

# STARPOWER

SEMICONDUCTOR

IGBT

## GD40PIY120C5S

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

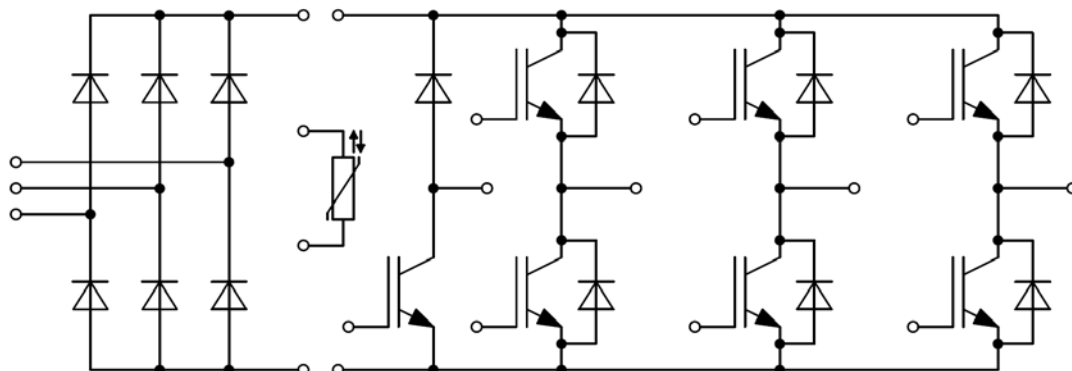
- Low  $V_{CE(sat)}$  Trench IGBT technology
- 10 $\mu$ s short circuit capability
- $V_{CE(sat)}$  with positive temperature coefficient
- Maximum junction temperature 175 $^{\circ}$ C
- Low inductance case
- Fast & soft reverse recovery anti-parallel FWD
- Isolated copper baseplate using DBC technology



### 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 @ $T_C=25^{\circ}\text{C}$	72	A
	@ $T_C=100^{\circ}\text{C}$	40	
$I_{CM}$	Pulsed Collector Current $t_p=1\text{ms}$	80	A
$P_D$	Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$	280	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	40	A
$I_{FSM}$	Surge Forward Current $V_R=0\text{V}, t_p=10\text{ms}, T_j=45^{\circ}\text{C}$	600	A
$I^2t$	$I^2t$ -value, $V_R=0\text{V}, t_p=10\text{ms}, T_j=45^{\circ}\text{C}$	1800	$\text{A}^2\text{s}$

**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 @ $T_C=25^{\circ}\text{C}$	30	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 @ $T_j=175^{\circ}\text{C}$	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	Values	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	$I_C=40\text{A}, V_{GE}=15\text{V}, T_j=25^\circ\text{C}$		1.70	2.15	V	
		$I_C=40\text{A}, V_{GE}=15\text{V}, T_j=125^\circ\text{C}$		1.95			
		$I_C=40\text{A}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}$		2.00			
$V_{GE(th)}$	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	$V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$		4.14		nF	
$C_{res}$	Reverse Transfer Capacitance				0.12		nF
$Q_G$	Gate Charge	$V_{GE}=-15\dots+15\text{V}$		0.31		$\mu\text{C}$	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=600\text{V}, I_C=40\text{A}, R_G=12\Omega, V_{GE}=\pm 15\text{V}, T_j=25^\circ\text{C}$		145		ns	
$t_r$	Rise Time			28		ns	
$t_{d(off)}$	Turn-Off Delay Time			194		ns	
$t_f$	Fall Time			295		ns	
$E_{on}$	Turn-On Switching Loss			1.89		mJ	
$E_{off}$	Turn-Off Switching Loss			2.31		mJ	
$t_{d(on)}$	Turn-On Delay Time		$V_{CC}=600\text{V}, I_C=40\text{A}, R_G=12\Omega, V_{GE}=\pm 15\text{V}, T_j=125^\circ\text{C}$		146		ns
$t_r$	Rise Time				30		ns
$t_{d(off)}$	Turn-Off Delay Time			208		ns	
$t_f$	Fall Time			466		ns	
$E_{on}$	Turn-On Switching Loss			2.31		mJ	
$E_{off}$	Turn-Off Switching Loss			3.51		mJ	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=600\text{V}, I_C=40\text{A}, R_G=12\Omega, V_{GE}=\pm 15\text{V}, T_j=150^\circ\text{C}$			148		ns
$t_r$	Rise Time				32		ns
$t_{d(off)}$	Turn-Off Delay Time			212		ns	
$t_f$	Fall Time			480		ns	
$E_{on}$	Turn-On Switching Loss			2.45		mJ	
$E_{off}$	Turn-Off Switching Loss			3.69		mJ	
$I_{SC}$	SC Data		$t_p \leq 10\mu\text{s}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}, V_{CC}=900\text{V}, V_{CEM} \leq 1200\text{V}$		160		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	$I_F=40\text{A}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$		2.00	2.45	V
		$I_F=40\text{A}, V_{GE}=0\text{V}, T_j=125^\circ\text{C}$		1.90		
		$I_F=40\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$		1.88		
$Q_r$	Recovered Charge	$V_R=600\text{V}, I_F=40\text{A},$ $-di/dt=1100\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=25^\circ\text{C}$		1.8		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			40		A
$E_{rec}$	Reverse Recovery Energy			0.93		mJ
$Q_r$	Recovered Charge	$V_R=600\text{V}, I_F=40\text{A},$ $-di/dt=1100\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=125^\circ\text{C}$		2.9		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			47		A
$E_{rec}$	Reverse Recovery Energy			2.19		mJ
$Q_r$	Recovered Charge	$V_R=600\text{V}, I_F=40\text{A},$ $-di/dt=1100\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=150^\circ\text{C}$		3.2		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			49		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	$I_F=40\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$		1.06		V
$I_R$	Reverse Current	$T_j=150^\circ\text{C}, V_R=1600\text{V}$			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	$I_C=15\text{A}, V_{GE}=15\text{V}, T_j=25^\circ\text{C}$		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	$V_{CC}=600\text{V}, I_C=15\text{A}, R_G=39\Omega, V_{GE}=\pm 15\text{V}, T_j=25^\circ\text{C}$		59		ns	
$t_r$	Rise Time			63		ns	
$t_{d(off)}$	Turn-Off Delay Time			201		ns	
$t_f$	Fall Time			149		ns	
$E_{on}$	Turn-On Switching Loss			1.39		mJ	
$E_{off}$	Turn-Off Switching Loss			0.85		mJ	
$t_{d(on)}$	Turn-On Delay Time		$V_{CC}=600\text{V}, I_C=15\text{A}, R_G=39\Omega, V_{GE}=\pm 15\text{V}, T_j=125^\circ\text{C}$		59		ns
$t_r$	Rise Time				70		ns
$t_{d(off)}$	Turn-Off Delay Time			283		ns	
$t_f$	Fall Time			196		ns	
$E_{on}$	Turn-On Switching Loss			1.87		mJ	
$E_{off}$	Turn-Off Switching Loss			1.24		mJ	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=600\text{V}, I_C=15\text{A}, R_G=39\Omega, V_{GE}=\pm 15\text{V}, T_j=150^\circ\text{C}$			59		ns
$t_r$	Rise Time				70		ns
$t_{d(off)}$	Turn-Off Delay Time			288		ns	
$t_f$	Fall Time			221		ns	
$E_{on}$	Turn-On Switching Loss			2.09		mJ	
$E_{off}$	Turn-Off Switching Loss			1.39		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)			0.535 1.068 0.914 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)		0.267 0.533 0.456 0.513 0.878 0.020		K/W
M	Mounting Torque, Screw:M5	3.0		6.0	N.m
G	Weight of Module		200		g

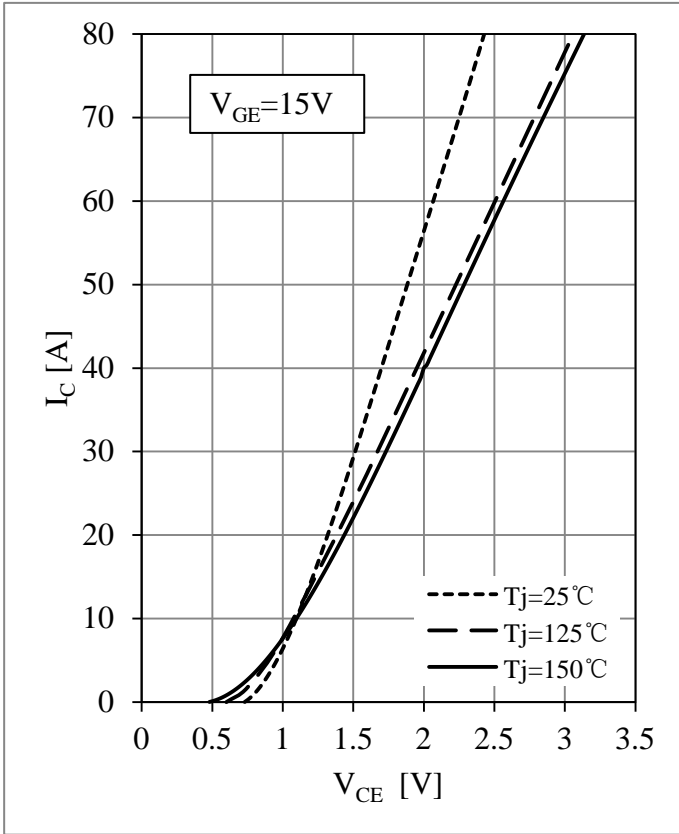


Fig 1. IGBT-inverter Output Characteristics

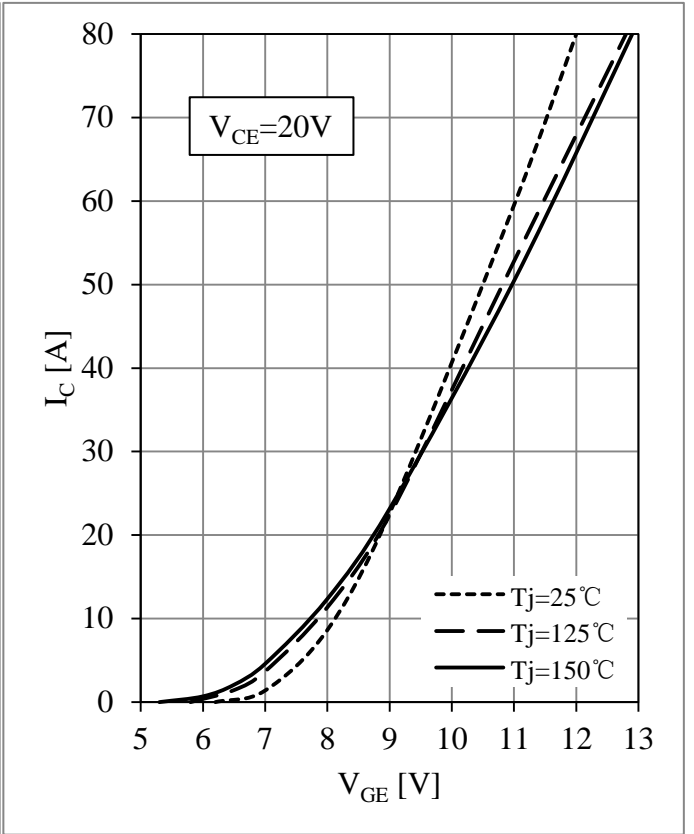


Fig 2. IGBT-inverter Transfer Characteristics

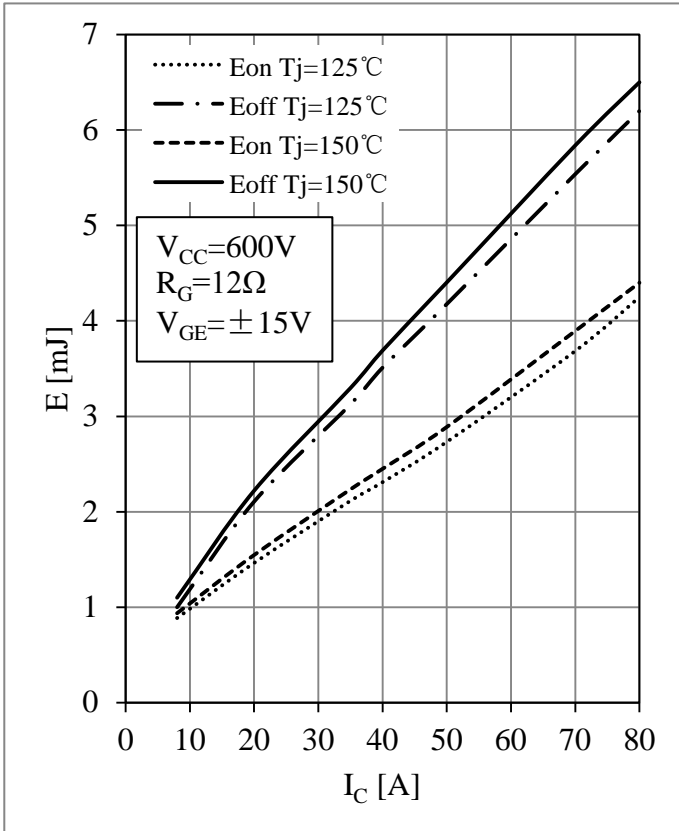


Fig 3. IGBT-inverter Switching Loss vs.  $I_C$

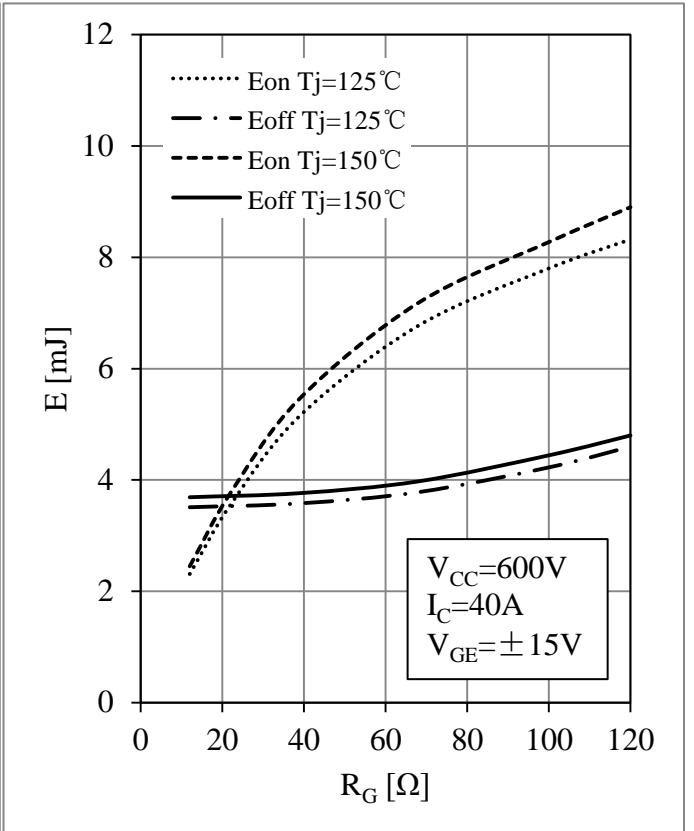


Fig 4. IGBT-inverter Switching Loss vs.  $R_G$



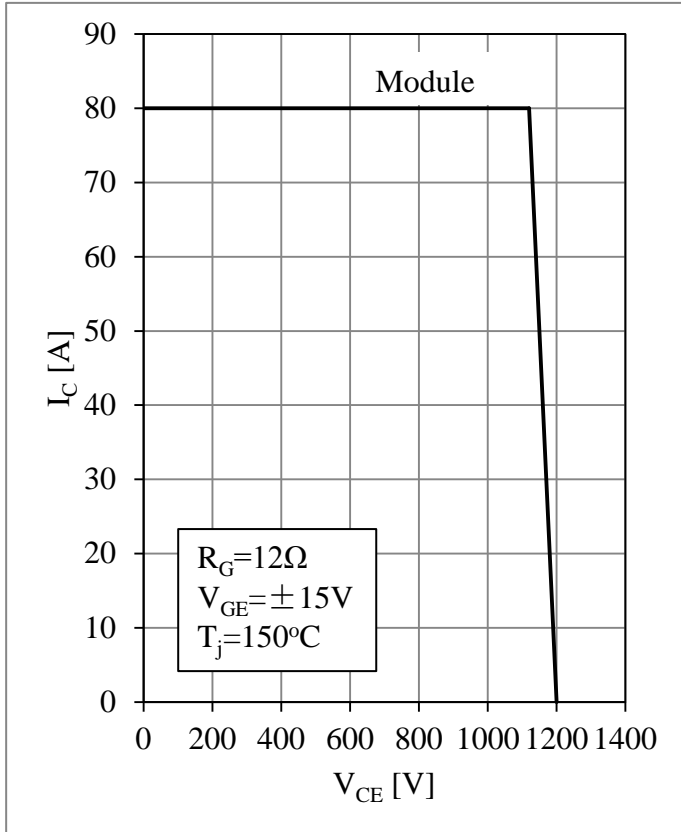


Fig 5. IGBT-inverter RBSOA

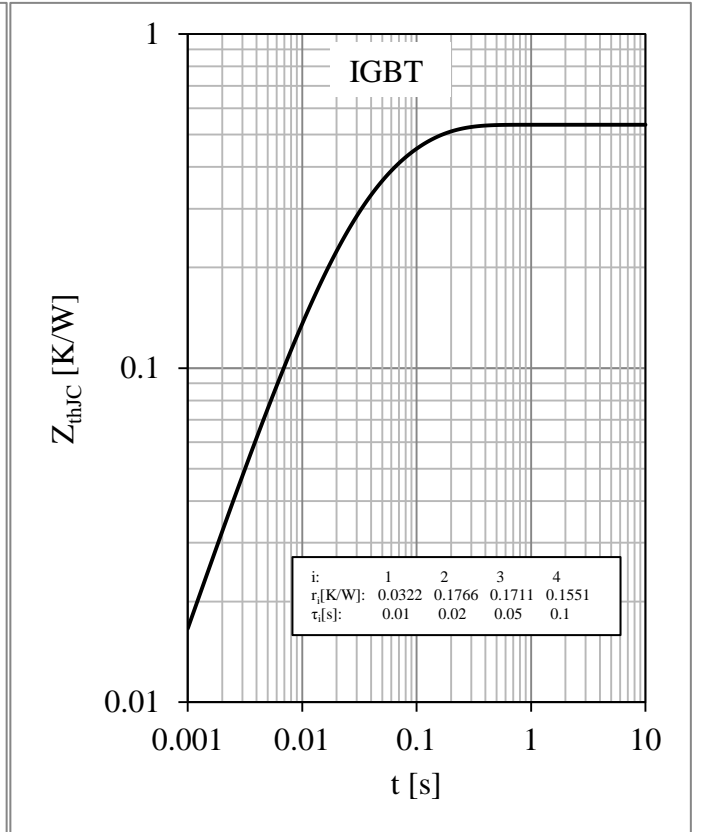


Fig 6. IGBT-inverter Transient Thermal Impedance

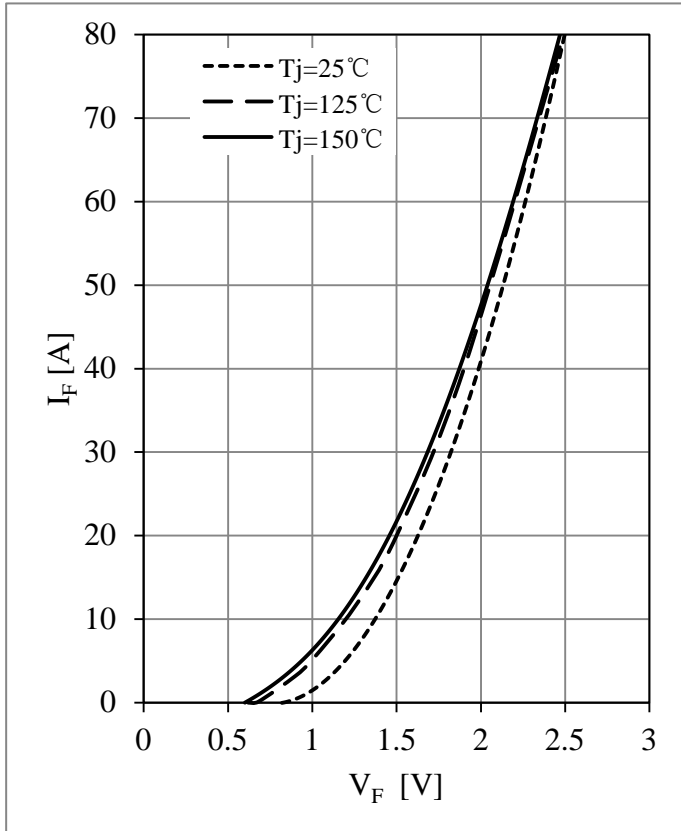


Fig 7. Diode-inverter Forward Characteristics

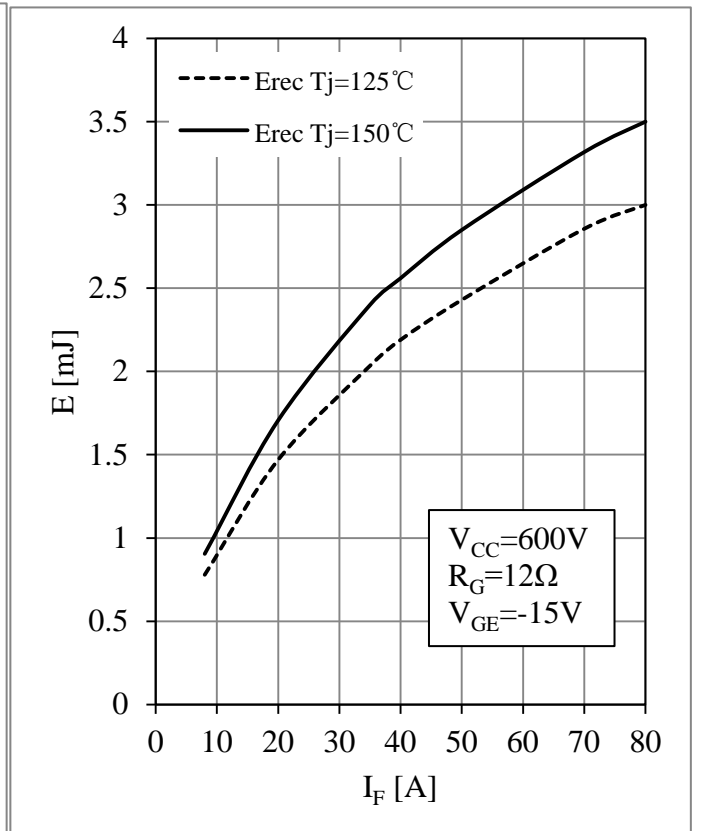


Fig 8. Diode-inverter Switching Loss vs.  $I_F$

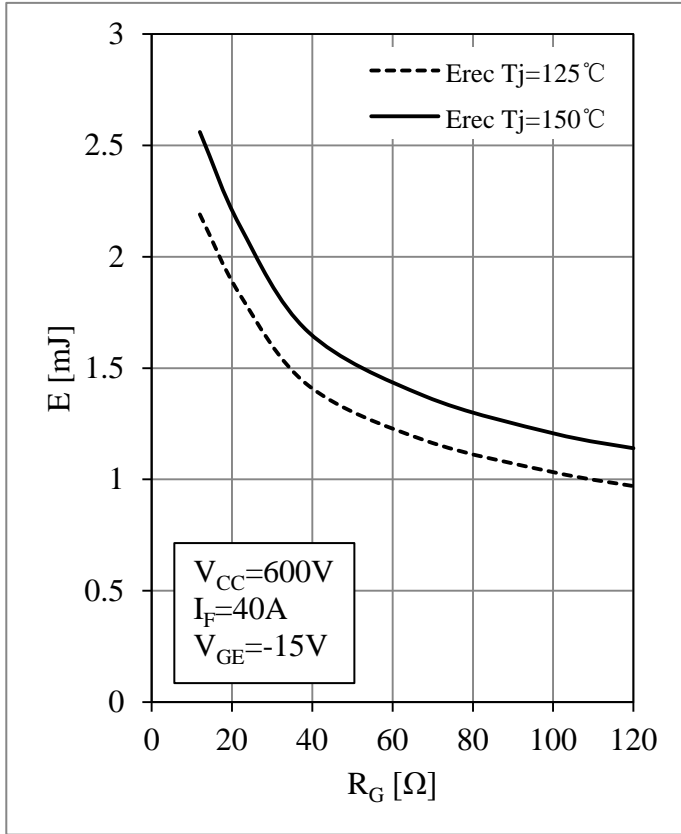


Fig 9. Diode-inverter Switching Loss vs.  $R_G$

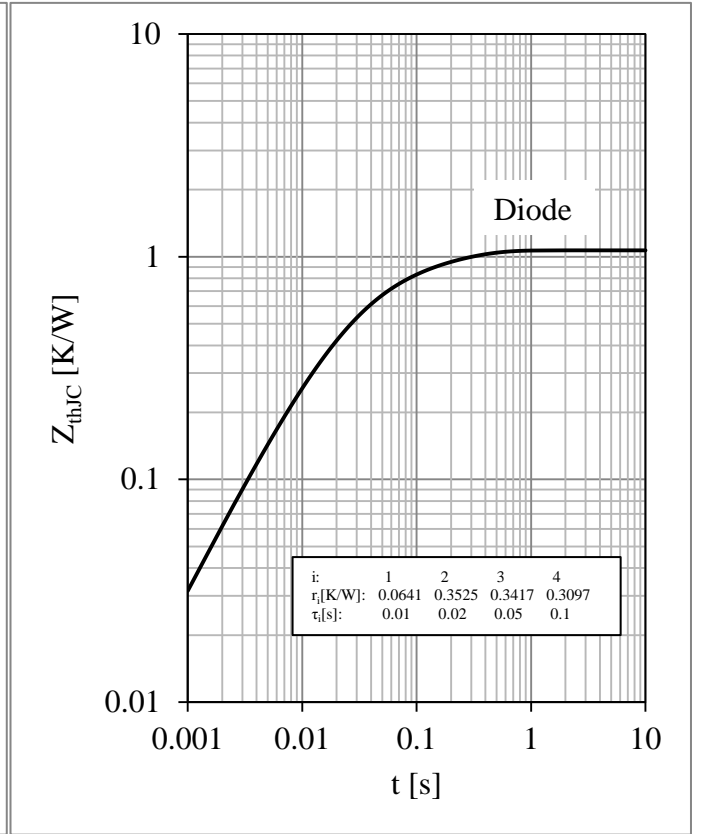


Fig 10. Diode-inverter Transient Thermal Impedance

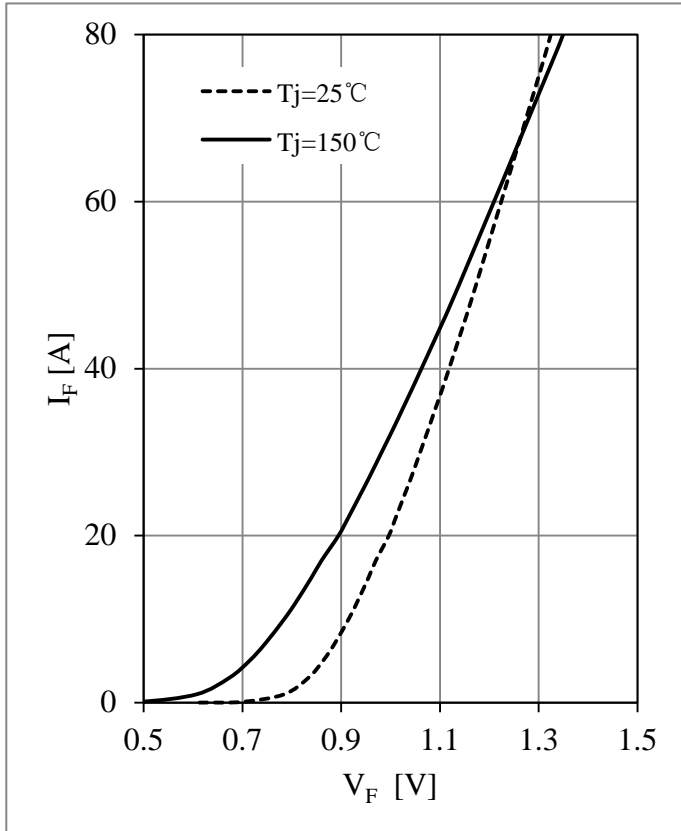


Fig 11. Diode-rectifier Forward Characteristics

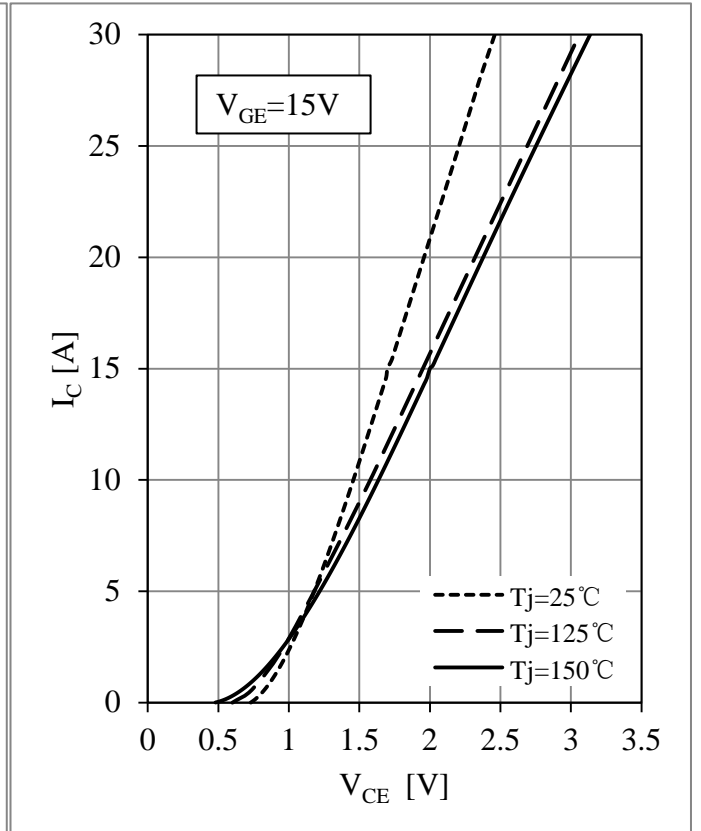


Fig 12. IGBT-brake-chopper Output Characteristics

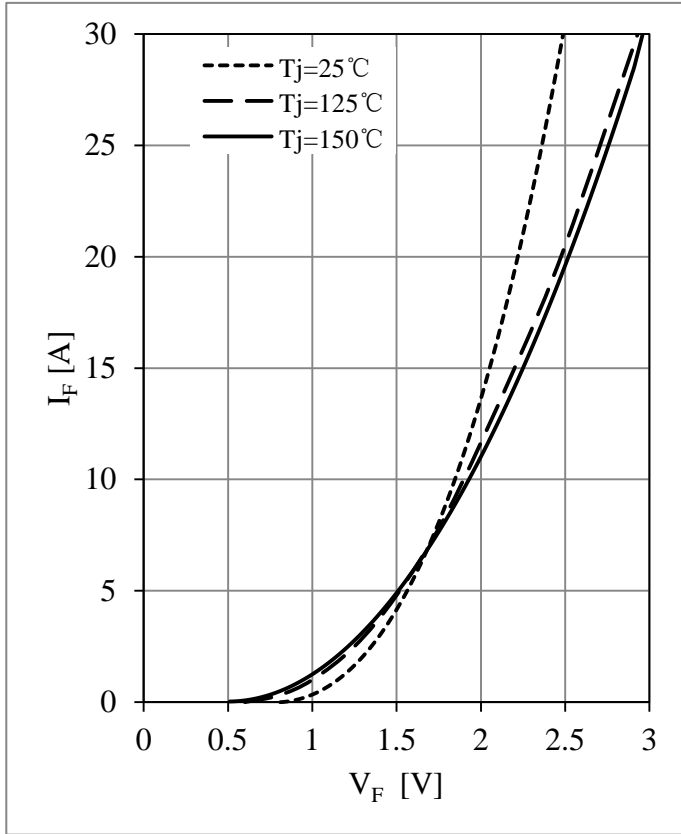
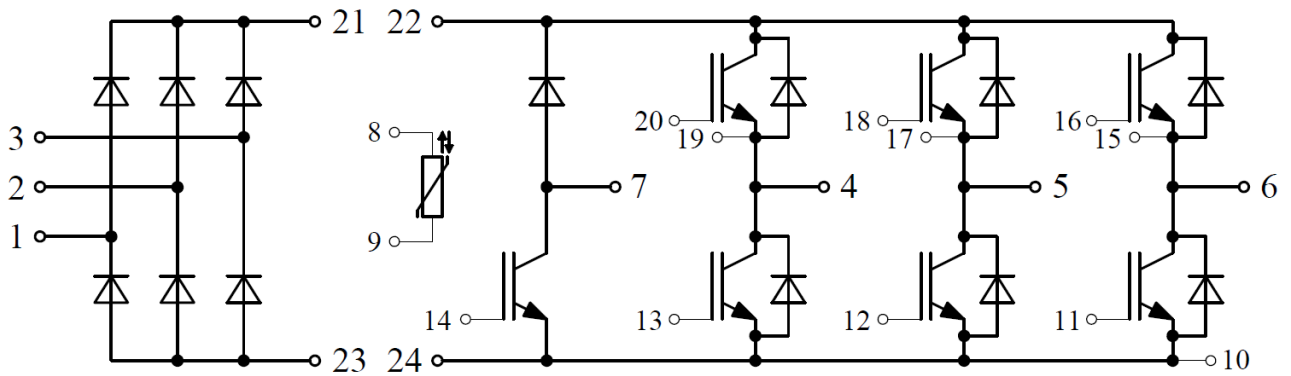


Fig 13. Diode-brake-chopper Forward Characteristics



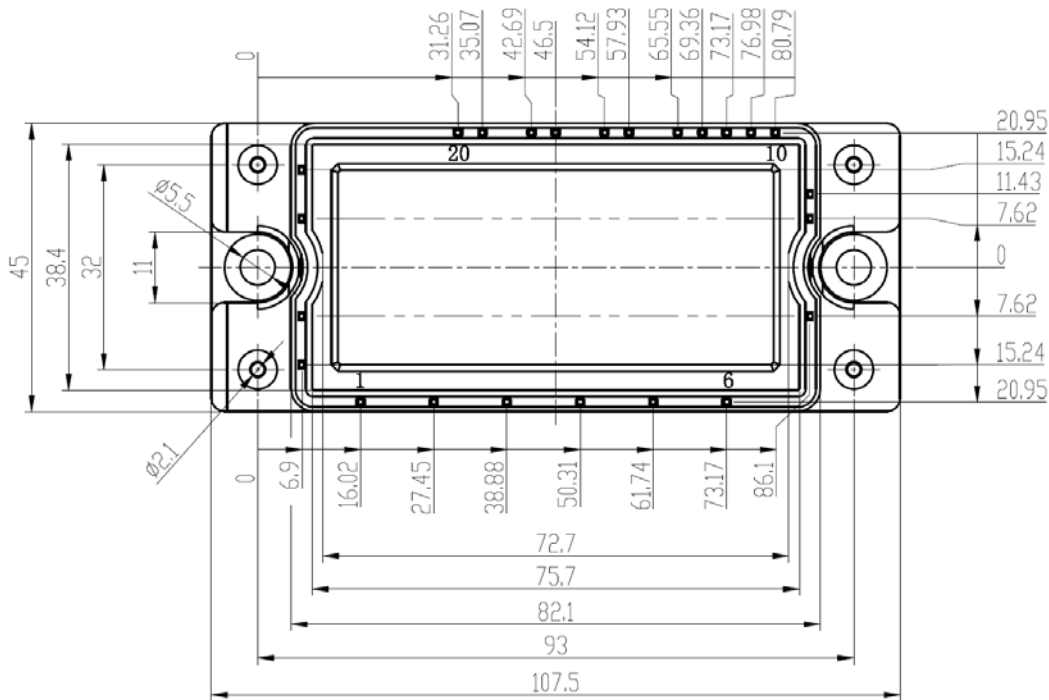
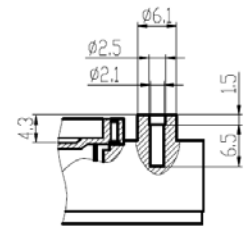
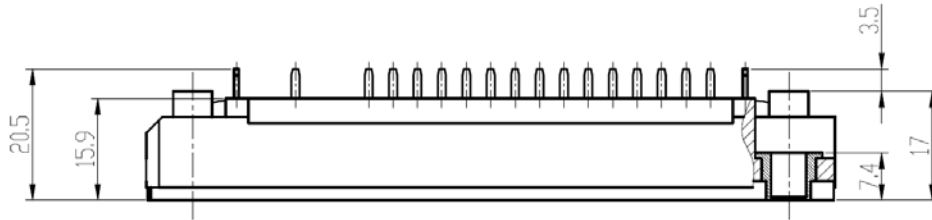
Fig 14. NTC Temperature Characteristic

**Circuit Schematic**



**Package Dimensions**

Dimensions in Millimeters



## Terms and Conditions of Usage

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