

# STARPOWER

SEMICONDUCTOR

**IGBT**

## GD40PIX120C5S

**1200V/40A 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.

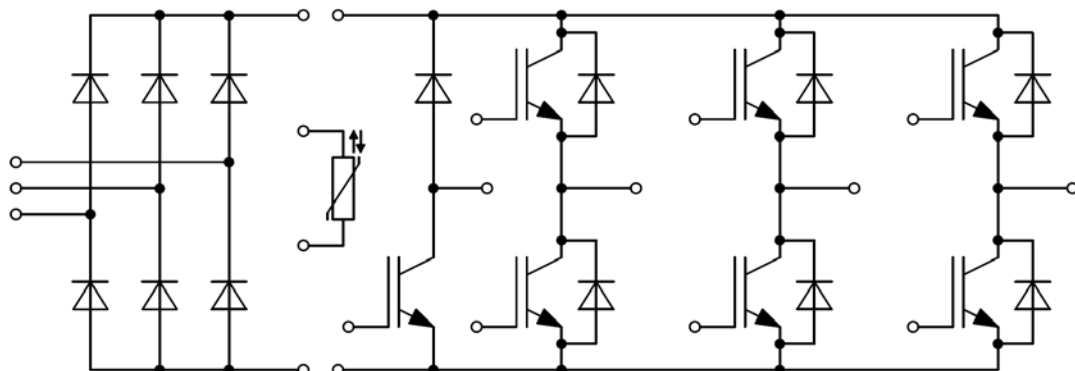
### Features

- Low  $V_{CE(sat)}$  Trench IGBT technology
- 10 $\mu$ s short circuit capability
- $V_{CE(sat)}$  with positive temperature coefficient
- Maximum junction temperature 175 $^{\circ}$ 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	1200	V
$V_{GES}$	Gate-Emitter Voltage	$\pm 20$	V
$I_C$	Collector Current @ $T_C=25^{\circ}\text{C}$ @ $T_C=100^{\circ}\text{C}$	69	A
		40	
$I_{CM}$	Pulsed Collector Current $t_p=1\text{ms}$	80	A
$P_D$	Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$	263	W

**Diode-inverter**

Symbol	Description	Value	Unit
$V_{RRM}$	Repetitive Peak Reverse Voltage	1200	V
$I_F$	Diode Continuous Forward Current	40	A
$I_{FM}$	Diode Maximum Forward Current $t_p=1\text{ms}$	80	A

**Diode-rectifier**

Symbol	Description	Value	Unit
$V_{RRM}$	Repetitive Peak Reverse Voltage	1600	V
$I_O$	Average Output Current 50Hz/60Hz,sine wave	35	A
$I_{FSM}$	Surge Forward Current $t_p=10\text{ms}$ @ $T_j=25^{\circ}\text{C}$ @ $T_j=150^{\circ}\text{C}$	450	A
		370	
$I^2t$	$I^2t$ -value, $t_p=10\text{ms}$ @ $T_j=25^{\circ}\text{C}$ @ $T_j=150^{\circ}\text{C}$	1000 685	$\text{A}^2\text{s}$

**IGBT-brake**

Symbol	Description	Value	Unit
$V_{CES}$	Collector-Emitter Voltage	1200	V
$V_{GES}$	Gate-Emitter Voltage	$\pm 20$	V
$I_C$	Collector Current @ $T_C=25^{\circ}\text{C}$ @ $T_C=100^{\circ}\text{C}$	30	A
		15	
$I_{CM}$	Pulsed Collector Current $t_p=1\text{ms}$	30	A
$P_D$	Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$	145	W

**Diode-brake**

Symbol	Description	Value	Unit
$V_{RRM}$	Repetitive Peak Reverse Voltage	1200	V
$I_F$	Diode Continuous Forward Current	15	A
$I_{FM}$	Diode Maximum Forward Current $t_p=1\text{ms}$	30	A

**Module**

Symbol	Description	Value	Unit
$T_{jmax}$	Maximum Junction Temperature(inverter,brake)	175	$^{\circ}\text{C}$
	Maximum Junction Temperature (rectifier)	150	
$T_{jop}$	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-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	$I_C=40\text{A}, V_{GE}=15\text{V}, T_j=25^\circ\text{C}$		1.80	2.25	V	
		$I_C=40\text{A}, V_{GE}=15\text{V}, T_j=125^\circ\text{C}$		2.15			
		$I_C=40\text{A}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}$		2.20			
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$I_C=1.00\text{mA}, V_{CE}=V_{GE}, T_j=25^\circ\text{C}$	5.2	6.0	6.8	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	$V_{GE}=V_{GES}, V_{CE}=0\text{V}, T_j=25^\circ\text{C}$			100	nA	
$R_{Gint}$	Internal Gate Resistance			0		$\Omega$	
$C_{ies}$	Input Capacitance	$V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$		3.62		nF	
$C_{res}$	Reverse Transfer Capacitance			0.10		nF	
$Q_G$	Gate Charge	$V_{GE}=-15\dots+15\text{V}$		0.27		$\mu\text{C}$	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=600\text{V}, I_C=40\text{A}, R_G=40\Omega, V_{GE}=\pm 15\text{V}, T_j=25^\circ\text{C}$		188		ns	
$t_r$	Rise Time			35		ns	
$t_{d(off)}$	Turn-Off Delay Time			374		ns	
$t_f$	Fall Time			90		ns	
$E_{on}$	Turn-On Switching Loss			4.59		mJ	
$E_{off}$	Turn-Off Switching Loss			2.38		mJ	
$t_{d(on)}$	Turn-On Delay Time		$V_{CC}=600\text{V}, I_C=40\text{A}, R_G=40\Omega, V_{GE}=\pm 15\text{V}, T_j=125^\circ\text{C}$		200		ns
$t_r$	Rise Time				47		ns
$t_{d(off)}$	Turn-Off Delay Time			521		ns	
$t_f$	Fall Time			171		ns	
$E_{on}$	Turn-On Switching Loss			6.10		mJ	
$E_{off}$	Turn-Off Switching Loss			3.60		mJ	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=600\text{V}, I_C=40\text{A}, R_G=40\Omega, V_{GE}=\pm 15\text{V}, T_j=150^\circ\text{C}$			200		ns
$t_r$	Rise Time				47		ns
$t_{d(off)}$	Turn-Off Delay Time			510		ns	
$t_f$	Fall Time			193		ns	
$E_{on}$	Turn-On Switching Loss			6.80		mJ	
$E_{off}$	Turn-Off Switching Loss			4.00		mJ	
$I_{SC}$	SC Data		$t_p \leq 10\mu\text{s}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}, V_{CC}=900\text{V}, V_{CEM} \leq 1200\text{V}$		140		A

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_F$	Diode Forward Voltage	$I_F=40\text{A}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$		2.08	2.53	V
		$I_F=40\text{A}, V_{GE}=0\text{V}, T_j=125^\circ\text{C}$		2.00		
		$I_F=40\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$		1.97		
$Q_r$	Recovered Charge	$V_R=600\text{V}, I_F=40\text{A},$ $-di/dt=1155\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=25^\circ\text{C}$		3.4		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			35		A
$E_{rec}$	Reverse Recovery Energy			1.10		mJ
$Q_r$	Recovered Charge	$V_R=600\text{V}, I_F=40\text{A},$ $-di/dt=1155\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=125^\circ\text{C}$		6.3		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			39		A
$E_{rec}$	Reverse Recovery Energy			2.25		mJ
$Q_r$	Recovered Charge	$V_R=600\text{V}, I_F=40\text{A},$ $-di/dt=1155\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=150^\circ\text{C}$		7.1		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			40		A
$E_{rec}$	Reverse Recovery Energy			2.56		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	$I_F=40\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$		0.99		V
$I_R$	Reverse Current	$T_j=150^\circ\text{C}, V_R=1600\text{V}$			2.0	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	$I_C=15\text{A}, V_{GE}=15\text{V}, T_j=25^\circ\text{C}$		1.70	2.15	V	
		$I_C=15\text{A}, V_{GE}=15\text{V}, T_j=125^\circ\text{C}$		1.95			
		$I_C=15\text{A}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}$		2.00			
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$I_C=0.38\text{mA}, V_{CE}=V_{GE}, T_j=25^\circ\text{C}$	5.2	6.0	6.8	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		$\Omega$	
$C_{ies}$	Input Capacitance	$V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$		1.55		nF	
$C_{res}$	Reverse Transfer Capacitance				0.04		nF
$Q_G$	Gate Charge	$V_{GE}=-15\dots+15\text{V}$		0.12		$\mu\text{C}$	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=600\text{V}, I_C=15\text{A}, R_G=39\Omega, V_{GE}=\pm 15\text{V}, T_j=25^\circ\text{C}$		68		ns	
$t_r$	Rise Time			19		ns	
$t_{d(off)}$	Turn-Off Delay Time			209		ns	
$t_f$	Fall Time			197		ns	
$E_{on}$	Turn-On Switching Loss			0.96		mJ	
$E_{off}$	Turn-Off Switching Loss			1.15		mJ	
$t_{d(on)}$	Turn-On Delay Time		$V_{CC}=600\text{V}, I_C=15\text{A}, R_G=39\Omega, V_{GE}=\pm 15\text{V}, T_j=125^\circ\text{C}$		64		ns
$t_r$	Rise Time				20		ns
$t_{d(off)}$	Turn-Off Delay Time			227		ns	
$t_f$	Fall Time			309		ns	
$E_{on}$	Turn-On Switching Loss			1.40		mJ	
$E_{off}$	Turn-Off Switching Loss			1.59		mJ	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=600\text{V}, I_C=15\text{A}, R_G=39\Omega, V_{GE}=\pm 15\text{V}, T_j=150^\circ\text{C}$			62		ns
$t_r$	Rise Time				20		ns
$t_{d(off)}$	Turn-Off Delay Time			250		ns	
$t_f$	Fall Time			340		ns	
$E_{on}$	Turn-On Switching Loss			1.54		mJ	
$E_{off}$	Turn-Off Switching Loss			1.75		mJ	
$I_{SC}$	SC Data		$t_p \leq 10\mu\text{s}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}, V_{CC}=900\text{V}, V_{CEM} \leq 1200\text{V}$		60		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	$I_F=15\text{A}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$		2.05	2.50	V
		$I_F=15\text{A}, V_{GE}=0\text{V}, T_j=125^\circ\text{C}$		2.20		
		$I_F=15\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$		2.25		
$Q_r$	Recovered Charge	$V_R=600\text{V}, I_F=15\text{A},$ $-di/dt=260\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=25^\circ\text{C}$		0.7		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			11		A
$E_{rec}$	Reverse Recovery Energy			0.54		mJ
$Q_r$	Recovered Charge	$V_R=600\text{V}, I_F=15\text{A},$ $-di/dt=260\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=125^\circ\text{C}$		2.4		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			13		A
$E_{rec}$	Reverse Recovery Energy			1.00		mJ
$Q_r$	Recovered Charge	$V_R=600\text{V}, I_F=15\text{A},$ $-di/dt=260\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=150^\circ\text{C}$		2.6		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			13		A
$E_{rec}$	Reverse Recovery Energy			1.12		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		60		nH
$R_{CC'+EE'}$ $R_{AA'+CC'}$	Module Lead Resistance, Terminal to Chip		4.00 3.00		m $\Omega$
$R_{thJC}$	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)			0.570 0.997 0.808 1.029 1.760	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)		0.291 0.509 0.412 0.525 0.898 0.020		K/W
M	Mounting Torque, Screw:M5	3.0		6.0	N.m
G	Weight of Module		200		g

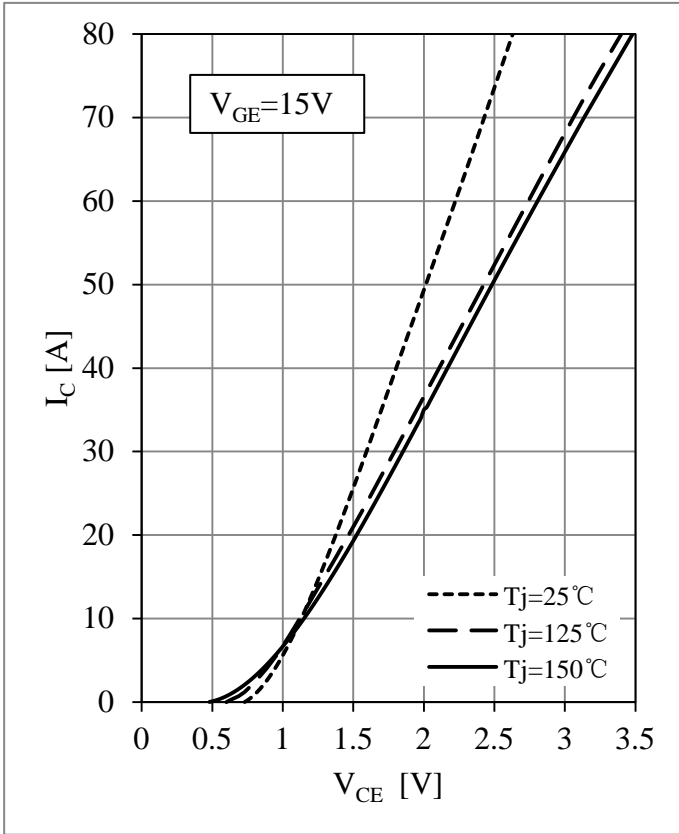


Fig 1. IGBT-inverter Output Characteristics

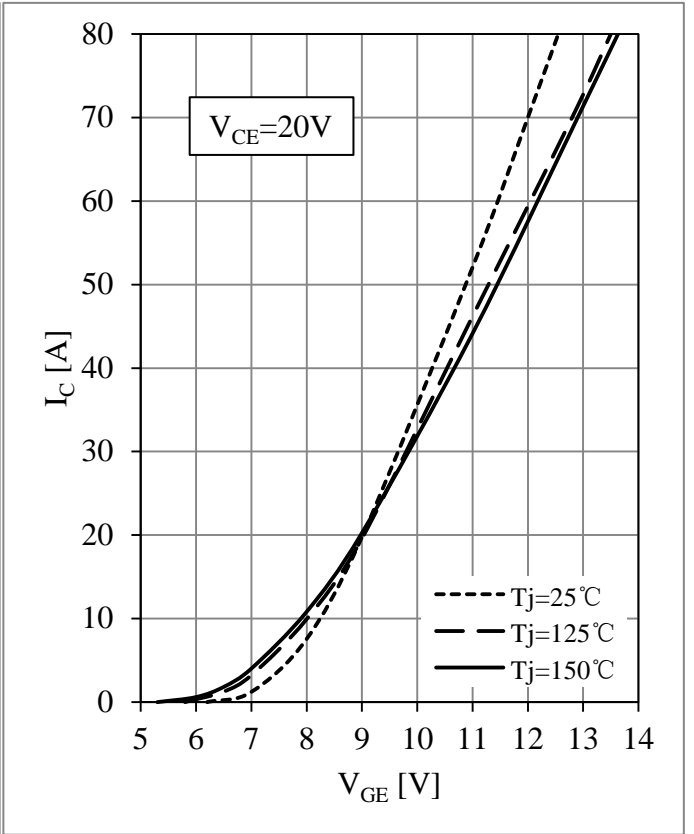


Fig 2. IGBT-inverter Transfer Characteristics

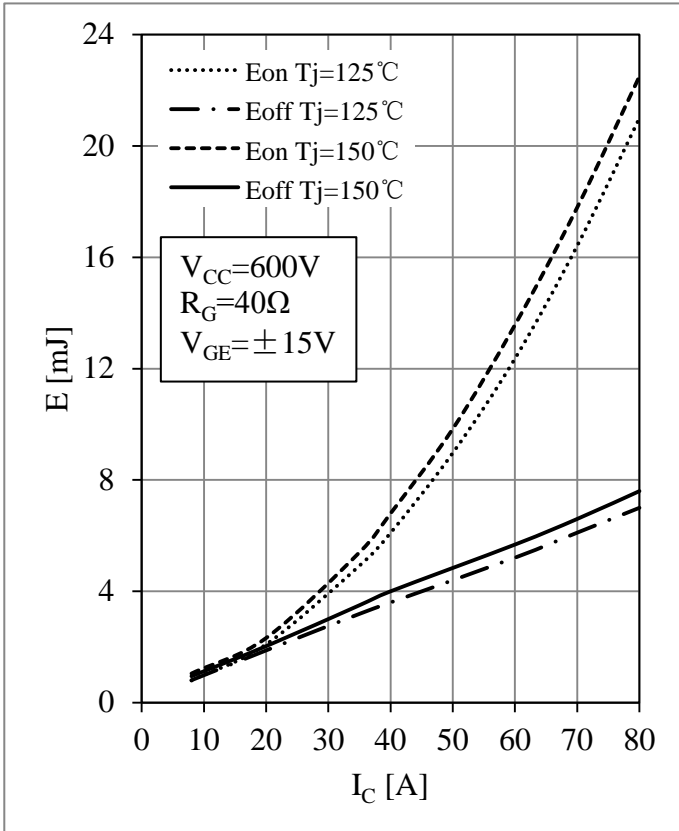


Fig 3. IGBT-inverter Switching Loss vs.  $I_C$

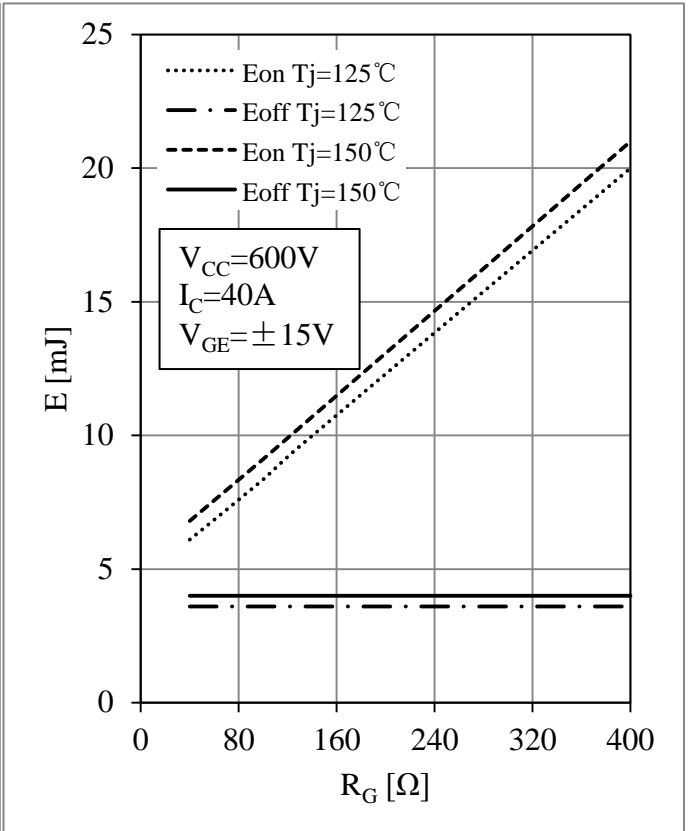


Fig 4. IGBT-inverter Switching Loss vs.  $R_G$



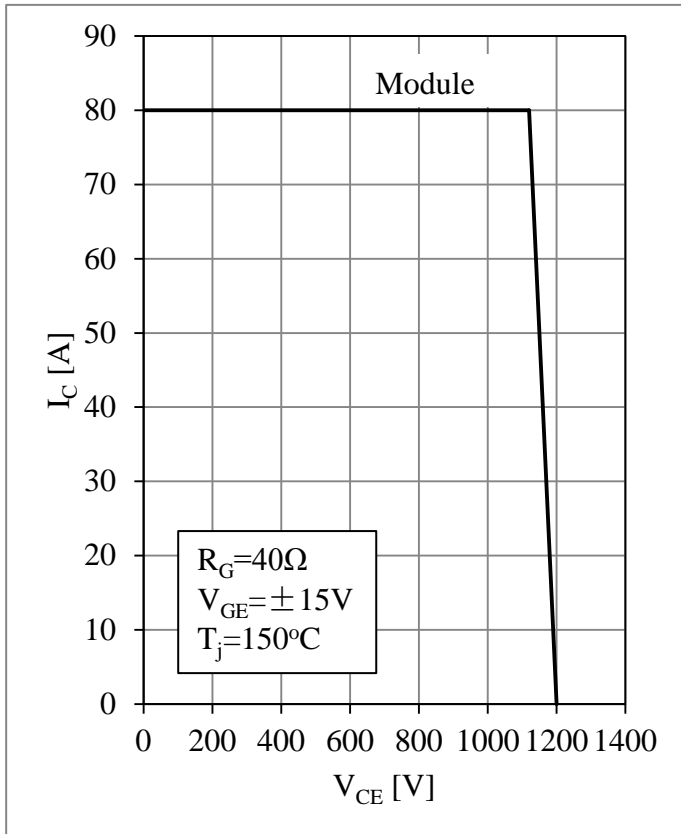


Fig 5. IGBT-inverter RBSOA

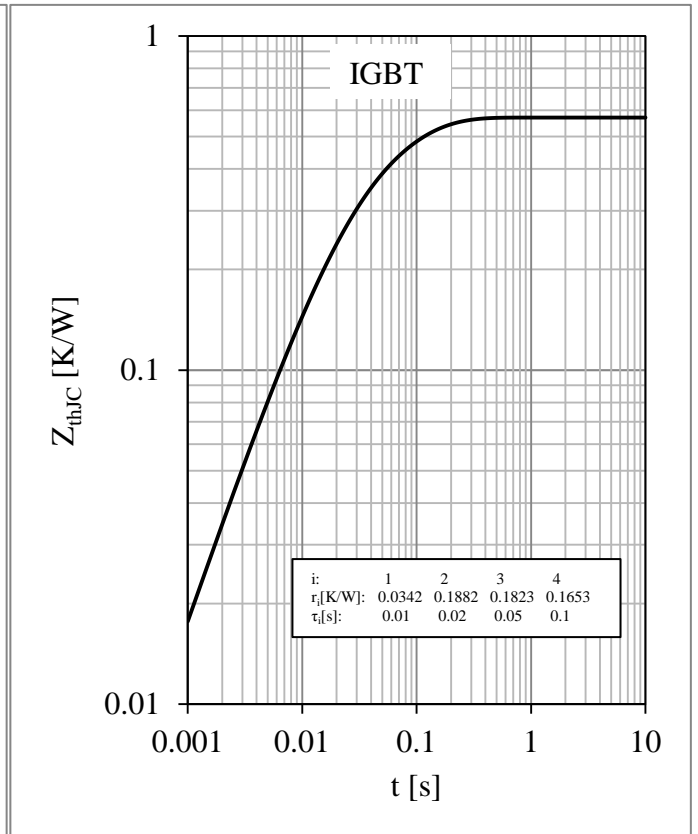


Fig 6. IGBT-inverter Transient Thermal Impedance

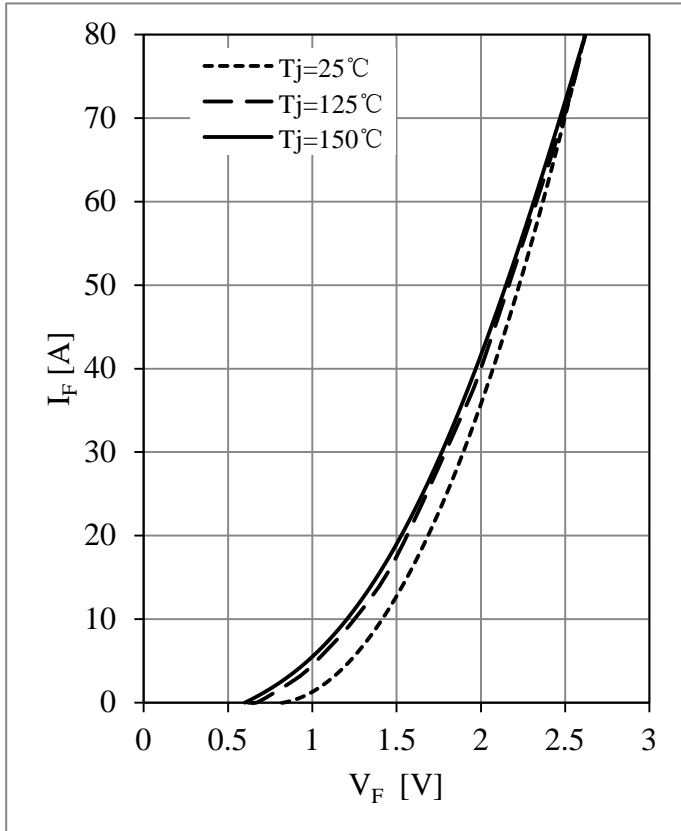


Fig 7. Diode-inverter Forward Characteristics

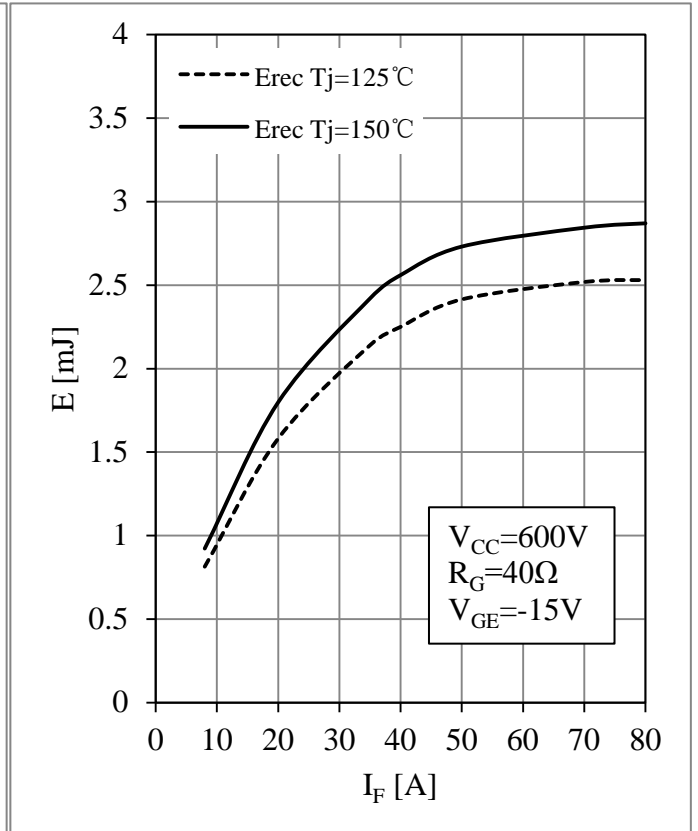


Fig 8. Diode-inverter Switching Loss vs.  $I_F$

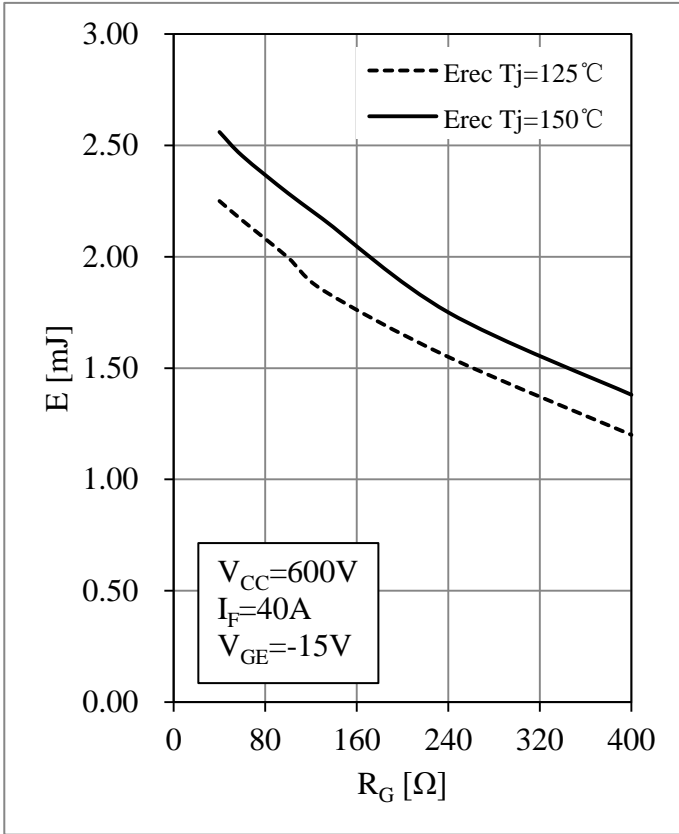


Fig 9. Diode-inverter Switching Loss vs.  $R_G$

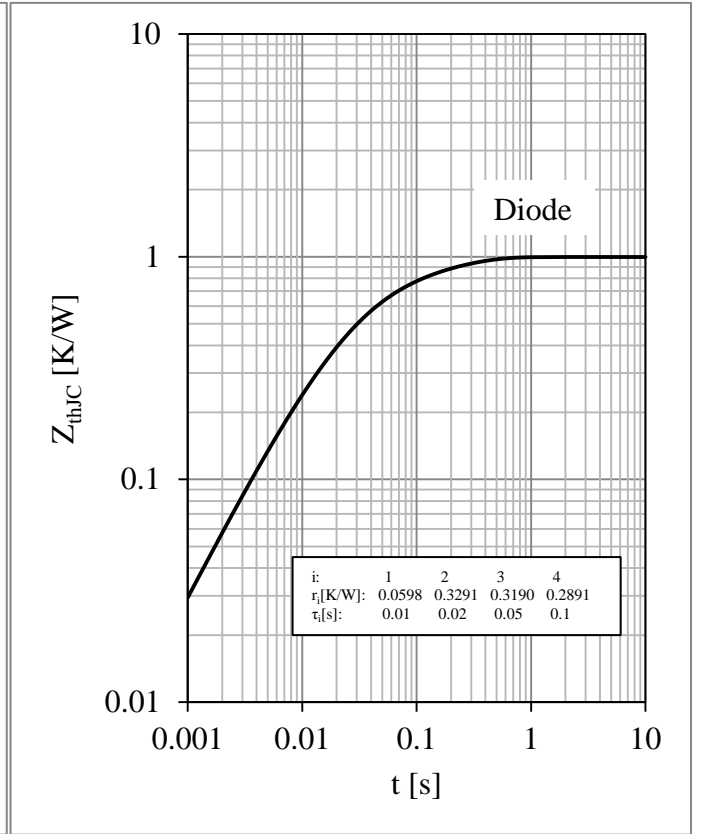


Fig 10. Diode-inverter Transient Thermal Impedance

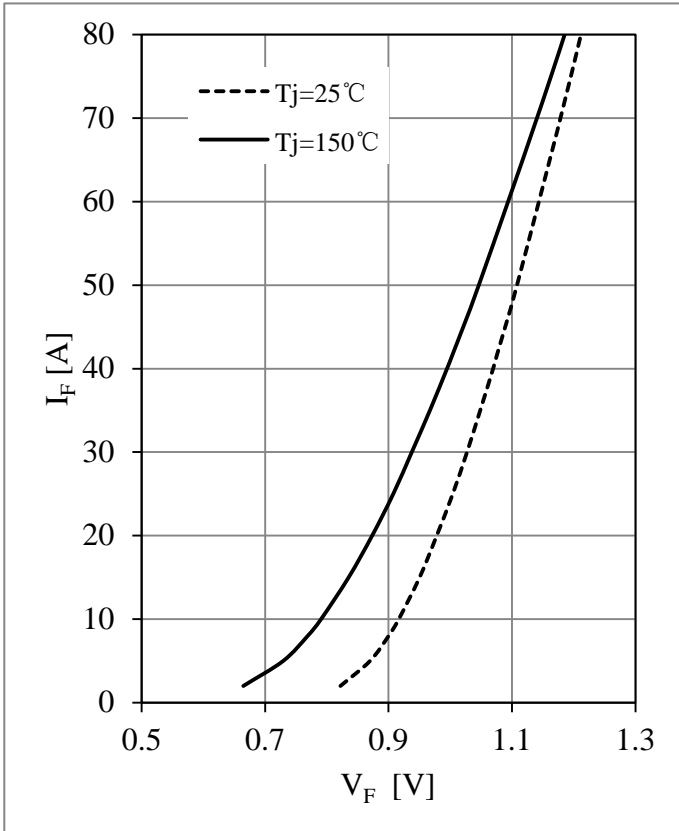


Fig 11. Diode-rectifier Forward Characteristics

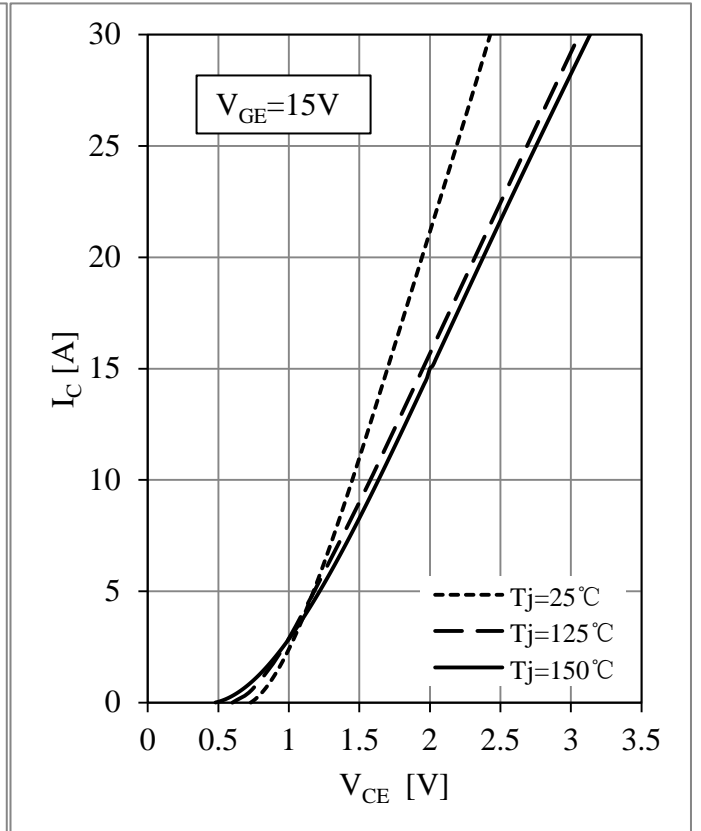


Fig 12. IGBT-brake-chopper Output Characteristics

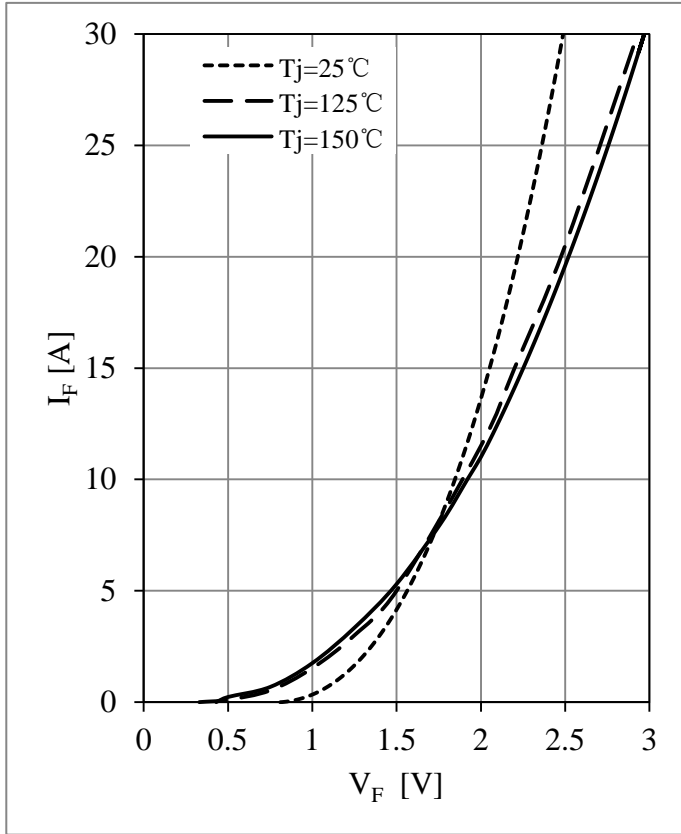


Fig 13. Diode-brake-chopper Forward Characteristics

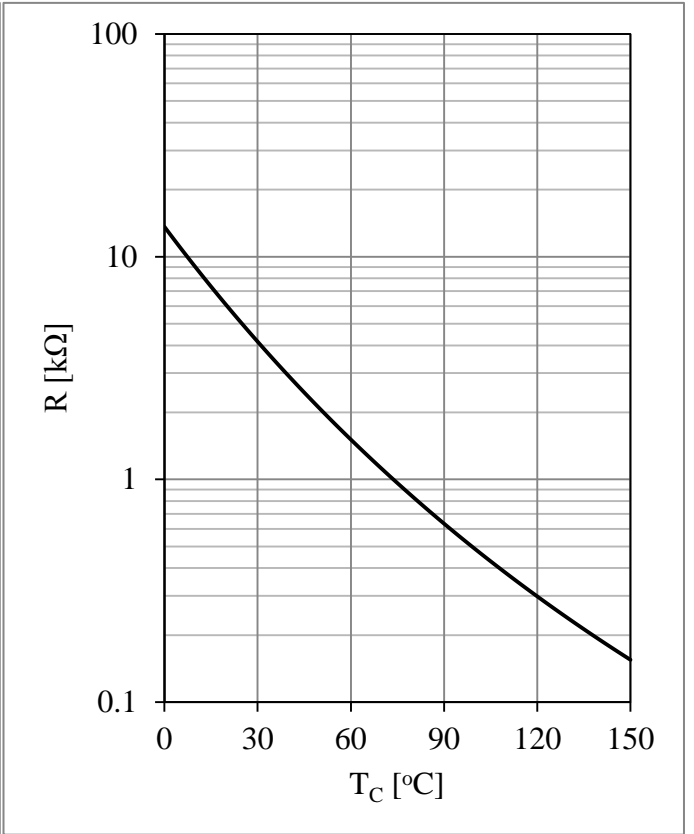
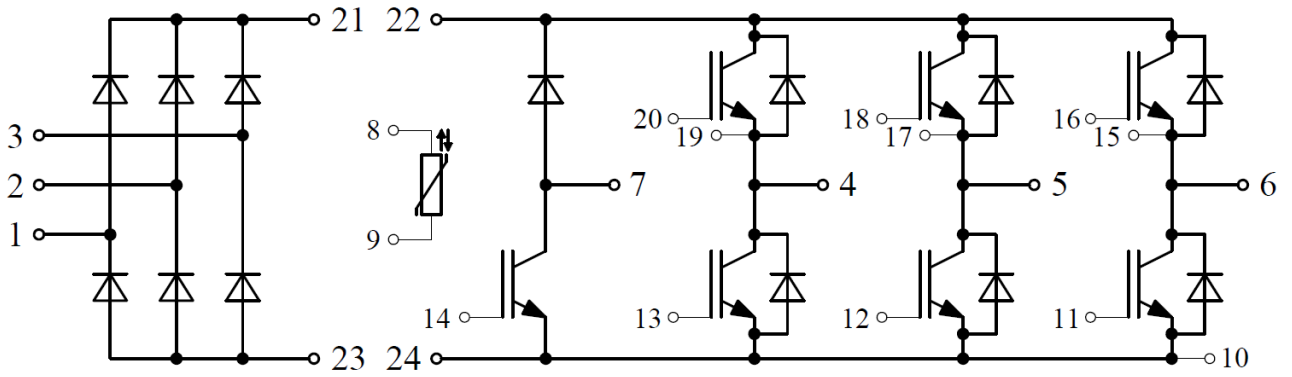


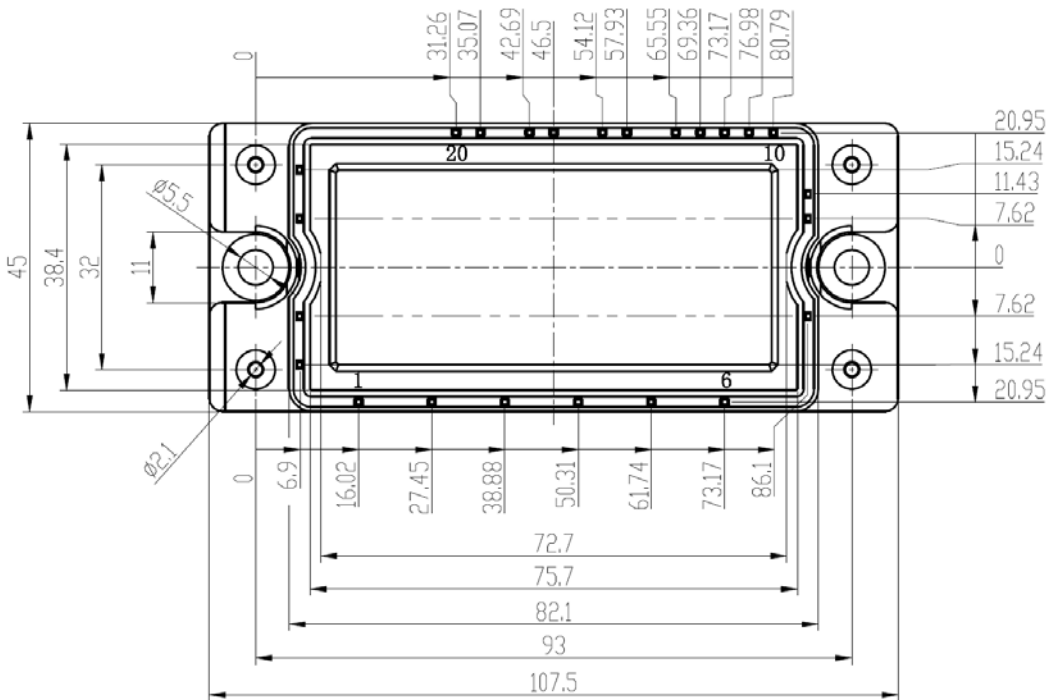
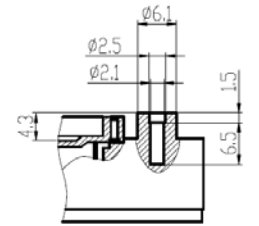
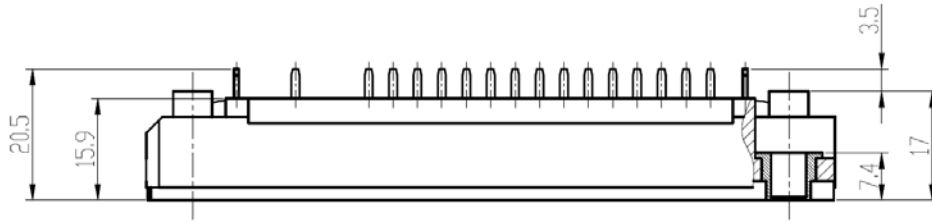
Fig 14. NTC Temperature Characteristic

**Circuit Schematic**



**Package Dimensions**

Dimensions in Millimeters



## Terms and Conditions of Usage

The data contained in this product datasheet is exclusively intended for technically trained staff. you and your technical departments will have to evaluate the suitability of the product for the intended application and the completeness of the product data with respect to such application.

This product data sheet is describing the characteristics of this product for which a warranty is granted. Any such warranty is granted exclusively pursuant the terms and conditions of the supply agreement. There will be no guarantee of any kind for the product and its characteristics.

Should you require product information in excess of the data given in this product data sheet or which concerns the specific application of our product, please contact the sales office, which is responsible for you (see [www.powersemi.cc](http://www.powersemi.cc)), For those that are specifically interested we may provide application notes.

Due to technical requirements our product may contain dangerous substances. For information on the types in question please contact the sales office, which is responsible for you.

Should you intend to use the Product in aviation applications, in health or live endangering or life support applications, please notify.

If and to the extent necessary, please forward equivalent notices to your customers.  
Changes of this product data sheet are reserved.