

# STARPOWER

SEMICONDUCTOR

**IGBT**

## GD20PJX65F3S

**650V/20A 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.

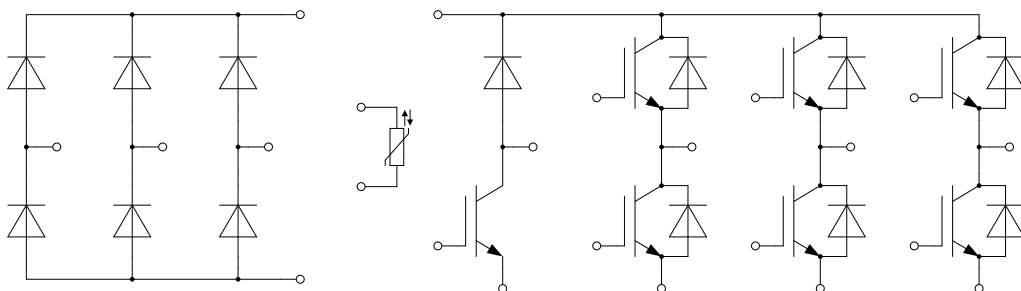
### Features

- Low  $V_{CE(sat)}$  Trench IGBT technology
- 6 $\mu$ 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 heatsink 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	$\pm 20$	V
$I_C$	Collector Current @ $T_C=25^{\circ}\text{C}$	35	A
	@ $T_C=100^{\circ}\text{C}$	20	
$I_{CM}$	Pulsed Collector Current $t_p=1\text{ms}$	40	A
$P_D$	Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$	102	W

**Diode-inverter**

Symbol	Description	Value	Unit
$V_{RRM}$	Repetitive Peak Reverse Voltage	650	V
$I_F$	Diode Continuous Forward Current	20	A
$I_{FM}$	Diode Maximum Forward Current $t_p=1\text{ms}$	40	A

**Diode-rectifier**

Symbol	Description	Value	Unit
$V_{RRM}$	Repetitive Peak Reverse Voltage	1600	V
$I_O$	Average Output Current 50Hz/60Hz,sine wave	20	A
$I_{FSM}$	Surge Forward Current $V_R=0\text{V}, t_p=10\text{ms}, T_j=45^{\circ}\text{C}$	270	A
$I^2t$	$I^2t$ -value, $V_R=0\text{V}, t_p=10\text{ms}, T_j=45^{\circ}\text{C}$	360	$\text{A}^2\text{s}$

**IGBT-brake**

Symbol	Description	Value	Unit
$V_{CES}$	Collector-Emitter Voltage	650	V
$V_{GES}$	Gate-Emitter Voltage	$\pm 20$	V
$I_C$	Collector Current @ $T_C=25^{\circ}\text{C}$	28	A
	@ $T_C=100^{\circ}\text{C}$	15	
$I_{CM}$	Pulsed Collector Current $t_p=1\text{ms}$	30	A
$P_D$	Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$	86	W

**Diode-brake**

Symbol	Description	Value	Unit
$V_{RRM}$	Repetitive Peak Reverse Voltage	650	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=50Hz,t=1min	4000	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	$I_C=20\text{A}, V_{GE}=15\text{V}, T_j=25^\circ\text{C}$		1.45	1.90	V	
		$I_C=20\text{A}, V_{GE}=15\text{V}, T_j=125^\circ\text{C}$		1.60			
		$I_C=20\text{A}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}$		1.70			
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$I_C=0.32\text{mA}, V_{CE}=V_{GE}, T_j=25^\circ\text{C}$	5.1	5.8	6.5	V	
$I_{CES}$	Collector Cut-Off Current	$V_{CE}=V_{CES}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$			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	$V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$		2.32		nF	
$C_{res}$	Reverse Transfer Capacitance				0.05		nF
$Q_G$	Gate Charge	$V_{GE}=-15\dots+15\text{V}$		0.14		$\mu\text{C}$	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=300\text{V}, I_C=20\text{A}, R_G=18\Omega, V_{GE}=\pm 15\text{V}, T_j=25^\circ\text{C}$		15		ns	
$t_r$	Rise Time			13		ns	
$t_{d(off)}$	Turn-Off Delay Time			96		ns	
$t_f$	Fall Time			56		ns	
$E_{on}$	Turn-On Switching Loss			0.32		mJ	
$E_{off}$	Turn-Off Switching Loss			0.35		mJ	
$t_{d(on)}$	Turn-On Delay Time		$V_{CC}=300\text{V}, I_C=20\text{A}, R_G=18\Omega, V_{GE}=\pm 15\text{V}, T_j=125^\circ\text{C}$		15		ns
$t_r$	Rise Time				16		ns
$t_{d(off)}$	Turn-Off Delay Time			112		ns	
$t_f$	Fall Time			76		ns	
$E_{on}$	Turn-On Switching Loss			0.44		mJ	
$E_{off}$	Turn-Off Switching Loss			0.45		mJ	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=300\text{V}, I_C=20\text{A}, R_G=18\Omega, V_{GE}=\pm 15\text{V}, T_j=150^\circ\text{C}$			15		ns
$t_r$	Rise Time				17		ns
$t_{d(off)}$	Turn-Off Delay Time			120		ns	
$t_f$	Fall Time			80		ns	
$E_{on}$	Turn-On Switching Loss			0.49		mJ	
$E_{off}$	Turn-Off Switching Loss			0.47		mJ	
$I_{SC}$	SC Data		$t_p \leq 6\mu\text{s}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}, V_{CC}=360\text{V}, V_{CEM} \leq 650\text{V}$		100		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	$I_C=20\text{A}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$		1.60	2.05	V
		$I_C=20\text{A}, V_{GE}=0\text{V}, T_j=125^\circ\text{C}$		1.55		
		$I_C=20\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$		1.50		
$Q_r$	Recovered Charge	$V_R=300\text{V}, I_F=20\text{A},$ $-di/dt=1800\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=25^\circ\text{C}$		1.00		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			30.0		A
$E_{rec}$	Reverse Recovery Energy			0.21		mJ
$Q_r$	Recovered Charge	$V_R=300\text{V}, I_F=20\text{A},$ $-di/dt=1800\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=125^\circ\text{C}$		1.75		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			32.0		A
$E_{rec}$	Reverse Recovery Energy			0.37		mJ
$Q_r$	Recovered Charge	$V_R=300\text{V}, I_F=20\text{A},$ $-di/dt=1800\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=150^\circ\text{C}$		2.20		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			34.0		A
$E_{rec}$	Reverse Recovery Energy			0.47		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	$I_F=20\text{A}, T_j=150^\circ\text{C}$		1.04		V
$I_R$	Reverse Current	$T_j=150^\circ\text{C}, V_R=1600\text{V}$			1.0	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	$I_C=15\text{A}, V_{GE}=15\text{V}, T_j=25^\circ\text{C}$		1.45	1.90	V	
		$I_C=15\text{A}, V_{GE}=15\text{V}, T_j=125^\circ\text{C}$		1.60			
		$I_C=15\text{A}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}$		1.70			
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$I_C=0.24\text{mA}, V_{CE}=V_{GE}, T_j=25^\circ\text{C}$	5.1	5.8	6.5	V	
$I_{CES}$	Collector Cut-Off Current	$V_{CE}=V_{CES}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$			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	$V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$		1.74		nF	
$C_{res}$	Reverse Transfer Capacitance			0.03		nF	
$Q_G$	Gate Charge	$V_{GE}=-15\dots+15\text{V}$		0.10		$\mu\text{C}$	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=300\text{V}, I_C=15\text{A}, R_G=22\Omega, V_{GE}=\pm 15\text{V}, T_j=25^\circ\text{C}$		14		ns	
$t_r$	Rise Time			11		ns	
$t_{d(off)}$	Turn-Off Delay Time			88		ns	
$t_f$	Fall Time			68		ns	
$E_{on}$	Turn-On Switching Loss			0.25		mJ	
$E_{off}$	Turn-Off Switching Loss			0.27		mJ	
$t_{d(on)}$	Turn-On Delay Time		$V_{CC}=300\text{V}, I_C=15\text{A}, R_G=22\Omega, V_{GE}=\pm 15\text{V}, T_j=125^\circ\text{C}$		14		ns
$t_r$	Rise Time				15		ns
$t_{d(off)}$	Turn-Off Delay Time			104		ns	
$t_f$	Fall Time			88		ns	
$E_{on}$	Turn-On Switching Loss			0.32		mJ	
$E_{off}$	Turn-Off Switching Loss			0.35		mJ	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=300\text{V}, I_C=15\text{A}, R_G=22\Omega, V_{GE}=\pm 15\text{V}, T_j=150^\circ\text{C}$			14		ns
$t_r$	Rise Time				15		ns
$t_{d(off)}$	Turn-Off Delay Time			112		ns	
$t_f$	Fall Time			96		ns	
$E_{on}$	Turn-On Switching Loss			0.36		mJ	
$E_{off}$	Turn-Off Switching Loss			0.37		mJ	
$I_{SC}$	SC Data		$t_p \leq 6\mu\text{s}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}, V_{CC}=360\text{V}, V_{CEM} \leq 650\text{V}$		75		A

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
$V_F$	Diode Forward Voltage	$I_C=15\text{A}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$		1.60	2.05	V
		$I_C=15\text{A}, V_{GE}=0\text{V}, T_j=125^\circ\text{C}$		1.55		
		$I_C=15\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$		1.50		
$Q_r$	Recovered Charge	$V_R=300\text{V}, I_F=15\text{A},$ $-di/dt=1600\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=25^\circ\text{C}$		0.8		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			23		A
$E_{rec}$	Reverse Recovery Energy			0.16		mJ
$Q_r$	Recovered Charge	$V_R=300\text{V}, I_F=15\text{A},$ $-di/dt=1600\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=125^\circ\text{C}$		1.4		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			25		A
$E_{rec}$	Reverse Recovery Energy			0.28		mJ
$Q_r$	Recovered Charge	$V_R=300\text{V}, I_F=15\text{A},$ $-di/dt=1600\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=150^\circ\text{C}$		1.7		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			26		A
$E_{rec}$	Reverse Recovery Energy			0.37		mJ

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$R_{25}$	Rated Resistance			22.0		$\text{k}\Omega$
$\Delta R/R$	Deviation of $R_{100}$	$T_C=100^\circ\text{C}, R_{100}=1486.1\Omega$	-5		5	%
$P_{25}$	Power Dissipation				200	mW
$B_{25/50}$	B-value	$R_2=R_{25}\exp[B_{25/50}(1/T_2-1/(298.15\text{K}))]$		4000		K

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

Symbol	Parameter	Min.	Typ.	Max.	Unit
$R_{thJC}$	Junction-to-Case (per IGBT-inverter)		1.332	1.465	K/W
	Junction-to-Case (per Diode-inverter)		2.158	2.374	
	Junction-to-Case (per Diode-rectifier)		1.305	1.436	
	Junction-to-Case (per IGBT-brake)		1.580	1.738	
	Junction-to-Case (per Diode-brake)		2.435	2.679	
$R_{thCH}$	Case-to-Heatsink (per IGBT-inverter)		0.620		K/W
	Case-to-Heatsink (per Diode-inverter)		1.004		
	Case-to-Heatsink (per Diode-rectifier)		0.607		
	Case-to-Heatsink (per IGBT-brake)		0.735		
	Case-to-Heatsink (per Diode-brake)		1.133		
	Case-to-Sink (per Module)		0.036		
M	Mounting Torque, Screw M4	2.0		2.2	N.m
G	Weight of Module		28		g

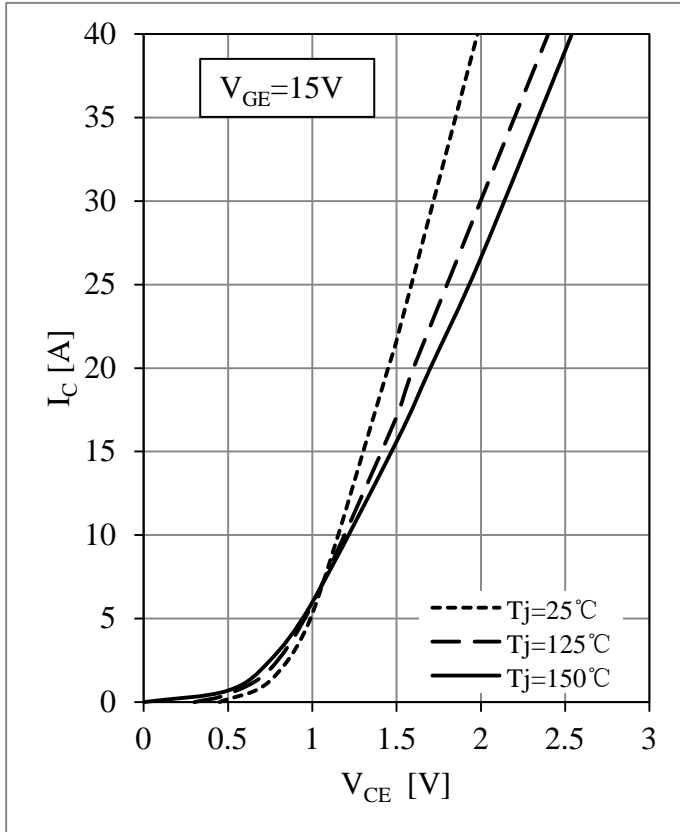


Fig 1. IGBT-inverter Output Characteristics

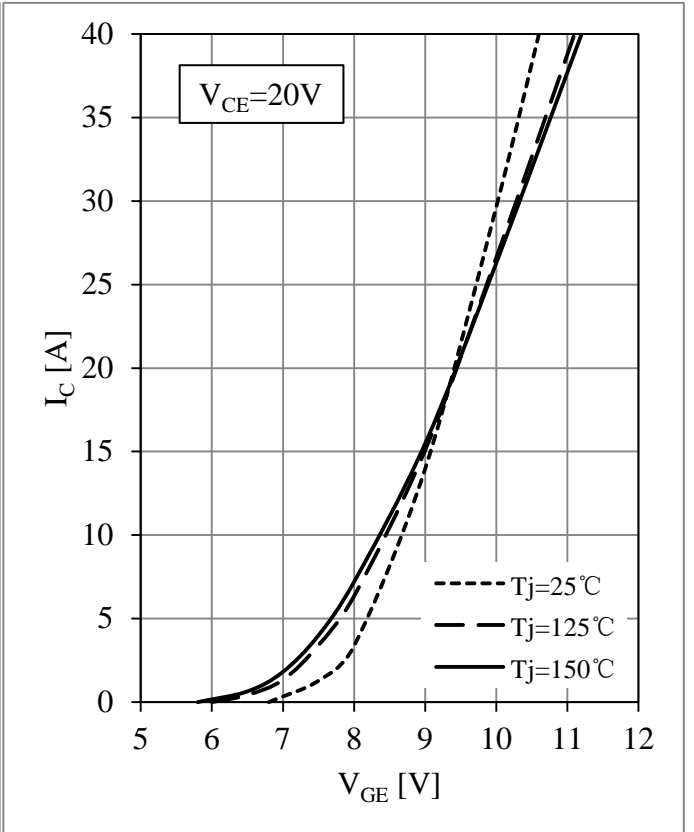


Fig 2. IGBT-inverter Transfer Characteristics

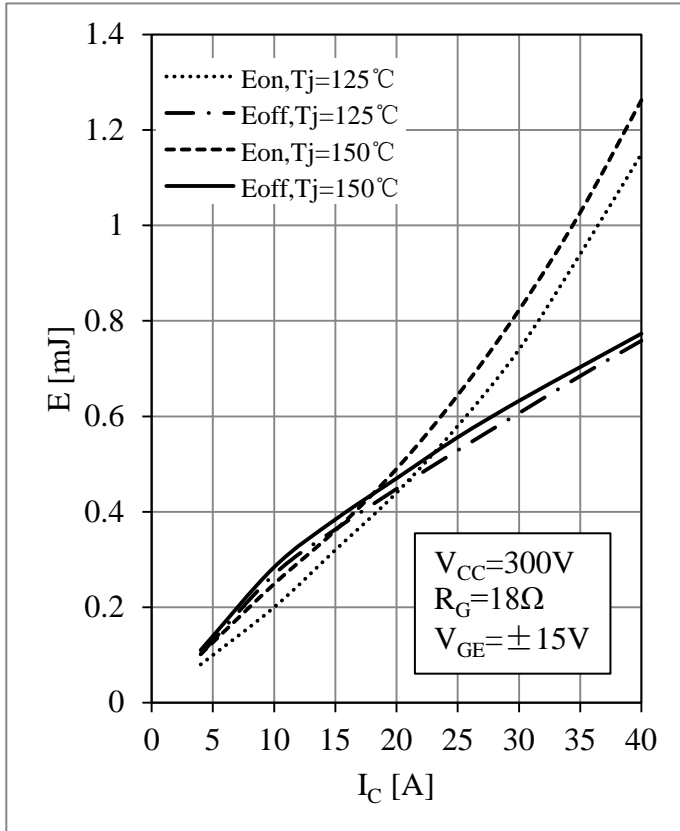


Fig 3. IGBT-inverter Switching Loss vs.  $I_C$

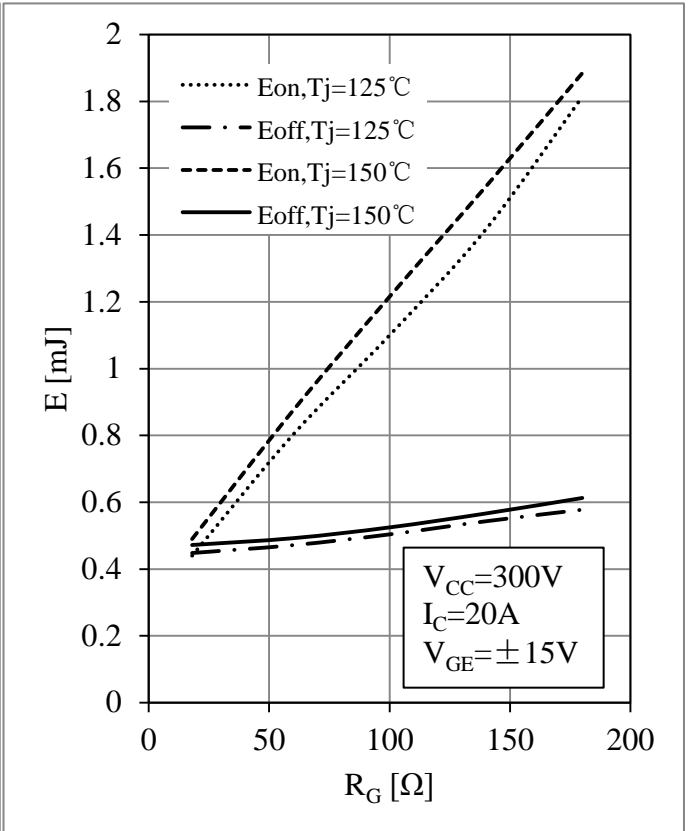


Fig 4. IGBT-inverter Switching Loss vs.  $R_G$

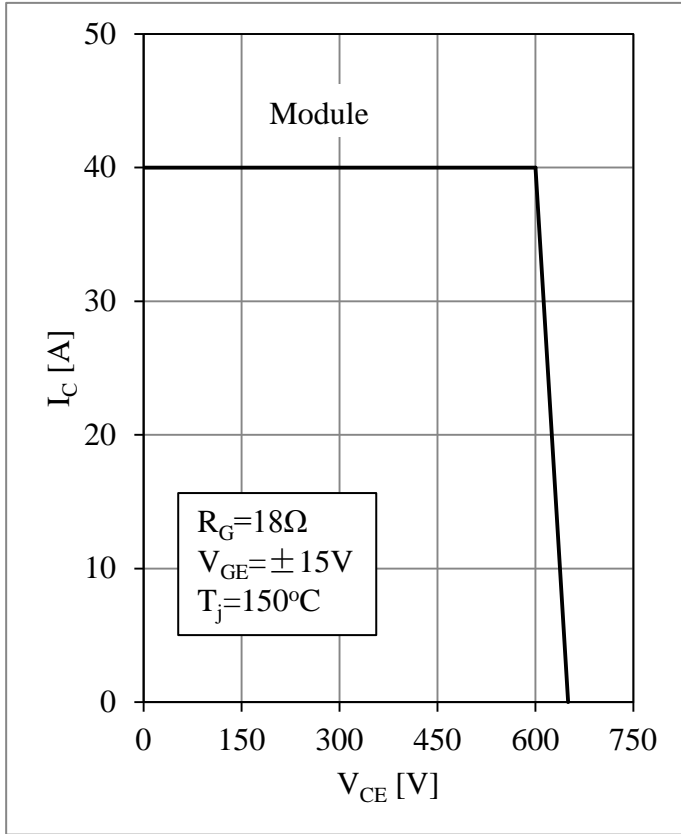


Fig 5. IGBT-inverter RBSOA

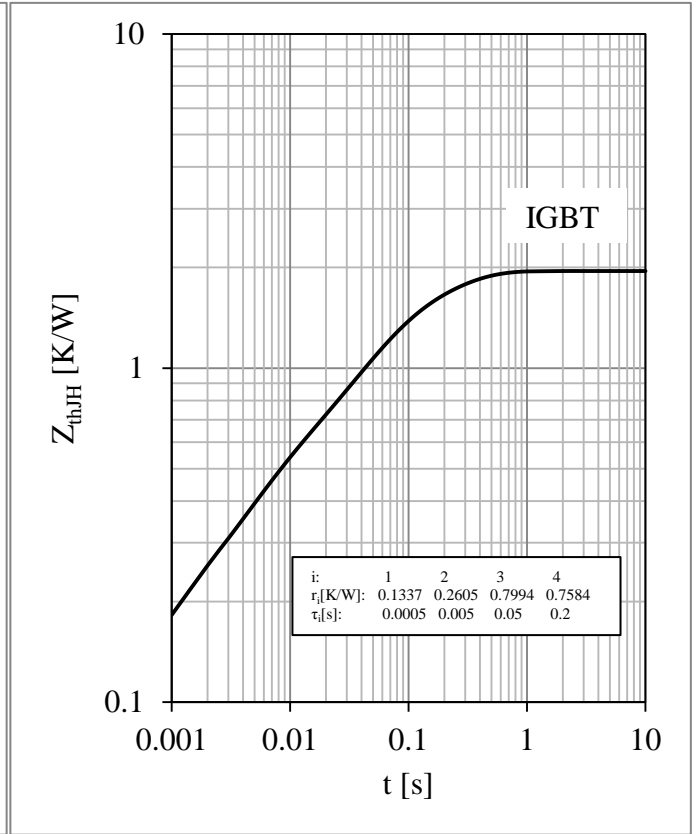


Fig 6. IGBT-inverter Transient Thermal Impedance

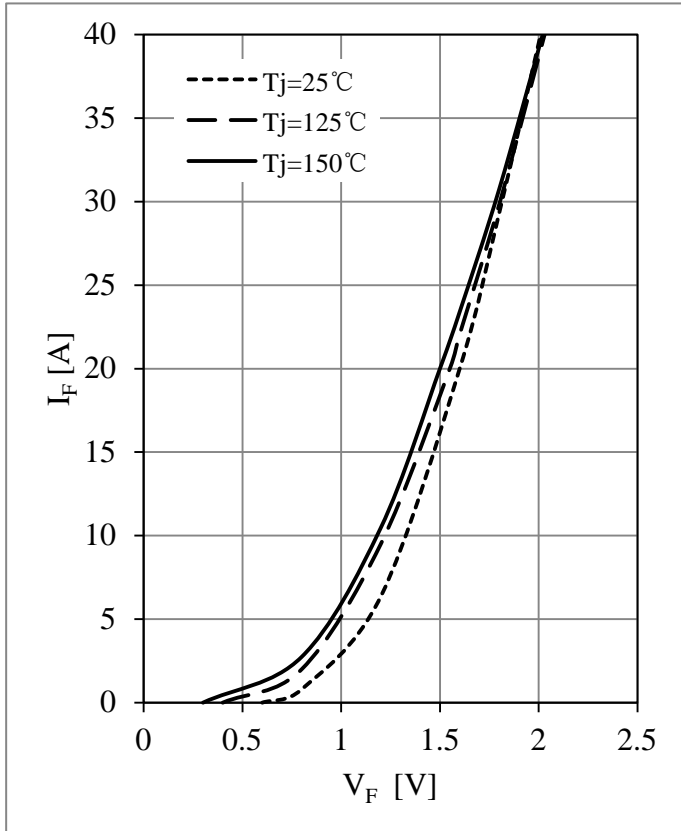


Fig 7. Diode-inverter Forward Characteristics

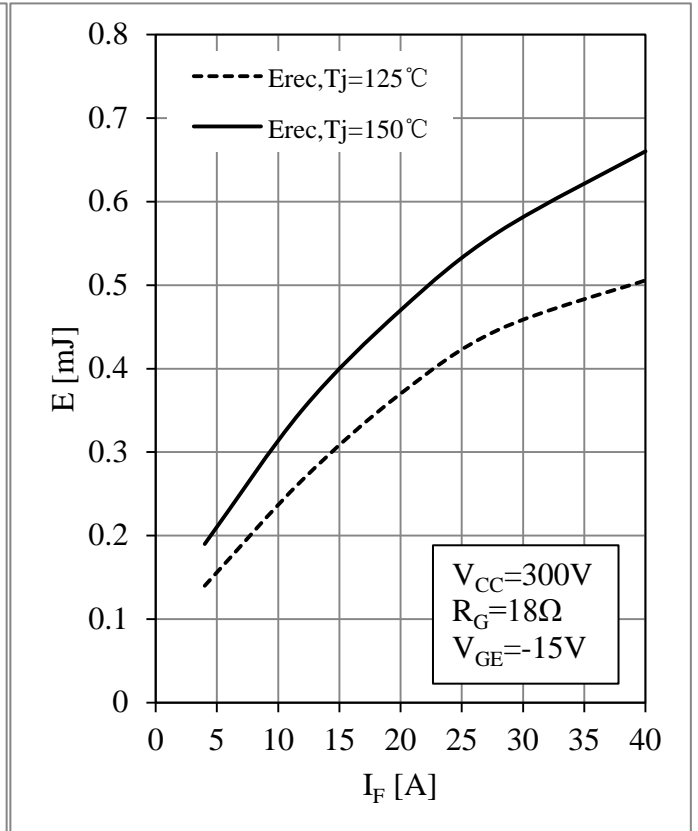


Fig 8. Diode-inverter Switching Loss vs.  $I_F$



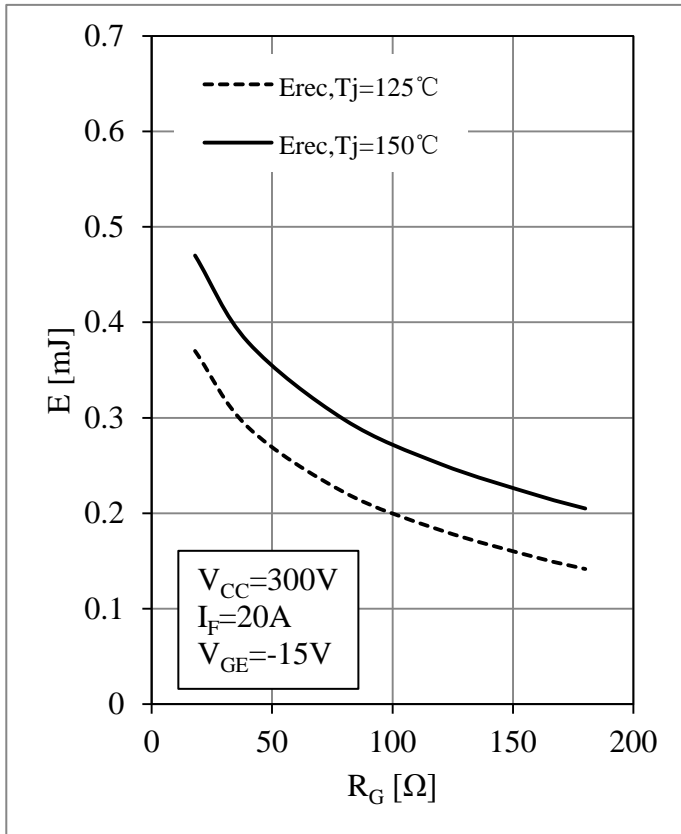


Fig 9. Diode-inverter Switching Loss vs.  $R_G$

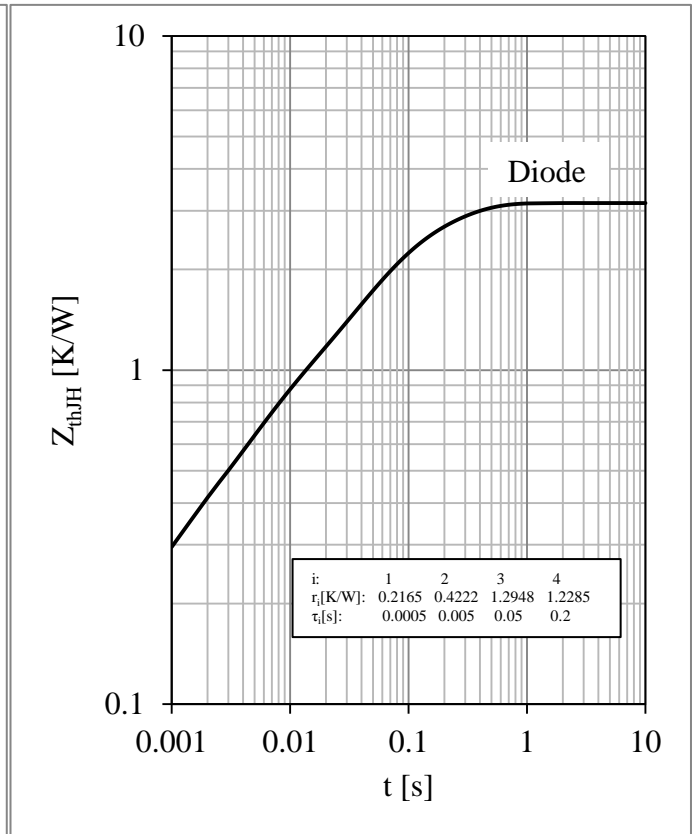


Fig 10. Diode-inverter Transient Thermal Impedance

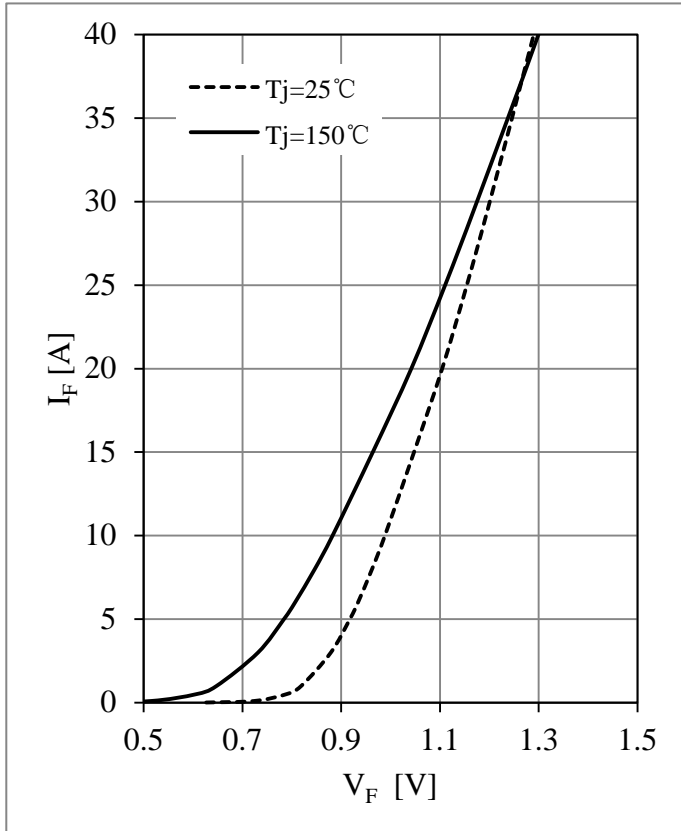


Fig 11. Diode-rectifier Forward Characteristics

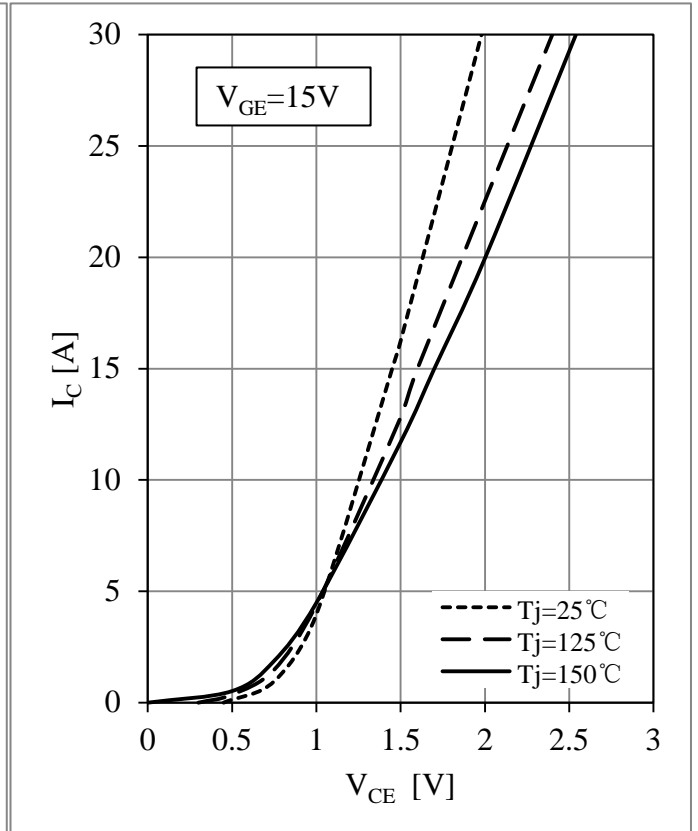


Fig 12. IGBT-brake Output Characteristics

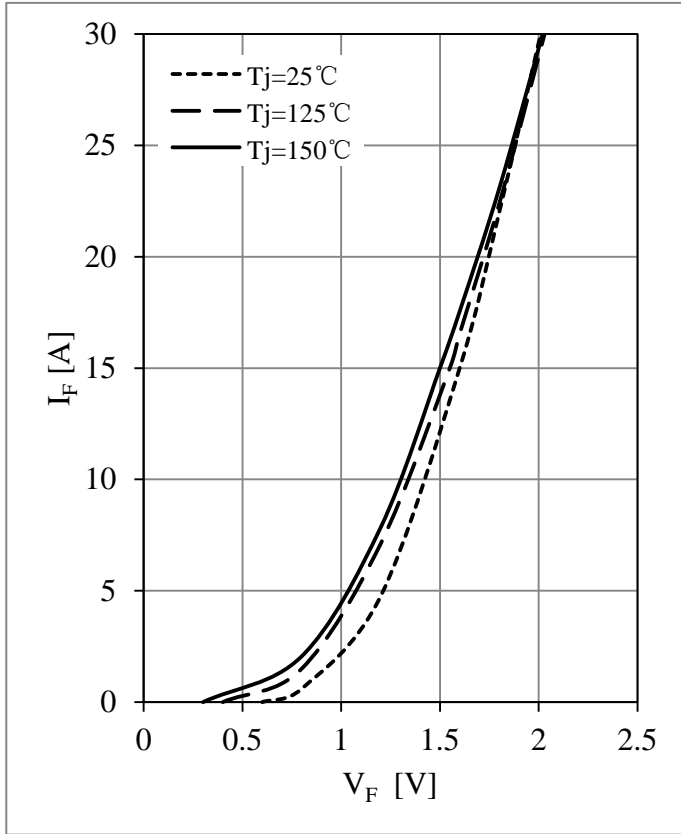


Fig 13. Diode-brake Forward Characteristics

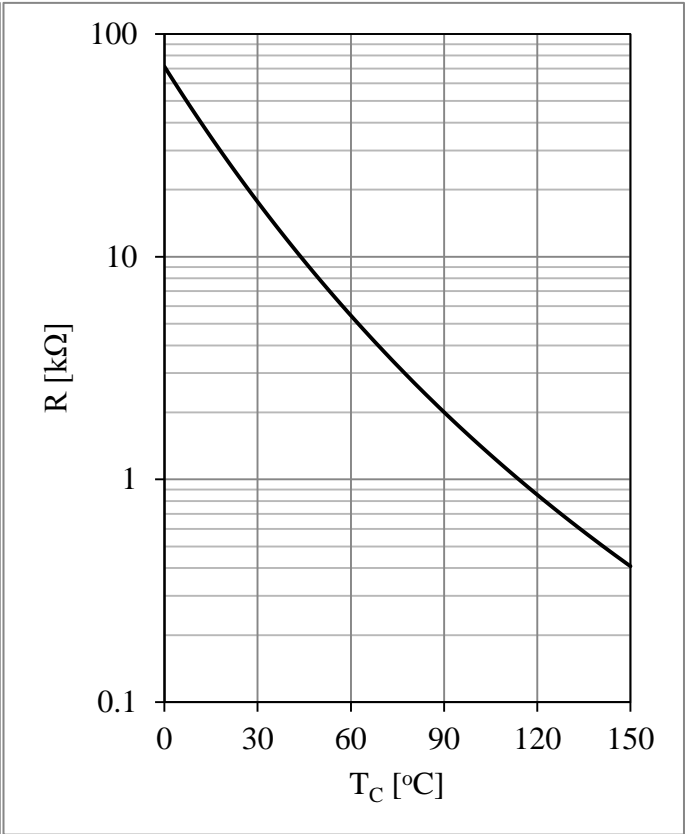
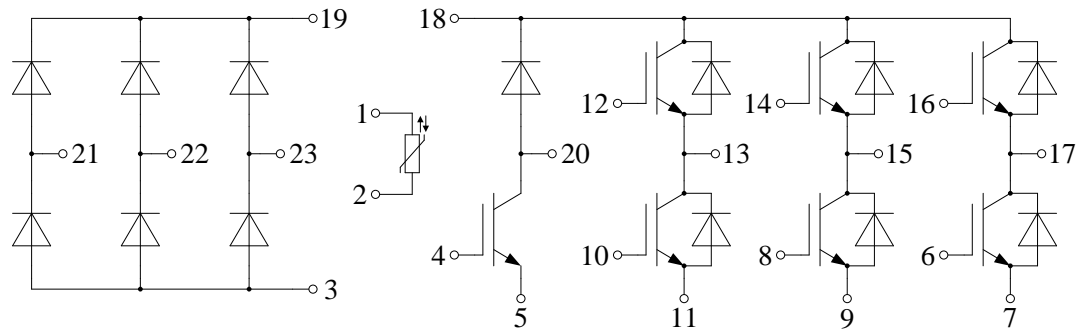


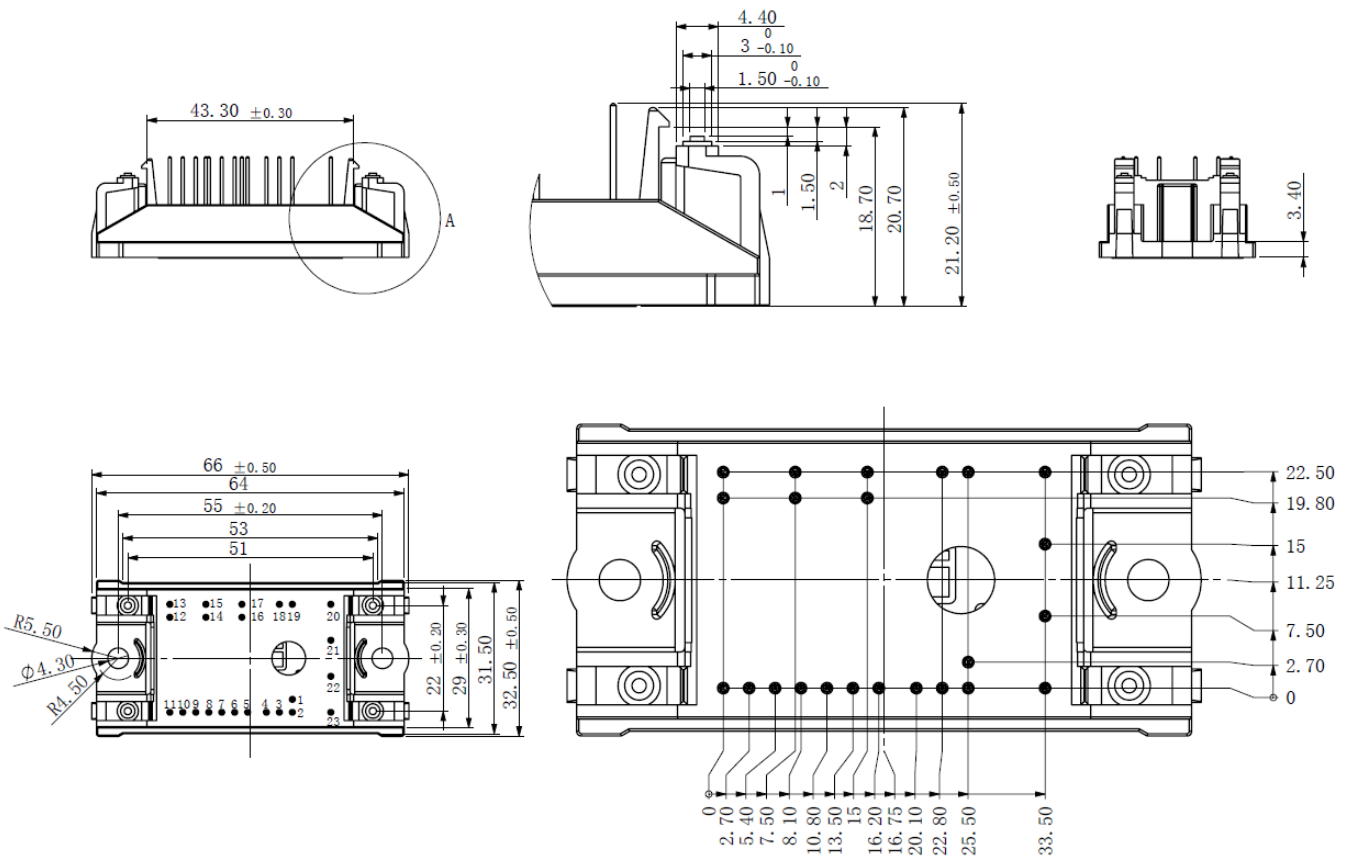
Fig 14. NTC Temperature Characteristic

**Circuit Schematic**



**Package Dimensions**

Dimensions in Millimeters



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