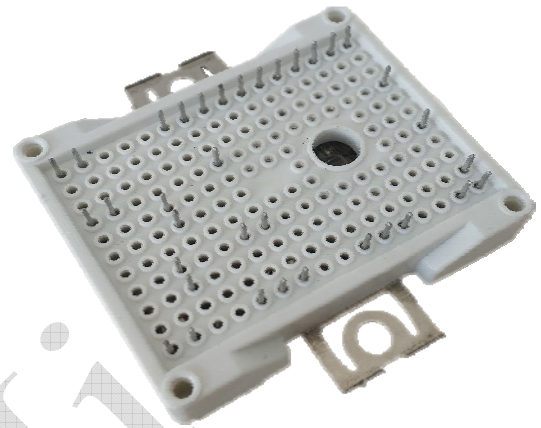


# GK50PI60B9H

## IGBT Module

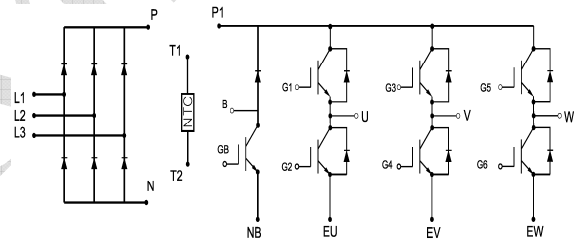
### Features:

- Short Circuit Rated >10 $\mu$ s
- Low Saturation Voltage:  $V_{CE(sat)} = 1.80V @ I_C = 50A, T_C=25^\circ C$
- Low Switching Loss
- 100% RBSOA Tested (2 $\times$ I<sub>C</sub>)
- Low Stray Inductance
- Lead Free, Compliant with RoHS Requirement



### Applications:

- Industrial Inverters
- Servo Applications



### IGBT, Inverter

#### Maximum Rated Values ( $T_C=25^\circ C$ unless otherwise specified)

$V_{CES}$	Collector-Emitter Blocking Voltage		600	V
$V_{GES}$	Gate-Emitter Voltage		$\pm 20$	V
$I_C$	Continuous Collector Current	$T_C = 80^\circ C,$	50	A
		$T_C = 25^\circ C$	100	A
$I_{CM}$	Repetitive Peak Collector Current	$T_J = 150^\circ C$	100	A
$t_{SC}$	Short Circuit Withstand Time		>10	$\mu$ s
$P_D$	Maximum Power Dissipation per IGBT	$T_C = 25^\circ C$	300	W
		$T_{Jmax}=150^\circ C$		

## Electrical Characteristics of IGBT ( $T_C=25^\circ\text{C}$ unless otherwise specified)

### Static characteristics

Symbol	Description	Conditions	Min	Typ	Max	Unit
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$I_C = 1 \text{ mA}, V_{CE} = V_{GE}$	3.0	4.5	5.0	V
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 50 \text{ A}, V_{GE} = 15\text{V}$	$T_J = 25^\circ\text{C}$	1.80	2.10	V
			$T_J = 125^\circ\text{C}$	2.00		V
$I_{CES}$	Collector-Emitter Leakage Current	$V_{GE} = 0\text{V}, V_{CE} = V_{CES}, T_J = 25^\circ\text{C}$			1	mA
$I_{GES}$	Gate-Emitter Leakage Current	$V_{GE} = \pm 20\text{V}, V_{CE} = 0\text{V}, T_J = 25^\circ\text{C}$			200	nA
$C_{ies}$	Input Capacitance	$V_{CE} = 25\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$		3.0		nF
$C_{oes}$	Output Capacitance			0.35		nF

### Switching Characteristics

$t_{d(on)}$	Turn-on Delay Time	$V_{CC} = 300\text{V}, I_C = 50\text{A}, R_G = 30 \Omega, V_{GE} = \pm 15\text{V},$ Inductive Load	$T_J = 25^\circ\text{C}$		110		ns
			$T_J = 125^\circ\text{C}$		100		
$t_r$	Rise Time		$T_J = 25^\circ\text{C}$		75		ns
			$T_J = 125^\circ\text{C}$		80		
$t_{d(off)}$	Turn-off Delay Time		$T_J = 25^\circ\text{C}$		220		ns
			$T_J = 125^\circ\text{C}$		240		
$t_f$	Fall Time		$T_J = 25^\circ\text{C}$		90		ns
			$T_J = 125^\circ\text{C}$		110		
$E_{on}$	Turn-on Switching Loss		$T_J = 25^\circ\text{C}$		0.68		mJ
			$T_J = 125^\circ\text{C}$		0.78		
$E_{off}$	Turn-off Switching Loss	$T_J = 25^\circ\text{C}$		0.75		mJ	
		$T_J = 125^\circ\text{C}$		0.92			
$Q_g$	Total Gate Charge		$T_J = 25^\circ\text{C}$		260		nC
RBSOA	Reverse Bias Safe Operation Area	$I_C=100\text{A}, V_{CC}=480\text{V}, V_p=600\text{V}, R_g = 15\Omega, V_{GE}=\pm 15\text{V to } 0\text{V}, T_J = 150^\circ\text{C}$	Trapezoid				
SCSOA	Short Circuit Safe Operation Area	$V_{CC} = 300\text{V}, V_{GE} = 15\text{V}, T_J = 150^\circ\text{C}$	10				$\mu\text{s}$
$R_{\theta JC}$	IGBT Thermal Resistance: Junction-To-Case			0.42			$^\circ\text{C/W}$

**Diode, Inverter**  
**Maximum Rated Values** ( $T_C=25^\circ\text{C}$  unless otherwise specified)

$V_{RRM}$	Repetitive Peak Reverse Voltage	600	V
$I_F$	Diode Continuous Forward Current	50	A
$I_{FM}$	Diode Maximum Forward Current	100	A

**Electrical Characteristics of FWD** ( $T_C=25^\circ\text{C}$  unless otherwise specified)

Symbol	Description	Conditions		Min	Typ	Max	Unit
$V_{FM}$	Forward Voltage	$I_F = 50\text{ A}$ , $V_{GE} = 0\text{ V}$	$T_J = 25^\circ\text{C}$	1.40	1.60	V	
			$T_J = 125^\circ\text{C}$	1.40			
$I_{rr}$	Peak Reverse Recovery Current		$T_J = 25^\circ\text{C}$	30		A	
			$T_J = 125^\circ\text{C}$	40			
$Q_{rr}$	Reverse Recovery Charge	$I_F=50\text{A}$ , $di/dt = 840\text{A}/\mu\text{s}$ , $V_{rr} = 300\text{V}$ , $V_{GE} = -15\text{V}$	$T_J = 25^\circ\text{C}$	2.4		$\mu\text{C}$	
			$T_J = 125^\circ\text{C}$	3.6			
$E_{rec}$	Reverse Recovery Energy		$T_J = 25^\circ\text{C}$	0.25		mJ	
			$T_J = 125^\circ\text{C}$	0.76			
$R_{\theta JC}$	Diode Thermal Resistance: Junction-To-Case			1.08		$^\circ\text{C}/\text{W}$	

**IGBT, Brake-Chopper**  
**Maximum Rated Values** ( $T_C=25^\circ\text{C}$  unless otherwise specified)

$V_{CES}$	Collector-Emitter Blocking Voltage		600	V
$V_{GES}$	Gate-Emitter Voltage		$\pm 20$	V
$I_C$	Continuous Collector Current	$T_C = 80^\circ\text{C}$ ,	30	A
		$T_C = 25^\circ\text{C}$	60	A
$I_{CM}$	Peak Collector Current Repetitive	$T_J = 150^\circ\text{C}$	60	A
$t_{SC}$	Short Circuit Withstand Time		>10	>10
$P_D$	Maximum Power Dissipation per IGBT	$T_C = 25^\circ\text{C}$ $T_{Jmax}=150^\circ\text{C}$	190	W

## Electrical Characteristics of IGBT ( $T_C=25^\circ\text{C}$ unless otherwise specified)

### Static characteristics

Symbol	Description	Conditions	Min	Typ	Max	Unit
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$I_C = 1 \text{ mA}, V_{CE} = V_{GE}$	3.0	4.5	5.0	V
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 30 \text{ A}, V_{GE} = 15\text{V}$	$T_J = 25^\circ\text{C}$	1.80	2.10	V
			$T_J = 125^\circ\text{C}$	2.00		V
$I_{CES}$	Collector-Emitter Leakage Current	$V_{GE} = 0\text{V}, V_{CE} = V_{CES}, T_J = 25^\circ\text{C}$			1	mA
$I_{GES}$	Gate-Emitter Leakage Current	$V_{GE} = \pm 20\text{V}, V_{CE} = 0\text{V}, T_J = 25^\circ\text{C}$			200	nA
$C_{ies}$	Input Capacitance	$V_{CE} = 25\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$		1.90		nF
$C_{oes}$	Output Capacitance			0.25		nF

### Switching Characteristics

$t_{d(on)}$	Turn-on Delay Time	$V_{CC} = 300\text{V}, I_C = 30\text{A}, R_G = 30 \Omega, V_{GE} = \pm 15\text{V},$ Inductive Load	$T_J = 25^\circ\text{C}$		65		ns
			$T_J = 125^\circ\text{C}$		60		
$t_r$	Rise Time		$T_J = 25^\circ\text{C}$		50		ns
			$T_J = 125^\circ\text{C}$		50		
$t_{d(off)}$	Turn-off Delay Time		$T_J = 25^\circ\text{C}$		120		ns
			$T_J = 125^\circ\text{C}$		130		
$t_f$	Fall Time		$T_J = 25^\circ\text{C}$		100		ns
			$T_J = 125^\circ\text{C}$		140		
$E_{on}$	Turn-on Switching Loss		$T_J = 25^\circ\text{C}$		0.25		mJ
			$T_J = 125^\circ\text{C}$		0.38		
$E_{off}$	Turn-off Switching Loss	$T_J = 25^\circ\text{C}$		0.28		mJ	
		$T_J = 125^\circ\text{C}$		0.44			
$Q_g$	Total Gate Charge	$T_J = 25^\circ\text{C}$		150		nC	
RBSOA	Reverse Bias Safe Operation Area	$I_C=60\text{A}, V_{CC}=480\text{V}, V_p=600\text{V}, R_g = 15\Omega, V_{GE}=\pm 15\text{V to } 0\text{V}, T_J = 150^\circ\text{C}$	Trapezoid				
SCSOA	Short Circuit Safe Operation Area	$V_{CC} = 300\text{V}, V_{GE} = 15\text{V}, T_J = 150^\circ\text{C}$	10			$\mu\text{s}$	
$R_{\theta JC}$	IGBT Thermal Resistance: Junction-To-Case			0.67		$^\circ\text{C/W}$	

**Diode, Brake-Chopper**  
**Maximum Rated Values** ( $T_C=25^\circ\text{C}$  unless otherwise specified)

$V_{RRM}$	Repetitive Peak Reverse Voltage	600	V
$I_F$	Diode Continuous Forward Current	30	A
$I_{FM}$	Diode Maximum Forward Current	60	A

**Electrical Characteristics of FWD** ( $T_C=25^\circ\text{C}$  unless otherwise specified)

Symbol	Description	Conditions	Min	Typ	Max	Unit
$V_{FM}$	Forward Voltage	$I_F = 30\text{ A}$ , $V_{GE} = 0\text{V}$	$T_J = 25^\circ\text{C}$	1.40	1.60	V
			$T_J = 125^\circ\text{C}$	1.40		
$I_{rr}$	Peak Reverse Recovery Current	$I_F = 30\text{A}$ , $di/dt = 960\text{A}/\mu\text{s}$ , $V_{rr} = 300\text{V}$ , $V_{GE} = -15\text{V}$	$T_J = 25^\circ\text{C}$	30		A
			$T_J = 125^\circ\text{C}$	35		
$Q_{rr}$	Reverse Recovery Charge	$I_F = 30\text{A}$ , $di/dt = 960\text{A}/\mu\text{s}$ , $V_{rr} = 300\text{V}$ , $V_{GE} = -15\text{V}$	$T_J = 25^\circ\text{C}$	1.5		$\mu\text{C}$
			$T_J = 125^\circ\text{C}$	2.4		
$E_{rec}$	Reverse Recovery Energy	$I_F = 30\text{A}$ , $di/dt = 960\text{A}/\mu\text{s}$ , $V_{rr} = 300\text{V}$ , $V_{GE} = -15\text{V}$	$T_J = 25^\circ\text{C}$	0.1		mJ
			$T_J = 125^\circ\text{C}$	0.30		
$R_{\theta JC}$	Diode Thermal Resistance: Junction-To-Case			1.63		$^\circ\text{C}/\text{W}$

**Diode, Rectifier** ( $T_C=25^\circ\text{C}$  unless otherwise specified)

$V_{RRM}$	Repetitive Peak Reverse Voltage	$T_J = 25^\circ\text{C}$	1200	V
$I_{FRMSM}$	Maximum RMS Forward Current per Chip	$T_J = 80^\circ\text{C}$	50	A
$I_{RMSM}$	Maximum RMS Current at Rectifier Output	$T_J = 80^\circ\text{C}$	60	A
$I_{FSM}$	Surge Current @ $t_p=10\text{ ms}$	$T_J = 25^\circ\text{C}$	420	A
		$T_J = 150^\circ\text{C}$	350	
$I^2t$	$I^2t$ - value	$T_J = 25^\circ\text{C}$	900	$\text{A}^2\text{s}$
		$T_J = 150^\circ\text{C}$	650	

### Electrical Characteristics of Diode ( $T_C=25^\circ\text{C}$ unless otherwise specified)

Symbol	Description	Conditions		Min	Typ	Max	Unit
$V_F$	Forward voltage	$I_F = 50\text{ A}$	$T_J = 25^\circ\text{C}$		1.2		V
			$T_J = 150^\circ\text{C}$		1.1		
$I_R$	Reverse current	$V_R = 600\text{V}$	$T_J = 25^\circ\text{C}$			1	mA
$R_{\theta JC}$	Diode Thermal Resistance: Junction-To-Case				0.59		$^\circ\text{C/W}$

### Internal NTC-Thermistor Characteristic

$R_{25}$	$T_C = 25^\circ\text{C}$	5		k $\Omega$
$\Delta R/R$	$T_C = 100^\circ\text{C}$ , $R_{100} = 481\Omega$		$\pm 5$	%
$P_{25}$	$T_C = 25^\circ\text{C}$	50		mW
$B_{25/50}$	$R_2 = R_{25} \exp[B_{25/50}(1/T_2 - 1/(298.15\text{K}))]$	3380		K
$B_{25/80}$	$R_2 = R_{25} \exp[B_{25/80}(1/T_2 - 1/(298.15\text{K}))]$	3440		K

### Module

Symbol	Description		Min	Typ	Max	Unit
$V_{iso}$	Isolation Voltage(All Terminals Shorted)	$f = 50\text{Hz}$ , 1minute			2500	V
$T_J$	Maximum Junction Temperature				150	$^\circ\text{C}$
$T_{JOP}$	Maximum Operating Junction Temperature Range		-40		+150	$^\circ\text{C}$
$T_{stg}$	Storage Temperature		-40		+125	$^\circ\text{C}$
$R_{\theta CS}$	Case-To-Sink (Conductive Grease Applied)			0.05		$^\circ\text{C/W}$
T	Mounting Screw:M4		2.0		2.3	N·m
G	Weight			40		g

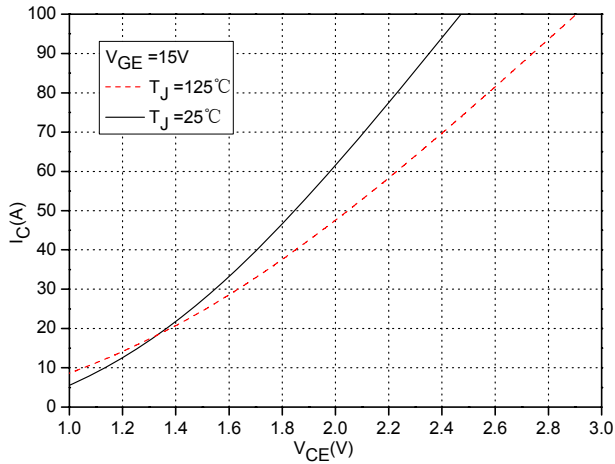


Fig.1 Typical Saturation Voltage Characteristics (Inverter)

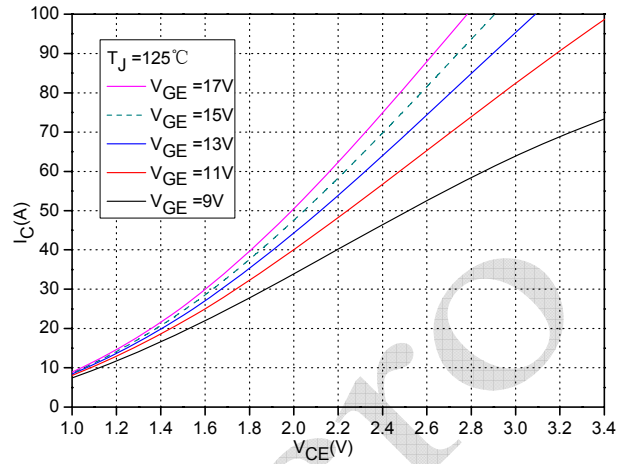


Fig.2 Typical Output Characteristics (Inverter)

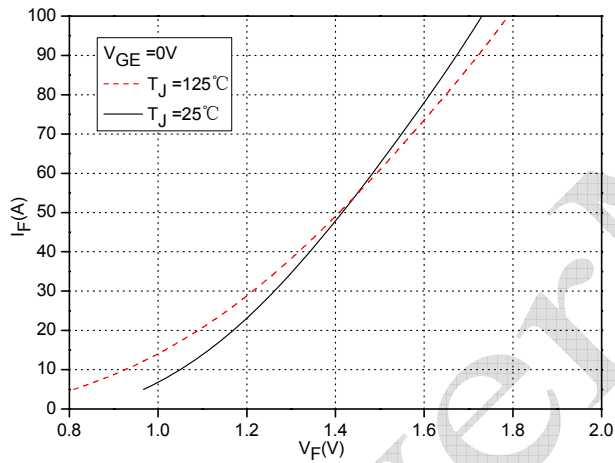


Fig.3 Forward Characteristics of FWD (Inverter)

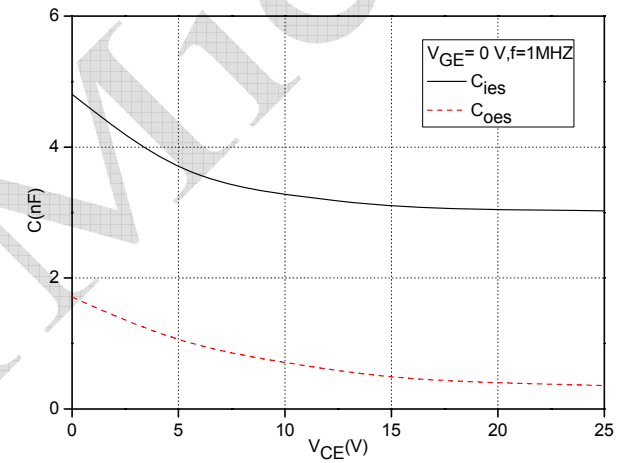


Fig.4 Capacitance Characteristics

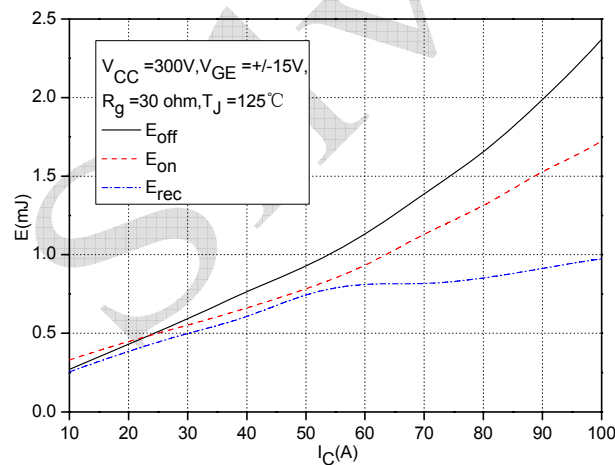


Fig.5 Typical Switching Loss vs. Collector Current (Inverter)

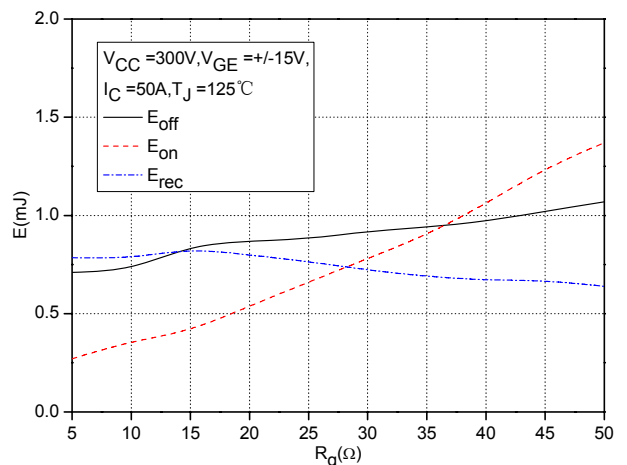


Fig.6 Typical Switching Loss vs. Gate Resistance (Inverter)

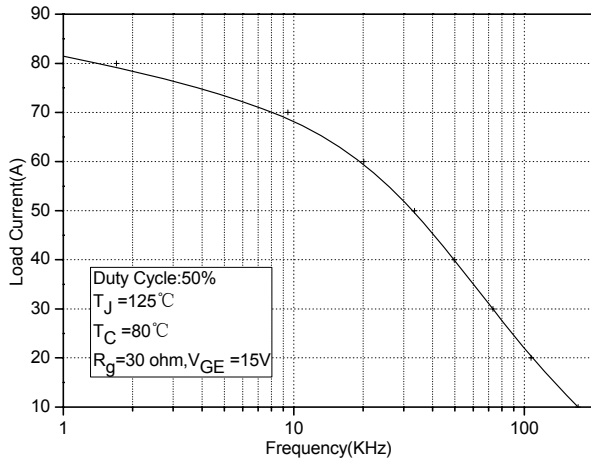


Fig.7 Typical Load Current vs. Frequency (Inverter)

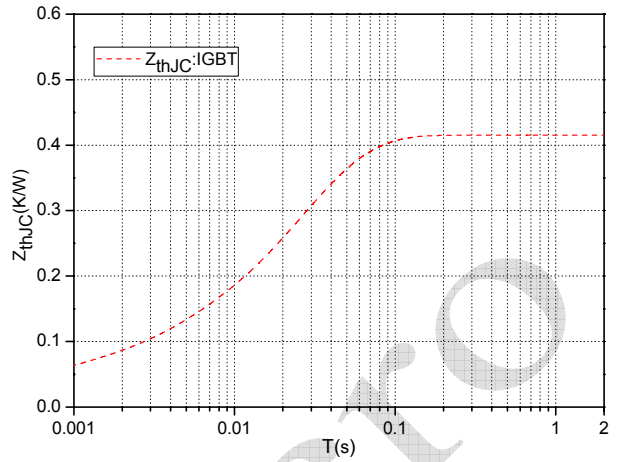


Fig.8 Transient Thermal Impedance IGBT (Inverter)

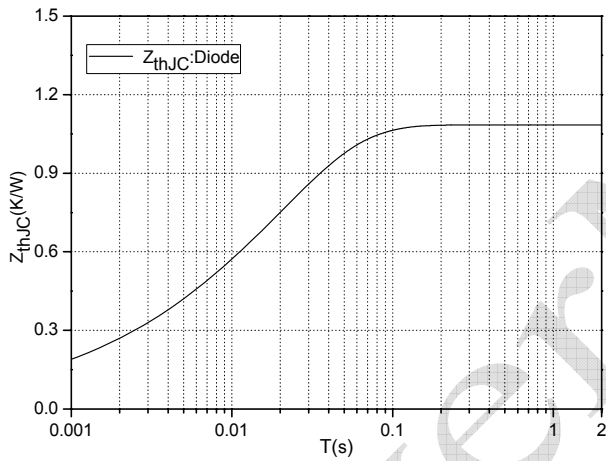


Fig.9 Transient thermal impedance Diode (Inverter)

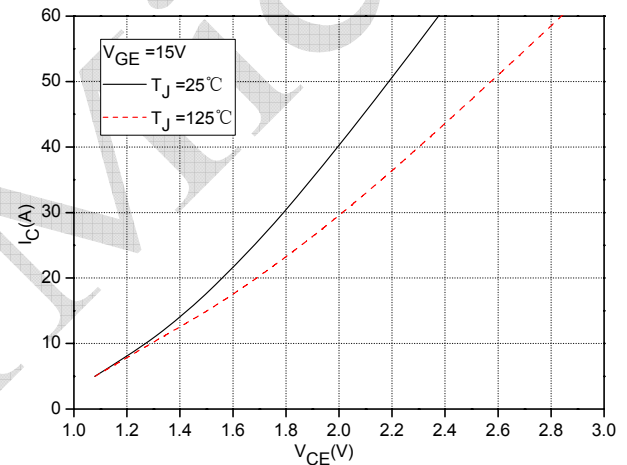


Fig.10 Typical Saturation Voltage Characteristics (Brake-Chopper)

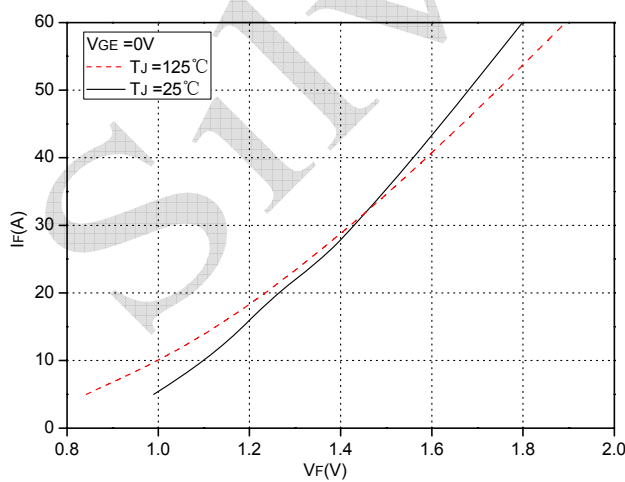


Fig.11 Forward Characteristics of FWD (Brake-Chopper)

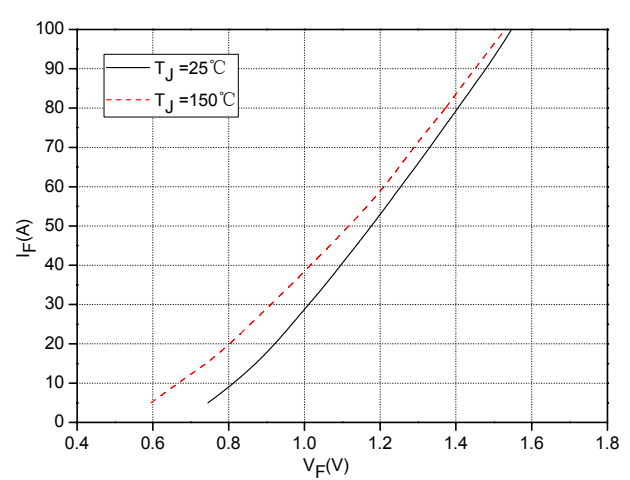


Fig.12 Forward Characteristics of Diode (Rectifier)



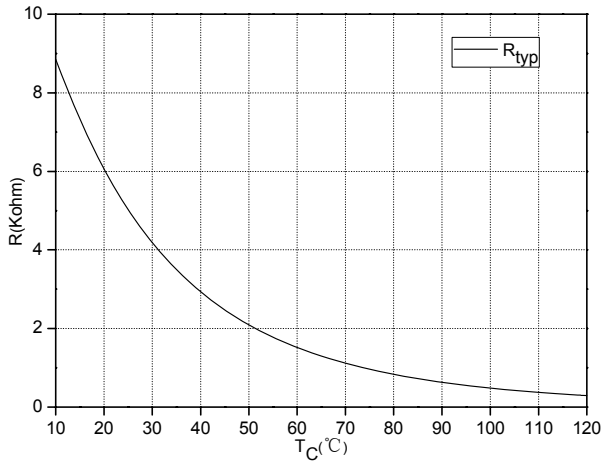


Fig.13 NTC Temperature characteristics

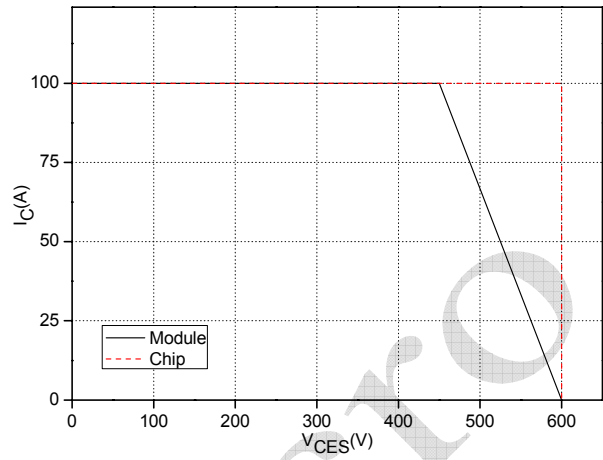
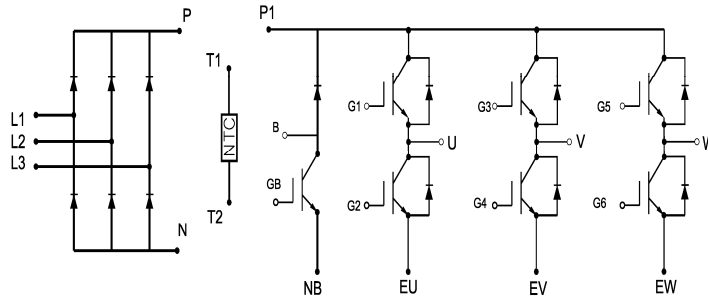


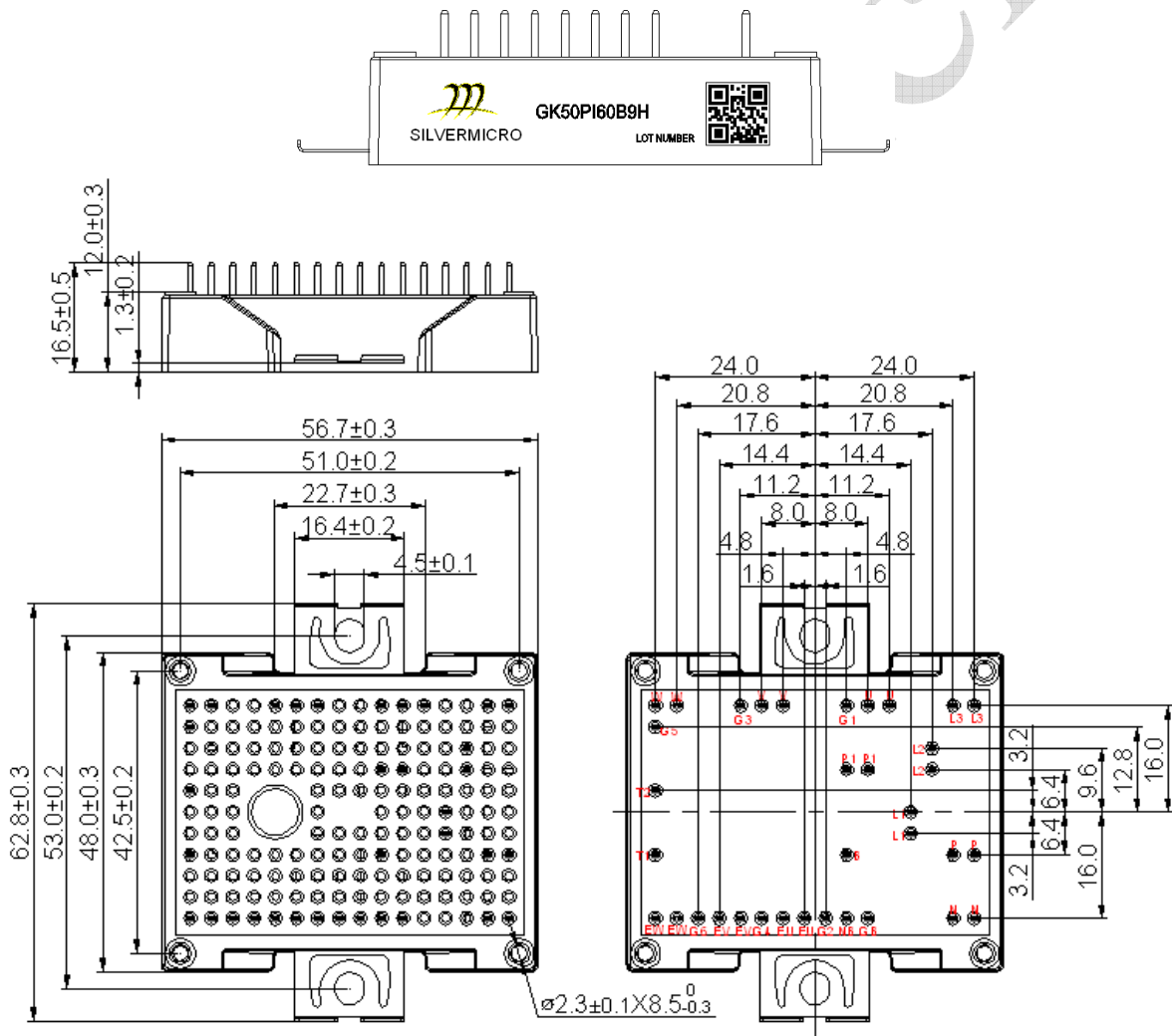
Fig.14 Reverse Bias Safe Operation Area (RBSOA)

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**Internal Circuit:**



**Package Outline (Unit: mm):**





Date	Revision	Notes
07/07/2019	A	Final Version

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