A}/\mu\text{s}, L_S=35\text{nH},$ $V_{GE}=-15\text{V}, T_{vj}=25^{\circ}\text{C}$		0.94		μC
I_{RM}	Peak Reverse Recovery Current			38		A
E_{rec}	Reverse Recovery Energy			0.07		mJ
Q_r	Recovered Charge	$V_R=300\text{V}, I_F=50\text{A},$ $-di/dt=2004\text{A}/\mu\text{s}, L_S=35\text{nH},$ $V_{GE}=-15\text{V}, T_{vj}=125^{\circ}\text{C}$		2.57		μC
I_{RM}	Peak Reverse Recovery Current			40		A
E_{rec}	Reverse Recovery Energy			0.44		mJ
Q_r	Recovered Charge	$V_R=300\text{V}, I_F=50\text{A},$ $-di/dt=1897\text{A}/\mu\text{s}, L_S=35\text{nH},$ $V_{GE}=-15\text{V}, T_{vj}=150^{\circ}\text{C}$		2.90		μC
I_{RM}	Peak Reverse Recovery Current			41		A
E_{rec}	Reverse Recovery Energy			0.50		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		40		nH
$R_{CC'+EE'}$ $R_{AA'+CC'}$	Module Lead Resistance, Terminal to Chip		4.00 3.00		m Ω
R_{thJC}	Junction-to-Case (per IGBT-inverter) Junction-to-Case (per Diode-inverter) Junction-to-Case (per Diode-rectifier) Junction-to-Case (per IGBT-brake) Junction-to-Case (per Diode-brake)			0.305 0.522 0.326 0.394 1.036	K/W
R_{thCH}	Case-to-Heatsink (per IGBT-inverter) Case-to-Heatsink (per Diode-inverter) Case-to-Heatsink (per Diode-rectifier) Case-to-Heatsink (per IGBT-brake) Case-to-Heatsink (per Diode-brake) Case-to-Heatsink (per Module)		0.146 0.249 0.156 0.188 0.495 0.009		K/W
M	Mounting Torque, Screw:M5	3.0		6.0	N.m
G	Weight of Module		300		g

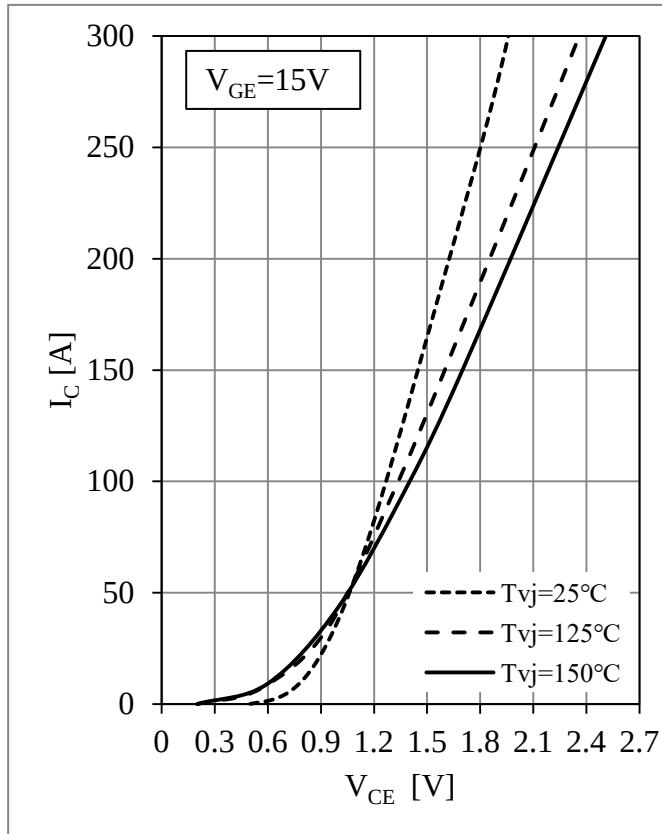


Fig 1. IGBT-inverter Output Characteristics

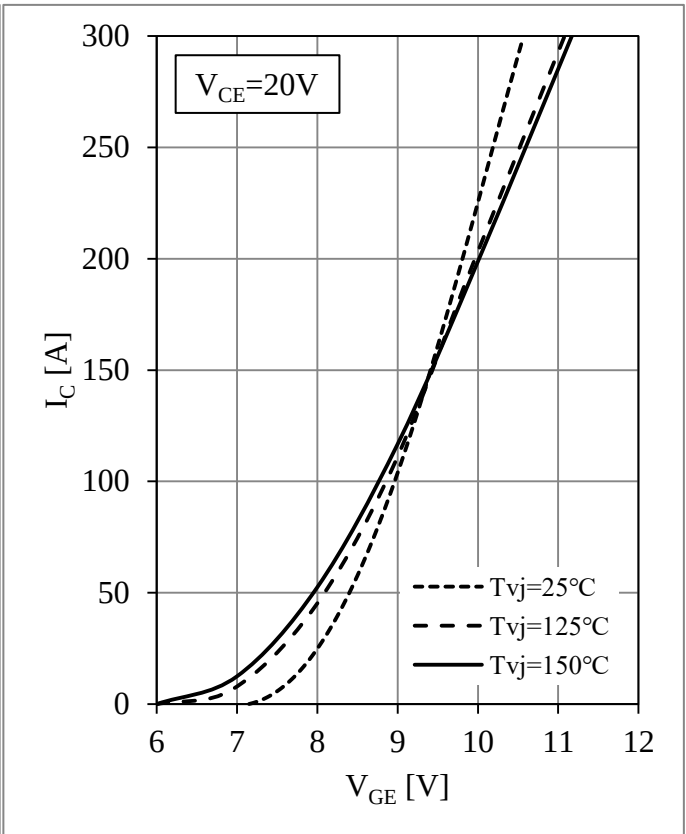
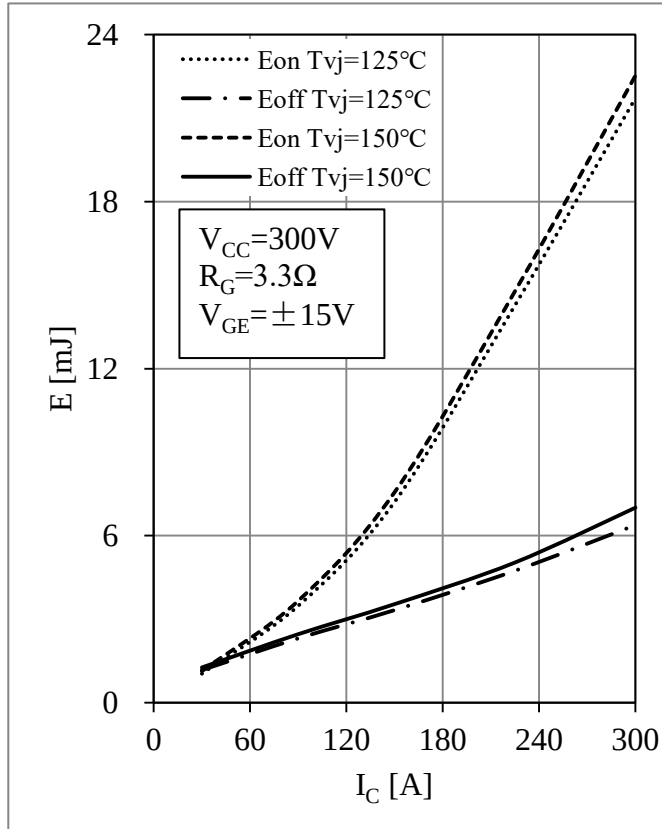
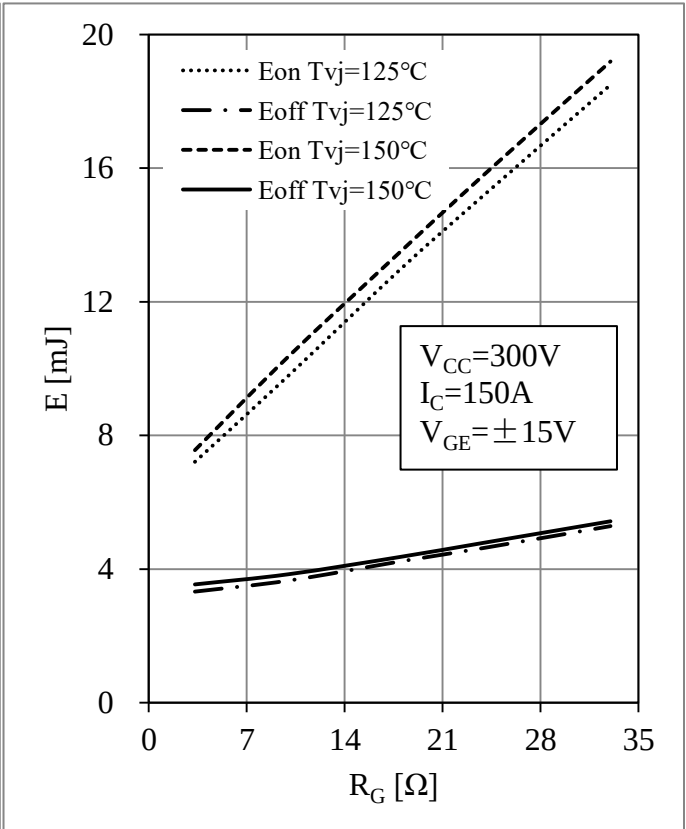


Fig 2. IGBT-inverter Transfer Characteristics

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

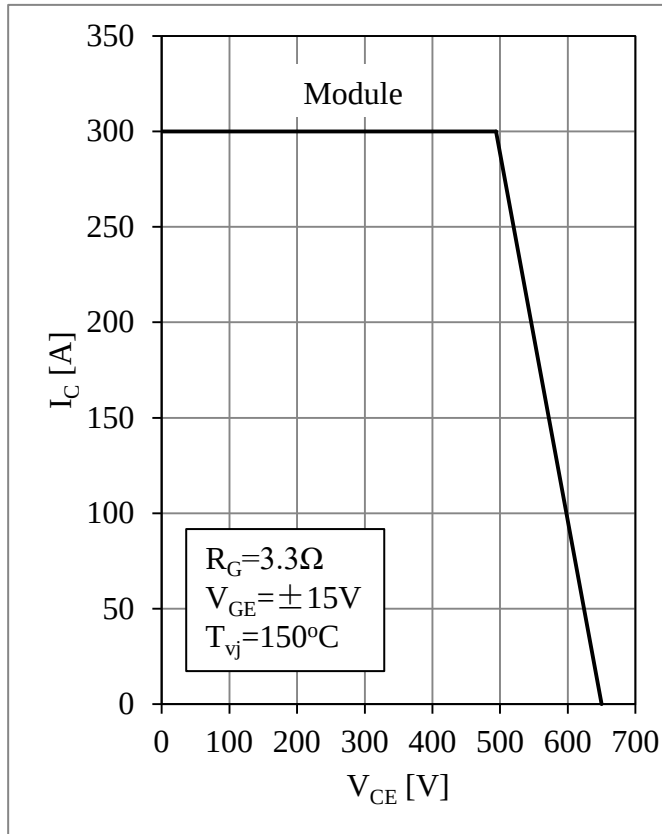


Fig 5. IGBT-inverter RBSOA

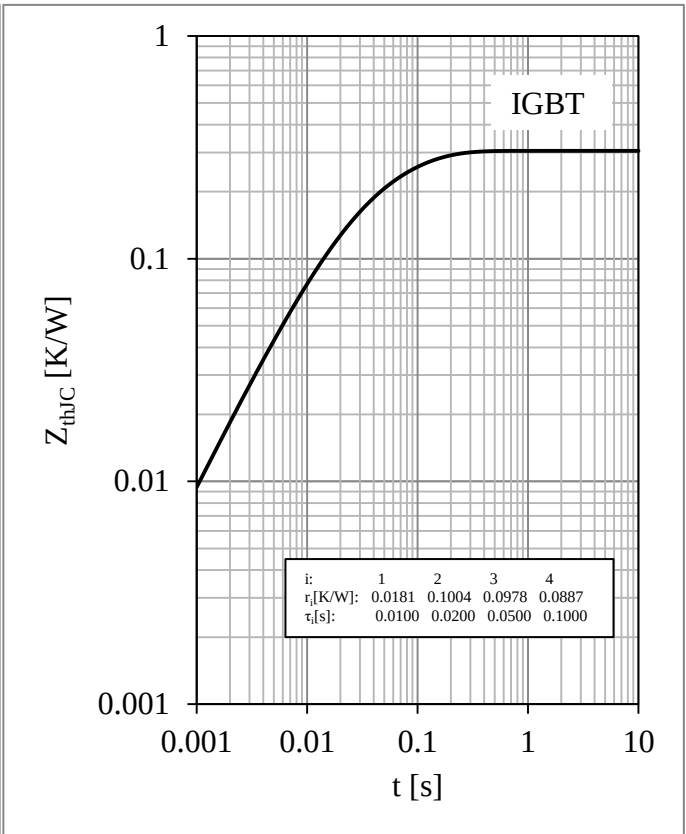


Fig 6. IGBT-inverter Transient Thermal Impedance

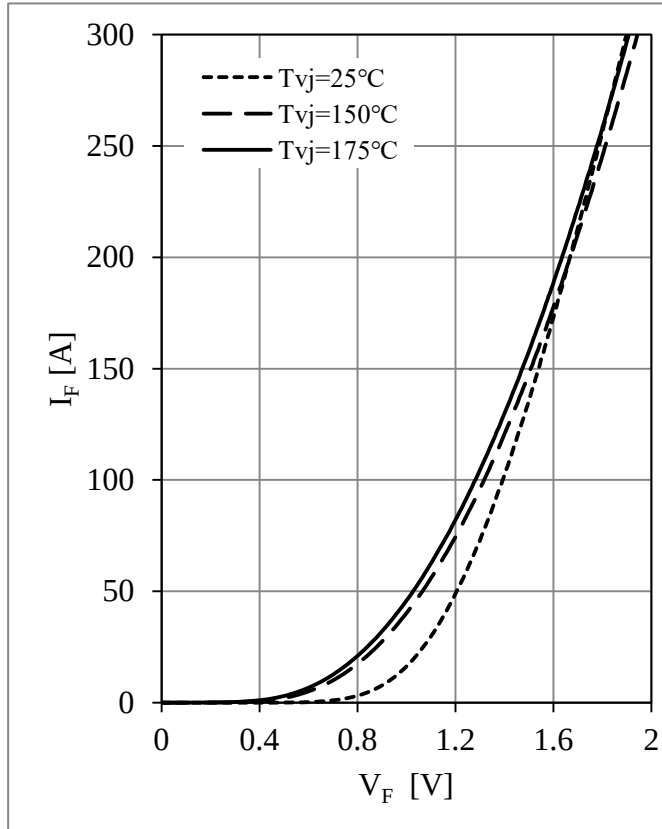
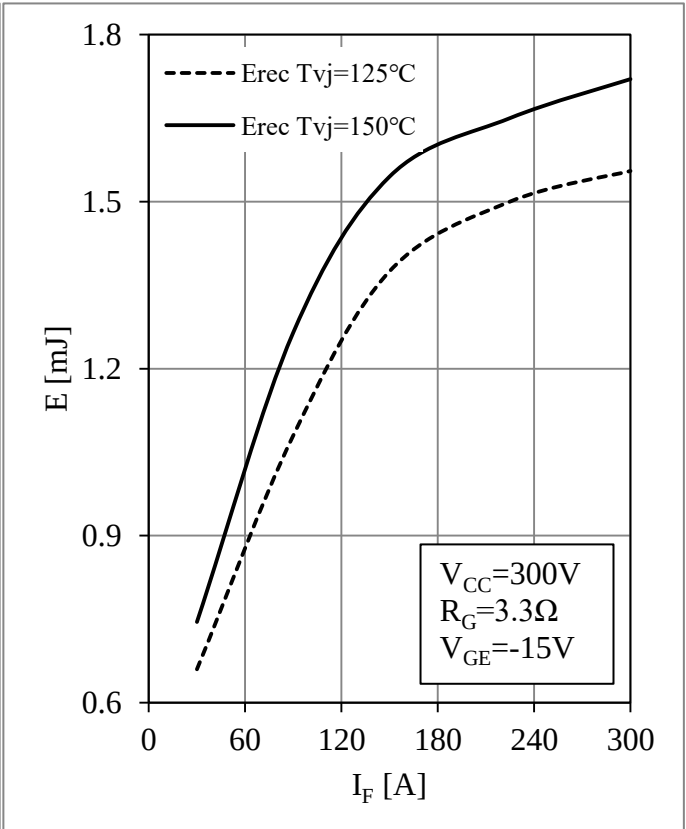


Fig 7. Diode-inverter Forward Characteristics

Fig 8. Diode-inverter Switching Loss vs. I_F

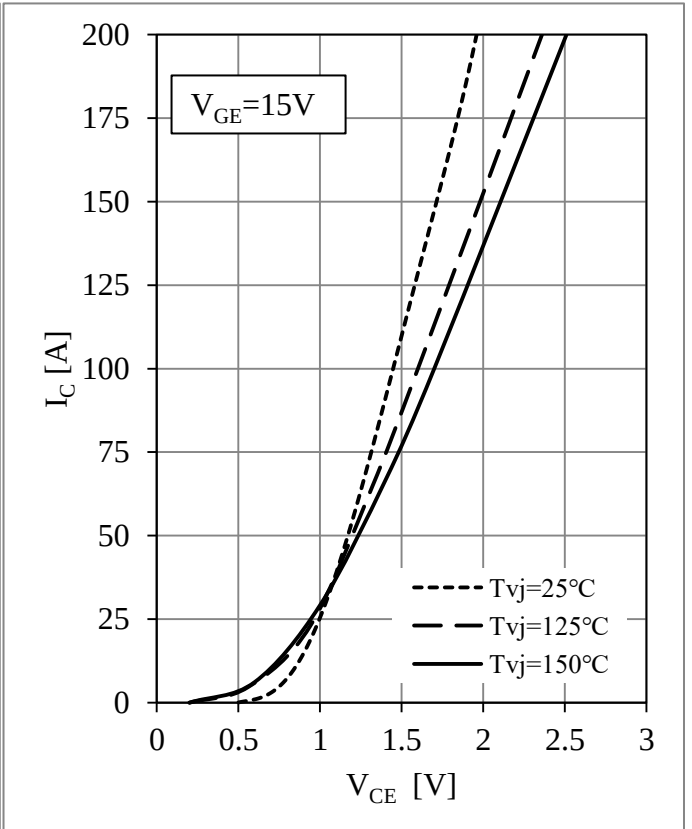
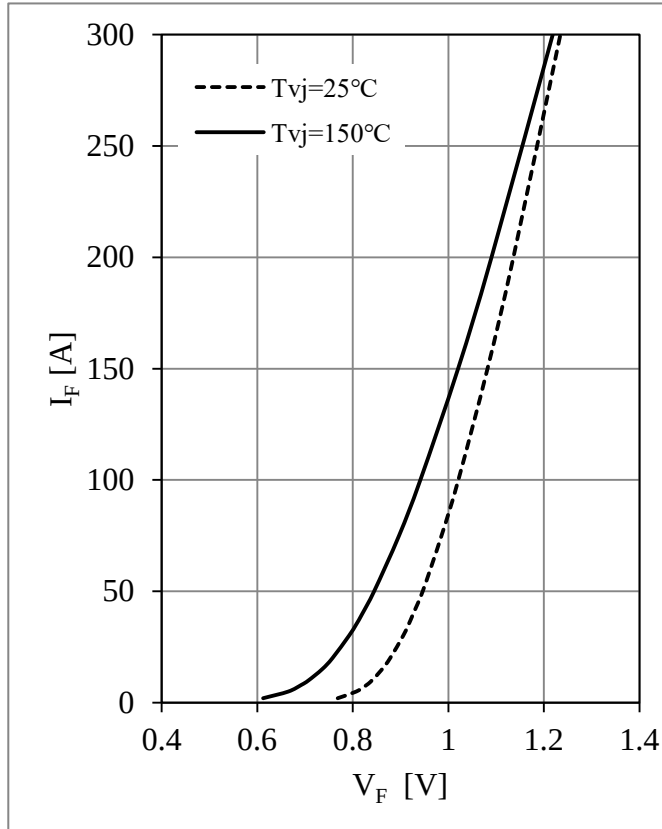
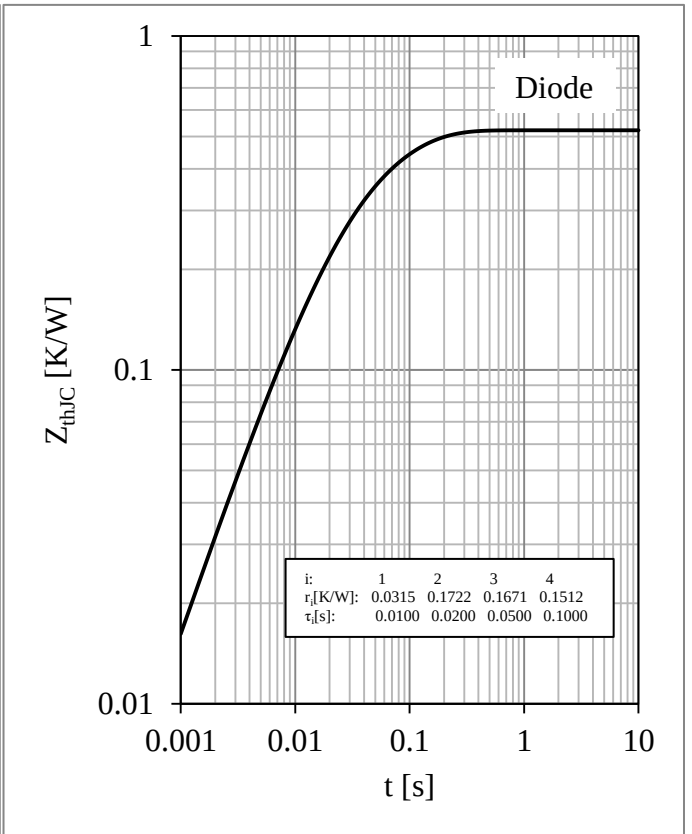
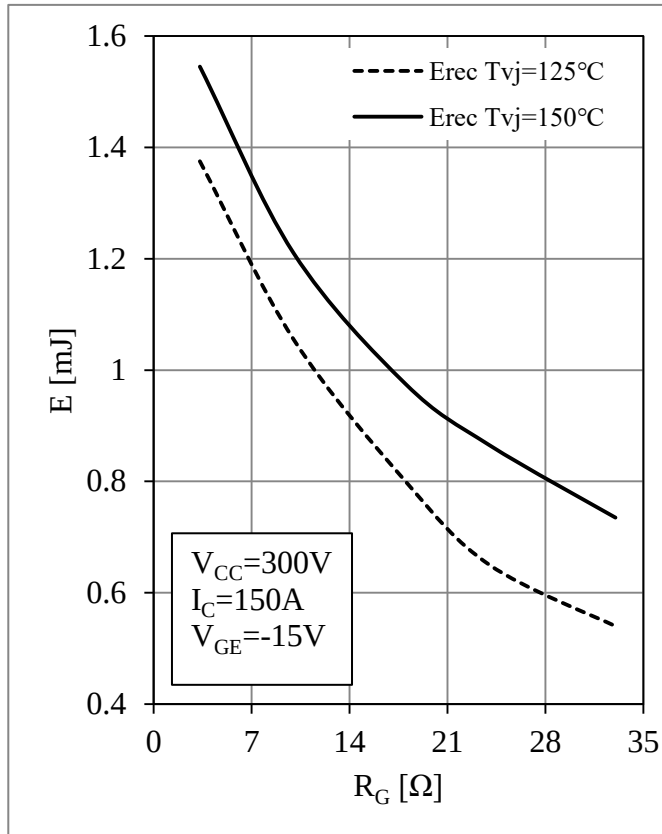


Fig 11. Diode-rectifier Forward Characteristics

Fig 12. IGBT-brake-chopper Output Characteristics

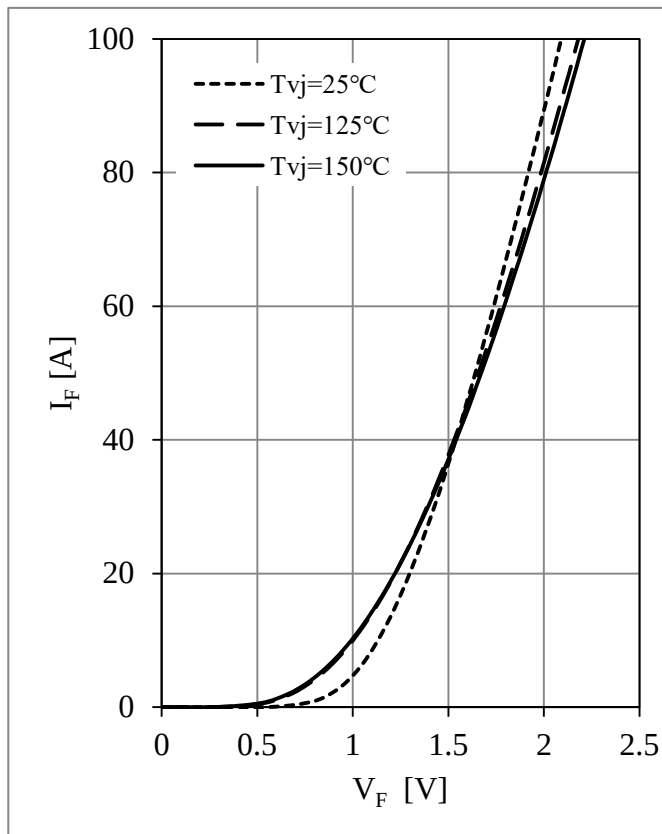


Fig 13. Diode-brake-chopper Forward Characteristics

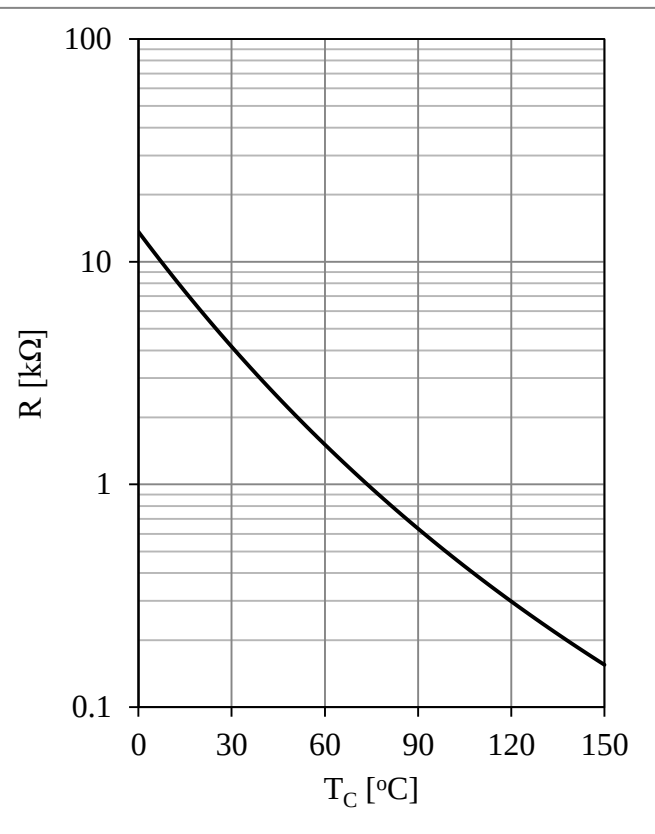
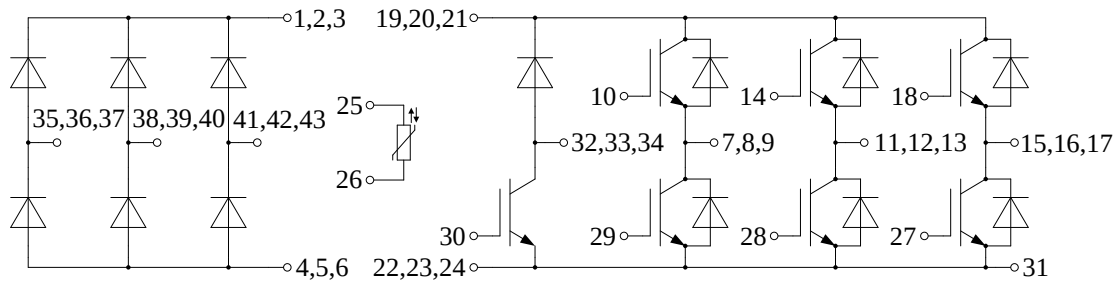


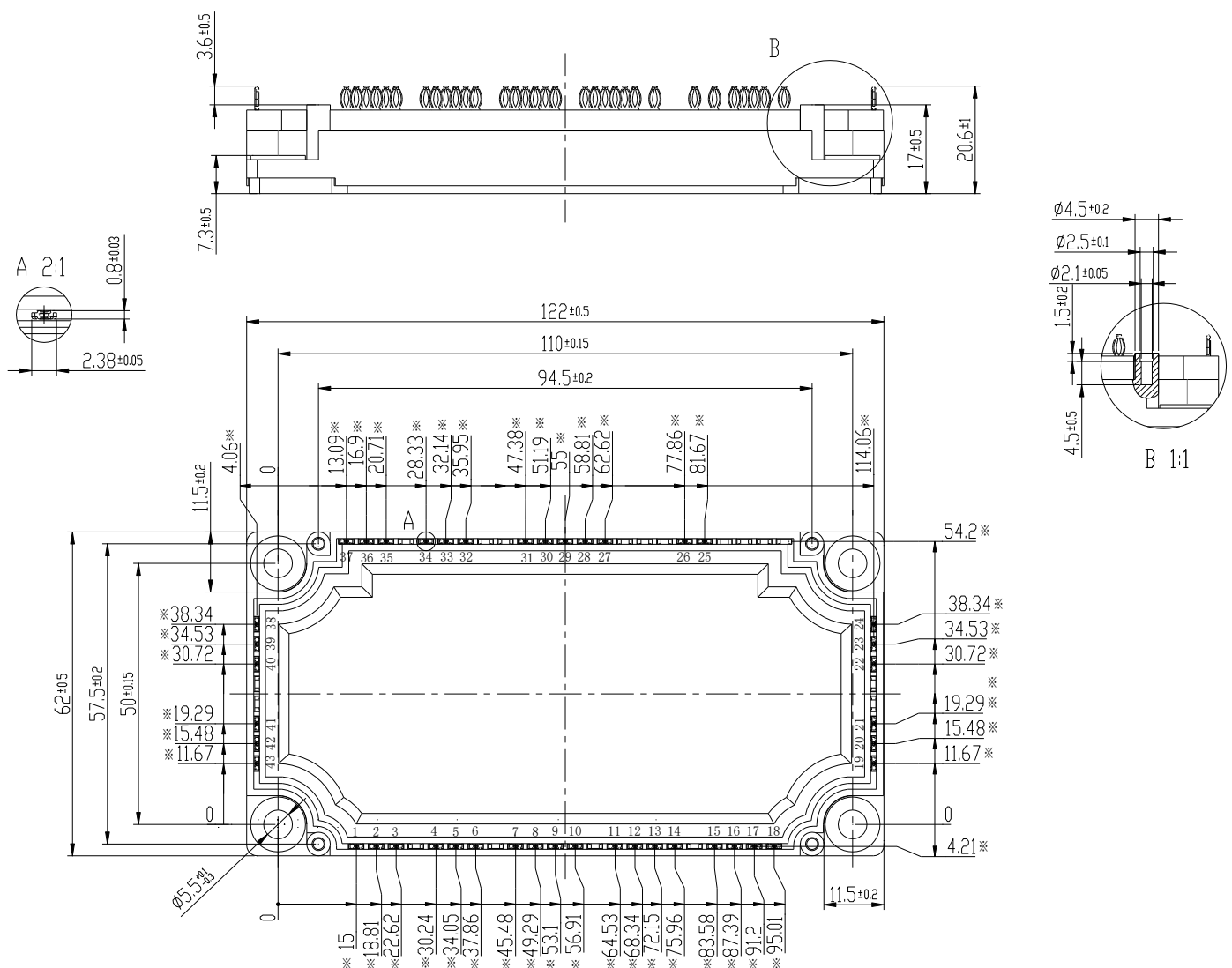
Fig 14. NTC Temperature Characteristic

Circuit Schematic



Package Dimensions

Dimensions in Millimeters



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