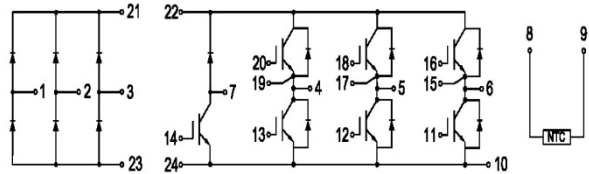


GK10PI60T5H

IGBT Module

Features:

- Non Punch Through (NPT) Technology
- Short Circuit Rated >10 μ s
- Low Saturation Voltage
- Low Switching Loss
- 100% RBSOA Tested(2 \times I_c)
- Low Stray Inductance
- Lead Free, Compliant with RoHS Requirement



Applications:

- Industrial Inverters

IGBT, Inverter

Maximum Rated Values (T_C=25°C unless otherwise specified)

V _{CES}	Collector-Emitter Blocking Voltage		600	V
V _{GES}	Gate-Emitter Voltage		±20	V
I _C	Continuous Collector Current	T _C =80°C	10	A
		T _C =25°C	20	A
I _{CM}	Repetitive Peak Collector Current	T _J =150°C	20	A
t _{SC}	Short Circuit Withstand Time		>10	μs
P _D	Maximum Power Dissipation per IGBT	T _C =25°C T _{Jmax} =150°C	84	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	$I_C=1\text{mA}$, $V_{CE}=V_{GE}$	4.5	5.0	6.0	V
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C=10\text{A}$, $V_{GE}=15\text{V}$	$T_J=25^\circ\text{C}$	2.10		V
			$T_J=125^\circ\text{C}$		2.50	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	$V_{CE}=25\text{V}$, $V_{GE}=0\text{V}$, $f=100\text{kHz}$		0.52		nF
C_{oes}	Output Capacitance			0.08		nF
C_{res}	Reverse Transfer Capacitance			0.02		nF

Switching Characteristics

$t_{d(on)}$	Turn-on Delay Time	$V_{CC}=300\text{V}$, $I_C=10\text{A}$, $R_{Gon}=36\Omega$, $V_{GE}=\pm 15\text{V}$, Inductive Load	$T_J=25^\circ\text{C}$	54		ns
			$T_J=125^\circ\text{C}$	57		
t_r	Rise Time	$V_{CC}=300\text{V}$, $I_C=10\text{A}$, $R_{Gon}=36\Omega$, $V_{GE}=\pm 15\text{V}$, Inductive Load	$T_J=25^\circ\text{C}$	24		ns
			$T_J=125^\circ\text{C}$	25		
$t_{d(off)}$	Turn-off Delay Time	$V_{CC}=300\text{V}$, $I_C=10\text{A}$, $R_{Goff}=36\Omega$, $V_{GE}=\pm 15\text{V}$, Inductive Load	$T_J=25^\circ\text{C}$	98		ns
			$T_J=125^\circ\text{C}$	99		
t_f	Fall Time	$V_{CC}=300\text{V}$, $I_C=10\text{A}$, $R_{Goff}=36\Omega$, $V_{GE}=\pm 15\text{V}$, Inductive Load	$T_J=25^\circ\text{C}$	210		ns
			$T_J=125^\circ\text{C}$	215		
E_{on}	Turn-on Switching Loss	$V_{CC}=300\text{V}$, $I_C=10\text{A}$, $R_{Gon}=36\Omega$, $V_{GE}=\pm 15\text{V}$, $di/dt=323\text{A}/\mu\text{s}$ ($T_J=125^\circ\text{C}$) Inductive Load	$T_J=25^\circ\text{C}$	0.39		mJ
			$T_J=125^\circ\text{C}$	0.43		
E_{off}	Turn-off Switching Loss	$V_{CC}=300\text{V}$, $I_C=10\text{A}$, $R_{Goff}=36\Omega$, $V_{GE}=\pm 15\text{V}$, $du/dt=1945\text{V}/\mu\text{s}$ ($T_J=125^\circ\text{C}$) Inductive Load	$T_J=25^\circ\text{C}$	0.13		mJ
			$T_J=125^\circ\text{C}$	0.20		
Q_g	Total Gate Charge	$V_{GE}=+15\text{V} \dots -15\text{V}$	$T_J=25^\circ\text{C}$	35		nC
RBSOA	$I_C=20\text{A}$, $V_{CC}=480\text{V}$, $V_p=600\text{V}$, $R_{Goff}=36\Omega$, $V_{GE}=+15\text{V}$ to 0V , $T_J=125^\circ\text{C}$			Trapezoid		
SCSOA	$V_{CC}=300\text{V}$, $V_{GE}=15\text{V}$, $T_J=125^\circ\text{C}$			10		μs
$R_{\theta JC}$	IGBT Thermal Resistance: Junction-To-Case(Per Leg)				1.49	$^\circ\text{C}/\text{W}$

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	10	A
I_{FM}	Diode Maximum Forward Current	20	A

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

Symbol	Description	Conditions	Min	Typ	Max	Unit	
V_{FM}	Forward Voltage	$I_F=10\text{A}$	$T_J=25^\circ\text{C}$	1.55		V	
			$T_J=125^\circ\text{C}$	1.55			
t_{rr}	Reverse Recovery Time	$I_F=10\text{A}$, $-di_F/dt = 1066\text{A}/\mu\text{s}(T_J=125^\circ\text{C})$, $V_{rr} = 300\text{V}$, $V_{GE} = -15\text{V}$	$T_J=25^\circ\text{C}$	109		ns	
			$T_J=125^\circ\text{C}$	119			
I_{rr}	Peak Reverse Recovery Current		$T_J=25^\circ\text{C}$	26.9		A	
			$T_J=125^\circ\text{C}$	28.4			
Q_{rr}	Reverse Recovery Charge		$T_J=25^\circ\text{C}$	0.47		μC	
			$T_J=125^\circ\text{C}$	0.67			
E_{rec}	Reverse Recovery Energy		$T_J=25^\circ\text{C}$	0.05		mJ	
			$T_J=125^\circ\text{C}$	0.10			
$R_{\theta JC}$	Diode Thermal Resistance: Junction-To-Case(Per Leg)				2.13	$^\circ\text{C}/\text{W}$	

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		± 20	V
I_C	Continuous Collector Current	$T_C=80^\circ\text{C}$	10	A
		$T_C=25^\circ\text{C}$	20	A
I_{CM}	Repetitive Peak Collector Current	$T_J=150^\circ\text{C}$	20	A
t_{SC}	Short Circuit Withstand Time		>10	μs
P_D	Maximum Power Dissipation per IGBT	$T_C=25^\circ\text{C}$ $T_{Jmax}=150^\circ\text{C}$	84	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	$I_C=1\text{mA}$, $V_{CE}=V_{GE}$	4.5	5.0	6.0	V
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C=10\text{A}$, $V_{GE}=15\text{V}$	$T_J=25^\circ\text{C}$	2.10		V
			$T_J=125^\circ\text{C}$	2.50		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	$V_{CE}=25\text{V}$, $V_{GE}=0\text{V}$, $f=100\text{kHz}$		0.52		nF
C_{oes}	Output Capacitance			0.08		nF
C_{res}	Reverse Transfer Capacitance			0.02		nF

Switching Characteristics

$t_{d(on)}$	Turn-on Delay Time	$V_{CC}=300\text{V}$, $I_C=10\text{A}$, $R_{Gon}=36\Omega$, $V_{GE}=\pm 15\text{V}$, Inductive Load	$T_J=25^\circ\text{C}$	54		ns
			$T_J=125^\circ\text{C}$	57		
t_r	Rise Time	$V_{CC}=300\text{V}$, $I_C=10\text{A}$, $R_{Gon}=36\Omega$, $V_{GE}=\pm 15\text{V}$, Inductive Load	$T_J=25^\circ\text{C}$	24		ns
			$T_J=125^\circ\text{C}$	25		
$t_{d(off)}$	Turn-off Delay Time	$V_{CC}=300\text{V}$, $I_C=10\text{A}$, $R_{Goff}=36\Omega$, $V_{GE}=\pm 15\text{V}$, Inductive Load	$T_J=25^\circ\text{C}$	98		ns
			$T_J=125^\circ\text{C}$	99		
t_f	Fall Time	$V_{CC}=300\text{V}$, $I_C=10\text{A}$, $R_{Goff}=36\Omega$, $V_{GE}=\pm 15\text{V}$, Inductive Load	$T_J=25^\circ\text{C}$	210		ns
			$T_J=125^\circ\text{C}$	215		
E_{on}	Turn-on Switching Loss	$V_{CC}=300\text{V}$, $I_C=10\text{A}$, $R_{Gon}=36\Omega$, $V_{GE}=\pm 15\text{V}$, $di/dt=323\text{A}/\mu\text{s}$ ($T_J=125^\circ\text{C}$) Inductive Load	$T_J=25^\circ\text{C}$	0.39		mJ
			$T_J=125^\circ\text{C}$	0.43		
E_{off}	Turn-off Switching Loss	$V_{CC}=300\text{V}$, $I_C=10\text{A}$, $R_{Goff}=36\Omega$, $V_{GE}=\pm 15\text{V}$, $du/dt=1945\text{V}/\mu\text{s}$ ($T_J=125^\circ\text{C}$) Inductive Load	$T_J=25^\circ\text{C}$	0.13		mJ
			$T_J=125^\circ\text{C}$	0.20		
Q_g	Total Gate Charge	$V_{GE}=+15\text{V} \dots -15\text{V}$	$T_J=25^\circ\text{C}$	35		nC
RBSOA	$I_C=20\text{A}$, $V_{CC}=480\text{V}$, $V_p=600\text{V}$, $R_{Goff}=36\Omega$, $V_{GE}=+15\text{V}$ to 0V , $T_J=125^\circ\text{C}$			Trapezoid		
SCSOA	$V_{CC}=300\text{V}$, $V_{GE}=15\text{V}$, $T_J=125^\circ\text{C}$			10		μs
$R_{\theta JC}$	IGBT Thermal Resistance: Junction-To-Case(Per Leg)				1.49	$^\circ\text{C}/\text{W}$

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	10	A
I_{FM}	Diode Maximum Forward Current	20	A

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

Symbol	Description	Conditions	Min	Typ	Max	Unit	
V_{FM}	Forward Voltage	$I_F=10\text{A}$	$T_J=25^\circ\text{C}$	1.55		V	
			$T_J=125^\circ\text{C}$	1.55			
t_{rr}	Reverse Recovery Time	$I_F=10\text{A}$, $-diF/dt = 1066\text{A}/\mu\text{s}(T_J=125^\circ\text{C})$, $V_{rr}=300\text{V}$, $V_{GE}=-15\text{V}$	$T_J=25^\circ\text{C}$	109		ns	
			$T_J=125^\circ\text{C}$	119			
I_{rr}	Peak Reverse Recovery Current		$T_J=25^\circ\text{C}$	26.9		A	
			$T_J=125^\circ\text{C}$	28.4			
Q_{rr}	Reverse Recovery Charge		$T_J=25^\circ\text{C}$	0.47		μC	
			$T_J=125^\circ\text{C}$	0.67			
E_{rec}	Reverse Recovery Energy		$T_J=25^\circ\text{C}$	0.05		mJ	
			$T_J=125^\circ\text{C}$	0.10			
$R_{\theta JC}$	Diode Thermal Resistance: Junction-To-Case(Per Leg)				2.13	$^\circ\text{C}/\text{W}$	

Diode, Rectifier

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

V_{RRM}	Repetitive Peak Reverse Voltage	$T_J=25^\circ\text{C}$	1600	V
I_{FRMSM}	Maximum RMS Forward Current per Chip	$T_J=80^\circ\text{C}$	20	A
I_{RMSM}	Maximum RMS Current at Rectifier Output	$T_J=80^\circ\text{C}$	30	A
I_{FSM}	Surge Current @ $t_p=10\text{ms}$	$T_J=25^\circ\text{C}$	300	A
		$T_J=150^\circ\text{C}$	250	
I^2t	I^2t - value	$T_J=25^\circ\text{C}$	450	A^2s
		$T_J=150^\circ\text{C}$	300	

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

Symbol	Description	Conditions		Min	Typ	Max	Unit
V_F	Forward Voltage	$I_F=10\text{ A}$	$T_J=25^\circ\text{C}$		1.10		V
			$T_J=150^\circ\text{C}$		1.00		
I_R	Reverse Current	$V_R=1200\text{V}$	$T_J=25^\circ\text{C}$			50	μA
$R_{\theta JC}$	Diode Thermal Resistance: Junction-To-Case					1.02	$^\circ\text{C}/\text{W}$

Internal NTC-Thermistor Characteristics

R_{25}	$T_C=25^\circ\text{C}$	5		$\text{k}\Omega$
$\Delta R/R$	$T_C=100^\circ\text{C}$, $R_{100}=481\Omega$		± 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	$^\circ\text{C}$
CTI	Comparative Tracking Index		200			
$R_{\theta CS}$	Case-To-Sink Thermally (Conductive Grease Applied)				0.04	$^\circ\text{C}/\text{W}$
M	Mounting Screw:M5		3.0		6.0	N·m
G	Weight			200		g

Ordering Information Table

Device code	G	K	10	PI	60	T5	H
	①	②	③	④	⑤	⑥	⑦

- ① - IGBT Module
- ② - Non Punch Through (NPT) Technology
- ③ - Rated Current (10=10A)
- ④ - Circuit Configuration (Power Integrated)
- ⑤ - Rated Voltage (60=600V)
- ⑥ - Package Type
- ⑦ - Test Level (Pass the Important Reliability Test-Industrial Grade)

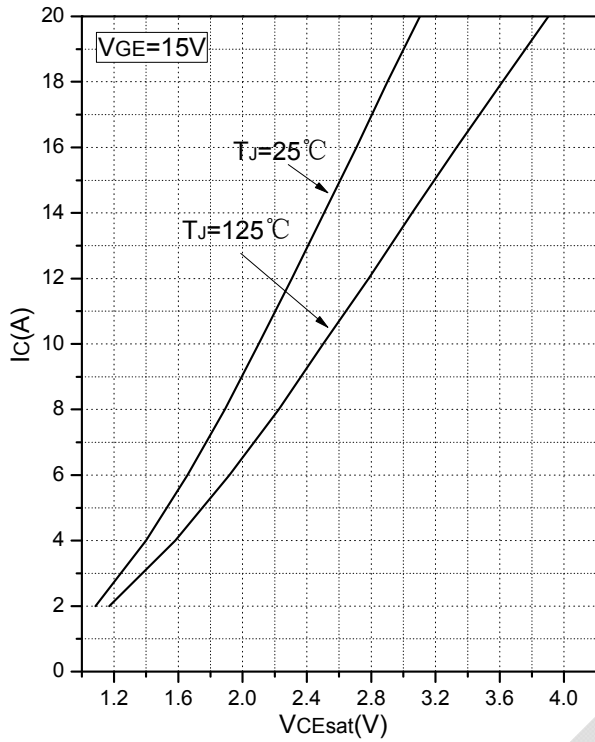


Fig.1 Typical Saturation Voltage Characteristics

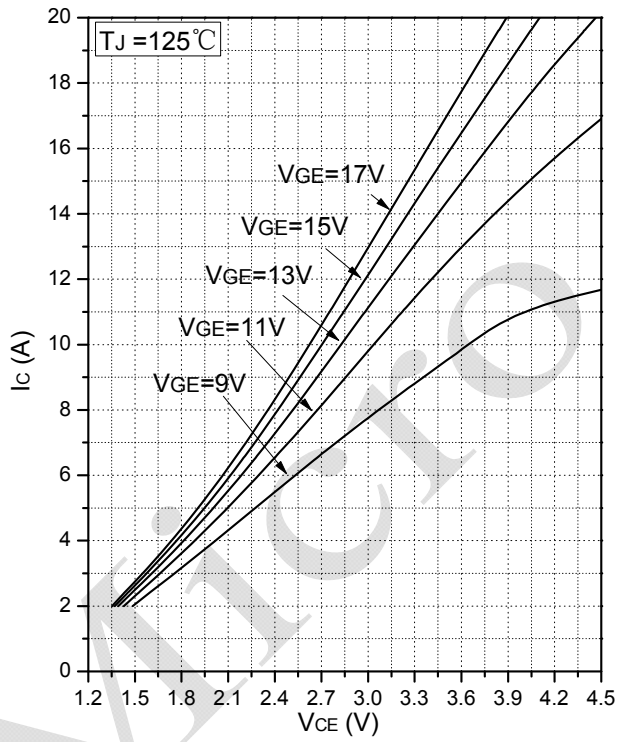


Fig.2 Typical Output Characteristics

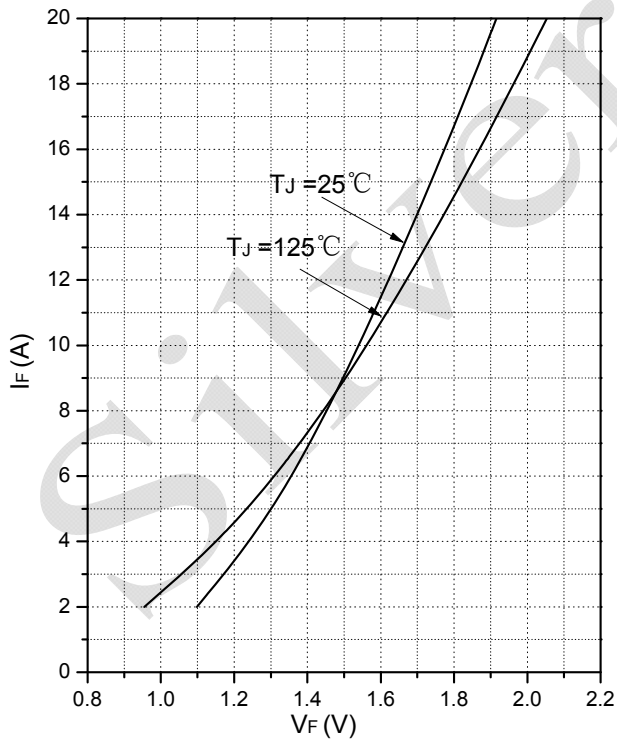


Fig.3 Forward Characteristics of Diode

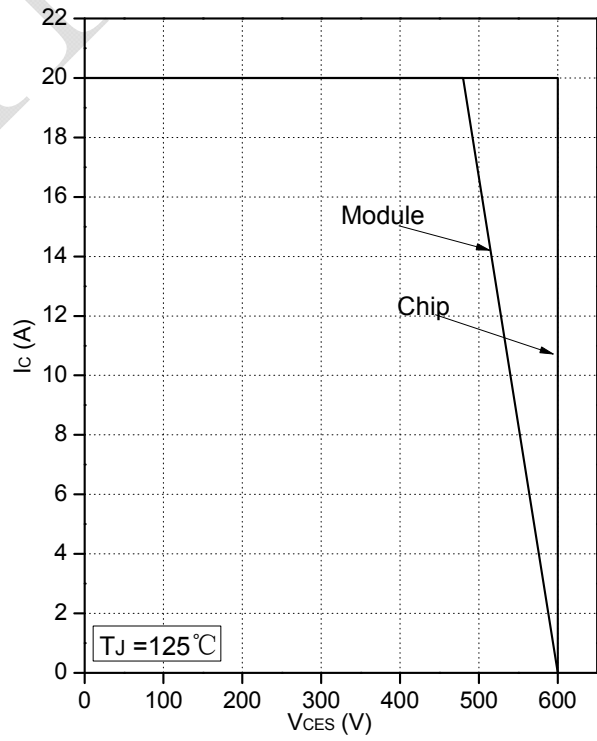


Fig.4 Reverse Bias Safe Operation Area (RBSOA)

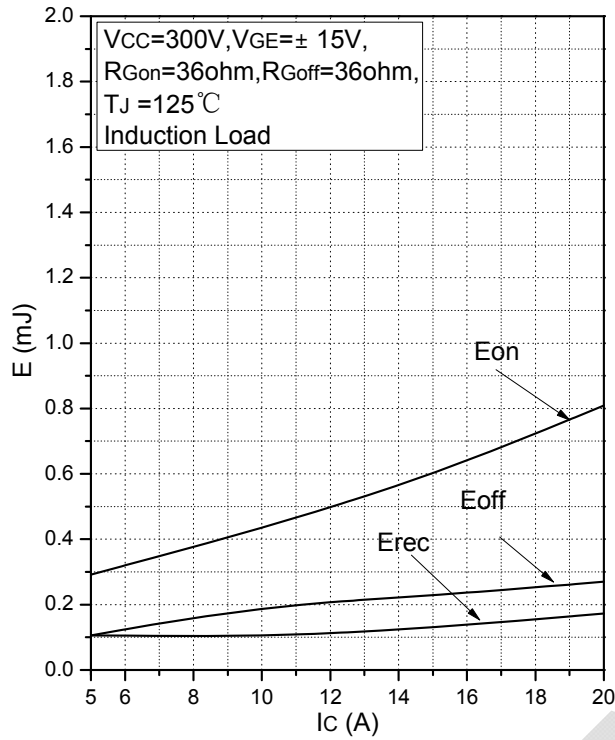


Fig.5 Typical Switching Loss vs. Collector Current

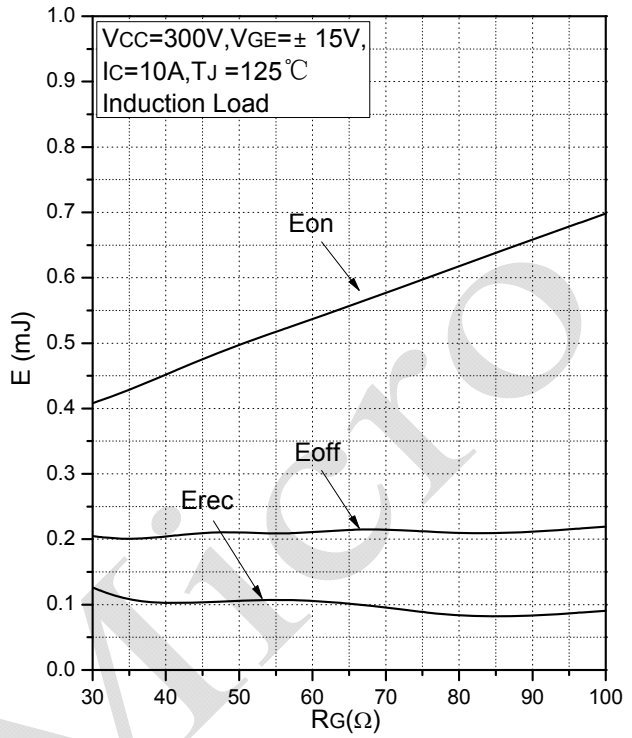


Fig.6 Typical Switching Loss vs. Gate Resistance

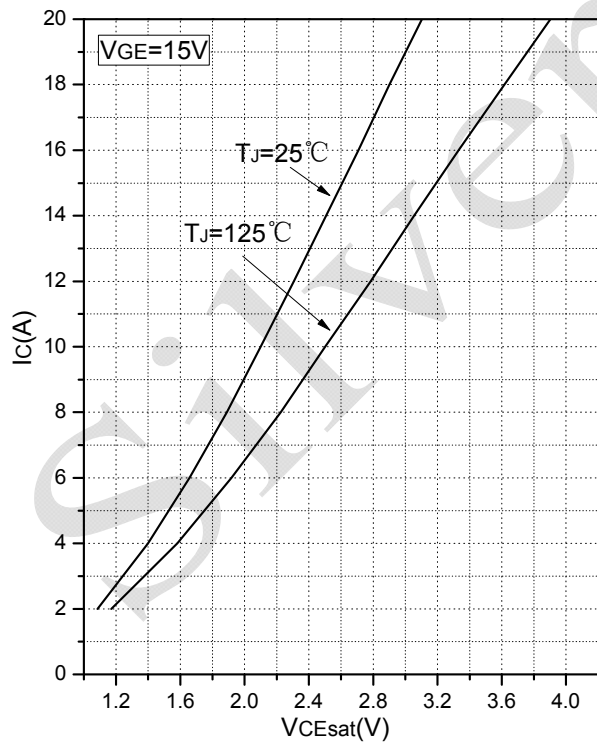


Fig.7 Typical Saturation Voltage Characteristics (Brake-Chopper)

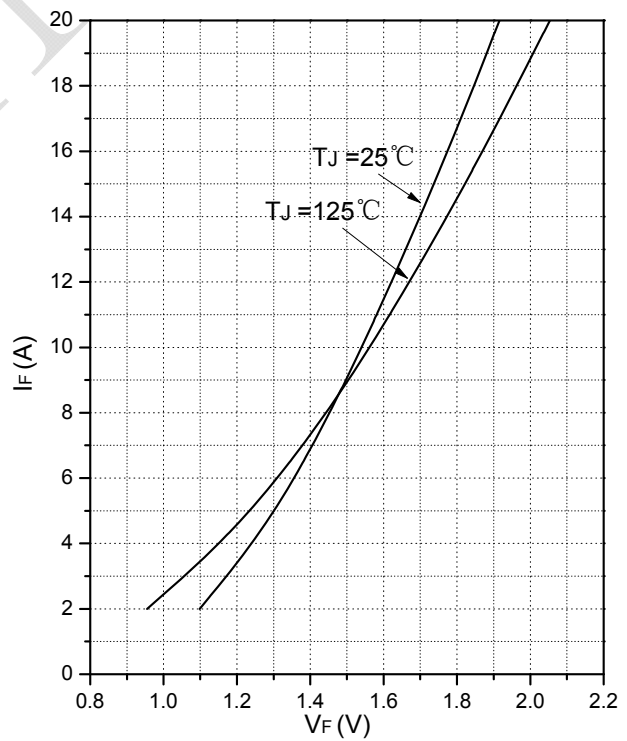


Fig.8 Forward Characteristics of Diode (Brake-Chopper)

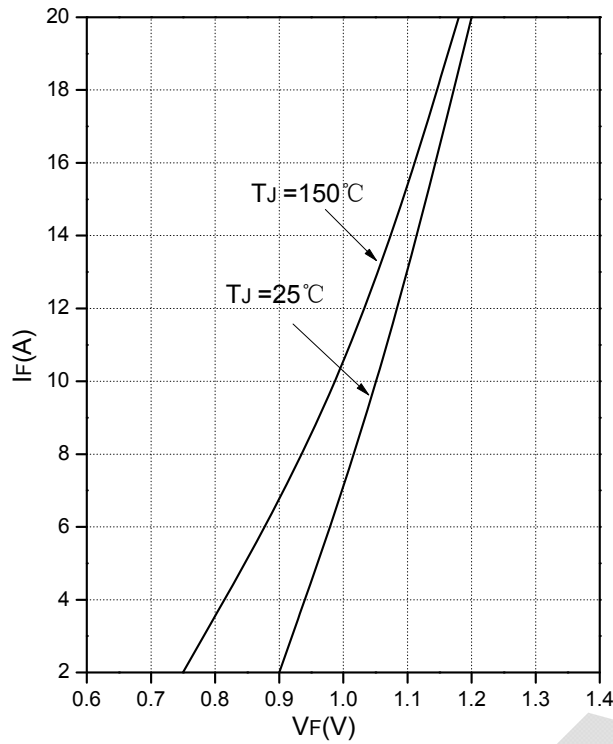


Fig.9 Forward Characteristics of Diode (Rectifier)

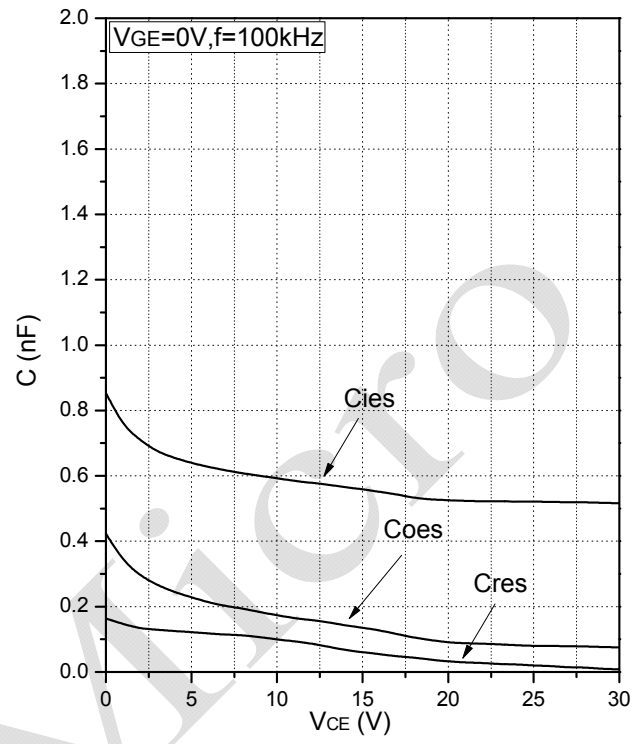


Fig.10 Capacitance Characteristics

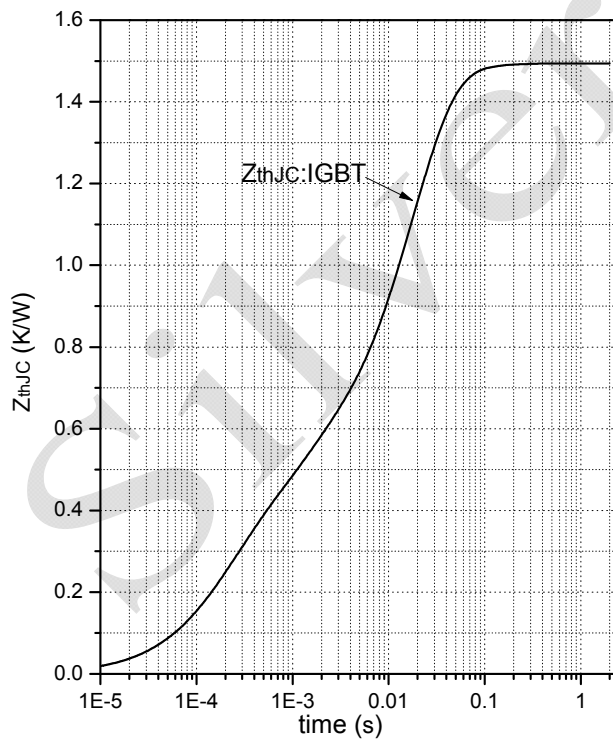


Fig.11 Transient Thermal Impedance IGBT (Inverter)

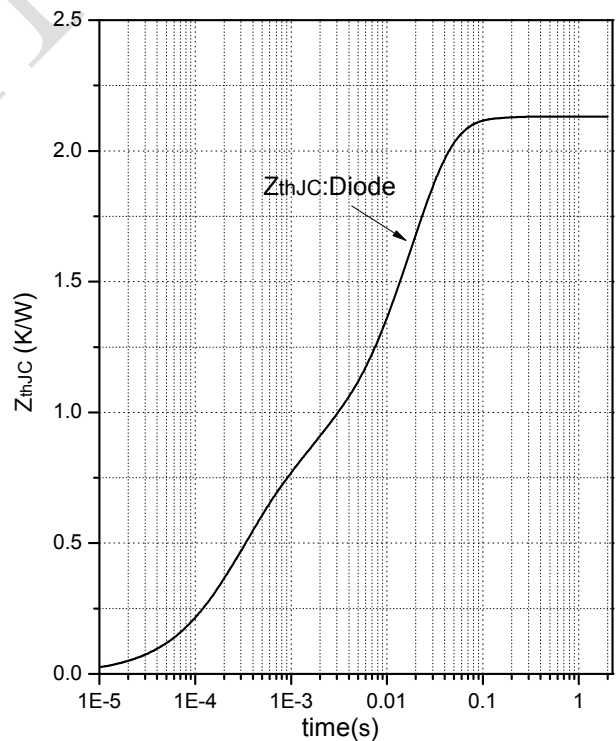


Fig.12 Transient Thermal Impedance Diode (Inverter)

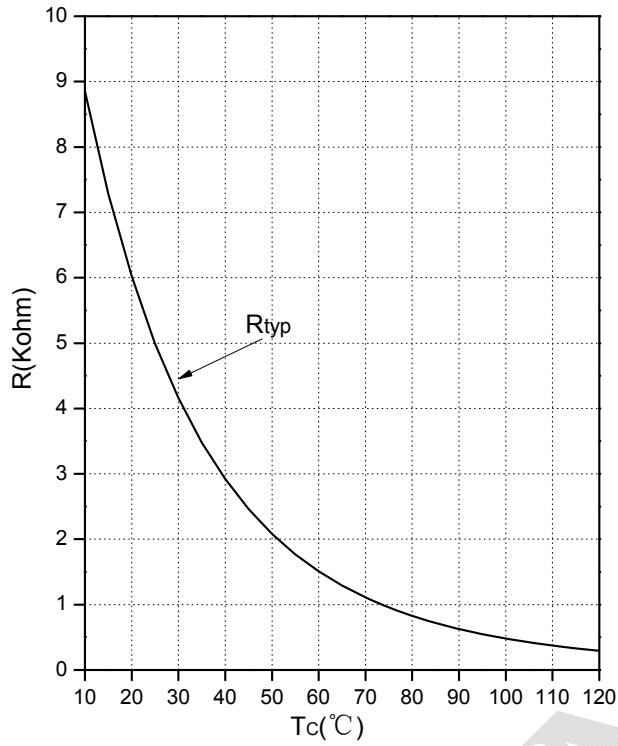
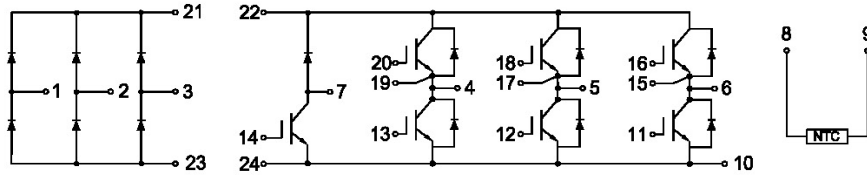


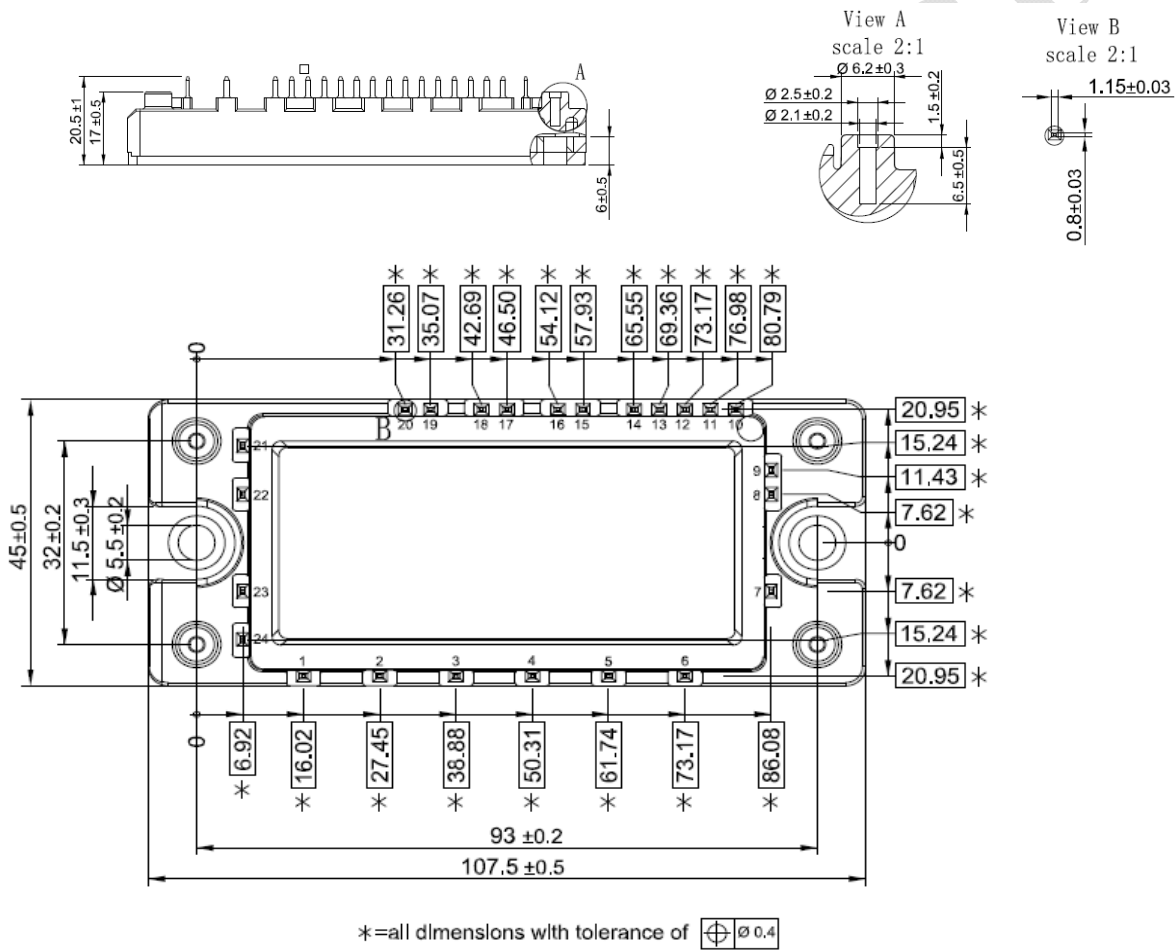
Fig.13 NTC Temperature Characteristics

SilverMicro

Internal Circuit



Package Outline (Unit: mm):





Date	Revision	Notes
01/18/2022	01	Initial Release
02/22/2022	A	Final Version
02/24/2022	B	Updated $V_{CE(sat)}$ and Qg Values

Announcement

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The datasheet with "REV." + "Arabic numerals" is based on engineering data for initial reference purpose only.

The released datasheet would be issued with "REV." + "alphabet characters".