

# STARPOWER

SEMICONDUCTOR

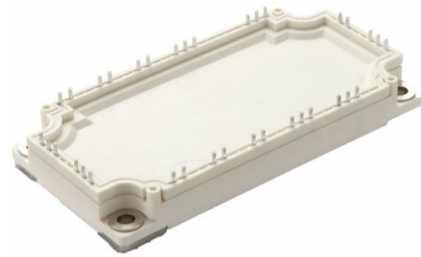
# IGBT

## GD50PIL120C6SN

**1200V/50A 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.



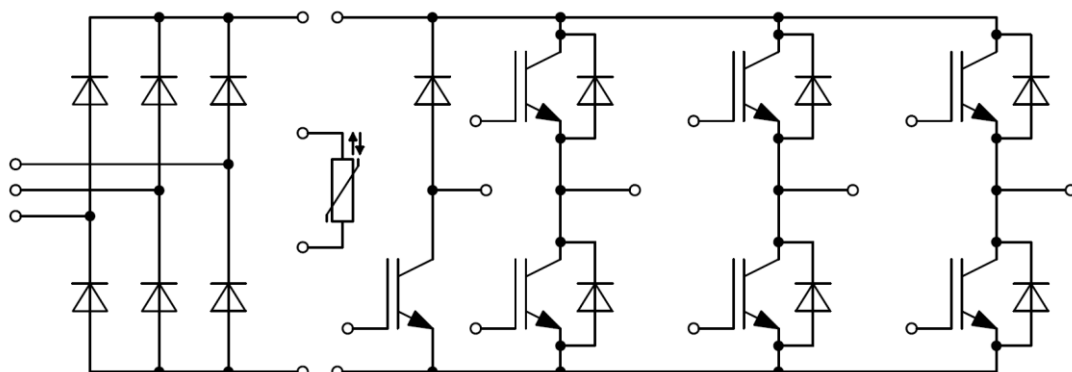
### Features

- Low  $V_{CE(sat)}$  SPT+ 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 @ $T_C=25^{\circ}\text{C}$	100	A
	@ $T_C=100^{\circ}\text{C}$	50	
$I_{CM}$	Pulsed Collector Current $t_p=1\text{ms}$	100	A
$P_D$	Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$	444	W

**Diode-inverter**

Symbol	Description	Value	Unit
$V_{RRM}$	Repetitive Peak Reverse Voltage	1200	V
$I_F$	Diode Continuous Forward Current	50	A
$I_{FM}$	Diode Maximum Forward Current $t_p=1\text{ms}$	100	A

**Diode-rectifier**

Symbol	Description	Value	Unit
$V_{RRM}$	Repetitive Peak Reverse Voltage	1600	V
$I_O$	Average Output Current 50Hz/60Hz,sine wave	50	A
$I_{FSM}$	Surge Forward Current $V_R=0\text{V}, t_p=10\text{ms}, T_j=45^{\circ}\text{C}$	850	A
$I^2t$	$I^2t$ -value, $V_R=0\text{V}, t_p=10\text{ms}, T_j=45^{\circ}\text{C}$	3610	$\text{A}^2\text{s}$

**IGBT-brake**

Symbol	Description	Value	Unit
$V_{CES}$	Collector-Emitter Voltage	1200	V
$V_{GES}$	Gate-Emitter Voltage	$\pm 30$	V
$I_C$	Collector Current @ $T_C=25^{\circ}\text{C}$	50	A
	@ $T_C=100^{\circ}\text{C}$	25	
$I_{CM}$	Pulsed Collector Current $t_p=1\text{ms}$	50	A
$P_D$	Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$	212	W

**Diode-brake**

Symbol	Description	Value	Unit
$V_{RRM}$	Repetitive Peak Reverse Voltage	1200	V
$I_F$	Diode Continuous Forward Current	25	A
$I_{FM}$	Diode Maximum Forward Current $t_p=1\text{ms}$	50	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, $f=50\text{Hz}, t=1\text{min}$	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	$I_C=50\text{A}, V_{GE}=15\text{V}, T_j=25^\circ\text{C}$		1.85	2.30	V	
		$I_C=50\text{A}, V_{GE}=15\text{V}, T_j=125^\circ\text{C}$		2.05			
		$I_C=50\text{A}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}$		2.10			
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$I_C=2.0\text{mA}, V_{CE}=V_{GE}, T_j=25^\circ\text{C}$	5.0	5.9	7.0	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			10		$\Omega$	
$C_{ies}$	Input Capacitance	$V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$		4.29		nF	
$C_{res}$	Reverse Transfer Capacitance			0.20		nF	
$Q_G$	Gate Charge	$V_{GE}=-15\dots+15\text{V}$		540		nC	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=600\text{V}, I_C=50\text{A}, R_G=15\Omega, V_{GE}=\pm 15\text{V}, T_j=25^\circ\text{C}$		392		ns	
$t_r$	Rise Time			74		ns	
$t_{d(off)}$	Turn-Off Delay Time			379		ns	
$t_f$	Fall Time			380		ns	
$E_{on}$	Turn-On Switching Loss			6.29		mJ	
$E_{off}$	Turn-Off Switching Loss			3.22		mJ	
$t_{d(on)}$	Turn-On Delay Time		$V_{CC}=600\text{V}, I_C=50\text{A}, R_G=15\Omega, V_{GE}=\pm 15\text{V}, T_j=125^\circ\text{C}$		403		ns
$t_r$	Rise Time				75		ns
$t_{d(off)}$	Turn-Off Delay Time			408		ns	
$t_f$	Fall Time			381		ns	
$E_{on}$	Turn-On Switching Loss			7.30		mJ	
$E_{off}$	Turn-Off Switching Loss			5.22		mJ	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=600\text{V}, I_C=50\text{A}, R_G=15\Omega, V_{GE}=\pm 15\text{V}, T_j=150^\circ\text{C}$			410		ns
$t_r$	Rise Time				76		ns
$t_{d(off)}$	Turn-Off Delay Time			420		ns	
$t_f$	Fall Time			382		ns	
$E_{on}$	Turn-On Switching Loss			7.75		mJ	
$E_{off}$	Turn-Off Switching Loss			5.70		mJ	
$I_{SC}$	SC Data		$t_p \leq 10\mu\text{s}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}, V_{CC}=900\text{V}, V_{CEM} \leq 1200\text{V}$		270		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	$I_F=50\text{A}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$		1.80	2.25	V
		$I_F=50\text{A}, V_{GE}=0\text{V}, T_j=125^\circ\text{C}$		1.85		
		$I_F=50\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$		1.85		
$Q_r$	Recovered Charge	$V_R=600\text{V}, I_F=50\text{A},$ $-di/dt=830\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=25^\circ\text{C}$		3.3		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			34		A
$E_{rec}$	Reverse Recovery Energy			1.28		mJ
$Q_r$	Recovered Charge	$V_R=600\text{V}, I_F=50\text{A},$ $-di/dt=830\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=125^\circ\text{C}$		6.5		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			47		A
$E_{rec}$	Reverse Recovery Energy			2.03		mJ
$Q_r$	Recovered Charge	$V_R=600\text{V}, I_F=50\text{A},$ $-di/dt=830\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=150^\circ\text{C}$		7.2		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			50		A
$E_{rec}$	Reverse Recovery Energy			2.25		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	$I_F=50\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$		1.03		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	$I_C=25\text{A}, V_{GE}=15\text{V}, T_j=25^\circ\text{C}$		1.90	2.35	V	
		$I_C=25\text{A}, V_{GE}=15\text{V}, T_j=125^\circ\text{C}$		2.30			
		$I_C=25\text{A}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}$		2.40			
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$I_C=1.2\text{mA}, V_{CE}=V_{GE}, T_j=25^\circ\text{C}$	5.0	6.3	7.5	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	$V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$		3.43		nF	
$C_{res}$	Reverse Transfer Capacitance			0.08		nF	
$Q_G$	Gate Charge	$V_{GE}=15\text{V}$		160		nC	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=600\text{V}, I_C=25\text{A}, R_G=33\Omega, V_{GE}=\pm 15\text{V}, T_j=25^\circ\text{C}$		233		ns	
$t_r$	Rise Time			66		ns	
$t_{d(off)}$	Turn-Off Delay Time			184		ns	
$t_f$	Fall Time			208		ns	
$E_{on}$	Turn-On Switching Loss			3.06		mJ	
$E_{off}$	Turn-Off Switching Loss			1.16		mJ	
$t_{d(on)}$	Turn-On Delay Time		$V_{CC}=600\text{V}, I_C=25\text{A}, R_G=33\Omega, V_{GE}=\pm 15\text{V}, T_j=125^\circ\text{C}$		310		ns
$t_r$	Rise Time				86		ns
$t_{d(off)}$	Turn-Off Delay Time			217		ns	
$t_f$	Fall Time			324		ns	
$E_{on}$	Turn-On Switching Loss			3.50		mJ	
$E_{off}$	Turn-Off Switching Loss			1.78		mJ	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=600\text{V}, I_C=25\text{A}, R_G=33\Omega, V_{GE}=\pm 15\text{V}, T_j=150^\circ\text{C}$			221		ns
$t_r$	Rise Time				68		ns
$t_{d(off)}$	Turn-Off Delay Time			225		ns	
$t_f$	Fall Time			347		ns	
$E_{on}$	Turn-On Switching Loss			4.45		mJ	
$E_{off}$	Turn-Off Switching Loss			2.02		mJ	
$I_{SC}$	SC Data		$t_p \leq 10\mu\text{s}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}, V_{CC}=900\text{V}, V_{CEM} \leq 1200\text{V}$		225		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	$I_F=25\text{A}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$		2.10	2.55	V
		$I_F=25\text{A}, V_{GE}=0\text{V}, T_j=125^\circ\text{C}$		2.15		
		$I_F=25\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$		2.15		
$Q_r$	Recovered Charge	$V_R=600\text{V}, I_F=25\text{A},$ $-di/dt=1000\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=25^\circ\text{C}$		1.3		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			31		A
$E_{rec}$	Reverse Recovery Energy			0.68		mJ
$Q_r$	Recovered Charge	$V_R=600\text{V}, I_F=25\text{A},$ $-di/dt=1000\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=125^\circ\text{C}$		2.2		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			38		A
$E_{rec}$	Reverse Recovery Energy			1.46		mJ
$Q_r$	Recovered Charge	$V_R=600\text{V}, I_F=25\text{A},$ $-di/dt=1000\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=150^\circ\text{C}$		2.4		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			40		A
$E_{rec}$	Reverse Recovery Energy			1.91		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

**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 $\Omega$
$R_{\theta JC}$	Junction-to-Case (per IGBT-inverter) Junction-to-Case (per Diode-inverter) Junction-to-Case (per Diode-rectifier) Junction-to-Case (per IGBT-brake-chopper) Junction-to-Case (per Diode-brake-chopper)			0.338 0.619 0.635 0.708 1.326	K/W
$R_{\theta CS}$	Case-to-Sink (per IGBT-inverter) Case-to-Sink (per Diode-inverter) Case-to-Sink (per Diode-rectifier) Case-to-Sink (per IGBT-brake-chopper) Case-to-Sink (per Diode-brake-chopper)		0.119 0.218 0.223 0.249 0.466		K/W
$R_{\theta CS}$	Case-to-Sink		0.009		K/W
M	Mounting Torque, Screw:M5	3.0		6.0	N.m
G	Weight of Module		300		g

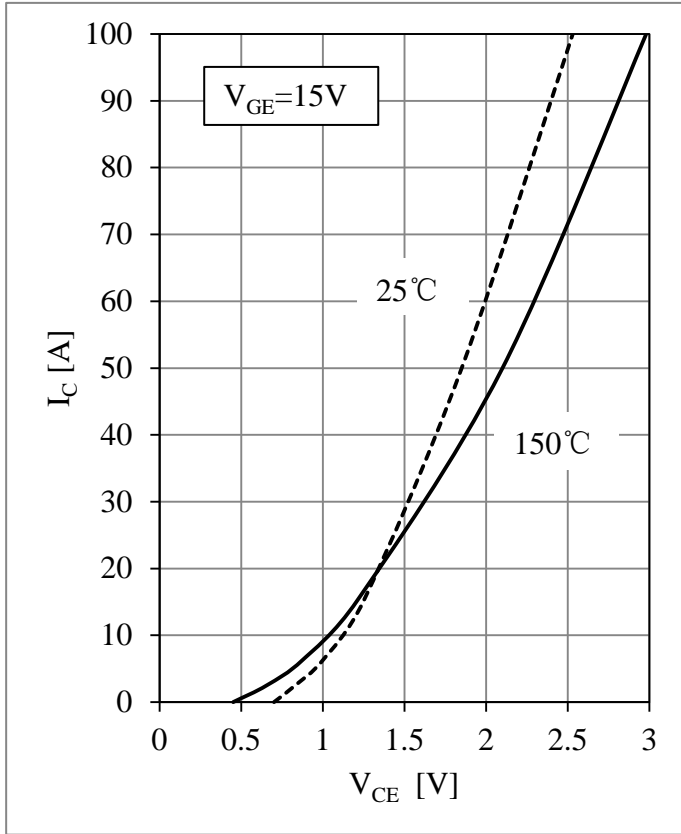


Fig 1. IGBT-inverter Output Characteristics

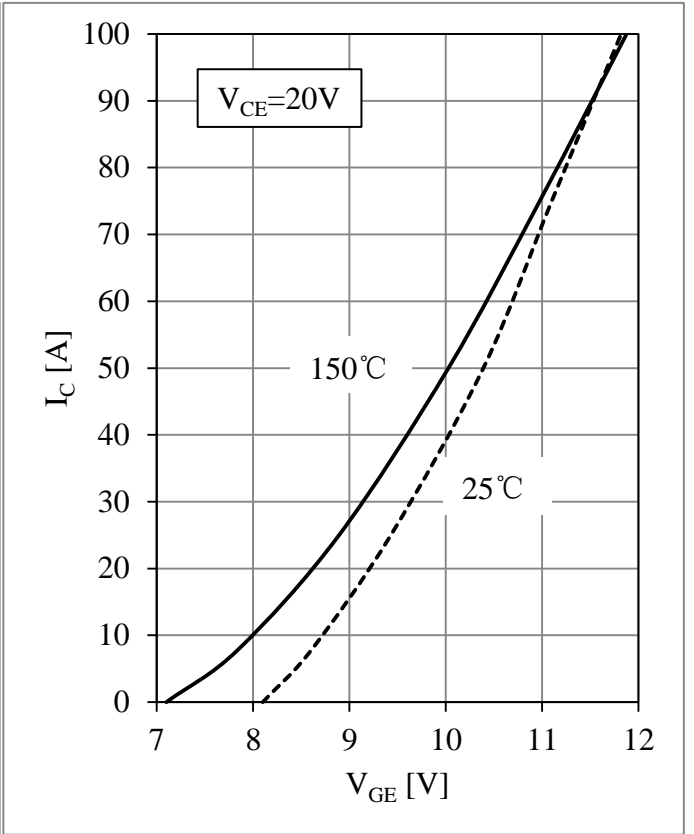


Fig 2. IGBT-inverter Transfer Characteristics

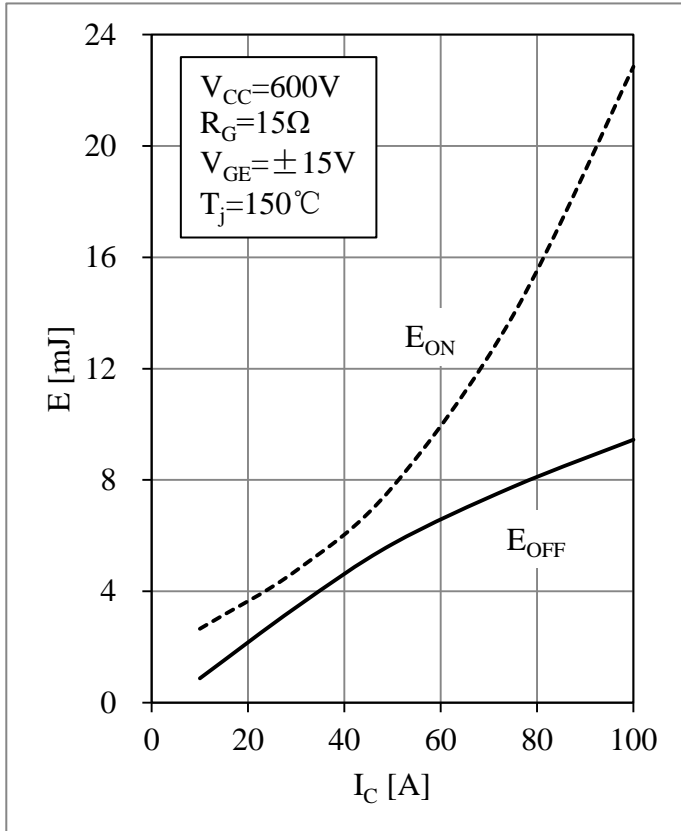


Fig 3. IGBT-inverter Switching Loss vs.  $I_c$

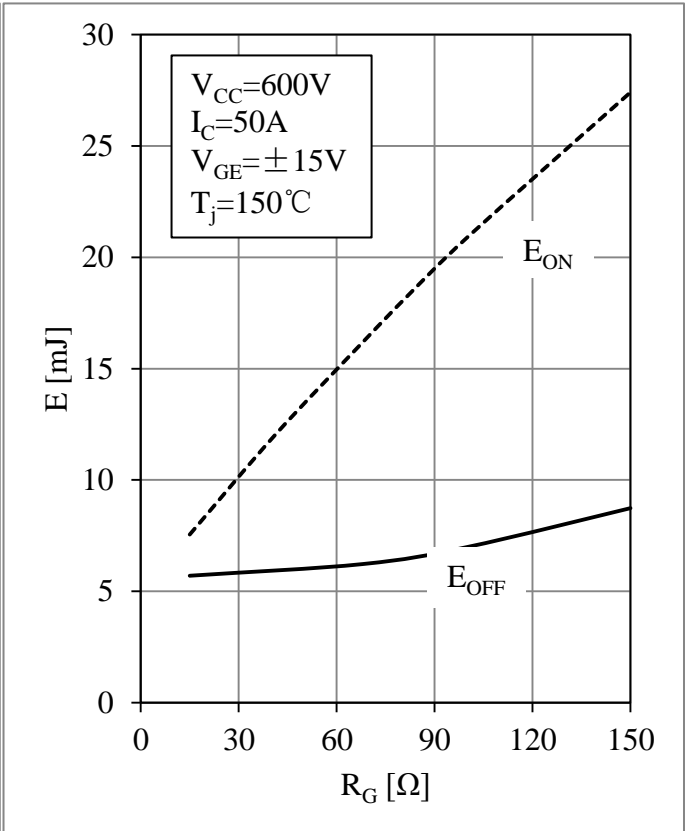


Fig 4. IGBT-inverter Switching Loss vs.  $R_G$



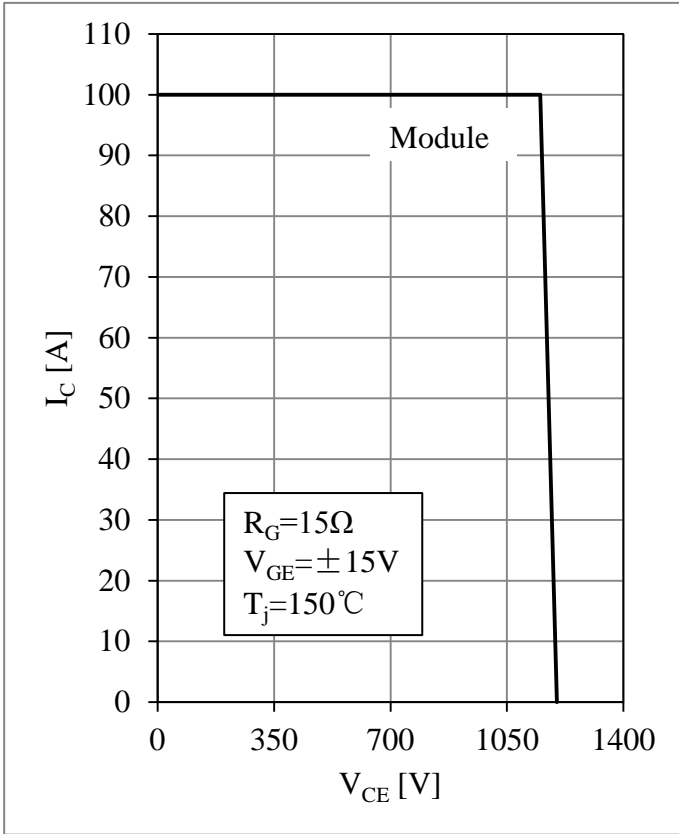


Fig 5. IGBT-inverter RBSOA

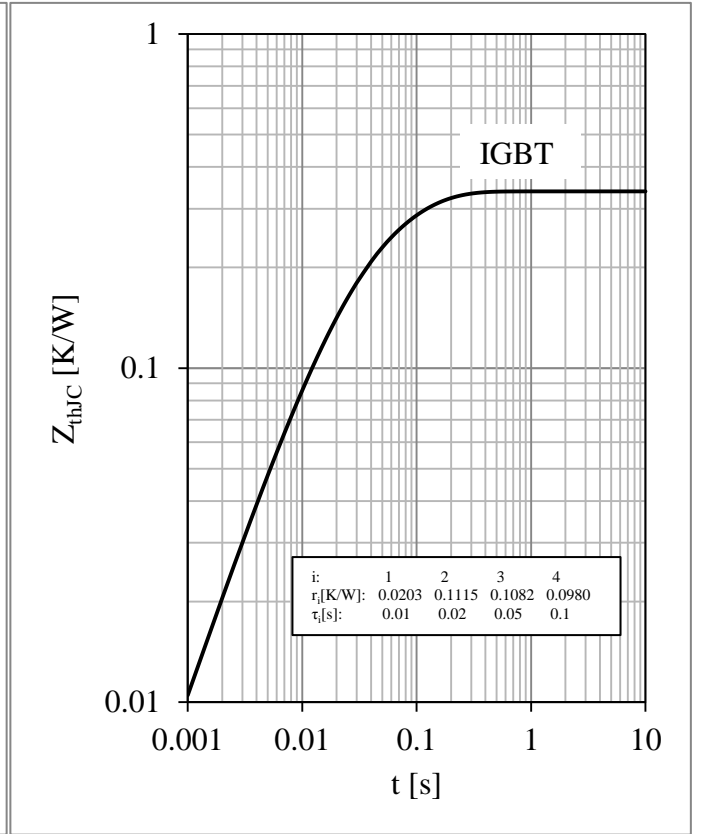


Fig 6. IGBT-inverter Transient Thermal Impedance

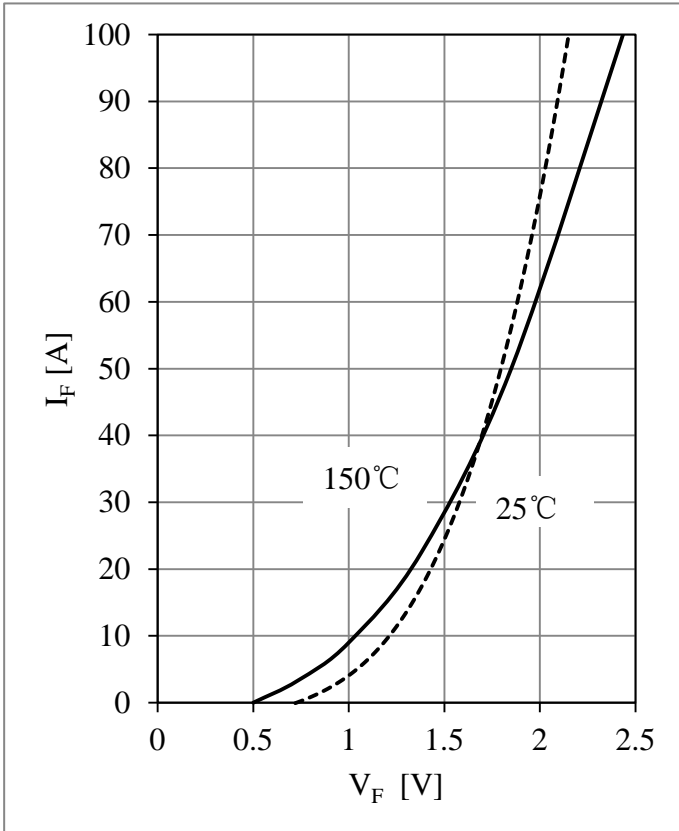


Fig 7. Diode-inverter Forward Characteristics

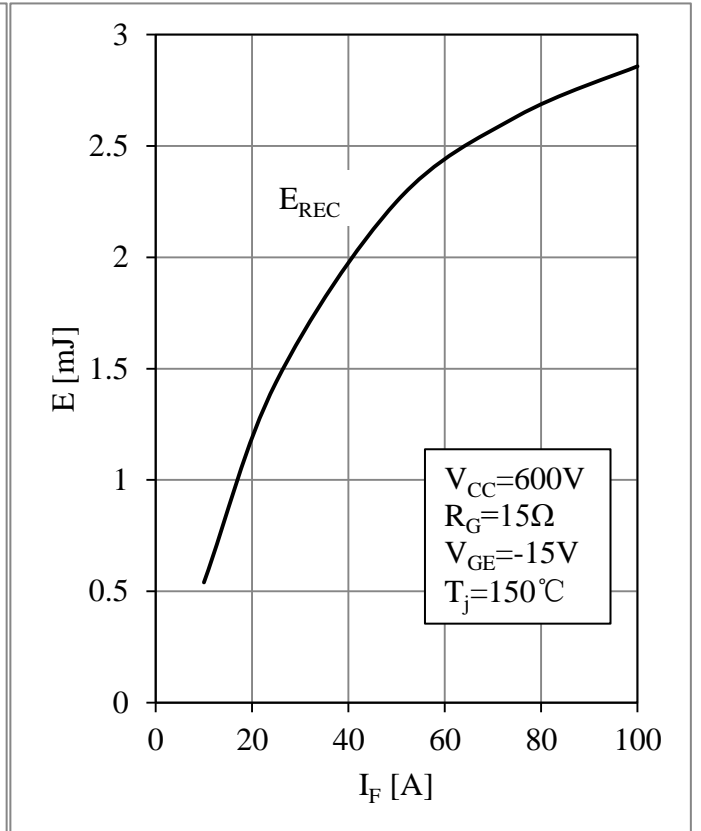


Fig 8. Diode-inverter Switching Loss vs.  $I_F$

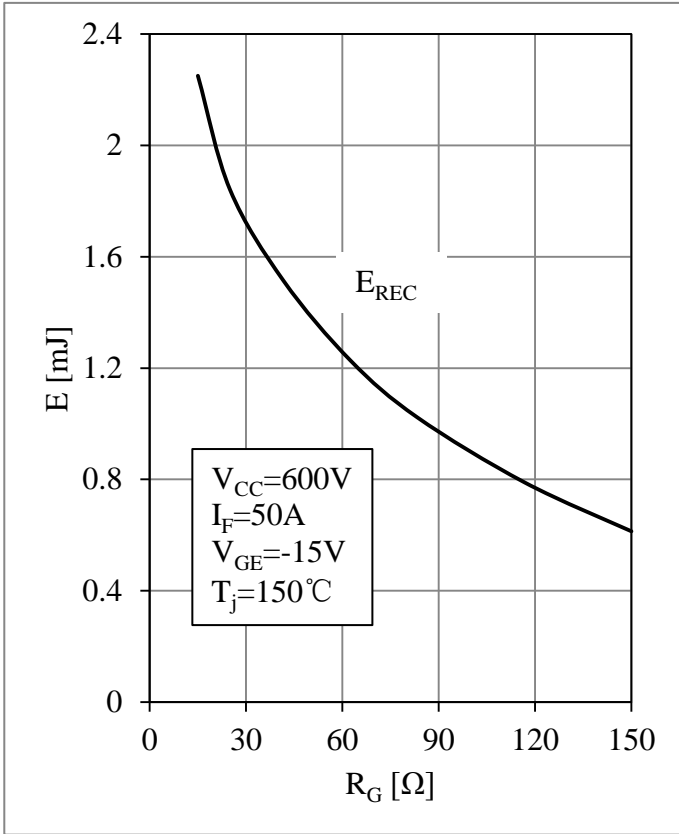


Fig 9. Diode-inverter Switching Loss vs.  $R_G$

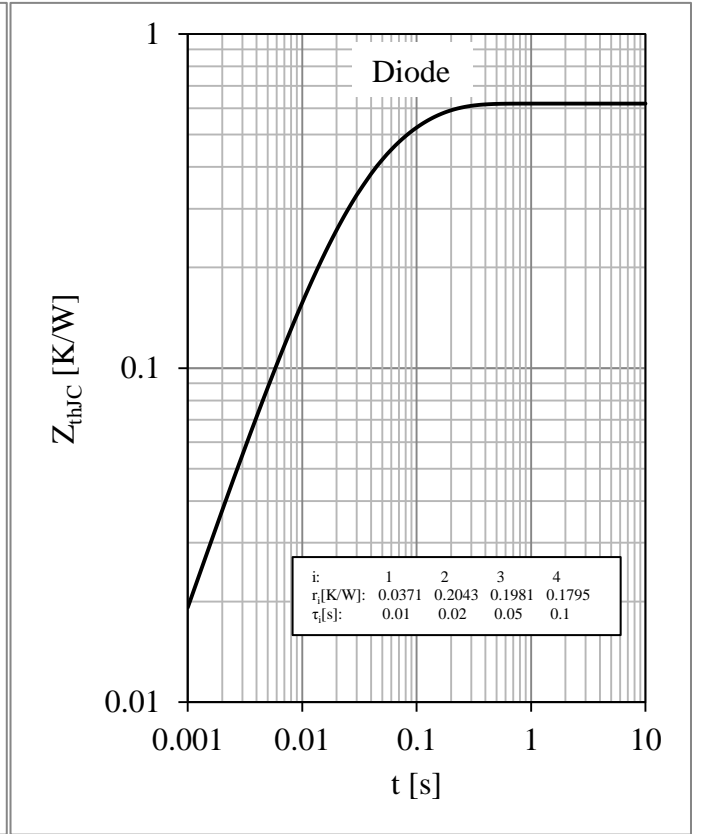


Fig 10. Diode-inverter Transient Thermal Impedance

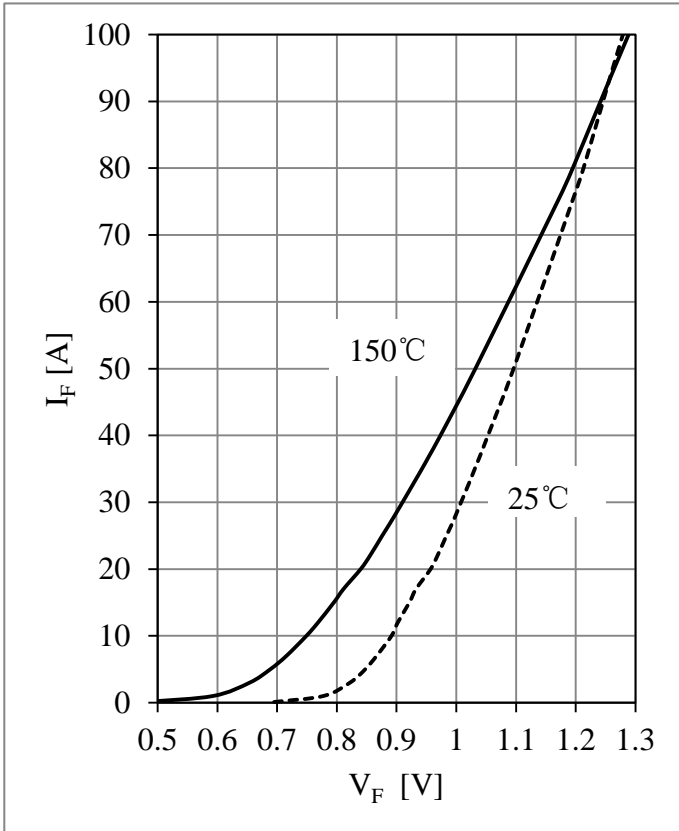


Fig 11. Diode-rectifier Forward Characteristics

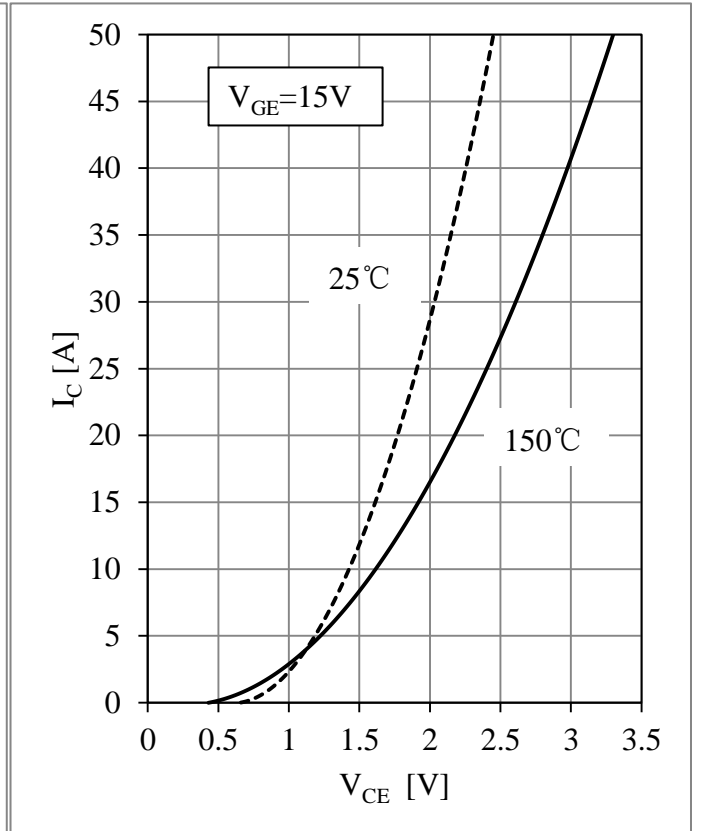


Fig 12. IGBT-brake-chopper Output Characteristics

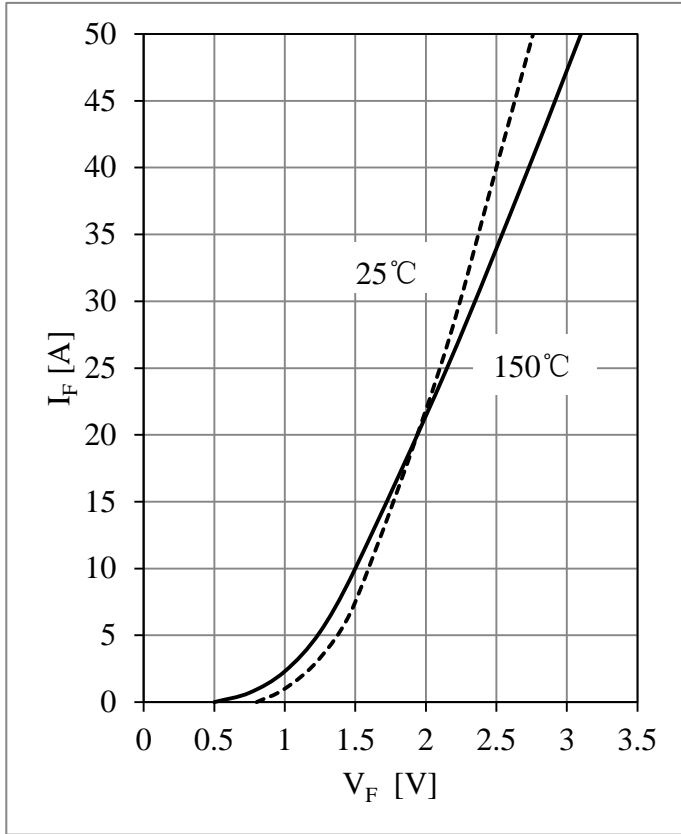


Fig 13. Diode-brake-chopper Forward Characteristics

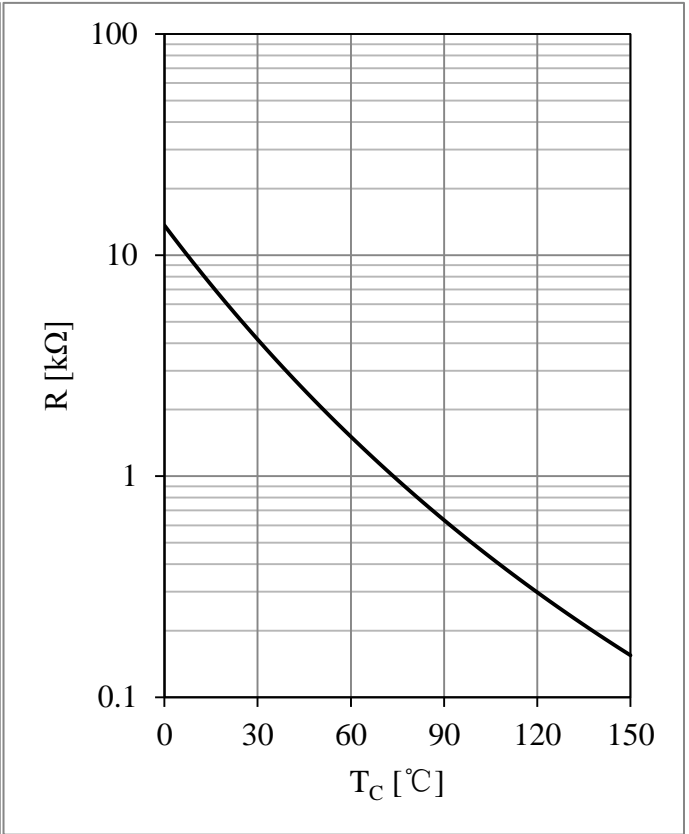


Fig 14. NTC Temperature Characteristic



## Terms and Conditions of Usage

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