

S2 Module with low loss IGBT and Fast recovery diode.

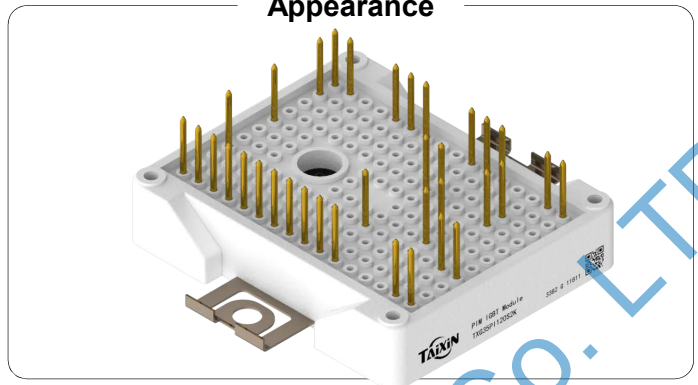
Feature

- Low $V_{CE(sat)}$ Trench IGBT technology
- 10 μ s short circuit capability
- Maximum junction temperature 175 $^{\circ}$ C

Applications

- Inverter for motor drive
- AC and DC servo drive amplifier
- Uninterruptible power supply

Appearance



Maximum Ratings of Inverter IGBT ($T_{vj}=25^{\circ}$ C unless otherwise noted)

Items	Symbol	Conditions	Maximum Rating	Units
Collector-emitter voltage	V_{CES}		1200	V
Gate-emitter voltage	V_{GES}		± 20	V
Collector current	I_C	$T_{vj}=25^{\circ}$ C	70	A
		$T_{vj}=100^{\circ}$ C	35	A
Pulsed collector current	I_{CM}	$t_p=1ms$	70	A
Short circuit current	I_{sc}	$V_{GE} \leq 15V, V_{CC}=600V, t_p=10\mu s$ $V_{CEmax}=V_{CES}-L_{sCE} \cdot di/dt$	160	A
Maximum power dissipation	P_D	$T_c=25^{\circ}$ C, $T_{vj}=150^{\circ}$ C	210	W

Electrical Characteristics of Inverter IGBT ($T_{vj}=25^{\circ}$ C unless otherwise noted)

Items	Symbol	Conditions	Min.	typ.	Max.	Units
Collector-emitter breakdown voltage	V_{CES}	$V_{GE}=0V, I_C=1mA$	1200			V
Collector -emitter leakage current	I_{CES}	$V_{CE}=1200V, V_{GE}=0V$			2.0	mA
Gate leakage current, forward	I_{GES}	$V_{GE}=20V, V_{CE}=0V$			400	nA
		$V_{GE}=-20V, V_{CE}=0V$			-400	nA
Gate threshold voltage	$V_{GE(th)}$	$V_{GE}=V_{CE}, I_C=24mA$	5.0	5.8	7.0	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	$V_{GE}=15V, I_C=35A, T_{vj}=25^{\circ}$ C		1.9	2.2	V
		$V_{GE}=15V, I_C=35A, T_{vj}=125^{\circ}$ C		2.1		V
Integrated gate resistor	R_{Gint}	$f=1MHz, V_{pp}=1V$		6.0		Ω
Input capacitance	C_{ies}	$V_{CE}=25V$		2.50		nF
Output capacitance	C_{oes}	$V_{GE}=0V$		0.20		nF
Reverse transfer capacitance	C_{res}	$f=1MHz$		0.09		nF
Total gate charge	Q_g	$V_{GE}=\pm 15V$		0.33		μC
Turn-on delay time	$t_{d(on)}$	$V_{CC}=600V$		90		ns
Rise time	t_r	$V_{GE}=\pm 15V$		30		ns
Turn-off delay time	$t_{d(off)}$	$I_C=35A$		420		ns
Fall time	t_f	$RG=22\Omega$		70		ns
Turn-on energy loss per pulse	E_{on}	Inductive Load $T_{vj}=25^{\circ}$ C		4.10		mJ
Turn-off energy loss per pulse	E_{off}			3.60		mJ
Turn-on delay time	$t_{d(on)}$	$V_{CC}=600V$		90		ns
Rise time	t_r	$V_{GE}=\pm 15V$		50		ns
Turn-off delay time	$t_{d(off)}$	$I_C=35A$		520		ns
Fall time	t_f	$RG=22\Omega$		90		ns
Turn-on energy loss per pulse	E_{on}	Inductive Load $T_{vj}=25^{\circ}$ C		5.7		mJ
Turn-off energy loss per pulse	E_{off}			4.20		mJ
Temperature under switching conditions	$T_{vj op}$		-55		150	$^{\circ}$ C

Maximum Ratings of Inverter Diode

Items	Symbol	Conditions	Maximum Rating	Units
Repetitive peak reverse voltage	V_{RRM}	$T_{vj}=25^{\circ}\text{C}$	1200	V
Diode continuous forward current	I_F	$T_{vj}=25^{\circ}\text{C}$	70	A
		$T_{vj}=100^{\circ}\text{C}$	35	A
Diode maximum forward current	I_{FM}	$t_p=1\text{ms}, T_{vj}=25^{\circ}\text{C}$	70	A

Electrical s Characteristics of Inverter Diode ($T_{vj}=25^{\circ}\text{C}$ unless otherwise noted)

Items	Symbol	Conditions	Min.	typ.	Max.	Units
Diode forward voltage	V_F	$I_F=35\text{A}, T_{vj}=25^{\circ}\text{C}$		1.7		V
		$I_F=35\text{A}, T_{vj}=125^{\circ}\text{C}$		1.7		V
Diode peak reverse recovery current	I_{rr}	$V_{CE}=600\text{V}, I_F=35\text{A}$		45		A
Diode reverse recovery charge	Q_{rr}	$dI_F/dt=900\text{A}/\mu\text{s}$		4.40		μC
Reverse recovery energy	E_{rec}	$T_{vj}=25^{\circ}\text{C}$		1.55		mJ
Diode peak reverse recovery current	I_{rr}	$V_{CE}=600\text{V}, I_F=35\text{A}$		46		A
Diode reverse recovery charge	Q_{rr}	$dI_F/dt=900\text{A}/\mu\text{s}$		8.40		nC
Reverse recovery energy	E_{rec}	$T_{vj}=25^{\circ}\text{C}$		3.10		mJ

Maximum Ratings of Rectifier Diode

Items	Symbol	Conditions	Maximum Rating	Units
Repetitive peak reverse voltage	V_{RRM}	$T_C=25^{\circ}\text{C}$	1600	V
Maximum RMS forward current per chip	I_{FRMSM}	$T_C=70^{\circ}\text{C}$	50	A
Maximum RMS current at rectifier output	I_{RMSM}	$T_C=70^{\circ}\text{C}$	50	A
Surge forward current	I_{FSM}	$T_{vj}=70^{\circ}\text{C}, t_p=10\text{ms}$	400	A
I^2t - value	I^2t	$t_p = 10 \text{ ms}, T_{vj} = 25^{\circ}\text{C}$	900	A^2s

Electrical s Characteristics of Rectifier Diode ($T_{vj}=25^{\circ}\text{C}$ unless otherwise noted)

Items	Symbol	Conditions	Min.	typ.	Max.	Units
Forward voltage	V_F	$I_F=35\text{A}, T_{vj}=25^{\circ}\text{C}$		1.00		V
Reverse current	I_r	$V_{CE}=1600\text{V}$		2.00		mA
Temperature under switching conditions	$T_{vj\text{ op}}$		-40		150	$^{\circ}\text{C}$

Maximum Ratings of Inverter Brake IGBT ($T_{vj}=25^{\circ}\text{C}$ unless otherwise noted)

Items	Symbol	Conditions	Maximum Rating	Units
Collector-emitter voltage	V_{CES}		1200	V
Gate-emitter voltage	V_{GES}		± 20	V
Collector current	I_C	$T_{vj}=25^{\circ}\text{C}$	50	A
		$T_{vj}=100^{\circ}\text{C}$	25	A
Pulsed collector current	I_{CM}	$t_p=1\text{ms}$	50	A
Short circuit current	I_{sc}	$V_{GE} \leq 15\text{V}, V_{CC}=600\text{V}, t_p=10\mu\text{s}$ $V_{CEmax}=V_{CES}-L_{sCE} \cdot di/dt$	90	A
Maximum power dissipation	P_D	$T_c=25^{\circ}\text{C}, T_{vj}=150^{\circ}\text{C}$	160	W

Electrical Characteristics of Brake IGBT ($T_{vj}=25^{\circ}\text{C}$ unless otherwise noted)

Items	Symbol	Conditions	Min.	typ.	Max.	Units
Collector-emitter breakdown voltage	V_{CES}	$V_{GE}=0V, I_C=1mA$	1200			V
Collector -emitter leakage current	I_{CES}	$V_{CE}=1200V, V_{GE}=0V$			1.0	mA
Gate leakage current, forward	I_{GES}	$V_{GE}=20V, V_{CE}=0V$			100	nA
		$V_{GE}=-20V, V_{CE}=0V$			-100	nA
Gate threshold voltage	$V_{GE(th)}$	$V_{GE}=V_{CE}, I_C=24mA$	5.0	5.8	7.0	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	$V_{GE}=15V, I_C=25A, T_{vj}=25^{\circ}\text{C}$		1.9	2.2	V
		$V_{GE}=15V, I_C=25A, T_{vj}=125^{\circ}\text{C}$		2.1		V
Integrated gate resistor	R_{Gint}	$f=1M; V_{pp}=1V$		0.0		Ω
Input capacitance	C_{ies}	$V_{CE}=25V$		1.40		nF
Output capacitance	C_{oes}	$V_{GE}=0V$		0.10		nF
Reverse transfer capacitance	C_{res}	$f=1MHz$		0.05		nF
Total gate charge	Q_g	$V_{CC}=600V, V_{GE}=15V, I_C=25A$		0.20		μC
Turn-on delay time	$t_{d(on)}$	$V_{CC}=600V$		160		ns
Rise time	t_r	$V_{GE}=\pm 15V$		30		ns
Turn-off delay time	$t_{d(off)}$	$I_C=25A$		330		ns
Fall time	t_f	$RG=20\Omega$		70		ns
Turn-on energy loss per pulse	E_{on}	Inductive Load		1.85		mJ
Turn-off energy loss per pulse	E_{off}	$T_{vj}=25^{\circ}\text{C}$		1.43		mJ
Turn-on delay time	$t_{d(on)}$	$V_{CC}=600V$		170		ns
Rise time	t_r	$V_{GE}=\pm 15V$		40		ns
Turn-off delay time	$t_{d(off)}$	$I_C=25A$		430		ns
Fall time	t_f	$RG=20\Omega$		150		ns
Turn-on energy loss per pulse	E_{on}	Inductive Load		2.50		mJ
Turn-off energy loss per pulse	E_{off}	$T_{vj}=25^{\circ}\text{C}$		2.10		mJ
Temperature under switching conditions	$T_{vj op}$		-55		150	$^{\circ}\text{C}$

Maximum Ratings of Brake Diode

Items	Symbol	Conditions	Maximum Rating	Units
Repetitive peak reverse voltage	V_{RRM}	$T_{vj}=25^{\circ}\text{C}$	1200	V
Diode continuous forward current	I_F	$T_{vj}=25^{\circ}\text{C}$	30	A
		$T_{vj}=100^{\circ}\text{C}$	15	A
Diode maximum forward current	I_{FM}	$t_p=1ms, T_{vj}=25^{\circ}\text{C}$	30	A

Electrical Characteristics of Brake Diode ($T_{vj}=25^{\circ}\text{C}$ unless otherwise noted)

Items	Symbol	Conditions	Min.	typ.	Max.	Units
Diode forward voltage	V_F	$I_F=15A, T_{vj}=25^{\circ}\text{C}$		1.7		V
		$I_F=15A, T_{vj}=125^{\circ}\text{C}$		1.7		V
Diode peak reverse recovery current	I_{rr}	$V_{CE}=600V, I_F=25A$		20		A
Diode reverse recovery charge	Q_{rr}	$dI_F/dt=900A/\mu s$		1.50		μC
Reverse recovery energy	E_{rec}	$T_{vj}=25^{\circ}\text{C}$		0.40		mJ
Diode peak reverse recovery current	I_{rr}	$V_{CE}=600V, I_F=25A$		30		A
Diode reverse recovery charge	Q_{rr}	$dI_F/dt=900A/\mu s$		2.70		nC
Reverse recovery energy	E_{rec}	$T_{vj}=25^{\circ}\text{C}$		0.90		mJ

Characteristics of NTC ($T_{vj}=25^{\circ}\text{C}$ unless otherwise noted)

Items	Symbol	Conditions	Min.	typ.	Max.	Units
Rated resistance	R_{25}			5.00		
Deviation of R100	$\Delta R/R$	$T_C = 100^{\circ}\text{C}$, $R_{100} = 493 \text{ W}$	-5		5	%
Power dissipation	P_{25}				20.0	mW
B-value	$B_{25/50}$	$R_2=R_{25} \exp [B_{25/50}(1/T_2-1/(298,15 \text{ K}))]$		3375		K
B-value	$B_{25/70}$	$R_2=R_{25} \exp [B_{25/70}(1/T_2-1/(298,15 \text{ K}))]$		3411		K
B-value	$B_{25/100}$	$R_2=R_{25} \exp [B_{25/100}(1/T_2-1/(298,15 \text{ K}))]$		3433		K

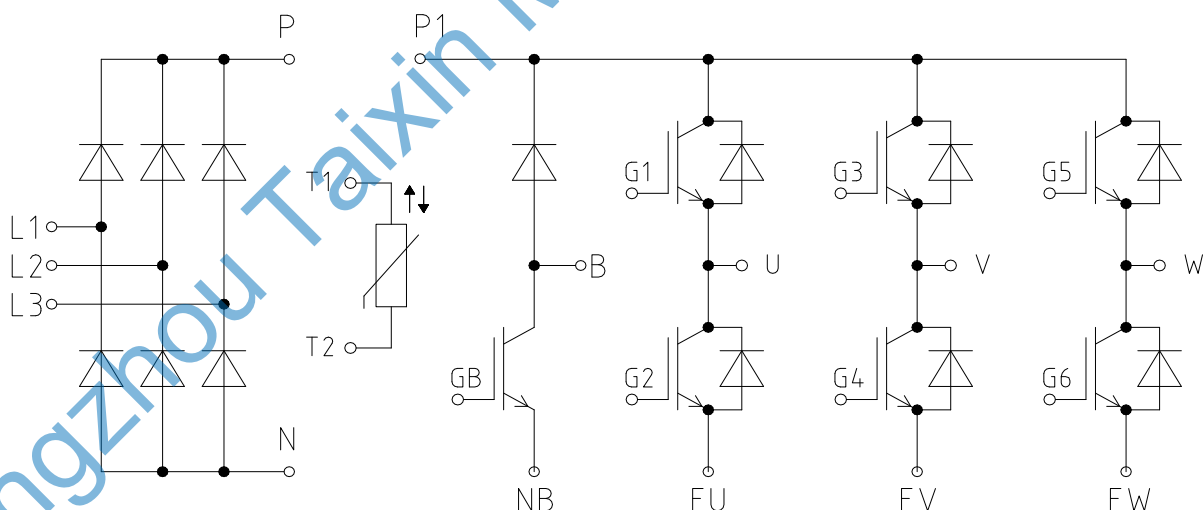
Thermal Characteristics

Items	Symbol	Min.	typ.	Max.	Units
Thermal resistance, junction to case for Inverter IGBT	$R_{th j-c}$			0.60	$^{\circ}\text{C/W}$
Thermal resistance, junction to case for Inverter Diode	$R_{th j-c}$			0.95	$^{\circ}\text{C/W}$
Thermal resistance, junction to case for Rectifier Diode	$R_{th j-c}$			1.00	$^{\circ}\text{C/W}$
Thermal resistance, junction to case for Brake IGBT	$R_{th j-c}$			1.20	$^{\circ}\text{C/W}$
Thermal resistance, junction to case for Brake Diode	$R_{th j-c}$			2.30	$^{\circ}\text{C/W}$
Thermal resistance, case to sink	$R_{th C-S}$		0.03		$^{\circ}\text{C/W}$

Module Characteristics

Items	Symbol	Conditions	Min.	typ.	Max.	Units
Material of module baseplate				Cu		
Internal isolation		terminal to terminal		Al_2O_3		
Isolation test voltage	V_{isol}	RMS, $f = 50 \text{ Hz}$, $t = 1 \text{ min.}$	2.5			kV
Stray inductance module	L_{sCE}			30		nH
Mounting torque for modul mounting	M	Screw M5	3.0		5.0	Nm
Storage temperature range	T_{STG}		-55		150	$^{\circ}\text{C}$
Weight of Module	W_t			170		g

Internal Circuit:



Representative Characteristics

Fig 1. Output characteristic IGBT

$$I_C = f(V_{CE}), V_{GE} = 15V$$

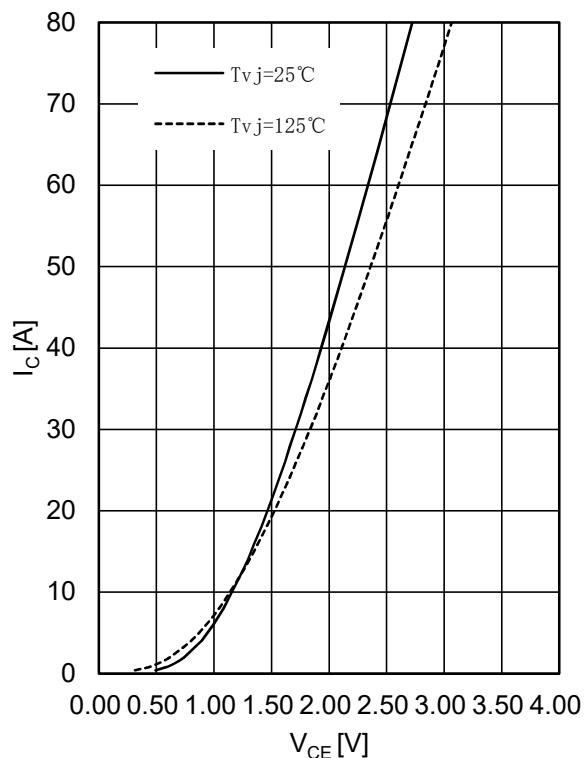


Fig 2. Output characteristic IGBT

$$I_C = f(V_{CE})$$

$$T_{vj} = 125^\circ C$$

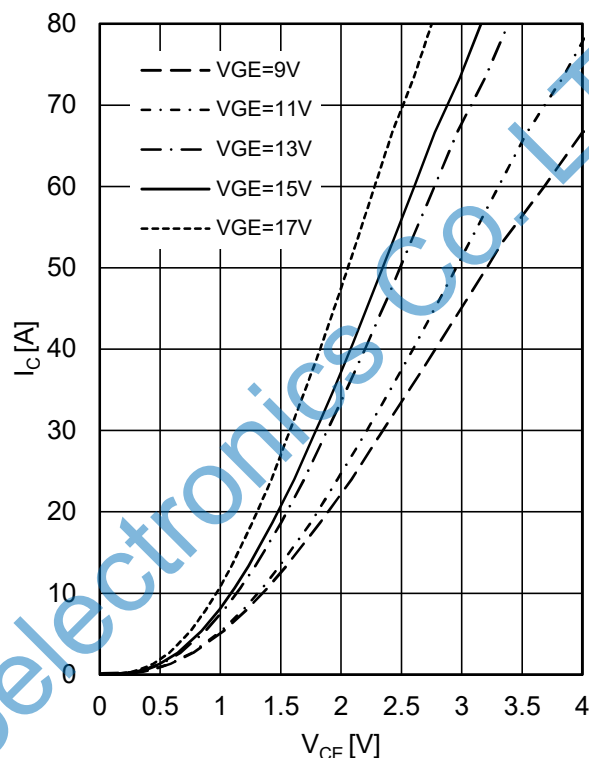


Fig 3. Transfer characteristic IGBT

$$I_C = f(V_{GE})$$

$$V_{CE} = 20V$$

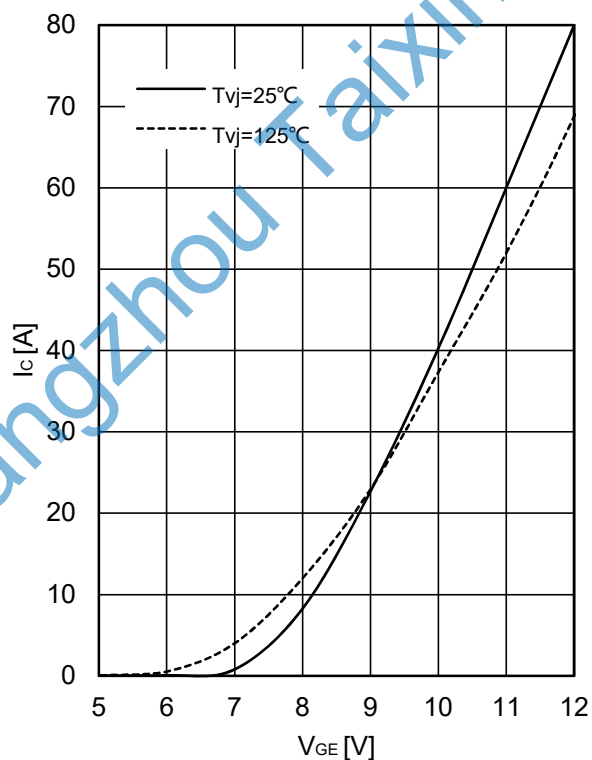


Fig 4. Switching losses IGBT

$$E_{on} = f(I_C), E_{off} = f(I_C)$$

$$V_{GE} = \pm 15V, R_G = 22\Omega, V_{CE} = 600V$$

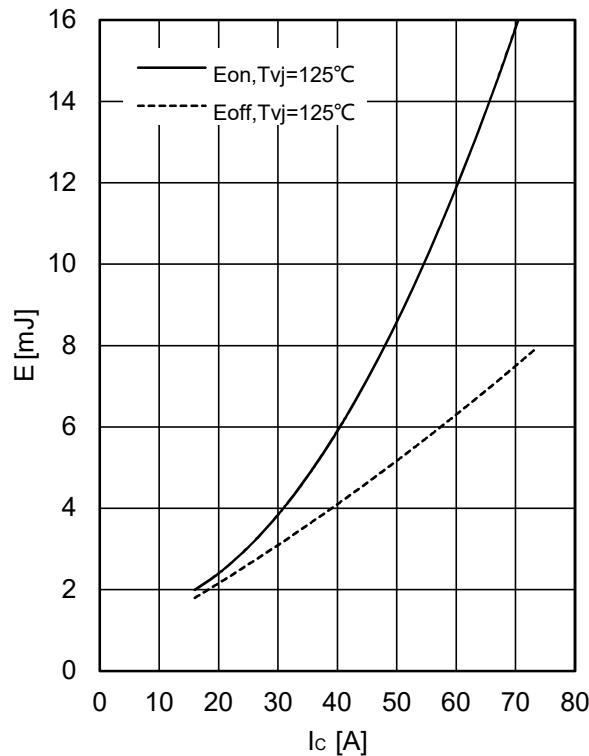


Fig 5. Switching losses IGBT
 $E_{on}=f(R_G), E_{off}=f(R_G),$
 $V_{GE}=\pm 15V, I_C=35A, V_{CE}=600V$

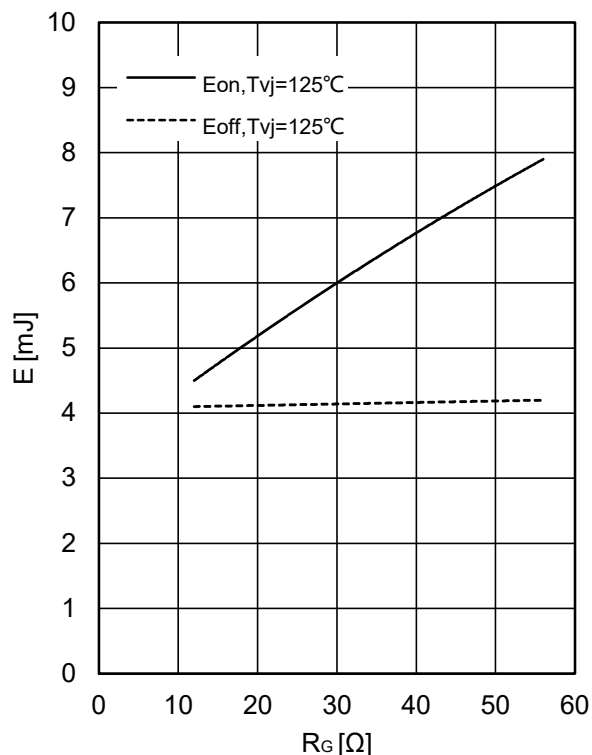


Fig 6. Transient thermal impedance IGBT
 $Z_{thjc}=f(t)$

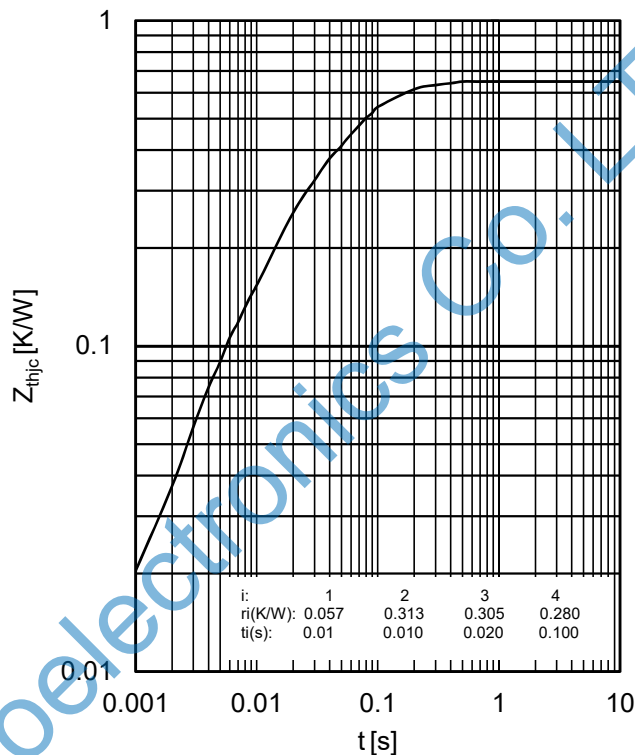


Fig 7. Reverse bias safe operating area IGBT,
 $I_C=f(V_{CE})$
 $V_{GE}=\pm 15V, R_{Goff}=22\Omega, T_{vj}=125^\circ C$

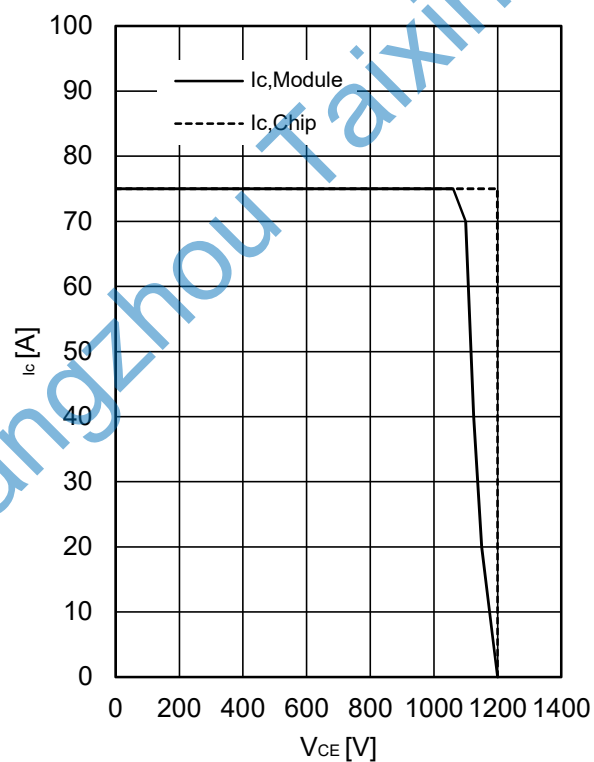


Fig 8. Forward characteristic of Diode
 $I_F=f(V_F)$

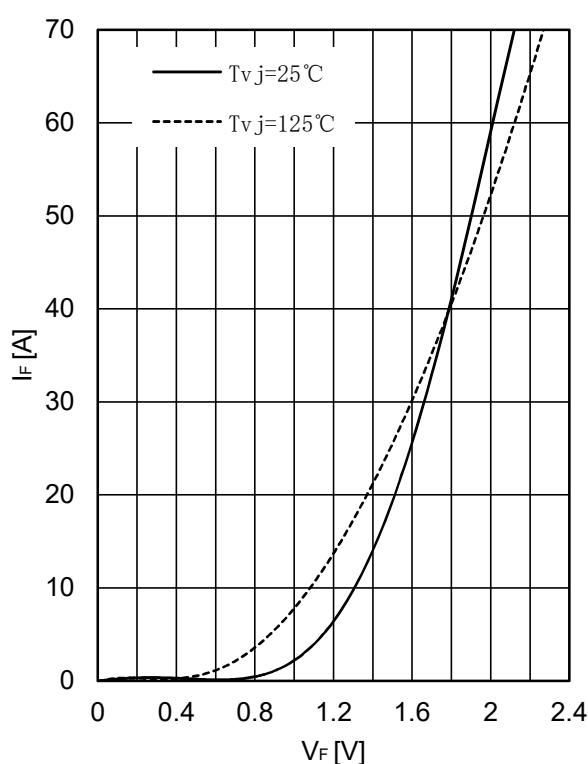


Fig 9. Switching losses Diode

$$E_{rec}=f(I_F)$$

$$R_G=22\Omega, V_{CE}=600V$$

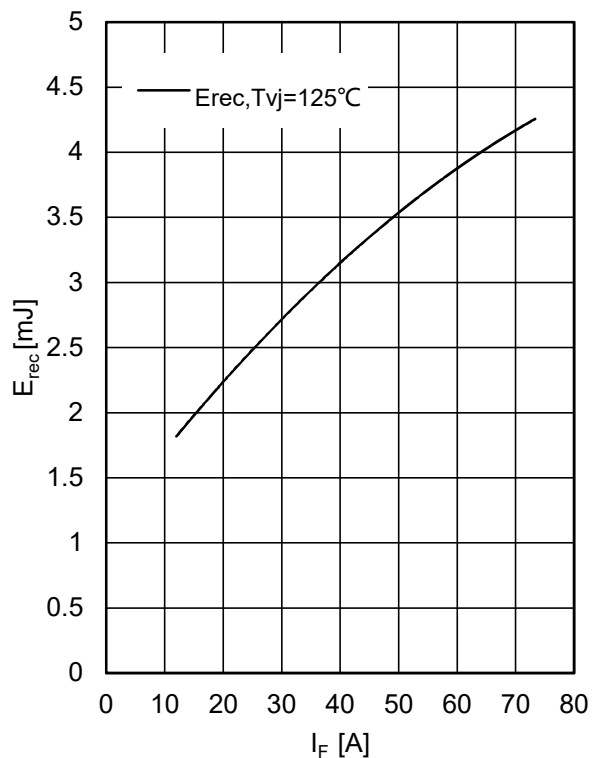


Fig 10. Switching losses Diode

$$E_{rec}=f(R_G)$$

$$I_F=35A, V_{CE}=600V$$

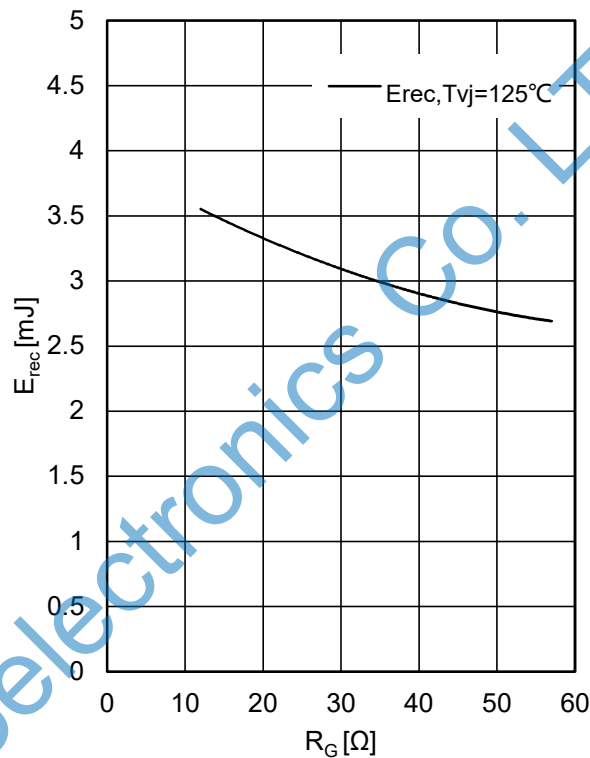


Fig 11. transient thermal impedance Inverter Diode

$$Z_{thjc}=f(t)$$

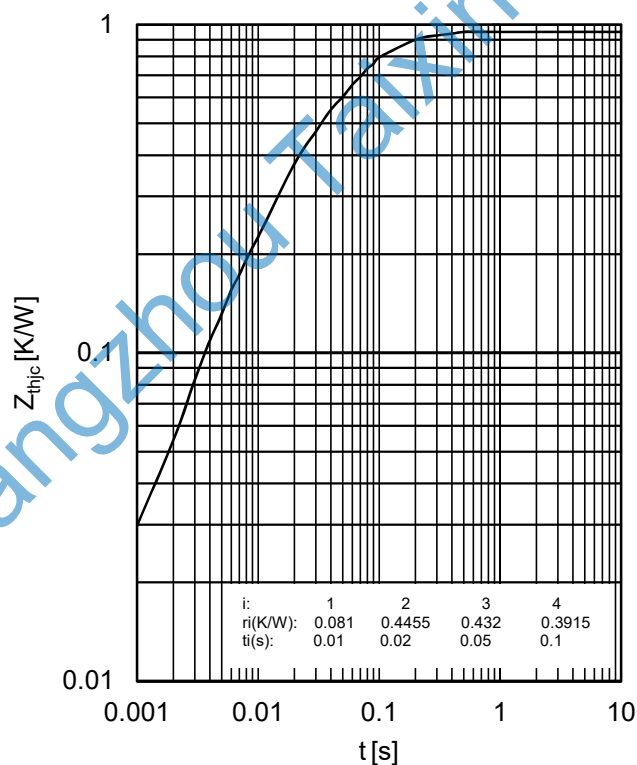
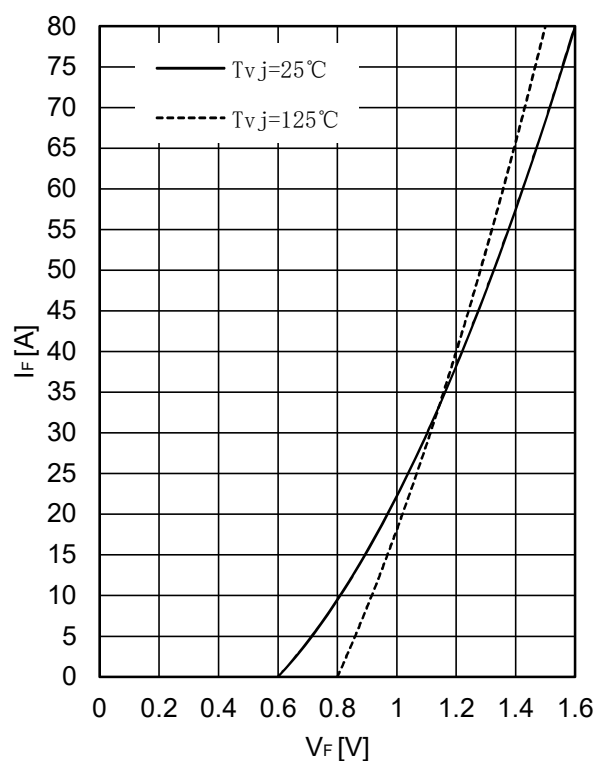


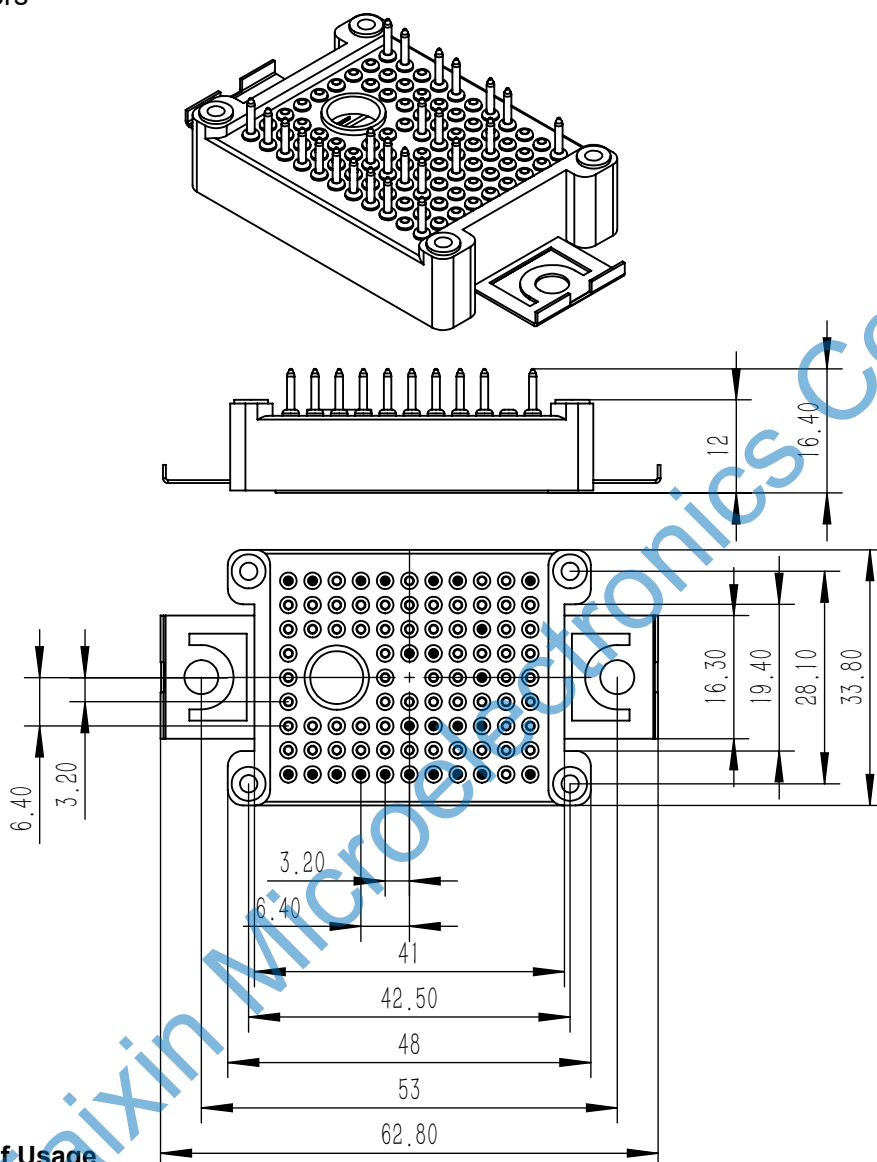
Fig12. Forward characteristic of Rectifier Diode

$$I_F=f(V_F)$$



Package Dimensions

Dimensions in Millimeters



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